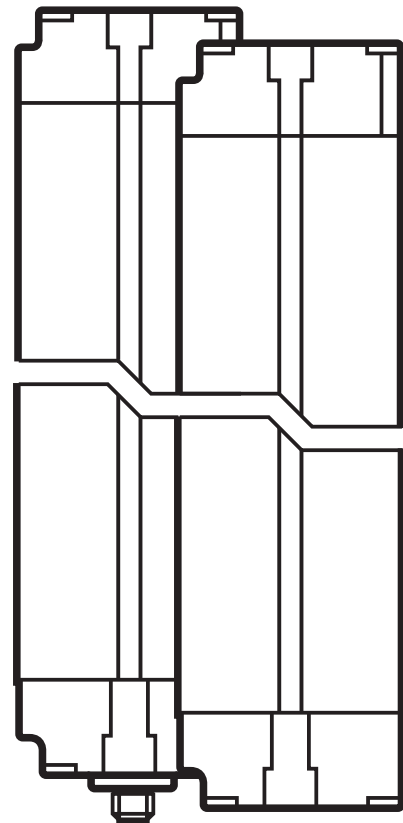


Original operating instructions
Photoelectric safety sensors
(safety light grid)
with active / passive system
OY90xS

UK

11510704 / 00 01 / 2023



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1 Preliminary note

The instructions are part of the unit. They are intended for authorised persons according to the EMC and Low Voltage Directive and safety regulations.

The instructions contain information about the correct handling of the product. Read the instructions before use to familiarise yourself with operating conditions, installation and operation. Adhere to the safety instructions.

1.1 Symbols used

▶ Instructions

> Reaction, result

→ Cross-reference

○ LED off

● LED on

⊗ LED flashes



Important note

Non-compliance can result in malfunction or interference.



Information

Supplementary note.



Access prevention body protection

1.2 Warning signs used

 **WARNING**

Warning of serious personal injury.

Death or serious irreversible injuries may result.

2 Safety instructions

- Follow the operating instructions.
- In case of non-observance of notes or standards, specially when tampering with and / or modifying the unit, any liability and warranty is excluded.
- The unit must be installed, connected and put into operation by a qualified electrician trained in safety technology.
- The applicable technical standards for the corresponding application must be complied with.
- For the installation the standards EN 60204, EN 999 and ISO 13855 have to be observed.
- In case of malfunction of the unit please contact the manufacturer. Tampering with the unit is not allowed.
- Disconnect the unit externally before handling it. Disconnect all relay load circuits that are supplied independently.
- After setup the system has to be subjected to a complete function check.
- Only use the unit under the specified operating conditions (→ 12 Technical data). In case of special operating conditions please contact the manufacturer.
- In case of any questions concerning safety - if required - contact the safety expert in charge of your country.

WARNING

In case of improper handling of the product, the safety and physical integrity of operators and machinery cannot be guaranteed.

Death or serious irreversible injuries may result.

- ▶ Observe all notes on installation and handling in these instructions.
- ▶ The photoelectric safety sensors must only be used under the specified operating conditions and in accordance with use as prescribed below.

2.1 Safety-related requirements regarding the application

It must be ensured that the safety requirements of the respective application correspond to the requirements stated in these instructions.

Observe the following requirements:

- ▶ Adhere to the specified operating conditions (→ 12 Technical data). Use of the photoelectric safety sensors in the vicinity of chemically and biologically active media as well as ionising radiation is not permitted.
- ▶ For applications in the food industry contact your ifm branch office to check the compatibility of the materials of the photoelectric safety sensors with the chemicals used.
- ▶ Adhere to the principle of normally closed operation for all external safety circuits connected to the system.
- ▶ If the photoelectric safety sensors go into the state defined as safe due to an internal fault, measures have to be taken to maintain the safe state when the installation resumes operation.
- ▶ Replace damaged units.

The protective function of the photoelectric safety sensors is only ensured with the following conditions:

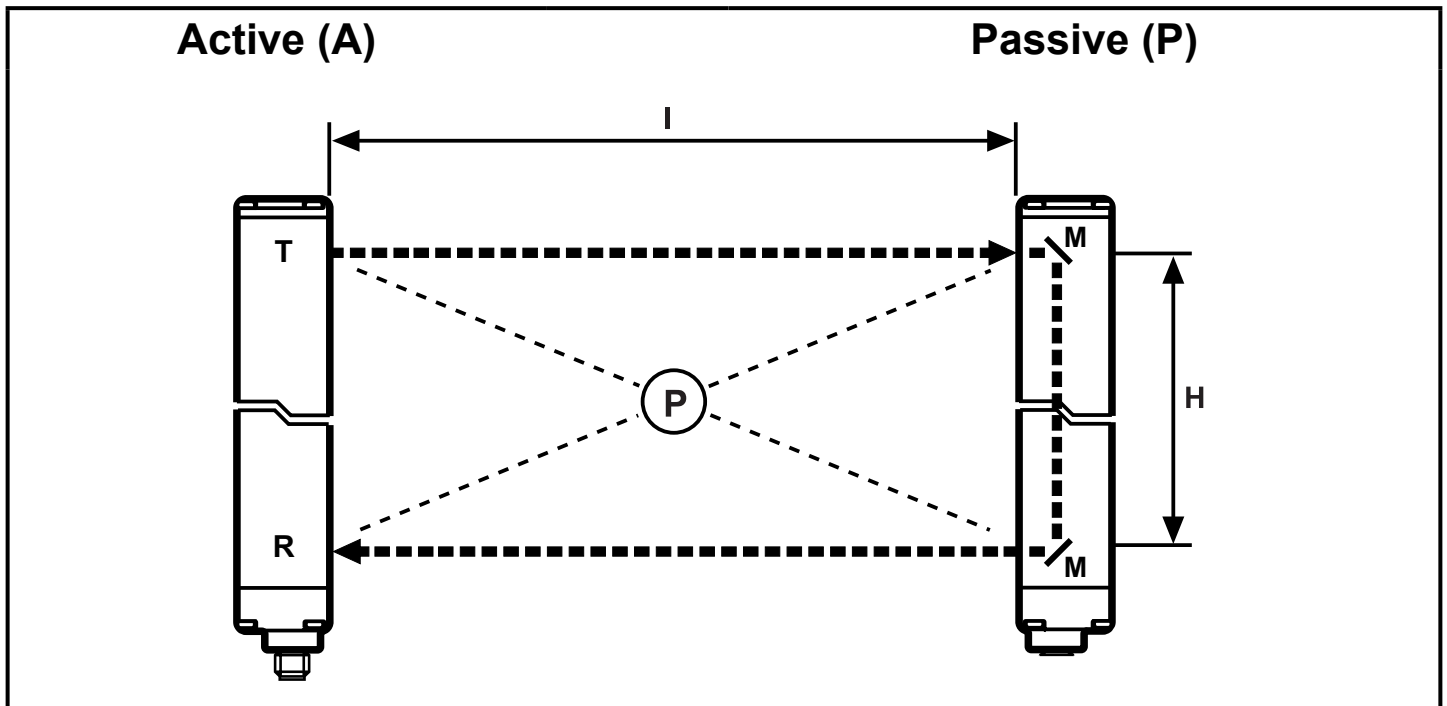
- The machine control can be electrically controlled and the hazardous machine motion can be stopped immediately at any time of the operation cycle.
- There is no danger for machine operators due to ejection of materials or machine parts.
- The hazardous area is only accessible via the protected area.

3 Items supplied

- 2 photoelectric safety sensors (1 active and 1 passive element)
- OY901S: 4 angle brackets, 4 slot nuts with M6 thread and suitable screws
- OY902S, OY903S: 6 angle brackets, 6 slot nuts with M6 thread and suitable screws
- 1 copy operating instructions photoelectric safety sensors, reference no. 704818

If one of the above-mentioned components is missing or damaged, please contact **UK** one of the ifm branch offices.

4 Functions and features



T = transmitter; R = receiver, M = mirror

P = protected area; I = protected area width (range); H = protected area height

The OY90xS safety light grids are multi-beam optoelectronic protective devices to IEC 61496 and consist of one active element (with transmitter and receiver) and one passive element (with reflecting mirror).

5 Function

The protected area (P) is generated between the active and the passive element and is defined by the protected area height (H) and the protected area width (range) (I).

The protected area height is the height protected by the safety light grid. It depends on the design (→ 12 Technical data).

The protected area width (range) is the maximum distance between the active and the passive element (→ 12 Technical data).

If the protected area is clear, the two outputs (OSSDs) are active.

When one of the light beams is interrupted, the light grid switches off the outputs.

6 Installation

6.1 Installation instructions

The following conditions are to be ensured before installation of the photoelectric safety sensors:

- The degree of protection of the electro-sensitive equipment (ESPE) has to correspond with the risk assessment of the machine to be monitored.
- The safety system ensures a safety function and is not required for the operation of a machine.
- It must be possible to stop any hazardous motion of the machine immediately. In this respect the shutdown delay of the machine has to be determined.



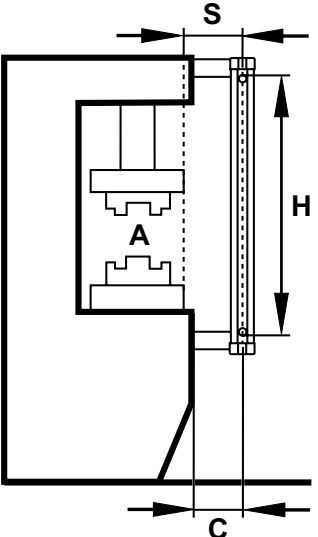
Install the photoelectric safety sensors so that the hazardous area can only be accessed via the protected area. Depending on the application other mechanical protective equipment may be necessary.

The operating conditions at the mounting location must not affect the functioning of the photoelectric safety sensors. Please note especially:

- The active and the passive element must not be affected by intensive light sources (emitters, sunlight etc.).
- The ambient temperature must be within the range indicated (→ 12 Technical data).
- Fogging of the lenses due to considerable temperature fluctuations can affect the functioning of the photoelectric safety sensors. Take appropriate measures to prevent this.
- Certain operating conditions can affect the functioning of the photoelectric safety sensors. For mounting locations where fog, rain, smoke or dust may occur, it is recommended to take appropriate measures.
- The standards EN 999 and ISO 13855 must be adhered to.

6.2 Calculation of the minimum safety distance

There must be a minimum safe distance between the photoelectric safety sensor and the point of danger. This distance must be ensured so that the point of danger cannot be accessed before the hazardous state of the machine has been stopped.



► Install the photoelectric safety sensor at a distance that is greater than or equal to the minimum safety distance (S) so that the hazardous area (A) can only be accessed after complete standstill of the hazardous machine motion.

According to the European Standard EN 999:2008 the following formula is to be used to calculate the minimum safety distance (S):

$$S = K (t_1 + t_2) + C$$

$$C = 8 (d - 14)$$

A = hazardous area

H = protected area height

S = minimum safety distance

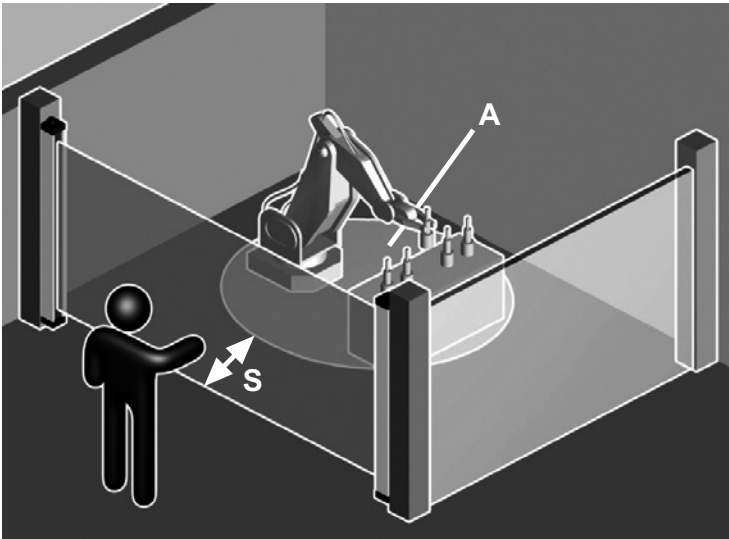
C = additional distance

S	Minimum safety distance	mm
K	Speed of approach of the object towards the hazardous area	mm/s
t₁	Total response time of the protective equipment, from release to switching off	s
t₂	Total response time of the machine, from the stop signal to switching off or to passing into the state defined as safe	s
C	Additional distance	mm
d	Resolution (detection capacity)	mm



Non-compliance with the minimum safety distance may lead to restrictions to or loss of the safety function.

Application example:



A = hazardous area
S = minimum safety distance

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6.3 Installation of the safety light grids



These versions of OY90xS safety light grids are suitable for access prevention for entire bodies.

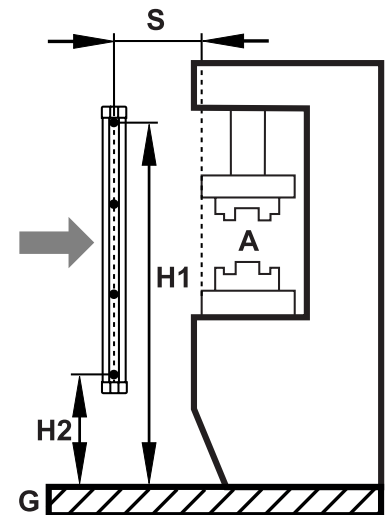


They must not be used for the protection of hands or body parts!

The minimum safety distance (S) is determined using the following formula:

$$S = 1600 (t + t_2) + 850$$

The height of the upper light beam (H1) measured from the reference level (G) must not be less than 900 mm while the height of the lowest light beam (H2) must not exceed 300 mm (ISO 13855).



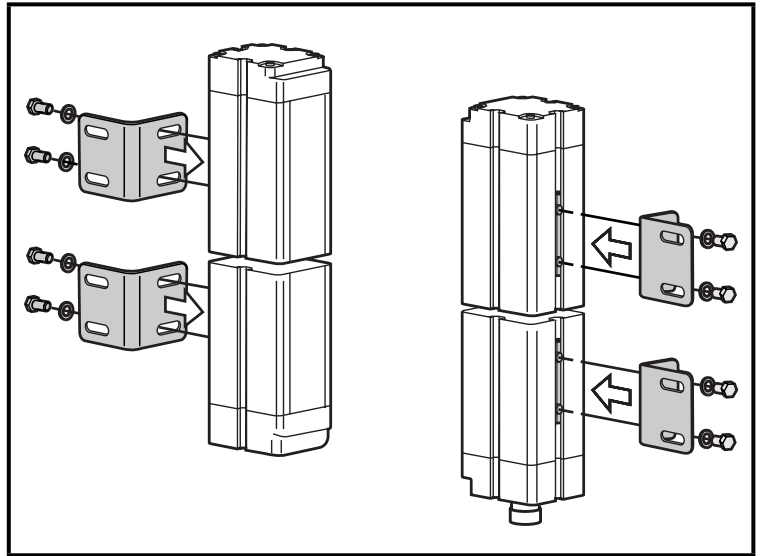
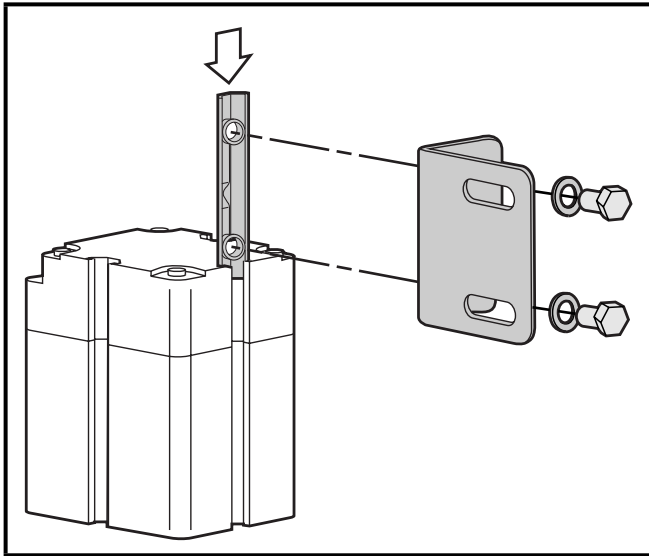
A = hazardous area
Hx = height

S = minimum safety distance
G = reference level

6.4 Fixing and optical alignment

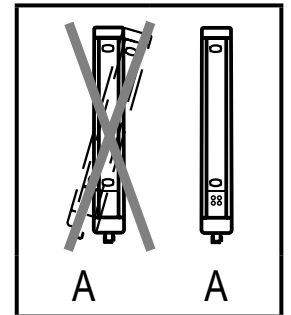
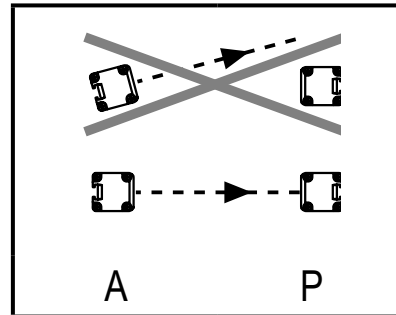
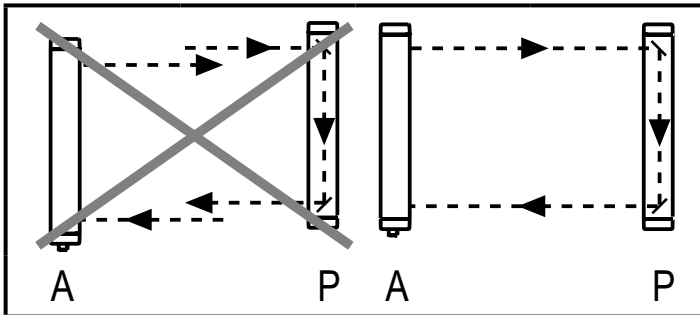


Correct alignment of the active and the passive element is decisive for the proper function of the photoelectric safety sensors.



- ▶ Install the active and the passive element using the supplied mounting accessories so that they are exactly opposite each other.

6.4.1 Optical alignment



A = Active; P = Passive

- ▶ Align the active and the passive element so that they are parallel at the same height.
- ▶ Securely fasten the active and the passive element.

The indication LEDs of the active element help to correctly align the photoelectric safety sensors. (→ 9.1 LED indicators for optical alignment)

6.5 Distance of reflective surfaces



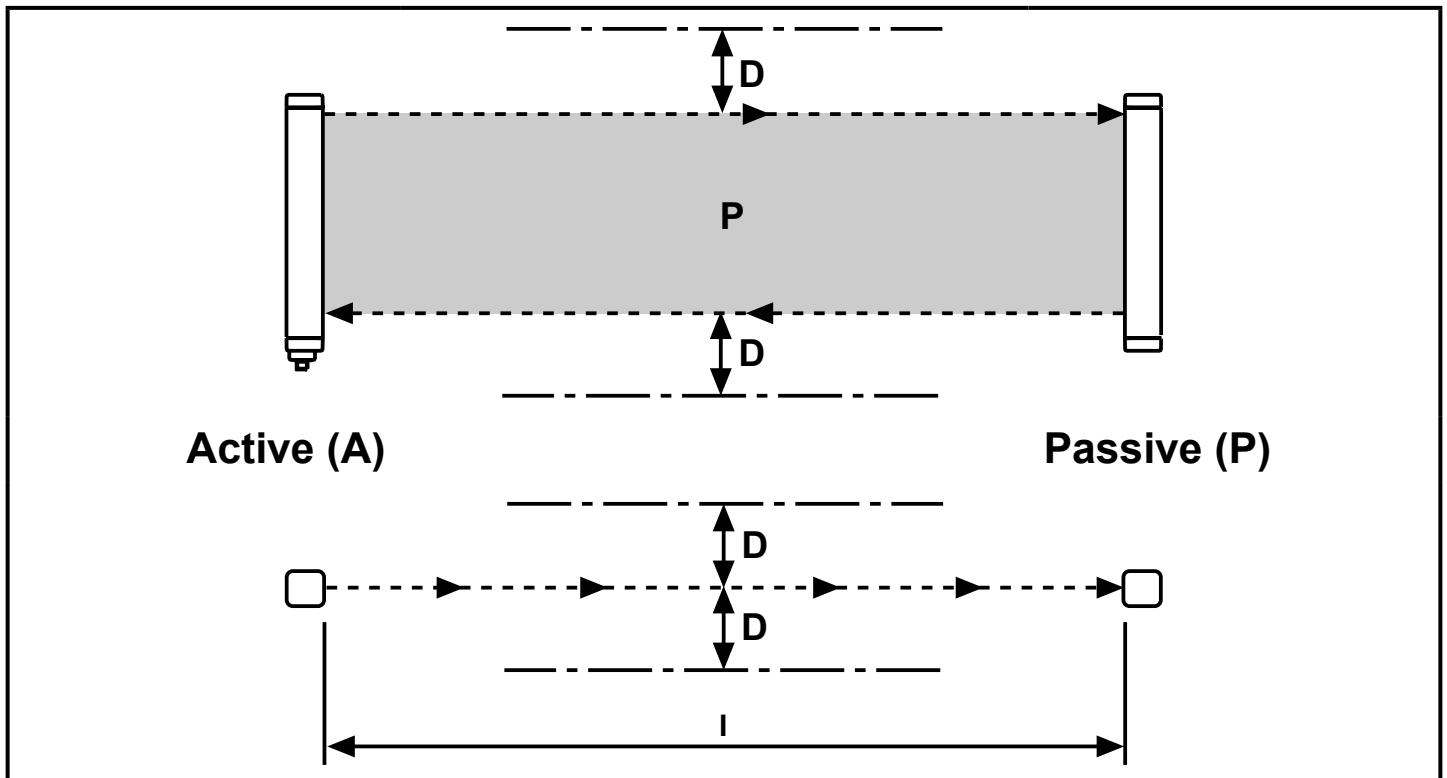
Reflective surfaces close to photoelectric safety sensors can disable the safety function of the system.

The minimum distance (D) depends on the protected area width (I) taking into consideration the projection and receiving angles.



The minimum distance (D) between reflective surfaces and the protected area (P) must be observed. In case of non-compliance an object which has to be detected cannot be sensed. In case of improper handling of the product, the safety and physical integrity of operators and machinery cannot be guaranteed.

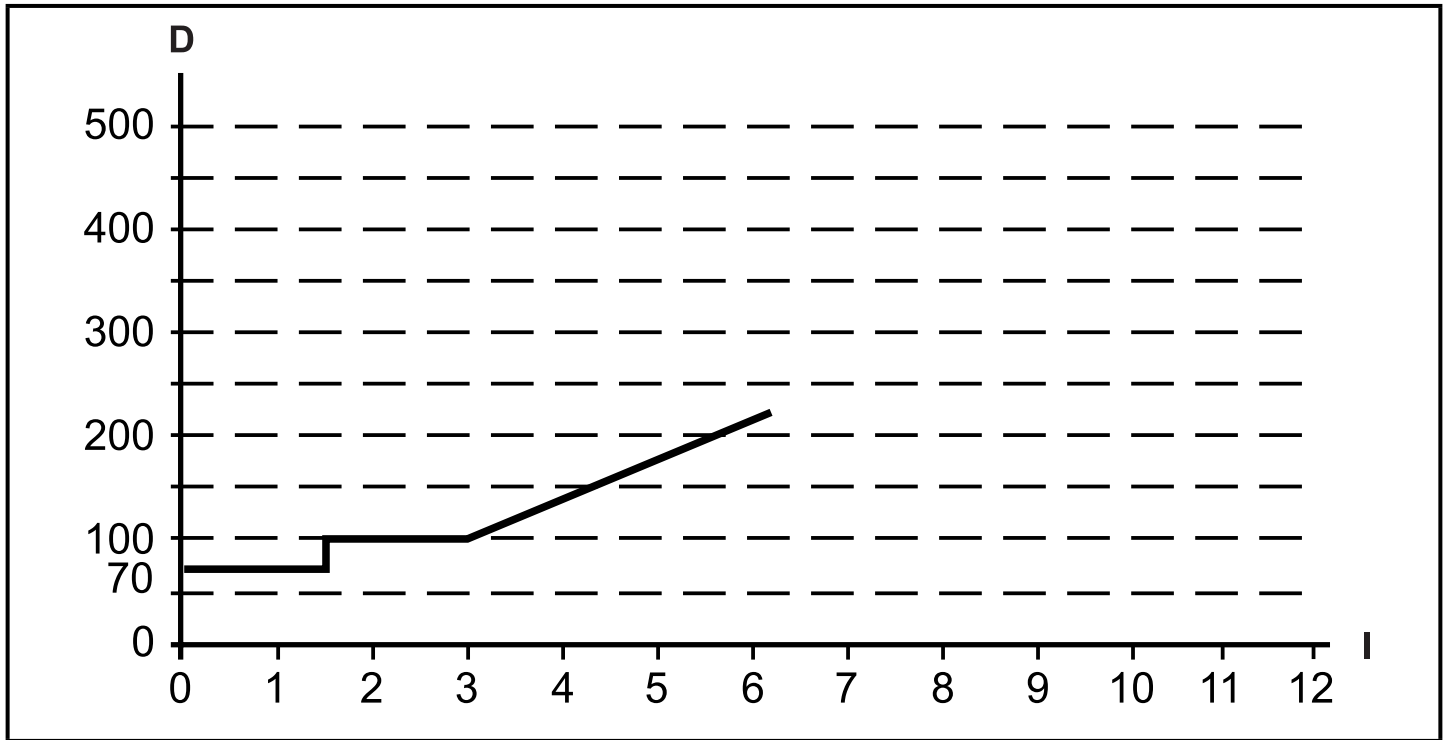
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D = minimum distance; I = protected area width (range); P = protected area

- Once installed ensure that reflective surfaces cannot affect the function of the photoelectric safety sensors by conducting an intentional interruption of the light beams in the protected area.

Minimum distance to reflective surfaces



D = minimum distance in [mm]; I = protected area width (range) [m]

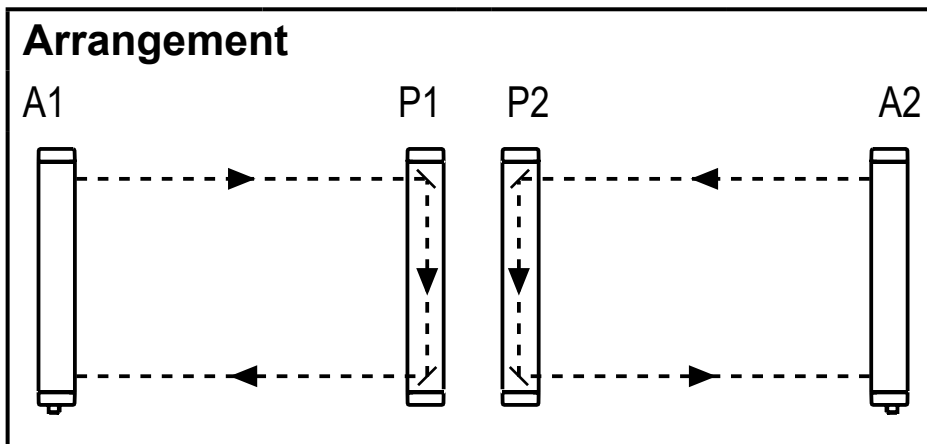
6.6 Multiple systems



The use of several safety light grids can lead to malfunction and disable the protective function.

The safety light grids are to be installed so that the beam sent by the transmitter of a system can only be detected by the respective receiver.

The following important rule for installation is to be observed to avoid mutual interference of several systems:



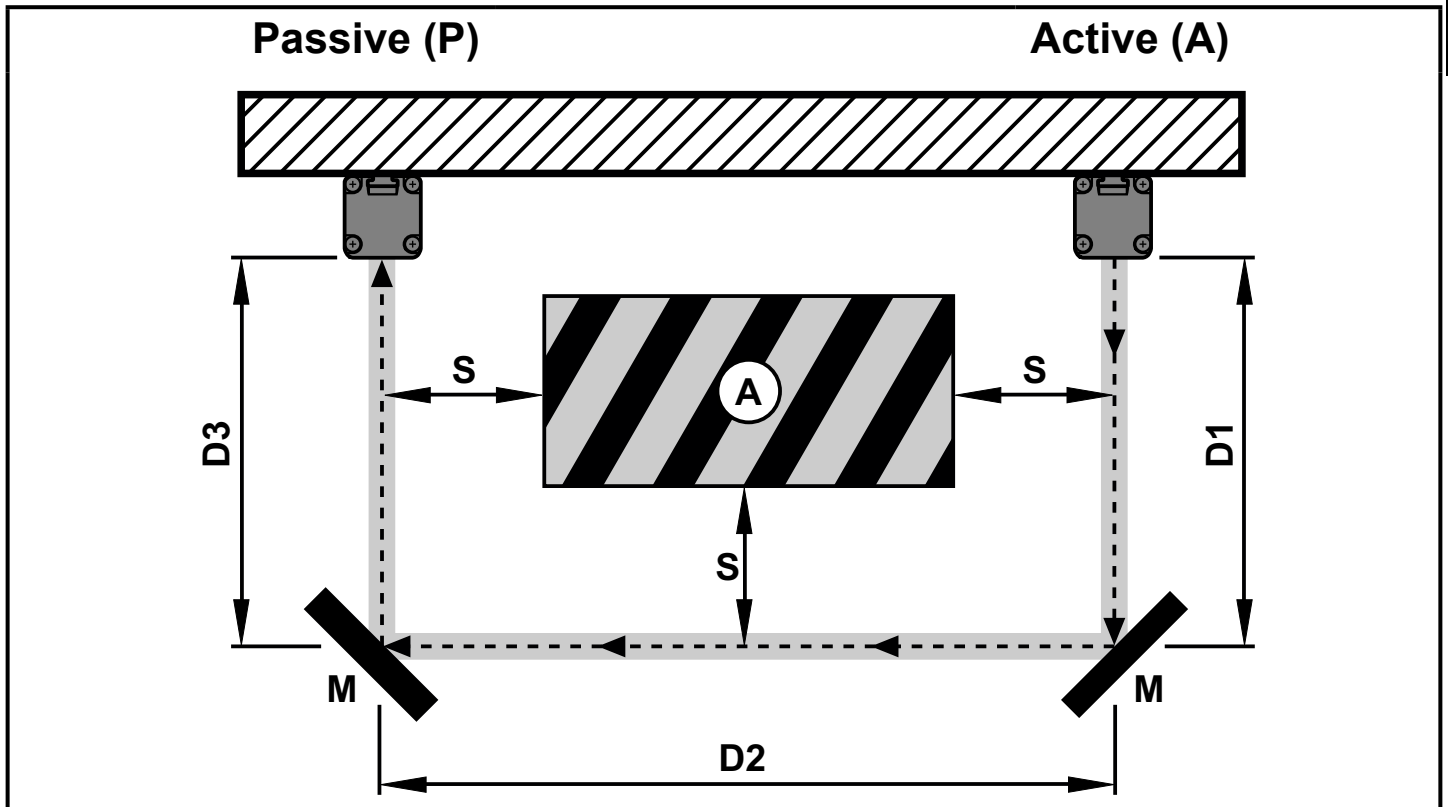
Position of both passive elements next to each other

6.7 Use of corner mirrors

To protect and monitor hazardous areas with access from several sides one or several corner mirrors can be used (available as accessory). By using mirrors the light beam emitted by the transmitter can be sent via several access sides.

- ▶ To obtain a reflection angle of 90° the mirrors are to be oriented in an angle of inclination of 45° .

The following image shows an application where U-shaped access protection is implemented using two mirrors.




A = hazardous area
M = corner mirror


S = minimum safety distance
Dx = side length


- ▶ Install the corner mirrors so that the minimum safety distance (S) is adhered to at each side of the hazardous area.
- ▶ During installation make sure that the reflecting area is plane and that no vibrations affect the safety device.
- The range is the sum of the length of all sides ($D1 + D2 + D3$) of the access to the protected area. The maximum range of the photoelectric safety sensors is reduced by 15% for each mirror.
- Do not use more than two mirrors.

7 Electrical connection

► Disconnect power. Also disconnect any independently supplied relay load circuits.

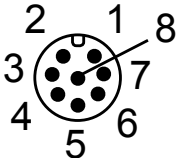
 The nominal voltage is 24 V DC. This voltage may vary between 19.2 V and 28.8 V.

 In case of a single fault the operating voltage must not exceed a maximum of 28.8 V DC. Therefore a safe separation between current supply and transformer is necessary.

 To guarantee functional reliability an output capacity of min. 2000 μ F / A has to be ensured if a power supply with diode bridge is used.


► Connect the unit as indicated in the following table:

7.1 Wiring active element

Pin layout	Pin	Name	Type	Description
	1	OSSD1	Output	Static safety-related output 1
	2	24 V DC	–	Operating voltage 24 V DC
	3	OSSD2	Output	Static safety-related output 2
	4	K1_K2	Input	External feedback contacts
	5	SEL_A	Input	Operating mode safety light grid
	6	SEL_B	Input	
	7	0 V DC	–	Operating voltage 0 V DC
	8	FE	–	Functional earth

For information about available sockets / connectors see:

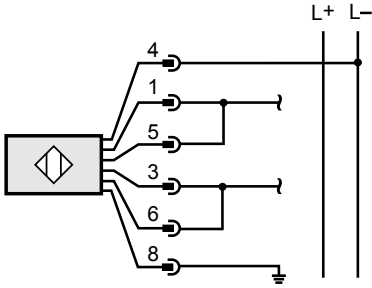
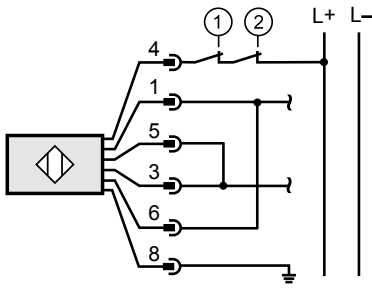
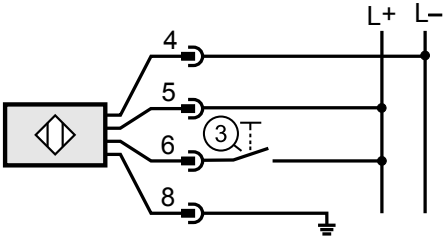
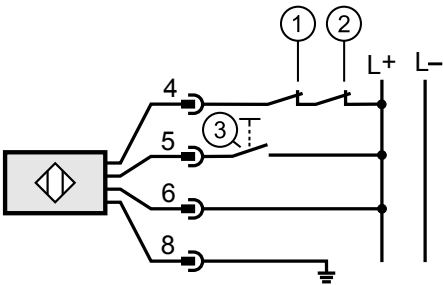
www.ifm.com → Products → Accessories

 Note: Lay the cables of the photoelectric safety sensors separately from sources of interference such as power lines.

► Connect to the functional earth.

8 Operating modes

The different operating modes of the OY90xS series safety light grids can be set via the respective connections on the 8-pole plug of the active element.

Operating modes	Connections		
	pin 4	pin 5	pin 6
A Automatic 	K1_K2 Connects to: L- (0 V DC)	SEL_A Connects to: O SSD1 (pin 1)	SEL_B Connects to: O SSD2 (pin 3)
B Automatic with monitoring of the feedback contacts 	K1_K2 Connects to: L+ (24 V DC) (via NC of the feedback contacts)	SEL_A Connects to: O SSD2 (pin 3)	SEL_B Connects to: O SSD1 (pin 1)
C Manual 	K1_K2 Connects to: L- (0 V DC)	SEL_A Connects to: L+ (24 V DC)	SEL_B / Restart Connects to: L+ (24 V DC) (via start button)
D Manually with monitoring of the feedback contacts 	K1_K2 Connects to: L+ (24 V DC) (via NC of the feedback contacts)	SEL_A / Restart Connects to: L+ (24 V DC) (via start button)	SEL_B Connects to: L+ (24 V DC)
1: Feedback contact 1 2: Feedback contact 2 3: Restart			

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8.1 Automatic operation

If the safety light grids are used in the automatic mode, monitored start is not possible.

The safety light grids automatically return to operation with clear protected area, the outputs (OSSDs) are activated.



Verify if this is compatible with the risk analysis of your machine.

In the automatic mode the OSSD1 and OSSD2 outputs follow the status of the safety light grids:

Protected area clear	Outputs = active logic "1"
Protected area interrupted	Outputs = deactivated logic "0"

8.2 Manual operation

Operation in the manual mode (Start / Restart) is always necessary when passage to a hazardous area is to be monitored (persons can be present in the hazardous area after accessing the protected area without being detected).

The start / restart button has to be outside the hazardous area. It has to be installed so that the hazardous area and access can be clearly seen. It must not be possible to activate the start / restart button from within the hazardous area.



In the manual mode the safety light grids comply with the function as "trip device" to IEC 61496. Non-compliance with this standard can lead to a hazard for people.

The OSSD1 and OSSD2 safety outputs are activated when the protected area is clear and the restart command is entered via a start button or via an input on the restart pin. In the operating mode "Manually without monitoring" the restart is carried out via pin 6, in the operating mode "Manually with monitoring of the feedback contacts" via pin 5.

If the safety light grids are activated by a person or an object, a restart command (24 V on pin 5 or 6) has to be released. Pulse duration > 400 ms.

8.3 Connection of external feedback contacts

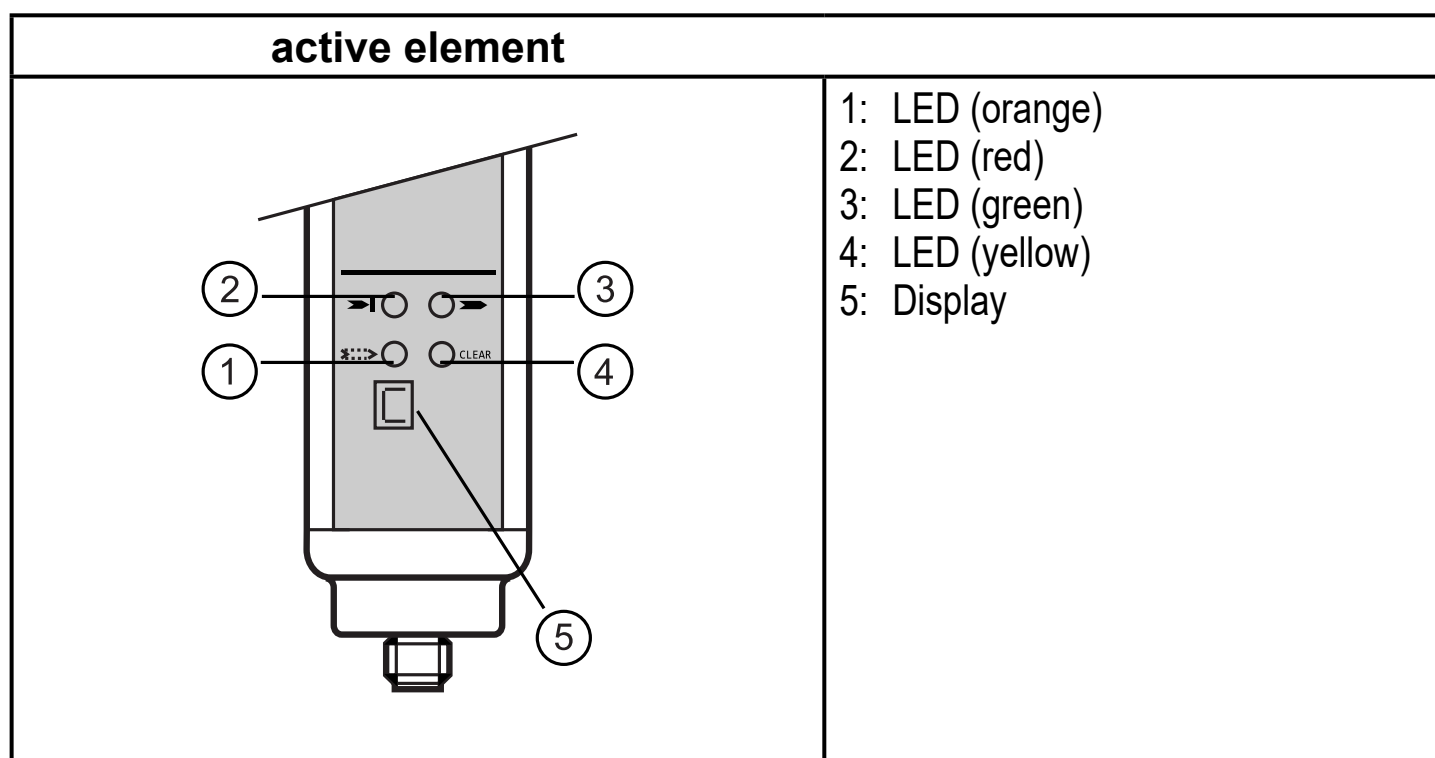
External feedback contacts can be integrated in the automatic or manual operating mode. The feedback contacts have to be connected in series between the operating voltage and K1_K2 (→ 8 Operating modes / table, fig. B and D).

8.4 Internal test function

Type 4 safety light grids continuously perform internal tests. Faults are detected within the response time of the respective model leading to switch-off (response times → 12 Technical data).

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9 Operating and display elements



9.1 LED indicators for optical alignment

The indication LEDs of the safety light grid help to correctly align the active and the passive element with each other.

9.1.1 Alignment in the automatic mode

Description	Active element LED			
	orange	red	green	yellow
Element does not detect any light beam	○	●	○	○
Element detects all light beams with a weak signal	●	○	●	○
Element detects all light beams	○	○	●	○

- ▶ Align the active element so that the green LED lights.
- ▶ Securely fasten the active and the passive element.

9.1.2 Alignment in the manual mode

In the manual operating mode the yellow LED lights instead of the green one. The light grid will then wait for the manual release.

Description	Active element LED			
	orange	red	green	yellow
Element does not detect any light beam	○	●	○	○
Element detects all light beams with a weak signal	●	○	○	●
Element detects all light beams	○	○	○	●

- ▶ Align the active element so that the yellow LED lights.
- ▶ Securely fasten the active and the passive element.

9.2 LED states

Description	Active element LED				
	orange	red	green	yellow	display
Activating the system, introductory test	●	●	●	●	8
Indication of the operating mode (when system is started)					
Automatic	●	○	○	○	C
Automatic with monitoring	●	○	○	●	C
Manual	○	○	○	○	C
Manually with monitoring	○	○	○	●	C
Normal operation					
Protected area interrupted, outputs deactivated	○	●	○	○	-
Protected area clear, outputs deactivated, waiting for restart	○	○	○	●	-
Protected area clear, outputs activated	○	○	●	○	-
Weak signal, protected area clear, outputs deactivated, waiting for restart	●	○	○	●	-
Weak signal, protected area clear, outputs activated	●	○	●	○	-

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10 Operation

10.1 Switching state of the outputs

The safety light grids have two outputs (OSSDs); the status depends on the condition of the protected area.

Any short circuits between the outputs or between an output and the operating voltage (24 V DC or 0 V DC) are detected by the safety light grids as a fault.

Output	Binary states			Description
OSSD1	1			Condition Protected area clear.
OSSD2	1			
OSSD1	1	0	0	Condition Protected area interrupted or fault detected.
OSSD2	0	1	0	

10.1.1 The safe state

The safe state is when at least one of the outputs (OSSDs) is switched off (zero-current state: logic "0").

If one of the outputs is switched off, the subsequent safety-related logic unit must bring the complete system into the state defined as safe.

10.1.2 The switched state

In switched state the active element provides a current of 24 V DC (logic "1") to both outputs.

Output characteristics

The output characteristics follow the characteristics of the input according to IEC 61496:

Logic "1"	24 V DC	max. 500 mA
Logic "0"	≤ 1.5 V DC	< 0.2 mA

10.1.3 Interface classification

The interface of the devices complies with interface type C class 3 according to the ZVEI position paper CB 24I Ed. 2.0

Identification key

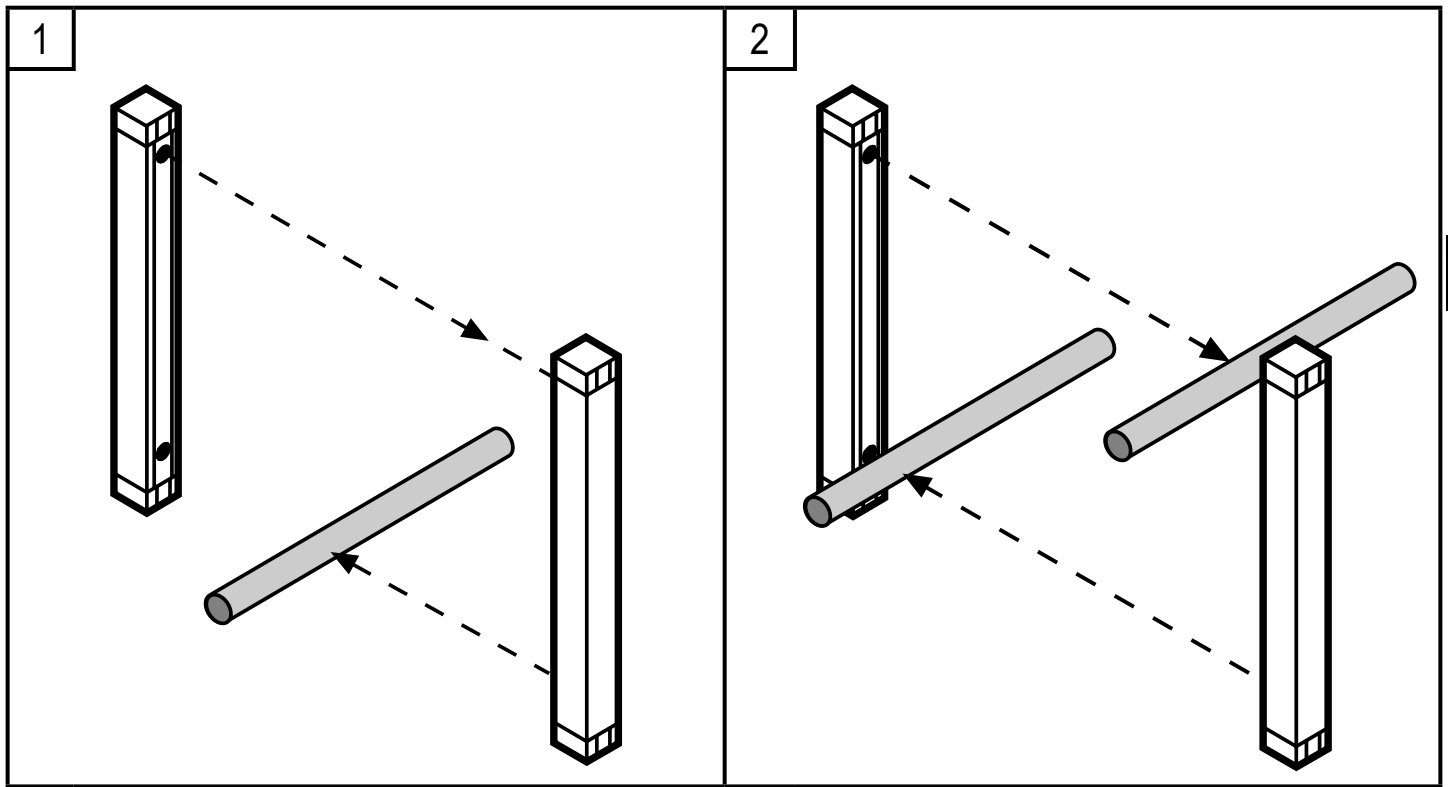
	Interface type		Suitable interface type		
Source	C3	Receiver	C1	C2	C3

10.2 Functional test of the safety light grids



Check the proper function of the safety light grids before work starts.

For the functional test an opaque test object has to be used.



- ▶ Interrupt the light beams with the test object. First of all in the centre (1) and then close to the active and the passive element (2).
- ▶ Make sure that the red LED on the active element is continuously lit during the interruption of the light beams.

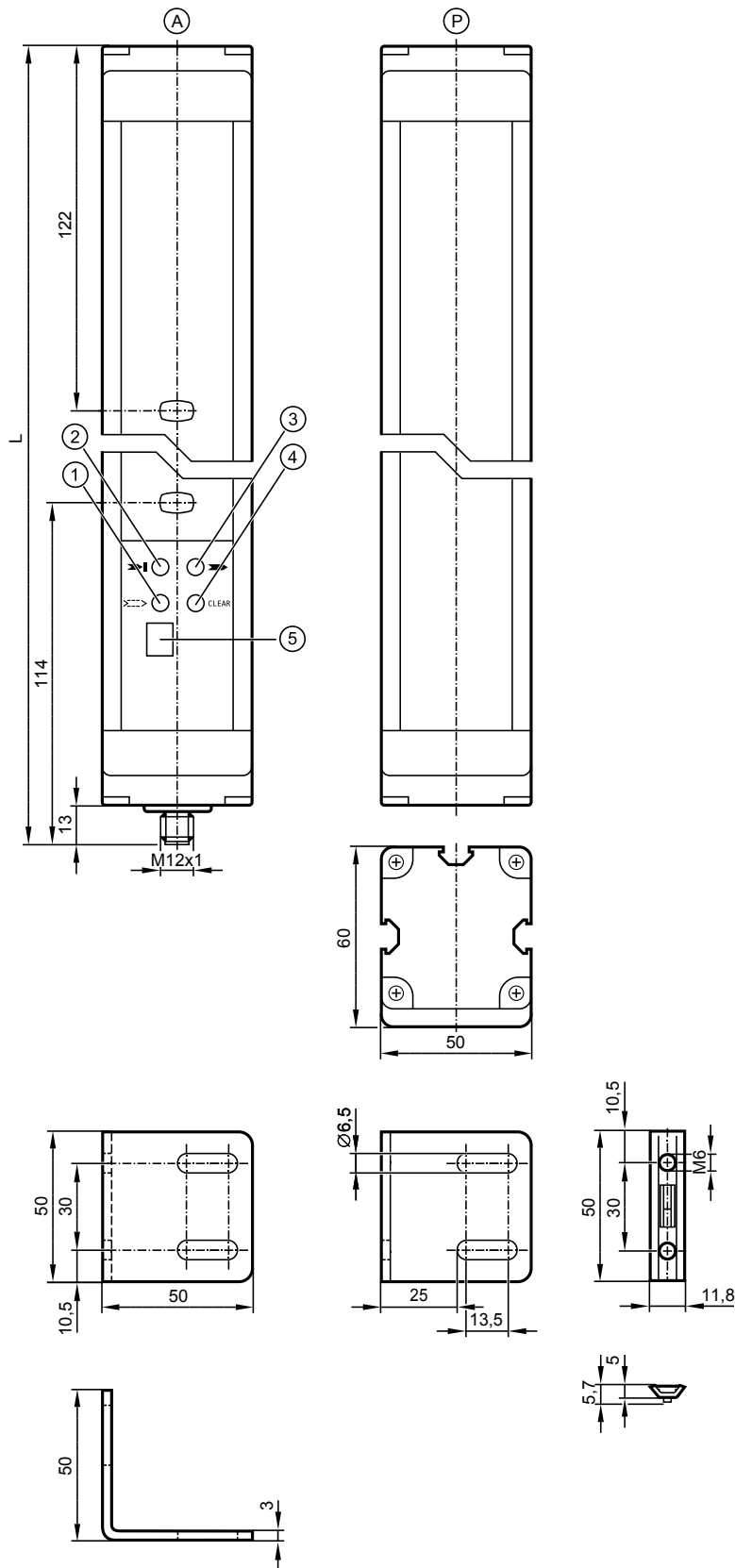


Observe the notes on maintenance of the safety light grids → 14 Maintenance, repair and disposal.



Notes on set-up → 17.1 Check list.

11 Scale drawing



- | | | |
|--------------------|-----------------|-----------------|
| A: Active element | 1: LED (orange) | 4: LED (yellow) |
| P: Passive element | 2: LED (red) | 5: Display |
| L: Total length* | 3: LED (green) | |

* Available lengths → 12 Technical data

11.1 Position of the light beams

Model	Beams	Position of the light beams measured from the lower edge of the connector [mm]
OY901S	2	114 - 614
OY902S	3 ^{*)}	114 - 484 - 544 - 914
OY903S	4	114 - 414 - 714 - 1014


^{*)} technically realised like a 4 beam light grid with a short distance between beam 2 and 3

12 Technical data

Meets the requirements of: Type 4 IEC 61496-1, SIL 3 IEC 61508, SILcl 3 IEC 62061, ISO 13849-1:2015 category 4 PL e	
Electrical design	DC / PNP
Operating voltage	24 DC (19.2...28.8)
Current consumption [mA]	250
Outputs (OSSDs)	2 x PNP
Current rating per output [mA]	500 (24 V)
Max. capacitive load CL_max [μ F]	2.2
Power-on delay time [s]	< 10
Mission time T _M [h]	175200
Protected area width (range) [m]	0...6
EMC	IEC 61496-1
Vibration	IEC 61496-1
Shock	IEC 61496-1
Ambient temperature [°C]	-10...55
Max. perm. relative air humidity [%]	95
Application	Class C to EN 60654-1, weatherproof application
Protection	IP 65 / III
Housing material	Aluminium / PC
Type of light	Infrared 950 nm
Display	LED yellow, LED green, LED red, LED orange, Display
Connection	M12 connector
Max. connection cable length [m]	100 *)

*) for wire cross-section 1 mm²

12.1.1 Safety light grids 2, 3 and 4 beams

	OY901S	OY902S	OY903S
Number of beams	2	3	4
Total length L [mm]			
Active element	736	1036	1136
Passive element	723	1023	1123
Protected area height [mm]	500	800	900
Response time [ms]	10	10.5	10.5
Safety-related reliability PFH _D [1/h]	4,8 ⁻⁰⁹	4,9 ⁻⁰⁹	5,0 ⁻⁰⁹
Test pulse duration t _i [μs]	90	90	90
Test pulse interval T [ms]	6,5	7,0	7,0
Ratio t _i / T [%]	1,4	1,3	1,3

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13 Troubleshooting

The LEDs of the active element indicate faulty operating states (→ 9 Operating and display elements). In case of system failures or errors an error code is displayed. In addition the red LED is lit. For a detailed fault description see the following tables.

13.1 Configuration error

Display	Possible cause	Troubleshooting
C	User configuration rejected	Check configuration
2	OSSD wrongly connected to 24V=	Check OSSD connection
E	External feedback contact missing	Check feedback contact

13.2 System error

Display	Possible cause	Troubleshooting
6	Short circuit	Check connections at terminals 1 and 3 (OSSD).
0	Overload static OSSD outputs	Check current through OSSD outputs, reduce load to max. 500 mA (2.2 μ F).
1	Interfering transmitter detected	Find interfering transmitter and take one of the following measures: <ul style="list-style-type: none"> - Exchange position of active and passive element. - Change location of the interfering transmitter so that the receiver is not influenced. - Screen the beams coming from the interfering transmitter using a mat protective device.

13.3 System failure

In case of a system failure an "F" is displayed alternating with an error code.

Display	Possible cause	Troubleshooting
3	Internal fault (main board)	Send device to ifm branch office for repair.
4	Internal fault (main board)	
5	Fault static OSSD outputs	
A	Internal fault (analogue basic input)	
H	Configuration change by user without system restart	Restart system.

14 Maintenance, repair and disposal

- Maintain the photoelectric protective equipment in accordance with the applicable national regulations in effect within the required intervals. The tests must be performed by qualified persons.
- It is recommended to regularly clean the front panes of the active and the passive element.
- Clean the unit with a clean, damp cloth. In particularly dusty environments we recommend to spray the cleaned front pane with an antistatic product.
- Do not use any aggressive or abrasion-developing cleaning agents since they could attack the surfaces. To avoid electrostatic charging on the front do not use any woollen cloths.



Scratches on the front panes of the photoelectric safety sensors can deviate the light beams and impair the protective function.

- Only the manufacturer is allowed to repair the unit.
- After use dispose of the unit in an environmentally friendly way in accordance with the applicable national regulations.

15 Terms and abbreviations

Blanking		Optional function ensuring that objects are in the protected area which are larger than the detection capacity without the OSSDs switching off.
ESPE	Electro-Sensitive Protective Equipment	
CCF	Common Cause Failure	
DC _{avg}	Average Diagnostic Coverage	
Muting		Temporary bridging of a safety function by safety-related parts of the control system.
MTTF _d	Mean Time To Dangerous Failure	
OSSD	Output Signal Switching Device	Static safety-related output.
PFH (PFH _D)	Probability of (dangerous) Failure per Hour	
PL	Performance Level	Capability of safety-related parts to perform a safety function at predictable conditions to fulfil the expected risk reduction.
SIL	Safety Integrity Level	SIL 1-4 to IEC 61508. The higher the SIL the lower the probability that a safety function will fail.
SIL _{cl}	Safety Integrity Level _{claim limit}	(to IEC 62061)
T _M	Mission Time	
T1	Test Interval	

16 Annex

16.1 Check list

This check list serves as help for setting up the safety light grids. The requirements in this check list should be met, however depending on the application and the directives / standards referred to.

1. Were the directives / standards valid for safety of machinery complied with?
2. Is access prevention to the point of danger only possible through the protected area of the safety light grids?
3. Have steps been taken to prevent reaching under, over or around the light guards to prevent attempts to defeat them?
4. Has the stop or shutdown delay of the machine been measured and adapted according to the installation of the safety light grids?
5. Have the safety light grids been duly fixed and secured against loosening or movement?
6. Have the safety light grids been checked according to the function and maintenance descriptions in these operating instructions?
7. Has external monitoring (EDM) of the control unit (e.g. contactor, valve etc.) been used?
8. Is the state defined as safe initiated when switching on / off the safety light grids?
9. Is / are there any soiling or scratches on the light-emitting surface?
10. Are the installation instructions of these operating instructions adhered to?



This check list does not replace checking or setup by a person trained in safety matters.