

the sensor people

SOLID-2

Safety Light Curtain




607374 - 2015/04
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Notes on Connecting and Operating Instructions

This connecting and operating instructions manual contains information on the proper use of SOLID-2 Safety Light Curtains in accordance with its intended purpose.



All the information contained herein, in particular the safety notes, need to be carefully observed.

Notes regarding safety and warnings are marked by this symbol .

Notes regarding important pieces of information are marked by the symbol .

This connecting and operating instructions manual must be stored carefully. It must be available for the entire operating time of the SOLID-2.

The Leuze electronic GmbH + Co. KG is not liable for damages caused by improper use. Acquaintance with these instructions is an element of the knowledge required for proper use.

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1 General

SOLID-2 Safety Light Curtains are type 2 Active Opto-electronic Protective Devices, (AOPDs) in accordance with EN/IEC 61496-1, EN/IEC 61496-2, PL c in accordance with ISO 13849-1, designed to Safety Integrated Level 1 (SIL 1) as per EN IEC 61508.

All SOLID-2 Safety Light Curtains are equipped with integrated cyclical testing and display elements (LEDs and 7-segment display). This is especially convenient when placing a unit in service or performing diagnostics.

The SOLID-2 is equipped with 2 OSSDs (transistor outputs) with M12 connectors as standard features.

In addition to the features of the Standard version, the Extended version also offers a selectable start/restart interlock and contactor monitoring feature.

To provide the best possible solutions for specific applications, SOLID-2 series devices are available in various resolutions and protective field heights.

1.1 Certifications

Company



Leuze electronic GmbH & Co. KG in D-73277 Owen - Teck, Germany, has a certified quality assurance system in compliance with ISO 9001.

Products



SOLID-2 Safety Light Curtains are developed and manufactured in compliance with applicable European directives and international standards.

EC prototype testing in accordance with
EN IEC 61496 Part 1 and Part 2
TÜV PRODUCT SERVICE GmbH, IQSE
Ridlerstrasse 65
D-80339 Munich

1.2 Symbols and terms

Symbols used:




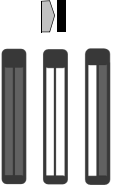

	<p>Warning notice. This symbol indicates possible dangers. Please pay especially close attention to these instructions!</p>
	<p>A note, which also refers to a course of action, provides information about special attributes or describes set-up procedures</p>
	<p>Notice on important information</p>
	<p>Symbols of the Transmitter SD2T General transmitter symbol</p> <p>Transmitter not active</p> <p>Transmitter active</p>
	<p>Symbols for Receiver SD2R General receiver symbol</p> <p>The receiver's active protective field is not free. Outputs in OFF state</p> <p>The receiver's active protective field is free. Outputs in ON state</p> <p>The receiver's active protective field is free. Outputs in OFF state</p>
	<p>Signal output</p> <p>Signal input</p> <p>Signal input and/or output</p>

Table 1.2-1: Symbols

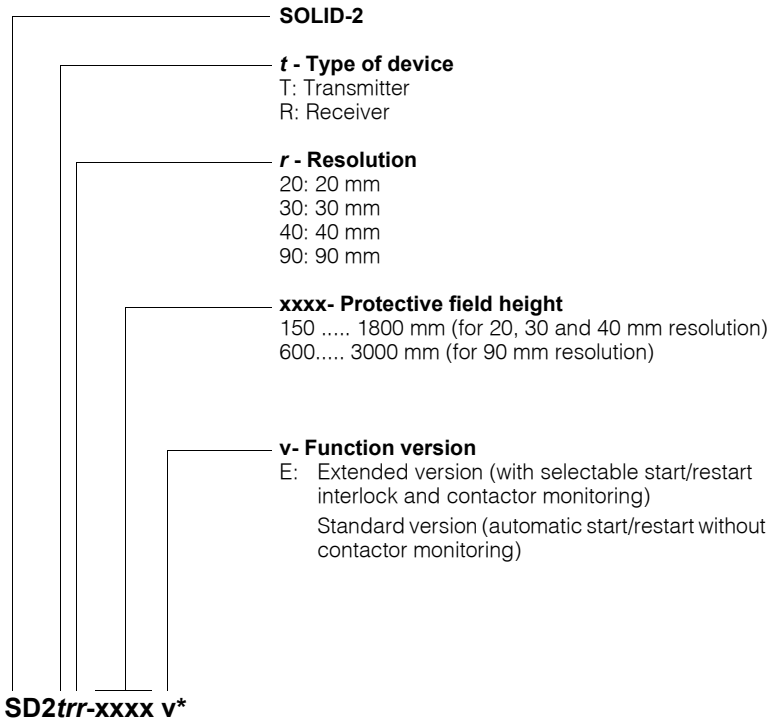
Terms used in this manual:

AOPD	A ctive O pto-electronic P rotective D evice
AutoReset	After an error indication, for example because of a faulty external wiring, the AOPD attempts to start again. If the error is no longer present, the AOPD returns to normal state.
Contactors monitoring (EDM)	Also called E xternal D evice M onitoring (EDM), monitors dynamically the positive-guided normally closed contacts of downstream relays, contactors or valves
OSSD1, OSSD2	Safety-related switch output O utput S ignal S witching D evice
RES	Start/ RES tart interlock
Response time of AOPD	The time lag between penetration into the active protective field of the AOPD and the actual switching off of the OSSDs
Scan	All beams, beginning with the synchronization beam, are pulsed by the transmitter in cycles one after the other
Start/restart interlock (RES)	Prevents automatic start after the supply voltage has been turned on, or after the protective field has been penetrated
TC1	Transmission channel 1
TC2	Transmission channel 2

Table 1.2-2: Terms

1.3 Selecting a SOLID-2

1.3.1 SOLID-2 Safety Light Curtains



*) In the Standard version this place in the product designation is not used

Fig. 1.3-1: Selecting a SOLID-2 Safety Light Curtain

2 Safety

Before using the safety sensor, a risk evaluation must be performed according to valid standards (e.g. EN ISO 14121, EN ISO 12100-1, ISO 13849-1, IEC 61508, EN 62061). The result of the risk assessment determines the required safety level of the safety sensor (see Table 2.1-1). For mounting, operating and testing, document "SOLID-2 Safety Light Curtain" as well as all applicable national and international standards, regulations, rules and directives must be observed. Relevant and supplied documents must be observed, printed out and handed to the affected personnel.

Before working with the safety sensor, completely read and understand the documents applicable to your task.

In particular, the following national and international legal regulations apply for the start-up, technical inspections and work with safety sensors:

- Machinery directive 2006/42/EC
- Low voltage directive 2006/95/EC
- Electromagnetic compatibility directive 2004/108/EC
- Use of Work Equipment Directive 89/655/EEC supplemented by Directive 95/63 EC
- OSHA 1910 Subpart O
- Safety regulations
- Accident-prevention regulations and safety rules
- Ordinance on Industrial Safety and Health and Labor Protection Act
- Device Safety Act



Notice!

For safety-related information you may also contact the local authorities (e.g., industrial inspectorate, employer's liability insurance association, labor inspectorate, occupational safety and health authority).

2.1 Approved purpose and foreseeable improper operation



Warning!

A running machine can cause severe injuries!

Make certain that, during all conversions, maintenance work and inspections, the system is securely shut down and protected against being restarted again.

2.1.1 Proper use

The safety sensor must only be used after it has been selected in accordance with the respectively applicable instructions and relevant standards, rules and regulations regarding labor protection and occupational safety, and after it has been installed on the machine, connected, commissioned, and checked by a competent person.

When selecting the safety sensor it must be ensured that its safety-related capability meets or exceeds the required performance level PL_r ascertained in the risk assessment.

The following table shows the safety-related characteristic parameters of the SOLID-2 Safety Light Curtain.

Type in accordance with IEC/EN 61496	Type 2
SIL in accordance with IEC 61508	SIL 1
SILCL in accordance with IEC/EN 62061	SILCL 1
Performance Level (PL) in accordance with ISO 13849-1: 2008	PL c
Category in accordance with ISO 13849	Cat. 2
Average probability of a failure to danger per hour (PFH _d) For protective field heights up to 900 mm, all resolutions For protective field heights up to 1800 mm, all resolutions For protective field heights up to 2850 mm, all resolutions	8.2 × 10 ⁻⁸ 1/h 8.9 × 10 ⁻⁸ 1/h On request
Service life (T _M)	20 years

Table 2.1-1: Safety-related characteristic parameters of the SOLID-2 Safety Light Curtain

- The safety sensor protects persons at access points or at points of operation of machines and plants.
- The safety sensor with vertical mounting detects the penetration by fingers and hands at points of operation or by the body at access points.
- The safety sensor only detects persons upon entry to the danger zone; it does not detect persons who are located within the danger zone. For this reason, a start/restart interlock is mandatory.
- The safety sensor with horizontal mounting detects persons who are located within the danger zone (presence detection).
- The construction of the safety sensor must not be altered. When manipulating the safety sensor, the protective function is no longer guaranteed. Manipulating the safety sensor also voids all warranty claims against the manufacturer of the safety sensor.
- The safety sensor must be tested regularly by competent personnel.
- The safety sensor must be exchanged after a maximum of 20 years. Repairs or the exchange of parts subject to wear and tear do not extend the service life.

2.1.2 Foreseeable misuse

In principle, the safety sensor is not suitable as a protective device in case of:

- danger of objects being expelled or hot or dangerous liquids spurting from the danger zone
- applications in explosive or easily flammable atmospheres

2.2 Competent personnel

Prerequisites for competent personnel:

- he has a suitable technical education
- he knows the rules and regulations for occupational safety, safety at work and safety technology and can assess the safety of the machine
- he knows the instructions for the safety sensor and the machine
- he has been instructed by the responsible person on the mounting and operation of the machine and of the safety sensor

2.3 Responsibility for safety

Manufacturer and operating company must ensure that the machine and implemented safety sensor function properly and that all affected persons are adequately informed and trained.

The type and content of all imparted information must not lead to unsafe actions by users.

The manufacturer of the machine is responsible for:

- safe machine construction
- safe implementation of the safety sensor
- imparting all relevant information to the operating company
- adhering to all regulations and directives for the safe starting-up of the machine

The company operating the machine is responsible for:

- instructing the operating personnel
- maintaining the safe operation of the machine
- adhering to all regulations and directives for occupational safety and safety at work
- regular testing by competent personnel

2.4 Exemption of liability

Leuze electronic GmbH + Co. KG is not liable in the following cases:

- safety sensor is not used as intended
- safety notices are not adhered to
- reasonably foreseeable misuse is not taken into account
- mounting and electrical connection are not properly performed
- Proper function is not tested (see Chapter 8)
- changes (e.g., constructional) are made to the safety sensor

2.5 Additional safety instructions for access guarding with SOLID-2



Warning!

SOLID-2 Safety Light Curtains with a resolution of 20, 30 or 40 mm detect hands, arms or bodies of a person entering the protective field, and therefore, it can be placed closer to the danger point or points than Safety Light Curtains with a resolution of 90 mm. In this case,

the height of the highest and lowest beam above the reference plane must be selected in accordance with EN ISO 13857.

Valid for all design types: In case of access guarding applications, the start/restart interlock function is obligatory due to the fact that only access to the danger zone, but not the area between the protective field and the danger points is monitored.

The start/restart button for unlocking the device must be mounted in such a way that it cannot be reached from inside the danger zone and the entire danger zone is fully visible from its installation position.

3 System design and selectable functions

3.1 The opto-electronic protective device

Working principle

SOLID-2 consists of a transmitter and a receiver. Beginning with the first beam (the synchronizing beam) directly after the display panel, the transmitter pulses beam for beam in rapid sequence. The synchronization between transmitter and receiver is performed optically.

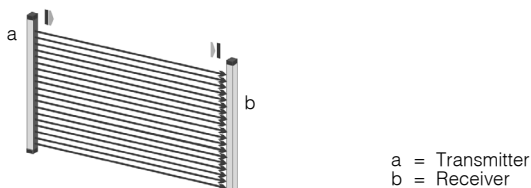


Fig. 3.1-1: Working principle of the opto-electronic protective device

The receiver recognizes the specially coded pulse packages of the transmitter beams and opens the corresponding receiver elements in sequence in the same rhythm. A protective field is consequently formed in the area between transmitter and receiver.

Its height depends on the geometrical dimensions of the protective device and its width is determined by the distance selected between the transmitter and receiver within the permissible detection range.

Functions such as start/restart interlock or contactor monitoring can optionally be performed by the Receiver Extended version.

3.2 Functions of the Transmitter

3.2.1 Transmission channel

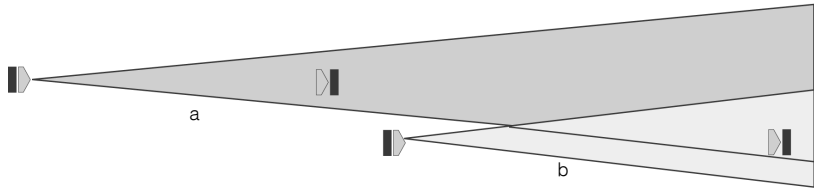
The infrared beams are modulated with specially coded pulse packages so that they are distinct from ambient light, thus ensuring undisturbed operation.

Welding sparks or warning flash lights from passing forklifts do not have any effect on the protective field.

If two protective fields are located directly next to each other for two adjacent machines, however, measures must be taken to ensure the optical protective devices do not affect each other.

Both transmitters should first be assembled “back to back” so that the beams radiate in opposite directions. This prevents one system from affecting the other.

Another possible way to suppress mutual influence is to switch one of the two protective devices from transmission channel 1 to 2 and thus to differently formed pulse packages. This solution should be considered when more than two optical safety systems must be arranged next to each other.



a = AOPD "A" transmission channel 1
 b = AOPD "B" transmission channel 2, not affected by AOPD "A"

Fig. 3.2-1: Transmission channel selection

Both the transmitter and the receiver of the optical protective system in question must be switched from transmission channel 1 to 2. For additional information, see Chapter 6.

3.2.2 Internal or external testing

If external testing is desired, the test input of the transmitter must be wired in accordance with the connection and operating instructions of the selected testing safety interface. The testing safety interface will turn the transmitter off and back on, verifying that the selected single OSSD of the receiver is turned off and on in accordance. For more details, see Chapter 6.1.1.2.

In most cases, however, internal cyclical testing is sufficient. For this purpose, the transmitter's test input must be connected with +24V DC. Both OSSDs must be integrated into the safety circuit as a two-channel system.

3.3 Selectable function of the Receiver Standard and Extended

3.3.1 Transmission channel

If the transmitter is switched to transmission channel 2, the corresponding receiver must also be set to transmission channel 2. See Chapter 6.

3.4 Additional functions of the Receiver Extended

3.4.1 Start/restart interlock (RES)

If the start/restart interlock function is activated, it prevents the safety circuits from being released automatically when the machine is turned on or the power supply is switched on or is restored after a power outage. The receiver only switches to the ON state by pressing and releasing the start/restart button within a time window.

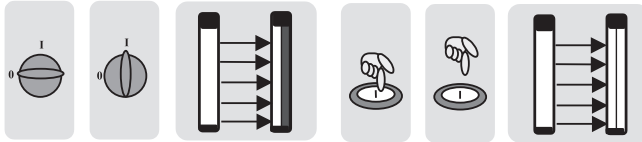


Fig. 3.4-1: Start/restart interlock function in effect when the supply voltage is turned on

If the protective field is interrupted, the start/restart interlock function ensures that the receiver will remain in the OFF state after the protective field is released again. The receiver will then not be switched back to the ON state until the start/restart button is pressed and released again.

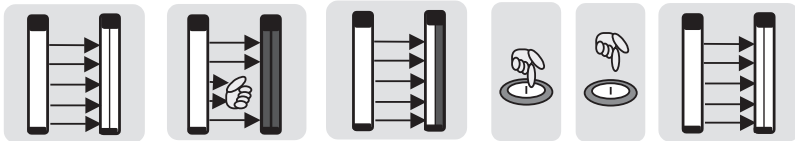


Fig. 3.4-2: The start/restart interlock function after the protective field has been penetrated

Activate the start/restart interlock:

- † with the circuitry in the Receiver Extended (see Chapter 6.1.3)
- † or in the downstream machine control unit
- † or in the downstream safety PLC

Once the internal start/restart interlock is activated as described in Chapter 6.1.3, this function is monitored dynamically. The receiver cannot be switched back to the ON state until the start/restart button is pressed and released again within a time window of 300 ms to 5 s, with the protective field free.

3.4.2 Contactor monitoring (EDM)

If the “Contactor monitoring” function is activated, it dynamically monitors contactors, relays or valves downstream from the SOLID-2. Precondition here are switching elements with positive-guided feedback contacts (normally closed).

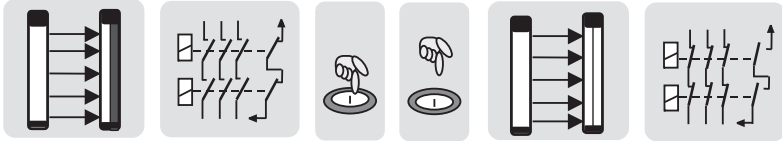


Fig. 3.4-3: Contactor monitoring function, combined in this example with a start/restart interlock

You can implement the contactor monitoring function with:

- † The internal contactor monitoring in the Receiver Extended (see Chapter 6.1.3)
- † or via a downstream safety PLC

If the internal contactor monitoring function is activated, it works dynamically, i.e. in addition to verifying that the feedback loop is closed before turning on the OSSDs the system checks whether the feedback circuit has opened within 500 ms of being enabled and whether it has closed again within 500 ms when turning off the OSSDs. If this is not the case, the OSSDs will assume an OFF state again shortly after turning on. A error message appears at the 7-segment display, E 30.

4 Display elements

4.1 Transmitter status displays

When the transmitter's green LED1 is lit, this indicates that the supply voltage is available.

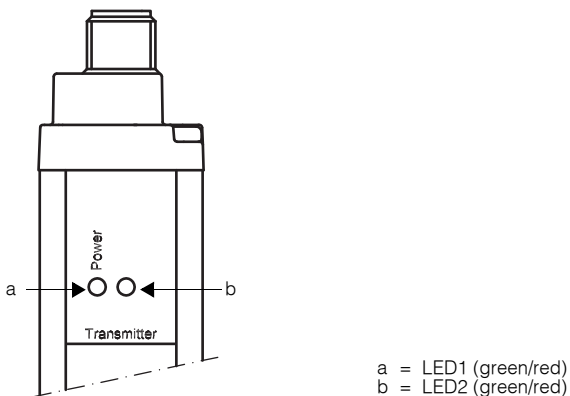


Fig. 4.1-1: Transmitter, LED status displays

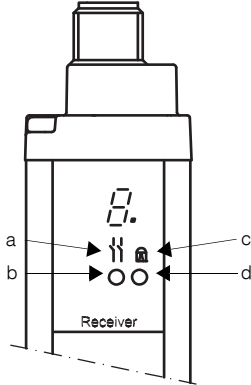
Display of the current state of the transmitter:

Indication		Meaning
LED1 green	LED2 off	Supply voltage present, TC1 selected
LED1 green	LED2 green	Supply voltage present, TC2 selected
LED1 green	LED2 red	Supply voltage present, TC1 or TC2 selected, external test signal activated
LED1 red	LED2 any state	Device fault

Table 4.1-1: Transmitter, LED status displays

4.2 Receiver status displays

LED1 and the 7-segment display report on the operating states of the Receiver Standard. LED2 is added in case of Receiver Extended.



- a = Symbol for OSSDs
- b = LED1 = red/green
- c = Symbol for interlocking state
- d = LED2 = yellow

Fig. 4.2-1: Receiver, status displays

4.2.1 7-segment display

After the electrical supply voltage is turned on, the following data appear on the receiver's 7- segment display:

7-segment display	Meaning
	Permanent display after startup
1 or 2	Indication of transmission channel TC1 or TC2

Table 4.2-1: Receiver, 7-segment permanent displays

7-segment display	Meaning
	Temporary event displays, 1 s per display
E xx	Locking status display "error", which can be eliminated by the user E xx = Error code (for example contactor monitoring error E 30, see Chapter 9). The display shows repeating the sequence of E, 3 (1st position) and 0 (2nd position).
F xx	Locking status display „device fault“ and an internal fault code. Receiver must be replaced.
1 or 2 flashing	Flashing transmission channel number → weak signal display, device not adjusted optimally or contaminated front screens

Table 4.2-2: Receiver, 7-segment temporary event display

4.2.2 LED displays

4.2.2.1 Receiver Standard, LED status displays

LED	Color	Meaning
LED1	red/ green	red = OSSDs safety outputs in the OFF state
		green = OSSDs safety outputs in the ON state
		No display = Device without supply voltage

Table 4.2-3: Receiver Standard, LED status displays

4.2.2.2 Receiver Extended, LED status displays

If the internal start/restart function is not activated, the Receiver Extended indicates only the status of the OSSDs safety outputs in the same way like the Receiver Standard, described under 4.2.2.1.

The following table is valid, if the internal start/restart function is activated.

LED	Color	Meaning
LED1	red/ green	red = OSSDs safety outputs in the OFF state
		green = OSSDs safety outputs in the ON state
		No display = No supply voltage to the device
LED2	yellow	ON = Internal start/restart interlock activated; The OSSDs safety outputs are switched to the OFF state. If the protective field is free, the device can be unlocked by pressing and releasing the start/restart button in a time window of 300 ms to 5 s.
		OFF = If the OSSDs are in ON state (LED1 green): Internal start/restart interlock function is not activated. If OSSDs are in OFF state (LED1 red): Internal start/restart function is activated and the protective field is not free.

Table 4.2-4: Receiver Extended, LED status displays when start/restart interlock function is activated

4.2.2.3 Receiver Extended, LED displays and protective field states when the internal start/restart interlock function is activated:

LED1	LED2	Protective field	Meaning
green	OFF	free	LED1 green = OSSDs safety outputs in the ON state
			LED2 OFF = Start/restart interlock not active, see Fig. 4.2-2 a
red	OFF	interrupted	LED1 red = OSSDs safety outputs in the OFF state
			LED2 OFF = Start/restart interlock not active. As long as the protective field is interrupted, it is not possible to start/restart the device, see Fig. 4.2-2 b
red	yellow	free	LED1 red = OSSDs safety outputs in the OFF state
			LED2 yellow = Start/restart interlock active. The OSSDs safety outputs are only turned on again after pressing and releasing the start/restart button in a time window of 300 ms to 5 s, see Fig. 4.2-2 c-e

Table 4.2-5: Receiver Extended with selected internal start/restart interlock function

The following illustrations show the behaviour of the LEDs and OSSDs in start/restart interlock operating mode.

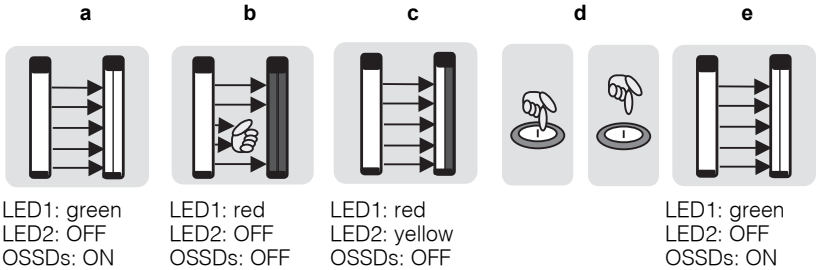


Fig. 4.2-2: Start/restart interlock function after intrusion into the protective field

5 Installation

This section contains important information on installing the SOLID-2. The effects of its effective protection are only guaranteed if the following installation requirements are observed. These installation specifications are based on the respective applicable versions of European standards such as EN 999 and EN ISO 13857. If SOLID-2 is used in countries outside of the EU, the valid requirements in those countries must also be observed. The installation depends greatly on the type of protection being provided.

Because of this, the situations of:

- Safeguarding danger points
- Safeguarding danger areas
- Access guarding

are considered separately below. The applicable distance from the protective device to reflective surfaces in the surrounding area are presented for all types of protection based on these situations.

5.1 Calculating minimum distances

Light curtains can only perform their protective function if they are mounted with a sufficient safety distance. The calculation formulas for the safety distance depend on the type of protection. In the harmonized European standard EN 999, "Positioning of protective devices with regard to approach speed of parts of the human body", the installation situations and calculation formulas for safety distance are described for the types of protection named above.

The formulas for the required distances to reflective surfaces are based on the European standard for "Active opto-electronic protective devices" prEN IEC 61496-2.

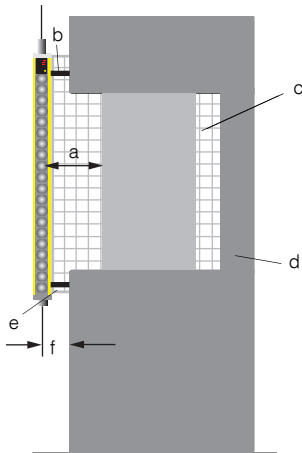
5.1.1 Safety distance for safeguarding danger points

Calculation of the safety distance for a SOLID-2 Safety Light Curtain with resolution of 20, 30 or 40 mm to safeguard danger points:

The safety distance S for safeguarding danger points is derived in accordance with EN 999 from the formula:

$$S \text{ [mm]} = K \text{ [mm/s]} \times T \text{ [s]} + C \text{ [mm]}$$

- S = Safety distance in mm
If the result is less than 100 mm, a distance of at least 100 mm must still be maintained.
 - K = Approach speed in mm/s
In the close range of 500 mm, 2000 mm/s is used for the calculation. If the distance greater than 500 mm is calculated, K = 1600 mm/s may be used. However, in this case a minimum safety distance of 500 mm is applied.
 - T = Total time of the delay in seconds;
Total of:
the response time of the protective device $t_{AOPD}^{a)}$
the response time of the safety interface, if any $t_{Interface}^{b)}$
and the machine's stopping time $t_{Machine}^{c)}$
 - C = $8 \times (d-14)$ in mm
Additional amount depending on depth of penetration into the protective field before switching of the AOPD
 - d = Resolution of the AOPD
- a) see Chapter 10.2
b) see specifications of the safety interface
c) Specifications of the machine or stopping time measurement



- a = Safety distance (S)
- b = Measures to prevent penetration from above
- c = Measures to prevent penetration from the sides
- d = Measures to prevent penetration from the rear
- e = Measures to prevent penetration from below
- f = 75 mm – Maximum distance to avoid walking behind*

Fig. 5.1-1: Safety distance (a) for safeguarding danger points

*) If because of the safety distance this value cannot be achieved, other measures e.g. mechanical barriers must provide this distance.

$$S \text{ [mm]} = 2000 \text{ [mm/s]} \times (t_{AOPD} + t_{Interface} + t_{Machine}) \text{ [s]} + 8 \times (d-14) \text{ [mm]}$$

Calculation example for safeguarding danger points:

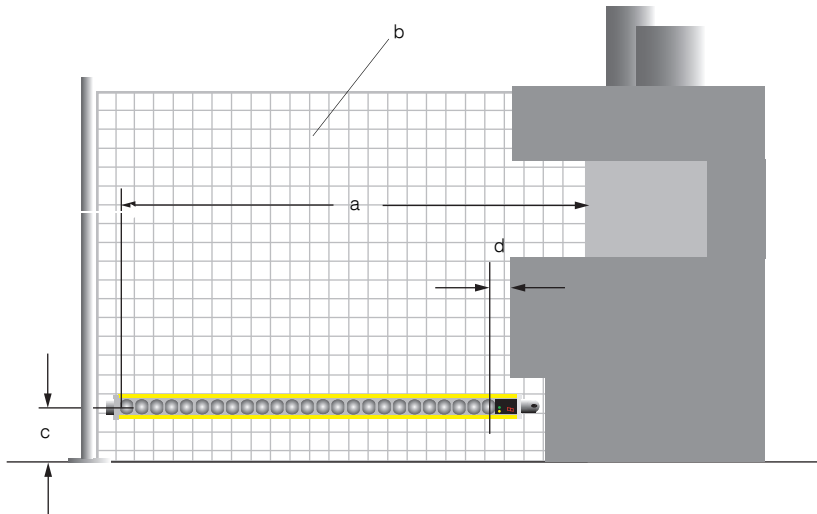
A light curtain with a resolution of 20 mm, protective field height 1500 mm is used on a machine with a stopping time of 150 ms. The response time of the safety interface is 20 ms.

Stopping time of the machine $t_{Machine}$	=	150 ms
Response time t_{AOPD}	=	49 ms
Response time $t_{Interface}$	=	20 ms
Resolution d of the AOPD	=	20 mm
$T = 0.150\text{ s} + 0.049\text{ s} + 0.020\text{ s}$	=	0.219 s
$S = 2000 \times 0.219 + 8 \times (20 -14)$	=	<u>486 mm</u>

Make certain during assembly that it is not possible to reach over, around or under or to walk behind the protective device.

5.1.2 Safety distance for safeguarding danger areas

Calculation of the safety distance and required resolution for a Safety Light Curtain to secure danger areas.



- a = Safety distance (S)
- b = Measures to prevent access from the sides
- c = Height above the reference plane
- d = max. distance < 75 mm*

Fig. 5.1-2: Safety distance (a) and height (c) for safeguarding danger areas

*) If this value can not be achieved because of the safety distance, other measures, e.g. mechanical barriers, must guarantee for that required maximum distance of 75 mm.

The height of the protective field H above the reference plane and the resolution d of the AOPD are related to each other as follows:

$$H_{\min} [\text{mm}] = 15 \times (d - 50) [\text{mm}] \quad \text{or} \quad d [\text{mm}] = H/15 + 50 [\text{mm}]$$

H = Height of the protective field above the reference plane, maximum 1000 mm
 Heights equal to or less than 300 mm are considered too low for adults to crawl under

d = Resolution of the AOPD

The safety distance S for safeguarding danger areas is derived in accordance with EN 999 from the formula:

$$S [\text{mm}] = K [\text{mm/s}] \times T [\text{s}] + C [\text{mm}]$$

S = Safety distance in mm

K = Approach speed of 1600 in mm/s.

T = Total time of the delay in seconds;

Total of:

the response time of the protective device $t_{\text{AOPD}}^{\text{a)}}$

the response time of the safety interface, if any $t_{\text{Interface}}^{\text{b)}}$

and the stopping time of the machine $t_{\text{Machine}}^{\text{c)}}$

C = (1200 mm – 0,4 H), but not less than 850 mm (arm's length)

H = Height of the protective field above the floor

a) see Chapter 10.2

b) see specifications of the safety interface

c) Specifications of the machine or stopping time measurement

$$S [\text{mm}] = 1600 [\text{mm/s}] \times (t_{\text{AOPD}} + t_{\text{Interface}} + t_{\text{Machine}}) [\text{s}] + (1200 - 0,4 H) [\text{mm}]$$

5.1.3 Safety distance and beam heights for access guarding

Determination of the beam heights and calculation of the safety distance of Safety Light Curtains with a resolution of 20, 30 or 40 mm for use as access guarding, for example with limited space between the protective field and a danger point.

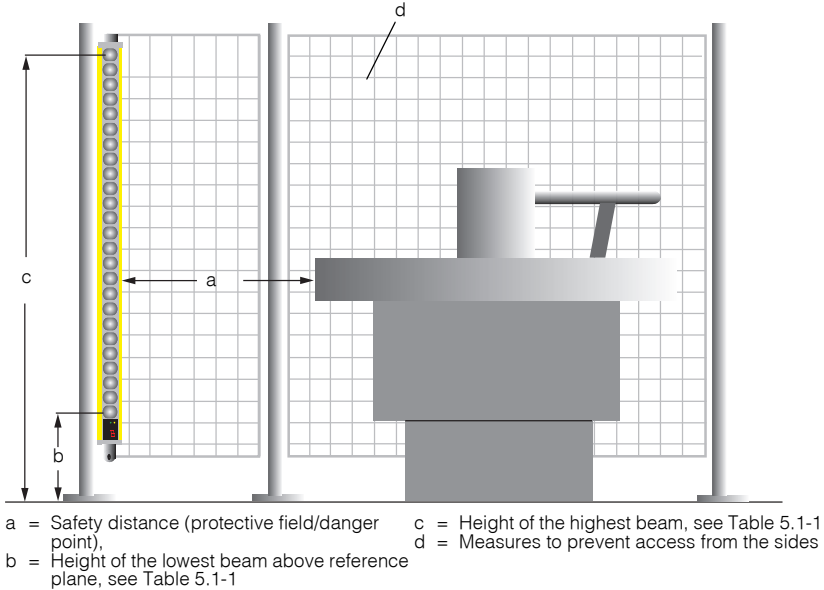


Fig. 5.1-3: Access guarding with Safety Light Curtain, resolution of 20, 30 or 40 mm



Warning!

Please consider the additional safety instructions for access guarding with SOLID-2 in Chapter 2.5.

Beam heights with use of Safety Light Curtain to guard access in accordance with EN 999 and EN ISO 13857:

Design	Resolution	Lowest beam above reference plane	Highest beam above reference plane	Additional amount C (see formula Chapter 5.1.1)
SD2-20-xxxx	20 mm	As per EN ISO 13857	As per EN ISO 13857	48 mm
SD2-30-xxxx	30 mm	As per EN ISO 13857	As per EN ISO 13857	128 mm
SD2-40-xxxx	40 mm	As per EN ISO 13857	As per EN ISO 13857	208 mm
SD2-90-xxxx	90 mm	300 mm	1200 mm	850 mm

Table 5.1-1: Beam heights above the reference plane and additional amount C for access guarding applications

Calculation formula for safety distance S based on EN 999:

Calculation of the safety distance for a Safety Light Curtain with a resolution of up to 40 mm, used to guard access. The safety distance S is calculated as described by EN 999 according to the formula:

$$S \text{ [mm]} = K \text{ [mm/s]} \times T \text{ [s]} + C \text{ [mm]}$$

- S = Safety distance in mm
 - K = Approach speed in mm/s
In the close area of 500 mm, the speed is calculated at 2000 mm/s. If the distance is greater than 500 mm, K can be calculated as 1600 mm/s. In this case, however, a minimum of 500 mm applies to the safety distance.
 - T = Total time of the delay in seconds;
Total of:
the response time of the protective device $t_{AOPD}^a)$
the response time of the safety interface, if any $t_{Interface}^b)$
and the stopping time of the machine $t_{Machine}^c)$
 - C = $8 \times (d-14)$ in mm
Additional amount depending on the depth of penetration into the protective field before turning on the AOPD
 - d = Resolution of AOPD up to a maximum of 40 mm
- a) see Chapter 10.2
b) see specifications of the safety interface
c) Specifications of the machine or stopping time measurement

$$S \text{ [mm]} = 2000 \text{ [mm/s]} \times (t_{AOPD} + t_{Interface} + t_{Machine}) \text{ [s]} + 8 \times (d-14) \text{ [mm]}$$

If the resolution is greater than 40 mm for example for SOLID-2 Safety Light Curtains with a resolution of 90 mm, an additional amount is required:

$$C = 850 \text{ mm (arm's length)}$$

The safety distance is thus calculated according to the following formula:

$$S \text{ [mm]} = 1600 \text{ [mm/s]} \times (t_{AOPD} + t_{Interface} + t_{Machine}) \text{ [s]} + 850 \text{ [mm]}$$

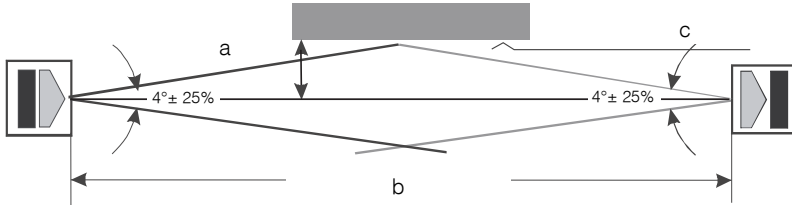


Warning!

Please consider the additional safety instructions for access guarding with SOLID-2 in Chapter 2.5.

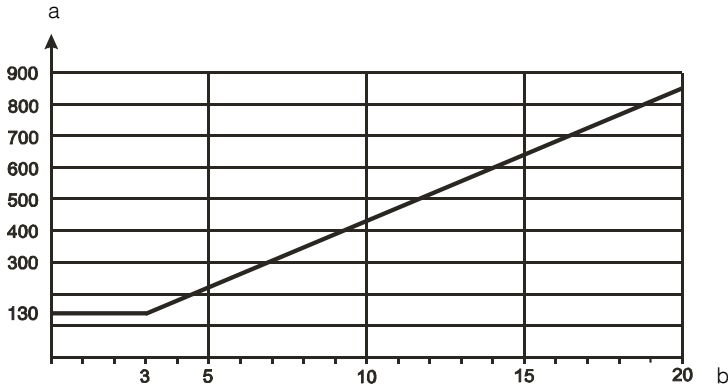
5.1.4 Minimum distance from reflective surfaces

Reflective surfaces in the area of opto-electronic protective devices can indirectly deflect beams from the transmitter into the receiver. This can cause an object in the protective field not to be detected! All reflective surfaces and objects (for example material containers, sheets) must be kept at a minimum distance „a“. The minimum distance depends on the distance „b“ between the transmitter and the receiver.



- a = Minimum distance
- b = Reflective surface
- c = Protective field width

Fig. 5.1-4: Minimum distances from reflective surfaces



- a = Required distance from reflective surfaces [mm]
- b = Width of protective field [m]

Fig. 5.1-5: Minimum distances from reflective surfaces as a function of the width of the protective field

Safety light curtains of the SOLID-2 product line are equipped with an optics of less beam aperture than required by EN IEC 61496-1, -2. Thus, less distances between reflecting surfaces and protective field are needed than typically required.



Warning!

Replacing with safety light curtains of different production lines fulfilling the minimum requirements of the above mentioned standards may request higher distances.

5.2 Mounting notes

Special notes on mounting a SOLID-2 Safety Light Curtain for **safeguarding danger points** (see Fig. 5.1-1):

- † Calculate the safety distance according to the formula in Chapter 5.1.1.
- † Ensure that it is impossible to reach under, over, around or walk behind the protective field.
- † Observe the maximum distance between machine table and protective field of 75 mm, with reference to a table height of 750 mm. If this is not possible because the safety distance is too big, e.g. a mechanical barrier must be provided.
- † Observe the minimum required distance to reflective surfaces.

Special notes on mounting a SOLID-2 Safety Light Curtain for safeguarding **danger areas** (see Fig. 5.1-2):

- † Calculate the safety distance according to the formula in Chapter 5.1.2.
- † The resolution determines the minimum height of the protective field above the floor. The calculation formula can also be found in Chapter 5.1.2.
- † Ensure that the maximum height of the protective field above the reference plane of 1000 mm is not exceeded and only heights equal to or less than 300 mm are considered impossible for an adult to crawl under (also see EN 999).
- † It must not be possible to step into the danger area from the sides. Suitable hard guards must be provided.
- † Consider the position of the last light beam before the machine. It must not be possible to stand undetected between this light beam and the machine.

Special notes on mounting a SOLID-2 Safety Light Curtain for **access guarding** (see Fig. 5.1-3):

- † Calculate the safety distance according to the formula in Chapter 5.1.3.
- † The highest and the lowest light beam and thus the height of the protective field for Safety Light Curtains with a resolution of 20, 30 or 40 mm is determined from the requirements described in EN ISO 13857.
- † Access guarding systems must only be operated with start/restart interlock. Activate the start/restart interlock internal or of a downstream safety interface and check to make sure it is working.
- † Ensure while installing the start/restart button, that it must only be impossible to press this button from the inside the danger zone. Make sure, that from the location of the button there is a complete overview over the danger zone.

5.3 Mechanical mounting

What should generally be taken into consideration during installation?

- † Make certain that the transmitter and receiver are mounted on even surfaces.
- † The transmitter and receiver must be positioned at the same height and their connection plugs must be pointing in the same direction.
- † Use screws for mounting that can only be loosened with a tool.
- † Fasten and secure the transmitter and receiver so that they cannot be swiveled or moved. Securing transmitter and receiver so they cannot be moved or swiveled is especially important in the close area with a narrow protective field.
- † The safety distance between the protective field and the danger zone must be observed.
- † Make certain that access to the danger point/danger area is only possible through the protective field. Additional access routes must be secured separately (for example by hard guards, additional safety light curtains or doors with locking devices).

5.4 Mounting types

5.4.1 Standard mounting

Four standard mounting brackets (two each for transmitter and receiver) are included with delivery.

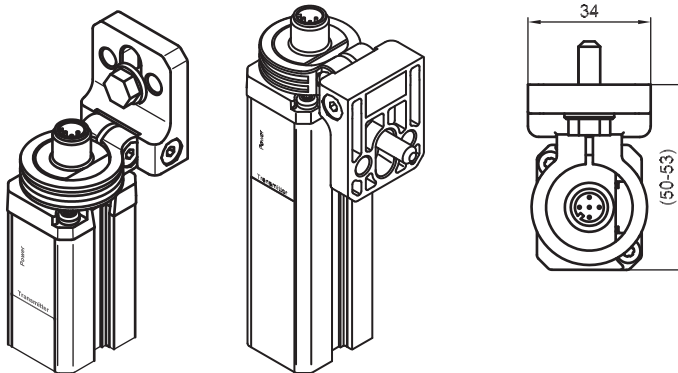


Fig. 5.4-1: Standard mounting bracket examples

5.4.2 Option: Mounting with swiveling brackets

Four swivel mounting brackets with shock absorbers can be ordered optionally. They are not included with delivery. The swivel range is $\pm 8^\circ$.

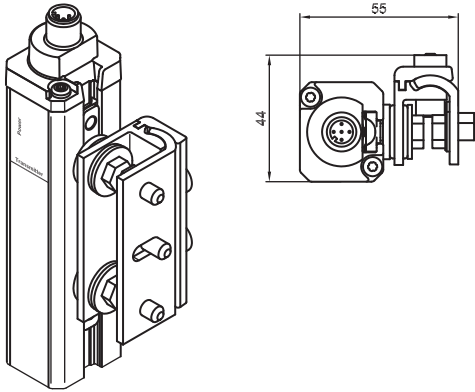


Fig. 5.4-2: Swiveling mounting bracket with shock absorber

5.4.3 Option: Side mounting

Optionally, mounting is possible with L- or Z-mounting brackets (with sliding nuts and screws) using the side groove. They are not included with delivery.

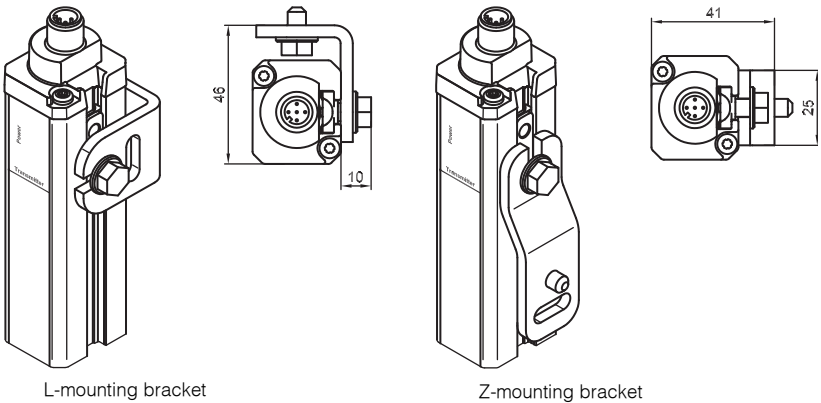


Fig. 5.4-3: Mounting examples, L-mounting bracket and Z-mounting bracket

6 Electrical connection

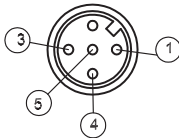


- The electrical connection must be performed by experienced personnel. Knowledge of all safety instructions in these connecting and operating instructions is part of this competence.
- The external supply voltage of 24V DC \pm 20 % must guarantee safe isolation from mains voltage and be able to bridge a power outage period of at least 20 ms. **Leuze electronic** offers suitable power supplies (see list of accessories in the Appendix).
- The power supply selected must not support any other parts of the machine with power other than the safety components connected. It must provide at least 1 A. Transmitter and receiver must be fused against overcurrent.
- It is vital during the electrical installation for the power of the machine or system to be protected is switched off and locked, so that the dangerous movements cannot be started unintentionally. Only after the safety function on the protective device is entirely checked, its connection to the machine is permissible. For more details see Chapter 8 and 11.4.

6.1 M12 connection

Transmitter and Receiver Standard are equipped with M12, 5-pin plugs while the Receiver Extended providing additional functions is equipped with a M12, 8-pin plug.

6.1.1 Transmitter



- 1 = brown
- 3 = blue
- 4 = black
- 5 = grey

Fig. 6.1-1: SD2T 5-pin (view of the pins)

Pin	Color	Assignment	Inputs/outputs
1	brown	⇐ Supply voltage	+24V DC for TC1 or 0V for TC2
2	white	nc.	
3	blue	⇐ Supply voltage	0V for TC1 or +24V DC for TC2
4	black	⇐ Test in	Test input Connected to +24V DC → internal test activated Connected to 0V or disconnected → external test activated
5	grey/ connector enclosure	⇐ Shield	Functional earth

Table 6.1-1: Transmitter, connection assignment

The polarity of of the power supply at Pin1 and Pin3 determines the selected optical transmission channel. If +24V DC is present on Pin1 and 0V on Pin3 transmission channel 1 is selected. If 0V is present on Pin1 and +24V DC on Pin3 transmission channel 2 is selected.

Make certain to select the same transmission channel for both, for transmitter and receiver.



Warning!

For optimal shielding cables must be used, where the shield is led on the knurled nut of the connecting cable socket (such cables are listed under accessories in Chapter 11.3).

6.1.1.1 Internal cyclical testing

To activate internal cyclical testing, connect Pin4 of the transmitter to +24V DC.



Warning!

While using the internal cyclical testing both of the OSSDs must by used to open the safety circuit redundant.

6.1.1.2 External test signal

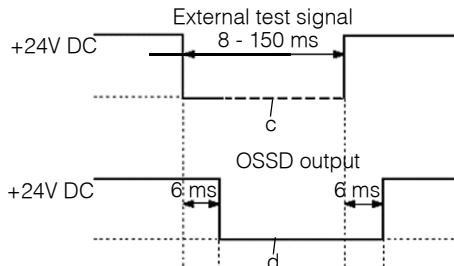
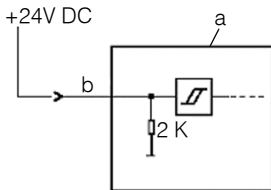
To use the external testing option, connect the test output of the corresponding testing safety interface with Pin4 of the transmitter. In case of using the external testing procedure in combination with a testing safety interface, only one of the OSSDs needs to be connected to the testing safety interface.



Note:

External testing takes precedence over the internal testing.

Test input Pin4 Transmitter:	+24V DC	test = not activated
	high impedance or 0V	test = activated

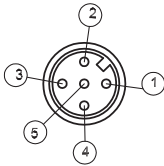


a = transmitter
b = test input pin4

c = high impedance or 0V
d = high impedance

Fig. 6.1-2: Transmitter, external testing

6.1.2 Receiver Standard



- 1 = brown
- 2 = white
- 3 = blue
- 4 = black
- 5 = grey

Fig. 6.1-3: SD2R 5-pin (view of the pins)

Pin	Color	Assignment	Inputs/outputs
1	brown	← Supply voltage	+24V DC for TC1 or 0V for TC2
2	white	⇒ Output	OSSD2, switching semiconfactor output
3	blue	← Supply voltage	0V for TC1 or +24V DC for TC2
4	black	⇒ Output	OSSD1, switching semiconfactor output
5	grey/ connector enclosure	← Shield	Functional earth

Table 6.1-2: Receiver Standard, connection assignment



Warning!

The Receiver Standard does not offer the functions start/restart interlock and EDM. These functions have to be carried out by the downstream machine control unit if required by the safety category.



Note:

For optional shielding cables must be used, where the shield is led on the knurled nut of the connecting cable socket (such cables are listed under accessories in Chapter 11.3).

The polarity of the power supply at Pin1 and Pin3 determines the selected optical transmission channel. If +24V DC is present on Pin1 and 0V on Pin3 transmission channel 1 is selected. If 0V is present on Pin1 and +24V DC on Pin3 transmission channel 2 is selected.



Note:

Make certain to select the same transmission channel for both, for receiver and transmitter.

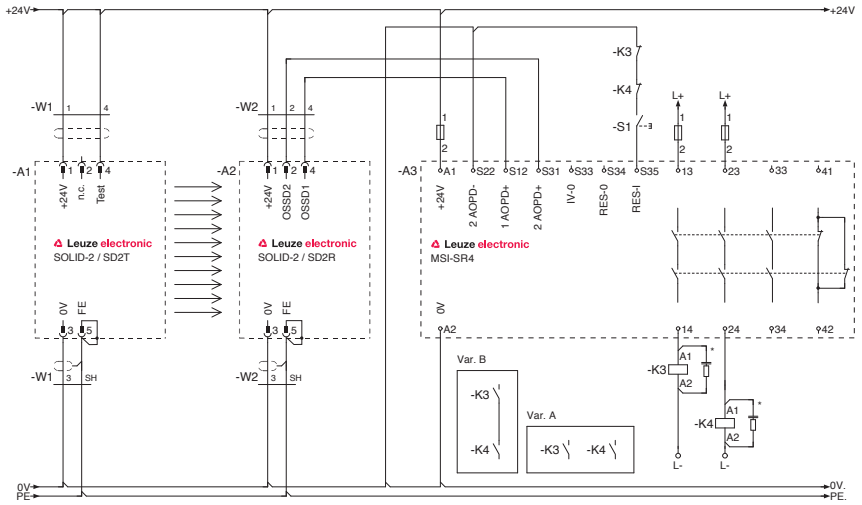
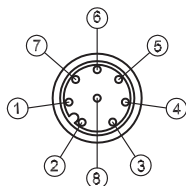


Fig. 6.1-4: Connection example SOLID-2 with MSI-SR4 Safety Relay

6.1.3 Receiver Extended



- 1 = white
- 2 = brown
- 3 = green
- 4 = yellow
- 5 = grey
- 6 = pink
- 7 = blue
- 8 = black

Fig. 6.1-5: SD2R 8-pin (view of the pins)

Pin	Color	Assignment		Inputs/outputs
1	white	⇐	Operating mode selection	Input BA1
2	brown	⇐	Supply voltage	+24V DC for TC1 or 0V for TC2
3	green	⇐	Operating mode selection	Input BA2
4	yellow		nc	
5	grey	⇒	Output	OSSD1, switching semiconductor output
6	pink	⇒	Output	OSSD2, switching semiconductor output
7	blue	⇐	Supply voltage	0V for TC1 or +24V DC for TC2
8	black/ connector enclosure	⇐	Shield	Functional earth

Table 6.1-3: Receiver Extended, connection assignment

6.1.3.1 Selection of the transmission channel

The polarity of of the power supply at pin2 and pin7 determines the selected optical transmission channel:

If +24V DC is present on pin2 and 0V on pin7 transmission channel 1 is selected.

If 0V is present on pin2 and +24V DC on pin7 transmission channel 2 is selected.



Note:

Make certain to select the same transmission channel for both, for transmitter and receiver.

For optimal shielding cables must be used, where the shield is led on the knurled nut of the connecting cable socket (such cables are listed under accessories in Chapter 11.3).

6.1.3.2 Operating mode selection RES and contactor monitoring (EDM)

The Receiver Extended has to be connected via the 8-pin M12 connector. The operating modes S/R and EDM can be activated in several combinations using the pins BA1 (pin1) and BA2 (pin3) .



Warning!

The adaptation of the operating mode is only be carried out in the switched off state of the receiver. If the adaptation is made during operation, the new values will not be accepted until the power supply was switched off.

	Without RES Without EDM	With RES Without EDM	Without RES With EDM	With RES With EDM
BA1 pin1	0V	Start/restart button to BA2	EDM feedback loop k1/k2 at +24V DC	EDM feedback loop k1/k2 at BA2
BA2 pin3	+24V DC	0V	n.c.	Via start/restart button to 0V
Connection				

Table 6.1-4: Receiver Extended, operating mode selection

6.1.3.3 Connection example

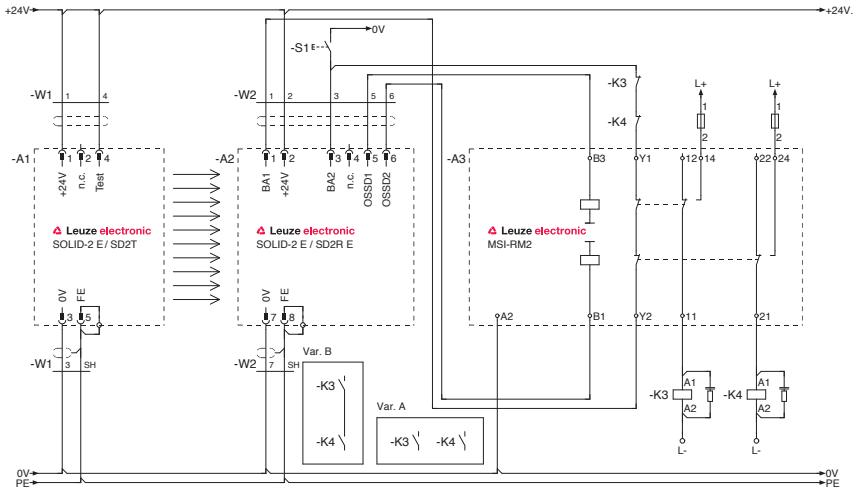


Fig. 6.1-6: Connection example SOLID-2E with MSI-RM2 Safety Relay

7 Commissioning



Warning!

Before placing the SOLID-2 in operation for the first time on a power-driven production machine, an experienced and commissioned person with suitable training must check the entire setup and the integration of the opto-electronic protective device into the machine control system.

Before connecting the supply voltage for the first time and while the transmitter and receiver are being aligned, it must be ensured that the outputs of the protective device do not have any effect on the machine. The switching elements that finally set the dangerous machine in motion must be safely switched off and secured from restarting.

The same precautionary measures apply after every change in operating mode made to the protective device, after repairs or during maintenance work.

Only after it has been determined that the optical protective device functions are correct it can be integrated into the machine's control circuit!

7.1 Startup



Warning!

Without internal start/restart interlock function and the protective field is free the OSSDs immediately switch to the ON state!

Make certain that the transmitter and receiver are protected against overcurrent (for fuse size see Chapter 10.1.2). There are special requirements for the supply voltage: The power supply must have a load current reserve of at least 1 A and the ability to bridge a power outage for at least 20 ms, and it must guarantee secure mains supply isolation.

7.1.1 Transmitter display

After the power supply is turned on and the selftest is completed, the LEDs indicate the current operating status (see Chapter 4.1).



Warning!

If the transmitter's LED1 lights permanently red, the 24V DC supply voltage and the wiring must be checked. If the error remains after it is turned on again, discontinue the setup process immediately and send in the malfunctioning transmitter to be checked.

7.1.2 Receiver display

After the receiver is turned on or restarted, the number of the selected transmission channel appears.



Warning!

In the event of an error or fault, the receiver's 7-segment display reports it with "E xx" or "F xx". The error code in Chapter 9 provides information on whether it is an error (E xx) in external wiring or an internal device fault (F xx). For internal faults, immediately interrupt the installation and send in the malfunctioning receiver to be checked.

However, if errors are found and cleared in the external wiring, the receiver will be restored to normal operation mode and startup can be continued.



Warning!

The Receiver Standard and the Receiver Extended without selected start/restart interlock does not show the yellow LED2 lit after turning on and the OSSDs immediately switch to the ON-state if the protective field is free. In this case, a downstream safety interface must provide the start/restart interlock function:

LED	Without internal RES, transmitter/receiver aligned and protective field free	Without internal RES, transmitter/receiver not aligned or protective field not free
LED1	green ON = OSSDs in the ON state	red ON = OSSDs in the OFF state
LED2	OFF = RES interlock not available or not activated	OFF = RES interlock not available or not activated

Table 7.1-1: Receiver Standard or Receiver Extended with start/restart interlock not activated, LED displays

The LEDs display of the Receiver Extended with activated internal start/restart interlock function after it is turned on (for activation see Chapter 6.1.3.2):

LED	With internal RES, before unlocking by the start/restart button while the protective field is free	With internal RES, after unlocking the start/restart button while the protective field is free
LED1	red ON = OSSDs in the OFF state	green ON = OSSDs in the ON state
LED2	yellow ON = RES locked	OFF = RES unlocked

Table 7.1-2: Receiver Extended with start/restart interlock activated, LED displays

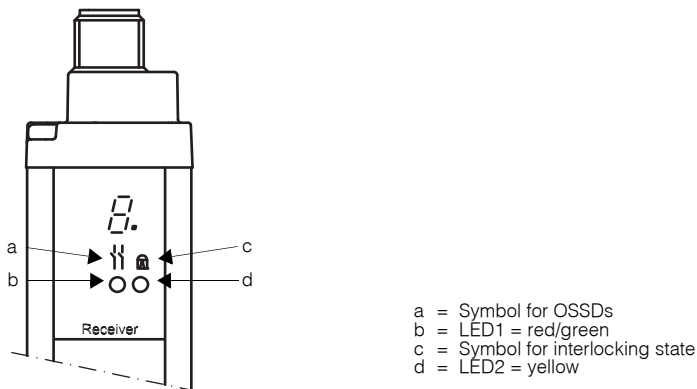


Fig. 7.1-1: Receiver Extended, LED display

7.2 Aligning transmitter and receiver

Transmitter and receiver must be mounted in place at the same height or, if they are used horizontally, at the same distance from the reference level.

7.2.1 Optimized aligning with the aid of the Receiver's 7-segment display

The distinction between protecting field is free (channel number is shown continuously) and the weak signal mode (channel number is flashing) can be used as a convenient alignment tool.

When the components are already almost aligned it is recommended to improve the alignment e.g. by turning the receiver. Turn the receiver with slightly loosened brackets until the 7-segment display starts to blink. Memorize this position. Now turn the receiver in the opposite direction until the display lights constantly and further, until it is blinking again. Now turn the receiver back in between the two positions determined. Screw the receiver firmly into place to prevent turning. Proceed with the transmitter in the same manner.

8 Testing

8.1 Testing before setting the protective device in service the first time

Testing by an experienced technician before initial startup must ensure that the optical protective device and any other safety components that might be present have been selected in accordance with the required specifications, especially the European Machine and Machine Utilization Directive, and that they provide the necessary protection when properly operated.

- † Use the regulations listed above, where required, with the help of the checklists provided in the Appendix of these instructions, to check that the protective devices are properly installed, that they are properly wired into the controls and that they work in all machine operating modes. When selecting the checklist, note the type of protection (danger point, danger area or access guarding).
- † The same testing requirements apply if the machine in question has not been operated for a longer period of time and after major modifications or repairs if this could affect the safety of the machine.
- † Observe the specifications regarding the instructing of operation personnel by experienced technicians before work is started. Instruction of personnel is the responsibility of the machine owner.

Leuze electronic offers a specialist service, which undertakes the required testing and monitoring tasks in accordance with the European regulations (www.leuze.de). The results of these tests are documented for the machine owner consistent with ISO 9000.

8.2 Regular tests

Regular tests must also be carried out in accordance with local regulations. They are designed to discover changes (e.g. in machine stopping times) or manipulations to the machine controls or protective device.

- † You must have the effectiveness of the protective device checked by an experienced technician at suitable intervals, but at least once per year.
- † The applicable checklist in the Appendix may also be used during regular testing.

Leuze electronic also provides a specialist service for regular tests.

8.3 Daily testing with the test rod

SOLID-2 Safety Light Curtains are subject to a cyclical testing. Nevertheless it is very important to check the protective field for its effectiveness daily to ensure that the protection stays effective at every point after an operation mode or tool change.

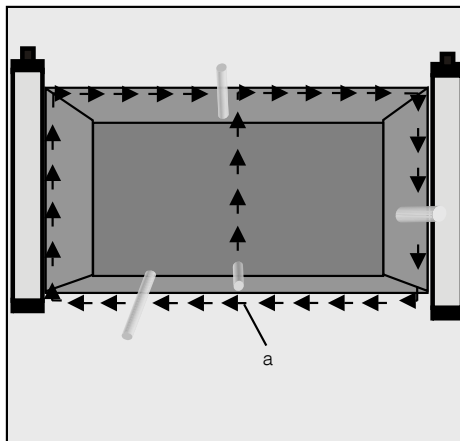


Warning!

Use the appropriate test rod (Accessory) but never your fingers, hand or arm for checking the system!

- † When selecting the test rod's diameter, use the nameplate of the receiver indicating the resolution as a guideline.
- † If for Receiver Extended the internal start/restart interlock function is selected and the AOPD is released, LED1 lights up green. When the test rod is inserted, LED1 switches

to red and LED2 stays in the OFF state. During the test procedure, the yellow LED2 must not light up at any point. Only after the test rod is removed out of the protective field, the LED2 is allowed to turn to yellow.



a = Beginning of test

Fig. 8.3-1: Testing the protective field with the test rod

‡ If the AOPD is being operated without the internal start/restart interlock, it is sufficient to watch LED1 on the receiver during the testing procedure. When the test rod is inserted into the protective field, this LED1 must switch from “green” to “red” and must not switch back to “green” at any point during the test procedure.



Warning!

If the test does not yield the desired result, the cause could be a protective field height that is too low or reflections from reflective metals or tools brought into the area. In this case the installation of the safety light curtain must be checked by a specialist. If the cause cannot be clearly defined and remedied, the machine or system must not be operated any more!

8.4 Cleaning the front screens

The front screens on the transmitters and receivers must be cleaned regularly depending on how dirty they are. A blinking 7-segment display with the protective field is free (LED1 is green) indicates a “weak signal reception”, cleaning is then required.

If cleaning the screens does not improve this, the detection range and alignment must be checked.

We recommend using a mild cleanser for cleaning the front screens. The screens are resistant to thinned acids or alkalis and resistant to organic solvents within limits.

9 Troubleshooting

The following information is used for rapid troubleshooting in the event of a malfunction.

9.1 What should I do if an error occurs?

If the AOPD shows an error on the display, the machine must be stopped immediately and checked by an experienced technician. If it is found that the error cannot be clearly defined and remedied, your local Leuze office and or the **Leuze electronic** hotline can assist.

9.2 Diagnostics

Operational malfunctions often have simple causes that you can remedy yourself. The following tables will help you do this.

9.2.1 Transmitter diagnostics

Symptom	Measure to eliminate error
LED is not lit	Check + 24 V DC supply voltage Check connection cable Replace transmitter if necessary
LED1 is lit red continuously	Check the test input, hardware fault, replace transmitter if necessary

Table 9.2-1: Transmitter diagnostics

9.2.2 Receiver diagnostics

The receiver distinguishes between error codes (E xx) and fault codes (F xx). Only error messages (E) provide information about events or states that you can eliminate. If the receiver shows a fault code (F), it must be replaced. Consequently, only error codes (E) are shown in the table below:

Code	Cause / significance	Measure to eliminate error
	LEDs and 7-segment displays are not lit	Check the + 24 V DC supply voltage Check the connection cable, replace the receiver if necessary
8	Lights continuously → Hardware error	Replace receiver
F xx	Internal hardware fault	Replace receiver
E 00	Source of failure in the ambient area	Eliminate the source of the failure
E 01	Short circuit between OSSD1 and OSSD 2	Eliminate short circuit

Table 9.2-2: Receiver diagnostics

Code	Cause / significance	Measure to eliminate error
E 06	Short circuit between GND and OSSD1	Eliminate short circuit
E 07	Short circuit between +24V DC and OSSD1	Eliminate short circuit
E 08	Short circuit between GND and OSSD2	Eliminate short circuit
E 09	Short circuit between +24V DC and OSSD2	Eliminate short circuit
E 14	Power supply undervoltage	Check power supply/load
E 17	Operating mode setting incorrect or start/restart button longer than 60 s pressed	Invalid wiring combination, check the wiring and/or button
E 18	Test signal time-limit exceeded	Test signal > 150 ms; check external test signal
E 22	Power supply overvoltage	Check the power supply
E 30	EDM error	Check connection of feed back contacts. Switch off power supply for setting back the system.

Table 9.2-2: Receiver diagnostics

9.3 AutoReset

After an error or a fault has been detected and displayed, an automatic restart occurs within

- about 2 seconds for the transmitter
- about 10 seconds for the receiver

for the device in question. If the error or fault is no longer present at that time, the machine or system can be started again.

For EDM errors (E 30) no AutoReset occurs. The Receiver Extended turns to a locking state. Recovering is possible by removing the supply voltage and checking out the contactors and wiring of the feed back loop. After the error has been eliminated, connect the supply voltage again.

10 Technical data

10.1 General data

10.1.1 Protective field data

Safety light curtain	Range		Physical resolution	Protective field height	
	min.	max.		min.	max.
SD2-20	0,5 m	15 m	20 mm	150 mm	1800 mm
SD2-30	0.2 m	10 m	30 mm	150 mm	1800 mm
SD2-40	0.8 m	20 m	40 mm	150 mm	1800 mm
SD2-90	0.8 m	20 m	90 mm	600 mm	1800 mm

Table 10.1-1: Beam and protective field data

10.1.2 Safety relevant technical data

Type in accordance with IEC/EN 61496	Type 2
SIL in accordance with IEC 61508	SIL 1
SILCL in accordance with IEC/EN 62061	SILCL 1
Performance Level (PL) in accordance with ISO 13849-1: 2008	PL c
Category in accordance with ISO 13849	Cat. 2
Average probability of a failure to danger per hour (PFH _d) For protective field heights up to 900 mm, all resolutions For protective field heights up to 1800 mm, all resolutions For protective field heights up to 2850 mm, all resolutions	8.2 x 10 ⁻⁸ 1/h 8.9 x 10 ⁻⁸ 1/h On request
Service life (T _M)	20 years

Table 10.1-2: Safety relevant technical data

10.1.3 General system data

Supply voltage U _v transmitter and receiver	+ 24V DC, ± 20 %, external power supply with secure mains supply isolation and equalization for a 20 ms power outage, minimum 1 A load current reserve
Residual ripple of supply voltage	± 5 % within the limits of U _v
Power consumption of transmitter	75 mA
Power consumption of receiver	140 mA without external load
Shared value for external fuse in the supply line for transmitter and receiver	1A
Permissible wire cross-section, Transmitter/Receiver Standard Receiver Extended	0,25 mm ² 0,14 mm ²
Transmitter: Class: Wave length: Pulse duration: Pulse pause: Output:	Light-emitting diodes as defined by EN 60825-1:1994+ A1:2002+A2:2001 1 950 nm 7 µs 3,1 ms < 10 µW
Synchronization	Optical between transmitter and receiver
Test repetition time for integrated cyclical test	100 ms
Safety class (VDE 106)	III*)
Type of protection	IP65**)
Ambient temperature, operation	0 ... 50 °C
Ambient temperature, storage	-25 ... 70 °C
Relative humidity	15 ... 95 %
Dimensions	See dimensional drawings and tables
Weight	See table in 10.2.1

*) The circuits connected to the input and outputs must maintain the clearance distances for safe isolation in the relevant standards
 **) Not suited for external operation areas.

Table 10.1-3: General system data

10.1.4 Transmitter signal inputs

Test input	Input: Contact or semiconductor to +24V DC Current load: 20 mA max.
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Table 10.1-4: Transmitter, Signal input

10.1.5 Receiver Extended signal inputs

BA1: Signal input:	Input: Contact or semiconductor to +24V DC or to GND Current load: 10 mA max.
BA2: Signal input:	Input: Contact or semiconductor to +24V DC or to GND Current load: 10 mA max.

Table 10.1-5: Receiver Extended, Signal inputs

10.1.6 Receiver transistor safety switch outputs

OSSDs transistor safety switch outputs	2 safety pnp transistor outputs, cross-circuit monitoring, short-circuit-proof		
	Minimum	Typical	Maximum
Switching voltage high active Switching voltage low Switching current Leakage current Load capacity Load inductivity	U _v - 1,9 V	U _v - 1 V 200 mV < 2 µA*)	U _v - 0,8 V + 1 V 250 mA < 2,2 µF 2,0 H
Permissible wire resistance for load	–	–	< 50 Ω**)
Permissible wire cross-section Receiver Standard Receiver Extended			0,25 mm ² 0,14 mm ²
Permissible cable length between Receiver and load	–	–	100 m***)
Auxiliary pulse width	20 µs	–	230 µs
Auxiliary pulse spacing	3,7 ms	–	46 ms
OSSD restart after beam interruption w/o RES	–	100 ms	–
OSSD response time	Depends on the number of beams. See the tables in Chapter 10.2		

*) In the event of an error (if the GND line is interrupted) the output behaves like a 120 kΩ to U_v. A downstream safety interface/PLC must not detect this as a logical "1".

**) Note the additional restrictions caused by cable length and load current.

***) The specified cable length may be limited by inductive or capacitive loads. This limitation can be eliminated by terminal resistors (2 kΩ) in parallel to each of the loads, connected between the OSSDs wire ends and 0V (Ground).

- Spark suppression is carried out by the transistor outputs. It is therefore not necessary to use spark extinguishers recommended by manufacturers of contactors and valves (RC modules, varistors or recovery diodes) with transistor outputs. These would extend the delay time of the inductive switching elements.

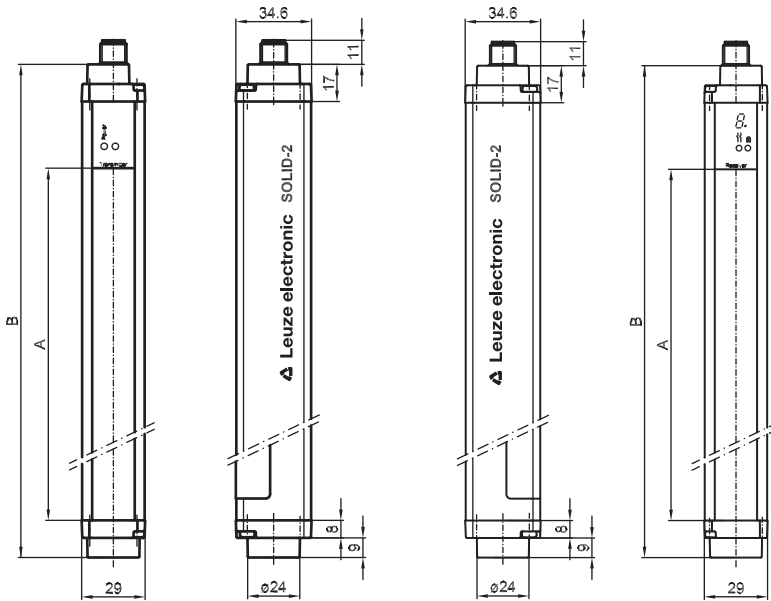
Table 10.1-6: Receiver, Transistor outputs

10.2 Dimensions, weights and response times

10.2.1 Safety Light Curtains

Type	Dimensions [mm]		Weight [kg]	Response time [ms]			
	Dim.A	Dim.B		SD2T/SD2R	SD2-20	SD2-30	SD2-40
SD2trr-150	150	225,5	0,3	12	7	7	
SD2trr -225	225	300,5	0,4	9	9	9	
SD2trr -300	300	375,5	0,4	12	12	12	
SD2trr -450	450	525,5	0,6	17	9	9	
SD2trr -600	600	675,5	0,7	21	12	12	8
SD2trr -750	750	825,5	0,9	26	14	14	10
SD2trr -900	900	975,5	1,0	31	17	17	12
SD2trr -1050	1050	1125,5	1,2	36	19	19	8
SD2trr -1200	1200	1275,5	1,3	41	21	21	8
SD2trr -1350	1350	1425,5	1,5	46	24	24	9
SD2trr -1500	1500	1575,5	1,6	51	26	26	10
SD2trr -1650	1650	1725,5	1,8	55	29	29	11
SD2trr -1800	1800	1875,5	1,9	60	31	31	12

Table 10.2-1: Safety Light Curtains, dimensions and response times



A = Protective field height B = Total height without plug

Fig. 10.2-1: Dimensions of Safety Light Curtains

10.2.2 Dimensions of mounting brackets

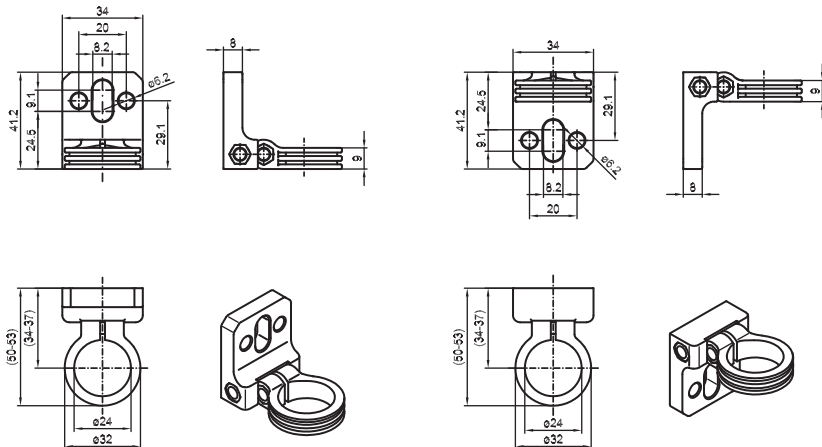
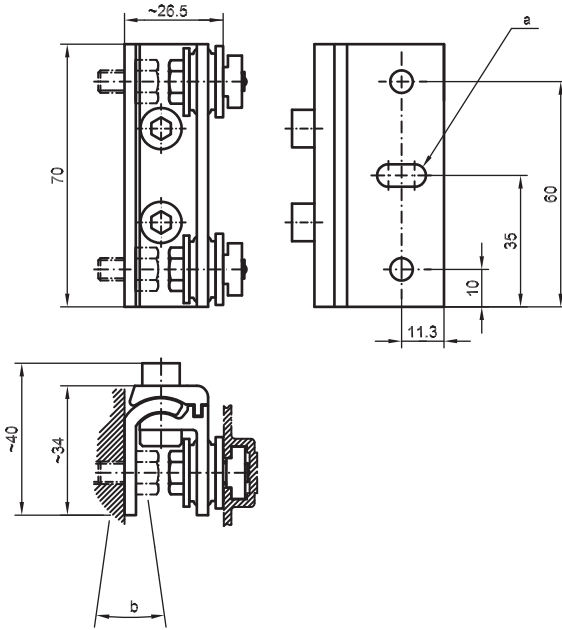


Fig. 10.2-2: 360° mounting bracket



- a = Slot 13 x 6
- b = Swiveling angle $\pm 8^\circ$

Fig. 10.2-3: Option: Swiveling mounting bracket with shock absorber

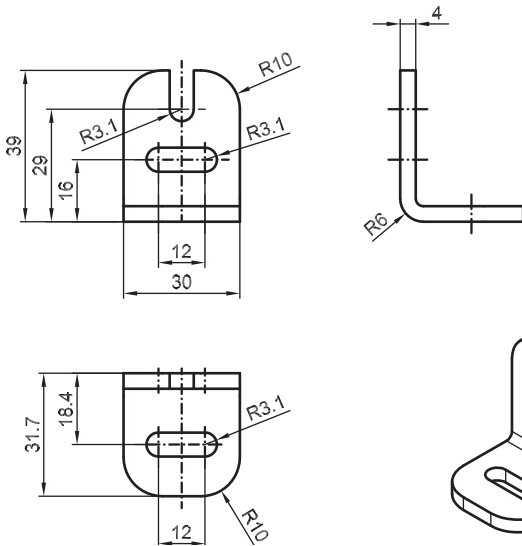


Fig. 10.2-4: Option: L-mounting bracket

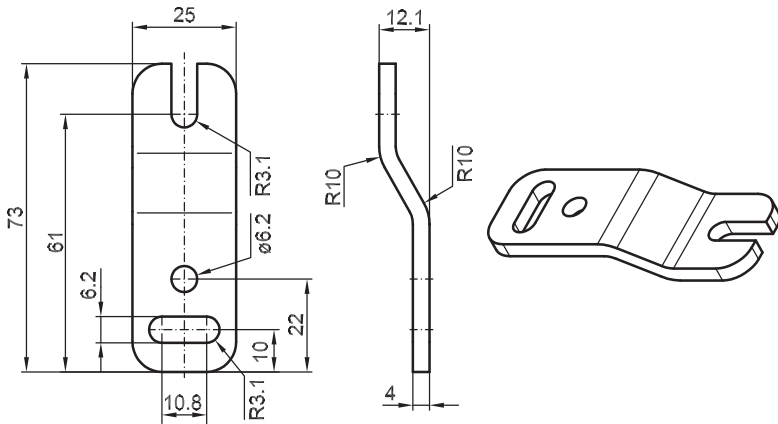


Fig. 10.2-5: Option: Z-mounting bracket

11 Appendix

11.1 SOLID-2 scope of delivery

- SOLID-2 Safety Light Curtains are delivered with:
- 1 SD2T transmitter unit
- 1 SD2R receiver unit
- 4 360° mounting bracket
- 1 Connection and Operating Instructions Manual

11.2 Order numbers

Transmitter	SD2-20	SD2-30	SD2-40	SD2-90
SD2Txx-150	67821701	67821801	67821901	
SD2Txx-225	67821702	67821802	67821902	
SD2Txx-300	67821703	67821803	67821903	
SD2Txx-450	67821704	67821804	67821904	
SD2Txx-600	67821706	67821806	67821906	67822006
SD2Txx-750	67821707	67821807	67821907	67822007
SD2Txx-900	67821709	67821809	67821909	67822009
SD2Txx-1050	67821710	67821810	67821910	67822010
SD2Txx-1200	67821712	67821812	67821912	67822012
SD2Txx-1350	67821713	67821813	67821913	67822013
SD2Txx-1500	67821715	67821815	67821915	67822015
SD2Txx-1650	67821716	67821816	67821916	67822016
SD2Txx-1800	67821718	67821818	67821918	67822018
Receiver Standard	SD2-20	SD2-30	SD2-40	SD2-90
SD2Rxx-150	67820201	67820601	67821001	
SD2Rxx-225	67820202	67820602	67821002	
SD2Rxx-300	67820203	67820603	67821003	
SD2Rxx-450	67820204	67820604	67821004	
SD2Rxx-600	67820206	67820606	67821006	67821406
SD2Rxx-750	67820207	67820607	67821007	67821407
SD2Rxx-900	67820209	67820609	67821009	67821409
SD2Rxx-1050	67820210	67820610	67821010	67821410
SD2Rxx-1200	67820212	67820612	67821012	67821412
SD2Rxx-1350	67820213	67820613	67821013	67821413
SD2Rxx-1500	67820215	67820615	67821015	67821415

SD2Rxx-1650	67820216	67820616	67821016	67821416
SD2Rxx-1800	67820218	67820618	67821018	67821418
Receiver Extended	SD2-20	SD2-30	SD2-40	SD2-90
SD2Rxx-150E	67820401	67820801	67821201	
SD2Rxx-225E	67820402	67820802	67821202	
SD2Rxx-300E	67820403	67820803	67821203	
SD2Rxx-450E	67820404	67820804	67821204	
SD2Rxx-600E	67820406	67820806	67821206	67821606
SD2Rxx-750E	67820407	67820807	67821207	67821607
SD2Rxx-900E	67820409	67820809	67821209	67821609
SD2Rxx-1050E	67820410	67820810	67821210	67821610
SD2Rxx-1200E	67820412	67820812	67821212	67821612
SD2Rxx-1350E	67820413	67820813	67821213	67821613
SD2Rxx-1500E	67820415	67820815	67821215	67821615
SD2Rxx-1650E	67820416	67820816	67821216	67821616
SD2Rxx-1800E	67820418	67820818	67821218	67821618

11.3 Accessories

Order number	Item	Description
429050	BT-360° mounting bracket	Support, 360° f.SOLID-2
429055	BT-360°-SET	Mounting set, consisting of 2 BT-360° mounting brackets
429056	BT-L-mounting set	Consisting of 2 L-type mounting brackets, sliding brackets included
429057	BT-Z-mounting set	Consisting of 2 Z-mounting brackets, sliding brackets included
560300	BT-SSD	Mounting bracket, swiveling with shock absorber
Connection cable, 5-wire for Transmitter and Receiver Standard		
429071	CB-M12-5000S-5GF	Connection cable shielded with M12 connection, straight, length 5 m
429072	CB-M12-5000S-5WF	Connection cable shielded with M12 connection, angled, length 5 m
429073	CB-M12-10000S-5GF	Connection cable shielded with M12 connection, straight, length 10 m
429074	CB-M12-10000S-5WF	Connection cable shielded with M12 connection, angled, length 10 m

Table 11.3-1: Accessories

Order number	Item	Description
429075	CB-M12-15000S-5GF	Connection cable shielded with M12 connection, straight, length 15 m
429076	CB-M12-15000S-5WF	Connection cable shielded with M12 connection, angled, length 15 m
Connection cable, 8-wire for Receiver Extended		
429081	CB-M12-5000S-8GF	Connection cable shielded with M12 connection, straight, length 5 m
429082	CB-M12-5000S-8WF	Connection cable shielded with M12 connection, angled, length 5 m
429083	CB-M12-10000S-8GF	Connection cable shielded with M12 connection, straight, length 10 m
429084	CB-M12-10000S-8WF	Connection cable shielded with M12 connection, angled, length 10 m
429085	CB-M12-15000S-8GF	Connection cable shielded with M12 connection, straight, length 15 m
429086	CB-M12-15000S-8WF	Connection cable shielded with M12 connection, angled, length 15 m
Power supply		
520060	SITOP power	Power supply 120/230 V AC @ 24 V DC / 5A, regulated
520061	LOGO! power	Power supply 120/230 V AC @ 24 V DC / 1,3A, regulated
Test rods		
349558	AC-TB 20	Test rod, 20 mm
349945	AC-TB 14/30	Test rod, 30 mm
349557	AC-TB 40	Test rod, 40 mm

Table 11.3-1: Accessories

11.4 Checklists

The inspection before the initial operation determines the safety related integration of the active opto-electronic protective device (AOPD) into the machine and its control. The results of the inspection must be written down and kept with the machine documents. They can then be used as a reference during the subsequent regular inspections.

11.4.1 Checklist for safeguarding danger points

SOLID-2 Safety Light Curtains (resolution 20 to 40 mm), normal approach to the protective field



This checklist represents a help tool. It supports but does not serve for the inspection before initial operation or the regular inspections by an expert.

- | | | |
|--|-----|----|
| • Is the safety distance calculated accordingly to the valid formula for safeguarding danger points , considering the resolution and the effective response time of the AOPD, the response time of a possibly used safety interface and the stopping time of the machine? Is this minimum distance between the protective field and danger points considered? | yes | no |
| • Is access to the danger point only possible through the protective field of the AOPD and are other possible accesses protected by suitable safety components? | yes | no |
| • Is the protective field effective at each position and positively checked according to Chapter 8.3? | yes | no |
| • Is reaching-over, reaching-under or reaching-around the protective field effectively prevented, e.g. by mechanical measures (welded or screwed)? | yes | no |
| • Is unprotected presence between the protective field and danger point safely excluded? | yes | no |
| • Are transmitter and receiver fixed against displacement after the alignment? | yes | no |
| • Are the protective device and the control devices in good condition? | yes | no |
| • Are all connectors and connection cables in fault-free conditions? | yes | no |
| • Is the start/restart button for resetting the AOPD positioned outside the danger zone and is it effective? | yes | no |
| • Are the safety outputs (OSSDs), linked into the subsequent machine control unit in accordance with the required safety category? | yes | no |
| • Are the subsequent circuit elements controlled by the AOPD monitored by the feedback circuit (EDM), e.g. contactors with positive-guided contacts or safety valves? | yes | no |
| • Does the actual integration of the AOPD into the machine control unit match the circuit diagrams? | yes | no |
| • Is the AOPD effective during the entire dangerous movement of the machine? | yes | no |
| • Is the dangerous movement stopped immediately if the supply voltage of the AOPD is interrupted and is the start/restart button required to start the machine again after the supply voltage returns? | yes | no |

11.4.2 Checklist for safeguarding danger areas


For SOLID-2 Safety Light Curtain, parallel approach to the protective field



This checklist represents a help tool. It supports but does not serve for the inspection before initial operation or the regular inspections by an expert.

- The minimum height of the protective field above the reference plane relates to the resolution of the AOPD. Was the resolution used during the calculation of the minimum height and is this result considered? yes no
- Has the safety distance been calculated according to the valid formula for **safeguarding danger areas** and has this minimum distance between the most distant beam and the danger point been observed? yes no
- During risk assessment, has it been ensured that only protective field heights less than 300 mm above the floor are regarded as low enough not to be crawled under (EN 999)? yes no
- Is the access to the danger point only possible through the protective field of the AOPD and are other access possibilities, especially from the sides, protected by suitable hard guards or other means? yes no
- Is unprotected presence between the next beam and the danger point definitively excluded? yes no
- Are transmitter and receiver fixed against displacement/turning after the alignment? yes no
- Are the protective device and the control devices in good condition? yes no
- Are all connectors and connection cables in fault-free conditions? yes no
- Is the start/restart button for starting/restarting the AOPD positioned outside the danger zone and is it effective? yes no
- Are the safety outputs (OSSDs), linked into the downstream machine control in accordance with the required safety category? yes no
- Are the downstream circuit elements controlled by the AOPD, e.g. contactors with positive-guided contacts or safety valves, monitored by the feedback circuit (EDM)? yes no
- Does the actual integration of the AOPD into the machine control unit match the circuit diagrams? yes no
- Is the AOPD effective during the entire dangerous movement of the machine? yes no
- Is a possibly connected Section Emergency STOP button effective and after its resetting, is pressing and releasing of the start/restart button required to start the machine again? yes no

11.4.3 Checklist for access guarding

 This checklist represents a help tool. It supports but does not serve for the inspection before initial operation or the regular inspections by an expert.

- Has the safety distance been calculated according to the valid formula for **access guarding** and is this minimum distance observed between the protective field and the danger point? yes no
- Are the required beam heights of the lowest and the highest beam realized (see Chapter 5.1.3)?
- If access to the danger points is possible through other routes than the protective field of the AOPD, are the other access options suitable secured by other means? yes no
- Are transmitter and receiver fixed against displacement/turning after the alignment? yes no
- Are the protective device and the control devices in good conditions? yes no
- Are all connectors and connection cables in fault-free conditions? Yes no
- Is the start/restart button for resetting the AOPD positioned outside the danger zone in line with the specifications so that it cannot be reached from inside? Is there a complete overview over the danger zone from the start/restart button position? yes no
- Are the safety outputs (OSSDs) linked into the subsequent machine control unit in accordance with the required safety category? yes no
- Are the subsequent switching elements controlled by the AOPD, e.g. contactors with positive-guided contacts or safety valves monitored via the feedback circuit (EDM)? yes no
- Does the actual integration of the AOPD into the machine control unit match the circuit diagrams? yes no
- Does the AOPD respond correctly when any beam is interrupted* and does the system lock (inevitable with activated start/restart interlock as only the access not the presence of a person in the danger zone is recognized)? yes no
- Does the dangerous movement stop immediately if the supply voltage of the AOPD is interrupted and is the start/restart button needed to start the machine again after the supply voltage returns? yes no

*) For Safety Light Curtains with resolutions of 20, 30 or 40 mm, the appropriate test rod should be moved up and down in the middle of the protective field. LED1 must stay "red" during the test and must not switch to "green" at any point. For Receiver Extended with selected internal start/restart interlock function the yellow LED2 must not switch to the ON state while the appropriate test rod is present at any point of the protective field (see Chapter 8.3).

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Der Hersteller	The Manufacturer	Le constructeur
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Angewandte EG-Richtlinie(n):	Applied EC Directive(s):	Directive(s) CE appliquées:
2006/42/EG 2004/108/EG	2006/42/EC 2004/108/EC	2006/42/CE 2004/108/CE
Angewandte Normen:	Applied standards:	Normes appliquées:
EN 61496-1:2009; IEC 61496-2:2006; EN 60825-1:2007 IEC 61508:1998-2000 Part 1-3 (SIL2); EN ISO 13849-1: 2008 (Kat. 3, PLd); EN 50178:1997; EN 55011/A2:2002		
Bevollmächtigter für die Zusammenstellung der technischen Unterlagen:	Authorized person to compile the technical file:	Personne autorisée à constituer le dossier technique:
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