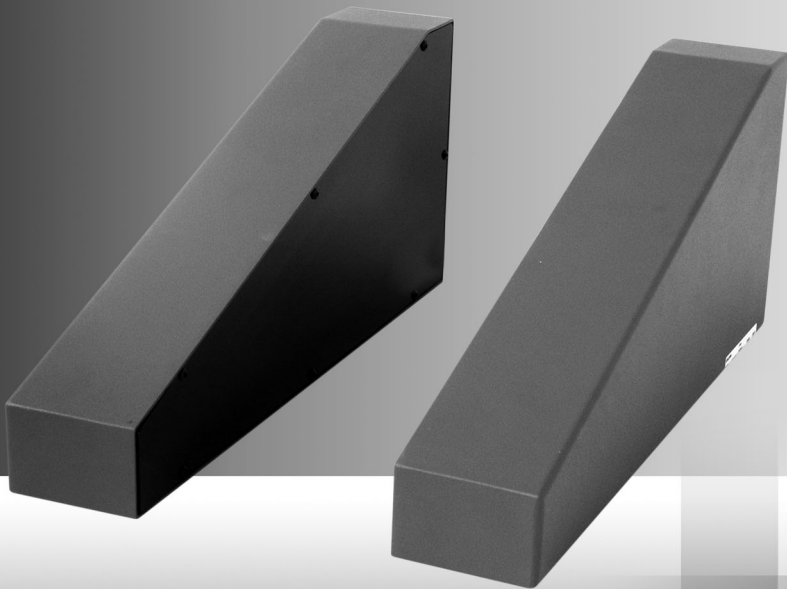


## **SOLID-4cutter**

Safety Light Curtain for cutting Machines




## About this Connecting and Operating Instructions Manual




This connecting and operating instructions manual contains information on the proper use of SOLID-4cutter Safety Light Curtains for cutting machines. It is included with delivery.

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

This connecting and operating instructions manual must be stored carefully. It must be available for the entire operating time of the optical safety device.

Notes regarding safety and warnings are marked by this symbol .

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

**Leuze electronic GmbH + Co. KG is not liable for damage resulting from improper use of its equipment. Acquaintance with these instructions is an element of the knowledge required for proper use.**

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<b>1</b>	<b>General</b> .....	<b>5</b>
1.1	Certifications .....	5
1.2	Symbols and terms .....	6
1.3	Type code for SOLID-4 <i>cut</i> ter Safety Light Curtains.....	7
<b>2</b>	<b>Safety</b> .....	<b>8</b>
2.1	Approved purpose and foreseeable improper operation.....	8
2.1.1	Proper use.....	8
2.1.2	Foreseeable misuse.....	9
2.2	Competent personnel.....	10
2.3	Responsibility for safety .....	10
2.4	Exemption of liability .....	10
2.5	SOLID-4 <i>cut</i> ter Safety Light Curtain areas of application .....	11
<b>3</b>	<b>System design and possible uses</b> .....	<b>12</b>
3.1	The opto-electronic protective device .....	12
<b>4</b>	<b>Transmitter and receiver functions</b> .....	<b>13</b>
4.1	Self-monitoring .....	13
4.2	Test input on the transmitter .....	13
<b>5</b>	<b>Display elements</b> .....	<b>14</b>
5.1	Status displays of the SD4CT Transmitter.....	14
5.2	Status displays of the SD4CR Receiver.....	15
<b>6</b>	<b>Installation</b> .....	<b>17</b>
6.1	Mechanical mounting .....	17
6.2	Safety distance (EN 1010-3).....	20
6.3	Minimum distance from reflective surfaces .....	22
<b>7</b>	<b>Electrical connection</b> .....	<b>24</b>
7.1	Transmitter and receiver connection.....	24
7.1.1	Variant 01 with Harting plug connectors .....	25
7.1.2	Variant 02 with Phoenix plug connectors .....	26
7.1.3	Variant 00 and 03 with 5-pin M12 plug connection .....	27
<b>8</b>	<b>Initial operation</b> .....	<b>28</b>
8.1	Switching on.....	28
8.1.1	Display sequence with SD4T Transmitter .....	28
8.1.2	Display sequence with SD4CR Receiver .....	29
8.2	Aligning transmitter and receiver.....	29

- 9      Testing ..... 30**
- 9.1    Testing before the initial operation ..... 30
- 9.2    Regular tests ..... 30
- 9.3    Daily testing with the test rods ..... 31
- 9.4    Cleaning the front screens ..... 32
  
- 10     Troubleshooting ..... 33**
- 10.1   What do I do if an error occurs? ..... 33
- 10.2   Diagnostics ..... 33
- 10.2.1 SD4CT Transmitter diagnostics ..... 33
- 10.2.2 Diagnostics on the SD4CR Receiver ..... 34
- 10.3   AutoReset ..... 34
  
- 11     Technical data ..... 35**
- 11.1   Protective field data ..... 35
- 11.2   Safety-relevant technical data ..... 35
- 11.3   General system data ..... 36
- 11.4   Transmitter test input ..... 36
- 11.5   Safety-related transistor outputs ..... 37
- 11.6   SOLID-4cutter Safety Light Curtain dimensions ..... 38
  
- 12     Appendix ..... 40**
- 12.1   SOLID-4cutter Safety Light Curtain scope of delivery ..... 40
- 12.2   SOLID-4cutter Safety Light Curtain ordering information ..... 40
- 12.3   Ordering information for SOLID-4cutter Safety Light Curtain ..... 40
- 12.4   Checklist ..... 41

## 1 General

The *SOLID-4cutter* Safety Light Curtain is a type 4 active opto-electronic protective device (AOPD) in accordance with IEC 61496-1, IEC 61496-2.

The *SOLID-4cutter* Safety Light Curtain is equipped with display elements (LEDs and 7-segment). This is especially convenient for the initial operation and diagnostics. It is equipped with 2 OSSDs (transistor safety-related switch outputs) with M12 connectors as standard features.

The mechanical mounting of the *SOLID-4cutter* Safety Light Curtain is performed on the transmitter and receiver side via an integrated mounting plate.

### 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



The *SOLID-4cutter* Safety Light Curtain is developed and manufactured in compliance with applicable European directives and standards.

EC prototype test in accordance with IEC 61496-1, IEC 61496-2

carried out by:







TÜV PRODUCT SERVICE GmbH, IQSE

Ridlerstrasse 65

D-80339 Munich, Germany

## 1.2 Symbols and terms

### Symbols used:

	Warning notice. This symbol indicates possible dangers. Please pay especially close attention to these instructions!
	Notes on important information.
	A note, which also refers to a course of action, provides information about special attributes or describes set-up procedures.
	General transmitter symbol
	General receiver symbol
	Signal output Signal input Signal input and/or output

**Table 1.2-1:** Symbols

### Terms used in this manual:

AOPD	Active opto-electronic protective device <b>(AOPD)</b>
AOPD response time	Time between penetration/entry into the active protective field of the AOPD and the actual switching off of the OSSDs.
AutoReset	After an error indication, with faulty external wiring, for example, the AOPD attempts to start again. If the error no longer exists, the AOPD returns to the normal state.
OSSD1 OSSD2	Safety-related switch output <b>Output Signal Switching Device</b>
Safeguarding danger points	Requires hand detection
Scan	All beams, beginning with the synchronization beam, are pulsed by the transmitter in cycles one after the other.
SD4C	SOLID-4 <i>cut</i> ter consisting of transmitter and receiver
SD4CR	SOLID-4 <i>cut</i> ter Receiver
SD4CT	SOLID-4 <i>cut</i> ter Transmitter

**Table 1.2-2:** Terms/terminology, SOLID-4*cut*ter Safety Light Curtain

### 1.3 Type code for SOLID-4cutter Safety Light Curtains

Code	Meaning
<b>SD4C</b>	<b>SOLID-4cutter</b>
<b>t</b>	<b>Type of device</b>
<b>T</b>	Transmitter
<b>R</b>	Receiver
<b>v</b>	<b>Variant</b>
<b>00</b>	Standard (without metal housing)
<b>01</b>	Standard (RAL 7012 and mounting plate, 192 x 77 mm)
<b>02</b>	(RAL 7035 and mounting plate, 85 x 50 mm)
<b>03</b>	(RAL 5012 and mounting plate, 192 x 77 mm)

**SD4C t v v**

**Fig. 1.3-1:** Type code for SOLID-4cutter Safety Light Curtains

## 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 Tabelle 2.1-1). For mounting, operating and testing, document "SOLID-4cutter Safety Light Curtainf or cutting Machines" 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-4*cutter* Safety Light Curtain.

Type in accordance with IEC/EN 61496	Type 4
SIL in accordance with IEC 61508	SIL 3
SILCL in accordance with IEC/EN 62061	SILCL 3
Performance Level (PL) in accordance with ISO 13849-1: 2008	PL e
Category in accordance with ISO 13849	Cat. 4
Average probability of a failure to danger per hour (PFH <sub>d</sub> ) 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	6.0 x 10 <sup>-9</sup> 1/h 7.3 x 10 <sup>-9</sup> 1/h On request
Service life (T <sub>M</sub> )	20 years

**Table 2.1-1:** Safety-related characteristic parameters of the SOLID-4*cutter* 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 operator of 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

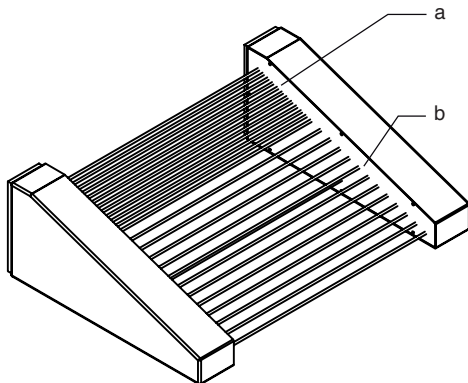
## 2.4 Exemption of liability

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 SOLID-4cutter Safety Light Curtain areas of application

The SOLID-4cutter Safety Light Curtain is an active opto-electronic protective device (AOPD). The physical resolution in the rear area is 20 mm and 30 mm in the front area. The maximum protective field width is 4 m.



a = 20 mm resolution  
 b = 30 mm resolution

**Fig. 2.5-1:** Physical resolution in the front and rear areas

The device is suitable for protection at danger points (hand protection). Access to the danger point must not be possible through the protective field. A safety distance must be maintained between the protective field and the danger point. The machine control in accordance with EN 1010-3 must be configured so that if at least one beam of the Safety Light Curtain is interrupted, the dangerous movement is prevented from starting and remains prevented until the restart interlock has been unlocked.



**Warning!**

*The two OSSD safety outputs of the SOLID-4cutter immediately switch to the ON state with free protective field (automatic start). The following control must therefore perform the start/restart interlock, two-hand activation, contactor monitoring and overtravel measurement functions.*

### 3 System design and possible uses

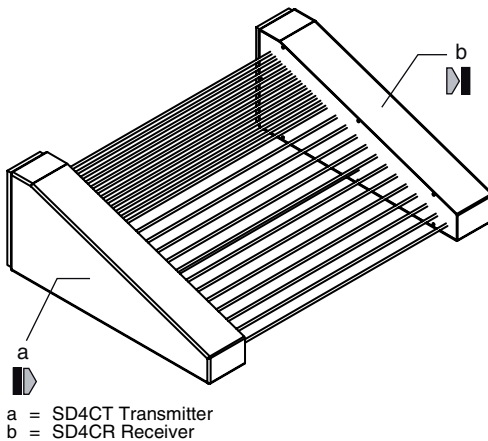
#### 3.1 The opto-electronic protective device

##### Mode of operation

The SOLID-4*cut*ter Safety Light Curtain consists of an SD4CT transmitter and an SD4CR receiver. Beginning with the first beam, the transmitter pulses beam for beam in rapid succession. The synchronization between transmitter and receiver is performed optically.

A protective field is consequently formed in the area between transmitter and receiver. Its width is determined by the distance selected between the transmitter and receiver within the permissible detection range.

If the protective field is penetrated a switching command is activated, which is processed by the machine control and stops the machine.



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

## **4 Transmitter and receiver functions**

### **4.1 Self-monitoring**

As a type 4 AOPD, the SOLID-4*cut*ter Safety Light Curtain has a constant self-monitoring function that independently detects errors in the system as well as cross and short circuits on the output cables of the machine interface. An external test signal is not required for this.

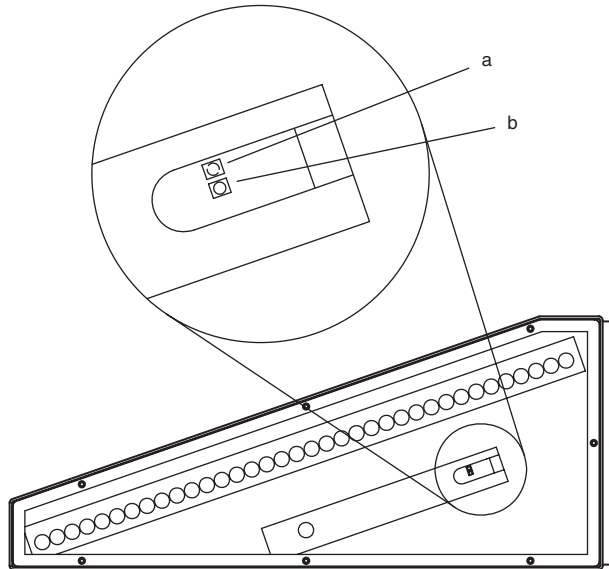
### **4.2 Test input on the transmitter**

To test the downstream contactors, an external control (e. g. protective combination) via a test signal can switch off the OSSD outputs of the receiver and test the drop-out of the switching element (assignment of the test connection, see Chapter 7 – Electrical connection). The test time signal time is a maximum 3 seconds. After the test the OSSDs go to the ON state, provided the protective field is not interrupted.

## 5 Display elements

### 5.1 Status displays of the SD4CT Transmitter

Two LEDs show the transmitter's current operating status. The meaning of the displays is explained in the following table.



a = LED1 (green/red)  
b = LED2 (green/red)

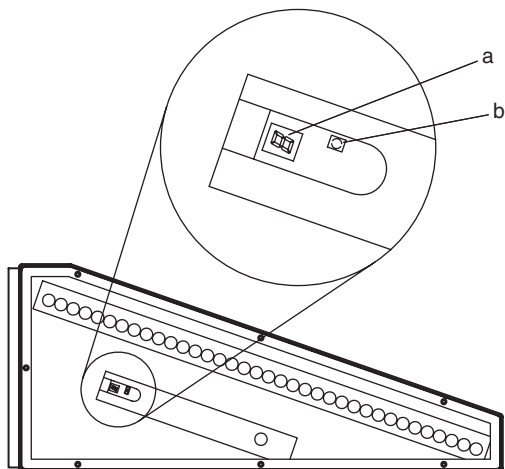
**Fig. 5.1-1:** SD4CT Transmitter status displays

LED1	LED2	Meaning
green	off	Supply voltage present
green	red	Operating voltage present, external test activated
red	any state	Device fault

**Table 5.1-1:** SD4CT Transmitter, LED status displays

### 5.2 Status displays of the SD4CR Receiver

An LED and a 7-segment display show the receiver's operating status. The meaning of the displays is explained in the following table.



- a = 7-segment display
- b = LED1, green/red for OSSDs

**Fig. 5.2-1:** SD4CR receiver status displays

#### 7-segment displays

After the electrical supply voltage is turned on, the following data appear on the receiver's 7-segment display. You will find a precise description of the fault display (F) in Chapter 10 – Troubleshooting.

7-segment display	Meaning
8.	Hardware reset when turned on
S	Self test running (for approx. 1.5 s)
1	Normal operation
	F = Device fault x = Fault number, alternating with "F"
1 flashing	Weak signal, device not optimally aligned or dirty

**Table 5.2-1:** SD4CR Receiver 7-segment display

**LED displays**

<b>LED1</b>	<b>Meaning</b>
red	OSSDs safety outputs in the OFF state
green	OSSDs safety outputs in the ON state

**Table 5.2-2:** SD4CR Receiver LED display



**Note!**

*If all displays are in the OFF-state at the same time, there is no supply voltage.*



## 6 Installation

This section contains important information on installing the SOLID-4cutter Safety Light Curtain. The effects of its effective protection are only guaranteed if the following installation requirements are observed. The basis of these installation specifications are the European standards in their respective versions, e.g. EN 1010-3. With use of the SOLID-4cutter Safety Light Curtain in countries outside Europe the regulations applicable in those countries must also be complied with.

Installation is dependent on the type of protection as described in Chapter 3.2.



### **Warning!**

*The SOLID-4cutter Safety Light Curtain is only permitted for safeguarding danger points at cutting machines in accordance with the European Standard, EN 1010-3. Danger area safeguarding or access guarding are not permitted with the SOLID-4cutter Safety Light Curtain.*

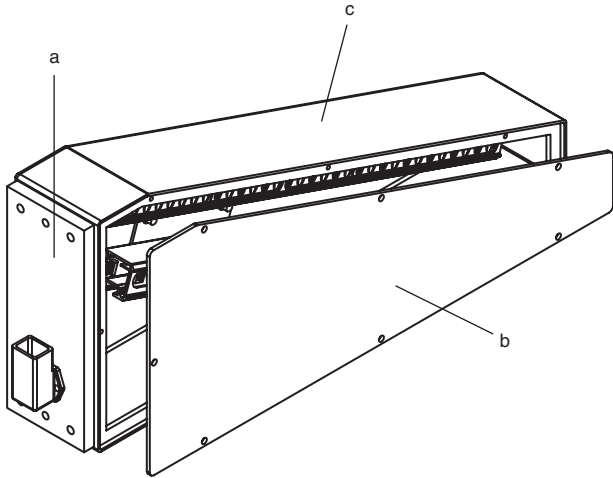
### **What should generally be taken into consideration during installation?**

- Ensure that transmitter and receiver are mounted at the same height on even surfaces that are aligned with one another.
- Use screws for mounting that can only be loosened with a tool.
- Fix the transmitter and receiver in position so that they cannot be shifted. Securing transmitter and receiver so they cannot be moved or swiveled is especially important in the close area for safety reasons.
- Ensure that the transmitter and receiver connections are pointing in the same direction.
- Ensure that the safety distance (S) between the protective field and danger point is observed when installing (see, Chapter 6.2).
- Ensure that the distance from reflective surfaces is observed (see, Chapter 6.3).
- Ensure that access to the danger point is only possible through the protective field. Reaching over, under or around must not be possible. The specifications of EN 1010-3 must be observed.

## 6.1 Mechanical mounting

Mounting the transmitter and the receiver is performed according to the variant with:

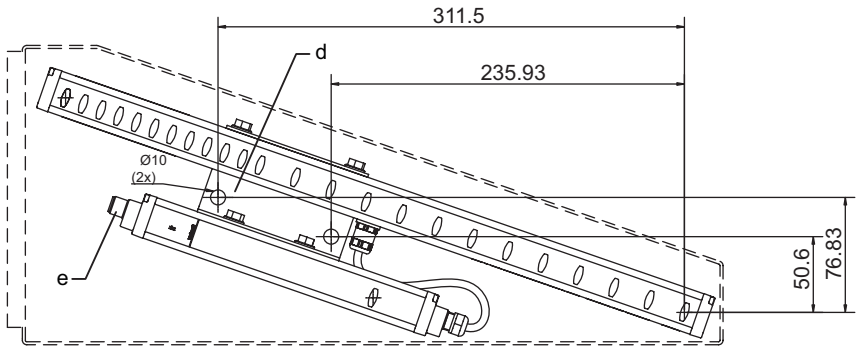
- Var. 00: Mounting drill hole in mounting bracket (d). An appropriate receiver must be provided for the mounting; for this, see Chapter 11. Electrical connection is made via a 5-pin M12 plug (e).
- Var. 01: Threaded holes on the mounting plate (a). The mounting can be performed without removing the plexiglass screen (b). Harting plugs (HAN 7D) are used for the electrical connection
- Var. 02: Mounting holes on the mounting plate (a). The plexiglass screen (b) must be removed for the mounting, so that the mounting screws and nuts can be screwed tight. MCVW-1.5/7-STF-3.81 Phoenix plug connectors are used in the housing for the electrical connection.
- Var. 03: Threaded holes and mounting holes on the mounting plate (a). Both mounting options described above are consequently possible. The electrical connection is performed via the 5-pin plug of the M12 connections routed to the outside.



- a = Mounting plate
- b = Plexiglass screen
- c = Housing

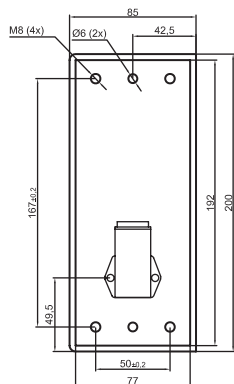
**Fig. 6.1-1:** Transmitter/receiver with protective screen removed

**Mounting plate overview**

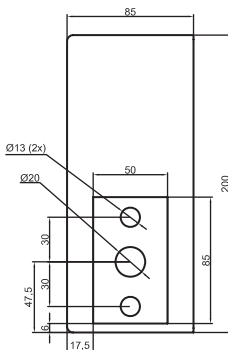


**Fig. 6.1-2:** Hole dimensioning Var. 00

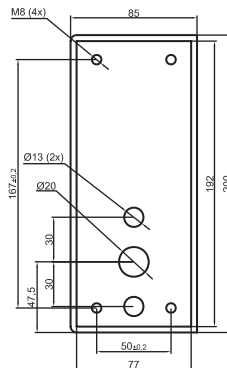
Variant 01 (Standard)



Variant 02



Variant 03



**Fig. 6.1-3:** Mounting plate holes of the 3 variants

## 6.2 Safety distance (EN 1010-3)

Please note that the following criteria must be met for the installation of the Safety Light Curtain and calculation of the safety distance so that the opto-electronic protective devices can be used on cutting machines:

- On stand-alone cutting machines with openings of 165 mm between the light barrier housing and worktop surface the safety distance (S) between the cutting level-cutting edge and the light barrier housing must be at least 550 mm.
- The front light beam of the light curtain,
  - must be arranged on the leg of the opening angle of max. 16°.
  - must be recessed at least 30 mm from the front edge of the machine table.
  - may not, however, be more than 185 mm above the table surface.
- The minimum distance to the cutting level must be at least 610 mm.
- For an automatic cutting sequence the additional light barrier in the safety light curtain must be within the field shown (see, Fig. 6.2-1). The distance must be 400 to 550 mm to the cutting level and 0 to 205 mm above the table surface.

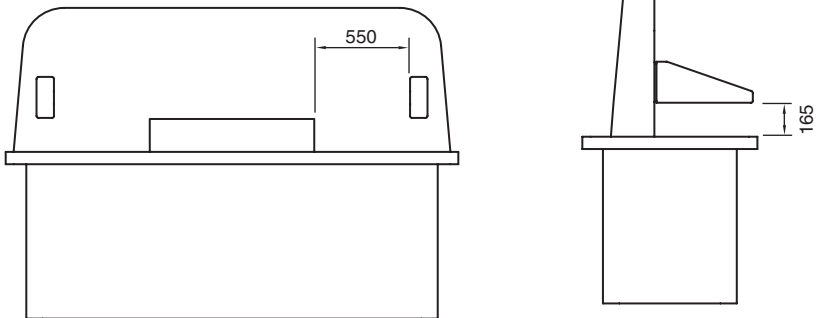
The safety distance (S) is calculated according to the formula:

$$S = 2000 \cdot T + 8 (d - 14)$$

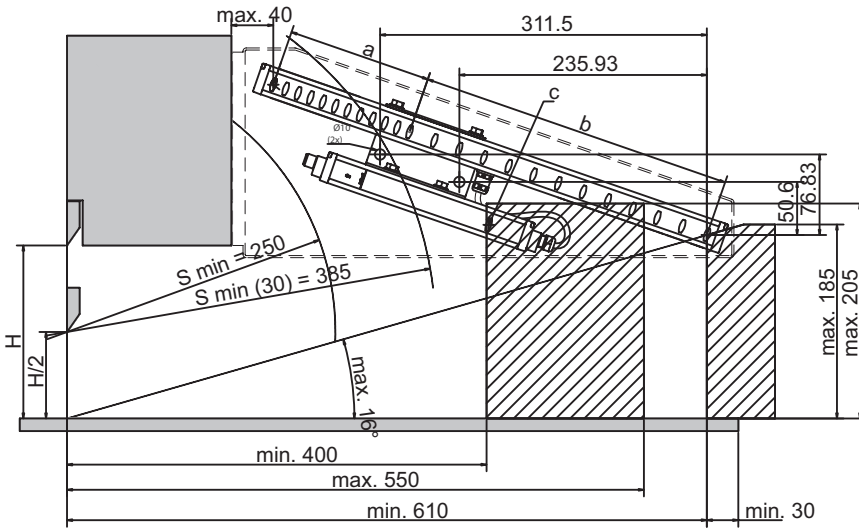
S = Safety distance in mm

T = Total response time (machine's stopping time + AOPD response time) in ms

d = Resolution in mm

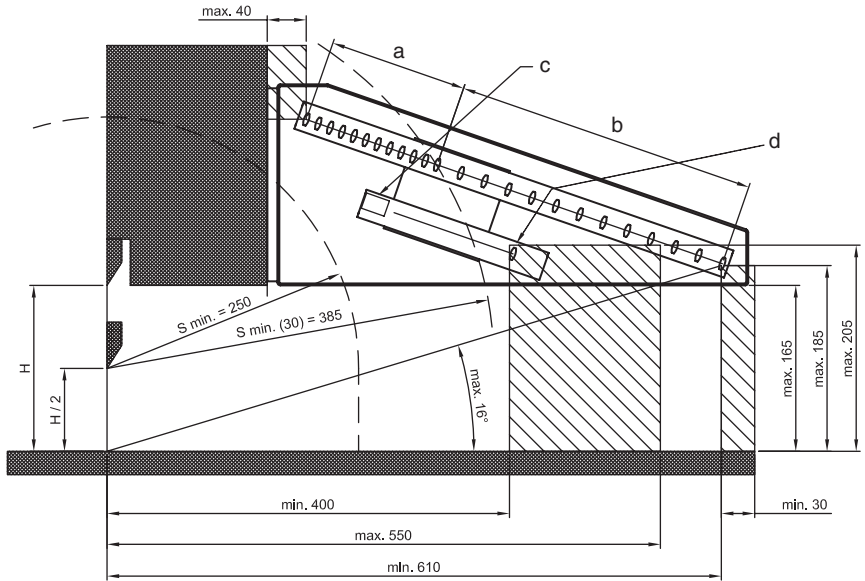


**Fig. 6.2-1:** Installation requirements with regard to the safety distance with openings with a max. height of 165 mm



- a = 20 mm resolution
- b = 30 mm resolution
- c = Receiver status display
- d = Light barrier for automatic cutting sequence

**Fig. 6.2-2:** Arrangement in accordance with EN 1010-3. S is the safety distance between half cutting height and the 1st beam for Var. 00



- a = 20 mm resolution
- b = 30 mm resolution
- c = Receiver status display
- d = Light barrier for automatic cutting sequence

**Fig. 6.2-3:** Arrangement in accordance with EN 1010-3. S is the safety distance between half cutting height and the 1st beam for Var. 01, 02 and 03

### 6.3 Minimum distance from reflective surfaces



**Warning!**

Reflective surfaces near optical safety devices can indirectly deflect the transmitter's beams into the receiver. This can cause an object in the protective field not to be detected! All reflective surfaces and objects (material containers, metal plates, for example) must be kept at a minimum distance "a" from the protective field. The minimum distance "a" is dependent on the distance "c" between the transmitter and the receiver.

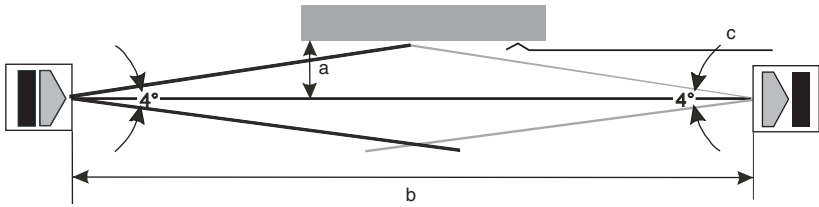
With the calculation of the minimum distance to reflective surfaces it must be ensured that with a protective field width of 3 m or less, at least a minimum distance of 131 mm is achieved. With protective field widths over 3 m the minimum distance "a" is calculated using the following formula:

$$a [m] = 0.044 \times b [m]$$



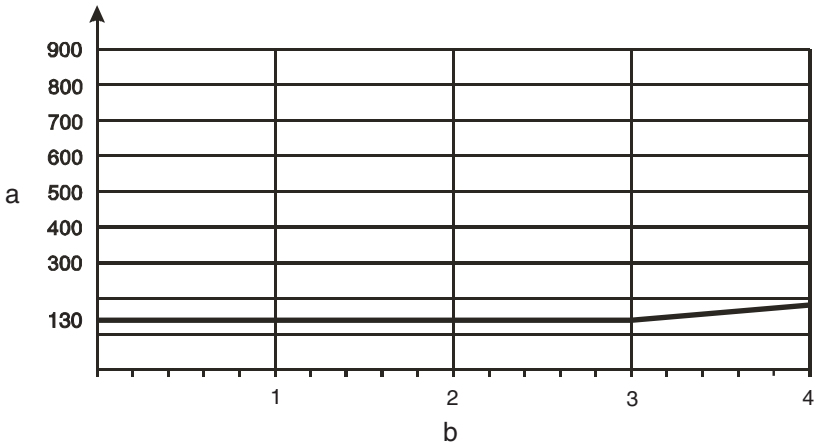
**Note!**

Reflective surfaces on the cutting machine can be prevented by using textured paint.



- a = Distance
- b = Protective field width
- c = Reflective surface

**Fig. 6.3-1:** Minimum distances from reflective surfaces



- a = Distance [mm]
- b = Width of protective field [m]

**Fig. 6.3-2:** Minimum distances from reflective surfaces dependant on the width of the protective field

## 7 Electrical connection

- The electrical connection must be performed by experienced personnel. Knowledge of all safety notes contained in these operating instructions is part of this competence.
- The external supply voltage of 24 V DC  $\pm 20\%$  must guarantee safe isolation from the mains voltage in accordance with IEC 60742 and be able to bridge a power outage period of at least 20ms. Leuze electronic offers suitable power supplies (see list of accessories in the Appendix Chapter 12.3). The power supply selected must not supply any other parts of the machine with power other than the safety components connected. Transmitters and receivers must be supplied from a shared power supply and must be fused against overcurrent.
- Signal outputs may not be used for switching safety-relevant signals.
- It is vital during the electrical installation that the power of the machine or system to be protected is switched off and locked, so that the dangerous movements cannot be started unintentionally.



### **Warning!**

*Basically both safety-related switching outputs OSSD1 and OSSD2 must be looped into the work circuit of the machine. Parallelswitching of the switching outputs is not permitted.*

### 7.1 Transmitter and receiver connection

The transmitter and receiver connection depends on the mounting variant.

Three variants are available:

- Variant 01 with Harting plug connectors
- Variant 01 with Phoenix plug connectors
- Variant 00 and 03 with M12 connectors

The following sections include an illustration of the individual plug connectors and the respective connection assignment at the transmitter and receiver side.



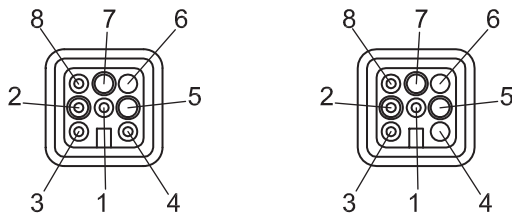
### **Warning!**

*To ensure safe operation of the SOLID-4cutter, only the connection cables and connection couplings listed in Chapter 12.3 – Accessories may be used.*



**7.1.1 Variant 01 with Harting plug connectors**

Transmitter and receiver are equipped with Harting Han® 7D plugs. The following table shows the connection assignment at the transmitter and receiver side.



**Fig. 7.1-1:** Harting Han® 7D plug

Pin	Transmitter	Receiver
1	24 V DC	24 V DC
2	GND	GND
3	Test input: Connected to 24 V DC (Pin3) = Normal operation to 0V or free = External test activated	OSSD1
4	24 V DC, can be jumpered to Pin3 to deactivate test input	OSSD2
5	Not assigned	Not assigned
6	Not assigned	Not assigned
7	Not assigned	Not assigned
8	FE	FE

**Table 7.1-1:** Transmitter and receiver connection assignment with Harting plugs

**7.1.2 Variant 02 with Phoenix plug connectors**

Transmitter and Receiver are equipped with Phoenix plug connectors. The following table shows the connection assignment at the transmitter and receiver side.



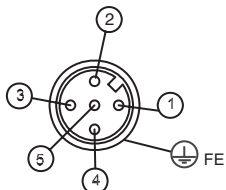
**Fig. 7.1-2:** Phoenix plug connector

Pin	Transmitter	Receiver
1	24 V DC	24 V DC
2	0 V	0 V
3	24 V DC, can be jumpered to Pin4 to deactivate test input	OSSD1
4	Test input: Connected to 24 V DC (Pin3) = Normal operation to 0 V or free = External test activated	OSSD2
5	Not assigned	Not assigned
6	Not assigned	Not assigned
7	FE	FE

**Table 7.1-2:** Transmitter and receiver connection assignment with Phoenix plug connectors

**7.1.3 Variant 00 and 03 with 5-pin M12 plug connection**

Transmitter and Receiver are equipped with M12 connection. The following table shows the connection assignment at the transmitter and receiver side.



**Fig. 7.1-3:** M12 connection

Pin	Transmitter	Receiver
1	24 V DC	24 V DC
2		OSSD2
3	0 V	0 V
4	Test input: to 24 V DC = Normal operation to 0 V or free = External test activated	OSSD1
5	Device-internally wired on housing	Shield (functional earth)
Connector housing, device	Shield (functional earth)	

**Table 7.1-3:** Transmitter and receiver connection assignment with M12 connection



**Note!**

For optimum shielding, connection cables with which the shield is routed on the knurled nut of the housing coupling must be used (suitable cables are listed under accessories in Chapter 12.3).

## 8 Initial operation

**Warning!**

*Before putting the SOLID-4cutter Safety Light curtain into operation for the first time on a power-driven cutting 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 transmitters and receivers are being aligned, it must also be ensured that the outputs of the optical safety 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, after repairs or during maintenance work.

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

### 8.1 Switching on

**Warning!**

*With a free protective field the OSSDs immediately switch to the ON state!*

Make sure that the transmitter and receiver are protected against overcurrent. There are special requirements for the supply voltage: The power supply unit must guarantee a load current reserve of at least 1 A, the capacity to bridge a power outage for at least 20ms, and it must guarantee secure supply isolation.

#### 8.1.1 Display sequence with SD4T Transmitter

After the power supply is turned on and the self-test is completed, the LEDs indicate the current operating status (see Chapter 5.1).

**Warning!**

*If the transmitter signals with error display (LED1 lights permanently red/LED2 any display), the 24V DC side 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.*

### 8.1.2 Display sequence with SD4CR Receiver

After the device is turned on, "8." appears for a few moments on the transmitter display followed by an "S" for about 1.5 seconds for the self test. The display then switches and permanently shows "1".

With free protective field the LED lights green and the switching outputs (OSSDs) are in the ON state (see Chapter 5.2).



**Warning!**

*If the receiver signals with the error display, the 24 V DC supply voltage and the wiring must be checked. If the display remains after it is turned on again, abort the setup process immediately and send in the malfunctioning receiver to be checked.*

## 8.2 Aligning transmitter and receiver

Transmitter and receiver must be mounted and aligned at exactly the same height. The specified narrow  $\pm 2^\circ$  opening angle requires the precise alignment of the two components with one another. The mounting surfaces must be even with one another.

## 9 Testing

### 9.1 Testing before the initial operation

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

- Use the regulations listed above, where required, with the help of the checklist 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.
- 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 instructing 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 in Germany, which undertakes the required testing and monitoring tasks in accordance with European regulations ([www.leuze.de](http://www.leuze.de)). The results of these tests are documented for the machine operator in accordance with ISO 9000.

### 9.2 Regular tests

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

**9.3 Daily testing with the test rods**

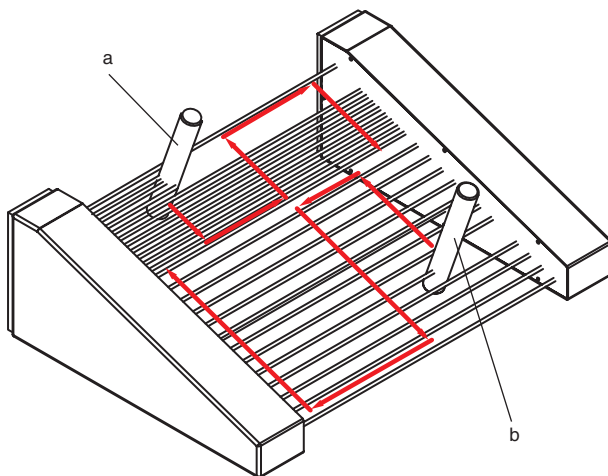
SOLID-4cutter is a self-monitoring safety light curtain. Nevertheless it is very important to check the protective field for its effectiveness daily to ensure that the protection remains effective at every point after setting machine parameters or a tool change.



**Warning!**

*Only carry out tests with the test rods supplied and never use your fingers, hand or arm for checking the system!*

- Only use the test rods supplied for the testing. The 30 mm test rod is used for testing the front protective field; the 20mm test rod for testing the rear protective field.
- Dip the test rod into the protective field and move the test rod through the protective field (see figure).  
Observe the receiver's LEDs while doing so.  
When the test rod is inserted into the protective field, this LED1 must switch from "green" to "red" and may not switch back to "green" at any point during the test.



a = 20 mm diameter      b = 30 mm diameter

**Fig. 9.3-1:** Testing the protective field with the test rod



**Warning!**

*If the test does not yield the desired result, the cause could be a reflection, e.g. 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 may not be used!*

## **9.4 Cleaning the front screens**

The front screens on the transmitters and receivers must be cleaned regularly depending on how dirty they are. A flashing 7-segment display with the protective field free (LED1 is green) indicates a "weak reception signal"; cleaning the front screen is then required. If cleaning the screens does not improve this, then observance of the maximum detection range and the alignment must be checked. We recommend using a mild cleanser for cleaning the plexiglass cover screens. The screens are resistant to thinned acids or alkalis and resistant to organic solvents within limits.



## 10 Troubleshooting

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

### 10.1 What do 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 determined that the error cannot be clearly defined and remedied, your local Leuze office and/or the Leuze electronic hotline can assist.

### 10.2 Diagnostics

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

#### 10.2.1 SD4CT Transmitter diagnostics

Symptom	Measure to eliminate error
LED is not lit	Check supply voltage, check connection cable, replace transmitter if necessary
LED1 is lit red continuously	Hardware error, replace transmitter
LED2 is lit red continuously	Check transmitter in test input test mode, connect to 24 V DC

**Table 10.2-1:** Transmitter diagnostics

### 10.2.2 Diagnostics on the SD4CR Receiver

The receiver displays faults and errors with Fxx codes. All possible codes and corresponding measures are then listed.

Code	Cause / significance	Measure to eliminate error
	LEDs and 7-segment displays are not lit	Check 24 V DC supply voltage, check connection cable, replace receiver if required
F4	Shift register longer than 240 beams	Send the device in
F6	Short circuit between ground and OSSD1	Clear grounded short circuit or overload
F7	OSSD short circuit after VCC or cross-circuit, output 1	Clear short circuit after VCC or cross-circuit, turn supply voltage off and on again, if it occurs again send the device in
F8	Short circuit between ground and OSSD2	Clear grounded short circuit or overload
F9	OSSD short circuit after VCC or cross-circuit, output 2	Clear short circuit after VCC or cross-circuit, turn supply voltage off and on again, if it occurs again send the device in
F20	Fault in the par. communication (INTERNAL)	Send the device in
F21	Internal fault	Send the device in
F22	An Asic always selected, Akon stuck at "0" (INTERNAL)	Send the device in
F23	No Asic selected, Akon stuck at "1" No shift register (cascade) available	Send the device in
F24	Different shift register lengths determined (INTERNAL)	Send the device in
F27	Program run monitoring (INTERNAL)	Send the device in
F28	PIC data "stuck-at" error (INTERNAL)	Send the device in
F29	Not plausible (inconsistent) data from PIC (INTERNAL)	Send the device in
F30	Error in semiconductor test (timeout or multifuse)	Switch supply voltage off and on again, if it occurs again send the device in
F36	Test identification signal from transmitter longer than 3 seconds	Check transmitter test input

**Table 10.2-2:** Receiver diagnostics

### 10.3 AutoReset

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

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

for the device in question. If the error or fault is then no longer present, the machine/application can be started again. The temporary fault error signal goes off.

## 11 Technical data

### 11.1 Protective field data

Detection range: 0.5 to 4 m

Physical resolution: 20/30 mm (see Abb. 11.6-2)

Protective area: 462 mm

### 11.2 Safety-relevant technical data

Type in accordance with IEC/EN 61496	Type 4
SIL in accordance with IEC 61508	SIL 3
SILCL in accordance with IEC/EN 62061	SILCL 3
Performance Level (PL) in accordance with ISO 13849-1: 2008	PL e
Category in accordance with ISO 13849	Cat. 4
Average probability of a failure to danger per hour (PFH <sub>d</sub> ) 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	6.0 x 10 <sup>-9</sup> 1/h 7.3 x 10 <sup>-9</sup> 1/h On request
Service life (T <sub>M</sub> )	20 years

**Table 11.2-1:** Safety-relevant technical data

### 11.3 General system data

Safety category	Type 4 in acc. with IEC 61496-1, IEC 61496-2
Supply voltage $U_v$ Transmitter and receiver	24 V DC, $\pm 20\%$ , external power supply with safe supply line isolation and equalization with a 20 ms loss in voltage required, at least 250 mA (plus OSSD load)
Residual ripple of supply voltage	$\pm 5\%$ within the limits of $U_v$
Power consumption of transmitter	75 mA
Power consumption of receiver	110 mA without external load
Shared value for external fuse in the supply line for transmitter and receiver	2 A melting fuse
Transmitter Class Wavelengths Power	Light-emitting diodes in acc. with EN 60825-1:1994 + A1:2002 + A2:2001 1 950 nm < 50 $\mu$ W
Synchronization	Optical between transmitter and receiver
Safety class (VDE 106):	III
Type of protection Var. 00	IP 65
Type of protection Var. 01 - 03	IP 54 *)
Ambient temperature, operation	0 ... 55 °C
Ambient temperature, storage	-25 ... 70 °C
Relative humidity	15 ... 95 %
Vibration fatigue limit	5 g, 10 - 55 Hz according to IEC/EN 60068-2-6
Resistance to shocks	10 g, 16 ms according to IEC/EN 60068-2-29
Dimensions	See dimensional drawings and tables Chapter 11.6
Weight	5.5 kg per transmitter/receiver

\*) Without additional measures the devices are not suited for outdoor use.

**Table 11.3-1:** General system data

### 11.4 Transmitter test input

Assignment of the test connection, see Chapter 7 – Electrical connection.

Test input:	Contact or transistor against 24 V DC 0 V or free = test Current load: 20 mA max.
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**Table 11.4-1:** Transmitter test input

### 11.5 Safety-related transistor outputs

OSSDs safety switch outputs	2 safety-related pnp semiconductor outputs, cross circuit monitored, resistant to short circuits		
	Minimum	Typical	Maximum
Switching voltage high active (U <sub>v</sub> – 1.6 V) with ohmic load I <sub>nominal</sub> = 250 mA Switching voltage low Switching current Leakage current Load capacity Load inductivity	-80 V **)	+22 V DC  0 V 250 mA < 5 µA	+2.8 V  < 20 µA < 220 nF < 2 H
Permissible wire resistance for load			< 300 Ohm *)
Permissible cable length between Receiver and load (at 0.25 mm <sup>2</sup> )			100 m
Test pulse width	30 µs		100 µs
Test pulse distance			22 ms
OSSD restart time after beam interruption	40 ms	100 ms	
OSSD response time	11 ms		

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

\*\*) Fast de-excitation voltage with contactors, otherwise 0 V

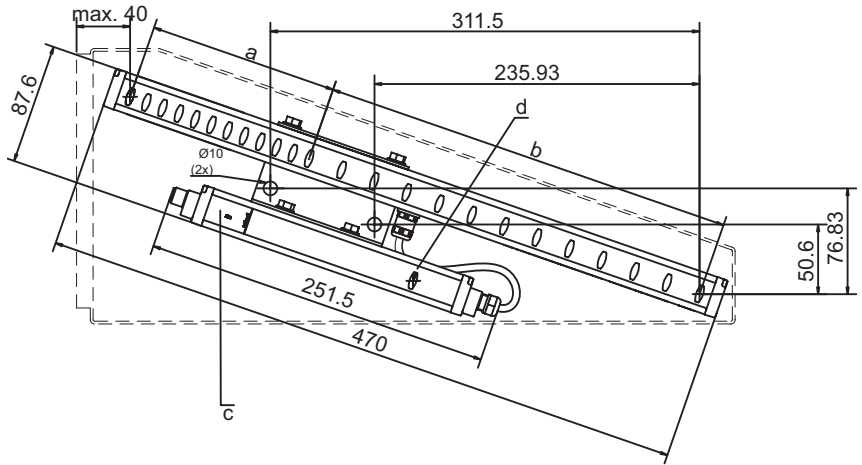
**Table 11.5-1:** Safety-related transistor outputs



**Note!**

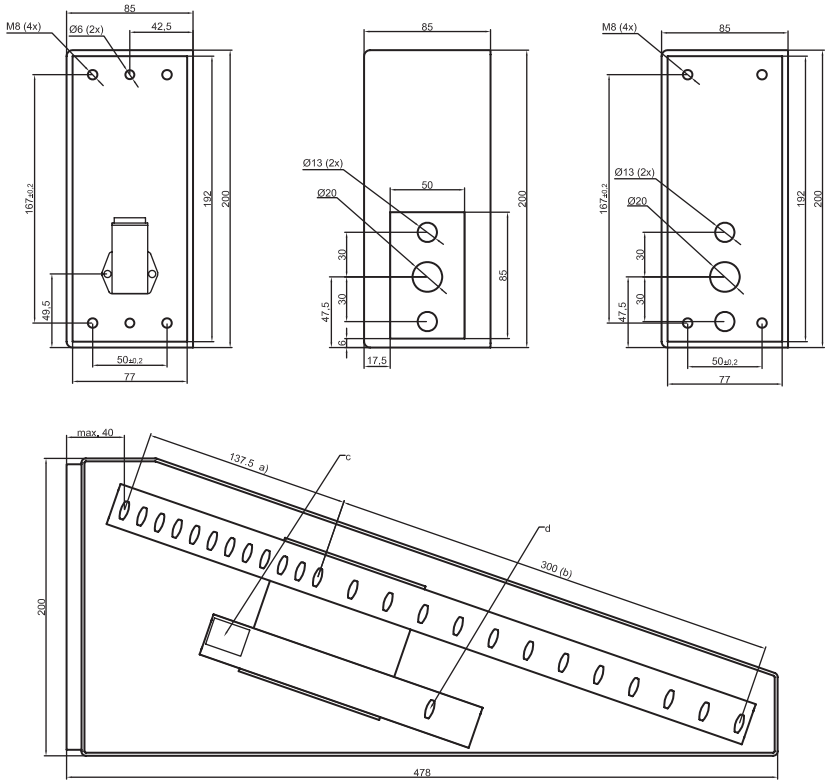
The OSSD output transistors carry out the spark extinction. It is therefore not necessary to use the spark extinction elements recommended by contactor/valve manufacturers etc. (RC modules, varistors or recovery diodes). These significantly extend the delay times of inductive switching elements.

11.6 SOLID-4cutter Safety Light Curtain dimensions



- a = 20 mm resolution
- b = 30 mm resolution
- a = 7-segment display
- d = Light barrier for automatic cutting sequence

**Fig. 11.6-1:** Transmitter and receiver dimensions Var. 00



a = 20 mm resolution      a = 7-segment display  
 b = 30 mm resolution      d = Light barrier for automatic cutting sequence

**Fig. 11.6-2:** Transmitter and receiver dimensions Var. 01, 02 and 03

## 12 Appendix

### 12.1 SOLID-4*cut*ter Safety Light Curtain scope of delivery

The SOLID-4*cut*ter Safety Light Curtain is delivered with:

- 1 SD4T transmission unit in the housing with mounting holes
- 1 SD4R receiver unit in the housing with mounting holes
- 1 test rod, 20 mm
- 1 test rod, 30 mm
- 1 Connecting and Operating Instructions Manual

### 12.2 SOLID-4*cut*ter Safety Light Curtain ordering information

Item	Item no.
<b>Transmitter</b>	
SD4CT00	67843700
SD4CT01	67843701
SD4CT02	67843702
SD4CT03	67843703
<b>Receiver</b>	
SD4CR00	67843600
SD4CR01	67843601
SD4CR02	67843602
SD4CR03	67843603

### 12.3 Ordering information for SOLID-4*cut*ter Safety Light Curtain

Item no.	Item	Description
<b>Connection cable, 5-pin for SD4CT Transmitter/SD4CR Receiver</b>		
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
<b>Power supply</b>		
520060	SITOPpower	Power supply, 120V/230V AC 24V/5A, regulated
520061	LOGO! power	Power supply, 120V/230V AC 24V/1.3A, regulated
<b>Test rods</b>		
349558	AC-TB20	Test Rod, 20 mm
349945	AC-TB14/30	Test rod, 14/30 mm



## 12.4 Checklist

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.



**Note!**

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

Is the safety distance calculated in accordance with the valid formulas for safeguarding danger points, while taking the effective resolution and the response time of the AOPD, the response time of a possibly used safety interface and the stopping time of the machine into consideration, and has this minimum distance between the protective field and danger point been observed?	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 side and positively tested according to Chapter 9.3?	Yes	No
Does the arrangement comply with the requirements of EN 1010-3 and is reaching-over, reaching-under or reaching-around the protective field effectively prevented?	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 two-hand activation installed and effective in accordance with EN 1010-3?	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
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 two-hand activation required to start the machine again after the supply voltage returns?	Yes	No
Is the plate with information about the daily check of the AOPD provided so that it can be seen easily by operating personnel?	Yes	No

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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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