



INSTRUCTION MANUAL

Modular Control System SafeBox SB4

Original Instructions



AOPD
3AA2

UL File Number: E215245

SafeBox



pf PEPPERL+FUCHS

The general terms of delivery for products and services in the electrical industry, issued by the German Electrical and Electronic Manufacturers' Association (ZVEI), shall apply in their latest version, as well as the added clause: "Extended Retention of Title"

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1 Introduction

1.1 Congratulations

You have decided to purchase a device from Pepperl+Fuchs. Pepperl+Fuchs develops, produces, and markets electronic sensors and interface modules worldwide for the automation technology market.

Please read the operating instructions carefully before installing this device and putting it into operation. The instructions and notes contained in this document will guide you step-by-step through the installation and commissioning procedures to ensure trouble-free use of this product. By doing so, you:

- Guarantee safe operation of the device
- Can utilize the entire range of device functions
- Avoid faulty operation and associated faults
- Reduce costs associated with downtime and incidental repairs
- Increase the effectiveness and operating efficiency of your plant.

Store these instructions somewhere safe in order to have them available for future work on the device.

Directly after opening the packaging, please ensure that the device is intact and that the package is complete.

1.2 Contact

If you have any questions about the device, its functions, or accessories, please contact us at:

Pepperl+Fuchs Group

Lilienthalstraße 200

68307 Mannheim, Germany

Tel.: +49 (0)621 776-1111

Fax: +49 (0)621 776-271111

E-mail: fa-info@de.pepperl-fuchs.com

1.3 Symbols Used

The following symbols are used in this manual:



Note!

This symbol draws your attention to important information.

2 Declaration of Conformity

All products were developed and manufactured under observance of the applicable European standards and guidelines.



Note!

A Declaration of Conformity may be requested from the manufacturer.

The product manufacturer, Pepperl+Fuchs Group, 68307 Mannheim, has a certified quality assurance system that conforms to ISO 9001.



3 Safety

3.1 Safety-Relevant Symbols



Danger!

This symbol warns of an immediate and present danger.
Failure to observe this warning may result in personal injury or even death.



Warning!

This symbol warns of a possible malfunction or hazard.
Failure to observe this warning may result in personal injury or extensive damage to property.



Caution!

This symbol warns of a possible malfunction.
Failure to observe this warning may result in damage to or complete failure of the device or connected systems and machines.

3.2 Intended Use

In connection with safety switches SLC and SLCS for contact-type or p-switching, SLA light barriers and/or SLG or SLP light grids and SLC light curtains, the evaluation system SafeBox SB4 forms a photoelectric safety device. The protection beams are formed between the emitters and receivers.



This system can be used as intended as an opto-electronic protective device to secure danger zones or areas from unauthorized entry or as a safety switching device for safety components according to the conditions described. If used for any other purpose, the intended function of the system cannot be guaranteed.

The applicable safety regulations, standards and provisions must be observed when operating the system, and the specific requirements of the application in question must be taken into consideration.

3.3 General Safety Information

The device must be operated only by specialist personnel who have received the relevant training, in accordance with these operating instructions.

The following basic instructions must be observed at all times:


- The device must not be commissioned until the manual has been read and understood
- The device must not be used out of specification without suitable protective measures
- Tampering with the device is not permitted
- Do not remove the warnings or rating plates


Before selecting and using the product, an assessment must be made to determine whether it is suitable for the application in question. Pepperl+Fuchs has no influence on the selection and use of this product. Liability is therefore restricted to the consistent quality of the product.

The product must be regularly checked and maintained by specialist personnel. The inspection and maintenance results must be logged. Only original spare parts from Pepperl+Fuchs may be used for repairs.


Responsibility for compliance with locally valid safety regulations is borne by the operator.

If you open or modify the device yourself, not only are you endangering yourself and others but you will void any warranty, the manufacturer's liability and the examination certificate. If serious faults occur on the device, switch the device off. Make sure that the device cannot be switched back on accidentally. If the device needs to be repaired, return it to Pepperl+Fuchs.

	<p>Note! Avoid electrostatic discharge through unprotected contact with the modules. Components destroyed by electrostatic discharge will render the warranty null and void.</p>
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	<p>Note! Observe the laws and guidelines applicable for the use or the intended purpose. The device is only approved for appropriate and intended use. Ignoring these instructions will void any warranty and absolve the manufacturer from any liability.</p>
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Store the device in the original packaging when not in use. This offers the device optimal protection against impact and moisture.

	<p>Note! Disposal Electronic waste is hazardous waste. When disposing of the equipment, observe the current statutory requirements in the respective country of use, as well as local regulations.</p>
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4 SB4 evaluation system features

The SB4 evaluation system is an opto-electronic protective device of type 4 (IEC 61496-1) or category 4 (EN ISO 13849).

This system has also been designed and tested in accordance with IEC 61508. The system meets the requirements of SIL3.

System features:

- 7 segment display for easy fault diagnosis
- A yellow status and fault indication LED for each input channel
- Easy selection of operating mode with DIP switch

5 The SB4 Evaluation Device

5.1 Product Description

Together with the light barriers, the SafeBox SB4 evaluation device builds up a single- or multi-beam opto-electronic safety device, which can be used to protect hazardous areas. The device meets the requirements of a safety switching device in accordance with category 4 PL e of EN ISO 13849 for contact-type or p-switching safety switches. It consists of several modules that can be combined as intended and accommodated in a module carrier with 2 or max. 8 slots.

5.2 Functional Principle

The SafeBox has a modular design and its basic configuration includes two plug-in modules, which are housed in a rack with a backplane. The system automatically detects the function of the modules. There is no need to address or program them. Unused slots remain free and are available for later upgrades. Alternatively, you can use a smaller rack with 2, 3, 4, 5, 6, or 8 slots.

In its basic configuration used to monitor just one hazardous area, you must use the OR modules in combination with a CP or XP module.

After switching on the evaluation device, the sensors connected to sensor modules 4C and 6C are read in. If a light barrier is connected to an input, the channel is operated as light barrier. If the input is open or connected to the corresponding emitter output, the system regards the connected sensor as a switch.

You can define the sensor types that can be connected to the 4X modules via the DIP switch. If the sensor type changes during operation, e.g. due to wire break at a light barrier, this leads to an error.

The OR module holds the supply voltage for the SafeBox. It has two secure outputs and enables a category 0 emergency stop. With this, according to EN 60204, an uncontrolled stop is defined to immediately interrupt the power supply. The OR module has inputs for resetting, restarting, and a disconnectable relay monitor to monitor downstream contacts, as well as the required connectors for signaling devices. As well as a red, yellow and green signal LED, the device has a 7-segment display for displaying error codes. You can easily locate the error with the flashing LED on the channel of the module in question.

After the cause has been eliminated, errors can be confirmed by actuating the reset input or by reconnecting the voltage.

The CP and XP modules have four input channels. The safety-oriented microprocessor control continuously monitors the function of all connected safety elements and the internal safety system and switches the allocated safety outputs of the OR module. Two adjacent channels can be monitored for simultaneity or antivalence. You can increase the number of channels by adding a 4C, 4X, or 6C module. It is possible to put multiple modules in a row, which means you can add up to 32 channels.

Safety devices such as emergency stop, contact strips, switching mats, magnetic switches, light barriers, light grids, light curtains, etc. can be switched on with the appropriate module type "C" or "X".

With the pure emergency stop function, the SafeBox offers additional features with its 2E and 4M modules.

The 2E module, for example, can perform a delayed switch-off with setting Stop 1, which means a process can be safely shut down a motion before the voltage for this area is completely removed. If you need to apply different delay times you can use multiple 2E modules.

With the 4M module you can implement the conventional muting applications. Just plug it in directly behind the sensor module that holds the safety devices you want to mute. The 4M module supports four muting operating modes and allows you to connect two muting lamps.

There are just a few simple rules to follow with the SafeBox: for module-related functions, such as relay delay times, there are DIP switches, while the logic of interaction is set to the position of the modules. As each type of module is provided with a fixed identifier in the factory, the system can uniquely identify and address each module by its ID and its slot number.

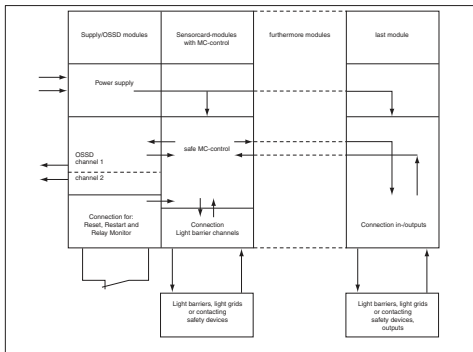


Figure 5.1: Device structure, schematic

5.3 Structure

Depending on the configuration, the opto-electronic safety device or safety equipment of the SafeBox SB4 versions described here consists of:

- An SB4-... evaluation device with at least 2 modules (OR and 4CP or 4XP module) or max. 8 modules (additional 4C or 4X, 2E or 4M modules)
- One or more SLA12 or SLA29 light barriers or SLG light grids (*C* modules) and/or
- One or more SLA 5 (S) or SLA40 light barriers or SLP light grids (4X* modules) and/or
- Contact-type safety equipment
- P-switching safety devices with internal cross-circuit monitoring, e. g. light curtains SLC and SLCS or SLCT
- Switching mats according to the 4-wire principle

Depending on the number and type of the sensor modules, up to 32 light barriers can be controlled. There are 4 and 6 channel sensor modules. Each evaluation device contains a voltage supply assembly, which generates the switch-off signals, and a sensor module, which contains the microprocessor control of the system. This sensor module has 4 sensor channels.

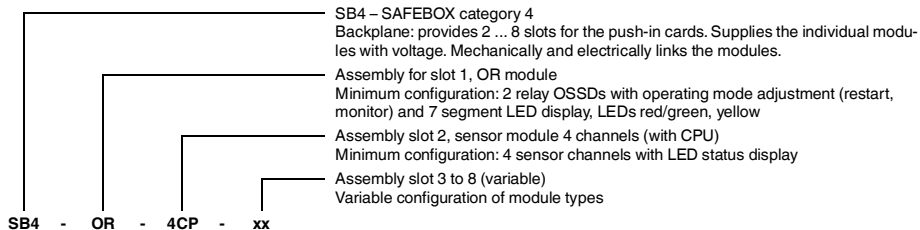
5.4 Housing

The SB4-... is located in a housing for top hat rail mounting. The installation width is a minimum of 45.2 mm for a device with 2 modules and 180.8 mm for a device with a maximum of 8 modules.

The housing can have 2 to 8 slots. The left slot has the number 1. The other slots follow on the right.

5.5 Designation Code

The designation of the individual SafeBox versions is structured in such a way that the device structure can be recognized immediately. For each assembly used, the module type of the respective assembly is stated starting from the left.



Short code	Model name	Description
OR	SB4 Module OR	SB4 basic module with 2 safety switching outputs and diagnosis
4CP	SB4 Module 4CP	SB4 sensor module with processor for 4 sensors, e.g. Pepperl+Fuchs 2-wire safety light barriers, sensors with NC contacts
4C	SB4 Module 4C	Same as SB4 Module 4CP, but without processor
6C	SB4 Module 6C	Same as SB4 Module 4C, but connectivity for 6 sensors
4XP	SB4 Module 4XP	SB4 sensor module with processor for 4 sensors, e.g. Pepperl+Fuchs 3-wire safety light barriers, sensors with PnP semiconductor outputs

4X	SB4 Module 4X	Same as SB4 Module 4XP, without processor
4M	SB4 Module 4M	SB4 muting module for 2, 4 or 2x2 muting sensors. Supports parallel, sequential, double muting, protective beam-limiting muting, override
2E	SB4 Module 2E	SB4 functional module, STOP 0, STOP 1, central Emergency-Stop

5.6 Device Versions

5.6.1 Standard Versions

To implement typical opto-electronic safety device applications, there are ready-made SB4 evaluation devices for these cases. These are suitable for safeguarding access to one or more entrances to dangerous areas.

5.6.1.1 4 channel evaluation device SB4-OR-4CP

Max. 4 safety light barriers can be connected to this evaluation device, e.g. the 2-wire light barriers SLA12 or SLA29. Instead of light barriers you can also connect contact-type safety devices.

The restart interlock is activated ex works. To enable the self-quitting operation mode the DIP switch adjustment can be changed.

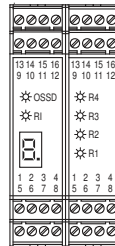


Figure 5.2: Front view SB4-OR-4CP

5.6.1.2 8 channel evaluation device SB4-OR-4CP-4C

The SB4-OR-4CP-4C is suitable for connecting 1 to 8 safety light barriers and adds 4 connections to the SB4-OR-4CP. The large number of sensor channels makes this evaluation device suitable for protecting several entries.

Other contact-type safety devices can be connected instead of the light barriers.

The restart interlock is activated ex works. To enable the self-quitting operation mode the DIP switch adjustment can be changed.

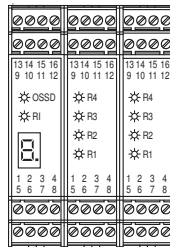


Figure 5.3:Front view of SB4-OR-4CP-4C

5.6.1.3 4-channel evaluation device with muting SB4-OR-4CP-4M

This evaluation device can be used for muting applications of 1 to 4 safety light barriers. Due to the adjustment options via the DIP switches of the muting module, optimum adaptation to the applications is possible.

For example, if two entries to the protected area, which are protected by 2 protection beams, are to be equipped with muting, this protection can be realized by the double muting operating mode with an evaluation device. The protection beams of light barrier channels 1 and 2 are muted with muting sensors 1 and 2, channels 3 and 4 are muted with muting sensors 3 and 4 (see module description Section 7.3).

The restart interlock is activated ex works. To enable the self-quitting operation mode the DIP switch adjustment can be changed.

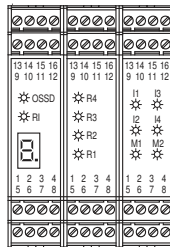


Figure 5.4:Front view of SB4-OR-4CP-4M

5.6.1.4 4-channel evaluation device SB4-OR-4XP

This evaluation device lets you connect SLP safety light grids with max. 4 protective beams or 3-wire safety light barriers (e.g. SLA5). Instead of light barriers you can also connect switching mats, contact strips and 2-channel p-switching safety devices with their own cross-circuit monitoring, e.g. compatible SLPC, SLPCM safety light grids or SLC safety light curtains.

The restart interlock is activated ex works. To enable the self-quitting operation mode the DIP switch adjustment can be changed.

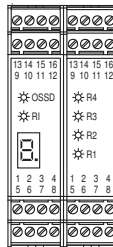


Figure 5.5: Front view of SB4-OR-4XP

5.6.1.5 8-channel evaluation device SB4-OR-4XP-4X

The SB4-OR-4XP-4X is the same as the SB4-OR-4XP, but with 4 extra channels. The large number of sensor channels makes this evaluation device suitable for protecting several entries.

The restart interlock is activated ex works. To enable the self-quitting operation mode the DIP switch adjustment can be changed.

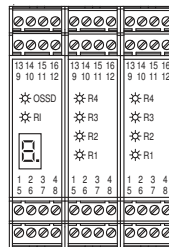


Figure 5.6: Front view of SB4-OR-4XP-4X

5.6.1.6 4-channel evaluation device with muting SB4-OR-4XP-4M

This evaluation device can be used for muting applications of 1 to 4 safety light barriers.

Due to the adjustment options via the DIP switches of the muting module, optimum adaptation to the applications is possible. You can also mute safety light curtains with 2 cross-circuit-monitored outputs (e.g. SLC family) with this evaluation device.

For example, if two entries to the protected area, which are protected by 2 protection beams, are to be equipped with muting, this protection can be realized by the double muting operating mode with an evaluation device. The protection beams of light barrier channels 1 and 2 are muted with muting sensors 1 and 2, channels 3 and 4 are muted with muting sensors 3 and 4 (see module description Section 7.3).

The restart interlock is activated ex works. To enable the self-quitting operation mode the DIP switch adjustment can be changed.

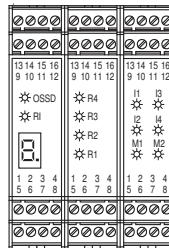


Figure 5.7: Front view of SB4-OR-4XP-4M

6 Functions of the SafeBox SB4

The SafeBox SB4 offers a variety of functions. A function is assigned to a module. Here is a general description of the function.

6.1 Restart

The restart function can optionally be activated or deactivated with DIP switches. If the function is deactivated, the OSSDs switch on after voltage connection and activated safety inputs or after all safety inputs have been activated. If the restart function is activated, the user must actuate a start key (normally closed contact) before switching on the OSSDs.

This applies after voltage connection and after initiation of a safety input.

6.2 Relay Monitor

With the OSSD switch outputs, the OR or 2E modules can, with the help of feedback contacts, perform safety-related monitoring of external switching elements that are correlated in terms of time. Normally closed contacts of force-guided relays must be used as feedback contacts. The feedback contacts of all downstream external switching elements are to be switched in series. This series switching is to be connected with the positive voltage supply on one side and with the relay monitor input on the other side.

The feedback contacts of the external switching elements must guarantee a reliable contact at a voltage of 20 V and a current of 5 mA. A surge voltage strength of 6 kV must be guaranteed between the feedback contacts and other contacts connected to a low voltage according to the Low Voltage Directive.

The external switching elements are monitored with a delay of 200 ms after the switching operation. If the new switching status has not been adopted after the expiration of the monitoring time, the OR module assumes the interlock mode, the 7-segment display shows an **F** and the restart display is flashing. This error can be confirmed by a reset after the cause has been eliminated.

6.3 Stop Categories

In accordance with EN 60204, **Stop function cat. 0** refers to an uncontrolled stop, i.e., the elements downstream of the OSSDs **immediately** interrupt the power supply. With stop function cat. 1 the stop command is triggered via the OSSDs. The OSSD module acting as a **Stop function cat. 1** delivers the **switch-off command** for the power supply **after** the selected **time delay** has expired.

Stop function cat. 1

The 2E stop module with stop function cat. 1 switches its OSSDs off with a delay. The delay time is set via 2 channels by means of a DIP switch. The control command for a controlled stop is supplied by the OSSD assembly immediately to the left, which works in Stop function cat. 0.

The Restart function of the module is obsolete in this operating mode.

The relay monitor can optionally be activated or deactivated.

6.4 Muting

6.4.1 General

The muting operating modes allow for a bypass of the protection beams as intended.

When using a muting module in SB4, muting according to IEC 61496-1 can be realized.

If an object is to be moved through the protection beams without the beams responding, muting sensors with a sensing range both in front of and behind the protection beams are required. The sensors must be arranged in such a way that the object causing the muting is detected completely by at least 2 muting sensors while passing through the protection beams.

Muting requires the connection of a signal lamp or the provision of a muting status signal. A signal lamp can be monitored by the muting module. If monitoring is active and the lamp is missing or defective, the system assumes the safe state (OSSDs off).



For the North American market, remember that the muting lamp monitoring function must be active to meet standard requirements.

In the case of a system with 3 modules, the muting status is reached approx. 91 ms after activation of the muting sensors. This system cancels the muting status approx. 50 ms after deactivation of the muting sensors. Further time data on the muting sensors and response times after the release of protection beams can be found in section "Technical Data".



The spatial arrangement of the muting sensors must ensure that muting can only be initiated by the added objects and not by persons. The arrangement of the muting sensors depends on the following factors:

- Specific application
- Type of muting sensors used
- Number of muting sensors
- The way the objects are added to the hazardous area
- Type and size of the objects to be added
- Speed of the objects
- Protection against the muting sensors being deceived

If muting is activated, the muting object should block the entry in the area of the protection beams in such a way that a person cannot enter the hazardous area unnoticed.

6.4.2 Mode of Operation

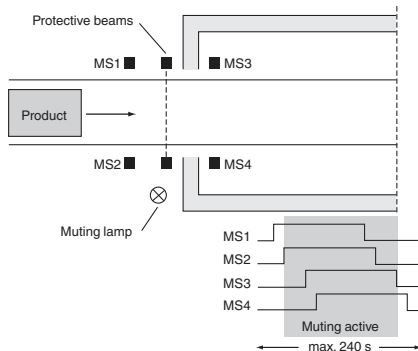
6.4.2.1 Evaluation of the muting sensor by parallel or sequential muting

Depending on the arrangement, the muting sensors are activated within a short period of time or successively. The sequence of the activation can be monitored by selecting between parallel and sequential muting.

Parallel muting

In the operating mode, parallel muting, the paired muting sensors (MS1 and MS2 or MS3 and MS4) must be activated within 2 s (simultaneity requirement). If just one of the muting sensors is activated in this time, it is blocked. As a result of the lock, the activation of the muting is blocked, the protection beams remain active. If the system locks the muting sensors, the LEDs of the affected sensor pair are flashing and the 7 segment display indicates error 7. The lock will only be removed once the sensor is no longer active. The removal of the lock resets the error displays.

Figure 6.1: Parallel muting



Sequential muting

In contrast to parallel muting where the activated sensors MS1 and MS2 or MS3 and MS4 fulfill the muting condition, sequential muting also allows sensors MS2 and MS3 to keep the muting condition. The muting sensors are activated successively. The arrangement of the sensors is to be selected in such a way that a person cannot unintentionally activate 2 sensors.

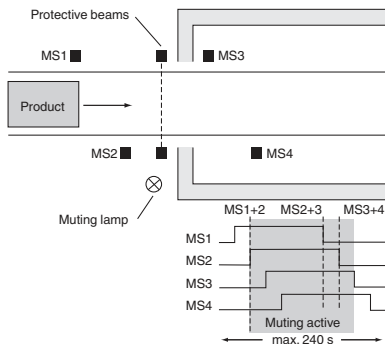


Figure 6.2: Sequential muting

6.4.2.2 Muting monitoring by time window-limited or protection beam-limited muting

To avoid a dangerous continuous muting in the case of a failure of the muting sensors, muting is operated either with a time window limit or a protection beam limit. You should enable time window-led muting if the objects that should pass by the protective beams unhindered, normally cross through the protective beams in less than approx. 240 seconds. If this is not long enough, you can use the protective beam-led muting function. It should be taken into account that muting is stopped approx. 440 ms after all protection beams have been released.

Time window-limited muting

If time window-limited muting is selected, each muting sensor is monitored in terms of time. Each sensor must be installed in max. 240 seconds. This means that the muting object must have passed the sensor within this period of time. If this time is exceeded, the SafeBox locks the sensor. If the sensor is locked (error 3), muting can no longer be activated. The sensor can only be released again once it has been deactivated.

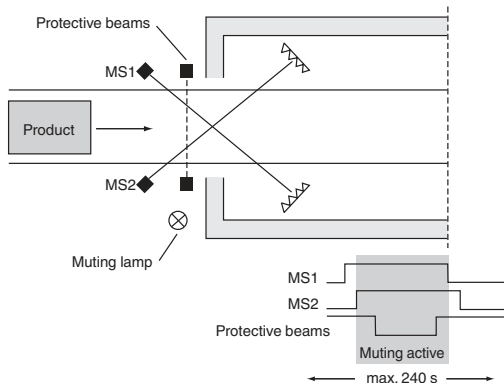


Figure 6.3: Time window-limited muting

Protection beam-limited muting

In the case of protection beam-limited muting, muting sensors are evaluated with respect to time after activation. Two activated muting sensors initiate the muting procedure. At the latest 240 seconds after activation (applies separately for each muting sensor), at least one protection beam must be interrupted. In contrast to time window-limited muting, the time measurement is stopped, thus enabling muting with no time limit. Approx. 440 ms after the protected area has been left (all protection beams have been released) and thus the passage way is free again, all activated muting sensors are locked, thus making muting impossible. As a result of this lock, all activated muting sensor displays are flashing and the 7-segment display shows a 3. After the muting sensors have been released, this display is reset.

7 Modules

For realizing the different functions, there are various modules for the SB4 evaluation device. The module with the power supply and the first OSSDs are located on the first slot on the left. Next to it on the second slot there is a module containing the sensor function and the control of the system.

You can insert additional modules according to the function you want to use. You can find a list of modules under Chapter 15.2.

7.1 SB4 basic module OR

7.1.1 Function

The OR module contains the power supply for the SafeBox, 2 OSSDs, the relay monitor and the restart connection. This module is located in slot 1 of the SafeBox and only exists once.

The OSSDs are designed as potential-free NO contacts. You can choose to use this module with or without the startup/restart interlock. Monitoring of the externally connected switching elements can also be activated (relay monitor). The OSSD On or Off statuses are indicated via a short-circuit-proof PnP signal output. The restart output is used to signal the start readiness status. In the case of an error, this output oscillates at 1 Hz.

7.1.2 Connections

The connections are designed as removable screw or spring terminals. The terminal assignment can be found in Table 7.1.



Terminal	Function
1	Reset input; normally closed contact
2	Restart input (RI); normally closed contact
3	24 VDC connection for reset, restart and RM
4	Relay monitor (RM)
5 – 6	OSSD1; potential-free relay contact; NO contact
7 – 8	OSSD2; potential-free relay contact; NO contact
9	OSSD signal output off
10	OSSD signal output on
11	Restart signal output
12	Leave free (n.c.)
13	+24 VDC supply voltage
14	0 VDC supply voltage
15	Functional ground
16	Leave free (n.c.)

Table 7.1: Terminal assignment of OR/supply module

Figure 7.1:

Front view of OR module

7.1.3 Connection Allocation

OSSD outputs

The OSSD outputs must be connected with the downstream safety equipment in such a way that the required safety category is met.



The load circuit of the external switching elements must be protected by a fuse with a maximum rated value of 60 % of the load capacity of the contacts in order to prevent the contacts from welding together. It must also be ensured that inductive loads are provided with a protective circuit against high induction voltage to protect the contacts of the OSSD outputs.

Signal outputs

The signal outputs are p-switching, short-circuit-proof semiconductor outputs. You can directly control lamps, relays or PLC inputs.

Output	Terminal	Description
OSSD OFF	9	OSSD outputs switched off
OSSD ON	10	OSSD outputs switched on
Ready to start	11	Continuous light: protected area free, OSSD off, ready to start, activate restart button
		Flashing (1 Hz): error on the card, in the switch group or system error

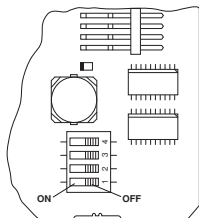
Table 7.2: Signal outputs

Reset, restart and relay monitor inputs

The inputs must be connected with normally closed contacts. If a function is not required, the respective input may also be open.

7.1.4 Settings

The assembly contains 4 DIP switches for selecting the restart and relay monitor functions. Two switches must always be activated in order to select a function.



Switch	Position	Operating mode
1 and 3	OFF	Without startup/restart interlock (restart, RI)
	ON	With startup/restart interlock (restart, RI)
2 and 4	OFF	Without relay monitor (RM)
	ON	With relay monitor (RM)

Table 7.3: DIP switches

Figure 7.2: DIP switch position

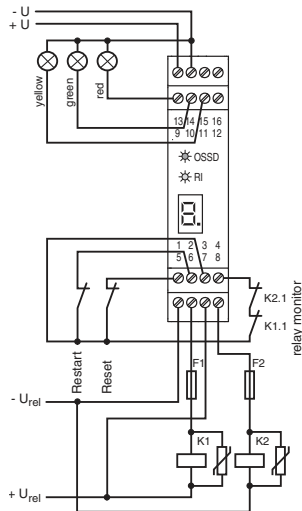


Figure 7.3: Connection example OR/supply module

7.1.5 Indicators

The OR module has a red/green LED for signaling the OSSD on/off statuses, a yellow LED for the "Ready for startup" status and a 7-segment display for diagnosis.

The 7-segment display uses error codes to signal the status of the system. If an error occurs the yellow LED of the first supply/OSSD card will flash and the indicators on the faulty assembly will also flash at 5 Hz.

The troubleshooting options are described in Section 12.

Figure 7.4 shows examples of errors:

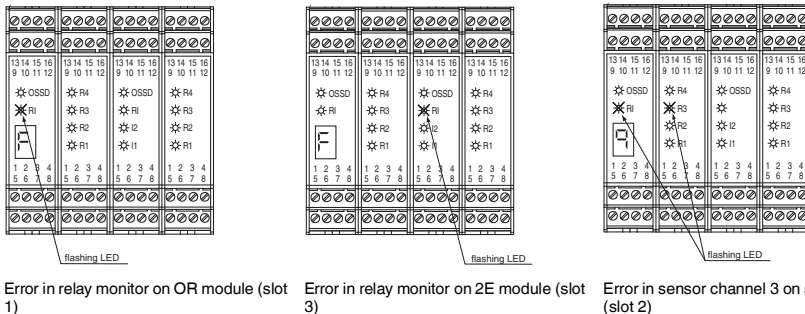










Figure 7.4: Examples of error signaling

Display	LED	Description
OSSD	Red	OSSD outputs switched off
	Green	OSSD outputs switched on
RI	Yellow	Continuous light: protection field-free, OSSD off, ready to start, Press the Restart button
		Flashing (5 Hz): error on the card or system errors (see status of 7-segment display)

Table 7.4: LED indicators

Display	7-segment display	Display	7-segment display
	DIP switch setting not identical		Error in sensor channel
	Incorrect configuration		Error in sensor inputs
	Time-out of one or more muting sensors		System error
	Emitter error		Relay monitor error







	Muting lamp error		Selection chain error
	Simultaneity monitoring error		Software unsuitable for configuration
	Receiver error		Low voltage or voltage surge detected

Table 7.5: 7-segment display

7.2 SB4 Function Module 2E

7.2.1 Function

The 2E module includes 2 OSSDs, the relay monitor, and 2 connections for contact-type safety signals (e.g. emergency off switch). This module may exist several times (max. 4) from position 3 in the SafeBox and may perform different functions depending on the switch position.

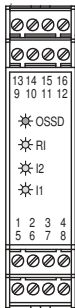
The OSSDs are designed as potential-free NO contacts. You can choose to use this module with or without the start-up/

restart interlock. Monitoring of the externally connected switching elements can also be activated (relay monitor). The OSSD On or Off statuses are indicated via a short-circuit-proof PnP signal output. The restart output is used to signal the start readiness status. In the case of an error, this output oscillates at 1 Hz.

The module can work in stop function cat. 0 or cat. 1.

7.2.2 Connections

The connections are designed as removable screw or spring terminals. The terminal assignment can be found in Table 7.6.



Terminal	Function	Terminal	Function
1	Safety element 1.1 Out	10	OSSD signal output on
2	Safety element 1.1 In	11	NC
3	Safety element 1.2 Out	12	Relay monitor (RM)
4	Safety element 1.2 In	13	+24 VDC supply voltage for signal outputs
5 – 6	OSSD1; potential-free relay contact; NO contact	14	+0 VDC supply voltage for signal outputs
7 – 8	OSSD2; potential-free relay contact; NO contact	15	24 VDC RM connection
9	OSSD signal output off	16	NC


Table 7.6: Terminal assignment of the 2E module

Figure 7.5: Front view of the 2E module

7.2.3 Connection Allocation

OSSD outputs

The OSSD outputs must be connected with the downstream safety equipment in such a way that the required safety category is met.

	<p>The load circuit of the external switching elements must be protected by a fuse with a maximum rated value of 60 % of the load capacity of the contacts in order to prevent the contacts from welding together.</p> <p>It must also be ensured that inductive loads are provided with a protective circuit against high induction voltage to protect the contacts of the OSSD outputs.</p>
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Signal outputs

The signal outputs are p-switching, short-circuit-proof semiconductor outputs. You can directly control lamps, relays or PLC inputs.

Output	Terminal	Description
OSSD OFF	9	OSSD outputs switched off
OSSD ON	10	OSSD outputs switched on

Table 7.7: Signal outputs

Relay monitor input

The input must be connected with normally closed contacts. If the function is not required, the input may also be open.

Sensor inputs

The inputs must be connected with NC contacts, for example a 2-channel emergency stop button. Outputs Out 1 and 2 generate signals that are directed to inputs IN1 and IN2. Due to internal monitoring, the inputs are protected against crossed circuit and short circuit. Insert a bridge if you want the inputs to remain unused; this also applies to the set Stop 1- function.

Only 2-channel safety devices can be connected to the inputs, which are monitored for simultaneity.

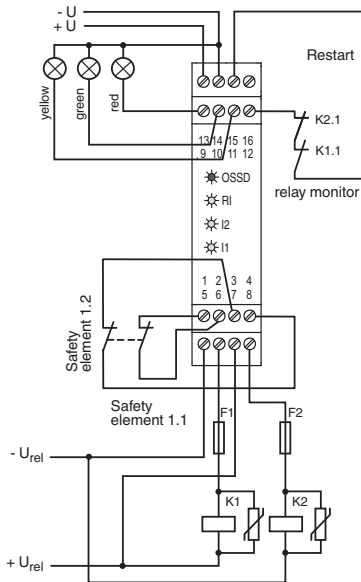


Figure 7.6: Connection example of a 2E module with Stop 0- function

7.2.4 Settings

The assembly contains 16 DIP switches for selecting the restart, relay monitor, OSSD assignment functions, and the time function. Two switches must always be activated in order to select a function.

Switch	Position	Operating mode
1 Groups 1 and 2	OFF	No function
2 Groups 1 and 2	OFF	No function
3 Groups 1 and 2	OFF	Without relay monitor (RM)
	ON	With relay monitor (RM)
4 Groups 1 and 2	OFF	Stop function cat. 0
	ON	Stop function cat. 1

Table 7.8: DIP switches, function selection

Time value [s]	Switch 1 Groups 1 and 2	Switch 2 Groups 1 and 2	Switch 3 Groups 1 and 2	Switch 4 Groups 1 and 2
0.0	OFF	OFF	OFF	OFF
0.3	ON	OFF	OFF	OFF
0.4	OFF	ON	OFF	OFF
0.5	ON	ON	OFF	OFF
0.63	OFF	OFF	ON	OFF
0.8	ON	OFF	ON	OFF
1.0	OFF	ON	ON	OFF
1.3	ON	ON	ON	OFF

1.6	OFF	OFF	OFF	ON
2.0	ON	OFF	OFF	ON
2.5	OFF	ON	OFF	ON
3.2	ON	ON	OFF	ON
4.0	OFF	OFF	ON	ON
5.0	ON	OFF	ON	ON
6.3	OFF	ON	ON	ON
8.0	ON	ON	ON	ON

Table 7.9: DIP switches, time setting

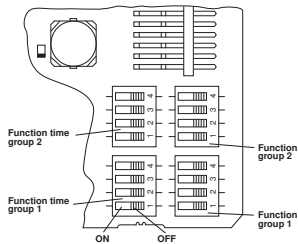


Figure 7.7: DIP switch position

7.2.5 Indicators

The OSSD assembly has a red/green LED for signaling the OSSD on/off statuses, a yellow LED for the "Ready to start" status, and 2 LEDs for the sensor channels.

If there is an error on the OSSD assembly itself, only the indicators on this assembly will flash.

Display	LED	Description
OSSD	Red	OSSD outputs switched off
	Green	OSSD outputs switched on
RI	Yellow	Continuous light: protected area free, OSSD off
		Flashing (5 Hz): error on the card or system error
I1, I2	Yellow	Continuous light: sensor channel closed
		Flashing (5 Hz). Sensor channel error

Table 7.10: 2E module indicators

7.3 Muting Module 4M

7.3.1 Function

The muting module provides the muting function for the sensor channels of the 4- or 6-channel sensor module immediately to the left of the module.

The user must make sure that only mutable sensors are connected to the sensor card to which the muting module is assigned. These include light barriers and light grids, for example.



Emergency stop buttons must not be muted.

For a detailed description of the muting operating modes, see Section 6.4.

7.3.2 Muting Sensors

Muting sensors are intended to detect the muting objects. If an object is detected, the output of the muting sensor switches through its supply voltage. Sensors with a relay or PnP output are suitable for this purpose. In a de-energized state, the output of the muting sensor must not be active. The sensor output should be able to reliably switch a load current of 8 mA at 20 V. Muting sensors with a current consumption of max. 30 mA can be supplied right from the muting module. Sensors with a higher current consumption have to be supplied externally.

Muting sensors must be selected so that they operate well even at supply voltage of at least 12 V.

The cables to the muting sensors must be laid in such a way that no short circuits are possible between the muting sensors.

The following sensors can be used as muting sensors, for example:

- dark ON or light ON retro-reflective light barriers (with reflector on object),

- light sensors (light ON),
- inductive sensors,
- mechanical switches.

7.3.3 Muting Lamps

When using muting, an indicator lamp must be used for signaling the muting status. As an option, the muting module monitors the current of the muting indicator lamp for a minimum value of 7.5 mA. This monitoring ensures that the muting indicator lamp fulfills its warning function correctly. If the muting indicator lamp is defective, the corresponding OSSD assembly assumes the interlock mode and indicates error **6** (muting lamp defective) on the display. While muting is active, the muting lamp can be controlled (muting lamp monitoring activated).

A maximum of 2 muting lamps can be connected to the muting module. In the case of double muting, a muting lamp is assigned to each pair of muting sensors or a half of the protection beams of a sensor module (See Section 7.3.5).

If single muting has been selected, both muting lamp outputs are active simultaneously. This makes it possible to increase the availability of the plant, as a defective muting lamp will not cause a malfunction.

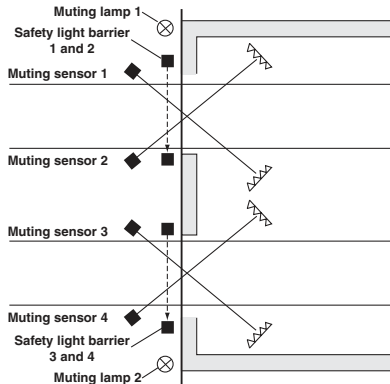
7.3.4 Emergency Muting (Override)

If the plant must be started up again to remove the blocking object from the protection field and muting sensor area, the emergency muting function is available. With emergency muting, the blocked muting sensors are re-analyzed for 4 seconds. As a result, the OSSDs are switched on again for 4 seconds. The emergency muting is triggered with the override switch (NC contact). To do this, at least one muting sensor must be enabled. This initialization can be re-triggered, i.e. by actuating the push button again within 4 s, the duration of the on status of the OSSDs can always be extended until the object has left the muting sensor area.

7.3.5 Double Muting

If the double muting operating mode is selected, 2 entries to a hazardous area can be protected and muted using a muting module and a sensor module.

This operating mode divides the sensor inputs of the sensor module to the left of the muting module, the muting sensor inputs, the muting lamps, and the override inputs into 2 separate areas (see Table 7.11).



The two muting areas thus created work completely independently from each another. Figure 7.8 shows a possible arrangement and Figure 7.9 shows the basic connection of the sensors and lamps to the modules.

With double muting, all other adjustable operating modes (e. g. protection beam limit or time limit) apply to both muting areas.

Figure 7.8: Double muting, example configuration

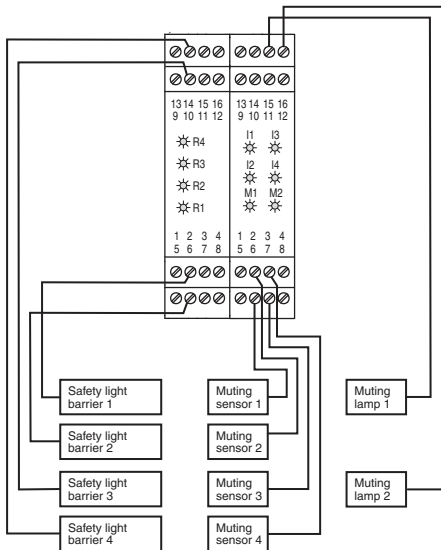


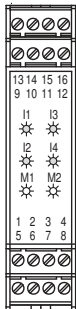
Figure 7.9: Double muting, schematic connection assignment of the modules

	Sensor input (light barrier) 4-channel sensor module	Sensor input (light barrier) 6-channel sensor module	Muting sensor input	Muting lamp output	Override input
Muting area 1	1 and 2	1, 2, 3	1 and 2	1	1
Muting area 2	3 and 4	4, 5, 6	3 and 4	2	2

Table 7.11: Sensor assignment, double muting

7.3.6 Connections

The connections are designed as removable screw or spring terminals. The terminal assignment can be found in Table 7.12.



Terminal	Function	Terminal	Function
1	24 V sensor supply	9	Input override 1
2	Sensor 2 In	10	24 V override 1
3	Sensor 4 In	11	24 V override 2
4	0 V sensor supply	12	Input override 2
5	24 V sensor supply	13	+24 VDC supply voltage for muting lamps
6	Sensor 1 In	14	+0 VDC supply voltage for muting lamps
7	Sensor 3 In	15	Muting lamp output1
8	0 V sensor supply	16	Muting lamp output2

Table 7.12: Terminal assignment of the muting module

Figure 7.10: Front view of the muting module

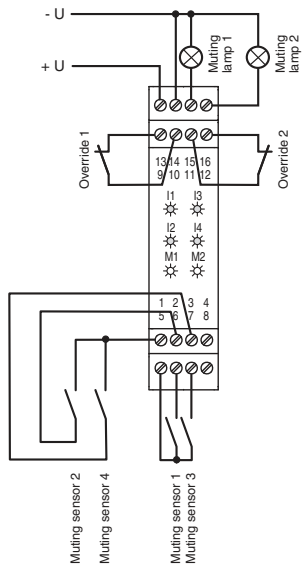


Figure 7.11: Connection assignment of the muting module

7.3.7 Settings

The assembly contains 8 DIP switches for selecting the different muting operating modes. Two switches must always be activated in order to select a function.

Switch	Position	Operating mode
1 Groups 1 and 2	OFF	Muting lamp monitoring inactive
	ON	Muting lamp monitoring active
2 Groups 1 and 2	OFF	Single muting
	ON	Double muting
3 Groups 1 and 2	OFF	Time window-limited muting
	ON	Protection beam-limited muting
4 Groups 1 and 2	OFF	Sequential muting
	ON	Parallel muting

Table 7.13: DIP switches, function selection

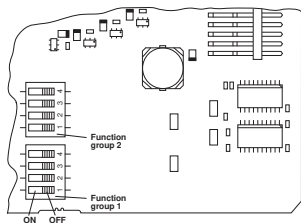


Figure 7.12: DIP switch position

7.3.8 Indicators

The muting module has a yellow display for each muting sensor. For each muting lamp there is a white display. If there is an error in the muting module, only the yellow displays on this assembly will flash. In the case of an error on the muting lamps, the white muting displays will flash

Display	LED	Description
I1 ... I4	Yellow	Continuous light: muting sensor activated
		Flashing (5 Hz). Muting sensor error
M1, M2	White	Continuous light: muting activated
		Flashing (5 Hz). Muting lamp error

Table 7.14: Muting module indicators

7.4 4- or 6-Channel Sensor Modules (*C*)

7.4.1 Function

With the 4- or 6-channel sensor module you can connect 2-wire light barriers or grids or contact-type safety sensors in a single or 2-channel arrangement. If you want to connect SLP safety light grids or 2-channel p-switching safety devices, use a module with the letter X instead of C in the module name (See Chapter 7.5).

The 4-channel sensor module is also available with MC control. This version only exists once in a system and is always located in slot 2 of the SafeBox.

When the system is switched on, the software determines whether a light barrier or a contact-type safety sensor is switched on in a channel and monitors its presence during operation.

Contact-type safety sensors that are connected to the SafeBox must operate in the "normally closed" switching mode. An open contact means "safe status".

Channels 1 and 2 as well as 3 and 4 (and 5 and 6) can be monitored for simultaneity or antivalence. If simultaneity monitoring is activated, 2-channel safety equipment is monitored for simultaneous opening or changing of the sig-

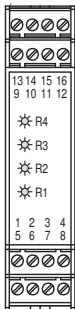
nals. The monitoring time is 2 seconds.

Antivalence monitoring expects the normally closed contact in channel 1 or 3 (or 5) and the normally open contact in channel 2 or 4 (or 6). If antivalence monitoring is performed without simultaneity monitoring, an incorrect contact position causes a switch-off and error message 7 after approx. 60 seconds.

7.4.2 Connections

The connections are designed as removable screw or spring terminals. The terminal assignment can be found in Table 7.15 or in Table 7.16.

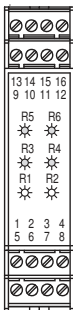
Up to 4 light barriers can be connected to the 4-channel sensor module. Unused channels must be deactivated by means of a bridge between the emitter output and receiver input.



Terminal	Function	Channel assignment	Terminal	Function	Channel assignment
1	Receiver 2 input	Input Channel 2	9	Emitter output 3	Output Channel 3
2	Receiver 2 +U		10	Emitter 3 +U	
3	Emitter 2 +U		11	Receiver 3 +U	
4	Emitter output 2	Output	12	Receiver 3 input	Input
5	Receiver 1 input	Input Channel 1	13	Emitter output 4	Output Channel 4
6	Receiver 1 +U		14	Emitter 4 +U	
7	Emitter 1 +U		15	Receiver 4 +U	
8	Emitter output 1	Output	16	Receiver 4 input	Input

Table 7.15: Sensor module (4C) connectors

Figure 7.13: Sensor module (4C) connectors



Terminal	Function	Terminal	Function
1	Emitter output 1	9	Receiver 1 input
2	Emitter output 2	10	Receiver 2 input
3	Emitter output 3	11	Receiver 3 input
4	Emitter 1 ... 3 +U	12	Receiver 1 ... 3 +U
5	Emitter output 4	13	Receiver 4 input
6	Emitter output 5	14	Receiver 5 input
7	Emitter output 6	15	Receiver 6 input
8	Emitter 4 ... 6 +U	16	Receiver 4 ... 6 +U

Table 7.16: 6-channel sensor module connections

Figure 7.14: 6-channel sensor module connections

7.4.3 Connection Allocation

7.4.3.1 Connection of light barriers or light grids

The light barrier emitters and receivers are connected to the sensor module according to the wire color or pin number.

The length of the connection cables between the evaluation device and the emitter or receiver must not exceed 100 m. The connection cable is specified in Section 13.

Light grid emitters and receivers are connected in such a way that they are assigned to a sensor module. If this is not possible, it must be ensured that the +U connections of the light grids are equally distributed. Unused channels must be bridged according to Table 7.18.

Light barrier			Evaluation device SB4
	Pin	Wire color	Sensor module terminal
Emitter	3	Blue (BU)	Emitter x output
	4	Black (BK)	Emitter x +U
Receiver	1	Brown (BN)	Receiver x +U
	3	Blue (BU)	Receiver x input

Table 7.17: Light barrier terminal assignment
Sensor module evaluation device

Light barrier to be replaced	Bridge	
	4-channel sensor module	6-channel sensor module
1	1 – 4	1 – 9
2	5 – 8	2 – 10
3	9 – 12	3 – 11
4	13 – 16	5 – 13
5		6 – 14
6		7 – 15

Table 7.18: unused sensor channels

Figure 7.15 shows a connection example for 2 light barriers (channel 3 and 4), one bridge (channel 1) and a 1-channel safety switch on channel 2.

LSS = emitter of light barrier, LSE = receiver of light barrier

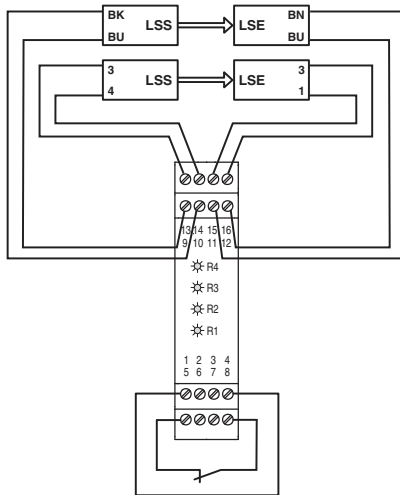


Figure 7.15: Connection example of a 4-channel sensor module

7.4.3.2 Connection of sensors with simultaneity or antivalence monitoring

Contact-type safety equipment can also be connected to sensor modules. If 2-channel signals are used, use simultaneity monitoring to detect errors in one of the channels.

Together, contact-type safety equipment and light barriers can be connected to one sensor module. In this case, simultaneity and antivalence monitoring is not effective for the light barriers. For contact-type signals, use channels 1 and 2 or 3 and 4 (and 5 and 6 with a 6-channel sensor module).

LSS = light barrier emitter
LSE = light barrier receiver

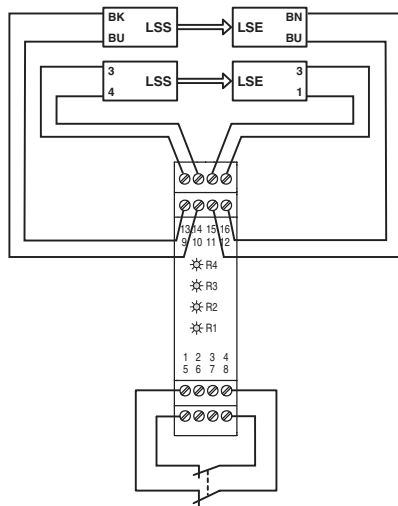


Figure 7.16: Connecting two light barriers and one 2-channel safety

device to a 4-channel sensor module

7.4.4 Settings

The assembly contains 4 DIP switches for selecting the simultaneity functions of neighboring channels (1 and 2, 3 and 4), and for an antivalent evaluation of neighboring channels (1 and 2, 3 and 4 or also 5 and 6). Two switches must always be activated in order to select a function. The functions are not effective if light barriers are connected.

Switch	Position	Operating mode
1 and 3	OFF	No antivalent evaluation
	ON	Antivalent evaluation active
2 and 4	OFF	No simultaneity evaluation
	ON	Simultaneity evaluation active

Table 7.19: Sensor module DIP switch

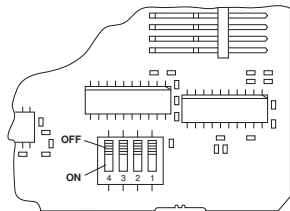


Figure 7.18: Position of the sensor module DIP switch

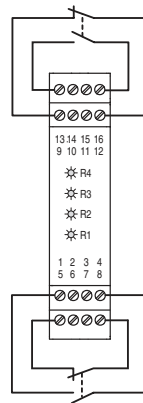


Figure 7.17: Connecting 2-channel, antivalent safety devices on a 4-channel sensor module

7.4.4.1 Indicators

For each channel, there is a yellow LED on the front panel of the module.

Display	LED	Description
R1 ... R4 (R1 ... R6)	Yellow	Status of light barrier 1 ... 4 (6)
		Off: light beam interrupted
		On: light beam released
		Flashing: light beam free, insufficient function reserve (frequency approx. 2.5 Hz)
		Rapid flashing: error (frequency approx. 5 Hz)

Table 7.20: Sensor module LEDs, 4 or 6 channels

7.5 4-Channel Sensor Module (4X*)

7.5.1 Function

The 4-channel sensor module -4X enables SLA series "3-wire" light barriers (such as SLA5) and SLP light grids to be connected. P-switching safety devices with dedicated cross-circuit monitoring can also be connected, such as SLC series safety light curtains. Switching mats designed according to the 4-wire principle and single- or 2-channel contact-type safety sensors can also be connected.

This module is also available with MC control. This version only exists once in a system and is always located in slot 2 of the SafeBox.

The assembly features a 6x DIP switch used to select the sensors to be connected. Select 2 switches in pairs. The safety sensors are connected on channels 1 and 2 or 3 and 4.

You can connect SLA and SLP "3-wire" light barriers and grids to channels 1 to 4.



The cables must be selected and routed to the light barriers and light grids in such a way as to ensure short circuits cannot occur between the receiver and the emitter wire.

Light curtains with semiconductor switching outputs and 2-channel contact-type safety sensors are monitored for simultaneity. With simultaneity monitoring, the safety equipment is monitored for simultaneous opening or changing of the signals. The monitoring time is 2 seconds.

Connect via channels 3 and 4 and/or 1 and 2.



Remember that these sensors require their own cross-circuit monitoring, as the module does not do this with these sensors.

Make sure self-monitoring safety devices with semi-conducting outputs Q1 and Q2 follow this testing pulse pattern: Testing pulse length T_1 should not exceed 300 μs and the refresh rate T_W should not be less than 500 μs .

SB4 quantity Modules	Refresh rate Test pulse
2	10 ms
3	14 ms
4	18 ms
5	22 ms
6	26 ms
8	34 ms

Table 7.21: Interval between test pulses based on module quantity

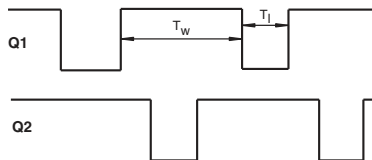


Figure 7.19: Time diagram for test pulses

If the test pulse length is greater than 300 μs , the refresh rate in relation to the number of cards of the SB4 switching device should not be below the value shown in Table 7.21, otherwise error messages may appear.

Switching mats designed in accordance with the 4-wire principle can be connected to channels 1 and 2 and/or 3 and 4. If the switching mat has a faulty connection, the system reports error 9 or error 8 as it does when detecting a 2-channel contact-type safety sensor.

7.5.2 Connections

The connections are designed as removable screw or spring terminals. The terminal assignment can be found in Table 7.22.

You can connect up to 4 light barriers or two 2-channel p-switching safety devices or 2 switching mats to the 4-channel sensor module. Unused channels must be deactivated by means of a bridge between the emitter output and receiver input.

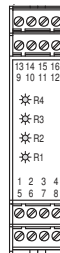


Figure 7.20: Front view and terminal assignment of 4X(P) module

Terminal	Function	Channel assignment	Connection Light Barrier / Light Grid	Connection 2-channel p-switching Safety Device	Connection Switching Mat	
1	Receiver 2 input	Channel 2	Input	Receiver output 2	OSSD output 1.2	Switching mat 1.4
2	Sensor 2 24 VDC +U			24 V receiver 2	24 V Supply 1	
3	Sensor 2 GND ground			0 V receiver 2, emitter 2	0 V Supply 1	
4	Emitter output 2		Output	Emitter input 2		Switching mat 1.3
5	Receiver 1 input	Channel 1	Input	Receiver output 1	OSSD output 1.1	Switching mat 1.2
6	Sensor 1 24 VDC +U			24 V receiver 1		
7	Sensor 1 GND ground			0 V receiver 1, emitter 1		
8	Emitter output 1		Output	Emitter input 1		Switching mat 1.1
9	Emitter output 3	Channel 3	Input	Emitter input 3		Switching mat 2.4
10	Sensor 3 GND ground			0 V receiver 3, emitter 3	0 V Supply 2	
11	Sensor 3 24V DC +U			24 V receiver 3	24 V Supply 2	
12	Receiver 3 input		Output	Receiver output 3	OSSD output 2.2	Switching mat 2.3
13	Emitter output 4	Channel 4	Input	Emitter input 4		Switching mat 2.2
14	Sensor 4 GND ground			0 V receiver 4, emitter 4		
15	Sensor 4 24V DC +U			24 V receiver 4		
16	Receiver 4 input		Output	Receiver output 4	OSSD output 2.1	Switching mat 2.1

Table 7.22: Terminal assignment of 4X(P) module and assignment to various sensors

7.5.3 Connection Allocation

7.5.3.1 Connecting light barriers/light grids

You can connect SLA5(S) or SLA40 light barriers or SLP light grids to these modules.

The light barrier emitters and receivers are connected to the sensor module according to the wire color or pin number. The length of the connection cables between the evaluation device and the emitter or receiver must not exceed 100 m.



The cables must be arranged and routed to the light barriers and light grids in such a way as to ensure short circuits cannot occur between the receiver and the emitter wire. The connection cable is specified in Section 13.

Light grid emitters and receivers are connected in such a way that they are assigned to a sensor module. If this is not possible, it must be ensured that the +U connections of the light grids are equally distributed. Unused channels must be bridged according to Table 7.24.

Figure 7.16 shows a connection example for 2 light barriers (channels 3 and 4) and a 2 channel safety switch on channels 1 and 2.

Light barrier		Evaluation device SB4
Pin	Wire color	Sensor module terminal
3	Blue (BU)	Emitter GND
4	Black (BK)	Emitter x output
1	Brown (BN)	Receiver 24 V 24 VDC +U
3	Blue (BU)	Receiver GND
4	Black (BK)	Receiver x input

Table 7.23: Terminal assignment of the sensor module evaluation device light barrier or grid

Light barrier to be replaced	Bridge
	4-channel sensor module
1	1-4
2	5-8
3	9-12
4	13-16

Table 7.24: Bridge with unused sensor channels

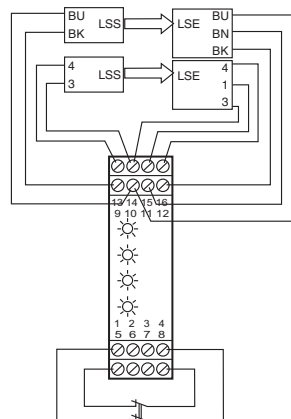


Figure 7.21: Connection example of a 4-channel sensor module 4X

7.5.3.2 Connecting switching mats and 2-channel p-switching safety devices

The following illustrations show connection examples for the combined use of safety light curtains and a switching mat on a 4X module.

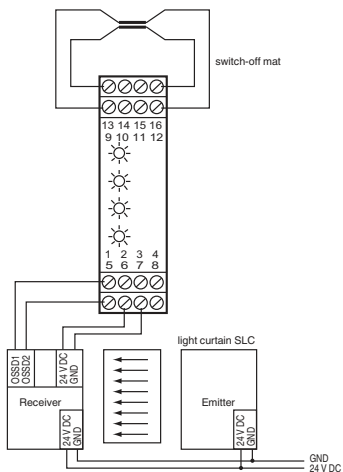
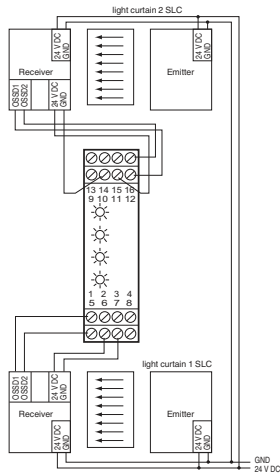


Figure 7.22: Connecting an SLC safety light curtain and a switching mat to a 4X module

Figure 7.23: Connecting 2 safety light curtains to a 4X module



7.5.4 Settings

6 DIP switches for selecting the sensor type and position are available on the module. There are six ways in which to combine the sensors. The required combination must be set in binary form. Two switches must always be actuated in order to select a function, i.e. DIP switches 1 ... 3 have the same switch position as DIP switches 4 ... 6.

DIP Switch			Operating mode
3 and 6	2 and 5	1 and 4	
0	0	0	SLA/SLP/bridge on channel 1 + 2 and channel 3 + 4
0	0	1	SLA/SLP/bridge on channel 1 + 2 and SLC channel 3 + 4
0	1	0	SLC on channel 1 + 2 and channel 3 + 4
0	1	1	SLA/SLP/bridge on channel 1 + 2 and pressure-sensitive mat on channel 3 + 4
1	0	0	Pressure-sensitive mat on channel 1 + 2 and channel 3 + 4
1	0	1	SLC on channel 1 + 2 and pressure-sensitive mat on channel 3 + 4

Table 7.25: Sensor module 4X(P) DIP switches

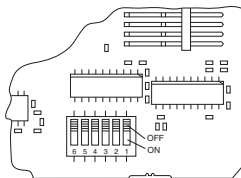


Figure 7.24: Position of the sensor module 4X(P) DIP switches

7.5.4.1 Indicators

For each channel, there is a yellow LED on the front panel of the module to indicate the status of the input channel.

Display	LED	Description
R1 - R4 (R1 - R6)	Yellow	Status of sensor inputs 1 ... 4
		Off: interrupted On: free
		Flashing: light beam free, insufficient function reserve (Frequency approx. 2.5 Hz)
		Rapid flashing: error (Frequency approx. 5 Hz)

Table 7.26: Display LEDs on the 4 X(P) module

7.6 Basic Housing and Accessories

An SB4 evaluation device can also be composed of individual components. For this purpose, additional components are available in addition to the modules already described. These are:

- SB4 Housing 2 ... 8 (basic housing with 2 ... 8 slots to accommodate single modules)
- SB4 Cape (blind cap for covering a slot of the basic housing).



The minimum configuration of a SafeBox consists of a basic housing and one assembly each for slot 1 and 2.

7.7 Mounting Notes for Modules and Basic Housings

Modules may only be operated within an SB4 evaluation device.

Mounting or replacing modules of a SafeBox may be necessary if you want to modify or extend the function of an evaluation device. In this case, it must be borne in mind that the type code is no longer correct and the response time must be corrected depending on the number of modules.



A changed response time must in any case be considered regarding the safety calculations.

A plug-in jumper must be inserted on the 2-pin pin strip in each last module (furthest to the right). Either the module that is currently located on the last slot can be moved further to the right or the plug-in jumper must be reconnected to the new module.

If an evaluation device is composed of individual modules at the user's, it must be ensured that:

- the desired safety function can be fulfilled by the selected modules and their connection sequence
- there is an OR module in slot 1

- there is a module with MC control in slot 2, e.g. 4CP or 4XP
- there is a module in each slot and that there are no gaps
- the plug-in jumper is connected to the last slot (to the right)
- blind caps cover the slots that are not used
- an ESD-compliant work place is used for mounting
- the response time according to the configuration is marked on the device.

For the smallest extension level, a basic housing, a module for slot 1 and a module for slot 2 are required. The module for slot 2 (SB4 Module 4CP) is supplied with a plug-in jumper. If additional modules are used, this plug-in jumper must be moved.

8 Setup and Mounting of the Light Barriers and Grids

The safety light barriers and grids should be arranged in such a way that the emitters that are connected to the sensor modules of an SB4 evaluation device cannot irradiate the receivers on other evaluation devices.

The installation must be carried out in such a way that it is not possible to enter the hazardous area by circumventing the safety beams.

It must not be possible:

- to crawl through under the lowest beam
- to reach over the highest beam or
- to pass between two beams



The calculation of the minimum distance of the light grids from the hazardous area can be found in the applicable guidelines and standards.

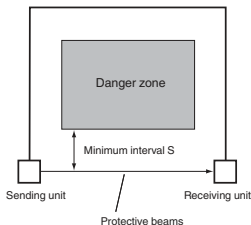


Figure 8.1: Minimum distance between opto-electronic safety device and hazardous area

The distance is calculated from the lag time of the machine, the response time of the safety system, and the speed of movement of the person entering the hazardous area (EN ISO 13855).

To comply with the necessary distances in the event that the protective field spreads, please refer to Table 1 of EN ISO 13855 to check the minimum distance for a vertically located protection field. If the table gives you a reading of 0, find the minimum distance with the following formula:

EN ISO 13855 states:

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

The following applies to a protection field installed perpendicular to the hazardous area:

S	Minimum safety distance in mm, i.e. the distance between the hazardous area and protection field
K	Constant in mm/s for the speed of approach, based on the detection capacity of the sensor
T	Total response time of the protective device in s ($T = t_1 + t_2$)

t_1	Response time of the protective equipment e.g. SLA light barriers with SB4 40 ms (relay OSSD)
t_2	Machine lag time
C	Additional distance in mm. See table
	2-, 3-, or 4-beam
	850 mm


Table 8.1: For arrangements other than a perpendicular arrangement of the protection field, see also EN ISO 13855.


Layout of individual beams

Number of beams	Height above the floor [mm]	Beam gap [mm]
2	400, 900	500
3	300, 700, 1100	400
4	300, 600, 900, 1200	300

The layout of the beams must prevent a person from being able to

- crawl under the lowest beam,
- climb over the highest beam, or
- climb between the two beams.

	<p>Note! If an applicable C standard recommends that the first beam be positioned at a height of 400 mm from the floor, you should follow this recommendation. If no recommendation has been made, use a risk analysis to determine whether the position is OK.</p>
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	<p>It must be ensured that reflective objects that may cause a light beam reflection around an obstacle are not located within the transmitting or receiving lobe (EN 61496-2).</p>
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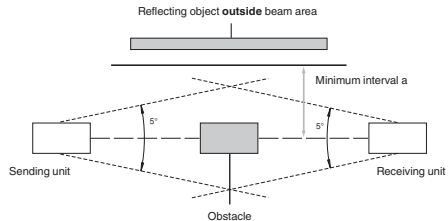


Figure 8.2: Reflection

9 Installation

When integrating the evaluation device and the safety light grids into the safety-related control system of the machine, the instructions in EN 61496-1 must be considered, among other things (connecting the control elements downstream of the opto-electronic safety device).



Note!

The relevant laws and standards that apply to the use of photoelectric protective devices must be followed. There are differences depending on the area of use.

The following general points should be observed during installation:

- Have the applicable standards and regulations been observed?
- Does the technical data of the opto-electronic safety device meet the requirements of the application?
- Have the necessary distances been observed?
- Are all inputs and outputs wired correctly?
- Do the non-floating inputs and outputs of the evaluation device have double or reinforced insulation to protect them against external circuits with dangerous voltages?
- Is the evaluation device built into a closed and locked housing or case (minimum protection degree of IP54 acc. EN 61496-1) to prevent unauthorized modifications of the electrical connections or to the device configuration and to protect from direct or indirect contact (acc. EN 60204-1:2007 bzw. IEC 60204-1:2009)?
- For sensors susceptible to short circuits, have the cables been routed in such a way as to make short circuits between inputs and outputs impossible?
- Is it impossible to circumvent the protective device?
- Is the restart button located so that all the hazardous area can be viewed?
- Is it impossible to press the restart button from inside the hazardous area?
- Are the muting sensors arranged correctly?
- Is the muting indicator lamp in a clearly visible position?

- Is the emergency muting button located so that all the hazardous area can be viewed?
- Is it impossible to press the emergency muting button from inside the hazardous area?
- Has the response time been marked according to the number of existing modules on the name plate (left side of the device)? (Only applies if the user himself removes or adds modules)

10 Commissioning

10.1 Adjusting Safety Beams

The emitters and receivers must be aligned with each other in such a way that they are standing in front of each other at the same height and that the lowest beam is at the correct height above the floor.

Adjustment of the emitters can be facilitated with a reflector. The reflector is fitted in front of the lens of the receiver. The system is switched on and a bearing takes place from the emitter in the direction of the reflector. The emitter must be adjusted in such a way that the red emitter light can be seen in the reflector. The emitter must be fixed in position. The receiver is now pivoted in such a way that the function indicator shows a continuous light.

10.2 Function Test

10.2.1 Testing the Detection Capacity of the Installed Opto-electronic Safety Device

The following tasks must be carried out to check the detection capacity:

- Remove all objects from the beam pathways
- Disconnect all light beams one by one while checking that the corresponding channel display turn dark
- Check whether interrupting the light beam causes the intended reaction in the downstream safety equipment

10.2.2 Checking the Sensors and Stop Functions

- Checking the sensor inputs (based on the LEDs per input)
- Checking the Stop function cat. 1

10.2.3 Checking Other Connected Safety Equipment

- Check whether the safety equipment has been connected according to the applicable guidelines and notes

10.2.4 Checking the Muting Function

- Checking the installation position of the muting sensors
- Checking the correct connection of the muting lamp
- Checking the selected muting operating mode and the muting process

11 Periodic Inspection

A daily inspection of the entire safety equipment is required if the OSSD outputs are relays and if it is not guaranteed that:

- the protection field is interrupted at least once a day
- or the device is not switched on at least once per day of operation

The inspection is carried out as follows:

- Release protection field and, if necessary, enable restart
- Interrupt any beam
Check whether the interruption of the light beam causes the intended reaction in the downstream safety equipment

If the evaluation device does not assume an error status, the inspection is complete.

Further inspections of the connected safety elements such as safety gate contacts must be carried out according to the required inspection cycles.



During the periodic inspection of the safety function of the plant in which the evaluation system SB4 is fitted, the functions of the opto-electronic safety device must also be checked. Among other things, the proper arrangement, installation as well as the required response time must be checked. Inspection records of the performed inspections must be maintained and kept.

12 Correction of errors

Errors in the system always cause the affected switch group to assume the safe interlock mode. There are errors that only affect the switch group and errors that affect the entire system. In the latter case, all OSSDs are switched off.

The 7-segment display indicates the detected error. The channel display of the faulty channel will flash on the faulty module concerned. If the error affects the entire module, all channel displays will flash. This way, the error can be easily detected and eliminated.








To confirm an error, the operator actuates the reset input for 0.4...1.2 s, thus performing a reset. After a successful system test, the SB4 assumes the operating status or stops in the error status with the respective error display.

Certain errors can only be eliminated by switching off the supply voltage and switching it on again, because the system must determine the new configuration.



If, after elimination of an error, the operating voltage is reconnected, the user must check the correct configuration of the system. To do this, enable every sensor once (e. g. with light barriers and grids by interrupting every beam) and check how the evaluation device responds or what the sensor display does.

The following lists possible self-help measures:

Display	Error	Solution
All displays of the SB4 are dark	Voltage supply is defective	Check voltage supply
LEDs of the channels do not light up	Safety beam interrupted or safety equipment triggered	Release safety beams. Check whether all emitters are functioning. Remove contamination. If necessary, readjust emitter and receiver. Activate safety equipment.
	DIP switch setting not identical	Check and correct switch position
	Incorrect configuration	The set configuration is faulty; check and correct configuration
	Time-out of one or more muting sensors	The error display disappears once the error has been eliminated (e.g. after muting ends with protection beam-limited muting); checking the muting sensors; use Override to clear the area of materials if necessary
	Emitter error	Checking the installation of the affected emitter
	Muting lamp error	Checking the muting lamp or the installation
	Error in simultaneity monitoring	May occur in the case of muting sensors or sensors with activated simultaneity monitoring; in the case of sensors, the error must be confirmed; in the case of muting sensors, the error is confirmed by deactivating the muting sensors
	Receiver error	Checking the installation of the affected receiver








	Error in sensor channel	Checking the installation of the affected channel
	Error in sensor channel	Checking the installation, as there may be a short circuit on the sensor inputs for the supply voltage
	System error	Delete error by means of reset or by switching off the voltage; if the error continues to exist, contact customer service or repair device
	Relay monitor error	Checking the wiring of the OSSDs and the external relays
	Selection chain error	Checking whether plug-in jumper is located in the last slot (several plug-in jumpers may be set)
	Configuration error	Change the configuration
	Under-/overvoltage detected	Checking the supply voltage; resetting of error by switching off voltage

Table 12.1: Troubleshooting

13 Technical Data

13.1 Functional Safety Data

Safety Integrity Level	SIL 3 (IEC 61508)
PFH _d	SB4-OR...: 3,47 E-09 (IEC 61508) The specified PFH _d value applies to all variations and up to the maximum ambient temperature
Performance Level	PL e (EN ISO 13849-1)
Category	4 (in accordance with ISO 13849-1)
Type	4 (in accordance with EN 61496-1)
Life time	20 a
B10D value (Relay OSSD version) DC-13, 24 V I = 2 A I ≤ 1 A	100,000 switching cycles 1,300,000 switching cycles For more detailed values, see OSSD Outputs


13.2 Conformity with Standards and Directives

Directive conformity	see Declaration of Conformity (included or available under www.pepperl-fuchs.com)
Conformity with standards	
Functional safety	IEC 61508 part 1-4
Standards	IEC 61496-1

13.3 Approvals and Certificates

CE conformity	CE
UKCA conformity	UKCA
UL approval	cULus Listed UL File Number E215245
TÜV approval	TÜV

13.4 Parameters

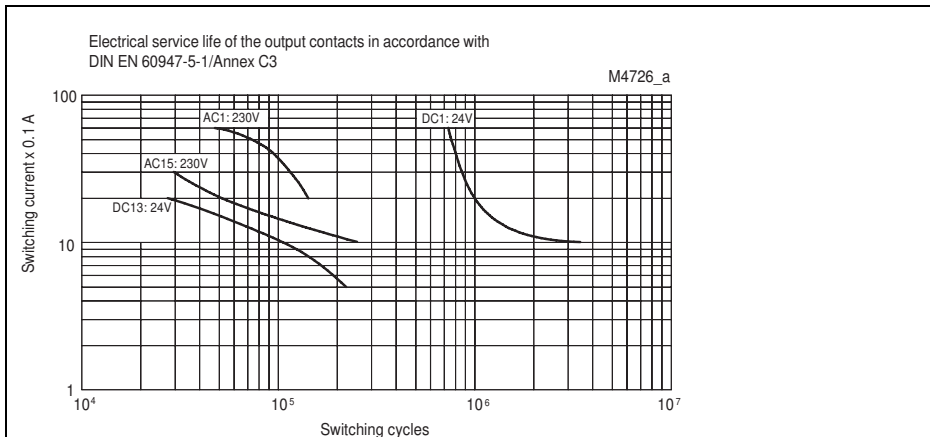
Number of protection beams	Maximum 32
Dimensions (H x W x D)	SB4-OR-4CP: 99 mm x 45.2 mm x 114.5 mm SB4-OR-4CP-4C and SB4-OR-4CP-4M: 99 mm x 67.8 mm x 114.5 mm General: 99 mm x (22.6 x number of slots) mm x 114.5 mm
Power supply	24 V DC \pm 20 % Power supply that meets requirements for safety extra-low voltage (e.g., PELV IEC 60204)
Protection class	Without marking, installation in appropriate switch cabinet required, protection class III for connected accessories  Danger: Danger to life from electric shock! Insufficient separation distances can cancel the safe isolation of a SELV/PELV supply of the auxiliary circuits of the protective device. This can lead to a life-threateningly high voltage on the device or connected system accessories. Observe the protection class III of the auxiliary circuits and the required safe isolation in the insulation coordination of the electrical system or machine. See also IEC 60204, IEC 60664 and IEC 61140 as well as corresponding national regulations.
Current consumption	max. 2 A ¹⁾
Power consumption	50 W

Safety output of OSSD

Normally open contacts, force-guided
Limiting current min. 10 mA, max. 6 A
Switching voltage min. 10 V AC/DC, max. 250 V AC/DC
Switching capacity: 24 VA DC, 230 VA AC
External fuse with $< 0.6 \times$ limit load current, quick-acting
Switching rate: max. 1/s



Attention: Relay output must be protected against fusing by means of a fuse.
The externally connected switching elements should be connected with max. 60 % of their rated load capacity to avoid an overload.



Reaction times	Response time: SB4-OR-4CP, SB4-OR-4XP: 30 ms SB4-OR-4CP-4C, SB4-OR-4CP-4M, SB4-OR-4XP-4X and SB4-OR-4XP-4M: 38 ms								
	In general:	Number of assemblies	2	3	4	5	6	7	8
		Switch-off time [ms] Relay OSSD	30	38	46	54	62	70	78
	Reactivation time after sensor channels have been released: SB4-OR-4CP, SB4-OR-4XP: 108 ms SB4-OR-4CP-4C, SB4-OR-4CP-4M, SB4-OR-4XP-4X and SB4-OR-4XP-4M: 156 ms								
	In general:	Number of assemblies	2	3	4	5	6	7	8
		Reactivation time [ms] Relay OSSD	108	156	204	252	300	348	396
Muting activation after activation of the muting sensors: SB4-OR-4CP-4M, SB4-OR-4XP-4M: 91 ms									
In general:	Number of assemblies	3	4	5	6	7	8		
	Activation time for muting [ms] Relay OSSD	91	119	147	175	203	230		
PnP outputs	Output voltage: supply voltage - 2 V, output current: max. 300 mA								
Muting lamp outputs	Output voltage: supply voltage - 2 V (when using LED lamps, the minimum voltage for sufficient brightness must be taken into account) Output current: 7.5 - 500 mA								
Indicators	OSSD status: LED red/green Error status: 7-segment display Restart: yellow LED Sensor status: one yellow LED per input Muting status: white LED								
Inputs (switch connections, relay monitor)	Input resistance approx. 2.2 kOhm Voltage: operating voltage - 1 V Current: approx. 10 mA								

Activation time for button connections (Reset, Restart, Override)	0.4 – 1.2 s
Sensor inputs (4C, 6C, 4X modules)	Voltage: operating voltage - 1 V Current: approx. 7 mA
Sensor supply (4X module)	Voltage: operating voltage - 1 V Power: max. 20 mA, short-circuit-proof
Muting sensor inputs	Input resistance approx. 2.2 kOhm Voltage: operating voltage - 1 V Current: approx. 10 mA
Connection	Removable screw terminal blocks or spring terminal blocks, conductor cross-section 0.2 ... 2 mm ²
Cable lengths	max: 100 m with max. line resistance of 3 Ohm
Degree of protection	IP 20; IP54 must be guaranteed for operation by means of an installation housing
Housing	Polyamide PA 6.6, UL94, V0, black
Operating temperature/storage temperature	0 ... + 50 °C/-25 ... + 85 °C
Air humidity	Max. 95 %, noncondensing
Shock resistance	Switching devices: stationary switch cabinet mounting without relevant mechanical stress Connected sensors: see respective datasheet
Vibration resistance	Switching devices: stationary switch cabinet mounting without relevant mechanical stress Connected sensors: see respective datasheet
Weight	SB4-OR-4CP: 320 g SB4-OR-4CP-4C and SB4-OR-4CP-4M: 430 g In general: 35 g + 150 g x number of slots

1) Evaluation device without connected external consumers e.g. lamps or relays

13.5 Dimensions

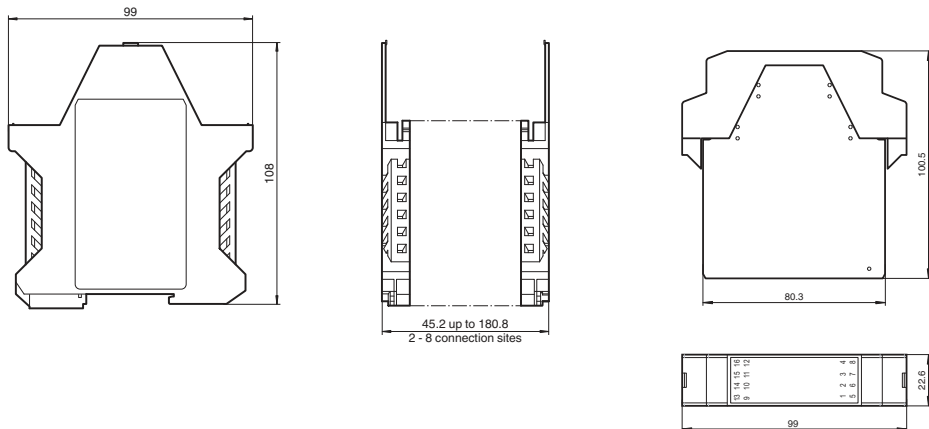


Figure 13.1: Dimensions of SB4 Housing and SB4 Module

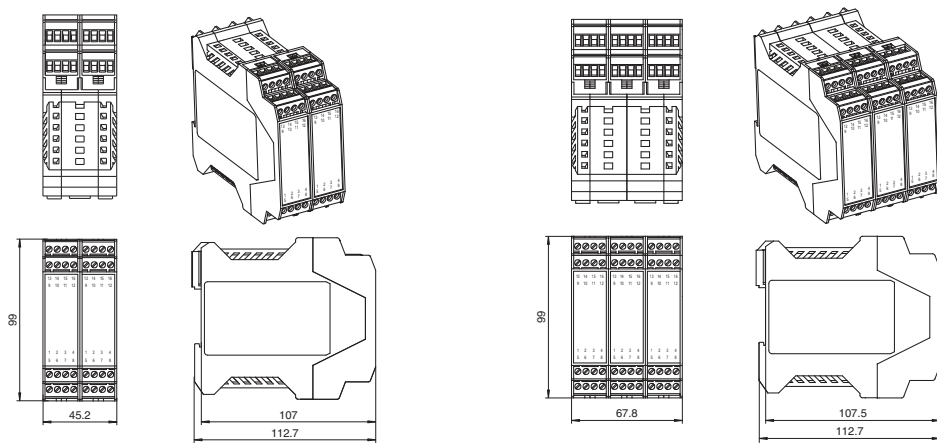


Figure 13.2: Dimensions of SB4-OR-4CP and SB4-OR-4CP-4C (SB4-OR-4CP-4M)

14 Application Checklist

A list of important points should help you avoid errors when planning, setting up, and using the protective device. This application checklist is not complete and must be modified to suit each specific application.



Note: Please observe applicable standards and laws!

The relevant laws and standards that apply to the use of photoelectric protective devices must be followed. There are differences depending on the area of use.

14.1 Before Installation

- Have all the applicable standards and regulations been observed?
- Does the technical data of the SB4-... meet the requirements of the application? (E.g. number of channels, module types, operating voltage)?
- Is the overvoltage category required by EN50178 or EN60947-1 met at the connections?
- Is the electrical equipment, wiring and overcurrent protection in accordance with IEC 60204-1: 2009?
- Is there enough space for fitting and dismantling components?
- On the connected safety light barriers and light grids, have the given distances between the protection field and the hazardous area and reflected surfaces been observed?

14.2 After Installation

- Is the startup enable input connected when the startup/restart interlock is activated?
- Is the ready to start signal lamp connected?
- Is the red/green indicator for signaling the status of the OSSD outputs in a visible location?
- Are all components correctly connected?
- Are the connected safety light barriers or grids positioned so that protection field cannot be bypassed and people cannot enter the hazardous area undetected?
- Are the connected safety light barriers and light grids aligned?

- Have the necessary safety distances been maintained?
- Are there fuses in the OSSD current circuits that are intended to prevent the contacts from fusing together?

14.3 Commissioning

- Did you check the detection capacity of the connected safety light barriers or light grids with the test rod? This test should take place at multiple locations and at least once in front of the emitter and receiver units as well as in the middle of the protection field.
- Do the OSSD switch outputs trigger the requisite stop?
- Has the response time been checked?

14.4 Periodic Inspection

- Have the requisite test steps and test intervals been specified?
- Are the protection beams interrupted at least 4 times each working day or is the system switched on in order to test the switch off function of the safety system?
- Is the detection capacity of the connected safety light barriers or light grids checked regularly?
- Are the response times checked at regular intervals?
- Is all machine safety equipment inspected at the required intervals?
- Are all inspections documented?

15 Ordering Information

15.1 Devices

Description	Description
SB4-OR-4CP	Evaluation device with 4 safety inputs to connect 2-wire safety thru-beam sensors SLA12 or SLA29 or IF-SB4 safety light grids SLCS or SLCT
SB4-OR-4CP-4M	Evaluation device with 4 safety inputs and 4 muting inputs to connect 2-wire safety thru-beam sensors SLA12 or SLA29 or IF-SB4 safety light grids SLCS or SLCT

SB4-OR-4CP-4C	Evaluation device with 8 safety inputs to connect 2-wire safety thru-beam sensors SLA12 or SLA29 or IF-SB4 safety light grids SLCS or SLCT
SB4-OR-4XP	Evaluation device with 4 safety inputs to connect safety light grids SLP, safety light curtains SLCS / SLCT or 3-wire light barriers (e.g. SLA5 / SLA40)
SB4-OR-4XP-4M	Evaluation device with 4 safety inputs to connect safety light grids SLP, safety light curtains SLCS / SLCT or 3-wire light barriers (e.g. SLA5 / SLA40) and 4 muting inputs
SB4-OR-4XP-4C	Evaluation device with 8 safety inputs to connect 2-wire light barriers (SLA12/SLA29), 3-wire light barriers (SLA5/SLA40), safety light grids SLP or safety light curtains SLCS or SLCT

15.2 Modules

Model name	Description
SB4 Module OR	SB4 basic module with 2 safety switching outputs and diagnosis
SB4 Module 4CP	SB4 sensor module with processor for 4 sensors, such as Pepperl+Fuchs 2-wire safety light barriers SLA12 or SLA29, sensors with NC contacts (with IF-SB4 safety light grids SLCS or SLCT)
SB4 Module 4C	Same as SB4 Module 4CP, but without processor
SB4 Module 6C	Same as SB4 Module 4C, but connectivity for 6 sensors
SB4 Module 4XP	SB4 sensor module with processor for 4 sensors, such as Pepperl+Fuchs 3-wire safety light barriers SLA5 or SLA40, sensors with PnP semiconductor outputs like SLCS or SLCT
SB4 Module 4X	Same as SB4 Module 4XP, without processor
SB4 Module 4M	SB4 muting module for 2, 4 or 2x2 muting sensors. Supports parallel, sequential, double muting, protective beam-limiting muting, override
SB4 Module 2E	SB4 function module with the functions STOP 0, STOP 1.
SB4 Housing 2	Module rack with backplane and 2 slots
SB4 Housing 3	Module rack with backplane and 3 slots
SB4 Housing 4	Module rack with backplane and 4 slots

SB4 Housing 5	Module rack with backplane and 5 slots
SB4 Housing 6	Module rack with backplane and 6 slots
SB4 Housing 8	Module rack with backplane and 8 slots
SB4 Cape	Cap for unused slots

16 Glossary

Startup/restart interlock	Device that prevents the OSSDs from switching on after the protection field has been cleared.
BWS	Opto-electronic safety device
EDM	External Device Monitoring , NO contact of the downstream safety elements that reports switching of the dangerous action to the SafeBox, also referred to as relay monitor
Function reserve	Distance of the receiver signal of the light barrier from the lower limit of the switching point of the light barrier
Muting	Intended bypassing of protection beams
Emergency muting	Switching on the OSSDs with invalid muting condition (only possible under certain conditions and when monitored by operator)
OSSD	Output switching elements of the safety circuit of the opto-electronic safety device; Output Signal Switching Device according to EN IEC 61496-1
Override	See emergency muting
Reset	Resetting a confirmable error
Restart	Releasing the restart of the opto-electronic safety device from the status of the startup/restart interlock
RM	Abbreviation for Relay Monitor , see also EDM
RI	Abbreviation for Restart Interlock , see also restart

The general terms of delivery for products and services in the electrical industry, issued by the German Electrical and Electronic Manufacturers' Association (ZVEI), shall apply in their latest version, as well as the added clause: "Extended Retention of Title"

FACTORY AUTOMATION – SENSING YOUR NEEDS



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