

Original operating instructions

MSI-SR5B Safety Relays

SAFE IMPLEMENTATION AND OPERATION



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1 About this document

1.1 Used symbols and signal words

Table 1.1: Warning symbols and signal words






	Symbol for dangers
NOTE	
	Signal word for property damage Indicates dangers that may result in property damage if the measures for danger avoidance are not followed.
CAUTION	
	Signal word for minor injuries Indicates dangers that may result in minor injury if the measures for danger avoidance are not followed.
WARNING	
	Signal word for serious injury Indicates dangers that may result in severe or fatal injury if the measures for danger avoidance are not followed.
DANGER	
	Signal word for life-threatening danger Indicates dangers with which serious or fatal injury is imminent if the measures for danger avoidance are not followed.

Table 1.2: Other symbols



	Symbol for tips Text passages with this symbol provide you with further information.
	Symbol for action steps Text passages with this symbol instruct you to perform actions.

Table 1.3: Terms and abbreviations

AOPD	Active optoelectronic protective device
OSSD	Output safety switching device
ESPE	Electro-sensitive protective equipment
EDM	External device monitoring
RES	Start/restart interlock (reset)
PFH _d	Probability of a dangerous failure per hour
MTTF _d	Mean time to dangerous failure
PL	Performance level

1.2 Checklists

The checklists (see chapter 9 "Testing") serve as a reference for the machine manufacturer or supplier. They replace neither testing of the complete machine or system prior to the initial start-up nor their periodic


testing by a competent person. The checklists contain minimum testing requirements. Depending on the application, other tests may be necessary.

1.3 Declaration of Conformity

The device meets the basic requirements and the other relevant provisions of the machinery directive 2006/42/EC.

The manufacturer of the product, Leuze electronic GmbH & Co KG in D-73277 Owen, possesses a certified quality assurance system in accordance with ISO 9001.

1.4 Download area

NOTE	
	<p>You can download the original operating instructions and the EC declaration of conformity from our website.</p> <ul style="list-style-type: none">↳ Call up the Leuze website: www.leuze.com↳ Enter the type designation or part number of the device as the search term. The part number can be found on the name plate of the device under the "Part No." entry.↳ The documents can be found on the product page for the device under the <i>Downloads</i> tab.

2 Safety

Before using the safety relay, a risk assessment must be performed according to valid standards (e.g. EN ISO 12100, EN ISO 13849-1, IEC/EN 61508-1, EN/IEC 62061). The result of the risk assessment determines the required safety level of the safety relay (see table 13.1). For mounting, operating and testing, this document as well as all applicable national and international standards, regulations, rules and directives must be observed. Relevant and supplied documents must be observed and handed to the affected personnel.

✚ Before working with the safety relay, 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 relays:

- Machinery directive 2006/42/EC
- Low voltage directive 2014/35/EU
- Electromagnetic compatibility 2014/30/EU
- Use of work equipment directive 2009/104/EC
- OSHA 1910 Subpart O
- Safety regulations
- Accident-prevention regulations and safety rules
- Ordinance on Industrial Safety and Health and employment protection act
- Product safety law (Produktsicherheitsgesetz)

NOTE



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

2.1 Intended use and foreseeable misuse

DANGER



Electrically live systems pose a risk of electric shock!

- ✚ During all conversions, maintenance work and inspections, make certain that the voltage supply is interrupted and protected against being restarted again.
- ✚ Only have work on the electrical system and electronics performed by a competent person.

2.1.1 Intended use

WARNING



A running machine may result in serious injury!

- ✚ Make certain that the safety relay is correctly connected and that the protective function of the protective device is ensured.
- ✚ Make certain that, during all conversions, maintenance work and inspections, the system is securely shut down and protected against being restarted.

Only if the safety relay is correctly connected and correctly started up is the protective function of the protective device ensured. To prevent misuse and resulting dangers, the following must be observed:

- These operating instructions are included in the documentation of the system on which the protective device is mounted and are available to the operating personnel at all times.
- The safety relay is used as a safety monitoring device in combination with safety sensors, switches and command devices for guarding danger zones or points of operation in machines and systems.
- The safety relay 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 safety at work, and after it has been installed, connected, checked and commissioned by a **competent person**.
- The safety relay must only be connected and commissioned in accordance with its specifications (technical data, environmental conditions, etc.).
- The "Reset" acknowledgment button for unlocking the start/restart interlock must be located outside of the danger zone.
- The entire danger zone must be visible from the installation site of the acknowledgment button.
- The safety relay must be selected so that its safety-related capability meets or exceeds the required Performance Level PL ascertained in the risk assessment (see table 13.1).
- The machine or system control must be electrically influenceable so that a switch command sent by the safety relay results in the immediate shutdown of the dangerous movement.
- The construction of the safety relay must not be altered. When manipulating the safety relay, the protective function is no longer guaranteed. Manipulating the safety relay also voids all warranty claims against the manufacturer of the safety relay.
- The safety relay must be tested regularly by a competent person (see chapter 9 "Testing").
- The safety relay must be exchanged after a maximum of 20 years. Repairs or the exchange of wear parts do not extend the mission time.

2.1.2 Using E-Stop buttons

It must be ensured that the EMERGENCY STOP function is always and immediately effective. An example showing the connection of a two-channel E-Stop button (see chapter 7.2.2 "Acceptance of pending sensor signals (S1 and S2), for both channel 1 (Sx1) and channel 2 (Sx2)").

E-Stop buttons connected to the safety relay act only on the safety circuit to which the AOPD or the safety switch is assigned. It can therefore be considered to be an area E-Stop. The limited sphere of action of the button is to be clearly marked for the operating personnel. E-Stop buttons must only be used for safety-related STOP signaling.

2.1.3 Using reset buttons

The "Reset" button for unlocking the start/restart interlock (RES)

- must be located outside of the danger zone.
- must be mounted so that the entire danger zone can be viewed from the installation site.
- must not be accessible from within the danger zone.

If, in the case of two danger zones, it is not possible to monitor both zones from just one location, two reset buttons (e.g. connected to the local socket of the AOPD) are to be used. The assignment of the buttons to the respective danger zone must be clearly labeled for the operating personnel.

2.1.4 Foreseeable misuse

Any use other than that defined under the "Approved purpose" or which goes beyond that use is considered improper use.

Alone, the safety relay is not a complete protective device. It is not suitable for use in the following cases:

- in explosive or easily flammable atmospheres.
- on machines or systems with long stopping times.

2.2 Competent persons

Prerequisites for competent persons:

- They have a suitable technical education.
- They know the rules and regulations for labor protection, safety at work and safety technology and can assess the safety of the machine.
- They know the instructions for the safety relay and the machine.
- They have been instructed by the responsible person on the mounting and operation of the machine and of the safety relay.

2.3 Responsibility for safety

Manufacturer and operating company must ensure that the machine and implemented safety relay 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 relay.
- 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 labor protection and safety at work.
- Regular testing by competent persons.

2.4 Exemption of liability

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

- Safety relay 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 9 "Testing").
- Changes (e.g., constructional) are made to the safety relay.

3 Device description

The safety relay serves as a link between one or more safety-related sensors and the machine control. These sensors may be

- type 4, type 3 or type 2 (self-testing) optoelectronic protective devices (AOPD),
- safety switches,
- safety locking devices,
- E-Stop buttons,
- safety rope switches or
- combinations of these sensors.

The safety relay includes a start/restart interlock that can be activated via the connection terminals, a contactor monitoring function (EDM) and features two safety-related relay outputs (OSSDs) and LED displays for status control.

The safety switch uses two terminal groups to connect the sensors and to signal their aggregate data via the OSSDs. Activation is only possible – taking into account RES and EDM – if the sensors on both channels and on both terminal groups are switched on.

If one of the sensors switches off, this causes the OSSDs of the safety relay to shut down immediately.

With appropriate bridging (see table 7.1), the evaluation can be reduced to just one sensor.

The safety system consists of the safety relay and the safety components connected to it. It enables machines or systems to assume a safe state before persons can be endangered. Through the flexible evaluation of two – possibly also different – sensors, the safety relay provides a compact, low-cost solution which, with performance level PL e in accordance with EN ISO 13849-1 and SIL 3 in accordance with IEC/EN 61508-1, satisfies the highest safety level.



Figure 3.1: MSI-SR5B with screw terminals



Figure 3.2: MSI-SR5B with spring-cage terminals

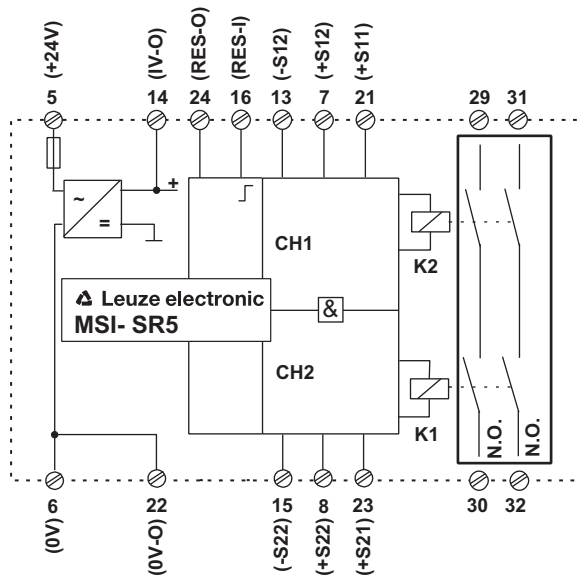


Figure 3.3: Internal circuit diagram

3.1 System overview

- Double sensor evaluation at two terminal groups
- 1- or 2-channel E-Stop circuit
- Cross-circuit detection
- Monitoring of external contactors in the reset circuit
- Monitored reset button (cross circuits between the button contacts and earth faults in the button circuit are detected.)
- Automatic or manual start/restart
- Stop category 0 (EN 60204-1:2018)
- 2 release circuits
- LED displays Power, K1 and K2, Reset
- Operating voltage 24 V AC/DC
- Housing width 22.5 mm
- Removable connection terminal blocks (screw terminals, spring-cage terminals)

3.2 Display elements

Four LEDs indicate the operating state of the safety relay.

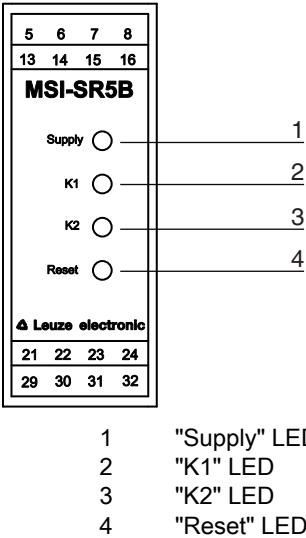


Figure 3.4: Display elements of the MSI-SR5B

Table 3.1: LED indicators

Designation	LED color	Meaning
Supply	Green	Supply voltage
K1	Green	Channel 1
K2	Green	Channel 2
Reset	Orange	Start/restart interlock locked

4 Functions

Start/restart interlock

The "start interlock function" ensures that when the system is switched on or when the supply voltage returns, even if the protective field is free, the safety-related output contacts (OSSDs) of the safety switch do not automatically switch to the ON state, but only after the reset button has been pressed and released. The "restart interlock function" prevents the OSSDs of the safety relay from automatically switching to the ON state if the protective fields of one or more of the connected AOPDs are again released following an interruption or if a safety switch is closed again. Here too, the reset button must be pressed and released to unlock the system.

If the "start/restart interlock function" operating mode is not selected for the safety relay, this function and the corresponding safety level must be ensured by other means.

Observe the safety notices (see chapter 2 "Safety").

Automatic start/restart

"Automatic start" ensures that, if the supply voltage is switched on or restored and with a free protective field or closed safety switch, the safety-relevant output contacts (OSSDs) of the safety relay automatically switch to the ON state.

"Automatic restart" ensures that the OSSDs automatically switch to the ON state if the protective fields of one or more of the connected AOPDs are again released following an interruption or if a safety switch is closed again.

If the "automatic start/restart" operating mode is selected for the safety relay, steps must be taken to ensure that it is not possible to step or reach behind or the appropriate safety level must be ensured by other means.

Observe the safety notices (see chapter 2 "Safety").

EDM contactor monitoring

The "contactor monitoring" function monitors the contactors or relays connected downstream of the safety relay. Before the OSSDs of the safety relay are switched to the ON state, a check is always performed to determine whether the downstream switching elements have closed and reopened. If they have not, the OSSDs remain in the OFF state. If functioning correctly, the start/restart interlock can be unlocked.

The "contactor monitoring" operating mode is selected for the safety relay by looping the EDM contacts of the subsequent switching elements (e.g. relays, contactors) into the remainder of the circuit. Alternatively, the corresponding safety level must be ensured by other means.

Reset button monitoring

To detect static faults or blocking of the reset button, the button function is monitored for signal changes. Enabling occurs when the button is released (1/0 signal change).

Cross-circuit detection

Cross-circuits are detected on the basis of the following correlations:

- AOPDs on the basis of the different test pulses of two transistor OSSDs
- AOPDs with relay OSSDs and two-channel safety switches using 24 V and 0 V
- Cross-circuit between the two channels of a terminal group (+S11, +S12, -S12 and +S21, +S22, -S22) by means of the 30 ms time window of a group.

If it is to be expected that two, single-channel, contact-controlled sensors will be switched on simultaneously, these must be connected at a terminal group or a protected cable layout must be selected.

5 Applications

- Sequential circuit for type 4 protective sensors with relay or semiconductor outputs
- Sequential circuit for type 3 laser scanners with semiconductor outputs
- Sequential circuit for type 2 photoelectric sensors (two-channel, self-testing)
- Single-channel E-Stop wiring (up to category 2, EN ISO 13849-1, separate testing)
- Two-channel E-Stop wiring (up to category 4, EN ISO 13849-1)
- Single-channel protective door monitoring (up to category 2, EN ISO 13849-1, separate testing)
- Two-channel protective door monitoring (up to category 4, EN ISO 13849-1)

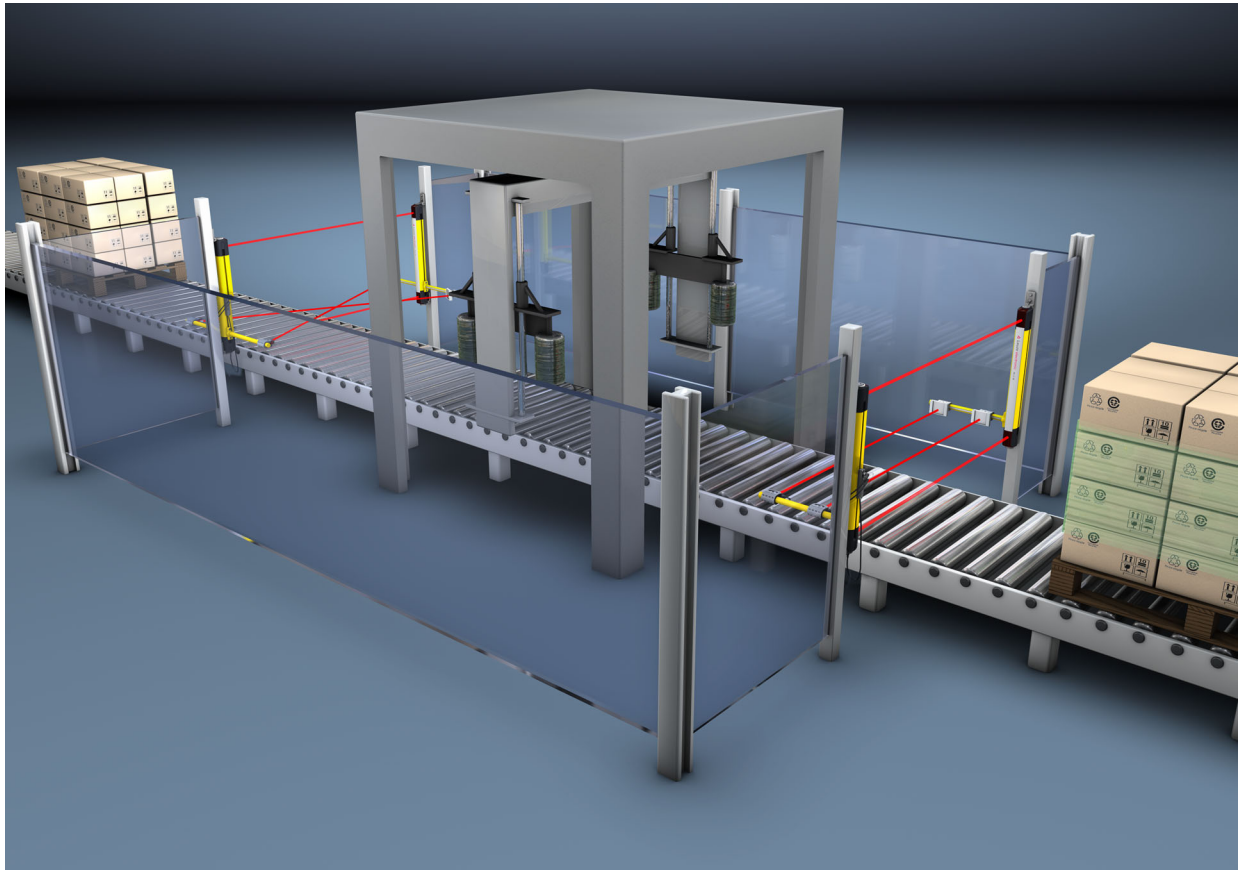


Figure 5.1: For double muting with entry and exit area, the safety relay evaluates e.g. two AOPDs with integrated muting function and two muting sensors for each AOPD.

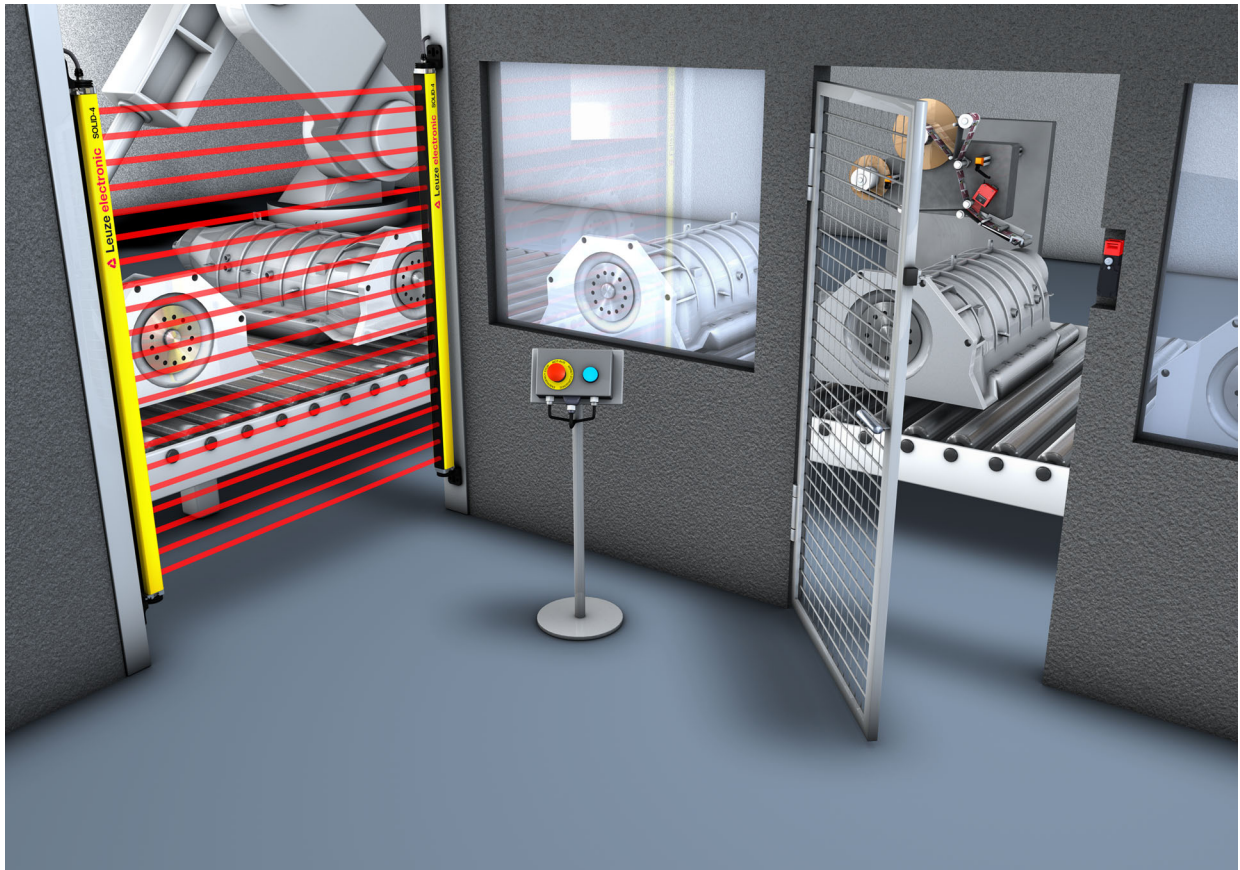




Figure 5.2: With this type of point of operation guarding with a service door, the safety relay evaluates the signals of the safety locking device and of the AOPD.

6 Mounting

 WARNING	
	<p>Improper mounting may result in serious injury!</p> <p>The protective function of the safety relay is only ensured if appropriately and professionally mounted for the respective, intended area of application.</p> <ul style="list-style-type: none">↳ Only allow competent persons to install the safety relay.↳ Observe the relevant standards, regulations and these instructions.

The safety relay is intended for mounting on a DIN rail in the switch cabinet.


Prerequisites for mounting:

- Switch cabinet with appropriate degree of protection (at least IP54).
- Sufficient space on the DIN rail.
- Arrangement of the protective device acc. to EN ISO 13855 and IEC/EN 61496-2.

↳ Snap the safety relay onto the DIN rail.


The safety relay can be connected to the safety sensors.

7 Electrical connection

⚠ DANGER	
	Risk of death by electric shock!
	Depending on external wiring, dangerous voltages may be present at the switching outputs. ⚡ During all work at the electrical system or electronics, make certain that each voltage supply has been interrupted and protected against being restarted.

The following must be observed for the current supply of the safety relay:

- Supply voltage 24 V DC $\pm 20\%$.
- Safe mains separation acc. to IEC/EN 61558-2-6 possible.
- A corresponding power supply unit handles interruptions of the supply voltage up to 10 ms in duration acc. to IEC/EN 61496-1.

⚠ WARNING	
	Improper electrical connection may result in serious injury!
	<ul style="list-style-type: none"> ⚡ Only allow competent persons to perform the electrical connection. ⚡ Make certain that supply and signal lines are laid separately from power lines. ⚡ Use appropriate spark extinction for contactors in the cabinet. ⚡ Observe the installation and operating information for the products that are to be evaluated via the safety relay (e.g. multiple light beam safety devices, safety switches, etc.). ⚡ Observe the installation and operating information for the products that are to be connected via the safety relay (e.g. drive motors, brakes, etc.). ⚡ When using contact-controlled sensors, separately laid supply lines are to be used for sensor 1 (+S11, +S12, -S12) and sensor 2 (+S21, +S22, -S22). Cross-circuit monitoring exists within the terminal groups, but not between the groups.

The following conditions apply for the electrical connection:


- Integration of the safety relay in the control circuit acc. to EN ISO 13849-1.
- Laying of the supply voltage cables separately acc. to EN ISO 13849-1.
- Shutdown of the supply voltage for operational purposes is to be made impossible.
- If the simultaneous switching of two single-channel, contact-controlled sensors is planned, these must be connected to **one terminal group**.
- If non-simultaneous switching of two single-channel, contact-controlled sensors is planned, these are to be connected separately to **two terminal groups** and the lines to the S inputs of the safety relay are to be laid in a protected manner.
- Connections 29, 30, 31 and 32 have increased isolation with respect to the housing and the other connections. The mixed connection of protective extra low voltage and low voltage (e.g. 240 V~) at terminals 29, 30, 31 and 32 is not permissible.
- It is not permissible to connect the sensor lines in parallel with third-party components.
- All available safety inputs must be occupied.
- To prevent welding of the output contacts, an external fuse must be connected upstream according to the technical specifications (see table 13.2).
- Terminals 14 and 22 are not intended for the operation of external devices, but rather only for supplying potential-free contacts.
- When connecting potential-free contacts at the S inputs (21, 13, 23, 15) of the safety relay, a safety fuse must be connected upstream acc. to EN 50156-1.

Connecting the signal lines

For reliable and touch-safe contacts, isolate the connection ends as follows:

- Screw terminals: 7 mm
- Spring-cage terminals: 8 mm

7.1 Terminal assignments

⚠ WARNING	
	<p>Selecting the wrong functions may result in serious accidents!</p> <ul style="list-style-type: none"> ⚡ Always connect protective sensors to an external safety relay and activate the restart interlock. ⚡ For access guarding, make certain that the restart interlock cannot be unlocked from within the danger zone but that the danger zone can be viewed from the acknowledgment button (Reset). ⚡ Select the functions so that the safety relay is used as intended (see chapter 2.1 "Intended use and foreseeable misuse").

Connected to the safety relay are 16 numbered terminals to which the cables for the various functions are connected.

The connection of the safety relay is divided into two sensor groups, additional functions, OSSDs and supply voltage.

Table 7.1: Terminal assignments

Terminal	Designation	Function
5	+Ub	Voltage supply, 24 V
6	0V	Voltage supply, 0 V
7	+S12	24 V input 1, channel 2
21	+S11	24 V input 1, channel 1
13	-S12	0 V input 1, channel 2
8	+S22	24 V input 2, channel 2
23	+S21	24 V input 2, channel 1
15	-S22	0 V input 2, channel 2
14	IV-O	24 V voltage supply, contacts
16	RES-I	Reset input
24	RES-O	Signal for automatic restart interlock
22	0V-O	0 V voltage supply, contacts
29	OSSD1	Relay contact 1
30	OSSD1	Relay contact 1
31	OSSD2	Relay contact 2
32	OSSD2	Relay contact 2

7.2 Sensor wiring

The following evaluation combinations can be selected through external wiring of the safety relay:

Table 7.2: Evaluation combinations

Evaluation	Operating mode	Connection, terminal	Bridging, if the adjacent terminal group is not needed
AOPD 1, self-testing (OSSD transistor)	Channel 1 Channel 2	→ 21 → 7 Bridge 22 → 13	14 → 21 14 → 7 22 → 13
AOPD 2, self-testing (OSSD transistor)	Channel 1 Channel 2	→ 23 → 8 Bridge 22 → 15	14 → 23 14 → 8 22 → 15
AOPD 1, self-testing (OSSD relay)	Channel 1 Channel 2	24V → SK → 21 0V → SK → 13 Bridge 14 → 7	14 → 21 22 → 13 14 → 7
AOPD 2, self-testing (OSSD relay)	Channel 1 Channel 2	24V → SK → 23 0V → SK → 15 Bridge 14 → 8	14 → 23 22 → 15 14 → 8
Safety switch 1, two-channel	Channel 1 Channel 2	24V → SK → 21 0V → SK → 13 Bridge 14 → 7	14 → 21 22 → 13 14 → 7
Safety switch 2, two-channel	Channel 1 Channel 2	24V → SK → 23 0V → SK → 15 Bridge 14 → 8	14 → 23 22 → 15 14 → 8
Safety switch 1, single-channel	Channel 1	24V → SK → 21 Bridge 21 → 7 Bridge 22 → 13	14 → 21 14 → 7 22 → 13
Safety switch 2, one-channel	Channel 2	24V → SK → 23 Bridge 23 → 8 Bridge 22 → 15	14 → 23 14 → 8 22 → 15
E-Stop command device 1, two-channel	Channel 1 Channel 2	24V → SK → 21 0V → SK → 13 Bridge 14 → 7	14 → 21 22 → 13 14 → 7
E-Stop command device 2, two-channel	Channel 1 Channel 2	24V → SK → 23 0V → SK → 15 Bridge 14 → 8	14 → 23 22 → 15 14 → 8
E-Stop command device 2, single-channel	Channel 1	24V → SK → 21 Bridge 21 → 7 Bridge 22 → 13	14 → 21 14 → 7 22 → 13
E-Stop command device 2, single-channel	Channel 2	24V → SK → 23 Bridge 23 → 8 Bridge 22 → 15	14 → 23 14 → 8 22 → 15

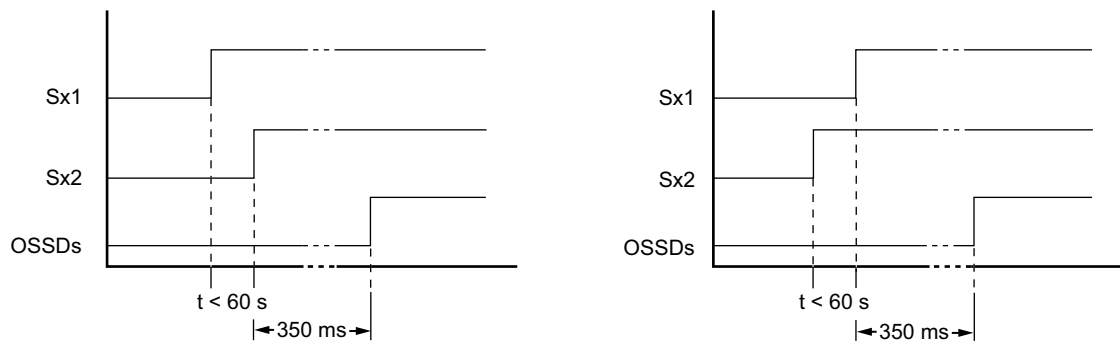
SK = safety-related contact

7.2.1 Selecting the operating modes

The following four operating modes can be selected through external wiring of the safety relay:

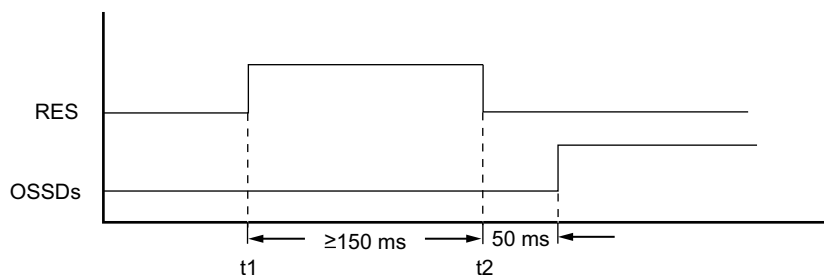
Automatic start/restart	Restart inter-lock	24 → 16
Start/restart interlock	RES	0V → RES → 16
Automatic start/restart and contactor monitoring	Restart inter-lock + EDM	24 → K3/K4 → 16
Start/restart interlock and contactor monitoring	RES + EDM	0V → K3/K4 → RES → 16

7.2.2 Acceptance of pending sensor signals (S1 and S2), for both channel 1 (Sx1) and channel 2 (Sx2)



- For the OSSDs to release, both sensors (S1 and S2) must have satisfied the conditions shown above.
- The time offset between the sensors (S1 and S2) is arbitrary.


7.2.3 Acceptance of the RES manual release signal via the start button at (RES-I)



- At time t_1 , all four channels (Sx1, Sx2) must have satisfied the release condition (see chapter 7.2.2 "Acceptance of pending sensor signals (S1 and S2), for both channel 1 (Sx1) and channel 2 (Sx2)").
- Release signal RES must be applied for at least $\geq 150 \text{ ms}$.

7.3 Circuit diagram examples

The following examples show possible connection combinations for AOPDs (relay, transistor), safety switches and E-Stop command devices on the safety relay.

NOTE	
	All available safety inputs must be occupied! Bridges are to connect the remaining sensor inputs where no components are connected (see table 7.2).

The following circuit shows the connection of two AOPDs with integrated muting function in a double-muting application, whereby the muting sensors are locally coupled to the AOPDs to reduce wiring.

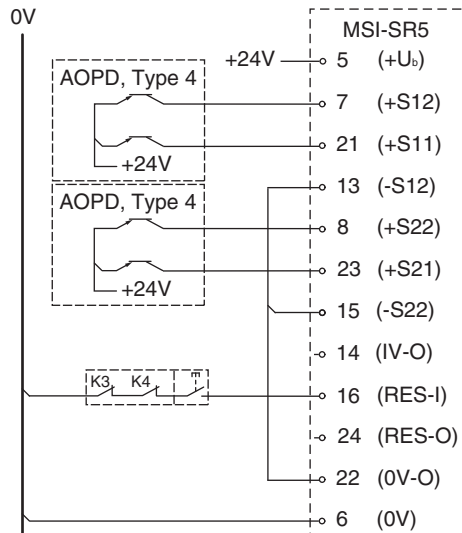


Figure 7.1: Two type 4 AOPDs each with two safety-relevant transistor outputs, manual restart (RES) and contactor monitoring (EDM, K3 and K4)

The following circuit shows the connection of an AOPD in a point of operation guarding system. An E-Stop button is provided in this circuit.

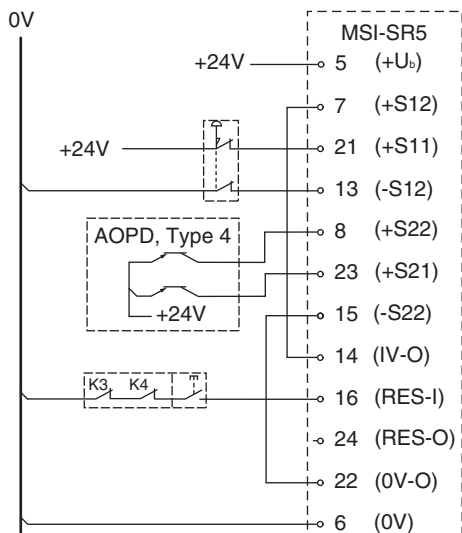


Figure 7.2: One type 4 AOPD with two safety-relevant transistor outputs, two-channel E-Stop button, RES and contactor monitoring (EDM, K3 and K4)

The following circuit shows the connection of an AOPD (laser scanner) in a danger zone safeguarding system. With this circuit, a reset button can deactivate the start/restart interlock.

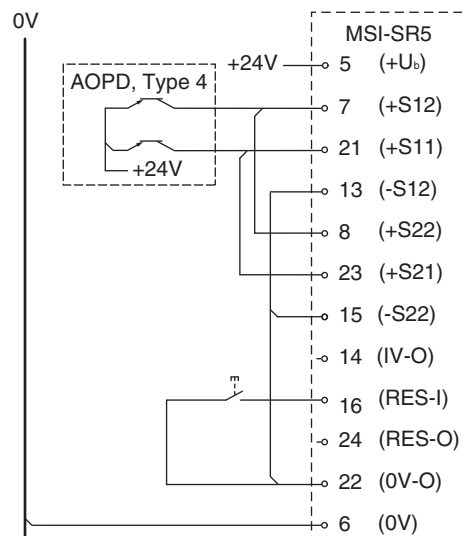


Figure 7.3: One type 4 AOPD with two safety-relevant transistor outputs, manual restart (RES), central wiring

The following circuit shows the connection of an AOPD with safety-related relay output contacts in a danger zone safeguarding system with contactor monitoring (EDM) in the button circuit. With this circuit, a reset button can deactivate the start/restart interlock.

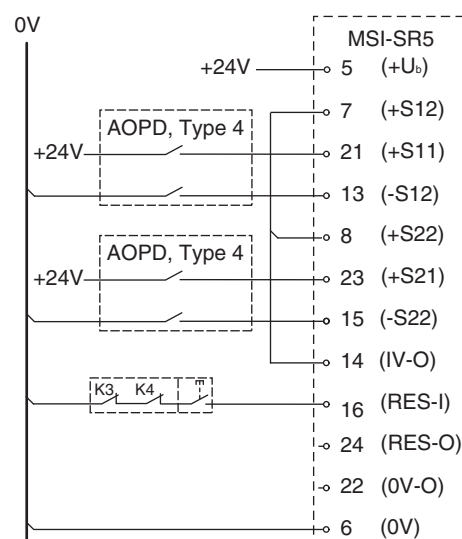


Figure 7.4: Two type 4 AOPDs, each with two normally open contacts, manual restart (RES) and contactor monitoring (EDM), separate supply lines to the AOPDs required, local wiring

The following circuit shows the connection of two safety switches for safeguarding flaps with no possibility of stepping or reaching behind. The automatic start/restart must be suitable for safety-related applications.

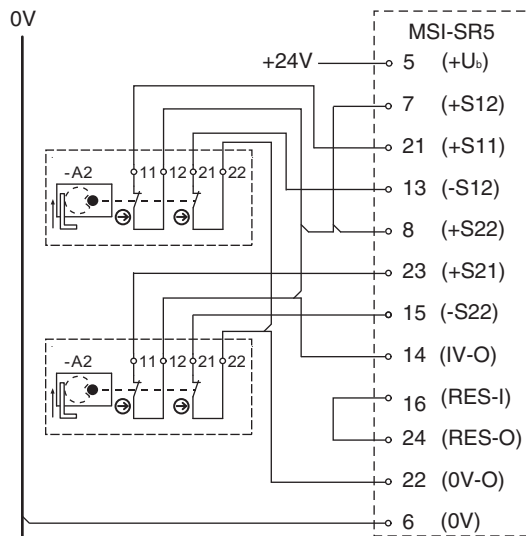
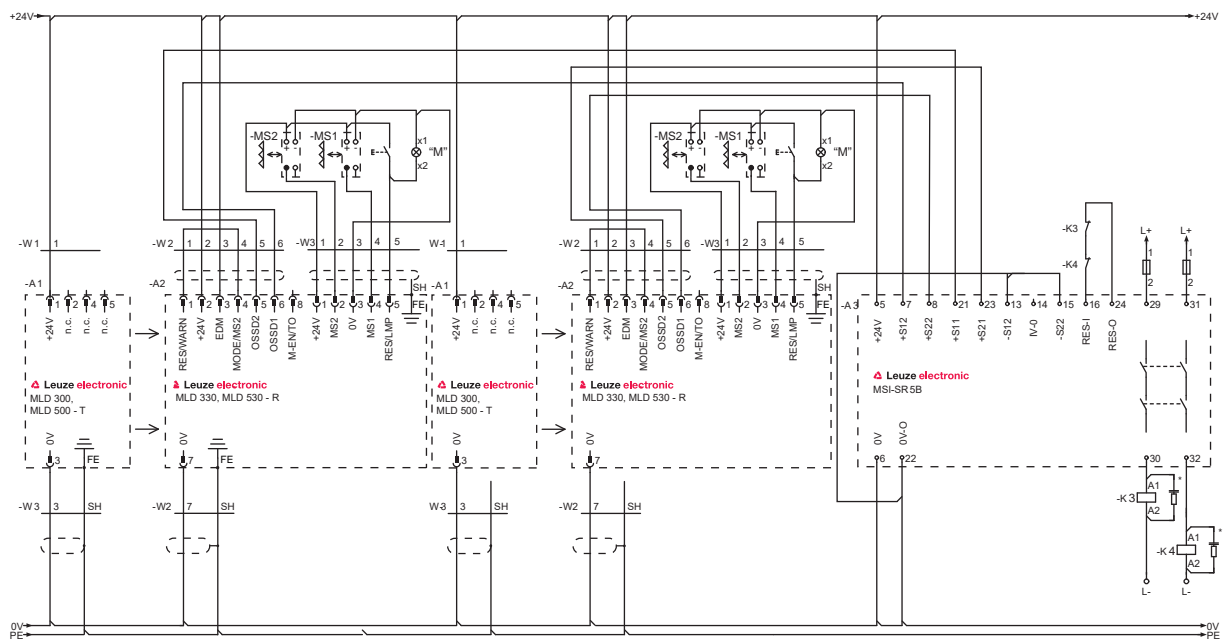


Figure 7.5: Two safety switches, two-channel, automatic restart, separate supply lines to the switches required, central wiring

The following connection example shows a double-muting application, each with two locally connected muting sensors and shared evaluation of the OSSDs by the safety relay. Optimization of the wiring is achieved by the local connection of the two reset buttons and by contactor monitoring via the safety relay in the cabinet. The muting function for each is integrated in the AOPDs.

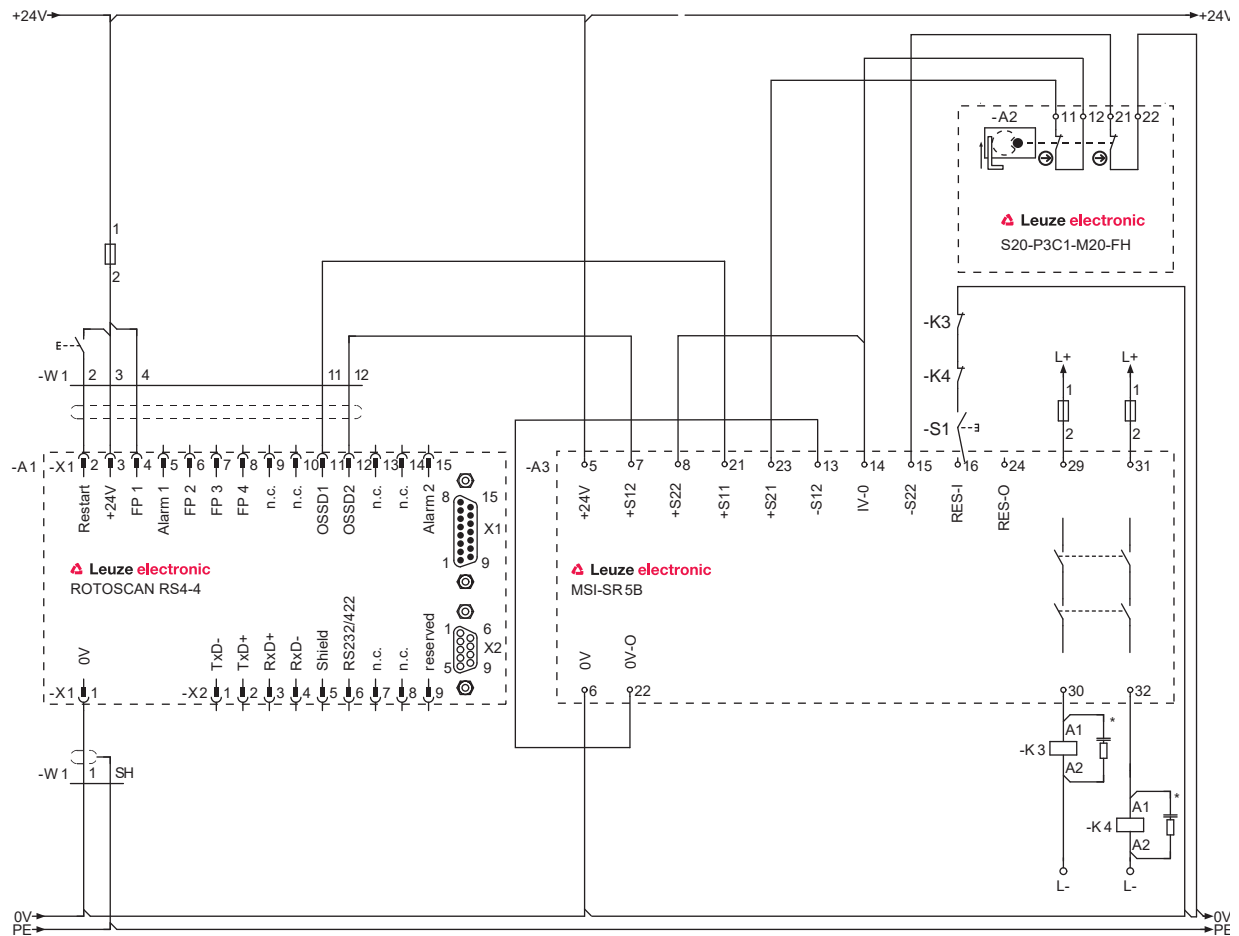


* Use appropriate spark extinction circuits

** Always use at least two contacts in the release circuit. Only use sequential contactors with positive-guided contacts.

Figure 7.6: Two type 4 AOPDs each with two safety-relevant transistor outputs, with two muting sensors, two manual restarts (RES) and contactor monitoring (EDM)

The following connection example shows danger zone guarding by means of a laser scanner and safeguarding of a service door with a safety switch. Due to the separate danger zones, a reset button is provided for each sensor for unlocking the start/restart interlock. Contactor monitoring is performed in the cabinet by the safety relay.



* Use appropriate spark extinction circuits

** Always use at least two contacts in the release circuit. Only use sequential contactors with positive-guided contacts.

Figure 7.7: One type 3 AOPD with two safety-related transistor outputs, one safety switch, manual re-start (RES) and contactor monitoring (EDM)



7.4 Connecting to the machine control

The safety-related parts of the control include, in addition to the safety relay described above, the subsequent control elements up to the power-transfer elements that are to be stopped safely and promptly. Special attention must be given here to the adherence to the required safety category. Important information on this topic can be found in harmonized European standard EN ISO 13849-1.

Essential prerequisites for safe operation are the abilities to electrically influence the interruption of the dangerous movement and to bring the machine to a standstill as quickly as possible. These must be taken into consideration in the calculation of the safety distance as must the response times of the safety-related chain (safety relay, AOPDs, contactors, etc.).

Other parameters, such as access speed or additional distance to be added to the safety distance, are dependent on the respective applications and the resolution of the used AOPD. European standard EN ISO 13855 includes calculation formulas and examples for various arrangements.

8 Starting up the device

 WARNING	
	<p>Improper use of the safety relay may result in serious injury!</p> <ul style="list-style-type: none"> ✚ Make certain that the entire device and the integration of the mechanical optoelectronic protective device was inspected by competent and instructed persons. ✚ Make certain that a dangerous process can only be started while the safety devices are switched on.

Prerequisites:

- Safety sensors, switches and safety relay were mounted and connected in accordance with the respective instructions.
- Operating personnel were instructed on proper use.
- Dangerous process was switched off and the system has been protected against being restarted again.

✚ During start-up, test the function of the safety relay (see chapter 9 "Testing").

8.1 Switching on

Requirements for the supply voltage (power supply unit):

- Safe mains separation is ensured (acc. to IEC/EN 61558-2-6).
- Changes and interruptions of the supply voltage are handled (acc. to IEC/EN 61496-1).
- The start/restart interlock function is connected and activated.

✚ Switch on the current supply.



✚ Check whether the "ON/OFF" LED on the safety relay lights up.

The safety relay is ready for use.

8.2 Start/restart

The start/restart button can be used to unlock the start/restart interlock. In this way, the responsible person can restore normal operation of the system following process interruptions (triggering of the protective function, failure of the voltage supply) (see chapter 8.2.1 "Unlocking start/restart interlock").

8.2.1 Unlocking start/restart interlock

 WARNING	
	<p>Premature unlocking of the start/restart interlock may result in serious injury!</p> <p>If the start/restart interlock is unlocked, the system can start up automatically.</p> <ul style="list-style-type: none"> ✚ Before unlocking the start/restart interlock, make certain that no people are in the danger zone.

The red and yellow LEDs illuminate as long as the restart is disabled.

✚ Make certain that the active protective field is clear.



✚ If the active protective field is not clear, select a different procedure.

✚ Make certain that there are no people in the danger zone.

✚ Press the start/restart button and release it again (after 0.06 ... 2 s).

The safety relay switches back to the "ON" state.

9 Testing

 WARNING	
	<p>A running machine may result in serious injury!</p> <p>☞ Make certain that, during all conversions, maintenance work and inspections, the system is securely shut down and protected against being restarted.</p>



The safety relays must be exchanged after a maximum of 20 years.

- ☞ Always exchange the entire safety relay.
- ☞ For the tests, observe nationally applicable regulations.
- ☞ Document all tests in a comprehensible manner.

9.1 Before the initial start-up and following modifications

Acc. to IEC/EN 62046-03 and international regulations (e.g. EU directive 2009/104/EC), tests are to be performed by competent persons in the following situations:

- Prior to the initial start-up
- Following modifications to the machine
- After longer machine downtime
- After retrofitting or reconfiguring the safety device (safety relay and/or safety sensors)

 WARNING	
	<p>Unpredictable machine behavior during initial start-up may result in serious injury!</p> <p>Make certain that there are no people in the danger zone.</p>

- ☞ Test the effectiveness of the shutdown function in all operating modes of the machine acc. to the corresponding checklist see chapter 9.1.1 "Checklist – initial start-up".
- ☞ Document all tests in a comprehensible manner and include the configuration of the safety relay along with the data for the safety and minimum distances in the documentation.
- ☞ Before they begin work, train the operating personnel on their respective tasks. The training is the responsibility of the operating company.
- ☞ Check whether the safety relay was correctly selected acc. to the locally applicable regulations and directives.
- ☞ Check whether the safety relay is operated acc. to the specified environmental conditions (see chapter 13 "Technical data").
- ☞ Make certain that the safety relay is protected against overcurrent.
- ☞ Perform a visual inspection for damage and test the electrical function see chapter 9.2 "To be performed periodically by a competent person".

Minimum requirements for the power supply unit:

- Safe mains separation.
- Power-failure bridging for at least 10 ms.

Not until proper function of the optoelectronic safety device and the safety relay is ascertained may they be integrated in the control circuit of the system.

9.1.1 Checklist – initial start-up

Interval: once, prior to the initial start-up and following modification

Tester: competent person

Table 9.1: Checklist – initial start-up

Items on the check list	Yes	No
Were all safety directives and standards relevant to this machine type observed?		
Does the declaration of conformity of the machine include a listing of these documents?		
Does the safety relay satisfy the safety-related capability (PL, SIL, category) as required by the risk assessment?		
Circuit diagram: Are the safety-related switching outputs (OSSDs) integrated in the downstream machine control acc. to the required safety category?		
Are the switching elements (e.g. contactors) with positive-guided contacts that are controlled by the safety relay monitored by an external device monitoring circuit (EDM)?		
Does the electrical wiring match the circuit diagrams?		
Have the required protective measures against electrical shock been effectively implemented?		
Has the maximum stopping time of the machine been remeasured and recorded in the machine documents?		
Is the required safety distance (protective field to the next point of operation) maintained?		
Are all points of operation of the machine accessible only through the protective field? Are all additional protective devices (e.g. safety guards) correctly mounted and protected against tampering?		
Is the command device for triggering the start/restart interlock of the safety relay or the machine mounted in accordance with specifications?		
Are safety relay, connecting cable, plug, protection caps and command devices undamaged and free of any signs of manipulation?		
Has the effectiveness of the protective function been ensured for all operating modes of the machine by means of a function test?		
Is the start/restart button for resetting the safety relay mounted outside of the danger zone in accordance with specifications in such a way that it cannot be reached from within the danger zone? Can the entire danger zone be seen from the place at which the start/restart button is installed?		
Does the interruption of any given beam cause the dangerous movement to stop?		
When the AOPD is separated from its supply voltage, does the dangerous movement stop, and, after the supply voltage has been restored, is it necessary to actuate the start/restart button to reset the machine?		
Is the safety relay/Are the safety sensors effective during the entire dangerous movement of the machine?		
Are the notices for daily testing of the safety sensor legible to the operating personnel and are they located in a highly visible location?		

📁 Store this checklist with the machine documents.

9.2 To be performed periodically by a competent person


The reliable interaction of safety sensor, safety relay and machine must be periodically tested in order to detect changes to the machine or impermissible tampering with the safety sensor. Testing intervals are determined by nationally applicable regulations (recommendation acc. to IEC/TS 62046: 6 months).


👤 Have all tests performed by competent persons.

↳ Observe the nationally applicable regulations and the time periods specified therein.

9.3 To be performed daily by the operating personnel

The function of the safety relay must be checked daily or at change of shifts, and at each change of machine operating mode as specified in the corresponding checklist (see chapter 9.3.1 "Check list – daily or at change of shift") so that damages or unauthorized manipulations can be detected.

⚠ WARNING	
	Unpredictable machine behavior during the test may result in serious injury! ↳ Make certain that there are no people in the danger zone.

⚠ WARNING	
	Faults during the daily inspection may result in serious injury! If you answer one of the items on the check list see table 9.2 with "no", the machine may no longer be operated. ↳ Have the entire machine inspected by a competent person see chapter 9.1 "Before the initial start-up and following modifications".

↳ Stop the dangerous state.

↳ Check the safety relay, sensors, switches and command devices for damage or tampering.

↳ Interrupt the light beam of the protective sensor and actuate the switches and command devices from a position outside the danger zone and ensure that the machine cannot be started when a light beam is interrupted.

↳ Start the machine.

↳ Ensure that the dangerous state is stopped as soon as a light beam is interrupted or a switch is actuated.

9.3.1 Check list – daily or at change of shift

Interval: daily or at shift change

Tester: authorized operating personnel or instructed person

Table 9.2: Check list – daily or at change of shift

Items on the check list	Yes	No
Are safety relay, protective sensor, connecting cables, plugs and command devices undamaged and free of any signs of manipulation?		
Are all points of operation at the machine accessible only through one or more protective fields of protective sensors?		
Are all additional protective devices mounted correctly (e.g., safety guard)?		
Does the start/restart interlock prevent the automatic start-up of the machine after the protective sensor/safety relay has been switched on or activated?		
↳ Interrupt a light beam of the protective sensor with a test object during operation. Is the dangerous movement shut down immediately?		

10 Maintenance

The safety relay is maintenance-free.

11 Disposing

↳ For disposal observe the applicable national regulations regarding electronic components.

12 Service and support

Service hotline

You can find the contact information for the hotline in your country on our website www.leuze.com under **Contact & Support**.

Repair service and returns


Defective devices are repaired in our service centers competently and quickly. We offer you an extensive service packet to keep any system downtimes to a minimum. Our service center requires the following information:

- Your customer number
- Product description or part description
- Serial number or batch number
- Reason for requesting support together with a description

Please register the merchandise concerned. Simply register return of the merchandise on our website www.leuze.com under **Contact & Support > Repair Service & Returns**.

To ensure quick and easy processing of your request, we will send you a returns order with the returns address in digital form.

What to do should servicing be required?

NOTE	
	<p>Please use this chapter as a master copy should servicing be required.</p> <p>✉ Enter the contact information and fax this form together with your service order to the fax number given below.</p>

Customer data (please complete)

Device type:	
Serial number:	
Firmware:	
Display messages	
Status of LEDs:	
Error description	
Company:	
Contact person/department:	
Phone (direct dial):	
Fax:	
Street / no.:	
ZIP code / City:	
Country:	

Leuze Service fax number:

+49 7021 573 - 199

13 Technical data

Table 13.1: Safety-relevant technical data

Type in accordance with EN IEC 61496-1:2020	Type 4		
Performance Level (PL) in accordance with EN ISO 13849-1:2015	PL e		
SIL in accordance with IEC/ EN 61508-1:2010	SIL 3		
Category in accordance with EN ISO 13849-1:2015	Category 4		
Stop category in accordance with EN 60204-1:2018	Stop 0		
Mean probability of a dangerous failure per hour (PFH _D) as a function of the mean number of annual switching cycles of the relay n _{op} *	100% Load	n _{op} = 4,800:	1 x 10 ⁻⁰⁸ 1/h
	60% Load	n _{op} = 4,800:	1 x 10 ⁻⁰⁸ 1/h
	100% Load	n _{op} = 28,800:	2 x 10 ⁻⁰⁸ 1/h
	60% Load	n _{op} = 8,800:	1 x 10 ⁻⁰⁸ 1/h
	100% Load	n _{op} = 86,400:	5 x 10 ⁻⁰⁸ 1/h
	60% Load	n _{op} = 86,400:	2 x 10 ⁻⁰⁸ 1/h
Number of cycles until 10% of the components have a dangerous failure (B10 _d)	400,000:	100% of the max. switching current of loading cases AC1 ... DC13	
	2,500,000:	60% of the max. switching current of loading cases AC1 ... DC13	
Mean time to dangerous failure (MTTF _D)	73 years		
Mission time (T _m)	20 years		
*n _{op} = mean number of annual actuations, see C.4.2 and C.4.3 of EN ISO 13849-1:2015			
Use the following formula to calculate the mean number of annual actuations: n _{op} = (d _{op} · h _{op} · 3600 s/h) ÷ t _{cycle}			
When doing so, assume the following with regard to the use of the component: h _{op} = mean operating time in hours per day d _{op} = mean operating time in days per year t _{cycle} = mean time between the start of two successive cycles of the component (e.g. switching of a valve) in seconds per cycle			

Table 13.2: General system data

Connectable safety sensors (+S11, +S12, -S12) (+S21, +S22, -S22)	Up to two type 4, type 3 or type 2 AOPDs, self-testing, (each acc. to EN IEC 61496-1:2020)
Connectable safety switches (except for solenoid switches) and E-Stop command devices (+S11, -S12) (+S21, -S22)	Safety switches acc. to EN ISO 14119 E-Stop buttons acc. to EN ISO 13850
Classification in acc. with ZVEI, CB24i Edition 2.0.1 (+S11, +S12, +S21, +S22)	Drain C1, max. impulse duration 1 ms; Compatible sources class C2, C3
Available functions	Start/restart interlock Contactor monitoring (EDM)

Control input RES-I Start/restart interlock (reset)	Potential-free normally open contact (RES button or key switch)
Control input RES-I Contactor monitoring (EDM)	Feedback of positive-guided contacts of sequential contactors (see connection diagram)
Operating voltage U_B	24 V DC \pm 20 % (PELV)
Power consumption	4.8 W
Max. input current	150 mA
External safeguarding for supply circuit	200 mA delay-action
Control voltage at inputs +S/-S	24 V DC / 0 V
Control current at +S/-S	40 mA
Admissible input line resistance	< 30 Ω
Pickup delay – manual start	50 ms
Pickup delay – automatic start	350 ms
Time window between two channels of a sensor	< 60 ms
Regression delay, response time	10 ms
Max. test pulse acceptance	1 ms
Switching capacity of OSSDs in accordance with EN 60947-5-1	Two safety-related normally open contacts AC-15: 230 V / 5 A 1.6 million switching cycles DC-13: 24 V / 3 A 1.3 million switching cycles
Max. continuous current per current path	2 A
Ext. contact fuse protection per current path	5 A quick-action or 3.15 A delay-action (4A gG D-fuse)
Max. switching frequency	3600 switching cycles/h
Mechanical life time	10 million switching cycles
Overvoltage category	III for rating voltage 300 V AC in accordance with VDE 0110 part 1
Degree of contamination	2
Interference emission	EN 55011, EN 61000-6-3:2007
Interference rejection	EN IEC 61496-1:2020, type 4
Vibration resistance	5 g, 10 - 55 Hz acc. to IEC/EN 60068-2-6, amplitude 0,35 mm
Shock resistance	10 g, 16 ms acc. to IEC/EN 60068-2-27
Degree of protection	Housing IP 40, terminals IP 20 for installation in cabinet or housing with minimum degree of protection IP 54 required
Mounting	On 35 mm DIN top-hat supporting rail in accordance with IEC/EN 60715
Permissible wire gauge screw terminals	0.2...2.5 mm ² (AWG 24-12)
Permissible wire gauge spring-cage terminals	0.2...1.5 mm ² (AWG 24-16)

Maximum tightening torque	0.52 Nm
OSSD-suitable spark extinction via the coils of the downstream relays	Required
Ambient temperature, operation	0 ... 55 °C
Ambient temperature, storage	-25 ... 70 °C
Relative humidity (non-condensing)	0 ... 95%
Dimensions	99 x 22.5 x 111.5 mm
Weight	170 g

13.1 Dimensions

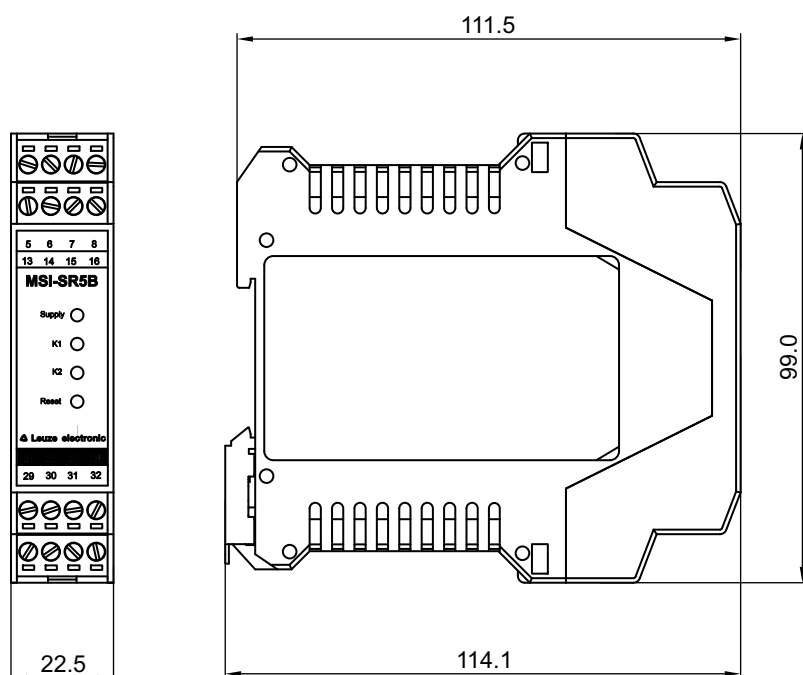


Figure 13.1: Dimensions of MSI-SR5B-01

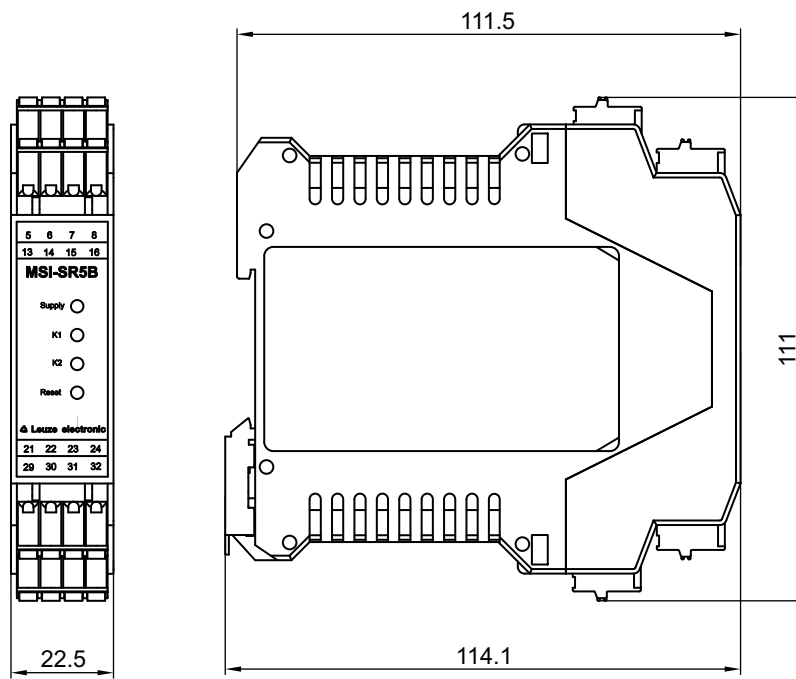


Figure 13.2: Dimensions of MSI-SR5B-02

14 Order guide

Table 14.1: MSI-SR5B safety relays

Part no.	Article	Description
547952	MSI-SR5B-01	Safety relay, screw terminals
547953	MSI-SR5B-02	Safety relay, spring-cage terminals