

MSI-SR5 Safety Relays



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Leuze electronic GmbH + Co. KG

In der Braike 1

D-73277 Owen - Teck / Germany

Phone: +49 7021 573-0

Fax: +49 7021 573-199

<http://www.leuze.com>

info@leuze.de

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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
NOTICE	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 injury 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 serious 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.
	Symbols 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
EDM	External Device Monitoring
ESPE	Electro-Sensitive Protective Equipment
RES	Start/restart interlock (reset)
PFH	Probability of a dangerous Failure per Hour
MTTF	Mean Time To Failure
PL	Performance Level
N.C.	Normal Closed Contact N/C
N.O.	Normal Open Contact N/O
K1 - K2	Indication Protected fields free/interrupted Display of the switching state of the Safety Relay's OSSD
K3 - K4	Downstream relays or contactors

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.

2 Safety

Before using the Safety Relay, a risk evaluation must be performed according to valid standards (e.g. ISO 14121, EN ISO 12100-1, EN ISO 13849-1:2008, EN 61508:2001, EN 62061:2005). 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 (e.g., regarding connected sensors such as AOPDs, Safety Switches) must be observed, printed out and be provided 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 sensors:

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



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

2.1 Approved purpose and foreseeable improper operation

WARNING
<p>Electrically live systems pose a risk of electric shock!</p> <p>↳ During all conversions, maintenance work and inspections, make certain that the voltage supply is interrupted and protected against being restarted again.</p> <p>↳ Only have work on the electrical system and electronics performed by a competent person.</p>

2.1.1 Proper use

WARNING
<p>A running machine may result in serious injury!</p> <p>↳ Make certain that the Safety Relay is correctly connected and that the protective function of the protective device is ensured.</p> <p>↳ Make certain that, during all conversions, maintenance work and inspections, the system is securely shut down and protected against being restarted again.</p>

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 information included in these operating instructions is observed.

- The Safety Relay is used as a safety monitoring device in combination with one or more AOPDs for safeguarding danger zones or locations of hazard on machines and systems.
- The Safety Relay is used as a safety monitoring device in combination with one or more Safety Switches for the position monitoring of guards.
- The Safety Relay is used as a safety monitoring device in combination with one or more E-STOP safety buttons or E-STOP Safety Rope Switches.
- The Safety Relay may only be used after it has been selected in accordance with the respectively applicable, relevant instructions and the relevant rules, standards and regulations regarding labor protection and safety at work, and after it has been mounted, connected, checked and started up by a competent person.
- The Safety Relay must only be connected and started up in accordance with its specifications (technical data, environmental conditions, etc., (see table 13.2)).
- The Safety Relay must be selected so that its safety-related capability meets or exceeds the required Performance Level PL ascertained in the risk evaluation (see table 13.1).
- The Safety Relay satisfies the requirements of safety category 4 in accordance with EN ISO 13849-1:2008. If, however, AOPDs or Safety Switches with a lower safety category are connected, the entire category for the corresponding path of the control cannot be higher than that of the connected AOPD.
- When connecting single-channel AOPDs or Safety Switches in accordance with Cat. 2 EN ISO 13849-1:2008, the testing specified in this standard is to be ensured separately.
- The machine or system control must be electrically influenceable so that a STOP command sent by the Safety Relay results in the immediate shutdown of the dangerous movement.
- Depending on external wiring, dangerous voltages may be present at the switching outputs. In addition to the supply voltage, these must be switched off and safeguarded against being switched back on prior to all work on the Safety Relay.
- The safety distance between the AOPD and the location of hazard is to be maintained. It is calculated according to the formulas for machine-specific C standards or given in the general B1 standard ISO 13855. The response time of the Safety Relay as well as the braking time of the machine must be taken into account.
- The safety distance between the guard used in combination with Safety Switches and the location of hazard is to be maintained. It is calculated according to the formulas for machine-specific C standards or given in the general B1 standard ISO 13855. The response time of the Safety Relay as well as the braking time of the machine must be taken into account; if necessary, a Safety Locking Device is to be used.
- Two switching contacts must always be looped into the switch-off circuit of the machine. To prevent welding, relay switching contacts must be fused/protected externally according to the technical data (see chapter 13 „Technical data“).
- The Safety Relay must be tested regularly by a competent person.
- The Safety Relay must be exchanged after a maximum of 20 years. Repairs or the exchange of parts subject to wear and tear do not extend the service life.
- 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.

2.1.2 Using E-STOP buttons

It must be ensured that the E-STOP function always acts directly and immediately. An example for the connection of a two-channel E-STOP button see chapter 7.1.3 „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. Thus, it can 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" 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 the overview of the situation is not ensured in the case of two danger zones, two reset buttons (e.g., connection at the local socket of the AOPD) are to be used. The assignment of the buttons for the respective danger zone is to be clearly labeled for the operating personnel.

2.1.4 Foreseeable misuse

Any use other than that defined in chapter Safety 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 without additional safety-related control measures.

2.2 Competent persons

Prerequisites for competent persons:

- They have a suitable technical education
- They know the rules and regulations for occupational safety, 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 safety-related components 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 and the sensors
- imparting all relevant information to the operating company
- adhering to all regulations and directives for the safe starting-up of the machine

The company operating the machine is responsible for:

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

2.4 Exemption of liability

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

- Safety 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.


Two terminal groups allow the Safety Relay to connect the sensors and signals their aggregate data via the OSSDs. Only if the sensors are switched-on on both channels and on both terminal groups is it possible to switch through - taking into account RES and EDM.

If one of the sensors switches off, this results in the immediate shutdown of the OSSDs of the Safety Relay. 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 achieve a safe state before persons can be endangered. Through the flexible evaluation of two - even different - sensors, the Safety Relay makes available a compact, economical Safety Relay which, with Performance Level (PL) e in accordance with EN ISO 13849-1:2008 and SIL-3 in accordance with EN 61508:2001, satisfies the highest safety level.

Leuze electronic offers a range of other MSI safety monitoring devices with standard and special functions, such as muting (suppression of the safety function in accordance with the intended application) or cycle control (one- or two-cycle operation).

All MSI safety monitoring devices are equipped with relay outputs. The extended versions (e.g. MSI-sx/Rx) offer, in addition to extended functionality, the additional connection of Safety Switches or E-STOP buttons up to and including safety category 4.

Certifications	
Europe EC Type Examination EN ISO 13849-1:2008 GS-ET-20 "Safety Relays"	
	TÜV SÜD
	NRTL, applied for

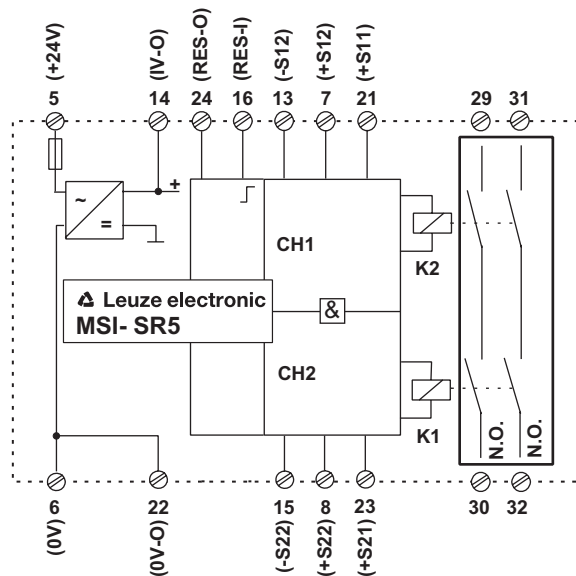


Figure 3.1: Internal circuit diagram

3.1 System overview

- Double sensor evaluation at two terminal groups
- 1- or 2-channel E-STOP circuit
- Cross-circuit recognition
- Monitoring of external contactors in the reset circuit
- Monitored reset button (cross connections between the button contacts and earth faults in the button circuit are detected.)
- Automatic or manual start/restart
- Stop category 0 (EN 60204-1:2006)
- 2 release circuits
- LED displays Power, K1 and K2, reset
- Operating voltage 24 V AC/DC
- Housing width, 22.5 mm

3.2 Application possibilities

- Sequential circuit for Light Beam Safety Devices type 4 with relay- or semiconductor outputs
- Sequential circuit for type 3 laser scanners with semiconductor outputs
- Sequential circuit for type 2 Light Beam Safety Devices (two-channel, self-testing)
- Single-channel E-STOP wiring, (up to category 2, EN ISO 13849-1:2008, separate testing)
- Two-channel E-STOP circuit (up to category 4, EN ISO 13849-1:2008)
- Single-channel protective door monitoring (up to category 2, EN ISO 13849-1:2008, separate testing)
- Two-channel protective door monitoring (up to category 4, EN ISO 13849-1:2008)

3.3 Display elements

Four LEDs indicate the operating state of the Safety Relay.

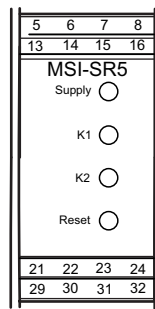


Figure 3.2: LED displays

Table 3.1: LED displays

Description	LED color	Message
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 if the supply voltage is switched on or restored - even with a clear protective field - the safety-relevant output contacts (OSSDs) of the Safety Relay do not automatically switch to the ON state, but instead do so only after the reset button is 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 again closed. Unlocking likewise occurs by pressing and again releasing the reset button.

If the “start/restart interlock function” operating mode is not selected for the Safety Relay, this function and the corresponding safety level are to be ensured by other means.

Observe the safety information (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, walking or reaching behind is to be made impossible or the appropriate safety level is to be ensured by other means.

Observe the safety information (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 that is not the case, 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 following switching elements (e.g. relays, contactors) into the remainder of the circuit. Alternatively, the corresponding safety level is to 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 recognition

Cross connections are detected on the basis of the following relationships:

- 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 connection 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 one terminal group or a protected cable layout must be selected.

5 Applications

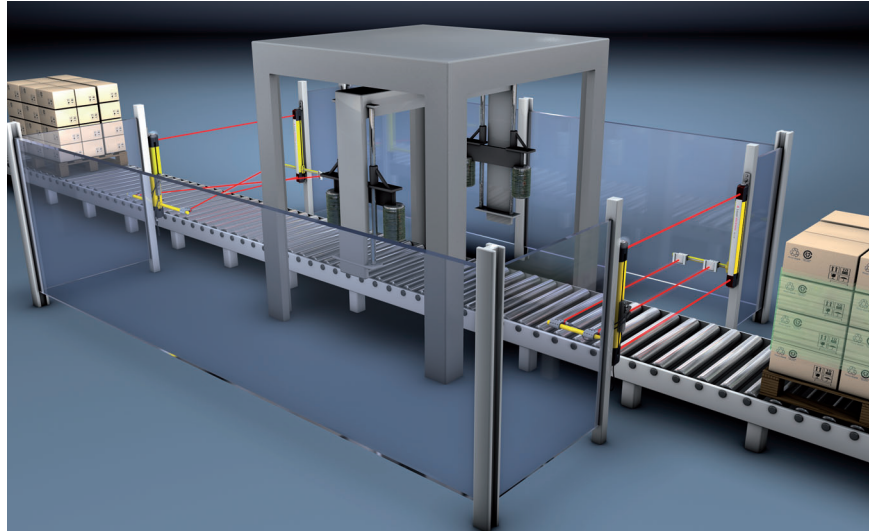


Figure 5.1: For double muting with entry and exit area, the Safety Relay evaluates, e.g., two AOPDs with integrated muting function and two muting sensors for each AOPD.

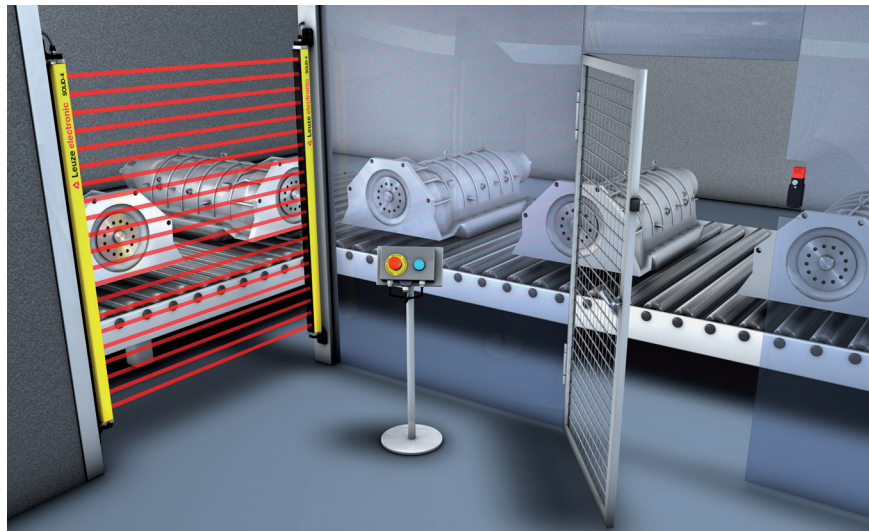


Figure 5.2: With this type of point of operation guarding with a service door, the Safety Relay evaluates the signals of the Safety Locking Device and of the AOPD.

6 Mounting



WARNING

Improper mounting may result in serious injury!

The protective function of the Safety Relay is only ensured if appropriately and professionally mounted for the respective, intended area of application.

- ↳ Only allow competent persons to install the Safety Relay.
- ↳ Observe the relevant standards, regulations and these instructions.

The Safety Relay is intended for DIN rail mounting in a cabinet. Depending on the environmental conditions at the end user, a suitable protective housing type must be determined and used.

Prerequisites for mounting:

- Cabinet with appropriate protection rating (at least IP 54, NEMA3)
- 35 mm-DIN top-hat supporting rail in accordance with DIN EN 50022
- ↳ Determine the type of protective housing and select the Safety Relay accordingly. Snap the Safety Relay onto the DIN rail.

The Safety Relay can be connected to the safety components.

7 Electrical connection

WARNING

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 again.

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 60742 possible
- Corresponding power supply unit handles interruptions of the supply voltage at full load for up to 20 ms acc. to EN 61496-1:2008.

WARNING

Improper electrical connection may result in serious injury!

↳ 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 13849-1:2008.
- Lay the supply voltage cables separately acc. to EN ISO 13849-1:2008.
- 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 at **one terminal group**.
- If non-simultaneous switching of two single-channel, contact-controlled sensors is planned, these are to be connected separately at **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;32 are equipped with reinforced isolation with respect to the housing and the other connections. The mixed connection of protective extra low voltage and low voltage (e.g., 240V~) at terminals 29; 30; 31; 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 the supply of potential-free contacts.
- When connecting potential-free contacts at inputs S (21, 13, 23, 15) of the Safety Relay, a safety fuse is to be interposed acc. to DIN EN 50156-1.

7.1 Terminal assignments

! WARNING

Selecting the wrong functions may result in serious accidents!

- ↳ Activate restart interlock if it is possible to reach or walk behind.
- ↳ 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 reset button.
- ↳ Select the functions so that the Safety Relay is used as intended (see chapter 2.1 „Approved purpose and foreseeable improper operation“).

There are 16 numbered terminals on the Safety Relay for connecting the cables. The connection of the Safety Relay is divided into two sensor groups, additional functions, OSSDs and supply voltage.

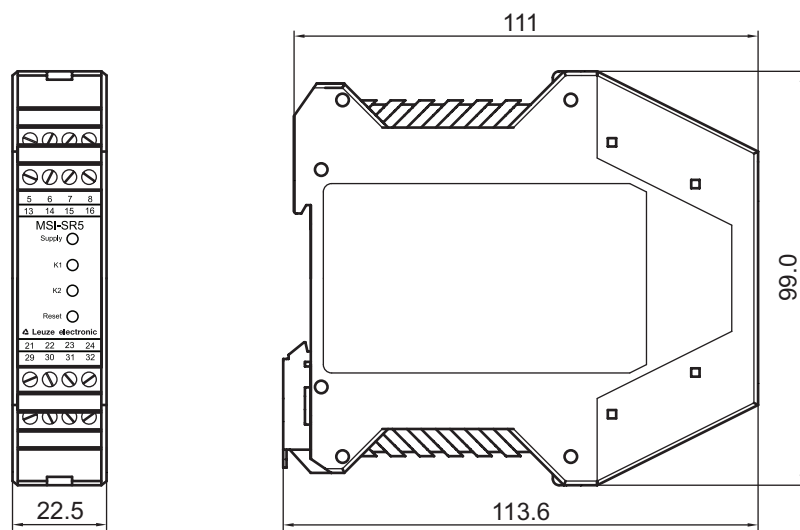


Figure 7.1: Housing and terminals

Terminal no.	Description	Function
5	+Ub	Voltage supply, 24V
6	0V	Voltage supply, 0V
7	+S12	24V input 1, channel 2
21	+S11	24V input 1, channel 1
13	-S12	0V input 1, channel 2
8	+S22	24V input 2, channel 2
23	+S21	24V input 2, channel 1
15	-S22	0V input 2, channel 2
14	IV-O	24V voltage supply, contacts
16	RES-I	Reset input
24	RES-O	Signal for automatic restart-disable
22	0V-O	0V voltage supply, contacts

Terminal no.	Description	Function
29	OSSD1	Relay contact 1
30	OSSD1	Relay contact 1
31	OSSD2	Relay contact 2
32	OSSD2	Relay contact 2

7.1.1 Sensor wiring

The following evaluation combinations can be selected through external wiring of the Safety Relay:

Table 7.1: 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, one-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

Evaluation	Operating mode	Connection, terminal	Bridging, if the adjacent terminal group is not needed
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, one-channel	Channel 1	24V → SK → 21 Bridge 21 → 7 Bridge 22 → 13	14 → 21 14 → 7 22 → 13
E-STOP command device 2, one-channel	Channel 2	24V → SK → 23 Bridge 23 → 8 Bridge 22 → 15	14 → 23 14 → 8 22 → 15

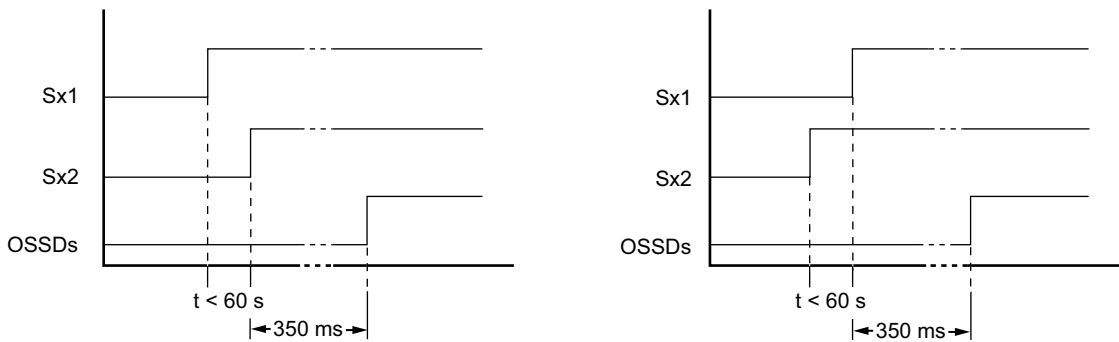
SK = safety-related contact

7.1.2 Selecting the operating modes

The following four operating modes can be selected through external wiring of the Safety Relay:

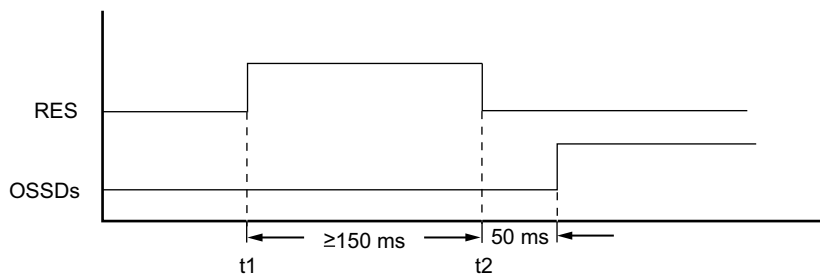
Automatic start/restart	RS	24 → 16
Start/restart interlock	RES	0V → RES → 16
Automatic start/restart and contactor monitoring	RS + EDM	24 → K3/K4 → 16
Start/restart interlock and contactor monitoring	RES + EDM	0V → K3/K4 → RES → 16

7.1.3 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.

7.1.4 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 7.1.3 „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 ≥ 150 ms.

7.2 Connection examples

The following examples show possible connection combinations for AOPDs (relay, transistor), Safety Switches and E-STOP command devices on the Safety Relay



All available safety inputs must be occupied! Bridges are to connect the remaining sensor inputs where no components are connected (see table 7.1).

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.

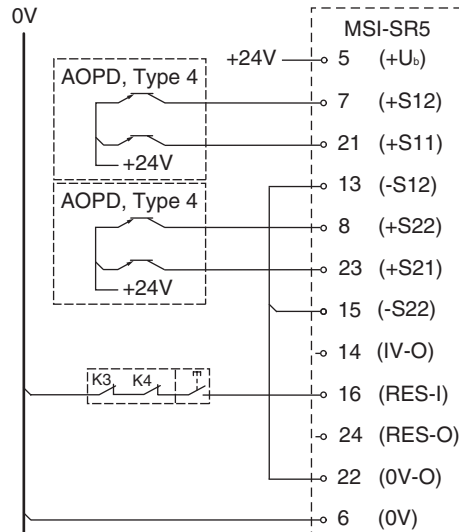


Figure 7.2: Example 1: Two type 4 AOPDs with two safety-relevant transistor outputs each, manual re-start (RES) and contactor monitoring (EDM, K3 and K4)

The following circuit shows the connection of an AOPD (e.g. SOLID series) in a location-of-hazard safeguard. An E-STOP button is provided in this circuit.

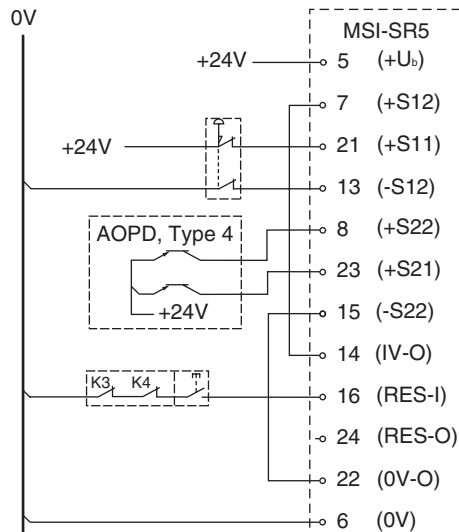


Figure 7.3: Example 2: One type 4 AOPD with two safety-relevant transistor outputs, two-channel E-STOP button, RES and contactor monitoring (EDM, K3 and K4)

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

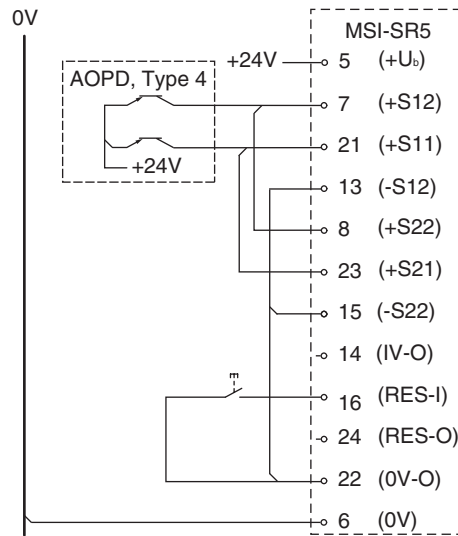


Figure 7.4: Example 3: One type 4 AOPD with two safety-relevant transistor outputs, manual restart (RES), central wiring

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

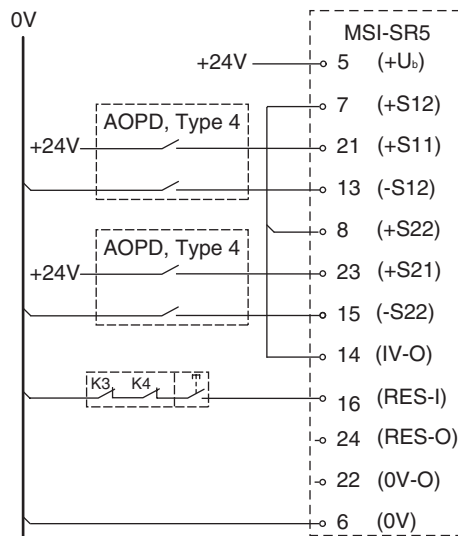


Figure 7.5: Example 4: Two type 4 AOPDs, each with two normally open contacts, manual restart (RES) and contactor monitoring (EDM), separate supply lines to the AOPDs required, local wiring

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

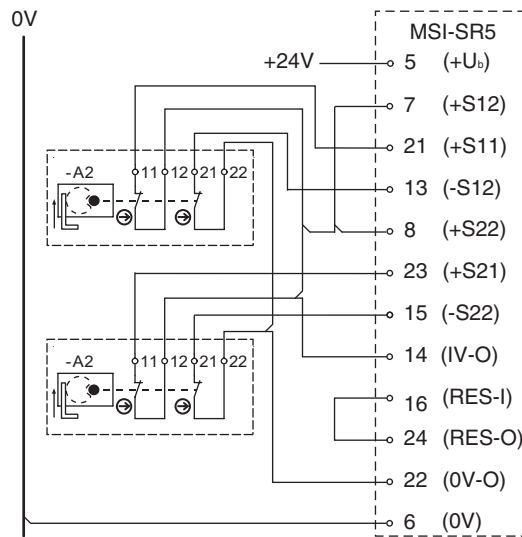


Figure 7.6: Example 5: Two Safety Switches, two-channel, automatic restart, separate supply lines to the switches required, central wiring

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.

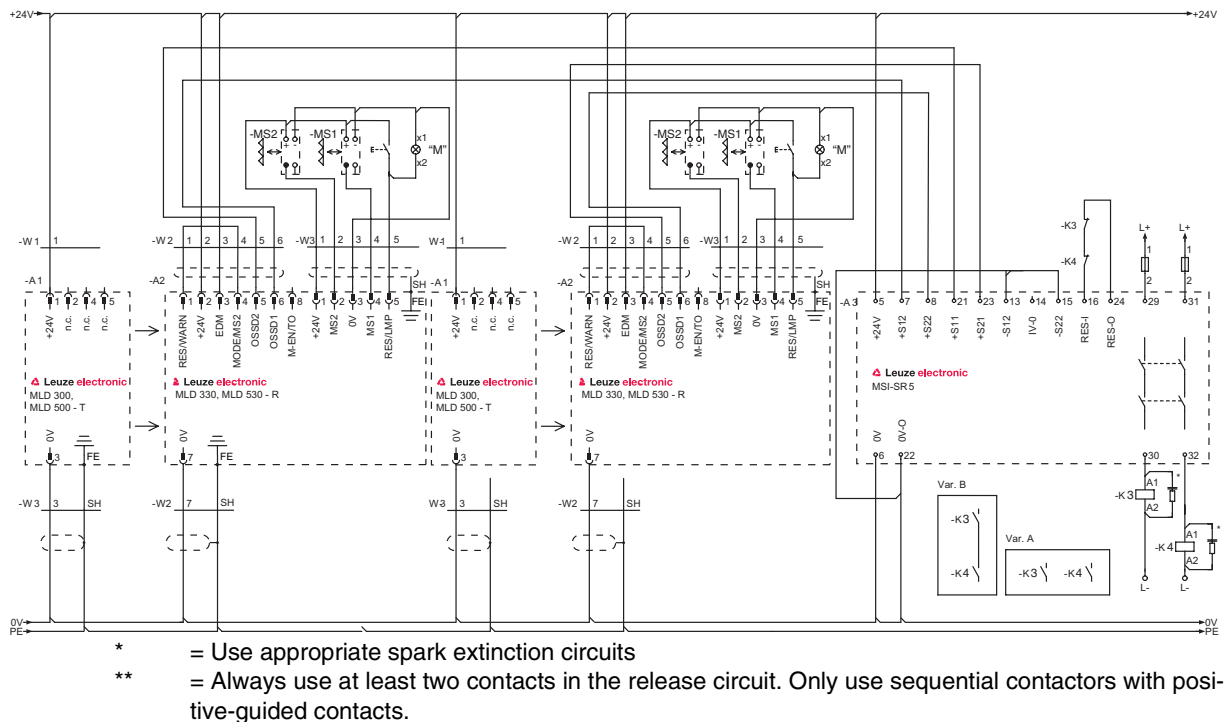


Figure 7.7: Example 6: Two type 4 AOPDs each with two safety-relevant transistor outputs, each with two muting sensors, two manual restarts (RES) and contactor monitoring (EDM)

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 occurs in the cabinet by the Safety Relay.

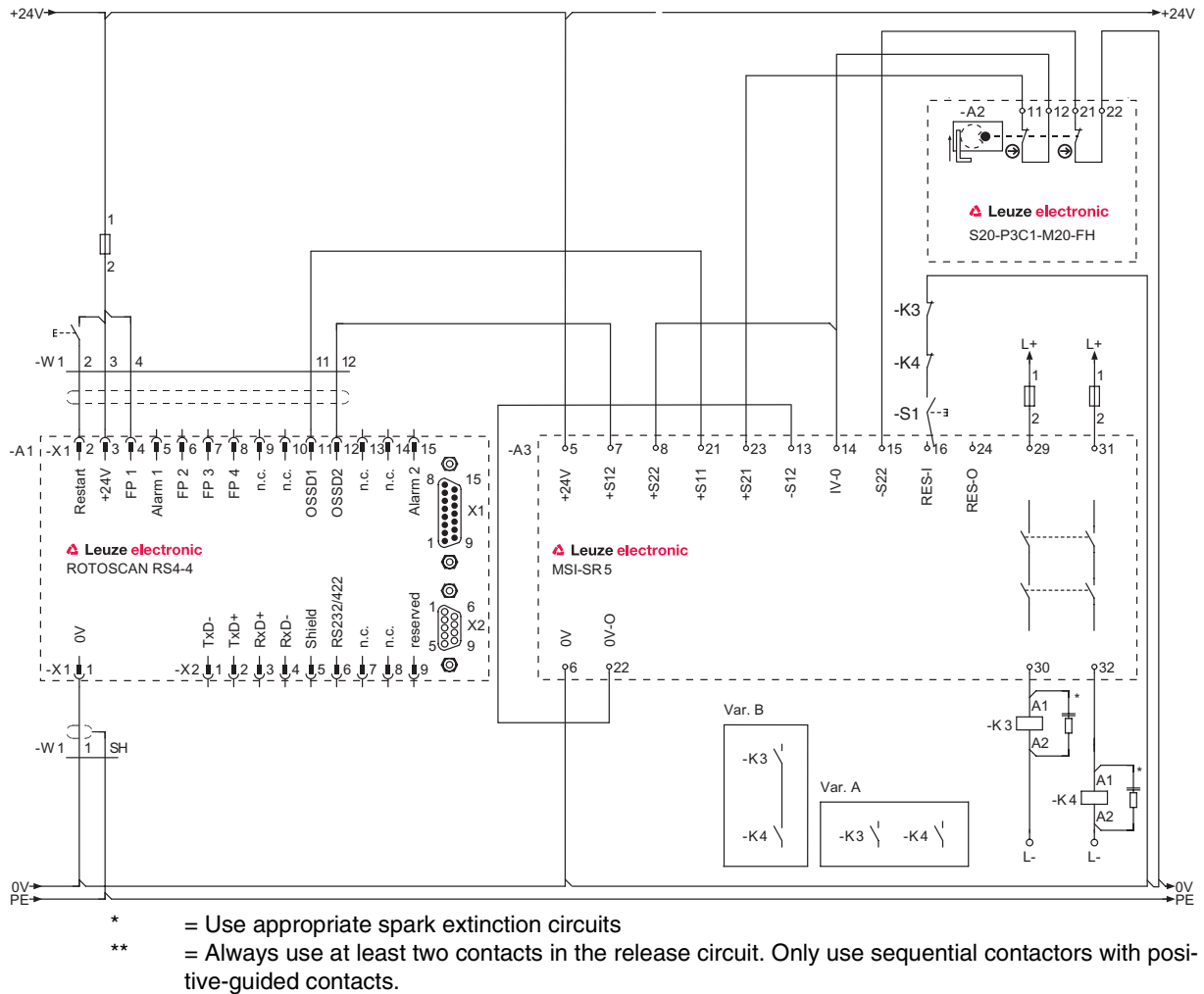


Figure 7.8: Example 6: One type 3 AOPD with two safety-related transistor outputs, one Safety Switch, manual restart (RES) and contactor monitoring (EDM)

7.3 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 timely. 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 13849-1:2008.

Essential prerequisite for the safe operation is the possibility of electrically influencing the interruption of the dangerous movement as well as a sufficiently short machine stand-still time. These must be incorporated 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 Setting the device into service



WARNING

Improper use of the Safety Relay may result in serious injury!

- ↪ Make certain that the entire device and the integration of the Optoelectronic Protective Device was inspected by competent and instructed persons.
- ↪ Make certain that a dangerous process can only be started while the safety sensor is switched on.

Prerequisites for start-up:

- The sensors (e.g., AOPDs, Safety Switches) and the Safety Relay have been mounted and connected in accordance with the respective instructions.
 - The operating personnel have been instructed on proper use.
 - The dangerous process is switched off, the outputs of the Safety Relay are disconnected, and the system is protected against being switched back on.
- ↪ During start-up, test the function of the Safety Relay (see chapter 9 „Testing“).
 - ↪ Prior to the initial start-up on a power-driven machine, make certain that a competent person inspects the connection of the connected protective device at the Safety Relay as well as the integration of the complete system in the machine control.
 - ↪ Before switching on the supply voltage for the first time, make certain that the outputs of the Safety Relay have no effect on the machine.
 - ↪ Make certain that the switching elements that put the machine which poses a danger into motion are safely switched off or disconnected and are protected against being switched back on.



The same safety measures apply after each function change, after repairs or during maintenance work.

8.1 Switching on

Requirements for the supply voltage (power supply unit):

- Safe mains separation is ensured (acc. to IEC 60742).
 - Changes and interruptions of the supply voltage are handled (acc. to EN 61496-1:2008).
 - The start/restart interlock function (where foreseen) is connected and activated.
- ↪ Switch on the current supply.
 - ↪ Check whether the “Supply” LED on the Safety Relay lights up.

The Safety Relay is ready for use.

8.2 Reset

The reset button can be used to unlock the start/restart interlock (where foreseen). 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**

Premature unlocking of the start/restart interlock may result in serious injury.

If the start/restart interlock is unlocked, the system can start-up.

↪ Before unlocking the start/restart interlock, make certain that no people are in the danger zone.

The orange "Reset" LED illuminates as long as the start/restart is locked.

↪ Make certain that the protective fields (AOPDs) are clear and doors, flaps, etc. (Safety Switches), are closed.

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

↪ Press and release the reset button.

The Safety Relay switches to the ON state.

9 Testing



WARNING

A running machine may result in serious injury!

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

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 To be performed prior to the initial start-up and following modification

Acc. to IEC TS 62046 and national regulations (e.g. EU directive 89/655 EEC), tests are to be performed by competent persons in the following situations:

- Prior to the initial start-up
- Following modification to the machine
- After longer machine downtime
- Following retrofitting or reconfiguring the safety device (Safety Relay, AOPDs, Safety Switch, etc.)



WARNING

Unpredictable machine behavior during initial start-up may result in serious injury!

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

- ↪ 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 the configuration of the safety device (AOPD, Safety Switch, Safety Relay, etc.) incl. the data for safety- and minimum distances as well as all tests in an understandable manner.
- ↪ 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 device (AOPD, Safety Switch, Safety Relay, etc.) was correctly selected in accordance with the locally applicable regulations and directives.
- ↪ Check whether the safety device (AOPD, Safety Switch, Safety Relay, etc.) is operated in accordance with the specific ambient conditions that are to be maintained (see the technical data of all relevant components of the safety system).
- ↪ 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
- Mains-failure bridging for at least 20 ms while at full load

Not until proper function of the safety device is ascertained may it 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 a feedback 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 between protective device and location of hazard maintained, taking into account all response times?		
Are all location of hazard of the machine accessible only through the safety device? Are all additional protective devices (e.g. safety guards) correctly mounted and protected against tampering?		
Are sensors, E-STOP button, Safety Relay, connecting cable, plug and protection caps 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 reset button (RES) for deactivating the start/restart interlock for resetting the Safety Relay mounted outside of the danger zone in accordance with specifications? Is it mounted in such a way that it cannot be reached from within the danger zone? Can the entire danger zone be seen from the operating position?		
Does the interruption of any given beam of the AOPD 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 reset button to reset the machine?		
When the Safety Switch 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 reset button to reset the machine?		
Are the AOPD, Safety Switch, E-STOP button, Safety Relay effective during the entire dangerous movement of the machine and do they cause the dangerous movement to stop?		
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 Relay and machine must be periodically tested in order to detect changes to the machine or impermissible tampering with the safety sensors. 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.



As a safety inspection, Leuze electronic offers testing by a competent person prior to the initial start-up (see chapter 12 „Service and support“).

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!
↪ During the daily inspection, make certain that there are no persons located within 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 must no longer be operated.
↪ Have the entire machine inspected by a competent person (see chapter 9.1 „To be performed prior to the initial start-up and following modification“).

- ↪ Stop the dangerous state.
- ↪ Check the safety device (AOPD, if applicable with Deflecting Mirrors, Safety Switch with actuator, Safety Relay, etc.) for damage or tampering.
- ↪ Interrupt the light beam of the AOPD from a position outside the danger zone and ensure that the machine cannot be started with an interrupted light beam.
- ↪ Open doors, flaps, etc. (Safety Switch) from a location outside of the danger zone and make certain that the machine cannot be started while the Safety Switch is open.
- ↪ Start the machine.
- ↪ Ensure that the dangerous state stops as soon as a light beam is interrupted or a Safety Switch is opened.

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 Relays, AOPD, if applicable with Deflecting Mirror, Safety Switch with actuator, connecting cable, plug, E-STOP command device and reset button undamaged and free of signs of tampering?		
Are all locations of hazard at the machine only accessible through one or more protective fields of AOPDs or moveable guards?		
Are all additional protective devices mounted correctly (e.g., safety guard)? Is it impossible to walk or reach behind?		
Does the start/restart interlock (where foreseen) prevent the automatic start-up of the machine after switching on or activating the AOPD, the Safety Switch, the E-STOP command device, the Safety Relay?		
Interrupt a light beam of the AOPD with a test object during operation. Open a door or flap (Safety Switch) during operation Is the dangerous movement shut down immediately?		

10 Care/Maintenance

The device does not require maintenance.

11 Disposing

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

12 Service and support

Telephone number for 24-hour standby service:

+ 49 (0) 70 21 / 5 73-0

Service hotline:

+49 (0) 81 41 / 53 50-1 11

Monday through Thursday 8:00 a.m. to 5:00 p.m. (UTC +1)

Friday 8:00 a.m. to 4:00 p.m. (UTC +1)

E-mail:

service.protect@leuze.de

Return address for repairs:

Service Center

Leuze electronic GmbH + Co. KG

In der Braike 1

D-73277 Owen

13 Technical data

The following table shows the safety-related characteristic parameters of the MSI-SR5 series.

Table 13.1: Safety-relevant technical data

Type acc. to EN 61496-1:2008	Type 4		
Performance Level (PL) in accordance with EN ISO 13849-1: 2008	up to PL e		
SIL acc. to EN 61508:2001	up to SIL 3		
Category acc. to EN ISO 13849-1:2008	category 4		
Stop category	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 failure to danger (B10 _d)	400.000:	100% of the max. switched current of loading cases AC1..DC13	
	2.500.000:	60% of the max. switched current of loading cases AC1..DC13	
Mean time to dangerous failure (MTTF _d)	73 years		
Service life (T _m)	20 years		
<p>*n_{op} = mean number of annual actuations, see C.4.2 and C.4.3 of EN ISO 13849-1:2008</p> <p>Use the following formula to calculate the mean number of annual actuations:</p> $n_{op} = (d_{op} \cdot h_{op} \cdot 3600 \text{ s/h}) \div t_{cycle}$ <p>In doing so, make the following assumptions with regard to the use of the component:</p> <p>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</p>			

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 61496-1:2008)
Connectable Safety Switches (except for solenoid switches) and E-STOP command devices (+S11, -S12) (+S21, -S22)	Safety Switches acc. to EN 1088 E-STOP buttons acc. to EN ISO 13850
Available functions	Start/restart interlock Contactor monitoring (EDM)
Control input RES-I Start/restart interlock (reset)	Potential-free N/O 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	24V 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: 230V / 5A 1.6 million switching cycles DC-13: 24V / 3A 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 300VAC rating voltage in accordance with VDE 0110 part 1
Dirt level	2
Interference emission	EN 55011, EN 61000-6-3:2007
Interference rejection	EN 61496-1:2008 type 4
Protection rating	Housing IP 40, terminals IP 20 for installation in cabinet or housing with protection rating of at least IP 54 required Finger-safe acc. to DIN VDE 0106 part 100, maximum stripped length of the connection cables: 8 mm
Mounting	On 35mm DIN top-hat supporting rail in accordance with DIN EN 50022
Connection cross-sections (GS-ET-20: 2009)	1 x 0.2 to 2.5 mm ² , fine-wired or 1 x 0.25 to 2.5 mm ² , fine-wired with wire-end sleeves 2 x 0.5 to 1.5 mm ² , fine-wired with Twin wire-end sleeves 1 x 0.2 to 2.5 mm ² , single-wired or 2 x 0.25 to 1.0 mm ² , fine-wired with wire-end sleeves 2 x 0.2 to 1.5 mm ² , fine-wired 2 x 0.2 to 1.0 mm ² , single-wired
OSSD-suitable spark extinction via the coils of the downstream relay	required

Operating voltage U_B	24V 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: 230V / 5A 1.6 million switching cycles DC-13: 24V / 3A 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 300VAC rating voltage in accordance with VDE 0110 part 1
Dirt level	2
Interference emission	EN 55011, EN 61000-6-3:2007
Interference rejection	EN 61496-1:2008 type 4
Protection rating	Housing IP 40, terminals IP 20 for installation in cabinet or housing with protection rating of at least IP 54 required Finger-safe acc. to DIN VDE 0106 part 100, maximum stripped length of the connection cables: 8 mm
Mounting	On 35mm DIN top-hat supporting rail in accordance with DIN EN 50022
Connection cross-sections (GS-ET-20: 2009)	1 x 0.2 to 2.5 mm ² , fine-wired or 1 x 0.25 to 2.5 mm ² , fine-wired with wire-end sleeves 2 x 0.5 to 1.5 mm ² , fine-wired with Twin wire-end sleeves 1 x 0.2 to 2.5 mm ² , single-wired or 2 x 0.25 to 1.0 mm ² , fine-wired with wire-end sleeves 2 x 0.2 to 1.5 mm ² , fine-wired 2 x 0.2 to 1.0 mm ² , single-wired
OSSD-suitable spark extinction via the coils of the downstream relay	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

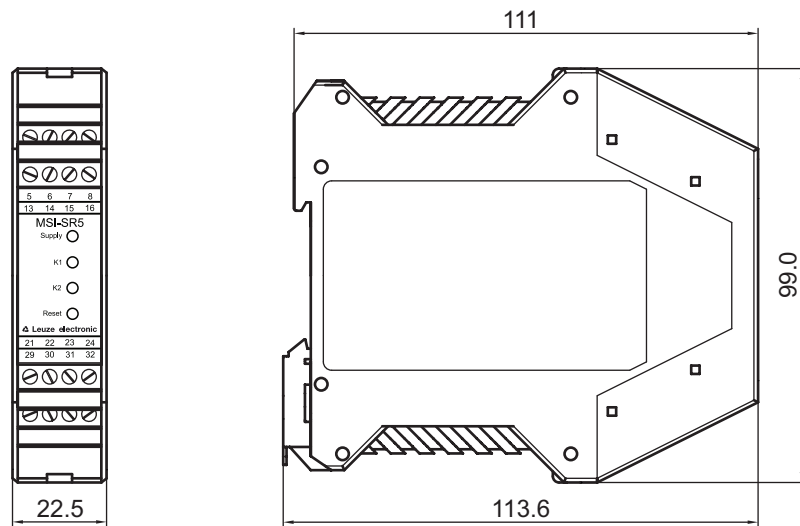


Figure 13.1: Housing dimensions

14 Ordering information

Part No.	Article	Description
549991	MSI-SR5	Safety Relay

15 EC Declaration of Conformity



the sensor people

EG-KONFORMITÄTS- ERKLÄRUNG (ORIGINAL)	EC DECLARATION OF CONFORMITY (ORIGINAL)	DECLARATION CE DE CONFORMITE (ORIGINAL)
Der Hersteller	The Manufacturer	Le constructeur
	Leuze electronic GmbH + Co. KG In der Braike 1, PO Box 1111 73277 Owen, Germany	
erklärt, dass die nachfolgend aufgeführten Produkte den einschlägigen Anforderungen der genannten EG-Richtlinien und Normen entsprechen.	declares that the following listed products fulfil the relevant provisions of the mentioned EC Directives and standards.	déclare que les produits identifiés suivants sont conformes aux directives CE et normes mentionnées.
Produktbeschreibung:	Description of product:	Description de produit:
Sicherheits-Schaltgerät MSI-SR5 Sicherheitsbauteil nach 2006/42/EG Anhang IV Seriennummer siehe Typschild	Safety relay MSI-SR5 safety component in acc. with 2006/42/EC annex IV Serial no. see name plates	Relais de sécurité MSI-SR5 Élément de sécurité selon 2006/42/CE annexe IV N° série voir plaques signalétiques
Angewandte EG-Richtlinie(n):	Applied EC Directive(s):	Directive(s) CE appliquées:
2006/42/EG 2004/108/EG	2006/42/EC 2004/108/EC	2006/42/CE 2004/108/CE
Angewandte Normen:	Applied standards:	Normes appliquées:
EN 61508-1, -2, -3, -4, -5, -6, -7:2001; EN 61000-4-4:2004; EN 61000-4-5:2006; EN 61000-6-3:2007; EN 60068-2-6:2008; EN 50205:2002; EN 61496-1:2009; EN 61326-3-1:2008	EN ISO 13849-1:2008; EN 62061:2005; EN 61000-4-6:2009; EN 61000-4-8:2001; EN 60068-2-27:2009; EN 60529:1991 + A1:2000 EN 61326-3-1:2008	EN 61000-4-3:2006 EN 61000-4-29:2000
Benannte Stelle / Baumusterprüfbescheinigung:	Notified Body / Certificate of Type Examination:	Organisme notifié / Attestation d'examen CE de type:
TÜV-SÜD PRODUCT SERVICE GmbH Zertifizierungsstelle Ridlerstraße 65 D-80339 München	/	Z10 11 02 22795 082
Bevollmächtigter für die Zusammenstellung der technischen Unterlagen:	Authorized person to compile the technical file:	Personne autorisée à constituer le dossier technique:
Robert Sammer; Leuze electronic GmbH + Co. KG, business unit safety systems Liebigstr. 4; 82256 Fuerstenfeldbruck; Germany		

Owen, 22.2.11
Datum / Date / Date

Dr. Harald Grübel, Geschäftsführer / Director / Directeur

Leuze electronic GmbH + Co. KG
In der Braike 1
D-73277 Owen
Telefon +49 (0) 7021 573-0
Telefax +49 (0) 7021 573-199
info@leuze.de
www.leuze.com

Leuze electronic GmbH + Co. KG, Sitz Owen, Registergericht Stuttgart, HRA 230712
Persönlich haftende Gesellschafterin Leuze electronic Geschäftsführungs-GmbH,
Sitz Owen, Registergericht Stuttgart, HRB 230550
Geschäftsführer: Dr. Harald Grübel (Vorsitzender), Karsten Just
USL-IdNr. DE 145912521 | Zolnummer 2554232
Es gelten ausschließlich unsere aktuellen Verkaufs- und Lieferbedingungen
Only our current Terms and Conditions of Sale and Delivery shall apply

Nr. 609063-2011/02

LEO-ZQM-149-01-FO

You can also download this EC Declaration of Conformity as a PDF from:
<http://www.leuze.com/relays>