ESR5-NO-31-230VAC

#ÈÁ¿ÐÎËÊÅ¿ Ïafety relay for emergency stop and safety door monitoring

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Service

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Original operating manual
The German-language edition of this document is the original operating manual.

Translation of the original operating manual
All editions of this document other than those in German language are translations of the original operating manual.

2nd Edition 2025, publication date 11/25
See revision protocol in the chapter “About this manual“.

Danger!
Dangerous electrical voltage!

Before commencing the installation

- Disconnect the power supply of the device.
- Ensure that devices cannot be accidentally restarted.
- Verify isolation from the supply.
- Earth and short circuit.
- Cover or enclose neighbouring units that are live.
- Follow the engineering instructions (AWA/IL) of the device concerned.
- Only suitably qualified personnel in accordance with EN 50110-1/-2 (VDE 0105 Part 100) may work on this device/system.
- Before installation and before touching the device ensure that you are free of electrostatic charge.
- The functional earth (FE) must be connected to the protective earth (PE) or to the potential equalisation. The system installer is responsible for implementing this connection.
- Connecting cables and signal lines should be installed so that inductive or capacitive interference does not impair the automation functions.
- Install automation devices and related operating elements in such a way that they are well protected against unintentional operation.
- Suitable safety hardware and software measures should be implemented for the I/O interface so that a line or wire breakage on the signal side does not result in undefined states in the automation devices.
- Ensure a reliable electrical isolation of the low voltage for the 24 volt supply. Only use power supply units complying with IEC 60364-4-41 (VDE 0100 Part 410) or HD 384.4.41 S2.
- Deviations of the mains voltage from the rated value must not exceed the tolerance limits given in the specifications, otherwise this may cause malfunction and dangerous operation.
- Emergency stop devices complying with IEC/EN 60204-1 must be effective in all operating modes of the automation devices. Unlatching the emergency-stop devices must not cause restart.
- Devices that are designed for mounting in housings or control cabinets must only be operated and controlled after they have been installed with the housing closed. Desktop or portable units must only be operated and controlled in enclosed housings.
- Measures should be taken to ensure the proper restart of programs interrupted after a voltage dip or failure. This should not cause dangerous operating states even for a short time. If necessary, emergency-stop devices should be implemented.
- Wherever faults in the automation system may cause damage to persons or property, external measures must be implemented to ensure a safe operating state in the event of a fault or malfunction (for example, by means of separate limit switches, mechanical interlocks etc.).

Content

0 About This Manual

This manual applies to the ESR5-NO-31-230VAC safety relay.

0.1 List of revisions

The following significant amendments have been introduced since previous issues:

Publication date	Page	Keyword	new	modified	deleted
12/19		First edition	–	–	–
11/25	6,11,12,17	Re-certification EN IEC 62061 SII, CLaim Limit removed	–	–	✓

0.2 Target group

This manual is intended for qualified personnel installing, operating, and maintaining the ESR5-NO-31-230VAC safety relay.

CAUTION

Installation requires a qualified electrician

0.3 Additional documents

For further information, see the following documentation:

- Instruction leaflet IL05013032Z
- Safety relay data sheet ESR5-NO-31-230VAC, article no. 119380

WARNING

Make sure you always use the latest documentation.
It can be downloaded from the product at: www.eaton.com/esr5

0.4 Abbreviations and symbols

The symbols used in this manual have the following meanings:

▶ indicates actions to be taken.

0.4.1 Risk of material damage

CAUTION

Warns about the possibility of material damage.

0.4.2 Hazard warnings of personal injury

CAUTION

Warns of the possibility of hazardous situations that may possibly cause slight injury.

WARNING

Warns of the possibility of hazardous situations that could result in serious injury or even death.

DANGER

Warns of hazardous situations that result in serious injury or death.

0.4.3 Tips

Indicates useful tips.

1 Safety notes

WARNING

Risk of electric shock
During operation, parts of electrical switching devices carry hazardous voltages.
Before working on the switching device, disconnect the power.
Please observe the safety regulations of electrical engineering and industrial safety and liability associations!
Disregarding these safety regulations may result in death, serious personal injury or damage to equipment.
Startup, mounting, modifications, and upgrades should only be carried out by a skilled electrical engineer!

WARNING

Risk of automatic machine restart!
For emergency stop applications, the machine must be prevented from restarting automatically by a higher-level control system.
Protective covers must not be removed when operating electrical switching devices.

WARNING

Danger due to faulty devices!
The devices may be damaged following an error and correct operation can no longer be ensured.
In the event of an error, replace the device immediately.
Repairs to the device, especially if the housing must be opened, may only be carried out by the manufacturer or authorized persons. Otherwise the warranty is invalidated.

CAUTION

Risk of damage to equipment due to incorrect installation
For reliable operation, the safety relay must be installed in housing protected from dust and humidity (IP54).
Carry out wiring according to the application.
Refer to the "Application examples" section for this.

CAUTION

Risk of damage to equipment due to noise emissions
When operating relay modules the operator must meet the requirements for noise emission for electrical and electronic equipment (EN 61000-6-4) on the contact side and, if required, take appropriate measures.

2 Description

The ESR5-NO-31-230VAC safety relay can be used in safety circuits according to EN 60240-1 and IEC 61508.

With this switching device, circuits are interrupted in a safety-oriented manner.

Control is via a single channel or two channels, either with automatic or manual monitored start circuit.

Depending on the external wiring, up to category 4, PL e according to EN ISO 13849-1 or SIL 3 according to EN 62061 can be achieved.

The safety relay is equipped with three enabling current paths that drop out without delay corresponding to stop category 0 according to EN 60204-1.

Features

- Emergency stop and safety door monitoring
- Suitable up to category 4, PL e (EN ISO 13849-1), SIL 3 (EN 62061)
- Single-channel or two-channel wiring with cross-circuit detection
- 3 enable current paths
- 1 signaling current path
- Screw terminal blocks for plug-in

3 Operating and indication elements

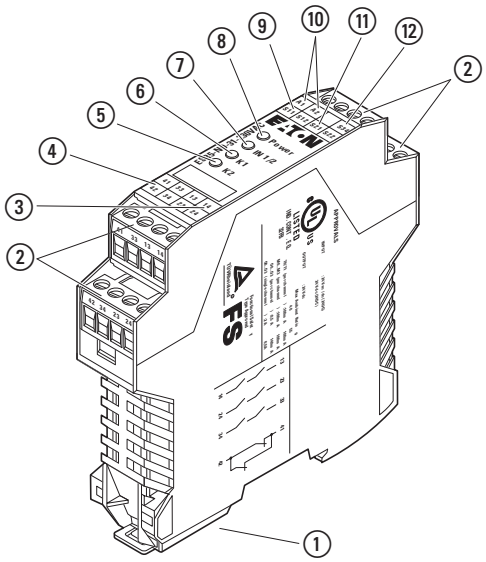

Figure 1: ESR5-NO-31-230VAC

① Metal lock for mounting on the DIN rail
② COMBICON plug-in screw terminal blocks
③ 13/14, 23/24, 33/34 - enabling current paths
④ 41/42 - signaling current path
⑤ LED status indicator, green - K2
⑥ LED status indicator, green - K1
⑦ LED status indicator, green - IN 1/2
⑧ LED status indicator, green - Power
⑨ S11/S12 - input circuit
⑩ S21/S22 - input circuit
⑪ Power supply
⑫ S34 - start circuit

4 Basic circuit diagram

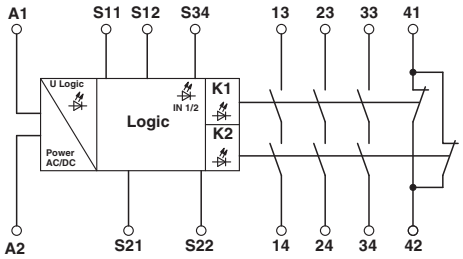

Figure 2: Block diagram

Designation	Explanation
A1/A2	Safety relay input voltage
S11/S12	Safety sensor/switch 1 input circuit
S21/S22	Safety sensor/switch 2 input circuit
S34	Start circuit
13/14	Undelayed enabling current path 1
23/24	Undelayed enabling current path 2
33/34	Undelayed enabling current path 3
41/42	Signaling current path

5 Derating

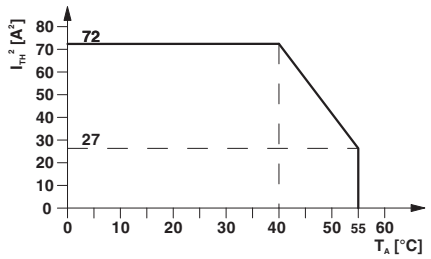

Figure 3: Derating curve

6 Diagnostics

○ – LED off

● – LED on

Table 1: Diagnostic description

	Power	IN1/2	K1	K2	Fault	Remedy
Connection/ voltage error	○	○	○	○	Supply voltage not present.	Apply supply voltage.
	●	●	●	○	Supply voltage too low.	Adjust supply voltage.
	●	○	○	○	The enable circuits are connected incorrectly or not connected at all.	Check the connection of the enable circuits.
Cross-circuit	○	○	○	○	Between both enable circuits S11- S12 and S21-S22. E.g., for emergency stop.	Remove cross-circuit.
Short circuit	○	○	○	○	Between contact points A1 and A2.	Remove short circuit.
	●	●	●	○	Between S11 and S12. Fault detection on next demand.	
	●	●	○	●	Between S21 and S22. Fault detection on next demand.	
Fault in reset circuit	●	●	○	○	Faulty reset button, short circuit between S12 and S34. No fault detection on initial start, only on first new demand.	Replace reset button. Remove short circuit.
Fault with internal cause	●	●	○	●	Enable contact(s) of K1 faulty.	Replace safety relays.
	●	●	●	○	Enable contact(s) of K2 faulty.	
	●	●	○	○	Enable contact(s) of K1 and K2 faulty.	

7 Application examples

7.1 Two-channel emergency stop circuit with cross-circuit detection

- Manual activation with connection at S12-S34
- Suitable up to category 4, PL e (EN ISO 13849-1), SIL 3 (EN 62061)

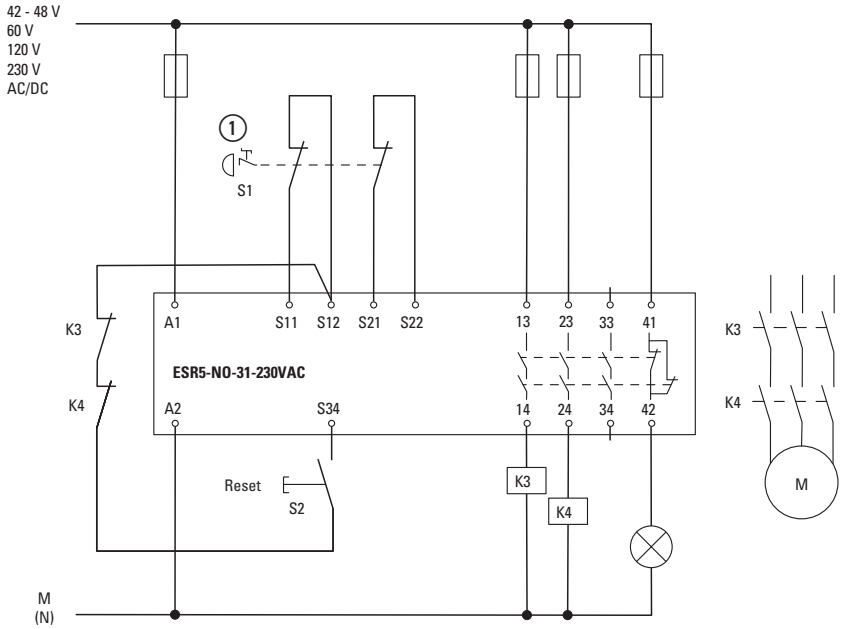

Figure 4: Emergency stop with cross-circuit detection and manually monitored reset

① Emergency stop

7.2 Single-channel emergency stop circuit

- Automatic activation with connection at S22-S34
- Suitable up to category 1, PL c (EN ISO 13849-1), SIL 1 (EN 62061)

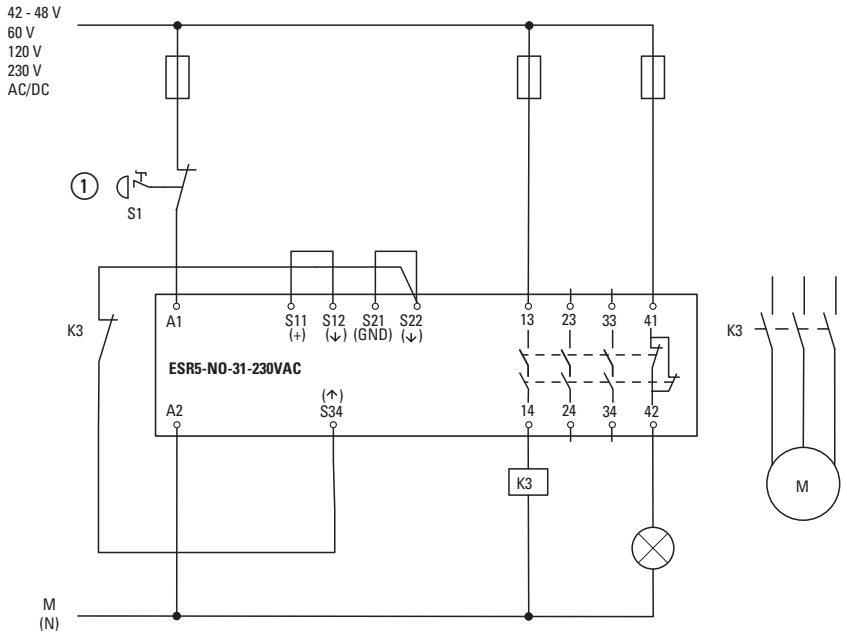

Figure 5: Emergency stop with automatic start

① Emergency stop

8 Technical data

Input data	
Nominal input voltage U_N	230 V AC/DC
Input voltage range (factor)	0.85 - 1,1
Typical input current	22 mA
Voltage at input/start and feedback circuit	~ 24 V DC
Max. permissible overall conductor resistance (Input and reset circuit at U_N)	50 Ω
Typical response time	40 ms (manual start)
Typical pick-up time	330 ms (when controlled via A1)
Typical release time	150 ms (when controlled via A1) 20 ms (when controlled via S11/S12 and S21/S22)
Recovery time	1 s
Maximum switching frequency	0.5 Hz
Operating voltage display	Green LED
Status display	Green LED
Protective circuit	Surge protection Varistor 275 V_{RMS} (A1-A2)
Output data	
Contact type	3 enabling current paths 1 signaling current path
Contact material	$AgSnO_2$ + 0,2 µm Au
Minimum switching voltage	10 V AC/DC
Maximum switching voltage	250 V AC/DC
Limiting continuous current	6 A (N/O contact) 5A (N/C contact)
Maximum inrush current	6 A
Inrush current, minimum	10 mA
Sq. Total current $(I_{TH})^2 = (I_1)^2 + (I_2)^2 + (I_3)^2$	72 A^2 (see derating curve → Figure 3, page 9)
Interrupting rating (ohmic load) max.	144 W (24 V DC, τ = 0 ms) 230 W (48 V DC, τ = 0 ms) 68 W (110 V DC, τ = 0 ms) 88 W (220 V DC, τ = 0 ms) 2000 VA (250 V AC, τ = 0 ms)
Maximum interrupting rating (inductive load)	48 W (24 V DC, τ = 40 ms) 40 W (48 V DC, τ = 40 ms) 35 W (110 V DC, τ = 40 ms) 33 W (220 V DC, τ = 40 ms)
Switching capacity min.	0.4 W
Mechanical service life	~ 10^7 cycles
Switching capacity (360 cycles/h)	6 A (24 V DC) 5 A (230 V AC)
Switching capacity (3600 cycles/h)	3 A (24 V (DC-13)) 3 A (230 V (AC-15))

Output fuse	10 A gL/gG NEOZED (N/O contact) 6 A gL/gG NEOZED (N/C contact)
General data	
Relay type	Electromechanically forcibly guided, dust-proof relay
Nominal operating mode	100 % operating factor
Degree of protection	IP20
Min. degree of protection of inst. location	IP54
Mounting position	any
Mounting type	DIN rail mounting
Air and creepage distances between the power circuits	DIN EN 50178/VDE 0160
Rated insulation voltage	250 V
Rated surge voltage / insulation	4 kV / basic insulation (safe isolation, reinforced insulation, and 6 kV between A1-A2/logic/enabling and signaling current paths)
Pollution degree	2
Surge voltage category	III
Dimensions	
W x H x D	22.5 x 99 x 114.5 mm
Connection data	
Conductor cross section, solid	0.2 mm^2 - 2.5 mm^2
Conductor cross section, stranded	0.2 mm^2 - 2.5 mm^2
Conductor cross section AWG/kcmil	24 - 12
Stripping length	7 mm
Ambient conditions	
Ambient temperature (operation)	-20 °C - 55 °C
Ambient temperature (storage/transport)	-40 °C - 70 °C
Max. permissible relative humidity (operation)	75 %
Max. permissible humidity (storage/transport)	75 %
Certification / Approvals	
Approvals	c UL us LISTED TÜVRheinland CERTIFIED Product Safety Functional Safety www.tuv.com ID 0600000000
Safety data	
Stop category according to IEC 60204	0
Safety parameters for IEC 61508 - High demand	
SIL	3
PFH_d	3.6 x 10^{-10} per hour
Demand rate	< 12 months
Proof test interval	240 months
Duration of use	240 months
The data only applies if the safety function is demanded at least once a year. The specifications apply assuming the following calculation basis	

B_{10d}	300000 (at 5 A DC-13)
d_{op}	365 days
h_{op}	24 h
t_{Cycle}	3600 s
Safety parameters for IEC 61508 - Low demand	
SIL	3
$MTTF_d$	19346 years
PFD_{avg}	1.50×10^{-4}
Proof test interval	78 months
Duration of use	240 months
Safety characteristic data according to EN ISO 13849	
Category	4
Performance Level	e
CCF	Passed
The data only applies if the safety function is demanded at least once a year. The specifications apply assuming the following calculation basis	
B_{10d}	300000 (at 5 A DC-13)
d_{op}	365 days
h_{op}	24 h
t_{Cycle}	3600 s

8 Technical data

9 Glossary

Abbreviation	Description
AC-15, DC-13	Standardized utilization categories and load cases from standard IEC 60947-5-1 that are used to test switching elements, i.e., switching on and off with defined voltages, currents, and loads (electromagnetic loads in particular in this case).
AOPD	**Active Opto-electronic Protective Device** Device with a sensor function that is implemented with optoelectronic transmission and reception elements that detect when an opaque object in the defined area of protection (or in the way of the light beam axis in the case of light barriers) is blocking the beams generated by the device. AOS is used as an abbreviation synonymous with AOPD in DIN EN 692 ("Machine tools - Mechanical presses - Safety"), DIN EN 693 ("Machine tools - Safety - Hydraulic presses"), and EN 12622 ("Safety of machine tools - Hydraulic press brakes").
AOPDDR	**Active Opto-electronic Protective Device responsive to Diffuse Reflection** Device with a sensor function that is implemented with optoelectronic transmission and reception elements that detect when an object in the area of protection defined with two dimensions diffusely reflects the beam generated by the device.
ESPE	**E**lectro-**s**ensitive **p**rotective **e**quipment
CCF	**Common Cause Failure** Common cause failure
DC	**Diagnostic Coverage** Diagnostic coverage
ESR	**E**lectronic **s**afety **r**elay
DF	Duty factor
PL	**Performance Level** Classification of safety functions used to meet a safety requirement.
HFT	**H**ardware **F**ault **T**olerance
Cat. / category	Classification of resistance to errors as defined in EN ISO 13849-1
Mission Time T_M	Lifetime
MTTF / $MTTF_d$	**Mean Time To Failure** Mean time to failure / mean time to dangerous failure
NC	**N**ormally **C**losed contact, break contact An NC breaks a circuit when it is energized.
NO	**N**ormally-**O**pen contact An NO closes when it is energized.
PFD	**Probability Failure on Demand (Low-Demand)** Probability of failure relative to the number of requests
PFH_d	**Probability of a Dangerous Failure per Hour** Probability of dangerous Failures per Hour
SIL	**Safety Integrity Level** Safety integrity level
SRCF	**Safety-Related Control Function** Safety-related control function
SRECS	**Safety-Related Electrical Control System** Safety related electrical, electronic, programmable electronic control system
SRP	**Safety-Related Part** Safety-related part
SRP/CS	**Safety-Related Parts of Control System** Safety-related part of a control system

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