

ESR5-NE-51-24VDC

Contact expansion for safety relay



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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.

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Subject to alteration.



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.).

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0 About this manual

This manual contains all the information you will need in order to use the ESR5-NE-51-24VDC safely and effectively.

The ESR5-NE-51-24VDC manual is considered an integral part of the device and must always be readily available in the device's close proximity so that users have access to it.

This manual describes all lifecycle stages of the device: transport, installation, commissioning, maintenance, storage and disposal.

It assumes you have electrical engineering knowledge and skills.



Due to the fact that we cannot know the details of your specific application, the information and examples in this document are meant to provide you solely with general assistance in regard to the use of safety control equipment to implement standards, guidelines, and directives.

The information and examples in this document do not claim to be exhaustive or legally binding.

For detailed information, please refer to the standards, guidelines, and directives that apply to your specific application.

0.1 List of revisions

The following significant amendments have been introduced since previous issues:

Publication date	Page	Keyword	New	Modifi- cation	Delete d
10/23	–	Initial issue	–	–	–
11/23	–	Second certification EN IEC 62061	–	✓	–

0.2 Target group

This manual is intended for qualified personnel that has appropriate electrical training and:

- Plans and develops safety equipment for machines and systems or
- Installs and commissions this safety equipment and
- Is familiar with the applicable standards and regulations regarding accident prevention and occupational health and safety



The term "qualified personnel" refers to individuals who are authorized, by the party responsible for the system's safety, to perform the required activities and can identify and avoid the corresponding potential hazards as a result of their training, experience, and briefing and their familiarity with the applicable standards, regulations, accident prevention regulations, and operating conditions.

Familiarity with the following is required:

- Machinery Directive/Machinery Regulation and functional safety
- Handling safety components
- Applicable EMC regulations
- Applicable accident prevention and occupational health and safety regulations

0.3 Additional documents

For further information, see the applicable documentation:

- IL049015ZU
- Safety relay data sheet ESR5-NE-51-24VDC, article no. 401063



ATTENTION

Make sure to always use the latest documentation for your device. The latest edition of this documentation and the applicable documents can be found on the Internet at [Eaton.com/esr5](https://www.eaton.com/esr5).

0.4 Abbreviations and symbols

The following symbols are used throughout this manual:

► Indicates instructions to be followed.

Hazard warnings of personal injury



DANGER

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



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.

Hazard warnings of material damages

ATTENTION

Warns about the possibility of material damage.

Tips



Indicates useful tips.

1 Description ESR5-NE-51-24VDC

1.1 Intended use

The ESR5-NE-51-24VDC safety relay can be used as a contact expansion module for controlled emergency (category 1) stop relays and two-hand controls.

When used in conjunction with a suitable base device used as an evaluation unit (e.g., a safety relay for controlled emergency (category 1) stops and protective door monitoring), this ESR5-NE-51-24VDC can be used to de-energize circuits for safety purposes.

Any other use must be discussed and agreed upon with the manufacturer in advance.

The ESR5-NE-51-24VDC is approved for use in control cabinets or enclosures with a minimum degree of protection of IP54..

The ESR5-NE-51-24VDC must be used only in locations for which the device is approved. Make sure to read and Observe the markings on the device, as well as section Approvals and standards in the appendix.



Please note that we assume no liability for damages, consequential damages, and/or accidents caused by the following:

- Failure to follow any applicable occupational health and safety rules, standards, and/or regulations
- Device failures or function disturbances
- Improper use and/or handling
- Not following the instructions or observing the information in the documentation for the device
- Alterations, changes, and repairs to the device

1.2 Possible signal encoders

- ESR5 series safety relays

1.3 Contact type

- 5 instantaneous enable current paths
- 1 instantaneous signaling current path (NC)
- 1 non-delayed feedback current path

The enable current paths, the signal current path and the feedback current path will drop out without a delay in conformity with Stop category 0 as defined in EN 60204-1.

1 Description ESR5-NE-51-24VDC

1.4 Actuation

- Single-channel or dual-channel

1.5 Achievable level of safety integrity

- Suitable for up to category 4, PLe (EN ISO 13849-1), SIL 3 (EN IEC 62061) when used in conjunction with a suitable base device used as an evaluation unit and depending on the specific application

1.6 Other Features

- Reinforced insulation
- Plug-in screw terminals
- 22.5 mm housing width

1.7 Approvals



1.8 Operator control and display elements

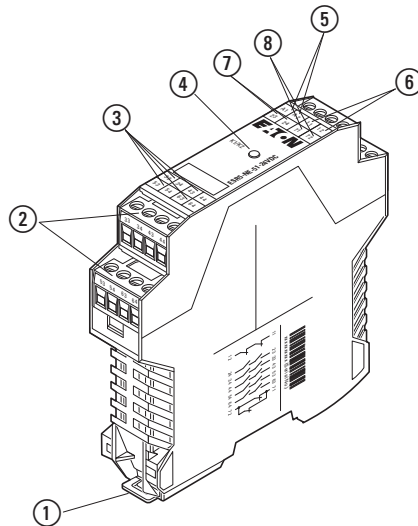


Figure 1: ESR5-NE-51-24VDC

- ① Metal lock for installation on the mounting rail
- ② Plug-in screw terminals COMBICON
- ③ 33/34, 43/44, 53/54, 63/64 – non-delayed enable current paths
- ④ LED status display, green – K1/K2
- ⑤ A1, A2 – supply voltage connection
- ⑥ 11, 12 – feedback current path, non-delayed
- ⑦ 23, 24 – enable current path, non-delayed
- ⑧ 71,72 - signal current path, non-delayed



The device's year of manufacture can be found underneath the CE marking on the housing.
XX/XX = calendar week / year

1 Description ESR5-NE-51-24VDC

1.9 Function description

The ESR5-NE-51-24VDC is used to provide a suitable base device with additional output contacts for safe shutdowns.

Single-channel or dual-channel circuitry

The external enable signal from the base device is connected to A1.

Optionally, the base device's external enable signal can additionally be connected to A2.

Automatic start

The ESR5-NE-51-24VDC contact expansion module is started automatically through digital input A1 when a 24 V voltage is applied (-20%/+10%).

The enable current paths 23/24, 33/34, 43/44, 53/54 and 63/64 close.

Feedback current path 11/12 and signal current path 71/72 will open.

Safe shut-down

A safe state is brought about when at least one of the relays (K1 or K2) is switched off.

The enable current paths 23/24, 33/34, 43/44, 53/54 and 63/64 open.

Feedback current path 11/12 and signal current path 71/72 will close.

1.10 Function and time diagrams

Time diagram automatic start

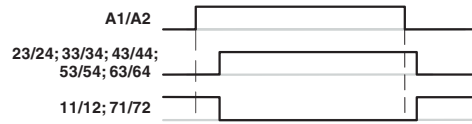


Figure 2: Time diagram automatic start

Designation	Explanation
A1/A2	Power supply/control
23/24, 33/34, 43/44, 53/54, 63/64	Enable current paths, non-delayed
11/12	Feedback current path, non-delayed
71/72	Signal current path, non-delayed

1.11 Heat dissipation calculation



The safety relay's total heat dissipation is yielded by the input heat dissipation and the contact heat dissipation with equal or different load currents.

Input heat dissipation

$$P_{\text{Input}} = U_B^2 / (U_N / I_N)$$

Contact heat dissipation

At equal load currents.

$$P_{\text{Contact}} = n \times I_L^2 \times 200 \text{ m}\Omega$$

At different load currents:

$$P_{\text{Contact}} = (I_{L1}^2 + I_{L2}^2 + \dots + I_{Ln}^2) \times 200 \text{ m}\Omega$$

Total heat dissipations

$$P_{\text{Total}} = P_{\text{Input}} + P_{\text{Contact}}$$

now then

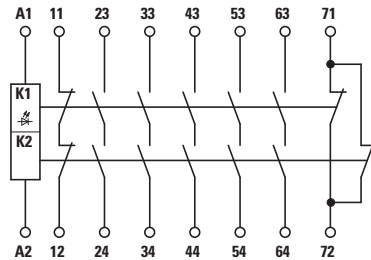
$$P_{\text{Total}} = U_B^2 / (U_N / I_N) + n \times I_L^2 \times 200 \text{ m}\Omega$$

or

$$P_{\text{Total}} = U_B^2 / (U_N / I_N) + (I_{L1}^2 + I_{L2}^2 + \dots + I_{Ln}^2) \times 200 \text{ m}\Omega$$

- P** Heat dissipation in mW
- U_B** Applied operating voltage
- U_N** Input rated voltage
- I_N** Input current
- n** Number of enable current paths used
- I_L** Contact load current

1.12 Block diagram



Designation	Explanation
A1	Power supply/control 24 VDC
A2	Power supply/control 0 V
11/12	Feedback current path, non-delayed
23/24	Enable current paths, non-delayed
33/34	Enable current paths, non-delayed
43/44	Enable current paths, non-delayed
53/54	Enable current paths, non-delayed
63/64	Enable current paths, non-delayed
71/72	Signal current path, non-delayed

Figure 3: Block diagram

Isolation co-ordination

	Enclosure material	A1/A2	11/12	23/24	33/34	43/44	53/54	63/64	71/72
Enclosure material	-	-	-	-	-	-	-	-	-
A1/A2	4 kV BI	-	4 kV BI	4 kV BI	6 kV ST	6 kV ST	6 kV ST	6 kV BI	4 kV BI
11/12	4 kV BI	-	-	4 kV BI	6 kV ST	6 kV ST	6 kV ST	6 kV ST	4 kV BI
23/24	4 kV BI	-	-	-	6 kV ST	6 kV ST	6 kV ST	6 kV ST	4 kV BI
33/34	4 kV BI	-	-	-	-	4 kV BI	4 kV BI	4 kV BI	6 kV ST
43/44	4 kV BI	-	-	-	-	-	4 kV BI	4 kV BI	6 kV ST
53/54	4 kV BI	-	-	-	-	-	-	4 kV BI	6 kV ST
63/64	4 kV BI	-	-	-	-	-	-	-	6 kV ST
71/72	4 kV BI	-	-	-	-	-	-	-	6 kV ST

Legend: BI - basic insulation, ST - safe isolation



Basic insulation

(rated surge voltage 4 kV)

Mixing low voltage and SELV is not permissible. Connect 250 VAC to one of the enable contacts only if the neighboring contact/enable current path is also carrying the same potential.

Safe isolation / reinforced insulation

(rated surge voltage 6 kV)

The reinforced insulation is designed one overvoltage category higher than the basic insulation (e.g., with greater clearances and creepage distances for the conductors). Accordingly, mixing SELV circuits with $V \leq 25$ VAC or $V \leq 60$ VDC and circuits with a higher voltage is possible.

1.13 Derating

The derating curve applies under the following conditions:

- Mounting on vertical or horizontal mounting rail
- Devices mounted without distance to each other
- with U_N up to max. 26.4 V DC (24 V -20%/+10%)
- $I_{max}^2 = I_1^2 + I_2^2 + I_3^2 + \dots$

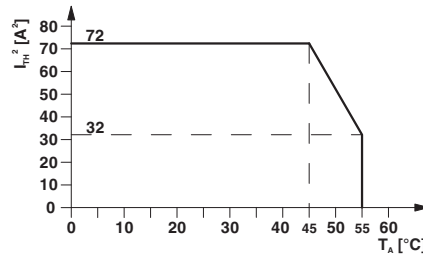


Figure 4: Derating curve – vertical and horizontal mounting positions, without distance

1.13.1 Use at altitudes greater than 2000 m above sea level. NN



The following section describes the special conditions for the use of an ESR5-NE-51-24VDC at altitudes greater than 2000 m above sea level.

Make sure to observe the corresponding device-specific specifications (technical data, derating, etc.).

The use of the device ESR5-NE-51-24VDC at altitudes **higher than 2000 m above sea level and up to a maximum of 4500 m above sea level** is allowed provided that:

1. Rated input voltage V_N : 24 VDC (-20%/+10%) is maintained and
2. The maximum switching voltage at the relay outputs for enable current paths 33/34, 43/44, 53/54, 63/64 and the feedback current path 11/12: min. 10 V, max. 250 VAC and signal current path 71/72: min 5 V, max. 250 VAC is not exceeded.

- 1. Reduce the maximum ambient temperature for operation by the corresponding temperature derating factor as per the following table.

Altitude above sea level	Temperatur-Derating-Factor
2000 m	1
2500 m	0.953
3000 m	0.906
3500 m	0.859
4000 m	0.813
4500 m	0.766

- ▶ 2.If derating is required, shift all the points in the derating curve by the temperature derating factor.

Calculation example for shifting the derating curve



Carry out the calculation and shift the derating curve as required for your application
 → Section 1.13, "Derating"

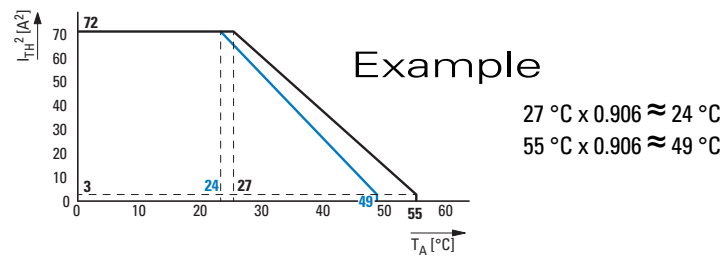


Figure 5: Example: Shifted derating curve (blue) at altitude of 3000 m above sea level

1.14 Load curve – resistive load

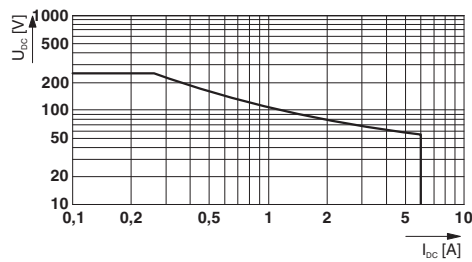


Figure 6: Load curve of the relay – resistive load

2 Safety regulations

2.1 Basics

The device has been designed according to the state of the art and all generally accepted safety rules and standards. However, this alone cannot eliminate all potential hazards, which is why it is necessary for you to be aware of all hazards and residual risks.

Do not run the device unless it is in perfect technical condition. Make sure to always operate it as specified in this document and for the intended purpose.



WARNING

Danger due to electric voltage!

Disregarding safety regulations may result in death, serious personal injury or damage to equipment!

Depending on the specific application in question, the improper use of the device may pose serious hazards to the user or result in serious property damage.

Please observe all safety standards, regulations, and instructions regarding electrical equipment, as well as those established by the applicable employers' liability insurance association!



WARNING

Danger posed by the machine restarting automatically!

When dealing with controlled emergency (category 1) stop applications, make sure that the higher-level control system will not cause the machine to restart automatically!

Do not remove any protective covers from electrical switchgear during operation!



WARNING

Danger posed by faulty devices!

After a fault, the devices may be damaged, in which case proper operation can no longer be guaranteed!

Turn off the device without fail after the first fault!

Repairs to the device, especially those involving opening the housing, must be carried out exclusively by the manufacturer or by a person authorized by the manufacturer to do so. Failure to observe this requirement will void any and all warranties!



WARNING

Danger due to electric voltage!

During operation, parts of electrical switching devices carry hazardous voltages!

During operation, the protective covers must not be removed from the electric switchgear!



CAUTION UV LIGHT

Plastics will become brittle when exposed to UV light. This artificial aging will reduce the device's lifespan. Protect the device from direct sunlight and other sources of UV radiation.

ATTENTION

Risk of property damage posed by improper installation

In order to ensure safe operation, install the safety relay in an enclosure protected from water sprays and limited dust ingress (IP54).

Wire the device as required for the intended use.

→ Section 5, "Application example", page 29.

ATTENTION

Risk of property damage posed by emitted interference

When operating relay modules, the company operating the system must ensure that the requirements for emitted interference for electrical and electronic equipment (EN 61000-6-4) are met on the contact side.

If necessary, corresponding measures must be taken.

ATTENTION

Follow the safety instructions for the ESR5-NE-51-24VDC!

The section on safety instructions must be read and understood by everyone who will be working with the ESR5-NE-51-24VDC before the actual work is performed. Contact expansion for safety relay.

2 Safety regulations

2.2 Mandatory requirements, personnel requirements

2.2.1 Occupational safety

All generally accepted occupational health and safety rules and standards (internal and national) must be complied with, as must be all applicable laws and regulations in the relevant country.

2.2.2 Personnel qualifications

The personnel responsible for installation, operation, maintenance, and repairs must have the necessary qualifications for the work they will be performing. They must be appropriately trained and/or briefed and be informed of all hazards and risks associated with the device.

2.2.3 Device documentation

This manual is considered an integral part of the ESR5-NE-51-24VDC and must always be readily available in the device's close proximity so that users have access to it.

Additional applicable documents and information on ESR5-NE-51-24VDC, including the installation instructions, can be found on the Internet, in the Eaton Download Center - Documentation and on the product pages.

Eaton.com/documentation

Eaton.com/esr5



WARNING

INCOMPLETE OPERATOR MANUAL COPIES.

Working with individual pages taken out from the manual may lead to bodily injury and property damage due to missing safety information.

- ▶ Always work with the complete documentation.

2.2.4 Installation, maintenance, and disposal

Make sure that the device is connected, installed, serviced, and disposed of professionally and in line with all relevant standards and safety rules.



CAUTION

Installation requires qualified electrician
A ESR5-NE-51-24VDC may only be fitted and connected by a qualified electrician or a person who is familiar with electrical installations.



Dispose of recyclables as required by your local recycling regulations.

Devices no longer being used must be professionally disposed of as per local regulations. To learn more, please visit:

Eaton.com/recycling.

2.2.5 Prerequisites for proper operation

In order for the device to be able to meet the contractually stipulated terms, the following must be observed:

- Only qualified personnel should be allowed to work with the device.
- The personnel working with the device must have read and understood all documents for the device and must follow all the instructions in them.
- The required ambient conditions must be met.
- Maintenance work must be carried out correctly.



Make sure to read the → disclaimer, → Section 1.1, "Intended use", page6

We assume no liability for damages, consequential damages, and/or accidents caused by the following:

- Failure to follow any applicable occupational health and safety rules, standards, and/or regulations
- Device failures or function disturbances
- Improper use and/or handling
- Not following the instructions or observing the information in the documentation for the device
- Alterations, changes, and repairs to the device

2.3 Device-specific hazards



CAUTION MALFUNCTION

The values specified in the technical data, as well as the device's electromagnetic compatibility (EMC), cannot be guaranteed if the following are used: unsuitable cables, improperly assembled and terminated cables, and/or wiring that does not conform to the applicable standards.
Only use cables assembled and terminated by professionals. The cables being used must be assembled according to the wiring specifications in this document.
All general Directives and standards must be complied with.

2.3.1 Direct/indirect contact

- ▶ For all the components connected to the system, ensure protection against direct and indirect contact in conformity with VDE 0100 Part 410. No cases of hazardous accidental energization must occur in the event of a fault (safety under single-fault conditions!).

2.3.2 Power supply units for 24 V supply

- ▶ Only use power supplies with safe isolation and SELV / PELV voltage.
- ▶ Protect the 24 V system with a suitable external fuse.
- ▶ Make sure that the power supply can deliver **four times** the rated current of the external fuse so as to ensure that the fuse will blow reliably in the event of a fault.
- ▶ Make sure that the output voltage of the power supply does not exceed 24 VDC -20%/+10% even in the event of a fault.

2.3.3 Mismatching and polarity reversal of connections

- ▶ Take measures to prevent mismatching, polarity reversal, and manipulation of connections.

2.4 In operation

During operation, parts of the electrical switching devices carry hazardous voltages.

- ▶ Do not remove any protective covers from electrical switchgear during operation!

In controlled emergency (category 1) stop applications, serious hazards to the user can be posed by the machine starting automatically.

- ▶ Make sure that the higher-level control system will not cause the machine to restart automatically.

In conformity with DIN EN ISO 13849-1, the manual monitored resetting device must not trigger a machine start.

Inductive loads can result in sticky relay contacts.

- ▶ Provide a suitable and effective protective circuit for inductive loads.
- ▶ Have the suppressor circuit be parallel to the load, not parallel to the switching contact.

Magnetic fields can affect the device. The surroundings' magnetic field strength must not exceed 30 A/m.

- ▶ Do not use the device in the proximity of strong magnetic fields (e.g., transformers or magnetite).

Emitted interference is possible when operating relay modules. Radio reception in residential areas can experience interference as a result.

The device is a class A product.

- ▶ Observe the requirements regarding emitted interference for electrical and electronic equipment (DIN EN IEC 61000-6-4).
- ▶ Take appropriate measures against emitted interference.

2.5 Defective devices

The devices may be damaged after a fault, in which case they are considered faulty.

Proper operation can no longer be guaranteed in this case.

- ▶ Replace the ESR5-NE-51-24VDC without fail after the first fault!



CAUTION DESTRUCTION

Repairs to the device, especially those involving opening the housing, must be carried out exclusively by the manufacturer.

2.6 Ensuring the safety of machinery or equipment

2.6.1 Elaborating and implementing a safety concept

The machine/system manufacturer and the company operating the machine/system are responsible for the safety of the machine/system and the application in which the machine/system is used. In order to use the device described here, you must have first elaborated a suitable safety concept for your machine or system. This includes a risk assessment in conformity with the Directives and standards specified in the EU Declaration of Conformity, etc.

2.6.2 Risk assessment, validation, and functional test

- ▶ Before using the device, carry out a risk assessment on the machine or system.
- ▶ Validate your overall safety system.
- ▶ After every change that is relevant to safety, carry out a new validation.
- ▶ Carry out functional tests on a regular basis.

2.6.3 Achievable level of safety integrity

Functional safety is ensured for the device as an individual component. However, this does not guarantee the functional safety of the whole machine or system. In order to be able to achieve the desired safety level for the entire machine or system, define the safety requirements for the machine or system and how they need to be implemented technically and organizationally.

3 Installation



CAUTION

Installation requires qualified electrician
A ESR5-NE-51-24VDC may only be fitted and connected by a qualified electrician or a person who is familiar with electrical installations.



WARNING

Danger due to electric voltage!

All installation work must be carried out with the entire installation in a de-energized state.

Always comply with all applicable country-specific safety rules and regulations:

- ▶ 1. Switch off and isolate
- ▶ 2. Secure against retriggering
- ▶ 3. Verify isolation from the supply
- ▶ 4. Earthing and short-circuiting
- ▶ 5. Cover or enclose any neighboring live parts.

What to do before turning the device back on

- ▶ 1. Remove all tools and materials
- ▶ 2. Leave the danger zone
- ▶ 3. Remove the short-circuiting and grounding at the area where work was performed and then elsewhere
- ▶ 4. Disconnect the ground wire from the system components first, then from the ground
- ▶ 5. Do not touch system components or cables without a ground wire (if there was one previously) anymore
- ▶ 6. Reinstall all safety covers, safety enclosures, safety labels, and safety signs.
- ▶ 7. Do not remove safety measures at switching points until you get the all-clear for the areas where work was performed

3 Installation

- ▶8. If carrying out work that involves more than one worker, make absolutely sure that nobody is still in the danger zone

3.1 Prerequisites for the location of use

The supply voltage must be guaranteed and must conform to the relevant specifications-

The devices are intended to be flush mounted in control cabinets, control panels, service distribution boards, or control consoles on a mounting rail.

The device can be installed in a horizontal or vertical position.

3.2 Unpacking and checking the equipment supplied

The device is delivered in a package together with the document IL049015ZU.

- Check the ESR5-NE-51-24VDC's packaging for transit damage.
- Carefully remove the packaging in order to avoid damaging the device.
- Check the package contents for visible transit damage.
- Keep the original packaging so that you will be able to use it in the future if you need to transport or ship the device.
- Carefully read the document IL049015ZU
- Make sure to also keep the document IL049015ZU and/or to give them to the end customer.

Missing parts or damage

If you notice anything wrong, please contact your distributor or Eaton Service +1 877-386-2273 (en) / 877-ETN-CARE (877-386-2273).

3.3 Mounting and disassembly

- ▶ Mount the device on a 35 mm mounting rail according to EN 60715.
- ▶ To remove it, release the locking base with a screwdriver.

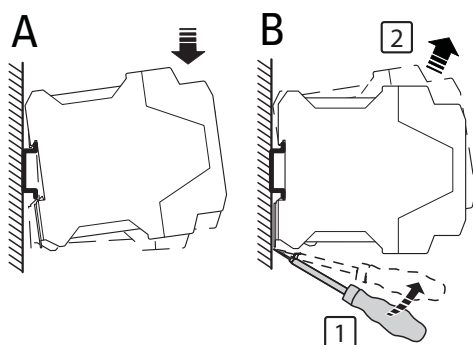
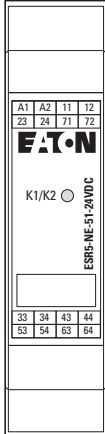


Figure 7: Mounting A and disassembly B

3.4 Connection

3.4.1 Pin assignment

	A1	Power supply/control 24 VDC
	A2	Power supply/control 0 V
	11/12	Feedback current path, non-delayed
	71/72	Signal current path, non-delayed
	K1/K2	Status display safety circuit; LED (green)
	23/24	Enable current path, non-delayed
	33/34	Enable current path, non-delayed
	43/44	Enable current path, non-delayed
	53/54	Enable current path, non-delayed
	63/64	Enable current path, non-delayed

3.4.2 ?Wiring topic

- ▶ Connect the cables to the connection terminals with the help of a screwdriver.

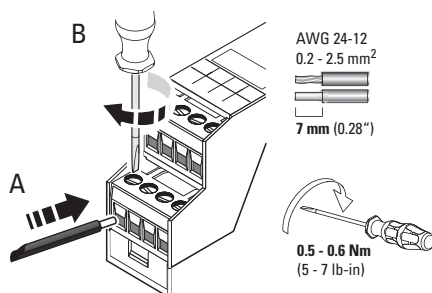


Figure 8: Connection of the cables

- ➔ Ferrules are recommended when connecting flexible cables.
- ➔ Use copper wire approved for temperatures of up to 60 °C/ 75 °C in order to meet the requirements for the UL listing.

3.4.3 Connecting to the basic unit

- ▶ Connect the basic unit to A1.
- ▶ Connect feedback current path 11/12 to the base device's feedback circuit.

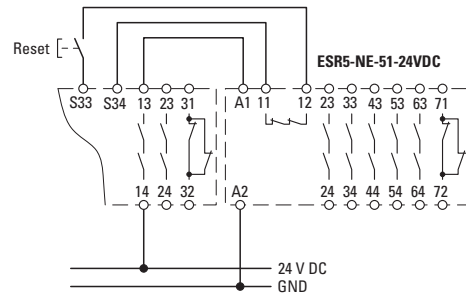


Figure 9: Single-channel configuration with feedback current path integration

- ▶ To monitor external contactors or expansion devices with positively driven contacts, connect the respective N/Cs to path 11/12 to the base device.

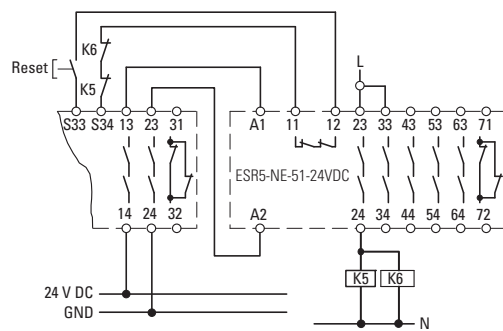


Figure 10: Single-channel configuration with feedback current path integration and externally monitored contacts

- ▶ For dual-channel operation, additionally connect the base device to A2 on the contact expansion module.

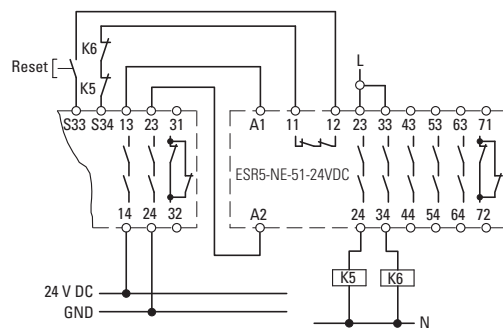


Figure 11: Dual-channel configuration with feedback current path integration and externally monitored contacts

4 Maintenance

4.1 Maintenance

The device is maintenance-free within its permissible service life of 240 months.

If required, carry out proof tests within the specified proof test interval → Section , "Technical safety data", page34.

Depending on the application and the connected peripherals, check the proper operation of the peripheral devices and of the safety chain on a regular basis.



Observe the manufacturer specifications concerning maintenance for the connected peripheral devices.

4.1.1 Proof-Test

The functional test is used to test the device's safety function. To verify the device's function, follow the steps below:

- ▶ Activate the safety function by activating the corresponding protective device, e.g., the emergency stop button.
- ▶ Check whether the safety function runs correctly by switching the device (and the contact expansion module as well as a result) back on with the sensor circuits.

If the ESR5-NE-51-24VDC does not switch back on, the device has failed the proof test. The device is considered defective. → Section 2.5, "Defective devices", page20



**WARNING
LOSS OF FUNCTIONAL SAFETY AS A RESULT OF
MALFUNCTION**

If the device fails the proof test, the device's proper operation is no longer guaranteed.
Replace the device.

4.2 Storage and transport

The device is delivered in cardboard packaging.

- Observe the handling instructions on and in the packaging.



Transport the device exclusively in its original packaging or in packaging suitable for transportation.

- For transportation and storage, observe the specifications regarding climatic ambient conditions in the technical data for the temperature range, humidity, and air pressure → Page 34

4.2.1 Decommissioning and disposal


For decommissioning, make sure to observe the requirements of the machine or system manufacturer.

When decommissioning the system or parts of the system, make sure to handle the used devices as follows.

If you will continue to use the device in conformity with its intended use:

- Store and transport the device in conformity with the corresponding specifications → Section 4.2, "Storage and transport", page 27

The device is no longer used:

	<p>ATTENTION</p> <p>Devices no longer being used must be professionally disposed or returned to the manufacturer or relevant sales department. For more information, see Eaton.com/recycling.</p>
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- ▶ Dispose of recyclables as required by your local recycling regulations.

4.2.2 Device replacement and repair

The device can be replaced if necessary.

If replacing the device:

- Use the same device type
- Use the same or a higher hardware/firmware version.

	<p>CAUTION DESTRUCTION</p> <p>Repairs to the device, especially those involving opening the housing, must be carried out exclusively by the manufacturer.</p>
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4.3 Diagnostics

The ESR5-NE-51-24VDC Contact expansion for safety relay does not run its own diagnostics.

Diagnostics can be implemented by integrating the feedback current path to a connected base device.

4.3.1 General states

Table 1 Diagnostics - general states

LED K1/K2	State	Remark
●	All relays are energized	

Legend: ○ – LED off, ● – LED on

4.3.2 Error Messages

Table 2 Diagnostics - error messages

LED K1/K2	Possible cause	Remedy
○	No supply voltage or undervoltage at A1/A2.	Check the input voltage.
	Short circuit between A1 and A2.	Turn off the input voltage and fix the short-circuit. Then carry out a functional test.
	Feedback-signal contacts 11 and 12 are defective.	Internal error: Perform a power-down reset followed by a function test. If the error occurs again after the function test, replace the device.
	Enable contact(s) of relay K1 and K2 defective	Internal error: Perform a power-down reset followed by a function test. If the error occurs again after the function test, replace the device.

Legend: ○ – LED off, ● – LED on

Table 3 Diagnostic description for EATON to date

	K1/K2	Errors	Remedy
Connection / voltage error	○	Supply voltage is not applied.	Apply supply voltage.
	○	Supply voltage too low.	Adjust supply voltage.
	○	Input circuit is not connected correctly or not connected at all.	Check the connection of the input circuit.
Short-circuit	○	Between the contact points A1 and A2.	Eliminate short circuit.
Internal error	○	Feedback-signal contacts 11 and 12 are defective.	Replace the safety relay.
	○	Release contact(s) of K1 and K2 defective.	Perform voltage reset.

5 Application example

5.1 Dual-channel EMERGENCY-STOP monitoring with contact expansion module

- Dual-channel EMERGENCY STOP monitoring
- Manual, monitored start
- Monitoring of external, interlocked opposing contactors
- Suitable for up to category 4, PLe (EN ISO 13849-1), SIL 3 (EN IEC 62061) if cross-faults in the control section for the contact expansion module can be ruled out.

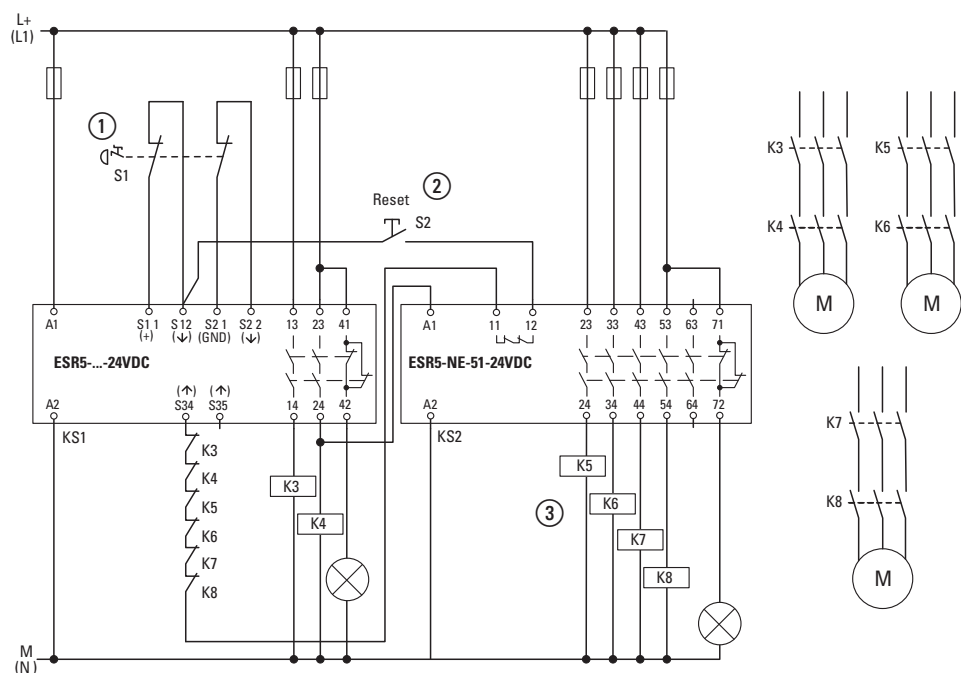


Figure 12: Dual-channel Emergency-stop monitoring with contact expansion module

- ① S1 – EMERGENCY-STOP pushbutton
- ② S2 – manual reset device
- ③ K3 - K8 – interlocked opposing contactors

6 Appendix

6.1 Data sheet and ordering data

The current specifications for the device can be found in the corresponding data sheet at Eaton.com/esr5

Article no. and type	Description
401063 ESR5-NE-51-24VDC	ESR5 Contact expansion for safety relay, 24VDC, 5 enable paths

6.2 Technical specifications

Hardware/Firmware version	
HW/FW	≥ 00/-- The technical data and safety parameters are valid as of the specified HW/FW version.



The specifications in the technical data applied to the ESR5-NE-51-24VDC at the time of this manual's publication and can accordingly differ from the specifications for the product found on the Internet.

Supply	
Rated control circuit supply voltage U_S	24 V DC -20 % / +10 %
Rated control supply current I_S	normally 70 mA (at U_S)
Power consumption at U_S	
Inrush current	
Filter time	
Suppressor circuit	Suppressor diode

Supply data	
Conductor cross-section, rigid	0.2 mm ² - 2.5 mm ²
Conductor cross-section, flexible	0.2 mm ² - 2.5 mm ²
Conductor cross section, AWG/kcmil	24 - 12
Strip length	7 mm
Screw thread	M3
Tightening torque	0.5 Nm0.6 Nm

6 Appendix

Digital inputs: A1	
Number of inputs	1
Input description	safety-related
Input voltage range "1"-signal	19.2 V ... 26.4 V
Inrush current	max. 110 mA (normally at $U_S, \Delta t = 3 \text{ ms}$)
Current consumption	75 mA
Filter time	
Maximum permissible total cable resistance	25 Ω
Simultaneity	∞
Suppressor circuit	Suppressor diode

Relay outputs : enable current paths 23/24... 63/64	
Number of outputs	5
Output description	2 NO in series each, safety-related, potential-free
Contact material	AgSnO ₂
Switching voltage	min. 10 V max. 250 V AC/DC
Limiting continuous current	6 A (observe derating and load limit curve)
Inrush current	min. 10 mA max. 20 A ($\leq 100\text{ms}$)
Square total current $I_{TH}^2 = I_1^2 + I_2^2 + \dots + I_N^2$	72 A ² (observe derating)
Switch capacity	min. 100 mW
Switching Frequency	max. 1 Hz
Lifespan, mechanical	10x 10 ⁶ switching operations
Switching capacity, to IEC 60947-5-1	3 A (AC15) 5 A (DC13)
Output fuse	10 A gL/gG 4 A gL/gG (for low-demand applications)

Relay outputs: signal current path 71/72

Number of outputs	1
Output description	2 NC in parallel, not safety-related, potential-free
Contact material	AgSnO ₂
Switching voltage	min. 5V AC/DC max. 250 V AC/DC
Limiting continuous current	6 A (observe derating and load limit curve)
Inrush current	min. 10 mA max. 6 A
Square total current $I_{TH}^2 = I_1^2 + I_2^2 + \dots + I_N^2$	36 A ² (observe derating)
Switch capacity	min. 50 mW
Switching Frequency	max. 1 Hz
Lifespan, mechanical	10x 10 ⁶ switching operations
Switching capacity, to IEC 60947-5-1	1.5 A (AC-15) 6 A (DC-13)
Output fuse	6 A gL/gG

Relay outputs: feedback current path 11/12

Number of outputs	1
Output description	Diagnostic contact, 2 NC in series, dry
Contact material	AgSnO ₂
Switching voltage	min. 10V max. 250 V AC/DC
Limiting continuous current	6 A (observe derating and load limit curve)
Inrush current	max. 6 A
Square total current $I_{TH}^2 = I_1^2 + I_2^2 + \dots + I_N^2$	36 A ² (observe derating)
Switch capacity	min. 100 mW
Switching Frequency	max. 0.5 Hz
Lifespan, mechanical	
Switching capacity, to IEC 60947-5-1	1.5 A (AC-15) 3 A (DC-13)
Output fuse	10 A gL/gG

Times

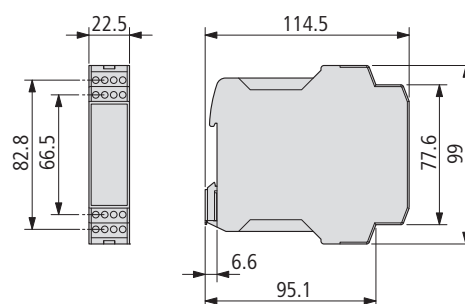
Normal pick-up time at U _s	< 25 ms (U _s if actuated via A1)
Normal response time at U _s	
Normal reset time at U _s	< 25 ms (U _s if actuated via A1)
Restart time	
Recovery time	<1 s
Start pulse duration	

6 Appendix

General data	
Relay type	Electromechanical relay with forcibly guided contacts according to IEC/EN 61810-3
Rated operating mode	100 % DF
Protection type	IP20
Protection type Installation location minimum	IP54
Mounting type	Rail mounting
Mounting position	Vertical or horizontal
Mounting instruction	See derating curve
Type of housing	
Operating voltage indication	1x LED green
status display	none
Clearances and creepage distances between circuits	according to DIN EN 60947-1
Rated insulation voltage	250 V
Rated surge voltage / insulation	4 kV / basic insulation (safe isolation, reinforced insulation and 6 kV between A1-A2 / logic / enable and signal current paths.) See section "Isolation co-ordination"
Pollution degree	2
Overvoltage category	III
Maximum power loss at nominal condition	16.6 W (at $U_S = 26.4 \text{ V}$, $I_L^2 = 72 \text{ A}^2$; $P_{\text{Total max}} = 2.2W + 14.4 \text{ W}$)
Note on heat dissipation	See chapter "Heat dissipation calculation"

Dimensions

W x H x D	22.5 x 99 x 114.5 mm
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Conformity/approvals

Conformity	CE
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Approvals



Ambient conditions	
Ambient temperature (operation)	-20 °C - 55 °C (observe derating)
Ambient temperature (storage/transport)	-40 °C - 70 °C
Max. permissible relative humidity (operation)	75% (on average, 85% occasionally, no condensation)
Max permissible relative humidity (storage/transport)	75% (on average, 85% occasionally, no condensation)
Applicable height	≤ 2000 m (above sea level)
Notes on applicable height	See section "Use at altitudes greater than 2000 m above sea level"
Impact resistance	15 g
Vibration (operation)	10 Hz - 150 Hz, amplitude 0.15 mm, 2 g

Technical safety data

Stop category according to EN60204	0
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Technical safety parameters for IEC 61508 – High Demand

The specifications apply only if the safety function is requested at least once a year and the feedback current path is integrated in conjunction with a suitable evaluation unit.

Device type (static)	Type A
HFT (Hardware Fault Tolerance)	1
SIL	SIL 3 (in conjunction with a suitable base device and depending on the specific application)
PFH _d	1.00 x 10 ⁻⁹ (3 A DC-13; 3 A AC-15; 8760 switching operations/year)
Demand level	< 12 months
Proof test interval	240 months
Lifetime	240 months

Technical safety parameters for IEC 61508 – Low Demand

Device type (static)	Type A
HFT (Hardware Fault Tolerance)	1
SIL	3 (in conjunction with a suitable base device and depending on the specific application)
PFD _{avg}	1.48x 10 ⁻⁴
Proof test interval	80 months
Lifetime	240 months

Technical safety parameters according to EN ISO 13849

Category	4 (in conjunction with a suitable base device and depending on the specific application)
Performance Level	e (in conjunction with a suitable base device and depending on the specific application)
Lifetime	240 months

For applications with PL e, a demand mode for the safety function of once per month is required.

Technical safety parameters for EN IEC 62061

SIL	3 (in conjunction with a suitable base device and depending on the specific application)
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6.3 Interface type (ZVEI classification)

Relay outputs : enable current paths 23/24, 63/64				
Source/drain	Interface type	Additional measure	Source/drain	Suitable interface type
Source	A	M	Drain	A
Source	C0	M	Drain	-

Interface-type A - source				
Parameter	min.	normally	max.	
Switching current I_i	10 mA	-	6 A	
Switching voltage U_i	10 V	-	250 V AC	
Internal resistance R_i (in switched state)	Load ≥ 1 A ≤ 200 m Ω	-	Load ≥ 10 mA ≤ 133.4 Ω	
Load capacity C_L	-	-	See switching capacity	
Inductive load L_L	-	-	See switching capacity	
Potential free	Yes	-	-	
Additional measure M	The inputs are not types according to IEC 61131-2.			

Interface type C0 source				
Parameter	min.	normally	max.	
Test pulse duration t_i	-	-	-	
Test pulse interval T	-	-	-	
Rated operational current I_N	-	-	6 A	
Load capacity C_L	-	-	See switching capacity	
Inductive load L_L	-	-	See switching capacity	
Additional measure M	The inputs are not types according to IEC 61131-2. No test pulses are output at the output.			

Relay outputs : signal current path 71/72				
Source/drain	Interface type	Additional measure	Source/drain	Suitable interface type
Source	A	M	Drain	A
Source	C0	M	Drain	-

Interface-type A - source				
Parameter	min.	normally	max.	
Switching current I_i	10 mA	-	6 A	
Switching voltage U_i	5 V	-	250 V AC	
Internal resistance R_i (in switched state)	Load ≥ 1 A ≤ 100 m Ω	-	Load ≥ 10 mA ≤ 20 Ω	
Load capacity C_L	-	-	See switching capacity	

Interface-type A - source			
Parameter	min.	normally	max.
Inductive load L_L	-	-	See switching capacity
Potential free	Yes	-	-
Additional measure M	The outputs are not types according to IEC 61131-2.		

Interface type C0 source			
Parameter	min.	normally	max.
Test pulse duration t_i	-	-	-
Test pulse interval T	-	-	-
Rated operational current I_N	-	-	6 A
Load capacity C_L	-	-	See switching capacity
Inductive load L_L	-	-	See switching capacity
Additional measure M	The inputs are not types according to IEC 61131-2. No test pulses are output at the output.		

Relay outputs: feedback current path 11/12				
Source/drain	Interface type	Additional measure	Source/drain	Suitable interface type
Source	A	M	Drain	A
Source	C0	M	Drain	-

Interface-type A - source			
Parameter	min.	normally	max.
Switching current I_i	10 mA	-	6 A
Switching voltage U_i	5 V	-	250 V AC
Internal resistance R_i (in switched state)	Load ≥ 1 A ≤ 100 m Ω	-	Load ≥ 10 mA ≤ 133.4 Ω
Load capacity C_L	-	-	See switching capacity
Inductive load L_L	-	-	See switching capacity
Potential free	Yes	-	-
Additional measure M	The outputs are not types according to IEC 61131-2.		

Interface type C0 source			
Parameter	min.	normally	max.
Test pulse duration t_i	-	-	-
Test pulse interval T	-	-	-
Rated operational current I_N	-	-	6 A
Load capacity C_L	-	-	See switching capacity
Inductive load L_L	-	-	See switching capacity
Additional measure M	The inputs are not types according to IEC 61131-2. No test pulses are output at the output.		

7 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	Electro-sensitive protective equipment
CCF	Common Cause Failure Common cause failure
DC	Diagnostic Coverage Diagnostic coverage
ESR	Electronic safety relay
DF	Duty factor
PL	Performance Level Classification of safety functions used to meet a safety requirement.
HFT	Hardware Fault Tolerance
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	Normally Closed contact, break contact An NC breaks a circuit when it is energized.
NO	Normally-Open 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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