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PSR-PS21

SIL coupling relay

Data sheet
106253_en_03

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1 Description

Intended Use

The SIL coupling relay is used to adjust the power and for electrical isolation in high- and low-demand applications.

The coupling relay safely interrupts circuits.

The category 3 device is designed for installation in zone 2 potentially explosive areas.

Possible signal generators

– Failsafe controllers

Contact type

– 1 undelayed, single-channel enabling current path
– 1 undelayed confirmation current path
– 1 digital signal output

The enabling current path drops out without delay according to stop category 0 (EN 60204-1).

Control

– Single-Channel
– Automatic start

Achievable safety integrity

– Suitable for high and low-demand applications up to SIL 2 in accordance with IEC 61508, IEC 61511, and IEC 50156

Additional features

– Easy proof test:
  - Visually on the device
  - Evaluation of the force-guided N/C contact
– Additional diagnostics status information
  - Active error acknowledgment via A1
  - Status information on M1
– Integrated test pulse filter.
– Corrosion protection through lacquering the printed-circuit board
– Fixed screw connection
– 6.8 mm housing width

Approvals

WARNING: Risk of electric shock

Observe the safety regulations and installation notes in the corresponding section.

Make sure you always use the latest documentation.
It can be downloaded from the product at phoenixcontact.net/products.

This document is valid for the products listed in the “Ordering data”.

This document meets the same requirements as the original operating instructions with respect to the contents.

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2 Table of contents

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3 Ordering data

Description	Type	Order No.	Pcs./Pkt.
Coupling relay for SIL 2 high- and low-demand applications, couples digital output signals to the I/O, 1 enabling current path, 1 confirmation current path, 1 digital signal output, safe state off applications, test pulse filter, fixed screw terminal block	PSR-PS21-1NO-1NC-24DC-SC	2700357	1

4 Technical data

Hardware/firmware version	
HW/FW	≥ 02/--
The technical data and safety characteristics are valid as of the specified HW/FW version.	

Supply	
Rated control circuit supply voltage U_S	24 V DC -15 % / +10 % (A1/A2)
Rated control supply current I_S	typ. 45 mA
Power consumption at U_S	typ. 1.08 W
Input voltage range "0" signal	0 V DC ... 5 V DC (for safe Off)
Input current range "0" signal	0 mA ... 2 mA (for safe Off)
Inrush current	typ. 400 mA ($\Delta t < 10$ µs at U_s)
Filter time	max. 2 ms (at A1-A2; test pulse width) ≥ 100 ms (at A1-A2; test pulse rate)
Diagnostic supply voltage U_D	24 V DC -15 % / +10 % (21/A2)
Input current at U_D	6 mA (at 21-A2 for U_D; depending on load + 100 mA at M1 and 22)
Inrush current at U_D	typ. 2.5 A ($\Delta t < 20$ µs at U_D)
Protective circuit	Serial protection against polarity reversal Suppressor diode 33 V (A1/A2), 38 V (21/A2)

Relay outputs: Enabling current path	
Number of outputs	1 (safety-related N/O contacts: 13/14)
Output description	1 N/O contact, without delay, floating
Contact material	$AgSnO_2$
Switching voltage	min. 12 V AC/DC max. 250 V AC/DC (Observe the load curve)
Limiting continuous current	6 A (High demand) 4 A (Low demand)
Inrush current	min. 3 mA max. 6 A
Sq. Total current $I_{TH}^2 = I_1^2 + I_2^2 + ... + I_N^2$	36 A^2 (observe derating)
Switching capacity	min. 60 mW
Switching frequency	max. 1 Hz

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Relay outputs: Enabling current path	
Mechanical service life	10x 10^6 cycles
Switching capacity according to IEC 60947-5-1	4 A (24 V (DC13)) 5 A (250 V (AC15))
Output fuse	6 A gL/gG 4 A gL/gG (for low-demand applications)

Relay outputs: Confirmation current path	
Number of outputs	1 (safety-related N/C contacts: 21/22)
Output description	1 N/C contact, without delay, not floating (reference ground: A2)
Contact material	AgCuNi, + Au (confirmation current path)
Switching voltage	min. 20.4 V DC max. 26.4 V DC
Limiting continuous current	100 mA
Inrush current	min. 1 mA max. 100 mA
Switching capacity	min. 20 mW
Switching frequency	max. 1 Hz
Mechanical service life	10x 10^6 cycles
Output fuse	150 mA Fast-blow

Alarm outputs	
Designation	M1
Number of outputs	1 (non-safety-related)
Output description	PNP
Voltage	approx. 22 V DC (U_D - 2 V)
Current	max. 100 mA
Maximum inrush current	500 mA (Δt = 1 ms at U_s)
Short-circuit protection	no
Output fuse	150 mA fast blow

Times	
Typical starting time with U_s	< 100 ms (with U_s when controlled via A1)
Typical release time with U_s	< 35 ms (when controlled via A1)
Recovery time	500 ms

General data	
Relay type	Electromechanical relay with forcibly guided contacts in accordance with IEC/EN 61810-3 (EN 50205)
Nominal operating mode	100% operating factor
Degree of protection	IP20
Min. degree of protection of inst. location	IP54
Mounting type	DIN rail mounting
Mounting position	vertical, horizontal, with front of module upward
Assembly instructions	See derating curve

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General data	
Dimensions (W/H/D)	6.8 x 93.1 x 102.5 mm
Type of housing	PBT yellow
Operating voltage display	1 x yellow LED
Status display	2 x green LEDs
Indication	1 x red LED
Air clearances and creepage distances between the power circuits	according to DIN EN 50178, EN 60079-15
Rated insulation voltage	250 V AC
Rated surge voltage/insulation See “Insulation coordination”	Safe isolation, 6 kV reinforced insulation from control circuit, start circuit, confirmation current path, signal output to the enabling current path; 4 kV/basic insulation between all current paths and housing
Degree of pollution	2
Overvoltage category	III
Maximum power dissipation for nominal condition	2.35 W (I_L^2 = 36 A^2)
Note on power dissipation	See “Calculating the power dissipation”

Connection data	
Connection method	Screw connection
Conductor cross section, solid	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	26 ... 12
Stripping length	12 mm
Screw thread	M3
Torque	0.5 Nm ... 0.6 Nm

Ambient conditions	
Ambient temperature (operation)	-40 °C ... 65 °C (observe derating)
Ambient temperature (storage/transport)	-40 °C ... 85 °C
Max. permissible relative humidity (operation)	75 % (on average, 85% infrequently, non-condensing)
Max. permissible humidity (storage/transport)	75 % (on average, 85% infrequently, non-condensing)
Maximum altitude	≤ 2000 m (Above sea level)
Information on operating height	See the “Using PSR devices at altitudes greater than 2000 m above sea level” section
Shock	15g
Vibration (operation)	10 Hz ...150 Hz, 2g

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Conformance/Approvals	
Conformance	CE-compliant
The full EC Declaration of Conformity can be downloaded for the product at phoenixcontact.net/products.	
Approvals	
IECEx (IECEx ULD 14.0003X)	Ex nA nC IIC T4 Gc
ATEX (DEMKO 14 ATEX 1284X)	II 3 G Ex nA nC IIC T4 Gc
UL, USA/Canada (E140324)	cULus
UL, USA/Canada (E360692)	Class I, Zone 2, AEx nA nC IIC T4 / Ex nA nC IIC Gc T4 X Class I, Div. 2, Groups A, B, C, D, T4
Shipbuilding (11253-14 HH)	C, EMC2
Environmental simulation test	ISA-S71.04 (G3)
Functional Safety in accordance with IEC 61508	to SIL 2

Safety data	
Stop category according to IEC 60204	0

Safety parameters for IEC 61508 - High demand	
Equipment type	Type A
HFT	0
SIL	2
PFH_D	8.8×10^{-9} (4 A DC13; 5 A AC15; 8760 switching cycles/year)
Demand rate	< 12 Months
Proof test interval	240 Months
Duration of use	240 Months
For use in high-demand applications, the diagnostics function must be implemented via the confirmation current path.	

Alternative illustration as 1oo1 structure	
Equipment type	Type A
HFT	0
SIL	2
Safe Failure Fraction (SFF)	99.18 %
λSD	494.66 FIT
λSU	79.10 FIT
λDD	494.66 FIT
λDU	8.80 FIT
λTotal	1077.22 FIT
MTBF	91.65 Years
PFH_D	8.8×10^{-9}
For use in high-demand applications, the diagnostics function must be implemented via the confirmation current path.	

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Safety parameters for IEC 61508 - Low demand	
Equipment type	Type A
HFT	0
SIL	2
PFD_{avg}	1.34×10^{-3}
Proof test interval	20 Months
Duration of use	240 Months

Alternative illustration as 1oo1 structure	
Equipment type	Type A
HFT	0
SIL	2
Safe Failure Fraction (SFF)	81.2 %
λSD	0 FIT
λSU	794.1 FIT
λDD	0 FIT
λDU	183.8 FIT
λTotal	977.9 FIT
MTBF	99 Years
PFD_{avg}	8.06×10^{-4} (For T1 = 1 year)

Safety parameters for EN 50156	
SIL	2

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5 Notes regarding documentation

5.1 Explanation of symbols used and signal words

This is the safety alert symbol. It is used to alert you to potential personal injury hazards. Obey all safety measures that follow this symbol to avoid possible injury or death.

There are three different categories of personal injury that are indicated with a signal word.

DANGER This indicates a hazardous situation which, if not avoided, will result in death or serious injury.

WARNING This indicates a hazardous situation which, if not avoided, could result in death or serious injury.

CAUTION This indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.

This symbol together with the signal word **NOTE** and the accompanying text alert the reader to a situation which may cause damage or malfunction to the device, hardware/software, or surrounding property.

This symbol and the accompanying text provide the reader with additional information or refer to detailed sources of information.

5.2 Validity

This data sheet is valid for the described product(s) from the hardware/firmware version specified in the technical data.

5.3 Target group

This data sheet is therefore aimed at:

- Qualified personnel who plan and design safety equipment for machines and systems and are familiar with regulations governing occupational safety and accident prevention.
- Qualified personnel who install and operate safety equipment in machines and systems.

Qualified personnel:

Qualified personnel are people who, because of their education, experience, and instruction and their knowledge of relevant standards, regulations, accident prevention, and service conditions, have been authorized by those responsible for the safety of the system to carry out any required operations and who are able to recognize and avoid any possible dangers.

Requirements:

Knowledge of the following topics is required:

- Handling safety components
- Valid EMC regulations
- Valid regulations governing occupational safety and accident prevention

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6 Safety regulations and installation notes

WARNING: Death, serious personal injury or damage to equipment

Depending on the application, incorrect handling of the device may pose serious risks for the user or cause damage to equipment.

- Observe all the safety notes and warning instructions provided in this chapter and elsewhere in this document.

General

- 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.

The device contains components that can be damaged or destroyed by electrostatic discharge.

- When handling the device, observe the necessary safety precautions against electrostatic discharge (ESD) according to EN 61340-5-1 and IEC 61340-5-1.

Direct/indirect contact

- Protection against direct and indirect contact according to VDE 0100 Part 410 must be ensured for all components connected to the system.

In the event of an error, parasitic voltages must not occur (single-fault tolerance).

Power supply units for 24 V supply

- Only use power supply units with safe isolation and SELV/PELV according to EN 50178/VDE 0160.
- Protect the 24 V area with a suitable external fuse.
- Make sure that the power supply unit is able to supply **four times** the nominal current of the external fuse, to ensure that it trips in the event of an error.
- Make sure that the output voltage of the voltage supply does not exceed 32 V even in the event of error.

Startup, mounting, and modifications

Startup, mounting, modifications, and upgrades may only be carried out by an electrically skilled person.

- Before working on the device, disconnect the power.
- Carry out wiring according to the application. Refer to the “Application examples” section for this.

Reliable operation is only ensured if the device is installed in housing protected from dust and humidity.

- Install the device in housing protected from dust and humidity (min. IP54).

In operation

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

- Protective covers must not be removed when operating electrical switching devices.

For emergency stop applications, automatic startup of the machine can pose serious risks for the user.

- The machine must be prevented from restarting automatically by a higher-level controller.

Inductive loads can lead to welded relay contacts.

- Connect a suitable and effective protective circuit to inductive loads.
- Implement the protective circuit parallel to the load and not parallel to the switch contact.

Magnetic fields can influence the device. The magnetic field strength of the environment must not exceed 30 A/m.

- Do not use the device in the vicinity of strong magnetic fields (e.g., caused by transformers or magnetic iron).

Noise emission may occur when operating relay modules. Wireless reception may be disrupted in residential areas.

The device is a Class A product.

- Observe the requirements for noise emission for electrical and electronic equipment (EN 61000-6-4).
- Implement appropriate precautions against noise emission.

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Faulty devices

The devices may be damaged following an error. Correct operation can no longer be ensured.

- In the event of an error, replace the device.

Only the manufacturer or their authorized representative may perform the following activities. Otherwise the warranty is invalidated.

– Repairs to the device
– Opening the housing

Taking out of service and disposal

- Dispose of the device in accordance with environmental regulations.
- Make sure that the device can never be reused.

6.1 Safety of machines or systems

Draw up and implement a safety concept

The machine or system manufacturer and the operator are responsible for the safety of the machine or system and the application in which the machine or system is used. In order to use the device described in this document, you must have drawn up an appropriate safety concept for your machine or system. This includes a risk assessment in accordance with the directives and standards specified in the EC Declaration of Conformity, as well as other standards.

The EC Declaration of Conformity can be downloaded for the product at phoenixcontact.net/products.

Risk assessment, validation and function test

- Before using the device, perform a risk assessment on the machine or system.
- Validate your entire safety system.
- Carry out a new validation every time you make a safety-related modification.
- Perform a function test on a regular basis.

Achievable safety integrity

Functional safety is guaranteed for the device as a single component. However, this does not guarantee functional safety for the entire machine or system. In order to achieve the desired safety level for the entire machine or system, define the safety requirements for the machine or system as well as how to implement them from both a technological and organizational perspective.

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6.2 Installation in potentially explosive area

WARNING: Explosion hazard when used in potentially explosive areas

Please make sure that the following notes and instructions are observed.

- The category 3 device is designed for installation in zone 2 potentially explosive areas. It satisfies the requirements of the following standards. Comprehensive details are to be found in the EU Declaration of Conformity which is enclosed and also available on our website in the latest version:

  EN 60079-0 and EN 60079-15
- When installing and connecting the supply and signal circuits observe the requirements of EN/IEC 60079-14.
- Only devices that are suitable for operation in Ex zone 2/Div. 2 and for the conditions prevalent at the installation location may be connected to the circuits in Zone 2/Div. 2.
- Do not connect any cables/lines within the potentially explosive area and do not disconnect any connections if they are live.
- The device must be stopped and immediately removed from the Ex area if it is damaged, was subject to an impermissible load, stored incorrectly or if it malfunctions.

6.3 Ambient temperature in potentially explosive area

- Observe the derating curves.
- Observe the special temperature conditions according to the rating plate.

Input	A1/A2 24 V DC, 45mA		
Output	13/14 NO-contact		M1, 21/22 DO, NC-contact
	250V AC, 24V DC 6A Resistive B300, R300	250V AC, 24V DC 2A Resistive B300, R300	24V DC 100mA Resistive
Surrounding Air Temperature	-40 °C to 45 °C	-40 °C to 55 °C	

Figure 1 Rating plate (laser printing)

6.4 Installation in areas with a danger of dust explosions

WARNING: Explosion hazard

The device is not designed for use in atmospheres with a danger of dust explosions.

7 Specific terms and conditions of use for ATEX/IECEx

- The device must be connected to supply circuits whose nominal voltage cannot be exceeded by 140 %, which is caused by transient interference.
- The device is to be installed in a housing (control or distributor box) that satisfies the requirements of EN/IEC 60079-15 and has at least IP54 degree of protection (EN/IEC 60529).
- The device is to be used in an environment that does not exceed pollution degree 2 in accordance with EN/IEC 60664-1.

8 UL notes

8.1 UL Ordinary Location

- Only use copper connecting cables providing the permitted temperature range (60°C/75°C).
- Tighten the screws on the screw terminal blocks with 5 ... 7 lb in (0.5 ... 0.6 Nm).

8.2 UL Hazardous Location

- This device must be installed in an area that is no longer classified as pollution degree 2 in accordance with IEC 60664-1.
- WARNING - Do not disconnect the terminal blocks when energized!
- The device must be installed in a housing that is certified for use in Class I, Zone 2, Group IIC and IP54 in accordance with IEC 60529 if it is used in the environments of Class I, Zone 2.
- A surge protection device must be provided outside of the device that is set to a level that does not exceed 140 % of the nominal voltage at the power supply connections of the device.

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9 Function description

9.1 Single-channel control

The external enable signal of the failsafe controller is switched at A1.

9.2 Compatibility

In order to establish the compatibility with the failsafe controller and use device-internal diagnostics, apply the diagnostic supply voltage.

9.3 Automatic start

The device starts automatically once it has received the external enable signal of the failsafe controller.

9.4 Safe shutdown

After deactivating the external enable signal of the failsafe controller, the enabling current path opens and the contacts enter the safe state.

When the enabling current path is open, the device is in the safe state.

The confirmation current path closes.

9.5 Diagnostics and status information

The device provides the following non-safety-relevant diagnostic capabilities and status information.

Prerequisite for this is that the diagnostics supply voltage is applied.

9.5.1 Active error acknowledgment via A1

The device reports a potential error via A1 to the respective digital output of the failsafe controller.

For active error acknowledgment, line load monitoring is required from the failsafe controller.

If an error occurs within the device, the device simulates an error that the safety controller detects when line load monitoring is switched on.

This diagnostic procedure is only possible with compatible controllers.

9.5.2 Status information on M1

Signal output M1 transmits non-safety-related status information.

The signal output is active when the enabling current path is open.

Prerequisite for this is that the diagnostics supply voltage is applied.

9.6 Proof-Test

The repeat testing required by standards can be carried out in the following ways:

1. Visually on the device via the diagnostics LEDs
2. Evaluation of the force-guided N/C contact

Prerequisite for this is that the diagnostics supply voltage is applied.

You can find information on executing and evaluating the proof test under the special sections “Proof test” and “Diagnostics”.

9.7 Test pulse filter

By filtering the control controller test pulses, premature failure of the forcibly guided safety relay is prevented.

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10 Function and time diagrams

10.1 Time diagram for automatic start

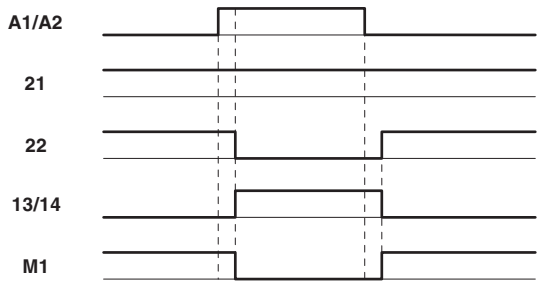

Figure 2 Time diagram for automatic start

Key:

A1/A2	Control
21	24 V DC diagnostics input
22	Diagnostic output 24 V DC
13/14	Enabling current path, undelayed
M1	Digital alarm output

11 Basic circuit diagram

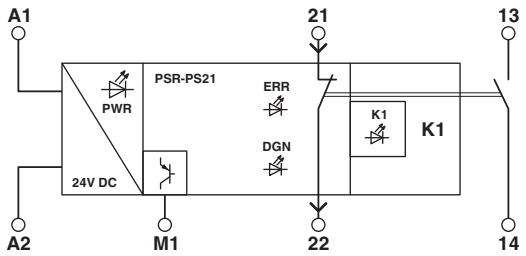

Figure 3 Block diagram

Key:

A1	24 V DC control
A2	0 V (GND)
M1	Signal output (PNP)
21	24 V DC diagnostics input
22	Diagnostic output 24 V DC
13/14	Enabling current path, undelayed
K1	Channel 1

Confirmation current path 21/22 (N/C contact) is **not** an electrically isolated current path and may only be connected to a maximum voltage of 26.4 V in relation to A2.

11.1 Insulation coordination

	A1/A2, 21/22, M1	13/14	Housing
A1/A2, 21/22, M1	-	6 kV ST	4 kV BI
13/14	-	-	4 kV BI
Housing	-	-	-

Key:

BI	Basic insulation
ST	Safe isolation

Basic insulation

(rated surge voltage of 4 kV)

A mixture of SELV and PELV is strictly prohibited. Only switch 250 V AC at one of the enable contacts if the adjacent contact/ enabling current path carries the same potential.

Safe isolation/reinforced insulation

(rated surge voltage of 6 kV)

Reinforced insulation (e.g., thanks to greater air clearances and creepage distances between conductive paths) is designed for one overvoltage category higher than basic insulation. This means that SELV circuits of U ≤ 25 V AC or U ≤ 60 V DC and circuits with higher voltages can be mixed.

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12 Derating

The temperature is measured at a 5 cm clearance below or to the side of the device.

Note section "Mounting positions".

12.1 Vertical mounting position

The derating curve applies for the following conditions:

– Mounting on a vertical DIN rail
– Devices mounted next to each other without spacing
– For enabling current path 13/14

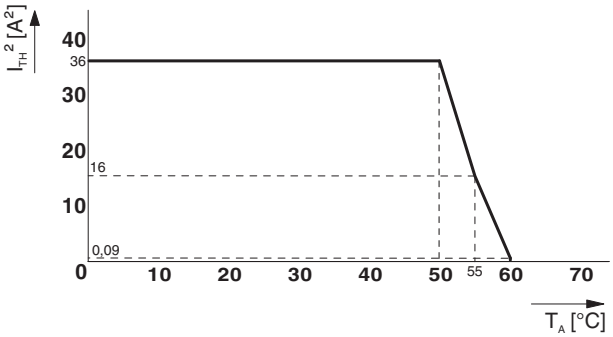

Figure 4 Derating curve - vertical mounting position, without spacing

Expanded ambient temperature range (with no distance): up to +65 °C

Conditions:

Max. rated control circuit supply voltage	24 V DC
Max. total current of the enabling current path	1 A²

12.2 Horizontal mounting position

The derating curve applies for the following conditions:

– Mounting on a horizontal DIN rail
– Devices mounted next to each other without spacing
– For enabling current path 13/14

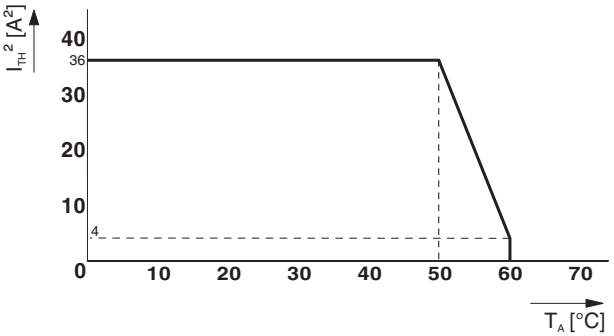

Figure 5 Derating curve - horizontal mounting position, without spacing

Expanded ambient temperature range (with no distance): up to +65 °C

Conditions:

Max. rated control circuit supply voltage	24 V DC
Max. total current of the enabling current path	250 mA²

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12.3 Mounting position with device front facing upwards

The derating curve applies for the following conditions:

– Mounting on a lying DIN rail with the device front facing upwards
– Devices mounted next to each other without spacing
– For enabling current path 13/14

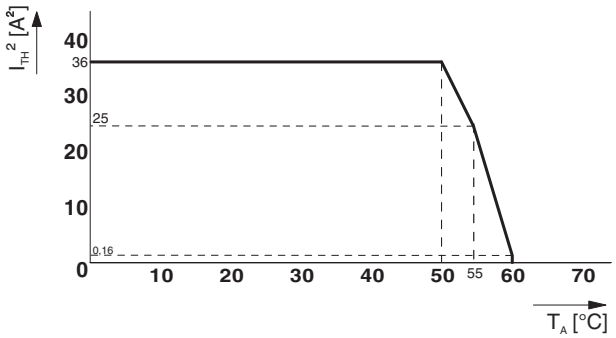

Figure 6 Derating curve - mounting position with module front at the top and aligned modules

Expanded ambient temperature range (with no distance): up to +65 °C

Conditions:

Max. rated control circuit supply voltage	24 V DC
Max. total current of the enabling current path	250 mA^2

13 Load curve

13.1 Ohmic and inductive load

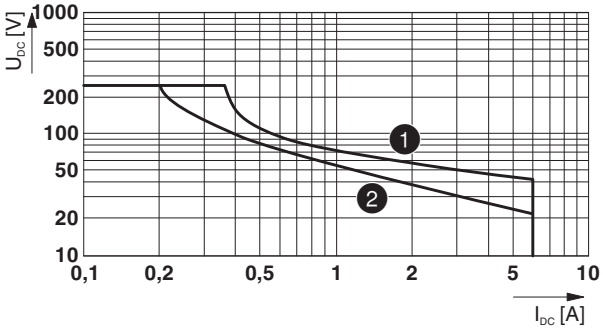

Figure 7 Relay load curve - ohmic and inductive load

Key:

1	Ohmic load	L/R = 0 ms
2	Inductive load	L/R = 40 ms

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14 Operating and indication elements

14.1 Connection versions

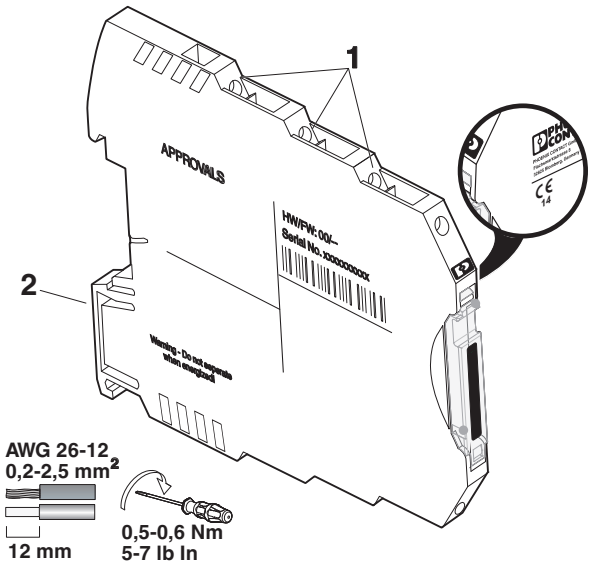

Figure 8 Connection versions

1 Fixed screw connection
2 Snap-on foot for DIN rail mounting

The year the device was constructed can be found underneath the CE designation on the housing.

14.2 Connection assignment

22	Diagnostic output 24 V DC
21	24 V DC diagnostics input
A2	0 V (GND)
A1	24 V DC control
PWR	Power LED (yellow)
K1	Status indicator safety circuit; LED (green)
ERR	Error LED (red)
DGN	Diagnostics LED (green)
13/14	Enabling current path, undelayed
M1	Signal output (PNP)

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15 Mounting and removing

- Mount the device on a 35 mm DIN rail according to EN 60715.
- To remove the device, use a screwdriver to release the snap-on foot.

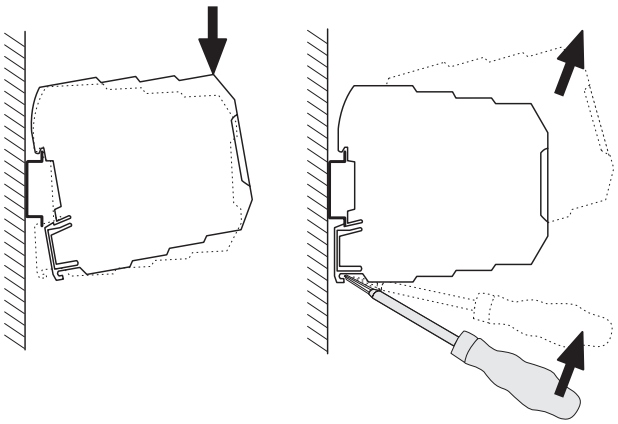

Figure 9 Mounting and removing

15.1 Mounting positions

The following mounting positions are permissible:

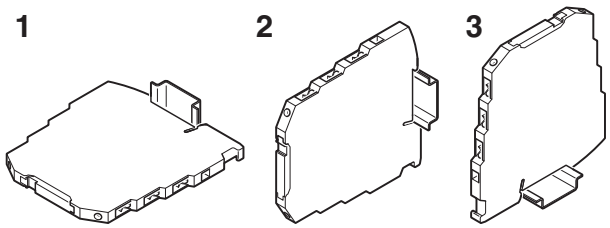

Figure 10 Permissible mounting positions

1 Vertical mounting position
2 Horizontal mounting position
3 Mounting position with device front facing upwards

Note the derating curves for various mounting positions.
See section "Derating".

16 Wiring

- Connect the cables to the connection terminal blocks using a screwdriver.

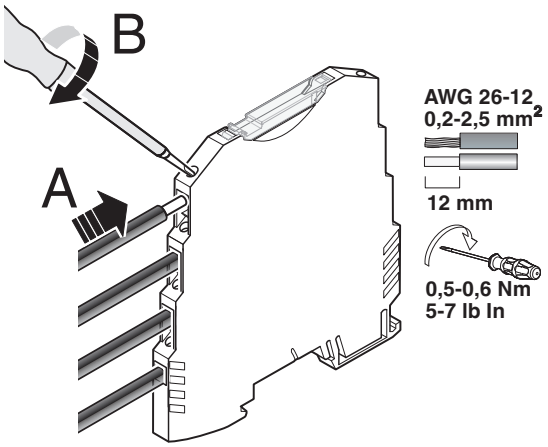

Figure 11 Connection of the cables

It is recommended that ferrules are used to connect stranded cables.

For compliance with UL approval, use copper wire that is approved up to 60°C/75°C.

16.1 Signal generator connection versions

- Connect suitable signal generators to A1/A2.

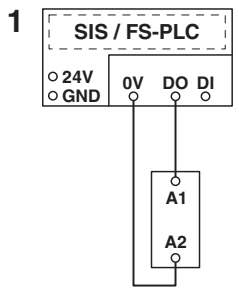

Figure 12 Signal generator connection versions

1 Single-channel control via failsafe controller

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16.2 Feedback circuit connection versions

- Connect the 24 V DC diagnostic supply voltage to terminal block 21.
- Read the confirmation current path back to a digital input of the failsafe controller via terminal block 22.
- Place the relevant N/C contact in the path from 21/22 to the digital input of the failsafe controller to monitor external contactors or extension devices with force-guided contacts.

WARNING: Loss of safe diagnostics!

The series connection of the confirmation current path of several devices results in an impermissible voltage drop of the diagnostics voltage U_D.

- Do **not** switch the N/C contacts in series.

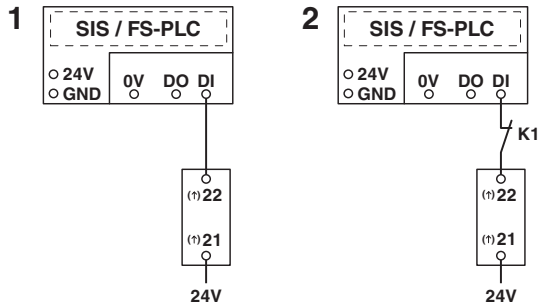

Figure 13 Feedback circuit connection versions

1 Confirmation current path without monitored contact extension

2 Confirmation current path with monitored contact extension

17 Startup

- Apply the diagnostic supply voltage (24 V DC) to terminal blocks 21/A2.

DGN LED lights up.

- Provide the external enable signal of the failsafe controller (24 V DC) at terminal blocks A1/A2.

PWR LED lights up.

K1 LED lights up.

Enabling current path 13/14 closes.

Confirmation current path 21/22 opens.

Signal output M1 is not active.

The DGN LED is switched off.

The diagnostic supply voltage makes the failsafe controller compatible and allows the use of the device-internal diagnostics.

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18 Calculating the power dissipation

The total power dissipation is based on the input power dissipation, the power dissipation of the diagnostic supply, and the contact power dissipation.

Input power dissipation

$P_{Input} = U_B^2 / (U_S/I_S)$

Power dissipation of diagnostic supply

$P_{Diagnostics} = U_{BD}^2 / (U_D/I_D)$

Contact power dissipation

With the same load currents:

$P_{Contact} = n \bullet I_L^2 \bullet 25\ m\Omega$

With different load currents:

$P_{Contact} = (I_{L1}^2 + I_{L2}^2 + ... + I_{Ln}^2) \bullet 25\ m\Omega$

Total power dissipation

$P_{Total} = P_{Input} + P_{Output} + P_{Contact}$

therefore

$P_{Total} = U_B^2 / (U_S/I_S) + U_{BD}^2 / (U_D/I_D) + n \bullet I_L^2 \bullet 25\ m\Omega$

or

$P_{Total} = U_B^2 / (U_S/I_S) + U_{BD}^2 / (U_D/I_D) + (I_{L1}^2 + I_{L2}^2 + - + I_{Ln}^2) \bullet 25\ m\Omega$

Key:

P	Power dissipation in mW
U_B	Applied operating voltage
U_S	Rated control circuit supply voltage
I_S	Rated control supply current
n	Number of enabling current paths used
I_L	Contact load current

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19 Proof test

To verify the device function, proceed according to one of the following diagnostic options.

WARNING: Loss of functional safety due to malfunction.

If the proof test contains errors, the device no longer functions correctly.

- Replace the device.

In order to establish the compatibility with the failsafe controller and use device-internal diagnostics, apply the diagnostic supply voltage.

19.1 Visually on the device via the diagnostics LEDs

Observe a potential error response time of 4 s for the diagnostics LEDs.

1. Deactivate A1.

Expectation (proof test passed):

When diagnostic supply voltage is applied:

– The LED DGN lights up green. All other LEDs are off.

Potential errors:

When diagnostic supply voltage is applied:

– The red ERR-LED lights up.
– The green DGN-LED and the red ERR-LED light up.
– Neither of the specified LEDs light up.

Overview of display options: See “Diagnostics via LEDs” section.

19.2 Evaluation of the force-guided N/C contact

1. Deactivate A1.
2. Read the confirmation current path back to a digital input of the failsafe controller via terminal block 22.
   Or:
   Measure the output voltage at contact 22.

Expectation (proof test passed):

When diagnostic supply voltage is applied:

– The failsafe controller receives a 24 V signal (U_D) via terminal block 22.
– On contact 22, 24 V DC (U_D) are measurable.

Behavior in the event of an error

– The failsafe controller **does not** receive a 24 V signal (U_D) via terminal block 22.
– On contact 22, **no** 24 V DC (U_D) are measurable.

See section "Evaluation of the confirmation current path".

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20 Diagnostics

20.1 Diagnostics via LEDs

PWR-LED	K1-LED	ERR-LED	DGN-LED	State	Proof test
Yellow on	Green on	OFF	OFF	A1 is activated.	Diagnostics not supported in an activated state.
OFF	OFF	OFF	Green on	A1 is **not** activated.	Proof test passed.
OFF	OFF	Red on	OFF		Proof test **not** passed.
OFF	OFF	OFF	OFF		Proof test **not** passed.
OFF	OFF	Red on	Green on		Proof test **not** passed.

20.2 Evaluation of the confirmation current path

PWR-LED	Terminal 21/A2	Terminal 22	M1 *)	State	Proof test
Yellow on	24 V	0 V	0 V	A1 is activated.	Diagnostics not supported in an activated state.
OFF	24 V	24 V	24 V	A1 is **not** activated.	Proof test passed.
OFF	24 V	0 V	0 V		Proof test **not** passed.

*) The signaling output M1 is not safety-relevant and therefore not suitable for the proof test.

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21 Application examples

21.1 High-demand application with failsafe controller

Application description:

The application example illustrates the safe disconnection of a load in high-demand mode. The safe coupling relay is controlled via a single channel using a failsafe controller. The device starts automatically.

Assumptions, information, and marginal conditions:

- It is assumed that errors in the cable installation have been eliminated
- Diagnostic supply voltage is present
- Integration of confirmation current path 21/22 in the safe controller
- The digital output (DO) of the failsafe controller meets SIL 2 requirements in accordance with IEC 61508.

Achievable safety integrity:

- Suitable for high-demand mode applications up to SIL 2 in accordance with IEC 61508, and IEC 50156

WARNING: Loss of functional safety due to infiltration of process safety time!

If the evaluation of the confirmation current path is not performed in high-demand applications within the process safety time, this may lead to a loss of functional safety.

- Ensure that the evaluation of the confirmation current path is performed in high-demand applications within the process safety time.

Cross-circuits in the cable installation can be excluded if the failsafe PLC, safety relay, and external contactors K1 and K2 are located in the same electrical installation space.

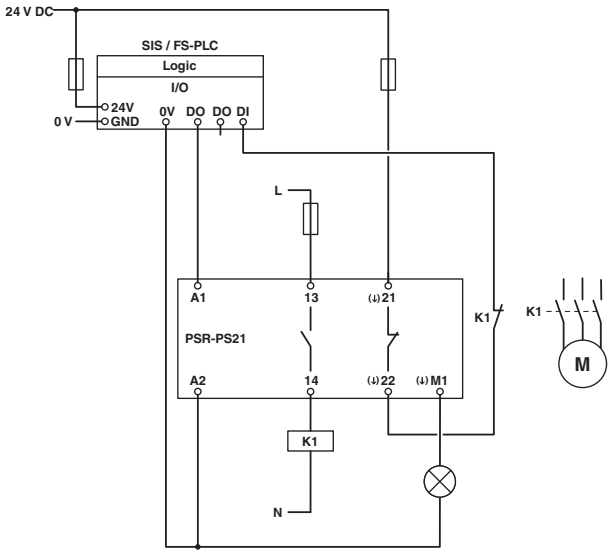

Figure 14 High-demand application with failsafe controller

Key:

SIS / FS-PLC	Safety Instrumented System / failsafe controller
DC	Diagnostic Coverage according to IEC 61508 (line/load diagnostics at DO)
DI	Digital input
DO	Digital output

Device data in the application example as 1oo1 structure	
Readback via N/C contact 22	
Device type	Type A
HFT	0
SIL	2
SFF	99.18 %
λ_{SD}	494.66 FIT
λ_{SU}	79.10 FIT
λ_{DD}	494.66 FIT
λ_{DU}	8.80 FIT
λ_{Total}	1077.22 FIT
MTBF	91.65 years
PFH_D	8.8×10^{-9}

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21.2 Low-demand application with failsafe controller

Application description:

The application example illustrates the safe disconnection of a load in low-demand mode. The safe coupling relay is controlled via a single channel using a failsafe controller. The device starts automatically.

Assumptions, information, and marginal conditions:

- It is assumed that errors in the cable installation have been eliminated
- Diagnostic supply voltage is present
- Error message about the diagnostic LEDs
- The digital output (DO) of the failsafe controller meets SIL 2 requirements in accordance with IEC 61508.

Achievable safety integrity:

- Suitable for low-demand applications up to SIL 2 in accordance with IEC 61508, IEC 61511, and EN 50156

Cross-circuits in the cable installation can be excluded if the failsafe PLC, safety relay, and external contactors K1 and K2 are located in the same electrical installation space.

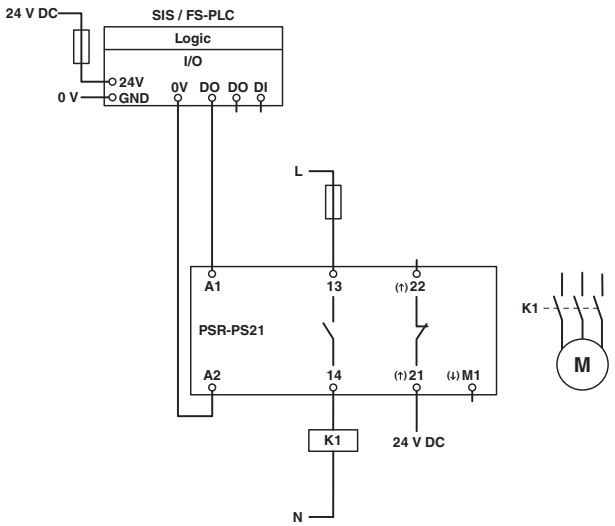

Figure 15 Low-demand application with failsafe controller

Key:

SIS / FS-PLC	Safety Instrumented System / failsafe controller
DC	Diagnostic Coverage according to IEC 61508 (line/load diagnostics at DO)
DI	Digital input
DO	Digital output

Device data in the application example as 1oo1 structure	
Error message about the diagnostic LEDs	
Device type	Type A
HFT	0
SIL	2
SFF	81.20 %
λ_{SD}	0 FIT
λ_{SU}	794.1 FIT
λ_{DD}	0 FIT
λ_{DU}	183.8 FIT
λ_{Total}	977.9 FIT
MTBF	99 years
PFD_{avg}	8.06 x 10^{-04} (for T1 = 1 year)

The configuration path is not absolutely necessary for low-demand applications. However, readback is recommended so a potential error in the switching operation can be read into the controller. In any case, verify proper function with regular proof tests.

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22 Attachment

22.1 Using PSR devices at altitudes greater than 2000 m above sea level

The following section describes the special conditions for using PSR devices at altitudes greater than 2000 m above sea level. Observe the relevant device-specific data (technical data, derating, etc.) according to the product documentation for the individual device.

Using the device at altitudes **greater than 2000 m above sea level up to max. 4500 m above sea level** is possible under the following conditions:

1. Limit the rated control circuit supply voltage (U_S) in accordance with the table below. Observe the technical data for the device.

U_S according to the technical data for the device	U_S when used at altitudes greater than 2000 m above sea level
< 150 V AC/DC	U_S according to the technical data for the device still valid
> 150 V AC/DC	Limited to max. 150 V AC/DC

2. Limit the maximum switching voltage in accordance with the table below. Observe the technical data for the device.

Max. switching voltage according to the technical data for the device	Max. switching voltage when used at altitudes greater than 2000 m above sea level
< 150 V AC/DC	Max. switching voltage according to the technical data for the device still valid
> 150 V AC/DC	Limited to max. 150 V AC/DC

3. Reduce the maximum ambient temperature for operation by the corresponding factor in accordance with the table below.
4. If derating is specified, offset all the points of the derating curve by the corresponding factor in accordance with the table below.

Altitude above sea level	Temperature 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

Example calculation for 3000 m

The following calculation and the illustrated derating curve are provided as examples. Perform the actual calculation and offset the derating curve for the device used according to the technical data and the “Derating” section.

27 °C • 0.906 ≈ 24 °C

55 °C • 0.906 ≈ 49 °C

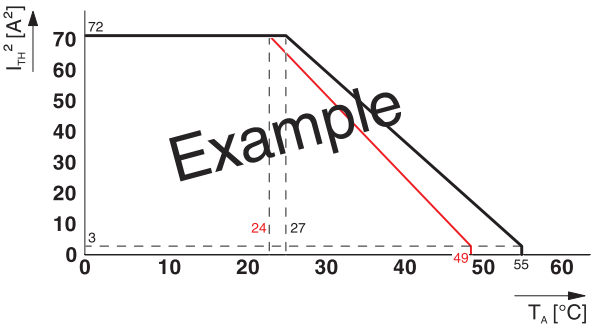

Figure 16 Example of a suspended derating curve (red)

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22.2 Revision history

Version	Date	Contents
00	2015-03-10	First publication
01	2015-04-29	Info box for application example 1 deleted
02	2015-07-14	Texts / safety notes regarding ATEX deleted
03	2018-10-19	New edition of the data sheet; ATEX/IECEx approval data added

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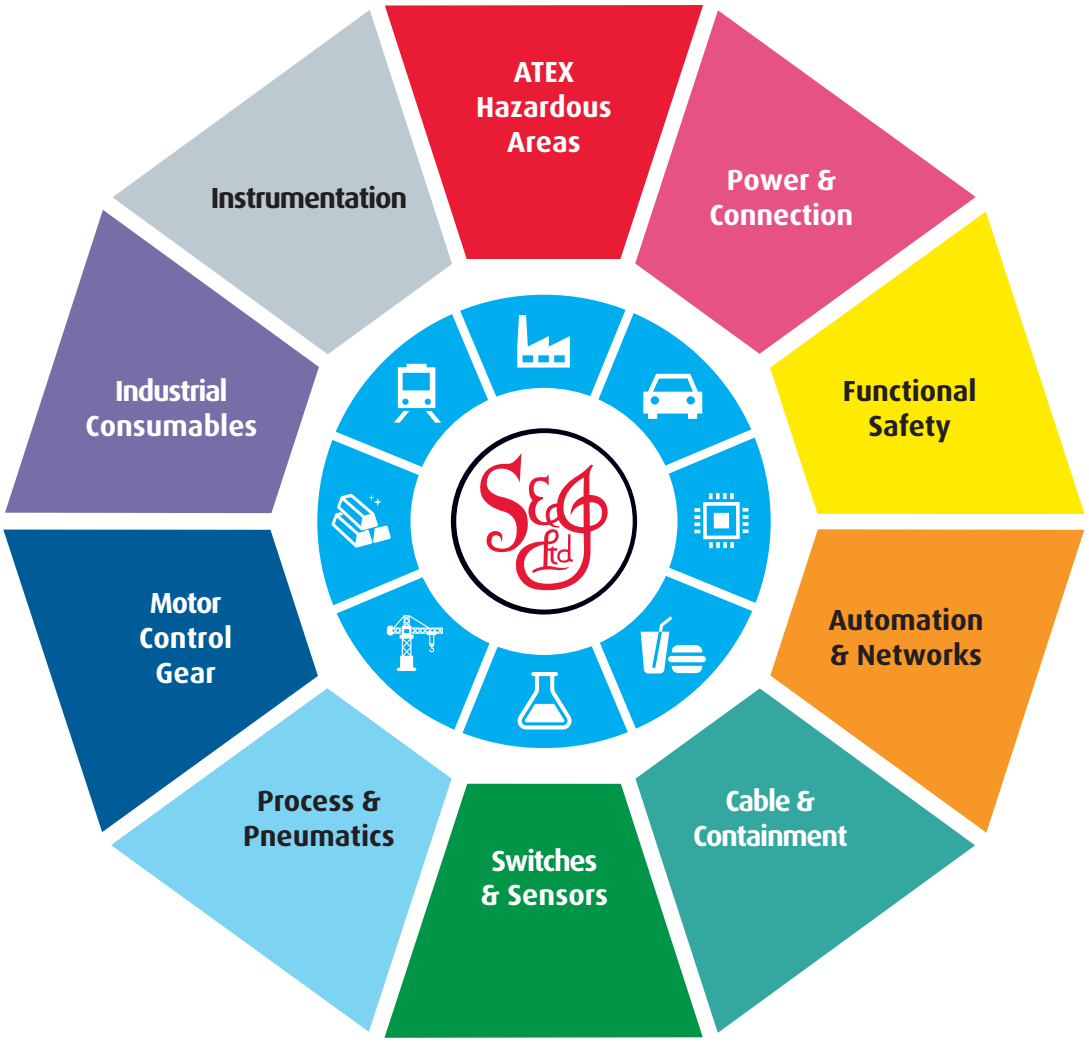

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