PSR-MC72

PL EN ISO 13849

SILCL IEC 62061

Safety relay for emergency stop, safety door, and light grid monitoring with adjustable off delay or on delay

Data sheet
106790_en_01

1 Description

Intended Use

The safety relay is used for emergency stop, safety door, and light grid monitoring. When the sensor circuit is interrupted, the safety relay initiates the safe state. The safety relay interrupts circuits in a safety-related way.

Possible signal generators

- Emergency stop button
- Door locking mechanisms
- Light grids

Contact type

- 1 undelayed, two-channel enabling current path
- 1 delayed, two-channel enabling current path
- 1 digital signal output

The undelayed enabling current path drops out according to stop category 0 (EN 60204-1). When configured accordingly, the delayed enabling current path drops out according to stop category 1 (EN 60204-1). When the enabling current paths are open, the signal output is active.

Control

- Single or two channel
- Automatic or manual, monitored start

Achievable safety integrity

- Suitable up to category 4, PL e (EN ISO 13849-1), SILCL 3 (EN 62061)

Additional features

- Adjustable off delay or on delay
- Retrigger function for delay time
- Option of screw or spring-cage terminal blocks for plug-in
- 12.5 mm housing width

Approvals

c UL us LISTED

EAC

TÜV Rheinland CERTIFIED Product Safety Functional Safety

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.

2 Table of contents

3 Ordering data

Description	Type	Order No.	Pcs./Pkt.
Safety relay for emergency stop, safety doors, light grid up to SILCL 3, Cat. 4, PL e, 1- or 2-channel operation, cross-circuit detection, can be retriggered, fall back/tightening delay 0.2 s to 60 s, 2 enabling current paths, U_S = 24 V DC, plug-in screw terminal block	PSR-MC72-2NO-1DO-24DC-SC	2702096	1
Safety relay for emergency stop, safety doors, light grid up to SILCL 3, Cat. 4, PL e, 1- or 2-channel operation, cross-circuit detection, can be retriggered, fall back/tightening delay 0.2 s to 60 s, 2 enabling current paths, U_S = 24 V DC, plug-in spring-cage terminal block	PSR-MC72-2NO-1DO-24DC-SP	2702097	1

4 Technical data

Hardware/firmware version	
HW/FW	≥ 00/100
The technical data and safety characteristics are valid as of the specified HW/FW version.	

Input data	
Rated control circuit supply voltage U_S	24 V DC -20 % / +25 %
Rated control supply current I_S	typ. 60 mA
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	25 A (Δt = 10 µs at U_s) < 11 mA (with U_s/I_x to S12/S22) < 8.6 mA (with U_s/I_x to S34)
Current consumption	< 4.1 mA (with U_s/I_x to S12/S22) < 3.2 mA (with U_s/I_x to S34)
Power consumption at U_S	typ. 1.44 W
Voltage at input/start and feedback circuit	24 V DC -20 % / +25 %
Filter time	10 ms (For the logic. At A1 in the event of voltage dips at U_s) max. 3 ms (at S12, S22, S34; test pulse width) min. 21 ms (at S12, S22, S34; test pulse rate) Test pulse rate = 7 x Test pulse width
Max. permissible overall conductor resistance (Input and reset circuit at U_S)	150 Ω
Typical response time at U_s	< 35 ms (automatic start) < 30 ms (manual, monitored start)
Typical release time with U_s	< 25 ms (when controlled via S12 (only for undelayed contact 13/14)) < 5 ms (when controlled via A1; applicative deactivation via A1/A2 is not permitted)
Delay time range	0.2 s ... 60 s ±5 % (can be set for 27/28)
Restart time	< 1 s (Boot time)
Maximum switching frequency	1 Hz

Input data	
Concurrence input 1/2	∞
Status display	5 x bi-color LED
Protective circuit	Surge protection Suppressor diode Protection against polarity reversal for rated control circuit supply voltage

Output data	
Contact type	2 enabling current paths
Contact material	$AgSnO_2$
Minimum switching voltage	12 V AC/DC
Maximum switching voltage	250 V AC/DC (Observe the load curve)
Limiting continuous current	6 A (observe derating)
Maximum inrush current	6 A
Inrush current, minimum	3 mA
Sq. Total current $I_{TH}^2 = I_1^2 + I_2^2 + ... + I_N^2$	72 A^2 (observe derating)
Switching capacity	min. 60 mW
Mechanical service life	10 x 10^6 cycles
Output fuse	6 A gL/gG (N/O contact) 4 A gL/gG (for low-demand applications)

Alarm outputs	
Number of outputs	1 (digital, PNP)
Voltage	23 V DC (U_S - 1 V)
Current	max. 100 mA
Maximum inrush current	500 mA (Δt = 1 ms at U_s)
Short-circuit protection	Yes

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 or horizontal
Assembly instructions	See derating curve
Type of housing	PBT yellow
Air clearances and creepage distances between the power circuits	according to DIN EN 50178
Rated insulation voltage	250 V AC

General data	
Rated surge voltage/insulation	Basic insulation 4 kV: between all current paths and housing Safe isolation, reinforced insulation 6 kV: between (A1, A2, S11, S12, S21, S22, S34, M1) and enabling current path (13/14) between (A1, A2, S11, S12, S21, S22, S34, M1) and enabling current path (27/28) between enabling current paths
Degree of pollution	2
Overvoltage category	III
Maximum power dissipation for nominal condition	5.78 W (at U_S = 30 V, I_L^2 = 72 A^2)
Note on power dissipation	See “Calculating the power dissipation”

Dimensions	Screw connection	Spring-cage connection
W x H x D	12.5 x 112.2 x 114.5 mm	12.5 x 116.6 x 114.5 mm

Connection data	Screw connection	Spring-cage connection
Conductor cross section, solid	0.2 mm^2 ... 2.5 mm^2	0.2 mm^2 ... 1.5 mm^2
Conductor cross section, flexible	0.2 mm^2 ... 2.5 mm^2	0.2 mm^2 ... 1.5 mm^2
Conductor cross section AWG/kcmil	24 ... 12	24 ... 16
Stripping length	7 mm	8 mm
Screw thread	M3	

Ambient conditions	
Ambient temperature (operation)	-35 °C ... 60 °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

Conformance/Approvals	
Conformance	CE-compliant
The full EC Declaration of Conformity can be downloaded for the product at phoenixcontact.net/products.	
Approvals	

Safety data	
Stop category according to IEC 60204	0 (undelayed contacts) 1 (delayed contacts)

Safety parameters for IEC 61508 - High demand	
SIL	3
PFH_D	1.5×10^{-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

Safety characteristic data according to EN ISO 13849	
Category	4
Performance level	e
Duration of use	240 Months
For applications in PL e, the required demand rate for the safety function is once per month.	
Calculation basis	4 A DC13; 5 A AC15; 8760 switching cycles/year

Safety parameters for EN 62061	
SILCL	3

5 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.

Power supply units for 24 V supply

- Only use power supply units with safe isolation and SELV/PELV according to EN 50178/VDE 0160.
- Provide external protection for the 24 V area.
- 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.

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.

With the manual, monitored reset device, a machine start may not be triggered in accordance with EN ISO 13849-1.

The device only ensures stop category 1 during error-free operation. In the event that the supply voltage is lost or an internal error occurs, the device behaves according to stop category 0.

- Do **not** use the device for applications in which stop category 1 also has to be observed in the event of an error.

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.

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 Function description

6.1 Single-channel sensor circuit

The sensor circuit is not designed with redundancy.

Cross-circuit detection is not possible.

6.2 Two-channel sensor circuit

The sensor circuit is designed with redundancy.

When cross-circuit detection is activated, the safety relay detects short circuits and cross-circuits in the sensor circuit.

6.3 Automatic start

The device starts automatically after the sensor circuit has been closed.

6.4 Manual, monitored start

When the sensor circuit is closed, the device starts once the start circuit has been closed and opened again by pressing and releasing the reset button.

A connected reset button is monitored.

6.5 Safe shutdown

When the sensor circuit is opened, enabling current path 13/14 opens without delay. Enabling current path 27/28 opens as per the configuration.

See “Off delay” section and “On delay” section.

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

Signal output M1 is active.

6.6 Cross-circuit detection

Cross-circuit monitoring should be activated or deactivated via the DIP switch on the device.

When cross-circuit monitoring is activated, the safety relay detects short circuits and cross-circuits in the sensor circuit.

Inputs S12, S22 expect clock signals of assigned clock outputs S11, S21.

WARNING: Reduced safety integrity when cross-circuit detection is deactivated

When cross-circuit detection is deactivated, some errors are no longer detected by the device. The achievable safety integrity is reduced to max. PL d (EN ISO 13849-1), SILCL 2 (EN 62061), if no additional measures are taken for error detection and fault avoidance.

- Take additional measures for error detection and fault avoidance in order to achieve higher safety integrity.

Deactivate cross-circuit detection for the single-channel connection of sensors and when using light grids or safe controllers.

6.7 Off delay

The off delay is configured via the DIP switch on the device.

The delay time of 0.2 s to 60 s is set in increments via the DIP switch on the device.

When the off delay is configured, enabling current path 27/28 drops out after the set delay time has elapsed (stop category 1).

If the safety function has been demanded, the delay time can be reset using the retrigger function. The delay time is restarted by the retrigger signal.

6.8 On delay

The on delay is configured via the DIP switch on the device.

The delay time of 0.2 s to 60 s is set in increments via the DIP switch on the device.

When the on delay is configured, enabling current path 27/28 closes after the set delay time has elapsed.

If the safety function has been demanded, the delay time can be reset using the retrigger function. The delay time is restarted by the retrigger signal.

The on delay function is only permitted in combination with the activated retrigger function.

6.9 Retrigger function

The retrigger function should be activated or deactivated via the DIP switch on the device.

If the safety function has been demanded, the retrigger signal resets the delay time. The delay time is restarted.

The retrigger signal is triggered depending on the selected startup behavior of the device.

Trigger the retrigger signal on an automatic start:

- Close the sensor circuit (e.g., release the emergency stop button) while the delay time is running.

Trigger the retrigger signal on a manual, monitored start:

- Close the sensor circuit (e.g., release the emergency stop button) while the delay time is running.
- Press the reset button and release it again while the delay time is running.

WARNING: No diagnostics for delayed enabling current path

The retrigger function means that the function of the internal relay of the delayed enabling current path (27/28) cannot be diagnosed while the delay time is running.

- Carry out a risk evaluation.

NOTE: Retrigger function blocked when monitoring external contacts

The retrigger function for the off delay is blocked when external contact monitoring is integrated in start circuit S11/S34 or S21/S34.

7 Function and time diagrams

7.1 Notes on function and time diagrams

Key:

A1/A2	Power supply
S12	Input sensor circuit (channel 1)
S22	Input sensor circuit (channel 2)
S34	Feedback circuit
13/14	Undelayed enabling current paths
27/28	Enabling current path, delayed
M1	Signal output (PNP), not safety-related

Meaning of the color markings:

	=	Boot phase
	=	Clock of S21
	=	Behavior depends on the configuration/ delay time
	=	(ERR) error

7.2 Startup behavior on power up

7.2.1 Automatic start

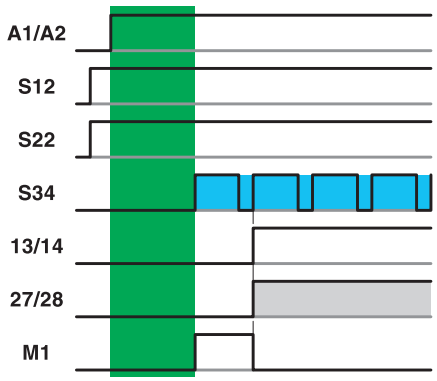


Figure 1 Time diagram for power-up, automatic start

7.2.2 Manual start

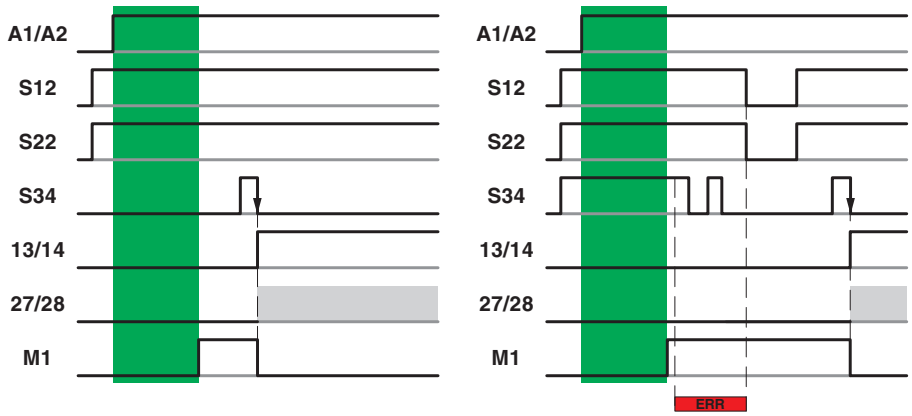


Figure 2 Time diagram for power-up, manual start

7.3 On delay

7.3.1 Automatic start

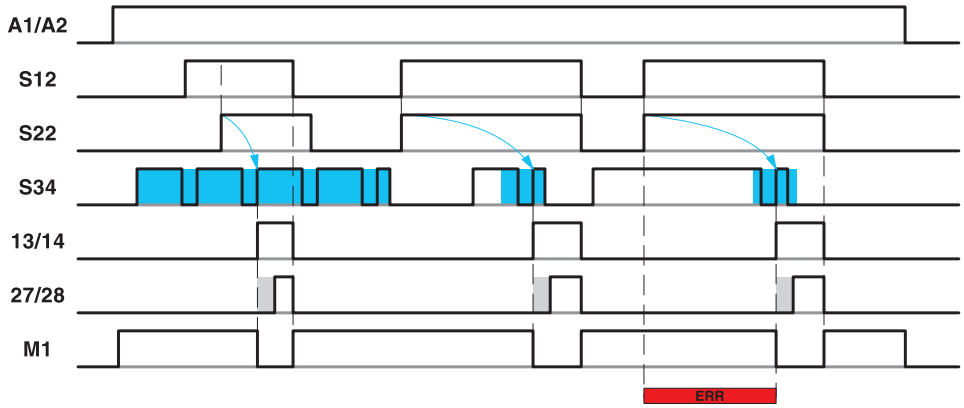


Figure 3 Time diagram for on delay, automatic start

7.3.2 Manual start

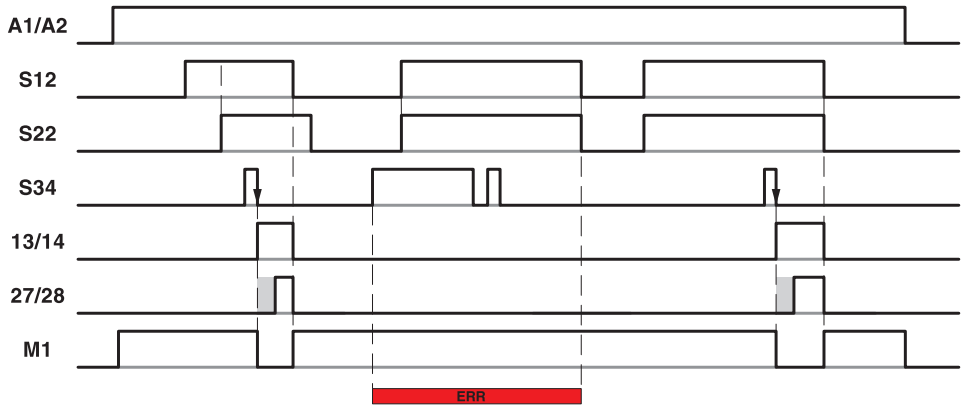


Figure 4 Time diagram for on delay, manual start

7.3.3 Manual start with retrigger function

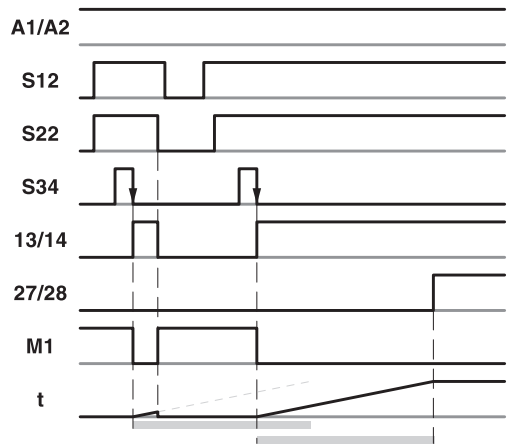


Figure 5 Time diagram for on delay, manual start, can be re-triggered

The behavior for automatic start is identical. The start conditions at S34 differ. See “Configuration” section.

7.4 Off delay

7.4.1 Automatic start

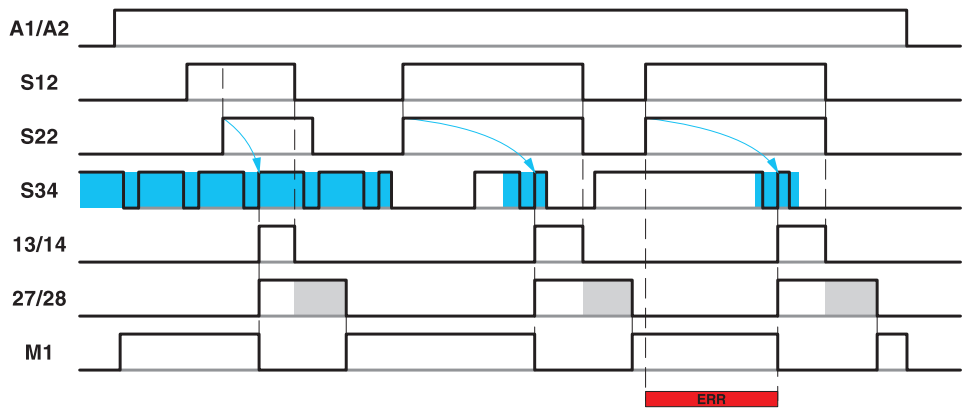


Figure 6 Time diagram for off delay, automatic start

7.4.2 Manual start

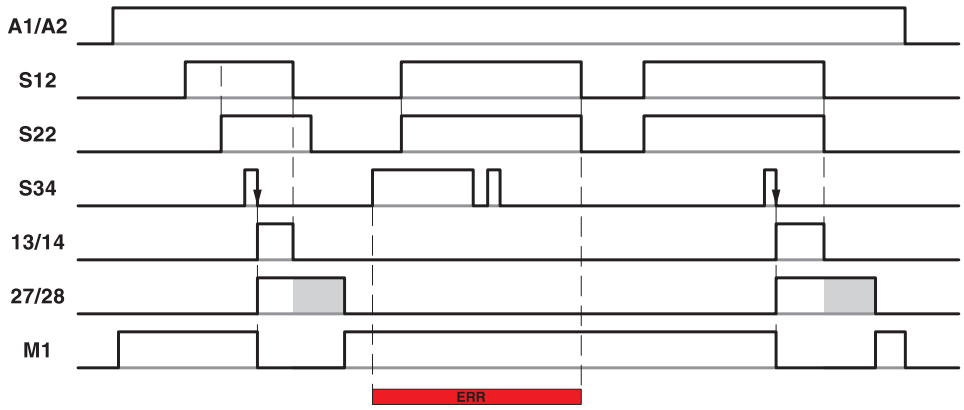


Figure 7 Time diagram for off delay, manual start

7.4.3 Manual start without retrigger function

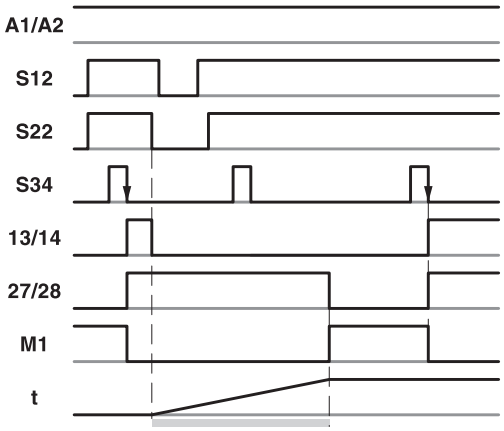


Figure 8 Time diagram for off delay, manual start, cannot be re-triggered

The behavior for automatic start is identical. The start conditions at S34 differ. See “Configuration” section.

7.4.4 Manual start with retrigger function

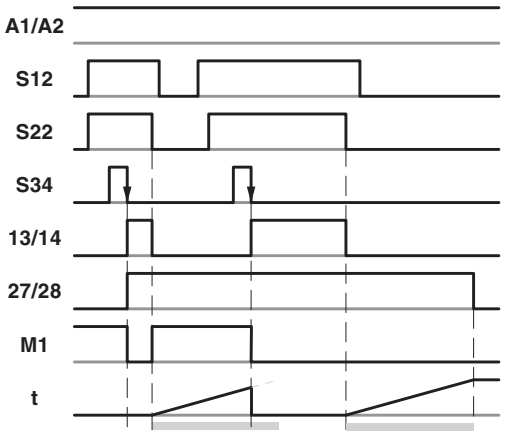


Figure 9 Time diagram for off delay, manual start, can be re-triggered

The behavior for automatic start is identical. The start conditions at S34 differ. See “Configuration” section.

8 Basic circuit diagram

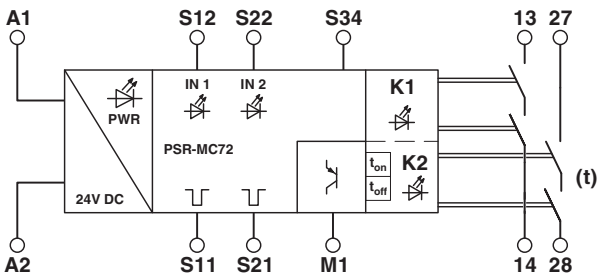


Figure 10 Block diagram

Key:

A1	+24 V power supply
A2	0 V power supply
S12	Input sensor circuit (channel 1)
S11	Clock output 24 V for sensor input S12
S22	Input sensor circuit (channel 2)
S21	Clock output 24 V for sensor input S22
S34	Start and feedback circuit
M1	Signal output (PNP), not safety-related
13/14	Enabling current path, undelayed
27/28	Enabling current path, delayed

9 Derating

9.1 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

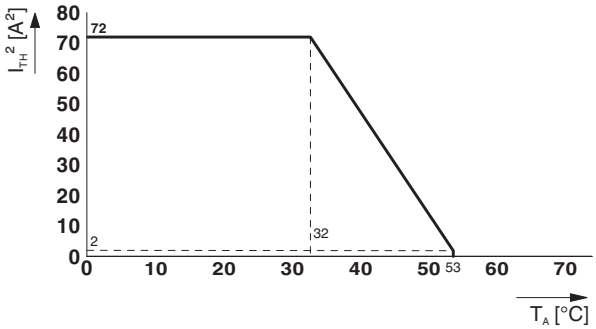


Figure 11 Derating curve - horizontal mounting position, without spacing

If the devices are mounted in the **horizontal** mounting position with ≥ 9 mm spacing between one another, no derating is required.

9.2 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

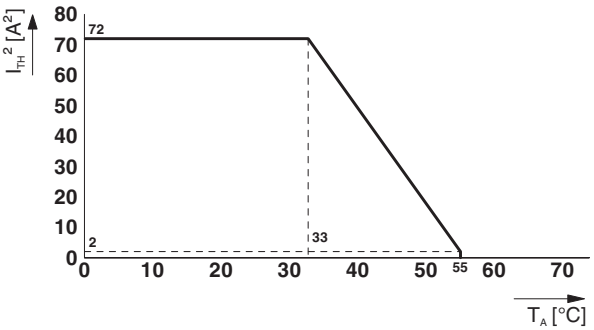


Figure 12 Derating curve - vertical mounting position, without spacing

If the devices are mounted in the **vertical** mounting position with ≥ 9 mm spacing between one another, no derating is required **up to 43°C**.

9.3 UL note

Observe the following information with regard to maintaining UL approval.

INPUT	Ambient temperature	Assembly	OUTPUT
24 V DC, max. 60 mA	30 °C	Vertical, without spacing between the devices	**NO/NC contact:** 250 V AC, 24 V DC, 6 A, resistive, B300, R300 **DO contact:** 100 mA, 24 V DC, resistive
	55°C	Vertical, without spacing between the devices	**NO/NC contact:** 250 V AC, 24 V DC, 1 A, resistive **DO contact:** 100 mA, 24 V DC, resistive
	43 °C	Vertical, with 10 mm spacing between the devices	**NO/NC contact:** 250 V AC, 24 V DC, 6 A, resistive, B300, R300 **DO contact:** 100 mA, 24 V DC, resistive

10 Load curve

10.1 Ohmic and inductive load

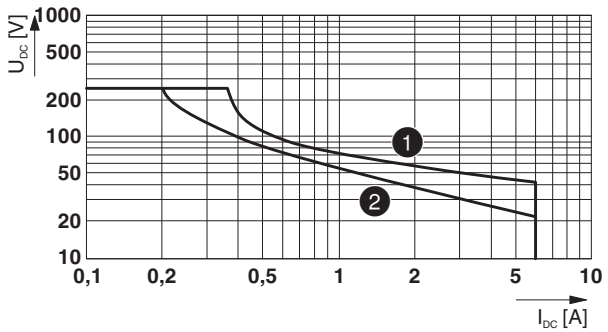


Figure 13 Relay load curve - ohmic and inductive load

Key:

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

11 Operating and indication elements

11.1 Connection versions

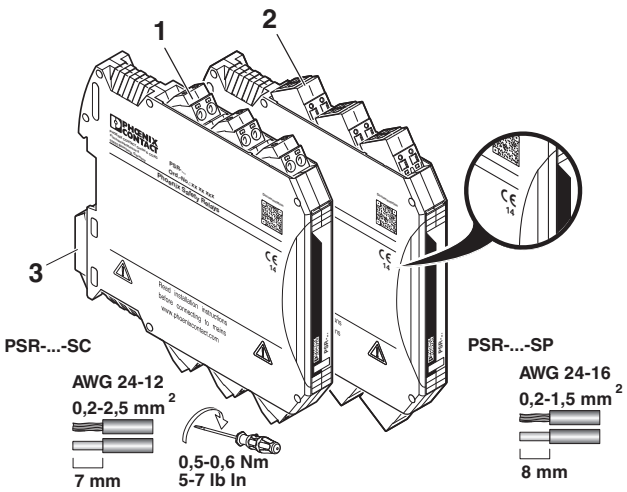
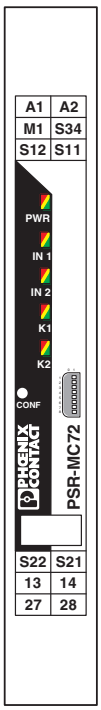


Figure 14 Connection versions

1 COMBICON plug-in screw terminal block
2 COMBICON plug-in spring-cage terminal block
3 Metal lock for fixing to DIN rail

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

11.2 Connection assignment



A1	+24 V power supply
A2	0 V power supply
M1	Signal output (PNP), not safety-related
S34	Start and feedback circuit
S12	Input sensor circuit (channel 1)
S11	Clock output 24 V for sensor input S12
PWR	Power LED (red, yellow, green)
IN 1	Status indicator sensor circuit; LED (red, yellow, green)
IN 2	Status indicator sensor circuit; LED (red, yellow, green)
K1	Status indicator safety circuit; LED (red, yellow, green)
K2	Status indicator safety circuit; LED (red, yellow, green)
CONF	CONF button for confirming/displaying the configuration
DIP switch	8-way switch for configuration of: Delay time (DP1 to 5) Off delay or on delay (DP6) Retrigger function activated/deactivated (DP7) Cross-circuit monitoring activated/deactivated (DP8)
S22	Input sensor circuit (channel 2)
S21	Clock output 24 V for sensor input S22
13/14	Enabling current path, undelayed
27/28	Enabling current path, delayed

12 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.

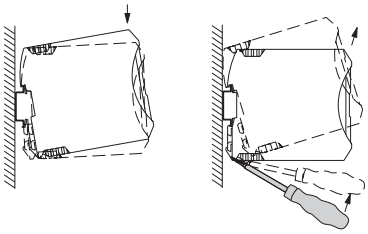


Figure 15 Mounting and removing

13 Wiring

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

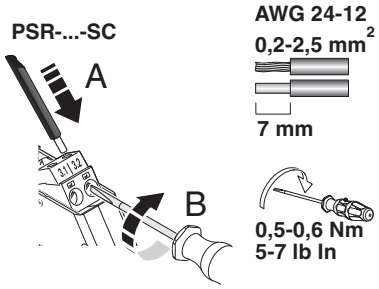


Figure 16 Connecting the cables for PSR-...-SC (screw terminal block)

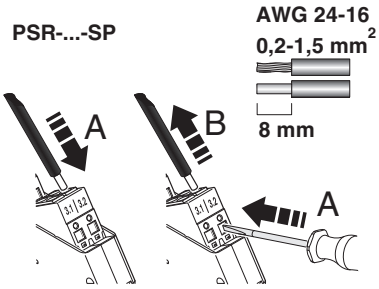


Figure 17 Connecting the cables for PSR-...-SC (spring-cage terminal block)

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.

13.1 Signal generator connection versions

- Connect suitable signal generators to S11/S12 and S21/S22.

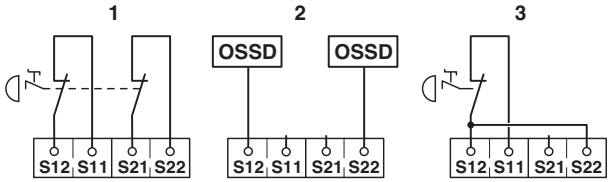


Figure 18 Signal generator connection versions

1 Two-channel connection
2 Two-channel OSSD signal
3 Single-channel connection

13.2 Start and feedback circuit connection variants

The startup behavior selected due to the corresponding wiring must be confirmed during configuration.
See “Configuration” section.

Automatic start

- Bridge the contacts S21/S34.

Manual, monitored start

- Connect a reset button to S11/S34.

A connected reset button is monitored.

Start and feedback circuit

- Place the relevant N/C contact in path S21/S34 or S11/S34 to monitor external contactors or extension devices with force-guided contacts.

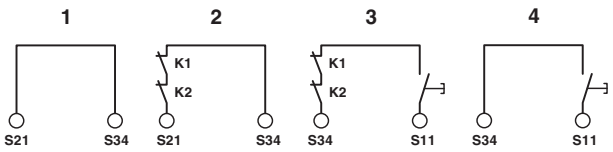


Figure 19 Start and feedback circuit connection variants

1 Automatic start
2 Automatic start with monitored contact extension
3 Manual, monitored start with monitored contact extension
4 Manual, monitored start

14 Configuration

14.1 Delivery state

Before being configured and started up for the first time, the device is in the following state:

– Off delay activated
– Set delay time: 0.2 s
– Retrigger function deactivated
– Cross-circuit detection activated

14.2 General information on configuration

Configuration is performed using the 8-way DIP switch and CONF button on the front of the safety relay.

By briefly pressing the CONF button, the safety relay indicates the delay time that is currently set via the LEDs on the front of the device.

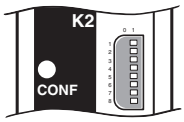


Figure 20 CONF button and DIP switch

The device functions to be configured should be assigned to the individual DIP switch poles (DPs) as follows.

DP	Function
1 ... 5	Delay time (in increments from 0.2 s ... 60 s)
6	Off delay or on delay
7	Retrigger function activated/deactivated
8	Cross-circuit monitoring activated/deactivated

14.3 Displaying the currently set delay time

- Press the CONF button for **< 2 s.**

The five LEDs on the front of the device **light up yellow** for around 3 s to indicate the configuration of DIP switch poles DP1 to DP5 that is currently stored in the memory.

LED OFF	=	Position 0
LED on	=	Position 1

See “Configuration table”.

The assignment of the LEDs to the DIP switch poles shown in the figure applies.

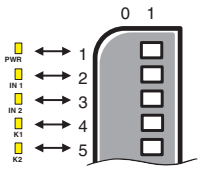


Figure 21 Assignment of LEDs and DIP switch poles

14.4 Applying the configuration

WARNING: Risk of automatic restart

If the safety relay is operated with automatic start, once configuration is completed the device starts up automatically when the sensor circuit is closed.

- Remember this when completing configuration.

1. Press the CONF button for **at least 3 s** to enter configuration mode.

The safety relay enters the safe state whereby the enabling current paths open.

If an off delay is configured for the delayed enabling current path (27/28), the path only opens once the selected delay time has elapsed.

The yellow flashing LEDs indicate the delay time that is currently set.

2. Apply the setting for the desired delay time via DIP switch poles **DP1 to DP5** (see “Configuration table”).

The new delay time setting is immediately played back via the yellow flashing LEDs for verification.

WARNING: Danger due to incorrect setting.

An incorrect configuration can result in dangerous machine or system states.

- If the LED display does not correspond to the switch position, repeat the process or replace the device.

3. Apply the setting for off delay/on delay functions, retrigger function, and cross-circuit monitoring via DIP switch poles **DP6 to DP8** (see “Configuration table”).
4. Confirm the configuration by double-clicking on the CONF button.

By confirming the configuration, you are also applying the wired startup behavior for the device.

Automatic start is only configured if the signal from S21 to S34 is present during confirmation of the configuration.

In all other cases, the device is configured with manual, monitored start.

The configuration is stored and the safety relay switches to the operating mode. The enabling current paths close according to the selected startup behavior (automatic or manual, monitored start).

WARNING: Danger due to incorrect setting.

An incorrect configuration can result in dangerous machine or system states.

- Check the configuration before starting up for the first time.

14.5 Protection against manipulation

Operate the safety relay in a locked control cabinet to protect the configuration against manipulation.

14.6 Configuration table

For the exact switch position for the desired configuration, refer to the following table.

Function		DIP switch pole							
		DP1	DP2	DP3	DP4	DP5	DP6	DP7	DP8
Delay time	Reserved	0	0	0	0	0	x	x	x
	0.2 s	0	0	0	0	1	x	x	x
	0.3 s	0	0	0	1	0	x	x	x
	0.4 s	0	0	0	1	1	x	x	x
	0.5 s	0	0	1	0	0	x	x	x
	0.6 s	0	0	1	0	1	x	x	x
	0.7 s	0	0	1	1	0	x	x	x
	0.8 s	0	0	1	1	1	x	x	x
	0.9 s	0	1	0	0	0	x	x	x
	1 s	0	1	0	0	1	x	x	x
	1.5 s	0	1	0	1	0	x	x	x
	2 s	0	1	0	1	1	x	x	x
	2.5 s	0	1	1	0	0	x	x	x
	3 s	0	1	1	0	1	x	x	x
	3.5 s	0	1	1	1	0	x	x	x
	4 s	0	1	1	1	1	x	x	x
	4.5 s	1	0	0	0	0	x	x	x
	5 s	1	0	0	0	1	x	x	x
	6 s	1	0	0	1	0	x	x	x
	7 s	1	0	0	1	1	x	x	x
	8 s	1	0	1	0	0	x	x	x
	9 s	1	0	1	0	1	x	x	x
	10 s	1	0	1	1	0	x	x	x
	12.5 s	1	0	1	1	1	x	x	x
	15 s	1	1	0	0	0	x	x	x
	17.5 s	1	1	0	0	1	x	x	x
	20 s	1	1	0	1	0	x	x	x
	25 s	1	1	0	1	1	x	x	x
	30 s	1	1	1	0	0	x	x	x
	40 s	1	1	1	0	1	x	x	x
	50 s	1	1	1	1	0	x	x	x
	60 s	1	1	1	1	1	x	x	x
Off delay		x	x	x	x	x	0	x	x
On delay (*)		x	x	x	x	x	1	1	x
Retrigger function deactivated		x	x	x	x	x	0	0	x
Retrigger function activated		x	x	x	x	x	x	1	x
Cross-circuit monitoring activated		x	x	x	x	x	x	x	0
Cross-circuit monitoring deactivated		x	x	x	x	x	x	x	1

x = DIP switch pole not relevant for the respective function

(*) The on delay function is only permitted in combination with the activated retrigger function.

15 Startup

- Apply the rated control circuit supply voltage (24 V DC) at terminal blocks A1/A2.

PWR LED lights up.

- Close sensor circuit.

The IN 1 and IN 2 LEDs light up.

Automatic start

The enabling current paths 13/14 and 27/28 close.

The K1 and K2 LEDs light up.

Signal output M1 is not active.

If an on delay is configured for the delayed enabling current path (27/28), the path only closes once the selected delay time has elapsed.

Manual, monitored start

- Press the reset button.
- Release the reset button.

The enabling current paths 13/14 and 27/28 close.

The K1 and K2 LEDs light up.

Signal output M1 is not active.

If an on delay is configured for the delayed enabling current path (27/28), the path only closes once the selected delay time has elapsed.

16 Calculating the power dissipation

The total power dissipation of the safety relay is based on the input power dissipation, the output power dissipation for clock and signal outputs, and the contact power dissipation for the same and for different load currents.

Input power dissipation for U_S = 24 V DC

P_{Input} = 1.48 W

Output power dissipation for I = 100 mA

P_{Output} = 0.31 W

Contact power dissipation

$P_{Contact} = (I_{L1}^2 + I_{L2}^2) \bullet 50\ m\Omega$

Total power dissipation

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

therefore

P_{Total} = 1.79 W + $P_{Contact}$

therefore

$P_{Total} = 1.79\ W + (I_{L1}^2 + I_{L2}^2) \bullet 50\ m\Omega$

Key:

P	Power dissipation in mW
U_S	Rated control circuit supply voltage
I	Current at clock and signal outputs
n	Number of enabling current paths used
I_L	Contact load current

17 Diagnostics

The following section describes the LED indicators for general states and error messages as well as possible causes and remedies.

Function test/proof test

Use the function test to test the safety function. To do this, request the safety function once by pressing the emergency stop button, for example. Check whether the safety function is executed correctly by then switching the device on again via the sensor circuits.

17.1 General states

PWR LED	IN1 LED	IN2 LED	K1 LED	K2 LED	State	Notes
Green ON	OFF	OFF	OFF	OFF	All relays are not activated. The sensor circuit is off.	-
Green ON	OFF	OFF	OFF	Green ON	Configuration: off delay Relay K2 remains picked up until the set delay time has elapsed.	Sensor circuit was opened during operation.
Green ON	Green ON	Green ON	OFF	Green ON	Configuration: off delay, manual start Relay K2 remains picked up until the set delay time has elapsed.	Sensor circuit was opened and closed again during operation.
Green ON	Green ON	Green ON	Green ON	OFF	Configuration: on delay Relay K2 remains open until the set delay time has elapsed.	-
Green ON	Green ON	Green ON	OFF	Green flashing	Relay K2 remains picked up until the set delay time has elapsed.	The CONF button was pressed for > 3 s during operation. After the set delay time has elapsed, the device automatically switches to configuration mode.
Green ON	Green ON	Green ON	OFF	OFF	Relays K1/K2 are ready to start and await reset/start command (S34).	Possible error see error messages
Green ON	Green ON	Green ON	Green ON	Green ON	All sensor circuits are active. All relays are picked up.	-

17.2 Error Messages

PWR LED	IN1 LED	IN2 LED	K1 LED	K2 LED	State	Possible cause	Corrective
Green ON	Green ON	Green ON	OFF	OFF	The sensor circuit is active. The reset/start circuit (S34) is/was activated. The safety circuit (K1 and K2) is not picking up.	External error: readback contact (external actuator) is open in the reset circuit.	Switch off the operating voltage and check the actuator. Then perform a function test.
Red ON	OFF	OFF	OFF	OFF	-	Internal error	Perform a power down reset with subsequent function test. **If the error occurs again after the function test, replace the device.**
Flashing red	OFF	OFF	OFF	OFF	-	The operating voltage is outside the permissible range.	Check the operating voltage. Make sure that the operating voltage is in the permissible range.
Flashing red	Red ON	Red ON	OFF	OFF	The sensor circuit is active. The reset/start circuit (S34) is/was activated. The safety circuit (K1 and K2) is not picking up.	Cross-circuit detection active. Possible cross-circuit in the sensor circuit (S12/S22).	Switch off the operating voltage and rectify the cross-circuit. Then perform a function test.
Flashing red	Red ON	Off/green on	OFF	OFF		Cross-circuit detection active. Possible cross-circuit in the sensor circuit (S12).	
Flashing red	Off/green on	Red ON	OFF	OFF		Cross-circuit detection active. Possible cross-circuit in the sensor circuit (S22).	
Flashing red	Red ON	Red ON	OFF	OFF		Implausible signal change at the inputs (S12/S22), e.g., due to defective signal generator.	Remove the error. Then perform a function test.

PWR LED	IN1 LED	IN2 LED	K1 LED	K2 LED	State	Possible cause	Corrective
Flashing red	Off/green on	Off/green on	Red ON	Red ON	For automatic start: The sensor circuit is active. The reset/start circuit (S34) is/was activated. The safety circuit (K1 and K2) is not picking up.	Short circuit between 24 V and S34.	Switch off the operating voltage and remove the error. Then perform a function test.
					For manual start: The sensor circuit is active. The reset/start circuit (S34) is/was activated. The safety circuit (K1 and K2) is not picking up.	Short circuit between 24 V and S34, before the sensor circuit is closed.	
Flashing red	Red ON	Red ON	Red ON	Red ON	For automatic start: The sensor circuit is active. The reset/start circuit (S34) is/was activated. The safety circuit (K1 and K2) is not picking up.	Short circuit between 24 V and S34 **and** implausible signal change at the inputs (S12/S22), e.g., due to defective signal generator.	
					For manual start: The sensor circuit is active. The reset/start circuit (S34) is/was activated. The safety circuit (K1 and K2) is not picking up.	Short circuit between 24 V and S34, before the sensor circuit is closed **and** implausible signal change at the inputs (S12/S22), e.g., due to defective signal generator.	
Green ON	Flashing red	Flashing red	OFF	Green ON	Configuration: off delay without retrigger function, automatic start Relay K2 remains picked up until the set delay time has elapsed.	Sensor circuit was opened and closed again during operation.	Wait the set delay time. The device then starts automatically.
					Configuration: off delay without retrigger function, manual start Relay K2 remains picked up until the set delay time has elapsed.	Sensor circuit was opened and closed again during operation and the manual start was performed.	Wait the set delay time. The device can then be activated again via a manual start.

17.3 Error messages regarding configuration

17.3.1 DIP switch moved

The safety relay detects if the 8-pos. DIP switch is moved during operation.

Consequently the device enters the safe state and indicates via LED combinations which DIP switch pole (DP1 to D8) has moved.

If an off delay is configured for the delayed enabling current path (27/28), the path only opens once the selected delay time has elapsed.

The table below applies in the event that a single DIP switch pole has moved. If multiple DIP switch poles moved at the same time, the following applies:

DP1 ... DP5: All moved DPs are indicated simultaneously.

DP6 ... DP8: The moved DPs are indicated according to their priority. Only the higher order DP is indicated (DP8 > DP7 > DP6).

PWR LED	IN1 LED	IN2 LED	K1 LED	K2 LED	Moved DIP switch pole	Corrective
Yellow flashing ❷	OFF	OFF	OFF	OFF	DP1	Correct the switch position. Perform a power down reset with subsequent function test or apply the new configuration in configuration mode (see “Applying the configuration” section).
OFF	Yellow flashing ❷	OFF	OFF	OFF	DP2	
OFF	OFF	Yellow flashing ❷	OFF	OFF	DP3	
OFF	OFF	OFF	Yellow flashing ❷	OFF	DP4	
OFF	OFF	OFF	OFF	Yellow flashing ❷	DP5	
Yellow flashing ❶	Yellow ON	OFF	OFF	OFF	DP6	
Yellow flashing ❶	OFF	Yellow ON	OFF	OFF	DP7	
Yellow flashing ❶	OFF	OFF	Yellow ON	OFF	DP8	

Note the different blink behavior, see ❶ or ❷ in the table and figure.

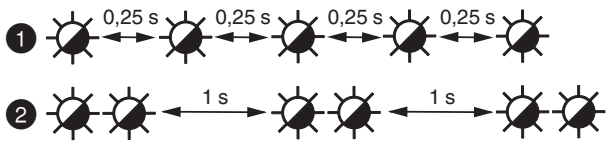


Figure 22 LED blink behavior

17.4 Invalid configuration frame

If a reserved or invalid configuration is selected during the configuration process, all LEDs flash yellow.

- Correct the configuration.

18 Application examples

18.1 Emergency stop monitoring/automatic start

- Two-channel emergency stop monitoring
- Automatic start
- Monitoring of external, force-guided contactors
- Suitable up to category 4, PL e (EN ISO 13849-1), SIL 3 (EN 62061), if cross-circuits in the control to the actuator can be ruled out

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

WARNING: Loss of functional safety in the event of errors in the FU.

The quick stop function of the frequency inverter is purely functional. It is not suitable for safety-related use. If an error occurs in the frequency inverter at the same time that the emergency stop control device is actuated, the quickest possible stop may not occur or the delay may be shorter.

The solution described is widely used and can be viewed as state of the art.

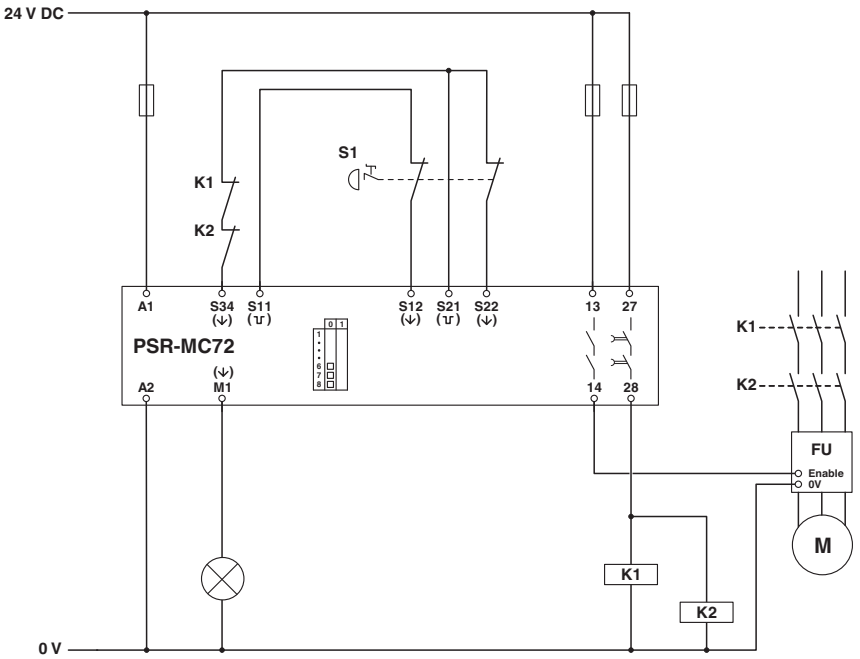


Figure 23 Emergency stop monitoring/automatic start

DIP switch setting	
DP1 ... DP5	According to the desired delay time (see “Configuration table”)
DP6	0
DP7	0
DP8	0

Key:

S1	Emergency stop button
K1/K2	Force-guided contactors
FU	Frequency inverter

18.2 Emergency stop monitoring/manual, monitored start

- Two-channel emergency stop monitoring
- Manual, monitored start
- Monitoring of external, force-guided contactors
- Suitable up to category 4, PL e (EN ISO 13849-1), SIL 3 (EN 62061), if cross-circuits in the control to the actuator can be ruled out

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

WARNING: Loss of functional safety in the event of errors in the FU.

The quick stop function of the frequency inverter is purely functional. It is not suitable for safety-related use. If an error occurs in the frequency inverter at the same time that the emergency stop control device is actuated, the quickest possible stop may not occur or the delay may be shorter.

The solution described is widely used and can be viewed as state of the art.

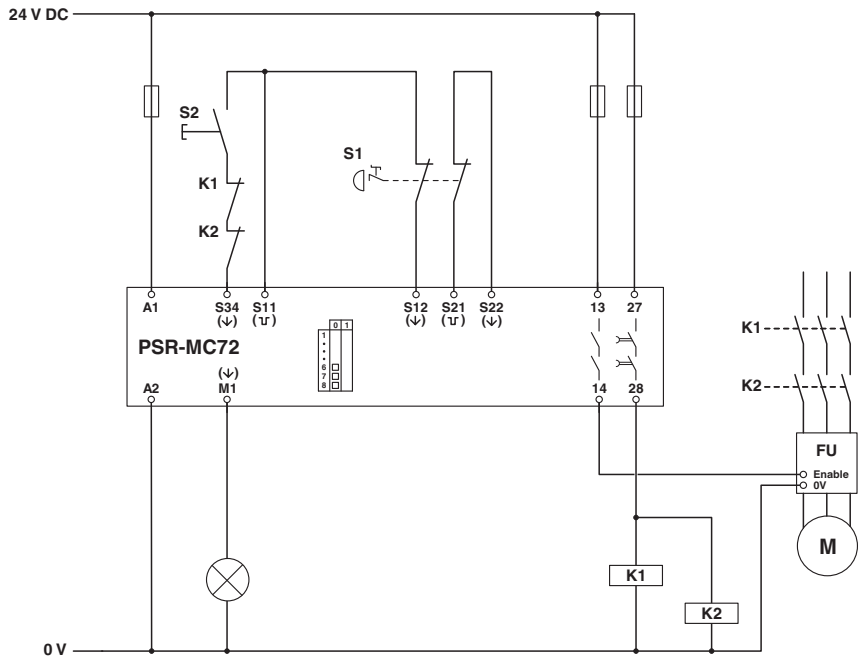


Figure 24 Emergency stop monitoring/manual, monitored start

DIP switch setting	
DP1 ... DP5	According to the desired delay time (see “Configuration table”)
DP6	0
DP7	0
DP8	0

Key:

S1	Emergency stop button
S2	Manual reset device
K1/K2	Force-guided contactors
FU	Frequency inverter

18.3 Single-channel emergency stop monitoring/manual, monitored start

- Single-channel emergency stop monitoring
- Manual, monitored start
- Monitoring of external contactors (optional)
- Suitable up to category 1, PL c (EN ISO 13849-1), SIL 1 (EN 62061)

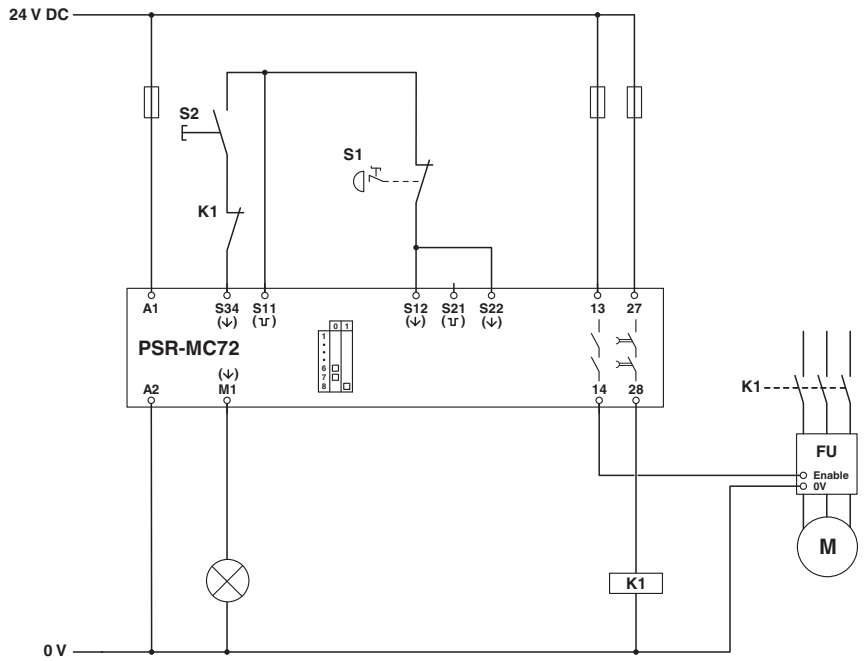


Figure 25 Single-channel emergency stop monitoring/manual, monitored start

DIP switch setting	
DP1 ... DP5	According to the desired delay time (see “Configuration table”)
DP6	0
DP7	0
DP8	1

Key:

S1	Emergency stop button
S2	Manual reset device
K1	Contactor
FU	Frequency inverter

18.4 Light grid monitoring/manual, monitored start

- Two-channel light grid monitoring
- Manual, monitored start
- Monitoring of external, force-guided contactors
- Suitable up to category 4, PL e (EN ISO 13849-1), SIL 3 (EN 62061), if cross-circuits in the control to the actuator can be ruled out

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

WARNING: Loss of functional safety!

Make sure that the signal generator and the safety relay have the same ground potential.

WARNING: Loss of functional safety in the event of errors in the FU.

The quick stop function of the frequency inverter is purely functional. It is not suitable for safety-related use. If an error occurs in the frequency inverter at the same time that the emergency stop control device is actuated, the quickest possible stop may not occur or the delay may be shorter.

The solution described is widely used and can be viewed as state of the art.

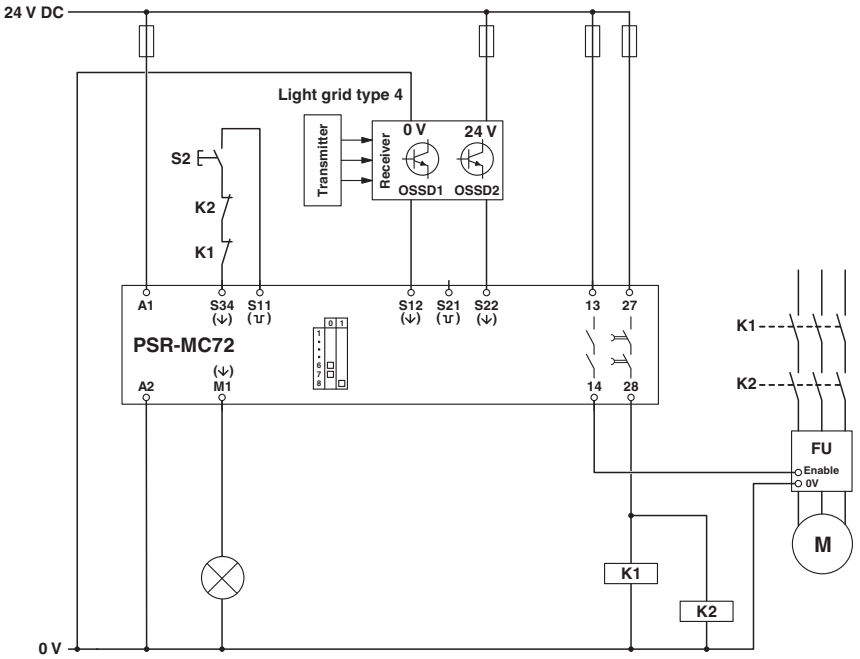


Figure 26 Light grid monitoring/manual, monitored start

DIP switch setting	
DP1 ... DP5	According to the desired delay time (see “Configuration table”)
DP6	0
DP7	0
DP8	1

Key:

S2	Manual reset device
K1/K2	Force-guided contactors
FU	Frequency inverter

19 Attachment

19.1 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

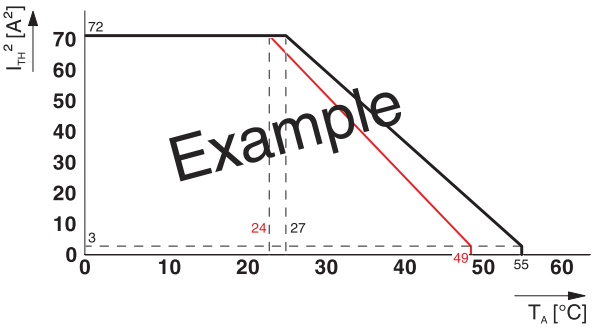


Figure 27 Example of a suspended derating curve (red)

19.2 Revision history

Version	Date	Contents
00	2016-03-18	First publication
01	2016-10-17	Safety notes added in Section 5; reset button connection adjusted in Figure 19