

PNOZ s1

PILZ
THE SPIRIT OF SAFETY

Safety relays

Operating Manual-21393-EN-10

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SD means Secure Digital

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Introduction

Validity of documentation

This documentation is valid for the product PNOZ s1. It is valid until new documentation is published.

This operating manual explains the function and operation, describes the installation and provides guidelines on how to connect the product.

Using the documentation

This document is intended for instruction. Only install and commission the product if you have read and understood this document. The document should be retained for future reference.

Definition of symbols

Information that is particularly important is identified as follows:



DANGER!

This warning must be heeded! It warns of a hazardous situation that poses an immediate threat of serious injury and death and indicates preventive measures that can be taken.



WARNING!

This warning must be heeded! It warns of a hazardous situation that could lead to serious injury and death and indicates preventive measures that can be taken.



CAUTION!

This refers to a hazard that can lead to a less serious or minor injury plus material damage, and also provides information on preventive measures that can be taken.



NOTICE

This describes a situation in which the product or devices could be damaged and also provides information on preventive measures that can be taken. It also highlights areas within the text that are of particular importance.



INFORMATION

This gives advice on applications and provides information on special features.

Safety

Intended use

The safety relay provides a safety-related interruption of a safety circuit.

The safety relay meets the requirements of EN 60947-5-1, EN 60204-1 and VDE 0113-1 and may be used in applications with

- E-STOP pushbuttons
- Safety gates

The following is deemed improper use in particular

- Any component, technical or electrical modification to the product,
- Use of the product outside the areas described in this manual,
- Use of the product outside the technical details (see Technical details [15]).



NOTICE

EMC-compliant electrical installation

The product is designed for use in an industrial environment. The product may cause interference if installed in other environments. If installed in other environments, measures should be taken to comply with the applicable standards and directives for the respective installation site with regard to interference.

Safety regulations

Safety assessment

Before using a device it is necessary to perform a safety assessment in accordance with the Machinery Directive.

Functional safety is guaranteed for the product as a single component. However, this does not guarantee the functional safety of the overall plant/machine. In order to achieve the required safety level for the overall plant/machine, define the safety requirements for the plant/machine and then define how these must be implemented from a technical and organisational standpoint.

Use of qualified personnel

The products may only be assembled, installed, programmed, commissioned, operated, maintained and decommissioned by competent persons.

A competent person is a qualified and knowledgeable person who, because of their training, experience and current professional activity, has the specialist knowledge required. To be able to inspect, assess and operate devices, systems and machines, the person has to be informed of the state of the art and the applicable national, European and international laws, directives and standards.

It is the company's responsibility only to employ personnel who

- Are familiar with the basic regulations concerning health and safety / accident prevention,
- Have read and understood the information provided in the section entitled Safety
- Have a good knowledge of the generic and specialist standards applicable to the specific application.

Warranty and liability

All claims to warranty and liability will be rendered invalid if

- The product was used contrary to the purpose for which it is intended,
- Damage can be attributed to not having followed the guidelines in the manual,
- Operating personnel are not suitably qualified,
- Any type of modification has been made (e.g. exchanging components on the PCB boards, soldering work etc.).

Disposal

- In safety-related applications, please comply with the mission time T_M in the safety-related characteristic data.
- When decommissioning, please comply with local regulations regarding the disposal of electronic devices (e.g. Electrical and Electronic Equipment Act).

For your safety

The unit meets all the necessary conditions for safe operation. However, please note the following:

- Note for overvoltage category III: If voltages higher than low voltage (>50 VAC or >120 VDC) are present on the unit, connected control elements and sensors must have a rated insulation voltage of at least 250 V.

Unit features

- Relay outputs:
  - 2 safety contacts (N/O), instantaneous
- 1 semiconductor output
- Connection options for:
  - E-STOP pushbutton
  - Safety gate limit switch
  - Start button
- A connector can be used to connect 1 PNOZsigma contact expansion module
- LED indicator for:
  - Supply voltage
  - Input status, channel 1
  - Input status, channel 2
  - Switch status of the safety contacts
  - Start circuit
  - Errors
- Plug-in connection terminals (either spring-loaded terminal or screw terminal)
- See order reference for unit types

Safety features

The safety relay meets the following safety requirements:

- The circuit is internally redundant with built-in self-monitoring.
- The safety device remains effective in the case of a component failure.
- The correct opening and closing of the safety device relays is tested automatically in each on-off cycle.

Block diagram/terminal configuration

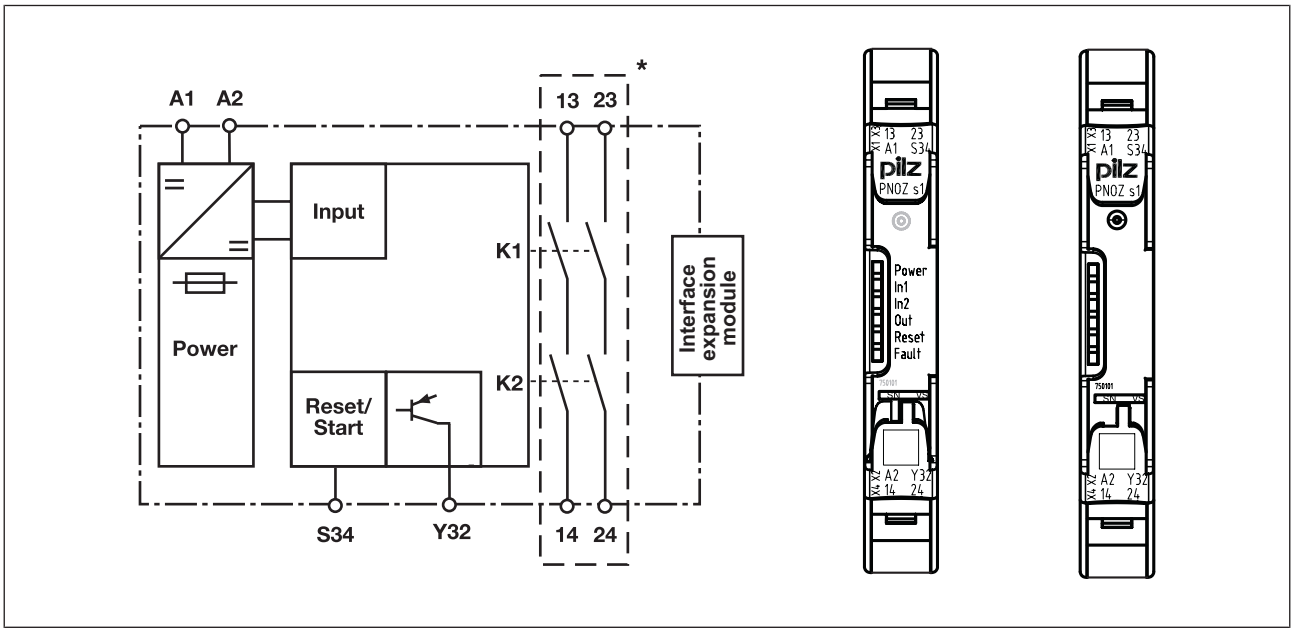


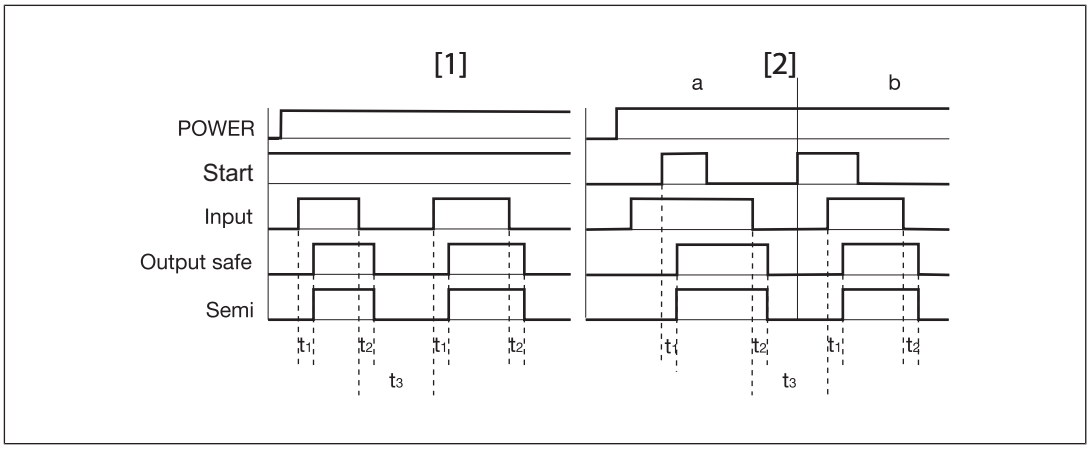
Fig.: Centre: Front view with cover, right: Front view without cover

*Insulation between the non-marked area and the relay contacts: Basic insulation (overvoltage category III), Protective separation (overvoltage category II)

Function description

- Single-channel operation: No redundancy in the input circuit, earth faults in the start and input circuit are detected.
- Automatic start: Unit is active once the input circuit has been closed.
- Manual start: Unit is active once the input circuit and the start circuit are closed.
- Increase in the number of available instantaneous safety contacts by connecting contact expander modules or external contactors/relays;
  A connector can be used to connect 1 PNOZsigma contact expander module.

Timing diagram



Legend

- POWER: Supply voltage
- Start: Start circuit
- Input: Input circuits
- Output safe: Safety contacts
- Semi: Semiconductor output
- [1]: Automatic start
- [2]: Manual start
- a: Input circuit closes before start circuit
- b: Start circuit closes before input circuit
- t_1: Switch-on delay
- t_2: Delay-on de-energisation
- t_3: Recovery time

Installation

Install base unit without contact expansion module:

- Ensure that the plug terminator is inserted at the side of the unit.

Connect base unit and PNOZsigma contact expansion module:

- Remove the plug terminator at the side of the base unit and at the contact expansion module.
- Connect the base unit and the contact expansion module to the supplied connector before mounting the units to the DIN rail.

Installation in control cabinet

- The safety relay should be installed in a control cabinet with a protection type of at least IP54.
- Use the notch on the rear of the unit to attach it to a DIN rail (35 mm).
- When installed vertically: Secure the unit by using a fixing element (e.g. retaining bracket or end angle).
- Push the device upwards or downwards before lifting it from the DIN rail.

Wiring

Please note:

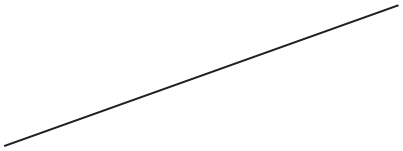
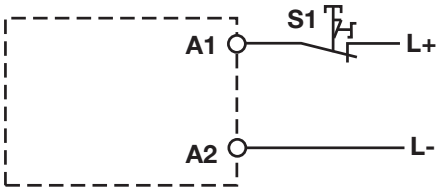
- Information given in the "Technical details [15]" must be followed.
- Outputs 13-14 and 23-24 are safety contacts, the semiconductor output Y32 is an auxiliary output (e.g. for display).
- Semiconductor output Y32 should **not** be used for safety circuits!
- To prevent contact welding, a fuse should be connected before the output contacts (see Technical details [15]).
- Calculation of the max. cable length l_{max} in the input circuit:

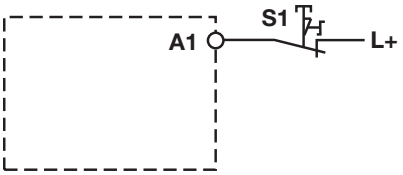
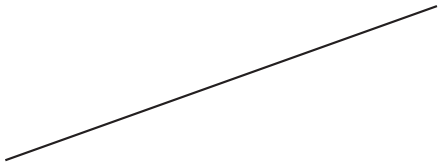
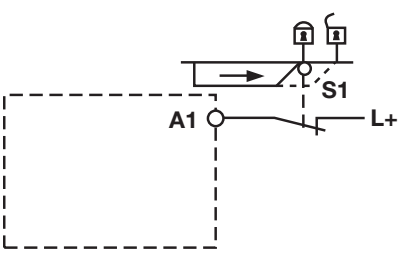
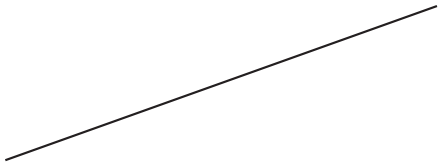
$$l_{max} = \frac{R_{lmax}}{R_l / km}$$

R_{lmax} = max. overall cable resistance (see Technical details [15])
R_l / km = cable resistance/km

- Use copper wire that can withstand 60/75 °C.
- Sufficient fuse protection must be provided on all output contacts with capacitive and inductive loads.
- Ensure the wiring and EMC requirements of EN 60204-1 are met.
- The power supply must comply with the regulations for extra low voltages with protective electrical separation (SELV, PELV) in accordance with VDE 0100, Part 410.

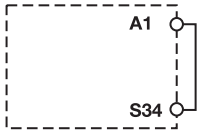
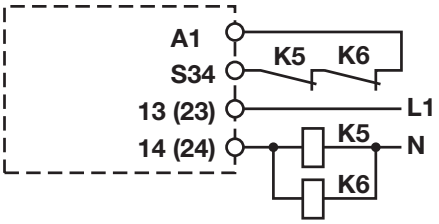
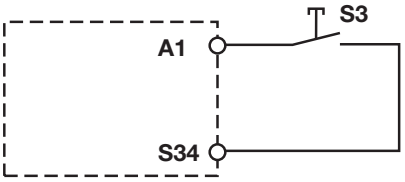
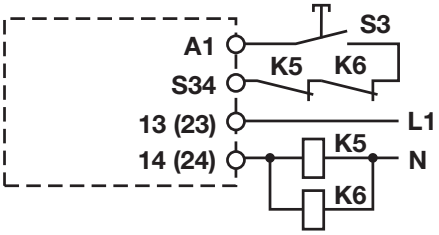
Preparing for operation

Supply voltage	AC	DC
		

Input circuit	Single-channel	Dual-channel
E-STOP **without** detection of shorts across contacts		
Safety gate **without** detection of shorts across contacts		

NOTICE

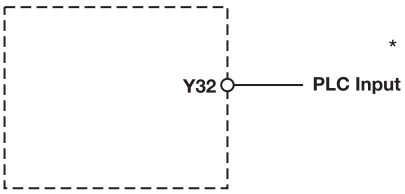
With single-channel wiring the safety level of your machine/plant may be lower than the safety level of the unit (see Safety characteristic data [18]).

Start circuit/feedback loop	Start circuit	Feedback loop
Automatic start		
Manual start		

NOTICE

In the event of an automatic start or manual start with bridged start contact (fault):

The unit starts up automatically when the safeguard is reset, e.g. when the E-STOP pushbutton is released. Use external circuit measures to prevent an unexpected restart.

Semiconductor output

*Connect together the 0V connections on all the external power supplies

Key

- S1: E-STOP pushbutton
- S3: Start button
- ⇑: Switch operated
- : Gate open
- : Gate closed

INFORMATION

If a base unit and a contact expansion module from the PNOZsigma range are connected via the connector, no additional wiring is necessary.

Operation

When the relay outputs are switched on, the mechanical contact on the relay cannot be tested automatically. Depending on the operational environment, measures to detect the non-opening of switching elements may be required under some circumstances.

When the product is used in accordance with the European Machinery Directive, a check must be carried out to ensure that the safety contacts on the relay outputs open correctly. Open the safety contacts (switch off output) and start the device again for SIL CL 2/PL c at least 1 x per year, so that the internal diagnostics can check that the safety contacts open correctly.

NOTICE

The safety function should be checked after initial commissioning and each time the plant/machine is changed. The safety functions may only be checked by qualified personnel.

The unit is ready for operation when the Power LED is permanently lit.

LEDs indicate the status and errors during operation:



LED on



LED flashes

INFORMATION

Status indicators and error indicators may occur independently. In the case of an error display, the "Fault" LED will light or flash (exception: "Supply voltage too low"). An LED that is also flashing indicates the potential cause of the error. An LED that is lit and is static indicates a normal operating status. Several status indicators and error indicators may occur simultaneously.

Status indicators

POWER, IN1, IN2
Input circuit is closed.

OUT
Safety contacts are closed and semiconductor output Y32 carries a high signal.

RESET

24 VDC is present at S34.

Error indicators

FAULT

Diagnostics: Plug terminator not connected

- Remedy: Insert plug terminator, switch supply voltage off and then on again.

FAULT

Diagnostics: Internal error, unit defective

- Remedy: Switch supply voltage off and then on again, change unit if necessary.

POWER

Diagnostics: Supply voltage too low

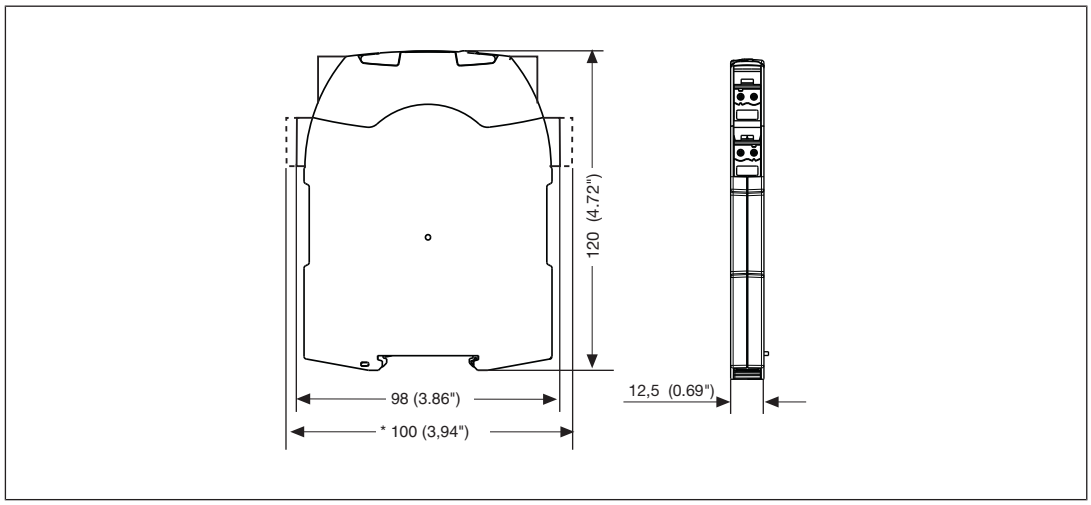
- Remedy: Check supply voltage and increase if necessary.

Faults - malfunctions

- Contact malfunctions: If the contacts have welded, reactivation will not be possible after the input circuit has opened.

Dimensions in mm

*with spring-loaded terminals



Technical Details

General	750101	751101
Approvals	**CCC, CE, EAC (Eurasian), KOSHA, TÜV, cULus Listed**	**CCC, CE, EAC (Eurasian), KOSHA, TÜV, cULus Listed**
Electrical data	**750101**	**751101**
Supply voltage		
Voltage	**24 V**	**24 V**
Kind	**DC**	**DC**
Voltage tolerance	**-15 %/+10 %**	**-15 %/+10 %**
Output of external power supply (DC)	**2 W**	**2 W**
Residual ripple DC	**20 %**	**20 %**
Duty cycle	**100 %**	**100 %**
Inputs	**750101**	**751101**
Number	**1**	**1**
Voltage at		
Input circuit DC	**24 V**	**24 V**
Start circuit DC	**24 V**	**24 V**
Feedback loop DC	**24 V**	**24 V**
Current at		
Input circuit DC	**60 mA**	**60 mA**
Start circuit DC	**20 mA**	**20 mA**
Feedback loop DC	**20 mA**	**20 mA**
Max. inrush current impulse		
Current pulse, input circuit	**1 A**	**1 A**
Pulse duration, input circuit	**5 ms**	**5 ms**
Current pulse, feedback loop	**0,2 A**	**0,2 A**
Pulse duration, feedback loop	**0,5 ms**	**0,5 ms**
Current pulse, start circuit	**0,2 A**	**0,2 A**
Pulse duration, start circuit	**0,5 ms**	**0,5 ms**
Max. overall cable resistance Rl-max		
Single-channel at UB DC	**30 Ohm**	**30 Ohm**
Semiconductor outputs	**750101**	**751101**
Number	**1**	**1**
Voltage	**24 V**	**24 V**
Current	**20 mA**	**20 mA**
Relay outputs	**750101**	**751101**
Number of output contacts		
Safety contacts (N/O), instantaneous	**2**	**2**
Max. short circuit current IK	**1 kA**	**1 kA**
Utilisation category		
In accordance with the standard	**EN 60947-4-1**	**EN 60947-4-1**

Relay outputs	750101	751101
Utilisation category of safety contacts		
AC1 at	**240 V**	**240 V**
Min. current	**0,02 A**	**0,02 A**
Max. current	**3 A**	**3 A**
Max. power	**720 VA**	**720 VA**
DC1 at	**24 V**	**24 V**
Min. current	**0,02 A**	**0,02 A**
Max. current	**3 A**	**3 A**
Max. power	**72 W**	**72 W**
Utilisation category		
In accordance with the standard	**EN 60947-5-1**	**EN 60947-5-1**
Utilisation category of safety contacts		
AC15 at	**230 V**	**230 V**
Max. current	**1,5 A**	**1,5 A**
DC13 (6 cycles/min) at	**24 V**	**24 V**
Max. current	**1,5 A**	**1,5 A**
Utilisation category in accordance with UL		
Voltage	**240 V AC G. P.**	**240 V AC G. P.**
With current	**3 A**	**3 A**
Voltage	**24 V DC G. P.**	**24 V DC G. P.**
With current	**3 A**	**3 A**
Pilot Duty	**B300, R300**	**B300, R300**
External contact fuse protection, safety contacts		
In accordance with the standard	**EN 60947-5-1**	**EN 60947-5-1**
Blow-out fuse, quick	**4 A**	**4 A**
Blow-out fuse, slow	**2 A**	**2 A**
Blow-out fuse, gG	**4 A**	**4 A**
Circuit breaker 24V AC/DC, characteristic B/C	**2 A**	**2 A**
Conventional thermal current	**3 A**	**3 A**
Contact material	**AgSnO2**	**AgSnO2**
Times	**750101**	**751101**
Switch-on delay		
With automatic start typ.	**100 ms**	**100 ms**
With automatic start max.	**150 ms**	**150 ms**
With automatic start after power on typ.	**100 ms**	**100 ms**
With automatic start after power on max.	**150 ms**	**150 ms**
With manual start typ.	**50 ms**	**50 ms**
With manual start max.	**60 ms**	**60 ms**

Times	750101	751101
Delay-on de-energisation		
With E-STOP typ.	**30 ms**	**30 ms**
With E-STOP max.	**40 ms**	**40 ms**
With power failure typ.	**30 ms**	**30 ms**
With power failure max.	**40 ms**	**40 ms**
Recovery time at max. switching frequency 1/s		
After E-STOP	**100 ms**	**100 ms**
After power failure	**100 ms**	**100 ms**
Supply interruption before de-energisation	**10 ms**	**10 ms**
Environmental data	**750101**	**751101**
Climatic suitability	**EN 60068-2-78**	**EN 60068-2-78**
Ambient temperature		
Temperature range	**-10 - 55 °C**	**-10 - 55 °C**
Storage temperature		
Temperature range	**-40 - 85 °C**	**-40 - 85 °C**
Climatic suitability		
Humidity	**93 % r. h. at 40 °C**	**93 % r. h. at 40 °C**
Condensation during operation	**Not permitted**	**Not permitted**
EMC	**EN 60947-5-1, EN 61000-6-2, EN 61000-6-4, EN 61326-3-1**	**EN 60947-5-1, EN 61000-6-2, EN 61000-6-4, EN 61326-3-1**
Vibration		
In accordance with the standard	**EN 60068-2-6**	**EN 60068-2-6**
Frequency	**10 - 55 Hz**	**10 - 55 Hz**
Amplitude	**0,35 mm**	**0,35 mm**
Airgap creepage		
In accordance with the standard	**EN 60947-1**	**EN 60947-1**
Overvoltage category	**III / II**	**III / II**
Pollution degree	**2**	**2**
Rated insulation voltage	**250 V**	**250 V**
Rated impulse withstand voltage	**4 kV**	**4 kV**
Protection type		
Housing	**IP40**	**IP40**
Terminals	**IP20**	**IP20**
Mounting area (e.g. control cabinet)	**IP54**	**IP54**
Mechanical data	**750101**	**751101**
Mounting position	**Any**	**Any**
Mechanical life	**5,000,000 cycles**	**5,000,000 cycles**
Material		
Bottom	**PC**	**PC**
Front	**PC**	**PC**
Top	**PC**	**PC**
Connection type	**Screw terminal**	**Spring-loaded terminal**

Mechanical data	750101	751101
Mounting type	**plug-in**	**plug-in**
Conductor cross section with screw terminals		
1 core flexible	**0,25 - 2,5 mm², 24 - 12 AWG**	–
2 core with the same cross section, flexible with crimp connectors, no plastic sleeve	**0,25 - 1 mm², 24 - 16 AWG**	–
2 core with the same cross section, flexible without crimp connectors or with TWIN crimp connectors	**0,2 - 1,5 mm², 24 - 16 AWG**	–
Torque setting with screw terminals	**0,5 Nm**	–
Conductor cross section with spring-loaded terminals: Flexible with/without crimp connector	–	**0,2 - 2,5 mm², 24 - 12 AWG**
Spring-loaded terminals: Terminal points per connection	–	**2**
Stripping length with spring-loaded terminals	–	**9 mm**
Dimensions		
Height	**98 mm**	**100 mm**
Width	**12,5 mm**	**12,5 mm**
Depth	**120 mm**	**120 mm**
Weight	**105 g**	**105 g**

Where standards are undated, the 2017-01 latest editions shall apply.

Safety characteristic data



NOTICE

You must comply with the safety-related characteristic data in order to achieve the required safety level for your plant/machine.

Operating Mode	EN ISO 13849-1: 2015 PL	EN ISO 13849-1: 2015 Category	EN 62061 SIL CL	EN 62061 PFH_D [1/h]	IEC 61511 SIL	IEC 61511 PFD	EN ISO 13849-1: 2015 T_M [year]
Safety contacts, instantaneous	**PL c**	**Cat. 3**	**SIL CL 2**	**2,00E-07**	**SIL 2**	**5,95E-03**	**20**

All the units used within a safety function must be considered when calculating the safety characteristic data.

INFORMATION

A safety function's SIL/PL values are **not** identical to the SIL/PL values of the units that are used and may be different. We recommend that you use the PAScal software tool to calculate the safety function's SIL/PL values.

Supplementary data

CAUTION!

It is essential to consider the values in the relays' service life table. The relay outputs' safety-related characteristic data is only valid if the values in the service life table are met.

The PFH value depends on the switching frequency and the load on the relay output.
If the values in the service life table are not accessible, the stated PFH value can be used irrespective of the switching frequency and the load, as the PFH value already considers the relay's B10d value as well as the failure rates of the other components.

Service life table

The service life table indicates the number of cycles from which failures due to wear must be expected. The wear is mainly caused by the electrical load; the mechanical load is negligible.

Load type	Switching current	Number of cycles
DC1	3 A	200,000
DC13	1.5 A	75,000
AC1	3 A	50,000
AC15	1.5 A	50,000

Permitted operating height

The values stated in the technical details apply to the use of the device in operating heights up to max. 2000 m above sea level. When used in greater heights, constraints have to be taken into account:

- Permitted maximum operating height 5000 m
- Reduction of rated insulation voltage and rated impulse withstand voltage for applications with safe separation:

Maximum operation height	Rated insulation voltage	Overvoltage category	Max. rated impulse withstand voltage
3000 m	150 V	II	2.5 kV
	100 V	III	2.5 kV
4000 m	150 V	II	2.5 kV
	100 V	III	2.5 kV
5000 m	100 V	II	1.5 kV
	24 V	III	0.8 kV

- Reduction of rated insulation voltage and rated impulse withstand voltage for applications with basic insulation:

Maximum operation height	Rated insulation voltage	Overvoltage category	Max. rated impulse withstand voltage
3000 m	250 V	II	2.5 kV
	150 V	III	2.5 kV
4000 m	250 V	II	2.5 kV
	150 V	III	2.5 kV
5000 m	150 V	II	1.5 kV
	100 V	III	1.5 kV

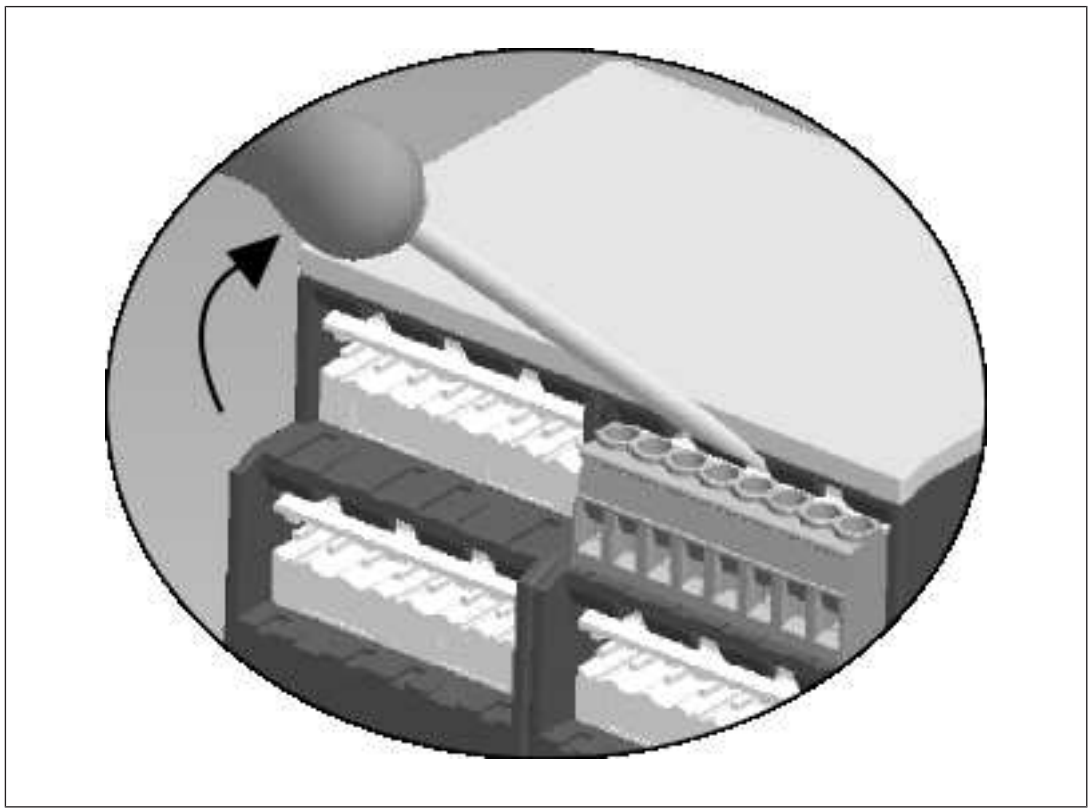
- From an operating height of 2000 m the max. permitted ambient temperature is reduced by 0.5 °C/100 m

Operating height	Permitted ambient temperature
3000 m	50 °C
4000 m	45 °C
5000 m	40 °C

Remove plug-in terminals

Procedure: Insert the screwdriver into the housing recess behind the terminal and lever the terminal out.

Do **not** remove the terminals by pulling the cables!



Order reference

Product type	Features	Connection type	Order No.
PNOZ s1	24 VDC	Screw terminals	750 101
PNOZ s1 C	24 VDC	Spring-loaded terminals	751 101

EC declaration of conformity

This product/these products meet the requirements of the directive 2006/42/EC for machinery of the European Parliament and of the Council. The complete EC Declaration of Conformity is available on the Internet at www.pilz.com/downloads.
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Support

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