

PNOZ s3

PILZ
THE SPIRIT OF SAFETY

Safety relays

Operating Manual-21395-EN-12

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SD means Secure Digital

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Introduction

Validity of documentation

This documentation is valid for the product PNOZ s3. 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
- Light grids and safety switches with detection of shorts across contacts

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 [18]).

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

- Positive-guided relay outputs:
  - 2 safety contacts (N/O), instantaneous
- 1 semiconductor output
- Connection options for:
  - E-STOP pushbuttons
  - Safety gate limit switches
  - Start buttons
  - Light grids and safety switches with detection of shorts across contacts
- A connector can be used to connect 1 PNOZsigma contact expansion module
- Operating modes can be set via rotary switch
- LED indicator for:
  - Supply voltage
  - Input status, channel 1
  - Input status, channel 2
  - Switch status channel 1/2
  - Start circuit
  - Error
- 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 redundant with built-in self-monitoring.
- The safety function remains effective in the case of a component failure.
- The correct opening and closing of the safety function relays is tested automatically in each on-off cycle.

Block diagram/terminal configuration

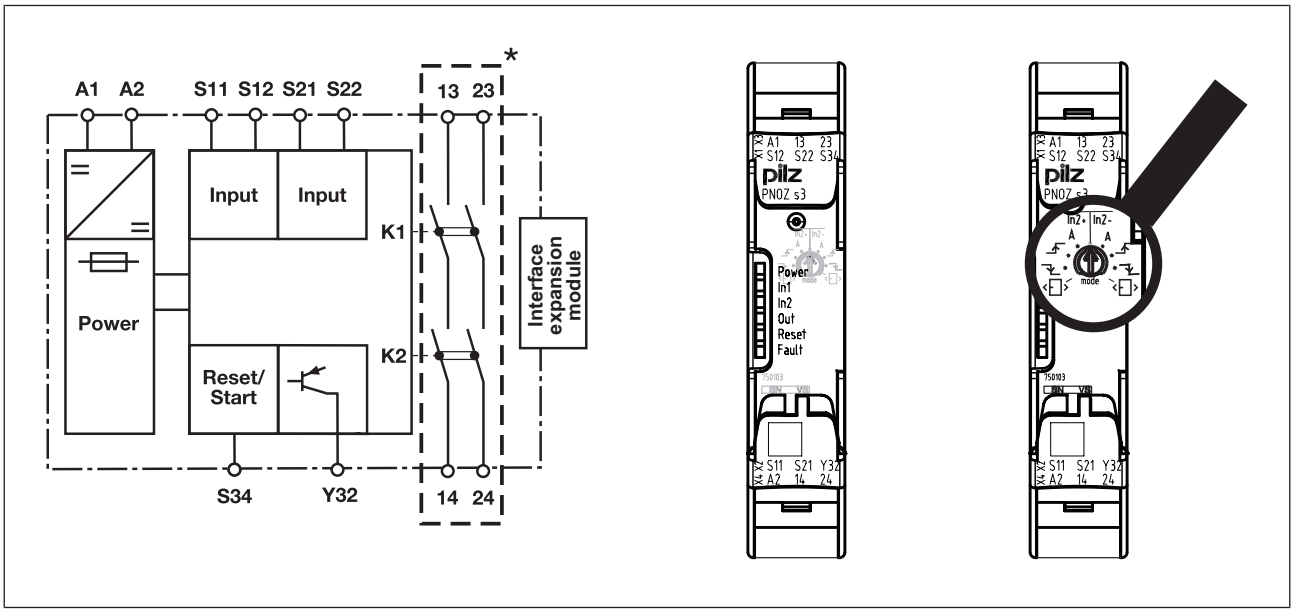


Fig.: Centre: Front view with cover, right: Front view without cover

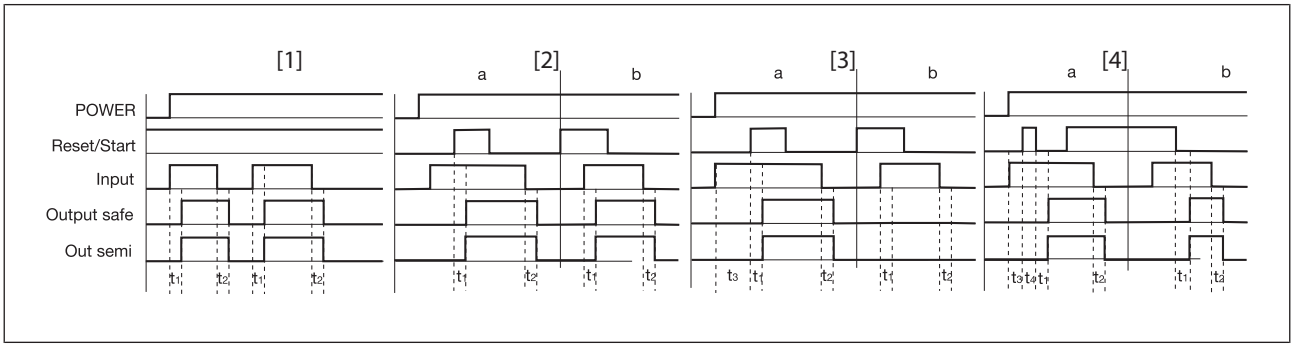
*Insulation between the non-marked area and the relay contacts: Basic insulation (overvoltage category III), Protective separation (overvoltage category II)

Function description

- In2+ Single-channel operation: no redundancy in the input circuit, earth faults in the start circuit and input circuit are detected.
- Dual-channel operation without detection of shorts across contacts: Redundant input circuit, detects PNOZ s3
  - earth faults in the start and input circuit,
  - short circuits in the input circuit and, with a monitored start, in the start circuit too.
- In2- Dual-channel operation with detection of shorts across contacts: Redundant input circuit, detects PNOZ s3
  - earth faults in the start and input circuit,
  - Short circuits in the input circuit and, with a monitored start, in the start circuit too,
  - Shorts across contacts in the input circuit.
- **A** 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.
- Monitored start with falling edge: Unit is active once
  - the input circuit is closed and then the start circuit is closed and opened again.
  - the start circuit is closed and then opened again once the input circuit is closed.
- Monitored start with rising edge: Unit is active once the input circuit is closed and once the start circuit is closed after the waiting period has elapsed (see technical details).

- Start with start-up test: The unit checks whether safety gates that are closed are opened and then closed again when supply voltage is applied.
- 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
- Out semi: Semiconductor output
- [1]: Automatic start
- [2]: Manual start
- [3]: Monitored start with rising edge
- [4]: Monitored start with falling edge
- 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: Waiting period with a monitored start
- t_4: Min. start pulse duration with a monitored start

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 [18]" 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 [18]).
- 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 [18])
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.
- When connecting magnetically operated, reed proximity switches, ensure that the max. peak inrush current (on the input circuit) does not overload the proximity switch.
- 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

Operating modes

The operating mode is set via the rotary switch on the unit. You can do this by opening the cover on the front of the unit.



NOTICE

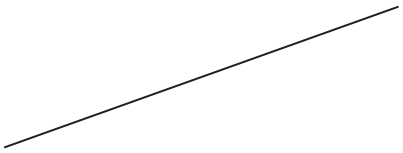
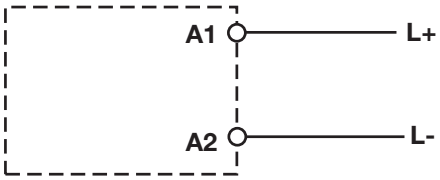
Do not adjust the rotary switch during operation, otherwise an error message will appear, the safety contacts will open and the unit will not be ready for operation until the supply voltage has been switched off and then on again.

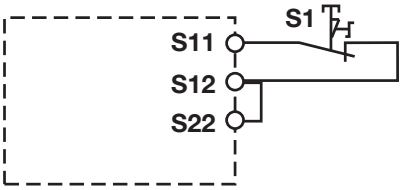
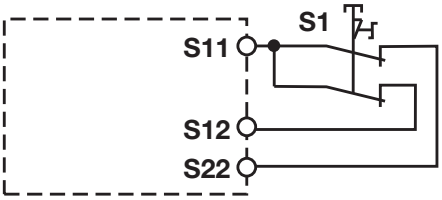
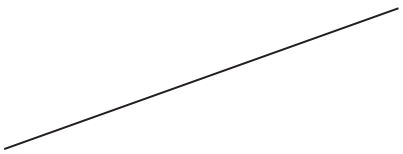
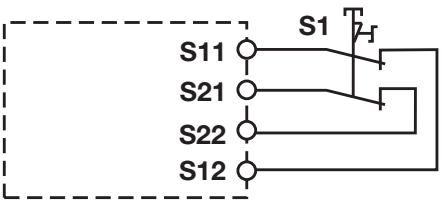
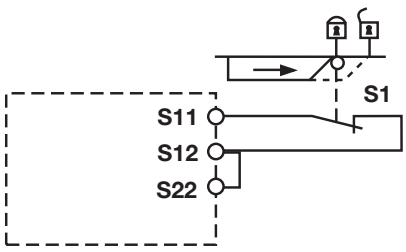
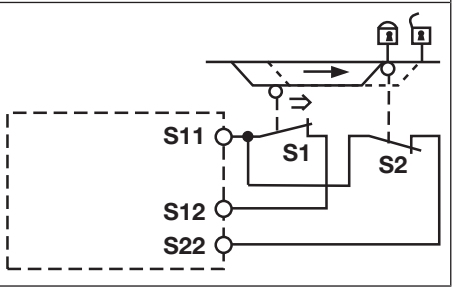
Set operating modes

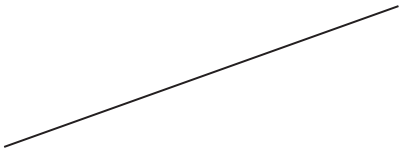
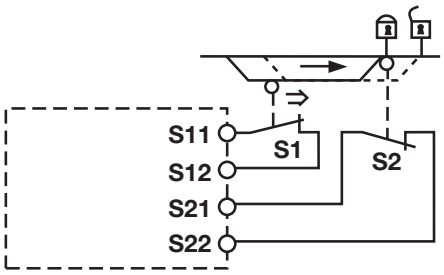
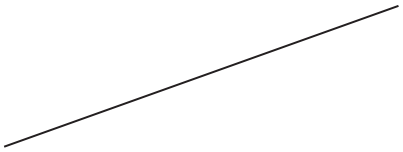
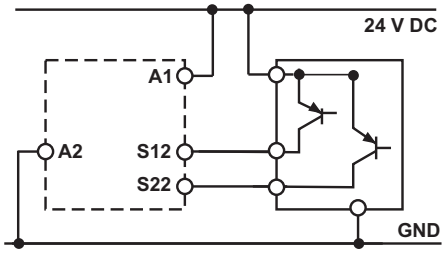
- Switch off supply voltage.
- Select operating mode via the operating mode selector switch "mode".
- If the operating mode selector switch "mode" is in its start position (vertical position), an error message will appear.

Operating mode selector switch "mode"	Automatic or manual start	Monitored start rising edge	Monitored start falling edge	Automatic start with start-up test
Without detection of shorts across contacts				
With detection of shorts across contacts				

Connection

Supply voltage	AC	DC
		

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

Input circuit	Single-channel	Dual-channel
Safety gate **with** detection of shorts across contacts		
Light beam device or safety switch, detection of shorts across contacts via ESPE		

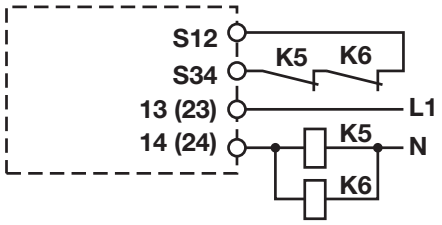
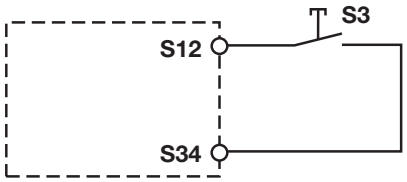
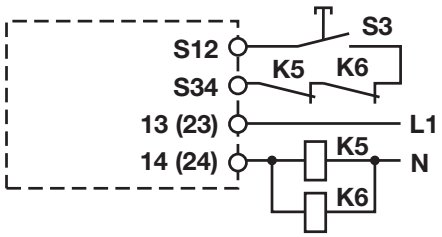
NOTICE

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 [📖 22]).

NOTICE

When operated with a light grid or sensor

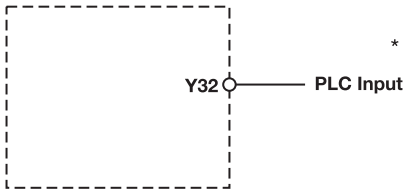
- It must not be possible to switch off the supply voltage for the PNOZ-sigma separately from the supply voltage for the light grid or safety switch.
- The operating mode selector switch must be set to "Without detection of shorts across contacts", as shorts across contacts are detected by the ESPE.

Start circuit/feedback loop	Without feedback loop monitoring	with feedback loop monitoring
Automatic start		
Monitored, manual start/restart		

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

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, so that the internal diagnostics can check that the safety contacts open correctly

- for SIL CL 3/PL e at least 1x per month
- for SIL CL 2/PL d at least 1x per year



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
- LED off



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
Supply voltage is present.

IN1
Input circuit at S12 is closed.

IN2
Input circuit at S22 is closed.

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

RESET
24 VDC is present at S34.

Error indicators

● **All LEDs off**

Diagnostics: Short across contacts/earth fault; unit switched off

- Remedy: Rectify short across contacts/earth fault, switch off supply voltage for 1 min.

☼ **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.

◐ **IN1, IN2 alternately** ☼ **FAULT**

Diagnostics: Connection error (possibly: cable resistance in the input circuit is too high) or short detected between S12 and S22

- Remedy: Rectify connection error or short across contacts, switch supply voltage off and then on again.

◐ **IN1** ☼ **FAULT**

Diagnostics: Power-up blocked due to short-term interruption at S12; input circuits not operated simultaneously

- Remedy: Open both input circuits, S12 and S22, simultaneously and then close again.

◐ **IN2** ☼ **FAULT**

Diagnostics: Power-up blocked due to short-term interruption at S22; input circuits not operated simultaneously

- Remedy: Open both input circuits, S12 and S22, simultaneously and then close again.

RESET **FAULT**

Diagnostics: Position of rotary switch is not permitted or rotary switch was adjusted during operation.

- Remedy: Switch supply voltage off and then on again.

POWER, IN1, IN2, OUT, RESET, FAULT

Diagnostics: The operating mode selector switch "mode" is in its start position (vertical position)

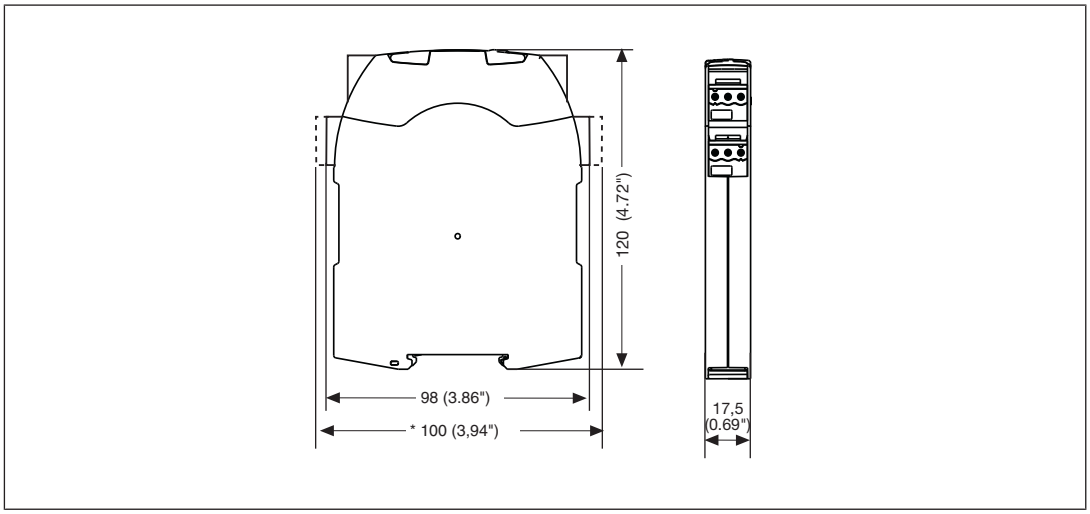
- Remedy: Switch off the supply voltage and set the required operating mode on operating mode selector switch "mode".

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	750103	751103
Approvals	CCC, CE, EAC (Eurasian), KOSHA, TÜV, cULus Listed	CCC, CE, EAC (Eurasian), KOSHA, TÜV, cULus Listed
Electrical data	**750103**	**751103**
Supply voltage		
Voltage	24 V	24 V
Kind	DC	DC
Voltage tolerance	-15 %/+10 %	-15 %/+10 %
Output of external power supply (DC)	2,5 W	2,5 W
Residual ripple DC	20 %	20 %
Duty cycle	100 %	100 %
Max. inrush current impulse		
Current pulse, A1	0,5 A	0,5 A
Pulse duration, A1	5 ms	5 ms
Inputs	**750103**	**751103**
Number	2	2
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	50 mA	50 mA
Start circuit DC	50 mA	50 mA
Feedback loop DC	50 mA	50 mA
Max. inrush current impulse		
Current pulse, input circuit	0,2 A	0,2 A
Pulse duration, input circuit	100 ms	100 ms
Current pulse, feedback loop	0,2 A	0,2 A
Pulse duration, feedback loop	15 ms	15 ms
Current pulse, start circuit	0,2 A	0,2 A
Pulse duration, start circuit	15 ms	15 ms
Min. input resistance at power-on	110 Ohm	110 Ohm
Max. overall cable resistance Rl-max		
Single-channel at UB DC	30 Ohm	30 Ohm
Dual-channel without detection of shorts across contacts at UB DC	60 Ohm	60 Ohm
Dual-channel with detection of shorts across contacts at UB DC	30 Ohm	30 Ohm
Semiconductor outputs	**750103**	**751103**
Number	1	1
Voltage	24 V	24 V

Semiconductor outputs	750103	751103
Current	**20 mA**	**20 mA**
Relay outputs	**750103**	**751103**
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**
Utilisation category of safety contacts		
AC1 at	**240 V**	**240 V**
Min. current	**0,01 A**	**0,01 A**
Max. current	**6 A**	**6 A**
Max. power	**1500 VA**	**1500 VA**
DC1 at	**24 V**	**24 V**
Min. current	**0,01 A**	**0,01 A**
Max. current	**6 A**	**6 A**
Max. power	**150 W**	**150 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	**5 A**	**5 A**
DC13 (6 cycles/min) at	**24 V**	**24 V**
Max. current	**5 A**	**5 A**
Utilisation category in accordance with UL		
Voltage	**240 V AC G.U. (same polarity)**	**240 V AC G.U. (same polarity)**
With current	**6 A**	**6 A**
Voltage	**24 V DC G. U.**	**24 V DC G. U.**
With current	**6 A**	**6 A**
External contact fuse protection, safety contacts		
In accordance with the standard	**EN 60947-5-1**	**EN 60947-5-1**
Max. melting integral	**260 A²s**	**260 A²s**
Blow-out fuse, quick	**10 A**	**10 A**
Blow-out fuse, slow	**6 A**	**6 A**
Blow-out fuse, gG	**10 A**	**10 A**
Circuit breaker 24V AC/DC, characteristic B/C	**6 A**	**6 A**
Conventional thermal current	**6 A**	**6 A**
Contact material	**AgCuNi + 0,2 µm Au**	**AgCuNi + 0,2 µm Au**

Times	750103	751103
Switch-on delay		
With automatic start typ.	**170 ms**	**170 ms**
With automatic start max.	**300 ms**	**300 ms**
With automatic start after power on typ.	**350 ms**	**350 ms**
With automatic start after power on max.	**600 ms**	**600 ms**
With manual start typ.	**40 ms**	**40 ms**
With monitored start with rising edge typ.	**35 ms**	**35 ms**
With monitored start with rising edge max.	**50 ms**	**50 ms**
With monitored start with falling edge typ.	**55 ms**	**55 ms**
With monitored start with falling edge max.	**70 ms**	**70 ms**
Delay-on de-energisation		
With E-STOP typ.	**10 ms**	**10 ms**
With E-STOP max.	**20 ms**	**20 ms**
With power failure typ.	**40 ms**	**40 ms**
With power failure max.	**60 ms**	**60 ms**
Recovery time at max. switching frequency 1/s		
After E-STOP	**100 ms**	**100 ms**
After power failure	**100 ms**	**100 ms**
Waiting period with a monitored start		
With rising edge	**120 ms**	**120 ms**
With falling edge	**250 ms**	**250 ms**
Min. start pulse duration with a monitored start		
With rising edge	**30 ms**	**30 ms**
With falling edge	**100 ms**	**100 ms**
Supply interruption before de-energisation	**20 ms**	**20 ms**
Simultaneity, channel 1 and 2 max.	∞	∞
Environmental data	**750103**	**751103**
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**

Environmental data	750103	751103
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	**750103**	**751103**
Mounting position	**Any**	**Any**
Mechanical life	**10,000,000 cycles**	**10,000,000 cycles**
Material		
Bottom	**PC**	**PC**
Front	**PC**	**PC**
Top	**PC**	**PC**
Connection type	**Screw terminal**	**Spring-loaded terminal**
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	**17,5 mm**	**17,5 mm**
Depth	**120 mm**	**120 mm**
Weight	**140 g**	**140 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 e**	**Cat. 4**	**SIL CL 3**	**2,31E-09**	**SIL 3**	**2,03E-06**	**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 relay's service life graphs. The relay outputs' safety-related characteristic data is only valid if the values in the service life graphs are met.

The PFH value depends on the switching frequency and the load on the relay output.
If the service life graphs 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 graph

The service life graphs indicate 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.

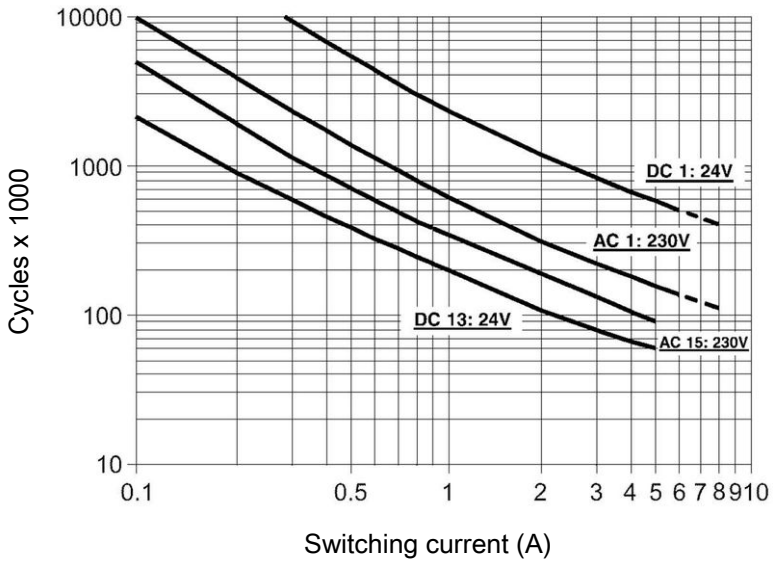


Fig.: Service life graphs at 24 V DC and 230 V AC

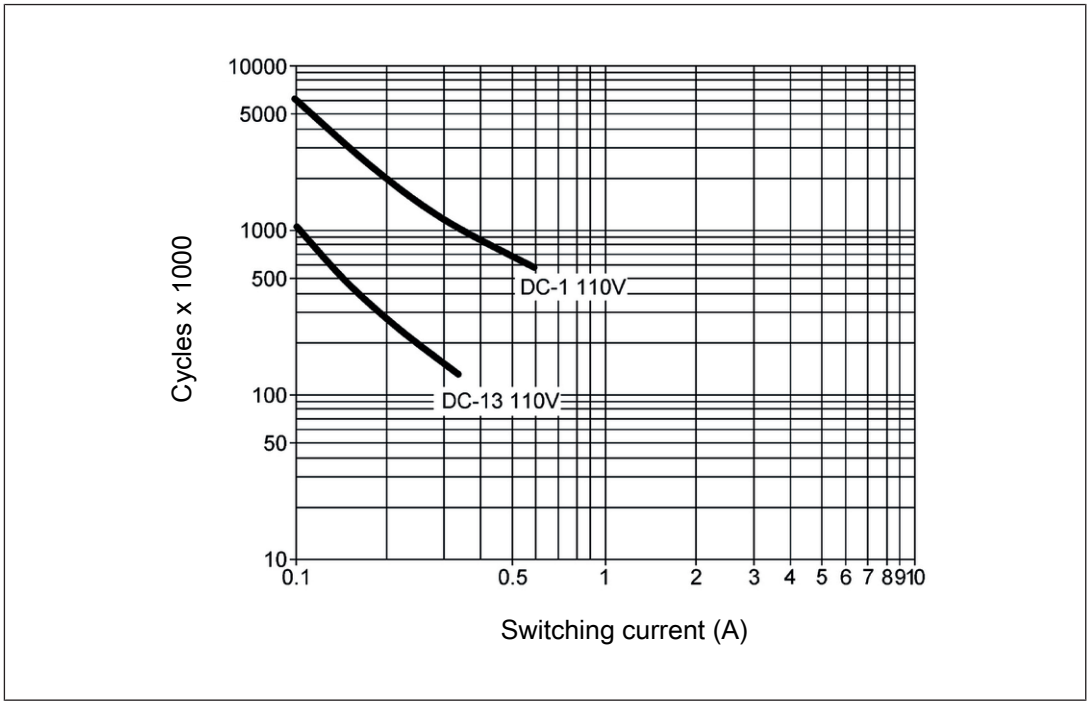


Fig.: Service life graphs at 110 V DC

Example

- Inductive load: 0.2 A
- Utilisation category: AC15
- Contact service life: 2 000 000 cycles

Provided the application to be implemented requires fewer than 2 000 000 cycles, the PFH value (see Technical details [18]) can be used in the calculation.

To increase the service life, sufficient spark suppression must be provided on all output contacts. With capacitive loads, any power surges that occur must be noted. With DC contactors, use flywheel diodes for spark suppression.

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

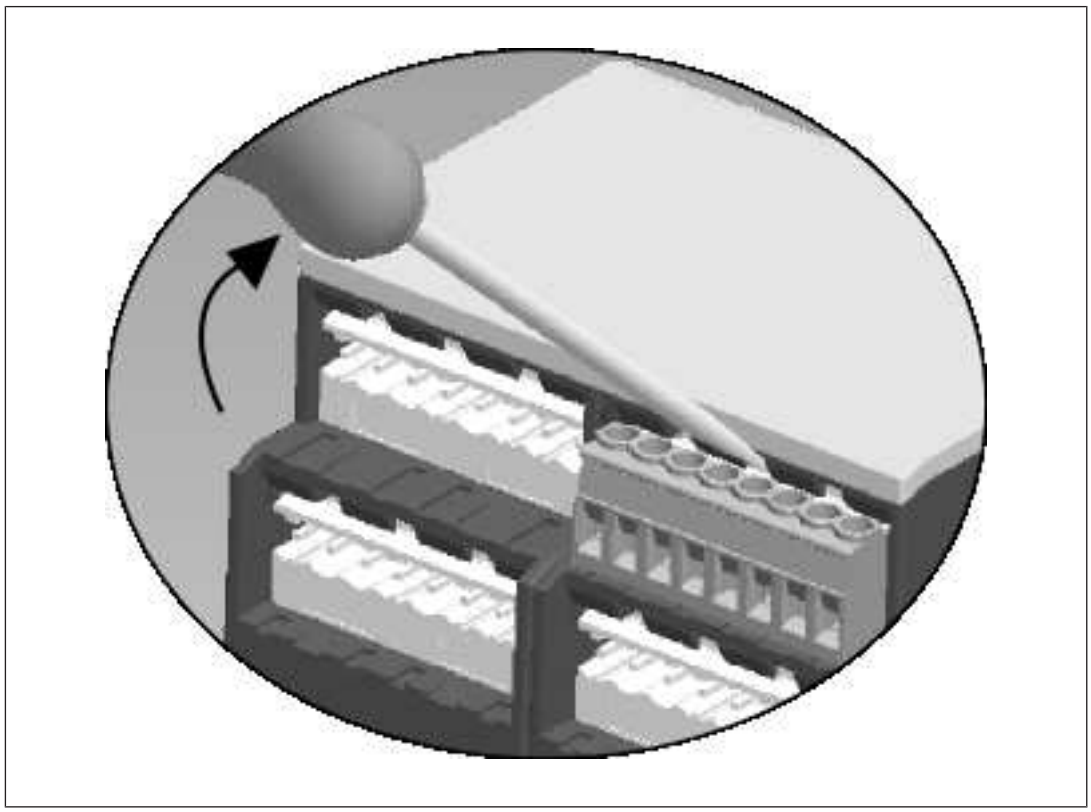
- From an operating height of 2000 m the max. permitted ambient temperature is reduced by 0.5 °C/100 m

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 s3	24 VDC	Screw terminals	750 103
PNOZ s3 C	24 VDC	Spring-loaded terminals	751 103

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.
Representative: Norbert Fröhlich, Pilz GmbH & Co. KG, Felix-Wankel-Str. 2, 73760 Ostfildern, Germany

Support

Technical support is available from Pilz round the clock.

Americas
Brazil
+55 11 97569-2804
Canada
+1 888-315-PILZ (315-7459)
Mexico
+52 55 5572 1300
USA (toll-free)
+1 877-PILZUSA (745-9872)

Asia
China
+86 21 60880878-216
Japan
+81 45 471-2281
South Korea
+82 31 450 0680

Australia
+61 3 95600621

Europe
Austria
+43 1 7986263-0
Belgium, Luxembourg
+32 9 3217575
France
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Germany
+49 711 3409-444
Ireland
+353 21 4804983
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+34 938497433
Switzerland
+41 62 88979-30
The Netherlands
+31 347 320477
Turkey
+90 216 5775552
United Kingdom
+44 1536 462203

You can reach our international hotline on:
+49 711 3409-444
support@pilz.com

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Pilz GmbH & Co. KG
Felix-Wankel-Straße 2
73760 Ostfildern, Germany
Tel.: +49 711 3409-0
Fax: +49 711 3409-133
info@pilz.com
www.pilz.com

PILZ
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