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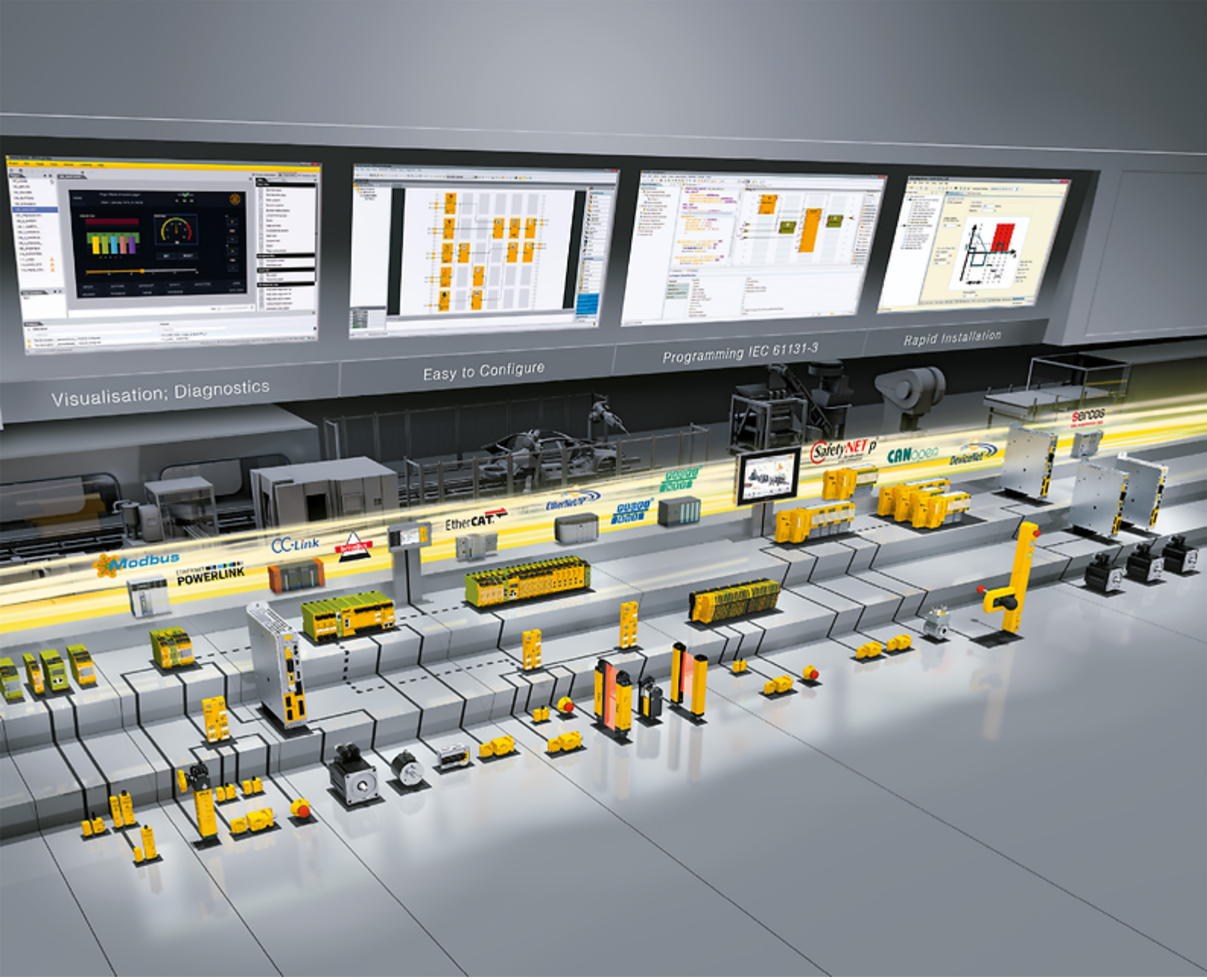
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PNOZ X1

PILZ
THE SPIRIT OF SAFETY

Safety relays

Operating Manual-19045-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 X1. 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 PNOZ X1 provides a safety-related interruption of a safety circuit.

The safety relay meets the requirements of EN 60947-5-1 and EN 60204-1 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 [📖 13]).



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, a safety assessment in accordance with the Machinery Directive is required.

The product as an individual component fulfils the functional safety requirements in accordance with EN ISO 13849 and EN 62061. However, this does not guarantee the functional safety of the overall plant/machine. To achieve the relevant safety level of the overall plant/machine's required safety functions, each safety function needs to be considered separately.

Use of qualified personnel

The products may only be assembled, installed, programmed, commissioned, operated, maintained and decommissioned by persons who are competent to do so.

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

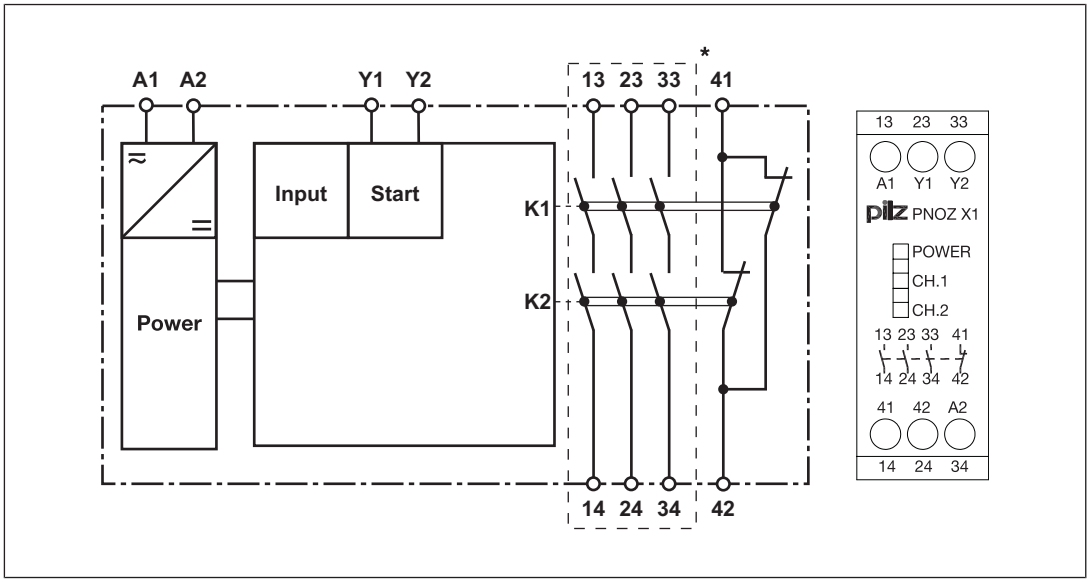
- Positive-guided relay outputs:
  - 3 safety contacts (N/O), instantaneous
  - 1 auxiliary contact (N/C), instantaneous
- Connection options for:
  - E-STOP pushbutton
  - Safety gate limit switch
  - Start button
- LED display for:
  - Supply voltage
  - Switch status of the safety contacts

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



*Safe separation from non-marked area in accordance with EN 60947-1, 6 kV, basic insulation between all safety contacts.

Function Description

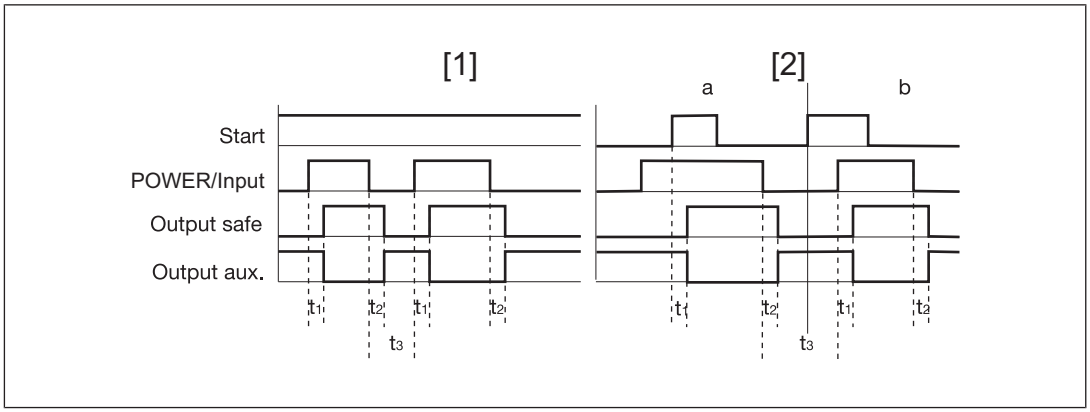
The safety relay PNOZ X1 provides a safety-oriented interruption of a safety circuit. When the supply voltage is applied via the E-STOP pushbutton, the “POWER” LED is lit. The unit is ready for operation when the start circuit Y1-Y2 is closed.

- Input circuit is closed (e.g. E-STOP pushbutton not operated):
  - LEDs "CH1" and "CH2" will light.
  - Safety contacts 13-14, 23-24 and 33-34 are closed, auxiliary contact 41-42 is open. The unit is active.
- Input circuit is opened (e.g. E-STOP pushbutton operated):
  - The LEDs "POWER", "CH1" and "CH2" go out.
  - Safety contacts 13-14, 23-24 and 33-34 are opened redundantly, auxiliary contact 41-42 is closed.

Operating modes

- 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 contacts by connecting contact expandsion modules or external contactors/relays.

Timing diagram



Legend

- Power/Input: Supply voltage/input circuit
- Start: Start circuit
- Output safe: Safety contacts
- Output aux: Auxiliary contact
- [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

- The unit 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).

Wiring

Please note:

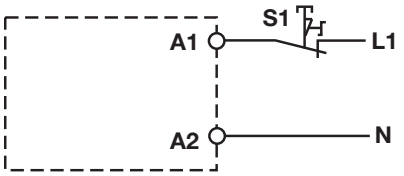
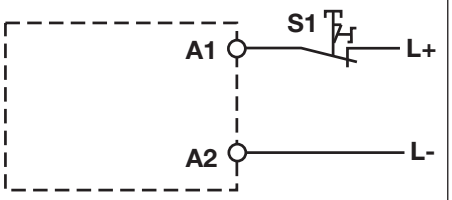
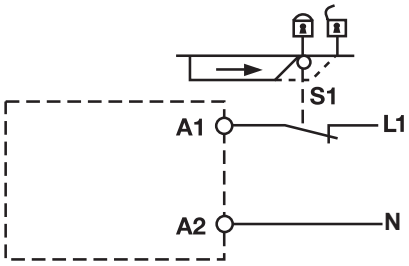
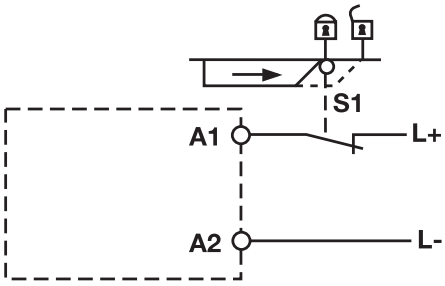
- Information given in the "Technical details [13]" must be followed.
- Outputs 13-14, 23-24, 33-34 are safety contacts; output 41-42 is an auxiliary contact (e.g. for display).
- Auxiliary contact 41-42 should **not** be used for safety circuits!
- To prevent contact welding, a fuse should be connected before the output contacts (see Technical details [13]).
- Calculation of the max. cable length l_{max} in the input circuit:

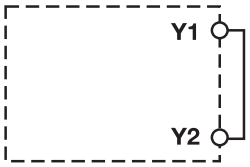
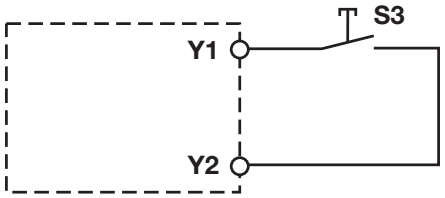
$$l_{max} = \frac{R_{lmax}}{R_l / km}$$

R_{lmax} = max. overall cable resistance (see Technical details [13])
R_l / km = cable resistance/km

- Use copper wiring with a temperature stability of 60/75 °C.
- To prevent EMC interferences (particularly common-mode interferences) the measures described in EN 60204-1 must be executed. This includes the separate routing of cables of the control circuits (input, start and feedback loop) from other cables for energy transmission or the shielding of cables, for example.
- Adequate protection must be provided on all output contacts with capacitive and inductive loads.
- Do not switch low currents using contacts that have been used previously with high currents.
- 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

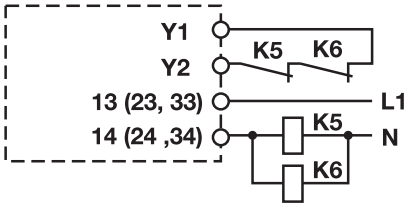
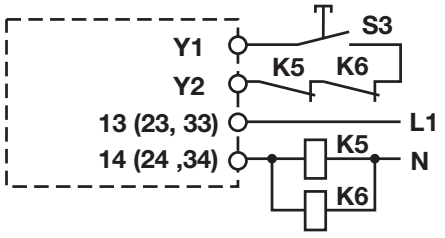
Supply voltage/input circuit	AC	DC
E-STOP		
Safety gate		

Start circuit	Automatic start	Manual start
E-STOP/safety gate		

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.

Feedback loop	Automatic start	Manual start
Contacts from external contactors		

Legend

- S1: E-STOP pushbuttons
- S3: Start button

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.

Status indicators

LEDs indicate the status and errors during operation:



LED on



POWER

Supply voltage is present and E-STOP pushbutton not operated.



CH.1
Safety contacts of channel 1 are closed.

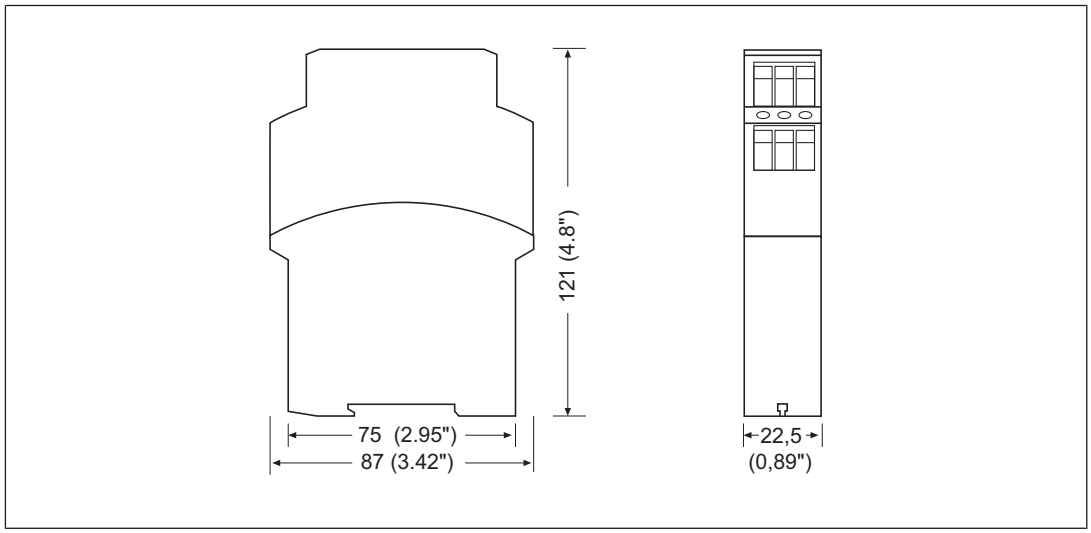


CH.2
Safety contacts of channel 2 are closed.

Faults – Interference

- Earth fault: The supply voltage fails and the safety contacts open. Once the cause of the respective fault has been rectified and the supply voltage is switched off for approx. 1 minute, the unit is ready for operation again.
- Contact malfunctions: If the contacts have welded, reactivation will not be possible after the input circuit has opened.

Dimensions in mm



Technical details

General	
Certifications	**CCC, CE, EAC (Eurasian), TÜV, cULus Listed**
Electrical data	
Supply voltage	
Voltage	**24 V**
Kind	**AC/DC**
Voltage tolerance	**-15 %/+10 %**
Output of external power supply (AC)	**4 VA**
Output of external power supply (DC)	**2 W**
Frequency range AC	**50 - 60 Hz**
Residual ripple DC	**160 %**
Duty cycle	**100 %**
Max. inrush current impulse	
Current pulse, A1	**2,5 A**
Pulse duration, A1	**5 ms**
Inputs	
Number	**1**
Voltage at	
Input circuit DC	**24 V**
Start circuit DC	**24 V**
Feedback loop DC	**24 V**
Current at	
Input circuit DC	**70 mA**
Start circuit DC	**40 mA**
Feedback loop DC	**40 mA**
Max. overall cable resistance Rlmax	
Single-channel at UB DC	**30 Ohm**
Single-channel at UB AC	**30 Ohm**
Relay outputs	
Number of output contacts	
Safety contacts (N/O), instantaneous	**3**
Auxiliary contacts (N/C)	**1**
Max. short circuit current IK	**1 kA**
Utilisation category	
In accordance with the standard	**EN 60947-4-1**

Relay outputs	
Utilisation category of safety contacts	
AC1 at	**240 V**
Min. current	**0,01 A**
Max. current	**6 A**
Max. power	**1500 VA**
DC1 at	**24 V**
Min. current	**0,01 A**
Max. current	**6 A**
Max. power	**150 W**
Utilisation category of auxiliary contacts	
AC1 at	**240 V**
Min. current	**0,01 A**
Max. current	**6 A**
Max. power	**1500 VA**
DC1 at	**24 V**
Min. current	**0,01 A**
Max. current	**6 A**
Max. power	**150 W**
Utilisation category	
In accordance with the standard	**EN 60947-5-1**
Utilisation category of safety contacts	
AC15 at	**230 V**
Max. current	**5 A**
DC13 (6 cycles/min) at	**24 V**
Max. current	**5 A**
Utilisation category of auxiliary contacts	
AC15 at	**230 V**
Max. current	**5 A**
DC13 (6 cycles/min) at	**24 V**
Max. current	**5 A**
Utilisation category in accordance with UL	
Voltage	**240 V AC G.U. (same polarity)**
With current	**6 A**
Voltage	**24 V DC G. P.**
With current	**6 A**
Pilot Duty	**R300**
External contact fuse protection, safety contacts	
In accordance with the standard	**EN 60947-5-1**
Max. melting integral	**260 A^2s**
Blow-out fuse, quick	**10 A**
Blow-out fuse, slow	**6 A**
Blow-out fuse, gG	**6 A**
Circuit breaker 24V AC/DC, characteristic B/C	**6 A**

Relay outputs	
External contact fuse protection, auxiliary contacts	
Max. melting integral	**160 A²s**
Blow-out fuse, quick	**10 A**
Blow-out fuse, slow	**6 A**
Blow-out fuse, gG	**6 A**
Circuit breaker 24 V AC/DC, characteristic B/C	**6 A**
Contact material	**AgCuNi + 0,2 µm Au**
Conventional thermal current while loading several contacts	
Ith per contact at UB AC; AC1: 240 V, DC1: 24 V	
Conv. therm. current with 1 contact	**6 A**
Conv. therm. current with 2 contacts	**6 A**
Conv. therm. current with 3 contacts	**5 A**
Ith per contact at UB DC; AC1: 240 V, DC1: 24 V	
Conv. therm. current with 1 contact	**6 A**
Conv. therm. current with 2 contacts	**6 A**
Conv. therm. current with 3 contacts	**5 A**
Times	
Switch-on delay	
With automatic start typ.	**60 ms**
With automatic start max.	**120 ms**
With manual start typ.	**50 ms**
With manual start max.	**120 ms**
Delay-on de-energisation	
With E-STOP typ.	**55 ms**
With E-STOP max.	**90 ms**
With power failure typ.	**55 ms**
With power failure max.	**90 ms**
Recovery time at max. switching frequency 1/s	
After E-STOP	**150 ms**
After power failure	**150 ms**
Supply interruption before de-energisation	**20 ms**
Environmental data	
Climatic suitability	**EN 60068-2-78**
Ambient temperature	
Temperature range	**-10 - 55 °C**
Storage temperature	
Temperature range	**-40 - 85 °C**
Climatic suitability	
Humidity	**93 % r. h. at 40 °C**
Condensation during operation	**Not permitted**
EMC	**EN 60947-5-1, EN 61000-6-2, EN 61326-3-1**

Environmental data	
Vibration	
In accordance with the standard	**EN 60068-2-6**
Frequency	**10 - 55 Hz**
Amplitude	**0,35 mm**
Airgap creepage	
In accordance with the standard	**EN 60947-1**
Overvoltage category	**III**
Pollution degree	**2**
Rated insulation voltage	**250 V**
Rated impulse withstand voltage	**6 kV**
Protection type	
Housing	**IP40**
Terminals	**IP20**
Mounting area (e.g. control cabinet)	**IP54**
Mechanical data	
Mounting position	**Any**
Mechanical life	**10,000,000 cycles**
Material	
Bottom	**PPO UL 94 V0**
Front	**ABS UL 94 V0**
Top	**PPO UL 94 V0**
Connection type	**Screw terminal**
Mounting type	**Fixed**
Conductor cross section with screw terminals	
1 core flexible	**0,2 - 4 mm², 24 - 10 AWG**
2 core with the same cross section, flexible with crimp connectors, no plastic sleeve	**0,2 - 2,5 mm², 24 - 14 AWG**
2 core with the same cross section, flexible without crimp connectors or with TWIN crimp connectors	**0,2 - 2,5 mm², 24 - 14 AWG**
Torque setting with screw terminals	**0,6 Nm**
Stripping length with screw terminals	**8 mm**
Dimensions	
Height	**87 mm**
Width	**22,5 mm**
Depth	**121 mm**
Weight	**175 g**

Where standards are undated, the 2020-07 latest editions shall apply.

Safety characteristic data

NOTICE

You must comply with the safety 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]
–	PL e	Cat. 4	SIL CL 3	2,31E-09	SIL 3	2,03E-06	20

Explanatory notes for the safety-related characteristic data:

- The SIL CL value in accordance with EN 62061 corresponds to the SIL value in accordance with EN 61508.
- T_M is the maximum mission time in accordance with EN ISO 13849-1. The value also applies as the retest interval in accordance with EN 61508-6 and IEC 61511 and as the proof test interval and mission time in accordance with EN 62061.

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 switch frequency and the load of the relay output.
If the service life graphs are not accessible, the stated PFH value can be used irrespective of the switch 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.

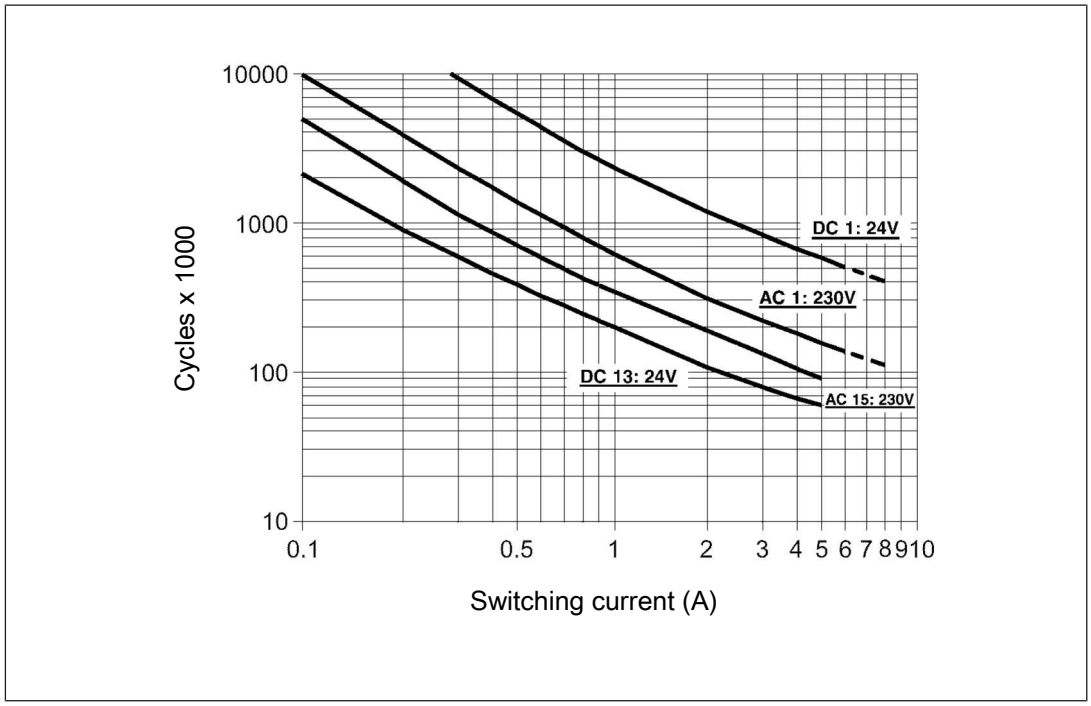


Fig.: Service life graphs at 24 V DC and 230 V AC

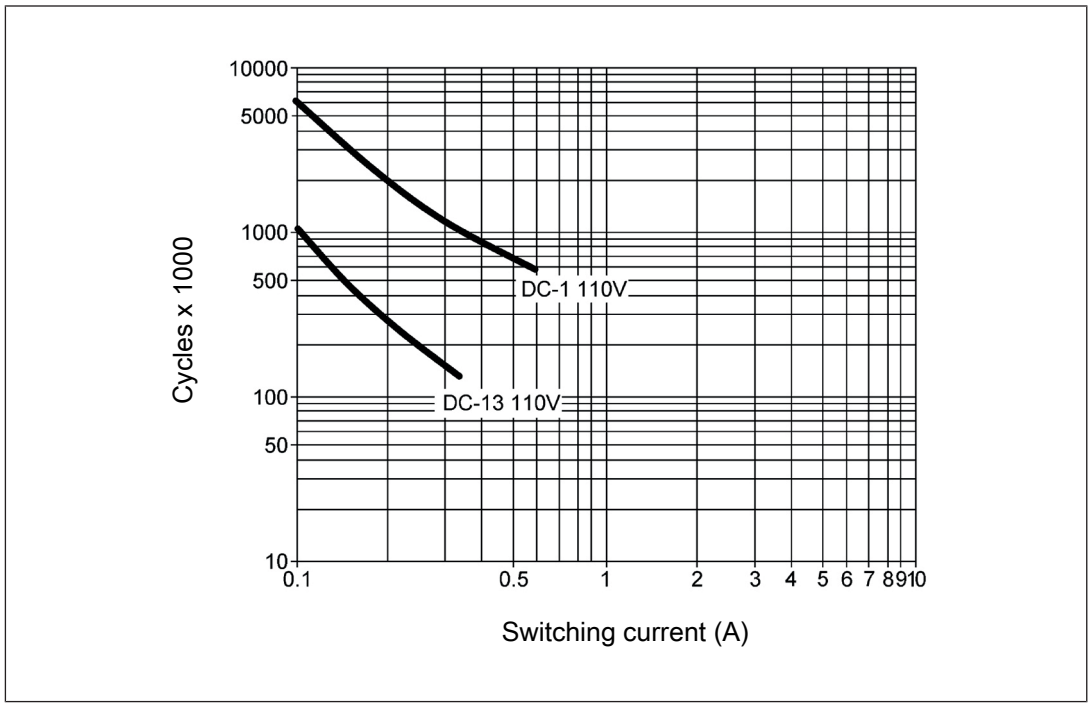


Fig.: Service life graphs at 110 V DC

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 [13]) 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.

Order reference

Product type	Features	Connection type	Order no.
PNOZ X1	24 VAC/DC	Screw terminals	774300

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

Support

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