PNOZ ms2p

PNOZmulti Modular Safety System

pilz

Contents

Contents

1 Introduction

1.1 Validity of documentation

This documentation is valid for the product **PNOZ ms2p**. It is valid until new documentation is published.

This operating manual explains the function and operation of the programmable safety system, describes the installation and provides guidelines on how to connect the product **PNOZ ms2p**.

Using the product **PNOZ ms2p**:

Speed monitor for connection to a base unit from the PNOZmulti modular safety system

1.1.1 Retaining the documentation

This documentation is intended for instruction and should be retained for future reference.

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1.2 Overview of documentation

1 Introduction

The introduction is designed to familiarise you with the contents, structure and specific order of this manual.

2 Overview

This chapter provides information on the device's most important features.

3 Safety

This chapter must be read as it contains important information on intended use.

4 Function description

This chapter describes the mode of operation of the device.

5 Installation

This chapter explains how to install the device.

6 Wiring

This chapter describes the device's wiring.

7 Operation

This chapter describes the commissioning of the product and gives tips in the case of a fault.

8 Technical Details

9 Application Examples

1.3 Definition of symbols

Information in this manual that is of particular importance can be 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 unit(s) could be damaged and also provides information on preventive measures that can be taken.

INFORMATION
This gives advice on applications and provides information on special features, as well as highlighting areas within the text that are of particular importance.

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1.3   Definition of symbols

2 Overview

2.1 Unit structure

2.1.1 Range

Scope of supply:
▶ Expansion module PNOZ ms2p
▶ Jumper: 774 639

2.1.2 Unit features

The product has the following features:
▶ Monitoring of 2 independent axes
▶ Connection per axis
  – 1 incremental encoder
    or
  – 2 proximity switches
    or
  – 1 incremental encoder and 1 proximity switch
▶ Measured variables:
  – Standstill
  – Speed (8 values can be set)
  – Direction of rotation
▶ Axis types, input device types and reset mode can be selected in the PNOZmulti Configurator
▶ Status indicators for
  – Supply voltage
  – Incremental encoders
  – Proximity switches
  – Axis status, standstill and excess speed
  – Faults on the system
▶ Proximity switch connection technology: Plug-in connection terminals (either cage clamp terminal or screw terminal)
▶ Incremental encoder connection technology:
  RJ-45 female connector
▶ Galvanic isolation between the connections X1, X12 and X22
▶ Max. 4 speed monitors can be connected to the base unit

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2.2   Front view
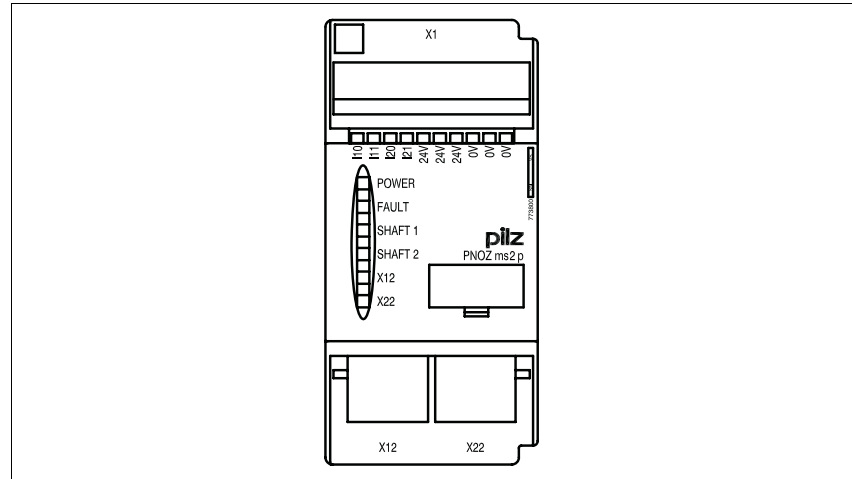
Key:
▸ X1:
  – I10, I11:
    connection terminals for proximity switch at axis 1
  – I20, I21:
    connection terminals for proximity switch at axis 2
  – 0 V, 24 V:
    supply connections
▸ X12:
  – female connector for the connection of an incremental encoder at
    axis 1
▸ X22:
  – female connector for the connection of an incremental encoder at
    axis 2
▸ LEDs:
  – POWER
  – FAULT
  – SHAFT 1
  – SHAFT 2
  – X12
  – X22

3.1 Intended use

The expansion module monitors standstill, speed and direction of rotation up to Category 3 of EN 954-1.

The expansion module may only be connected to a base unit from the PNOZmulti modular safety system.

The PNOZmulti modular safety system is used for the safety-related interruption of safety circuits and is designed for use on:
▸ Emergency stop equipment
▸ Safety circuits in accordance with VDE 0113 Part 1 and EN 60204-1

⚠ **WARNING!**
Users must take appropriate measures to detect or exclude errors (e.g. slippage or broken shearpin) which mean that the frequency of the input device signal is no longer proportional to the monitored speed.
Appropriate measures are:
▸ use of the input device to be monitored also for drive controlling
▸ mechanical solutions
▸ monitoring for broken shearpin by means of the speed monitor

⚠ **WARNING!**
A single-channel open circuit/input device error is recognised and leads to safe condition of outputs at the relevant axis.
For applications according to category 3, the "Overspeed" output must be integrated into the safety function in **every** operating mode and evaluated so that a shutdown occurs if the output switches to a safe condition ("Overspeed" output = "0").

3.1   Intended use

> ⚠ **CAUTION!**
> If there are frequency differences between tracks A and B of the incremental encoder and/or between the proximity switches on inputs I10 (I20) and I11 (I21), the PNOZmulti changes to the safe condition if frequency exceeds the configured standstill frequency. If the speed monitor detects different rotation directions, note the following:
> ‣ With version 1.X devices the PNOZmulti changes to STOP.
> ‣ With devices from version 2.0, the axis in question changes to the safe condition. The safe condition is cleared again as soon as the error is remedied. Hazards that can arise through an automatic restart must be excluded from the application program.

3.2   System requirements

▸ PNOZmulti Configurator: from Version 5.1.0
▸ Base unit PNOZ m1p: from Version 5.2
▸ Base unit PNOZ m2p: from Version 2.2

Please contact Pilz if you have an older version.

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3.3   Safety regulations

3.3.1   Use of qualified personnel

The products may only be assembled, installed, programmed, commissioned, operated, maintained and decomissioned by qualified personnel. Qualified personnel are people who, because they are:

▸ Qualified electrical engineers or
▸ Have received training from qualified electrical engineers

are suitably experienced to operate devices, systems, plant and machinery in accordance with the general standards and guidelines for safety technology.

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 safety guidelines given in this description
▸ Have a good knowledge of the generic and specialist standards applicable to the specific application.

3.3.2   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.).

3.3.3   Disposal

The product must be disposed of properly when it reaches the end of its service life.

3.3.4   For your safety

The unit meets all necessary conditions for safe operation. However, you should always ensure that the following safety requirements are met:

▸ This operating manual only describes the basic functions of the unit. Information on the advanced functions can be found in the online help

3.3   Safety regulations

for the PNOZmulti Configurator and in the PNOZmulti technical catalogue. Only use these functions after you have read and understood the documentation. All necessary documentation can be found on the PNOZmulti Configurator CD.

‣ Do not open the housing or make any unauthorised modifications.

‣ Please make sure you shut down the supply voltage when performing maintenance work (e.g. exchanging contactors).

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3.3   Safety regulations

4 Function description

4.1 Device properties

4.1.1 Integrated protection mechanisms

The relay conforms to the following safety criteria:
- ▸ The circuit is redundant with built-in self-monitoring.
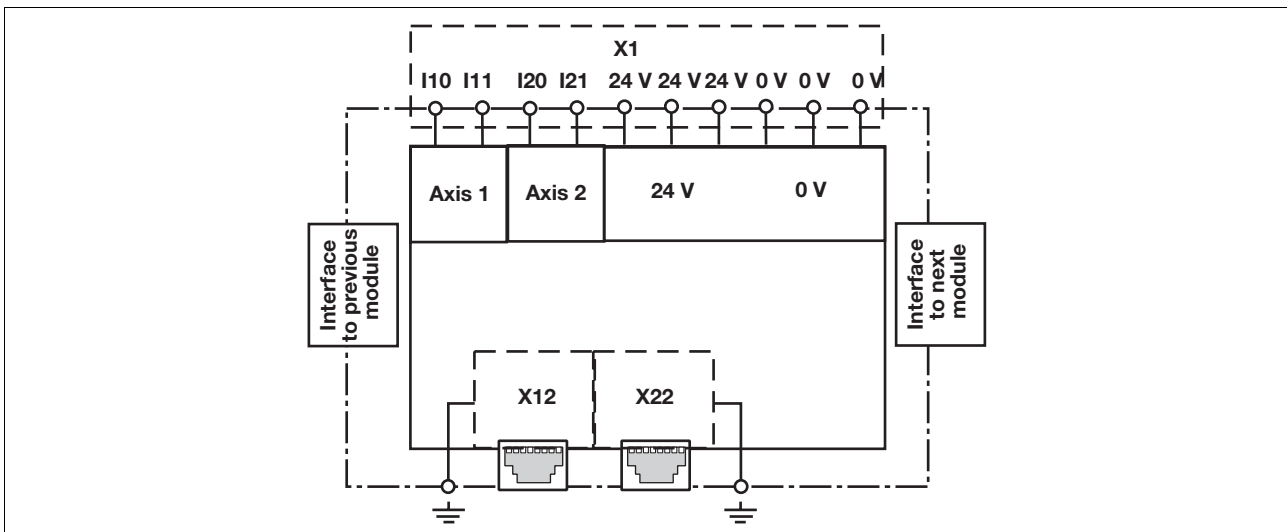- ▸ The safety function remains effective in the case of a component failure.

4.1.2 Function description

4.1.2.1 Operation

The speed monitor can independently monitor two axes for standstill, speed and direction of rotation. The speed monitor signals the status of the monitored values to the base unit. Depending on the safety circuit loaded, the values can be transferred from the base unit, e.g. to a relay output on the safety system. Incremental encoders and/or proximity detectors can be used to record the values.

The configuration of the speed monitor is described in detail in the PNOZmulti Configurator's online help.

4.1.2.2 Block diagram

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4.2   Input device types

4.2.1   Proximity switch

4.2.1.1   Requirements of the proximity switches

▸ Only proximity switches of type "pnp" are allowed to be used (N/O contact, switching to positive).

▸ The proximity switches require a 24 VDC supply.

▸ The proximity switches must be fitted such that at least one is always activated (provides a high signal).

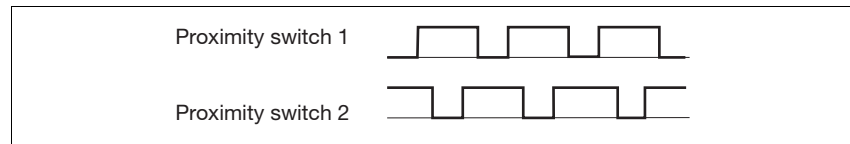▸ The proximity switches must be fitted such that the recorded signals overlap.

Fig. 4-1:   Example proximity switch signal behaviour

⚠ **CAUTION!**
Appropriate installation measures should be taken to prevent a foreign body coming between the signal input device and the proximity switch. The foreign body could cause one of the proximity switches to be constantly energised (constant high signal).

▸ Pay attention to the values in the technical details

4.2.2   Incremental encoders

4.2.2.1   Requirements of the incremental encoders

▸ Only incremental encoders with a differential output of the following type are permitted
– Sin/Cos
– TTL (RS 422)
– HTL (24 V)

▸ Please note the values stated in the technical details

4.2   Input device types

4.2.2.2   Adapter for incremental encoders

The adapter records the data between the incremental encoder and the drive and makes it available to the speed monitor via the RJ-45 female connector.

Pilz supplies complete adapters as well as ready-made cable with RJ-45 female connectors, which can be used when making your own adapter. The range of products in this area is constantly being expanded. Please contact us about the range of adapters that is currently available.

4.2.3   Incremental encoder and proximity switch on one axis

In order to increase the availability, a proximity switch and an incremental encoder can be configured on one axis for the speed monitor. That way the speed monitor can monitor 3 signals on one axis: Track A and track B of the incremental encoder and the proximity switch:

Standstill monitoring

Standstill is detected when at least two of these signals fall below the standstill frequency.

Monitoring for broken shearpins

If the Broken shearpin monitoring option is activated, a shearpin break is recognised if
▸ both signals of the incremental encoder fall below the set standstill frequency (standstill)
  and
▸ the proximity switch exceeds the set standstill frequency (rotating shaft).

The recognised broken shearpin leads to safe condition (see status B2 in "Signal statuses" table in Chapter 8). If individual or multiple signals change, the safe condition is cleared again as required (see "Signal statuses" table).

Hazards that can arise through an automatic restart must be excluded from the application program.

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4.2 Input device types

5 Installation

5.1 General installation guidelines

▸ The safety system should be installed in a control cabinet with a protection type of at least IP54. Fit the safety system to a horizontal DIN rail. The venting slots must face upward and downward. Other mounting positions could destroy the safety system.

▸ Use the notches on the back of the unit to attach it to a DIN rail. Connect the safety system to the DIN rail in an upright position so that the earthing springs on the safety system are pressed on to the DIN rail.

▸ The ambient temperature of the PNOZmulti units in the control cabinet must not exceed the figure stated in the technical details, otherwise air conditioning will be required.

▸ To comply with EMC requirements, the DIN rail must have a low impedance connection to the control cabinet housing.
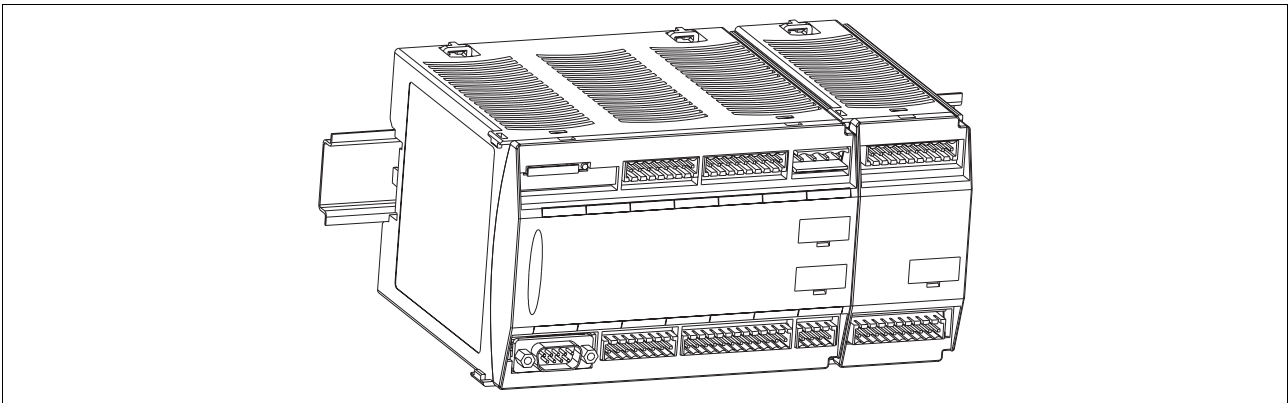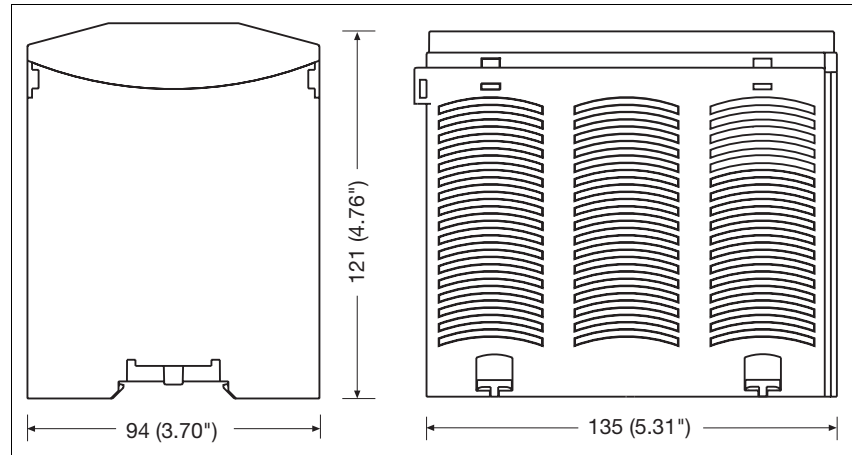

⚠ **CAUTION!**
Damage due to electrostatic discharge!
Electrostatic discharge can damage components. Ensure against discharge before touching the product, e.g. by touching an earthed, conductive surface or by wearing an earthed armband.

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5 Installation

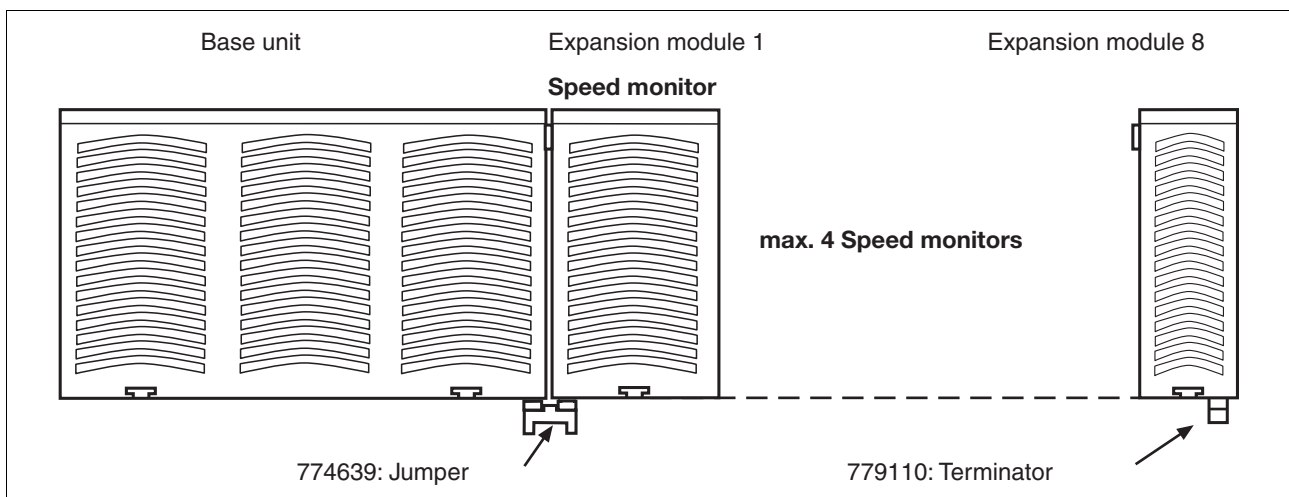## 5.1 General installation guidelines

5.1.1 Dimensions

5.2 Connecting the base unit and expansion modules

Connect the base unit and the expansion modules as described in the operating manuals for the base modules.

‣ The terminator must be fitted to the last expansion module

‣ Install the expansion module in the position configured in the PNOZ-multi Configurator.

You can install a maximum of 4 speed monitors to the right of the base unit.

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5.2   Connecting the base unit and expansion modules

6.1 General wiring guidelines

The wiring is defined in the circuit diagram of the PNOZmulti Configurator.

Details of the input type, axis type and reset mode, plus the values for standstill, speed monitoring and direction of rotation are also defined in the PNOZmulti Configurator.

Please note:
▸ Information given in the "Technical details" must be followed.
▸ Use copper wire that can withstand 75 °C.

⚠ **CAUTION!**
The configurable switch-off delay when reaching the overspeed increases the reaction time of the system of base unit and speed monitor by the entered value (see technical details). This must not impermissibly delay the occurrence of a safe condition. The configuration of the switch-off delay must be considered in the risk assessment as regards hazards, reaction time and safety distance.

On each of the 2 axes you can connect as required:
▸ 1 incremental encoder
  or
▸ 2 proximity switches
  or
▸ 1 incremental encoder and 1 proximity switch

	Incremental encoders	Proximity switch
Connection axis 1	X12	-
	-	I10, I11, 0 V
	X12	I10, 0 V
Connection axis 2	X22	-
	-	I20, I21, 0 V
	X22	I21, 0 V

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6.2   Preparing for operation

6.2.1   Connection of proximity switches

Proceed as follows when connecting proximity switches:
▸ Terminals I10 and I11: connect the proximity switch for axis 1
▸ Terminals I20 and I21: connect the proximity switch for axis 2.
▸ If only one axis is to be monitored, either terminals I10 and I11 or terminals I20 and I21 will remain free.
▸ When connecting incremental encoders and proximity switches on an axis:
  – Terminals I10: connect proximity switch for axis 1 (I11 is not used)
  – Terminals I20: connect proximity switch for axis 2 (I21 is not used)
▸ The proximity switch must always be connected to a 0 V terminal of the speed monitor. The 0 V terminals are connected internally.
▸ Connect proximity switch to 24 VDC of the power supply or the speed monitor (the 24 V terminals of the speed monitor are connected internally)
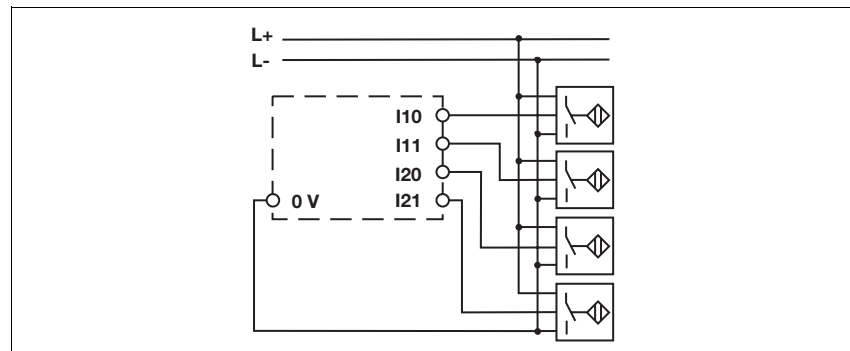

Fig. 6-2:   Connection to proximity switch

6.2.2   Connection of the incremental encoder

Follow the instructions below when connecting the incremental encoder:
▸ The incremental encoder can be connected via an adapter (e.g. PNOZ msi4p) or can be connected directly to the speed monitor.
▸ The incremental encoder on connector X12 monitors axis 1; the incremental encoder on connector X22 monitors axis 2.
▸ Only use shielded cables for all connections
▸ Always connect 0 V on the incremental encoder and speed monitor.
▸ Position the terminating resistors on the signal lines as close as possible to the input on the speed monitor.

6.2 Preparing for operation

6.2.2.1 Connect signals of the incremental encoder to the speed monitor

Input device types: 1 Vss, 5 V-TTL

▸ Only supply 5 VDC to the incremental encoder
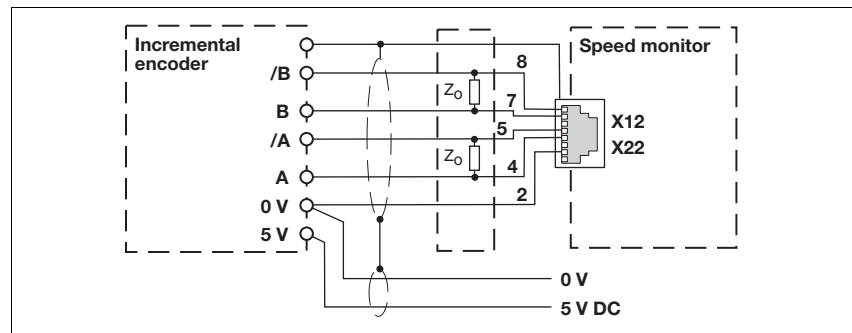
▸ Terminate incremental encoder with $Z_O = 120$ Ohm

Fig. 6-3: Connection to incremental encoder type 1 Vss, 5 V-TTL

Input device types: 24 V-HTL

▸ Only supply 24 VDC supply voltage to the incremental encoder

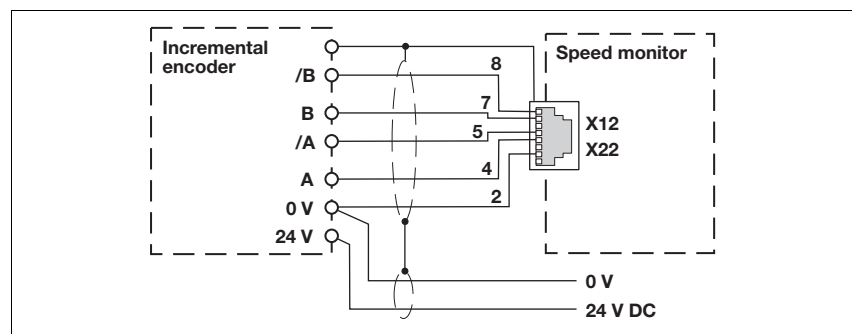▸ Do not terminate incremental encoder with $Z_0 = 120$ Ohm

Fig. 6-4: Connection to incremental encoder type 24 V-HTL

6.2.2.2 Connect incremental encoder to the speed monitor via an adapter

▸ The adapter (e.g. PNOZ msi6p) is connected between the incremental encoder and the drive. The output on the adapter is connected to the RJ-45 female connector on the speed monitor.

▸ The adapter can also be used without connecting a drive. The signal lines can then terminate directly at the adapter with $Z_O = 120$ Ohm.

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6.2 Preparing for operation

▸ If the signal lines in the drive are already terminated with Z_O = 120 Ohm, the incremental encoder may no longer be terminated.

▸ The signals that are relevant for the speed monitor are recorded in parallel within the adapter. The information stated in section 7.2.2.1 and in the adapter operating manual must be observed when connecting the supply voltage.

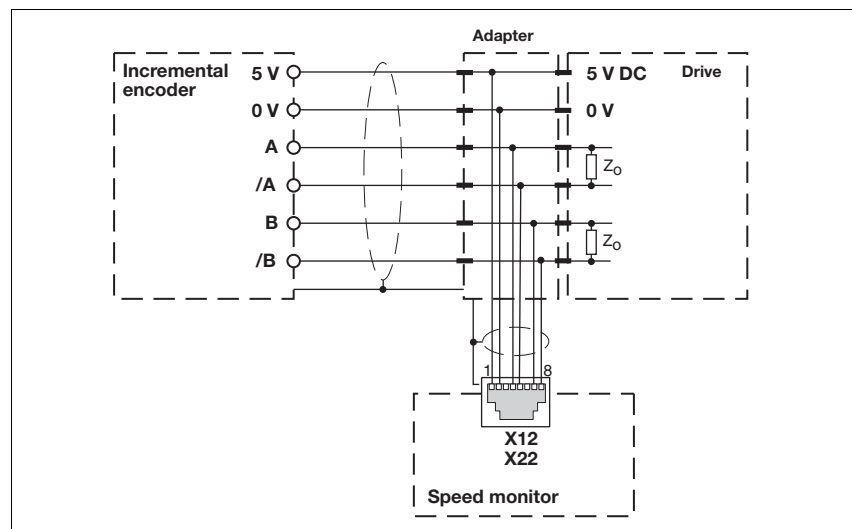▸ Only supply incremental encoder with 5 V DC. 24 V-HTL signals may not be terminated.

Fig. 6-5:   Connection via adapter and drive
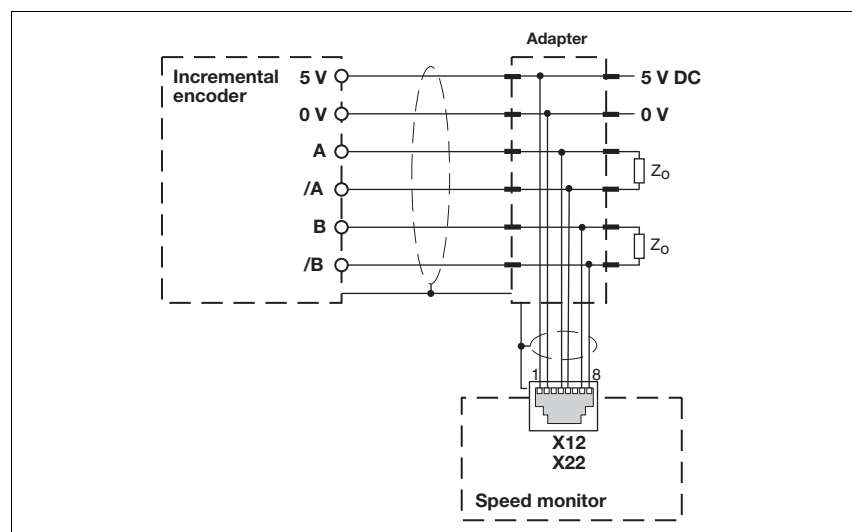
Fig. 6-6:   Connection via adapter

6.2 Preparing for operation

6.2.3 Connection of proximity switches and incremental encoder

6.2.3.1 Proximity switch and incremental encoder on various axes

Axis 1:
proximity switch on I10, I11
or
incremental encoder on X12

Axle 2:
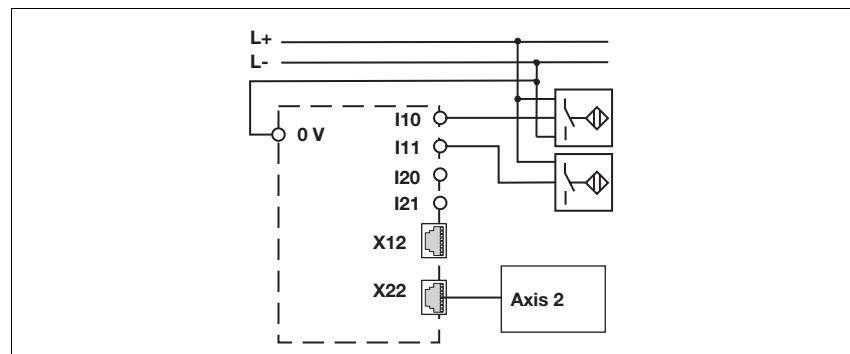proximity switch on I10, I21
or
incremental encoder on X22

Fig. 6-7: Proximity switch and incremental encoder on various axes

6.2 Preparing for operation

6.2.3.2 Proximity switch and incremental encoder on one axis

Axis 1:
Proximity switch at I10 (I11 is unused)
and
Incremental encoder at X12
Axis 2:
Proximity switch at I20 (I21 is unused)
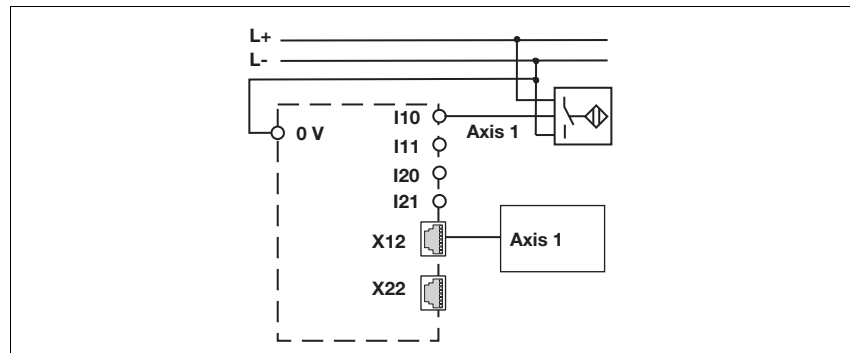and
Incremental encoder at X22

Fig. 6-7: Proximity switch and incremental encoder on one axis

6.2 Preparing for operation

6.2.4 Connection examples

6.2.4.1 Connection of 2 proximity switches and an incremental encoder

Description
- ▸ 2 proximity switches, pnp-switching
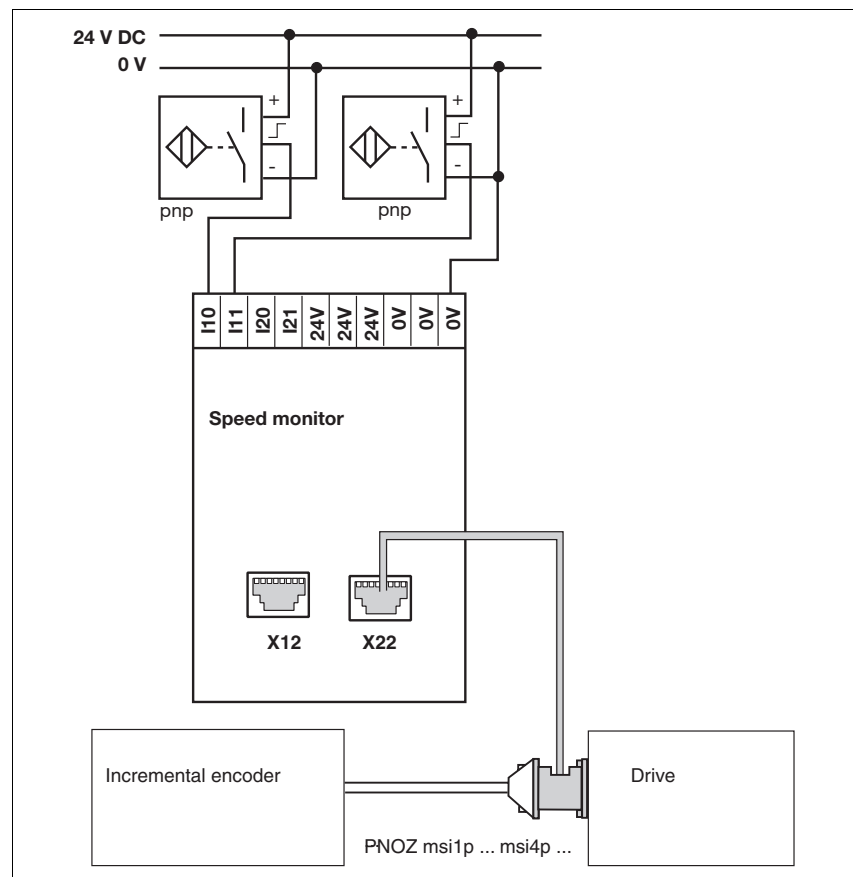- ▸ 1 incremental encoder

Fig. 6-9:   Connection of 2 proximity switches, pnp-switching, one incremental encoder

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6.2 Preparing for operation

6.2.4.2 Connection of 4 proximity switches

Description

▸ 4 proximity switches, pnp-switching
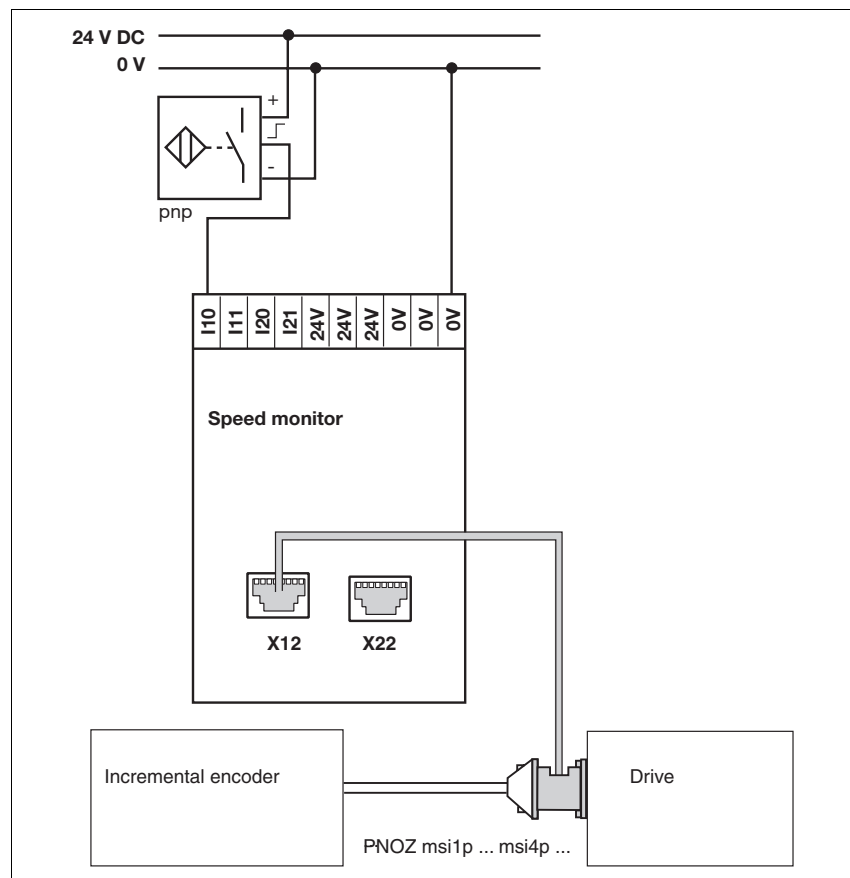▸ Connection through 24 V terminals and 0 V

Fig. 6-10:   Connection of 4 proximity switches, pnp-switching, connection through 24 V terminals and 0 V

6.2   Preparing for operation

6.2.4.3   Connection of an incremental encoder and proximity switch on an axis

Description

▶ 1 proximity switch, pnp-switching

▶ 1 incremental encoder
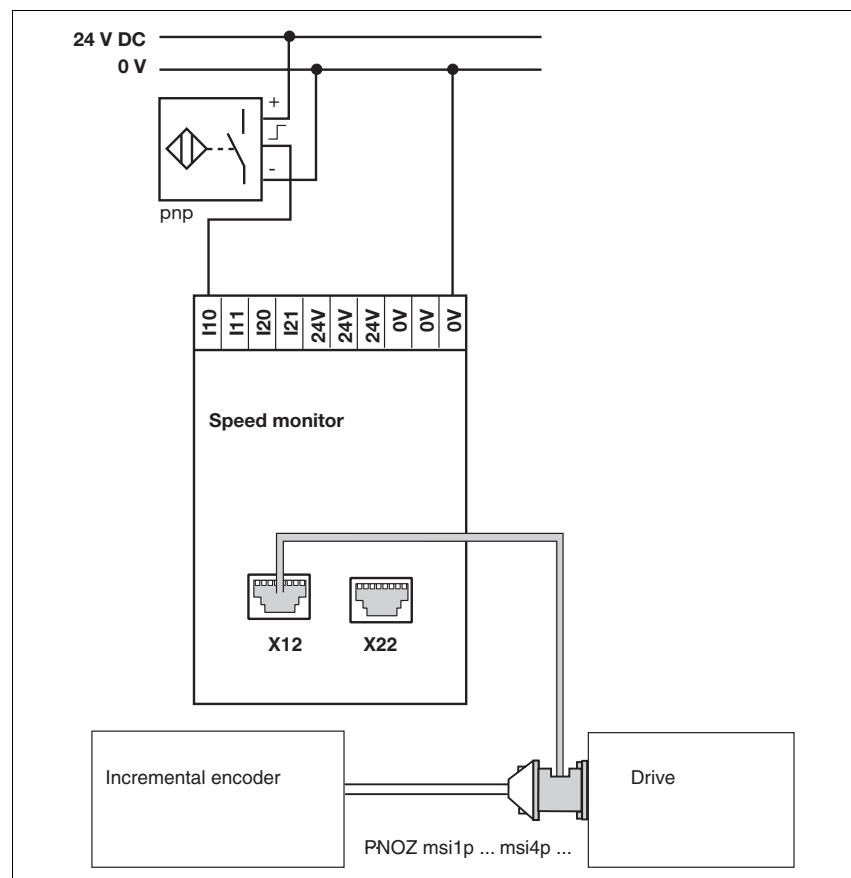
▶ Incremental encoder and proximity switch on one axis

Fig. 6-11:   Connection of an incremental encoder and proximity switch, pnp-switching, on an axis

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6.2 Preparing for operation

7.1 Messages

When the supply voltage is switched on, the PNOZmulti safety system copies the configuration from the chip card.

The LEDs "POWER", "DIAG", "FAULT", "IFAULT" and "OFAULT" light up on the base unit.

The PNOZmulti safety system is ready for operation when the "POWER" and "RUN" LEDs on the base unit and the "READY" LED on the **PNOZ ms2p** are lit continuously.

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7.2 Display elements

Key:

	☼	LED on
	◐	LED flashes
	●	LED off

7.2.1 Display elements for device diagnostics

| LED	LED status	Meaning
POWER	☼	Supply voltage is present
FAULT	☼	External fault leading to a safe condition; the fault is at the incremental encoder inputs whose LEDs are flashing, e.g. short across the contacts
	◐	Internal fault leading to safe condition
SHAFT1 SHAFT2	◐	Encoder or wiring fault
	●	Axis 1 and/or axis 2 are in the normal range (no standstill, no overspeed)
	☼	Axis 1 and/or axis 2 signalling standstill
	◐	Axis 1 and/or axis 2 signalling overdrive
X12 X22	☼	Incremental encoders on terminals X12 and/or X22 are connected correctly
I10, I11, I20, I21	☼	Proximity switch on terminal I10, I11, I20, I21 is energised

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7.3   Signal statuses

Status	Key	Encoder inputs ***)			Outputs		Diagnostic word ****)			
		Incremental encoder track A	Incremental encoder track B	Proximity switch	Standstill	Overspeed, no fault on the speed monitor	Bit 9: Proximity switch fault	Bit 9: Incremental encoder fault	Bit 10: Frequency difference, track A and B	Entry in the error stack
A	Standstill, no fault	0	0	0	1	1	0	0	0	0
B1 *)	Standstill, fault on proximity switch	0	0	1	1	1	0	1	0	0
B2 *)	Broken shearpin	0	0	1	0	0	0	1	0	1
C	Standstill, unwanted signal change, track A	0	1	0	1	1	0	0	0	0
D	Rotating shaft, fault, track A	0	1	1	0	0/1 **)	0	0	1	1
E	Standstill, unwanted signal change, track B	1	0	0	1	1	0	0	0	0
F	Rotating shaft, fault, track B	1	0	1	0	0/1 **)	0	0	1	1
G	Rotating shaft, fault at proximity switch	1	1	0	0	0/1 **)	1	0	0	1
H	Rotating shaft, no fault	1	1	1	0	0/1 **)	0	0	0	0

*) Status B only leads to a safe shutdown when the "broken shearpin monitoring" option is activated (B2). If the option is not activated (B1), only bit 9 of the diagnostic word will be set.

**) The speed output is "1" if the configured overspeed is not exceeded.

***) Input = 1: Speed monitor detects impulses

Input = 0: Speed monitor detects no impulses

****) For explanations of the speed monitor's diagnostic word, see the PNOZmulti Configurator's online help

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7.4 Faults - malfunctions

Monitoring the direction of rotation: If an internal error occurs or there is an error due to a defective incremental encoder ("FAULT" LED illuminates or flashes), an incorrect direction of rotation can be signalled for approx. 500 ms.

8.1   Technical details

Technical details	
Electrical data	
Supply voltage (U_B) via base unit	**24 VDC**
Voltage tolerance	**-15% ... 20%**
Power consumption at U_B via base unit	**Typ. 1 W**
Residual ripple U_B	**+/- 5 %**
Timers	
Supply interruption before de-energisation	**Min. 20 ms**
Configurable switch-off delay	**0 ... 2500 ms**
Response time f $\geq$ 100 Hz: Configurable switch-off delay + Switch-off delay PNOZ m1p +	**10 ms**
f < 100 Hz: Configurable switch-off delay + Switch-off delay PNOZ m1p +	**10 ms + 1/f**
Proximity switch input	
Number of inputs	**4 (2 axes)**
Signal level at the inputs "1" Signal (high)	**11 V ... 30 V**
"0" Signal (low)	**-3 ... 5 V**
Input resistance	**3 kOhm**
Input's frequency range	**0 ... 3 kHz**
Configurable monitoring frequency Without hysteresis	**0,1 Hz ... 3 kHz**
With hysteresis	**0,2 Hz ... 3 kHz**
Connection type	**cage clamp terminals**
Cross section of external conductors Rigid single-core, flexible multi-core or multi-core With crimp connector	**0.5 ... 2,5 mm^2**
Flexible multi-core with plastic sleeve	**0.5 ... 1.5 mm^2**
Incremental encoder input	
Number of inputs	**2 (2 axes)**
Supply voltage for incremental encoders	**Independent**
Signal level at the inputs	**0.5 V$_{SS}$ ... 30 V$_{SS}$**
Phase position for the differential signals A, /A and B	**90° ±30°**
Overload protection	**-30 V ... +30 V**
Input resistance	**20 kOhm**
Input's frequency range	**0 ... 500 kHz**
Configurable monitoring frequency Without hysteresis	**0,1 Hz ... 500 kHz**
With hysteresis	**0,2 Hz ... 500 kHz**
Connection type	**RJ-45 female connector**
Environmental data	
Airgap creepage	**DIN VDE 0110-1, 04/97**
Vibration in accordance with **EN 60068-2-6, 04/95** Frequency:	**10 ... 55 Hz**
Amplitude:	**0,35 mm**
Climatic suitability	**DIN IEC 60068-2-3, 12/86** **DIN CEI 60068-2-3, 12/86**
EMC	**EN 60947-5-1, 01/00**

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8.1   Technical details

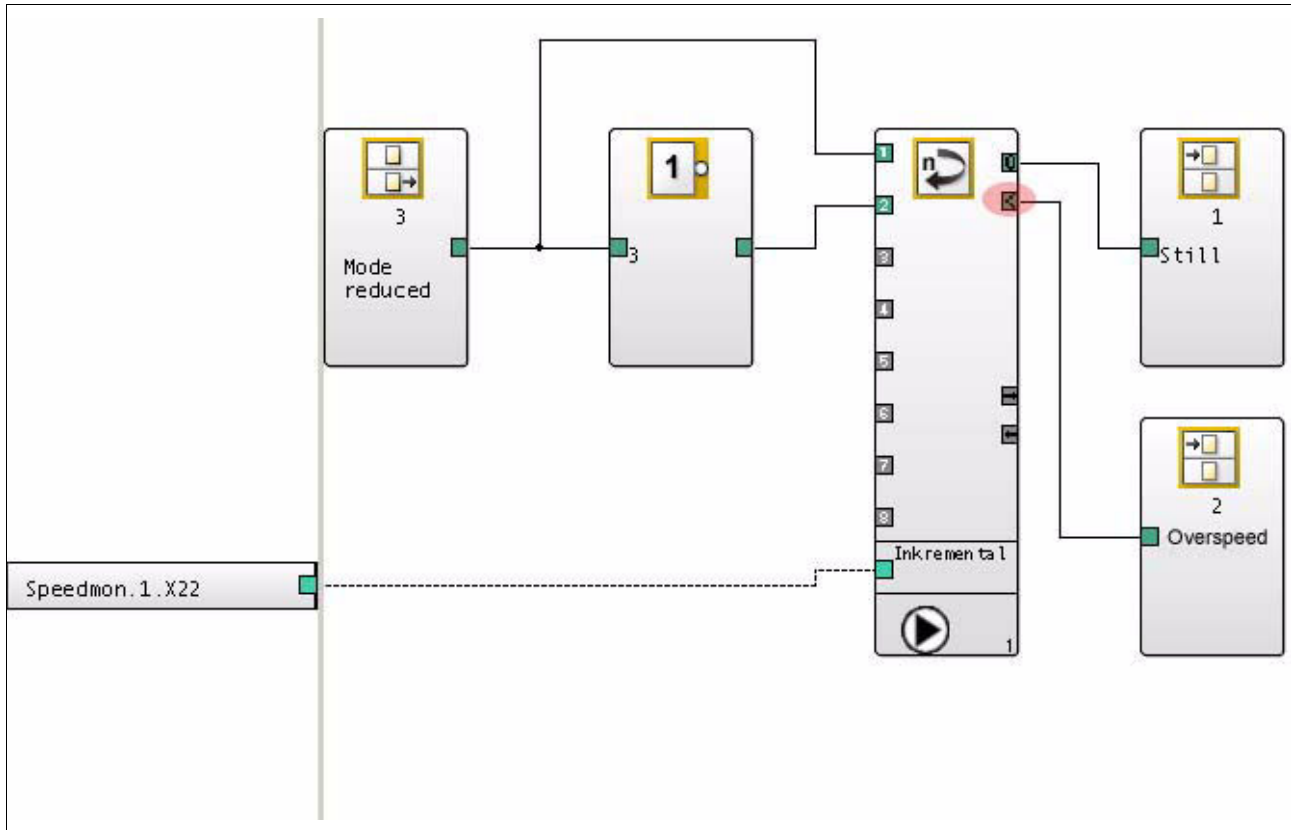| Environmental data	
Ambient temperature	**0 ... +55 °C**
Storage temperature	**-25 ... +70 °C**
Mechanical data	
Protection type Mounting (e.g. cabinet) Housing Terminals	 **IP 54** **IP20** **IP20**
DIN rail Top hat rail Recess width	 **35 x 7.5 EN 50022** **27 mm**
Torque setting for connection terminals (screws)	**0,4 ... 0,5 Nm**
Housing material Housing Front	 **PPO UL 94 V0** **ABS UL 94 V0**
Dimensions (H x W x D)	**94 x 45 x 121 mm**
Weight with connector	**220 g**

Safe standstill monitoring
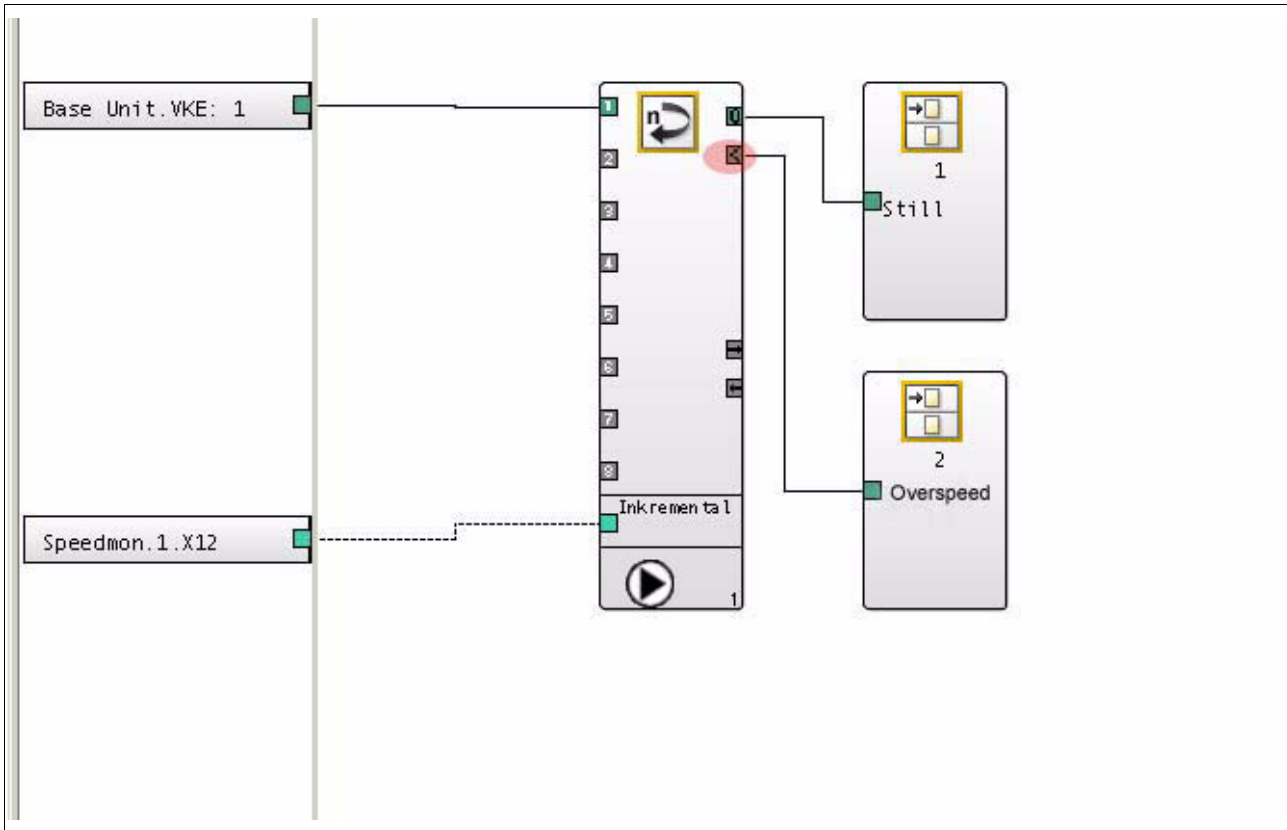
Configuration in the PNOZmulti Configurator

‣ Standstill: depending on requirement

‣ Speed n1: greater than the maximum permitted speed.

If the "Overspeed" output (see red marking) = "0", either the maximum permitted speed has been exceeded or the speed monitor has recognised a fault.

"Overdrive" output = "0" must lead to the shutdown of the relevant axis.

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Safe monitoring with "reduced speed" operating mode

Configuration in the PNOZmulti Configurator
▸ Standstill: depending on requirement
▸ Speed n1: reduced speed, depending on requirement
▸ Speed n2: greater than the maximum permitted speed.

If the "Overspeed" output (see red marking) = "0", either the maximum permitted speed has been exceeded or the speed monitor has recognised a fault.
"Overdrive" output = "0" must lead to the shutdown of the relevant axis, irrespective of whether the "reduced speed" operating mode is active.
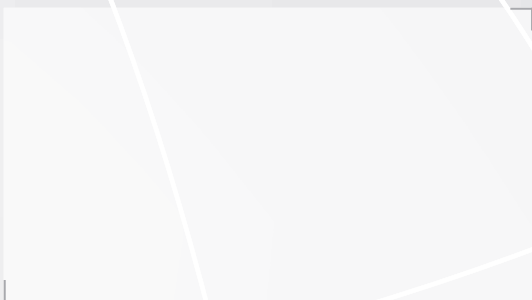
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headquarters.

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