PNOZ m EF 1MM

▸ Configurable control systems PNOZmulti 2

PILZ

THE SPIRIT OF SAFETY

1 Introduction

1.1 Validity of documentation

This documentation is valid for the product PNOZ m EF 1MM from Version 2.0 .

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

1.2 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.

1.3 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.

2 Overview

2.1 Scope of supply

▸ Expansion module PNOZ m EF 1MM

▸ Jumper

2.2 Unit features

Using the product PNOZ m EF 1MM:

Expansion module for connection to a base unit from the configurable control system PNOZmulti 2 .

The product has the following features:

▸ Can be configured in the PNOZmulti Configurator

▸ Monitoring of 1 axis

▸ Measured value recorded by proximity switch and encoder

▸ Monitoring functions

– Safe speed monitoring (SSM)

– Safe speed range monitoring (SSR-M)

– Safe direction of movement monitoring (SDI-M)

– Safe operating stop monitoring (SOS-M)

– Safe stop 1 monitoring (SS1-M)

– Safe stop 2 monitoring (SS2-M)

– Analogue voltage (track S)

▸ LED indicator for:

– Supply voltage

– Diagnostics

– Axis status

– Error

▸ Please refer to the document "PNOZmulti System Expansion" for the PNOZmulti base units that can be connected.

2.3 Front view
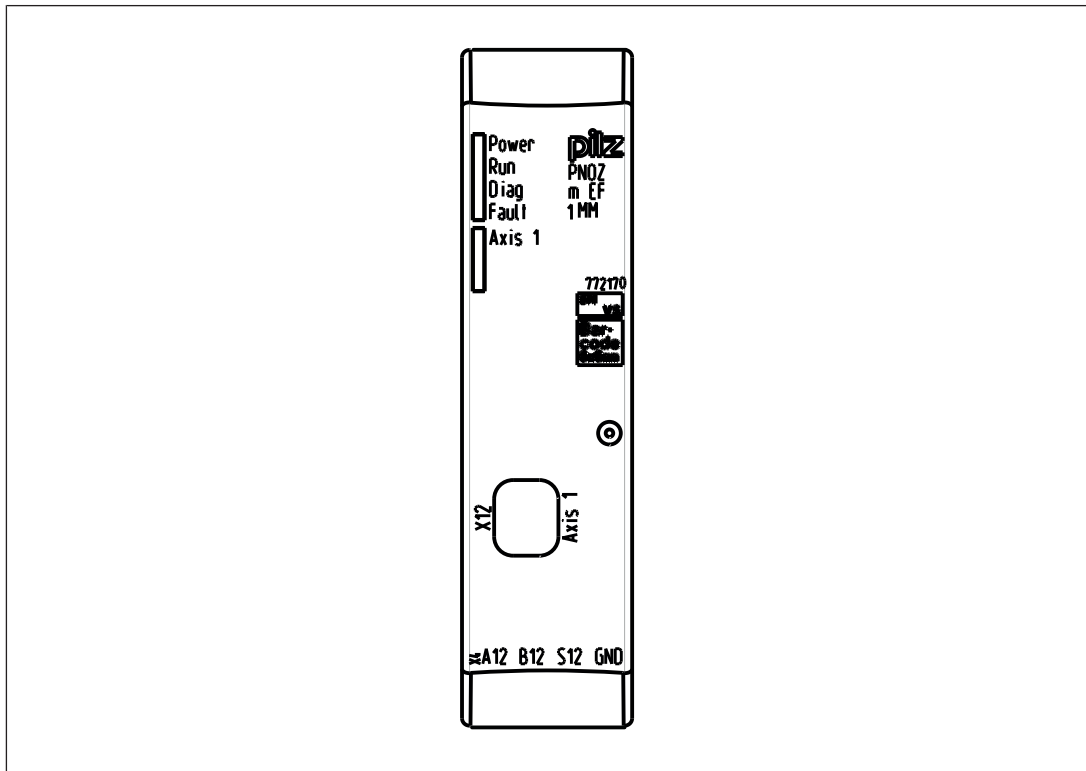
Legend:

▶ X4: Connection for proximity switch at axis 1

▶ X12: Mini IO socket for connecting encoder or proximity switch at axis 1.

▶ LEDs:

– Power

– Run

– Diag

– Fault

– Axis 1

3   Safety

3.1   Intended use

The motion monitoring expansion module monitors safety functions in accordance with EN 61800-5-2 for safe motion monitoring.

The following monitoring functions are performed:

▶   Safe Direction Monitoring (SDI-M)

▶   Safe Operating Stop Monitoring (SOS-M)

▶   Safe Speed Range Monitoring (SSR-M)

▶   Safe Speed Monitoring (SSM)

▶   Safe Stop 1 Monitoring (SS1-M)

▶   Safe Stop 2 Monitoring (SS2-M)

The expansion module meets the requirements of EN IEC 61508 up to SIL 3 and EN ISO 13849-1 up to PL e.

The expansion module may only be connected to a base unit from the configurable system PNOZmulti 2 (please refer to the document "PNOZmulti System Expansion" for details of the base units that can be connected).

The configurable system PNOZmulti 2 is used for the safety-related interruption of safety circuits and is designed for use in:

▶   Emergency stop equipment

▶   Safety circuits in accordance with VDE 0113 Part 1 and EN 60204-1

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 [📖 37]).

!	**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.

3.2   System requirements

Please refer to the "Product Modifications PNOZmulti" document in the "Version overview" section for details of which versions of the base unit and PNOZmulti Configurator can be used for this product.

3.3 Safety regulations

3.3.1 Safety assessment

Before using a unit 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.

3.3.2 Use of qualified personnel

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

A competent person is someone who, because of their training, experience and current professional activity, has the specialist knowledge required to test, assess and operate the work equipment, 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 information provided in this description under "Safety"

▶ And have a good knowledge of the generic and specialist standards applicable to the specific application.

3.3.3 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.).

3.3.4 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).

3.3.5 For your safety

The unit meets all the 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. The expanded functions are described in the PNOZmulti Configurator's online help. Only use these functions once you have read and understood the documentations.

▸ 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).

4 Function description

4.1 Operation

The motion monitoring module PNOZ m EF 1MM can monitor one axis. The motion monitoring module signals the status of the monitored values to the base unit. Depending on the implemented safety circuit, the values may be transferred from the base unit to an output on the control system. Proximity switches or encoders are used to record the values.

The configuration of the motion monitoring module is described in detail in the PNOZmulti Configurator's online help.

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.

4.2 Block diagram
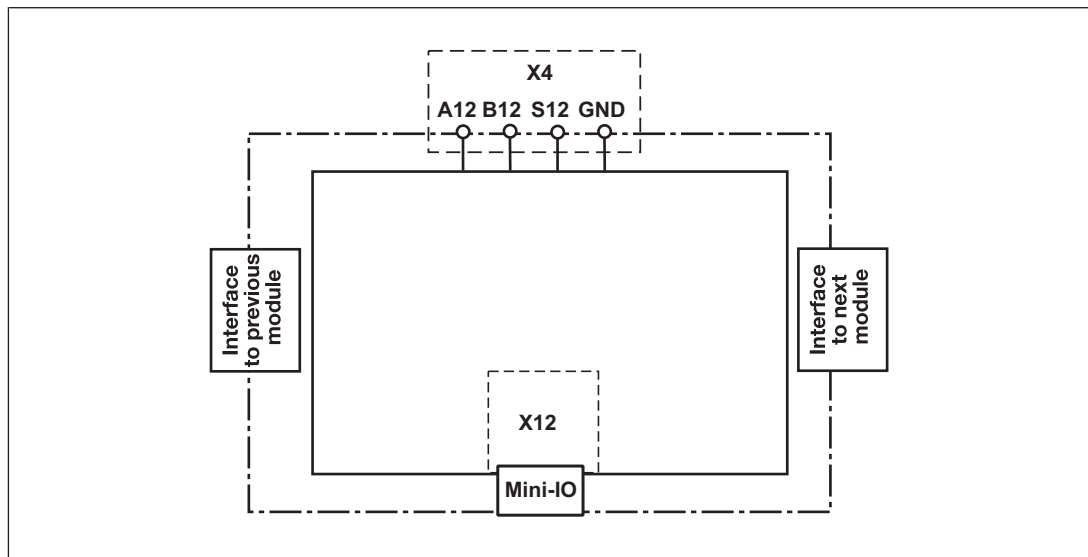
4.3 Monitoring functions

The motion monitoring module PNOZ m EF 1MM supports the following monitoring functions.

Please note that the position monitoring functions SOS-M, SDI-M and SS2-M cannot be used in conjunction with 2 proximity switches, as no position can be detected.

Safe speed monitoring

The *Safe speed monitoring* function (SSM) monitors the current speed to see if a limit value is exceeded.

If the configured limit value is exceeded, the output switches off. As soon as the value falls below the limit value (plus hysteresis), the output switches off again.
If a manual reset is configured, the output will not switch back on until the value is inside the limit value (plus hysteresis) and the reset input is activated.

12 limit values can be configured per axis in the PNOZmulti Configurator.

A tolerance range may also be set for the limit values used to monitor the speed. This tolerance range modifies the set limit values. As a result, one-off or periodic overshoots that exceed the limit values can be tolerated.

The following values can be configured for the tolerance range:

▶ Tolerance time (t1), which takes into account the length of the overshoots (maximum time for which the limit value may be exceeded). It must not be possible that the sum of all the overshoots exceeds the tolerance time (t1) within a tolerance period (t2).

▶ Tolerance period (t2), which takes into account the oscillation period (minimum time that must elapse between one limit value overshoot and the next)

▶ Tolerance amount (%), which takes into account the amplitude of the overshoots (maximum permitted percentage by which the configured limit values may be exceeded)
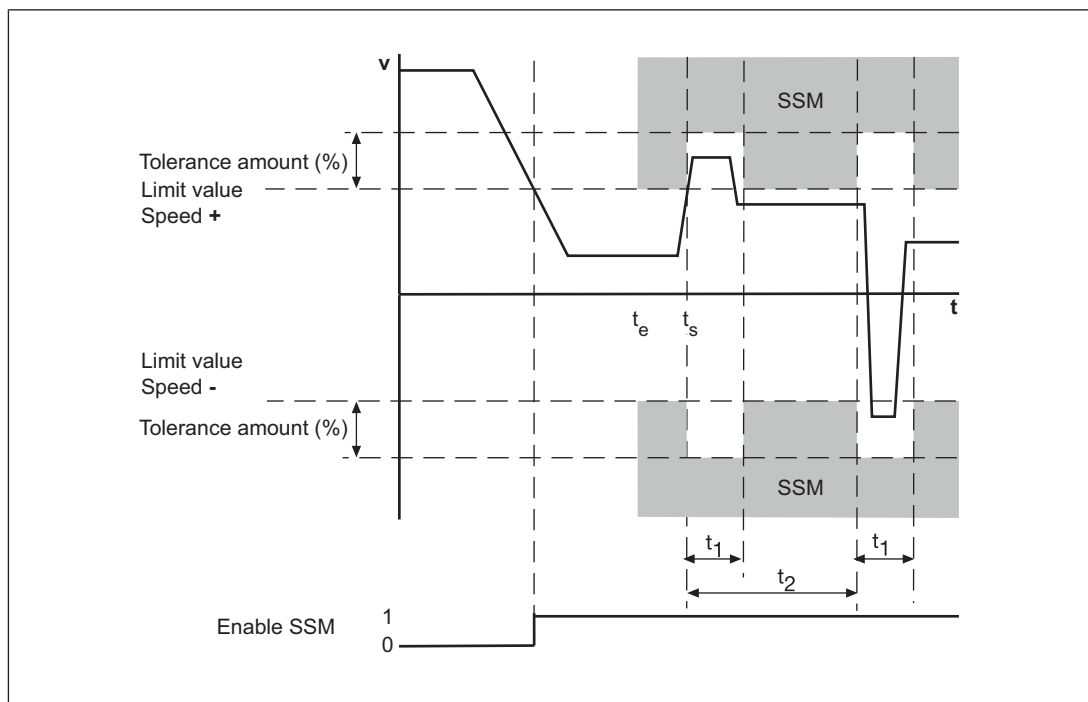
Legend:

▶ Enable SSM:

– "1": Monitored limit value not exceeded

– "0": Monitored limit value exceeded

▶ t_s: Speed v exceeds the limit value and activates the tolerance range (tolerance time, tolerance period, tolerance amount)

▶ t_1: Tolerance time

▶ t_2: Tolerance period

▶ Tolerance amount (%): Tolerance amount of limit value in both directions

Safe speed range monitoring

The *Safe speed range monitoring* function (SSR-M) monitors the current speed to ensure it stays within a maximum and minimum permitted limit value.

If the speed is outside the configured range, the output switches off. As soon as the speed returns within the configured range (plus hysteresis), the output switches back on.
If manual reset is configured, the output will not switch back on until the value is below the limit value (plus hysteresis) and the reset input is activated.

2 ranges can be configured per axis in the PNOZmulti Configurator.

A tolerance range may also be set for the limit values used to monitor the speed range. This tolerance range modifies the set limit values. As a result, one-off or periodic over-shoots that exceed the range limits can be tolerated.

The following values can be configured for the tolerance range:

▸ Tolerance time (t1), which takes into account the length of the overshoots (maximum time for which the limit value may be exceeded). It must not be possible that the sum of all the overshoots exceeds the tolerance time (t1) within a tolerance period (t2).

▸ Tolerance period (t2), which takes into account the oscillation period (minimum time that must elapse between one limit value overshoot and the next)

▸ Tolerance amount as a %, which takes into account the amplitude of the overshoots (maximum permitted percentage by which the limit value may be exceeded)
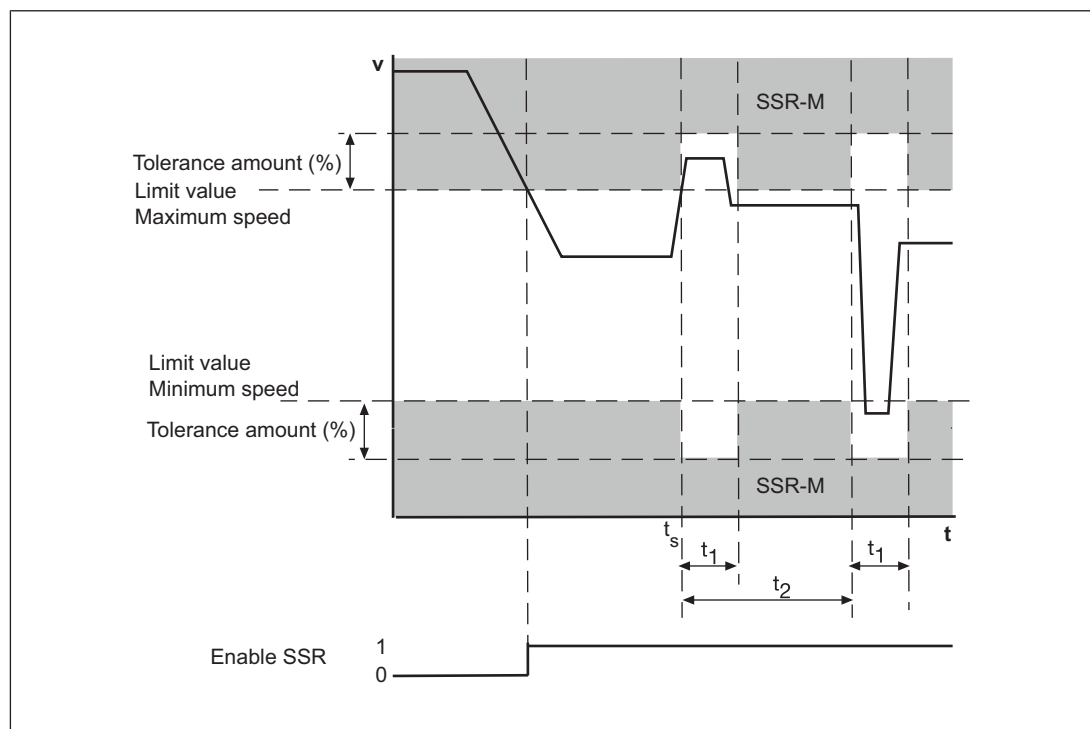
Legend:

▸ Enable SSR:

   – "1": Speed is within the configured range

   – "0": Speed is outside the configured range

▸ t_s: Speed v exceeds the limit value and activates the tolerance range (tolerance time, tolerance period, tolerance amount)

▶ t_1: Tolerance time

▶ t_2: Tolerance period

▶ Tolerance amount (%): Tolerance amount of the two limit values, maximum and minimum speed

Safe direction monitoring

The *Safe direction monitoring* function (SDI-M) monitors the direction of movement defined for the drive axis (positive or negative). Safe direction of movement monitoring is activated via the start input. It remains active until the configured tolerance is exceeded in the opposite direction. The function can be retriggered at any time by a rising edge at the start input. As a result, the current position can be used at any time as the start point for the monitoring function.

One SDI-M element can be configured per axis for each direction in the PNOZmulti Configurator.

Please note:
This monitoring function cannot be used in conjunction with 2 proximity switches because position detection is not possible.

> ⚠ **WARNING!**
>
> Potential loss of safety function with a tolerance value >24,900,000 increments!
>
> The following applies when using a PNOZmulti Configurator **Version <10.0**:
> If a tolerance value >24,900,000 increments is configured in the PNOZmulti Configurator, the monitoring function will no longer be evaluated correctly.
> Depending on the application, serious injury or death may result.
> Make sure that a tolerance value <24,900,000 increments is configured.
> From Version 10.0 of the PNOZmulti Configurator, the feasibility of the value will be checked automatically.

Safe operating stop monitoring

The **Safe operating stop monitoring** function (SOS-M) monitors whether the standstill position remains within a configured tolerance window. Safe operating stop monitoring is activated within a rising edge at the start input. It remains active until the value is outside the tolerance band. The function can be retriggered at any time by a rising edge at the start input. As a result, the current position can be used at any time as the start point for the monitoring function.

3 SOS-M elements can be configured per axis in the PNOZmulti Configurator.
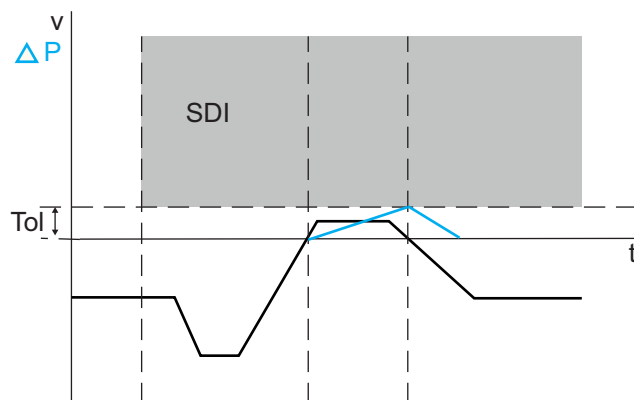
Please note:
This monitoring function cannot be used in conjunction with 2 proximity switches because position detection is not possible.

> **WARNING!**
>
> Potential loss of safety function with a tolerance value >24,900,000 increments!
>
> The following applies when using a PNOZmulti Configurator **Version <10.0**:
> If a tolerance value >24,900,000 increments is configured in the PNOZmulti Configurator, the monitoring function will no longer be evaluated correctly. Depending on the application, serious injury or death may result.
> Make sure that a tolerance value <24,900,000 increments is configured.
> From Version 10.0 of the PNOZmulti Configurator, the feasibility of the value will be checked automatically.

Legend:

▸ t_e: Activation of the monitoring function SOS

Safe stop 1 monitoring

The **Safe stop 1 monitoring** function (SS1-M) monitors whether the set delay time has elapsed (until controlled braking of the motor) or the value for standstill detection for automatic STO is below the limit value.

▸ If the monitoring function SS1-M is triggered, the **Braking ramp** output is switched off. The drive controller's braking ramp is activated.

‣ After the set delay time has elapsed or the value for the automatic STO is below the limit value, the output **ST** switches off. The safety function **Safe torque off** (STO) is activated.

A maximum of 1 SS1-M element can be configured per axis in the PNOZmulti Configurator.

Sequence without standstill detection limit value for automatic STO:
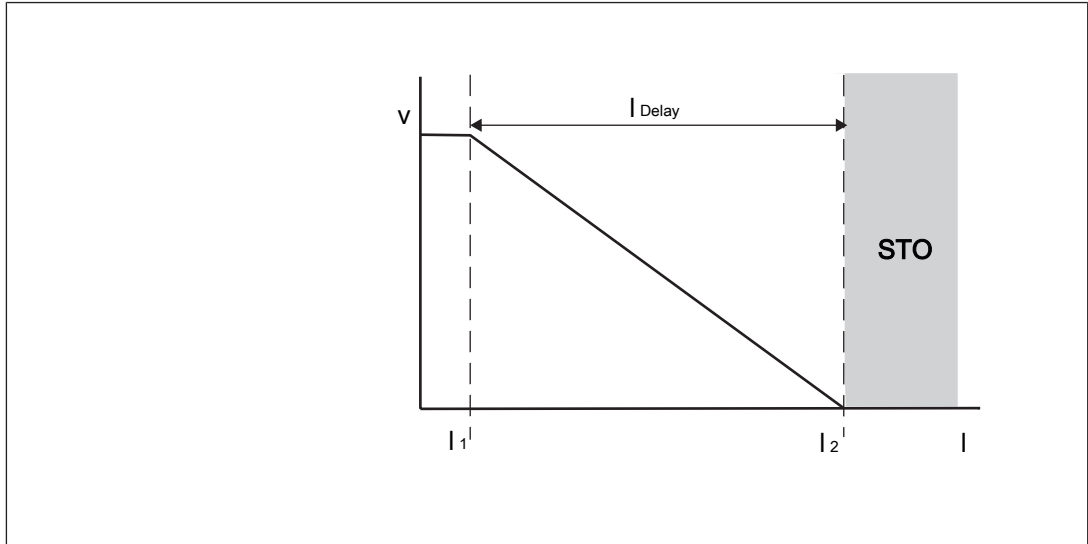
Legend

t_1:	Monitoring function SS1-M is activated
t_2:	Delay time elapses, safety function "Safe torque off" (STO) is activated
t_{Delay}:	Set delay time for controlled braking of motor

Sequence with standstill detection limit value for automatic STO:
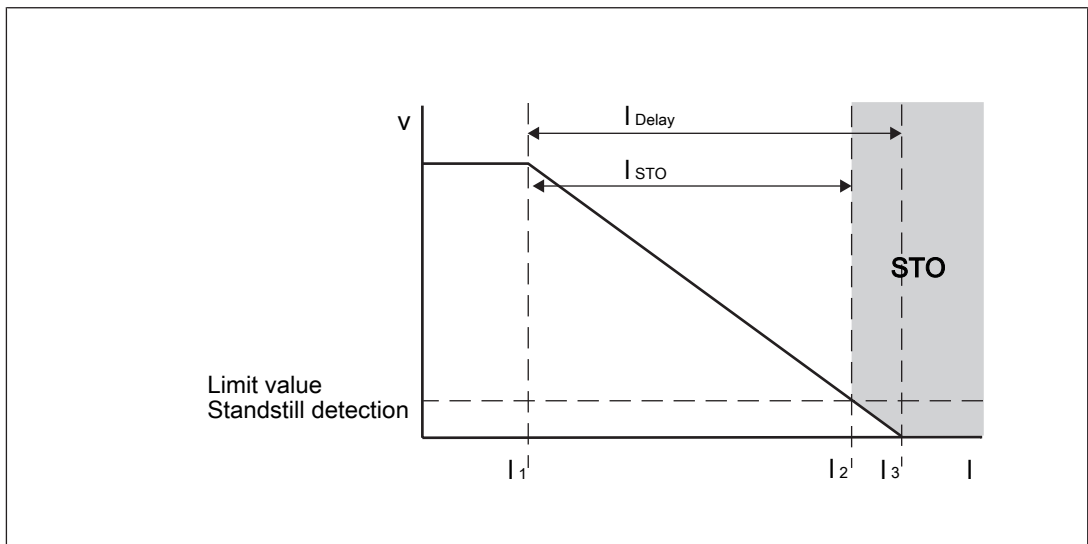
Legend

t_1:	Monitoring function SS1-M is activated
t_2:	Standstill detection limit value for automatic STO reached, safety function "Safe torque off" (STO) is activated
t_3:	Delay time elapses

t_{Delay}:   Set delay time for controlled braking of motor

t_{STO}:   Actual time from activation of monitoring function until STO is activated

Safe stop 2 monitoring

The *Safe stop 2 monitoring* function (SS2-M) monitors

▶ Whether the set delay time has expired (to controlled braking of the motor) or the value for standstill detection for automatic SOS is below the limit value

and

▶ Whether the standstill position ultimately remains within a configured tolerance window.

Reaction:

▶ If the monitoring function SS2-M is triggered, the "Braking ramp" output switches off. The drive controller's braking ramp is activated.

▶ If the set delay time has elapsed or the value for the automatic SOS is below the limit value, the standstill position is monitored, the *Position monitoring* output switches on. If the standstill position is outside the tolerance window, the *Position monitoring* and *STO* outputs switch off, the safety function *Safe torque off* (STO) is activated.

A maximum of 1 SS2-M element can be configured per axis in the PNOZmulti Configurator.

Please note:
This monitoring function cannot be used in conjunction with 2 proximity switches because position detection is not possible.

Sequence without standstill detection limit value for automatic SOS:
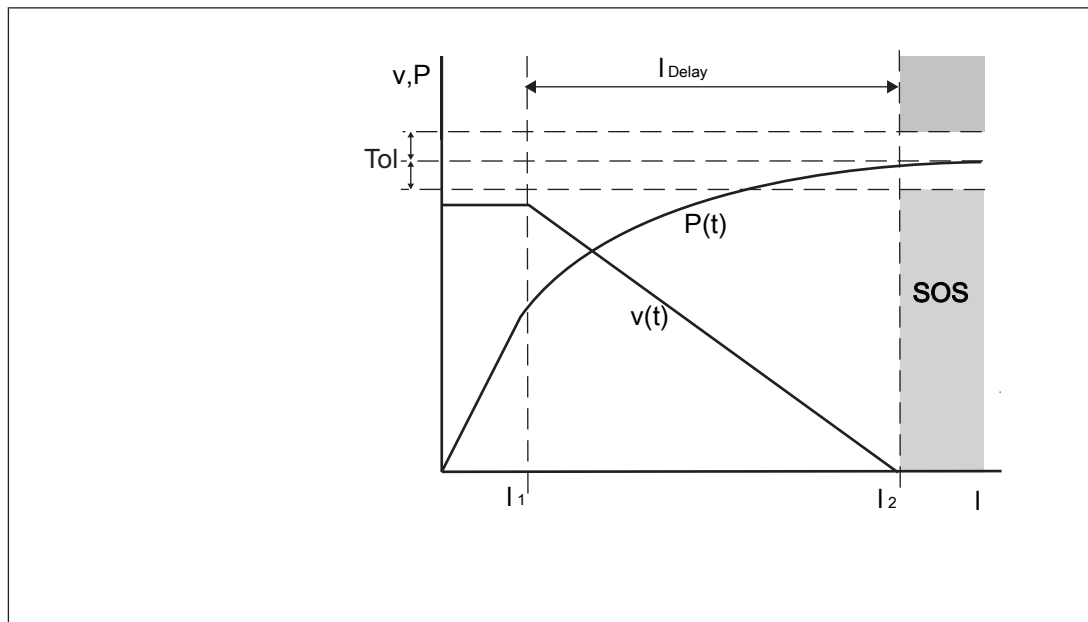
Legend

t_1:   Activation of the monitoring function SS2-M

t_2:   Delay time elapses, monitoring of standstill position (SOS) is activated

t_{Delay}:   Set delay time for controlled braking of motor

Sequence with standstill detection limit value for automatic SOS:
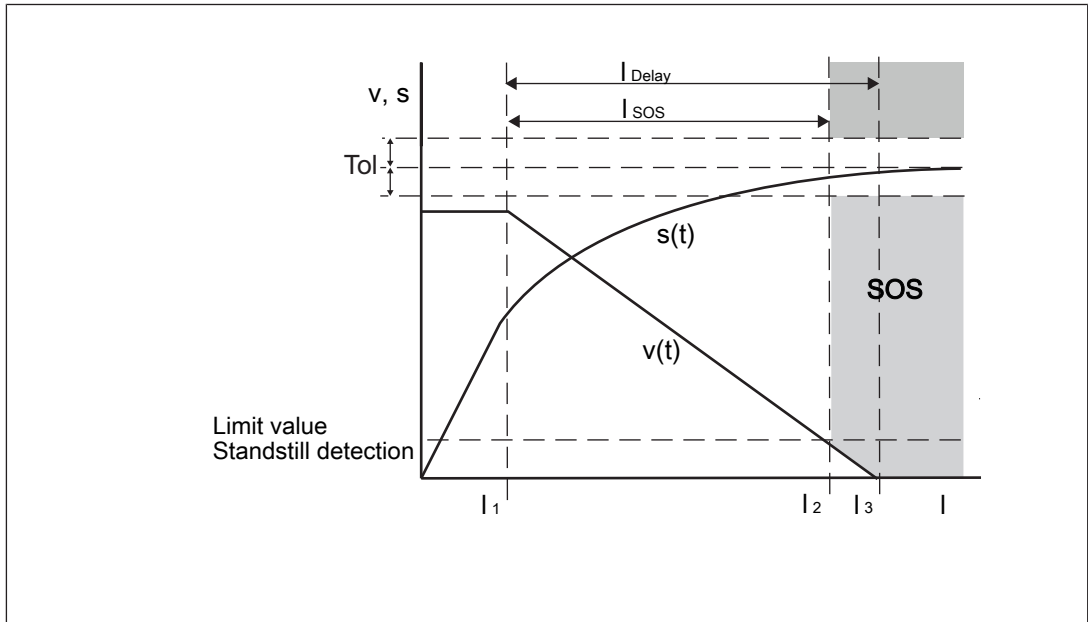
Legend

t_1:	Activation of the monitoring function SS2-M
t_2:	Standstill detection limit value for automatic SOS reached, monitoring of standstill position (SOS) is activated
t_3:	Delay time elapses
t_{Delay}:	Set delay time for controlled braking of motor
t_{STO}:	Actual time from activation of monitoring function until STO is activated

Sequence when standstill position is violated:
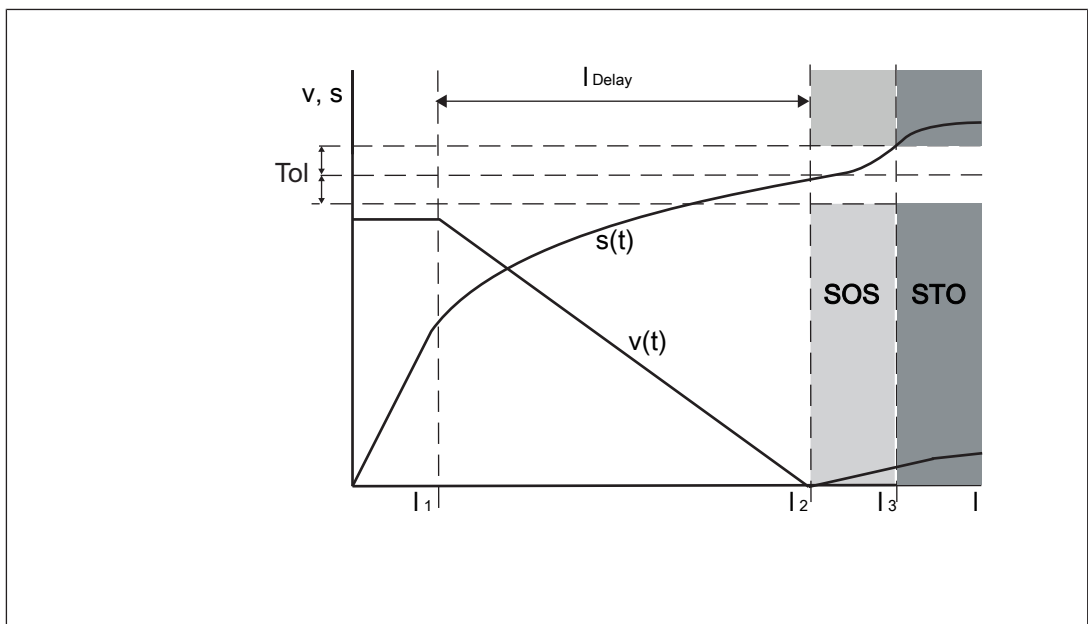
Legend

t_1:	Activation of the monitoring function SS2-M
t_2:	Standstill detection limit value for automatic SOS reached, monitoring of standstill position (SOS) is activated
t_3:	Standstill position outside of tolerance window, safety function "Safe torque off" (STO) is activated
t_{Delay}:	Set delay time for controlled braking of motor

Hysteresis

A hysteresis can be configured for the monitoring functions. This prevents the outputs from bouncing if there are fluctuations around the response value. The hysteresis takes effect when the output is switched on.

Validation cut-off frequency

As implausible signals may arise due to edge jitter on the sensors around the standstill position, a validation cut-off frequency must be configured for sensor types with proximity switches in the PNOZmulti Configurator (edge jitter is caused by the position control of the drive frequency converter or by external interference signals).

If the value of the validation cut-off frequency falls below the configured value, the feasibility check of the sensors will no longer be run.

4.4 System reaction time

Calculation of the maximum reaction time between an input switching off and a linked output in the system switching off is described in the document "PNOZmulti System Expansion".

4.5 Proximity switches

▸ The following proximity switches can be used with a pnp or npn output:

– Inductive

– Capacitive

▸ The proximity switches must be fitted so that at least one is always activated. In other words, the proximity switches must be fitted so that the recorded signals always overlap.

▸ The cable used to connect the proximity switches must be shielded (see connection diagrams in the chapter entitled "EMC-compliant wiring").

▸ A DC voltage in the range of 0 - 30 V can be monitored via track S. It should be used to monitor the supply voltage of the proximity switches.

> **CAUTION!**
>
> Please note: Connection of the proximity switches may only be performed in three-wire technology and not in two-wire technology.

Proximity switch assembly:

Ini 1   Ini 2
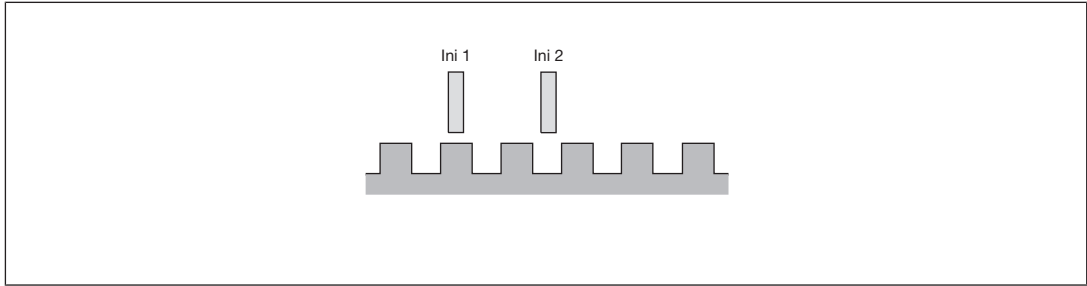
Signal characteristics:

Proximity switch combinations	Signal image in an energised state
PNP / PNP	
NPN / NPN	
NPN / PNP	
PNP / NPN	

CAUTION!

Make sure that the proximity switches are installed as described in the operating manual and that only those combinations described in the table are used.

> **WARNING!**
>
> Potential loss of safety function due to implausible signals from the proximity switch
>
> Depending on the application, serious injury or death may result.
>
> – Make sure that the proximity switches are installed as described in the operating manual and that only those combinations described in the signal characteristics table are used.
>
> – Appropriate installation measures should be taken to prevent a foreign body coming between the signal encoder and the proximity switch. If not, the foreign body could cause invalid signals.
>
> – Please note the values stated in the sensor's technical details.

▶ For a full configuration, the maximum frequency of the sensors you are using must be entered in the PNOZmulti Configurator (see sensor's data sheet).

4.6   Encoder

▶ The following encoders can be used:
  – TTL, HTL (single-ended or differential signals)
  – Sin/Cos 1 Vss
  – Hiperface®

▶ The encoders can be connected with or without Z index (0 index).

▶ The cables used to connect the encoders must be shielded (see connection diagrams in the chapter entitled "EMC-compliant wiring").

▶ A proximity switch can also be connected to track Z to monitor for broken shearpins.
Please note:
Broken shearpin monitoring only becomes active when

  – The minimum speed is exceeded

    and

  – The tolerance for detecting feasibility errors has elapsed.

The minimum speed and tolerance depend on the ratio of the frequency on tracks AB "f_{AB}" to the frequency on track Z "f_Z" in your configuration (see PNOZmulti Configurator *Motion Monitor Element*, *Calculated Ratio AB/Z*).
Minimum speed:

  – Calculated ratio AB/Z ≥ 1.0
    f_Z = 10 mHz or f_{AB} = (f_{AB}/f_Z) x 10 mHz

  – at f_{AB}/f_Z *Ratio* < 1.0
    f_{AB} = 10 mHz or f_Z = 10 mHz/(f_{AB}/f_Z)

Tolerance for detecting feasibility errors:

  – at f_{AB}/f_Z *Ratio* ≥ 1.0
    7.5 Z pulses or 7.5 x (f_{AB}/f_Z) AB pulses

– at f_{AB}/f_Z **Ratio <** 1.0

     4.5 AB pulses or 4.5 x (f_{AB}/f_Z) Z pulses

▸ With Hiperface encoders, the Sin- Cos track is recorded and monitored via an adapter (see Adapters for encoders [📖 24]).

▸ Track S can be used:

     – To connect an encoder's error output.

     – To monitor voltages between 0 V and 30 V for a permitted upper and lower limit. For example, the encoder's supply voltage can be monitored.

▸ The maximum frequency of the used encoders must be entered for a complete configuration.

▸ Pay attention to the values in the technical details.

4.6.1   Output signals

Output signals TTL, HTL

Single ended
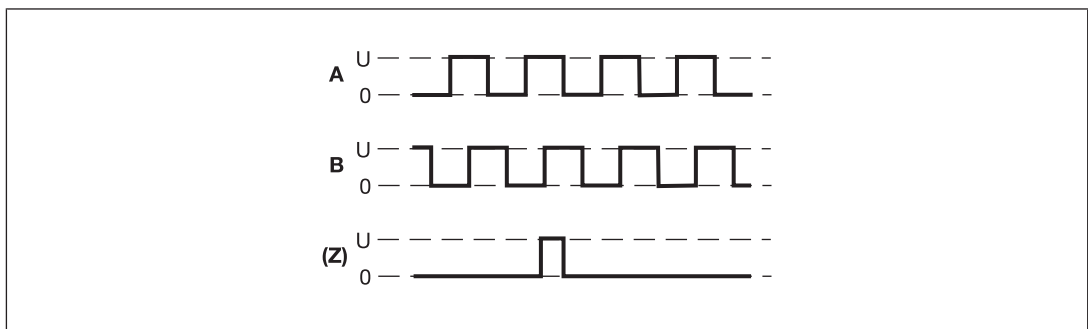
Differential
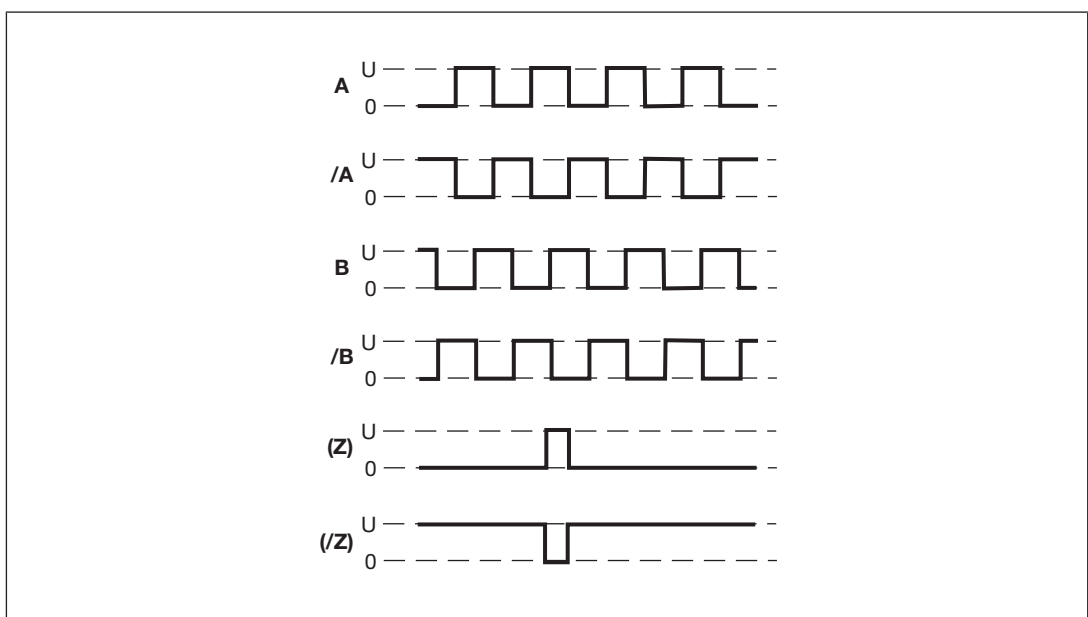
Output signals Sin/Cos (1 Vss)

Single ended with reference track (e.g. Hiperface ®)
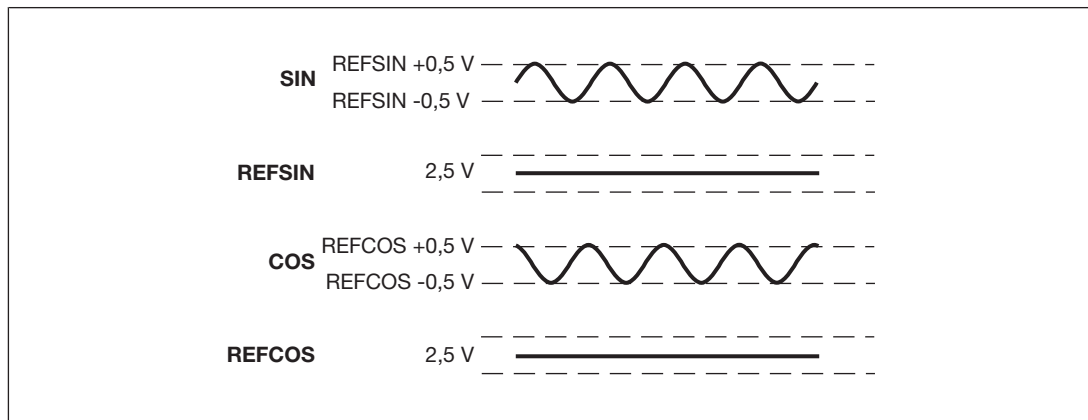
Differential with/without Z index (e.g. Heidenhain 1 Vss)
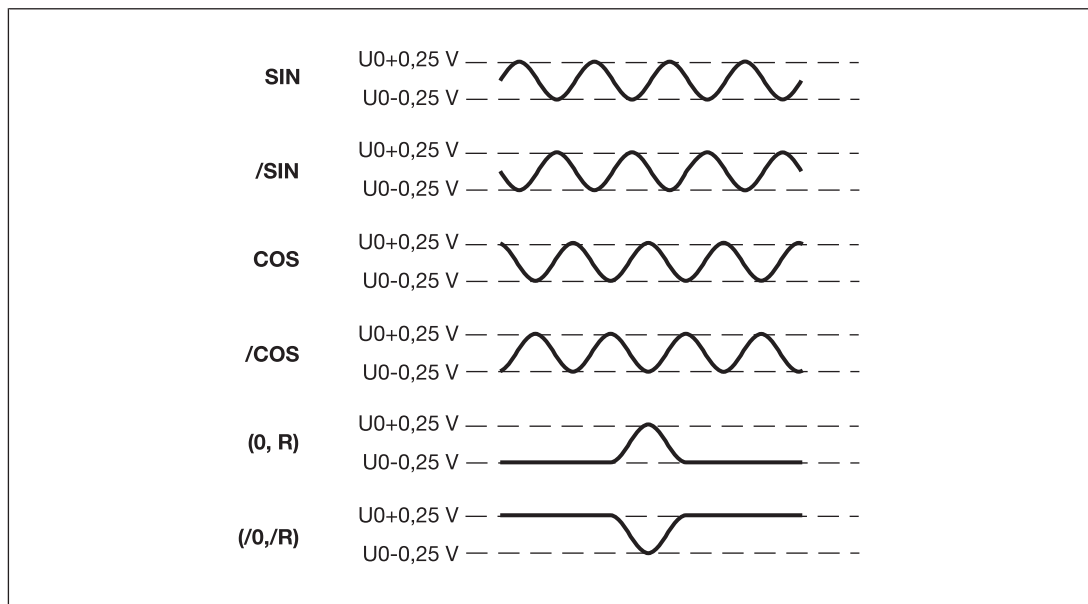
4.6.2   Adapters for encoders

The adapter records the data between the encoder and the drive and makes it available to the PNOZ m EF 1MM via the socket.

Pilz supplies complete adapters as well as ready-made cable with connector, 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.

5   Installation

5.1   General installation guidelines

▶ The unit should be installed in a control cabinet with a protection type of at least IP54.

▶ Install the system vertically on to a horizontal mounting rail. The venting slots must face upward and downward. Other mounting positions could damage the safety system.

▶ Use the locking elements on the rear of the unit to attach it to a mounting rail.

▶ In environments exposed to heavy vibration, the unit should be secured using a fixing element (e.g. retaining bracket or end angle).

▶ Open the locking slide before lifting the unit from the mounting rail.

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

▶ 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.

▶ The unit may be exposed to various types of acceleration during operation. Please note the values stated in the technical details for vibration and shock stress. The acceleration values do not apply when mechanical resonances occur, so the whole system should be subjected to extensive testing.

▶ For the unit to work properly, it must not be constantly exposed to heavy vibration.

! **NOTICE**

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.

5.2   Dimensions in mm
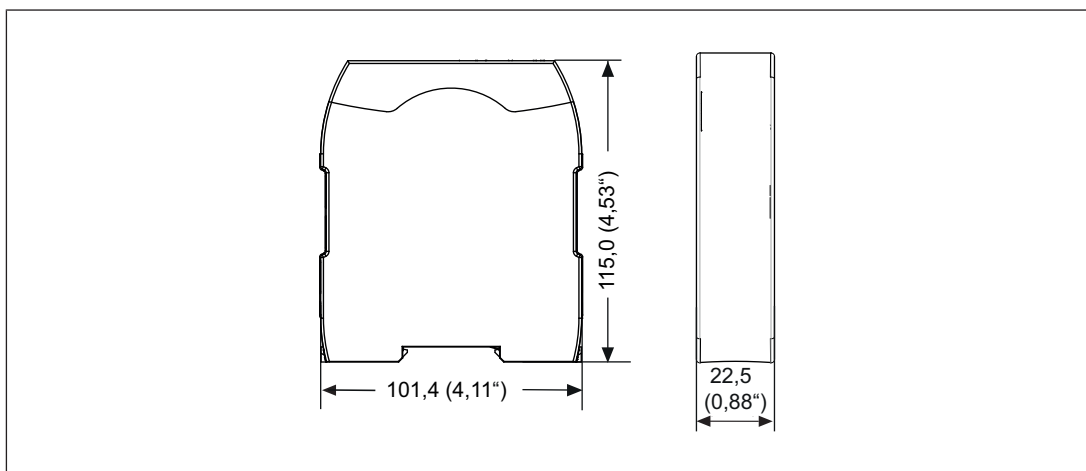
5.3 Connect the base unit and expansion modules

Connect the base unit and the expansion module as described in the operating instructions for the base units.

▸ Connect the black/yellow terminator to the expansion module.

▸ Install the expansion module in the position in which it is configured in the PNOZmulti Configurator.

The position of the expansion modules is defined in the PNOZmulti Configurator. The expansion modules are connected to the left or right of the base unit, depending on the type.

Please refer to the document "PNOZmulti System Expansion" for details of the number of modules that can be connected to the base unit and the module types.

6 Commissioning

6.1 Wiring

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

Please note:

▶ Information given in the Technical details [📖 37] must be followed.

▶ Use copper wire that can withstand 75° C.

▶ The cable used to connect the encoders and proximity switches must be shielded (see connection diagrams in the chapter entitled "EMC-compliant wiring").

▶ The shield may only be connected to earth at a single point.

▶ Earth loops should be avoided.

▶ If possible, the connections for the various earth potentials ( ) should not be connected on the PNOZ m EF 1MM but should be connected directly to the GNDs on the connected units, otherwise noise susceptibility may be increased significantly (conductor loops are not permitted).

> **CAUTION!**
>
> Only connect and disconnect the expansion module when the supply voltage is switched off.

6.2 Pin assignment of Mini-IO socket

Mini-IO socket 8-pin	PIN	Track
	1	S
	2	GND
	3	Z
	4	A
	5	/A
	6	/Z
	7	B
	8	/B

6.3 Connection of proximity switches

The following proximity switch combinations can be connected:

▸ A: pnp, B: pnp

▸ A: npn, B: npn

▸ A: pnp, B: npn

▸ A: npn, B: pnp

When connecting proximity switches please note:

▸ Proximity switches are connected to terminals A12, B12, GND or tracks A, B and GND of the Mini-IO socket.

▸ Track S (S12) should be used to monitor the supply voltage (see drawing). A permitted voltage range can be entered in the menu.

▸ Connect the proximity switch to 24 VDC of the power supply.

▸ When connecting the proximity switches, please refer to the chapter entitled "EMC-compliant wiring".

▸ Invalid signals may occur with cable lengths >50 m. In this case we recommend that you connect a resistor between the signal lines, as shown in the diagrams.

▸ Connection of the proximity switches may only be performed in three-wire technology and not in two-wire technology.
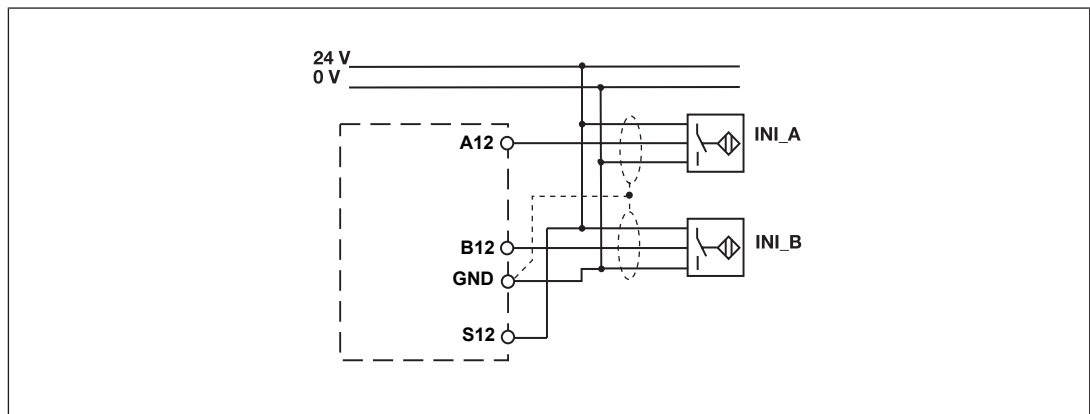
pnp proximity switch with resistor R = 10 kOhm
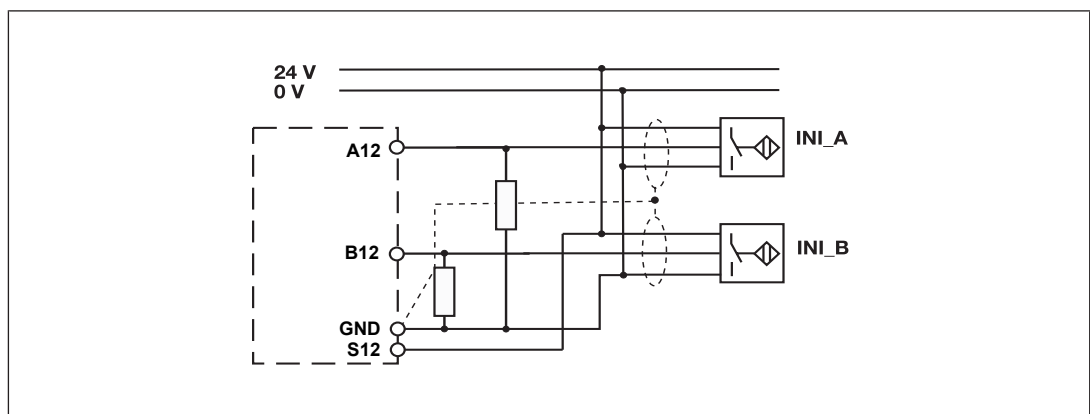
npn proximity switch with resistor R = 47 kOhm
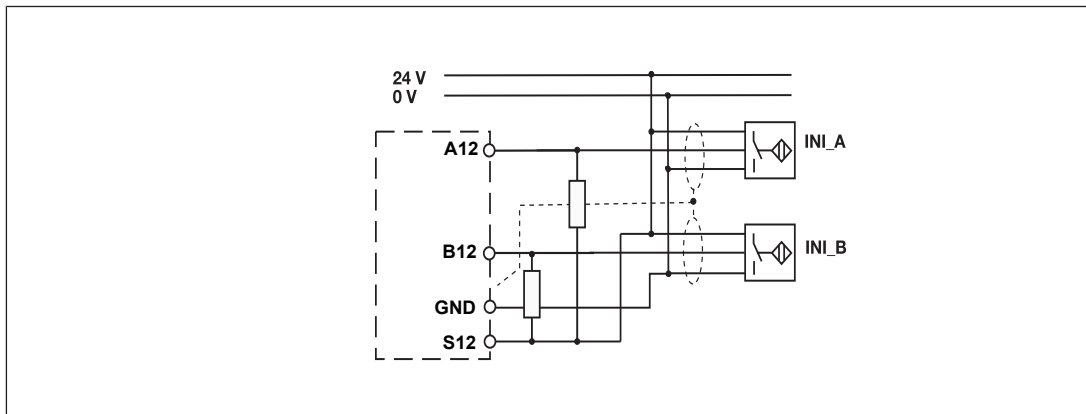
6.4   Connection of an encoder

Proceed as follows when connecting the encoder:

▶ The encoder can be connected via an adapter (e.g. MM A Mini-IO-CAB99) or directly to the PNOZ m EF 1MM.

▶ Use only shielded cables for all connections. Please refer to the chapter entitled "EMC-compliant wiring".

▶ Always connect GND on the encoder to GND on the Mini-IO connector.

▶ If the encoder signals are not terminated with 120 Ohm in the frequency converter or adapter cable longer than 5 metres is used, the encoder signals must be terminated with Z_0 = 120 Ohm between A and /A, B and /B, Z and /Z.

6.4.1   Connect encoder

Encoder types:

▶ TTL single ended

▶ HTL single ended

Please note:

▶ Tracks/A, /B, Z, and /Z must remain free
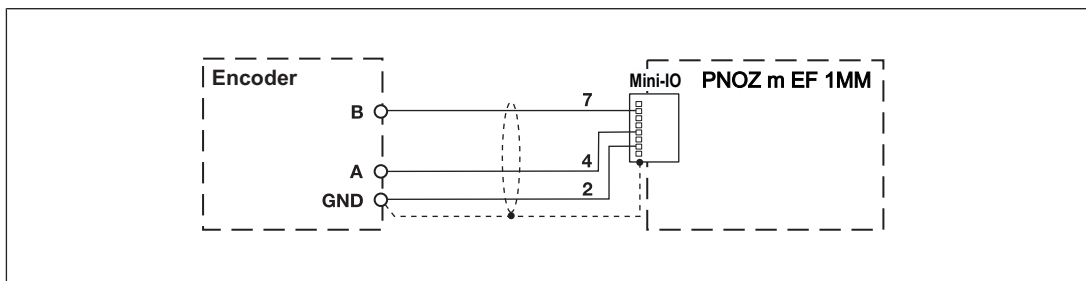
Encoder types:

▶ TTL differential

▶ HTL differential

▶ sin/cos 1 Vss

▶ Hiperface

Please note:

▸ Tracks/A, /B, Z, and /Z must remain free
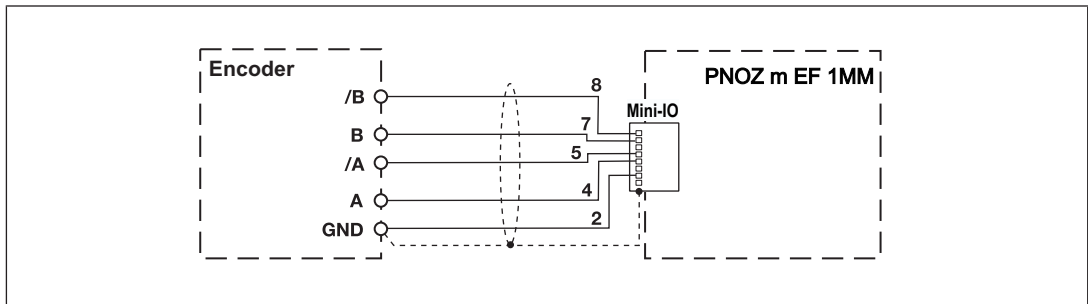
6.4.2 Connect encoder with Z index

Encoder types:

▸ TTL single Z Index

▸ HTL single Z Index

Please note:

▸ Tracks /A, /B and /Z must remain free
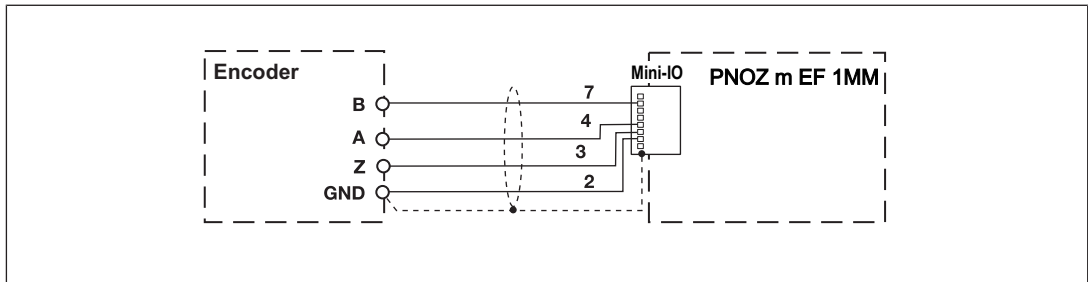
Encoder types:

▸ TTL diff. Z Index

▸ HTL diff. Z Index

▸ sin/cos 1 Vss Z Index
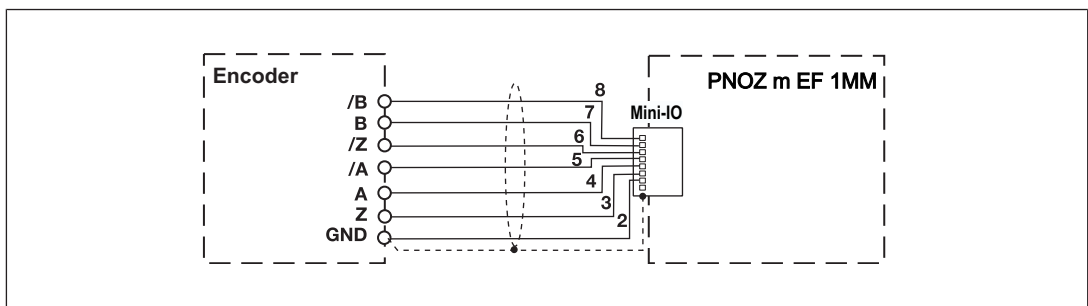
6.4.3   Connect encoder via an adapter

The adapter (see Accessories [51]) is connected between the encoder and the drive. The output on the adapter is connected to the Mini-IO socket on the PNOZ m EF 1MM.
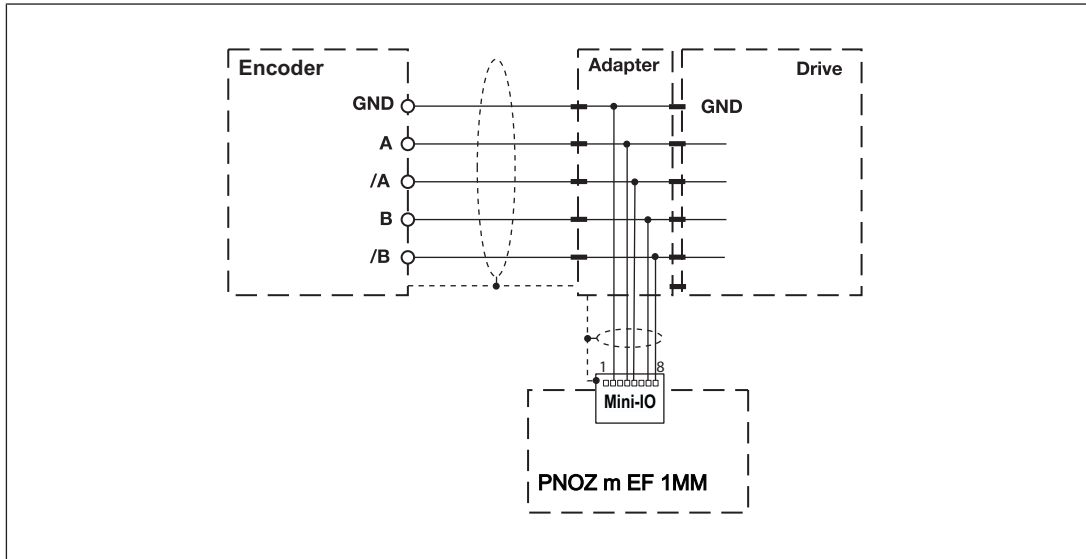
6.5   Connection of proximity switch and encoder

When connecting the encoders and proximity switches, please refer to the chapter entitled "EMC-compliant wiring".

Sensor types:

▸ Configuration: HTL single Z Freq. Ini pnp

– HTL single ended (A,B) + Ini pnp (Z)

– HTL single ended (A,B) + HTL differential (A as Z)

– HTL single ended (A,B) + HTL single ended (A as Z)

▸ Configuration: TTL single Z Freq. Ini pnp

– TTL single ended (A,B) + Ini pnp (Z)

– TTL single ended (A,B) + HTL differential (A as Z)

– TTL single ended (A,B) + HTL single ended (A as Z)

Please note:
Tracks /A, /B and /Z must remain free.
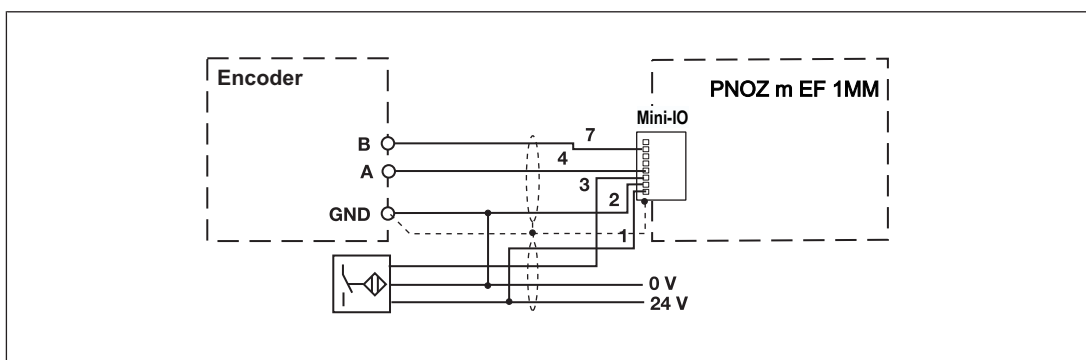
Sensor types:

▸ Configuration: TTL differential Z Freq. Ini pnp

– TTL differential (A,/A,B,/B) + Ini pnp (Z)

– TTL differential (A,/A,B,/B) + HTL differential (A as Z)

– TTL differential (A,/A,B,/B) + HTL single ended (A as Z)

▸ Configuration: HTL differential Z Freq. Ini pnp

– HTL differential (A,/A,B,/B) + Ini pnp (Z)

– HTL differential (A,/A,B,/B) + HTL differential (A as Z)

– HTL differential (A,/A,B,/B) + HTL single ended (A as Z)

▸ Configuration: sin/cos 1 Vss Z Freq. Ini pnp

– sin/cos 1 Vss (A,/A,B,/B) + Ini pnp (Z)

– sin/cos 1 Vss (A,/A,B,/B) + HTL differential (A as Z)

– sin/cos 1 Vss (A,/A,B,/B) + HTL single ended (A as Z)

▸ Configuration: Hiperface Z Freq. Ini pnp

– Hiperface (A,/A,B,/B) + Ini pnp (Z)

– Hiperface (A,/A,B,/B) + HTL differential (A as Z)

– Hiperface (A,/A,B,/B) + HTL single ended (A as Z)

Please note:

Track /Z must remain free!!
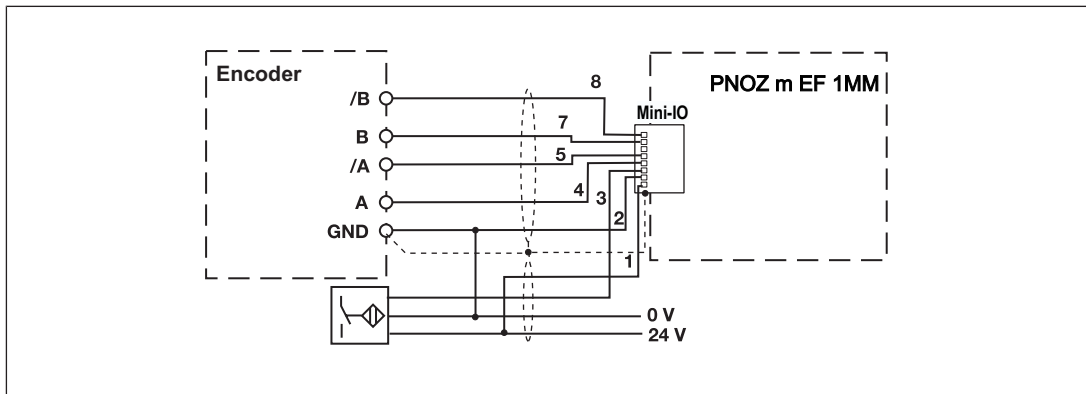
6.6   EMC-compliant wiring

EMC-compliant wiring for connecting an encoder
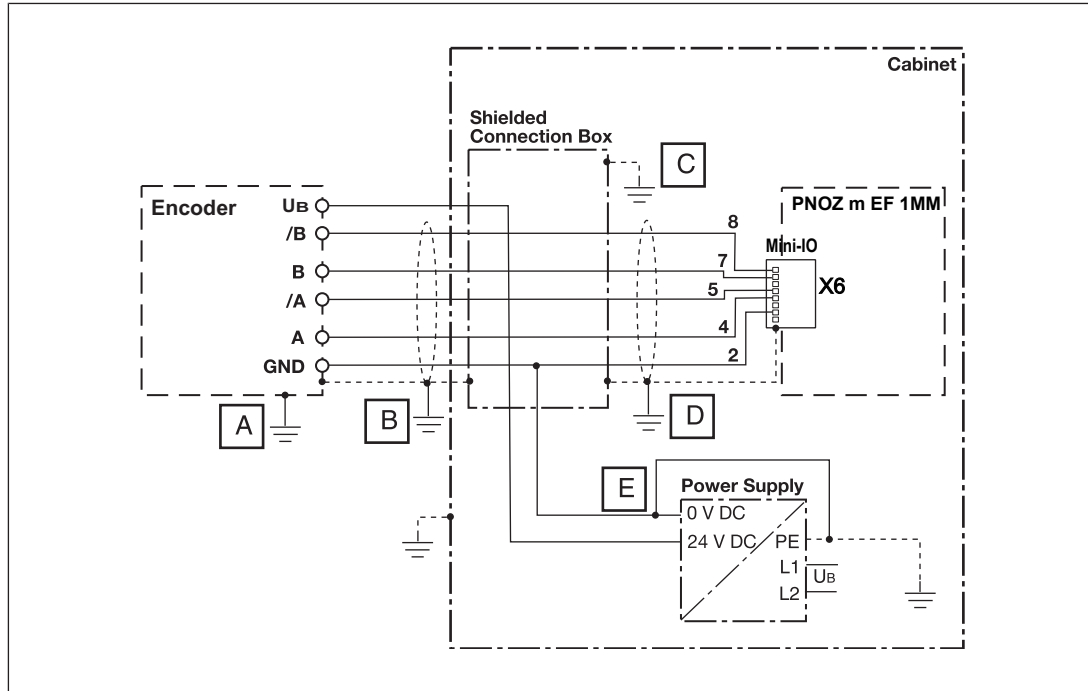
To avoid EMC interference we recommend that the shield on the sensor cables or the housing of the shielded junction box is only connected to earth at a single point:
A **or** B **or** C **or** D **or** E
Conductor loops outside the shield must be avoided.
If a shielded junction box is not used, the shield must run continuously from the sensor to the evaluation device.

EMC-compliant wiring for connecting an encoder with drive
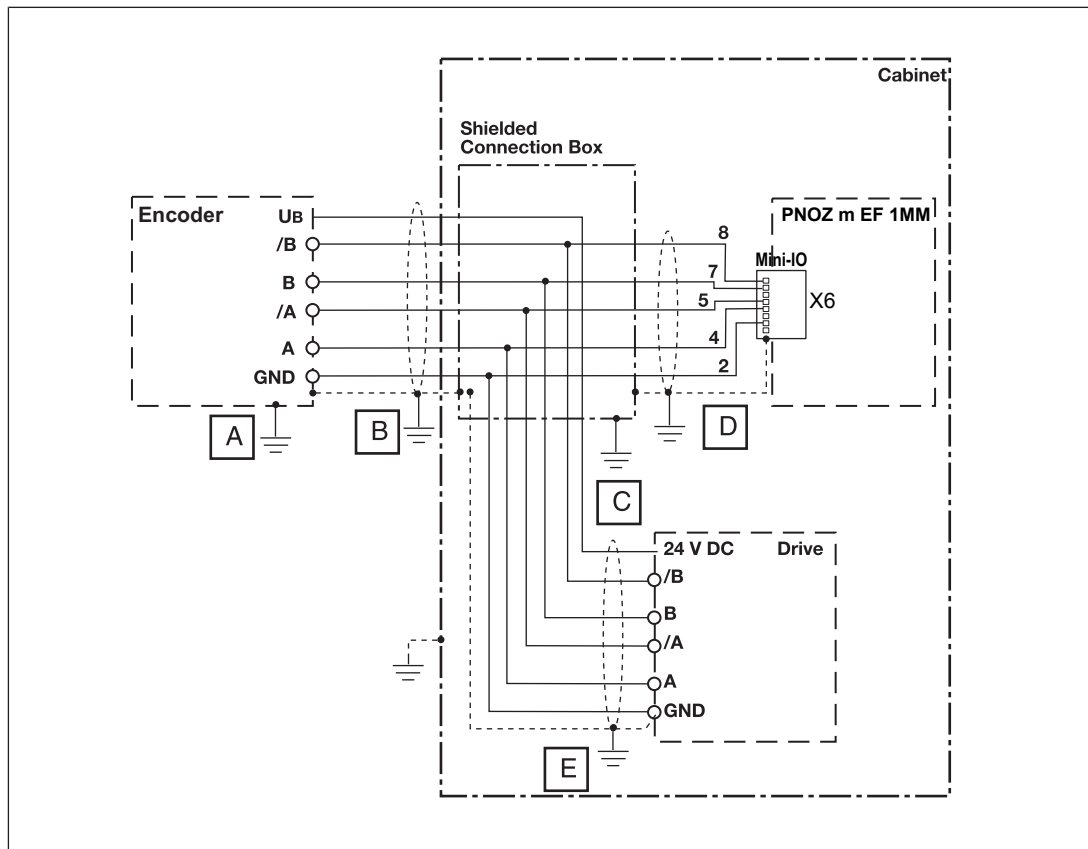
To avoid EMC interference we recommend that the shield on the sensor cables or the housing of the shielded junction box is only connected to earth at a single point:
A **or** B **or** C **or** D **or** E
Conductor loops outside the shield must be avoided.
If a shielded junction box is not used, the shield must run continuously from the sensor to the evaluation device.

EMC-compliant wiring for connecting 2 proximity switches
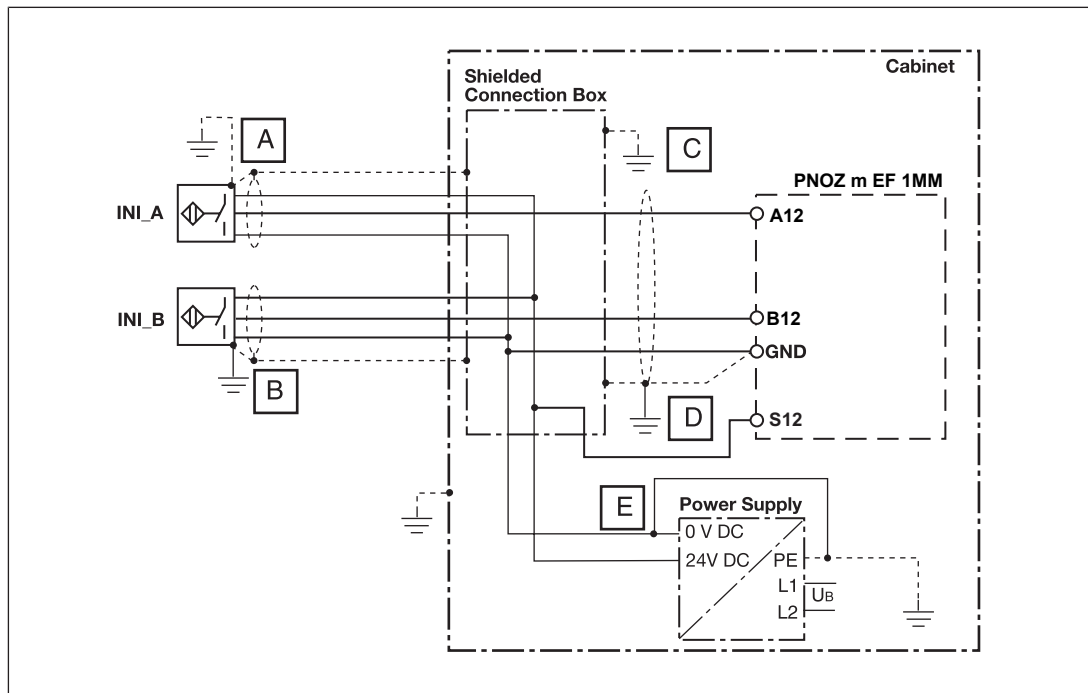
To avoid EMC interference we recommend that the shield on the sensor cables or the housing of the shielded junction box is only connected to earth at a single point:
A **or** B **or** C **or** D **or** E
Conductor loops outside the shield must be avoided.
If a shielded junction box is not used, the shield must run continuously from the sensor to the evaluation device.

6.7   Download modified project to the PNOZmulti system

As soon as an additional expansion module has been connected to the system, the project must be amended using the PNOZmulti Configurator. Proceed as described in the operating instructions for the base unit.

> **NOTICE**
>
> For the commissioning and after every program change, you must check whether the safety devices are functioning correctly.

7 Operation

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" will light up on the base unit.

7.1 Messages

Legend

⌖	LED on
◖	LED flashes
●	LED off

LED					Error
Power	Run	Diag	Fault	Axis 1	
					No supply voltage
⌖	⌖				Expansion module PNOZ m EF 1MM running without error.
⌖					Expansion module PNOZ m EF 1MM is in a STOP condition.
⌖	⌖			⌖	Axis is configured and is running.
⌖			◖		Internal error on the expansion module PNOZ m EF 1MM or on the overall system. Expansion module is in a safe condition.
⌖			⌖		External error on the expansion module PNOZ m EF 1MM or on the overall system. Expansion module is in a safe condition.
⌖				◖	Internal error on axis 1 of the expansion module PNOZ m EF 1MM. Expansion module is in a safe condition.
⌖	⌖	◖		◖	Implausible sensor signal
⌖	⌖	◖	◖	◖	Implausible sensor signal or internal error

8 Technical details

General	
Approvals	**BG, CCC, CE, EAC (Eurasian), TÜV, cULus Listed**
Application range	**Failsafe**
Module's device code	**00E3h**
Electrical data	
Supply voltage	
for	**Module supply**
internal	**Via base unit**
Voltage	**24 V**
Kind	**DC**
Current consumption	**90 mA**
Power consumption	**2 W**
Max. power dissipation of module	**2,2 W**
Status indicator	**LED**
Proximity switch input	
Number of inputs	**2**
Input signal level	
Signal level at "1"	**11 - 30 V**
Signal level at "0"	**0 - 3 V**
Input resistance	**22 kOhm**
Input's frequency range	**0 - 5 kHz**
Configurable monitoring frequency	
Without hysteresis	**0.1 Hz - 5 kHz**
Incremental encoder input	
Number of inputs	**1**
Connection type	**Mini-IO female connector, 8-pin**
Input signal level	**0,5 - 30 Vss**
Phase position for the differential signals A, /A and B,/B	**90° ±30°**
Overload protection	**-50 - 65 V**
Input resistance	**20 kOhm**
Input's frequency range	**0 - 500 kHz**
Configurable monitoring frequency	
Without hysteresis	**0.1 Hz - 500 kHz**
Inputs	
Potential isolation	**yes**
Times	
Reaction time after limit value is exceeded	**1/f_ist + 16 ms**
Environmental data	
Ambient temperature	
In accordance with the standard	**EN 60068-2-14**
Temperature range	**0 - 60 °C**
Forced convection in control cabinet off	**55 °C**

Environmental data	
Storage temperature	
In accordance with the standard	**EN 60068-2-1/-2**
Temperature range	**-25 - 70 °C**
Climatic suitability	
In accordance with the standard	**EN 60068-2-30, EN 60068-2-78**
Condensation during operation	**Not permitted**
EMC	**EN 61131-2**
Vibration	
In accordance with the standard	**EN 60068-2-6**
Frequency	**5 - 150 Hz**
Acceleration	**1g**
Shock stress	
In accordance with the standard	**EN 60068-2-27**
Acceleration	**15g**
Duration	**11 ms**
Max. operating height above sea level	**2000 m**
Airgap creepage	
In accordance with the standard	**EN 61131-2**
Overvoltage category	**II**
Pollution degree	**2**
Rated insulation voltage	**30 V**
Protection type	
In accordance with the standard	**EN 60529**
Mounting area (e.g. control cabinet)	**IP54**
Housing	**IP20**
Terminals	**IP20**
Potential isolation	
Potential isolation between	**Sensor and system voltage**
Type of potential isolation	**Functional insulation**
Rated surge voltage	**2500 V**
Mechanical data	
Mounting position	**Horizontal on top hat rail**
DIN rail	
Top hat rail	**35 x 7,5 EN 50022**
Recess width	**27 mm**
Material	
Bottom	**PC**
Front	**PC**
Top	**PC**
Connection type	**Spring-loaded terminal, screw terminal**
Mounting type	**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 without crimp connectors or with TWIN crimp connectors	**0,2 - 1,5 mm², 24 - 16 AWG**

Mechanical data	
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	**101,4 mm**
Width	**22,5 mm**
Depth	**111 mm**
Weight	**90 g**

Where standards are undated, the 2013-01 latest editions shall apply.

8.1 Safety characteristic data

Operating mode	EN ISO 13849-1: 2008 PL	EN ISO 13849-1: 2008 Category	EN IEC 62061 SIL CL	EN IEC 62061 PFH_D [1/h]	IEC 61511 SIL	IEC 61511 PFD	EN ISO 13849-1: 2008 T_M [year]
Monitoring 1 encoder	**PL d**	**Cat. 2**	**SIL CL 2**	**1,80E-08**	**SIL 2**	**1,58E-03**	**20**
Monitoring 2 encoder	**PL e**	**Cat. 3**	**SIL CL 3**	**1,01E-09**	**SIL 3**	**8,41E-05**	**20**
Monitoring safe encoder	**PL e**	**Cat. 4**	**SIL CL 3**	**2,35E-09**	**SIL 3**	**2,04E-04**	**20**
Logic	**PL e**	**Cat. 4**	**SIL CL 3**	**3,37E-10**	**SIL 3**	**2,88E-05**	**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.

9 Supplementary data

9.1 Categories

9.1.1 Safety level

The maximum achievable safety level depends, among other things, on the sensor, the wiring and the operating mode of the PNOZ m EF 1MM.

> **INFORMATION**
>
> The safety-related characteristic data of the PNOZ m EF 1MM and all other devices that are used must be taken into account when calculating the safety level. We recommend that you use the PAScal software tool to calculate the safety function's SIL/PL values.
>
> The safety assessments below only consider the subsystems *Sensor* and PNOZ m EF 1MM. The *Actuator* subsystem depends on the application and must also be considered in the overall assessment.

Information on the safety-related characteristic data for the subsystems *Sensor* and PNOZ m EF 1MM

Example:

Sensor subsystem			Subsystem PNOZ m EF 1MM	
Category	MTTFd	DC	Operating mode	PFH [1/h]
2	Manufacturer-specific	90 %	Monitoring 1 sensor	1,83E-08

The values for *Category* and *DC* can be set for the sensor subsystem, bearing in mind the restrictions stated in the respective chapter. The MTTFd value must be stated by the sensor manufacturer.

The values for *DC* refer to the standard EN 61508.

Assuming that all faults are dangerous, MTTF = MTTFd can be set.
The characteristic value MTTF is a property of the sensor, which may only be stated by the manufacturer.

Forced dynamisation:
When monitoring sensors with square output signals (TTL, HTL) or safe sensors, the axis must be moved within 8 hours so that the signal changes on all the connected tracks.

Key:
SRP/CS = Safety-related part of a control system (EN 13849-1, Tab. 2)

9.1.2 Safety functions

The following safe monitoring functions are available:

▸ Safe Speed Monitoring (SSM)

▸ Safe Speed Range Monitoring (SSR-M)

▸ Safe Direction Monitoring (SDI-M)

▸ Safe Operating Stop Monitoring (SOS-M)

▸ Safe Stop 1 Monitoring (SS1-M)

▸ Safe Stop 2 Monitoring (SS2-M)

The safety functions of the PNOZ m EF 1MM are monitoring functions, whereby a safe output signal is used to show if defined limit values are exceeded.

The reaction function that takes place (e.g. shutting down the drive, activating a mechanical brake) when exceeded limit values are detected during the normal operation of the safety function must be defined and implemented by the machine/plant developer and does not form part of the PNOZ m EF 1MM.

The monitoring function of the PNOZ m EF 1MM can be used to implement safety functions defined in the standard EN 61800-5-2 for Adjustable speed electrical power drive systems.

Safety functions in accordance with EN 61800-5-2	Implemented with monitoring function of the PNOZ m EF 1MM
Safe Operating Stop (SOS)	Safe Operating Stop Monitoring (SOS-M)
Safe Speed Range (SSR)	Safe Speed Range Monitoring (SSR-M)
Safe Direction (SDI)	Safe Direction Monitoring (SDI-M)
Safe Speed Monitoring (SSM)	Safe Speed Monitoring (SSM)
Safe Stop 1 (SS1)	Safe Stop 1 Monitoring (SS1-M)
Safe Stop 2 (SS2)	Safe Stop 2 Monitoring (SS2-M)

9.1.3 Safety-related characteristic data for operation with non-safety-related encoder without additional requirements

9.1.3.1 Permitted sensor types and output signals

Permitted encoder types:

▸ Rotary non-safety-related encoders

▸ Linear non-safety-related encoders

Permitted output signals:

▸ Square output signals TTL, single ended

▸ Square output signals TTL, differential

▸ Square output signals HTL, single ended

- ▸ Square output signals HTL, differential
- ▸ Sin/Cos output signals 1Vss, reference voltage
- ▸ Sin/Cos output signals 1Vss, differential

9.1.3.2 Safety-related architecture

To calculate the safety function you will need the following data for the "sensor" subsystem and the subsystem PNOZ m EF 1MM:

Sensor			Subsystem PNOZ m EF 1MM	
Category	MTTFd	DC	Operating mode	PFH (1/h)
1*	Manufacturer-specific	0 %	Monitoring 1 sensor	1,83E-08

The values for *DC* refer to the standard EN 61508.

*In accordance with EN ISO 13849-1, Category 1 is only met if the sensor is a "well-tried component".

9.1.3.3 Achievable safety level

Monitoring function	PL in accordance with EN ISO 13849-1: 2006	SIL CL in accordance with EN IEC 62061
SOS-M SSR-M SDI-M SSM SS1-M SS2-M	PL c (Cat.1)	-

9.1.4 Safety-related characteristic data for operation with non-safety-related encoder with mechanical fault exclusion

In accordance with EN 61800-5-2: 2007, Table D.16 (Motion and position feedback sensors), fault exclusions are permitted for faults in the mechanical connection between the sensor and motor.

9.1.4.1 Permitted sensor types and output signals

Permitted encoder types:

- ▸ Rotary non-safety-related encoders

Permitted output signals:

- ▸ Sin/Cos output signals 1Vss, reference voltage
- ▸ Sin/Cos output signals 1Vss, differential

<table>
<tr><td>!</td><td>**NOTICE**

The signal tracks Cos and Sin must be generated independently. This means that the sine and cosine signals in the encoder must be conducted in independent channels, from the optics to the interface.

The two signal tracks must not be generated by a common processor.

One signal may not be derived from the other signal via an electronic circuit.</td></tr>
</table>

9.1.4.2 Safety-related architecture
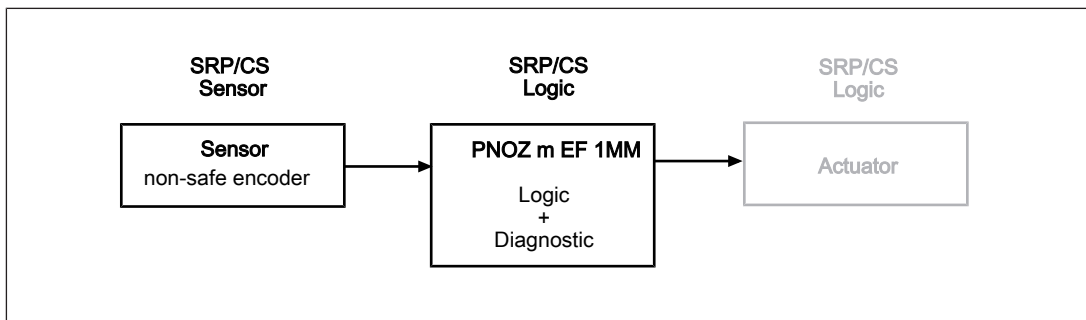
To calculate the safety function you will need the following data for the "sensor" subsystem and the subsystem PNOZ m EF 1MM:

Sensor			Subsystem PNOZ m EF 1MM	
Category	MTTFd	DC	Operating mode	PFH (1/h)
2	Manufacturer-specific	90 %	Monitoring 1 sensor	1,83E-08

The values for *DC* refer to the standard EN 61508.

9.1.4.3 Achievable safety level

Monitoring function	PL of EN ISO 13849-1: 2006	SIL CL in accordance with EN IEC 62061
SOS-M SSR-M SDI-M SSM SS1-M SS2-M	PL d (Cat.2)	2

9.1.5 Safety-related characteristic data for operation with non-safety-related encoder with diagnostics via the drive controller

The detection of sensor errors (diagnostics for the sensor subsystem via the evaluation device) can be supplemented with a drive controller.

9.1.5.1 Permitted sensor types and output signals

Permitted sensor types:

▸ Rotary non-safety-related encoders

▸ Linear non-safety-related encoders

Permitted output signals:

▸ Square output signals TTL, single ended

▸ Square output signals TTL, differential

▸ Square output signals HTL, single ended

▸ Square output signals HTL, differential

▸ Sin/Cos output signals 1Vss, reference voltage

▸ Sin/Cos output signals 1Vss, differential

9.1.5.2 Requirements of the drive controller

▸ Parameters for the control loops and motor control must be set in such a way as to guarantee stabile operation.
Drag error detection (see below) must be capable of operating in accordance with the requirements of the safety function.

▸ The motor must be operated with a current impressing control procedure, based on the rotor position (field-oriented control). If the analogue track signals are idle, field-oriented control will brake and/or stop the rotor.

▸ The drive controller must be in position control operating mode.

▸ If a maximum error variable is exceeded (set/true comparison) the drive controller must switch to a fault condition and stop the drive (drag error detection). The error reaction to drag error detection should be a controlled motor stop.

▸ Fault detection via the error variable with subsequent shutdown must meet the requirements of the safety function, with regard to reaction times for example.

▸ The drive controller must evaluate the same incremental/SinCos signals from the encoder for control as are processed by the safe evaluation device (important on encoders with combined analogue/digital interface).

9.1.5.3 Safety-related architecture
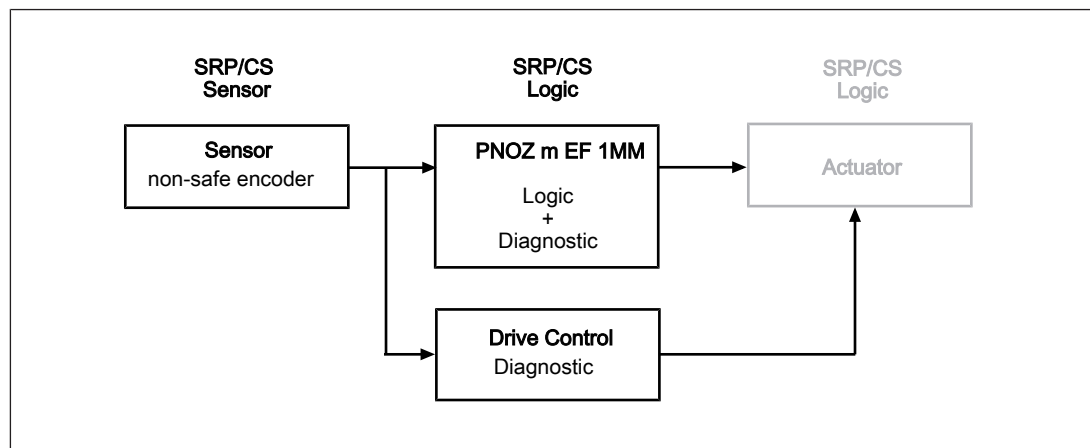
To calculate the safety function you will need the following data for the "sensor" subsystem and the subsystem PNOZ m EF 1MM:

Sensor			Subsystem PNOZ m EF 1MM	
Category	**MTTFd**	**DC**	**Operating mode**	**PFH (1/h)**
2	Manufacturer-specific	90 %	Monitoring 1 sensor	1,83E-08

The values for *DC* refer to the standard EN 61508.

9.1.5.4 Achievable safety level

Monitoring function	PL of EN ISO 13849-1: 2006	SIL CL in accordance with EN IEC 62061
SOS-M SSR-M SDI-M SSM SS1-M SS2-M	PL d (Cat.2)	2

9.1.6 Safety-related characteristic data for operation with a safe encoder

Safe encoders are certified in accordance with EN 61508, EN 13849 and EN 62061. In order to achieve the safety level stated by the encoder, the safe evaluation device (PNOZ m EF 1MM) must normally detect designated errors. Details of the safe encoder's requirements of the evaluation device can be found in the user documentation for the safe encoder. The encoder and evaluation device must be compatible.

9.1.6.1 Permitted sensor types and output signals

Permitted encoder types:

▸ Rotary safety-related encoders

▸ Linear safety-related encoders

Permitted output signals:

▸ Sin/Cos output signals 1Vss, reference voltage

▸ Sin/Cos output signals 1Vss, differential

9.1.6.2 Safety-related architecture
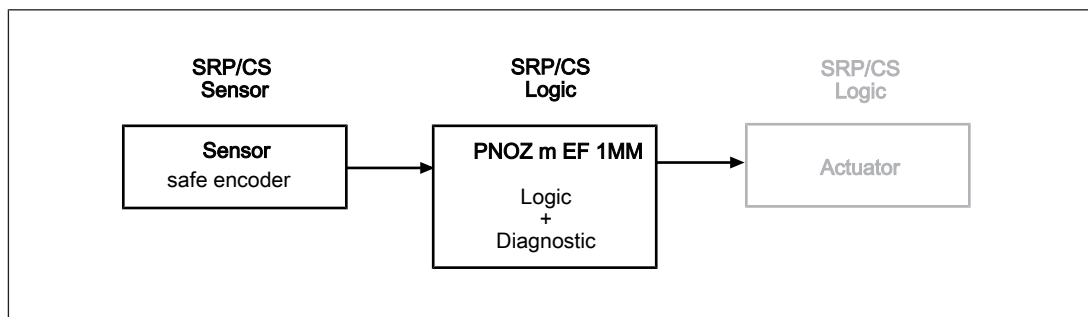
To calculate the safety function you will need the following data for the "sensor" subsystem and the subsystem PNOZ m EF 1MM:

Sensor			Subsystem PNOZ m EF 1MM	
PL	SIL	PFH (1/h)	Operating mode	PFH (1/h)
See manufacturer			Monitoring Safe sensor	2,69E-09

9.1.6.3 Achievable safety level

Monitoring function	PL of EN ISO 13849-1: 2006	SIL CL in accordance with EN IEC 62061
SOS-M SSR-M SDI-M SSM SS1-M SS2-M	PL e (Cat.4)	3

9.1.7 Safety-related characteristic data for operation with a safe encoder with Z index

Safe encoders are certified in accordance with EN 61508, EN 13849 and EN 62061. In order to achieve the safety level stated by the encoder, the safe evaluation device (PNOZ s30) must normally detect designated errors. Details of the safe encoder's requirements of the evaluation device can be found in the user documentation for the safe encoder. The encoder and evaluation device must be compatible.

### 9.1.7.1 Permitted sensor types and output signals

Permitted encoder types:

▸ Rotary safety-related encoders
▸ Linear safety-related encoders

Permitted output signals:

▸ Square output signals TTL, differential with Z index
▸ Square output signals HTL, differential with Z index
▸ Sin/Cos output signals 1Vss, reference voltage with Z index
▸ Sin/Cos output signals 1Vss, differential with Z index

9.1.7.2   Safety-related architecture
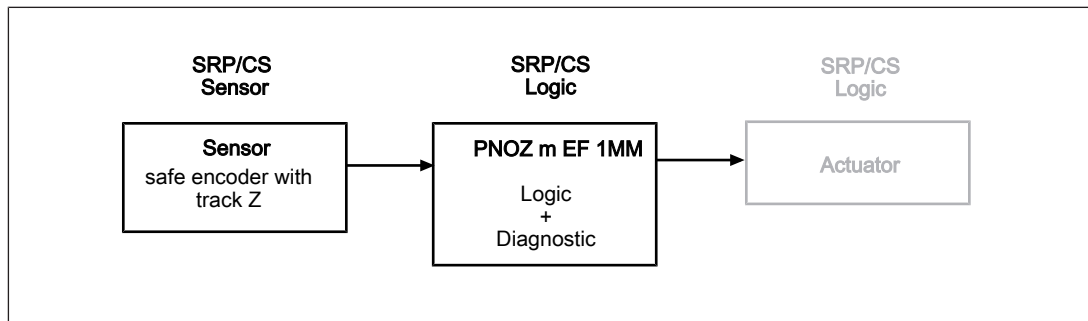
To calculate the safety function you will need the following data for the "sensor" subsystem and the subsystem PNOZ m EF 1MM:

Sensor			Subsystem PNOZ m EF 1MM	
PL	SIL	PFH (1/h)	Operating mode	PFH (1/h)
See manufacturer			Monitoring 2 sensors	1,35E-09

9.1.7.3   Achievable safety level

Monitoring function	PL of EN ISO 13849-1: 2006	SIL CL in accordance with EN IEC 62061
SOS-M SSR-M SDI-M SSM SS1-M SS2-M	PL e (Cat.4)	3

9.1.8   Safety-related characteristic data for operation with non-safety-related encoder and proximity switch

The speed monitoring of the non-safety-related encoder can be verified via an additional reference sensor.

9.1.8.1   Permitted sensor types and output signals

**Non-safety-related encoder**

Permitted encoder types:

▶   Rotary non-safety-related encoders

▶   Linear non-safety-related encoders

Permitted output signals:

▶   Square output signals TTL, single ended

▶   Square output signals TTL, differential

▶   Square output signals HTL, single ended

▶   Square output signals HTL, differential

▶   Sin/Cos output signals 1Vss, reference voltage

> ▸ Sin/Cos output signals 1Vss, differential

Reference sensor

Permitted encoder types:

▸ Rotary non-safety-related encoders

▸ Linear non-safety-related encoders

▸ Inductive proximity switches

Permitted output signals:

▸ Square output signals HTL, single ended

▸ Square output signal 24 V, pnp

9.1.8.2 Safety-related architecture
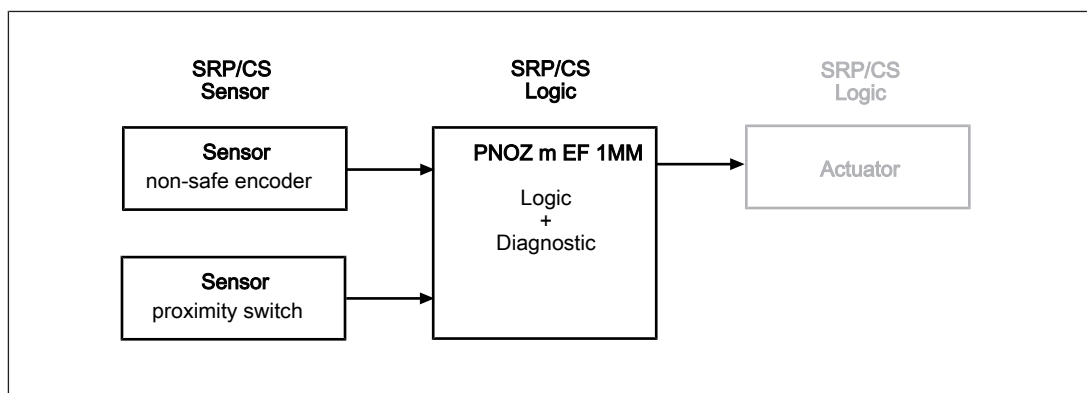
To calculate the safety function you will need the following data for the "sensor" subsystem and the subsystem PNOZ m EF 1MM:

Sensor			Subsystem PNOZ m EF 1MM	
Category	**MTTFd**	**DC**	**Operating mode**	**PFH (1/h)**
4	Manufacturer-specific	90 %	Monitoring 2 sensors	1,35E-09

In a worst case scenario, the sensor subsystem's characteristic value MTTFd is calculated from the inferior (lower) value of the two sensors.

The values for *DC* refer to the standard EN 61508.

9.1.8.3 Achievable safety level

Monitoring function	PL of EN ISO 13849-1: 2006	SIL CL in accordance with EN IEC 62061
SOS-M SDI-M SS2-M	PL c (Cat.1)	-
SSR-M SSM SS1-M	PL e (Cat.4)	3

Please note:

For the "sensor" subsystem, a minimum speed must be exceeded within forced dynamisation.

The minimum speed depends on the ratio of the frequency at tracks AB "f_{AB}" to the frequency at track Z "f_Z" in your configuration (see PNOZmulti Configurator *Element Motion Monitor*, value *Calculated Ratio AB/Z*) and is determined as follows:

▸ when f_{AB}/f_Z *Ratio* ≥ 1.0
  f_Z = 10 mHz or f_{AB} = (f_{AB}/f_Z) x 10 mHz

▸ when f_{AB}/f_Z *Ratio* < 1.0
  f_{AB} = 10 mHz or f_Z = 10 mHz/(f_{AB}/f_Z)

At the very latest, a feasibility error will be detected when a tolerance expires. The tolerance level depends on the ratio of the frequency at tracks AB "f_{AB}" to the frequency at track Z "f_Z" in your configuration (*fAB/fZ Verh.* setting in the menu) and is calculated as follows:

▸ when f_{AB}/f_Z *Ratio* ≥ 1.0
  7.5 Z-pulses or 7.5 x *(f_{AB}/f_Z)* AB-pulses

▸ when f_{AB}/f_Z *Ratio* < 1.0
  4.5 AB-pulses or *4.5/(f_{AB}/f_Z)* Z-pulses

9.1.9 Safety-related characteristic data for operation with 2 proximity switches

9.1.9.1 Permitted sensor types and output signals
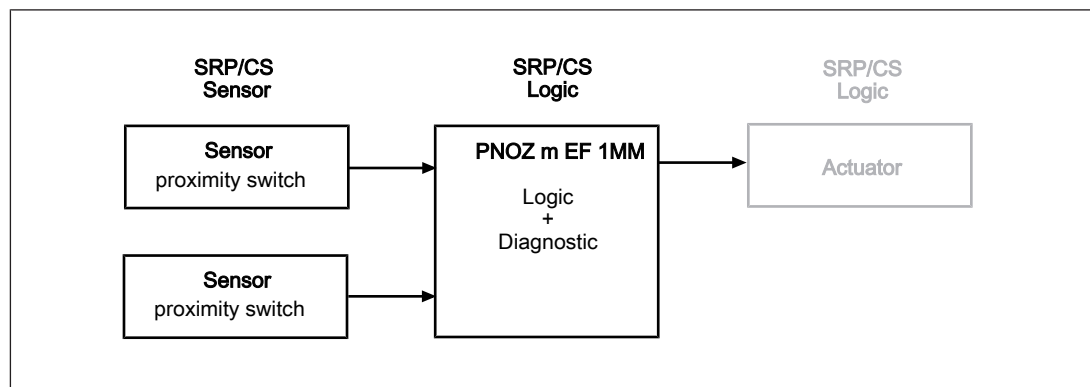
Non-safety-related sensor

Permitted sensor types:

▸ Inductive proximity switches

Permitted output circuits:

▸ pnp

▸ npn

9.1.9.2 Safety-related architecture

To calculate the safety function you will need the following data for the "sensor" subsystem and the subsystem PNOZ m EF 1MM:

Sensor			Subsystem PNOZ m EF 1MM	
Category	MTTFd	DC	Operating mode	PFH (1/h)
4	Manufacturer-specific	90 %	Monitoring 2 sensors	1,35E-09

In a worst case scenario, the sensor subsystem's characteristic value MTTFd is calculated from the inferior (lower) value of the two sensors.

The values for *DC* refer to the standard EN 61508.

9.1.9.3   Achievable safety level

Monitoring function	PL of EN ISO 13849-1: 2006	SIL CL in accordance with EN IEC 62061
SOS-M SDI-M SS2-M	-	-
SSR-M SSM SS1-M	PL e (Cat.4)	3

Please note:
Common cause failures (CCF) are possible for the sensor subsystem. An appropriate analysis must be carried out.

To use proximity switches 1 and 2 we recommend that you:

▸ Use different technologies/design or physical principles (e.g. different manufacturers) and

▸ Evaluate the sensor supply via track S

10   Order reference

10.1   Product

Product type	Features	Order no.
PNOZ m EF 1MM	Expansion module	772 170

10.2   Accessories

Connection terminals

Product type	Features	Order no.
Spring terminals PNOZ mmcxp 1 pc.	Spring-loaded terminals, 1 pieces	783 542
Screw terminals PNOZ mmcxp 1 pc.	Screw terminals, 1 piece	793 542

Terminator, jumper

Product type	Features	Order No.
PNOZ mm0.xp connector left	Jumper yellow/black to connect the modules, 10 piece	779 260

Adapter cable

Product type	Features	Order No.
MM A MINI-IO CAB99	1.50 m	772 200
MM A MINI-IO CAB99	2.50 m	772 201
MM A MINI-IO CAB99	5.0 m	772 202

Product type	Features	Order No.
PNOZ msi b4 Box	Connection box	773 845

▶ Support

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