
# PSEN enc sincos/HTL

PILZ
THE SPIRIT OF SAFETY

- PSEN sensor technology

**Operating Manual-1005022-EN-01**

# Contents

# 1 General information

This operating manual contains the following topics:

- General functional description
- Basic safety information with declaration of the intended use
- Characteristics
- Mounting
- Installation/Commissioning
- Error causes and remedies

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.

## 1.1 Applicability

This documentation is valid for the products:

- PSEN enc sincos 4096 hs
- PSEN enc sincos 4096 ss
- PSEN enc HTL 1024 ss
- PSEN enc HTL 1024 hs

It is valid until new documentation is published.

## 1.2 Abbreviations and terms used

| | |
|---|---|
| $DC_{avg}$ | ***D***iagnostic ***C***overage<br>Average diagnostic coverage |
| ESD | ***E***lectro ***S***tatic ***D***ischarge |
| EU | ***E***uropean ***U***nion |
| EMC | ***E***lectro***M***agnetic ***C***ompatibility |
| Functional safety (FS) | Part of the overall system safety, which depends on the correct functioning of safety-related systems for risk reduction. Functional safety is ensured when each safety function is executed as specified. |
| Fault exclusion | Compromise between the technical safety requirements and the theoretical possibility of an error occurring |
| HTL | ***H***igh-***T***hreshold-***L***ogic |
| IEC | International Electrotechnical Commission |
| IEEE | ***I***nstitute of ***E***lectrical and ***E***lectronics ***E***ngineers |
| ISO | ***I***nternational ***S***tandard ***O***rganization |
| $MTTF_d$ | ***M***ean ***T***ime ***T***o ***F***ailure (dangerous)<br>Mean time until dangerous failure |
| $PFD_{av}$ | ***Av***erage ***P***robability of ***F***ailure on ***D***emand<br>Average probability of failure of a safety function with low demand |
| PFH | ***P***robability of ***F***ailure per ***H***our<br>Operating mode with high requirement rate or continuous demand. Probability of dangerous failure per hour. |
| $PFH_D$ | ***P***robability of a **d**angerous ***F***ailure per ***H***our<br>Average probability of a dangerous failure per hour according to ISO 13849-1. |
| PL | ***P***erformance ***L***evel, according to ISO 13849-1: Discrete level, which specifies the capability of safety-related parts of a control to execute a safety function under foreseeable conditions. |
| SIL | ***S***afety ***I***ntegrity ***L***evel, according to IEC 62061: Four discrete levels (SIL1 to SIL4). The higher the SIL of a safety-related system, the lower the probability that the system cannot execute the required safety functions. |
| SIS | ***S***afety ***I***nstrumented ***S***ystem: is used to protect a dangerous process and reduce the risk of an accident. Process instruments are a constituent of a Safety Instrumented System. This comprises the essential components of a complete safety-relevant process unit:<br>Sensor, fail-safe processing unit (control, evaluation device) and actuator |
| STP | ***S***hielded ***T***wisted ***P***air |
| VDE | ***V***erband ***d***er ***E***lektrotechnik, Elektronik und Informationstechnik (Association for Electrical, Electronic and Information Technologies) |
| Repeat test (proof test) | Repetitive test to detect hidden dangerous failures in a safety-related system. |

## 1.3 General functional description

The rotary measuring system is a safe and incremental position measuring system.

The measuring system has been designed so that it can be used in systems which require the following safety functions according to EN 61800-5-2:

- Safe Direction (SDI)
- Safe Stop 1 (SS1)
- Safe Stop 2 (SS2)
- Safe Operating Stop (SOS)
- Safely Limited Speed (SLS)
- Safe Speed Range (SSR)
- Safe Speed Monitor (SSM)
- Safely-Limited Acceleration (SLA)
- Safe Acceleration Range (SAR)
- Safely-Limited Position (SLP)
- Safely-Limited Increment (SLI)
- Safe Cam (SCA)

The measuring system as a sensor is always part of a safety chain.

The following shaft designs can be used for the mechanical coupling:

- Solid shaft
- Hollow shaft

Depending on the safety functions safety-related differences arise:

- SIL3/PLe/Cat.3, in conjunction with velocity oriented safety functions
- SIL2/PLd/Cat.3, in conjunction with positioning oriented safety functions

## 1.3.1 Main features

The entire system electronics has a discrete design. Neither microcontrollers nor programmable logic elements are contained in the system electronics. There is no interpolation or signal multiplexing. All signal lines are led separately within the electronics.

### 1.3.1.1 PSEN enc sincos 4096 hs, PSEN enc sincos 4096 ss

Incremental interface with sinusoidal output signals A, /A, B, /B, Z, /Z; output level 1 Vss.
The safety-evaluated measuring system is designed for the implementation of safety-related functions in relation to speed and direction of rotation. In the downstream fail-safe evaluation device an ideal error detection also occurs through evaluation of the magnitude “$SIN(x)^2 + COS(x)^2 = 1$”.
The Z-, /Z-signals are not evaluated from a safety viewpoint and may not be used for safety-oriented purposes.

### 1.3.1.2 PSEN enc HTL 1024 ss, PSEN enc HTL 1024 hs

Incremental interface with digital square-wave output signals A, /A, B, /B, Z, /Z; output level in HTL logic.
The safety-evaluated measuring system is designed for the implementation of safety-related functions in relation to speed and direction of rotation.
An internal signal monitor constantly checks the magnitude "$SIN(x)^2 + COS(x)^2 = 1$". Safety-relevant errors are indicated by switching of the signal outputs to high impedance. The Z-, /Z-signals are not evaluated from a safety viewpoint and may not be used for safety-oriented purposes.

## 1.3.2 Principle of the safety function

System safety results when:

- the scanning channel is single fault safe thanks to its own diagnostic measures and circuit measures
- the evaluation device checks that the received incremental data meet the expected tolerance window according to the application.
- for PSEN enc sincos the evaluation device also checks the magnitude $SIN(x)^2 + COS(x)^2 = 1$; if the result is outside the tolerance range, the incremental data must be evaluated as unsafe. In this way the control achieves an ideal error detection.
- when errors are detected the evaluation device introduces appropriate safety measures defined by the system manufacturer
- the system manufacturer ensures, through correct mounting of the measuring system, that the measuring system is always driven by the axis to be measured and is not overloaded. A fault exclusion is required for mounting the measuring system to the drive function.
- the system manufacturer carries out a proven test during commissioning
- the downstream fail-safe evaluation device evaluates the measuring system differentially

# 2 Basic safety information

## 2.1 Definition of symbols and notes

**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.

indicates important information or features and application tips for the product used.

means that appropriate protective measures against ESD according to DIN EN 61340 5-1 Supplement 1 must be applied.

## 2.2 General risks when using the product

The product, hereinafter referred to as ***the measuring system***, is manufactured according to state-of-the-art technology and accepted safety rules. ***Nevertheless, non-intended use can pose a danger to life and limb of the user or third parties, or lead to impairment of the measuring system or other property!***
Only use the measuring system in perfect technical condition, paying attention to safety and dangers, and in compliance with the ***operating manual***! Faults which could threaten safety should be eliminated without delay!

## 2.3 Intended use

The safety measuring system can be used for the detection of angular movement and processing of measured data for a downstream evaluation device in systems in which the **protection goals** of **"Protection of speed"** and **"Protection of direction of movement"** must be safely achieved. The complete processing chain of the safety function must then satisfy the requirements of the applied safety standard.
The safety measuring system may only be used in safety applications in conjunction with an evaluation device certified according to the applied safety standard.
The system manufacturer must check that the characteristics of the measuring system satisfy his application-specific safety requirements. The responsibility or decision regarding the use of the measuring system lies with the system manufacturer.

**Intended use also includes:**

- observing all instructions in this operating manual,
- observing the nameplate and any prohibition or instruction symbols on the measuring system,
- observing the operating instructions from the machine/system manufacturer,
- operating the measuring system within the limit values specified in the technical data,
- ensuring that the fail-safe evaluation device fulfils all required safety functions,
- observing and using the checklist in the appendix,
- safe mounting (form closure) of the measuring system to the driving axis, also see chapter Mounting

## 2.4 Non-intended use

**WARNING!**
***Danger of death, physical injury and damage to property in case of non-intended use of the measuring system!***

- The following areas of use are especially forbidden:
  - in environments where there is an explosive atmosphere,
  - for medical purposes

## 2.5 Safety functions of the fail-safe evaluation device

The evaluation device, to which the measuring system is connected, must perform the following safety checks.
With regard to "Single fault safety" and "Ideal error detection" please see IFA directive "GS-IFA-M21".

To enable the correct measures to be taken in the case of error, the following applies:

- **Safe state – passive, only for measuring system – PSEN enc sincos**
  In passive safe state the measuring system does not output any valid sinusoidal output signals to the downstream fail-safe evaluation device. The evaluation device detects the error through evaluation of the magnitude $SIN(x)^2 + COS(x)^2 = 1$. If the result is outside the tolerance range, the incremental data are evaluated as unsafe. The downstream fail-safe evaluation device has an ideal error detection.
- **Safe state – active, only for measuring system – PSEN enc HTL**
  In active safe state the signal outputs are switched to high impedance. The evaluation device detects the error via an implemented cable breakage detection.

### 2.5.1 Mandatory safety checks / measures

| **Measures for commissioning, changes** | **Error reaction evaluation device** |
|---|---|
| Check that the desired automation task is executed as required. | STOP |

| **Check by the evaluation device** | **Error reaction evaluation device** |
|---|---|
| Check of incremental data according to the present automation task and safety function. | STOP |
| Two-channel monitoring of incremental outputs for cable breakage. | For high impedance -> STOP |
| Only for PSEN enc sincos<br>Evaluation of the condition $SIN(x)^2 + COS(x)^2 = 1$. The number of checks / revolution corresponds to the number of periods/revolution.<br>For the safety functions SDI, SS1, SS2, SOS, SSR, SSM a magnitude monitoring with DC = 90 % is required.<br>For the SLS safety function a two-channel evaluation of the frequency from (SIN/COS) with a DC of 90 % is required. | If outside tolerance -> STOP |
| Only for PSEN enc HTL<br>A cable break detection is required for the evaluation of the square pulse signals.<br>In the safe state, the output drivers are high impedance. | If a cable break is detected -> STOP |
| Only for PSEN enc HTL<br>Evaluation of the incremental data in differential mode and verification with respect to antivalence, quadrature and against phase equivalence between channels A and B | If outside tolerance -> STOP |

## 2.6 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 operating 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.)

## 2.7 Organizational measures

- The operating manual must always be kept ready-to-hand at the place of use of the measuring system.
- In addition to the operating manual the generally valid legal and other binding regulations on accident prevention and environmental protection must be observed and communicated.
- The respective applicable national, local and system-specific provisions and requirements must be observed and communicated.
- The operator is obliged to inform personnel about special operating features and requirements.
- Prior to commencing work, personnel working with the measuring system must have read and understood the chapter "Basic safety information".
- The type plate and any prohibition or instruction symbols applied on the measuring system must always be maintained in a legible state.
- Do not undertake any mechanical or electrical modifications to the measuring system, except for those expressly described in this operating manual.
- Repairs may only be undertaken by the manufacturer or a center or person authorized by the manufacturer.

## 2.8 Personnel selection and qualification; basic obligations

The products may only be assembled, installed, programmed, commissioned, operated, maintained and decommissioned by competent persons.
A competent person is a qualified and knowledgeable person who, because of their training, experience and current professional activity, has the specialist knowledge required. To be able to inspect, assess and operate devices, systems and machines, the person has to be informed of the state of the art and the applicable national, European and international laws, directives and standards.
It is the company’s responsibility only to employ personnel who

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

## 2.9 Safety information

**Please note:**

- Only carry out wiring work or opening and closing of electrical connections with the system de-energized.
- Do not undertake any welding work if the measuring system is already wired or switched on.
- Falling below or exceeding the permissible ambient temperature limit values must be prevented through an appropriate heating/cooling measure at the place of installation.
- The measuring system must be installed so that no direct moisture can affect the measuring system.
- Suitable aeration/ventilation and heating/cooling measures must be provided at the place of installation to prevent the temperature falling below the dew point (condensation).
- Potential hazards resulting from interactions with other systems and equipment which are or will be installed in the vicinity must be checked. The user is responsible for taking appropriate measures.
- The power supply must be protected with a fuse suitable for the supply lead cross-section.
- Cables used must be suitable for the temperature range.
- A defective measuring system must not be operated.
- Make sure that the installation environment is protected from aggressive media (acids etc.)
- Avoid shocks (e.g. hammer blows) to the shaft during installation.
- Opening the measuring system is forbidden.
- When storing and operating the measuring system unused connection plugs must either be provided with a mating plug or a protective cap. The appropriate IP protection class must be selected to meet the relevant requirements.
- The type plate specifies the technical characteristics of the measuring system. If the type plate is no longer legible or if the type plate is completely missing, the measuring system must not be operated.

**The measuring system contains components and assemblies susceptible to electrical discharge, which can be destroyed if incorrectly handled.**

– Touching the measuring system connection contacts with the fingers must be avoided, or the relevant ESD protective measures must be applied.

**Disposal**

– If disposal has to be undertaken after the lifespan of the device, the applicable country-specific regulations must be observed.

# 3 Transport / Storage

- Shipping information
  - Do not drop the device or subject it to heavy impacts!
    The device contains an optical system.
  - Use only the original packaging!
    Inappropriate packaging material may cause damage to the device in transit.

- Storage
  - Storage temperature: -40 to +90 °C
  - Store in a dry place

# 4 Technical data

## 4.1 Safety

| | |
|---|---|
| **Functional safety** | |
| DIN EN 61508 part 1 to 7 | **S**afety **I**ntegrity **L**evel (SIL): |
| - [1] SDI, SS1, SS2, SOS, SLP, SLI, SCA | - 2 |
| - [1] SLS, SSR, SSM, SLA, SAR | - 3 |
| EN ISO 13849-1 | **P**erformance **L**evel: |
| - [1] SDI, SS1, SS2, SOS, SLP, SLI, SCA | - PLd / Cat. 3 |
| - [1] SLS, SSR, SSM, SLA, SAR | - PLe / Cat. 3 |
| **Startup time** | Time between POWER-UP and safe incremental output |
| PSEN enc sincos | ≤ 30 ms |
| PSEN enc HTL | ≤ 50 ms |
| **PFH / $PFH_D$, "High demand" operating mode** | |
| PSEN enc sincos | $5{,}34 * 10^{-9}$ 1/h |
| PSEN enc HTL | $6.57 * 10^{-9}$ 1/h |
| Notice | Measuring system is used only in applications with high or continuous demand rate |
| **$MTTF_d$** | high |
| PSEN enc sincos | 1558 a |
| PSEN enc HTL | 622 a |
| [2] $DC_{avg}$ | medium (90 %) |
| **Internal process safety time** | Time between occurrence of an F-error and alarm indication |
| Overall system | ≤ 1 ms |
| **Process safety angle** | Angle between error occurrence and alarm indication |
| Through channel-internal self-diagnosis | ± 0.3510°, at 1024 periods;<br>± 0.0879°, at 4096 periods;<br>in relation to the measuring system shaft |
| **$T_1$, repeat test (proof test)** | 20 years |

[1] In accordance with EN 61800-5-2

[2] The assessment occurred in accordance with Note 2 on Table 6 of EN ISO 13849-1

## 4.2 Electrical characteristics

### 4.2.1 General

| | |
|---|---|
| **Supply voltage** | 10…30 V DC according to IEC 60364-4-41, SELV/PELV |
| Reverse polarity protection | yes |
| Short-circuit protection | yes, by internal 1 A safety fuse |
| Overvoltage protection | yes, up to ≤ 60 V DC |
| **Power consumption without load** | at 24 V DC |
| Analogue output signals | < 20 mA |
| Square-wave output signals | < 40 mA |

### 4.2.2 Device-specific

| | |
|---|---|
| **Accuracy** | |
| Usable resolution | 10 bit, 11 bit, 12 bit; depending on the device configuration |
| Safety-related | + 2 bit interpolated |
| Functional | + 8 bit interpolated |
| **PSEN enc sincos** | |
| **Incremental analogue output signals** | |
| Periods / revolution | 4096 |
| Incremental signals | A, /A, B, /B |
| Track position, electrical | 90 ° |
| Reference signals | Z, /Z, once per revolution |
| Output level | 1 Vss ± 0.2 V at 100 Ω, differential |
| Output current | 20 mA |
| Output frequency | ≤ 500 KHz |
| Short-circuit proof | yes |
| Cable specification | see Cable specification |
| **PSEN enc HTL** | |
| **Incremental square-wave output signals** | |
| Pulses / revolution | 1024 |
| Incremental signals | A, /A, B, /B |
| Track position, electrical | 90 ° |
| Zero pulse | Z, /Z, once per revolution |
| Output level HTL | Push-pull, supply voltage |
| Output current | 50 mA, per channel |
| Output frequency | ≤ 100 KHz |
| Short-circuit proof | yes |
| Cable specification | see Cable specification |

## 4.3 Ambient conditions

| | |
|---|---|
| **Vibration** | |
| DIN EN 60068-2-6 | ≤ 100 m/s², sine 50-2000 Hz |
| **Shock** | |
| DIN EN 60068-2-27 | ≤ 1000 m/s², half sine 11 ms |
| **EMC** | |
| Immunity to disturbance | EN 61000-6-2 |
| Transient emissions | EN 61000-6-3 |
| **Working temperature** | -40…+90 °C |
| Derating Hollow shaft, > 3000 rpm | Ta = 90 – 0,0062 * (n – 3000) in °C |
| **Storage temperature** | -40 °…+90 °C, dry |
| **Relative air humidity, DIN EN 60068-3-4** | 98 %, non-condensing |
| **[3] Protection class, DIN EN 60529** | |
| Shaft side | IP 65 |
| Housing side | IP 67 |

[3] valid with screwed-on mating connector and/or screwed-on cable gland

## 4.4 Mechanical characteristics

### 4.4.1 Solid shaft

| | |
|---|---|
| **Mechanically permissible speed** | ≤ 12,000 rpm |
| **Electrically permissible speed** | |
| $n_{electric}$ [rpm] = (output frequency [Hz] / no. of pulses per rev.) * 60 rpm | |
| **Bearing life** | ≥ 3.9 * $10^{10}$ revolutions at |
| Speed | ≤ 6000 rpm |
| Operating temperature | ≤ 60 °C |
| Shaft load, flange + 10 mm | ≤ 50 N axial, ≤ 100 N radial |
| **Permissible angular acceleration** | ≤ $10^4$ rad/$s^2$ |
| **Moment of inertia, typical** | 4.9 * $10^{-6}$ kg $m^2$ |
| **Start-up torque** | |
| at 20 °C | 3.4 Ncm |
| at 0 °C | 3.6 Ncm |
| at -20 °C | 7.8 Ncm |
| at -40 °C | 20 Ncm |
| **Weight, typical** | 0.3…0.5 kg |

### 4.4.2 Hollow shaft

| | |
|---|---|
| **Mechanically permissible speed** | ≤ 6,000 rpm |
| Note | Observe Derating for permissible ambient temperature |
| **Electrically permissible speed** | |
| $n_{electric}$ [rpm] = (output frequency [Hz] / no. of pulses per rev.) * 60 rpm | |
| **Shaft load, axial/radial** | Own mass |
| **Bearing life** | ≥ 3.9 * $10^{10}$ revolutions at |
| Speed | ≤ 6000 rpm |
| Operating temperature | ≤ 60 °C |
| **Permissible angular acceleration** | ≤ $10^4$ rad/$s^2$ |
| **Moment of inertia, typical** | 8.8 * $10^{-6}$ kg $m^2$ |
| **Start-up torque** | |
| at 20 °C | 3.4 Ncm |
| at 0 °C | 3.6 Ncm |
| at -20 °C | 3.8 Ncm |
| at -40 °C | 16 Ncm |
| **Runout tolerance** | ± 0.05 mm |
| **Weight, typical** | 0.3…0.5 kg |

# 5 Mounting

**DANGER!**

**Danger of death, serious physical injury and/or damage to property due to deactivation of safety functions, caused by an unstable shaft drive!**

- The system manufacturer must implement suitable design measures, so that the drive of the measuring system is ensured at all times through the shaft and mounting of the measuring system (fault exclusion). The specifications of ***DIN EN 61800-5-2*** "Adjustable speed electrical power drive systems, Safety requirements, Table D.8 – Motion and position sensors" must be observed.
- In general, the requirements and acceptance conditions for the complete system must be taken into account for mounting.
- All fastening screws must be secured against unintentional loosening.
- Use at low ambient temperatures results in increased values for the start-up torque. This fact must be taken into account for mounting, design of the shaft coupling and shaft drive.

## 5.1 Solid shaft

### 5.1.1 Requirements

**As the installation situation is application-dependent, the following notes are not exhaustive.**

- A suitable coupling with form closure must be used for the application. The coupling must be dimensioned so that fault exclusion is ensured for the mechanical mounting of the measuring system in accordance with DIN EN 61800-5-2, depending on the static and dynamic load cases. If this is not possible, the hazard must be incorporated into the risk assessment for the application in the form of a coupling breakage.

- The coupling manufacturer's information and installation requirements must be observed.

- In particular, you must ensure that
  - the coupling is suitable for the specified speed and the potential axial offset,
  - installation is on a grease-free shaft,
  - the coupling and the measuring system are not axially loaded,
  - the clamping screws are tightened with the torque defined by the coupling manufacturer,
  - the coupling screws are secured against unintentional loosening.

- Axial slipping of the measuring system on the drive shaft must be prevented by the coupling fixing, see Figure 1, (1).

- Radial slipping (slip) of the measuring system on the drive shaft must be prevented by means of form closure by using a parallel key / groove combination (Figure 1, (2)); a coupling with groove must be used for this purpose.

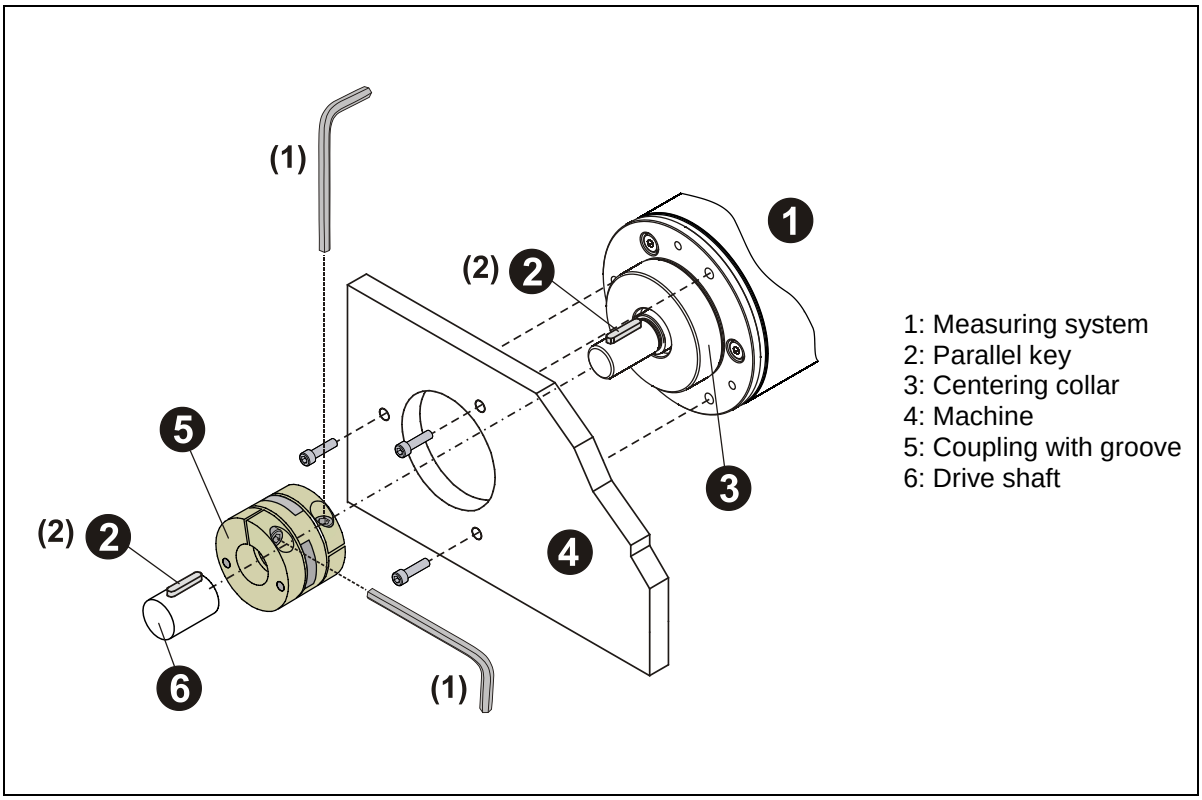



**Figure 1: Flange mounting**

## 5.2 Hollow shaft

### 5.2.1 Requirements

**As the installation situation is application-dependent, the following notes are not exhaustive.**

- The measuring system must be installed on a grease-free shaft.
- Axial slipping of the measuring system on the drive shaft must be prevented by the fixing of the clamping ring, see Figure 3.
- Further measures may be required to prevent axial slipping of the measuring system.
- The clamping of the measuring system must not be axially loaded.
- The screw of the clamping ring must be tightened with 3 Nm using a torque wrench.
- The screw must be secured against unintentional loosening.
- Radial slipping of the measuring system on the drive shaft must be prevented by means of form closure, using a parallel key / groove combination; the measuring system must be fixed on the drive shaft using a dowel pin, see Figure 2. The dowel pin must extend at least 4 mm into the groove insertion.

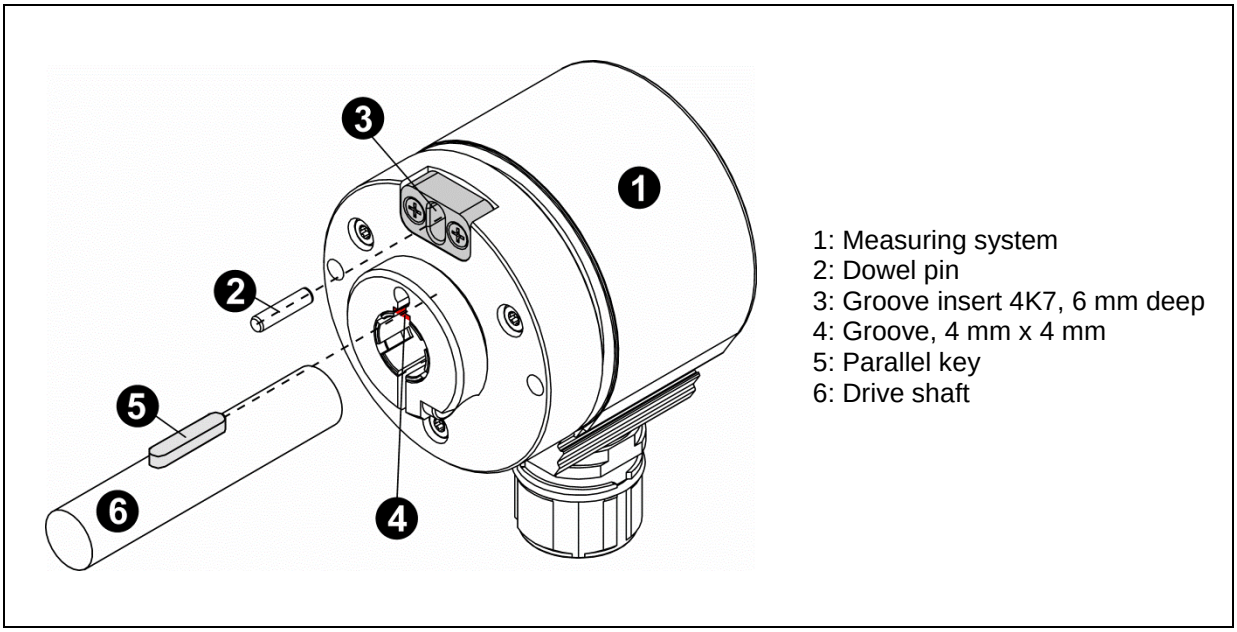



**Figure 2: Form closure**

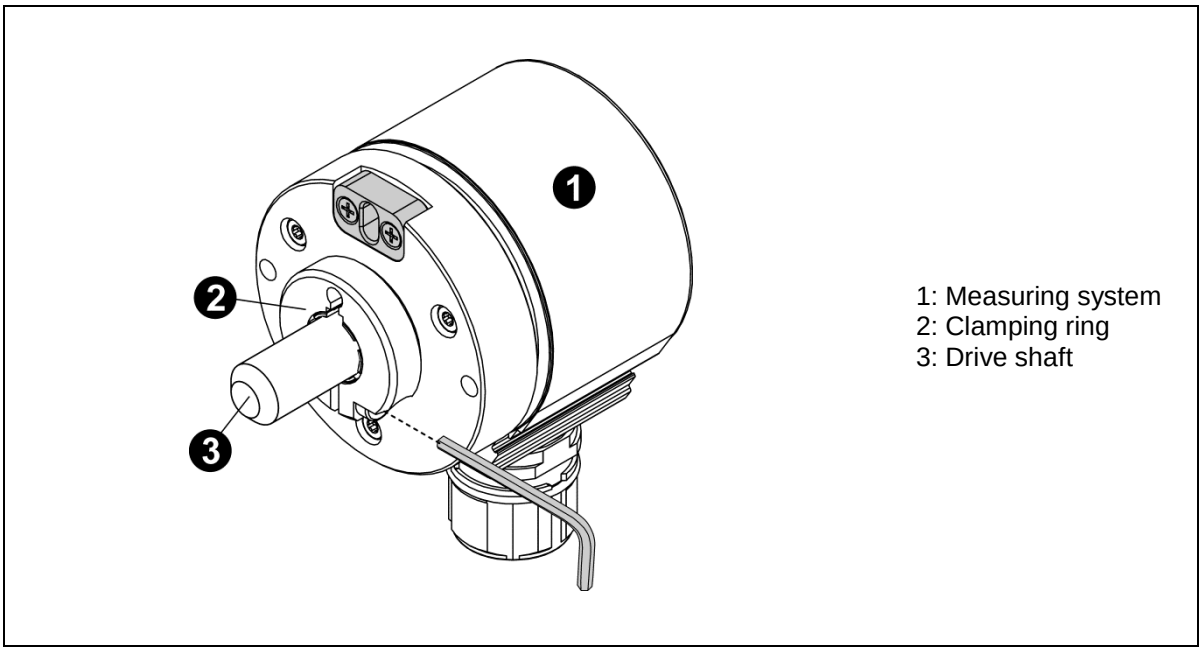



**Figure 3: Friction locking**

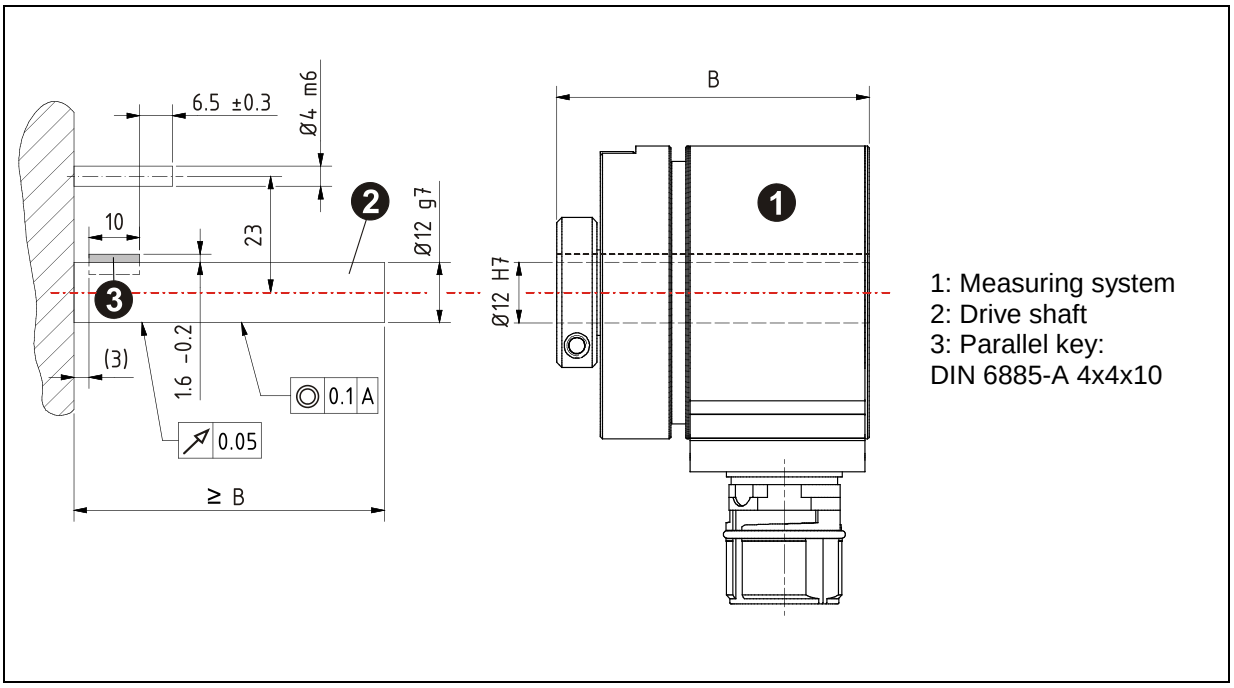



**Figure 4: Requirements for the shaft mounting, example with shaft ø 12 H7**

# 6 Installation / Preparation for Commissioning

## 6.1 Notes for PSEN enc sincos

**WARNING!**
***Loss of the safety function by overvoltage!***

- Overvoltages >7 V at the outputs A, /A, B, /B, Z or /Z can put the safety function out of operation. This may cause serious injury and death.

  If accidentally an overvoltage of >7 V DC was applied to the outputs A, /A, B, /B, Z or /Z it is necessary to
  - ➢ immediately decommission the measuring system and
  - ➢ to send the measuring system to Pilz for testing, together with the information why or how the overvoltage occurred.

**WARNING!**
***Loss of the safety function by short across contacts!***

- Shorts across the connection lines can put the safety function out of order. This may cause serious injury and death.
  - ➢ To prevent short circuits, the cable must be laid permanently (fixed) and protected against external damage, for example, using a cable duct or an armoured conduit.
  - ➢ If a cable is damaged, the measuring system must be decommissioned immediately.

## 6.2 EMC requirements

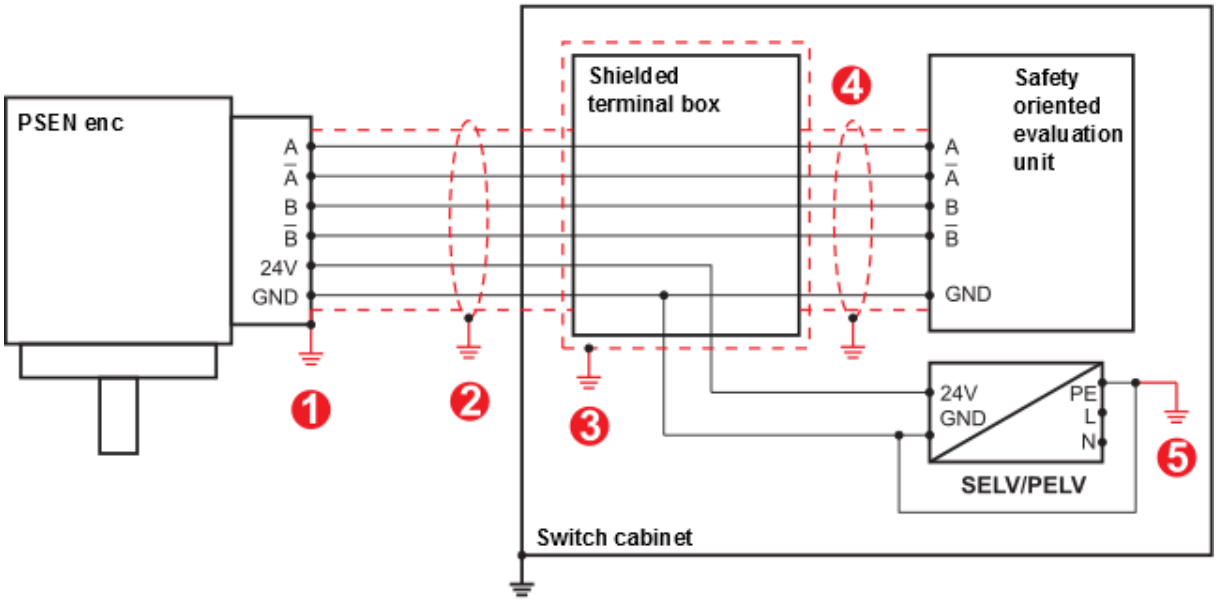
**WARNING!**

***Deactivation of the safety function due to radiated or conducted interference sources!***

- Radiated interference sources due to radiophones, lightning strikes in networks, mobile phones and emissions from individual devices can cause malfunctions in the measuring system.
- Conducted interference sources in particular, such as frequency-controlled drives (system perturbations), have a negative effect on the function of the measuring system.
  - ➢ The 24 V power supplies used must fulfil the requirements according to IEC 60364-4-41 SELV/PELV.
  - ➢ The shielding effect of cables must also be guaranteed after installation (bending radii!) and after connector changes. In cases of doubt, use more flexible and more reliable cables.
  - ➢ A 5-wire cable with a PE-conductor isolated from the N-conductor (so-called TN network) is recommended for the drive/motor cabling. This will largely prevent equipotential bonding currents and the development of interference.
  - ➢ A shielded and stranded data cable must be used to ensure high electromagnetic interference stability of the system. The shielding should be connected with low resistance to protective ground using large shield clips **at both ends**. The shielding should be grounded **in the switch cabinet only** if the machine ground is heavily contaminated with interference towards the switch cabinet ground.
  - ➢ Equipotential bonding measures must be provided for the complete processing chain of the system. Compensating currents due to potential differences across the shield to the measuring system must be avoided in particular.
  - ➢ Power and signal cables must be laid separately. During installation observe the national safety and installation guidelines for data and energy cables.
  - ➢ Observe the manufacturer's instructions for the installation of converters and for shielding power cables between frequency converter and motor.
  - ➢ Ensure adequate dimensioning of the energy supply.
  - ➢ Separation or delimitation of the measuring system from potential jammers.
  - ➢ Provide the use of filters.
  - ➢ Observe requirements for external and internal lightning protection.
  - ➢ To ensure safe and fault-free operation, the pertinent standards and directives must be observed. In particular, the applicable EMC directive and the shielding and grounding directives must be observed!
  - ➢ Upon completion of installation, a visual inspection with report should be carried out.

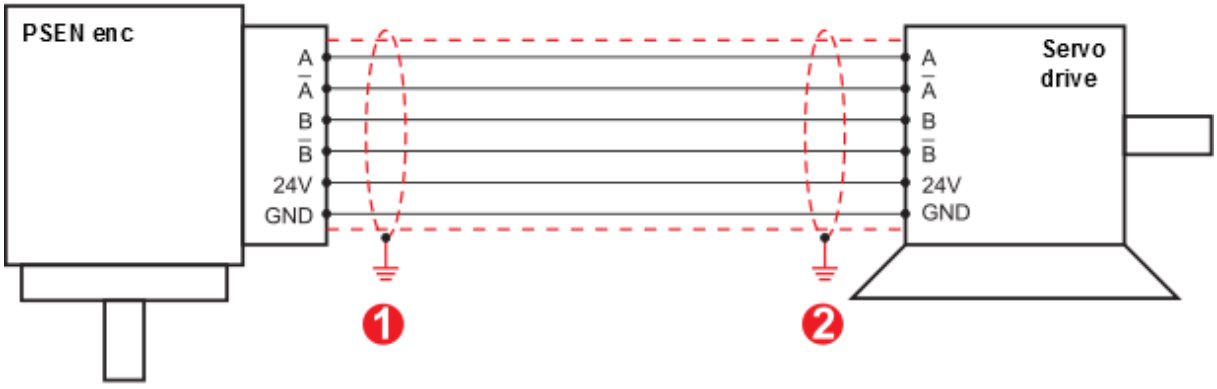
## 6.3 EMC conform wiring schemes

### 6.3.1 Connection scheme 1



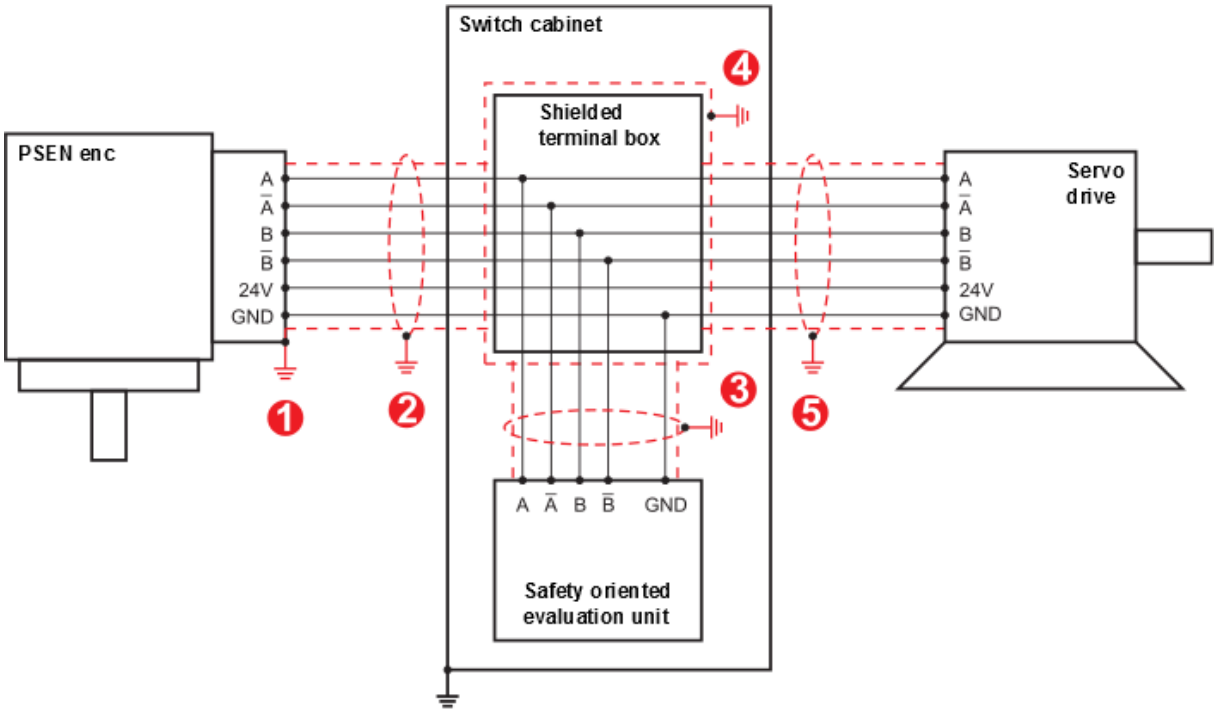

- 1x Ground connection (connection possibilities ❶, ❷, ❸, ❹ or ❺)
- Avoid ground loops
- Connect all shields double-sided
- Shielding must not be interrupted
- Twisted pair wires (A,/A), (B,/B)

### 6.3.2 Connection scheme 2




- 1x Ground connection (connection possibilities ❶ or ❷)
- Avoid ground loops
- Connect all shields double-sided
- Shielding must not be interrupted
- Twisted pair wires (A,/A), (B,/B)

### 6.3.3 Connection scheme 3




- 1x Ground connection (connection possibilities ❶, ❷, ❸, ❹ or ❺)
- Avoid ground loops
- Connect all shields double-sided
- Shielding must not be interrupted
- Twisted pair wires (A,/A), (B,/B)

## 6.4 Ground connection – measuring system

In principle, it is recommended that the ground connection of the measuring system has a good conductive connection to the functional earth of the machine.
This particularly applies to measuring systems with hollow or blind shaft at which the functional earth of the machine to the measuring system should be connected e.g. by cable eyes and a cable with min. 4 mm² (not contained in the extent of supply). For this purpose, corresponding thread drillings are available in the measuring system flange.

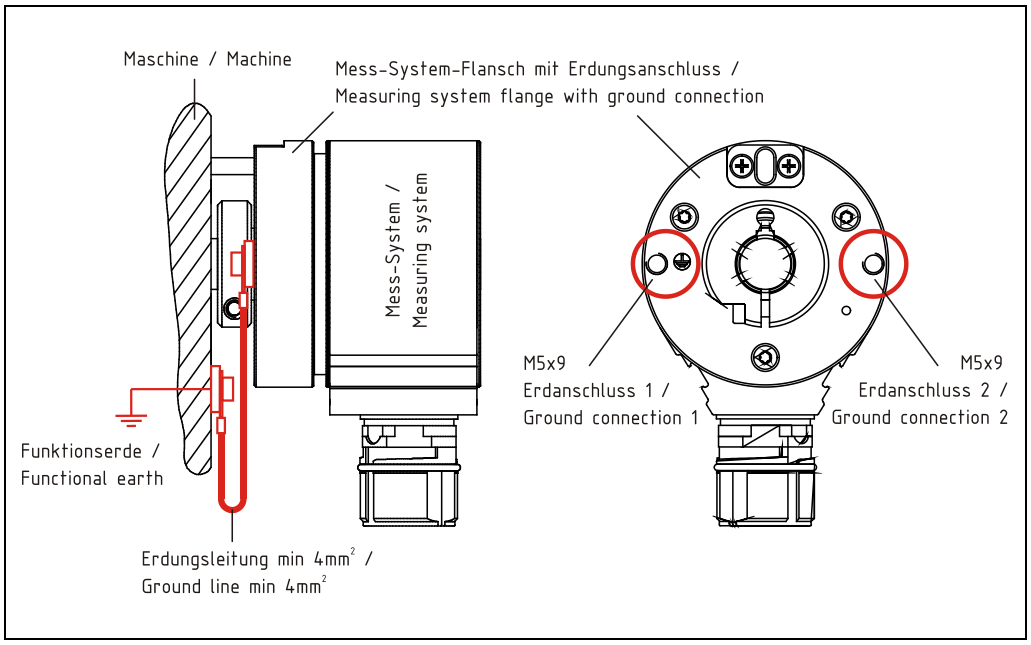



**Figure 5: Ground connection – measuring system**

## 6.5 Cable specification

Analogue incremental signals (SIN/COS)

| Signal | Description |
|---|---|
| Supply | Min. 0.34 mm² and shielded, 0.5 mm² recommended. Generally the cable cross-section must be matched to the cable length. |
| A, /A | Min. 0.14 mm² and shielded, 0.25 mm² recommended. However, to ensure the signal quality and to minimize possible environmental influences, we recommend twisting each signal pair (±). |
| B, /B | |
| [4]Z, /Z | |

Square-wave incremental signals (HTL)

| Signal | Description |
|---|---|
| Supply | Min. 0.34 mm² and shielded, 0.5 mm² recommended. Generally the cable cross-section must be matched to the cable length. |
| A, /A | Min. 0.14 mm² and shielded, 0.25 mm² recommended. However, to ensure the signal quality and to minimize possible environmental influences, we recommend twisting each signal pair (±). |
| B, /B | |
| [4]Z, /Z | |

[4] optional, the Z, /Z-signal is not evaluated from a safety viewpoint

## 6.6 Permitted cable length

The permissible cable length at the transmission of incremental signals depends on the output frequency, the applied supply voltage and the ambient temperature of the measuring system. With Pilz cables up to 30 m, no restrictions are to be taken into account with regard to the output frequency, the supply voltage and the ambient temperature. When longer cables are used, there may be restrictions.

## 6.7 Pin assignment

### 6.7.1 PSEN enc SIN/COS

| Pin | Assignment | Description | Level | Driver | NC | Colour |
|---|---|---|---|---|---|---|
| 1 | A | Track A | Sinus 1Vss | | | white |
| 2 | /A | Track A inverted | Sinus 1Vss | | | brown |
| 3 | not connected | | | | | |
| 4 | B | Track B | Sinus 1Vss | | | yellow |
| 5 | /B | Track B inverted | Sinus 1Vss | | | gray |
| 6 | not connected | | | | | |
| 7 | Z | Track Z | Sinus 1Vss | | | blue |
| 8 | /Z | Track Z inverted | Sinus 1Vss | | | red |
| 9 | not connected | | | | | |
| 10 | not connected | | | | | |
| 11 | UB | Supply voltage | 10 - 30 V | | | gray/pink |
| 12 | GND | Ground | 0 V | | | red/blue |

**WARNING!**

***Short-circuits, voltage peaks, etc. can cause operating failures and uncontrolled operating states, as well as serious personal injuries and damage to property***.

De-energize the system before carrying out wiring work or opening and closing electrical connections!

### 6.7.2 PSEN enc HTL

| Pin | Assignment | Description | Level | Driver | NC | Color |
|---|---|---|---|---|---|---|
| 1 | A | Track A | 10 - 30 V | HTL | | white |
| 2 | /A | Track A inverted | 10 - 30 V | HTL | | brown |
| 3 | not connected | | | | | |
| 4 | B | Track B | 10 - 30 V | HTL | | yellow |
| 5 | /B | Track B inverted | 10 - 30 V | HTL | | gray |
| 6 | not connected | | | | | |
| 7 | Z | Track Z | 10 - 30 V | HTL | | blue |
| 8 | /Z | Track Z inverted | 10 - 30 V | HTL | | red |
| 9 | not connected | | | | | |
| 10 | not connected | | | | | |
| 11 | UB | Supply voltage | 10 - 30 V | | | gray/pink |
| 12 | GND | Ground | 0 V | | | red/blue |

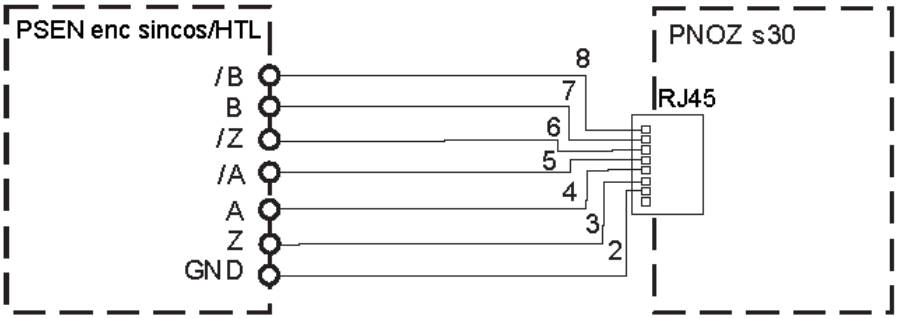
**WARNING!**

***Short-circuits, voltage peaks, etc. can cause operating failures and uncontrolled operating states, as well as serious personal injuries and damage to property***.

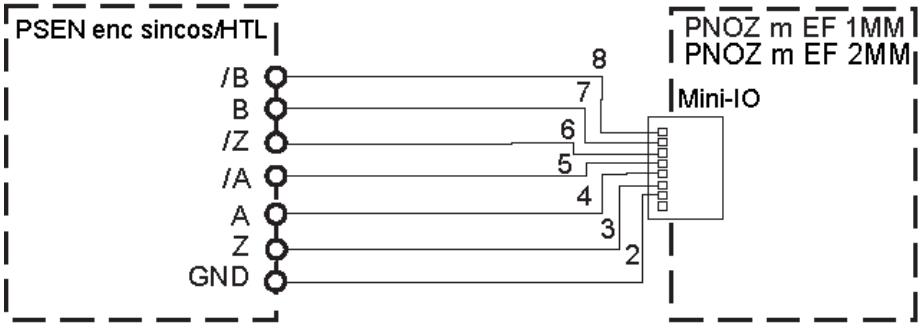
De-energize the system before carrying out wiring work or opening and closing electrical connections!

## 6.8 Connection to evaluation device

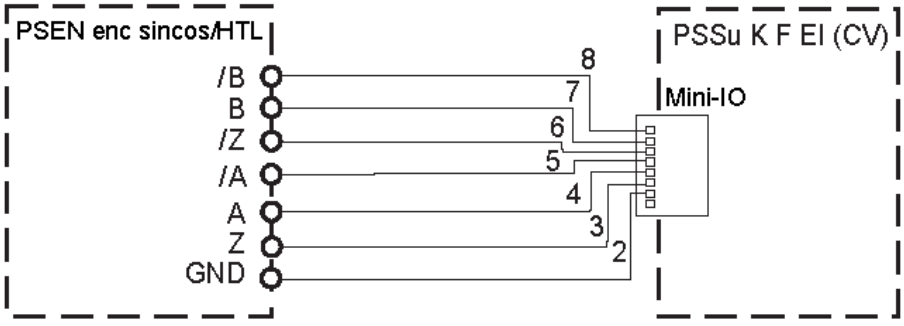
### 6.8.1 Evaluation device PNOZ s30




### 6.8.2 Evaluation device PNOZ m EF 1/2MM




### 6.8.3 Evaluation device PSSu K F EI (CV)



# 7 Incremental interface

**CAUTION!**

***Danger of damage to subsequent electronics due to overvoltages caused by a missing ground reference point!***

- If the ground reference point is completely missing, e.g. 0 V of the power supply not connected, voltages equal to the supply voltage can occur at the outputs of this interface.
  - ➢ It must be ensured that a ground reference point is present at all times,
  - ➢ or the system operator must provide appropriate protective mechanisms for the subsequent electronics.
- If the input voltage exceeds 30 V, these voltages occur accordingly at the HTL outputs. This can lead to damage of the output or input circuit of the downstream evaluation device.

The measuring system acquires the angular information from the connected process via the rotation of the shaft. A pulse disk is fixed to the shaft; this acquires the angular increments with a defined number of periods per revolution. A scanning unit with integrated optoelectronics generates electrical signals and outputs signal periods, which can be processed in a signal conditioner afterwards.

The resolution of the measuring system is defined by the number of light/dark segments (pulse number per revolution) on the pulse disk. A signal sequence of e.g. 1024 periods is output during one revolution. To evaluate the counting direction, a 2nd signal sequence with a 90° phase offset is output for the evaluation device.

The counter of an external evaluation device can be reset with an additional zero pulse, and the mechanics - evaluation device reference point can thus be defined.

## 7.1 Analogue incremental signals (SIN/COS)

Measuring the signals against 0 V gives the following signal curve:

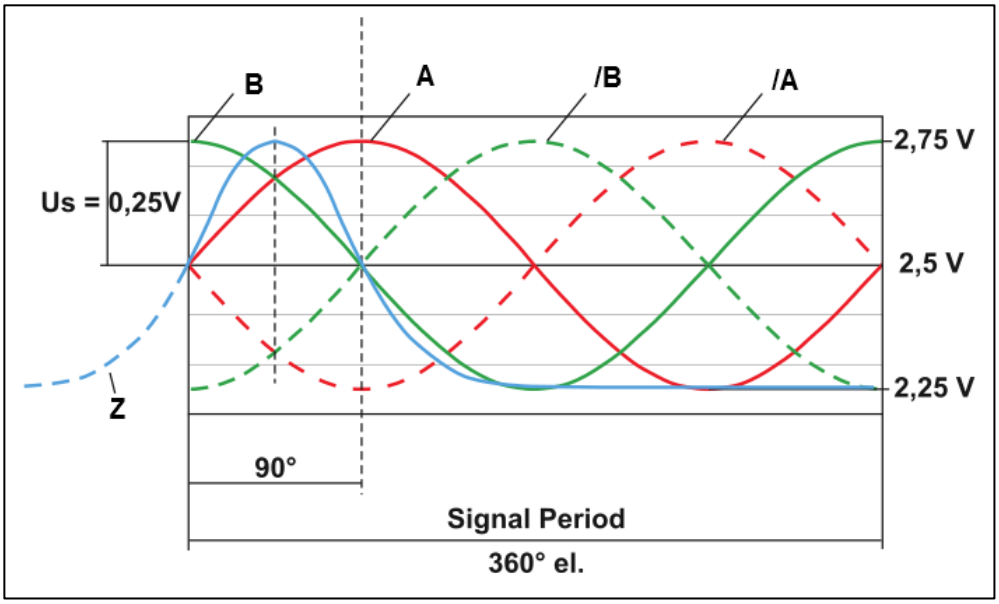



**Figure 6: Signal curve with clockwise direction of rotation looking at the flange connection**

Differential measurement of the signals gives the following signal curve:

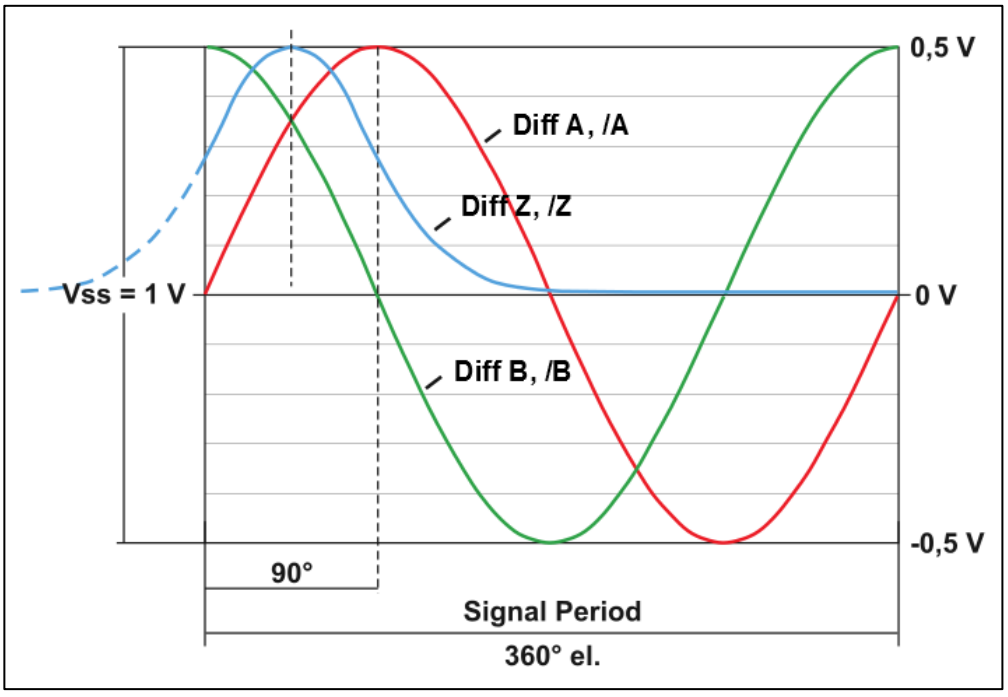



**Figure 7: Signal curve with clockwise direction of rotation looking at the flange connection**

## 7.2 Square-wave incremental signals (HTL)

The output levels are also specified by the factory setting.

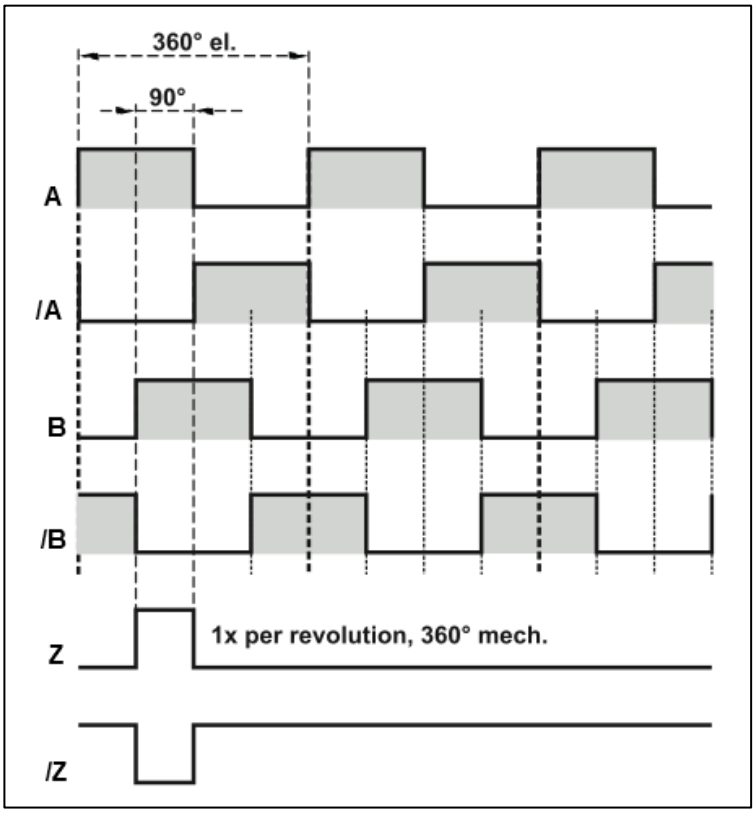



**Figure 8: Signal curve with clockwise direction of rotation looking at the flange connection**

# 8 Checklist

We recommend that you work through the checklist during commissioning and when replacing the measuring system and store it as part of the overall system documentation.

| Documentation basis | Date | Edited | Checked |
|---|---|---|---|
| | | | |

| Sub-item | To note | Can be found under | yes |
|---|---|---|---|
| Check that the measuring system can be used for the present automation task on the basis of the specified safety requirements | • Intended use<br>• Safety functions of the fail-safe evaluation device<br>Compliance with all technical data | • Intended use<br>• Safety functions of the fail safe evaluation device<br>• Technical Data | ☐ |
| Fulfilment of the installation requirements | • Connection of the measuring system - shaft to the drive must be designed as form closure<br>• The coupling to the drive must be over-dimensioned in accordance with **DIN EN 61800-5-2** | • Mounting | ☐ |
| Voltage supply requirement | • The power supply used must meet the requirements of SELV/PELV (IEC 60364-4-41) | • Electrical characteristics<br>• EMC requirements | ☐ |
| Correct electrical installation (shielding) | • Observance of basic rules for installation<br>• Observance of wiring standards | • Installation / Preparation for Commissioning | ☐ |
| System test after commissioning and modifications | • During commissioning and after any modifications all affected safety functions must be checked | • Safety functions of the fail-safe evaluation device | ☐ |
| Device replacement | • It must be ensured that the new device corresponds to the replaced device<br>• All affected safety functions must be checked | • Safety functions of the fail-safe evaluation device | ☐ |

# 9 Order reference

## 9.1 Measuring System

| Product type | Features | Order no. |
|---|---|---|
| PSEN enc sincos 4096 ss | 4096 pulses/revolution, sin/cos, solid shaft | 6Z000001 |
| PSEN enc sincos 4096 hs | 4096 pulses/revolution, sin/cos, hollow shaft | 6Z000002 |
| PSEN enc HTL 1024 ss | 1024 pulses/revolution, HTL, solid shaft | 6Z000003 |
| PSEN enc HTL 1024 hs | 1024 pulses/revolution, HTL, hollow shaft | 6Z000004 |

## 9.2 Accessories

| Product type | Features | Order no. |
|---|---|---|
| PSEN cable M23-12sf, 5m | Cable 5 m, M23-socket, 12-pin | 6Z000005 |
| PSEN cable M23-12sf, 10m | Cable 10 m, M23- socket, 12-pin | 6Z000006 |
| PSEN cable M23-12sf, 20m | Cable 20 m, M23- socket, 12-pin | 6Z000007 |
| PSEN cable M23-12sf, 30m | Cable 30 m, M23- socket, 12-pin | 6Z000008 |

# 10 EC declaration of conformity

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