Original manual

Absolute Encoder CD_-75 Safety Manual

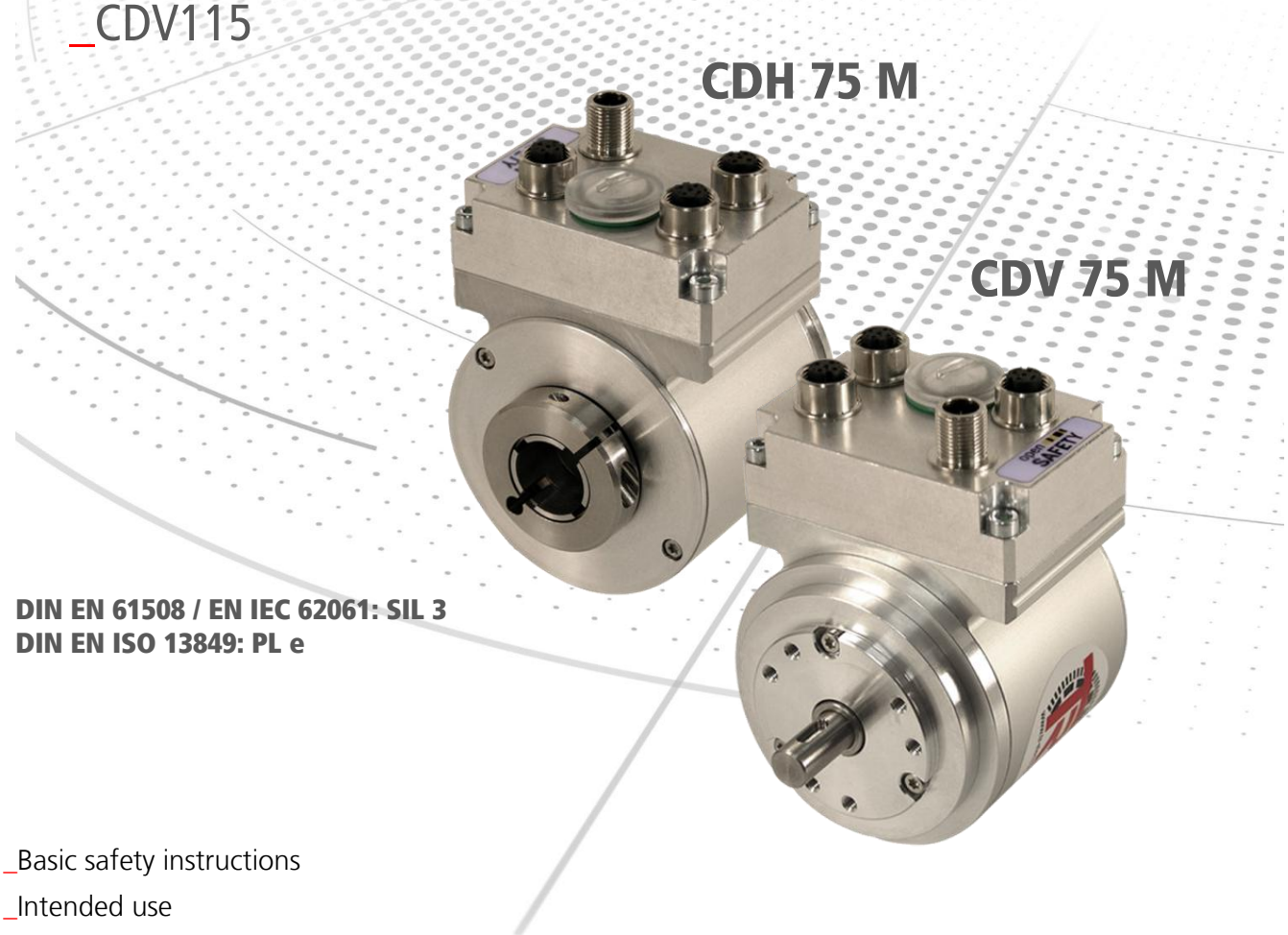
Explosion Protection Enclosure

_A**75*

_A**88*

Protection Enclosure

_CDV115



DIN EN 61508 / EN IEC 62061: SIL 3
DIN EN ISO 13849: PL e

_Basic safety instructions
_Intended use
_General functional description
_General characteristics
_Assembly

Safety Manual

TR-ECE-BA-GB-0107 v27 11/20/2026

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First edition	02/11/2015	00
PROFINET variant added	07/13/2015	01
PROFIBUS variant added	10/22/2015	02
Differentiation Tu = f(n) in case of IP54 and IP65	11/04/2015	03
EtherCAT/FSoE variant added	02/04/2016	04
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Additional notice, electrically permissible speed	03/01/2016	06
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- Draw-wire box added - Other applicable documents	06/14/2018	15
- EX Protection Enclosure A**100* added - Mounting declared as a generic procedure.	11/06/2019	16
- EX Protection Enclosure A**115* added	11/19/2020	17
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In the new edition of EN IEC 62061:2021, the term SIL CL is omitted	09/19/2023	20
Updating the declaration of conformity	09/27/2023	21
- Warning notice "Handheld radio devices", in accordance with DIN EN 61800-5-2, chapter 7.2, subsection c)	07/08/2024	22
- Chapter “IT security vulnerabilities” added - Updating the declaration of conformity	05/05/2025	23
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1 General

This Manual addresses the following topics:

- General functional description
- Basic safety information with declaration of the intended use
- General specifications
- Assembly

Since it has a modular structure, this Manual is supplementary to other documentations, such as product data sheets, dimensional drawings, brochures, interface-specific user manuals, etc.

1.1 Scope

This Manual is only applicable to measuring system model ranges having the following type designation codes:

* 1	* 2	* 3	* 4	* 5	-	* 6	* 6	* 6	* 6	* 6

Position	Designation	Description
* 1	A C	Explosion protection enclosure (ATEX); Absolute encoder, programmable
* 2	D	Redundant dual scanning unit
* 3	V H S W	Solid shaft Hollow shaft Blind-hole shaft Rope length transmitter (wire)
* 4	75 88	External diameter ∅ 75 mm External diameter ∅ 88 mm
* 5	M	Multi-turn
* 6	-	Consecutive number

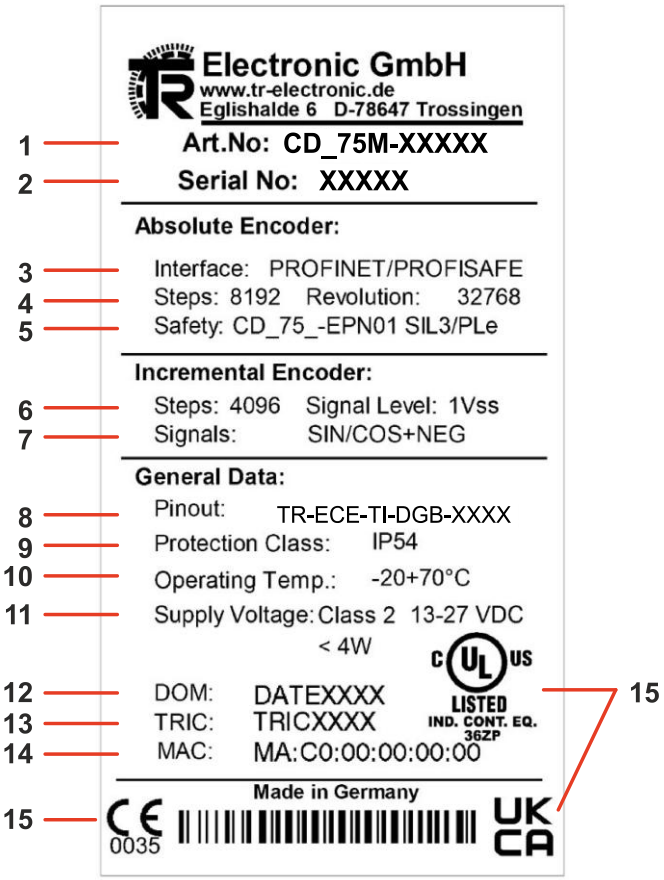
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Type key
See revision list:
www.tr-electronic.de/f/TR-ECE-TI-DGB-0396

The products are labeled with affixed nameplates and are components of a system.

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Example of a nameplate:



1:	Article no. or Order no.
2:	Devices – serial no.
3:	Measuring system – Interface / Safety protocol, see -> Interface-specific user manual
4:	Resolution in steps per revolution
5:	Maximum achievable safety integrity level or performance level; see chapter 4.1 on page 20
6:	Pulses/Steps and signal output levels of the additional interface
7:	Signal output of the additional interface
8:	Number or identifier of the enclosed pin assignment
9:	Protection class (IP code), in accordance with DIN EN 60529
10:	Operating temperature
11:	- Supply voltage range, maximum power consumption, see -> device-specific product data sheet - Class 2 power supply with UL / CSA approval; see ch. 2.5 on page 12.
12:	Date of manufacture in the format YYYY: Year, MM: Month, DD: Day
13:	TR identification code
14:	MAC address, for IP-based measuring system – interface
15:	Approvals

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1.2 Other applicable documents

- The responsible organization's system-specific operating instructions
- This Safety Manual
- Pin assignment
- Interface-specific User Manual
- Product data sheet
- Optional: Ex User Manual

1.3 Abbreviations and terms used

A**75*	Explosion protection enclosure with ∅ 75 mm and built-in measuring system, all variants
A**88*	Explosion protection enclosure with ∅ 88 mm and built-in measuring system, all variants
$B10_d$	Number of operations that a device will operate prior to 10 % of a sample of those devices would fail to danger
CD_	Absolute encoder with redundant dual scanning feature, all designs
EMC	***E***lectro***M***agnetic ***C***ompatibility
ESD	***E***lectro***S***tatic ***D***ischarge
Fault exclusion	Compromise between technical safety requirements and the theoretical possibility that an error occurs
Functional safety	Part of the overall system safety, which depends on the correct functioning of safety instrumented systems for risk reduction. Functional safety is ensured when each safety function is executed as specified.
IEC	International Electrotechnical Commission
ISO	***I***nternational ***O***rganization for ***S***tandardization
$MTTF_d$	***M***ean ***T***ime ***T***o ***F***ailure, ***d***angerous
n_{op}	Number of operations/cycles in one year
PL	***P***erformance ***L***evel according to EN ISO 13849-1
SIL	***S***afety ***I***ntegrity ***L***evel: Four discrete levels (SIL1 to SIL4). The higher the SIL of a safety instrumented system, the lower the probability that the system cannot execute the required safety functions.
Standard measuring-system	Definition: Safety instrumented measuring system, without explosion protection
VDE	Association for Electrical, Electronic & Information Technologies

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1.4 General functional description

The rotary measuring system is a safe and absolute multi-turn position measuring system with a safety protocol and a standardized interface that is, however, NOT safety instrumented.

The measuring system has primarily been designed for use in systems that require safe position detection.

The safety measuring system consists of **a redundant, dual-channel system** in which

- variant 1: optical and magnetic scanning units, or
- variant 2: two magnetic scanning units

are arranged on a drive shaft that is designed either as hollow shaft or as solid shaft.

The measuring system was designed primarily for use in systems where reliable position detection is required.
The additional reliable speed detection enables the following safety functions to be implemented in accordance with DIN EN 61800-5-2 and DIN EN IEC 61800-5-3:

DIN 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 Position (SLP)
- Safe Cam (SCA)

DIN EN IEC 61800-5-3:

- Safe Absolut Position (SAP)
- Safe Speed Value (SSV)



As a sensor, the measuring system is always part of a safety chain. The safety functions mentioned above are all derived, in one form or another, from the reliable position and speed measurements provided by the measuring system. It is the user's responsibility to implement these safety functions and to verify that they are suitable for the safety-related application.

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2 Basic safety instructions

2.1 Definition of symbols and notes

⚠ DANGER	means that death or serious injury will occur if the user fails to take the respective precautionary measures.
⚠ WARNING	means that death or serious injury may occur if the user fails to take the respective precautionary measures.
⚠ CAUTION	means that minor injuries may occur if the user fails to take the respective precautionary measures.
NOTICE	means that damage to property may occur if the user fails to take the respective precautionary measures.
	indicates important information or features and application tips for the product used.
	means that appropriate ESD protective measures according to DIN EN 61340-5-1 supplementary sheet 1 must be taken.

2.2 General risks when using the product

The product, hereinafter referred to as ***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 values!***
The measuring system may only be used in technically perfect condition in accordance with its intended use and the instructions set out in the ***Other applicable documents*** and only by safety-conscious persons who are fully aware of the risks involved in operating the measuring system. Faults which could threaten safety should be eliminated without delay!

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2.3 IT security vulnerabilities

The measuring system has a digital fieldbus interface that is designed for operation in networked control systems. The measuring system contains software that enables network communication. No sensitive information is stored on the device itself. The standardized fieldbus protocols are not protected against attacks, e.g., MITM (man in the middle), by default.

The following notes and recommendations are intended to protect against machine corruption:

- The measuring system should only be operated within the plant's trusted control networks. No open connections via gateways to the WAN, the Internet, or other IP-based networks should be established.
- The control network in which the measuring system operates must be segmented; that is, the control network must be self-contained. Connections to higher-level IP networks are permitted only via secure gateways or control units. To this end, measures such as DMZs, VPNs, firewalls, IDSs, etc., must be implemented.
- Remote maintenance on the measuring system such as a software update may only be performed when the machine or application is not in regular production operation.
- The measuring system has only wired connections; if the automation network also includes wireless connections, the system integrator must account for these connections in their risk analysis.
- Physical access to the measuring system, its ports, and the corresponding connections to the downstream evaluation unit should be restricted or limited.
- The cabling between the measuring system and the downstream evaluation unit should be protected against unauthorized access, e.g., by using shielded cables.
- Access to the measuring system's power supply must be assessed in accordance with the requirements of EN 50742 and protected accordingly.
- To detect tampering, it is recommended to seal the connections on the measuring system and the downstream control unit.
- Vulnerabilities must be reported to the PSIRT at TR Electronic GmbH (www.tr-electronic.com/psirt). The security contacts at TR Electronic GmbH can be reached via the canonical URI "www.tr-electronic.de/.well-known/security.txt".

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2.4 Residual risk

According to EN ISO 12100-1 “Safety of machinery – Basic concepts, general principles for design”, residual risk is defined as the risk remaining after application of all protective measures.
Risk itself is defined as the “combination of the likelihood of a hazard and the severity of the potential damage”.

During the entire safety lifecycle, TR Electronic has applied risk minimizing measures and methods according to the state of the art and technology – however, residual risks still remain even when properly using the measuring system!

Residual risks are not only indicated in this chapter, but also in all relevant parts of the entire document, in some cases also by referencing the corresponding interface-specific user manual.

The risk assessment of the entire system required by the EU Machinery Directive requires knowledge of all Other Applicable Documents, including any documented general conditions, safety instructions and residual risks, and to incorporate such into the company’s own risk assessment.

2.5 UL / CSA approval

Measuring systems with this approval are signed with the UL Symbol on the name plate:

c UL US
LISTED
IND. CONT. EQ.
36ZP
Class 2
File No.: E300802

Measuring system running UL applications may therefore only be operated on NEC Class 2 approved power supply units. For further information, please refer to this document: TR-ECE-TI-DGB-0152

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2.6 Intended use

The safety measuring system can be used for the detection of angular movement and processing of measured data for a downstream safety host in systems in which the **safety-related requirements of "Safeguarding travel", "Safeguarding velocity" or "Safeguarding direction of travel"** must be reliably achieved. In this case, the complete processing chain of the safety function must satisfy the requirements of the applied safety standard.
The safety measuring system may only be used in safety applications in conjunction with a control certified according to the applied safety standard.
The system manufacturer must verify that the properties 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:

- following all instructions given in the other applicable documents;
- observing the nameplate and any prohibition or instruction symbols on the measuring system;
- observing the enclosed documents;
- operating the measuring system within the limit values specified in the technical data;
- ensuring that the fail-safe processing unit fulfills all required safety functions;
- ensuring that the checklist – part 1 in the present document and part 2 in the interface-specific User Manual – is used and went through completely;
- safely attaching (form-locking; recommended) the measuring system to the driving axis, see also the chapter "Assembly" starting on page 27.

2.7 Non-intended use

Any non-intended use of the measuring system results in the risk of death, physical injury and damage to property.

⚠ WARNING

NOTICE

- The following areas of use are especially forbidden:
  - Standard measuring system:
    in environments where there is an explosive atmosphere in accordance with the ATEX Directive
  - for medical purposes in accordance with the Medical Devices Directive
  - as a step or climbing aid
  - for wiring as anti-twist protection (torque arm)
  - as an abutment for tension chains and belts

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2.8 Usage in explosive atmospheres

When used in explosive atmospheres, the standard measuring system has to be installed in an appropriate explosion protective enclosure and subject to requirements.

The products are labeled with an additional Ex marking on the nameplate.

The “intended use” as well as any information on the safe usage of the ATEX-compliant measuring system in explosive atmospheres are contained in the Ex User Manual.

Standard measuring systems that are installed in the explosion protection enclosure and are intended for use with safety instrumented applications can therefore be used in explosive atmospheres. In case of the **ADW**** the information out of chapter 2.9 from page 14 must be observed.

When the measuring system is installed in the explosion protection enclosure, which means that it meets explosion protection requirements, the properties of the measuring system will no longer be as they were originally.

Following the specifications in the Ex User Manual, please check whether the properties defined in that manual meet the application-specific requirements.

Fail-safe usage requires additional measures and requirements. Such measures and requirements must be determined prior to initial commissioning and must be taken and met accordingly.

2.9 Combination measuring system and draw-wire box (CDW** / ADW**)

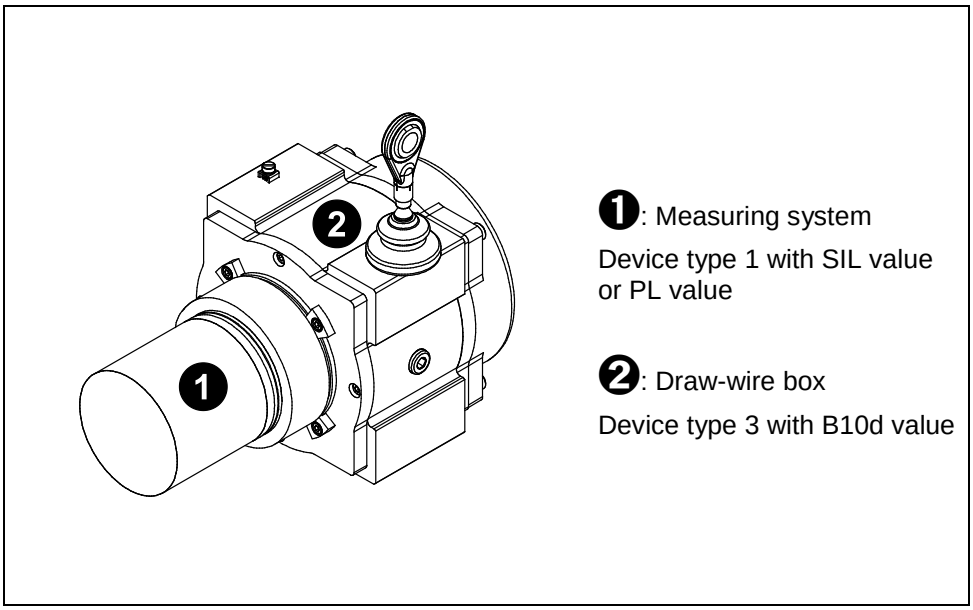


Figure 1: Combination measuring system and draw-wire box

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From a safety viewpoint the combination of measuring system and draw-wire box is a series connection with a device type 1 (measuring system) and a device type 3 with a category 1 structure in accordance with EN ISO 13849-1 (draw-wire box).

Device type 1 is characterized by the fact that the device can already be used as the safety-relevant part of a control system.

Device type 3 refers to devices with a failure behavior which is dependent on the switching frequency (cycle) and in terms of the draw-wire corresponds to complete extension and retraction of the wire. This fact is expressed by the **B10d-value** and represents the average number of cycles by which 10 % of the components have failed dangerously. The draw-wire box has not been developed in accordance with any specific safety standard, but this does not in principle exclude its use in accordance with DIN EN 61508, EN ISO 13849-1 or IEC 62061.
Generally, however, the use of such devices, if they are used as a safety-relevant part of a control system, must be independently assessed by the user in relation to safety.

As the combination of measuring system and draw-wire box is a series connection, this "unified structure" must be reassessed in relation to safety. The component with the lowest reliability in the series connection is determining for the highest possible level of safety that can be achieved. For mechanical reasons draw-wires only have a limited number of cycles, which in turn is strongly dependent on the type used.

In practice this means that the draw-wire is the limiting component in the series connection and the safety requirement level of the measuring system can never be achieved for the unified structure. For this reason there is also no TÜV certification for the combination of measuring system and draw-wire box!

This fact means that the unified structure may only be used as the subsystem of a safety function if the safety requirement level of the unified structure corresponds to the required safety requirement level for the subsystem.

To enable the user to assess the safety function, TR Electronic GmbH provides the relevant safety indicators in the product data sheets valid for the respective measuring system, see https://www.tr-electronic.com/s/S019325.

TR Electronic GmbH can provide the relevant B10d value for the draw-wire box on request.

1) The $MTTF_d$ value for the draw-wire box can be calculated as follows:

$$MTTF_d = \frac{B10_d}{0.1 * n_{op}}$$

The total $MTTF_d$ value for the draw-wire box + measuring system can be calculated from this:

$$MTTF_{d\ (total)} = \frac{(\ MTTF_{d\ (draw\text{-}wire\ box)}\ *\ MTTF_{d\ (measuring\ system)}\ )}{(\ MTTF_{d\ (draw\text{-}wire\ box)}\ +\ MTTF_{d\ (Mess\text{-}System)}\ )} = \text{value in years [a]}$$

1) Abbreviations, also see page 7

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2.10 Safety functions of the fail-safe processing unit

It is absolutely necessary that the **safety control** to which the measuring system is connected carries out the safety checks required according to the interface-specific User Manual.

2.11 Warranty and liability

The “General Terms and Conditions” of TR Electronic GmbH are applicable as a general rule. They will be submitted to the responsible organization along with the order confirmation or on conclusion of the contract at the latest. Warranty and liability claims in the event of personal injury or damage to property are excluded if they result from one or more of the following causes:

- Non-intended use of the measuring system.
- Improper assembly, installation, commissioning and programming of the measuring system.
- Work on the measuring system that is carried out improperly.
- Operation of the measuring system with technical defects.
- Unauthorized mechanical or electrical modifications to the measuring systems.
- Unauthorized repairs.
- Catastrophic events beyond human control and acts of God.

2.12 Organizational measures

- The other applicable documents must always be kept ready-to-hand at the place of use of the measuring system.
- In addition to the other applicable documents, 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 responsible organization is obliged to inform personnel on special operating features and requirements.
- Prior to commencing work, personnel handling the measuring system must have read and understood the Safety Manual, especially the chapter on “Basic safety instructions”.
- It must be ensured that the nameplate and any prohibition or instruction symbols provided on the measuring system are always legible.
- Do not modify the measuring system in any mechanical or electrical way; the only modifications allowed are those expressly described in the other applicable documents.
- Repairs may only be made by the manufacturer or a center or person authorized by the manufacturer.

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2.13 Personnel selection and qualification; basic duties

- Only qualified personnel is allowed to work with the measuring system. Qualified personnel are persons, who, through their training, experience and instruction, as well as their knowledge of the relevant standards, provisions, accident prevention regulations and operating conditions, have been authorized by the persons responsible for the system to carry out the required work and are able to recognize and avoid potential hazards. They are capable of identifying and avoiding potential hazards.

- The additional definitions of “qualified personnel” given in the VDE 0105-100 and IEC 364 standards must also be understood (source: e.g. Beuth Verlag GmbH, VDE-Verlag GmbH).

- The responsibilities for assembly, installation, commissioning and operation must be clearly defined. Personnel to be trained or educated must be supervised.

2.14 Technical safety instructions

- **Destruction, damage, or malfunction of the measurement system or the subsequent electronics!**
  - Wiring work may only be carried out and electrical connections only be opened and closed while the system is de-energized.
  - Voltages equal to the supply voltage at the additional incremental interface output. Ensure the ground reference point is present at all times, respectively the organization responsible for the system must provide appropriate protective measures for downstream electronic devices.
  - Cable outlets of mating connectors must always be secured with a cable grip against pulling out.

⚠ WARNING

NOTICE

  - Do not carry out any welding work after the measuring system has already been wired or switched on.
  - Ambient temperature values may never fall below or exceed the permissible limit values; this must be ensured by taking the appropriate heating/cooling measures at the place of installation.
  - The measuring system must be installed such that it is not exposed to any direct moisture.
  - Suitable aeration/ventilation and heating/cooling measures must be taken at the place of installation to prevent the temperature falling below the dew point (condensation).
  - If an overvoltage of >36 V DC is inadvertently applied, the measuring system must be inspected at the factory, with specification of the reasons or circumstances.

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- Potential hazards resulting from interactions with other systems and equipment which are or will be installed in the vicinity must be determined. The user is responsible for taking appropriate measures.
- Voltage supply must be protected with a fuse suitable for the supply lead cross-section.
- Cables used must be suitable for the temperature range.
- If defective, the measuring system may 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.
- It is prohibited to open the measuring system.

⚠ WARNING

- After having set the address switches and LEDs, ensure that they are no longer accessible by firmly closing the access with the screw plug.

NOTICE

- Connector plugs of the measuring system that are unused during storage and/or operation of the system have to be provided either with a mating connector or with a protective cap. The IP degree of protection is to be selected according to requirements.
- The measuring system is designed for use in environments with pollution degree 2 according to IEC 60664-1: *"Only non-conductive pollution occurs; however, temporary conductivity due to condensation must be expected occasionally"* (e.g., due to hand perspiration). Therefore, care must be taken during installation to ensure that pollution degree 2 is maintained. This applies in particular to the installation of connections, the attachment of protective caps to unconnected connections, and the replacement of the device.
- The nameplate specifies the technical properties of the measuring system. If the nameplate is no longer legible or is completely missing, the measuring system may no longer be put into operation.
- The measuring system cannot detect a break in the coupling or the torque arm. The operator must include this circumstance in the safety concept of the system.

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- **Deactivation of the safety function by radiation-bound sources of interference**

⚠ WARNING

NOTICE

Handheld radio devices that are operated within a radius of less than 20 cm of the power drive system (e.g. motor, frequency converter, measuring system, etc.) can deactivate the safety function of the measuring system or the safety sub-function of the complete power drive system.

- It must be ensured that handheld radio devices can only be operated at a distance of more than 20 cm from the measuring system.



- **The measuring system contains components and assemblies susceptible to electrical discharge, which can be destroyed if incorrectly handled.**
  - Do not touch the measuring system connection contacts with your fingers, or take the relevant ESD protective measures.



- **Disposal**
  - If the device has be disposed of after its service life has elapsed, the respective applicable country-specific regulations must be observed.

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3 Transport / storage

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

- **Storage**
  - Storage temperature: see product data sheet
  - Store at a dry place

4 General technical data

4.1 Functional safety

The achievable Safety Integrity Level or Performance Level depends on the device and is noted on the nameplate.

DIN EN 61508 Part 1-7, Safety Integrity Level (SIL), EN IEC 62061	SIL 3
EN ISO 13849-1, Performance Level	PLd / Kat. 3 oder PLe / Kat. 4

4.2 Safety functions

DIN EN 61800-5-2, Electric power drive systems	SDI, SS1, SS2, SOS, SLS, SSR, SSM, SLP, SCA
DIN EN IEC 61800-5-3, Electric power drive systems	SAP, SSV
Operating mode or requirement rate, DIN EN 61508 ...	high or continuous

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

4.3 Supply

The measuring system may only be operated on SELV/PELV (IEC 60364-4-41:2005) compliant power supply units.
Measuring system running UL applications may only be operated on NEC Class 2 approved power supply units.

Nominal voltage	24 V DC
Power consumption	≤ 4 W

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4.4 Ambient conditions

4.4.1 CDV75 / CDH75

Vibration

DIN EN 60068-2-6 ..... ≤ 100 m/s², sine 50-2000 Hz

Shock

DIN EN 60068-2-27 ..... ≤ 600 m/s², half-sine 5 ms

EMC

Immunity to disturbance ..... EN 61000-6-2

Transient emissions ..... EN 61000-6-3

Magnetic fields ..... DIN EN 61000-4-8

Characteristic ..... 30 A/m

Criterion ..... A

Room orientation ..... X, Y, Z

Working temperature ..... Tu = f(n) = -20…+70 °C

POWERLINK/EtherCAT variant ..... Tu = f(n) = -25…+65 °C

Scanning system, double magnetic ..... Tu = f(n) = -40…+65 °C

CDV75, for n >100 1/min, IP54 ..... Tu = f(n) = 70 °C – (0.002 * n)

POWERLINK/EtherCAT ..... Tu = f(n) = 65 °C – (0.002 * n)

CDV75, for n >100 1/min, IP65 ..... Tu = f(n) = 66 °C – (0.002 * n)

POWERLINK/EtherCAT,
Scanning system, double magnetic .... Tu = f(n) = 65 °C – (0.002 * n)

CDH75, for n >100 1/min, IP54 ..... Tu = f(n) = 70 °C – (0.005 * n)

POWERLINK/EtherCAT ..... Tu = f(n) = 65 °C – (0.005 * n)

CDH75, for n >100 1/min, IP65 ..... Tu = f(n) = 60 °C – (0.01 * n)

Optional HTL level ..... According to the interface-specific User Manual

Storage temperature ..... see chapter: 3 “Transport / storage”

Relative air humidity, DIN EN 60068-3-4 ..... 98 %, non-condensing

Degree of protection, DIN EN 60529 [1)] ..... IP 54

Optional ..... IP 65

Installation height ..... ≤ 5000 m above sea level

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

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4.4.2 CDV115

Vibration

DIN EN 60068-2-6 ..... ≤ 100 m/s², sine 50-2000 Hz

Shock

DIN EN 60068-2-27 ..... ≤ 600 m/s², half-sine 5 ms

EMC

Immunity to disturbance ..... EN 61000-6-2

Transient emissions ..... EN 61000-6-3

Magnetic fields ..... DIN EN 61000-4-8

Characteristic ..... 30 A/m

Criterion ..... A

Room orientation ..... X, Y, Z

Working temperature ..... Tu = f(n) = -25…+70 °C

POWERLINK/EtherCAT variant ..... Tu = f(n) = -25…+65 °C

Scanning system, double magnetic ..... Tu = f(n) = -40…+65 °C

for n >100 1/min, IP65 ..... Tu = f(n) = 66 °C – (0.002 * n)

POWERLINK/EtherCAT,

Scanning system, double magnetic .... Tu = f(n) = 65 °C – (0.002 * n)

Optional HTL level ..... According to the interface-specific User Manual

Storage temperature ..... see chapter: 3 “Transport / storage

Relative air humidity, DIN EN 60068-3-4 ..... 98 %, non-condensing

Degree of protection, DIN EN 60529 [1)] ..... IP 65

Installation height ..... ≤ 5000 m above sea level

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

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4.5 Mechanical specifications

4.5.1 CDV75

Mechanically permissible speed ..... ≤ 6000 min^{-1}
Electrically permissible speed
* Scanning system, double magnetic ..... ≤ 3000 min^{-1}
Shaft load, at the shaft end ..... ≤ 50 N axial, ≤ 90 N radial
Bearing life time ..... ≥ 3.9 * 10^{10} revolutions at
Speed ..... ≤ 3000 min^{-1}
Operating temperature ..... ≤ 60 °C
Shaft load, at the shaft end ..... ≤ 50 N axial, ≤ 90 N radial
Degree of contamination ..... normal
Permissible angular acceleration ..... ≤ 10^4 rad/s^2
Inertia torque ..... Typically 2.6 * 10^{-5} kg m^2
Start-up torque at 20 °C ..... Typically 0.6 Ncm
with radial shaft seal ..... Typically 2 Ncm
Mass ..... Typically 1 kg

4.5.2 CDH75

Availability ..... Only with optical/magnetic scanning system
Mechanically allowed speed ..... ≤ 3000 min^{-1}
Shaft load ..... Own mass
Bearing life time ..... ≥ 3.9 * 10^{10} revolutions at
Speed ..... ≤ 1000 min^{-1}
Operating temperature ..... ≤ 50 °C
Degree of contamination ..... normal
Permissible angular acceleration ..... ≤ 10^4 rad/s^2
Start-up torque at 20 °C ..... Typically 6 Ncm
Mass ..... Typically 1 kg

4.5.3 CDV115

Mechanically permissible speed ..... ≤ 3600 min^{-1}
Shaft load, at the shaft end ..... ≤ 100 N axial, ≤ 150 N radial
Bearing life time ..... ≥ 2.8 * 10^{10} revolutions at
Speed ..... ≤ 3000 min^{-1}
Operating temperature ..... ≤ 60 °C
Shaft load, at the shaft end ..... ≤ 60 N axial, ≤ 90 N radial
Degree of contamination ..... normal
Permissible angular acceleration ..... ≤ 10^4 rad/s^2
Inertia torque ..... Typically 2.6 * 10^{-5} kg m^2
Start-up torque at 20 °C ..... Typically 0.6 Ncm
Mass ..... Typically 6 kg

* Limitation by the scanning chip. When the speed is exceeded, plus an individual tolerance, the measuring system is switched into the fail-safe status. Error acknowledgment about supply voltage OFF/ON.

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4.6 Tolerance ranges - safety-related speed output

In accordance with DIN EN 61800-5-2 "Electrical power drive systems", the tolerance ranges of the safety-related speed output are specified and explained in more detail below.

The measuring systems were measured accordingly and the data evaluated. The specified tolerance ranges were multiplied by a safety factor (4) in order to compensate for construction-related specimen scatter.

In principle, the measuring system is subject to a static measurement inaccuracy, which is larger with a purely magnetic scanning system (CD_75MM) than with an optical/magnetic (CD_75M) scanning system.

Due to the fact that the speed value must first be calculated (integration time) before it can be output, there is always a delayed speed output (tracking error) in the acceleration phases, in addition to the measurement inaccuracy. The size of the tracking error is proportional to the acceleration.

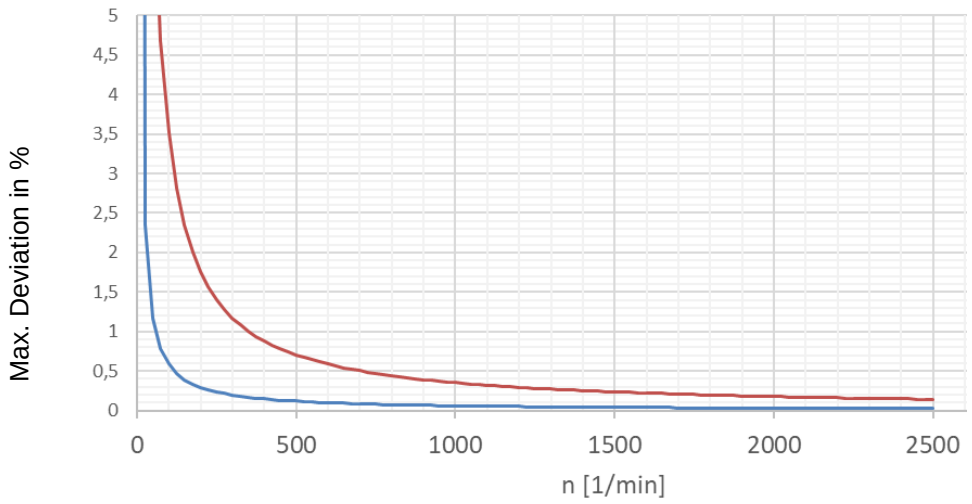
4.6.1 Static measurement inaccuracy



As the value of the absolute error does not change with different `Integration times` or `Resolutions` (Number of steps/Revolutions), these two variables have no influence on the specified tolerance range.

Scanning type	**Tolerance range** [1/min]
optical/magnetic	± 0.6
magnetic/magnetic	± 3.6

The lower the speed, the larger the effect of the tolerance range on the percentage deviation from the real actual value. The following figure provides an overview of the specified tolerance range:



blue curve: scanning mode = optical/magnetic; red curve: scanning mode = magnetic/magnetic

Figure 2: Estimation of the deviation of the speed specification in percent via the speed

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4.6.2 Tracking error



The size of the tracking error depends on the acceleration. If the acceleration = 0 and no filtering is set, the tracking error will be 0 after the integration time has been reached at the latest.

The maximum tracking error results from the difference between the `Target Position` and the `Actual Position` and can be calculated using the following formula:

$$\text{Tracking error}_{max} = (a * t_{int}) - ((0.5 * a * t_{int}^{2}) / t_{int})$$

a: Acceleration in [revolutions/(min*s)]
t_{int}: Adjusted integration time in [ms]

The following example should illustrate the circumstances better:

Given:
Integration time t_{int} = 100 ms
Acceleration of a = 5000 rev. / (min*s) to the target speed of 2000 rev. / min

Note:
With this acceleration, the target speed of 2000 rpm would be reached after just 0.4 s.

Searched for:
Maximum tracking error in revolutions / min, according to the formula above:

= (5000 rev. / (min * s) * 0.1 s) – (0.5 * 5000 rev. / (min*s) * (0.1 s^2)) / 0.1 s

$$= \frac{5000 \text{ rev.} * 0.1 \text{ s}}{\text{min} * \text{s}} - \frac{0.5 * 5000 \text{ rev.} * 0.1 \text{ s}^2}{\text{min} * \text{s} * 0.1 \text{ s}}$$

$$= \frac{500 \text{ rev.}}{\text{min}} - \frac{250 \text{ rev.}}{\text{min}}$$

= **250 revolutions / min**

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Curve of the specified calculation example:

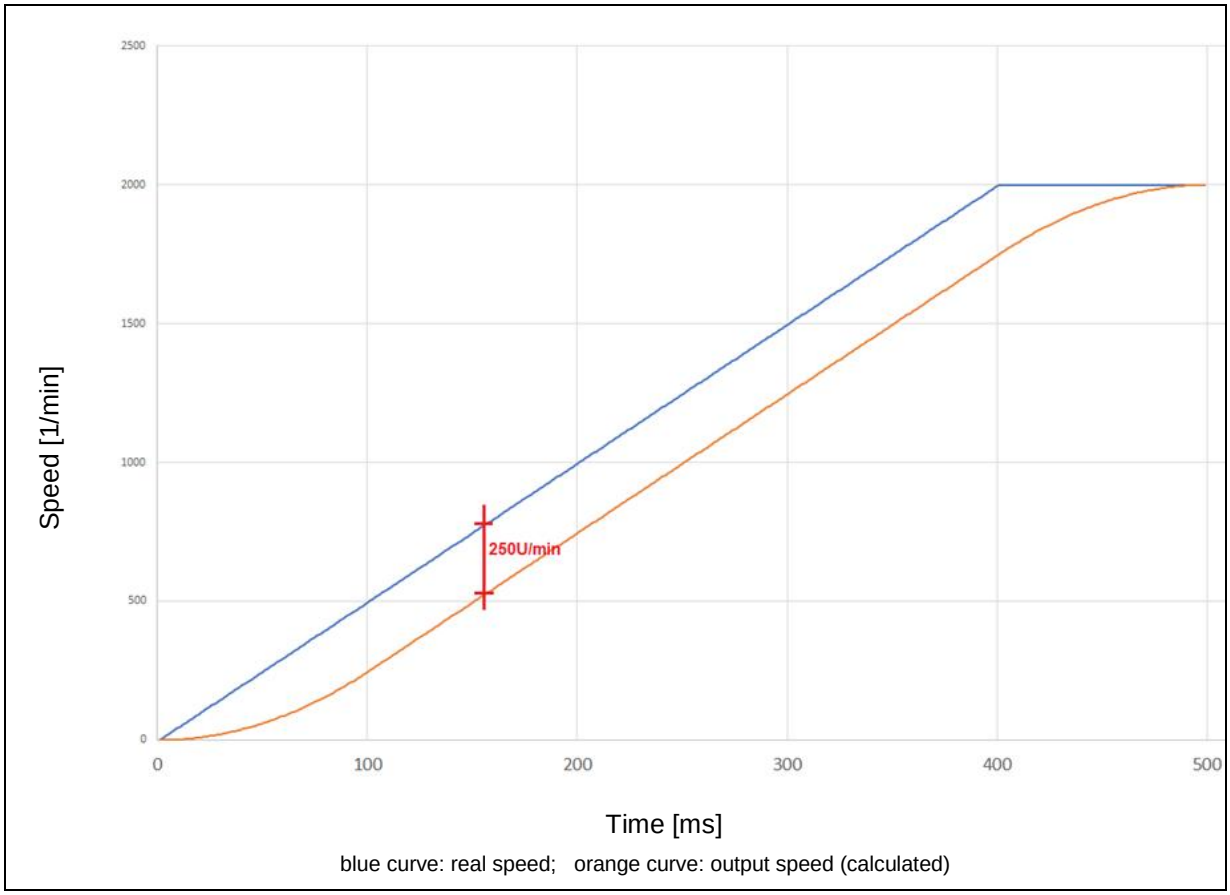


Figure 3: Estimation of the tracking error at an acceleration speed of 5000 rev./(min*s)

With an integration time of 100 ms, the reference calculation value is already modified with a new value after a quarter of the acceleration phase. From this point onwards, the tracking error no longer increases. After the integration time of 100 ms has been reached, the maximum value is therefore 250 rpm. At the end of the acceleration phase, it takes another 100 ms until the speed no longer shows a tracking error.

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5 Assembly

- **If the safety functions are deactivated because of an unstable shaft drive, there will be the danger of death, serious physical injury and/or damage to property!**
  - ➢ The system manufacturer must ensure "**Failure Exclusion**" through design measures: The mechanical coupling of the measuring system via the shaft and its mounting must be guaranteed at all times. To this end, the requirements of the following standards, each under the heading "Adjustable speed electrical power drive systems – Safety requirements," must be complied with:
    - DIN EN 61800-5-2:2017: Complete drive systems
      – in particular Table D.8: "Motion and position feedback sensors"
    - DIN EN IEC 61800-5-3:2024: Safety instrumented measuring system (Encoder)
      – in particular Table G.1: "Mechanic fault list and fault exclusions"

⚠ DANGER

NOTICE

- ➢ As a general rule, it is recommended to prevent radial slippage of the measuring system on the drive shaft by using a parallel key / groove combination to ensure a form-locking.
- ➢ In general, the requirements and acceptance conditions for the complete system must be taken into account when the measuring system is attached.
- ➢ All fastening screws must be secured such that they cannot be loosened accidentally.
- ➢ In case of applications with low ambient temperatures, the start-up torque will be increased. This fact must be taken into account during assembly and when providing the shaft drive.



Due to the variety of measurement system series (75/88/100/115...) and the variety of types within a measurement system series, the following text and dimensions information must be considered as exemplary and have to be adapted to the specific product.

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5.1 Solid shaft

Since the installation situation depends on the particular application and type of device, the following instructions are not exhaustive.

5.1.1 Requirements

- Tolerances and mounting capabilities have to be gathered from the customized dimensional drawing
- The coupling used must be suitable for the application and allow form-locking connection. When used in potentially explosive atmospheres, the coupling must have the appropriate certification; see Ex-user manual. The coupling must be sized based on the static and dynamic load conditions to ensure that the mechanical mounting of the measuring system complies with DIN EN 61800-5-2. If this is not possible, the hazard posed by a coupling failure must be included in the application's risk assessment.
- 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,
  - there is no axial load on the coupling and the measuring system,
  - the clamping screws are tightened with the torque defined by the coupling manufacturer,
  - the coupling screws are secured such that they cannot be loosened accidentally.
- Axial slipping of the measuring system on the drive shaft must be prevented by fixing the coupling in position.
- General recommendation: Radial slipping of the measuring system on the drive shaft should be prevented by a form-locking connection, using a parallel key / groove combination for example; a coupling with groove can be used for this purpose.

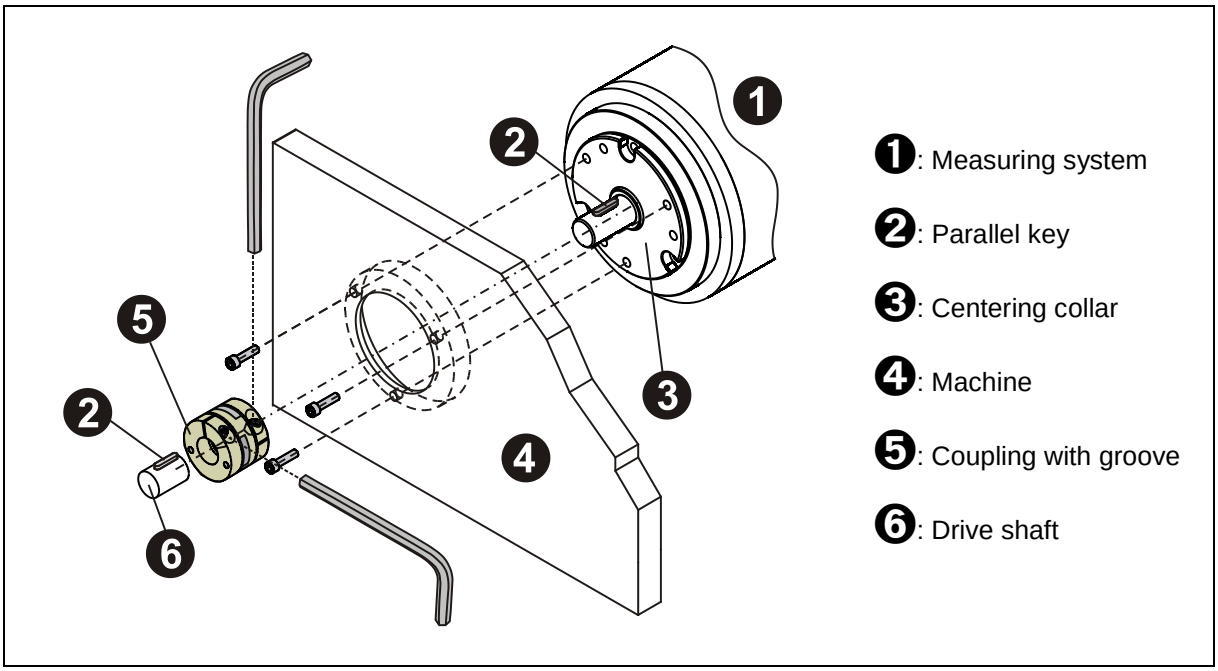


Figure 4: Installing the flange

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5.1.2 Start-up torque

Temperature [°C]	Radius [cm]	Force [N]	Start-up torque [Ncm]
25	1.5	0.5	0.75
-20	1.5	1.5	2.25
-40	1.5	6.7	10.05

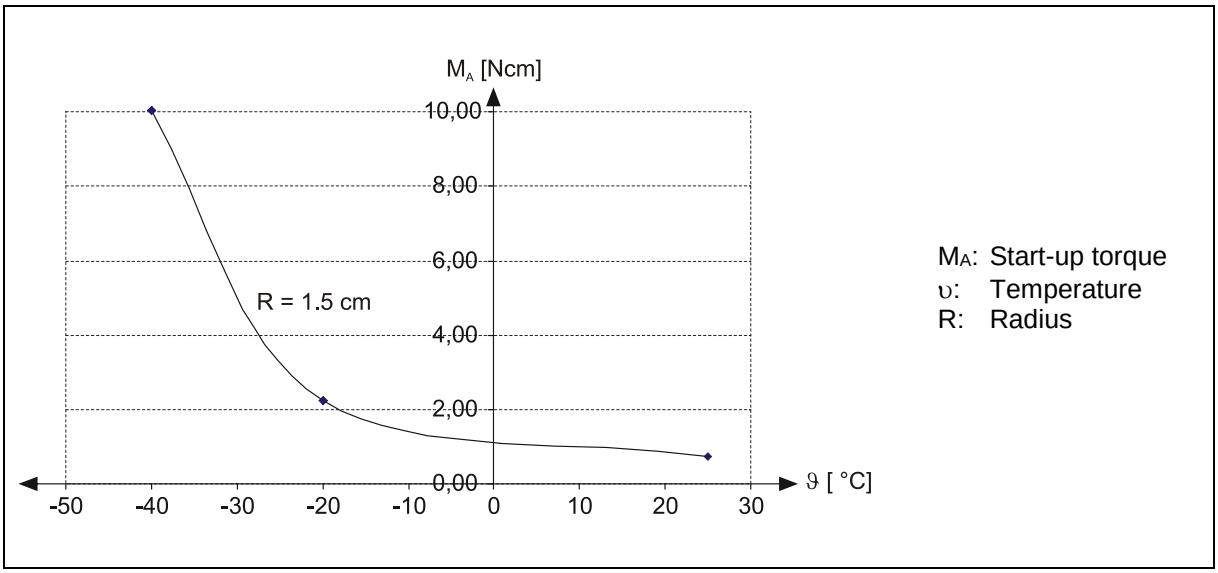


Figure 5: Start-up torque

The starting torque is the maximum torque required to set the shaft in motion after it has been subjected to temperature stress. After the shaft has started moving, the running torque must be applied to keep it moving. The difference between starting torque and running torque arises, for example, due to ice formation at low temperatures. See Section 5.4, “Start-up torque,” on page 36.

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5.2 Hollow shaft

The following information does not claim to be complete as the assembly situation depends on the application or model.

5.2.1 Requirements

- Please refer to the customer-specific drawing for any variations in size and individual assembly options.
- 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 fixing the clamping ring in position, see Figure 6.
- Further measures may be required to prevent axial slipping of the measuring system.
- There may be no axial load on the clamping mechanism of the measuring system.
- The screw of the clamping ring must be tightened with 3 Nm using a torque wrench.
- The screw of the clamping ring must be secured such that it cannot be loosened accidentally.
- General recommendation: Radial slipping of the measuring system on the drive shaft should be prevented by a form-locking connection, using a parallel key/groove combination for example.

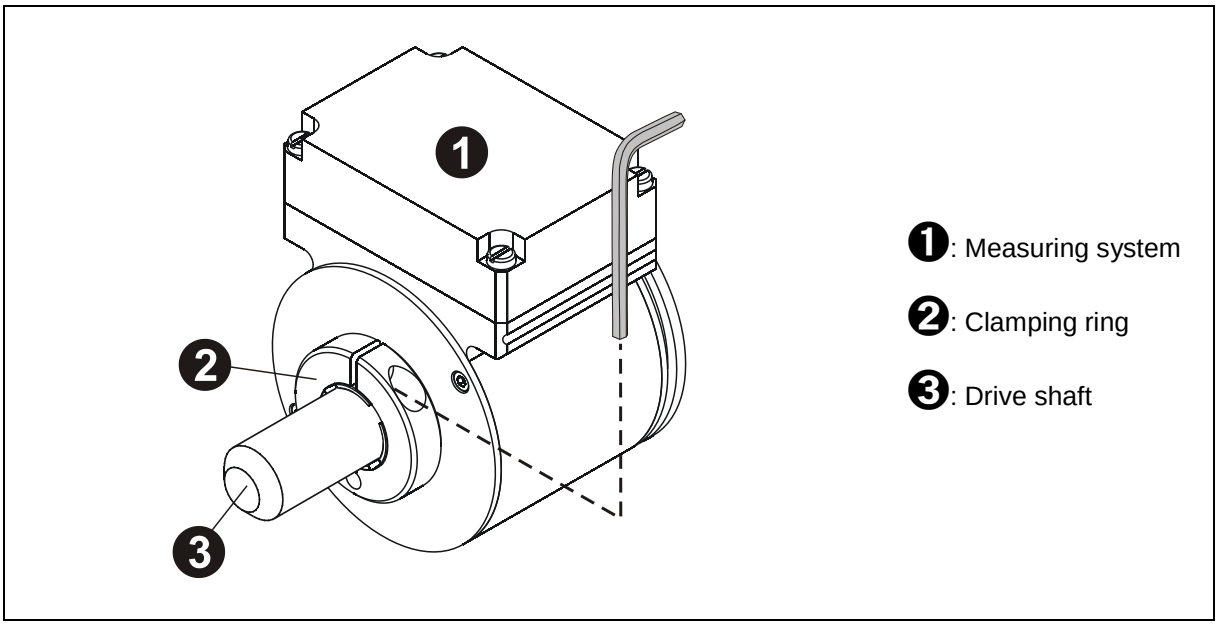


Figure 6: Friction locking

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5.2.2 Dowel pin / groove insert

- A dowel pin is used to fix the measuring system on the drive end, see Figure 7.
- The dowel pin must extend at least 4 mm into the groove insert (max. 5.5 mm). The distance from the measuring system flange **Y** to the customer-provided device plane **X** must be> 1.5 mm, see Figure 8.
- The clamping ring assembly requirements must be observed, see Chapter: 5.2.1 “Requirements”.

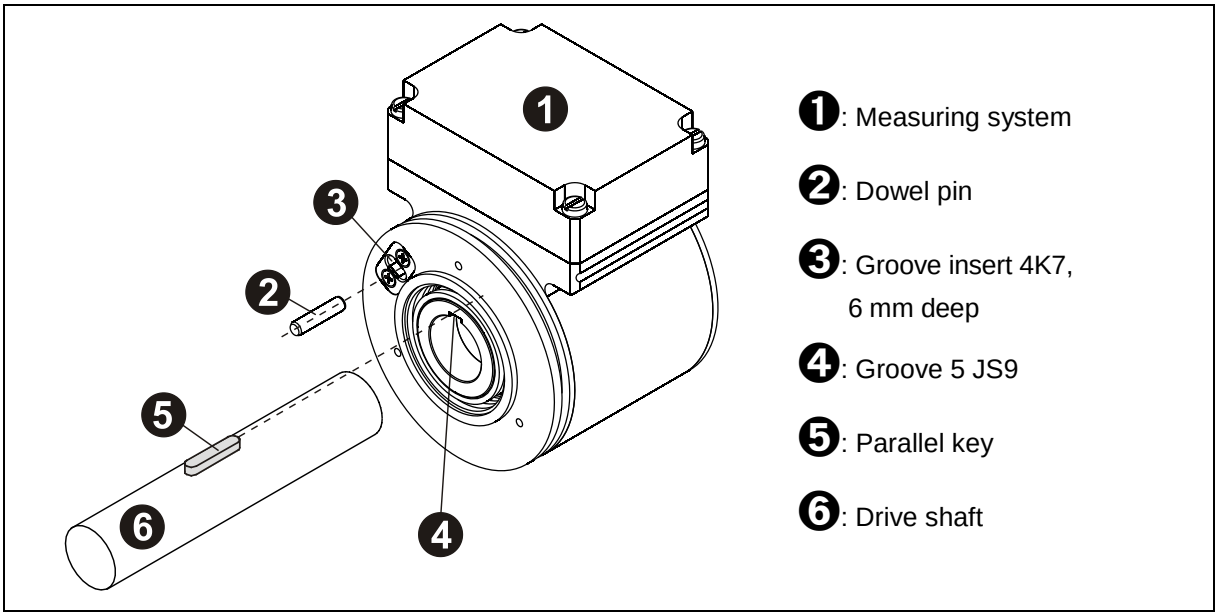


Figure 7: Form-locking

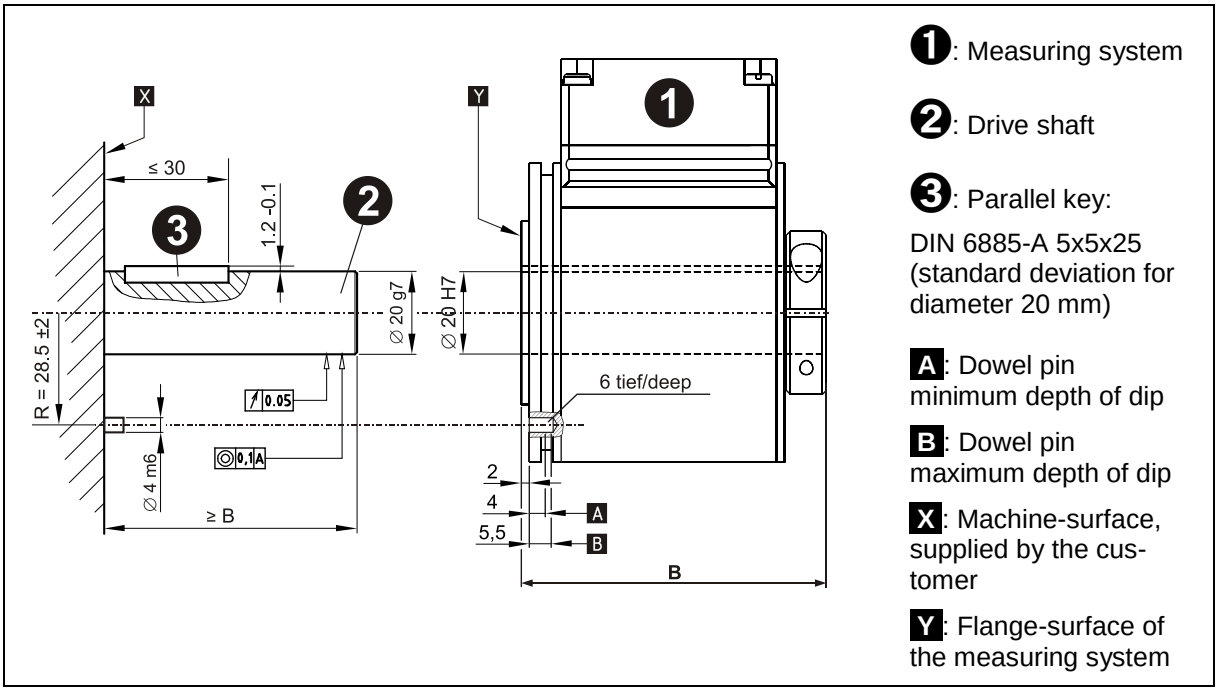


Figure 8: Shaft receptacle requirements

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5.2.3 Joint head rod

- Please refer to the customer-specific drawing for any variations in size and individual assembly options. Please refer to the manufacturer's individual technical data for joint head rod specifications, such as the permissible tilt angle of the joint head.
- Two joint heads, a threaded rod and two M5 cheese head screws are required for assembly. See Chapter: 10 "Accessories".
- The joint head rod can be positioned on the measuring system flange in several ways. See Figure 11: Joint head rod – mounting variants.
- For maximum support of the measuring system, the joint head rod must be mounted at a 90° angle to the line connecting the threaded hole to the center of the shaft, see Figure 11.
- The M5 screws must be tightened with a tightening torque of 2.2 Nm and secured against unintentional loosening with a medium-strength screw locking device.
  - Ensure the thread is sufficiently long for the screws to be completely screwed in.
- The minimum thread reach into the flange plate (machine) is 4 mm in steel and 6 mm in aluminum. The minimum thread reach into the measuring system flange is 6 mm.
- The mounting surfaces should be free of any lubricants or dirt.
- The clamping ring assembly requirements must be observed, see Chapter: 5.2.1 "Requirements".

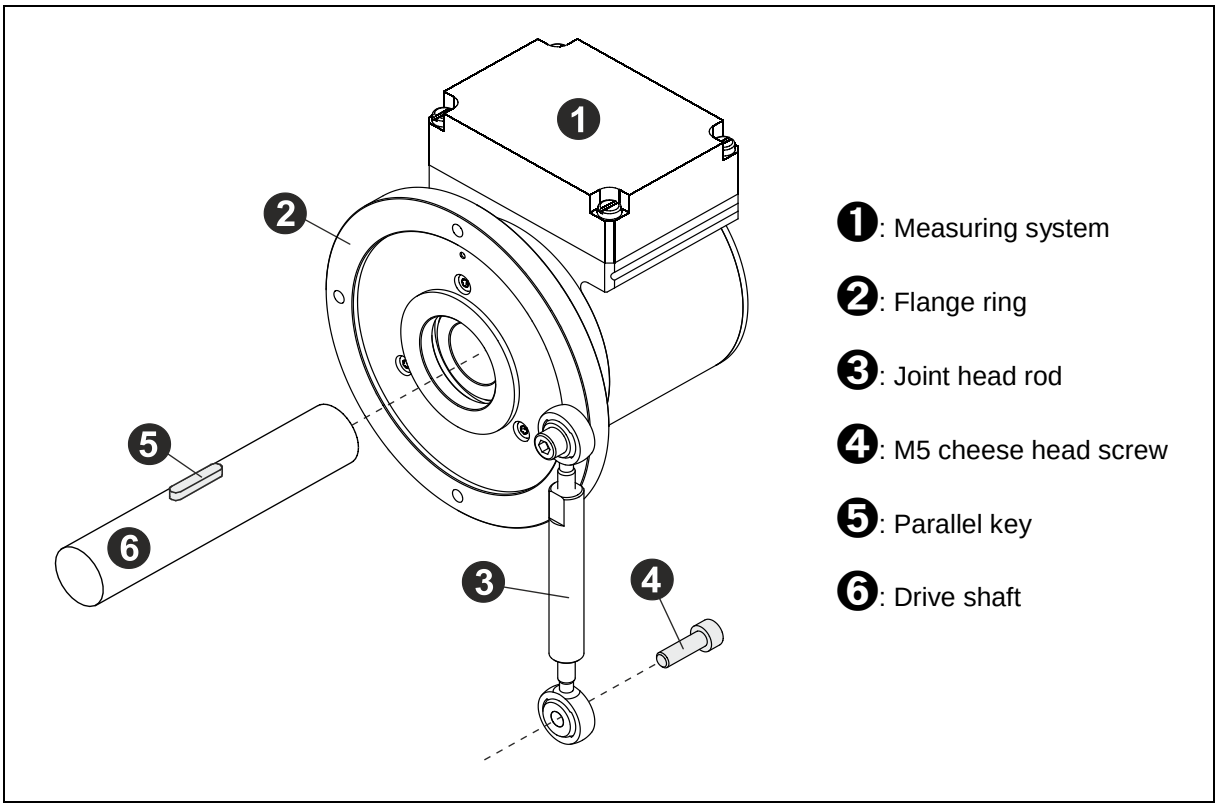


Figure 9: Positive engagement and joint head rod

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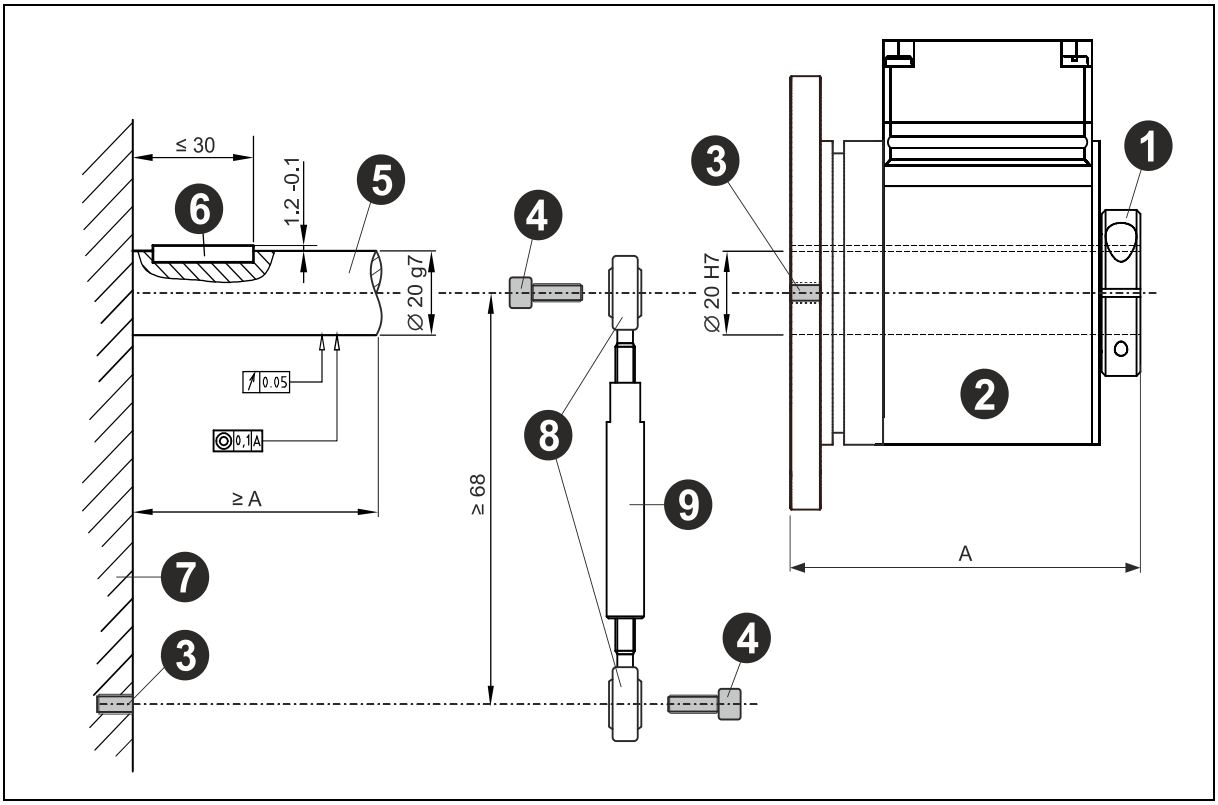


Figure 10: Shaft accommodation requirements

Components:

1: Clamping ring with screw
2: Measuring system with hollow shaft (H7 fit, according to article number in referenced drawing)
3: M5 threaded hole
4: 2x M5 cheese head screws
5: Drive shaft with g7 fit, provided by customer
6: Parallel key, according to the article number in the referenced drawing
7: Flange plate (machine)
8: 2x joint head
9: Threaded rod

Mounting variants:

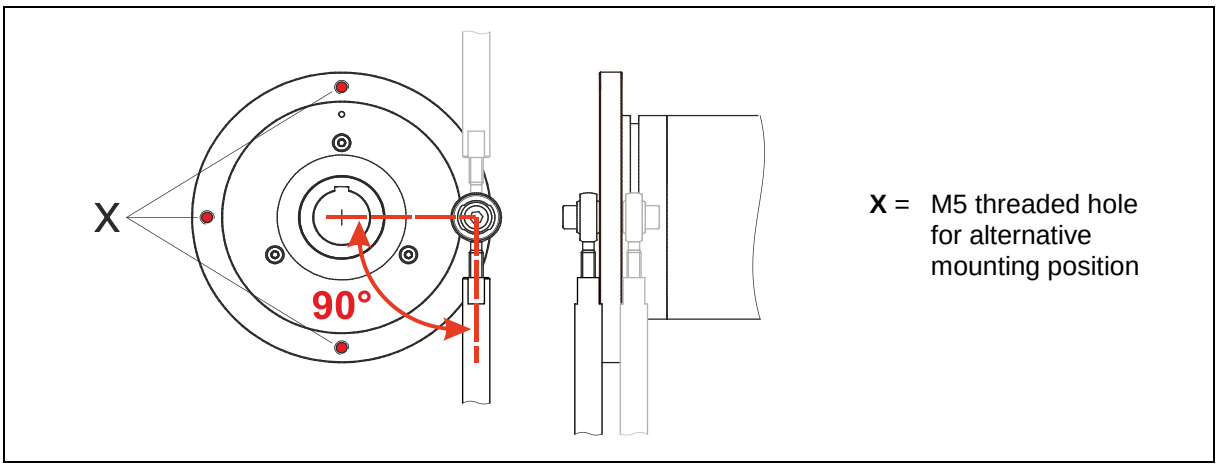


Figure 11: Joint head rod – mounting variants

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5.3 Blind-hole shaft

Since the installation situation depends on the particular application and type of device, the following instructions are not exhaustive.

5.3.1 Requirements

- Tolerances and mounting capabilities have to be gathered from the customized dimensional drawing
- 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 fixing the clamping ring in position, see Figure 12.
- Further measures may be required to prevent axial slipping of the measuring system.
- There may be no axial load on the clamping mechanism of the measuring system.
- The screw of the clamping ring must be tightened with 3 Nm using a torque wrench.
- The screw of the clamping ring must be secured such that it cannot be loosened accidentally.
- General recommendation: Radial slipping of the measuring system on the drive shaft should be prevented by a form-locking connection, using a cylinder pin / groove combination for example; in this case the measuring system can be fixed in position on the drive end using a dowel pin, see Figure 13. The dowel pin must extend at least 4 mm into the groove insert.

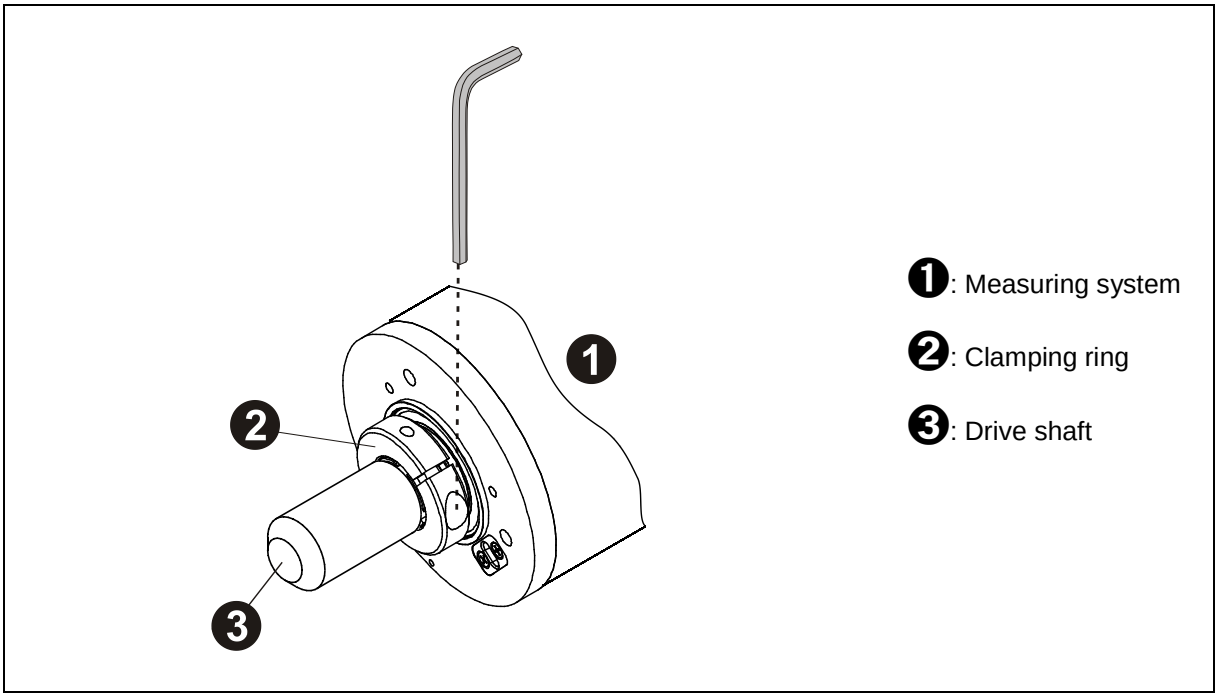


Figure 12: Friction locking

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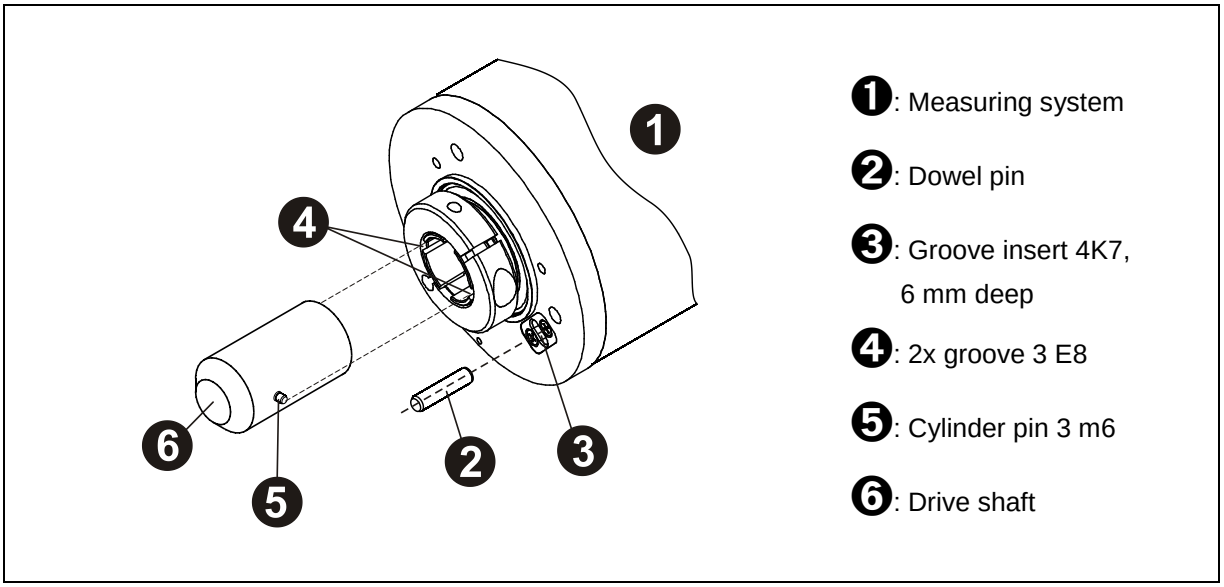


Figure 13: Form-locking

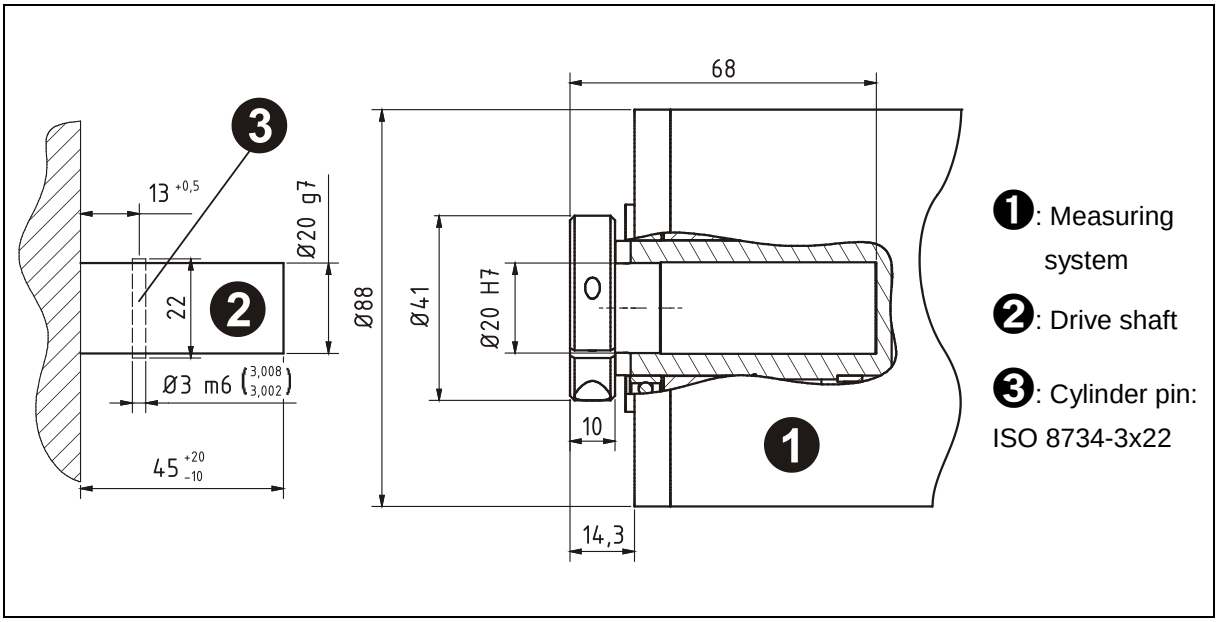
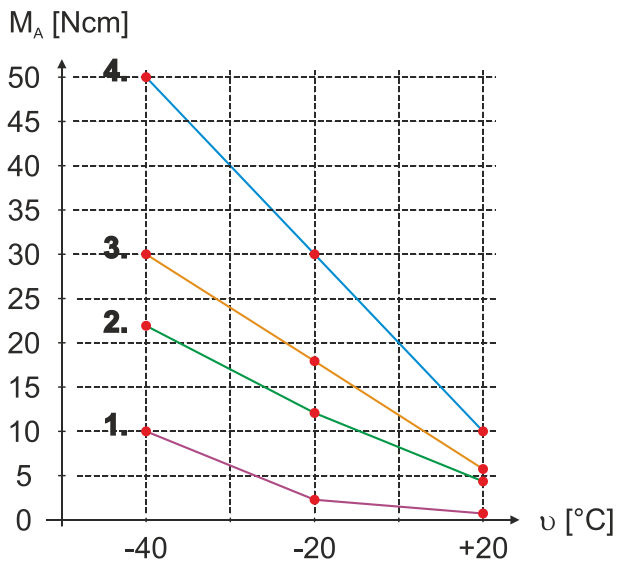


Figure 14: Shaft receptacle requirements

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5.4 Start-up torque

Temperature [°C]	Starting torques in [Ncm] at +6 σ			
	1. Solid shaft (IP54)	**2.** Solid shaft (IP65)	**3.** Hollow shaft (IP54)	**4.** Hollow shaft (IP65)
+20	0.75	4	6	10
-20	2.25	12	18	30
-40	10	22	30	50



M_A: Starting torque
ϑ: Ambient temperature

At +6 Sigma

Figure 15: Starting torques

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6 Replacing the measuring system

Ensure that you meet the following requirements while replacing the measuring system:

- The new measuring system must have the same article number as the measuring system being replaced; any deviations must be expressly clarified with TR Electronic GmbH.
- When the new measuring system is used, it must be ensured that the hardware switch settings comply with the previous settings.
- The new measuring system must be installed in accordance with the specifications and requirements in chapter “Assembly” on page 27.
- The new measuring system must be connected in accordance with the specifications in the interface-specific User Manual.
- Since the parameters of the measuring system are usually stored in the control, the new measuring system is parameterized with the projected settings in the start-up phase. If this mechanism fails, it must be ensured that the settings for the new measuring system are the same as those for the old one.
- Depending on the application, the output position value must possibly be adjusted to the reference position of the machine. The position value must be adjusted as specified in the interface-specific User Manual.
- Before the replaced measuring system is recommissioned, its proper functioning must be verified in a protected test run.

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7 Checklist, part 1 of 2

We recommend that you print out and work through the checklist when commissioning and replacing the measuring system and when changing the parameterization of a previously accepted system and store it as part of the overall system documentation.

Documentation reason	Date	Processed	Reviewed

Sub-item	Please ensure	Can be found under	Yes
The present Safety Manual has been read and understood	–	Document no.: TR-ECE-BA-GB-0107	☐
Interface-specific User Manual	• Go through and use the checklist part 2 of 2	See chapter Document download on page 42	☐
Verify that the measuring system can be used for the present automation task on the basis of the specified safety requirements	• Intended use • Comply with all technical data	• Chapter Intended use, page 13 • Chapter General technical data, page 20 • Interface-specific User Manual (checklist part 2 of 2)	☐
Meet the assembly requirements defined in the Safety Manual	• Safe mechanical attachment of the measuring system. General recommendation: Form-locking connection of the driving shaft to the measuring system	• Chapter Assembly, page 27	☐
Power supply	• The power supply used must meet the specified requirements	• Chapter Document download -> Product data sheet. page 42 • Interface-specific User Manual (checklist part 2 of 2)	☐
Correct – electric installation (shielding) – network installation	• Comply with general installation rules • Comply with wiring standards • Comply with the guidelines provided by the particular field bus user organizations	• Interface-specific User Manual (checklist part 2 of 2)	☐
After Commissioning and Parameter Changes - System Test - Validation (Settings – Axis)	• During startup and after every parameter change - all affected safety functions must be checked; - if there are multiple (identical) axes, it must be ensured that the settings have also been applied to the desired axis	• Interface-specific User Manual (checklist part 2 of 2)	☐

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Sub-item	Please ensure	Can be found under	Yes
Preset adjustment function	• Legacy operation: The preset adjustment function may only be executed when the axis in question is at standstill • Ensure that the preset adjustment function is prevented from being triggered accidentally • After execution of the preset adjustment function, the new position must be checked before restarting	• Interface-specific User Manual (checklist part 2 of 2)	☐
Device replacement	• Ensure that the new device corresponds to the replaced device • Check all safety functions involved	• Chapter Replacing the measuring system, page 37 • Interface-specific User Manual (checklist part 2 of 2)	☐
Verification and validation of the programming system (Control system / Software)	• Ensure that all functional and performance related requirements for the safety-related parts of the programming system are met. Particularly, this applies to changing the program version.	• Safety of machinery – safety related parts of control systems – DIN EN ISO 13849-1 – DIN EN ISO 13849-2	☐

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8 Maintenance

The measuring system requires no maintenance by the operator.

However, if the bearing life of the product is exceeded within a service life of 20 years, the metering system must be taken out of service and sent to the manufacturer.

After 20 years of use, the measuring system must be subjected to a proof test.

For more information, please refer to these standards

– DIN EN 62061 and
– DIN EN 61508

titled “Safety of Machinery – Functional safety of electrical/electronic/programmable electronic safety-related systems”.

The procedure must be coordinated with the manufacturer.

9 Decommissioning / demounting

When decommissioning or demounting, the following instructions from the chapter "Safety-related instructions" must be observed in particular:

– Wiring work may only be carried out and electrical connections only be opened and closed while the system is de-energized.

– Avoid shocks (e.g., hammer blows) to the shaft during installation / demounting.

Connector plugs of the measuring system that are unused during storage, operation and/or demounting of the system have to be provided either with a mating connector or a protective cap. The IP degree of protection is to be selected according to requirements.

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10 Accessories

Protective Caps / O-Rings

Description	Order no.:
Protective cap yellow, M12x1 female thread with O-ring, IP65. Suitable for supply voltage connector	62-000-1664
Protective cap black, M12x1 male thread without O-ring, IP50. Suitable for bus and incremental interface connector	62-000-1344
O-ring DIN-3771 7x1 NBR 70 SHORE Suitable for protective cap 62-000-1344 --> IP65	26-000-332

Optional torque support with swivel head and M5 threaded rod

Description	Order no.:
Joint head M5	49-280-002
Threaded rod M5, Ø 10 mm x 60 mm	49-917-026
Threaded rod M5, Ø 10 mm x 105 mm	49-995-200
Threaded rod M5, Ø 10 mm x 360 mm	49-917-022

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11 Document download

Safety manual	Link
Absolute Encoder CD_-75	www.tr-electronic.de/f/TR-ECE-BA-GB-0107

Interface-specific user manuals	Link
PROFIBUS/PROFIsafe	www.tr-electronic.de/f/TR-ECE-BA-GB-0092
PROFINET/PROFIsafe	www.tr-electronic.de/f/TR-ECE-BA-GB-0095
POWERLINK/openSAFETY	www.tr-electronic.de/f/TR-ECE-BA-GB-0110
EtherCAT/FSoE	www.tr-electronic.de/f/TR-ECE-BA-GB-0118

Product data sheets	Link
Absolut Encoders / Functional Safety	www.tr-electronic.com/s/S027274

Pin assignments
www.tr-electronic.com/service/downloads/pin-assignments.html

TÜV Certificate
www.tr-electronic.de/f/TR-ECE-TI-DGB-0297

Revision list
www.tr-electronic.de/f/TR-ECE-TI-DGB-0396

Declaration of conformity
EU Declaration of conformity: www.tr-electronic.de/f/TR-ECE-KE-DGB-0337 UK Declaration of conformity: www.tr-electronic.de/f/TR-ECE-KE-GB-0370

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