Functional Safety Type Approved

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Translation of the original manual

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CDV 75 M

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ADV75
ADH75

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User Manual

Absolute rotary encoder series CDx-75 with PROFINET IO interface and PROFIsafe profile

- Basic safety instructions
- Intended use
- General functional description
- Characteristics
- Mounting
- Installation/Commissioning
- Parameterization
- Cause of faults and remedies

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Revision index

Revision	Date	Index
First release	08/06/12	01
Modification of the service life from 15 years to 20 years	11/06/12	02
• Notes for use in explosive areas • Incremental output: optional with 13-27 V DC	05/07/13	03

1 General information

This Manual contains the following topics:

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

As the documentation is arranged in a modular structure, the User Manual is supplementary to other documentation, such as product data sheets, dimensional drawings, brochures, etc.

The User Manual may be included in the customer's specific delivery package or it may be requested separately.

1.1 Applicability

This User Manual applies exclusively to measuring system models according to the following type designation code with ***PROFINET IO*** interface and ***PROFIsafe*** profile:

A	* 1	* 2	* 3	* 4	-	* 5	* 5	* 5	* 5	* 5

Position	Notation	Description
A	A C	Explosion protection enclosure (ATEX); ⟨Ex⟩ Absolute Encoder, programmable
* 1	D	redundant dual scanning unit
* 2	V H	Solid shaft Hollow shaft
* 3	75	External diameter ∅ 75 mm
* 4	M	Multi turn
* 5	-	Consecutive number

* = Wild cards

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

Depending of the device type, the following documentation therefore also applies:

- the operator's operating instructions specific to the system
- this User Manual
- the ⟨Ex⟩-User Manual **TR-ECE-BA-GB-0099**,
  75 series built-in in the explosion protection enclosure "ADV75 / ADH75"

1.2 Applied directives and standards

The measuring systems in series CDx-75 have been developed, designed and manufactured taking account of the applicable European and international standards, directives and requirements.

Directives	
- 2004/108/EC (L 390/24)	EMC Directive
- 2006/42/EC (L 157/24)	Machinery Directive
EMC; Immunity to disturbance acc. to EN 61000-6-2:2005/AC:2005, industrial environments:	
- DIN EN 61000-4-2:2009	Electrostatic discharge, ESD
- DIN EN 61000-4-3:2011	Radio-frequency electromagnetic fields
- DIN EN 61000-4-4:2010	Fast transient electrical disturbances, burst
- DIN EN 61000-4-5:2007	Surge
- DIN EN 61000-4-6:2009	Immunity to conducted disturbances, induced by radio-frequency fields
- DIN EN 61000-4-8:2010	Power frequency magnetic fields
- DIN EN 61326-3-2:2008	Immunity to disturbance requirements for safety-related systems and for devices
- EN 62061:2005/AC:2010, Appendix E	Electromagnetic phenomena and increased levels of immunity to disturbance for SRECS, which are intended for use in industrial environments in accordance with IEC61000-6-2
EMC; Transient emissions acc. to EN 61000-6-3:2007/A1:2011, residential environments:	
- EN 55011:2009/A1:2010	Disturbance field strength, 30 MHz - 1 GHz
- EN 55011:2009/A1:2010	Interference voltage, < 30 MHz
Safety	
- DIN EN 61508 Part 1-7:2010	Functional safety
- EN 61800-5-2:2007	Adjustable speed electrical power drive systems; Safety requirements - Functional
- EN 60204-1:2006/AC:2010, in extracts	Safety of machinery - Electrical equipment of machines - Part 1: General requirements
- EN 62061:2005/AC:2010, Appendix F	Safety of machinery - Functional safety of safety-related E/E/PE control systems
- EN ISO 13849-1:2008/AC:2009	Safety of machinery - Safety-related parts of control systems
Environmental influences	
- DIN EN 60068-2-6:2008	Vibration (sinusoidal)
- DIN EN 60068-2-64:2009	Broadband random
- DIN EN 60068-2-27:2010	Single shock
- DIN EN 60068-2-1:2008	Cold
- DIN EN 60068-2-2:2008	Dry heat
- DIN EN 60068-2-14:2010	Change of temperature
- DIN EN 60529:2000	Degrees of protection provided by enclosures (IP code)
GS - ET - 26, Certification of bus systems	
Final draft by Electrotechnical Expert Committee for the inspection and certification of:	"Bus systems for the transmission of safety-relevant messages"

1.3 General functional description

The CDx-75 rotary measuring system is a safe and absolute Multi-Turn position measuring system with PROFINET IO interface and PROFIsafe protocol.

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

The safety measuring system consists of a **redundant, two-channel system**, in which **optical** and **magnetic scanning units** are arranged on a drive shaft, designed as a hollow shaft or solid shaft.

1.3.1 Main features

- PROFINET IO interface with PROFIsafe protocol, for transfer of a safe position and speed
- Quick process data channel via PROFINET IO, not safety-oriented
- Additional incremental or SIN/COS interface, not safety-oriented
- Two-channel scanning system, for generation of safe measured data through internal channel comparison
  - Channel 1, master system:
    optical Single-Turn scanning via code disk with transmitted light and magnetic Multi-Turn scanning
  - Channel 2, inspection system:
    magnetic Single and Multi-Turn scanning
- A common drive shaft

Due to its technology the optical system possesses greater accuracy, therefore it is used as master system. The data of the master system are unevaluated in the non-safety-oriented process data channel with normal PROFINET IO protocol, but are made available with a short cycle time.

The magnetic scanning system serves for the internal safety check. The "safe data" obtained through two-channel data comparison are packed into the PROFIsafe protocol and also transmitted to the control via the PROFINET IO.

The incremental interface, or the optionally available SIN/COS interface, is derived from the master system and is not evaluated in relation to safety.

1.3.2 Principle of the safety function

System safety results when:

- Each of the two scanning channels is largely fail-safe thanks to individual diagnostic measures
- The measuring system internally compares the positions detected by both channels in two channels, also determines the speed in two channels and transfers the safe data to the PROFINET IO in the PROFIsafe protocol
- In the event of a failed channel comparison or other errors detected through internal diagnostic mechanisms, the measuring system switches the PROFIsafe channel into error state
- The measuring system initialization and execution of the preset adjustment function are appropriately verified
- The control additionally checks whether the obtained position data lie in the position window expected by the control. Unexpected position data are e.g. position jumps, tracking error deviations and incorrect direction of travel
- When errors are detected the control 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 for measurement
- The system manufacturer performs a verified test during commissioning and in the event of any parameter modification

2 Basic safety instructions

2.1 Definition of symbols and notes

⚠ DANGER	means that death or serious injury will occur if the required precautions are not met.
⚠ WARNING	means that death or serious injury can occur if the required precautions are not met.
⚠ CAUTION	means that minor injuries can occur if the required precautions are not met.
NOTICE	means that damage to property can occur if the required precautions are not met.
	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 supplementary sheet 1 must be applied.
	indicates additional information's for the operational in explosive endangered atmospheres.

2.2 Use in potentially explosive atmospheres

By means of the build-in of the standard measuring system CDV75/CDH75 into the explosion protective housing ADV75/ADH75 and compliance with the explosion protection requirements, changes in the original properties of the measuring system arise.
Furthermore, additional work, inspections, monitoring, and special measures are required. Additional relevant qualifications are required for the various jobs in potentially explosive atmospheres.

This interface-specific user manual describes the standard measuring system without explosion protective housing.
All information on the safe use of the ATEX-compliant measuring system in potentially explosive atmospheres are contained in the Ex-User manual.

The only outer difference between the devices is the additional explosion protection type plate. With regards to the electronic interfaces the two devices are identical.

Significant characteristics and requirements for the ATEX device:

- Limited permissible maximum speed
- Extended working temperature range
- Special conditions for safe use with regards to the labelling "X". Because of these measures there is a higher IP-degree of protection.
- Special requirements for the electrical installations design, selection and erection in potentially explosive atmospheres, as well as the respective qualification requirements for the performing personnel (IEC 60079-14/DIN EN 60079-14). Among other things this results in the requirement that shaft driving elements need to be ATEX-compliant and that special conditions are attached to the potential equalization.
- Special requirements for the testing and maintenance of electrical systems in potentially explosive atmospheres, as well as the respective qualification requirements for the performing personnel (IEC 60079-17/DIN EN 60079-17). Among other things this results in the requirement that relevant visual inspections have to be performed directly on the device.

2.3 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, and only for its intended use, paying attention to safety and dangers, and in compliance with the ***User Manual*** and the ***Ex-User Manual!*** Faults which could threaten safety should be eliminated without delay!

2.4 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 (F-Host) in systems in which the **goal of "Protection of travel"** 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 must only be used in safety applications in conjunction with a control 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 User Manual and Ex-User Manual,
- observing the nameplate and any prohibition or instruction symbols on the measuring system,
- observing the enclosed documentation, e.g. product insert, connector configuration etc.,
- 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 processing unit (F-Host) fulfils all required safety functions,
- observing and using the checklist in the Appendix,
- safe mounting (form-closed) of the measuring system to the driving axis

2.5 Non-intended use

⚠ WARNING

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

NOTICE

➢ The following areas of use are especially forbidden:

- in environments where there is an explosive atmosphere
- for medical purposes

2.6 Safety functions of the fail-safe processing unit

The **F-Host**, to which the measuring system is connected, must perform the following safety checks.

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

If no safe position can be output due to an error detected by the measuring system, the PROFIsafe data channel is automatically put into fail-safe status. In this status so-called "passivated data" are output via PROFIsafe. Also see the chapter "Output of passivated data (substitute values) in case of error" on page 53.

Passivated data from the viewpoint of the measuring system are:

- PROFIsafe data channel: all outputs are set to 0
- PROFIsafe status: error bit 2^1 `Device_Fault` is set
- PROFIsafe-CRC: valid

Upon receipt of passivated data, the F-Host must put the system into a safe state. It is only possible to leave this error state by eliminating the error and then switching the supply voltage off and on again!

The process data channel addressable via PROFINET IO is not necessarily affected by this. If the internal diagnosis in the master channel does not detect an error, the process data are still output. However, these data are not safe for the purposes of a safety standard.

2.6.1 Mandatory safety checks / measures

Measures for commissioning, changes	F-Host error reaction
Application-dependent parameterization and definition of the necessary `iParameters`, see chapter "iParameters" on page 51.	–
In the event of parameter changes, check that the measure is executed as desired.	STOP

Check by F-Host	F-Host error reaction
Cyclical consistency check of the current safety-oriented data from the `CD_75_-EPN I/O safety` module in relation to the previous data.	STOP
Travel curve calculation and monitoring by means of cyclical data from the `CD_75_-EPN I/O safety` module.	STOP
Monitoring of cyclical data from the `CD_75_-EPN I/O safety` module, and the process data from the `CD_75_-EPN I/O` module.	Receipt of passivated data --> STOP
Timeout: Monitoring of the measuring system - response time. For checking e.g. cable breakage, power failure etc.	STOP

2.7 Warranty and liability

In principle the "General Terms and Conditions" of TR-Electronic GmbH apply. These are available to the operator with the Order Confirmation or when the contract is concluded at the latest. Warranty and liability claims in the case 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, start-up and programming of the measuring system.
- Work carried out incorrectly on the measuring system
- Operation of the measuring system with technical defects.
- Mechanical or electrical modifications to the measuring systems undertaken autonomously.
- Repairs carried out autonomously.
- Third party interference and Acts of God.

2.8 Organizational measures

- The User Manual must always be kept ready-to-hand at the place of use of the measuring system.
- In addition to the User Manual, 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 on special operating features and requirements.
- Prior to commencing work, personnel working with the measuring system must have read and understood the chapter "Basic safety instructions".
- The nameplate 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 User Manual.
- Repairs may only be undertaken by the manufacturer or a center or person authorized by the manufacturer.

2.9 Personnel selection and qualification; basic obligations

- All work on the measuring system must only be carried out by qualified personnel. Qualified personnel includes 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 definition of “qualified personnel” also includes an understanding of the standards VDE 0105-100 and IEC 364 (source: e.g. Beuth Verlag GmbH, VDE-Verlag GmbH).

- The responsibility for assembly, installation, commissioning and operation must be clearly defined. The obligation exists to provide supervision for trainee personnel.

2.10 Safety information

- **Destruction, damage and malfunction of the measuring system!**
  - 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).

⚠ WARNING

  - If an overvoltage of >36 V DC is inadvertently applied the measuring system must be inspected in the factory, with specification of the reasons or circumstances.

NOTICE

  - 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.
  - Make sure that the access to the address switches and LEDs is locked after the settings with the screw plug. Tighten firmly!
  - 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 respective applicable country-specific regulations are to 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 unit in transit.

- **Storage**
  - Storage temperature: -30 to +80°C
  - Store in a dry place

4 Assembly

4.1 Solid shaft version CDV-75

4.1.1 Requirements

- **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 61800-5-2:2008 "Adjustable speed electrical power drive systems, Safety requirements - Functional, Table D.16 – 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.

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

- ➢ All fastening screws must be secured against unintentional loosening.
- ➢ A suitable coupling with positive connection must be used for the application.

⚠ DANGER

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

NOTICE

- ➢ 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 of the measuring system on the drive shaft must be prevented by means of form closure, using a parallel key / groove combination (Figure 1, (2)); a coupling with groove must be used for this purpose.
- ➢ In case of applications with low ambient temperatures, increased values for the start-up torque result. This fact is to be considered when the assembling and wave drive is performed.

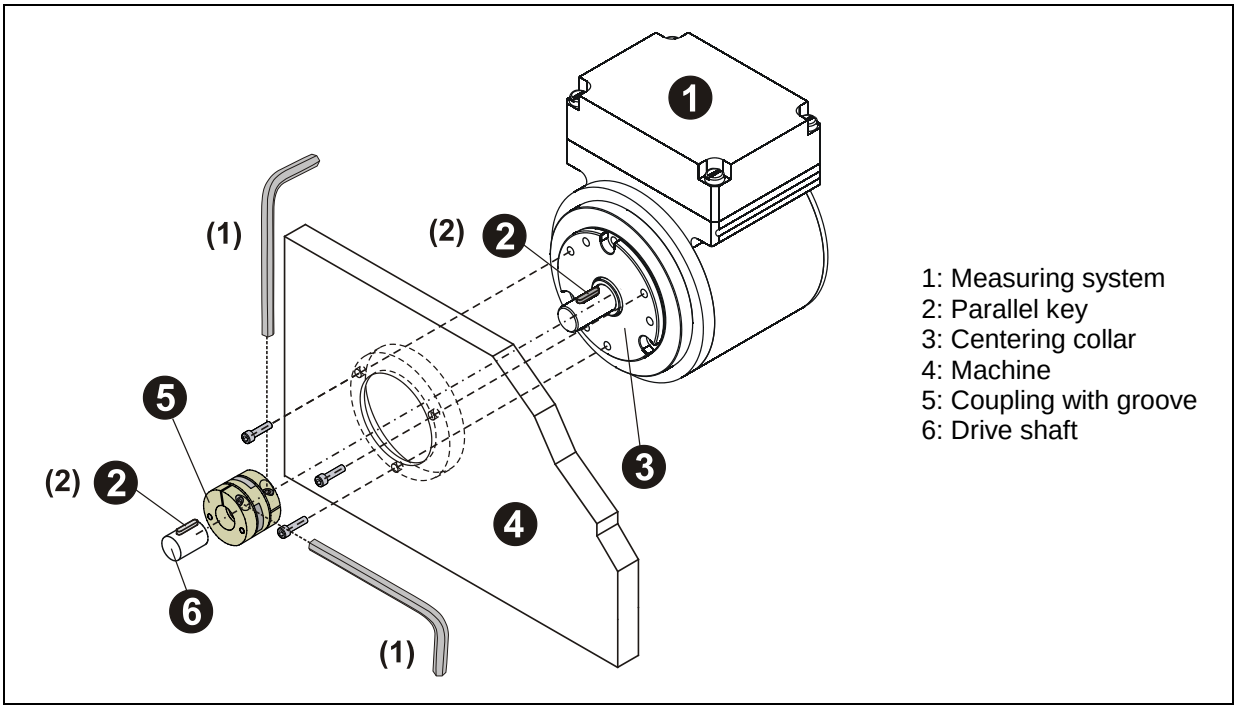


Figure 1: Flange installation

4.1.2 Start-up torque of the shaft, in dependence of the temperature

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

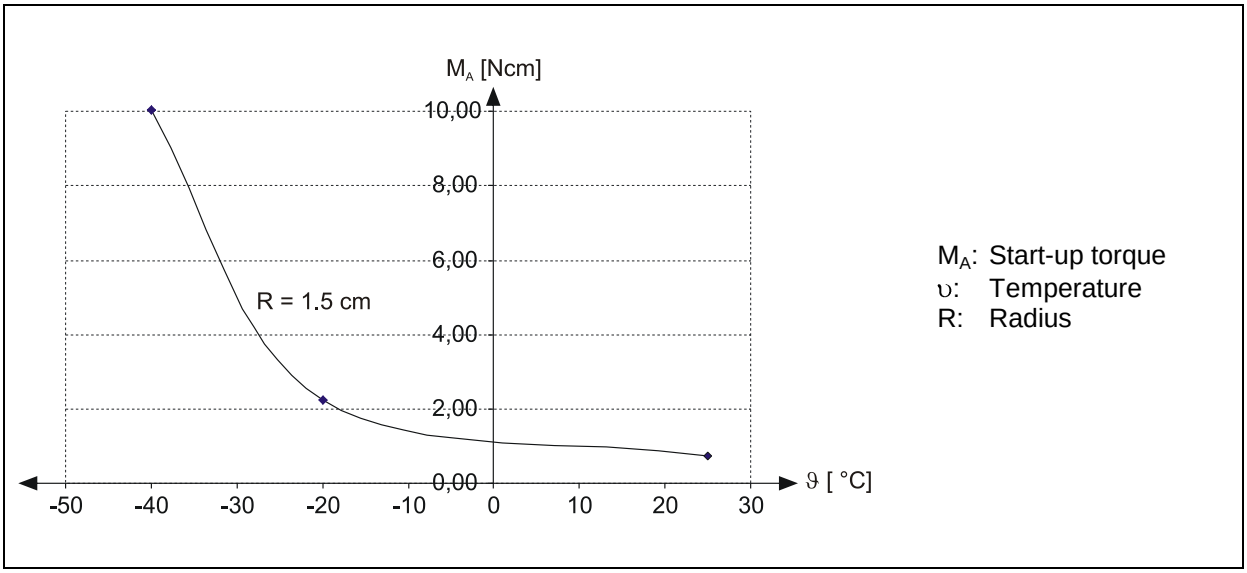


Figure 2: Start-up torque

4.2 Hollow shaft version CDH-75

4.2.1 Requirements

- **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 61800-5-2:2008 "Adjustable speed electrical power drive systems, Safety requirements - Functional, Table D.16 – 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.

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

⚠ DANGER

NOTICE

- ➢ 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 side of the drive using a dowel pin, see Figure 4.
- ➢ In case of applications with low ambient temperatures, increased values for the start-up torque result. This fact is to be considered when the assembling and wave drive is performed.

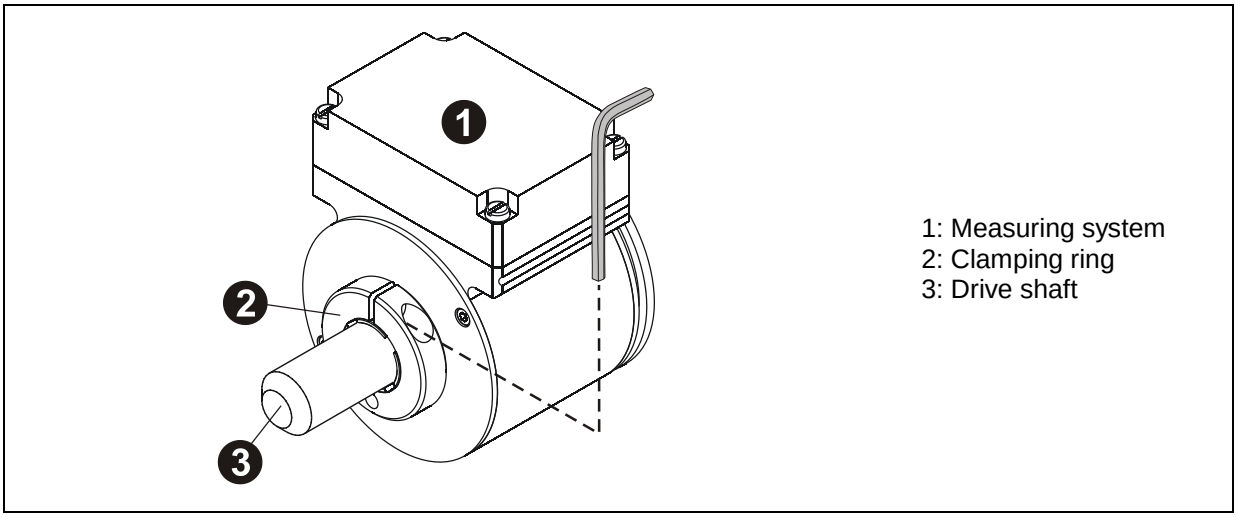


Figure 3: Friction locking

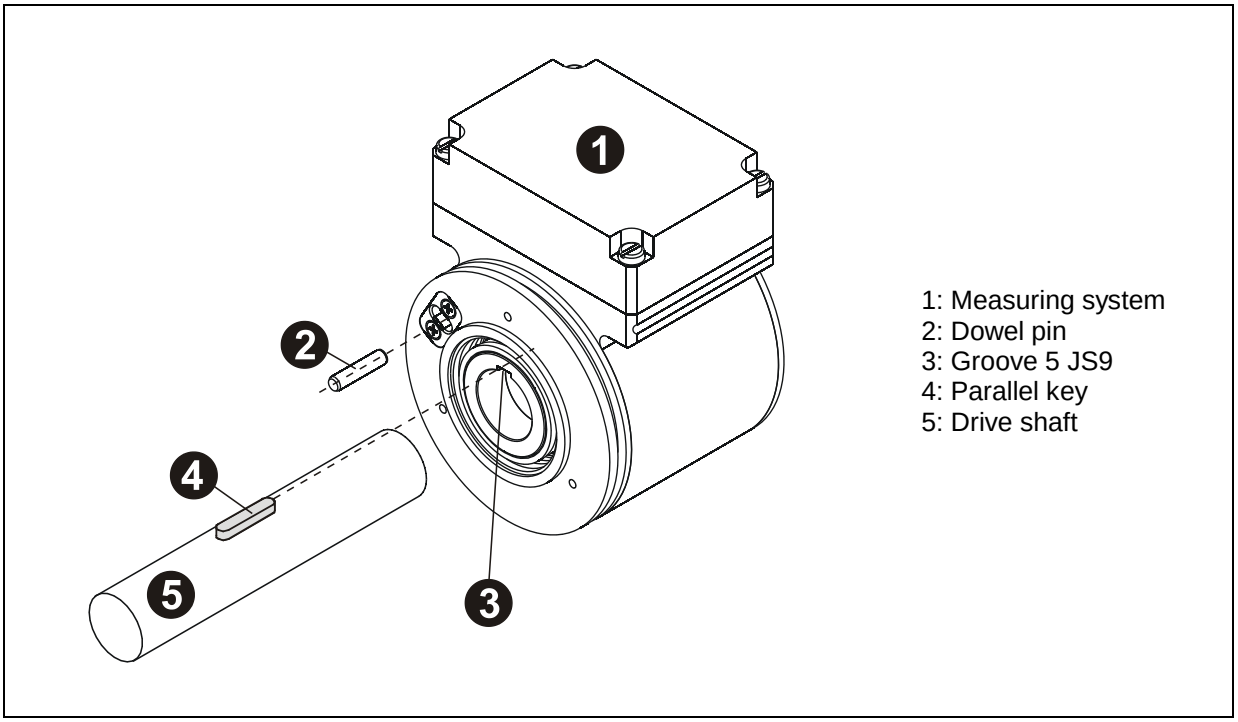


Figure 4: Form closure

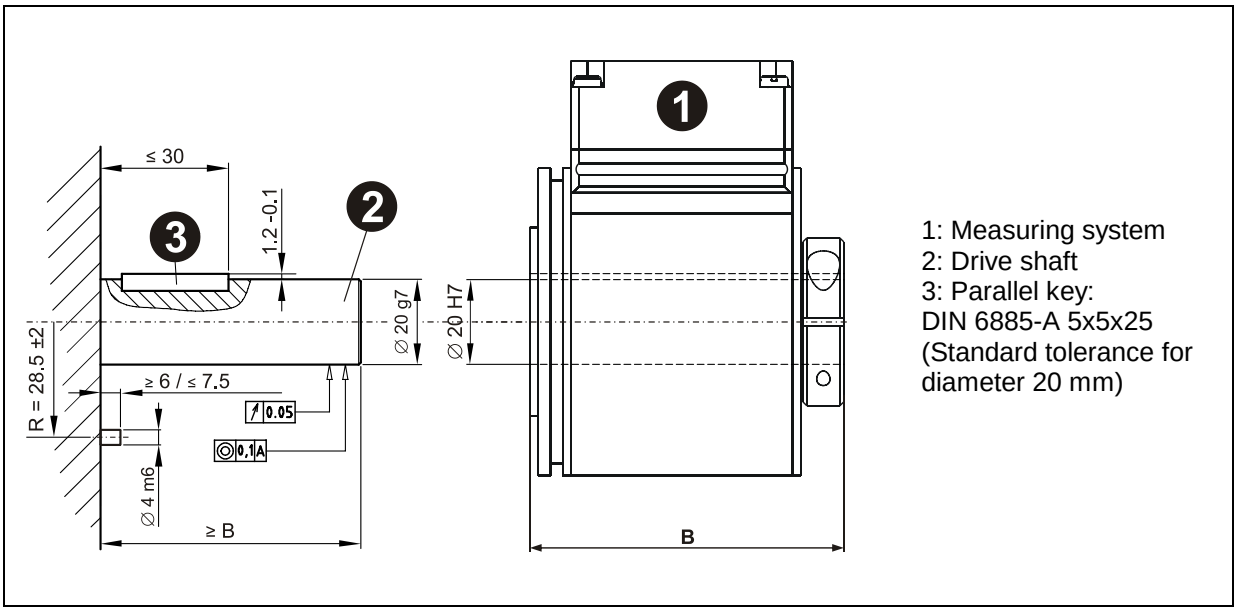


Figure 5: Requirements for the shaft mounting

4.2.2 Dowel pin

Simultaneous rotation of the measuring system, caused by the developing torque, is prevented by a dowel pin on the machine side. The measuring system has a groove insertion 4K7, 6mm deep on the back, for mounting the dowel pin. The dowel pin must extend at least 4 mm into the groove insertion.

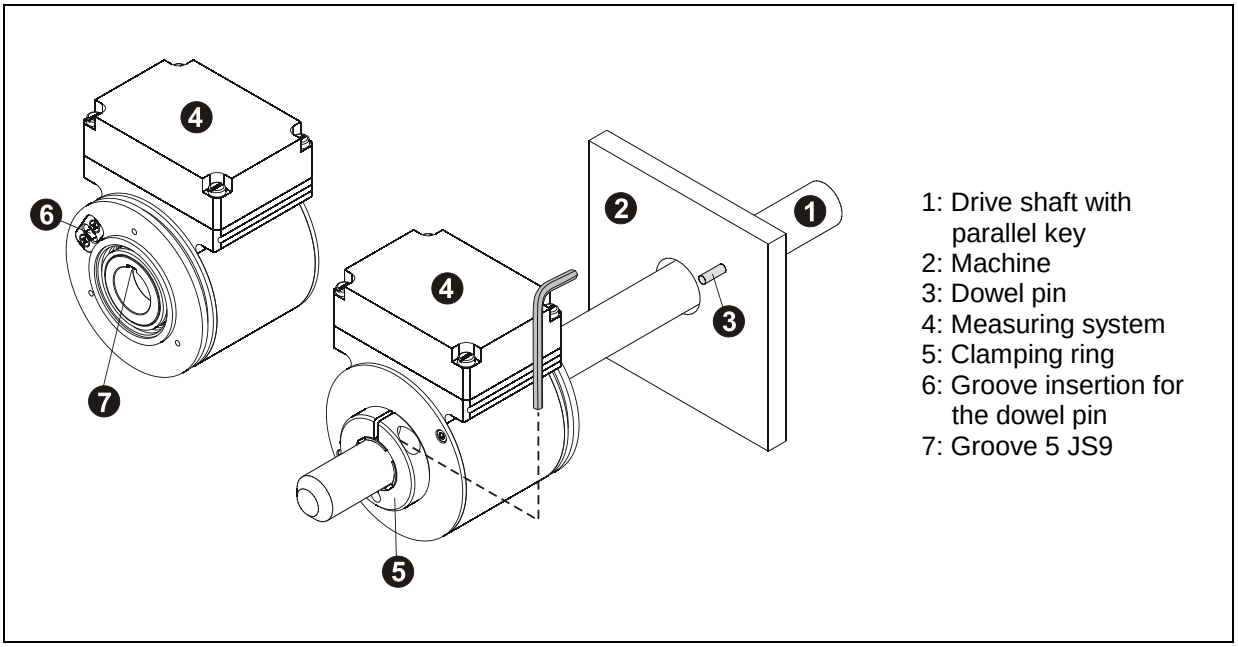


Figure 6: Preventing simultaneous rotation using a dowel pin

When pushing on the measuring system, position it so that the dowel pin fits into the seat of the groove insertion. The measuring system is protected against slipping on the shaft by tightening the clamping ring with the Allen wrench.

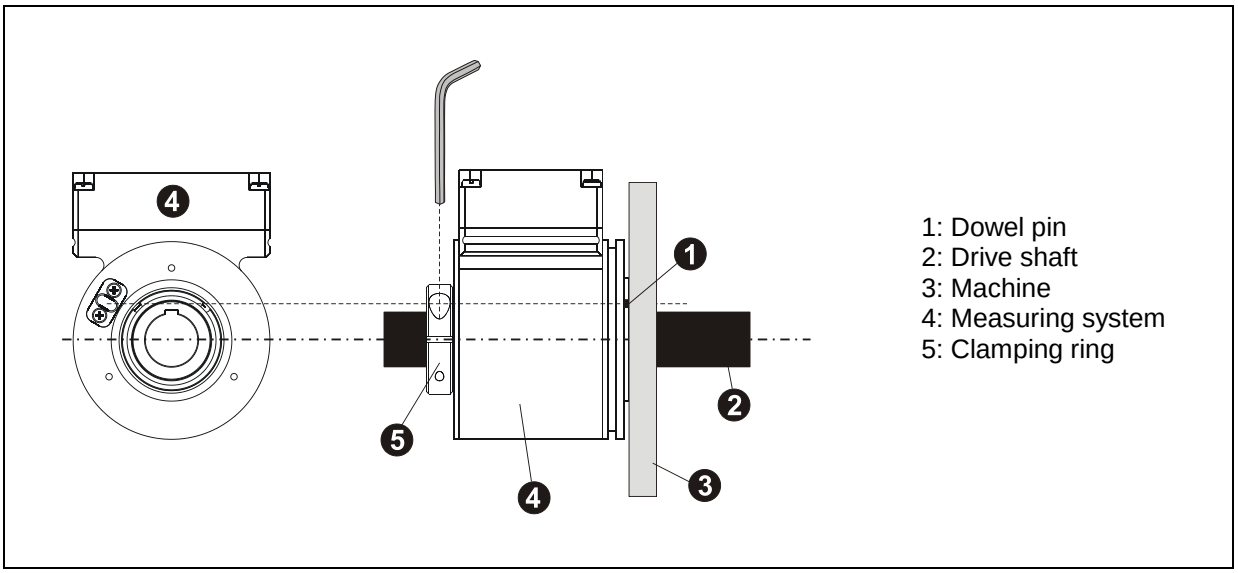


Figure 7: Installation diagram

5 Installation / Preparation for Commissioning

5.1 Basic rules

⚠ WARNING ***Deactivation of the safety function through conducted interference sources!***

- All nodes of the safety-relevant communication must be certified according to IEC 61010 or must have a corresponding EC conformity declaration.
- All PROFIsafe devices used on the bus must have a PROFINET and a PROFIsafe - certificate.
- All safety devices must also have a certificate from a "Notified Body" (e.g. TÜV, BIA, HSE, INRS, UL, etc.).
- The 24V power supplies used must not cut out in the event of a fault in the energy supply (safe under single fault conditions) and must fulfil SELV/PELV.
- Only cables and connectors which are provided with a PROFINET manufacturer's declaration are to be used.
- The shielding effect of cables must also be guaranteed after installation (bending radii/tensile strength!) and after connector changes. In cases of doubt, use more flexible cables with a higher current carrying capacity.
- Only use M12 connectors for connecting the measuring system, which guarantee good contact between the cable shield and connector housing. The cable shield must be connected to the connector housing over a large area.
- A 5-wire cable with a PE-conductor isolated from the N-conductor (so-called TN network) must be used 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.
- Power and signal cables must be laid separately. During installation, observe the applicable national safety and installation regulations for data and power 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.

Upon completion of installation, a visual inspection with report should be carried out. Wherever possible, the quality of the network should be verified using a suitable bus analysis tool: no duplicate IP-addresses, no reflections, no telegram repetitions etc.

To ensure safe and fault-free operation, the

- *PROFINET Design Guideline, PNO Order no.: 8.062*
- *PROFINET Assembly Guideline, PNO Order no.: 8.072*
- *PROFINET Commissioning Guideline, PNO Order no.: 8.082*
- *PROFIsafe "Environmental Requirements", PNO Order no.: 2.232*
- *and the referenced Standards and PNO Documents contained in it must be observed!*

In particular the EMC directive in its valid version must be observed!

5.2 PROFINET IO transfer technology, cable specification

The safety-related PROFIsafe communication as well as the PROFINET communication is transferred about the same network.

PROFINET supports linear, tree or star structures. The bus or linear structure used in the field buses is thus also available for Ethernet. This is particularly practical for system wiring, as a combination of line and stubs is possible. Because the measuring system already has an integrated switch, the line topology can be realized in a simple manner.

Use only cables and connectors which are provided with a PROFINET manufacturer's declaration. The cable type A/B/C, the mechanical and chemical properties as well as the type of the PROFINET cable have to be defined according to the automation task. The cables are designed for bit rates of up to 100 Mbit/s. The transmission speed is automatically detected by the measuring system and does not have to be set by means of switches.

Addressing by switches as in the case of the PROFIBUS-DP is also not necessary, this is done automatically using the addressing options of the PROFINET-Controller, however the PROFIsafe destination address “F_Dest_Add” must be adjusted, see page 31.

The cable length including patch cables in case of copper wiring between two suscribers may amount max. 100 m. This transmission link has been defined as *PROFINET end-to-end link*. Within an end-to-end link the number of detachable links is limited up to six connector pairs (male connector/female connector). If more than six connector pairs are required, make sure that the attenuation values for the entire link are observed (channel class-D values).

In case of IRT communication the topology is projected in a connection table. Thereby you must pay attention on a right connection of the ports 1 and 2.
With RT communication this is not the case, it can be cabled freely.

5.3 Connection

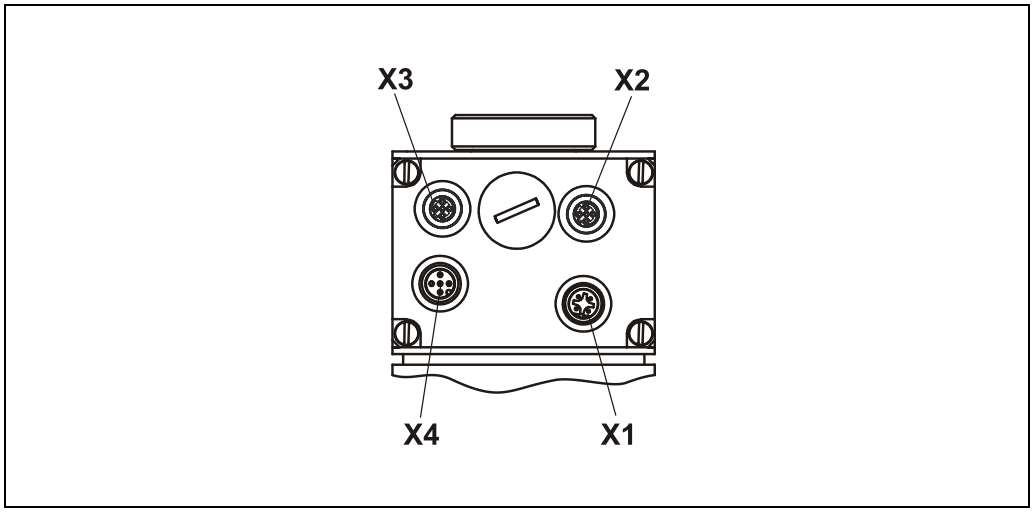


Figure 8: Connector assignment

5.3.1 Supply voltage

NOTICE

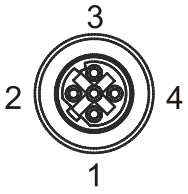
Danger of unnoticed damage to the internal electronics, due to unacceptable overvoltages!

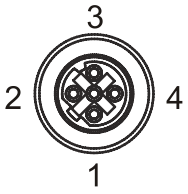
- If an overvoltage of >36 V DC is inadvertently applied, the measuring system must be checked in the factory. The measuring system is permanently switched off for safety reasons, if the overvoltage is applied for more than 200 ms.
  - ➢ The measuring system must be shut down immediately
  - ➢ When sending the measuring system to the factory, the reasons and circumstances relating to the overvoltage must be specified
  - ➢ The power supply used must meet the requirements of SELV/PELV (IEC 60364-4-41:2005)

X1	Signal	Description	Pin, M12x1, 4 pole
1	+ 24 V DC (13…27 V DC)	supply voltage	A-coded 4 1 3 2
2	n.c.	-	
3	0 V	GND	
4	n.c.	-	

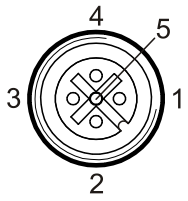
Cable specification: min. 0.5 mm^2, stranded in pairs and shielded

5.3.2 PROFINET

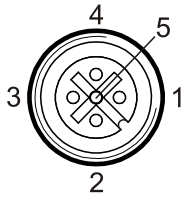
X2	Signal	Description	Socket, M12x1, 4 pol.
1	TxD+, Transmission Data +	PORT 2	D-coded 
2	RxD+, Receive Data +		
3	TxD–, Transmission Data –		
4	RxD–, Receive Data –		

X3	Signal	Description	Socket, M12x1, 4 pol.
1	TxD+, Transmission Data +	PORT 1	D-coded 
2	RxD+, Receive Data +		
3	TxD–, Transmission Data –		
4	RxD–, Receive Data –		

5.3.3 Incremental interface / SIN/COS interface

X4	Signal	Description	Socket, M12x1, 5 pole
[1)] 1	Channel B +	5 V differential / 13…27 V DC	A-coded 
[1)] 2	Channel B –	5 V differential / 13…27 V DC	
[1)] 3	Channel A +	5 V differential / 13…27 V DC	
[1)] 4	Channel A –	5 V differential / 13…27 V DC	
5	0 V, GND	Data reference potential	

Alternative with SIN/COS signals

X4´	Signal	Description	Socket, M12x1, 5 pole
1	SIN +	1 Vss, differential	A-coded 
2	SIN –	1 Vss, differential	
3	COS +	1 Vss, differential	
4	COS –	1 Vss, differential	
5	0 V, GND	Data reference potential	

Cable specification: min. 0.25 mm^2, stranded in pairs and shielded

[1)] TTL/HTL – Level variant: see type plate

5.4 PROFIsafe Destination address “F_Dest_Add”

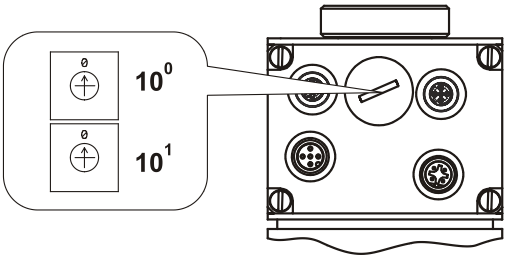
⚠ WARNING ***Destruction, damage and malfunction of the measuring system in case of infiltration of foreign substances and damp!***

NOTICE

- The access to the address switches has to be locked after the settings with the screw plug. Tighten firmly!

The PROFIsafe destination address corresponds to the F-parameter `F_Dest_Add` and defines an unique source address within a PROFIsafe cluster.

Valid addresses: 1…99, also see chapter “F_Source_Add / F_Dest_Add” on page 48.



5.5 Incremental interface / SIN/COS interface

In addition to the PROFINET IO interface for output of the absolute position, the measuring system in the standard version also has an incremental interface.

However, this can alternatively also be designed as a SIN/COS interface.

⚠ WARNING ***This additional interface is not evaluated in relation to safety and must not be used for safety-oriented purposes!***

- The measuring system checks the outputs of this interface for the feed-in of external voltages. In the event of voltages > 5.7 V, the measuring system is switched off for safety reasons. In this state the measuring system behaves as if it were not connected.

- The interface is generally used as position feedback for motor control applications.

NOTICE

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 guaranteed that a ground reference point is present at all times,
  - ➢ or corresponding protective measures by the system operator must be provided for subsequent electronics.

The signal characteristics of the two possible interfaces are shown below.

5.5.1 Signal characteristics

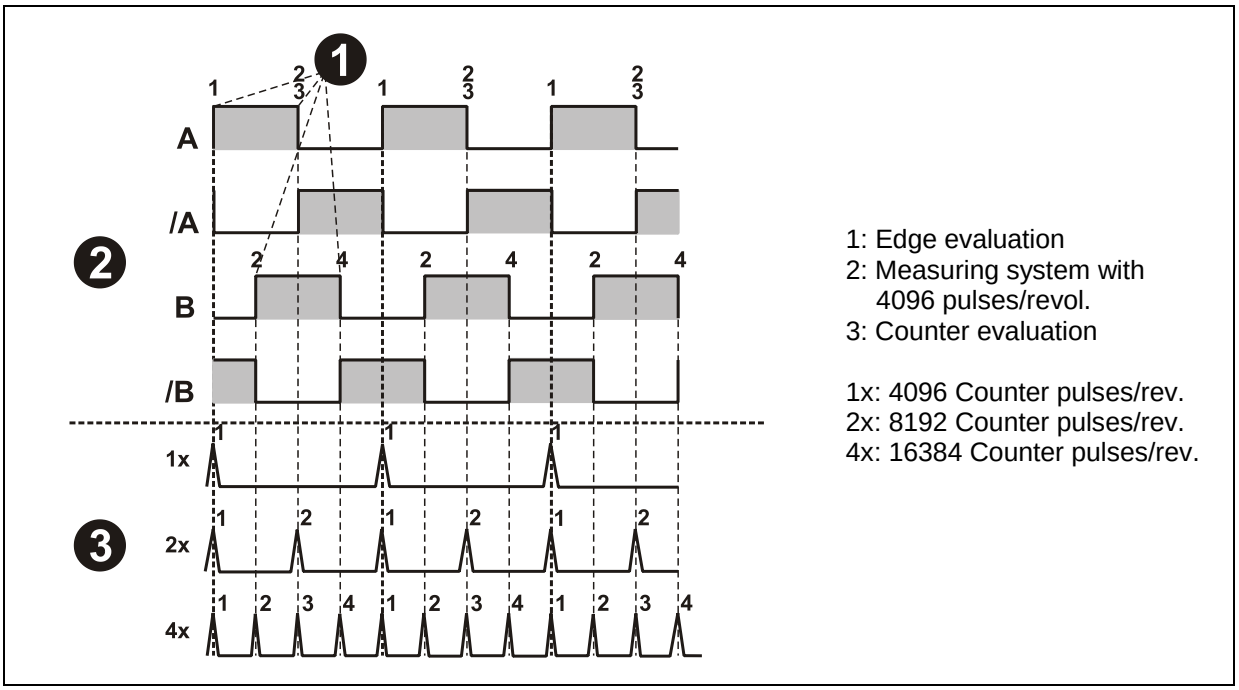


Figure 9: Counter evaluation, incremental interface

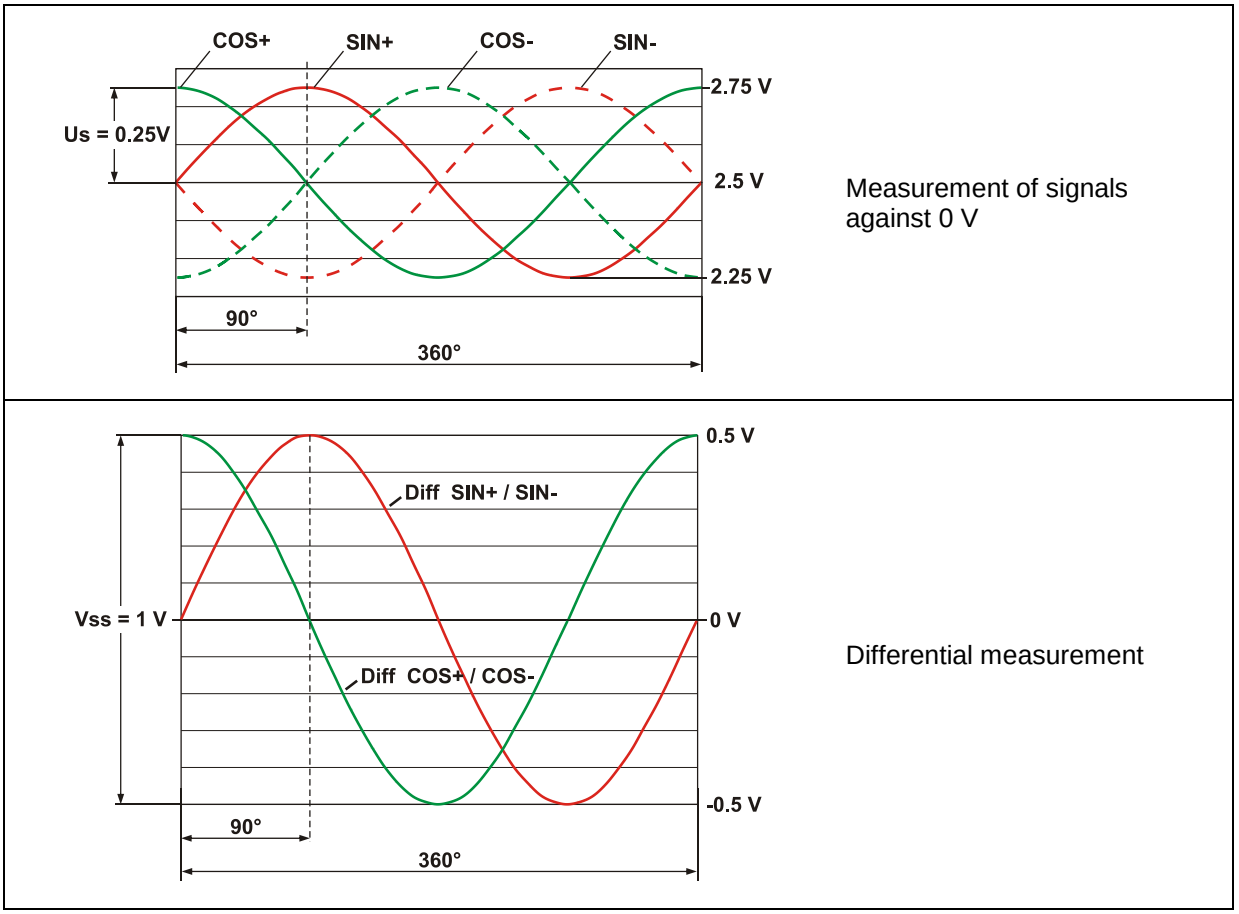


Figure 10: Level definition, SIN/COS interface

5.5.2 Option HTL-Level, 13…27 VDC

Optionally the incremental interface is available also with HTL levels. For technical reasons, the user must consider the following boundary conditions at this variant: Ambient temperature, cable length, cable capacitance, supply voltage and output frequency.
In this case the maximum reachable output frequencies about the incremental interface are a function of the cable capacitance, the supply voltage and the ambient temperature. Therefore, the use of this interface is reasonable only if the interface characteristics meet the technical requirements.

From the view of the measuring system, the transmission cable represents a capacitive load which must be reloaded with each impulse. In dependence of the cable capacitance, the load quantity necessary for it varies very strongly. Exactly this reloading of the cable capacitances is responsible for the high dissipation and heat, which result thereby in the measuring system.

Example: Cable with 75 pF/m, cable length = 100 m, half limiting frequency related to the rated voltage of 24 VDC: It results a twice as high current consumption of the measuring system.

By the arising heat the measuring system may be only operated with approx. 80% of the given working temperature.

The following diagram shows the different dependences with respect to three different supply voltages.

Fixed items are

- Capacity of the cable: 75 pF/m
- Ambient temperature: 40 °C and 70 °C

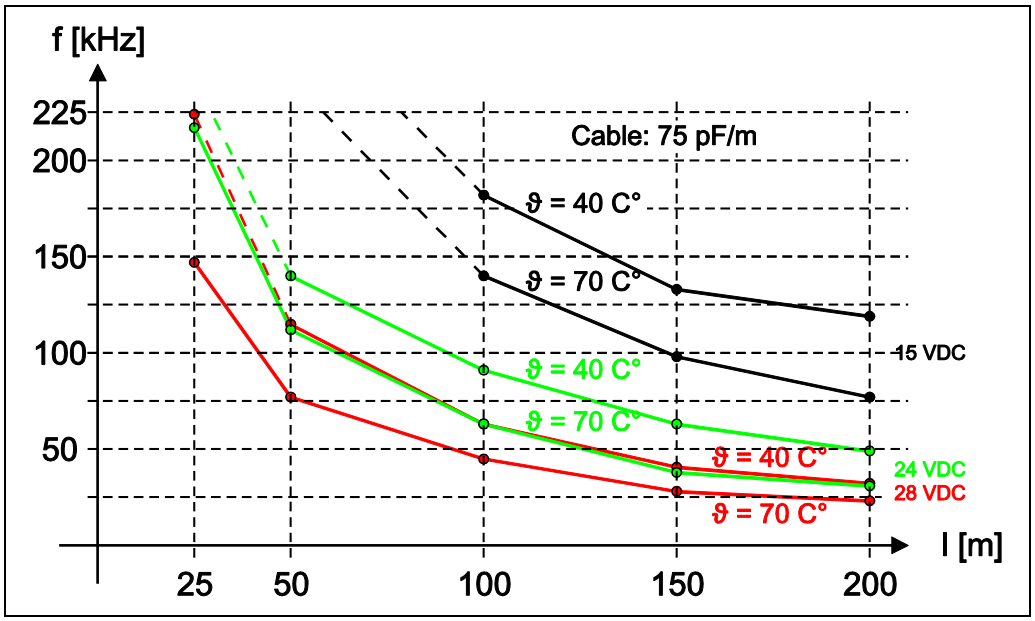


Figure 11: Cable lengths / Limiting frequencies

Other cable parameters, frequencies and ambient temperatures as well as bearing heat and temperature increase over the shaft and flange, can produce a considerably worse result in the practice.

Therefore, the fault-free function of the incremental interface with the application-dependent parameters has to be checked prior to the productive operation.

6 Commissioning

6.1 PROFINET IO

Important information for the commissioning can be found in the PROFINET Guideline:

- PROFINET Commissioning Guideline, Order No.: 8.082

These and further information on PROFINET or PROFIsafe are available from the offices of the PROFIBUS User Organization:

PROFIBUS Nutzerorganisation e.V.,
Haid-und-Neu-Str. 7,
D-76131 Karlsruhe,
http://www.profibus.com/
http://www.profisafe.net/
Tel.: ++ 49 (0) 721 / 96 58 590
Fax: ++ 49 (0) 721 / 96 58 589
Email: mailto:germany@profibus.com

6.1.1 Device classes

In a PROFINET IO - system the following device classes are differentiated:

- **IO-Controller**
  For example a PLC, which controls the connected IO-Device.

- **IO-Device**
  Decentralized arranged field device (measuring system), which is assigned to one or several IO-Controllers and transmits, additionally to the process and configuration data, also alarms.

- **IO-Supervisor** (Engineering Station)
  A programming device or an Industrial PC, which has also access to all process- and parameter data additionally to an IO-Controller.

6.1.2 Device description file (XML)

The GSDML file and the corresponding bitmap file are components of the measuring system: ***"GSDML-V2.2-TR-0153-CD_75_-EPN-current date.xml"***.
The files are on the Software/Support DVD:
Order number: 490-01001, Soft-No.: 490-00423.

6.1.3 Device identification

Each PROFINET IO-Device possesses a device identification. It consists of a firm identification, the Vendor-ID, and a manufacturer-specific part, the Device-ID. The Vendor-ID is assigned by the PNO. For TR-Electronic the Vendor-ID contains the value 0x0153, the Device-ID has the value 0x0401.
When the system boots up the projected device identification is examined. In this way errors in the project engineering can be recognized.

6.1.4 Distribution of IP addresses

Parameter	Default value	Description
MAC Address	-	By default in the delivery state the measuring system has saved his *MAC-Address* which is printed on the connection hood of the device, e.g. “00-03-12-04-00-60”. The MAC-Address is not changeable.
Device type	TR CD_75_-EPN	The name for the device type is “TR CD_75_-EPN” and is allocated by TR-Electronic. The Device type is not changeable.
Device name	-	Before an IO-Device can be controlled by an IO-Controller, it must have a *Device name*, because the IP-Address is assigned directly to the Device name. If necessary when the system boots up the IO-Controller distributes the IP-addresses to the IO-Devices according to their device names. This procedure has the advantage that names can be handled more simply than complex IP-Addresses. Assigning a device name for a concrete IO-Device is to compare with the adjusting of the PROFIBUS address in case of a DP-slave. In the delivery state as well as after a system boot up the measuring system has not saved a device name. Only after assignment of a device name with the engineering tool the measuring system for an IO-Controller is addressable, e. g. for the transmission of the project engineering data (e.g. the IP-Address) when the system boots up or for the user data exchange in the cyclic operation. The name assignment is executed by the engineering tool before the beginning of operation. In case of PROFINET IO-Field devices the standard DCP-Protocol is used.
IP Address	0.0.0.0	In the delivery state as well as after a system boot up the measuring system has not saved an IP-Address.
Subnet mask	0.0.0.0	In the delivery state as well as after a system boot up the measuring system has not saved a Subnet mask.

Proceeding at the distribution of Device names and Addresses
in case of an IO-Device

- Define Device name, IP-Address and Subnet mask. Depending on configuration this process can be executed also automatically by the IO-Controller.
- Device name is assigned to an IO-Device (MAC-Address)
  - Transmit Device name to the device
- Load projection into the IO-Controller
- When the system boots up the IO-Controller distributes the IP-Addresses to the Device names. The distribution of the IP-Address also can be switched off, in this case the existing IP-Address in the IO-Device is used.

6.2 PROFINET IO System boot

With a successful system boot the IO-Devices start automatically with the data transmission. In case of PROFINET IO a communication relation always follows the provider consumer model. With cyclical transmission of the measuring value, the IO-Device corresponds to the provider of the data, the IO-Controller (e.g. a PLC) corresponds to the consumer. The transferred data always contains a status (good or bad).

6.3 Bus status display

⚠ WARNING ***Destruction, damage and malfunction of the measuring system in case of infiltration of foreign substances and damp!***

NOTICE

- The access to the LEDs has to be locked after the settings with the screw plug. Tighten firmly!

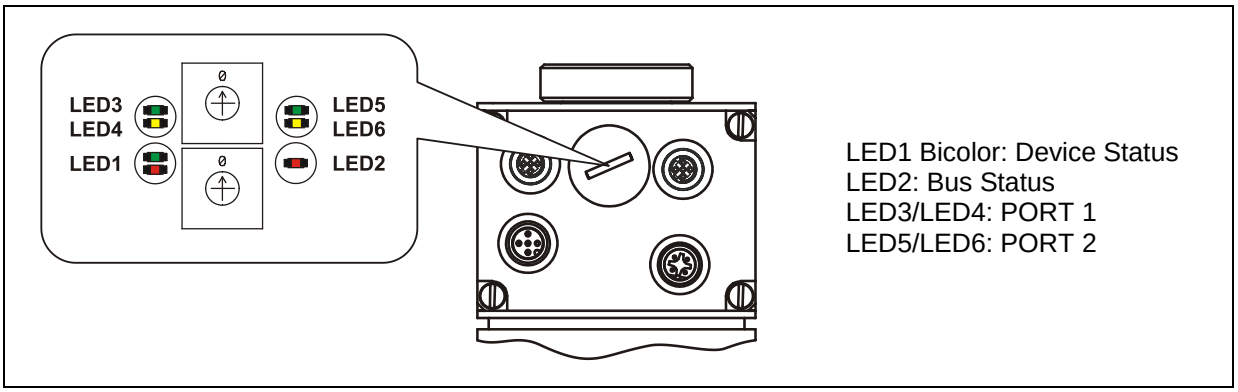


Figure 12: Bus status display

■	ON
□	OFF
▬	FLASHING

Device Status, LED1 Bicolor	
	green
□	No supply voltage, hardware error
■	Operational
▬	Operator acknowledgment required, 3x 5 Hz

	red
■	System or safety relevant error

Bus Status, LED2

	red
	No error
	Parameter- or F-Parameter error; 0.5 Hz
	No link to the IO-Controller

PORT 1; LED3 = Link, LED4 = Data Activity

	LED3, green	Ethernet connection established
	LED4, yellow	Data transfer TxD/RxD

PORT 2; LED5= Link, LED6 = Data Activity

	LED5, green	Ethernet connection established
	LED6, yellow	Data transfer TxD/RxD

For appropriate measures in case of error, see chapter "Troubleshooting and Diagnosis Options", page 55.

6.4 Configuration

The following definition applies:
Data flow for input data: F-Device --> F-Host
Data flow for output data: F-Host --> F-Device

6.4.1 Safety-oriented data, module “CD_75_-EPN I/O safety”

Structure of the input data

Byte	Bit	Input data	
X+0	2^8-2^{15}	Cams	Unsigned16
X+1	2^0-2^7		
X+2	2^8-2^{15}	TR-Status	Unsigned16
X+3	2^0-2^7		
X+4	2^8-2^{15}	Speed	Integer16
X+5	2^0-2^7		
X+6	2^8-2^{15}	Actual value, Multi-Turn, 15 bit	Integer16
X+7	2^0-2^7		
X+8	2^8-2^{15}	Actual value, Single-Turn, 13 bit	Integer16
X+9	2^0-2^7		
X+10	2^0-2^7	Safe status	Unsigned8
X+11	2^{16}-2^{23}	CRC2	3 Bytes
X+12	2^8-2^{15}		
X+13	2^0-2^7		

Structure of the output data

byte	Bit	Output data	
X+0	2^8-2^{15}	TR-Control1	Unsigned16
X+1	2^0-2^7		
X+2	2^8-2^{15}	TR-Control2	Unsigned16
X+3	2^0-2^7		
X+4	2^8-2^{15}	Preset, Multi-Turn	Integer16
X+5	2^0-2^7		
X+6	2^8-2^{15}	Preset, Single-Turn	Integer16
X+7	2^0-2^7		
X+8	2^0-2^7	Safe Control	Unsigned8
X+9	2^{16}-2^{23}	CRC2	3 Bytes
X+10	2^8-2^{15}		
X+11	2^0-2^7		

6.4.1.1 Input data

6.4.1.1.1 Cams

Unsigned16

Byte	X+0	X+1
Bit	15 – 8	7 – 0
Data	2^{15} – 2^{8}	2^{7} – 2^{0}

Bit	Description
2^{0}	Speed overflow The bit is set if the speed value is outside the range of –32768…+32767.
2^{1}…2^{15}	reserved

6.4.1.1.2 TR-Status

Unsigned16

Byte	X+2	X+3
Bit	15 – 8	7 – 0
Data	2^{15} – 2^{8}	2^{7} – 2^{0}

Bit	Description
2^{0}	Preset_Status The bit is set if the F-Host triggers a preset request. When the preset has been executed, the bit is automatically reset.
2^{1}…2^{14}	reserved
2^{15}	Error The bit is set if a preset request could not be executed due to excessive speed. The current speed must be in the range of the speed set under `Preset Standstill Tolerance`. The bit is reset after the host has cleared the variable associated to the control bit 2^{0} `iPar_EN`, also see page 54.

6.4.1.1.3 Speed

Integer16

Byte	X+4	X+5
Bit	15 – 8	7 – 0
Data	$2^{15} – 2^{8}$	$2^{7} – 2^{0}$

The speed is output as a two's complement value with preceding sign.

Setting the direction of rotation = forward

– Looking at the flange connection, turn the shaft clockwise:
--> positive speed output

Setting the direction of rotation = backward

– Looking at the flange connection, turn the shaft clockwise:
--> negative speed output

If the measured speed exceeds the display range of
–32768…+32767, this results in an overflow, which is reported in the cams register via bit 2^{0}. At the time of the overflow the speed stops at the respective +/- maximum value, until the speed is once again in the display range. In this case the message in the cams register is also cleared.
The speed is specified in `increments` per `Integration time Safe`.

6.4.1.1.4 Multi turn / Single turn

Multi-Turn, Integer16

Byte	X+6	X+7
Bit	15 – 8	7 – 0
Data	$2^{15} – 2^{8}$	$2^{7} – 2^{0}$

Single-Turn, Integer16

Byte	X+8	X+9
Bit	15 – 8	7 – 0
Data	$2^{15} – 2^{8}$	$2^{7} – 2^{0}$

The number of revolutions is noted in the `Multi-Turn` register, and the current Single-Turn position is noted in steps in the `Single-Turn` register. Together with the measuring system resolution, max. number of steps per revolution according to type plate, the actual position can then be calculated:

Position in steps = (steps per revolution * number of revolutions) + Single-Turn position

Steps per revolution: 8192 ≙ 13 bit

Number of revolutions: 0…32767 ≙ 15 bit

The output position does not have a preceding sign.

6.4.1.1.5 Safe status

Unsigned8

Byte	X+10
Bit	7 – 0
Data	2^7 – 2^0

Bit	Description
2^0	**iPar_OK:** New iParameter values have been assigned to the F-Device
2^1	**Device_Fault:** Error in F-Device or F-Module
2^2	**CE_CRC:** Checksum error in communication
2^3	**WD_timeout:** Watchdog timeout during communication
2^4	**FV_activated:** Fail-safe values activated
2^5	**Toggle_d:** Toggle bit
2^6	**cons_nr_R:** Virtual consecutive number has been reset
2^7	reserved

Safe status can only be indirectly accessed from the safety program with the aid of variables, see chapter "Access to the safety-oriented data channel" on page 53.

A detailed description of the status bits can be taken from the PNO document "PROFIsafe – Profile for Safety Technology on PROFIBUS DP and PROFINET IO", Order No.: 3.192b.

6.4.1.2 Output data

6.4.1.2.1 TR-Control1

Unsigned16

Byte	X+0	X+1
Bit	15 – 8	7 – 0
Data	$2^{15} – 2^{8}$	$2^{7} – 2^{0}$

Bit	Description
2^{0}	Preset_Request The bit serves to control the preset adjustment function. When this function is executed, the measuring system is set to the position value stored in the `Preset Multi-Turn`/`Preset Single-Turn` registers. A precise sequence must be observed in order to execute the function, see chapter "Preset Adjustment Function" on page 54.
$2^{1}…2^{15}$	reserved

6.4.1.2.2 TR-Control2

Reserved.

6.4.1.2.3 Preset multi turn / Preset single turn

Preset Multi-Turn, Integer16

Byte	X+4	X+5
Bit	15 – 8	7 – 0
Data	$2^{15} – 2^{8}$	$2^{7} – 2^{0}$

Preset single turn, Integer16

Byte	X+6	X+7
Bit	15 – 8	7 – 0
Data	$2^{15} – 2^{8}$	$2^{7} – 2^{0}$

The desired preset value must be in the range of 0 to 268 435 455 (28 bit). Together with the measuring system resolution, max. number of steps per revolution according to type plate (8192), the corresponding values for `Preset Multi-Turn/Preset Single-Turn` can then be calculated:

Number of revolutions = desired preset value / steps per revolution

The integer part from this division gives the number of revolutions and must be entered in the `Preset Multi-Turn` register.

Single-Turn-Position = desired preset value – (steps per revolution * no. of revolutions)

The result of this calculation is entered in the `Preset Single-Turn` register.

The preset value is set as new position when the preset adjustment function is executed, see chapter "Preset Adjustment Function" on page 54.

6.4.1.2.4 Safe-Control

Unsigned8

Byte	X+8
Bit	7 – 0
Data	2^7 – 2^0

Bit	Description
2^0	**iPar_EN:** iParameter assignment unlocked
2^1	**OA_Req:** Operator acknowledgment required
2^2	**R_cons_nr:** Resetting of the counter for the virtual consecutive no.
2^3	reserved
2^4	**activate_FV:** Activate fail-safe values
2^5	**Toggle_h:** Toggle bit
2^6-2^7	reserved

The Safe-Control register can only be indirectly accessed from the safety program with the aid of variables, see chapter "Access to the safety-oriented data channel" on page 53.

A detailed description of the control bits can be taken from the PNO document "PROFIsafe – Profile for Safety Technology on PROFIBUS DP and PROFINET IO", Order No.: 3.192b.

6.4.2 Not safety-oriented Process data, module “CD_75_-EPN I/O”

Structure of the input data

Byte	Bit	Input data	
X+0	2^8-2^{15}	Cams	Unsigned16
X+1	2^0-2^7		
X+2	2^8-2^{15}	Speed	Integer16
X+3	2^0-2^7		
X+4	2^8-2^{15}	Actual value, Multi-Turn, 15 bit	Integer16
X+5	2^0-2^7		
X+6	2^8-2^{15}	Actual value, Single-Turn, 13 bit	Integer16
X+7	2^0-2^7		

6.4.2.1 Input data

6.4.2.1.1 Cams

Unsigned16

Byte	X+0	X+1
Bit	15 – 8	7 – 0
Data	2^{15} – 2^8	2^7 – 2^0

Bit	Description
2^0	Speed overflow The bit is set if the speed value is outside the range of –32768…+32767.
2^1…2^{15}	reserved

6.4.2.1.2 Speed

Integer16

Byte	X+2	X+3
Bit	15 – 8	7 – 0
Data	$2^{15} – 2^{8}$	$2^{7} – 2^{0}$

The speed is output as a two's complement value with preceding sign.

Setting the direction of rotation = forward

– Looking at the flange connection, turn the shaft clockwise:
--> positive speed output

Setting the direction of rotation = backward

– Looking at the flange connection, turn the shaft clockwise:
--> negative speed output

If the measured speed exceeds the display range of
–32768…+32767, this results in an overflow, which is reported in the cams register via bit 2^{0}. At the time of the overflow the speed stops at the respective +/- maximum value, until the speed is once again in the display range. In this case the message in the cams register is also cleared.
The speed is specified in `increments` per `Integration time Unsafe`.

6.4.2.1.3 Multi turn / Single turn

Multi-Turn, Integer16

Byte	X+4	X+5
Bit	15 – 8	7 – 0
Data	$2^{15} – 2^{8}$	$2^{7} – 2^{0}$

Single-Turn, Integer16

Byte	X+6	X+7
Bit	15 – 8	7 – 0
Data	$2^{15} – 2^{8}$	$2^{7} – 2^{0}$

The number of revolutions is noted in the `Multi-Turn` register, and the current Single-Turn position is noted in steps in the `Single-Turn` register. Together with the measuring system resolution, max. number of steps per revolution according to type plate, the actual position can then be calculated:

Position in steps = (steps per revolution * number of revolutions) + Single-Turn position

Steps per revolution: 8192 ≙ 13 bit

Number of revolutions: 0…32767 ≙ 15 bit

The output position does not have a preceding sign.

6.5 Parameterization

Normally the configuration program provides an input box for the IO-Controler with which the user can enter parameter data or select from a list. The structure of the input box is stored in the device master file.

⚠ DANGER

NOTICE

- **Danger of death, serious physical injury and/or damage to property due to malfunction, caused by incorrect parameterization!**
  - ➢ The system manufacturer must ensure correct functioning by carrying out a protected test run during commissioning and after each parameter change.

6.5.1 F-Parameters (F_Par)

The F-Parameters supported by the measuring system are listed below.

Byte order = Big Endian

Byte	Parameter	Type	Description		Page
X+0	-	Bit	Bit 0 = 0: not used		-
	F_Check_iPar	Bit	Bit 1 = 0: No check		47
	F_SIL	Bit range	Bit 3-2	00: SIL1 01: SIL2 10: SIL3 [default] 11: no SIL	48
	F_CRC_Length	Bit range	Bit 5-4	00: 3-Byte-CRC	48
X+1	F_Block_ID	Bit range	Bit 5-3	001: 1	48
	F_Par_Version	Bit range	Bit 7-6	01: V2-Mode	48
X+2	F_Source_Add	Unsigned16	Source address, Default = 1 Range: 1-65534		48
X+4	F_Dest_Add	Unsigned16	Destination address, Default = 1 Range: 1-99		48
X+6	F_WD_Time	Unsigned16	Watchdog time, Default = 125 Range: 125-10000		48
X+8	F_iPar_CRC	Unsigned32	CRC of i-Parameters, Default = 1132081116 Range: 0-4294967295		48
X+12	F_Par_CRC	Unsigned16	CRC of F-Parameters, Default = 17033 Range: 0-65535		48

6.5.1.1 F_Check_iPar

The parameter is set to "NoCheck" and cannot be changed. This means the check sum value is not evaluated about the iParameters.

6.5.1.2 F_SIL

F_SIL specifies the SIL which the user expects from the respective F-Device. This is compared with the locally saved manufacturer's specification. The measuring system support the safety classes no SIL and SIL1 to SIL3, SIL3 = standard value.

6.5.1.3 F_CRC_Length

The measuring system supports the CRC length of 3 bytes. This value is predefined and cannot be changed.

6.5.1.4 F_Block_ID

As the measuring system supports device-specific safety parameters such as e.g. "Integration time Safe", this parameter is preconfigured with the value "1 = generate F_iPar_CRC" and cannot be changed.

6.5.1.5 F_Par_Version

The parameter identifies the PROFIsafe version "V2-Mode" implemented in the measuring system. This value is predefined and cannot be changed.

6.5.1.6 F_Source_Add / F_Dest_Add

The parameter `F_Source_Add` defines a unique source address within a PROFIsafe cluster. The parameter `F_Dest_Add` defines a unique destination address within a PROFIsafe cluster.
The PROFIsafe destination address must correspond to the address set by the address switches implemented in the measuring system, also see page 31.
Valid addresses: 1…99.
Standard value `F_Source_Add` = 1, Standard value `F_Dest_Add` = 1,
`F_Source_Add` ≠ `F_Dest_Add`.

6.5.1.7 F_WD_Time

This parameter defines the monitoring time [ms] in the measuring system. A valid current safety telegram must arrive from the F-Host within this time, otherwise the measuring system will be set to safe status.
The predefined value is 125 ms.
The watchdog time must generally be set at a level where telegram runtimes are tolerated by the communication, but it must also allow quick execution of the error reaction function in case of error.

6.5.1.8 F_iPar_CRC

This parameter represents the checksum value (CRC3), which is calculated from all iParameters of the device-specific part of the measuring system and ensures safe transmission of the iParameters. The calculation occurs in a program called "TR_iParameter" provided by TR-Electronic. The checksum value calculated there must then be manually entered in the F-Host engineering tool, also see chapter "Parameter Definition / CRC Calculation" on page 51.

6.5.1.9 F_Par_CRC

This parameter represents the checksum value (CRC1), which is calculated from all F-Parameters of the measuring system and ensures safe transmission of the F-Parameters. The calculation occurs externally in the F-Host engineering tool and must then be entered here under this parameter, or is generated automatically.

6.5.2 iParameters (F_iPar)

Application-dependent device characteristics are defined with the iParameters. A CRC calculation is necessary for safe transmission of the iParameters, see chapter "iParameters" on page 51.
The iParameters supported by the measuring system are listed below.

Byte order = Big Endian

Byte	Parameter	Type	Description	Page
X+0	Integration time Safe	Unsigned16	Default = 2 Range: 1-10	49
X+2	Integration time Unsafe	Unsigned16	Default = 20 Range: 1-100	49
X+4	Window increments	Unsigned16	Default = 1000 Range: 50-4000	49
X+6	Idleness tolerance Preset	Unsigned8	Default = 1 Range: 1-5	50
X+7	Direction	Bit	0: Backward 1: Forward [default]	50

6.5.2.1 Integration time Safe

This parameter is used to calculate the safe speed, which is output via the cyclical data of the CD_75_-EPN I/O safety module. High integration times enable high-resolution measurements at low speeds. Low integration times show speed changes more quickly and are suitable for high speeds and high dynamics. The time basis is predefined to 50 ms. 50…500 ms can thus be set using the value range of 1…10. Standard value = 100 ms.

6.5.2.2 Integration time Unsafe

This parameter is used to calculate the unsafe speed, which is output via the process data of the CD_75_-EPN I/O module. High integration times enable high-resolution measurements at low speeds. Low integration times show speed changes more quickly and are suitable for high speeds and high dynamics. The time basis is predefined to 5 ms. 5…500 ms can thus be set using the value range of 1…100.
Standard value = 100 ms.

6.5.2.3 Window increments

This parameter defines the maximum permissible position deviation in increments of the master / slave scanning units integrated into the measuring system. The permissible tolerance window is basically dependent on the maximum speed occurring in the system and must first be determined by the system operator. Higher speeds require a larger tolerance window. The value range extends from 50…4000 increments. Standard value = 1000 increments.

The larger the window increments, the larger the angle until an error will be recognized.

6.5.2.4 Idleness tolerance Preset

This parameter defines the maximum permissible speed in `increments` per `Integration time Safe` for performance of the preset function, see page 54. The permissible speed is dependent on the bus behavior and the system speed, and must be determined by the system operator first. The value range extends from 1 increment per `Integration time Safe` to 5 increments per `Integration time Safe`. That means that the shaft of the measuring system must be nearly at rest, so that the preset function can be executed.
Standard value = 1 increment per standard value `Integration time Safe`.

6.5.2.5 Direction

This parameter defines the current counting direction of the position value looking at the flange connection, turning the shaft clockwise.

Forward = Counting direction increasing
Backward = Counting direction decreasing

Standard value = Forward.

7 Parameter Definition / CRC Calculation

It is best to define the known parameters before configuration in the F-Host, so that they can be taken into account during configuration.

The TR_iParameter software required for the CRC calculation is a constituent of the software and support DVD, art. no.: 490-01001, also see chapter "Accessories" on page 73.
The program can be found on this DVD under
English --> Tools --> CRC calculation, TR_iParameter.

7.1 iParameters

The iParameters are preconfigured with meaningful values in the default setting and should only be changed if expressly required by the automation task. A CRC calculation is necessary for safe transmission of the individually set iParameters. This must be performed when changing the predefined iParameters via the TR program "TR_iParameter". The calculated checksum as decimal value corresponds to the F-Parameter F_iPar_CRC. This must be entered in the field with the same name in the F-Host when configuring the measuring system.

Procedure - CRC-calculation

- Start TR_iParameter by means of the start file "TR_iParameter.exe", then open the template file provided with the measuring system with the menu Datei --> Vorlage öffnen...

- Modify the relevant parameters if necessary, then click on the CRC bilden switch for the F_iPar_CRC calculation. The result is displayed in the field F_iPar_CRC as decimal value.

Each parameter change requires a new F_iPar_CRC calculation, which must then be taken into account in the projection.

7.2 F-Parameters

The F-Parameters are already preconfigured with meaningful values in the default setting and should only be changed if expressly required by the automation task. A CRC which is usually automatically calculated by the Engineering tool is necessary for safe transmission of the individually set F-Parameters. This checksum corresponds to the F-Parameter F_Par_CRC.

Each parameter change, including F_iPar_CRC, also gives a new F_Par_CRC value.

8 Integration of the measuring system into the safety program

This chapter describes the necessary steps for the integration of the measuring system into the safety program and is not related to a certain control unit. The exact process is control specific and must be taken from the system documentation of the control unit manufacturer.

8.1 Prerequisites

⚠ WARNING ***Danger of deactivation of the fail-safe function through incorrect configuration of the safety program!***

- The safety program must be created in conjunction with the system documentation provided by the control unit manufacturer.
- It is essential to observe and comply with the information and instructions provided in the system documentation, particularly the safety instructions and warnings.

8.2 Hardware configuration

- Create a new project
- Perform the general hardware configuration (CPU, Voltage supply)
- Provide a digital input module, in order to be able to carry out the operator acknowledgment
- Install the GSDML file belonging to the measuring system
- Defining the properties of the hardware configuration
  - Access protection via password allocation
  - Ethernet (IP-Address, Subnet mask, Device Name, Synchronization)
  - I/O modules (Operating mode, F-Parameter, Diagnosis, Arrangements for the operator acknowledgment)

8.3 Parameterization

- Parameterize device specific `iParameter` in the module `CD_75_-EPN I/O`, also see starting from page 49 and 51
- Define PROFIsafe specific `F-Parameter` in the module `CD_75_-EPN I/O safety`, also see starting from page 47 and 51
- Save and if necessary compile hardware configuration

8.4 Generating the safety program

- Define the program structure, access protection via password allocation
- Create modules for the program call, Diagnosis, Data, Program, Functions, Periphery, System etc., can partly performed also automatically
- Edit modules for the program call, operator acknowledgment of the safety-oriented periphery
- Define program sequence
- Define cycle time for the program call of the safety program
- Generate safety program
- Load safety program into the control unit
- Perform a complete functional test of the safety program according to the automation task
- Perform an acceptance test of the safety system by an independent expert

8.5 Access to the safety-oriented data channel

The safety-oriented data channel in the `CD_75_-EPN I/O safety` module of the measuring system may only be accessed from the safety program. A direct access is not permitted.
For this reason the registers `Safe-Control` and `Safe-Status` can be accessed only indirectly about variables. The range of the variables and the way how the variables can be addressed is control dependent. This information must be taken from the system documentation provided by the control unit manufacturer.

The variables must be accessed in the following cases:

- during operator acknowledgment of the measuring system after communication errors or after the start-up phase, is indicated via the status LED see page 36
- during execution of the preset adjustment function
- when analyzing whether passivated or cyclical data are output
- if the cyclical data of the `CD_75_-EPN I/O safety` module are to be passivated depending on defined states of the safety program

8.5.1 Output of passivated data (substitute values) in case of error

The safety function requires that for passivation in the safety-oriented channel in the `CD_75_-EPN I/O safety` module, the substitute values (0) are used in the following cases instead of the cyclically output values. Dependent on the control, this condition is indicated over an appropriate variable.

- at start-up of the safety-oriented system
- in the case of errors in the safety-oriented communication between control unit and measuring system via the PROFIsafe protocol
- if the value set for the `Window increments` under the `iParameters` is exceeded and/or the internally calculated PROFIsafe telegram is defective
- if the permissible ambient temperature range, as defined under the corresponding article number, is fallen below or exceeded
- if the measuring system is supplied with >36 V DC for longer than 200 ms
- Hardware related errors in the measuring system

9 Preset Adjustment Function

⚠ WARNING

NOTICE

- **Danger of death, serious physical injury and/or damage to property due to uncontrolled start-up of the drive system during execution of the preset adjustment function!**
  - ➢ Execute preset function only in the standstill, see chapter “Idleness tolerance Preset” on page 50
  - ➢ The relevant drive systems must be locked to prevent automatic start-up
  - ➢ It is advisable to protect the preset triggering via the F-Host by means of additional protective measures, such as e.g. key-operated switch, password etc.
  - ➢ The operational sequence described below is to be kept mandatorily. In particular the status bits are to be evaluated by the F-host, in order to check the successful and/or incorrect execution.
  - ➢ The new position must be checked after execution of the preset function

The preset adjustment function is used to set the currently output position value to any position value within the measuring range. The displayed position can thus be set to a machine reference position purely electronically.

9.1 Procedure

- ➢ Prerequisite: The measuring system is in cyclical data exchange.
- ➢ Write the `Preset Multi-Turn` and `Preset Single-Turn` registers in the output data of the `CD_75_-EPN I/O safety` module with the desired preset value.
- ➢ The F-Host must set the variable associated to the control bit 2^0 `iPar_EN` to 1. With the rising edge, the measuring system is now switched ready to receive.
- ➢ With the rising edge of Bit 2^0 `Preset_Request` in the `TR-Control1` register, the preset value is accepted. The receipt of the preset value is acknowledged in the `TR-Status` register by setting Bit 2^0 `Preset_Status`.
- ➢ After receipt of the preset value, the measuring system checks that all prerequisites for execution of the preset adjustment function are fulfilled. If so, the preset value is written as the new position value. In case of error, the execution is rejected and an error message is output via the `TR-Status` register by setting Bit 2^{15} `Error`.
- ➢ After successful execution of the preset adjustment function, the measuring system sets the variable associated to the status bit 2^0 `iPar_OK` to 1 and thus indicates to the F-Host that the preset execution is complete.
- ➢ The F-Host must now reset the variable associated to the control bit 2^0 `iPar_EN` to 0. The variable associated to the status bit 2^0 `iPar_OK` and Bit 2^0 `Preset_Status` in the `TR-Status` register are thus also reset with the falling edge. Bit 2^0 `Preset_Request` in the `TR-Control1` register must be reset manually again.
- ➢ Finally, the F-Host must check that the new position corresponds to the new nominal position.

10 Troubleshooting and Diagnosis Options

10.1 Optical displays

For assignment and position of the status LEDs see chapter "Bus status display" on page 37.

10.1.1 Device Status, LED1 Bicolor

green	*Cause*	*Remedy*
OFF	Power supply absent	Check power supply, wiring
	Hardware error, measuring system defective	Replace measuring system
3x 5 Hz repeating	– Measuring system could not synchronize with the F-Host in the start-up phase and requests an operator acknowledgment – An error in the safety-oriented communication or a parameterization error was detected, and has been eliminated	For the operator acknowledgment of the measuring system an acknowledgment about the safety program at the corresponding variable is required
ON	Measuring system ready for operation	–

red	*Cause*	*Remedy*
ON	**A safety-relevant error was detected, the measuring system was put into fail-safe status and is outputting its passivated data:**	**In order to restart the measuring system after a passivation the error must generally be eliminated first of all and then the supply voltage switched OFF/ON.**
	– Error in the safety-oriented communication	– Try to localize the error with the aid of diagnosis variables (dependent on the control unit) – Check that the set value for the `F_WD_Time` parameter is suitable for the automation task, see chapter "F_WD_Time" on page 48 – Check whether the PROFINET connection between F-CPU and measuring system is faulty
	– The set value for the `Window increments` parameter was exceeded	– Check that the set value for the `Window increments` parameter is suitable for the automation task, see chapter "Window increments" on page 49
	– The permissible ambient temperature range, as defined under the corresponding article number, was fallen below or exceeded	– Suitable measures must be taken to ensure that the permissible ambient temperature range can be observed at all times
	– The measuring system was supplied with >36 V DC for longer than 200 ms	– The measuring system must be shut down immediately and checked in the factory. When sending the measuring system to the factory, the reasons and circumstances relating to the overvoltage must be specified
	– The internally calculated PROFIsafe telegram is defective	– Power supply OFF/ON. If the error persists after this measure, the measuring system must be replaced

10.1.2 Bus Status, LED2

red LED	Cause	Remedy
OFF	No error	–
0.5 Hz	– F-Parameterization defective, e.g. incorrectly set PROFIsafe destination address `F_Dest_Add` – Incorrectly configured `F_iPar_CRC` value	– Check the PROFIsafe destination address set with the hardware switches. Valid PROFIsafe destination addresses: 1–99, see chapter PROFIsafe Destination address “F_Dest_Add” on page 31 – The checksum calculated for the defined iParameter set is incorrect, or was not included in the projection, see chapter "Parameter Definition / CRC Calculation" on page 51
ON	– No connection to the IO-Controller	– Check Device name, IP-address and Subnet mask

10.1.3 Link Status, PORT1:LED3; PORT2:LED5

green LED	Cause	Remedy
OFF	Voltage supply absent or too low	Check voltage supply and wiring
	No Ethernet connection	Check Ethernet cable
	Hardware error, measuring system defective	Replace measuring system
ON	Measuring system ready for operation, Ethernet connection established	-

10.2 PROFINET IO Diagnostic

PROFINET IO supports a continuous diagnostic concept, which makes possible an efficient fault locating and recovery. At occurrence of an error the faulty IO-Device generates a diagnostic alarm to the IO-Controller. This alarm calls a corresponding program routine in the user program to initiate a reaction to the error.

By means of record data, alternatively the diagnostic information can be read directly from the IO-Device and can be displayed on an IO-Supervisor.

10.2.1 Diagnostic alarm

Alarms are part of the acyclic frames which are transferred about the cyclical RT-channel. They are also indicated with the EtherType 0x8892.

The measuring system supports only manufacturer specific diagnostic alarms which can be identified about the *UserStructureIdentifier* 0x5555. After this identification a 4 byte error code (*user data)* follows. Here the first occurred error is reported, saved and is displayed about the LED “Device Status, LED1 Bicolor”. The IOPS bit is set to *BAD*.

Because the measuring system can generate hundreds of error codes, these are not indicated here.

Error remedy see chapter “Optical displays”. If the error cannot be eliminated, the error code with information of the article number can be transmitted for evaluation to the company TR-Electronic.

10.2.2 Diagnostics about Record Data

Diagnostic data can be requested also with an acyclic read service *RecordDataRead(DiagnosisData)*, if they were saved in the IO-Device.
For the requested diagnostic data from the IO-Controller a read service with the corresponding record index must be sent.

The diagnostic information is evaluated on different addressing levels:

- AR (Application Relation)
- API (Application Process Identifier)
- Slot
- Subslot

A group of diagnostic records are available at each addressing level. The exact structure and the respective size is indicated in the PROFINET specification *Application Layer protocol for decentralized periphery and distributed automation,* order no.: 2.722.

Synonymously to the manufacturer specific diagnostic alarm, the diagnostic data can be read also manually about the record index 0xE00C. Similar as in the case of a diagnostic alarm a saved error is indicated with the *UserStructureIdentifier* 0x5555. Immediately afterwards the error code is transferred, see diagnostic alarm above.

10.3 Data status

With cyclic Real-Time communication the transferred data contains a status message. Each subslot has its own status information: *IOPS*/*IOCS*.

This status information indicates whether the data are valid = *GOOD* (1) or invalid = *BAD* (0).

During parameterization, as well as in the boot-up phase the output data can change to *BAD* for a short time. With a change back to the status *GOOD* a “Return-Of-Submodule-Alarm” is transferred.

In the case of a diagnostic alarm the status is also set to *BAD*, but can be reset only with a re-start.

Example: Input data IO-Device --> IO-Controller

VLAN	Ethertype	Frame-ID	Data	IOPS	...	IOPS	...		Cycle	Data Status	Transfer Status	CRC
4	0x8892	2	1..	1		1			2	1	1	4

Example: Output data IO-Controller --> IO-Device

VLAN	Ethertype	Frame-ID	IOCS	IOCS	...	Data	IOPS ...	Data ...IOPS.	Cycle	Data Status	Transfer Status	CRC
4	0x8892	2	1..	1		1 ...		1..	2	1	1	4

10.4 Return of Submodule Alarm

By the measuring system a so-called “Return-of-Submodule-Alarm” is reported if

- the measuring system for a specific input element can provide valid data again and in which it is not necessary to execute a new parameterization
- or if an output element can process the received data again.

In this case the status for the measuring system (submodule) IOPS/IOCS changes from the condition “BAD” to “GOOD”.

10.5 Information & Maintenance

10.5.1 I&M0, 0xAFF0

The measuring system supports the I&M-Function **“I&M0 RECORD”** (60 byte), like PROFIBUS “Profile Guidelines Part 1”.
I&M-Functions specify the way how the device specific data, like a nameplate, must be created in a device.

The I&M record can be read with an acyclic read service.
The record index is 0xAFF0, the read service is sent to module 1 / submodule 1.

The received 60 bytes have the following contents:

Contents	Number of bytes
Manufacturer specific (block header type 0x20)	6
Manufacturer_ID	2
Order-No.	20
Serial-No.	16
Hardware revision	2
Software revision	4
Revision state	2
Profile-ID	2
Profile-specific type	2
I&M version	2
I&M support	2

11 Replacing the Measuring System

The following points must be noted when 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.
- It must be ensured that the PROFIsafe destination address set via hardware switch for the new measuring system matches the previous PROFIsafe destination address.
- The new measuring system must be installed in accordance with the specifications and requirements in chapter "Assembly" on page 21.
- The new measuring system must be connected in accordance with the specifications in chapter "Connection" on page 29.
- As the F-Parameters and iParameters of the measuring system are stored in the safety program of the control, the new measuring system is parameterized with the projected settings in the start-up phase.
- If the project does not support a neighborhood detection, in case of a device replacement it must be ensured that the device name assigned before also is assigned to the new device. When the system boots up the Device name is detected again and the new MAC-Address and IP-Address is assigned to the Device name automatically.
- When recommissioning the replaced measuring system, correct functioning must be ensured first of all by means of a protected test run.

12 Checklist

We recommend that you print out and work through the checklist for commissioning, 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	Edited	Checked

Sub-item	To note	Can be found under	yes
Present user manual has been read and understood	–	Document no.: TR-ECE-BA-GB-0095	☐
Check that the measuring system can be used for the present automation task on the basis of the specified safety requirements	• Intended use • Compliance with all technical data	• Chapter Intended use, Page 14 • Chapter Technical Data, Page 63	☐
Fulfillment of the installation requirements defined in the user manual	• Safe mechanical fixing of the measuring system and safe positive connection of the driving shaft with the measuring system	• Chapter Assembly, Page 21	☐
Requirement for the power supply	• The power supply used must meet the requirements of SELV/PELV (IEC 60364-4-41:2005)	• Chapter Supply voltage, Page 29	☐
Correct PROFINET installation	• Observance of the international standards valid for PROFINET / PROFIsafe or the directives specified by the PROFIBUS User Organization	• Chapter Installation / Preparation for Commissioning, Page 27 • Chapter Commissioning, page 35	☐
System test after commissioning and parameter changes	• During commissioning and after each parameter change all affected safety functions must be checked	• Chapter Parameterization, Page 47	☐

Continued

Sub-item	To note	Can be found under	yes
Preset Adjustment Function	• The preset adjustment function may only be executed when the affected axis is stationary • It must be ensured that the preset adjustment function cannot be inadvertently triggered • After execution of the preset adjustment function the new position must be checked before restarting	• Chapter Preset Adjustment Function, Page 54	☐
Device replacement	• It must be ensured that the new device corresponds to the replaced device • All affected safety functions must be checked	• Chapter Parameterization, Page 47 • Chapter Replacing the Measuring System, Page 60	☐

13 Technical Data

13.1 Safety

Functional safety

DIN EN 61508 Part 1-7:2010..... **S**afety **I**ntegrity **L**evel (SIL): CL3

EN ISO 13849-1:2008/AC:2009 .... **P**erformance **L**evel (PL): e

Startup time..... Time between POWER-UP and safe position output

Overall system..... ≤ 7 s with SIMATIC S7, CPU317F-2

PFH, "High demand" operating mode . $1.46 * 10^{-9}$ 1/h

PFD_{av} (T_1 = 20 a)..... $1.27 * 10^{-4}$

$MTTF_d$ high..... 421 a

*** DC_{avg} high**..... 95 %

Internal process safety time ..... Time between occurrence of an F-Error and alarm indication

Overall system..... ≤ 6.5 ms

Process safety angle..... Angle between error occurrence and alarm indication

Through channel comparison..... Parameterizable with iParameter
`Window increments`

T_1, Proof Test ..... 20 years

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

13.2 Electrical characteristics

13.2.1 General

Supply voltage..... 13…27 V DC acc. to IEC 60364-4-41, SELV/PELV

Feed ..... single feed input, but electrically separated internally by means of two power supplies

Reverse polarity protection..... yes

Short-circuit protection ..... yes, by internal 500 mA safety fuse

Overvoltage protection ..... yes, up to ≤ 36 V DC

Current consumption without load..... < 180 mA at 24 V DC

Option HTL-Level, 13…27 VDC .... increased current consumption, see page 34

13.2.2 Device-specific

Total resolution ..... ≤ 28 bit

Number of steps / revolution ..... ≤ 8.192

Number of revolutions ..... ≤ 32.768

Accuracy ..... 13 bit, Single-Turn

Safety principle ..... 2 redundant scanning units with internal triangulation

PROFINET IO interface ..... according to IEC 61158, IEC 61784
- PROFIsafe profile ..... 3.192b according to IEC 61784-3-3
- Additional functions ..... Preset
- * Parameter
  - Integration time Safe ..... 50 ms…500 ms
  - Integration time Unsafe ..... 5 ms…500 ms
  - Size of monitoring window ..... 50…4000 increments
  - Idleness tolerance Preset ..... 1…5 increments/Integration time Safe
  - Counting direction ..... forward, backward
- PROFINET specification V2.2
- Software stack V3.2.0.1
- Conformance class ..... Conformance Class B, C
- Physical Layer ..... PROFINET 100Base-TX, Fast Ethernet, ISO/IEC 8802-3
- Output code ..... Binary
- Cycle time ..... ≥ 1 ms (IRT / RT)
- Transmission rate ..... 100 Mbit/s
- Transmission ..... CAT-5 cable, shielded (STP), ISO/IEC 11801
- ***** Addressing ..... Per Name (name allocation about engineering tool). Assignment Name→MAC during system boot
- Real-Time-Classes ..... RT Class 1 Frames (RT), RT Class 2 Frames (RT), RT Class 3 Frames (IRT)
- * TR-specific functions ..... Speed output in increments/Integration time Safe

Incremental interface ..... Signals twisted in pairs and shielded
- Pulses / revolution ..... 4.096, 8.192, 12.288, 16.384, 20.480, via factory setting
- A, /A, B, /B, TTL ..... RS422 (2-wire) according to EIA standard
- A, /A, B, /B, HTL ..... optional 13…27 V DC, see page 34
- Output frequency, TTL ..... ≤ 500 KHz
- Output frequency, HTL ..... see page 34

SIN/COS interface, alternative ..... Signals twisted in pairs and shielded
- Number of periods ..... 4096 / revolution
- SIN+, SIN–, COS+, COS– ..... 1 Vss ± 0.2 V at 100 Ω, differential
- Short-circuit proof ..... yes

Cycle time
- Not safety-oriented ..... 0.5 ms, output via CD_75_-EPN I/O module
- Safety-oriented ..... 5 ms, output via CD_75_-EPN I/O safety module

Preset write cycles ..... ≥ 4 000 000

* parameterizable via PROFINET IO

13.3 Environmental conditions

Vibration

DIN EN 60068-2-6:2008 ..... ≤ 100 m/s^2, sine 50-2000 Hz

Shock

DIN EN 60068-2-27:2010 ..... ≤ 600 m/s^2, half-sine 5 ms

EMC

Immunity to disturbance ..... EN 61000-6-2:2005/AC:2005

Transient emissions ..... EN 61000-6-3:2007/A1:2011

Working temperature ..... 0 °C…+60 °C

Optional ..... -20 °C…+70 °C

- Functionality ..... limited
- Speed CDH75 ..... ≤ 300 min^{-1}

Option HTL-Level, 13…27 VDC ..... see page 34

Storage temperature..... -30 °C…+80 °C, dry

Relative air humidity, DIN EN 60068-3-4:2002..... 98 %, non-condensing

Protection class, DIN EN 60529: 2000 [1] ..... IP 54

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

13.4 Mechanical characteristics

13.4.1 CDV-75

Mechanically permissible speed..... ≤ 6.000 min^{-1}

Shaft load, at the shaft end..... ≤ 50 N axial, ≤ 90 N radial

Bearing life time..... ≥ 3.9 * 10^{10} revolutions at

Speed ..... ≤ 3.000 min^{-1}

Operating temperature ..... ≤ 60 °C

Shaft load, at the shaft end ..... ≤ 50 N axial, ≤ 90 N radial

Permissible angular acceleration..... ≤ 10^4 rad/s^2

Moment of inertia..... typically 2.6 * 10^{-5} kg m^2

Start-up torque at 20 °C ..... typically 0.6 Ncm

Mass..... typically 1 kg

13.4.2 CDH-75

Mechanically permissible speed..... ≤ 3.000 min^{-1}

Shaft load ..... Own mass

Bearing life time..... ≥ 3.9 * 10^{10} revolutions at

Speed ..... ≤ 1.500 min^{-1}

Operating temperature ..... ≤ 60 °C

Permissible angular acceleration..... ≤ 10^4 rad/s^2

Start-up torque at 20 °C ..... typically 6 Ncm

Mass..... typically 1 kg

14 Appendix

14.1 References

1.	IEC/PAS 62411	Real-time Ethernet PROFINET IO International Electrotechnical Commission
2.	IEC 61158	Digital data communications for measurement and control - Fieldbus for use in industrial control systems
3.	IEC 61784	Digital data communications for measurement and control - Fieldbus for use in industrial control systems - Profile sets for continuous and discrete manufacturing relative to fieldbus use in industrial control systems
4.	ISO/IEC 8802-3	Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications
5.	IEEE 802.1Q	IEEE Standard for Priority Tagging
6.	IEEE 1588-2002	IEEE Standard for a Precision Clock Synchronization Protocol for Networked Measurement and Control Systems
7.	PROFINET Guideline	PROFIsafe – Environmental Requirements Order-No.: 2.232
8.	PROFIBUS Guideline	Profile Guidelines Part 1: Identification & Maintenance Functions. Order-No.: 3.502
9.	PROFINET Guideline	Design Guideline Order-No.: 8.062
10.	PROFINET Guideline	Installation Guideline for Cabling and Assembly Order-No.: 8.072
11.	PROFINET Guideline	Installation Guideline for Commissioning Order-No.: 8.082

14.2 Abbreviations and terms used

0x	Hexadecimal representation
CAT	***Cat***egory: Organization of cables, which is used also in connection with Ethernet.
CDH	Absolute encoder with redundant dual scanning, hollow shaft design
CDV	Absolute encoder with redundant dual scanning, solid shaft design
CDx	Absolute encoder with redundant dual scanning, all designs
CRC	***C***ylic ***R***edundancy ***C***heck
DC_{avg}	***D***iagnostic ***C***overage Average diagnostic coverage
EC	***E***uropean ***C***ommunity
EMC	***E***lectro ***M***agnetic ***C***ompatibility
Engineering tool	Projection and commissioning tool
ESD	***E***lectro ***S***tatic ***D***ischarge
F	Generally stands for the term safety or fail-safe
F-Device	Safety device for safety applications
Fault exclusion	Compromise between the technical safety requirements and the theoretical possibility of an error occurring
F-Host	Safety control for safety applications
FMEA	***F***ailure ***M***ode and ***E***ffects ***A***nalysis, reliability engineering methods, for finding potential weak points
Functional safety	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.
GSD	Device Master File
GSDML	***G***eneral ***S***tation ***D***escription ***M***arkup ***L***anguage
I&M	***I***dentification & ***M***aintenance
IEC	***I***nternational ***E***lectrotechnical ***C***ommission
IEEE	***I***nstitute of ***E***lectrical and ***E***lectronics ***E***ngineers
IOCS	***IO C***onsumer ***S***tatus: Thus the Consumer of an IO Data Element signals the condition (good, bad with error location)
IOPS	***IO P***rovider ***S***tatus: Thus the Provider of an IO Data Element signals the condition (good, bad with error location)
IP	***I***nternet ***P***rotocol
IRT	***I***sochronous ***R***eal-***T***ime communication
ISO	***I***nternational ***S***tandard ***O***rganization

MAC	***M***edia ***A***ccess ***C***ontrol, Ethernet-ID
$MTTF_d$	***M***ean ***T***ime ***T***o ***F***ailure (dangerous) Mean time until dangerous failure
NRT	***N***on-***R***eal-***T***ime communication
Operator acknowl-edgment	Switching from substitute values to process data
PAS	***P***ublicly ***A***vailable ***S***pecification
Passivation	In the case of an F-Periphery with outputs, the F-System transmits substitute values (e.g. 0) to the fail-safe outputs during a passivation instead of the output values provided in the process image by the safety program.
PFD_{av}	***Av***erage ***P***robability of ***F***ailure on ***D***emand Average probability of failure of a safety function with low demand
PFH	***P***robability of ***F***ailure per ***H***our Operating mode with high requirement rate or continuous demand. Probability of dangerous failure per hour.
PNO	PROFIBUS User Organization (***P***ROFIBUS ***N***utzer***O***rganisation e.V.)
PROFIBUS	Manufacturer independent, open field bus standard
PROFINET	PROFINET is the open Industrial Ethernet Standard of the PROFIBUS User Organization for the automation.
Proof test	Recurring check for detection of hidden dangerous failures in a safety-related system.
RT	***R***eal-***T***ime communication
SCS	***S***afety ***C***omputer ***S***ystem with control function, also referred to as F-Host in relation to PROFIsafe
SIL	***S***afety ***I***ntegrity ***L***evel: 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: Sensor, fail-safe processing unit (control) and actuator
Slot	Plug-in slot: can be meant also in the logical sense as addressing of modules.
Subslot	Adressing of data
SNMP	***S***imple ***N***etwork ***M***anagement ***P***rotocol
STP	***S***hielded ***T***wistet ***P***air
TCP	***T***ransmission ***C***ontrol ***P***rotocol
UDP	***U***ser ***D***atagram ***P***rotocol
VDE	***V***erein ***D***eutscher ***E***lektrotechniker (Association of German Electrotechnicians)
XML	E***X***tensibl***e*** ***M***arkup ***L***anguage

14.3 TÜV certificate

TÜVRheinland®

ZERTIFIKAT
CERTIFICATE

EC Type-Examination Certificate

Reg.-Nr./No.: 01/205/5338/13

Prüfgegenstand **Product tested**	Absolutes Multi-Turn-Winkelmesssystem mit ProfiNet / ProfiSafe Interface Absolute Multi Turn Rotary Encoder with ProfiNet / ProfiSafe Interface	**Zertifikats-inhaber** **Certificate holder**	TR - Electronic GmbH Eglishalde 6 78647 Trossingen Germany
Typbezeichnung **Type designation**	CDH 75 M EPN, CDV 75 M EPN, CDV 75 M 0002-00019, ADH 75 M EPN, ADV 75 M EPN	**Hersteller** **Manufacturer**	wie Zertifikatsinhaber see certificate holder
Prüfgrundlagen **Codes and standards forming the basis of testing**	EN 61800-5-2:2007 EN 62061:2005 + AC:2010 + A1:2013 EN ISO 13849-1:2008 EN ISO 13849-1:2008 + AC:2009	EN 60204-1:2006 + A1:2009 + AC:2010 (in extracts) IEC 61508 Parts 1-7:2010 EN 50178:1997	
Bestimmungsgemäße Verwendung **Intended application**	Die Geräte erfüllen die Anforderungen der Prüfgrundlagen (Kat. 4 / PL e nach EN ISO 13849-1, SIL CL 3 nach EN 62061 / IEC 61508, EN 61800-5-2) und können in Anwendungen bis Kat. 4 / PL e nach EN ISO 13849-1 und SIL 3 nach EN 62061 / IEC 61508 eingesetzt werden. The devices comply with the requirements of the relevant standards (Cat. 4 / PL e acc. to EN ISO 13849-1, SIL CL 3 acc. to EN 62061 / IEC 61508, EN 61800-5-2) and can be used in applications up to Cat. 4 / PL e acc. to EN ISO 13849-1 and SIL 3 acc. to EN 62061 / IEC 61508.		
Besondere Bedingungen **Specific requirements**	Die Hinweise in der zugehörigen Installations- und Betriebsanleitung sind zu beachten. The instructions of the associated Installation and Operating Manual shall be considered.		
Es wird bestätigt, dass der Prüfgegenstand mit den Anforderungen nach Anhang I der Richtlinie 2006/42/EG über Maschinen übereinstimmt. It is confirmed that the product under test complies with the requirements for machines defined in Annex I of the EC Directive 2006/42/EC.			
Dieses Zertifikat ist gültig bis 10.07.2018. This certificate is valid until 2018-07-10.			

TÜVRheinland CERTIFIED

Functional Safety Type Approved

www.tuv.com
ID 0600000000

Der Ausstellung dieses Zertifikates liegt eine Prüfung zugrunde, deren Ergebnisse im Bericht-Nr. 968/M 271.03/13 vom 10.07.2013 dokumentiert sind.
Der Inhaber eines für den Prüfgegenstand gültigen Genehmigungs-Ausweises ist berechtigt, die mit dem Prüfgegenstand übereinstimmenden Erzeugnisse mit dem abgebildeten Prüfzeichen zu versehen.
The issue of this certificate is based upon an examination, whose results are documented in report-no.: 968/M 271.03/13 dated 2013-07-10.
The holder of a valid licence certificate for the product tested is authorized to affix the test mark shown opposite to products, which are identical with the product tested.

TÜVRheinland® 0035 Notified Body

Berlin, 2013-07-10

Certification Body for Machinery, NB 0035

Dipl.-Ing. Jelena Stenzel

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TÜV Rheinland Industrie Service GmbH, Alboinstr. 56, 12103 Berlin / Germany
Tel.: +49 30 7562-1557, Fax: +49 30 7562-1370, E-Mail: industrie-service@de.tuv.com

TR-ECE-TI-DGB-0220-01

14.4 PROFINET IO certificate

PROFIBUS • PROFINET

Certificate

PROFIBUS Nutzerorganisation e.V. grants to

TR-Electronic
Eglishalde 6, 78647 Trossingen, Germany

the Certificate No: **Z10472** for the PROFINET IO Device:

Model Name:	**CD_75_-EPN**
Revision:	**1; SW/FW: V 1.0.5; HW: 1**
GSD:	**GSDML-V2.2-TR-0153-CD_75_-EPN-20120703.xml**
Identnumber:	**0x0153; 0x0401**
DAP:	**IDD_1: CD_75_-EPN V2.2, 0x00000001**

This certificate confirms that the product has successfully passed the certification tests with the following PROFINET scope:

☑ Hardware	Auto_Negotiation, Auto_Polarity, Auto_Crossover
☑ Conformance Class B, C	RT_CLASS_1, RT_CLASS_2, RT_CLASS_3, RTA, LLDP, SNMP, MIB-II, LLDP-MIB

Test Report Number: **PN173-1, IRT031-1**
Authorized Test Laboratory: **Siemens AG, Fürth, Germany**

The tests were executed in accordance with the following documents:
"Test Specifications for PROFINET IO devices, Version 2.2.3 from September 2010" and
"Test Cases for PN-Tester for PROFINET IO devices, Version 2.2.2.14.20".
"Test Specifications for PROFINET IO devices, Version V2.2.4 from December 2010",
"PROFINET IO IRT Test Cases V2.2.4.2 from December 2010",
"test system V2.2.2.14.21 with annex spirta 2.2.4.2.212".
This certificate is granted according to the document:
"Framework for testing and certification of PROFIBUS and PROFINET products".
For all products that are placed in circulation by May 08, 2015 the certificate is valid for life.

(Official in Charge)

Board of PROFIBUS Nutzerorganisation e. V.

(Karsten Schneider)

(K.-P. Lindner)

PROFINET®

TR-ECE-TI-GB-0217-01

14.5 PROFIsafe certificate

PROFIBUS • PROFINET

Certificate

PROFIBUS Nutzerorganisation e.V. grants to

TR-Electronic
Eglishalde 6, 78647 Trossingen, Germany

the Certificate No: **Z20068** for the PROFIsafe device:

Model Name:	**CD_75_-EPN**
Order Number:	**CD_75_-EPN**
Revision:	**1; SW: V 1.0.5; HW: 1**
Application CRC:	**Channel A: 0x485D 58AE**
	Channel B: 0x9EDA 4B69

This certificate confirms that the product has successfully passed the certification tests with the following PROFIsafe scope:

☑ PROFIsafe_V2 functionality on PROFINET IO

Test Report Number:	**PS042-1**
Authorized Test Laboratory:	**SIEMENS AG, Fürth, Germany**

The tests were executed in accordance with the following documents:
"PROFIsafe - Test Specification for F-Slaves, F-Devices, and F-Hosts, Version 2.1, March 2007".
This certificate is granted according to the document:
"Framework for testing and certification of PROFIBUS and PROFINET products".
For all products that are placed in circulation by May 08, 2015 the certificate is valid for life.

(Official in Charge)

Board of PROFIBUS Nutzerorganisation e. V.

(Karsten Schneider)

(K.-P. Lindner)

PROFIsafe

TR-ECE-TI-GB-0218

14.6 EC Declaration of Conformity

Expansion in Automation

EC Declaration of Conformity

The Rotative Measuring System CDx75M EPN, SIL3 PROFIsafe via PROFINET

Type: CDV75M, CDH75M
Order-No.: CDV75M-xxxxx, CDH75M-xxxxx

was developed, designed and manufactured to comply with the
- **EC directive 2004/108/EC (L 390/24)** "Electromagnetic Compatibility" and
- **EC directive 2006/42/EC (L 157/24)** "Machinery" under the sole responsibility of

TR-Electronic GmbH
Eglishalde 6
D - 78647 Trossingen
Tel.: +49 7425/228-0
Fax: +49 7425/228-33
Germany

The following harmonized standards were applied:

EN 61000-6-2: 2005/AC:2005 with increased test standards: DIN IEC 61326-3: 2004	Generic standards - Electromagnetic compatibility, Immunity (Industrial environments)
EN 61000-6-3: 2007/A1:2011	Generic standards - Electromagnetic compatibility, Emissions (Commercial environments)
EN 61800-5-2: 2007	Adjustable speed electrical power drive systems Safety requirements - Functional
EN ISO 13849-1: 2008/AC:2009	Safety of machinery - Safety-related parts of control systems General principles for design
EN 60204-1: 2006/AC:2010 (in extracts)	Safety of machinery - Electrical equipment of machines General requirements
EN 62061: 2005/AC:2010	Safety of machinery - Functional safety of safety-related electrical, electronic and programmable electronic control systems

Other applied standards:

DIN EN 61508 Part 1-7: 2010	Functional safety of electrical/electronic/programmable electronic safety-related systems

The EC type examination and certification according to the EC machinery directive as Logic Unit For Safety Functions was carried out by the notified body:

NB0035, TÜV Rheinland Industrie Service GmbH,
Alboinstr. 56,
12103 Berlin
Certificate-No.: 01/205/5338/13

Authorized to compile the technical file:

TR-Electronic GmbH, Eglishalde 6, 78647 Trossingen, Germany

Trossingen, 09.08.2013

Thanassakis Andreas, Business Management

TR-ECE-KE-DGB-0278-01.DOC

14.7 Accessories

490-00101		Info
	Switch cabinet module PT-6	TR-V-TI-GB-0020

490-00105		Info
	Switch cabinet module PT-15/2	TR-V-TI-GB-0060

490-01001	
	Software and Support DVD: - GSD, EDS, Type and XML Files + Documentations - Tools - Programming Software - Driver

14.8 Drawings

see subsequent pages