

# Robust solutions for wind turbines

- Azimuth and pitch adjustment
- Generator speed monitoring



application  
wind energy

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## Exemption note

We expressly point out that the details, measurement values and tolerances provided in the drawings are not binding. They are subject to technology and design modifications. Their only objective is to illustrate the product. Please contact our sales and distribution team if you need a concrete offer with a binding drawing.

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# Overview

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## Functional safety in wind turbines

The Machinery Directive has had a powerful impact on the implementation of safety requirements in automation technology. These methods are also increasingly applied for the design and construction of wind turbines. Different requirements result, depending on the function for which a component is used. TR-Electronic meets these challenges and thanks to its many years of experience is a reliable and expert partner for manufacturers of wind turbines and system suppliers. TR-Electronic develops and produces certified components with functional safety.

### Previous solution

The respective manufacturer is responsible for the safety design of different regulation, control and monitoring functions. Each manufacturer has designed its own individual (sub-)system and must prove its capability.

### Certified solution

The standards for the safety assessment of systems and components are now established in general automation technology and have proven themselves.

TR-Electronic provides the necessary characteristics. Wind turbine manufacturers and system suppliers receive certified sensors individually tailored to requirements. These components are therefore considered safe and are suitable for the desired safety function.

This saves users of TR-Electronic's components from having

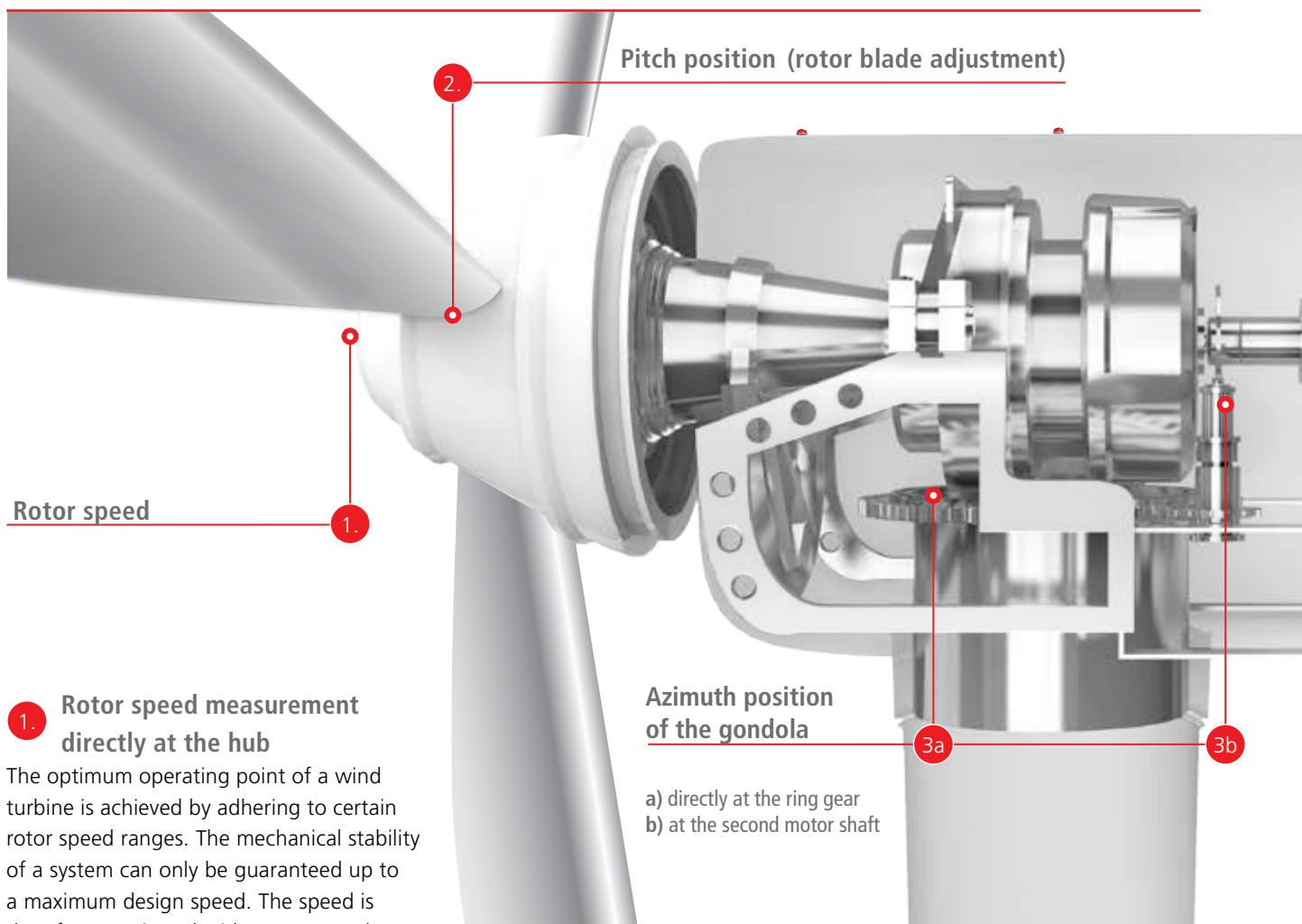
to provide their own proof for the sensors. The CD\_75 M absolute rotary encoder records the revolution information by means of mechanical transmission without battery-buffered rev counter. The development, technology and production of these devices are certified by TÜV. They are used in systems which require Safety Integrity Level 3 (SIL 3: IEC 61508/EN 62061) or Performance Level e (PLe: EN ISO 13849 -1). The CD\_75 PROFIsafe also outputs speed values which are deemed safe.

TR follows the concept of integrated safety here. The measured values are output directly via certified safety buses. Additional evaluation units are unnecessary. The measured values are transparently available in the higher level (safety) control.

### Graduated safety concepts

The safety requirements of the individual functions in a wind turbine are subject to different degrees of safety. In pitch adjustment, for example, the requirements are high. Therefore redundant systems have previously been used. In order to continue to guarantee and increase this safety, the use of safety-certified rotary encoders from TR-Electronic is recommended.

The design of other axes is facilitated by the fact that the necessary safety factors are supplied by the component manufacturer (determination of PL according to EN ISO 13849-1 from the component failure rates).



**Rotor speed**

**1. Rotor speed measurement directly at the hub**

The optimum operating point of a wind turbine is achieved by adhering to certain rotor speed ranges. The mechanical stability of a system can only be guaranteed up to a maximum design speed. The speed is therefore monitored with rotary encoders.

**2. Pitch adjustment**

The wind turbine is adapted to the different wind speeds by adjusting the setting angle of the rotor blades ("pitch"). The setting angle is continuously regulated in order to achieve optimal energy generation even in gusty wind conditions. The pitch adjustment also plays an important part under normal conditions of use - the system can be decelerated gently by leaving the optimal setting angle, before the mechanical brakes are applied.

**3. Azimuth tracking of gondolas**

The gondola of the wind turbine is aligned according to the wind direction. Position detection is possible at the ring gear of the gondola (3a) or directly at the drive motor (3b). The gondola position must be absolutely detected over a number of revolutions.

The connecting lines between gondola and foundation do not allow endless rotation in one direction. Like pitch adjustment, azimuth tracking is also used to put the system into a safe condition.

**Pitch position (rotor blade adjustment)**

**Azimuth position of the gondola**

a) directly at the ring gear  
b) at the second motor shaft

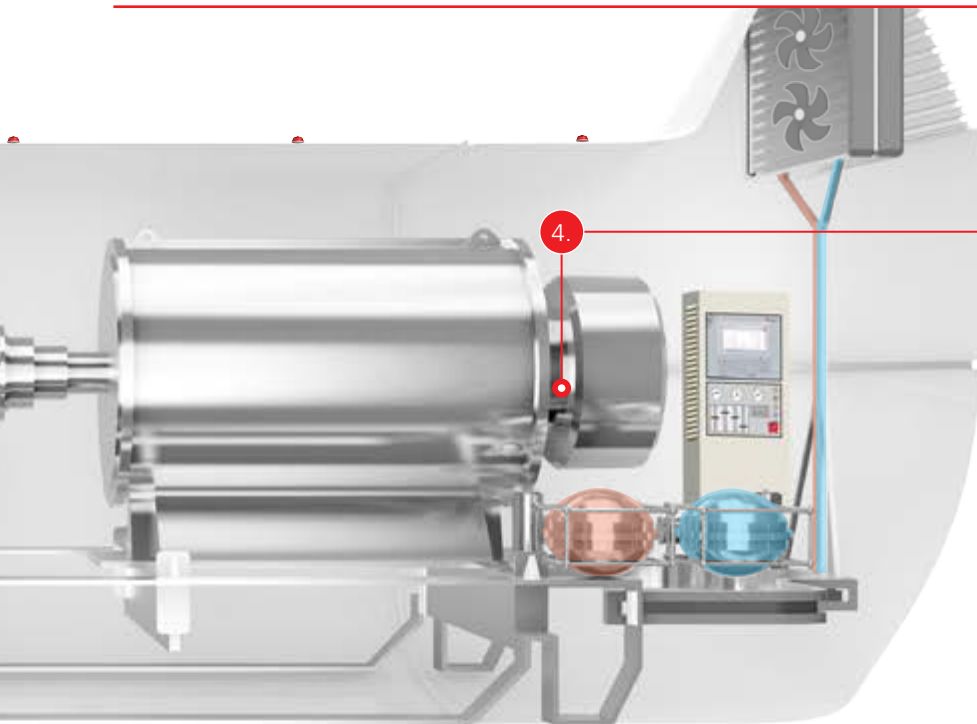
**4. Generator speed measurement**

Another important control variable for energy generation is the generator speed. Depending on the further implementation of the generated energy, the absolute position angle within the generator revolution can also be significant. Absolute rotary encoders are then used.

**Integrated safety thanks to SIL-certified rotary encoders.**

TR-Electronic is one of the first manufacturers to produce certified absolute rotary encoders with integrated safety. Safe absolute rotary encoders from TR are proven in countless applications where the protection of personnel and machinery matters most. The development, production and technology of these devices are certified by an independent body.

The position and speed values are transmitted directly to a suitable control via secure bus systems. Safe measured values are thus directly available through additional components. Measured values are also available for the control processes via unsecured (and therefore usually faster) protocols. Additional incremental signals directly from the sensor also allow secondary speed control without additional sensors.



### Generator speed

**CEH 80**  
 - Shaft diameter  
 16–27 mm



**CEH 110**  
 - Shaft diameter  
 27–50 mm



### Safe absolute rotary encoders CD\_75 and CD\_582+FS

With certified rotary encoders CD\_75 and CD\_582+FS you can optimally protect your system and fulfill the highest safety standards. The absolute rotary encoder with Functional safety records the revolution information by means of mechanical transmission without a battery-buffered rev counter.

The measured values are transmitted with PROFIBUS or PROFINET via the PROFIsafe protocol or with Ethernet Powerlink via the openSAFETY protocol. Even in their basic configuration these systems are designed for many years of use under tough conditions. They can also be adapted to extremely inhospitable environments with special housings and sealing systems. Currently, CD\_582+FS is the smallest available absolute rotary encoder with PROFINET/PROFISAFE and SIL3. These encoder systems are suitable for all rotating measurements, particularly electrical pitch and azimuth adjustment.

**CDV582+FS**



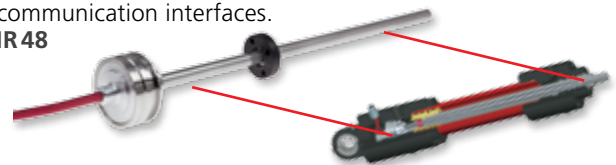
**CDV 75 M**



### LMR48 linear encoder for direct cylinder installation

Thanks to compact sensor electronics, the LMR48 linear encoder can be completely integrated into hydraulic cylinders. The measuring process is absolute, non-contacting and thus also wear-free, ensuring a long service life. Analog interfaces (current/voltage) and digital SSI/CAN are available as communication interfaces.

**LMR 48**



Standard rotary encoders for adverse ambient conditions  
 Depending on local regulations and standards and the subsequent evaluation, the safety-relevant axes can also be equipped with standard components.

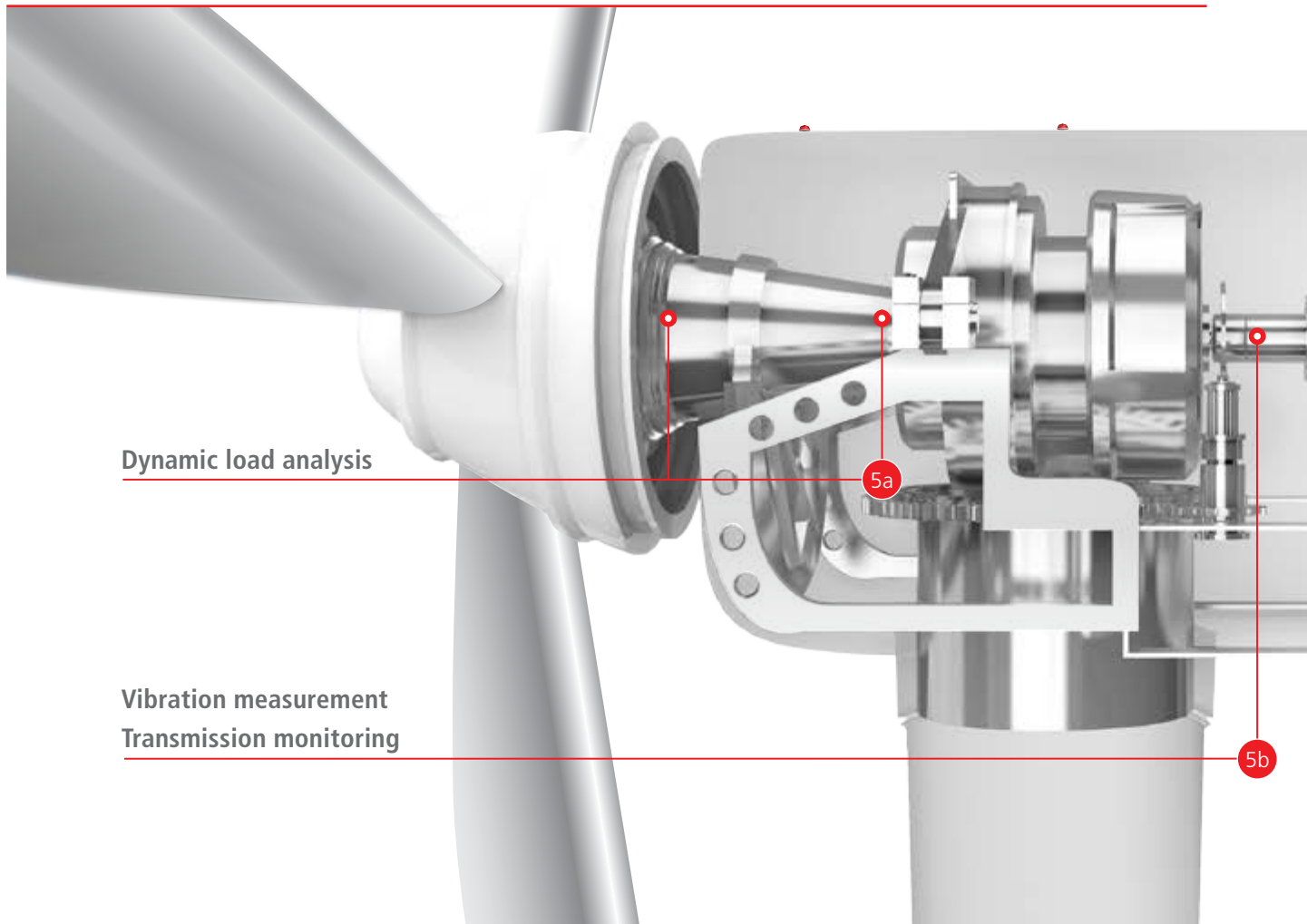
With compact 58 mm outer diameter, the absolute rotary encoders in the C\_582 series are suitable for virtually any installation situation - with collar bearing and pinion or as a hollow shaft device for the second end of the motor shaft. Extension options enable tightness up to IP67. Absolute encoders C\_H80 and C\_H110 accept larger shaft diameters: Shaft diameters up to 27 or 50 mm can be inserted directly through these hollow shaft encoders. A wide range of interfaces are available in all series; from direct SSI output through to fast Industrial Ethernet directly into the sensor.

**CEV 582**



**CEH 582**





**5. Load analysis (5 a), vibration measurement and transmission monitoring (5 b) with SmartControl**

Deformations and material damage can mean the end for the system. It must therefore operate completely safely in defined load limiting ranges.

All recorded values are monitored and logged. SmartControl, with its specially developed Piezo sensors, is used for this purpose. The system visualizes, measures and checks all

sensor signals and combines them. Any violation of preset target or limit values is indicated and recorded.

It is quick to install and ready for operation in a few easy steps. Convenient data output/evaluation is enabled by special software on the powerful industrial PC. SmartControl reliably protects the system.

**SmartControl**

- \_ or surface defects
- \_ the SmartLine software indicates important processes and faults
- \_ parallel recording of up to 12 measuring channels possible
- \_ 24 VDC operating voltage

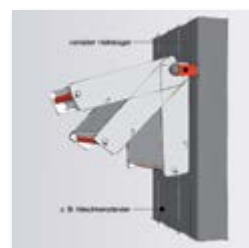
**smartLINE touch surface**

- \_ easy to operate
- \_ intuitive navigation



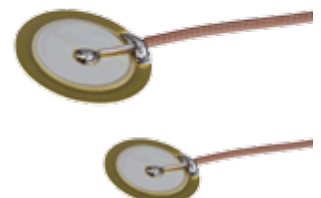
**Combi mounting bracket**

- \_ The PC can be mounted horizontally or vertically

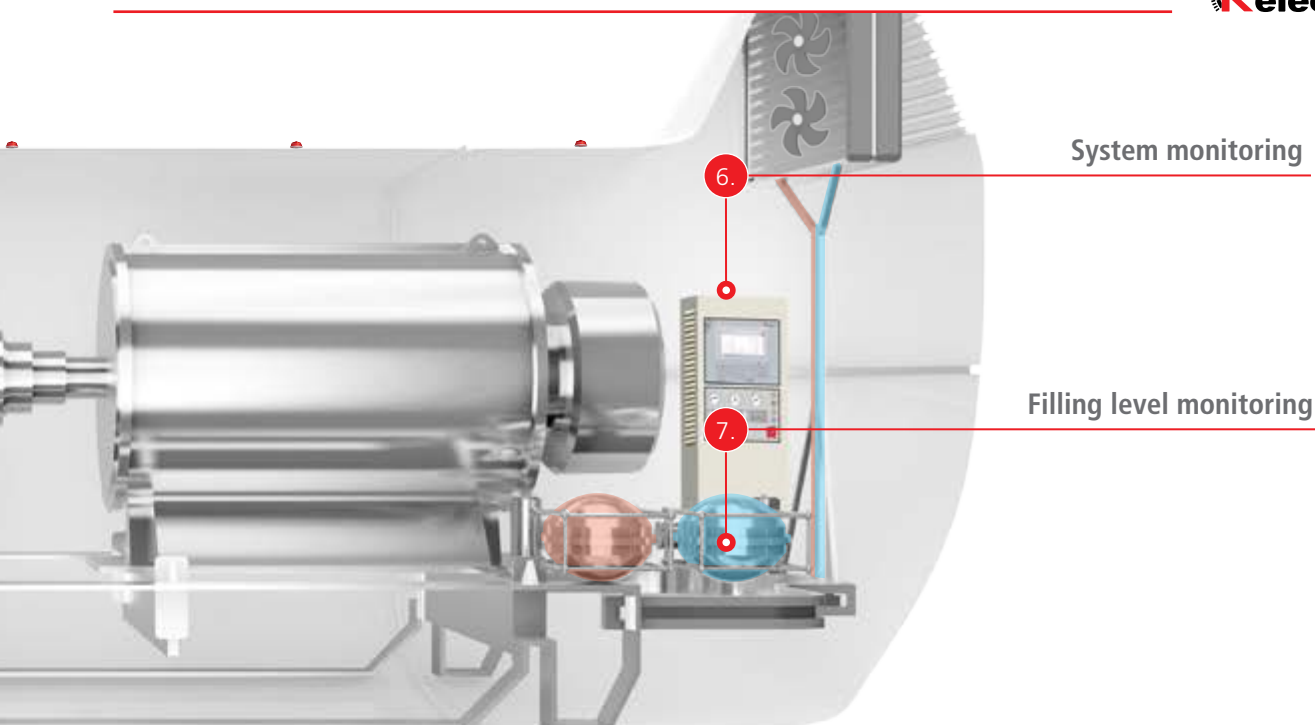


**Piezo sensors**

- \_ easy to install
- \_ robust handling
- \_ two sizes to choose from







### 6. System monitoring with box or panel PC

The control technology of wind turbines is now completely PC-based. Control system, monitoring or remote monitoring can run in an industrial PC. Panel PCs and box PCs from TRsystems can be integrated optimally into the environment. Ventilated wall or DIN-rail mountable PCs can be perfectly accommodated in the switch cabinet. Panel PCs are a convenient solution for the operating interface. Arm-mounted PCs have the same interface, but are sealed on all sides and can be freely positioned.

Moving parts are minimized to give a particularly long service life. Cooling is guaranteed by a coordinated system of heat pipes and heat sinks. The hard disk is replaced by Flash modules, and access is minimized by intelligent writing technology. Keyboards or conventional operating elements such as emergency stop, maintenance and key-operated switches can be integrated into the front panel according to customer requirement; USB access can also be provided for simple local data exchange. Cutting-edge multi-touch devices enable operating concepts with gesture recognition. The displays have a diagonal of 10 to 19 inches, in an aspect ratio of 16:9 or 4:3. The devices are usually pre-equipped with two network interfaces for Industrial Ethernet; traditional field buses such as CANopen and Profibus are integrated as option cards.

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### 7. Level monitoring for cooling and braking systems

Many wind turbines have hydraulic systems for cooling or for the operation of safety brakes. Thanks to continuous monitoring of the levels in the tanks, leaks are detected at an early stage. Consequential costs are minimized or even eliminated. The LA 80 from TR-Electronic is one such level measuring system.

The plastic (PP) housing is resistant even to aggressive coolants or oil additives. The LMR48 or LA 46 with float gauge are also suitable for simpler applications. Medium temperatures up to +85 °C present no problem. The systems are contactless, pressure-tight and have no openings below the liquid line. Consequently their use does not affect the leak tightness of the overall system. In order to achieve a high chemical resistance, the measuring system and electronics are installed in a tube with a polypropylene flange.

The measuring principle is based on a travel time measurement in the ultrasonic range. It is touchless, wear and tear free and hot influenced by medium.

LA 80



# TR-Electronic – your partner in automation

## Rotary encoders

**Absolute encoder, incremental rotary encoder, wire-actuated encoder**

Rotary encoders with optical and magnetic scanning function register the precise position in a wide variety of applications and industries.

In medical engineering, miniature versions ensure correct positioning while SIL3-approved absolute rotary encoders provide the necessary safety. We offer not only high-quality rotary encoders (from Ø 22 to 160 mm) for almost any application but also comprehensive accessories.

## Linear encoders

**Linear absolute measuring systems, laser displacement measurement**

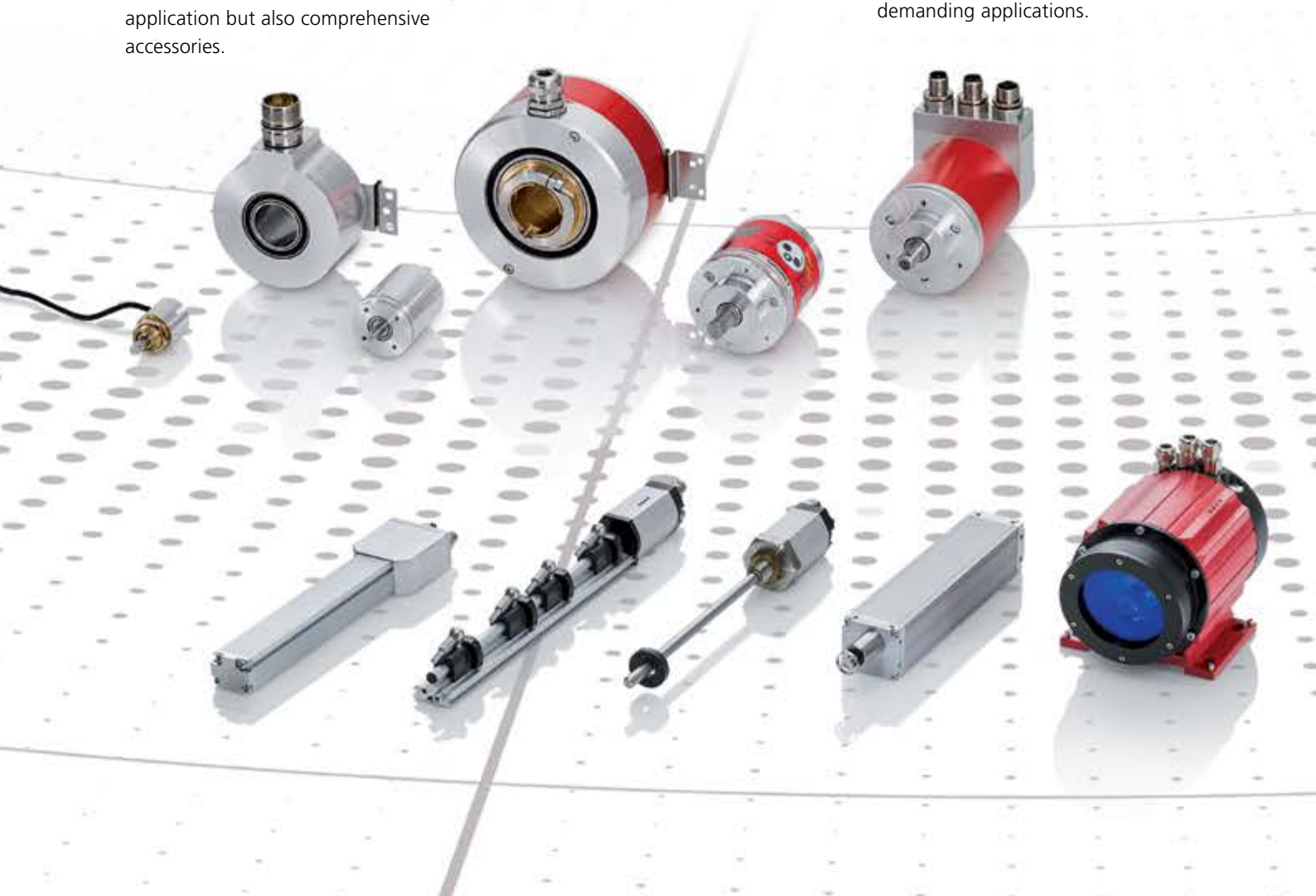
Linear encoders register linear motions in machines, tools and systems according to specific requirements using different technologies.

Linear encoders allow measuring distances of max. 20 m almost without any wear. This value is max. 240 m for laser measuring systems. Machines and systems can be precisely controlled to reach their desired positions.

## Motion

**Servo drives, compact drives, process drives**

Intelligent encoTRive drives are available with the current field bus systems, such as PROFIBUS, PROFINET and CANopen, within a power range of up to 300 watts. The drives are configured to meet customer requirements and can be freely combined with precision gear, holding brake and I/O. Values of up to 4,350 rpm and powerful 200 Nm are available to cope with demanding applications.





## Components

**Industrial PC, field bus I/O,  
PLC, HMI controller**

Industrial PCs are available in numerous variants and offer customized calculation power for PC-assisted automation. Programmable logic controllers (PLC) are the traditional means for automation. HMI controllers establish the interface to the user. Field bus nodes, I/O modules and cam controllers complete the range of automation components.

## Automation

**Consulting and implementation  
for new machines and retrofit**

You want to set up a largely automated new machine or retrofit and modernize your existing machine with automation systems? Then you just need our extensive expert knowledge and the more than 20 years of our experience.

## Unidor

**Blanking and forming,  
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Trendsetting blanking and forming technology for more than 30 years. We are your reliable partner in the world of blanking and pressing and can prove this with thousands of machines which we have successfully installed all over the world. Sensors, controls and systems ensure optimal results in machines, tools and retrofit projects.



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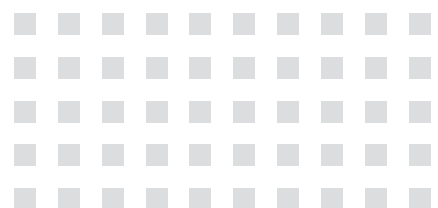
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Subject to technology and design modifications.

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