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The Encoder Experts

Whitepaper
Comparison of optical and magnetic encoders

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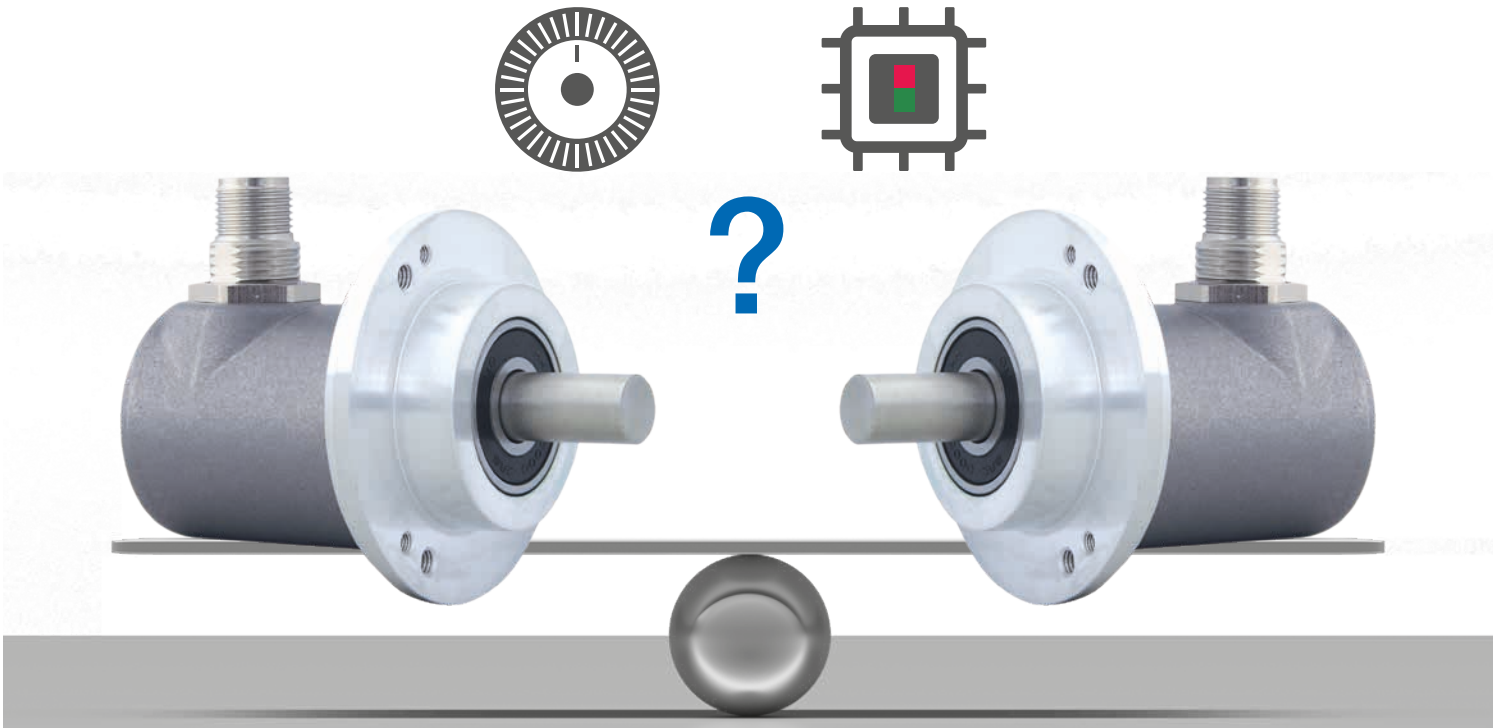
Functionality
Influencing factors
Robustness and environmental resistance
Costs
Areas of application
Long-term considerations



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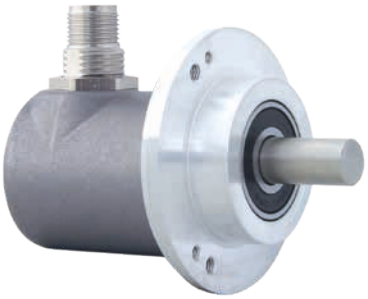
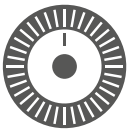
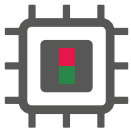
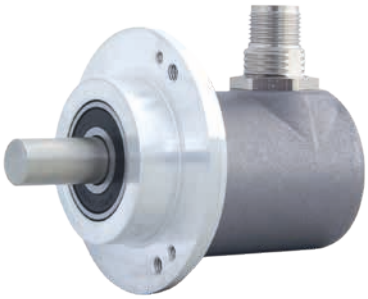








Optical encoders

Functional principle

Principle: Optical encoders are based on the use of light to measure position and movement. They typically consist of the following components:

- Light source: An LED or laser that generates light beams.
- Coded disc: A rotating disc with a pattern of transparent and opaque segments, often made of glass or plastic.
- Photodetectors: Sensors that detect the light beams that pass through the coded disc.

Functionality:
- The light source shines light onto the coded disc.
- The disc consists of a combination of transparent and opaque areas that transmit or block the light accordingly.
- The photodetectors detect the transmitted light patterns and convert them into electrical signals.
- The position of the disc, and therefore of the wave, is determined by the patterns of light rays detected by the detectors.

Accuracy and resolution

Accuracy: Optical encoders can offer very high accuracy and precision as they can read fine details of the encoded disc. Typical accuracies range from a few arc seconds to a fraction of an arc second.
Resolution: The resolution of an optical encoder is high and depends on the number of lines on the encoded disc. In high-quality applications, optical encoders can offer resolutions in the range of millions of pulses per revolution.

Influencing factors:
- Disc resolution: The number of lines on the disc directly influences the resolution.
- Optical components: The quality of the light source and the detectors determines the precision.

Magnetic encoders

Functional principle

Principle: Magnetic rotary encoders use magnetic fields to determine position and typically consist of:

- Magnets: A magnet that is attached to the rotating shaft.
- Magnetic field sensors: Sensors that detect changes in the magnetic field, such as Hall effect sensors or magnetoresistance sensors.

Functionality:
- The magnet generates a magnetic field that changes as the shaft rotates.
- The magnetic field sensors measure the variations in the magnetic field and convert them into electrical signals.
- The position of the shaft is determined by analysing the changes in the magnetic field.
- Temperature fluctuations: Extreme temperatures can deform the optical components and reduce accuracy.

Accuracy and resolution

Accuracy: Magnetic encoders are generally less accurate than optical encoders, but can still provide precise measurements. The accuracy can range from a few tenths to a few hundredths of a degree, depending on the technology and the magnet.
Resolution: The resolution of magnetic encoders is generally lower than that of optical encoders, although modern magnetic encoders can also achieve very high resolutions thanks to advances in sensor technology.

Influencing factors:
- Magnet quality: The precision of the magnet influences the accuracy of the measurement.
- Sensor quality: The type and sensitivity of the magnetic field sensors are decisive for the resolution.

Optical encoders

Robustness and environmental resistance

Sensitivities: Optical encoders are sensitive to:

- Dirt: Dust and dirt can block the optical components and impair performance.
- Moisture: Condensation or moisture can impair the optical elements.
- Temperature fluctuations: Extreme temperatures can deform the optical components and reduce accuracy.

Protection measures:

- Housings with protection ratings such as IP65 or IP67 can protect the encoders from environmental influences.
- In extreme environments, additional protective devices are required to ensure the service life of the encoders.

Cost factors

Cost factors:

- Manufacture: The manufacture of precise optical components and adjustment are cost-intensive.
- Calibration: Higher costs for calibration and maintenance.

Price range:

- Optical encoders are often more expensive, especially for high-precision models. The costs can vary considerably depending on the accuracy and requirements.

Areas of application

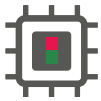
Typical applications:

- CNC machines / machine tools: High precision and resolution are required for precise machining.
- Robotics: Precise position control for industrial robots.
- Medical devices: Applications that require high accuracy, e.g. surgical instruments.

Advantages:

- Very high accuracy and precision.
- Ideal for clean and controlled environments.

Magnetic encoders



Robustness and environmental resistance

Robustness: Magnetic encoders are more resistant to:

- Contamination: Magnetic sensors are less susceptible to contamination.
- Moisture: Magnetic components are generally less sensitive to moisture.
- Temperature fluctuations: Magnetic encoders can tolerate wider temperature ranges.

Protection measures

- Many magnetic encoders are already designed for harsh environments and require fewer protective devices.
- Robust housings and seals are often integrated to extend the service life.

Cost factors

Cost factors:

- Production: Lower costs for production and calibration compared to optical encoders.
- Maintenance: Less complex maintenance and lower costs over the service life.

Price range:

- Magnetic encoders are generally less expensive and offer a good price-performance ratio, especially for applications where extreme precision is not required.

Areas of application

Typical applications:

- Packaging machines / marking systems: Position / speed measurement on conveyor belts or in the packaging process.
- Textile machines: e.g. control of camera systems for quality control.
- Heavy industry: Applications in harsh and dirty environments.
- Outdoor applications / mobile machinery: Position detection in applications that are exposed to extreme conditions.

Advantages:

- High robustness and environmental resistance.
- Lower costs and maintenance requirements.

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Optical encoders

Service life and maintenance

- Higher maintenance requirements due to susceptibility to dirt and moisture. The service life can be extended through regular maintenance.

Availability and support:

- Often offered by specialised manufacturers who may offer more extensive technical support.

Magnetic encoders

Robustness and environmental resistance

- Longer service life with less maintenance. Less susceptibility to environmental influences leads to more stable performance over time.

Availability and support:

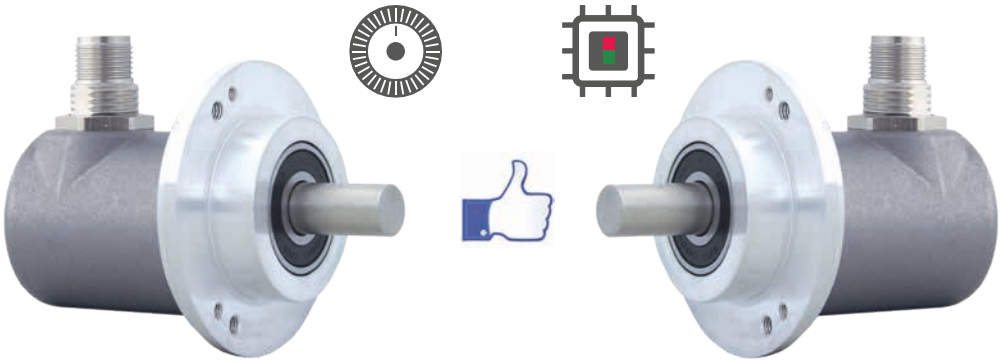
- More commonly available from a wide range of manufacturers, often with standardised support and spare parts.

Summary

Optical and magnetic encoders have different strengths and weaknesses that make them more or less suitable for different applications.

While magnetic incremental encoders are competitive in many standard standard applications and many of the previous disadvantages compared to optical encoders have been greatly minimised or eliminated, there are still specific scenarios where optical encoders can be superior. Especially in applications that require extremely high accuracy and resolution, optical encoders are often the better choice.

choice. However, in harsh, dirty or humid environments and in applications where cost and maintenance are important factors, magnetic encoders have clear advantages. The choice between these two types ultimately depends on the specific requirements of the application, the environmental conditions and the budget.



Any Questions? Just call us at +49 (0) 67 22 / 99 65 414, send us an E-Mail to support-wa@wachendorff.de or call your local distributor: **www.wachendorff-automation.com**

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