

LEINE  LINDE



ENCODERS FOR

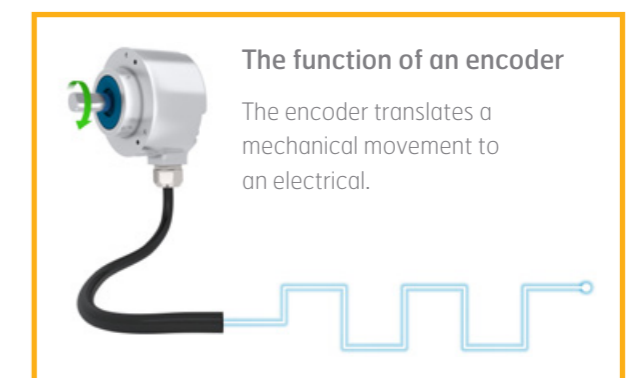
MOTORS & DRIVES



The best of both worlds

An encoder operates on the threshold between mechanics and electronics, and these two worlds require completely different qualities of the encoder. On the electrical side, an encoder must offer the highest level of reliability, precision and accuracy. On the mechanical side, it must withstand powerful forces, vibrations and extreme temperatures.

In a drive system, the encoder provides the link between motor and frequency converter. This brochure outlines the criteria to be considered when choosing a solution optimised for both worlds.



The function of an encoder

The encoder translates a mechanical movement to an electrical.

Precision at the highest speeds

At a paper mill the paper progresses at high speed through the manufacturing process. The paper is carried by a large number of rolls driven by various motors. The speed of each motor must be controlled and synchronised with the other motors in the line.

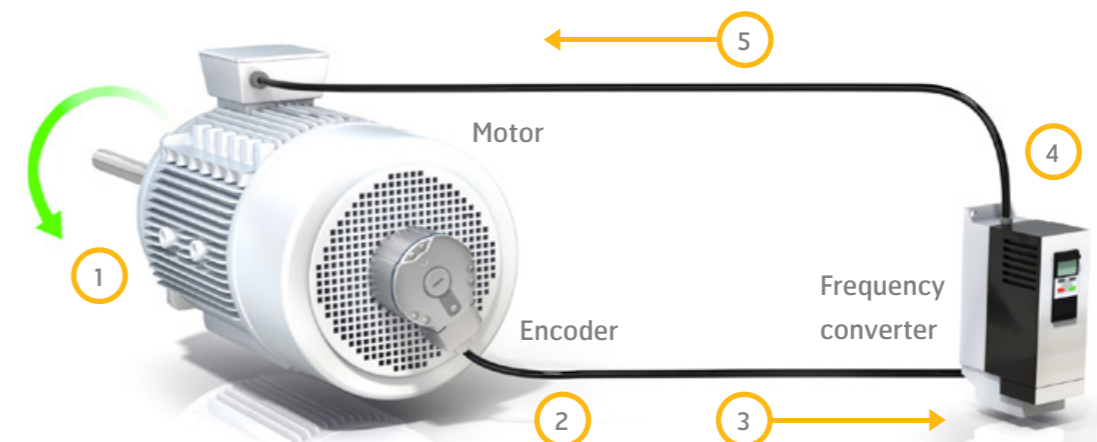
It is vital to be able to regulate the motor speed with great precision, particularly on start-up and when changing operating speed. During operation, the speed of the various motors must be able to compensate for factors such as the elasticity of the paper. Otherwise there is a risk that the paper may tear, resulting in expensive stoppages.

With its accurate speed feedback function, the encoder plays a central role in this system.

Key features of a drive system

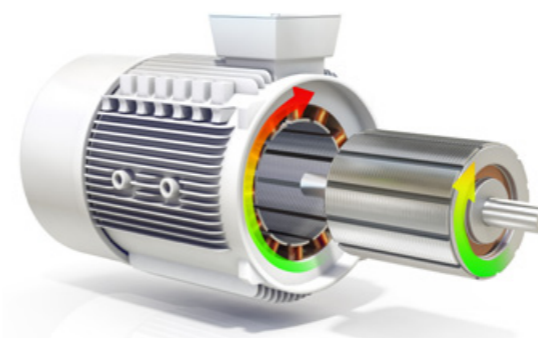
- Immediate adjustment of deviations helps to maintain a constant speed.
- Accurate speed information, even at very low shaft speeds (for example, on start-up).
- Controlled speed adjustment in the event of acceleration.
- Speeds are adjusted according to current production demands.
- Optimisation of torque and speed helps to reduce energy consumption by the motor.

The principle behind a drive system



1. The motor shaft drives a load at a certain torque. Intentional speed adjustments may be required during operation; but also, unintentional changes in speed can occur, as the speed is affected by a number of factors, for instance, a variation in the load and by slip.
2. The encoder is mounted directly on the rotor and measures the real speed of the motor shaft.
3. The encoder sends a constant stream of feedback of the speed to the frequency converter.
4. The frequency converter interprets the encoder signals and calculates the necessary compensation for the speed.
5. The frequency converter regulates frequency and voltage, which control the speed of the stator's rotating magnetic field.

Electric motor



Stator – rotating magnetic field

Rotor – rotating motor shaft

Inside an encoder

The internal structure of an encoder is based on a rotating disc with a large number of measurement points around its circumference. With a pulse rate of 1,024 ppr, one revolution will provide 4,096 measurement points. This means that the encoder can detect a movement of 0.1 mechanical degrees and that an updated speed can be calculated 4,096 times during each revolution. This enables immediate compensation for deviations, so that the preferred speed can be maintained.



Challenging environments

Leine & Linde specialises in encoders for motors used in exposed environments, where heat, cold, rain, dirt, mechanical forces and vibrations are the norm. The best test of all is real operation in the field, where the products have a long history of successful operation in applications with extremely demanding surroundings.

Temperature

Encoders are used in a vast range of environments. Some must withstand intense cold during the winter, while others are exposed to heat in, for example, metal processing. There are encoder models designed for use in various temperature ranges between -50 °C and +100 °C.

Explosion protection

Leine & Linde's encoders are approved for use in potentially explosive environments. Standard products comply with the requirements for zones 2/22, but there are also specific models intended for use in more hazardous zones.

- II 3 G Ex nA IIB 120°C
- II 3 D Ex tD A22 IP6X T120°C
- II 2 GD Ex d IIC T6 Ex tD A21 IP65 T71°C
- II 2 GD Ex d IIC T5 Ex tD A21 IP65 T91°C
- II 2 GD Ex d IIC T5 Ex tD A21 IP65 T95°C

Encapsulation

All Leine & Linde's encoders are tested and verified for use in applications where moisture and dirt are present. The encapsulating cover has a seal in accordance with IP66 or IP67. The surface normally comprises anodised aluminium, which is salt water-resistant. Special solutions in stainless steel can also be produced for the majority of models.

Mechanical forces, vibrations and shock

Leine & Linde's encoders are built using robust bearings and vibration-resistant electronics. Each application has its own demands as regards robustness, and the encoder shall be chosen accordingly. Detailed data is provided in the data sheet for each model.



The right encoder in the right place

Leine & Linde produces several different encoder series which differ in terms of size, robustness and functionality. Each series offers a wide range of mechanical and electrical options, all designed to suit the application in question. The design guide on the following pages describes solutions in Leine & Linde's range and provides guidelines for the encoder's design criteria based on the system where it is used.

PRODUCT FINDER

Visit www.leinelinde.com to find the product you are looking for. Using the Product Finder you can

- combine options and create your own encoder
- generate a detailed data sheet for your exact variant.



1000 Extreme

Description	Very robust encapsulation and extremely resistant to mechanical forces.
Dimensions	115 mm in diameter ~ 250 mm in length
Shaft dimensions	≤ 20 mm solid shaft
Functionality	Incremental, absolute, dual



800 Heavy Duty

Description	For applications in the heavy duty segment with high mechanical forces and high reliability demands.
Dimensions	110 mm in diameter ~ 70 mm in length
Shaft dimensions	≤ 25,4 mm hollow shaft ≤ 11 mm solid shaft
Functionality	Incremental, ADS™, Ex, Optolink, dual

News 2012



700 Compact

Description	Compact yet robust for applications with medium mechanical forces.
Dimensions	110 mm in diameter ~ 55 mm in length
Shaft dimensions	≤ 25,4 mm hollow shaft
Functionality	Incremental



600 Industrial

Description	Absolute encoder series for applications with limited mechanical forces.
Dimensions	58 mm in diameter ~ 55 mm in length
Shaft dimensions	≤ 12 mm hollow shaft ≤ 10 mm solid shaft
Functionality	Absolute, fieldbus



500 Robust

Description	Space-saving and versatile series for applications with limited mechanical forces.
Dimensions	58 mm in diameter ~ 40 mm in length
Shaft dimensions	≤ 15 mm hollow shaft ≤ 10 mm solid shaft
Functionality	Incremental, absolute, dual

Shafts and flanges

– mechanical solutions for easy assembly

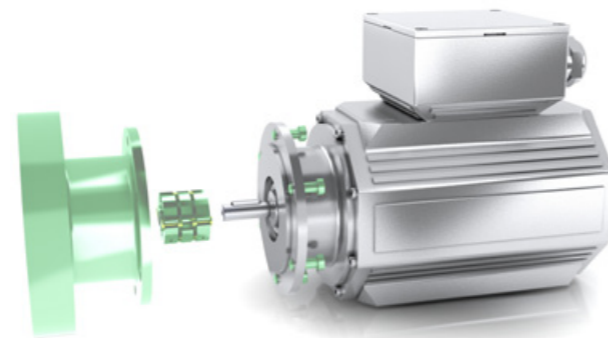
Flange and solid shaft

An encoder with a solid shaft is fixed to the motor with the aid of a mounting flange. The assembly is very stable and prevents the encoder moving.

Shaft rotation is transferred by means of a flexible shaft coupling that compensates for axial and radial movement of the motor shaft. This reduces wear on the encoder's bearings, maximising its service life.

Leine & Linde offers a large number of industrial grade flanges, for example, clamping flange, synchro flange and euro flange, as well as several customised versions.

- Key characteristic: Stable assembly
- Fixing: Shaft coupling
- Available in the 1000, 800, 600 and 500 series



Through-going hollow shaft

This assembly is the most space-efficient axially. The encoder's hollow shaft is mounted directly on to the motor shaft, meaning there are no protruding shafts or intermediate couplings taking up valuable space. A clamping ring is used to fix the encoder to the motor shaft.

Leine & Linde's 700 series is, despite its robust design, built to be axially as short as possible, making it ideal for applications where space is at a premium.

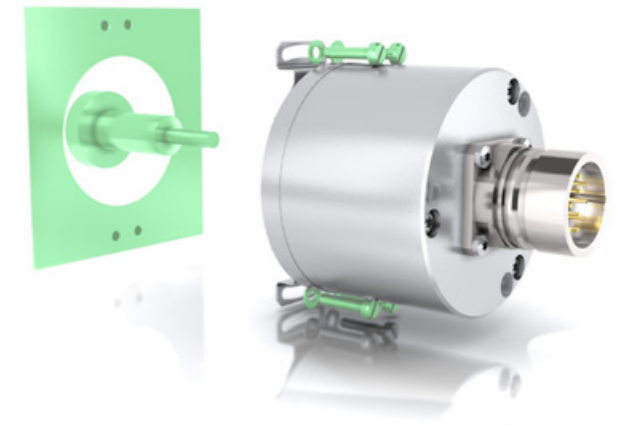
- Key characteristic: Short build length
- Fixing: Clamping ring
- Available in the 800, 700, 600 and 500 series



Blind hollow shaft

If space is limited radially, a good solution is to choose an encoder with a blind hollow shaft. This feature makes an axial output possible, which avoids adding anything to the radius. To prevent the encoder rotating with the shaft, it is fitted with a flexible stator coupling, which has also been designed to add as little as possible to the radius.

- Key characteristic: Minimal radial space
- Fixing: Clamping ring
- Available in the 600 and 500 series



Hollow shaft with axial mounting screw

A common fixing solution is to secure the encoder's hollow shaft to the motor shaft using an axial screw. With a prepared mating shaft, assembly can be performed quickly and easily, during both manufacture of the motor and servicing. This solution also facilitates the process of centering the encoder to the mating shaft.

- Key characteristic: Easily accessible assembly
- Fixing: Axial screw
- Available in the 800 and 500 series



Flexible fixing

A hollow shaft encoder must have an attachment point that prevents it moving as the shaft rotates. It is important that the assembly be flexible, so that the encoder has a degree of freedom to move if the motor shaft moves radially or axially. If the assembly is rigid, there is a risk that the movement of the motor shaft will wear down the encoder's bearings prematurely. Leine & Linde offers a number of solutions for optimised installation.

- **Torque arms** – in different lengths, insulated
- **Torque arm brackets** – several different types
- **Stator couplings** – several different types

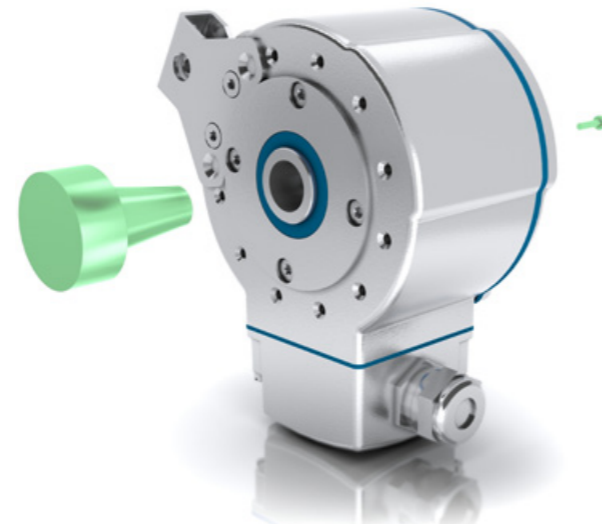


Expanded solutions for special requirements

Taper hollow shaft with axial mounting screw

Leine & Linde's 800 series includes an option with a taper hollow shaft. When the mounting screw passes through the hollow shaft of the encoder into the motor shaft, the cone is pressed against the motor shaft along its entire surface. This guarantees maximum friction between the shafts and ensures that the encoder is centred.

- Key characteristic: Maximum friction and centring
- Fixing: Axial screw
- Available in the 800 series



Key and keyway

In safety-critical applications there are sometimes demands for mating shafts to be connected by a keyway, which guarantees to counteract slippage. Leine & Linde's shaft encoders can be supplied with a key, while hollow shaft encoders can be supplied with a keyway.

- Key characteristic: Counteracts slippage
- Fixing: Shaft coupling/axial screw
- Available in the 1000 and 800 series



Insulated shafts

A motor driven by a frequency converter can be affected by voltages passing over the motor shaft. This can lead to currents passing through the bearings of the motor or encoder, which dramatically reduces the service life of the bearings. Leine & Linde has developed several different types of shaft insulation to help overcome this problem.

- **Peek insert** – insulates the encoder's hollow shaft from the motor shaft. Available in the 800, 700 and 500 series.
- **Hybrid bearings** – insulates the encoder's hollow shaft from the motor shaft. Available in the 800 series.
- **Insulated shaft coupling** – solution for encoders with a solid shaft. Available in the 1000, 800 and 500 series.
- **Shaft grounding ring** – directs currents away from the motor shaft via the encoder's cover. Available in the 800 series.



Resolution

– function adapted for each motor

Asynchronous motors

Asynchronous motors often use incremental encoders to provide direct speed feedback and to enable necessary speed adjustments.

Leine & Linde offers a huge range of pulse rates from 1 to 10,000 ppr. When deciding on a pulse rate, it is necessary to consider the speed at which the motor is expected to operate as well as the frequency that can be handled by the receiving electronics. The following formula can be used as a guideline:

$$\text{pulse rate [ppr]} < \frac{\text{frequency}_{\text{max}} [\text{Hz}]}{\text{shaft speed}_{\text{max}} [\text{rpm}]} \cdot 60$$

If the motor is designed to operate at low speeds, a high pulse rate is often selected to ensure that pulses are produced at sufficiently close intervals to guarantee accuracy. However, if the motor is designed to operate at high speeds, a low pulse rate is chosen to prevent the frequency exceeding the receiving electronics' limit value.

Synchronous motors

Synchronous motors often require absolute feedback on the shaft position. Each marking on the code disc of an absolute position encoder generates a unique code, allowing the shaft's exact position to be read directly on start-up of the motor.

The resolution is normally 25 bits. This is equivalent to 8,192 unique positions on each individual revolution, multiplied by 4,096 distinguishable revolutions. Other resolutions may be available on request.

Electronics

– feedback via many interfaces

Square waves

Square waves are the most common signal type for an incremental encoder. Leine & Linde's products are supplied as standard with 6 channels. Signal S00 is followed by signal S90, which is displaced 90 electrical degrees. The two inverted signals S00\ and S90\ enable differential transmission, which reduces the sensitivity of the signals to electrical interference. To check the position of the shaft, a reference pulse is produced once per revolution, Sref with its inverse Sref\.

There are several variations of electrical interface with different supply voltages and signal levels. When choosing an interface, it is necessary to take into account factors in the motor's operating environment. The exact properties of the interface is affected by frequency, cable length and temperature.



Interface	TTL	RS-422	HTL	HC-HTL
Supply	5 Vdc	9-30 Vdc	9-30 Vdc	9-30 Vdc
Output signal	5 Vdc	5 Vdc	9-30 Vdc	9-30 Vdc
Suitable for	Low frequencies over short cables	High frequencies over long cables	High frequencies over medium-length cables	Medium frequencies over long cables
Max frequency	50 kHz	1000 kHz	300 kHz	100 kHz
Max cable length	50 m at 50 kHz	1000 m at 1000 kHz	100 m at 100 kHz	350 m at 100 kHz
Temperature	-40 .. +100 °C	-40 .. +100 °C	-40 .. +100 °C	-40 .. +80 °C
Available in	1000, 800, 700, 500	1000, 800, 700, 500	1000, 800, 700, 500	1000, 800, 700, 500

Sine waves

Sine waves are another form of output signal. The analog signal produces a unique amplitude for each position on the wave, allowing interpolation and very high resolutions. The interface 1 Vpp is often used in safety-critical applications where detection are required of extremely small movements.



- Available in the 800 and 700 series

Optical transmission

Optical transmission via fibres produces signals that are unaffected by electrical interference in the environment. It also enables transmission over distances of kilometres, and the use of optical fibres reduces the system weight compared with normal cables. Optolink is available integrated into the 800 series or as an accessory gateway for other series.

- Available in the 800 series



Absolute position encoders

Absolute position encoders are offered with serial interfaces such as SSI and EnDat or with integrated fieldbus communication of various kinds, ready for installation in an existing fieldbus system.

- Available in the 1000, 600 and 500 series



Increased function and safety

Dual solutions

Two separate encoders can be integrated into one and the same cover. This solution provides added safety in the form of true redundancy, something required in critical applications where the risk of component faults must be avoided. The two outputs can also be connected to two separate systems with different functions, and there are solutions for combining an incremental and an absolute output in one and the same product.

- Available in the 1000, 800 and 500 series



ADS Online

ADS Online is an Advanced Diagnostic System that continuously monitors the encoder function. If the encoder is nearing the end of its life, a warning is transmitted, enabling action to be taken in good time before problems arise. This system is integrated into the encoder and is used in applications with high demands for reliability, for example, in motors for continuous operation at a paper mill.

- Available in the 800 series



Connection

– a quick and easy process

Cable

The encoder can be supplied with a cable pre-installed. The exact cable length is defined upon order to ensure a perfect fit for each installation.

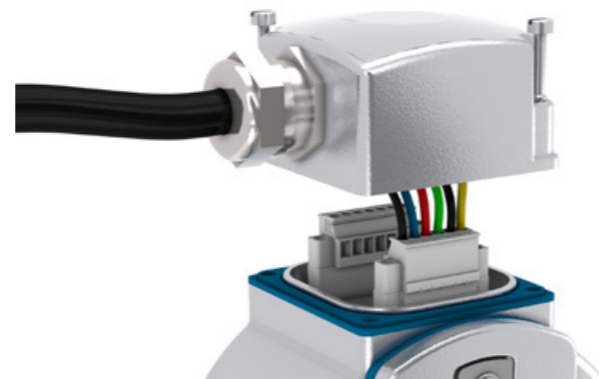
- Available in the 1000, 800, 700, 600 and 500 series



Screw terminal

If long cable lengths are required during installation, it is a good idea to choose an encoder with terminals that allow the user to connect their own cable. This makes it easy to adjust the length of the cable on site and replace the cable if need be.

- Available in the 1000, 800 and 600 series



Connector

There is a wealth of different connectors to choose from, for example, M23 and M12. With a connector, the connection can be prepared at the factory to make on-site installation easier. It also helps to avoid incorrect connection. Connectors also make it simple to replace encoders during servicing.

- Available in the 800, 700, 600 and 500 series



Cable with connector for panel mount

A cable with a pre-installed connector simplifies the installation process when assembling the motor. The length of the cable is specified upon order to fit the exact installation where the connection is made to a panel or terminal box. There the connector is screwed securely into place, forming a tight seal with the surface to prevent penetration by moisture or dust.

- Available in the 1000, 800, 700, 600 and 500 series



Axial or radial output

The direction of the encoder's connection output can be selected to best suit the installation. A radial output means a shorter encoder, while an axial output is better if space around the encoder is limited.



Mating connectors

Suitable mating connectors can be ordered as accessories, with or without a pre-installed cable.



Contact us

Through local presence we support our customers, wherever they are, with a high level of availability and service.

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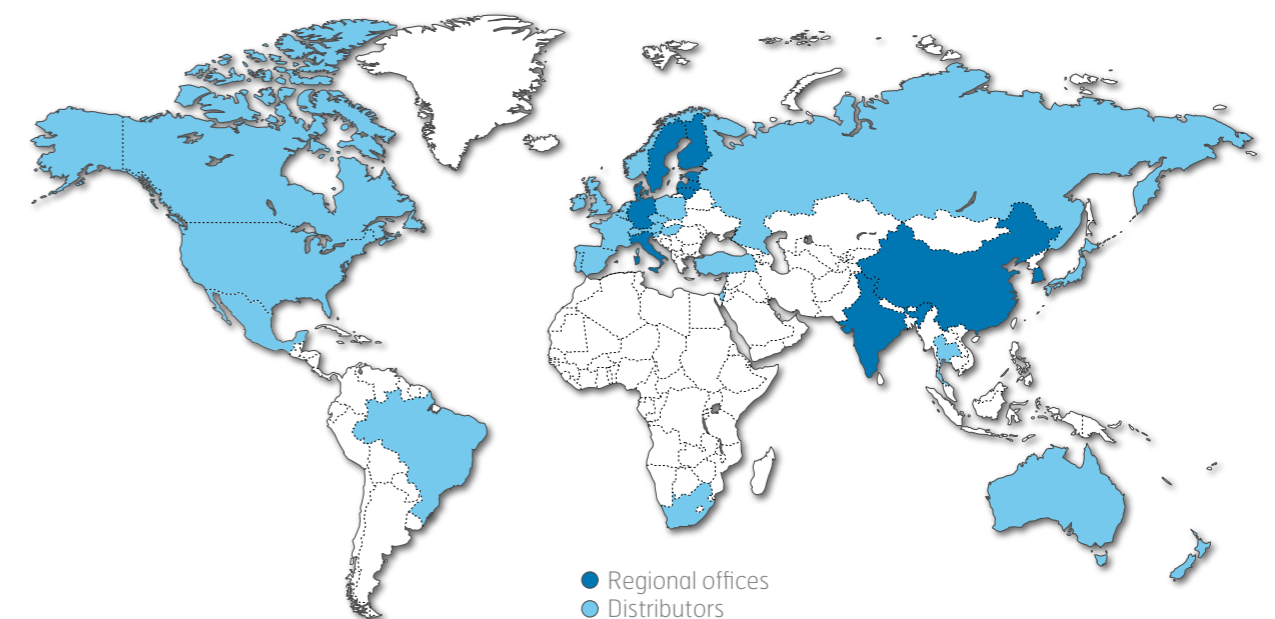
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Leine & Linde's worldwide presence. Read more at www.leinelinde.com





The best encoders are those you never have to think about. Those that simply do their job – year after year. Leine & Linde develops and manufactures customised encoder solutions for demanding environments, advanced measuring systems for accurate feedback of speed and position.

LEINE  LINDE

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