FAULHABER

Encoders
Technical Information

WE CREATE MOTION

EN

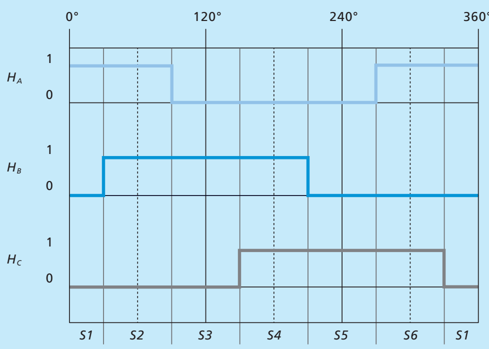
Encoders
Technical Information

General information

FAULHABER Motors are available with a variety of sensors and encoders for providing solutions to a wide range of drive applications – from speed control to high-precision positioning.

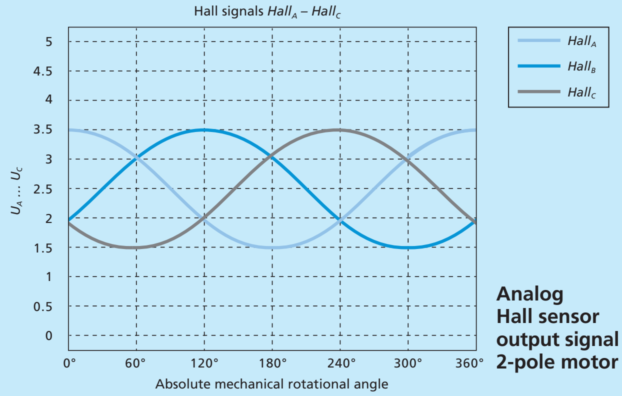
Sensors and encoders
FAULHABER Motors are offered in combination with sensors and encoders. An encoder is a sensor for angle measurement that is usually used for speed or position control.

The term sensor refers to digital or analog Hall sensor which, in the FAULHABER Brushless DC-Motors, are usually mounted directly on the motor circuit board. Digital Hall sensors are used primarily for the commutation of the Brushless DC-Motors and for simple speed control. Almost all FAULHABER Brushless DC-Motors are equipped standard with three integrated digital Hall sensors.



Digital Hall sensor output signal 2-pole motor

In addition, analog Hall sensors are generally available as an option.



Analog Hall sensor output signal 2-pole motor

Due to the higher resolution, the analog Hall sensors can also be used for precise speed or position control, making them an especially economical, lightweight and compact alternative to encoders. The option for analog Hall sensors can be found directly in the data sheets of the motors under "Controller combinations". If this option is selected, no encoder is needed. The space and cost advantages make analog Hall sensors the preferred solution for most positioning applications with Brushless DC-Motors. When selecting this option, it is recommended that the sensors be operated with FAULHABER Controllers, which are perfectly designed for the analog Hall signals.

Functionality

Measurement principle
The FAULHABER Sensors and Encoders are based on magnetic or optical measurement principles.

Magnetic encoders are especially insensitive to dust, humidity and thermal and mechanical shock. In magnetic encoders, sensors are used that determine the changes of the magnetic field. The magnetic field is changed by the movement of a magnetic object. This can be the magnet of the motor or an additional sensor magnet with a defined measuring element that is secured to the shaft of the motor. With encoders, an additional sensor magnet is usually necessary.

In the case of integrated digital or analog Hall sensors, the movement of the rotor magnet of the motor can be measured directly. With the integrated Hall sensors, an additional sensor magnet is therefore normally not necessary.

Optical encoders are characterised by a very high position accuracy and repeatability and a very high signal quality due to the precise measuring element. Furthermore, they are insensitive to magnetic interference. In optical encoders, a code disc with a measuring element is used that is attached to the shaft of the motor. A distinction is made between reflective and transmissive optical encoders. With reflective encoders, the light from an LED is reflected back to the code disc by a reflective surface and collected by photodetectors. Reflective optical encoders are especially compact since the LED, the photodetectors and the electronics can be mounted on the same circuit board or even on the same chip. FAULHABER therefore primarily uses reflective optical encoders. With transmissive encoders, the light from the LED passes through slits in the code disc and is collected by photodetectors on the other side of the code disc.

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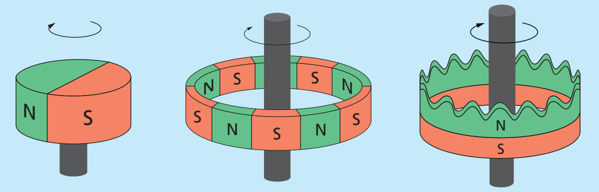
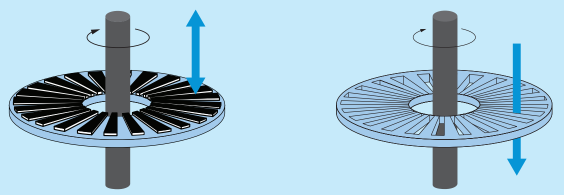
Moving Element
Depending on the measurement principle and dimensional constraints different moving elements are applied in different types of FAULHABER Encoders. The moving element has a significant impact on the accuracy and resolution of the encoder. In general, the higher the physical (native) resolution of the moving element, the higher the resolution and accuracy of the encoder as a whole.

In magnetic encoders, simple, two-pole sensor magnets and magnetic rings are used. The magnetic rings have several signal periods per revolution through the use of a special tooth structure or targeted magnetisation. The number of signal periods corresponds to the physical resolution of the magnetic rings.



Two-pole sensor magnet with one signal period | Multi-pole magnetic ring with multiple signal periods | Magnetic ring with tooth structure with multiple signal periods

In optical encoders, moving elements in the form of code discs are used. With reflective encoders, these consist of a series of surfaces that alternately reflect or absorb light. With transmissive encoders, the code discs consist of a series of bars and slits. The number of reflective surfaces or slits corresponds to the physical resolution. In general, optical encoders can have a significantly higher native resolution than magnetic encoders.



Code disc for reflective encoders with high number of signal periods | Code disc for transmissive encoders with high number of signal periods

Signal processing and interpolation
In addition to the sensors for signal acquisition, the FAULHABER Encoders also include electronic components for signal processing. These process the signals from the sensors and generate the standardised output signals of the encoders. In many cases, the signals are also interpolated, i.e., multiple signal periods are generated by interpolating a single physically measured signal period. The physical resolution of the measuring element can thereby be increased many times over.

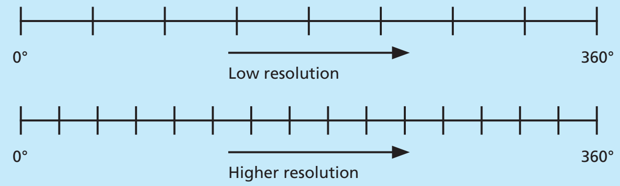
Characteristic encoder features

The quality of an encoder is largely determined by the resolution and the accuracy.

Resolution
The resolution is the number of edges or steps that an encoder produces within a revolution. The resolution is determined from the physical resolution of the moving element and the interpolation of the physical signal via the electronics. Due to the large amount of information that is made available per motor revolution, a high resolution offers various advantages for a drive system:

- Smoother speed control and lower audible noise
- Operation at lower speed

A high resolution in excess of 4 000 edges or steps is relevant if the motor is used as a direct drive for positioning or if the motor is operated at very low speeds.



Distribution of encoder edges during rotation of the motor shaft

Accuracy
Independent of the resolution, the accuracy also plays an important role. The accuracy is determined by the physical resolution of the moving element and the precision with which not only the moving element and the encoder are manufactured, but the entire drive system as well. If an encoder has a high accuracy, it always transmits the signals at the same spacing for each and every motor revolution and thus has a high signal quality.

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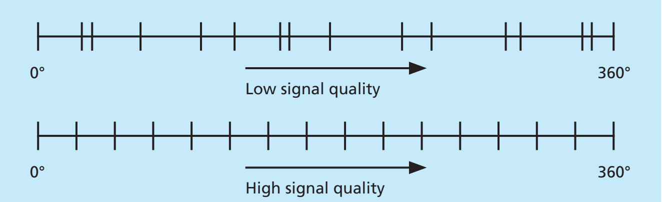


Distribution of encoder edges during rotation of the motor shaft

The most important parameter for the signal quality of the FAULHABER Encoders is the phase shift tolerance (Δ□). If the phase shift tolerance is low, the encoder transmits uniform signals. While FAULHABER magnetic encoders have a high signal quality with a phase shift tolerance of approximately 45 °e, FAULHABER optical encoders demonstrate an especially high signal quality with a phase shift tolerance of approximately 20 °e . Optical encoders are generally more accurate than magnetic encoders.

Detailed information for the calculation of the phase shift tolerance can be found in the chapter “Notes on technical data sheet” under the heading “phase shift”.

A high accuracy or a high signal quality has multiple advantages for a drive system:

- Exact determination of the position and, thus, accurate positioning
- Smoother speed control and lower audible noise

A high accuracy is relevant above all if the motor is used as a direct drive and exact positioning is necessary.

To position a drive system precisely, a highly accurate encoder is not enough. Tolerances in the entire drive system must be taken into account, such as the concentricity tolerance of the motor shaft. The accuracy and the phase shift tolerance of the FAULHABER Encoders is therefore determined in combination with the FAULHABER Motors. The specified position accuracy and repeatability is the system accuracy that a FAULHABER Motor-Encoder combination actually achieves in an application.

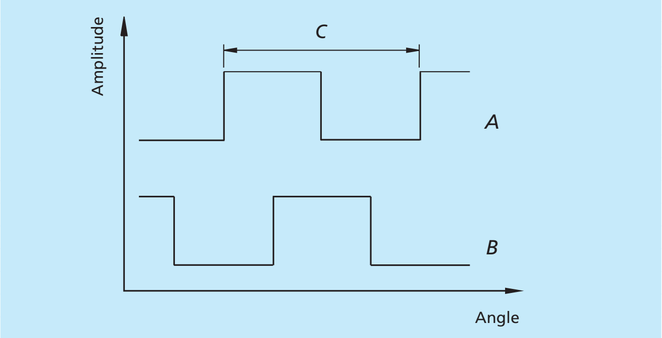
Output signal

Incremental encoder

Incremental encoders transmit a specific number of uniformly distributed pulses per revolution. All FAULHABER Incremental Encoders have at least two channels: *A* and *B*. Both channels supply a square wave signal, shifted by 90 °e with respect to one another, i.e., one quarter cycle *C*. Through the shift of the pulses, the direction of rotation of the motor can be determined.

The highest angular resolution of incremental encoders is not determined by the number of pulses per revolution but rather the total number of signal edges.

For encoders with at least two channels, the state of channel *A* or channel *B* changes every 90 °e due to the phase offset. The edges, i.e., the state change of the encoder channels, are evaluated for determining the position. Because four edges occur per pulse, the resolution of the FAULHABER Incremental Encoders is four times their pulse number. Thus, an encoder with 10 000 pulses per revolution, for example, has 40 000 edges per revolution, which corresponds to a very high angular resolution of 360°/40 000 = 0,009°.



An incremental encoder does not measure absolute positions, but rather relative positions. Incremental encoders determine a position relative to another reference position. For this purpose, the signal edges must be counted forward or backward by the motor control using a square counter according to their edge sequence. This position value is lost if the power supply is interrupted. A positioning system must therefore move to a defined reference position during commissioning or after a power interruption to initialise the position counter (homing). For the determination of the reference position, an external additional sensor, such as a reference switch or limit switch, is usually used.

To determine the reference position with an especially high level of accuracy, the FAULHABER 3 Channel Encoders have an additional channel – the index. Here, a single index pulse is generated once per revolution. External reference switches or limit switches can have a comparably high position error due to environmental influences and can sometimes trigger a little earlier, sometimes a little later. To nevertheless accurately determine the reference position, the drive system can move back after the limit switch until the first signal edge of the index pulse occurs. This point can then be used as an exact reference position.

The index pulse has a width of 90 °e and always occurs at defined states of channels *A* and *B*. For longer travel distances and multiple revolutions of the encoder, the index pulse can also be used to verify the counted number of edges.

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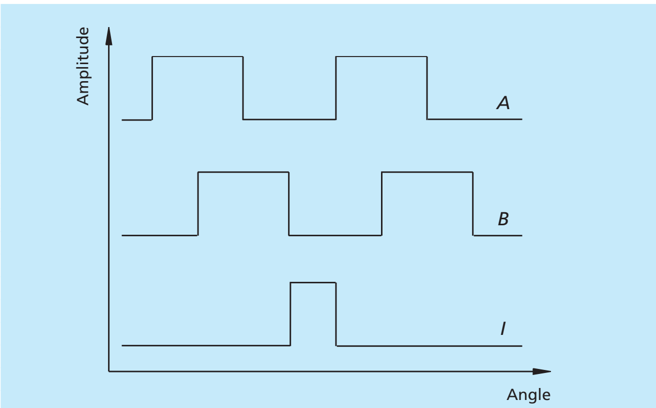


Absolute encoder

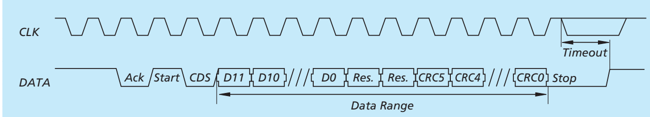
Unlike the incremental encoder, an absolute encoder determines absolute positions, not relative positions. After switching on the absolute encoder, an absolute return value is available for each position of the motor shaft. A distinction is made between single turn and multi turn encoders. The FAULHABER Absolute Encoders are single turn encoders.

With the single turn encoders, each position of the motor shaft corresponds to a specific return value. After a complete revolution of the motor shaft, the signals repeat. Thus, the single turn encoder supplies no absolute information about the number of completed revolutions. Positioning over more than one revolution is, however, still possible with the single turn encoder. Like with the incremental encoder, this is performed by counting the number of revolutions forward or backward using a counter on the motor control. For travel distances greater than one motor revolution, referencing is therefore necessary after a power interruption. No referencing is necessary for travel distances of less than one motor revolution.

Unlike single turn encoders, multi turn encoders also capture the number of travelled revolutions by means of an additional sensor and an electronic memory element or via a gearhead. Thus, multi turn encoders supply an absolute return value over multiple revolutions of the motor shaft within a defined maximum amount of revolutions that can be captured by the electronic memory element or the gearhead. Referencing is generally not necessary if the maximum amount of revolutions is not exceeded.

The analog Hall sensors, which are mounted directly in the FAULHABER Brushless DC-Motors as an option, supply absolute return values within one revolution of the motor shaft in combination with the motors with 2-pole technology and absolute return values within half of a revolution of the motor shaft in combination with motors with 4-pole technology. When using the analog Hall sensors, a reference motion is, therefore, not necessary if positioning within one or one half revolution of the motor shaft.

The resolution of an absolute encoder is defined via the number of steps per revolution and is specified in bits. Absolute encoders generate a serial code from multiple bits. The FAULHABER Absolute Encoders support the SSI Interface with BISS-C Protocol. BISS-C supports communication with clock speeds of up to 2 MHz. Here, the absolute position value (DATA) is transferred in synch with a cycle (CLK) specified by the controller.



Interface protocol (BISS-C) of an absolute encoder

Line Driver

Some of the FAULHABER Encoders are equipped with a Line Driver. The Line Driver generates an additional differential signal for all channels. With an incremental encoder with three channels, *A, B, I* and $\overline{A}$, $\overline{B}$ and $\overline{I}$ are thus available. With an absolute encoder, the inverted signals $\overline{CLK}$ and $\overline{DATA}$ are available in addition to *CLK* and *DATA*. Electromagnetic interference can thereby be eliminated during signal transmission. Especially if the encoder signals must be transmitted over long distances of 5 m and more and for position control, the use of a Line Driver is therefore recommended.

On the control side, these differential signals must be combined again with a receiver module. The actually achievable line length is dependent on the ambient conditions and the type of analysis. Ideally, the differential signals are twisted pairs as well as shielded against the motor phases to allow the coupled interference at the end of the line to be decoded as error-free as possible. For longer line lengths, one may wish to consider buffering the encoder voltage supply at the end of the line on the encoder side to ensure a stable voltage supply. Furthermore, a line terminator with characteristic impedance (100 ... 120 Ω) may be useful with longer line lengths.

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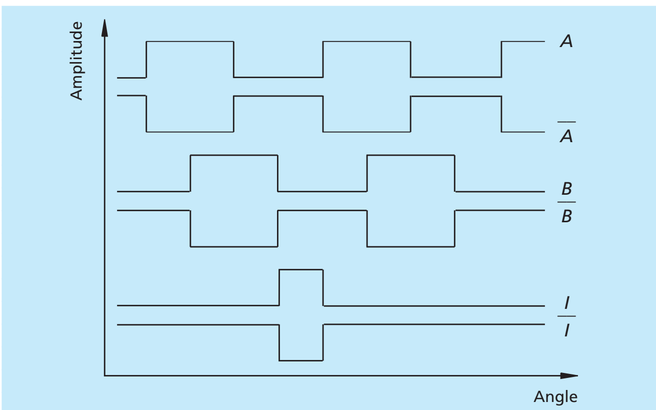
This must be tested in the given application. The Line Drivers from FAULHABER are TIA-422 compatible. TIA-422, also known as EIA-422 or RS-422, is an interface standard for cable-based differential, serial data transfer.



CMOS and TTL

The FAULHABER Encoders are normally compatible with the CMOS and TTL standard. This means that the "low" logic state is typically at 0V and the "high" logic state at 5V. It is important to note that the tolerances indicated in the controller specification must be observed.

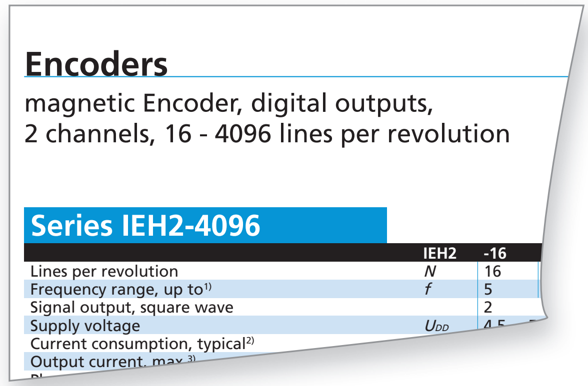
Integrated solutions

Many FAULHABER Encoders are highly integrated into the existing geometry of the motor. By integrating the solutions in the motor, they are especially lightweight, compact and economical.

For the Brushless DC-Motors, these include the integrated digital and analog Hall sensors and encoders IEM3-1024 and AESM-4096. The outer dimensions of the motors are not affected by these solutions.

For the DC-Micromotors of the FAULHABER SR series, the following integrated encoders are available, which lengthen the motors by just 1,4 – 1,7 mm: IE2-400, IE2-1024, IEH2-4096 and IEH3-4096.

In combination with the Flat DC-Micromotors, the FAULHABER SR-Flat series includes integrated encoders that lengthen the motors by just 2,3 mm: IE2-8 and IE2-16.



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magnetic Encoder, digital outputs,
2 channels, 16 - 4096 lines per revolution

Series IEH2-4096

		IEH2 -16
Lines per revolution	*N*	16
Frequency range, up to[1]	*f*	5
Signal output, square wave		2
Supply voltage	U_{DD}	
Current consumption, typical[2]		
Output current, max.[3]		

Notes on technical data sheet

Lines per revolution *(N)*

Specifies how many pulses are generated at the incremental encoder outputs per channel on each motor shaft revolution. Through the phase offset of encoder channels *A* and *B*, four edges are available per line. Thus, the resolution of the incremental encoder is four times the number of pulses. If, for example, an encoder has 1 024 lines per revolution, the resolution is 4 096 edges per revolution.

Steps per revolution

The value for "steps per revolution" specifies the number of position values per motor shaft revolution. The value is generally used with absolute encoders and corresponds to the resolution or number of edges for incremental encoders.

Resolution

Number of binary bits of the output signal. The steps per revolution of an absolute or incremental encoder correspond to the resolution of $2^{\text{number of bits}}$.

Frequency range, up to *(f)*

Indicates the maximum encoder frequency. This is the maximum frequency at which the encoder electronics can switch back and forth between the low and high signal level. The maximum achievable operating speed *(n)* for the encoder can be derived from this value and the pulse number *(N)*. If this frequency range and the resulting speed are exceeded, the result may be the transmission of incorrect data or the premature failure of the encoder. For very high-speed applications, it may be necessary to select a correspondingly low pulse number.

$$n = \frac{60 \cdot f}{N}$$

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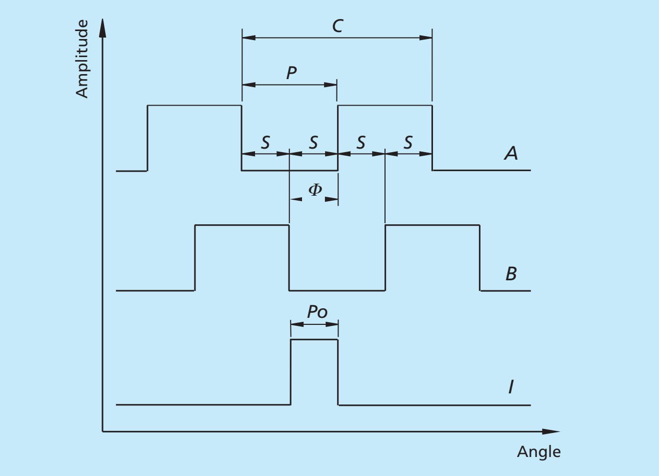
Signal output
With incremental encoders, square wave signals are output. 2 channel encoders have two channels: *A* and *B*. 3 channel encoders have an additional index channel.



With absolute encoders, a digital word is output. FAULHABER Encoders use a SSI Interface with BISS-C Protocol. SSI is an interface for absolute encoders with which absolute position information is made available via serial data transfer.

Supply voltage *(U_{DD})*
Defines the range of supply voltage necessary for the encoder to function properly. To avoid damaging the encoder, this range must always be adhered to.

Current consumption *(I_{DD})*
Indicates the current consumption of the encoder at the given operating voltage. Normally, typical and partial maximum values are specified.

Output current, max. *(I_{OUT})*
Indicates the maximum allowable output current at the signal outputs. If necessary, this value should be aligned with the controller that is used.

Pulse width *(P)*
Width of the output pulse (in °e) of encoder channels *A* and *B*. It is ideally 180 °e.

Index pulse width *(P_0)*
The index pulse width specifies the width of the index pulse (in °e) and is ideally 90 °e.

The index pulse width error (ΔP_0) is the deviation from the ideal value of 90 °e.

Permissible deviation ΔP_0:

$$\Delta P_0 = \left| 90° - \frac{P_0}{P} * 180° \right|$$

Phase shift, channel *A* to *B* *(Φ)*
The phase shift (in °e) in between output signals *A* and *B* is referred to as phase shift and is ideally 90 °e.

The phase shift tolerance ($\Delta\Phi$) is the deviation of two successive edges at outputs *A* and *B* from the ideal value of 90 °e.

Permissible deviation $\Delta\Phi$:

$$\Delta\Phi = \left| 90° - \frac{\Phi}{P} * 180° \right|$$

Logic state width *(S)*
Distance of two adjacent edges (in °e) between the two channels *A* and *B*. There are four logic state widths *(S)* per cycle. Ideally, a logic state width is 90 °e.

Cycle *(C)*
The duration of a total period (in °e) on channel *A* or *B*. Normally, a cycle is 360 °e.

Signal rise/fall time, max. *(tr/tf)*
Maximum time for changing from the lower to the higher signal level or vice versa. This describes the edge steepness of the encoder signals. C_{LOAD} specifies the maximum permissible load of the signal line at which the edge steepness is still reached.

Clock frequency, max. *(CLK)*
Maximal permissible clock frequency for reading the BISS-C Protocol.

Input - low / high level *(CLK)*
The level of the CLK input signal must lie in the specified value range in order to ensure reliable signal detection.

Setup time after power on, max.
Maximum time to availability of the output signals, as of when supply voltage is applied.

Timeout
Refers to the time after which communication is terminated by the encoder, when the master is no longer transmitting a clock rate.

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Inertia of sensor magnet / code disc *(J)*
Indicates the amount by which the rotor inertia of the motor is increased by the sensor magnet or the code disc.

Operating temperature range
Indicates the minimum and maximum permissible operating temperature for encoder operation.

Accuracy
Indicates the average position error of the encoder in mechanical degrees (°*m*). This describes the extent to which the current position of the encoder can deviate from the target position.

Repeatability
Indicates the average repeatability error of the encoder in mechanical degrees (°*m*). This describes the average deviation of multiple position values for the encoder when positioning at the same position multiple times. Repeatability shows how precisely a certain position can be reached when repeatedly moving to the same position.

Hysteresis
Indicates the dead angle during a change in direction in which no information related to the position is output.

Edge spacing, min.
The minimum spacing between two successive edges of channels *A* and *B*. For a reliable evaluation of the square wave signal, a controller that is able to detect this minimum edge spacing is required. If no information on the minimum edge spacing is available, this can also be determined as an approximate value.

$$T_{min} = \frac{1}{f \cdot 4} \cdot \left(1 - \frac{\Delta\Phi}{90°}\right)$$

Mass
The typical mass of the encoder, including housing and adapter flange with standard cable without connector.

Battery voltage
Specifies the voltage range in which the counter state of a multiturn encoder is reliably detected and incremented by means of an external backup battery. If the battery voltage is too low, an error bit is set.

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How to select an appropriate sensor

This chapter describes how a suitable sensor is selected for FAULHABER Motors. Which sensors can be used depends primarily on the selected motor technology. A distinction is to be made between:

- DC-Motors
- Brushless DC-Motors
- Stepper Motors
- Linear DC-Servomotors

Depending on the motor technology, the sensor is necessary not only for speed or position control, but also for the commutation of the motors.

	Commutation	Speed control	Position control
DC-Motors			
Sensors		■ encoders	■ encoders
Without sensors	■ mechanical	■ back-EMF	
Brushless DC-Motors			
Sensors	Block commutation: ■ integrated digital Hall sensors Sinus commutation: ■ integrated analog Hall sensors ■ encoders	■ integrated digital Hall sensors ■ integrated analog Hall sensors ■ encoders	■ integrated analog Hall sensor ■ encoders
Without sensors	Block commutation: ■ back-EMF	■ back-EMF	
Stepper Motors			
Sensors		■ encoders	■ encoders
Without sensors	■ stepper mode	■ stepper mode	■ stepper mode
Linear DC-Servomotors			
Sensors	■ integrated analog Hall sensors		■ integrated analog Hall sensors

DC-Motors

Commutation

The commutation of DC-Motors with precious metal or graphite brushes is mechanical and therefore requires neither a sensor nor a motor control.

Speed and position control

For some applications, the DC-Motors are operated without a sensor and without a controller. In these cases, a specific voltage is applied to the motors at which a specific speed is produced when operated at a constant load.

A controller is necessary in order to regulate the speed. Simple speed control is possible by measuring the back electromotive force (EMF). For precise speed control, an encoder is necessary. For position control, an encoder is absolutely required.

For DC-Motors, a large selection of incremental encoders is available.

Brushless DC-Motors

Commutation

The Brushless DC-Motors are electronically commutated. For their operation, a controller is therefore always necessary.

Most of the FAULHABER Brushless DC-Motors are equipped with three digital, integrated Hall sensors that determine the position of the motor shaft and supply a commutation signal.

The exception here are motors for simple speed applications, which can be commutated with the help of the back electromotive force (EMF). Here, the controller evaluates the zero crossing of the back-EMF and then commutates the motor after a speed-dependent delay. The zero crossing of the back-EMF cannot be evaluated while the motor is at a standstill and, thus, the position of the rotor cannot be detected. When starting, it is therefore possible that the motor first moves in the wrong direction.

If digital Hall sensors are selected or in sensorless operation with back-EMF, the Brushless DC-Motors are block commutated. With block commutation, the voltage characteristics of the three 120° offset windings are block shaped. The windings are abruptly switched every 60°. The FAULHABER Speed Controllers use this commutation form.

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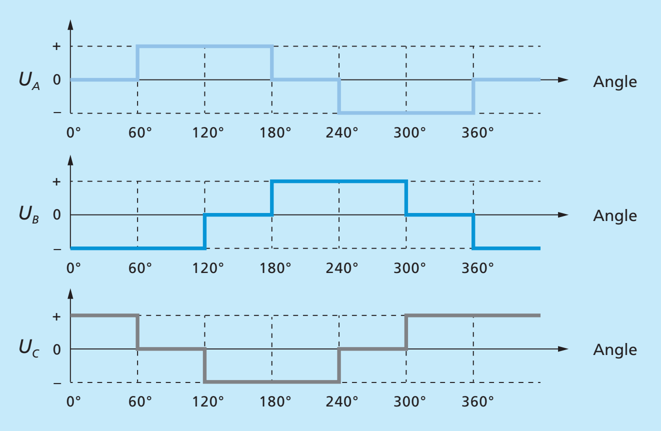
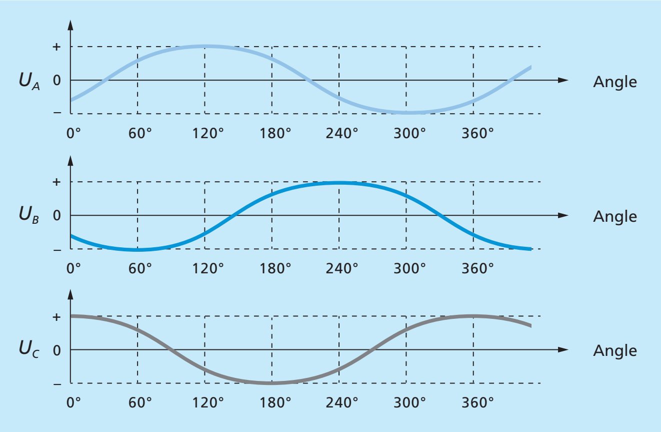


A better running smoothness with a lower torque ripple is achieved through sinus commutation.
With sinus commutation, the phase voltages have a sinusoidal characteristic. The FAULHABER Motion Controllers use this commutation form as standard. For sinus commutation, analog Hall sensors or encoders are required.



Speed and position control
For speed control, digital Hall sensors are generally used. The back electromotive force is only suitable for simple speed control at higher speeds. Analog Hall sensors or an encoder are necessary if the drive system is operated at low speeds or a very high running smoothness is required.

For position control, encoders or integrated Hall sensors are needed. Almost all FAULHABER Brushless DC-Motors are offered with integrated analog Hall sensors as an option. For most applications, operation with the analog Hall sensors is recommended. Encoders are needed if the application requires a higher resolution or accuracy or if the motor is operated at very low speeds.

For the Brushless DC-Motors, a large selection of incremental and absolute encoders is available.

Stepper Motors

The control of stepper motors in full step, half step and micro step operation enables exact speed and position control in an open control loop. As a result, sensors are not generally needed in the application – a decisive cost advantage of stepper motors. A closed control loop is, however, often required during development for verifying the function or for minimizing power consumption and motor heating. The FAULHABER product range includes magnetic (IE3) and optical encoders (PE22) compatible with the stepper motor series. Other combinations of stepper motors with encoders are possible on request.

Linear DC-Servomotors

The linear DC-Servomotors are equipped with analog Hall sensors. By integrating sensors in the motor, this solution is very compact, lightweight and economical. As a result, an additional encoder is not necessary.

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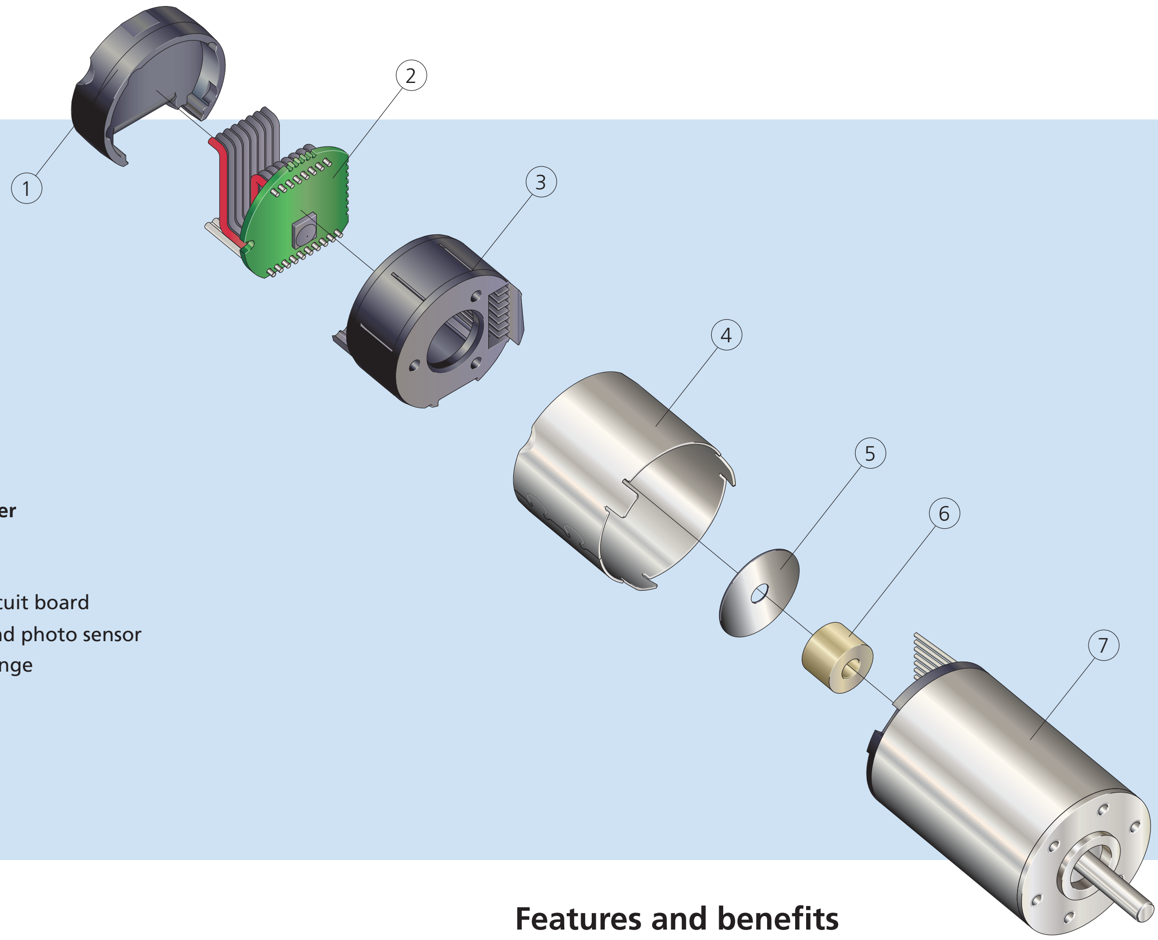
Optical Encoders



Optical Encoder

① Cover
② Encoder circuit board
with LED and photo sensor
③ Adapter flange
④ Housing
⑤ Code disc
⑥ Hub
⑦ Motor

Function

Encoders of the IER3-10000 (L) series consist of a high-resolution code disc that is attached to the motor shaft, a light source and a photo sensor with interpolator and driver stages. The light from the light source is reflected or absorbed by the code disc. The reflected light is collected by the photo sensor and the signal processed into a high-resolution encoder signal. With this, two square wave signals that are phase-shifted by 90 °e, as well as an index signal to display output shaft rotation, are available at the outputs. A Line Driver is also available as an option.

The high-precision optical encoders are ideally suited for position control.

Features and benefits

- Very high resolution of up to 40 000 edges per revolution (corresponds to a 0,009° angle resolution)
- Very high position accuracy, repeatability and high signal quality
- Various resolutions available as standard feature
- Insensitive to magnetic interference

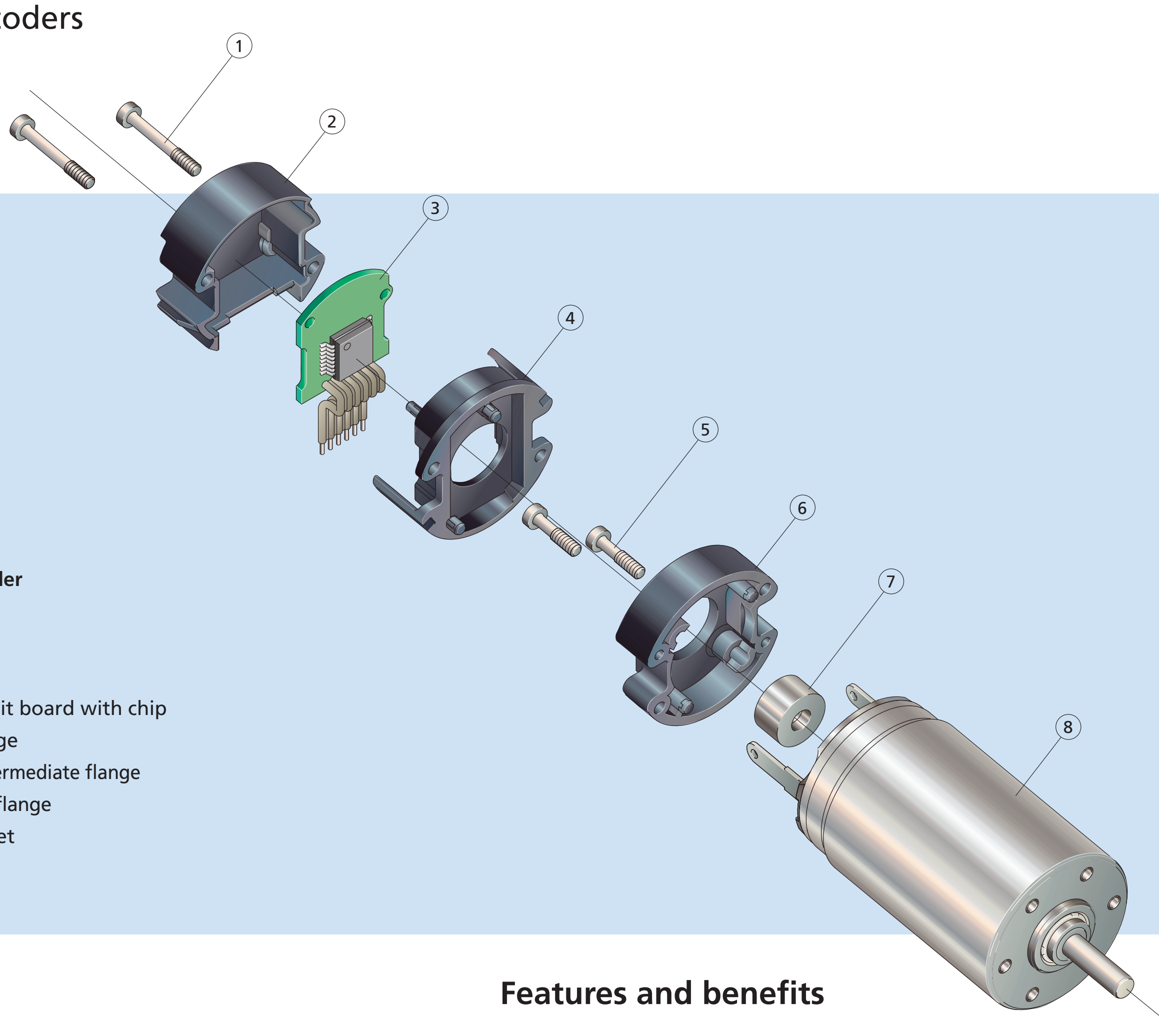
Product code

IER 3 – 6800 L

IER	encoder series
3	3 channel
6800	lines per revolution
L	with integrated Line Driver

Encoders

Magnetic Encoders



Magnetic Encoder

① Screws
② Cover
③ Encoder circuit board with chip
④ Adapter flange
⑤ Screws for intermediate flange
⑥ Intermediate flange
⑦ Sensor magnet
⑧ Motor

Function

Encoders of the IE3-1024 (L) series consist of a diametrically magnetized, two-pole sensor magnet which is fastened to the motor shaft. A special angle sensor for detecting the motor shaft position is positioned in an axial direction in relation to the sensor magnet. The angle sensor comprises all necessary functions, such as Hall sensors, an interpolator and driver stages. Analog signals of the sensor magnets are detected by the Hall sensors and, after suitable amplification, passed along to the interpolator. By means of a special processing algorithm, the interpolator generates the high-resolution encoder signal.

With this, two square wave signals that are phase-shifted by 90 °e, as well as an index signal to display output shaft rotation are available at the outputs.

Features and benefits

- Compact modular system and robust housing
- Various resolutions available as standard feature
- Index channel for referencing a rotation of the drive shaft
- Also available as Line Driver version
- Standardized electronic encoder interface
- Flexible customer-specific modifications including custom resolution, direction of rotation, index pulse width and index position are possible

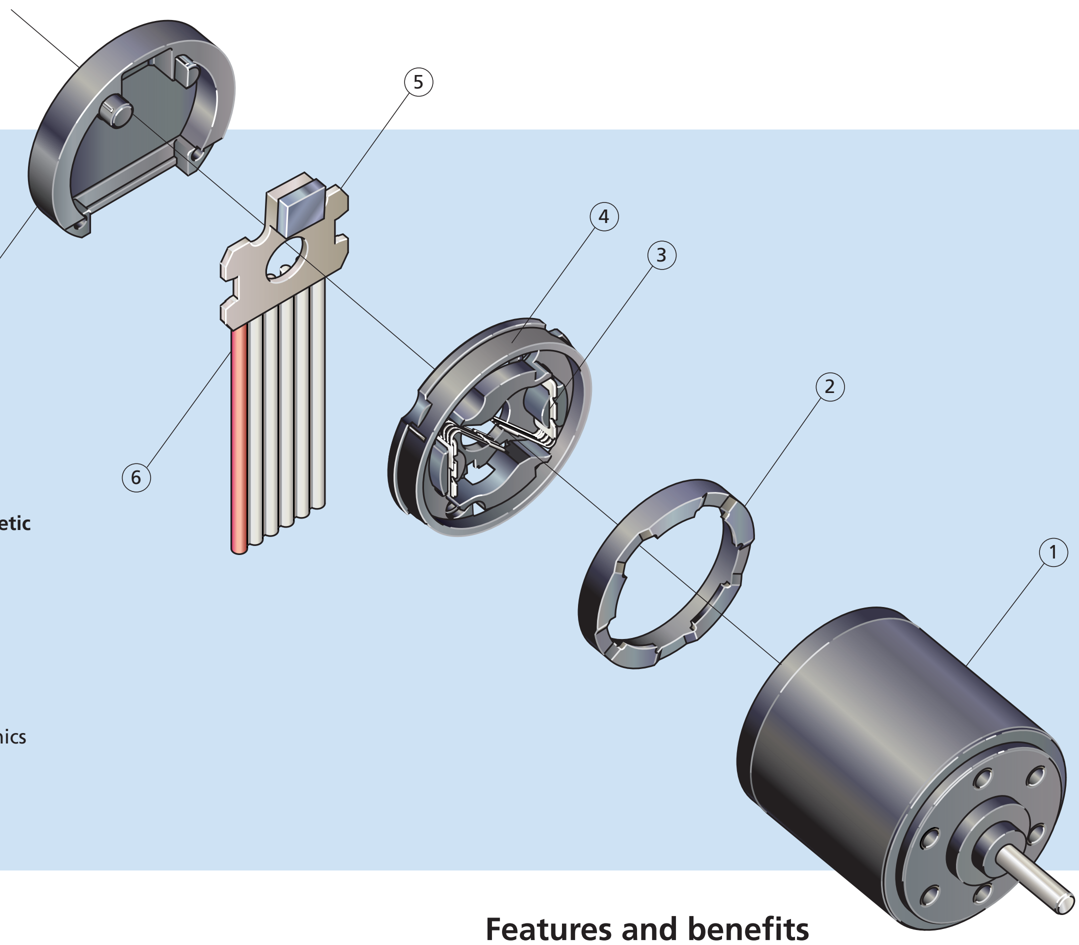
Product code

IE3 – 1024 L

IE	encoder series
3	3 channel
1024	lines per revolution
L	with integrated Line Driver

Encoders

Integrated Magnetic Encoders



Integrated Magnetic Encoder

① Motor
② Magnet wheel
③ Brushes
④ Brush cover
⑤ Sensor electronics
⑥ Flat cable
⑦ Cover

Function

The encoders of the IEH2-4096 and IEH3-4096 series consist of a multi-part magnetic ring, which is attached to the rotor, and an angle sensor. The angle sensor comprises all necessary functions, such as Hall sensors, an interpolator and driver stages. Analog signals of the sensor magnets are detected by the Hall sensors and, after suitable amplification, passed along to the interpolator.
By means of a special processing algorithm, the interpolator generates the high-resolution encoder signal. With this, two square wave signals that are phase-shifted by 90 °e, with up to 4 096 lines per revolution, as well as one additional index signal are available at the outputs.
The encoder is integrated in the motors of the SR series and lengthens these by just 1,4 mm.

Features and benefits

- Extremely compact
- High resolution of up to 16 384 edges per revolution (corresponds to a 0,022° angle resolution)
- No pull-up resistors are necessary at the outputs because there are no open collector outputs
- Symmetric switching edges, CMOS and TTL-compatible
- Different resolutions, according to encoder type, from 16 to 4 096 lines, are available for standard delivery
- High signal quality

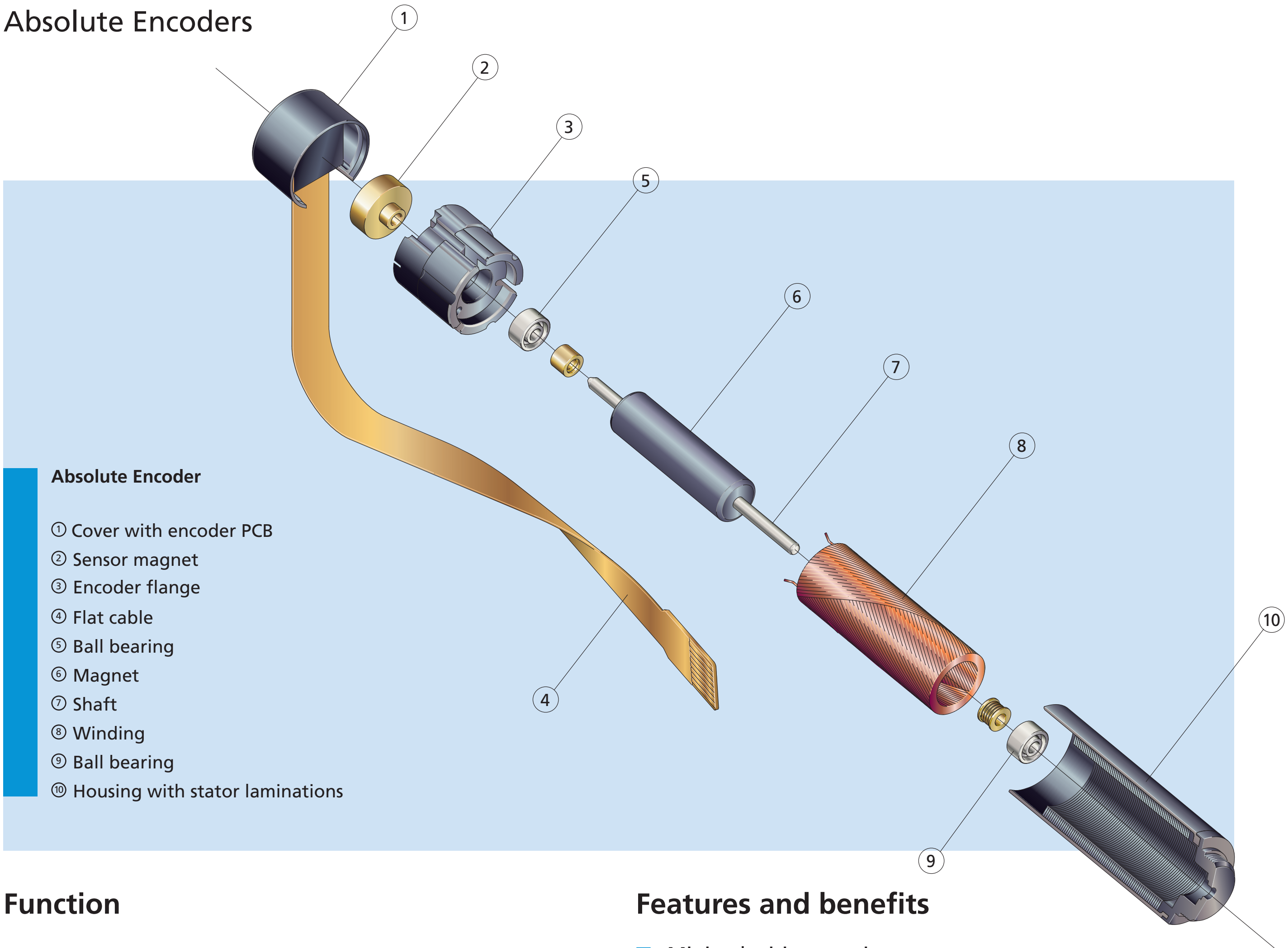
Product code

IEH2 – 4096

IEH	encoder series
2	2 channel
4096	lines per revolution

Encoders

Absolute Encoders



Function

Encoders of the AESM-4096 series consist of a diametrically magnetized, two-pole sensor magnet which is fastened to the motor shaft. A special angle sensor for detecting the motor shaft position is positioned in an axial direction in relation to the sensor magnet. The angle sensor comprises all necessary functions, such as Hall sensors, an interpolator and driver stages. The analog signal of the sensor magnet detected by the Hall sensors is processed, after appropriate amplification, by a special algorithm to produce a high-resolution encoder signal. At the output there is absolute angle information available with a resolution of 4 096 steps per revolution. This data can be queried by a SSI Interface with BISS-C Protocol. The absolute encoder is ideal for commutation, speed control and position control.

Features and benefits

- Minimal wiring requirement
- Absolute angle information directly after power-on
- No referencing necessary
- Enhanced control characteristics even at low rotational speeds
- Flexible customisation of resolution and direction of rotation is possible

Product code

AESM – 4096

AESM	encoder series
4096	steps per revolution

Notes

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