VarioCODER
Inductive rotor position encoder

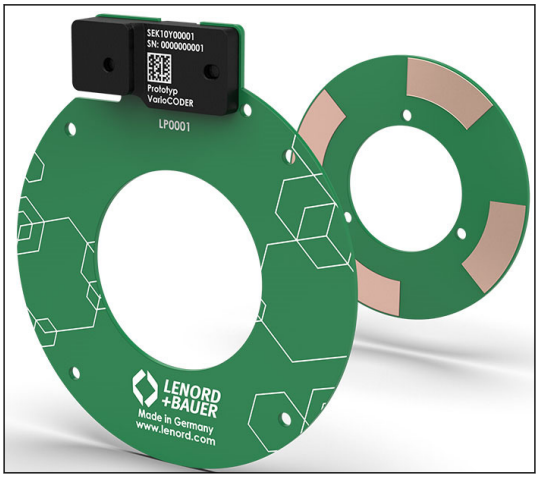
GEL SEK10

Technical information

Version 2024-05-02

General

- Mechanically individually configurable encoder kit for convenient integration in electric drives
- Ideal for detection of pole position, angle and rotational speed
- Contactless measurement by inductive scanning
- sin/cos output signals, single-ended or differential



Properties

- Rotational speed: ≤ 100,000 r.p.m.
- Accuracy: < 0.5° electrical
- Latency: < 5 µs
- Rotor material: Conductive material ≥ 35 µm (PCB, aluminum, steel)
- Operating temperature: -40 °C to +125 °C, short-term +150 °C
- Integrated signal processing
- Line driver for cable lengths up to 30 m
- Prepared for ASIL C and ASIL D (internal self-diagnosis)
- **Configurable parameters:**

Number of pole pairs	1 to 64
Outside diameter stator	52 mm to 200 mm
Shaft diameter rotor	2 mm to 138 mm
Fastening stator	2 to 32 bores or slotted holes
Fastening rotor	2 to 32 screws/gluing/clamping possible
Connector outlet	Tangential/axial
Output signal (sin/cos)	Single-ended/differential

Advantages

- Can be integrated into all motor designs in minimum space with high mounting tolerances
- Immediate signal output after switching on without any reference search routine
- High accuracy without calibration
- High reliability with regard to mechanical loads
- Initial sample or prototypes available short-term
- Price/performance better than a mass-produced rotary encoder
- Magnet-free and not sensitive to magnetic fields
- High sensor accuracy leads to high drive energy efficiency
- Small dimensions, low moment of inertia
- Large axial and radial mounting tolerances
- Maintenance and wear-free thanks to the bearing-free design
- Assembly and material cost savings are possible due to direct scanning of structures on a rotor shaft

Field of application

- E-mobility on-road, off-road, marine, industrial
- Motor commutation, position and rotational speed acquisition
- Applications with large shaft diameters and hollow shafts

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Technical data

Electrical data	
Supply voltage U_B (short-circuit-proof)	5 V DC
Current consumption I_B (without load)	< 30 mA
Output signals (short-circuit-proof)	sin/cos Single ended: Two sinusoidal signals phase-shifted by 90° Differential: Two sinusoidal signals phase-shifted by 90° and their inverse signals
Output signal level (1) (Single ended)	2 V_{pp}
Accuracy per period	< 0.5° electrical
Latency	< 5 µs
Number of periods per mechanical revolution	1 to 64
Frequency range	0 kHz to 10 kHz
Recommended output current	< 5 mA
Mechanical data encoder kit	
Weight	< 100 g(2)
Air gap (nominal)	2.0 mm
Mechanical data stator	
Material	Plastic; electronics in plastic housing
Outside diameter D_{OS}	52 mm to 200 mm
Housing material	Plastics
Mounting types	Screw mounting, bonding, clamping
Axial overall height	minimum 10.6 mm
Mechanical data rotor	
Material	Conductive material ≥ 35 µm (PCB, aluminum, steel)
Rotational speed(3)	≤ 100,000 r.p.m.
Shaft diameter D_{IR}	2 mm to 138 mm
Environmental testing	
Operating temperature range	-40 °C to +125 °C in accordance with ISO 16750-4:2010, for short periods up to +150 °C(4)
Storage temperature range	-40 °C to +125 °C
Degree of protection	IP 30 (higher upon request)
Dielectric strength	ISO 16750-1 to ISO 16750-5
Electromagnetic compatibility(5)	DIN EN 61000-4-4; DIN EN 61000-4-2 ISO 10605 ECE-R10
Vibration resistance	DIN EN 60068-2- 64; DIN EN 60068- 2-6 ISO 16750-3
Shock resistance	DIN EN 60068-2-27 ISO 16750-3
Chemical loads	ISO 16750-5
MTTF value	≥ 3,000,000 h at 55 °C

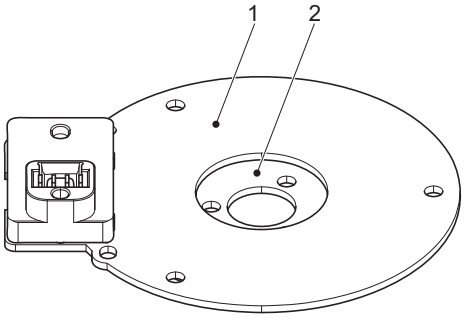
The technical data depends on the configured variant. Other parameters are available upon request.

The encoder kit is explained using the generally applicable properties as an example. Due to a range of different configurations, individual technical specifications may differ. These are listed in full in the technical drawing for the configured encoder kit.

(1) depending on output current and temperature
(2) depending on configuration (especially of diameter and of rotor material)
(3) depending on the number of pole pairs, mounting type, diameter and material
(4) depending on availability of safety function, operating temperature range and service life (MTTF value)
(5) Observe EMC notes in the mounting/operating instructions

Encoder kit construction

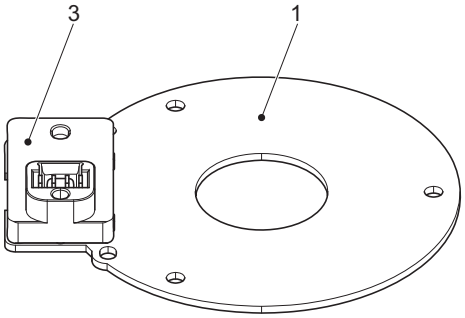
The inductive rotor position encoder consists of a stator and a rotor. This compact system is particularly well suited for integration in electric drives with high electromagnetic compatibility requirements. The encoder kit can be integrated in almost any environment due to the configuration of diameter, number of periods and the slim design.
The contactless and wear-free system requires no bearings or couplings. The complete scanning over mechanical 360° leads to a high mounting tolerance without affecting function and accuracy significantly.
Internal signal evaluation and processing provide signals which can be directly processed in standard inputs without any additional effort. The sin/cos signals are almost offset free and amplitude stable even with high mounting tolerances.
Stable signals are output even at high speeds and extreme temperatures and allow precise and reliable determination of pole position and speed over the entire operating area.



1 Stator
2 Rotor

Stator

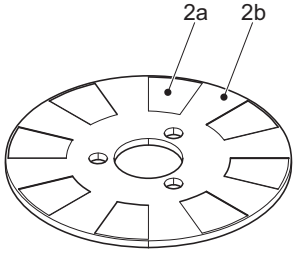
The stator consists of a printed circuit board with attached cover to protect the electronic components.
The large bore allows shafts with large diameters to pass. The stator is attached to the drive housing, for example, by a number of screws adapted to the size of the printed circuit board. The stator electrical connection is via a plug connector (axial or tangential connector outlet).
A safety distance to the electronics and the rotary encoder system must only be maintained in a defined circuit and in a defined area of the connection technology.



1 Stator
3 Housing

Rotor

The rotor can be a thin plate with alternating conductive and non-conductive surface segments. The number of segment pairs must match the number of pole pairs on the stator. In the simplest case, a printed circuit board can be used where copper surfaces allow the rotor position to be detected. The rotor can also be made entirely of conductive material such as aluminum or steel. In principle, surface structures of existing rotor components can also be scanned. This prevents mechanical interfaces and keeps tolerance chains short. Costs are reduced and overall system reliability is also increased.



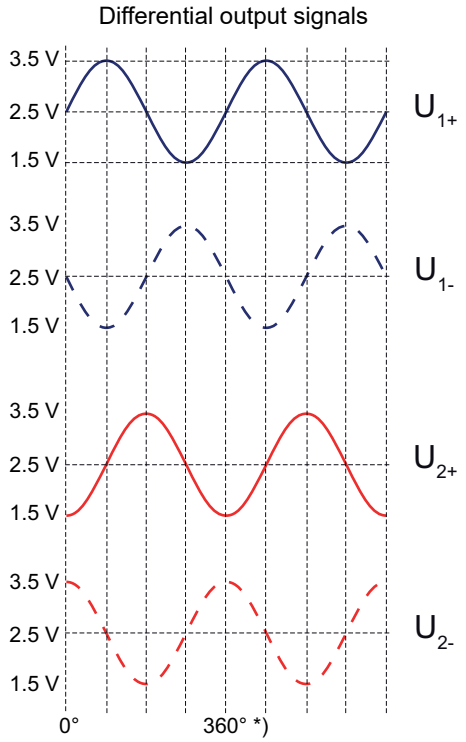
Example rotor with 8 pole pairs

2a Conductive surface segments
(for example, copper surface of a printed circuit board)
2b Non-conductive surface segments
(for example, printed circuit board material)

Output signals

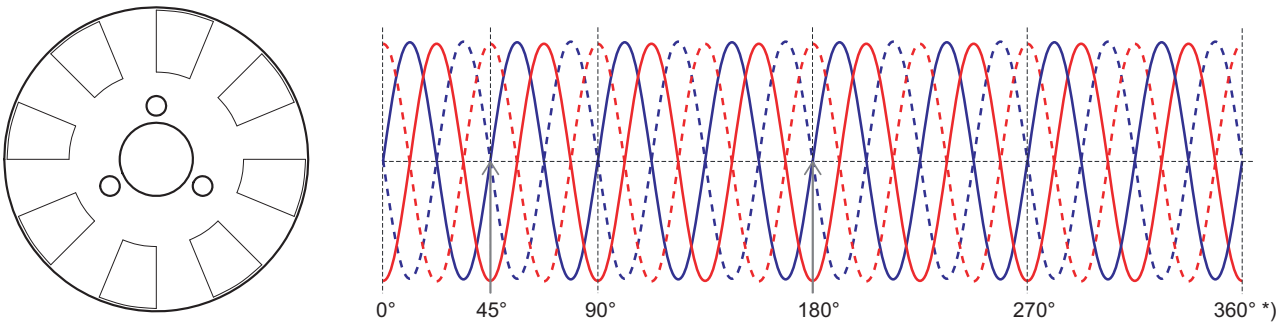
The number of pole pairs on the encoder kit matches the number of sine/cosine periods.

Output signals for application with one pole pair



If single ended output signals (i.e. not differential but only U_{1+} and U_{2+}) are used, it must be ensured that the connections for the signals U_{1-} and U_{2-} are not connected.

Application example: Rotor with eight pole pairs

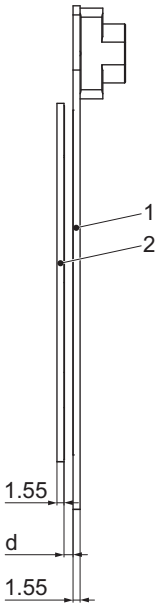


*) 360° ≙ 1 mechanical revolution

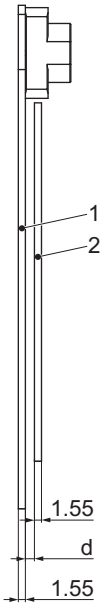
Installation

The rotor can move in front of or behind the stator depending on mounting requirements.

Rotor behind the stator (standard)



Rotor in front of the stator



1 Stator
2 Rotor
d Air gap

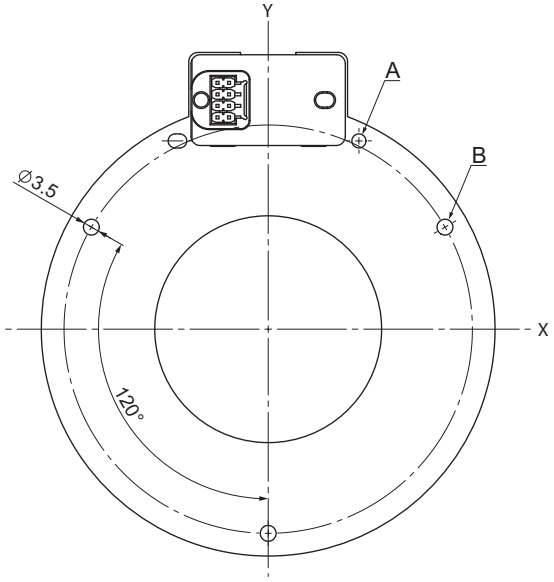
The encoder kit is delivered with a nominal air gap of 2 mm. Deviating from this dimension changes the amplitudes of the output signals. Air gap changes of 0.5 mm influence the interpolation capability only slightly.

Stator assembly

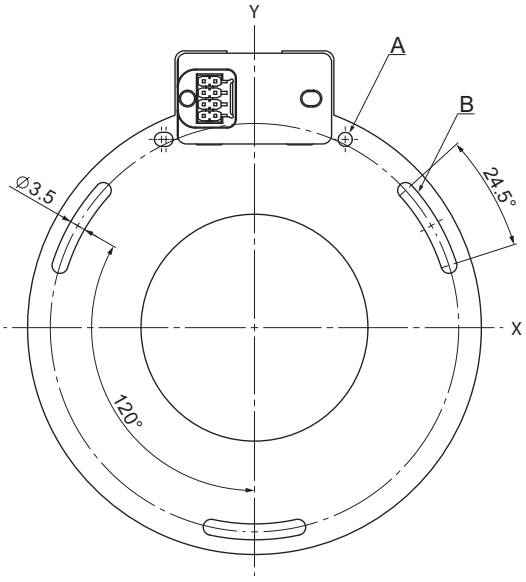
The stator is mounted using the freely selectable number of screw mountings. The fastening bores are designed for M3 screws, for example. A distinction is made between whether the zero position of the stator is coordinated electrically at the controller/inverter (variant 1) or mechanically at the sensor (variant 2) with the rotor pole position of the drive system.

Assembly example with 3 fastening bores (spacing 120° each)

Variant 1



Variant 2



A Internal center holes (2×)
B Fastening bores

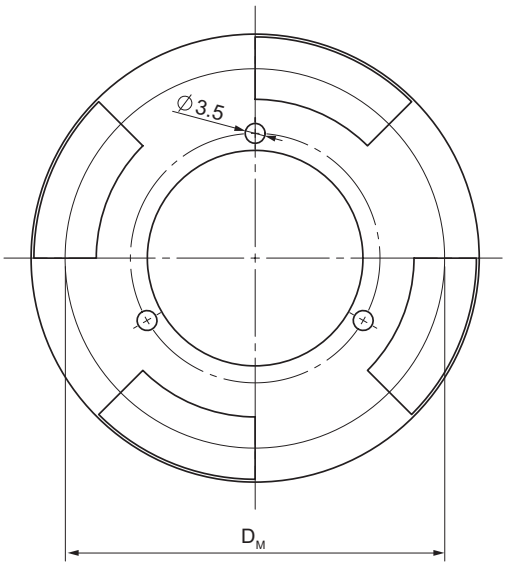
Deviations of 0.5 mm in the X or Y direction do not (coaxiality) have a major effect on system accuracy.

Assembly and installation

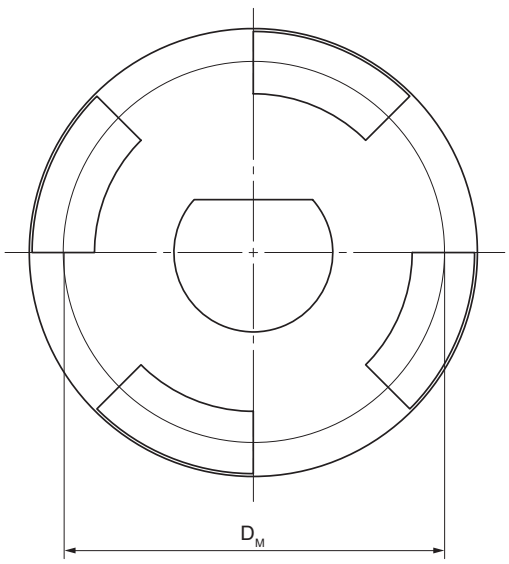
Rotor assembly

In variant 1 the rotor is mounted via the configurable number of screw mountings. The fastening bores are designed for M3 screws. Variant 2 shows the option of clamping and bonding the rotor. It is possible to integrate the rotor directly into the application.

Example variant 1



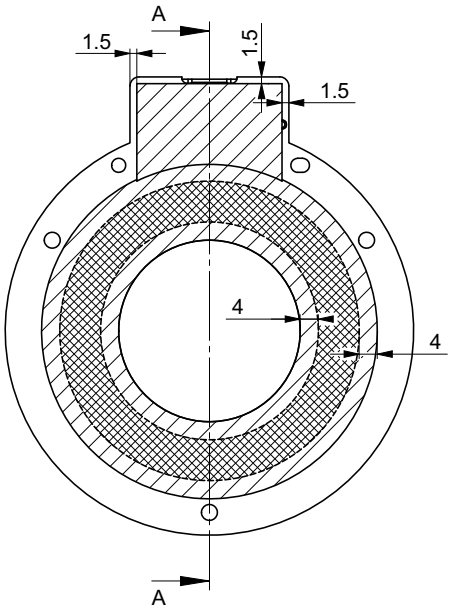
Example variant 2

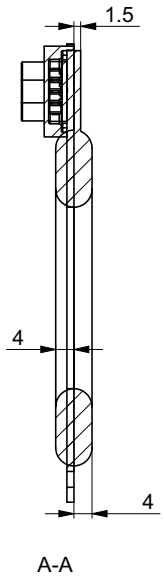


D_M Center diameter rotor

Safety distances stator

No conductive contours are allowed at a distance of 4 mm around the stator coil system.
The distance at the stator housing and electrically conductive materials must be > 1.5 mm.





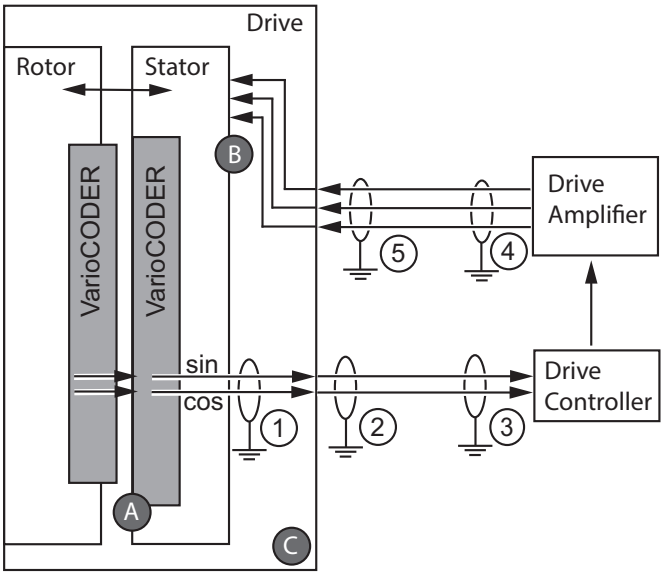
A-A

Assembly notes

- Recommended cable fixation: 80 mm from the connector
- Tightening torque for M3 screws: 1.3 Nm

Screening concept

The encoder kit itself does not cause any electromagnetic interference and is sufficiently insensitive to interference at its mounting position. Depending on the application, the connection cable of the encoder kit may have to be integrated into the screening concept of the drive system.
The electromagnetic environment of the drive system is not affected by the encoder kit.



Schematic sample illustration

Special installation conditions

- A: Spatial environment of the VarioCoder
- B: Drive supply line
- C: Drive housing

Interfaces considered separately

- 1: Electrical connection to VarioCoder
- 2: Connection between motor and encoder kit
- 3: Input at motor control system
- 4: Output power cable at drive amplifier
- 5. Input power cable at motor

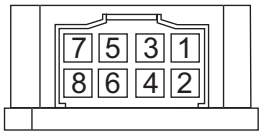
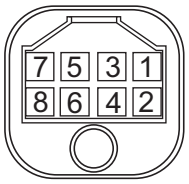
Despite the high electromagnetic immunity, depending on the application, integration into a screening concept may be required for the encoder kit.
Depending on the installation conditions (A, B and C) of the encoder kit, different conditions must be observed for the shielding concept.
In particular, the shielding connections at positions 1, 2, 3, 4 and 5 must be considered as a whole, depending on the options and conditions in the application, in order to avoid unfavorable constellations.

During configuration of the encoder kit and also following it, Lenord+Bauer offers support based on extensive knowledge and experience in integrating the encoder kit into the screening concept of the application.

Assignment

Connector at stator

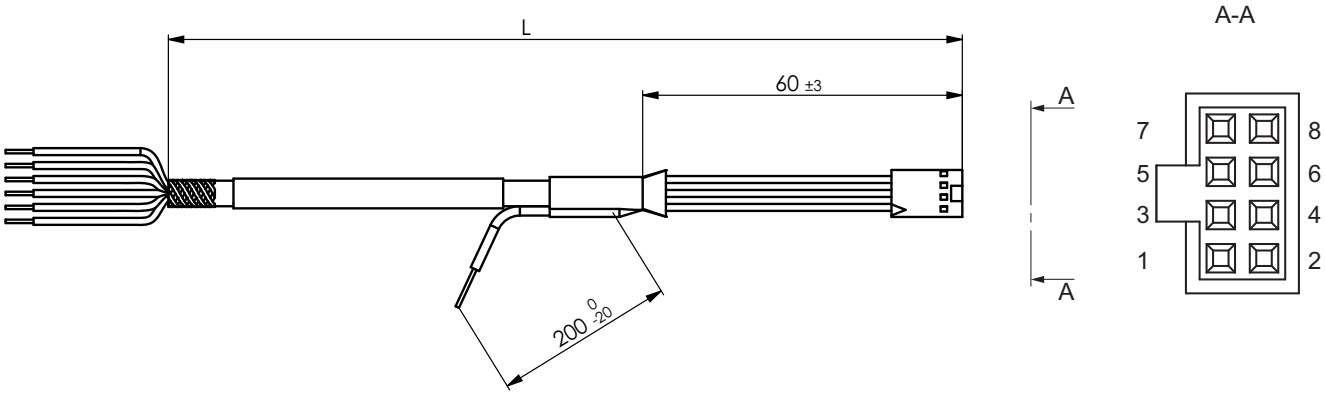
Assignment

8-pole, male contact (plug-in view)		Pin assignment	Signal identifier
Tangential connector outlet		1	unallocated
		2	unallocated
		3	U_{1+}
		4	U_{1-}
Axial connector outlet		5	U_{2+}
		6	U_{2-}
		7	GND
		8	U_B

If single ended output signals (i.e. not differential but only U_{1+} and U_{2+}) are used, it must be ensured that the connections for the signals U_{1-} and U_{2-} are not connected.

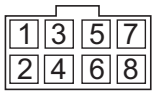
Connection cable

Item	Length L	Cross section	Signal	Number of cores
ZKSEK10Y00000	3000 mm	0.25 mm^2	Differential	6-core
ZKSEK10Y00002	3000 mm	0.25 mm^2	Single ended	4-core
ZKSEK10Y00003	3000 mm	0.50 mm^2	Differential	6-core
ZKSEK10Y00004	3000 mm	0.50 mm^2	Single ended	4-core



The encoder kit itself does not cause any electromagnetic interference and is sufficiently insensitive to interference at its mounting position.
Depending on the application, the connection cable of the encoder kit may have to be integrated into the screening concept of the drive system.
Lenord und Bauer therefore offers a connection cable with shield connection strand for testing the application.
In most cases, this is not required.

Assignment

8-pole, female (plug-in view) Type: AMPMODU MODU IV/V, order number: 104483-1, manufacturer: TE Connectivity	Pin assignment	Signal identifier	Core color
	1	unallocated	-
	2	unallocated	-
	3	U_{1+}	white
	4	U_{1-}	brown
	5	U_{2+}	yellow
	6	U_{2-}	black
	7	GND	blue
	8	U_B	red

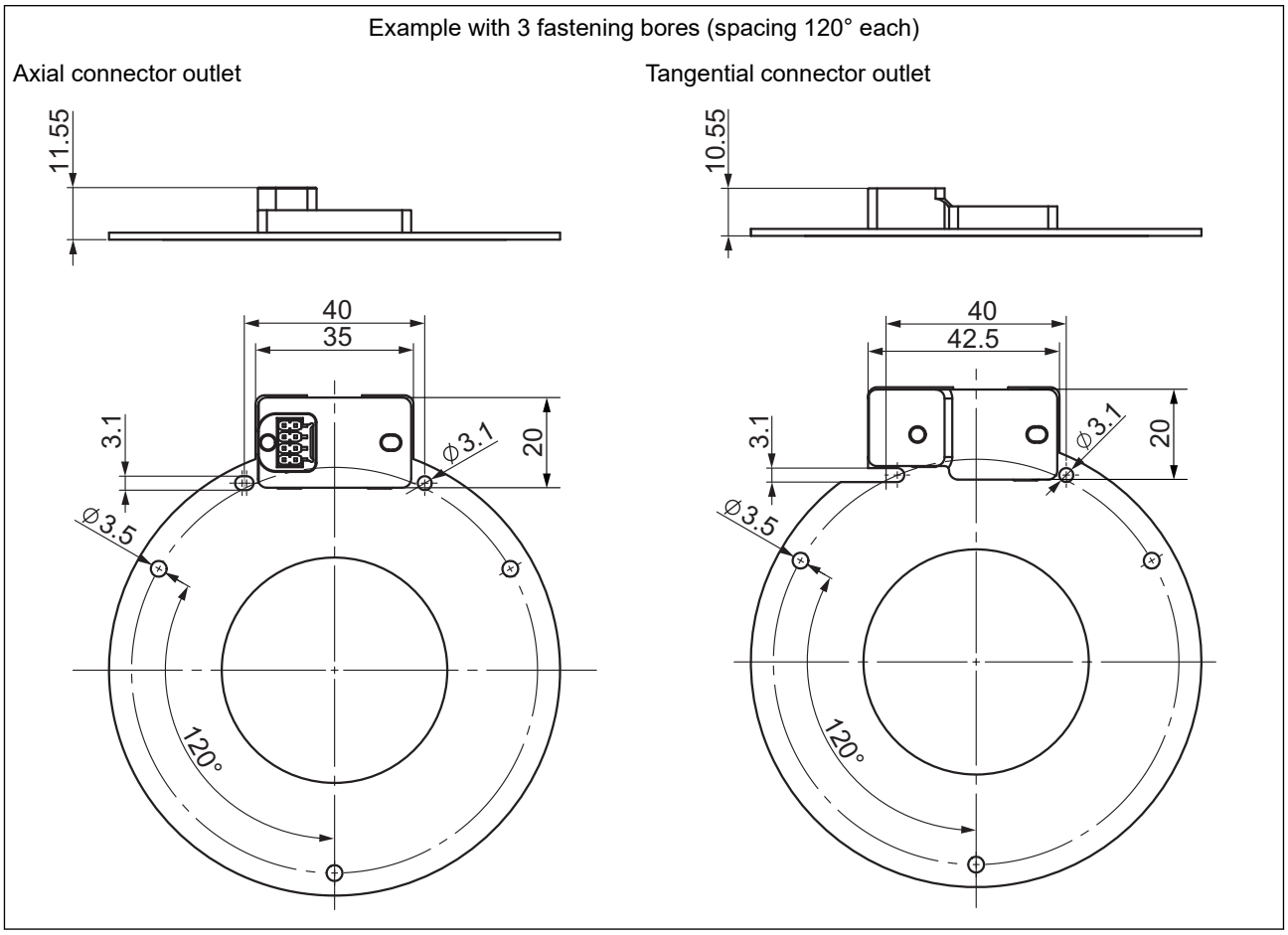
Unlocking tool

Unlocking tool ZBSEK10Y00002	When removing the connection cable from the connector outlet, we recommend using the unlocking tool to prevent damage.

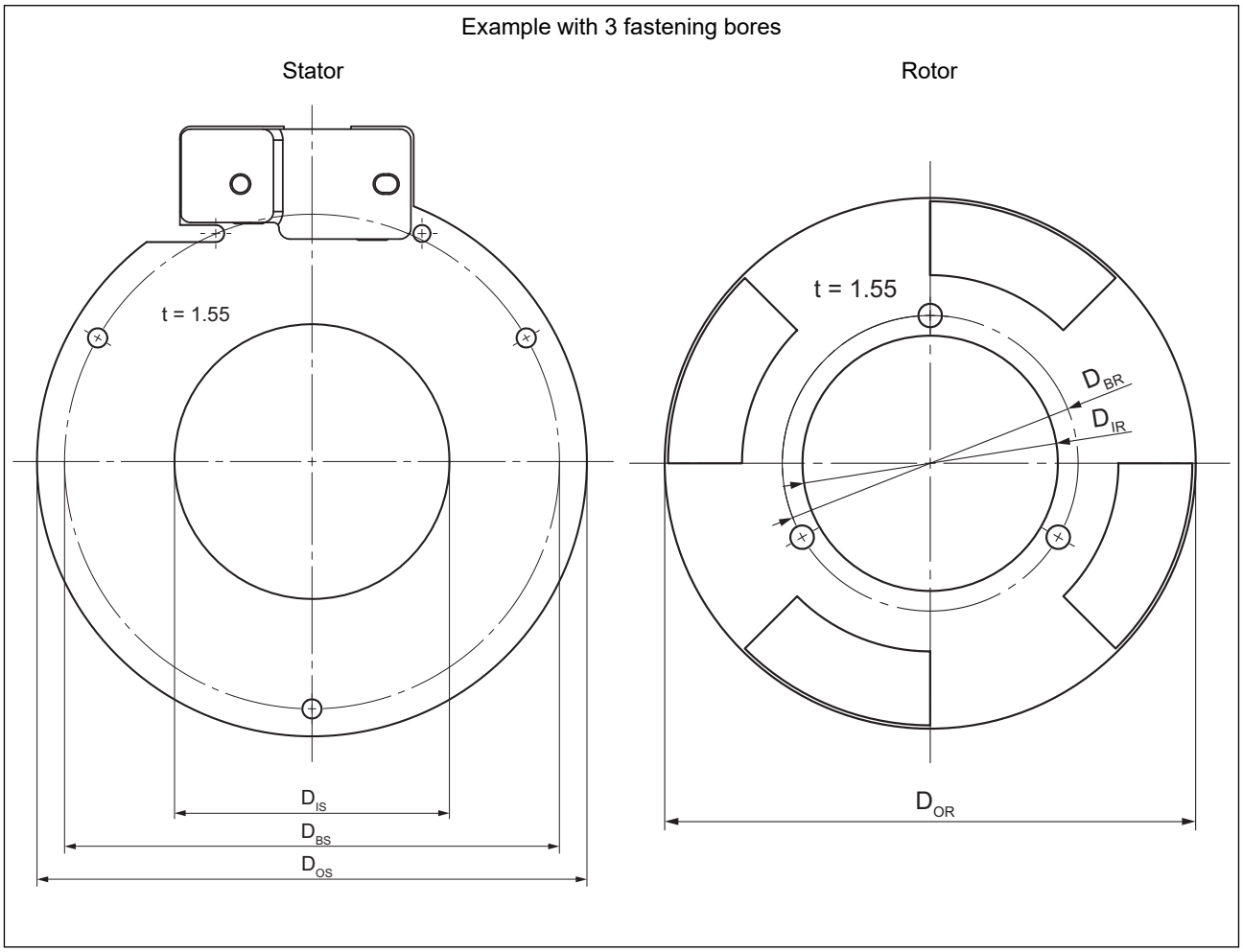
Dimensional drawings

All dimensions in millimeters, general tolerance DIN ISO 2768 mK

Stator



Configurable diameters



Dimensions

Stator		**Rotor**	
D_{OS}	52 mm to 200 mm	D_{OR}	31 mm to 179 mm
D_{BS}	42 mm to 190 mm	D_{BR}	8 mm to 144 mm
D_{IS}	6 mm to 176 mm	D_{IR}	2 mm to 140 mm

Do you have special requirements regarding shaft diameters, mounting solutions, encoder shape, number of pole pairs, cable protection, cable outlet, connector assembly or scanning of conductive structures on a rotor shaft?
Talk to us. We can work together to design the optimal solution for your application and will advise you how to customize your solution in the most cost-efficient way.
Write to: support@lenord.de or call: +49 208 9963-215.

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