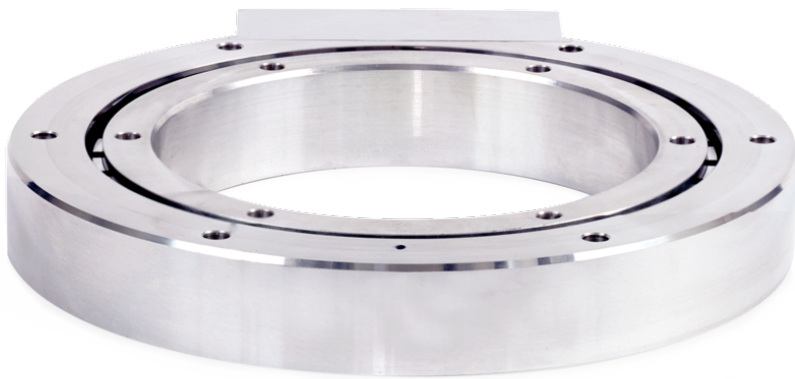




HEIDENHAIN



Product Information

ECI 4010 **EBI 4010**

Absolute Hollow-Shaft Rotary
Encoders without Integral Bearings

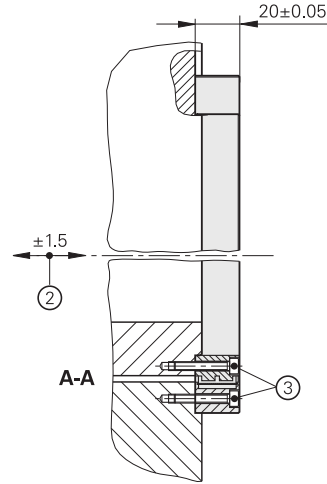
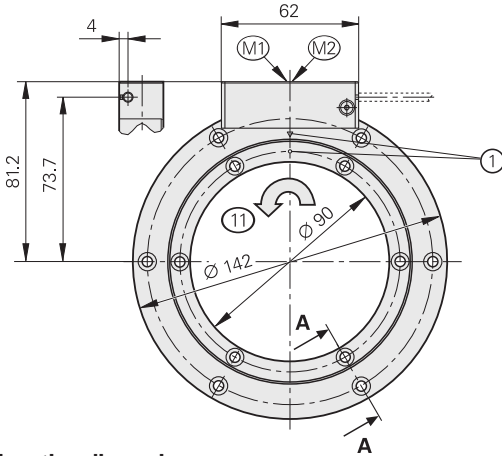
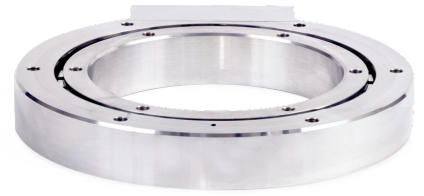
Suited for safety-related applications
up to SIL 3 when coupled with
additional measures

**Functional
Safety**

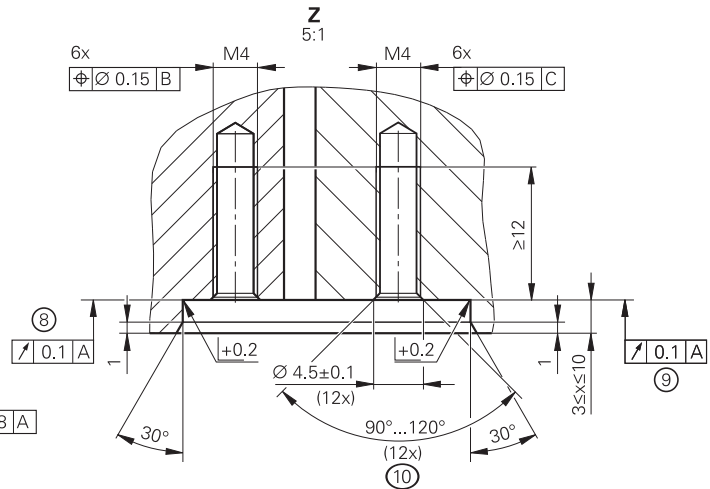
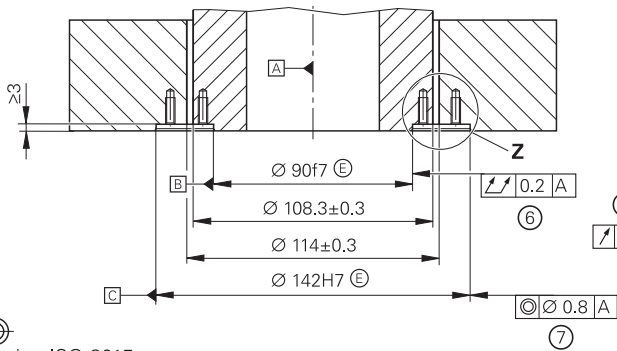
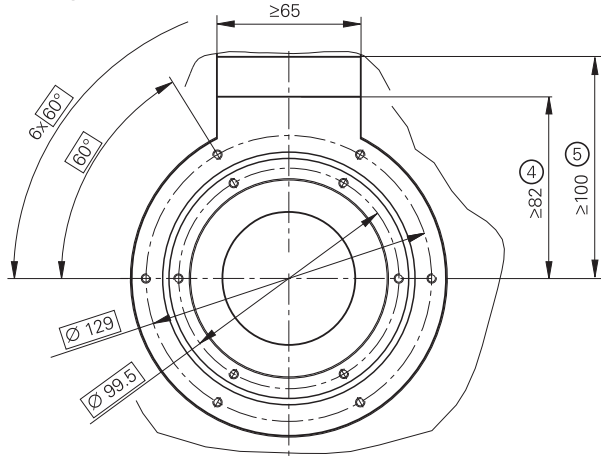
ECI 4010, EBI 4010

Rotary encoders for absolute position values with safe singletum information

- Rugged inductive scanning principle
- Hollow through shaft $\varnothing 90$ mm
- EBI 4010: Multiturn function via battery-buffered revolution counter
- Consists of scanning unit and scale drum



Required mating dimensions



mm
 Tolerancing ISO 8015
 ISO 2768 - m H
 < 6 mm: ± 0.2 mm

- = Bearing of mating shaft
- M1 = Measuring point for operating temperature on housing
- M2 = Measuring point for vibration on housing
- 1 = Datum position ± 5°
- 2 = Maximum permissible axial deviation between shaft and flange surfaces.
 Compensation of mounting tolerances and thermal expansion. Dynamic motion permitted over entire range.
- 3 = Use screws with material bonding anti-rotation lock, ISO 4762 – M4 x 25 – 8.8 – MKL as per DIN 267-27 (not included in enthalten ID 202264-88). Anzugsmoment 2.2 Nm ± 0.13 Nm
- 4 = Space required when encoder cover is closed
- 5 = Space required for opening the encoder cover
- 6 = Total runout of mating shaft
- 7 = Coaxiality of stator mating surface
- 8 = Bearing surface of rotor
- 9 = Bearing surface of stator
- 10 = Chamfer is obligatory at start of thread for materially bonding anti-rotation lock
- 11 = Direction of shaft rotation for output signals according to interface description

Specifications	ECI 4010 – Singletum	EBI 4010 – Multitum
Consisting of	<i>AE scanning unit</i> : ID 1130167-02	<i>AE scanning unit</i> : ID 1130173-02
	<i>TTR scale drum</i> : ID 1130175-02	
Functional safety for applications up to	As single-encoder system for monitoring and closed-loop functions <ul style="list-style-type: none"> • SIL 2 as per EN 61508 (further basis for testing: EN 61800-5-2) • Category 3 PL d according to EN ISO 13849-1:2008 With additional measures as per document 1000344 for safety-related applications up to SIL 3 or category 4, PL e Safe in singleturn range	
PFH	<i>SIL 2</i> : $\leq 15 \times 10^{-9}$ (probability of dangerous failure per hour) <i>SIL 3</i> : $\leq 2 \times 10^{-9}$	
Safe position ¹⁾	<i>Encoder</i> : $\pm 0.44^\circ$ (safety-related measuring step: SM = 0.176°) Fault exclusion for loosening of <i>AE scanning unit</i> and <i>TTR scale drum</i> , designed for acceleration at <i>AE</i> : $\leq 400 \text{ m/s}^2$; at <i>TTR</i> : $\leq 600 \text{ m/s}^2$	
Interface/ordering designation	EnDat 2.2/EnDat22	
Position values/revolution	1 048 576 (20 bits)	
Revolutions	-	65 536 (16 bits)
Calculation time t_{cal} Clock frequency	$\leq 5 \mu\text{s}$ $\leq 16 \text{ MHz}$	
System accuracy	$\pm 25''$	
Electrical connection	15-pin PCB connector (with connection for external temperature sensor ²⁾)	
Cable length	$\leq 100 \text{ m}$ (see EnDat description in the <i>Interfaces of HEIDENHAIN Encoders</i> catalog)	
Voltage supply	DC 3.6 V to 14 V	<i>Rotary encoder</i> U_P : DC 3.6 V to 14 V <i>Backup battery</i> U_{Bat} : DC 3.6 to 5.25 V
Power consumption ³⁾ (max.)	At 3.6 V: $\leq 630 \text{ mW}$; At 14 V: $\leq 700 \text{ mW}$	
Current consumption (typical)	At 5 V: 95 mA (without load)	<i>Normal operation at 5 V</i> : 95 mA (without load) <i>Backup battery</i> ⁴⁾ : 220 μA (rotating shaft) 25 μA (at standstill)
Shaft	Hollow through shaft $\varnothing 90 \text{ mm}$	
Spindle speed	$\leq 6000 \text{ rpm}$	
Moment of inertia of rotor	$4.26 \times 10^{-4} \text{ kgm}^2$ (without screws)	
Angular acceleration of rotor	$\leq 2 \times 10^4 \text{ rad/s}^2$	
Axial motion of measured shaft	$\leq \pm 1.5 \text{ mm}$	
Vibration 55 to 2000 Hz ⁵⁾ Shock 6 ms	<i>AE scanning unit</i> : $\leq 400 \text{ m/s}^2$; <i>TTR scale drum</i> : $\leq 600 \text{ m/s}^2$ (EN 60 068-2-6) $\leq 2000 \text{ m/s}^2$ (EN 60 068-2-27)	
Operating temperature	-40 °C to 115 °C (at the measuring point and the entire scale drum)	
Trigger threshold of error message for excessive temperature	130 °C (measuring accuracy of internal temperature sensor: $\pm 1 \text{ K}$)	
Relative humidity	$\leq 93 \%$ (40 °C/21 d as per EN 60 068-2-78); without condensation	
Protection EN 60 529	IP40 (see <i>Insulation</i> under <i>Electrical safety</i> in the <i>Interfaces of HEIDENHAIN Encoders</i> catalog)	
Mass	<i>AE scanning unit</i> : $\approx 0.27 \text{ kg}$; <i>TTR scale drum</i> : $\approx 0.17 \text{ kg}$	

- 1) Further tolerances may occur in subsequent electronics after position value comparison (contact manufacturer of subsequent electronics)
- 2) See *Temperature measurement in motors* in the *Encoders for Servo Drives* catalog
- 3) See *General electrical information* in the *Interfaces of HEIDENHAIN Encoders* catalog
- 4) With T = 25 °C; $U_{\text{Bat}} = 3.6 \text{ V}$
- 5) AE: 10 Hz to 55 Hz constant over 6.5 mm distance peak to peak; TTR: 10 Hz to 55 Hz constant over 10 mm distance peak to peak

EBI 4010 – external backup battery

The multiturm function of the EBI 4010 is realized through a revolution counter. To prevent loss of the absolute position information during power failure, the EBI must be driven with an external backup battery.

A lithium thionyl chloride battery with 3.6 V and 1200 mAh is recommended as backup battery. The typical service life is over 6 years with appropriate conditions (two shifts of ten hours each in normal operation; battery temperature 25 °C; typical self-discharging). To achieve this, the main power supply (U_P) must be connected to the encoder while connecting the backup battery, or directly thereafter, in order for the encoder to become fully initialized after having been completely without power. Otherwise, the encoder's current consumption from the battery will be significantly higher until the main power supply is connected for the first time.

Ensure correct polarity of the backup battery in order to avoid damage to the encoder. HEIDENHAIN recommends operating each encoder with its own backup battery.

If the application requires compliance with DIN EN 60 086-4 or UL 1642, an appropriate protective circuit is required for protection from wiring errors.

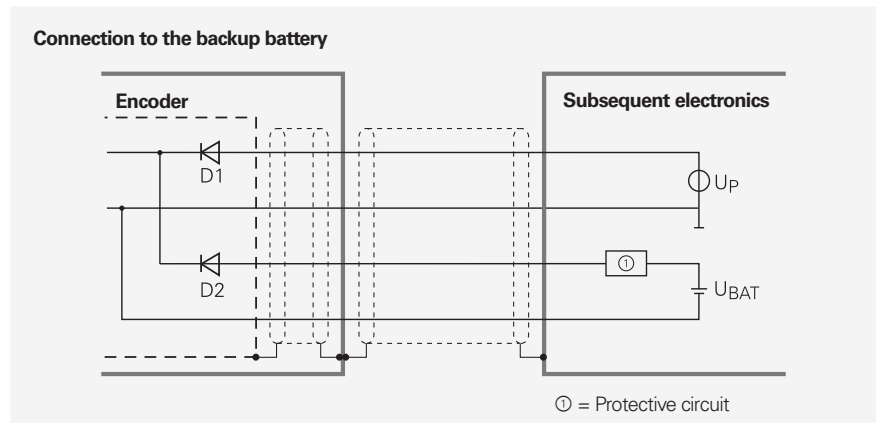
If the voltage of the buffer battery falls below certain thresholds, the encoder will set warning or error messages that are transmitted via the EnDat interface:

- **"Battery charge" warning**
 $\leq 2.8 \text{ V} \pm 0.2 \text{ V}$
 In normal operation mode
- **"M power failure" error message**
 $\leq 2.2 \text{ V} \pm 0.2 \text{ V}$ In battery buffered operating mode (encoder must be re-referenced)

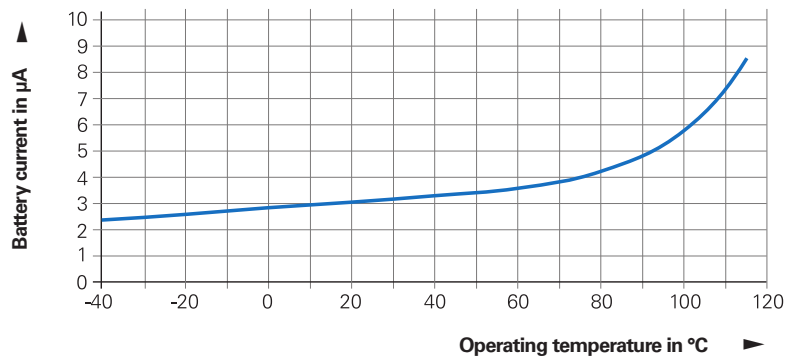
The EBI uses low battery current even during normal operation. The amount of current depends on the operating temperature.

Please note:

Compliance with the EnDat specification 297403 and the EnDat Application Notes 722024, Chapter 13, *Battery-buffered encoders* is required for correct control of the encoder. The datum setting and referencing are to be in the form of an EnDat datum shift. The EBI 4010 does not support the multiturm counter reset function.



Connection to the backup battery



Typical discharge current in normal operation ($U_{BAT} = 3.6 \text{ V}$)

Mounting

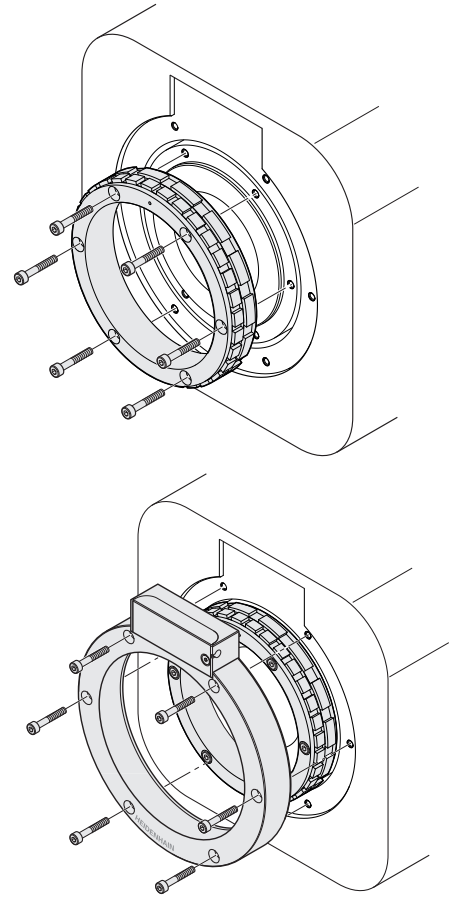
The scale drum of the rotary encoder is slid onto the measured shaft's centering collar and fastened. The stator is mounted via an external centering diameter. In each case, use screws with materially bonding anti-rotation lock (see *Mounting accessories*).

Conditions required on the motor side for a safe mechanical connection:

	Mating shaft/stator	
Material	Steel	Aluminum
Tensile strength R_m	$\geq 600 \text{ N/mm}^2$	$\geq 220 \text{ N/mm}^2$
Shear strength τ_m	$\geq 390 \text{ N/mm}^2$	$\geq 130 \text{ N/mm}^2$
Interface pressure P_G	$\geq 500 \text{ N/mm}^2$	$\geq 250 \text{ N/mm}^2$
Surface roughness R_z	$\leq 16 \mu\text{m}$	
Coefficient of expansion α_{therm} (at 20 °C)	$(10 \text{ to } 17) \times 10^{-6} \text{ K}^{-1}$	$\leq 25 \times 10^{-6} \text{ K}^{-1}$

Protection against contact (EN 60529)

After encoder installation, all rotating parts must be protected against accidental contact during operation.



Mounting accessories

Screws

Screws are not included in delivery. They can be ordered separately.

ECI 4010; EBI 4010	Screws ¹⁾		Lot size
Mounting screws for stator and rotor	ISO 4762-M4×25-8.8-MKL	ID 202264-88	60 or 300 pieces

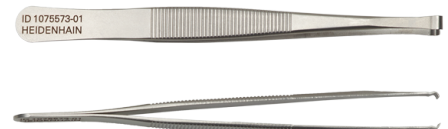
1) With coating for materially bonding anti-rotation lock

Please note the information on screws from HEIDENHAIN in the catalog titled *Encoders for Servo Drives*, chapter *General Mechanical Information* under *Rotary encoders with functional safety*.

Mounting aid

The mounting aid serves to plug and unplug the PCB connector. It prevents damage to the wires and crimp contacts because the strain is applied only to the connector. The wires must not be pulled.





ID 1075573-01







For further mounting information and mounting aids, refer to the Mounting Instructions and the *Encoders for Servo Drives* catalog.

Electrical connection – pin layout

Pin layout of ECI

	Voltage supply				Absolute position values				Other signals ¹⁾	
 M12	8	2	5	1	3	4	7	6	/	/
 M23	3	7	4	8	5	6	1	2	/	/
	13	11	14	12	7	8	9	10	5	6
	U_P	Sensor U_P	0 V	Sensor 0 V	DATA	DATA	CLOCK	CLOCK	T+²⁾	T-²⁾
	Brown/ Green	Blue	White/ Green	White	Gray	Pink	Violet	Yellow	Brown	Green

Pin layout of EBI

	Voltage supply				Absolute position values				Other signals ¹⁾	
 M12	8	2	5	1	3	4	7	6	/	/
 M23	3	7	4	8	5	6	1	2	/	/
	13	11	14	12	7	8	9	10	5	6
	U_P	U_{BAT}	0 V³⁾	0 V BAT³⁾	DATA	DATA	CLOCK	CLOCK	T+²⁾	T-²⁾
	Brown/ Green	Blue	White/ Green	White	Gray	Pink	Violet	Yellow	Brown	Green

1) Only for encoder cables within the motor

2) Connections for external temperature sensor (depending on the encoder cable inside the motor); evaluation optimized for KTY 84-130 (see *Temperature measurement in motors* in the *Encoders for Servo Drives* catalog)

3) Connected inside encoder

Cable shield connected with housing; **U_P** = Power supply



Sensor: The sensor line is connected in the encoder with the respective voltage supply

Vacant pins and wires must not be used.

Note for safety-related applications: Only completely assembled HEIDENHAIN cables are qualified. Exchange connectors or modify cables only after consultation with HEIDENHAIN Traunreut.





Electrical connection

Cables

Encoder cable inside the motor EPG Ø 3.7 mm; [(1×4×0.06)+(4×0.06)] mm ² ; A _P = 0.06 mm ² ; wires for temperature sensor TPE [2×0.16] mm ²		
Complete with PCB connector (15-pin) and M23 SpeedTEC right-angle socket (male) 9-pin; wires for temperature sensor		ID 1120940-30 ¹⁾ ; length 0.3 m max. 1 m possible
Complete with PCB connector (15-pin) and M23 SpeedTEC right-angle socket (male) 9-pin		ID 1121041-03 ¹⁾ ; length 0.3 m max. 1 m possible

SpeedTEC is a registered trademark of Intercontec Pfeiffer Industriesteckverbindungen GmbH.

1) Operating temperature range (conditional): -20 °C to 120 °C

Connecting cable PUR Ø 6 mm; [(4×0.14 mm ²) + (4×0.34 mm ²); A _P = 0.34 mm ²	M12 connector, 8-pin	M23 connector, 9-pin
Complete with connector (female) and M12 coupling (male), 8 pins		ID 368330-xx
Complete with M12 connector (female), 8-pin, and D-sub connector (female), 15-pin		ID 533627-xx
Complete with M12 connector (female), 8-pin, and D-sub connector (male), 15-pin		ID 524599-xx
With one M12 connector (female), 8-pin		ID 634265-xx ¹⁾

A_P: Cross section of power supply lines

1) Connecting element must be suitable for the maximum clock frequency used.

Note for safety-related applications: Provide bit error rate as per specification 533095!

HEIDENHAIN

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This Product Information supersedes all previous editions, which thereby become invalid. The basis for ordering from HEIDENHAIN is always the Product Information document edition valid when the order is made.

Related documents: Adhere to the information in the following documents to ensure the correct and intended operation of the encoder:

- Catalog: *Position Encoders for Servo Drives*: 208922-xx
- Mounting instructions: *AE ECI 4010, EBI 4010*: 1152725-xx, *TTR EXI 4000*: 1147618-xx
- Technical Information: *Safety-Related Position Measuring Systems*: 596632
- For implementation in a safe control or inverter: Specification: 533095 and *supplementary measures catalog (SIL 3, PL e)*: 1000344
- Catalog: *Interfaces of HEIDENHAIN Encoders*: 1078628