Product Information

ECI 4010
EBI 4010
Absolute Rotary Encoders with 180 mm Hollow shaft

Suited for Safety-Related Applications up to SIL 3 when Coupled with Additional Measures
**ECI 4010, EBI 4010**

Rotary encoders for absolute position values with safe singletum information
- Rugged inductive scanning principle
- Hollow through shaft Ø 180 mm
- **EBI 4010**: Multiturn function through battery-buffered revolution counter
- Consists of scanning unit and scale drum

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**Required mating dimensions**

- **M1**: Measuring point for operating temperature
- **M2**: Measuring point for vibration on scanning unit
- **Mark for 0° position ±5°**
- **Slot for machine key DIN 6885–A–10x8x20**
- **Machine key as per DIN 6885–A–10x8x20**
- **Maximum permissible axial deviation between shaft and flange surfaces. Compensation of mounting tolerances and thermal expansion. Dynamic motion permitted over entire range.**
- **Mounting screws: ISO 4762–M4x25–8.8. Tightening torque 2.2 Nm ±0.13 Nm. A suitable anti-rotation lock is to be used for the screw connection (e.g. screw with material bonding anti-rotation lock, ISO 4762–M4x25–8.8 MKL as per DIN 267-27 ID 202264-88).**
- **Space necessary when encoder cover is closed**
- **Space required when encoder cover is open**
- **Cooxiality of stator mating surface**
- **Chamfer at start of thread is obligatory for materially bonding anti-rotation lock**
- **Bearing surface of stator**
- **Bearing surface of rotor**
- **Direction of shaft rotation for output signals according to interface description**
## Specifications

### Consisting of

<table>
<thead>
<tr>
<th>Specifications</th>
<th>ECI 4010 – Singleturn</th>
<th>EBI 4010 – Multiturn</th>
</tr>
</thead>
<tbody>
<tr>
<td>AE ECI4010 scanning unit</td>
<td>ID 1087526-02</td>
<td>AE EBI4010 scanning unit: ID 1097530-02</td>
</tr>
<tr>
<td>TTR EXI4000 scale drum</td>
<td>ID 1113606-02</td>
<td></td>
</tr>
</tbody>
</table>

### Functional safety

#### For applications up to

- Single-encoder system for monitoring and closed-loop functions
- SIL 2 according to EN 61 508 (further basis for testing: EN 61 800-5-2)
- Category 3, PL d according to EN ISO 13849-1:2015
- With additional measures as per document 1000344 for safety-related applications up to SIL 3 or category 4, PL e
- Safe in the singleturn range

#### PFH

- SIL 2: \( \leq 15 \cdot 10^{-9} \) (Probability of dangerous Failure per Hour)
- SIL 3: \( \leq 2 \cdot 10^{-9} \)

#### Safe position

- Encoder: \( \pm 0.44° \) (safety-related measuring step: \( SM = 0.176° \))
- Mechanical coupling: \( \pm 0.5° \) (Fault exclusion for the loosening of AE scanning unit and TTR scale drum, designed for acceleration of AE: \( 400 \, m/s^2 \); of TTR: \( 600 \, m/s^2 \))

### Interface/ordering designation

- EnDat 2.2/EnDat22

### Position values/revolution

- 1048576 (20 bits)
- 65536 (16 bits)

### Calculation time \( t_{cal} / \) clock frequency

- \( \leq 5 \mu s / 16 \, MHz \)

### System accuracy

- \( \pm 40° \)

### Electrical connection

- 15-pin PCB connector (with connection for external temperature sensor)

### Cable length

- \( \leq 100 \, m \) (see EnDat description in the brochure Interfaces of HEIDENHAIN encoders)

### Voltage supply

<table>
<thead>
<tr>
<th>Voltage supply</th>
<th>ECI 4010 – Singleturn</th>
<th>EBI 4010 – Multiturn</th>
</tr>
</thead>
<tbody>
<tr>
<td>DC 3.6 V to 14 V</td>
<td>DC 3.6 V to 14 V</td>
<td>DC 3.6 V to 14 V</td>
</tr>
<tr>
<td>Vm</td>
<td>25 °C; UBAt = 3.6 V</td>
<td>25 °C; UBAt = 3.6 V</td>
</tr>
</tbody>
</table>

### Power consumption

- (maximum) At 3.6 V: \( \leq 630 \, mW \), at 14 V: \( \leq 700 \, mW \)
- Normal operating at 5 V: 95 mA (without load)
- Buffer mode: 220 \( \mu A \) (rotating shaft)
- 25 \( \mu A \) (at standstill)

### Current consumption (typical)

- At 5 V: 95 mA (without load)
- 220 \( \mu A \) (rotating shaft)
- 25 \( \mu A \) (at standstill)

### Shaft

- Hollow through shaft \( \varnothing 180 \, mm \) (with keyway)

### Speed

- \( \leq 6000 \, rpm \)

### Moment of inertia of rotor

- \( 3.1 \cdot 10^{-3} \, kgm^2 \) (without screws, without machine key)

### Angular acceleration of rotor

- \( \leq 2 \cdot 10^3 \, rad/s^2 \)

### Axial motion of measured shaft

- \( \leq 1.5 \, mm \)

### Vibration

- 55 to 2000 Hz
- 6 ms

### Shock

- 2000 m/s^2 (EN 60068-2-27)

### 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: \( \pm 1 \, K \))

### Relative humidity

- \( \leq 93 \% \) (40 °C/21 d as per EN 60068-2-78); without condensation

### Protection

- EN 60529
- Complete encoder in mounted condition: IP20 [5]; scanning unit: IP40 (see Insulation under Electrical safety in the brochure Interfaces of HEIDENHAIN Encoders)

### Mass

- AE scanning unit: \( \approx 0.39 \, kg \)
- TTR scale drum: \( \approx 0.33 \, kg \)

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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 brochure Encoders for Servo Drives
3) See General electrical information in the brochure Interfaces of HEIDENHAIN Encoders
4) At T = 25 °C; UBAt = 3.6 V
5) AE: 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
6) The encoder must be protected in use against abrasive and harmful media. Use an appropriate enclosure if required.
EBI 4010 – external buffer battery

The multiturn 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 six 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 (UP) 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 powerless. Otherwise the encoder will consume a significantly higher amount of battery current until main power is supplied the first time.

Ensure correct polarity of the buffer 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 60086-4 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 operating 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.
Mounting

The scale drum of the rotary encoder is slid onto the centering collar of the measured shaft with machine key 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:

<table>
<thead>
<tr>
<th>Material</th>
<th>Steel</th>
<th>Aluminum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tensile strength $R_m$</td>
<td>$\geq 600 \text{ N/mm}^2$</td>
<td>$\geq 220 \text{ N/mm}^2$</td>
</tr>
<tr>
<td>Shear strength $\tau_m$</td>
<td>$\geq 390 \text{ N/mm}^2$</td>
<td>$\geq 130 \text{ N/mm}^2$</td>
</tr>
<tr>
<td>Interface pressure $P_G$</td>
<td>$\geq 660 \text{ N/mm}^2$</td>
<td>$\geq 250 \text{ N/mm}^2$</td>
</tr>
<tr>
<td>Surface roughness $R_z$</td>
<td>$\leq 16 \mu m$</td>
<td></td>
</tr>
<tr>
<td>Coefficient of thermal expansion $\alpha_{\text{therm}}$ (at 20 °C)</td>
<td>$(10 \text{ to } 17) \cdot 10^{-6} \text{ K}^{-1}$</td>
<td>$\leq 25 \cdot 10^{-6} \text{ K}^{-1}$</td>
</tr>
</tbody>
</table>

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.

<table>
<thead>
<tr>
<th>ECI 4010/EBI 4010</th>
<th>Screws</th>
<th>Lot size</th>
</tr>
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<tbody>
<tr>
<td>Mounting screws</td>
<td>ISO 4762-M4×25-8.8 MKL</td>
<td>ID 202264-88 60 or 300 pieces</td>
</tr>
</tbody>
</table>

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.

Machine key
The machine keys are not included in delivery.

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 Encoders for Servo Drives catalog.
# Electrical connection – pin layout

## Pin layout of ECI

<table>
<thead>
<tr>
<th>8-pin coupling M12</th>
<th>9-pin right-angle socket M23</th>
<th>15-pin PCB connector</th>
</tr>
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<tbody>
<tr>
<td><img src="image1" alt="Diagram" /></td>
<td><img src="image2" alt="Diagram" /></td>
<td><img src="image3" alt="Diagram" /></td>
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### Power supply

<table>
<thead>
<tr>
<th>M12</th>
<th>8</th>
<th>2</th>
<th>5</th>
<th>1</th>
<th>3</th>
<th>4</th>
<th>7</th>
<th>6</th>
<th>/</th>
<th>/</th>
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<tr>
<td>M23</td>
<td>3</td>
<td>7</td>
<td>4</td>
<td>8</td>
<td>5</td>
<td>6</td>
<td>1</td>
<td>2</td>
<td>/</td>
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</tr>
</tbody>
</table>

### Sensor

- Brown/Green
- Blue
- White/Green
- White
- Gray
- Pink
- Violet
- Yellow
- Brown
- Green

### 9-pin right-angle socket M23

- Sensor
- 0 V
- DATA
- DATA
- CLOCK
- CLOCK
- T+
- T–

### Pin layout of EBI

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<td>7</td>
<td>4</td>
<td>8</td>
<td>5</td>
<td>6</td>
<td>1</td>
<td>2</td>
<td>/</td>
<td>/</td>
</tr>
</tbody>
</table>

### Sensor

- Brown/Green
- Blue
- White/Green
- White
- Gray
- Pink
- Violet
- Yellow
- Brown
- Green

### 9-pin right-angle socket M23

- U_P
- Sensor U_P
- 0 V
- Sensor 0 V
- DATA
- DATA
- CLOCK
- CLOCK
- T+
- T–

### Pin layout of HEIDENHAIN (cables inside motor housing)

- Only for cables inside the motor housing

### 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 x 4 x 0.06) + (4 x 0.06)] mm²; Aᵦ = 0.06 mm²;

<table>
<thead>
<tr>
<th>Complete</th>
<th>Description</th>
<th>ID/Option</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>with PCB connector (15-pin) and M23 SpeedTEC right-angle socket (male) 9-pin; wires for temperature sensor</td>
<td>1120940-30; length 0.3 m</td>
</tr>
<tr>
<td></td>
<td>with PCB connector (15-pin) and M23 SpeedTEC right-angle socket (male) 9-pin</td>
<td>1121041-03; length 0.3 m</td>
</tr>
</tbody>
</table>

**PUR connecting cable** Ø 6 m; [(4 x 0.14 mm²) + (4 x 0.34 mm²)]; Aᵦ = 0.34 mm²

<table>
<thead>
<tr>
<th>Complete</th>
<th>Description</th>
<th>M12 connector, 8-pin</th>
<th>M23 connector, 9-pin</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>with connector (female) and M12 coupling (male), 8-pin</td>
<td>ID 368330-xx</td>
<td>ID 745796-xx</td>
</tr>
<tr>
<td></td>
<td>with M12 connector (female), 8-pin, and D-sub connector (female), 15-pin</td>
<td>ID 533627-xx</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td>with M12 connector (female), 8-pin, and D-sub connector (male), 15-pin</td>
<td>ID 524599-xx</td>
<td>–</td>
</tr>
<tr>
<td>With one</td>
<td>M12 connector (female), 8-pin</td>
<td>ID 634265-xx</td>
<td>–</td>
</tr>
</tbody>
</table>

Aᵦ: 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!

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