Encoders for Servo Drives
This brochure is not an exhaustive overview of the HEIDENHAIN product program, but rather provides a selection of encoders designed for use on electric motors.

The selection tables provide an overview of all HEIDENHAIN encoders intended for use on electric motors, along with the most relevant specifications. The descriptions of the technical features contain fundamental information on the use of rotary, angular, and linear encoders on electric motors.

The mounting information and detailed specifications refer to rotary encoders developed specifically for servo motors. For information about other rotary encoders, please refer to the appropriate product documentation.

Further information:

Regarding the linear encoders and angle encoders listed in the selection tables, please refer to the respective product documentation to find detailed descriptions, including mounting information, specifications, and dimensions.

Further information:

Detailed descriptions of all available interfaces, as well as general electrical information, can be found in the Interfaces of HEIDENHAIN Encoders brochure.

This brochure supersedes all previous editions, which thereby become invalid. The basis for ordering from HEIDENHAIN is always the brochure edition and product documentation valid when the order is placed.

Standards (ISO, EN, etc.) apply only where explicitly stated in the brochure.
Encoders for electric motors

Controller systems for electric motors require encoders that provide feedback for the position and speed controllers, and for electronic commutation.

Encoder attributes have a critical impact on important motor characteristics, such as:
- Positioning accuracy
- Speed stability
- Bandwidth, and therefore command and disturbance behavior
- Power dissipation
- Size
- Acoustic noise
- Safety

All of the HEIDENHAIN encoders listed in this brochure have been designed for minimized mounting and cabling effort on the part of the motor manufacturers. Overall rotary motor length can also be kept low. The special design of some encoders can even eliminate the need for safety devices such as limit switches.

HEIDENHAIN can provide a well-matched solution for rotary and linear motors used in a variety of applications:
- Absolute and incremental rotary encoders with and without commutation tracks
- Absolute and incremental angle encoders
- Absolute and incremental linear encoders
- Absolute and incremental modular encoders

Digital position control and speed control

Motor for digital drive systems (digital position and speed control)
Information about the selection tables

The selection tables on the following pages list the encoders that are suitable for each motor design. Each table contains encoders with different dimensions and output signals for the various motor types (DC or three-phase AC motors).

Rotary encoders for mounting on motors
Rotary encoders for motors with forced ventilation are either mounted on the motor housing or installed within it. These rotary encoders are often exposed to the motor’s unfiltered forced-air stream and must therefore possess a high protection class of IP64 or better. The permissible operating temperature seldom exceeds 100 °C.

The selection table contains the following encoders:
- Rotary encoders with mounted stator coupling with high natural frequency—virtually eliminating any limits on the bandwidth of the drive
- Rotary encoders for separate shaft couplings, thus particularly well suited for electrically isolated mounting
- Absolute rotary encoders with purely digital data transfer or additional sinusoidal TTL or HTL incremental signals
- Incremental rotary encoders with high-quality sinusoidal output signals for digital speed control
- Incremental rotary encoders with TTL or HTL compatible output signals
- Information on functional-safety rotary encoders available as safety-related position measurement systems

For the selection table, see page 12

Rotary encoders for mounting inside motors
In motors without forced ventilation, the rotary encoder is installed inside the motor housing. As a result, the encoder does not require a high protection class. Nevertheless, the operating temperature inside the motor housing can reach 100 °C or more.

The selection table contains the following encoders:
- Absolute rotary encoders for operating temperatures of up to 115 °C
- Rotary encoders with mounted stator coupling with high natural frequency—virtually eliminating any limits on the bandwidth of the drive
- Absolute rotary encoders with purely digital data transmission (suitable for the HMC 6 and HMC 2 single-cable solutions) or additional sinusoidal incremental signals
- Incremental rotary encoders for digital speed control, featuring high-quality sinusoidal output signals, even under high operating temperatures
- Incremental rotary encoders with an additional commutation signal for BLDC motors
- Incremental rotary encoders with TTL-compatible output signals
- Information on functional-safety rotary encoders available as safety-related position measurement systems

For the selection table, see page 8

Rotary encoders, modular encoders, and angle encoders for built-in and hollow-shaft motors
The rotary encoders and angle encoders for these motors feature hollow shafts, allowing supply lines to be routed through the hollow shaft of both the motor and the encoder. Depending on the operating conditions, these encoders must either have an IP66 rating or be protected from contamination through the machine design (as with optical modular encoders).

The selection table contains the following encoders:
- Encoders with high-quality absolute and/or incremental output signals
- Angle encoders and modular encoders with the measuring standard on an aluminum or steel drum for shaft speeds of up to 42 000 rpm
- Encoders with integral bearing, with stator coupling or modular design
- Encoders with good acceleration performance for high control-loop bandwidth

For the selection table, see page 18

Linear encoders for linear motors
Linear encoders installed on linear motors provide actual-value feedback for the position and speed controllers. These encoders have a decisive impact on the control characteristics of the linear motor. The linear encoders recommended for this type of application exhibit the following characteristics:
- Low position error during acceleration in the direction of measurement
- High tolerance to acceleration and lateral vibration
- Design suitability for high shaft speeds
- Absolute position information with purely digital data transmission or high-quality sinusoidal incremental signals

Exposed linear encoders are characterized by:
- Higher accuracy grades
- Higher traversing speeds
- Contact-free scanning (i.e., no friction between scanning head and scale)

Exposed linear encoders are suitable for applications in clean environments (e.g., in measuring machines or production equipment in the semiconductor industry).

For the selection table, see page 20

Sealed linear encoders feature the following characteristics:
- High protection class
- Easy mounting

Sealed linear encoders are thus suitable for applications in high-contamination environments (e.g., in machine tools).

For the selection table, see page 22
## Selection guide
### Rotary encoders for mounting inside motors

**Protection class:** up to IP40 (EN 60529)

<table>
<thead>
<tr>
<th>Series</th>
<th>Main dimensions</th>
<th>Mechanically permissible shaft speed</th>
<th>Natural frequency ( f_N ) (typical) of the coupling</th>
<th>Maximum operating temperature</th>
<th>Supply voltage</th>
<th>Signal periods per revolution</th>
<th>Positions per revolution</th>
<th>Distinguishable revolutions</th>
<th>Interface</th>
<th>Model</th>
<th>Further information</th>
</tr>
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<tbody>
<tr>
<td><strong>Rotary encoders without integral bearing</strong></td>
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<tr>
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<td>110 °C</td>
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<td>524 288 (19 bits)</td>
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<td>EnDat 2.2/22</td>
<td>ECI 1119/EQI 1131</td>
<td>Page 68</td>
</tr>
<tr>
<td>ECI/EQI 1100 with synchro flange</td>
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<td>ECI 1119/EBI 1135</td>
<td>Page 72</td>
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<tr>
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<td>–</td>
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<td>DC 3.6 V to 14 V</td>
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<td>524 288 (19 bits)</td>
<td>–</td>
<td>EnDat 2.2/22</td>
<td>ECI 1139/EQI 1331</td>
<td>Page 74</td>
</tr>
<tr>
<td>ECI/EBI 100</td>
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<td>115 °C</td>
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<td>524 288 (19 bits)</td>
<td>–</td>
<td>EnDat 2.1/01 with ( \sim 1 ) Vpp</td>
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<td>Page 80</td>
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<td>115 °C</td>
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<td>1 048 576 (20 bits)</td>
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<td>Page 82</td>
</tr>
<tr>
<td>ERO 1200</td>
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<td>≤ 25 000 rpm</td>
<td>–</td>
<td>100 °C</td>
<td>DC 5 V ±0.5 V</td>
<td>1024/2048</td>
<td>–</td>
<td>–</td>
<td>( \sim ) ( \sim 1 ) Vpp</td>
<td>ERO 1225</td>
<td>Page 86</td>
</tr>
<tr>
<td>ERO 1400</td>
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<td>≤ 30 000 rpm</td>
<td>–</td>
<td>70 °C</td>
<td>DC 5 V ±0.5 V</td>
<td>512/1000/1024</td>
<td>–</td>
<td>–</td>
<td>( \sim ) ( \sim 1 ) Vpp</td>
<td>ERO 1420</td>
<td>Page 88</td>
</tr>
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</table>

1) Also available with functional safety
2) After internal 5/10/20/25-fold interpolation
3) Multiturn function via battery-buffered revolution counter

DRIVE-CLiQ is a registered trademark of Siemens AG.
### Rotary encoders with integral bearing and mounted stator coupling

<table>
<thead>
<tr>
<th>Series</th>
<th>Main dimensions</th>
<th>Mechanically permissible shaft speed</th>
<th>Natural frequency ( f_n ) (typical) of the coupling</th>
<th>Maximum operating temperature</th>
<th>Supply voltage</th>
<th>Signal periods per revolution</th>
<th>Positions per revolution</th>
<th>Distinguishable revolutions</th>
<th>Interface</th>
<th>Model</th>
<th>Further information</th>
</tr>
</thead>
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<tr>
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<td>115 °C</td>
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<td>512</td>
<td>8192 (13 bits)</td>
<td>-4096</td>
<td>EnDat 2.2/01 with 1 Vpp</td>
<td>DRIVE-CLIQ</td>
<td>ECN 1113/EQN 1125</td>
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<td></td>
<td>95 °C</td>
<td>DC 10 V to 29.9 V</td>
<td>-</td>
<td>8388608 (23 bits)</td>
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<td>ECN 1123S/EQN 1135S</td>
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<td>115 °C</td>
<td>DC 3.6 V to 14 V</td>
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<td></td>
<td>ECN 1123 /EQN 1135 1)</td>
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<td></td>
<td>≤ 6,000 rpm</td>
<td>1600 Hz</td>
<td>90 °C</td>
<td>DC 5 V ±0.5 V</td>
<td>500 to 8192</td>
<td>3 block commutation signals</td>
<td></td>
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<td>TTL</td>
<td>ERN 1123</td>
<td>Page 58</td>
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<td>ECN/EQN/ERN 1300</td>
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<td>≤ 15,000 rpm</td>
<td>120 °C</td>
<td>DC 5 V ±0.5 V</td>
<td>1024/2048/4096</td>
<td>-</td>
<td>2 block commutation signals</td>
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<td>DC 5 V ±0.25 V</td>
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<td>DC 10 V to 28.8 V</td>
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</tbody>
</table>

1) Also available with functional safety

DRIVE-CLIQ is a registered trademark of Siemens AG.
Rotary encoders for mounting on motors
Protection class: up to IP64 (EN 60529)

<table>
<thead>
<tr>
<th>Series</th>
<th>Main dimensions</th>
<th>Mechanically permissible shaft speed</th>
<th>Natural frequency ( f_0 ) (typical) of the coupling</th>
<th>Maximum operating temperature</th>
<th>Supply voltage</th>
<th>Signal periods per revolution</th>
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<th>Interface</th>
<th>Model</th>
<th>Further information</th>
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<tr>
<td>Rotary encoders with integral bearing and mounted stator coupling</td>
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<tr>
<td>ECN/ERN 100</td>
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<td>≤ 30 mm: ≤ 6000 rpm ≤ 30 mm: ≤ 4000 rpm</td>
<td>1000 Hz</td>
<td>100 °C</td>
<td>DC 3.6 V to 14 V</td>
<td>2048</td>
<td>8192 (13 bits)</td>
<td>–</td>
<td>1 Vpp</td>
<td>EnDat 2.2/01 with EnDat 2.2/22</td>
<td>ECN 113</td>
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<td></td>
<td></td>
<td>85 °C</td>
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<td>1000 to 5000</td>
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<td>–</td>
<td>–</td>
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<td>–</td>
<td>E RN 130</td>
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<td>Stator coupling for plane surfaces</td>
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<td>2048</td>
<td>8192 (13 bits)</td>
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<td>1 Vpp</td>
<td>EnDat 2.2/01 with EnDat 2.2/22</td>
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<td>–</td>
<td>–</td>
<td>–</td>
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<td>E RN 413E/4G 425</td>
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<td>Stator coupling: 1400 Hz</td>
<td>Universal stator coupling: 1400 Hz</td>
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<td>–</td>
<td>E RN 413/3/22</td>
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<td>DC 4.75 V to 30 V</td>
<td>Universal stator coupling: 1400 Hz</td>
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<td>E RN 413/3/22</td>
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<td>DC 5 V ±0.5 V</td>
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<td>8192 (13 bits)</td>
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<td>E RN 413/3/22</td>
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<td>EnDat 2.2/22/22</td>
<td>E RN 413/3/22</td>
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<td>1500 Hz</td>
<td>512</td>
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<td>E RN 413/3/22</td>
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<td>DC 10 V to 30 V</td>
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<td>8192 (13 bits)</td>
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<td>E RN 413/3/22</td>
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<td>DC 10 V to 30 V</td>
<td>1000 to 5000</td>
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<td>–</td>
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<td>E RN 413/3/22</td>
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<td>Stator coupling for plane surfaces</td>
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<td>EnDat 2.2/01 with EnDat 2.2/22</td>
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<td>E RN 413/3/22</td>
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<td>E RN 413/3/22</td>
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<td>1000 to 5000</td>
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<td>–</td>
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<td>E RN 413/3/22</td>
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<td>Expanding ring coupling</td>
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<td>8192 (13 bits)</td>
<td>–</td>
<td>1 Vpp</td>
<td>EnDat 2.2/01 with EnDat 2.2/22</td>
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<td>Expanding ring coupling: 1800 Hz</td>
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<td>–</td>
<td>EnDat 2.2/22/22</td>
<td>E RN 413/3/22</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Expanding ring coupling: 1800 Hz</td>
<td>Universal stator coupling: 1400 Hz</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>EnDat 2.2/22/22</td>
<td>E RN 413/3/22</td>
<td></td>
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<tr>
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<td></td>
<td>Expanding ring coupling: 1800 Hz</td>
<td>Stator coupling: 1400 Hz</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>EnDat 2.2/22/22</td>
<td>E RN 413/3/22</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>Expanding ring coupling: 1800 Hz</td>
<td>Universal stator coupling: 1400 Hz</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>EnDat 2.2/22/22</td>
<td>E RN 413/3/22</td>
<td></td>
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</tr>
<tr>
<td></td>
<td></td>
<td>Expanding ring coupling: 1800 Hz</td>
<td>Universal stator coupling: 1400 Hz</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>EnDat 2.2/22/22</td>
<td>E RN 413/3/22</td>
<td></td>
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<tr>
<td></td>
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<td>Expanding ring coupling: 1800 Hz</td>
<td>Universal stator coupling: 1400 Hz</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>EnDat 2.2/22/22</td>
<td>E RN 413/3/22</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Expanding ring coupling: 1800 Hz</td>
<td>Universal stator coupling: 1400 Hz</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>EnDat 2.2/22/22</td>
<td>E RN 413/3/22</td>
<td></td>
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</tr>
<tr>
<td></td>
<td></td>
<td>Expanding ring coupling: 1800 Hz</td>
<td>Universal stator coupling: 1400 Hz</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>EnDat 2.2/22/22</td>
<td>E RN 413/3/22</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1) Also available with functional safety

DRIVE-CLIQ is a registered trademark of Siemens AG.
### Rotary encoders for mounting on motors

**Protection class: up to IP64 (EN 60529)**

<table>
<thead>
<tr>
<th>Series</th>
<th>Main dimensions</th>
<th>Mechanically permissible shaft speed</th>
<th>Natural frequency fn (typical) of the coupling</th>
<th>Maximum operating temperature</th>
<th>Supply voltage</th>
<th>Signal periods per revolution</th>
<th>Positions per revolution</th>
<th>Distinguishable revolutions</th>
<th>Interface</th>
<th>Model</th>
<th>Further information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rotary encoders with integral bearing and mounted stator coupling</td>
<td></td>
<td>≤ 12,000 rpm</td>
<td>1500 Hz</td>
<td>100 °C</td>
<td>DC 3.6 V to 14 V</td>
<td>512</td>
<td>8192 (13 bits)</td>
<td>~4096</td>
<td>EnDat 2.2/01 with 1 Vpp</td>
<td>ECN 1013/EQN 1025</td>
<td>Brochure: Rotary Encoders</td>
</tr>
<tr>
<td></td>
<td></td>
<td>95 °C</td>
<td>DC 10 V to 28.8 V</td>
<td></td>
<td>DC 5 V ±0.5 V</td>
<td>100 to 3600</td>
<td></td>
<td>9,388,608 (23 bits)</td>
<td>EnDat 2.2/22</td>
<td>ECN 1023/EQN 1035</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>70 °C</td>
<td>DC 10 V to 30 V</td>
<td>DC 5 V ±0.25 V</td>
<td>100 to 3600</td>
<td></td>
<td></td>
<td>DRIVE-CLIQ</td>
<td>ECN 1023 S/EQN 1035 S</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>≤ 6,000 rpm</td>
<td>1600 Hz</td>
<td>90 °C</td>
<td>DC 5 V ±0.5 V</td>
<td>500 to 8192</td>
<td>3 block commutation signals</td>
<td>TTL/HTL/1 Vpp</td>
<td>TTL/HTL</td>
<td>E RN 1020/ERN 1080</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>DC 5 V ±0.25 V</td>
<td>5000 to 36,000(1)</td>
<td></td>
<td></td>
<td>HTLs</td>
<td>E RN 1030</td>
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</tr>
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</table>

(1) After internal 5/10/20/25-fold interpolation
## Rotary encoders for mounting on motors

Protection class: up to IP64 (EN 60529)

<table>
<thead>
<tr>
<th>Series</th>
<th>Main dimensions</th>
<th>Mechanically permissible shaft speed</th>
<th>Natural frequency (f_n) (typical) of the coupling</th>
<th>Maximum operating temperature</th>
<th>Supply voltage</th>
<th>Signal periods per revolution</th>
<th>Positions per revolution</th>
<th>Distinguishable revolutions</th>
<th>Interface</th>
<th>Model</th>
<th>Further information</th>
</tr>
</thead>
<tbody>
<tr>
<td>ROC/ROD/ROD 400</td>
<td>Synchro flange</td>
<td>≤ 12 000 rpm</td>
<td>–</td>
<td>100 °C</td>
<td>DC 3.6 V to 14 V</td>
<td>512</td>
<td>3192 (13 bits)</td>
<td>~4096</td>
<td>EnDat 2.2/01 with ~ 1 Vpp</td>
<td>ROC 413/ROD 425</td>
<td>Brochure: Rotary Encoders</td>
</tr>
<tr>
<td>Clamping flange</td>
<td></td>
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</tr>
<tr>
<td>ROC/ROD/ROD 1000</td>
<td>Clamping flange</td>
<td>≤ 12 000 rpm</td>
<td>–</td>
<td>100 °C</td>
<td>DC 3.6 V to 14 V</td>
<td>512</td>
<td>3192 (13 bits)</td>
<td>~4096</td>
<td>EnDat 2.2/01 with ~ 1 Vpp</td>
<td>ROC 1013/ROD 1025</td>
<td>Brochure: Rotary Encoders</td>
</tr>
<tr>
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</tr>
<tr>
<td>ROD 600</td>
<td></td>
<td>≤ 12 000 rpm</td>
<td>–</td>
<td>80 °C</td>
<td>DC 5 V ±0.5 V</td>
<td>512</td>
<td>5000</td>
<td>–</td>
<td>~ 1 Vpp</td>
<td>ROD 620</td>
<td></td>
</tr>
<tr>
<td>ROD 1900</td>
<td></td>
<td>≤ 4000 rpm</td>
<td>–</td>
<td>70 °C</td>
<td>DC 10 V to 30 V</td>
<td>600 to 2400</td>
<td>–</td>
<td>~ 1 Vpp</td>
<td>ROD 1930</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1) Also available with functional safety  
2) After integrated 5/10-fold interpolation  
3) Only clamping flange

DRIVE-CLiQ is a registered trademark of Siemens AG.
## Angle encoders for built-in and hollow-shaft motors

### Angle encoders with integral bearing and integrated stator coupling

<table>
<thead>
<tr>
<th>Series</th>
<th>Main dimensions</th>
<th>Diameter</th>
<th>Mechanically permissible shaft speed</th>
<th>Natural frequency (f_N) (typical) of the coupling</th>
<th>Maximum operating temperature</th>
<th>Supply voltage</th>
<th>System accuracy</th>
<th>Signal periods per revolution</th>
<th>Positions per revolution</th>
<th>Interface</th>
<th>Model</th>
<th>Further information</th>
</tr>
</thead>
<tbody>
<tr>
<td>RCN 2001</td>
<td>D1: 20 mm and 100 mm</td>
<td>≤ 1500 rpm (depending on the interface and operating temperature)</td>
<td>1000 Hz</td>
<td>RCN 20x7: 60 °C RCN 25x7: 50 °C</td>
<td>DC 3.6 V to 14 V</td>
<td>±4° to ±2°</td>
<td>–</td>
<td>16 384 (26 bits)</td>
<td>67 104864 (28 bits)</td>
<td>EnDat 2.202 with 1 Vpp</td>
<td>Fanuc</td>
<td>Mitsubishi</td>
</tr>
<tr>
<td>RCN 5011</td>
<td>D1: 35 mm</td>
<td>≤ 1500 rpm (depending on the interface and operating temperature)</td>
<td>1000 Hz</td>
<td>RCN 53x7: 60 °C RCN 55x7: 50 °C</td>
<td>DC 3.6 V to 14 V</td>
<td>±4° to ±2°</td>
<td>–</td>
<td>16 384 (26 bits)</td>
<td>67 104864 (28 bits)</td>
<td>EnDat 2.202 with 1 Vpp</td>
<td>Fanuc</td>
<td>Mitsubishi</td>
</tr>
<tr>
<td>RCN 8001</td>
<td>D1: 60 mm</td>
<td>≤ 500 rpm (depending on the interface and operating temperature)</td>
<td>900 Hz</td>
<td>50 °C</td>
<td>DC 3.6 V to 14 V</td>
<td>±2° to ±1°</td>
<td>–</td>
<td>32 768 (26 bits)</td>
<td>538 870 912 (29 bits)</td>
<td>EnDat 2.202 with 1 Vpp</td>
<td>Fanuc</td>
<td>Mitsubishi</td>
</tr>
</tbody>
</table>

### Modular angle encoders with optical scanning

| Model | Scale drum with centering collar; screwed to shaft on front face | D1: 70 mm to 512 mm D2: 104.3 mm to 560.46 mm | ≤ 15 000 rpm to ≤ 8500 rpm | – | 70 °C | DC 3.6 V to 14 V | ±3° to ±1.5° | – | – | EnDat 2.2 | Fanuc | Mitsubishi | ECA 4410 | ECA 4490 F | ECA 4490 M |
|-------|----------------------------------------------------------------|-----------------------------------------------|------------------------------|----------------|---------------|----------------|-----------------|---------------|---------------|---------------|----------------|----------------|----------------|----------------|
| ERA 4x80 | Scale drum with centering collar; screwed to shaft on front face | D1: 40 mm to 512 mm D2: 76.5 mm to 560.46 mm | ≤ 10 000 rpm to ≤ 1500 rpm | – | 80 °C | DC 5 V ±0.5 V | ±5° to ±2° | 12 000 to 52 000 | – | 1 Vpp | ERA 4280 C | Brochure: Modular Angle Encoders With Optical Scanning |
| ERA 4282 | Scale drum for increased accuracy; screwed to shaft on front face | D1: 40 mm to 270 mm D2: 76.5 mm to 331.31 mm | ≤ 10 000 rpm to ≤ 2500 rpm | – | 80 °C | DC 5 V ±0.5 V | ±4° to ±1.7° | 12 000 to 52 000 | – | 1 Vpp | ERA 4282 C |

### Modular angle encoders with magnetic scanning

| Model | Scale period of approx. 200 µm | D1: 40 mm to 410 mm D2: 64.37 mm to 452.64 mm | ≤ 22 000 rpm to ≤ 30 000 rpm | – | ERM 24x0: 100 °C ERM 22x0: 60 °C | DC 5 V ±0.5 V | – | 512 to 3600 | – | TTL | ERM 2420 | Brochure: Modular Angle Encoders With Magnetic Scanning |
|-------|---------------------------------|-----------------------------------------------|------------------------------|----------------|-----------------|----------------|---------------|---------------|---------------|---------------|----------------|----------------|----------------|----------------|
| ERM 2400 | Scale period of approx. 400 µm | D1: 30 mm to 100 mm D2: 45.26 mm to 128.75 mm | ≤ 60 000 rpm to ≤ 20 000 rpm | – | 100 °C | DC 5 V ±0.5 V | – | 360 to 1024 | – | 1 Vpp | ERM 2484 |
| ERM 2900 | Scale period of approx. 1000 µm | D1: 35 mm to 100 mm D2: 54.43 mm to 120.96 mm | ≤ 50 000 rpm/ ≤ 16 000 rpm | – | 100 °C | DC 5 V ±0.5 V | – | 180 to 400 | – | – | ERM 2984 |

1) Other interfaces upon request  2) Not used  3) Also available with functional safety
## Exposed linear encoders for linear motors

<table>
<thead>
<tr>
<th>Series</th>
<th>Main dimensions</th>
<th>Traversing speed</th>
<th>Acceleration in measuring direction</th>
<th>Accuracy grade</th>
<th>Measuring lengths</th>
<th>Supply voltage</th>
<th>Signal period</th>
<th>Cutoff frequency -3 dB</th>
<th>Switching output</th>
<th>Interface</th>
<th>Model</th>
<th>Further information</th>
</tr>
</thead>
<tbody>
<tr>
<td>LIP 6000</td>
<td>[Image]</td>
<td>≤ 240 m/min</td>
<td>≤ 500 m/s²</td>
<td>≤ 1 μm</td>
<td>20 mm to 3040 mm</td>
<td>DC 5 V ±0.5 V</td>
<td>4 μm</td>
<td>≥ 1 MHz</td>
<td>Horn芒 track Limit switch</td>
<td>~ 1 Vpp</td>
<td>TTL</td>
<td>LIP 6081</td>
</tr>
<tr>
<td>LIF 400</td>
<td>[Image]</td>
<td>≤ 240 m/min</td>
<td>≤ 400 m/s²</td>
<td>±1 μm</td>
<td>70 mm to 1020 mm</td>
<td>DC 5 V ±0.25 V</td>
<td>4 μm</td>
<td>≥ 1 MHz</td>
<td>Horn芒 track Limit switch</td>
<td>~ 1 Vpp</td>
<td>TTL</td>
<td>LIF 481</td>
</tr>
<tr>
<td>LIC 2100</td>
<td>Absolute linear encoder</td>
<td>≤ 600 m/min</td>
<td>≤ 500 m/s²</td>
<td>±15 μm</td>
<td>120 mm to 3020 mm</td>
<td>DC 3.6 V to 14 V</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>EnDat 2.2/22 Resolution: 0.05 μm</td>
<td>LIC 2107</td>
<td></td>
</tr>
<tr>
<td>LIC 4100²</td>
<td>Absolute linear encoder</td>
<td>≤ 600 m/min</td>
<td>≤ 500 m/s²</td>
<td>±5 μm</td>
<td>140 mm to 27 040 mm</td>
<td>DC 3.6 V to 14 V</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>EnDat 2.2/22 Resolution: 0.001 μm</td>
<td>LIC 4115</td>
<td></td>
</tr>
<tr>
<td>LIC 4100³</td>
<td>Absolute linear encoder</td>
<td>≤ 600 m/min</td>
<td>≤ 500 m/s²</td>
<td>±5 μm</td>
<td>140 mm to 6040 mm</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>LIC 4117</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LIC 4100⁴</td>
<td>Absolute linear encoder</td>
<td>≤ 600 m/min</td>
<td>≤ 500 m/s²</td>
<td>±3 μm or ±15 μm</td>
<td>70 mm to 1020 mm</td>
<td>DC 3.6 V to 14 V</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>LIC 4119⁴</td>
<td></td>
</tr>
<tr>
<td>LIDA 400</td>
<td>[Image]</td>
<td>≤ 480 m/min</td>
<td>≤ 500 m/s²</td>
<td>±5 μm</td>
<td>140 mm to 30 040 mm</td>
<td>DC 5 V ±0.25 V</td>
<td>20 μm</td>
<td>≥ 400 kHz</td>
<td>Limit switch</td>
<td>~ 1 Vpp</td>
<td>TTL</td>
<td>LIDA 485</td>
</tr>
<tr>
<td>LIDA 200</td>
<td>[Image]</td>
<td>≤ 600 m/min</td>
<td>≤ 200 m/s²</td>
<td>±15 μm</td>
<td>Up to 10 000 mm</td>
<td>DC 5 V ±0.25 V</td>
<td>200 μm</td>
<td>≥ 50 kHz</td>
<td>–</td>
<td>~ 1 Vpp</td>
<td>TTL</td>
<td>LIDA 287</td>
</tr>
</tbody>
</table>

1) With Zerodur glass ceramic up to a measuring length of 1020 mm
2) Also available with Fanuc, Mitsubishi, Panasonic, and Yaskawa interfaces
3) After linear error compensation
4) Also available with functional safety
Sealed linear encoders for linear motors
Protection class: IP53 to IP64 (EN 60529)

<table>
<thead>
<tr>
<th>Series</th>
<th>Main dimensions</th>
<th>Traversing speed</th>
<th>Acceleration in direction of measurement</th>
<th>Measuring lengths</th>
<th>Accuracy grade</th>
<th>Supply voltage</th>
<th>Signal period</th>
<th>Cutoff frequency</th>
<th>Resolution</th>
<th>Interface</th>
<th>Model</th>
<th>Further information</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Linear encoders with slimline scale housing</strong></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
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</tr>
<tr>
<td>LF</td>
<td>≤ 60 m/min</td>
<td>≤ 100 m/s²</td>
<td>≤ 100 m/s²</td>
<td>50 mm to 1220 mm</td>
<td>±5 µm</td>
<td>DC 5 V ±0.25 V</td>
<td>4 µm</td>
<td>≥ 250 kHz</td>
<td></td>
<td>–</td>
<td>LF 485  Brochure: Linear Encoders for Numerically Controlled Machine Tools</td>
<td></td>
</tr>
<tr>
<td>LC</td>
<td>≤ 180 m/min</td>
<td>≤ 100 m/s²</td>
<td>≤ 100 m/s²</td>
<td>70 mm to 2040 mm</td>
<td>±5 µm</td>
<td>DC 3.6 V to 14 V</td>
<td>–</td>
<td>–</td>
<td>Down to 0.01 µm</td>
<td>–</td>
<td>LC 415 4) Also available with functional safety</td>
<td></td>
</tr>
<tr>
<td>Absolute linear encoder</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>±3 µm</td>
<td>–</td>
<td>–</td>
<td>Down to 0.05 µm</td>
<td>–</td>
<td>–</td>
<td>LC 485</td>
<td></td>
</tr>
<tr>
<td><strong>Linear encoders with full-size scale housing</strong></td>
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</tr>
<tr>
<td>LF</td>
<td>≤ 60 m/min</td>
<td>≤ 100 m/s²</td>
<td>≤ 100 m/s²</td>
<td>140 mm to 3040 mm</td>
<td>±2 µm; ±3 µm</td>
<td>DC 5 V ±0.25 V</td>
<td>4 µm</td>
<td>≥ 250 kHz</td>
<td></td>
<td>–</td>
<td>LF 185  Brochure: Linear Encoders for Numerically Controlled Machine Tools</td>
<td></td>
</tr>
<tr>
<td>LC</td>
<td>≤ 180 m/min</td>
<td>≤ 100 m/s²</td>
<td>≤ 100 m/s²</td>
<td>140 mm to 4240 mm</td>
<td>±5 µm</td>
<td>DC 3.6 V to 14 V</td>
<td>–</td>
<td>–</td>
<td>Down to 0.01 µm</td>
<td>–</td>
<td>LC 115 4) Also available with functional safety</td>
<td></td>
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<tr>
<td>Absolute linear encoder</td>
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<td></td>
<td></td>
<td></td>
<td>±3 µm</td>
<td>–</td>
<td>–</td>
<td>Down to 0.05 µm</td>
<td>–</td>
<td>–</td>
<td>LC 185</td>
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<tr>
<td></td>
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<td></td>
<td></td>
<td></td>
<td>140 mm to 3040 mm</td>
<td>±5 µm</td>
<td>–</td>
<td>Down to 0.01 µm</td>
<td>–</td>
<td>–</td>
<td>LC 211</td>
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<td></td>
<td></td>
<td>140 mm to 3040 mm</td>
<td>±5 µm</td>
<td>–</td>
<td>Down to 0.01 µm</td>
<td>–</td>
<td>–</td>
<td>LC 281</td>
<td></td>
</tr>
<tr>
<td>LB</td>
<td>≤ 120 m/min (180 m/min upon request)</td>
<td>≤ 180 m/min (180 m/min upon request)</td>
<td>≤ 100 m/s²</td>
<td>440 mm to 28 040 mm</td>
<td>±5 µm</td>
<td>DC 3.6 V to 14 V</td>
<td>–</td>
<td>–</td>
<td>Down to 0.01 µm</td>
<td>–</td>
<td>LB 382</td>
<td></td>
</tr>
</tbody>
</table>

1) After mounting in accordance with mounting instructions
2) Interfaces for Siemens, Fanuc, and Mitsubishi controls available upon request
3) At or above a measuring length of 1340 mm: only with mounting spar or clamping elements
4) Also available with functional safety
Rotary encoders and angle encoders for DC and three-phase AC motors

General information

Speed stability
In order to obtain good motor speed stability, the encoder must provide a high number of measuring steps per revolution. For this reason, the HEIDENHAIN product portfolio includes encoders that output a sufficient number of measuring steps per revolution for the required speed stability.

HEIDENHAIN rotary encoders and angle encoders with an integral bearing and stator coupling exhibit particularly advantageous behavior: shaft misalignment within a certain tolerance range does not induce position errors or impaired speed stability (see Specification).

Position errors within one signal period adversely affect the positioning accuracy and speed stability of the motor. At low feed rates, the motor mimics the position error within one signal period.

Transmission of measuring signals
For good dynamic performance with digital speed control, the clock time of the speed controller should not exceed approximately 125 µs. In addition, the actual values for the position controller and speed controller must be available to the controlling system with the least possible delay.

High clock frequencies are needed to fulfill such demanding time requirements on position-value transmission from the encoder to the controlling system with serial data transmission (see also the Interfaces of HEIDENHAIN Encoders brochure). This is why HEIDENHAIN encoders for electric motors output the position values over the fast, purely serial ENDat 2.2 or ENDat 3 interface or transmit additional incremental signals that are available to the subsequent electronics virtually without delay for speed or position control.

For standard drives, manufacturers primarily use the especially robust EC/EB/EGI encoders without integral bearing or rotary encoders with TTL or HTL compatible output signals—as well as additional commutation signals for permanent DC drives.

For digital speed control on machines with high dynamic-performance requirements, a large number of measuring steps are required—usually more than 500 000 per revolution. For applications with standard motors, approximately 60 000 measuring steps per revolution are sufficient (similar to resolvers).

HEIDENHAIN encoders for motors with digital position and speed control are therefore equipped with the purely serial ENDat 2/3 interface, or they output additional sinusoidal incremental signals at 1 Vpp signal levels (ENDat 1). The high internal resolution of the ENDat 2 and ENDat 3 encoders permits resolutions of up to 19 bits (±242288 measuring steps) in inductive systems and at least 25 bits (approx. 33 million measuring steps) in photoelectric encoders.

Thanks to their high signal quality, the sinusoidal incremental signals of the ENDat 1 encoder can be highly subdivided in the subsequent electronics (see Figure 1). Even at speeds of 12 000 rpm, the signal arrives at the input circuit of the controlling system with a frequency of only approximately 400 kHz (see Figure 2). Cable lengths of up to 150 m are possible with 1 Vpp incremental signals (see also 1 Vpp incremental signals).

HEIDENHAIN absolute encoders for “digital” motors deliver additional sinusoidal incremental signals with the same characteristics as those described above. Absolute encoders from HEIDENHAIN use the EnDat interface (see Encoder Data for the serial data transmission of absolute position values and other information for automatic self-configuration, monitoring and diagnosis). This makes it possible to use the same subsequent electronics and cabling technology for all HEIDENHAIN encoders.

With EnDat 2/3 (HMI 8) and EnDat 3 (HMI 2) the serial data transfer can take place directly within the motor cable, thus significantly reducing cabling and costs.

For automatic configuration, important encoder specifications can be read from the memory of the EnDat encoder, and motor-specific parameters can be saved in the encoder’s OEM memory area. The usable size of the OEM memory for the rotary encoders listed in the current brochures is at least 1.4 KB (±704 EnDat words).

Most absolute encoders internally subdivide the sinusoidal scanning signals by a factor of 4096 or greater. When these systems are operated with sufficiently fast transmission of the absolute position values (e.g., at a clock frequency of 2 MHz with EnDat 2.1 or 16 MHz with EnDat 2.2 or EnDat 3 H25 or 26 MHz), incremental signal evaluation can be eliminated altogether.

The benefits of this data transmission technology are higher noise immunity along the transmission path and less expensive connectors and cables. A large share of rotary encoders equipped with the EnDat 2.2 or EnDat 3 interface are also able to evaluate an external temperature sensor (e.g., located in the motor winding). The digitized temperature values are transmitted as part of the EnDat 2.2 or EnDat 3 protocol without an additional line.

Bandwidth
The attainable gain levels for the position and speed control loops, and therefore the bandwidth of the motor with regard to command and disturbance behavior, may be limited by the rigidity of the coupling between the motor shaft and the encoder shaft, as well as by the natural frequency of the stator coupling. HEIDENHAIN therefore offers rotary and angle encoders for high-rigidity shaft couplings.

The stator couplings mounted on the encoder exhibit high natural frequencies fN. With modular and inductive rotary encoders, the stator and rotor are firmly screwed to the motor housing and the shaft (see also Mechanical design types and mounting). This mechanical design therefore permits optimal coupling rigidity.

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Fault exclusion for mechanical coupling
HEIDENHAIN encoders designed for functional safety can be mounted in such a way that the rotor or stator fastening does not accidentally loosen.

Size
The higher a motor’s permissible operating temperature is, the smaller the motor can be made for a given torque. Since the temperature of the motor also affects the temperature of the encoder, HEIDENHAIN offers encoders for permissible operating temperatures of up to 120 °C. These encoders make it possible to implement smaller motors.

Power dissipation and acoustic noise
While the motor is running, encoder position errors within one signal period affect the motor’s power dissipation as well as the heat generation and acoustic noise that go along with it. For this reason, rotary encoders with high signal quality better than ±1% of the signal period are preferred (see also Measuring accuracy).

Bit error rate
For rotary encoders with a purely serial interface for installation within motors, HEIDENHAIN recommends conducting a type test for the bit error rate.

The use of functionally safe encoders without closed metal housings and/or with cable assemblies that do not comply with the electrical connection directives (see General electrical information) always requires the bit error rate to be measured in a type test under application conditions.

Preventive maintenance
Encoders with serial data transfer provide information that enables monitoring of the operating status and thus preventive maintenance:

- Diagnostics
- Clearance gap for optimized and verifiable mounting and application conditions
- Connectable external temperature sensor
HMC 2 and HMC 6
Single-cable solutions for servomotors

Servomotors normally require two separate cables:
• One encoder cable for the motor encoder
• One power cable for the motor supply

With the HMC solution (Hybrid Motor Cable), HEIDENHAIN has integrated the encoder cable into the power cable. Thus, only a single cable is now needed between the motor and the electrical cabinet.

The HMC 6 single-cable solution was specifically designed for the HEIDENHAIN EnDat22 interface, and the HMC 2 version is for EnDat3. With purely serial data transmission, cable lengths of up to 100 m can be realized. However, with HMC 6 all other encoders equipped with a purely serial RS-485 interface (e.g., SSI) can be connected as well. A wide range of encoders can therefore be used without the need for introducing a new interface.

The HMC solution combines the wires for the encoder, motor, and brake into a single cable, which is connected to the motor via a special connector. For connection to the frequency inverter, the cable is split into power connections, brake connections, and an encoder connector.

When the components are correctly assembled, the connecting elements attain an IP67 rating.

Benefits
The HMC single-cable solutions offer a series of cost and quality benefits for motor and machine manufacturers:
• Continued use of existing interfaces
• Realization of smaller drag chains
• Significant improvement in drag-chain suitability thanks to fewer cables
• Wide range of available encoders for HMC 2 and HMC 6 transmission

The universal design of the HMC solution gives motor and machine manufacturers high flexibility, letting them use standard components on both the motor and the control.

All HEIDENHAIN encoders with EnDat22 interface or with purely serial data transfer without battery buffering as per RS-485 are suited for the HMC 6 single-cable solution. This includes motor encoders for servomotors in various sizes, linear and angle encoders used in direct drive motors, as well as encoders for functional safety up to SIL 3.

The HMC 2 single-cable solution can be used with motor encoders featuring the EnDat 3 interface (ordering designation: E30-R2) and purely serial data transmission via two wires. The ExI 1100/1300 and ExN 1300 series rotary encoders are available for functional safety applications with up to SIL 3.

For the controlling hardware you can continue to use already deployed frequency inverters or controller units. The HMC cables have been designed for easy assembly of the matching connecting elements. Importantly, this does not impair the noise immunity.

Components
Preparing a motor for the single-cable solution requires only a handful of components.

Connecting element on the motor
The motor housing is equipped with a standard flange socket for HMC 2 or a special angle flange socket for HMC 6. This angle flange socket brings together the wires for the encoder, motor power, and brake.

Crimping tools for the power wires
The crimp contacts for the power and brake wires are assembled with the usual tools.

Output cables inside the motor housing
The rotary encoder is connected by means of the output cables inside the motor housing: your pre-assembled communication element for the HMC 6 or the two contacts for HMC 2 are simply plugged into the angle flange socket.

Cable with hybrid connector
The HMC connecting cable contains the wires for the encoder, power supply, and brake.

Further information:
For more information about HMC 6 and HMC 2, refer to the respective Product Information document and visit www.endat.de.
Safety-related position measuring systems

Safe axes
Driven axes and moving parts can represent a great hazard for humans. Particularly if the human interacts with the machine (e.g., during workpiece setup), it must be ensured that the machine does not make any uncontrolled movements. Here, the position information of axes is needed to conduct a safety function. As an evaluating safety module, the control has the task of detecting faulty position information and reacting to it accordingly. Various safety strategies can be pursued, depending on the topology of the axis and the evaluation capabilities of the control. In a single-encoder system, for example, only one encoder per axis is evaluated for the safety function. However, on axes with two encoders, such as a linear axis with a rotary and a linear encoder, the two redundant position values can be compared with each other in the control. Safe fault detection can be ensured only if the two components—control and encoder—are properly adapted to one another. Here, it is to be noted that the safety designs of control manufacturers differ from one another. This also means that the requirements to be fulfilled by the connected controls of safety-related position measuring systems with EnDat 2.2 differ.

Type-examined encoders
Encoders from HEIDENHAIN are used successfully on a variety of controls in widely differing safety designs. This applies particularly to the type-examined encoders with EnDat and DRIVE-CLIQ interfaces. The encoders can be operated as single-encoder systems in conjunction with a suitable control in applications with the control category SIL 3 (according to EN 61508) or performance level “e” (cf. EN ISO 13849). Unlike incremental encoders, absolute encoders always provide a safe absolute position value—including immediately after switch-on or a power failure. The reliable transmission of the position is based on two independently generated absolute position values and on error bits provided to the safe control. The purely serial data transmission also offers other advantages, such as greater reliability, improved accuracy, diagnostic capabilities, and reduced costs through simpler connection technology.

Standard encoders
In addition to those encoders explicitly qualified for safety applications, standard encoders (e.g., with Fanuc interface or 1 Vpp-signal) can also be used in safe axes. In such cases, the characteristics of the encoders must be matched to the requirements of the respective control. To this end, HEIDENHAIN can provide additional data about the individual encoders (failure rate, fault model as per EN 61800-5-2).

Fault exclusion for the loosening of the mechanical connection
Irrespective of the interface, many safety designs require the safe mechanical connection of the encoder. The standard for electric drives, EN 61800-5-2, includes the loosening of the mechanical connection between the encoder and the drive as a fault that requires consideration. Because the control may not be able to detect such errors, fault exclusion is required in many cases. The requirements on a fault exclusion can result in additional constraints in the permissible limit values in the specifications. In addition, fault exclusions for the loss or loosening of the mechanical coupling usually require additional measures when mounting the encoders or in the event of servicing, e.g., anti-rotation lock for screws. These factors must be considered for the selection of a suitable encoder or a mounting mode.

Further information:
The safety-related characteristic values are listed in the specifications of the encoders. The Technical Information document “Safety-Related Position Measuring Systems” provides explanations of the characteristic values. Upon request, HEIDENHAIN can likewise provide additional data about the individual products (failure rate, fault model as per EN 61800-5-2) for the use of standard encoders in safety-related applications.

Further information:
Adhere to the information in the following documents to ensure the correct and intended operation of the encoder:
• Mounting Instructions
• Product Information
• Customer information about fault exclusion
• Technical Information document: Safety-Related Position Measuring Systems 596632
For implementation in a control with EnDat 2.2:
• Specification for Safe Control 592832
For implementation in a control with EnDat 3:
• Application Conditions for Functional Safety 3000003

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**Measuring principles**

**Measuring standard**

HEIDENHAIN encoders with optical scanning incorporate measuring standards consisting of periodic structures known as graduations. These graduations are applied to a substrate of glass or steel. For encoders with large diameters, steel tape is used as the substrate.

HEIDENHAIN manufactures its precision substrate. These graduations are applied to a substrate consisting of periodic structures known as graduations.

A separate incremental track, or the track with the finest grating period, is interpolated for the position value and is simultaneously used to generate an optional incremental signal. Singuletum rotary encoders repeat the absolute position information with each revolution. Multiturn encoders can distinguish between additional revolutions.

In the **absolute measuring method**, the position value is available immediately upon encoder switch-on and can be requested by the subsequent electronics at any time. There is therefore no need to search for the reference position by jogging the axes. This absolute position information is ascertained from the graduation of the graduated disk, which contains a code structure or consists of multiple parallel graduation tracks.

For magnetic encoders, a substrate made of magnetizable steel alloy is used. Within it, a graduation consisting of north and south poles is created with a grating period of 400 µm. Due to the short range of electromagnetic interactions and the resulting narrowness of the scanning gap, finer magnetic graduations are not practical.

Encoders that use the inductive scanning principle employ metal graduations or copper/nickel-based graduations. These graduation structures are applied to a printed-circuit carrier material.

In the **incremental measuring method**, the graduation consists of a periodic grating structure. Position information is obtained through the counting of individual increments (measuring steps) starting from a freely settable point of origin. Since position ascertainment requires an absolute reference, the graduated disks have an additional track containing a reference mark.

**Scanning methods**

Photolithographic processes: graduations in specially developed, photolithographic processes:

- AURODUR: matte-etched lines on a gold-plated steel tape, typical grating period: 40 µm
- METALLUR: contamination-tolerant graduation consisting of metal lines on gold, typical grating period: 20 µm
- DIADUR: extremely robust chromium lines on glass (typical grating period: 20 µm), or three-dimensional chromium structures (typical grating period: 8 µm) on glass
- SUPRADUR phase grating: optically three-dimensional, planar structure; particularly tolerant to contamination; typical grating period: 8 µm and finer
- OPTODUR phase grating: optically three-dimensional, planar structure with particularly high reflectance; typical graduation period: 2 µm and finer

The ERN/ECN/EQN/ERO and ROD/RCN/RON rotary encoders are designed in accordance with the imaging scanning principle. Put simply, the imaging scanning principle uses projected light signal generation: two gratings with equal or similar grating periods—the graduated disk and the scanning reticle—are moved relative to each other. The carrier material of the scanning reticle is transparent, whereas the graduation of the measuring standard may likewise be applied to a transparent material or to a reflective material. When parallel light passes through a grating structure, light and dark fields are projected at a certain distance. At this location there is an index grating with the same or similar grating period. When the two graduations move relative to each other, the incident light is modulated if the gaps are aligned, light passes through. If the lines of one grating coincide with the gaps of the other, no light passes through. Photocells or a structured photosensor convert these fluctuations in light into nearly sinusoidal electrical signals. In encoders that use the imaging scanning principle, workable mounting tolerances are attainable starting at a minimum grating period of 10 µm.

Photoelectric scanning:

Most HEIDENHAIN encoders utilize the photoelectric scanning principle. Photoelectric scanning is performed contact-free and thus does not induce wear. This method detects even extremely fine graduation lines down to a width of only a few micrometers and generates output signals with very small signal periods.

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Other scanning principles:

Some encoders operate in accordance with other scanning methods. As their measuring standard, ERN/ECN/ERO, and ROD/RCN/RON encoder switch-on and can be requested by the subsequent electronics at any time. There is therefore no need to search for the reference position by jogging the axes. This absolute position information is ascertained from the graduation of the graduated disk, which contains a code structure or consists of multiple parallel graduation tracks.

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Electronic commutation with position encoders

Commutation with permanent-magnet three-phase AC motors

Electronic commutation for a permanent-magnet three-phase AC motor requires the position of the rotor as an absolute value prior to motor start-up. HEIDENHAIN rotary encoders come with different types of rotor position recognition:

- Absolute rotary encoders in singleturn and multiturn versions provide the absolute position information immediately after switch-on, allowing the exact position of the rotor to be derived for electronic commutation.

- Along with delivering incremental signals, incremental rotary encoders with a second track—the Z1 track—provide one sine and one cosine signal (C and D) for each revolution of the motor shaft. For sine commutation, rotary encoders with a Z1 track simply require a subdivision unit and a signal multiplexer in order to obtain the absolute rotor position down to an accuracy of ±5° from the Z1 track and to obtain the position information for speed and position control from the incremental track (see also Interfaces: Commutation signals).

- Incremental rotary encoders with block commutation tracks also output three commutation signals U, V, and W, which are used to directly drive the power electronics. These rotary encoders are available with various commutation tracks. Typical versions have three signal periods (120° mech.) or four signal periods (90° mech.) per commutation signal and revolution. Irrespective of this, the incremental square-wave signals are used for position and speed control (see also Interfaces: Commutation signals).

Commutation of synchronous linear motors

Like absolute rotary and angular encoders, the LIC and LC absolute linear encoder series provide the exact position of the motor’s moving component immediately upon switch-on. Maximum holding load is thereby possible even at standstill.

Further information:

Please note the switch-on behavior of the encoders (see the Interfaces of HEIDENHAIN Encoders brochure).

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Please note the switch-on behavior of the encoders (see the Interfaces of HEIDENHAIN Encoders brochure).
Application-dependent errors

For rotary encoders with an integral bearing, the specified system accuracy already takes the error of the bearing into account. In the case of angle encoders with a separate shaft coupling (ROD, ROC, ROQ), the angular error of the coupling must be considered as well (see Mechanical design types and mounting). For angle encoders with a stator coupling (ERN, ECN, EQN), the system accuracy already includes the error of the shaft coupling.

In contrast, for encoders without integral bearing, the mounting, as well as the adjustment of the scanning head, has a decisive influence on the attainable overall accuracy. Of particular importance are both the mounting eccentricity of the graduation and the radial runout of the measured shaft. Evaluation of the overall accuracy of these encoders requires that their application-dependent errors be individually measured and taken into account.

Rotary encoders with photoelectric scanning

In addition to the system accuracy, the mounting quality and adjustment of the scanning head also have a significant effect on the attainable overall accuracy of rotary encoders without an integral bearing but with photoelectric scanning. Of particular importance are the mounting eccentricity of the graduation and the radial runout of the measured shaft.

Example

For an ERO 1420 rotary encoder with a mean graduation diameter of 24.85 mm: A radial runout of the measured shaft of 0.02 mm results in a position error of ±30 arc seconds within one revolution. To evaluate the accuracy of modular rotary encoders without an integral bearing (ERO), the relevant errors must be considered individually.

1. Directional errors of the graduation

ERO: The extreme values of the directional errors relative to their mean are listed in the Specifications as the accuracy of the graduation. The system accuracy consists of the graduation accuracy and position error within one signal period.

2. Errors due to eccentricity of the graduation relative to the bearing

During mounting of the disk/hub assembly, it is to be expected that the bearing will exhibit radial runout or eccentricity errors. When centering the centering collar of the hub, bear in mind that HEIDENHAIN guarantees an eccentricity of the graduation relative to the centering collar of less than 5 µm for the encoders listed in this brochure. With modular encoders, this stated accuracy presupposes a diameter error of zero between the motor shaft and the "master shaft."

In the worst-case scenario, if the centering collar is centered relative to the bearing, then the two eccentricity vectors may be cumulative.

The following relationship exists between the eccentricity \( e \), the mean graduation diameter \( D \), and the measuring error \( \Delta \theta \) (see figure below):

\[
\Delta \theta = \frac{\pm 412 \cdot e}{D}
\]

\( \Delta \theta = \) Measuring error in ° (arc seconds)

\( e = \) Eccentricity of the radial grating relative to the bearing in µm

\( D = \) Mean graduation diameter in mm

3. Radial runout of the bearing

The stated relationship for the measuring error \( \Delta \theta \) also applies to the radial runout of the bearing when the eccentricity is replaced by one half of the radial runout (half of the displayed value).

Bearing compliance under a radial load applied to the shaft causes similar errors.

4. Position error within one signal period \( \Delta \phi_u \)

The scanning units of all HEIDENHAIN encoders are adjusted such that, without any further electrical adjustment during mounting, the maximum position error within one signal period (listed below) is not exceeded.

Since inductive rotary encoders use circumferential scanning, their overall error is generally lower than that of optical rotary encoders without an integral bearing. Because overall error cannot be determined through a simple calculation, these values are provided in the following table.

Rotary encoders with inductive scanning

As with all rotary encoders without an integral bearing, the attainable accuracy of inductive-scanning encoders without an integral bearing depends on the mounting and application conditions. The stated system accuracy assumes a temperature of 20 °C and a low shaft speed. The utilization of all permissible tolerances for the operating temperature, speed, supply voltage, scanning gap, and mounting condition must be taken into account for determining the typical total error.

3534
Mechanical design types and mounting
Rotary encoders with integral bearing and stator coupling

The ECN/EQN/ERN rotary encoders feature an integral bearing and a mounted stator coupling. With these models, the encoder shaft is directly connected to the measured shaft. During angular acceleration of the shaft, the stator coupling must absorb only the torque arising from friction within the bearing. ECN/EQN/ERN rotary encoders thus exhibit excellent dynamic performance and a high natural frequency.

Benefits of the stator coupling:
- No axial mounting tolerance between the shaft and stator housing
- High natural frequency of the coupling
- High torsional rigidity of shaft coupling
- Minimized space requirement for external and internal mounting
- Easy axial mounting

Mounting the ECN/EQN 1100 and ECN/EQN/ERN 1300
The blind hollow shaft or the tapered shaft of the rotary encoder is connected at the encoder's front face to the measured shaft by way of a central screw. Proper centering onto the motor shaft is accomplished via the hollow shaft or tapered shaft. On its stator side, the ECN/EQN 1100 is connected to a plane surface with two clamping screws (without a centering collar). The stator side of the ECN/EQN/ERN 1300 is clamped in a mating hole with an axial screw. The versions with fault exclusion feature an additional nose for a positive lock in the stator.

Mounting accessories
ECN/EQN/ECI/EQI 1100: Mounting aid
For turning the encoder shaft from the rear. This facilitates finding the positive-locking connection between the encoder and the measured shaft.
ID 821077-03
ERN/EQN/EON 1300: Inspection tool
For inspecting the shaft connection (fault exclusion for rotor coupling).
ID 680644-01
HEIDENHAIN recommends inspecting the holding torque of non-positive-locking shaft connections (e.g., tapered shafts, blind hollow shafts).

The inspection tool is screwed into the M10 back-off thread from the rear of the encoder. Due to the short thread engagement, the fastening screw for the shaft is not touched. With the motor shaft locked in place, the testing torque is applied to the extension by means of a torque wrench (hexagonal, width A/F: 6.3 mm). After any nonrecurring settling, it must be ensured that there is no relative motion between the motor shaft and the encoder shaft.

Mounting the ECN/EQN/ERN 1000 and ERN 1x23
The hollow shaft of these rotary encoders is slid onto the measured shaft and clamped on the rotor side with two screws. These encoders are mounted on the stator side without a centering flange onto a plane surface via four clamping screws or via two clamping screws and washers. The ECN/EQN/ERN 1000 encoders have a blind hollow shaft, but the ERN 1123 has a hollow through shaft.

Accessory for ECN/EQN/ERN 1000
Washer
For increasing the natural frequency f_N when fastening with only two screws. ID 334653-01 (2 washers)
ECI/EBI/EQI rotary encoders without integral bearing

The ECI/EBI/EQI inductive encoders have no integral bearing. This means that the mounting and operating conditions influence the encoder’s function reserves. It is also essential to ensure that the specified mating dimensions and tolerances are maintained for all operating conditions (see mounting instructions).

The application analysis must yield values within specification for all possible operating conditions (particularly under maximum load and at minimum and maximum operating temperature) and with the signal amplitude taken into account (inspection of the scanning gap and mounting tolerance at room temperature). This particularly applies to the following determined factors:
- Maximum radial runout of the motor shaft
- Maximum axial runout of the motor shaft relative to the mounting surface
- Maximum and minimum scanning gap \(a\), including in combination with, for example, the following:
  - The length ratio between the motor shaft and the motor housing under the influence of temperature \(T_1; T_2; x_1; x_2\)
  - The bearing play \(C_x\)
  - Non-dynamic shaft offsets due to load \(X_1\)
  - The effect of the motor brakes being engaged \(X_2\)

The ECI/EBI 100 rotary encoders are pre-aligned on a plane surface and, with their hollow shaft locked, are slid onto the measured shaft. Fastening and shaft clamping are achieved with axial screws.

The ECI/EBI/EQI 1100 inductive rotary encoders are mounted flush on their axis. Their blind hollow shaft is fastened with a central screw. The stator of these rotary encoders is clamped onto a shoulder with two axial screws.

Mounting accessory
Mounting aid for removing the PCB connector (see page 42).

Permissible scanning gap
The size of the scanning gap between the rotor and the stator is dictated by the mounting situation. Later adjustment is only possible through the insertion of shim rings.

The maximum permissible error specified in the mating dimensions applies to both mounting and operation. Thus, the tolerances exploited during mounting are no longer available during operation.

Once the encoder has been mounted, the actual scanning gap between the rotor and the stator can be indirectly measured with the PWM 21 adjusting and testing package using a signal amplitude inside the rotary encoder. The characteristic curves illustrate the relationship between the signal amplitude and the deviation from the ideal scanning gap under different ambient conditions.

The example of the ECI/EBI 1100 shows the resulting deviation from the ideal scanning gap for a signal amplitude of 80% under ideal conditions. Due to tolerances within the rotary encoder, the deviation is between +0.03 mm and +0.2 mm. Thus, the maximum permissible motion of the measured shaft during operation ranges from –0.33 mm to +0.1 mm (green arrows).

Display of the scanning gap
The latest generation of encoders supports the display of the mounting dimension in the ATS software. This additional data can also be requested by the drive during closed-loop operation.

<table>
<thead>
<tr>
<th>ID</th>
<th>Exl mounting wizard</th>
<th>Mounting interface</th>
<th>ID</th>
<th>Exl mounting wizard</th>
<th>Mounting interface</th>
<th>ID</th>
<th>Exl mounting wizard</th>
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</tr>
</tbody>
</table>
The ECI/EBI/EQI 1300 inductive rotary encoders are mounted flush on their axis. Their blind hollow shaft is fastened with a central screw. The stator of these rotary encoders is clamped to a shoulder by three axial screws.

The scale drum of the ECI/EBI 4000 inductive rotary encoders is slid onto the centering collar of the measured shaft and fastened (with or without a key, depending on the version). Then the stator is fastened via an external centering diameter.

Mounting the ECI/EBI 1300
with EnDat22 and EnDat3

The ERO rotary encoders without an integral bearing consist of a scanning head and a graduated disk that must be brought into mutual alignment during mounting. Precise alignment is an important factor in reaching the attainable measuring accuracy.

The ERO modular rotary encoders consist of a disk/hub assembly and a scanning unit. These encoders are particularly well suited for limited installation space, low axial offsets, and low radial runout, or for applications where friction of any type must be avoided.

In the ERO 1200 series, the disk/hub assembly is pressed onto the shaft and brought into alignment with the scanning unit. The scanning unit is aligned on a centering collar and fastened to the mounting surface.

The encoders of the ERO 1400 series are miniaturized modular rotary encoders. These encoders feature a special built-in mounting aid that centers the graduated disk relative to the scanning unit and adjusts the gap between the graduated disk and the scanning reticle. Short installation time can thus be attained. The encoder comes with a cover cap for protection against extraneous light.

Mounting accessories for the ERO 1400

Mounting accessory
Aid for removing the clip in order to achieve optimal encoder mounting.
ID 510175-01

Accessory
Housing for the ERO 14xx with an axial PCB connector and central hole.
ID 331727-23

Mounting accessories for the ERO 1400
Information on output cables

Mounting and commissioning must be performed with appropriate ESD protection. Do not engage or disengage the connecting element when it is under power. To avoid overstressing the individual wires during disengagement of the connecting element, HEIDENHAIN recommends using the mounting aid for disconnecting the PCB connector.

Strain relief
Avoid torque or tensile stress, and use strain relief wherever necessary.

Straight M12 flange socket
Retention force of polarizing key:

- For M12, M23: \( \min T_t \leq 0.4 \text{ Nm} \)
- \( \max T_t \leq 1 \text{ Nm} \)

Minimum tensile strength of the screws: \( 800 \text{ N/mm}^2 \)

To prevent self-loosening of the screws, HEIDENHAIN recommends using a material bonding threadinglock.

Cable length (rated length)
For output cables with a crimp on the encoder side for strain relief and a shield contact, the cable length is specified up to the crimp sleeve. Exceptions apply, for example, to output cables without a crimp on the encoder side and to those with a sensor connection at the subsequent electronics or with a shield connection clamp. Upon request, you can obtain binding information (a dimension drawing) corresponding to the ID number of the respective output cable (see Cables and connecting elements).

Electromagnetic compatibility
Cables from HEIDENHAIN are tested for electromagnetic compatibility. For output cables with wires for temperature sensors, electromagnetic compatibility must be ensured in the entire system.

Crimp connector
For joining (crimping) the wires of the temperature-sensor output cable to the wires of the temperature sensor inside the motor (ID 1148157-01).

General testing accessories for modular encoders and the PWM 21

Testing cable for directly connecting a modular rotary encoder to a PWM 21

- Testing cable for modular rotary encoders with EnDat (EnDat2, EnDat1, or E30-R2) or SSI interface
  - Includes three 15-pin adapter connectors and three 15-pin adapter connectors.
  - ID 621742-01

- Connecting cable for EnDat or SSI interface
  - For extending the testing cable: completely assembled with a 15-pin D-sub connector (male) and a 15-pin D-sub connector (female), max. \( 3 \text{ m} \).
  - ID 1080091-xx

- Testing cable for modular rotary encoders with DRIVE-CLIQ interface
  - Includes three 15-pin adapter connectors and three 15-pin adapter connectors.
  - ID 621742-01

  - Only in connection with:
    - Adapter cable for DRIVE-CLIQ, \( \Omega \leq 6.8 \text{ mm} \)
    - 15-pin D-sub connector (female) and 6-pin RJ45 Ethernet connector with IP20 metal housing.
  - ID 1228389-01

- Adapter connector for ID 621742-01
  - Three connectors for replacement.
  - \( 12 \text{ m} \): ID 528694-01
  - \( 15 \text{ pin} \): ID 528694-02

- Adapter connector should be replaced after 500 connection cycles.

Testing cable for the ERN 138xx, with commutation signals for sinusoidal commutation

- Includes three 14-pin adapter connectors.
- ID 1118982-02

Connecting cable for ENR 1387
- For extending the testing cable: completely assembled with 15-pin D-sub connector (male) and 15-pin D-sub connector (female), max. \( 3 \text{ m} \).
- ID 675682-xx

- Connecting cable for ID 1118982-02
  - Three connectors for replacement.
  - ID 528694-04

- EnDat 3 adapter (SA 1210)
  - Adapter for connecting an encoder with EnDat 3 (E30-R2) to the PWM 21 21
  - 15-pin D-sub connector (male) and 15-pin D-sub connector (female)
- ID 1317260-01

Adaptor connector \( * \) for ID 621742-01
- Three connectors for replacement.
- \( 12 \text{ m} \): ID 528694-01
- \( 15 \text{ pin} \): ID 528694-02
- *Adapter connector should be replaced after 500 connection cycles.

- Testing cable for V8xx, with commutation signals for sinusoidal commutation
  - Includes three 8-pin adapter connectors.
  - ID 1118982-02

Designation of the cable components

**Wire length**

- Cable length (L1) of the additional cable

**Temperature sensor signals via electrical connection 1**

- Temperature sensor signals via rotary encoder PCBA.

**Cable bushing 1 or shield and shield assembly 1**

**Cable bushing 2 or shield and shield assembly 2**

**Cable length (L1)**

- Electrical connection 1 (customer/side) Pin layout 1
- Electrical connection 1 (customer/side) Pin layout 1
- Electrical connection 1 (customer/side) Pin layout 1
- Electrical connection 1 (customer/side) Pin layout 1

**Cable length (L)**

- Cable length (L1) of the additional cable
- Cable length (L1) of the additional cable
- Cable length (L1) of the additional cable

**Cable design**

- Cable design 1 (data transmission)
- Cable type 1, color, number of shields, outer shield
- Pin layout 2
- Cable design 1 (data transmission)
- Cable design 2 (temperature sensor)
- Pin layout 2

**Electrical connection**

- Electrical connection 5 Pin layout 2

**Temperature sensor signals via electrical connection 2**

- Temperature sensor signals via rotary encoder PCBA.

**Wire length**

- Cable length (L1)
- Cable design 1 (data transmission)
- Cable type 1, color, number of shields, outer shield
- Pin layout 2

**Temperature sensor signals via electrical connection 3**

- Temperature sensor signals via rotary encoder PCBA.
Mating dimensions and tolerances must be taken into account during the mounting of rotary encoders. Within some rotary encoder series, the mating dimensions may exhibit only slight differences or even be identical. Certain rotary encoders are therefore mounting-compatible with each other, allowing different encoders to be mounted to the same motor as the requirements dictate.

All dimensions, tolerances, and required mating dimensions are indicated in the dimension drawing of the respective series. Deviating values for rotary encoders with functional safety (FS) are provided in the corresponding Product Information documents.

All absolute rotary encoders of the ECN/EQN 1100 FS, ECI/EBI 1100, and ECI/EQI 1100 series are mounting-compatible within the respective series, exhibiting only minor differences in the permissible deviation between the shaft surface and coupling surface.

Some rotary encoders of the ERN 1300, ECN/EQN 1300, ECI/EBI/EQI 1300 FS, and ECN/EQN 400 series are also mounting-compatible with each other and can be mounted to identical motors. Minor differences, such as the anti-rotation element and a limited tolerance for the inside diameter, must be taken into account.

### Series Differences

#### ECN/EQN 1100 FS
- Standard, with slot for FS devices

#### ECN/EQN 1100 FS
- Same as ECN/EQN 1100 FS, but with a different tolerance for the deviation between the shaft and coupling surfaces

#### ECI 1118/EBI 1135
- Same as ECN/EQN 1100 FS, but with a different tolerance for the deviation between the shaft and coupling surfaces

#### ECI 1119/EQI 1131
- Same as ECN/EQN 1100 FS, but with a different tolerance for the deviation between the shaft and coupling surfaces

### Series Required mating dimensions

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<tr>
<th>Series</th>
<th>ERN 1300</th>
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<th>ECI/EBI/ EQI 1300 FS</th>
<th>ECN/ EQN 400 FS</th>
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### Series Differences

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<tr>
<th>Series</th>
<th>ERN 1300</th>
<th>ECI 1100</th>
</tr>
</thead>
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<tr>
<td>ERN 1300</td>
<td>Standard, deployable for taper shaft</td>
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</tr>
<tr>
<td>ECN/EQN 1300</td>
<td>Same as ERN 1300, but with an additional ridge as an anti-rotation element (stator coupling)</td>
<td></td>
</tr>
<tr>
<td>ECI/EBI/EQI 1300 FS</td>
<td>Same as ERN 1300, but with an anti-rotation element (flange)</td>
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### Mounting accessories

#### Screwdriver bits
- For HEIDENHAIN shaft couplings
- For ExN shaft clampings and stator couplings
- For ERD shaft clampings

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<tr>
<th>Width across flats</th>
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<td>350378-05</td>
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<td>TX15</td>
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#### Screwdriver
- When using screwdrivers with adjustable torque, make sure that they comply with DIN EN ISO 6789 for fulfilling the required torque tolerances.

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#### Screws

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#### Fastener kit
- M3 fixing clamp
- Spring washer: 3x0.70 DIN 128 A-FS ISO
- Screw: M3x10 8.8 DIN EN ISO 4762

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<tr>
<td>Spring washer: 3x0.70 DIN 128 A-FS ISO</td>
<td>200 pieces: 1264352-02</td>
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General information

Alignment of rotor positions between encoders and motors

Immediately after a synchronous motor is switched on, information is needed about its absolute rotor position. Rotary encoders with additional commutation signals are suitable for this task but provide comparatively rough position information. Absolute rotary encoders in singleturn or multturn designs are also well suited, delivering the exact angular position down to an accuracy of a few arc seconds (see also Electronic commutation with position encoders). To achieve the most constant motor currents possible, the rotor positions of the motor and of the encoder must be brought into mutual alignment when the encoder is mounted. Inadequate alignment of the rotor positions will cause significant motor noise and high power dissipation.

First, the rotor of the motor is turned to the preferred position through the application of a DC current.

Rotary encoders with commutation signals are then roughly aligned (e.g., using the line markers on the encoder or the reference mark signal) and are mounted to the motor shaft. Fine adjustment is then performed with the PWT 101 testing device (see Diagnostics, and inspection and testing equipment): the stator of the rotary encoder is turned until the PWT 101 displays a distance from the reference mark of nearly zero.

Absolute rotary encoders are first completely mounted, after which a datum shift is used to assign the value “zero” to the preferred motor position. This is performed with the adjusting and testing package (see Diagnostics, and inspection and testing equipment). This package features complete EnDat functionality, allowing not only datum shifts but also the use of other inspection functions and the setting of write-protection to prevent unintentional changes to saved values.

For the EC/EOI rotary encoders with additional 1 Vp-p signals, manual adjustment is possible as well. Please follow the information in the respective mounting instructions.

General mechanical information

Certification by NRTL (Nationally Recognized Testing Laboratory)

All of the rotary encoders in this brochure comply with the UL safety regulations for the U.S. and the CSA safety regulations for Canada.

Accelerations

During mounting and operation, encoders are subjected to various types of acceleration.

- **Vibration**
  The encoders are qualified on a test stand under the acceleration values stated in the specifications at frequencies of 55 Hz to 2000 Hz in accordance with EN 60068-2-7 (55 Hz to 2000 Hz for non-repetitive, semi-sinusoidal shock. Continuous shock loads are therefore not covered and must be tested in the application).

- **Shock**
  The encoders are qualified on a test stand under the acceleration values stated in the specifications and under the exposure times in accordance with EN 60068-2-27 for non-repetitive, semi-sinusoidal shock. Continuous shock loads are therefore not covered and must be tested in the application.

- **The maximum angular acceleration is 10^6 radi/s^2.** This is the maximum permissible angular acceleration of the rotor without the encoder incurring damage. The actual attainable angular acceleration is within the same order of magnitude but can vary depending on the type of shaft connection (for deviating values for the ECN/ERN 100, see the Specifications). An adequate safety factor must be determined through system tests.

Deviation values for rotary encoders with functional safety are provided in the corresponding Product Information documents.

Natural frequencies

In conjunction with the stator coupling, the ECN/ERN rotary encoders form an oscillation-capable spring-mass system whose natural frequency \( f_N \) of the coupling should be as high as possible in the direction of measurement. The natural frequency of the coupling is influenced by the rigidity of the stator coupling and by the customer-specific mounting situation. The stated typical natural frequencies may vary depending on the encoder variant (e.g., singleturn or multturn), production tolerances, and differing mounting conditions. If radial and/or axial acceleration forces also come into play, then the rigidity of the encoder bearing and of the encoder stator has an effect as well. If such loads occur within your application, HEIDENHAIN recommends consulting with the main factory in Traunreut.

HEIDENHAIN generally recommends determining the natural frequency of the stator coupling in the complete system.

Humidity

The maximum permissible relative humidity is 75%. A relative humidity of 93% is temporarily permissible. Condensation is not permissible.

Magnetic fields

Magnetic fields > 30 mT can affect encoder functions. Please contact HEIDENHAIN in Traunreut, Germany, as needed.

Acoustic noise

Running noise can occur during operation. This is particularly true of encoders with integral bearing and multturn rotary encoders (with gears). The intensity may vary depending on the mounting situation and shaft speed.

Starting torque and operating torque

The starting torque is the torque required to put the rotor into motion from standstill. If the rotor is already rotating, then a certain operating torque is acting on the encoder. The starting torque and operating torque are influenced by various factors, such as the temperature, prior standstill time, and the amount of wear on the bearings and seals.

The typical values stated in the specifications are mean values based on encoder-specific test series performed at room temperature and at a stabilized operating temperature. The typical operating torques are also based on constant shaft speeds. For applications in which the torque has a significant influence, HEIDENHAIN recommends consulting with the main factory in Traunreut.

Protection against contact (EN 60529)

After completed installation, any rotating parts must be sufficiently protected from unintentional contact during operation.

Protection EN 60529

The ingress of contamination can impair proper functioning of the encoder. Unless otherwise indicated, all of the rotary encoders have an IP64 rating (EN/IEC 60529: 4D). This results in an IPX7 protection rating (EN/IEC 60529: 7X). These specifications apply to the housing, cable outlet, and flange socket versions when engaged.

The shaft inlet meets an IP66 rating. Splash water must not be allowed to have any harmful effect on the encoder’s parts. If the protection rating of the shaft inlet is not sufficient (e.g., due to vertical mounting of the encoder), then the encoders should be additionally protected with labyrinth seals. Many encoders are also available with an IP65 rating for the shaft inlet. Depending on the application, the radial shaft seal rings used for sealing are subjected to wear due to friction.
System tests

Encoders from HEIDENHAIN are usually integrated as components into complete systems. Such applications require comprehensive testing of the complete system, irrespective of the encoder’s specifications. The specifications provided in this brochure apply only to the encoder and not to the complete system. Any operation of the encoder outside of the specified range or outside of its proper and intended use is solely at the user’s own risk.

Mounting

The steps and dimensions that must be complied with during mounting are specified solely in the mounting instructions supplied with the device. All mounting-related information in this brochure is therefore only provisional and non-binding, and will not become the subject matter of a contract. All provided information on screw connections assumes a mounting temperature of 15 °C to 35 °C.

Screws with material bonding anti-rotation lock

Mounting screws and central screws from HEIDENHAIN (not included in delivery) feature a coating that, after hardening, provides a material bonding anti-rotation lock. As a result, these screws cannot be reused. Their minimum shelf life is two years (storage at ≤ 30 °C and ≤ 65% relative humidity). Their expiration date is printed on the package.

Screw insertion and the application of tightening torque must therefore be completed within five minutes. The required strength is reached at room temperature after six hours. The lower the temperature is, the longer the curing process will take. Curing temperatures below 5 °C are not permissible. Screws with material bonding anti-rotation lock must not be used more than once. If a replacement becomes necessary, reut the threads and use new screws. On threaded holes, a chamfer is required in order to keep the adhesive coating from being scraped off.

4948

<figure>

<image>

Measuring the actual operating temperature at the defined measuring point of the rotary encoder (see Specifications)

</figure>

For the fault exclusion design for functional safety, the following material properties and conditions for the mating surfaces are assumed:

For encoders from HEIDENHAIN in Traunreut, Germany.

Mounting screws and central screws from HEIDENHAIN in their delivery condition.

Tightening procedure

Use a signal-emitting torqued wrench in accordance with DIN EN ISO 6789, with an accuracy of ±6%.

Rotary encoders may exert a torque of up to 1 Nm on the mating shaft. The customer-side mechanical design must be made for this load. The respective Product information documents will describe any other prerequisites.

Modifications to the encoder

The proper functioning and accuracy of encoders from HEIDENHAIN are ensured only if the encoders have not been modified. Any modification, even a minor one, can impair the proper functioning, reliability, and safety of the encoder, and result in a loss of warranty. This also includes the use of any additional or non-prescribed locking vanishes, lubricants (e.g., for screws), or adhesives. If you are in doubt, we recommend that you consult with HEIDENHAIN in Traunreut, Germany.

Conditions for longer storage periods

For a storage period of twelve months or longer, HEIDENHAIN recommends the following:

• Leave the encoders in their original packaging

• The storage location should be dry, free of dust, and temperature-regulated. It should also be free of vibration, mechanical shock, and chemical environmental influences

• Every twelve months, rotate the shafts of the encoders with integral bearing at low speed and without axial or radial shaft loading so that the bearing lubrication becomes evenly redistributed (e.g., such as when first breaking in an encoder)

Parts subject to wear

Encoders from HEIDENHAIN are designed for a long service life. Preventive maintenance is not required. However, they do contain components that are subject to wear, depending on the application and how they are deployed. This especially applies to cables that are subjected to frequent flexing. Other parts subject to wear are the bearings in encoders with integral bearing, the radial shaft seal rings in rotary encoders and angle encoders, and the sealing lips on sealed linear encoders. In order to avoid damage from current flows, some rotary encoders are available with hybrid bearings. In general, these bearings exhibit greater wear at high temperatures than standard bearings.

Service life

Unless otherwise specified, HEIDENHAIN encoders are designed for a service life of 20 years, which is equivalent to 40,000 operating hours under typical operating conditions.

Temperature ranges

For encoders still in their packaging, a storage temperature range of –30 °C to 65 °C applies (HR 1120: –30 °C to 70 °C). The operating temperature range specifies the temperatures that a rotary encoder is permitted to reach during operation in the actual installation environment. Within this range, proper functioning of the rotary encoder is ensured. The operating temperature is measured at the defined measuring point (see dimension drawing) and must not be confused with the ambient temperature.

The temperature of the rotary encoder is influenced by the following factors:

• Installation situation

• Ambient temperature

• Encoder self-heating

An encoder’s susceptibility to self-heating depends both on its design characteristics (stator coupling / solid shaft, shaft sealing ring, etc.) and on its operating parameters (shaft speed, supply voltage). A temporary period of intensified self-heating can also occur after very long breaks in operation (of several months). Please allow for a two-minute break-in period at low shaft speeds. The greater susceptibility to self-heating that an encoder exhibits, the lower the ambient temperature needs to be in order to keep the encoder within its permissible operating temperature range.

This table shows the approximate self-heating values of a rotary encoder at maximum permissible shaft speed based on its design characteristics. The relationship between shaft speed and heat generation is nearly linear.

<table>
<thead>
<tr>
<th>Solid shaft / tapered shaft</th>
<th>Blind hollow shaft</th>
<th>Hollow through-shaft</th>
</tr>
</thead>
<tbody>
<tr>
<td>ExN 400/1300</td>
<td>EAN/EQN/ERN 400</td>
<td>EAN/EQN/ERN 1000</td>
</tr>
<tr>
<td>+ 5 K</td>
<td>+ 30 K</td>
<td>+ 40 K</td>
</tr>
<tr>
<td>+ 10 K for IP64 protection</td>
<td>+ 50 K</td>
<td>for IP66 protection</td>
</tr>
</tbody>
</table>

Typical self-heating values of a rotary encoder at maximum permissible shaft speed based on its design characteristics. The relationship between shaft speed and heat generation is nearly linear.
Electrical resistance

Encoders with an integral bearing, pluggable output cable, and standard bearing
Check the resistance between the flange socket and the rotor.
Nominal value: < 1 ohm

Nominal value: < 1 ohm

Encoders with hybrid bearing or EnDat 3 (E30-R2)
Check the resistance between the flange socket and the rotor (a), and between the flange socket and the stator (metal housing) (b).
Nominal value: < 1 ohm

Exposed encoders (ExI 100) without integral bearing but with a pluggable cable
Check the electrical resistance between the flange socket and the rotor (mounting screw) (b), and between the flange socket and the stator (a).
Nominal value: < 1 ohm

Exposed encoders (ExI 1000, ExI 1300) without an integral bearing but with a pluggable output cable
Check the resistance between the flange socket and the rotor (a), and between the flange socket and the stator (metal housing) (b).
Nominal value: < 1 ohm

Exposed encoders (ExI 4000) without an integral bearing but with a pluggable output cable
Check the electrical resistance between the flange socket and the rotor (a), the flange socket and the stator (b), and the crimp sleeve (c).
Nominal value: < 1 ohm

Clamp must be screwed to the motor housing so as to be conductive.

Further information:
When connecting an external temperature sensor, please refer to the information about electromagnetic compatibility in the General electrical information section of the Interfaces of HEIDENHAIN Encoders brochure.

Temperature measurement in motors

Transmission of temperature values
To protect the motor from overloads, the motor manufacturer usually monitors the temperature of the motor winding. In classic applications, the temperature sensor data are sent via two separate lines to the subsequent electronics, where they are then evaluated. Depending on their version, HEIDENHAIN rotary encoders with the EnDat 2.2, EnDat 3, or DRIVE-CLiQ interface feature an internal temperature sensor integrated into the encoder electronics and an evaluation circuit for connection to an external temperature sensor. In both cases, the respective digitalized measured temperature value is transmitted purely serially over the interface protocol. As a result, no separate lines are needed from the motor to the motor controller.

Signaling of a temperature exceedance
When it comes to the internal temperature sensor, such rotary encoders can support the dual-level cascaded signaling of a temperature exceedance. This signaling consists of a warning (only EnDat) and an error message. The integrated memory can be read to determine whether the respective encoder supports this warning and error message functionality. The warning threshold for the internal temperature sensor can be individually adjusted. At the time the encoder is shipped, a default value equivalent to the maximum permissible operating temperature is stored here (temperature at measuring point M1 as per the dimension drawing). The temperature measured by the internal temperature sensor is higher by a device-specific amount than the temperature at measuring point M1.

The encoder features a further, albeit non-adjustable trigger threshold for the internal temperature sensor; an error message is output when this threshold is reached. This trigger threshold is device-specific and, if present, is stated in the specifications.

Further information:
When connecting an external temperature sensor, please refer to the information about electromagnetic compatibility in the General electrical information section of the Interfaces of HEIDENHAIN Encoders brochure.

Further information:
When connecting an external temperature sensor; an error message is output when this threshold is reached. This trigger threshold is device-specific and, if present, is stated in the specifications.

For more information on configuring and reading the temperature information, please refer to the respective Application Notes: EnDat 2.2: Document 722024 EnDat 3: Document 3000005 DRIVE-CLiQ: Document 1238334

<table>
<thead>
<tr>
<th>Encoder</th>
<th>Interface</th>
<th>Internal temperature sensor</th>
<th>External temperature sensor</th>
<th>Connection</th>
</tr>
</thead>
<tbody>
<tr>
<td>ECI/EGI 1100</td>
<td>EnDat22</td>
<td>✓ (±1 K) Possible</td>
<td>Possible</td>
<td></td>
</tr>
<tr>
<td>ECI/EBI 1100</td>
<td>EnDat22</td>
<td>✓ (±5 K) –</td>
<td>–</td>
<td></td>
</tr>
<tr>
<td>ECN/EGN 1100</td>
<td>EnDat22</td>
<td>✓ (±5 K) Possible</td>
<td>Possible</td>
<td></td>
</tr>
<tr>
<td>–</td>
<td>EnDat01</td>
<td>–</td>
<td>–</td>
<td></td>
</tr>
<tr>
<td>–</td>
<td>DQ</td>
<td>✓ (±7 K) Possible</td>
<td>Possible</td>
<td></td>
</tr>
<tr>
<td>ECN/EGN 1300</td>
<td>EnDat22</td>
<td>✓ (±4 K) Possible</td>
<td>Possible</td>
<td></td>
</tr>
<tr>
<td>ECI/EBI 1300</td>
<td>EnDat22</td>
<td>✓ (±1 K) Possible</td>
<td>Possible</td>
<td></td>
</tr>
<tr>
<td>ECI/EGI 1300 S</td>
<td>EnDat22</td>
<td>✓ (±1 K) Possible</td>
<td>Possible</td>
<td></td>
</tr>
<tr>
<td>ECI/EBI 100</td>
<td>EnDat22</td>
<td>✓ (±4 K) Possible</td>
<td>Possible</td>
<td></td>
</tr>
<tr>
<td>–</td>
<td>EnDat01</td>
<td>–</td>
<td>–</td>
<td></td>
</tr>
<tr>
<td>ECN/EGN 400</td>
<td>EnDat22</td>
<td>✓ (±4 K) Possible</td>
<td>Possible</td>
<td></td>
</tr>
<tr>
<td>–</td>
<td>EnDat01</td>
<td>–</td>
<td>–</td>
<td></td>
</tr>
</tbody>
</table>

HEIDENHAIN recommends adjusting the warning threshold based on the application such that this threshold is sufficiently below the trigger threshold for the “Temperature exceedance” error message. Compliance with the operating temperature at measuring point M1 is also required for adherence to the encoder’s proper and intended use.

Further information:
When connecting an external temperature sensor, please refer to the information about electromagnetic compatibility in the General electrical information section of the Interfaces of HEIDENHAIN Encoders brochure.
Information on connecting an external temperature sensor

- The external temperature sensor must comply with the following requirements as per EN 61800-5-1:
  - Voltage class A
  - Contamination level 2
  - Overvoltage category 3
- The connections for the temperature sensor are galvanically connected with the encoder electronics.
- Depending on the application, the temperature sensor assembly (sensor + cable assembly) must be mounted such that it is insulated from its environment with double or reinforced insulation.
- The accuracy of the temperature measurement depends on the temperature range.
- Take into account the tolerance of the temperature sensor.
- The motor manufacturer is responsible for the quality and accuracy of the temperature sensor.
- Use a crimp connector with a suitable cable assembly.
- Connect only passive temperature sensors.
- The connections for the temperature sensor, as well as for the encoder electronics.
- The accuracy of the temperature measurement depends on the sensor being used and on the temperature range.
- Depending on the application, the temperature sensor assembly (sensor + cable assembly) must be mounted such that it is insulated from its environment with double or reinforced insulation.
- The accuracy of the temperature measurement depends on the temperature range.

Connectable temperature sensors

With EnDat22 encoders, the temperature evaluation performed within the rotary encoder is designed for a KTY 84-130 PTC thermistor. For other temperature sensors, the output value (value in additional data 1) must be converted into a temperature value.

Figure 1 illustrates the relationship between the output value and the resistance of the temperature sensor.

When a KTY 84-130 is used, the temperature value equals the output value. The value has an increment of 0.1 kelvins.

Figure 2 illustrates the relationship for EnDat22 encoders between the output value and the temperature value for a PT 1000. In the graph, the temperature value for the PT 1000 can be determined based on the output value.

Notes on the conversion:
- The conversion for PT 1000 and KTY 83-110 must be performed for encoders that do not inherently support this conversion.
- For PT 1000, the following polynomial can be used to calculate the temperature value:

\[
\text{Temperature}_{PT1000} = 1.3823 \cdot 10^{-7} \cdot A^3 - 1.205 \cdot 10^{-3} \cdot A^2 + 4.6897 \cdot A - 5.2276 \cdot 10^3
\]

A = Output value. The PT 1000 polynomial is valid for: 3400 ≤ A ≤ 4810.

Example for the PT 1000 temperature sensor:
- Output value = 3761  →  Temperature value = 2734 (equivalent to 0.3 °C).

The following polynomial can be used to calculate the temperature value:

\[
\text{Temperature}_{KTY83-110} = 3.007 \cdot 10^{-6} \cdot A^3 - 3.041 \cdot 10^{-5} \cdot A^2 + 1.786 \cdot A - 1.027 \cdot 10^3
\]

A = Output value. The KTY83-110 polynomial is valid for: 2880 ≤ A ≤ 5460.

For encoders with E30-R2 and DRIVE-CLiq interface, the encoder can be configured for the connected temperature sensor. The correct temperature value is then output directly over the interface.

Cable configuration of the temperature wires in the motor

The accuracy of the temperature measurement depends on the sensor being used and on the temperature range.

<table>
<thead>
<tr>
<th>Specifications for the evaluation</th>
<th>KTY 83-110</th>
<th>KTY 84-130</th>
<th>PT 1000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resolution</td>
<td>0.1 K (with KTY 84-130)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Supply voltage of sensor</td>
<td>3.3 V over dropping resistor RV = 2 kΩ</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Measuring current (typical)</td>
<td>1.2 mA at 595 Ω, 1.0 mA at 990 Ω</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total delay</td>
<td>160 ms max.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cable length (^1)</td>
<td>≤ 1 m</td>
<td></td>
<td></td>
</tr>
<tr>
<td>With wire cross section of 0.16 mm(^2) for TPE, or 0.25 mm(^2) for cross-linked polyethylene</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\(^1\) Filter time constants and conversion time are taken into account; the time constants / response delay of the temperature sensor and the time lag for reading via the encoder interface are not included in this.

\(^2\) Limitation of the cable length due to interference; the measuring error due to the line resistance is negligible.

Figure 1: Relationship between the output value and temperature value using the example of the KTY 83-110 and KTY 84-130 temperature sensors.

Example for the KTY 84-130 temperature sensor:
- Sensor resistance = 1000 Ω  →  Output value (temperature value) = 3761, which is equal to 376.1 K or 102 °C.

Example for the PT 1000 temperature sensor:
- Output value = 2734  →  Temperature value = 2.734 °C.

The following polynomial can be used to calculate the temperature value:

\[
\text{Temperature}_{KTY83-110} = 3.007 \cdot 10^{-6} \cdot A^3 - 3.041 \cdot 10^{-5} \cdot A^2 + 1.786 \cdot A - 1.027 \cdot 10^3
\]

A = Output value. The KTY83-110 polynomial is valid for: 2880 ≤ A ≤ 5460.
ECN/EQN 1100 series

**Absolute rotary encoders**
- 75A stator coupling for plane surface
- Blind hollow shaft
- Encoders available with functional safety

### Required mating dimensions

- **10 = Possible centering hole**
- **9 = ECI/EBI flange surface; ensure full-surface contact!**
- **8 = Maximum permissible deviation between the shaft surface and coupling surfaces. Compensation of mounting tolerances and thermal expansion,**
- **7 = Maximum permissible deviation between shaft and coupling surfaces. Compensation of mounting tolerances and thermal expansion,**
- **6 = Coupling surface of ECN/EQN**
- **5 = ECI/EQI FS flange surface: ensure full-surface contact!**
- **4 = Slot required only for ECN/EQN and ECI/EQI, WELLA1 = 1KA**
- **3 = Shaft surface; ensure full-surface contact!**
- **2 = Chamfer at start of thread is mandatory for material bonding anti-rotation lock**
- **1 = Contact surface of slot**

**M2 = Measuring point for vibration**
**M1 = Measuring point for operating temperature**

**M3**
- 5 V:
  - **Power consumption (without load):**
    - **3.6 V:** 85 mA
    - **14 V:** 105 mA
    - **28.8 V:** 105 mA
  - **Current consumption (without load):**
    - **3.6 V:** 24 V
    - **14 V:** 24 V
    - **28.8 V:** 24 V

**M2 = Measuring point for vibration**
**M1 = Measuring point for operating temperature**

### Interface

**Absolute**

<table>
<thead>
<tr>
<th>Interface</th>
<th>ECN 1113</th>
<th>ECN 1123</th>
<th>ECN 1123 S</th>
<th>EQN 1125</th>
<th>EQN 1135</th>
<th>EQN 1135 S</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interface</td>
<td>EnDat 2.2</td>
<td>EnDat 2.2</td>
<td>EnDat 2.2</td>
<td>EnDat 2.2</td>
<td>EnDat 2.2</td>
<td>EnDat 2.2</td>
</tr>
<tr>
<td>Ordering designation</td>
<td>EnDat01</td>
<td>EnDat22</td>
<td>EnDat22</td>
<td>EnDat01</td>
<td>EnDat22</td>
<td>EnDat22</td>
</tr>
<tr>
<td>Position values per rev.</td>
<td>8192 (13 bits)</td>
<td>8192 (13 bits)</td>
<td>8192 (13 bits)</td>
<td>8192 (13 bits)</td>
<td>8192 (13 bits)</td>
<td>8192 (13 bits)</td>
</tr>
<tr>
<td>Revolutions</td>
<td>4,086 (12 bits)</td>
<td>4,086 (12 bits)</td>
<td>4,086 (12 bits)</td>
<td>4,086 (12 bits)</td>
<td>4,086 (12 bits)</td>
<td>4,086 (12 bits)</td>
</tr>
<tr>
<td>Elec. permiss. shaft speed/revolutions</td>
<td>12,000 rpm/±16 LSB</td>
<td>12,000 rpm/±16 LSB</td>
<td>12,000 rpm/±16 LSB</td>
<td>12,000 rpm/±16 LSB</td>
<td>12,000 rpm/±16 LSB</td>
<td>12,000 rpm/±16 LSB</td>
</tr>
<tr>
<td>Mech. permiss. shaft speed</td>
<td>4,000 rpm/±1 LSB</td>
<td>4,000 rpm/±1 LSB</td>
<td>4,000 rpm/±1 LSB</td>
<td>4,000 rpm/±1 LSB</td>
<td>4,000 rpm/±1 LSB</td>
<td>4,000 rpm/±1 LSB</td>
</tr>
<tr>
<td>Power consumption</td>
<td>3.6 V: 0.7 W</td>
<td>3.6 V: 0.7 W</td>
<td>3.6 V: 0.7 W</td>
<td>3.6 V: 0.7 W</td>
<td>3.6 V: 0.7 W</td>
<td>3.6 V: 0.7 W</td>
</tr>
<tr>
<td>Max. operating temperature</td>
<td>115 °C</td>
<td>115 °C</td>
<td>115 °C</td>
<td>115 °C</td>
<td>115 °C</td>
<td>115 °C</td>
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<tr>
<td>Min. operating temperature</td>
<td>40 °C</td>
<td>40 °C</td>
<td>40 °C</td>
<td>40 °C</td>
<td>40 °C</td>
<td>40 °C</td>
</tr>
</tbody>
</table>

### System accuracy

- **±0.5°**

### Electrical connection

- **15-pin**
  - **15-pin**
  - **15-pin**

### Specifications

**ID number**
- **803427-xx**
- **803429-xx**
- **803428-xx**
- **803430-xx**
- **803432-xx**

### Mechanical specifications

- **Max. operating temperature:** 115 °C
- **Min. operating temperature:** 40 °C

### Inspection points

- **2) Deviating tolerances Signal amplitude: 0.80 Vpp to 1.2 Vpp Asymmetry: 0.05° Signal ratio: 0.9 to 1.1 Phase angle: 90° elec. ±5° elec.**

### General notes

- **See Temperature measurement in motors**
- **For dimensions and specifications of encoders with functional safety, see the Product Information document.**
ERN 1023
Incremental rotary encoders
- Stator coupling for plane surface
- Blind hollow shaft
- Block commutation signals

**Interface**

<table>
<thead>
<tr>
<th>Signal periods per rev.*</th>
<th>500</th>
<th>512</th>
<th>600</th>
<th>1000</th>
<th>1024</th>
<th>1250</th>
<th>2000</th>
<th>2048</th>
<th>2500</th>
<th>4096</th>
<th>5000</th>
<th>8192</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reference mark</td>
<td>One</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output frequency</td>
<td>≤ 300 kHz</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Edge separation a</td>
<td>≥ 0.41 µs</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Commutation signals</strong></td>
<td>TTL (3 commutation signals U, V, W)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Width*</td>
<td>2 x 180° (C01); 3 x 120° (C02); 4 x 90° (C03)</td>
<td></td>
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<td></td>
</tr>
<tr>
<td><strong>System accuracy</strong></td>
<td>±260&quot; ±130&quot;</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td><strong>Electrical connection</strong></td>
<td>Cable 1 m, 5 m, without coupling</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td><strong>Supply voltage</strong></td>
<td>DC 5 V ±0.5 V</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td><strong>Current consumption (without load)</strong></td>
<td>≤ 70 mA</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
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<td></td>
</tr>
<tr>
<td><strong>Shaft</strong></td>
<td>Blind hollow shaft Ø 6 mm</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Mech. perm. shaft speed n</td>
<td>≤ 6000 rpm</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Starting torque (typical)</td>
<td>0.005 Nm (at 20 °C)</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Moment of inertia of rotor</td>
<td>0.5 · 10⁻⁶ kgm²</td>
<td></td>
<td></td>
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<td></td>
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<td></td>
</tr>
<tr>
<td>Permissible axial motion of measured shaft</td>
<td>±0.15 mm</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td><strong>Vibration</strong></td>
<td>25 Hz to 2000 Hz</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Shock</strong></td>
<td>6 ms</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>1)  Three square-wave signals with signal periods with 90°, 120°, or 180° mech. phase shift; see Commutation signals for block commutation in the Interfaces of HEIDENHAIN Encoders brochure</td>
<td></td>
<td></td>
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<td></td>
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<td></td>
<td></td>
</tr>
</tbody>
</table>

**Bold:** This preferred version is available on short notice

* Please select when ordering

1) Three square-wave signals with signal periods with 90°, 120°, or 180° mechanical phase shift; see Commutation signals for block commutation in the Interfaces of HEIDENHAIN Encoders brochure

---

**Notes:**
- k = Required mating dimensions
- M = Measuring point for operating temperature
- 1 = Two screws in clamping ring; tightening torque: 0.6 Nm ±0.1 Nm; width A/F 1.5
- 2 = Reference mark position ±10°
- 3 = Compensation of mounting tolerances and thermal expansion, no dynamic motion permitted
- 4 = Ensure protection against contact (EN 60529)
- 5 = Direction of shaft rotation for ascending position values

---

**ISO 2768 - m H**
- ø 6 mm: ±0.2 mm
### ERN 1123

Incremental rotary encoders
- Stator coupling for plane surface
- Hollow through shaft
- Block commutation signals

#### Interface

<table>
<thead>
<tr>
<th>Signal periods per rev.*</th>
<th>500</th>
<th>512</th>
<th>600</th>
<th>1000</th>
<th>1024</th>
<th>1250</th>
<th>2000</th>
<th>2048</th>
<th>2500</th>
<th>4096</th>
<th>5000</th>
<th>8192</th>
</tr>
</thead>
</table>

#### Reference mark
- One

#### Output frequency
- ≤ 300 kHz
- ≥ 0.41 µs

#### Commutation signals
- TTL (3 commutation signals U, V, W)

#### Width
- 2 x 180° (C01); 3 x 120° (C02); 4 x 90° (C03)

#### System accuracy
- ±260°
- ±130°

#### Electrical connection
- 15-pin

#### Supply voltage
- DC 5 V ±0.5 V

#### Current consumption
- ≤ 70 mA

#### Shaft
- Hollow through shaft (Ø 8 mm)

#### Mech. permissible shaft speed
- ≤ 6000 rpm

#### Starting torque (typical)
- 0.005 Nm (at 20 °C)

#### Moment of inertia of rotor
- 0.5 · 10^{-6} kgm²

#### Permissible axial motion of measured shaft
- ±0.15 mm

#### Vibration
- 25 Hz to 2000 Hz
- ≤ 100 m/s² (EN 60068-2-6)
- ≤ 1000 m/s² (EN 60068-2-27)

#### Operating temperature
- -20 °C to 90 °C

#### Protection
- EN 60529 IP00

#### Mass
- 0.06 kg

#### ID number
- 694702-xx

* Please select when ordering

1) Three square-wave signals with signal periods with 90°, 120°, or 180° mech. phase shift; see Commutation signals for block commutation in the Interfaces of HEIDENHAIN Encoders brochure

2) Electromagnetic compatibility must be ensured in the entire system

---

**Bold:** This preferred version is available on short notice

Symbols:
- = Bearing of mating shaft
- = Required mating dimensions
M = Measuring point for operating temperature
1 = Two screws in clamping ring; tightening torque: 0.6 Nm ±0.1 Nm; width A/F 1.5
2 = Reference mark position ±10°
3 = 15-pin PCB connector
4 = Compensation of mounting tolerances and thermal expansion, no dynamic motion permitted
5 = Ensure protection against contact (EN 60529)
6 = Direction of shaft rotation for ascending position values

---

mm

ISO 8015
ISO 7808 + m H
≤ 6 mm: ±0.2 mm
ECN/EQN 1300 series

Absolute rotary encoders
- 07B stator coupling with anti-rotation element for axial mounting
- 65B tapered shaft
- Encoders available with functional safety
- Fault exclusion for rotor coupling and stator coupling as per EN 61800-5-2 possible

<table>
<thead>
<tr>
<th>Interface</th>
<th>ECN 1313</th>
<th>ECN 1325</th>
<th>EQN 1325</th>
<th>EQN 1337</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ordering designation</td>
<td>EnDat01</td>
<td>EnDat22</td>
<td>EnDat01</td>
<td>EnDat22</td>
</tr>
<tr>
<td>Position values per rev.</td>
<td>8192 (13 bits)</td>
<td>33554432 (25 bits)</td>
<td>8192 (13 bits)</td>
<td>33554432 (25 bits)</td>
</tr>
<tr>
<td>Revolutions</td>
<td>4096 (12 bits)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Elec. permiss. shaft speed/ deviations¹</td>
<td>512 lines: 5 000 rpm±1 LSB 12 000 rpm±100 LSB 2048 lines: 1500 rpm±1 LSB 12 000 rpm±60 LSB</td>
<td>512 lines: 5 000 rpm±1 LSB 12 000 rpm±100 LSB 2048 lines: 1500 rpm±1 LSB 12 000 rpm±60 LSB</td>
<td>512 lines: 5 000 rpm±1 LSB 12 000 rpm±100 LSB 2048 lines: 1500 rpm±1 LSB 12 000 rpm±60 LSB</td>
<td>512 lines: 5 000 rpm±1 LSB 12 000 rpm±100 LSB 2048 lines: 1500 rpm±1 LSB 12 000 rpm±60 LSB</td>
</tr>
<tr>
<td>Calculation time tcalc</td>
<td>9 µs 2 MHz</td>
<td>7 µs 8 MHz</td>
<td>9 µs 2 MHz</td>
<td>7 µs 8 MHz</td>
</tr>
<tr>
<td>System accuracy</td>
<td>512 lines: ±0.5°; 2048 lines: ±0.2°</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Electrical connection</td>
<td>12-pin 16-pin with connection for temperature sensor³</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Power consumption (maximum)</td>
<td>3.6 V ≤ 0.6 W 14 V ≤ 0.8 W</td>
<td>3.6 V ≤ 0.7 W 14 V ≤ 0.8 W</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Current consumption (typical)</td>
<td>5 V ≤ 55 mA (without load)</td>
<td>5 V ≤ 105 mA (without load)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shaft</td>
<td>Tapered shaft Ø 8.25 mm; taper 1:10</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mech. permiss. shaft speed n</td>
<td>≤ 15 000 rpm</td>
<td>≤ 12 000 rpm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Starting torque (typical)</td>
<td>0.01 Nm (at 20 °C)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Moment of inertia of rotor</td>
<td>2.6 · 10⁻⁶ kgm²</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Natural frequency fn (typical)</td>
<td>1800 Hz</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Permissible axial motion of measured shaft</td>
<td>±0.5 mm</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vibration (55 Hz to 2000 Hz)</td>
<td>≤ 300 m/s² (EN 60068-2-6) ≤ 2000 m/s² (EN 60068-2-27)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shock (6 ms)</td>
<td>≤ 150 m/s² (EN 60068-2-27)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operating temperature</td>
<td>-40 °C to 115 °C</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Protection</td>
<td>IP40 when mounted</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mass</td>
<td>≤ 0.25 kg</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

For dimensions and specifications of encoders with functional safety, see the Product Information document.

¹ Deviating tolerances
- Signal amplitude: 0.8 Vpp to 1.2 Vpp
- Asymmetry: ±0.05
- Amplitude ratio: 0.9 to 1.1
- Phase angle: 90° electric ±5° electric
- Signal-to-noise ratio: E/F ≤ 100 mV

² Speed-dependent deviations between absolute and incremental signals

³ Evaluation optimized for KTY 84-130

⁴ Valid as per standard at room temp.; the following applies at operating temps. up to 100 °C: ≤ 300 m/s², up to 115 °C: ≤ 150 m/s²

For dimensions and specifications of encoders with functional safety, see the Product Information document.
ECN/EQN 1300 S series

Absolute rotary encoders
- 07B stator coupling with anti-rotation element for axial mounting
- 65B tapered shaft
- Encoders available with functional safety
- Fault exclusion for rotor coupling and stator coupling as per EN 61800-5-2 possible

Interface

```
<table>
<thead>
<tr>
<th>Absolute</th>
<th>ECN 1324S</th>
<th>EQN 1336S</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interface</td>
<td>DRIVE-CLiQ</td>
<td></td>
</tr>
<tr>
<td>Ordering designation</td>
<td>DQ01</td>
<td></td>
</tr>
<tr>
<td>Position values per rev.</td>
<td>16 777 216 (24 bits)</td>
<td>4096 (12 bits)</td>
</tr>
<tr>
<td>Revolutions</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shaft speed</td>
<td>≤ 15 000 rpm (at ≤ 2 position requests per revolution)</td>
<td>≤ 12 000 rpm (at ≤ 2 position requests per revolution)</td>
</tr>
<tr>
<td>Calculation time</td>
<td>TIME_MAX_ACTVAL</td>
<td>≤ 8 µs</td>
</tr>
<tr>
<td>Incremental signals</td>
<td>--</td>
<td></td>
</tr>
<tr>
<td>System accuracy</td>
<td>±20&quot;</td>
<td></td>
</tr>
</tbody>
</table>
```

```
| Electrical connection | 16-pin with connection for temperature sensor |
| Supply voltage DC | 10 V to 28 V |
| Power consumption (maximum) | 10 V: ≤ 0.9 W | 28.8 V: ≤ 1 W |
| Current consumption (typical) | 24 V: 38 mA (without load) | 24 V: 43 mA (without load) |
| Shaft | Tapered shaft Ø 9.25 mm; taper 1:10 |
| Starting torque (typical) | 0.01 Nm (at 20 °C) |
| Moment of inertia of rotor | 2.6 · 10⁻⁶ kgm² |
| Natural frequency fNy (typical) | 1800 Hz |
| Permissible axial motion of measured shaft | ±0.5 mm |
| Vibration | 65 Hz to 2000 Hz |
| Shock 0 ms | ≤ 300 m/s² (EN 60068-2-6) |
| Operating temperature | -30 °C to 100 °C |
| Protection | EN 60529 |
| Mass | ≈ 0.25 kg |
| ID number | 1179144-xx | 1179145-xx |

For dimensions and specifications of encoders with functional safety, see the Product Information document.

1) Evaluation optimized for the KTY 84-130 and PT 1000 (see Temperature measurement in motors)

DRIVE-CLiQ is a registered trademark of Siemens AG.
**ECN/EQN 400 series**

**Absolute rotary encoders**

- 07B stator coupling with anti-rotation element for axial mounting
- 65B tapered shaft
- Encoders available with functional safety
- Fault exclusion for rotor coupling and stator coupling as per EN 61800-5-2 possible

**Required mating dimensions**

<table>
<thead>
<tr>
<th>ID number</th>
<th>1065922-xx</th>
<th>683644-xx</th>
<th>1109258-xx</th>
<th>683648-xx</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ID number</strong></td>
<td><strong>1065922-xx</strong></td>
<td><strong>683644-xx</strong></td>
<td><strong>1109258-xx</strong></td>
<td><strong>683648-xx</strong></td>
</tr>
<tr>
<td><strong>Interface</strong></td>
<td>EnDat 22</td>
<td>EnDat22</td>
<td>EnDat22</td>
<td>EnDat22</td>
</tr>
<tr>
<td><strong>Ordering designation</strong></td>
<td>EnDat01</td>
<td>EnDat22</td>
<td>EnDat01</td>
<td>EnDat22</td>
</tr>
<tr>
<td><strong>Position values per rev.</strong></td>
<td>8192 (13 bits)</td>
<td>33554432 (25 bits)</td>
<td>8192 (13 bits)</td>
<td>33554432 (25 bits)</td>
</tr>
<tr>
<td><strong>Revolutions</strong></td>
<td>4096 (12 bits)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Elec. permiss. shaft speed/ deviations</strong></td>
<td>1500 rpm/±1 LSB</td>
<td>12 000 rpm/±50 LSB</td>
<td>15 000 rpm (for continuous position value)</td>
<td>12 000 rpm/±50 LSB</td>
</tr>
<tr>
<td><strong>Clock frequency</strong></td>
<td>≤ 9 µs ≤ 2 MHz</td>
<td>≤ 7 µs ≤ 16 MHz</td>
<td>≤ 9 µs ≤ 2 MHz</td>
<td>≤ 7 µs ≤ 16 MHz</td>
</tr>
<tr>
<td><strong>Incremental signals</strong></td>
<td>1 Vpp 1)</td>
<td>–</td>
<td>1 Vpp 1)</td>
<td>–</td>
</tr>
<tr>
<td><strong>Line count</strong></td>
<td>2048</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Cutoff frequency</strong></td>
<td>≥ 400 kHz</td>
<td>–</td>
<td>≥ 400 kHz</td>
<td>–</td>
</tr>
<tr>
<td><strong>System accuracy</strong></td>
<td>±20°</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Electrical connection</strong></td>
<td>Cable (6 m) with or without M23 coupling</td>
<td>Cable (6 m) with M12 coupling</td>
<td>Cable (6 m) with or without M23 coupling</td>
<td>Cable (6 m) with M12 coupling</td>
</tr>
<tr>
<td><strong>Supply voltage</strong></td>
<td>DC 3.6 V to 14 V</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Power consumption</strong></td>
<td>3.6 V: 0.6 W</td>
<td>14 V: 0.8 W</td>
<td>3.6 V: 0.7 W</td>
<td>14 V: 0.8 W</td>
</tr>
<tr>
<td><strong>Current consumption</strong></td>
<td>5 V: 85 mA (without load)</td>
<td>5 V: 105 mA (without load)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Mech. permiss. shaft speed</strong></td>
<td>≤ 15 000 rpm</td>
<td>≤ 12 000 rpm</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Starting torque (typical)</strong></td>
<td>0.01 Nm (at 20 °C)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Moment of inertia of rotor</strong></td>
<td>2.6 · 10⁻⁶ kg²</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Natural frequency f₀ (typical)</strong></td>
<td>1800 Hz</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Permissible axial motion of measured shaft</strong></td>
<td>±0.5 mm</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Vibration</strong></td>
<td>≤ 300 m/s² (EN 60088-2-6)</td>
<td>≤ 2000 m/s² (EN 60088-2-27)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Max. operating temp.</strong></td>
<td>100 °C</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Min. operating temperature</strong></td>
<td>Fixed cable: –40 °C</td>
<td>Moving cable: –10 °C</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Protection</strong></td>
<td>EN 60529</td>
<td>IP64 when mounted</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Mass</strong></td>
<td>0.25 kg</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1) Please select when ordering

For dimensions and specifications of encoders with functional safety, see the Product Information document.

---

1. Deviating tolerances
   - Signal amplitude: 0.8 Vpp to 1.2 Vpp
   - Asymmetry: 0.05
   - Amplitude ratio: 0.9 to 1.1
   - Phase angle: ±5° elec., ±5° elec.

2. Speed-dependent deviations between absolute and incremental signals
ERN 1300 series

Incremental rotary encoders
- 06 stator coupling for axial mounting
- 65B tapered shaft

**ERN 1211**
- 12-pin, 14-pin, or 16-pin PCB connector
- Reference mark position on shaft and cap
- M10 back-off thread

**ERN 1381**
- 8192 lines: 80 °C

**ERN 1387**
- 2048 lines: ±20 °C

**ERN 1326**
- 2048 lines: ±15 °C

**ERN 1321**
- 1024 lines: ±64 °C

**ERN 1381**
- 2048 lines: ±32 °C

**ERN 1387**
- 4096 lines: ±16 °C

**ERN 1326**
- 8192 lines: ±16 °C

**Interface**

**ERN 1300 series**

**ERN 1211**
- 12-pin, 14-pin, or 16-pin PCB connector
- Reference mark position on shaft and cap
- M10 back-off thread

**ERN 1381**
- 8192 lines: 80 °C

**ERN 1387**
- 2048 lines: ±20 °C

**ERN 1326**
- 2048 lines: ±15 °C

**ERN 1321**
- 1024 lines: ±64 °C

**ERN 1381**
- 2048 lines: ±32 °C

**ERN 1387**
- 4096 lines: ±16 °C

**ERN 1326**
- 8192 lines: ±16 °C

**Reference mark**

- One

**Output frequency**

- ≤ 300 kHz
- ≥ 210 kHz

**Cutoff frequency -3 dB**

- ≤ 0.35 μs
- ≥ 0.35 μs

**Commutation signals**

- 1 Vpp

**Width**

- 3 x 120°; 4 x 90°

**Electrical connection**

- DC 5 V ±0.5 V

**Supply voltage**

- DC 5 V ±0.25 V

**Current consumption (without load)**

- ≤ 120 mA
- ≤ 130 mA
- ≤ 150 mA

**Shaft**

- Tapered shaft Ø 8.25 mm; taper 1:10

**Mech. permis. shaft speed**

- ≤ 15 000 rpm

**Starting torque (typical)**

- 0.01 Nm (at 20 °C)

**Moment of inertia of rotor**

- 2.6 · 10⁻⁶ kgm²

**Permissible axial motion of measured shaft**

- ±0.5 mm

**Vibration**

- 65 Hz to 2000 Hz

**Shock**

- 300 m/s²
- 2000 m/s²

**Max. operating temperature**

- 120 °C

**Min. operating temperature**

- –40 °C

**Protection**

- EN 60529

**Mass**

- 0.25 kg

**ID number**

- 385423-xx
- 534118-xx
- 749144-xx
- 574485-xx

1) Please select when ordering.

1) Deviating tolerances

**Signal amplitude:**

- 0.8 Vpp to 1.2 Vpp

**Asymmetry:**

- 0.05

**Amplitude ratio:**

- 0.9 to 1.1

**Phase angle:**

- 90° elec. ±5° elec.

**Signal-to-noise ratio E, F:**

- 100 mV

2) One sine and one cosine signal per revolution; see the Interfaces of HEIDENHAIN Encoders brochure

3) Three square-wave signals with signal periods with 90° or 120° mech. phase shift; see the Interfaces of HEIDENHAIN Encoders brochure

4) Valid as per standard at room temperature; at operating temperatures up to 100 °C: ≤ 300 m/s²;

5) Up to 120 °C: ≤ 150 m/s²

* Via integrated signal doubling

**Alternative:**

ERN 1300 mating dimensions with slot for stator coupling for the anti-rotation element are also usable.
ECI/EQI 1100 series

Absolute rotary encoders
- Flange for axial mounting
- Blind hollow shaft
- Without integral bearing

### ECI 1119
- Absolute, singleturn
  - Interface: EnDat 2.2
  - Ordering designation: EnDat22
  - Position values per rev.: 524,288 (19 bits)
  - Revolutions: --
  - Calculation time $t_{\text{cal}}$: ≤ 5 µs
  - Clock frequency: ≤ 16 MHz
  - Positioner time: 14 µs (typical)
  - System accuracy: ±120"

### EQI 1131
- Absolute, multiturn
  - Interface: EnDat 3
  - Ordering designation: E30-R2
  - Position values per rev.: 4096 (12 bits)
  - Revolutions: --
  - Calculation time $t_{\text{cal}}$: ≤ 5 µs
  - Clock frequency: ≤ 16 MHz
  - Positioner time: 14 µs (typical)
  - System accuracy: ±120"

### Electrical connection
- 15-pin (with connection for external temperature sensor)
- Cable length:
  - EnDat 3: ≤ 100 m at 12.5 Mbit/s; ≤ 40 m at 25 Mbit/s
  - EnDat 2.2: ≤ 100 m

### Supply voltage
- DC 3.6 V to 14 V

### Power consumption
- (maximum)
  - 3.6 V: ≤ 0.65 W
  - 14 V: ≤ 0.7 W
  - 12 V: 45 mA (without communication)

### Current consumption (typical)
- 5 V:
  - 95 mA (without load)
  - 12 V: ≤ 0.85 W; 14 V: ≤ 0.9 W
  - 5 V: 115 mA (without load)
  - 12 V: ≥ 0.95 W; 14 V: ≤ 1 W

### Shaft
- Blind hollow shaft for axial clamping Ø 6 mm without positive-locking element (82A) or with positive-locking element (1KA)

### Shaft speed
- 15 000 rpm

### Moment of inertia of rotor
- 0.2 · 10⁻⁶ kgm²

### Angular acceleration of rotor
- ≤ 1 · 10⁵ rad/s²

### Permissible axial motion of measured shaft
- ±0.4 mm

### Vibration
- 55 Hz to 2000 Hz

### Shock 6 ms
- Stator: ≤ 400 m/s²; rotor: ≤ 600 m/s² (EN 60068-2-6) ≤ 2000 m/s² (EN 60068-2-27)

### Operating temperature
- −40 °C to 110 °C

### Trigger threshold of temperature exceedance
- 125 °C (measuring accuracy of the internal temperature sensor: ±1 K)

### Protection
- EN 60529
  - IP20 when mounted

### Mass
- 0.04 kg

### ID number
- 1164809-xx
- 1259551-xx
- 1164811-xx
- 1259552-xx

### Required mating dimensions

---

1. Bearing of mating shaft
2. Measuring point for operating temperature
3. Measuring point for vibration
4. Contact surface of slot
5. Shaft surface; ensure full-surface contact!
6. Coupling surface of ECI/EQI
7. Mounting dimension: maximum permissible deviation between the shaft surface and coupling surface; compensation of mounting tolerances and thermal expansion, of which ±0.15 mm of dynamic axial motion is permitted (ECN/EQN)
8. Maximum permissible deviation between the shaft surface and flange surface; compensation of mounting tolerances and thermal expansion; dynamic motion permitted over entire range (ECN/EQN)
9. ECI/EQI flange surface; ensure full-surface contact!
10. Undercut
11. Possible centering hole
12. Distance to cover; note the opening for header, header connector, and wires
13. Screw; ISO 4762 – M3x10 – 8.8 – MKL; tightening torque: 1 Nm ±0.1 Nm
14. Screw; ISO 4762 – M3x25 – 8.8 – MKL; tightening torque: 1 Nm ±0.1 Nm
15. Positive-locking element; ensure correct engagement in the slot (e.g., by measuring the device overhang)
16. Direction of shaft rotation for ascending position values
17. 15-pin header
18. Dimension for JH standard cable
19. Ensure installation space for cable

For dimensions and specifications of encoders with functional safety, see the Product Information document.

---

1. EnDat22: Evaluation optimized for the KTY 84-130 temperature sensor; E30-R2: Evaluation optimized for the KTY 84-130 and PT 1000 (see Temperature measurement in motors)
2. See the Interfaces of HEIDENHAIN Encoders brochure.
3. See Electromagnetic compatibility under General electrical information in the Interfaces of HEIDENHAIN Encoders brochure.
ECI/EQI 1100 series

Absolute rotary encoders
- 70F synchro flange for axial mounting
- 82A blind hollow shaft
- Without integral bearing
- Mounting-compatible with ECN/EQN 1100 optical rotary encoders and the ECI/EBI/EQI 1100 inductive series

**Required mating dimensions**

- **a** = Bearing of mating shaft
- **M** = Measuring point for operating temperature
- **1** = Direction of shaft rotation for ascending position values
- **2** = Shaft surface; ensure full-surface contact!
- **3** = Flange surface; ensure full-surface contact!
- **4** = Slot necessary only for 1KA shaft
- **5** = Mounting dimension: maximum permissible deviation between the shaft surface and flange surface; compensation of mounting tolerances and thermal expansion; ECI/EQI/EBI; dynamic motion permitted over entire range; ECN/EQN: ±0.15 mm dynamic axial motion permitted
- **6** = Chamfer of connection thread is mandatory for material bonding anti-rotation lock
- **7** = Shaft fastening screw: DIN EN ISO 4762 – M3x25 – 8.8 with material bonding anti-rotation lock: ID 202264-86; tightening torque: 1 Nm ±0.1 Nm
- **8** = Clamping surface
- **9** = Contact surface of slot
- **10** = Possible flange fastening with fastening kit (ID 1264352-xx); tightening torque: 1 Nm ±0.1 Nm; pay attention to the orientation of the flat!
- **11** = Possible centering hole
- **12** = 15-pin header
- **13** = Dimension for JH standard cable
- **14** = Ensure installation space for cable
- **15** = Distance to cover; note the opening for header, header connector, and wires
- **16** = Undercut
- **17** = Coupling surface of ECN/EQN

**Series Name**
- **E1** = ECI/EQI 1100
- **E2** = ECI/EQI 1100
- **E3** = ECI/EQI 1100
- **E4** = ECI/EQI 1100
- **E5** = ECI/EQI 1100

**Flange**
- **1KA/82A**
- **70F**
- **82A**
- **82C**

**Shaft Interface**
- **EnDat01/22**
- **EnDat22**

**Ordering designation**
- **EnDat22**

**Position values per rev.**
- 524288 (19 bits)

**Revolutions**
- –

**Calculation time tcal**
- ≤ 5 µs

**Clock frequency**
- ≤ 16 MHz

**System accuracy**
- ±120°

**Electrical connection**
- 15-pin (with connection for external temperature sensor)\(^1\)

**Cable length**
- ≤ 100 m

**Supply voltage**
- DC 3.8 V to 14 V

**Power consumption**
- (maximum)
  - 3.6 V: 0.165 W
  - 14 V: 0.57 W

**Current consumption**
- (typical)
  - 3.6 V: 0.165 W
  - 14 V: 0.169 W

**Shaft**
- Blind hollow shaft for axial clamping Ø 6 mm
- Shaft speed
  - ≤ 15 000 rpm
  - ≤ 12 000 rpm

**Moment of inertia of rotor**
- 0.2 \( \cdot 10^{-6} \) kgm²

**Permissible axial motion of measured shaft**
- ±0.4 mm

**Vibration**
- 55 Hz to 2000 Hz
- Shock 6 ms
- Stator: ≤ 400 m/s²; rotor: ≤ 600 m/s² (EN 60068-2-6)
- ≤ 2000 m/s² (EN 60068-2-27)

**Operating temperature**
- –40 °C to 110 °C

**Protection**
- EN 60029 I/P00 when mounted\(^2\)

**Mass**
- 0.04 kg

**ID number**
- 1164812-xx

---

\(^1\) Evaluation optimized for the KTY 84-130 temperature sensor (see Temperature measurement in motors)

\(^2\) See Electromagnetic compatibility under General electrical information in the Interfaces of HEIDENHAIN Encoders brochure.
ECI/EBI 1100 series

Absolute rotary encoders
- Flange for axial mounting
- Blind hollow shaft
- Without integral bearing
- EBI 1135: multturn functionality via battery-buffered revolution counter

**Interface**

<table>
<thead>
<tr>
<th>Absolute</th>
<th>EBI 1118</th>
<th>EBI 1135</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ordering designation</td>
<td>EnDat 2.2</td>
<td>EnDat 2.2</td>
</tr>
<tr>
<td>Position values per rev.</td>
<td>262,144 (18 bits)</td>
<td>262,144 (18 bits; 19-bit data word length with LSB = 0)</td>
</tr>
<tr>
<td>Revolutions</td>
<td>~</td>
<td>65,536 (16 bits)</td>
</tr>
<tr>
<td>Calculation time $t_{calc}$</td>
<td>≤ 6 µs</td>
<td>≤ 8 MHz</td>
</tr>
<tr>
<td>Clock frequency</td>
<td>~</td>
<td>~</td>
</tr>
<tr>
<td>System accuracy</td>
<td>±120&quot;</td>
<td>~</td>
</tr>
</tbody>
</table>

**Electrical connection**

- EnDat 2.2
- Ordering designation EnDat 2.2
- Position values per rev. 262,144 (18 bits) 262,144 (18 bits; 19-bit data word length with LSB = 0)
- Revolutions ~ 65,536 (16 bits)
- Calculation time $t_{calc}$ ≤ 6 µs
- Clock frequency ≤ 8 MHz
- System accuracy ±120"

**Power consumption**

- Normal operation at 3.6 V: 0.52 W
- Normal operation at 14 V: 0.6 W

**Shaft**

- Blind hollow shaft Ø 6 mm, axial clamping

**Mech. permiss. shaft speed**

- ≤ 15,000 rpm
- ≤ 12,000 rpm

**Mech. permiss. acceleration**

- ≤ $10^9$ rad/s²

**Moment of inertia of rotor**

- 0.2 · 10⁻⁶ kgm²

**Permissible axial motion of measured shaft**

- ±0.3 mm

**Vibration**

- 55 Hz to 2000 Hz
- 6 ms

**Shock**

- 300 m/s² (EN 60068-2-6)
- 1000 m/s² (EN 60068-2-27)

**Operating temperature**

- –20 °C to 115 °C

**Protection**

- EN 60529

**Mass**

- 0.02 kg

**ID number**

- 728563-xx
- 820725-xx

---

1) External temperature sensor and online diagnostics are not supported.
2) See Electromagnetic compatibility under General electrical information in the Interfaces of HEIDENHAIN Encoders brochure.
ECI/EBI/EQI 1300 series

Absolute rotary encoders

- Mounting-compatible with photoelectric rotary encoders with a 07B stator coupling
- 08A flange for axial mounting
- 44C blind hollow shaft Ø 12.7 mm
- Without integral bearing
- Cost-optimized mating dimensions upon request

---

**Diagram**

**Required mating dimensions**

- **D1**
  - Ø 12.75 mm
  - Ø 12.76 mm

- **D2**
  - Ø 12.75 mm
  - Ø 12.76 mm

---

**Diagram**

**Interface**

<table>
<thead>
<tr>
<th>ECI 1319</th>
<th>EQI 1331</th>
<th>EBI 1335</th>
</tr>
</thead>
<tbody>
<tr>
<td>EnDat 2.2</td>
<td>EnDat 2.2</td>
<td>EnDat 2.2</td>
</tr>
</tbody>
</table>

**Ordering designation**

EnDat 2.2

**Position values per rev.**

524,288 (19 bits)

**Revolutions**

- 4096 (12 bits)
- 65536 (16 bits)

**Elec. permiss. shaft speed/ deviations**

- ≤ 15,000 rpm (for continuous position value)

**Calculation time t_cal**

- ≤ 5 µs
- ≤ 16 MHz

**System accuracy**

- ± 65°

**Electrical connection**

16-pin with connection for temperature sensor

**Cable length**

- ≤ 100 m

**Supply voltage**

DC 3.6 V to 14 V

**Power consumption**

- 3.6 V: ≤ 0.85 W
- 14 V: ≤ 0.75 W

**Current consumption (typical)**

- 5 V: 86 mA (without load)
- 5 V: 115 mA (without load)

**Mech. permiss. shaft speed**

- ≤ 15,000 rpm
- ≤ 12,000 rpm

**Moment of inertia of rotor**

- 2.6 · 10^-6 kgm²

**Permissible axial motion of measured shaft**

- ± 0.5 mm

**Vibration**

65 Hz to 2000 Hz

**Shock**

6 ms

**Operating temperature**

- –40 °C to 115 °C

**Trigger threshold of temperature exceedance**

130 °C (measuring accuracy of the internal temperature sensor: ± 1 K)

**Protection**

IP20 when mounted

**Mass**

- 0.13 kg

**ID number**

- 810661-xx
- 810662-xx
- 1230275-xx

---

1) Evaluation optimized for KTY 84-130
2) At T = 25 °C; U_BAT = 3.6 V
3) Compliance with EnDat Specification 29403 and the EnDat Application Notes 722024, Chapter 13, Battery-buffered encoders, is required for correct control of the encoder

For dimensions and specifications of encoders with functional safety, see the Product Information document.
**ECI 1319, EQI 1331**

Rotary encoders for absolute position values with safe singleturn information

- Robust inductive scanning principle
- Mounting-compatible with photoelectric rotary encoders with a 07B stator coupling
- 0°A mounting flange
- Blind hollow shaft for axial clamping Ø 12.7 mm (44C) or Ø 12 mm (44A)
- Cost-optimized mating dimensions upon request

---

**Absolute**

**Interface**

<table>
<thead>
<tr>
<th>ECI 1319 singletum</th>
<th>EQI 1331 multiturn</th>
</tr>
</thead>
<tbody>
<tr>
<td>EnDat 3</td>
<td></td>
</tr>
</tbody>
</table>

**Ordering designation**

E30–R2

**Position values per rev.**

524 288 (19 bits)

**Revolutions**

= 4096 (12 bits)

**XEL.time HPFout data rate**

≤ 11 µs at 12.5 Mbit/s

≤ 8.2 µs at 25 Mbit/s

**Propagation time**

14 µs (typical)

**System accuracy**

±0.5°

**Electrical connection**

16-pin PCB connector (12+4); with separate connection option for external temperature sensor

**Cable length**

At 12.5 Mbit/s: ≤ 100 m; at 25 Mbit/s: ≤ 40 m

**Supply voltage**

DC 4 V to 14 V (recommended: 12 V)

**Power consumption**

- 4 V: ≤ 0.85 W
- 14 V: ≤ 0.95 W

**4 V:**

- ≤ 0.9 W
- ≤ 1 W

**Current consumption**

- 12 V: ≤ 0.85 W
- 14 V: ≤ 1 W

**Shaft speed**

- Blind hollow shaft for axial clamping Ø 12.7 mm (44C) or Ø 12 mm (44A)

- 15 000 rpm

- ≤ 12 000 rpm

**Moment of inertia of rotor**

2.45 · 10⁻⁶ kgm²

2.6 · 10⁻⁶ kgm²

**Angular acceleration of rotor**

≤ 1 · 10⁵ rad/s²

2.6 · 10⁻⁶ kgm²

**Axial motion of measured shaft**

≤ ±0.5 mm

**Vibration**

65 Hz to 2000 Hz

Stator: ≤ 400 m/s²; rotor: ≤ 600 m/s²

6 ms

- ≤ 2000 m/s² (EN 60068-2-27)

**Operating temperature**

-40 °C to 115 °C

**Trigger threshold of temperature exceedance error message**

130 °C (measuring accuracy of the internal temperature sensor: ±1 K)

**Relative humidity**

≤ 93% (40 °C/21 d as per EN 60068-2-78); condensation excluded

**Protection rating**

EN 60529

IP20

**Mass**

= 0.13 kg

**ID number**

44C shaft: 1286377-01; 44A shaft: 1286377-06

44C shaft: 1286378-01; 44A shaft: 1286378-06

---

1) See EnDat Application Notes

2) See General electrical information in the Interfaces of HEIDENHAIN Encoders brochure or at www.heidenhain.com

3) Evaluation optimized for the KTY 84-130 and PT 1000 (see Temperature measurement in motors)

For dimensions and specifications of encoders with functional safety, see the Product Information document.
ECI/EQI 1300 S series

Absolute rotary encoders
• Mounting-compatible with photoelectric rotary encoders with a 07B stator coupling
• 08A flange for axial mounting
• 44C blind hollow shaft Ø 12.7 mm
• Without integral bearing
• Cost-optimized mating dimensions upon request

Required mating dimensions

<table>
<thead>
<tr>
<th>Description</th>
<th>Dimensions</th>
</tr>
</thead>
<tbody>
<tr>
<td>D1</td>
<td>12.76 ± 0.8 mm</td>
</tr>
<tr>
<td>D2</td>
<td>12.76 ± 0.8 mm</td>
</tr>
</tbody>
</table>

Absolute ECI 1319 S

Interface
DRIVE-CLiQ

Ordering designation
DQ01

Position values per rev.
524,288 (19 bits)

Revolutions
–

Calculation time
TIME_MAX_ACTVAL ≤ 12 µs

System accuracy
±0.5°

Electrical connection
16 pin with connection for temperature sensor

Cable length
≤ 40 m

Supply voltage
DC 24 V (10 V to 28.8 V; up to DC 36 V possible without impairing the functional safety)

Power consumption (maximum)
18 V: ≤ 1.1 W
28.8 V: ≤ 1.25 W

Current consumption (typical)
24 V: 40 mA (without load)

Shaft
Blind hollow shaft for axial clamping Ø 12.7 mm

Mech. permis. shaft speed n
≤ 15,000 rpm
≤ 12,000 rpm

Moment of inertia of rotor
2.6 · 10⁻⁶ kgm²

Permissible axial motion of measured shaft
±0.5 mm

Vibration
55 Hz to 2000 Hz
Shock 6 ms

Operating temperature
–40 °C to 100 °C

Trigger threshold of temperature exceedance
120 °C (measuring accuracy of the internal temperature sensor: ±1 K)

Protection
EN 60529: IP20 when mounted

Mass
≈ 0.13 kg

ID number
1222049-xx

For dimensions and specifications of encoders with functional safety, see the Product Information document.

DRIVE-CLiQ is a registered trademark of Siemens AG.

1) Evaluation optimized for the KTY 84-130 and PT 1000 (see Temperature measurement in motors)
ECI/EBI 100 series

Absolute rotary encoders
• Flange for axial mounting
• Hollow through shaft
• Without integral bearing
• EBI 135: multiturn functionality via battery-buffered revolution counter

Absolute ECI 119 EBI 135

Interface
EnDat 2.1 EnDat 2.2 EnDat 2.2

Ordering designation
EnDat01 EnDat221) EnDat221)

Position values per rev. 524,288 (19 bits)

Revolutions – 65,536 (16 bits)2)

Elec. permissible shaft speed/ deviations3)
≤ 3,000 rpm ± 128 LSB ≤ 6,000 rpm ± 256 LSB ≤ 6,000 rpm (for continuous position value)

Calculation time tcalc
≤ 8 μs ≤ 2 MHz ≤ 6 μs ≤ 16 MHz

Incremental signals
- - - 

Line count 32 – – 

Cutoff frequency -3 dB
≥ 6 kHz (typical) – – 

System accuracy ±90°

Electrical connection
15-pin 15-pin with connection for temperature sensor4)

Cable length ≤ 100 m

Supply voltage
DC 3.6 V to 14 V DC 3.6 V to 14 V DC 3.6 V to 5.25 V

Power consumption (maximum)
3.6 V: 0.58 W 0.53 W 0.53 W
14 V: 0.7 W 0.63 W 0.63 W

Current consumption (typical)
5 V: 80 mA 75 mA
(without load) (without load)
5 V: 75 mA (without load) 12 μA (rotating shaft)

Shaft1) Hollow through shaft Ø = 30 mm, 38 mm, 50 mm

Mech. permissible speed n ≤ 6000 rpm

Moment of inertia of rotor
Ø = 30 mm: 64 · 10–6 kgm²
Ø = 38 mm: 58 · 10–6 kgm²
Ø = 50 mm: 64 · 10–6 kgm²

Permissible axial motion of measured shaft ±0.3 mm

Vibration 55 Hz to 2000 Hz
≤ ± 300 m/s² (EN 60068-2-6)

Shock 6 ms
≤ ± 1000 m/s² (EN 60068-2-27)

Operating temperature –30 °C to 115 °C

Protection EN 60529
IP20 when mounted6)

Mass
Ø = 30 mm: 0.19 kg
Ø = 38 mm: 0.16 kg
Ø = 50 mm: 0.14 kg

ID number 823406-xx 823407-xx 823405-xx

1) Please select when ordering
2) Valuation numbers are not supported
3) Compliance with EnDat Specification 29403 and the EnDat Application Notes 722924, Chapter 13, Battery-buffered encoders, is required for correct control of the encoder
4) Speed-dependent deviations between absolute and incremental signals
5) At T = 25 °C, UBAT = 3.6 V
6) See Electromagnetic compatibility under General electrical information in the Interfaces of HEIDENHAIN Encoders brochure.
ECI 4010, EBI 4010, ECI 4090 S

Rotary encoders for absolute position values
• Robust inductive scanning principle
• Hollow through shaft (Ø 90 mm)
• EBI 4010: multiturn functionality through battery-buffered revolution counter
• Consists of a scanning unit and scale drum

- Rotary encoders for absolute position values

- Robust inductive scanning principle

- Hollow through shaft (Ø 90 mm)

- EBI 4010: multiturn functionality through battery-buffered revolution counter

- Consists of a scanning unit and scale drum

Specifications ECI 4010 singleturn EBI 4010 multiturn ECI 4090 S singleturn

Interface/ ordering designation EnDat 2.2 / EnDat22 DRIVE-CLiQ / DQ01

Position values per rev. 1 048 576 (20 bits)

Revolutions –

Calculation time \( t_{cal} \) per clock frequency ≤ 5 \( \mu \text{s} \), 16 MHz ≤ 11 \( \mu \text{s} \)

System accuracy ±25°

Electrical connection 16-pin with connection for temperature sensor

Cable length ≤ 100 m ≤ 40 m

Supply voltage DC 3.6 V to 14 V

DC 3.8 V to 14 V

DC 3.6 V to 5.25 V

DC 24 V (10 V to 28.8 V);

up to 36 V possible without impairing the functional safety

Power consumption

(maximum)

3.6 V: ≤ 0.63 W

14 V: ≤ 0.7 W

3.6 V: ≤ 0.83 W

14 V: ≤ 0.7 W

10 V: ≤ 1.1 W

28.9 V: ≤ 1.25 W

Current consumption

(at typical)

5 V: 95 mA (without load)

Buffer mode: 220 \( \mu \text{A} \)

25 \( \mu \text{A} \)

24 V: 40 mA

5 V: 95 mA

24 V: 40 mA

Shaf

Hollow through shaft (Ø 90 mm)

Shaft speed ≤ 6000 rpm

Moment of inertia of rotor 4.26 · 10⁻⁴ kgm²

Angular acceleration of rotor ≤ 2 · 10⁴ rad/s²

Axial motion of measured shaft ≤ ±1.5 mm

Vibration

55 Hz to 2000 Hz

Normal operation at 5 V:

96 mA (without load)

Buffer mode:

220 \( \mu \text{A} \) (rotating shaft)

25 \( \mu \text{A} \) (at standstill)

Shock

6 ms

AE scanning unit:

400 m/s²

TTR scale drum:

600 m/s²

2000 m/s²

EN 60068-2-27

Operating temperature

–40 °C to 115 °C

(60068-2-27)

–40 °C to 100 °C

(60068-2-27)

Trigger threshold of temperature exceedance

error message

130 °C

(see Interfaces of HEIDENHAIN Encoders brochure)

120 °C

(see Interfaces of HEIDENHAIN Encoders brochure)

Protection

EN 60529

Complete encoder, mounted: TTR scale drum:

IP20

(see Interfaces of HEIDENHAIN Encoders brochure)

Shielding

Complete encoder, mounted: TTR scale drum:

IP20

(see Interfaces of HEIDENHAIN Encoders brochure)

Mass

AE scanning unit: 0.27 kg

TTR scale drum: 0.17 kg

ID number

AE ECI4010 scanning unit: AE EBI4010 scanning unit: AE ECI4090S scanning unit:

ID 1130167-xx

ID 1130173-xx

ID 1130171-xx

TTR EXI4000 scale drum: ID 1130175-xx

DRIVE-CLiQ is a registered trademark of Siemens AG.
ECI 4010, EBI 4010, ECI 4090 S

Rotary encoders for absolute position values
- Robust inductive scanning principle
- Hollow through shaft (Ø 180 mm)
- EBI 4010: multiturn functionality through battery-buffered revolution counter
- Consists of a scanning unit and scale drum

Specifications

<table>
<thead>
<tr>
<th>ECI 4010</th>
<th>EBI 4010</th>
<th>ECI 4090 S</th>
</tr>
</thead>
<tbody>
<tr>
<td>singletum</td>
<td>multitum</td>
<td>singletum</td>
</tr>
<tr>
<td>Interface/ordering designation</td>
<td>EnDat 2.2 / EnDat22</td>
<td>DRIVE-CLiQ / DQ01</td>
</tr>
<tr>
<td>Position values per rev.</td>
<td>1 048 576 (20 bits)</td>
<td>65536 (16 bits)</td>
</tr>
<tr>
<td>Revolutions</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Calculation time (t_{\text{calc}}/) clock frequency</td>
<td>(\leq 5 \mu s/16 \text{ MHz} )</td>
<td>(\leq 11 \mu s)</td>
</tr>
<tr>
<td>System accuracy</td>
<td>±40&quot;</td>
<td>±40&quot;</td>
</tr>
<tr>
<td>Electrical connection</td>
<td>16-pin with connection for temperature sensor</td>
<td>16-pin with connection for temperature sensor</td>
</tr>
<tr>
<td>Cable length</td>
<td>(\leq 100 \text{ m} )</td>
<td>(\leq 40 \text{ m} )</td>
</tr>
<tr>
<td>Supply voltage</td>
<td>DC 3.6 V to 14 V</td>
<td>Rotary encoder Uc= DC 3.6 V to 14 V</td>
</tr>
<tr>
<td>Power consumption</td>
<td>3.6 V: 0.63 W; 14 V: 0.7 W</td>
<td>Normal operation at 5 V: 96 mA (without load) Buffer model: 220 µA (rotating shaft) 25 µA (shaft at standstill)</td>
</tr>
<tr>
<td>Current consumption (typical)</td>
<td>5 V: 95 mA (without load)</td>
<td>Buffer mode: 220 µA (rotating shaft) 25 µA (shaft at standstill)</td>
</tr>
<tr>
<td>Shaft</td>
<td>Hollow through shaft (Ø 180 mm) (with keyway)</td>
<td>(\leq 6000 \text{ rpm} )</td>
</tr>
<tr>
<td>Shaft speed</td>
<td>(\leq 6000 \text{ rpm} )</td>
<td>6.0 mm</td>
</tr>
<tr>
<td>Moment of inertia of rotor</td>
<td>3.1 (\cdot 10^{-4} \text{ kgm}^2 ) (without screws, without key)</td>
<td>(\leq 10^{-4} \text{ rad}^2 )</td>
</tr>
<tr>
<td>Angular acceleration of rotor</td>
<td>(\leq 2 \cdot 10^{4} \text{ rad/s}^2 )</td>
<td></td>
</tr>
<tr>
<td>Axial motion of measured shaft</td>
<td>(\leq 1.5 \text{ mm} )</td>
<td></td>
</tr>
<tr>
<td>Vibration 55 Hz to 2000 Hz</td>
<td>AE scanning unit: (\leq 400 \text{ m/s}^2 ); TTR scale drum: (\leq 600 \text{ m/s}^2 ) (EN 60068-2-6) (\leq 2000 \text{ m/s}^2 ) (EN 60068-2-27)</td>
<td></td>
</tr>
<tr>
<td>Shock 6 ms</td>
<td>AE scanning unit: (\leq 400 \text{ m/s}^2 ); TTR scale drum: (\leq 600 \text{ m/s}^2 ) (EN 60068-2-6) (\leq 2000 \text{ m/s}^2 ) (EN 60068-2-27)</td>
<td></td>
</tr>
<tr>
<td>Operating temperature</td>
<td>(-40^\circ \text{ C} ) to (115^\circ \text{ C} ) (at the measuring point and on the entire scale drum)</td>
<td>(-40^\circ \text{ C} ) to (100^\circ \text{ C} ) (at the measuring point and on the entire scale drum)</td>
</tr>
<tr>
<td>Trigger threshold</td>
<td>120 °C (measuring accuracy of the internal temperature sensor: ±1 K)</td>
<td>120 °C (measuring accuracy of the internal temperature sensor: ±1 K)</td>
</tr>
<tr>
<td>Protection EN 60529</td>
<td>Complete encoder; mounted: TIP02, scanning unit: IP24 (read about isolation under Electrical safety in the Interfaces of HEIDENHAIN Encoders brochure)</td>
<td></td>
</tr>
<tr>
<td>Mass</td>
<td>AE scanning unit: (\leq 0.39 \text{ kg} ); TTR scale drum: (\leq 0.33 \text{ kg} )</td>
<td></td>
</tr>
<tr>
<td>ID number</td>
<td>AE ECI4010 scanning unit: ID 1087526-xx</td>
<td>AE EBI4010 scanning unit: ID 1097530-xx</td>
</tr>
<tr>
<td>TTR EXI4000 scale drum: ID 1113606-xx</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1) Calculation time \(\text{TIME\_MAX\_ACTVAL} \)
2) Evaluation optimized for the KTY 84-130, with DQ01 also for the PT 1000 (see Temperature measurement in motors)
3) At an output cable length (inside motor) \(\leq 1 \text{ m} \)
4) See General electrical information in the Interfaces of HEIDENHAIN Encoders brochure
5) At \(T = 25^\circ \text{ C} \), \(U_{\text{BAT}} = 3.6 \text{ V} \)
6) The encoder must be protected from abrasive and harmful media in the application; Use an appropriate enclosure as needed.

For dimensions and specifications of encoders with functional safety, see the Product Information document.

DRIVE-CLiQ is a registered trademark of Siemens AG.
EROS 1200 series

Incremental rotary encoders
- Flange for axial mounting
- Hollow through shaft
- Without integral bearing

<table>
<thead>
<tr>
<th>ERO 1225</th>
<th>ERO 1285</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interface</td>
<td>TTL/TTL</td>
</tr>
<tr>
<td>Line count*</td>
<td>1024 2048</td>
</tr>
<tr>
<td>Accuracy of gradation</td>
<td>± 6°</td>
</tr>
<tr>
<td>Reference mark</td>
<td>One</td>
</tr>
<tr>
<td>Output frequency</td>
<td>≤ 300 kHz</td>
</tr>
<tr>
<td>Edge separation a</td>
<td>≥ 0.39 µs</td>
</tr>
<tr>
<td>Cutoff frequency -3 dB</td>
<td>≥ 180 kHz (typical)</td>
</tr>
<tr>
<td>System accuracy 1)</td>
<td>1024 lines: ±92° 2048 lines: ±73°</td>
</tr>
<tr>
<td>1024 lines: ±67° 2048 lines: ±60°</td>
<td></td>
</tr>
<tr>
<td>Electrical connection</td>
<td>12-pin</td>
</tr>
<tr>
<td>Supply voltage</td>
<td>DC 5 V ±0.5 V</td>
</tr>
<tr>
<td>Current consumption (without load)</td>
<td>≤ 150 mA</td>
</tr>
<tr>
<td>Shaft *</td>
<td>Hollow through shaft Ø = 10 mm or Ø = 12 mm</td>
</tr>
<tr>
<td>Moment of inertia of rotor</td>
<td>Shelf Ø 10 mm: 2.2 · 10⁻⁶ kgm²  Shelf Ø 12 mm: 2.2 · 10⁻⁶ kgm²</td>
</tr>
<tr>
<td>Mech. permiss. shaft speed n</td>
<td>≤ 25,000 rpm</td>
</tr>
<tr>
<td>Permissible axial motion of measured shaft</td>
<td></td>
</tr>
<tr>
<td>1024 lines: ±0.2 mm 2048 lines: ±0.05 mm  ±0.03 mm</td>
<td></td>
</tr>
<tr>
<td>Vibration 65 Hz to 2000 Hz</td>
<td>≤ 100 m/s² (EN 60068-2-6)  ≤ 1000 m/s² (EN 60068-2-27)</td>
</tr>
<tr>
<td>Shock 6 ms</td>
<td>100 m/s² (EN 60068-2-6) 1000 m/s² (EN 60068-2-27)</td>
</tr>
<tr>
<td>Operating temperature</td>
<td>–40 °C to 100 °C</td>
</tr>
<tr>
<td>Protection (EN 60068)</td>
<td>IP60</td>
</tr>
<tr>
<td>Mass</td>
<td>&lt;= 0.07 kg</td>
</tr>
<tr>
<td>ID number</td>
<td>1037521-xx (scanning unit) 332378-xx (disk/hub assembly)</td>
</tr>
<tr>
<td>1037522-xx (scanning unit) 332378-xx (disk/hub assembly)</td>
<td></td>
</tr>
</tbody>
</table>

* Please select when ordering
1) When not mounted; additional deviations due to mounting and bearing of the measured shaft are not taken into account
2) For other errors, see Measuring accuracy
ERO 1400 series

Incremental rotary encoders
- Flange for axial mounting
- Hollow through shaft
- Without integral bearing; self-centering

**With axial PCB connector**

**Axial PCB connector and round cable**

**Axial PCB connector and ribbon cable**

**Bend radius R**

| Yielding ISO 8015 | ≤ 6 mm: ±0.2 mm |

**Electrical connection**

| 12-pin, axial² |

**Supply voltage**

| DC 5 V ±0.5 V | DC 5 V ±0.25 V | DC 5 V ±0.5 V |

**Current consumption**

| ≤ 150 mA | ≤ 155 mA | ≤ 200 mA | ≤ 150 mA |

**Shaft**

| Blind hollow shaft Ø 4 mm, Ø 6 mm, or Ø 8 mm, or hollow through shaft in housing with bore (accessory) |

**Moment of inertia of rotor**

| Shaft Ø 4 mm: 0.28 · 10⁻⁶ kgm² | Shaft Ø 6 mm: 0.27 · 10⁻⁶ kgm² | Shaft Ø 8 mm: 0.25 · 10⁻⁶ kgm² |

**Mech. permiss. shaft speed n**

| ≤ 30 000 rpm |

**Permissible axial motion of measured shaft**

| ±0.1 mm | ±0.05 mm |

**Vibration 85 Hz to 2000 Hz**

| ≤ 100 m/s² (EN 60068-2-6) | ≤ 1000 m/s² (EN 60068-2-27) |

**Operating temperature**

| –10 °C to 70 °C |

**Protection EN 60529**

| With PCB connector: IP00 | With cable outlet: IP40 |

**Mass**

| 0.07 kg |

**ID number**

| 360731-xx | 360736-xx | 360737-xx |

**Bold:** This preferred version is available on short notice

* Please select when ordering

¹ When not mounted; additional deviations due to mounting and bearing of the measured shaft are not taken into account

² Upon request, cable (1 m), radial, free cable end (not for ERO 1470)
HEIDENHAIN encoders with the \(~1\, V_{PP}\) interface provide voltage signals that are highly interpolatable.

The sinusoidal incremental signals \(A\) and \(B\) are phase-shifted by 90° elec. and have a typical amplitude of \(1\, V_{PP}\). The illustrated sequence of output signals—\(A\) and \(B\)—with \(B\) lagging \(A\)—applies to the direction of motion shown in the dimension drawing. The reference mark signal \(R\) has a unique assignment to the incremental signals. The output signal may be lower next to the reference mark.

Further information:
For detailed descriptions of all available interfaces, as well as general electrical information, please refer to the Interfaces of HEIDENHAIN Encoders brochure.

### Pin layout

#### 12-pin M23 coupling

- **Power supply**: 12, 4, 11, 6, 5, 8, 3, 1, 10, 9, 7
- **Incremental signals**: A, B, R
- **Other signals**: 2a, 2b, 1a, 1b, 6a, 6b, 5a, 5b, 4b, 4a, 3b, 3a

#### 15-pin D-sub connector for PWM 21

- **Power supply**: 12, 4, 11, 6, 5, 8, 3, 1, 10, 9, 7
- **Incremental signals**: A, B, R
- **Other signals**: 2a, 2b, 1a, 1b, 6a, 6b, 5a, 5b, 4b, 4a, 3b, 3a

#### 12-pin PCB connector

- **Power supply**: 12, 4, 11, 6, 5, 8, 3, 1, 10, 9, 7
- **Incremental signals**: A, B, R
- **Other signals**: 2a, 2b, 1a, 1b, 6a, 6b, 5a, 5b, 4b, 4a, 3a, 3b

#### Output cable for ERN 1381 inside the motor housing

- **Power supply**: 12, 4, 11, 6, 5, 8, 3, 1, 10, 9, 7
- **Incremental signals**: A, B, R
- **Other signals**: 2a, 2b, 1a, 1b, 6a, 6b, 5a, 5b, 4b, 4a, 3a, 3b

### Interfaces

\(\sim 1\, V_{PP}\) incremental signals

HEIDENHAIN encoders with the \(\sim 1\, V_{PP}\) interface incorporate electronics that digitize sinusoidal scanning signals with or without interpolation.

The incremental signals are transmitted as the square-wave pulse trains \(U_{A1}\) and \(U_{A2}\) phase-shifted by 90° elec. The reference mark signal consists of one or more reference pulses \(U_{A0}\), which are gated with the incremental signals. In addition, the integrated electronics produce their inverted signals \(U_{A0}^\sim\), \(U_{A1}^\sim\), and \(U_{A2}^\sim\) for noise-proof transmission. The illustrated sequence of output signals—with \(U_{A2}\) lagging \(U_{A1}\)—applies to the direction of motion shown in the dimension drawing.

The fault detection signal \(U_{S}\) indicates malfunctions such as an interruption in the supply lines, failure of the light source, etc.

### TTL incremental signals

HEIDENHAIN encoders with the TTL interface incorporate electronics that digitize sinusoidal scanning signals with or without interpolation.

The incremental signals are transmitted as the square-wave pulse trains \(U_{A1}\) and \(U_{A2}\) phase-shifted by 90° elec. The reference mark signal consists of one or more reference pulses \(U_{A0}\), which are gated with the incremental signals. In addition, the integrated electronics produce their inverted signals \(U_{A0}^\sim\), \(U_{A1}^\sim\), and \(U_{A2}^\sim\) for noise-proof transmission. The illustrated sequence of output signals—with \(U_{A2}\) lagging \(U_{A1}\)—applies to the direction of motion shown in the dimension drawing.

The fault detection signal \(U_{S}\) indicates malfunctions such as an interruption in the supply lines, failure of the light source, etc.

### Further information:
For detailed descriptions of all available interfaces, as well as general electrical information, please refer to the Interfaces of HEIDENHAIN Encoders brochure.
Pin layout for ERN 1023

Power supply | Incremental signals | Other signals
---|---|---
12 | / | / 4 5 6 14 17 9 8
15 | / | / 2a 8b 8a 6b 6a 7b 7a

Cable shield connected to housing; \( U_p \) = Power supply

Sensor: The sense line is connected in the encoder with the corresponding power line. Vacant pins or wires must not be used!

Commutation signals for block commutation

The block commutation signals \( U, V, \) and \( W \) are obtained from three separate absolute tracks. They are transmitted as square-wave signals in TTL levels.

The \( ERN \ 1x23 \) and \( ERN \ 1326 \) are rotary encoders with commutation signals for block commutation.

Further information:
Detailed descriptions of all available interfaces, as well as general electrical information, can be found in the Interfaces of HEIDENHAIN Encoders brochure.
Commutation signals for sine commutation

The commutation signals C and D are obtained from the Z1 track and are equal to one sine or cosine period per revolution. They have a signal amplitude of 1 VPP (typical) at 1 kΩ instead of 120 Ω.

The ERN 1387 is a rotary encoder with output signals for sinusoidal commutation.

Pin layout

17-pin M23 flange socket or coupling

<table>
<thead>
<tr>
<th>Power supply</th>
<th>Incremental signals</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>1</td>
</tr>
<tr>
<td>10</td>
<td>4</td>
</tr>
<tr>
<td>11</td>
<td>15</td>
</tr>
<tr>
<td>16</td>
<td>12</td>
</tr>
<tr>
<td>13</td>
<td>3</td>
</tr>
<tr>
<td>2</td>
<td></td>
</tr>
</tbody>
</table>

1b 7a 5b 3a 6b 2a 3b 5a 4b 4a

Up Sensor 0V Sensor 0V Internal shield A+ A– B+ B– R+ R–

Brown/ Green Blue White/ Green White / Green/ Black Yellow/ Black Blue/ Black Red Black Red Black

Other signals

14 17 9 8 5 6

7b 1a 2b 6a 6b 1a 2b 5a 4b 3b 6b 1a 2b 5a

Cable shield connected to housing; Up = Voltage supply; T = Temperature

Sensor: The sense line is connected internally to the respective power line. Vacant pins or wires must not be used!

1) Connections for an external temperature sensor (only for output cables inside the motor, see Temperature measurement in motors); if used, please refer to the information about electromagnetic compatibility in the General electrical information section of the Interfaces of HEIDENHAIN Encoders brochure.

Further information:

Detailed descriptions of all available interfaces, as well as general electrical information, can be found in the Interfaces of HEIDENHAIN Encoders brochure.

Position values **EnDat 2.2**

The EnDat interface is a digital, bidirectional interface for encoders. It is capable of outputting position values, reading information stored in the encoder, updating this information, and storing new information. Because the interface uses serial transmission, only four signal lines are required. The data (DATA) are transmitted in synchronism with the CLOCK signal from the subsequent electronics. The type of transmission (position values, parameters, diagnostics, etc.) is selected via mode commands that the subsequent electronics send to the encoder. Some functions are available only with EnDat 2.2 mode commands.

### Pin layout for EnDat01/EnDat02

17-pin M23 flange socket or coupling

<table>
<thead>
<tr>
<th>Power supply</th>
<th>Incremental signals</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>1</td>
</tr>
<tr>
<td>10</td>
<td>4</td>
</tr>
<tr>
<td>11</td>
<td>15</td>
</tr>
<tr>
<td>16</td>
<td>12</td>
</tr>
<tr>
<td>13</td>
<td>3</td>
</tr>
<tr>
<td>2</td>
<td></td>
</tr>
</tbody>
</table>

1b 6a 4b 3a / 2a 5b 4a 3b 6b 1a 2b 5a

Up Sensor 0V Sensor 0V Internal shield A+ A– B+ B–

Brown/ Green Blue White/ Green White / Green/ Black Yellow/ Black Blue/ Black Red Black Red Black

Other signals

5 6

Cable shield connected to housing; Up = Power supply; T = Temperature

Sensor: The sense line is connected in the encoder with the corresponding power line. Vacant pins or wires must not be used!

2) Connections for an external temperature sensor (only for output cables inside the motor, see Temperature measurement in motors); if used, please refer to the information about electromagnetic compatibility in the General electrical information section of the Interfaces of HEIDENHAIN Encoders brochure.
**EnDat22 pin layout**

- **8-pin M12 coupling or flange socket**
- **9-pin M23 SpeedTEC angle flange socket**

**16-pin PCB connector**

<table>
<thead>
<tr>
<th>Power supply</th>
<th>Serial data transmission</th>
<th>Other signals</th>
</tr>
</thead>
<tbody>
<tr>
<td>M12</td>
<td>8</td>
<td>2</td>
</tr>
<tr>
<td>M23</td>
<td>3</td>
<td>7</td>
</tr>
</tbody>
</table>

**15-pin PCB connector**

<table>
<thead>
<tr>
<th>Power supply</th>
<th>Serial data transmission</th>
<th>Other signals</th>
</tr>
</thead>
<tbody>
<tr>
<td>M12</td>
<td>8</td>
<td>2</td>
</tr>
<tr>
<td>M23</td>
<td>3</td>
<td>7</td>
</tr>
<tr>
<td>1b</td>
<td>6a</td>
<td>4b</td>
</tr>
</tbody>
</table>

Cable shield connected with housing. **Up** = Power supply; **T** = Temperature

**Sensor** The sense line is connected in the encoder with the corresponding power line.

Vacant pins or wires must not be used!

1° Connections for an external temperature sensor (only EnDat22, except ECI 1118, see Temperature measurement in motors); if used, please refer to the information about electromagnetic compatibility in the General electrical information section of the Interfaces of HEIDENHAIN Encoders brochure.

**Pin layout for EBI 135/EBI 1135/EBI 4010**

**15-pin PCB connector**

<table>
<thead>
<tr>
<th>Power supply</th>
<th>Serial data transmission</th>
<th>Other signals</th>
</tr>
</thead>
<tbody>
<tr>
<td>M12</td>
<td>8</td>
<td>2</td>
</tr>
<tr>
<td>M23</td>
<td>3</td>
<td>7</td>
</tr>
<tr>
<td>1b</td>
<td>6a</td>
<td>4b</td>
</tr>
</tbody>
</table>

**8-pin M12 flange socket**

<table>
<thead>
<tr>
<th>Power supply</th>
<th>Serial data transmission</th>
<th>Other signals</th>
</tr>
</thead>
<tbody>
<tr>
<td>M12</td>
<td>8</td>
<td>2</td>
</tr>
<tr>
<td>M23</td>
<td>3</td>
<td>7</td>
</tr>
<tr>
<td>1b</td>
<td>6a</td>
<td>4b</td>
</tr>
</tbody>
</table>

**9-pin M23 SpeedTEC angle flange socket**

- **Power supply**
- **Serial data transmission**
- **Other signals**

**Brown/Green**

**White/Green**

**White**

**Gray**

**Pink**

**Violet**

**Yellow**

**Brown**

**Green**

Vacant pins or wires must not be used!

1° Only for EBI 135

2° Connected inside encoder

**Connections for an external temperature sensor (see Temperature measurement in motors); if used, please refer to the information about electromagnetic compatibility in the General electrical information section of the Interfaces of HEIDENHAIN Encoders brochure.**

**Pin layout**

**HMC 6 flange socket**

**16-pin PCB connector**

<table>
<thead>
<tr>
<th>Power supply</th>
<th>Serial data transmission</th>
<th>Other signals</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>1b</td>
<td>6a</td>
<td>4b</td>
</tr>
</tbody>
</table>

**15-pin PCB connector**

<table>
<thead>
<tr>
<th>Power supply</th>
<th>Serial data transmission</th>
<th>Other signals</th>
</tr>
</thead>
<tbody>
<tr>
<td>M12</td>
<td>8</td>
<td>2</td>
</tr>
<tr>
<td>M23</td>
<td>3</td>
<td>7</td>
</tr>
<tr>
<td>1b</td>
<td>6a</td>
<td>4b</td>
</tr>
</tbody>
</table>

**Encoder**

**Motor**

<table>
<thead>
<tr>
<th>Brake</th>
<th>Power</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>8</td>
</tr>
</tbody>
</table>

**Travel range**

**SpeedTEC** is a registered trademark of TE Connectivity Industrial GmbH.
EnDat 3 combines the features and benefits of EnDat in a new architecture and offers interesting enhanced functions for digital production. EnDat 3 requires two wires for communication, and usually two additional wires for encoder power. Since the digital data current has no DC component, it is possible to modulate the communication on the supply wires, and so to reduce the number of wires for certain applications (e.g., hybrid motor cables) to a total of just two wires (HMC 2). The EnDat 3 interface specification is oriented on the standardized OSI layer model.

The encoder side of the interface is referred to as the slave, and the subsequent electronics side as the master. A communication cycle consists of a request from the master followed by a response from the slave.

**Further information:**
Find out more about EnDat at www.endat.de

---

**Ordering designations**
The ordering designation defines key communication characteristics:

<table>
<thead>
<tr>
<th>Supported communication types</th>
<th>E30-R2</th>
<th>E30-R4</th>
<th>E30-RB</th>
</tr>
</thead>
<tbody>
<tr>
<td>Communication modulated onto power supply wires</td>
<td>✓</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Communication + separate power supply wires (4 wires)</td>
<td>–</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Bus operation</td>
<td>–</td>
<td>–</td>
<td>✓</td>
</tr>
<tr>
<td>Sensor box integration</td>
<td>–</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>

---

**Pin layout of ECI, EQI 11xx**

8-pin M12 SpeedTEC angle flange socket

<table>
<thead>
<tr>
<th>Encoder</th>
<th>Power supply / Serial data transfer</th>
<th>Other signals</th>
</tr>
</thead>
<tbody>
<tr>
<td>M12</td>
<td>A</td>
<td>B</td>
</tr>
<tr>
<td>15</td>
<td>9</td>
<td>10</td>
</tr>
<tr>
<td>E30-R2</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>P_SD+</td>
<td>–</td>
<td>P_SD–</td>
</tr>
<tr>
<td>Violet</td>
<td>Yellow</td>
<td>Brown</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Motor</th>
<th>Brake</th>
<th>Power</th>
</tr>
</thead>
<tbody>
<tr>
<td>M12</td>
<td>C</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Brake</td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>–</td>
<td></td>
<td>4</td>
</tr>
<tr>
<td>U</td>
<td>V</td>
<td>W</td>
</tr>
</tbody>
</table>

1. Power supply and data: P_SD+ includes UP; P_SD– includes 0 V
2. Connections for an external temperature sensor; evaluation optimized for KTY 84-130, PT 1000, and others; (see Temperature measurement in motors; if used, please refer to the information about electromagnetic compatibility in the General electrical information section of the Interfaces of HEIDENHAIN Encoders brochure.

Vacant pins or wires must not be used!

SpeedTEC is a registered trademark of TE Connectivity Industrial GmbH.
HEIDENHAIN encoders with the code letter S after the model designation are suitable for connection to Siemens controls with the DRIVE-CLiQ interface.

- Ordering designation: DQ01

DRIVE-CLiQ is a registered trademark of Siemens AG.

Siemens pin layout for encoder cables (AGK)

<table>
<thead>
<tr>
<th>Encoder</th>
<th>Power supply / Serial data transfer</th>
<th>Other signals</th>
</tr>
</thead>
<tbody>
<tr>
<td>M23</td>
<td>A</td>
<td>/</td>
</tr>
<tr>
<td>12</td>
<td>2b</td>
<td>5a</td>
</tr>
<tr>
<td>4</td>
<td>/</td>
<td>/</td>
</tr>
<tr>
<td>M23</td>
<td>/</td>
<td>/</td>
</tr>
<tr>
<td>12</td>
<td>/</td>
<td>1a</td>
</tr>
<tr>
<td>4</td>
<td>/</td>
<td>1b</td>
</tr>
<tr>
<td>2</td>
<td>/</td>
<td>/</td>
</tr>
</tbody>
</table>

Siemens pin layout for adapter cables (APK) and connecting cables (VBK)

<table>
<thead>
<tr>
<th>Motor</th>
<th>Brake</th>
<th>Power</th>
</tr>
</thead>
<tbody>
<tr>
<td>M23</td>
<td>C</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>Brake +</td>
<td>U</td>
<td>V</td>
</tr>
</tbody>
</table>

Siemens pin layout for encoder cables (AGK)

<table>
<thead>
<tr>
<th>Encoder</th>
<th>Power supply / Serial data transfer</th>
<th>Other signals</th>
</tr>
</thead>
<tbody>
<tr>
<td>M12</td>
<td>8 2 1 5</td>
<td>/</td>
</tr>
<tr>
<td>M23</td>
<td>3 7 8 4</td>
<td>5 6 1 2</td>
</tr>
<tr>
<td>16</td>
<td>1b 6a 3a 4b</td>
<td>6b 1a 2b 5a 8a 8b</td>
</tr>
<tr>
<td>15</td>
<td>13 11 12 14</td>
<td>7 8 9 10 5 6</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Motor</th>
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<tr>
<td></td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>Brake +</td>
<td>U</td>
<td>V</td>
</tr>
</tbody>
</table>

Siemens pin layout for adapter cables (APK) and connecting cables (VBK)

<table>
<thead>
<tr>
<th>Encoder</th>
<th>Power supply</th>
<th>Serial data transfer</th>
</tr>
</thead>
<tbody>
<tr>
<td>RJ45</td>
<td>A</td>
<td>B</td>
</tr>
<tr>
<td>M12</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>M23</td>
<td>8</td>
<td>4</td>
</tr>
<tr>
<td>U_P</td>
<td>0V</td>
<td>TXP</td>
</tr>
</tbody>
</table>

Vacant pins or wires must not be used.

Output cables with a cable length > 0.5 m require strain relief for the cable.

Further information:
For detailed descriptions of all available interfaces, as well as general electrical information, please refer to the Interfaces of HEIDENHAIN Encoders brochure.

Pin layout of ECI, EQI, ECN, EQN 13xx

<table>
<thead>
<tr>
<th>Encoder</th>
<th>Power supply / Serial data transfer</th>
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</tr>
</thead>
<tbody>
<tr>
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<td>A</td>
<td>/</td>
</tr>
<tr>
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<tr>
<td></td>
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<td>4</td>
</tr>
<tr>
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<td>V</td>
</tr>
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</table>

Cable shield connected to housing. U_P = Power supply voltage. Vacant pins or wires must not be used.

Output cables with a cable length > 0.5 m require strain relief for the cable.

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Cable shield connected to housing. U_P = Power supply voltage. Vacant pins or wires must not be used.

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Further information:
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<td>U</td>
<td>V</td>
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</table>

Cable shield connected to housing. U_P = Power supply voltage. Vacant pins or wires must not be used.

Output cables with a cable length > 0.5 m require strain relief for the cable.

Further information:
For detailed descriptions of all available interfaces, as well as general electrical information, please refer to the Interfaces of HEIDENHAIN Encoders brochure.
The multiturn functionality of the EBI 1135, EBI 1335, EBI 135, and EBI 4010 is implemented by means of a revolution counter. In order for the absolute position information to still be available after loss of power, the EBI must be operated with an external backup battery. A lithium thionyl chloride battery with 3.6 V and 1200 mAh is recommended for the backup battery. The typical battery service life is over nine years (EBI 1135/135) or six years (EBI 4010, EBI 1335) under the right conditions (two ten-hour shifts under normal operation, battery temperature of 25 °C, and typical self-discharging). In order for this to be achieved, the main power supply (UP) must be connected to the encoder during or immediately after connection of the backup battery so that the encoder is fully initialized after being completely without power. Otherwise, the encoder will consume a significantly higher amount of battery current until main power is first supplied.

To avoid damage to the encoder, ensure the correct polarity of the backup battery. HEIDENHAIN recommends operating each encoder with its own backup battery.

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

If the backup battery voltage falls below certain thresholds, the encoder issues the following warnings or error messages, which are transmitted over the EnDat interface:

- **“Battery charge” warning** (2.8 V ± 0.2 V in normal operating mode)
- **“M Power interruption” error message** (2.2 V ± 0.2 V in battery-buffered mode; encoder must be re-referenced)

Low battery current continues to flow even during normal operation of the EBI. The amount of current depends on the operating temperature.

Please note:
Compliance with EnDat Specification 297 403 and the EnDat Application Notes 722024, Chapter 13, Battery-buffered encoders is required for correct control of the encoder.

### EBI 1135/EBI 1335/EBI 135/EBI 4010: external backup battery

![Backup battery connection](image)

### SSI position values

The position value is transmitted, starting with the most significant bit (MSB), over the data lines (DATA) in synchronism with a clock signal (CLOCK) provided by the control. The SSI standard data word length for singleturn encoders is 13 bits, and for multiturn encoders, 25 bits. In addition to the absolute position values, incremental signals can be transmitted as well. For a description of the signals, see 1 VPP incremental signals.

The following functions can be activated via programming inputs:
- Direction of rotation
- Zeroing (setting to zero)

#### Data transmission

- **T** = 1 to 10 µs
- **t1**: See Specifications
- **t2**: 0.4 µs (without cable)
- **t3**: 17 to 20 µs
- **n**: Data word length
- **13 bits for ECN/ROC; 25 bits for EQN/ROQ**

#### Pin layout

<table>
<thead>
<tr>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
<th>13</th>
<th>14</th>
<th>15</th>
<th>16</th>
<th>17</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Power supply</strong></td>
<td><strong>Incremental signals</strong></td>
<td><strong>Serial data transmission</strong></td>
<td><strong>Other signals</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Up</strong></td>
<td>Sensor</td>
<td>0 V</td>
<td>Sensor</td>
<td><strong>Internal shield</strong>(^1)</td>
<td><strong>A</strong></td>
<td><strong>A</strong></td>
<td><strong>B</strong></td>
<td><strong>B</strong></td>
<td><strong>DATA</strong></td>
<td><strong>DATA</strong></td>
<td><strong>CLOCK</strong></td>
<td><strong>CLOCK</strong></td>
<td><strong>Dir of rotation</strong></td>
<td><strong>Zeroing</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Brown/ Green</td>
<td>Blue</td>
<td>White/ Green</td>
<td>White</td>
<td>/</td>
<td>Green/ Black</td>
<td>Yellow/ Black</td>
<td>Blue/ Black</td>
<td>Red/ Black</td>
<td>Gray</td>
<td>Pink</td>
<td>Violet</td>
<td>Yellow</td>
<td>Black</td>
<td>Green</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\(^1\) Vacant with the ECN/ECQ 10xx and ROC/ROQ 10xx

Shield on housing; Up = Power supply voltage

Sensor: With a 5 V supply voltage, the sense line is connected in the encoder with the corresponding power line.

For detailed information, please refer to the Interfaces of HEIDENHAIN Encoders brochure.
## Cables and connecting elements
### Output cables inside the motor housing

<table>
<thead>
<tr>
<th>Rotary encoder</th>
<th>Interface</th>
<th>PCB connector</th>
<th>Crimp sleeve</th>
<th>With PCB connector and 17-pin M23 angle flange socket, and wires for temperature sensor (cross-linked polyolefin 2 x 0.25 mm²)</th>
<th>With PCB connector and 9-pin M23 angle flange socket, and wires for temperature sensor (TPE 2 x 0.16 mm²)</th>
<th>With PCB connector and 8-pin M12 flange socket (TPE single wires with braided sleeve without shield), and wires for temperature sensor (TPE 2 x 0.16 mm²)</th>
<th>With PCB connector and contact insert for HMC 6 hybrid connecting element, and wires for temperature sensor (TPE 2 x 0.16 mm²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ECI 119</td>
<td>EnDat01</td>
<td>15-pin</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>ECI 119</td>
<td>EnDat22</td>
<td>15-pin</td>
<td>-</td>
<td>1120347-xx 1)  1) EPG 1 x 14 x 0.06 mm² + 4 x 0.06 mm²</td>
<td>1119952-xx 1) 1) TPE 8 x 0.16 mm²</td>
<td>110800-xx 1) 1) TPE 8 x 0.16 mm²</td>
<td>1072652-xx 1) 1) EPG 1 x (4 x 0.06 mm²) + 4 x 0.06 mm²</td>
</tr>
<tr>
<td>EBI 135</td>
<td>EnDat22</td>
<td>15-pin</td>
<td>-</td>
<td>1120347-xx 1) 1) EPG 1 x 14 x 0.06 mm² + 4 x 0.06 mm²</td>
<td>1119952-xx 1) 1) TPE 8 x 0.16 mm²</td>
<td>110800-xx 1) 1) TPE 8 x 0.16 mm²</td>
<td>1072652-xx 1) 1) EPG 1 x (4 x 0.06 mm²) + 4 x 0.06 mm²</td>
</tr>
<tr>
<td>ECI 119</td>
<td>EnDat22</td>
<td>15-pin</td>
<td>-</td>
<td>1119952-xx 1) 1) TPE 8 x 0.16 mm²</td>
<td>110800-xx 1) 1) TPE 8 x 0.16 mm²</td>
<td>110800-xx 1) 1) TPE 8 x 0.16 mm²</td>
<td>1072652-xx 1) 1) EPG 1 x (4 x 0.06 mm²) + 4 x 0.06 mm²</td>
</tr>
<tr>
<td>EBI 1131</td>
<td>ECI 1131</td>
<td>15-pin</td>
<td>-</td>
<td>1270430-xx 1) 1) EPG 1 x (4 x 0.06 mm²) + 4 x 0.06 mm²</td>
<td>1302701-xx 1) 1) EPG 2 x 0.15 mm²</td>
<td>1302701-xx 1) 1) EPG 2 x 0.15 mm²</td>
<td>1302701-xx 1) 1) EPG 2 x 0.15 mm²</td>
</tr>
<tr>
<td>ECI 1118</td>
<td>EnDat22</td>
<td>15-pin</td>
<td>-</td>
<td>805320-xx 1) 1) TPE 8 x 0.16 mm²</td>
<td>72584-xx 1) 1) TPE 8 x 0.16 mm²</td>
<td>1035387-xx 1) 1) TPE 8 x (4 x 0.06 mm²) + 4 x 0.06 mm²</td>
<td>1035387-xx 1) 1) TPE 8 x (4 x 0.06 mm²) + 4 x 0.06 mm²</td>
</tr>
<tr>
<td>EBI 1135</td>
<td>EnDat22</td>
<td>15-pin</td>
<td>-</td>
<td>604305-xx 1) 1) TPE 8 x 0.16 mm²</td>
<td>72584-xx 1) 1) TPE 8 x 0.16 mm²</td>
<td>1035387-xx 1) 1) TPE 8 x (4 x 0.06 mm²) + 4 x 0.06 mm²</td>
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</tr>
<tr>
<td>ECI 1319</td>
<td>EGI 1331</td>
<td>15-pin or 12-pin + 4-pin Ø 6 mm</td>
<td>-</td>
<td>1120345-xx 1) 1) EPG 2 x (2 x 0.06 mm²) + 4 x 0.06 mm²</td>
<td>1117280-xx 1) 1) TPE 8 x 0.16 mm²</td>
<td>110800-xx 1) 1) TPE 8 x 0.16 mm²</td>
<td>1072652-xx 1) 1) EPG 1 x (4 x 0.06 mm²) + 4 x 0.06 mm²</td>
</tr>
<tr>
<td>EBI 1335</td>
<td>ECI 1335</td>
<td>15-pin or 12-pin + 4-pin Ø 6 mm</td>
<td>-</td>
<td>1120345-xx 1) 1) EPG 2 x (2 x 0.06 mm²) + 4 x 0.06 mm²</td>
<td>1117280-xx 1) 1) TPE 8 x 0.16 mm²</td>
<td>110800-xx 1) 1) TPE 8 x 0.16 mm²</td>
<td>1072652-xx 1) 1) EPG 1 x (4 x 0.06 mm²) + 4 x 0.06 mm²</td>
</tr>
<tr>
<td>ECI 1319</td>
<td>EnDat3</td>
<td>4-pin rotary temp. sensor</td>
<td>-</td>
<td>1302701-xx 1) 1) EPG 2 x 0.15 mm²</td>
<td>1302701-xx 1) 1) EPG 2 x 0.15 mm²</td>
<td>1302701-xx 1) 1) EPG 2 x 0.15 mm²</td>
<td>1302701-xx 1) 1) EPG 2 x 0.15 mm²</td>
</tr>
<tr>
<td>ECI 1319 S</td>
<td>EGI 1313S</td>
<td>DRIVE-CLIQ 16-pin or 12-pin + 4-pin Ø 6 mm</td>
<td>-</td>
<td>1120345-xx 1) 1) EPG 2 x (2 x 0.06 mm²) + 4 x 0.06 mm²</td>
<td>1117280-xx 1) 1) TPE 8 x 0.16 mm²</td>
<td>110800-xx 1) 1) TPE 8 x 0.16 mm²</td>
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<tr>
<td>ECI 1319</td>
<td>ECI 1335</td>
<td>DRIVE-CLIQ 16-pin or 12-pin + 4-pin Ø 6 mm</td>
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<td>1072652-xx 1) 1) EPG 1 x (4 x 0.06 mm²) + 4 x 0.06 mm²</td>
</tr>
<tr>
<td>ECN 1113</td>
<td>ENQ 1125</td>
<td>15-pin Ø 4.5 mm</td>
<td>606079-xx 1) 1) EPG 16 x 0.06 mm²</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>ECN 1123</td>
<td>ENQ 1136</td>
<td>15-pin Ø 4.5 mm</td>
<td>-</td>
<td>1117280-xx 1) 1) TPE 8 x 0.16 mm²</td>
<td>110800-xx 1) 1) TPE 8 x 0.16 mm²</td>
<td>110800-xx 1) 1) TPE 8 x 0.16 mm²</td>
<td>1072652-xx 1) 1) EPG 1 x (4 x 0.06 mm²) + 4 x 0.06 mm²</td>
</tr>
<tr>
<td>ECN 1123S</td>
<td>ENQ 1135S</td>
<td>15-pin Ø 4.5 mm</td>
<td>-</td>
<td>127143-xx 1) 1) EPG 2 x (2 x 0.06 mm²) + 4 x 0.06 mm²</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>ECN 1313</td>
<td>ENQ 125</td>
<td>12-pin Ø 6 mm</td>
<td>332201-xx 1) 1) EPG 16 x 0.06 mm²</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

**Attention:**

1) With cable clamp for shield connection
2) Single wires in heat shrink tubing without shield
3) Note the max. temperature (see the interfaces of HEIDENHAIN Encoders brochure)
4) SpeedTEC angle flange socket (male) with O-ring for vibration protection (for threaded connector with O-ring; for SpeedTEC connector, remove O-ring)
5) EPG cable with one-sided shield connection
6) Not suited for HMC 6, not supported by the TNC

---

1) Connecting element must be suitable for the maximum data rate used
2) Single wires without heat shrink tubing, without shield
3) Single wires in heat shrink tubing, without shield, with connector; 2 pin only for temperature sensor
4) Twisted single wires, without shield
5) 8-pin M23 SpeedTEC angle flange socket without vibration O-ring
6) 8-pin M12 SpeedTEC angle flange socket (male), bolt circle dia. 23.75 mm, without vibration O-ring
7) With wires for temperature sensor (ETFE 2 x 0.15 mm²) in heat shrink tubing

---

Further information:

For more information about HMC 6 or HMC 2, refer to the respective Product Information document. For information about output cables inside the motor, please refer to the Cables and Connectors brochure.
### Output cables inside the motor housing

Cable diameter: 4.5 mm, 3.7 mm or TPE single wires with shrink-wrap or braided sleeve.

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<th>Rotary encoder</th>
<th>Interface</th>
<th>PCB connector</th>
<th>Crimp sleeve</th>
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<td>ERN 1123</td>
<td>TTL</td>
<td>15-pin</td>
<td>–</td>
</tr>
<tr>
<td>ERN 1321</td>
<td>TTL 1 Vpp</td>
<td>12-pin</td>
<td>Ø 6 mm</td>
</tr>
<tr>
<td>ERN 1326</td>
<td>TTL</td>
<td>16-pin</td>
<td>Ø 6 mm</td>
</tr>
<tr>
<td>ERN 1387</td>
<td>1 Vpp</td>
<td>14-pin</td>
<td>Ø 6 mm</td>
</tr>
<tr>
<td>ERO 1225</td>
<td>TTL 1 Vpp</td>
<td>12-pin</td>
<td>Ø 4.5 mm</td>
</tr>
<tr>
<td>ERO 1420</td>
<td>TTL 1 Vpp</td>
<td>12-pin</td>
<td>Ø 4.5 mm</td>
</tr>
<tr>
<td>ECI 4090</td>
<td>EnDat22</td>
<td>15-pin</td>
<td>Ø 4.5 mm</td>
</tr>
<tr>
<td>ECI 4090 S</td>
<td>DRIVE-CLiQ</td>
<td>15-pin</td>
<td>Ø 4.5 mm</td>
</tr>
</tbody>
</table>

### Rotary encoder Interfaces

- **ERN 1123 (TTL)**
  - With cable clamp for shield connection
  - With wires for temperature sensor
  - With wires for temp. sensor
  - With wires for temperature sensor
  - With wires for temperature sensor

- **ERN 1321 (TTL)**
  - Single wires with heat shrink tubing, without shield

- **ERN 1326 (TTL)**
  - Single wires with heat shrink tubing, without shield

- **ERN 1387 (1 Vpp)**
  - Single wires with heat shrink tubing, without shield

- **ERO 1225 (TTL)**
  - Single wires with heat shrink tubing, without shield

- **ERO 1420 (TTL)**
  - Single wires with heat shrink tubing, without shield

- **ECI 4090 (TTL)**
  - Drive-CLiQ
  - Single wires with heat shrink tubing, without shield

### Angle Flange Socket Options

1) With cable clamp for shield connection
2) With wires for temperature sensor, and wires for temperature sensor (TPE 2 x 0.16 mm²)
3) With wires for temperature sensor (TPE 2 x 0.16 mm²)
4) With PCB connector and 9-pin M23 angle flange socket, and wires for temperature sensor (TPE 2 x 0.16 mm²)

<table>
<thead>
<tr>
<th>Rotary encoder</th>
<th>Interface</th>
<th>PCB connector</th>
<th>Crimp sleeve</th>
</tr>
</thead>
<tbody>
<tr>
<td>ERN 1123</td>
<td>TTL</td>
<td>15-pin</td>
<td>–</td>
</tr>
<tr>
<td>ERN 1321</td>
<td>TTL 1 Vpp</td>
<td>12-pin</td>
<td>Ø 6 mm</td>
</tr>
<tr>
<td>ERN 1326</td>
<td>TTL</td>
<td>16-pin</td>
<td>Ø 6 mm</td>
</tr>
<tr>
<td>ERN 1387</td>
<td>1 Vpp</td>
<td>14-pin</td>
<td>Ø 6 mm</td>
</tr>
<tr>
<td>ERO 1225</td>
<td>TTL 1 Vpp</td>
<td>12-pin</td>
<td>Ø 4.5 mm</td>
</tr>
<tr>
<td>ERO 1420</td>
<td>TTL 1 Vpp</td>
<td>12-pin</td>
<td>Ø 4.5 mm</td>
</tr>
<tr>
<td>ECI 4090</td>
<td>EnDat22</td>
<td>15-pin</td>
<td>Ø 4.5 mm</td>
</tr>
<tr>
<td>ECI 4090 S</td>
<td>DRIVE-CLiQ</td>
<td>15-pin</td>
<td>Ø 4.5 mm</td>
</tr>
</tbody>
</table>

### Further information:

For more information about HMC 6, please refer to the HMC 6 Product Information document.

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1) With cable clamp for shield connection.
2) Single wires with heat shrink tubing, without shield.
3) Note the max. temperature (see the Interfaces of HEIDENHAIN Encoders brochure).
4) SpeedTEC angle flange socket (male) with O-ring for vibration protection (for threaded connector with O-ring; for SpeedTEC connector, remove O-ring).

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5) Not suited for HMC 6, not supported by the TNC.
6) Connecting element must be suitable for the maximum data rate used.
7) Single wires without heat shrink tubing, without shield.
HEIDENHAIN encoders provide all of the information needed for commissioning, monitoring, and diagnostics. The type of information available depends on whether the encoder is incremental or absolute and on which interface is being used.

Incremental encoders have 1 Vpp, TTL, or HTL interfaces. TTL and HTL encoders monitor their signal amplitudes internally and generate a simple fault detection signal. With 1 Vpp signals, an analysis of the output signals is possible only with external testing devices or through the expenditure of computation resources in the subsequent electronics (analog diagnostic interface).

Absolute encoders employ serial data transmission. Depending on the interface, additional 1 Vpp incremental signals can be output. The signals are extensively monitored within the encoder. The monitoring results (particularly valuation numbers) can be transmitted to the subsequent electronics along with the position values via the serial interface (digital diagnostics interface).

The following information is available:
- Error message: position value is not reliable
- Warning: an internal functional limit of the encoder has been reached
- Valuation numbers:
  - Detailed information on the encoder's function reserve
  - Identical scaling for all HEIDENHAIN encoders
  - Cyclic reading is possible

This enables the subsequent electronics to evaluate the current status of the encoder with little effort, even in Closed Loop mode.

For the analysis of these encoders, HEIDENHAIN offers the appropriate PWM inspection devices and PWT testing devices. Based on how these devices are integrated, a distinction is made between two types of diagnostics:
- Encoder diagnostics: the encoder is connected directly to the inspection or testing device, thereby enabling a detailed analysis of encoder functions.
- Monitoring mode: the PWM inspection device is interposed within the closed control loop (via suitable testing adapters as needed). This enables real-time diagnosis of the machine or equipment during operation. The available functions depend on the interface.

### PW T101

The PWT 101 is a testing device for the functional testing and adjustment of incremental and absolute HEIDENHAIN encoders. Thanks to its compact dimensions and rugged design, the PWT 101 is ideal for portable use.

<table>
<thead>
<tr>
<th>Encoder input only for HEIDENHAIN encoders</th>
</tr>
</thead>
<tbody>
<tr>
<td>EnDat</td>
</tr>
<tr>
<td>Fanuc Serial Interface</td>
</tr>
<tr>
<td>Mitsubishi high speed interface</td>
</tr>
<tr>
<td>Panasonic Serial Interface</td>
</tr>
<tr>
<td>Yaskawa Serial Interface</td>
</tr>
<tr>
<td>1 Vpp</td>
</tr>
<tr>
<td>12 µAPP</td>
</tr>
<tr>
<td>TTL</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Display</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.3-inch color flat-panel display (touchscreen)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Supply voltage</th>
</tr>
</thead>
<tbody>
<tr>
<td>DC 24 V</td>
</tr>
<tr>
<td>Power consumption: max. 15 W</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Operating temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 °C to 40 °C</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Protection EN 60529</th>
</tr>
</thead>
<tbody>
<tr>
<td>IP20</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Dimensions</th>
</tr>
</thead>
<tbody>
<tr>
<td>145 mm x 85 mm x 35 mm</td>
</tr>
</tbody>
</table>
ATS Software
Product Information
For more information, see the PWM 21, an adjustment and testing package for the diagnosis and adjustment of HEIDENHAIN encoders.

PWM 21
The PWM 21 phase angle measuring unit, in conjunction with the included ATS adjustment and testing software, provides an adjustment and testing package for the diagnosis and adjustment of HEIDENHAIN encoders.

Encoder input
- EnDat 2.1, EnDat 2.2, or EnDat 3 (absolute value with or without incremental signals)
- DRIVE-CLIQ
- Fanuc Serial Interface
- Mitsubishi high speed interface
- Yaskawa Serial Interface
- Panasonic serial interface
-SSI
- 1 Vpp TTL/1 µA-p
- HFL (via signal adapter)

Interface
USB 2.0

Supply voltage
AC 100 V to 240 V or DC 24 V

Dimensions
258 mm × 154 mm × 55 mm

System requirements and recommendations
PC (dual-core processor > 2 GHz)
RAM > 2 GB
Operating systems: Windows 7, 8, and 10 (32-bit / 64-bit)
500 MB of free hard drive space

DRIVE-CLIQ is a registered trademark of Siemens AG.

ATS
Languages
German or English (selectable)

Functions
- Position display
- Connection dialog
- Diagnostics
- Mounting wizard for EBl/ECl/EQI, LJP 200, LIC 4000 and others
- Additional functions (if supported by the encoder)
- Memory contents

For complete and further addresses see www.heidenhain.com