RESOLUTE™ ETR (Extended Temperature Range) absolute encoder

RESOLUTE™ ETR is a true-absolute fine-pitch optical rotary (angle) encoder system, with guaranteed operation down to −40 °C (−40 °F).

The RESOLUTE encoder system combines 18, 26 or 32 bit resolution with exceptionally high speeds of up to 18 000 rev/min (50 metres/second) and high accuracy stainless steel ring scales.

RESOLUTE encoder systems use a single optical absolute track with a nominal pitch of 30 μm, combined with sophisticated optics to ensure wide set-up tolerances and impressive low-noise performance. The detection method also intrinsically provides very low sub-divisional error of ±40 nm and ultra-low noise (jitter) less than 10 nm RMS, resulting in better velocity control performance and rock solid positional stability.

Operation down to −40 °C (−40 °F) in non-condensing environments is guaranteed, making this product suitable for use in applications such as telescopes, scientific research, military and aerospace. The encoder is also tough enough to survive the physical punishment of harsh environments, with high vibration resistance and solid stainless steel ring scales.

The RESOLUTE encoder system ensures reliability with excellent dirt immunity and a built-in separate position-checking algorithm, which actively checks every reading.

- True-absolute non-contact optical encoder system: no batteries required
- Operates down to −40 °C (−40 °F) and up to +80 °C (+176 °F)
- Wide set-up tolerances for quick and easy installation
- High immunity to dirt, scratches and light oils
- resolutions to 32 bit rotary
- 50 m/s maximum speed for all resolutions (to 18 000 rev/min)
- ±40 nm sub-divisional error for smooth velocity control
- Less than 10 nm RMS jitter for improved positional stability
- Built-in separate position-checking algorithm provides inherent safety
- High shock and vibration resistance
- IP64 sealed readhead for high reliability in harsh environments
- Integral set-up LED enables easy installation and provides diagnostics at a glance
- Integral over-temperature alarm
- BiSS® serial communications for high RFI immunity

Compatible with:
- RESA30 angle encoders
- Ultra-high accuracy REXA30 angle encoders
- Optional Advanced Diagnostic Tool ADTa-100
System features

**Unique single-track absolute optical scale**
- Absolute position is determined immediately upon switch-on
- No battery back-up
- No yaw de-phasing unlike multiple-track systems
- Fine pitch (30 µm nominal period) optical scale for superior motion control compared to inductive, magnetic or other non-contact optical absolute encoders
- High-accuracy graduations marked directly onto tough engineering materials for outstanding metrology and reliability

**High dirt immunity**
- Advanced optics and embedded surplus code means the RESOLUTE encoder system even reads dirty scale
- Absolute position can be determined in all three cases shown here; clean scale (left), grease contamination (below-left), particle contamination (below)

**Unique detection method**
- Readhead acts like an ultra-fast miniature digital camera, taking photos of a coded scale
- Photos are analysed by a high-speed digital signal processor (DSP) to determine absolute position
- Built-in position-check algorithm constantly monitors calculations for ultimate safety and reliability
- Advanced optics and position determination algorithms are designed to provide low noise (jitter < 10 nm RMS) and low sub-divisional error (SDE ±40 nm)

**Optional Advanced Diagnostic Tool**
The RESOLUTE encoder system is compatible with the Advanced Diagnostic Tool ADTa-100* and ADT View software, which acquire detailed real-time data from the readhead to allow easy set-up, optimisation and in-field fault finding. The intuitive software interface provides:
- Digital readout of encoder position and signal strength
- Graph of signal strength over the entire axis travel
- Ability to set a new zero position for the encoder system
- System configuration information

* ADTa-100 compatible readheads are marked with the symbol ADT
RESOLUTE ETR (Extended Temperature Range) absolute encoder

Angle absolute encoder version

Resolution

RESOLUTE encoders are available with a variety of resolutions, to meet the needs of a wide range of applications.

The choice of resolutions depends on the serial protocol being used, but there are no limitations due to ring size; for example BiSS 26 bit resolution is available on all ring sizes.

RESOLUTE ETR encoders with BiSS C serial comms are available with the following resolution options:

<table>
<thead>
<tr>
<th>Resolution</th>
<th>Counts per revolution</th>
<th>Arc second</th>
</tr>
</thead>
<tbody>
<tr>
<td>18 bit</td>
<td>262 144</td>
<td>≈ 4.94</td>
</tr>
<tr>
<td>26 bit</td>
<td>67 108 864</td>
<td>≈ 0.019</td>
</tr>
<tr>
<td>32 bit</td>
<td>4 294 967 296</td>
<td>≈ 0.00030</td>
</tr>
</tbody>
</table>

NOTE: 32 bit resolution is below the noise floor of the RESOLUTE encoder.

Speed and accuracy

<table>
<thead>
<tr>
<th>RESA30 diameter (mm)</th>
<th>Maximum reading speed (rev/min)</th>
<th>System accuracy (arc second)</th>
</tr>
</thead>
<tbody>
<tr>
<td>52</td>
<td>18 000</td>
<td>±5.49</td>
</tr>
<tr>
<td>57</td>
<td>18 000</td>
<td>±4.89</td>
</tr>
<tr>
<td>75</td>
<td>12 500</td>
<td>±3.82</td>
</tr>
<tr>
<td>100</td>
<td>9 500</td>
<td>±2.86</td>
</tr>
<tr>
<td>103</td>
<td>9 250</td>
<td>±2.72</td>
</tr>
<tr>
<td>104</td>
<td>9 000</td>
<td>±2.69</td>
</tr>
<tr>
<td>115</td>
<td>8 250</td>
<td>±2.44</td>
</tr>
<tr>
<td>150</td>
<td>6 000</td>
<td>±1.91</td>
</tr>
<tr>
<td>200</td>
<td>4 750</td>
<td>±1.43</td>
</tr>
<tr>
<td>206</td>
<td>4 600</td>
<td>±1.42</td>
</tr>
<tr>
<td>209</td>
<td>4 500</td>
<td>±1.4</td>
</tr>
<tr>
<td>229</td>
<td>4 150</td>
<td>±1.27</td>
</tr>
<tr>
<td>255</td>
<td>3 700</td>
<td>±1.11</td>
</tr>
<tr>
<td>300</td>
<td>3 150</td>
<td>±0.95</td>
</tr>
<tr>
<td>350</td>
<td>2 700</td>
<td>±0.82</td>
</tr>
<tr>
<td>413</td>
<td>2 300</td>
<td>±0.69</td>
</tr>
<tr>
<td>417</td>
<td>2 250</td>
<td>±0.68</td>
</tr>
<tr>
<td>489</td>
<td>1 950</td>
<td>±0.59</td>
</tr>
<tr>
<td>550</td>
<td>1 700</td>
<td>±0.52</td>
</tr>
</tbody>
</table>

System accuracy is graduation accuracy plus SDE. Effects such as eccentricity influence installed accuracy; for application advice, contact your local Renishaw representative.

For REXA30 speed and accuracy figures, refer to the REXA30 ultra-high accuracy absolute angle encoder data sheet (Renishaw part no. L-9517-9405).

Rotary scale specifications

For more detailed scale information, refer to the relevant scale data sheet.

<table>
<thead>
<tr>
<th>Material</th>
<th>303/304 stainless steel</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coefficient of thermal expansion (at 20 °C)</td>
<td>15 ±0.5 µm/m°C</td>
</tr>
</tbody>
</table>
## General specifications

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Power supply</strong></td>
<td>5 V ±10%</td>
</tr>
<tr>
<td></td>
<td>1.25 W maximum (250 mA @ 5 V)</td>
</tr>
<tr>
<td><strong>NOTE:</strong></td>
<td>Current consumption figures refer to terminated RESOLUTE systems. Renishaw encoder systems must be powered from a 5 Vdc supply complying with the requirements for SELV of standard IEC 60950-1.</td>
</tr>
<tr>
<td>Ripple</td>
<td>200 mVpp maximum @ frequency up to 500 kHz maximum</td>
</tr>
<tr>
<td><strong>Temperature</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Storage</strong></td>
<td>−40 °C to +80 °C</td>
</tr>
<tr>
<td><strong>Humidity</strong></td>
<td>95% relative humidity (non-condensing) to IEC 60068-2-78</td>
</tr>
<tr>
<td><strong>Sealing</strong></td>
<td>IP64</td>
</tr>
<tr>
<td><strong>Acceleration (readhead)</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Operating</strong></td>
<td>300 m/s², 3 axes</td>
</tr>
<tr>
<td>(−40 °C to 0 °C)</td>
<td></td>
</tr>
<tr>
<td>(0 °C to 80 °C)</td>
<td></td>
</tr>
<tr>
<td><strong>Shock (readhead)</strong></td>
<td>1000 m/s², 6 ms, ½ sine, 3 axes</td>
</tr>
<tr>
<td><strong>Non-operating</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Maximum acceleration of scale with respect to readhead</strong></td>
<td>2000 m/s²</td>
</tr>
<tr>
<td><strong>NOTE:</strong></td>
<td>This is the worst-case figure that is correct for the slowest communications request rates. For faster request rates, the maximum acceleration of scale with respect to the readhead can be higher. For more details, contact your local Renishaw representative.</td>
</tr>
<tr>
<td><strong>Vibration</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Operating</strong></td>
<td>300 m/s² max @ 55 Hz to 2000 Hz, 3 axes</td>
</tr>
<tr>
<td><strong>Random vibration</strong></td>
<td>0.175 g²/Hz ASD 20-1000 Hz, −6dB roll off 1-2 kHz</td>
</tr>
<tr>
<td><strong>Mass</strong></td>
<td></td>
</tr>
<tr>
<td>Readhead</td>
<td>18 g</td>
</tr>
<tr>
<td>Cable</td>
<td>32 g/m</td>
</tr>
<tr>
<td><strong>Cable</strong></td>
<td>7 core, tinned and annealed copper, 28 AWG</td>
</tr>
<tr>
<td></td>
<td>Single-shielded, outside diameter 4.7 ±0.2 mm</td>
</tr>
<tr>
<td></td>
<td>Flex life &gt; 40 × 10⁶ cycles at 20 mm bend radius</td>
</tr>
<tr>
<td><strong>NOTE:</strong></td>
<td>Cable must be held static for operation below 0 °C</td>
</tr>
<tr>
<td></td>
<td>UL recognised component</td>
</tr>
<tr>
<td><strong>Communication format</strong></td>
<td>RS485/RS422 differential line-driven signal</td>
</tr>
</tbody>
</table>

**NOTE:** If using RESA30, the hub should be made of a material with a CTE of between 14 and 18 μm/m/°C. If using REXA30, contact your local Renishaw representative. Further environmental testing has been carried out. Contact Renishaw if you have specific requirements.
Set-up LED

Vapour permeable membrane

Riole centreline

Optical centreline

2 mounting holes M3 through, counterbored each side, 3 deep

6.5 min

(6aw tol. ±0.5°)

0.31

(Yaw tol. ±0.5°)

(10 typ)

Optical centreline

Scale and optical centreline

Forward' direction of ring
(increasing count) irrespective of readhead orientation

* Extent of mounting faces
† 0.8 ±0.1 mm on 52 mm rings
‡ Recommended thread engagement 5 mm (8 mm including counterbore). Recommended tightening torque 0.5 to 0.7 Nm
RESOLUTE readhead side exit cable installation drawing (on REXA30 ring)

Dimensions and tolerances in mm

Set-up LED

Vapour permeable membrane

R> 20 Dynamic bend radius
R> 10 Static bend radius

0.8 ± 0.1 mm on 52 mm rings

Recommended tightening torque 0.5 to 0.7 Nm
### RESOLUTE angle readhead nomenclature

**Series**
- **R** = RESOLUTE

**Scale form**
- **A** = Angular

**Protocol**
- 18B = BiSS 18 bit
- 26B = BiSS 26 bit
- 32B = BiSS 32 bit

**Mechanical option**
- **T** = Extended Temperature Range (standard cable outlet)
- **C** = Extended Temperature Range (side cable outlet)

**Gain option**
- **A** = Standard

**Ring diameter**
- 052 = 52 mm ring
- 057 = 57 mm ring
- 075 = 75 mm ring
- 100 = 100 mm ring
- 103 = 103 mm ring
- 104 = 104 mm ring
- 115 = 115 mm ring
- 150 = 150 mm ring
- 183 = 183 mm ring (REXA30 only)
- 200 = 200 mm ring
- 206 = 206 mm ring
- 209 = 209 mm ring
- 229 = 229 mm ring
- 255 = 255 mm ring
- 300 = 300 mm ring
- 350 = 350 mm ring
- 413 = 413 mm ring (REXA30 only)
- 417 = 417 mm ring
- 489 = 489 mm ring (REXA30 only)
- 550 = 550 mm ring (REXA30 only)

**Scale code option**
- **B** = Standard scale code

**Cable length**
- 02 = 0.2 m
- 05 = 0.5 m
- 10 = 1 m
- 15 = 1.5 m
- 30 = 3 m
- 50 = 5 m
- 90 = 9 m
- 99 = 10 m

**Termination**
- **A** = 9-way D-type connector
- **F** = Flying lead (unterminated)

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**NOTES:**
- Not all combinations are valid. Check valid options online at [www.renishaw.com/epc](http://www.renishaw.com/epc)
- Contact your local Renishaw representative if you have specific ETR requirements.
RESOLUTE ETR series compatible products

Linear scales are not available with RESOLUTE Extended Temperature Range

RESA30 stainless steel ring
REXA30 high-accuracy stainless steel ring

Advanced Diagnostic Tool ADTa-100 (A-6525-0100)

Lid orientation in photos is for illustration purposes only.

For more information about the ADTa-100 and the scale, refer to the relevant data sheets and installation guides which can be downloaded from www.renishaw.com/opticalencoders.