RESOLUTE™ absolute optical encoder with Mitsubishi serial communications

RESOLUTE™ is a true-absolute fine-pitch optical encoder system with excellent metrology performance.

Patented RESOLUTE encoder technology combines 1 nm resolution with exceptionally high speed, up to 100 m/s (36 000 rev/min), reading from a range of high-accuracy linear tape and spar scales or angle encoder rings.

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

The RESOLUTE system ensures reliability with excellent dirt immunity, built-in separate position-checking algorithm and IP64 sealed readhead with wipe-clean recovery.

RESOLUTE encoders are available with a variety of serial protocols. Contact your local Renishaw representative for details.

- True-absolute non-contact optical encoder system: no batteries required
- Wide set-up tolerances for quick and easy installation
- High immunity to dirt, scratches and light oils
- Resolutions to 1 nm linear or 27 bit rotary
- 100 m/s maximum speed for all resolutions (to 36 000 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
- IP64 sealed readhead for high reliability in harsh environments
- Integral set-up LED enables easy installation and provides diagnostics at a glance
- Operates up to 80 °C
- Integral over-temperature alarm

Compatible with:

- RELA30 low-expansion, high-stability spar scales
- RSLA30 stainless steel spars
- RTLA30 with FASTRACK™ carrier
- RTLA30-S self-adhesive tape scale
- RESA30 angle encoders
- Ultra-high accuracy REXA30 angle encoders
- Optional Advanced Diagnostic Tool ADTa-100
Data sheet
RESOLUTE absolute optical encoder (Mitsubishi)

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
**Linear absolute encoder version**

**Resolutions and scale lengths**

The maximum scale length is determined by the readhead resolution and the number of position bits in the serial word. For RESOLUTE readheads with fine resolution and short word length, the maximum scale length will be limited accordingly. Conversely, coarser resolutions or longer word lengths enable the use of longer scale lengths.

RESOLUTE encoders are available with a variety of serial protocols. The table shows a RESOLUTE system using Mitsubishi protocol with 40 bit position word length.

<table>
<thead>
<tr>
<th>Resolution</th>
<th>1 nm</th>
<th>50 nm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum scale length (L) with 40 bit position word</td>
<td>2.1 m</td>
<td>21 m</td>
</tr>
<tr>
<td>Maximum reading speed</td>
<td>100 m/s</td>
<td>100 m/s</td>
</tr>
</tbody>
</table>

Contact your local Renishaw representative for details of other serial protocols.

**Scale specifications**

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

<table>
<thead>
<tr>
<th>Description</th>
<th>RELA30</th>
<th>RSLA30</th>
<th>RTLA30/FASTRACK</th>
<th>RTLA30-S</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>High-performance low-expansion spar scale for very high-accuracy applications.</td>
<td>High-performance stainless steel spar scale for very high-accuracy applications with longer axis lengths.</td>
<td>Track-mounted hardened stainless steel tape scale for high-performance motion control systems requiring easier and faster scale installation and field replacement.</td>
<td>Self-adhesive hardened stainless steel tape scale for high-performance motion control systems requiring simple installation.</td>
</tr>
<tr>
<td></td>
<td>Lengths up to 1.5 m</td>
<td>Lengths up to 5 m*</td>
<td>RTLA30 lengths up to 21 m*</td>
<td>Lengths up to 21 m*</td>
</tr>
<tr>
<td></td>
<td>RSLA30</td>
<td>RTLA30/FASTRACK</td>
<td><strong>FASTRACK</strong> lengths up to 25 m</td>
<td><strong>FASTRACK</strong> lengths up to 25 m</td>
</tr>
<tr>
<td><strong>Accuracy</strong></td>
<td>RELA30</td>
<td>RSLA30</td>
<td>RTLA30/FASTRACK</td>
<td>RTLA30-S</td>
</tr>
<tr>
<td>(at 20 °C)</td>
<td>±1 µm up to 1 m</td>
<td>±1 µm/m for lengths from 1 m to 1.5 m</td>
<td>±2.25 µm for lengths from 1 m to 2 m</td>
<td>±3 µm for lengths from 2 m to 3 m</td>
</tr>
<tr>
<td></td>
<td>RSLA30</td>
<td>RTLA30/FASTRACK</td>
<td>±4 µm for lengths from 3 m to 5 m</td>
<td>±5 µm/m</td>
</tr>
<tr>
<td></td>
<td>±1.5 µm up to 1 m</td>
<td>RTLA30 lengths up to 21 m*</td>
<td><strong>FASTRACK</strong> lengths up to 25 m</td>
<td><strong>FASTRACK</strong> lengths up to 25 m</td>
</tr>
<tr>
<td></td>
<td>RTLA30-S</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>±5 µm/m</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Coefficient of thermal expansion</strong> (at 20 °C)</td>
<td>RELA30</td>
<td>RSLA30</td>
<td>RTLA30/FASTRACK</td>
<td>RTLA30-S</td>
</tr>
<tr>
<td></td>
<td>0.75 ±0.35 µm/m°C</td>
<td>10.1 ±0.2 µm/m°C</td>
<td>10.1 ±0.2 µm/m°C</td>
<td>10.1 ±0.2 µm/m°C</td>
</tr>
</tbody>
</table>

* Limited to 2.1 m when using RESOLUTE Mitsubishi readhead with 1 nm resolution
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 Mitsubishi 27 bit resolution is available on all ring sizes.

RESOLUTE with Mitsubishi 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>23 bit</td>
<td>8 388 608</td>
<td>≈ 0.15</td>
</tr>
<tr>
<td>27 bit</td>
<td>134 217 728</td>
<td>≈ 0.0097</td>
</tr>
</tbody>
</table>

For resolution options on other protocols, contact your local Renishaw representative.

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>36 000</td>
<td>± 5.49</td>
</tr>
<tr>
<td>57</td>
<td>33 000</td>
<td>± 4.89</td>
</tr>
<tr>
<td>75</td>
<td>25 000</td>
<td>± 3.82</td>
</tr>
<tr>
<td>100</td>
<td>19 000</td>
<td>± 2.86</td>
</tr>
<tr>
<td>103</td>
<td>18 500</td>
<td>± 2.72</td>
</tr>
<tr>
<td>104</td>
<td>18 000</td>
<td>± 2.69</td>
</tr>
<tr>
<td>115</td>
<td>16 500</td>
<td>± 2.44</td>
</tr>
<tr>
<td>150</td>
<td>12 000</td>
<td>± 1.91</td>
</tr>
<tr>
<td>200</td>
<td>9 500</td>
<td>± 1.43</td>
</tr>
<tr>
<td>206</td>
<td>9 200</td>
<td>± 1.42</td>
</tr>
<tr>
<td>209</td>
<td>9 000</td>
<td>± 1.4</td>
</tr>
<tr>
<td>229</td>
<td>8 300</td>
<td>± 1.27</td>
</tr>
<tr>
<td>255</td>
<td>7 400</td>
<td>± 1.11</td>
</tr>
<tr>
<td>300</td>
<td>6 300</td>
<td>± 0.95</td>
</tr>
<tr>
<td>350</td>
<td>5 400</td>
<td>± 0.82</td>
</tr>
<tr>
<td>413</td>
<td>4 600</td>
<td>± 0.69</td>
</tr>
<tr>
<td>417</td>
<td>4 500</td>
<td>± 0.68</td>
</tr>
<tr>
<td>489</td>
<td>3 900</td>
<td>± 0.59</td>
</tr>
<tr>
<td>550</td>
<td>3 400</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.

CAUTION: Very high speed motion axes require additional design consideration. For applications that will exceed 50% of the rated maximum reading speed of the ring, 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 (angle and linear)

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Power supply</strong></td>
<td>5 V ±10% 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><strong>Ripple</strong></td>
<td>200 mVpp maximum @ frequency up to 500 kHz maximum</td>
</tr>
<tr>
<td><strong>Temperature</strong></td>
<td>Storage: −20 °C to +80 °C, Operating: 0 °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>Operating: 500 m/s², 3 axes, Non-operating: 1000 m/s², 6 ms, ½ sine, 3 axes</td>
</tr>
<tr>
<td><strong>Shock (readhead)</strong></td>
<td>Non-operating: 1000 m/s², 6 ms, ½ sine, 3 axes</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>Operating: 300 m/s² max @ 55 Hz to 2000 Hz, 3 axes</td>
</tr>
<tr>
<td><strong>Mass</strong></td>
<td>Readhead: 18 g, Cable: 32 g/m</td>
</tr>
<tr>
<td><strong>Cable</strong></td>
<td>7 core, tinned and annealed copper, 28 AWG, Single-shielded, outside diameter 4.7 ±0.2 mm, Flex life &gt; 40 x 10⁶ cycles at 20 mm bend radius, UL recognised component 🌐</td>
</tr>
</tbody>
</table>
Data sheet
RESOLUTE absolute optical encoder (Mitsubishi)

RESOLUTE readhead installation drawing (on RSLA30/RELA30 scale)

Dimensions and tolerances in mm

For detailed drawings, refer to the RESOLUTE linear or rotary encoder installation guides at www.renishaw.com/encoderinstallationguides

† Thread depth from mounting face. Recommended thread engagement 5 mm (8 including counterbore). Recommended tightening torque 0.5 to 0.7 Nm.

* Extent of mounting faces.
RESOLUTE readhead side exit cable installation drawing (on RSLA30/RELA30 scale)

Dimensions and tolerances in mm

For detailed drawings, refer to the RESOLUTE linear or rotary encoder installation guides at www.renishaw.com/encoderinstallationguides
Data sheet
RESOLUTE absolute optical encoder (Mitsubishi)

RESOLUTE angle readhead nomenclature

Series
R = RESOLUTE

Scale form
A = Angular

Protocol
23M = Mitsubishi 23 bit, 2 wire
23N = Mitsubishi 23 bit, 4 wire
27N = Mitsubishi 27 bit, 4 wire

Mechanical option
B = Standard IP64
R = 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 (RESA30 only)
417 = 417 mm ring
489 = 489 mm ring (RESA30 only)
550 = 550 mm ring (RESA30 only)

Scale code option
B = Standard scale code

Cable length
02 = 0.2 m
05 = 0.5 m
10 = 1.0 m
15 = 1.5 m
30 = 3 m
50 = 5 m
90 = 9 m
99 = 10 m

NOTE: Cable lengths longer than 1 m are available on special order

Termination
A = 9-way D-type connector
F = Flying lead (unterminated)
N = 15-way D-type for Mitsubishi
P = 10-way Mitsubishi connector
L = Lemo in-line connector

RESOLUTE linear readhead nomenclature

Series
R = RESOLUTE

Scale form
L = Linear

Protocol
40M = Mitsubishi 40 bit 2 wire
40N = Mitsubishi 40 bit 4 wire

Mechanical option
B = Standard IP64
R = Side cable outlet

Gain option
T = RTLA30/RTLA30-S
S = RSLA30
E = RELA30

Resolution
001 = 1 nm
050 = 50 nm

Scale code option
B = RTLA30/RTLA30-S (20 mm to 10 m)
C = RSLA30 (20 mm to 5 m)/RELA30 (> 1.13 m to 1.5 m)
D = RELA30 (20 mm to 1.13 m)
E = RTLA30/RTLA30-S (> 10 m to 21 m)

Cable length
02 = 0.2 m
05 = 0.5 m
10 = 1.0 m
15 = 1.5 m
30 = 3 m
50 = 5 m
90 = 9 m
99 = 10 m

NOTE: Cable lengths longer than 1 m are available on special order

Termination
A = 9-way D-type connector
F = Flying lead (unterminated)
N = 15-way D-type for Mitsubishi
P = 10-way Mitsubishi connector
L = Lemo in-line connector

NOTES:
 ▶ Not all combinations are valid. Check valid options online at www.renishaw.com/epc
 ▶ For more information about Mitsubishi drives, contact Mitsubishi.

* 2 wire: MR-J4 series
RESOLUTE series compatible products:

- RESA30 stainless steel ring
- REXA30 high-accuracy stainless steel ring
- Advanced Diagnostic Tool ADTa-100 (A-6525-0100)
- RELA30 self-adhesive or clip/clamp mounted ZeroMet™ spar scale
- RSLA30 self-adhesive or clip/clamp mounted stainless steel spar scale
- RTLA30 tape scale and FASTrack carrier
- RTLA30-S self-adhesive tape scale

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.