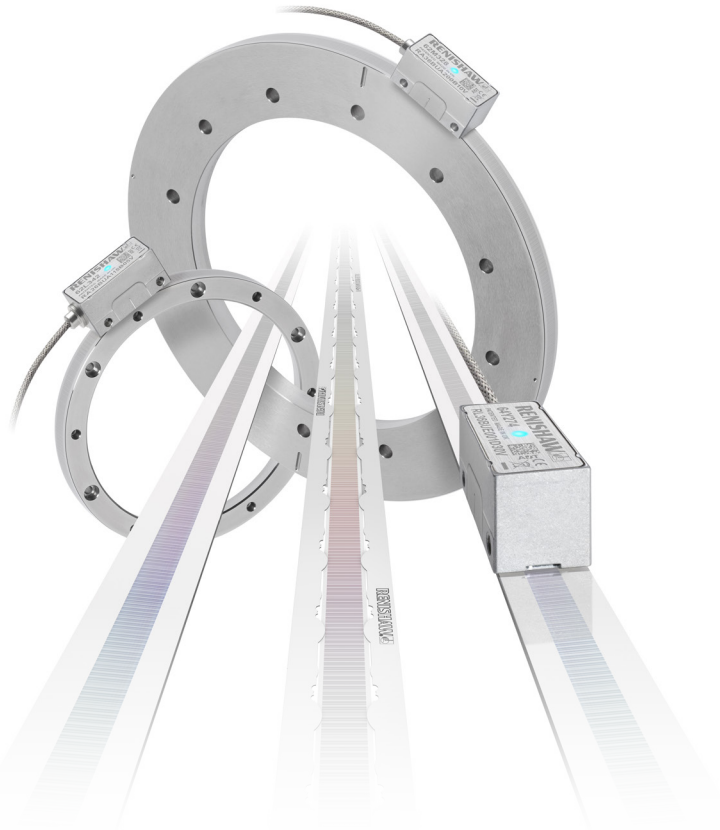


# RESOLUTE™ UHV absolute optical encoder system



Renishaw's true-absolute optical encoder, RESOLUTE™, offers Ultra-High Vacuum compatibility in both linear and rotary (angle) encoder formats.

The RESOLUTE encoder determines position immediately upon switch-on, without the need for any movement or battery back-up. This means complete control of axes can be achieved immediately, thus eliminating risks of unchecked movements or collisions, a critical advantage in applications such as wafer handling where safe extraction of high-value products is essential after loss of power.

RESOLUTE encoders have inherently very low sub-divisional error (SDE), so the fidelity of feedback is improved. This has several benefits, including minimising velocity ripple, reducing vibration, increasing scanning performance and cutting the amount of heat generated in motors. The RESOLUTE system also has low positional noise (jitter) of less than 10 nm RMS, so positional stability is significantly improved. Resolutions are available to 1 nm (linear) or 32 bit (rotary), with a maximum speed up to 100 m/s.

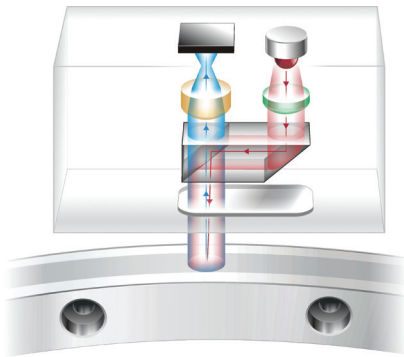
RESOLUTE UHV encoders are available with a range of serial protocols for excellent noise immunity, including BiSS® C and Panasonic.

- Clean residual gas analysis (RGA)
- Low outgassing rate
- Bake-out temperature of 120 °C
- True-absolute non-contact optical encoder system: no batteries required
- Wide set-up tolerances for quick and easy installation
- Resolutions to 1 nm linear or 32 bit rotary
- Up to 100 m/s maximum speed (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
- Integral set-up LED enables easy installation and provides diagnostics at a glance
- Operates up to 75 °C
- Integral over-temperature alarm
- Compatible with a wide range of linear and rotary scales
- 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  $\mu\text{m}$  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



### Unique detection method

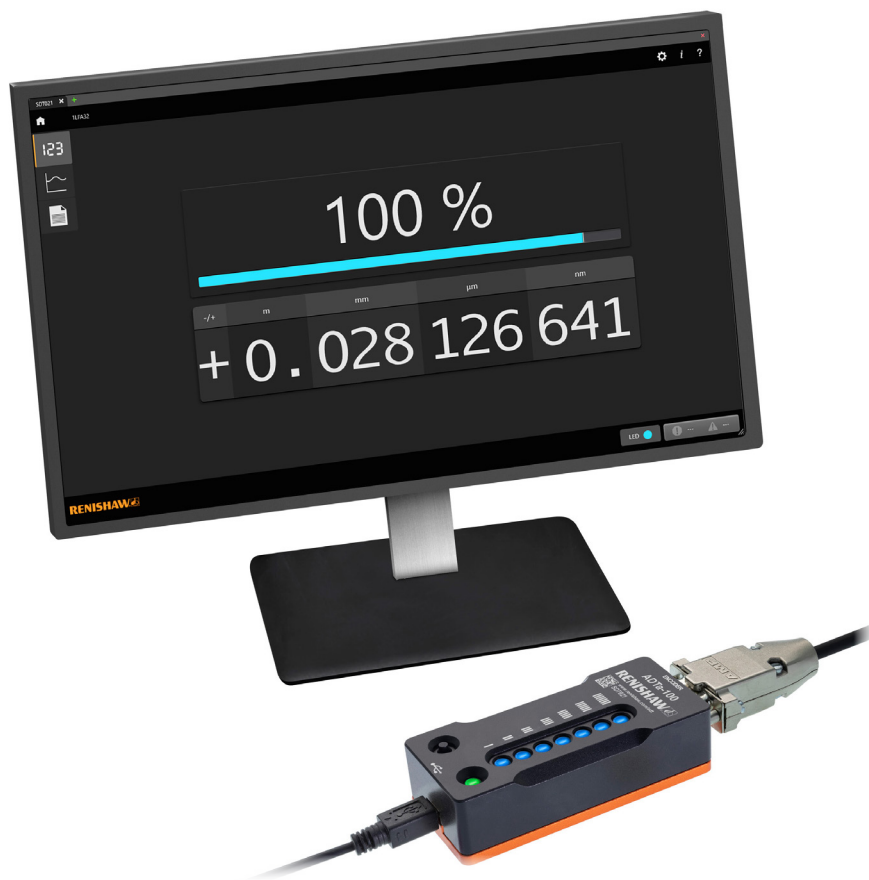
- Readhead acts like an ultra-fast miniature digital camera, taking photos of a coded scale
- Photos are analysed by a high-speed digital signal processor (DSP) to determine absolute position
- Built-in position-check algorithm constantly monitors calculations for ultimate safety and reliability
- Advanced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

## Optional Advanced Diagnostic Tool

The RESOLUTE encoder system is compatible with the Advanced Diagnostic Tool ADTa-100<sup>1</sup> 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:

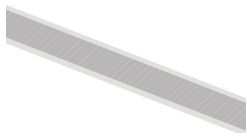
- Digital readout of encoder position and signal strength
- Graph of signal strength over the entire axis travel
- Ability to set a new zero position for the encoder system
- System configuration information


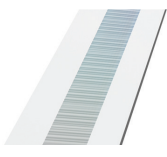


<sup>1</sup> ADTa-100 compatible readheads are marked with the symbol **ADT**

## Compatible linear scales

	<b>RTLA30-S<sup>1</sup></b> Self-adhesive mounted stainless steel tape scale	<b>RTLA30 (with FASTRACK™ carrier)</b> Stainless steel tape scale and self-adhesive mounted carrier
		
<b>Form (height x width)</b>	0.4 mm x 8 mm including adhesive	RTLA30 scale: 0.2 mm x 8 mm FASTRACK carrier: 0.4 mm x 18 mm including adhesive
<b>Accuracy (at 20 °C)</b>	±5 µm/m	±5 µm/m
<b>Maximum length<sup>2</sup></b>	21 m	RTLA30 lengths up to 21 m FASTRACK carrier lengths up to 25 m
<b>Coefficient of thermal expansion (at 20 °C)</b>	10.1 ±0.2 µm/m/°C	10.1 ±0.2 µm/m/°C

	<b>RKLA30-S</b> Self-adhesive mounted stainless steel tape scale
	
<b>Form (height x width)</b>	0.15 mm x 6 mm including adhesive
<b>Accuracy (at 20 °C)</b>	±5 µm/m
<b>Maximum length<sup>2</sup></b>	21 m
<b>Coefficient of thermal expansion (at 20 °C)</b>	Matches that of substrate material when the scale ends are rigidly fixed <sup>3</sup>

	<b>RELA30</b> Self-adhesive or clip/clamp mounted low-expansion ZeroMet™ spar scale	<b>RSLA30</b> Self-adhesive or clip/clamp mounted stainless steel spar scale
		
<b>Form (height x width)</b>	1.5 mm x 14.9 mm	1.6 mm x 14.9 mm
<b>Accuracy (at 20 °C)</b>	Up to 1 m : ±1 µm 1 m to 1.5 m : ±1 µm/m	Up to 1 m : ±1.5 µm 1 m to 2 m : ±2.25 µm 2 m to 3 m : ±3 µm 3 m to 5 m : ±4 µm
<b>Maximum length<sup>2</sup></b>	1.5 m	5 m
<b>Coefficient of thermal expansion (at 20 °C)</b>	0.75 ±0.35 µm/m/°C	10.1 ±0.2 µm/m/°C



<sup>1</sup> For RTLA30-S axis lengths > 2 m, the FASTRACK carrier with RTLA30 is recommended.

<sup>2</sup> The maximum scale length may be limited for some serial interfaces and resolutions; refer to 'Resolution and scale lengths' on page 6 for details.

<sup>3</sup> Scale mastering is not guaranteed after system bakeout.

For more information about the linear scales refer to the relevant absolute scale data sheet which can be downloaded from [www.renishaw.com/resolutedownloads](http://www.renishaw.com/resolutedownloads).

## Compatible rotary scales

	<b>RESA30</b>	<b>REXA30</b>
	<b>303/304 stainless steel ring</b>	<b>Ultra-high accuracy 303/304 stainless steel ring</b>
		
<b>Accuracy (at 20 °C)</b>	±1.9 arc second (Typical installed accuracy for a 550 mm diameter ring) <sup>1</sup>	±1 arc second <sup>2</sup> (Total installed accuracy for ring diameters ≥ 100 mm)
<b>Ring diameters</b>	52 mm to 550 mm	52 mm to 417 mm
<b>Coefficient of thermal expansion (at 20 °C)</b>	15.5 ±0.5 µm/m/°C	15.5 ±0.5 µm/m/°C

<sup>1</sup> 'Typical' installations are a result of graduation and installation errors combining and, to some magnitude, cancelling.

<sup>2</sup> Accuracy when using two RESOLUTE readheads. For the accuracy value of ring diameters < 100 mm, see *REXA30 ultra-high accuracy absolute angle encoder* data sheet (Renishaw part no. L-9517-9405).

For more information about the rotary scales refer to the relevant absolute scale data sheet which can be downloaded from [www.renishaw.com/resolutedownloads](http://www.renishaw.com/resolutedownloads).

## Linear encoder system

### Resolution and scale lengths

The maximum scale length depends upon the serial interface, readhead resolution and the number of position bits.

The table below shows the maximum scale length for each system:

Serial interfaces	Position bits	Resolution			
		1 nm	5 nm	50 nm	100 nm
BiSS-C (unidirectional)	26 bit	67 mm	336 mm	3.355 m	-
	32 bit	4.295 m	21 m	21 m	-
	36 bit	21 m	21 m	21 m	-
Panasonic	48 bit	21 m	-	21 m	21 m

### Speed

The table below shows the maximum speed for each system:

Serial interfaces	Position bits	Resolution			
		1 nm	5 nm	50 nm	100 nm
BiSS-C (unidirectional)	26 bit	100 m/s	100 m/s	100 m/s	-
	32 bit	100 m/s	100 m/s	100 m/s	-
	36 bit	100 m/s	100 m/s	100 m/s	-
Panasonic	48 bit (when used with A5 series)	0.4 m/s	-	20 m/s	40 m/s
	48 bit (when used with A6 series)	4 m/s	-	100 m/s	100 m/s

## Angle encoder system

### Resolution

RESOLUTE angle encoders are available with a variety of resolutions, dependent upon the serial interface being used.

All ring sizes are available for all serial interfaces and resolutions

Serial interfaces	Resolution	Counts per revolution	Arc second
BiSS-C (unidirectional)	18 bit	262 144	≈ 4.94
	26 bit	67 108 864	≈ 0.019
	32 bit	4 294 967 296	≈ 0.0003
Panasonic	23 bit	8 388 608	≈ 0.15
	32 bit	4 294 967 296	≈ 0.0003

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

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## Angle absolute encoder

### Speed and accuracy

The table below shows the maximum speed and typical installed accuracy for RESOLUTE readheads with standard diameter RESA30 rings.

RESA30 diameter (mm)	Maximum reading speed (rev/min)		Typical installed accuracy <sup>1</sup> (arc second)
	BiSS C (unidirectional)	Panasonic	
52	36 000	7 200 <sup>2</sup>	±12.7
57	33 000	7 200 <sup>2</sup>	±11.8
75	25 000	7 200 <sup>2</sup>	±9.5
100	19 000	7 200 <sup>2</sup>	±7.5
101	19 000	7 200 <sup>2</sup>	±7.5
103	18 500	7 200 <sup>2</sup>	±7.4
104	18 000	7 200 <sup>2</sup>	±7.3
115	16 500	6 600	±6.8
124	15 000	6 100	±6.3
150	12 000	5 000	±5.5
165	11 500	4 600	±7.0
172	11 000	4 400	±5.0
183	10 400	4 200	±4.7
200	9 500	3 800	±4.3
206	9 200	3 700	±4.2
209	9 000	3 600	±4.2
229	8 300	3 300	±3.9
255	7 400	2 900	±3.6
280	6 800	2 700	±3.4
300	6 300	2 500	±3.1
330	5 700	2 300	±2.9
350	5 400	2 100	±2.8
413	4 600	1 840	±2.4
417	4 500	1 800	±2.4
489	3 900	1 500	±2.1
550	3 400	1 300	±1.9

**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).

<sup>1</sup> 'Typical' installations are a result of graduation and installation errors combining and, to some magnitude, cancelling.

<sup>2</sup> The maximum speed depends on the driver, motor and mechanical components. Contact Renishaw or Panasonic regarding the maximum speed.



## General specifications

		BiSS C (unidirectional) and Panasonic
Power supply	5 V ±10%	1.25 W maximum (250 mA @ 5 V) <sup>1</sup>
	Ripple	200 mVpp maximum @ frequency up to 500 kHz maximum
Temperature	Storage	0 °C to 80 °C
	Operating	0 °C to +75 °C
	Bake-out (non-operating)	120 °C
Humidity		95% relative humidity (non-condensing) to IEC 60068-2-78
Sealing		IP30
Acceleration	Operating	500 m/s <sup>2</sup> , 3 axes
Maximum acceleration of scale with respect to readhead <sup>2</sup>		2000 m/s <sup>2</sup>
Vibration	Operating	Sinusoidal 100 m/s <sup>2</sup> , 55 Hz to 2000 Hz, 3 axes
		Random vibration 0.15 g <sup>2</sup> /Hz ASD 20 -1000 Hz, -6dB roll off 1-2 kHz, 3 axes
Shock	Non-operating	1000 m/s <sup>2</sup> , 6 ms, ½ sine, 3 axes
Mass	Readhead	19 g
	Readhead cable	19 g/m
EMC compliance (system)		IEC 61326-1
Readhead cable	Mechanical option 'U'	Silver-coated copper braided single screen. FEP core insulation, over tin-plated copper wire.
	Mechanical option 'F'	Stainless steel cable braid.
Communication format - BiSS		RS485/RS422 differential line-driven signal
Compatible drivers - Panasonic		A5 family drivers (only compatible with RESOLUTE linear): A5, A5II, A5L, A5N, A5NL, A5BL. A6 family drivers (RESOLUTE rotary will be available for all A6 family drivers): A6SM, A6SL, A6NM, A6NL.

**CAUTION:** The RESOLUTE encoder system has been designed to the relevant EMC standards, but must be correctly integrated to achieve EMC compliance. In particular, attention to shielding arrangements is essential.

<sup>1</sup> 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.

<sup>2</sup> This is the worst case figure that is correct for the slowest communications clock rates. For faster clock rates, the maximum acceleration of scale with respect to the readhead can be higher. For more details, contact your local Renishaw representative.

## RGA results

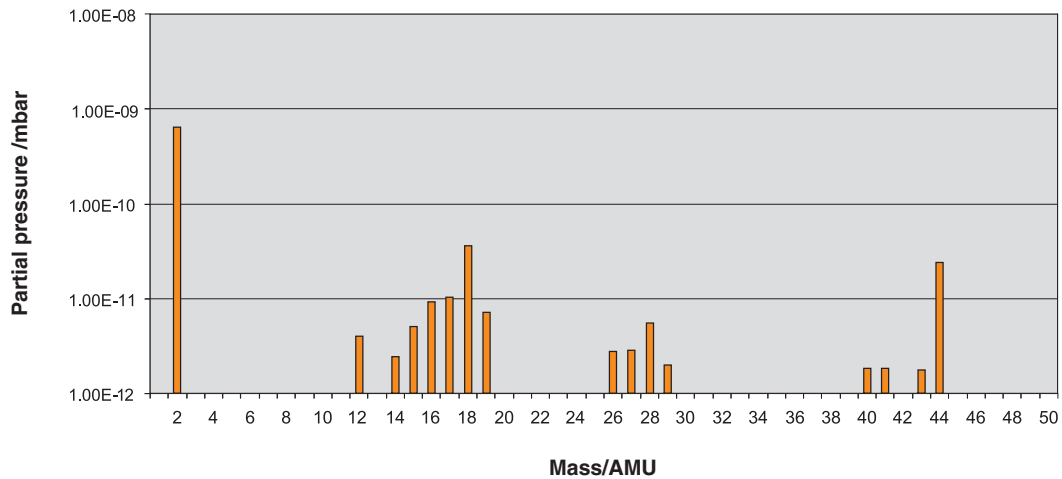
### Test schedule

A quadrupole mass spectrometer (AccuQuad 200 RGA) was used to collect RGA data. Chamber pressure was measured with an Ion Gauge (G8130). After initial conditioning of the system, a background spectrum was recorded together with the total pressure in the test chamber.

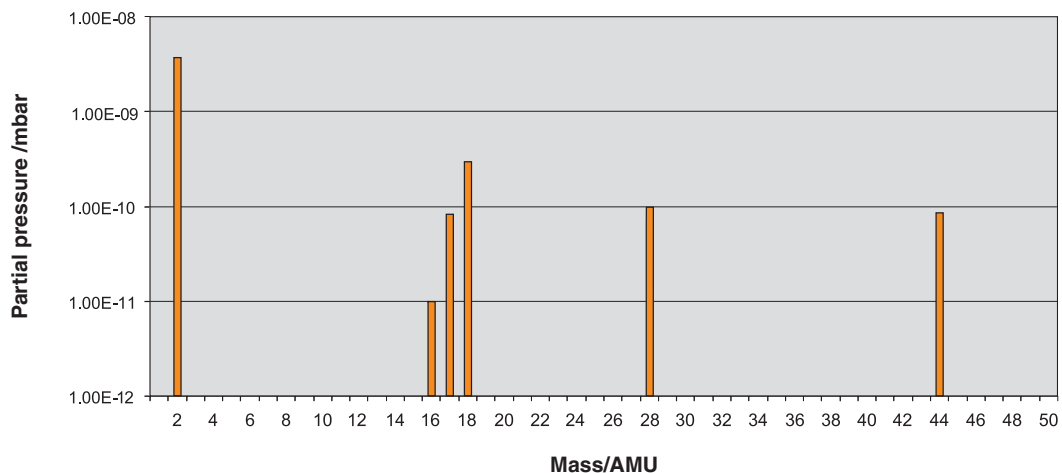
The component was placed in the vacuum system (0.0035 m<sup>3</sup>) which was then pumped using an KJL Lion 802 (800/s) diode ion pump and a Divac diaphragm pump at ambient temperature for 24 hours, after which a background scan and the total pressure in the test chamber were recorded again. If the system pressure was better than  $5 \times 10^{-9}$  mbar, the test specimen was baked at 120 °C for 48 hours. The system was then allowed to cool to ambient temperature before a final mass spectrum and total pressure measurement were taken. The final RGA scans are shown below.

**NOTE:** Exact reproduction of these results should not be expected, as RGA data depends on the condition, specification and performance of the vacuum system. However, the RGA results shows no significant contamination attributable to RESOLUTE UHV encoders and that UHV conditions can be achieved in the presence of this product.

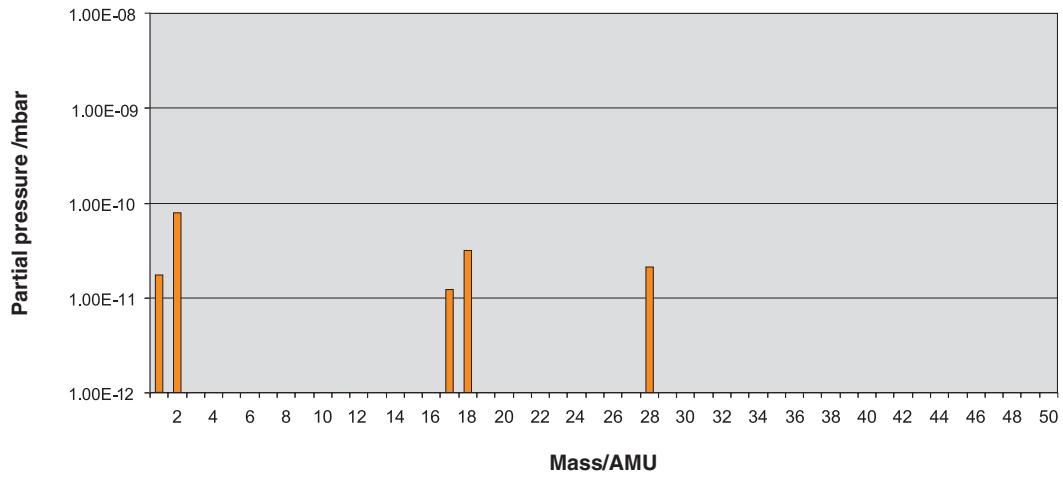
**RESOLUTE UHV readhead with 1.0 m cable after bake-out (total pressure =  $8 \times 10^{-10}$  mbar)**



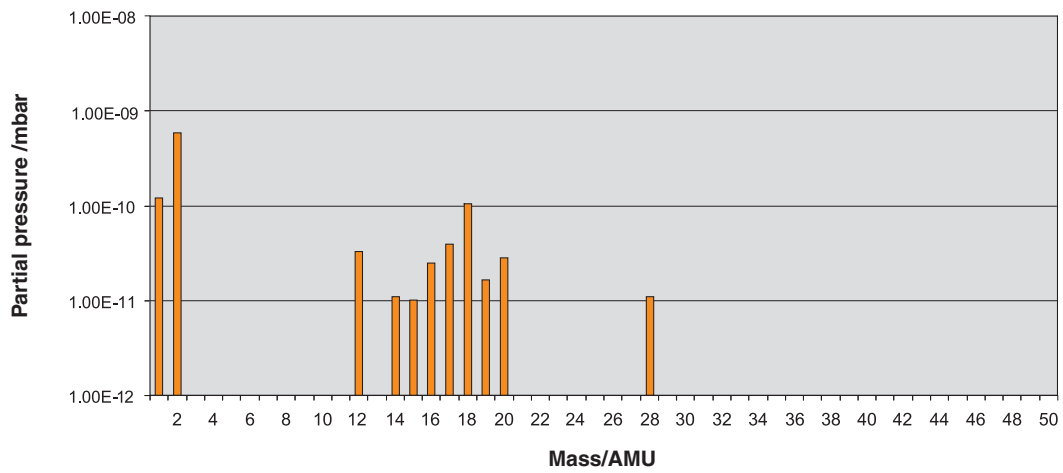
**RSLA30 linear scale (180 mm length) with 2 clips and 1 clamp after bake-out (total pressure =  $3.0 \times 10^{-10}$  mbar)**



RTLA30-S linear scale (300 mm length) after bake-out (total pressure =  $1.69 \times 10^{-10}$  mbar)

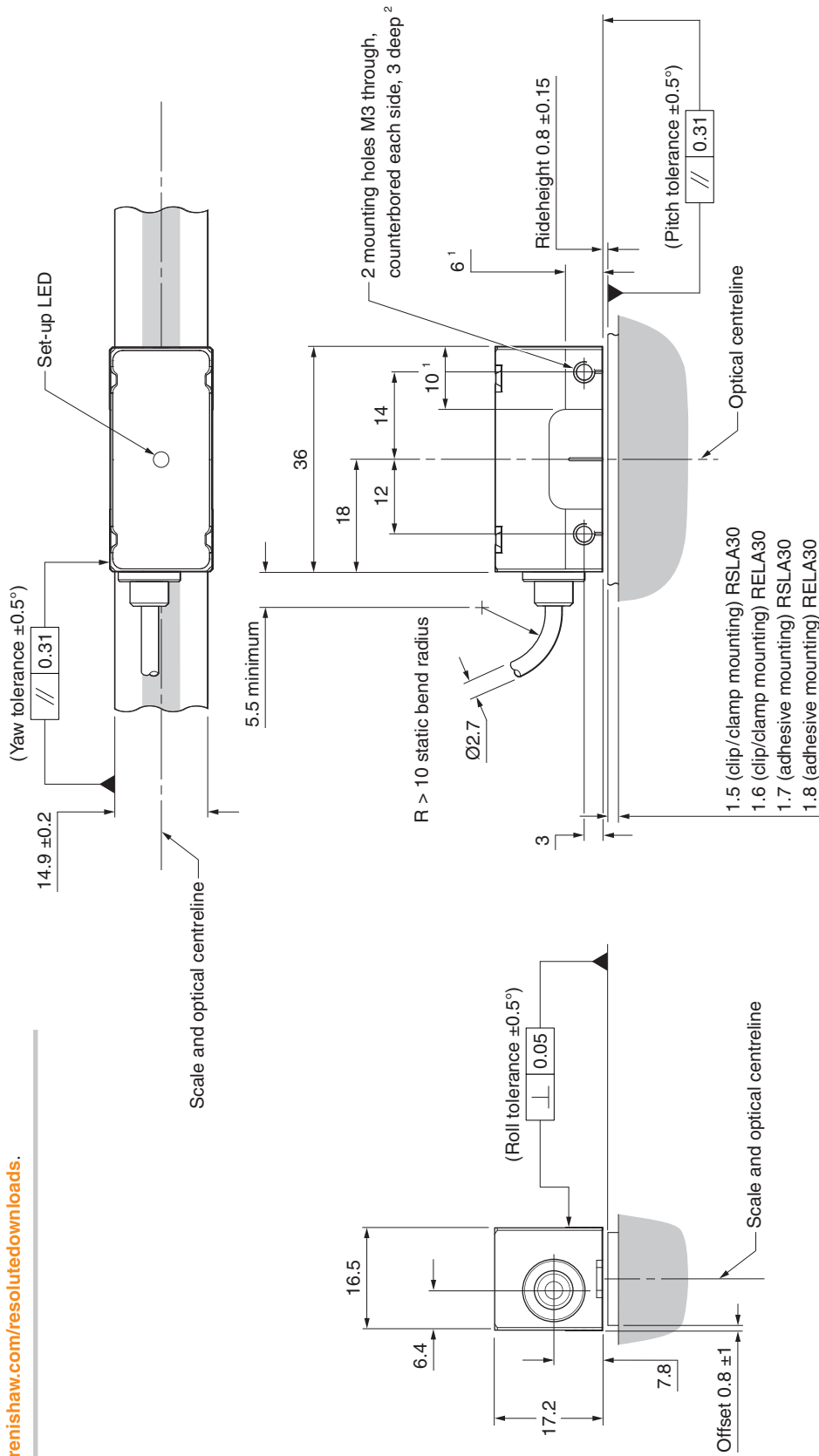


RESA30 (Ø115 mm) after bake-out (total pressure =  $7.76 \times 10^{-10}$  mbar)



# RESOLUTE UHV readhead installation drawing

Dimensions and tolerances in mm



**NOTE:** RESOLUTE readhead shown with RSLA30/RELA30 spar scale. For installation drawings showing other scale types refer to the relevant RESOLUTE installation guides at [www.renishaw.com/resolutedownloads](http://www.renishaw.com/resolutedownloads).

<sup>1</sup> Extent of mounting faces.  
<sup>2</sup> The recommended thread engagement is 5 mm minimum (8 mm including counterbore) and the recommended tightening torque is 0.5 Nm to 0.7 Nm.

## RESOLUTE UHV linear readhead part numbers

**R L 32B U S 001 C 30 V**

**Series** \_\_\_\_\_

R = RESOLUTE

**Scale form** \_\_\_\_\_

L = Linear

**Serial interface** \_\_\_\_\_

26B = BiSS 26 bit

32B = BiSS 32 bit

36B = BiSS 36 bit

48P = Panasonic 48 bit

**Mechanical option** \_\_\_\_\_

U = Ultra High Vacuum (silver coated copper braid cable)

F = Ultra High Vacuum (stainless steel cable braid)

**Gain option** \_\_\_\_\_

T = RTLA30 / RTLA30-S / RKLA30-S

S = RSLA30

E = RELA30

**Resolution** \_\_\_\_\_

001 = 1 nm

005 = 5 nm (BiSS only)

050 = 50 nm

100 = 100 nm (Panasonic only)

**Scale code option**<sup>1</sup> \_\_\_\_\_

B = RTLA30 / RTLA30-S / RKLA30-S (20 mm to 10 m scale length)

C = RSLA30 (20 mm to 5 m scale length) / RELA30 (> 1.13 m to 1.5 m scale length)

D = RELA30 (20 mm to 1.13 m scale length)

E = RTLA30 / RTLA30-S / RKLA30-S (> 10 m to 21 m scale length)

**Cable length** \_\_\_\_\_

02 = 0.2 metres

15 = 1.5 metres

90 = 9.0 metres

05 = 0.5 metres

30 = 3.0 metres

99 = 10.0 metres

10 = 1.0 metres

50 = 5.0 metres

**Cable termination** \_\_\_\_\_

V = Vacuum flying lead (unterminated cable)

Valid system configurations (readheads and scale) can be checked at [www.renishaw.com/epc](http://www.renishaw.com/epc).

<sup>1</sup> The maximum scale length may be limited for some serial interfaces and resolutions; refer to 'Resolution and scale lengths' on page 6 for details.

# RESOLUTE UHV rotary readhead part numbers

**R A 32B U A 052 B 30 V**

**Series** \_\_\_\_\_

R = RESOLUTE

**Scale form** \_\_\_\_\_

A = Angular

**Serial interface** \_\_\_\_\_

18B = BiSS 18 bit

26B = BiSS 26 bit

32B = BiSS 32 bit

23P = Panasonic 23 bit

32P = Panasonic 32 bit

**Mechanical option** \_\_\_\_\_

U = Ultra High Vacuum (silver coated copper braid cable)

F = Ultra High Vacuum (stainless steel cable braid)

**Gain option** \_\_\_\_\_

A = Standard

**Ring diameter** \_\_\_\_\_

052 = 52 mm

150 = 150 mm

280 = 280 mm (RESA30 only)

057 = 57 mm

165 = 165 mm

300 = 300 mm

075 = 75 mm

172 = 172 mm

330 = 330 mm (RESA30 only)

100 = 100 mm

183 = 183 mm

350 = 350 mm

101 = 101 mm (RESA30 only)

200 = 200 mm

413 = 413 mm (RESA30 only)

103 = 103 mm

206 = 206 mm

417 = 417 mm

104 = 104 mm

209 = 209 mm

489 = 489 mm (RESA30 only)

115 = 115 mm

229 = 229 mm

550 = 550 mm (RESA30 only)

124 = 124 mm (RESA30 only)

255 = 255 mm

**Scale code option** \_\_\_\_\_

B = Standard scale code

**Cable length** \_\_\_\_\_

02 = 0.2 metres

15 = 1.5 metres

90 = 9.0 metres

05 = 0.5 metres

30 = 3.0 metres

99 = 10.0 metres

10 = 1.0 metres

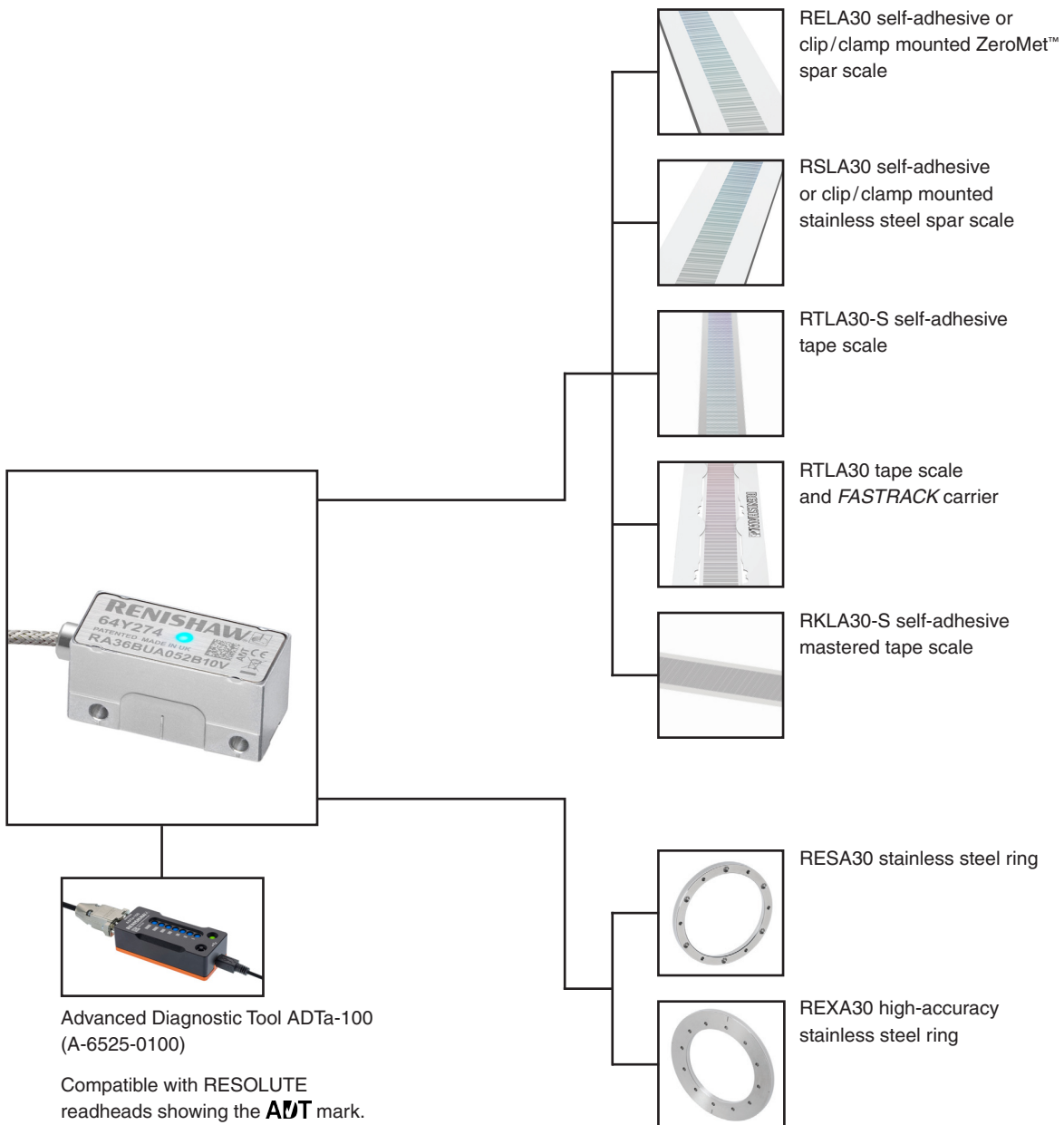
50 = 5.0 metres

**Cable termination** \_\_\_\_\_

V = Vacuum flying lead (unterminated cable)

Valid system configurations (readheads and scale) can be checked at [www.renishaw.com/epc](http://www.renishaw.com/epc).


## RESOLUTE series compatible products



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/resolutedownloads](http://www.renishaw.com/resolutedownloads).

[www.renishaw.com/contact](http://www.renishaw.com/contact)

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Part no.: L-9517-9530-04-B

Issued: 04.2024