Data sheet
L-9518-0013-01-A

RENISHAW
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RESOLUTE™ absolute optical encoder system

- 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 32 bit rotary
- 100 m/s maximum speed for all resolutions (up 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 a wide range of linear, rotary, and partial arc scales

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, 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 and ultra-low noise (jitter), 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 BiSS-C (unidirectional), FANUC, Mitsubishi, Panasonic, Siemens DRIVE-CLiQ and Yaskawa serial interfaces.

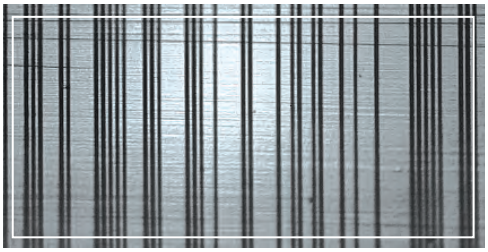
www.renishaw.com/resolutedownloads

#renishaw

System features

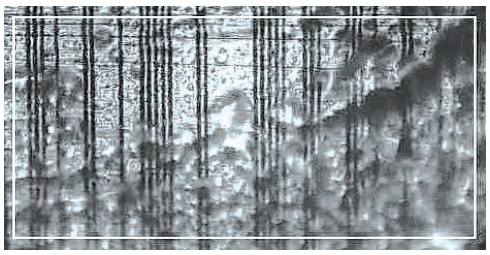
Unique single-track absolute optical scale

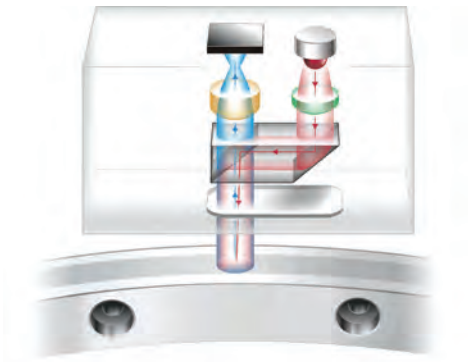
- Absolute position is determined immediately upon switch-on
- No battery back-up
- No yaw de-phasing unlike multiple-track systems
- Fine pitch (30 µm nominal period) optical scale for superior motion control compared to inductive, magnetic or other non-contact optical absolute encoders
- High-accuracy 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

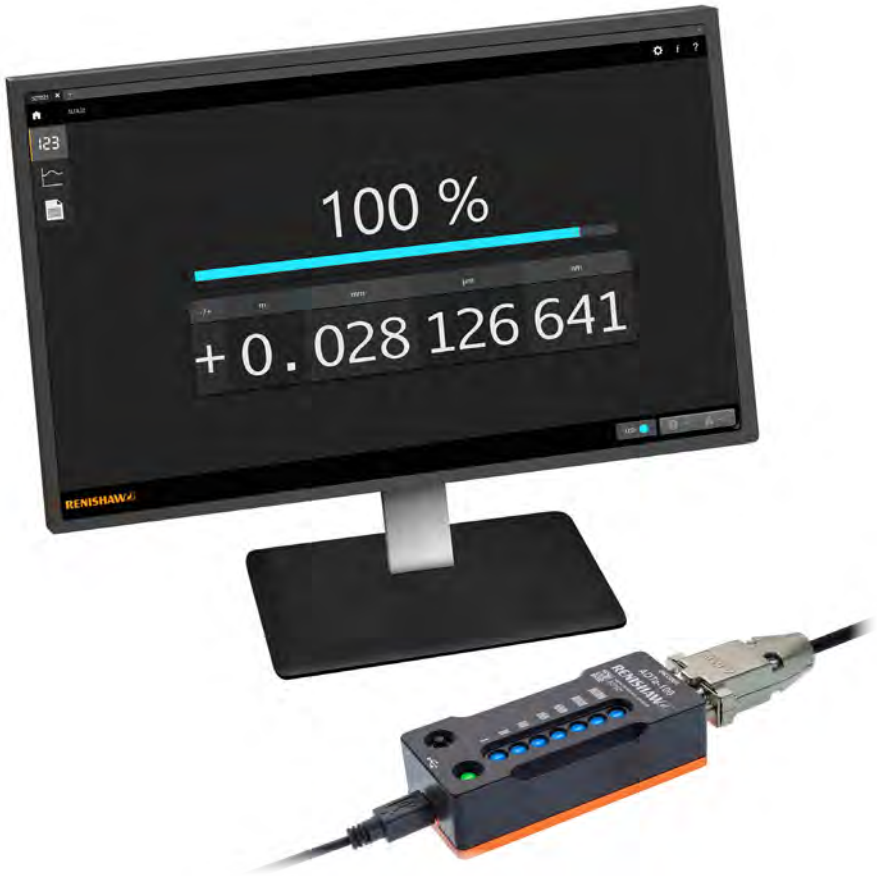
- Readhead acts like an ultra-fast miniature digital camera, taking photos of a coded scale
- Photos are analysed by a high-speed digital signal processor (DSP) to determine absolute position
- Built-in position-check algorithm constantly monitors calculations for ultimate safety and reliability
- Advanced 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 [1] 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



[1] ADTa-100 compatible readheads are marked with the symbol ADT

RESOLUTE serial interfaces

RESOLUTE readheads are available in a range of serial interfaces:

Linear readheads

	Readhead type			
Serial interfaces	**Standard**	**Ultra-high vacuum (UHV) [1]**	**Extended temperature range (ETR) [1]**	**Functional safety (FS) [1]**
BiSS-C (uni-directional)	✔	✔	✔	-
BiSS Safety	-	-	-	✔
FANUC	✔	-	-	-
Mitsubishi	✔	-	-	-
Panasonic	✔	✔	-	-
Siemens DRIVE-CLiQ	✔	-	-	✔
Yaskawa	✔	-	-	-

Rotary readheads

	Readhead type		
Serial interfaces	**Standard**	**Ultra-high vacuum (UHV) [1]**	**Functional safety (FS) [1]**
BiSS C (uni-directional)	✔	✔	-
BiSS Safety	-	-	✔
FANUC	✔	-	-
Mitsubishi	✔	-	-
Panasonic	✔	✔	-
Siemens DRIVE-CLiQ	✔	-	✔
Yaskawa	✔	-	-

Partial arc readheads

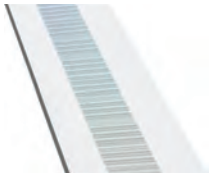
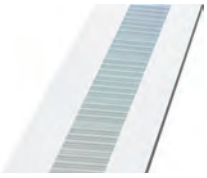
	Readhead type
Serial interfaces	**Standard**
BiSS C (uni-directional)	✔
FANUC	✔
Mitsubishi	✔
Panasonic	✔
Siemens DRIVE-CLiQ	✔
Yaskawa	✔

[1] Separate data sheets are available for ETR, UHV and Functional Safety RESOLUTE readheads at www.renishaw.com/resolutedownloads.

Compatible linear scales

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

	RKLA30-S
	Self-adhesive mounted stainless steel tape scale
	
Form (height × width)	0.15 mm × 6 mm including adhesive
Accuracy (at 20 °C)	±5 µm/m
Maximum length [2]	21 m
Coefficient of thermal expansion (at 20 °C)	Matches that of substrate material when scale ends fixed by epoxy mounted end clamps

	RELA30	RSLA30
	Self-adhesive or clip/clamp mounted low-expansion ZeroMet™ spar scale	Self-adhesive or clip/clamp mounted stainless steel spar scale
		
Form (height × width)	1.5 mm × 14.9 mm	1.6 mm × 14.9 mm
Accuracy (at 20 °C)	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
Maximum length [2]	1.5 m	5 m
Coefficient of thermal expansion (at 20 °C)	0.75 ±0.35 µm/m/°C	10.1 ±0.2 µm/m/°C

[1] For RTLA30-S axis lengths > 2 m, the *FASTRACK* carrier with RTLA30 is recommended.

[2] The maximum scale length may be limited for some serial interfaces and resolutions; refer to 'Resolution and scale lengths' on page 7 for details.

For more information about the linear scales refer to the relevant absolute scale data sheet which can be downloaded from **www.renishaw.com/resolutedownloads**.

Compatible rotary scales

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

Compatible partial arc scales

	RKLA30-S
	Self-adhesive mounted stainless steel tape scale
	
Form (height × width)	0.15 mm × 6 mm including adhesive
Accuracy (at 20 °C)	±5 µm/m
Maximum length [3]	21 m
Coefficient of thermal expansion (at 20 °C)	10.1 ±0.2 µm/m/°C
Minimum arc radius [4]	50 mm

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

2 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).

3 The maximum scale length may be limited for some serial interfaces and resolutions; refer to 'Resolution and scale lengths' on page 7 for details.

4 For smaller radii, contact your local Renishaw representative.

For more information about the rotary scales refer to the relevant absolute scale data sheet which can be downloaded from **www.renishaw.com/resolutedownloads**.

Linear/partial arc 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:

		Resolution			
Serial interfaces	**Position bits**	**1 nm**	**5 nm**	**50 nm**	**100 nm**
BiSS-C (uni-directional)	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	-
FANUC	37 bit	21 m	-	21 m	-
Mitsubishi	40 bit	2.1 m	-	21 m	-
Panasonic	48 bit	21 m	-	21 m	21 m
Siemens DRIVE-CLiQ	28 bit	-	-	13.42 m	-
	34 bit	17.18 m	-	-	-
Yaskawa	36 bit	1.8 m	-	21 m	-

Speed

The table below shows the maximum speed for each system:

		Resolution			
Serial interfaces	**Position bits**	**1 nm**	**5 nm**	**50 nm**	**100 nm**
BiSS-C (uni-directional)	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	-
FANUC	37 bit	100 m/s	-	100 m/s	-
Mitsubishi	40 bit	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
Siemens DRIVE-CLiQ	28 bit	-	-	100 m/s	-
	34 bit	100 m/s	-	-	-
Yaskawa	36 bit	3.6 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 (uni-directional)		18 bit	262 144	≈ 4.94
		26 bit	67 108 864	≈ 0.019
		32 bit	4 294 967 296	≈ 0.0003
FANUC		27 bit	134 217 728	≈ 0.0097
		31 bit	2 147 483 648	≈ 0.0006
Mitsubishi		23 bit	8 388 608	≈ 0.15
		27 bit	134 217 728	≈ 0.0097
Panasonic		23 bit	8 388 608	≈ 0.15
		32 bit	4 294 967 296	≈ 0.0003
Siemens DRIVE-CLiQ		26 bit	67 108 864	≈ 0.019
		29 bit	536 870 912	≈ 0.0024
Yaskawa	Rotary servomotors	24 bit	16 777 216	≈ 0.077
	Full closed loop control	23 bit	8 388 608	≈ 0.15
		26 bit	67 108 864	≈ 0.019
		30 bit	1 073 741 824	≈ 0.0012

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

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 [1] (arc second)
	BiSS, FANUC, Mitsubishi, Siemens DRIVE-CLiQ	Panasonic	Yaskawa				
			23 bit	24 bit	26 bit	30 bit	
52	36 000	7 200 [2]	14 600	14 600	3 250	203	±12.7
57	33 000	7 200 [2]	14 600	14 600	3 250	203	±11.8
75	25 000	7 200 [2]	14 600	14 600	3 250	203	±9.5
100	19 000	7 200 [2]	14 600	14 600	3 250	203	±7.5
101	19 000	7 200 [2]	14 600	14 600	3 250	203	±7.5
103	18 500	7 200 [2]	14 600	14 600	3 250	203	±7.4
104	18 000	7 200 [2]	14 600	14 600	3 250	203	±7.3
115	16 500	6 600	14 600	14 600	3 250	203	±6.8
124	15 000	6 100	14 600	14 600	3 250	203	±6.3
150	12 000	5 000	12 000	12 000	3 250	203	±5.5
165	11 500	4 600	11 500	11 500	3 250	203	±7.0
172	11 000	4 400	11 000	11 000	3 250	203	±5.0
183	10 400	4 200	10 400	10 400	3 250	203	±4.7
200	9 500	3 800	9 500	9 500	3 250	203	±4.3
206	9 200	3 700	9 200	9 200	3 250	203	±4.2
209	9 000	3 600	9 000	9 000	3 250	203	±4.2
229	8 300	3 300	8 300	8 300	3 250	203	±3.9
255	7 400	2 900	7 400	7 400	3 250	203	±3.6
280	6 800	2 700	6 800	6 800	3 250	203	±3.4
300	6 300	2 500	6 300	6 300	3 250	203	±3.1
330	5 700	2 300	5 700	5 700	3 250	203	±2.9
350	5 400	2 100	5 400	5 400	3 250	203	±2.8
413	4 600	1 840	4 600	4 600	3 250	203	±2.4
417	4 500	1 800	4 500	4 500	3 250	203	±2.4
489	3 900	1 500	3 900	3 900	3 250	203	±2.1
550	3 400	1 300	3 400	3 400	3 250	203	±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).

[1] 'Typical' installations are a result of graduation and installation errors combining and, to some magnitude, cancelling.

[2] The maximum speed depends on the driver, motor and mechanical components. Contact Renishaw or Panasonic regarding the maximum speed.

General specifications

		BiSS C (undirectional), FANUC, Mitsubishi, Panasonic and Yaskawa	Siemens DRIVE-CLiQ
Power supply		5 V ±10% 1.25 W maximum (250 mA @ 5 V) [1] Ripple: 200 mVpp maximum @ frequency up to 500 kHz maximum	Single readhead system: 3.05 W maximum (readhead: 1.25 W + single input interface: 1.8 W). Dual readhead system: 4.3 W maximum (2 × readheads: 1.25 W each + dual input interface: 1.8 W). 24 V power is provided by the DRIVE-CLiQ network. Ripple: 200 mVpp maximum @ frequency up to 500 kHz maximum
Temperature	Storage	–20 °C to 80 °C	–20 °C to 70 °C
	Installation	+20 °C ±5 °C	+20 °C ±5 °C
	Operating	0 °C to +80 °C	0 °C to +80 °C (readhead) 0 °C to +55 °C (interface)
Humidity		95% relative humidity (non-condensing) to IEC 60068-2-78	
Sealing		IP64	IP64 (readhead) IP67 (interface)
Acceleration	Operating	500 m/s², 3 axes (readhead only)	
Maximum acceleration of scale with respect to readhead [2]		2000 m/s²	
Vibration	Operating	300 m/s², 55 Hz to 2000 Hz, 3 axes	300 m/s², 55 Hz to 2000 Hz, 3 axes (readhead) 100 m/s², 55 Hz to 2000 Hz, 3 axes (interface)
Shock	Non-operating	1000 m/s², 6 ms, ½ sine, 3 axes	500 m/s², 11 ms, ½ sine, 3 axes
Mass	Readhead	18 g	18 g
	Readhead cable	32 g/m	32 g/m
	Interface	-	218 g
EMC compliance		IEC 61800-5-2 Annex E	
Readhead cable		7 core, tinned and annealed copper, 28 AWG Single-shielded, outside diameter 4.7 ±0.2 mm Flex life > 40 × 10⁶ cycles at 20 mm bend radius UL recognised component	
Maximum readhead cable length		10 m	10 m (to controller or interface) (refer to Siemens DRIVE-CLiQ specifications for maximum cable length from interface to controller)

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.

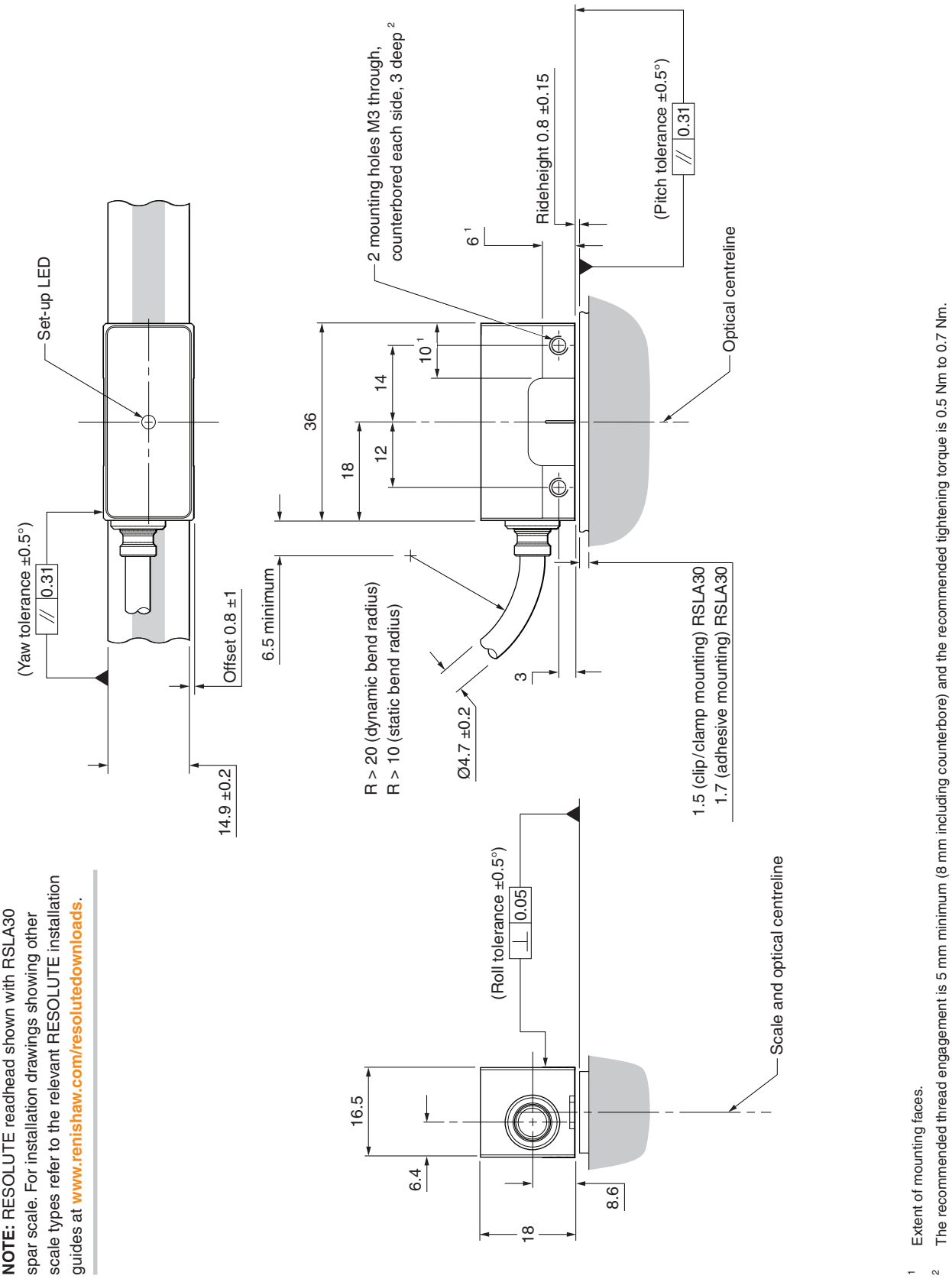
NOTE: For Extended Temperature Range (ETR), Ultra-high vacuum (UHV), and Functional Safety RESOLUTE readhead specifications refer to the relevant data sheets which can be downloaded from **www.renishaw.com/resolutedownloads**.

[1] 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.

[2] 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.

RESOLUTE readhead installation drawing

Dimensions and tolerances in mm



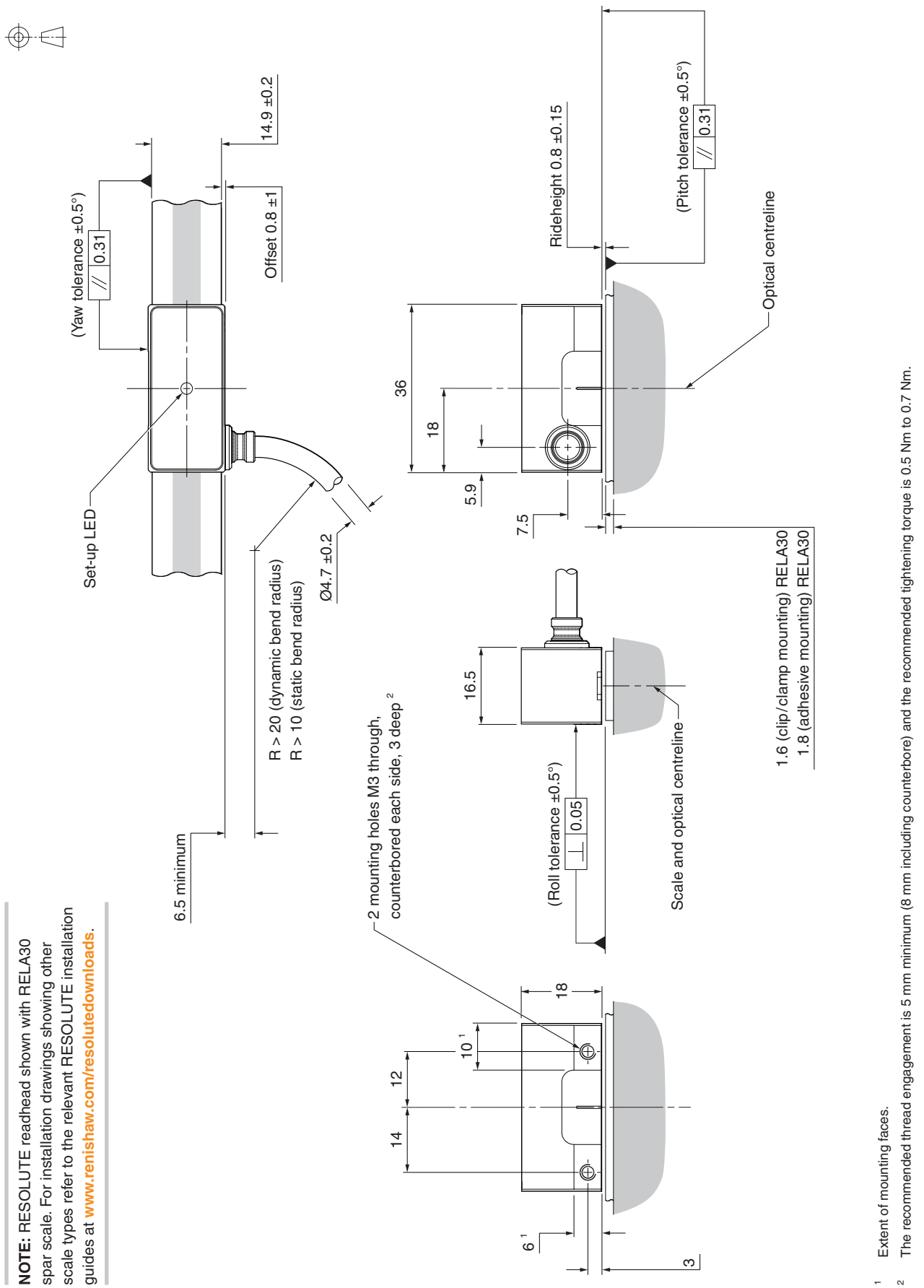
NOTE: RESOLUTE readhead shown with RSLA30 spar scale. For installation drawings showing other scale types refer to the relevant RESOLUTE installation guides at **www.renishaw.com/resolutedownloads**.

[1] Extent of mounting faces.

[2] 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 side exit cable readhead installation drawing

Dimensions and tolerances in mm



NOTE: RESOLUTE readhead shown with RELA30 spar scale. For installation drawings showing other scale types refer to the relevant RESOLUTE installation guides at www.renishaw.com/resolutedownloads.

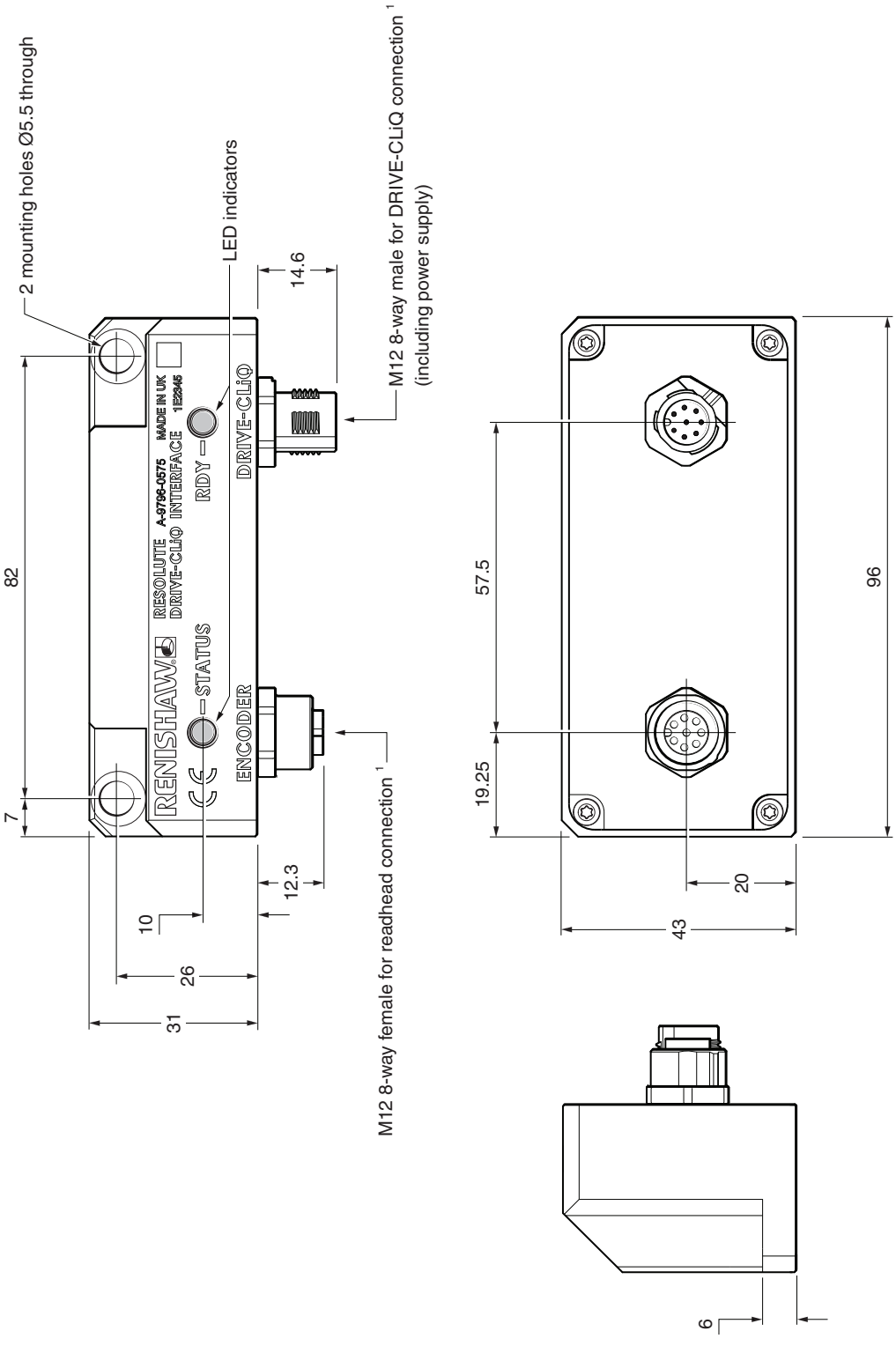
[1] Extent of mounting faces.

[2] 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.

Siemens DRIVE-CLiQ interface drawing

Dimensions and tolerances in mm

Single readhead input (A-9796-0575)

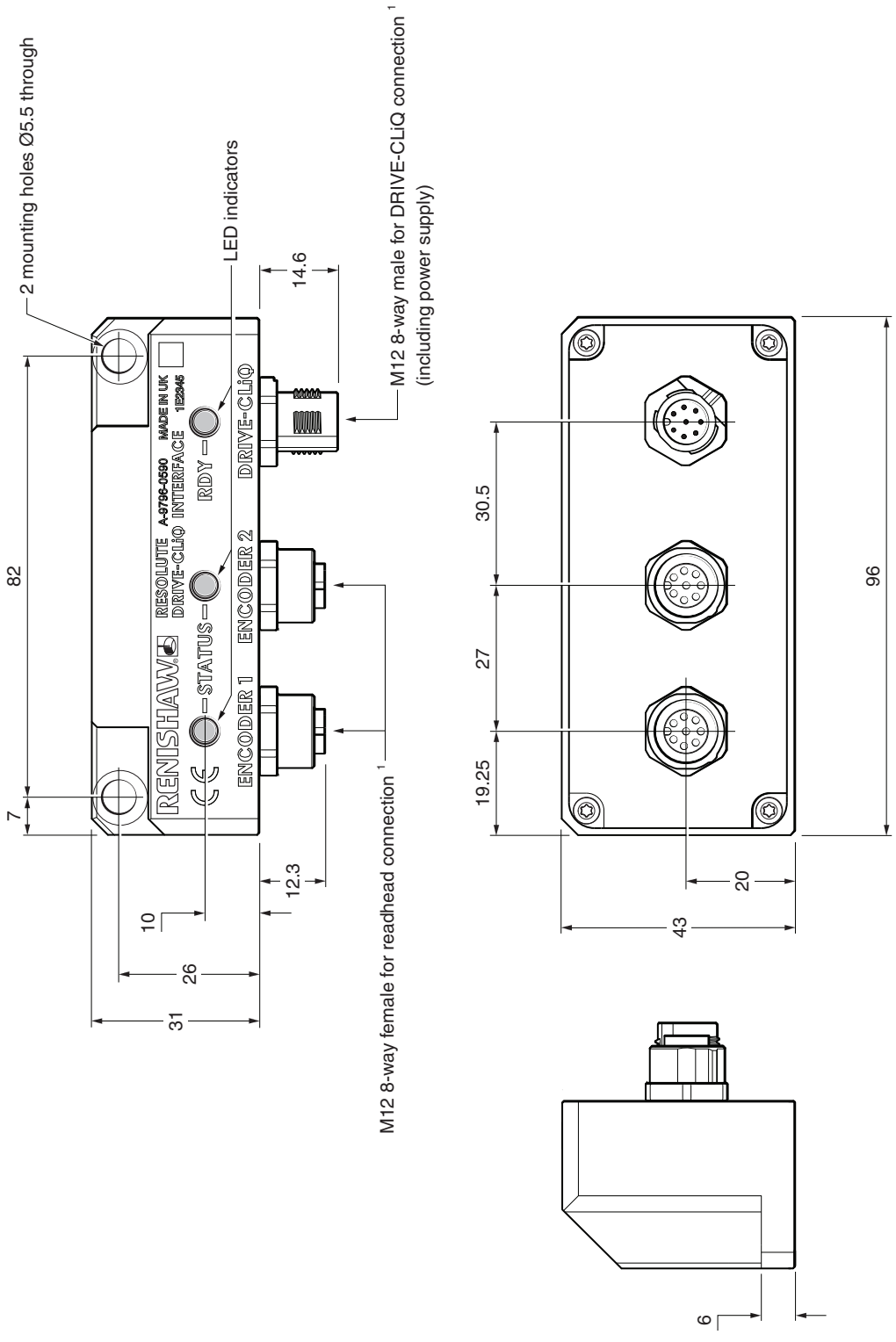


[1] Maximum tightening torque 4 Nm.

Siemens DRIVE-CLiQ interface drawing

Dimensions and tolerances in mm

Dual readhead input (A-9796-0590)



[1] Maximum tightening torque 4 Nm.

RESOLUTE BiSS readhead part numbers

Linear and partial arc readheads

R L 32B B T 001 E 30 A

Series

R = RESOLUTE

Scale form

L = Linear/partial arc

Serial interface

26B = BiSS 26 bit

32B = BiSS 32 bit

36B = BiSS 36 bit

Mechanical option

B = Standard cable outlet

R = Side cable outlet

Gain option

T = RTLA30 / RTLA30-S / RKLA30-S

S = RSLA30

E = RELA30

Resolution

001 = 1 nm

005 = 5 nm

050 = 50 nm

Scale code option [1]

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
05 = 0.5 metres
10 = 1.0 metres
15 = 1.5 metres
30 = 3.0 metres
50 = 5.0 metres
90 = 9.0 metres
99 = 10.0 metres

Cable termination

A = 9-way D-type connector

F = Flying lead (unterminated cable)

L = LEMO in-line connector

S = M12 (sealed) connector

For RESOLUTE BiSS UHV and Functional Safety linear readhead part numbers see the relevant data sheet at **www.renishaw.com/resolutedownloads**.

Valid system configurations (readheads and scale) can be checked at **www.renishaw.com/epc**.

[1] The maximum scale length may be limited for some serial interfaces and resolutions; refer to 'Resolution and scale lengths' on page 7 for details.

RESOLUTE BiSS readhead part numbers

Rotary readheads

R A 32B B A 052 B 30 A

Series

R = RESOLUTE

Scale form

A = Angular

Serial interface

18B = BiSS 18 bit
26B = BiSS 26 bit
32B = BiSS 32 bit

Mechanical option

B = Standard cable outlet
R = Side cable outlet

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

A = 9-way D-type connector
F = Flying lead (unterminated cable)
L = LEMO in-line connector
S = M12 (sealed) connector

For RESOLUTE BiSS ETR, UHV and Functional Safety linear readhead part numbers see the relevant data sheet at **www.renishaw.com/resolutedownloads**.

Valid system configurations (readheads and scale) can be checked at **www.renishaw.com/epc**.

RESOLUTE FANUC readhead part numbers

Linear and partial arc readheads

R L 37F B S 001 C 30 A

Series

R = RESOLUTE

Scale form

L = Linear/partial arc

Serial interface

37F = FANUC α and α*i* (37 bit)

Mechanical option

B = Standard cable outlet

R = Side cable outlet

Gain option

T = RTLA30 / RTLA30-S / RKLA30-S scales

S = RSLA30 scale

E = RELA30 scale

Resolution

001 = 1 nm

050 = 50 nm

Scale code option

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

A = 9-way D-type connector

F = Flying lead (unterminated cable)

H = 20-way FANUC compatible connector

L = LEMO in-line connector

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

RESOLUTE FANUC readhead part numbers

Rotary readheads

R A 27F B A 052 B 30 A

Series

R = RESOLUTE

Scale form

A = Angular

Serial interface

27F = FANUC α High Type B and αi (27 bit)

31F = FANUC αi (31 bit)

Mechanical option

B = Standard cable outlet

R = Side cable outlet

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

A = 9-way D-type connector

F = Flying lead (unterminated cable)

H = 20-way FANUC compatible connector

L = LEMO in-line connector

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

RESOLUTE Mitsubishi readhead part numbers

Linear and partial arc readheads

R L 40M B S 001 C 30 N

Series

R = RESOLUTE

Scale form

L = Linear/partial arc

Serial interface

40M = Mitsubishi 40 bit, 2 wire [1]

40N = Mitsubishi 40 bit, 4 wire [1]

Mechanical option

B = Standard cable outlet

R = Side cable outlet

Gain option

T = RTLA30 / RTLA30-S / RKLA30-S scales

S = RSLA30 scale

E = RELA30 scale

Resolution

001 = 1 nm

050 = 50 nm

Scale code option

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

A = 9-way D-type connector

F = Flying lead (unterminated cable)

L = LEMO in-line connector

N = 15-way D-type connector for Mitsubishi

P = 10-way Mitsubishi connector

For more information about Mitsubishi drives, contact Mitsubishi.

Valid system configurations (readheads and scale) can be checked at **www.renishaw.com/epc**.

[1] 2 wire: MR-J4 series/MR-J5 series
4 wire: MDS-D2/DH2/DM2/DJ

RESOLUTE Mitsubishi readhead part numbers

Rotary readheads

R A 23M B A 052 B 30 N

Series

R = RESOLUTE

Scale form

A = Angular

Serial interface

23M = Mitsubishi 23 bit, 2 wire [1]

23N = Mitsubishi 23 bit, 4 wire [2]

27N = Mitsubishi 27 bit, 4 wire [2]

Mechanical option

B = Standard cable outlet

R = Side cable outlet

Gain option

A = Standard

Ring diameter

052 = 52 mm
057 = 57 mm
075 = 75 mm
100 = 100 mm
101 = 101 mm (RESA30 only)
103 = 103 mm
104 = 104 mm
115 = 115 mm
124 = 124 mm (RESA30 only)
150 = 150 mm
165 = 165 mm
172 = 172 mm
183 = 183 mm
200 = 200 mm
206 = 206 mm
209 = 209 mm
229 = 229 mm
255 = 255 mm
280 = 280 mm (RESA30 only)
300 = 300 mm
330 = 330 mm (RESA30 only)
350 = 350 mm
413 = 413 mm (RESA30 only)
417 = 417 mm
489 = 489 mm (RESA30 only)
550 = 550 mm (RESA30 only)

Scale code option

B = Standard scale code

Cable length

02 = 0.2 metres
05 = 0.5 metres
10 = 1.0 metres
15 = 1.5 metres
30 = 3.0 metres
50 = 5.0 metres
90 = 9.0 metres
99 = 10.0 metres

Cable termination

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

For more information about Mitsubishi drives, contact Mitsubishi.

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

[1] 2 wire: MR-J4 series

[2] 4 wire: MDS-D2/DH2/DM2/DJ

RESOLUTE Panasonic readhead part numbers

Linear and partial arc readheads

R L 48P B S 001 C 30 A

Series

R = RESOLUTE

Scale form

L = Linear/partial arc

Serial interface

48P = Panasonic 48 bit

Mechanical option

B = Standard cable outlet

R = Side cable outlet

Gain option

T = RTLA30 / RTLA30-S / RKLA30-S scales

S = RSLA30 scale

E = RELA30 scale

Resolution

001 = 1 nm

050 = 50 nm

100 = 100 nm

Scale code option

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

A = 9-way D-type connector

F = Flying lead (unterminated cable)

L = LEMO in-line connector

S = M12 (sealed) connector

For the part numbers of the RESOLUTE Panasonic UHV variant, refer to the *RESOLUTE™ UHV absolute optical encoder* data sheet (Renishaw part no. L-9517-9530), which can be downloaded from **www.renishaw.com/resolutedownloads**.

Valid system configurations (readheads and scale) can be checked at **www.renishaw.com/epc**.

RESOLUTE Panasonic readhead part numbers

Rotary readheads

R A 23P B A 052 B 30 A

Series

R = RESOLUTE

Scale form

A = Angular

Serial interface

23P = Panasonic 23 bit

32P = Panasonic 32 bit

Mechanical option

B = Standard cable outlet

R = Side cable outlet

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

A = 9-way D-type connector

F = Flying lead (unterminated cable)

L = LEMO in-line connector

S = M12 (sealed) connector

For the part numbers of the RESOLUTE Panasonic UHV variant, refer to the *RESOLUTE™ UHV absolute optical encoder* data sheet (Renishaw part no. L-9517-9530), which can be downloaded from **www.renishaw.com/resolutedownloads**.

Valid system configurations (readheads and scale) can be checked at **www.renishaw.com/epc**.

RESOLUTE Siemens DRIVE-CLiQ readhead part numbers

Linear and partial arc readheads

R L 34D B S 001 C 30 S

Series

R = RESOLUTE

Scale form

L = Linear/partial arc

Serial interface

28D = Siemens DRIVE-CLiQ 28 bit (for 50 nm resolution) [1]

34D = Siemens DRIVE-CLiQ 34 bit (for 1 nm resolution) [1]

Mechanical option

B = Standard cable outlet

R = Side cable outlet

Gain option

T = RTLA30 / RTLA30-S / RKLA30-S scales

S = RSLA30 scale

E = RELA30 scale

Resolution

001 = 1 nm

050 = 50 nm

Scale code option [2]

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

F = Flying lead (unterminated cable)

S = M12 (sealed) connector

For the part numbers of the RESOLUTE Siemens DRIVE-CLiQ Functional Safety variant, refer to the *RESOLUTE™ FS absolute with Siemens DRIVE-CLiQ serial communications* data sheet (Renishaw part no. L-9517-9701), which can be downloaded from **www.renishaw.com/resolutedownloads**.

Valid system configurations (readheads and scale) can be checked at **www.renishaw.com/epc**.

[1] For linear Siemens DRIVE-CLiQ variants 'Serial interface' and 'Resolution' must be selected in certain combinations.
- 28D must be selected for 50 nm resolution systems.
- 34D must be selected for 1nm resolution systems.

Other combinations are not valid.

[2] The maximum scale length may be limited for some serial interfaces and resolutions; refer to 'Resolution and scale lengths' on page 7 for details.

RESOLUTE Siemens DRIVE-CLiQ readhead part numbers

Rotary readheads

R A 26D B A 052 B 30 S

Series

R = RESOLUTE

Scale form

A = Angular

Serial interface

26D = Siemens DRIVE-CLiQ 26 bit

29D = Siemens DRIVE-CLiQ 29 bit

Mechanical option

B = Standard cable outlet

R = Side cable outlet

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

F = Flying lead (unterminated cable)

S = M12 (sealed) connector

For the part numbers of the RESOLUTE Siemens DRIVE-CLiQ Functional Safety variant, refer to the *RESOLUTE™ FS absolute with Siemens DRIVE-CLiQ serial communications* data sheet (Renishaw part no. L-9517-9701), which can be downloaded from **www.renishaw.com/resolutedownloads**.

Valid system configurations (readheads and scale) can be checked at **www.renishaw.com/epc**.

RESOLUTE Yaskawa readhead part numbers

Linear and partial arc readheads

R L 36Y B S 001 C 30 A

Series

R = RESOLUTE

Scale form

L = Linear/partial arc

Serial interface

36Y = Yaskawa 36 bit

Mechanical option

B = Standard cable outlet

R = Side cable outlet

Gain option

T = RTLA30 / RTLA30-S / RKLA30-S scales

S = RSLA30 scale

E = RELA30 scale

Resolution

001 = 1 nm

050 = 50 nm

Scale code option [1]

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
05 = 0.5 metres
10 = 1.0 metres
15 = 1.5 metres
30 = 3.0 metres
50 = 5.0 metres
90 = 9.0 metres
99 = 10.0 metres

Cable termination

A = 9-way D-type connector

F = Flying lead (unterminated cable)

L = LEMO in-line connector

S = M12 (sealed) connector

Valid system configurations (readheads and scale) can be checked at **www.renishaw.com/epc**.

[1] The maximum scale length may be limited for some serial interfaces and resolutions; refer to 'Resolution and scale lengths' on page 7 for details.

RESOLUTE Yaskawa readhead part numbers

Rotary readheads

R A 24Y B A 052 B 30 A

Series

R = RESOLUTE

Scale form

A = Angular

Serial interface

23Y = Yaskawa 23 bit [1]
24Y = Yaskawa 24 bit [2]
26Y = Yaskawa 26 bit [1]
30Y = Yaskawa 30 bit [1]

Mechanical option

B = Standard cable outlet
R = Side cable outlet

Gain option

A = Standard

Ring diameter

052 = 52 mm
057 = 57 mm
075 = 75 mm
100 = 100 mm
101 = 101 mm (RESA30 only)
103 = 103 mm
104 = 104 mm
115 = 115 mm
124 = 124 mm (RESA30 only)
150 = 150 mm
165 = 165 mm
172 = 172 mm
183 = 183 mm
200 = 200 mm
206 = 206 mm
209 = 209 mm
229 = 229 mm
255 = 255 mm
280 = 280 mm (RESA30 only)
300 = 300 mm
330 = 330 mm (RESA30 only)
350 = 350 mm
413 = 413 mm (RESA30 only)
417 = 417 mm
489 = 489 mm (RESA30 only)
550 = 550 mm (RESA30 only)

Scale code option

B = Standard scale code

Cable length

02 = 0.2 metres
05 = 0.5 metres
10 = 1.0 metres
15 = 1.5 metres
30 = 3.0 metres
50 = 5.0 metres
90 = 9.0 metres
99 = 10.0 metres

Cable termination

A = 9-way D-type connector
F = Flying lead (unterminated cable)
L = LEMO in-line connector
S = M12 (sealed) connector

[1] For fully-closed loop control.
[2] For rotary servomotors.

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

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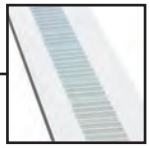
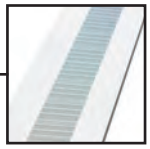
RESOLUTE series compatible products

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

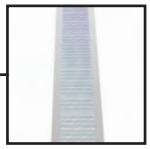
Compatible with RESOLUTE
readheads showing the **ADT** mark.



RELA30 self-adhesive or clip/clamp mounted ZeroMet™ spar scale



RSLA30 self-adhesive or clip/clamp mounted stainless steel spar scale

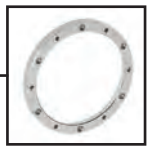


RTLA30-S self-adhesive tape scale

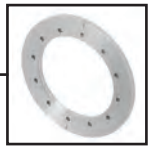
RTLA30 tape scale and *FASTRACK* carrier

RKLA30-S self-adhesive tape scale (linear)

RKLA30-S self-adhesive tape scale (partial arc)



RESA30 stainless steel ring



REXA30 high-accuracy stainless steel ring

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.

www.renishaw.com/contact

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Part no.: L-9518-0013-01-A
Issued: 07.2023

Data sheet
L-9518-0020-01-A

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RESOLUTE™ Functional Safety absolute optical encoder system

RESOLUTE™ Functional Safety (FS) is a true-absolute fine-pitch optical encoder system offering an impressive specification that is certified to Functional Safety standards.

Patented RESOLUTE encoder technology combines 1 nm resolution with exceptionally high speed, 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 and ultra-low noise (jitter), resulting in better velocity control performance and rock solid positional stability.

RESOLUTE FS encoders are for use in Functional Safety applications being certified to ISO 13849 Category 3 PLd, IEC 61508 SIL2 and IEC 61800-5-2 SIL2.

- **True-absolute non-contact optical encoder system: no batteries required**
- **ISO 13849 Category 3 PLd**
- **IEC 61508 SIL2**
- **IEC 61800-5-2 SIL2**
- **Wide set-up tolerances for quick and easy installation**
- **Resolutions to 1 nm linear or 32 bit rotary**
- **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 with an integral over-temperature alarm**
- **Compatible with a wide range of linear and rotary scales**
- **Available with BiSS Safety and Siemens DRIVE-CLiQ serial interfaces**

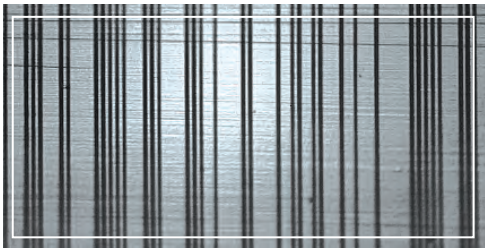
www.renishaw.com/resolutedownloads

#renishaw

System features

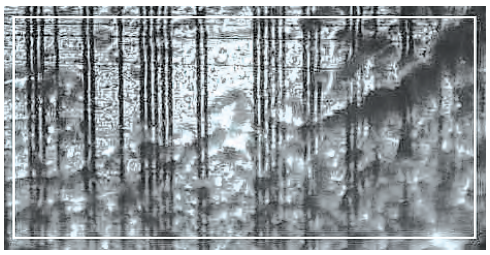
Unique single-track absolute optical scale

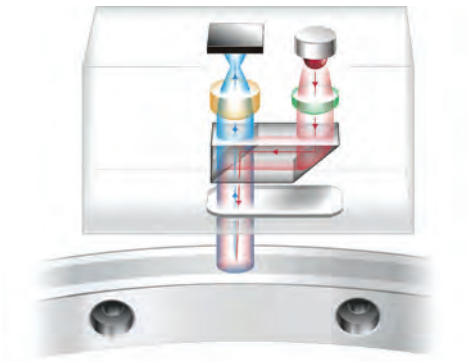
- Absolute position is determined immediately upon switch-on
- No battery back-up
- No yaw de-phasing unlike multiple-track systems
- Fine pitch (30 µm nominal period) optical scale for superior motion control compared to inductive, magnetic or other non-contact optical absolute encoders
- High-accuracy 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

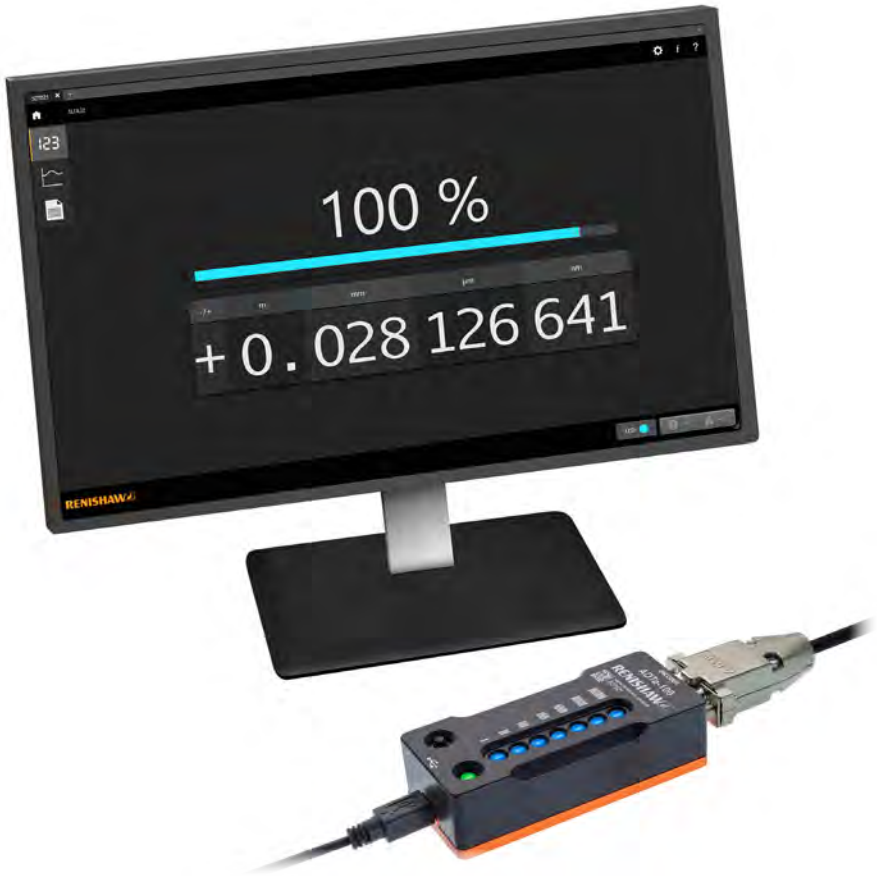
- Readhead acts like an ultra-fast miniature digital camera, taking photos of a coded scale
- Photos are analysed by a high-speed digital signal processor (DSP) to determine absolute position
- Built-in position-check algorithm constantly monitors calculations for ultimate safety and reliability
- Advanced 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 [1] 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:

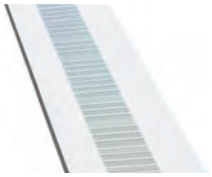
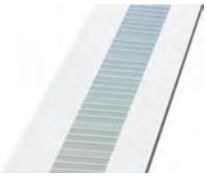
- Digital readout of encoder position and signal strength
- Graph of signal strength over the entire axis travel
- System configuration information



[1] ADTa-100 compatible readheads are marked with the symbol ADT

Compatible linear scales

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

	RELA30	RSLA30
	Self-adhesive mounted low-expansion ZeroMet™ spar scale	**Self-adhesive mounted stainless steel spar scale**
		
Form (height × width)	1.5 mm × 14.9 mm	1.6 mm × 14.9 mm
Accuracy (at 20 °C)	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
Maximum length [2]	1.5 m	5 m
Coefficient of thermal expansion (at 20 °C)	0.75 ±0.35 µm/m/°C	10.1 ±0.2 µm/m/°C

[1] For RTLA30-S axis lengths > 2 m, the FASTRACK carrier with RTLA30 is recommended.

[2] The maximum scale length may be limited for some serial interfaces and resolutions; refer to 'Linear encoder system' on page 6 for details.

For more information about the linear scales refer to the relevant absolute scale data sheet which can be downloaded from **www.renishaw.com/resolutedownloads**.

Compatible rotary scales

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

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

2 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**.

Linear encoder system

Scale lengths and speed

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

The table shows the maximum scale length and speed for each system:

		Resolution		Maximum reading speed
Serial interfaces	**Position bits**	**1 nm**	**50 nm**	
BiSS Safety	28 bit	-	13.42 m	100 m/s
	36 bit	21 m	-	
Siemens DRIVE-CLiQ	28 bit	-	13.42 m	100 m/s
	34 bit	17.18 m	-	

Angle encoder system

Resolution

RESOLUTE 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 Safety	32 bit	4 294 967 296	≈ 0.0003
Siemens DRIVE-CLiQ	26 bit	67 108 864	≈ 0.019
	29 bit	536 870 912	≈ 0.0024

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

Accuracy

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

RESA30 diameter (mm)	Typical installed accuracy [1] (arc second)
52	±12.7
57	±11.8
75	±9.5
100	±7.5
101	±7.5
103	±7.4
104	±7.3
115	±6.8
124	±6.3
150	±5.5
165	±7.0
172	±5.0
183	±4.7

RESA30 diameter (mm)	Typical installed accuracy [1] (arc second)
200	±4.3
206	±4.2
209	±4.2
229	±3.9
255	±3.6
280	±3.4
300	±3.1
330	±2.9
350	±2.8
413	±2.4
417	±2.4
489	±2.1
550	±1.9

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

Speed

The maximum speed of the RESOLUTE FS encoder system depends on the mounting method and the scale type.

For further information, refer to the *RESOLUTE™ Functional Safety installation guide and safety manual BiSS Safety encoder system* (Renishaw part no. M-9755-9109) or the *RESOLUTE™ Functional Safety installation guide and safety manual Siemens DRIVE-CLiQ encoder system* (Renishaw part no. M-9796-9134). These documents are available at **www.renishaw.com/fsencoders**.

[1] 'Typical' installations are a result of graduation and installation errors combining and, to some magnitude, cancelling.

General specifications

		BiSS Safety	Siemens DRIVE-CLiQ
Power supply		5 V ±10% 1.25 W maximum (250 mA @ 5 V) [1] Ripple: 200 mVpp maximum @ frequency up to 500 kHz maximum	Voltage and current 4.3 W maximum 24 V power is provided by the DRIVE-CLiQ network Interface over voltage protection –36 to +36 V
Temperature	Storage	–20 °C to 80 °C	–20 °C to 70 °C
	Installation	+20 °C ±5 °C	+20 °C ±5 °C
	Operating	0 °C to +80 °C	0 °C to +80 °C (readhead) 0 °C to +55 °C (interface)
Humidity		95% relative humidity (non-condensing) to IEC 60068-2-78	
Sealing		IP64	IP64 (readhead) IP67 (interface)
Environmental protection		Protection class III Pollution degree II Altitude 2000 m	
Acceleration	Operating	500 m/s², 3 axes (readhead only)	
Maximum acceleration of scale with respect to readhead [2]		2000 m/s²	
Vibration	Operating	300 m/s², 55 Hz to 2000 Hz, 3 axes	300 m/s², 55 Hz to 2000 Hz, 3 axes (readhead) 100 m/s², 55 Hz to 2000 Hz, 3 axes (interface)
Shock	Non-operating	1000 m/s², 6 ms, ½ sine, 3 axes	500 m/s², 11 ms, ½ sine, 3 axes
Mass	Readhead	18 g	18 g
	Readhead cable	32 g/m	32 g/m
	Interface	-	218 g
EMC compliance		IEC 61800-5-2 Annex E	
Readhead cable		7 core, tinned and annealed copper, 28 AWG Single-shielded, outside diameter 4.7 ±0.2 mm Flex life > 40 × 10⁶ cycles at 20 mm bend radius UL recognised component	
Maximum readhead cable length		10 m	10 m (to controller or interface) (refer to Siemens DRIVE-CLiQ specifications for maximum cable length from interface to controller)

CAUTION: The RESOLUTE encoder system has been designed to meet the requirements of IEC 61800-5-2: Annex E second environment, but must be correctly integrated to achieve EMC compliance. In particular, attention to shielding arrangements is essential.

[1] Current consumption figures refer to a terminated RESOLUTE BiSS safety system. BiSS Safety encoder systems must be powered from a 5 Vdc supply complying with the requirements for PELV of standard IEC 60950-1.

[2] 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.

Safety sub-functions

The RESOLUTE Functional Safety BiSS Safety encoder and Siemens DRIVE-CLiQ encoder systems provide safe position data that supports the following safety sub-functions defined by IEC 61800-5-2:2016:

- Safe stop 1 (SS1) and Safe stop 2 (SS2)
- Safe operating stop (SOS)
- Safe limited acceleration (SLA) ≤ 500 m/s^2
- Safe acceleration range (SAR) ≤ 500 m/s^2
- Safe limited speed (SLS) [1] ≤ 100 m/s
- Safe speed range (SSR) [1] ≤ 100 m/s
- Safely limited position (SLP)
- Safely limited increment (SLI)
- Safe direction (SDI)
- Safe speed monitor (SSM) [1] ≤ 100 m/s

The system must be installed and operated in accordance with the instructions defined by the installation guide. Failure to follow the correct use instructions and failure to heed the limitations may result in PLd and / or SIL2 not being achieved and will invalidate the functional safety certification.

NOTE: For the maximum permitted speeds for the range of ring diameters refer to the installation guides.These are available at **www.renishaw.com/fsencoders**.

[1] For further details see the *RESOLUTE™ Functional Safety installation guide and safety manual BiSS Safety encoder system (Renishaw part no. M-9755-9109) or the RESOLUTE™ Functional Safety installation guide and safety manual Siemens DRIVE-CLiQ encoder system (Renishaw part no. L-9796-9134)*. These documents are available at **www.renishaw.com/fsencoders**.

Functional Safety data declaration

IEC 61508 safety data

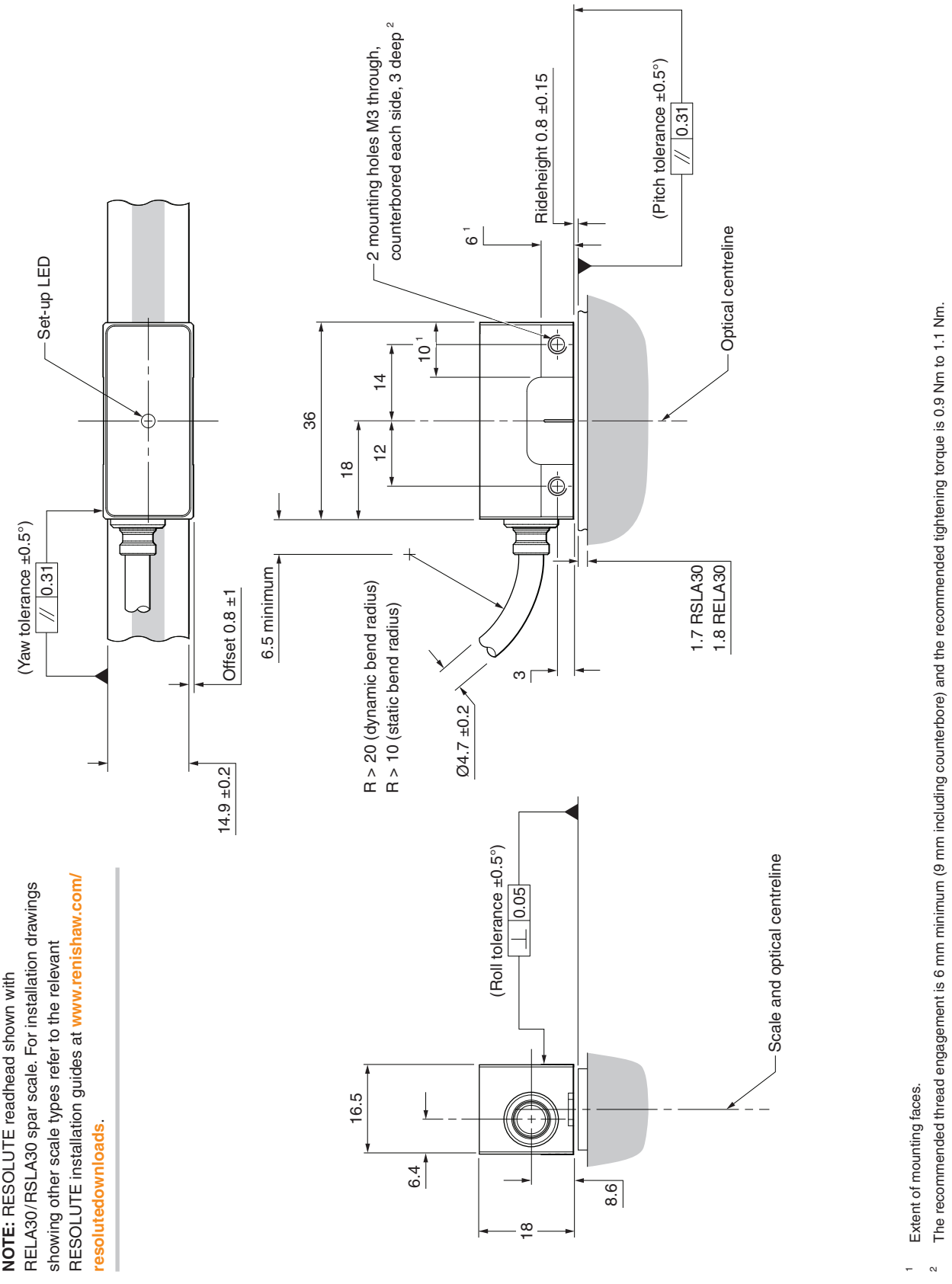
	RESOLUTE™ Functional Safety with BiSS® Safety encoder system	RESOLUTE™ Functional Safety Siemens DRIVE-CLiQ encoder system	
		Single readhead systems	Dual readhead systems
Safety Integrity Level	2		
Random Hardware Failures (per hour)	$\lambda_S = 5.94 \times 10^{-7}$ $\lambda_D = 8.80 \times 10^{-7}$ $\lambda_{DD} = 7.92 \times 10^{-7}$ $\lambda_{DU} = 8.80 \times 10^{-8}$	$\lambda_S = 6.86 \times 10^{-7}$ $\lambda_D = 1.07 \times 10^{-6}$ $\lambda_{DD} = 9.64 \times 10^{-7}$ $\lambda_{DU} = 1.07 \times 10^{-7}$	$\lambda_S = 1.26 \times 10^{-6}$ $\lambda_D = 1.95 \times 10^{-6}$ $\lambda_{DD} = 1.76 \times 10^{-6}$ $\lambda_{DU} = 1.96 \times 10^{-7}$
PFD_{avg}	Not applicable due to continuous demand mode		
PFH (per hour)	$\lambda_{DU} = 8.80 \times 10^{-8}$	$\lambda_{DU} = 1.07 \times 10^{-7}$	$\lambda_{DU} = 1.95 \times 10^{-7}$
Architectural Constraints	Type B HFT = 0 SFF = 94%		
Hardware safety integrity compliance	Route 1H		
Systematic safety integrity compliance	Route 1S		
Systematic capability	SC2		
Demand mode	Continuous		
Proof test interval	Not required for continuous demand mode		

ISO 13849 safety data

	RESOLUTE™ Functional Safety with BiSS® Safety encoder system	RESOLUTE™ Functional Safety Siemens DRIVE-CLiQ encoder system	
		Single readhead systems	Dual readhead systems
$MTTF_D$ (years)	130	106	58
Diagnostic coverage	Medium (90%)		
Category	3		
Performance level	d		
Lifetime/Replacement limits	20 years		

RESOLUTE FS readhead installation drawing

Dimensions and tolerances in mm



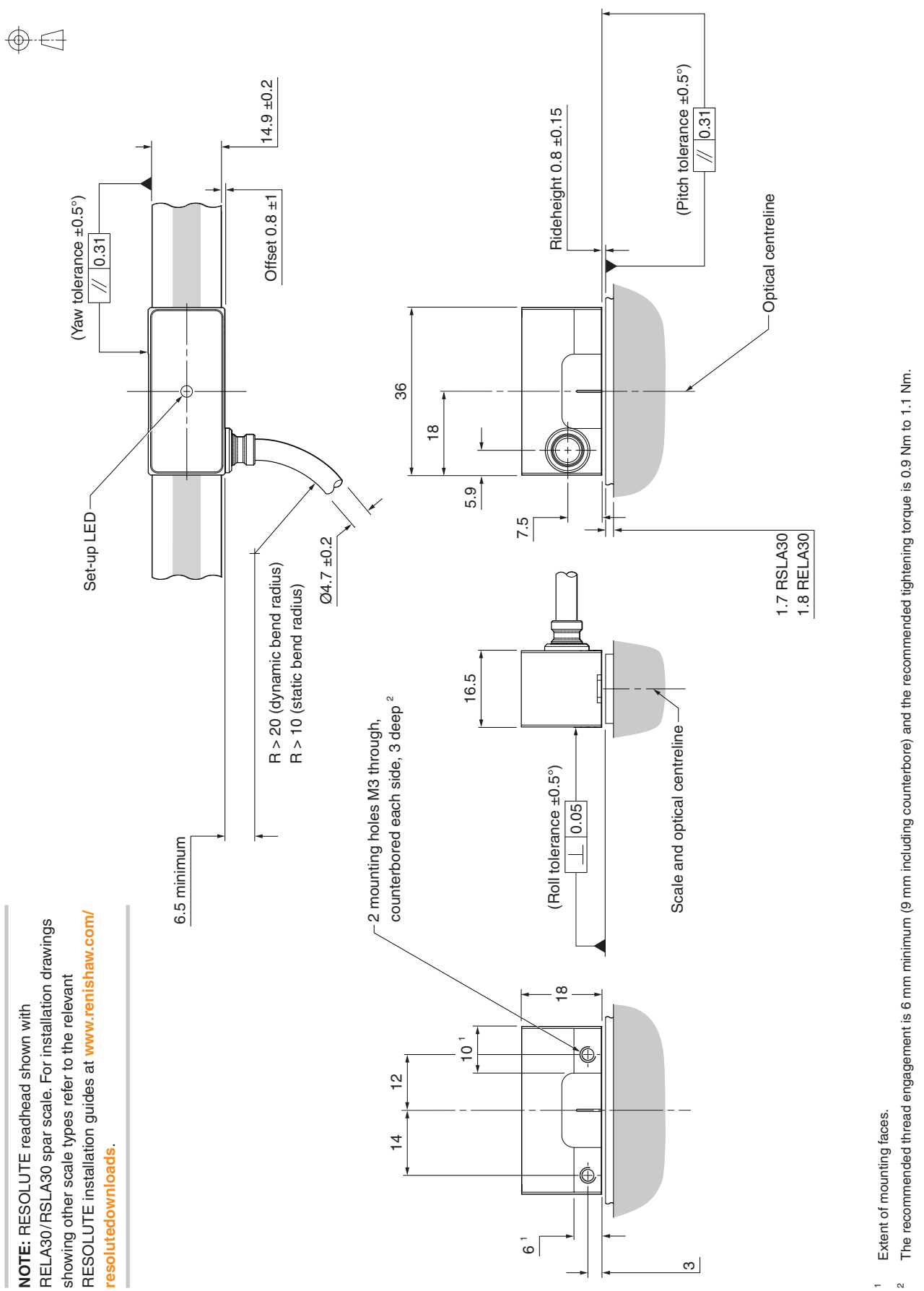
NOTE: RESOLUTE readhead shown with RELA30/RSLA30 spar scale. For installation drawings showing other scale types refer to the relevant RESOLUTE installation guides at **www.renishaw.com/resolutedownloads**.

[1] Extent of mounting faces.

[2] The recommended thread engagement is 6 mm minimum (9 mm including counterbore) and the recommended tightening torque is 0.9 Nm to 1.1 Nm.

RESOLUTE FS side exit cable readhead installation drawing

Dimensions and tolerances in mm



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

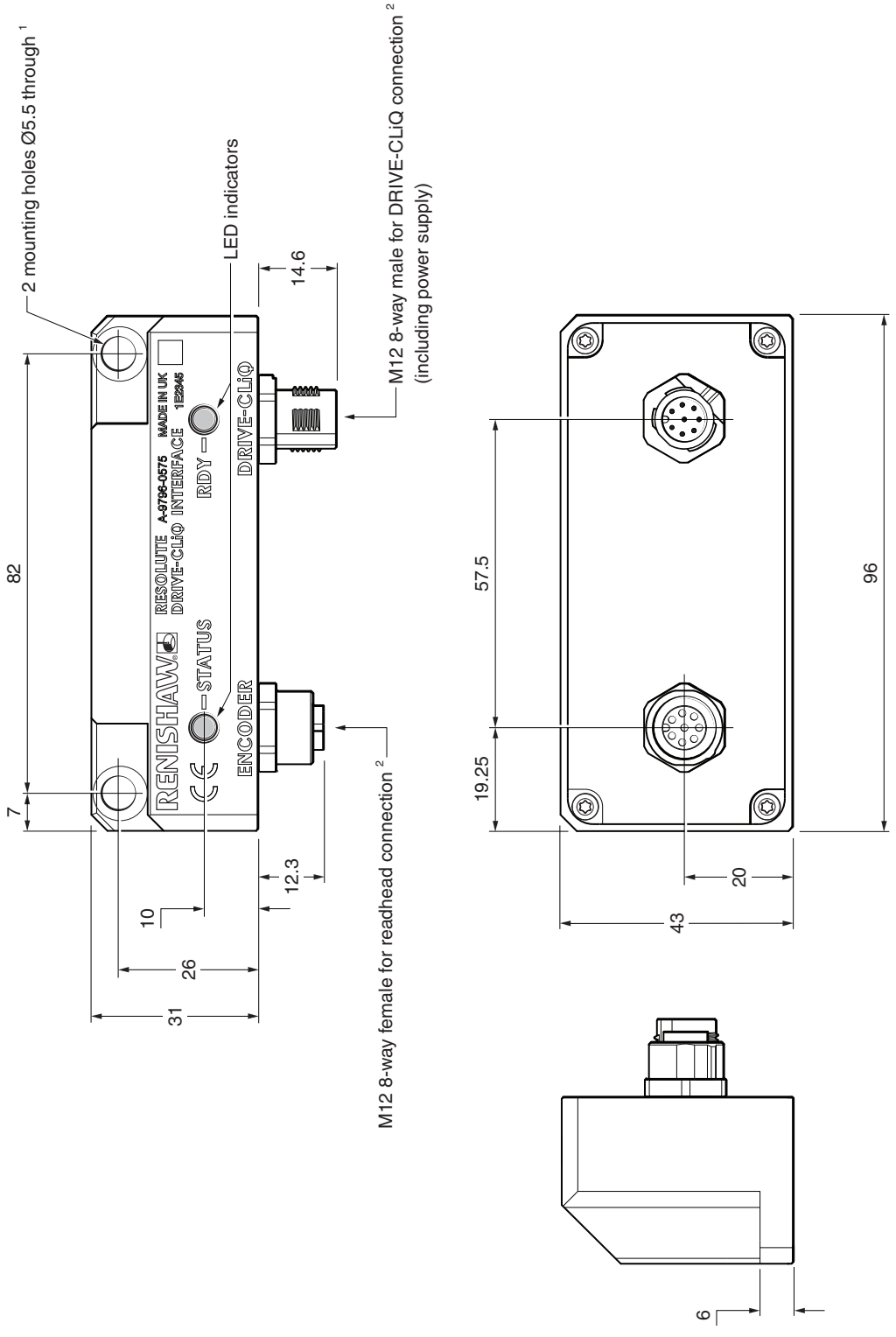
[1] Extent of mounting faces.

[2] The recommended thread engagement is 6 mm minimum (9 mm including counterbore) and the recommended tightening torque is 0.9 Nm to 1.1 Nm.

Siemens DRIVE-CLiQ interface drawing

Dimensions and tolerances in mm

Single readhead input (A-9796-0575)



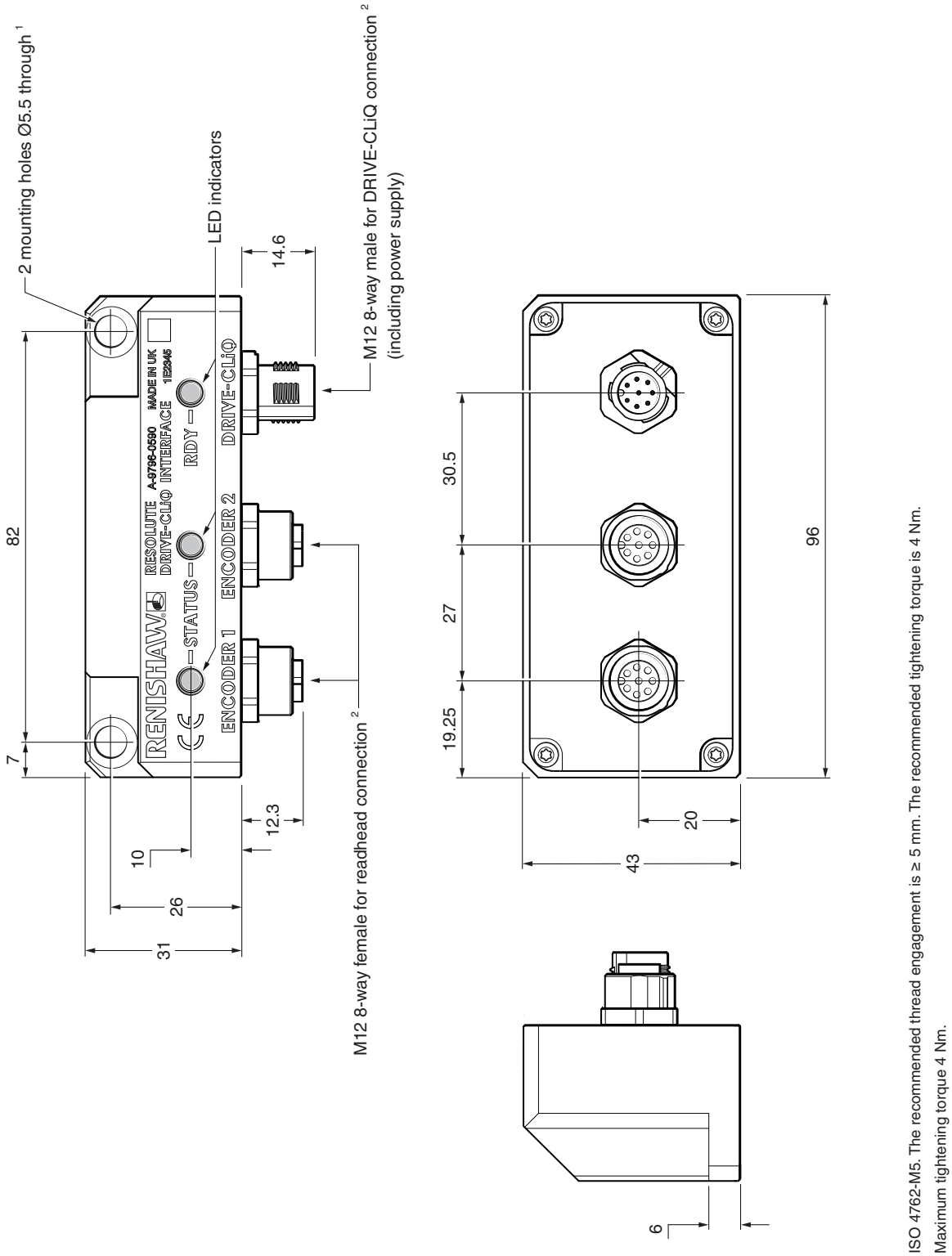
[1] ISO 4762-M5. The recommended thread engagement is ≥ 5 mm. The recommended tightening torque is 4 Nm.

[2] Maximum tightening torque 4 Nm.

Siemens DRIVE-CLiQ interface drawing

Dimensions and tolerances in mm

Dual readhead input (A-9796-0590)



[1] ISO 4762-M5. The recommended thread engagement is ≥ 5 mm. The recommended tightening torque is 4 Nm.

[2] Maximum tightening torque 4 Nm.

RESOLUTE BiSS Safety readhead part numbers

Linear readheads

S L 36B B S 001 C 30 A

Series

S = RESOLUTE Functional Safety

Scale form

L = Linear

Serial interface

28B = BiSS 28 bit (select 50 nm resolution) [1]

36B = BiSS 36 bit (select 1 nm resolution) [1]

Mechanical option

B = Standard cable outlet

R = Side cable outlet

Gain option

T = RTLA30 / RTLA30-S scales

S = RSLA30 scale

E = RELA30 scale

Resolution

001 = 1 nm (select 36B serial interface) [1]

050 = 50 nm (select 28B serial interface) [1]

Scale code option

B = RTLA30 / RTLA30-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 (> 10 m to 21 m scale length) [2]

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

A = 9-way D-type connector

S = M12 (sealed) connector

Valid system configurations (readheads and scale) can be checked at **www.renishaw.com/epc**.

[1] For linear BiSS Safety variants, 'Serial interface' and 'Resolution', must be selected in certain combinations.
- 28B must be selected for 50 nm resolution systems.
- 36B must be selected for 1 nm resolution systems.

Other combinations are not valid.

[2] The maximum scale length may be limited for some serial interfaces and resolutions; refer to 'Linear encoder system' on page 6 for details.

RESOLUTE BiSS Safety readhead part numbers

Angular readheads

S A 32B B A 052 B 30 A

Series

S = RESOLUTE Functional Safety

Scale form

A = Angular

Serial interface

32B = BiSS 32 bit

Mechanical option

B = Standard cable outlet

R = Side cable outlet

Gain option

A = Standard

Ring diameter

052 = 52 mm
057 = 57 mm
075 = 75 mm
100 = 100 mm
101 = 101 mm (RESA30 only)
103 = 103 mm
104 = 104 mm
115 = 115 mm
124 = 124 mm (RESA30 only)
150 = 150 mm
165 = 165 mm
172 = 172 mm
183 = 183 mm
200 = 200 mm
206 = 206 mm
209 = 209 mm
229 = 229 mm
255 = 255 mm
280 = 280 mm (RESA30 only)
300 = 300 mm
330 = 330 mm (RESA30 only)
350 = 350 mm
413 = 413 mm (RESA30 only)
417 = 417 mm
489 = 489 mm (RESA30 only)
550 = 550 mm (RESA30 only)

Scale code option

B = Standard scale code

Cable length

02 = 0.2 metres
05 = 0.5 metres
10 = 1.0 metres
15 = 1.5 metres
30 = 3.0 metres
50 = 5.0 metres
90 = 9.0 metres
99 = 10.0 metres

Cable termination

A = 9-way D-type connector

S = M12 (sealed) connector

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

RESOLUTE FS Siemens DRIVE-CLiQ readhead part numbers

Linear readheads

S L 34D B S 001 C 30 S

Series

S = RESOLUTE Functional Safety

Scale form

L = Linear

Serial interface

28D = Siemens DRIVE-CLiQ 28 bit (select 50 nm resolution) [1]

34D = Siemens DRIVE-CLiQ 34 bit (select 1 nm resolution) [1]

Mechanical option

B = Standard cable outlet

R = Side cable outlet

Gain option

T = RTLA30 / RTLA30-S scales

S = RSLA30 scale

E = RELA30 scale

Resolution

001 = 1 nm (select 34D serial interface)

050 = 50 nm (select 28D serial interface)

Scale code option

B = RTLA30 / RTLA30-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 (> 10 m to 21 m scale length) [2]

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

S = M12 (sealed) connector

F = Flying lead (unterminated cable)

Valid system configurations (readheads and scale) can be checked at **www.renishaw.com/epc**.

[1] For linear Siemens DRIVE-CLiQ Functional Safety variants, 'Serial interface' and 'Resolution', must be selected in certain combinations.
- 28D must be selected for 50 nm resolution systems.
- 34D must be selected for 1 nm resolution systems.

Other combinations are not valid.

[2] The maximum scale length may be limited for some serial interfaces and resolutions; refer to 'Linear encoder system' on page 6 for details.

RESOLUTE FS Siemens DRIVE-CLiQ readhead part numbers

Angular readheads

S A 29D B A 052 B 30 S

Series

S = RESOLUTE Functional Safety

Scale form

A = Angular

Serial interface

26D = Siemens DRIVE-CLiQ 26 bit

29D = Siemens DRIVE-CLiQ 29 bit

Mechanical option

B = Standard cable outlet

R = Side cable outlet

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

S = M12 (sealed) connector

F = Flying lead (unterminated cable)

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

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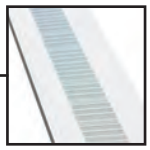
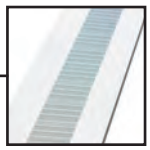
RESOLUTE FS series compatible products

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

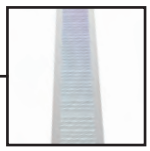
Compatible with RESOLUTE
readheads showing the **ADT** mark.



RELA30 self-adhesive mounted ZeroMet™ spar scale

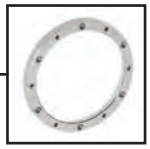


RSLA30 self-adhesive mounted stainless steel spar scale

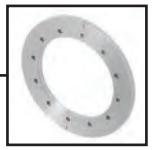


RTLA30-S self-adhesive tape scale

RTLA30 tape scale and *FASTRACK* carrier



RESA30 stainless steel ring



REXA30 high-accuracy stainless steel ring

Installation information can be found in the *RESOLUTE™ Functional Safety installation guide and safety manual BiSS Safety encoder system* (Renishaw part no. M-9755-9109) or the *RESOLUTE™ Functional Safety installation guide and safety manual Siemens DRIVE-CLiQ encoder system* (Renishaw part no. L-9796-9134). These documents are available at **www.renishaw.com/fsencoders**.

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**.

www.renishaw.com/contact

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Part no.: L-9518-0020-01-A
Issued: 07.2023

Data sheet
L-9517-9530-03-B

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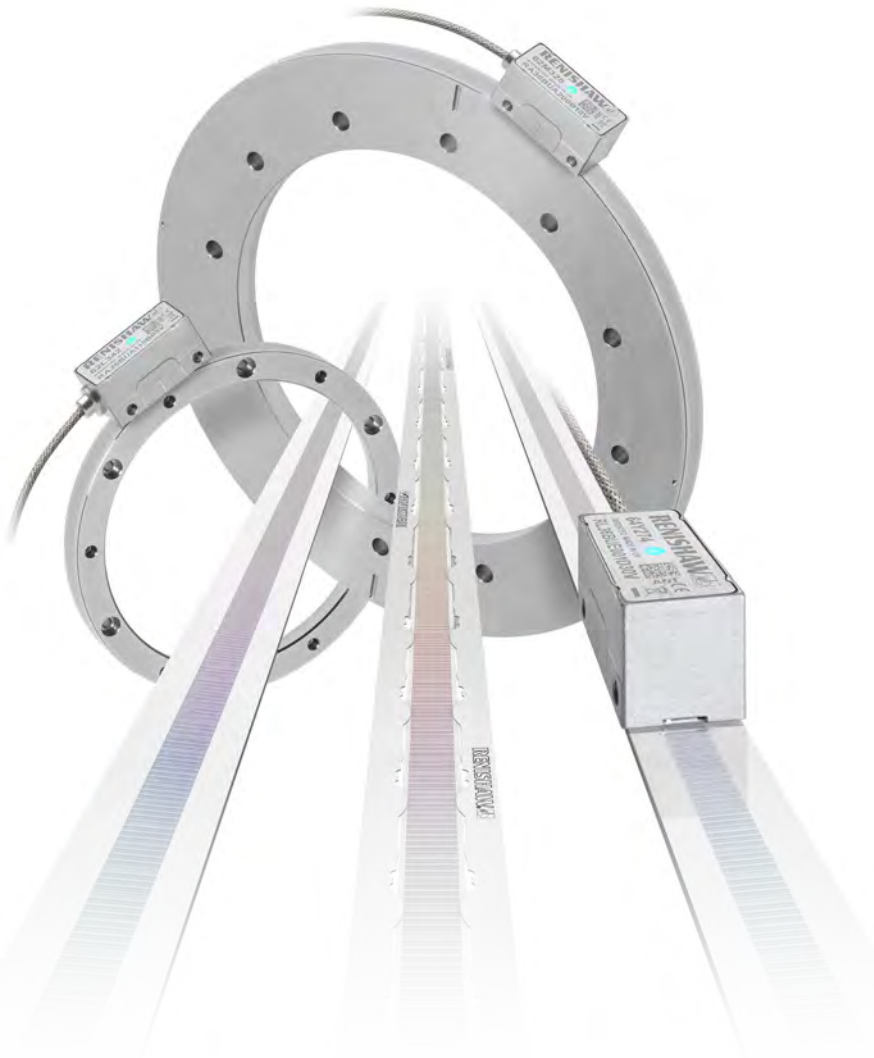
RESOLUTE™ UHV absolute optical encoder



- 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

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.

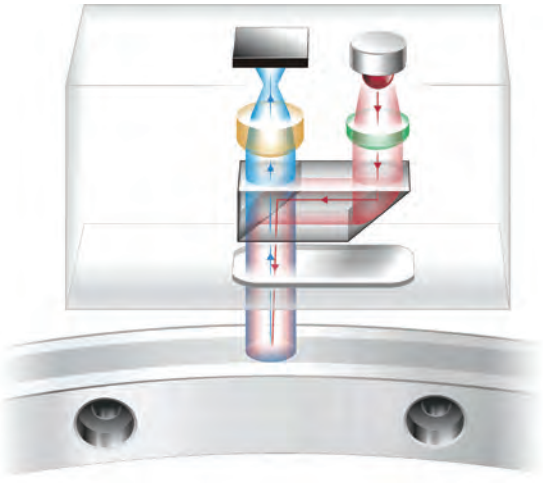
RESOLUTE encoders have inherently very low sub-divisional error (SDE), so the fidelity of feedback is improved. This has several benefits, including minimising velocity ripple, reducing vibration, increasing scanning performance and cutting the amount of heat generated in motors. The RESOLUTE system 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.

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



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

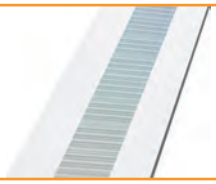
The RESOLUTE encoder system is compatible with the Advanced Diagnostic Tool ADTa-100* and ADT View software, which acquire detailed real-time data from the readhead to allow easy set-up, optimisation and in-field fault finding.
The intuitive software interface provides:

- 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

Compatible linear scales

	RTLA30-S*	RTLA30 / *FASTRACK*™	RKLA30-S
	Self-adhesive mounted stainless steel tape scale	Stainless steel tape scale and self-adhesive mounted carrier	Self-adhesive mounted stainless steel tape scale
			
Form (H × W)	0.4 mm × 8 mm including adhesive	RTLA30 scale: 0.2 mm × 8 mm *FASTRACK* carrier: 0.4 mm × 18 mm including adhesive	0.15 mm × 6 mm including adhesive
Accuracy (at 20 °C)	±5 µm/m	±5 µm/m	±5 µm/m
Maximum length	21 m	RTLA30 lengths up to 21 m *FASTRACK* carrier lengths up to 25 m	21 m
Coefficient of thermal expansion (at 20 °C)	10.1 ±0.2 µm/m/°C	10.1 ±0.2 µm/m/°C	Matches that of substrate material when scale ends fixed by epoxy mounted end clamps

	RELA30	RSLA30
	Self-adhesive or clip/clamp mounted low-expansion ZeroMet™ spar scale	Self-adhesive or clip/clamp mounted stainless steel spar scale
		
Form (H × W)	1.5 mm × 14.9 mm	1.6 mm × 14.9 mm
Accuracy (at 20 °C)	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
Maximum length	1.5 m	5 m
Coefficient of thermal expansion (at 20 °C)	0.75 ±0.35 µm/m/°C	10.1 ±0.2 µm/m/°C

* For RTLA30-S axis lengths > 2 m, *FASTRACK* carrier with RTLA30 is recommended.

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

Compatible rotary scales

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

* When using two RESOLUTE readheads.

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

Linear absolute encoder version

Resolutions, speed and scale lengths

RESOLUTE encoder system with BiSS C (uni-directional)

RESOLUTE readheads using **BiSS C** (uni-directional) protocol are available with three options for the position word length: 36 bit, 32 bit and 26 bit. The maximum scale length is determined by the readhead resolution and the number of position bits in the serial word.
Shorter word lengths combined with fine resolution limit maximum scale length. Conversely, coarser resolutions or longer word lengths enable the use of longer scale lengths.

The 36 bit and 32 bit position word facilitates longer lengths that can be a significant benefit, especially at fine resolutions.

	Resolution		
	1 nm	**5 nm**	**50 nm**
Maximum scale length with 36 bit position word	21 m	21 m	21 m
Maximum scale length with 32 bit position word	4.295 m	21 m	21 m
Maximum scale length with 26 bit position word	67 mm	336 mm	3.355 m
Maximum reading speed	100 m/s	100 m/s	100 m/s

RESOLUTE encoder system with Panasonic

RESOLUTE readheads using **Panasonic** serial comms are available with 1 nm, 50 nm and 100 nm resolution options. For the **Panasonic** protocol, maximum scale length is available at all resolutions.

		Resolution		
		1 nm	**50 nm**	**100 nm**
Maxiumum speed (m/s)	**Panasonic A5 series**	0.4	20	40
	Panasonic A6 series	4	100	100

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

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

Resolution	Counts per revolution	Arc second
18 bit	262 144	≈ 4.94
26 bit	67 108 864	≈ 0.019
32 bit*	4 294 967 296	≈ 0.00030

RESOLUTE encoders with Panasonic serial comms are available with the following resolution options:

Resolution	Counts per revolution	Arc second
23 bit	8 388 608	≈ 0.15
32 bit*	4 294 967 296	≈ 0.0003

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

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

Speed and accuracy

RESA30 diameter (mm)	BiSS maximum reading speed (rev/min)	Panasonic maximum reading speed (rev/min)	Typical installed accuracy (arc second) ‡
52	36 000	7 200†	±12.7
57	33 000	7 200†	±11.8
75	25 000	7 200†	±9.5
100	19 000	7 200†	±7.5
103	18 500	7 200†	±7.4
104	18 000	7 200†	±7.3
115	16 500	6 600	±6.8
150	12 000	5 000	±5.5
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
300	6 300	2 500	±3.1
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).

† The maximum speed depends on the driver, motor and mechanical components. Contact Renishaw or Panasonic regarding the maximum speed.

‡ 'Typical' installations are a result of graduation and installation errors combining and, to some magnitude, cancelling.

General specifications (angle and linear)

Power supply	5 V ±10%	1.25 W maximum (250 mA @ 5 V) **NOTE:** 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.
	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 (readhead)	Operating	500 m/s², 3 axes
Shock (readhead)	Non-operating	1000 m/s², 6 ms, ½ sine, 3 axes
Maximum acceleration of scale with respect to readhead		2000 m/s² **NOTE:** 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.
Vibration	Operating	100 m/s² max @ 55 Hz to 2000 Hz, 3 axes Random vibration 0.15 g²/Hz ASD 20-1000 Hz, –6dB roll off 1-2 kHz
Mass	Readhead	19 g
	Cable	19 g/m
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 Panasonic Drivers		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.

RGA results

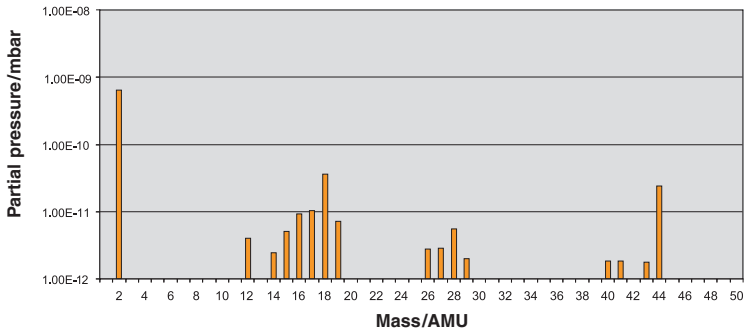
Test schedule

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^3) 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 5×10^{-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.

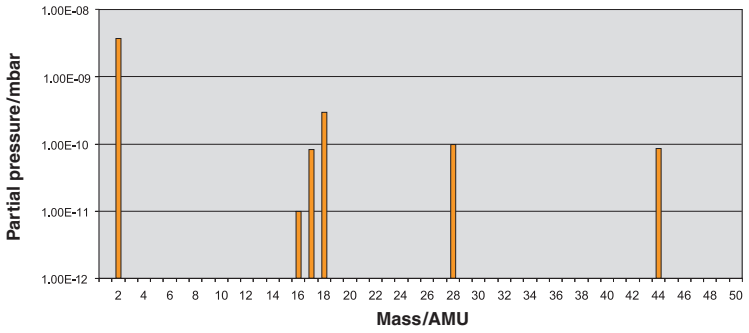
NOTE: Exact reproduction of these results should not be expected, as RGA data depends on the condition, specification and performance of the vacuum system. However, the RGA results shows no significant contamination attributable to RESOLUTE UHV encoders and that UHV conditions can be achieved in the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

RESOLUTE readhead with 1.0 m cable after bake-out (total pressure = 8×10^{-10} mbar)

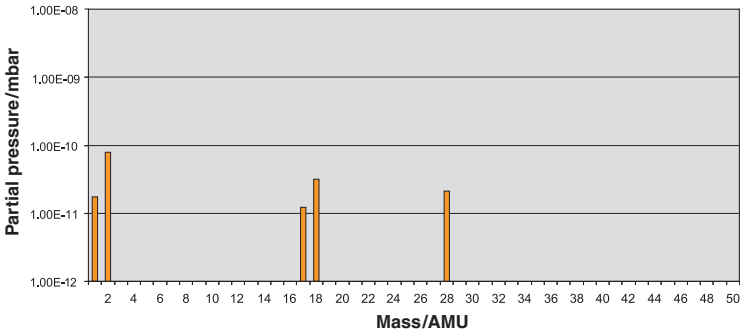


RGA results (continued)

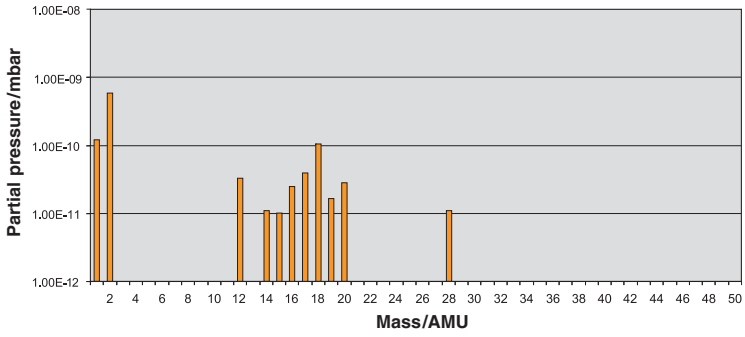
RSLA30 linear scale (180 mm length) with 2 clips and 1 clamp after bake-out (total pressure = 3.0 × 10^{-10} mbar)



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



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



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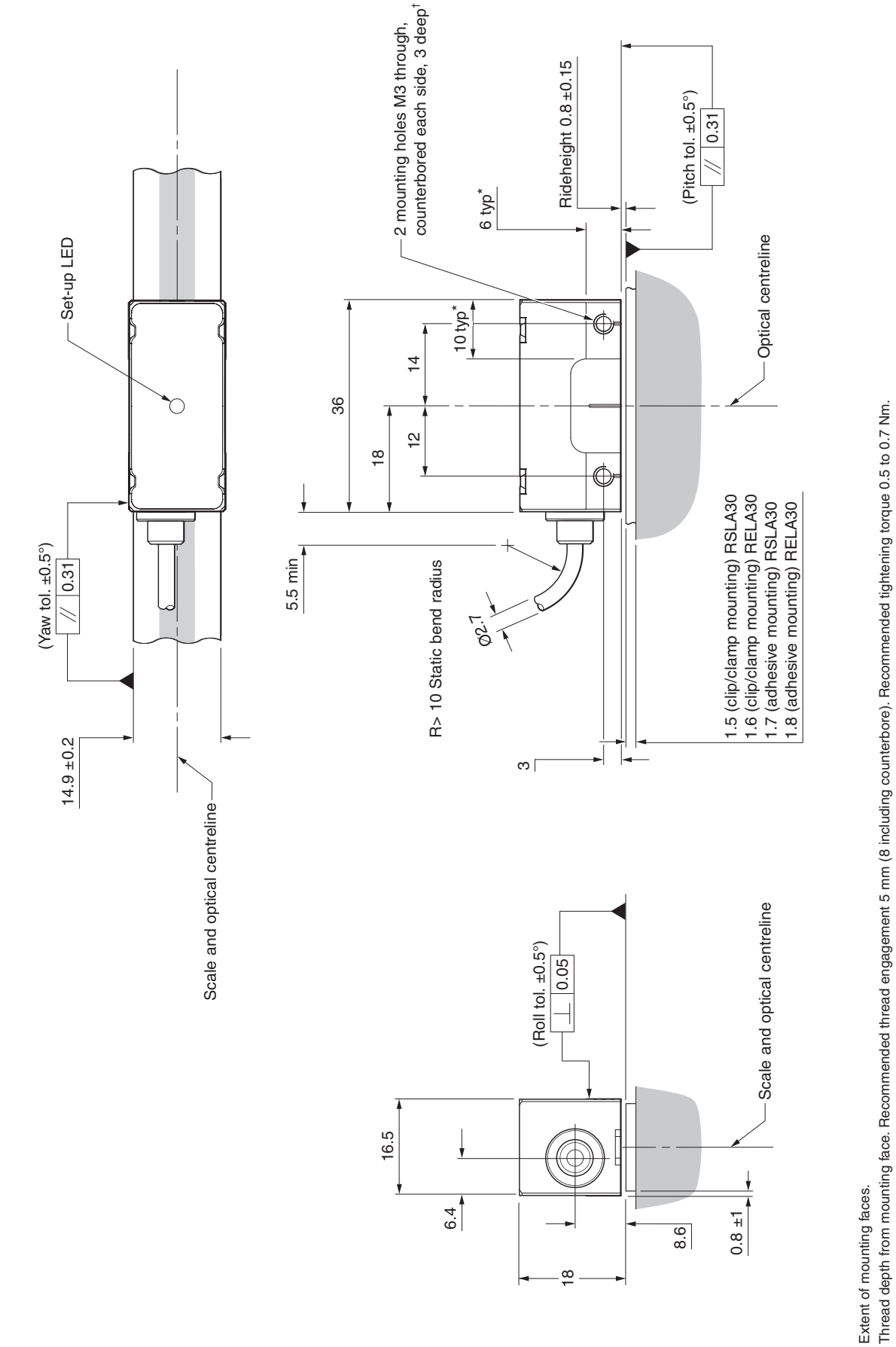
RESOLUTE UHV readhead installation drawing (on RSLA30/RELA30 scale)

Dimensions and tolerances in mm



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

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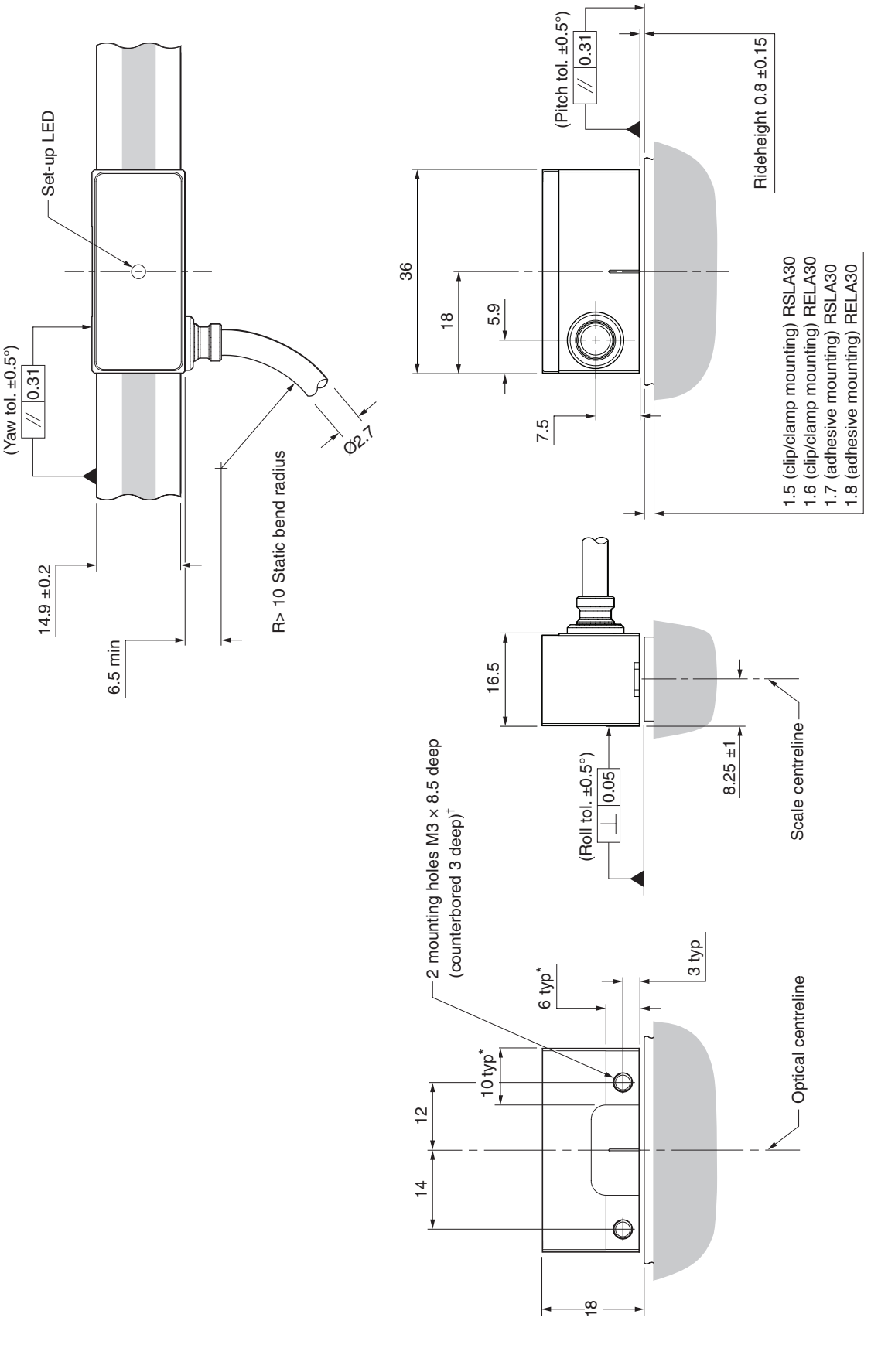
RESOLUTE readhead side exit cable installation drawing (on RSLA30/RELA30 scale)

Dimensions and tolerances in mm



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

RESOLUTE angle readhead nomenclature

RA 26B UA 052B 30 V

Series
R = RESOLUTE

Scale form
A = Angular

Protocol
18B = BiSS 18 bit
26B = BiSS 26 bit
32B = BiSS 32 bit
23P = Panasonic 23 bit
32P = Panasonic 32 bit

Mechanical option
F = Ultra High Vacuum
(stainless steel cable braid)
U = Ultra High Vacuum
(silver coated copper braid cable)

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 m
15 = 1.5 m
30 = 3 m
50 = 5 m
90 = 9 m
99 = 10 m

Termination
V = Vacuum flying lead

RESOLUTE linear readhead nomenclature

RL 32B US 001C 30 V

Series
R = RESOLUTE

Scale form
L = Linear

Protocol
26B = BiSS 26 bit
32B = BiSS 32 bit
36B = BiSS 36 bit
48P = Panasonic 48 bit

Mechanical option
F = Ultra High Vacuum
(stainless steel cable braid)
U = Ultra High Vacuum
(silver coated copper braid cable)

Gain option
T = RTLA30/RTLA30-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
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 m
15 = 1.5 m
30 = 3 m
50 = 5 m
90 = 9 m
99 = 10 m

Termination
V = Vacuum flying lead

NOTE: Not all combinations are valid. Check valid options online at www.renishaw.com/epc

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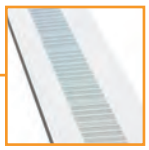
RESOLUTE UHV series compatible products:

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

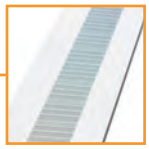
Compatible with RESOLUTE readheads showing the **ADT** mark.

RESA30 stainless steel ring

REXA30 high-accuracy stainless steel ring

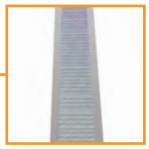


RELA30 self-adhesive or clip/clamp mounted ZeroMet spar scale



RSLA30 self-adhesive or clip/clamp mounted stainless steel spar scale

RTLA30 tape scale and *FASTRACK* carrier



RTLA30-S self-adhesive tape scale

RKLA30-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.

For worldwide contact details, visit www.renishaw.com/contact

Part no.: L-9517-9530-03-B
Issued: 12.2022

Data sheet
L-9517-9420-04-C

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RESOLUTE™ ETR (Extended Temperature Range) absolute encoder

- 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

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.

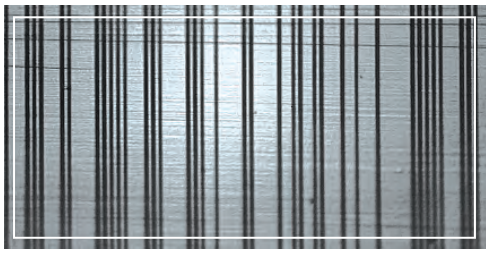
Operation down to –40 °C (–40 °F) in non-condensing environments is guaranteed, making this product suitable for use in applications such as telescopes, scientific research, military and aerospace. The encoder is also tough enough to survive the physical punishment of harsh environments, with high vibration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

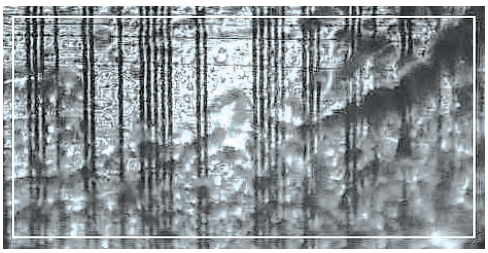
The RESOLUTE encoder system ensures reliability with excellent dirt immunity and a built-in separate position-checking algorithm, which actively checks every reading.

System features

Unique single-track absolute optical scale

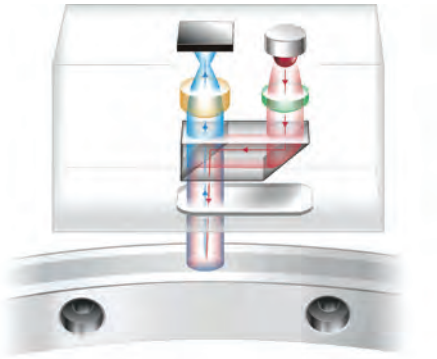
- Absolute position is determined immediately upon switch-on
- No battery back-up
- No yaw de-phasing unlike multiple-track systems
- Fine pitch (30 µm nominal period) optical scale for superior motion control compared to inductive, magnetic or other non-contact optical absolute encoders
- High-accuracy 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

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:

Resolution	Counts per revolution	Arc second
18 bit	262 144	≈ 4.94
26 bit	67 108 864	≈ 0.019
32 bit	4 294 967 296	≈ 0.00030

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

Speed and accuracy

RESA30 diameter (mm)	Maximum reading speed (rev/min)	Typical installed accuracy (arc second)*
52	18 000	±12.7
57	18 000	±11.8
75	12 500	±9.5
100	9 500	±7.5
103	9 250	±7.4
104	9 000	±7.3
115	8 250	±6.8
150	6 000	±5.5
200	4 750	±4.3
206	4 600	±4.2
209	4 500	±4.2
229	4 150	±3.9
255	3 700	±3.6
300	3 150	±3.1
350	2 700	±2.8
413	2 300	±2.4
417	2 250	±2.4
489	1 950	±2.1
550	1 700	±1.9

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

* 'Typical' installations are a result of graduation and installation errors combining and, to some magnitude, cancelling.

Rotary scale specifications

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

Material	303/304 stainless steel
Coefficient of thermal expansion (at 20 °C)	15 ±0.5 µm/m/°C

General specifications

Power supply	5 V ±10%	1.25 W maximum (250 mA @ 5 V) **NOTE:** 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.
	Ripple	200 mVpp maximum @ frequency up to 500 kHz maximum
Temperature	Storage	–40 °C to +80 °C
Humidity		95% relative humidity (non-condensing) to IEC 60068-2-78
Sealing		IP64
Acceleration (readhead)	Operating	
	(–40 °C to 0 °C)	300 m/s², 3 axes
	(0 °C to 80 °C)	500 m/s², 3 axes
Shock (readhead)	Non-operating	1000 m/s², 6 ms, ½ sine, 3 axes
Maximum acceleration of scale with respect to readhead		2000 m/s² **NOTE:** 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.
Vibration	Operating	300 m/s² max @ 55 Hz to 2000 Hz, 3 axes Random vibration 0.175 g²/Hz ASD 20-1000 Hz, –6dB roll off 1-2 kHz
Mass	Readhead	18 g
	Cable	32 g/m
Cable		7 core, tinned and annealed copper, 28 AWG Single-shielded, outside diameter 4.7 ±0.2 mm Flex life > 40 × 10⁶ cycles at 20 mm bend radius **NOTE:** Cable must be held static for operation below 0 °C UL recognised component
Communication format		RS485/RS422 differential line-driven signal

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.

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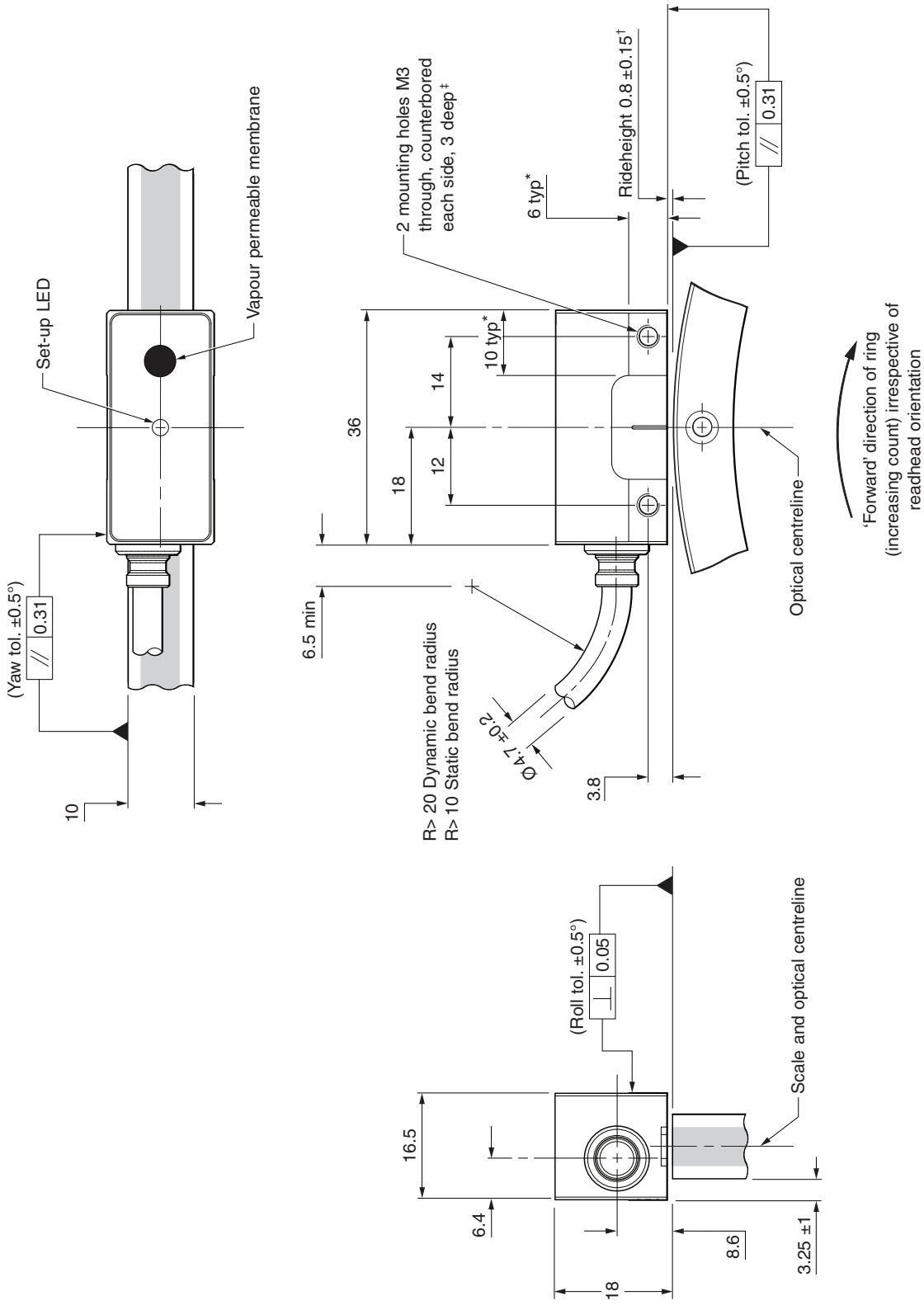
RESOLUTE readhead installation drawing (on RESA30 ring)

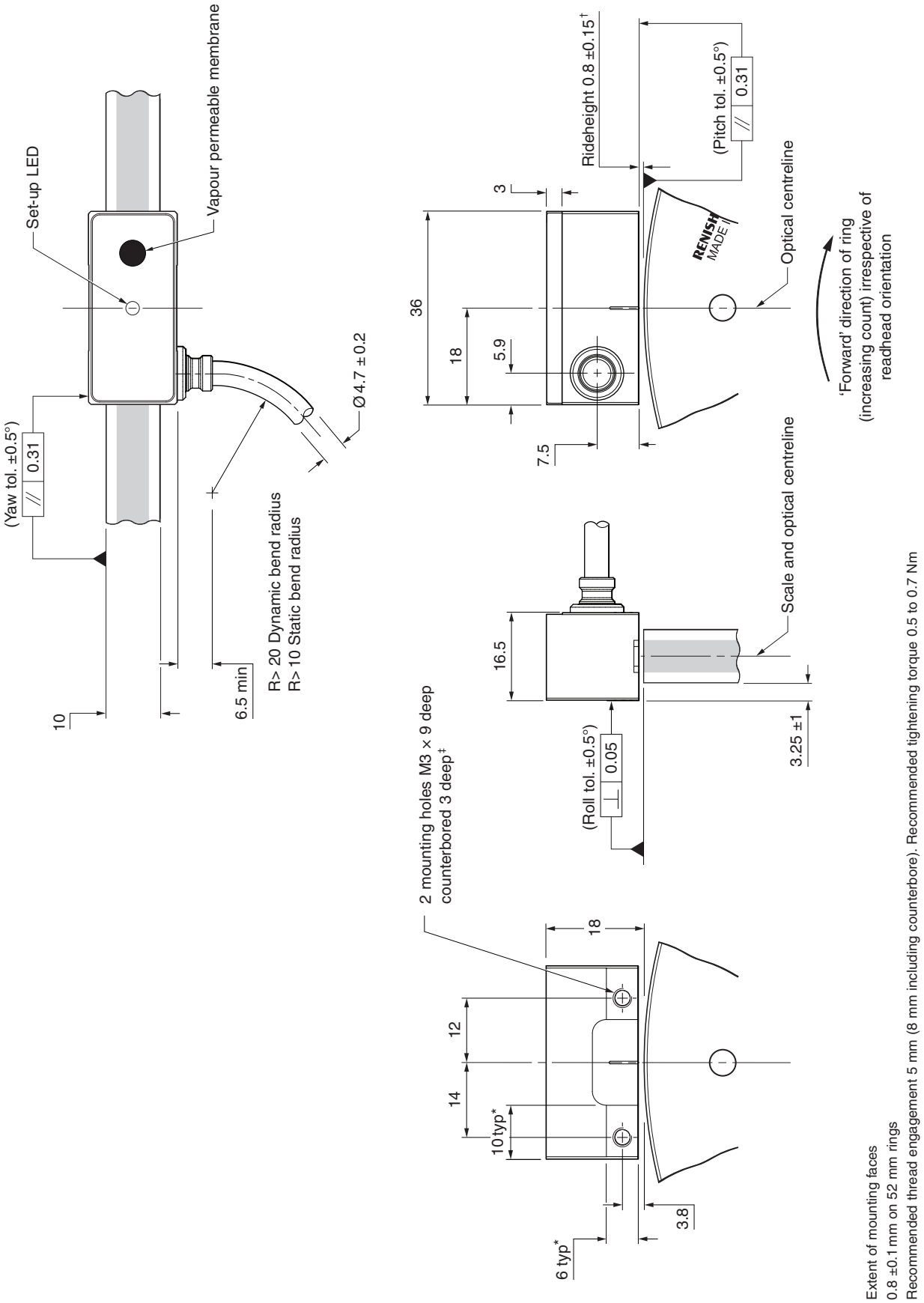
Dimensions and tolerances in mm



* 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



* 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 angle readhead nomenclature

RA 26B TA 052B 30 A

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 (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 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)

NOTES:

- Not all combinations are valid. Check valid options online at www.renishaw.com/epc
- Contact your local Renishaw representative if you have specific ETR requirements.

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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.

For worldwide contact details, visit www.renishaw.com/contact

Part no.: L-9517-9420-04-C
Issued: 12.2022

Data sheet
L-9517-9884-02-B

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BiSS® Safety for RESOLUTE™ and FORTiS™ encoders

www.renishaw.com/functional-safety

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About Renishaw encoders with BiSS® interface

Renishaw BiSS encoders have options to use the C-mode (unidirectional) BiSS serial interface, (**www.renishaw.com/biss-protocol-support**), or BiSS Safety serial interface. This datasheet describes BiSS Safety interface.

- RESOLUTE rotary encoders are single-turn (with 2^n counts per revolution and no revolution counting).
- RESOLUTE and FORTiS linear encoders are available with a range of different resolutions (and maximum measuring lengths) as specified on the product data sheet.

More information on BiSS serial interfaces is available on the BiSS website: **www.biss-interface.com**.

Description of the BiSS Safety interface

BiSS Safety is a fast synchronous serial interface for acquiring position data from an encoder in applications requiring Functional Safety. RESOLUTE FS and FORTiS FS use BiSS Safety communications and are certified to the following Functional Safety standards:

- ISO 13849 Category 3 PLd
- IEC 61508 SIL2
- IEC 61800-5-2 SIL2

BiSS Safety is a master-slave interface. The master controls the timing of position acquisition and the data transmission speed, and the encoder is the slave. The interface consists of two unidirectional differential pairs of lines:

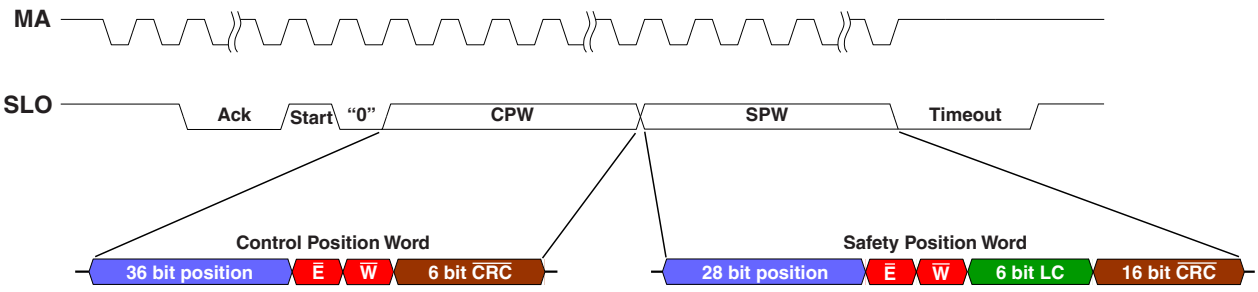
- MA transmits position acquisition requests and timing information (clock) from master to encoder.
- SLO transfers position data from encoder to master, synchronised to MA.

The diagram below shows the data transmitted.

The master-slave signal communication format is RS485/RS422 differential line-driven.

Data format

Example shown for 36 bit control position word (CPW):



A typical request cycle proceeds as follows:

1. When idle, the master holds MA high. The encoder indicates it is ready by holding SLO high.
2. The master requests position acquisition by starting to transmit clock pulses on MA.
3. The encoder responds by setting SLO low on the second rising edge on MA.
4. After the Ack period is complete, the encoder transmits data to the master synchronised with the clock as shown on page 2.
5. When all data has been transferred, the master stops the clock and sets MA high.
6. If the encoder is not yet ready for the next request cycle, it sets SLO low (the Timeout period).
7. When the encoder is ready for the next request cycle, it indicates this to the master by setting SLO high.

Description of data

Ack

This is the period during which the readhead calculates the absolute position. See the timing information table on page 5.

Start and “0” (1 bit each)

The encoder transmits the start bit to signal to the master that it is starting to transmit data. The start bit is always high and the “0” bit is always low.

Control position word (CPW)

The control position word (CPW) is used for motor control, has high resolution and is protected against transmission errors with a standard 6 bit CRC (HD = 3). The control position word comprises:

- **Position (28, 32 or 36 bits)**

  The absolute position data is sent MSB first in binary format. For linear encoders, the LSB is equivalent to one unit of resolution of the encoder, as specified in the data sheet. Lower resolutions may be achieved by ignoring the least significant bit(s) of the position data.

- **Error (1 bit)**

  The error bit is active low: “1” indicates that the transmitted position information has been verified by the readhead’s internal safety checking algorithm and is correct; “0” indicates that the internal check has failed and the position information should not be trusted. The error bit is also set to “0” if the temperature exceeds the maximum specified for the product. The operating temperature limits of Renishaw encoders are specified in the product data sheets.

- **Warning (1 bit)**

  The warning bit is active low: “0” indicates that the encoder scale (and/or reading window) should be cleaned.

  NOTE: The warning bit is not an indication of the trustworthiness of the position data. Only the error bit should be used for this purpose.

- **CRC for position data (6 bit)**

  The CRC polynomial for position, error and warning data is: 0x43. The CRC start value is 0x00. It is transmitted MSB first and inverted. The start bit and “0” bit are omitted from the CRC calculation.

Safety position word (SPW)

The safety position word (SPW) is strongly protected with a safety capable 16 bit CRC (HD = 6). The SPW brings an additional integrated 6 bit sign-of-life counter to detect missing or reordered position values. The SPW may have lower resolution than the control word. The purpose of the SPW is to ensure the validity of the control word. The safety position word comprises:

- **Position (24, 28 or 32 bits)**

  The absolute position data is sent MSB first in binary format. The position data in SPW in linear applications is shorter than the position data in CPW, so the resolution of the SPW is also lower (for 28 bit CPW and 24 bit SPW, it is 16 times lower; for 36 bit CPW and 28 bit SPW, it is 256 times lower).

- **Error (1 bit)**

  The error bit is active low: “1” indicates that the transmitted position information has been verified by the readhead’s internal safety checking algorithm and is correct; “0” indicates that the internal check has failed and the position information should not be trusted. The error bit is also set to “0” if the temperature exceeds the maximum specified for the product. The operating temperature limits of Renishaw encoders are specified in the product data sheets.

- **Warning (1 bit)**

  The warning bit is active low: “0” indicates that the encoder scale (and/or reading window) should be cleaned.

  NOTE: The warning bit is not an indication of the trustworthiness of the position data. Only the error bit should be used for this purpose.

- **LC Sign-of-Life (6 bit)**

  The sign-of-life counter represents a uniquely consecutive number within 63 SCD frames. The sign-of-life counter with its consecutive number can be used to detect unwanted repetition, wrong sequencing, loss and insertion. The sign-of-life counter's first value will be 0x01 and once the maximum value of 0x3F (decimal value = 63) is reached, the counter rolls over to 0x01.

- **CRC for position data (16 bit)**

  The SPW CRC polynomial is: 0x190D9. The CRC start value is 0x00. It is transmitted MSB first and inverted.

		Control position word (CPW)				Safety position word (SPW)			
Encoder type	**BiSS Safety configuration type** [1]	**Resolution of position**	**Number of position bits**	**CRC length**	**CRC polynomial**	**Resolution of position**	**Number of position bits**	**CRC length**	**CRC polynomial**
RESOLUTE rotary	LMM	0.0003 arc seconds	32	6 bits	0x43	0.0003 arc seconds	32	16 bits	0x190D9
RESOLUTE linear	RSM	50 nm	28	6 bits	0x43	800 nm	24	16 bits	0x190D9
RESOLUTE linear	RSH	1 nm	36	6 bits	0x43	256 nm	28	16 bits	0x190D9
FORTiS linear	RSH	10 nm	36	6 bits	0x43	2560 nm	28	16 bits	0x190D9
FORTiS linear	RSH	1 nm	36	6 bits	0x43	256 nm	28	16 bits	0x190D9

Timeout

RESOLUTE and FORTiS encoders are capable of acquiring a new position reading every 31.25 µs (a maximum request cycle rate of 32 kHz). Therefore 31.25 µs must elapse between the start of one request cycle and the start of the next. However, it is possible for data transmission to be complete before 31.25 µs have elapsed. In this case, the encoder signals this to the master by holding the SLO line low until 31.25 µs have elapsed. This is the timeout period.

[1] BiSS Safety configuration types are defined in the BiSS Safety concept document from iC-Haus.

Line-delay compensation

Signals travelling between master and encoder experience a time delay due to the cable length and signal propagation delays within the master and encoder. The time delay has no effect at low clock speeds (where the time delay is much shorter than the clock period). However, for high clock speeds, it is necessary for the master to implement line-delay compensation.

The master determines the round-trip time delay by measuring the time between transmitting the second rising edge on MA and receiving the falling edge of Ack on SLO.

MA clock speed	Maximum cable length	
	Without line-delay compensation	With line-delay compensation
250 kHz	95 m	100 m
1 MHz	20 m	100 m
2 MHz	8 m	100 m
5 MHz	0.5 m	100 m
10 MHz	-	50 m

NOTES: All figures relate to installations using original Renishaw readhead and extension cables. See the relevant product data sheet for details of options and limitations.

Care should be taken to ensure supply voltage is maintained within 5 V ±10% at the readhead connector.

Great care should be taken with cables to ensure signal integrity. For cable lengths greater than 50 m, contact Renishaw for recommendations.

This table makes no allowance for propagation delays within the master.

Timing information

	Minimum	Typical	Maximum	Units	Notes
Ack time	-	-	16	µs	The Ack period always ends on a rising edge of MA. Therefore at low MA clock frequencies, the Ack time may exceed 16 µs.
MA clock frequency	0.25	-	10	MHz	Within any one request cycle, the MA clock frequency must be constant. The duty cycle should be 1:1.
Request cycle rate	-	-	32	kHz	32 kHz is not achievable for all MA clock frequencies (because data transmission takes too long).
Sampling moment	3.225	3.250	3.275	µs	Timed from the first rising edge on MA.
RESOLUTE/FORTiS internal line-delay	-	-	42.5	ns	This is the internal propagation delay (MA-SLO) within RESOLUTE/FORTiS encoders.
Line-delay due to cable length	-	10	-	ns/m	This is the round-trip delay experienced by signal travelling through the cable (that is, from master to encoder and back to master again).

For information on the actions required for safe integration of the RESOLUTE or FORTiS Functional Safety encoder with BiSS Safety into a functionally safe system, refer to the product installation guide and safety manual.

IMPORTANT: Failure to follow the correct use instructions and heed the limitations may result in SIL2 and/or PLd not being achieved and will invalidate the Functional Safety certification.

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Part no.: L-9517-9884-02-B
Issued: 05.2023

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BiSS® C-mode (unidirectional) for RESOLUTE™ and FORTiS™ encoders

About Renishaw encoders with BiSS interface

Renishaw BiSS encoders have options to use the C-mode (unidirectional) BiSS serial interface, (**www.renishaw.com/biss-protocol-support**).

- RESOLUTE rotary encoders are single-turn (with 2^n counts per revolution and no revolution counting).
- RESOLUTE and FORTiS linear encoders are available with a range of different resolutions (and maximum measuring lengths) as specified on the product data sheet.

More information on BiSS serial interfaces is available on the BiSS website: **www.biss-interface.com**.

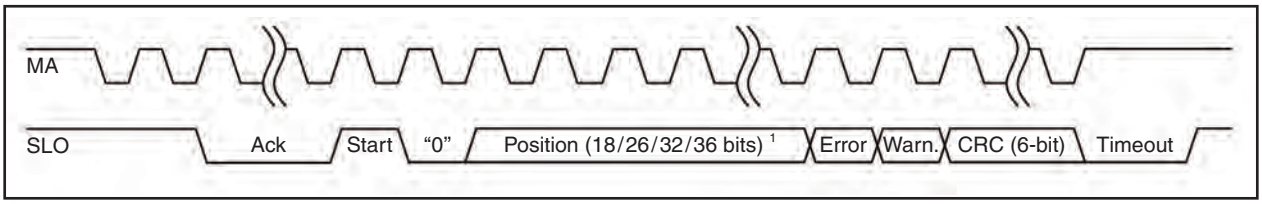
Description of the BiSS interface

BiSS C-mode (unidirectional) is a fast synchronous serial interface for acquiring position data from an encoder. It is a master-slave interface. The master controls the timing of position acquisition and the data transmission speed, and the encoder is the slave. The interface consists of two unidirectional differential pairs of lines:

- MA transmits position acquisition requests and timing information (clock) from master to encoder.
- SLO transfers position data from encoder to master, synchronised to MA.

The diagram below shows the data transmitted.

Data format



The master-slave signal communication format is RS485/RS422 differential line-driven.

[1] For limitations on position word length on FORTiS encoders, please see “Position” under the section headed “Description of data”.

A typical request cycle proceeds as follows:

1. When idle, the master holds MA high. The encoder indicates it is ready by holding SLO high.
2. The master requests position acquisition by starting to transmit clock pulses on MA.
3. The encoder responds by setting SLO low on the second rising edge on MA.
4. After the Ack period is complete, the encoder transmits data to the master synchronised with the clock as shown above.
5. When all data has been transferred, the master stops the clock and sets MA high.
6. If the encoder is not yet ready for the next request cycle, it sets SLO low (the Timeout period).
7. When the encoder is ready for the next request cycle, it indicates this to the master by setting SLO high.

Description of data

Ack

This is the period during which the readhead calculates the absolute position. See the timing information table on the next page.

Start and “0” (1 bit each)

The encoder transmits the start bit to signal to the master that it is starting to transmit data. The start bit is always high and the “0” bit is always low.

Position (18, 26, 32 or 36 bits)

The absolute position data is sent MSB first in binary format. For rotary encoders, there are exactly 2^n counts per revolution, after which the count “wraps around” to zero. Lower resolutions may be achieved by ignoring the least significant bit(s) of the position data.

For FORTiS encoders, the standard position word length is 36 bits and this should be used whenever possible. For special requirements, 26 bit word length is available with 50 nm resolution, and 32 bit word length is available with 10 nm resolution.

Error (1 bit)

The error bit is active low: “1” indicates that the transmitted position information has been verified by the readhead’s internal safety checking algorithm and is correct; “0” indicates that the internal check has failed and the position information should not be trusted. The error bit is also set to “0” if the temperature exceeds the maximum specified for the product. The operating temperature limits of RESOLUTE and FORTiS systems are specified in the product data sheets.

Warning (1 bit)

The warning bit is active low: “0” indicates that the encoder scale (and / or reading window) should be cleaned.

NOTE: The warning bit is not an indication of the trustworthiness of the position data. Only the error bit should be used for this purpose.

CRC for position data (6 bit)

The CRC polynomial for position, error and warning data is: $x^6 + x^1 + x^0$. The CRC start value is 0x00. It is transmitted MSB first and inverted. The start bit and “0” bit are omitted from the CRC calculation.

Timeout

RESOLUTE and FORTiS encoders are capable of acquiring a new position reading every 31.25 µs (a maximum request cycle rate of 32 kHz). Therefore 31.25 µs must elapse between the start of one request cycle and the start of the next. However, it is possible for data transmission to be complete before 31.25 µs have elapsed. In this case, the encoder signals this to the master by holding the SLO line low until 31.25 µs have elapsed. This is the timeout period.

Resetting the encoder

The master may reset the encoder at any time during a request cycle by stopping the clock and setting MA high. MA must be held high for the remaining duration of the full request cycle, including timeout period if applicable.

NOTE: SLO may be high or low during resetting (typically depending on the state of the last bit transmitted).

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Line delay compensation

Signals travelling between master and encoder experience a time delay due to the cable length and signal propagation delays within the master and encoder. The time delay has no effect at low clock speeds (where the time delay is much shorter than the clock period). However, for high clock speeds, it is necessary for the master to implement line delay compensation.

The master determines the round-trip time delay by measuring the time between transmitting the second rising edge on MA and receiving the falling edge of “Ack” on SLO.

MA clock speed	Maximum cable length	
	Without line-delay compensation	With line-delay compensation
250 kHz	95 m	100 m
1 MHz	20 m	100 m
2 MHz	8 m	100 m
5 MHz	0.5 m	100 m
10 MHz	-	50 m

NOTES:

- All figures relate to installations using either:
  - RESOLUTE readhead with original Renishaw cable up to 10 m in length, with the remainder cable length consisting of Renishaw approved extension cable or,
  - FORTiS encoder with original Renishaw cables as specified in the ‘Cables for FORTiS™ absolute encoders’ data sheet (Renishaw part no. L-9517-0069).
- Care should be taken to ensure supply voltage is maintained within 5 V ±10% at the readhead connector. For FORTiS encoders, the restrictions detailed in the section “Maximum cable lengths” in the ‘Cables for FORTiS™ absolute encoders’ data sheet (Renishaw part no. L-9517-0069) must be followed.
- This table makes no allowance for propagation delays within the master.

Timing information

	Minimum	Typical	Maximum	Units	Notes
Ack time	-	-	16	µs	The Ack period always ends on a rising edge of MA. Therefore at low MA clock frequencies, the Ack time may exceed 16 µs.
MA clock frequency	0.25	-	10	MHz	Within any one request cycle, the MA clock frequency must be constant. The duty cycle should be 1:1.
Request cycle rate	-	-	32	kHz	32 kHz is not achievable for all MA clock frequencies (because data transmission takes too long).
Sampling moment	3.225	3.250	3.275	µs	Timed from the first rising edge on MA.
RESOLUTE/FORTiS internal line-delay	-	-	42.5	ns	This is the internal propagation delay (MA-SLO) within RESOLUTE and FORTiS encoders.
Line-delay due to cable length	-	10	-	ns/m	This is the round-trip delay experienced by signal travelling through the cable (that is, from master to encoder and back to master again).

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Part no.: L-9709-9005-05-A
Issued: 06.2023

Data sheet
L-9517-9418-07-A

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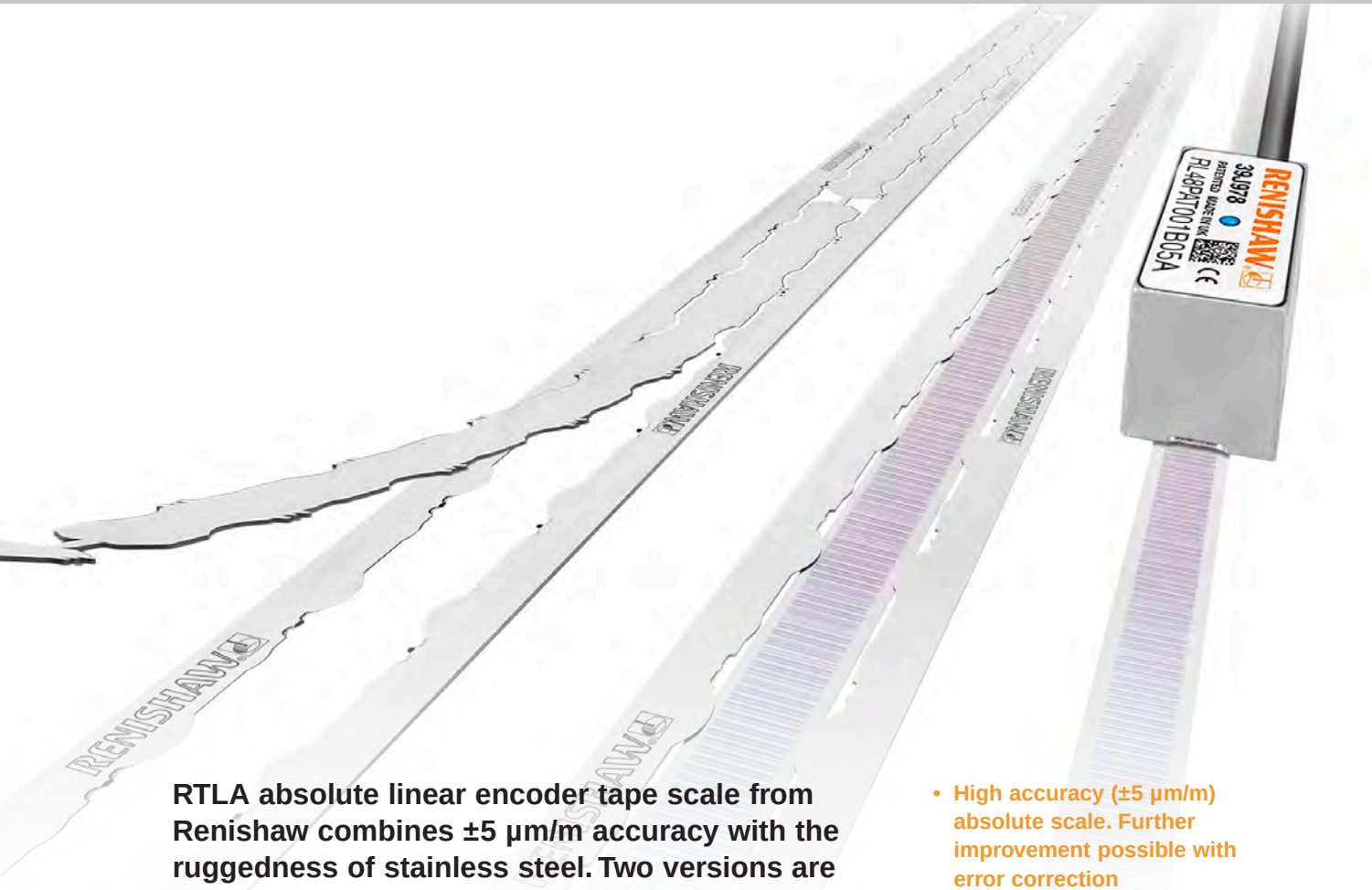
RTLA high accuracy absolute linear encoder scale system



RTLA absolute linear encoder tape scale from Renishaw combines ±5 µm/m accuracy with the ruggedness of stainless steel. Two versions are available: self-adhesive RTLA-S and RTLA for use with the revolutionary *FASTRACK*™ track system from Renishaw.

Designed for applications that demand high-accuracy and an independent expansion coefficient with tape scale convenience, RTLA-S and RTLA are read by Renishaw's ground-breaking RESOLUTE™ absolute readhead. 1 nm resolution, 100 m/s maximum speed, ultra low SDE and jitter result in a linear encoder system that outperforms any other encoder in its class.

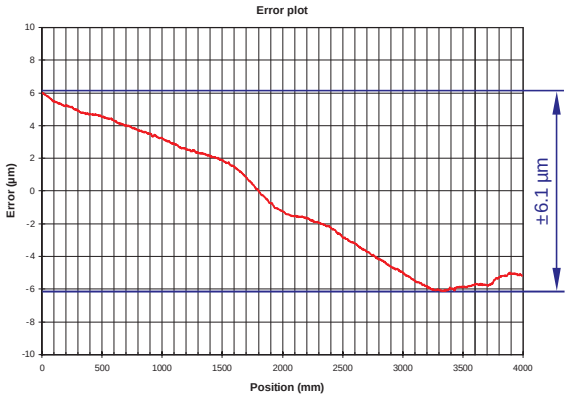
RTLA-S is laid onto the substrate using its self-adhesive backing tape. A patented application tool makes this a quick, simple and inexpensive process. A clamp is fitted at a single point to lock the scale to the substrate.

RTLA (without self-adhesive) is used with *FASTRACK*. In this case, the scale is held securely in place by two miniature, yet rugged, guide rails. Again, the scale is clamped in a single point to allow independent expansion with extremely low hysteresis, even over wide temperature ranges. If damaged, the scale can be pulled out of the guide rails and quickly replaced, even where access is limited, thus reducing machine downtime. This feature also makes the new linear encoder system ideal for large machines that need to be sectioned for transportation.

RTLA-S and RTLA with *FASTRACK* are suitable for many applications, including FPD manufacturing and inspection machines, P-V manufacturing, linear motors with aluminium substrates, axes that are exposed to potential damage, large CMMs and other machines that require the scale to be installed/removed for transit, or simply for any application where thermal expansion of the scale must be independent of the machine structure.

- **High accuracy (±5 µm/m) absolute scale. Further improvement possible with error correction**
- **Compatible with RESOLUTE absolute readheads**
- **RTLA scale expands at its own low thermal coefficient (10.1 ± 0.2 µm/m/°C@20°C)**
- **Use with *FASTRACK* for very low hysteresis**
- ***FASTRACK* guide rails are pre-aligned in reels for cut-to-suit flexibility**
- **Quick installation. *FASTRACK* adds fast scale replacement capability**
- **Scale can be locked to the substrate at a single datum point anywhere along the axis**
- **RTLA scale can bridge gaps in the *FASTRACK* of up to 25 mm**
- **High solvent immunity**

System features



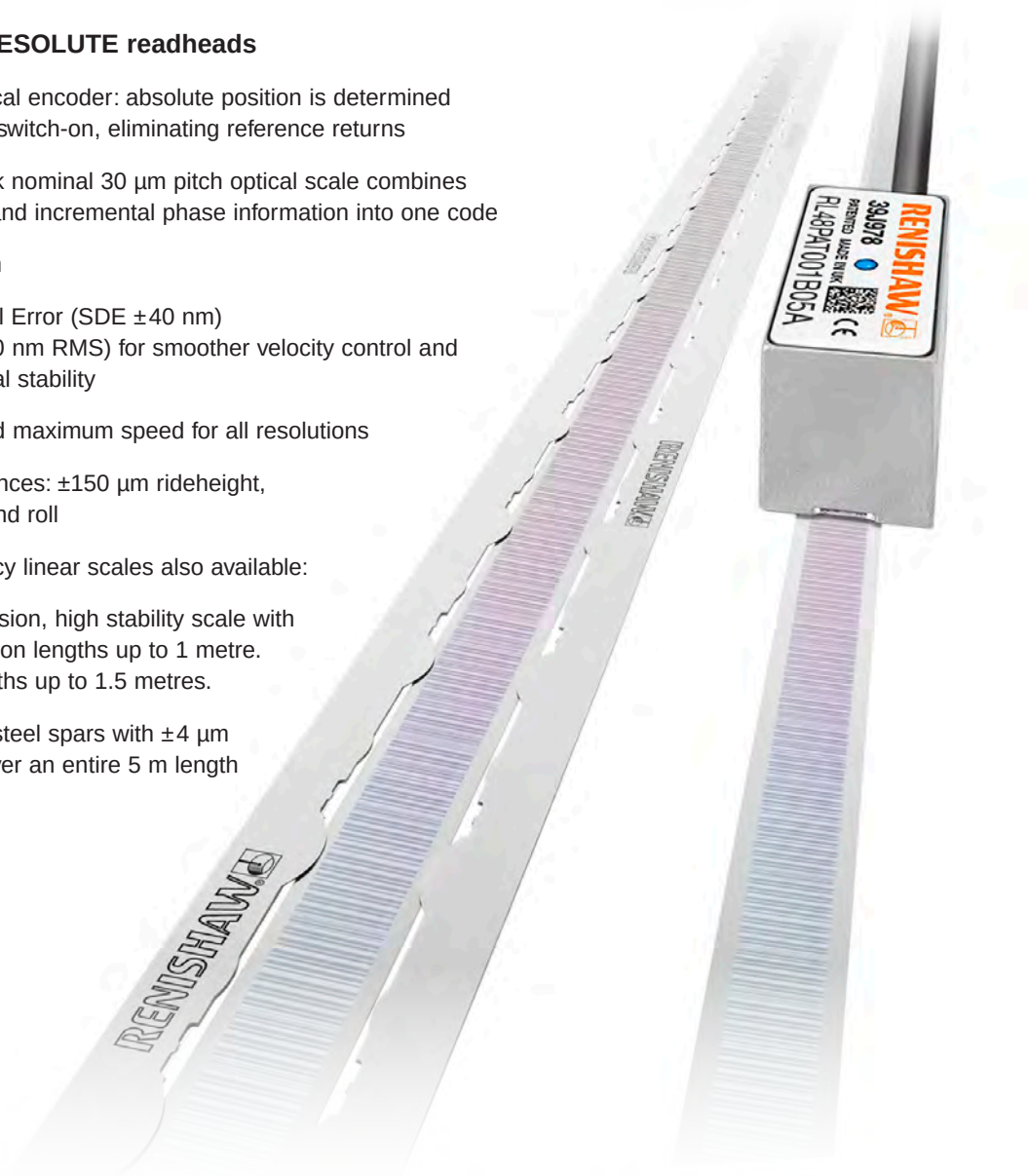
Example accuracy test result of 4000 mm length of RTLA scale

High accuracy RTLA and RTLA-S scale

- ±5 µm/m accuracy@20 °C, including slope and linearity. Further improvement possible with error correction
- Hardened stainless steel construction is rugged and reliable, with high scratch and solvent resistance
- Independent expansion coefficient (10.1 ±0.2 µm/m/°C @20 °C)
- Very low hysteresis: sub-micron on a centre-clamped 2 m axis over the entire operating temperature range, for example
- Nominal 30 µm absolute graduations
- Scale can be cut to length using a guillotine for easy customisation
- Track mounted using the revolutionary new *FASTRACK* or self-adhesive mounted (RTLA-S)

Compatible with RESOLUTE readheads

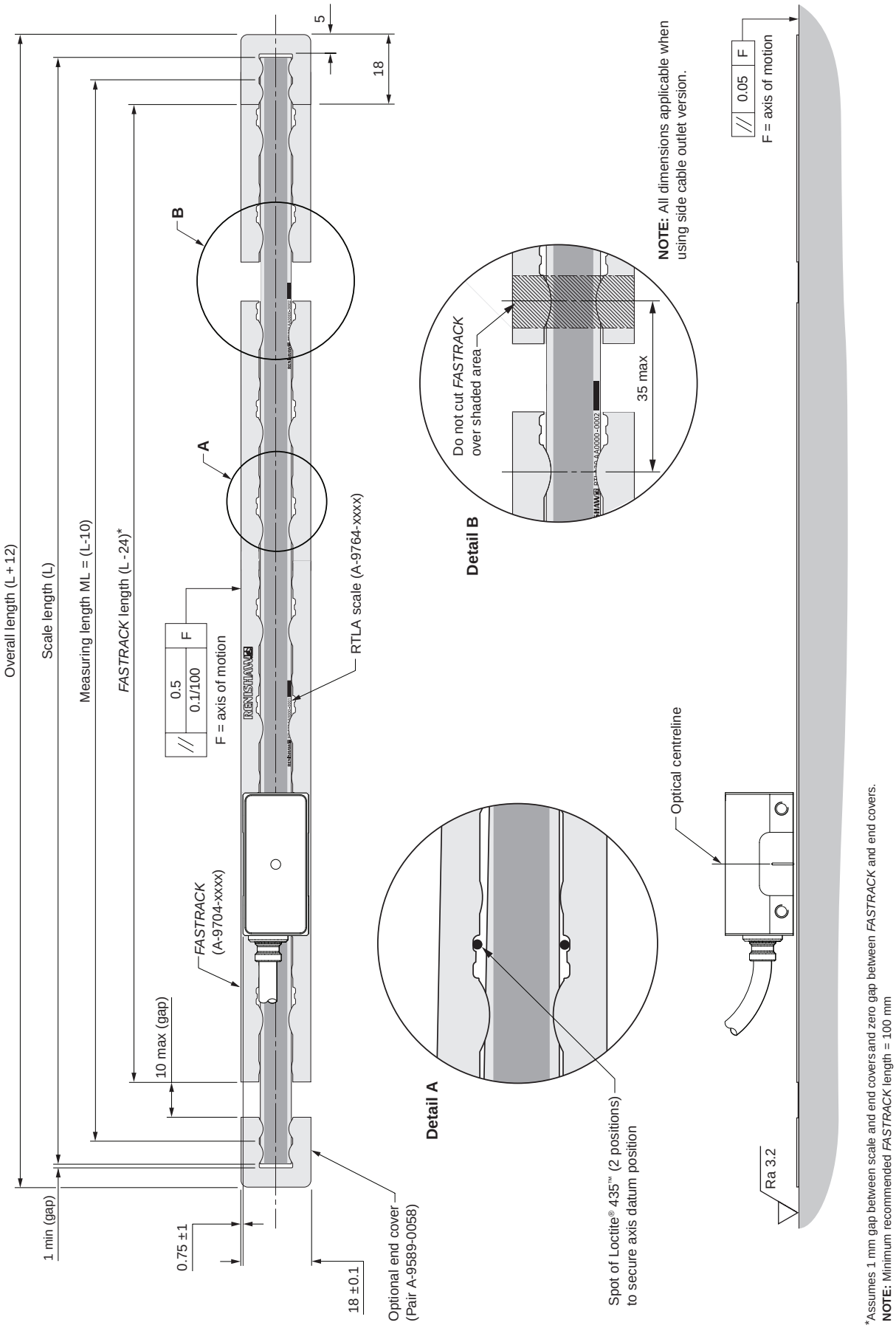
- True absolute optical encoder: absolute position is determined immediately upon switch-on, eliminating reference returns
- Unique single track nominal 30 µm pitch optical scale combines absolute position and incremental phase information into one code
- Resolution to 1 nm
- Low Sub-Divisional Error (SDE ±40 nm) and low jitter (to 10 nm RMS) for smoother velocity control and rock-solid positional stability
- 100 metres/second maximum speed for all resolutions
- Wide set-up tolerances: ±150 µm rideheight, ±0.5° yaw, pitch and roll
- Other high-accuracy linear scales also available:
  - RELA low expansion, high stability scale with ±1 µm accuracy on lengths up to 1 metre. Available in lengths up to 1.5 metres.
  - RSLA stainless steel spars with ±4 µm total accuracy over an entire 5 m length



RTLA with *FASTRACK* carrier installation drawing (adhesive datum clamp)

For further details, please refer to RESOLUTE RTLA and *FASTRACK* installation guide (M-9533-9134)

Dimensions and tolerances in mm

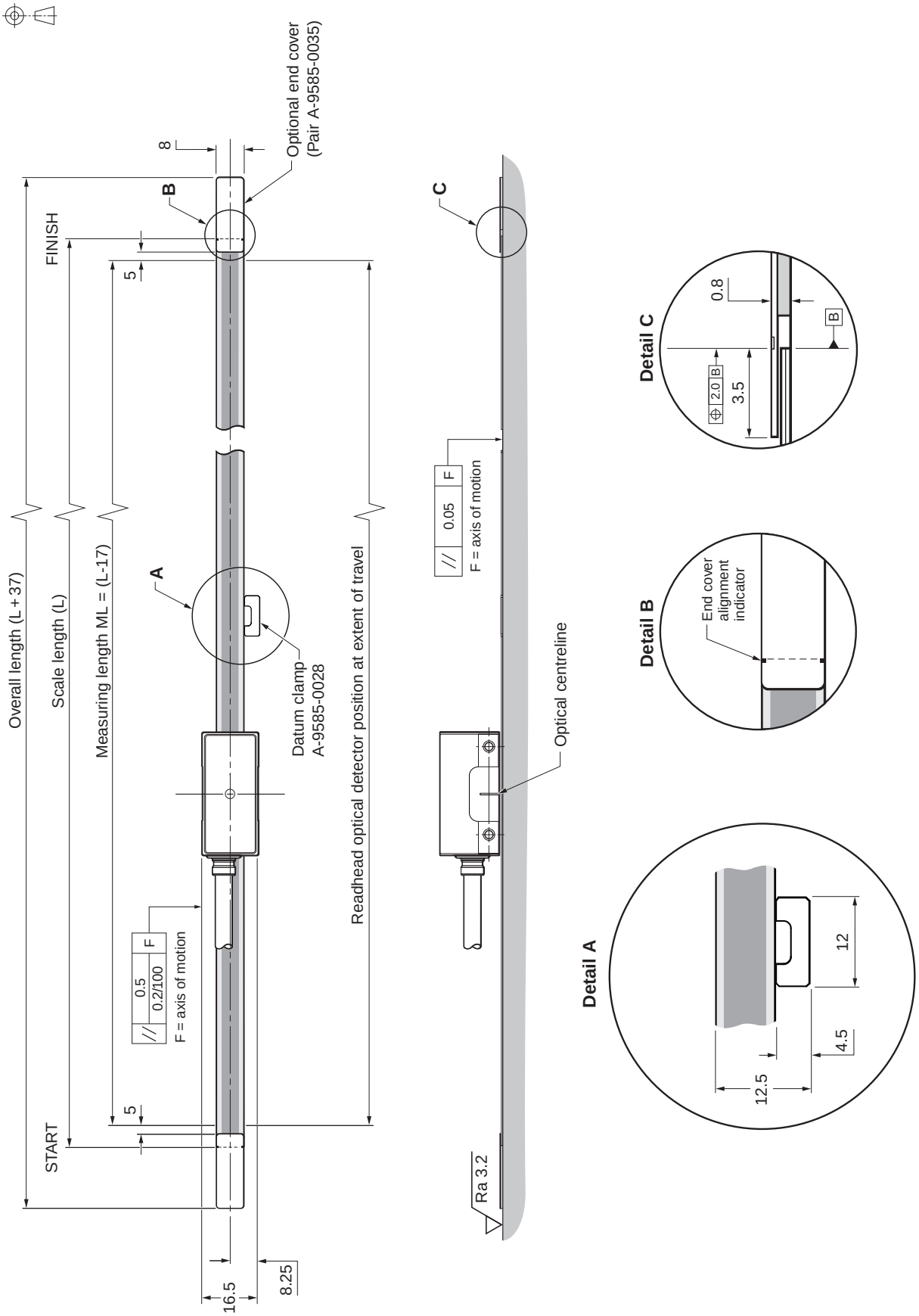


*Assumes 1 mm gap between scale and end covers and zero gap between *FASTRACK* and end covers.
NOTE: Minimum recommended *FASTRACK* length = 100 mm

RTLA-S installation drawing (mechanical datum clamp)

For further details, please refer to RESOLUTE RTLA-S installation guide (M-9553-9433)

Dimensions and tolerances in mm



RTLA-S, RTLA and *FASTRACK* specifications

Description	RTLA-S	Self-adhesive absolute high-accuracy hardened and tempered martensitic stainless steel for use with RESOLUTE readheads.
	RTLA	Absolute high-accuracy hardened and tempered martensitic stainless steel scale for use with *FASTRACK* and RESOLUTE readheads.
	FASTRACK	Hardened stainless steel guide rails with integral sacrificial spacers, with self-adhesive backing tape for easy installation
Form	RTLA-S	0.4 mm x 8 mm (H x W) including adhesive
	FASTRACK	0.4 mm x 18 mm (H x W) including adhesive
Accuracy	RTLA/RTLA-S	±5 µm/m @20 °C
Thermal expansion	RTLA/RTLA-S	10.1 ±0.2 µm/m/°C @20 °C
	FASTRACK	10.1 ±0.2 µm/m/°C @20 °C
Temperature (system)	Storage	-20 °C to +80 °C
	Operating	0 °C to +80 °C
Humidity (system)		95% maximum relative humidity (non-condensing) to EN 60068-2-78
Shock (system)	Non-operating	1000 m/s^2, 6 ms, ½ sine, 3 axes
Vibration (system)	Operating	100 m/s^2 max@55 to 2000 Hz, 3 axes
Mass	RTLA-S	12.9 g/m
	RTLA	12.2 g/m
	FASTRACK	24 g/m
Minimum recommended length	*FASTRACK*	100 mm
Maximum supplied length	RTLA-S	21 m
	RTLA	21 m
	FASTRACK	25 m

Resolution and scale lengths

RESOLUTE is available with a variety of resolutions. The choice of resolution depends on the serial protocol being used.
RESOLUTE with ***BiSS*-C** serial comms is available with 1 nm, 5 nm and 50 nm resolution options.
The maximum scale length is determind by the readhead resolution and the number of position bits in the serial word.

Resolution	Maximum scale length (m)		
	36 bit position word	32 bit position word	26 bit position word
1 nm	21	4.295	0.067
5 nm	21	21	0.336
50 nm	21	21	3.355

RESOLUTE with **Siemens DRIVE-CLiQ** serial comms is available with 1 nm and 50 nm resolution options.
The maximum scale word length is determined by the readhead resolution and the number of position bits in the serial word.

Resolution	Maximum scale length (m)	
	34 bit position word	28 bit position word
1 nm	17.18	N/A
50 nm	N/A	13.42

RESOLUTE with **Mitsubishi** serial comms is available with 1 nm and 50 nm resolution options.
The maximum scale word length is determined by the readhead resolution and the number of position bits in the serial word.

Resolution	Maximum scale length (m) with 40 bit position word
1 nm	2.1
50 nm	21

RESOLUTE with **Yaskawa** serial comms is available with 1 nm and 50 nm resolution options.
The maximum scale word length is determined by the readhead resolution and the number of position bits in the serial word.

Resolution	Maximum scale length (m) with 36 bit position word
1 nm	1.8
50 nm	21

RESOLUTE with **FANUC** serial comms is available with 1 nm and 50 nm resolution options.
For **FANUC** protocol, maximum scale length is available at all resolutions.

RESOLUTE with **Panasonic** serial comms is available with 1 nm, 50 nm and 100 nm resolution options.
For **Panasonic** protocol, maximum scale length is available at all resolutions.

Speed

For the maximum speed of the various serial protocols please refer to the relevant RESOLUTE protocol Data sheet.

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RTLA-S, RTLA and *FASTRACK* part numbers

Scale type	Length	Available in increments of:	Part number (where xxxx is the length in cm)
RTLA-S	100 mm to 21 m	10 mm	A-9763-xxxx
RTLA	100 mm to 21 m	10 mm	A-9764-xxxx
FASTRACK	100 mm to 25 m	25 mm*	A-9704-xxxx

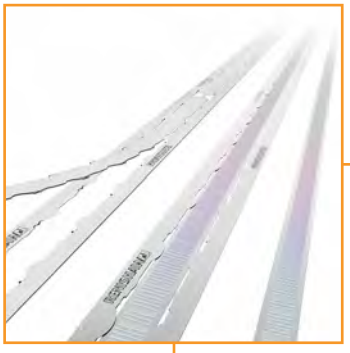
***NOTE:** Part numbers for *FASTRACK* lengths ending in 25 mm are: A-9704-xxx3
Part numbers for *FASTRACK* lengths ending in 75 mm are: A-9704-xxx8

Accessories

Datum clamp	
Adhesive datum clamp (RTLA-S only)	A-9585-0028
Adhesive for clamp (Loctite 435)	P-AD03-0012
Bolted datum clamp (*FASTRACK* only)	A-9589-0096
Setting gauge	
RTLA with *FASTRACK* 0.6 mm setting shim (red)	M-9589-0090
RTLA-S 0.8 mm setting shim (blue)	M-9517-0122
Separator kit (*FASTRACK* only)	
RTLA/RESOLUTE - centre section removal tool	A-9589-0066
End cover	
End cover kit (*FASTRACK* only)	A-9589-0058
End cover kit (RTLA-S only)	A-9585-0035
Scale/track cutting jig	
Guillotine kit	A-9589-0071

FASTRACK compatible products

***FASTRACK*/RTLA**



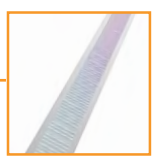
RESOLUTE

Installation guide M-9553-9134
Data sheet *BiSS* L-9517-9448
FANUC L-9517-9442
Mitsubishi L-9517-9454
Panasonic L-9517-9460
Siemens DRIVE-CLiQ L-9517-9524
Yaskawa L-9517-9436

RESOLUTE UHV

Data sheet L-9517-9530

RTLA-S



Installation guide M-9553-9433

For worldwide contact details, please visit our main website at www.renishaw.com/contact

L-9517-9418-07

Data sheet
L-9517-9918-01-D

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RKLA30 absolute linear encoder scale

RKLA30 is a robust, 6 mm wide stainless steel encoder tape scale with a thickness of 0.15 mm. This allows the scale, when rigidly fixed to a machine axis, to become 'mastered' to the machine substrate, matching its thermal expansion coefficient and behaviour. Differential movement between the scale and the machine is thus minimised, improving the metrological performance that can be achieved with simple thermal system compensation.

Designed for applications that demand high accuracy and absolute positioning, RKLA30 is read by Renishaw's RESOLUTE™ absolute readhead, which offers resolutions down to 1 nm, 100 m/s maximum speed, ultra low Sub-Divisional Error (SDE) and jitter, resulting in a linear encoder system that outperforms any other encoder in its class.

RKLA30 tape scale also combines ±5 µm/m accuracy with the mechanical and chemical ruggedness of stainless steel, easy coiling and cut-to-length convenience.

RKLA30 is installed onto the axis substrate by a self-adhesive backing tape and a simple application tool makes this a quick, straightforward and inexpensive process. The scale ends are rigidly fixed to the axis substrate by means of epoxy fastened end clamps, eliminating the need to drill holes.

- **Mastered scale matches the coefficient of thermal expansion of the substrate**
- **High accuracy (±5 µm/m) absolute scale. Further improvement possible with error correction.**
- **Narrow 6 mm wide scale suitable for confined spaces**
- **Suitable for partial arc applications**
- **'Cut-to-length' convenience**
- **Lengths up to 21 m**
- **Compatible with RESOLUTE™ absolute readheads**
- **High solvent immunity**

RKLA30 scale specifications*

Form (H × W)		0.15 mm × 6 mm including adhesive
Pitch		30 µm
Accuracy (at 20 °C)		±5 µm/m
Supplied length		20 mm to 21 m
Material		Hardened and tempered stainless steel
Mass		4.6 g/m
Coefficient of thermal expansion (at 20 °C)		Matches that of substrate material when scale ends fixed by epoxy mounted end clamps
Temperature	Storage	–20 °C to +80 °C
	Operating†	0 °C to +70 °C
	Installation	+10 °C to +35 °C
Humidity		95% relative humidity (non-condensing) to IEC 60068-2-78
Shock	Operating	500 m/s², 11 ms, ½ sine, 3 axes
Vibration	Operating	300 m/s² max @ 55 to 2000 Hz, 3 axes
End fixing		Epoxy mounted end clamps (A-9523-4015)
		Approved epoxy adhesive (A-9531-0342)
		Scale end movement typically < 1 µm up to 40 °C

* For information on partial arc applications refer to *RKL scale for partial arc applications* data sheet (Renishaw part no. L-9517-9897).

† To limit maximum tension in the scale $(CTE_{substrate} - CTE_{scale}) \times (T_{use\ extreme} - T_{install}) \leq 550$ µm/m where CTE_{scale} = ~ 10.1 µm/m/°C.

Compatible with RESOLUTE readheads

- True absolute optical encoder: absolute position is determined immediately upon switch-on, eliminating reference returns
- Single track nominal 30 µm pitch optical scale combines absolute position and incremental phase information into one code
- Resolution to 1 nm
- Low SDE (±40 nm) and low jitter (to 10 nm RMS) for smoother velocity control and rock-solid positional stability
- 100 m/s maximum speed for all resolutions
- Wide set-up tolerances: ±150 µm rideheight, ±0.5° yaw, pitch and roll
- Other high-accuracy linear scales also available:
  - RELA30 low expansion, high stability scale with ±1 µm accuracy on lengths up to 1 metre. Available in lengths up to 1.5 metres.
  - RSLA30 stainless steel spars with ±4 µm total accuracy over an entire 5 m length
  - RTLA30/RTLA30-S stainless steel tape scale with ±5 µm/m accuracy. Available in lengths up to 21 metres.

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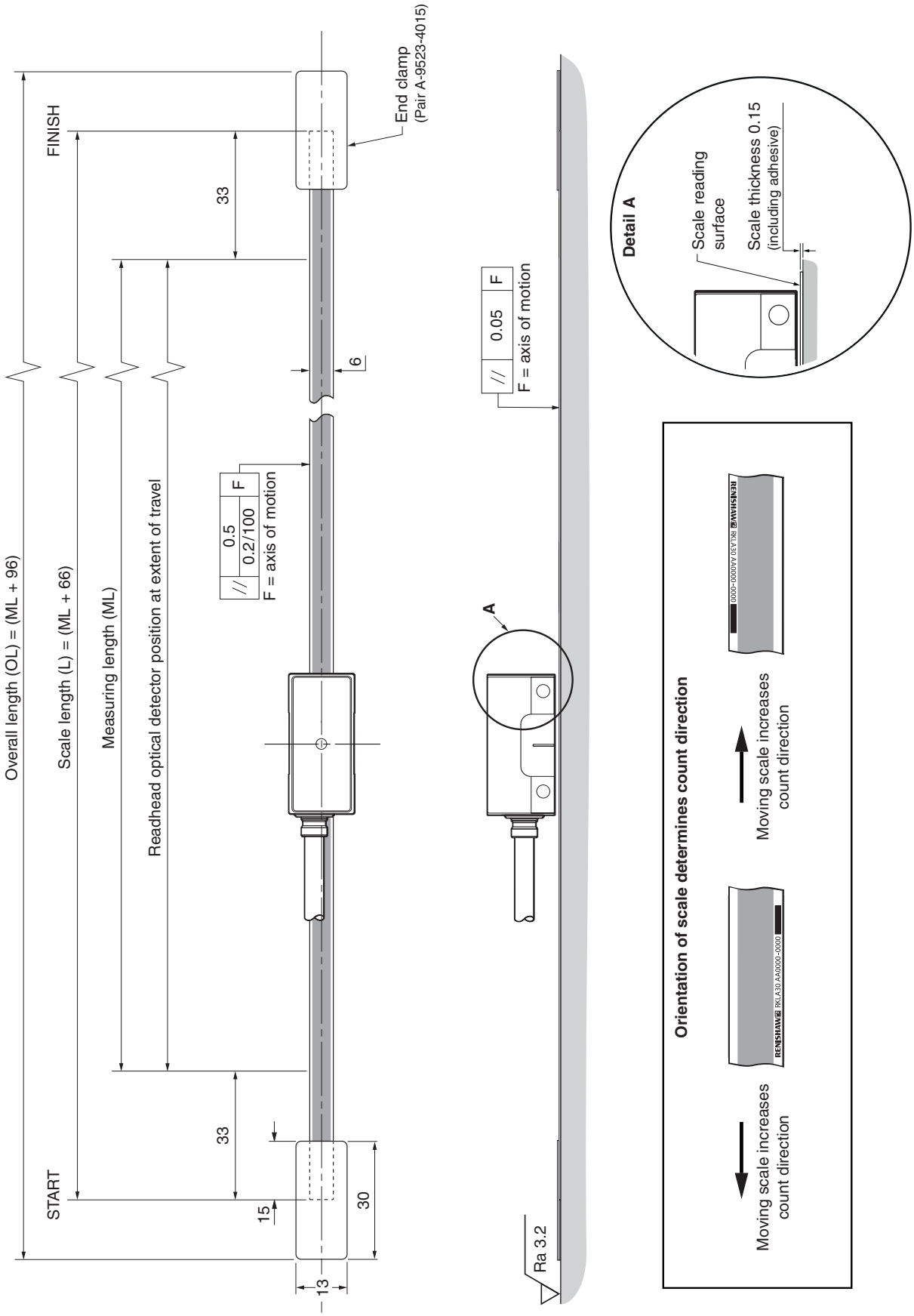
RKLA30 scale installation drawing

Dimensions and tolerances in mm



Resolution, speed and scale lengths

RESOLUTE is available with a variety of resolutions. The choice of resolution depends on the serial protocol being used.

RESOLUTE with **BiSS C** serial comms is available with 1 nm, 5 nm and 50 nm resolution options.
The maximum reading speed is 100 m/s.
The maximum scale length is determined by the readhead resolution and the number of position bits in the serial word.

Resolution	Maximum scale length (m)		
	36 position bits	32 position bits	26 position bits
1 nm	21	4.295	0.067
5 nm	21	21	0.336
50 nm	21	21	3.355

RESOLUTE with **Siemens DRIVE-CLiQ** serial comms is available with 1 nm and 50 nm resolution options.
The maximum reading speed is 100 m/s.
The maximum scale length is determined by the readhead resolution and the number of position bits in the serial word.

Resolution	Maximum scale length (m)	
	36 bit position bits	26 position bits
1 nm	17.18	-
50 nm	-	13.42

RESOLUTE with **Mitsubishi** serial comms is available with 1 nm and 50 nm resolution options.
The maximum reading speed is 100 m/s.
The maximum scale length is determined by the readhead resolution and the number of position bits in the serial word.

Resolution	Maximum scale length (m) with 40 position bits
1 nm	2.1
50 nm	21

RESOLUTE with **Yaskawa** serial comms is available with 1 nm and 50 nm resolution options.
The maximum scale length is determined by the readhead resolution and the number of position bits in the serial word.

Resolution	Maximum scale length (m) with 36 position bits	Maximum reading speed (m/s)
1 nm	1.8	3.6
50 nm	21	100

RESOLUTE with **Panasonic** serial comms is available with 1 nm, 50 nm and 100 nm resolution options.
For the **Panasonic** protocol, the maximum scale length of 21 m is available at all resolutions.

Resolution	Maximum reading speed (m/s)	
	Panasonic A5 series	Panasonic A6 series
1 nm	0.4	4
50 nm	20	100
100 nm	40	100

RESOLUTE with **FANUC** serial comms is available with 1 nm and 50 nm resolution options.
The maximum reading speed is 100 m/s.
For the **FANUC** protocol, the maximum scale length of 21 m is available at all resolutions.

RKLA30-S part numbers

Part number	Available lengths	Available in increments of	Ordering instructions
A-6667-xxxx	20 mm to 21 m	10 mm	xxxx is the length in cm. Ordering A-6667-0450, for example, will result in a length of 4500 mm.

Accessory part numbers

RKLA30 scale

Part description	Part number	Product image
Guillotine (For cutting RKLA30 scale)	A-9589-0071	
RKLA30-S side mount scale applicator	A-6547-1918	

End clamp

Part description	Part number	Product image
RGC-F End clamp kit - epoxy mounted. The RGC-F end clamps master the RKLA30 scale to the substrate material to match its thermal expansion.	A-9523-4015	
End clamp kit, epoxy mounted, narrow The end clamps master the RKLA30 scale to the substrate material to match its thermal expansion.	A-9523-4027	
RGG-2 (2 part epoxy) The RGG-2 epoxy is recommended for the mounting of end clamps.	A-9531-0342	

Setting Gauge

Part description	Part number	Product image
0.8 mm setting shim (blue)	M-9517-0122	

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Compatible products

RKLA30 scale

RESOLUTE standard readheads

For worldwide contact details, visit www.renishaw.com/contact

L-9517-9918-01

Part no.: L-9517-9918-01-D
Issued: 06.2020

Data sheet
L-9517-9897-02-A

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RKL scale for partial arc applications

Measuring a partial arc of rotation is made easy with Renishaw's flexible RKL encoder scales. The flexible nature of the small cross-sectional area of these scales allows them to be wrapped around a drum, shaft or arc with a minimum radius of 26 mm.

RKL scale is compatible with Renishaw's QUANTiC™, VIONiC™, TONiC™, ATOM DX™, ATOM™ and RESOLUTE™ readheads providing a partial arc solution for a wide range of applications.

RKL scale is installed onto the axis substrate by a self-adhesive backing tape making this a quick, straightforward and inexpensive process. The scale ends are rigidly fixed to the axis substrate by means of epoxy or epoxy fastened end clamps, eliminating the need to drill holes.

- **Small cross-sectional area making it ideal for partial arc rotation applications**
- **Suitable for external radii down to 26 mm**
- **Compatible with a wide range of Renishaw's incremental and absolute readheads**
- **20 µm, 30 µm and 40 µm pitch versions available**
- **'Cut-to-length' convenience**
- ***IN-TRAC*™ optical reference marks**
- **High solvent immunity**

www.renishaw.com/opticalencoders

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RKL partial arc scale specifications

		Incremental			Absolute
		RKLC20-S	**RKLC40-S**	**RKLF40-S**	**RKLA30-S**
Compatible readheads		VIONiC and TONiC	QUANTiC	ATOM and ATOM DX [1]	RESOLUTE
Form (height × width)		0.15 mm × 6 mm (including adhesive)			
Pitch		20 µm	40 µm	40 µm	30 µm
Accuracy (at 20 °C) (based on neutral axis)		±5 µm/m	±15 µm/m	±15 µm/m	±5 µm/m (including slope and linearity)
Linearity (at 20 °C) (based on neutral axis)		±2.5 µm/m	±3 µm/m	±3 µm/m	-
Supplied length		20 mm to 20 m (> 20 m available on request)		20 mm to 10 m (> 10 m available on request)	20 mm to 21 m
Material		Hardened and tempered stainless steel			
Mass		4.6 g/m			
Coefficient of thermal expansion (at 20 °C)		10.1 ±0.2 µm/m/°C			
Temperature	Storage	–20 °C to +80 °C			
	Operating [2]	0 °C to +70 °C			
	Installation	+10 °C to +35 °C			
Humidity		95% relative humidity (non-condensing) to IEC 60068-2-78			
Shock	Operating	500 m/s², 11 ms, ½ sine, 3 axes			
Vibration	Operating	300 m/s² maximum @ 55 to 2000 Hz, 3 axes			
Recommended end fixing	R≥ 75 mm	Epoxy mounted end clamps (A-9523-4015)			
	R≥ 26 mm	Approved epoxy adhesive (A-9531-0342)			
Minimum arc radius [3]		30 mm	26 mm	26 mm	50 mm

Reference mark [4]

RKLC20-S and RKLC40-S [5]	*IN-TRAC* reference mark, directly embedded into incremental track. Bi-directional position repeatable to unit of resolution throughout specified speed. 50 mm spacing, first reference mark 50 mm from scale end. Reference mark at mid-point of scale length for lengths < 100 mm.
RKLF40-S	Customer de-selectable auto-phase optical reference mark. Bi-directional position repeatable to unit of resolution throughout specified speed. 50 mm spacing, first reference mark 50 mm from scale end. Reference mark at mid-point of scale length for lengths < 100 mm.
RKLA30-S	No reference mark

1 40 µm ATOM and ATOM DX readhead variants only.

2 To limit the maximum tension in the scale $(CTE_{substrate} - CTE_{scale}) \times (T_{use\ extreme} - T_{install}) \leq 550$ µm/m where CTE_{scale} = ~ 10.1 µm/m/°C.

3 For smaller radii contact your local Renishaw representative.

4 Only the calibrated reference mark is phased.

5 Where a specific reference mark location is required, contact your local Renishaw representative for advice on the best method to achieve this.

Compatible readheads

	Incremental		
	VIONiC	**TONiC**	**QUANTiC**
			
Readhead size (length × width × height in mm)	35 × 13.5 × 10	35 × 13.5 × 10	35 × 13.5 × 10
Interface	-	Ti, TD or DOP	-
Scale type	RKLC20-S	RKLC20-S	RKLC40-S
Output	Digital resolutions from 5 µm to 2.5 nm direct from the readhead	Analogue 1 Vpp. Digital resolutions from 5 µm to 1 nm from an interface.	Analogue 1 Vpp. Digital resolutions from 10 µm to 50 nm direct from the readhead.
Sub-divisional error (typical)	< ±15 nm	< ±30 nm	< ±150 nm (partial arc radius > 67.5 mm) < ±80 nm [1] (partial arc radius ≤ 67.5 mm)
Maximum speed	12 m/s	10 m/s	24 m/s [1]
Diagnostic tool	ADTi-100 and ADT View	TONiC diagnostic tool	ADTi-100 and ADT View

	Incremental		
	ATOM [2]	**ATOM DX [2]**	**RESOLUTE**
			
Readhead size (length × width × height in mm)	20.5 × 12.7 × 7.85 (FPC variant: 20.5 × 12.7 × 6.8)	20.5 × 12.7 × 10.85 (Top exit variant: 20.5 × 12.7 × 7.85)	36 × 16.5 × 17.2
Interface	Ri, Ti, ACi	-	DRIVE-CLiQ only
Scale type	RKLF40-S	RKLF40-S	RKLA30-S
Output	Analogue 1 Vpp. Digital resolutions from 10 µm to 2 nm from an interface.	Digital resolutions from 10 µm to 5 nm direct from the readhead.	BiSS, Siemens DRIVECLiQ, FANUC, Mitsubishi, Panasonic, Yaskawa
Sub-divisional error (typical)	< ±120 nm	< ±120 nm	±40 nm
Maximum speed	20 m/s	20 m/s	100 m/s
Diagnostic tool	ATOM diagnostic tool	ADTi-100 and ADT View	ADTa-100 and ADT View

NOTE: If installing RKL scale on a partial arc for a UHV or ETR application, contact your local Renishaw representative for more information.

1 Digital variants only.

2 40 µm ATOM and ATOM DX readhead variants only.

RKLC partial arc installation drawing

Dimensions and tolerances in mm

Z	=	Axis of rotation
R1	=	Substrate radius
R^N	=	Neutral axis radius (R1 + 100 µm)
ML	=	Measuring length
L	=	Scale length [2]
		with end clamps L = ML + 40 [3]
		without end clamps L = ML + 20
OL	=	Overall length
		with end clamps OL = ML + 70 [3]

NOTE: The drawing is applicable for all compatible readheads.

NOTE: The surface roughness of the substrate must be better than 3.2 µm. The parallelism of the scale surface to the axis guideway (readhead ride height variation) must be within 0.05 mm.

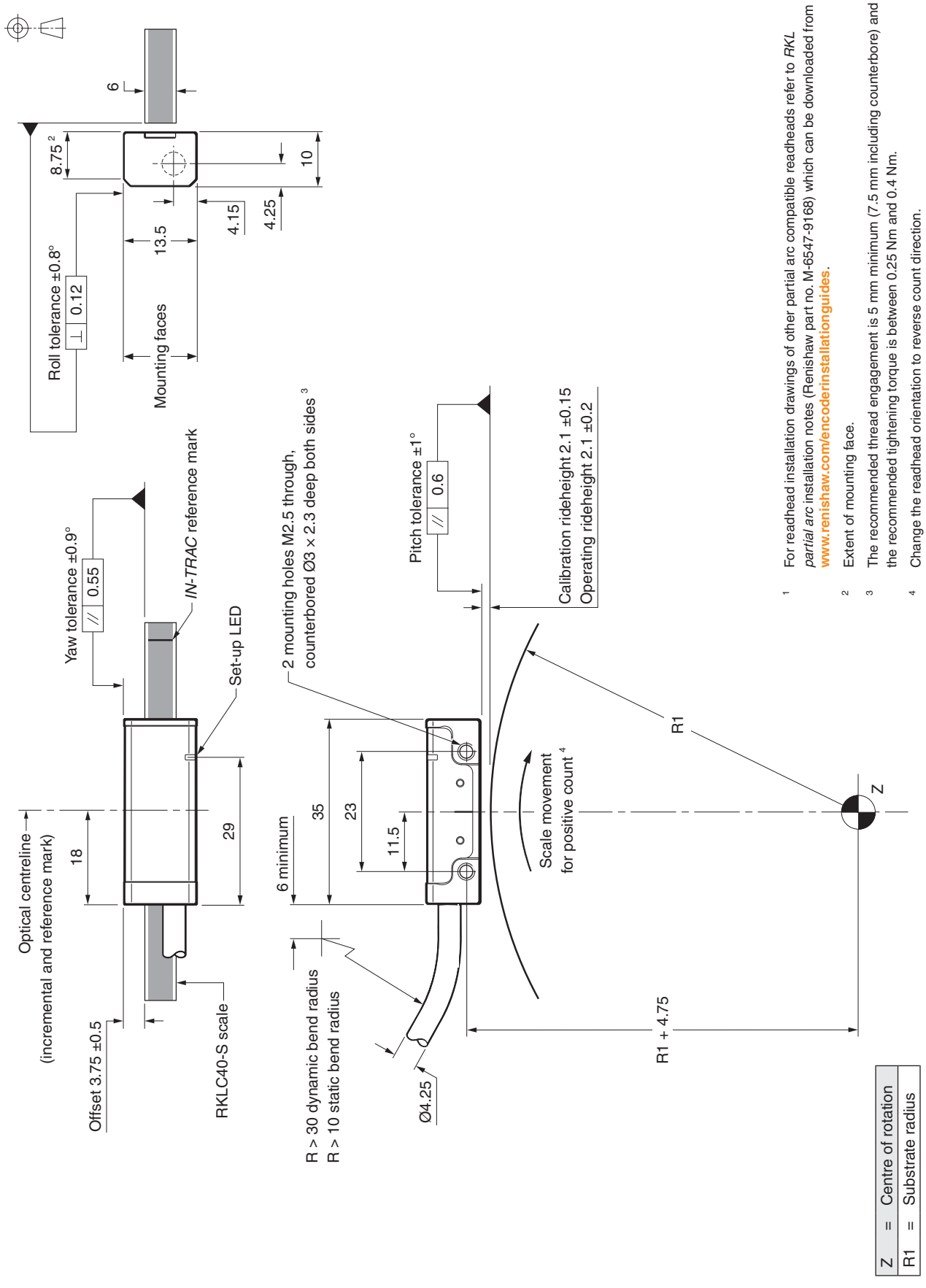
1 When not using end clamps, the scale ends must be secured using an alternative method. For further information refer to *RKL partial arc installation notes* (Renishaw part no. M-6547-9168) which can be downloaded from www.renishaw.com/encoderinstallationguides.

2 When calculating scale length, the first reference mark is 50 mm from scale end.

3 For RESOLUTE systems: To ensure readhead does not clash with the end clamps, L = ML + 66 and OL = ML + 96.

QUANTiC readhead installation drawing [1]

Dimensions and tolerances in mm



1 For readhead installation drawings of other partial arc compatible readheads refer to *RKL partial arc* installation notes (Renishaw part no. M-6547-9168) which can be downloaded from www.renishaw.com/encoderinstallationguides.

2 Extent of mounting face.

3 The recommended thread engagement is 5 mm minimum (7.5 mm including counterbore) and the recommended tightening torque is between 0.25 Nm and 0.4 Nm.

4 Change the readhead orientation to reverse count direction.

Scale part numbers

Scale type	Part number (where xxxx is the scale length in cm) [1]	Available lengths	Compatible readheads
RKLC40-S	A-6665-xxxx	20 mm to 20 m (> 20 m available on request)	QUANTiC
RKLC20-S	A-6663-xxxx	20 mm to 20 m (> 20 m available on request)	VIONiC and TONiC
RKLF40-S	A-6769-xxxx	20 mm to 20 m (> 20 m available on request)	ATOM and ATOM DX [2]
RKLA30-S	A-6667-xxxx	20 mm to 21 m	RESOLUTE

[1] For example, ordering A-6663-0110 will result in a 110 cm length of RKLC20-S.

[2] 40 µm ATOM and ATOM DX readhead variants only.

Accesssory part numbers

RKL scale accessories

Part description	Part number	Product image
Guillotine (for cutting RKL scale)	A-9589-0071	
Shears (for cutting RKL scale)	A-9589-0133	
RKLC-S side mount scale applicator (compatible with VIONiC, TONiC and QUANTiC side mount systems)	A-6547-1912	
RKLC-S top mount scale applicator (required for TONiC top mounted systems only)	A-6547-1915	
RKLF-S side mount applicator (compatible with ATOM and ATOM DX)	A-6547-1943	
RKLF-S top mount applicator (compatible with ATOM and ATOM DX)	A-6547-1939	
RKLF-S slim side mount applicator (compatible with ATOM and ATOM DX)	A-6547-1947	
RKLA-S scale applicator (compatible with RESOLUTE)	A-6547-1918	

End clamp accessories

Part description	Part number	Product image
RGC-F end clamp kit - epoxy mounted (the RGC-F end clamps fix the ends of the partial arc scale to the substrate material)	A-9523-4015	
RGG-2 two part epoxy (the RGG-2 epoxy is recommended for the mounting of end clamps and scale ends)	A-9531-0342	

Reference mark accessories

Part description	Part number	Product image
Reference mark de-selector stickers (pack of 20 de-selector stickers - RKLF ATOM /ATOM DX systems only)	A-9402-0049	

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Part no.: L-9517-9897-02-A
Issued: 08.2023

Data sheet
L-9517-9393-04-D

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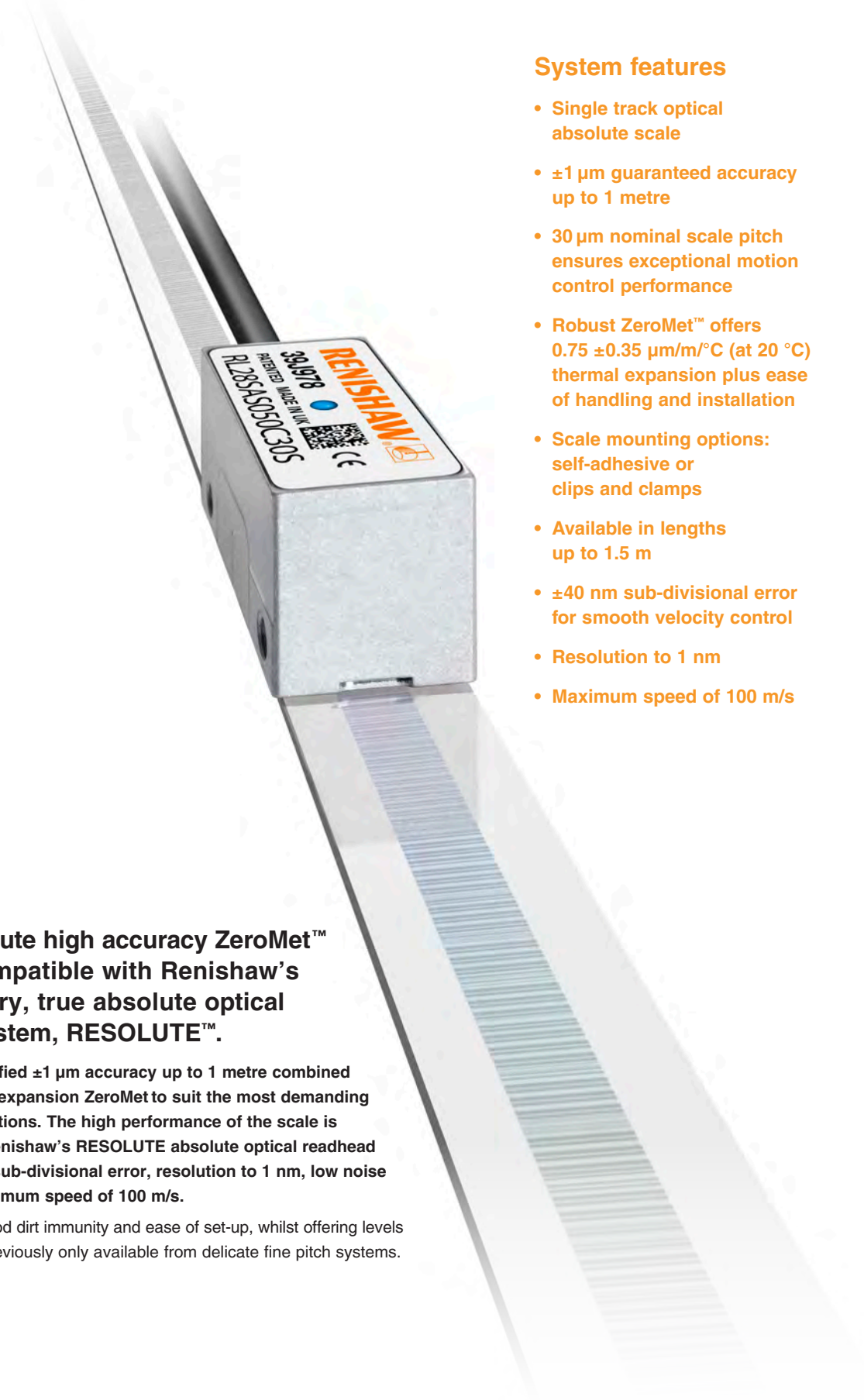
RELA absolute high accuracy scale



System features

- Single track optical absolute scale
- ±1 µm guaranteed accuracy up to 1 metre
- 30 µm nominal scale pitch ensures exceptional motion control performance
- Robust ZeroMet™ offers 0.75 ±0.35 µm/m/°C (at 20 °C) thermal expansion plus ease of handling and installation
- Scale mounting options: self-adhesive or clips and clamps
- Available in lengths up to 1.5 m
- ±40 nm sub-divisional error for smooth velocity control
- Resolution to 1 nm
- Maximum speed of 100 m/s

RELA absolute high accuracy ZeroMet™ scale is compatible with Renishaw's revolutionary, true absolute optical encoder system, RESOLUTE™.

RELA offers certified ±1 µm accuracy up to 1 metre combined with low thermal expansion ZeroMet to suit the most demanding precision applications. The high performance of the scale is augmented by Renishaw's RESOLUTE absolute optical readhead offering ±40 nm sub-divisional error, resolution to 1 nm, low noise (jitter) and a maximum speed of 100 m/s.

RELA provides good dirt immunity and ease of set-up, whilst offering levels of performance previously only available from delicate fine pitch systems.

Specifications

Scale	Track	Single absolute optical track
	Pitch	30 µm
	Form (H x W)	1.6 mm x 14.9 mm
	Maximum length	1.5 m
	Measuring length	See below
	Accuracy	Certified to ±1 µm up to 1 m, ±1 µm/m for lengths >1 m. Calibration traceable to Internation Standards
	Material	ZeroMet. High stability, low-expansion nickel-iron alloy
	Thermal expansion (at 20 °C)	0.75 ±0.35 µm/m/°C
	Mounting	Epoxy datum point and adhesive tape or mechanical datum clamp and mounting clips. Adhesive backing tape is included with all scale (nominal thickness 0.2 mm)
	Mass	184 g/m

For further information on installation and mounting options, please refer to the **RESOLUTE** RSLA/RELA linear installation guide (M-9553-9128), which is available from your local representative or can be downloaded from **www.renishaw.com** or **www.renishawsupport.com**

Measuring lengths

Scale length L (mm)	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**110**
Measuring length ML (mm)	10	20	30	40	50	60	70	100

Scale length L (mm)	**130**	**150**	**180**	**230**	**250**	**280**	**330**	**380**
Measuring length ML (mm)	120	140	170	220	240	270	320	370

Scale length L (mm)	**430**	**480**	**530**	**580**	**630**	**680**	**730**	**780**
Measuring length ML (mm)	420	470	520	570	620	670	720	770

Scale length L (mm)	**880**	**980**	**1030**	**1130**	**1230**	**1330**	**1430**	**1500**
Measuring length ML (mm)	870	970	1020	1120	1220	1320	1420	1490

Resolution, speed and scale lengths

RESOLUTE is available with a variety of resolutions. The choice of resolution depends on the serial protocol being used.

RESOLUTE with ***BiSS*-C** serial comms is available with 1 nm, 5 nm and 50 nm resolution options.
The maximum reading speed is 100 m/s.
The maximum scale length is determined by the readhead resolution and the number of position bits in the serial word.

Resolution	Maximum scale length (m)		
	36 position bits	32 position bits	26 position bits
1 nm	1.5*	1.5*	0.067
5 nm	1.5*	1.5*	0.336
50 nm	1.5*	1.5*	1.5*

RESOLUTE with **Siemens DRIVE-CLiQ** serial comms is available with 1 nm and 50 nm resolution options.
The maximum reading speed is 100 m/s.
The maximum scale length is determined by the readhead resolution and the number of position bits in the serial word.

Resolution	Maximum scale length (m)	
	34 position bits	28 position bits
1 nm	1.5*	N/A
50 nm	N/A	1.5*

RESOLUTE with **Mitsubishi** serial comms is available with 1 nm and 50 nm resolution options.
The maximum reading speed is 100 m/s.
The maximum scale length is determined by the readhead resolution and the number of position bits in the serial word.

Resolution	Maximum scale length (m) with 40 position bits
1 nm	1.5*
50 nm	1.5*

RESOLUTE with **Yaskawa** serial comms is available with 1 nm and 50 nm resolution options.
The maximum scale length is determined by the readhead resolution and the number of position bits in the serial word.

Resolution	Maximum scale length (m) with 36 position bits	Maximum reading speed (m/s)
1 nm	1.5*	3.6
50 nm	1.5*	100

RESOLUTE with **Panasonic** serial comms is available with 1 nm, 50 nm and 100 nm resolution options.
For the **Panasonic** protocol, the maximum scale length of 1.5 m* is available at all resolutions.

Resolution	Maximum reading speed (m/s)	
	Panasonic A5 series	Panasonic A6 series
1 nm	0.4	4
50 nm	20	100
100 nm	40	100

RESOLUTE with **FANUC** serial comms is available with 1 nm and 50 nm resolution options.
The maximum reading speed is 100 m/s.
For the **FANUC** protocol, the maximum scale length of 1.5 m* is available at all resolutions

*RELA scale is available up to 1.5 m. For longer lengths, consider RSLA scale (up to 5 m) or RTLA scale (up to 21 m).
For alternative longer length scales visit www.renishaw.com

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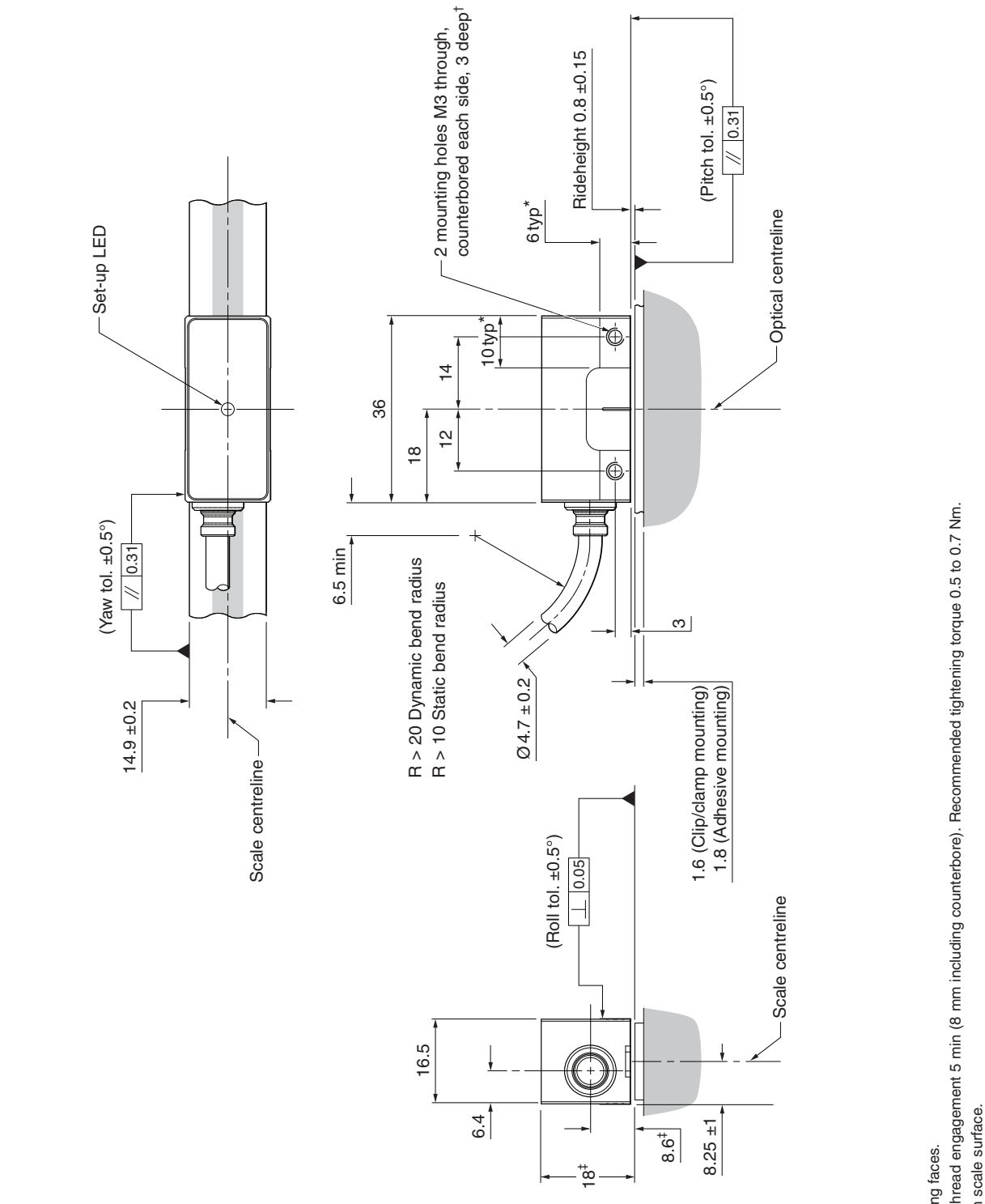
RESOLUTE installation drawing (on RELA scale)

Dimensions and tolerances in mm



* Extent of mounting faces.
† Recommended thread engagement 5 min (8 mm including counterbore). Recommended tightening torque 0.5 to 0.7 Nm.
‡ Dimensions from scale surface.

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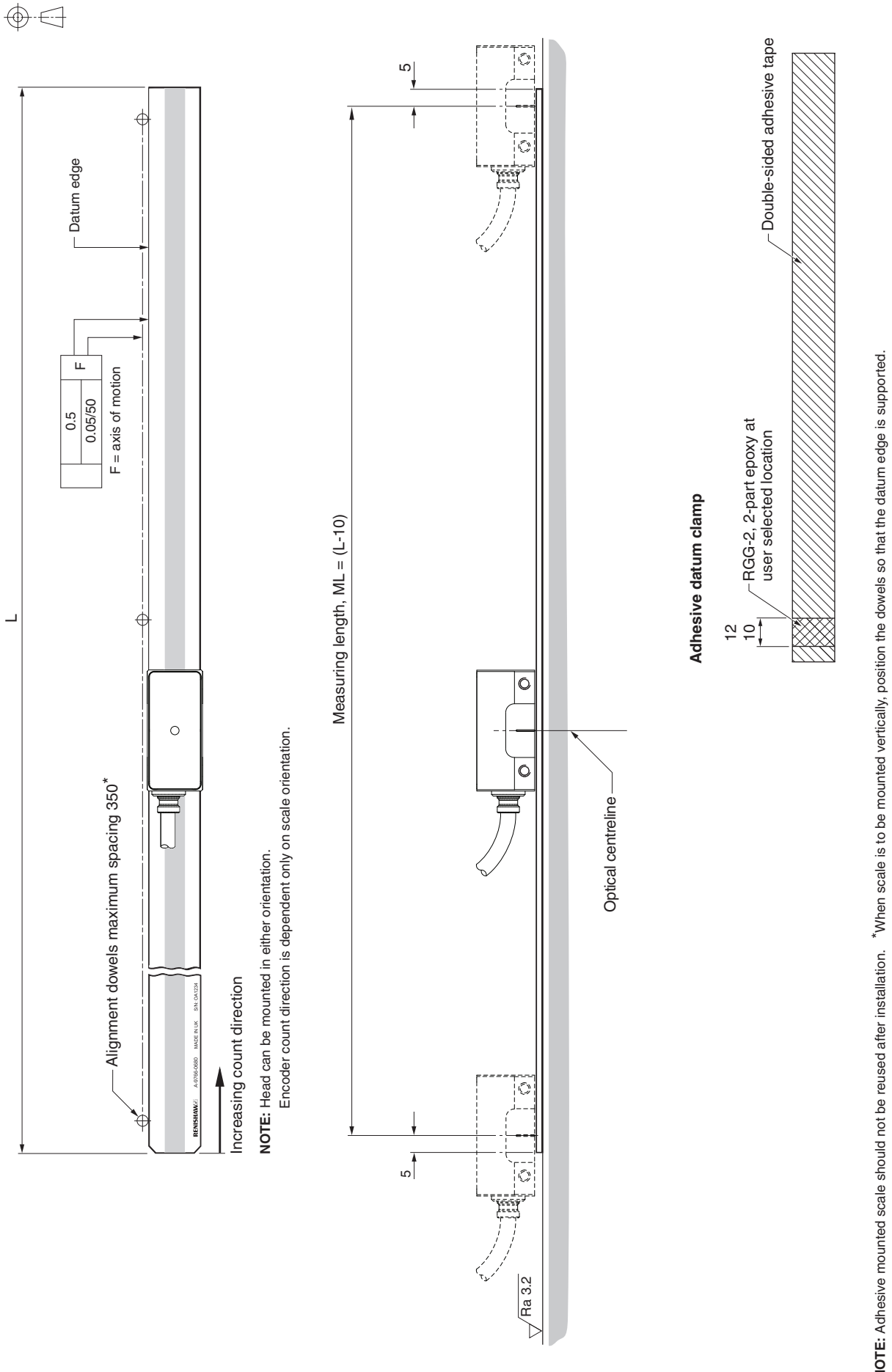
RELA installation drawing (adhesive mount)

Dimensions and tolerances in mm



NOTE: Adhesive mounted scale should not be reused after installation. *When scale is to be mounted vertically, position the dowels so that the datum edge is supported.

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Scale part numbers

Part number is A-9766-xxxx where xxxx is the total scale length in mm *(see available lengths in table below)*

Actual spar length (mm)

0020	0110	0330	0680	1330
0030	0130	0380	0730	1430
0040	0150	0430	0780	1500
0050	0180	0480	0880	
0060	0230	0530	0980	
0070	0250	0580	1030	
0080	0280	0630	1230	

RELA compatible readheads

RELA

RESOLUTE

Installation guide M-9553-9128

Data sheet *BiSS* L-9517-9448
FANUC L-9517-9442
Mitsubishi L-9517-9454
Panasonic L-9517-9460
Siemens DRIVE-CLiQ L-9517-9524
Yaskawa L-9517-9436

RESOLUTE UHV

Data sheet L-9517-9530

For worldwide contact details, visit www.renishaw.com/contact

L-9517-9393-04

Part no.: L-9517-9393-04-D
Issued: 06.2021

Data sheet
L-9517-9387-03-C

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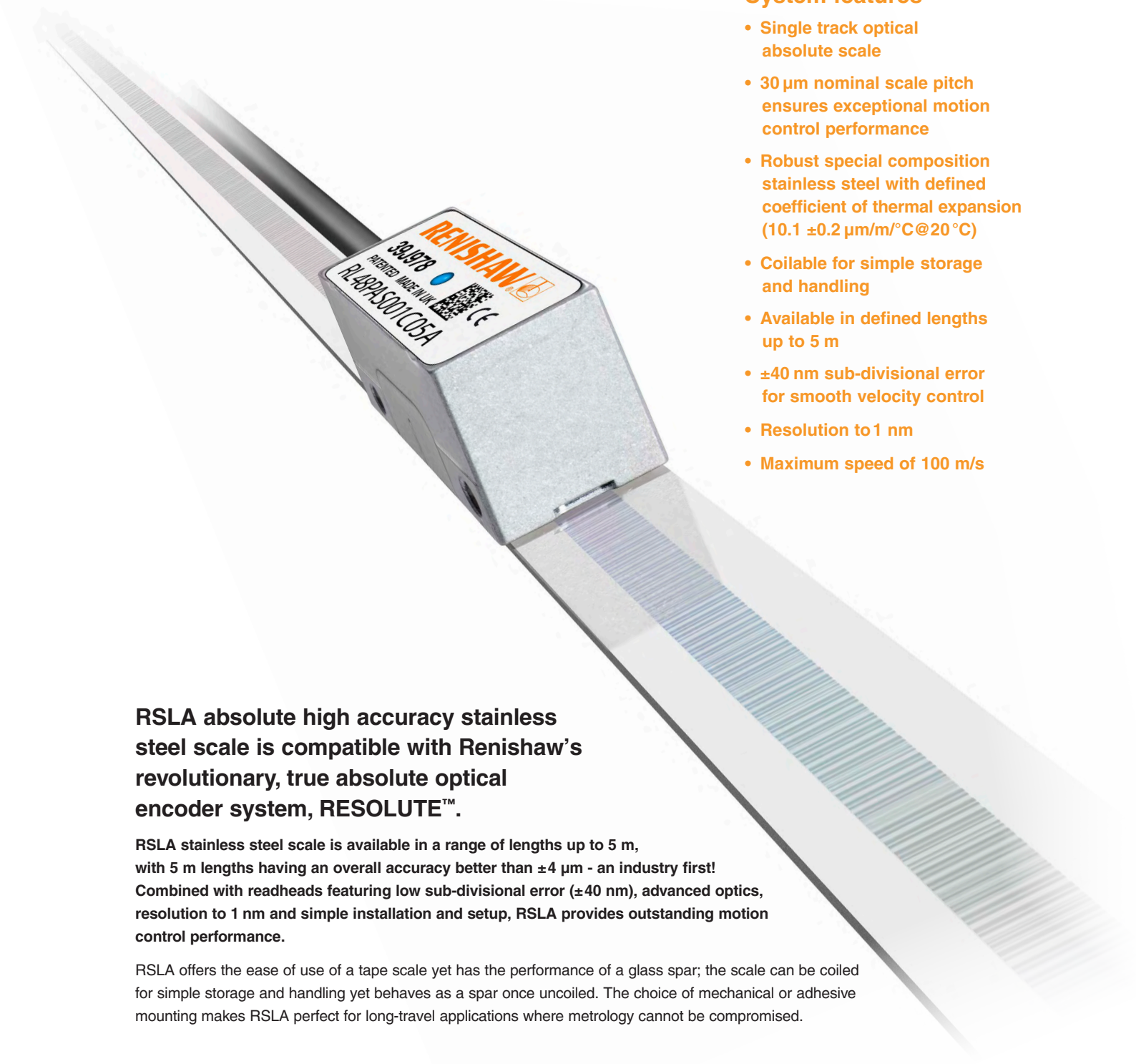
RSLA absolute high accuracy stainless steel scale



System features

- Single track optical absolute scale
- 30 µm nominal scale pitch ensures exceptional motion control performance
- Robust special composition stainless steel with defined coefficient of thermal expansion (10.1 ±0.2 µm/m/°C@20 °C)
- Coilable for simple storage and handling
- Available in defined lengths up to 5 m
- ±40 nm sub-divisional error for smooth velocity control
- Resolution to 1 nm
- Maximum speed of 100 m/s

RSLA absolute high accuracy stainless steel scale is compatible with Renishaw's revolutionary, true absolute optical encoder system, RESOLUTE™.

RSLA stainless steel scale is available in a range of lengths up to 5 m, with 5 m lengths having an overall accuracy better than ±4 µm - an industry first! Combined with readheads featuring low sub-divisional error (±40 nm), advanced optics, resolution to 1 nm and simple installation and setup, RSLA provides outstanding motion control performance.

RSLA offers the ease of use of a tape scale yet has the performance of a glass spar; the scale can be coiled for simple storage and handling yet behaves as a spar once uncoiled. The choice of mechanical or adhesive mounting makes RSLA perfect for long-travel applications where metrology cannot be compromised.

Specifications

Scale	Track	Single, absolute optical track
	Pitch	30 µm
	Form (H x W)	1.5 mm x 14.9 mm
	Maximum length	5 m (See 'Scale part numbers' for available lengths)
	Measuring length	See RSLA installation drawing
	Accuracy (at 20 °C)	±1.5 µm up to 1 m ±2.25 µm from 1 m to 2 m ±3 µm from 2 m to 3 m ±4 µm from 3 m to 5 m (includes slope and linearity) Calibration traceable to Internation Standards
	Material	Hardened martensitic stainless steel
	Thermal expansion (at 20 °C)	10.1 ± 0.2 µm/m/°C
	Mounting	Epoxy datum point and adhesive tape or mechanical datum clamp and mounting clips. Adhesive backing tape is included with all scale (nominal thickness 0.2 mm)
	Mass	172 g/m
	Storage	Lengths over 1.13 m are coiled (>600 mm diameter)

For further information on installation and mounting options, please refer to the **RESOLUTE** linear installation guide (M-9553-9128), which is available from your local representative or can be downloaded from www.renishaw.com or www.renishawsupport.com.

Resolution, speed and scale lengths

RESOLUTE is available with a variety of resolutions. The choice of resolution depends on the serial protocol being used.

RESOLUTE with ***BiSS*-C** serial comms is available with 1 nm, 5 nm and 50 nm resolution options.
The maximum reading speed is 100 m/s.
The maximum scale length is determined by the readhead resolution and the number of position bits in the serial word.

Resolution	Maximum scale length (m)		
	36 position bits	32 position bits	26 position bits
1 nm	5*	4.295	0.067
5 nm	5*	5*	0.336
50 nm	5*	5*	3.355

RESOLUTE with **Siemens DRIVE-CLiQ** serial comms is available with 1 nm and 50 nm resolution options.
The maximum reading speed is 100 m/s.
The maximum scale length is determined by the readhead resolution and the number of position bits in the serial word.

Resolution	Maximum scale length (m)	
	34 bit position bits	28 position bits
1 nm	5*	N/A
50 nm	N/A	5*

RESOLUTE with **Mitsubishi** serial comms is available with 1 nm and 50 nm resolution options.
The maximum reading speed is 100 m/s.
The maximum scale length is determined by the readhead resolution and the number of position bits in the serial word.

Resolution	Maximum scale length (m) with 40 position bits
1 nm	2.1
50 nm	5*

RESOLUTE with **Yaskawa** serial comms is available with 1 nm and 50 nm resolution options.
The maximum scale length is determined by the readhead resolution and the number of position bits in the serial word.

Resolution	Maximum scale length (m) with 36 position bits	Maximum reading speed (m/s)
1 nm	1.8	3.6
50 nm	5*	100

RESOLUTE with **Panasonic** serial comms is available with 1 nm, 50 nm and 100 nm resolution options.
For the **Panasonic** protocol, the maximum scale length of 5 m* is available at all resolutions.

Resolution	Maximum reading speed (m/s)	
	Panasonic A5 series	Panasonic A6 series
1 nm	0.4	4
50 nm	20	100
100 nm	40	100

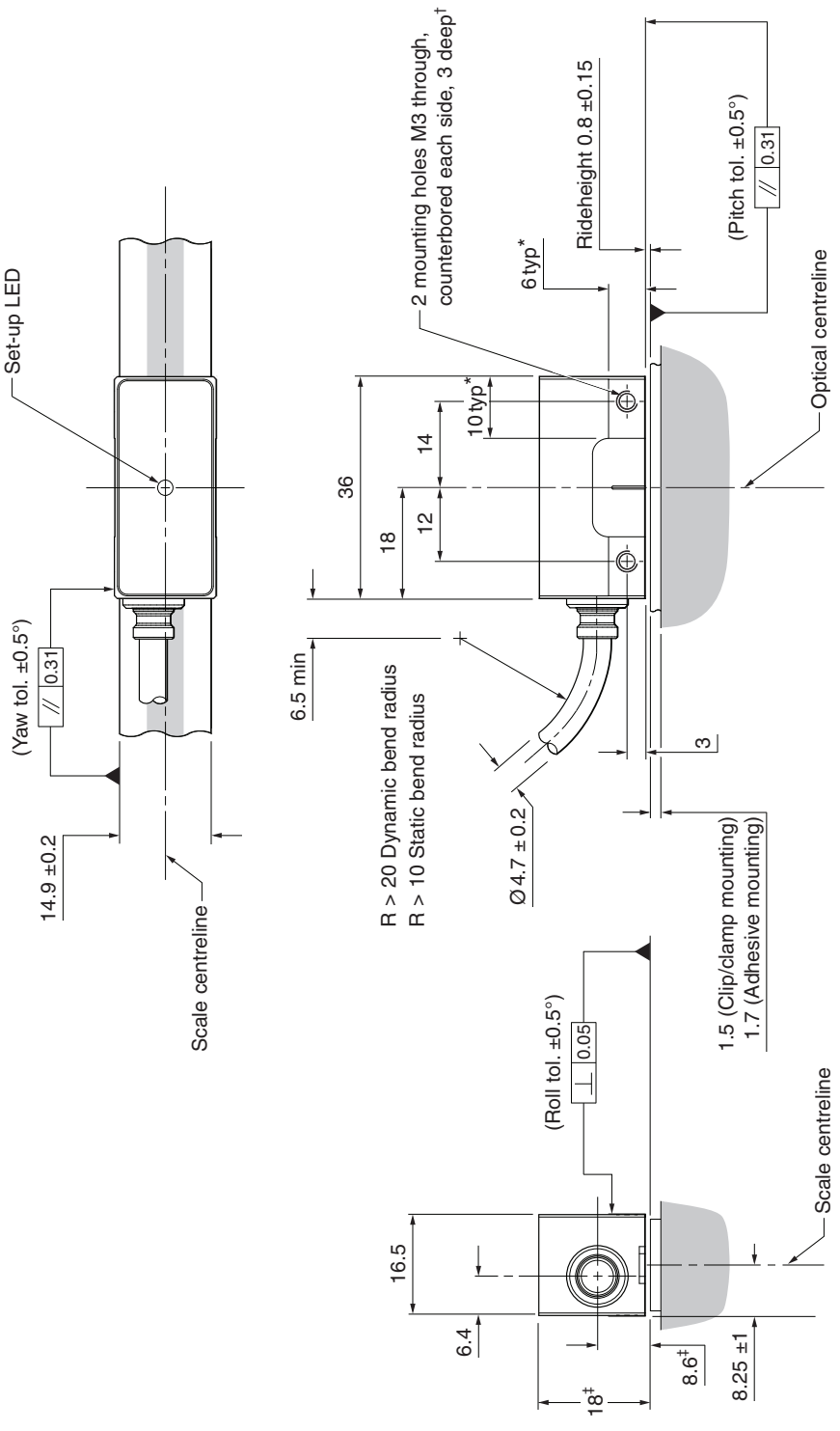
RESOLUTE with **FANUC** serial comms is available with 1 nm and 50 nm resolution options.
The maximum reading speed is 100 m/s.
For the **FANUC** protocol, the maximum scale length of 5 m* is available at all resolutions

*RSLA scale is available up to 5 m. For longer lengths, consider RTLA scale (up to 21 m).

For alternative longer length scales visit www.renishaw.com.

RESOLUTE installation drawing (on RSLA scale)

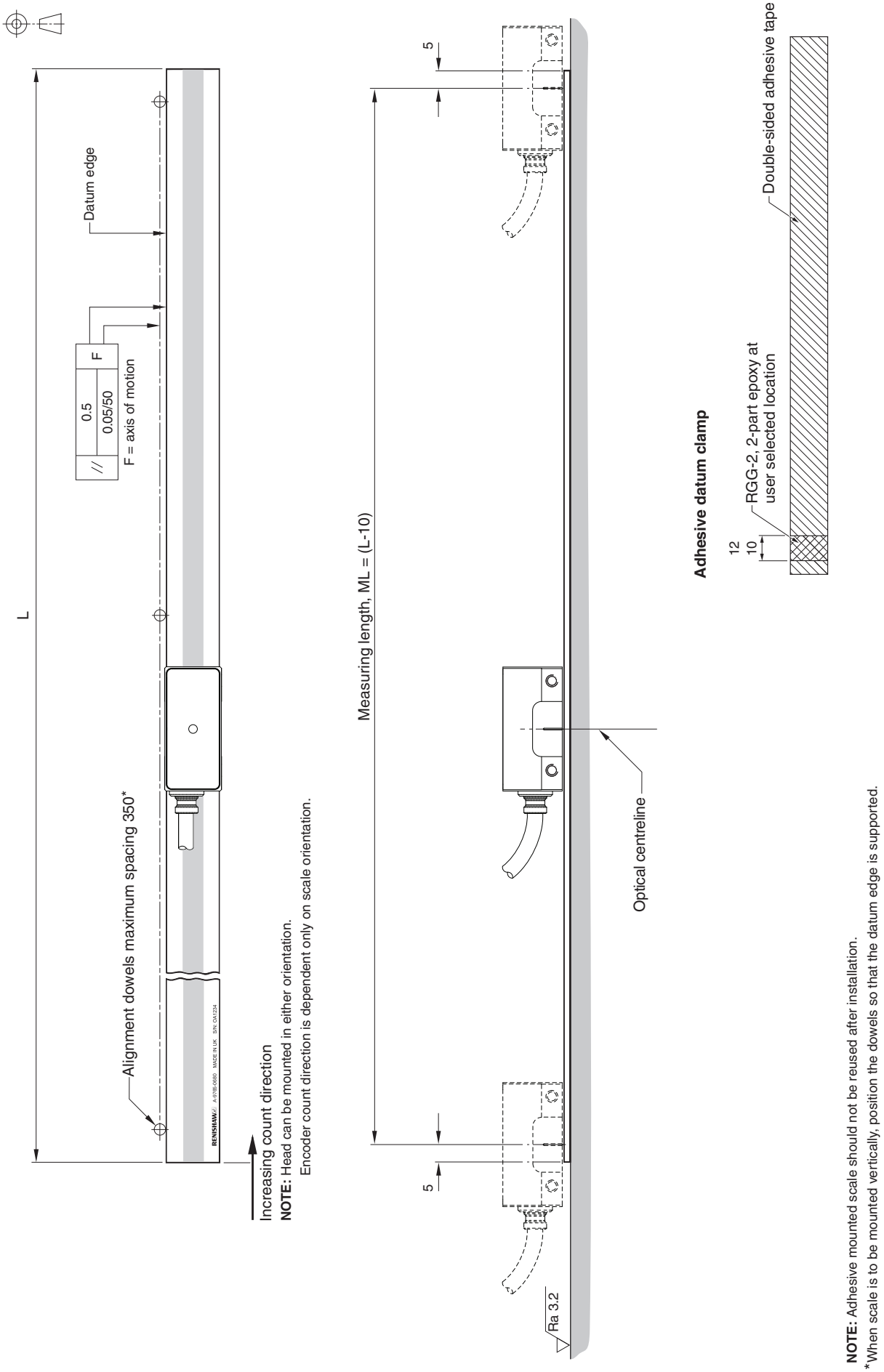
Dimensions and tolerances in mm



* Extent of mounting faces.
† Recommended thread engagement 5 min (8 mm including counterbore). Recommended tightening torque 0.5 to 0.7 Nm.
‡ Dimensions from scale surface.

RSLA installation drawing (adhesive mount)

Dimensions and tolerances in mm



NOTE: Adhesive mounted scale should not be reused after installation.
*When scale is to be mounted vertically, position the dowels so that the datum edge is supported.

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Scale part numbers

Part number is A-9765-xxxx where xxxx is the total scale length in mm *(see available lengths in table below)*

Actual spar length (mm)

0020	0150	0530	1000	1700	2700	4000
0030	0180	0580	1030	1800	2800	4100
0040	0200	0630	1130	1900	2900	4200
0050	0230	0680	1200	2000	3000	4300
0060	0280	0730	1230	2100	3100	4400
0070	0330	0780	1270	2200	3200	4500
0080	0380	0830	1330	2300	3400	4600
0100	0430	0880	1430	2400	3500	4700
0120	0480	0930	1500	2500	3700	4900
0130	0500	0980	1600	2600	3800	5000

RSLA compatible readhead

RSLA

RESOLUTE

Installation guide M-9553-9128

Data sheet *BiSS* L-9517-9448
FANUC L-9517-9442
Mitsubishi L-9517-9454
Panasonic L-9517-9460
Siemens DRIVE-CLiQ L-9517-9524
Yaskawa L-9517-9436

RESOLUTE UHV

Data sheet L-9517-9530

For worldwide contact details, visit www.renishaw.com/contact

L-9517-9387-03

Part no.: L-9517-9387-03-C
Issued: 06.2021

Data sheet
L-9517-9399-04-A

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RESA30 absolute angle encoder

RESA30 is a one-piece stainless steel ring with a single-track, true-absolute scale marked directly onto the periphery.

Read by Renishaw's absolute fine pitch encoder system, RESOLUTE™, it has high tolerance to dirt, scratches and greasy fingerprints that can cause other encoder systems to miscount.

The RESA30 offers impressive accuracy with resolution to 0.00030 arc second, suiting the most demanding precision applications.

The low-profile RESA30, with large internal diameter, is easy to design into most installations. Equally importantly, its low-mass, low-inertia design does not compromise system performance.

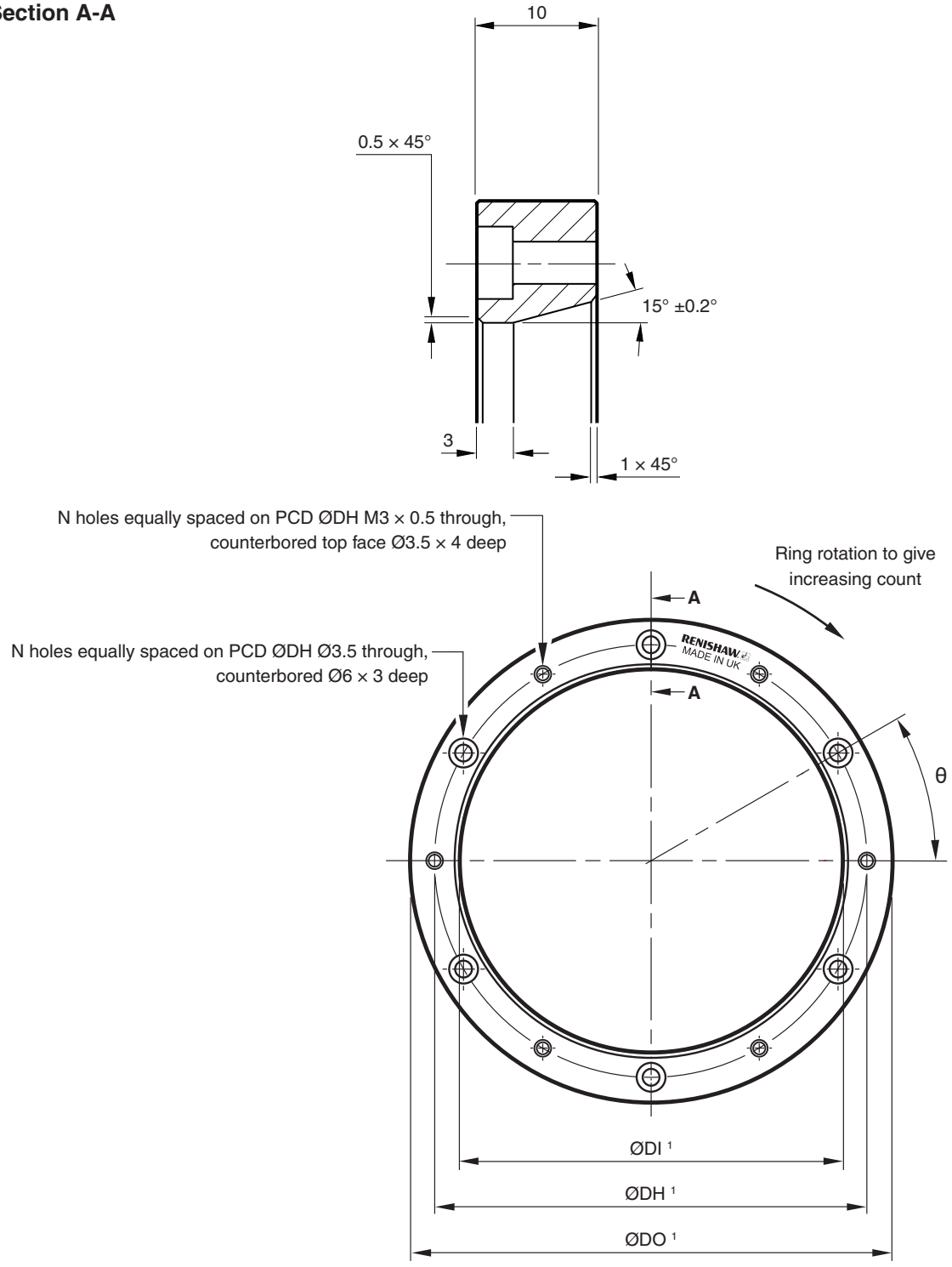
RESA30 is available in a wide range of sizes and line counts, providing compatibility with industry-standard controllers.

- **Compatible with RESOLUTE true-absolute encoder**
- **Angular resolution to 0.00030 arc second**
- **System repeatability to 0.0075 arc second**
- **36 000 rev/min maximum speed for all resolutions**
- **Patented taper mount simplifies integration and minimises installation errors**
- **Large internal diameter for ease of integration**
- **Available in sizes from Ø52 mm to Ø550 mm**
- **Custom sizes also available**
- **Low mass and low inertia**
- **Ultra-low inertia versions also available**
- **Integral set-up LED on readhead for quick set-up and instant 'health check' at any time**
- **30 µm nominal scale pitch ensures exceptional motion control performance**
- **Operates down to –40 °C with RESOLUTE Extended Temperature Range (ETR) variant**

RESA30 installation drawing (‘A’ section)

Dimensions and tolerances in mm

Section A-A



NOTES:

- θ is the angle between one tapped hole and the adjacent clearance hole. For example, the angle between two clearance holes is 2θ.
- When using a RESOLUTE ETR, the hub should be made of a material with a CTE between 14 and 18 µm/m/°C. Contact your local Renishaw representative for more information.

[1] The dimensions DO, DI and DH for the RESA30 'A' section rings are listed on the following page.

RESA30 ‘A’ section ring dimensions

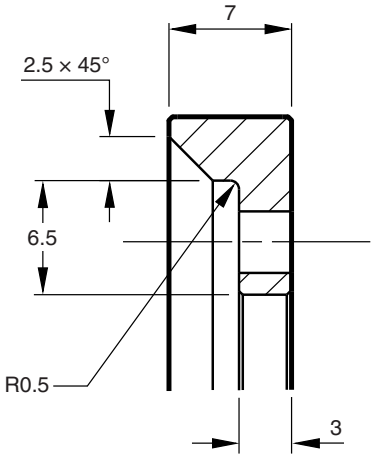
Nominal external diameter (mm)	DO (mm)	DI (mm)	Mounting holes		
			DH (mm)	N	θ
52	52.20 52.10	30.04 30.00	40	6	30°
57	57.35 57.25	37.04 37.00	47	6	30°
75	75.40 75.30	55.04 55.00	65	6	30°
100	100.30 100.20	80.04 80.00	90	6	30°
101	101.30 102.20	80.04 80.00	90	6	30°
103	103.20 103.00	80.04 80.00	90	6	30°
104	104.40 104.20	80.04 80.00	90	6	30°
115	114.70 114.50	95.04 95.00	105	6	30°
124	124.10 123.90	104.04 104.00	114	6	30°
150	150.40 150.20	130.04 130.00	140	9	20°
172	172.04 171.84	152.04 152.00	162	9	20°
183	183.45 183.25	163.04 163.00	173	9	20°
200	200.40 200.20	180.04 180.00	190	12	15°
206	206.50 206.10	186.05 186.00	196	12	15°
209	208.80 208.40	186.05 186.00	196	12	15°
229	229.40 229.00	209.05 209.00	219	12	15°
255	254.80 254.40	235.06 235.00	245	12	15°
280	280.30 279.90	260.06 260.00	270	12	15°
300	300.40 300.20	280.06 280.00	290	16	11.25°
330	350.40 350.20	310.06 310.00	320	16	11.25°
350	350.40 350.20	330.06 330.00	340	16	11.25°
413	412.70 412.30	392.08 392.00	402	18	10°
417	417.40 417.00	380.10 380.00	390	18	10°
489 [1]	489.12 488.72	451.10 450.90	462	20	18°
550	550.20 549.80	510.10 510.00	520	20	9°

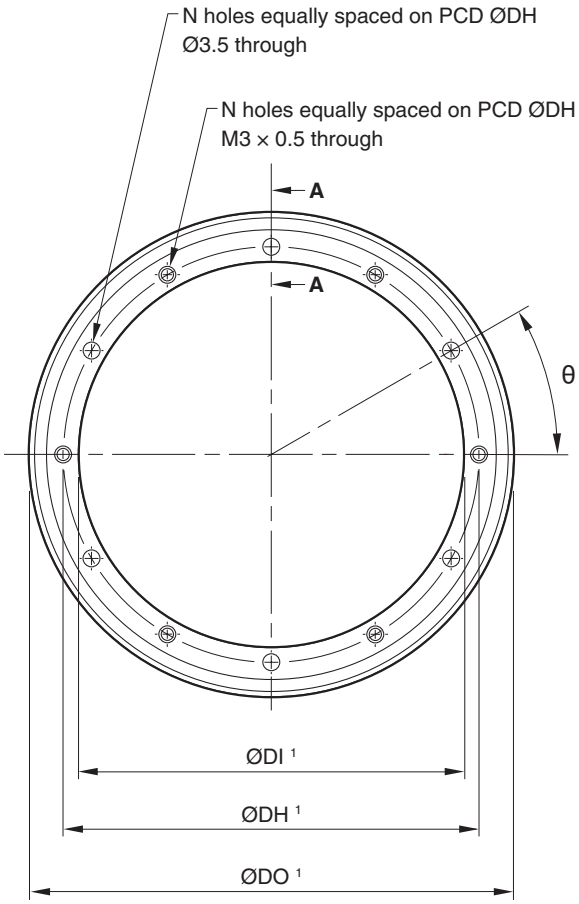
[1] There are no tapped holes on the 489 mm ring.

RESA30 installation drawing (‘B’ section)

Dimensions and tolerances in mm

Section A-A

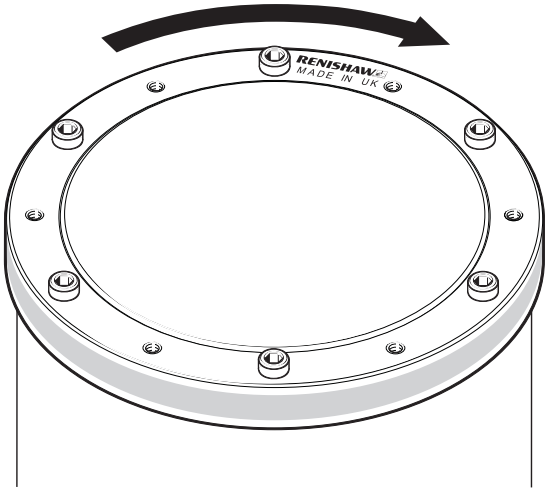




NOTES:

- θ is the angle between one tapped hole and the adjacent clearance hole. For example, the angle between two clearance holes is 2θ.
- When using a RESOLUTE ETR, the hub should be made of a material with a CTE between 14 and 18 µm/m/°C. Contact your local Renishaw representative for more information.

Ring rotation to give increasing count

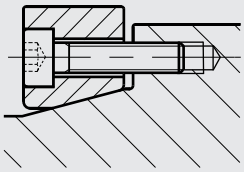
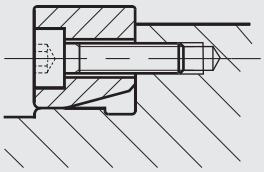
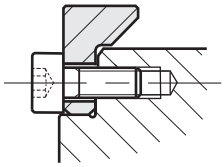


[1] The dimensions DO, DI and DH for the RESA30 'B' section rings are listed on the following page.

RESA30 ‘B’ section ring dimensions

Nominal external diameter (mm)	DO (mm)	DI (mm)	Mounting holes		
			DH (mm)	N	θ
52	52.20 52.10	32.04 32.00	38	6	30°
57	57.35 57.25	37.04 37.00	43	6	30°
75	75.40 75.30	55.04 55.00	61	6	30°
100	100.30 100.20	80.04 80.00	86	6	30°
115	114.70 114.50	95.04 95.00	101	6	30°
150	150.40 150.20	130.04 130.00	136	9	20°
165	165.10 164.90	145.04 145.00	151	9	20°
200	200.40 200.20	180.04 180.00	186	12	15°

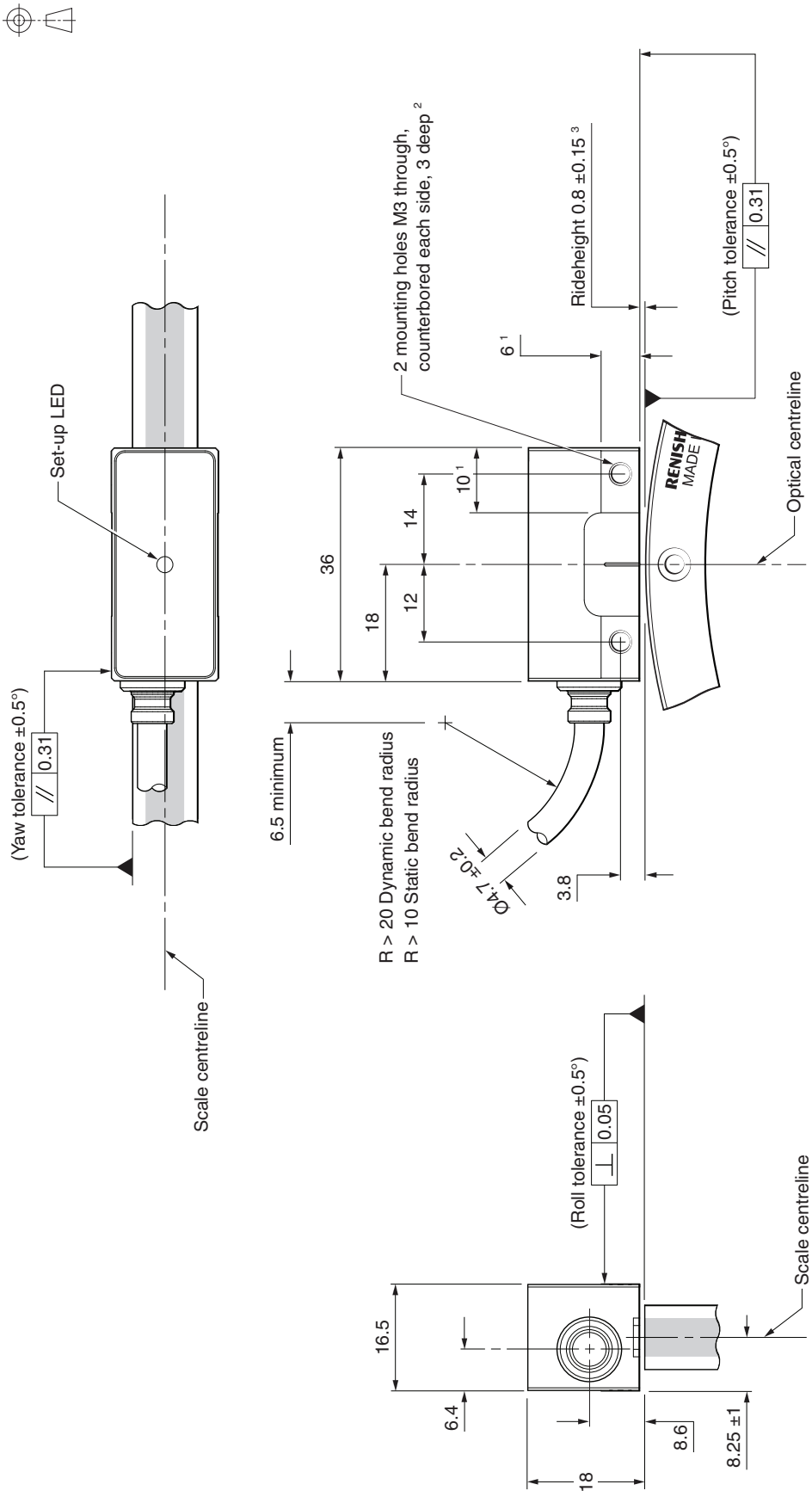
RESA30 mounting methods

	Taper mount	Interference fit
'A' section		
'B' section	Not applicable	
Notes	**Recommended for all installations** • Enables simplest adjustment. • Offers highest accuracy. • Enables eccentricity to be compensated. • Offers excellent mechanical stability against thermal cycling, shock and vibration. • Minimises cost of substrate preparation.	**Alternative installation** • Will not correct eccentricity of the supporting shaft.

For further information on installation and mounting options, refer to the *RESOLUTE™ RESA30 and REXA30 absolute angle encoders* installation guide (Renishaw part no. M-9553-9735) which is available from your local Renishaw representative, or can be downloaded from: **www.renishaw.com/resolutedownloads**.

RESOLUTE readhead installation drawing

Dimensions and tolerances in mm



1 Extent of mounting faces.

2 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.

3 0.8 ±0.1 mm on 52 mm rings.

For more information on installation and mounting options, refer to the *RESOLUTE™ RESA30 and REXA30 absolute angle encoders* installation guide (Renishaw part no. M-9553-9735). This can be downloaded from our website **www.renishaw.com/resolutedownloads** or contact your local Renishaw representative.

Operating specifications

Material			303/304 stainless steel
Coefficient of thermal expansion (at 20 °C)			15.5 ±0.5 µm/m/°C
Temperature	**(system)**	Storage	Standard readhead: –20 °C to +80 °C
			ETR readhead: –40 °C to +80 °C
			UHV readhead: 0 °C to +80 °C
	(readhead)	Operating	Standard readhead: 0 °C to +80 °C
			ETR readhead: –40 °C to +80 °C
			UHV readhead: 0 °C to +75 °C
	(interface)		DRIVE-CLIQ interface: 0 °C to +55 °C

Nominal external diameter (mm)		**52**	**57**	**75**	**100**	**101**	**103**	**104**
Nominal internal diameter (mm)		30 [1]	37	55	80	80	80	80
Mass (kg)	‘A’ section	0.098	0.1	0.15	0.2	0.22	0.24	0.26
	‘B’ section	0.043	0.049	0.068	0.094	-	-	-
Moment of inertia (kgmm²)	‘A’ section	46	61	161	425	477	519	561
	‘B’ section	22	31	79	202	-	-	-

Nominal external diameter (mm)		**115**	**124**	**150**	**165**	**172**	**183**	**200**
Nominal internal diameter (mm)		95	104	130	145	152	163	180
Mass (kg)	‘A’ section	0.23	0.26	0.32	-	0.36	0.40	0.43
	‘B’ section	0.10	-	0.15	0.16	-	-	0.2
Moment of inertia (kgmm²)	‘A’ section	644	849	1 581	-	2 400	3 006	3 928
	‘B’ section	296	-	740	970	-	-	1 822

Nominal external diameter (mm)		**206**	**209**	**229**	**255**	**280**	**300**	**330**
Nominal internal diameter (mm)		186	186	209	235	260	280	310
Mass (kg)	‘A’ section	0.44	0.5	0.5	0.54	0.61	0.66	0.72
	‘B’ section	-	-	-	-	-	-	-
Moment of inertia (kgmm²)	‘A’ section	4 315	4 960	6 000	8 112	11 233	13 962	18 476
	‘B’ section	-	-	-	-	-	-	-

Nominal external diameter (mm)		**350**	**413**	**417**	**489**	**550**
Nominal internal diameter (mm)		330	392	380	451	510
Mass (kg)	‘A’ section	0.78	0.93	1.76	2.13	2.53
	‘B’ section	-	-	-	-	-
Moment of inertia (kgmm²)	‘A’ section	22 606	37 945	70 386	118 244	178 598
	‘B’ section	-	-	-	-	-

[1] 32 mm for ‘B’ section ring.

Accuracy

Nominal external diameter	Typical installed accuracy [2]			
	'A' section [1]		'B' section	
mm	arc second	µm	arc second	µm
52	±12.7	±1.6	±21.1	±2.7
57	±11.8	±1.6	±19.5	±2.7
75	±9.5	±1.7	±14.9	±2.7
100	±7.5	±1.8	±11.3	±2.7
101	±7.5	±1.8	-	-
103	±7.4	±1.8	-	-
104	±7.3	±1.8	-	-
115	±6.8	±1.9	±9.9	±2.8
124	±6.3	±1.9	-	-
150	±5.5	±2.0	±7.7	±2.8
165	-	-	±7.0	±2.8
172	±5.0	±2.1	-	-
183	±4.7	±2.1	-	-
200	±4.3	±2.1	±5.8	±2.8
206	±4.2	±2.1	-	-
209	±4.2	±2.1	-	-
229	±3.9	±2.2	-	-
255	±3.6	±2.2	-	-
280	±3.4	±2.3	-	-
300	±3.1	±2.3	-	-
330	±2.9	±2.3	-	-
350	±2.8	±2.4	-	-
413	±2.4	±2.4	-	-
417	±2.4	±2.4	-	-
489	±2.1	±2.5	-	-
550	±1.9	±2.6	-	-

NOTE: Installation errors will dominate accuracy; typical figures cannot be assumed.

[1] Taper mounted installations recommend an installation of ±3 µm at the bolt hole locations; adjustments are not possible for bore mounted systems.

[2] 'Typical' installations are a result of graduation and installation errors combining and, to some magnitude, cancelling.

All rings supplied are tested to ensure a minimum installed accuracy grade. The manufactured installed accuracy limit is dependent on the ring type:

- A section rings : ±5 µm (±7.5 µm for Ø413 mm ring)
- B section rings : ±8 µm

NOTE: Bore mounted A section rings, have an assumed ±8 µm installed accuracy. Refer to your local Renishaw representative for more information.

$$\text{Minimum installed accuracy in arc seconds} = \frac{\text{Minimum installed accuracy (µm)}}{\text{Ring diameter (mm)}} \times 412.5$$

Refer to Appendix for system accuracy figures.

Speed

Nominal external diameter (mm)	Maximum reading speed (rev/min)
52	36 000
57	33 000
75	25 000
100	19 000
101	19 000
103	18 500
104	18 000
115	16 500
124	15 000
150	12 000
165	11 500
172	11 000
183	10 400
200	9 500
206	9 200
209	9 000
229	8 300
255	7 400
280	6 800
300	6 300
330	5 700
350	5 400
413	4 600
417	4 500
489	3 900
550	3 400

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 further advice.

Resolution

RESOLUTE is 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, FANUC 27 bit resolution is available on all ring sizes.

BiSS RESOLUTE resolution options:

Resolution	Counts per revolution	Arc second
18 bit	262 144	≈ 4.94
26 bit	67 108 864	≈ 0.019
32 bit	4 294 967 296	≈ 0.00030

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

FANUC RESOLUTE resolution options:

Resolution	Counts per revolution	Arc second
27 bit	134 217 728	≈ 0.0097
31 bit	2 147 483 648	≈ 0.0006

Mitsubishi RESOLUTE resolution options:

Resolution	Counts per revolution	Arc second
23 bit	8 388 608	≈ 0.15
27 bit	134 217 728	≈ 0.0097

Panasonic RESOLUTE resolution options:

Resolution	Counts per revolution	Arc second
23 bit	8 388 608	≈ 0.15
32 bit	4 294 967 296	≈ 0.0003

Siemens DRIVE-CLiQ RESOLUTE resolution options:

Resolution	Counts per revolution	Arc second
26 bit	67 108 864	≈ 0.019
29 bit	536 870 912	≈ 0.0024

Yaskawa RESOLUTE resolution options:

	Resolution	Counts per revolution	Arc second
Rotary servomotors:	24 bit	16 777 216	≈ 0.077
Fully closed loop control:	23 bit	8 388 608	≈ 0.154
	26 bit	67 108 864	≈ 0.019
	30 bit	1 073 741 824	≈ 0.0012

Angle encoder part numbers

RESA 30U S A 300 B

Scale code

B = Standard

Scale code

052 = 52 mm	115 = 115 mm	206 = 206 mm	350 = 350 mm
057 = 57 mm	124 = 124 mm	209 = 209 mm	413 = 413 mm
075 = 75 mm	150 = 150 mm	229 = 229 mm	417 = 417 mm
100 = 100 mm	165 = 165 mm	255 = 255 mm	489 = 489 mm
101 = 101 mm	172 = 172 mm	280 = 280 mm	550 = 550 mm
103 = 103 mm	183 = 183 mm	300 = 300 mm	
104 = 104 mm	200 = 200 mm	330 = 330 mm	

Form

A = Tapered internal diameter

B = Low inertia (only available in 52 mm, 57 mm, 75 mm, 100 mm, 115 mm, 150 mm, 165 mm and 200 mm diameters)

Material

S = Stainless steel

Pitch

30U = 30 µm

Absolute angle encoder series

Compatible products

RESA30

RESOLUTE standard readheads

RESOLUTE UHV readheads

RESOLUTE ETR readheads

RESOLUTE FS (Functional Safety) readheads

Appendix

Graduation and system accuracy

Nominal external diameter (mm)	Graduation accuracy (arc second)	System accuracy (arc second)
52	±1.7	±2.4
57	±1.7	±2.3
75	±1.6	±2.1
100	±1.5	±1.9
101	±1.5	±1.9
103	±1.5	±1.9
104	±1.5	±1.8
115	±1.5	±1.8
124	±1.4	±1.7
150	±1.4	±1.6
165	±1.4	±1.6
172	±1.4	±1.7
183	±1.4	±1.6
200	±1.5	±1.7
206	±1.3	±1.4
209	±1.3	±1.4
229	±1.2	±1.4
255	±1.2	±1.3
280	±1.1	±1.3
300	±1.1	±1.3
330	±1.1	±1.2
350	±1.1	±1.2
413	±1.0	±1.1
417	±1.0	±1.1
489	±1.0	±1.1
550	±1.0	±1.1

Graduation accuracy is the maximum difference between the angle measured by a single readhead and the true rotation of the encoder as graduated. Application disturbances such as eccentricity are not included.

System accuracy is graduation accuracy plus SDE. For application advice, contact your local Renishaw representative.

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Part no.: L-9517-9399-04-A
Issued: 02.2023

Data sheet
L-9517-9405-03-B

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REXA ultra-high accuracy absolute angle encoder

With zero coupling losses and exceptional repeatability, the REXA ultra-high accuracy angle encoder achieves better than ±1 arc second total installed accuracy.

Like the RESA encoder, the REXA is a stainless steel ring with the scale graduations marked axially onto the periphery, but with a number of differences to improve upon RESA's already impressive accuracy.

REXA has a thicker cross-section to ensure that the only significant installation error is eccentricity. Eccentricity is easily removed by using 2 readheads, and combining the signals inside the host controller.

The only errors remaining are graduation errors and readhead SDE, both of which are so small they are often negligible.

As a non-contact encoder, REXA offers dynamic performance advantages, eliminating coupling losses, oscillation, shaft torsion and other hysteresis errors that plague enclosed encoders.

The REXA system operates at temperatures up to +80 °C and speeds to 8 500 rev/min.

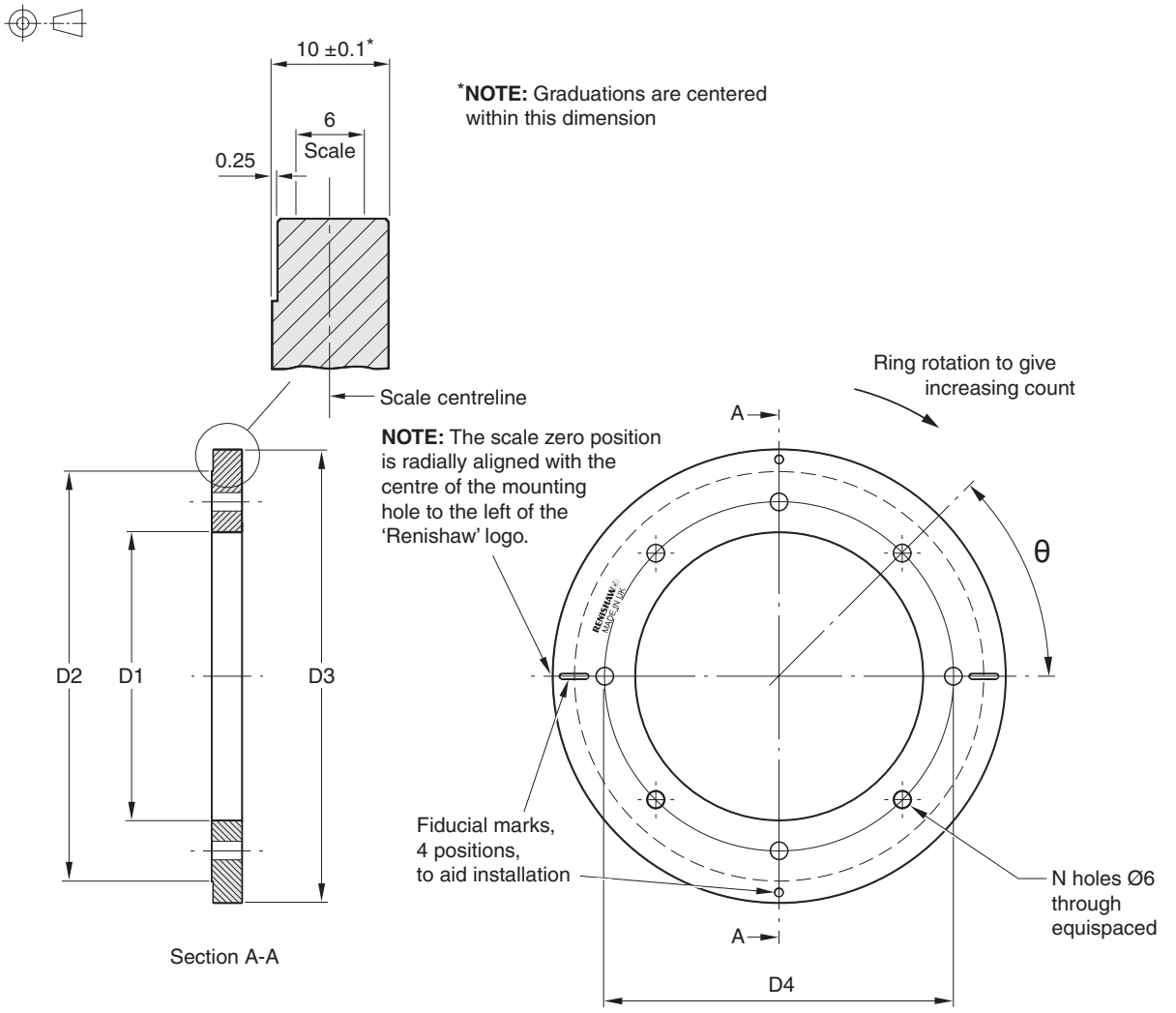
REXA total installed accuracy grades:

REXA diameter	Total installed accuracy (with 2 readheads)
≥100 mm	±1 arc second
75 mm	±1.5 arc second
≤57 mm	±2 arc second

- **Use with two RESOLUTE™ readheads to give ultra-high accuracy**
- **Installed accuracy to ±1 arc second with dual readheads**
- **Sub-divisional error to ±0.04 arc second**
- **Resolutions to 0.00030 arc second**
- **Repeatability to 0.01 arc second**
- **Wide range of standard sizes from 52 mm to 417 mm**
- **Large internal diameter for ease of integration**
- **Flange mounted with easy 4-point adjustment method**

Installation drawing

Dimensions and tolerances in mm



Nominal external diameter (mm)	Dimensions			Mounting Holes		
	D1	D2	D3	N	D4	θ
52†	26	50	52.1 – 52.2	4	38	90°
57†	26	50	57.25 – 57.35	4	38	90°
75	40.5	64.5	75.3 – 75.4	8	52.5	45°
100	57.5	97.5	100.2 – 100.3	8	77.5	45°
103	57.5	97.5	103.0 – 103.2	8	77.5	45°
104	57.5	97.5	104.2 – 104.4	8	77.5	45°
115	68	108	114.5 – 114.7	8	88	45°
150	96	136	150.2 – 150.4	8	116	45°
183	122.5	162.5	183.2 – 183.4	12	142.5	30°
200	136	176	200.2 – 200.4	12	156	30°
206	140.5	180.5	206.1 – 206.5	12	160.5	30°
209	140.5	180.5	208.4 – 208.8	12	160.5	30°
229	160.5	200.5	229.0 – 229.4	12	180.5	30°
255	180.5	220.5	254.4 – 254.8	12	200.5	30°
300	216	256	300.2 – 300.4	12	236	30°
350	256	296	350.2 – 350.4	16	276	22.5°
417	305	345	417.0 – 417.4	16	325	22.5°

†52 mm and 57 mm rings have dimple fiducial features and no slots.

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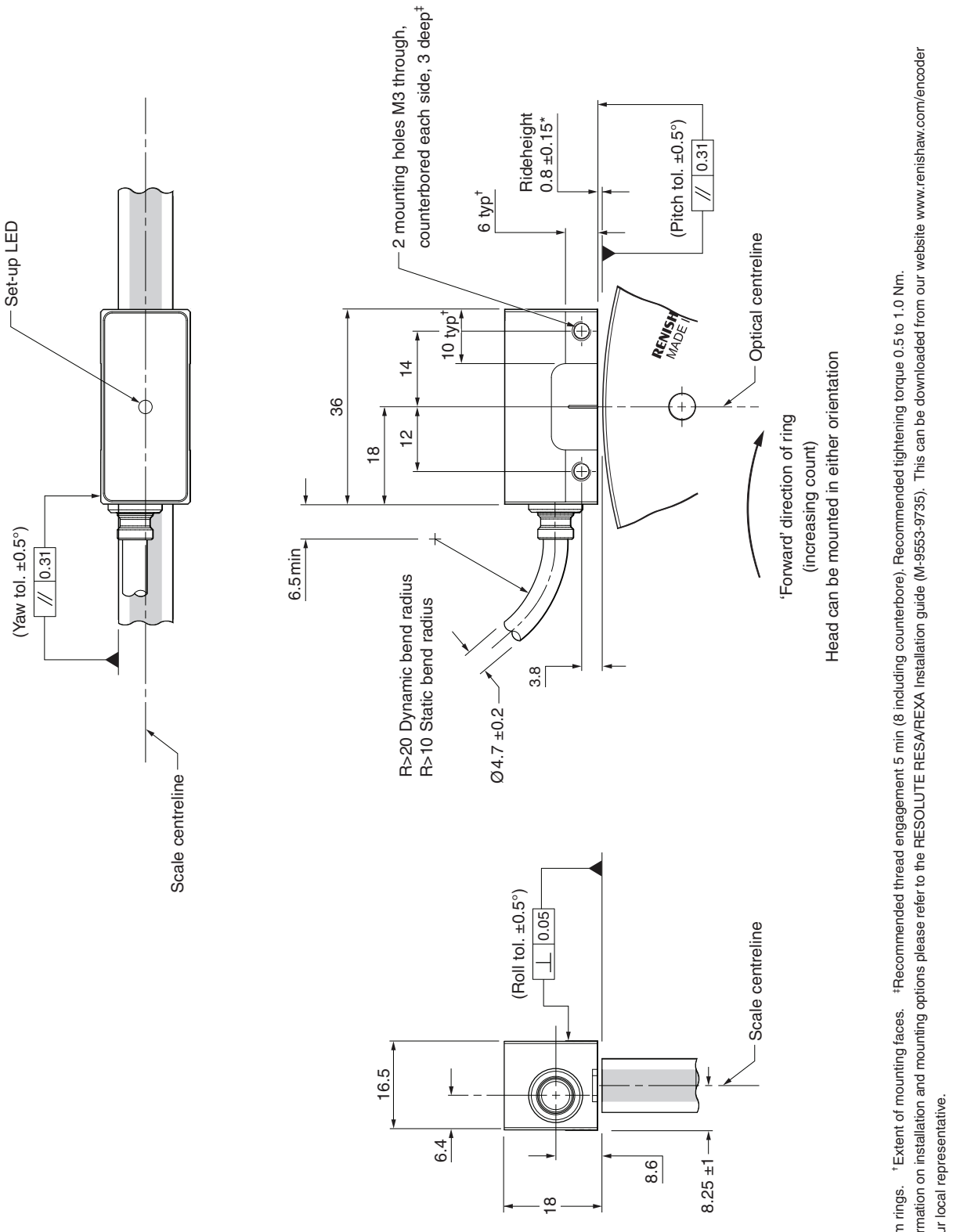
RESOLUTE installation drawing

Dimensions and tolerances in mm

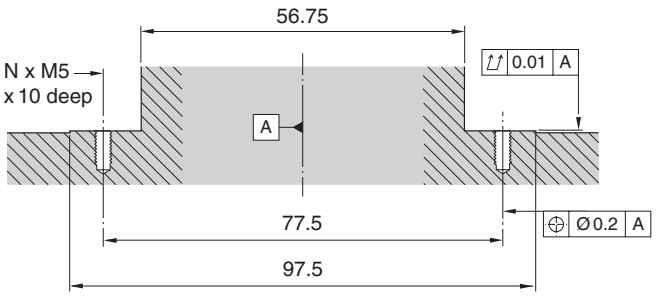


*0.1 on 52 mm rings. †Extent of mounting faces. ‡Recommended thread engagement 5 min (8 including counterbore). Recommended tightening torque 0.5 to 1.0 Nm.
For more information on installation and mounting options please refer to the RESOLUTE RESA/REXA Installation guide (M-9553-9735). This can be downloaded from our website www.renishaw.com/encoder or contact your local representative.

Mounting method

(**Important**: flange mount only. Do **NOT** interference fit)

NOTE: If using REXA with a RESOLUTE ETR, please contact your local Renishaw representative for more information.

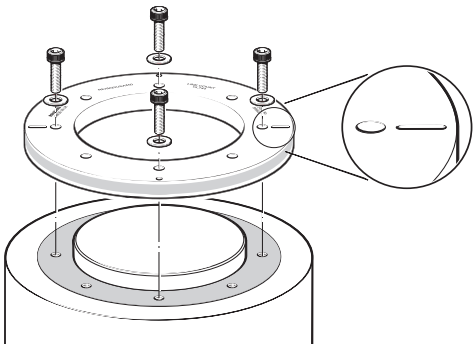


For other ring sizes refer to the RESOLUTE RESA/REXA installation guide (M-9553-9735) which can be found on **www.renishawsupport.com/encoders**

Example of mounting surface for 104 mm REXA

Installation technique

(Please refer to the RESA/REXA installation guide (M-9553-9735) for full details).



REXA rings are made with 4 fiducial points engraved onto the top surface, which simplify alignment.

Using a suitable dial test indicator, positioned so that the stylus ball touches directly onto the scale surface, the ring only needs to be adjusted for run-out at the 4 fiducial points.

Operating specifications

Material		303/304 stainless steel
Coefficient of expansion (at 20 °C)		15.5 ±0.5 µm/m/°C
Temperature (system)	Storage	Standard RESOLUTE: -20 °C to +80 °C
		ETR: -40 °C to +80 °C
		UHV: 0 °C to +75 °C
(readhead)	Operating	Standard RESOLUTE: 0 °C to +80 °C
		ETR: -40 °C to +80 °C
		UHV: 0 °C to +75 °C
(interface)	Operating	Siemens DRIVE-CLiQ: 0 °C to +55 °C

Ring mass and inertia

Ring diameter (mm)	52	57	75	100	103	104	115	150	183
Mass (kg)	0.12	0.16	0.24	0.41	0.45	0.47	0.53	0.84	1.16
Inertia (kg-cm²)	0.52	0.79	2.22	6.94	7.89	8.31	11.7	33.3	70.4

Ring diameter (mm)	200	206	209	229	255	300	350	417
Mass (kg)	1.35	1.43	1.49	1.68	2.02	2.73	3.59	5.09
Inertia (kg-cm²)	99	111	118	164	246	468	845	1 700

Resolution

RESOLUTE is 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, eg **FANUC** 27 bit resolution is available on all ring sizes.

***BiSS* RESOLUTE** resolution options:
18 bit (262 144 counts per revolution, ≈ 4.94 arc second)
26 bit (67 108 864 counts per revolution, ≈ 0.019 arc second)
32 bit (4 294 967 296 counts per revolution, ≈ 0.00030 arc second)
Note that 32 bit resolution is below the noise floor of the RESOLUTE encoder.

FANUC and **Mitsubishi RESOLUTE** resolution options:
23 bit (8 388 608 counts per revolution, ≈ 0.15 arc second)
27 bit (134 217 728 counts per revolution, ≈ 0.0097 arc second)

Pansonic RESOLUTE resolution option:
23 bit (8 388 608 counts per revolution, ≈ 0.15 arc second)

Yaskawa RESOLUTE resolution option:
24 bit (16 777 216 counts per revolution, ≈ 0.077 arc second)

Siemens DRIVE-CLiQ RESOLUTE resolution options:
26 bit (67 108 864 counts per revolution, ≈ 0.019 arc second)
29 bit (536 870 912 counts per revolution, ≈ 0.0024 arc second)

For resolution options on other protocols, please contact Renishaw.

Speed

REXA diameter (mm)	Maximum speed (rev/min)
52	8 500
57	7 300
75	7 100
100	4 700
103	4 400
104	4 400
115	3 800
150	2 700
183	2 500
200	2 200
206	2 100
209	2 000
229	1 800
255	1 600
300	1 200
350	1 200
417	900

NOTE: Maximum speed for REXA rings is limited by mechanical effects. The readhead is capable of reading much higher speeds. For more information and advice on using angle encoders at high speed, please contact Renishaw.

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REXA absolute ultra high accuracy angle encoder part numbers

REXA 30U S A 150 B

Scale code options
B - Standard

Diameter (mm)

052 = 52 mm	200 = 200 mm
057 = 57 mm	206 = 206 mm
075 = 75 mm	209 = 209 mm
100 = 100 mm	229 = 229 mm
103 = 103 mm	255 = 255 mm
104 = 104 mm	300 = 300 mm
115 = 115 mm	350 = 350 mm
150 = 150 mm	417 = 417 mm
183 = 183 mm	

Form
A = (Standard section)

Material
S = Stainless steel

Pitch
30U = 30 µm

Absolute ultra-high accuracy angle encoder series

REXA compatible readhead

REXA

RESOLUTE

Installation guide M-9553-9735

Data sheet *BiSS* L-9517-9448
FANUC L-9517-9442
Mitsubishi L-9517-9454
Siemens DRIVE-CLiQ L-9517-9524
Yaskawa L-9517-9436
Panasonic L-9517-9460

RESOLUTE UHV

Data sheet L-9517-9530

RESOLUTE ETR

Data sheet L-9517-9420

For worldwide contact details, please visit our main website at www.renishaw.com/contact

L-9517-9405-03

Data sheet
L-9517-9834-01-D

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Advanced Diagnostic Tool ADTa-100

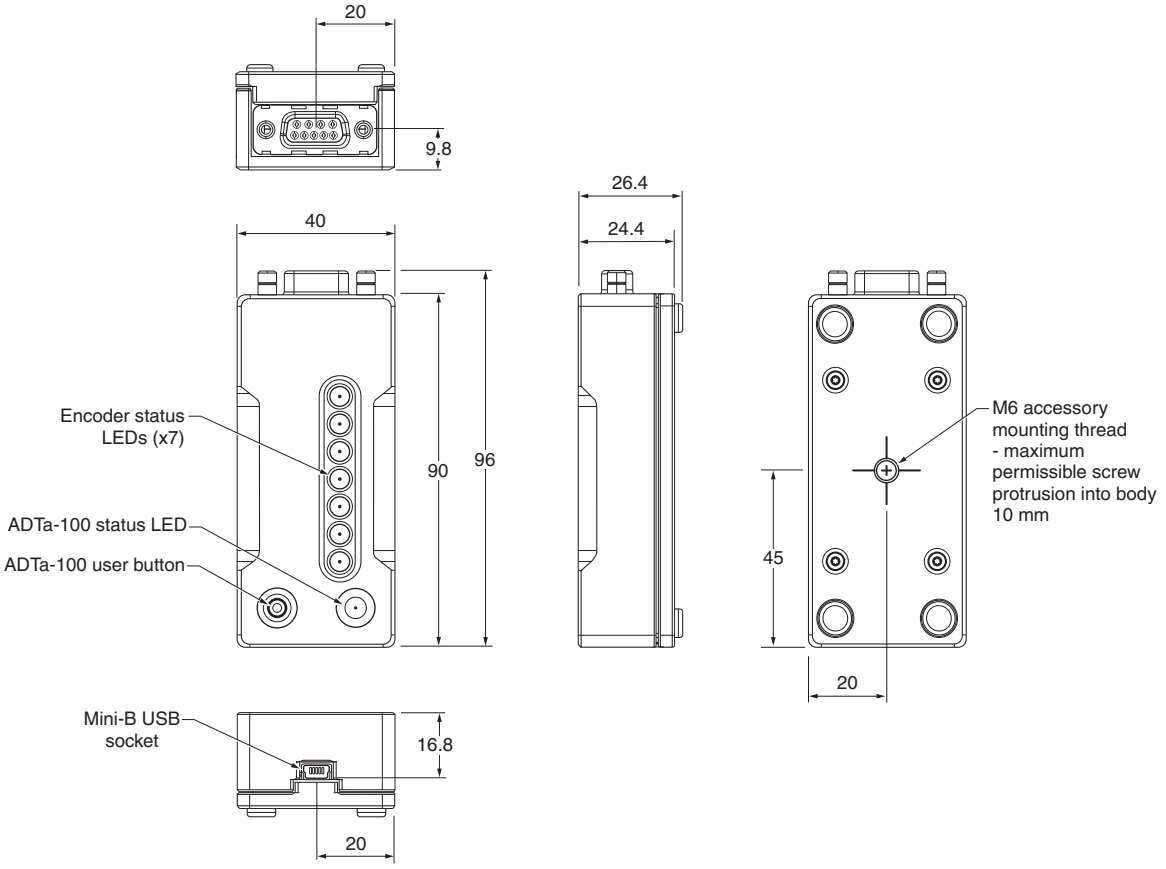
The ADTa-100 (A-6525-0100) is a set-up tool and diagnostic accessory specifically designed to be used with Renishaw absolute encoder products. It also allows for writing a new zero position.*

It can be used in a stand-alone mode or in conjunction with a PC‡ running the ADT View software.

*Write zero command is available only for BiSS C, Yaskawa and Panasonic protocols.

‡Supported Windows® operating systems (x86 or x64): 7 SP1, 8.1, 10.

Function	Signal		Encoder input pins
Power	5 V		4, 5
	0 V		8, 9
Serial communications	REQ/SD	+	2
		–	3
Shield (case)	Outer		Cable screen
Not connected	-		1, 6, 7



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General specifications

Power supply	5V ±10%	Typically < 340 mA (ADTa-100 and readhead)
		Power from a 5 Vdc supply complying with the requirements for SELV of standard IEC 60950-1 or via PC's USB port
	Typical power consumption	< 1.25 W
	Ripple	200 mVpp maximum @ frequency up to 500 kHz
Temperature	Storage	–20 °C to +70 °C
	Operating	0 °C to +55 °C
Humidity		95% relative humidity (non-condensing) to IEC 60068-2-78
Sealing		IP20
Shock	Operating	500 m/s², 11 ms, ½ sine, 3 axes
Vibration	Operating	40 m/s² max @ 55 Hz to 2000 Hz
Mass		155 g
EMC compliance		IEC 61326-1

For available adapter cables with alternative readhead terminations contact your local Renishaw representative.
Using the recommended USB cable (A-9572-0098) the ADTa-100 can be connected direct to a PC.

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