

# QUANTiC™ series encoder system



The QUANTiC™ encoder series provides robust incremental position measurement for linear, partial arc and rotary systems with excellent metrology and wide installation tolerances. This reduces or eliminates the need for mounting adjustment during the installation process.

QUANTiC encoders include Renishaw's high-performance integrated interpolation technology, removing the need for additional adaptors or separate interfaces. This provides stable and reliable position signals for a wide range of demanding measurement and motion control applications.

The easy-to-use built-in installation and calibration functions can be enhanced with the optional Advanced Diagnostic Tool ADTi-100, providing comprehensive real-time encoder feedback during installation and diagnostics.

In addition to Renishaw's proven unique filtering optics, QUANTiC encoders have a new detector design which gives superior signal purity and dirt immunity. They are combined in a compact readhead body, joining the VIONiC™ and TONiC™ family of encoders.

- Compact, all-in-one, optical encoder with analogue or digital output
- Wide tolerances
  - Rideheight from  $\pm 0.3$  mm
  - Yaw  $\pm 0.9^\circ$
- Compatible with a wide range of linear, partial arc and rotary scales with *IN-TRAC*™ auto-phase reference mark (datum)
- Maximum speed to 24 m/s (3.63 m/s at 0.1  $\mu$ m resolution)
- Excellent dirt immunity
- Resolutions from 10  $\mu$ m to 50 nm
- Integrated set-up LED for ease of installation
- Auto Gain Control (AGC), Auto Balance Control (ABC) and Auto Offset Control (AOC) ensure consistent signal strength for long-term reliability
- Integrated dual limits (linear only)
- Optional Advanced Diagnostic Tool ADTi-100 to optimise set-up and assist with system diagnostics

## System features

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### In-built reliability and ease of installation

▶ **Robust position measurement over contamination**

QUANTiC encoder readheads ensure excellent motion control performance in a wide range of applications by minimising positional error over scale contamination. A new detector design provides an additional layer of signal filtering which helps to eliminate non-harmonic signal frequencies, ensuring low sub-divisional error (SDE) and minimal signal variation over dirt or contamination on the scale.

▶ **Easy installation and setup**

The advanced optical design and signal processing of the QUANTiC encoder provides increased installation and operational tolerances whilst maintaining metrological performance. Low cost of ownership is achieved through reduced installation and setup times.

▶ **High speed performance**

With best-in-class signal processing and optimum detector design, QUANTiC can achieve speeds up to 24 m/s to meet the most demanding motion control requirements. This enables end users to increase system throughput reducing cost per part to the end user.



### Optional Advanced Diagnostic Tool ADTi-100\*


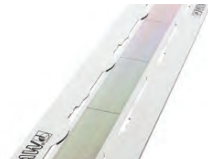

The QUANTiC encoder system is compatible with the Advanced Diagnostic Tool ADTi-100 and ADT View software. They provide comprehensive real-time encoder data feedback to aid more challenging installations and diagnostics. The intuitive software interface can be used for:

- ▶ Remote calibration
- ▶ Signal optimisation over the entire axis length
- ▶ Readhead pitch indication
- ▶ Limit and reference mark indication
- ▶ Readout of encoder position (relative to scale)
- ▶ Monitoring velocity
- ▶ Exporting and saving data

\* For more information refer to *Advanced Diagnostic Tool ADTi-100* data sheet (Renishaw part no. L-9517-9699).

## Compatible scales


### Linear scales

	RTL40-S	RTL40 / FASTRACK™	RKLC40-S†
	Self-adhesive mounted stainless steel tape scale	Stainless steel tape scale and self-adhesive mounted carrier	Self-adhesive mounted stainless steel tape scale
			
<b>Form</b> (H × W)	0.4 mm × 8 mm including adhesive	RTL40 scale: 0.2 mm × 8 mm FASTRACK carrier: 0.4 mm × 18 mm including adhesive	0.15 mm × 6 mm including adhesive
<b>Accuracy</b> (includes slope and linearity)	RTL40-S: ±15 µm/m RTL40H-S: ±5 µm/m	RTL40: ±15 µm/m RTL40H: ±5 µm/m	RKLC40-S: ±15 µm/m RKLC40H-S: ±5 µm/m
<b>Linearity</b> (Figures achievable with two-point error correction)	RTL40-S: ±5 µm/m RTL40H-S: ±2.5 µm/m	RTL40: ±5 µm/m RTL40H: ±2.5 µm/m	RKLC40-S: ±3 µm/m RKLC40H-S: ±2.5 µm/m
<b>Maximum length</b>	10 m* (> 10 m available on request)	10 m (> 10 m available on request)	20 m (> 20 m available on request)
<b>Coefficient of thermal expansion</b> (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

\* For RTL40-S axis lengths > 2 m, FASTRACK carrier with RTL40 is recommended

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

### Rotary scales

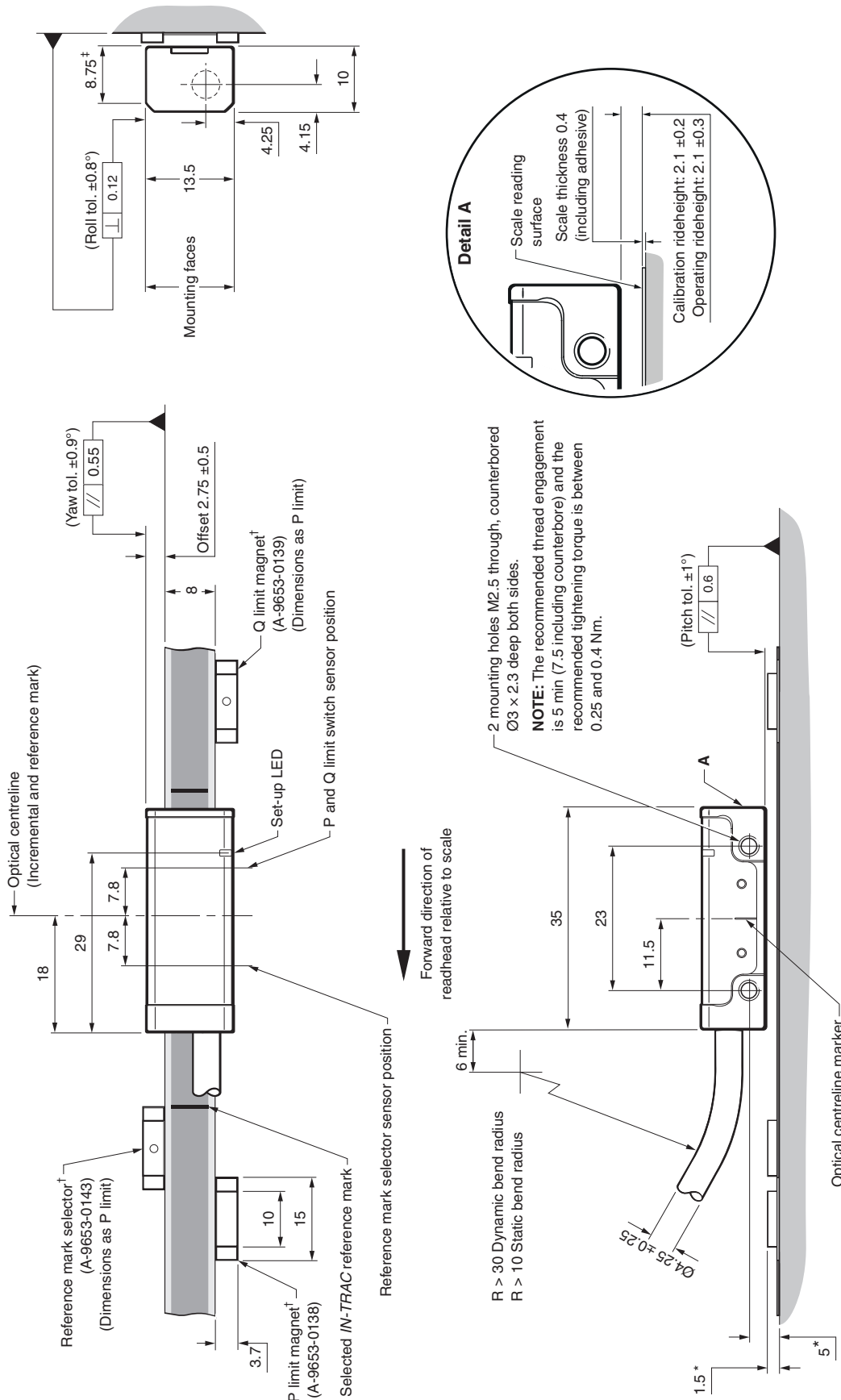
	RESM40
	Stainless steel ring
	
<b>Typical installed accuracy</b> †	±1.9 arc second (550 mm diameter RESM40 ring)
<b>Ring diameters</b>	52 mm to 550 mm
<b>Coefficient of thermal expansion</b> (at 20 °C)	15.5 ±0.5 µm/m/°C

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

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

**QUANTiC encoder system installation drawing (on RTLC40-S scale)**

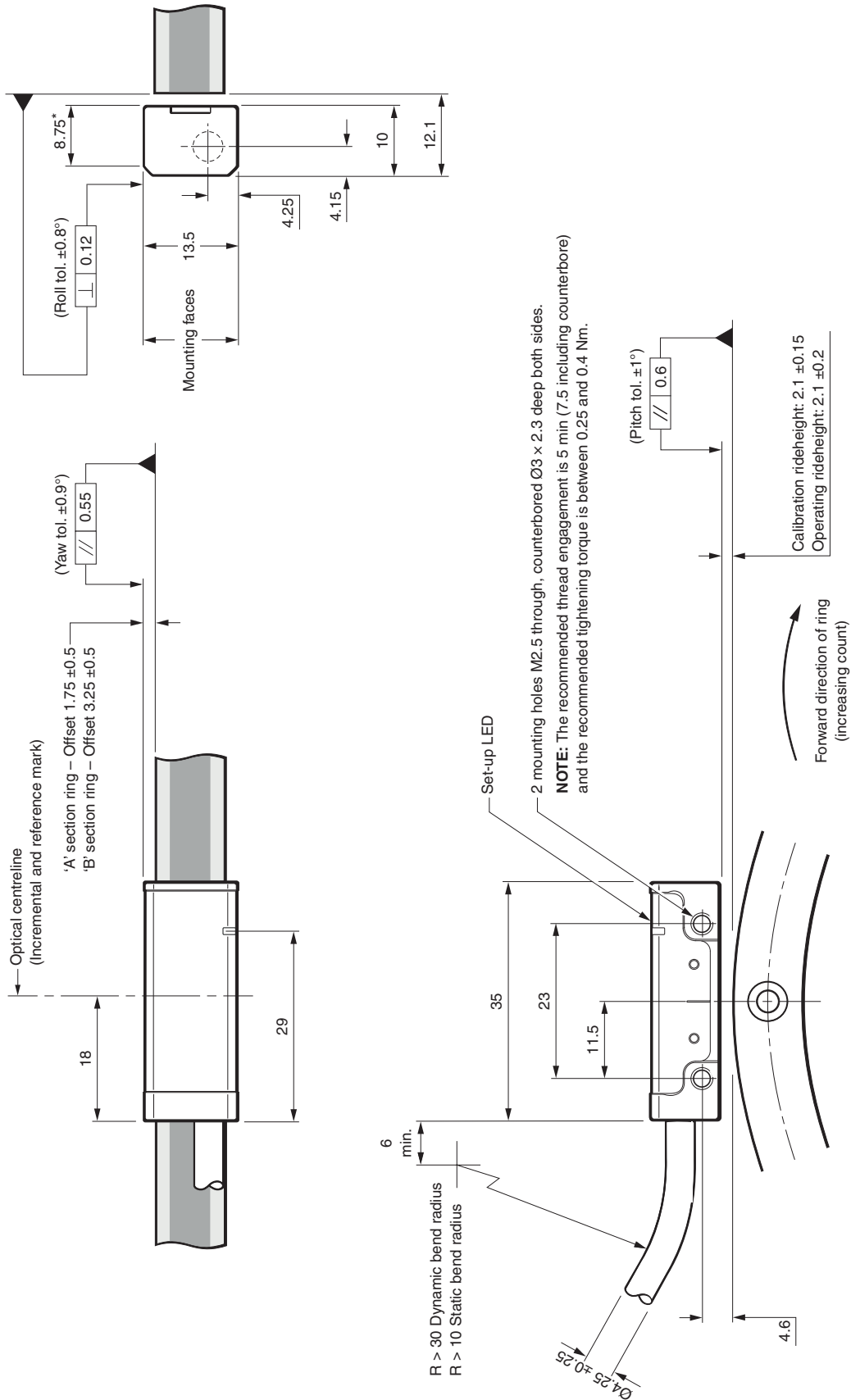
Dimensions and tolerances in mm



\* Dimensions from substrate surface. † Bolted reference mark selector magnet and limit magnet available. See the relevant QUANTiC encoder system installation guide for further details. ‡ Extent of mounting faces.  
**NOTES:** QUANTiC encoder system on RTLC40-S shown. For detailed installation drawings for other scale types, refer to the relevant QUANTiC encoder system installation guide or scale data sheet.  
 External magnetic fields greater than 6 mT, in the vicinity of the readhead, may cause false activation of the limit and reference sensors.


**QUANTiC encoder system installation drawing (on RESM40 ring)**

Dimensions and tolerances in mm



\* Extent of mounting face.  
**NOTES:** QUANTiC encoder system on RESM40 ring shown. For detailed installation drawings for other scale types, refer to the relevant QUANTiC encoder system installation guide or scale data sheet.  
 External magnetic fields greater than 6 mT, in the vicinity of the readhead, may cause false activation of the limit and reference sensors.

## General specifications

<b>Power supply</b>	5 V -5%/+10%	Typically 150 mA fully terminated (analogue output) Typically 200 mA fully terminated (digital output) Power 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	
<b>Temperature</b> (system)	Storage	-20 °C to +70 °C	
	Operating	0 °C to +70 °C	
<b>Humidity</b> (system)		95% relative humidity (non-condensing) to IEC 60068-2-78	
<b>Sealing</b>		IP40	
<b>Acceleration</b>	Operating	400 m/s <sup>2</sup> , 3 axes	
<b>Shock</b>	Operating	500 m/s <sup>2</sup> , 11 ms, ½ sine, 3 axes	
<b>Vibration</b>	Operating	100 m/s <sup>2</sup> max @ 55 Hz to 2000 Hz, 3 axes	
<b>Mass</b>	Readhead	9 g	
	Cable	26 g/m	
<b>EMC compliance</b>		IEC 61326-1	
<b>Readhead cable</b>		Single-shielded, outside diameter 4.25 ±0.25 mm Flex life > 20 × 10 <sup>6</sup> cycles at 30 mm bend radius UL recognised component 	
	Maximum cable length*	5 m (analogue output) 3 m (digital output)	
<b>Connector options</b>	<b>Code - connector type</b>		
	A - 9-way D-type - Digital output only		
	L - 15-way D-type (standard pin-out) - Analogue output only		
	D - 15-way D-type (standard pin-out) - Digital output only		
	H - 15-way D-type (alternative pin-out)		
	X - 12-way circular connector - Digital output only		
	J - 14-way JST connector		
<b>Typical sub-divisional error (SDE)</b>		<b>Analogue output</b> †	<b>Digital output</b>
	Linear	< ±120 nm	< ±80 nm
	Rotary ≤ Ø135 mm	< ±120 nm	< ±80 nm
	Rotary > Ø135 mm	< ±150 nm	< ±150 nm

\* Extension cables available. Contact your local Renishaw representative for further details.

† SDE has been measured when used with a Ti interface.

## Speed

### Digital readheads

Clocked output option (MHz)	Maximum speed (m/s)							Minimum edge separation* (ns)
	T (10 µm)	D (5 µm)	X (1 µm)	Z (0.5 µm)	W (0.2 µm)	Y (0.1 µm)	H (50 nm)	
50	24	24	24	18.13	7.25	3.626	1.813	25.1
40	24	24	24	14.50	5.80	2.900	1.450	31.6
25	24	24	18.13	9.06	3.63	1.813	0.906	51.0
20	24	24	16.11	8.06	3.22	1.611	0.806	57.5
12	24	24	10.36	5.18	2.07	1.036	0.518	90.0
10	24	24	8.53	4.27	1.71	0.853	0.427	109
08	24	24	6.91	3.45	1.38	0.691	0.345	135
06	24	24	5.37	2.69	1.07	0.537	0.269	174
04	24	18.13	3.63	1.81	0.73	0.363	0.181	259
01	9.06	4.53	0.91	0.45	0.18	0.091	0.045	1038

### Analogue readheads

Maximum speed: 20 m/s (-3dB)<sup>†</sup>

### Angular speeds

Angular speed depends on ring diameter – use the following equation to convert to rev/min:

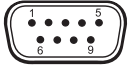
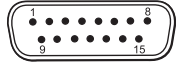

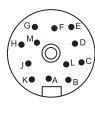

$$\text{Angular speed (rev/min)} = \frac{V \times 1000 \times 60}{\pi D} \quad \text{Where } V = \text{maximum linear speed (m/s) and} \\ D = \text{external diameter of RESM40 ring (mm).}$$

\* For a readhead with a 1 m cable.

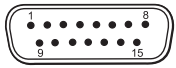

<sup>†</sup> At speeds > 20 m/s, SDE may be affected.

## Output signals

### Digital outputs

							
Function	Signal	Colour	9-way D-type (A)	15-way D-type (D)	15-way D-type alternative pin-out (H)	12-way circular connector†	14-way JST‡
Power	5 V	Brown	5	7, 8	4, 12	G	10
	0 V	White	1	2, 9	2, 10	H	1
Incremental	A	+	2	14	1	M	7
		-	6	6	9	L	2
	B	+	4	13	3	J	11
		-	8	5	11	K	9
Reference mark	Z	+	3	12	14	D	8
		-	7	4	7	E	12
Limits	P	Pink	-	11	8	A	14
	Q	Black	-	10	6	B	13
Alarm	E	Orange	-	3	13	F	3
Remote CAL*	CAL	Clear	9	1	5	C	4
Shield	-	Screen	Case	Case	Case	Case	Ferrule

### Analogue outputs

						
Function	Signal	Colour	15-way D-type (L)	15-way D-type alternative pin-out (H)	14-way JST‡	
Power	5 V	Brown	4, 5	4, 12	10	
	0 V	White	12, 13	2, 10	1	
Incremental	Cosine	$V_1$	+	9	1	7
			-	1	9	2
	Sine	$V_2$	+	10	3	11
			-	2	11	9
Reference mark	$V_0$	+	3	14	8	
		-	11	7	12	
Limits	$V_p$	Pink	7	8	14	
	$V_q$	Black	8	6	13	
Setup	$V_x$	Clear	6	13	6	
Remote CAL*	CAL	Orange	14	5	4	
Shield	-	Screen	Case	Case	Ferrule	

\* Remote CAL line must be connected for use with ADTi-100

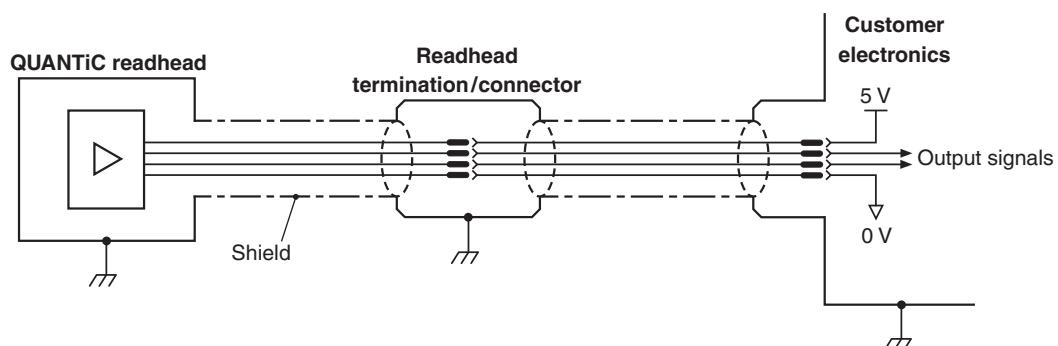
† 12-way circular Binder mating socket - A-6195-0105.

‡ Pack of 5 14-way JST SH mating sockets: A-9417-0025 - Bottom mount; A-9417-0026 - Side mount.



## Electrical connections

### Grounding and shielding



**IMPORTANT:** The shield should be connected to the machine earth (Field Ground).  
For JST variants the ferrule should be connected to the machine earth.

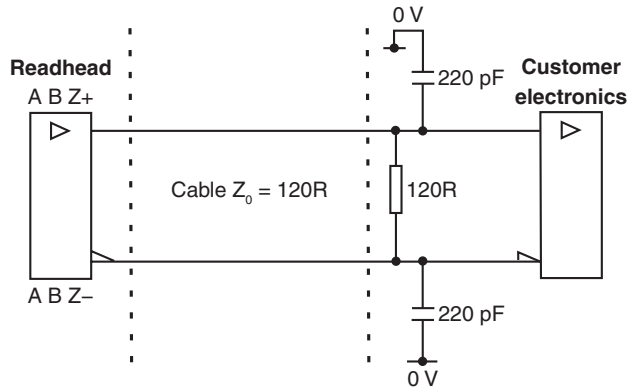
### Maximum cable length

	Analogue	Digital
Readhead cable	5 m	3 m
Maximum extension cable length	Dependent on cable type, readhead cable length and clocked output option. Contact your local Renishaw representative for more information.	
Readhead to ADTi-100	5 m	3 m

## Electrical connections (continued)

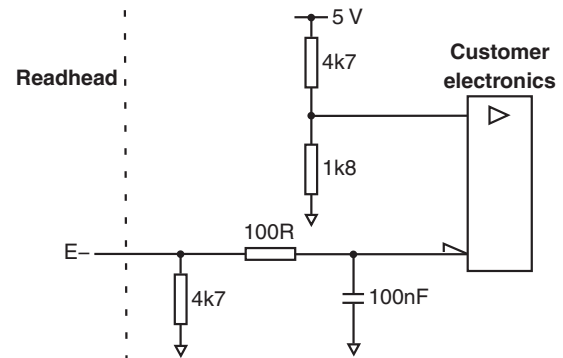
### Recommended signal termination

#### Digital outputs

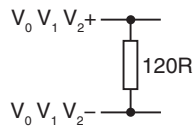


Standard RS422A line receiver circuitry.  
Capacitors recommended for improved noise immunity.

#### Single ended alarm signal termination (Not available with 'A' cable termination)



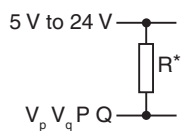
#### Analogue outputs



**NOTE:** 120R termination on the analogue output signals is essential for correct AGC operation.

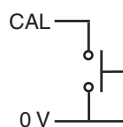
#### Limit output

(Not available with 'A' cable termination)



\* Select R so that maximum current does not exceed 20 mA.  
Alternatively, use a suitable relay or opto-isolator.

### Remote CAL operation



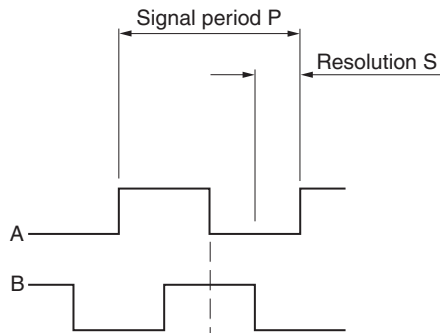
Remote operation of the CAL/AGC is possible via CAL signal.

## Output specifications

### Digital output signals

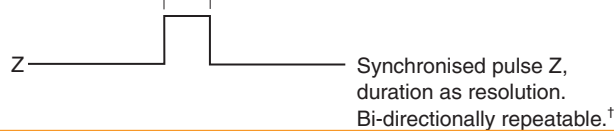
Form – Square wave differential line driver to EIA RS422A (except limits P and Q)

**Incremental\*** 2 channels A and B in quadrature (90° phase shifted)



Resolution option code	P (µm)	S (µm)
T	40	10
D	20	5
X	4	1
Z	2	0.5
W	0.8	0.2
Y	0.4	0.1
H	0.2	0.05

### Reference\*

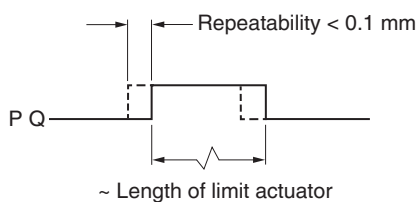


**NOTE:** A wide reference mark option, outputting a reference pulse for the duration of the signal period is available. Contact your local Renishaw representative for more information.

### Limits

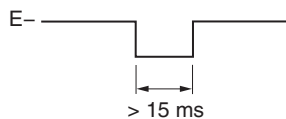
Open collector output, asynchronous pulse  
(Not available with 'A' cable termination)

#### Active high



### Alarm

**Line driven** (Asynchronous pulse)  
(Not available with 'A' cable termination)



Alarm asserted when:

- Signal amplitude < 20% or > 135%
- Readhead speed too high for reliable operation

### or 3-state alarm

Differentially transmitted signals forced open circuit for > 15 ms when alarm conditions valid.

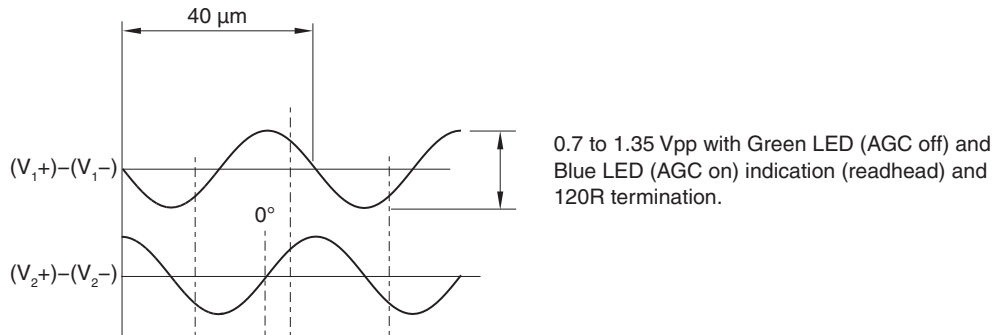
\* Inverse signals not shown for clarity.

† Only calibrated reference mark is bi-directionally repeatable.

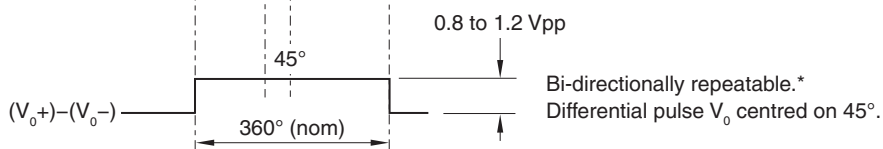
## Output specifications (continued)

### Analogue output signals

**Incremental** 2 channels  $V_1$  and  $V_2$  differential sinusoids in quadrature, centred on  $\sim 1.65$  V ( $90^\circ$  phase shifted)



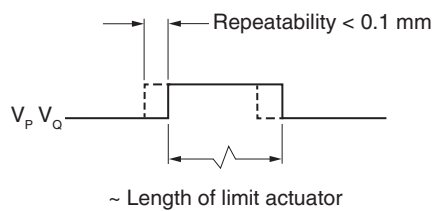
### Reference



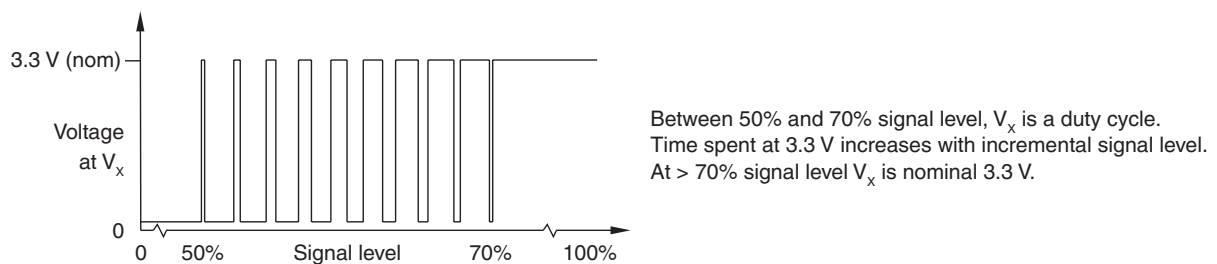
### Limits

Open collector output, asynchronous pulse

#### Active high



### Set-up†



\* Only calibrated reference mark is bi-directionally repeatable.

† Set-up signal as shown is not present during calibration routine.







## Analogue linear readhead part numbers

	Q4	B	C	A	30	L	00	T
<b>Readhead series</b>	Q4 - 40 µm QUANTiC							
<b>Readhead type</b>	B - Linear							
<b>Scale type compatibility</b>	C - RTLC40 / RTLC40-S / RKLC40-S							
<b>Output</b>	A - 1 Vpp differential analogue signal							
<b>Cable length*</b>	02 - 0.2 m (not available with 'J' cable termination)    20 - 2 m (not available with 'J' cable termination) 05 - 0.5 m    30 - 3 m 10 - 1 m    50 - 5 m (not available with 'J' cable termination) 15 - 1.5 m (not available with 'J' cable termination)							
<b>Cable termination</b>	L - 15-way D-type plug (standard pin-out) H - 15-way D-type plug (alternative pin-out) J - 14-way JST connector (0.5 m, 1 m, 3 m and 5 m cables only)							
<b>Clocked output option</b>	00 - No clock							
<b>Reference mark options†</b>	T - Customer selectable reference mark U - All reference marks are output							

\* Extension cables available. Contact your local Renishaw representative for further details.

† T - 'Customer selectable reference mark' - Reference pulse triggered only with selector magnet. Allows activation of specific reference mark when scale has multiple *IN-TRAC* reference marks.

U - 'All reference marks are output' - Reference pulse triggered without selector magnet. Recommended for scale with single *IN-TRAC* reference mark. Only calibrated reference mark is bi-directionally repeatable.

**NOTE:** Not all combinations are valid. Check valid options online at [www.renishaw.com/epc](http://www.renishaw.com/epc)



## Analogue rotary readhead part numbers

	Q4	B	J	A	30	L	00	U
<b>Readhead series</b>	Q4 - 40 µm QUANTiC							
<b>Readhead type</b>	B - Rotary > Ø135 mm ('J' scale type compatibility only) C - Rotary ≤ Ø135 mm ('K' and 'L' scale compatibility only)							
<b>Scale type compatibility</b>	J - RESM40 > Ø135 mm ('B' readhead type only) K - RESM40 Ø60 mm to Ø135 mm ('C' readhead type only) L - RESM40 < Ø60 mm ('C' readhead type only)							
<b>Output</b>	A - 1 Vpp differential analogue signal							
<b>Cable length*</b>	02 - 0.2 m (not available with 'J' cable termination)    20 - 2 m (not available with 'J' cable termination) 05 - 0.5 m    30 - 3 m 10 - 1 m    50 - 5 m (not available with 'J' cable termination) 15 - 1.5 m (not available with 'J' cable termination)							
<b>Cable termination</b>	L - 15-way D-type plug (standard pin-out) H - 15-way D-type plug (alternative pin-out) J - 14-way JST connector (0.5 m, 1 m, 3 m and 5 m cables only)							
<b>Clocked output option</b>	00 - No clock							
<b>Reference mark options</b>	U - All reference marks are output							

\* Extension cables available. Contact your local Renishaw representative for further details.

**NOTE:** Not all combinations are valid. Check valid options online at [www.renishaw.com/epc](http://www.renishaw.com/epc)

## Analogue partial arc readhead part numbers

	Q4	B	R	A	30	L	00	U
<b>Readhead series</b>	Q4 - 40 µm QUANTIC							
<b>Readhead type</b>	B - Partial arc radius > 67.5 mm ('R' scale type compatibility only) C - Partial arc radius ≤ 67.5 mm ('S' and 'T' scale compatibility only)							
<b>Scale type compatibility</b>	R - RKLC40-S partial arc radius > 67.5 mm ('B' readhead type only) S - RKLC40-S partial arc radius 30 mm to 67.5 mm ('C' readhead type only) T - RKLC40-S partial arc radius 26 mm to 29 mm ('C' readhead type only)							
<b>Output</b>	A - 1 Vpp differential analogue signal							
<b>Cable length*</b>	02 - 0.2 m (not available with 'J' cable termination)    20 - 2 m (not available with 'J' cable termination) 05 - 0.5 m    30 - 3 m 10 - 1 m    50 - 5 m (not available with 'J' cable termination) 15 - 1.5 m (not available with 'J' cable termination)							
<b>Cable termination</b>	L - 15-way D-type plug (standard pin-out) H - 15-way D-type plug (alternative pin-out) J - 14-way JST connector (0.5 m, 1 m, 3 m and 5 m cables only)							
<b>Clock output option</b>	00 - No clock							
<b>Reference mark options†</b>	U - All reference marks are output							

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

\* Extension cables available. Contact your local Renishaw representative for further details.

† Only calibrated reference mark is bi-directionally repeatable.

**NOTE:** Not all combinations are valid. Check valid options online at [www.renishaw.com/epc](http://www.renishaw.com/epc)

## Optional Advanced Diagnostic Tool ADTi-100

Part description	Part number	Product image
ADTi-100	A-6195-0100	
ADT View software	Free to download from <a href="http://www.renishaw.com/adt">www.renishaw.com/adt</a>	
Termination tool (analogue readheads only)	A-6195-2132	

### Adaptor cables

#### Digital readheads

Cable termination	Pin-out	Part number
A	9-way D-type	A-6195-0102
H	15-way D-type (alternative pin-out)	A-6195-0103
X	12-way circular	A-6195-0104
J	14-way JST	A-6195-2073

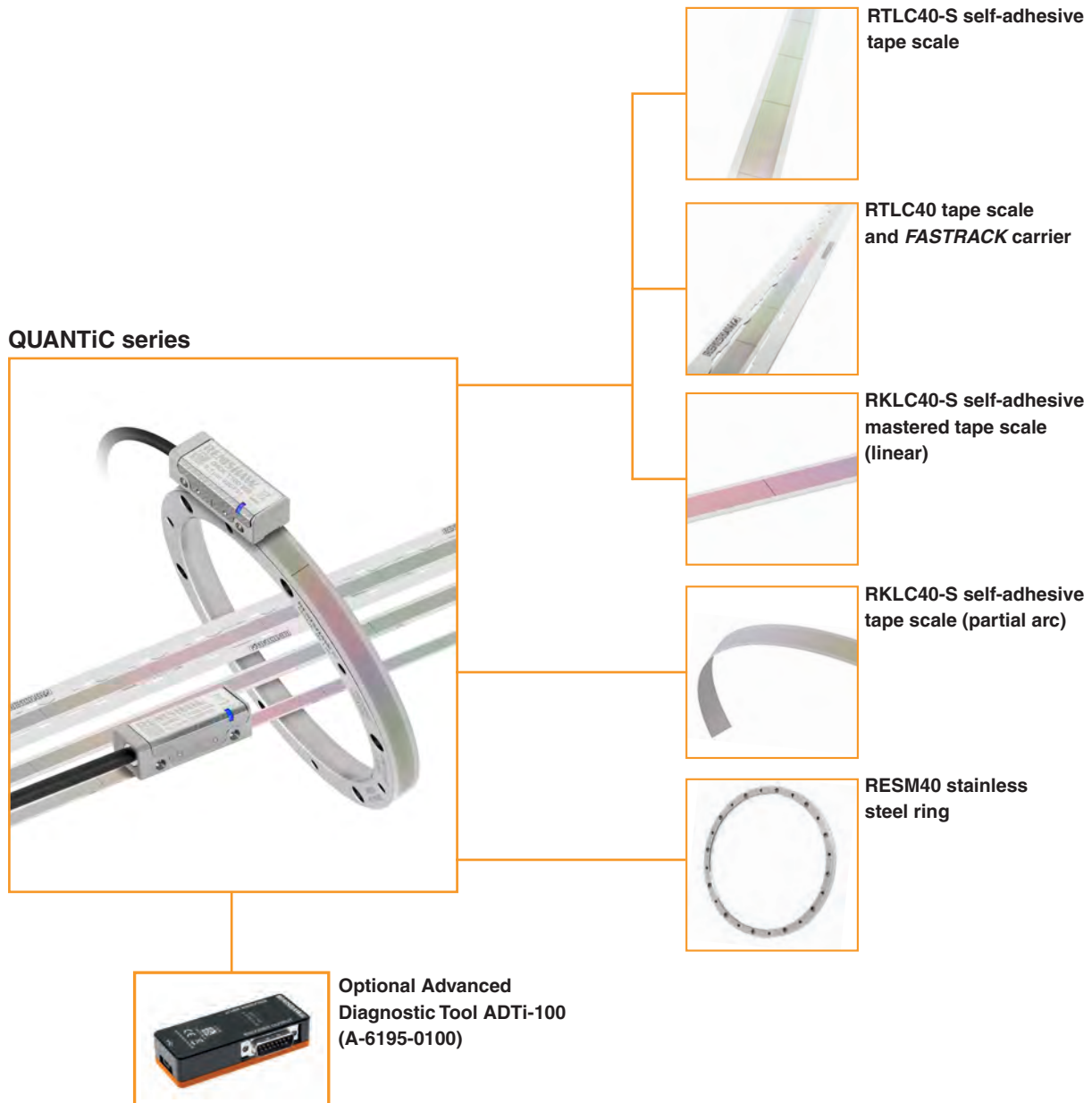
**NOTE:** Standard 15-way D-type readheads can be plugged directly into the ADT. No adaptor cable is required.

#### Analogue readheads

Cable termination	Pin-out	Part number
L	15-way D-type (standard pin-out)	A-6637-1540
H	15-way D-type (alternative pin-out)	A-6195-0103
J	14-way JST	A-6195-2073

For more information on the ADT refer to the *Advanced Diagnostic Tool ADTi-100* data sheet (Renishaw part no. L-9517-9699), *Advanced Diagnostic Tool ADTi 100 and ADT View software* user guide (Renishaw part no. M-6195-9413) and *Advanced Diagnostic Tool ADTi 100 and ADT View software* quick-start guide (Renishaw part no. M-6195-9321).

## QUANTiC compatible products:



For more information about the ADTi-100 and the scale refer to the relevant data sheets and installation guides which can be downloaded from [www.renishaw.com/quanticdownloads](http://www.renishaw.com/quanticdownloads).

For worldwide contact details, visit [www.renishaw.com/contact](http://www.renishaw.com/contact)

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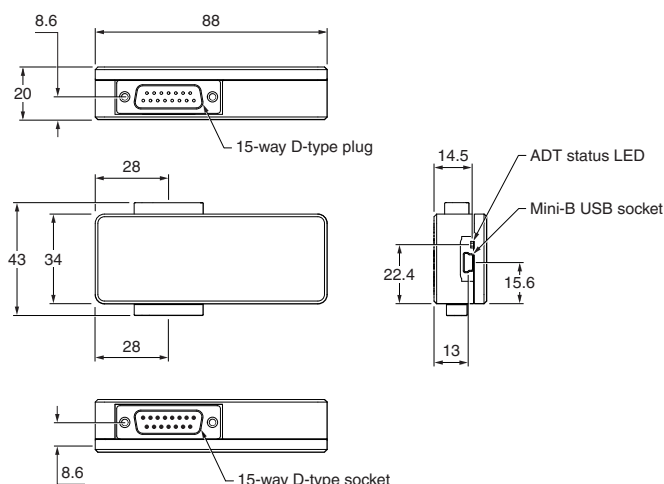
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Part no.: L-9517-9778-07-D  
Issued: 12.2022

# Advanced Diagnostic Tool ADTi-100



The ADTi-100 (A-6195-0100) is used in conjunction with a PC\* running the ADT View software†.

It provides comprehensive real-time feedback from QUANTiC™, VIONiC™ and ATOM DX™ encoders, aiding installation and diagnostics, as well as allowing system optimisation.

Function	Signal	Encoder input/output 15-way D-type	
Power	5 V	7, 8	
	0 V	2, 9	
Incremental	A	+	14
		-	6
	B	+	13
		-	5
Reference mark	Z	+	12
		-	4
Limits‡	P	11	
	Q	10	
Alarm	E -	3	
Remote CAL‡	CAL	1	
Shield	-	Case	

‡ On input connector only.

‡ Limits not available with ATOM DX.

## General specifications

<b>Power supply</b>	5V -5%/+10%	Typically 200 mA fully terminated (ADTi-100 and readhead)
		Power from a 5 V dc supply complying with the requirements for SELV of standard IEC 60950-1 or via PC's USB port
	Ripple	200 mVpp maximum @ frequency up to 500 kHz
<b>Temperature</b>	Storage	-20 °C to +70 °C
	Operating	0 °C to +55 °C
<b>Humidity</b>		95% relative humidity (non-condensing) to IEC 60068-2-78
<b>Sealing</b>		IP20
<b>Shock</b>	Operating	500 m/s <sup>2</sup> , 11 ms, ½ sine, 3 axes
<b>Vibration</b>	Operating	40 m/s <sup>2</sup> max @ 55 Hz to 2000 Hz
<b>Mass</b>		110 g
<b>EMC compliance</b>		IEC 61326-1: 2013

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

† Free ADT View software download is available directly from [www.renishaw.com/adt](http://www.renishaw.com/adt).

## ADT and accessory part numbers

Part description	Part number	Product image
ADTi-100	A-6195-0100	
USB cable (ADTi-100 to PC)	A-9572-0098	
ADT View software	Free to download from <a href="http://www.renishaw.com/adt">www.renishaw.com/adt</a>	

### Adaptor cables

Adaptor cables enable readheads with different terminations to be connected to the 15-way D-type input of the ADTi-100. Consists of two cables. One from readhead cable to ADTi-100. The other, if required, from the ADTi-100 to the controller cable.

### Digital readheads

Readhead cable termination*	Pin-out	Part number
D	15-way D-type (standard pin-out)	None required. Readhead plugs directly into ADTi-100.
A	9-way D-type	A-6195-0102
K	10-way JST	A-6195-2074
H	15-way D-type (alternative pin-out)	A-6195-0103
X	12-way circular	A-6195-0104
J	14-way JST	A-6195-2073

### Analogue readheads

**NOTE:** The ADT will require 120 Ω termination. This must be provided by, either the controller, or the termination tool. Refer to *Advanced Diagnostic Tools and ADT View software User guide* (Renishaw part no. M-6195-9413) for more information.

Readhead cable termination*	Pin-out	Part number
L	15-way D-type (standard pin-out)	A-6637-1540
H	15-way D-type (alternative pin-out)	A-6195-0103
J	14-way JST	A-6195-2073

Part description	Product image	Part number
Termination tool (For use with analogue variant of QUANTiC)		A-6195-2132

\* Determined from readhead nomenclature. Refer to relevant readhead series data sheet for full readhead nomenclatures.

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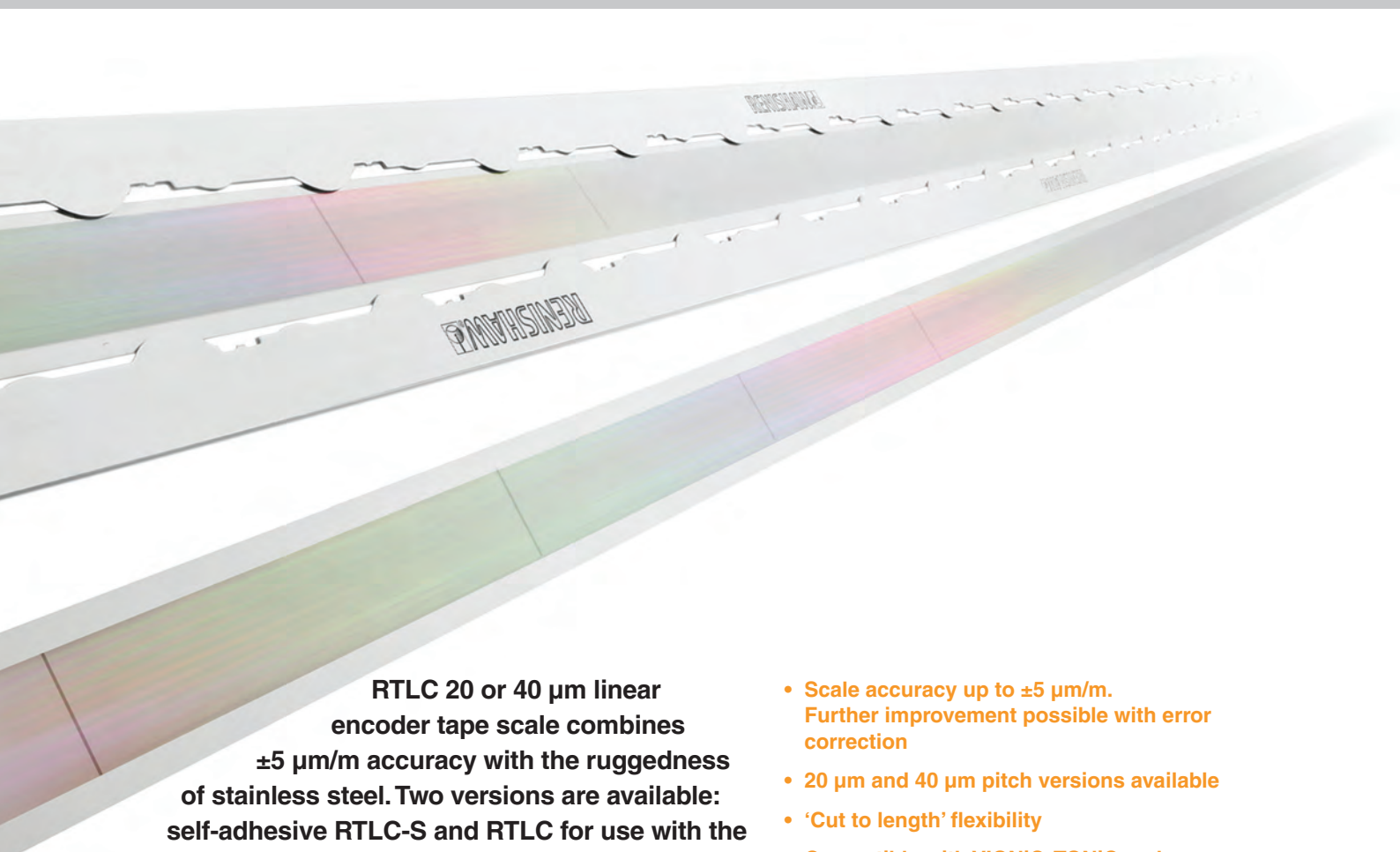
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L - 9517 - 9699 - 03

Part no.: L-9517-9699-03-B  
Issued: 09.2021

## RTLC incremental linear scale



**RTLC 20 or 40 µm linear encoder tape scale combines ±5 µm/m accuracy with the ruggedness of stainless steel. Two versions are available: self-adhesive RTLC-S and RTLC 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, RTLC is read by Renishaw's compact and reliable VIONiC™, TONiC™ and QUANTiC™ readheads.

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

RTLC (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.

- Scale accuracy up to ±5 µm/m. Further improvement possible with error correction
- 20 µm and 40 µm pitch versions available
- 'Cut to length' flexibility
- Compatible with VIONiC, TONiC and QUANTiC high-performance readheads
- RTLC 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
- RTLC scale can bridge gaps in the *FASTRACK* up to 25 mm
- High solvent immunity

## General specifications

<b>Coefficient of thermal expansion</b> (at 20 °C)	10.1 ±0.2 µm/m/°C
<b>Temperature</b> (system)	Storage -20 °C to +70 °C
	Operating 0 °C to +70 °C
<b>Humidity</b> (system)	95% relative humidity (non-condensing) to IEC 60068-2-78
<b>Shock</b> (system)	Operating 500 m/s <sup>2</sup> , 11 ms, ½ sine, 3 axe
<b>Vibration</b> (system)	Operating 100 m/s <sup>2</sup> max @ 55 to 2000 Hz, 3 axes

## RTLC-S scale specifications

Self-adhesive incremental scale

<b>Form</b> (H × W)	0.4 mm × 8 mm including adhesive
<b>Pitch</b>	RTLC20-S 20 µm
	RTLC40-S / RTLC40H-S 40 µm
<b>Accuracy</b> (at 20 °C)	RTLC20-S / RTLC40H-S ±5 µm/m
	RTLC40-S ±15 µm/m
<b>Linearity</b>	RTLC20-S / RTLC40H-S ±2.5 µm/m achievable with two point error correction
	RTLC40-S ±5 µm/m achievable with two point error correction
<b>Maximum supplied length</b>	10 m <sup>†</sup>
<b>Material</b>	Hardened and tempered stainless steel
<b>Mass</b>	12.9 g/m

## RTLC scale and *FASTRACK* carrier specifications

Incremental scale for use with *FASTRACK* carrier self-adhesive mounting system

<b>Form</b> (H × W)	0.4 mm × 18 mm including adhesive
<b>Pitch</b>	RTLC20 20 µm
	RTLC40 / RTLC40H 40 µm
<b>Accuracy</b> (at 20 °C)	RTLC20 / RTLC40H ±5 µm/m
	RTLC40 ±15 µm/m
<b>Linearity</b>	RTLC20 / RTLC40H ±2.5 µm/m achievable with two point error correction
	RTLC40 ±5 µm/m achievable with two point error correction
<b>Maximum supplied length</b>	RTLC 10 m
	<i>FASTRACK</i> 25 m
<b>Minimum recommended length of <i>FASTRACK</i></b>	100 mm
<b>Material</b>	RTLC Hardened and tempered stainless steel
	<i>FASTRACK</i> Hardened stainless steel
<b>Mass</b>	RTLC 12.2 g/m
	<i>FASTRACK</i> 24 g/m

<sup>†</sup> For lengths >2 m *FASTRACK* with RTLC is recommended.

## Reference mark




<b>Type</b>	<i>IN-TRAC</i> ™ reference mark, directly embedded into incremental track 50 mm (nominal) spacing. Bi-directional position repeatability
<b>Selection</b>	Single reference mark selection by magnetic actuator (A-9653-0143) customer positioned
<b>Repeatability</b>	Unit of resolution repeatability (bi-directional) across full system rated speed and temperature ranges

## Limit switches

<b>Type</b>	Magnetic actuators; with dimple triggers Q limit, without dimple triggers P limit (see RTLC scale installation drawing)
<b>Trigger point</b>	The limit output is nominally asserted when the readhead limit switch sensor passes the limit magnet leading edge, but can trigger up to 3 mm before that edge
<b>Mounting</b>	Customer placed at desired locations
<b>Repeatability</b>	< 0.1 mm



## Compatible readheads

	VIONiC	TONiC	QUANTiC
			
<b>Scale type</b>	RTLC20	RTLC20	RTLC40
<b>Pitch</b>	20 µm	20 µm	40 µm
<b>Outputs</b>	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.
<b>SDE (typical)</b>	< ±15 nm	±30 nm	< ±80 nm*
<b>Jitter (RMS)</b>	down to 1.6 nm	down to 0.5 nm	down to 2.73
<b>Maximum speed</b>	12 m/s	10 m/s	24 m/s*

\*Digital variants.

### Readhead features

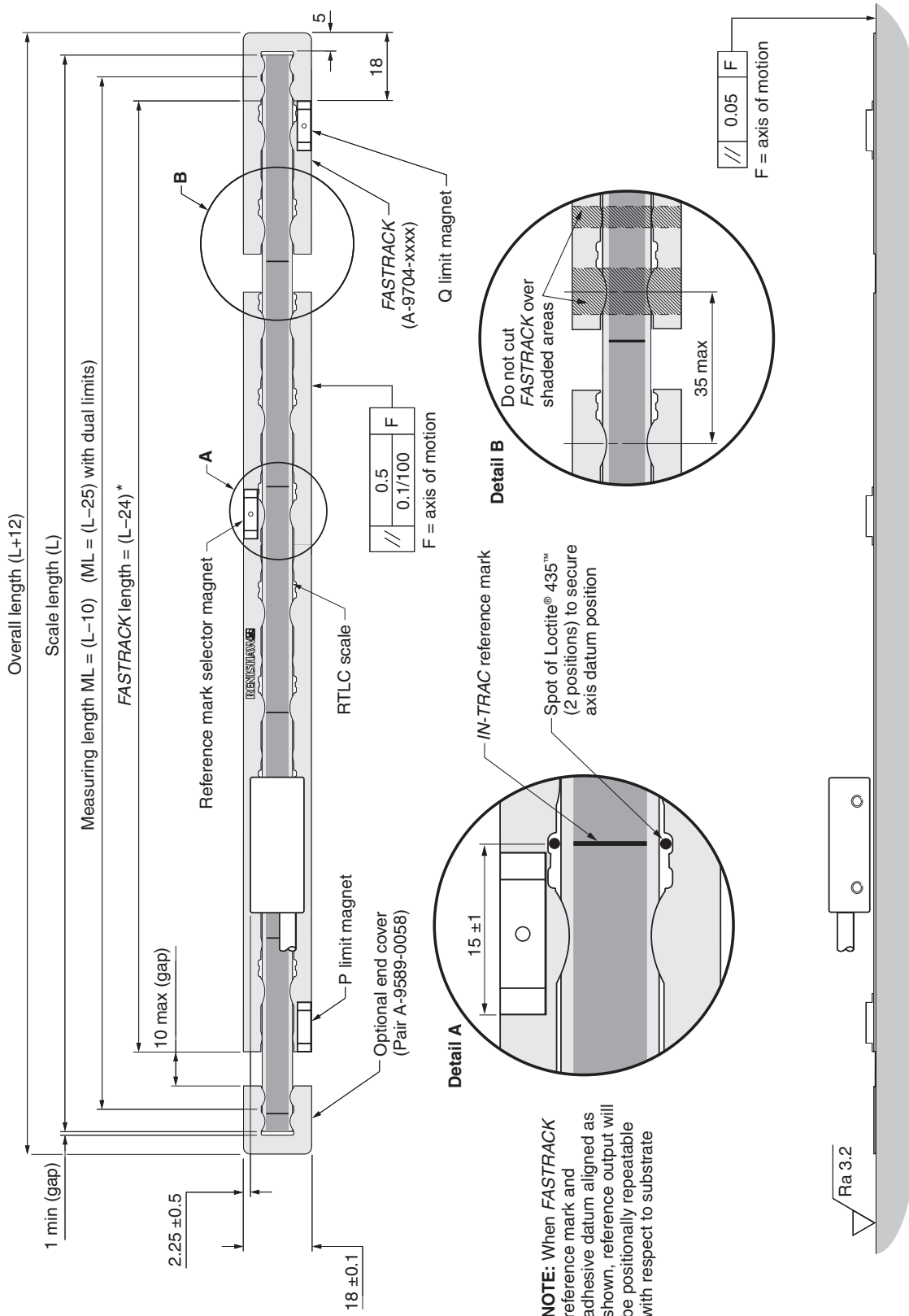
- ▶ Filtering optics and Auto Gain Control for high reliability and solid Lissajous signals.
- ▶ Dynamic signal processing ensures ultra-low sub-divisional error (SDE).  
Result: smoother scanning performance.
- ▶ High signal-to-noise ratio provides ultra-low jitter for optimum positional stability.
- ▶ Auto-phasing of *IN-TRAC* reference mark.
- ▶ Clocked outputs ensure optimised speed performance for all resolutions, for a wide variety of industry-standard controllers.
- ▶ DOP Dual output interfaces available to provide simultaneous analogue and digital outputs (TONiC systems only).

## RTLC and FASTRACK carrier installation drawing (adhesive datum clamp method†)

For further details, please refer to the relevant system installation guides.



Dimensions and tolerances in mm



\* Assumes 1 mm gap between scale and end covers and zero gap between FASTRACK and end covers. † For alternative mechanical datum clamp method refer to the relevant system installation guide.

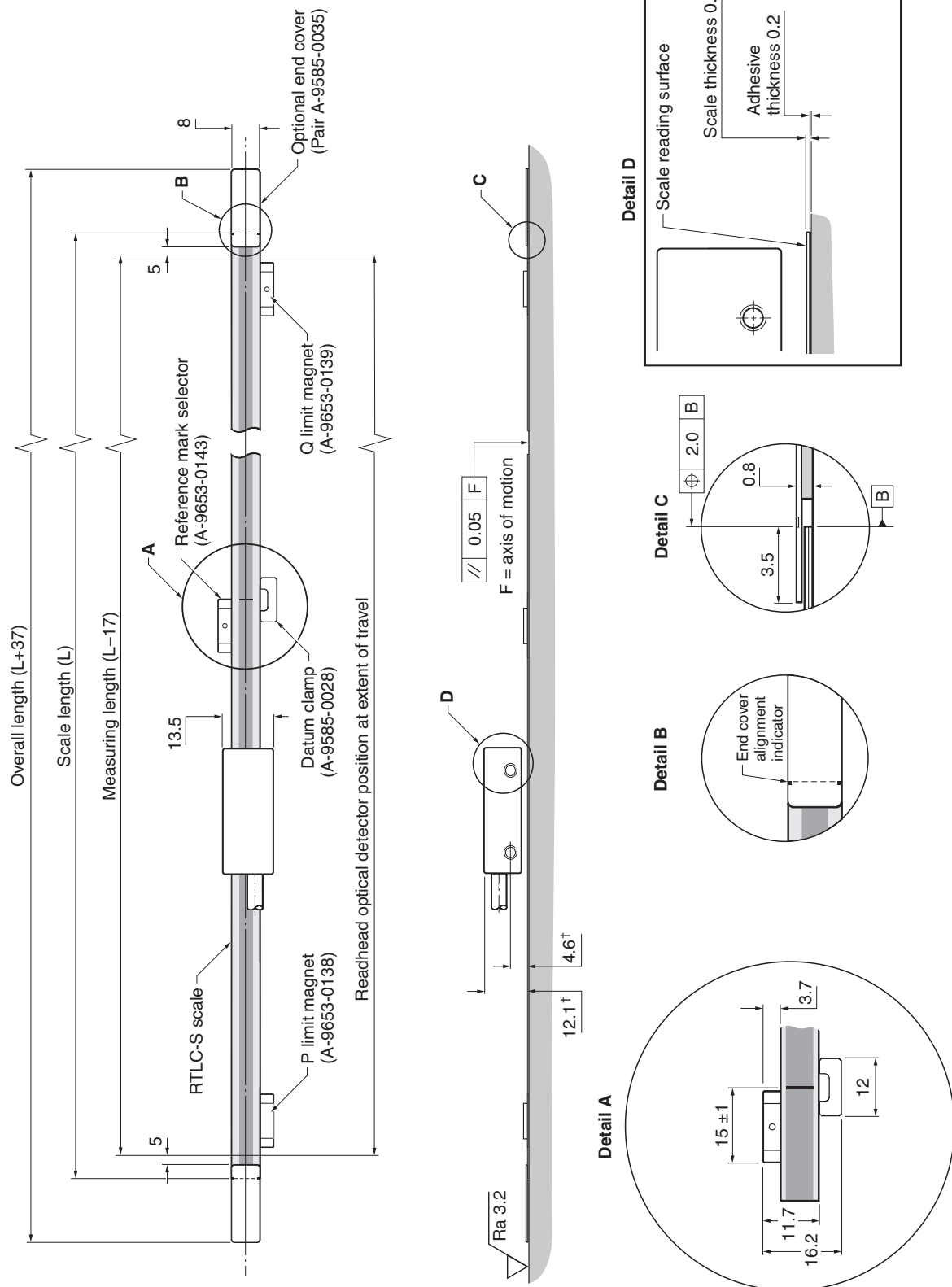
NOTES: Minimum recommended FASTRACK length = 100 mm. The reference mark selector and limit actuator locations are correct for the readhead orientation shown.

## RTALC-S installation drawing (Adhesive datum clamp method)

For further details, please refer to the relevant system installation guides.



Dimensions and tolerances in mm



<sup>1</sup>Dimensions from scale surface. **NOTE:** Bolted reference mark selector and limits also available. See the relevant system installation guide for details.

## Scale part numbers

### RTLC

Stainless steel tape scale for use with the *FASTRACK* carrier.

Available lengths	Available in increments of	Reference mark spacing	Distance from scale end to first reference mark	Part number (where xxxx is the length in cm)*		
				RTLC20 (Compatible with VIONiC and TONiC)	RTLC40 (Compatible with QUANTiC)	RTLC40H (Compatible with QUANTiC)
20 mm to 100 mm	10 mm	Middle of scale length	Middle of scale length	A-9705-xxxx	A-6566-xxxx	A-6668-xxxx
> 100 mm to 10 m	10 mm	50 mm	50 mm			

### *FASTRACK* carrier

Stainless steel carrier for use with RTLC tape scale.

Available lengths	Available in increments of	Part number (where xxxx is the length in cm)*
100 mm to 25 m	25 mm <sup>†</sup>	A-9704-xxxx

<sup>†</sup> 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

### RTLC-S








Stainless steel tape scale with self-adhesive backing tape.

Available lengths	Available in increments of	Reference mark spacing	Distance from scale end to first reference mark	Part number (where xxxx is the length in cm)*		
				RTLC20-S (Compatible with VIONiC and TONiC)	RTLC40-S (Compatible with QUANTiC)	RTLC40H-S (Compatible with QUANTiC)
20 mm to 100 mm	10 mm	Middle of scale length	Middle of scale length	A-9715-xxxx	A-6567-xxxx	A-6670-xxxx
> 100 mm to 10 m	10 mm	50 mm	50 mm			

\*Ordering A-9705-0070, for example, will result in a length of 70 cm of RTLC20.





## Accessory part numbers

### Reference mark and limit magnets†

Part description	Part number	Product image
Reference mark selector magnet – Adhesive mounted	A-9653-0143	
Bolted reference mark selector magnet (For use with RTLC-S only)	A-9653-0290	
Q limit switch actuator magnet – Adhesive mounted	A-9653-0139	
Bolted Q limit switch actuator magnet (For use with RTLC-S only)	A-9653-0291	
P limit switch actuator magnet – Adhesive mounted	A-9653-0138	
Bolted P limit switch actuator magnet (For use with RTLC-S only)	A-9653-0292	
Magnet applicator device (Aids positioning)	A-9653-0201	



† Longer limit magnets are available. Contact your local Renishaw representative for more information.

### Datum clamps

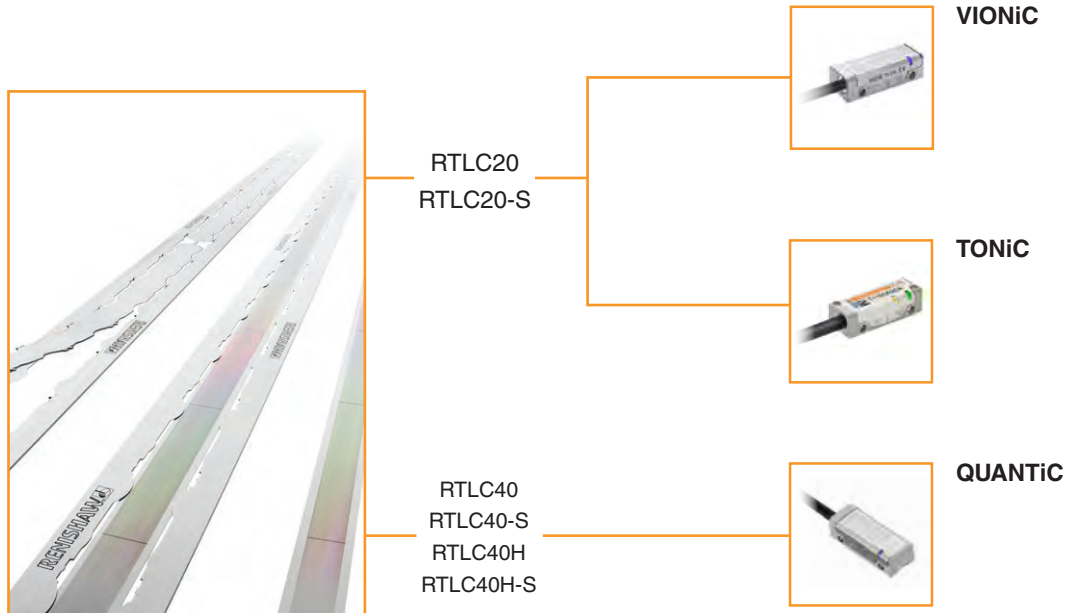
Part description	Part number	Product image
Self-adhesive datum clamp (For use with RTLC-S only)	A-9585-0028	
Loctite 435 adhesive – 20 g bottle (For securing axis datum position of RTLC in <i>FASTRACK</i> carrier or RTLC-S)	P-AD03-0012	
Dispensing tip for Loctite 435 adhesive	P-TL50-0209	
Bolted datum clamp (For use with RTLC and <i>FASTRACK</i> only)	A-9589-0077	

**Accessory part numbers** (continued)

**RTALC/RTALC-S scale and *FASTRACK* accessories**

Part description	Part number	Product image
Guillotine (For cutting RTALC/RTALC-S scale and <i>FASTRACK</i> carrier)	A-9589-0071	
Shears (For cutting RTALC/RTALC-S scale and <i>FASTRACK</i> carrier)	A-9589-0133	
RTALC-S scale applicator	A-9589-0115	
<i>FASTRACK</i> centre section removal tool (Removes centre section of <i>FASTRACK</i> when carrier has been mounted)	A-9589-0066	
<i>FASTRACK</i> separator assembly (Removes centre section of <i>FASTRACK</i> when carrier has been mounted – includes removable side panels for use when <i>FASTRACK</i> is mounted against a ledge or dowels)	A-9589-0122	
RTALC scale pulling tool (Aids installation of RTALC scale through the <i>FASTRACK</i> carrier)	A-9589-0420	
End cover kit (RTALC-S only)	A-9585-0035	
End cover kit ( <i>FASTRACK</i> only)	A-9589-0058	

## Compatible products



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L - 9517 - 9417 - 06

Part no.: L-9517-9417-06-B  
Issued: 12.2020

## RKLC incremental linear scale



**RKLC 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.**

**Index positions are provided by *IN-TRAC*™ optical reference marks which are directly embedded into the incremental scale markings to enable auto-phasing. The combination of these compact reference marks with the narrow 6 mm wide scale facilitates encoder installation in space-constrained applications.**




RKLC tape scale also combines  $\pm 5 \mu\text{m/m}$  accuracy with the mechanical and chemical ruggedness of stainless steel, easy coiling and cut-to-length convenience.

RKLC 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
- Narrow 6 mm wide scale suitable for confined spaces
- Suitable for partial arc applications
- *IN-TRAC* optical reference marks
- 20  $\mu\text{m}$  and 40  $\mu\text{m}$  pitch versions available
- ‘Cut-to-length’ convenience
- Up to 20 m lengths (> 20 m available on request)
- Compatible with *VIONiC*™, *TONiC*™ and *QUANTIc*™ high-performance readheads
- High solvent immunity
- Scale accuracy up to  $\pm 5 \mu\text{m/m}$ . Further improvement possible with error correction



## Compatible readheads

	VIONiC	TONiC	QUANTiC
			
<b>Scale type</b>	RKLC20-S	RKLC20-S	RKLC40-S/RKLC40H-S
<b>Pitch</b>	20 $\mu\text{m}$	20 $\mu\text{m}$	40 $\mu\text{m}$
<b>Outputs</b>	Digital resolutions from 5 $\mu\text{m}$ to 2.5 nm direct from the readhead.	Analogue 1 Vpp. Digital resolutions from 5 $\mu\text{m}$ to 1 nm from an interface.	Analogue 1 Vpp. Digital resolutions from 10 $\mu\text{m}$ to 50 nm direct from the readhead.
<b>SDE (typical)</b>	< $\pm 15$ nm	$\pm 30$ nm	< $\pm 80$ nm <sup>†</sup>
<b>Jitter (RMS)</b>	down to 1.6 nm	down to 0.5 nm	down to 2.73 nm
<b>Maximum speed</b>	12 m/s	10 m/s	24 m/s <sup>†</sup>
<b>UHV variant</b>	No	Yes*	No

\* Scale mastering is not guaranteed after system bakeout.

<sup>†</sup> Digital variants.

### Readhead features

- ▶ Filtering optics and Auto Gain Control for high reliability and solid Lissajous signals.
- ▶ Dynamic signal processing ensures ultra-low sub-divisional error (SDE).  
Result: smoother scanning performance.
- ▶ High signal-to-noise ratio provides ultra-low jitter for optimum positional stability.
- ▶ Auto-phasing of *IN-TRAC* reference mark.
- ▶ Clocked outputs ensure optimised speed performance for all resolutions, for a wide variety of industry-standard controllers.
- ▶ Diagnostic tool compatibility for detailed information on encoder performance.
- ▶ DOP Dual output interfaces available to provide simultaneous analogue and digital outputs (TONiC systems only).

## RKLC scale specifications\*

<b>Form</b> (H × W)	0.15 mm × 6 mm including adhesive	
<b>Pitch</b>	RKLC20-S	20 μm
	RKLC40-S / RKLC40H-S	40 μm
<b>Accuracy</b> (at 20 °C)	RKLC20-S / RKLC40H-S	±5 μm/m
	RKLC40-S	±15 μm/m
<b>Linearity</b> (at 20 °C)	RKLC20-S / RKLC40H-S	±2.5 μm/m achievable with two point error correction
	RKLC40-S	±3 μm/m achievable with two point error correction
<b>Supplied length</b>	20 mm to 20 m (> 20 m available on request)	
<b>Material</b>	Hardened and tempered stainless steel	
<b>Mass</b>	4.6 g/m	
<b>Coefficient of thermal expansion</b> (at 20 °C)	Matches that of substrate material when scale ends fixed by epoxy mounted end clamps	
<b>Temperature</b>	Storage	-20 °C to +80 °C
	Operating†	0 °C to +70 °C
	Installation	+10 °C to +35 °C
<b>Humidity</b>	95% relative humidity (non-condensing) to IEC 60068-2-78	
<b>Shock</b>	Operating	500 m/s <sup>2</sup> , 11 ms, ½ sine, 3 axes
<b>Vibration</b>	Operating	300 m/s <sup>2</sup> max @ 55 to 2000 Hz, 3 axes
<b>End fixing</b>	Epoxy mounted end clamps (A-9523-4015)	
	Approved epoxy adhesive (A-9531-0342)	
	Scale end movement typically < 1 μm‡	

## Reference mark

<b>Type</b>	<i>IN-TRAC</i> reference mark <sup>⋄</sup> , directly embedded into incremental track, 50 mm (nominal) spacing
<b>Selection</b>	Single reference mark selection by magnetic actuator (A-9653-0143) customer positioned
<b>Repeatability</b>	Unit of resolution repeatability (bi-directional) across full system rated speed and temperature ranges

## Limit switches

<b>Type</b>	Magnetic actuators; with dimple triggers Q limit, without dimple triggers P limit (see RKLC scale installation drawings)
<b>Trigger point</b>	The limit output is nominally asserted when the readhead limit switch sensor passes the limit magnet leading edge, but can trigger up to 3 mm before that edge
<b>Mounting</b>	Customer placed at desired locations
<b>Repeatability</b>	< 0.1 mm

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

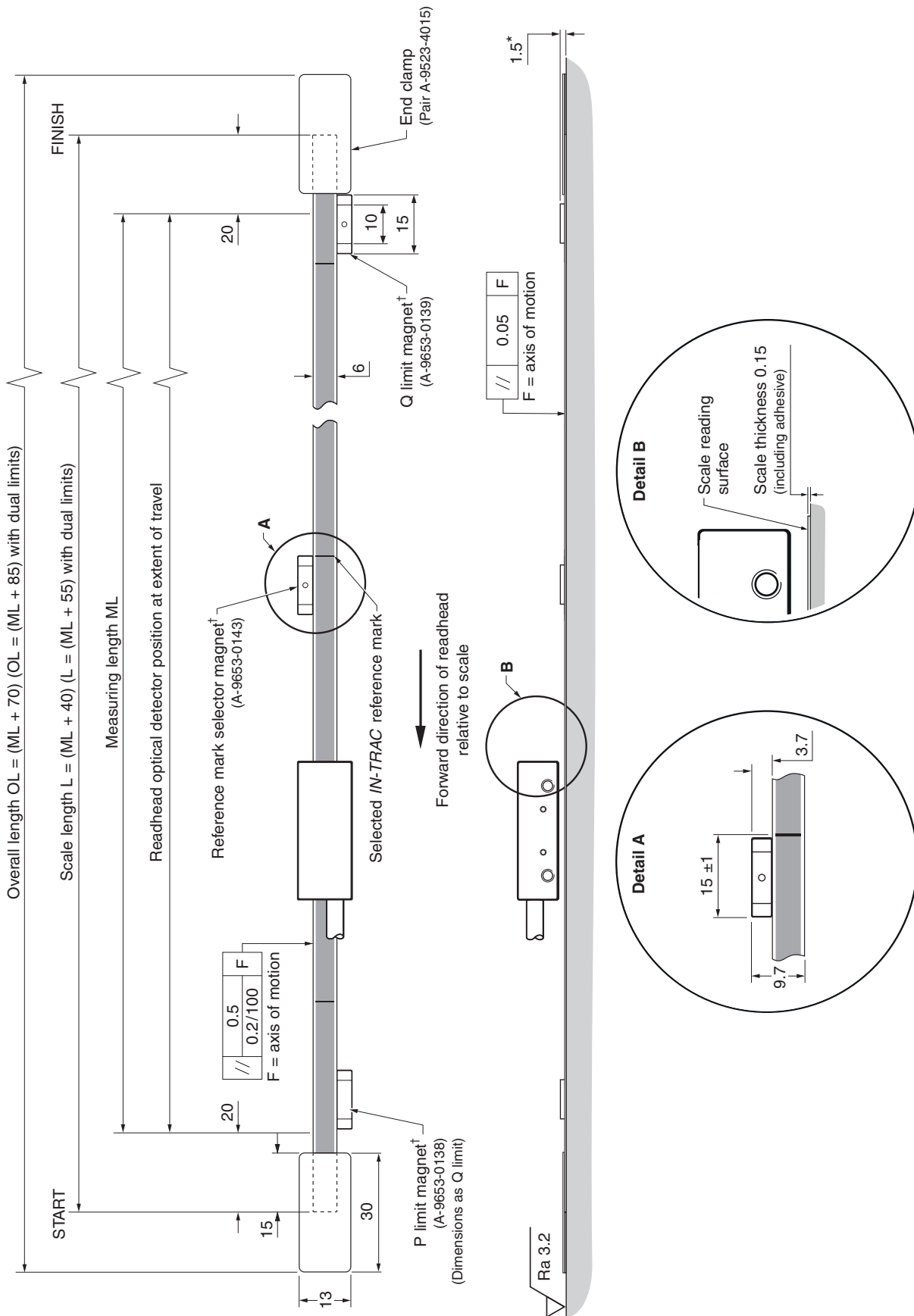
† To limit maximum tension in the scale  $(CTE_{\text{substrate}} - CTE_{\text{scale}}) \times (T_{\text{use extreme}} - T_{\text{install}}) \leq 550 \mu\text{m/m}$  where  $CTE_{\text{scale}} = \sim 10.1 \mu\text{m/m/}^\circ\text{C}$ .

‡ Ensure that scale and end clamps have been installed following the installation process described in the relevant RKLC installation guide.

⋄ Scale available with no *IN-TRAC* reference mark; see scale part numbers for details.

**RKLC scale installation drawing**

Dimensions and tolerances in mm



\* Dimensions from substrate surface. † Bolted reference mark selector magnet and limit magnet available. See relevant system installation guide for further details.  
**NOTE:** The reference mark selector and limit actuator locations are correct for the readhead orientation shown.

## Scale part numbers

### RKLC-S

Stainless steel tape scale with self-adhesive backing tape.

Available lengths	Available in increments of	Reference mark spacing*	Distance from scale end to first reference mark	Part number (where xxxx is the length in cm) <sup>†</sup>		
				RKLC20-S (Compatible with VIONiC and TONiC)	RKLC40-S (Compatible with QUANTiC)	RKLC40H-S (Compatible with QUANTiC)
20 mm to 100 mm	10 mm	Middle of scale length	Middle of scale length	A-6663-xxxx	A-6665-xxxx	A-6685-xxxx
> 100 mm to 20 m <sup>‡</sup>	10 mm	50 mm	50 mm			

### RKLR-S (no reference mark)

Stainless steel tape scale with self-adhesive backing tape.

Available lengths	Available in increments of	Part number (where xxxx is the length in cm) <sup>†</sup>	
		RKLR20-S (Compatible with VIONiC and TONiC)	RKLR40-S (Compatible with QUANTiC)
20 mm to 20 m <sup>‡</sup>	10 mm	A-6753-xxxx	A-6744-xxxx








\* Only calibrated reference mark is bi-directionally repeatable.

<sup>†</sup> Ordering A-6663-0070 for example, will result in a 70 cm length of RKLC20-S.

<sup>‡</sup> Lengths greater than 20 m available on request.





## Accessory part numbers

### Reference mark and limit magnets\*




Part description	Part number	Product image
Reference mark selector magnet – Adhesive mounted	A-9653-0143	
Bolted reference mark selector magnet	A-9653-0290	
Q limit switch actuator magnet – Adhesive mounted	A-9653-0139	
Bolted Q limit switch actuator magnet	A-9653-0291	
P limit switch actuator magnet – Adhesive mounted	A-9653-0138	
Bolted P limit switch actuator magnet	A-9653-0292	
Magnet applicator device (Aids positioning)	A-9653-0201	

\* Longer limit magnets are available. Contact your local Renishaw representative for more information.

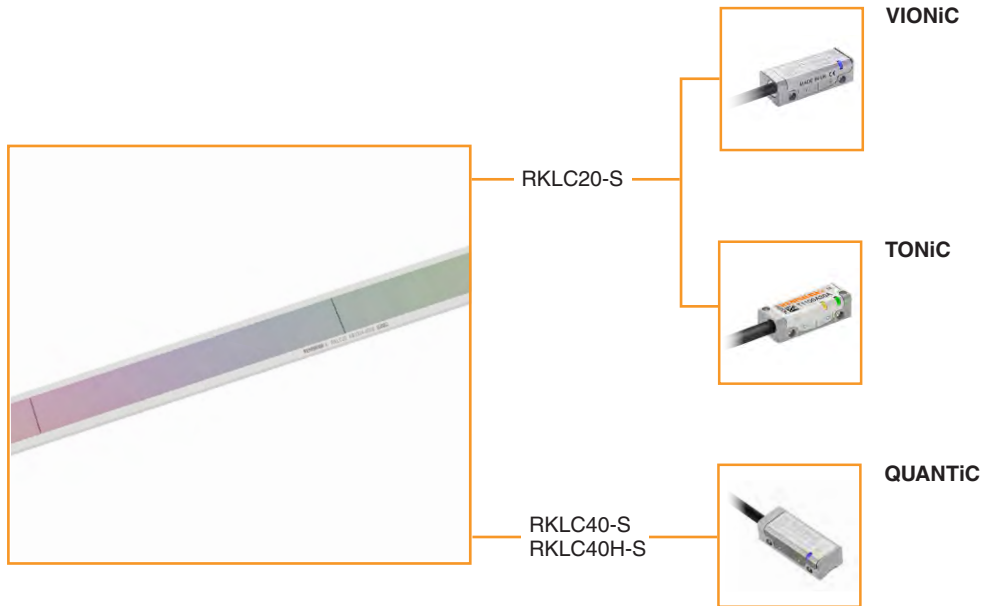
### RKLC scale accessories

Guillotine (For cutting RKLC scale)	A-9589-0071	
Shears (For cutting RKLC scale)	A-9589-0133	
RKLC-S side mount scale applicator (Compatible with all 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	

**End clamp accessories**

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

## Compatible products



For worldwide contact details, visit [www.renishaw.com/contact](http://www.renishaw.com/contact)

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L - 9517 - 9862 - 01

Part no.: L-9517-9862-01-D  
Issued: 12.2020

# 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



## 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 <sup>1</sup>	RESOLUTE
Form (height x width)	0.15 mm x 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 <sup>2</sup>	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/s <sup>2</sup> , 11 ms, ½ sine, 3 axes		
Vibration	Operating	300 m/s <sup>2</sup> 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 <sup>3</sup>	30 mm	26 mm	26 mm	50 mm

## Reference mark <sup>4</sup>

RKLC20-S and RKLC40-S <sup>5</sup>	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

<sup>1</sup> 40 µm ATOM and ATOM DX readhead variants only.




<sup>2</sup> To limit the maximum tension in the scale  $(CTE_{\text{substrate}} - CTE_{\text{scale}}) \times (T_{\text{use extreme}} - T_{\text{install}}) \leq 550 \mu\text{m/m}$  where  $CTE_{\text{scale}} = \sim 10.1 \mu\text{m/m/}^\circ\text{C}$ .




<sup>3</sup> For smaller radii contact your local Renishaw representative.

<sup>4</sup> Only the calibrated reference mark is phased.

<sup>5</sup> 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
			
<b>Readhead size (length x width x height in mm)</b>	35 x 13.5 x 10	35 x 13.5 x 10	35 x 13.5 x 10
<b>Interface</b>	-	Ti, TD or DOP	-
<b>Scale type</b>	RKLC20-S	RKLC20-S	RKLC40-S
<b>Output</b>	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.
<b>Sub-divisional error (typical)</b>	< ±15 nm	< ±30 nm	< ±150 nm (partial arc radius > 67.5 mm) < ±80 nm <sup>1</sup> (partial arc radius ≤ 67.5 mm)
<b>Maximum speed</b>	12 m/s	10 m/s	24 m/s <sup>1</sup>
<b>Diagnostic tool</b>	ADTi-100 and ADT View	TONiC diagnostic tool	ADTi-100 and ADT View

	Incremental		
	ATOM <sup>2</sup>	ATOM DX <sup>2</sup>	RESOLUTE
			
<b>Readhead size (length x width x height in mm)</b>	20.5 x 12.7 x 7.85 (FPC variant: 20.5 x 12.7 x 6.8)	20.5 x 12.7 x 10.85 (Top exit variant: 20.5 x 12.7 x 7.85)	36 x 16.5 x 17.2
<b>Interface</b>	Ri, Ti, ACi	-	DRIVE-CLiQ only
<b>Scale type</b>	RKLF40-S	RKLF40-S	RKLA30-S
<b>Output</b>	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
<b>Sub-divisional error (typical)</b>	< ±120 nm	< ±120 nm	±40 nm
<b>Maximum speed</b>	20 m/s	20 m/s	100 m/s
<b>Diagnostic tool</b>	ATOM diagnostic tool	ADTi-100 and ADT View	ADTa-100 and ADT View

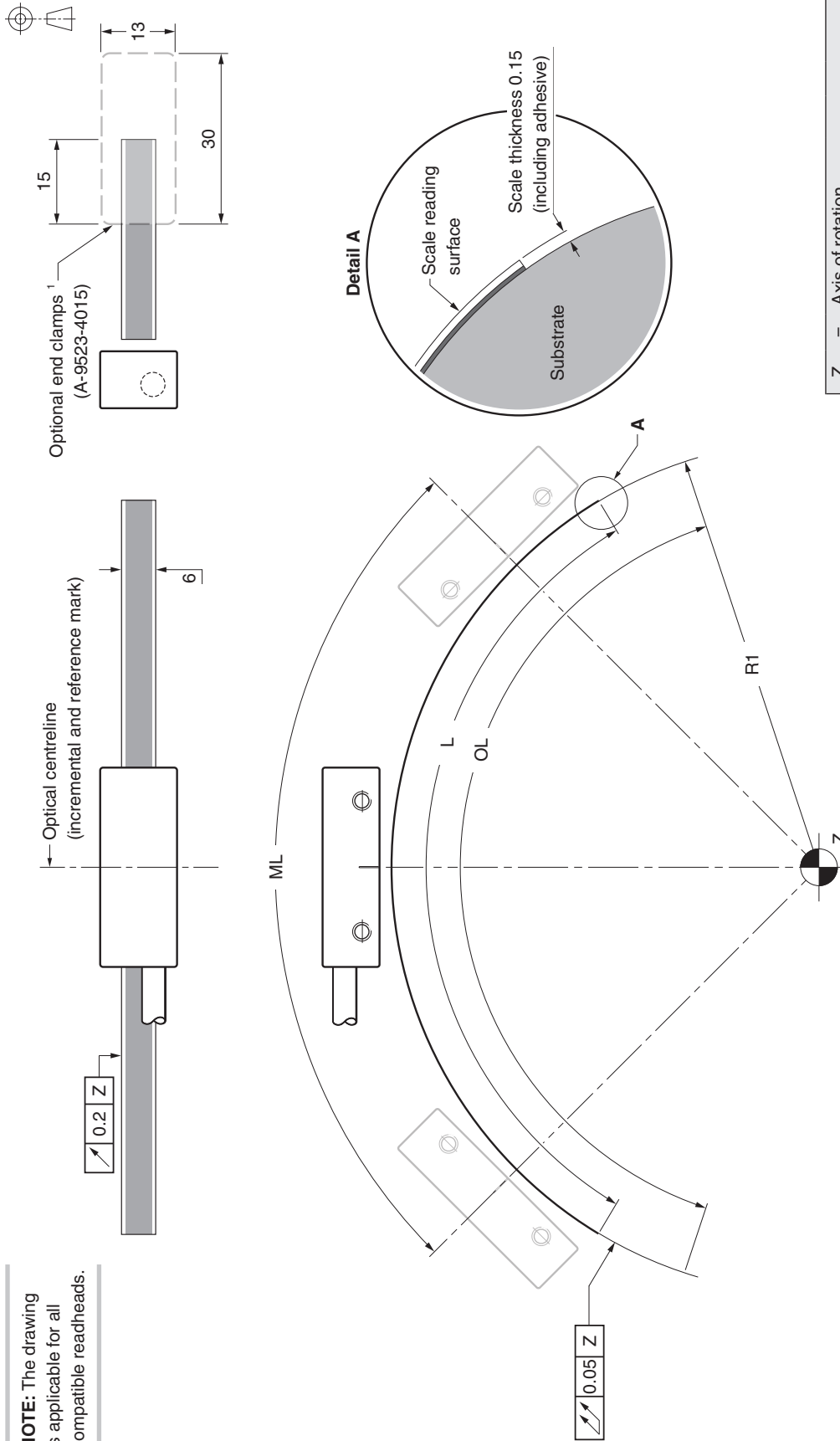
**NOTE:** If installing RKL scale on a partial arc for a UHV or ETR application, contact your local Renishaw representative for more information.

<sup>1</sup> Digital variants only.

<sup>2</sup> 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 <sup>N</sup>	=	Neutral axis radius (R1 + 100 μm)
ML	=	Measuring length
L	=	Scale length <sup>2</sup>
		with end clamps
		without end clamps
OL	=	Overall length
		with end clamps
		without end clamps

**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.

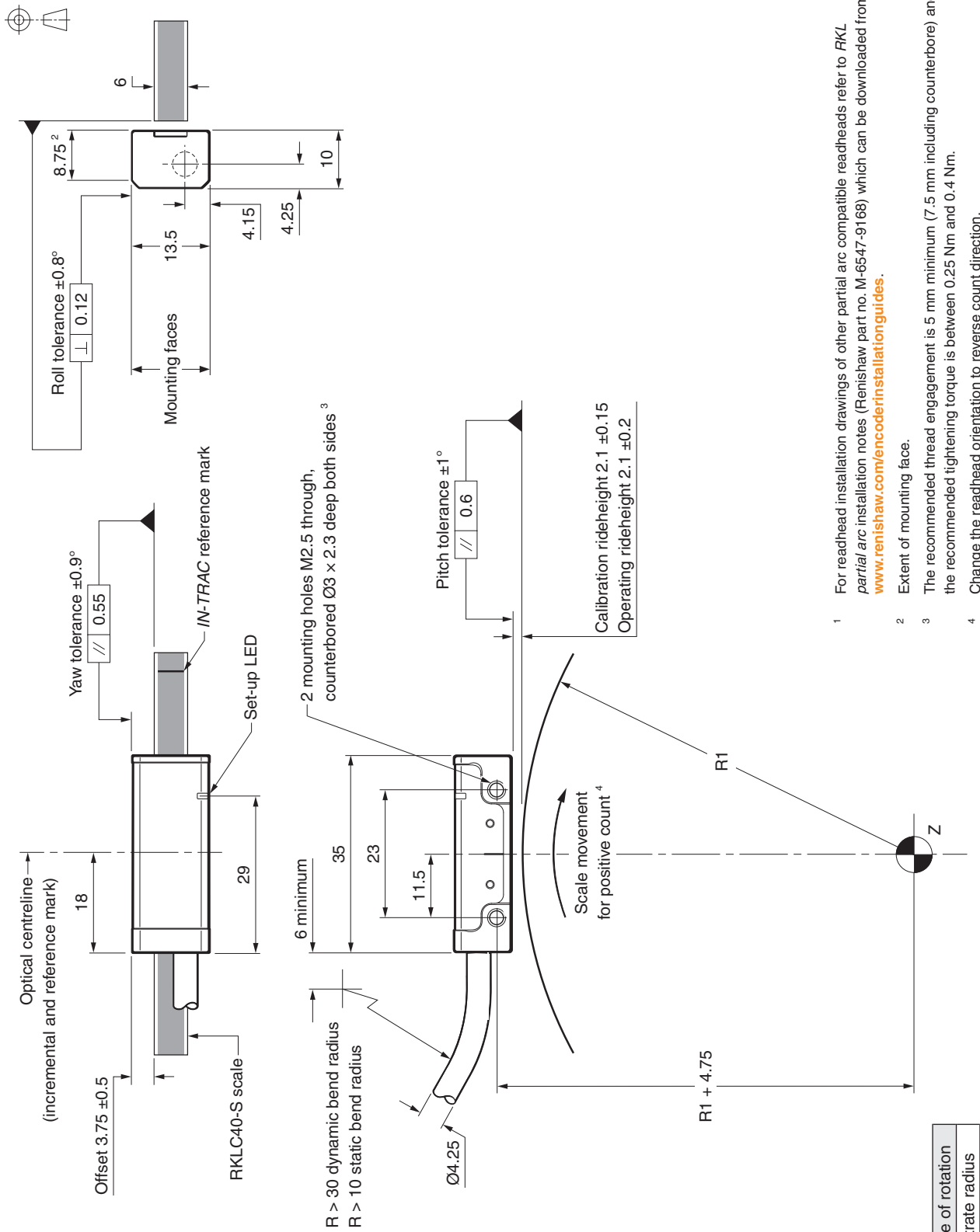
<sup>1</sup> When not using end clamps, the scale ends must be secured using an alternative method. For further information refer to *RKLC partial arc installation notes* (Renishaw part no. M-6547-9168) which can be downloaded from [www.renishaw.com/encoderinstallationguides](http://www.renishaw.com/encoderinstallationguides).

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

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

# QUANTiC readhead installation drawing <sup>1</sup>

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/encoder/installationguides](http://www.renishaw.com/encoder/installationguides).
- 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.

Z	=	Centre of rotation
R1	=	Substrate radius

## Scale part numbers

Scale type	Part number (where xxxx is the scale length in cm) <sup>1</sup>	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 <sup>2</sup>
RKLA30-S	A-6667-xxxx	20 mm to 21 m	RESOLUTE

<sup>1</sup> For example, ordering A-6663-0110 will result in a 110 cm length of RKLC20-S.



<sup>2</sup> 40 µm ATOM and ATOM DX readhead variants only.

## Accessory 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

# RESM rotary scale



**The RESM is a one-piece stainless steel ring with 20 µm or 40 µm scale marked directly onto the periphery, featuring the *IN-TRAC*™ auto-phase optical reference mark.**

The RESM offers impressive accuracy with resolution to 0.00075 arc second, suiting the most demanding precision applications.

Read by Renishaw's VIONiC™, TONiC™ and QUANTiC™ encoder systems, it has high tolerance to dirt, scratches and greasy fingerprints that can cause other encoder systems to miscount.

The low profile RESM, with large internal diameter, is easy to design into most installations. Equally important, its low mass, low inertia design does not compromise system performance. Available in a wide range of sizes and line counts, providing compatibility with industry standard controllers.

## System features

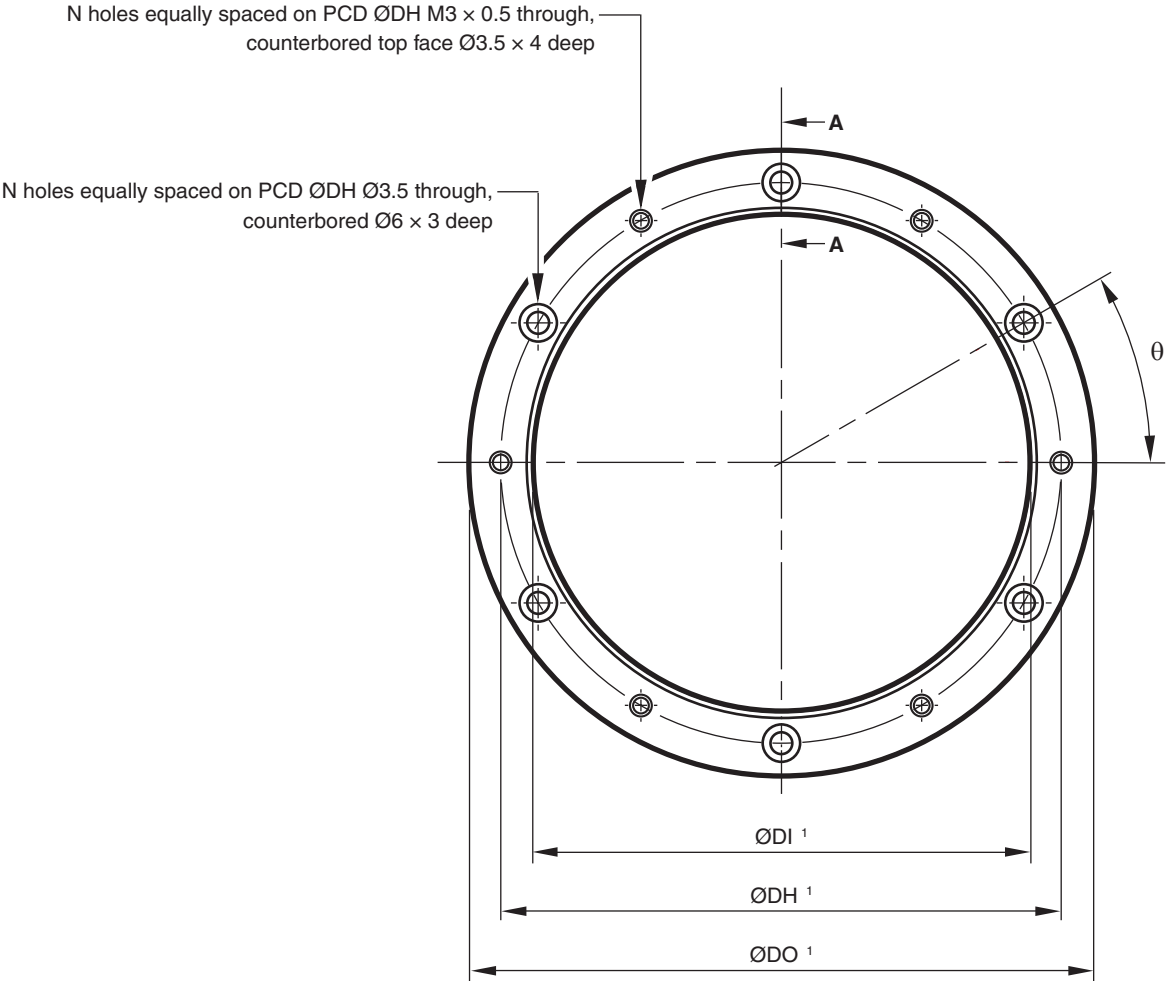
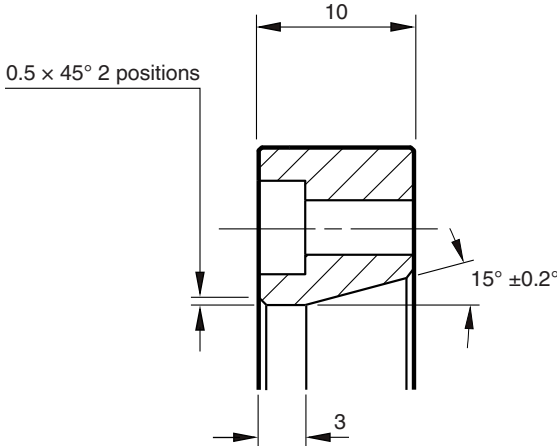
- Compatible with the VIONiC, TONiC and QUANTiC encoder systems offering industry standard analogue or digital incremental outputs
- *IN-TRAC* bi-directional optical reference mark
- Typical installed accuracy to  $\pm 1.9$  arc second (550 mm ring)
- Patented taper mount simplifies integration and minimises installation errors
- Large internal diameter for ease of integration
- Available in sizes from  $\text{Ø}52$  mm to  $\text{Ø}550$  mm with line counts from 4 096 to 86 400
- Custom sizes also available
- Low mass and low inertia
- Ultra-low inertia versions also available
- REST20 is a RESM20 with two reference marks, for use on dual readhead systems in partial arc applications



# RESM installation drawing ('A' section)

Dimensions and tolerances in mm

## Section A-A



**NOTE:** θ is the angle between one tapped hole and the adjacent clearance hole. For example, the angle between two clearance holes is 2θ.

<sup>1</sup> The dimensions DO, DI and DH for the RESM 'A' section rings are listed on the following page.

## RESM specifications ('A' section)

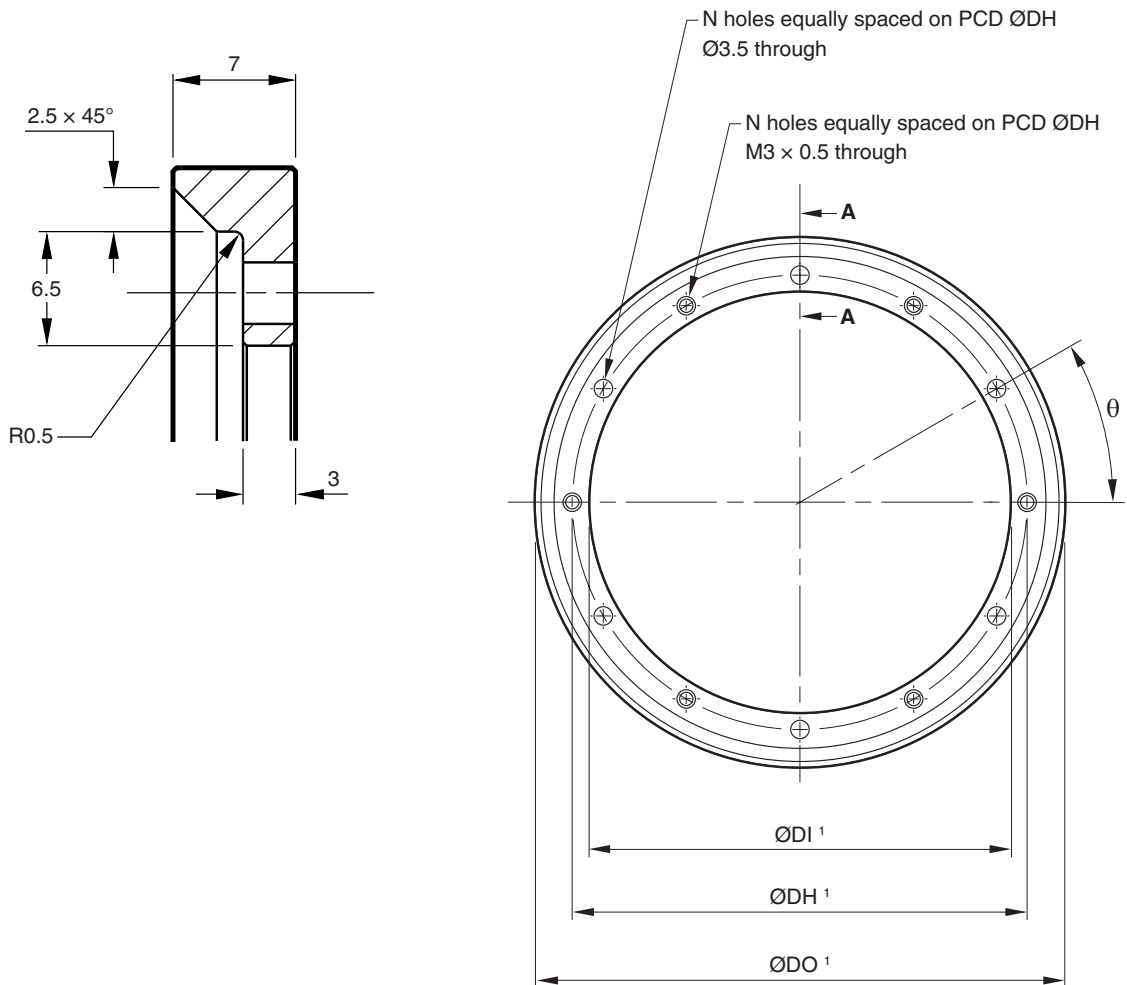
Nominal external diameter (mm)	Line count		DO (mm)	DI (mm)	Mounting holes		
	RESM20	RESM40			DH (mm)	N	θ
52	8 192	4 096	52.20 52.10	30.04 30.00	40	6	30°
57	9 000	4 500	57.35 57.25	37.04 37.00	47	6	30°
75	11 840	5 920	75.40 75.30	55.04 55.00	65	6	30°
94	14 800	7 400	94.30 94.26	74.59 74.55	84.5	6	30°
100	15 744	7 872	100.30 100.20	80.04 80.00	90	6	30°
103	16 200	8 100	103.20 103.00	80.04 80.00	90	6	30°
104	16 384	8 192	104.40 104.20	80.04 80.00	90	6	30°
115	18 000	9 000	114.70 114.50	95.04 95.00	105	6	30°
124	19 478	9 740	124.10 123.90	104.04 104.00	114	6	30°
150	23 600	11 800	150.40 150.20	130.04 130.00	140	9	20°
172	27 000	13 500	172.04 171.84	152.04 152.00	162	9	20°
183	28 800	14 400	183.45 183.25	163.04 163.00	173	9	20°
200	31 488	15 744	200.40 200.20	180.04 180.00	190	12	15°
206	32 400	16 200	206.50 206.10	186.05 186.00	196	12	15°
209	32 768	16 384	208.80 208.40	186.05 186.00	196	12	15°
229	36 000	18 000	229.40 229.00	209.05 209.00	219	12	15°
255	40 000	20 000	254.80 254.40	235.06 235.00	245	12	15°
300	47 200	23 600	300.40 300.20	280.06 280.00	290	16	11.25°
350	55 040	27 520	350.40 350.20	330.06 330.00	340	16	11.25°
413	64 800	32 400	412.70 412.30	392.08 392.00	402	18	10°
417	65 536	32 768	417.40 417.00	380.10 380.00	390	18	10°
489 <sup>1</sup>	76 800	38 400	489.12 488.72	451.10 450.90	462	20	18°
550	86 400	43 200	550.20 549.80	510.10 510.00	520	20	9°

<sup>1</sup> There are no tapped holes on the 489 mm ring.

## RESM installation drawing ('B' section)

Dimensions and tolerances in mm

### Section A-A



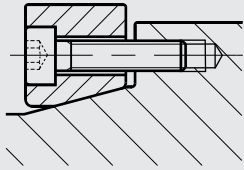
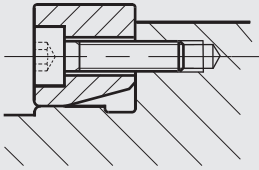
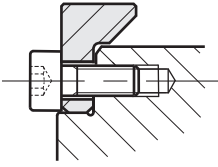
**NOTE:**  $\theta$  is the angle between one tapped hole and the adjacent clearance hole. For example, the angle between two clearance holes is  $2\theta$ .

<sup>1</sup> The dimensions DO, DI and DH for the RESM 'B' section rings are listed on the following page.

## RESM specifications ('B' section)

Nominal external diameter (mm)	Line count		DO (mm)	DI (mm)	Mounting holes		
	RESM20	RESM40			DH (mm)	N	θ
52	8 192	4 096	52.20 52.10	32.04 32.00	38	6	30°
57	9 000	4 500	57.35 57.25	37.04 37.00	43	6	30°
75	11 840	5 920	75.40 75.30	55.04 55.00	61	6	30°
100	15 744	7 872	100.30 100.20	80.04 80.00	86	6	30°
115	18 000	9 000	114.70 114.50	95.04 95.00	101	6	30°
150	23 600	11 800	150.40 150.20	130.04 130.00	136	9	20°
165	25 920	12 960	165.10 164.90	145.04 145.00	151	9	20°
200	31 488	15 744	200.40 200.20	180.04 180.00	186	12	15°

## RESM mounting methods

	Taper mount	Interference fit
'A' section		
'B' section	Not applicable	
Notes	<p><b>Recommended for all installations</b></p> <ul style="list-style-type: none"> <li>• Enables simplest adjustment.</li> <li>• Offers highest accuracy.</li> <li>• Enables eccentricity to be compensated.</li> <li>• Offers excellent mechanical stability against thermal cycling, shock and vibration.</li> <li>• Minimises cost of substrate preparation.</li> </ul>	<p><b>Alternative installation</b></p> <ul style="list-style-type: none"> <li>• Will not correct eccentricity of the supporting shaft.</li> </ul>

For further information on installation and mounting options, refer to the relevant system installation guides, which are available from your local Renishaw representative, or can be downloaded from: [www.renishaw.com/encoderinstallationguides](http://www.renishaw.com/encoderinstallationguides).




## Reference mark position



*IN-TRAC* reference mark is embedded in the scale, radially aligned with the centre of the mounting hole to the left of the 'Renishaw' logo, within  $\pm 0.5$  mm. No external actuators or physical adjustment are required.

**NOTE:** For REST20 rings the second reference mark is located 180° from the first reference mark.

## Compatible readheads

	VIONiC	TONiC	QUANTiC
			
<b>Scale type</b>	RESM20/REST20	RESM20/REST20	RESM40
<b>Pitch</b>	20 µm	20 µm	40 µm
<b>Outputs</b>	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
<b>SDE (typical)</b>	$\varnothing > 135 \text{ mm}$ < ±15 nm $\varnothing \leq 135 \text{ mm}$ < ±20 nm	±30 nm	$\varnothing > 135 \text{ mm}$ < ±150 nm $\varnothing \leq 135 \text{ mm}$ < ±80 nm <sup>1</sup>
<b>Jitter (RMS)</b>	down to 1.6 nm	down to 0.5 nm	down to 2.73 nm
<b>Maximum speed</b>	12 m/s	10 m/s	24 m/s <sup>1</sup>

<sup>1</sup> Digital variants

## Readhead features

- Filtering optics and Auto Gain Control for high reliability and solid Lissajous signals.
- Dynamic signal processing ensures ultra-low Sub-Divisional Error (SDE). Result: smoother scanning performance.
- High signal-to-noise ratio provides ultra-low jitter for optimum positional stability.
- Auto-phasing of *IN-TRAC* reference mark.
- Clocked outputs ensure optimised speed performance for all resolutions, for a wide variety of industry-standard controllers.
- DOP Dual output interfaces available to provide simultaneous analogue and digital outputs (TONiC systems only).

## Operating specifications

<b>Material</b>	303/304 stainless steel	
<b>Coefficient of thermal expansion (at 20 °C)</b>	15.5 ±0.5 µm/m/°C	
<b>Temperature</b>	Storage	-20 °C to +70 °C
	Operating	0 °C to +70 °C

<b>Nominal external diameter (mm)</b>		<b>52</b>	<b>57</b>	<b>75</b>	<b>94</b>	<b>100</b>	<b>103</b>	<b>104</b>
Nominal internal diameter (mm)		30 <sup>1</sup>	37	55	75	80	80	80
Line count	RESM20 (20 µm)	8 192	9 000	11 840	14 800	15 744	16 200	16 384
	RESM40 (40 µm)	4 096	4 500	5 920	7 400	7 872	8 100	8 192
Mass (kg)	'A' section	0.098	0.1	0.15	0.18	0.2	0.24	0.26
	'B' section	0.043	0.049	0.068	-	0.094	-	-
Moment of inertia (kg mm <sup>2</sup> )	'A' section	46	61	161	338	425	519	561
	'B' section	22	31	79	-	202	-	-

<b>Nominal external diameter (mm)</b>		<b>115</b>	<b>124</b>	<b>150</b>	<b>165</b>	<b>172</b>	<b>183</b>	<b>200</b>
Nominal internal diameter (mm)		95	104	130	145	152	163	180
Line count	RESM20 (20 µm)	18 000	19 478	23 600	25 920	27 000	28 800	31 488
	RESM40 (40 µm)	9 000	9 740	11 800	12 960	13 500	14 400	15 744
Mass (kg)	'A' section	0.23	0.26	0.32	-	0.36	0.40	0.43
	'B' section	0.1	-	0.15	0.16	-	-	0.2
Moment of inertia (kg mm <sup>2</sup> )	'A' section	644	849	1 581	-	2 400	3 006	3 928
	'B' section	296	-	740	970	-	-	1 822

<b>Nominal external diameter (mm)</b>		<b>206</b>	<b>209</b>	<b>229</b>	<b>255</b>	<b>300</b>	<b>350</b>	<b>413</b>
Nominal internal diameter (mm)		186	186	209	235	280	330	392
Line count	RESM20 (20 µm)	32 400	32 768	36 000	40 000	47 200	55 040	64 800
	RESM40 (40 µm)	16 200	16 384	18 000	20 000	23 600	27 520	32 400
Mass (kg)	'A' section	0.44	0.5	0.5	0.54	0.66	0.78	0.93
	'B' section	-	-	-	-	-	-	-
Moment of inertia (kg mm <sup>2</sup> )	'A' section	4 315	4 960	6 000	8 112	13 962	22 606	37 945
	'B' section	-	-	-	-	-	-	-

<b>Nominal external diameter (mm)</b>		<b>417</b>	<b>489</b>	<b>550</b>
Nominal internal diameter (mm)		380	451	510
Line count	RESM20 (20 µm)	65 536	76 800	86 400
	RESM40 (40 µm)	32 768	38 400	43 200
Mass (kg)	'A' section	1.76	2.13	2.53
	'B' section	-	-	-
Moment of inertia (kg mm <sup>2</sup> )	'A' section	70 386	118 244	178 598
	'B' section	-	-	-

<sup>1</sup> 32 mm for 'B' section ring.

## Accuracy

Nominal external diameter	Typical installed accuracy <sup>2</sup>					
	'A' section <sup>1</sup>		'B' section		'A' section - dual head	
mm	arc second	µm	arc second	µm	arc second	µm
52	±12.7	±1.6	±21.1	±2.7	±3.4	±0.4
57	±11.8	±1.6	±19.5	±2.7	±3.2	±0.4
75	±9.5	±1.7	±14.9	±2.7	±2.6	±0.5
94	±7.9	±1.8	-	-	±2.25	±0.5
100	±7.5	±1.8	±11.3	±2.7	±2.2	±0.5
103	±7.4	±1.8	-	-	±2.1	±0.5
104	±7.3	±1.8	-	-	±2.1	±0.5
115	±6.8	±1.9	±9.9	±2.8	±2	±0.5
124	±6.3	±1.9	-	-	±1.8	±0.5
150	±5.5	±2.0	±7.7	±2.8	±1.6	±0.6
165	-	-	±7.0	±2.8	-	-
172	±5.0	±2.1	-	-	±1.45	±0.6
183	±4.7	±2.1	-	-	±1.35	±0.6
200	±4.3	±2.1	±5.8	±2.8	±1.3	±0.6
206	±4.2	±2.1	-	-	±1.3	±0.6
209	±4.2	±2.1	-	-	±1.3	±0.6
229	±3.9	±2.2	-	-	±1.2	±0.7
255	±3.6	±2.2	-	-	±1.1	±0.7
300	±3.1	±2.3	-	-	±1	±0.7
350	±2.8	±2.4	-	-	±0.9	±0.8
413	±2.4	±2.4	-	-	±0.8	±0.8
417	±2.4	±2.4	-	-	±0.8	±0.8
489	±2.1	±2.5	-	-	±0.7	±0.8
550	±1.9	±2.6	-	-	±0.6	±0.9

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

<sup>2</sup> '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.

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

Refer to Appendix for system accuracy figures.



## Maximum speed (rev/min)

For details of maximum speeds for other clocked options, contact your local Renishaw representative.

### VIONiC system: For 50 MHz clocked option

Nominal external diameter (mm)	Line count	Output resolution												
		5 µm	1 µm	0.5 µm	0.2 µm	0.1 µm	50 nm	40 nm	25 nm	20 nm	10 nm	5 nm	2.5 nm	
52	8 192	4 407	4 407	4 407	2 663	1 332	666	533	333	266	133	66	33	
57	9 000	4 021	4 021	4 021	2 429	1 215	607	486	304	243	122	61	30	
75	11 840	3 056	3 056	3 056	1 846	923	462	369	231	185	92	46	23	
94	14 800	2 438	2 438	2 438	1 473	738	368	295	184	147	74	37	18	
100	15 744	2 292	2 292	2 292	1 385	693	346	277	173	138	69	35	17	
103	16 200	2 225	2 225	2 225	1 344	672	336	269	168	134	67	34	17	
104	16 384	2 204	2 204	2 204	1 331	666	333	266	166	133	67	33	17	
115	18 000	1 993	1 993	1 993	1 204	602	301	241	150	120	60	30	15	
124	19 478	1 848	1 848	1 848	1 117	559	279	223	140	112	56	28	14	
150	23 600	1 528	1 528	1 528	923	462	231	185	115	92	46	23	12	
165	25 920	1 389	1 389	1 389	839	420	210	168	105	84	42	21	11	
172	27 000	1 332	1 332	1 332	805	403	201	161	101	81	40	20	10	
183	28 800	1,252	1,252	1,252	757	379	189	151	95	76	38	19	9	
200	31 488	1 146	1 146	1 146	692	346	173	138	87	69	35	17	8.7	
206	32 400	1 113	1 113	1 113	672	336	168	134	84	67	34	17	8.4	
209	32 768	1 097	1 097	1 097	663	331	166	133	83	66	33	17	8.3	
229	36 000	1 001	1 001	1 001	605	302	151	121	76	60	30	15	7.6	
255	40 000	899	899	899	543	272	136	109	68	54	27	14	6.8	
300	47 200	764	764	764	462	231	115	92	58	46	23	12	5.8	
350	55 040	655	655	655	396	198	99	79	49	40	20	10	5.0	
413	64 800	555	555	555	335	168	84	67	42	34	17	8.4	4.2	
417	65 536	550	550	550	332	166	83	66	41	33	17	8.3	4.2	
489	76 800	469	469	469	283	142	71	57	35	28	14	7.1	3.6	
550	86 400	417	417	417	252	126	63	50	31	25	13	6.3	3.2	

## Maximum speed (rev/min)

For details of maximum speeds for other clocked options, contact your local Renishaw representative.

### TONiC system: For 50 MHz clocked option

Nominal external diameter (mm)	Line count	Digital output resolution										Analogue output	
		Ti0004 5 µm	Ti0020 1 µm	Ti0040 0.5 µm	Ti0100 0.2 µm	Ti0200 0.1 µm	Ti0400 50 nm	Ti1000 20 nm	Ti2000 10 nm	Ti4000 5 nm	Ti10KD 2 nm		Ti20KD 1 nm
52	8 192	3 673	3 673	3 673	2 380	1 190	597	238	119	59	24	12	3 673
57	9 000	3 351	3 351	3 351	2 171	1 086	544	217	109	54	22	11	3 351
75	11 840	2 546	2 546	2 546	1 650	825	414	165	83	41	17	8.1	2 546
94	14 800	2 032	2 032	2 032	1 317	658	330	132	66	33	13	7	2 032
100	15 744	1 910	1 910	1 910	1 238	619	310	124	62	31	12	6.1	1 910
103	16 200	1 854	1 854	1 854	1 202	601	301	120	60	30	12	5.9	1 854
104	16 384	1 836	1 836	1 836	1 190	595	298	119	59	30	12	5.9	1 836
115	18 000	1 661	1 661	1 661	1 076	538	270	108	54	27	11	5.3	1 661
124	19 478	1 540	1 540	1 540	998	499	250	100	50	25	10	5	1 540
150	23 600	1 273	1 273	1 273	825	413	207	83	41	21	8.3	4.1	1 273
165	25 920	1 157	1 157	1 157	750	375	188	75	38	19	8	4	1 157
172	27 000	1 110	1 110	1 110	720	360	180	72	36	18	7	4	1 110
183	28 800	1 044	1 044	1 044	676	338	170	68	34	17	7	3	1 044
200	31 488	955	955	955	619	309	155	62	31	15	6.2	3.1	955
206	32 400	927	927	927	601	300	151	60	30	15	6.0	3.0	927
209	32 768	914	914	914	592	296	148	59	30	15	5.9	2.9	914
229	36 000	834	834	834	540	270	136	54	27	14	5.4	2.7	834
255	40 000	749	749	749	485	243	122	49	24	12	4.9	2.4	749
300	47 200	637	637	637	413	206	103	41	21	10	4.1	2.0	637
350	55 040	546	546	546	354	177	89	35	18	8.8	3.5	1.7	546
413	64 800	462	462	462	300	150	75	30	15	7.5	3.0	1.5	462
417	65 536	458	458	458	297	148	74	30	15	7.4	3.0	1.5	458
489	76 800	391	391	391	253	127	63	25	13	6.3	2.5	1.2	391
550	86 400	347	347	347	225	113	56	23	11	5.6	2.3	1.1	347

## Maximum speed (rev/min)

For details of maximum speeds for other clocked options, contact your local Renishaw representative.

### QUANTiC system: For 50 MHz clocked option

Nominal external diameter (mm)	Line count	Digital output resolution							Analogue output 1 Vpp
		10 µm	5 µm	1 µm	0.5 µm	0.2 µm	0.1 µm	50 nm	
52	4 096	8 815	8 815	8 815	6 659	2 663	1 332	666	7 346
57	4 500	8 042	8 042	8 042	6 075	2 429	1 215	607	6 701
75	5 920	6 112	6 112	6 112	4 617	1 846	923	462	5 093
94	7 400	4 876	4 876	4 876	3 684	1 473	737	368	4 064
100	7 872	4 584	4 584	4 584	3 463	1 385	693	346	3 820
103	8 100	4 450	4 450	4 450	3 362	1 344	672	336	3 708
104	8 192	4 407	4 407	4 407	3 329	1 331	666	333	3 673
115	9 000	3 986	3 986	3 986	3 011	1 204	602	301	3 321
124	9 740	3 697	3 697	3 697	2 792	1 117	558	279	3 080
150	11 800	3 056	3 056	3 056	2 308	923	462	231	2 546
165	12 960	2 778	2 778	2 778	2 099	839	420	210	2 315
172	13 500	2 665	2 665	2 665	2 013	805	403	201	2 221
183	14 400	2 505	2 505	2 505	1 892	757	378	189	2 087
200	15 744	2 292	2 292	2 292	1 731	692	346	173	1 910
206	16 200	2 225	2 225	2 225	1 681	672	336	168	1 854
209	16 384	2 193	2 193	2 193	1 657	663	331	166	1 828
229	18 000	2 002	2 002	2 002	1 512	605	302	151	1 668
255	20 000	1 798	1 798	1 798	1 358	543	272	136	1 498
300	23 600	1 528	1 528	1 528	1 154	462	231	115	1 273
350	27 520	1 310	1 310	1 310	989	396	198	99	1 091
413	32 400	1 110	1 110	1 110	838	335	168	84	925
417	32 768	1 099	1 099	1 099	830	332	166	83	916
489	38 400	937	937	937	708	283	142	71	781
550	43 200	833	833	833	630	252	126	63	694

# Resolution

## VIONiC with RESM20

The RESM20 offers a range of standard ring diameters, as well as sizes that offer line counts that provide 2<sup>n</sup> counts per revolution or resolutions that are precise sub-divisions of degrees or arc seconds.

**NOTE:** 1 arc second resolution = 1.296 × 10<sup>6</sup> counts per revolution ≈ 2.778 × 10<sup>-4</sup> degree resolution.

	Nominal external diameter (line count)	VIONiC digital resolution (interpolation factor)											
		5 μm (×4)	1 μm (×20)	0.5 μm (×40)	0.2 μm (×100)	0.1 μm (×200)	50 nm (×400)	40 nm (×500)	25 nm (×800)	20 nm (×1 000)	10 nm (×2 000)	5 nm (×4 000)	2.5 nm (×8 000)
Standard outside diameters	75 mm (11 840)	≈ 27.4"	≈ 5.47"	≈ 2.74"	≈ 1.1"	≈ 0.55"	≈ 0.27"	≈ 0.22"	≈ 0.14"	≈ 0.11"	≈ 0.055"	≈ 0.028"	≈ 0.014"
	94 mm (14 800)	≈ 21.9"	≈ 4.4"	≈ 2.2"	≈ 0.9"	≈ 0.44"	≈ 0.22"	≈ 0.18"	≈ 0.11"	≈ 0.09"	≈ 0.044"	≈ 0.022"	≈ 0.011"
	100 mm (15 744)	≈ 20.6"	≈ 4.12"	≈ 2.06"	≈ 0.82"	≈ 0.41"	≈ 0.21"	≈ 0.16"	≈ 0.10"	≈ 0.082"	≈ 0.041"	≈ 0.021"	≈ 0.010"
	124 mm (19 478)	≈ 16.6"	≈ 3.3"	≈ 1.7"	≈ 0.7"	≈ 0.33"	≈ 0.17"	≈ 0.13"	≈ 0.08"	≈ 0.07"	≈ 0.033"	≈ 0.017"	≈ 0.008"
	150 mm (23 600)	≈ 13.7"	≈ 2.75"	≈ 1.37"	≈ 0.55"	≈ 0.27"	≈ 0.14"	≈ 0.11"	≈ 0.07"	≈ 0.055"	≈ 0.028"	≈ 0.014"	≈ 0.007"
	172 mm (27 000)	≈ 12.0"	≈ 2.4"	≈ 1.2"	≈ 0.5"	≈ 0.24"	≈ 0.12"	≈ 0.10"	≈ 0.06"	≈ 0.05"	≈ 0.024"	≈ 0.012"	≈ 0.006"
	200 mm (31 488)	≈ 10.3"	≈ 2.06"	≈ 1.03"	≈ 0.41"	≈ 0.21"	≈ 0.1"	≈ 0.08"	≈ 0.05"	≈ 0.041"	≈ 0.021"	≈ 0.010"	≈ 0.005"
	255 mm <sup>1</sup> (40 000)	≈ 8.1"	≈ 1.62"	≈ 0.81"	≈ 0.32"	≈ 0.16"	≈ 0.081"	≈ 0.06"	≈ 0.04"	≈ 0.032"	≈ 0.016"	≈ 0.0081"	≈ 0.004"
	300 mm (47 200)	≈ 6.9"	≈ 1.37"	≈ 0.69"	≈ 0.27"	≈ 0.14"	≈ 0.069"	≈ 0.05"	≈ 0.03"	≈ 0.027"	≈ 0.014"	≈ 0.0069"	≈ 0.003"
	350 mm (55 040)	≈ 5.9"	≈ 1.18"	≈ 0.59"	≈ 0.24"	≈ 0.12"	≈ 0.059"	≈ 0.05"	≈ 0.03"	≈ 0.024"	≈ 0.012"	≈ 0.0059"	≈ 0.003"
	489 mm (76 800)	≈ 4.22"	≈ 0.84"	≈ 0.42"	≈ 0.17"	≈ 0.084"	≈ 0.042"	≈ 0.03"	≈ 0.02"	≈ 0.017"	≈ 0.0084"	≈ 0.0042"	≈ 0.002"
	550 mm (86 400)	≈ 3.75"	≈ 0.75"	≈ 0.38"	≈ 0.15"	≈ 0.075"	≈ 0.38"	≈ 0.03"	≈ 0.02"	≈ 0.015"	≈ 0.0075"	≈ 0.0038"	≈ 0.002"
2 <sup>n</sup> line count	52 mm (8 192)	≈ 39.6"	≈ 7.9"	≈ 3.96"	≈ 1.58"	≈ 0.79"	≈ 0.4"	≈ 0.32"	≈ 0.20"	≈ 0.16"	≈ 0.079"	≈ 0.040"	≈ 0.020"
	104 mm (16 384)	≈ 19.8"	≈ 3.96"	≈ 1.98"	≈ 0.79"	≈ 0.4"	≈ 0.2"	≈ 0.16"	≈ 0.10"	≈ 0.08"	≈ 0.040"	≈ 0.020"	≈ 0.010"
	209 mm (32 768)	≈ 9.89"	≈ 1.98"	≈ 0.99"	≈ 0.4"	≈ 0.2"	≈ 0.1"	≈ 0.8"	≈ 0.05"	≈ 0.04"	≈ 0.02"	≈ 0.0099"	≈ 0.005"
	417 mm (65 536)	≈ 4.9"	≈ 0.99"	≈ 0.49"	≈ 0.2"	≈ 0.1"	≈ 0.05"	≈ 0.04"	≈ 0.02"	≈ 0.02"	≈ 0.0099"	≈ 0.0049"	≈ 0.002"
Subdivisions of degrees	57 mm (9 000)	0.01°	0.002°	0.001°	0.0004°	0.0002°	0.0001°	0.00008°	0.00005°	0.00004°	0.00002°	0.00001°	0.000005°
	115 mm (18 000)	0.005°	0.001°	0.0005°	0.0002°	0.0001°	0.00005°	0.00004°	0.00003°	0.00002°	0.00001°	0.000005°	0.000003°
	229 mm (36 000)	0.0025°	0.0005°	0.00025°	0.0001°	0.00005°	0.000025°	0.00002°	0.00001°	0.00001°	0.000005°	0.0000025°	0.000001°
Subdivisions of arc second	103 mm (16 200)	20"	4"	2"	0.8"	0.4"	0.2"	0.16"	0.10"	0.08"	0.040"	0.020"	0.010"
	165 mm (25 920)	12.50"	2.5"	1.25"	0.5"	0.25"	0.125"	0.1"	0.0625"	0.05"	0.025"	0.0125"	0.00625"
	183 mm (28 800)	11.25"	2.25"	1.125"	0.45"	0.225"	0.1125"	0.09"	0.05625"	0.045"	0.0225"	0.01125"	0.005625"
	206 mm (32 400)	10"	2"	1"	0.4"	0.2"	0.1"	0.08"	0.05"	0.04"	0.020"	0.010"	0.0050"
	413 mm (64 800)	5"	1"	0.5"	0.2"	0.1"	0.05"	0.04"	0.03"	0.02"	0.010"	0.0050"	0.003"

<sup>1</sup> Line count as a multiple of 1 000.

### NOTES:

- The symbol " indicates units of arc seconds.
- Numbers preceded with a ≈ symbol show rounded resolution values. To calculate the exact resolution in arc seconds, use the following equation:

$$\theta \text{ (arc seconds)} = \frac{1.296 \times 10^6}{[\text{Line count}] \times [\text{Interpolation factor}]}$$

# Resolution

## TONiC with RESM20

The RESM20 offers a range of standard ring diameters, as well as sizes that offer line counts that provide 2<sup>n</sup> counts per revolution or resolutions that are precise sub-divisions of degrees or arc seconds.

**NOTE:** 1 arc second resolution = 1.296 × 10<sup>6</sup> counts per revolution ≈ 2.778 × 10<sup>-4</sup> degree resolution.

	Nominal external diameter (line count)	TONiC digital resolution (interpolation factor)										
		5 μm (×4)	1 μm (×20)	0.5 μm (×40)	0.2 μm (×100)	0.1 μm (×200)	50 nm (×400)	20 nm (×1 000)	10 nm (×2 000)	5 nm (×4 000)	2 nm (×10 000)	1 nm (×20 000)
Standard outside diameters	75 mm (11 840)	≈ 27.4"	≈ 5.47"	≈ 2.74"	≈ 1.1"	≈ 0.55"	≈ 0.27"	≈ 0.11"	≈ 0.055"	≈ 0.028"	≈ 0.011"	≈ 0.0055"
	94 mm (14 800)	≈ 21.9"	≈ 4.38"	≈ 2.19"	≈ 0.88"	≈ 0.44"	≈ 0.22"	≈ 0.09"	≈ 0.044"	≈ 0.022"	≈ 0.009"	≈ 0.0044"
	100 mm (15 744)	≈ 20.6"	≈ 4.12"	≈ 2.06"	≈ 0.82"	≈ 0.41"	≈ 0.21"	≈ 0.082"	≈ 0.041"	≈ 0.021"	≈ 0.0082"	≈ 0.0041"
	124 mm (19 478)	≈ 16.6"	≈ 3.33"	≈ 1.66"	≈ 0.67"	≈ 0.33"	≈ 0.17"	≈ 0.07"	≈ 0.033"	≈ 0.017"	≈ 0.007"	≈ 0.0033"
	150 mm (23 600)	≈ 13.7"	≈ 2.75"	≈ 1.37"	≈ 0.55"	≈ 0.27"	≈ 0.14"	≈ 0.055"	≈ 0.028"	≈ 0.014"	≈ 0.0055"	≈ 0.0027"
	172 mm (27 000)	≈ 12.0"	≈ 2.40"	≈ 1.2"	≈ 0.48"	≈ 0.24"	≈ 0.12"	≈ 0.05"	≈ 0.024"	≈ 0.012"	≈ 0.005"	≈ 0.0024"
	200 mm (31 488)	≈ 10.3"	≈ 2.06"	≈ 1.03"	≈ 0.41"	≈ 0.21"	≈ 0.1"	≈ 0.041"	≈ 0.021"	≈ 0.010"	≈ 0.0041"	≈ 0.0020"
	255 mm <sup>1</sup> (40 000)	≈ 8.1"	≈ 1.62"	≈ 0.81"	≈ 0.32"	≈ 0.16"	≈ 0.081"	≈ 0.032"	≈ 0.016"	≈ 0.0081"	≈ 0.0032"	≈ 0.0016"
	300 mm (47 200)	≈ 6.9"	≈ 1.37"	≈ 0.69"	≈ 0.27"	≈ 0.14"	≈ 0.069"	≈ 0.027"	≈ 0.014"	≈ 0.0069"	≈ 0.0027"	≈ 0.0014"
	350 mm (55 040)	≈ 5.9"	≈ 1.18"	≈ 0.59"	≈ 0.24"	≈ 0.12"	≈ 0.059"	≈ 0.024"	≈ 0.012"	≈ 0.0059"	≈ 0.0024"	≈ 0.0012"
	489 mm (76 800)	≈ 4.22"	≈ 0.84"	≈ 0.42"	≈ 0.17"	≈ 0.084"	≈ 0.042"	≈ 0.017"	≈ 0.0084"	≈ 0.0042"	≈ 0.0017"	≈ 0.00084"
	550 mm (86 400)	≈ 3.75"	≈ 0.75"	≈ 0.38"	≈ 0.15"	≈ 0.075"	≈ 0.38"	≈ 0.015"	≈ 0.0075"	≈ 0.0038"	≈ 0.0015"	≈ 0.00075"
2 <sup>n</sup> line count	52 mm (8 192)	≈ 39.6"	≈ 7.9"	≈ 3.96"	≈ 1.58"	≈ 0.79"	≈ 0.4"	≈ 0.16"	≈ 0.079"	≈ 0.040"	≈ 0.016"	≈ 0.0079"
	104 mm (16 384)	≈ 19.8"	≈ 3.96"	≈ 1.98"	≈ 0.79"	≈ 0.4"	≈ 0.2"	≈ 0.08"	≈ 0.040"	≈ 0.020"	≈ 0.0080"	≈ 0.0040"
	209 mm (32 768)	≈ 9.89"	≈ 1.98"	≈ 0.99"	≈ 0.4"	≈ 0.2"	≈ 0.1"	≈ 0.04"	≈ 0.02"	≈ 0.0099"	≈ 0.0040"	≈ 0.0020"
	417 mm (65 536)	≈ 4.9"	≈ 0.99"	≈ 0.49"	≈ 0.2"	≈ 0.1"	≈ 0.05"	≈ 0.02"	≈ 0.0099"	≈ 0.0049"	≈ 0.0020"	≈ 0.00099"
Subdivisions of degrees	57 mm (9 000)	0.01°	0.002°	0.001°	0.0004°	0.0002°	0.0001°	0.00004°	0.00002°	0.00001°	0.000004°	0.000002°
	115 mm (18 000)	0.005°	0.001°	0.0005°	0.0002°	0.0001°	0.00005°	0.00002°	0.00001°	0.000005°	0.000002°	0.000001°
	229 mm (36 000)	0.0025°	0.0005°	0.00025°	0.0001°	0.00005°	0.000025°	0.00001°	0.000005°	0.0000025°	0.000001°	0.0000005°
Subdivisions of arc second	103 mm (16 200)	20"	4"	2"	0.8"	0.4"	0.2"	0.08"	0.040"	0.020"	0.0080"	0.0040"
	165 mm (25 920)	12.5"	2.5"	1.25"	0.5"	0.25"	0.125"	0.05"	0.025"	0.0125"	0.005"	0.0025"
	183 mm (28 800)	11.25"	2.25"	1.125"	0.45"	0.225"	0.1125"	0.05"	0.0225"	0.01125"	0.005"	0.00225"
	206 mm (32 400)	10"	2"	1"	0.4"	0.2"	0.1"	0.04"	0.020"	0.010"	0.0040"	0.0020"
	413 mm (64 800)	5"	1"	0.5"	0.2"	0.1"	0.05"	0.02"	0.010"	0.0050"	0.0020"	0.0010"

<sup>1</sup> Line count as a multiple of 1 000.

### NOTES:

- The symbol " indicates units of arc seconds.
- Numbers preceded with a ≈ symbol show rounded resolution values. To calculate the exact resolution in arc seconds, use the following equation:

$$\theta \text{ (arc seconds)} = \frac{1.296 \times 10^6}{[\text{Line count}] \times [\text{Interpolation factor}]}$$

# Resolution

## QUANTiC with RESM40

The RESM40 offers a range of standard ring diameters, as well as sizes that offer line counts that provide 2<sup>n</sup> counts per revolution or resolutions that are precise sub-divisions of degrees or arc seconds.

**NOTE:** 1 arc second resolution = 1.296 × 10<sup>6</sup> counts per revolution ≈ 2.778 × 10<sup>-4</sup> degree resolution.

	Nominal external diameter (line count)	QUANTiC digital resolution (interpolation factor)						
		10 μm (×4)	5 μm (×8)	1 μm (×40)	0.5 μm (×80)	0.2 μm (×200)	0.1 μm (×400)	50 nm (×800)
Standard outside diameters	75 mm (5 920)	≈ 54.73"	≈ 27.36"	≈ 5.47"	≈ 2.74"	≈ 1.09"	≈ 0.55"	≈ 0.27"
	94 mm (7 400)	≈ 43.8"	≈ 21.9"	≈ 4.4"	≈ 2.2"	≈ 0.876"	≈ 0.438"	≈ 0.219"
	100 mm (7 872)	≈ 41.16"	≈ 20.58"	≈ 4.12"	≈ 2.06"	≈ 0.82"	≈ 0.41"	≈ 0.21"
	124 mm (9 740)	≈ 33.3"	≈ 16.6"	≈ 3.3"	≈ 1.7"	≈ 0.665"	≈ 0.333"	≈ 0.166"
	150 mm (11 800)	≈ 27.46"	≈ 13.73"	≈ 2.75"	≈ 1.37"	≈ 0.55"	≈ 0.27"	≈ 0.14"
	172 mm (13 500)	≈ 24.0"	≈ 12.0"	≈ 2.4"	≈ 1.2"	≈ 0.48"	≈ 0.24"	≈ 0.12"
	200 mm (15 744)	≈ 20.58"	≈ 10.29"	≈ 2.06"	≈ 1.03"	≈ 0.41"	≈ 0.21"	≈ 0.10"
	255 mm* (20 000)	≈ 16.20"	≈ 8.10"	≈ 1.62"	≈ 0.81"	≈ 0.32"	≈ 0.16"	≈ 0.08"
	300 mm (23 600)	≈ 13.73"	≈ 6.86"	≈ 1.37"	≈ 0.69"	≈ 0.27"	≈ 0.14"	≈ 0.07"
	350 mm (27 520)	≈ 11.77"	≈ 5.89"	≈ 1.18"	≈ 0.59"	≈ 0.24"	≈ 0.12"	≈ 0.06"
	489 mm (38 400)	≈ 8.44"	≈ 4.22"	≈ 0.84"	≈ 0.42"	≈ 0.17"	≈ 0.08"	≈ 0.04"
	550 mm (43 200)	≈ 7.50"	≈ 3.75"	≈ 0.75"	≈ 0.38"	≈ 0.15"	≈ 0.08"	≈ 0.04"
2 <sup>n</sup> line count	52 mm (4 096)	≈ 79.10"	≈ 39.55"	≈ 7.91"	≈ 3.96"	≈ 1.58"	≈ 0.79"	≈ 0.40"
	104 mm (8 192)	≈ 39.55"	≈ 19.78"	≈ 3.96"	≈ 1.98"	≈ 0.79"	≈ 0.40"	≈ 0.20"
	209 mm (16 384)	≈ 19.78"	≈ 9.89"	≈ 1.98"	≈ 0.99"	≈ 0.40"	≈ 0.20"	≈ 0.10"
	417 mm (32 768)	≈ 9.89"	≈ 4.94"	≈ 0.99"	≈ 0.49"	≈ 0.20"	≈ 0.10"	≈ 0.05"
Subdivisions of degrees	57 mm (4 500)	0.02°	0.01°	0.002°	0.001°	0.0004°	0.0002°	0.0001°
	115 mm (9 000)	0.01°	0.005°	0.001°	0.0005°	0.0002°	0.0001°	0.00005°
	229 mm (18 000)	0.005°	0.0025°	0.0005°	0.00025°	0.0001°	0.00005°	0.000025°
Subdivisions of arc second	103 mm (8 100)	40"	20"	4"	2"	0.8"	0.4"	0.2"
	165 mm (12 960)	25"	12.5"	2.5"	1.25"	0.5"	0.25"	0.125"
	183 mm (14 400)	22.5"	11.25"	2.25"	1.125"	0.45"	0.225"	0.1125"
	206 mm (16 200)	20"	10"	2"	1"	0.4"	0.2"	0.1"
	413 mm (32 400)	10"	5"	1"	0.5"	0.2"	0.1"	0.05"

<sup>1</sup> Line count as a multiple of 1 000.

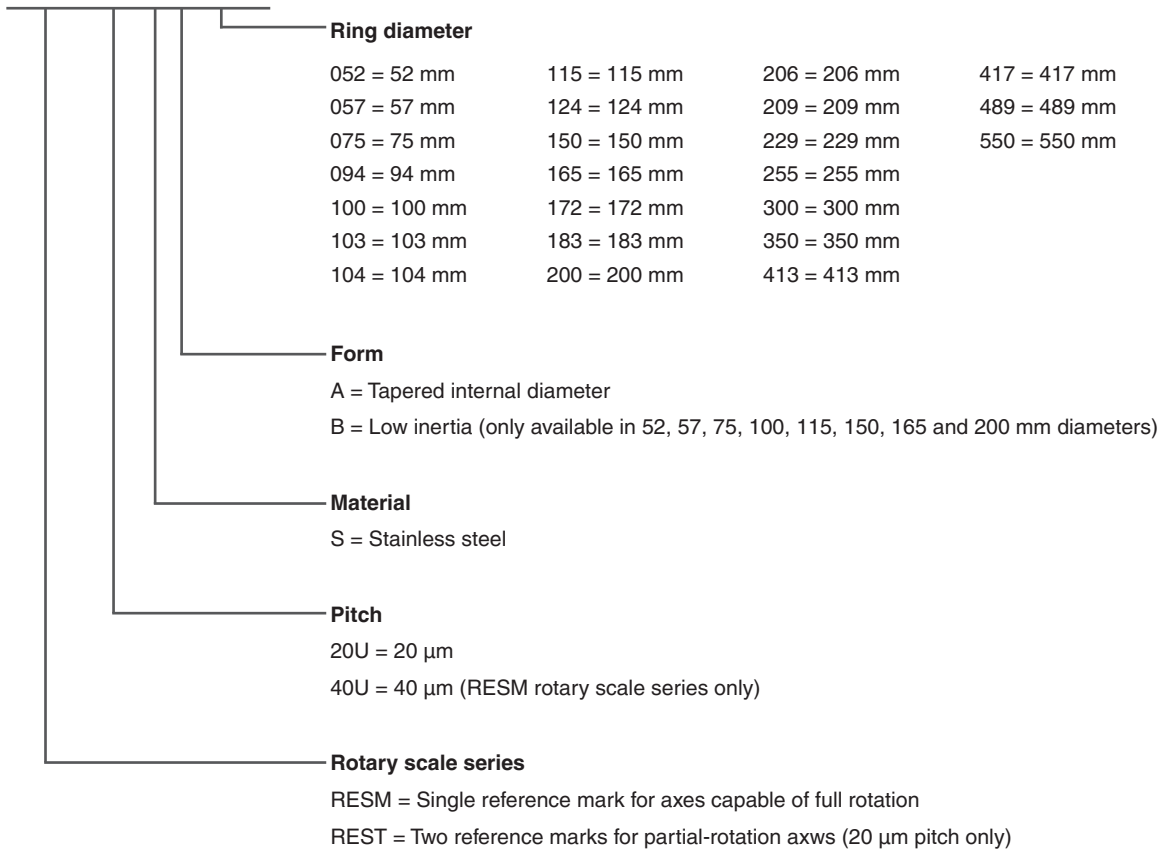
### NOTES:

- The symbol " indicates units of arc seconds.
- Numbers preceded with a ≈ symbol show rounded resolution values. To calculate the exact resolution in arc seconds, use the following equation:

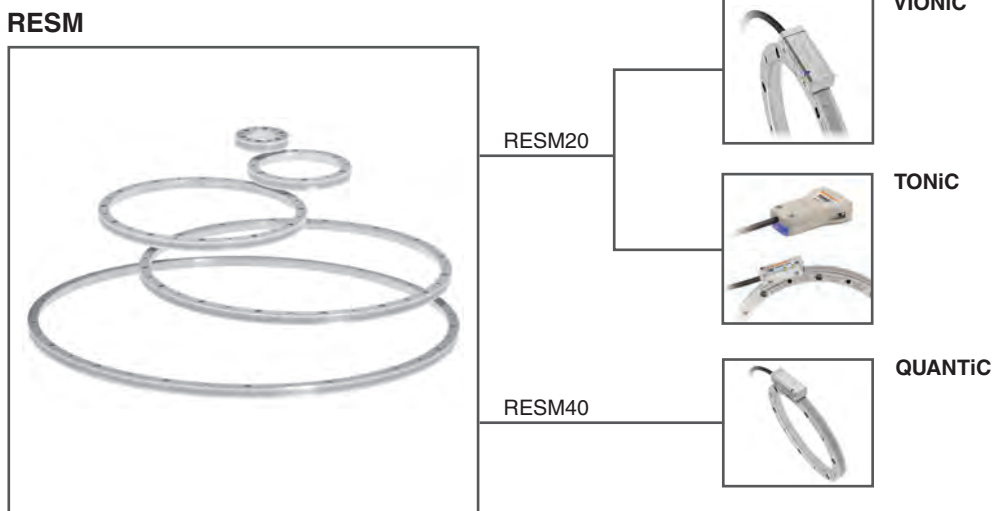
$$\theta \text{ (arc seconds)} = \frac{1.296 \times 10^6}{[\text{Line count}] \times [\text{Interpolation factor}]}$$

## Rotary scale part numbers

### RESM 20U S A 300



## Compatible products



## Appendix

### Graduation and system accuracy

Nominal external diameter	Graduation accuracy		System accuracy		
	arc second	µm	VIONiC arc second	TONiC arc second	QUANTiC arc second
52	±2.3	±0.3	±2.4	±2.5	±2.9
57	±2.2	±0.3	±2.3	±2.4	±2.8
75	±1.9	±0.4	±2.0	±2.1	±2.4
94	±1.7	±0.4	±1.8	±1.9	±2.1
100	±1.7	±0.4	±1.7	±1.8	±2.0
103	±1.6	±0.4	±1.7	±1.8	±2.0
104	±1.6	±0.4	±1.7	±1.8	±1.9
115	±1.6	±0.4	±1.6	±1.7	±1.8
124	±1.6	±0.4	±1.7	±1.7	±1.9
150	±1.4	±0.5	±1.4	±1.4	±1.6
165	±1.3	±0.5	±1.4	±1.4	±1.5
172	±1.3	±0.5	±1.3	±1.4	±1.5
183	±1.3	±0.5	±1.3	±1.3	±1.4
200	±1.2	±0.6	±1.2	±1.2	±1.3
206	±1.2	±0.6	±1.2	±1.2	±1.3
209	±1.2	±0.6	±1.2	±1.2	±1.3
229	±1.1	±0.6	±1.1	±1.2	±1.2
255	±1.0	±0.7	±1.1	±1.1	±1.2
300	±1.0	±0.7	±1.0	±1.0	±1.1
350	±0.9	±0.8	±0.9	±0.9	±1.0
413	±0.8	±0.8	±0.8	±0.9	±0.9
417	±0.8	±0.8	±0.8	±0.8	±0.9
489	±0.8	±0.9	±0.8	±0.8	±0.8
550	±0.7	±1.0	±0.7	±0.7	±0.8

**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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