

RGH40 RESR40 angle encoder system



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Product compliance



Renishaw plc declares that RGH40 complies with the applicable standards and regulations. A copy of the EC Declaration of Conformity is available on request.

FCC compliance

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

The user is cautioned that any changes or modifications not expressly approved by Renishaw plc or authorised representative could void the user's authority to operate the equipment.

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment.

This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

NOTE: This unit was tested with shielded cables on the peripheral devices. Shielded cables must be used with the unit to ensure compliance.

RoHS compliance

Compliant with EC directive 2011/65/EU (RoHS)

Patents

Features of Renishaw's encoder systems and similar products are the subjects of the following patents and patent applications:

US6481115	IL138995	EP1094302	CN1293983	GB2397040
JP4813018	US7723639	JP5442174	DE10297440	CN1314511
JP4423196	EP1469969	JP5002559	US7367128	US8987633
US8466943	EP1552248			

Further information

Further information relating to the RGH40 encoder range can be found in the RGH40 System Data sheet (L-9517-9752). This can be downloaded from our website www.renishaw.com/encoder and is also available from your local representative. This document may not be copied or reproduced in whole or in part, transferred to any other media or language, by any means without the written prior permission of Renishaw. The publication of material within this document does not imply freedom from the patent rights of Renishaw plc.

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The packaging of our products contains the following materials and can be recycled.

Packaging Component	Material	ISO 11469	Recycling Guidance
Outer box	Cardboard	Not applicable	Recyclable
	Polypropylene	PP	Recyclable
Inserts	Low Density Polyethylene Foam	LDPE	Recyclable
	Cardboard	Not applicable	Recyclable
Bags	High Density Polyethylene Bag	HDPE	Recyclable
	Metalised Polyethylene	PE	Recyclable

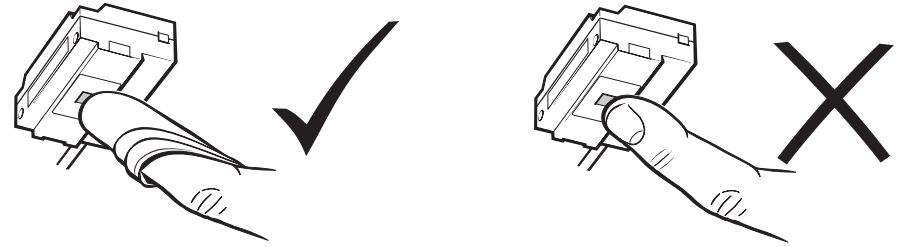
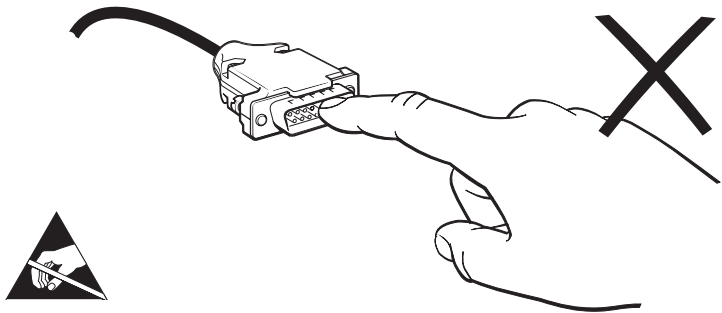
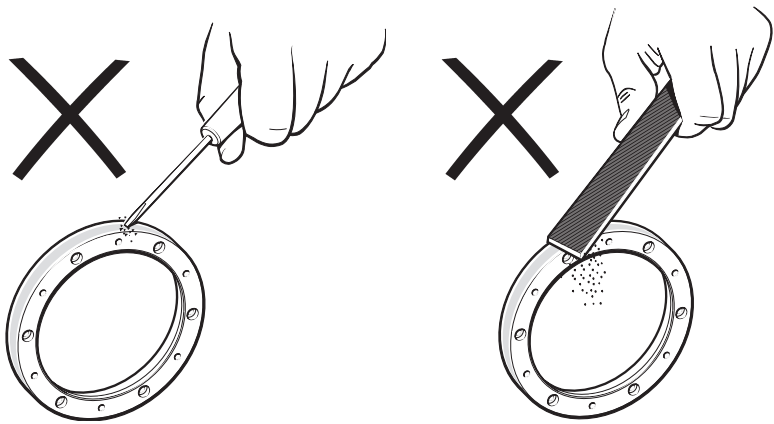
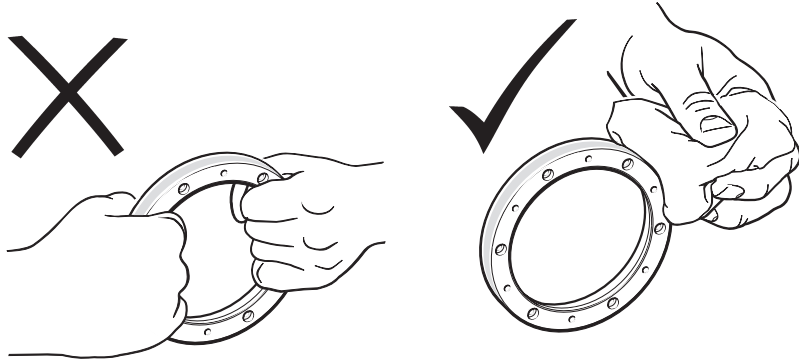


The use of this symbol on Renishaw products and/or accompanying documentation indicates that the product should not be mixed with general household waste upon disposal. It is the responsibility of the end user to dispose of this product at a designated collection point for waste electrical and electronic equipment (WEEE) to enable reuse or recycling. Correct disposal of this product will help to save valuable resources and prevent potential negative effects on the environment. For more information, please contact your local waste disposal service or Renishaw distributor.

Storage and handling

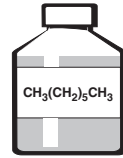
The RESR is a non-contact optical encoder that provides good immunity against contaminants such as dust, fingerprints and light oils.

However, in harsh environments such as machine tool applications, protection should be provided to prevent ingress of coolant or oil.

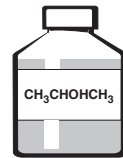


Ring and readhead

N-heptane

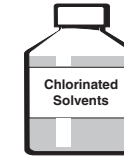
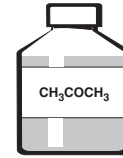


Propan-2-ol



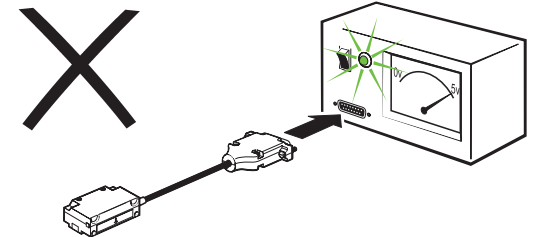
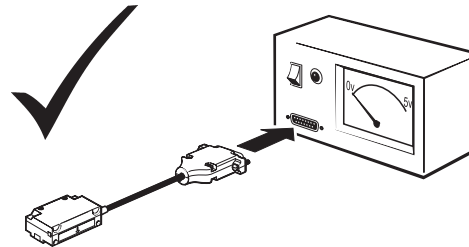
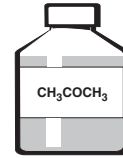
Ring only

Acetone



Readhead only

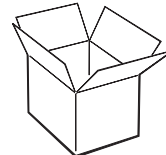
Acetone



Storage



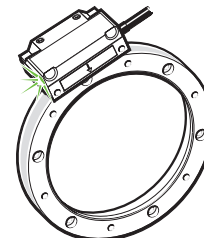
+70 °C
-20 °C



Operating

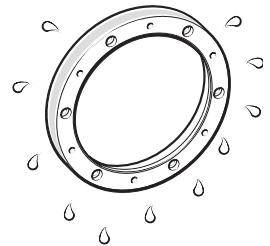
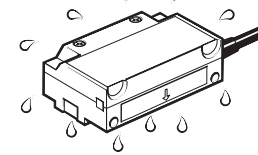


+55 °C
0 °C



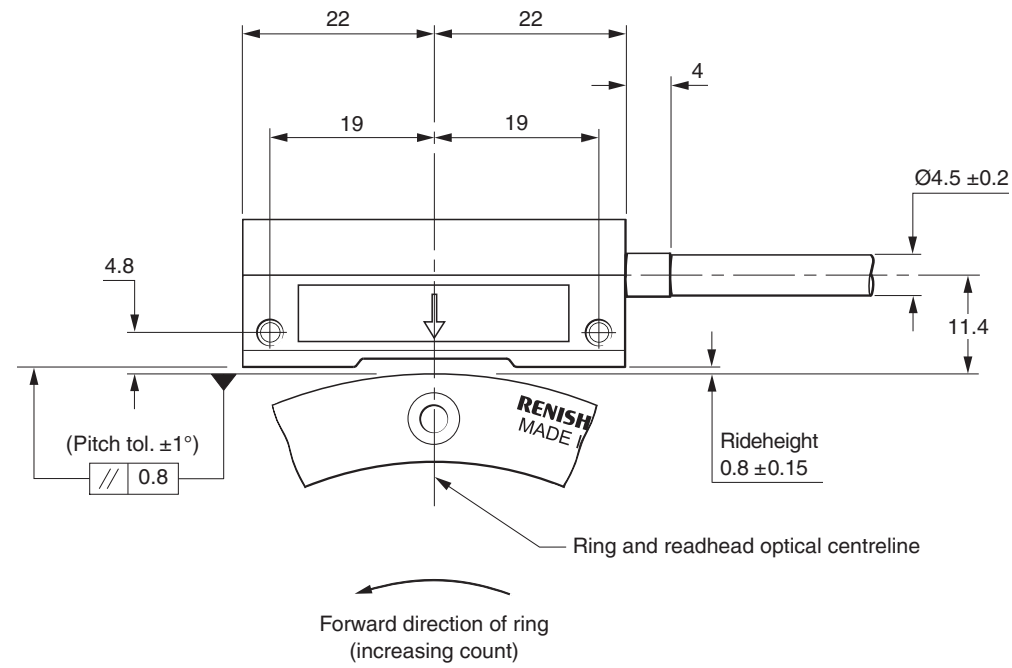
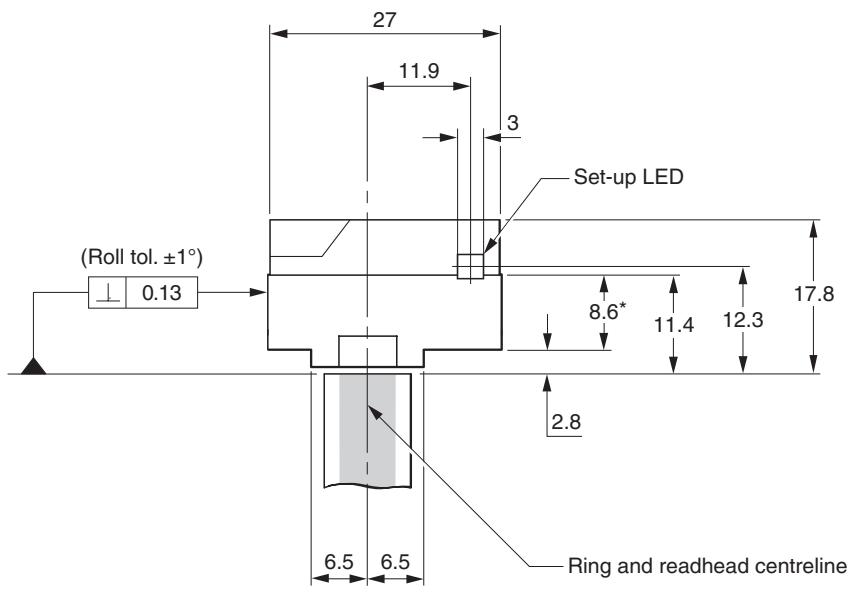
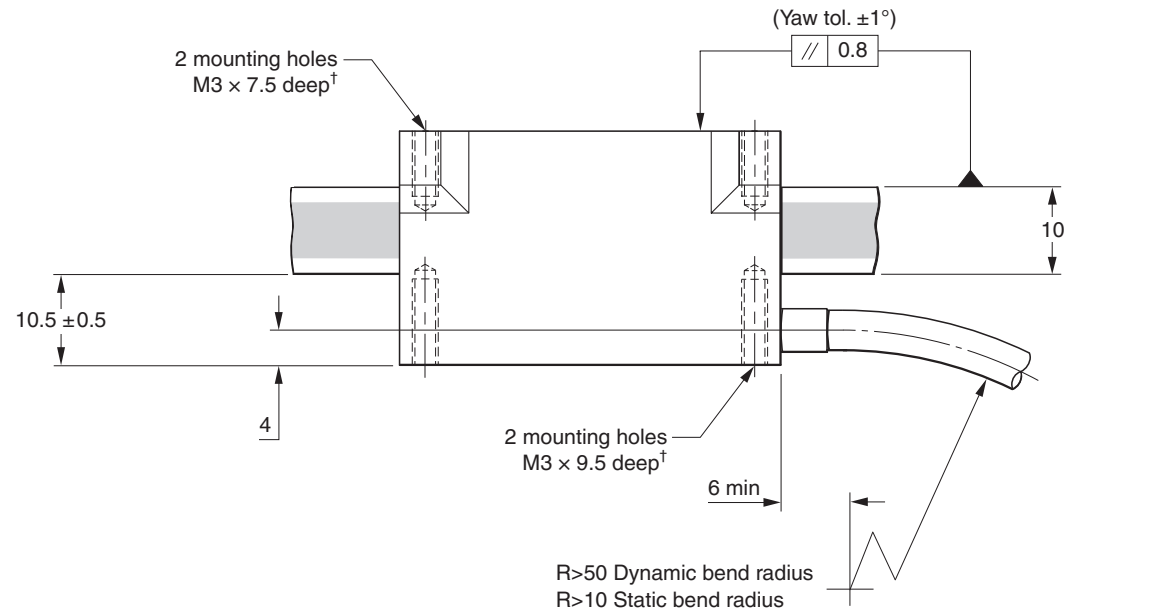
Humidity

95% relative humidity
(non-condensing)
to EN 60068-2-78



RGH40 readhead installation drawing (RESR 'A' section ring shown)

Dimensions and tolerances in mm

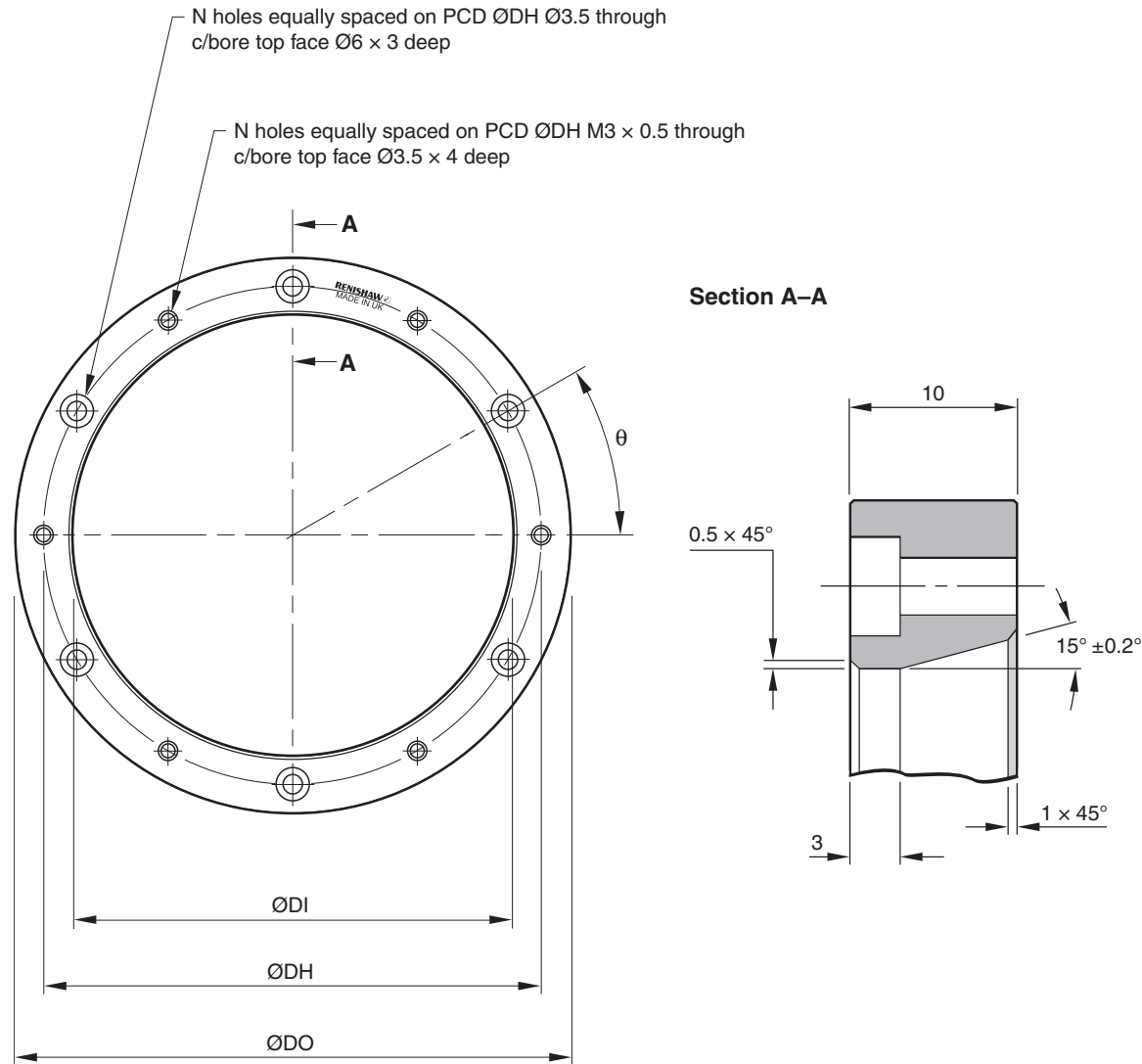


*Extent of mounting faces

†The recommended thread engagement is 5 mm. The recommended tightening torque is between 0.5 and 0.7 Nm.

RESR40 ring installation drawing ('A' section)

Dimensions and tolerances in mm



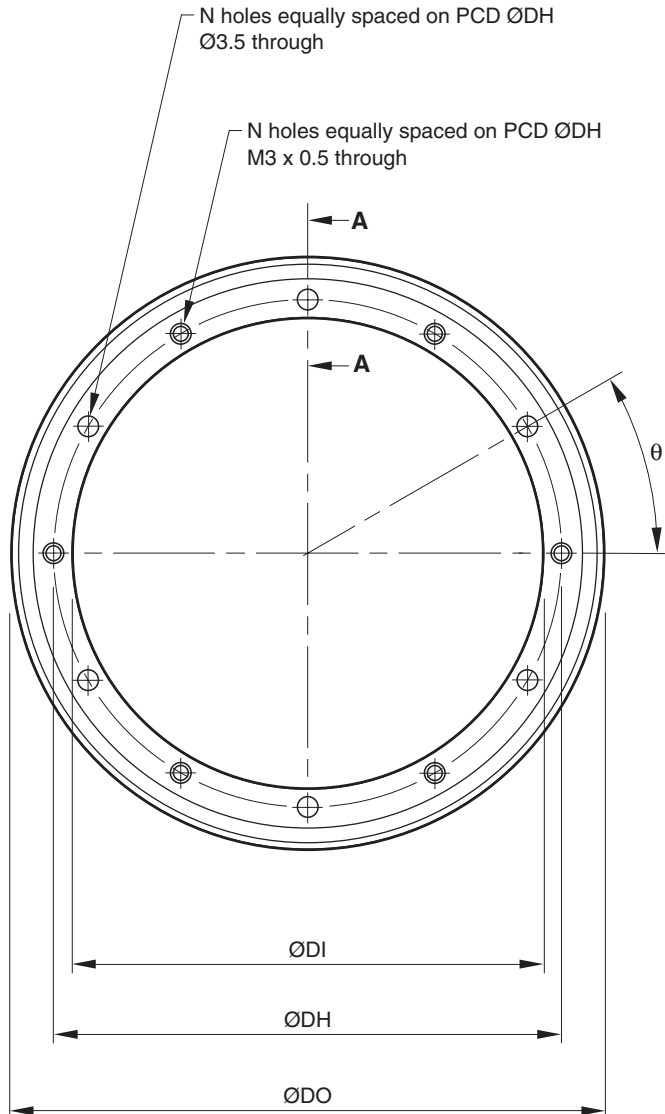
NOTE: θ is the angle between one tapped hole and the adjacent clearance hole. The angle between two clearance holes is 2θ.

Nominal external diameter (mm)	Line count 40 µm pitch	DO (mm)	DI (mm)	Mounting holes		
				DH (mm)	N	θ
52	4 096	52.20 52.10	30.04 30.00	40	6	30°
57	4 500	57.35 57.25	37.04 37.00	47	6	30°
75	5 920	75.40 75.30	55.04 55.00	65	6	30°
100	7 872	100.30 100.20	80.04 80.00	90	6	30°
103	8 100	103.20 103.00	80.04 80.00	90	6	30°
104	8 192	104.40 104.20	80.04 80.00	90	6	30°
115	9 000	114.70 114.50	95.04 95.00	105	6	30°
150	11 800	150.40 150.20	130.04 130.00	140	9	20°
200	15 744	200.40 200.20	180.04 180.00	190	12	15°
206	16 200	206.50 206.10	186.05 186.00	196	12	15°
209	16 384	208.80 208.40	186.05 186.00	196	12	15°
229	18 000	229.40 229.00	209.05 209.00	219	12	15°
255	20 000	254.80 254.40	235.06 235.00	245	12	15°
300	23 600	300.40 300.20	280.06 280.00	290	16	11.25°
350	27 520	350.40 350.20	330.06 330.00	340	16	11.25°
413	32 400	412.70 412.30	392.08 392.00	402	18	10°
417	32 768	417.40 417.00	380.10 380.00	390	18	10°
489*	38 400	489.12 488.72	451.10 450.90	462	20	18°*
550	43 200	550.20 549.80	510.10 510.00	520	20	9°

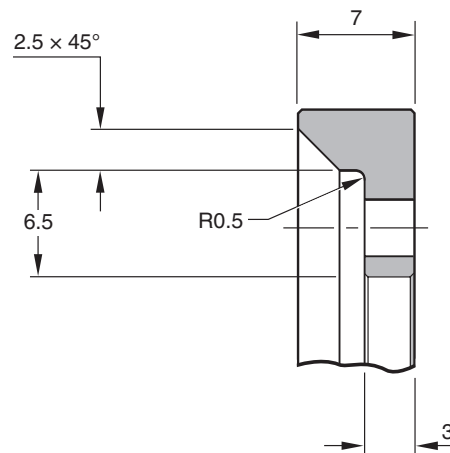
*There are no tapped holes on the 489 mm ring.

RESR40 ring installation drawing ('B' section)

Dimensions and tolerances in mm



Section A-A



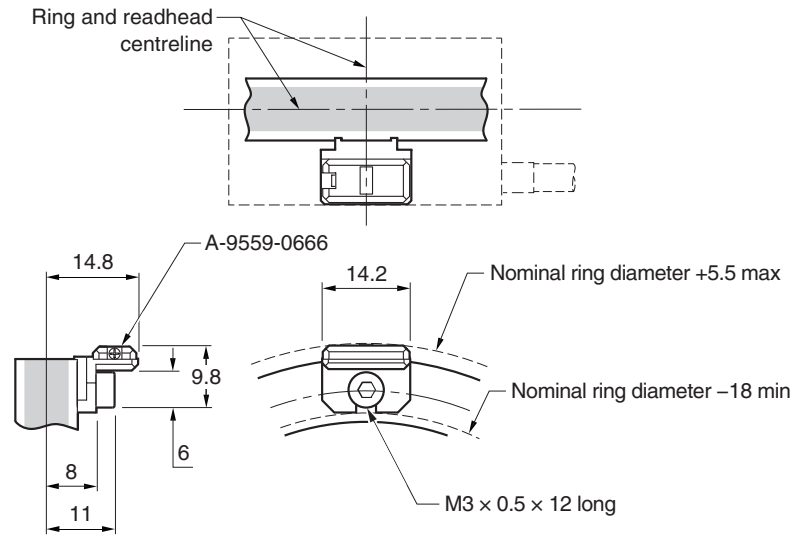
Nominal external diameter (mm)	Line count	DO (mm)	DI (mm)	Mounting holes		
	40 μ m pitch			DH (mm)	N	θ
52	4 096	52.20 52.10	32.04 32.00	38	6	30°
75	5 920	75.40 75.30	55.04 55.00	61	6	30°
100	7 872	100.30 100.20	80.04 80.00	86	6	30°
115	9 000	114.70 114.50	95.04 95.00	101	6	30°
150	11 800	150.40 150.20	130.04 130.00	136	9	20°
200	15 744	200.40 200.20	180.04 180.00	186	12	15°

NOTE: θ is the angle between one tapped hole and the adjacent clearance hole.
 The angle between two clearance holes is 2θ .

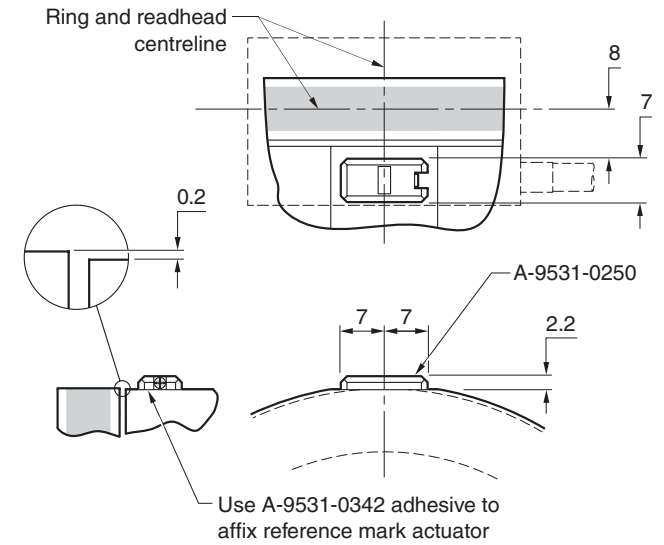
RGH40 reference mark options

Dimensions and tolerances in mm

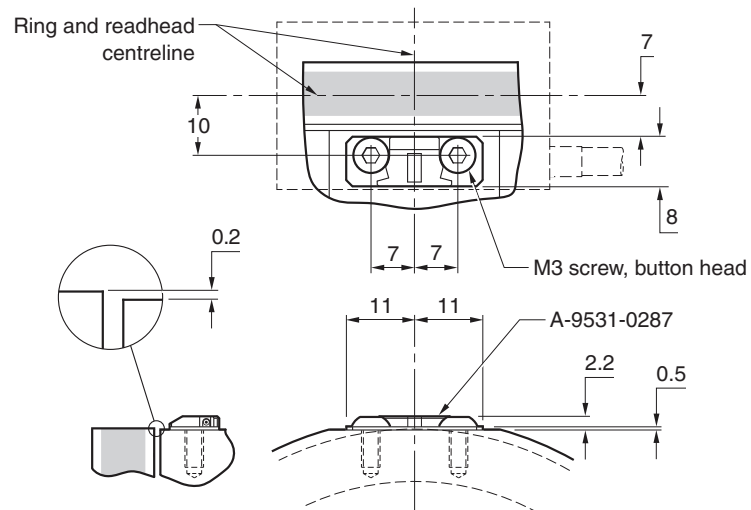
1. Using A-9559-0666



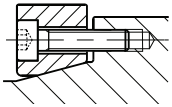
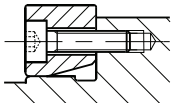
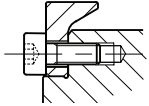
2. Using A-9531-0250



3. Using A-9531-0287

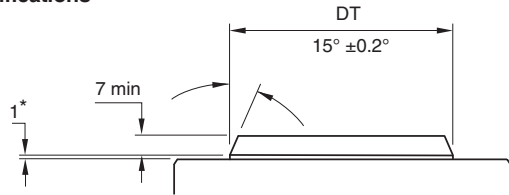


Select a mounting option

	Taper mount	Interference fit
'A' section		
'B' section	Not applicable	
Notes	<p>Recommended for all installations</p> <ul style="list-style-type: none"> 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 	<p>Alternative installation</p> <p>Will not correct eccentricity of the supporting shaft</p>

Taper mount method Step 1

Mounting shaft specifications



*Allow 2 mm for 417 mm, 489 mm and 550 mm rings only

Recommended taper roundness

Diameter (mm)	Roundness value (mm TIR)
≤ 115	0.025
150 to 255	0.050
≥ 300	0.075

Recommended surface finish
≤ Ra 1.2

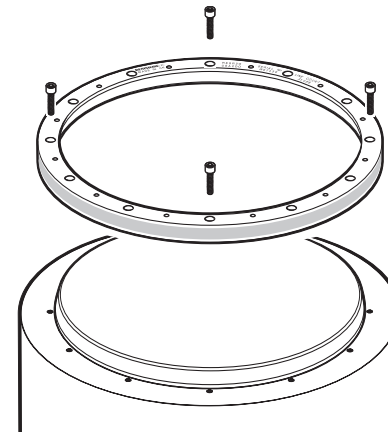
NOTE: It is recommended that the mounting surface is a turned, rather than ground finish.

Recommended taper diameter (DT)

DO (mm)	DT (mm)	DO (mm)	DT (mm)	DO (mm)	DT (mm)
52	33.85	150	133.85	350	333.85
	33.65		133.65		333.65
57	40.85	200	183.85	413	395.85
	40.65		183.65		395.65
75	58.85	206	189.85	417	383.85
	58.65		189.65		383.65
100	83.85	209	189.85	489	454.85
	83.65		189.65		454.65
103	83.85	229	212.85	550	513.85
	83.65		212.65		513.65
104	83.85	255	238.85		
	83.65		238.65		
115	98.85	300	283.85		
	98.65		283.65		

DO = Nominal external diameter

Taper mount method Step 2



▶ Clean shaft taper and internal taper of RESR as recommended in the storage and handling section.

▶ Insert the first screws:

For RESR rings with 6, 9 or 18 mounting holes, use 3 equally spaced M3 screws.

For RESR rings with 12, 16 or 20 mounting holes, use 4 equally spaced M3 screws.

NOTE: Do not lubricate screws.

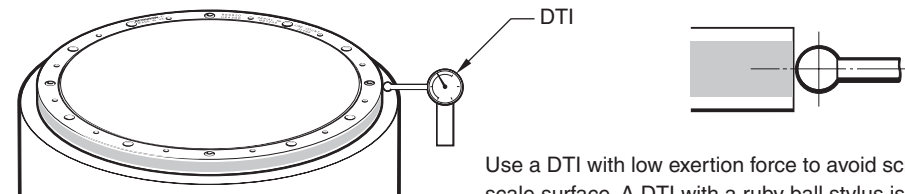
Recommended screw type M3 × 0.5:

ISO 4762/DIN 912 grade 10.9 minimum/ANSI B18.3.1M.

▶ Insert the screws so that the RESR is loosely connected to the shaft, then roughly align the ring by eye and touch.

▶ Lightly tighten the screws. Use a Dial Test Indicator (DTI) to check the radial displacement at the screw locations.

NOTE: Disregard the radial displacement between the screw locations.

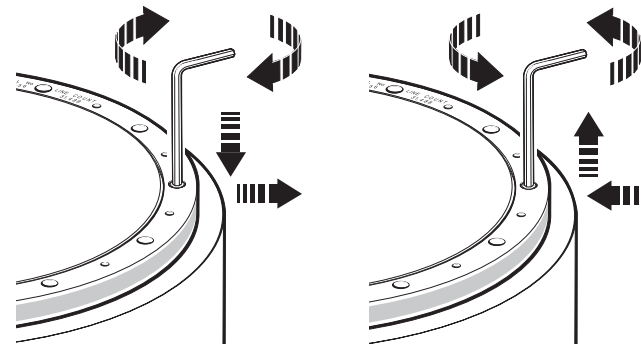


Use a DTI with low exertion force to avoid scratching the scale surface. A DTI with a ruby ball stylus is recommended as a further precaution against scratches.

▶ Adjust the screws to reduce the range of radial displacement. When adjusting, identify the screw location with the lowest radial displacement and tighten that screw, aiming for the average of the highest and lowest indicator readings.

▶ Repeat this process until the DTI readings are within ±5 μm at the screw locations.

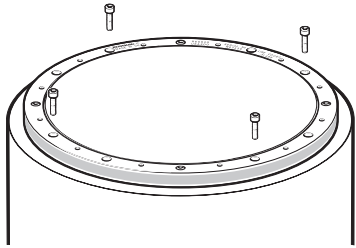
NOTE: It may be necessary to loosen screws whilst tightening other screws.



NOTE: At this stage, the screws should only be lightly tightened (less than 0.5 Nm) to allow further final adjustment.

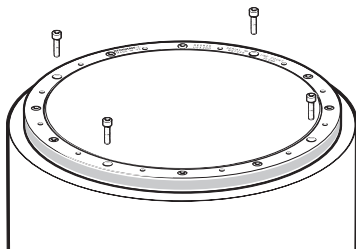
Select a mounting option (continued)

Taper mount method **Step 3**



- ▶ Insert the next screws:
For RESR rings with 6, 9 or 12 mounting holes, insert all the remaining M3 screws.
For RESR rings with 16 mounting holes, insert 3 equally spaced M3 screws.
For RESR rings with 18 mounting holes, insert 6 equally spaced M3 screws.
For RESR rings with 20 mounting holes, insert 8 equally spaced M3 screws (in four groups of two) between existing screws.
 - ▶ As described in Step 2, adjust all the screws inserted thus far, so that the radial displacement at each screw location is within $\pm 5 \mu\text{m}$.
 - ▶ Again, at this stage, the screws should only be lightly tightened (less than 0.5 Nm).
- NOTE:** You may notice that the torque required to achieve the radial displacement tolerance will be slightly higher during step 3 than during step 2. This is normal.

Taper mount method **Step 4**



- ▶ Insert screws into the remaining mounting holes.

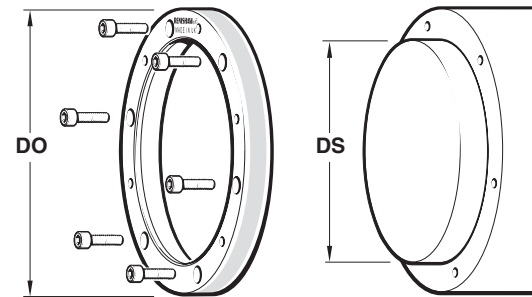
Taper mount method **Step 5**

Diameter (mm)	Recommended torque range (Nm)
≤ 115	1.5 - 2.1
150 to 255	0.8 - 1.1
300 to 413	0.5 - 0.7
≥ 417	1.2 - 1.7

- ▶ Rotate the RESR ring, measuring the radial displacement at all of the screw locations.
- ▶ Tighten the screw with the lowest radial displacement so that it matches the average radial displacement, whilst ensuring the maximum torque specified in the table is not exceeded.
- ▶ Again, rotate the RESR ring and re-check the radial displacement at all of the screw locations, tightening the screw with the lowest radial displacement so that it matches the average.
- ▶ Repeat this process until the radial displacement at all of the screw locations is within $\pm 3 \mu\text{m}$ and that all screw torques are within the specified range.
- ▶ Excessive tightening of screws can have a small effect on accuracy. Please contact your local representative for more details.

Interference fit method

Mounting shaft specifications.



NOTE: 417, 489 and 550 mm rings should be taper mounted only.

DO = Nominal external diameter
DS = Recommended shaft diameter to enable interference fit

*52 mm 'B' section ring = $\frac{32.033}{32.017}$

DO (mm)	DS (mm)
52*	30.033 30.017
57	37.033 37.017
75	55.039 55.020
100	80.045 80.023
103	80.045 80.023
104	80.045 80.023
115	95.045 95.023
150	130.052 130.027
200	180.052 180.027
206	186.060 186.031
209	186.060 186.031
229	209.060 209.031
255	235.060 235.031
300	280.066 280.034
350	330.073 330.037
413	392.073 392.037

Readhead mounting and alignment

Mounting brackets

The bracket must have a flat mounting surface, and should provide adjustment to enable conformance to the installation tolerances, allow adjustment to the rideheight of the readhead, and be sufficiently stiff to prevent deflection or vibration of the readhead during operation.

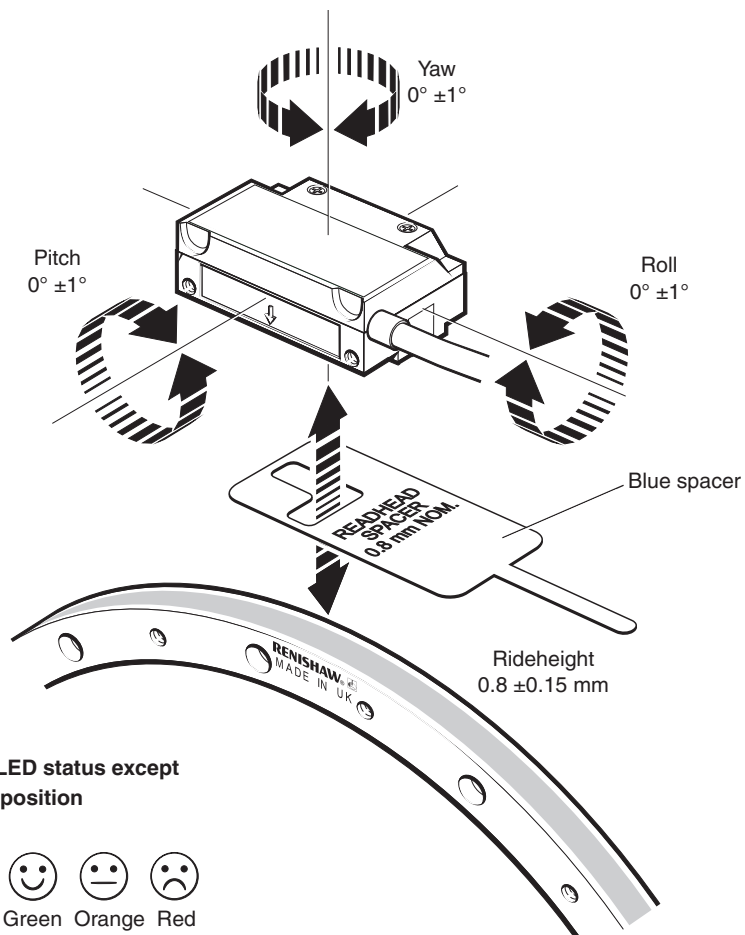
Readhead set-up

Ensure that the scale, readhead optical window and mounting face are clean and free from obstructions. To set nominal rideheight place the Blue readhead spacer with the 'L' shaped aperture under the optical centre of the readhead to allow normal LED function during set-up procedure.

Adjust the readhead to maximise the signal strength and achieve a Green set-up LED over the full rotation.

NOTE: Ensure readhead fixing screws are tightened to 0.5 Nm to 0.7 Nm.

An external set-up signal, X, is also available on RGH40 readheads for use where the LED is not visible. See 'Output specifications' for further details.



Readhead set-up LED status except at reference mark position



Reference mark set-up

To ensure uni-directional repeatability, the reference mark requires phasing with the scale in the direction of normal datuming operation.

A reference pulse is output in both directions, but repeatability is guaranteed only in the phased direction.

Ensure the readhead is set up correctly ensuring a Green LED indication over the full rotation.

The reference mark actuator should be installed as shown on the installation drawing.

NOTE: It is recommended that a datum procedure is performed as part of any power-up sequence to ensure the correct datum position is recorded.

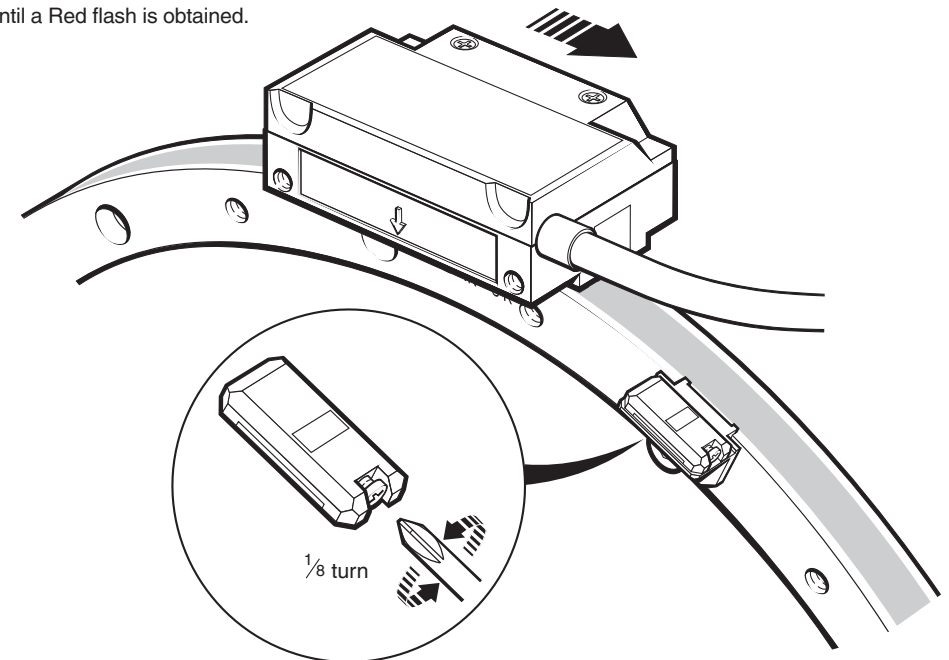
NOTE: Reference mark output is synchronised with the incremental channels, giving unit of resolution pulse width. For further details see 'Output specifications'.

Phasing procedure

The readhead must be moved over the reference mark in the direction to be used for the datuming operation.

The reference mark is phased correctly when the set-up LED flashes Red for 0.25 seconds.

If it flashes Orange or goes Blank, the reference mark adjuster screw should be turned anti-clockwise by $\frac{1}{8}$ turn and the procedure repeated until a Red flash is obtained.



Readhead set-up LED flash during reference mark traverse only



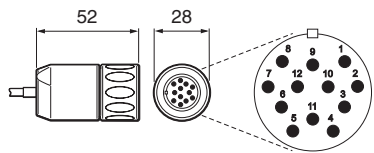
Output signals

RGH40A 1Vpp Analogue

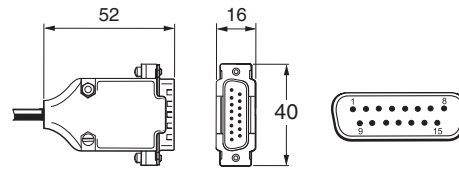
Function	Signal	Colour	15 way D-type plug (L)	12 way circular (V)	12 way circular coupling (W)	16 way in-line connector (X)
Power	5 V	Brown	4	2	2	A
		Brown (link)	5	12	12	M
	0 V	White	12	10	10	B
		White (link)	13	11	11	N
Incremental signals	V ₁	+	9	5	5	F
		-	1	6	6	R
	V ₂	+	10	8	8	D
		-	Green	2	1	1
Reference mark	V ₀	+	3	3	3	K
		-	Grey	11	4	4
Limit switch	V _q	Pink	8	N/C	N/C	H
	V _p	Clear	7	N/C	N/C	E
BID DIR connections*	BID	Black	6	9 [†]	9 ^{††}	I
	DIR	Orange	14	7 [†]	7 ^{††}	P
Shield	Inner	Green / Yellow	15	11 (link)	11 (link)	L
	Outer	-	Case	Case	Case	Case

[†]Only connected with option 17 ^{††}Only connected with option 18

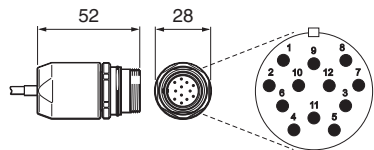
12 pin circular plug (termination code V)



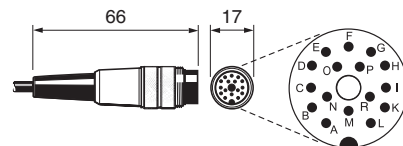
15 pin D-type plug (termination code L)



12 pin circular coupling (termination code W)



16 way in-line connector plug (termination code X)



*Reference mark uni-directional operation

The RGH40 reference mark output is repeatable for one direction of travel only.

Certain controllers will flag an error when they detect different reference mark positions in the forward and reverse directions.

BID/DIR pins allow the readhead to be configured to ignore the reference pulse output in one direction (see section 'Reference mark set-up').

BID/DIR connections

BID / DIR connection For bi-directional operation (normal)	To:-	Reference mark output direction
BID	+5 V or not connected	Forward and reverse
DIR	Do not connect	

BID / DIR connection For uni-directional operation	To:-	Reference mark output direction
BID	0 V	
DIR	+5 V or not connected	Forward only
DIR	0 V	Reverse only

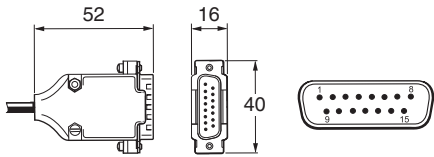
Output signals (continued)

RGH40T, D, G, X, N, W, Y, H RS422A digital

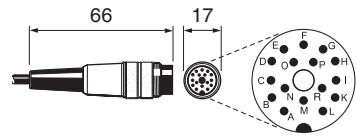
Function	Signal	Colour	15 way D-type plug (D)	16 way in-line connector (X)	
Power	5 V	Brown	7	A	
		Brown (link)	8	M	
	0 V	White	2	B	
		White (link)	9	N	
Incremental signals	A	+	Green	14	G
		-	Yellow	6	D
	B	+	Blue	13	R
		-	Red	5	F
Reference mark	Z	+	Violet	12	K
		-	Grey	4	O
Limit switch	Q	Pink	10	H	
	P	Black	11	I	
Alarm*	E-	Orange	3	P	
External set-up	X	Clear	1	E	
Shield	Inner	Green / Yellow	15	L	
	Outer	-	Case	Case	

*Alarm channel E- (Option 05) or line driver 3-state (Option 06)

15 pin D-type plug (termination code D)



16 way in-line connector plug (termination code X)



Speed

Digital readheads

Non-clocked output readheads

Head type	Maximum speed (m/s)	Lowest recommended counter input frequency (MHz)
T (10 μm)	10	$\left(\frac{\text{Encoder velocity (m/s)}}{\text{Resolution (μm)}} \right) \times 4 \text{ safety factor}$
D (5 μm)		
G (2 μm)		
X (1 μm)		

Clocked output readheads

The RGH40N, W, Y, H readheads are available with a variety of different clocked outputs. Customers must ensure they comply with the lowest recommended counter input frequency.

Options	Maximum speed (m/s)				Lowest recommended counter input frequency (MHz)
	Head type				
	N (0.4 μm)	W (0.2 μm)	Y (0.1 μm)	H (50 nm)	
61	3	2.5	1.3	0.6	20
62	2.6	1.3	0.7	0.3	10
63	1.3	0.7	0.35	0.15	5

Analogue readheads

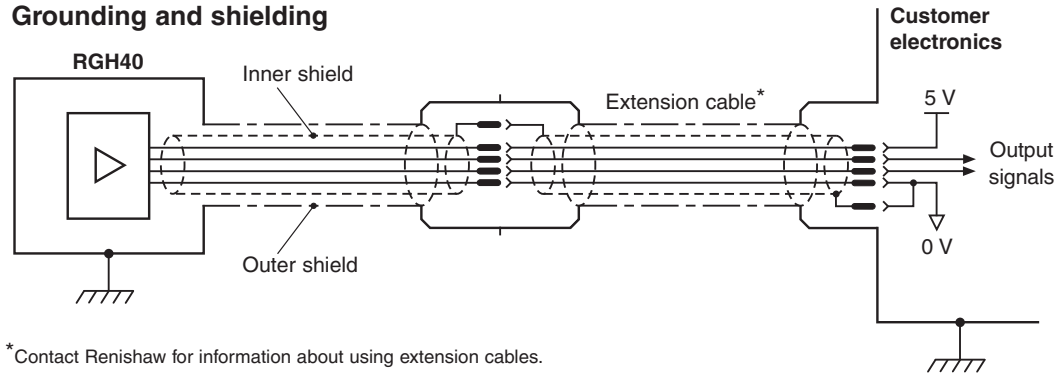
RGH40A - 8 m/s (-3dB)

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

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

Electrical connections

Grounding and shielding

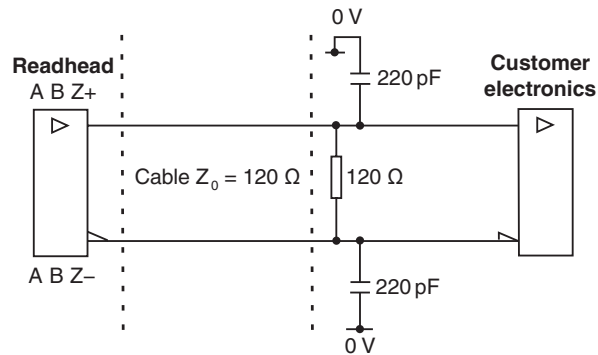


*Contact Renishaw for information about using extension cables.

IMPORTANT: The outer shield should be connected to the machine earth (Field Ground). The inner shield should be connected to 0 V at receiving electronics only. Care should be taken to ensure that the inner and outer shields are insulated from each other. If the inner and outer shields are connected together, this will cause a short between 0 V and earth, which could cause electrical noise issues.

Recommended signal termination

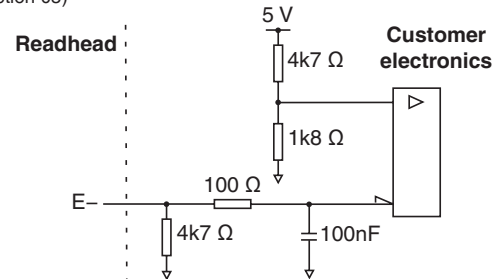
Digital outputs – RGH40T, D, G, X, N, W, Y, H



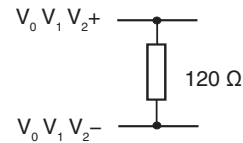
Standard RS422A line receiver circuitry
Capacitors recommended for improved noise immunity.

Single ended alarm signal termination

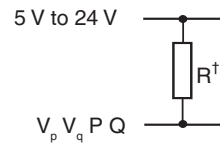
(option 05)



Analogue output – RGH40A



Limit output



[†]Select R so that the maximum current does not exceed 20 mA.

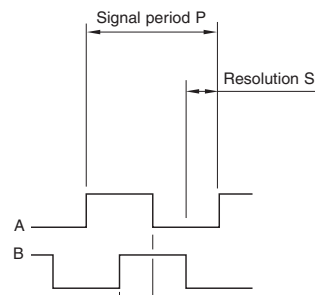
Alternatively, use a suitable relay or opto-isolator.

Output specifications

Digital output signals - RGH40T, D, G, X, N, W, Y, H

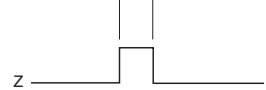
Form - Square wave differential line driver to EIA RS422A (except limit switch P, Q, Alarm E- and external set-up signal, X)

Incremental[†] 2 channels A and B in quadrature (90° phase shifted)



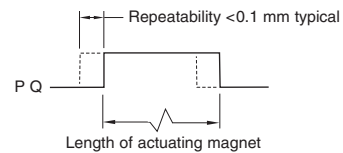
Model	P (μm)	S (μm)
RGH40T	40	10
RGH40D	20	5
RGH40G	8	2
RGH40X	4	1
RGH40N	1.6	0.4
RGH40W	0.8	0.2
RGH40Y	0.4	0.1
RGH40H	0.2	0.05

Reference[†]



Synchronised pulse Z, duration as resolution S. Repeatability of position (uni-directional) maintained within ±10 °C from temperature at time of phasing and for speeds <250 mm/s. For RGH40N, W, Y, H only Z pulse re-synchronised at power-up with any one of the quadrature states (00, 01, 11, 10).

Limit open collector output, asynchronous pulse



[†]Inverse signal not shown for clarity

Alarm

RGH40T, D, G and X

Alarm output asserted when <15% signal

Option	Alarm type
05	single ended line driven output
06	3-state output

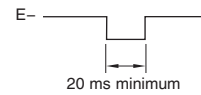
RGH40N, W, Y and H

Options 61, 62 and 63

Single ended line driven output alarm asserted when >150% signal or overspeed

3-state output alarm asserted when <15% signal

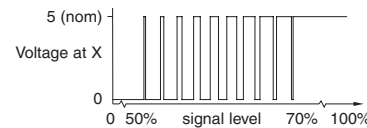
Line driven alarm output



3-state alarm output

Differentially transmitted signals forced open circuit for >20 ms when alarm conditions valid.

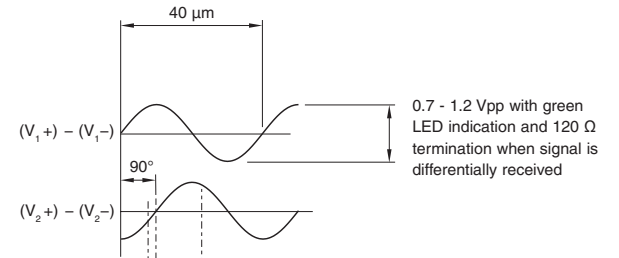
Set-up



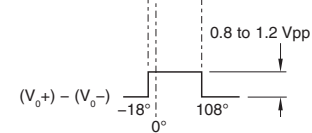
Between 50% and 70% signal level X is a duty cycle. Time spent at 5 V increases with signal level. At >70% signal level X is nominal 5V.

Analogue output signals - RGH40A

Incremental 2 channels V_1 and V_2 differential sinusoids in quadrature (90° phase shifted)

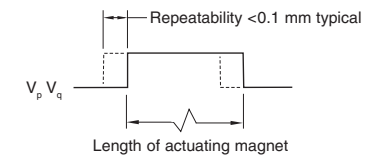


Reference



Differential pulse V_0 -18° to 108°. Duration 126° (electrical). Repeatability of position (uni-directional) maintained within ±10 °C from temperature at time of phasing and for speeds <250 mm/s

Limit open collector output, asynchronous pulse



General specifications

Power supply	5 V ± 5%	RGH40A, T, D, G and X <120 mA RGH40N, W, Y and H <150 mA NOTE: Current consumption figures refer to unterminated readheads. For digital outputs a further 35 mA per channel pair (e.g. A+, A-) will be drawn when terminated with 120 Ω. For analogue outputs a further 20 mA will be drawn when terminated with 120 Ω. Power from a 5 V dc supply complying with the requirements for SELV of standard IEC BS EN 60950-1.
	Ripple	200 mVpp@frequency up to 500 kHz maximum.
Temperature	Storage	-20 °C to +70 °C
	Operating	0 °C to +55 °C
Humidity		95% relative humidity (non-condensing) to EN 60068-2-78
Sealing		IP50
Acceleration	Operating	500 m/s ² , 3 axes
Shock	Non-operating	1000 m/s ² , 6 ms, ½ sine, 3 axes
Vibration	Operating	100 m/s ² max @ 55 Hz to 2000 Hz, 3 axes
Mass	Readhead	50 g
	Cable	38 g/m
Cable		12 core, double shielded, outside diameter 4.5 ±0.2 mm. Flex life >20 × 10 ⁶ cycles at 50 mm bend radius.

The RGH40 series readheads have been designed to the relevant EMC standards, but must be correctly integrated to achieve EMC compliance. In particular, attention to shielding and earthing arrangements is essential.

Ring technical specifications

Material	303/304 stainless steel
Coefficient of thermal expansion (at 20 °C)	15.5 ±0.5 µm/m/°C
Scale period	40 µm
Available diameters	52 mm, 57 mm, 75 mm, 100 mm, 103 mm, 104 mm, 115 mm, 150 mm, 200 mm, 206 mm, 209 mm, 229 mm, 255 mm, 300 mm, 350 mm, 413 mm, 417 mm, 489 mm, 550 mm
Temperature	Determined by readhead

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