

# RESR angle encoder system



## The RESR is a one-piece stainless steel ring with graduations marked directly onto the periphery.

The RESR offers impressive accuracy with resolution to 0.008 arc second, suiting the most demanding precision applications.

Read by Renishaw's filtering optics readheads, including the RGH20, RGH34, RGH35 and RGH40, the system has a high tolerance to dirt, scratches and greasy fingerprints that can cause other encoder systems to miscount.

The low profile RESR, with a large internal diameter, is easy to design into most installations. More importantly, its low mass, low inertia design will not compromise system performance. A repeatable reference mark is available to provide a home (datum) position, while Renishaw's RGH40 readhead with filtering optics offers dual limit sensors.

## System features

- High speed, non-contact, optical performance
- Graduation accuracy to  $\pm 0.5$  arc second
- Angular resolution to 0.008 arc second
- System repeatability to 0.008 arc second
- Wide range of sizes and line counts provide compatibility with industry standard controllers ( $\varnothing 52$  mm to  $\varnothing 550$  mm with line counts from 4,096 to 86,400)
- Patented taper mount simplifies integration and minimises installation errors
- Filtering optics provide excellent dirt immunity
- UHV compatible
- Low magnetic permeability as standard
- Compact size for easy integration
- Low mass and low inertia
- Compatible with RGH20, RGH34, RGH35 or RGH40 readheads to offer industry standard analogue or digital incremental outputs with reference mark option
- Integral set-up LED on all Renishaw encoders for quick set-up and instant "health check" at any time
- Ultra-low inertia versions also available in 75 mm, 100 mm, 150 mm and 200 mm sizes

**Data sheet**  
RESR angle encoder system

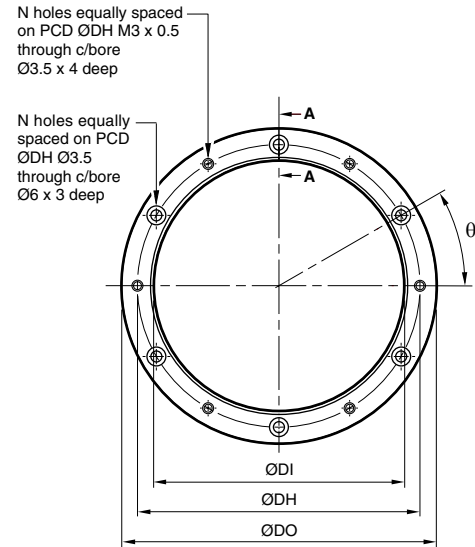
**Installation drawing ('A' section)**

| Nominal external diameter (mm) |                  | 52             | 57             | 75             | 100              | 103              | 104              |
|--------------------------------|------------------|----------------|----------------|----------------|------------------|------------------|------------------|
| Line count                     | 20 $\mu$ m pitch | 8,192          | 9,000          | 11,840         | 15,744           | 16,200           | 16,384           |
|                                | 40 $\mu$ m pitch | 4,096          | 4,500          | 5,920          | 7,872            | 8,100            | 8,192            |
| DO (mm)                        |                  | 52.20<br>52.10 | 57.35<br>57.25 | 75.40<br>75.30 | 100.30<br>100.20 | 103.20<br>103.00 | 104.40<br>104.20 |
| DI (mm)                        |                  | 30.04<br>30.00 | 37.04<br>37.00 | 55.04<br>55.00 | 80.04<br>80.00   | 80.04<br>80.00   | 80.04<br>80.00   |
| Mounting Holes                 | DH (mm)          | 40             | 47             | 65             | 90               | 90               | 90               |
|                                | N                | 6              | 6              | 6              | 6                | 6                | 6                |
|                                | $\theta$         | 30°            | 30°            | 30°            | 30°              | 30°              | 30°              |

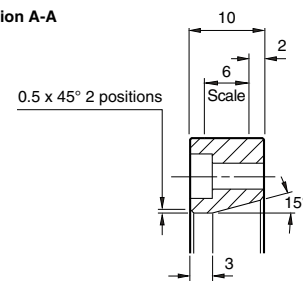
| Nominal external diameter (mm) |                  | 115              | 150              | 200              | 206              | 209              | 229              |
|--------------------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|
| Line count                     | 20 $\mu$ m pitch | 18,000           | 23,600           | 31,488           | 32,400           | 32,768           | 36,000           |
|                                | 40 $\mu$ m pitch | 9,000            | 11,800           | 15,744           | 16,200           | 16,384           | 18,000           |
| DO (mm)                        |                  | 114.70<br>114.50 | 150.40<br>150.20 | 200.40<br>200.20 | 206.50<br>206.10 | 208.80<br>208.40 | 229.40<br>229.00 |
| DI (mm)                        |                  | 95.04<br>95.00   | 130.04<br>130.00 | 180.04<br>180.00 | 186.05<br>186.00 | 186.05<br>186.00 | 209.05<br>209.00 |
| Mounting Holes                 | DH (mm)          | 105              | 140              | 190              | 196              | 196              | 219              |
|                                | N                | 6                | 9                | 12               | 12               | 12               | 12               |
|                                | $\theta$         | 30°              | 20°              | 15°              | 15°              | 15°              | 15°              |

| Nominal external diameter (mm) |                  | 255              | 300              | 350              | 413              | 417              | 550              |
|--------------------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|
| Line count                     | 20 $\mu$ m pitch | 40,000           | 47,200           | 55,040           | 64,800           | 65,536           | 86,400           |
|                                | 40 $\mu$ m pitch | 20,000           | 23,600           | 27,520           | 32,400           | 32,768           | 43,200           |
| DO (mm)                        |                  | 254.80<br>254.40 | 300.40<br>300.20 | 350.40<br>350.20 | 412.70<br>412.30 | 417.40<br>417.00 | 550.20<br>549.80 |
| DI (mm)                        |                  | 235.06<br>235.00 | 280.06<br>280.00 | 330.06<br>330.00 | 392.08<br>392.00 | 380.10<br>380.00 | 510.10<br>510.00 |
| Mounting Holes                 | DH (mm)          | 245              | 290              | 340              | 402              | 390              | 520              |
|                                | N                | 12               | 16               | 16               | 18               | 18               | 20               |
|                                | $\theta$         | 15°              | 11.25°           | 11.25°           | 10°              | 10°              | 9°               |

**General outline and dimensions** Dimensions and tolerances in mm



**Section A-A**

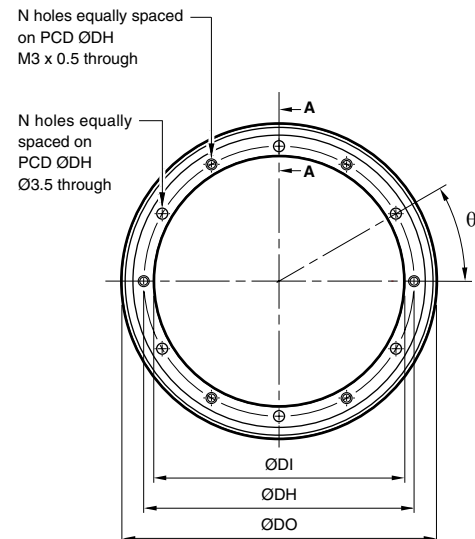
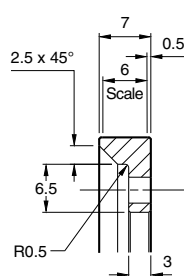


**Note:**  $\theta$  is the angle between one tapped hole and the adjacent clearance hole. For example, the angle between two clearance holes is 20°.

**Installation drawing ('B' section)**

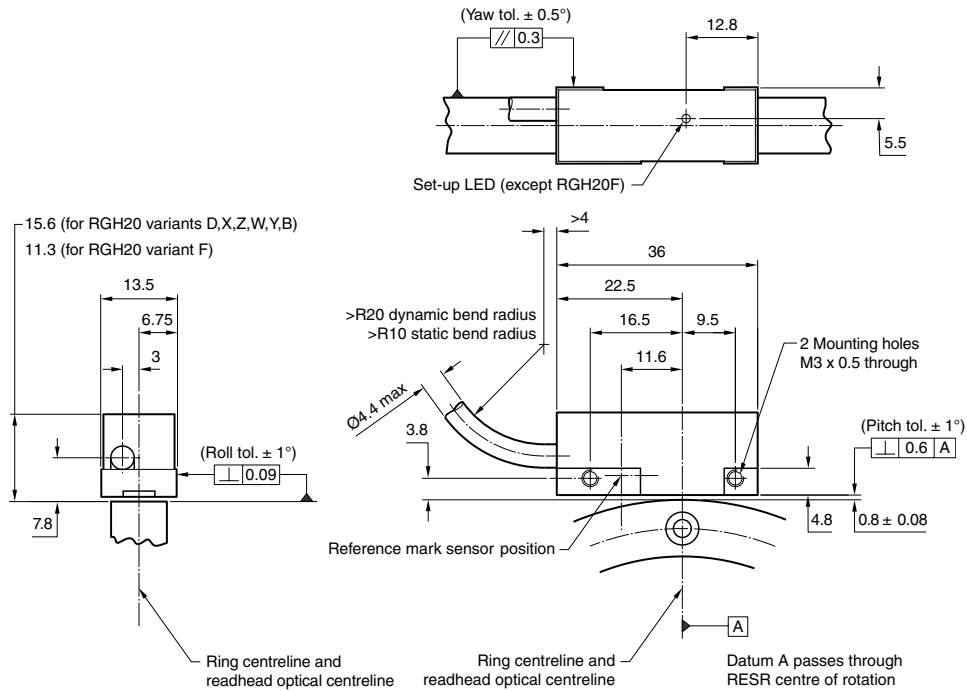
| Nominal external diameter (mm) |                  | 75             | 100              | 150              | 200              |
|--------------------------------|------------------|----------------|------------------|------------------|------------------|
| Line count                     | 20 $\mu$ m pitch | 11,840         | 15,744           | 23,600           | 31,488           |
|                                | 40 $\mu$ m pitch | 5,920          | 7,872            | 11,800           | 15,744           |
| DO (mm)                        |                  | 75.40<br>75.30 | 100.30<br>100.20 | 150.40<br>150.20 | 200.40<br>200.20 |
| DI (mm)                        |                  | 55.04<br>55.00 | 80.04<br>80.00   | 130.04<br>130.00 | 180.04<br>180.00 |
| Mounting Holes                 | DH (mm)          | 61             | 86               | 136              | 186              |
|                                | N                | 6              | 6                | 9                | 12               |
|                                | $\theta$         | 30°            | 30°              | 20°              | 15°              |

**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 20°.

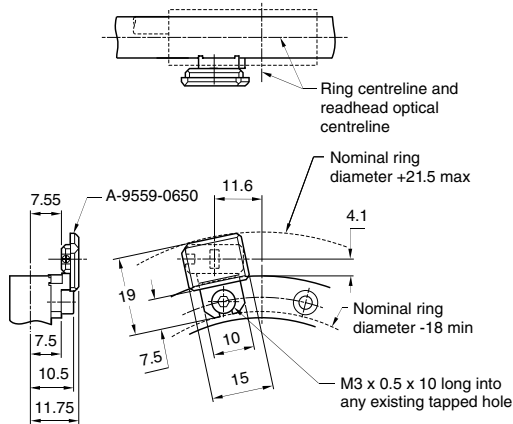
**RGH20 on 'A' section RESR** General outline and dimensions. Dimensions and tolerances in mm  
(Please see RESR Installation guide M-9559-0675 for installation drawings of RGH34, RGH35 and RGH40 mounted on RESR)



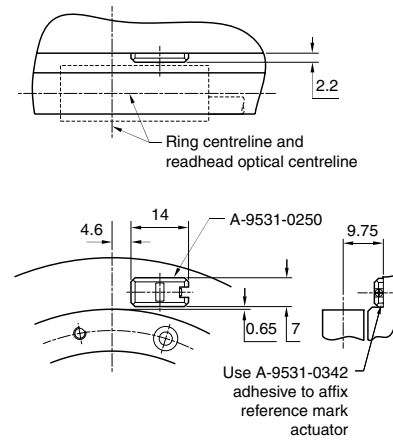
**RGH20 reference mark options**

(Please see RESR Installation guide M-9559-0675 for details of reference mark options for RGH34, RGH35 and RGH40)

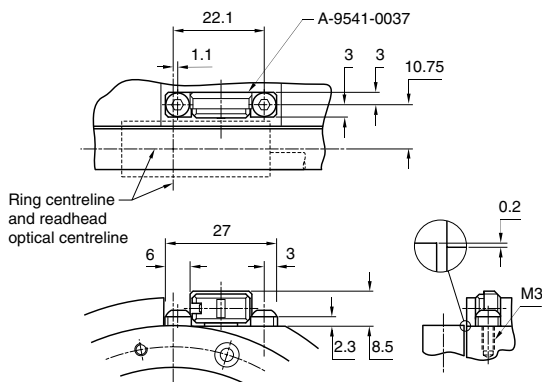
1. Using A-9559-0650



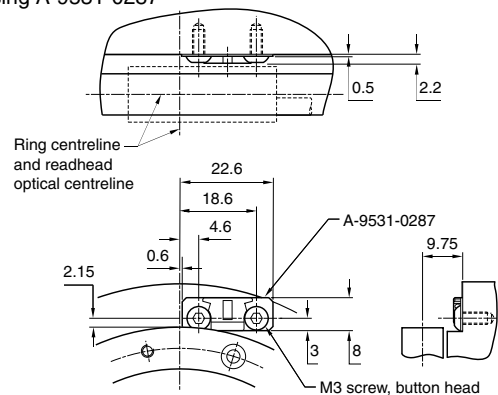
2. Using A-9531-0250



3. Using A-9541-0037



4. Using A-9531-0287





## Maximum speed (rpm)

### For RGH20 readhead reading from 20 µm pitch rings.

For details of maximum speeds for other readhead resolution/ring options, please contact your local representative.

| Nominal external diameter | Line count | Digital readhead resolution |       |       |        |         |         |        |         | Analogue<br>1 Vpp |
|---------------------------|------------|-----------------------------|-------|-------|--------|---------|---------|--------|---------|-------------------|
|                           |            | 20 µm                       | 5 µm  | 1 µm  | 0.5 µm | 0.2 µm* | 0.1 µm† | 50 nm† | 20 nm†† |                   |
| 52 mm                     | 8,192      | 2,938                       | 1,836 | 1,101 | 257    | 257     | 129     | 110    | 55      | 1,652             |
| 57 mm                     | 9,000      | 2,680                       | 1,675 | 1,005 | 235    | 235     | 117     | 101    | 50      | 1,507             |
| 75 mm                     | 11,840     | 2,037                       | 1,273 | 763   | 178    | 178     | 89      | 76     | 38      | 1,146             |
| 100 mm                    | 15,744     | 1,527                       | 954   | 572   | 134    | 134     | 67      | 57     | 29      | 859               |
| 103 mm                    | 16,200     | 1,483                       | 926   | 556   | 130    | 130     | 65      | 56     | 28      | 834               |
| 104 mm                    | 16,384     | 1,469                       | 918   | 550   | 129    | 129     | 64      | 55     | 28      | 826               |
| 115 mm                    | 18,000     | 1,328                       | 830   | 498   | 116    | 116     | 58      | 50     | 25      | 747               |
| 150 mm                    | 23,600     | 1,018                       | 636   | 381   | 89     | 89      | 45      | 38     | 19      | 573               |
| 200 mm                    | 31,488     | 763                         | 477   | 286   | 67     | 67      | 33      | 29     | 14      | 429               |
| 206 mm                    | 32,400     | 741                         | 463   | 277   | 65     | 65      | 32      | 28     | 14      | 417               |
| 209 mm                    | 32,768     | 731                         | 457   | 274   | 64     | 64      | 31      | 27     | 14      | 411               |
| 229 mm                    | 36,000     | 667                         | 417   | 250   | 58     | 58      | 29      | 25     | 13      | 375               |
| 255 mm                    | 40,000     | 599                         | 374   | 224   | 52     | 52      | 26      | 22     | 11      | 337               |
| 300 mm                    | 47,200     | 509                         | 318   | 190   | 45     | 45      | 22      | 19     | 10      | 286               |
| 350 mm                    | 55,040     | 436                         | 272   | 163   | 38     | 38      | 19      | 16     | 8.2     | 245               |
| 413 mm                    | 64,800     | 370                         | 231   | 138   | 32     | 32      | 16      | 14     | 6.9     | 208               |
| 417 mm                    | 65,536     | 366                         | 229   | 137   | 32     | 32      | 16      | 14     | 6.9     | 206               |
| 550 mm                    | 86,400     | 278                         | 174   | 104   | 24     | 24      | 12      | 10     | 5.2     | 156               |

\*6 MHz version †12 MHz version ††RGH20F with RGF interface

## Maximum speed (rpm)

### For RGH40 readhead reading from 40 µm pitch rings.

For details of maximum speeds for other readhead resolution/ring options, please contact your local representative.

| Nominal external diameter | Line count | Digital readhead resolution |       |       |       |      |          |          | Analogue<br>1 Vpp |
|---------------------------|------------|-----------------------------|-------|-------|-------|------|----------|----------|-------------------|
|                           |            | 40 µm                       | 10 µm | 5 µm  | 2 µm  | 1 µm | 0.2 µm** | 0.1 µm** |                   |
| 52 mm                     | 4,096      | 3,687                       | 2,938 | 2,209 | 1,472 | 918  | 479      | 221      | 2,938             |
| 57 mm                     | 4,500      | 3,352                       | 2,680 | 2,011 | 1,341 | 838  | 436      | 201      | 2,680             |
| 75 mm                     | 5,920      | 2,553                       | 2,037 | 1,532 | 1,021 | 637  | 332      | 153      | 2,037             |
| 100 mm                    | 7,872      | 1,911                       | 1,527 | 1,146 | 764   | 477  | 248      | 115      | 1,527             |
| 103 mm                    | 8,100      | 1,858                       | 1,483 | 1,114 | 743   | 464  | 241      | 111      | 1,483             |
| 104 mm                    | 8,192      | 1,840                       | 1,469 | 1,104 | 736   | 460  | 239      | 110      | 1,469             |
| 115 mm                    | 9,000      | 1,662                       | 1,328 | 997   | 665   | 415  | 216      | 100      | 1,328             |
| 150 mm                    | 11,800     | 1,274                       | 1,018 | 764   | 510   | 318  | 166      | 76       | 1,018             |
| 200 mm                    | 15,744     | 955                         | 763   | 573   | 382   | 239  | 124      | 57       | 763               |
| 206 mm                    | 16,200     | 927                         | 741   | 556   | 371   | 232  | 121      | 56       | 741               |
| 209 mm                    | 16,384     | 915                         | 731   | 549   | 366   | 229  | 119      | 55       | 731               |
| 229 mm                    | 18,000     | 834                         | 667   | 501   | 334   | 209  | 108      | 50       | 667               |
| 255 mm                    | 20,000     | 749                         | 599   | 449   | 300   | 187  | 97       | 45       | 599               |
| 300 mm                    | 23,600     | 637                         | 509   | 382   | 255   | 159  | 83       | 38       | 509               |
| 350 mm                    | 27,520     | 546                         | 436   | 328   | 218   | 136  | 71       | 33       | 436               |
| 413 mm                    | 32,400     | 463                         | 370   | 278   | 185   | 116  | 60       | 28       | 370               |
| 417 mm                    | 32,768     | 458                         | 366   | 275   | 183   | 114  | 59       | 27       | 366               |
| 550 mm                    | 43,200     | 347                         | 278   | 208   | 139   | 87   | 45       | 20       | 278               |

\*\*20 MHz version

## Resolution

The RESR offers a range of standard ring diameters, as well as sizes that offer line counts that provide 2° counts per revolution or resolutions that are precise sub-divisions of degrees or arc seconds.

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

### 20 µm pitch RESR

|                            | Nominal external diameter (line count) | RGH20 digital resolution (interpolation factor) |             |               |                |                |               |                 |                 |
|----------------------------|--|---|-------------|---------------|----------------|----------------|---------------|-----------------|-----------------|
|                            |  | 5 µm (x 4)                                      | 1 µm (x 20) | 0.5 µm (x 40) | 0.2 µm (x 100) | 0.1 µm (x 200) | 50 nm (x 400) | 20 nm* (x 1000) | 10 nm* (x 2000) |
| Standard outside diameters | 75 mm (11,840)                         | ≈ 27.4"   | ≈ 5.47"     | ≈ 2.74"       | ≈ 1.1"         | ≈ 0.55"        | ≈ 0.27"       | ≈ 0.11"         | ≈ 0.055"        |
|                            | 100 mm (15,744)                        | ≈ 20.6"   | ≈ 4.12"     | ≈ 2.06"       | ≈ 0.82"        | ≈ 0.41"        | ≈ 0.21"       | ≈ 0.082"        | ≈ 0.041"        |
|                            | 150 mm (23,600)                        | ≈ 13.7"   | ≈ 2.75"     | ≈ 1.37"       | ≈ 0.55"        | ≈ 0.27"        | ≈ 0.14"       | ≈ 0.055"        | ≈ 0.027"        |
|                            | 200 mm (31,488)                        | ≈ 10.3"   | ≈ 2.06"     | ≈ 1.03"       | ≈ 0.41"        | ≈ 0.21"        | ≈ 0.1"        | ≈ 0.041"        | ≈ 0.021"        |
|                            | 300 mm (47,200)                        | ≈ 6.9"  | ≈ 1.37"     | ≈ 0.69"       | ≈ 0.27"        | ≈ 0.14"        | ≈ 0.069"      | ≈ 0.027"        | ≈ 0.014"        |
|                            | 350 mm (55,040)                        | ≈ 5.9"  | ≈ 1.18"     | ≈ 0.59"       | ≈ 0.24"        | ≈ 0.12"        | ≈ 0.059"      | ≈ 0.024"        | ≈ 0.012"        |
|                            | 550 mm (86,400)                        | ≈ 3.75"   | ≈ 0.75"     | ≈ 0.38"       | ≈ 0.15"        | ≈ 0.08"        | ≈ 0.04"       | ≈ 0.015"        | ≈ 0.008"        |
| 2° line count              | 52 mm (8,192)                          | ≈ 39.6"   | ≈ 7.9"      | ≈ 3.96"       | ≈ 1.58"        | ≈ 0.79"        | ≈ 0.4"        | ≈ 0.16"         | ≈ 0.08"         |
|                            | 104 mm (16,384)                        | ≈ 19.8"   | ≈ 3.96"     | ≈ 1.98"       | ≈ 0.79"        | ≈ 0.4"         | ≈ 0.2"        | ≈ 0.08"         | ≈ 0.04"         |
|                            | 209 mm (32,768)                        | ≈ 9.89"   | ≈ 1.98"     | ≈ 0.99"       | ≈ 0.4"         | ≈ 0.2"         | ≈ 0.1"        | ≈ 0.04"         | ≈ 0.02"         |
|                            | 417 mm (65,536)                        | ≈ 4.9"  | ≈ 0.99"     | ≈ 0.49"       | ≈ 0.2"         | ≈ 0.1"         | ≈ 0.05"       | ≈ 0.02"         | ≈ 0.01"         |
| Subdivisions of degrees    | 57 mm (9,000)                          | 0.01°   | 0.002°      | 0.001°        | 0.0004°        | 0.0002°        | 0.0001°       | 0.00004°        | 0.00002°        |
|                            | 115 mm (18,000)                        | 0.005°  | 0.001°      | 0.0005°       | 0.0002°        | 0.0001°        | 0.00005°      | 0.00002°        | 0.00001°        |
|                            | 229 mm (36,000)                        | 0.0025°   | 0.0005°     | 0.00025°      | 0.0001°        | 0.00005°       | 0.000025°     | 0.00001°        | 0.000005°       |
| Subdivisions of arc second | 103 mm (16,200)                        | 20"   | 4"          | 2"            | 0.8"           | 0.4"           | 0.2"          | 0.08"           | 0.04"           |
|                            | 206 mm (32,400)                        | 10"   | 2"          | 1"            | 0.4"           | 0.2"           | 0.1"          | 0.04"           | 0.02"           |
|                            | 255 mm <sup>1</sup> (40,000)           | 8.1"  | 1.62"       | 0.81"         | 0.32"          | 0.16"          | 0.081"        | 0.032"          | 0.016"          |
|                            | 413 mm (64,800)                        | 5"  | 1"          | 0.5"          | 0.2"           | 0.1"           | 0.05"         | 0.02"           | 0.01"           |

\*Resolutions achieved using RGH20F with RGF interface <sup>1</sup>Line count as a multiple of 1000

## 40 µm pitch RESR

|                            | Nominal external diameter (line count) | RGH40 digital resolution (interpolation factor) |            |             |             |                |                |               |
|----------------------------|--|---|------------|-------------|-------------|----------------|----------------|---------------|
|                            |  | 10 µm (x 4)                                     | 5 µm (x 8) | 2 µm (x 20) | 1 µm (x 40) | 0.2 µm (x 200) | 0.1 µm (x 400) | 50 nm (x 800) |
| Standard outside diameters | 75 mm (5,920)                          | ≈ 54.7"   | ≈ 27.4"    | ≈ 11"       | ≈ 5.47"     | ≈ 1.1"         | ≈ 0.55"        | ≈ 0.27"       |
|                            | 100 mm (7,872)                         | ≈ 41.2"   | ≈ 20.6"    | ≈ 8.23"     | ≈ 4.12"     | ≈ 0.82"        | ≈ 0.41"        | ≈ 0.21"       |
|                            | 150 mm (11,800)                        | ≈ 27.5"   | ≈ 13.7"    | ≈ 5.5"      | ≈ 2.75"     | ≈ 0.55"        | ≈ 0.27"        | ≈ 0.14"       |
|                            | 200 mm (15,744)                        | ≈ 20.6"   | ≈ 10.3"    | ≈ 4.12"     | ≈ 2.06"     | ≈ 0.41"        | ≈ 0.21"        | ≈ 0.1"        |
|                            | 300 mm (23,600)                        | ≈ 13.8"   | ≈ 6.9"     | ≈ 2.75"     | ≈ 1.37"     | ≈ 0.27"        | ≈ 0.14"        | ≈ 0.069"      |
|                            | 350 mm (27,520)                        | ≈ 11.8"   | ≈ 5.9"     | ≈ 2.36"     | ≈ 1.18"     | ≈ 0.24"        | ≈ 0.12"        | ≈ 0.059"      |
|                            | 550 mm (43,200)                        | ≈ 7.5"  | ≈ 3.75"    | ≈ 1.5"      | ≈ 0.75"     | ≈ 0.15"        | ≈ 0.08"        | ≈ 0.04"       |
| 2 <sup>nd</sup> line count | 52 mm (4,096)                          | ≈ 79.1"   | ≈ 39.6"    | ≈ 15.8"     | ≈ 7.9"      | ≈ 1.58"        | ≈ 0.79"        | ≈ 0.4"        |
|                            | 104 mm (8,192)                         | ≈ 39.6"   | ≈ 19.8"    | ≈ 7.91"     | ≈ 3.96"     | ≈ 0.79"        | ≈ 0.4"         | ≈ 0.2"        |
|                            | 209 mm (16,384)                        | ≈ 19.7"   | ≈ 9.89"    | ≈ 3.96"     | ≈ 1.98"     | ≈ 0.4"         | ≈ 0.2"         | ≈ 0.1"        |
|                            | 417 mm (32,768)                        | ≈ 9.9"  | ≈ 4.9"     | ≈ 1.98"     | ≈ 0.99"     | ≈ 0.2"         | ≈ 0.1"         | ≈ 0.05"       |
| Subdivisions of degrees    | 57 mm (4,500)                          | 0.02°   | 0.01°      | 0.004°      | 0.002°      | 0.0004°        | 0.0002°        | 0.0001°       |
|                            | 115 mm (9,000)                         | 0.01°   | 0.005°     | 0.002°      | 0.001°      | 0.0002°        | 0.0001°        | 0.00005°      |
|                            | 229 mm (18,000)                        | 0.005°  | 0.0025°    | 0.001°      | 0.0005°     | 0.0001°        | 0.00005°       | 0.000025°     |
| Subdivisions of arc second | 103 mm (8,100)                         | 40"   | 20"        | 8"          | 4"          | 0.8"           | 0.4"           | 0.2"          |
|                            | 206 mm (16,200)                        | 20"   | 10"        | 4"          | 2"          | 0.4"           | 0.2"           | 0.1"          |
|                            | 255 mm <sup>†</sup> (20,000)           | 16.2"   | 8.1"       | 3.24"       | 1.62"       | 0.32"          | 0.16"          | 0.081"        |
|                            | 413 mm (32,400)                        | 10"   | 5"         | 2"          | 1"          | 0.2"           | 0.1"           | 0.05"         |

<sup>†</sup>Line count as a multiple of 1000

## Accuracy

| Nominal external diameter | Graduation error (arc second) | System error (arc second) for 20 µm systems | System error (arc second) for 40 µm systems |
|---------------------------|-------------------------------|---|---|
| 52 mm                     | ± 4.0                         | ± 5.6                                       | ± 6.3                                       |
| 57 mm                     | ± 3.6                         | ± 5.1                                       | ± 5.8                                       |
| 75 mm                     | ± 2.8                         | ± 3.9                                       | ± 4.4                                       |
| 100 mm                    | ± 2.1                         | ± 2.9                                       | ± 3.3                                       |
| 103 mm                    | ± 2.0                         | ± 2.8                                       | ± 3.2                                       |
| 104 mm                    | ± 2.0                         | ± 2.8                                       | ± 3.2                                       |
| 115 mm                    | ± 1.8                         | ± 2.5                                       | ± 2.9                                       |
| 150 mm                    | ± 1.4                         | ± 1.9                                       | ± 2.2                                       |
| 200 mm                    | ± 1.0                         | ± 1.4                                       | ± 1.7                                       |
| 206 mm                    | ± 1.0                         | ± 1.4                                       | ± 1.6                                       |
| 209 mm                    | ± 1.0                         | ± 1.4                                       | ± 1.6                                       |
| 229 mm                    | ± 0.9                         | ± 1.3                                       | ± 1.4                                       |
| 255 mm                    | ± 0.8                         | ± 1.1                                       | ± 1.3                                       |
| 300 mm                    | ± 0.7                         | ± 1.0                                       | ± 1.1                                       |
| 350 mm                    | ± 0.6                         | ± 0.8                                       | ± 0.9                                       |
| 413 mm                    | ± 0.5                         | ± 0.7                                       | ± 0.8                                       |
| 417 mm                    | ± 0.5                         | ± 0.7                                       | ± 0.8                                       |
| 550 mm                    | ± 0.4                         | ± 0.5                                       | ± 0.6                                       |

Graduation error 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 error is graduation error plus SDE.

Effects such as eccentricity influence installed performance; for application advice please contact your local representative.

For worldwide contact details, please visit our main website at [www.renishaw.com/contact](http://www.renishaw.com/contact)

