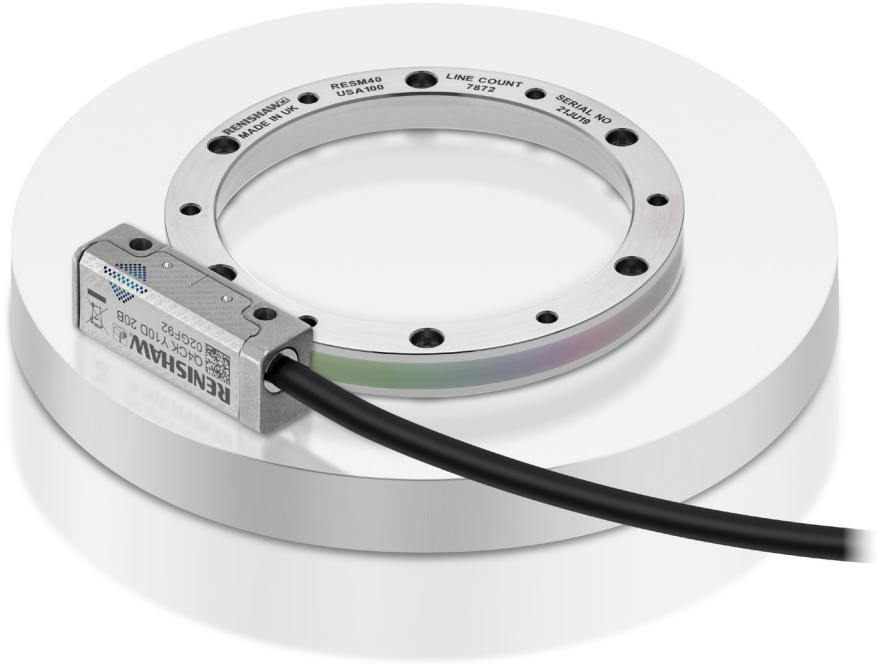
Installation guide
M-9417-9201-04-A

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QUANTiC™ RESM40 angle encoder system



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Legal notices

Patents

Features of Renishaw's QUANTiC™ and RESM40 encoder systems are the subjects of the following patents and patent applications:

EP1173731	US6775008	JP4750998	CN100543424	EP1766334
JP4932706	US7659992	CN100507454	EP1766335	IN281839
JP5386081	US7550710	CN101300463	EP1946048	JP5017275
US7624513	CN101310165	EP1957943	US7839296	CN108351229
EP3347681	JP2017042570	KR20180052676	US20180216972	WO2017203210
EP1094302	JP5442174	US6481115	CN1293983	EP10297440
GB2397040	JP4813018	US7723639	CN1314511	EP1469969
EP2390045	JP5002559	US8987633	US8466943	US7367128
JP4423196				

Terms and conditions and warranty

Unless you and Renishaw have agreed and signed a separate written agreement, the equipment and/or software are sold subject to the Renishaw Standard Terms and Conditions supplied with such equipment and/or software, or available on request from your local Renishaw office.

Renishaw warrants its equipment and software for a limited period (as set out in the Standard Terms and Conditions), provided that they are installed and used exactly as defined in associated Renishaw documentation. You should consult these Standard Terms and Conditions to find out the full details of your warranty.

Equipment and/or software purchased by you from a third-party supplier is subject to separate terms and conditions supplied with such equipment and/or software. You should contact your third-party supplier for details.

Declaration of Conformity

Renishaw plc hereby declares that the QUANTiC encoder system is in compliance with the essential requirements and other relevant provisions of:

- the applicable EU directives
- the relevant statutory instruments under UK law

The full text of the declaration of conformity is available at: **www.renishaw.com/productcompliance**.

Compliance

Federal Code Of Regulation (CFR) FCC Part 15 – RADIO FREQUENCY DEVICES

47 CFR Section 15.19

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.

47 CFR Section 15.21

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.

47 CFR Section 15.105

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.

47 CFR Section 15.27

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

Supplier's Declaration of Conformity

47 CFR § 2.1077 Compliance Information

Unique Identifier: QUANTiC

Responsible Party - U.S. Contact Information

Renishaw Inc.
1001 Wesemann Drive
West Dundee
Illinois
IL 60118
United States
Telephone number: +1 847 286 9953
Email: usa@renishaw.com

ICES-003 – Information Technology Equipment (including Digital Apparatus)

This ISM device complies with Canadian ICES-003(A).

Cet appareil ISM est conforme à la norme ICES-003(A).

Intended use

The QUANTiC encoder system is designed to measure position and provide that information to a drive or controller in applications requiring motion control. It must be installed, operated, and maintained as specified in Renishaw documentation and in accordance with the Standard Terms and Conditions of the Warranty and all other relevant legal requirements.

Further information

Further information relating to the QUANTiC encoder range can be found in the following documents:

QUANTiC™ incremental optical encoder system data sheet (Renishaw part no. L-9517-9778)
RESM rotary scale data sheet (Renishaw part no. L-9517-9154)
ADTpro-100 Advanced Diagnostic Tool data sheet (Renishaw part no. L-9518-0078)
ADTi-100 Advanced Diagnostic Tool data sheet (Renishaw part no. L-9517-9699)
ADTpro-100 Advanced Diagnostic Tool user guide (Renishaw part no. M-6647-9138)
ADT View software user guide (Renishaw part no. M-6195-9413)

These can be downloaded from our website at www.renishaw.com/quanticdownloads and are also available from your local Renishaw representative.

Packaging

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

Packing 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

REACH regulation

Information required by Article 33(1) of Regulation (EC) No. 1907/2006 (“REACH”) relating to products containing substances of very high concern (SVHCs) is available at **www.renishaw.com/REACH**.

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The QUANTiC product includes embedded software (firmware) to which the following notices apply:

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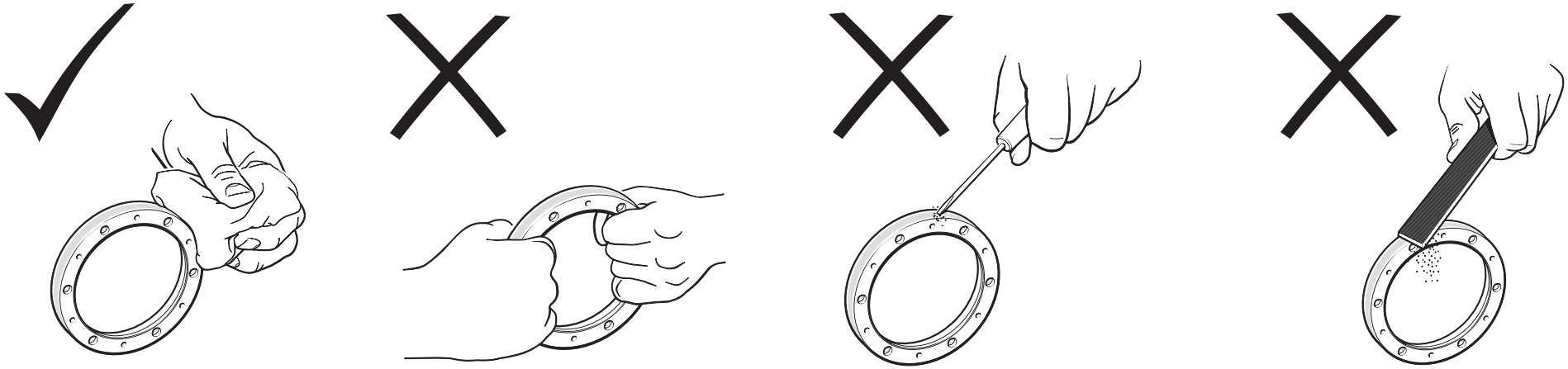
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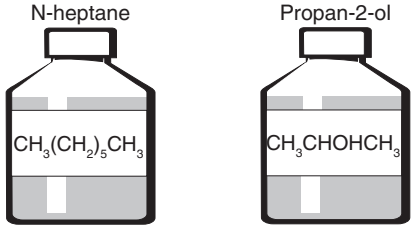
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Storage and handling

QUANTiC non-contact optical encoder systems provide 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

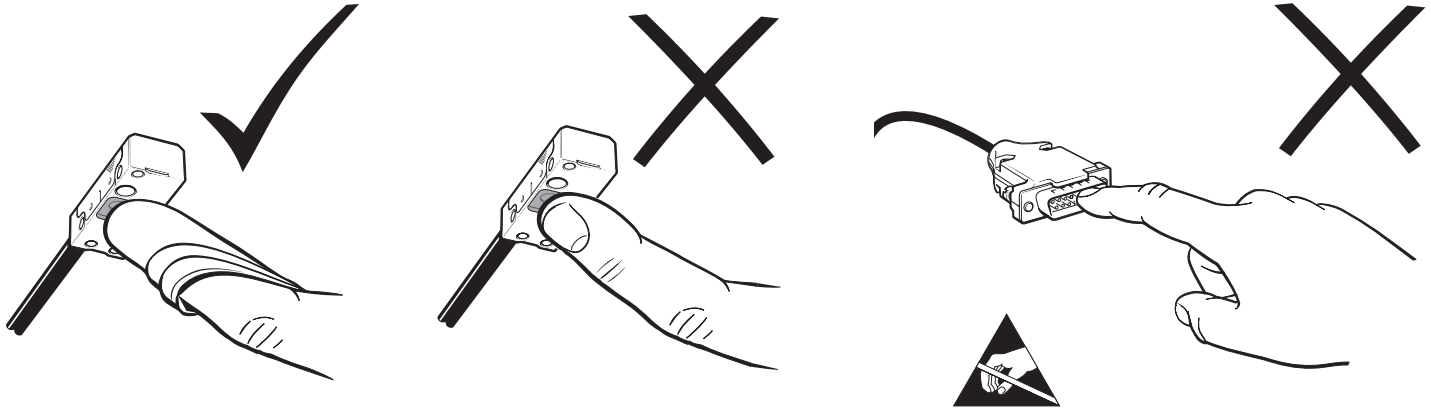


Ring only



Readhead only



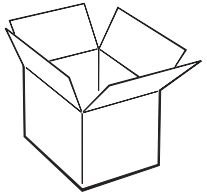


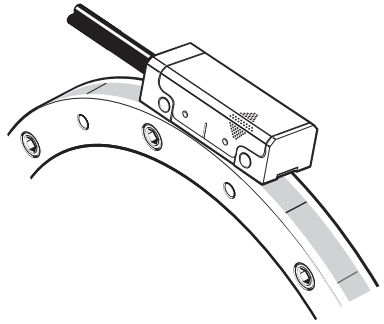


Temperature

Storage	
System	–20 °C to +70 °C

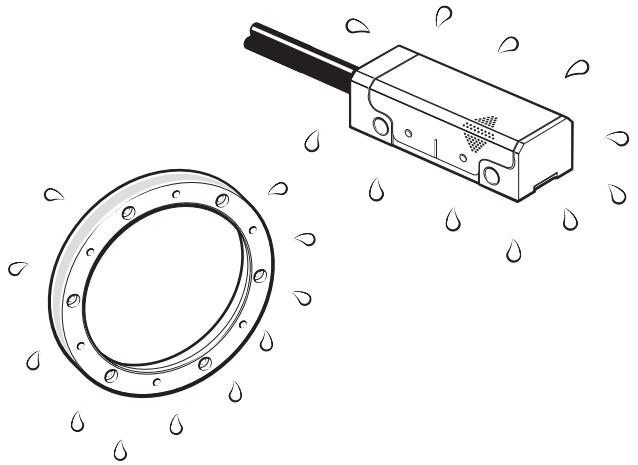
Operating	
System	0 °C to +70 °C





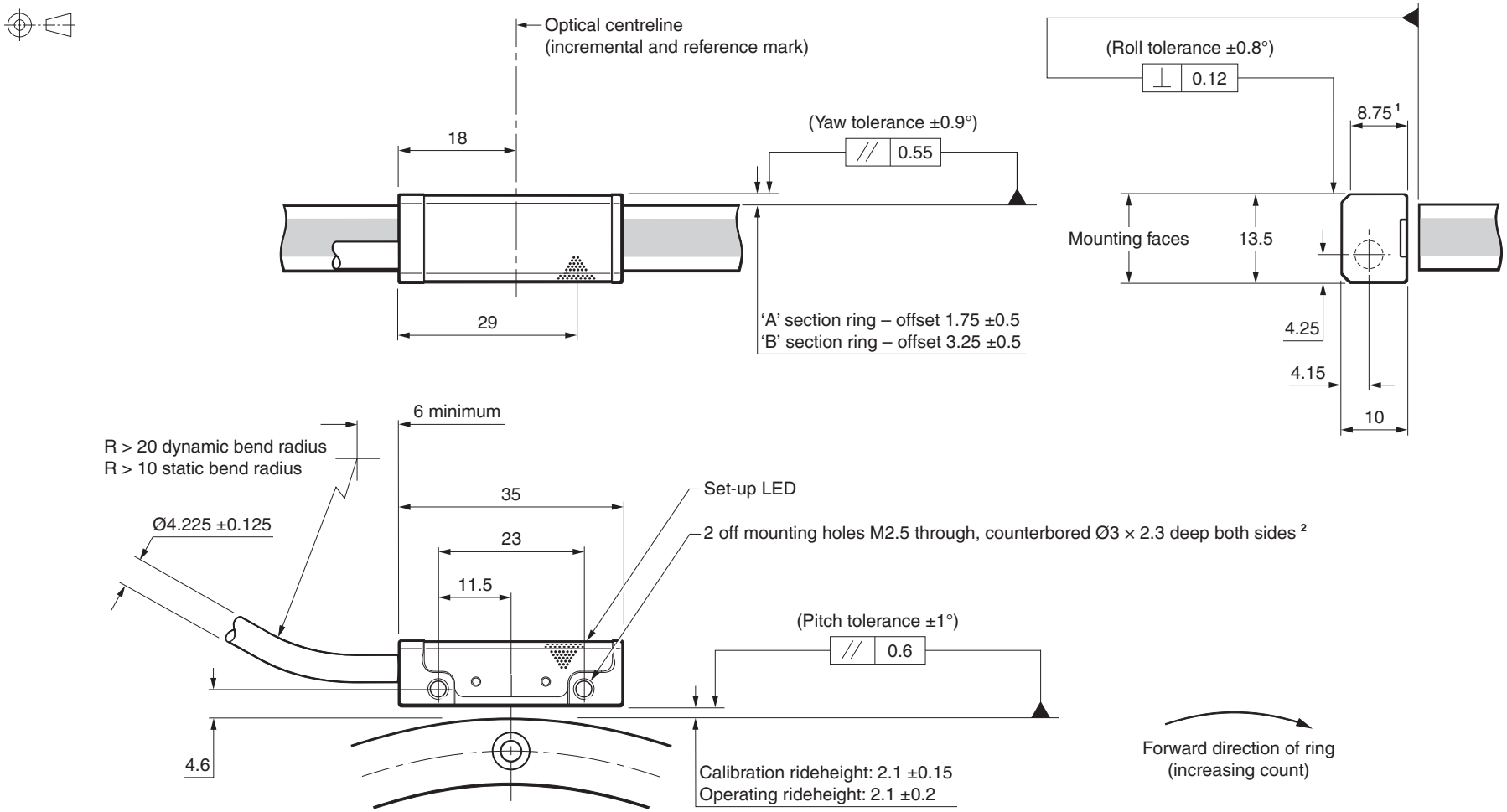
Humidity

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



QUANTiC readhead installation drawing

Dimensions and tolerances in mm

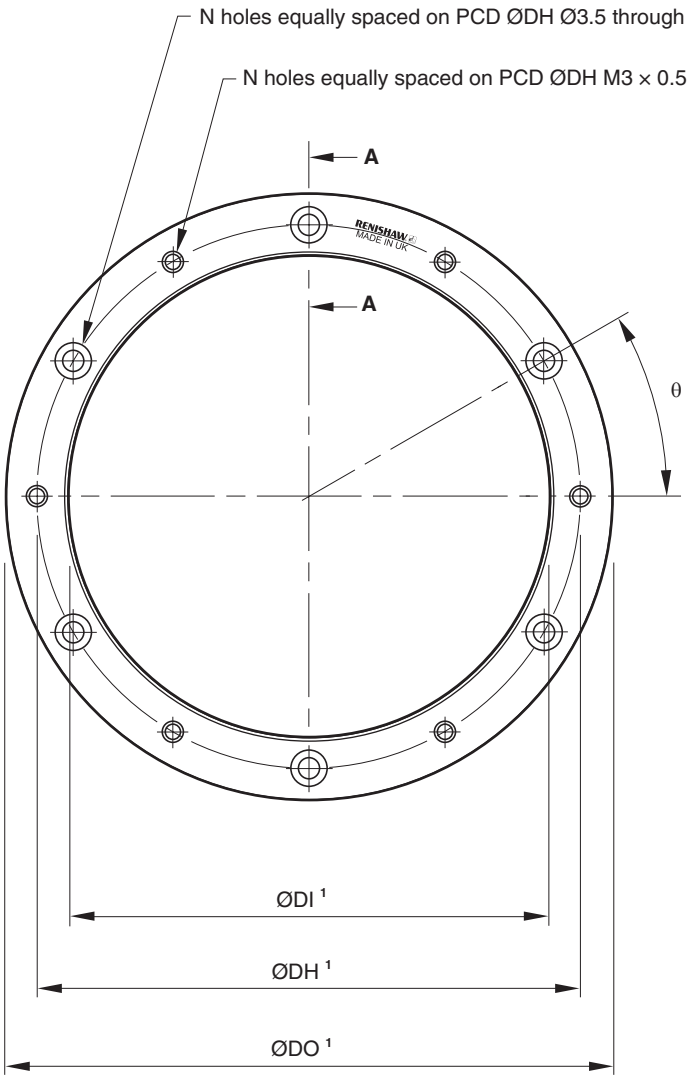


1 Extent of mounting faces.

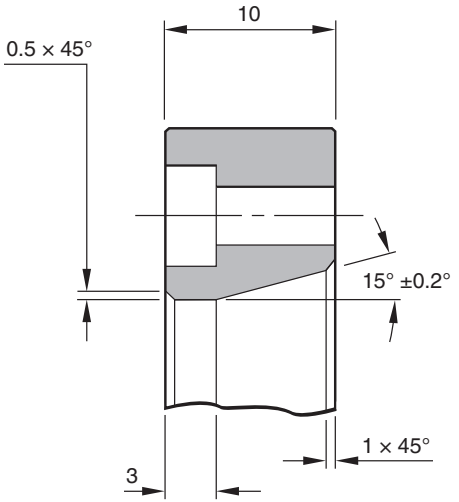
2 The recommended thread engagement is 5 mm minimum (7.5 mm including counterbore) and the recommended tightening torque is between 0.25 Nm and 0.4 Nm.

RESM40 ‘A’ section ring installation drawing

Dimensions and tolerances in mm



Section A–A



[1] Refer to ‘RESM40 ‘A’ section ring dimensions’ on page 13 for dimension and hole information.

RESM40 ‘A’ section ring dimensions

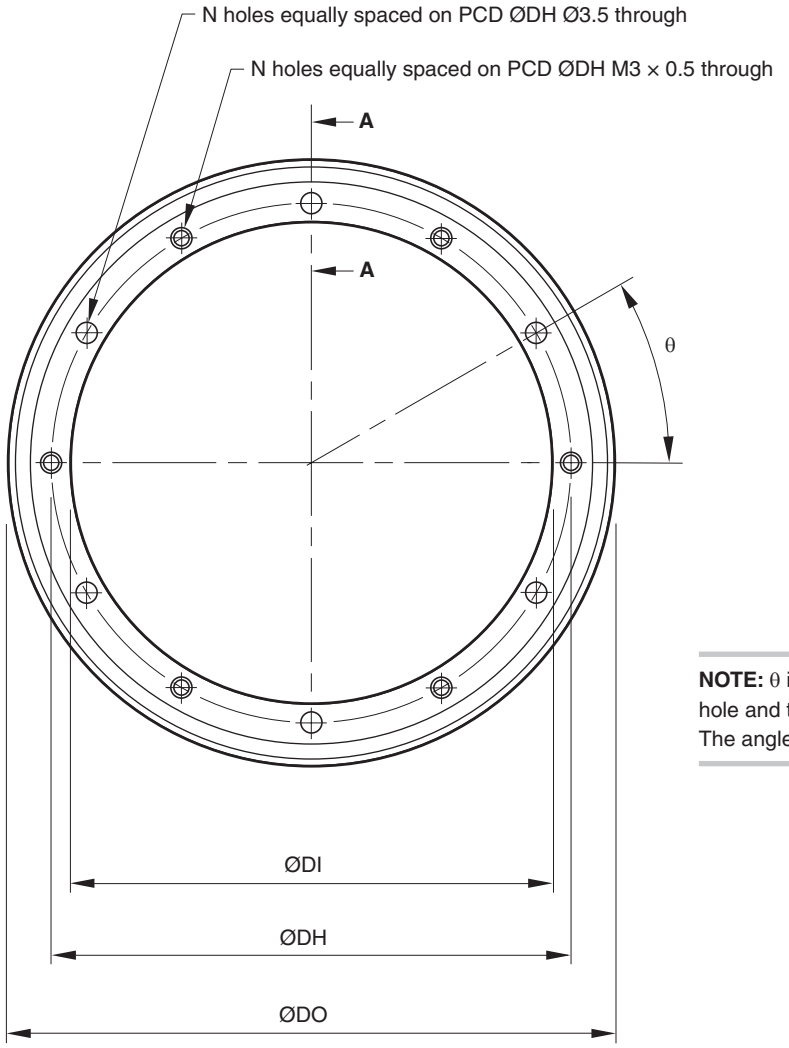
Nominal external diameter (mm)	Line count	DO (mm)	DI (mm)	Mounting holes			Readhead model
				DH (mm)	N	θ	
52	4 096	52.20 52.10	30.04 30.00	40	6	30°	Q4CL
57	4 500	57.35 57.25	37.04 37.00	47	6	30°	
75	5 920	75.40 75.30	55.04 55.00	65	6	30°	Q4CK
94	7 400	94.30 94.26	74.59 74.55	84.5	6	30°	
100	7 872	100.30 100.20	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°	
124	9 740	124.10 123.90	104.04 104.00	114	6	30°	

Nominal external diameter (mm)	Line count	DO (mm)	DI (mm)	Mounting holes			Readhead model
				DH (mm)	N	θ	
150	11 800	150.40 150.20	130.04 130.00	140	9	20°	Q4BJ
172	13 500	172.04 171.84	152.04 152.00	162	9	20°	
183	14 400	183.45 183.25	163.04 163.00	172	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 [1]	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°	

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

RESM40 ‘B’ section ring installation drawing

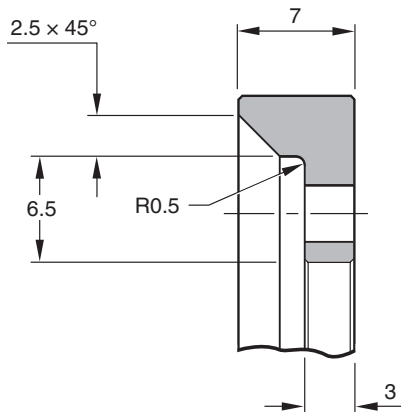
Dimensions and tolerances in mm



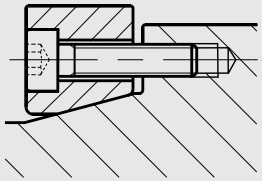
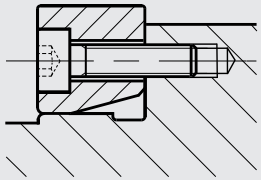
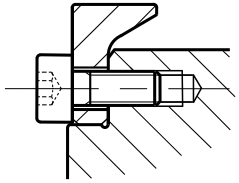
Nominal external diameter (mm)	Line count	DO (mm)	DI (mm)	Mounting holes			Readhead model
				DH (mm)	N	θ	
52	4 096	52.20 52.10	32.04 32.00	38	6	30°	**Q4CL**
57	4 500	57.35 57.25	37.04 37.00	43	6	30°	
75	5 920	75.40 75.30	55.04 55.00	61	6	30°	**Q4CK**
100	7 872	100.30 100.20	80.04 80.00	86	6	30°	
115	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°	**Q4BJ**
165	12 960	165.10 164.90	145.04 145.00	151	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.

Section A–A



RESM40 ring mounting options

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

Taper mounting the RESM40 ‘A’ section ring

Required parts:

- Appropriate RESM40 ‘A’ section ring (see ‘RESM40 ‘A’ section ring dimensions’ on page 13)
- Appropriate number of screws for ring size (see ‘RESM40 ‘A’ section ring dimensions’ on page 13)

  NOTE: Recommended screw type M3 × 0.5: ISO 4762/DIN 912 grade 10.9 minimum/ANSI B18.3.1M.

- Dial Test Indicator (DTI) with a ruby ball stylus
- Appropriate cleaning solvents (see ‘Storage and handling’ on page 9)
- Hex key
- Torque wrench

Optional parts:

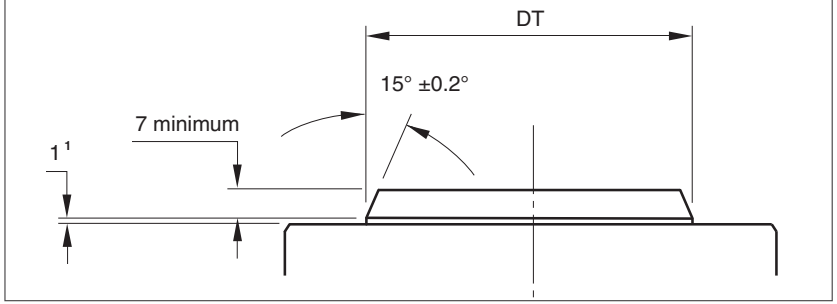
- Renishaw scale wipes (A-9523-4040)
- Lint-free cloth

Mounting shaft specifications

Recommended taper roundness:

Diameter (mm)	Roundness value (mm TIR)
≤ 115	0.025
150 to 225	0.050
≥ 300	0.075

Dimensions and tolerances in mm



Recommended taper roundness when using two heads and DSi:

Diameter (mm)	Roundness value (mm TIR)
≤ 115	0.0125
150 to 225	0.025
≥ 300	0.0375

Recommended taper diameter (DT):

DO (mm)	DT (mm)
52	33.85 33.65
57	40.85 40.65
75	58.85 58.65
94	77.85 77.65
100	83.85 83.65
103	83.85 83.65
104	83.85 83.65
115	98.85 98.65
124	107.85 107.65
150	133.85 133.65
172	155.85 155.65

DO (mm)	DT (mm)
183	166.85 166.65
200	183.85 183.65
206	189.85 189.65
209	189.85 189.65
229	212.85 212.65
255	238.85 238.65
300	283.85 283.65
350	333.85 333.65
413	395.85 395.65
417	383.85 383.65
489	454.85 454.65
550	513.85 513.65

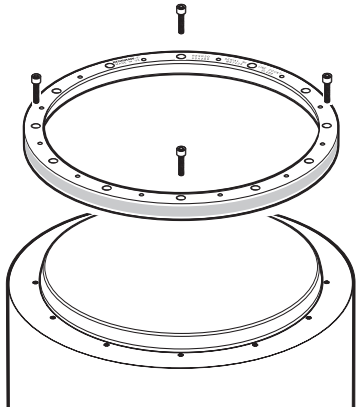
DO = Nominal external diameter.

Recommended surface finish ≤ Ra 1.2.

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

[1] Allow 2 mm for 417 mm, 489 mm and 550 mm rings only.

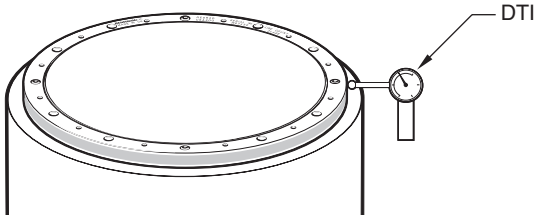
Mounting the ring



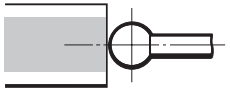
1. Remove the protective film from the surface of the RESM40 ring.
2. Clean the shaft taper and the internal taper of the RESM40 ring as recommended in 'Storage and handling' on page 9.
3. Insert the first screws:
   - For RESM40 rings with 6, 9 or 18 mounting holes, use 3 equally spaced M3 screws.
   - For RESM40 rings with 12, 16 or 20 mounting holes, use 4 equally spaced M3 screws.

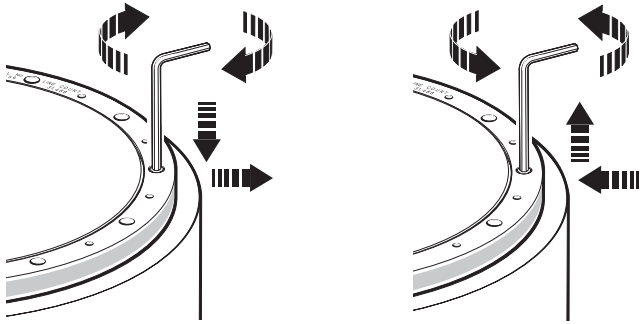
   NOTE: Do not lubricate the screws.
4. Insert the screws so that the RESM40 ring is loosely connected to the shaft, then roughly align the ring by eye and touch.
5. Lightly tighten the screws. Use a Dial Test Indicator (DTI) to check the radial displacement at the screw locations.

   NOTE: Disregard the radial displacement between the screw locations.



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

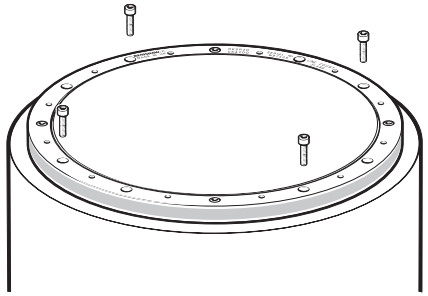




7. Adjust the screws to reduce the range of radial displacement. When adjusting, identify the screw location with the lowest radial displacement and tighten that screw, aiming for the average of the highest and lowest indicator readings.
8. Repeat step 7 until the DTI readings are within ±5 µm at the screw locations.

   NOTES:
   - It may be necessary to loosen some screws whilst tightening other screws.
   - At this stage, the screws should only be lightly tightened (less than 0.5 Nm) to allow further final adjustment.

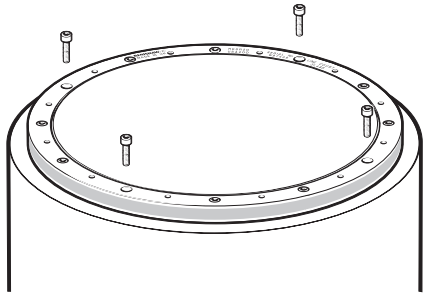
9. Insert the next screws:
   - For RESM40 rings with 6, 9 or 12 mounting holes, insert all the remaining M3 screws.
   - For RESM40 rings with 16 mounting holes, insert 4 equally spaced M3 screws.
   - For RESM40 rings with 18 mounting holes, insert 6 equally spaced M3 screws.
   - For RESM40 rings with 20 mounting holes, insert 8 equally spaced M3 screws (in four groups of two) between existing screws.



10. As described in step 7, adjust all of the screws inserted thus far, so that the radial displacement at each screw location is within ±5 µm.
11. 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 10 than during step 7. This is normal.

12. Insert screws into all of the remaining mounting holes.



13. Rotate the RESM40 ring, measuring the radial displacement at all of the screw locations.
14. 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.

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

15. Again, rotate the RESM40 ring and recheck the radial displacement at all of the screw locations, tightening the screw with the lowest radial displacement so that it matches the average.
16. Repeat this process until the radial displacement at all of the screw locations is within ±3 µm and that all screw torques are within the specified range.
17. Excessive tightening of the screws can have a small effect on accuracy. Contact your local Renishaw representative for more details.
18. Clean the ring using Renishaw scale wipes or a clean, dry, lint-free cloth.

Interference fit mounting the RESM40 ‘A’ section and RESM40 ‘B’ section rings

Required parts:

- Appropriate RESM40 ‘A’ or ‘B’ section ring (see ‘RESM40 ‘A’ section ring installation drawing’ on page 12 or ‘RESM40 ‘B’ section ring installation drawing’ on page 14)
- Appropriate number of screws for ring size (see ‘RESM40 ‘A’ section ring installation drawing’ on page 12 or ‘RESM40 ‘B’ section ring installation drawing’ on page 14)

NOTE: Recommended screw type M3 × 0.5: ISO 4762/DIN 912 grade 10.9 minimum/ANSI B18.3.1M.

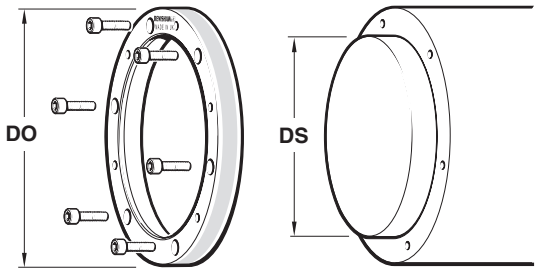
- Appropriate cleaning solvents (see ‘Storage and handling’ on page 9)
- Hex key
- Torque wrench

Optional parts:

- Renishaw scale wipes (A-9523-4040)
- Lint-free cloth

Mounting the ring

1. Remove the protective film from the surface of the RESM40 ring.
2. Clean the mounting faces of the shaft and the RESM40 ring as recommended in 'Storage and handling' on page 9.
3. Place RESM40 ring on the shaft.



DO = Nominal external diameter.

DS = Recommended shaft diameter to enable interference fit.

4. Insert screws into all of the mounting holes.
5. Tighten all of the screws.
6. Clean the ring using Renishaw scale wipes or a clean, dry, lint-free cloth.

NOTES: Ensure that all of the screws are tightened to 1.6 Nm.

The recommended thread engagement is 6 mm.

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

DO (mm)	DS (mm)
52 [1]	30.033 30.017
57	37.033 37.017
75	55.039 55.020
94	74.589 74.570
100	80.045 80.023
103	80.045 80.023
104	80.045 80.023
115	95.045 95.023
124	104.045 104.023
150	130.052 130.027
165 [2]	145.052 145.027

DO (mm)	DS (mm)
172	152.052 152.027
183	163.052 163.027
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

[1] 52 mm 'B' section ring DS (mm) = 32.033 / 32.017

[2] Only available as a 'B' section ring.

QUANTiC readhead quick-start guide

This section is a quick-start guide to installing a QUANTiC readhead. More detailed information on installing the readhead is contained on pages 23 to 27 of this installation guide.

The Advanced Diagnostic Tools, ADTpro-100 or ADTi-100 with ADT View software, can be used to aid installation and calibration. See **www.renishaw.com/adt** for more information about the advanced diagnostic tools.

INSTALLATION

Ensure that the ring, readhead optical window, and mounting faces are clean and free from obstructions.

↓

Connect the readhead to the receiving electronics and power-up. The set-up LED on the readhead will flash.

↓

Install and align the readhead to maximise signal strength over the full axis of rotation as indicated by a green flashing LED.

CALIBRATION

Cycle the power to the readhead to initiate the calibration routine. The LED will single-flash blue.

↓

Rotate the axis at slow speed (< 100 mm/s), without passing the reference mark, until the LED starts double-flashing blue.

No reference mark

If a reference mark is not being used, the calibration routine should now be exited by cycling the power. The LED will stop flashing.

Reference mark

Move the readhead back and forth over the reference mark until the LED stops flashing.

↓

The system is now calibrated and ready for use. Calibration values, Automatic Gain Control (AGC) and Automatic Offset Control (AOC) status, are stored in the readhead non-volatile memory at power down.

NOTE: If the calibration routine fails (LED remains single-flashing blue), restore the readhead factory defaults (see 'Restoring factory defaults' on page 27) and repeat the installation and calibration routine.

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 ring, readhead optical window, and mounting face are clean and free from obstructions.

NOTES:

- Ensure the protective film is removed from the ring before installing the readhead.
- When cleaning the readhead and the ring apply the cleaning fluid sparingly, do not soak.

1. Mount the readhead to the bracket using 2 M2.5 screws.
2. To set the nominal rideheight, place the green spacer with the aperture under the optical centre of the readhead to allow normal LED function during the set-up procedure.
3. Adjust the readhead to achieve a flashing green LED for a complete rotation. The faster the flash rate, the closer it is to optimum set-up.

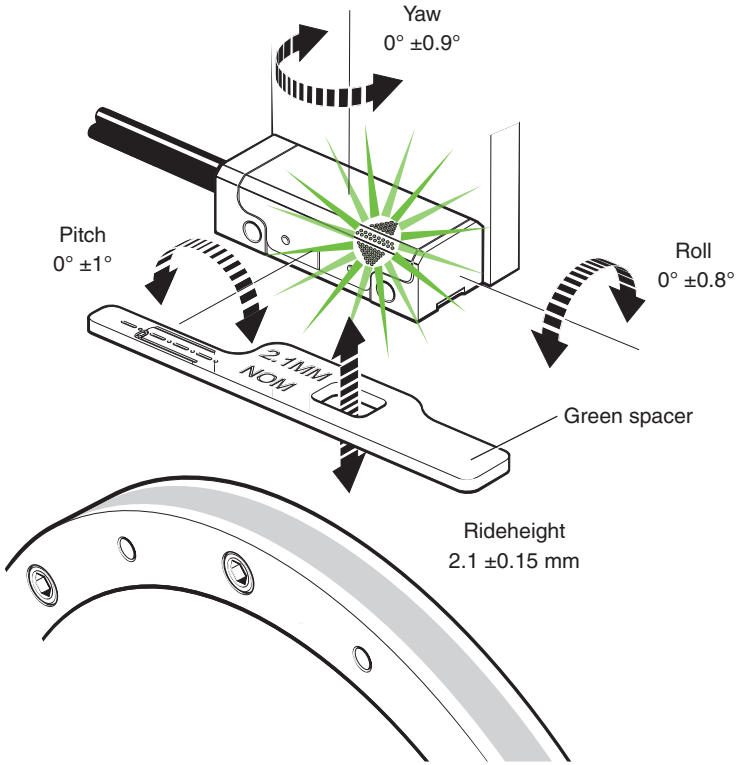
The Advanced Diagnostic Tools, ADTpro-100 or ADTi-100 and ADT View software, can also be used to help optimise signal strength in challenging installations. Refer to the ADTpro-100 user guide (Renishaw part no. M-6647-9138) or ADT View user guide (Renishaw M-6195-9413) for more information.

NOTE: When reinstalling the readhead the factory defaults should be restored (see 'Restoring factory defaults' on page 27).

Readhead set-up LED status



NOTE: For full readhead LED diagnostics, see 'Readhead LED diagnostics' on page 24.



Readhead LED diagnostics

Mode	LED	Status
Installation mode	Green flashing	Good set-up: maximise flash rate for optimum set-up
	Orange flashing	Poor set-up: adjust readhead to obtain green flashing LED
	Red flashing	Poor set-up: adjust readhead to obtain green flashing LED
Calibration mode	Blue single-flashing	Calibrating incremental signals
	Blue double-flashing	Calibrating reference mark
Normal operation	Blue	AGC on; optimum set-up
	Green	AGC off; optimum set-up
	Red	Poor set-up; signal may be too low for reliable operation
	Blank flash	Reference mark detected (visible indication at speed < 100 mm/s only)
Alarm	Four red flashes	Low signal, over signal, or overspeed; system in error
	Red and purple flashing (analogue variant only)	AGC out of normal operating range

NOTE: See 'Troubleshooting' on page 28 for more information on diagnosing faults.

Reference mark position



IN-TRAC™ reference mark is integrated in the incremental track of the ring, radially aligned with the centre of the mounting hole to the left of the 'Renishaw' logo within ±0.5 mm. No external actuators or physical adjustment are required.

System calibration

NOTE: The system calibration can also be carried out using the Advanced diagnostic tools ADTpro-100 or ADTi-100 and ADT View software. Refer to the ADTpro-100 user guide (Renishaw part no. M-6647-9138) or ADT View user guide (Renishaw M-6195-9413) for more information.

Before system calibration:

1. Clean the ring and readhead optical window.
2. If reinstalling, restore the factory defaults (see 'Restoring factory defaults' on page 27).
3. Maximise the signal strength around the full axis of rotation (set-up LED is flashing green).

NOTE: During calibration the speed should not exceed 100 mm/s or the readheads' maximum speed, whichever is slowest.

Incremental signal calibration

1. Cycle the power to the readhead or connect the 'Remote CAL' output pin to 0 V for < 3 seconds. The readhead will then periodically single-flash blue to indicate it is in calibration mode as detailed in 'Readhead mounting and alignment' on page 23. The readhead will only enter calibration mode if the LED is flashing green.
2. Rotate the axis at slow speed, ensuring the readhead does not pass the reference mark, until the LED starts double-flashing. This indicates that the incremental signals are now calibrated and the new settings are stored in the readhead memory.
3. The system is now ready for reference mark phasing. For systems without a reference mark, cycle the power to the readhead or connect the 'Remote CAL' output pin to 0 V for < 3 seconds to exit calibration mode.
4. If the system does not automatically enter the reference mark phasing stage (LED continues single-flashing) the calibration of the incremental signals has failed. After ensuring failure is not due to overspeed (> 100 mm/s, or exceeding the readhead maximum speed), exit the calibration routine, restore factory defaults (see 'Restoring factory defaults' on page 27) and check the readhead installation and system cleanliness before repeating the calibration routine.

NOTE: For analogue variants of QUANTiC ensure correct termination of output signals ('Recommended signal termination' on page 36).

Reference mark phasing

1. Move the readhead back and forth over the reference mark until the LED stops flashing and remains solid blue. The reference mark is now phased.
2. The system automatically exits the calibration routine and is ready for operation.
3. AGC and AOC are automatically switched on once calibration is complete. To switch off AGC refer to 'Switching Automatic Gain Control (AGC) on or off' on page 27.
4. If the LED continues double-flashing after repeatedly passing the reference mark it is not being detected. Ensure correct readhead alignment.

Calibration routine manual exit

To exit the calibration routine at any stage, cycle the power to the readhead or connect the 'Remote CAL' output pin to 0 V for < 3 seconds. The LED will stop flashing.

LED status during system calibration

LED	Setting stored
Blue single-flashing	None, restore factory defaults and recalibrate
Blue double-flashing	Incremental only
Blue (auto-complete)	Incremental and reference mark

Restoring factory defaults

When realigning the readhead, reinstalling the system, or in the case of continued calibration failure, factory defaults must be restored.

NOTE: Factory defaults can also be restored using the ADTpro-100 or ADTi-100 and ADT View software. Refer to the ADTpro-100 user guide (Renishaw part no. M-6647-9138) or ADT View user guide (Renishaw M-6195-9413) for more information.

To restore factory defaults:

1. Switch the system off.
2. Obscure the readhead optical window (using the green spacer supplied with the readhead ensuring the cut-out is NOT under the optical window) or connect the 'Remote CAL' output pin to 0 V.
3. Power the readhead.
4. Remove the spacer or, if using, the connection from the 'Remote CAL' output pin to 0 V.
5. The LED will start continuously flashing indicating factory defaults have been restored and the readhead is in installation mode.
6. Repeat 'Readhead set-up' procedure on page 23.

Switching Automatic Gain Control (AGC) on or off

The AGC is automatically enabled once the system has been calibrated (indicated by a blue LED). AGC can be manually switched off by connecting the 'Remote CAL' output pin to 0 V for > 3 seconds < 10 seconds. The LED will be solid green.

NOTE: AGC can also be switched on or off using the ADTpro-100 or ADTi-100 and ADT View software. Refer to the ADTpro-100 user guide (Renishaw part no. M-6647-9138) or ADT View user guide (Renishaw M-6195-9413) for more information.

Troubleshooting

Fault	Cause	Possible solutions
LED on the readhead is blank	There is no power to the readhead	• Ensure 5 V is supplied at the readhead • For cable variants, check the correct wiring of the connector • If using the analogue variant of QUANTiC with the ADTi-100, ensure the appropriate adaptor cables are connected

LED on the readhead is flashing red during installation mode	The signal strength is < 50%	• Check the readhead optical window and the ring are clean and free from contamination
		• Restore factory defaults (see page 27) and check the alignment of the readhead. In particular:
		  • Rideheight
		  • Yaw
		  • Offset
		• Ensure the correct ring and readhead combination

Unable to get a green LED around the full axis of rotation	System run-out is not within specification	• Use a DTi gauge and check the run-out is within specifications • Restore factory defaults (see page 27) • Realign the readhead to obtain a green flashing LED at the mid-point of the run-out • Recalibrate the system (see page 25)
Can't initiate the calibration routine	Signal size is < 70%	• Realign the readhead to obtain a green flashing LED

Fault	Cause	Possible solutions
During calibration the LED on the readhead remains single-flashing blue even after moving it around the full axis of rotation	The system has failed to calibrate the incremental signals due to the signal strength being < 70%	• Exit the CAL mode and restore factory defaults (see page 27) • Check the readhead set-up and alignment (see page 23)
	Incorrect termination (analogue variant only)	• Check the output signal termination (see page 36) • When using with ADTi-100 in stand-alone mode ensure the Termination tool is connected (A-6195-2132) • Exit the CAL mode and restore factory defaults (see page 27) • Check the readhead set-up and alignment (see page 23)
During calibration the LED on the readhead is double-flashing blue even after moving it past the reference mark several times	The readhead is not seeing a reference mark	• Ensure you are moving the readhead past the reference mark several times • Check the readhead optical window and the ring are clean and free from contamination • Check the readhead is configured for 'All reference marks' to be ouput

No reference mark output		• Ensure you are not moving the readhead too fast during calibration mode (maximum speed < 100 mm/sec) or beyond the readheads maximum speed (whichever is slower)
		• Calibrate the system (see page 25)
		  • If the system completes the calibration mode, it has successfully seen and calibrated the reference mark. If you still do not see a reference mark, check the system wiring.
		  • If the system does not calibrate the reference mark (LED on the readhead remains double-flashing blue), see above for possible solutions.

Reference mark is not repeatable		• The readhead bracket must be stable and not allow any mechanical movement of the readhead • Clean the ring and readhead optical window, and check for damage, then recalibrate the system, ensuring all the incremental signal calibration steps and the reference mark phasing steps are completed (see page 25)

Fault	Cause	Possible solutions
LED on the readhead is flashing red over the reference mark	The reference mark is not phased	• Clean the ring and readhead optical window, and check for scratches, then recalibrate the system, ensuring all the incremental signal calibration steps and the reference mark phasing steps are completed (see page 25)
LED on the readhead is flashing red and purple (analogue variant only)	AGC is outside of the normal operating range	• Check the output signal termination (see page 36) • When using with ADTi-100 in stand-alone mode, ensure the Termination tool is connected (A-6195-2132) • Check the cable continuity • Ensure the correct ring and readhead combination
LED on the readhead is flashing red four times upon switch on	Low signal, over signal, or the readhead speed is too fast; system in error	• Check the readhead set-up and alignment (see page 23)
	Incorrect termination (analogue variant only)	• Check the output signal termination (see page 36) • When using with ADTi-100 in stand-alone mode, ensure the Termination tool is connected (A-6195-2132) • Exit the CAL mode and restore factory defaults (see page 25) • Check the readhead set-up and alignment (see page 23)

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 (X)	14-way JST (J)
Power	5 V		Brown	5	7, 8	4, 12	G	10
	0 V		White	1	2, 9	2, 10	H	1
Incremental	A	+	Red	2	14	1	M	7
		–	Blue	6	6	9	L	2
	B	+	Yellow	4	13	3	J	11
		–	Green	8	5	11	K	9
Reference mark	Z	+	Violet	3	12	14	D	8
		–	Grey	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 [1]	CAL		Clear	9	1	5	C	4
Shield	-		Screen	Case	Case	Case	Case	Ferrule

[1] The remote CAL line must be connected for use with ADTi-100.

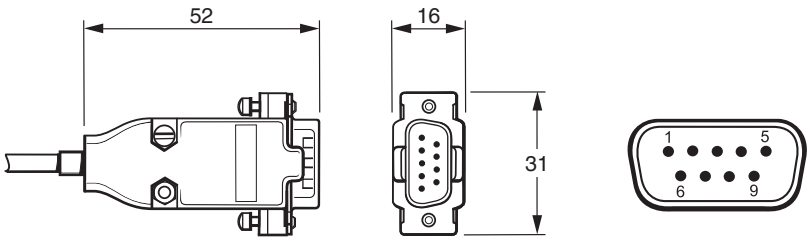
Analogue outputs

Function		Signal		Colour	15-way D-type (L)	15-way D-type alternative pin-out (H)	14-way JST (J)
Power		5 V		Brown	4, 5	4, 12	10
		0 V		White	12, 13	2, 10	1
Incremental	**Cosine**	V_1	+	Red	9	1	7
			–	Blue	1	9	2
	Sine	V_2	+	Yellow	10	3	11
			–	Green	2	11	9
Reference mark		V_0	+	Violet	3	14	8
			–	Grey	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 [1]		CAL		Orange	14	5	4
Shield		-		Screen	Case	Case	Ferrule

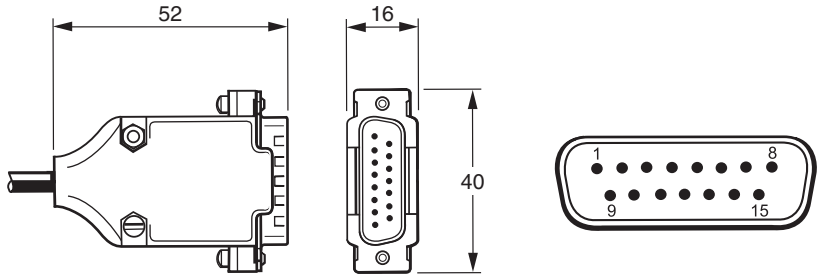
[1] The remote CAL line must be connected for use with ADTi-100.

QUANTiC readhead termination options

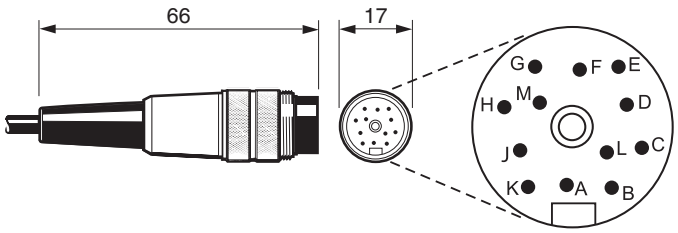
9-way D-type connector (termination code A)



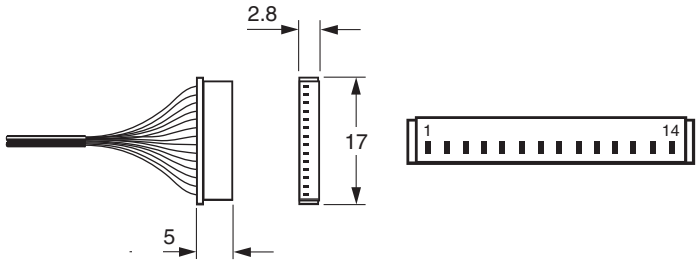
15-way D-type connector (termination code D, L, H)



12-way in-line circular connector (termination code X) [1]



14-way JST connector (termination code J) [2]



[1] 12-way circular Binder mating socket (A-6195-0105).

[2] Pack of 5 14-way JST SH mating sockets:
Bottom mount (A-9417-0025);
Side mount (A-9417-0026).
Maximum of 20 insertion cycles for JST connector.

Speed

Digital readheads

Clocked output option (MHz)	Maximum speed (m/s)							Minimum edge separation [1] (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) [2]

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

$$\text{Angular speed (rev/min)} = \frac{V \times 1000 \times 60}{\pi D}$$

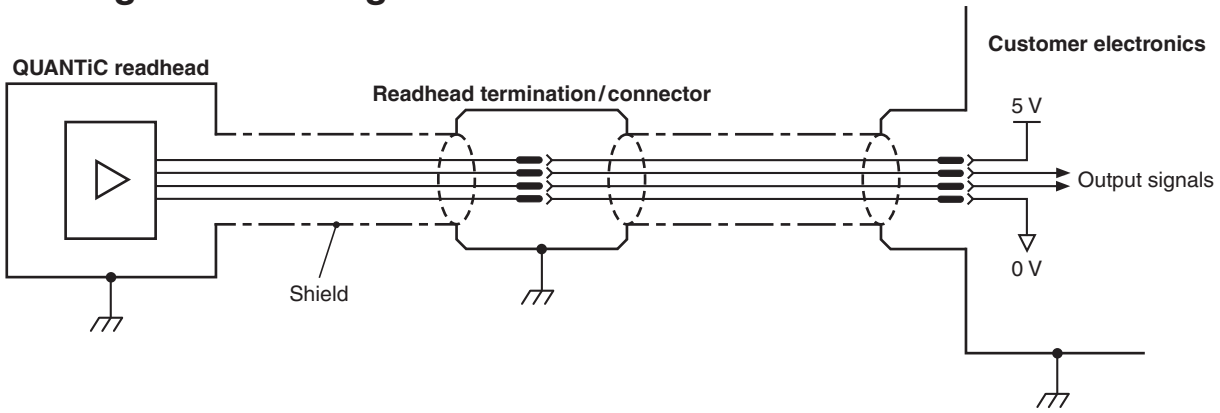
Where V = maximum linear speed (m/s) and D = external diameter of the RESM40 ring (mm)

[1] For a readhead with a 1 m cable.

[2] If the speed exceeds 20 m/s, SDE performance cannot be guaranteed.

Electrical connections

Grounding and shielding

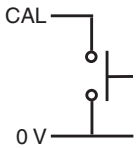


IMPORTANT: The shield should be connected to the machine earth (Field Ground). For JST variants the ferrule should be connected to the machine earth.

Maximum cable length

Readhead cable	10 m
Maximum extension cable length	Dependent on the cable type, the readhead cable length and the clocked output option. Contact your local Renishaw representative for more information.
Readhead to Advanced Diagnostic Tool	10 m

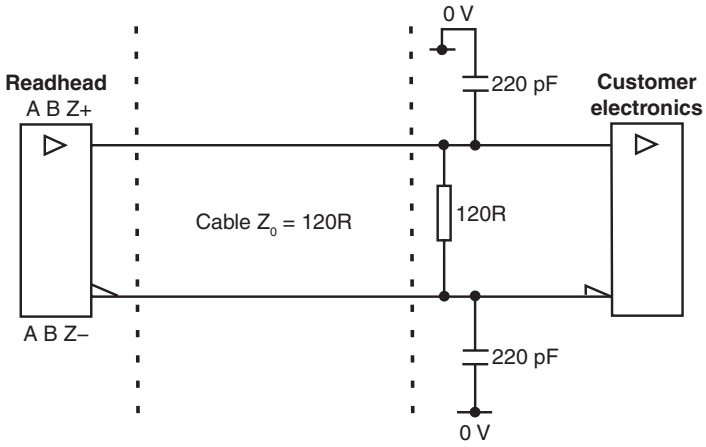
Remote CAL operation



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

Recommended signal termination

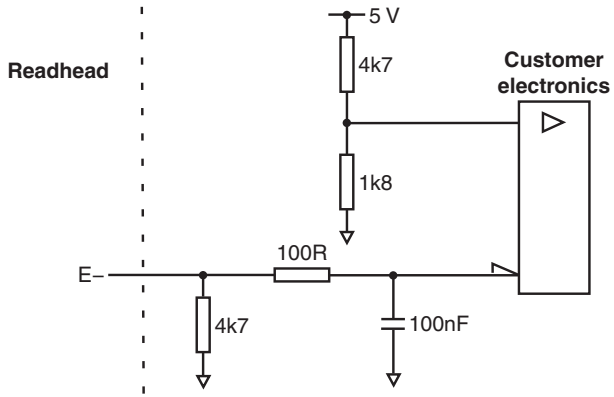
Digital outputs



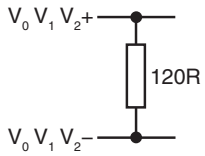
Standard RS422A line receiver circuitry.
The capacitors are recommended for improved noise immunity.

Single-ended alarm signal termination

(not available with 'A' cable termination)



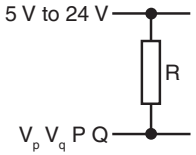
Analogue outputs



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

Limit output

(not available with 'A' cable termination)



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

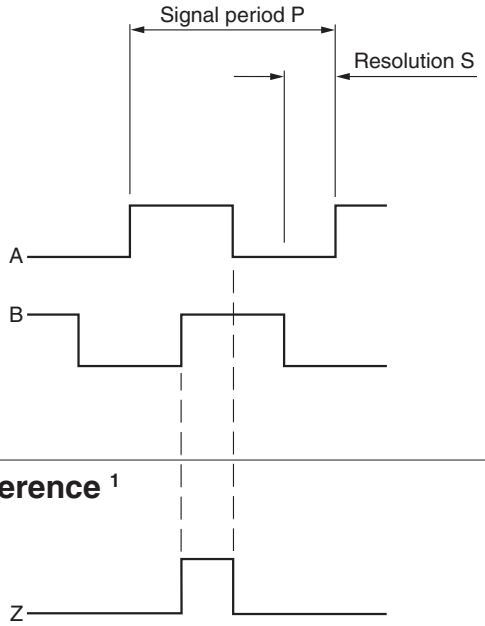
Output specifications

Digital output signals

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

Incremental [1]

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 [1]

Synchronised pulse Z, duration as resolution. Bi-directionally repeatable.

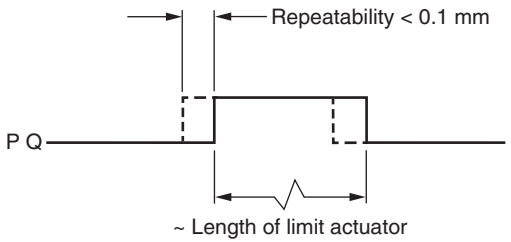
NOTE: A wide reference mark option, outputting a reference pulse for the duration of the signal period is available. Contact your local Renishaw representative for more information.

[1] For clarity, the inverse signals are not shown.

Limits

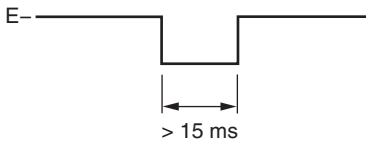
Open collector output, asynchronous pulse (not available with 'A' cable termination)

Active high



Alarm

Line driven (asynchronous pulse) (not available with 'A' cable termination)



Alarm asserted when:

- The signal amplitude is < 20% or > 135%
- The readhead speed is too high for reliable operation

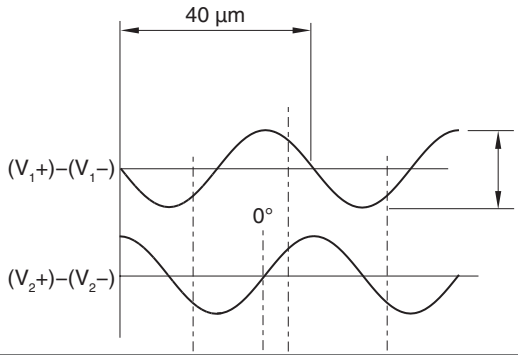
or 3-state alarm

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

Analogue output signals

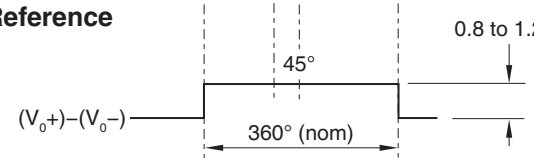
Incremental

2 channels V_1 and V_2 differential sinusoids in quadrature, centred on ~1.65 V (90° phase shifted)



0.7 to 1.35 Vpp with green LED (AGC off) and blue LED (AGC on) indication (readhead) and 120R termination.

Reference

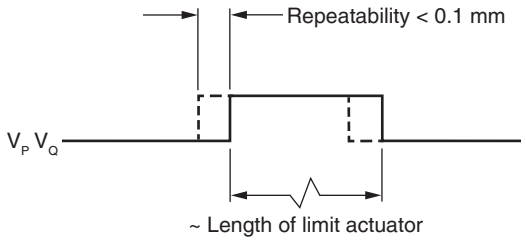


Bi-directionally repeatable. Differential pulse V_0 centred on 45°.

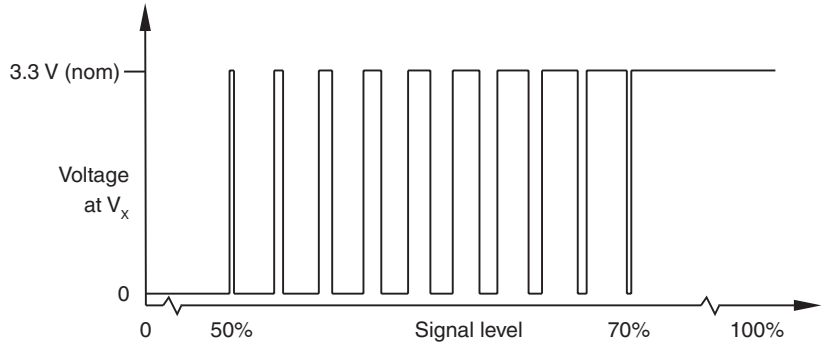
Limits

Open collector output, asynchronous pulse

Active high



Set-up [1]



Between 50% and 70% signal level, V_X is a duty cycle. Time spent at 3.3 V increases with incremental signal level. At > 70% signal level V_X is nominal 3.3 V.

[1] The set-up signal as shown is not present during the calibration routine.

General specifications

Power supply	5V –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
Temperature	System (storage)	–20 °C to +70 °C
	System (operating)	0 °C to +70 °C
Humidity	System	95% relative humidity (non-condensing) to IEC 60068-2-78
Sealing		IP40
Acceleration	System (operating)	400 m/s², 3 axes
Shock	System (operating)	500 m/s², 11 ms, ½ sine, 3 axes
Vibration	Readhead (operating)	Sinusoidal 100 m/s² max @ 55 Hz to 2000 Hz, 3 axes
Mass	Readhead	9 g
	Cable	32 g/m
EMC compliance		IEC 61326-1
Readhead cable		Single-shielded, 28 AWG cores, outside diameter 4.225 ±0.125 mm Flex life > 20 × 10^6 cycles at 20 mm bend radius UL recognised component
	Maximum length	10 m
Connector options		**Code - connector type - output type** 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) - analogue and digital output X - 12-way circular connector - digital output only J - 14-way JST connector - analogue and digital output
Typical sub-divisional error (SDE)		**Analogue output** **Digital output**
	Rotary > ∅135 mm	< ±150 nm < ±150 nm
	Rotary ≤ ∅135 mm	< ±120 nm < ±80 nm

CAUTION: Renishaw encoder systems have been designed to the relevant EMC standards, but must be correctly integrated to achieve EMC compliance. In particular, attention to shielding arrangements is essential.

RESM40 ring specifications

Pitch	40 µm
Material	303/304 stainless steel
Coefficient of thermal expansion (at 20 °C)	15.5 ±0.5 µm/m/°C

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Part no.: M-9417-9201-04-A
Issued: 11.2026