Installation guide
M-9653-9248-04-B

RENISHAW
apply innovation™

T20x1 REXM/REXT ultra-high accuracy angle encoder system

CE

Renishaw plc declares that TONiC 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 2002/95/EC (RoHS)

LED classification

Class 1 LED product. Invisible LED radiation.

BS EN 60825-1: 1994 + A1: 2002 + A2: 2001

Patents

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

JP 3,202,316	US 5,241,173	EP 0514081	EP 0543513	US 5,861,953
EP 0748436	US 6,481,115 B1	US 6,775,008 B2	EP 1173731	GB 2397040
CN 1293983C	US 7,367,128			

Further information

Further information relating to the TONiC encoder range can be found in the TONiC system Data sheet (L-9517-9337). This can be downloaded from our website www.renishawsupport.com/encoder and is also available from your local representative. This document may not be copied or reproduced in whole or in part, or 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.

Disclaimer

RENISHAW HAS MADE CONSIDERABLE EFFORTS TO ENSURE THE CONTENT OF THIS DOCUMENT IS CORRECT AT THE DATE OF PUBLICATION BUT MAKES NO WARRANTIES OR REPRESENTATIONS REGARDING THE CONTENT. RENISHAW EXCLUDES LIABILITY, HOWSOEVER ARISING, FOR ANY INACCURACIES IN THIS DOCUMENT.

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.

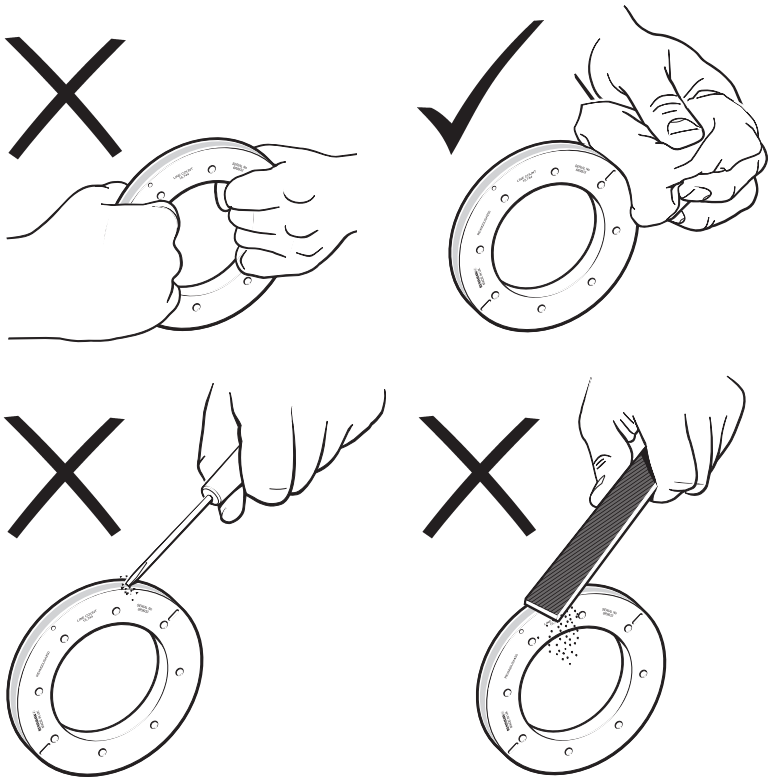
Storage and handling

The REXM/REXT 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.

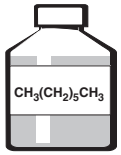
Readhead

Ring

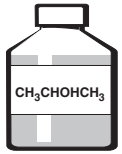


Ring and readhead

N-heptane

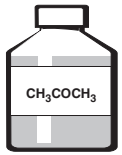


Propan-2-ol



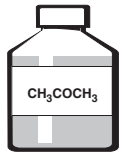
Ring only

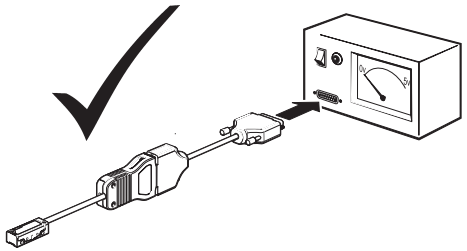
Acetone

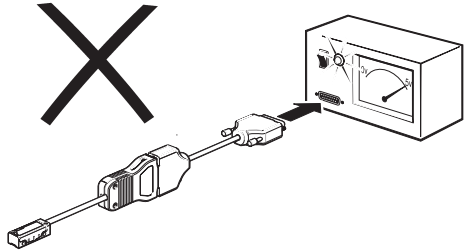


Readhead only

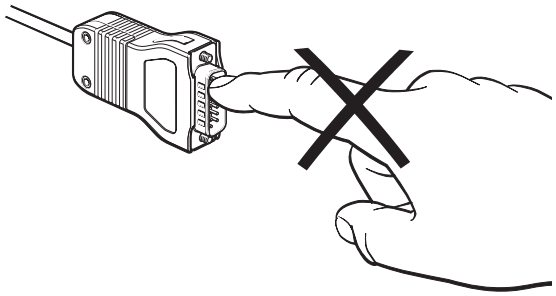
Acetone



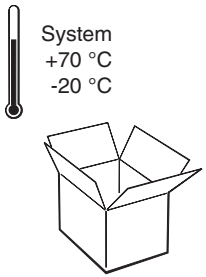




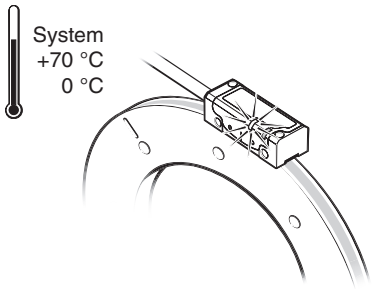
Interface



Storage

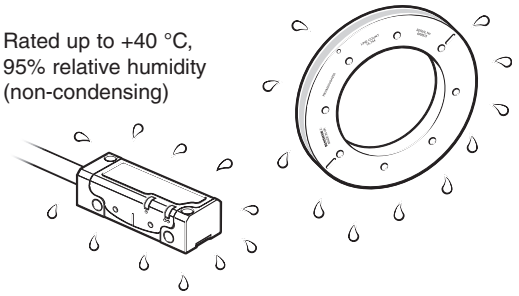


Operating



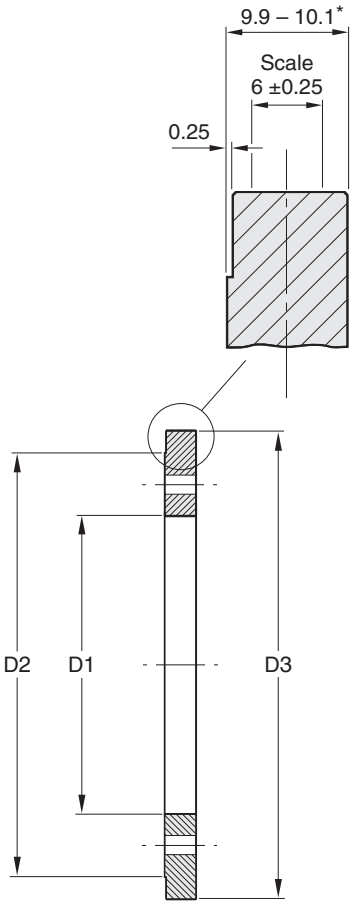
System

Rated up to +40 °C,
95% relative humidity
(non-condensing)



Installation drawing

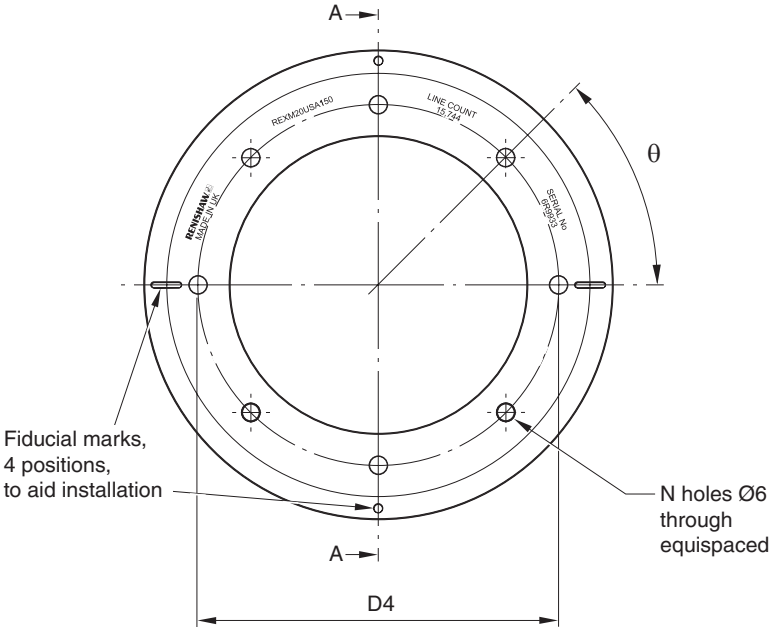
Dimensions and tolerances in mm



Section A-A

*__NOTE:__ Graduations are centered within this dimension

__NOTE:__ For REXT partial arc please refer to 'Ring orientation for partial arc applications' section.

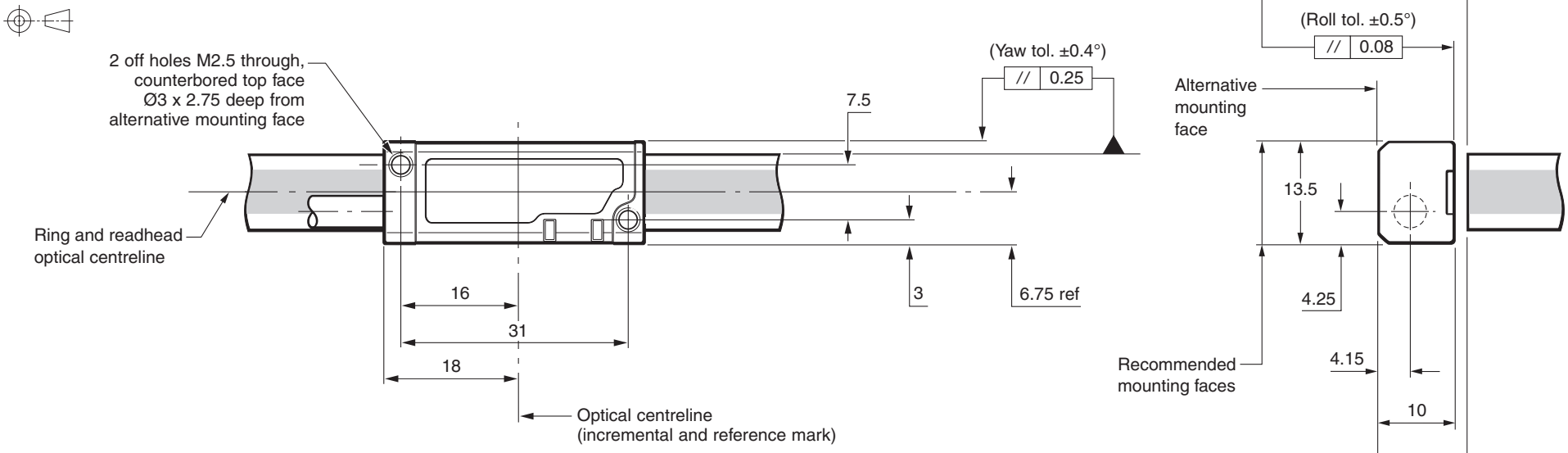


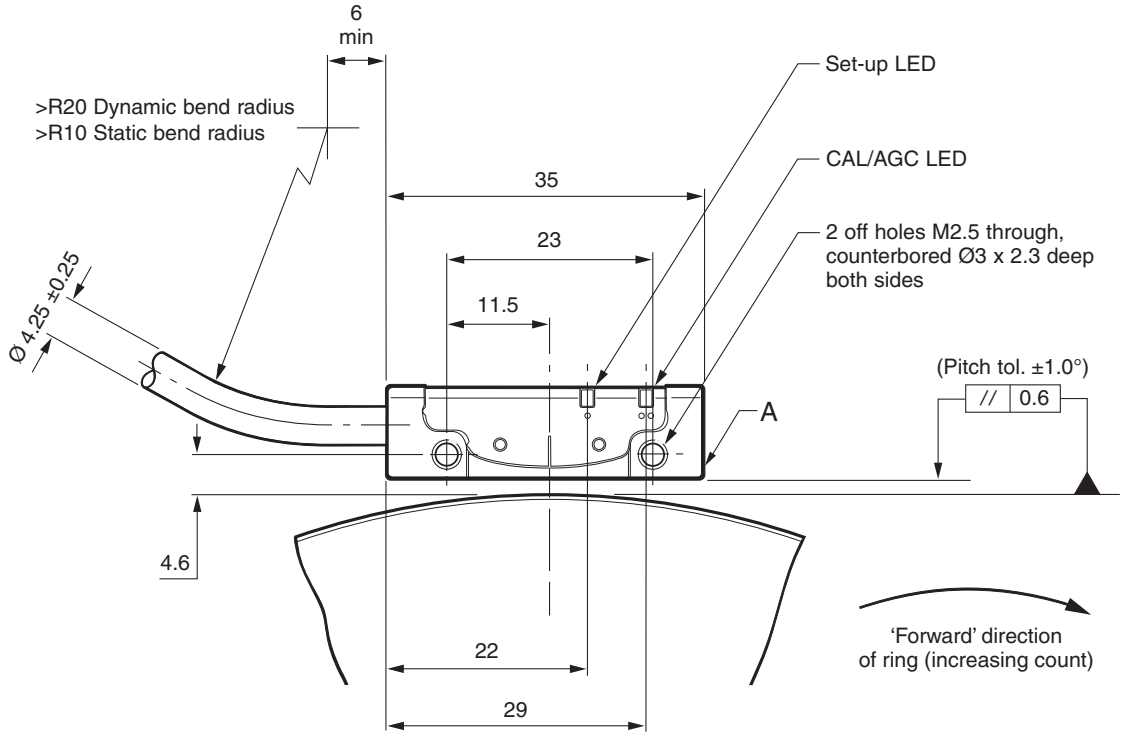
Nominal external diameter (mm)	Line count	Dimensions			Holes		
		D1	D2	D3	N	D4	θ
52*	8 192	26	50	52.1 – 52.2	4	38	90°
57*	9 000	26	50	57.25 – 57.35	4	38	90°
75	11 840	40.5	64.5	75.3 – 75.4	8	52.5	45°
100	15 744	57.5	97.5	100.2 – 100.3	8	77.5	45°
103	16 200	57.5	97.5	103.0 – 103.2	8	77.5	45°
104	16 384	57.5	97.5	104.2 – 104.4	8	77.5	45°
115	18 000	68	108	114.5 – 114.7	8	88	45°
150	23 600	96	136	150.2 – 150.4	8	116	45°
183	28 800	122.5	162.5	183.2 – 183.4	12	142.5	30°
200	31 488	136	176	200.2 – 200.4	12	156	30°
206	32 400	140.5	180.5	206.1 – 206.5	12	160.5	30°
209	32 768	140.5	180.5	208.4 – 208.8	12	160.5	30°
229	36 000	160.5	200.5	229.0 – 229.4	12	180.5	30°
255	40 000	180.5	220.5	254.4 – 254.8	12	200.5	30°
300	47 200	216	256	300.2 – 300.4	12	236	30°
350	55 040	256	296	350.2 – 350.4	16	276	22.5°
417	65 536	305	345	417.0 – 417.4	16	325	22.5°

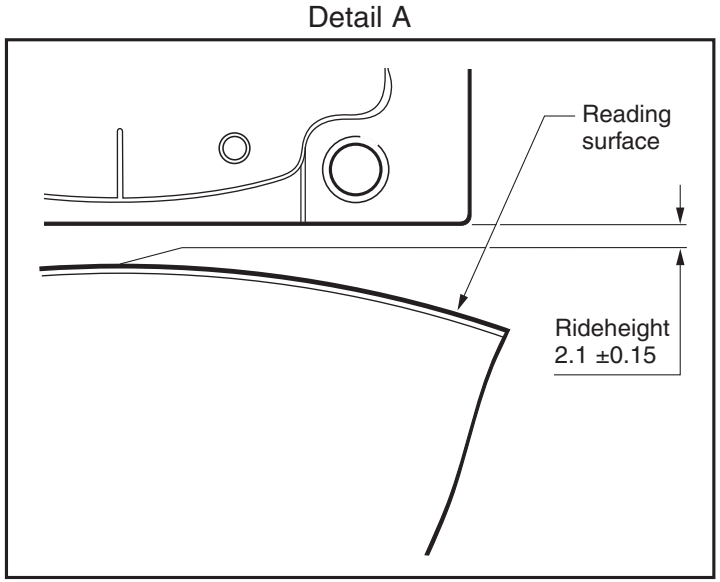
*52 mm and 57 mm rings have dimple fiducial features and no slots.

TONiC T20x1 installation drawing (on REXM/REXT)

Dimensions and tolerances in mm



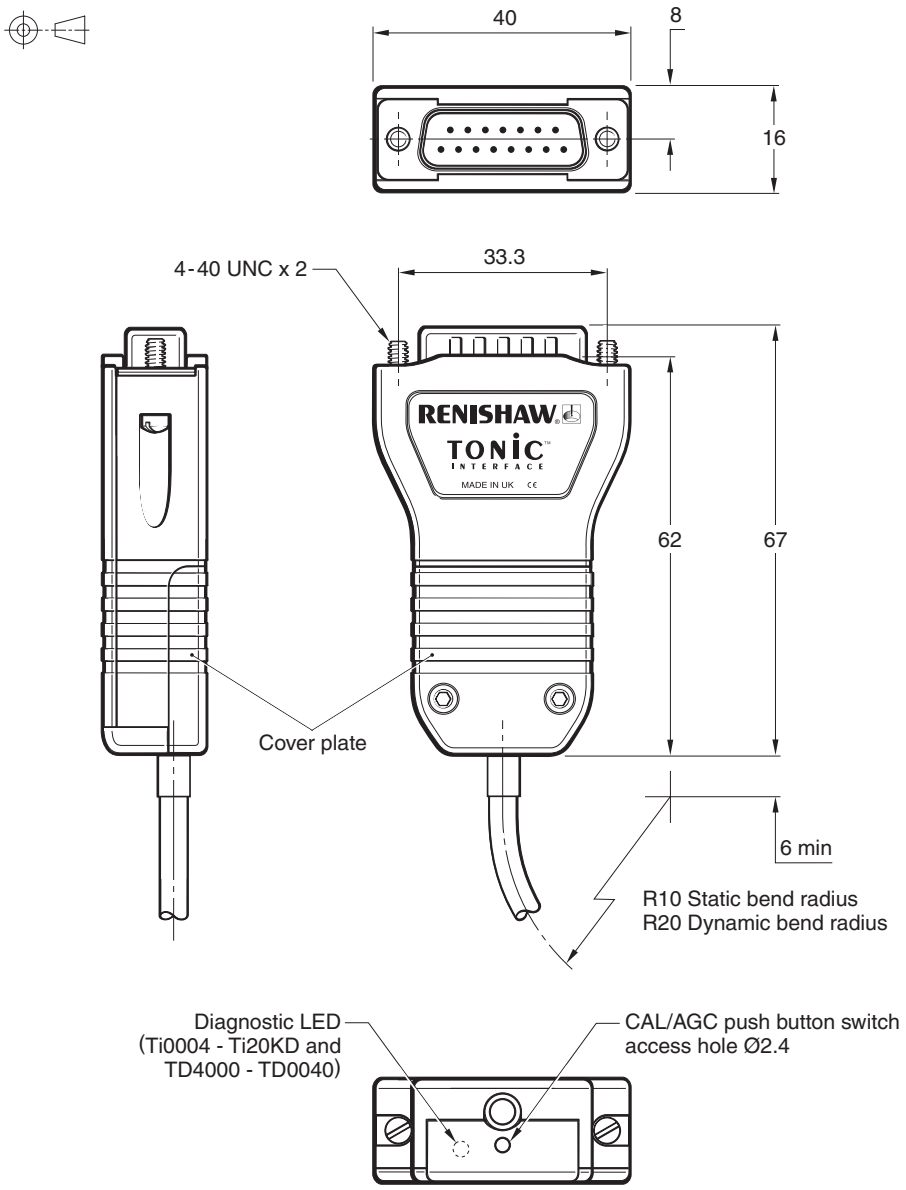




NOTE: Ring centreline refers to the centre of the ring based on the full thickness, ie, including the raised flat portion.

TONiC interface installation drawing

Dimensions and tolerances in mm



CAL button operation

Push and release (<3 seconds) - CAL routine enable/disable
Push and release (>3 seconds) - AGC enable/disable
Push and hold during power 'Off/On' cycle - Restore factory defaults
Refer to readhead LED functionality chart for CAL LED indications

TONiC quick-start guide

This section is a quick-start guide to installing a TONiC system.
More detailed information on installing the system is contained in the following sections of the installation guide.

INSTALLATION

Ensure scale, readhead optical window and mounting faces are clean and free from obstructions.

If required, ensure reference mark selector magnet is correctly positioned.

Plug the readhead cable into the Ti interface under the cover plate and reassemble interface.
Connect to receiving electronics and power-up.

Ensure AGC is switched off - the CAL LED on the readhead should be off (if not press and hold the CAL button on the interface until the CAL LED on the readhead switches off).

Install and align the readhead to maximise signal strength over the full axis travel as indicated by the readhead and interface set-up LEDs (readhead green; interface - ideally blue/purple).

CALIBRATION

Press and release the CAL button on the interface.
The CAL LED on the readhead will be single flashing.

Move the readhead along the scale at slow speed (<100 mm/s), without passing a reference mark, until the CAL LED starts double flashing.

If a reference mark is not being used, the calibration routine should now be exited by pressing the CAL button.

Move the readhead back and forth over the selected reference mark until the CAL LED stops flashing and remains 'off'.

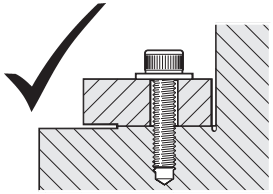
The system is now calibrated and ready for use.
AGC can now be switched on if required by pressing and holding the CAL button until the CAL LED on the readhead switches on.
CAL values and AGC status are stored in readhead non-volatile memory at power down.

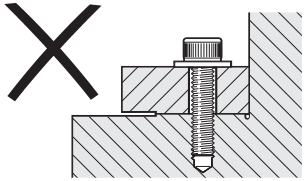
NOTE: If calibration fails restore factory defaults by pressing and holding the CAL button whilst switching on. Then repeat the installation and calibration routine.

Installation

REXM/REXT should be flange mounted onto a flat surface, this eliminates all installation errors except eccentricity, which can be compensated using twin readheads.

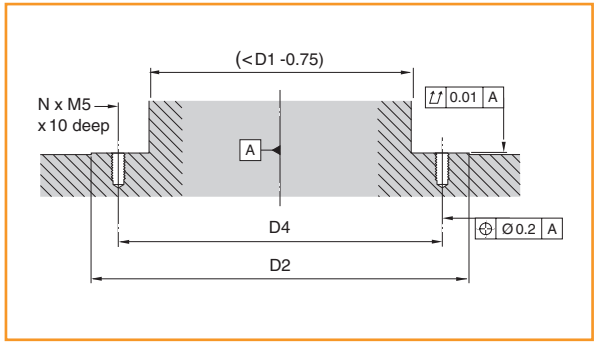
- Although taper mounting is best for thin cross-section rings, it is not suitable for thick cross-section REXM/REXT rings.
- The REXM/REXT ring should be flange mounted onto a flat surface to minimise 2-per-rev distortion.
- Some eccentricity of the ring is acceptable because it will be compensated by the use of twin readheads.
- To avoid distorting to the scale, the REXM/REXT should not be interference fitted.

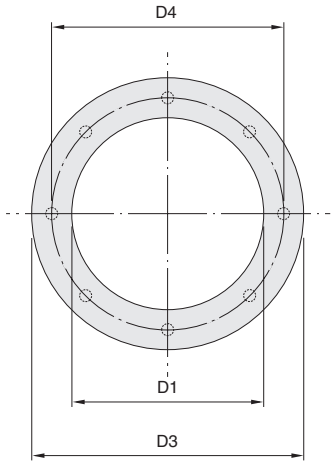




Shaft preparation Step 1

There is a mounting face on the lower side of the REXM/REXT ring. A flat surface should be prepared on the mounting shaft to match. The total axial run-out of the mounting surface should be within 10 µm.





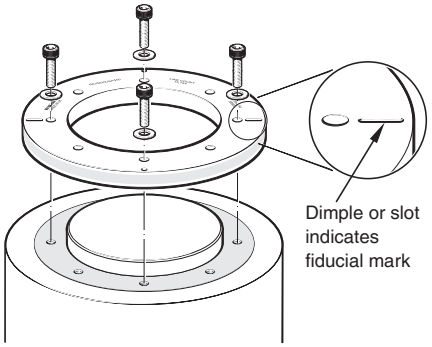
For dimensions D1, D2, D3, D4 and number of holes N, please refer to ring drawing.

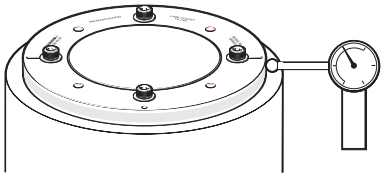
Mounting Step 2

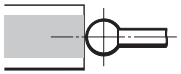
- Clean the mounting face on the lower side of the REXM/REXT. Clean the mating surface on the mounting shaft.
- Place the REXM/REXT onto the mounting shaft, then insert four off M5 screws with flat washers into the four screw holes by the fiducial marks. DO NOT tighten the screws at this point – simply engage the threads ensuring that the heads do not touch the ring.

NOTE: For partial arc applications refer to 'Ring orientation for partial arc applications' section.

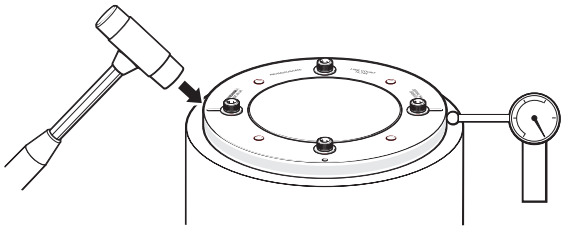
- Set up a Dial Test Indicator (DTI) to measure the run-out on the REXM/REXT ring.
- **NOTE:** At this stage the ring is not firmly fixed, so to avoid causing the ring to shift position, rotate the ring slowly and smoothly.
- Where the DTI shows the lowest radius reading, gently tap the opposite side of the ring on the edge using a rubber mallet, until the DTI reading is approximately at the 'mid point' of the run-out.
- Now find the new lowest radius reading and again tap the opposite side of the ring with a rubber mallet until the DTI reading is at the 'mid point' of the run-out.
- Continue this process until the run-out of the ring is approximately 30 µm (0.0012 inches).





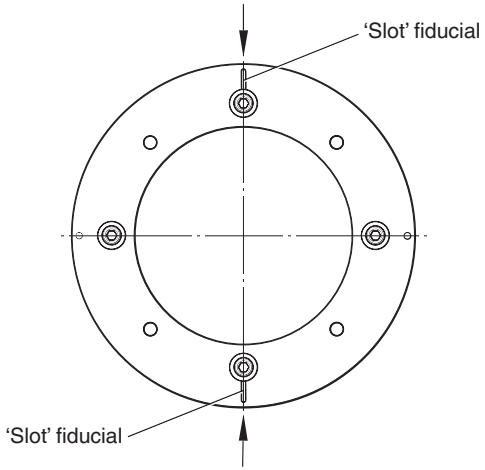


Use a DTI with low exertion force to avoid scratching the scale surface. A DTI with a ruby ball stylus is recommended as a further precaution against scratches.



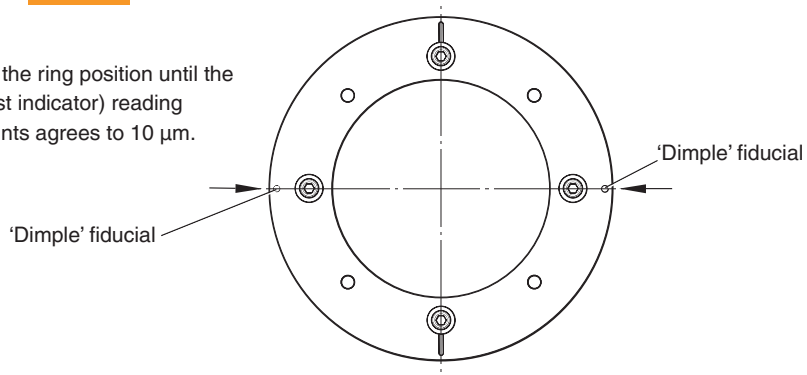
Mounting Step 3

Adjust ring position until the DTI (dial test indicator) reading at these points agrees to 10 µm.



Mounting Step 4

Now adjust the ring position until the DTI (dial test indicator) reading at these points agrees to 10 µm.



Mounting Step 5

- Re-check the run-out at the two 'slot' fiducial points, to ensure the run-out at the two 'slot' points is still within 10 µm. Adjust if necessary.
- Gradually tighten the 4 screws, a quarter-turn at a time so as to avoid moving the position of the ring. Finally, insert the remaining M5 screws and torque all the screws to 4 Nm.
- Re-check the run-out at the two 'slot' fiducial points, then at the two 'dimple' fiducial points. The run-out values at the 'slot' fiducial points do not have to match the run-out values at the 'dimple' fiducial points. If the ring has moved position outside the 10 µm limit, the screws must be loosened and the ring adjusted.

Alternative method -using adjustment screws

It is essential that 4 adjustment screws are used, aligned to the 4 fiducial points (indicated by a 'slot' or 'dimple' mark machined into the front face of the ring).

IMPORTANT: To achieve the highest accuracy, the ring must not be distorted. When adjusting the ring position using adjustment screws, always work in opposing pairs, loosening one screw before tightening the other. Once the ring has been set to 10 µm in one plane, loosen both those adjustment screws before adjusting the other plane.

For ease of adjustment, 4 off M5 screws with washers should be inserted into the ring and tightened finger-tight. These mounting screws should be fitted in the bolt holes aligned to the 4 fiducial marks.

Take run-out measurements at the opposing fiducial points and centre the ring in that plane to within 10 µm. Next, centre the ring in the other direction to within 10 µm in the same way. Note that the run-out at the 'slots' does not have to equal the run-out at the 'dimples'. Finally, re-check the original plane. Note that 52 mm and 57 mm rings have dimple marks only, so select diametrically opposed dimples as adjustment points.

Once the ring is set in both planes fit the remaining M5 screws and torque to 4 Nm.

Ring orientation for partial arc applications

The partial arc DSi is based on a ring with two reference marks opposite each other.
The ring must be installed so that when the ring rotates **only** H1 can see R1 and **only** H2 can see R2.

Small angular movements

To allow the DSi to operate with very small angular movements the ring must be mounted in a certain way in relation to the two readheads. Figure 1(a) shows how the ring must be initially mounted with reference mark **R1** to the left of readhead **H1**. This position could be the maximum travel the ring can be rotated in an anti-clockwise direction (limited by the user).

The angle Φ determines the minimum amount of angular movement the ring can be rotated for the DSI to become initialised. With optimum readhead and ring positioning, the minimum angle of rotation required to initialise a system is 3°. This is to make sure that there is enough rotational travel for both readheads to see a reference mark. The ring will now be rotated clockwise so that H1 will see R1 and H2 will see R2, at this point the DSI will become initialised (Figure 1(b)).

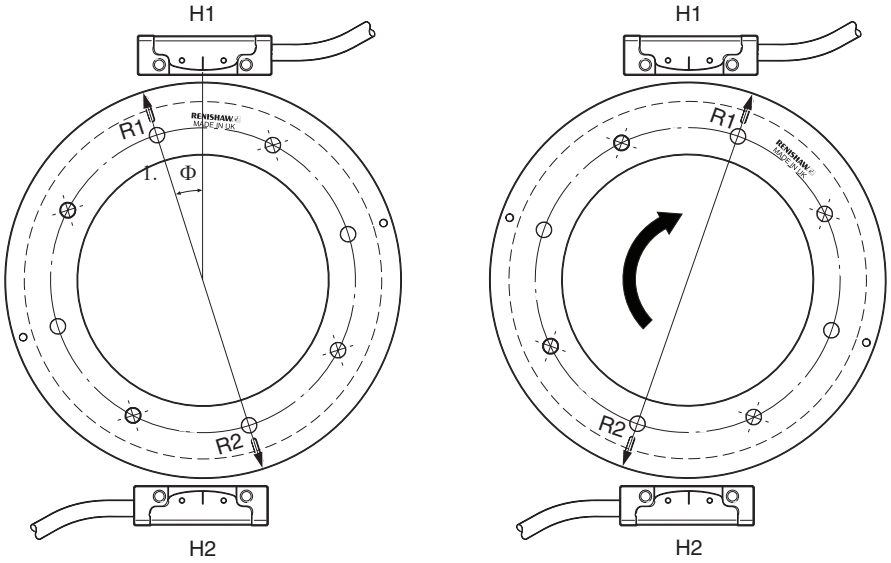


Figure 1 : Small angular movements

Large angular movements (<357°)

When the DSi is used in applications where large amounts of rotation are required the ring must be installed correctly. Figure 2(a) shows the maximum position the ring can be rotated in an anti-clockwise direction. Reference mark R1 must be positioned to the left of H2 so H2 will **never** see R1 upon initialisation. The angular position Φ of R1 to H2 must again be greater than 1.5°, therefore the maximum amount of angular movement of the ring, this being 357°.

Figure 2(b) shows the ring after it has been fully rotated in a clockwise direction to its maximum travel. During this rotation H1 would have seen R1 and H2 would of seen R2. The DSI is now initialised.

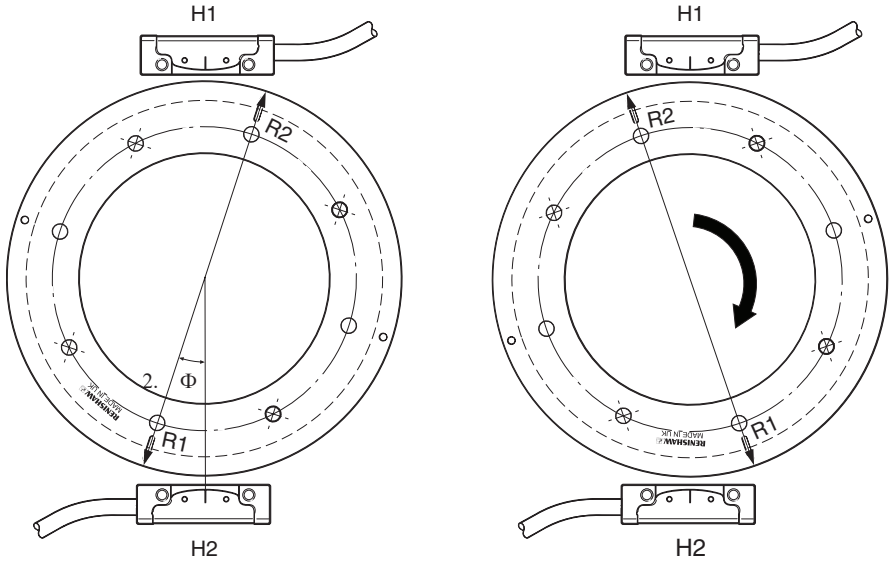


Figure 2 : Large angular movements

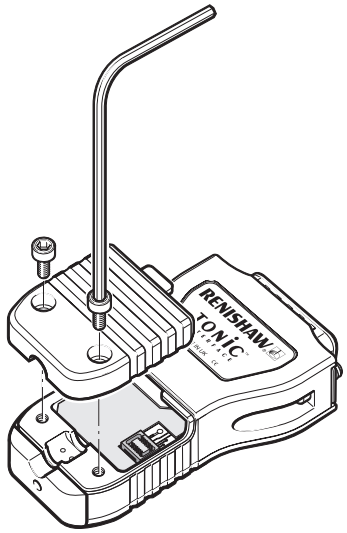
System connection

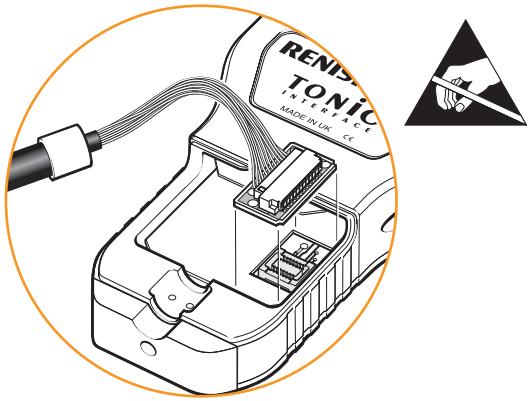
Approved ESD precautions must be followed at all times during readhead and interface electrical connections.
The readhead is connected to the Ti interface via a small, rugged connector to allow for easy feed-through during installation.

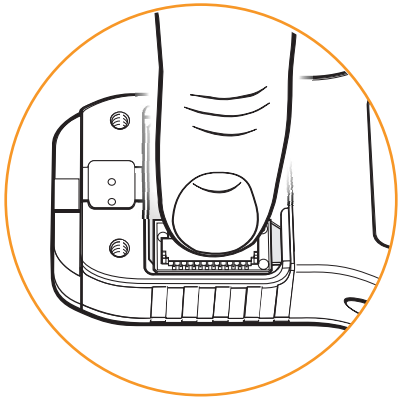
Connecting the readhead

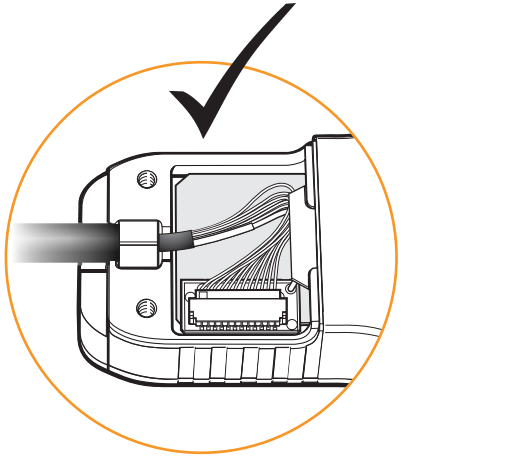
- Remove the cover plate as shown (2 x M2.5 hex head screws).
- Taking care not to touch the pins, plug the connector into the socket in the interface, ensuring correct orientation as shown.
- Refit the cover plate ensuring the cable ferrule is located in the recess on the inside and no wires are trapped under the cover plate.

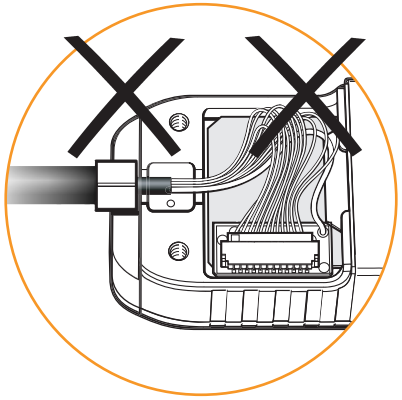
  NOTE: The tightening torque should be between 0.25 Nm and 0.4 Nm.





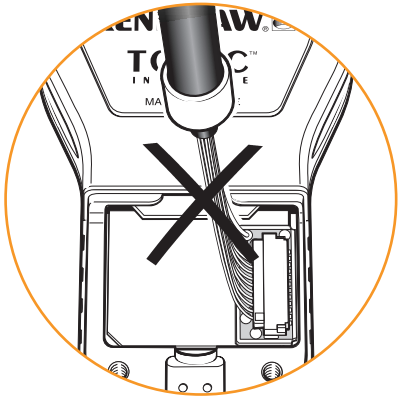


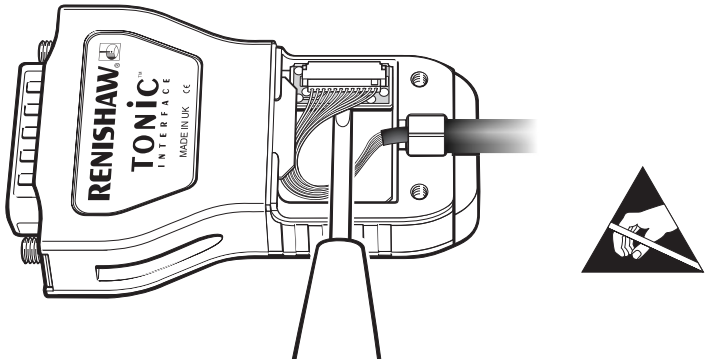




Disconnecting the readhead

- Remove the cover plate on the interface (2 x M2.5 hex head screws).
- Gently lever the connector PCB (on the end of the cable) out of the socket.
- Place the connector in an anti-static bag.
- Refit the cover plate.





T20x1 readhead and REXM/REXT compatibility

T20x1 readhead models are compatible with a range of REXM/REXT ring sizes.
The optical configuration is optimised for the following conditions:

Readhead model	REXM/REXT diameter range (mm)
T2001	>136
T2011	60 to 136
T2021	<60

Published performance specifications and operating tolerances only apply where the correct readhead model conforms to the REXM/REXT size range. Ensure readhead part number and REXM/REXT size range compatibility at the time of ordering and installation.

Reference mark position

REXM

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

REXT

The second reference mark is 180° from the first.

Readhead mounting and alignment

Mounting brackets

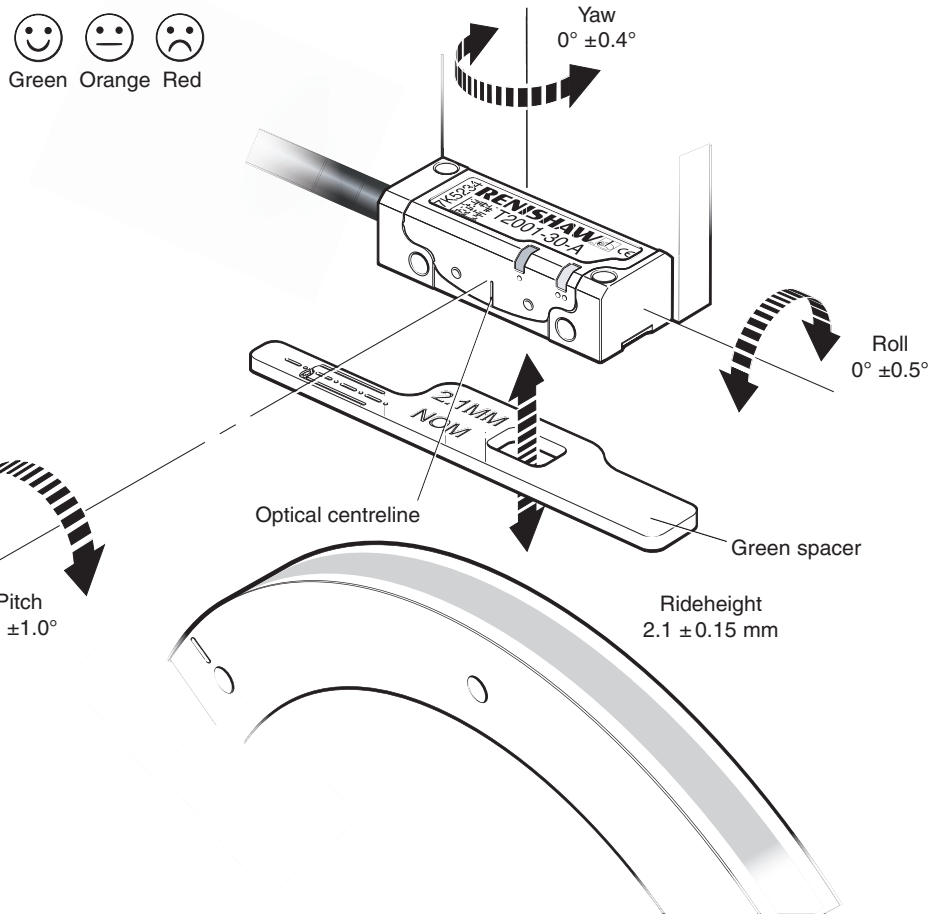
The bracket must have a flat mounting surface and should enable conformance to the installation tolerances, allow adjustment to the rideheight of the readhead, and be sufficiently stiff to prevent deflection or vibration of the readhead during operation.

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 readhead spacer with the 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 on the readhead (70 to 135% signal). If a digital Ti interface is used, aim for a blue LED on the interface.

NOTE: The readhead should be installed and set-up with the AGC switched off.

Readhead set-up LED status

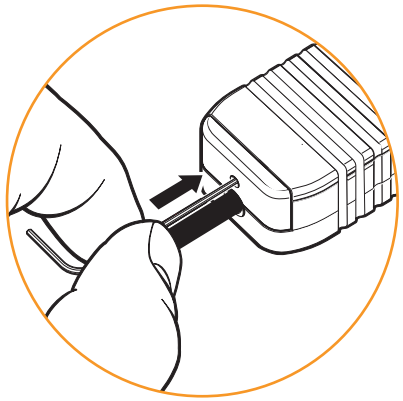


System calibration

Calibration is an essential operation that completes readhead set-up, with the optimum incremental and reference mark signal settings stored in the readhead's non-volatile memory.
Before system calibration, install the readhead to maximise the signal strength along the full axis travel.

NOTE: CAL routine maximum speed <100 mm/s (all Ti/TD interface models)

Step 1 – Incremental signal calibration



- Ensure Automatic Gain Control is switched off (CAL LED on readhead is not illuminated) before beginning calibration.
- Press and release the CAL button on the end of the interface using a 2 mm allen key or similar tool.
- The CAL LED will now periodically single-flash to indicate that it is in incremental signal calibration routine.
- Move the readhead along the axis, ensuring you do not pass the selected reference mark, until the CAL LED starts double-flashing, indicating the incremental signal is now calibrated and the new settings are stored in the readhead memory.
- The system is now ready for reference mark phasing.

For systems without reference mark, go to 'Calibration routine - manual exit'

Step 2 – Reference mark phasing

- Move the readhead back and forth over the selected reference mark until the CAL LED stops flashing and remains off. The reference mark is now phased.
- The system automatically exits the CAL routine and is ready for operation.

Calibration routine - manual exit

- To exit the calibration routine at any stage press the CAL button.
- If the system does not automatically enter the reference mark phasing stage (no double-flashing of the CAL LED) the calibration of the incremental signals has failed. After ensuring failure is not due to overspeed (>100 mm/s), exit the calibration routine, restore factory defaults and check the readhead installation and system cleanliness before repeating the calibration routine.
- If the reference mark is not being used, exit the calibration routine after step 1 is completed.
- If the readhead continues double flashing after passing the chosen reference mark many times, it is not detecting the reference mark. Ensure that the correct head is being used.
  Heads can either output all reference marks or only output a reference mark where a reference selector magnet is fitted.

Restoring factory defaults

When re-installing the system, or in the case of continued calibration failure, factory defaults should be restored.

To restore factory defaults;

- Switch system off.
- Press and hold the CAL button whilst switching the system on. The CAL LED on the readhead will flash several times, indicating that the factory defaults have been restored.
- Release CAL button.
- Check the 'Readhead mounting/installation' and re-calibrate the system.

NOTE: System must be re-calibrated after restoring factory defaults.

Switching Automatic Gain Control on or off

AGC can be switched on or off via the interface.

- Press and hold the CAL button on the interface for >3 seconds to switch AGC on or off.
  The CAL LED on the readhead will be illuminated when AGC is active.

NOTE: The system must be calibrated before switching AGC.

T20x1 readhead LED diagnostics

LED		Indication	Status
Set-up	Incremental	Green	Normal set-up: signal level 70% to 135%
		Orange	Acceptable set-up; signal level 50% to 70%
		Red	Poor set-up; signal may be too low for reliable operation; signal level <50%
	Reference mark	Green (flash)*	Normal phasing
		Orange (flash)	Acceptable phasing
		Red (flash)	Poor phasing; recalibrate
CAL	Operating	On	Automatic Gain Control – On
		Off	Automatic Gain Control – Off
	Calibration	Single flashing	Calibrating incremental signals
		Double flashing	Calibrating reference mark
	Reset	Flashing at power-up (<2s)	Restore factory defaults

*Flash will effectively be invisible when incremental signal level is >70% when passing reference mark.

Ti0004 to Ti20KD and TD4000 to TD0040 interface LED diagnostics

Signal	Indication	Status	Alarm output*
Incremental	Purple	Normal setup; signal level 110% to 135%	No
	Blue	Optimum setup; signal level 90% top 110%	No
	Green	Normal set-up: signal level 70% to 90%	No
	Orange	Acceptable set-up; signal level 50% to 70%	No
	Red	Poor set-up; signal may be too low for reliable operation; signal level <50%	No
	Purple / blank - flashing	Over signal; system in error	Yes
	Blue / blank - flashing	Over speed; system in error	Yes
	Red / blank - flashing	Poor set-up; signal level <20%; system in error	Yes
Reference mark	Blank flash	Reference mark detected (speed <100mm/s only)	No

*-Alarm output will take the form of 3-state or line driven E signal depending on interface configuration.
Also, some configurations do not output overspeed alarm. See product nomenclature for details.
-Momentary status only, while fault condition remains.
-Alarm may result in axis position error, re-datum to continue.

Connections

Interface output (analogue) Ti0000 only

Function	Output type		Signal	Pin
Power			5 V Power	4
			5 V Sense	5
			0 V Power	12
			0 V Sense	13
Incremental signals	Analogue	Cosine	V_1+	9
			V_1-	1
		Sine	V_2+	10
			V_2-	2
Reference mark	Analogue		V_0+	3
			V_0-	11
Limits	Open collector		V_p	7
			V_q	8
Set-up	–		V_X	6
Calibrate	–		CAL	14
Shield	–		Inner shield	Not connected
	–		Outer shield	Case

T20x1 readhead output

Function	Output type		Signal	Colour
Power			5 V Power	Brown
			0 V Power	White
Incremental signals	Analogue	Cosine	V_1+	Red
			V_1-	Blue
		Sine	V_2+	Yellow
			V_2-	Green
Reference mark	Analogue		V_0+	Violet
			V_0-	Grey
Limits	Open collector		V_p	Pink
			V_q	Black
Set-up	–		V_X	Clear
Calibrate	–		CAL	Orange
Shield	–		Inner shield	Green/Yellow
	–		Outer shield	

Connections

Interface output (digital) Ti0004 to Ti20KD and TD 4000 to TD0040

Function	Output type	Signal	Pin
Power		5 V Power	7
		5 V Sense	8
		0 V Power	2
		0 V Sense	9
Incremental signals	RS422A Digital	A+	14
		A-	6
		B+	13
		B-	5
Reference mark	RS422A Digital	Z+	12
		Z-	4
Limits	Open collector	P*	11
		Q‡	10
Alarm†	RS422A Digital	E-	3
Set-up	–	X	1
Shield	–	Inner shield	Not connected
	–	Outer shield	Case

†The alarm signal can be output as a line driver signal or 3-state. Please select the preferred option at time of ordering.

*Becomes alarm (E+) for options E, F, G, H

‡On TD interfaces Pin 10 should be connected to 0 V to switch to lower resolution.

15 way 'D' type plug

NOTE: T2000 series readheads are fitted with P and Q 'end of travel' limit switch sensors, typically used for linear motion applications.

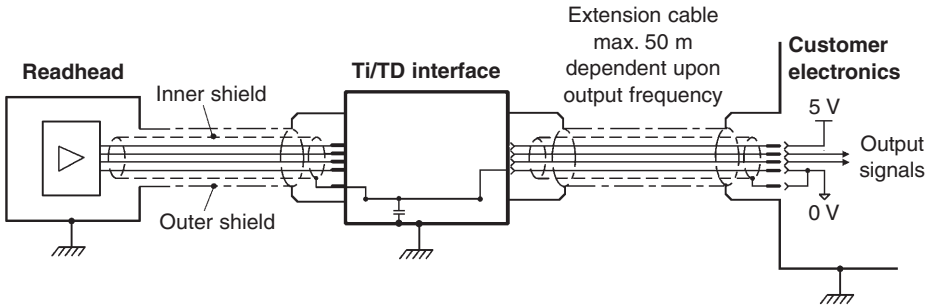
P and Q limit actuators are not suitable for ring encoder (REXM/REXT) installation.

Limit switch signal detail is included here for information only.

Please contact your local Renishaw representative if you require limits on your rotary installation.

Electrical connections

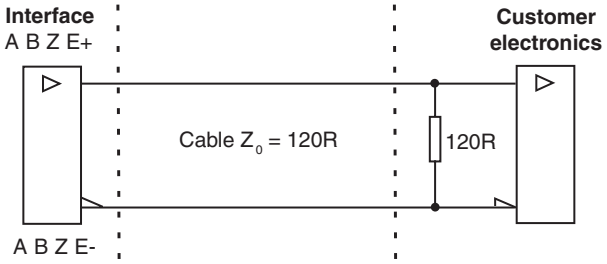
TONiC grounding and shielding



IMPORTANT: The outer shield should be connected to the machine earth (Field Ground). The inner shield should be connected to 0 V. 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.

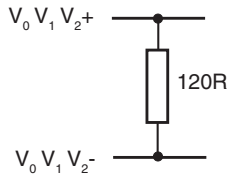
Recommended signal termination

Digital outputs

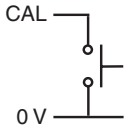


Standard RS422A line receiver circuitry

Analogue outputs

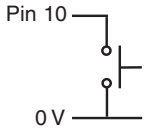


Remote CAL operation (Analogue versions only)



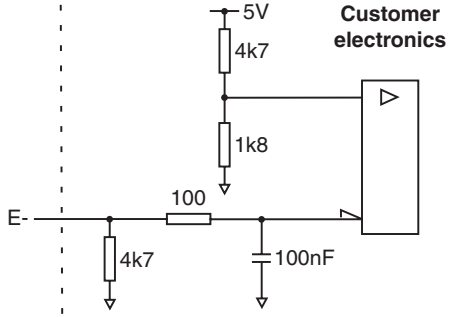
All Ti interfaces include a push button switch to enable CAL/AGC features. Remote operation of the CAL/AGC is possible via pin 14 of analogue Ti0000 interfaces. For applications where no Ti interface is used, remote operation of CAL/AGC is essential.

TD interface resolution switching



Connect Pin 10 to 0 V to switch to lower resolution

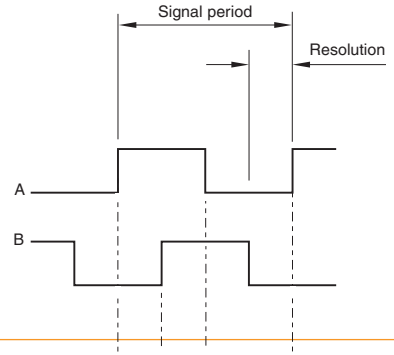
Single ended alarm signal termination (Options A, B, C, D)



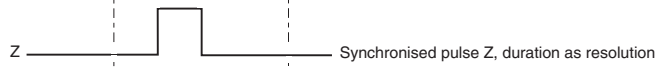
Output specifications

Digital output signals - Form - Square wave differential line driver to EIA RS422A (except limits P and Q)

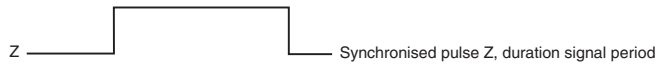
†**Incremental** 2 channels A and B in quadrature (90° phase shifted)



†**Reference**

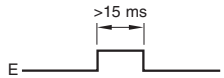


†**Wide reference**



NOTE: Select 'standard' or 'wide' reference at time of ordering, to match the requirements of the controller being used.

†**Alarm** Asynchronous pulse



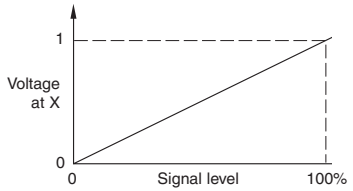
Alarm asserted when signal level is less than 20% or greater than 135%. Alarm is also asserted if readhead speed is too high for reliable operation.

E- output only for options A, B, C, D

or 3-state alarm

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

***Set-up**



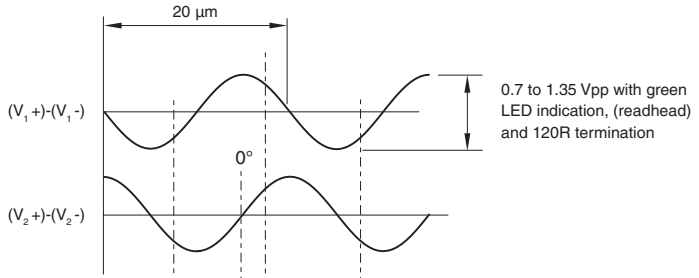
Setup signal voltage proportional to incremental signal amplitude

†Inverse signals not shown for clarity

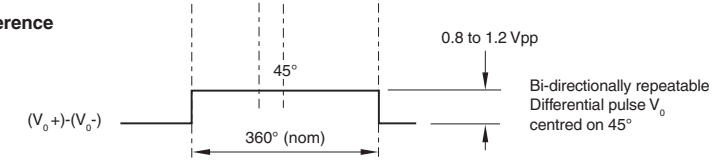
*Set-up signals as shown are not present during calibration routine

Analogue output signals

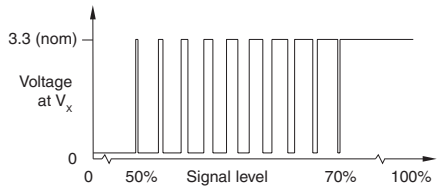
Incremental 2 channels V_1 and V_2 differential sinusoids in quadrature (90° phase shifted)



Reference



***Set-up**



Between 50% and 70% signal level, V_x is a duty cycle, 20 µm duration.
Time spent at 3.3 V increases with incremental signal level.
At >70% signal level V_x is nominal 3.3 V.

General specifications

Power supply	5 V ±10%	T20x1 <100 mA T20x1 with Ti0000 <100 mA T20x1 with Ti0004 - Ti20KD or TD4000 - TD0040 <200 mA **NOTE:** Current consumption figures refer to unterminated systems. For digital outputs a further 25 mA per channel pair (eg 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 EN (IEC) 60950.
	Ripple	200 mVpp maximum @ frequency up to 500 kHz maximum.
Sealing (readhead)		IP40
(interface)		IP20
Acceleration (readhead)	Operating	500 m/s^2 BS EN 60068-2-7:1993 (IEC 68-2-7:1983)
Shock (system)	Non-operating	1000 m/s^2, 6 ms, ½ sine BS EN 60068-2-27:1993 (IEC 68-2-27:1987)
Vibration (system)	Operating	100 m/s^2, 55 Hz to 2000 Hz BS EN 60068-2-6:1996 (IEC 68-2-6:1995)
Mass		Readhead 10 g Interface 100 g Cable 26 g/m
Environmental		Compliant with EU Directive 2002/95/EC (RoHS)
Readhead cable		Double shielded, outside diameter 4.25 ±0.25 mm Flex life >20 x 10^6 cycles at 20 mm bend radius UL recognised component
Maximum cable length		
Readhead to interface		10 m
Interface to controller		

Receiver clock frequency (MHz)	Maximum cable length (m)
40 to 50	25
<40	50
analogue	50

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.

Speed

Minimum receiver clock frequency (MHz)	Maximum speed (m/s)					
	Ti0004 5 µm	Ti0020 1 µm	Ti0040 0.5 µm	Ti0100 0.2 µm	Ti0200 0.1 µm	Ti0400 50 nm
50	10	10	10	6.48	3.240	1.625
40	10	10	10	5.40	2.700	1.350
25	10	10	8.10	3.24	1.620	0.810
20	10	10	6.75	2.70	1.350	0.670
12	10	9	4.50	1.80	0.900	0.450
10	10	8.10	4.00	1.62	0.810	0.400
8	10	6.48	3.24	1.29	0.648	0.324
6	10	4.50	2.25	0.90	0.450	0.225
4	10	3.37	1.68	0.67	0.338	0.169
1	4.2	0.84	0.42	0.16	0.084	0.042
Analogue output	10 (-3dB)					

Minimum receiver clock frequency (MHz)	Maximum speed (m/s)				
	Ti1000 20 nm	Ti2000 10 nm	Ti4000 5 nm	Ti10KD 2 nm	Ti20KD 1 nm
50	0.648	0.324	0.162	0.065	0.032
40	0.540	0.270	0.135	0.054	0.027
25	0.324	0.162	0.081	0.032	0.016
20	0.270	0.135	0.068	0.027	0.013
12	0.180	0.090	0.045	0.018	0.009
10	0.162	0.081	0.041	0.016	0.0081
8	0.130	0.065	0.032	0.013	0.0065
6	0.090	0.045	0.023	0.009	0.0045
4	0.068	0.034	0.017	0.0068	0.0034
1	0.017	0.008	0.004	0.0017	0.0008
Analogue output	10 (-3dB)				

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

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

Where V = maximum linear speed (m/s) and D = external diameter of REXM/REXT (mm)

NOTE: TD maximum speeds are resolution dependant as defined above.

Renishaw plc
New Mills, Wotton-under-Edge,
Gloucestershire GL12 8JR
United Kingdom

T +44 (0)1453 524524
F +44 (0)1453 524901
E uk@renishaw.com
www.renishaw.com

RENISHAW
apply innovation™

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