RENISHAW®
apply innovation™

TONiC™ T103x RKLC20-S linear encoder system

Contents

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EP1173731	JP4750998	US6775008	CN100543424	EP1766334
JP4932706	US7659992	CN100507454	EP1766335	IN281839
JP5386081	US7550710	CN101300463	EP1946048	US7624513
JP5017275	CN101310165	US7839296	EP1957943	EP2390045
CN1314511	EP1469969	JP5002559	US8466943	US8987633

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A copy of the EU declaration of conformity is available from our website at
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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.

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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.

Further information

Further information relating to the TONiC encoder range can be found in the *TONiC™ encoder system* Data sheet (Renishaw part no. L-9517-9337). This document can be downloaded from our website at **www.renishaw.com/tonicdownloads** and is also available from your local Renishaw representative.

Packaging

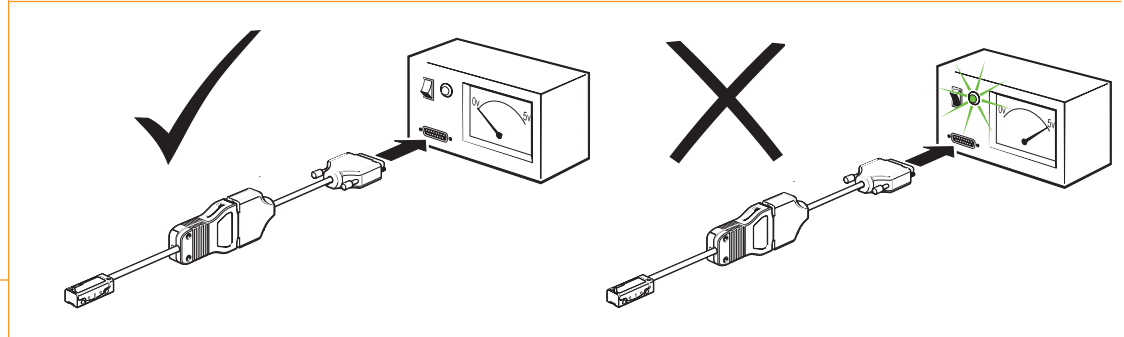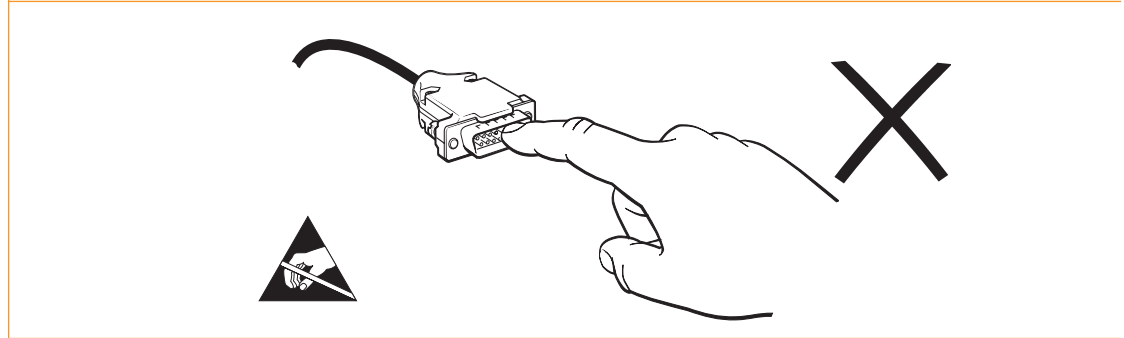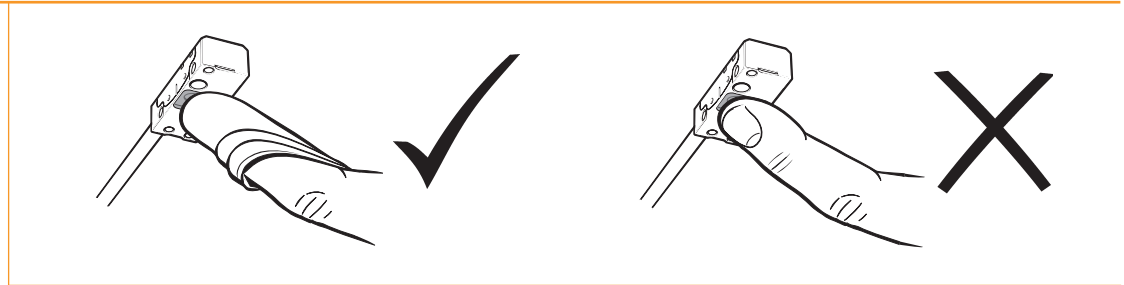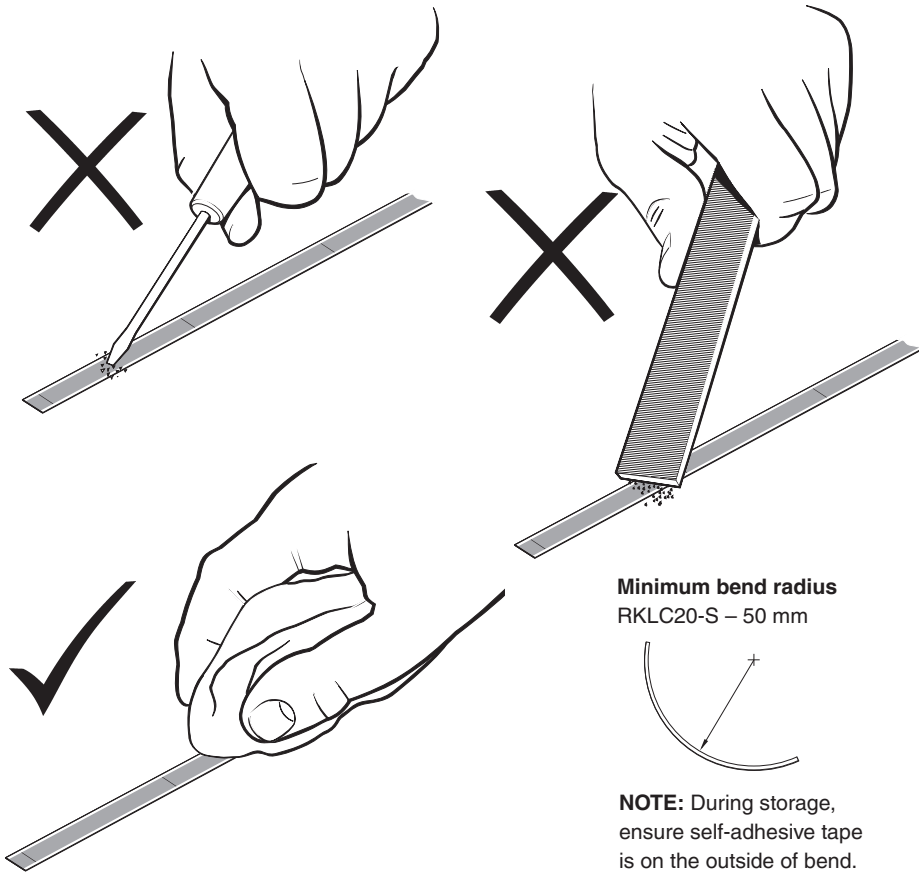| Packaging Component	Material	ISO 11469	Recycling Guidance
Outer box	Cardboard	Not applicable	Recyclable
	Polypropylene	PP	Recyclable
Inserts	Low density polyethylene foam	LDPE	Recyclable
	Cardboard	Not applicable	Recyclable
Bags	High density polyethylene bag	HDPE	Recyclable
	Metalised polyethylene	PE	Recyclable

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**.
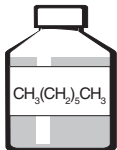
WEEE recycling guidelines

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

Minimum bend radius
RKLC20-S – 50 mm

NOTE: During storage, ensure self-adhesive tape is on the outside of bend.

Scale and readhead

N-heptane

$CH_3(CH_2)_5CH_3$

Propan-2-ol

$CH_3CHOHCH_3$

Readhead only

Acetone

CH_3COCH_3

Chlorinated Solvents

Methylated Spirits

Storage

+70 °C
−20 °C

Installation

+35 °C
+10 °C

Operating

+70 °C
0 °C

Humidity

95% relative humidity (non-condensing) to IEC 60068-2-78
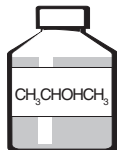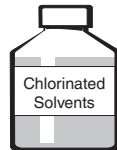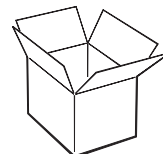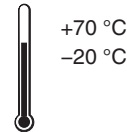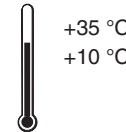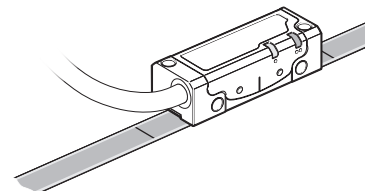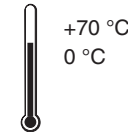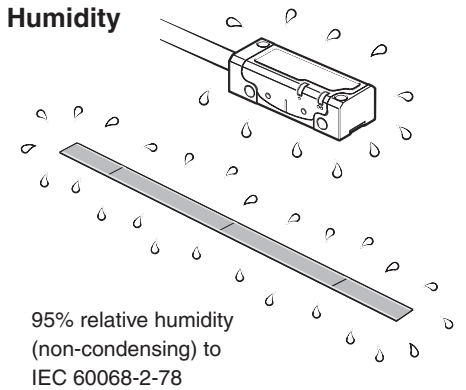
TONiC T103x readhead installation drawing

2 off holes M2.5 through, counterbored Ø3 × 2.75 deep from alternative mounting face

Reference mark selector magnet

18

31

16

3

7.8   7.8

Forward direction of readhead relative to scale

(Yaw tol. ±0.4°)

Offset 3.75 ±0.5

// 0.25

(Roll tol. ±0.5°)

⊥ 0.08

8.75 *

13.5   11 *

4.25

P limit magnet

Selected *IN-TRAC™* reference mark

3

Q limit magnet

Reference mark selector sensor position

22

29

P and Q limit switch sensor position

Alternative mounting faces   4.15

Recommended mounting faces

10

Optical centreline
(incremental and reference mark)

Set-up LED

6 min

R > 20 Dynamic bend radius
R > 10 Static bend radius

CAL/AGC LED

35

23

11.5

2 off mounting holes M2.5 through, counterbored Ø3 × 2.3 deep both sides.
NOTE: The recommended thread engagement is 5 min (7.5 including counterbore) and the recommended tightening torque is between 0.25 and 0.4 Nm.

Detail A

Scale reading surface

Scale thickness 0.15
(including adhesive)

Ø 4.25 ±0.25

A

(Pitch tol. ±1°)

// 0.6

Rideheight: 2.1 ±0.15

4.75 †

Optical centreline marker

* Extent of mounting faces.   † Dimension from substrate surface.

TONiC RKLC20-S linear installation guide

3

Ti interface drawing

16

8

40

67

6 min

62

33.3

R > 20 Dynamic bend radius
R > 10 Static bend radius

4-40 UNC x 2

Cover plate

CAL/AGC push button switch
access hole Ø2.4

Diagnostic LED
(Ti0004 - Ti20KD and TD4000 - TD0040)

RENISHAW TONiC INTERFACE MADE IN UK CE
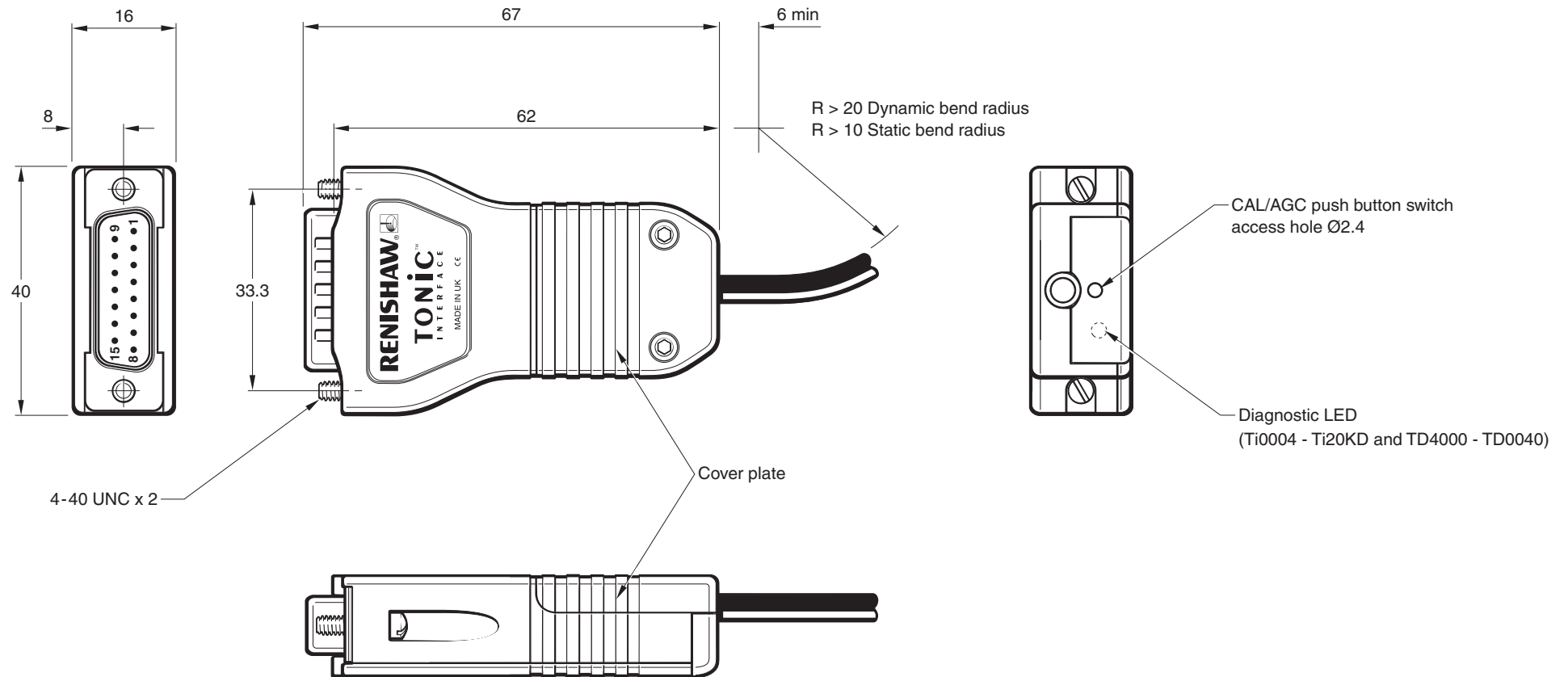
CAL button operation
Push and release (< 3 seconds) - Calibration (CAL) routine enable/disable
Push and release (> 3 seconds) - Automatic Gain Control (AGC) enable/disable
Push and hold during power 'Off/On' cycle - Restore factory defaults
Refer to readhead LED functionality chart for CAL LED indications

RKLC20-S scale installation drawing

Dimensions and tolerances in mm

Overall length (L + 30)

Scale length (L)

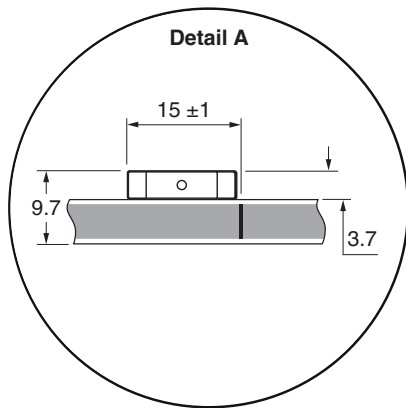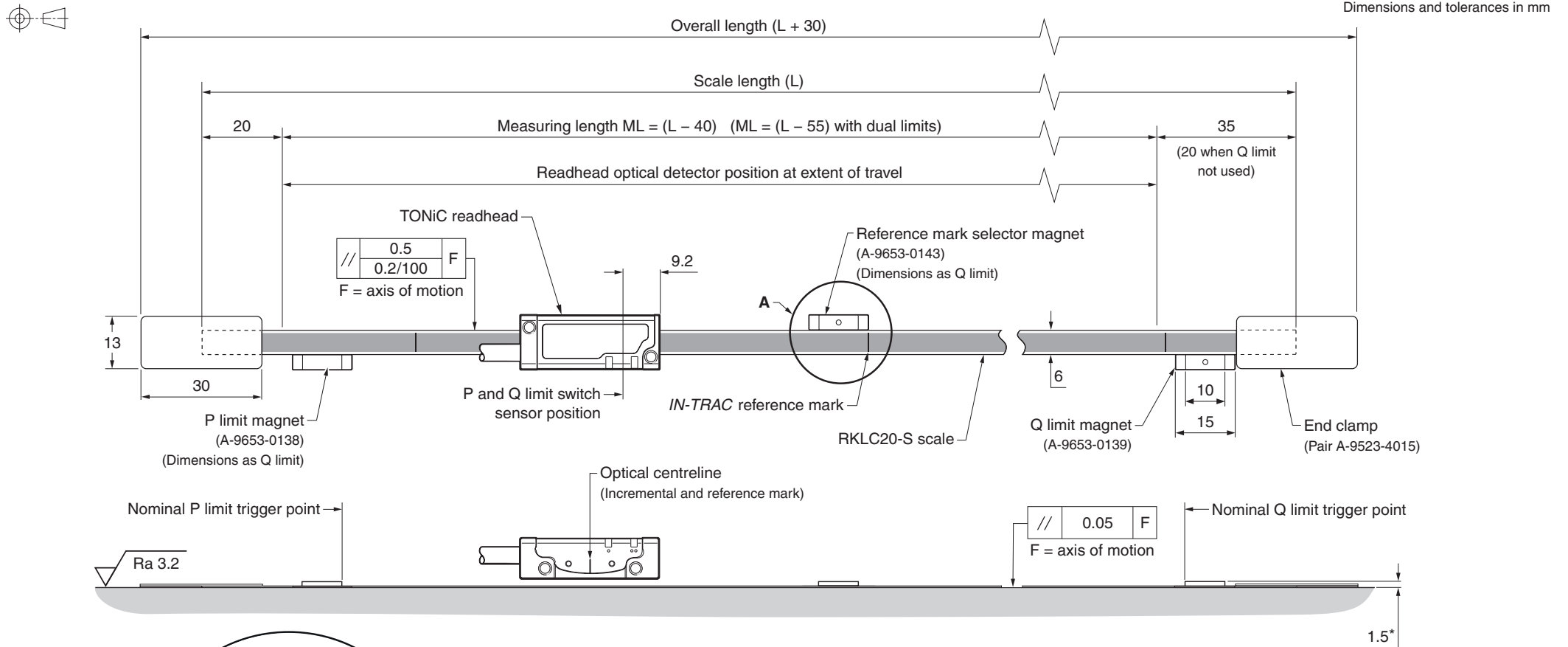| 20 | Measuring length ML = (L – 40)   (ML = (L – 55) with dual limits) | 35 |

(20 when Q limit not used)

Readhead optical detector position at extent of travel

TONiC readhead

| // | 0.5 | F |
| | 0.2/100 | |

F = axis of motion

9.2

Reference mark selector magnet
(A-9653-0143)
(Dimensions as Q limit)

A

13

30

P limit magnet
(A-9653-0138)
(Dimensions as Q limit)

P and Q limit switch
sensor position

IN-TRAC reference mark

RKLC20-S scale

6

10

15

Q limit magnet
(A-9653-0139)

End clamp
(Pair A-9523-4015)

Optical centreline
(Incremental and reference mark)

Nominal P limit trigger point

Ra 3.2

| // | 0.05 | F |

F = axis of motion

Nominal Q limit trigger point

1.5*

Detail A

15 ±1

9.7

3.7

Optional bolted reference mark selector and limit magnets

Bolted magnet type	Part number
Reference mark selector	A-9653-0290
Q limit	A-9653-0291
P limit	A-9653-0292

22

18

10

Ø2.2[†]

1.85

3.7

18.5 ±1
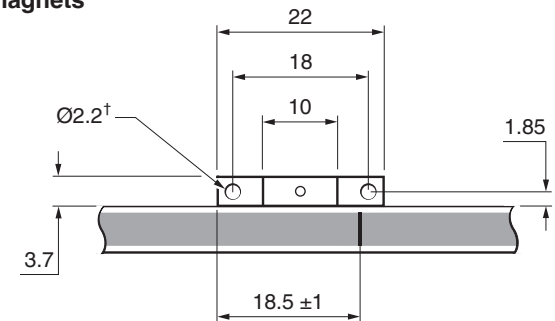
* Dimension from substrate. [†] Supplied with 2 × M2 × 4 screws.

NOTES: The reference mark selector and limit actuator locations are correct for the readhead orientation shown.
External magnetic fields greater than 6 mT, in the vicinity of the readhead, may cause false activation of the limit and reference sensors.

RKLC20-S scale application

Suitable for:

▶ RKLC20 tape scale (any length)

Required parts:

▶ Appropriate length of RKLC20-S scale ('RKLC20-S scale installation drawing', page 5)

▶ Scale applicator - side mounted (A-6547-1912) or top mounted (A-6547-1915)

▶ End clamp kit (A-9523-4015)

▶ RGG-2 two part epoxy adhesive (A-9531-0342)

▶ Appropriate cleaning solvents ('Storage and handling', page 2)

▶ 2 × M2.5 screws

▶ Green spacer (supplied with TONiC readhead)

Optional parts:

▶ Renishaw scale wipes (A-9523-4040)

▶ Lint-free cloth

▶ Magnet applicator tool (A-9653-0201)

▶ Limit magnets (P limit - A-9653-0138, Q limit - A-9653-0139)

▶ Reference mark selector magnet[*] (A-9653-0143)

▶ Guillotine (A-9589-0071) or shears (A-9589-0133) for cutting RKLC20-S to length required

[*] The reference mark selector magnet is only required for 'Customer selectable reference mark' readheads.

Cutting scale

If required cut scale to length using guillotine or shears.

Using the guillotine

The guillotine should be held securely in place, using a suitable vice or clamping method.

Once secured, feed the RKLC20-S scale through the guillotine as shown, and place guillotine press block down onto the scale. Ensure the block is in the correct orientation (as shown).
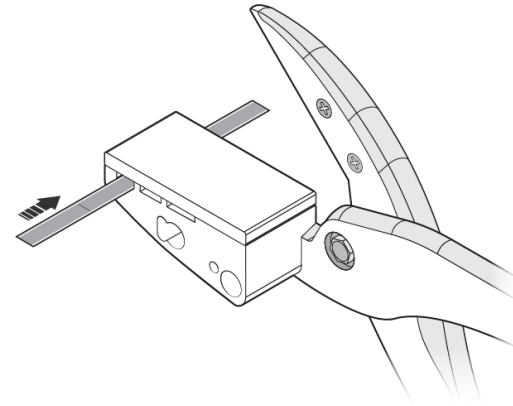
Whilst holding the block in place, in a smooth motion, pull down the lever to cut through the scale.

Guillotine press block orientation when cutting RKLC20-S scale

Guillotine press block
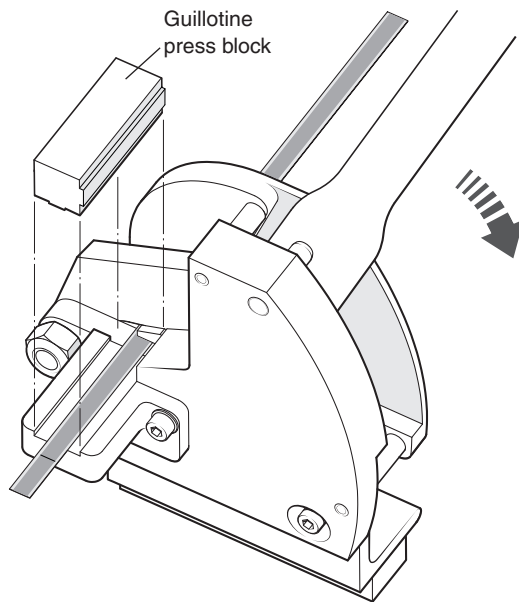
Using the shears

Feed the RKLC20-S scale through the first apperture on the shears (as shown).


Hold the scale in place and close the shears in a smooth motion to cut through the scale.

RKLC20-S scale application (continued)

There are two versions of applicator for use with RKLC20-S scale: side mounted and top mounted. The side mounted version is shown below, but the application method is the same for both versions of the applicator.

1. Allow scale to acclimatise to installation environment prior to installation.

   NOTE: RKLC scale should be installed between +10 °C and +35 °C to ensure scale mastering.

2. Mark out the start position for the scale on the axis substrate – ensure that there is room for the end clamps ('RKLC20-S scale installation drawing', page 5).

3. Thoroughly clean and degrease the substrate using recommended solvents ('Storage and handling', page 2). Allow substrate to dry before applying scale.

4. Mount the scale applicator to the readhead mounting bracket. Place the green spacer supplied with the readhead between the applicator and substrate to set the nominal height.
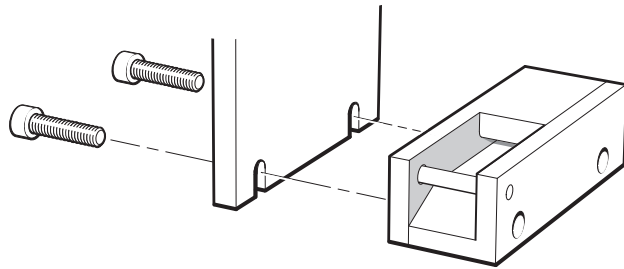

   NOTE: Scale applicator can be mounted either way round to enable easiest orientation for scale installation.

5. Move axis to scale start position, leaving enough room for the scale to be inserted through the applicator, as shown below.

6. Begin to remove the backing paper from the scale and insert scale into the applicator up to the start position (as shown). Ensure backing paper is routed under the splitter screw.

Start position

Splitter screw

M2.5 mounting holes
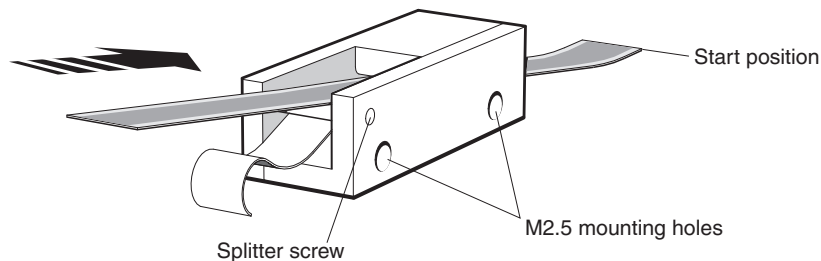
7. Apply firm finger pressure via a clean, dry, lint-free cloth to ensure scale end adheres well to the substrate.

8. Slowly and smoothly move the applicator through the entire axis of travel, ensuring the backing paper is pulled manually from the scale and does not catch under the applicator.

Direction of scale application

RKLC20-S

Backing tape

Splitter screw

Start position
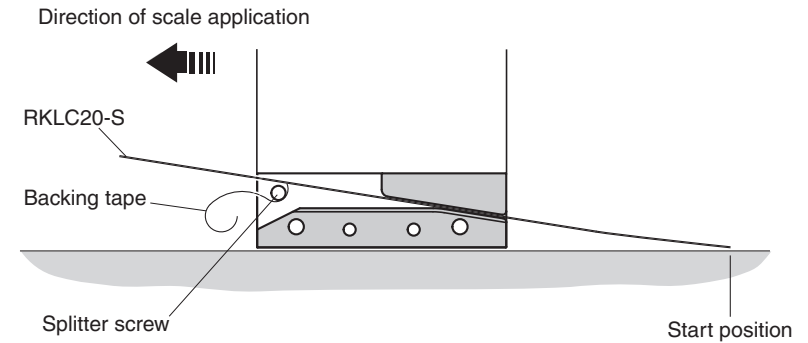
9. During installation ensure scale is adhered to substrate using light finger pressure.

10. Remove applicator carefully. Apply firm finger pressure via a clean lint-free cloth along the length of the scale after application to ensure complete adhesion.

11. Clean the scale using Renishaw scale wipes or a clean, dry, lint-free cloth.

12. Fit end clamps ('End clamps', page 9).

End clamps

The end clamp kit is designed to be used with Renishaw RKLC20-S scale. Alternative, narrow 6 mm wide end clamps (A-9523-4111), are also available.

NOTE: End clamps can be mounted before or after readhead installation.

1. Clean ends of scale and the area where end clamps are to be fitted using Renishaw scale wipes or one of the recommended solvents ('Storage and handling', page 2).
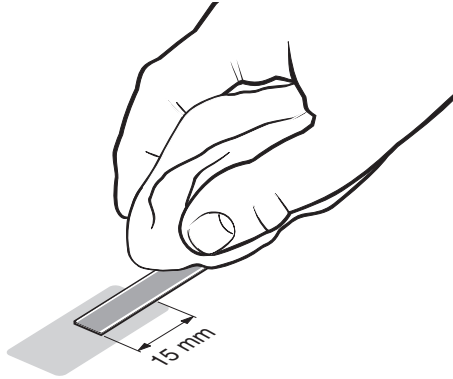

2. Thoroughly mix up a sachet of RGG-2 two part epoxy adheisve and apply a small amount to the underside of the end clamp.
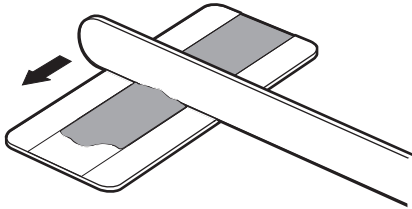
3. The end clamp features two small regions of contact adhesive. These will temporarily hold the end clamp in position while the adhesive cures. Remove the backing tape from either side.
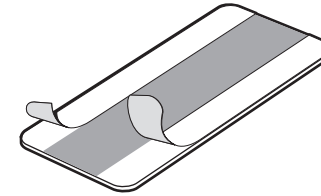
4. Immediately position end clamp over the end of the scale and push down to ensure complete adhesion. Allow 24 hours at 20 °C for full cure.*
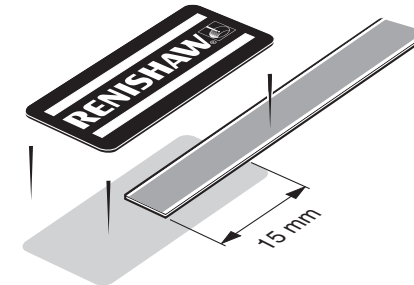
CAUTION: Ensure that excess adhesive is wiped away from scale as it may affect the readhead signal level.

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* To ensure scale end movement of typically < 1 µm, stabilise the system at least 5 °C higher than the maximum customer application temperature for a minimum of 8 hours.
For example: Customer application = 23 °C axis temperature. Stabilise the system at 28 °C for a minimum of 8 hours.

Reference mark selector and limit magnet installation

**IMPORTANT:** Allow 24 hours after scale application before fitting magnets.

For accuracy and ease of positioning of reference mark selector and limit magnets, the applicator tool should be used. The magnet should be attached to the applicator tool as shown. Limit magnets can be positioned at any user defined location along the scale, but the reference mark selector magnet should be positioned adjacent to the selected *IN-TRAC* reference mark as shown.

As the TONiC readhead passes the reference mark selector magnet or limit switch magnet, a force of up to 0.2 N is generated between the magnet and the concentrators on the readhead. The design of the bracket should be sufficiently stiff so that it is able to tolerate such force without distorting.

Following the clamping instructions on the scale installation will prevent this magnetic force from disturbing the scale.

Limit trigger point
The limit output is nominally asserted when the readhead limit switch sensor passes the limit magnet leading edge, but can trigger up to 3 mm before that edge ('RKLC20-S scale installation drawing', page 5).

Magnet applicator tool

Remove self-adhesive backing paper

Reference mark selector magnet

P limit magnet

Selected *IN-TRAC* reference mark
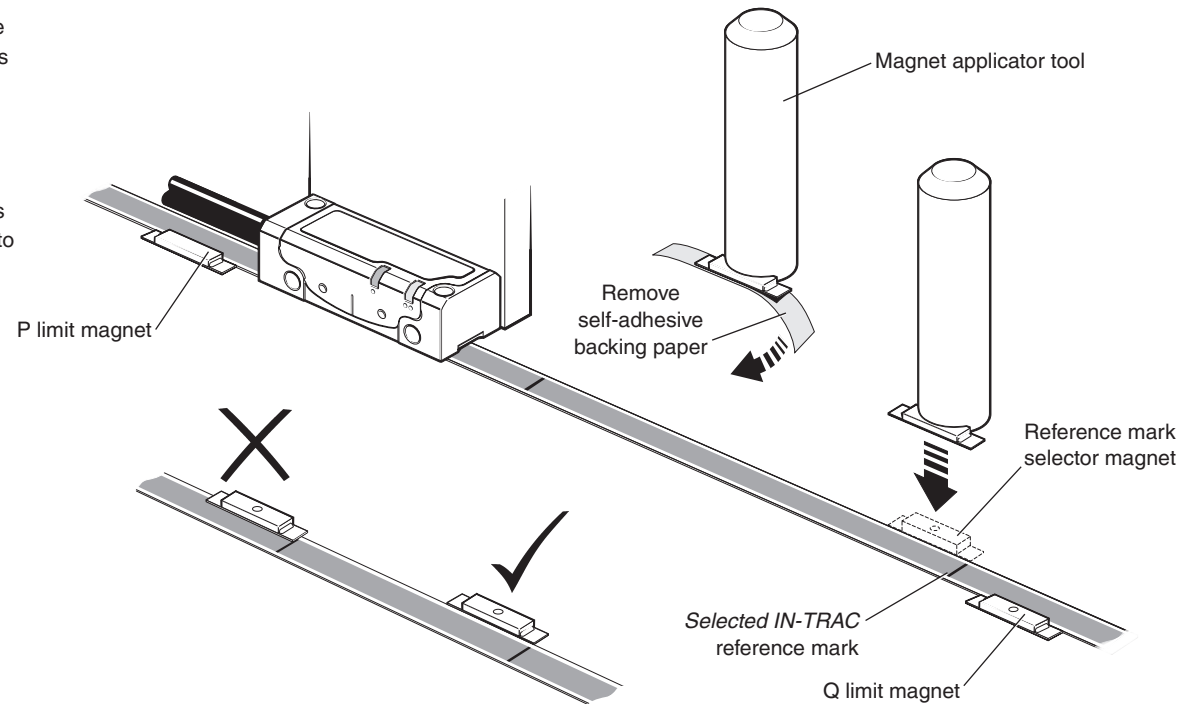
Q limit magnet

NOTES:

▶ Reference and limit magnets may creep when influenced by magnetic materials in close proximity. In such cases, they should be held in place using an additional fillet of epoxy glue or similar along the outer edge of the magnet assembly.
Optional bolted reference and limit magnets are available
('RKLC20-S scale installation drawing', page 5).

▶ The reference mark selector and limit actuator locations are correct for the readhead orientation shown.

▶ The reference mark selector magnet is only required for 'Customer selectable reference mark' readheads. For more information refer to *TONiC™ encoder system* Data sheet (Renishaw part no. L-9517-9337).

▶ External magnetic fields greater than 6 mT, in the vicinity of the readhead, may cause false activation of the limit and reference sensors.

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 on pages 12 to 15 of this 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 ('RKLC20-S scale installation drawing', page 5).

Plug the readhead cable into the Ti / TD 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.

No reference mark	**Reference mark**
If a reference mark is not being used, the calibration routine should now be exited by pressing and releasing the CAL button. The CAL LED will stop flashing. (Incremental CAL values are automatically stored)	Move the readhead back and forth over the selected reference mark until the CAL LED stops flashing and remains 'off'. (Incremental and reference mark CAL values are automatically stored)

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.
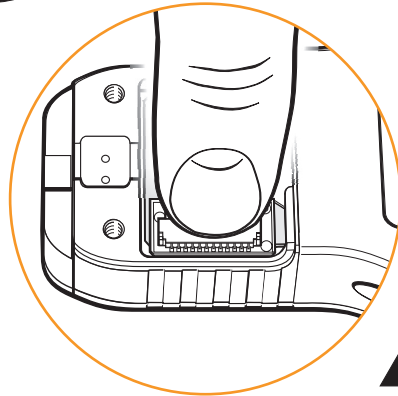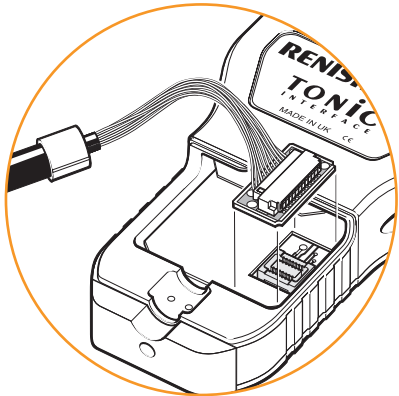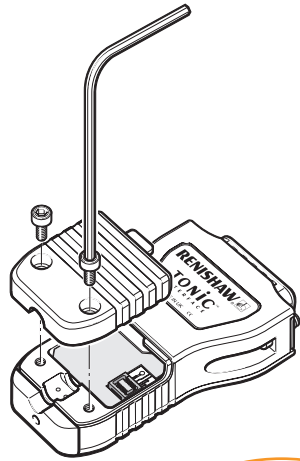
NOTE: If calibration fails, restore factory defaults by pressing and holding the CAL button whilst switching on ('Restoring factory defaults', page 15).
Repeat the installation and calibration routine.

System connection

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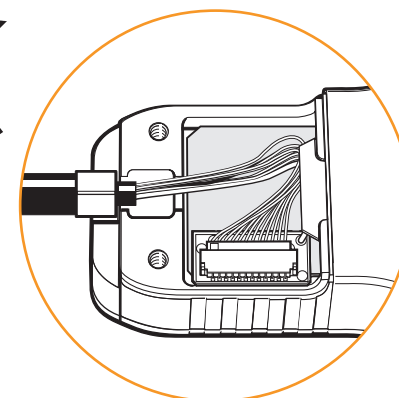
Connecting the readhead

▶ 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.

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.

Do not pull the cable to remove the connector.

▶ Place the connector in an anti-static bag.

▶ Refit the cover plate.

▶ 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.

Readhead mounting and alignment

Mounting brackets

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

Readhead set-up

Ensure that the scale, readhead optical window and mounting face are clean and free from obstructions.
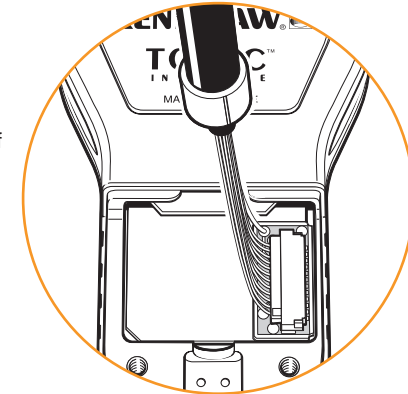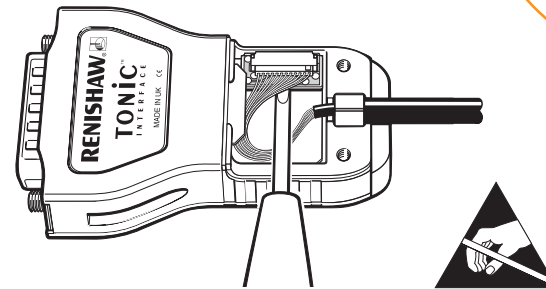
NOTE: When cleaning readhead and scale apply cleaning fluid sparingly, do not soak.

To set nominal rideheight, place the green 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 along the full axis of travel to achieve a Green set-up LED on the readhead (> 70% signal). If a digital Ti/TD 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 (CAL LED off). When re-installing, factory defaults should be restored ('Restoring factory defaults', page 15).

Readhead set-up LED status

Yaw
0° ±0.4°

Roll
0° ±0.5°

Pitch
0° ±1°

2.1MM NOM

Green spacer

Rideheight
2.1 ±0.15 mm

Green   Orange   Red
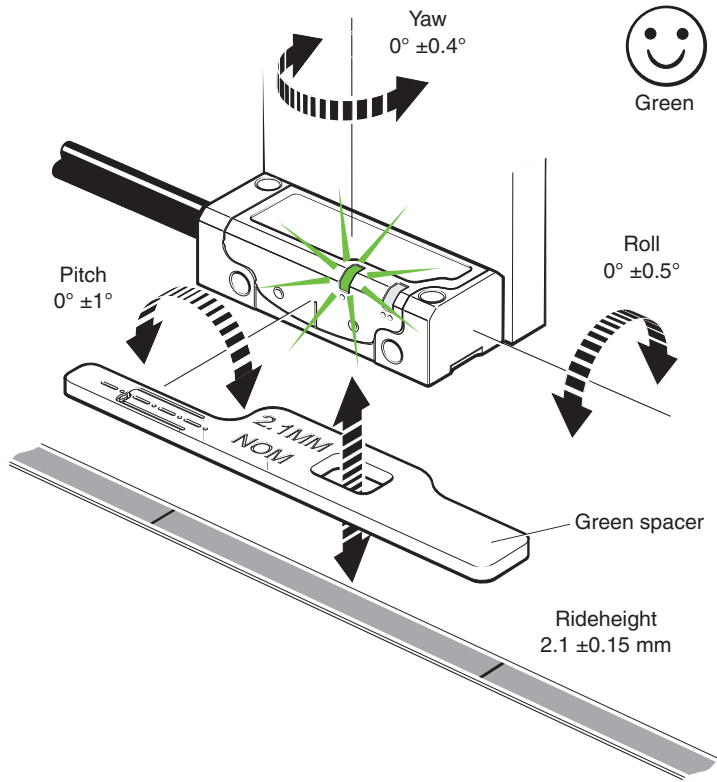
T103x readhead LED diagnostics

LED		Indication	Status
Set-up	Incremental	Green	Normal set-up: signal level > 70%
		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; clean scale and recalibrate if required
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 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% to 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
	Red / blank - flashing	Poor set-up; signal level < 20%; system in error	Yes
	Blue / blank - flashing	Over speed; system in error	Yes
	Purple / blank - flashing	Over signal; system in error	Yes
Reference mark	Blank flash	Reference mark detected (speed < 100 mm/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.
  - Momentary status only, while fault condition remains.
  - Alarm may result in axis position error, re-datum to continue.
See the *TONiC encoder system* Data sheet (Renishaw part no. L-9517-9337) for interface configuration details.
This can be downloaded from our website at **www.renishaw.com/tonicdownloads** and is also available from your local Renishaw representative.

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:

▶ Clean the scale and readhead optical window (contamination around the reference mark may result in reference mark dephasing).

▶ If reinstalling, restore factory defaults ('Restoring factory defaults', page 15).

▶ Ensure Automatic Gain Control (AGC) is switched off (CAL LED on readhead is not illuminated)

▶ Maximise the signal strength along full axis of travel.

   NOTE: CAL routine maximum speed: < 100 mm/s or less than the readhead maximum speed, whichever is slowest (all Ti / TD interface models). TD interface can be calibrated in either resolution.

Step 1 – Incremental signal calibration

▶ Press the CAL button on the end of the interface for < 2 seconds using a 2 mm allen key or similar tool.

   WARNING! Activating the CAL switch only requires 2.5 N force. Applying excess force may permanently damage the switch.

▶ 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. This indicates 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'

▶ 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, or exceeding the readhead maximum speed), exit the calibration routine, restore factory defaults ('Restoring factory defaults', page 15) and check the readhead installation and system cleanliness before repeating the calibration routine.
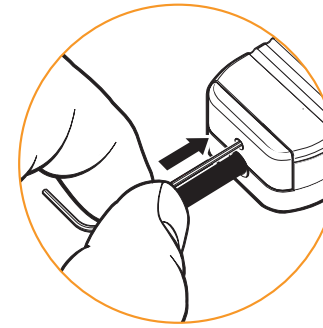
Step 2 – Reference mark phasing

▶ 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.

   NOTE: Only the chosen reference mark that has been used in the calibration routine is guaranteed to remain phased.

▶ The system automatically exits the CAL routine and is ready for operation.

▶ If the CAL LED continues double-flashing after repeatedly passing the chosen reference mark it is not being detected.

   - Ensure that the correct readhead configuration is being used. Readheads can either output all reference marks or only output a reference mark where a reference selector magnet is fitted depending on the options chosen when ordering.
   - Check reference mark selector magnet is fitted in the correct location relative to readhead orientation ('RKLC20-S scale installation drawing', page 5).

Calibration routine manual exit

▶ To exit the calibration routine at any stage, press the CAL button. The CAL button will stop flashing.

CAL LED	Settings stored
Single flashing	None, restore factory defaults and recalibrate
Double flashing	Incremental only
Off (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 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 and alignment', page 13 and recalibrate the system ('System calibration', page 14).

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

Switching Automatic Gain Control (AGC) 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 on ('System calibration', page 14).

Output signals

Interface output (analogue) Ti0000 only

Function	Output type		Signal		Interface Ti0000 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
				−	1
		Sine	V_2	+	10
				−	2
Reference mark	Analogue		V_0	+	3
				−	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

Readhead output

Function	Output type		Signal		Colour
Power	-		5 V Power		Brown
			0 V Power		White
Incremental signals	Analogue	Cosine	V_1	+	Red
				−	Blue
		Sine	V_2	+	Yellow
				−	Green
Reference mark	Analogue		V_0	+	Violet
				−	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		Outer screen

Interface output (digital) Ti0004 to Ti20KD and TD4000 to TD0040

Function	Output type	Signal		Interface Ti0004 - Ti20KD Pin	Interface TD4000 - TD0040 Pin
Power	-	5 V		7, 8	7, 8
		0 V		2, 9	2, 9
Incremental	RS422A digital	A	+	14	14
			−	6	6
		B	+	13	13
			−	5	5
Reference mark	RS422A digital	Z	+	12	12
			−	4	4
Limits	Open collector	P*		11	-
		Q‡		10	-
Set-up	RS422A digital	X		1	1
Alarm†	-	E	+	-	11
			−	3	3
Resolution switching‡	-	-		-	10
Shield	-	Inner shield		-	-
	-	Outer shield		Case	Case

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

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

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

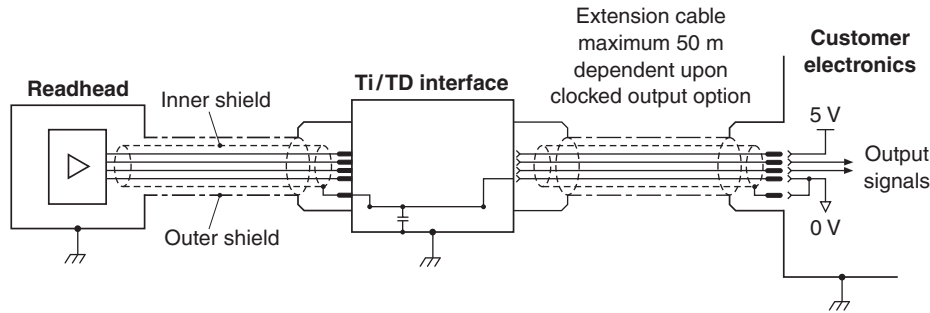Output connector for all interfaces;
15 way D-type plug

Speed

Clocked output option (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	Ti1000 20 nm	Ti2000 10 nm	Ti4000 5 nm	Ti10KD 2 nm	Ti20KD 1 nm
50	10	10	10	6.48	3.24	1.62	0.648	0.324	0.162	0.0654	0.032
40	10	10	10	5.40	2.70	1.35	0.540	0.270	0.135	0.054	0.027
25	10	10	8.10	3.24	1.62	0.810	0.324	0.162	0.081	0.032	0.016
20	10	10	6.75	2.70	1.35	0.675	0.270	0.135	0.068	0.027	0.013
12	10	9	4.50	1.80	0.900	0.450	0.180	0.090	0.045	0.018	0.009
10	10	8.10	4.05	1.62	0.810	0.405	0.162	0.081	0.041	0.016	0.0081
08	10	6.48	3.24	1.29	0.648	0.324	0.130	0.065	0.032	0.013	0.0065
06	10	4.50	2.25	0.90	0.450	0.225	0.090	0.045	0.023	0.009	0.0045
04	10	3.37	1.68	0.67	0.338	0.169	0.068	0.034	0.017	0.0068	0.0034
01	4.2	0.84	0.42	0.16	0.084	0.042	0.017	0.008	0.004	0.0017	0.0008
Analogue output	10 (–3dB)										

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

Electrical connections

Grounding and shielding

Extension cable
maximum 50 m
dependent upon
clocked output option

Readhead   Inner shield   **Ti/TD interface**   **Customer electronics**

5 V

Output signals

0 V

Outer shield

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

NOTE: Maximum cable length between readhead and Ti/TD interface is 10 m

Remote CAL operation (Analogue versions only)

CAL

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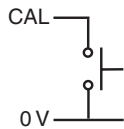
All Ti/TD interfaces include a push button switch to enable CAL/AGC features. However, remote operation of the CAL/AGC is possible via pin 14 of analogue Ti0000 interfaces. For applications where no interface is used, remote operation of CAL/AGC is essential.
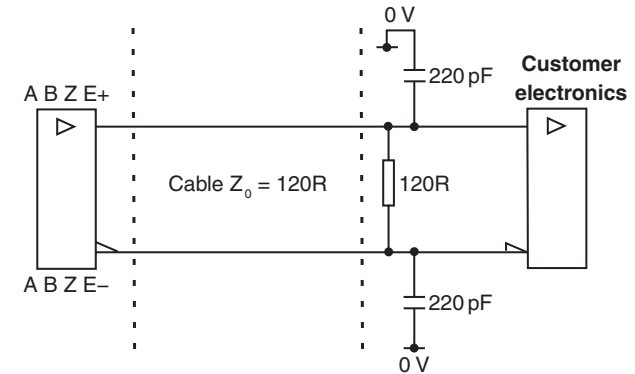
TD interface resolution switching

Pin 10

0 V
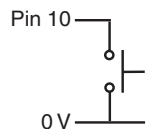
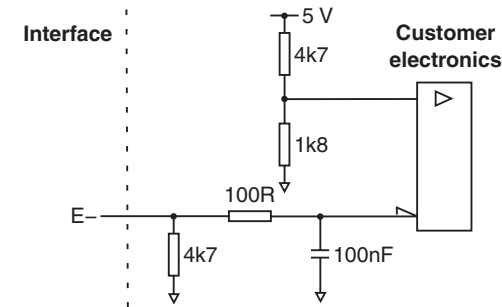Connect pin 10 to 0 V to switch to lower resolution.

Recommended signal termination

Digital outputs

0 V

A B Z E+

Customer electronics

220 pF
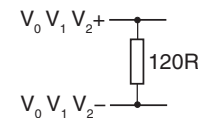
Cable Z_0 = 120R   120R

A B Z E−

220 pF

0 V

Standard RS422A line receiver circuitry
Capacitors recommended for improved noise immunity

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

Interface   5 V   **Customer electronics**

4k7

1k8

100R

E−

4k7   100nF

Analogue outputs

V_0 V_1 V_2+

120R

V_0 V_1 V_2−

Limit output (No limits on TD interfaces)
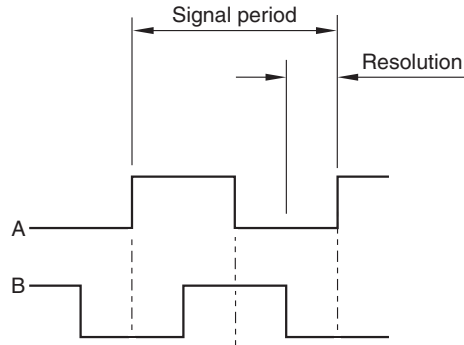
5 to 24 V

R*

V_p V_q P Q
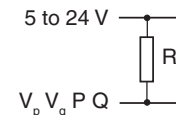
* Select R so maximum current does not exceed 20 mA. Alternatively use a suitable relay or opto-isolator.
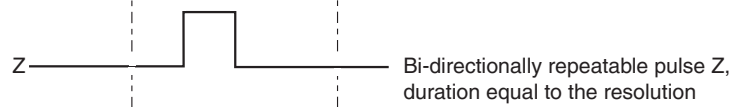
Output specifications

Digital output signals

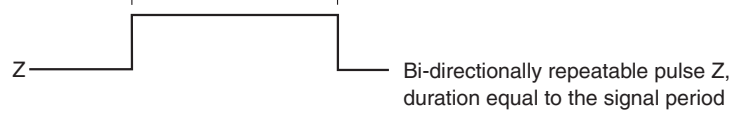Form – Square wave differential line driver to EIA RS422A (except limits P and Q)

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


Reference*

Bi-directionally repeatable pulse Z, duration equal to the resolution

Wide reference*

Bi-directionally repeatable pulse Z, duration equal to the signal period

NOTE: Select 'standard' or 'wide' reference at time of ordering, to match the requirements of the controller being used. Wide reference mark not available on Ti0004 interfaces.

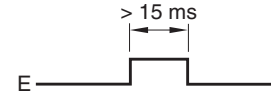**Limits** Open collector output, asynchronous pulse

Digital Ti interfaces only

Active high   or   Active low

Repeatability < 0.1 mm

Length of limit actuator
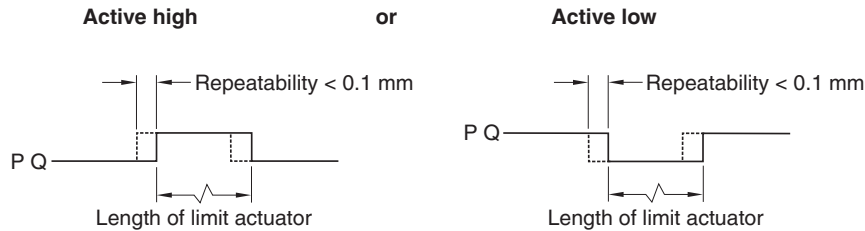
NOTE: No limits on TD interfaces. P limit becomes E+ for options E, F, G, H.

Alarm
Line driven* **(**Asynchronous pulse)
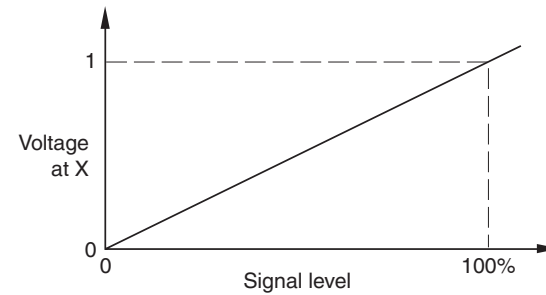

> 15 ms

E

Alarm asserted when:

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

E– output only for Ti options A, B, C, D

or 3-state alarm

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

Set-up[†]

Voltage at X

Signal level

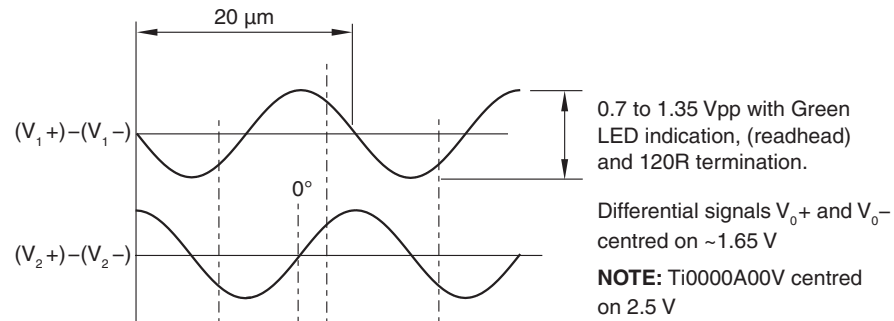Set-up signal voltage proportional to incremental signal amplitude

* Inverse signals not shown for clarity
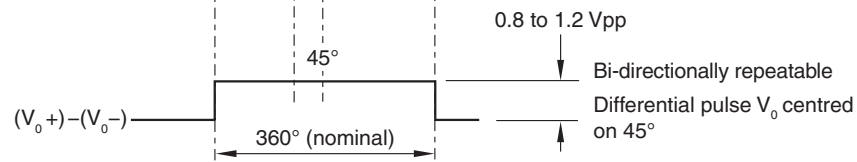[†] Set-up signals as shown are not present during calibration routine.

Output specifications (continued)

Analogue output signals

Incremental 2 channels V_1 and V_2 differential sinusoids in quadrature centred on 1.65 V (90° phase shifted)
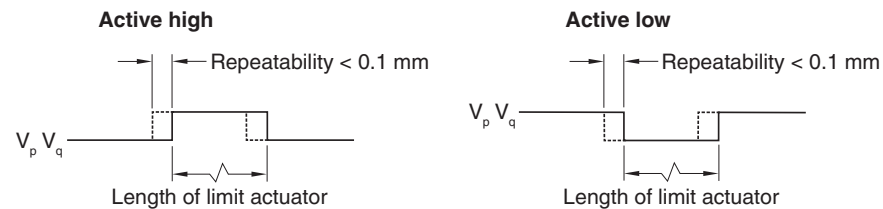
20 µm

$(V_1+)-(V_1-)$

0°

$(V_2+)-(V_2-)$

0.7 to 1.35 Vpp with Green LED indication, (readhead) and 120R termination.

Differential signals V_0+ and V_0- centred on ~1.65 V

NOTE: Ti0000A00V centred on 2.5 V

Reference

45°

$(V_0+)-(V_0-)$

360° (nominal)

0.8 to 1.2 Vpp

Bi-directionally repeatable

Differential pulse V_0 centred on 45°

Limits Open collector output, asynchronous pulse

Ti0000 interfaces only

T103x readhead only

Active high

Repeatability < 0.1 mm

V_p V_q

Length of limit actuator

Active low

Repeatability < 0.1 mm

V_p V_q

Length of limit actuator

NOTE: Ti0000 interface contains a transistor to invert the readhead's 'active low' signal to give an 'active high' output.

Set-up*

3.3 (nom)

Voltage at V_x

0

0   50%   Signal level   70%   100%
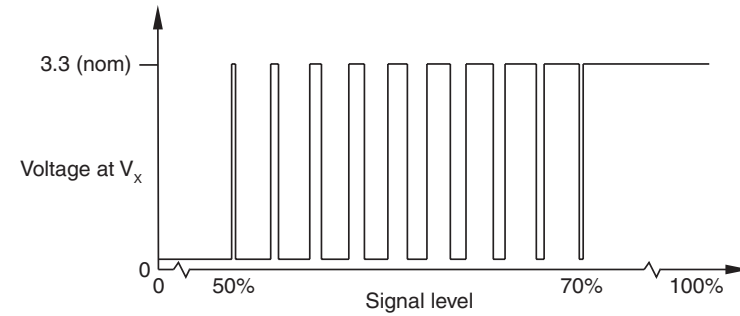
Between 50% and 70% signal level, V_x is a duty cycle.

Time spent at 3.3 V increases with incremental signal level.

At > 70% signal level V_x is nominal 3.3 V.

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

General specifications

Power supply	5 V ±10%	Readhead only < 100 mA
		T103x with Ti0000 < 100 mA
		T103x 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 120R.
		For analogue outputs a further 20 mA in total will be drawn when terminated with 120R.
		Power from a 5 V dc 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
	Installation	+10 °C to +35 °C*
	Operating	0 °C to +70 °C
Humidity (system)		95% relative humidity (non-condensing) to IEC 60068-2-78
Sealing (readhead)		IP40
(interface)		IP20
Acceleration (readhead)	Operating	500 m/s^2, 3 axes
Shock (system)	Operating	500 m/s^2, 11 ms, ½ sine, 3 axes
Vibration (readhead)	Operating	100 m/s^2, 55 Hz to 2000 Hz, 3 axes
(scale)	Operating	300 m/s^2, 55 Hz to 2000 Hz, 3 axes
Mass (readhead)		10 g
(interface)		100 g
(cable)		26 g/m
Readhead cable		Double shielded, outside diameter 4.25 ±0.25 mm
		Flex life > 20 ×10^6 cycles at 20 mm bend radius
		UL recognised component ⓊⓁ

Maximum cable length	Readhead to interface	10 m	
	Interface to controller		

Clocked output option (MHz)	Maximum cable length (m)
40 to 50	25
< 40	50
Analogue	50

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.

* To limit maximum tension in the scale $(CTE_{substrate} - CTE_{scale}) \times (T_{use\ extreme} - T_{install}) \leq 550$ µm/m where $CTE_{scale} = \sim 10.1$ µm/m/°C

RKLC20-S scale specifications

Form (H × W)	0.15 mm × 6 mm including adhesive
Pitch	20 µm
Accuracy (at 20 °C)	±5 µm/m
Linearity	±2.5 µm/m achievable with two point error correction
Supplied length	20 mm up to 20 m (> 20 m on request)
Material	Hardened and tempered martensitic stainless steel fitted with a self-adhesive backing tape
Mass	4.6 g/m
Coefficient of thermal expansion (at 20 °C)	Matches that of substrate material when scale ends fixed by epoxy mounted end clamps
Instalation temperature	+10 °C to + 35 °C
End fixing	Epoxy mounted end clamps (A-9523-4015)
	Approved epoxy adhesive (A-9531-0342)
	Scale end movement typically < 1 µm*

Reference mark

Type	Customer selected *IN-TRAC* reference mark, directly embedded into incremental track.
	Bi-directional position repeatability
Selection	Single reference mark selection by selector magnet (A-9653-0143) customer positioned.
L ≤ 100 mm	Single reference mark at scale centre
L > 100 mm	Reference marks at 50 mm spacing (first reference mark 50 mm from scale end)
Repeatability	Unit of resolution repeatability (bi-directional) across full system rated speed and temperature ranges

Limit switches

Type	Magnetic actuators; with dimple triggers Q limit, without dimple triggers P limit ('RKLC20-S scale installation drawing', page 5)
Trigger point	The limit output is nominally asserted when the readhead limit switch sensor passes the limit magnet leading edge, but can trigger up to 3 mm before that edge
Mounting	Customer placed at desired locations
Repeatability	< 0.1 mm

* The scale and end clamps must be installed following the installation process, see page 8 and page 9.

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