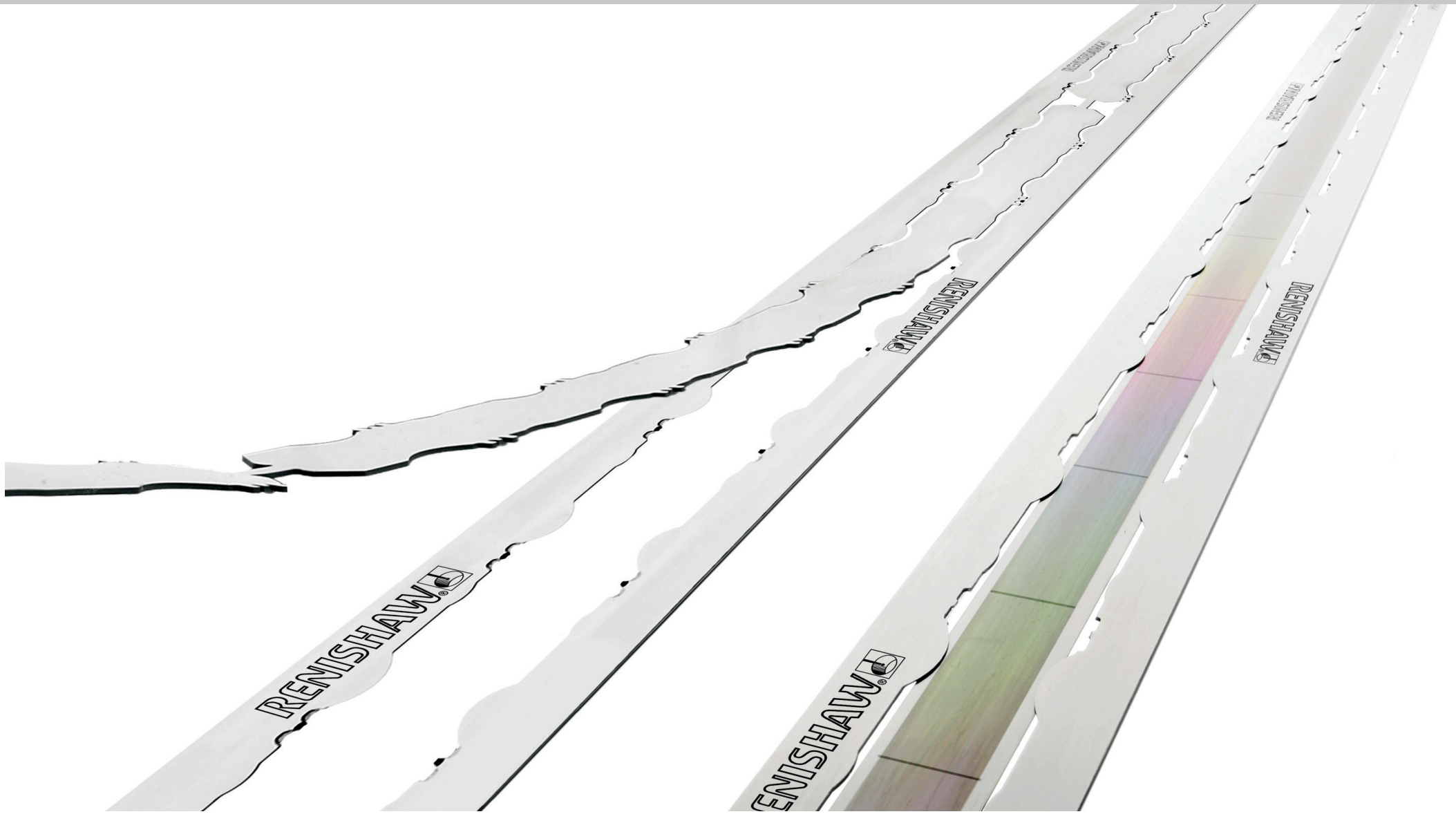


# TONiC™ T103x RTLC20/FASTRACK linear encoder system



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EP0748436	US5861953	EP1173731	US6775008B2	JP4750998
CNCN100543424C	US7659992	JP4932706	CNCN100507454C	US7550710
EP1766335	CNCN101300463B	EP1946048	US7624513B2	JP5017275
CNCN101310165B	US7839296	EP1957943	US8141265	EP2294363
CN102057256	JP5475759	JP5755299	KR20110033204	CN1314511
EP1469969	JP5002559	US8466943	US8987633	

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Renishaw plc hereby declares that the TONiC™ 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](http://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.

### ICES-001 — Industrial, Scientific and Medical (ISM) Equipment (Canada)

This ISM device complies with Canadian ICES-001.

Cet appareil ISM est conforme à la norme ICES-001 du Canada.

## Further information

Further information relating to the TONiC encoder range can be found in the *TONiC encoder system* data sheet (L-9517-9337). This can be downloaded from our website [www.renishaw.com/tonicdownloads](http://www.renishaw.com/tonicdownloads) and is also available from your local Renishaw representative.

## Legal notices (continued)

### Packaging

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

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

### REACH regulation

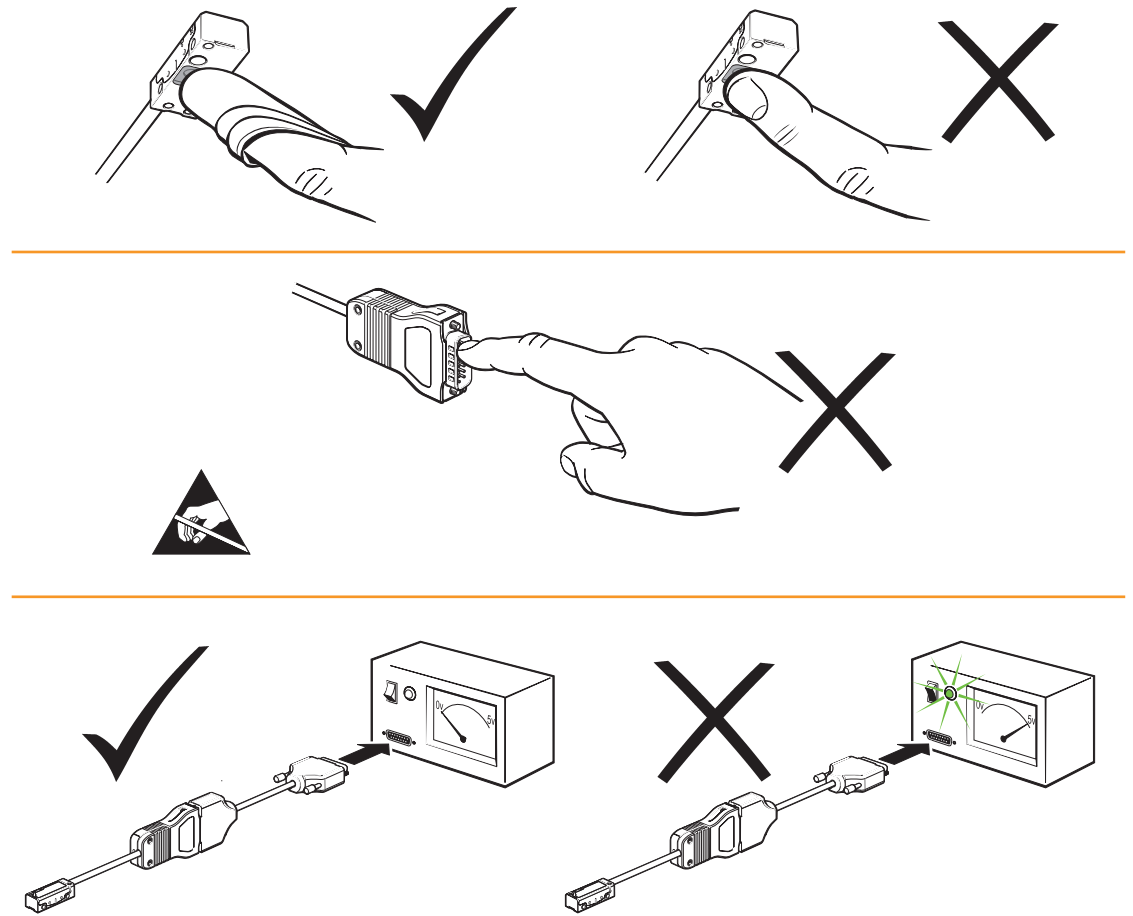
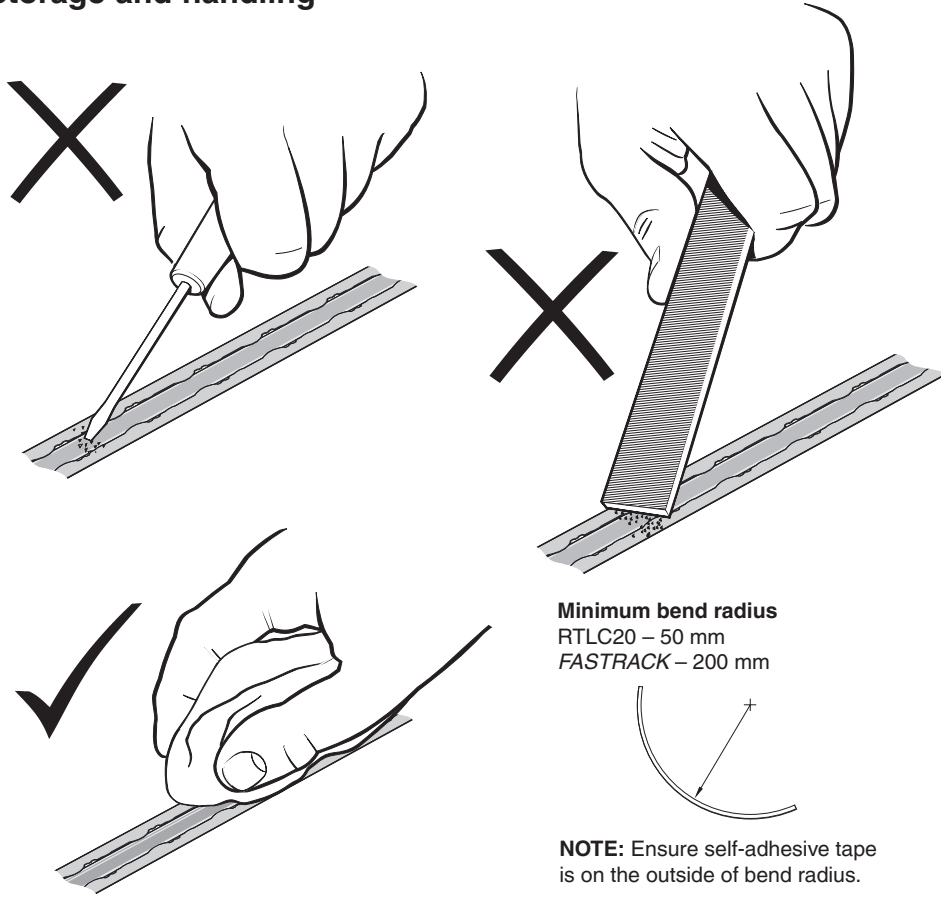
Information required by Article 33(1) of Regulation (EC) No. 1907/2006 ('REACH') relating to products containing substances of very high concern (SVHCs) is available at: [www.renishaw.com/REACH](http://www.renishaw.com/REACH)

### WEEE recycling guidelines



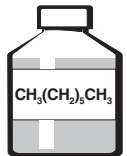
The use of this symbol on Renishaw products and/or accompanying documentation indicates that the product should not be mixed with general household waste upon disposal. It is the responsibility of the end user to dispose of this product at a designated collection point for waste electrical and electronic 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



## Scale and readhead

N-heptane

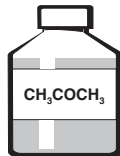


Propan-2-ol



## Readhead only

Acetone

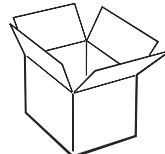


## Storage



+70 °C  
-20 °C

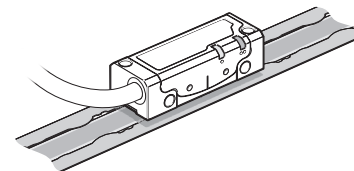
UHV readhead  
Bakeout +120 °C



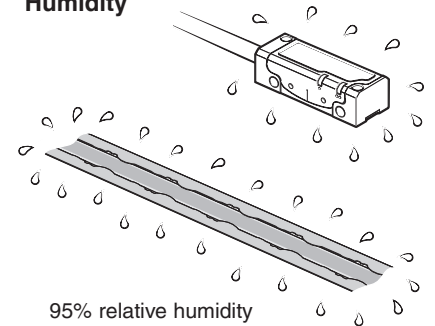
## Operating



+70 °C  
0 °C

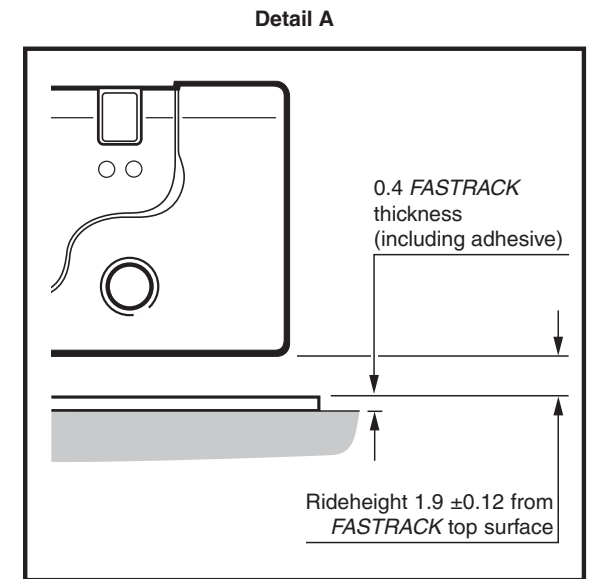
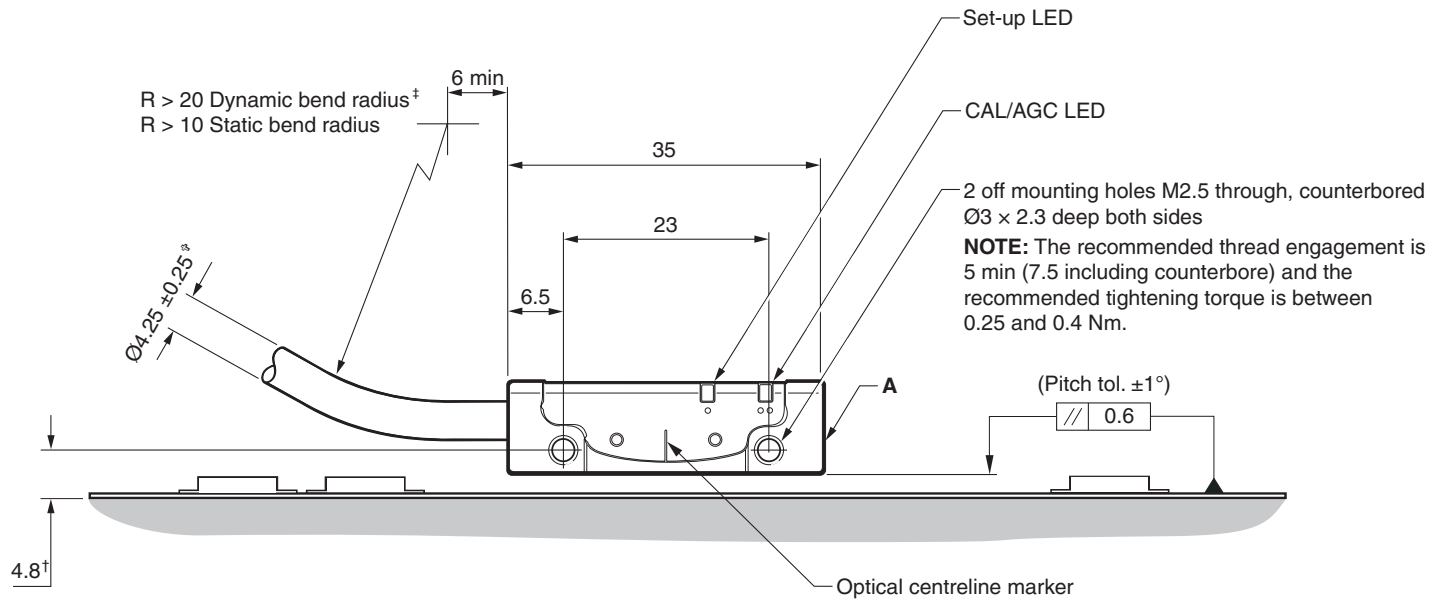
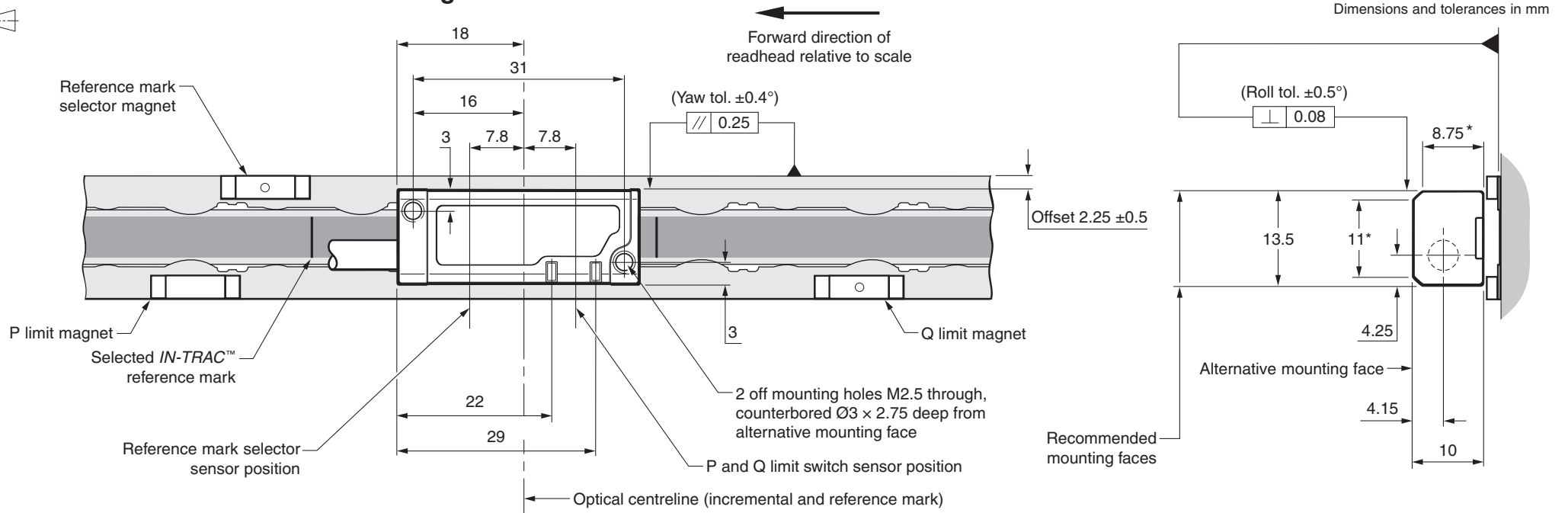


## Humidity



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

# TONiC T1030 readhead installation drawing

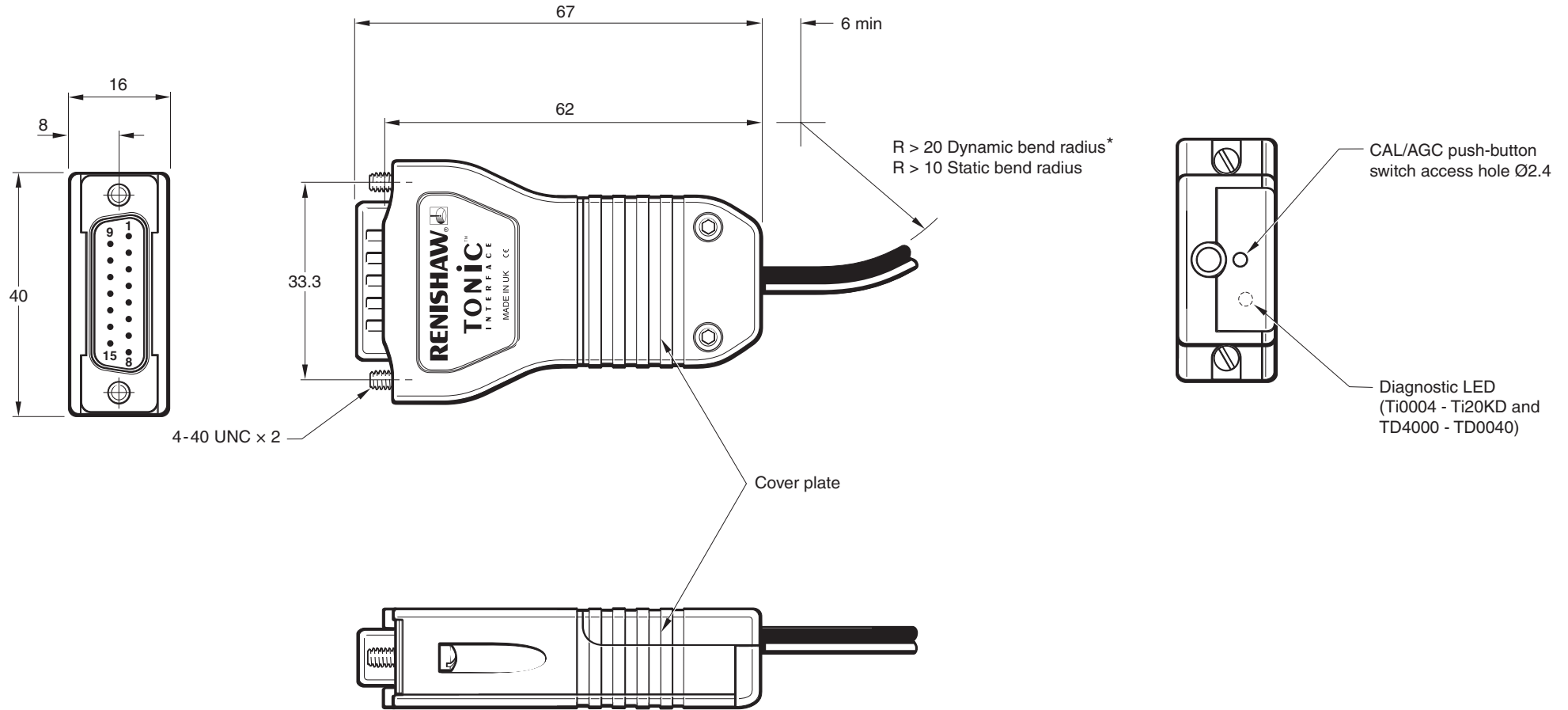


\*Extent of mounting faces. †Dimensions from substrate surface. ‡Dynamic bend radius not applicable for UHV cable. §UHV cable diameter 3.0 approx.

# TONiC interface drawing



Dimensions and tolerances in mm



\* Dynamic bend radius not applicable for UHV cables.

### CAL/Calibration button operation

Push and release (< 3 seconds) – CAL routine enable/disable.

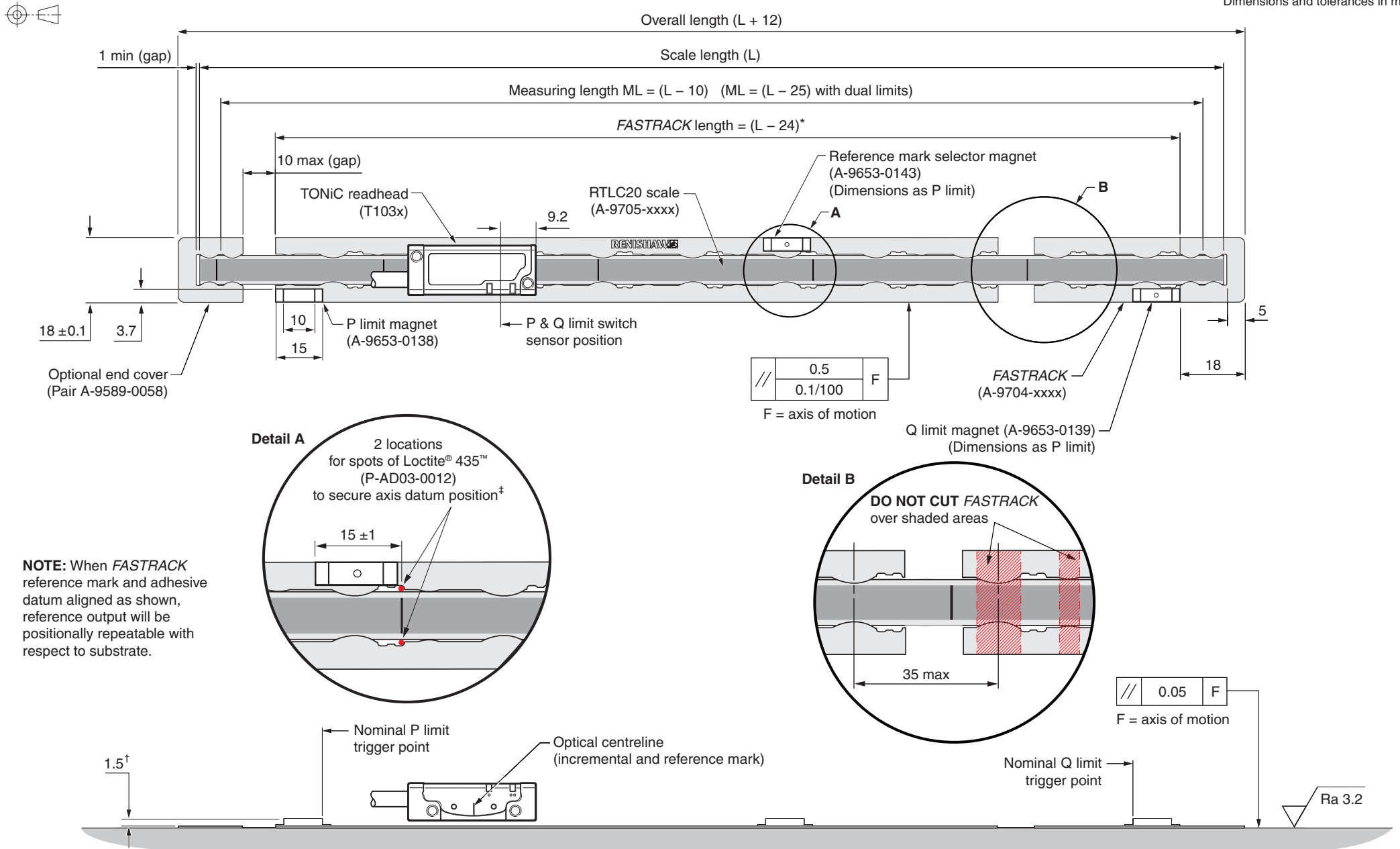
Push and release (> 3 seconds) – AGC enable/disable.

Push and hold during power 'Off/On' cycle – Restore factory defaults.

Refer to readhead LED functionality chart for CAL LED indications.

# RTL20/FASTRACK installation drawing (adhesive datum clamp\*)

Dimensions and tolerances in mm



**NOTE:** When FASTRACK reference mark and adhesive datum aligned as shown, reference output will be positionally repeatable with respect to substrate.

\* Assumes 1 mm gap between scale and end covers and zero gap between FASTRACK and end covers. † Dimension from FASTRACK surface. ‡ For alternative mechanical datum clamp methods see 'Scale datum', page 10.

**NOTES:** Minimum recommended FASTRACK length = 100 mm.

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.



# RTL20/FASTRACK scale system installation

## Equipment

### Required parts

- ▶ Appropriate length of RTL20 scale ('RTL20/FASTRACK installation drawing', page 6)
- ▶ Appropriate length of *FASTRACK* carrier ('RTL20/FASTRACK installation drawing', page 6)
- ▶ Loctite® 435™ (P-AD03-0012) \*
- ▶ Appropriate cleaning solvents ('Storage and handling', page 3)
- ▶ Centre section removal tool (A-9589-0122)
- ▶ Small pair of pliers
- ▶ Dial test indicator (DTi)
- ▶ Protective gloves

\*Used to secure axis datum position.

### Optional parts

- ▶ Scale end cover (A-9589-0058)
- ▶ Renishaw scale wipes (A-9523-4040)
- ▶ Lint-free cloth
- ▶ Loctite® 435™ dispensing tip (P-TL50-0209)
- ▶ RTL20 scale installation tool (A-9589-0420)
- ▶ Guillotine (A-9589-0071) or shears (A-9589-0133) for cutting RTL20 scale and *FASTRACK* carrier to length required

## RTL20/FASTRACK scale system installation (continued)

### Cutting scale and FASTRACK carrier

During handling or installation of FASTRACK suitable gloves should be worn to protect against injury from sharp edges. If required, cut FASTRACK and scale to length (separately) using guillotine or shears after referring to the installation drawing.

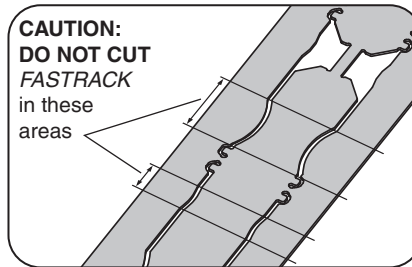
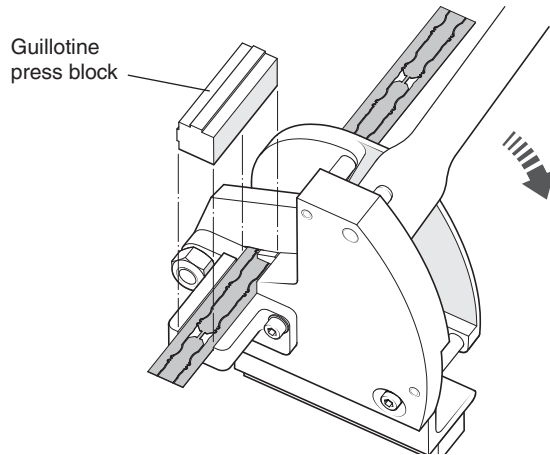
### Using the guillotine

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

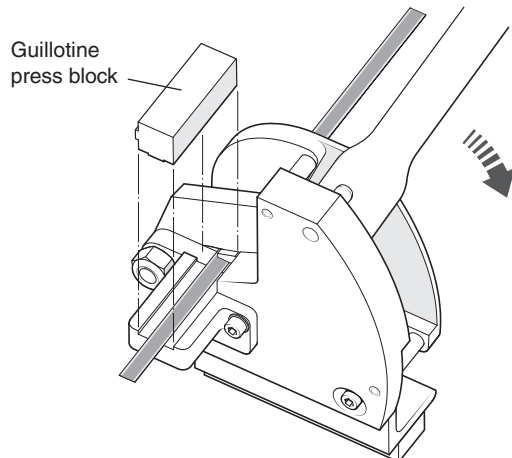
Once secured, feed the FASTRACK or scale through the guillotine as shown, and place the guillotine press block down onto the FASTRACK/scale. Ensure the block is in the correct orientation (as shown).

Whilst holding the block in place, in a smooth motion pull down the lever to cut through the FASTRACK/scale.

### Guillotine press block orientation when cutting FASTRACK carrier



### Guillotine press block orientation when cutting RTL20 scale

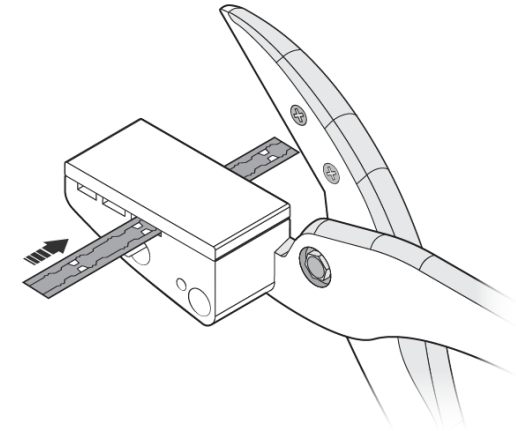


### Using the shears

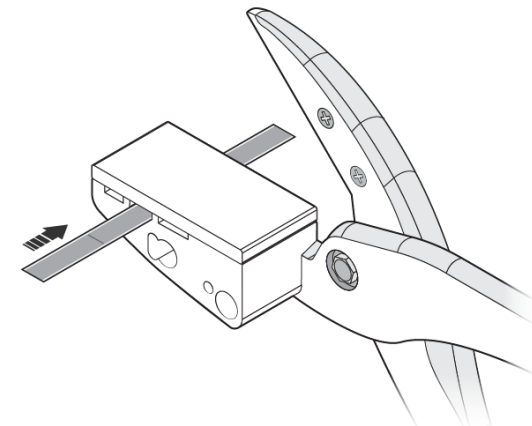
Feed the FASTRACK or scale through the appropriately sized aperture on the shears (as shown below).

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

### Insertion of FASTRACK carrier through widest aperture



### Insertion of RTL20 scale through the middle aperture



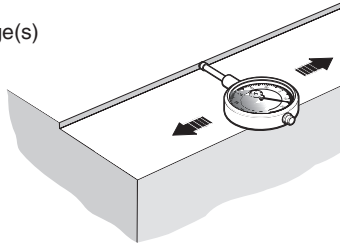
## RTLC20/FASTRACK scale system installation (continued)

### RTLC20 and FASTRACK application

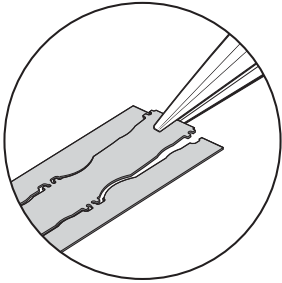
1. Thoroughly clean and degrease the substrate and allow to dry.

For *FASTRACK* location a ledge, separate straight edge(s) or dowels can be used.

Check alignment of ledge/separate straight edge(s) with respect to axis of motion ('RTLC20/FASTRACK installation drawing', page 6).



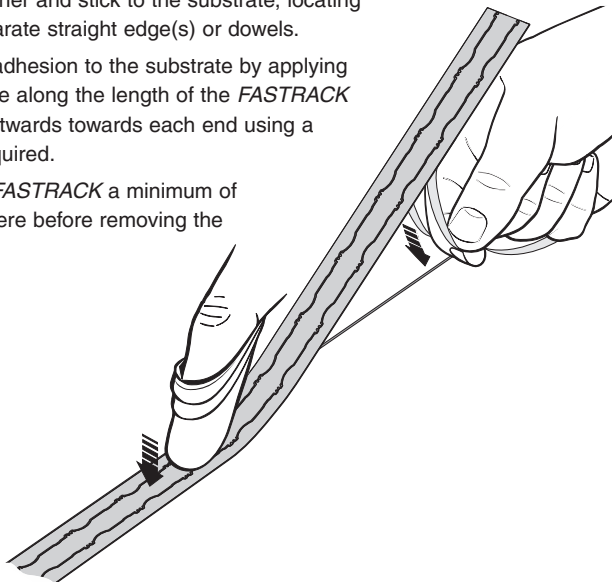
2. Before sticking *FASTRACK* to the substrate bend the centre section upwards slightly using a small pair of pliers.



3. Remove backing liner and stick to the substrate, locating against ledge/separate straight edge(s) or dowels.

Ensure complete adhesion to the substrate by applying firm finger pressure along the length of the *FASTRACK* from the centre outwards towards each end using a lint-free cloth if required.

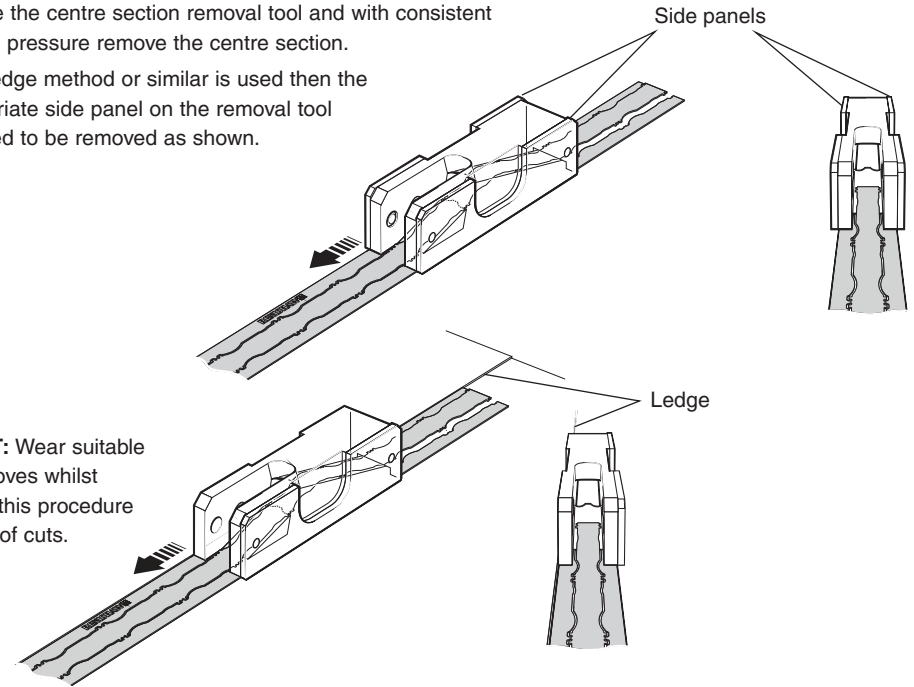
**NOTE:** Allow the *FASTRACK* a minimum of 20 minutes to adhere before removing the centre section.



4. Engage the centre section removal tool and with consistent forward pressure remove the centre section.

If the ledge method or similar is used then the appropriate side panel on the removal tool will need to be removed as shown.

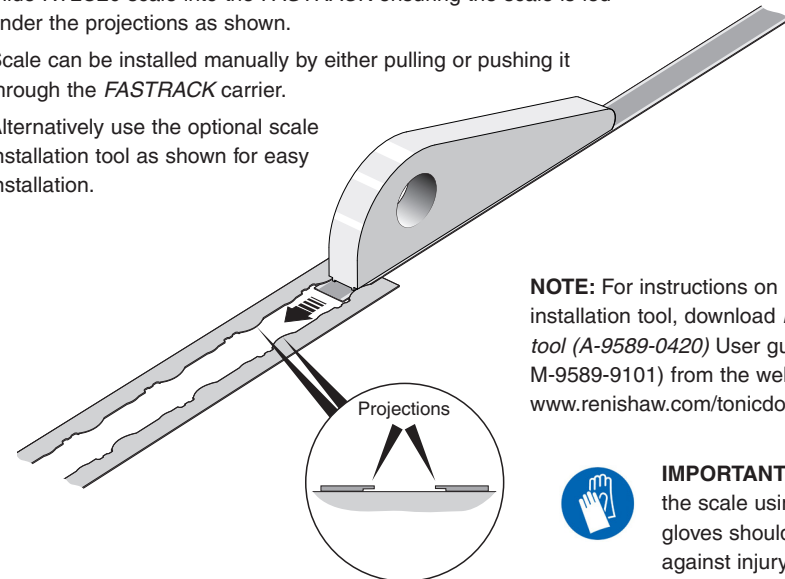
**IMPORTANT:** Wear suitable protective gloves whilst carrying out this procedure to avoid risk of cuts.



5. Slide *RTLC20* scale into the *FASTRACK* ensuring the scale is fed under the projections as shown.

Scale can be installed manually by either pulling or pushing it through the *FASTRACK* carrier.

Alternatively use the optional scale installation tool as shown for easy installation.



**NOTE:** For instructions on how to use the scale installation tool, download *RTL\* scale installation tool (A-9589-0420)* User guide (Renishaw part no. M-9589-9101) from the website at [www.renishaw.com/tonicdownloads](http://www.renishaw.com/tonicdownloads)



**IMPORTANT:** If manually installing the scale using fingers, suitable gloves should be worn to protect against injury from sharp edges.

## RTL20/FASTRACK scale system installation (continued)

### RTL20 and FASTRACK application (continued)

#### 6. Scale datum

The datum clamp fixes the RTL20 scale rigidly to the substrate at the location chosen.

**The metrology of the system may be compromised if the datum clamp is not used.**

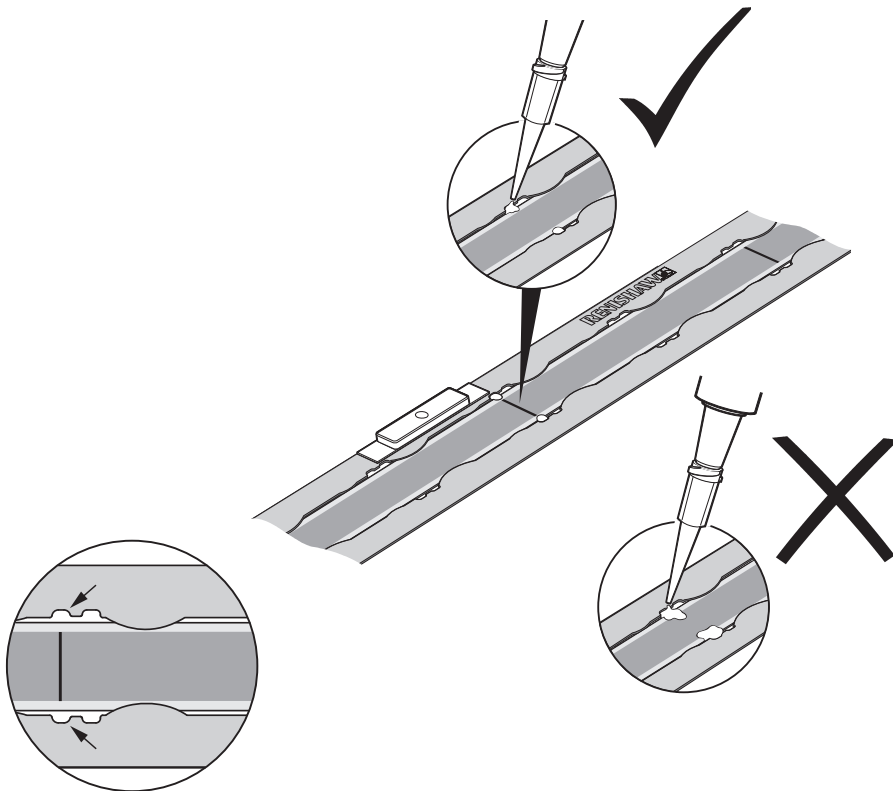
The datum clamp does not need to be fitted adjacent to a reference mark.

It can be positioned anywhere along the axis, depending upon the customer's requirements.

#### Adhesive clamp

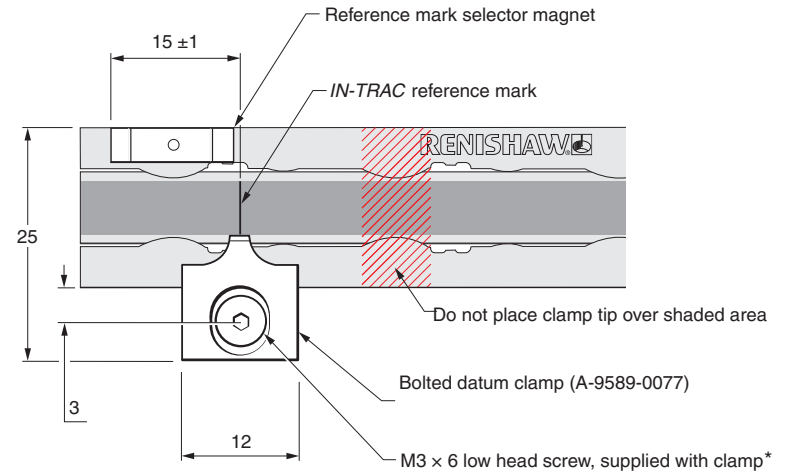
Using dispensing tip apply Loctite 435 between scale and FASTRACK so it wicks underneath adjacent to the user selected datum location as shown.

**NOTE:** The drawing shows the scale datum adjacent to the chosen reference mark.

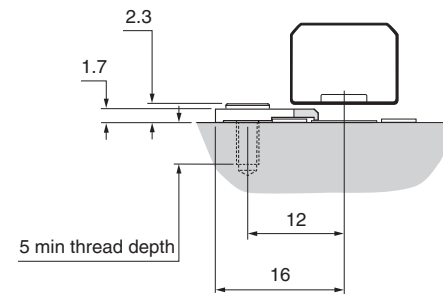


**NOTE:** Only apply Loctite 435 in these gaps to ensure the best bond. Loctite 435 will wick under the scale to lock it to the substrate.

#### Mechanical clamp



\* Additional screws available (pack of 25, A-9584-2047).

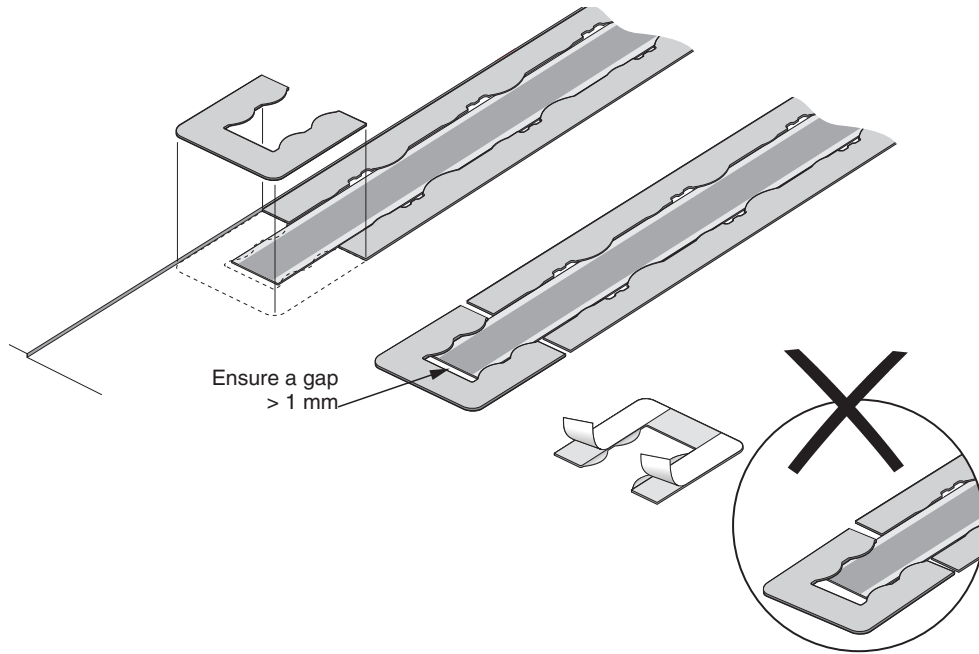


**NOTE:** When the reference mark and the datum clamp are aligned as shown, the reference output will be positionally repeatable with respect to the substrate.

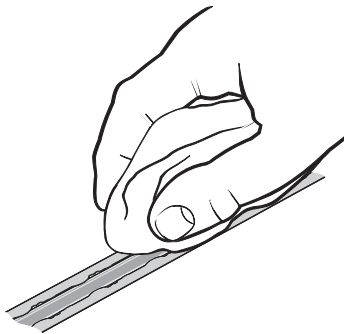
## RTL20/FASTRACK scale system installation (continued)

### RTL20 and FASTRACK application (continued)

- Optional: fix self-adhesive end covers ensuring a gap of at least 1 mm between the end of the scale and the end cover.



- Clean *FASTRACK* and scale using a lint-free cloth.



## Reference mark selector and limit magnet installation

**IMPORTANT:** Allow 24 hours after *RTL20/FASTRACK* 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 below and outlined with the outer edge of the *FASTRACK*. Limit magnets can be positioned at any user-defined location along the *FASTRACK*, but the reference mark selector magnet should be positioned adjacent to the chosen *IN-TRAC* reference mark as shown below.

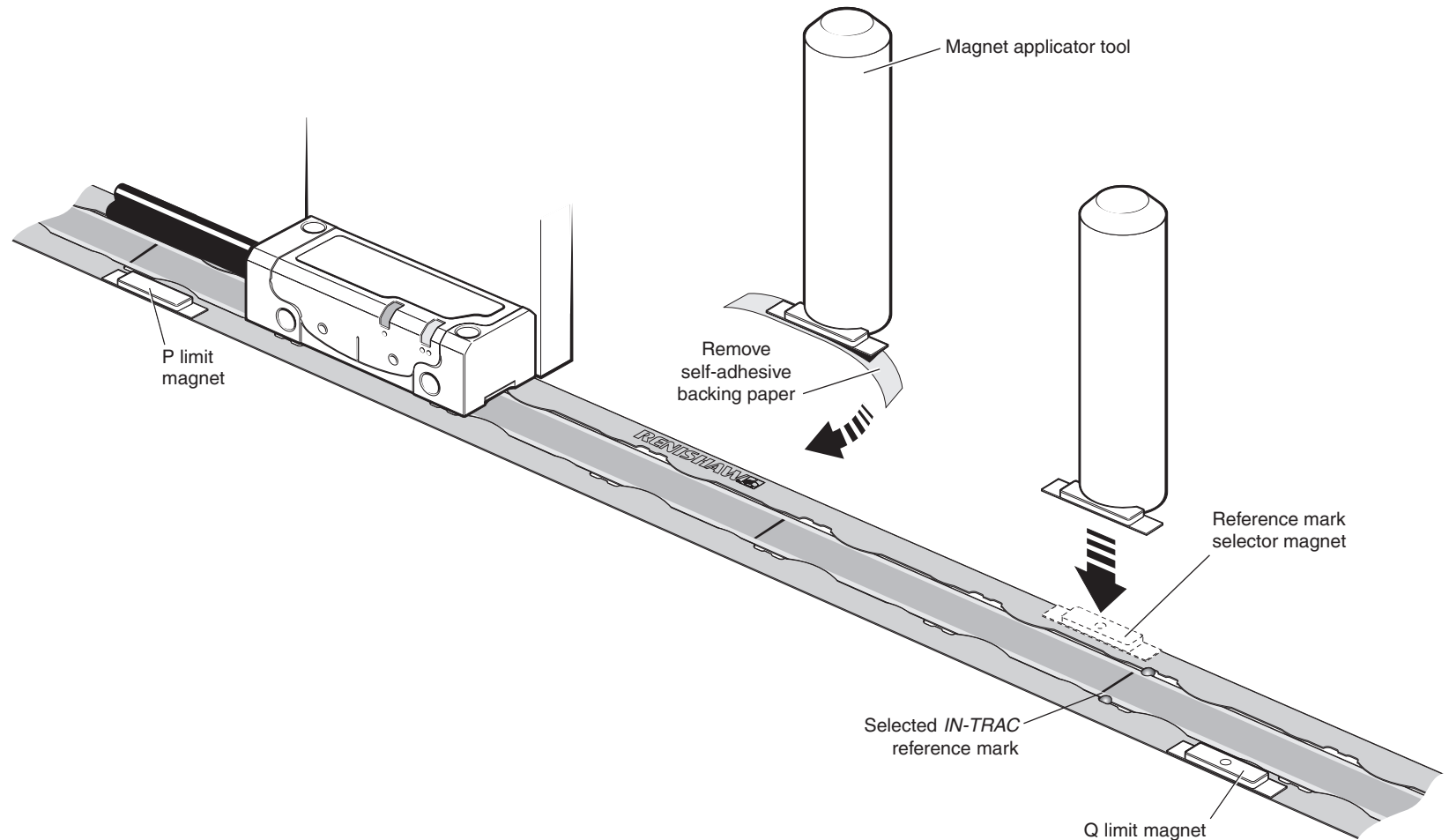
As the *TONiC* readhead passes the reference mark selector magnet or limit switch magnet, a force of up to 0.2 N is generated between the magnet and the readhead. The design of the bracket should be sufficiently stiff so that it is able to tolerate such force without distorting. Following the scale installation instructions 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 ('*RTL20/FASTRACK* installation drawing', page 6).

### 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.
- ▶ The reference mark selector and limit actuator locations are correct for the readhead installation shown.
- ▶ All limit and reference selector magnets should be aligned with the outer edges of the *FASTRACK*.
- ▶ 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 6mT, 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 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 ('RTL20/FASTRACK installation drawing', page 6).



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 of 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

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.)

#### Reference mark

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 17). Then repeat the installation and calibration routine.

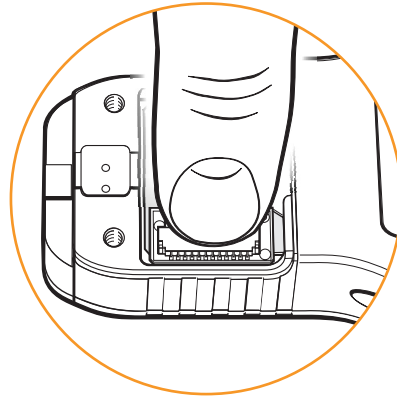
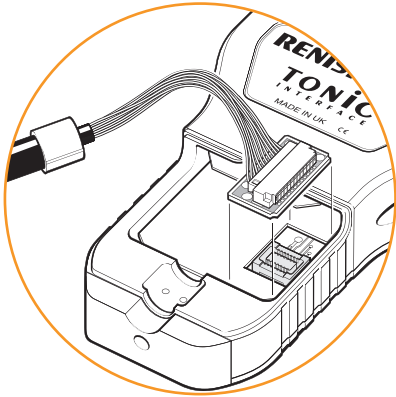
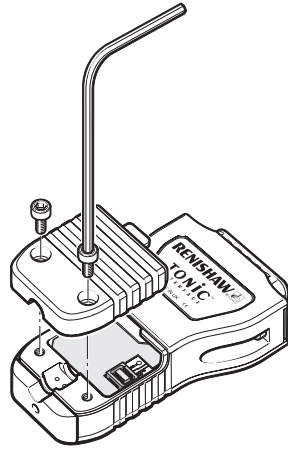
## System connection

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 PCB connector to allow for easy feed-through during installation.

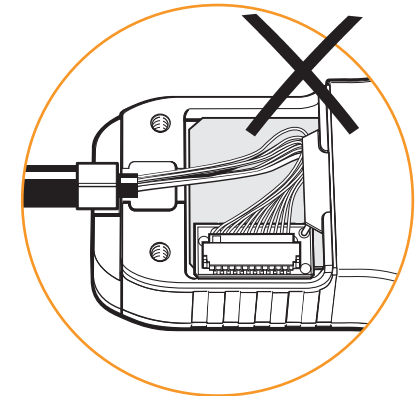
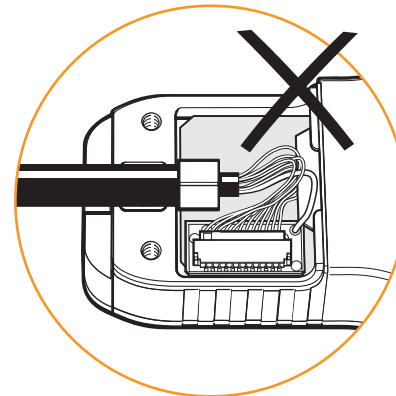
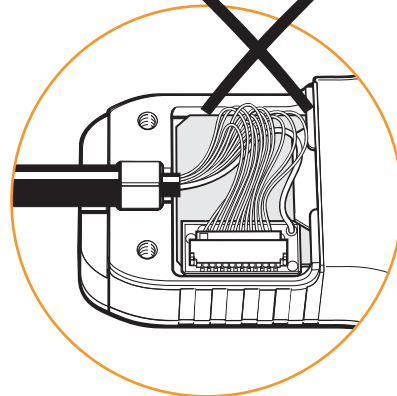
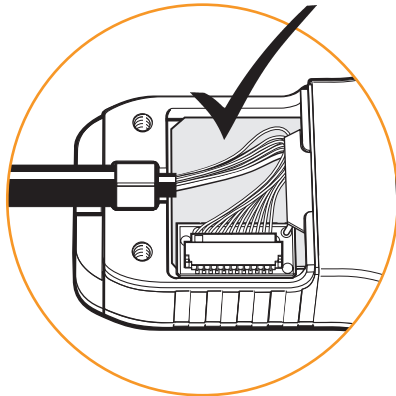
### Connecting the readhead

1. Remove the cover plate as shown (2 × M2.5 hex head screws).
2. Taking care not to touch the pins, plug the connector into the socket in the interface, ensuring correct orientation as shown. Press-fit the PCB connector to ensure a good connection.



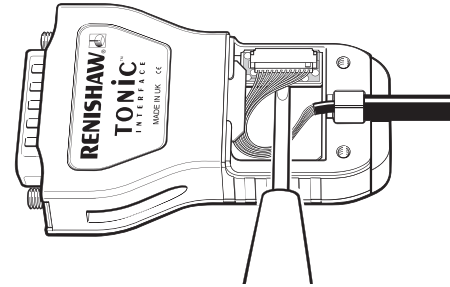
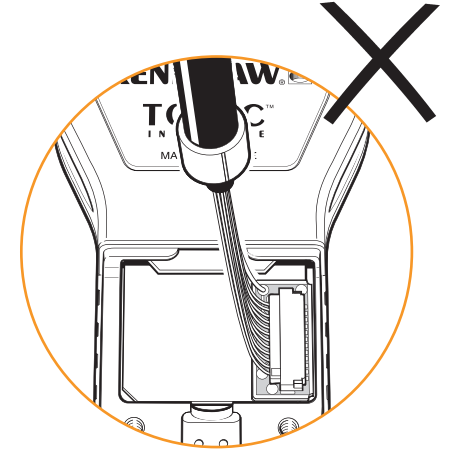
3. Refit the cover plate ensuring the cable ferrule is located in the recess on the inside and no wires are trapped under the cover plate.

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



### Disconnecting the readhead

1. Remove the cover plate on the interface (2 × M2.5 hex head screws).
2. Gently lever the connector PCB (on the end of the cable) out of the socket. Do not pull the cable to remove the connector.
3. Place the connector in an anti-static bag.
4. Refit the cover plate.





## 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.

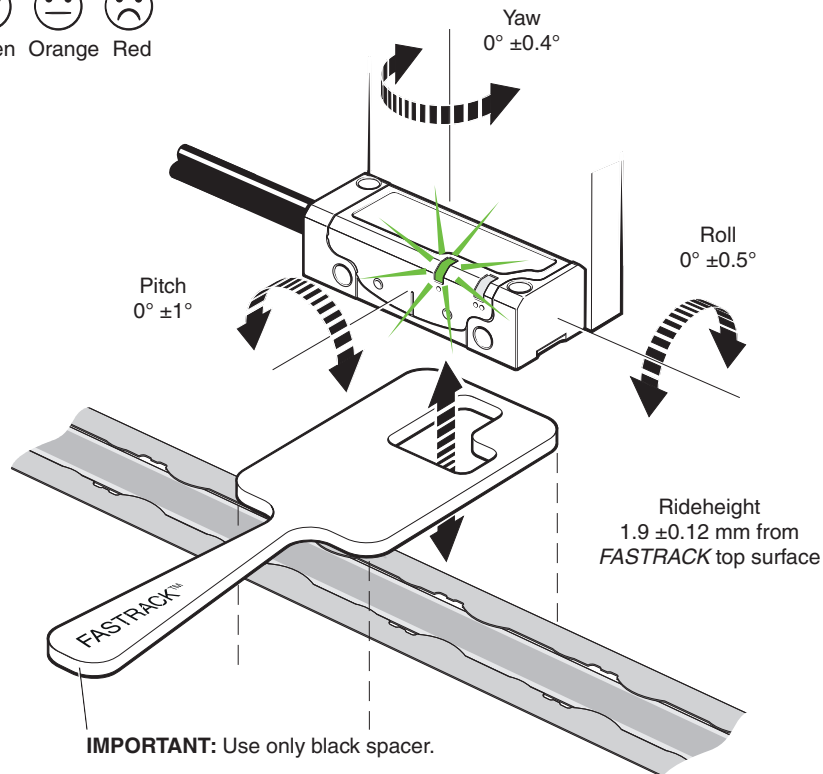
**NOTE:** When cleaning the readhead and scale apply cleaning fluid sparingly, do not soak.

To set nominal rideheight, place the black 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 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 reinstalling, the factory defaults should be restored ('Restoring factory defaults', page 17).

### Readhead set-up LED status



### 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	AGC – On
		Off	AGC – 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 set-up; signal level 110% to 135%	No
	Blue	Optimum set-up; 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 speed; 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 output 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](http://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.

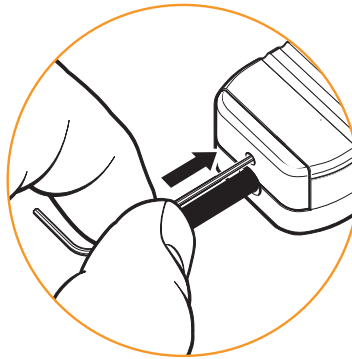
### Before system calibration

- ▶ Clean the scale and readhead optical window (contamination around the reference mark may result in reference mark dephasing).
- ▶ If re-installing, restore factory defaults ('Restoring factory defaults', page 17).
- ▶ Ensure Automatic Gain Control (AGC) is switched off (CAL LED on readhead is not illuminated).
- ▶ Maximise the signal strength along full axis of travel.

**NOTES:** CAL routine maximum speed < 100 mm/s (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 requires only 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), exit the calibration routine, restore factory defaults ('Restoring factory defaults', page 17) 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 ('RTL20/FASTRACK installation drawing', page 6).

TONiC RTL20/FASTRACK linear encoder system

## 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 re-calibrate
Double-flashing	Incremental only
Off (auto-complete)	Incremental and reference mark

## 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 'Readhead mounting and alignment', page 15, and recalibrate the system ('System calibration', page 16).

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

### Enabling/disabling AGC

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 16).

## Output signals

### Interface output (analogue) Ti0000 only

Interface output (analogue) Ti0000 only			Interface Ti0000	
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 <sub>1</sub> +	9
			V <sub>1</sub> -	1
	Sine	V <sub>2</sub> +	10	
		V <sub>2</sub> -	2	
Reference mark	Analogue	V <sub>0</sub>	+	3
			-	11
Limits	Open collector	V <sub>p</sub>	7	
		V <sub>q</sub>	8	
Set-up	-	V <sub>x</sub>	6	
Calibrate	-	CAL	14	
Shield	-	Inner shield	Not connected	
	-	Outer shield	Case	

### Readhead output

Function	Output type	Signal	Colour	
Power	-	5 V	Brown	
		0 V	White	
Incremental signals	Analogue	Cosine	V <sub>1</sub> +	Red
			V <sub>1</sub> -	Blue
	Sine	V <sub>2</sub> +	Yellow	
		V <sub>2</sub> -	Green	
Reference mark	Analogue	V <sub>0</sub>	+	Violet
			-	Grey
Limits	Open collector	V <sub>p</sub>	Pink	
		V <sub>q</sub>	Black	
Set-up	-	V <sub>x</sub>	Clear	
Calibrate	-	CAL	Orange	
Shield	-	Inner shield*	Green/Yellow	
	-	Outer shield	Outer screen	

\*No inner shield on UHV cases.

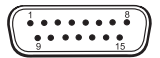
### Interface output (digital) Ti0004 to Ti20KD and TD4000 to TD0040

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

<sup>†</sup>Becomes alarm (E+) for Ti options E, F, G, H.

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

<sup>‡</sup>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

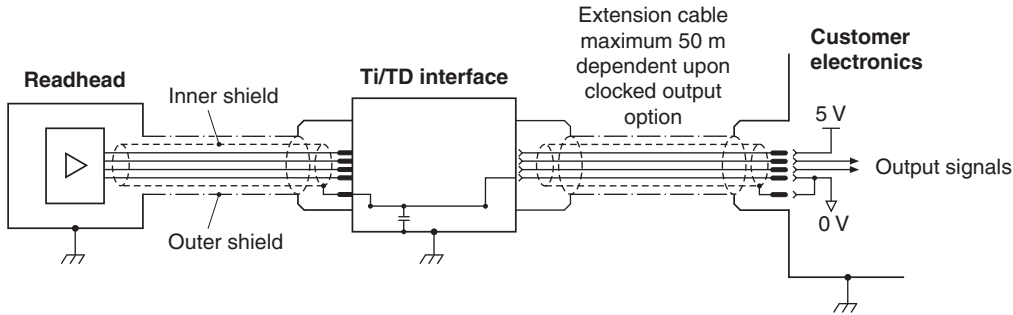
## Speed

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

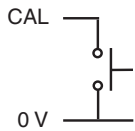


**IMPORTANT:** The outer shield must be connected to the machine earth (Field Ground). The inner shield\* must be connected to 0 V at receiving electronics only. Care should be taken to ensure that the inner and outer shields are insulated from each other. If the inner and outer shields are connected 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.

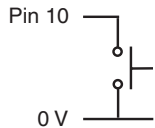
\*For UHV there is no inner shield to be connected.

### Remote CAL operation (analogue versions only)



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.

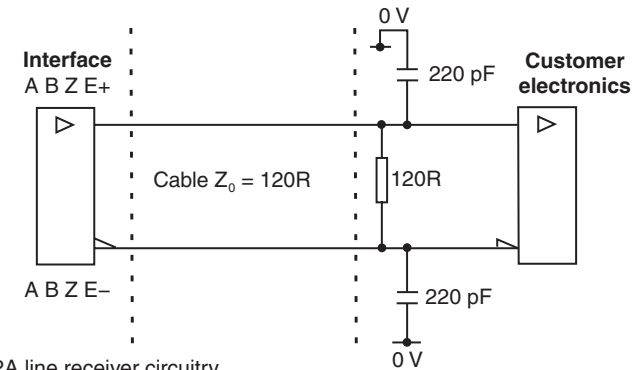
### TD interface resolution switching



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

### Recommended signal termination

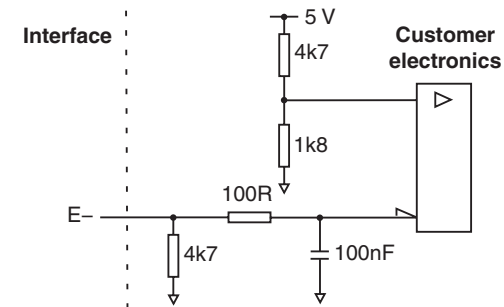
#### Digital outputs



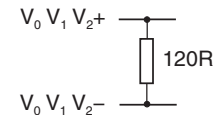
Standard RS422A line receiver circuitry.

Capacitors recommended for improved noise immunity.

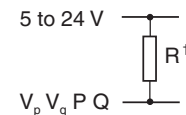
#### Single ended alarm signal termination (Ti options A, B, C, D)



#### Analogue outputs



#### Limit output (no limits on TD interfaces)



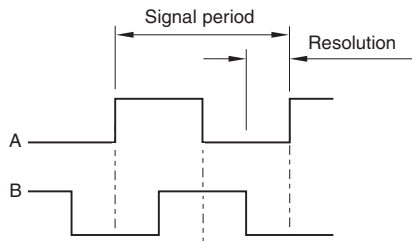
†Select R so maximum current does not exceed 20 mA. Alternatively use a suitable relay or opto-isolator.

# Output specifications

## Digital output signals

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

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



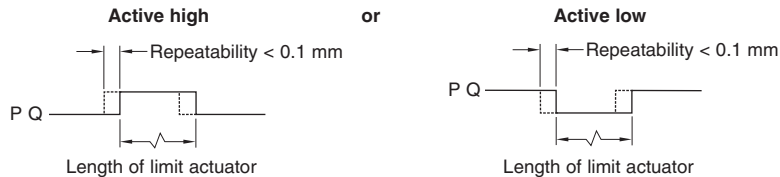
**Reference<sup>†</sup>**  
Z — Synchronized pulse Z, duration as resolution

**Wide reference<sup>†</sup>**  
Z — Synchronized pulse Z, duration as 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.

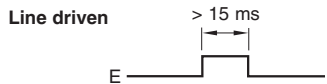
**Limits** Open collector output, asynchronous pulse

Digital Ti interfaces only



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

**Alarm<sup>†</sup>** Asynchronous pulse



Alarm asserted when:

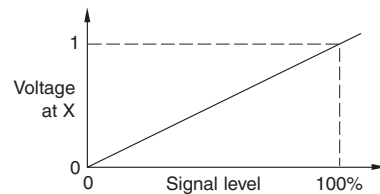
- Signal amplitude < 20% or > 135%.
- Readhead speed too high for reliable operation.

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<sup>\*</sup>**

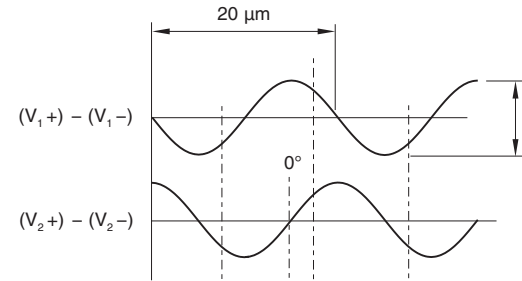


Set-up signal voltage proportional to incremental signal amplitude.

<sup>†</sup> Inverse signals not shown for clarity.

## Analogue output signals

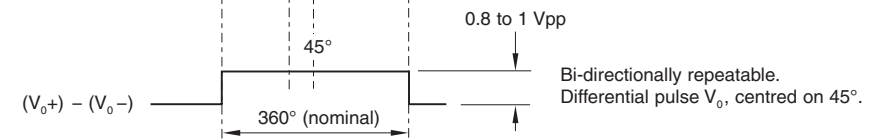
**Incremental** 2 channels  $V_1$  and  $V_2$  differential sinusoids in quadrature centred on 1.65 V (90° phase shifted).



0.7 to 1.35 Vpp with Green LED 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**

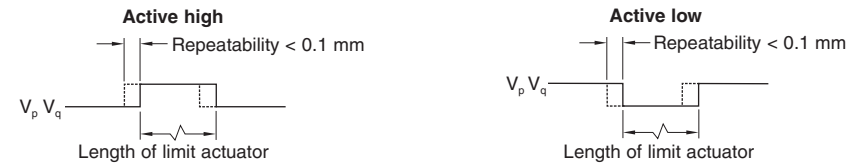


Bi-directionally repeatable.  
Differential pulse  $V_0$ , centred on 45°.

**Limits** Open collector output, asynchronous pulse

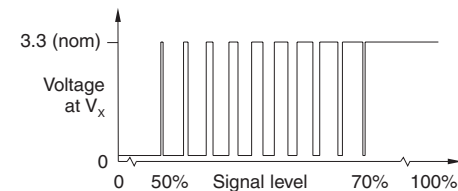
Ti0000 interface only

T103x readhead only



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


**Set-up<sup>\*</sup>**



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.

<sup>\*</sup> Set-up signals as shown are not present during calibration routine.

## General specifications

<b>Power supply</b>	5 V ±10%	Readhead only < 100 mA T103x with Ti0000 < 100 mA T103x with Ti0004 – Ti20KD and TD4000 – TD0040 < 200 mA <b>NOTE:</b> Current consumption figures refer to unterminated systems. For digital outputs a further 25 mA per channel pair (e.g., 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 Vdc supply complying with the requirements for SELV of standard IEC 60950-1.	
	Ripple	200 mVpp maximum @ frequency up to 500 kHz	
<b>Temperature</b> (system)	Storage	-20 °C to +70 °C	
	Operating	0 °C to +70 °C	
	(UHV readhead) Bakeout	+120 °C	
<b>Humidity</b> (system)		95% relative humidity (non-condensing) to IEC 60068-2-78	
<b>Sealing</b> (readhead)		IP40	
	(Ti interface)	IP20	
<b>Acceleration</b> (readhead)	Operating	500 m/s <sup>2</sup> , 3 axes	
<b>Shock</b> (system)	Operating	500 m/s <sup>2</sup> , 11 ms, ½ sine, 3 axes	
<b>Vibration</b> (system)	Operating	100 m/s <sup>2</sup> , 55 Hz to 2000 Hz, 3 axes	
<b>Mass</b>	Readhead	10 g	
	Interface	100 g	
	Cable	26 g/m	
	UHV cable	14 g/m	
<b>Readhead cable</b> (standard)		Double-shielded, outside diameter 4.25 ±0.25 mm Flex life > 20 × 10 <sup>6</sup> cycles at 20 mm bend radius UL recognised component 	
	(UHV)	Tin coated braided single screen, FEP core insulation	
<b>Maximum cable length</b>	Readhead to interface	10 m	
	Interface to controller	<b>Clocked output option (MHz)</b>	<b>Maximum cable length (m)</b>
		<b>40 to 50</b>	25
		<b>&lt; 40</b>	50
		<b>Analogue</b>	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.



## RTL20 scale technical specifications

<b>Form</b> (H × W)	0.2 mm × 8 mm
<b>Pitch</b>	20 µm
<b>Accuracy</b> (at 20 °C) (includes slope and linearity)	±5 µm/m calibration traceable to International Standards
<b>Linearity</b>	2.5 µm/m achievable with 2 point error correction
<b>Supplied length</b>	20 mm up to 10 m (> 10 m available on request)
<b>Material</b>	Hardened and tempered martensitic stainless steel
<b>Coefficient of thermal expansion</b> (at 20 °C)	10.1 ±0.2 µm/m/°C
<b>Installation temperature</b>	15 °C to 35 °C
<b>Datum fixing</b>	Loctite 435 or mechanical clamp (A-9589-0077)

## FASTRACK technical specifications

<b>Form</b> (H × W)	0.4 mm × 8 mm (including adhesive)
<b>Minimum recommended length</b>	100 mm
<b>Supplied length</b>	100 mm to 25 m
<b>Material</b>	Hardened and tempered martensitic stainless steel
<b>Coefficient of thermal expansion</b> (at 20 °C)	10 ±0.2 µm/m/°C
<b>Installation temperature</b>	15 °C to 35 °C
<b>Mounting</b>	Self-adhesive backing tape

## Reference mark

<b>Type</b>	Customer selected <i>IN-TRAC</i> reference mark, directly embedded into incremental track. Bi-directional position repeatability.
<b>Selection</b>	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)
<b>Repeatability</b>	Unit of resolution repeatability (bi-directional) across full system rated speed and temperature ranges

## Limit switches

<b>Type</b>	Magnetic actuators; with dimple triggers Q limit, without dimple triggers P limit ('RTL20/FASTRACK installation drawing', page 6).
<b>Trigger point</b>	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
<b>Mounting</b>	Customer placed at desired locations
<b>Repeatability</b>	< 0.1 mm

TONiC RTL20/FASTRACK linear encoder system

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