Installation guide
M-9653-9225-05-D

RENISHAW
apply innovation™

TONiC™ T101x RSLM/RELM high accuracy linear encoder system

Contents

Product compliance

CE

Renishaw plc declares that TONiC complies with the applicable standards and regulations.
A copy of the EC Declaration of Conformity is available on request.

FCC compliance

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

The user is cautioned that any changes or modifications not expressly approved by Renishaw plc or authorised representative could void the user's authority to operate the equipment.

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

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

RoHS compliance

Compliant with EC directive 2011/65/EU (RoHS)

Patents

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

EP1173731	US6775008B2	JP4750998	CNCN100543424C	US7659992
EP1766334	JP4932706	CNCN100507454C	US7550710	JP5386081
EP1766335	CNCN101300463B	EP1946048	US7624513B2	JP5017275
CNCN101310165B	US7839296	EP1957943	CN1314511	EP1469969
JP5002559	US8987633	US8466943		

Further information

Further information relating to the TONiC encoder range can be found in the TONiC system Data sheet (L-9517-9337). This can be downloaded from our website www.renishaw.com/encoder and is also available from your local representative. This document may not be copied or reproduced in whole or in part, or transferred to any other media or language, by any means without the written prior permission of Renishaw. The publication of material within this document does not imply freedom from the patent rights of Renishaw plc.

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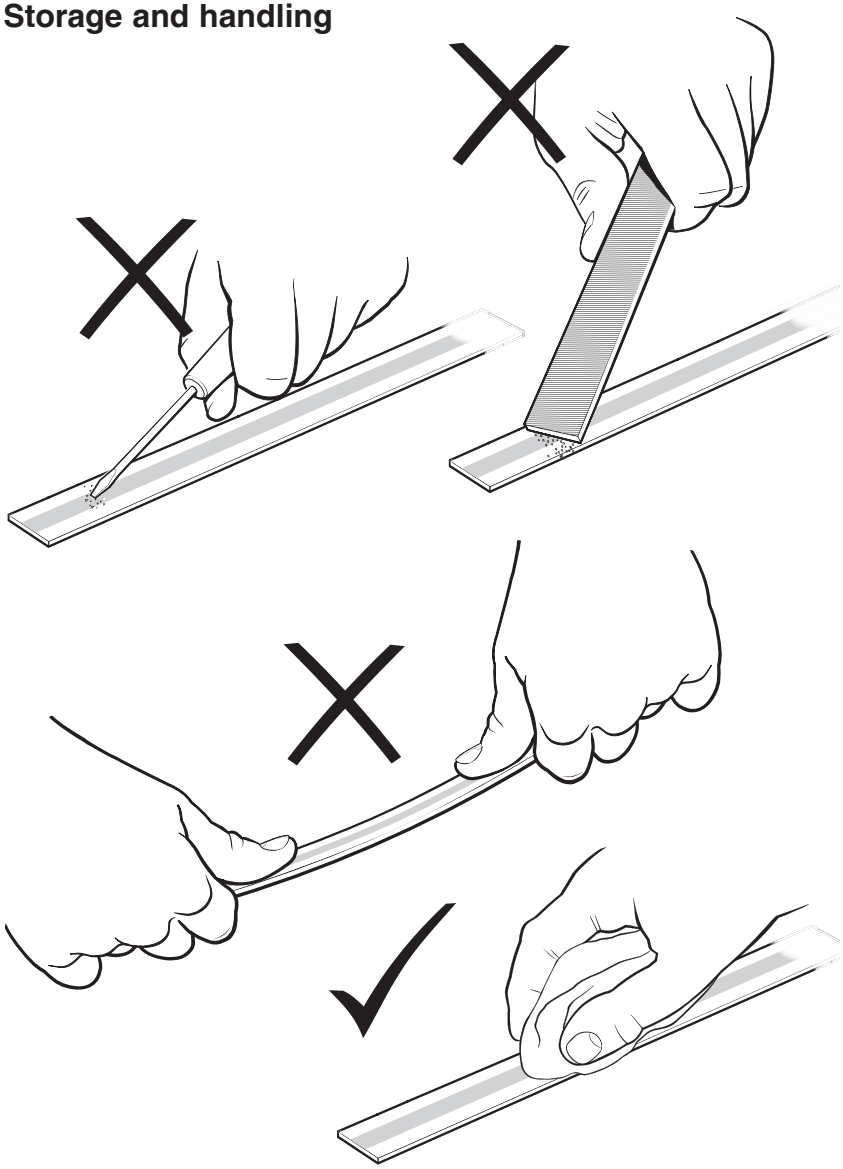
The packaging of our products contains the following materials and can be recycled.

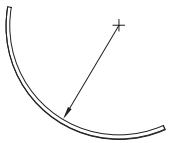
Packaging Component	Material	ISO 11469	Recycling Guidance
Outer box	Cardboard	Not applicable	Recyclable
	Polypropylene	PP	Recyclable
Inserts	Low Density Polyethylene Foam	LDPE	Recyclable
	Cardboard	Not applicable	Recyclable
Bags	High Density Polyethylene Bag	HDPE	Recyclable
	Metalised Polyethylene	PE	Recyclable

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

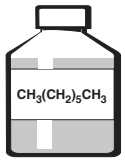


RSLM – 250 mm
RELM – DO NOT BEND

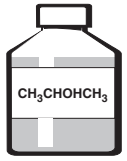
NOTE: Ensure self-adhesive tape is on outside of bend.

Scale and readhead

N-heptane

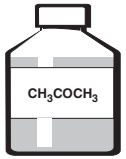


Propan-2-ol



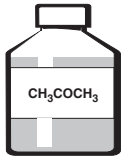
Scale only

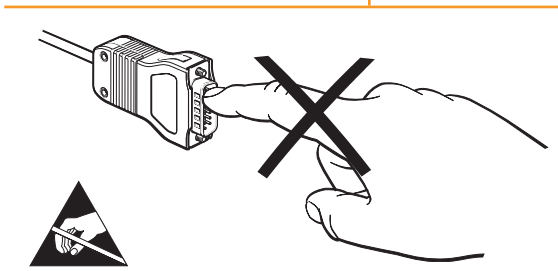
Acetone

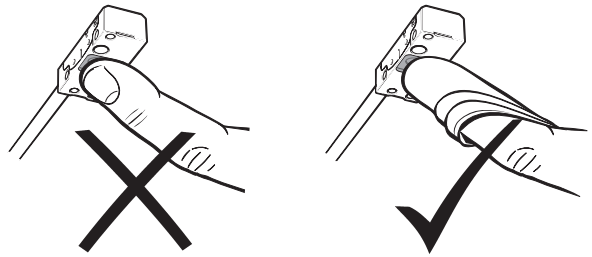


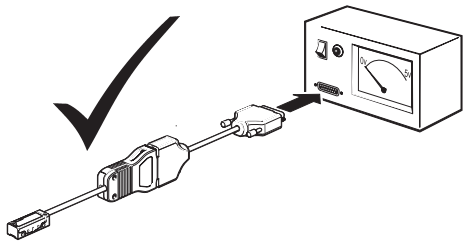
Readhead only

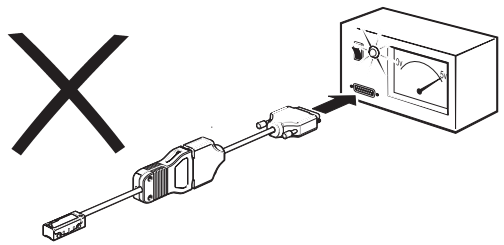
Acetone



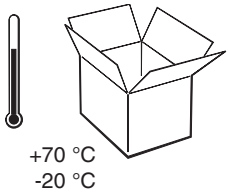






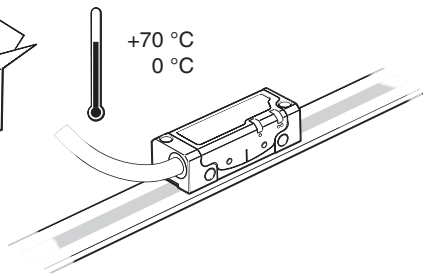


Storage

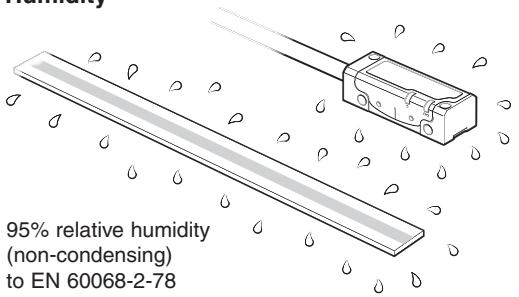


UHV readhead
Bakeout +120 °C

Operating



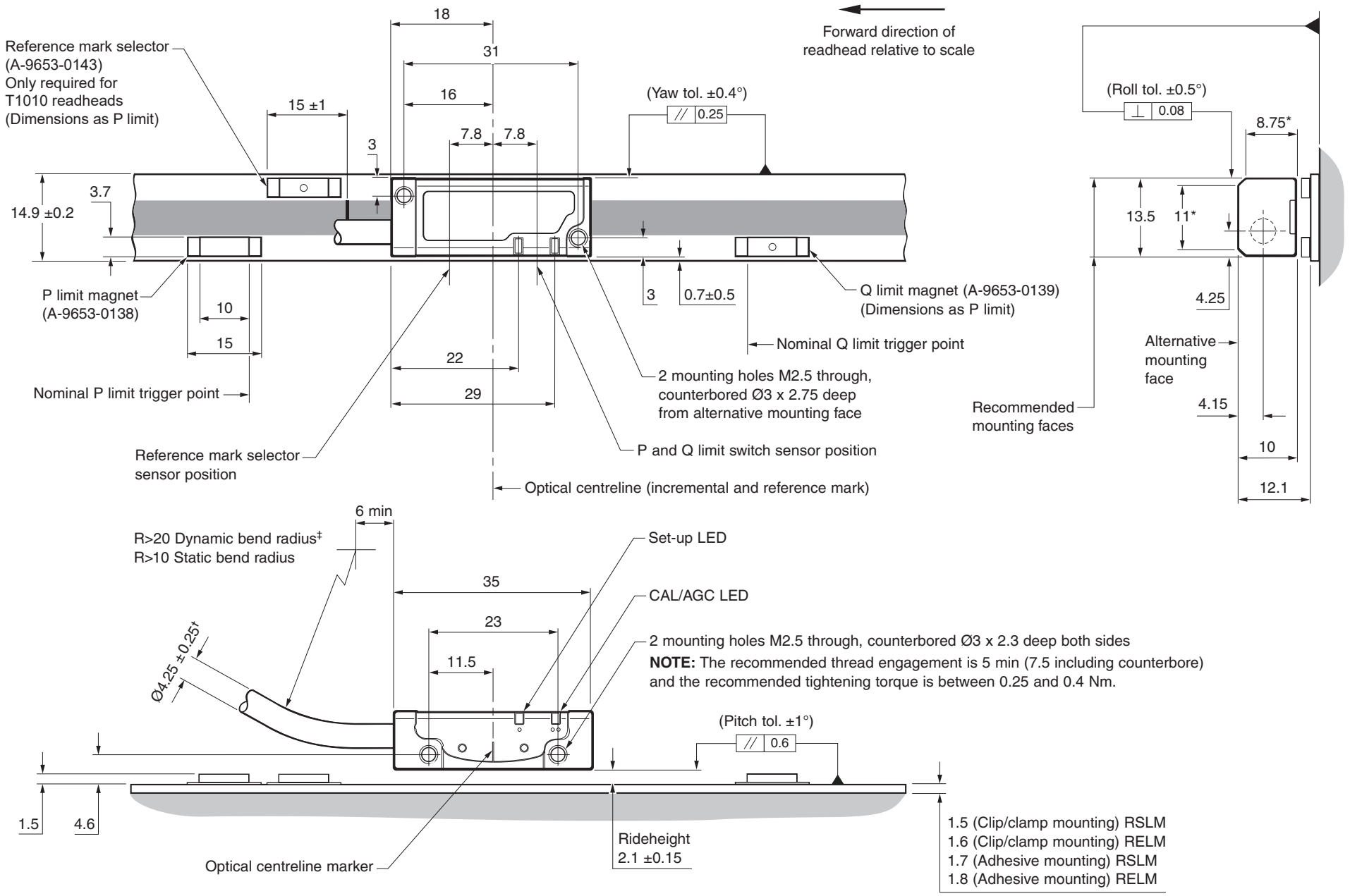
Humidity



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

TONiC T101x readhead installation drawing

Dimensions and tolerances in mm

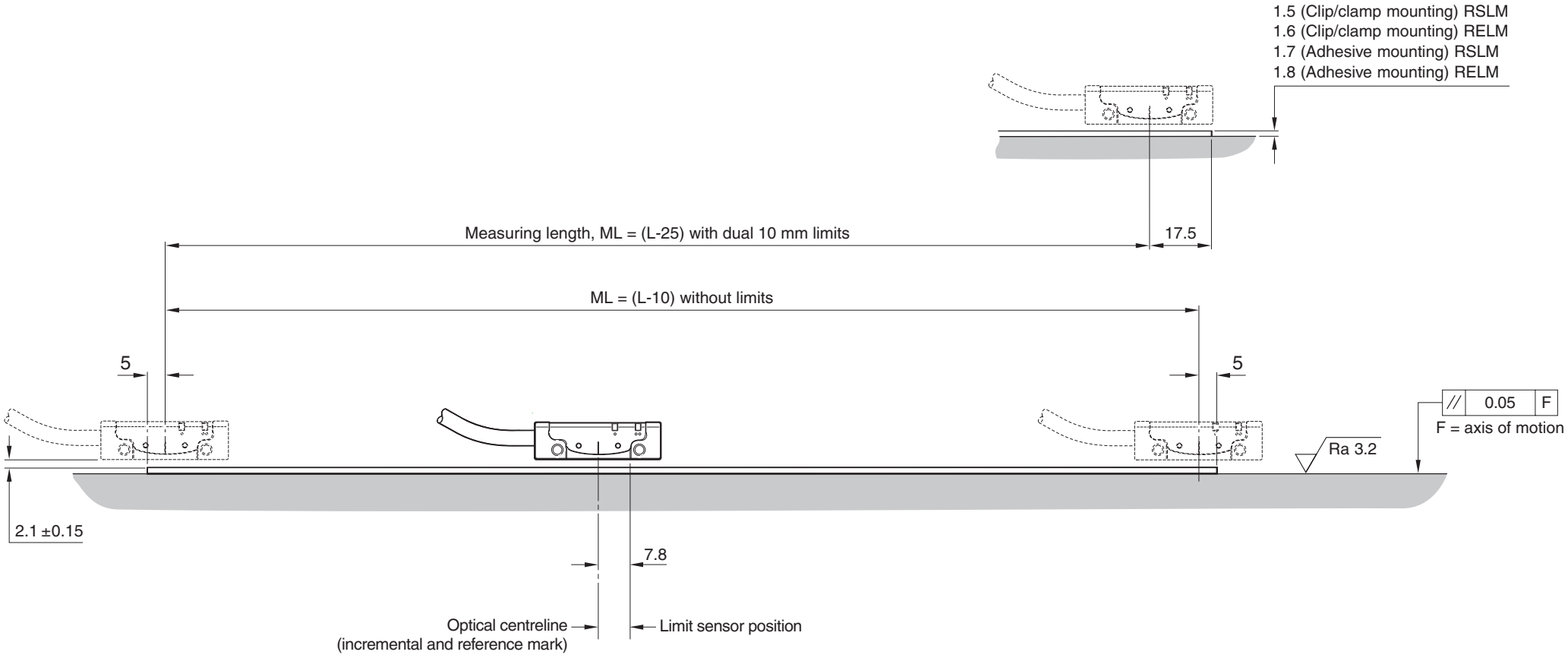


*Extent of mounting faces. †UHV cable diameter 3.0 approx. ‡Dynamic bend radius not applicable for UHV cables.

NOTE: External magnetic fields greater than 6 mT, in the vicinity of the readhead, may cause false activation of the limit sensor.

Measuring lengths

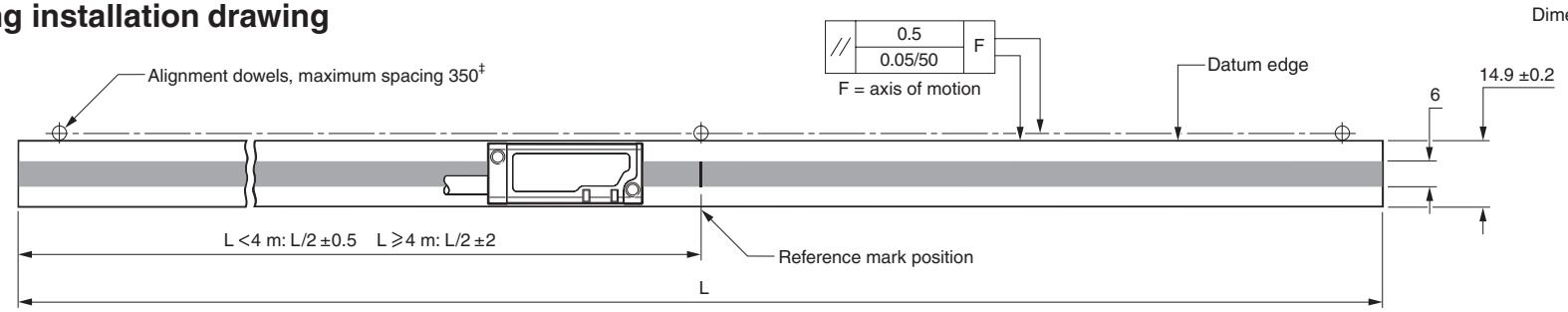
Dimensions and tolerances in mm



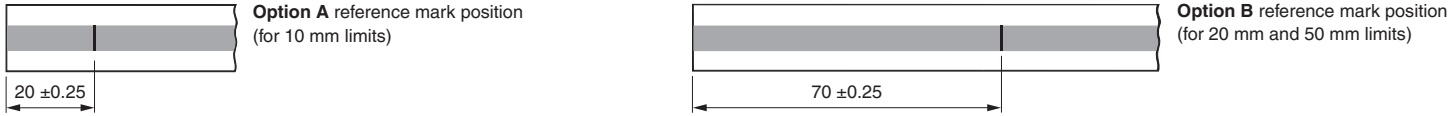
Adhesive mounting installation drawing

Dimensions and tolerances in mm

RSLM Use with T1011 readhead
(Centre reference mark)



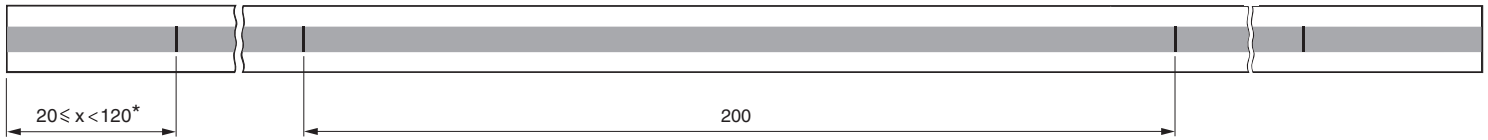
RSLE Use with T1011 readhead
(End reference mark)



Option A reference mark position
(for 10 mm limits)

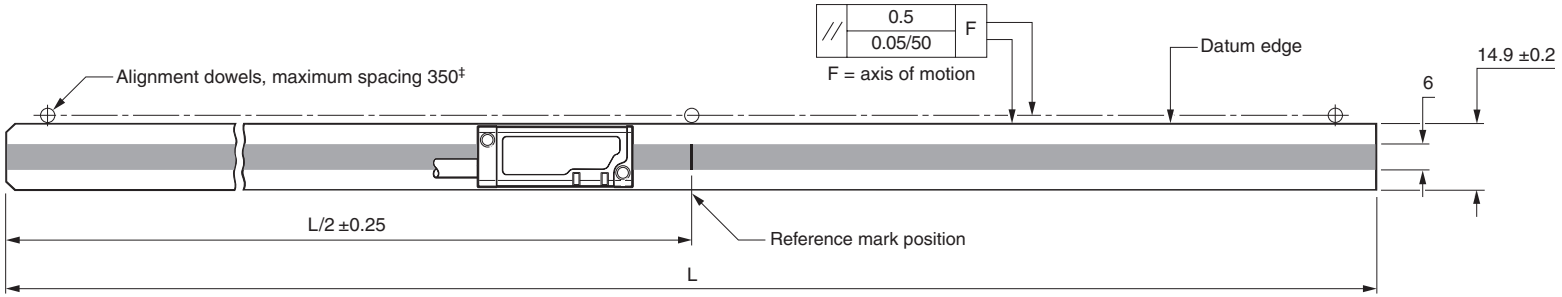
Option B reference mark position
(for 20 mm and 50 mm limits)

RSLC Use with T1010 readhead
(Customer selected reference mark)

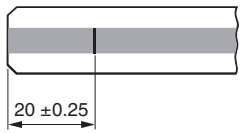


Select one or more reference marks using reference mark selector magnet (A-9653-0143)

RELM Use with T1011 readhead
(Centre reference mark)



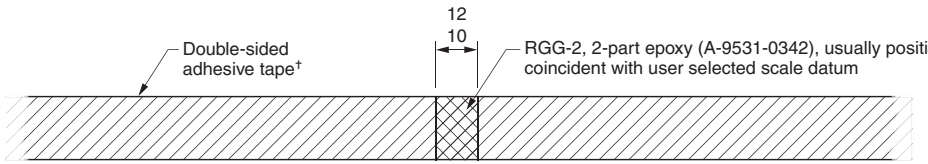
RELE Use with T1011 readhead
(End reference mark)



NOTES:
Adhesive mounted scale should not be re-used after installation.
For readhead dimensions see 'Readhead installation drawing'.
When installing in a groove allow a tolerance for scale width.
See 'Measuring length' for information on using limits.

Adhesive datum clamp

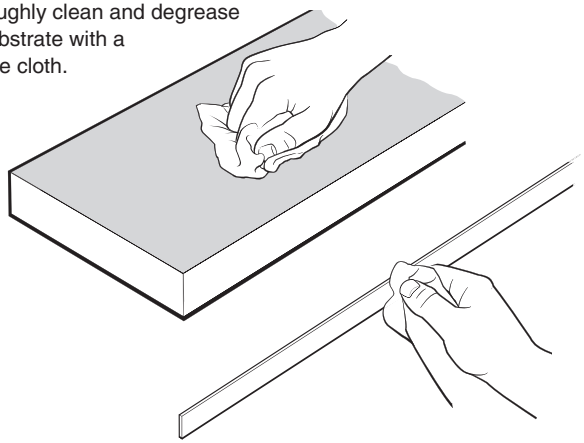
Clamping in this way ensures scale positional stability relative to substrate.



*Reference marks positioned equi-distant from scale ends.
†Double-sided adhesive tape is included with all scale lengths.
‡When scale is to be mounted horizontally on a vertical surface, position the dowels so that the datum edge is supported.

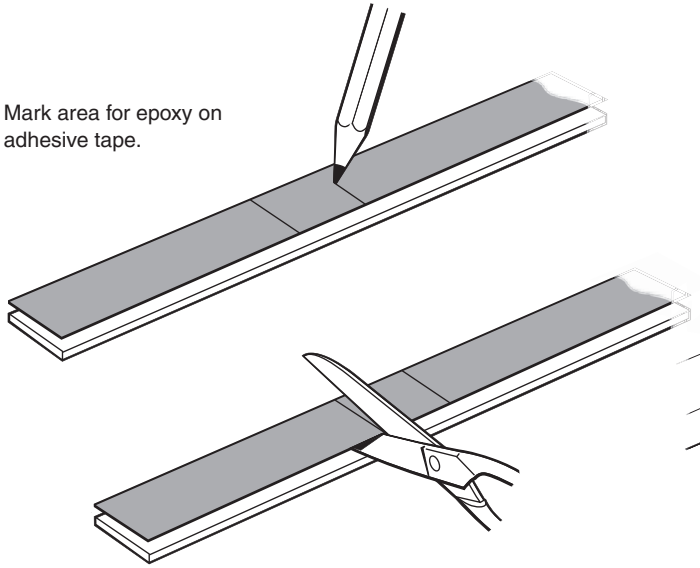
Adhesive mounting installation

1 Thoroughly clean and degrease the substrate with a lint-free cloth.

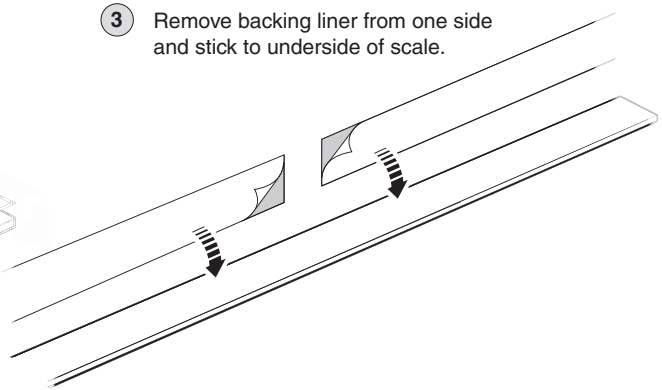


Clean underside of scale using approved solvents (see 'Storage and handling').

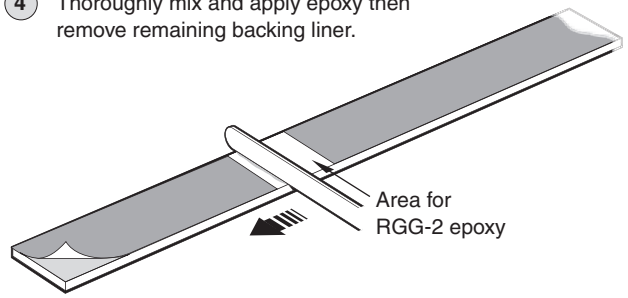
2 Mark area for epoxy on adhesive tape.



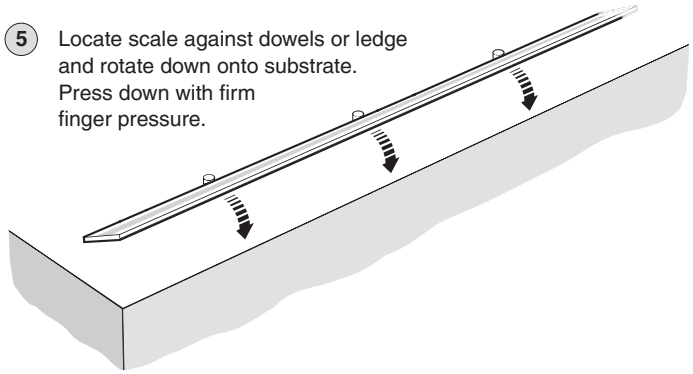
3 Remove backing liner from one side and stick to underside of scale.



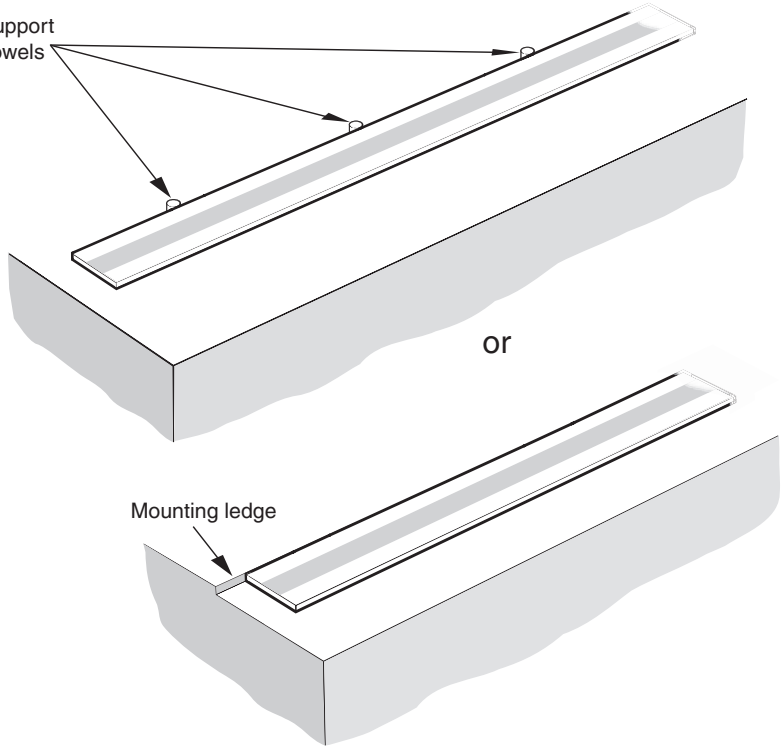
4 Thoroughly mix and apply epoxy then remove remaining backing liner.



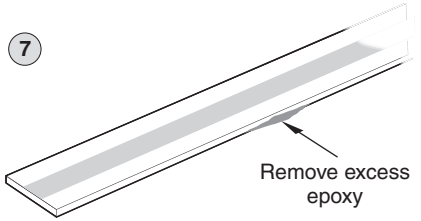
5 Locate scale against dowels or ledge and rotate down onto substrate. Press down with firm finger pressure.



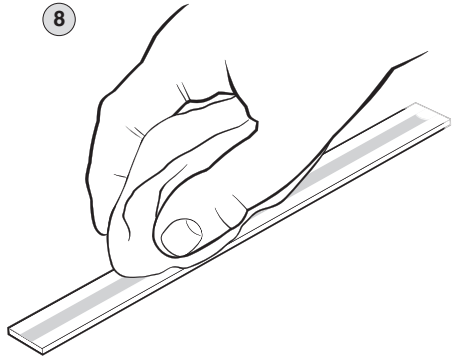
6 Support dowels



7



8



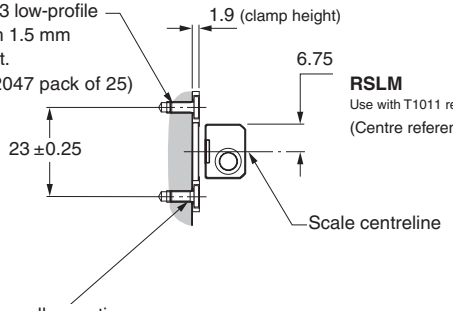
Allow 24 hours for epoxy to cure fully, then clean scale using Renishaw scale wipes (A-9523-4040) or a clean, dry, lint-free cloth.

Clip/clamp mounting installation drawing

Dimensions and tolerances in mm

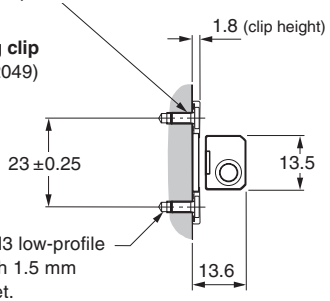
Datum clamp
(A-9584-2050)

Special M3 low-profile screw with 1.5 mm hex socket.
(A-9584-2047 pack of 25)



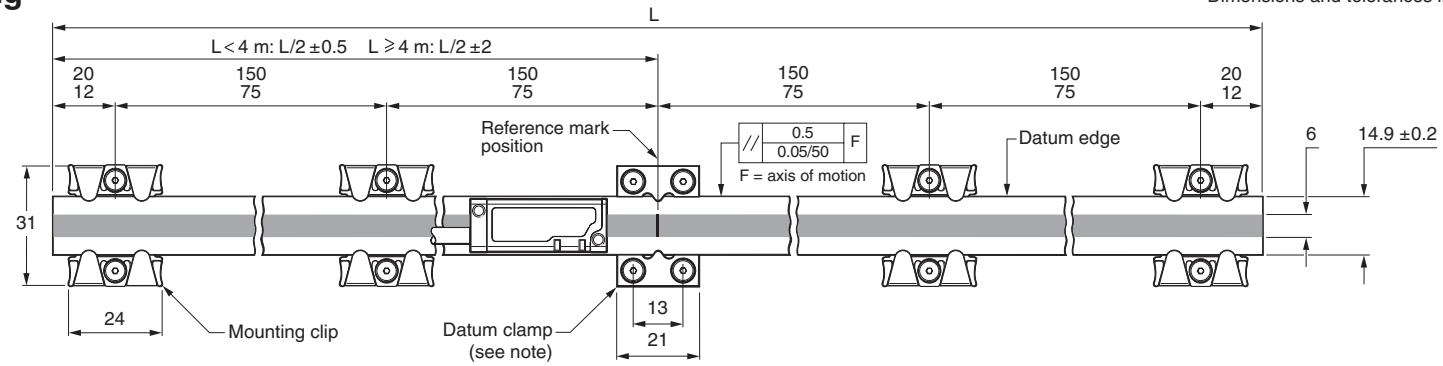
Counterbore all mounting holes 3.2 mm diameter 1 mm to 1.5 mm deep 6 mm minimum depth full thread.

Mounting clip
(A-9584-2049)

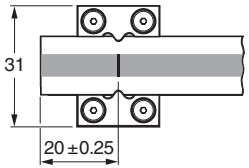


Special M3 low-profile screw with 1.5 mm hex socket.
(A-9584-2047 pack of 25)

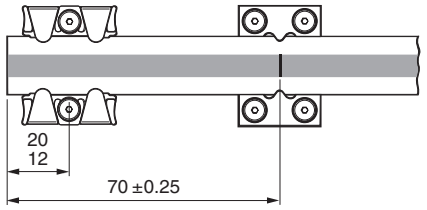
RSLM
Use with T1011 readhead
(Centre reference mark)



RSLE
Use with T1011 readhead
(End reference mark)

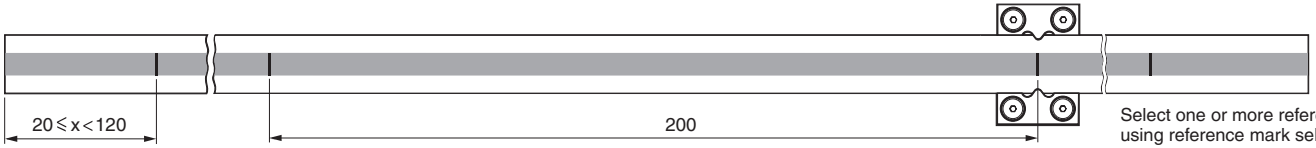


Option A
Reference mark position
(for 10 mm limits)



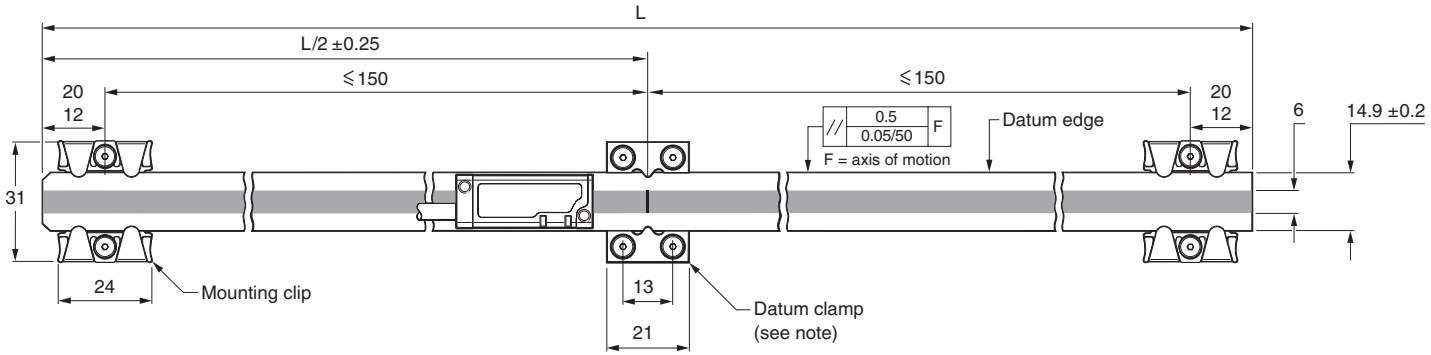
Option B
Reference mark position
(for 20 mm and 50 mm limits)

RSLC*
Use with T1010 readhead
(Customer selected reference mark)

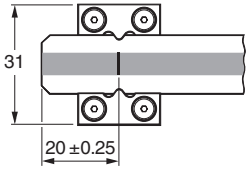


Select one or more reference marks using reference mark selector magnet (A-9653-0143)

RELM
Use with T1011 readhead
(Centre reference mark)



RELE
Use with T1011 readhead
(End reference mark)



NOTES:

Datum clamp usually coincident with selected *IN-TRAC* reference mark. However the position is user selectable depending upon application. For lengths 80≤ L ≤190 ensure scale is clamped or clipped in the middle as well as at both ends.

*Clips omitted for clarity. Reference marks positioned equi-distant from scale ends.

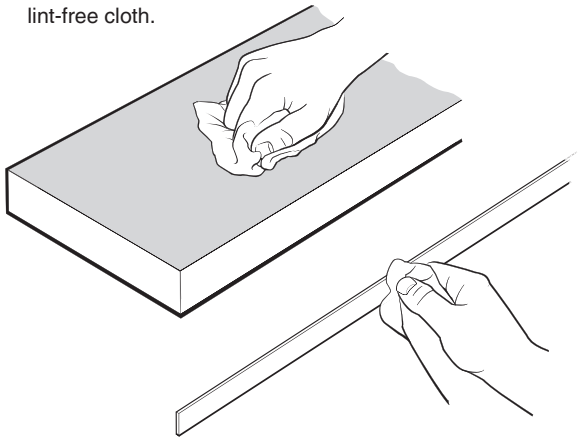
For optimum performance the readhead should be installed close to nominal geometry.

Care should be taken to ensure sufficient clearance between the readhead/mounting bracket and clips/datum clamp.

Only special low-profile screws should be used. Screws are provided with all clips/datum clamps and spares can be supplied if required.

Clip/clamp mounting installation

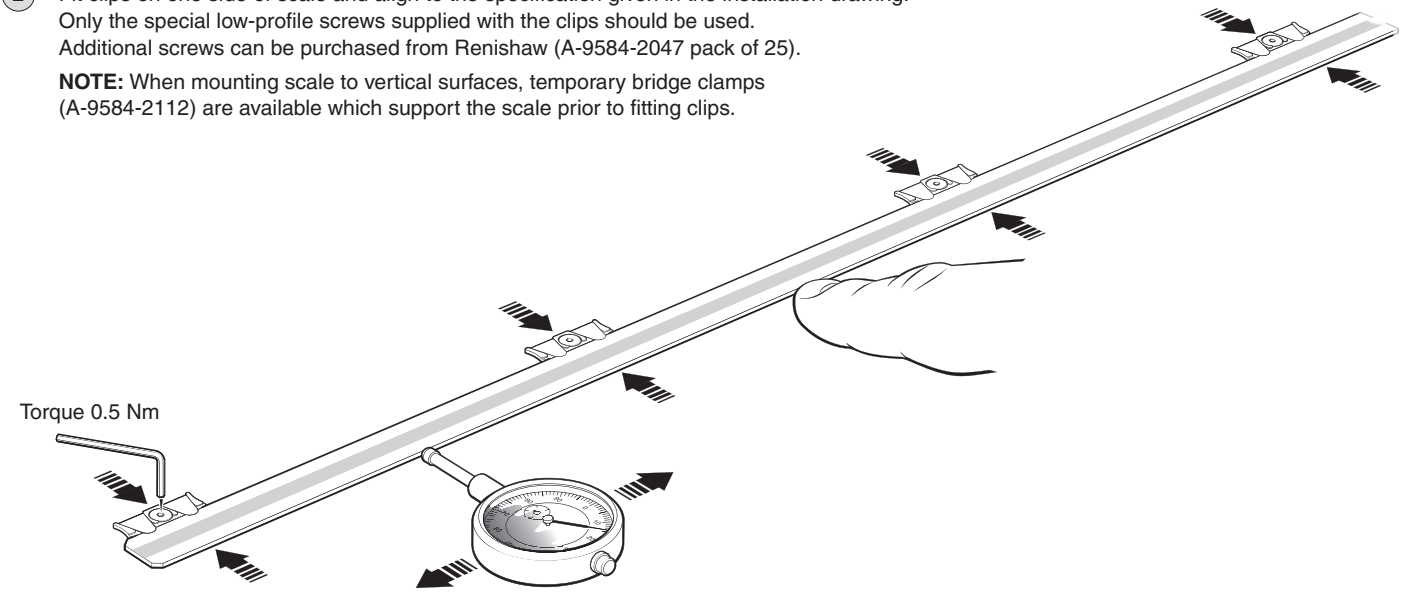
1 Thoroughly clean and degrease the substrate with a lint-free cloth.



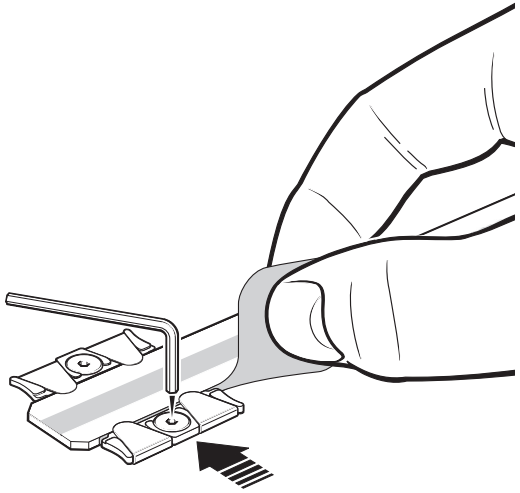
Clean underside of scale using approved solvents (see 'Storage and handling').

2 Fit clips on one side of scale and align to the specification given in the installation drawing. Only the special low-profile screws supplied with the clips should be used. Additional screws can be purchased from Renishaw (A-9584-2047 pack of 25).

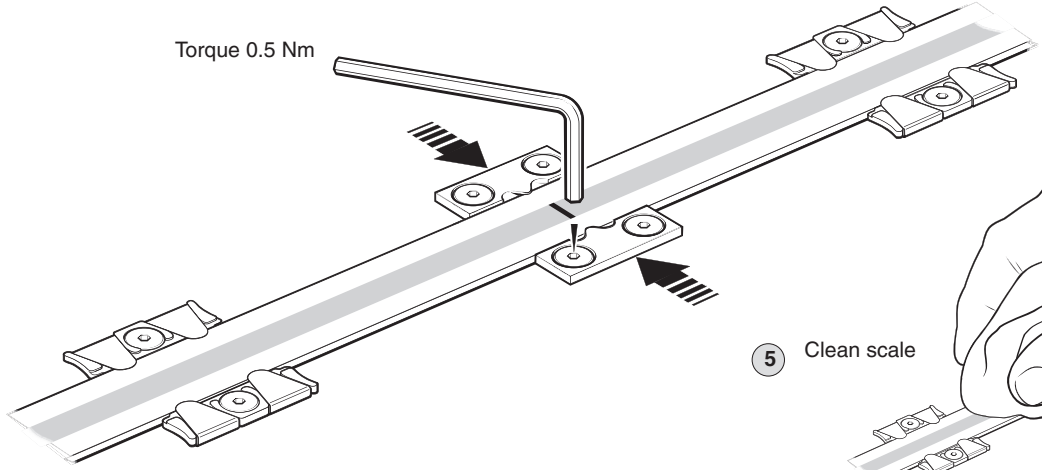
NOTE: When mounting scale to vertical surfaces, temporary bridge clamps (A-9584-2112) are available which support the scale prior to fitting clips.



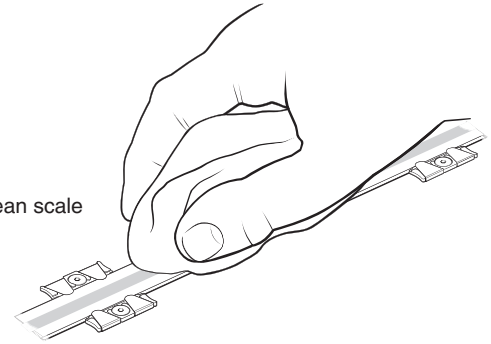
3 Fit remaining clips using clip setting shim M-9584-0928 (provided with A-9584-2050 clamp set).



4 Place datum clamps against scale and secure using the special M3 low-profile screws supplied.

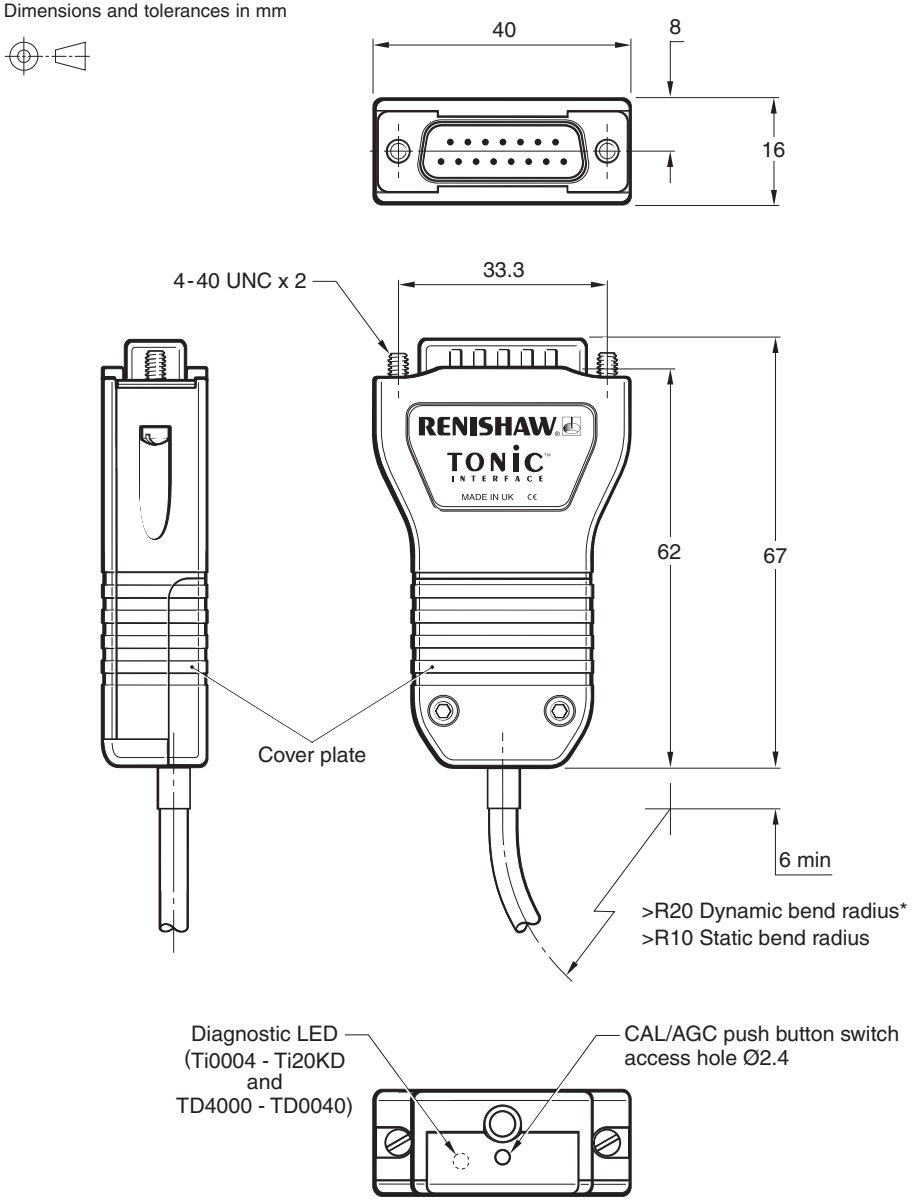


5 Clean scale



TONiC interface drawing

Dimensions and tolerances in mm



*Dynamic bend radius not applicable for UHV cables.

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

TONiC quick-start guide

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

INSTALLATION

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

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

Plug the readhead cable into the Ti/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.

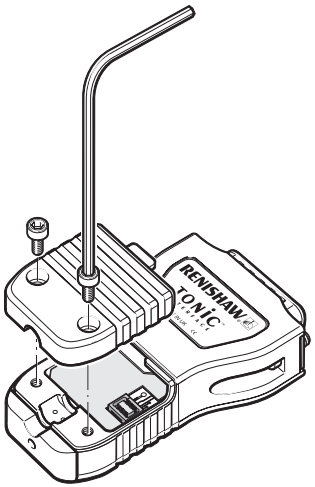
NOTE: If calibration fails, restore factory defaults by pressing and holding the CAL button whilst switching on. Then repeat the installation and calibration routine.

System connection

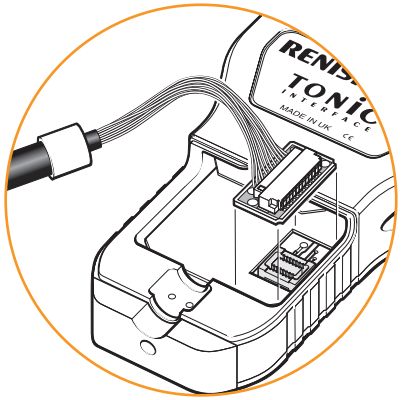
Approved ESD precautions must be followed at all times during readhead and interface electrical connections. The readhead is connected to the Ti/TD interface via a small, rugged connector to allow for easy feed-through during installation.

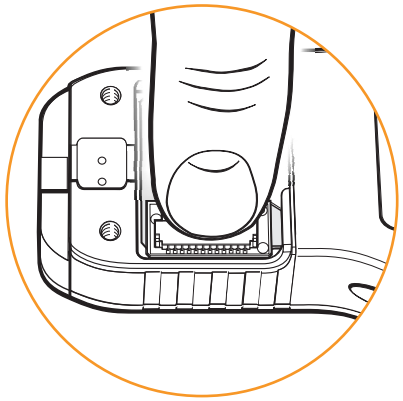
Connecting the readhead

1. Remove the cover plate as shown (2 x M2.5 hex head screws).



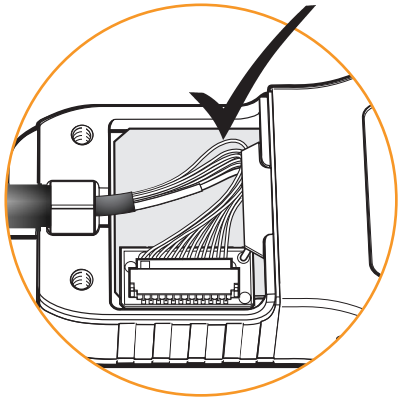
2. Taking care not to touch the pins, plug the connector into the socket in the interface, ensuring correct orientation as shown.

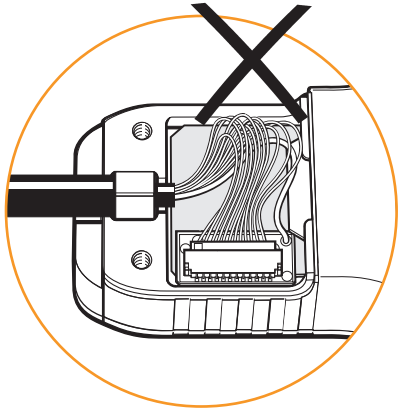


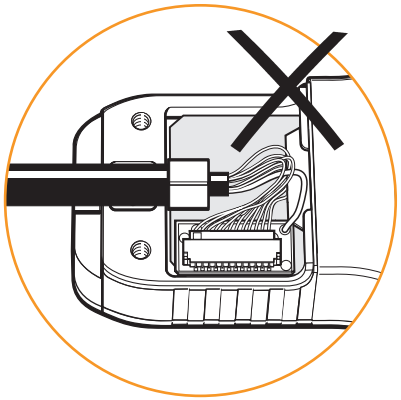


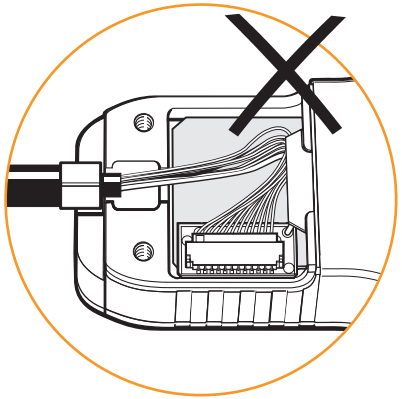
3. Refit the cover plate ensuring the cable ferrule is located in the recess on the inside and no wires are trapped under the cover plate.

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







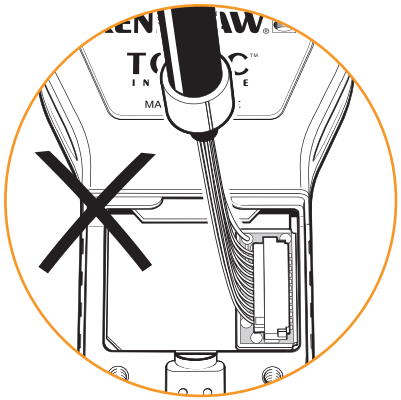


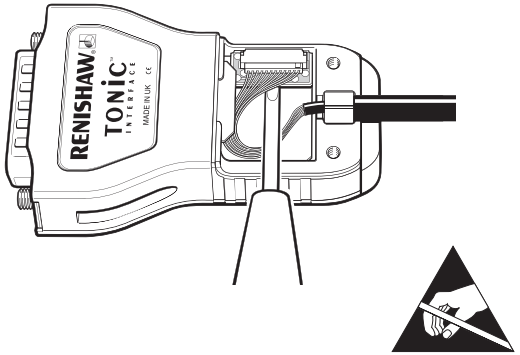
Disconnecting the readhead

1. Remove the cover plate on the interface (2 x 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

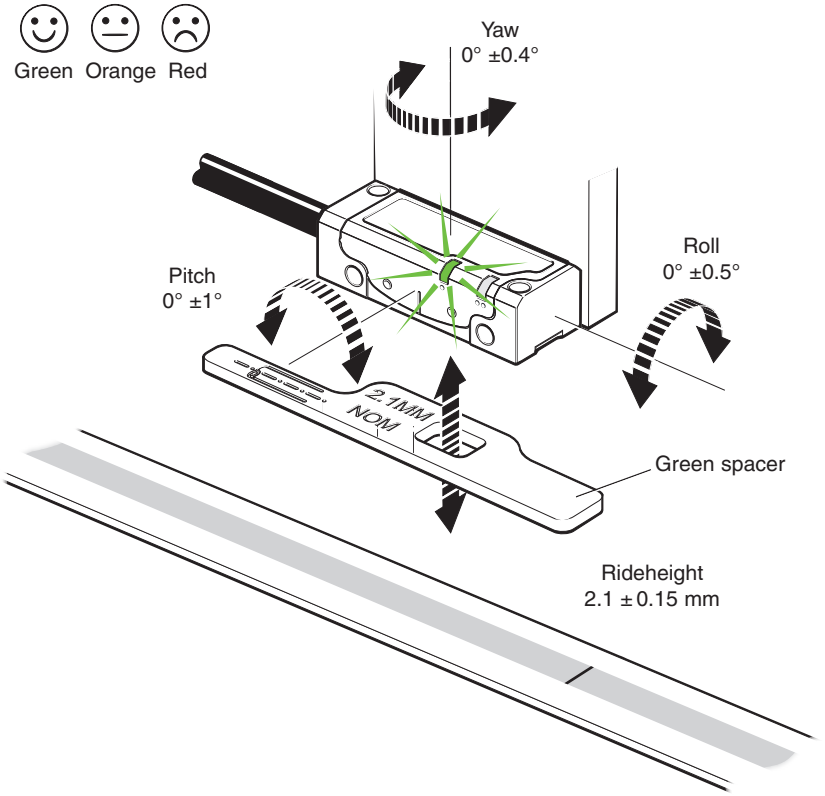
The bracket must have a flat mounting surface and should provide adjustment to enable conformance to the installation tolerances, allow adjustment to the rideheight of the readhead, and be sufficiently stiff to prevent deflection or vibration of the readhead during operation.

Readhead set-up

Ensure that the scale, readhead optical window and mounting face are clean and free from obstructions. To set nominal rideheight, place the Green 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 re-installing, factory defaults should be restored.

Readhead set-up LED status

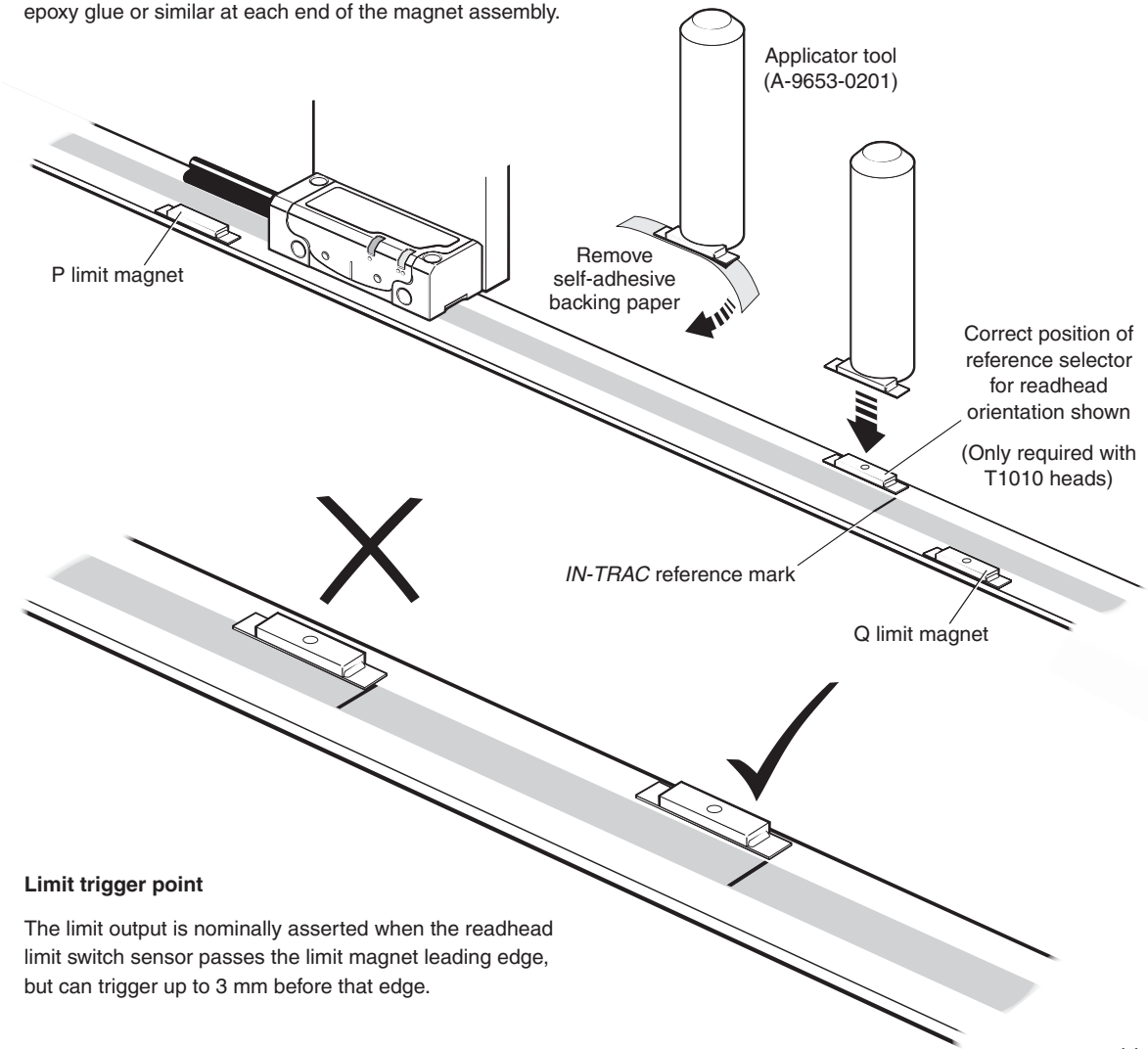


Reference mark selector and limit magnet installation

For accuracy and ease of positioning of reference mark selector and limit magnets, the applicator tool (A-9653-0201) should be used. The magnet should be attached to the applicator tool as shown below.
Limit magnets can be positioned at any user defined location along the scale, but the reference mark selector magnet (T1010 readhead only) 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 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.

NOTE: 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 at each end of the magnet assembly.



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.

System calibration

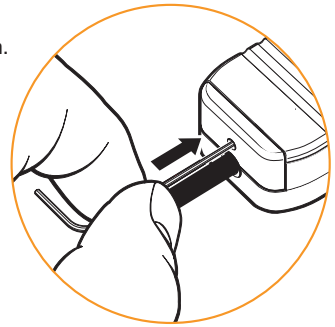
Calibration is an essential operation that completes readhead set-up, with the optimum incremental and reference mark signal settings stored in the readhead's non-volatile memory.

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.
- Maximise the signal strength along full axis of travel.

NOTE: 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



- Ensure Automatic Gain Control is switched off (CAL LED on readhead is not illuminated) before beginning calibration.
- Press and release the CAL button on the end of the interface using a 2 mm allen key or similar tool.
  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 mode.
- Move the readhead along the axis, ensuring you do not pass the selected reference mark, until the CAL LED starts double-flashing, indicating the incremental signal is now calibrated and the new settings are stored in the readhead memory.
- The system is now ready for reference mark phasing.
- For systems without reference mark, go to 'Calibration routine - manual exit'
- If the system does not automatically enter the reference mark phasing stage (no double-flashing of the CAL LED) the calibration of the incremental signals has failed. After ensuring failure is not due to overspeed (>100 mm/s), exit the calibration routine, restore factory defaults and check the readhead installation and system cleanliness before repeating the calibration routine.

Step 2 – Reference mark phasing

- Move the readhead back and forth over the selected reference mark until the CAL LED stops flashing and remains off. The reference mark is now phased.
- The system automatically exits the CAL routine and is ready for operation.
- If the CAL LED continues double-flashing after passing the chosen reference mark many times, it is not detecting the reference mark. 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.

Calibration routine – manual exit

- To exit the calibration routine at any stage press the CAL button. The CAL button will then 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 the 'Readhead mounting/installation' and re-calibrate the system.

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.

T101x 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 level is >70% when passing reference mark.

Ti0004 to Ti20KD and TD4000 to TD0040 Interface LED diagnostics

Signal	Indication	Status	Alarm output*
Incremental	Purple	Normal setup; signal level 110% to 135%	No
	Blue	Optimum setup; signal level 90% 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. See product nomenclature for details.
-Momentary status only, while fault condition remains.
-Alarm may result in axis position error, re-datum to continue.

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		Brown
			0 V		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

*No inner shield on UHV cables.

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

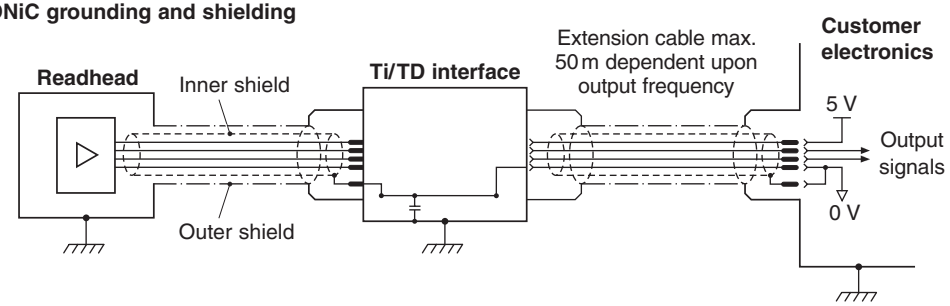
Speed

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

TONiC grounding and shielding

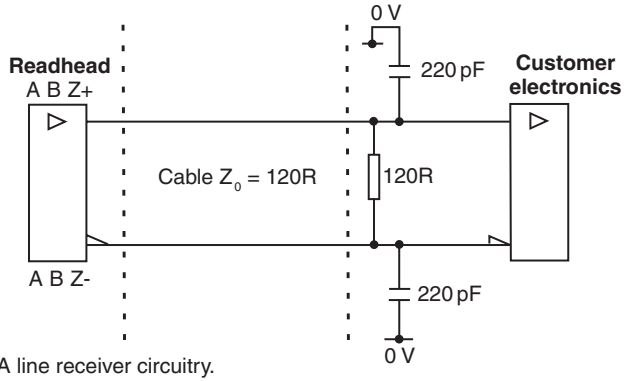


IMPORTANT: The outer shield should be connected to the machine earth (Field Ground). The inner shield should be connected to 0 V at receiving electronics only. Care should be taken to ensure that the inner and outer shields are insulated from each other. If the inner and outer shields are connected together,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

Recommended signal termination

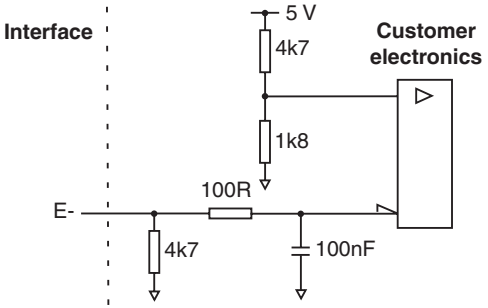
Digital outputs



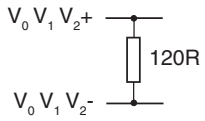
Standard RS422A line receiver circuitry.

Capacitors recommended for improved noise immunity.

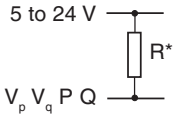
Single ended alarm signal termination (Ti options A, B, C, D)



Analogue outputs

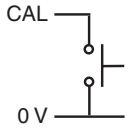


Limit output (No limits on TD interfaces)



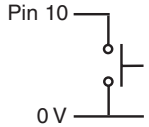
*Select R so maximum current does not exceed 20 mA.
Alternatively use a suitable relay or opto-isolator.

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



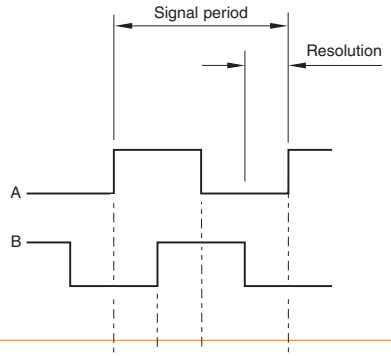
Connect pin 10 to 0 V to switch to lower resolution.

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†

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

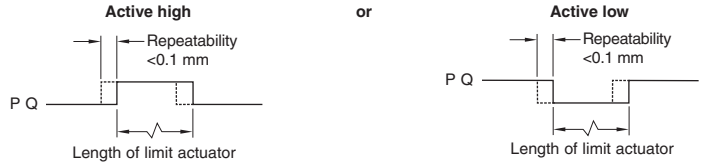
Wide reference†

Z — 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

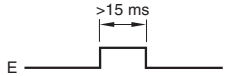
Digital Ti interfaces only



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

Alarm† Asynchronous pulse

Line driven



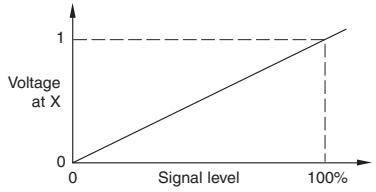
Alarm asserted when signal level is less than 20% or greater than 135%. Alarm is also asserted if readhead speed is too high for reliable operation.

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

or 3-state alarm

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

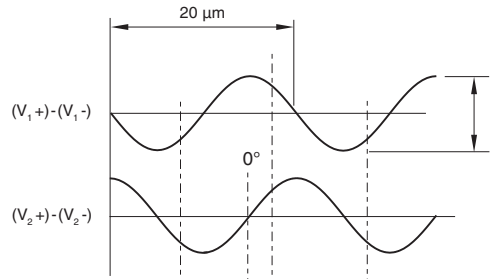
Set-up*



Set-up signal voltage proportional to incremental signal amplitude

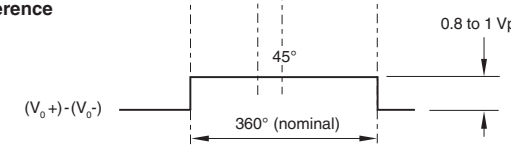
Analogue output signals

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



0.7 to 1.35 Vpp with Green LED indication, (readhead) and 120R termination.
Centred on 1.65 V
NOTE: Ti0000A00V centred on 2.5 V

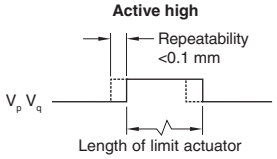
Reference



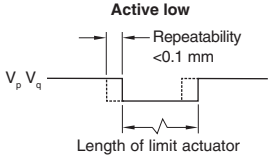
Bi-directionally repeatable Differential pulse V_0, centred on 45°

Limits Open collector output, asynchronous pulse

Ti0000 interface only

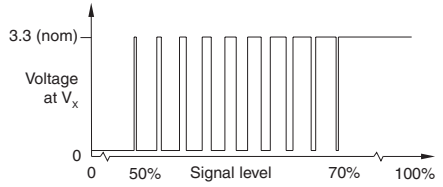


T101x readhead only



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

Set-up*



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

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

†Inverse signals not shown for clarity

General specifications

Power supply	5 V ±10%	Readhead only <100 mA T101x with Ti0000 <100 mA T101x 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 BS EN 60950-1.
	Ripple	200 mVpp maximum @ frequency up to 500 kHz
Temperature (system)	Storage	-20 °C to +70 °C
	Operating	0 °C to +70 °C
(UHV readhead)	Bakeout	+120 °C
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 (system)	Operating	100 m/s^2, 55 Hz to 2000 Hz, 3 axes
Mass		Readhead 10 g Interface 100 g Cable 26 g/m UHV cable 14 g/m
Environmental		Compliant with EU Directive 2011/65/EU (RoHS)
Readhead cable (standard)		Double shielded, outside diameter 4.25 ±0.25 mm. Flex life >20 x 10^6 cycles at 20 mm bend radius. UL recognised component .
(UHV)		Tin coated braided single screen FEP core insulation.
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

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.

Scale technical specifications

Mounting	Epoxy datum point and adhesive tape (nominal thickness 0.2 mm) or datum clamp and mounting clips.
Reference mark	*IN-TRAC* auto phase optical reference mark repeatable to unit of resolution throughout specified temperature speed and range. See installation drawings for information on reference mark position.

RSLM

Material	Hardened martensitic stainless steel.
Form	1.5 mm x 14.9 mm (H x W)
Accuracy	±1.5 µm up to 1 m ±2.25 from 1 m to 2 m ±3 µm from 2 m to 3 m ±4 µm from 3 m to 5 m (includes slope and linearity @20 °C). Calibration traceable to International Standards.
Thermal expansion	10.1 ±0.2 µm/m/°C @20 °C
Maximum length	5 m

RELM

Material	ZeroMet™. High stability, low-expansion nickel-iron alloy.
Form	1.6 mm x 14.9 mm (H x W)
Accuracy	Certified to ±1µm (includes slope and linearity)@20 °C. Calibration traceable to International Standards.
Thermal expansion	0.75 ±0.35 µm/m/°C @20 °C
Maximum length	1.5 m

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