Installation guide
M-9653-9278-01-D

RENISHAW
apply innovation™

TONiC™ DOP (dual output) encoder system

CE

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

FCC compliance

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

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

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

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

RoHS compliance

Compliant with EC directive 2002/95/EC (RoHS)

Patents

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

JP 3,202,316	US 5,241,173	EP 0514081	EP 0543513	US 5302820
US 5,861,953	EP 0748436	US 6,481,115 B1	IL 138995	US 6,775,008 B2
EP 1173731	IL146001	GB 2397040	CN 1293983C	US 7,367,128
JP2005533247	CN 100543424	US 7659992	US 7624513	

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.

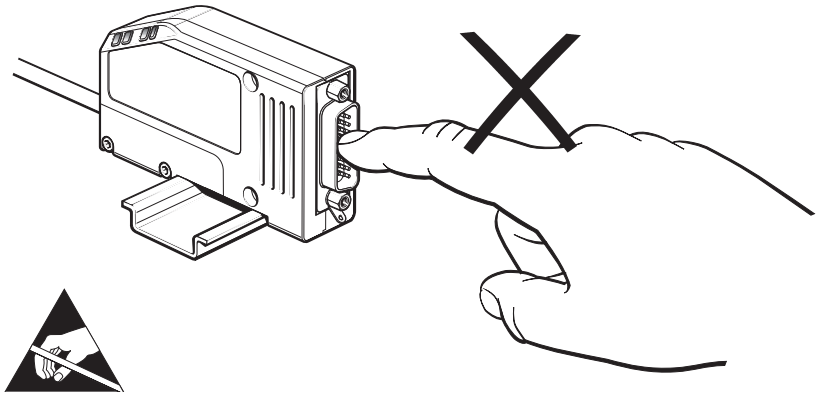
Disclaimer

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

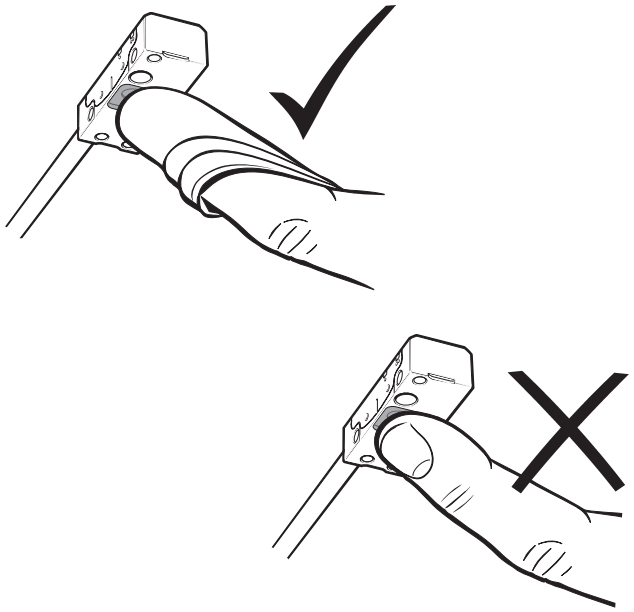
The use of this symbol on Renishaw products and/or accompanying documentation indicates that the product should not be mixed with general household waste upon disposal. It is the responsibility of the end user to dispose of this product at a designated collection point for waste electrical and electronic equipment (WEEE) to enable reuse or recycling. Correct disposal of this product will help to save valuable resources and prevent potential negative effects on the environment. For more information, please contact your local waste disposal service or Renishaw distributor.

Storage and handling

Interface

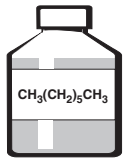


Readhead

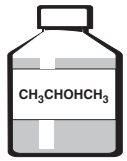


Readhead

N-heptane

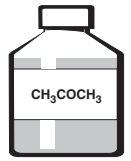


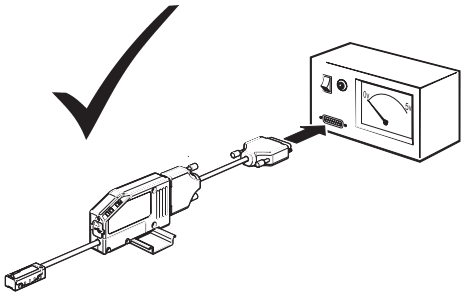
Propan-2-ol

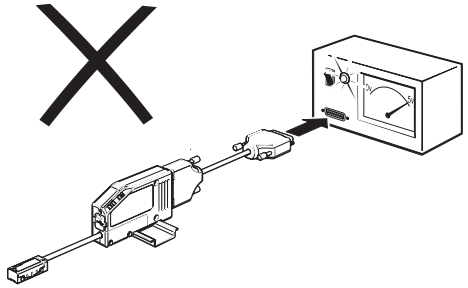


Readhead

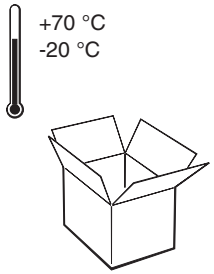
Acetone



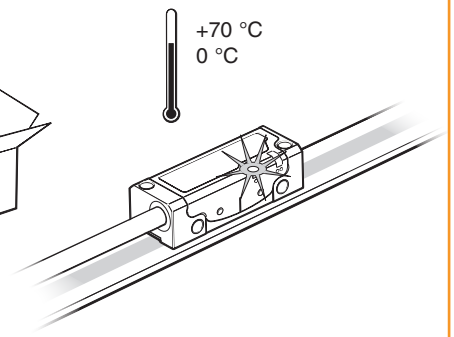




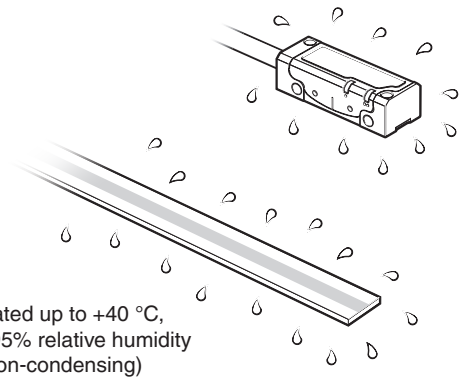
Storage



Operating



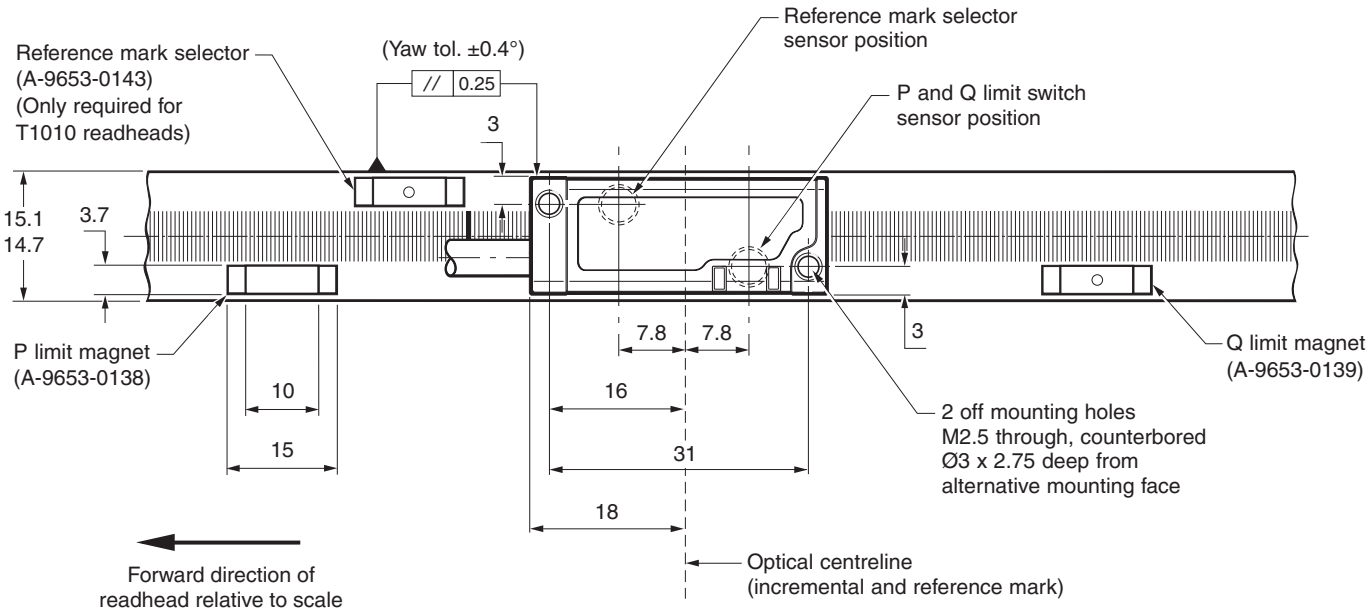
Humidity

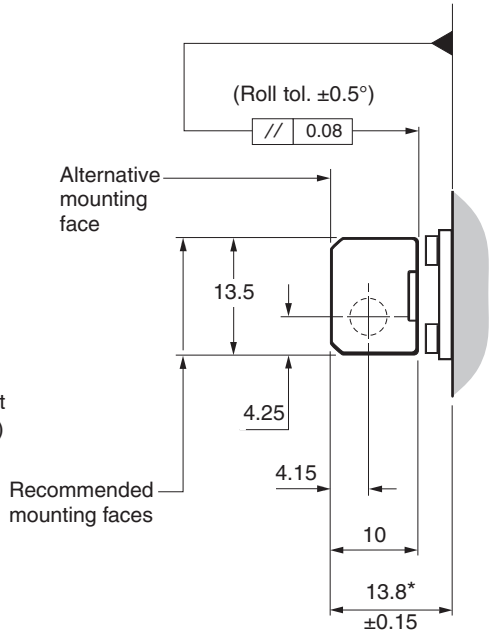


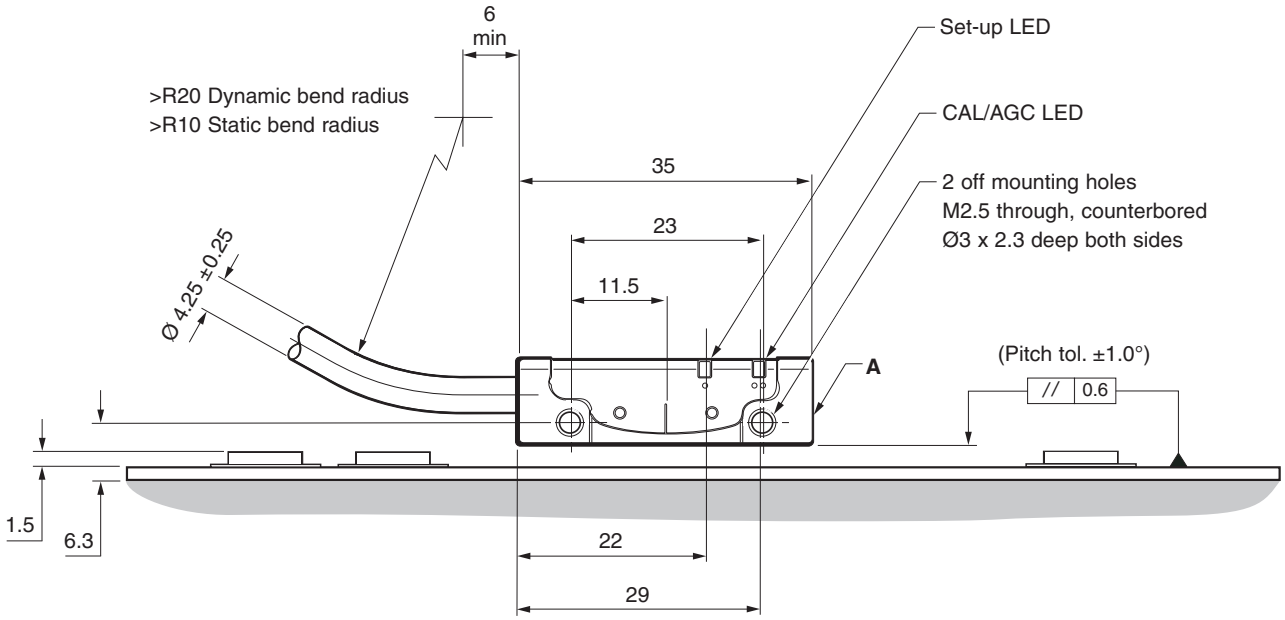
Rated up to +40 °C,
<95% relative humidity
(non-condensing)

TONiC readhead installation drawing (RELM/RSLM scale shown. For other scales, see relevant system installation guide)

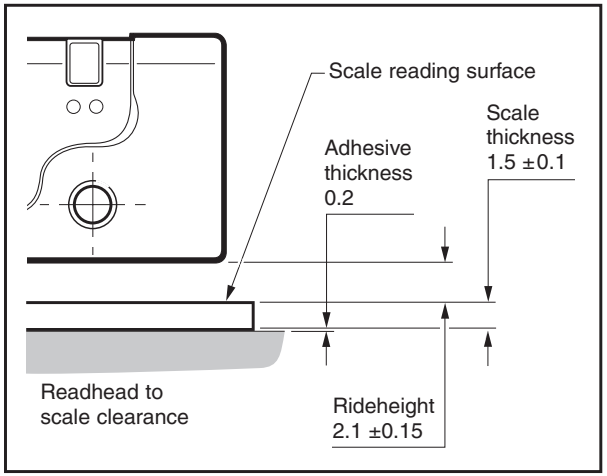
Dimensions and tolerances in mm







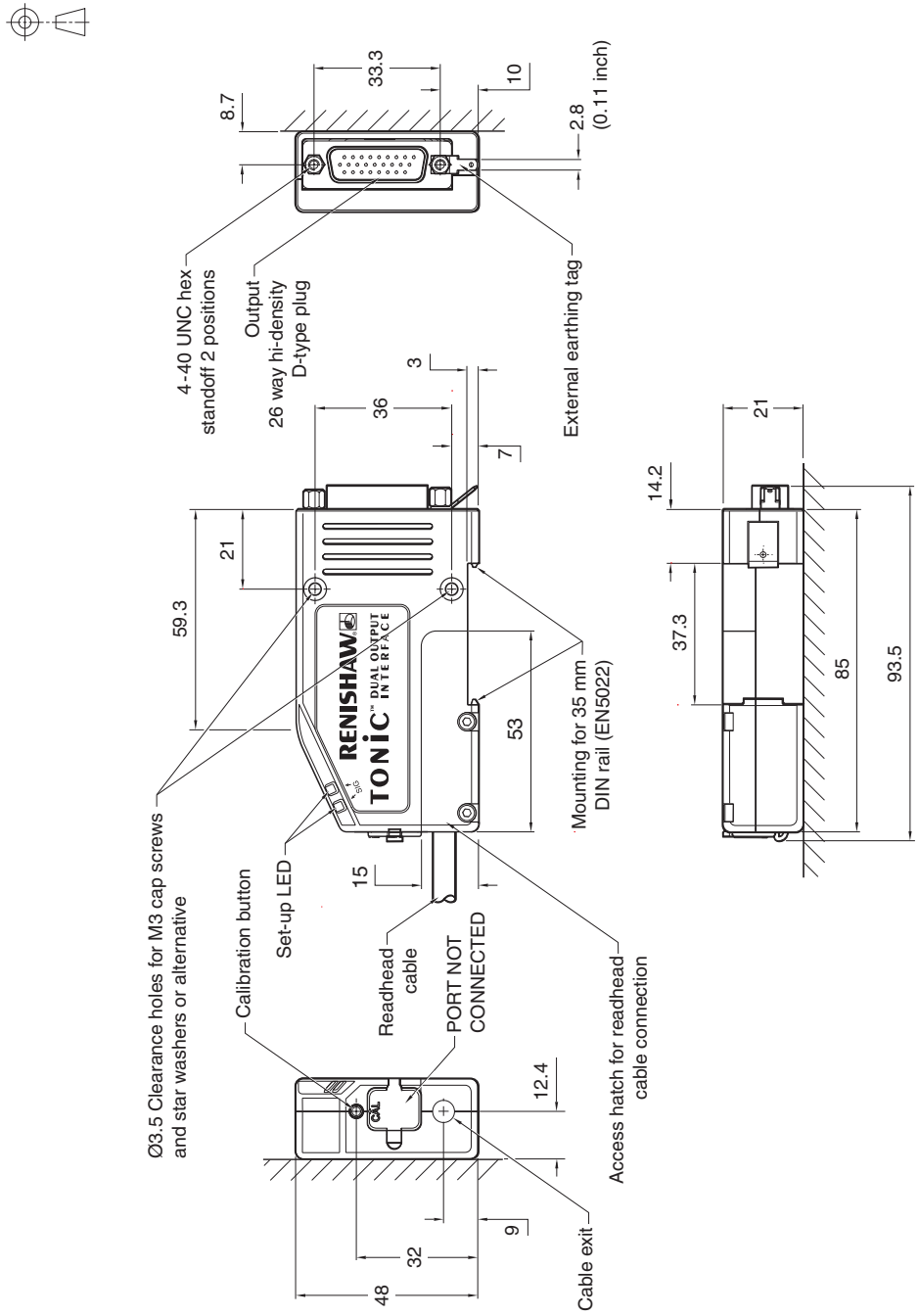
Detail A



*Dimensions from substrate surface

TONiC DOP interface installation drawing

Dimensions and tolerances in mm



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.

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

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

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

CALIBRATION

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

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

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

If a reference mark is being used move the readhead back and forth over the selected reference mark until the CAL LED stops flashing and remains ‘off’.

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

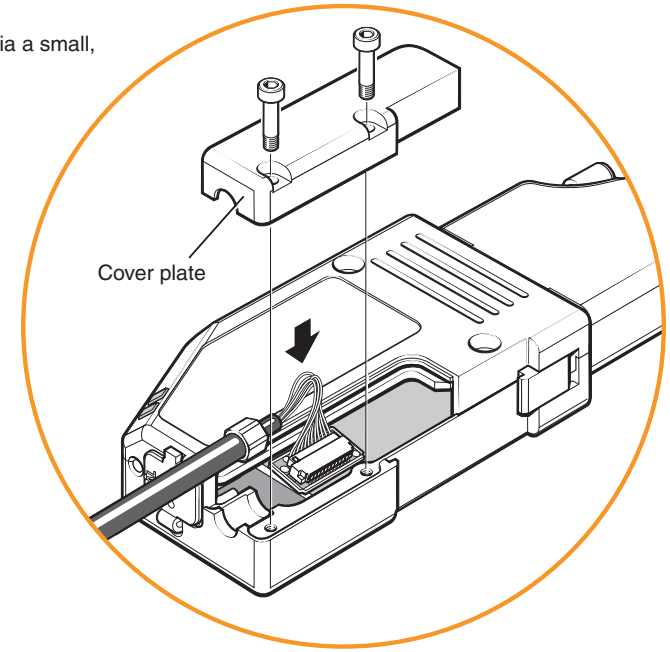
NOTE: If calibration fails restore factory defaults by pressing and holding the CAL button whilst switching on. Then repeat the installation and calibration routine.

System connection

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

Connecting the readhead

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



Disconnecting the readhead

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

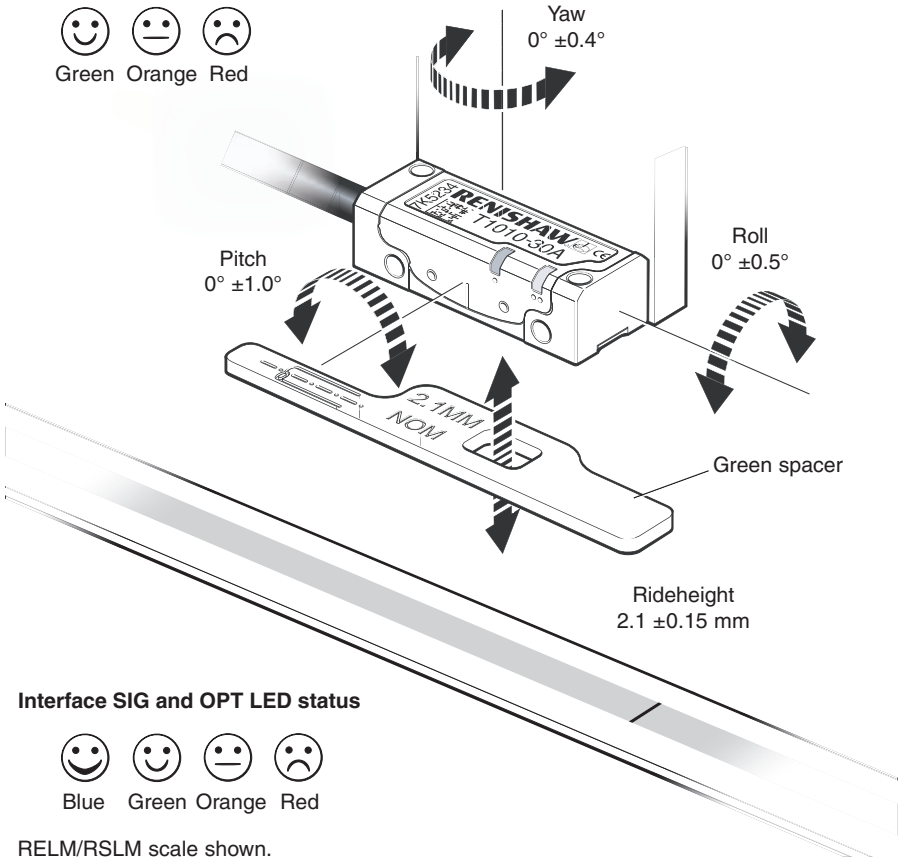
Readhead mounting and alignment

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

Readhead set-up
Ensure that the scale, readhead optical window and mounting face are clean and free from obstructions. To set nominal rideheight, place the readhead spacer with the aperture under the optical centre of the readhead to allow normal LED function during set-up procedure. Adjust the readhead to maximise the signal strength and achieve a green set-up LED on the readhead (70 to 135% signal). Aim for a blue LED on the interface.

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

Readhead set-up LED status



Interface SIG and OPT LED status

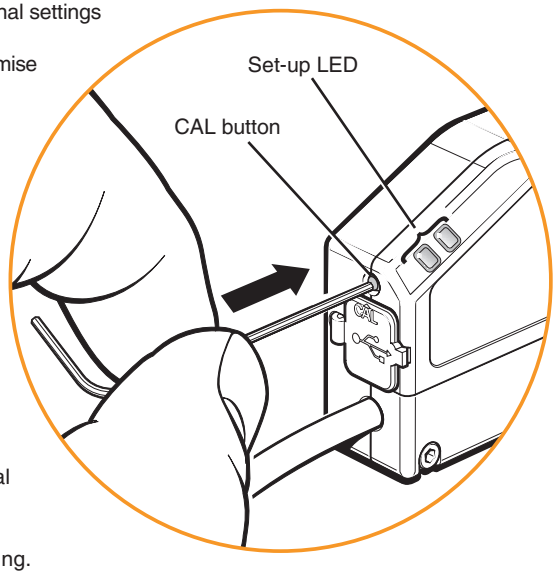
Blue Green Orange Red

RELM/RSLM scale shown.
For other scales, see relevant system installation guide.

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 non-volatile memory.
Before system calibration, install the readhead to maximise the signal strength throughout the axis travel.

NOTE: CAL routine maximum speed <100 mm/s



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 as shown.
- The CAL LED will now periodically single-flash to indicate that it is in incremental signal calibration routine.
- Move the axis at slow speed, ensuring you do not pass the reference mark. The CAL LED will double-flash periodically, 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.

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

Step 2 – Reference mark phasing

- Move the axis until the reference mark passes the readhead optical centre in any direction, the CAL LED will continue to double flash periodically.
- Move the readhead back over the selected reference mark; the CAL LED will stop flashing and remain off. The reference mark is now phased.
- The system automatically exits the CAL routine and is ready for operation.

Calibration routine - manual exit

- To exit the calibration routine at any time press and release the CAL button.
- The CAL LED will stop flashing and remain off.
- If step 1 is complete (CAL LED is periodically double-flashing) the incremental signal CAL settings will be stored.
- Reference mark phasing settings will not be stored for CAL manual exit.
- If the calibration routine has not been completed, restore factory defaults and then repeat the full calibration.

Restoring factory defaults

When re-installing the system, or in the case of incomplete calibration, the 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.

NOTE: The LED on the interface will flash blank when the reference mark is detected (<100 mm/s only). It indicates the presence of a reference mark not the phasing status.

Switching Automatic Gain Control on or off

AGC can be switched on or off via the DOP interface CAL push button switch.

- 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.

Txxxx Readhead LED diagnostics

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

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

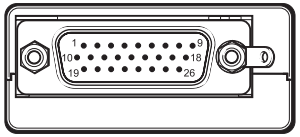
DOP interface set-up LED diagnostics

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

*-Alarm output will take the form of 3-state or line driven E signal depending on interface configuration.
Also, some configurations do not output overspeed alarm. See TONiC DOP Data Sheet (L-9517-9411) for details of interface configuration.
-Momentary status only, while fault condition remains.
-Alarm may result in axis position error, re-datum to continue.

Connections

DOP output

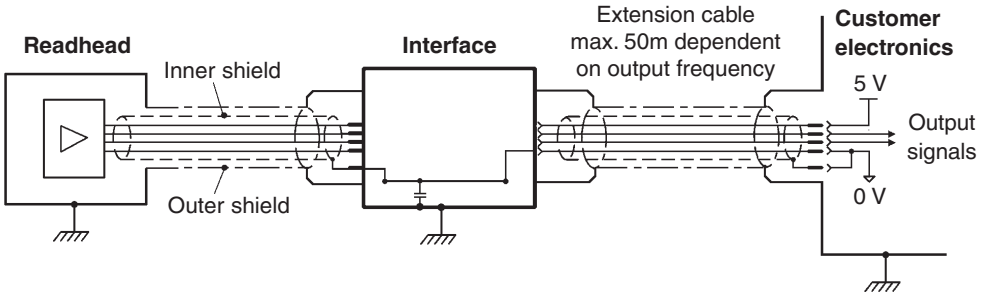


26 pin high density D type plug

Function	Output type		Signal	Pin
Power			5 V Power	26
			5 V Sense	18
			0 V Power	9
			0 V Sense	8
Incremental signals	RS422A digital		A+	24
			A-	6
			B+	7
			B-	16
	Analogue	Cosine	V_1+	1
			V_1-	19
		Sine	V_2+	2
			V_2-	11
Reference mark	RS422A digital		Z+	15
			Z-	23
	Analogue		V_0+	12
			V_0-	20
Alarm	RS422A digital		E+	25
			E-	17
Limits	Open collector		P	4
			Q	13
Readhead set-up	–		X	10
Shield	–		Inner shield	Not connected
	–		Outer shield	Case

Electrical connections

TONiC DOP system grounding and shielding



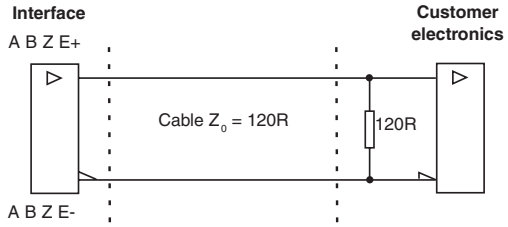
IMPORTANT: The outer shield should be connected to the machine earth (Field Ground). The inner shield should be connected to 0 V at receiving electronics only. Care should be taken to ensure that the inner and outer shields are insulated from each other. If the inner and outer shields are connected together,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

NOTE: The external earthing tag on the interface should be used when mounting the interface on a DIN rail.

NOTE: Maximum cable length between readhead and interface is 10 m.

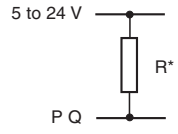
Recommended signal termination

Digital outputs



Standard RS422A line receiver circuitry

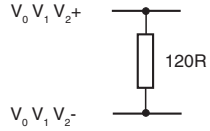
Limit outputs



*Select R so max. current does not exceed 20 mA

Alternatively, use a suitable relay or opto-isolator

Analogue outputs

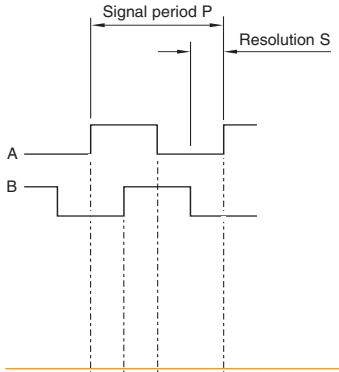


Output specifications

Digital output signals

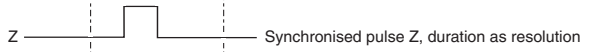
Form - Square wave differential line driver to EIA RS422A (except limits P and Q)

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

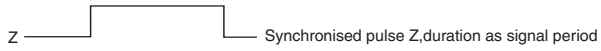


Model	P (µm)	S (µm)
DOP0004	20	5
DOP0020	4	1
DOP0040	2	0.5
DOP0100	0.8	0.2
DOP0200	0.4	0.1
DOP0400	0.2	0.05
DOP1000	0.08	0.02
DOP2000	0.04	0.01
DOP4000	0.02	0.005
DOP10KD	0.008	0.002
DOP20KD	0.004	0.001

Reference†



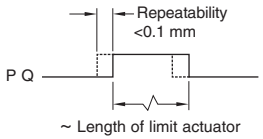
Wide reference†



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

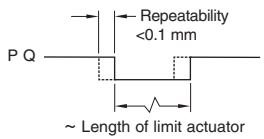
Limits Open collector output, asynchronous pulse

Active high

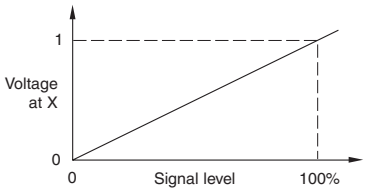


or

Active low



Set-up*



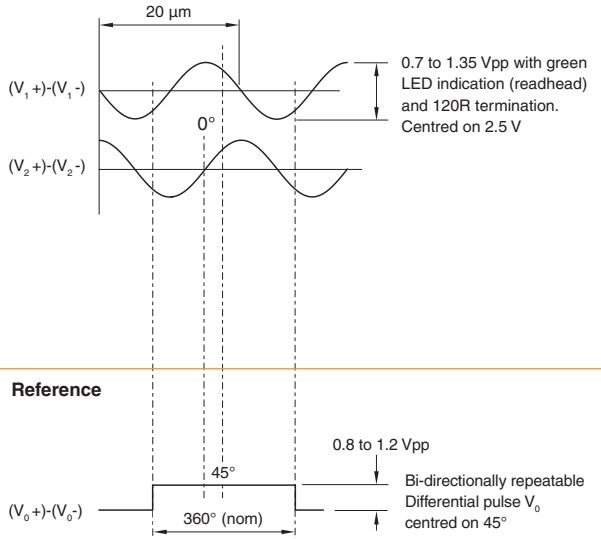
Setup signal voltage proportional to incremental signal amplitude

*Set-up signal as shown is not present during calibration routine

Analogue output signals

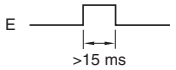
NOTE: Analogue signals are also available direct from all TONiC readheads

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



Reference

Alarm† Asynchronous pulse



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

or 3-state alarm (option)

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

†Inverse signals not shown for clarity

General specifications

Power supply	5 V ±10%	Readhead only <100 mA System <275 mA **NOTE:** Current consumption figures refer to unterminated systems. For digital outputs a further 25 mA per channel pair (eg A+, A-) will be drawn when terminated with 120 Ω. For analogue outputs, a further 20 mA in total will be drawn when terminated with 120 Ω. Power from a 5 V dc supply complying with the requirements for SELV of standard EN (IEC) 60950.
	Ripple	200 mVpp maximum @ frequency up to 500 kHz
Temperature (system)	Storage	-20 °C to +70 °C
	Operating	0 °C to +70 °C
Sealing (readhead)		IP40
(interface)		IP30
Acceleration (readhead)	Operating	500 m/s^2 BS EN 60068-2-7:1993 (IEC 68-2-7:1983)
Shock (system)	Non-operating	1000 m/s^2, 6 ms, ½ sine BS EN 60068-2-27:1993 (IEC 68-2-27:1987)
Vibration (system)	Operating	100 m/s^2, 55 Hz to 2000 Hz BS EN 60068-2-6:1996 (IEC 68-2-6:1995)
Mass		Readhead 10 g Interface 205 g Cable 26 g/m
Environmental		Compliant with EU Directive 2002/95/EC (RoHS)
Readhead cable		Double shielded, outside diameter 4.25 ±0.25 mm. Flex life >20 x 10^6 cycles at 20 mm bend radius. UL recognised component

Maximum cable length

Readhead to interface: 10 m

Interface to controller:

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

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

Speed

Minimum receiver clock frequency (MHz)	Maximum speed (m/s)										
	DOP 0004 5 µm	**DOP 0020 1 µm**	**DOP 0040 0.5 µm**	**DOP 0100 0.2 µm**	**DOP 0200 0.1 µm**	**DOP 0400 50 nm**	**DOP 1000 20 nm**	**DOP 2000 10 nm**	**DOP 4000 5 nm**	**DOP 10KD 2 nm**	**DOP 20KD 1 nm**
50	10	10	10	6.48	3.24	1.62	0.648	0.324	0.162	0.065	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
8	10	6.48	3.24	1.29	0.648	0.324	0.130	0.065	0.032	0.013	0.0065
6	10	4.50	2.25	0.90	0.450	0.225	0.090	0.045	0.023	0.009	0.0045
4	10	3.37	1.68	0.67	0.338	0.169	0.068	0.034	0.017	0.0068	0.0034
1	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)										

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

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

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

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

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

RENISHAW
apply innovation™

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