Data sheet
L-9517-9411-04-B

RENISHAW
apply innovation™

TONiC™ DOP (dual output) encoder system



Renishaw's TONiC series encoders are now available with simultaneous dual output interfacing.

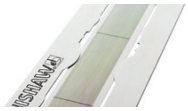
The robust DOP interface can be situated up to 10 m from the TONiC readhead and offers simultaneous analogue and digital outputs with interpolation to 1 nm resolution. Digital outputs are clocked for optimised speed performance at all resolutions for industry-standard controllers.

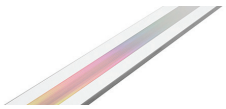
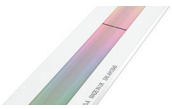
The readhead is compatible with a wide range of linear, partial arc and rotary scales with bi-directional optical IN-TRAC™ reference marks. For ultimate reliability and high dirt immunity, TONiC readheads incorporate Renishaw's market proven filtering optics, tuned for even lower noise (jitter), further enhanced by dynamic signal processing including Auto Gain Control (AGC) and Auto Offset Control (AOC). The result is ultra-low sub-divisional error (SDE) giving smoother velocity control for improved scanning performance and increased positional stability.

- **Compact readhead (35 mm × 13.5 mm × 10 mm)**
- **Detachable DOP interface with integral interpolation to 1 nm resolution (0.00075 arc seconds) and simultaneous digital and analogue outputs**
- **Compatible with a wide range of linear, partial arc and rotary scales with customer selectable IN-TRAC auto-phase optical reference mark (datum)**
- **Optimised filtering optics for even lower noise (jitter)**
- **Dynamic signal processing inside the readhead, provides ultra-low SDE of typically ±30 nm**
- **Auto Gain Control ensures consistent signal strength for long-term reliability**
- **Increased ride height tolerance and integral set-up LED for ease of installation**
- **Maximum speed to 10 m/s (3.24 m/s at 0.1 µm resolution)**
- **Integral dual limits (linear only)**
- **Operating temperature to 70 °C**

Compatible scales

Linear scales

	RTLC20-S	RTLC20/FASTRACK™	RKLC20-S [2]
	Self-adhesive mounted stainless-steel tape scale	**Stainless-steel tape scale and self-adhesive mounted carrier**	**Self-adhesive mounted stainless-steel tape scale**
			
Form (height × width)	0.4 mm × 8 mm including adhesive	RTLC20 scale: 0.2 mm × 8 mm FASTRACK carrier: 0.4 mm × 18 mm including adhesive	0.15 mm × 6 mm including adhesive
Accuracy (includes slope and linearity)	±5 µm/m	±5 µm/m	±5 µm/m
Linearity (figures achievable with two-point error correction)	±2.5 µm/m	±2.5 µm/m	±2.5 µm/m
Maximum length	10 m [1] (> 10 m available on request)	10 m (> 10 m available on request)	20 m (> 20 m available on request)
Coefficient of thermal expansion (at 20 °C)	10.1 ±0.2 µm/m/°C	10.1 ±0.2 µm/m/°C	Matches that of substrate material when scale ends fixed by epoxy-mounted end clamps

	RSLM20	RELM20
	Self-adhesive or clip/clamp mounted stainless-steel spar scale	**Self-adhesive or clip/clamp mounted low-expansion ZeroMet™ spar scale**
		
Form (height × width)	1.5 mm × 14.9 mm	1.6 mm × 14.9 mm
Accuracy (includes slope and linearity)	±4 µm (total accuracy over a complete 5 m length)	±1 µm (total accuracy up to 1 m)
Linearity (figures achievable with two-point error correction)	N/A	N/A
Maximum length	5 m	1.7 m
Coefficient of thermal expansion (at 20 °C)	10.1 ±0.2 µm/m/°C	0.75 ±0.35 µm/m/°C

NOTE: For more information about the. scales refer to the relevant scale data sheet which can be downloaded from **www.renishaw.com/tonicdownloads**.

[1] For RTLC20-S axis lengths > 2 m, FASTRACK with RTLC20 is recommended.

[2] Suitable for partial arc applications. For more information refer to *RKL scale for partial arc applications* data sheet (Renishaw part no. L-9517-9897).

Rotary scales

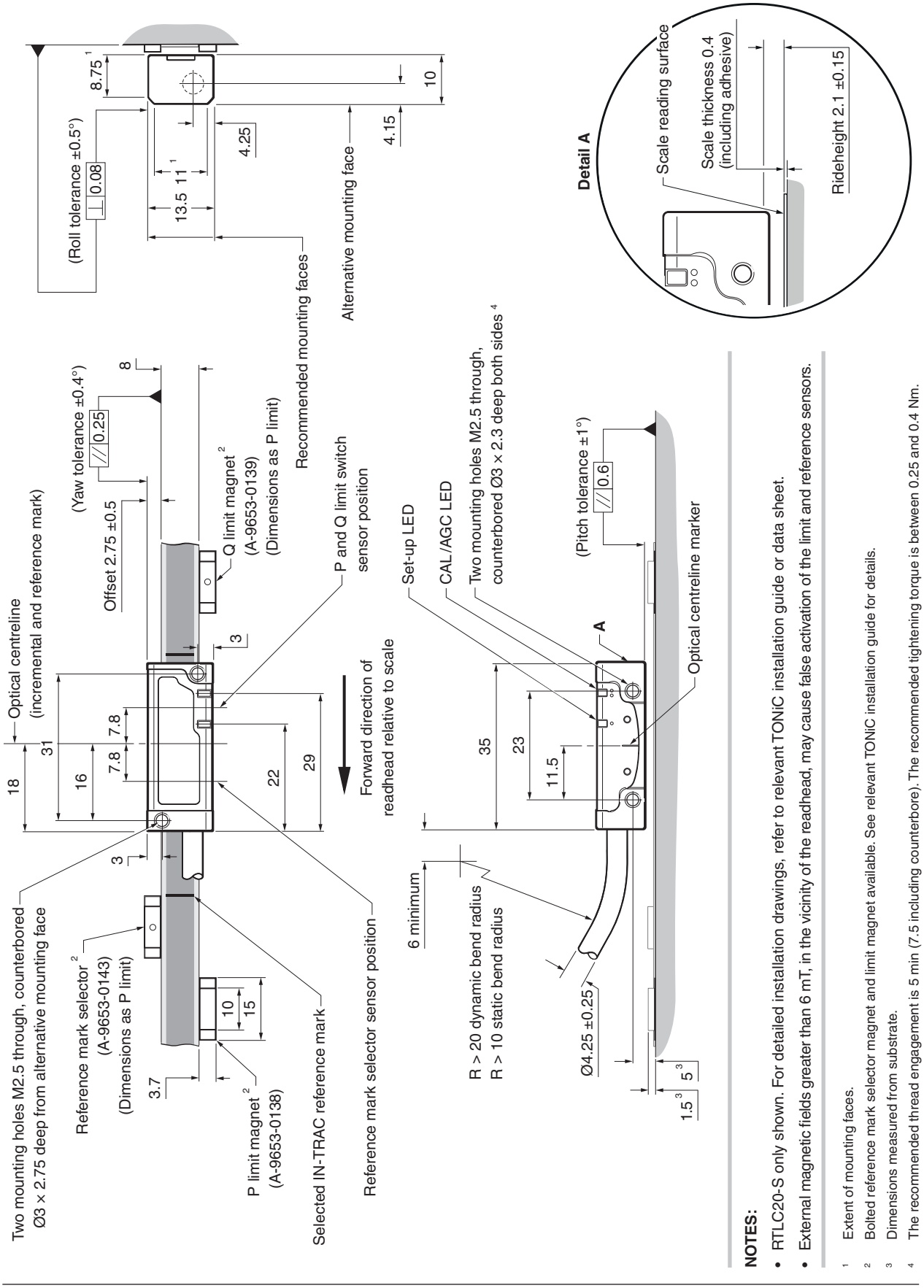
	RESM20	REXM20
	Stainless-steel ring	**Ultra-high accuracy stainless-steel ring**
		
Accuracy	±1.9 arc second (typical installed accuracy for a 550 mm diameter RESM20 ring) [1]	±1 arc second [2] (total installed accuracy for a 417 mm diameter REXM20 ring)
Ring diameters	52 mm to 550 mm	52 mm to 417 mm
Coefficient of thermal expansion (at 20 °C)	15.5 ±0.5 µm/m/°C	15.5 ±0.5 µm/m/°C

[1] "Typical" installations are a result of graduation and installation errors combining and, to some magnitude, cancelling.

[2] When using two readheads and an additional DSi interface.

TONiC readhead installation drawing (on RTLC20-S scale)

Dimensions and tolerances in mm



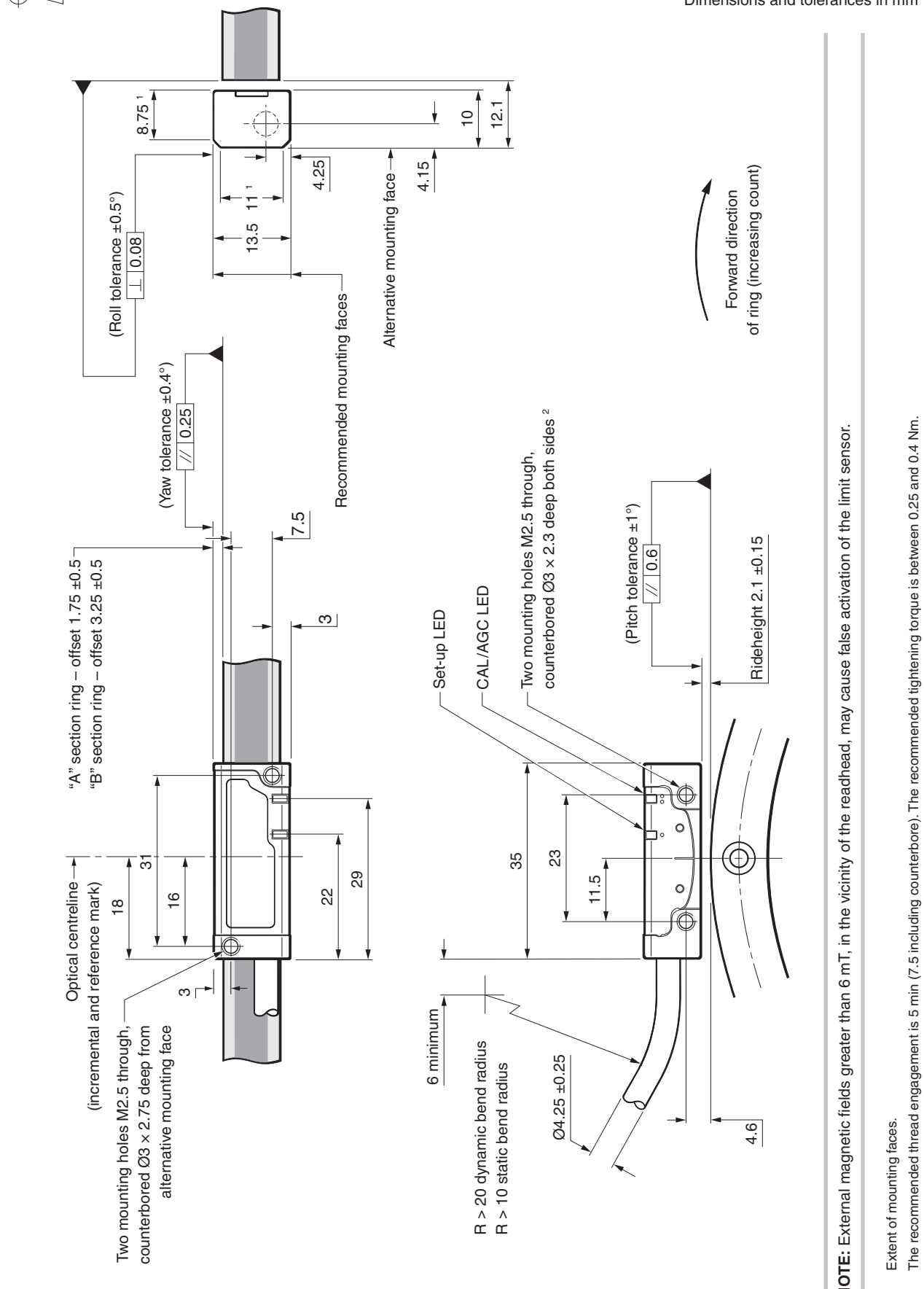
NOTES:

- RTLC20-S only shown. For detailed installation drawings, refer to relevant TONiC installation guide or data sheet.
- External magnetic fields greater than 6 mT, in the vicinity of the readhead, may cause false activation of the limit and reference sensors.

1. Extent of mounting faces.
2. Bolted reference mark selector magnet and limit magnet available. See relevant TONiC installation guide for details.
3. Dimensions measured from substrate.
4. The recommended thread engagement is 5 min (7.5 including counterbore). The recommended tightening torque is between 0.25 and 0.4 Nm.

TONiC readhead installation drawing (on RESM20 ring)

Dimensions and tolerances in mm



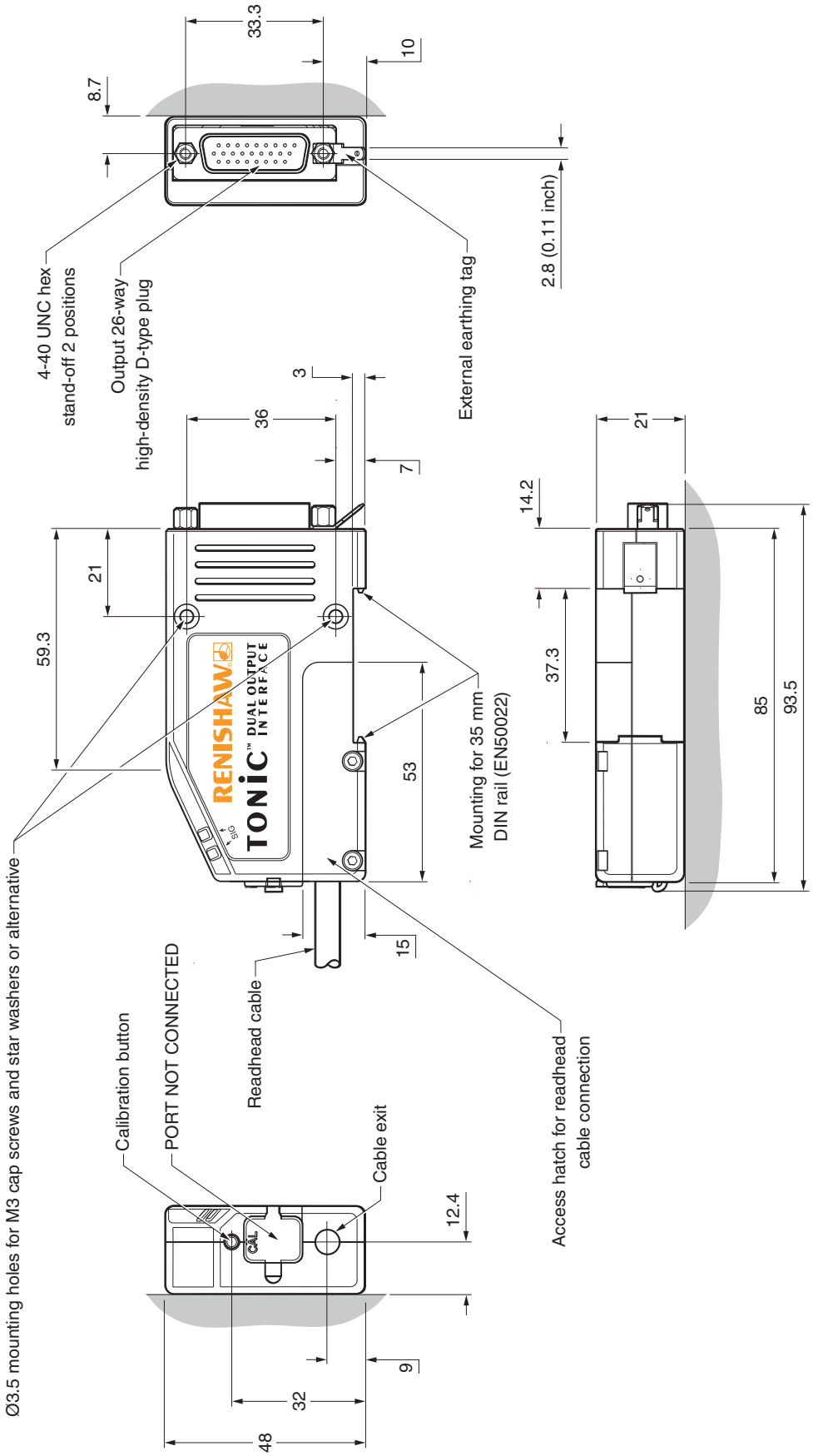
NOTE: External magnetic fields greater than 6 mT, in the vicinity of the readhead, may cause false activation of the limit sensor.

[1] Extent of mounting faces.

[2] The recommended thread engagement is 5 min (7.5 including counterbore). The recommended tightening torque is between 0.25 and 0.4 Nm.

DOP interface dimension drawing

Dimensions and tolerances in mm



General specifications

Power supply [1]	5V ±10%	Readhead only < 100 mA System < 250 mA (typical) 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
Temperature (system)	Storage	–20 °C to +70 °C
	Operating	0 °C to +70 °C
Humidity (system)		95% relative humidity (non-condensing) to IEC 60068-2-78
Sealing	Readhead	IP40
	Interface	IP30
Acceleration (readhead)	Operating	500 m/s², 3 axes
Shock (system)	Non-operating	1000 m/s², 6 ms, ½ sine, 3 axes
Vibration (system)	Operating	Sinusoidal 100 m/s² max @ 55 Hz to 2000 Hz, 3 axes
Mass	Readhead	10 g
	Interface	205 g
	Cable	26 g/m
EMC compliance (system)		IEC 61326-1
Readhead cable		Double-shielded, outside diameter 4.25 ±0.25 mm Flex life > 20 × 10^6 cycles at 20 mm bend radius UL recognised component
Typical sub-divisional error (SDE)		±30 nm

[1] Current consumption figures refer to unterminated systems.

Speed

Clocked output option (MHz)	Maximum speed (m/s)					
	DOP0004 5 µm	DOP0020 1 µm	DOP0040 0.5 µm	DOP0100 0.2 µm	DOP0200 0.1 µm	DOP0400 50 nm
50	10	10	10	6.48	3.240	1.625
40	10	10	10	5.40	2.700	1.350
25	10	10	8.10	3.24	1.620	0.810
20	10	10	6.75	2.70	1.350	0.670
12	10	9	4.50	1.80	0.900	0.450
10	10	8.10	4.05	1.62	0.810	0.400
08	10	6.48	3.24	1.29	0.648	0.324
06	10	4.50	2.25	0.90	0.450	0.225
04	10	3.37	1.68	0.67	0.338	0.169
01	4.2	0.84	0.42	0.16	0.084	0.042
Analogue output	10 (–3 dB)					

Clocked output option (MHz)	Maximum speed (m/s)				
	DOP1000 20 nm	DOP2000 10 nm	DOP4000 5 nm	DOP10KD 2 nm	DOP20KD 1 nm
50	0.648	0.324	0.162	0.065	0.032
40	0.540	0.270	0.135	0.054	0.027
25	0.324	0.162	0.081	0.032	0.016
20	0.270	0.135	0.068	0.027	0.013
12	0.180	0.090	0.045	0.018	0.009
10	0.162	0.081	0.041	0.016	0.0081
08	0.130	0.065	0.032	0.013	0.0065
06	0.090	0.045	0.023	0.009	0.0045
04	0.068	0.034	0.017	0.0068	0.0034
01	0.017	0.008	0.004	0.0017	0.0008
Analogue output	10 (–3 dB)				

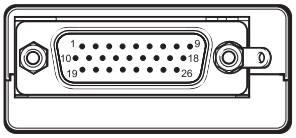
Angular speed depends on ring diameter – use the following equation to convert to rev/min:

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

Where V = maximum linear speed (m/s) and
D = external diameter of RESM20 or REXM20 ring (mm).

DOP output signals

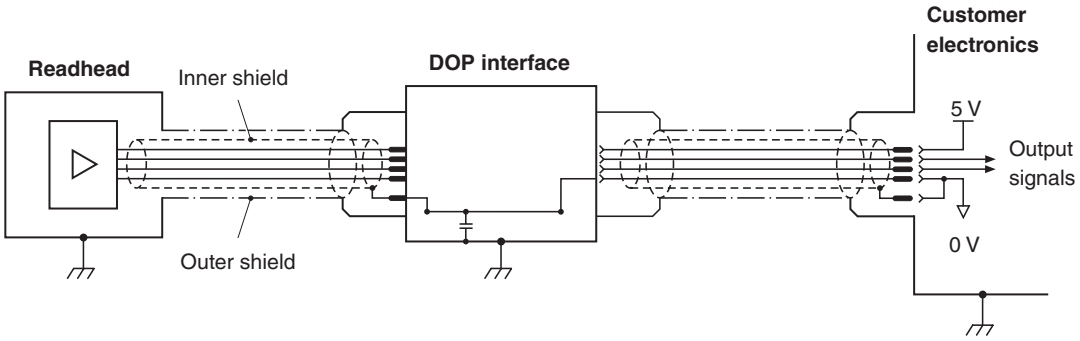
Function	Output signals		Signal	Pin
Power	-		5 V Power	26
			5 V Sense	18
			0 V Power	9
			0 V Sense	8
Incremental signals	RS422A digital		A+	24
			A–	6
			B+	7
			B–	16
	Analogue	Cosine	V_1+	1
			V_1–	19
		Sine	V_2+	2
			V_2–	11
Reference mark	RS422A digital		Z+	15
			Z–	23
	Analogue		V_0+	12
			V_0–	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



26-pin high-density D-type plug

Electrical connections

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.

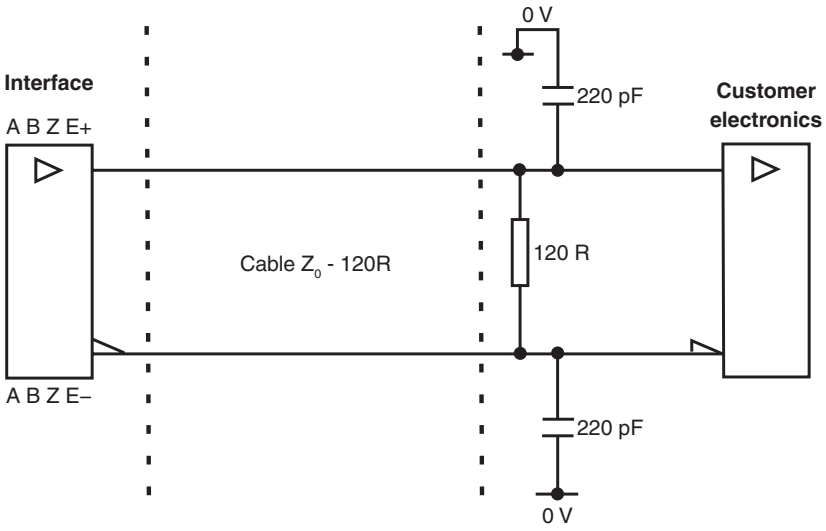
Maximum cable length

Readhead to interface: 10 m

Interface to controller: Dependent on clocked output option. See table below for details.

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

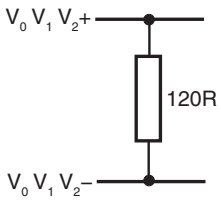
Recommended signal termination



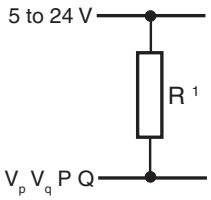
Standard RS422A line receiver circuitry.

Capacitors recommended for improved noise immunity.

Analogue outputs



Limit outputs



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

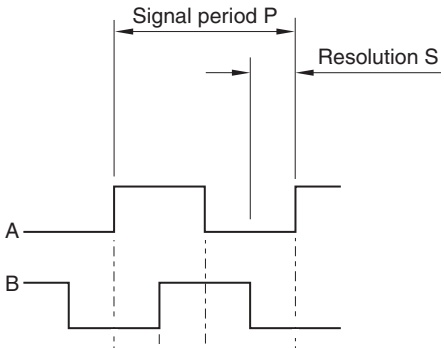
Output specifications

Digital output signals

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

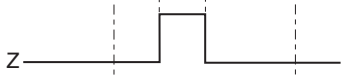
Incremental [1]

Two 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 [1]



Synchronised pulse Z, duration as resolution.
Bi-directionally repeatable. [2]

Wide reference [1]



Synchronised pulse Z, duration as signal period.
Bi-directionally repeatable. [2]

NOTES:

- Select “standard” or “wide” reference at time of ordering, to match the requirements of the controller being used.
- Wide reference mark not available with DOP0004.

[1] For clarity, the inverse signals are not shown.

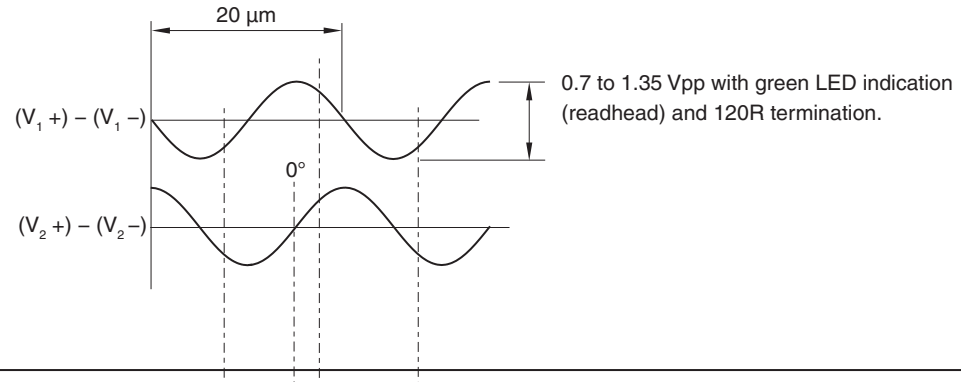
[2] Only the calibrated reference mark is bi-directionally repeatable.

Analogue output signals

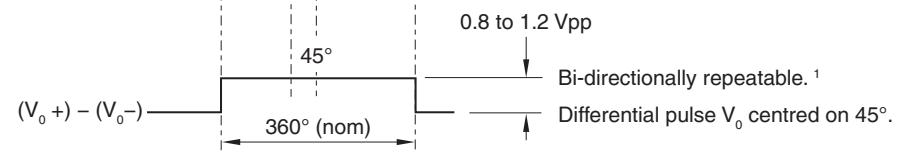
NOTE: Analogue signals are also available direct from all TONiC readheads.

Incremental

Two channels V_1 and V_2 differential sinusoids in quadrature, centred on 2.5 V (90° phase shifted).



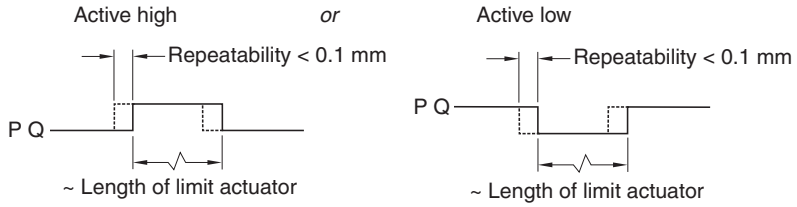
Reference



[1] Only the calibrated reference mark is bi-directionally repeatable.

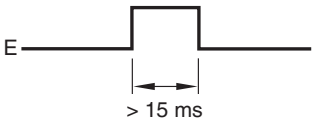
Limits

Open collector output, asynchronous pulse.



Alarm [1]

Line driven (asynchronous pulse)



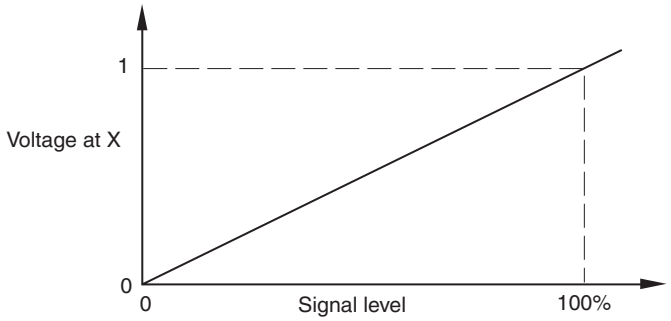
Alarm asserted when:

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

or 3-state alarm

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

Set-up [2]

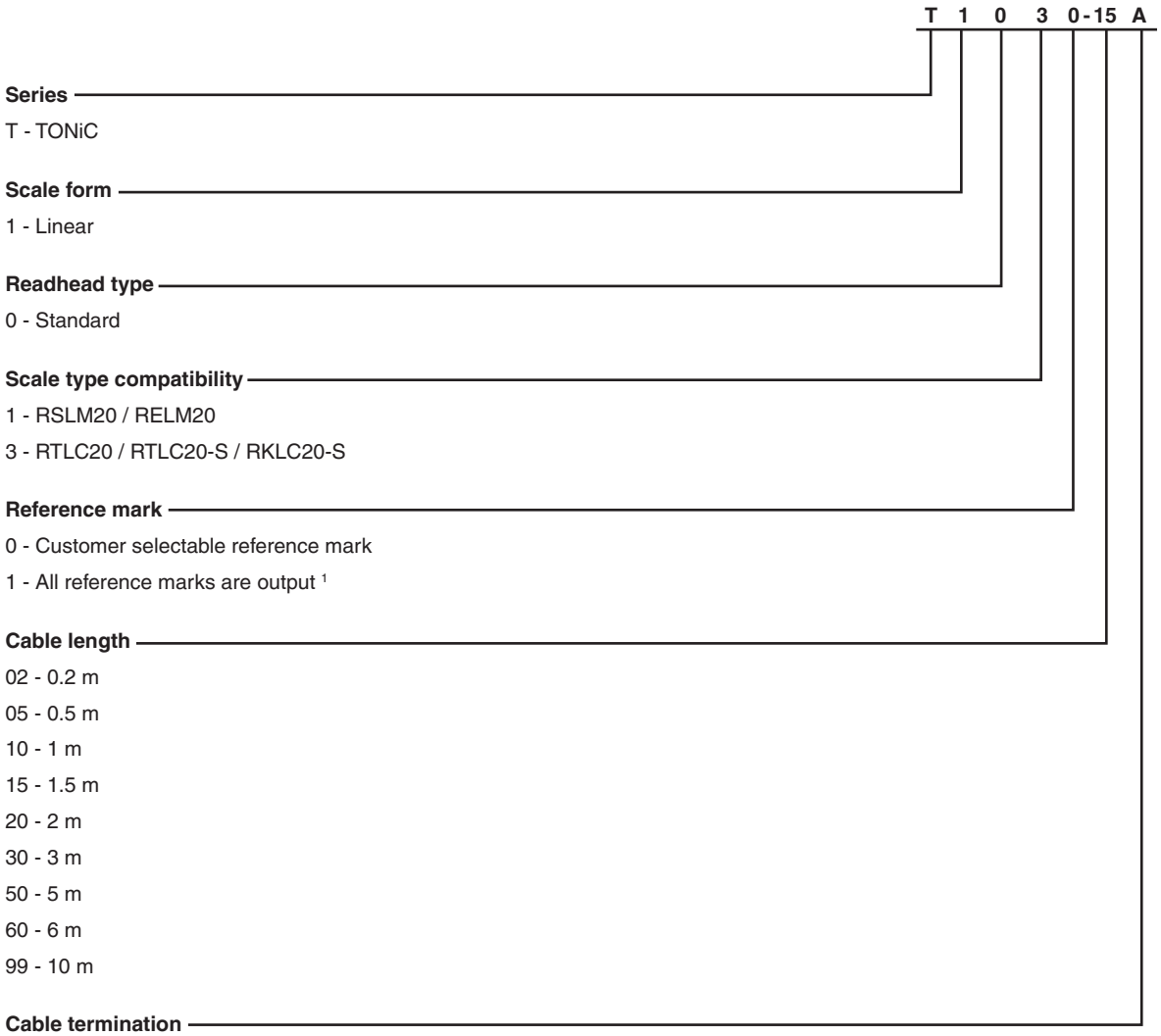


The set-up signal voltage is proportional to incremental signal amplitude.

[1] For clarity, the inverse signals are not shown.

[2] The set-up signal as shown is not present during the calibration routine.

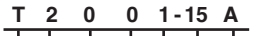
Linear readhead part numbers



NOTE: Not all combinations are valid. Check valid options online at **www.renishaw.com/epc**.

[1] Only the calibrated reference mark is bi-directionally repeatable.

Rotary readhead part numbers



Series

T - TONiC

Scale form

2 - Rotary

Readhead type

0 - Standard

Ring diameter

0 - RESM20 / REXM20 > Ø135 mm

1 - RESM20 / REXM20 Ø60 mm to Ø135 mm

2 - RESM20 / REXM20 < Ø60 mm

Reference mark

1 - All reference marks are output

Cable length

02 - 0.2 m

05 - 0.5 m

10 - 1 m

15 - 1.5 m

20 - 2 m

30 - 3 m

50 - 5 m

60 - 6 m

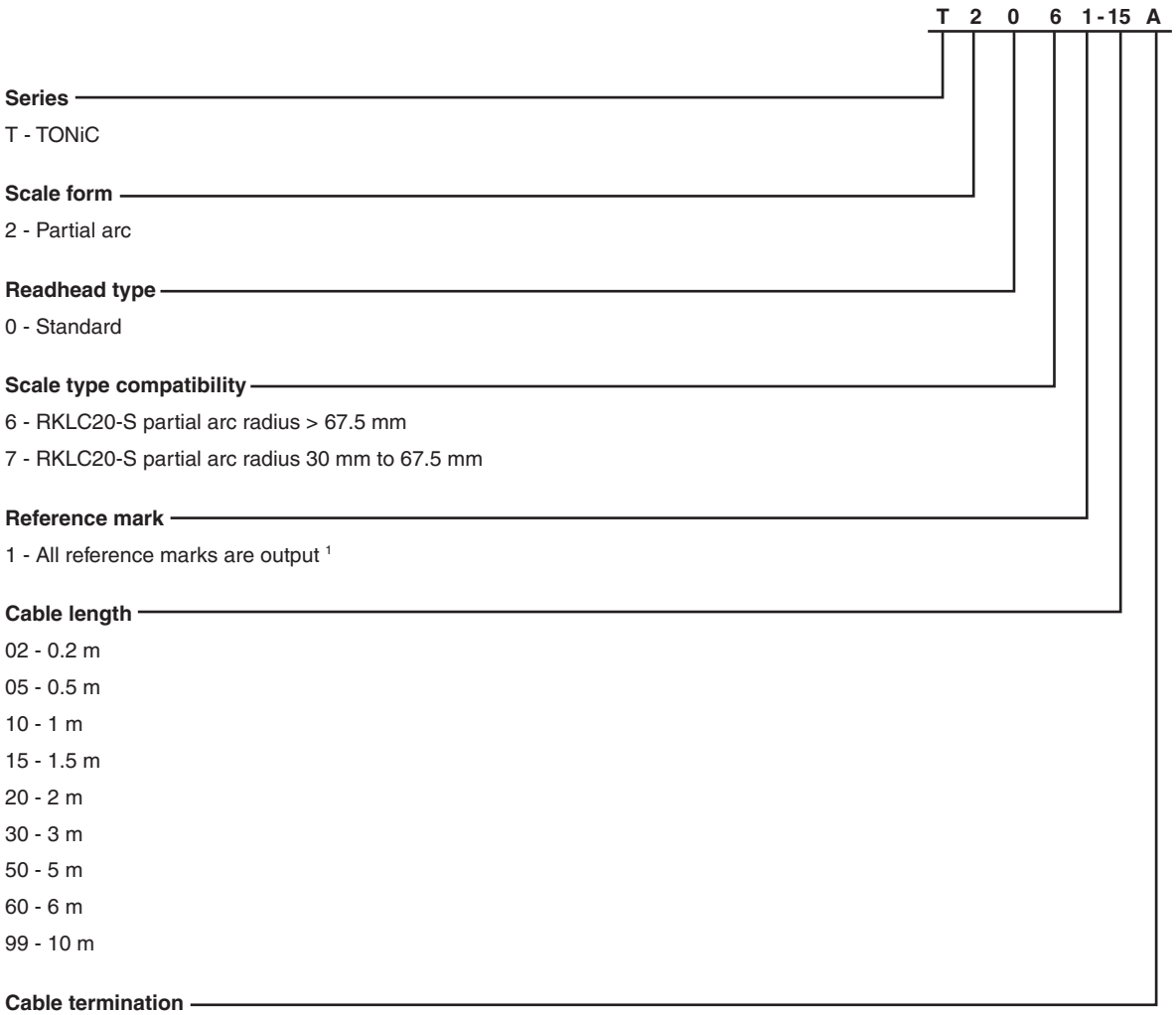
99 - 10 m

Cable termination

A - Standard mini connector to mate with the DOP interface

NOTE: Not all combinations are valid. Check valid options online at www.renishaw.com/epc.

Partial arc readhead part numbers



NOTES:

- For more information refer to *RKL scale for partial arc applications* data sheet (Renishaw part no. L-9517-9897).
- Not all combinations are valid. Check valid options online at **www.renishaw.com/epc**.

[1] Only the calibrated reference mark is bi-directionally repeatable.

DOP interface part numbers

Compatible with all TONiC readheads

DOP 0200 A 20 A

Series

DOP - TONiC dual output interface

Interpolation factor/resolution [1]

0004 - 5 µm [2]	1000 - 20 nm
0020 - 1 µm	2000 - 10 nm
0040 - 0.5 µm	4000 - 5 nm
0100 - 0.2 µm	10KD - 2 nm
0200 - 0.1 µm	20KD - 1 nm
0400 - 50 nm	

Alarm format and conditions [3]

A - Line driven E output; All alarms

B - Line driven E output; Low signal and high signal alarms only

E - 3-state; All alarms

F - 3-state; Low signal and high signal alarms only

Clocked output option [3]

50 - 50 MHz	10 - 10 MHz
40 - 40 MHz	08 - 8 MHz
25 - 25 MHz	06 - 6 MHz
20 - 20 MHz	04 - 4 MHz
12 - 12 MHz	01 - 1 MHz

Options

A - P/Q limits – “active high”, standard reference mark

B - P/Q limits – “active low”, standard reference mark

C - P/Q limits – “active high”, wide reference mark [2]

D - P/Q limits – “active low”, wide reference mark [2]

NOTE: Not all combinations are valid. Check valid options online at **www.renishaw.com/epc**.

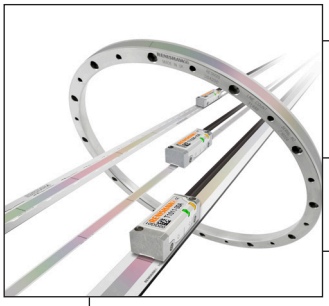
[1] Additional interpolation factors available. Contact your local Renishaw representative for further details.

[2] Wide reference mark not available on DOP0004 (5 µm) interfaces.

RENISHAW
apply innovation™

TONiC compatible products

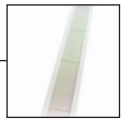
TONiC series



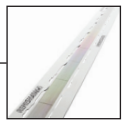
TONiC DOP
Dual output interface



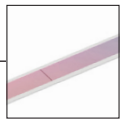
RTLC20-S self-adhesive tape scale



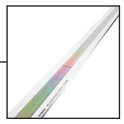
RTLC20 tape scale and FASTRACK carrier



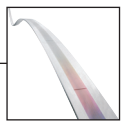
RKLC20-S self-adhesive mastered tape scale



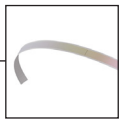
RELM20 self-adhesive or clip/clamp mounted ZeroMet spar scale



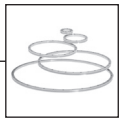
RSLM20 self-adhesive or clip/clamp mounted stainless steel spar scale



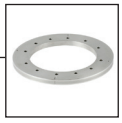
RKLC20-S self-adhesive tape scale (partial arc)



RESM20 stainless-steel ring



REXM20 high-accuracy stainless-steel ring



www.renishaw.com/contact

#renishaw

+44 (0) 1453 524524 uk@renishaw.com

© 2009–2026 Renishaw plc. All rights reserved. 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 prior written permission of Renishaw.
RENISHAW® and the probe symbol are registered trade marks of Renishaw plc. Renishaw product names, designations and the mark "apply innovation" are trade marks of Renishaw plc or its subsidiaries. Other brand, product or company names are trade marks of their respective owners.
WHILE CONSIDERABLE EFFORT WAS MADE TO VERIFY THE ACCURACY OF THIS DOCUMENT AT PUBLICATION, ALL WARRANTIES, CONDITIONS, REPRESENTATIONS AND LIABILITY, HOWSOEVER ARISING, ARE EXCLUDED TO THE EXTENT PERMITTED BY LAW.
RENISHAW RESERVES THE RIGHT TO MAKE CHANGES TO THIS DOCUMENT AND TO THE EQUIPMENT, AND/OR SOFTWARE AND THE SPECIFICATION DESCRIBED HEREIN WITHOUT OBLIGATION TO PROVIDE NOTICE OF SUCH CHANGES.
Renishaw plc. Registered in England and Wales. Company no: 1106260. Registered office: New Mills, Wotton-under-Edge, Glos, GL12 8JR, UK.

Part no.: L-9517-9411-04-B
Issued: 11.2026