Data sheet
L-9517-9411-03-E

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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.

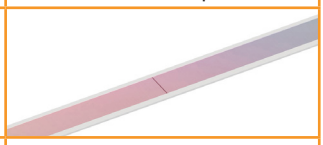
The readhead is compatible with a wide range of linear, partial arc and rotary scales with bi-directional optical *IN-TRAC*™ reference marks.

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**

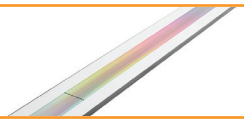
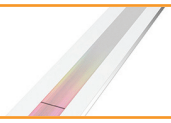
Compatible scales

Linear scales

	RTLC20-S	RTLC20/*FASTRACK*™	RKLC20-S†
	Self-adhesive mounted stainless steel tape scale	Stainless steel tape scale and self-adhesive mounted carrier	Self-adhesive mounted stainless steel tape scale
			
Form (H × W)	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* (> 10 m available on request)	10 m (> 10 m on available 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

* For RTLC20-S axis lengths > 2 m, *FASTRACK* with RTLC20 is recommended.

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

	RSLM20	RELM20
	Self-adhesive or clip/clamp mounted stainless steel spar scale	Self-adhesive or clip/clamp mounted low-expansion ZeroMet™ spar scale
		
Form (H × W)	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 (Total accuracy up to 1 m)
Linearity (Figures achievable with two-point error correction)	N/A	N/A
Maximum length	5 m	1.5 m
Coefficient of thermal expansion (at 20 °C)	10.1 ±0.2 µm/m/°C	0.75 ±0.35 µm/m/°C

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

Rotary scales

	RESM20	REXM20
	Stainless steel ring	Ultra-high accuracy stainless steel ring
		
Accuracy	±1.9 arc second (Typical installed accuracy for 550 mm diameter RESM20 ring) *	±1 arc second † (Total installed accuracy for 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

* Typical' installations are a result of graduation and installation errors combining and, to some magnitude, cancelling.

† When using two readheads and an additional DSi interface.

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

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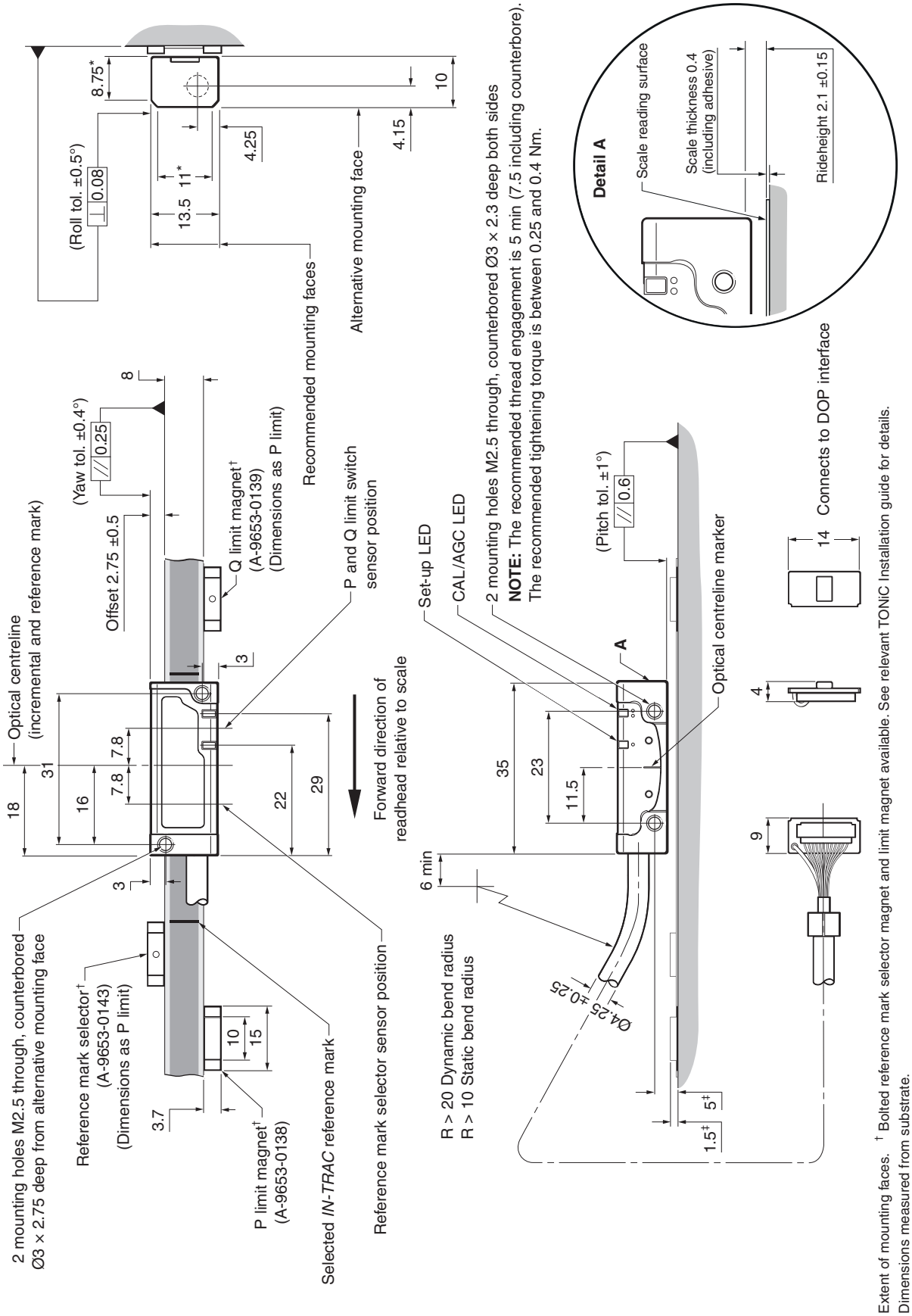
TONiC readhead installation drawing (on RTLC20-S scale)

Dimensions and tolerances in mm



* Extent of mounting faces. † Bolted reference mark selector magnet and limit magnet available. See relevant TONiC Installation guide for details.
‡ Dimensions measured from substrate.

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.

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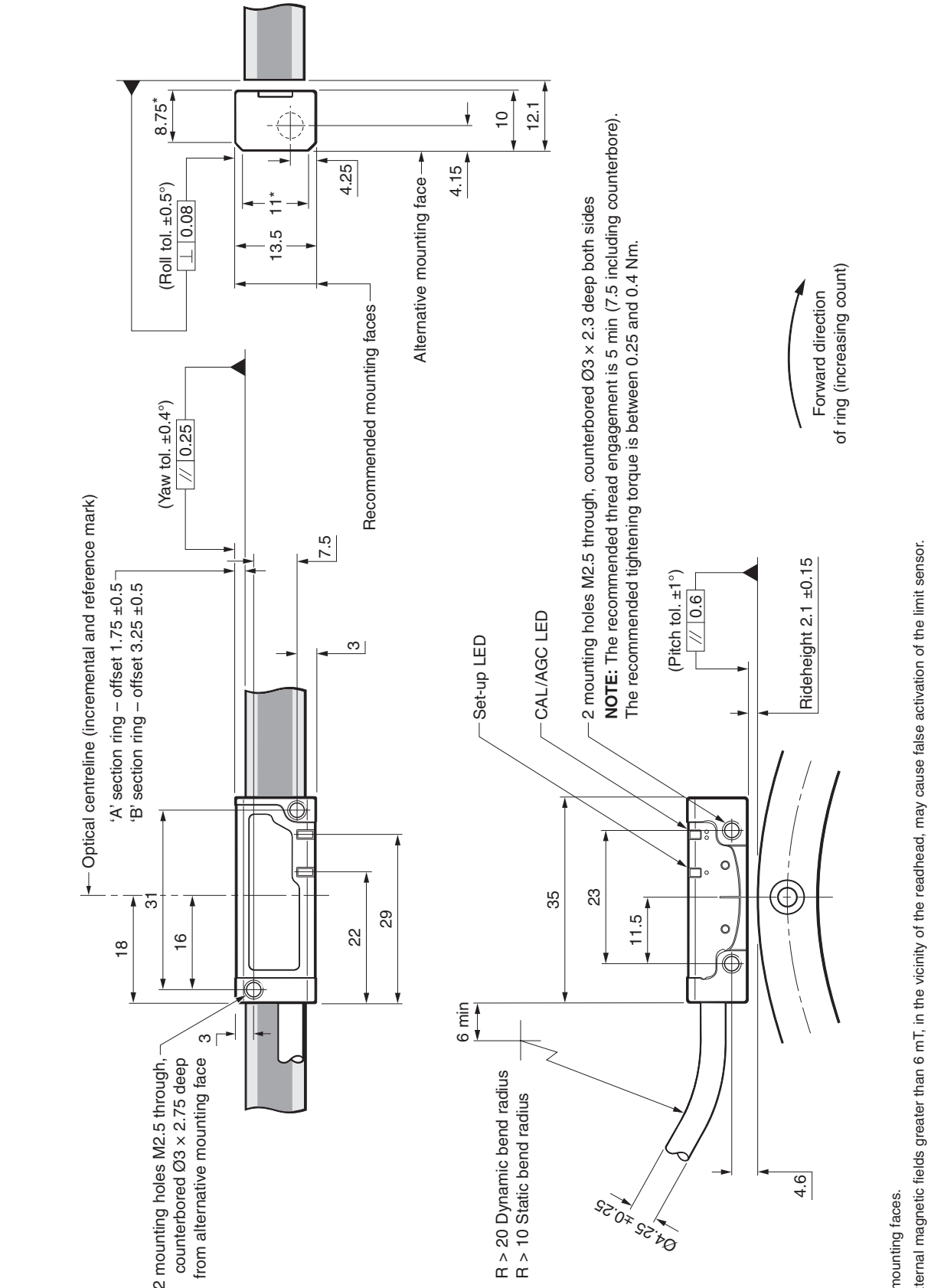
TONiC readhead installation drawing (on RESM20 ring)

Dimensions and tolerances in mm



* Extent of mounting faces.

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

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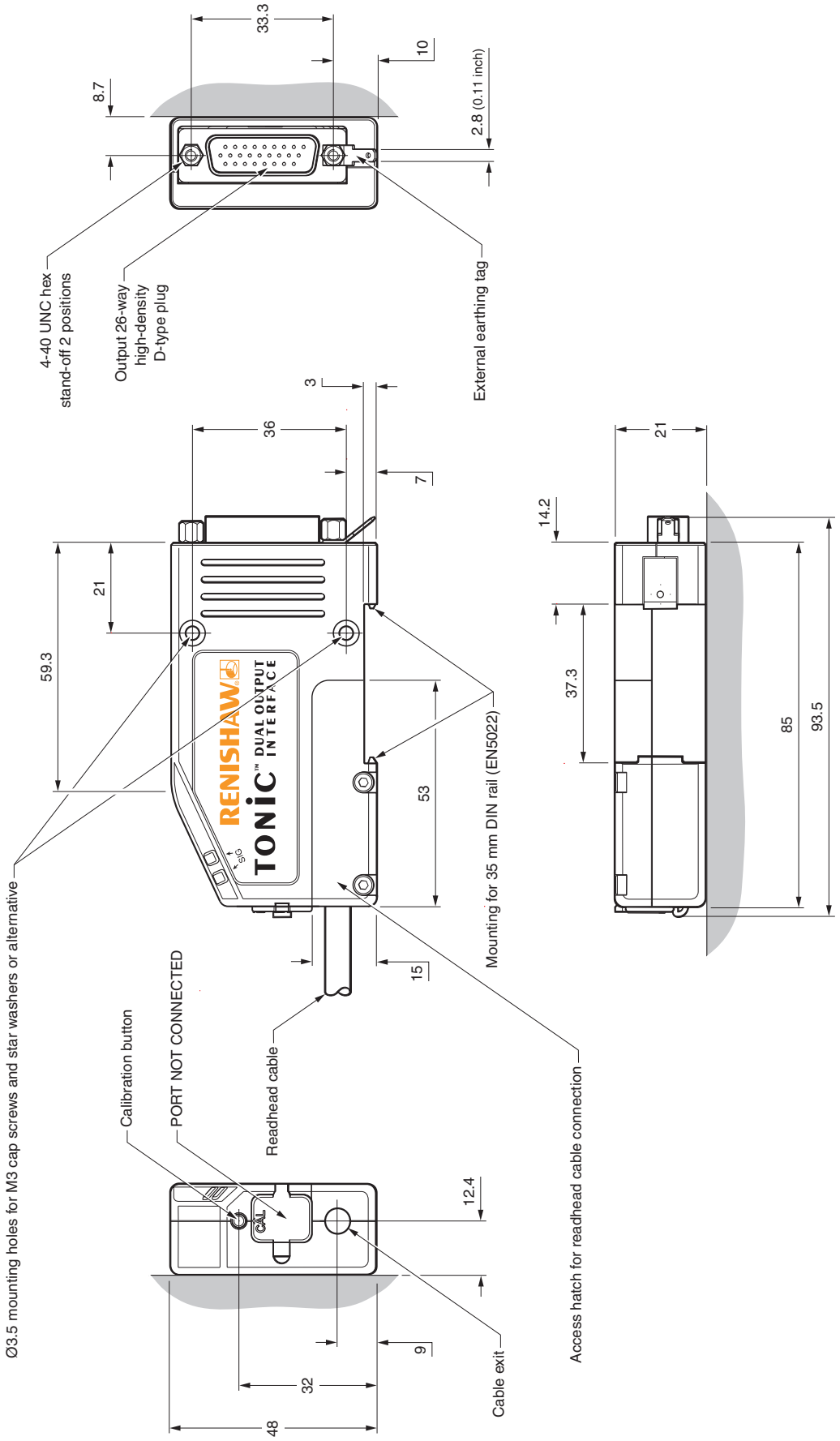
DOP interface dimension drawing

Dimensions and tolerances in mm



General specifications

Power supply	5V ±10%	Readhead only < 100 mA
		System < 275 mA (typical)
		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 R.
		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	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

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	DOP1000 20 nm	DOP2000 10 nm	DOP4000 5 nm	DOP10KD 2 nm	DOP20KD 1 nm
50	10	10	10	6.48	3.24	1.625	0.648	0.324	0.162	0.065	0.032
40	10	10	10	5.4	2.7	1.35	0.54	0.27	0.135	0.054	0.027
25	10	10	8.1	3.24	1.62	0.81	0.324	0.162	0.081	0.032	0.016
20	10	10	6.75	2.7	1.35	0.67	0.27	0.135	0.068	0.027	0.013
12	10	9	4.5	1.8	0.9	0.45	0.18	0.09	0.045	0.018	0.009
10	10	8	4.05	1.62	0.81	0.4	0.162	0.081	0.041	0.016	0.0081
08	10	6.48	3.24	1.29	0.648	0.324	0.13	0.065	0.032	0.013	0.0065
06	10	4.5	2.25	0.9	0.45	0.225	0.09	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)										

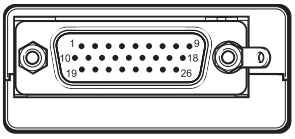
Angular speed depends on ring diameter – use the following equation to convert to rev/min:

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

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

DOP output signals

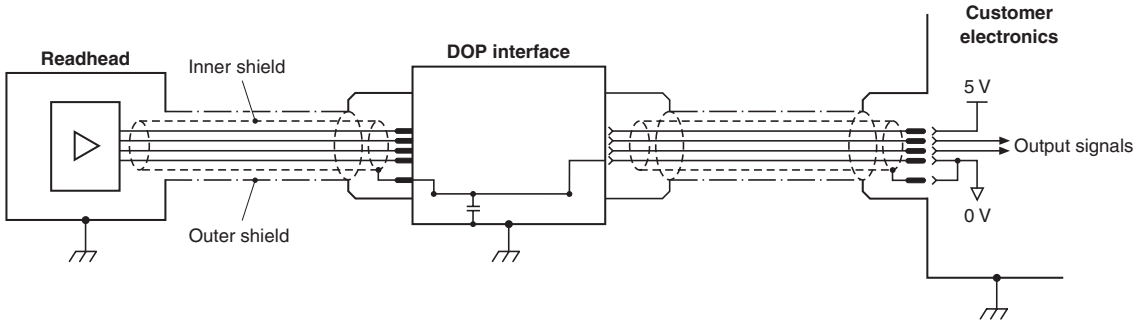
Function	Output signals		Signal	Pin
Power	-		5 V Power	26
			5 V Sense	18
			0 V Power	9
			0 V Sense	8
Incremental signals	RS422A digital		A+	24
			A–	6
			B+	7
			B–	16
	Analogue	Cosine	V_1+	1
			V_1–	19
		Sine	V_2+	2
			V_2–	11
Reference mark	RS422A digital		Z+	15
			Z–	23
	Analogue		V_0+	12
			V_0–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

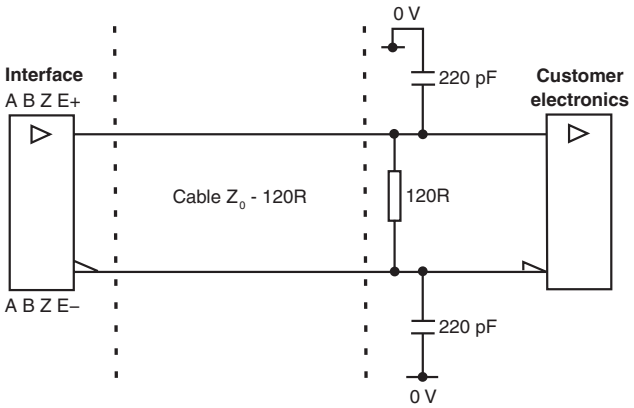
Readhead to interface: 10 m

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

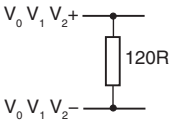
Recommended signal termination

Digital outputs

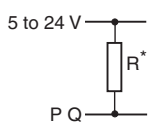


Standard RS422A line receiver circuitry.
Capacitors recommended for improved noise immunity.

Analogue outputs



Limit outputs



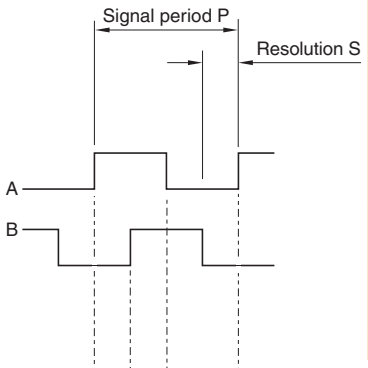
* Select R so maximum current does not exceed 20 mA.
Alternatively, use a suitable relay or opto-isolator.

Output specifications

Digital output signals

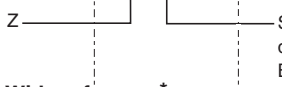
Form – Square wave differential line driver to EIA RS422A (except limits P and Q)

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



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*



Synchronised pulse Z, duration as resolution. Bi-directionally repeatable.†

Wide reference*

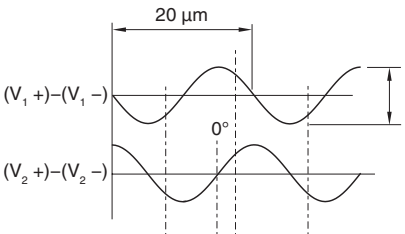
Synchronised pulse Z, duration as signal period. Bi-directionally repeatable.†

NOTE: 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 (5 µm resolution).

Analogue output signals

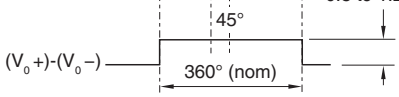
NOTE: Analogue signals are also available direct from all TONiC readheads

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



0.7 to 1.35 Vpp with green LED indication (readhead) and 120R termination. Centred on 2.5 V.

Reference



0.8 to 1.2 Vpp

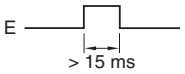
Bi-directionally repeatable. Differential pulse V_0 centred on 45°.

Limits Open collector output, asynchronous pulse

Active high or **Active low**

Alarm* Asynchronous pulse

Line driven

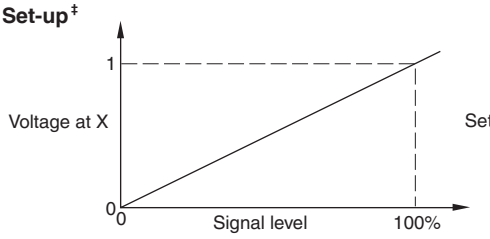


Alarm asserted when:
– Signal amplitude < 20% or > 135%
– Readhead speed too high for reliable operation

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.

* Inverse signals not shown for clarity.
† Only calibrated reference mark is bi-directionally repeatable.
‡ Set-up signal as shown is not present during calibration routine.

Linear readhead part numbers

Series

T - TONiC

Scale form

1 - Linear

Readhead type

0 - Standard

Scale type compatibility

1 - RSLM20 / RELM20

3 - RTLC20 / RTLC20-S / RKLC20-S

Reference mark

0 - Customer selectable 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 DOP interface

* Only calibrated reference mark is bi-directionally repeatable.

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

Rotary readhead part numbers

T 2 0 0 1 - 15 A

Series
T - TONiC

Scale form
2 - Rotary

Readhead type
0 - Standard

Ring diameter
0 - RESM20 / REXM20 > ∅135 mm
1 - RESM20 / REXM20 ∅60 mm to ∅135 mm
2 - RESM20 / REXM20 < ∅60 mm

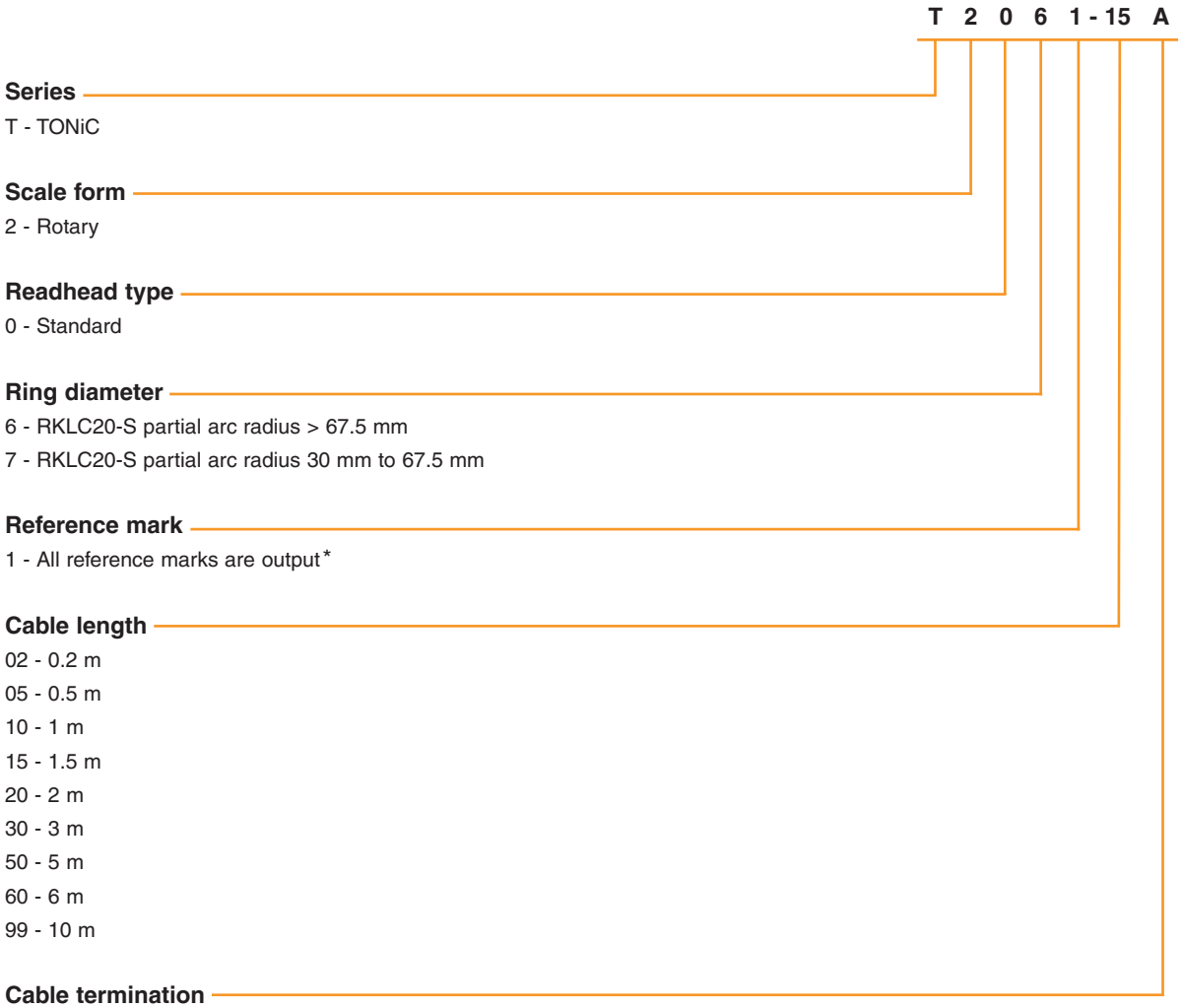
Reference mark
1 - All reference marks are output

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 DOP interface

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

Partial arc readhead part numbers



* Only calibrated reference mark is bi-directionally repeatable.

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

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

DOP interface part numbers

Compatible with all TONiC readheads

DOP 0200 A 20 A

Series

DOP - TONiC dual output interface

Interpolation factor / resolution*

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

Alarm format and conditions

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

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

Reference mark

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†
D - P/Q limits - 'Active low', wide reference mark†

* Additional interpolation factors available. Contact your local Renishaw representative for further details.

† Wide reference mark not available with DOP0004 (5 µm) interfaces.

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

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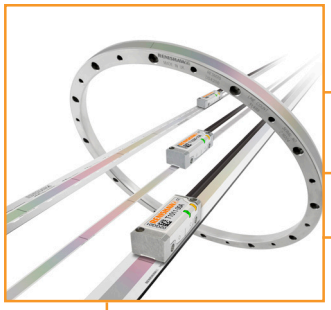
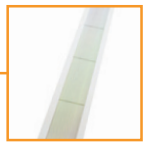
TONiC series compatible products

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

For worldwide contact details, visit www.renishaw.com/contact

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