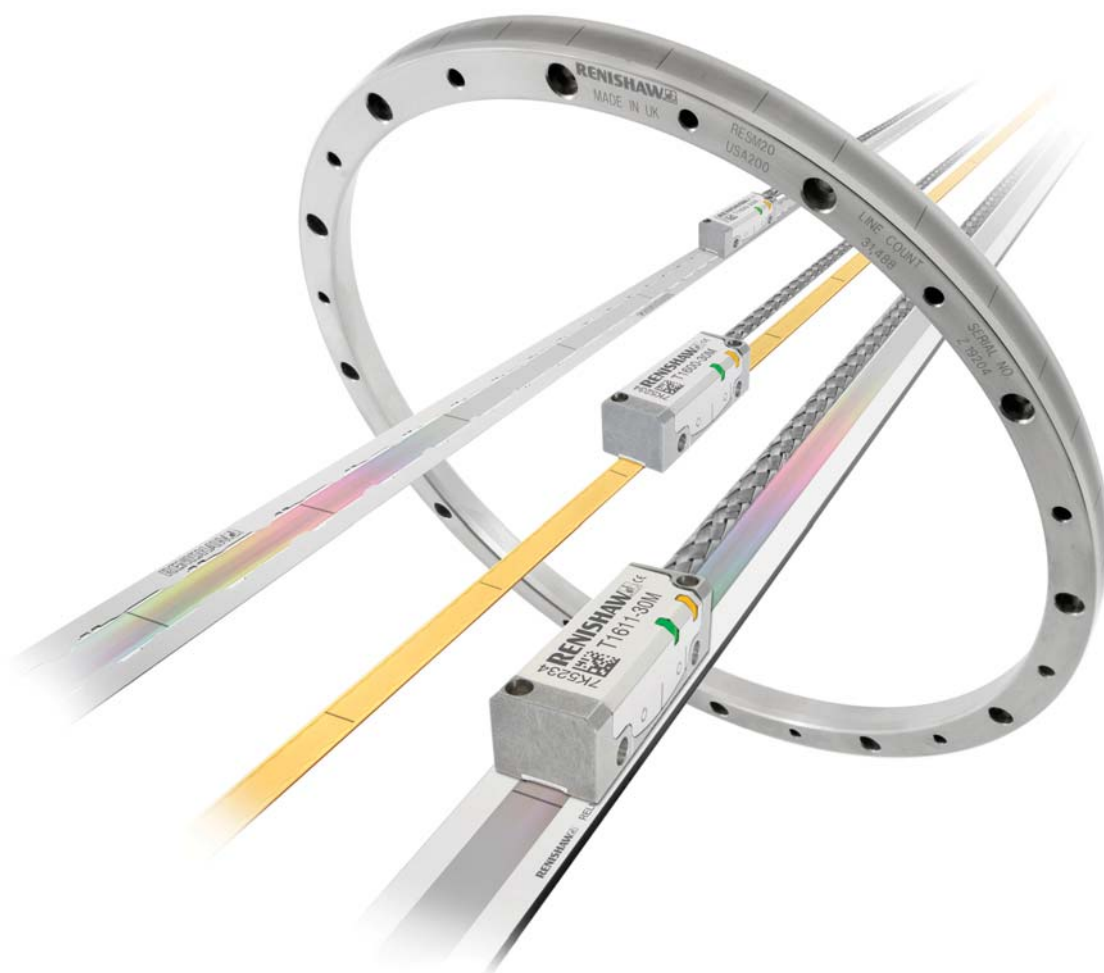


TONiC™ UHV encoder system



TONiC UHV encoder offers all the benefits of the established TONiC linear and angle encoder systems, in a readhead that has been designed and constructed using Ultra-High Vacuum compatible materials and processes.

The TONiC UHV readhead is complemented by the latest evolution of RGSZ20 gold tape scale, along with a range of highly accurate linear and angle encoder scales, all featuring optical *IN-TRAC*™ reference marks, easy installation, rugged construction and proven clean RGA spectra.

For ultimate reliability and high immunity to optical degradation, TONiC UHV readheads incorporate third-generation filtering optics, tuned for even lower noise (jitter), further enhanced by dynamic signal processing including Auto Gain Control and Auto Offset Control.

The result is low sub-divisional error (SDE) giving smoother velocity control for improved scanning performance and increased positional stability.

TONiC UHV readheads also feature a detachable analogue or digital interface in the form of a robust, convenient connector that can be located up to 10 m from the readhead.

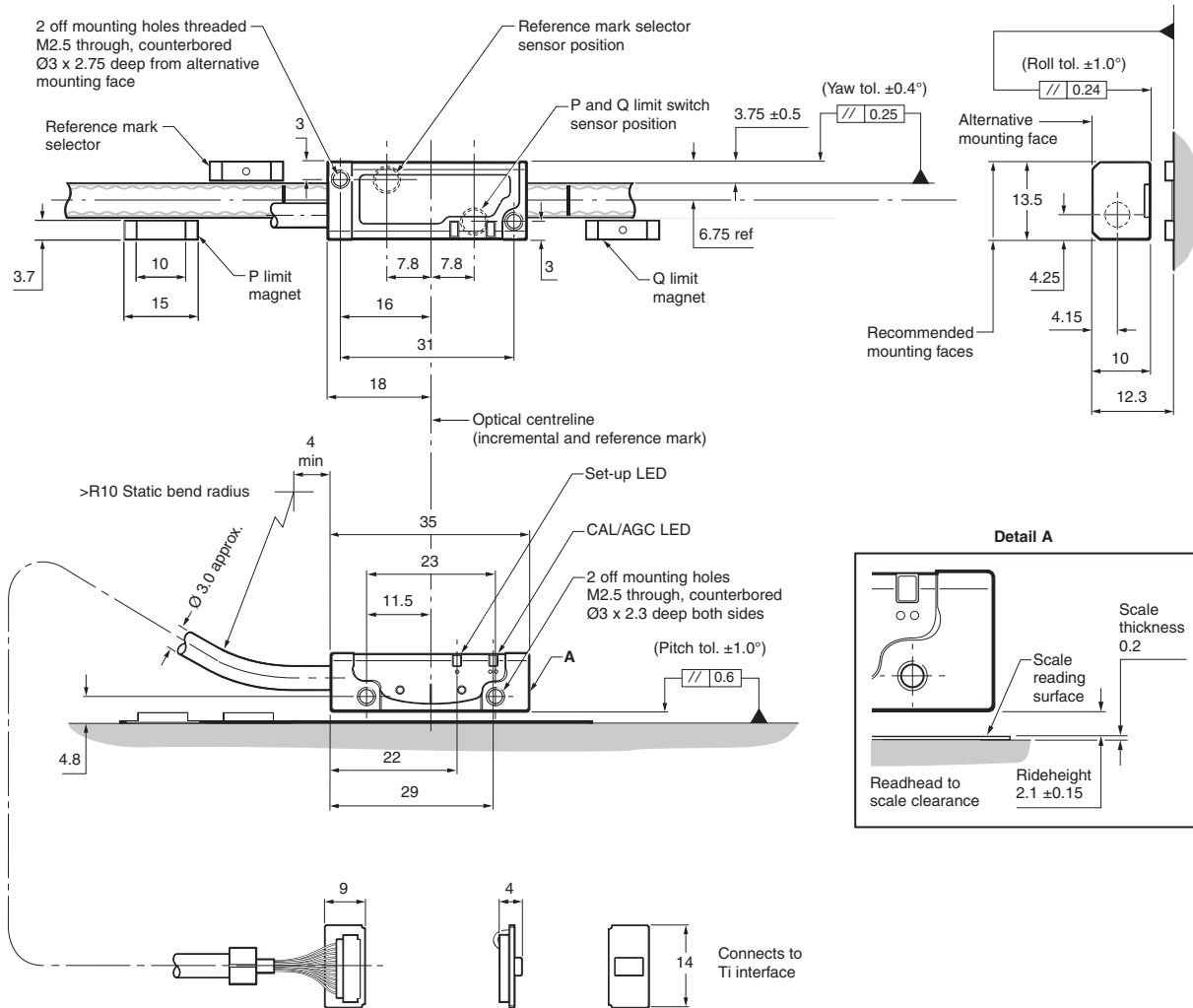
The interface offers digital interpolation to 1 nm resolution, with clocked outputs for optimised speed performance at all resolutions for industry-standard controllers.

The readhead carries an integral set-up LED that enables quick and easy installation. All of these readheads are supplied with an RFI screened UHV compatible cable as standard.

- Clean RGA
- Low outgassing rates
- High bake-out temperature of 120 °C
- Low power consumption readheads
- Non-contact open optical system
- Resolution to 1 nm
- Dynamic signal processing provides ultra low cyclic error of typically ± 30 nm
- Auto Gain Control ensures constant signal strength for long term reliability
- Compatible with RGSZ20 gold scale, *FASTRACK*/RTLC scale system, RSLM, RELM, RESM and REXM

TONiC UHV readhead installation drawing

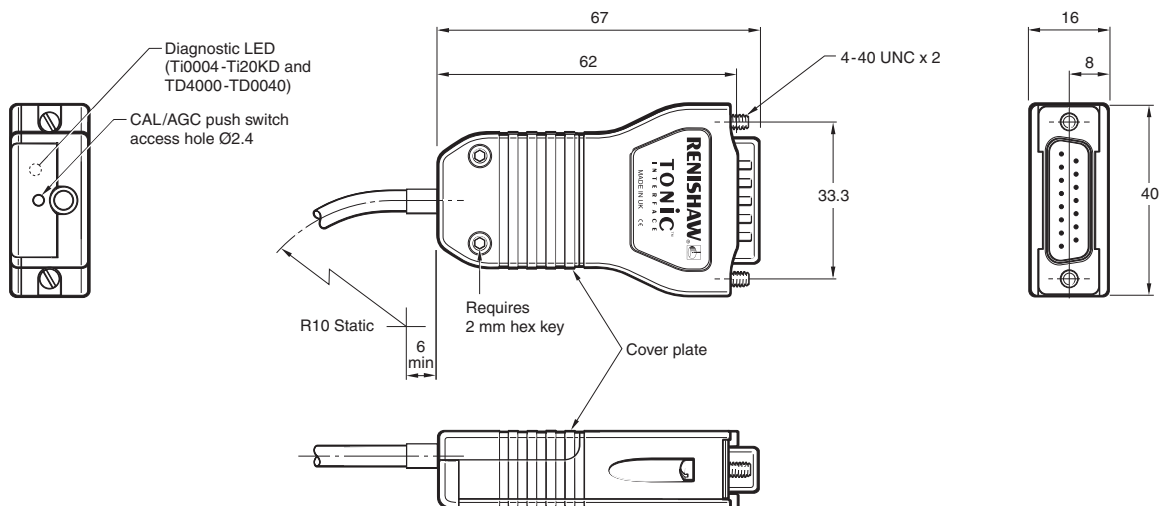
Dimensions and tolerances in mm



NOTE: RGSZ20 only shown. For detailed installation drawings, refer to relevant TONiC Installation guide or Data sheet

Ti/TD interface installation drawing

Dimensions and tolerances in mm



Operating and electrical specifications

Power supply	5V ±10%	Readhead only <100 mA T16xx/T26xx + Ti0000 <100 mA T16xx/T26xx + 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 120 Ω. For analogue outputs, a further 20 mA 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
	(readhead) Bakeout	120 °C
Humidity (system)	Rated up to 40 °C, 95% relative humidity (non-condensing)	
Sealing (readhead)	IP20	
	(interface)	IP20
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 max @ 55 Hz to 2000 Hz BS EN 60068-2-6:1996 (IEC 68-2-6:1995)
Mass	Readhead	10 g
	Interface	100 g
	Cable	14 g/m
EMC compliance (system)	BS EN 61326-1: 2006	
Environmental	Compliant with EU Directive 2002/95/EC (RoHS)	
Readhead cable	Tinned copper braided single screen. FEP core insulation	

Speed

Minimum receiver clock frequency (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	3.240	1.625	0.648	0.324	0.162	0.065	0.032
40	10	10	10	5.40	2.700	1.350	0.540	0.270	0.135	0.054	0.027
25	10	10	8.10	3.24	1.620	0.810	0.324	0.162	0.081	0.032	0.016
20	10	10	6.75	2.70	1.350	0.670	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	4.00	1.62	0.810	0.400	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.

$$\text{Angular speed (rev/min)} = \frac{V \times 1000 \times 60}{\pi D} \quad \text{Where } V = \text{maximum linear speed (m/s) and } D = \text{external diameter of RESM or REXM (mm)}$$

TD interface maximum speeds are resolution dependent as defined above.

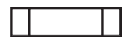
System features

Reference mark

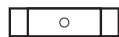
Form	<i>IN-TRAC</i> reference mark, directly in incremental track Refer to RGSZ, <i>FASTRACK/RTL</i> C, RELM, RSLM, RESM, RESD or REXM Data sheets for reference mark location Bi-directionally repeatable across full speed and temperature range Electronically phased, requires no physical adjustment
Selection	T16x0 : Single reference mark selection by magnetic actuator (A-9653-0143), customer positioned T16x1 and T26x1 : No selector required, all reference marks output
Repeatability	Unit of resolution repeatability, over full operating temperature and speed

Dual limit switches (linear systems only, not available on TD interfaces)

Form	Magnetic actuators for P and Q limit switches 10 mm P limit, North pole facing – A-9653-0138 10 mm Q limit, South pole facing – A-9653-0139 20 mm P limit, North pole facing – A-9653-0237 20 mm Q limit, South pole facing – A-9653-0238 50 mm P limit, North pole facing – A-9653-0235 50 mm Q limit, South pole facing – A-9653-0236
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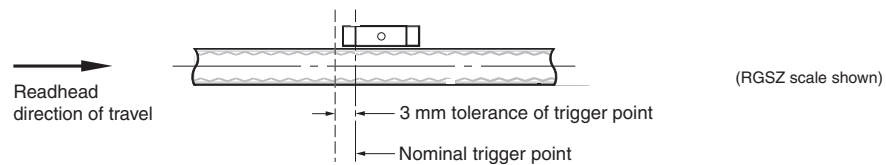
Typical P magnet



Typical Q magnet

Trigger point	Leading edge of magnet from direction of travel
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Trigger point tolerance



Mounting	Self-adhesive (same as RGSZ-S scale)
Position	Customer placed at desired locations
Repeatability	<0.1 mm

Dynamic signal processing

Real time signal conditioning for optimized performance across a range of operating conditions

- Automatic Gain Control (AGC)
- Automatic Offset Control (AOC)

Ultra low cyclic error of typically ± 30 nm

Calibration

Simple calibration at the press of a button, no physical adjustment required

Optimization of incremental and reference mark signals

TD dual resolution interface

Allows output to be switched between two resolutions.

NOTE: It is recommended that movement should be halted before switching resolutions.

See part number section for details of available resolutions.

No limit outputs

RGA results

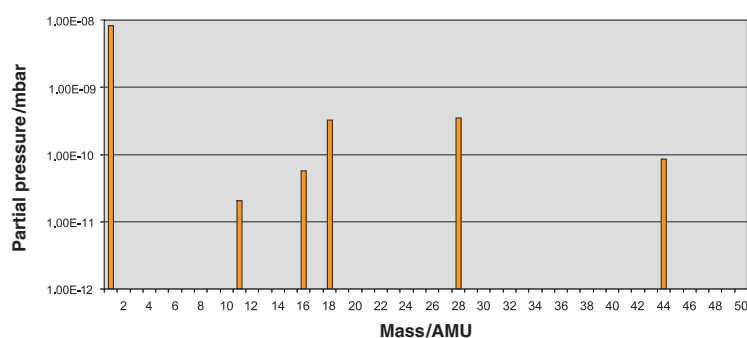
Test schedule

A quadrupole mass spectrometer (AccuQuad 200 RGA), set to 200AMU scan range, was used to collect RGA (residual gas analysis) data and to measure total chamber pressure. After initial conditioning of the system, a background spectrum was recorded together with the total pressure in the test chamber.

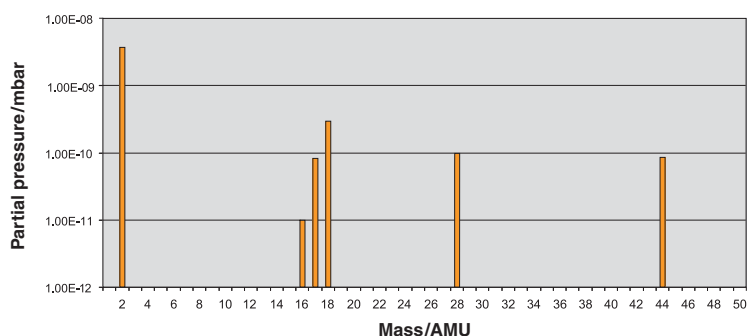
The component was placed in the vacuum chamber (0.015 m³) and the system was then pumped using an KJL Lion 802 (800/s) diode ion pump and a Divac diaphragm pump at ambient temperature for 24 hours, after which a background scan and the total pressure in the test chamber were recorded again. If the system pressure was better than 5×10^{-9} mbar, the test specimen was baked at 120 °C for 48 hours. The system was then allowed to cool to ambient temperature before a final mass spectrum and the total pressure in the test chamber were recorded. These final RGA scans are shown below.

NOTE: Exact reproduction of these results should not be expected, as RGA data depends on many factors including environmental factors and initial chamber conditions. However, the data is fully representative of vacuum performance.

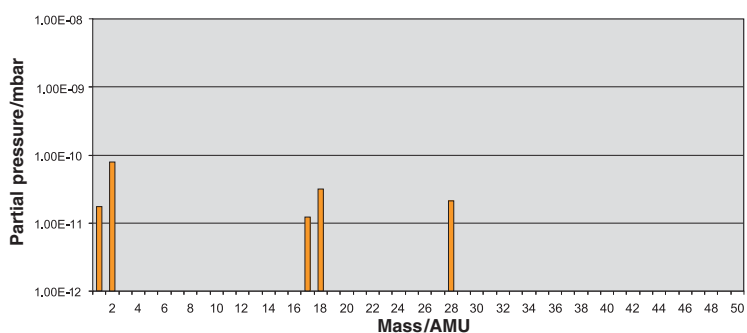
TONiC readhead with 1.0 m cable after bake-out (total pressure = 9.0×10^{-10} mbar)



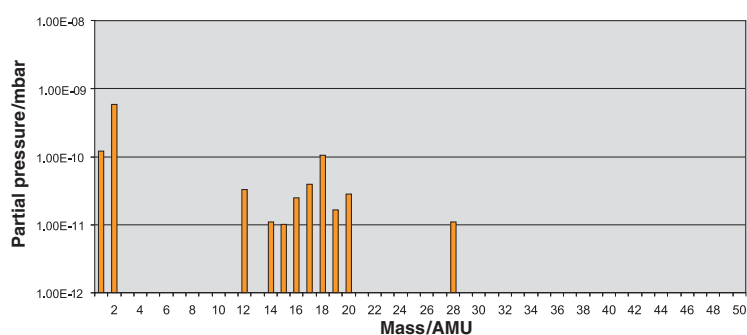
RSLM linear scale (180 mm length) with 2 clips and 1 clamp after bake-out (total pressure = 3.0×10^{-10} mbar)



RGSZ-S linear scale (300 mm length) after bake-out (total pressure = 1.69×10^{-10} mbar)



RESR (Ø115 mm) after bake-out (total pressure = 7.76×10^{-10} mbar)



Connector pin configuration

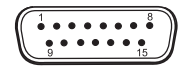
Digital outputs

Function	Signal	Interface	
		Ti0004 - Ti20KD	TD4000 - TD0040
Power	5 V	7, 8	7, 8
	0 V	2, 9	2, 9
Incremental	A+	14	14
	A-	6	6
	B+	13	13
	B-	5	5
Reference mark	Z+	12	12
	Z-	4	4
Limits	P+	11	–
	Q	10	–
Set-up	X	1	1
Alarm [†]	E+	–	11
	E-	3	3
Resolution switching [‡]	–	–	10
Shield	Inner	–	–
	Outer	Case	Case

Analogue outputs

Function	Signal	Readhead	Interface
		T1xxx/2xxx	Ti0000
Power	5 V	Brown	4, 5
	0 V	White	12, 13
Incremental	Cosine	V ₁₊	9
		V ₁₋	1
	Sine	V ₂₊	10
		V ₂₋	2
Reference mark	V ₀₊	Violet	3
	V ₀₋	Grey	11
Limits	V _p	Pink	7
	V _q	Black	8
Set-up	V _x	Clear	6
Remote CAL	CAL	Orange	14
Shield	Inner	Green/Yellow*	–
	Outer	Outer screen	Case

*Inner shield is connected to 0 V inside the Ti/TD interface



15 pin 'D' type connector

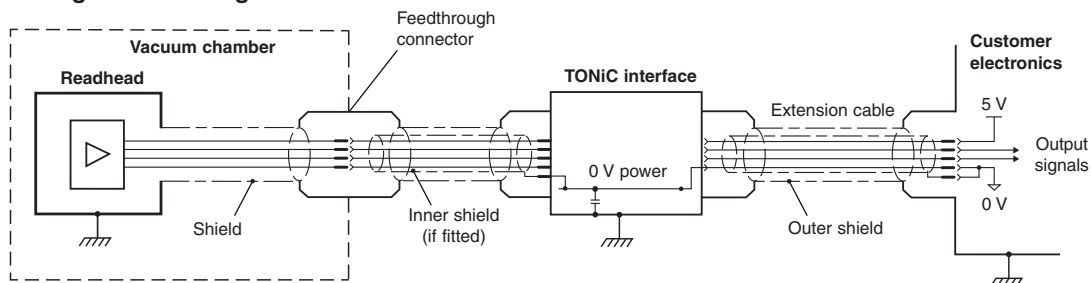
[†]Becomes alarm (E+) for Ti options E, F, G, H

[‡]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.

Electrical connections

Grounding and shielding



IMPORTANT: The outer shield should be connected to the machine earth (Field Ground). The inner shield should be connected to 0V 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 0V and earth, which could cause electrical noise issues.

Maximum cable length

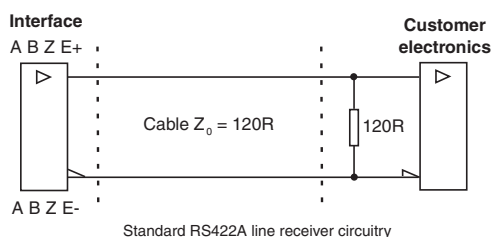
Readhead to interface: 10 m

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

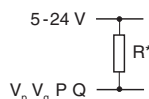
Receiver clock frequency (MHz)	Maximum cable length (m)
40 to 50	25
<40	50
analogue	50

Recommended signal termination

Digital outputs

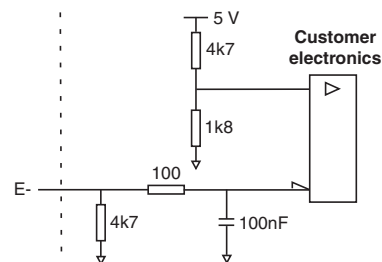


Limit outputs (Ti interface only)

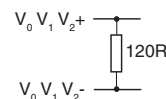


*Select R so max current does not exceed 20 mA. Alternatively, use a suitable relay or opto-isolator

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



Analogue outputs



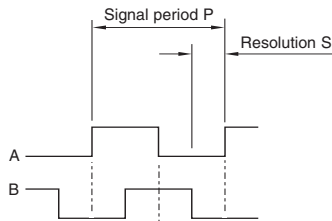
Output specifications

Digital output signals

- Interface models Ti0004 - Ti20KD and TD4000 - TD0040

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)
Ti0004	20	5
Ti0020	4	1
Ti0040	2	0.5
Ti0100	0.8	0.2
Ti0200	0.4	0.1
Ti0400	0.2	0.05
Ti1000	0.08	0.02
Ti2000	0.04	0.01
Ti4000	0.02	0.005
Ti10KD	0.008	0.002
Ti20KD	0.004	0.001

Reference[†]

Z — Synchronised pulse Z, duration as resolution

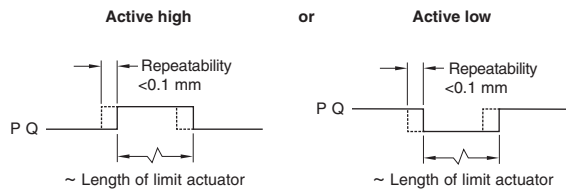
Wide reference[†]

Z — Synchronised pulse Z, duration as signal period

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

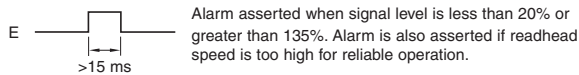
Limits Open collector output, asynchronous pulse

Digital Ti interfaces only



NOTE: No limits on TD interfaces.

Alarm[†] Asynchronous pulse

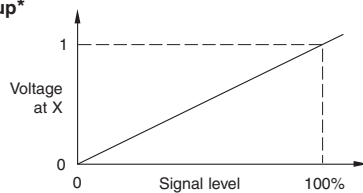


E- output only for Ti options A, B, C, D

3-state alarm (option)

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

Set-up*



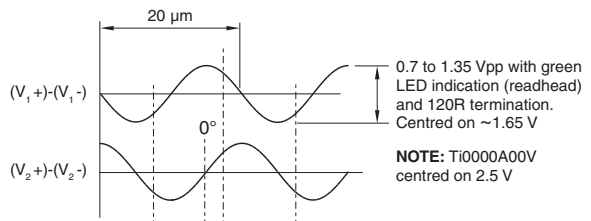
Setup signal voltage proportional to incremental signal amplitude

[†]Inverse signals not shown for clarity

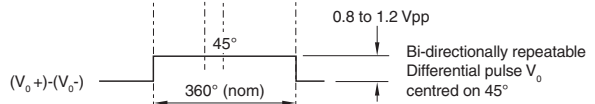
Analogue output signals

- Interface model Ti0000 and direct output from all readheads

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



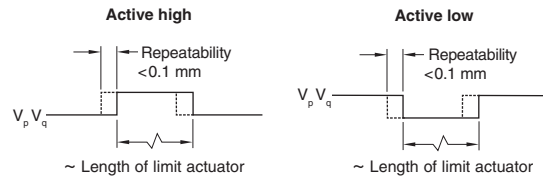
Reference



Limits Open collector output, asynchronous pulse

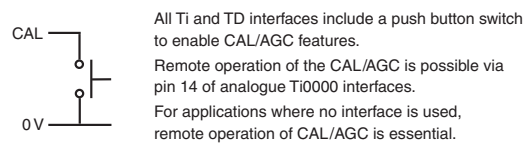
Ti0000 interface only

Direct output from readhead

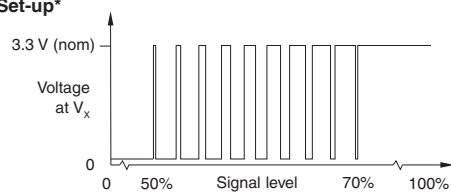


NOTE: Ti0000 interface contains a transistor to invert the readhead's 'active low' signal to give an 'active high' output.

Remote CAL operation (analogue versions only)



Set-up*



Between 50% and 70% signal level, V_x is a duty cycle when encoder is moved, 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

T16xx linear readhead

Compatible with RGSZ20, RTLC, RSLM or RELM scale.

Readhead part number	T 1 6 0 0 - 15 M
Series	T = TONiC
Scale form	1 = Linear
Readhead type	6 = Vacuum
Scale type compatibility	0 = RGSZ20/RGSN20 1 = RSLM/RELM 3 = RTLC/ RTLC-S
Reference mark	0 = Output with selector only 1 = All reference marks are output
Cable length	10 = 1 m 15 = 1.5 m 30 = 3 m 50 = 5 m 99 = 10 m
Cable termination	M = Vacuum cable

T26xx rotary readhead

Compatible with RESM, RESD and REXM rings

Readhead part number	T 2 6 0 1 - 15 M
Series	T = TONiC
Scale form	2 = Rotary
Readhead type	6 = Vacuum
Ring diameter	0 = RESM/REXM/RESD >135 mm 1 = RESM/REXM/RESD 60 to 135 mm 2 = RESM/REXM/RESD <60 mm 4 = RGSZ/RGSN partial arc >135 mm 5 = RGSZ/RGSN partial arc <135 mm
Reference mark	0 = Customer selectable reference mark 1 = All reference marks are output (rotary standard)
Cable length	05 = 0.5 m 10 = 1 m 15 = 1.5 m 30 = 3 m 50 = 5 m 99 = 10 m
Cable termination	M = Vacuum cable

NOTE: Ti and TD interfaces are not UHV compatible

Please contact your local Renishaw representative if you require a partial arc application

Ti interface

Compatible with all **TONiC** readheads

Interface part numbers

Analogue:	Ti 0000 A 00 A
Options	A = dual active high limits V = 2V5 Vmid dual active high limits
Digital:	Ti 0200 A 20 A
Series	Ti = TONiC
Interpolation factor/resolution*	0004 = 5 µm 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	A = Line driven E- output; All alarms B = Line driven E- output; low signal, high signal E = 3 state; All alarms F = 3 state; low signal, high signal
Minimum receiver clock frequency	50, 40, 25, 20, 12, 10, 8, 6, 4, 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 D = P/Q limits - 'active low', wide reference mark E = Q limit only, differential alarm - 'active high', standard reference mark F = Q limit only, differential alarm - 'active low', standard reference mark G = Q limit only, differential alarm - 'active high', wide reference mark H = Q limit only, differential alarm - 'active low', wide reference mark
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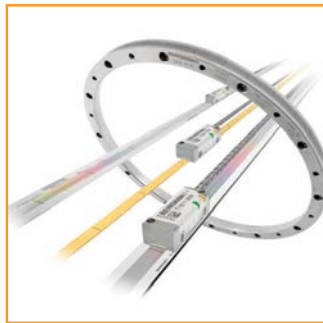
Dual resolution:	TD 4000 A 20 A
Series	TD = TONiC dual resolution
Interpolation factor/resolution*	Pin 10 open Pin 10 = 0 V 4000 = 5 nm 10 nm 2000 = 10 nm 20 nm 1000 = 20 nm 40 nm 0400 = 50 nm 0.1 µm 0200 = 0.1 µm 0.2 µm 0040 = 0.5 µm 1 µm
Alarm format and conditions	A = Line driven, differential output; All alarms B = Line driven, differential output; low signal, high signal E = 3 state; All alarms F = 3 state; low signal, high signal
Minimum receiver clock frequency	50, 40, 25, 20, 12, 10, 8, 6, 4, 1 (MHz)
Options	A = Standard reference mark B = Wide reference mark

*Contact Renishaw for other interpolation factors.

TONiC

UHV compatible products:

TONiC



T1xxx

T2xxx

RGSZ20



T100x RGSZ
 Installation guide M-9653-9154
 Data sheet L-9517-9348

RELM



T101x RSLM/RELM
 Installation guide M-9653-9225
 Data sheet L-9517-9219

RSLM



T101x RSLM/RELM
 Installation guide M-9653-9225
 Data sheet L-9517-9305

FASTRACK/RTLС



T103x *FASTRACK*/RTLС
 Installation guide M-9589-9002
 Data sheet L-9517-9417

RTLС-S



T103x RTLС-S
 Installation guide M-9589-9013
 Data sheet L-9517-9417

TONiC



DOP (dual output)
 encoder system
 Installation guide
 M-9653-9278
 Data sheet
 L-9517-9411

RESM



T20x1 RESM
 Installation guide M-9653-9161
 Data sheet L-9517-9154

REXM



T20x1 REXM
 Installation guide M-9653-9248
 Data sheet L-9517-9318

TONiC DSi



DSi dual readhead rotary encoder system
 Installation guide M-9653-9298
 Data sheet L-9517-9466

RESD



T20x1 RESD
 Installation guide M-9676-9000
 Data sheet L-9517-9375

RGSZ20 Partial arc



Contact your
 local Renishaw
 representative for
 more information

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

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