Data sheet
L-9517-9426-02-A

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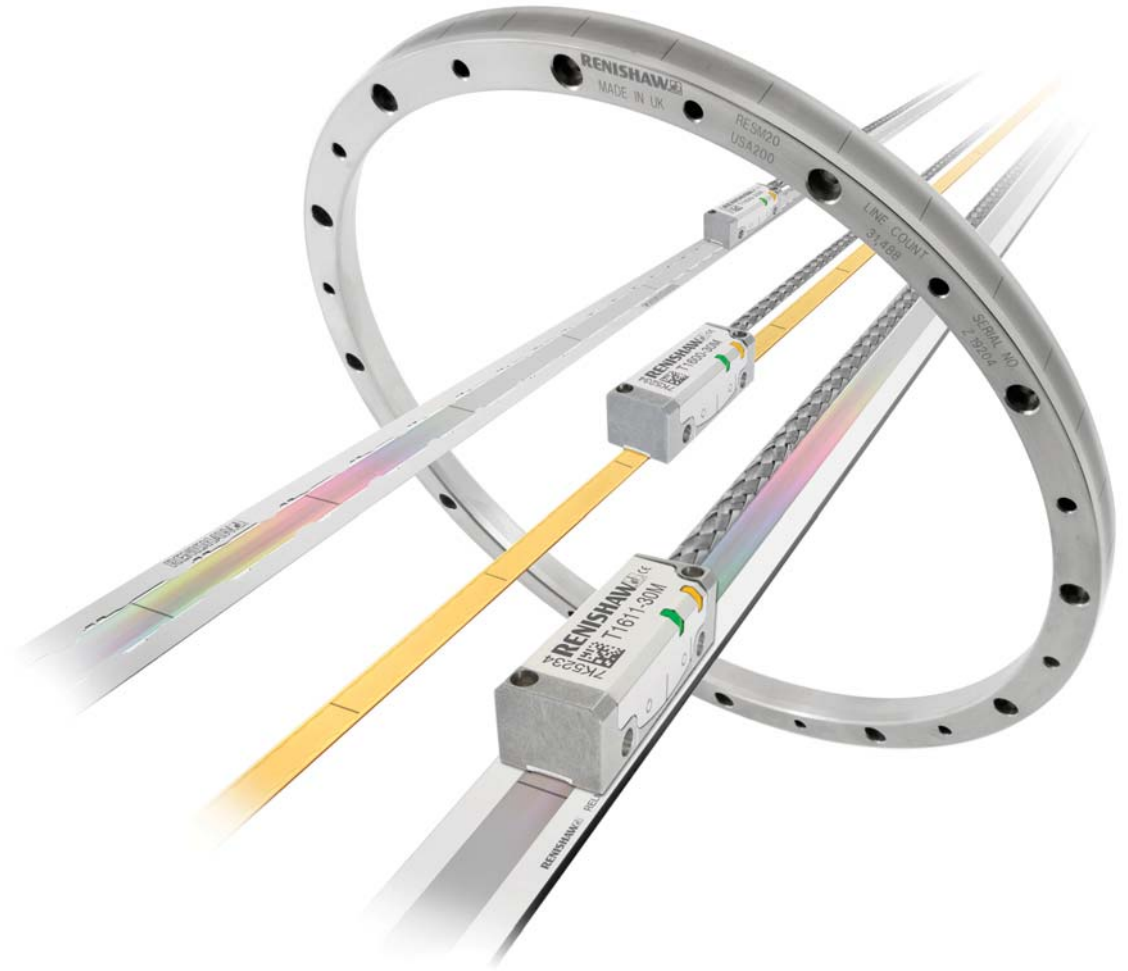
TONiC™ UHV encoder system



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**

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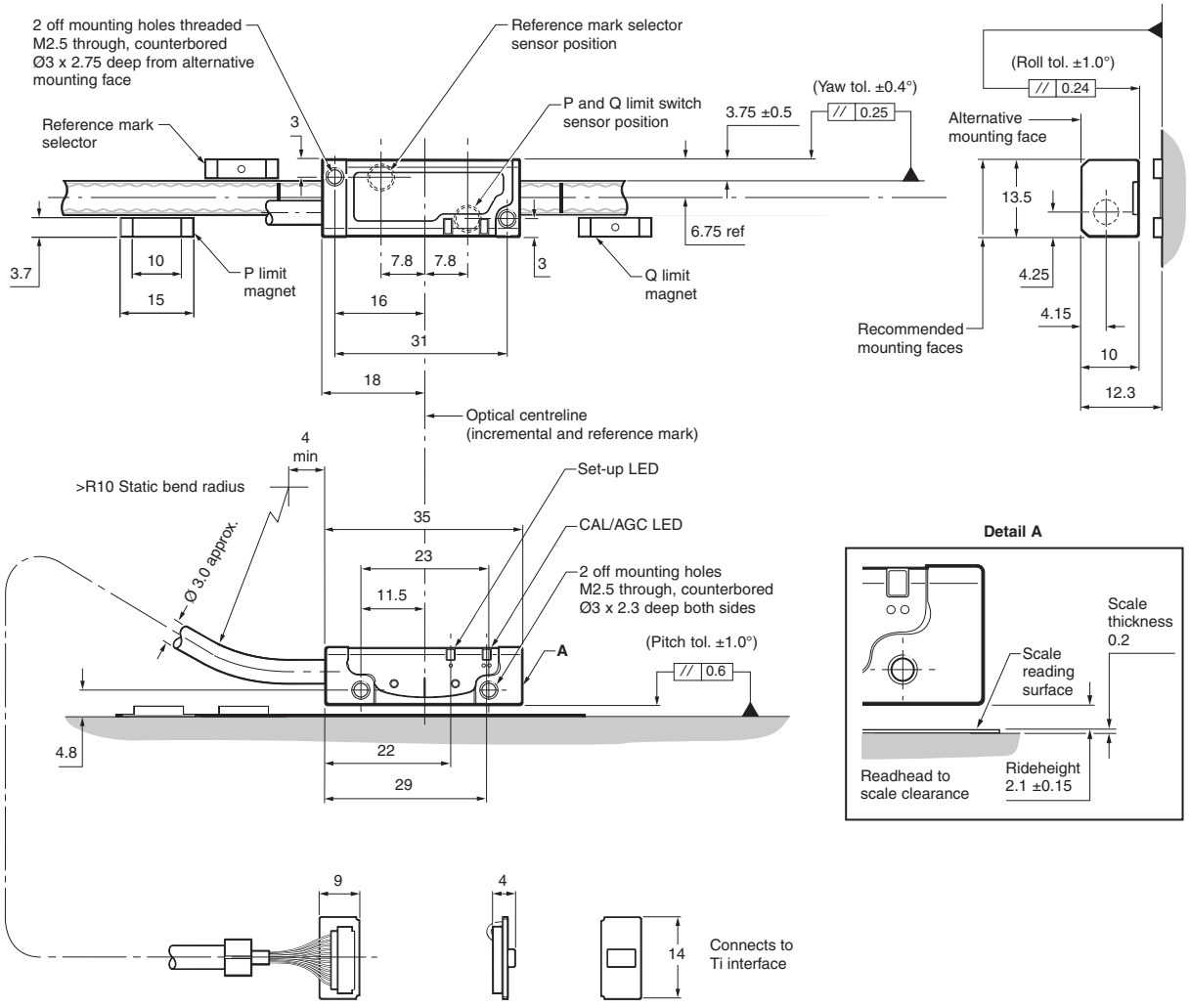
TONiC UHV readhead installation drawing

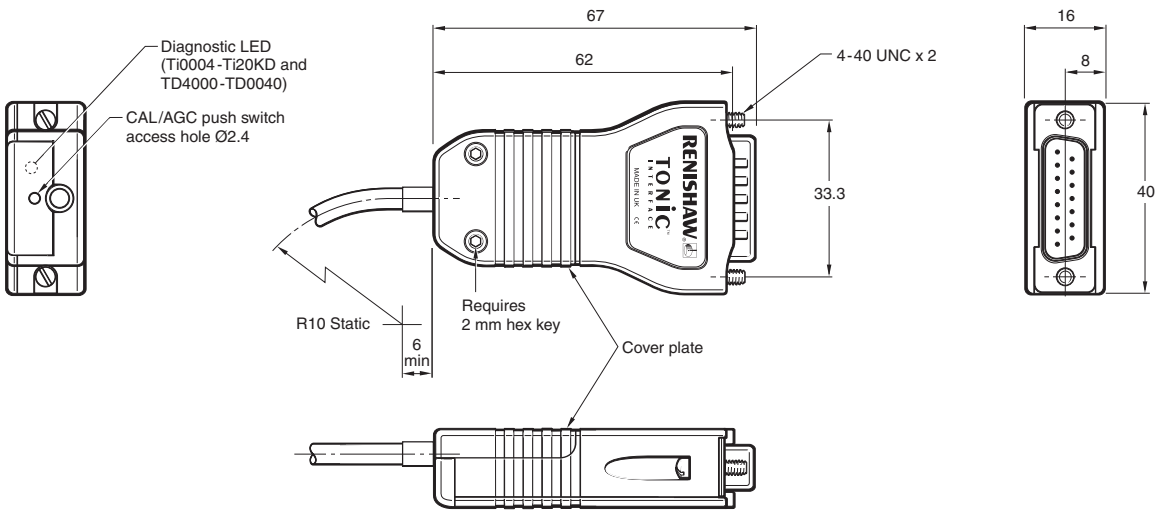
Dimensions and tolerances in mm



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



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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/s² BS EN 60068-2-7:1993 (IEC 68-2-7:1983)
Shock (system)	Non-operating	1000 m/s², 6 ms, ½ sine BS EN 60068-2-27:1993 (IEC 68-2-27:1987)
Vibration (system)	Operating	100 m/s² 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.

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

TD interface maximum speeds are resolution dependent as defined above.

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System features

Reference mark

Form	*IN-TRAC* reference mark, directly in incremental track
	Refer to RGSZ, *FASTRACK*/RTLC, 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

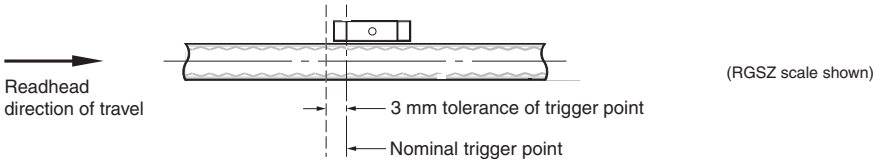
Magnetic actuators for P and Q limit switches

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

Typical P magnet Typical Q magnet

Trigger point: Leading edge of magnet from direction of travel

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

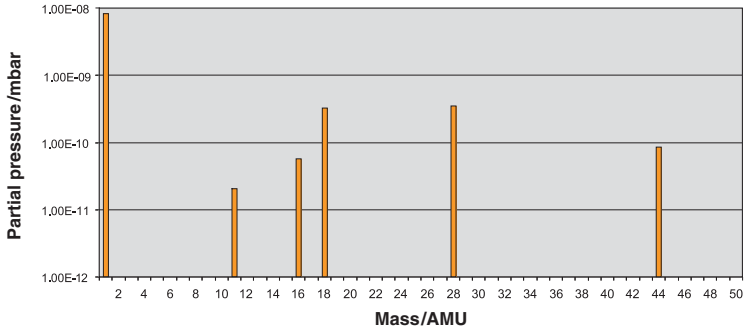
Test schedule

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.

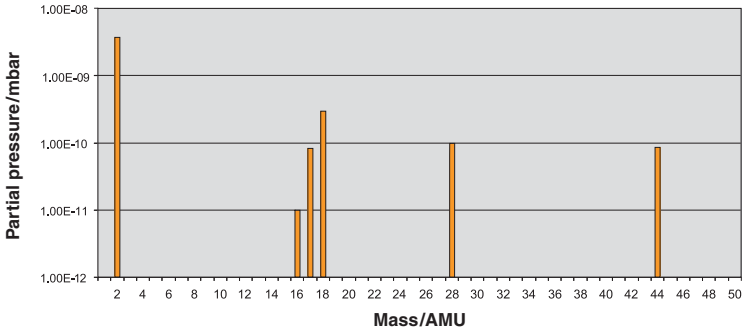
The component was placed in the vacuum chamber (0.015 m^3) and the system was then pumped using an KJL Lion 802 (800/s) diode ion pump and a Divac diaphragm pump at ambient temperature for 24 hours, after which a background scan and the total pressure in the test chamber were recorded again. If the system pressure was better than 5 x 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.

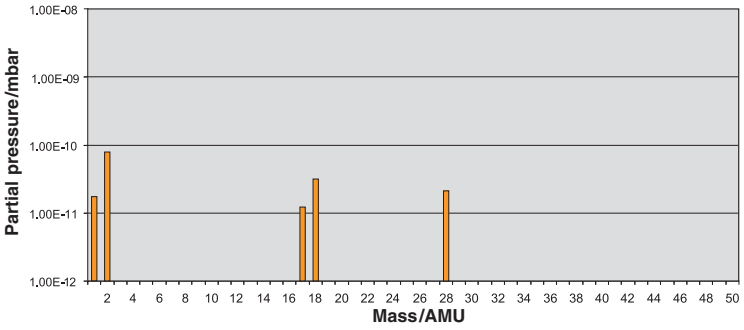
TONiC readhead with 1.0 m cable after bake-out (total pressure = 9.0 x 10^{-10} mbar)



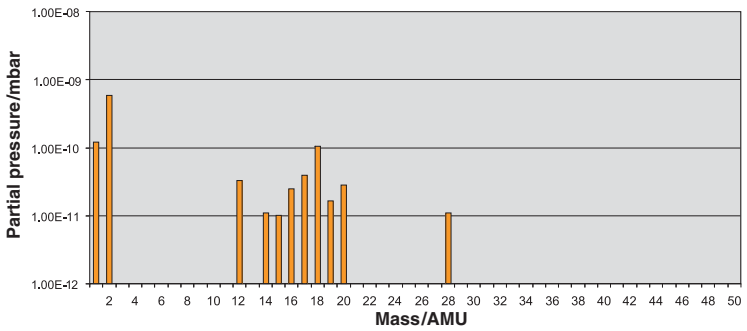
RSLM linear scale (180 mm length) with 2 clips and 1 clamp after bake-out (total pressure = 3.0 x 10^{-10} mbar)



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



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



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Connector pin configuration

Digital outputs

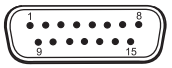
		Interface	
		Ti0004 - Ti20KD	TD4000 - TD0040
Function	**Signal**	**Pin**	**Pin**
Power	5 V	7, 8	7, 8
	0 V	2, 9	2, 9
Incremental	A+	14	14
	A-	6	6
	B+	13	13
	B-	5	5
Reference mark	Z+	12	12
	Z-	4	4
Limits	P†	11	–
	Q	10	–
Set-up	X	1	1
Alarm‡	E+	–	11
	E-	3	3
Resolution switching♆	–	–	10
Shield	Inner	–	–
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

†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.

Analogue outputs

			Readhead T1xxx/2xxx	Interface Ti0000
Function		**Signal**	**Colour**	**Pin**
Power		5 V	Brown	4, 5
		0 V	White	12, 13
Incremental	**Cosine**	V_1+	Red	9
		V_1-	Blue	1
	Sine	V_2+	Yellow	10
		V_2-	Green	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

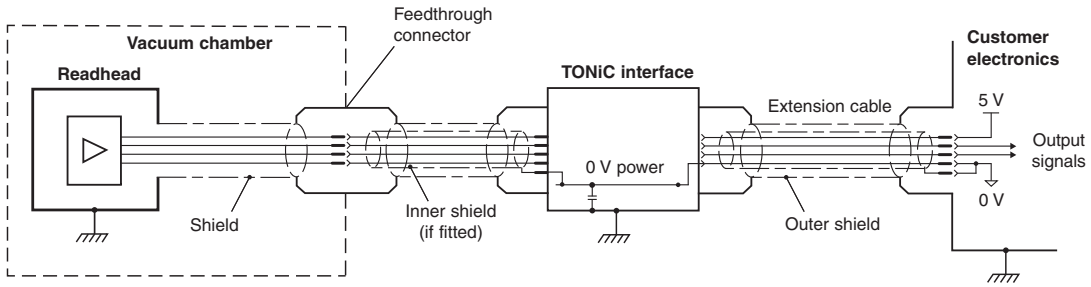
*Inner shield is connected to 0 V inside the Ti/TD interface



15 pin 'D' type connector

Electrical connections

Grounding and shielding



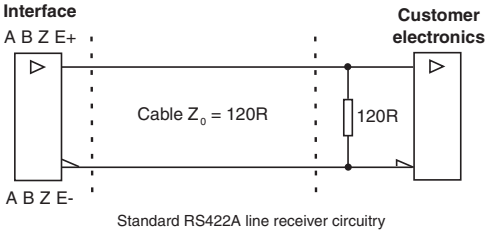
IMPORTANT: The outer shield should be connected to the machine earth (Field Ground). The inner shield should be connected to 0 V at receiving electronics only. Care should be taken to ensure that the inner and outer shields are insulated from each other. If the inner and outer shields are connected together,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

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

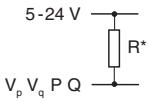
Recommended signal termination

Digital outputs



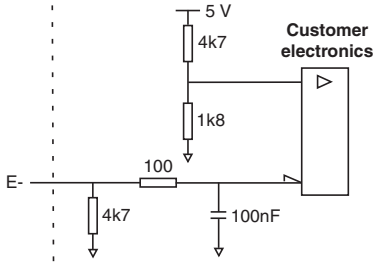
Standard RS422A line receiver circuitry

Limit outputs
(Ti interface only)

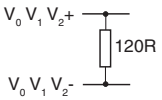


*Select R so max current does not exceed 20 mA
Alternatively, use a suitable relay or opto-isolator

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



Analogue outputs



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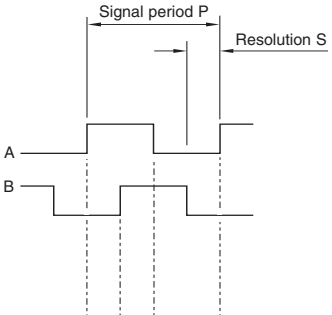
Output specifications

Digital output signals

- Interface models Ti0004 - Ti20KD and TD4000 - TD0040

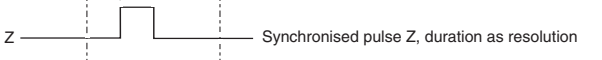
Form - Square wave differential line driver to EIA RS422A (except limits P and Q)

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

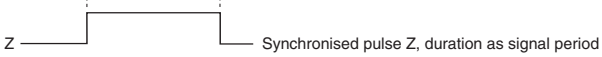


Model	P (µm)	S (µm)
Ti0004	20	5
Ti0020	4	1
Ti0040	2	0.5
Ti0100	0.8	0.2
Ti0200	0.4	0.1
Ti0400	0.2	0.05
Ti1000	0.08	0.02
Ti2000	0.04	0.01
Ti4000	0.02	0.005
Ti10KD	0.008	0.002
Ti20KD	0.004	0.001

Reference†



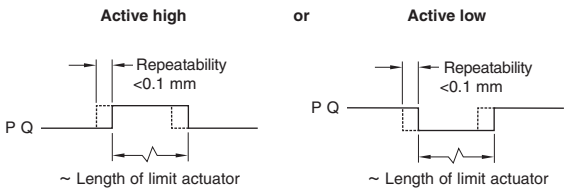
Wide reference†



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

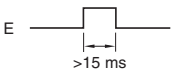
Limits Open collector output, asynchronous pulse

Digital Ti interfaces only



NOTE: No limits on TD interfaces.

Alarm† Asynchronous pulse

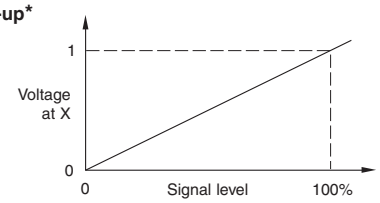


Alarm asserted when signal level is less than 20% or greater than 135%. Alarm is also asserted if readhead speed is too high for reliable operation.

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*



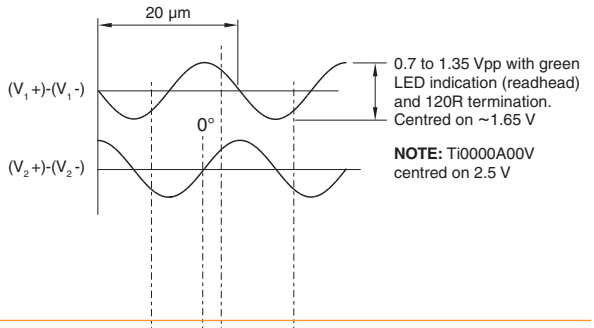
Setup signal voltage proportional to incremental signal amplitude

†Inverse signals not shown for clarity

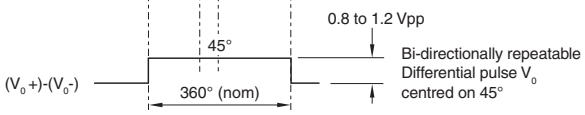
Analogue output signals

- Interface model Ti0000 and direct output from all readheads

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

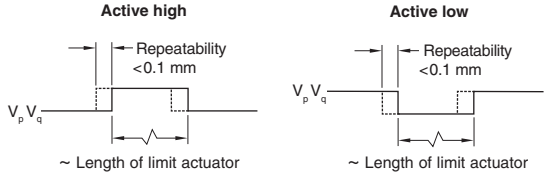


Reference



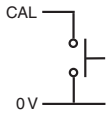
Limits Open collector output, asynchronous pulse

Ti0000 interface only **Direct output from readhead**



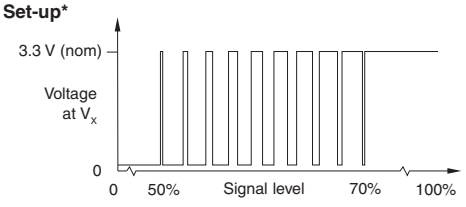
NOTE: Ti0000 interface contains a transistor to invert the readhead's 'active low' signal to give an 'active high' output.

Remote CAL operation (analogue versions only)



All Ti and TD interfaces include a push button switch to enable CAL/AGC features.
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.

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

Data sheet
TONiC UHV encoder system

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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

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.

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T1xxx

RGSZ20

T100x RGSZ
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Data sheet L-9517-9348

RELM

T101x RSLM/RELM
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Data sheet L-9517-9219

RSLM

T101x RSLM/RELM
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Data sheet L-9517-9305

***FASTRACK*/RTLC**

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

RTLC-S

T103x RTLC-S
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Data sheet L-9517-9417

T2xxx

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

RESM

T20x1 RESM
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REXM

T20x1 REXM
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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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