Data sheet
L-9517-9337-06-A

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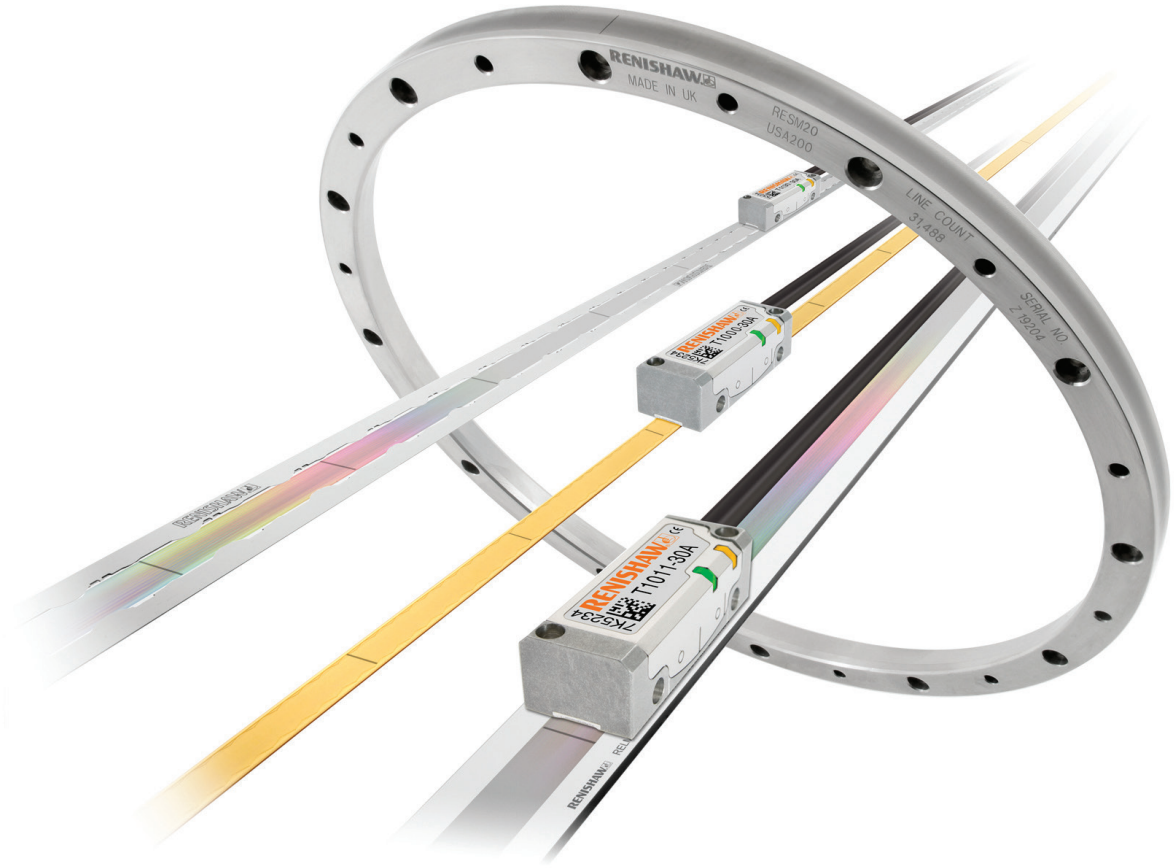
TONiC™ encoder system



Renishaw's TONiC series represents a new generation of super-compact encoders, designed for highly-dynamic precision motion systems, bringing higher accuracy, speed and greater reliability to a wide variety of demanding industry sectors.

The readhead is complemented by the latest evolution of RGSZ20 gold tape scale, REXM ultra-high accuracy angle encoder and *FASTRACK*™/RTLC scale system with bi-directional optical *IN-TRAC*™ reference marks, in addition to established RSLM stainless steel scale, RELM high accuracy low expansion, high stability scale and RESM rotary rings.

For ultimate reliability and high dirt immunity, TONiC 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 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.

- **Compact readhead (35 x 13.5 x 10 mm)**
- **Compatible with RGSZ20 gold tape scale, *FASTRACK*/RTLC scale system, RSLM, RELM, RESM, RESD and REXM with customer-selectable *IN-TRAC* auto-phase optical reference mark (datum)**
- **Third-generation filtering optics optimised for even lower noise (jitter)**
- **Dynamic signal processing provides ultra-low cyclic error 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)**
- **Detachable analogue or digital connector with integral interpolation to 1 nm resolution (0.00075 arc seconds)**
- **Integral dual limits (linear only)**
- **Operating temperature to 70 °C**
- **Dual resolution version available**

RoHS

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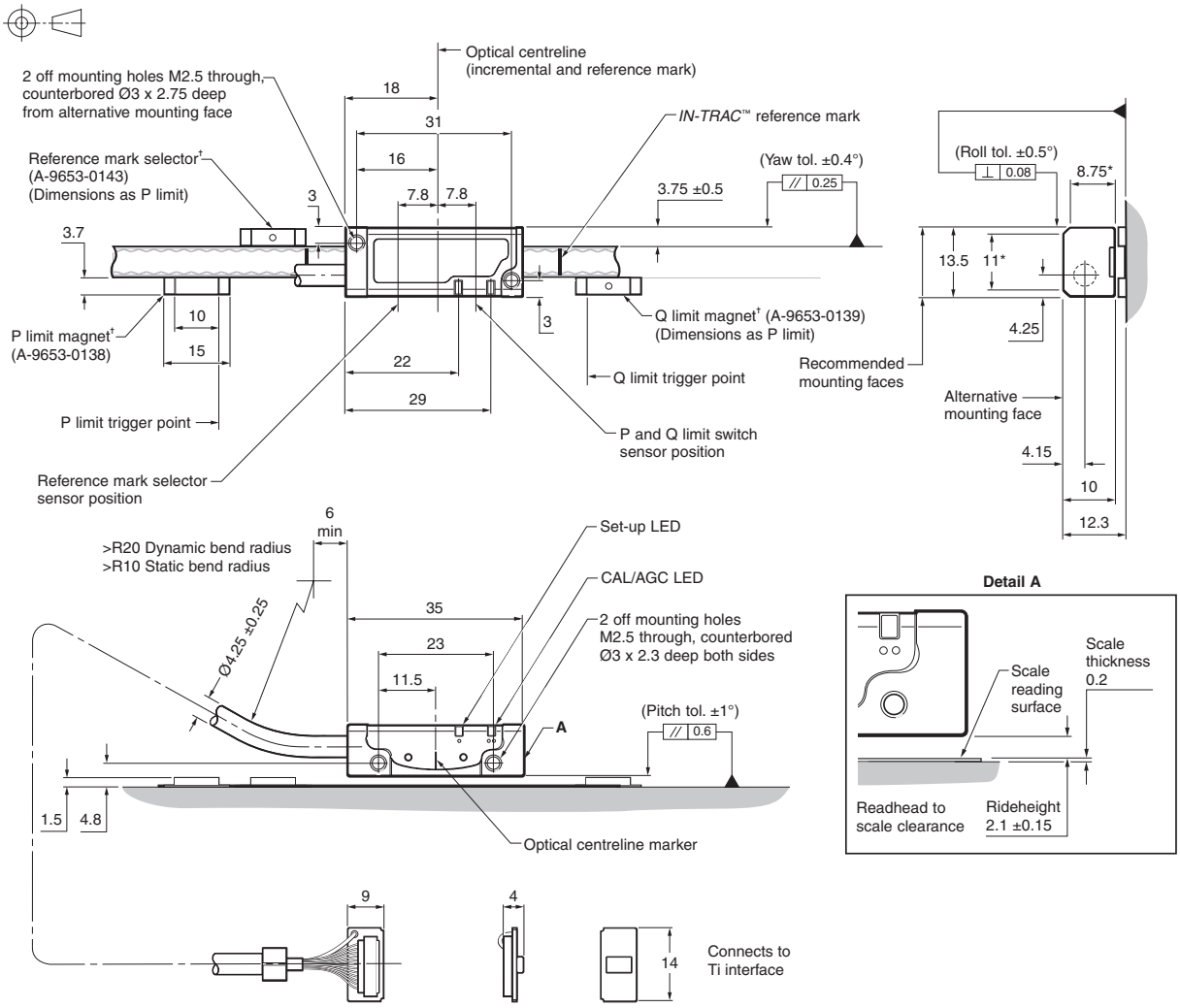
TONiC readhead installation drawing (on RGSZ scale)

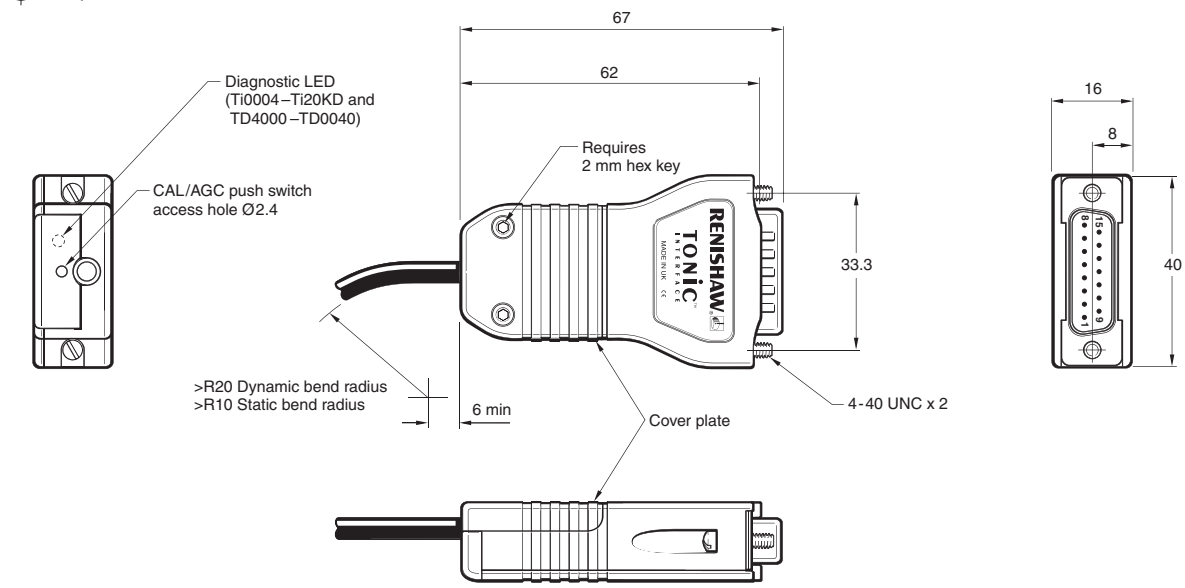
Dimensions and tolerances in mm



*Extent of mounting faces.
†Bolted reference mark selector magnet and limit magnet available. See relevant TONiC Installation guide for details.
NOTE: RGSZ20 only shown. For detailed installation drawings, refer to relevant TONiC Installation guide or Data sheet.

Ti/TD interface dimension drawing

Dimensions and tolerances in mm



General specifications

Power supply	5V ±10%	Readhead only <100 mA T1xxx/T2xxx with Ti0000 <100 mA T1xxx/T2xxx with 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 R. For analogue outputs, a further 20 mA in total will be drawn when terminated with 120 R. 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
Humidity (system)		Rated up to 40 °C, 95% relative humidity (non-condensing)
Sealing (readhead)		IP40
(interface)		IP20
Acceleration (readhead)	Operating	500 m/s² BS EN 60068-2-7:1993
Shock (system)	Operating	500 m/s², 11 ms, ½ sine BS EN 60068-2-27:1993
Vibration (system)	Operating	100 m/s² max @ 55 Hz to 2000 Hz BS EN 60068-2-6:1996
Mass	Readhead	10 g
	Interface	100 g
	Cable	26 g/m
EMC compliance (system)		BS EN 61326-1: 2006
Environmental		Compliant with EU Directive 2011/65/EU (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

Speed

Clocked output option (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	4.05	1.62	0.810	0.400	0.162	0.081	0.041	0.016	0.0081
08	10	6.48	3.24	1.29	0.648	0.324	0.130	0.065	0.032	0.013	0.0065
06	10	4.50	2.25	0.90	0.450	0.225	0.090	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)										

NOTE: TD interface maximum speeds are resolution dependent as defined above.

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)

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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

T1xx0: Single reference mark selection by magnetic actuator (self adhesive A-9653-0143 or bolted A-9653-0290), customer positioned.

T1xx1 and **T2xx1:** 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

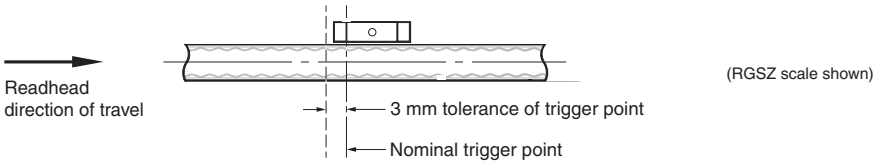
Magnetic actuators for P and Q limit switches

	Self-adhesive	Bolted
10 mm P limit	A-9653-0138	A-9653-0292
10 mm Q limit	A-9653-0139	A-9653-0291
20 mm P limit	A-9653-0237	–
20 mm Q limit	A-9653-0238	–
50 mm P limit	A-9653-0235	–
50 mm Q limit	A-9653-0236	–

Trigger point

Leading edge of magnet from direction of travel.

Trigger point tolerance



Mounting

Self-adhesive or bolted.

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.

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Output signals

Digital outputs

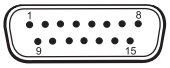
Function	Signal		Interface Ti0004 – Ti20KD Pin	Interface TD4000 – TD0040 Pin
Power	5 V		7, 8	7, 8
	0 V		2, 9	2, 9
Incremental	A	+	14	14
		-	6	6
	B	+	13	13
		-	5	5
Reference mark	Z	+	12	12
		-	4	4
Limits	P†		11	–
	Q♆		10	–
Set-up	X		1	1
Alarm‡	E	+	–	11
		-	3	3
Resolution switching♆	–		–	10
Shield	Inner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

Function		Signal		Readhead T1xxx/2xxx Colour	Interface Ti0000 Pin
Power		5 V		Brown	4, 5
		0 V		White	12, 13
Incremental	Cosine	V_1	+	Red	9
			-	Blue	1
	Sine	V_2	+	Yellow	10
			-	Green	2
Reference mark		V_0	+	Violet	3
			-	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

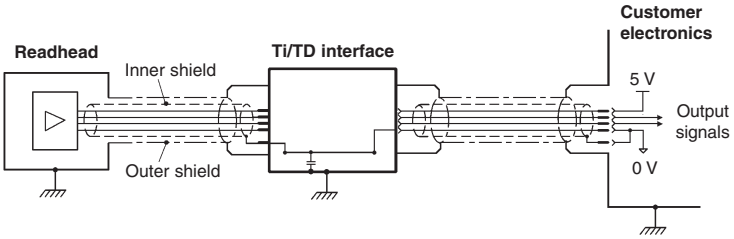
*Inner shield is connected to 0 V inside the Ti/TD interface.



15 pin D-type connector

Electrical connections

Grounding and shielding



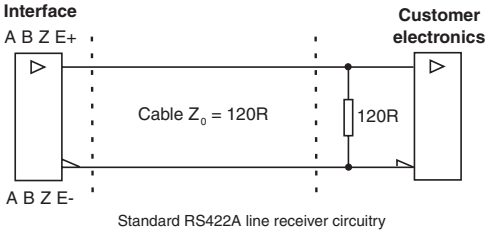
IMPORTANT: The outer shield should be connected to the machine earth (Field Ground). The inner shield should be connected to 0 V at receiving electronics only. Care should be taken to ensure that the inner and outer shields are insulated from each other. If the inner and outer shields are connected together, 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 clocked output option. See table below for details.

Clocked output option (MHz)	Maximum cable length (m)
40 to 50	25
<40	50
analogue	50

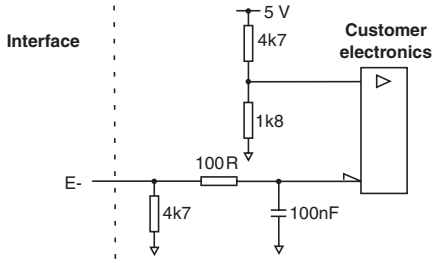
Recommended signal termination

Digital outputs

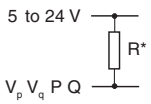


Standard RS422A line receiver circuitry

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

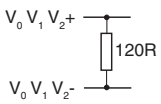


Limit outputs (Ti interface only)



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

Analogue outputs



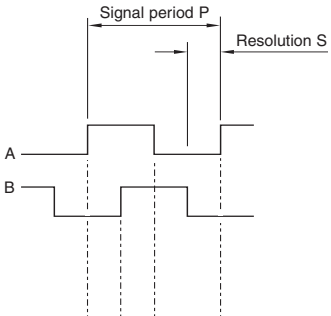
Output specifications

Digital output signals

– Interface models Ti0004 - Ti20KD and TD4000 - TD0040

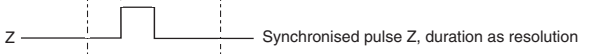
Form – Square wave differential line driver to EIA RS422A (except limits P and Q)

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

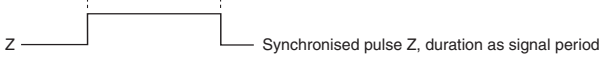


Model	P (µm)	S (µm)
Ti0004	20	5
Ti0020	4	1
Ti0040	2	0.5
Ti0100	0.8	0.2
Ti0200	0.4	0.1
Ti0400	0.2	0.05
Ti1000	0.08	0.02
Ti2000	0.04	0.01
Ti4000	0.02	0.005
Ti10KD	0.008	0.002
Ti20KD	0.004	0.001

Reference†



Wide reference†

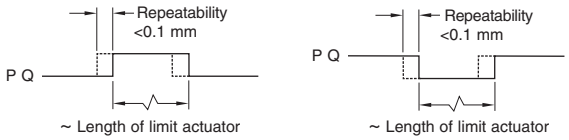


NOTE: Select 'standard' or 'wide' reference at time of ordering, to match the requirements of the controller being used.
Wide reference mark not available on Ti0004.

Limits Open collector output, asynchronous pulse

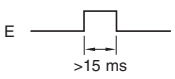
Digital Ti interfaces only

Active high or **Active low**



NOTE: No limits on TD interfaces.
P limit becomes E+ for Ti options E, F, G and H.

Alarm† Asynchronous pulse



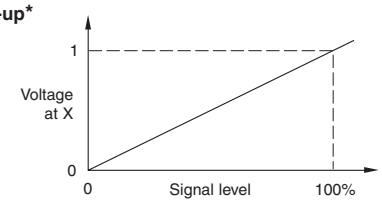
Alarm asserted when signal level is less than 20% or greater than 135%. Alarm is also asserted if readhead speed is too high for reliable operation.

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

or 3-state alarm

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

Set-up*

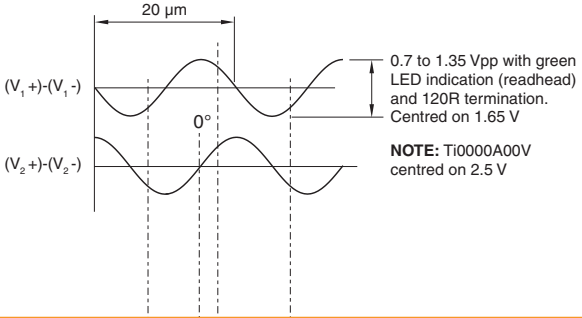


Setup signal voltage proportional to incremental signal amplitude

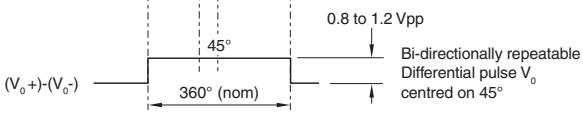
Analogue output signals

– Interface model Ti0000 and direct output from all readheads

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



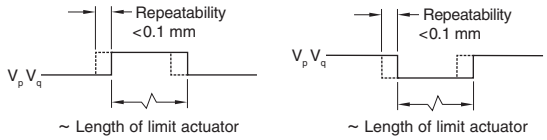
Reference



Limits Open collector output, asynchronous pulse

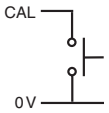
Ti0000 interface only **Direct output from readhead**

Active high **Active low**



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)

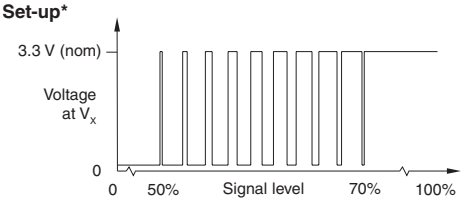


All Ti and TD interfaces include a push button switch to enable CAL/AGC features.

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, 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.

†Inverse signals not shown for clarity
*Set-up signals as shown are not present during calibration routine

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T1xxx linear readhead

Compatible with RGSZ20, RTLC, RSLM or RELM scale

Readhead part number T 1 0 0 0 - 15 A

Series
T = TONiC

Scale form
1 = Linear

Readhead type
0 = Standard

Scale type compatibility
0 = RGSZ20/RGSN20
1 = RSLM/RELM
3 = RTLC
4 = RGSZ20-P/RGSN20-P

Reference mark
0 = Customer selectable reference mark
1 = All reference marks are output

Cable length
05 = 0.5 m
10 = 1 m
15 = 1.5 m
30 = 3 m
50 = 5 m
99 = 10 m

Cable termination
A = Standard mini connector to mate with Ti/TD interface

T2xxx rotary readhead

Compatible with RESM, RESD and REXM rings

Readhead part number T 2 0 0 1 - 15 A

Series
T = TONiC

Scale form
2 = Rotary

Readhead type
0 = Standard

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
A = Standard mini connector to mate with Ti/TD interface

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

Ti interface

Compatible with all TONiC readheads

Interface part number

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	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, high signal
E = 3 state; All alarms
F = 3 state; low signal, high signal

Clocked output option†
50, 40, 25, 20, 12, 10, 08, 06, 04, 01 (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

Clocked output option†
50, 40, 25, 20, 12, 10, 08,06, 04, 01 (MHz)

Options
A = Standard reference mark
B = Wide reference mark

*Contact Renishaw for other interpolation factors.

†When using with a DSi, the interface should be configured with line driven alarm outputs and a clocked output option of 01, 04, 06, 08, 10, 12 or 20.

‡Wide reference mark not available on Ti0004 (5 µm) interfaces.

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TONiC compatible products:

TONiC

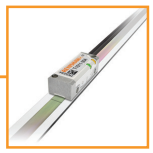
T1xxx

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

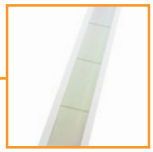
RSLM

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

***FASTRACK*/RTLC**

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

RTLC-S



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

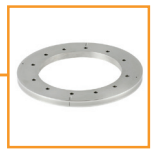
TONiC

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

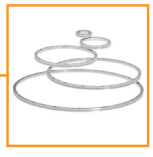


T20x1 REXM
Installation guide M-9653-9248
Data sheet L-9517-9318

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

Contact your local Renishaw representative for more information

RGSZ20 Partial arc

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

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