Data sheet
L-9517-9337-02-A

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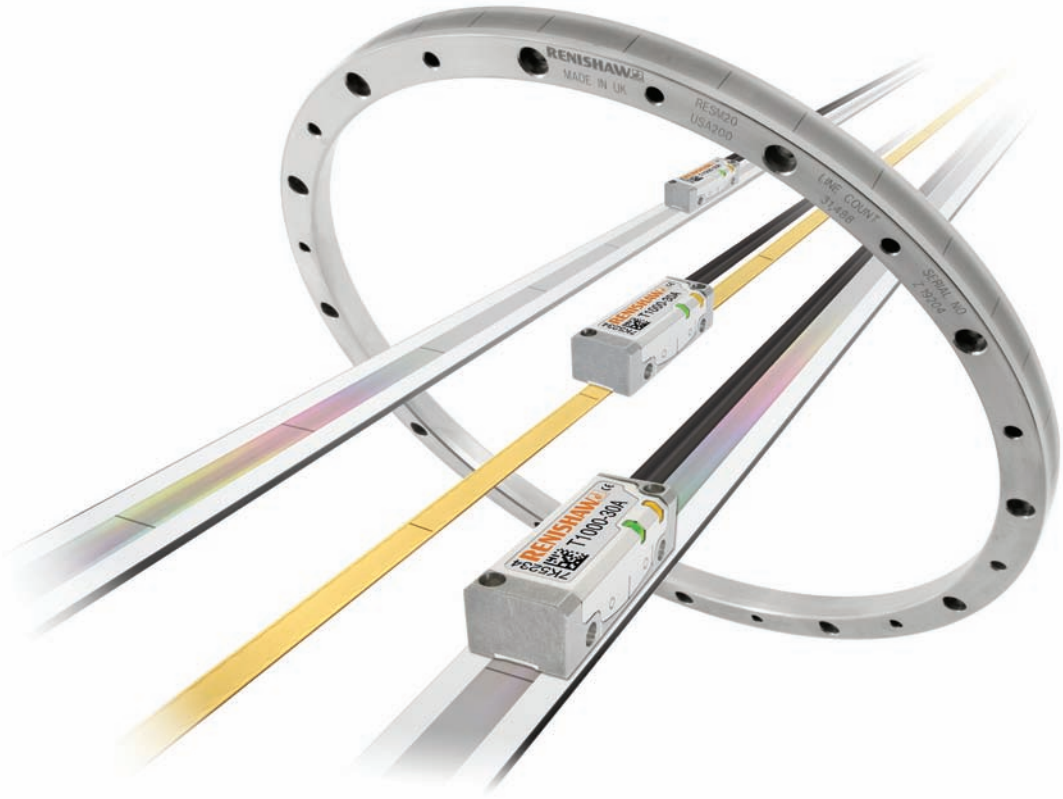
TONiC™ encoder system



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, with bi-directional optical *IN-TRAC*™ reference marks, in addition to established RSLM stainless steel scale, RELM high accuracy invar 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.

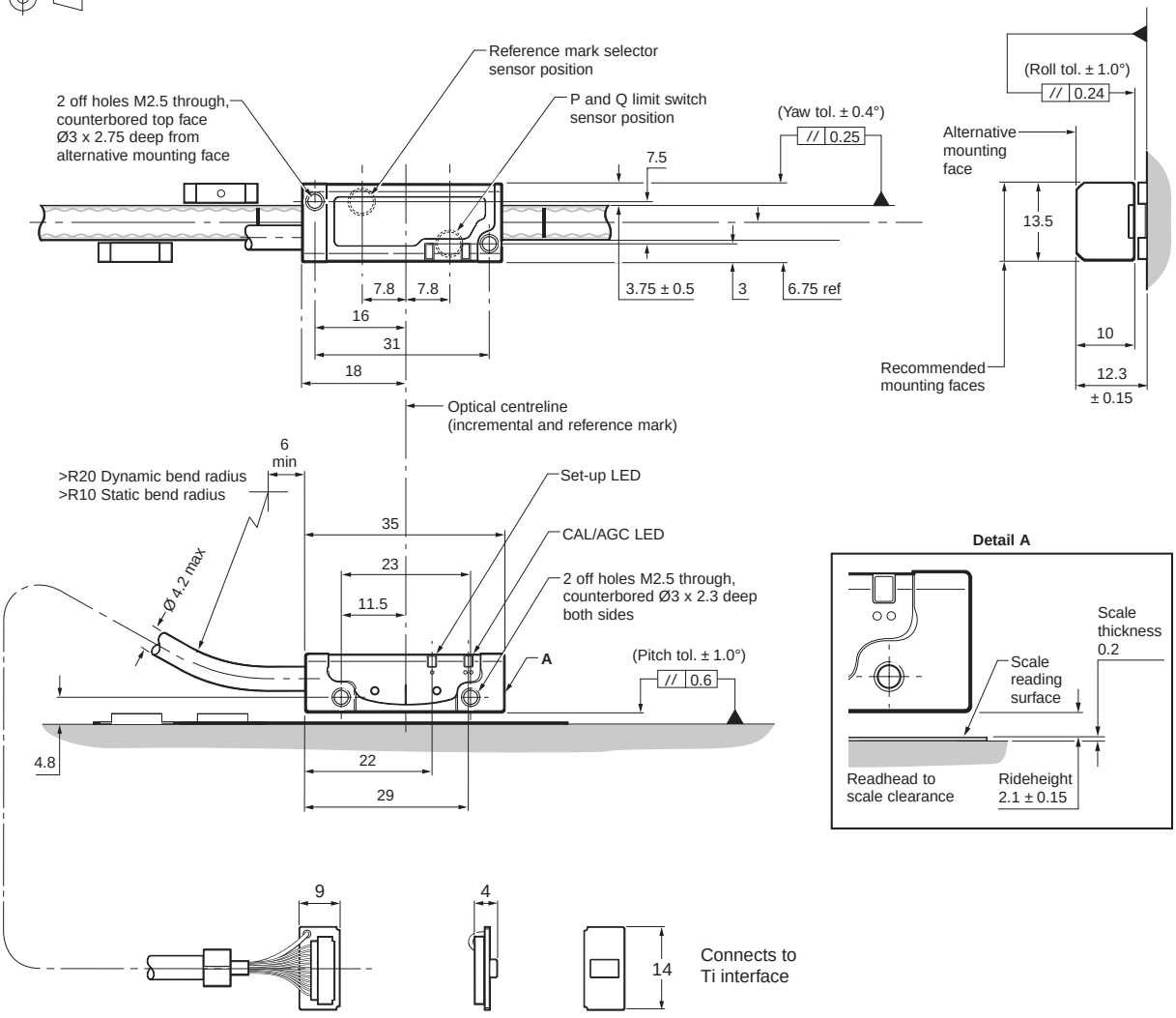
TONiC™ readheads also feature a detachable analogue or digital interface in the form of a robust, convenient connector that can be located up to 10 m from the readhead.
The interface offers digital interpolation to 5 nm resolution, with clocked outputs for optimised speed performance at all resolutions for industry-standard controllers.

- **Compact readhead (35 x 13.5 x 10 mm)**
- **Compatible with RGSZ20 gold tape scale, RSLM, RELM and RESM with customer-selectable *IN-TRAC*™ auto-phase optical reference mark (datum)**
- **Third-generation filtering optics optimised for even lower noise (jitter)**
- **Dynamic signal processing inside the readhead, provides ultra-low cyclic error of ±30 nm**
- **Auto Gain Control ensures consistent signal strength for long-term reliability**
- **Increased ride height tolerance and patented 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 5 nm resolution (0.0038 arc seconds)**
- **Integral dual limits (linear only)**
- **Operating temperature to 70 °C**

RoHS

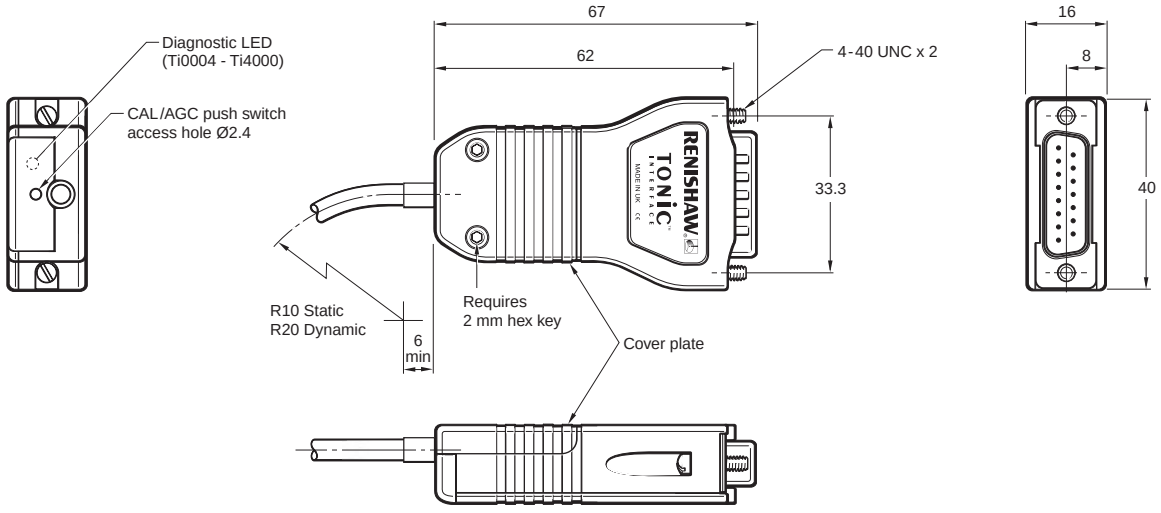
TONiC™ readhead installation drawing

Dimensions and tolerances in mm



Note: RGSZ20 only shown. For detailed installation drawings, refer to RELM (M-9584-5500), RSLM (M-9672-0010) T1000 (M-9653-9154), T1010 (M9653-9225) and T2000 (M-9653-9161) Installation guides. Refer to RGSZ20 (L-9517-9348) RELM (L-9517-9219), RSLM (L-9517-9305) and RESM (L-9517-9154) Data sheets for scale information.

Ti interface dimension drawing



Operating and electrical specifications

Power supply	5V ±10%	T1XXX/2XXX + Ti0000 <100 mA T1XXX/2XXX + Ti0004 - Ti4000 <285 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
(readhead)	Operating	0 °C to +70 °C
(interface)	Operating	0 °C to +70 °C
Humidity	Storage	95% maximum relative humidity (non-condensing)
	Operating	80% maximum relative humidity (non-condensing)
Sealing (readhead)		IP40
(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	26 g/m
EMC compliance (system)	BS EN 61000 BS EN 55011	
Environmental	Compliant with EU Directive 2002/95/EC (RoHS)	
Readhead cable	Double-shielded, outside diameter 4.2 mm maximum Flex life >20 x 10^6 cycles at 20 mm bend radius UL recognised component	

NOTE: Class 1 LED product. Invisible LED radiation.

Speed

Minimum receiver clock frequency (MHz)	Maximum speed (m/s)								
	Ti-0004 5 µm	**Ti-0020 1 µm**	**Ti-0040 0.5 µm**	**Ti-0100 0.2 µm**	**Ti-0200 0.1 µm**	**Ti-0400 50 nm**	**Ti-1000 20 nm**	**Ti-2000 10 nm**	**Ti-4000 5 nm**
50	10	10	10	6.48	3.240	1.625	0.648	0.324	0.162
40	10	10	10	5.40	2.700	1.350	0.540	0.270	0.135
25	10	10	8.10	3.24	1.620	0.810	0.324	0.162	0.081
20	10	10	6.75	2.70	1.350	0.670	0.270	0.135	0.068
12	10	9	4.50	1.80	0.900	0.450	0.180	0.090	0.045
10	10	8.10	4.00	1.62	0.810	0.400	0.162	0.081	0.041
8	10	6.48	3.24	1.29	0.648	0.324	0.130	0.065	0.032
6	10	4.50	2.25	0.90	0.450	0.225	0.090	0.045	0.023
4	10	3.37	1.68	0.67	0.338	0.169	0.068	0.034	0.017
1	4.2	0.84	0.42	0.16	0.084	0.042	0.017	0.008	0.004
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 (mm)

System features

Reference mark

Form	*IN-TRAC*™ reference mark, directly in incremental track
	Refer to RGSZ, RELM, RSLM or RESM Data sheets for reference mark location
	Bi-directionally repeatable accross full speed and temperature range
	Electronically phased, requires no physical adjustment
Selection	**T1XX0:** Single reference mark selection by magnetic actuator (A-9653-0143), customer positioned
	T1XX1 and **T2001:** No selector required, all reference marks output
Repeatability	Unit of resolution repeatability, over full operating temperature and speed

Dual limit switches (linear systems only)

Form	Magnetic actuators for P and Q limit switches
	P – North pole facing (A-9653-0138) – 
	Q – South pole facing (A-9653-0139) – 
Trigger point	Leading edge of magnet from direction of travel
Mounting	Adhesive
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)

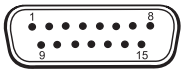
Ultra low cyclic error of ± 30 nm

Calibration

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

Optimization of incremental and reference mark signals

Connector pin configuration



15 pin 'D' type connector

Digital outputs

Function	Signal	Interface Ti0004-4000 Pin
Power	5 V	7, 8
	0 V	2, 9
Incremental	A+	14
	A-	6
	B+	13
	B-	5
Reference mark	Z+	12
	Z-	4
Limits	P	11
	Q	10
Set-up	X	1
Alarm†	E-	3
Shield	Inner	*
	Outer	Case

†The alarm signal can be output as a line driver signal or 3-state. Please select the preferred option at time of ordering.

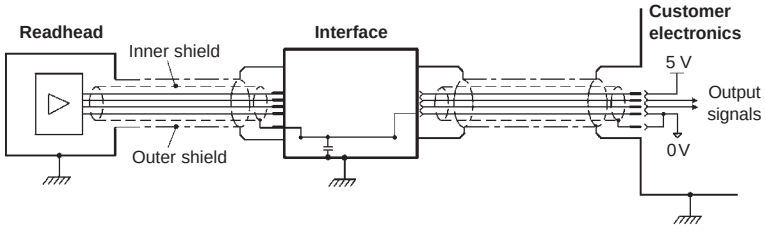
Analogue outputs

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
		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 0V inside the Ti interface

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

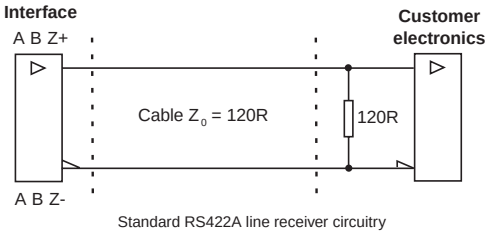
Readhead to interface: 10 m

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

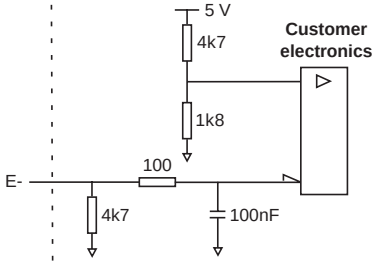
Recommended signal termination

Digital outputs

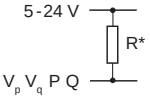


Standard RS422A line receiver circuitry

Alarm signal termination



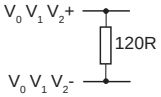
Limit outputs



*Select R for I max <20 mA

Alternatively, use a suitable relay or opto-isolator

Analogue outputs



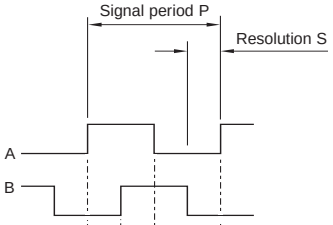
Output specifications

Digital output signals
- Interface models Ti0004 - Ti4000

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)
Ti-0004	20	5
Ti-0020	4	1
Ti-0040	2	0.5
Ti-0100	0.8	0.2
Ti-0200	0.4	0.1
Ti-0400	0.2	0.05
Ti-1000	0.08	0.02
Ti-2000	0.04	0.01
Ti-4000	0.02	0.005



†**Reference**

Synchronised pulse Z, duration as resolution

†**Wide reference**

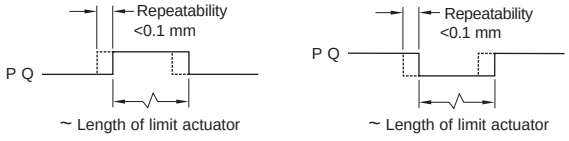
Synchronised pulse Z, duration as signal period

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

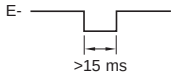
Limits Open collector output, asynchronous pulse

Digital Ti0004 - Ti4000 only

Active high or **Active low**



Alarm Asynchronous pulse

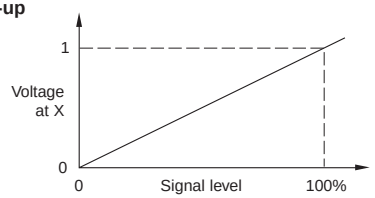


Alarm asserted when signal level is less than 20% or greater than 135%. Alarm is also asserted if readhead speed is too high for reliable operation.

3-state alarm (option)

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

***Set-up**



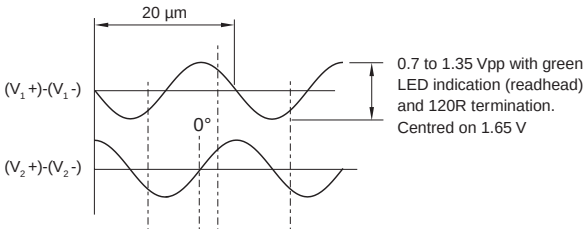
Setup signal voltage proportional to incremental signal amplitude

† **Note:** Inverse signals not shown for clarity

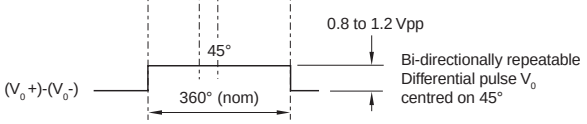
Analogue output signals
- Interface model Ti0000 and T1XXX/2XXX readhead

Note: Analogue signals are available direct from the T1000/T2000 readhead

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



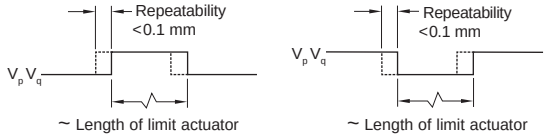
Reference



Limits Open collector output, asynchronous pulse

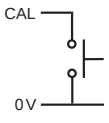
Ti0000 interface only **T1XXX readhead only**

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)

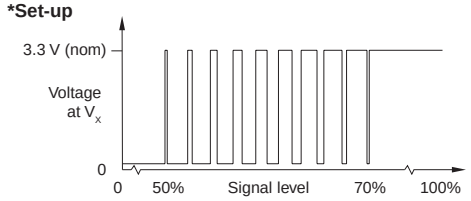


All Ti interfaces include a push button switch to enable CAL/AGC features.

Remote operation of the CAL/AGC is possible via pin 14 of analogue Ti0000 interfaces.

For applications where no Ti 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.

*Set-up signals as shown are not present during calibration routine

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T1XXX linear readhead

Compatible with RGSZ20, 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
1 = RSLM/RELM

Reference mark
0 = Output with selector only
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 interface

T2XXX rotary readhead

Compatible with RESM rings

Readhead part number T 2 0 0 0 - 15 A

Series
T = TONiC™

Scale form
2 = Rotary

Readhead type
0 = Standard

Ring diameter
0 = RESM >135 mm
1 = RESM 55 to 135 mm
2 = RESM <55 mm
4 = RGSZ partial arc >135 mm
5 = RGSZ 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 interface

Ti interface

Compatible with all TONiC™ readheads

Interface part numbers

- analogue: Ti 0000 A 00 A

- 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

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

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

*Contact Renishaw for other interpolation factors.

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

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TONiC™ compatible products:

TONiC™

T1XXX

RGSZ20

T1000 Installation guide M-9653-9154

Data sheet L-9517-9348

RELM

T1010 Installation guide M-9653-9225

Data sheet L-9517-9219

RSLM

T1010 Installation guide M-9653-9225

Data sheet L-9517-9305

T2XXX

RESM

T2000 Installation guide M-9653-9161

Data sheet L-9517-9154

REXM

T2000 Installation guide M-9653-9161

Data sheet L-9517-9318

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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