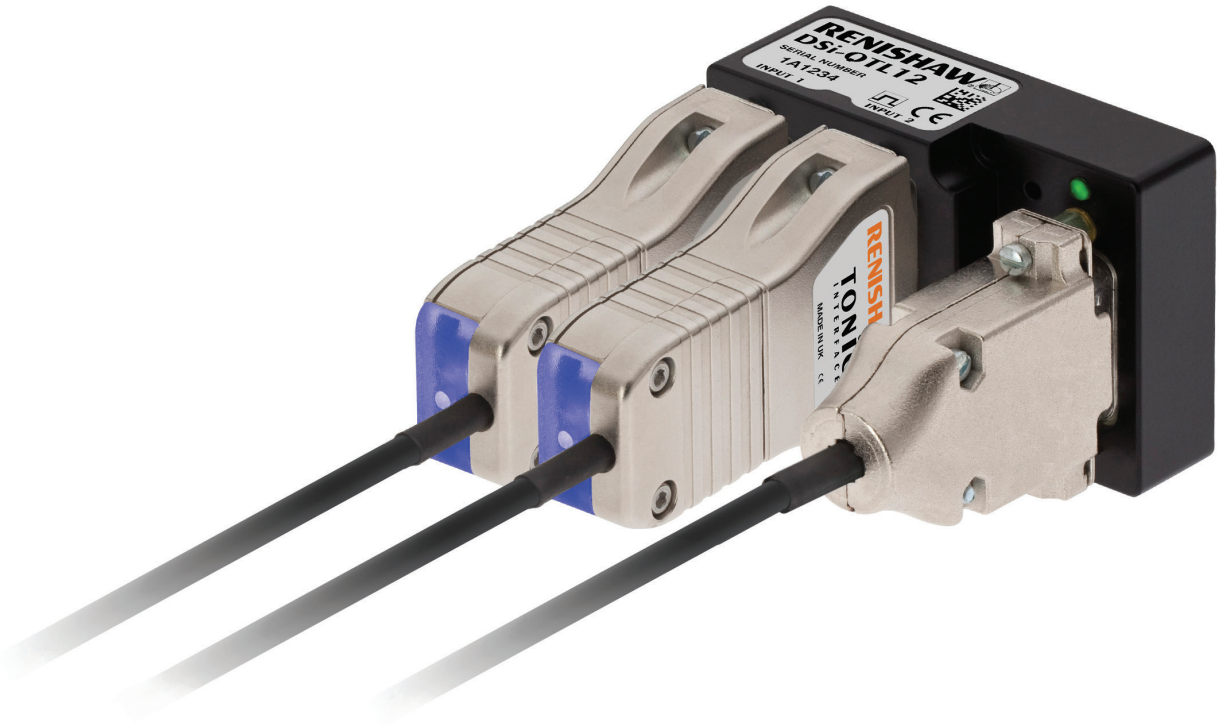
Data sheet
L-9517-9466-02-B

RENISHAW
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DSi dual readhead angle encoder system



DSi brings higher accuracy and a selectable reference output position to rotary and partial rotation axes.

Using two readheads on a rotary system improves its accuracy by eliminating eccentricity, bearing wander and all odd error harmonics. DSi makes adding that second readhead easy by taking care of the combination of incremental channels and reference mark processing.

DSi features patented *propoZ*™ technology that allows the customer to select a reference output position with the press of a button. The *propoZ* output position is angularly repeatable, regardless of bearing wander or power cycling.

DSi is available with line driven or 3-state alarms and a range of retiming frequencies to suit industry standard controllers. The system resolution is determined by the connected encoder systems.

- **Compatible with VIONiC™ and TONiC™ angle encoder systems**
- **Compensates encoder measurement errors caused by:**
  - **bearing wander**
  - **eccentricity**
  - **all odd error harmonics**
- ***propoZ* customer-selected reference output position**
- ***propoZ* is angularly repeatable and unaffected by bearing wander or power cycling**
- **RS422 digital quadrature signals**

System features

proproZ reference mark

The DSi processes the reference mark signals from the two connected encoder systems and outputs a single, angularly repeatable reference position that is unaffected by bearing wander, or power cycling, thus improving the metrology of the complete system. The position of this reference signal can be selected by the customer.

NOTE: The system must rotate so that both readheads pass the *IN-TRAC*™ reference mark on the ring to determine the propoZ position. For partial rotation a REXT or REST ring, with two reference marks 180 degrees apart, is required and each readhead must see a single reference mark.

Accuracy

The DSi compensates the effects of bearing wander and eliminates all odd error harmonics, including eccentricity.

The total installed accuracy of REXM/REXT with two readheads and a DSi is:

Ring diameter	Total installed accuracy
≥ 100 mm	±1 arc second
75 mm	±1.5 arc second
≤ 57 mm	±2 arc second

For optimum accuracy, the two readheads should be mounted diametrically opposite each other so that the optical centrelines are 180 ±1° apart.

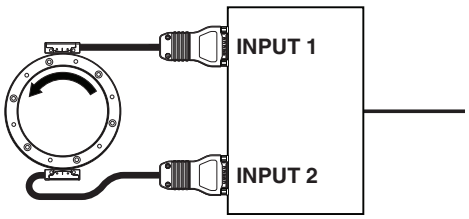
Contact your local Renishaw representative for further detail on accuracy when using a RESM/REST ring.

Readhead orientation

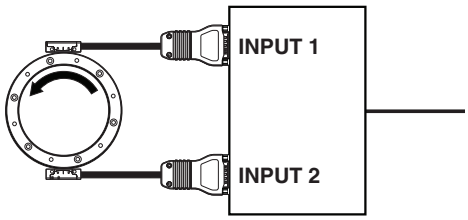
The DSi enables any readhead orientation to be selected with a switch.

NOTE: 'Option 1' should be used where possible, to achieve the highest accuracy. 'Option 2' can be used where space is limited, but the accuracy will be degraded. Contact your local Renishaw representative for further details.

Option 1: recommended for highest accuracy



Option 2: alternative configuration, only for applications where space is limited. Accuracy will be degraded



TONiC encoder systems and RESM rings shown

Compatible readheads

		VIONiC	TONiC
			
Scale type [1]	Full rotation	REXM20 or RESM20	
	Partial rotation	REXT20 or REST20	
Pitch		20 µm	
Outputs		Digital resolutions from 5 µm to 2.5 nm direct from the readhead	Digital resolutions from 5 µm to 1 nm from an interface
SDE (typical)	> Ø135 mm	< ±15 nm	±30 nm
	≤ Ø135 mm	< ±20 nm	±30 nm
Jitter (RMS)		down to 1.6 nm	down to 0.5 nm
Maximum speed		12 m/s	10 m/s

System requirements

Both of the encoder systems connected to the DSi must:

- Be configured with line driven alarm outputs
- Have the same interpolation factor and resolution
- Have a clocked output option the same or lower than the connected DSi

Refer to the *VIONiC™ incremental optical encoder system* data sheet (Renishaw part no. L-9517-9678) or the *TONiC™ incremental optical encoder system* data sheet (Renishaw part no. L-9517-9337) for details about readhead configuration.

Partial rotation applications

A REXT or REST ring with 2 reference marks is required. The ring must be installed so that, when it is rotated, each readhead only sees a single reference mark.

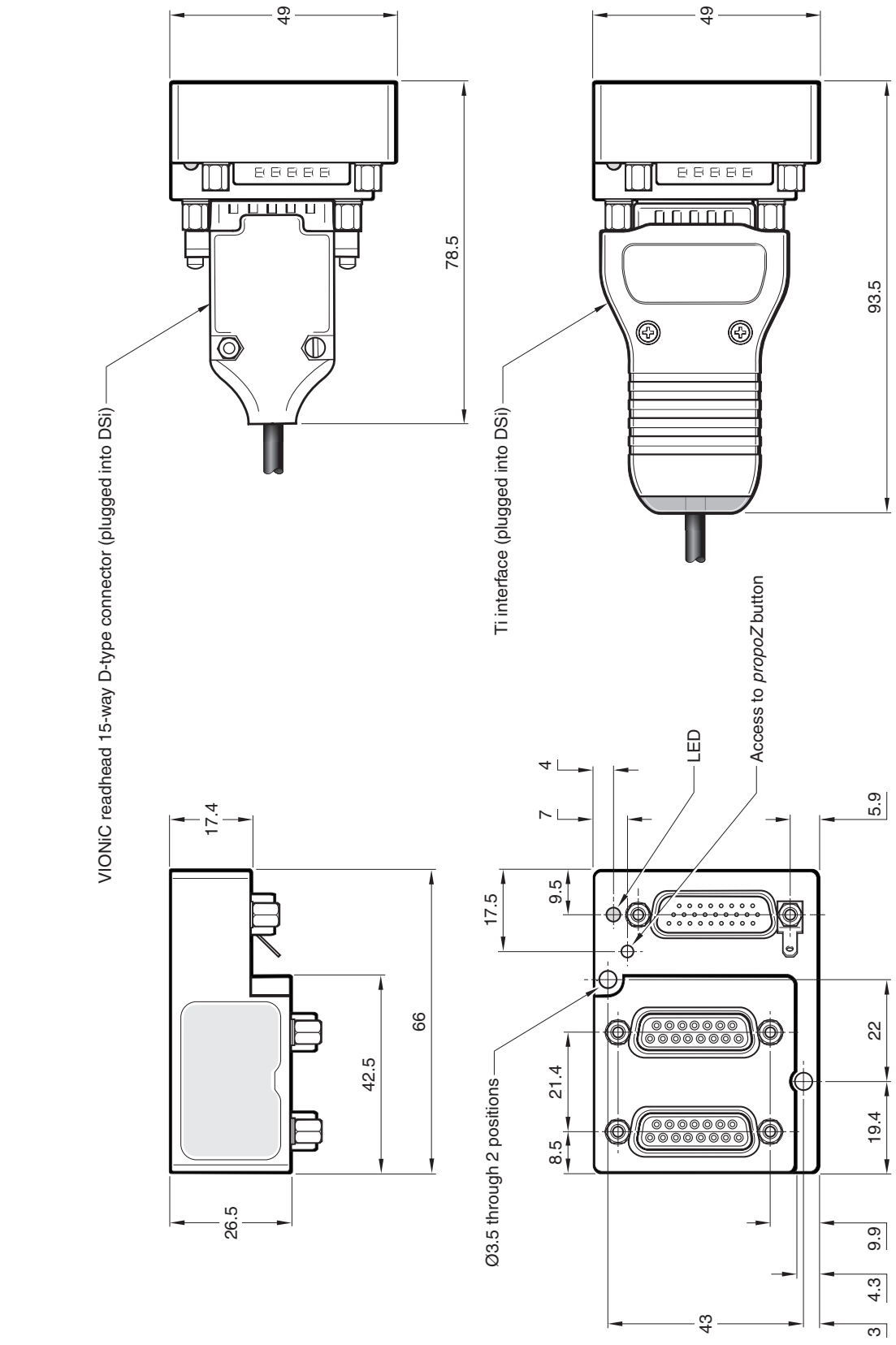
- The maximum rotation of the shaft / hub is 357°
- The minimum angle of rotation of the shaft / hub is 3°

For more information refer to the *VIONiC REXM20/REXT20 ultra-high accuracy angle encoder system* installation guide (Renishaw part no. M-6195-9239) or the *TONiC T20x1 REXM20/REXT20 ultra-high accuracy angle encoder system* installation guide (Renishaw part no. M-9653-9248).

[1] For more information refer to thr *RESM rotary scale* data sheet (Renishaw part no. L-9517-9154) and the *REXM20 ultra-high accuracy angle encoder* data sheet (Renishaw part no. L-9517-9318).

DSi installation drawing

Dimensions and tolerances in mm



DSi variants

There are two variants of DSi, local and remote.

Local

- Compatible with TONiC system only
- The TONiC Ti interfaces plug directly into the DSi

Remote

- Compatible with VIONiC or TONiC systems
- The VIONiC readheads plug directly into the DSi
- The TONiC Ti interfaces are connected via an extension cable to the DSi
- Ensure the correct voltage at the DSi and the Ti interface

Compatible systems

	Local		Remote	
	Full rotation	**Partial rotation**	**Full rotation**	**Partial rotation**
TONiC	DSi-QTL DSi-QTM	DSi-QUL DSi-QUM	DSi-QTR DSi-QTS	DSi-QUR DSi-QUS
VIONiC	-	-	DSi-QTR DSi-QTS	DSi-QUR DSi-QUS

For full part number details, refer to 'Full rotation part numbers' on page 14 and 'Partial rotation part numbers' on page 15.

General specifications

Power supply	5V +10%	1 Amp maximum when terminated with 120 ohms. Renishaw encoder systems must be powered from a supply complying with the requirements for SELV of standard IEC 60950-1.
	Ripple	200 mVpp maximum @ frequency up to 500 kHz
Temperature	Storage (system)	–20 °C to +70 °C
	Operating (system)	0 °C to +70 °C
Humidity		95% relative humidity (non-condensing) to IEC 60068-2-78
Sealing	Readhead	IP40
	Ti interface	IP20
	DSi	IP20
Acceleration	Operating (VIONiC readhead)	400 m/s², 3 axes
	Operating (TONiC readhead)	500 m/s², 3 axes
Shock	Operating (system)	500 m/s², 11 ms, ½ sine, 3 axes
Vibration	Operating (local mounting)	30 m/s², 55 Hz to 2000 Hz, 3 axes
	Operating (remote mounting)	100 m/s², 55 Hz to 2000 Hz, 3 axes
Mass	VIONiC readhead	8.6 g
	TONiC readhead	10 g
	Ti interface	100 g
	DSi	85 g
	Cable	26 g/m
Readhead cable	VIONiC readhead	Single-shielded, outside diameter 4.25 ±0.25 mm Flex life > 20 × 10⁶ cycles at 30 mm bend radius UL recognised component
	TONiC readhead	Double-shielded, outside diameter 4.25 ±0.25 mm Flex life > 20 × 10⁶ cycles at 20 mm bend radius UL recognised component
Maximum cable length [1]	VIONiC readhead to DSi	3 m
	TONiC readhead to Ti interface	10 m

CAUTION: Renishaw encoder systems have been designed to the relevant EMC standards, but must be correctly integrated to achieve EMC compliance. In particular, attention to shielding arrangements is essential.

[1] For maximum extension cable lengths see the electrical connections drawings on page 9 and page 10.

Speed

The maximum speed of the system will depend on the VIONiC readheads or Ti interfaces connected to the DSi.

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 the ring (mm)

VIONiC speed

Clocked output option [1] (MHz)	Maximum speed (m/s)											
	5 µm (D)	1 µm (X)	0.5 µm (Z)	0.2 µm (W)	0.1 µm (Y)	50 nm (H)	40 nm (M)	25 nm (P)	20 nm (I)	10 nm (O)	5 nm (Q)	2.5 nm (R)
20	12	12	8.06	3.22	1.61	0.806	0.645	0.403	0.322	0.161	0.081	0.040
12	12	10.36	5.18	2.07	1.04	0.518	0.414	0.259	0.207	0.104	0.052	0.026
10	12	8.53	4.27	1.71	0.850	0.427	0.341	0.213	0.171	0.085	0.043	0.021
08	12	6.91	3.45	1.38	0.690	0.345	0.276	0.173	0.138	0.069	0.035	0.017
06	12	5.37	2.69	1.07	0.540	0.269	0.215	0.134	0.107	0.054	0.027	0.013
04	12	3.63	1.81	0.730	0.360	0.181	0.145	0.091	0.073	0.036	0.018	0.009
01	4.53	0.910	0.450	0.180	0.090	0.045	0.036	0.023	0.018	0.009	0.005	0.002

TONiC speed

Clocked output option [1] (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
20	10	10	6.75	2.70	1.35	0.675	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	0.405	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

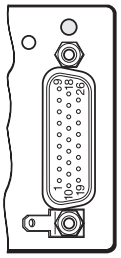
[1] The DSi must have a clock frequency the same or higher than the connected encoder system.

Output signals

DSi interface output

Function	Output type	Signal		Output
Power	-	5 V power		26
		5 V sense		18
		0 V power		9
		0 V sense		8
Incremental signals	RS422A	A	+	24
			–	6
		B	+	7
			–	16
Reference mark	RS422A	Z	+	15
			–	23
Alarm	RS422A	E	+	25
			–	17
Limits	Open collector	P		4
		Q		13
Initialization status	Open collector	K		3
Shield	-	Inner		Not connected
	-	Outer		Case
Do not connect	-	-		1, 2, 5, 10, 11, 12, 14, 19, 20, 21, 22

NOTE: VIONiC and TONiC readheads are fitted with P and Q 'end of travel' limit switch sensors, typically used for linear motion applications. P and Q limit actuators are not suitable for ring encoder installation. Limit switch signal detail is included here for information only. Contact your local Renishaw representative if you require limits on your rotary installation.

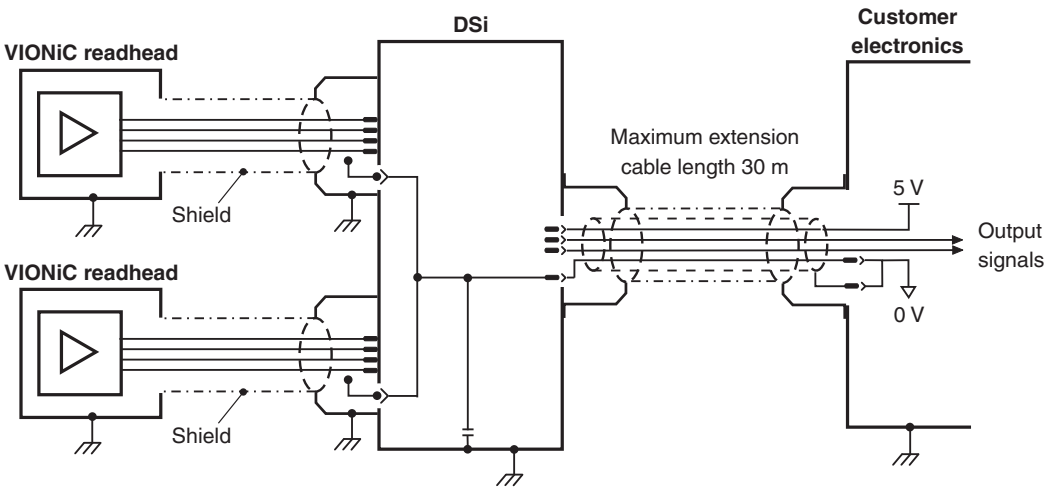


26-way high-density
D-type plug

Electrical connections

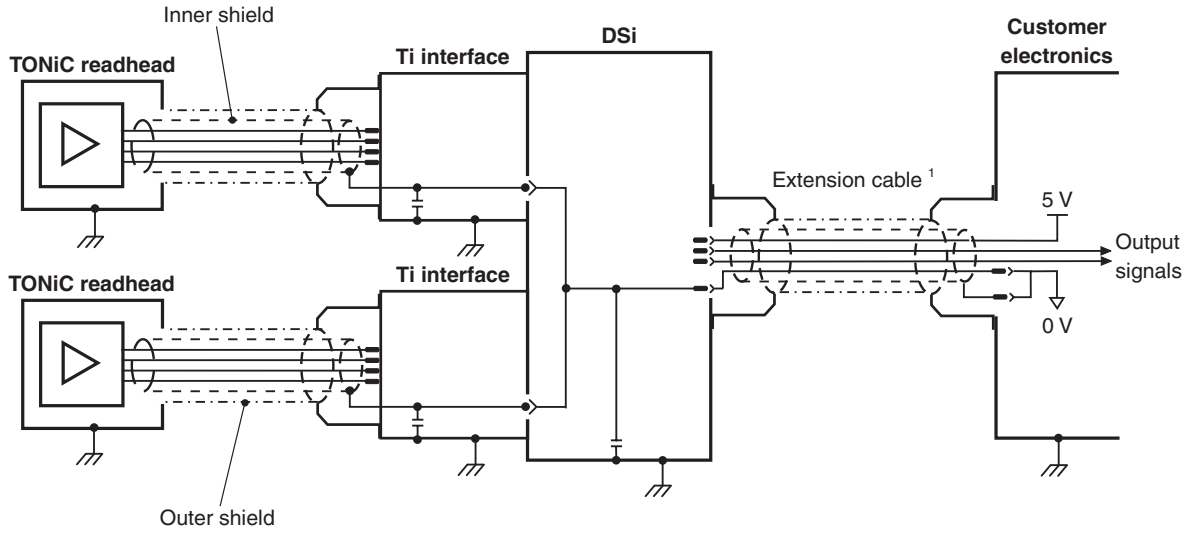
Grounding and shielding

VIONiC system and remote DSi



IMPORTANT: The shield should be connected to the machine earth (Field Ground).

TONiC system and local DSi

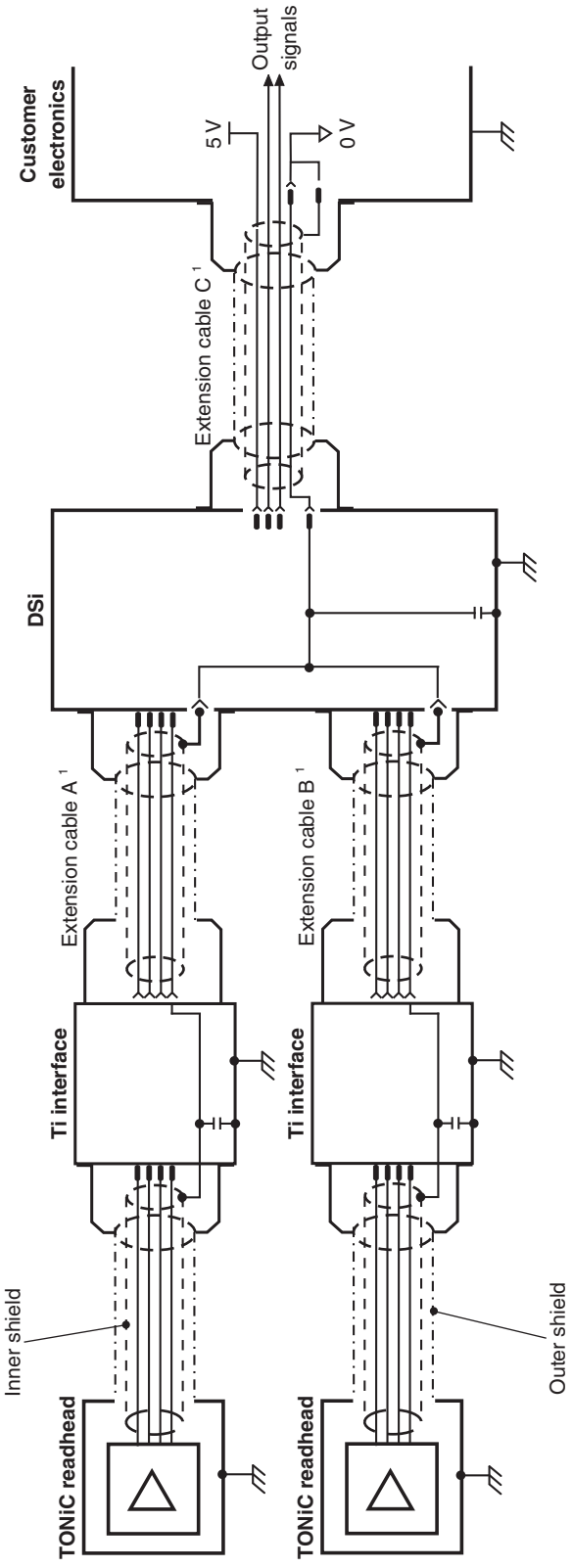


[1] The maximum length of the extension cable depends upon the output frequency of the Ti interfaces.

- 15 MHz to 20 MHz output frequency - 25 m maximum
- ≤ 14 MHz output frequency - 30 m maximum

Grounding and shielding

TONiC system and remote DSi



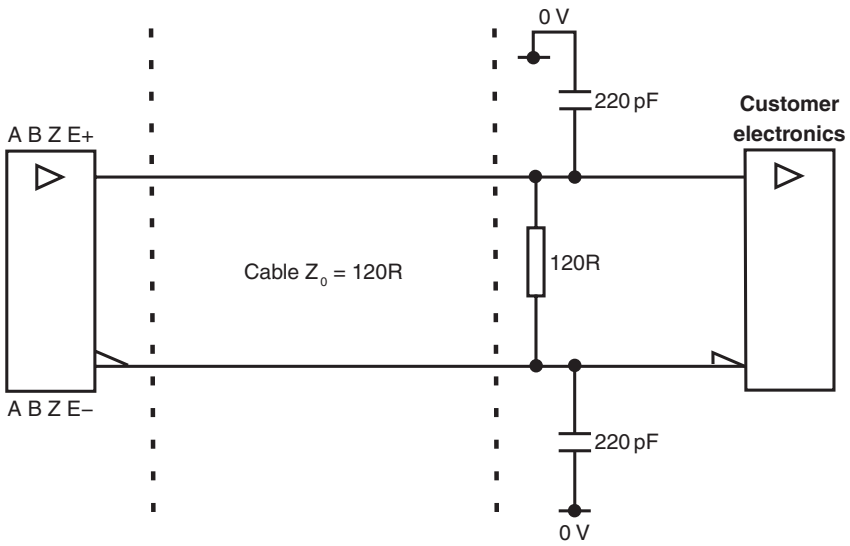
[1] The total length of the extension cables between a Ti interface and the customer electronics (A + C and B + C) depends upon the output frequency of the Ti interface.

- 15 MHz to 20 MHz output frequency - 25 m maximum
- ≤ 14 MHz output frequency - 30 m maximum

For example. for a DSIQTR20 the combined total extension cable A and C must be < 25 m,

Recommended signal termination

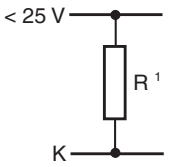
Digital outputs



Standard RS422A line receiver circuitry.

The capacitors are recommended for improved noise immunity.

Initialisation status output



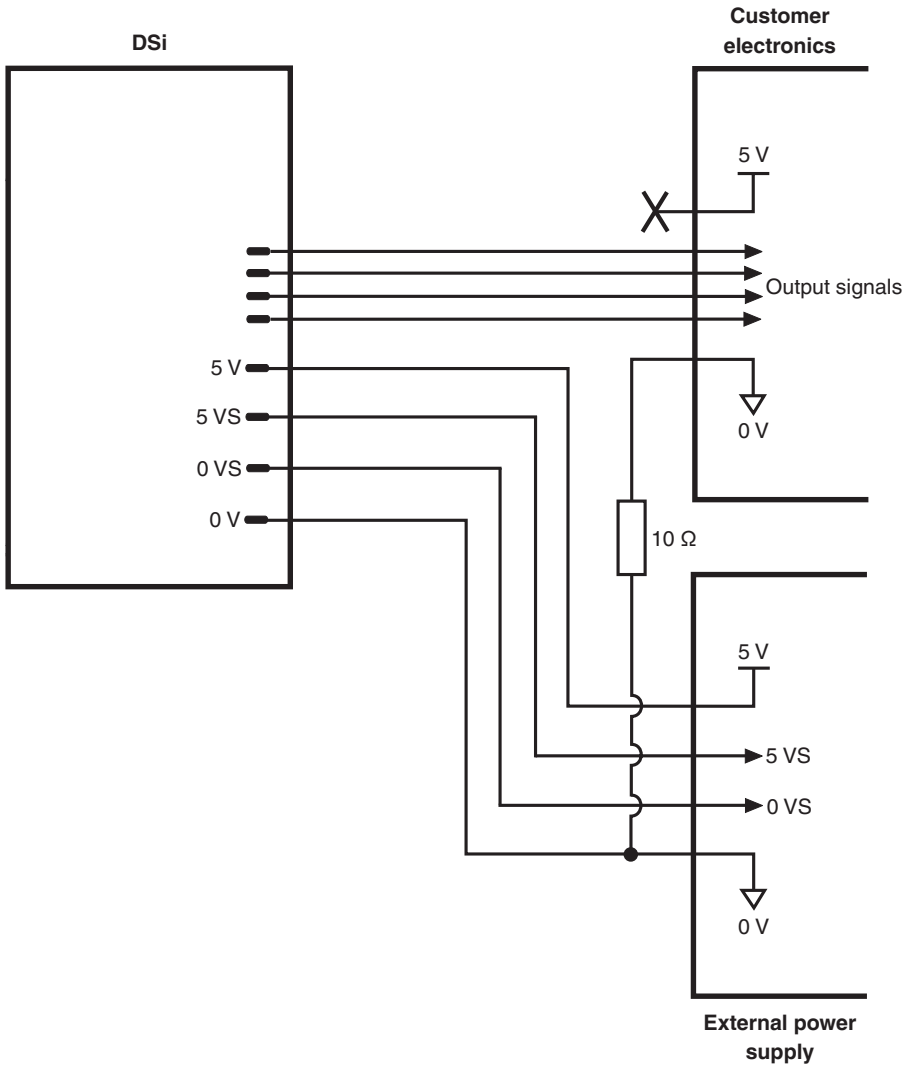
[1] Select R so max. current does not exceed 20 mA. Alternatively, use a suitable relay or opto-isolator.

Connecting a separate power supply

Many controllers cannot supply 1 amp at 5 volts, so it may be necessary to connect a separate power supply. To ensure correct operation, the separate power supply should be connected as per the diagram below.

The 0 V of the separate power supply should be connected to the 0 V of the controller to ensure that the line driver in the DSi and line receiver in the controller are using the same reference voltage.

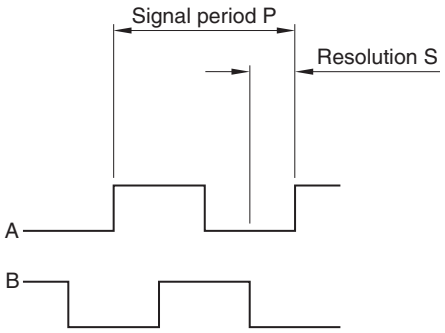
The 10 ohm resistor minimises current flow due to different 0 V potentials.



DSi output specifications

Form - Square wave differential line driver to EIA RS422A
(except initialisation status)

Incremental [1] 2 channels A and B in quadrature (90° phase shifted)



Resolution and retiming frequency are determined by the encoder systems connected to the DSi.

Always ensure that the connected encoder systems have the same part numbers.

propoZ reference [1]



Duration as resolution S.

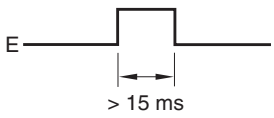
Customer-positionable.

To maintain angular repeatability regardless of bearing wander, the *propoZ* reference output will be re-synchronised at power-up with any one of the quadrature states (00, 01, 11, 10). [2]

Alarm

Alarm is asserted when either encoder goes into an alarm condition or when the DSi detects that a miscount has occurred. The alarm will be cleared when the DSi detects the correct count.

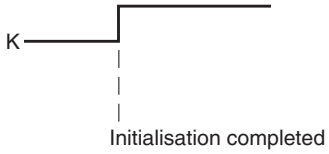
Line driven [1] **or** **3-state** [3]



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

Initialisation status

Open collector output



Initialisation status goes low when DSi is in initialisation mode (occurs when DSi is powered-up or when an alarm condition has been cleared). When initialization is complete the signal will go high.

1 Inverse signals not shown for clarity.

2 DSi's that only synchronise the *propoZ* reference mark with A high B high quadrature states are available. For further information, contact your local Renishaw representative.

3 Connected encoders must be configured with line driven alarm outputs.

Full rotation part numbers

For use with VIONiC systems

DSi-Q T R 12

Series
DSi

Input
Q - Quadrature

Ring compatibility
T - REXM/RESM

Output options
R - Remote, line driven alarm
S - Remote, 3-state alarm [1]

Clocked output option (MHz)

20 - 20 MHz	06 - 6 MHz
12 - 12 MHz	04 - 4 MHz
10 - 10 MHz	01 - 1 MHz
08 - 8 MHz	

For use with TONiC systems

DSi-Q T L 12

Series
DSi

Input
Q - Quadrature

Ring compatibility
T - REXM/RESM

Output options
L - Local, line driven alarm
M - Local, 3-state alarm [1]
R - Remote, line driven alarm
S - Remote, 3-state alarm [1]

Clocked output option (MHz)

20 - 20 MHz	06 - 6 MHz
12 - 12 MHz	04 - 4 MHz
10 - 10 MHz	01 - 1 MHz
08 - 8 MHz	

[1] Connected VIONiC readheads and Ti interfaces must be configured for line driven alarm.

Partial rotation part numbers

NOTE: For partial rotation applications a REXT/REST ring (two IN-TRAC reference marks positioned 180° apart) is required.

For use with VIONiC systems

DSi-Q U R 12

Series
DSi

Input
Q - Quadrature

Ring compatibility
U - REXT/REST

Output options
R - Remote, line driven alarm
S - Remote, 3-state alarm [1]

Clocked output option (MHz)

20 - 20 MHz	06 - 6 MHz
12 - 12 MHz	04 - 4 MHz
10 - 10 MHz	01 - 1 MHz
08 - 8 MHz	

For use with TONiC systems

DSi-Q U L 12

Series
DSi

Input
Q - Quadrature

Ring compatibility
U - REXT/REST

Output options
L - Local, line driven alarm
M - Local, 3-state alarm [1]
R - Remote, line driven alarm
S - Remote, 3-state alarm [1]

Clocked output option (MHz)

20 - 20 MHz	06 - 6 MHz
12 - 12 MHz	04 - 4 MHz
10 - 10 MHz	01 - 1 MHz
08 - 8 MHz	

[1] Connected VIONiC readheads and Ti interfaces must be configured for line driven alarm.

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