

TONiC™ DSi dual readhead rotary encoder system



DSi brings higher accuracy to rotary axes whilst *propoZ*™ technology offers a selectable reference mark position.

Using two readheads on an angle encoder improves the accuracy of the system 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 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 in two versions, known as 'local' and 'remote'. The local version is mounted directly onto the readhead interfaces, while the remote version can be mounted up to 30 metres away.

Each version is available with either line-driven or 3-state alarms.

Resolution is determined by the encoder interfaces that are connected to the DSi.

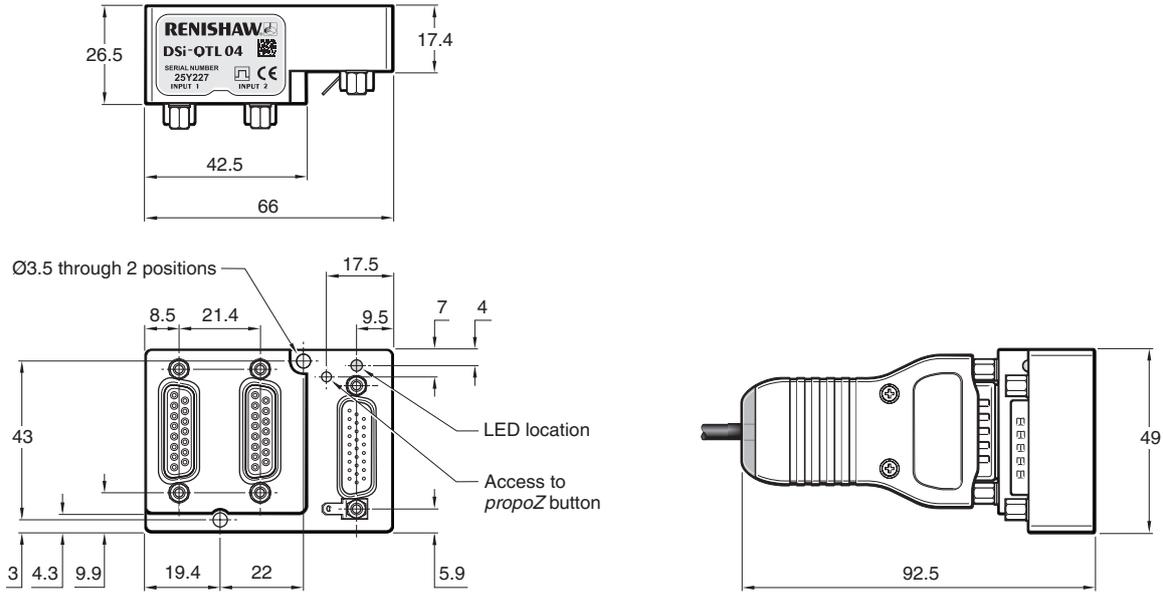
DSi is available with several retiming frequencies to suit industry-standard controllers.

Version now available for partial arc applications.

- Works with TONiC™ system angle encoders to give very high accuracy
- 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
- 'Local' version mounts directly onto the rear of the TONiC system interfaces
- 'Remote' version can be located up to 30 metres from the TONiC system interfaces
- RS422 digital quadrature signals

DSi installation drawing

Dimensions and tolerances in mm



General specifications

Power supply	5V +10%	1 amp maximum when terminated with 120 ohms. Renishaw encoder systems must be powered from a 5 Vdc supply complying with the requirements for SELV of standard IEC 60950-1.					
	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 + DSi)	Operating 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 (readhead)	Operating	500 m/s ² , 3 axes					
DSi unit only							
Shock	Non-operating	1000 m/s ² , 6 ms, ½ sine, 3 axes					
Vibration	Operating	50 m/s ² , 55 Hz to 2000 Hz, 3 axes					
Mass	Readhead	10 g					
	Interface	100 g					
	DSi	85 g					
	Cable	26 g/m					
EMC compliance (system)		IEC 61326-1					
Environmental		Compliant with EU Directive 2002/95/EC (RoHS)					
Readhead cable		Double-shielded, outside diameter 4.25 ±0.25 mm Flex life > 20 × 10 ⁶ cycles at 20 mm bend radius UL recognised component					
Maximum cable length	Readhead to interface	10 m					
	Interface to DSi (remote version) and DSi to controller	<table border="1"> <thead> <tr> <th>Output frequency (MHz)</th> <th>Maximum cable length (m)</th> </tr> </thead> <tbody> <tr> <td>15 to 20</td> <td>25</td> </tr> <tr> <td>≤14</td> <td>30</td> </tr> </tbody> </table>	Output frequency (MHz)	Maximum cable length (m)	15 to 20	25	≤14
Output frequency (MHz)	Maximum cable length (m)						
15 to 20	25						
≤14	30						

NOTE: When using extension cables customers should ensure correct voltage at DSi unit and also correct voltage at TONiC syetem interface for remote versions.

The TONiC and DSi encoder system conforms to the relevant harmonised European standards for electromagnetic compatibility, but must be correctly integrated to achieve EMC compliance. In particular, attention to shielding arrangements is essential.

The *propoZ* reference output

Reference mark position

On a single readhead system the TONiC encoder outputs a reference signal when the *IN-TRAC*™ reference mark passes the readhead. However, because the DSi system uses two encoders it can apply further processing to the reference signal to increase the angular repeatability of the zero position, thus improving the metrology of the complete system. Instead of outputting a reference signal when the *IN-TRAC* reference mark passes a readhead, the DSi outputs a reference signal at the position selected by the customer. This new standard in metrology is called *propoZ*.

Reference mark repeatability

The *propoZ* position is angularly repeatable, regardless of bearing wander or power cycling. Furthermore, the position is even repeatable if the centre of rotation changes while the axis is switched off. This is achieved because the DSi determines the centre of rotation by using the physical *IN-TRAC* reference mark. The DSi performs this calculation every time it is switched on.

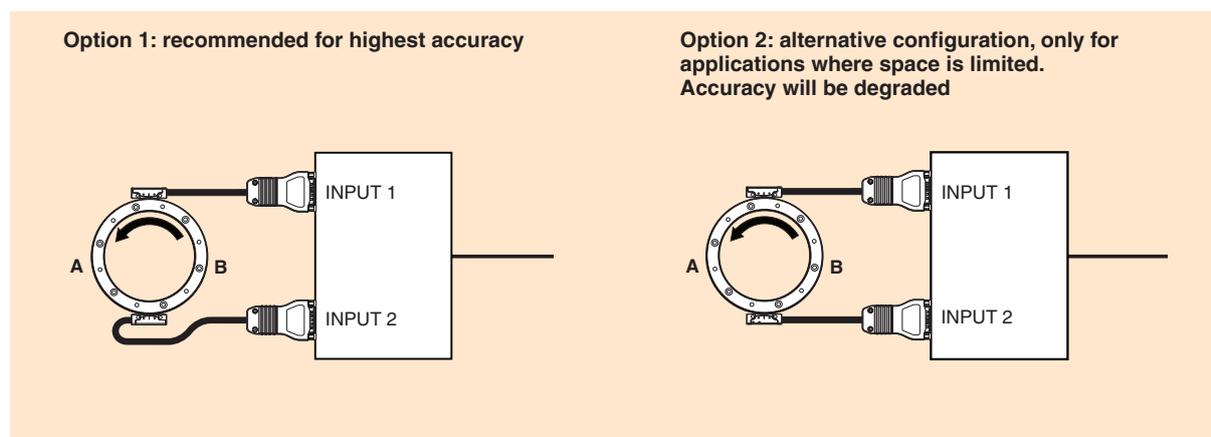
DSi initialisation

To determine the *propoZ* position the *IN-TRAC* reference mark must pass both readheads, so the axis may need to be rotated up to one full revolution. This occurs each time the DSi is switched on, or after an alarm condition has occurred. After initialisation the DSi will then give the *propoZ* reference output each time it arrives at the customer-determined *propoZ* position. DSI-QT will not work in partial rotary applications unless during the first initialisation (calibration) a full 360° rotation can be achieved so that it can 'learn' the pulse count.

For partial arc applications a REST or REXT ring with two reference marks is required with a DSI-QU (see part number section for more details).

Readhead orientation

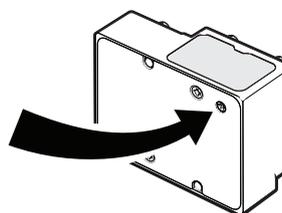
The DSi enables any readhead orientation to be selected with a switch. The configuration shown below in 'Option 1' should be used where possible, to achieve the highest accuracy. 'Option 2' can be used where space is limited, but the accuracy will be degraded. Please contact your local Renishaw representative for further details.



For more information refer to the TONiC DSi installation guide.



Ensure that the orientation switch is set correctly for your application. Refer to the DSi installation guide.



Resolution

The output resolution of DSi is determined by the resolution of the TONiC encoders connected to the DSi. TONiC interfaces are available in the following resolutions: 5 µm, 1 µm, 0.5 µm, 0.2 µm, 0.1 µm, 50 nm, 20 nm, 10 nm, 5 nm, 2 nm and 1 nm.

NOTE: DSi does not work with analogue versions of TONiC.

Retiming

DSi is available with the following retiming frequencies: 20 MHz, 12 MHz, 10 MHz, 8 MHz, 6 MHz, 4 MHz and 1 MHz. These figures refer to the minimum counter clock frequency required of the host controller. There is no 40 MHz or 50 MHz version.

As with a single readhead system, the retiming frequency should be selected so that it is the same or slower than the counter clock frequency of the receiving electronics. The retiming frequency of the Ti interfaces should match that of the DSi, although it is OK to use Ti interfaces with slower retiming frequencies. Do not use Ti interfaces that have a faster retiming frequency than the selected DSi.

Example: If the counter clock frequency of the receiving electronics is 14 MHz, the 12 MHz DSi and 12 MHz, Ti interfaces should be used.

Refer to the *TONiC encoder system* data sheet (Renishaw part number L-9517-9337) for further details.

Accuracy

DSi compensates the effects of bearing wander and eliminates all odd error harmonics including eccentricity. However, 'even' error harmonics such as ovality remain. The total installed error is affected by the spread of error harmonics, but in most RESM/REST installations with two readheads, the total installed error generally increases if the supporting shaft is eccentric because the ring is swashed to correct the eccentricity. For the highest accuracy the roundness (including eccentricity) of the supporting shaft should be controlled to the values shown in the table here:

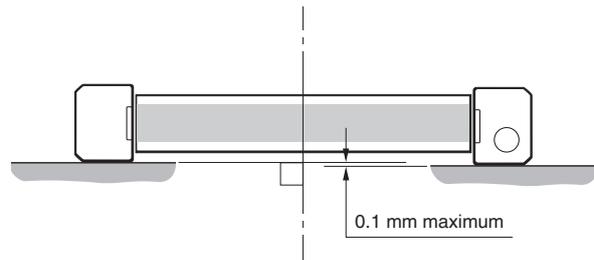
Recommended taper roundness when using two heads and DSi

Diameter (mm)	Roundness value (mm TIR)
≤115	0.0125
150 to 255	0.025
≥300	0.0375

Swash of the ring can also induce a once-per-revolution component that is not compensated by the DSi box.

To minimise this, the following conditions must be met:

- The readheads should be mounted on the same mounting face, i.e. the cables should be pointing in opposite directions. This ensures that the optical centrelines are coincident upon the ring.
- The axial misalignment of the readhead mounting faces should be within 0.1 mm, as shown in the diagram. Again, this ensures that the optical centrelines are coincident upon the ring.



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

NOTE: For ring alignment in partial arc applications refer to the RESM/REST or REXM/REXT installation guides.

The total installed accuracy of an A-section ring RESM/REST installed so that the radial deflection measured at the screw locations agrees to within ±3 µm and using two TONiC encoders and DSi will be as described in the following table.

Ring diameter (mm)	Typical accuracy (arc seconds)	Worst case accuracy (arc seconds)
52	±8.9	±21.7
57	±6.2	±14.5
75	±5.9	±14.1
100	±4.7	±11.4
103	±4.5	±11.1
104	±4.0	±9.4
115	±3.0	±7.2
150	±2.8	±6.1
200	±2.1	±4.3
206	±1.9	±3.8

Ring diameter (mm)	Typical accuracy (arc seconds)	Worst case accuracy (arc seconds)
209	±1.8	±3.6
229	±1.8	±3.6
255	±1.8	±3.5
300	±1.8	±3.5
350	±1.7	±3.5
413	±1.7	±2.9
417	±1.7	±2.9
489	±1.0	±1.4
550	±0.9	±1.4

It should be noted that although the use of two readheads compensates the effects of bearing wander upon the encoder reading, in most applications there are metrology effects that are associated with the workpiece moving as the bearing wanders.

REXM/REXT accuracy

Total installed accuracy of REXM/REXT with two TONiC encoders and DSi will be better than ±1 arc second.

Electrical connections

Connecting a separate power supply

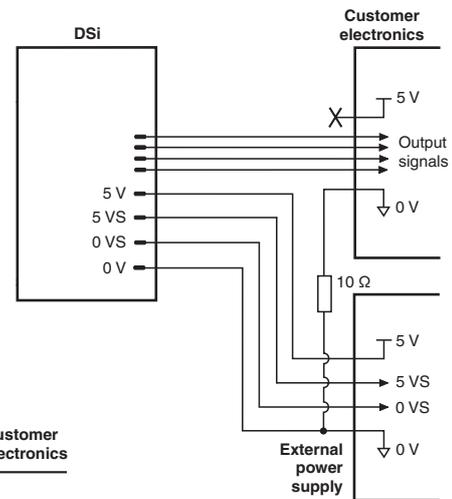
Many controllers cannot supply 1 amp at 5 volts, so it may be necessary to connect a separate power supply.

To ensure correct operation, the separate power supply should be connected as per the diagram opposite.

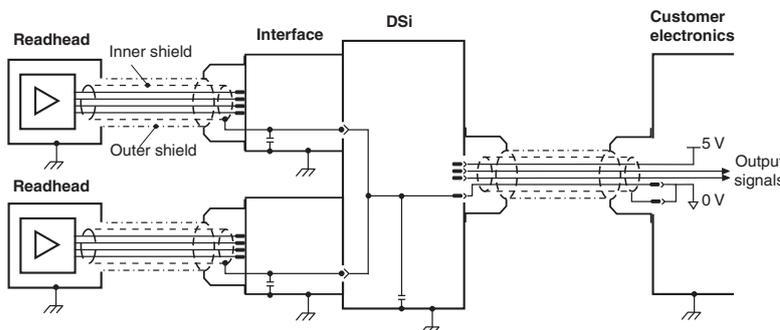
The 0 V of the separate power supply should be connected to the 0 V of the controller to ensure that the line driver in the DSi and line receiver in the controller are using the same reference voltage.

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

Connecting power supply

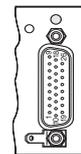


System grounding and shielding



Connections

DSi output



26-way 'D' type plug

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
		A-	6
		B+	7
		B-	16
Reference mark	RS422A	Z+	15
		Z-	23
Alarm [†]	RS422A	E+	25
		E-	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

[†]Alarm format can be 3-state or line driven. Please specify at time of ordering (refer to part numbers on back page of this data sheet).

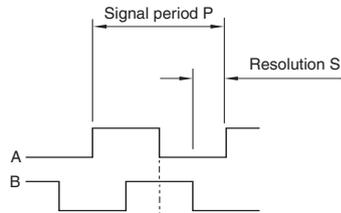
NOTE: Although the DSi can be supplied to output alarms in either line-driven or 3-state alarm formats, the input to the DSi must be a Ti interface configured with line-driven alarm format only.

*Limit switch outputs are taken directly from the readhead connected to input 1.

DSi output specifications

Form – Square wave differential line driver to EIA RS422A
(except limit switch and initialisation monitor)

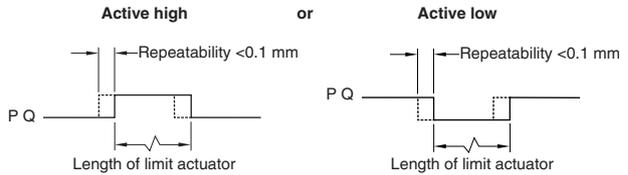
Incremental† 2 channels A and B in quadrature
(90° phase shifted)



Resolution and retiming frequency are determined by the TONiC Ti interfaces connected to the DSi.
Always ensure that the two Ti interfaces have the same part numbers.

Limits

Open collector output, asynchronous pulse



DSi outputs the limit switch from the encoder connected to input 1

propoZ reference†



Synchronised pulse Z, 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).

Alarm†



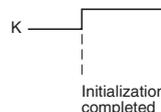
3-state or line-driven alarm format should be chosen at time of order.*

Alarm is asserted when either encoder goes into an alarm condition or when the DSi detects that a miscount has occurred.

Miscount alarm will be cleared when DSi detects correct count.

Initialisation monitor

Open collector output



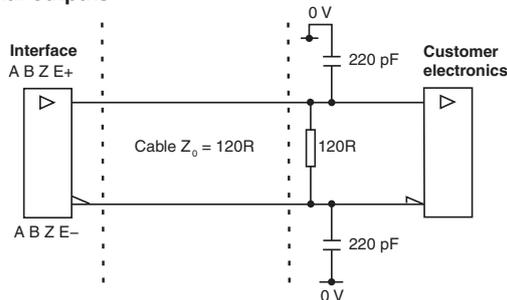
Initialisation monitor goes low when DSi is in initialisation mode (occurs when DSi is powered-up or when an alarm condition has been cleared). When initialization is complete, signal will go high.

† Inverse signals not shown for clarity.

* Ensure only Ti interfaces with line-driven alarm are connected to the DSi.

Recommended signal termination

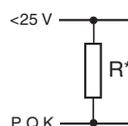
Digital outputs



Standard RS422A line receiver circuitry.

Capacitors recommended for improved noise immunity.

Limits and initialisation monitor outputs



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

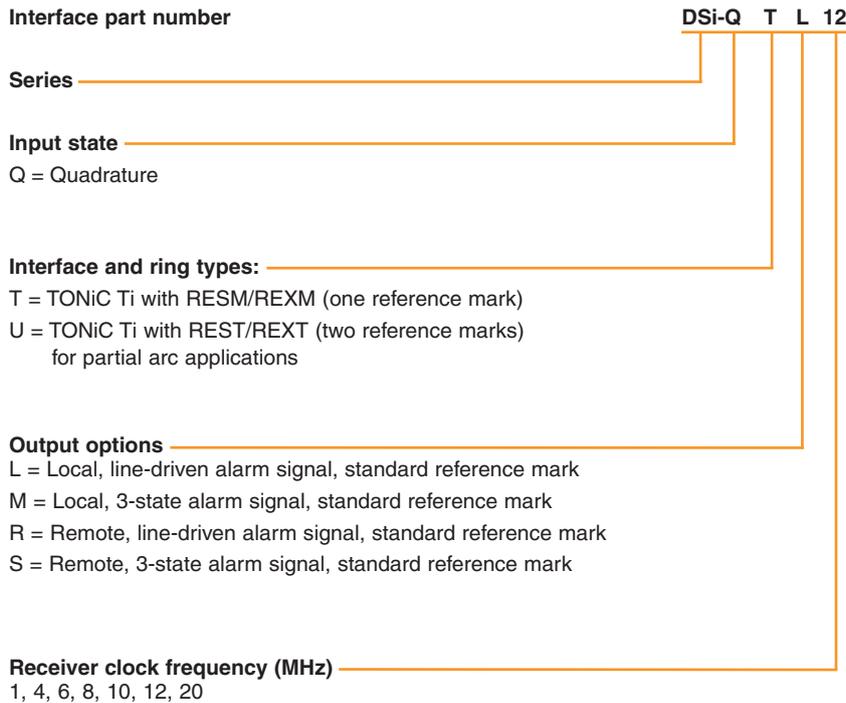
Part numbers

The partial arc DSi (DSi-QU) system should only be considered when:

- The customer has an axis which is limited to <math><360^\circ</math> rotation.
- The readheads can be diametrically opposed as per full axis DSi.

The partial arc DSi should always be used with an encoder ring which has two reference marks. These being either rings with a prefix of REST or REXT (the T denoting 'two').

The current structure for DSi is as follows:



NOTE: If a variant of the DSi is not currently available please speak to Renishaw UK so that this part can be added to the sales system.

For worldwide contact details, visit www.renishaw.com/contact

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