

# VIONiC™ RKLC20-S linear encoder system



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## Legal notices

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EP1173731	JP4750998	US6775008	CN100543424	EP1766334
JP4932706	US7659992	CN100507454	EP1766335	IN281839
JP5386081	US7550710	CN101300463	EP1946048	JP5017275
US7624513	CN101310165	EP1957943	US7839296	WO2017203210
CN1314511	EP1469969	EP2390045	JP5002559	US8987633
US8466943				

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### Product compliance

Renishaw plc declares that the VIONiC™ encoder system complies with the applicable standards and regulations. A copy of the EU declaration of conformity is available from our website at

[www.renishaw.com/productcompliance](http://www.renishaw.com/productcompliance)

### Compliance

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions:

(1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

The user is cautioned that any changes or modifications not expressly approved by Renishaw plc or authorised representative could void the user's authority to operate the equipment.

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

**NOTE:** This unit was tested with shielded cables on the peripheral devices. Shielded cables must be used with the unit to ensure compliance.

### Further information

Further information relating to the VIONiC encoder range can be found in the *VIONiC series encoder system* data sheet (Renishaw part no. L-9517-9678), *Advanced Diagnostic Tool ADTi-100* data sheet (Renishaw part no. L-9517-9699), *Advanced Diagnostic Tool ADTi-100 and ADT View software* quick-start guide (Renishaw part no. M-6195-9321), and the *Advanced Diagnostic Tool ADTi-100 and ADT View software* user guide (Renishaw part no. M-6195-9413). These can be downloaded from our website [www.renishaw.com/vionicdownloads](http://www.renishaw.com/vionicdownloads) and are also available from your local Renishaw representative.

## Legal notices (continued)

### Packaging

The packaging of our products contains the following materials and can be recycled.

Packaging Component	Material	ISO 11469	Recycling Guidance
Outer box	Cardboard	Not applicable	Recyclable
	Polypropylene	PP	Recyclable
Inserts	Low density polyethylene foam	LDPE	Recyclable
	Cardboard	Not applicable	Recyclable
Bags	High density polyethylene bag	HDPE	Recyclable
	Metalised polyethylene	PE	Recyclable

### REACH regulation

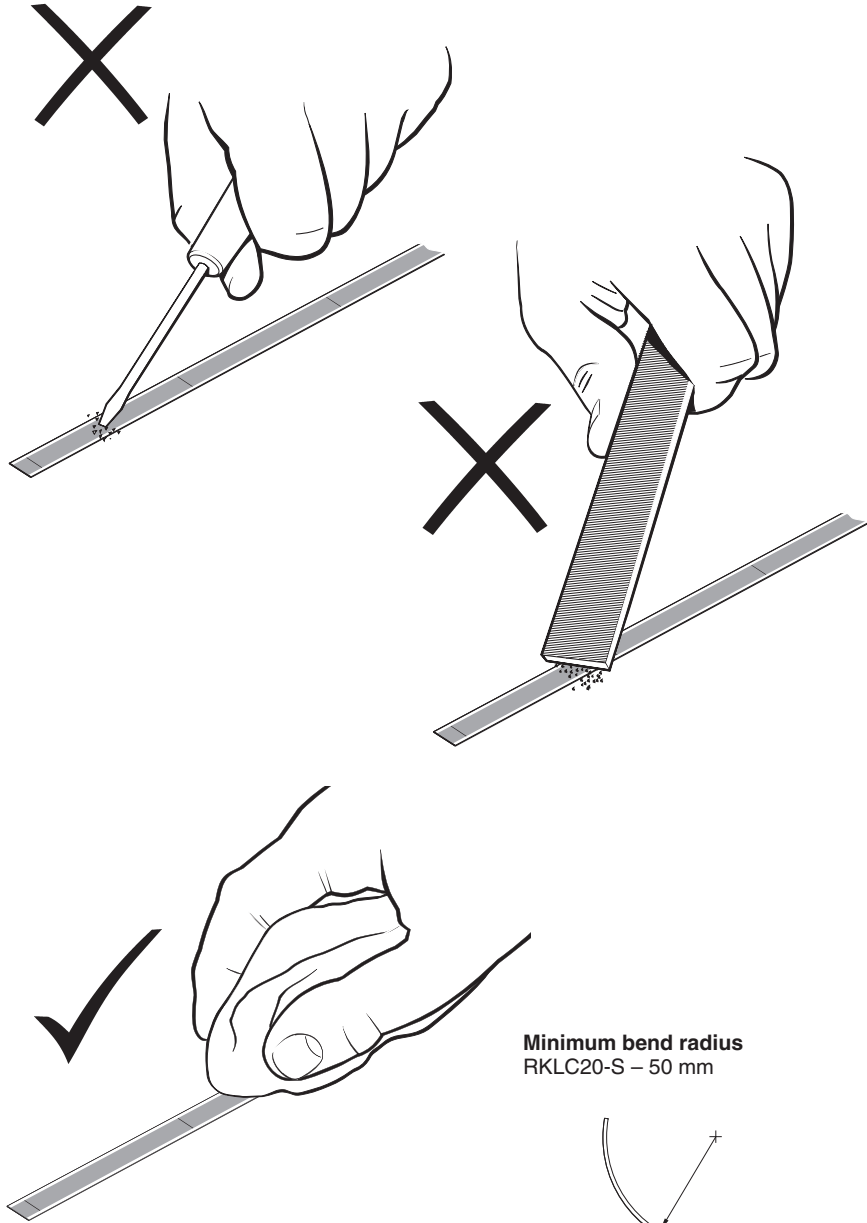
Information required by Article 33(1) of Regulation (EC) No. 1907/2006 ("REACH") relating to products containing substances of very high concern (SVHCs) is available at [www.renishaw.com/REACH](http://www.renishaw.com/REACH)

### WEEE recycling guidelines



The use of this symbol on Renishaw products and/or accompanying documentation indicates that the product should not be mixed with general household waste upon disposal. It is the responsibility of the end user to dispose of this product at a designated collection point for waste electrical and electronic equipment (WEEE) to enable reuse or recycling. Correct disposal of this product will help to save valuable resources and prevent potential negative effects on the environment. For more information, please contact your local waste disposal service or Renishaw distributor.

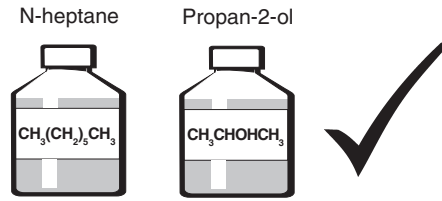
## Storage and handling



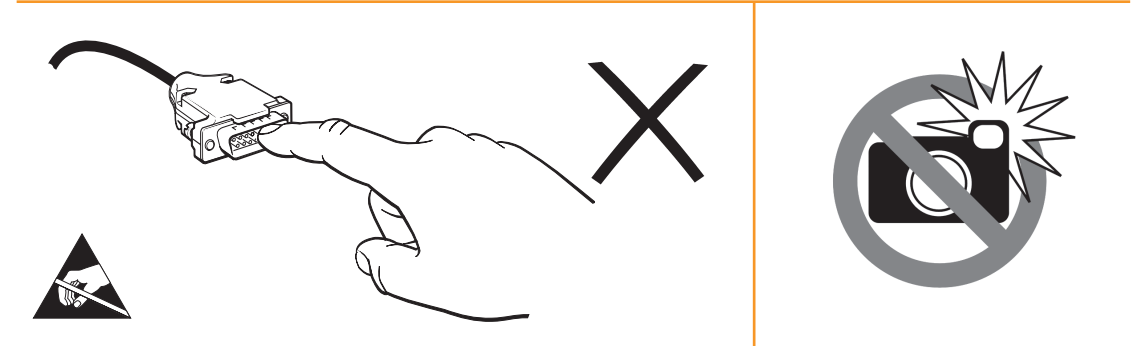
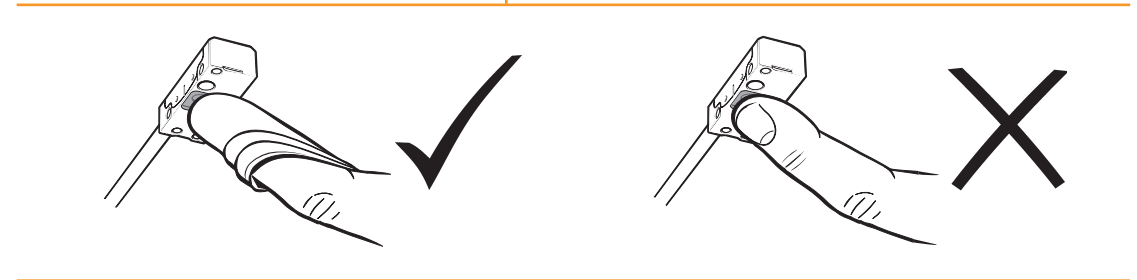
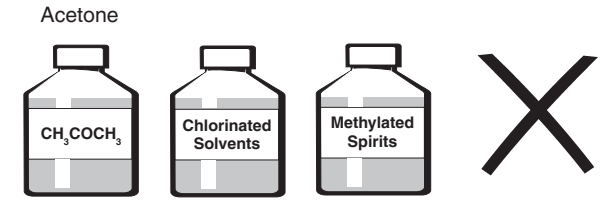
Minimum bend radius  
RKLC20-S – 50 mm

**NOTE:** During storage, ensure self-adhesive tape is on the outside of bend.

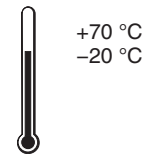
## Scale and readhead



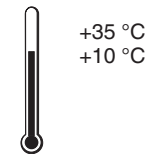
## Readhead only



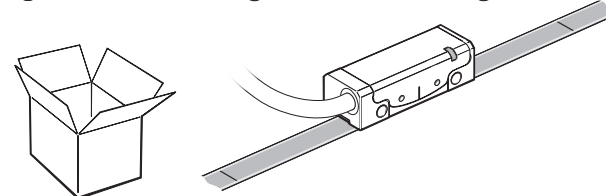
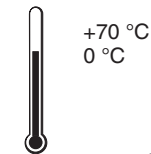
## Storage



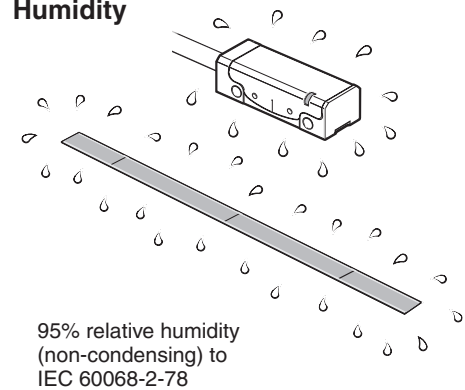
## Installation



## Operating

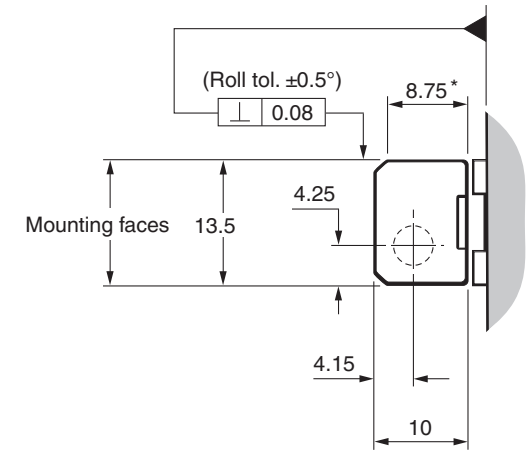
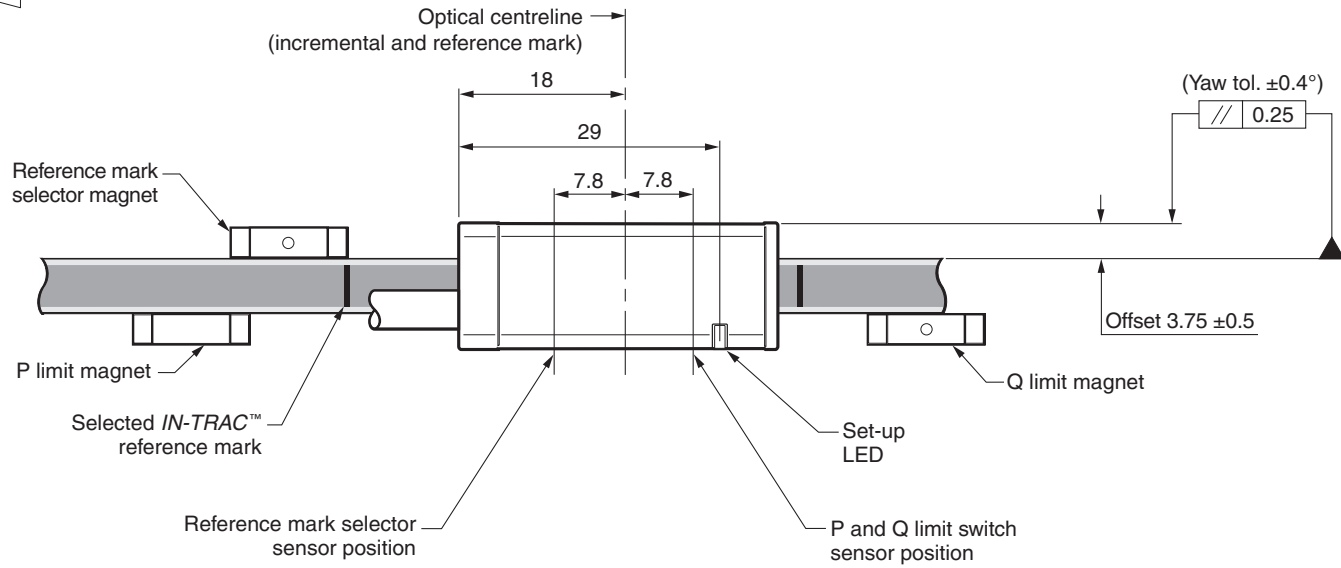


## Humidity

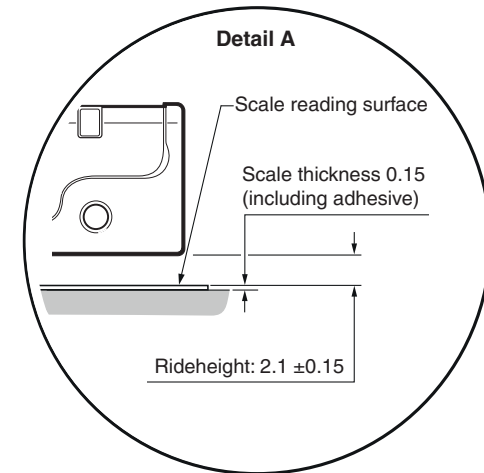
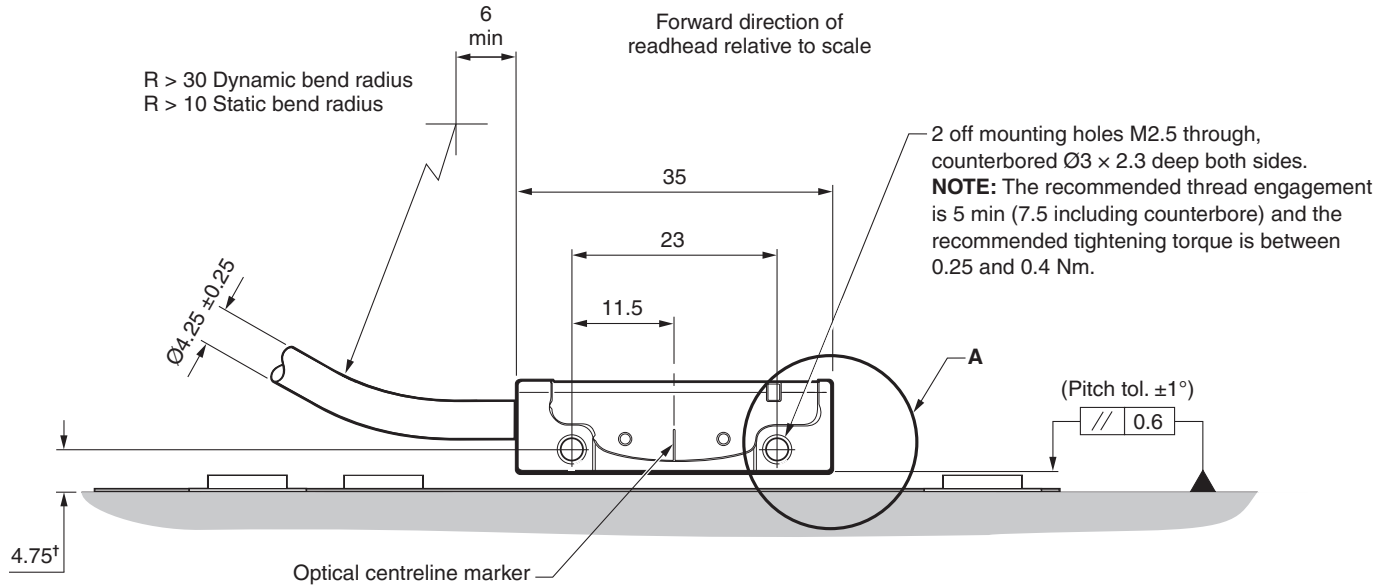


# VIONiC readhead installation drawing

Dimensions and tolerances in mm



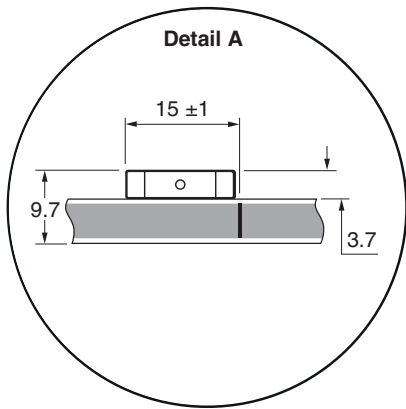
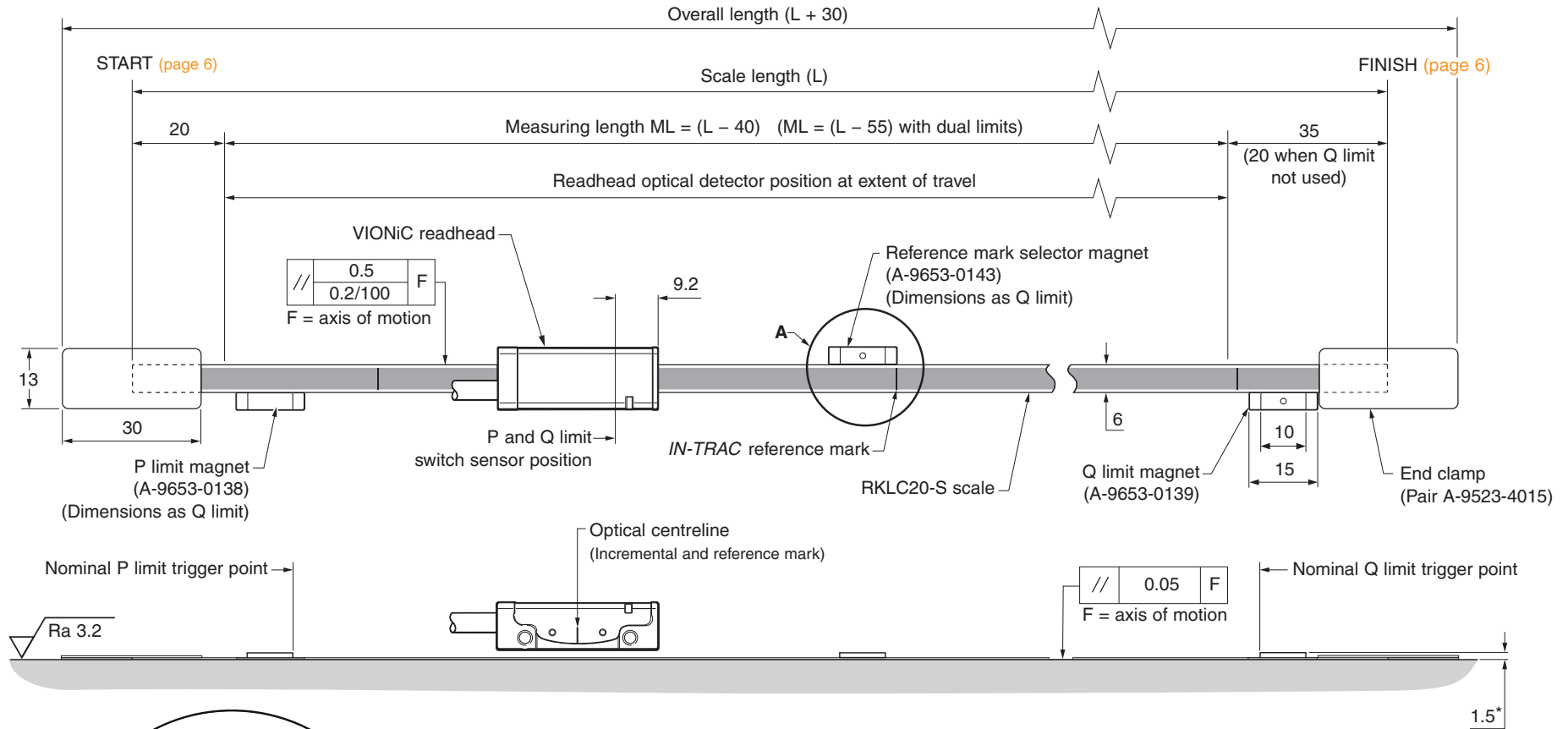
← Forward direction of readhead relative to scale



\* Extent of mounting face. † Dimension from substrate surface.

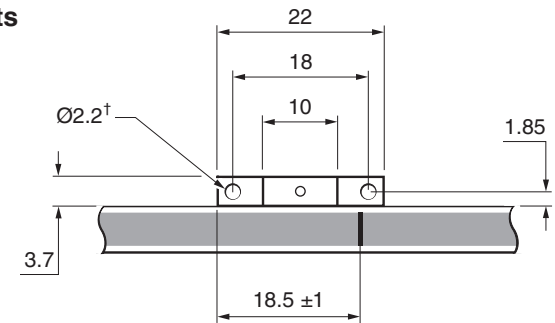
# RKLC20-S scale installation drawing

Dimensions and tolerances in mm



## Optional bolted reference mark selector or limit magnets

Bolted magnet type	Part number
Reference mark selector	A-9653-0290
Q limit	A-9653-0291
P limit	A-9653-0292



\*Dimension from substrate. † Supplied with 2 × M2 × 4 screws.

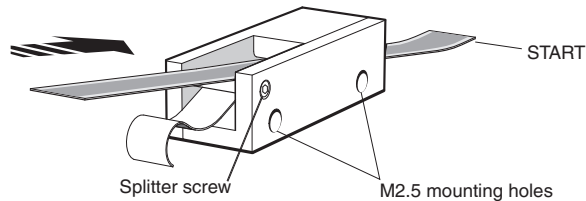
**NOTES:** The reference mark selector and limit actuator locations are correct for the readhead orientation shown.

External magnetic fields greater than 6 mT, in the vicinity of the readhead, may cause false activation of the limit and reference sensors.

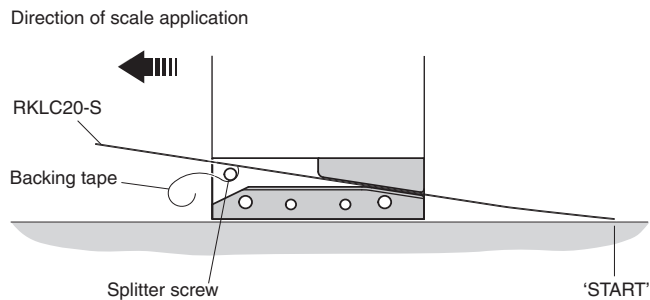
## Scale application

Scale applicator (A-6547-1912) is designed for use with RKLC20-S scale.

1. Allow the scale to acclimatise to the installation environment prior to installation.  
**NOTE:** RKLC scale should be installed between +10 °C and +35 °C to ensure scale mastering.
2. Mark out the 'START' and 'FINISH' points for the scale on the axis substrate – ensure that there is room for the end clamps ('RKLC20-S scale installation drawing', page 5).
3. Thoroughly clean and degrease the substrate using recommended solvents ('Storage and handling', page 3). Allow the substrate to dry before applying scale.
4. Mount the scale applicator to the readhead mounting bracket using M2.5 screws. Place the shim supplied with the readhead between the applicator and substrate to set the nominal height.  
**NOTE:** The scale applicator can be mounted either way round to enable easiest orientation for scale installation.
5. Move the axis to the scale 'START' position, leaving enough room for the scale to be inserted through the applicator.



6. Begin to remove the backing paper from the scale and insert the scale into the applicator up to the 'START' point (as shown). Ensure the backing paper is routed under the splitter screw.
7. Ensure that the end of the scale is in line with the 'START' position on the axis and apply finger pressure via a clean lint-free cloth to ensure scale end adheres well to the substrate.



8. Slowly and smoothly move the applicator through the entire axis of travel, ensuring the backing paper is pulled manually from the scale and does not catch under the applicator.
9. During installation ensure the scale is adhered to the substrate using light finger pressure.

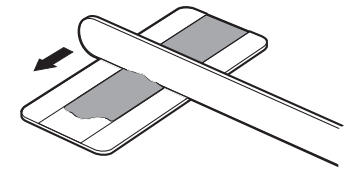
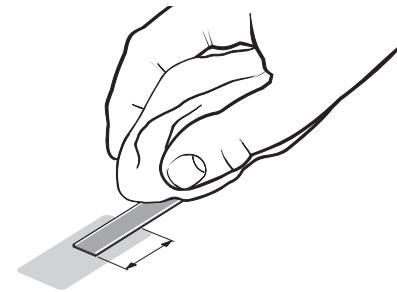
10. Remove the applicator carefully. Apply firm finger pressure via a clean lint-free cloth along the length of the scale after application to ensure complete adhesion.
11. Clean the scale using Renishaw scale wipes (A-9523-4040) or a clean, dry, lint-free cloth.
12. Fit end clamps: see 'End clamps' below.

## End clamps

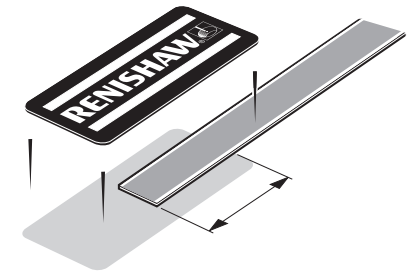
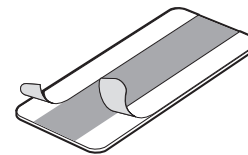
A-9523-4015 is an end clamp kit designed to be used with Renishaw RKLC20-S scale. (Alternative narrow 6 mm wide end clamps (A-9523-4111) are also available.)

**NOTE:** End clamps can be mounted before or after readhead installation.

1. Clean the ends of the scale and the area where end clamps are to be fitted using Renishaw scale wipes (A-9523-4040) or one of the recommended solvents ('Storage and handling', page 3).
2. Thoroughly mix up a sachet of glue (A-9531-0342) and apply a small amount to the underside of the end clamp.



3. The end clamp features two small regions of contact adhesive. These will temporarily hold the end clamp in position while the glue cures. Remove the backing tape from either side.
4. Immediately position the end clamp over the end of the scale and push down to ensure complete adhesion. Allow 24 hours at 20 °C for full cure.\*



**!** Ensure that excess glue is wiped away from the scale as it may affect the readhead signal level.

\*To ensure scale end movement of typically < 1 µm, stabilise the system at least 5 °C higher than the maximum customer application temperature for a minimum of 8 hours.

For example: Customer application = 23 °C axis temperature. Stabilise the system at 28 °C for a minimum of 8 hours.



## Reference mark selector and limit magnet installation

**IMPORTANT:** Allow 24 hours after scale application before fitting magnets.

For accuracy and ease of positioning of reference mark selector and limit magnets, the applicator tool (A-9653-0201) should be used. The magnet should be attached to the applicator tool as shown below. Limit magnets can be positioned at any user-defined location along the scale, but the reference mark selector magnet should be positioned adjacent to the selected *IN-TRAC* reference mark as shown.

As the VIONiC readhead passes the reference mark selector magnet or limit switch magnet, a force of up to 0.2 N is generated between the magnet and the concentrators on the readhead. The design of the bracket should be sufficiently stiff so that it is able to tolerate such force without distorting.

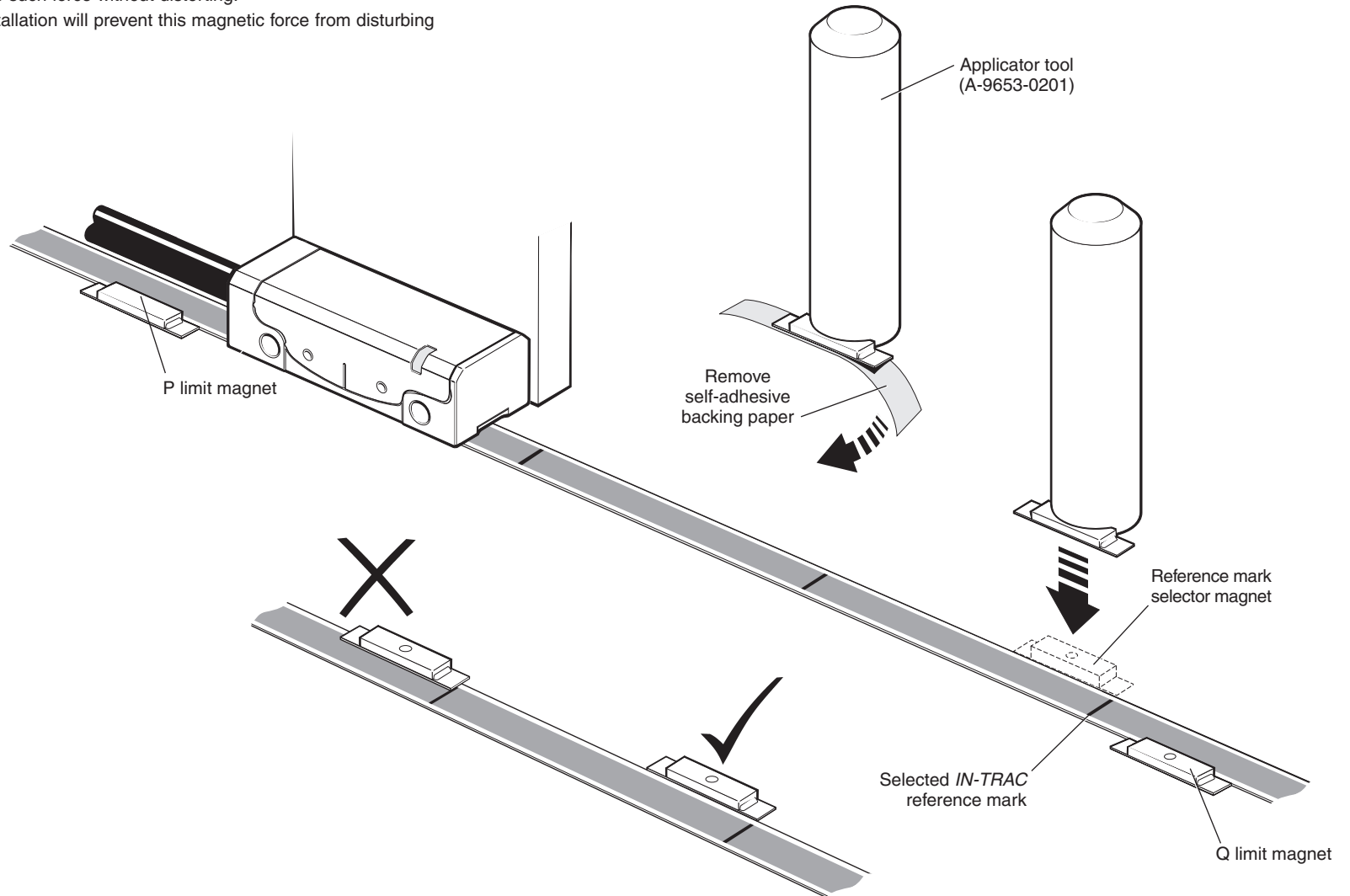
Following the clamping instructions on the scale installation will prevent this magnetic force from disturbing the scale.

### Limit trigger point

The limit output is nominally asserted when the readhead limit switch sensor passes the limit magnet leading edge, but can trigger up to 3 mm before that edge ('RKLC20-S scale installation drawing', page 5).

### NOTES

- ▶ Reference and limit magnets may creep when influenced by magnetic materials in close proximity. In such cases, they should be held in place using an additional fillet of epoxy glue or similar along the outer edge of the magnet assembly. Optional bolted reference and limit magnets are available ('RKLC20-S scale installation drawing', page 5).
- ▶ The reference mark selector and limit actuator locations are correct for the readhead orientation shown.
- ▶ The reference mark selector magnet is only required for 'Customer selectable reference mark' readheads. For more information refer to *VIONiC series encoder system* data sheet (Renishaw part no. L-9517-9678).
- ▶ External magnetic fields greater than 6mT, in the vicinity of the readhead, may cause false activation of the limit and reference sensors.



# VIONiC encoder system quick-start guide

This section is a quick-start guide to installing a VIONiC encoder system.

More detailed information on installing the system is contained on [page 9](#) and [page 10](#) of this installation guide.

The optional Advanced Diagnostic Tool ADTi-100\* (A-6165-0100) and ADT View software† can be used to aid installation and calibration.

## INSTALLATION

Ensure scale, readhead optical window and mounting faces are clean and free from obstructions.



If required, ensure reference mark selector magnet is correctly positioned ('[RKLC20-S scale installation drawing](#)', [page 5](#)).



Connect the readhead to receiving electronics and power-up. The set-up LED on the readhead will flash.



Install and align the readhead to maximise signal strength over the full axis of travel as indicated by a Green flashing LED.

## CALIBRATION

Cycle the power to the readhead to initiate the calibration routine. The LED will single flash Blue.



Move the readhead along the scale at slow speed (< 100 mm/s), without passing a reference mark, until the LED starts double flashing Blue.



### No reference mark

If a reference mark is not being used, the calibration routine should now be exited by cycling the power. The LED will stop flashing.

### Reference mark

Move the readhead back and forth over the selected reference mark until the LED stops flashing.



The system is now calibrated and ready for use. Calibration values, Automatic Gain Control (AGC) and Automatic Offset Control (AOC) status, are stored in readhead non-volatile memory at power down.

**NOTE:** If calibration fails (LED remains single flashing blue), restore factory defaults by obscuring the readhead optical window on power-up ([page 11](#)). Repeat the installation and calibration routine.

\*For more details refer to the *Advanced Diagnostic Tool ADTi-100 and ADT View software* quick-start guide (Renishaw part no. M-6195-9321) and *Advanced Diagnostic Tool ADTi-100 and ADT View software* user guide (Renishaw part no. M-6195-9413).

†The software can be downloaded for free from [www.renishaw.com/adt](http://www.renishaw.com/adt)

## Readhead mounting and alignment

### Mounting brackets

The bracket must have a flat mounting surface and should provide adjustment to enable conformance to the installation tolerances, allow adjustment to the rideheight of the readhead, and be sufficiently stiff to prevent deflection or vibration of the readhead during operation.

### Readhead set-up

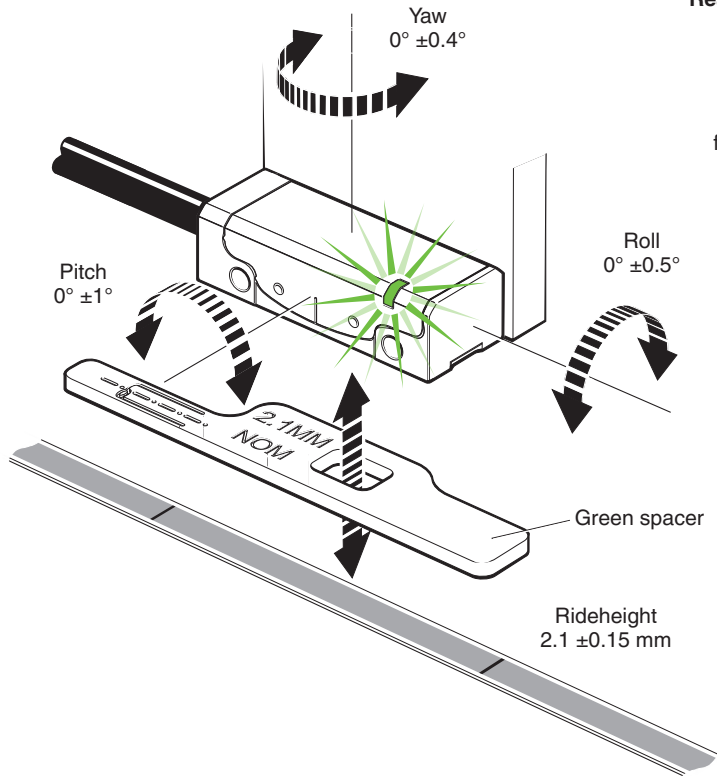
Ensure that the scale, readhead optical window and mounting face are clean and free from obstructions.

**NOTE:** When cleaning readhead and scale apply cleaning fluid sparingly; do not soak.

To set nominal rideheight, place the green spacer with the aperture under the optical centre of the readhead to allow normal LED function during set-up procedure. Adjust the readhead to achieve a flashing Green LED along the full axis of travel. The faster the flash rate, the closer it is to optimum set-up. The optional Advanced Diagnostic Tool ADTi-100 (A-6195-0100) and ADT View software can be used to optimise signal strength in challenging installations. See [www.renishaw.com/adt](http://www.renishaw.com/adt) for more information.

**NOTE:** When re-installing the readhead factory defaults should be restored (page 11).

### Readhead set-up LED status



### Readhead LED diagnostics

Mode	LED	Status
Installation mode	Green flashing	Good set-up, maximise flash rate for optimum set-up
	Orange flashing	Poor set-up, adjust readhead to obtain Green flashing LED
	Red flashing	Poor set-up, adjust readhead to obtain Green flashing LED
Calibration mode	Blue single flashing	Calibrating incremental signals
	Blue double flashing	Calibrating reference mark
Normal operation	Blue	AGC on, optimum set-up
	Green	AGC off, optimum set-up
	Red	Poor set-up; signal may be too low for reliable operation
	Blank flash	Reference mark detected (visible indication at speed < 100 mm/s only)
Alarm	4 red flashes	Low signal, over signal, or overspeed; system in error

## System calibration

**NOTE:** The functions described below can also be carried out using the optional ADT and ADT View software. See [www.renishaw.com/adt](http://www.renishaw.com/adt) for more information.

Ensure signal strength has been optimised along the full axis of travel, the LED will be flashing Green. Cycle the power to the readhead or connect the 'Remote CAL' output pin to 0 V for < 3 seconds. The readhead will then single flash Blue to indicate it is in calibration mode as detailed in 'Readhead mounting and alignment', page 9. The readhead will only enter calibration mode if the LED is flashing Green.

### Step 1 – Incremental signal calibration

- ▶ Move the readhead along the axis at slow speed (< 100 mm/s or less than the readhead maximum speed, whichever is slowest) ensuring it does not pass a reference mark, until the LED starts double-flashing indicating the incremental signals are now calibrated and the new settings are stored in the readhead memory.
- ▶ The system is now ready for reference mark phasing. For systems without a reference mark, cycle the power to the readhead or connect the 'Remote CAL' output pin to 0 V for < 3 seconds to exit calibration mode.
- ▶ If the system does not automatically enter the reference mark phasing stage (LED continues single flashing) the calibration of the incremental signals has failed. After ensuring failure is not due to overspeed (> 100 mm/s or exceeding the readhead maximum speed) exit the calibration routine, restore factory defaults as detailed below, and check the readhead installation and system cleanliness before repeating the calibration routine.

### Step 2 – Reference mark phasing

- ▶ Move the readhead back and forth over the selected reference mark until the LED stops flashing and remains solid Blue (or Green if AGC is disabled). The reference mark is now phased.
- ▶ The system automatically exits the calibration routine and is ready for operation.
- ▶ AGC and AOC are automatically switched on once calibration is complete. To switch off AGC refer to 'Enabling/disabling AGC', page 11.
- ▶ If the LED continues double-flashing after repeatedly passing the chosen reference mark it is not being detected.
  - Ensure that the correct readhead configuration is being used. Readheads can either output all reference marks or only output a reference mark where a reference selector magnet is fitted depending on the options chosen when ordering.
  - Check reference mark selector magnet is fitted in the correct location relative to readhead orientation ('RKLC20-S scale installation drawing', page 5).

### Calibration routine manual exit

- ▶ To exit the calibration routine at any stage cycle the power to the readhead or connect the 'Remote CAL' output pin to 0 V for < 3 seconds. The LED will then stop flashing.

LED	Settings stored
Blue single flashing	None, restore factory defaults and recalibrate
Blue double flashing	Incremental only
Blue (auto-complete)	Incremental and reference mark

## Restoring factory defaults

When re-installing the system, or in the case of continued calibration failure, factory defaults should be restored.

**NOTE:** Restoring factory defaults can also be carried out using the optional ADTi-100 and ADT View software. See [www.renishaw.com/adt](http://www.renishaw.com/adt) for more information.

### To restore factory defaults:

- ▶ Switch system off.
- ▶ Obscure the readhead optical window (using the spacer supplied with the readhead ensuring the cut-out is NOT under the optical window) or connect the 'Remote CAL' output pin to 0 V.
- ▶ Power the readhead.
- ▶ Remove the spacer or, if using, the connection from the 'Remote CAL' output pin to 0 V.
- ▶ The LED will start continuously flashing indicating factory defaults have been restored and the readhead is in installation mode (flashing set-up LED).
- ▶ Repeat 'Readhead set-up' procedure on [page 9](#).

## Enabling/disabling AGC

The AGC is automatically enabled once the system has been calibrated (indicated by a Blue LED). AGC can be manually switched off by connecting the 'Remote CAL' output pin to 0 V for > 3 seconds < 10 seconds. The LED will then be solid Green.

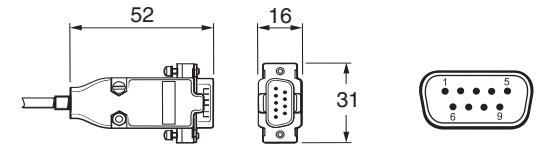
**NOTE:** AGC can be switched on or off using the optional ADTi-100 and ADT View software. See [www.renishaw.com/adt](http://www.renishaw.com/adt) for more information.

## Output signals

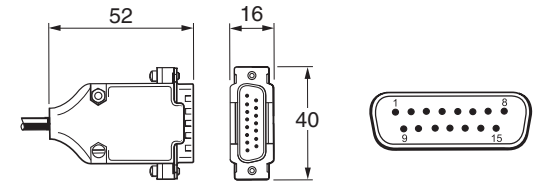
### Digital outputs

Function	Signal	Colour	9-way D-type (A)	15-way D-type (D)	15-way D-type alternative pin-out (H)	12-way circular connector <sup>†</sup> (X)	14-way JST (J) <sup>‡</sup>	
Power	5 V	Brown	5	7, 8	4, 12	G	10	
	0 V	White	1	2, 9	2, 10	H	1	
Incremental	A	+	Red	2	14	1	M	7
		-	Blue	6	6	9	L	2
	B	+	Yellow	4	13	3	J	11
		-	Green	8	5	11	K	9
Reference mark	Z	+	Violet	3	12	14	D	8
		-	Grey	7	4	7	E	12
Limits	P	Pink	-	11	8	A	14	
	Q	Black	-	10	6	B	13	
Alarm	E	-	Orange	-	3	13	F	3
Remote CAL *	CAL	Clear	9	1	5	C	4	
Shield	-	Screen	Case	Case	Case	Case	Ferrule	

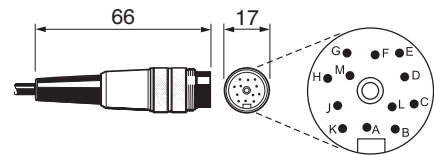
9-way D-type connector (termination code A)



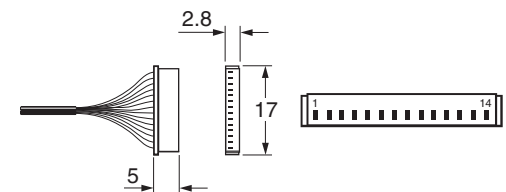
15-way D-type connector (termination code D, H)



12-way in-line circular connector (termination code X)



14-way JST connector (termination code J)<sup>‡</sup>



\* Remote CAL line must be connected for use with ADTI-100.

<sup>†</sup> 12-way circular Binder mating socket – A-6195-0105.

<sup>‡</sup> Pack of 5 14-way JST SH mating sockets:

A-9417-0025 – Bottom mount;

A-9417-0026 – Side mount.

Maximum of 20 insertion cycles for JST connector.

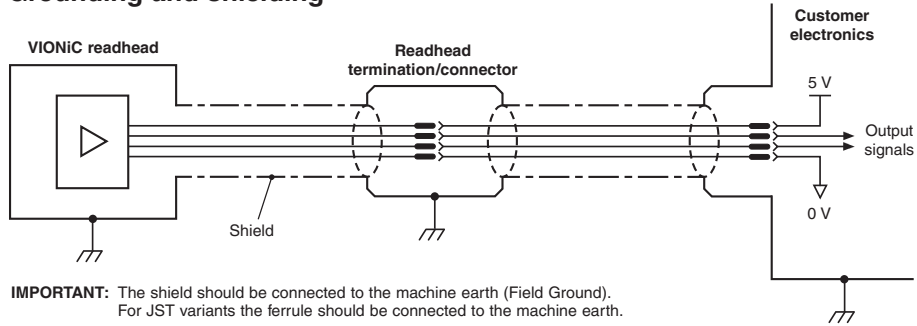
## Speed

Clocked output option (MHz)	Maximum speed (m/s)												Minimum edge separation* (ns)
	5 $\mu$ m (D)	1 $\mu$ m (X)	0.5 $\mu$ m (Z)	0.2 $\mu$ m (W)	0.1 $\mu$ m (Y)	50 nm (H)	40 nm (M)	25 nm (P)	20 nm (I)	10 nm (O)	5 nm (Q)	2.5 nm (R)	
50	12	12	12	7.25	3.63	1.81	1.45	0.906	0.725	0.363	0.181	0.091	25.3
40	12	12	12	5.80	2.90	1.45	1.16	0.725	0.580	0.290	0.145	0.073	31.8
25	12	12	9.06	3.63	1.81	0.906	0.725	0.453	0.363	0.181	0.091	0.045	51.2
20	12	12	8.06	3.22	1.61	0.806	0.645	0.403	0.322	0.161	0.081	0.040	57.7
12	12	10.36	5.18	2.07	1.04	0.518	0.414	0.259	0.207	0.104	0.052	0.026	90.2
10	12	8.53	4.27	1.71	0.850	0.427	0.341	0.213	0.171	0.085	0.043	0.021	110
08	12	6.91	3.45	1.38	0.690	0.345	0.276	0.173	0.138	0.069	0.035	0.017	136
06	12	5.37	2.69	1.07	0.540	0.269	0.215	0.134	0.107	0.054	0.027	0.013	175
04	12	3.63	1.81	0.730	0.360	0.181	0.145	0.091	0.073	0.036	0.018	0.009	259
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	1038

\*For a readhead with a 1 m cable.

# Electrical connections

## Grounding and shielding



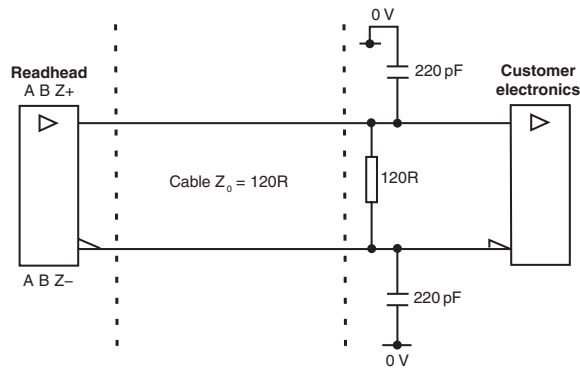
**IMPORTANT:** The shield should be connected to the machine earth (Field Ground).  
For JST variants the ferrule should be connected to the machine earth.

**Maximum readhead cable length:** 3 m

**Maximum extension cable length:** Dependent on cable type, readhead cable length and clock speed.  
Contact your local Renishaw representative for more information.

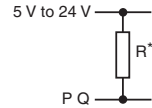
**NOTE:** The maximum cable length between the readhead and the ADTi-100 is 3 m.

## Recommended signal termination



### Limit output

(Not available with 'A' cable termination)



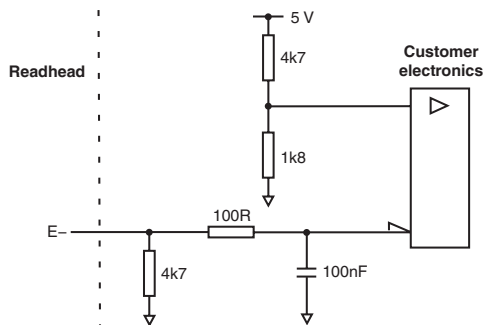
\* Select R so that maximum current does not exceed 10 mA.  
Alternatively, use a suitable relay or opto-isolator.

Standard RS422A line receiver circuitry.

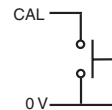
Capacitors recommended for improved noise immunity.

## Single ended alarm signal termination

(Not available with 'A' cable termination)



## Remote CAL operation



Remote operation of the CAL/AGC is possible via CAL signal.

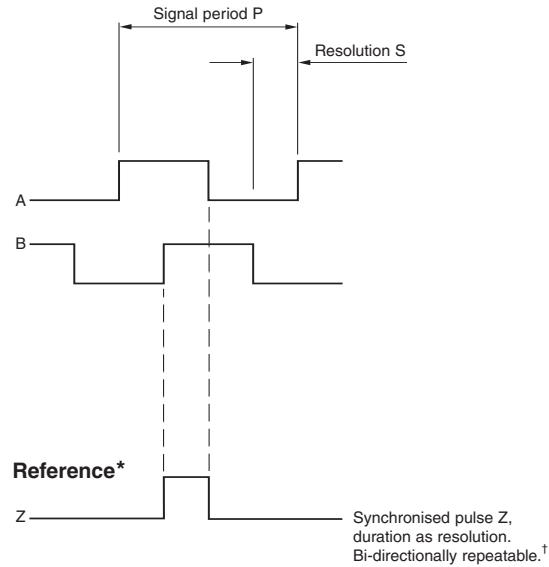


# Output specifications

## Digital output signals

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

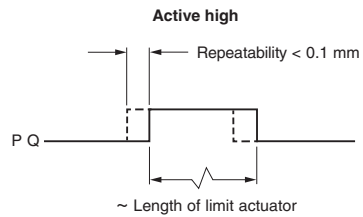
**Incremental\*** 2 channels A and B in quadrature (90° phase shifted)



Resolution option code	P (µm)	S (µm)
D	20	5
X	4	1
Z	2	0.5
W	0.8	0.2
Y	0.4	0.1
H	0.2	0.05
M	0.16	0.04
P	0.1	0.025
I	0.08	0.02
O	0.04	0.01
Q	0.02	0.005
R	0.01	0.0025

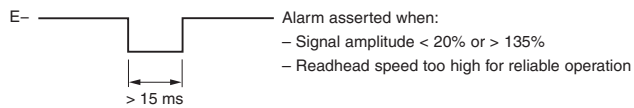
**NOTE:** A wide reference mark option, outputting a reference pulse for the duration of the signal period is available. Contact your local Renishaw representative for more information.

**Limits** Open collector output, asynchronous pulse  
(Not available with 'A' cable termination)



## Alarm

**Line driven** (Asynchronous pulse)  
(Not available with 'A' cable termination)




**or 3-state alarm**

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

\* Inverse signals not shown for clarity.

† Only calibrated reference mark is bi-directionally repeatable.

## General specifications

<b>Power supply</b>	5V -5%/+10%	Typically 200 mA fully terminated
		Power 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
<b>Temperature</b> (system)	Storage	-20 °C to +70 °C
	Installation	+10 °C to +35 °C *
	Operating	0 °C to +70 °C
<b>Humidity</b> (system)		95% relative humidity (non-condensing) to IEC 60068-2-78
<b>Sealing</b>		IP40
<b>Acceleration</b> (system)	Operating	400 m/s <sup>2</sup> , 3 axes
<b>Shock</b> (system)	Operating	500 m/s <sup>2</sup> , 11 ms, ½ sine, 3 axes
<b>Vibration</b> (readhead)	Operating	100 m/s <sup>2</sup> max @ 55 Hz to 2000 Hz, 3 axes
	(scale)	Operating 300 m/s <sup>2</sup> max @ 55 Hz to 2000 Hz, 3 axes
<b>Mass</b>	Readhead	8.6 g
	Cable	26 g/m
<b>Readhead cable</b>		Single-shielded, outside diameter 4.25 ±0.25 mm
		Flex life > 20 × 10 <sup>6</sup> cycles at 30 mm bend radius
		UL recognised component 
<b>Maximum readhead cable length</b> †		3 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.

\*To limit maximum tension in the scale  $(CTE_{\text{substrate}} - CTE_{\text{scale}}) \times (T_{\text{use extreme}} - T_{\text{install}}) \leq 550 \mu\text{m/m}$  where  $CTE_{\text{scale}} = \sim 10.1 \mu\text{m/m/}^\circ\text{C}$ .

† Extension cables available. Contact your local Renishaw representative for further details.

## RKLC20-S scale specifications

<b>Form</b> (H × W)	0.15 mm × 6 mm including adhesive
<b>Pitch</b>	20 µm
<b>Accuracy</b> (at 20 °C)	±5 µm/m
<b>Linearity</b>	±2.5 µm/m achievable with two point error correction
<b>Supplied length</b>	20 mm up to 20 m (> 20 m available on request)
<b>Material</b>	Hardened and tempered stainless steel fitted with a self-adhesive backing tape
<b>Mass</b>	4.6 g/m
<b>Coefficient of thermal expansion</b> (at 20 °C)	Matches that of substrate material when scale ends fixed by epoxy mounted end clamps
<b>Installation temperature</b>	+10 °C to +35 °C
<b>End fixing</b>	Epoxy mounted end clamps (A-9523-4015) Approved epoxy adhesive (A-9531-0342) Scale end movement typically < 1 µm *

## Reference mark

<b>Type</b>	Customer selected <i>IN-TRAC</i> reference mark, directly embedded into incremental track. Bi-directional position repeatability
<b>Selection</b>	Single reference mark selection by selector magnet (A-9653-0143) customer positioned L ≤ 100 mm Single reference mark at scale centre L > 100 mm Reference marks at 50 mm spacing (first reference mark 50 mm from scale end)
<b>Repeatability</b>	Unit of resolution repeatability (bi-directional) across full system rated speed and temperature ranges

## Limit switches

<b>Type</b>	Magnetic actuators; with dimple triggers Q limit, without dimple triggers P limit ( <a href="#">‘RKLC20-S scale installation drawing’, page 5</a> )
<b>Trigger point</b>	The limit output is nominally asserted when the readhead limit switch sensor passes the limit magnet leading edge, but can trigger up to 3 mm before that edge
<b>Mounting</b>	Customer placed at desired locations
<b>Repeatability</b>	< 0.1 mm

\*The scale and end clamps must be installed following the installation process, see [page 6](#).

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