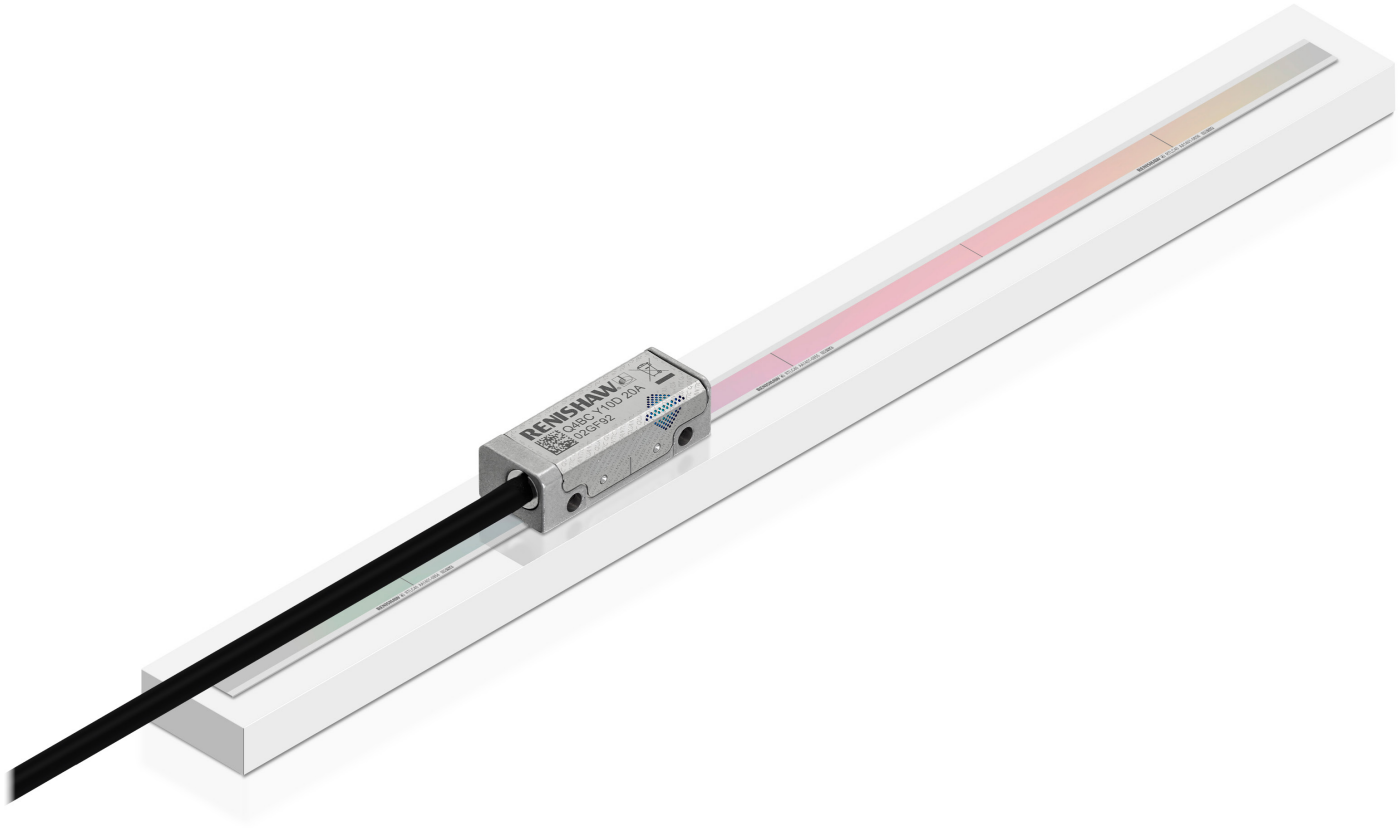
**Installation guide**
M-9417-9255-05-A

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# QUANTiC™ RTLC40-S incremental linear encoder system




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# Legal notices

## Patents

Features of Renishaw's QUANTiC™ and RTLC40-S encoder systems are the subjects of the following patents and patent applications:

| | | | | |
|---|---|---|---|---|
| EP1173731 | US6775008 | JP4750998 | CN100543424 | EP1766334 |
| JP4932706 | US7659992 | CN100507454 | EP1766335 | IN281839 |
| JP5386081 | US7550710 | CN101300463 | EP1946048 | JP5017275 |
| US7624513 | CN101310165 | EP1957943 | US7839296 | CN108351229 |
| EP3347681 | JP2018530751 | KR20180052676 | US20180216972 | WO2017203210 |
| CN1314511 | EP1469969 | EP2390045 | JP5002559 | US8987633 |
| US8466943 | | | | |

## Terms and conditions and warranty

Unless you and Renishaw have agreed and signed a separate written agreement, the equipment and/or software are sold subject to the Renishaw Standard Terms and Conditions supplied with such equipment and/or software, or available on request from your local Renishaw office.

Renishaw warrants its equipment and software for a limited period (as set out in the Standard Terms and Conditions), provided that they are installed and used exactly as defined in associated Renishaw documentation. You should consult these Standard Terms and Conditions to find out the full details of your warranty.

Equipment and/or software purchased by you from a third-party supplier is subject to separate terms and conditions supplied with such equipment and/or software. You should contact your third-party supplier for details.

## Declaration of Conformity

Renishaw plc hereby declares that the QUANTiC encoder system is in compliance with the essential requirements and other relevant provisions of:

- the applicable EU directives
- the relevant statutory instruments under UK law

The full text of the declaration of conformity is available at: **www.renishaw.com/productcompliance**.

## Compliance

### Federal Code Of Regulation (CFR) FCC Part 15 – RADIO FREQUENCY DEVICES

#### 47 CFR Section 15.19

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.

#### 47 CFR Section 15.21

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.

#### 47 CFR Section 15.105

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.

### 47 CFR Section 15.27

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

### Supplier's Declaration of Conformity

### 47 CFR § 2.1077 Compliance Information

**Unique Identifier:** QUANTiC

**Responsible Party - U.S. Contact Information**

Renishaw Inc.
1001 Wesemann Drive
West Dundee
Illinois
IL 60118
United States
Telephone number: +1 847 286 9953
Email: usa@renishaw.com

### ICES-003 – Information Technology Equipment (including Digital Apparatus)

This ISM device complies with Canadian ICES-003(A).

Cet appareil ISM est conforme à la norme ICES-003(A).

## Intended use

The QUANTiC encoder system is designed to measure position and provide that information to a drive or controller in applications requiring motion control. It must be installed, operated, and maintained as specified in Renishaw documentation and in accordance with the Standard Terms and Conditions of the Warranty and all other relevant legal requirements.

## Further information

Further information relating to the QUANTiC encoder range can be found in the following documents:

| |
|---|
| *QUANTiC™ incremental optical encoder system* data sheet (Renishaw part no. L-9517-9778) |
| *RTLC incremental linear scale* data sheet (Renishaw part no. L-9517-9417) |
| *ADTpro-100 Advanced Diagnostic Tool* data sheet (Renishaw part no. L-9518-0078) |
| *ADTi-100 Advanced Diagnostic Tool* data sheet (Renishaw part no. L-9517-9699) |
| *ADTpro-100 Advanced Diagnostic Tool* user guide (Renishaw part no. M-6647-9138) |
| *ADT View software* user guide (Renishaw part no. M-6195-9413) |

These can be downloaded from our website at **www.renishaw.com/quanticdownloads** and are also available from your local Renishaw representative.

## Packaging

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

| Packing 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**.

## Disposal of waste electrical and electronic equipment



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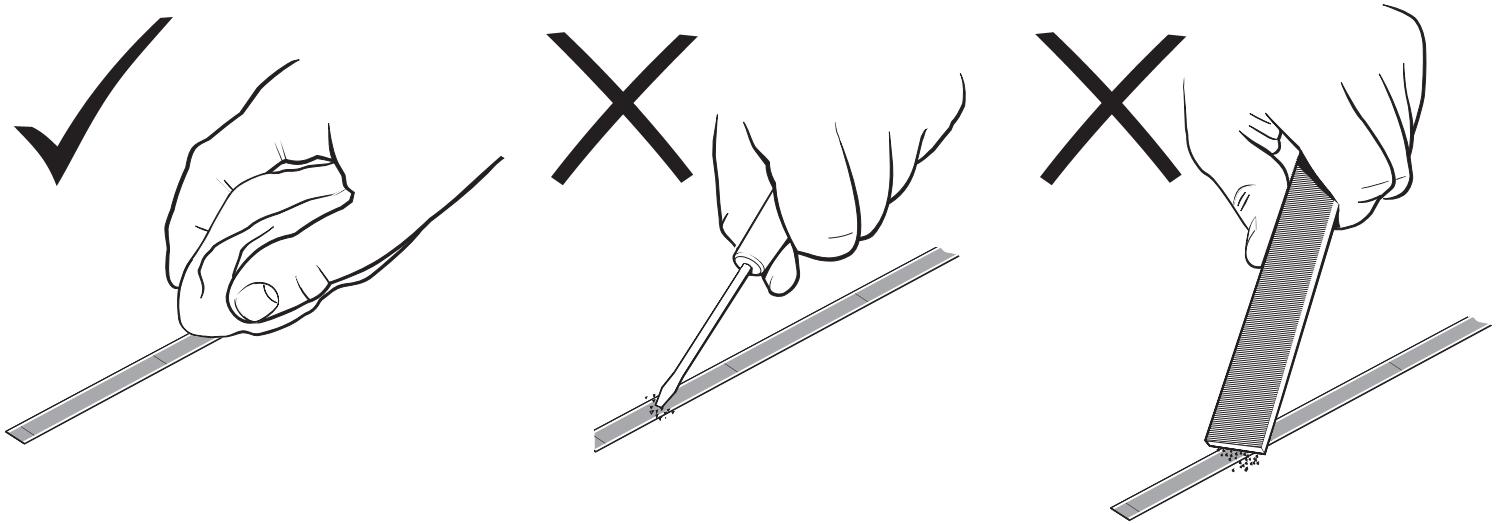
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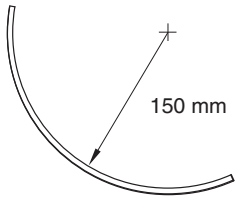
Renishaw software is licensed in accordance with the Renishaw licence at: **www.renishaw.com/legal/softwareterms**.

# Storage and handling

QUANTiC non-contact optical encoder systems provide good immunity against contaminants such as dust, fingerprints and light oils. However, in harsh environments such as machine tool applications, protection should be provided to prevent ingress of coolant or oil.

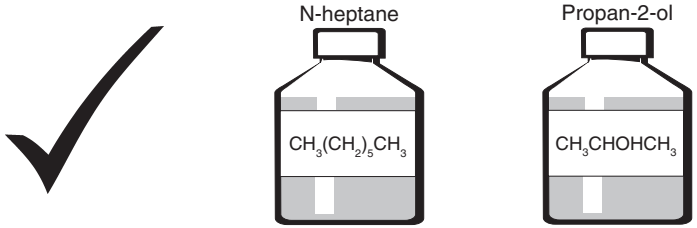


## Minimum bend radius

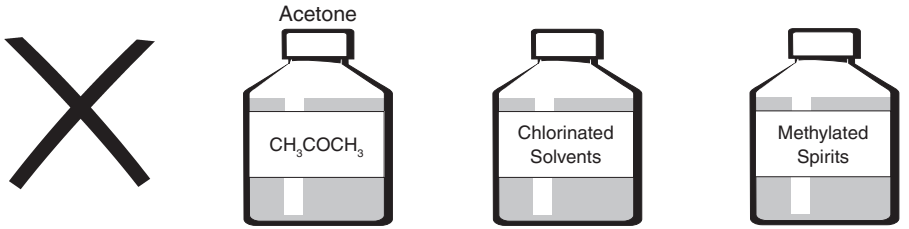


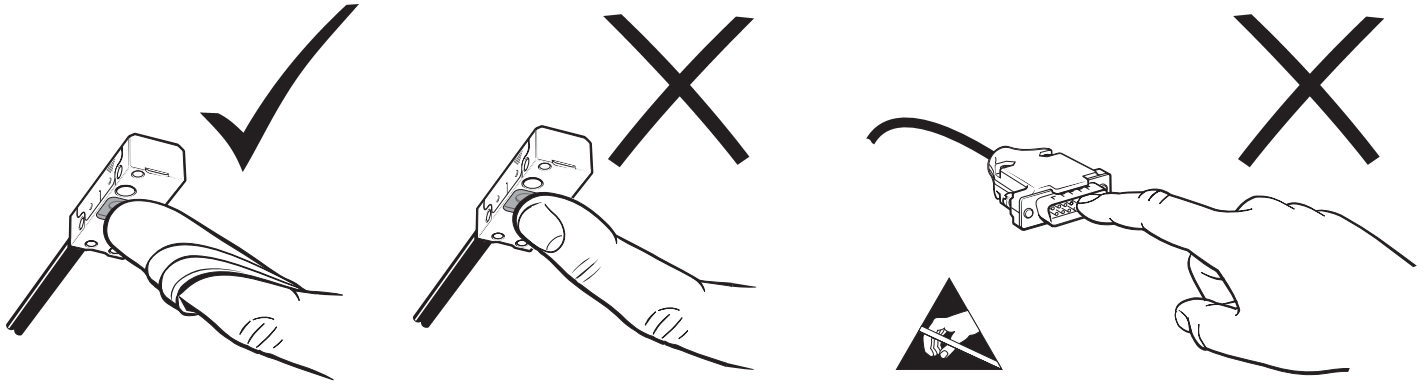

**NOTE:** During storage ensure the self-adhesive tape is on the outside of the bend.

## Scale and readhead




## Readhead only

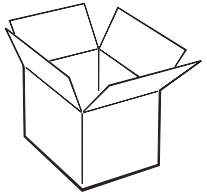




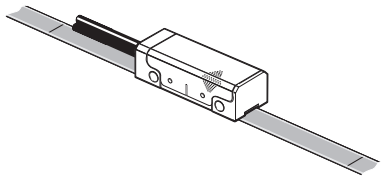


## Temperature

| Storage | |
|---|---|
| **System** | –20 °C to +70 °C |

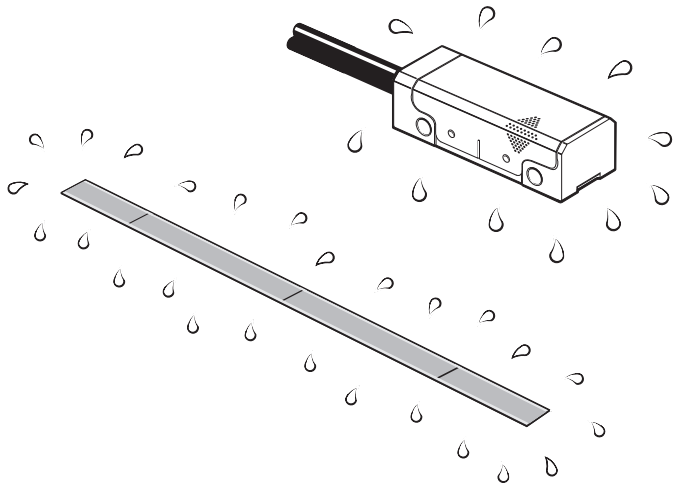


| Operating | |
|---|---|
| **System** | 0 °C to +70 °C |



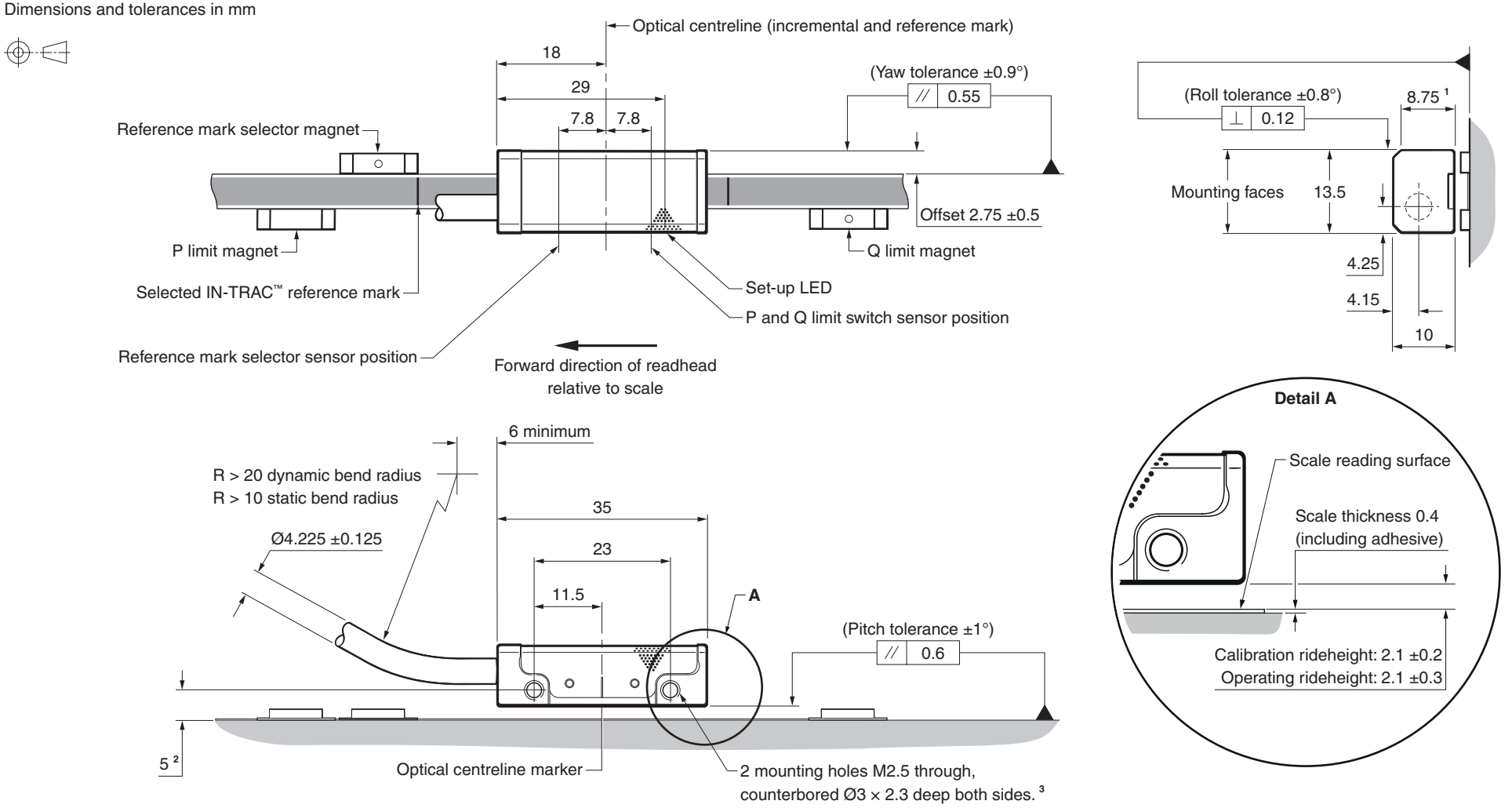
## Humidity

95% relative humidity (non-condensing) to IEC 60068-2-78



# QUANTiC readhead installation drawing

Dimensions and tolerances in mm



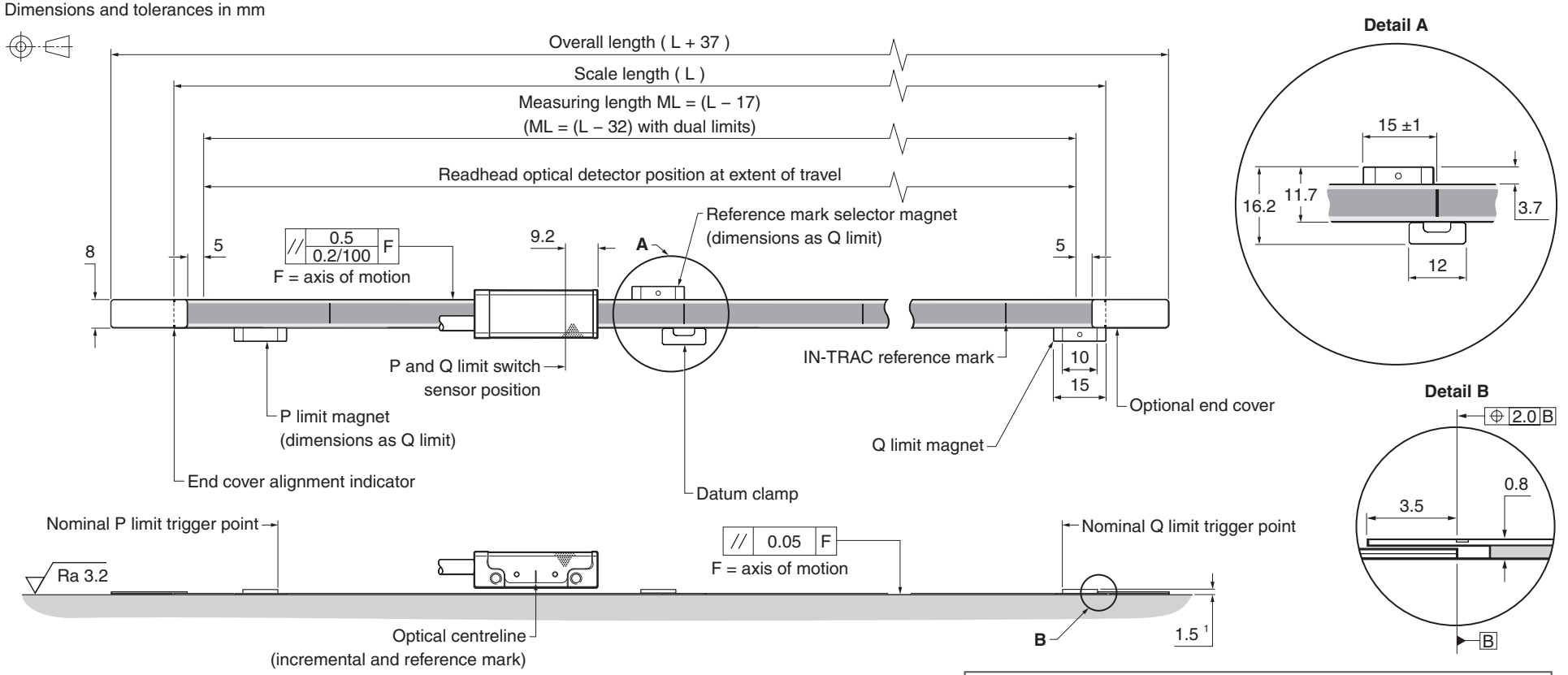

1 Extent of mounting faces.

2 Dimension from substrate.

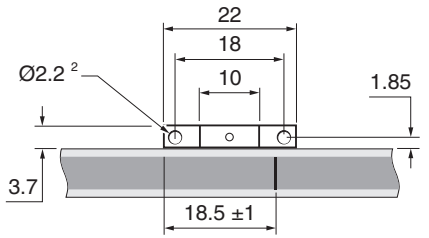
3 The recommended thread engagement is 5 mm minimum (7.5 mm including counterbore) and the recommended tightening torque is 0.25 Nm to 0.4 Nm.

# RTLC40-S scale installation drawing

Dimensions and tolerances in mm




**Alternative bolted reference mark selector and limit magnets**




**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.

1 Dimension from substrate.

2 Supplied with 2 M2 × 4 screws.

# Equipment for installing the RTLC40-S scale

## Required parts:

- Appropriate length of RTLC40-S scale (see 'RTLC40-S scale installation drawing' on page 12)
- Datum clamp (A-9585-0028)
- Loctite® 435™ (P-AD03-0012)
- Appropriate cleaning solvents (see 'Storage and handling' on page 9)
- RTLC40-S scale applicator (A-9589-0115)
- 2 M2.5 screws
- Green spacer (supplied with the QUANTiC readhead)
- Lint-free cloth

## Optional parts:

- A pair of end covers (A-9585-0035)
- Renishaw scale wipes (A-9523-4040)
- Loctite 435 dispensing tip (P-TL50-0209)
- Guillotine (A-9589-0071) or shears (A-9589-0133) for cutting the RTLC40-S scale to the length required
- Magnet applicator tool (A-9653-0201)
- Reference mark and limit magnets; see table below

| Magnet type | Part number | |
|---|---|---|
| | Adhesive mounted magnets (standard) | Bolted magnets |
| **Reference mark selector** [1] | A-9653-0143 | A-9653-0290 |
| **Q limit** | A-9653-0139 | A-9653-0291 |
| **P limit** | A-9653-0138 | A-9653-0292 |

[1] The reference mark selector magnet is only required for 'Customer selectable reference mark' readheads. For more information refer to *QUANTiC™ incremental optical encoder system* data sheet (Renishaw part no. L-9517-9778).

# Cutting the RTLC40-S scale

If required cut the RTLC40-S scale to length using a guillotine or the shears.

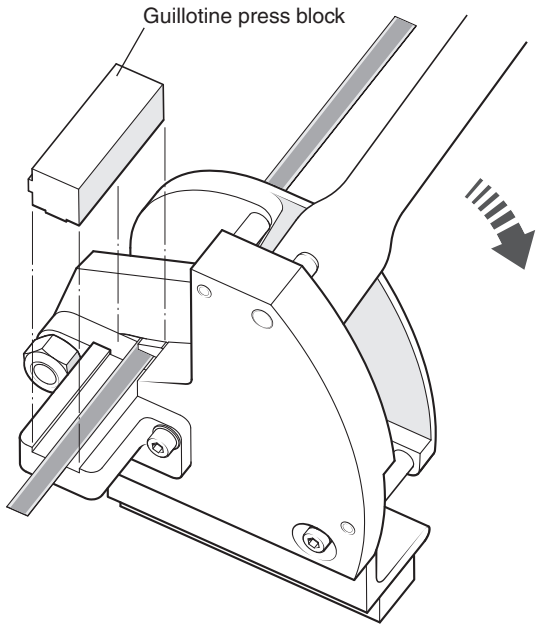
## Using the guillotine

The guillotine should be held securely in place, using a suitable vice or clamping method.

Once secured, feed the RTLC40-S scale through the guillotine as shown, and place the guillotine press block down onto the scale.

**NOTE:** Ensure the block is in the correct orientation (as shown below).

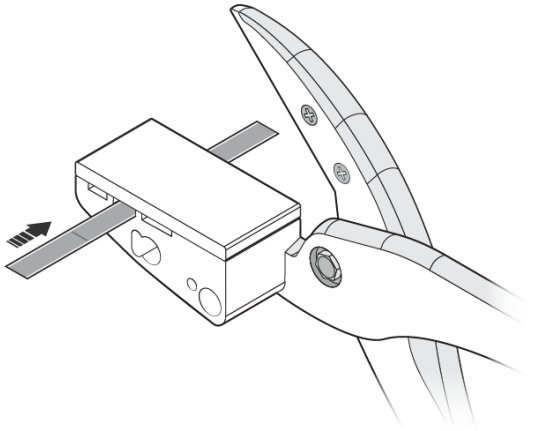
### Guillotine press block orientation when cutting RTLC40-S scale




Whilst holding the block in place, in a smooth motion, pull down the lever to cut through the scale.

## Using the shears

Feed the RTLC40-S scale through the first aperture on the shears (as shown).



Hold the scale in place and close the shears in a smooth motion to cut through the scale.

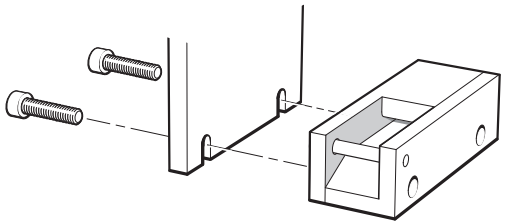
# Applying the RTLC40-S scale

1. Allow the scale to acclimatise to the installation environment prior to installation.

2. Mark out the start position for the scale on the axis substrate ensuring that there is enough room for the optional end covers if required (see 'RTLC40-S scale installation drawing' on page 12).

3. Thoroughly clean and degrease the substrate using the recommended solvents (see 'Storage and handling' on page 9). Allow the substrate to dry before applying the scale.

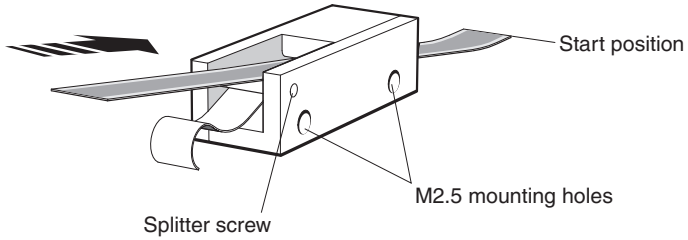
4. Mount the scale applicator to the readhead mounting bracket. Place the spacer supplied with the readhead between the applicator and the substrate to set the nominal height.



**NOTE:** The scale applicator can be mounted either way round to enable the easiest orientation for the installation of the scale.

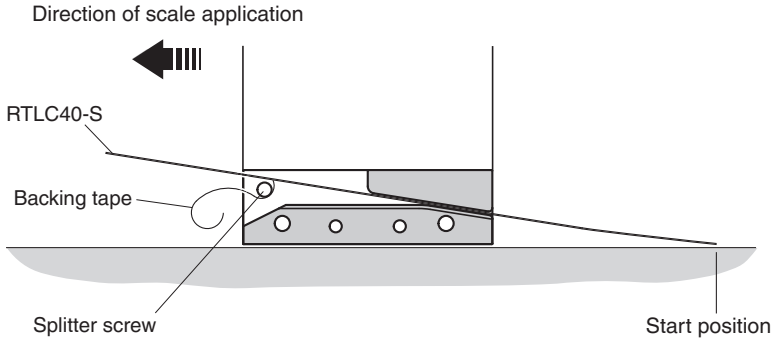
5. Move the axis to the start of travel leaving enough room for the scale to be inserted through the applicator, as shown below.

6. Begin to remove the backing paper from the scale and insert the scale into the applicator up to the start position. Ensure the backing tape is routed under the splitter screw.




7. Apply firm finger pressure via a clean, dry, lint-free cloth to ensure the scale end adheres well to the substrate.

8. Slowly and smoothly move the applicator through the entire axis of travel. Ensure the backing paper is pulled manually from the scale and does not catch under the applicator.




9. During installation ensure the scale adheres to the substrate using light finger pressure.

10. Remove the applicator and, if necessary, adhere the remaining scale manually.

11. Apply firm finger pressure via a clean, dry, lint-free cloth along the length of the scale after application to ensure complete adhesion.

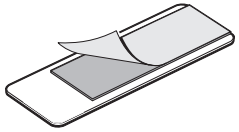
12. Clean the scale using Renishaw scale wipes or a clean, dry, lint-free cloth.

# Fitting the end covers

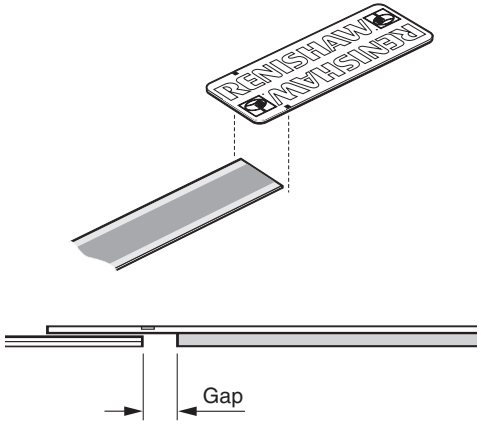
The end cover kit is designed to be used with the RTLC40-S scale to provide protection for exposed scale ends.

**NOTE:** The end covers are optional and can be fitted before or after installation of the readhead.

1. Remove the backing tape from the adhesive tape on the back of the end cover.



2. Align the marker on the edges of the end cover with the end of the scale and place the end cover over the scale.




**NOTE:** There will be a gap between the end of the scale and the adhesive tape on the end cover.

# Fitting the datum clamp

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

The datum clamp fixes the RTLC40-S scale rigidly to the substrate at the location chosen.

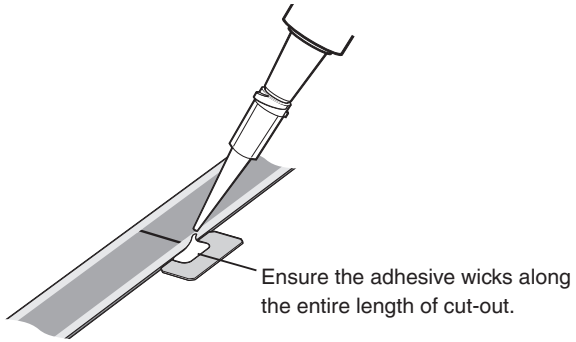
**CAUTION:** The metrology of the system may be compromised if the datum clamp is not used.

The datum clamp does not need to be fitted adjacent to a reference mark. It can be positioned anywhere along the axis depending upon the customers' requirements.

1. Remove the backing paper from the datum clamp.
2. Place the datum clamp with cut-out against the scale at the chosen location.



3. Place a small amount of adhesive (Loctite 435) in the cut-out on the datum clamp, ensuring none of the adhesive wicks onto the scale surface. Dispensing tips are available.



# Reference mark selector and limit magnet installation

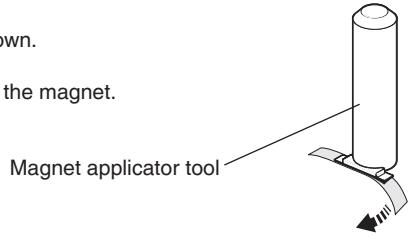
**IMPORTANT:** Allow 24 hours after the scale application before fitting the magnets.

As the 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.
- Fitting the scale according to the instructions in this manual prevents the magnetic force from disturbing the scale.

For accuracy and ease of positioning of the reference mark selector and limit magnets, the applicator tool should be used.

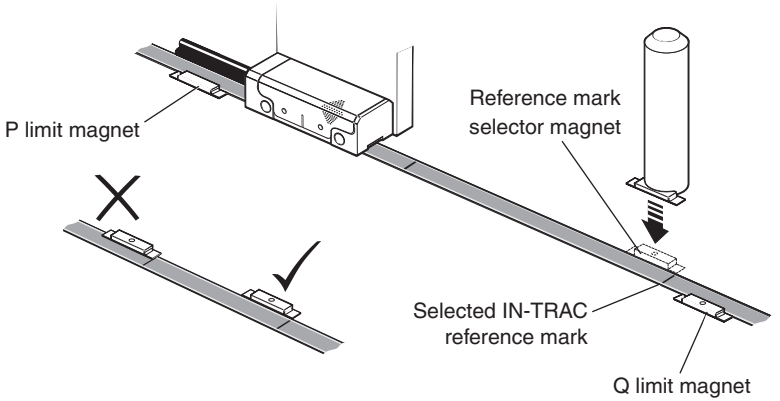
1. Attach the magnet to the applicator tool as shown.
2. Remove the self-adhesive backing paper from the magnet.




**NOTES:**

- 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 (see 'RTLC40-S scale installation drawing' on page 12).
- The 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. Alternative bolted reference and limit magnets are available (see 'RTLC40-S scale installation drawing' on page 12).
- External magnetic fields greater than 6 mT, in the vicinity of the readhead, may cause false activation of the limit and reference sensors.

3. Place the magnet in the chosen location alongside the edge of the scale ensuring that it is not mounted on the scale.
   - Limit magnets can be positioned at any user defined location along the axis length.
   - The reference mark selector magnet should be positioned adjacent to the selected IN-TRAC reference mark as shown. [1]




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

4. Apply firm finger pressure to the magnet via a clean, dry, lint-free cloth to ensure complete adhesion

[1] The reference mark selector magnet is only required for 'Customer selectable reference mark' readheads. For more information refer to *QUANTiC™ incremental optical encoder system* data sheet (Renishaw part no. L-9517-9778).

# QUANTiC readhead quick-start guide

This section is a quick-start guide to installing a QUANTiC readhead. More detailed information on installing the readhead is contained on page 20 to page 24 of this installation guide.

The Advanced Diagnostic Tools, ADTpro-100 or ADTi-100 with ADT View software, can be used to aid installation and calibration. See **www.renishaw.com/adt** for more information about the advanced diagnostic tools.

## INSTALLATION

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

↓

If required, ensure the reference mark selector magnet is correctly positioned (see 'RTLC40-S scale installation drawing' on page 12).

↓

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

↓

Install and align the readhead to maximise the 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 the calibration routine fails (LED remains single-flashing blue), restore the readhead factory defaults (see 'Restoring factory defaults' on page 24) and repeat the installation and calibration routine.

# 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 the readhead and the scale apply the cleaning fluid sparingly, do not soak.

1. Mount the readhead to the bracket using 2 M2.5 screws.
2. To set the nominal rideheight, place the green spacer with the aperture under the optical centre of the readhead to allow normal LED function during the set-up procedure.
3. 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.

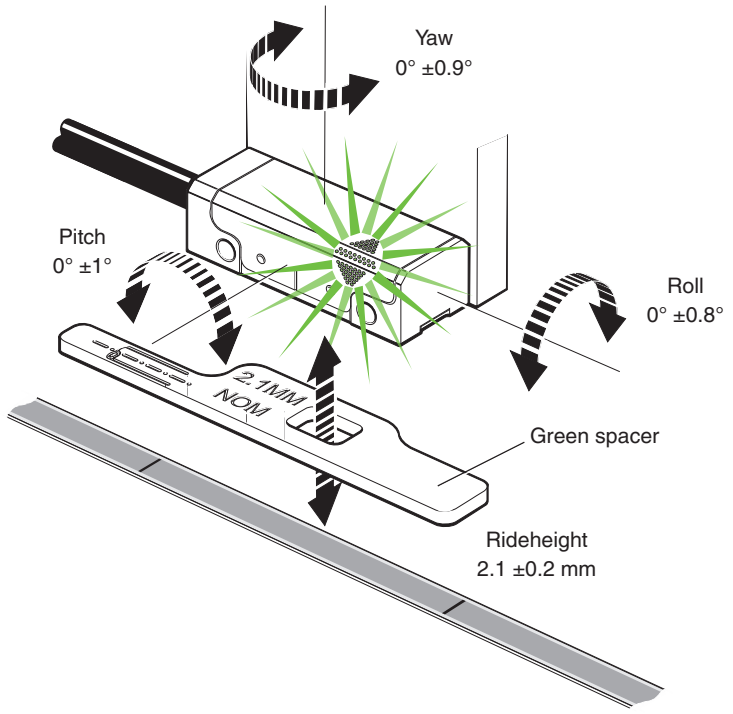
The Advanced Diagnostic Tools, ADTpro-100 or ADTi-100 and ADT View software, can also be used to help optimise signal strength in challenging installations. Refer to the ADTpro-100 user guide (Renishaw part no. M-6647-9138) or ADT View user guide (Renishaw M-6195-9413) for more information.

**NOTE:** When reinstalling the readhead the factory defaults should be restored (see 'Restoring factory defaults' on page 24).

## Readhead set-up LED status

| Green flashing | Orange flashing | Red flashing |
|---|---|---|

**NOTE:** For full readhead LED diagnostics, see 'Readhead LED diagnostics' on page 21.



## 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** | Four red flashes | Low signal, over signal, or overspeed; system in error |
| | Red and purple flashing (analogue variant only) | AGC out of normal operating range |

**NOTE:** See 'Troubleshooting' on page 25 for more information on diagnosing faults.

# System calibration

**NOTE:** The system calibration can also be carried out using the Advanced diagnostic tools ADTpro-100 or ADTi-100 and ADT View software. Refer to the ADTpro-100 user guide (Renishaw part no. M-6647-9138) or ADT View user guide (Renishaw M-6195-9413) for more information.

## Before system calibration:

1. Clean the scale and readhead optical window.
2. If reinstalling, restore the factory defaults (see 'Restoring factory defaults' on page 24).
3. Maximise the signal strength along the full length of travel (set-up LED is flashing green).

**NOTE:** During calibration the speed should not exceed 100 mm/s or the readheads' maximum speed, whichever is slowest.

## Incremental signal calibration

1. Cycle the power to the readhead or connect the 'Remote CAL' output pin to 0 V for < 3 seconds. The readhead will then periodically single-flash blue to indicate it is in calibration mode as detailed in 'Readhead mounting and alignment' on page 20. The readhead will only enter calibration mode if the LED is flashing green.
2. Move the readhead at slow speed along the axis, 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.
3. 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.
4. 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 (see 'Restoring factory defaults' on page 24) and check the readhead installation and system cleanliness before repeating the calibration routine.

**NOTE:** For analogue variants of QUANTiC ensure the correct termination of output signals (see 'Recommended signal termination' on page 33).

## Reference mark phasing

1. Move the readhead back and forth over the selected reference mark until the LED stops flashing and remains solid blue. The reference mark is now phased.

   **NOTE:** Only the chosen reference mark that has been used in the calibration routine is guaranteed to remain phased.

2. The system automatically exits the calibration routine and is ready for operation.
3. AGC and AOC are automatically switched on once calibration is complete. To switch off AGC refer to 'Switching Automatic Gain Control (AGC) on or off' on page 24.
4. 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 that the reference mark selector magnet is fitted in the correct location relative to readhead orientation (see 'RTLC40-S scale installation drawing' on page 12).

## 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 stop flashing.

## LED status during system calibration

| 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 realigning the readhead, reinstalling the system, or in the case of continued calibration failure, factory defaults must be restored.

**NOTE:** Factory defaults can also be restored using the ADTpro-100 or ADTi-100 and ADT View software. Refer to the ADTpro-100 user guide (Renishaw part no. M-6647-9138) or ADT View user guide (Renishaw M-6195-9413) for more information.

## To restore factory defaults:

1. Switch the system off.
2. Obscure the readhead optical window (using the green 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.
3. Power the readhead.
4. Remove the spacer or, if using, the connection from the 'Remote CAL' output pin to 0 V.
5. The LED will start continuously flashing indicating factory defaults have been restored and the readhead is in installation mode.
6. Repeat the 'Readhead set-up' procedure on page 20.

# Switching Automatic Gain Control (AGC) on or off

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 also be switched on or off using the ADTpro-100 or ADTi-100 and ADT View software. Refer to the ADTpro-100 user guide (Renishaw part no. M-6647-9138) or ADT View user guide (Renishaw M-6195-9413) for more information.

# Troubleshooting

| Fault | Cause | Possible solutions |
|---|---|---|
| **LED on the readhead is blank** | There is no power to the readhead | • Ensure 5 V is supplied at the readhead<br>• For cable variants, check the correct wiring of the connector<br>• If using the analogue variant of QUANTiC with the ADTi-100, ensure the appropriate adaptor cables are connected |
| **LED on the readhead is flashing red during installation mode** | The signal strength is < 50% | • Check the readhead optical window and scale are clean and free from contamination<br>• Restore factory defaults (see page 24) and check the alignment of the readhead. In particular:<br>  • Rideheight<br>  • Yaw<br>  • Offset<br>• Ensure the correct scale and readhead combination |
| **Unable to get a green LED over the complete axis length** | System run-out is not within specification | • Use a DTi gauge and check the run-out is within specifications<br>• Restore factory defaults (see page 24)<br>• Realign the readhead to obtain a green flashing LED at the mid-point of the run-out<br>• Recalibrate the system (see page 22) |
| **Can't initiate the calibration routine** | Signal size is < 70% | • Realign the readhead to obtain a green flashing LED |

| Fault | Cause | Possible solutions |
|---|---|---|
| **During calibration the LED on the readhead remains single-flashing blue even after moving it along the full axis length** | The system has failed to calibrate the incremental signals due to the signal strength being < 70% | • Exit CAL mode and restore factory defaults (see page 24)<br>• Check the readhead set-up and alignment (see page 20) |
| | Incorrect termination (analogue variant only) | • Check the output signal termination (see page 33)<br>• When using the readhead with the ADTi-100 in stand-alone mode ensure the Termination tool (A-6195-2132) is connected<br>• Exit CAL mode and restore factory defaults (see page 24)<br>• Check the readhead set-up and alignment (see page 20) |
| **During calibration the LED on the readhead is double-flashing blue even after moving it past the reference mark several times** | The readhead is not seeing a reference mark | • Ensure correct position of the reference mark selector magnet<br>• Ensure you are moving the readhead past your chosen reference mark several times<br>• Check the readhead/selector magnet orientation<br>• Check the readhead optical window and scale are clean and free from contamination |
| **No reference mark output** | | • Ensure you are not moving the readhead too fast during calibration mode (maximum speed < 100 mm/sec)<br>• Calibrate the system (see page 22)<br>  • If the system completes the calibration mode, it has successfully seen and calibrated the reference mark. If you still do not see a reference mark, check the system wiring.<br>  • If the system does not calibrate the reference mark (LED on the readhead remains double-flashing blue), see above for possible solutions. |
| **Reference mark is not repeatable** | Only the chosen reference mark that has been used in the calibration sequence is repeatable; other reference marks may not be phased | • Ensure you are using the reference mark that has been calibrated for referencing your system<br>• The readhead bracket must be stable and not allow any mechanical movement of the readhead<br>• Clean the scale and readhead optical window and check for damage then recalibrate the system over the chosen reference mark (see page 22) |

| Fault | Cause | Possible solutions |
|---|---|---|
| **LED on the readhead is flashing red over the reference mark** | The reference mark is not phased | • Ensure you are using the reference mark that has been calibrated for referencing your system, as only this reference mark will be guaranteed to remain phased<br>• Clean the scale and readhead optical window and check for scratches, then recalibrate the system over the chosen reference mark (see page 22) |
| **Multiple reference marks are being output** | The readhead reference mark option is either option B or F, 'All reference marks are output' | • Calibrate the system ensuring all the incremental signal calibration steps and the reference mark phasing steps are completed (see page 22)<br>• Ensure you calibrate the reference mark used for referencing your system, as only this reference mark will be guaranteed to remain phased |
| **LED on the readhead is flashing red and purple (analogue variant only)** | AGC is outside of the normal operating range | • Check the output signal termination (see page 33)<br>• When using the readhead with the ADTi-100 in stand-alone mode, ensure the Termination tool (A-6195-2132) is connected<br>• Check the the cable continuity<br>• Ensure the correct scale and readhead combination |
| **LED on the readhead is flashing red four times upon switch on** | Low signal, over signal, or the readhead speed is too fast. The system is in error. | • Check the readhead set-up and alignment (see page 20) |
| | Incorrect termination (analogue variant only) | • Check the output signal termination (see page 33)<br>• When using the readhead with the ADTi-100 in stand-alone mode, ensure the Termination tool (A-6195-2132) is connected<br>• Exit the CAL mode and restore factory defaults (see page 24)<br>• Check the readhead set-up and alignment (see page 20) |

# 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 (X) | 14-way JST (J) |
|---|---|---|---|---|---|---|---|---|
| **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** [1] | CAL | | Clear | 9 | 1 | 5 | C | 4 |
| **Shield** | - | | Screen | Case | Case | Case | Case | Ferrule |

[1] The remote CAL line must be connected for use with the Advanced Diagnostic Tools.

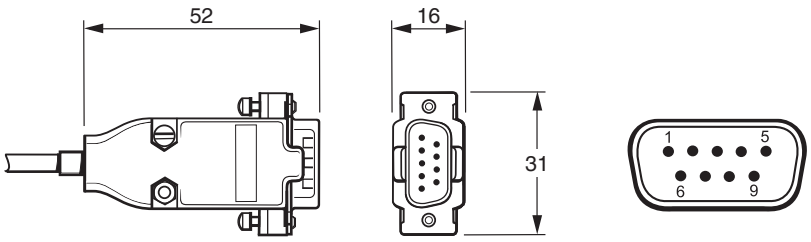
## Analogue outputs

| Function | | Signal | | Colour | 15-way D-type (L) | 15-way D-type alternative pin-out (H) | 14-way JST (J) |
|---|---|---|---|---|---|---|---|
| **Power** | | 5 V | | Brown | 4, 5 | 4, 12 | 10 |
| | | 0 V | | White | 12, 13 | 2, 10 | 1 |
| **Incremental** | **Cosine** | $V_1$ | + | Red | 9 | 1 | 7 |
| | | | – | Blue | 1 | 9 | 2 |
| | **Sine** | $V_2$ | + | Yellow | 10 | 3 | 11 |
| | | | – | Green | 2 | 11 | 9 |
| **Reference mark** | | $V_0$ | + | Violet | 3 | 14 | 8 |
| | | | – | Grey | 11 | 7 | 12 |
| **Limits** | | $V_p$ | | Pink | 7 | 8 | 14 |
| | | $V_q$ | | Black | 8 | 6 | 13 |
| **Setup** | | $V_x$ | | Clear | 6 | 13 | 6 |
| **Remote CAL** [1] | | CAL | | Orange | 14 | 5 | 4 |
| **Shield** | | - | | Screen | Case | Case | Ferrule |

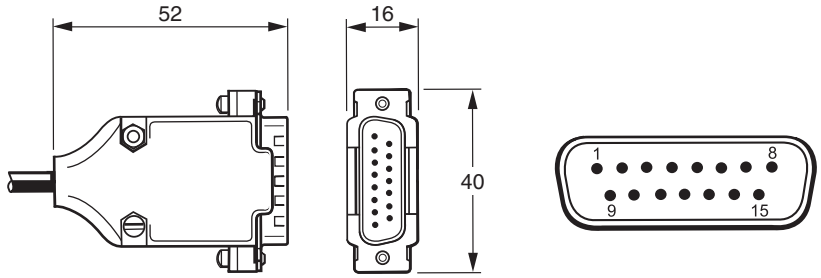
[1] The remote CAL line must be connected for use with the Advanced Diagnostic Tools.

# QUANTiC readhead termination options

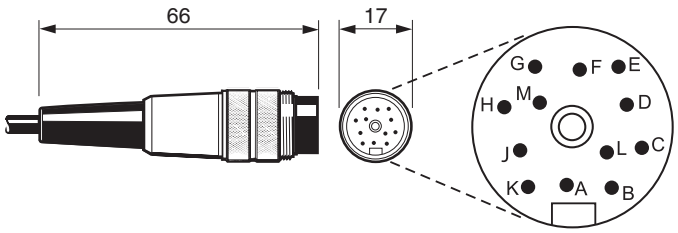
## 9-way D-type connector (termination code A)



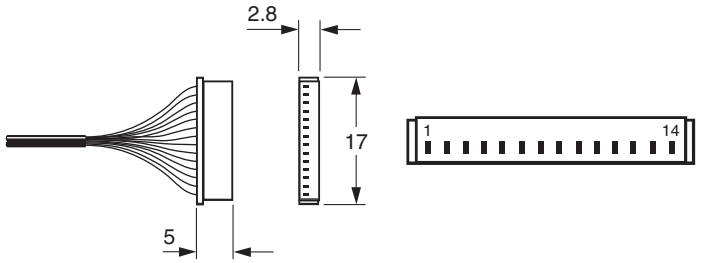

## 15-way D-type connector (termination code D, L, H)




## 12-way in-line circular connector (termination code X) [1]




## 14-way JST connector (termination code J) [2]




[1] 12-way circular Binder mating socket (A-6195-0105).

[2] Pack of five 14-way JST SH mating sockets:
Bottom mount (A-9417-0025);
Side mount (A-9417-0026).
Maximum of 20 insertion cycles for JST connector.

# Speed

## Digital readheads

| Clocked output option (MHz) | Maximum speed (m/s) | | | | | | | Minimum edge separation [1] (ns) |
|---|---|---|---|---|---|---|---|---|
| | T (10 µm) | D (5 µm) | X (1 µm) | Z (0.5 µm) | W (0.2 µm) | Y (0.1 µm) | H (50 nm) | |
| **50** | 24 | 24 | 24 | 18.13 | 7.25 | 3.626 | 1.813 | 25.1 |
| **40** | 24 | 24 | 24 | 14.50 | 5.80 | 2.900 | 1.450 | 31.6 |
| **25** | 24 | 24 | 18.13 | 9.06 | 3.63 | 1.813 | 0.906 | 51.0 |
| **20** | 24 | 24 | 16.11 | 8.06 | 3.22 | 1.611 | 0.806 | 57.5 |
| **12** | 24 | 24 | 10.36 | 5.18 | 2.07 | 1.036 | 0.518 | 90.0 |
| **10** | 24 | 24 | 8.53 | 4.27 | 1.71 | 0.853 | 0.427 | 109 |
| **08** | 24 | 24 | 6.91 | 3.45 | 1.38 | 0.691 | 0.345 | 135 |
| **06** | 24 | 24 | 5.37 | 2.69 | 1.07 | 0.537 | 0.269 | 174 |
| **04** | 24 | 18.13 | 3.63 | 1.81 | 0.73 | 0.363 | 0.181 | 259 |
| **01** | 9.06 | 4.53 | 0.91 | 0.45 | 0.18 | 0.091 | 0.045 | 1038 |

## Analogue readheads

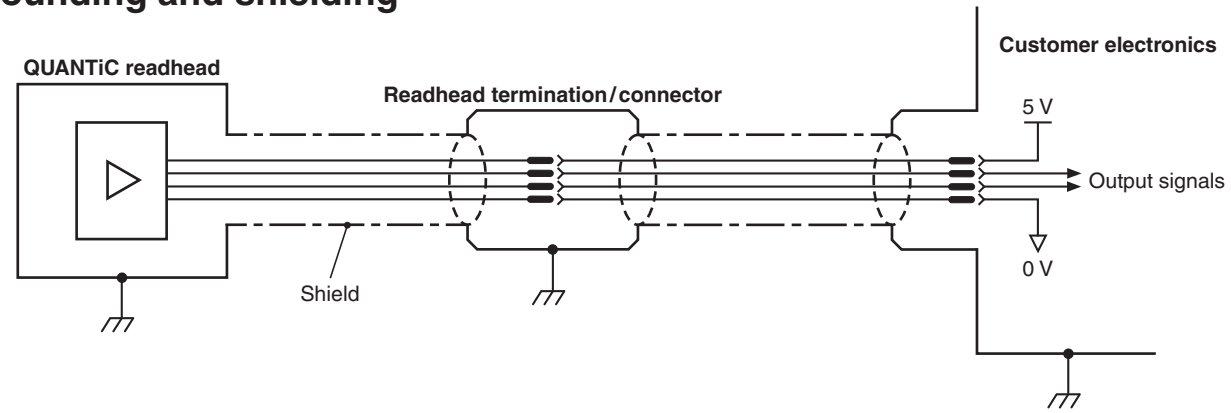
Maximum speed: 20 m/s (–3dB) [2]

[1] For a readhead with a 1 m cable.

[2] If the speed exceeds 20 m/s, SDE performance cannot be guaranteed.

# Electrical connections

## Grounding and shielding

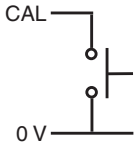



**IMPORTANT:** The shield should be connected to the machine earth (Field Ground). For JST variants the ferrule should be connected to the machine earth.

## Maximum cable length

| | |
|---|---|
| **Readhead cable** | 10 m |
| **Maximum extension cable length** | Dependent on the cable type, the readhead cable length and the clocked output option. Contact your local Renishaw representative for more information. |
| **Readhead to Advanced Diagnostic Tool** | 10 m |

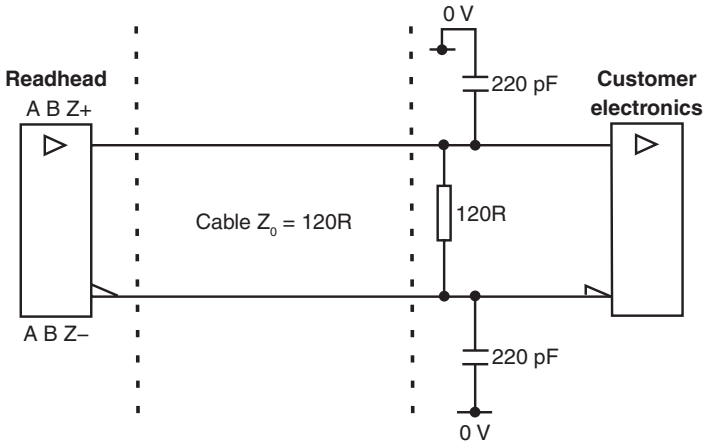
## Remote CAL operation




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

# Recommended signal termination

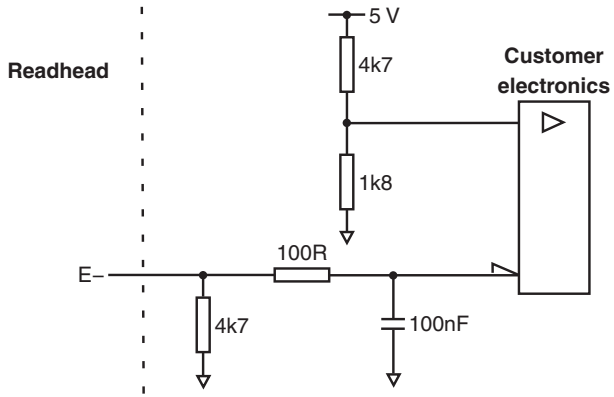
## Digital outputs



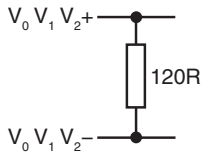

Standard RS422A line receiver circuitry.
The capacitors are recommended for improved noise immunity.

## Single-ended alarm signal termination

(not available with 'A' cable termination)



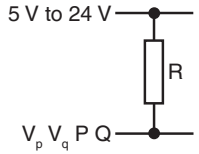

## Analogue outputs




**NOTE:** 120R termination on the analogue output signals is essential for correct AGC operation.

## Limit output

(not available with 'A' cable termination)




**NOTE:** Select R so that the maximum current does not exceed 20 mA. Alternatively, use a suitable relay or opto-isolator.

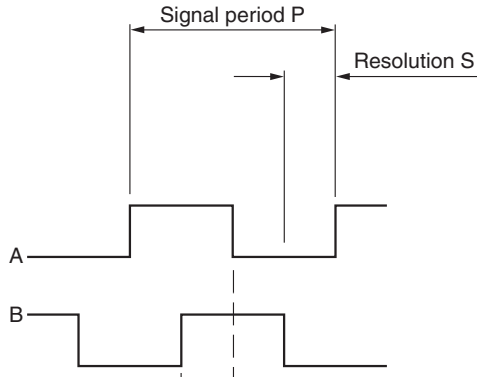
# Output specifications

## Digital output signals

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

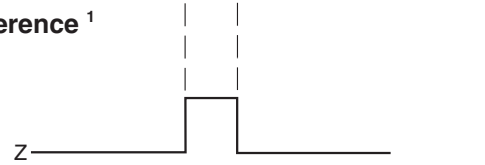
### Incremental [1]

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




| Resolution option code | P (µm) | S (µm) |
|---|---|---|
| **T** | 40 | 10 |
| **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 |

### Reference [1]




Synchronised pulse Z, duration as resolution. Bi-directionally repeatable. [2]

**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.

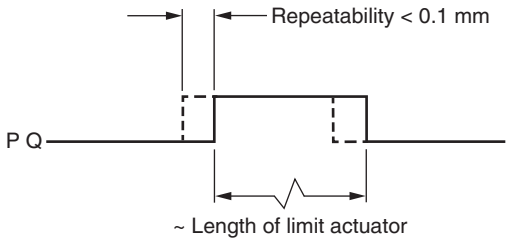
[1] For clarity, the inverse signals are not shown.

[2] Only the calibrated reference mark is bi-directionally repeatable.

### Limits

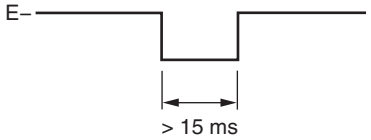
Open collector output, asynchronous pulse (not available with 'A' cable termination)

**Active high**




### Alarm

**Line driven** (asynchronous pulse)
(not available with 'A' cable termination)




Alarm asserted when:

- The signal amplitude is < 20% or > 135%
- The readhead speed is too high for reliable operation

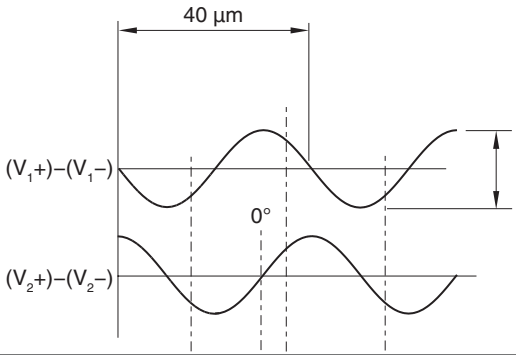
**or 3-state alarm**

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

# Analogue output signals

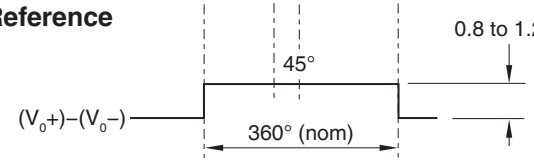
## Incremental

2 channels $V_1$ and $V_2$ differential sinusoids in quadrature, centred on ~1.65 V (90° phase shifted)




0.7 to 1.35 Vpp with green LED (AGC off) and blue LED (AGC on) indication (readhead) and 120R termination.

## Reference

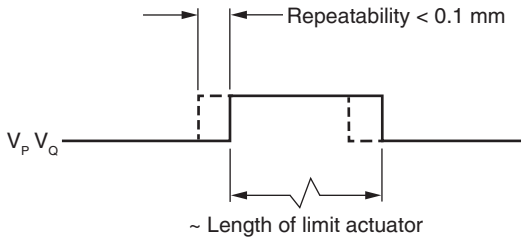



Bi-directionally repeatable. [1]
Differential pulse $V_0$ centred on 45°.

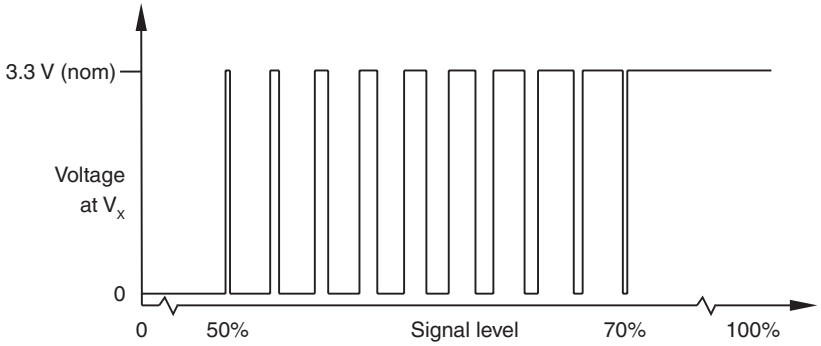
## Limits

Open collector output, asynchronous pulse

**Active high**




## Set-up [2]




Between 50% and 70% the signal level $V_X$ is a duty cycle. Time spent at 3.3 V increases with incremental signal level. At > 70% the signal level $V_X$ is nominal 3.3 V.

[1] Only the calibrated reference mark is bi-directionally repeatable.

[2] The set-up signal as shown is not present during the calibration routine.

# General specifications

| | | |
|---|---|---|
| **Power supply** | 5V –5%/+10% | Typically 150 mA fully terminated (analogue output)<br>Typically 200 mA fully terminated (digital output)<br>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 |
| **Temperature** | System (storage) | –20 °C to +70 °C |
| | System (operating) | 0 °C to +70 °C |
| **Humidity** | System | 95% relative humidity (non-condensing) to IEC 60068-2-78 |
| **Sealing** | | IP40 |
| **Acceleration** | System (operating) | 400 m/s², 3 axes |
| **Shock** | System (operating) | 500 m/s², 11 ms, ½ sine, 3 axes |
| **Vibration** | Readhead (operating) | Sinusoidal 100 m/s² max @ 55 Hz to 2000 Hz, 3 axes |
| | Scale (operating) | Sinusoidal 300 m/s² max @ 55 Hz to 2000 Hz, 3 axes |
| **Mass** | Readhead | 9 g |
| | Cable | 32 g/m |
| **EMC compliance** | | IEC 61326-1 |
| **Readhead cable** | | Single-shielded, 28 AWG cores, outside diameter 4.225 ±0.125 mm<br>Flex life > 20 × $10^6$ cycles at 20 mm bend radius<br>UL recognised component |
| | Maximum length | 10 m |
| **Connector options** | | **Code - connector type - output type**<br>A - 9-way D-type - digital output only<br>L - 15-way D-type (standard pin-out) - analogue output only<br>D - 15-way D-type (standard pin-out) - digital output only<br>H - 15-way D-type (alternative pin-out) - analogue and digital output<br>X - 12-way circular connector - digital output only<br>J - 14-way JST connector - analogue and digital output |
| **Typical sub-divisional error (SDE)** | Analogue output | < ±120 nm |
| | Digital output | < ±80 nm |

**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.

# RTLC40-S scale specifications

| | | |
|---|---|---|
| **Form (height × width)** | | 0.4 mm × 8 mm (including adhesive) |
| **Pitch** | | 40 µm |
| **Accuracy (at 20 °C) (includes slope and linearity)** | RTLC40-S | ±15 µm/m calibration traceable to International Standards |
| | RTLC40H-S | ±5 µm/m calibration traceable to International Standards |
| **Linearity** | RTLC40-S | ±5 µm/m (achievable with 2 point error correction) |
| | RTLC40H-S | ±2.5 µm/m (achievable with 2 point error correction) |
| **Supplied length** | | 20 mm to 10 m [1] (> 10 m available on request) |
| **Material** | | Hardened and tempered martensitic stainless steel fitted with a self-adhesive backing tape |
| **Mass** | | 12.9 g/m |
| **Coefficient of thermal expansion (at 20 °C)** | | 10.1 ±0.2 µm/m/°C |
| **Installation temperature** | | +15 °C to +35 °C |
| **Datum fixing** | | Loctite 435 with A-9585-0028 clamp |

# Reference mark

| | |
|---|---|
| **Type** | Customer selected IN-TRAC reference mark, directly embedded into the incremental track. Bi-directional position repeatability |
| 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) |
| **Selection** | Customer positioned selector magnet (A-9653-0143) for selecting desired IN-TRAC reference mark |
| **Repeatability** | Unit of resolution repeatability (bi-directional) across full system rated speed and temperature ranges |

# Limit switches

| | |
|---|---|
| **Type** | Magnetic actuators; with dimple triggers Q limit, without dimple triggers P limit (see 'RTLC40-S scale installation drawing' on page 12) |
| **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 ed.e |
| **Mounting** | Customer placed at desired locations |
| **Repeatability** | < 0.1 mm |

[1] For lengths > 2 m the FASTRACK™ carrier with the RTLC40 scale is recommended. Refer to the *QUANTiC™ RTLC40/FASTRACK™ incremental linear encoder system* installation guide (Renishaw part no. M-9417-9248).

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