

# FORTiS-N™ enclosed encoder system



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# 1 Legal notices

## 1.1 Copyright

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## 1.2 Trade marks

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Other brand, product or company names are trade marks of their respective owners.

## 1.3 Patents

Features of Renishaw's encoder systems and similar products are the subjects of the following patents and patent applications:

|               |             |               |           |               |
|---------------|-------------|---------------|-----------|---------------|
| CN1260551     | US7499827   | JP4008356     | GB2395005 | US20100163536 |
| US20150225858 | CN102197282 | EP2350570     | JP5480284 | US8505210     |
| KR1630471     | CN102388295 | EP2417423     | KR1701535 | US2012007980  |
| CN102460077   | EP2438402   | US20120072169 | KR1851015 | JP6074392     |
| JP5755223     | EP01103791  | US6465773     |           |               |

## 1.4 Disclaimer

WHILE CONSIDERABLE EFFORT WAS MADE TO VERIFY THE ACCURACY OF THIS DOCUMENT AT PUBLICATION, ALL WARRANTIES, CONDITIONS, REPRESENTATIONS AND LIABILITY, HOWSOEVER ARISING, ARE EXCLUDED TO THE EXTENT PERMITTED BY LAW.

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## 1.5 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.

## 1.6 Product compliance

Renishaw plc declares that the FORTiS™ enclosed 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)

## 1.7 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.

## 1.8 Warnings

In all applications involving the use of machine tools, eye protection is recommended.

## 1.9 Further information

Further information relating to the FORTiS encoder range can be found in the FORTiS data sheets available from your local Renishaw representative. See also: [www.renishaw.com](http://www.renishaw.com)

## 1.10 Packaging

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

| Packaging component | Material                      | ISO 11469      | Description |
|---------------------|-------------------------------|----------------|-------------|
| 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  |

\*For some system lengths the packaging material will be wood.

## 1.11 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)

## 1.12 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.

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## 2 Overview of the FORTiS encoder system

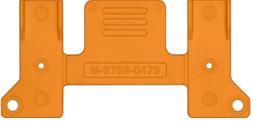
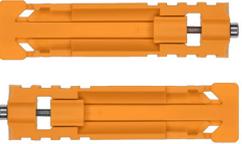
This system is an enclosed linear optical encoder designed for use in harsh industrial environments where high-precision feedback and metrology are required. Based upon Renishaw's award-winning absolute technology, the rugged non-contact design has no internal moving parts, such as bearings or wheeled readhead carriages, thus improving the overall reliability. Additionally, hysteresis and backlash errors associated with mechanical contact system designs are reduced.

In addition to enhanced breakage resistance, the robust steel scale has a coefficient of thermal expansion similar to the base material used in the majority of machines, reducing errors due to thermal effects whilst increasing measurement certainty.

Renishaw's patented set-up LED provides instant verification of the encoder's signal strength and therefore its accurate alignment. This intuitive procedure eliminates the need for additional peripheral diagnostics equipment during installation. When combined with Renishaw's carefully designed installation accessories, these unique tools make installation easier and faster compared to traditional methods, whilst building confidence in a right-first-time installation.

### 3 Parts list

#### 3.1 Included in the box

|   | Item   | Description   |
|---|--|---|
|    | <b>FORTiS encoder unit</b>                   | The FORTiS enclosed encoder unit  |
|    | <b>18 mm readhead setting shim</b>           | Plastic shim to be used as an installation aid  |
|    | <b>Air connection fitting</b>                | To enable connection to one of the encoder air purge inlets   |
|    | <b>Cable connection wrench</b>               | Used for securely connecting the encoder cable to the readhead  |
|   | <b>Alignment brackets</b>                    | 2 × brackets secure the readhead during transit, and set the correct readhead alignment during installation. <b>IMPORTANT:</b> Retain until the installation is complete. |
|  | <b>Serrated washers</b>                      | 2 × M8 serrated washers for mounting an extrusion with standard end caps  |
|  | <b>Serrated washers</b>                      | 2 × M4 serrated washers for mounting the readhead to the machine slideway   |
|   | <b>FORTiS quality inspection certificate</b> | Certifies specific encoder performance and provides traceability  |

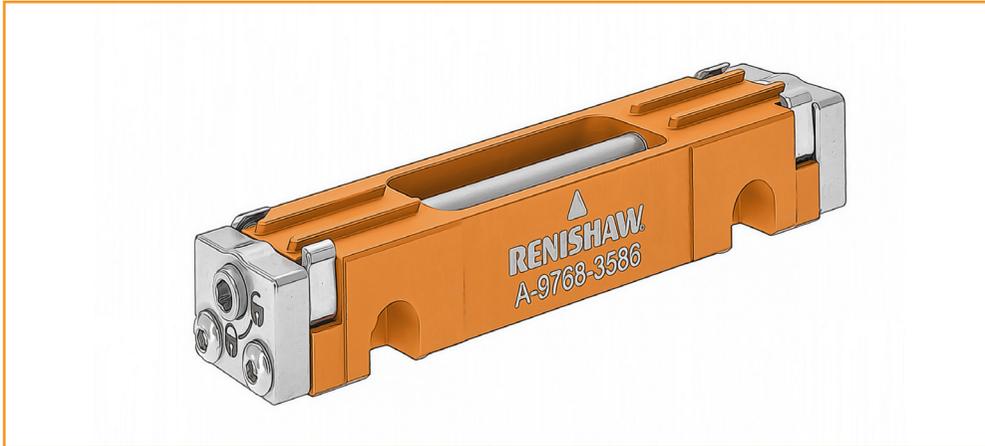
#### 3.2 Not included / required tools

|   | Item                      | Description  |
|---|---------------------------|--|
|  | <b>6 mm torque wrench</b> | To tighten extrusion mounting screws                       |
|  | <b>3 mm torque wrench</b> | To tighten readhead mounting screws                        |
|  | <b>1.5 mm hex key</b>     | Air bung removal (only if air purge is required)           |
|  | <b>3 mm hex key</b>       | Alignment bracket removal                                  |
|  | <b>M8 screws</b>          | 2 × M8 × 1.25 screws length ≥ 20 mm for mounting extrusion |
|  | <b>M4 screws</b>          | 2 × M4 × 0.7 screws length ≥ 20 mm for mounting readhead   |

### 3.3 Optional extras

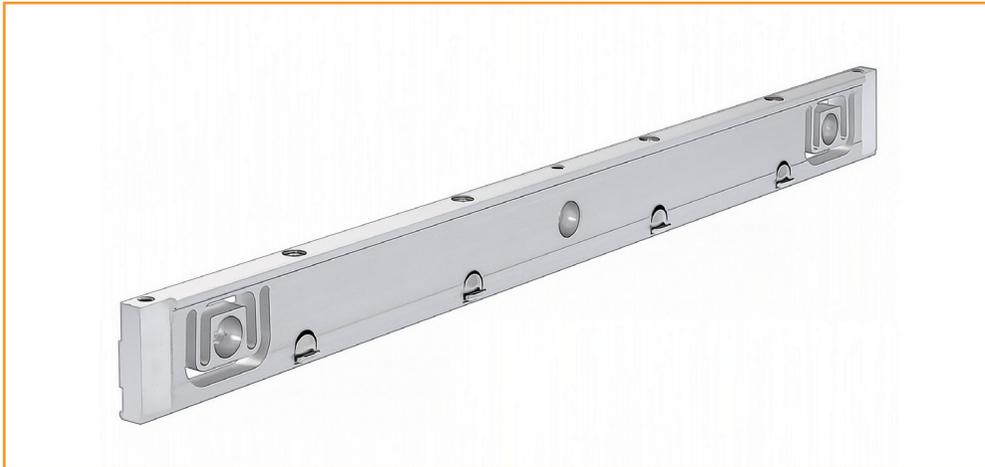
#### 3.3.1 Mounting aid (part number A-9768-3586)

Optional installation aid to assist with mounting the readhead to a machine slideway that has more than one degree of freedom (see section 8.5 on page 22).



#### 3.3.2 Mounting spar

For measuring lengths greater than 620 mm Renishaw recommends the use of a mounting spar (see section 7.4 on page 14).

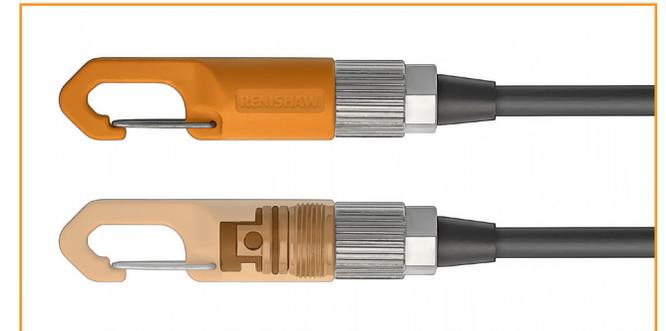


### 3.4 Cable options (cables not included)

|   | Item                          | Description   |
|---|-------------------------------|---|
|  | <b>Encoder cable type A</b>   | OD: 4.7 mm, 28 AWG, 7 core, single screen, black jacket<br>Length options: 0.5 m, 1 m, 3 m, 6 m, 9 m  |
|  | <b>Encoder cable type B</b>   | OD: 6.5 mm, 23 AWG, 6 core (3 x twisted pairs), single screen, green jacket<br>Length options: 0.5 m, 1 m, 3 m, 6 m, 9 m                          |
|  | <b>Encoder cable type D</b>   | Armoured: OD 10 mm, 28 AWG, 7 core<br>Length options: 1 m, 3 m, 6 m, 9 m  |
|  | <b>Extension cable type B</b> | OD: 6.5 mm, 23 AWG, 6 core (3 x twisted pairs), single screen, green jacket<br>Length options: 1 m, 3 m, 6 m, 9 m, 15 m, 20 m                     |
|  | <b>Extension cable type C</b> | OD: 7.8 mm, 20 AWG (power), 8 core (3 x twisted pairs + 2 power sense), single screen, green jacket<br>Unterminated lengths available up to 100 m |

#### 3.4.1 FORTiS connector

All encoder cables include a custom FORTiS connector that connects to the readhead. The connector is covered with a protective cap with an integrated clip; this clip can be used to assist with cable routing.



## 4 Storage and handling

**IMPORTANT:** Handle carefully to avoid damage to the location faces when unpacking and installing.

### Storage temperature

-20 °C to +70 °C



### Operating temperature

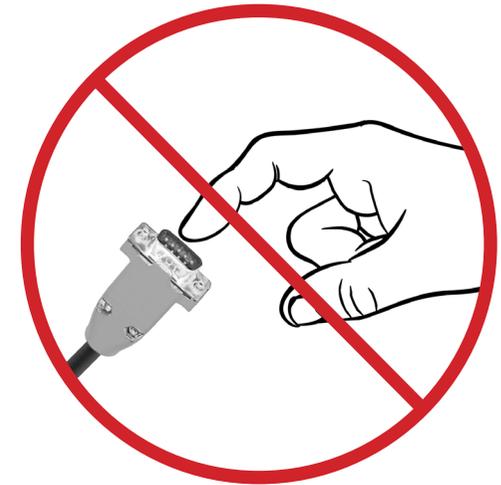
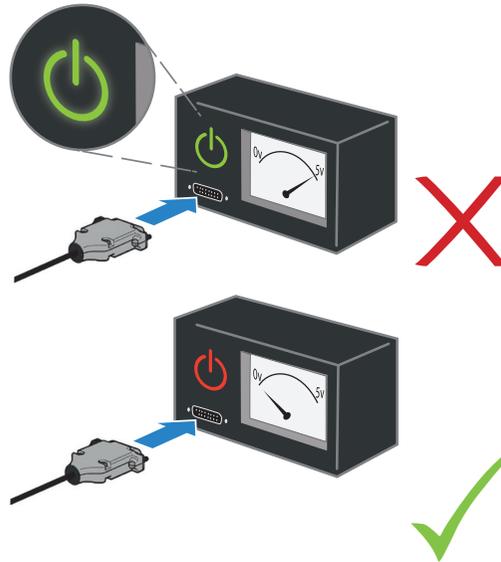
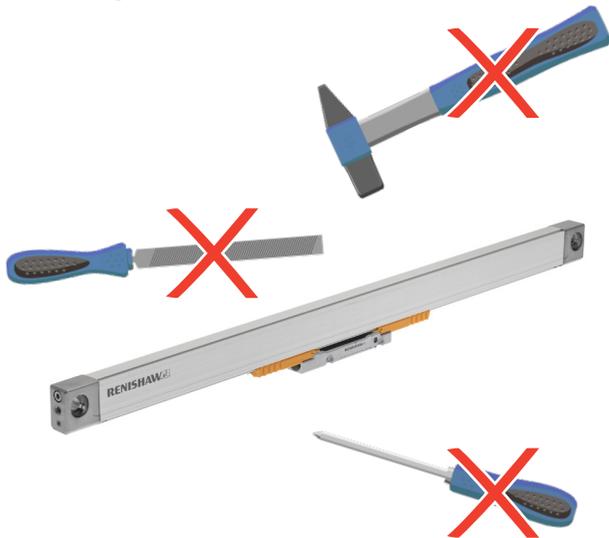
0 °C to +50 °C



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



### Handling instructions



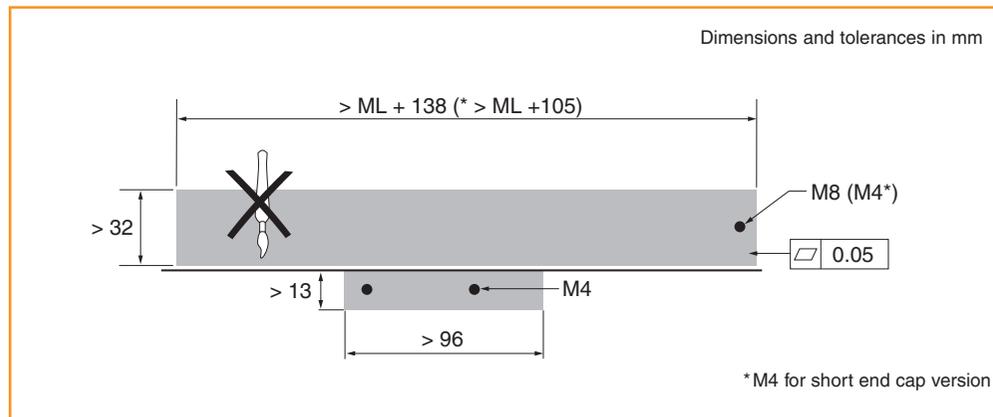
## 5 Installation drawings

### 5.1 Mounting surface preparation

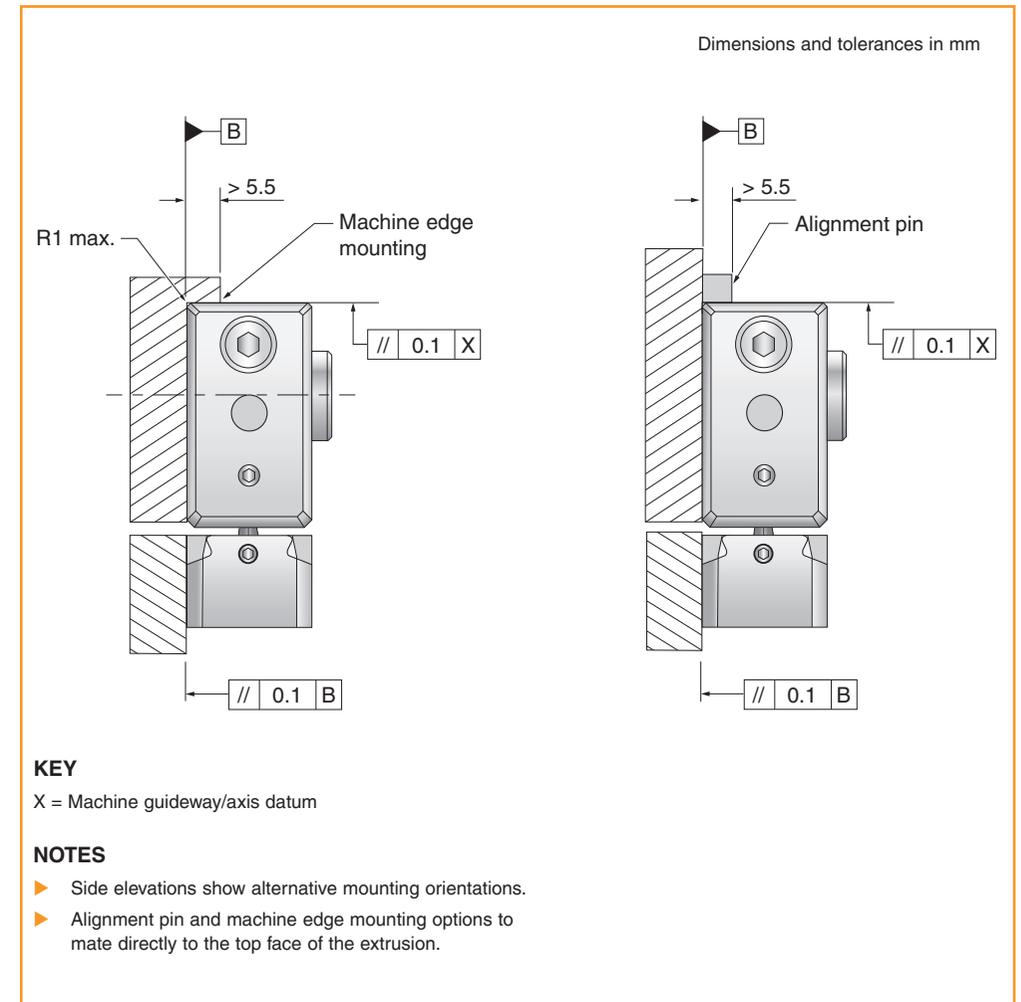
To ensure correct operation, the mounting surface should be prepared as follows:

- surface flatness requirement of 0.05 mm/m
- surface should be free of paint and burrs
- refer to installation drawing for required mounting hole positions (see page 9).

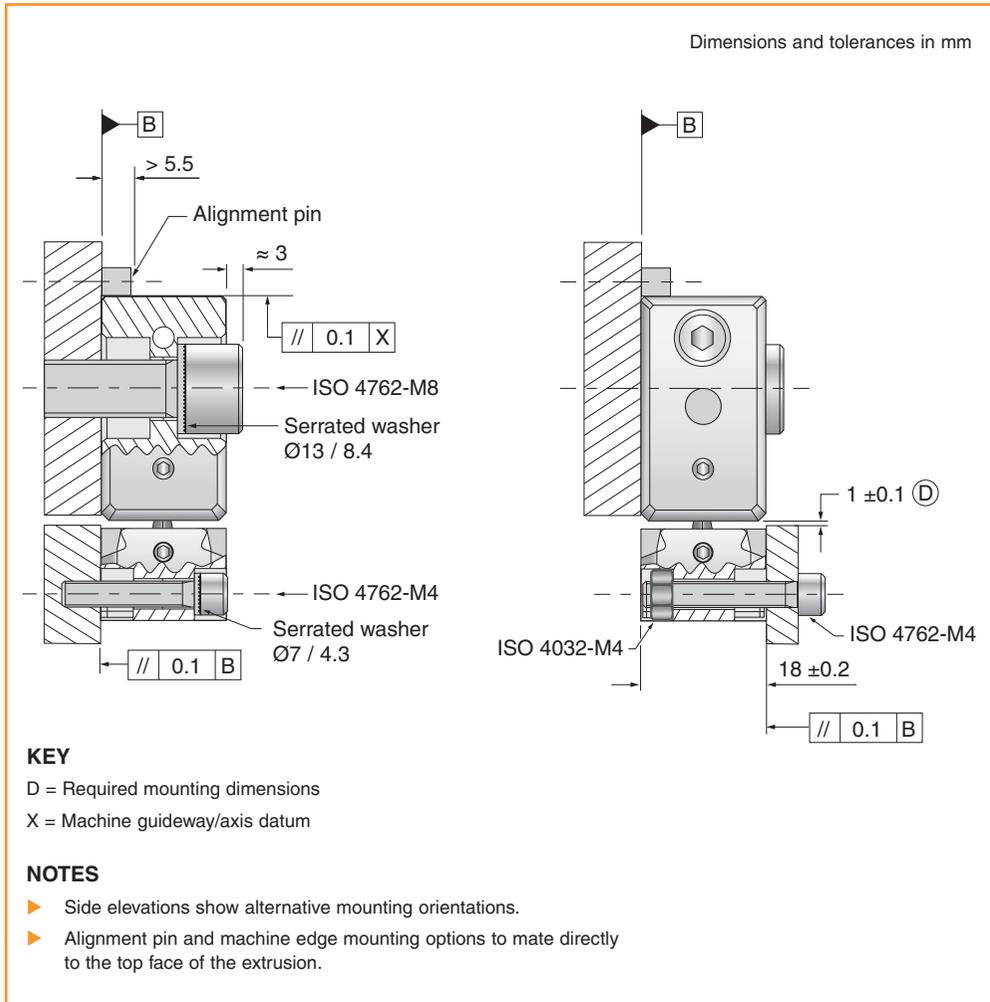
To further simplify and help reduce installation time, it is recommended that the machine axis to which the encoder is to be mounted is prepared with a datum edge or aligned dowel pins to help locate the edge of the extrusion and ensure parallelism to the axis of motion.



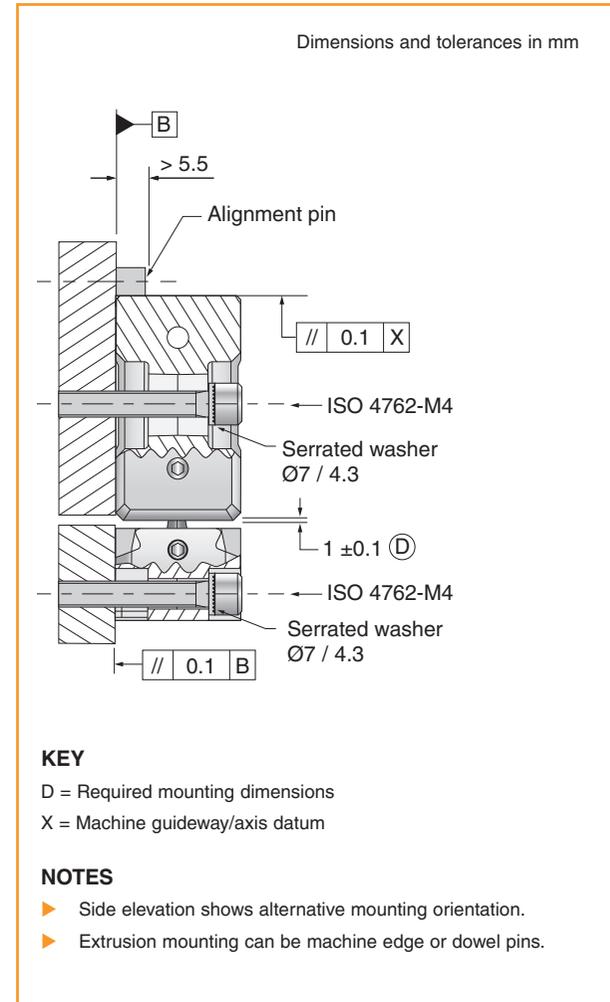
### 5.2 Datum location edge or dowel pins – standard end caps



### 5.3 Mounting orientations – standard end caps



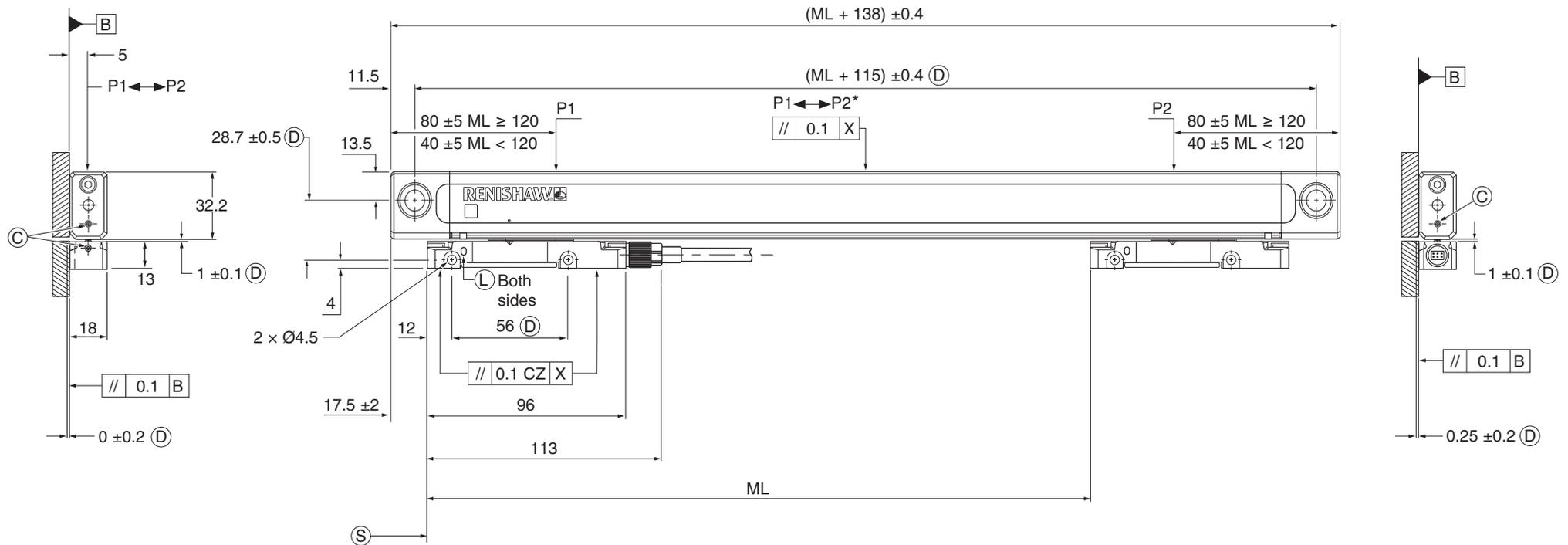
### 5.4 Mounting orientations – short end caps



## 5.5 FORTiS system installation drawing – standard end caps

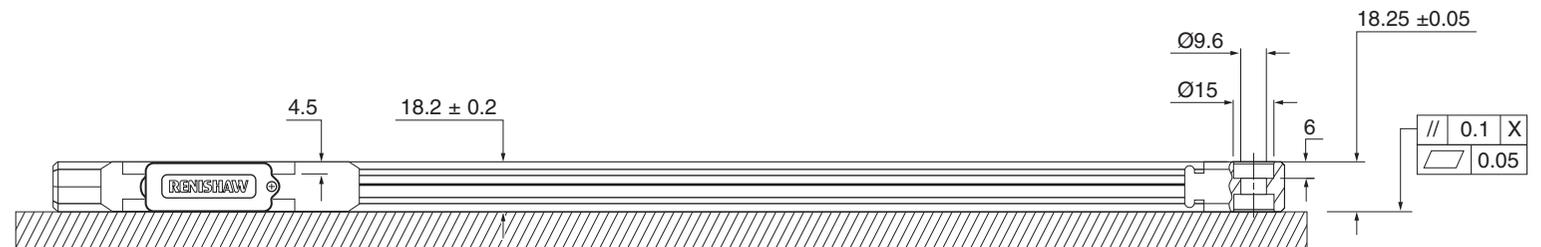
(ML 320 mm shown)

Dimensions and tolerances in mm



\*The parallelism between the machine guideway and the mounting surface from P1 to P2 should be under 0.1 mm.

Dowel pins should ideally be located on P1 and P2. Other positions are permissible (not on endcaps).



### KEY

- C = Compressed air inlet fitting
- D = Required mounting dimensions
- L = LED set-up illumination
- ML = Measuring length
- P = Gauging points for alignment
- S = Start of measuring length
- X = Machine guideway/axis datum

| ML | 70 | 120 | 170 | 220 | 270 | 320 | 370 | 420 | 470 | 520 | 570 | 620 | 670 | 720 | 770 | 820 | 920 | 1020 | 1140 | 1240 | 1340 | 1440 | 1540 | 1640 | 1740 | 1840 | 2040 |
|----|----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|------|------|------|------|------|
|----|----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|------|------|------|------|------|



## 6 Product specification

|   |   |
|---|---|
| <b>Measuring standard</b>                             | Renishaw stainless steel scale with single track absolute encoding  |
| <b>Coefficient of thermal expansion</b><br>(at 20 °C) | 10.1 ±0.2 µm/m/°C   |
| <b>Thermal datum</b>                                  | At centre position (encoder position of 0.5 × measuring length)   |
| <b>Measuring lengths available (mm)</b>               | 70, 120, 170, 220, 270, 320, 370, 420, 470, 520, 570, 620, 670, 720, 770, 820, 920, 1020, 1140, 1240, 1340, 1440, 1540, 1640, 1740, 1840, 2040<br>(mounting spar available – recommended for > 620 mm length) |
| <b>Accuracy grades</b>                                | High grade: ±3 µm<br>Standard grade: ±5 µm  |
| <b>Resolution</b>                                     | 1 nm, 1.25 nm (FANUC only), 10 nm, 12.5 nm (FANUC only), 50 nm  |
| <b>Absolute position protocols</b>                    | BiSS C, Siemens DRIVE-CLiQ (with external interface), FANUC ( $\alpha/\alpha_i$ ), Panasonic, Mitsubishi  |
| <b>Encoder electrical connection</b>                  | Cable connector M12 custom  |
| <b>Controller electrical connection</b>               | 8-way M12, FANUC 20-way, 10-way Mitsubishi, 17-way M23, 9-way D-Type, 14-way LEMO, flying lead  |
| <b>Cable length</b>                                   | Up to 100 m (with extension cable)  |
| <b>Power supply</b>                                   | 5 V ±10%    1.25 W maximum (250 mA @ 5 V)   |
|   | <b>NOTE:</b> Current consumption figures refer to terminated FORTiS systems. 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  |

|  |  |
|--|--|
| <b>Set-up LED</b>  | Signal strength indicator LED colour:<br>Excellent: BLUE<br>Good: GREEN<br>Satisfactory: ORANGE<br>Poor: RED<br>No signal: Flashing RED  |
| <b>Maximum speed</b>   | 4 m/s  |
| <b>Acceleration</b><br>(readhead relative to scale)                                    | < 200 m/s <sup>2</sup> in measuring direction  |
| <b>Moving force</b><br>(maximum force required to move the readhead through the seals) | < 4 N  |
| <b>Vibration</b> (55 Hz to 2000 Hz)  | Readhead: < 300 m/s <sup>2</sup> to IEC 60068-2-6<br>Housing without mounting spar: < 200 m/s <sup>2</sup> to IEC 60068-2-6<br>Housing with mounting spar: < 300 m/s <sup>2</sup> to IEC 60068-2-6                     |
| <b>Shock 11 ms half-sine</b>   | < 300 m/s <sup>2</sup> IEC 60068-2-27  |
| <b>Operating temperature</b>   | 0 °C to 50 °C  |
| <b>Environment protection</b>  | IP53 when installed correctly, IP64 with air purge   |
| <b>Air purge requirements</b>  | Air supply pressure = 1 bar at encoder<br>At correct supply pressure the supplied air connection fitting restricts the air flow rate to 2 l/min<br>Air quality: see <a href="#">section 8.8 on page 26</a> for details |
| <b>Weight</b>  | 0.11 kg + 0.45 kg/m  |

**IMPORTANT:** Specifications are subject to the correct installation procedures as set out in this installation guide. If in doubt, contact your local Renishaw representative.

## 7 Installation procedure – extrusion

Please note that fitment of the extrusion is independent of readhead mounting. For illustrative purposes, a datum edge is displayed, but the procedure is identical for dowel pins. Where neither an edge or dowel pins are available, begin by aligning extrusion mounting holes.

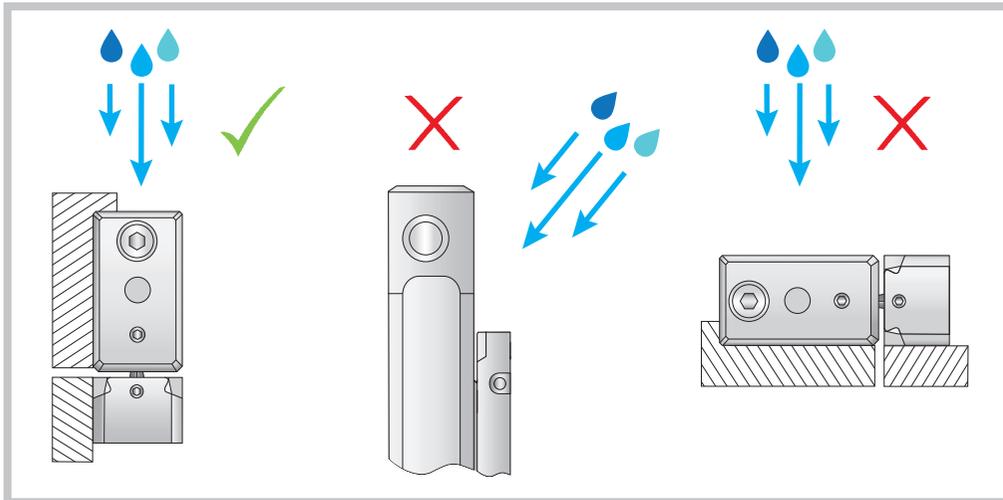
### NOTES

- ▶ If a suitable reference edge or dowel pins are not available then we recommend that the extrusion is checked against a dial gauge to ensure parallelism to the machine axis.
- ▶ For measuring lengths greater than 620 mm Renishaw recommends the use of a mounting spar (see section 7.4 on page 14).

Ensure the mounting faces are clean before installation.

### 7.1 Protection for sealed linear encoders

IP53 requires installation with sealing lips positioned away from splash water in accordance with EN 60529/IEC 60529. For ingress protection to IP64, please see section 8.8 on page 26.



### 7.2 Thermal datum

The thermal datum of the encoder is located centrally. The coefficient of thermal expansion (CTE) of the encoder is  $10.1 \pm 0.2 \mu\text{m}/^\circ\text{C}$ .

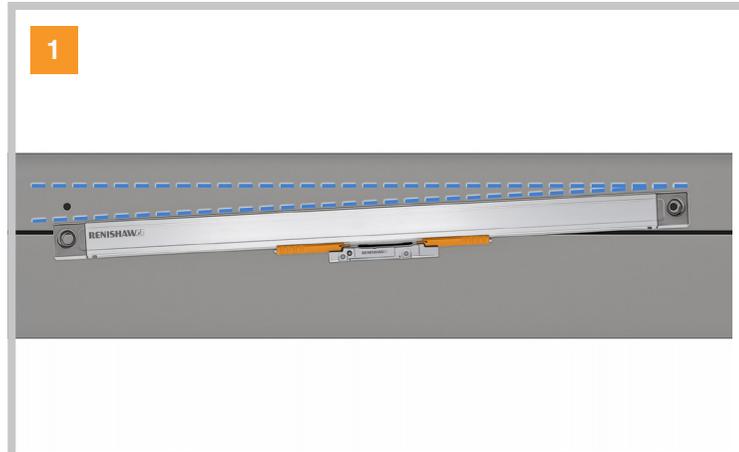
The standard end cap version is mounted using two M8 screws; a high clamping torque of 20 Nm enables the extrusion to follow the expansion of the mounting surface material.

For measuring lengths > 620 mm a mounting spar is recommended; please refer to sections 7.4, 7.5 and 7.6 for full details. (If required, a mounting spar can be used for measuring lengths under 620 mm.) The aluminium mounting spar's fixed central mounting hole provides a centrally located thermal datum position. The other mounting positions use flexures to allow the spar to effectively float over the machine's surface, ensuring reproducible thermal behaviour.

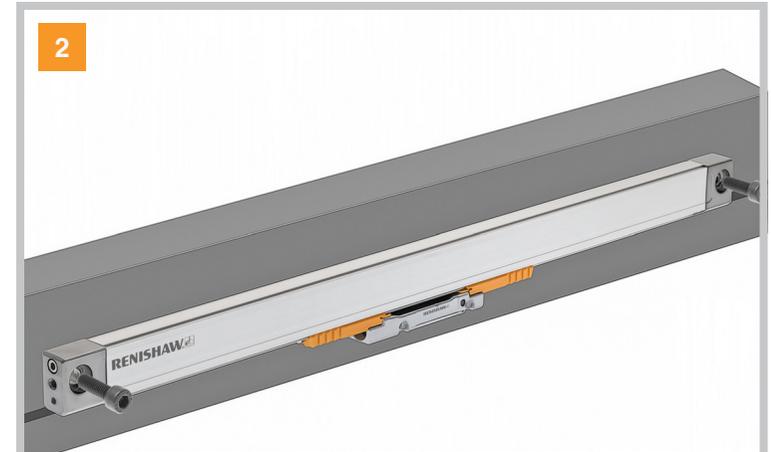
A short end cap version is recommended for use with the mounting spar.

**NOTE:** If the short end cap version of the encoder is installed directly onto a different mounting surface using two M4 screws without using the mounting spar, its thermal datum properties will be compromised.

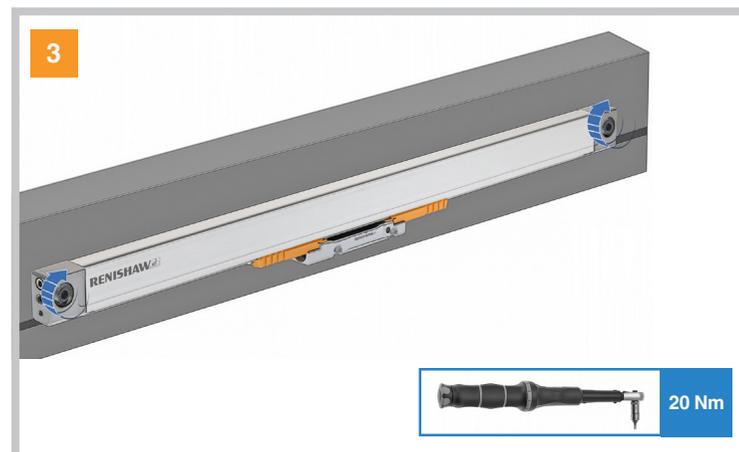
### 7.3 Extrusion installation without mounting spar



Place the encoder on the mounting surface and firmly push against mounting edge/dowel pins. Position the encoder to align mounting holes.



Loosely secure the extrusion to the mounting surface with the two supplied serrated washers and M8 screws placed in the end cap mounting holes.

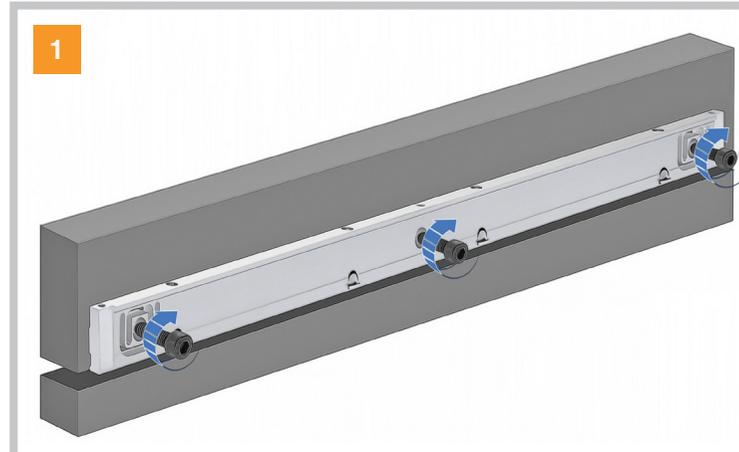


Tighten to a torque of 20 Nm.

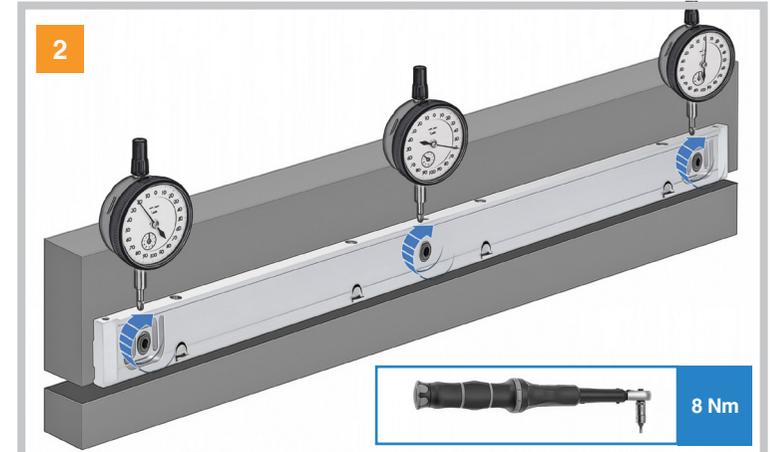
## 7.4 Installation with mounting spar

For measuring lengths greater than 620 mm Renishaw recommends the use of a mounting spar.

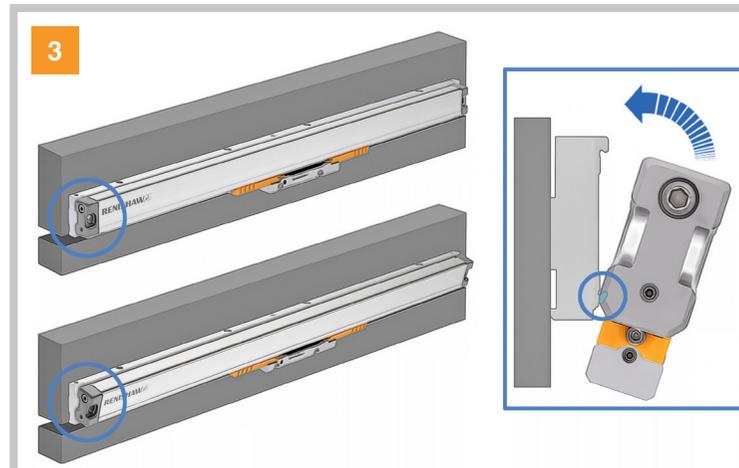
The spar should be installed prior to fitting the encoder.



Place the mounting spar on the mounting surface and firmly push against the mounting edge/dowel pins. Position the spar to align to the surface mounting holes. Loosely secure the mounting spar to the mounting surface with appropriate M6 screws.

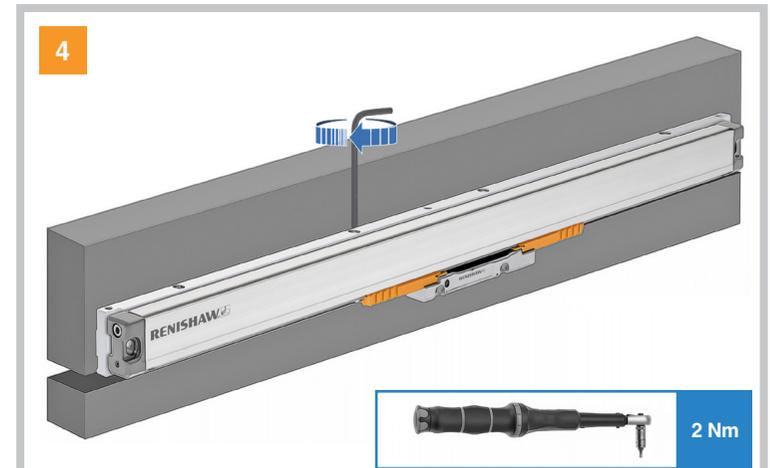


Use a dial gauge to ensure the mounting spar is set to the correct parallelism compared to the machine guideway. Once aligned tighten the screws to a torque of 8 Nm.



Position the encoder against the spar.

Inset: Ensure the clips on the mounting spar engage correctly with the extrusion profile.



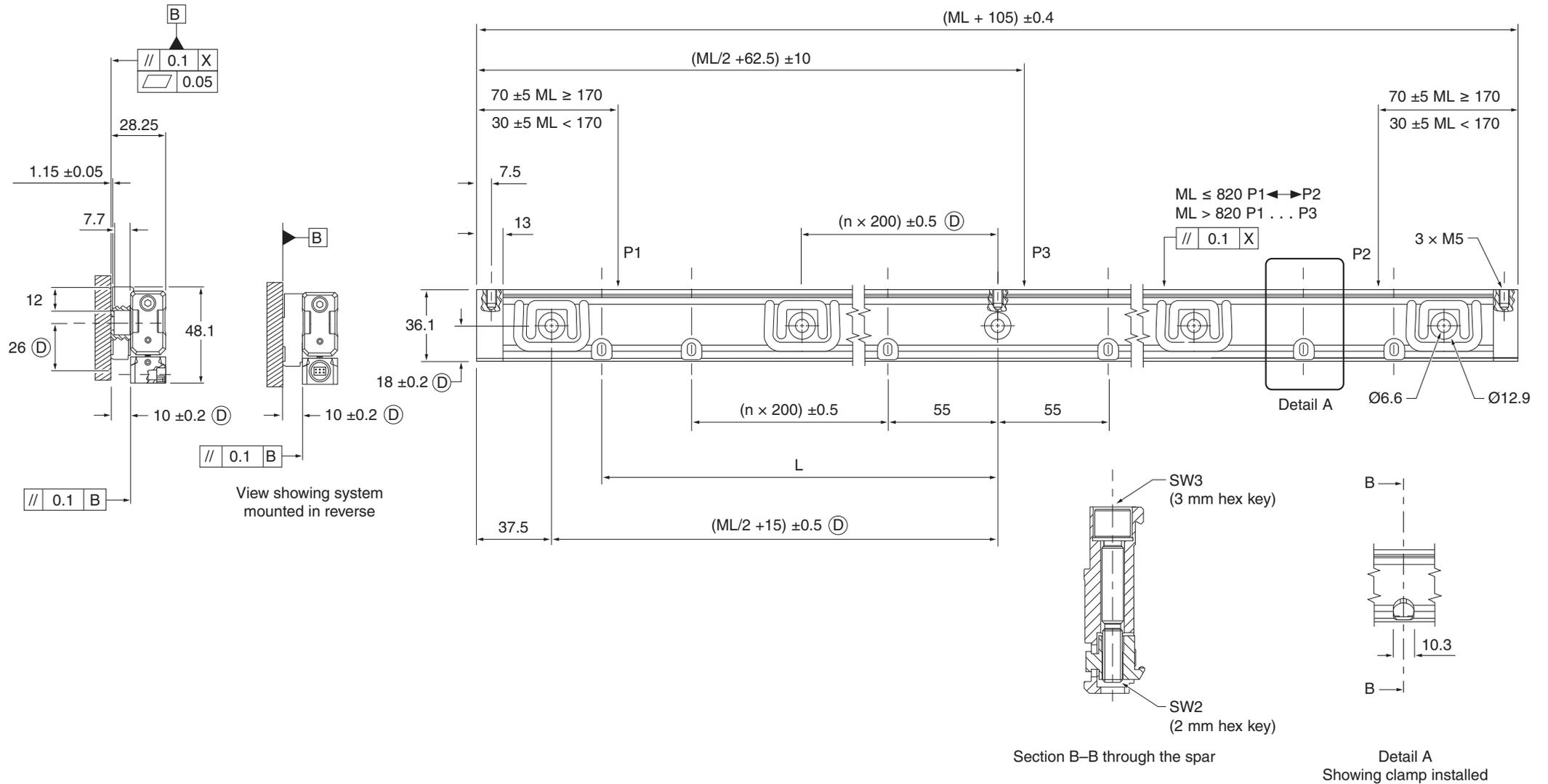
Tighten the screws on the top of the mounting spar to secure the encoder firmly to the mounting spar.

Tighten all bolts, working from left to right.

## 7.5 Mounting spar installation drawing

(ML 620 mm shown)

Dimensions and tolerances in mm



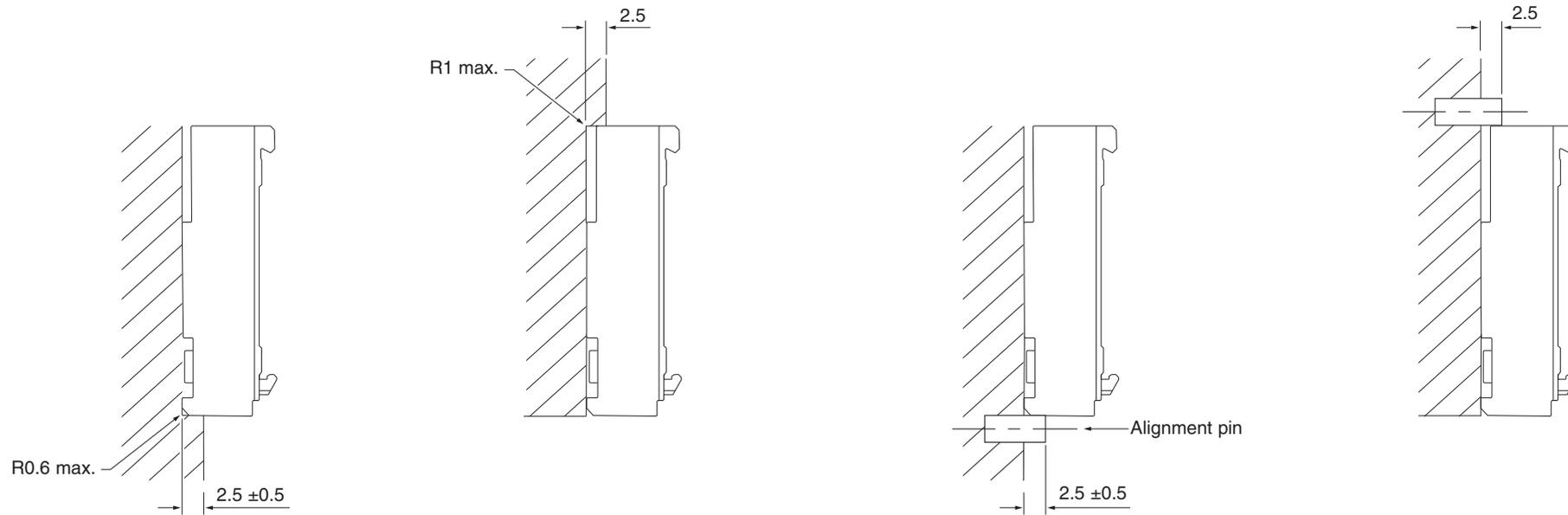
### KEY

D = Required mounting dimensions  
 ML = Measuring length  
 P = Gauging points for alignment  
 X = Machine guideway/axis datum

| ML | 70   | 120 | 170 | 220 | 270 | 320 | 370 | 420 | 470 | 520 | 570 | 620 | 670 | 720 | 770 | 820 | 920 | 1020 | 1140 | 1240 | 1340 | 1440 | 1540 | 1640 | 1740 | 1840 | 2040 |
|----|------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|------|------|------|------|------|
| L  | 37.5 | 55  | 75  | 100 | 115 | 140 | 175 | 200 | 225 | 250 | 275 | 300 | 325 | 350 | 375 | 400 | 450 | 500  | 550  | 640  | 655  | 710  | 760  | 810  | 855  | 910  | 1010 |
| n  | -    | -   | -   | -   | -   | -   | -   | -   | -   | -   | -   | 1   | 1   | 1   | 1   | 1   | 1   | 2    | 2    | 2    | 2    | 3    | 3    | 3    | 3    | 4    | 4    |

## 7.6 Spar mounting options

Dimensions and tolerances in mm



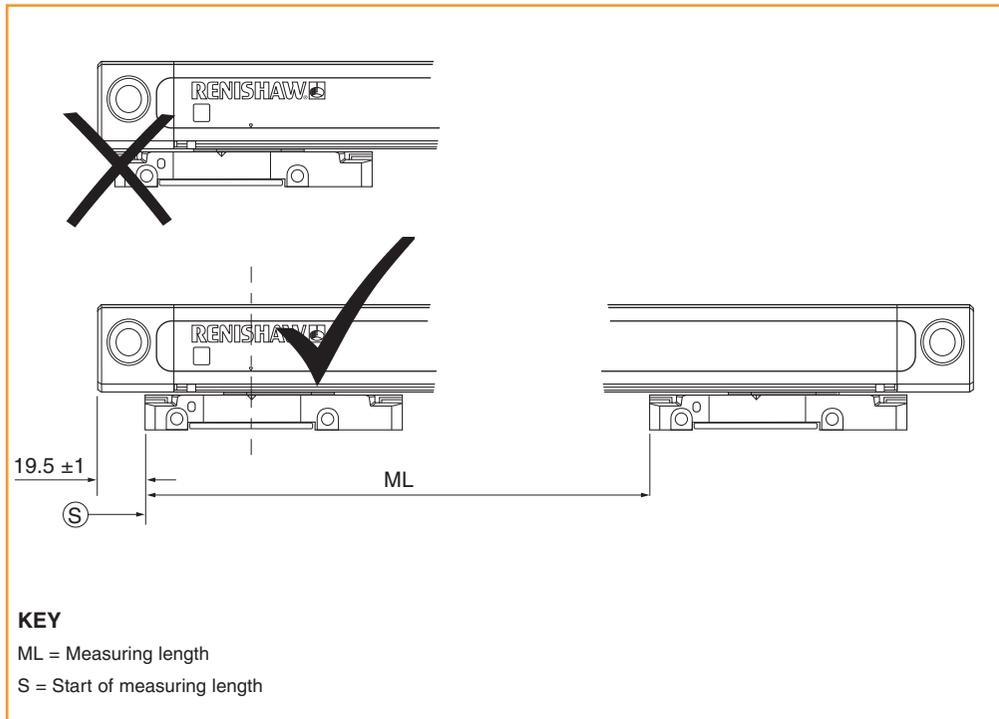
## 8 Installation procedure – readhead

Three different methods may be used to install the readhead, making installation easier for a wide range of machine types and mounting surfaces. These are outlined in the following sections.

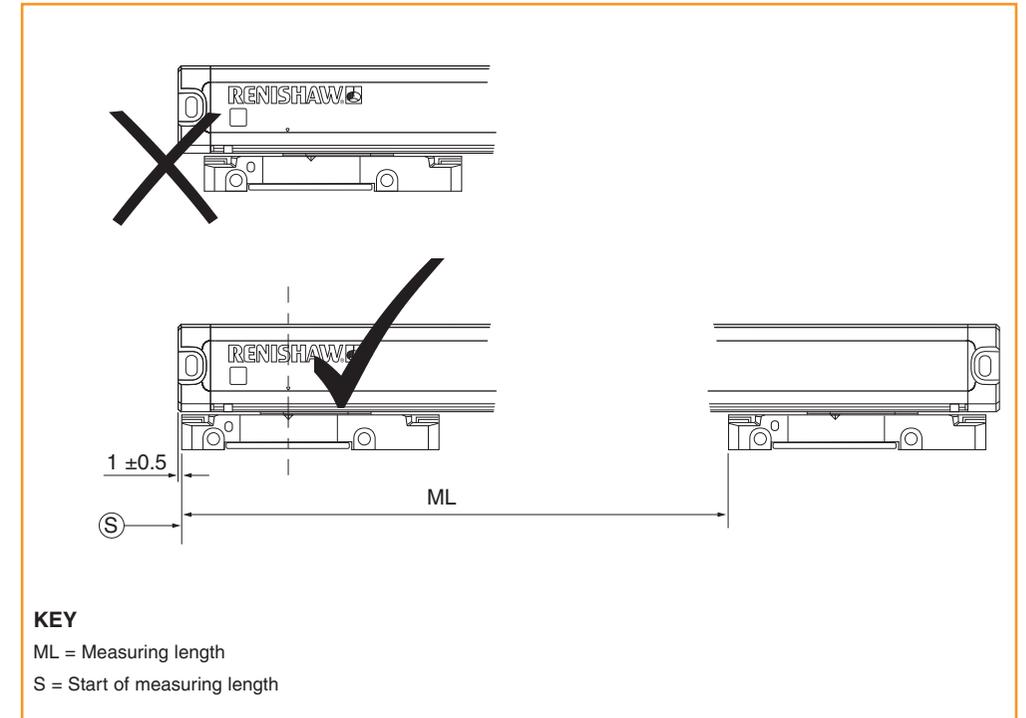
Please note, installation of the extrusion follows the procedure outlined in [section 7 on page 12](#) and is independent of the readhead installation method being used.

### 8.1 Start of measuring length – standard

The start of the measuring length (ML) is indicated by the triangular marking on the extrusion; a corresponding arrow on the readhead should be aligned to this arrow to ensure the readhead is within the encoder measuring length.



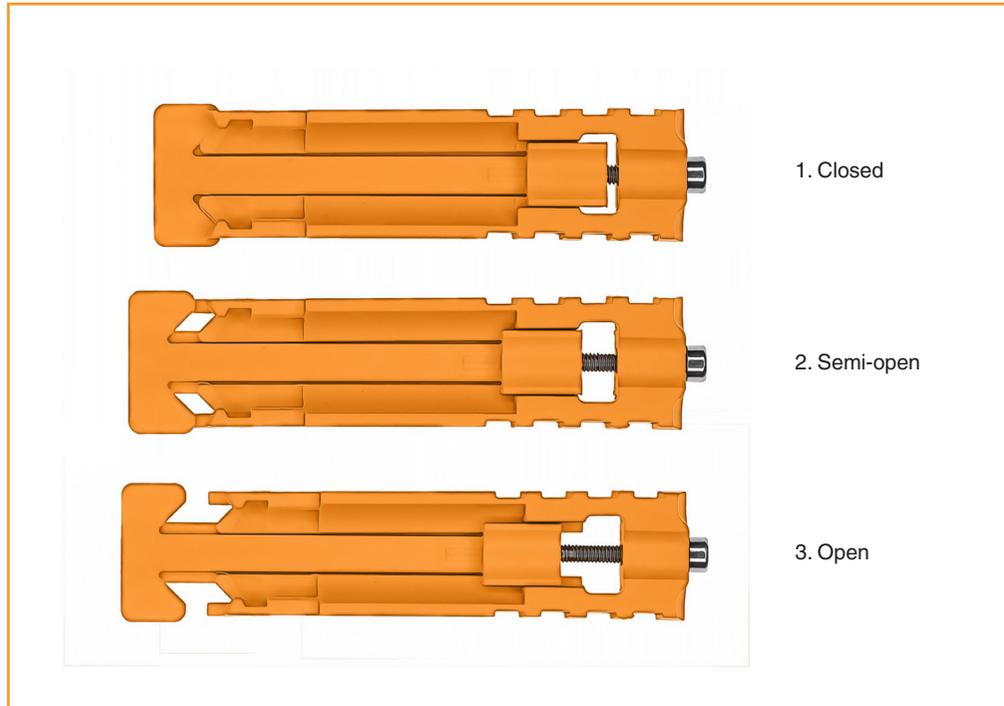
### 8.2 Start of measuring length – short end caps



**WARNING:** Failure to ensure the readhead is within the measuring length of the encoder could lead to a collision and damage.

### 8.3 Alignment bracket method

Pre-fitted alignment brackets help protect and secure the readhead to the extrusion during transit. These alignment brackets can also be used to set the readhead at the nominal installation rideheight and remain in place during installation.

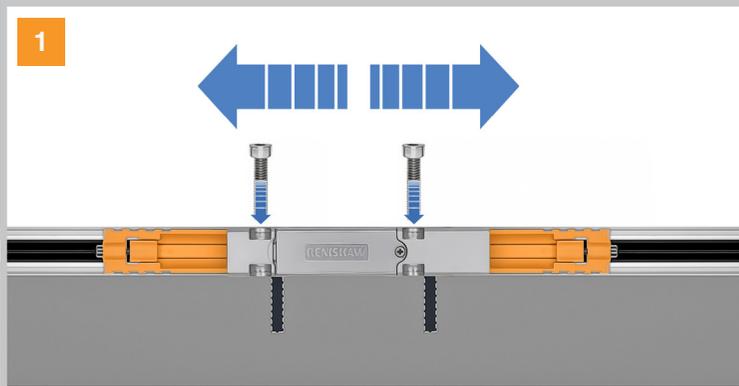


The alignment bracket can be loosened to allow position adjustment of the readhead (whilst maintaining the correct rideheight) by loosening the M2.5 screw at the end of the bracket. The alignment brackets must be fully removed following installation.

**NOTE:** This method cannot be used if an armoured cable is fitted, due to space restrictions.

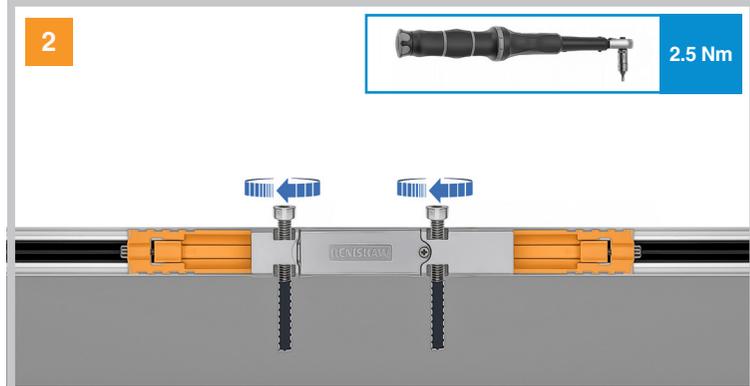
### 8.3.1 Installation using the alignment bracket method

**1**



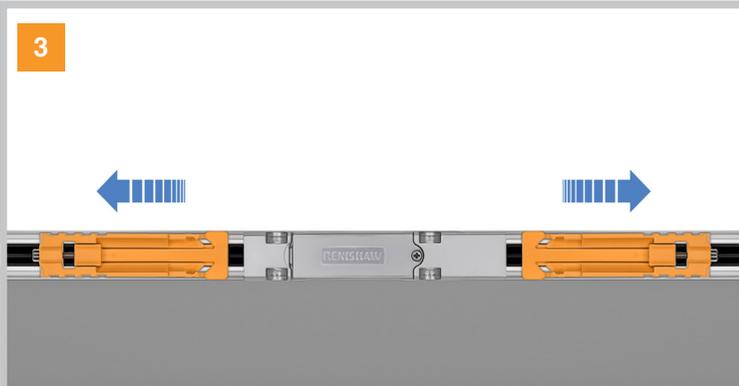
Align the readhead mounting holes to the machine slideway mounting holes. Loosen the transit brackets enough to be able to move the readhead up and down the extrusion. Align the readhead mounting holes to the machine slideway mounting holes.

**2**



Secure the readhead to the machine slideway with the two supplied serrated washers and M4 screws placed in the end cap mounting holes. Tighten the screws to a torque of 2.5 Nm.

**3**



Remove the alignment brackets from the readhead and lift off the extrusion.

**4**

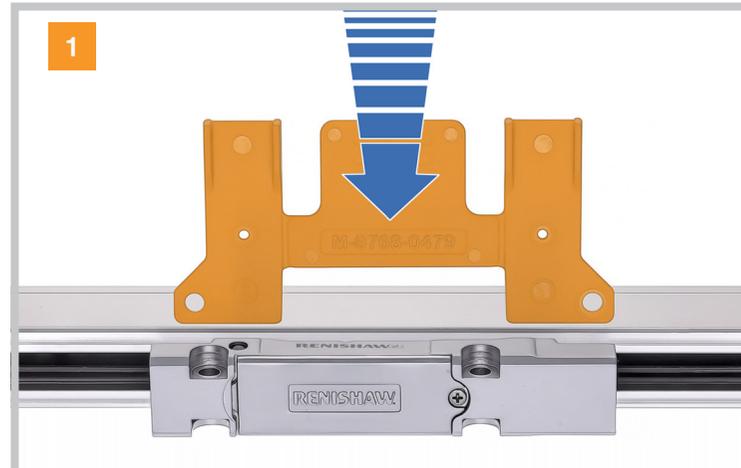


**NOTE:** The alignment brackets must be removed after installation.

## 8.4 Set-up shim method

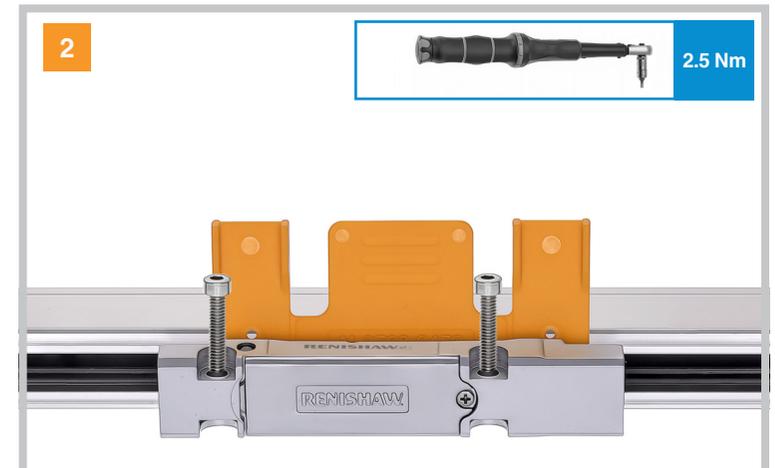
When using this method, remove the alignment brackets (see section 8.3 on page 18) just prior to installation. Where access to the readhead from either side is restricted in the installation position, a set-up shim can be used instead of the alignment brackets to ensure correct positioning of the readhead relative to the extrusion. This shim is easily inserted between the readhead and encoder extrusion.

### 8.4.1 Front setting shim procedure



Place set-up shim between the readhead and the extrusion.

Push the readhead lightly against the shim to set rideheight and align the readhead mounting holes.

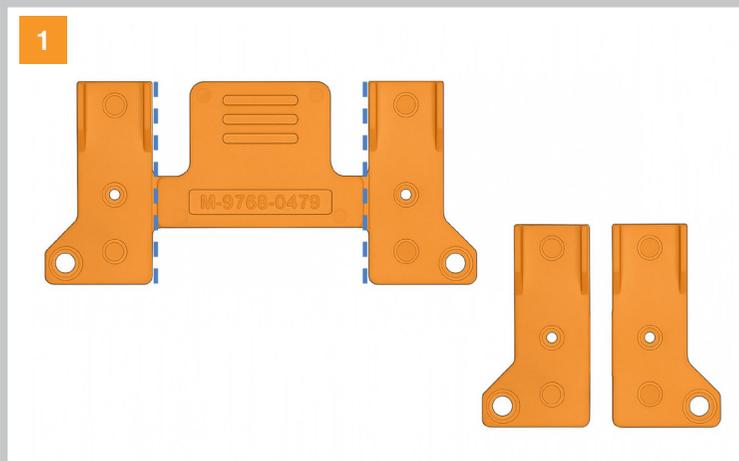


Whilst maintaining light pressure on the readhead, secure the readhead with 2 × M4 screws. Tighten the screws to 2.5 Nm to complete the installation.

Remove the setting shim.

## 8.4.2 Side setting shim procedure

1

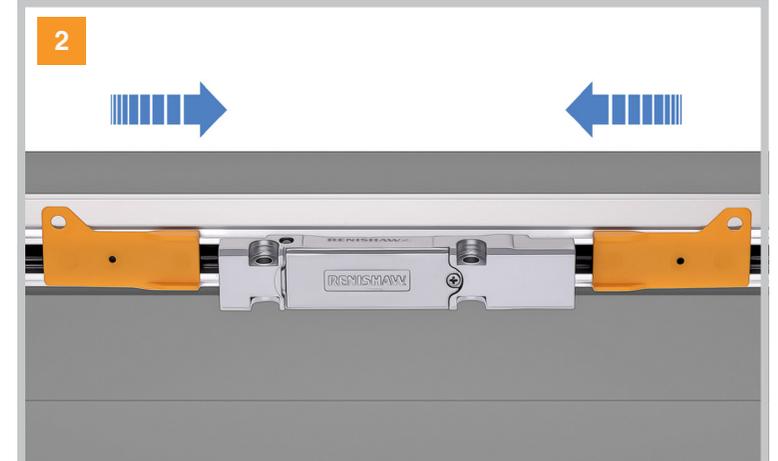


M-9768-0479

Snap shim to detach the two end section parts as shown above.

This diagram shows an orange plastic shim with a central section and two end sections. The central section has a textured surface and the part number 'M-9768-0479' embossed on it. The end sections are L-shaped with two circular holes each. The shim is shown being snapped apart, with the two end sections separated from the central section.

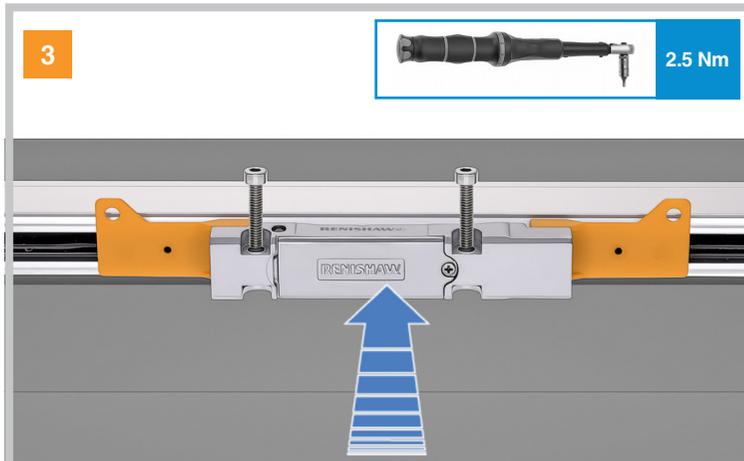
2



Place a section of the separated shim parts at either side of the readhead.

This diagram shows a readhead assembly with two orange shim sections placed on either side. Blue arrows indicate the direction of placement. The readhead is a silver metal component with a central lens and two screws. The shim sections are L-shaped with two circular holes each.

3



2.5 Nm

Whilst maintaining light pressure on the readhead, secure the readhead with 2 x M4 screws, tighten the screws to 2.5 Nm to complete installation. Remove the setting shim parts.

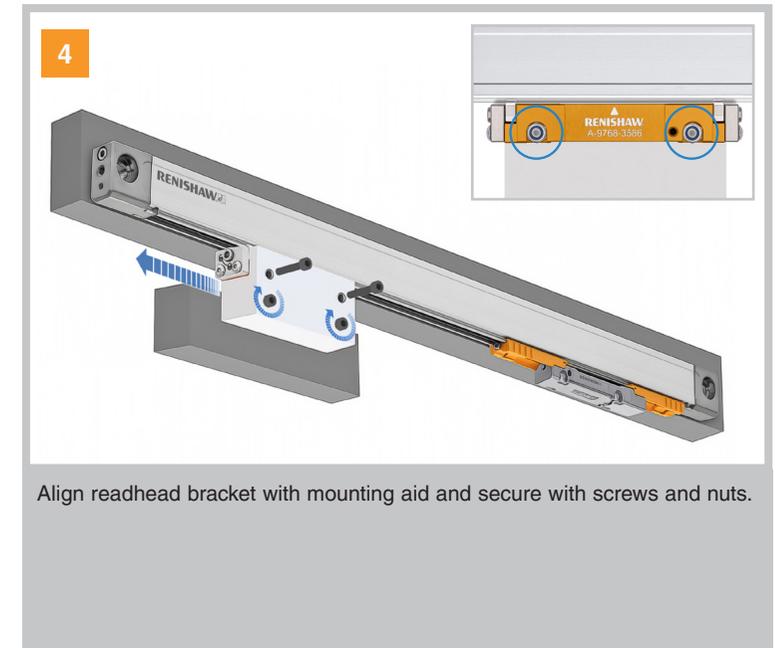
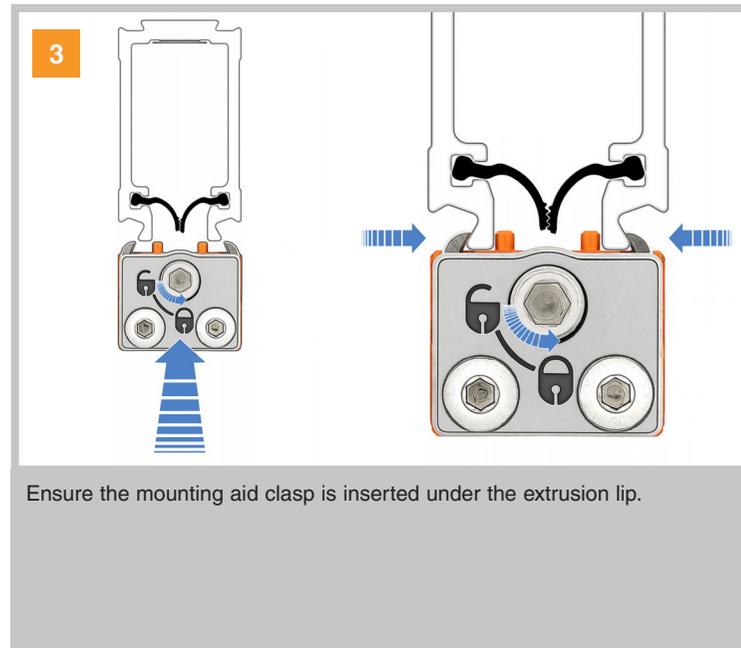
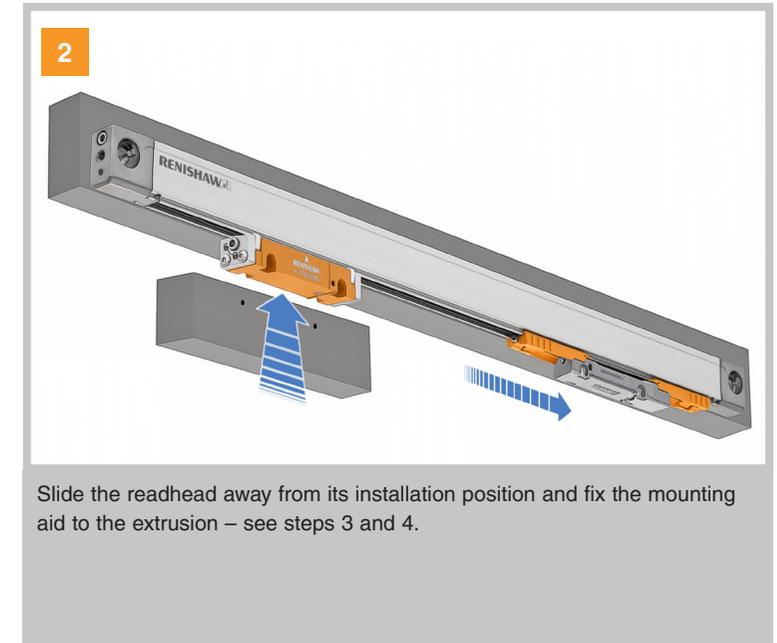
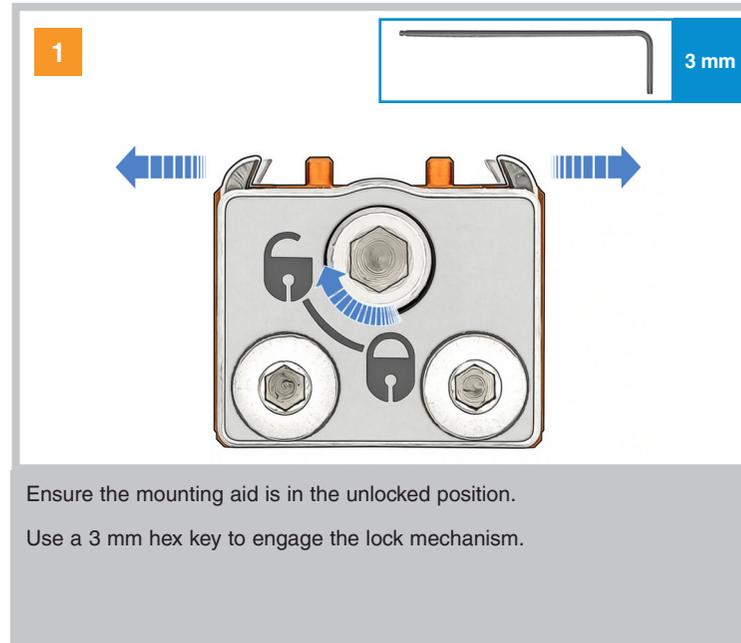
This diagram shows the readhead assembly with two M4 screws being tightened. A blue arrow points to the screws. An inset image shows a torque wrench with the value '2.5 Nm' displayed. The readhead is a silver metal component with a central lens and two screws. The shim sections are L-shaped with two circular holes each.

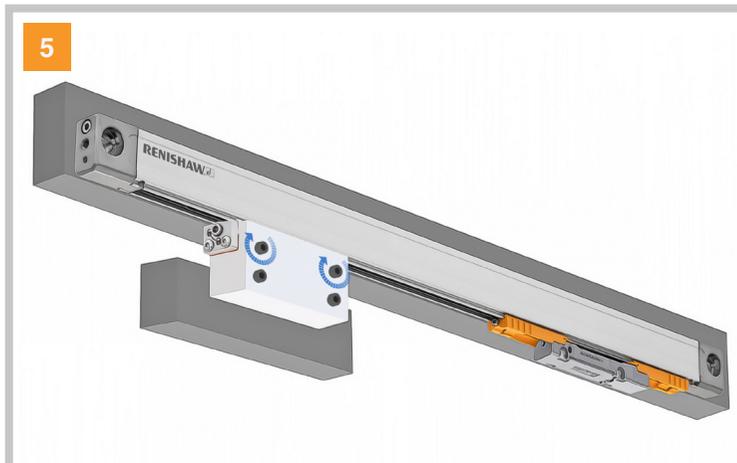
## 8.5 Installation using the mounting aid method

Remove alignment brackets prior to installation using the setting shim.

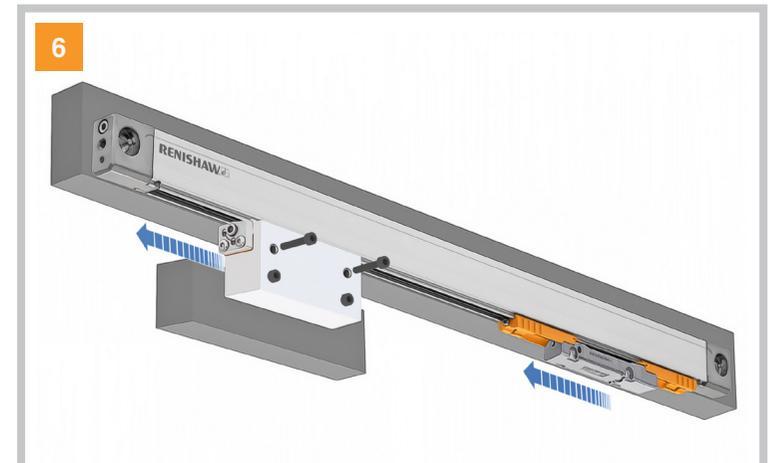
When mounting a readhead to a machine slideway via an unconstrained bracket, an installation mounting aid can be used to accurately position, secure and fit the bracket to the slideway. The mounting aid clamps securely to the extrusion, allowing any machine slideway to be adjusted and secured horizontally in the correct location before readhead mounting.

**18 mm mounting aid and 3 mm hex key required.**

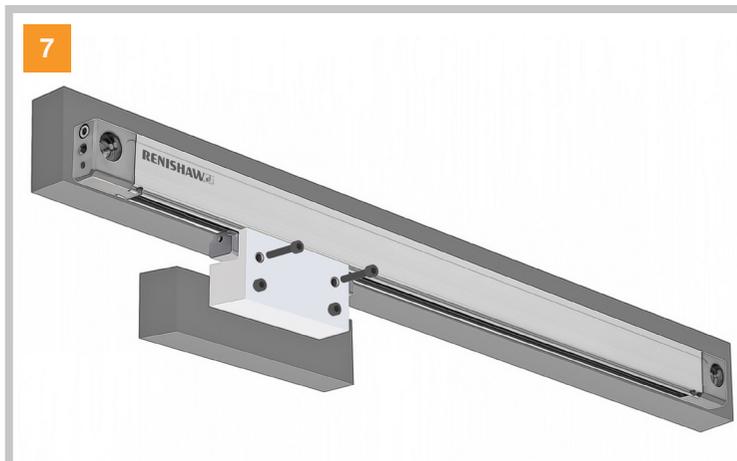




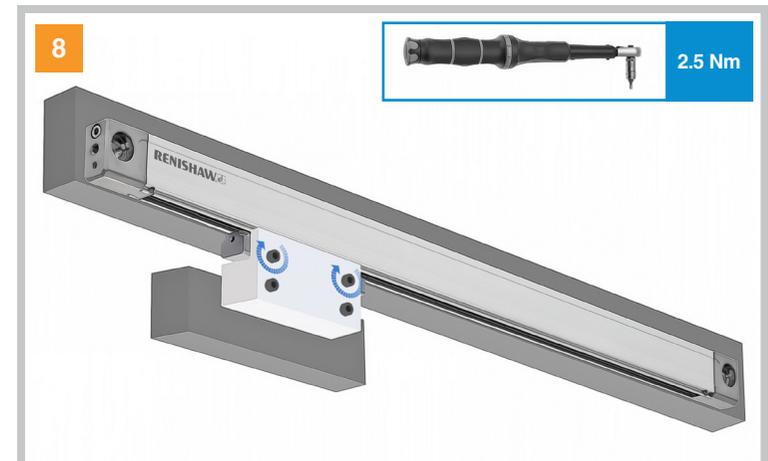
Align the axis slideway with readhead bracket and secure using M4 screws.



Remove the screws and nuts from the mounting aid, unlock and remove from the extrusion.



Align the readhead with the readhead mounting bracket and secure with M4 screws and nuts.



Using the correct tool, tighten the screws to a torque of 2.5 Nm.

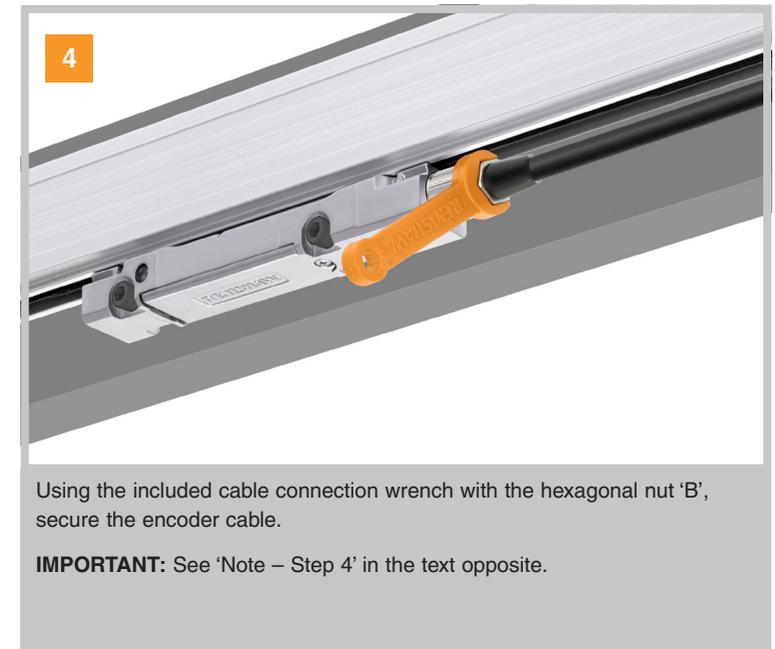
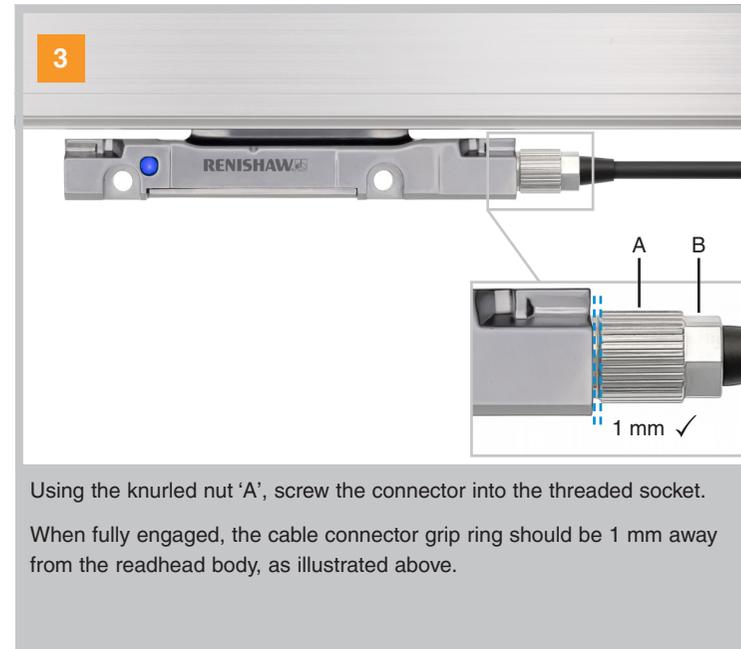
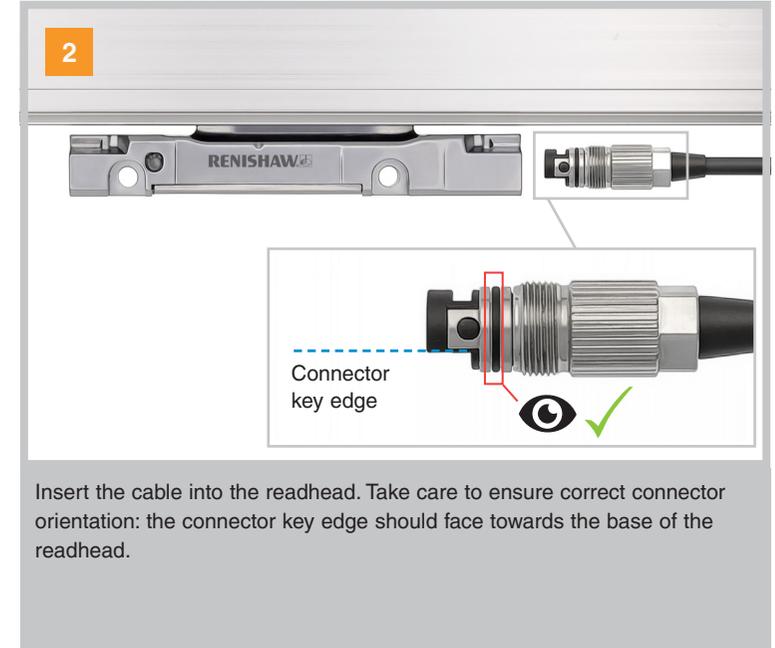
## 8.6 FORTiS cable connection

To assist with cable management the FORTiS-N system has a cable entry port, allowing the cable to be inserted into the side of the readhead.

The default cable port output direction is as per the installation drawing in [section 5.5 on page 9](#). If an alternative cable output port direction is needed please contact your local Renishaw representative.

### NOTE – STEP 4

Once the connector is engaged as shown, apply a further torque by hand on the knurled nut 'A' to ensure there is an adequate ground connection. The measured resistance of the ground connection (between the readhead body and the shield connection at the controller end of the cable assembly) must be less than 1 ohm.

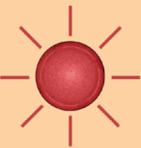


## 8.7 Validating an installation

To validate the encoder installation the set-up LED provides instant verification of the encoder's signal strength and therefore its accurate alignment and installation.

The encoder requires power to enable the set-up LED; this can be via an appropriate cable plugged into the machine's controller. See [section 9 on page 27](#) for encoder power supply requirements.

**NOTE:** If the set-up LED is obscured then the signal strength can be obtained using the Advanced Diagnostic Tool for absolute encoders (ADTa-100).

| LED status   | Description                      | Required action   |
|--|----------------------------------|---|
|  BLUE         | Signal level is optimal          | No adjustment required  |
|  GREEN        | Signal level is good             | No adjustment required  |
|  ORANGE       | Signal level is acceptable       | Ensure the extrusion is parallel to the machine axis of motion ( <a href="#">see section 5 on page 7</a> ) and adjust the readhead to maximise the signal strength along the full axis of travel to achieve a Green or Blue LED |
|  RED          | Signal level is NOT acceptable   |   |
|  FLASHING RED | Unable to determine the position | Readhead not picking up the scale due to contamination or poor installation<br><br><b>NOTE:</b> Flashing LED indicates scale reading error. Flashing state is latched for some serial protocols. Remove power to reset.         |

## 8.8 Air filtration

FORTiS encoders can be operated with an additional compressed air supply to increase the level of ingress protection from IP53 to IP64. If using air purge the air supply must meet pressure and cleanliness criteria as shown in the table below at the supply input of the encoder.

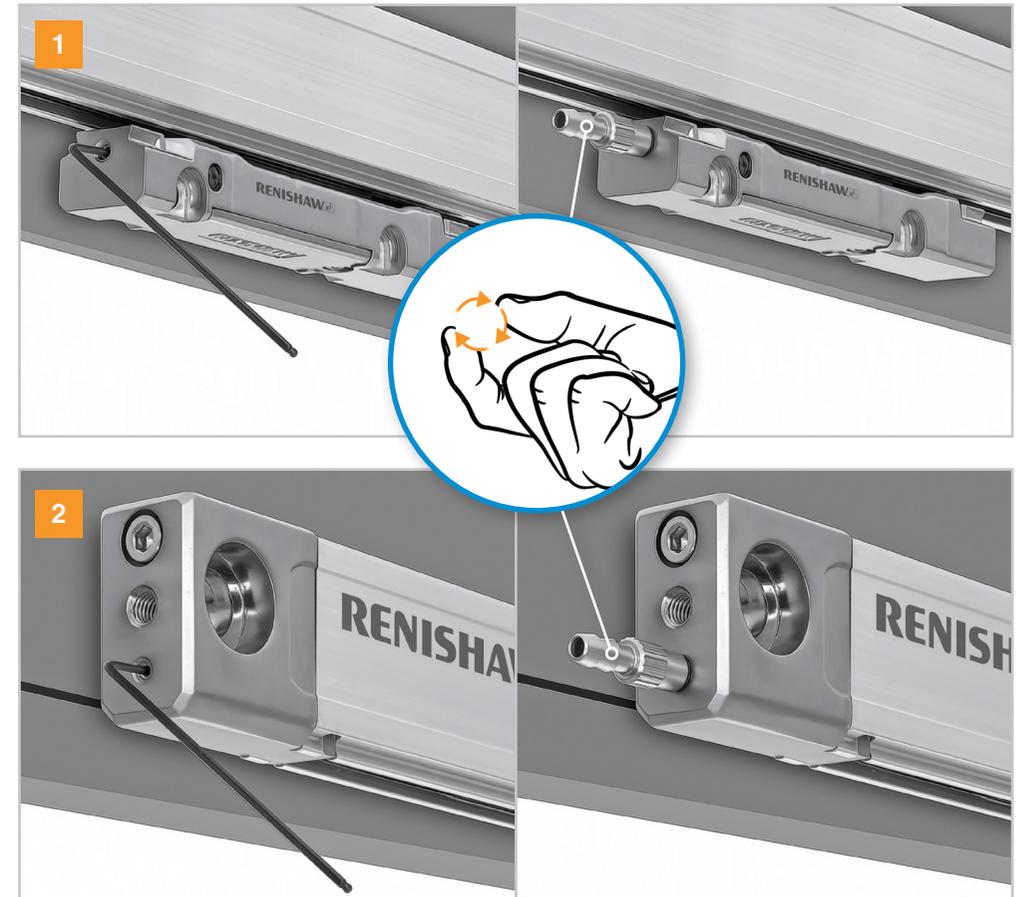
| Air supply cleanliness requirements |   |                                     |
|-------------------------------------|---|-------------------------------------|
| <b>Air supply pressure</b>          | 1 bar (pressure at encoder air inlet; air inlet connector has an integrated throttle that ensures the correct volume of airflow of 2 l/min through the encoder) |                                     |
| <b>Air quality</b>                  | Particle size   | No. of particles per m <sup>3</sup> |
|                                     | 0.1 µm to 0.5 µm  | ≤ 20 000                            |
|                                     | 0.5 µm to 1.0 µm  | ≤ 400                               |
|                                     | 1.0 µm to 5.0 µm  | ≤ 10                                |
| <b>Max pressure dew point</b>       | ISO 8573-1 Class 4 (pressure dew point at 3 °C)   |                                     |
| <b>Total oil content</b>            | ISO 8573-1 Class 1 (max. oil concentration: 0.01 mg/m <sup>3</sup> )  |                                     |

It may be convenient to connect the air purge supply to the system part that will be fixed, i.e. depending on the machine configuration and axis movement, either the extrusion or the readhead may move with the machine slideway.

Air inlets are included on one side of the readhead and on both the extrusion end caps. Use a suitable air supply hose with a 4 mm bore.

**WARNING:** Remove the blanking plug only from the position at which the purge air supply is to be connected, or the sealing integrity may be compromised.

Removal of the air supply bung and fitment of the air connection fitting into either the readhead (top) or extrusion end cap (bottom). Finger tighten (0.3 Nm maximum).



## 9 Electrical connections

### 9.1 Electrical preparation

It is necessary to power the FORTiS readhead to install the system correctly.

- Input voltage requirement at readhead carriage: 5 Vdc  $\pm$ 10%.
- Operating current: 250 mA.
- Operating power @5 V: 1.25 W.

System must be earthed as per the image opposite.

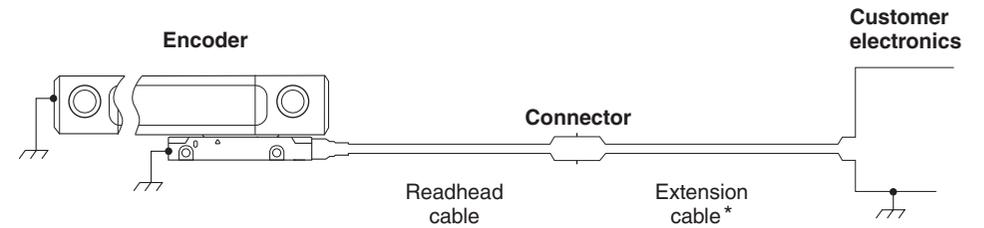
### 9.2 FORTiS grounding and shielding

**NOTE:** On Siemens DRIVE-CLiQ systems, the connector between the readhead cable and extension cable will mate via the A-9796-0575 interface.

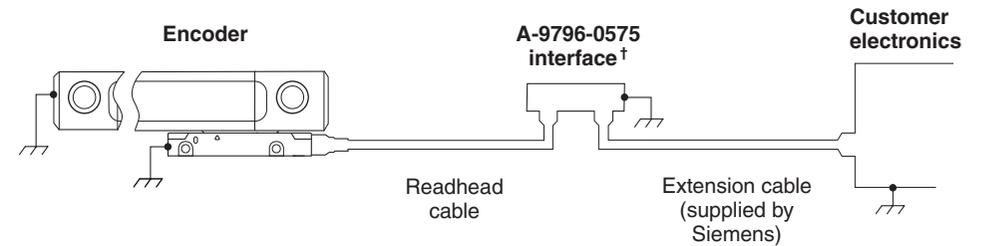
**IMPORTANT:** The shield should be connected to the machine Earth (Field Ground).

**IMPORTANT:** If the flying lead variant is used or the connector is modified or replaced, the customer must ensure that both 0 V cores (White and Green) are connected to 0 V. In such situations, care should also be taken to ensure that 0 V and Earth remain properly insulated from each other throughout the cable run.

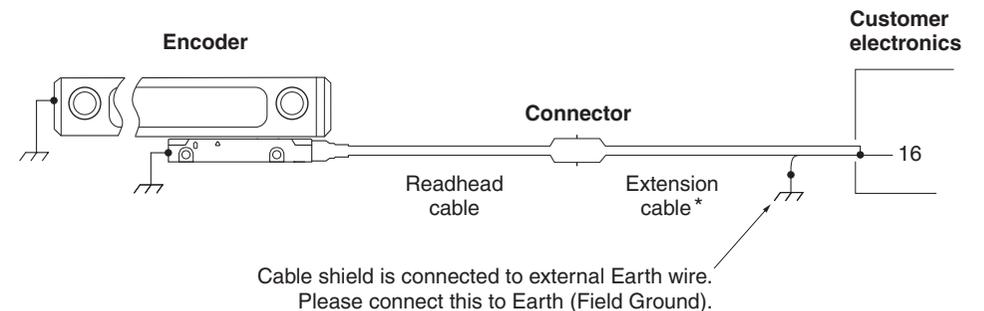
#### 1) Standard arrangement



#### 2) Arrangement for Siemens DRIVE-CLiQ versions



#### 3) Arrangement when 20-way Honda connector (plastic body) is used with FANUC



\*For maximum extension cable length please consult your local Renishaw representative.

†See [page 32](#) for details.

# 10 Cables and protocols

## 10.1 General specifications

|  |        |  |
|--|--------|--|
| <b>Readhead cable</b>                  | Type A | Ø4.7 mm, 28 AWG, 7 core, single screen, black jacket<br>Flex life > 20 × 10 <sup>6</sup> cycles at 20 mm bend radius<br>Minimum static bend radius (internal radius): 15 mm  |
|  | Type B | OD: 6.3 mm, 23 AWG, 6 core (3 × twisted pairs), single screen, green jacket<br>Flex life > 20 × 10 <sup>6</sup> cycles at 75 mm bend radius<br>Minimum static bend radius (internal radius): 31.5 mm                       |
|  | Type D | Armoured: OD 10 mm, 28 AWG, 7 core<br>Flex life > 20 × 10 <sup>6</sup> cycles at 100 mm bend radius<br>Minimum static bend radius (internal radius): 35 mm   |
| <b>Extension cable (if applicable)</b> | Type B | OD: 6.3 mm, 23 AWG, 6 core (3 × twisted pairs), single screen, green jacket<br>Flex life > 20 × 10 <sup>6</sup> cycles at 75 mm bend radius<br>Minimum static bend radius (internal radius): 31.5 mm                       |
|  | Type C | OD: 7.8 mm, 20 AWG (power), 8 core (3 × twisted pairs + 2 power sense), single screen, green jacket<br>Flex life > 20 × 10 <sup>6</sup> cycles at 75 mm bend radius<br>Minimum static bend radius (internal radius): 58 mm |

**CAUTION:** The FORTiS encoder system has been designed to the relevant EMC standards, but must be correctly integrated to achieve EMC compliance. In particular, attention to shielding arrangements is essential.

## 10.2 Permissible cable lengths

The tables below show permissible cable and extension cable combinations for the FORTiS range of enclosed linear encoders. For longer extension cable lengths, a shorter readhead cable is required. This information is valid for all communication protocols and connector types. At the worst case the minimum acceptable supply voltage is 4.5 Vdc.

### Type B extension cables

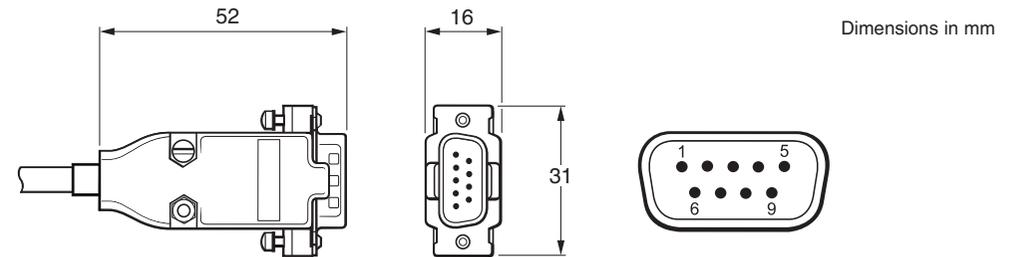
|                           |                   | Extension cable length (m) |   |   |   |    |    |    |   |
|---------------------------|-------------------|----------------------------|---|---|---|----|----|----|---|
|                           |                   | 1                          | 3 | 6 | 9 | 12 | 15 | 20 |   |
| Readhead cable length (m) | Type A            | 0.5                        | ✓ | ✓ | ✓ | ✓  | ✓  | ✓  | ✓ |
|                           |                   | 1                          | ✓ | ✓ | ✓ | ✓  | ✓  | ✓  | ✓ |
|                           |                   | 3                          | ✓ | ✓ | ✓ | ✓  | ✓  | ✓  | ✓ |
|                           |                   | 6                          | ✓ | ✓ | ✓ | ✓  | ✗  | ✗  | ✗ |
|                           |                   | 9                          | ✓ | ✓ | ✗ | ✗  | ✗  | ✗  | ✗ |
|                           | Type B            | 0.5                        | ✓ | ✓ | ✓ | ✓  | ✓  | ✓  | ✓ |
|                           |                   | 1                          | ✓ | ✓ | ✓ | ✓  | ✓  | ✓  | ✓ |
|                           |                   | 3                          | ✓ | ✓ | ✓ | ✓  | ✓  | ✓  | ✓ |
|                           |                   | 6                          | ✓ | ✓ | ✓ | ✓  | ✓  | ✓  | ✓ |
|                           |                   | 9                          | ✓ | ✓ | ✓ | ✓  | ✓  | ✓  | ✗ |
|                           | Type C (armoured) | 1                          | ✓ | ✓ | ✓ | ✓  | ✓  | ✓  | ✓ |
|                           |                   | 3                          | ✓ | ✓ | ✓ | ✓  | ✓  | ✓  | ✓ |
| 6                         |                   | ✓                          | ✓ | ✓ | ✓ | ✗  | ✗  | ✗  |   |
| 9                         |                   | ✓                          | ✓ | ✗ | ✗ | ✗  | ✗  | ✗  |   |

## Type C extension cables

|                           |        | Extension cable length (m) |      |
|---------------------------|--------|----------------------------|------|
| Readhead cable length (m) | Type A | 0.5                        | ≤ 65 |
|                           |        | 1                          | ≤ 62 |
|                           |        | 3                          | ≤ 50 |
|                           |        | 6                          | ≤ 30 |
|                           |        | 9                          | ≤ 12 |
|                           | Type B | 0.5                        | ≤ 67 |
|                           |        | 1                          | ≤ 65 |
|                           |        | 3                          | ≤ 62 |
|                           |        | 6                          | ≤ 56 |
|                           |        | 9                          | ≤ 50 |

## 10.3 BiSS C serial communications

### 9-way D-type

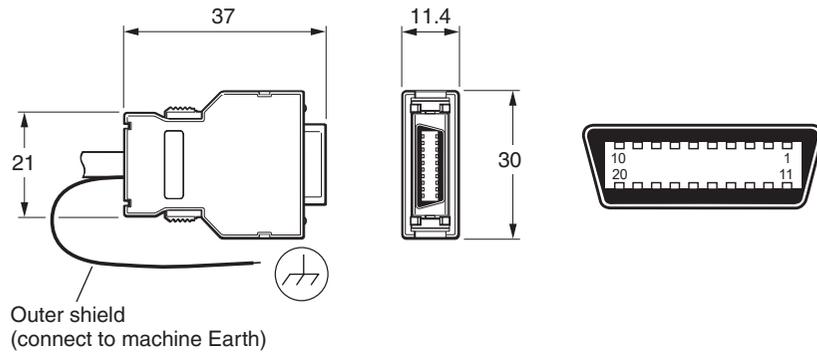


### BiSS C (unidirectional) output signals

| Function              | Signal | Wire colour | Pin-out 9-way D |
|-----------------------|--------|-------------|-----------------|
| Power                 | 5 V    | Brown       | 4, 5            |
|                       | 0 V    | White       | 8, 9            |
| Serial communications | MA+    | Violet      | 2               |
|                       | MA-    | Yellow      | 3               |
|                       | SLO+   | Grey        | 6               |
|                       | SLO-   | Pink        | 7               |
| Shield                | Shield | Cable braid | Case            |

## 10.4 FANUC serial communications

### 20-way plug



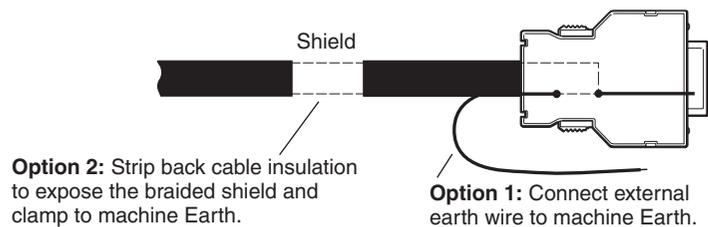
### FANUC output signals

| Function              | Signal  |                | Wire colour | Pin-out 20-way |
|-----------------------|---------|----------------|-------------|----------------|
|                       | FANUC α | FANUC αi       |             |                |
| Power                 | 5 V     | 5 V            | Brown       | 9, 20          |
|                       | 0 V     | 0 V            | White       | 12, 14         |
| Serial communications | REQ+    | REQ+ / SD+     | Violet      | 5              |
|                       | REQ-    | REQ- / SD-     | Yellow      | 6              |
|                       | SD+     | Do not connect | Grey        | 1              |
|                       | SD-     |                | Pink        | 2              |
| Shield                | Shield  | Shield         | Cable braid | External       |

### Connecting the cable screen

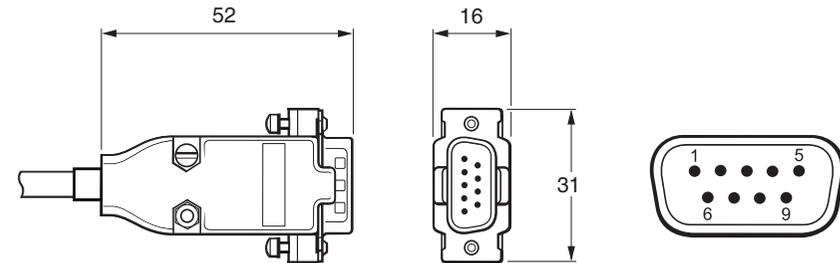
⚠ The following arrangement should be applied to FANUC versions only.

The cable is supplied with the shield connected to pin 16 inside the connector, making the required connection to the FANUC equipment. The Shield must also be connected to machine Earth, either by using the external Earth wire provided, or by cutting back the cable insulation to expose the shield and clamping that to machine Earth.

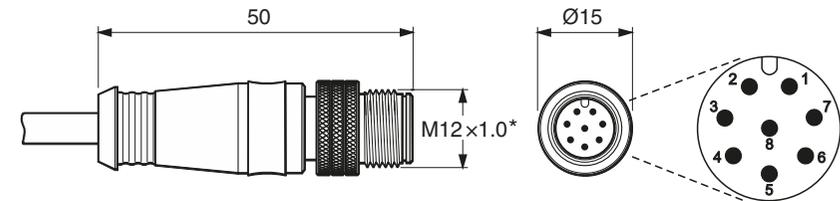


## 10.5 Panasonic serial communications

### 9-way D-type



### M12



\*The recommended tightening torque is 4 Nm.

### Panasonic

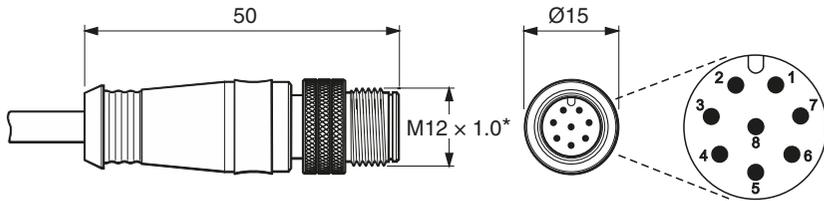
| Function              | Signal         | Wire colour | Pin-out 9-way D | Pin-out M12 |
|-----------------------|----------------|-------------|-----------------|-------------|
| Power                 | 5 V            | Brown       | 4, 5            | 2           |
|                       | 0 V            | White       | 8, 9            | 5, 8        |
| Serial communications | REQ+ / SD+     | Violet      | 2               | 3           |
|                       | REQ- / SD-     | Yellow      | 3               | 4           |
| Reserved              | Do not connect | Grey        | 6               | 7           |
|                       |                | Pink        | 7               | 6           |
| Shield                | Shield         | Cable braid | Case            | Case        |

## 10.6 Siemens DRIVE-CLiQ serial communications

### Siemens DRIVE-CLiQ specifications

|                                    |   |  |
|------------------------------------|---|--|
| <b>Power supply</b>                | 24 V  | 1.8 W maximum (75 mA @ 24 V), 24 V as per DRIVE-CLiQ specification. 24 V power is provided by the DRIVE-CLiQ network<br><b>NOTE:</b> The Renishaw DRIVE-CLiQ interface must be powered from a 24 Vdc supply complying with the requirements for SELV of standard IEC 60950-1 |
|                                    | Ripple  | 200 mVpp maximum @ frequency up to 500 kHz   |
| <b>Maximum total cable length</b>  | Readhead to DRIVE-CLiQ interface 9 m<br>(Refer to Siemens DRIVE-CLiQ specifications for maximum cable length from interface to controller)<br>Extension cables from the FORTiS DRIVE-CLiQ interface to controller should be sourced directly from Siemens |  |
| <b>Connector tightening torque</b> | M12 – 4 Nm  |  |

M12



\*The recommended tightening torque is 4 Nm.

### Siemens DRIVE-CLiQ signals between readhead and interface

| Function                     | Signal         | Wire colour | Pin-out M12 |
|------------------------------|----------------|-------------|-------------|
| <b>Power</b>                 | 5 V            | Brown       | 2           |
|                              | 0 V            | White       | 5, 8        |
| <b>Serial communications</b> | A+             | Violet      | 3           |
|                              | A-             | Yellow      | 4           |
| <b>Reserved</b>              | Do not connect | Grey        | 7           |
|                              |                | Pink        | 6           |
| <b>Shield</b>                | Shield         | Cable braid | Case        |

## 10.7 Siemens DRIVE-CLiQ interface

### RDY LED functions

| Colour                            | Status           | Description  |
|-----------------------------------|------------------|--|
| -                                 | Off              | Power supply is missing or outside permissible tolerance range   |
| <b>Green</b>                      | Continuous light | The component is ready for operation and cyclic DRIVE-CLiQ communication is taking place   |
| <b>Orange</b>                     | Continuous light | DRIVE-CLiQ communication is being established  |
| <b>Red</b>                        | Continuous light | At least one fault is present in this component<br><b>NOTE:</b> The LED is activated regardless of whether the corresponding messages have been reconfigured |
| <b>Green/Orange or Red/Orange</b> | Flashing light   | Component recognition via LED is activated (p0144)<br><b>NOTE:</b> Both options depend on the LED status when component recognition is activated via p0144=1 |

### Status LED function

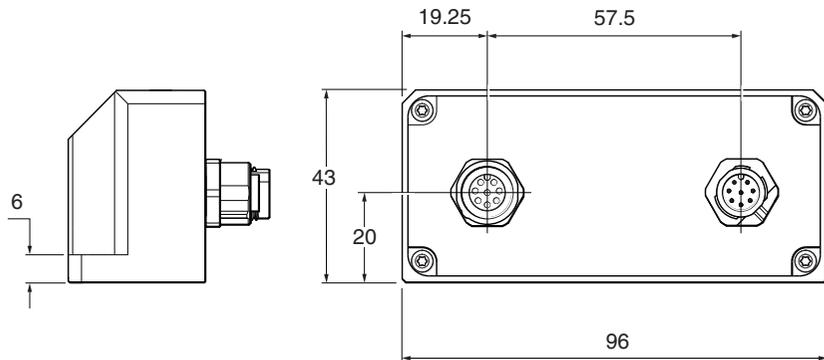
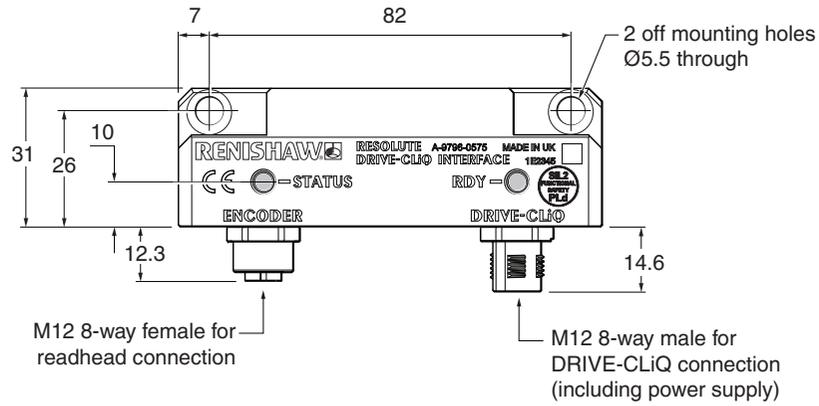
STATUS displays the readhead set-up status as shown on the readhead set-up LED; see [section 8.7 on page 25](#) for more details.

### Siemens DRIVE-CLiQ interface output

| Function                         | Signal | Pin-out M12 |
|----------------------------------|--------|-------------|
| <b>Power</b>                     | 24 V   | 1           |
|                                  | 0 V    | 5           |
| <b>DRIVE-CLiQ communications</b> | RX+    | 3           |
|                                  | RX-    | 4           |
|                                  | TX+    | 7           |
|                                  | TX-    | 6           |
| <b>Shield</b>                    | Shield | Case        |

## Siemens DRIVE-CLiQ interface installation drawing

### Single readhead (A-9796-0575)



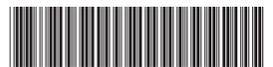
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M - 9768 - 9887 - 02

Part no.: M-9768-9887-02-B  
Issued: 02.2021