

# FORTiS-N™ enclosed encoder system



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# 1 Legal notices

## 1.1 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		

## 1.2 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.

## 1.3 Declaration of Conformity

Renishaw plc hereby declares that the FORTiS-N™ 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](http://www.renishaw.com/productcompliance)

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

### FCC Compliance Statement

#### 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 their 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

**Unique Identifier:** FORTiS-N

**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](mailto: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).

### 1.5 Intended use

The FORTiS encoder system is designed for metrology in industrial environments, such as machine tools. It must be installed, operated, and maintained as specified in Renishaw documentation and in accordance to the Standard Terms and Conditions of the Warranty and all other relevant legal requirements.

### 1.6 Warnings

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

## 1.7 Packaging

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

Packaging components			
Packaging component	Material	ISO 11469	Recycling guidance
Wooden box	Plywood and softwood	Not applicable	Recyclable
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
	Metallised polyethylene	PE	Recyclable

## 1.8 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)

## 1.9 Disposal of waste electrical and electronic equipment



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, contact your local waste disposal service or Renishaw distributor.

## 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.

### 2.1 Commissioning test

Relevant commissioning tests should be carried out in accordance with the installer/user's normal procedure.

The following test **MUST** be performed when commissioning the FORTiS-N encoder system and after any repair or maintenance of the system.

**Resolution check:** Move the axis by a known distance and confirm that the position changes as expected.

### 2.2 Maintenance

The maintenance check intervals will be defined by the system manufacturer according to their risk assessment. There are no user-serviceable parts within the FORTiS-N encoder system.

The following maintenance actions are advised:

- Check the extrusion screws and readhead retaining screws are correctly tightened.
- Check for worn or damaged cables and connectors.
- Check the cable connectors are correctly tightened/located.
- Check the air supply fitting is correctly tightened and the air hose is correctly fitted.
- When the DRIVE-CLiQ interface is used check the retaining screws are correctly tightened.

### 2.3 Repair

- Repair of the FORTiS-N encoder system is only by replacement of parts.
- The replacement parts must have the same part number as the original parts.
- The repaired encoder system must be installed and commissioned in accordance with the "Commissioning test" above.
- In the event of failure the affected parts should be returned to Renishaw for further analysis.
- Using damaged parts invalidates the warranty.



## 2.4 Further information

Further information relating to the FORTiS encoder range can be found in the FORTiS data sheets available from your local Renishaw representative or from our website:

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





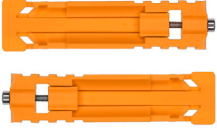



See also the data sheets *Cables for FORTiS absolute encoders* (Renishaw part no. L-9517-0069) and *BiSS C-mode (unidirectional) for RESOLUTE and FORTiS encoders* (Renishaw part no. L-9709-9005).

For further details regarding FORTiS enclosed linear encoder variants refer to the following table.









Encoder system description	Part numbers	
	Data sheet	Installation guide
<b>FORTiS-S</b>	L-9517-9934	M-9768-9857
<b>FORTiS-S enclosed encoder system with multiple readheads</b>	Refer to installation guide	M-6725-9176
<b>FORTiS-S functional safety (FS) system</b>	L-9517-9958	M-6725-9016
<b>FORTiS-S functional safety (FS) system with multiple readheads</b>	Refer to installation guide	M-6725-9188
<b>FORTiS-N</b>	L-9517-9946	M-9768-9887
<b>FORTiS-N enclosed encoder system with multiple readheads</b>	Refer to installation guide	M-6725-9200
<b>FORTiS-N functional safety (FS) system</b>	L-9517-9970	M-6725-9026
<b>FORTiS-N functional safety (FS) system with multiple readheads</b>	Refer to installation guide	M-6725-9212

### 3 Parts list

#### 3.1 Included in the box

Item		Description
	<b>FORTiS-N encoder unit</b>	The FORTiS-N 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>	Two brackets to secure the readhead during transit and set the correct readhead alignment during installation <hr/> <b>IMPORTANT:</b> Retain until 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
	<b>Siemens DRIVE-CLiQ interface</b>	Included with Siemens-only versions of FORTiS (see <a href="#">section 10.7</a> on page 45)

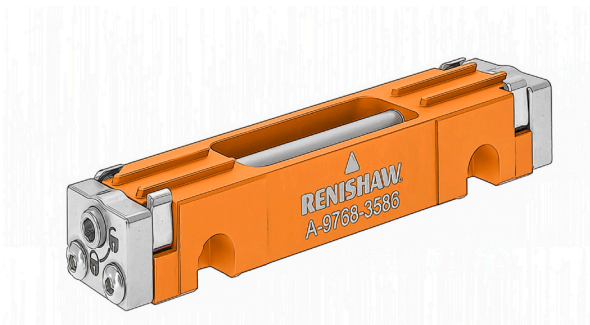
### 3.2 Not included / required tools

Item		Description
	<b>6 mm torque wrench</b>	To tighten the extrusion mounting screws
	<b>3 mm torque wrench</b>	To tighten the readhead mounting screws
	<b>1.5 mm hex key</b>	Air bung removal (only if air purge is required)
	<b>2 mm hex key</b>	To fit the mounting spar when tightening the extrusion mounting screws from the underside, if required (non-preferred method)  Alignment bracket removal
	<b>3 mm hex key</b>	For locking the mounting aid
	<b>M8 screws</b>	2 × M8 × 1.25 screws length ≥ 20 mm for mounting the extrusion
	<b>M4 screws</b>	2 × M4 × 0.7 screws length ≥ 20 mm for mounting the readhead
	<b>Loctite 243</b>	All fastenings (except air bung and cable connection) should be secured with Loctite 243
	<b>Loctite 222</b>	If an air bung requires replacement or repositioning it should be secured with Loctite 222. The cable connector should also be secured with Loctite 222.

### 3.3 Optional extras

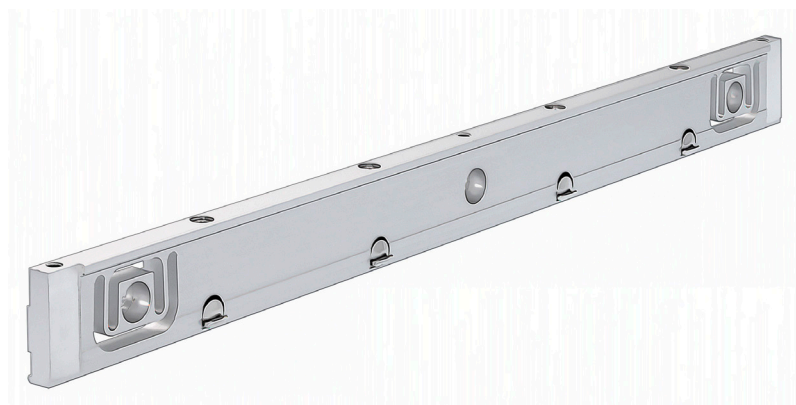
#### 3.3.1 Mounting aid (Renishaw part no. A-9768-3586)

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 31).



#### 3.3.2 Mounting spar

For measuring lengths greater than 620 mm Renishaw recommends the use of a mounting spar (see [section 8.2](#) on page 26).



#### 3.3.3 Clamping elements (Renishaw part no. A-9768-1003)

Optional clamping element. Recommended for measuring lengths greater than 620 mm when the use of a mounting spar is not possible.








#### 3.3.4 Captive nuts (Renishaw part no. A-9768-2248)

Optional fastening method for mounting the readhead to the bracket. It allows bolts to be screwed into the readhead rather than the bracket.



### 3.4 Cable options (cables not included)

Further information relating to cables for the FORTiS encoder range can be found in the data sheet *Cables for FORTiS absolute encoders* (Renishaw part no. L-9517-0069). This can be downloaded from our website [www.renishaw.com/fortisdownloads](http://www.renishaw.com/fortisdownloads) and is also available from your local Renishaw representative.

Item		Description
	<b>Encoder cable type A</b>	OD: 4.7 mm, 28 AWG, 7 core, single screen, black jacket Length options: 0.5 m, 1 m, 3 m, 6 m, 9 m
	<b>Encoder cable type B</b>	OD: 6.3 mm, 23 AWG, 6 core (3 × twisted pairs), single screen, green jacket 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 Length options: 1 m, 3 m, 6 m, 9 m
	<b>Extension cable type B</b>	OD: 6.3 mm, 23 AWG, 6 core (3 × twisted pairs), single screen, green jacket Length options: 1 m, 3 m, 6 m, 9 m, 15 m, 20 m
	<b>Extension cable type C</b>	OD: 7.8 mm, 2 × 20 AWG (power), 4 × 23 AWG (signal), 2 × 28 AWG (sense), single screen, green jacket 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

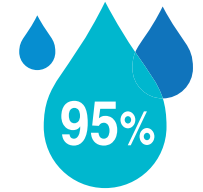


### Operating temperature

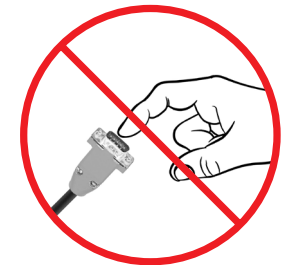
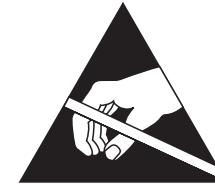
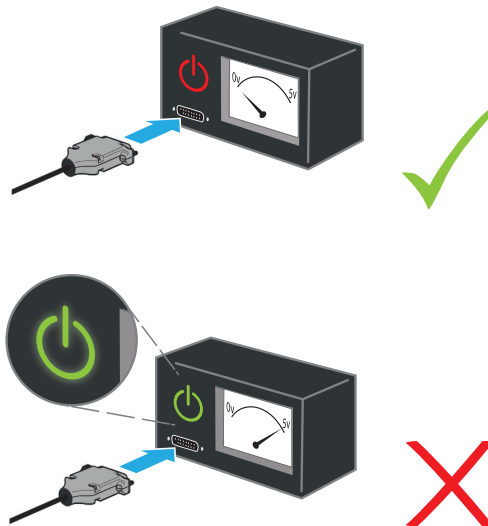
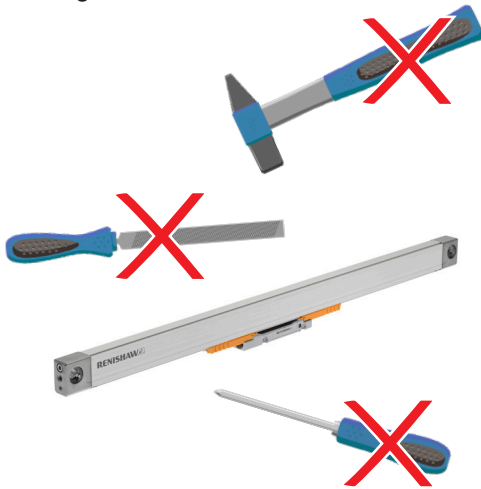
0 °C to +50 °C



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



### Handling instructions



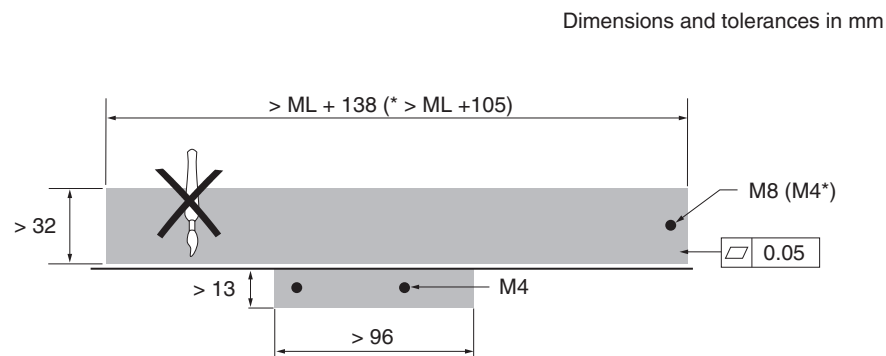
## 5 Installation drawings

### 5.1 Mounting surface preparation

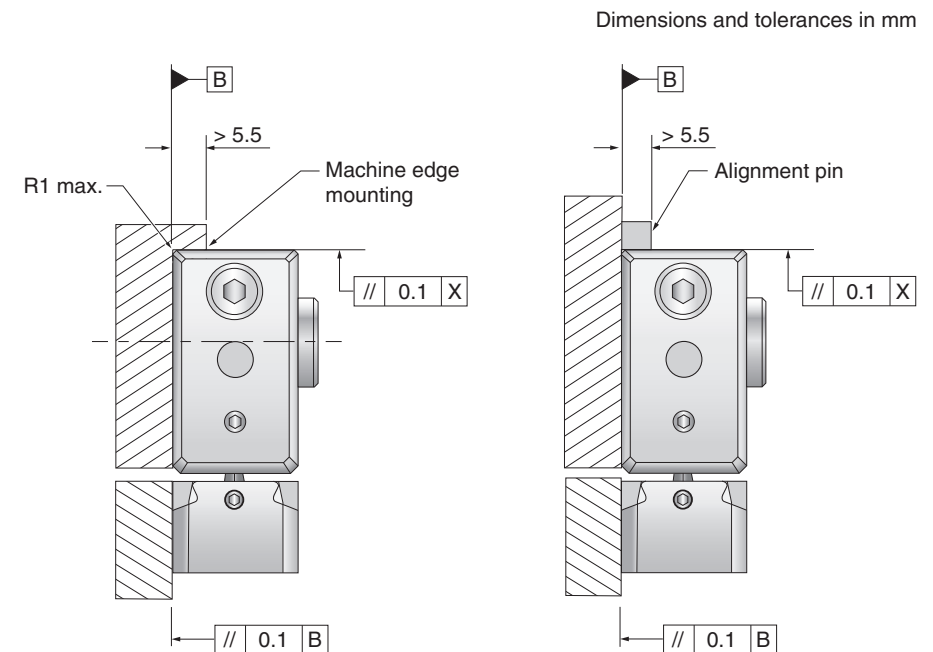
To ensure correct operation, the mounting surface should be prepared as follows:

- 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 section 5.5 on page 17).

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



#### KEY

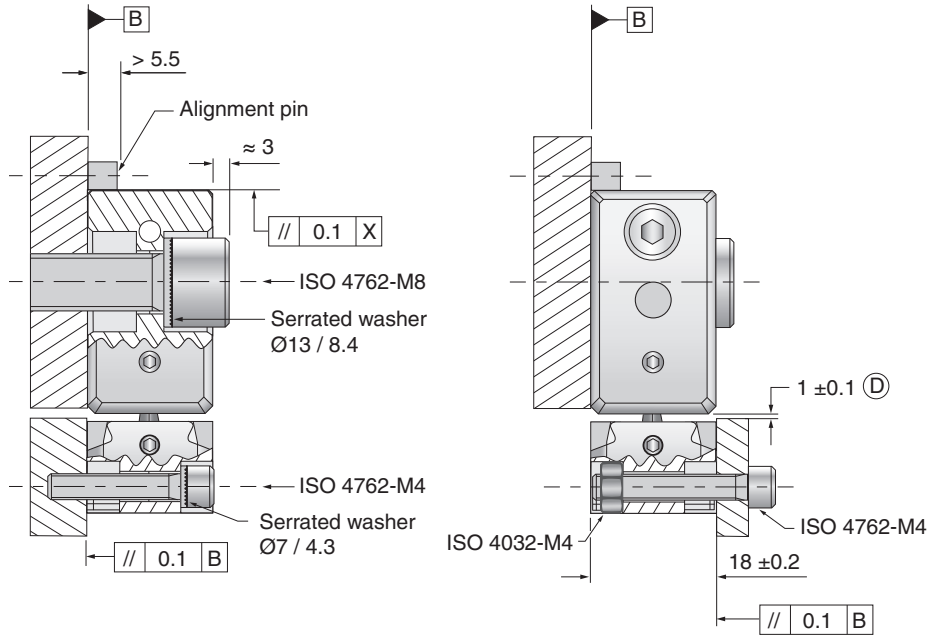
X = Machine guideway/axis datum

#### NOTES:

1. Side elevations show alternative mounting orientations.
2. Alignment pin and machine edge mounting options to mate directly to the top face of the extrusion.

### 5.3 Mounting orientations – standard end caps

Dimensions and tolerances in mm



**KEY**

D = Required mounting dimensions

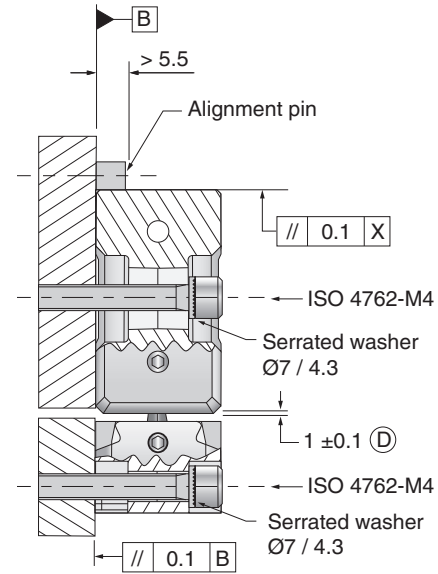
X = Machine guideway/axis datum

**NOTES:**

1. Side elevations show alternative mounting orientations.
2. Alignment pin and machine edge mounting options to mate directly to the top face of the extrusion.

### 5.4 Mounting orientations – short end caps

Dimensions and tolerances in mm



**KEY**

D = Required mounting dimensions

X = Machine guideway/axis datum

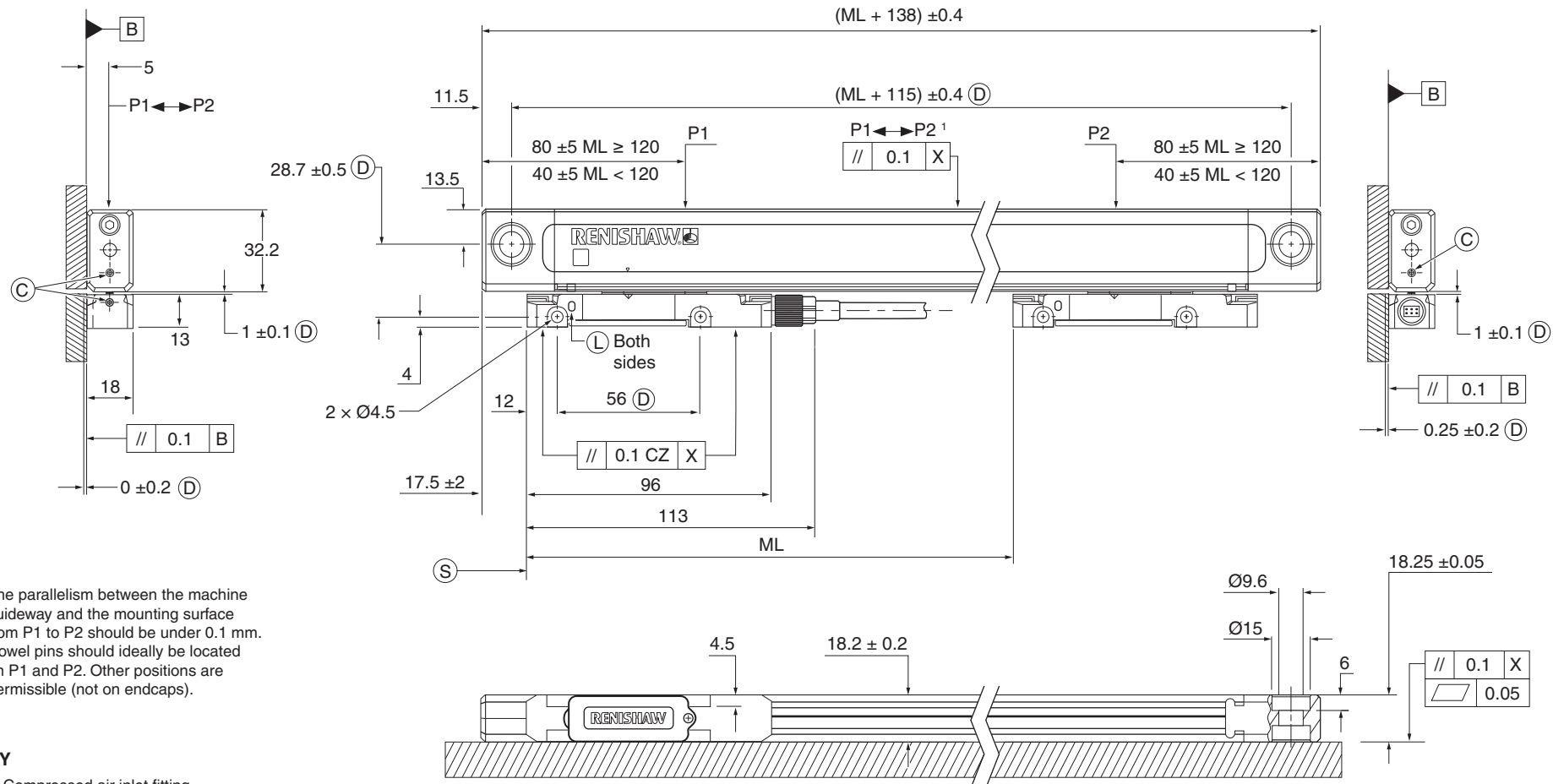
**NOTES:**

1. Side elevation shows alternative mounting orientation.
2. Extrusion mounting can be machine edge or dowel pins.



## 5.5 FORTiS system installation drawing – standard end caps (ML 320 mm shown)

Dimensions and tolerances in mm



<sup>1</sup> 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
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## 6 Product specification

<b>Measuring standard</b>	Renishaw stainless-steel scale with single track absolute encoding
<b>Coefficient of thermal expansion</b> (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 (mounting spar available – recommended for > 620 mm length)
<b>Accuracy grades</b>	High grade: ≤ ±3 µm Standard grade: ≤ ±5 µm
<b>Resolution <sup>1</sup></b>	0.5 nm, 1 nm, 1.25 nm, 10 nm, 12.5 nm, 25 nm, 50 nm
<b>Sub-Divisional Error (typical)</b>	±40 nm
<b>Jitter (RMS)</b>	10 nm
<b>Absolute position serial interface</b>	BiSS C, FANUC ( $\alpha/\alpha_i$ ), Mitsubishi, Panasonic, Siemens DRIVE-CLiQ (with external interface), Yaskawa
<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 <sup>2</sup></b>	5 V ±10%    1.25 W maximum (250 mA @ 5 V) Ripple    200 mVpp maximum @ frequency up to 500 kHz
<b>Set-up LED</b>	Signal strength indicator LED colour: Excellent: BLUE Good: GREEN Satisfactory: ORANGE Poor: RED No signal: Flashing RED

<sup>1</sup> See tables on page 20 for relevant accuracy grade and serial interface.

<sup>2</sup> 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.

<b>Maximum speed</b>	4 m/s
<b>Acceleration</b> (readhead relative to scale)	< 200 m/s <sup>2</sup> in measuring direction
<b>Moving force</b> (maximum force required to move the readhead through the seals)	< 4 N
<b>Vibration</b> (55 Hz to 2 000 Hz)	Readhead: < 300 m/s <sup>2</sup> to IEC 60068-2-6 Housing without mounting spar: < 200 m/s <sup>2</sup> to IEC 60068-2-6 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 At correct supply pressure the supplied air connection fitting restricts the air flow rate to 2 l/min Air quality: see <a href="#">section 8.8</a> on page 35 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.

## Product specification (continued)

### Resolution per accuracy grade and serial interface – standard options

Accuracy grade	Serial interface	Resolution nm	
		Single	Dual
3 µm	BiSS C, Mitsubishi, Panasonic, Siemens DRIVE-CLiQ, Yaskawa	1	
	FANUC		1 / 0.5
			10 / 1.25
5 µm	BiSS C, Mitsubishi, Panasonic, Siemens DRIVE-CLiQ, Yaskawa	10	
		50	
	FANUC		50 / 12.5
			50 / 25

**NOTE:** For BiSS C encoders, the standard position word length is 36 bits long. However, to accommodate controllers that require a shorter position word length, versions with 26 bit or 32 bit word length are also available (with standard 5 µm accuracy grade only).

Position word length	Nomenclature code	Accuracy grade	Resolution options (nm)		
			1	10	50
36 bit	36B	3 µm	OK	N/A	N/A
		5 µm	N/A	OK	OK
32 bit	32B		N/A	OK	N/A
26 bit	26B		N/A	N/A	OK

**NOTE:** For Siemens DRIVE-CLiQ encoders, the position word length is linked to the resolution, which in turn is linked to the accuracy grade. Here are the three options.

Position word length	Nomenclature code	Accuracy grade	Resolution options (nm)
34 bit	34D	3 µm	1
30 bit	30D	5 µm	10
28 bit	28D	5 µm	50

## 7 Installation procedure – extrusion

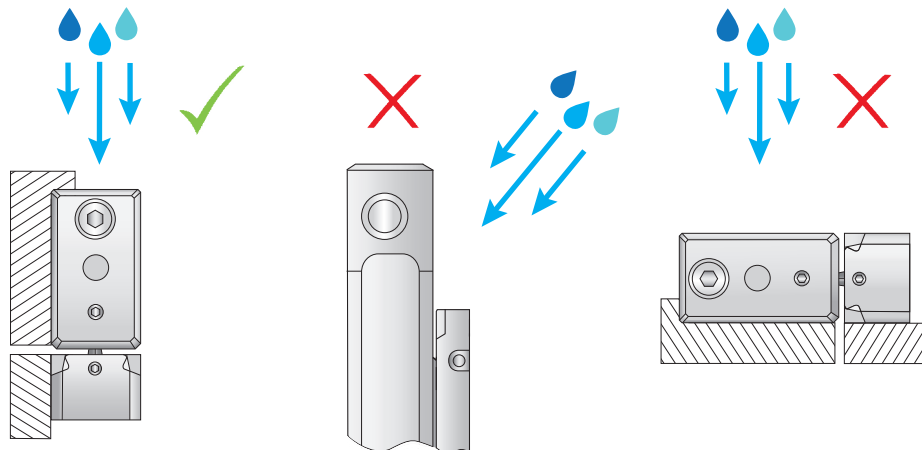
Please note that fitment of the extrusion is independent of readhead mounting. For illustrative purposes, a datum edge is displayed, but the procedure is identical for dowel pins. Where neither an edge or dowel pins are available, begin by aligning the extrusion mounting holes.

### NOTES:

1. 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.
2. For measuring lengths greater than 620 mm Renishaw recommends the use of a mounting spar (see [section 7.4](#) on page 23).
3. 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 35.



### 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.

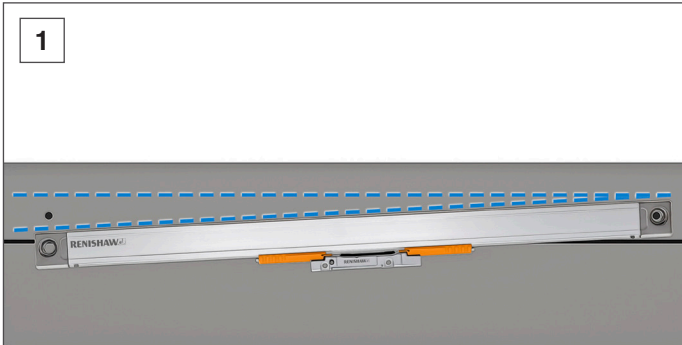
For measuring lengths > 620 mm a mounting spar is recommended; please refer to [sections 7.4, 7.5 and 7.6](#) for full details. (If required, a mounting spar can be used for measuring lengths under 620 mm.) The aluminium mounting spar's fixed central mounting hole provides a centrally located thermal 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.

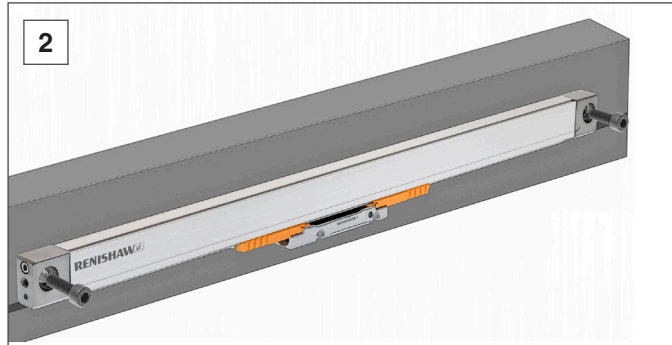
### 7.3 Extrusion installation without mounting spar

**1**



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

**2**



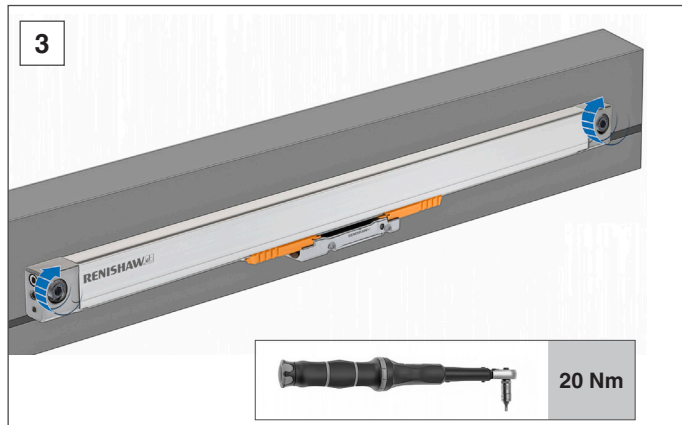
Loosely secure the extrusion to the mounting surface with the two supplied serrated washers and M8 screws placed in the end cap mounting holes.

---

**NOTE:** Secure fastenings with Loctite 243.

---

**3**



Tighten to a torque of 20 Nm.

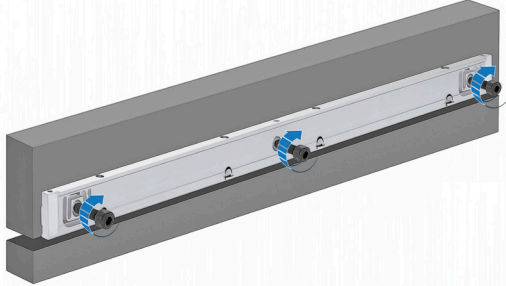
## 7.4 Installation with mounting spar

Renishaw recommends the use of a mounting spar where measuring lengths are greater than 620 mm. This requires encoders with short end caps. Where measuring lengths are less than 620 mm, if short end caps are specified, the mounting spar should also be used. If in doubt, please contact your local Renishaw representative.

The spar should be installed prior to fitting the encoder.

**NOTE:** Secure fastenings with Loctite 243.

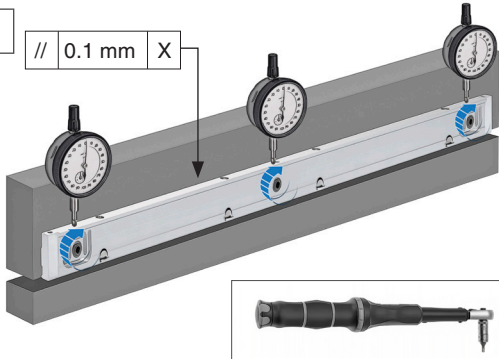
**1**



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.

**NOTE:** Secure fastenings with Loctite 243.

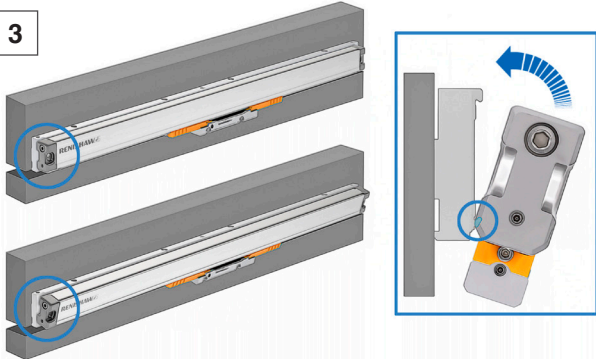
**2**



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.

X = Machine guideway axis/datum.

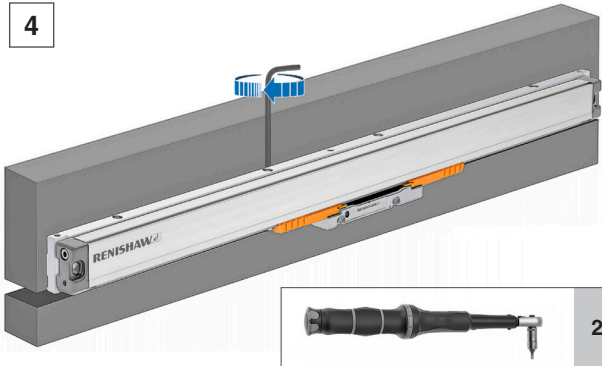
**3**



Position the encoder against the spar.

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

**4**

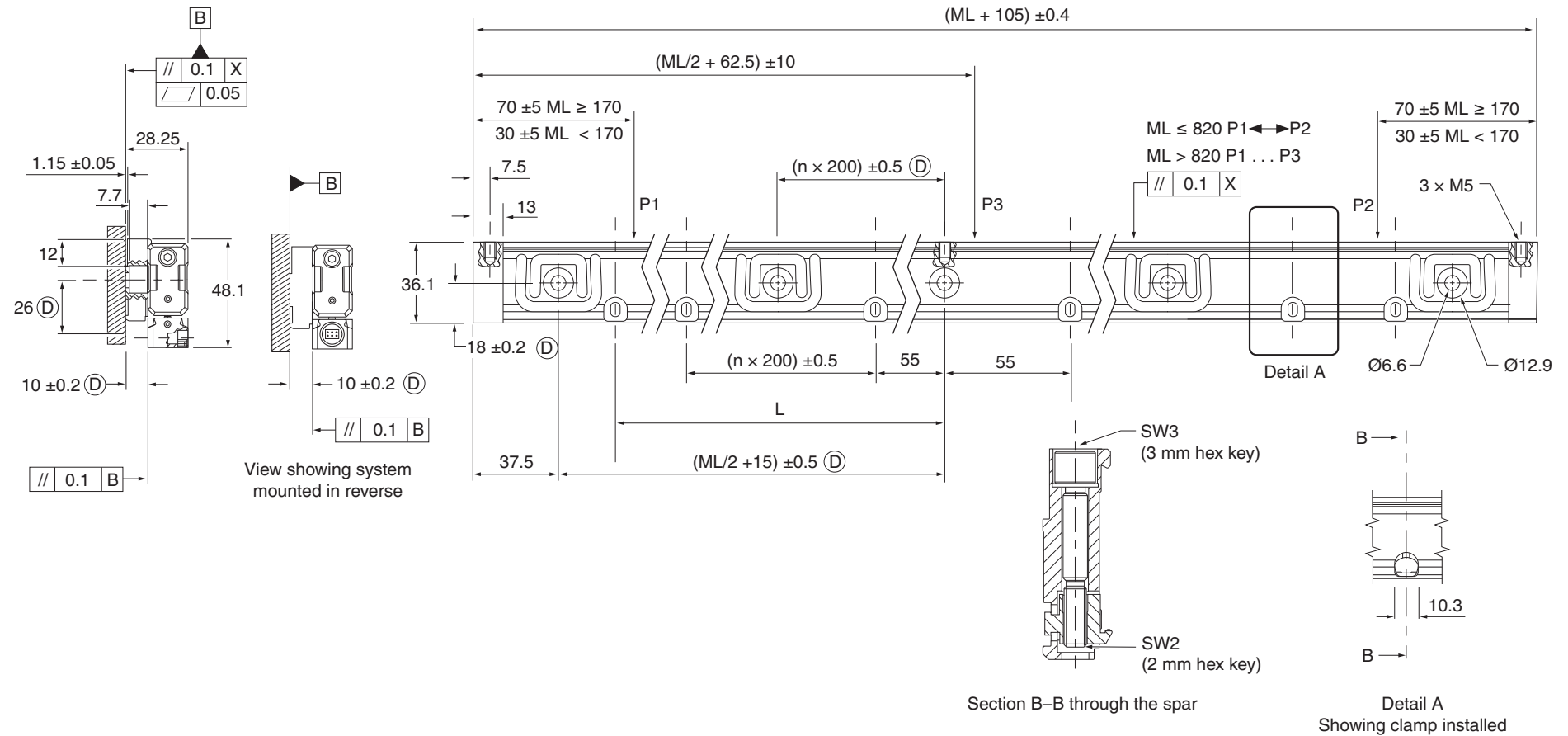


Tighten the screws on the top of the mounting spar to secure the encoder firmly to the mounting spar.

Tighten all bolts, working from left to right.

## 7.5 Mounting spar installation drawing (ML 620 mm shown)

Dimensions and tolerances in mm



### KEY

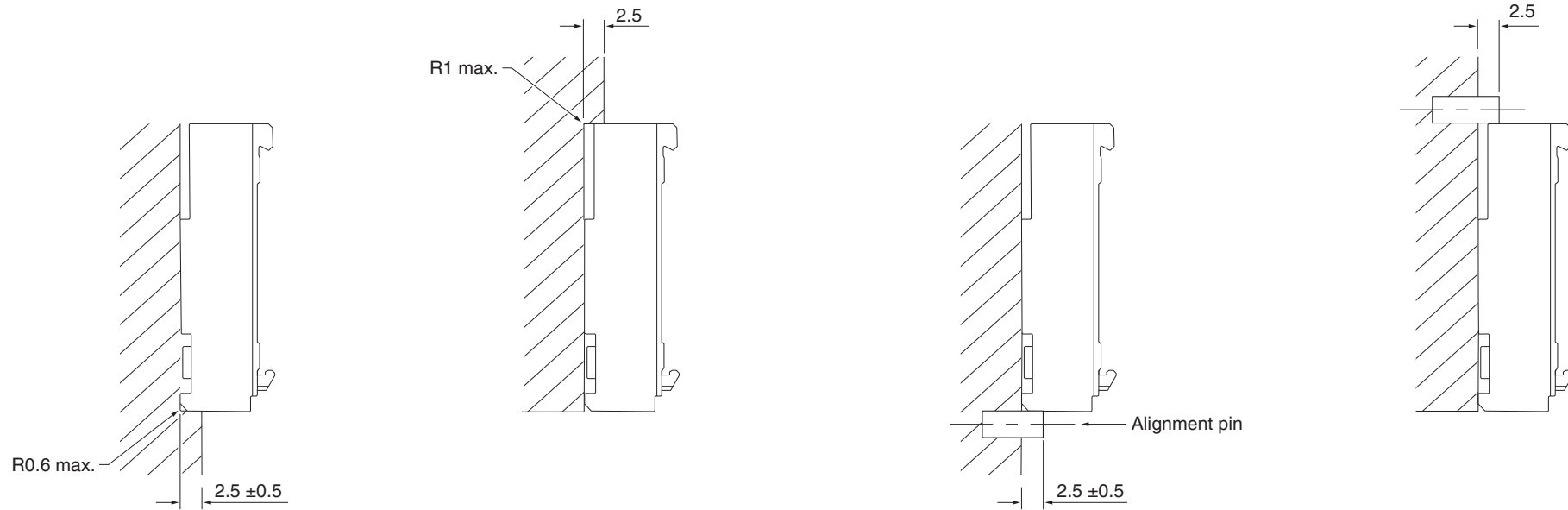
D = Required mounting dimensions  
 ML = Measuring length  
 P = Gauging points for alignment  
 X = Machine guideway/axis datum

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



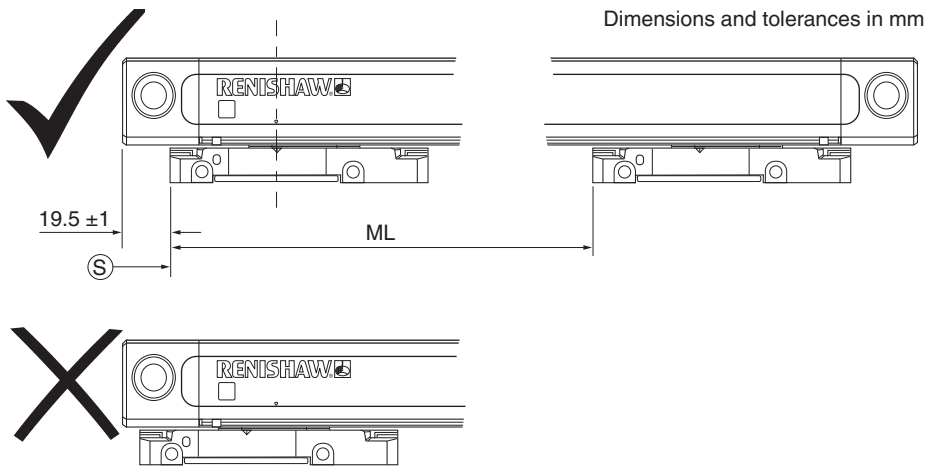
## 8 Installation procedure – readhead

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.

**NOTE:** Installation of the extrusion follows the procedure outlined in [section 7](#) on page 21 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.



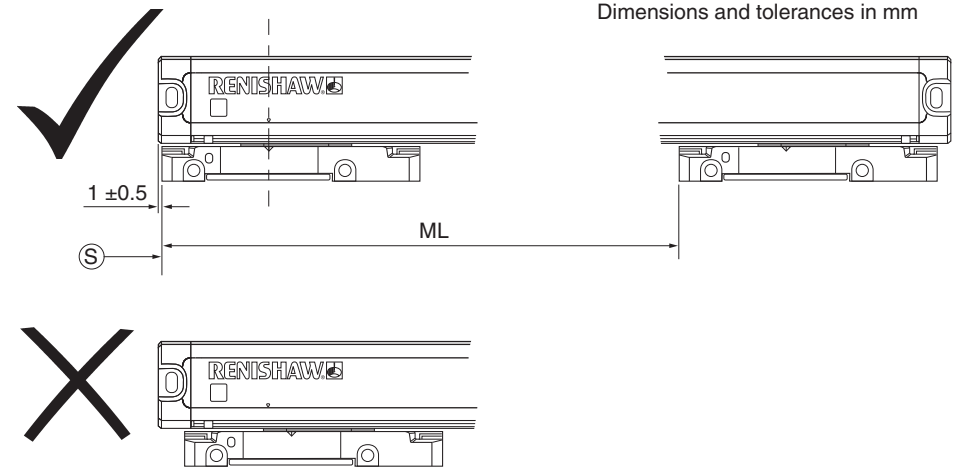
**KEY**

ML = Measuring length

S = Start of measuring length

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

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



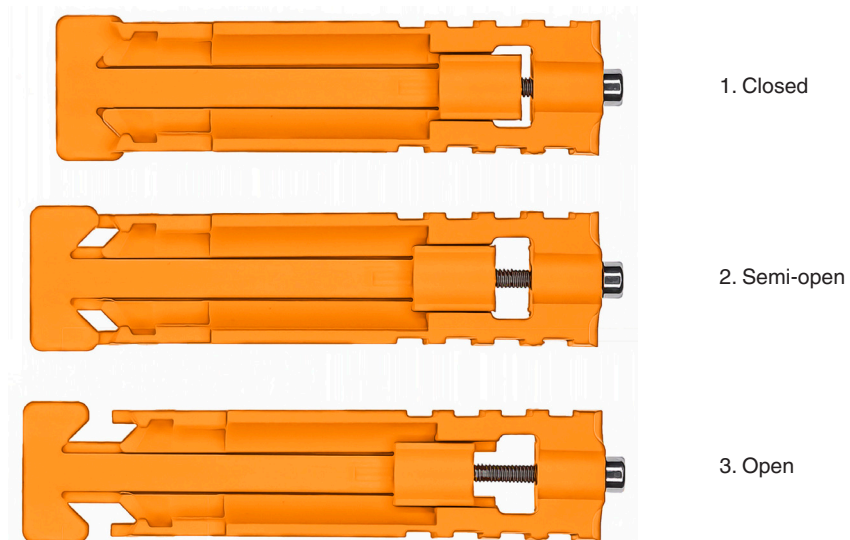
**KEY**

ML = Measuring length

S = Start of measuring length

## 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.

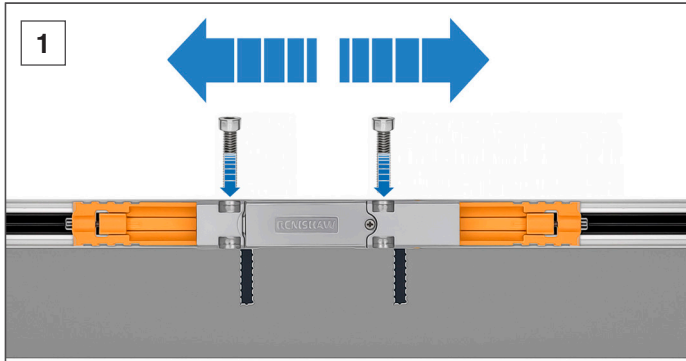
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**NOTE:** This method cannot be used if an armoured cable is fitted, due to space restrictions.

---

### 8.3.1 Installation using the alignment bracket method

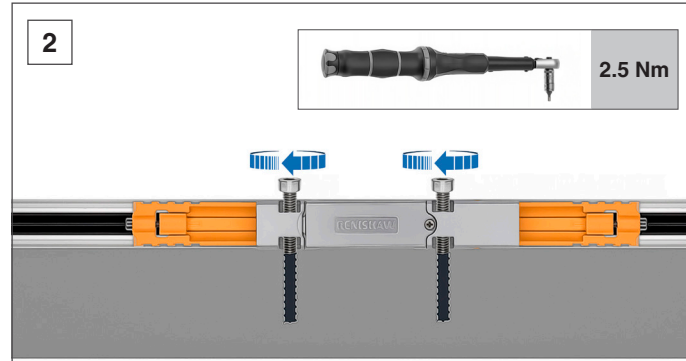
**1**



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.

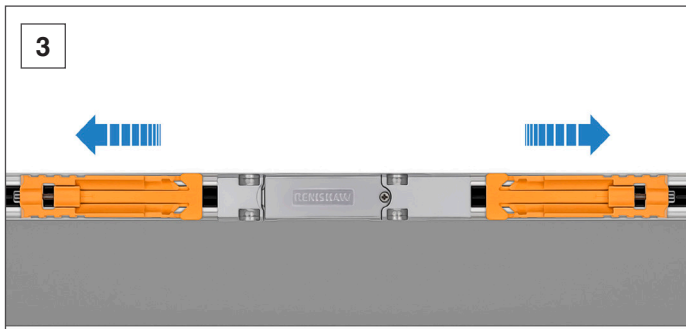
**2**



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.


**NOTE:** Secure fastenings with Loctite 243.

**3**



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

**4**

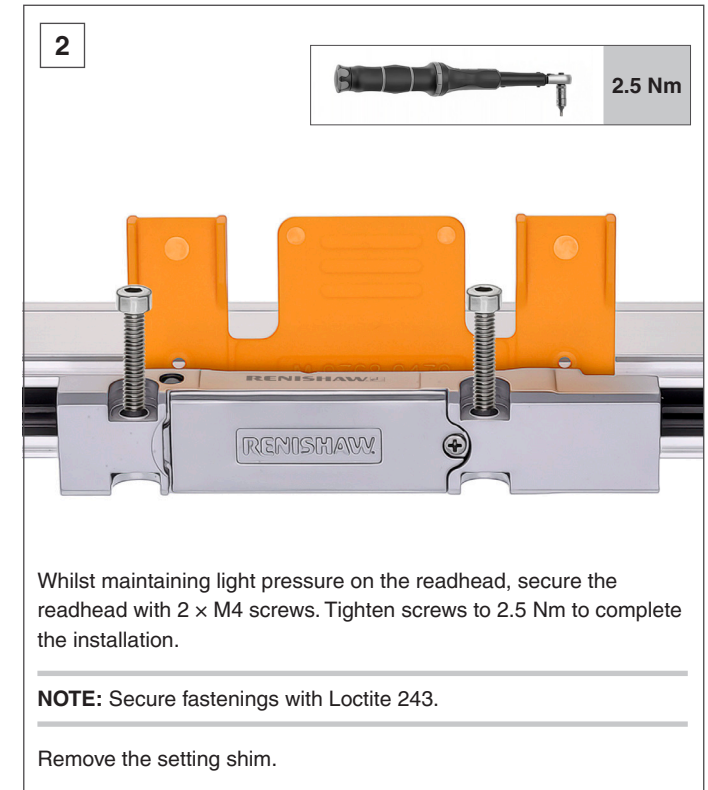
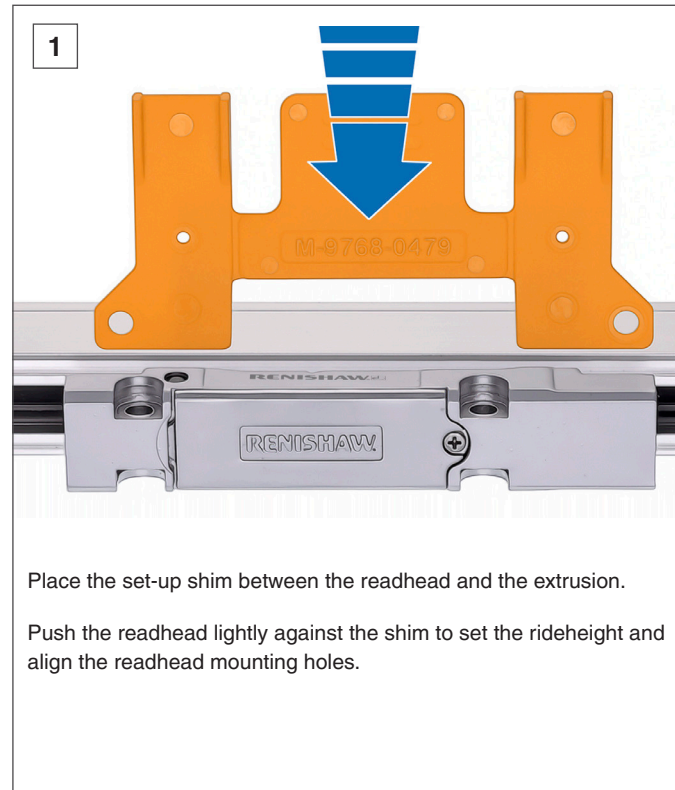


**IMPORTANT:** The alignment brackets must be removed after installation.

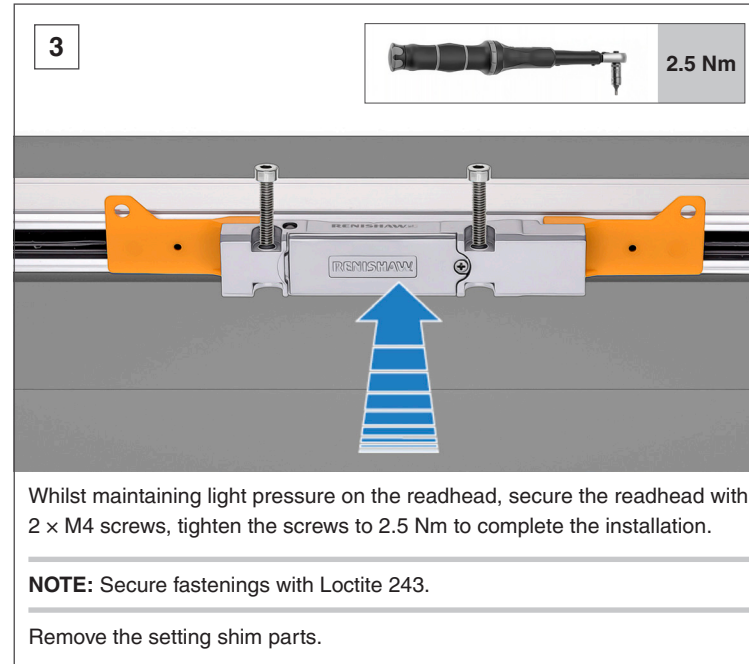
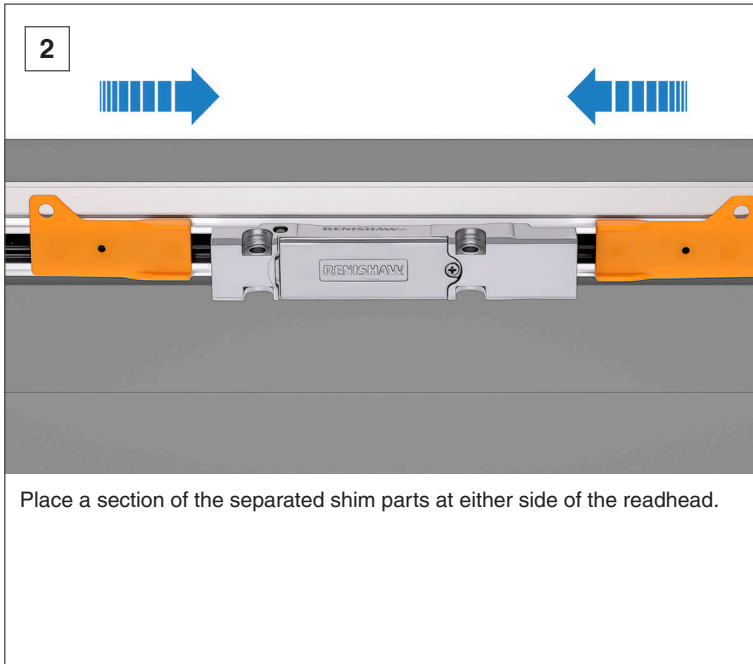
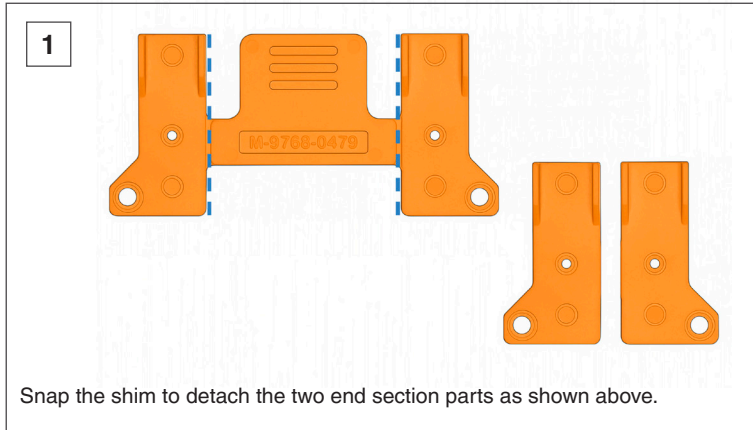
## 8.4 Set-up shim method 8.4.1 Front setting shim procedure

When using this method, remove the alignment brackets (see [section 8.3](#) on page 27) 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. The shim is easily inserted between the readhead and encoder extrusion.



## 8.4.2 Side setting shim procedure

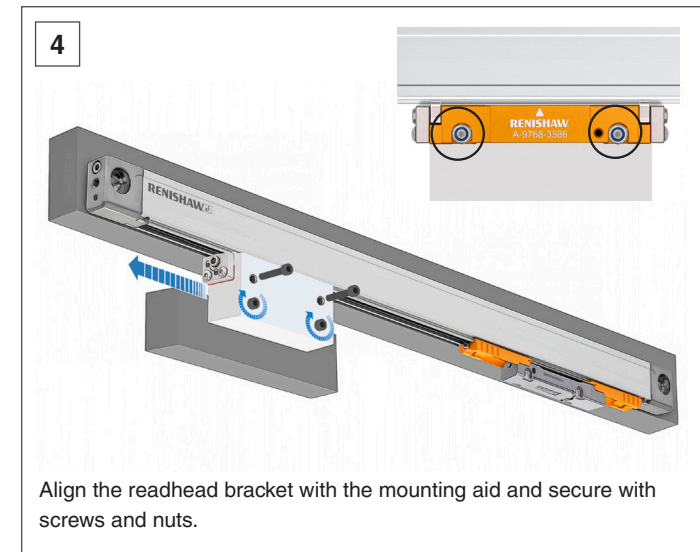
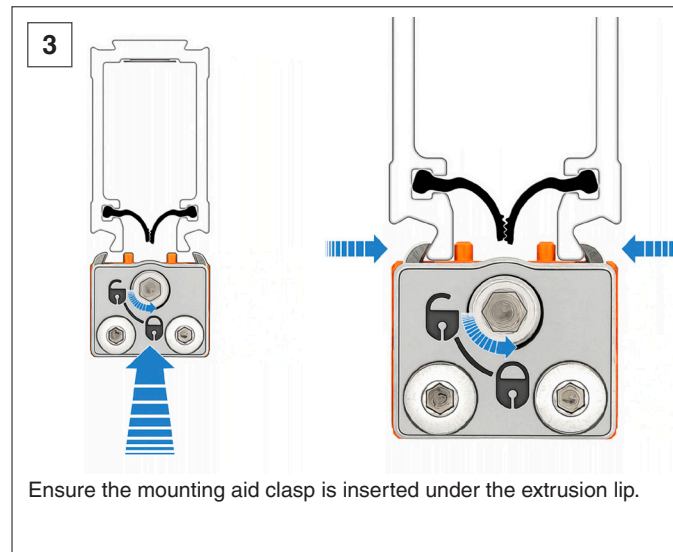
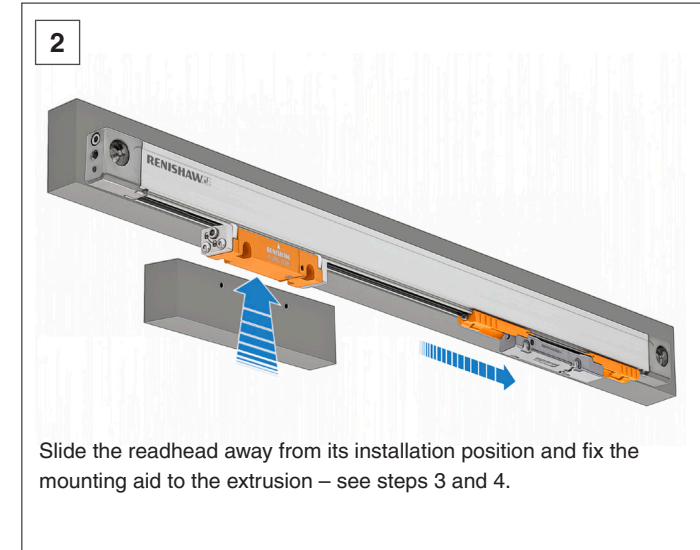
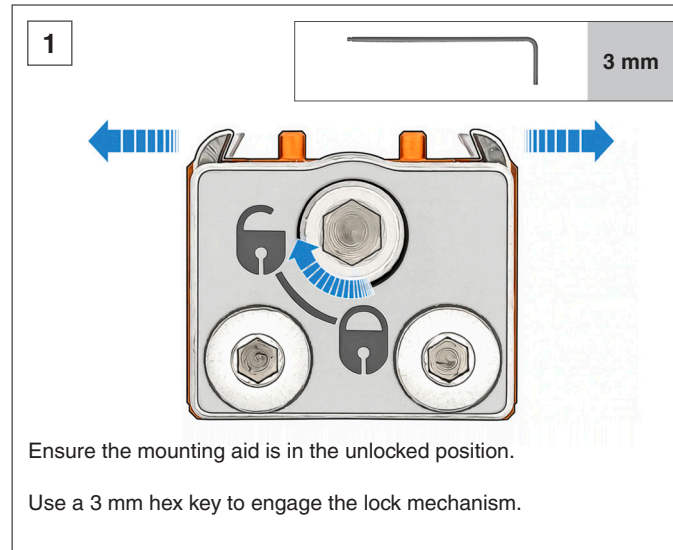


## 8.5 Installation using the mounting aid method

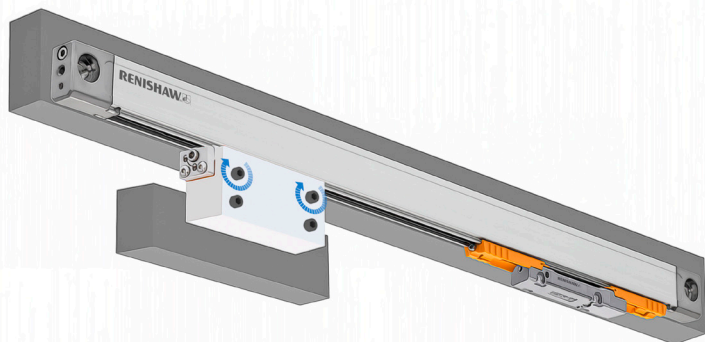
Remove the alignment brackets prior to installation using the setting shim.

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.

**NOTE:** 18 mm mounting aid and 3 mm hex key required (see [section 3.3.1](#) on page 12).

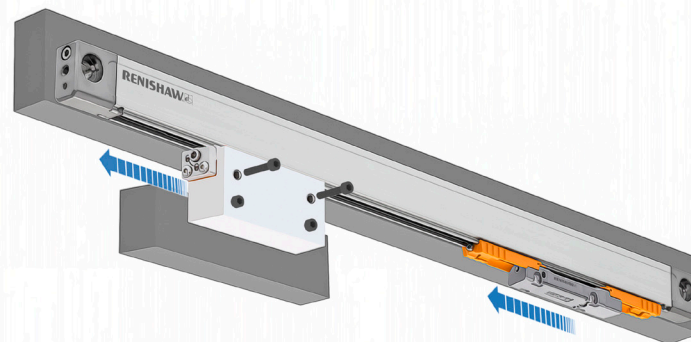


5



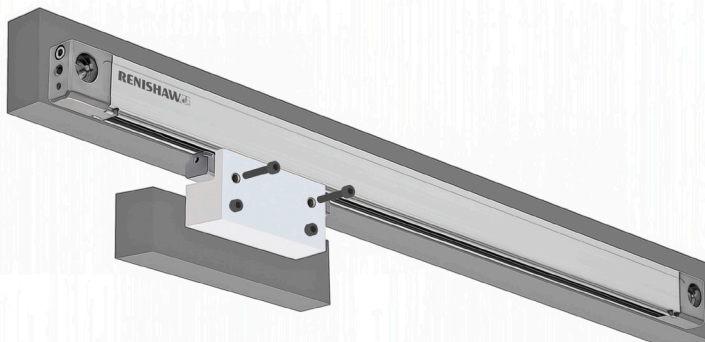
Align the axis slideway with the readhead bracket and secure using M4 screws.

6



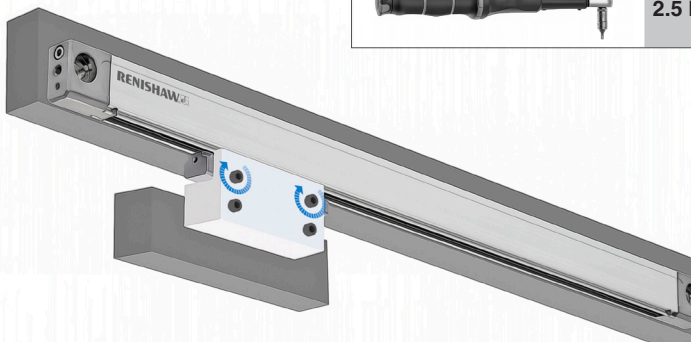
Remove the screws and nuts from the mounting aid, unlock and remove from the extrusion.

7



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

8



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

**NOTE:** Secure fastenings with Loctite 243.



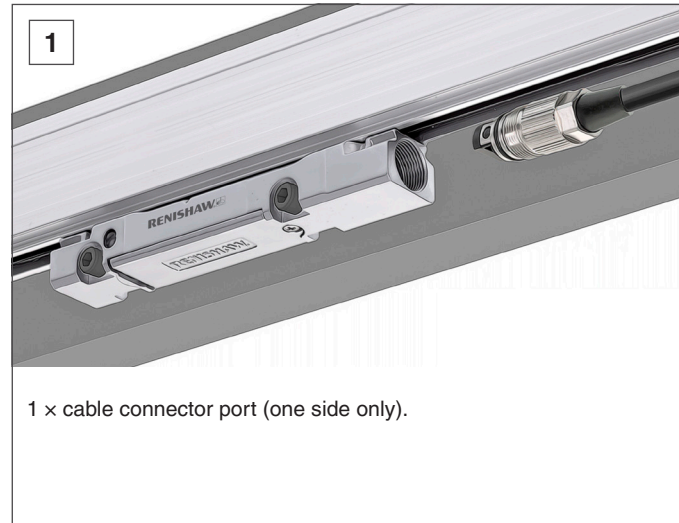
## 8.6 FORTiS cable connection

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.

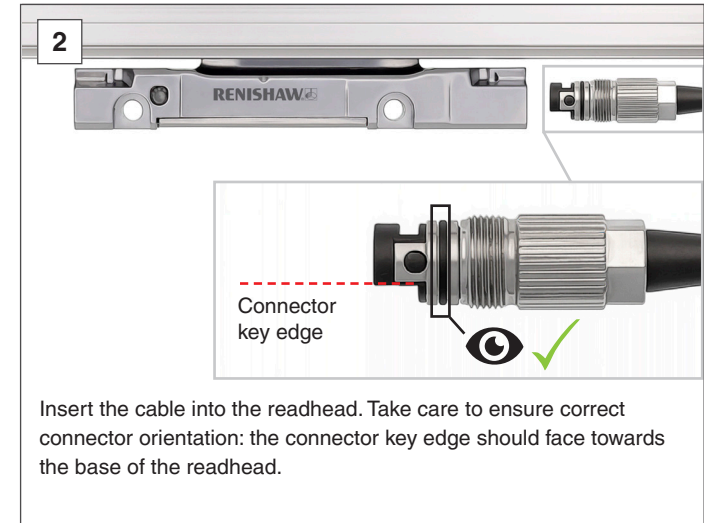
The default cable port output direction is as per the installation drawing in [section 5](#) on page 15. If an alternative cable output port direction is needed please contact your local Renishaw representative.

### NOTE – STEP 4:

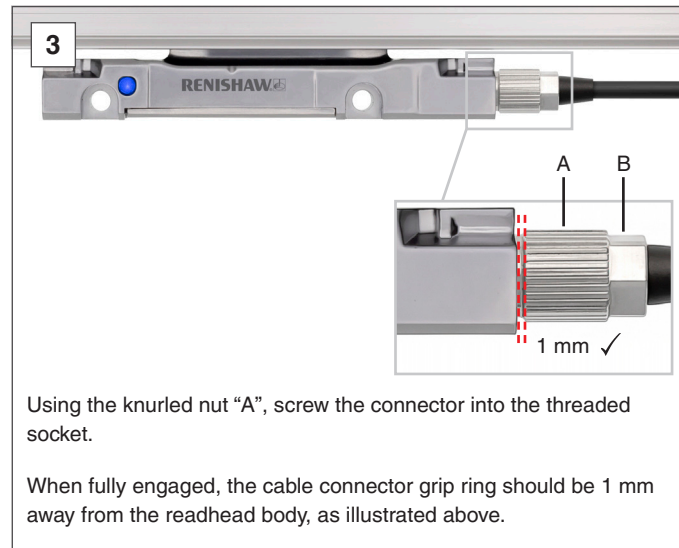
Once the connector is engaged as shown, apply a further torque by hand on the knurled nut “A” to ensure there is an adequate ground connection. The measured resistance of the ground connection (between the readhead body and the shield connection at the controller end of the cable assembly) must be less than 1 ohm. Cable connection thread should be secured with Loctite 222.



1 × cable connector port (one side only).

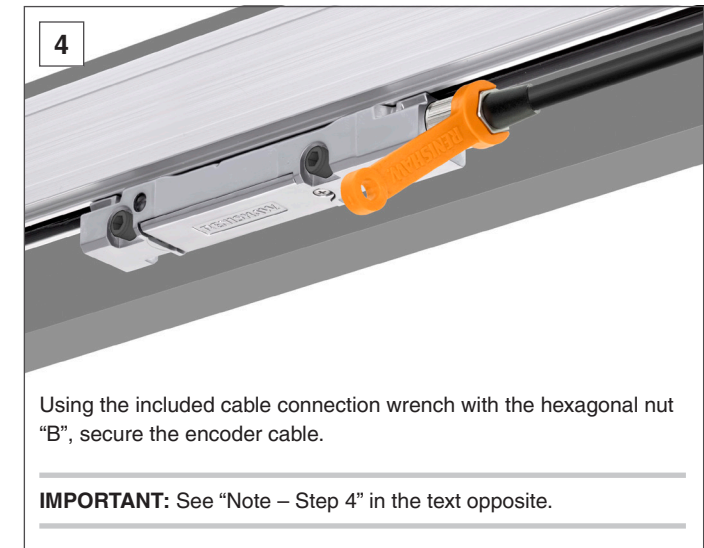


Insert the cable into the readhead. Take care to ensure correct connector orientation: the connector key edge should face towards the base of the readhead.



Using the knurled nut “A”, screw the connector into the threaded socket.

When fully engaged, the cable connector grip ring should be 1 mm away from the readhead body, as illustrated above.



Using the included cable connection wrench with the hexagonal nut “B”, secure the encoder cable.

**IMPORTANT:** See “Note – Step 4” in the text opposite.

## 8.7 Validating an installation





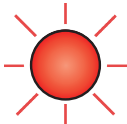
To validate the encoder installation the set-up LED provides instant verification of the encoder's signal strength and therefore its accurate alignment and installation.

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 [36](#) 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).

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LED status	Description	Required action
 <b>BLUE</b>	Signal level is optimal	No adjustment required
 <b>GREEN</b>	Signal level is good	No adjustment required
 <b>ORANGE</b>	Signal level is acceptable	Ensure the extrusion is parallel to the machine axis of motion (see <a href="#">section 5</a> on page <a href="#">15</a> ) and adjust the readhead to maximise the signal strength along the full axis of travel to achieve a Green or Blue LED
 <b>RED</b>	Signal level is NOT acceptable	Ensure the extrusion is parallel to the machine axis of motion (see <a href="#">section 5</a> on page <a href="#">15</a> ) and adjust the readhead to maximise the signal strength along the full axis of travel to achieve a Green or Blue LED
 <b>FLASHING RED</b>	Unable to determine the position	The readhead not picking up the scale due to contamination or poor installation  <b>NOTE:</b> Flashing LED indicates scale reading error. Flashing state is latched for some serial interfaces.  Remove power to reset.

## 8.8 Air supply

FORTiS system 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>Maximum particulate contamination</b>	ISO 8573-1 Class 1	
	Particle size	
	0.1 µm to 0.5 µm	No. of particles per m <sup>3</sup> ≤ 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 (maximum oil concentration: 0.01 mg/m <sup>3</sup> )	

The air purge supply is normally connected to the system part that will be stationary. Depending on the machine configuration, either the extrusion or the readhead will move with the machine guideway.

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

For compatible air supply components refer to the data sheet *Air filtration systems for use with FORTiS encoders* (Renishaw part number L-9517-9982).

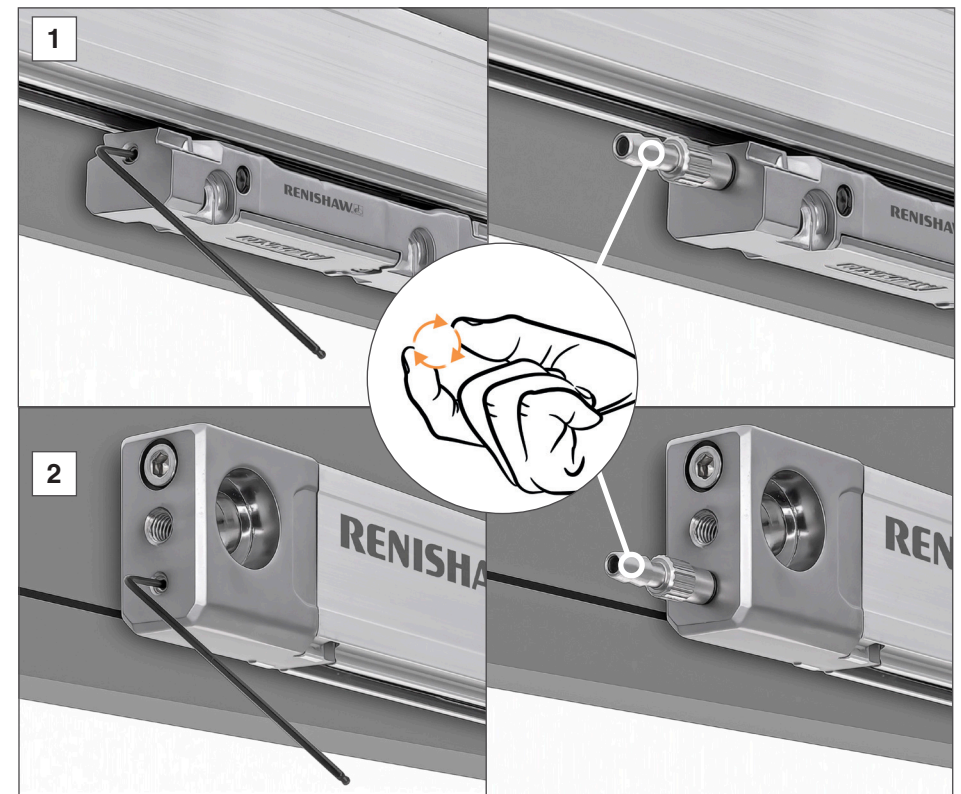


Full-size air filter  
Renishaw part no. A-9768-4353



Reduced-size air filter  
Renishaw part no. A-9768-4354

**NOTE:** If an air bung or air connector screw requires replacement or repositioning it should be secured with Loctite 222.



**Removal of the air supply bung and fitment of the air connection fitting into either the readhead (1) or extrusion end cap (2). Finger tighten (0.3 Nm maximum).**

**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.

## 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.

The system must be earthed as per the image opposite.

### 9.2 FORTiS grounding and shielding

#### IMPORTANT:

1. The shield should be connected to the machine earth (field ground).
2. 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.

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

Figure 1 Standard arrangement.

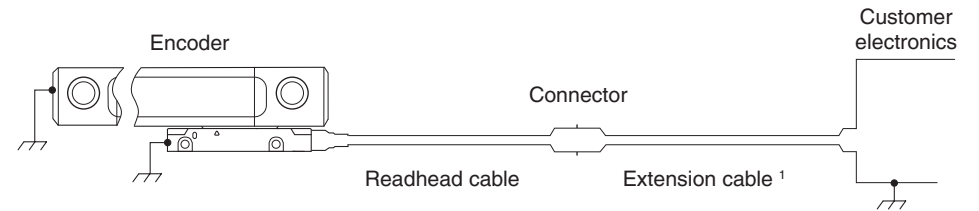


Figure 2 Arrangement for Siemens DRIVE-CLiQ versions.

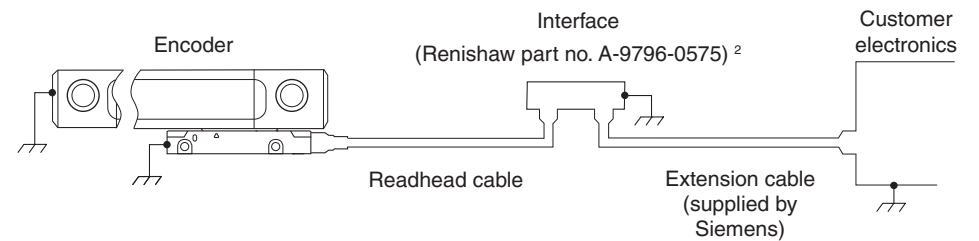
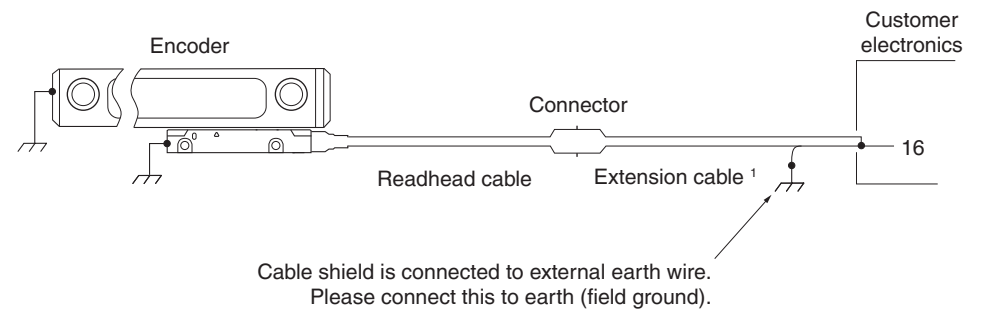


Figure 3 Arrangement when 20-way Honda connector (plastic body) is used with FANUC.



<sup>1</sup> For maximum extension cable length please consult your local Renishaw representative.

<sup>2</sup> See page 45 for details.

## 10 Cables and serial interfaces

Further information relating to cables for the FORTiS encoder range can be found in the data sheet *Cables for FORTiS absolute encoders* (Renishaw part no. L-9517-0069). This can be downloaded from our website [www.renishaw.com/fortisdownloads](http://www.renishaw.com/fortisdownloads) and is also available from your local Renishaw representative.

### 10.1 General specifications

<b>Readhead cable</b>	Type A	Ø4.7 mm, 28 AWG, 7 core, single screen, black jacket Flex life > 20 × 10 <sup>6</sup> cycles at 20 mm bend radius 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 Flex life > 20 × 10 <sup>6</sup> cycles at 75 mm bend radius Minimum static bend radius (internal radius): 31.5 mm
	Type D	Armoured: OD 10 mm, 28 AWG, 7 core Flex life > 20 × 10 <sup>6</sup> cycles at 100 mm bend radius 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 Flex life > 20 × 10 <sup>6</sup> cycles at 75 mm bend radius Minimum static bend radius (internal radius): 31.5 mm
	Type C	OD: 7.8 mm, 2 × 20 AWG (power), 4 × 23 AWG (signal), 2 × 28 AWG (sense), single screen, green jacket Flex life > 20 × 10 <sup>6</sup> cycles at 75 mm bend radius 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.

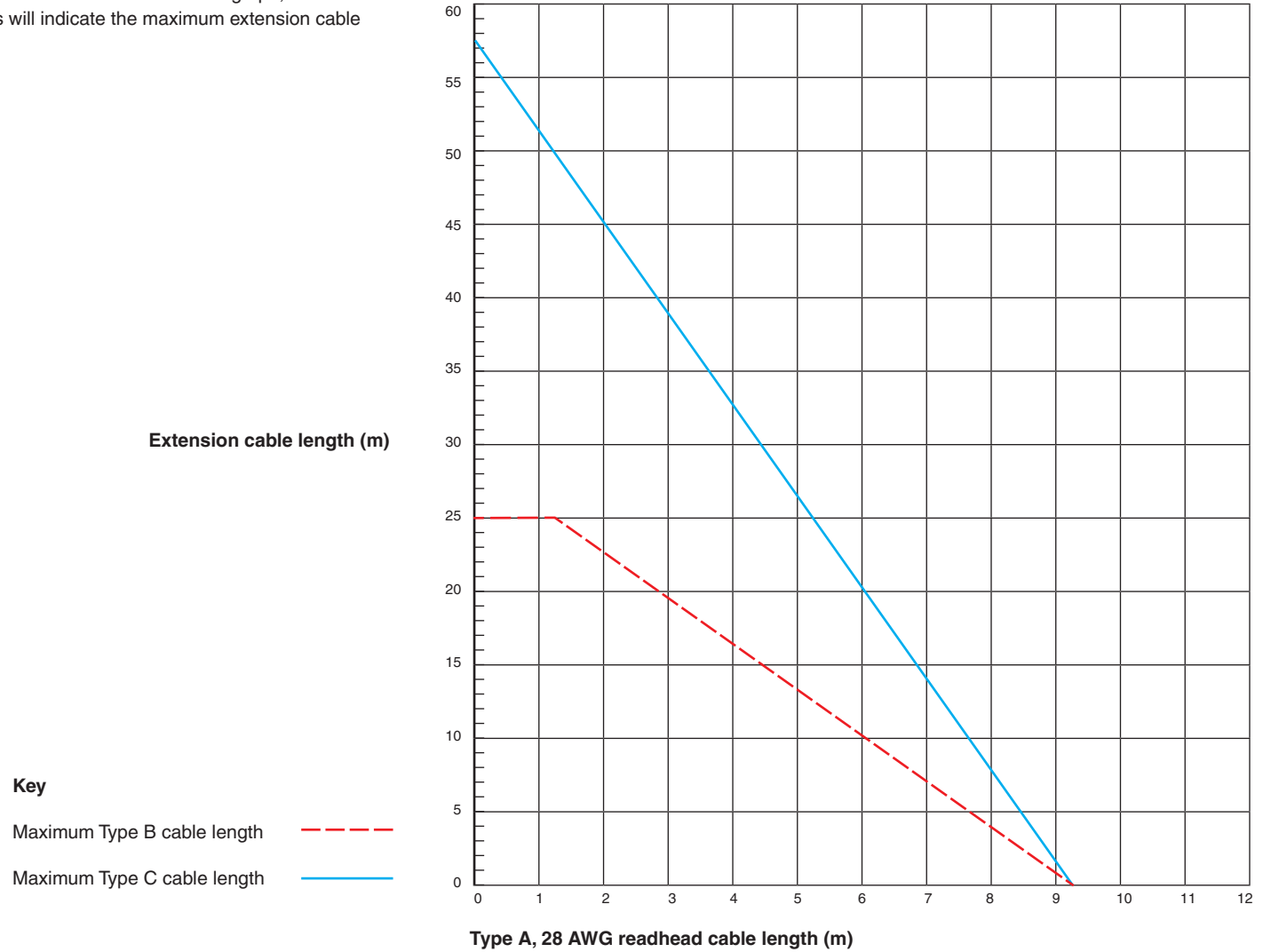
### 10.2 Permissible cable lengths

The following graphs 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 serial interfaces and connector types. At the worst case the minimum acceptable supply voltage is 4.75 Vdc.

**NOTE:** For Siemens systems, the distance between the readhead and the DRIVE-CLiQ interface must adhere to the restrictions shown in the graphs in this section, but the combination of readhead cable and extension cable **MUST NOT EXCEED 25 m**.

## 10.2.1 Type A readhead cable combined with an extension cable

The following graph shows the maximum length for a cable run when a combination of Type A readhead cable and either Type B or Type C extension cable is used. To read this graph, find the length of readhead cable on the x axis, then the y axis will indicate the maximum extension cable length for each type of extension cable.



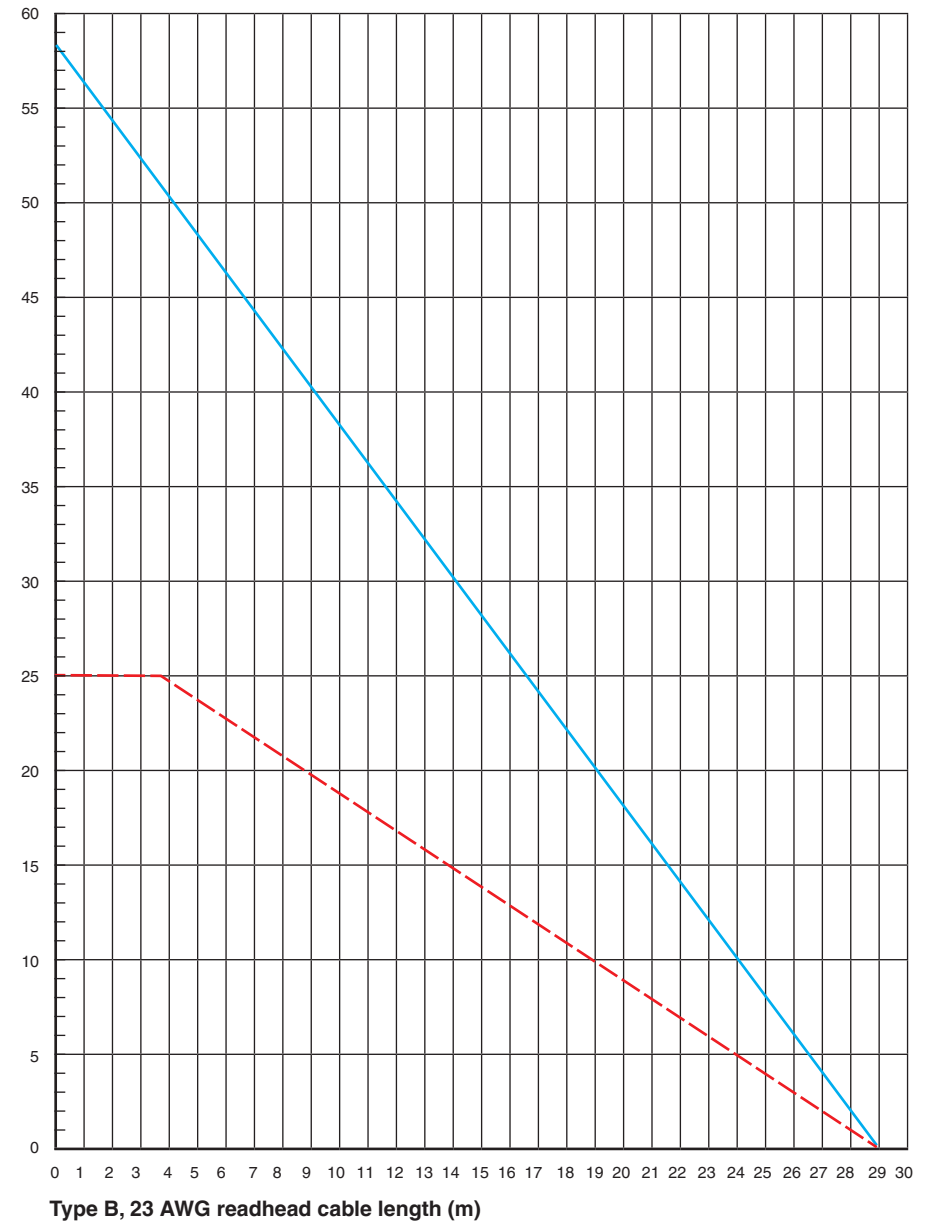
## 10.2.2 Type B readhead cable combined with an extension cable

The following graph shows the maximum length for a cable run when a combination of Type B readhead cable and either Type B or Type C extension cable is used. To read this graph, find the length of readhead cable on the x axis, then the y axis will indicate the maximum extension cable length for each type of extension cable.

Extension cable length (m)

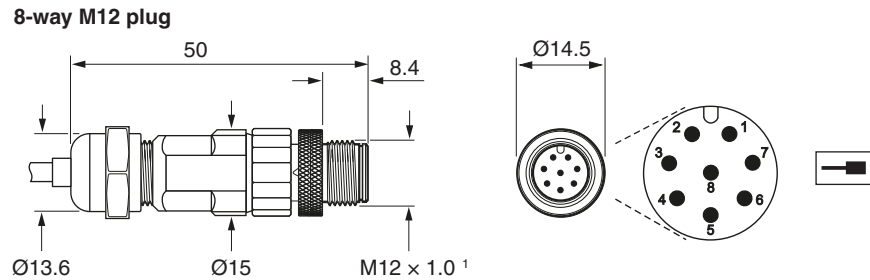
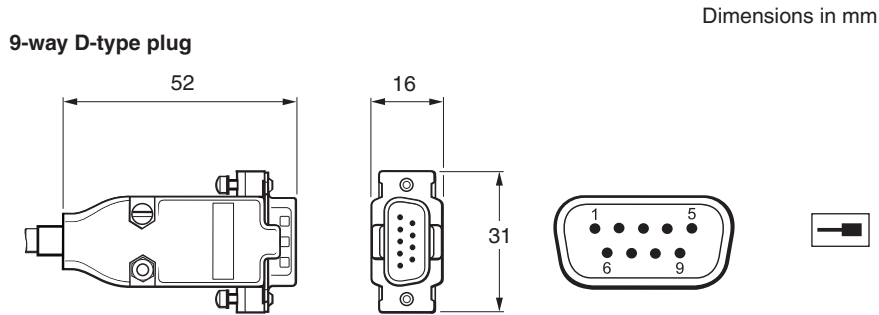
**Key**

- Maximum Type B cable length - - - - -
- Maximum Type C cable length —————

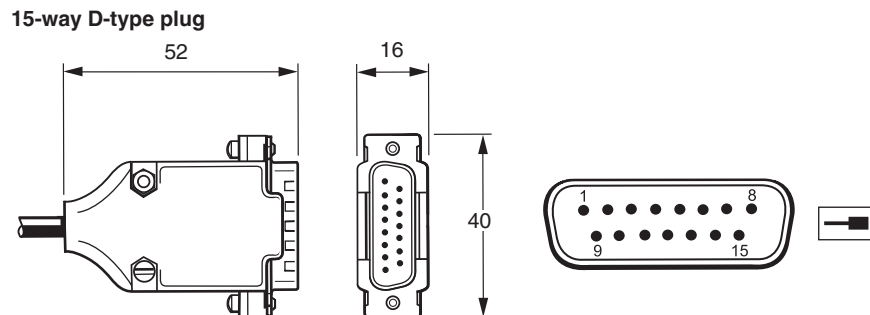


## 10.3 BiSS C serial interface

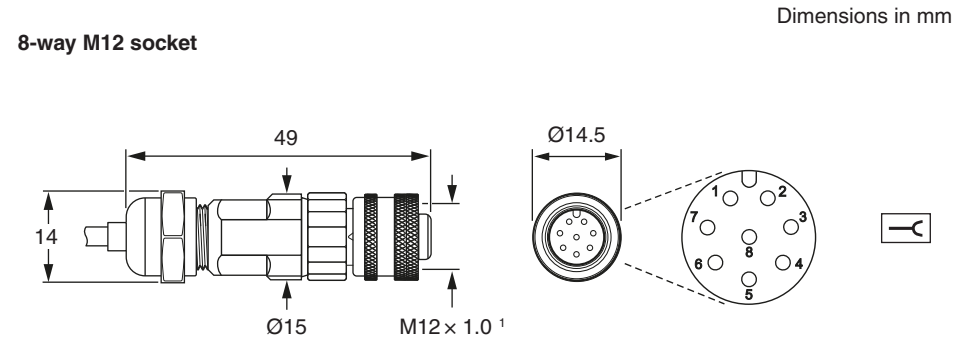
### 10.3.1 Controller connector



<sup>1</sup> The recommended tightening torque is 4 Nm.



### 10.3.2 In-line connector



<sup>1</sup> The recommended tightening torque is 4 Nm.

### 10.3.3 Output signals

Function	Signal	Flying lead wire colour (F)	Pin-out		
			9-way D-type (A)	8-way M12 (S)	15-way D-type (D)
Power	5 V	Brown	4, 5	2	4, 12
	0 V	White	8, 9	5, 8	2, 10
Serial interface	MA+	Violet	2	3	8
	MA-	Yellow	3	4	15
	SLO+	Grey	6	7	5
	SLO-	Pink	7	6	13
Shield	Shield	Shield	Case	Case	Case

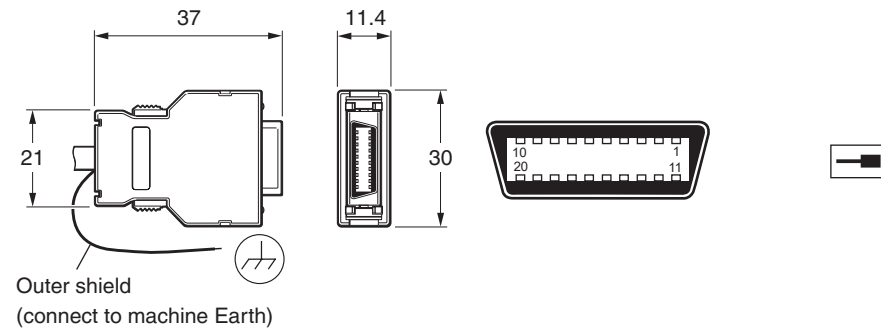


## 10.4 FANUC serial interface

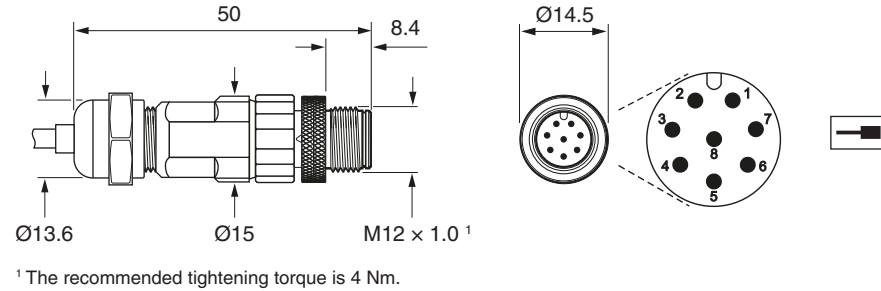
### 10.4.1 Controller connector

Dimensions in mm

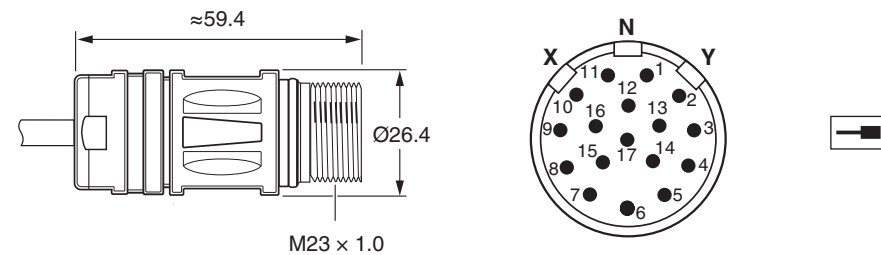
#### 20-way plug



#### 8-way M12 plug



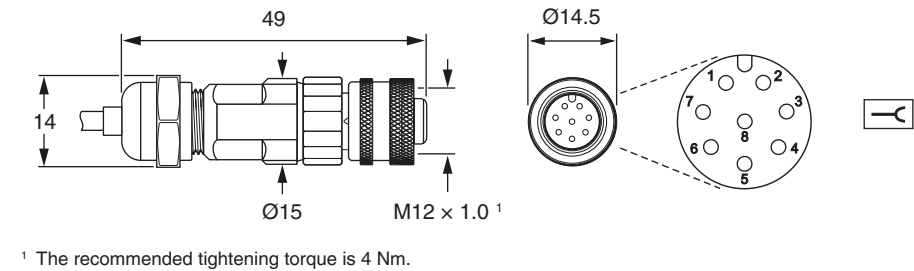
#### 17-way M23 plug



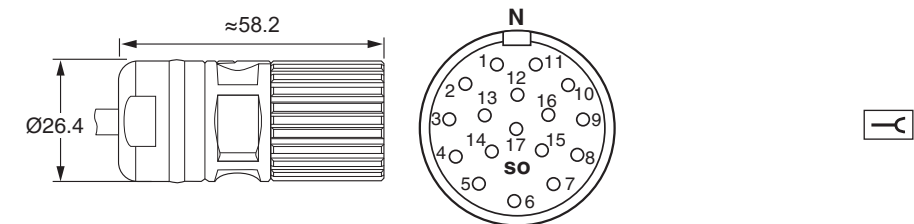
### 10.4.2 In-line connector

Dimensions in mm

#### 8-way M12 socket




#### 17-way M23 socket



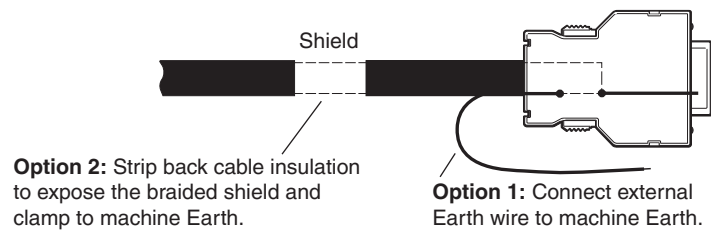
### 10.4.3 Output signals

Function	Signal		Flying lead wire colour (F)	Pin-out			
	FANUC $\alpha$	FANUC $\alpha$ i		20-way plug (H)	8-way M12 (S)	8-way M12 (T)	17-way M23 (C)
Power	5 V	5 V	Brown	9, 20	2	8	1, 7
	0 V	0 V	White	12, 14	5, 8	5	4, 10
Serial interface	REQ+	REQ+ / SD+	Violet	5	3	7	8
	REQ-	REQ- / SD-	Yellow	6	4	6	9
	SD+	Do not connect	Grey	1	7	3	14
	SD-		Pink	2	6	4	17
Shield	Shield	Shield	Cable braid	16, External	Case	Case	Case

### 10.4.4 Connecting the cable screen on H terminations

 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.

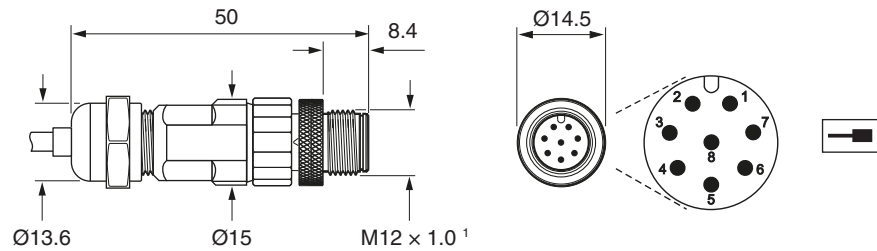


## 10.5 Mitsubishi serial interface

### 10.5.1 Controller connector

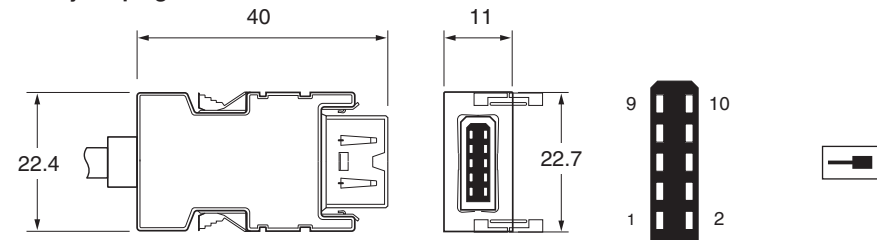
Dimensions in mm

#### 8-way M12 plug

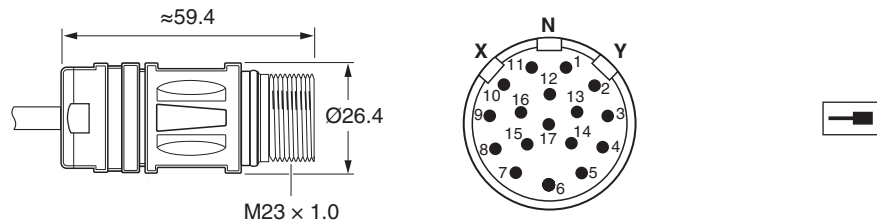


<sup>1</sup> The recommended tightening torque is 4 Nm.

#### 10-way 3M plug



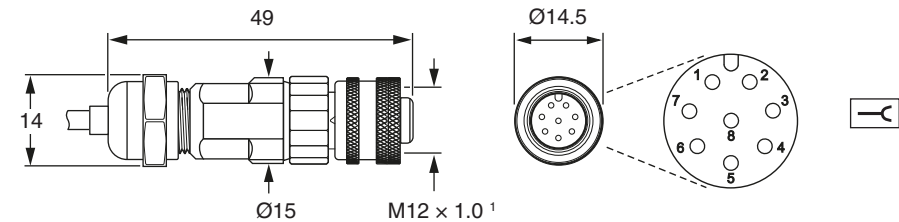
#### 17-way M23 plug



### 10.5.2 In-line connector

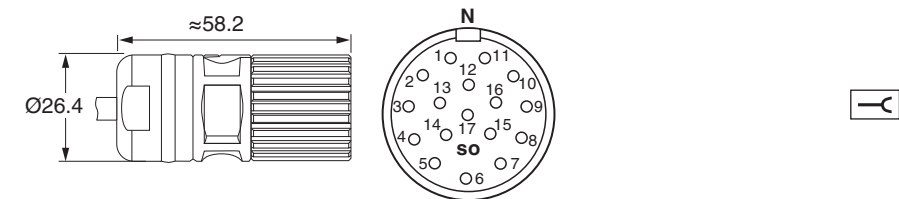
Dimensions in mm

#### 8-way M12 socket



<sup>1</sup> The recommended tightening torque is 4 Nm.

#### 17-way M23 socket

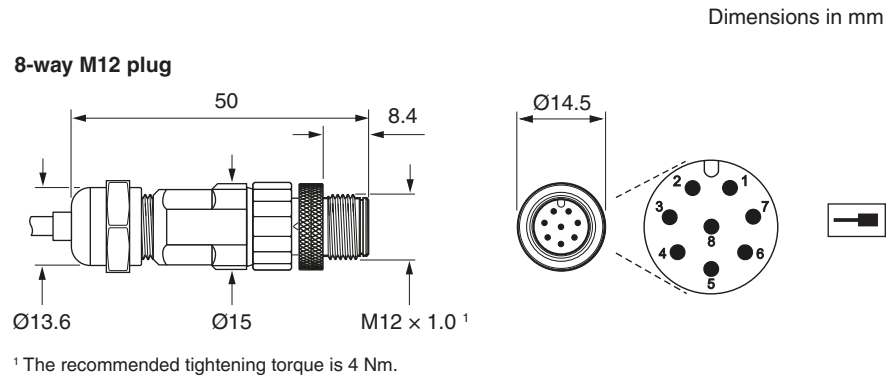


### 10.5.3 Output signals

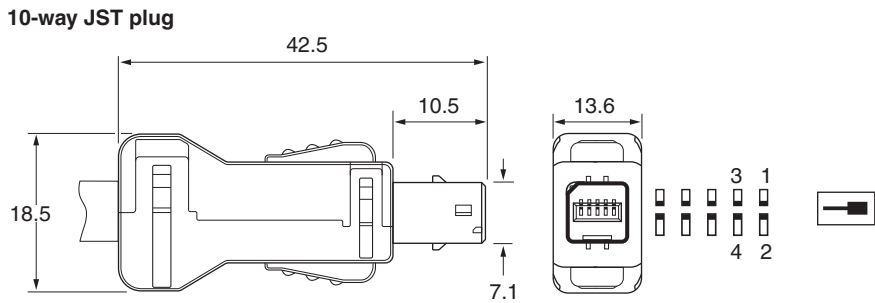
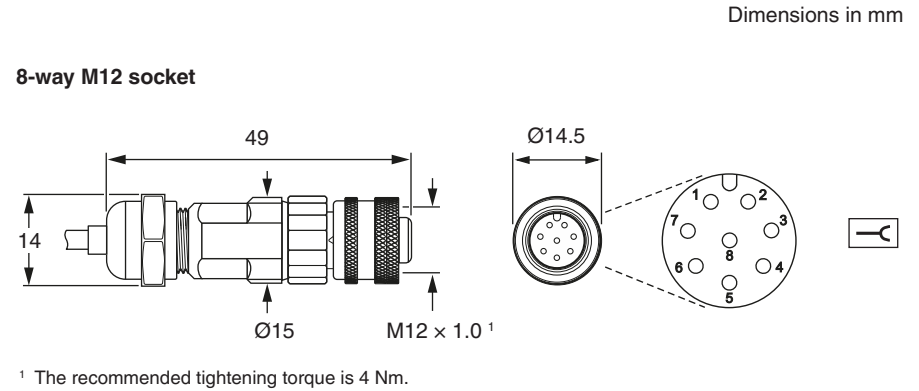
Function	Signal	Flying lead wire colour (F)	Pin-out		
			10-way 3M (P)	8-way M12 (S)	8-way M12 (T)
Power	5 V	Brown	1	2	8
	0 V	White	2	5, 8	5
Serial interface	MR	Violet	3	3	7
	MRR	Yellow	4	4	6
	MD	Grey	7	7	3
	MDR	Pink	8	6	4
Shield	Shield	Shield	Case	Case	Case

## 10.6 Panasonic serial interface

### 10.6.1 Controller connector



### 10.6.2 In-line connector



### 10.6.3 Output signals

Function	Signal	Flying lead wire colour (F)	Pin-out	
			8-way M12 (S)	10-way JST (J)
Power	5 V	Brown	2	1
	0 V	White	5, 8	2
		Green	-	-
Serial interface	PS	Violet	3	3
	$\overline{PS}$	Yellow	4	4
Reserved	Do not connect	Grey	7	-
		Pink	6	-
Shield	Shield	Shield	Case	Case

## 10.7 Siemens serial interface

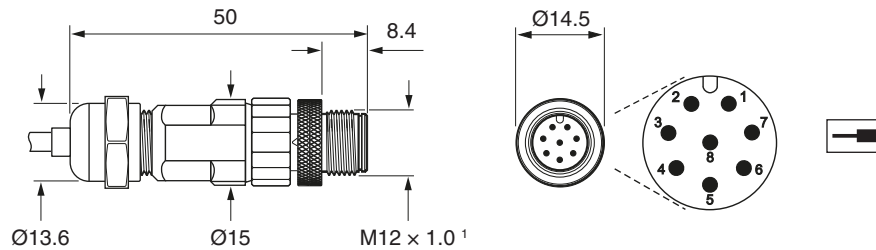
Included with Siemens-only versions of FORTiS.

DRIVE-CLiQ interface connector		
<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 Overvoltage protection for DRIVE-CLiQ: -36V to +36V
	Ripple	200 mVpp maximum @ frequency up to 500 kHz
<b>Maximum total cable length</b>	Readhead to DRIVE-CLiQ interface 9 m (Refer to Siemens DRIVE-CLiQ specifications for maximum cable length from interface to controller) Extension cables from the FORTiS DRIVE-CLiQ interface to controller should be sourced directly from Siemens	
<b>Connector tightening torque</b>	M12 – 4 Nm	

### 10.7.1 Controller connector

Dimensions in mm

8-way M12 plug

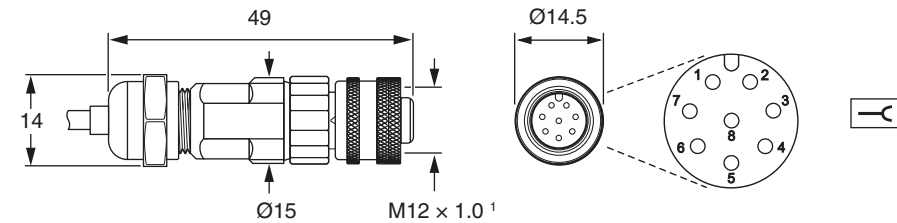


<sup>1</sup> The recommended tightening torque is 4 Nm.

### 10.7.2 In-line connector

Dimensions in mm

8-way M12 socket



<sup>1</sup> The recommended tightening torque is 4 Nm.

### 10.7.3 Output signals

Function	Signal	Wire colour	Pin-out
			8-way M12 (S)
Power	5 V	Brown	2
	0 V	White	5, 8
Serial interface	A+	Violet	3
	A-	Yellow	4
Reserved	Do not connect	Grey	7
		Pink	6
Shield	Shield	Shield	Case

## 10.7.4 Siemens DRIVE-CLiQ serial interface

### 10.7.4.1 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  <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)  <b>NOTE:</b> Both options depend on the LED status when component recognition is activated via p0144=1.

### 10.7.4.2 Status LED function

STATUS displays the readhead set-up status as shown on the readhead set-up LED; see [section 8.7](#) on page 34 for more details.

## 10.7.5 Siemens DRIVE-CLiQ interface output

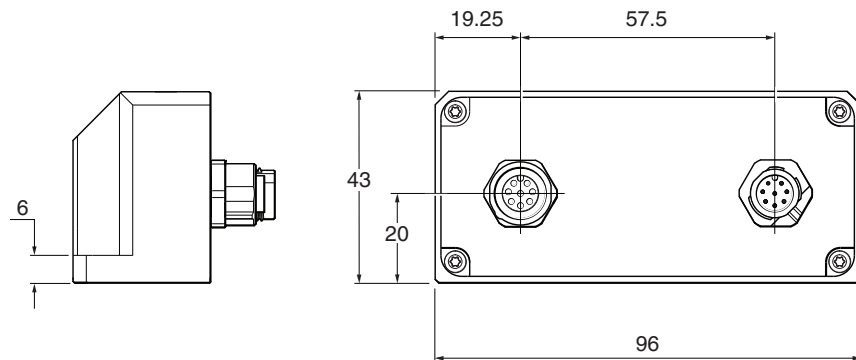
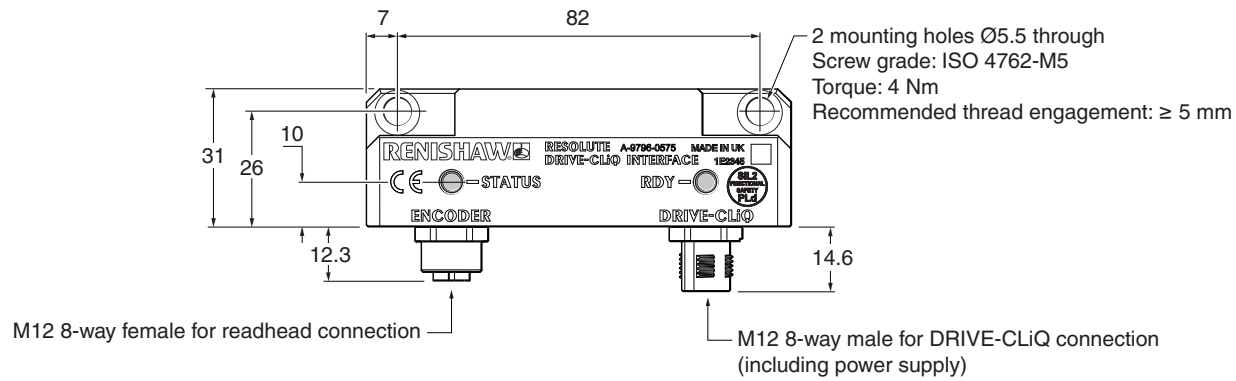
Function	Signal	Pin-out M12
<b>Power</b>	24 V	1
	0 V	5
<b>DRIVE-CLiQ serial interface</b>	RX+	3
	RX-	4
	TX+	7
	TX-	6
<b>Shield</b>	Shield	Case

### 10.7.6 Siemens DRIVE-CLiQ interface installation drawing

Single readhead (Renishaw part no. A-9796-0575)



Dimensions in mm

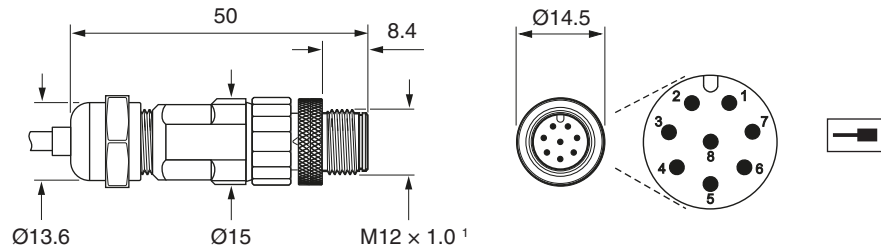


## 10.8 Yaskawa serial interface

### 10.8.1 Controller connector

Dimensions in mm

#### 8-way M12 plug

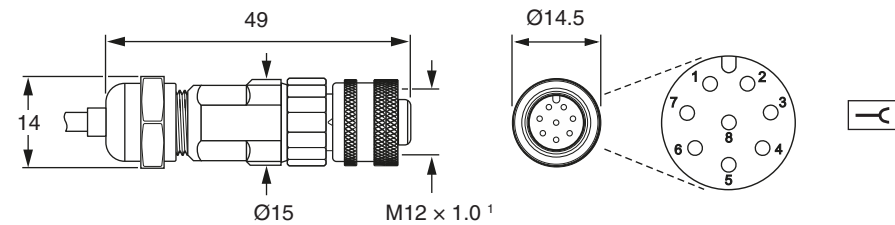


<sup>1</sup> The recommended tightening torque is 4 Nm.

### 10.8.2 In-line connector

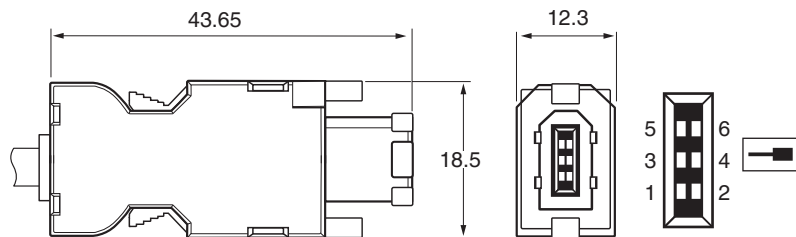
Dimensions in mm

#### 8-way M12 socket



<sup>1</sup> The recommended tightening torque is 4 Nm.

#### 6-way Molex plug





### 10.8.3 Output signals

Function	Signal	Flying lead wire colour (F)	Pin-out	
			8-way M12 (S)	6-way Molex (Y)
Power	5 V	Brown	2	1
	0 V	White	5, 8	2
		Green		Not connected
Serial interface	S	Violet	3	5
	$\bar{S}$	Yellow	4	6
Reserved	Do not connect	Grey	7	-
		Pink	6	-
Shield	Shield	Shield	Case	Case



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 #renishaw

 +44 (0) 1453 524524  [uk@renishaw.com](mailto:uk@renishaw.com)

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