

# FORTiS-S™ enclosed encoder system



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## Contents

1	Legal notices .....	5
1.1	Patents .....	5
1.2	Terms and Conditions and Warranty .....	5
1.3	Declaration of Conformity .....	5
1.4	Federal Code Of Regulation (CFR) FCC Part 15 – RADIO FREQUENCY DEVICES .....	5
1.5	Intended use .....	6
1.6	Warnings .....	6
1.7	Packaging .....	6
1.8	REACH regulation .....	6
1.9	Disposal of waste electrical and electronic equipment .....	6
2	Overview of the FORTiS encoder system .....	7
2.1	Commissioning test .....	7
2.2	Maintenance .....	7
2.3	Repair .....	7
2.4	Further information .....	8
3	Parts list .....	9
3.1	Included in the box .....	9
3.2	Not included / required tools .....	10
3.3	Optional extras .....	11
3.4	Cable options .....	11
4	Storage and handling .....	12
5	Installation drawings .....	13
5.1	Mounting surface preparation .....	13
5.2	Location edge or dowel pins .....	13

5.3	Mounting orientations . . . . .	14
5.4	FORTiS system installation drawings . . . . .	15
5.5	Mounting holes positions table . . . . .	16
6	Product specification . . . . .	17
7	Installation procedure – extrusion . . . . .	19
7.1	Protection for sealed linear encoders . . . . .	19
7.2	Fitment – general . . . . .	20
8	Installation procedure – readhead . . . . .	21
8.1	Measuring length . . . . .	21
8.2	Alignment bracket method . . . . .	21
8.3	Set-up shim method . . . . .	23
8.4	Installation using the mounting aid method . . . . .	25
8.5	FORTiS cable connection . . . . .	27
8.6	Validating an installation . . . . .	28
8.7	Air supply . . . . .	29
9	Electrical connections . . . . .	30
9.1	Electrical preparation . . . . .	30
9.2	FORTiS grounding and shielding . . . . .	30
10	Cables and serial interfaces . . . . .	31
10.1	General specifications . . . . .	31
10.2	Permissible cable lengths . . . . .	31
10.3	BiSS C serial interface . . . . .	33
10.4	FANUC serial interface . . . . .	34
10.5	Mitsubishi serial interface . . . . .	36
10.6	Panasonic serial interface . . . . .	37
10.7	Siemens serial interface . . . . .	38
10.8	Yaskawa serial interface . . . . .	41



# 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-S™ 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-S

**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-001 — Industrial, Scientific and Medical (ISM) Equipment (Canada)

This ISM device complies with Canadian ICES-001.  
Cet appareil ISM est conforme à la norme ICES-001.

### 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
	Metalised 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-S 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-S 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-S 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)

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-S encoder unit</b>	The FORTiS-S enclosed encoder system
	<b>37 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 <hr/>
	<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 38)

### 3.2 Not included / required tools

Item		Description
	<b>5 mm torque wrench</b>	To tighten the extrusion and the readhead mounting screws
	<b>1.5 mm hex key</b>	Air bung removal (only if air purge is required)
	<b>4 mm hex key</b>	For locking the mounting aid For use with the M5 extrusion and M5 readhead screw options
	<b>5 mm hex key</b>	For securing of the readhead
	<b>M6 screws</b>	2 × M6 × 1.0 screws length ≥ 35 mm for mounting readhead M6 × 1.0 screws length ≥ 20 mm for mounting the extrusion to the machine bed (see table in <a href="#">section 5.5</a> on page 16 for required quantity)
	<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-9768-3580)

Optional installation aid to assist with mounting the readhead to a machine slideway that has more than one degree of freedom (see [section 8.4](#) on page 25).



### 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 x 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 x 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 x 20 AWG (power), 4 x 23 AWG (signal), 2 x 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.

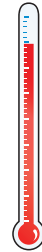


## 4 Storage and handling

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

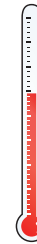
### Storage temperature

-20 °C to +70 °C



### Operating temperature

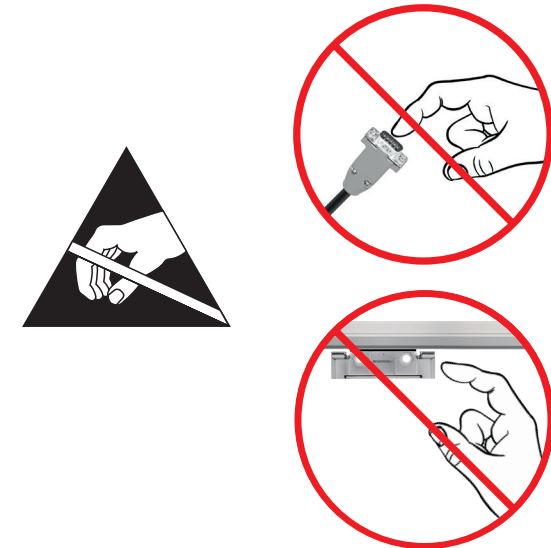
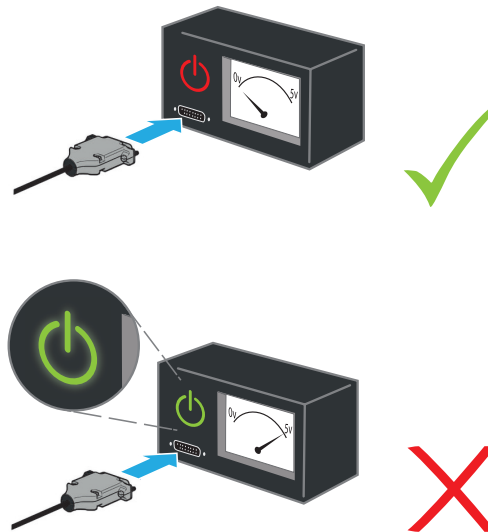
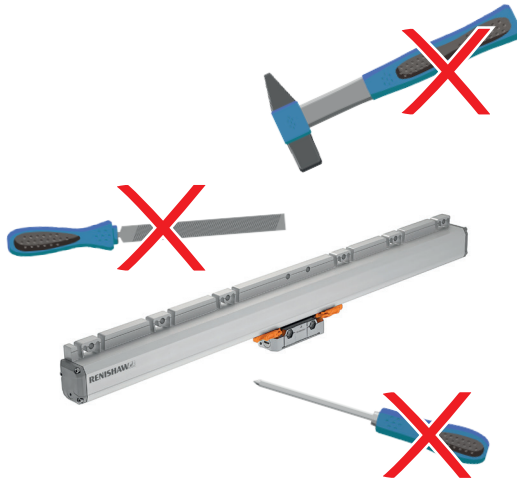
0 °C to +50 °C



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



### Handling instructions





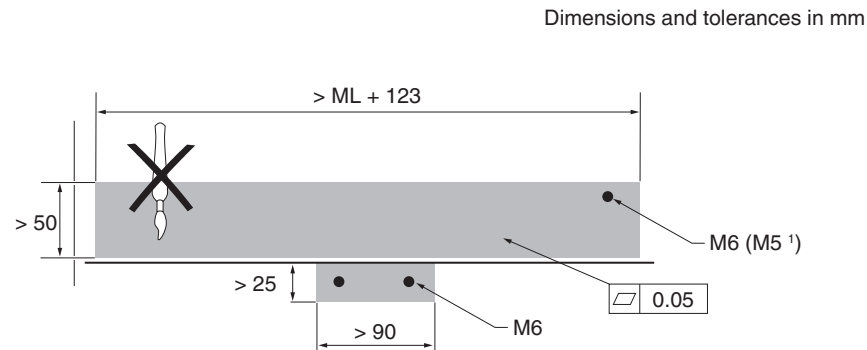
## 5 Installation drawings

### 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 5.4](#) on page 15).

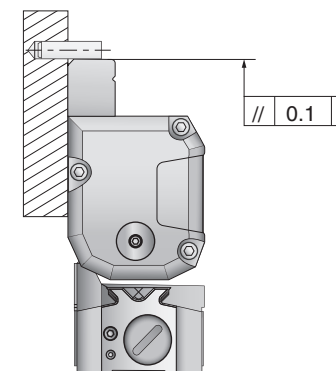
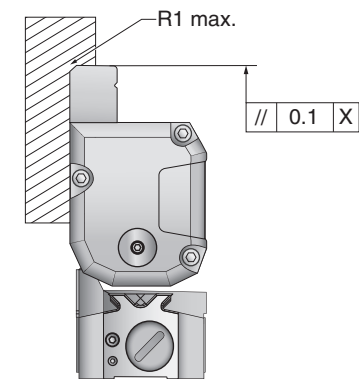
To further simplify and help reduce installation time, it is recommended that the machine axis to which the encoder is to be mounted is prepared with a datum edge or aligned dowel pins to help locate the edge of the extrusion and ensure parallelism to the axis of motion.



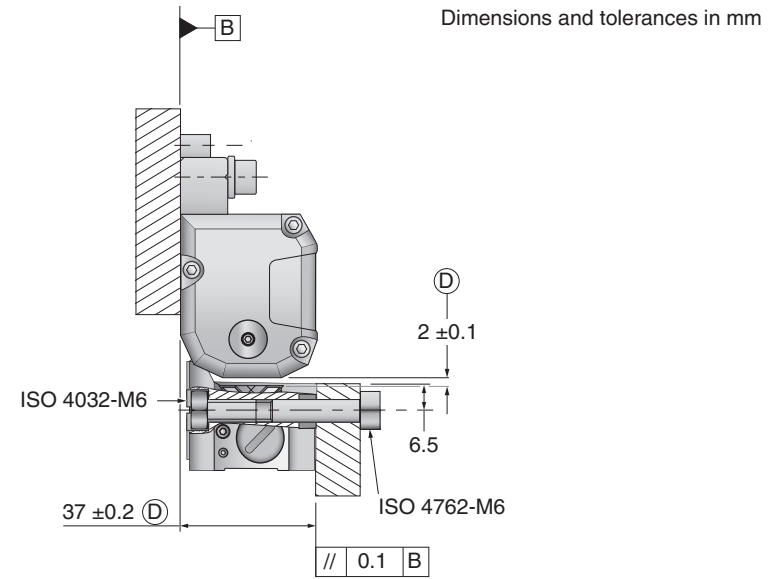
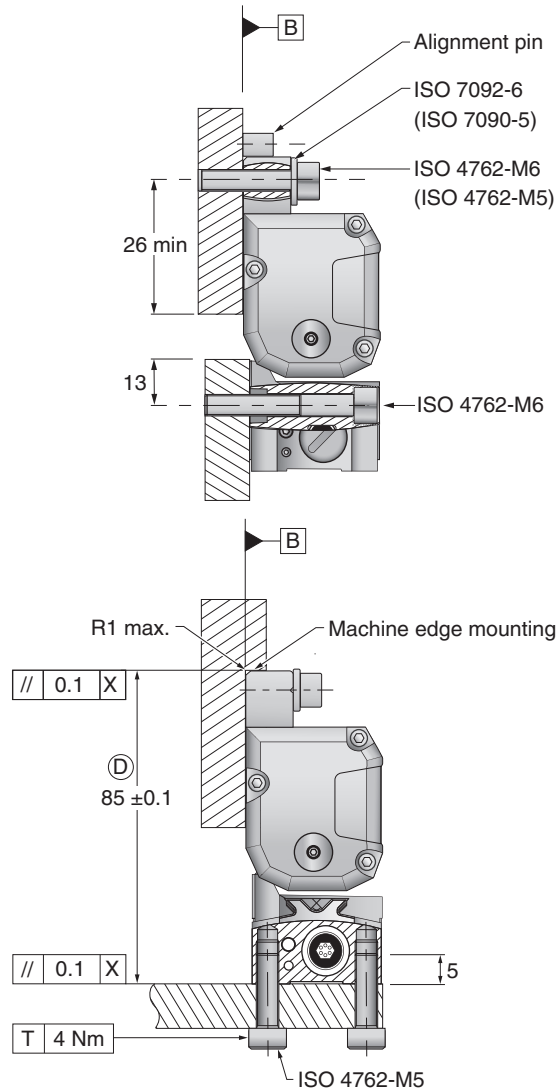
¹ Permissible alternative screw size.

### 5.2 Location edge or dowel pins

Dimensions and tolerances in mm



### 5.3 Mounting orientations



#### KEY

D = Required mounting dimensions

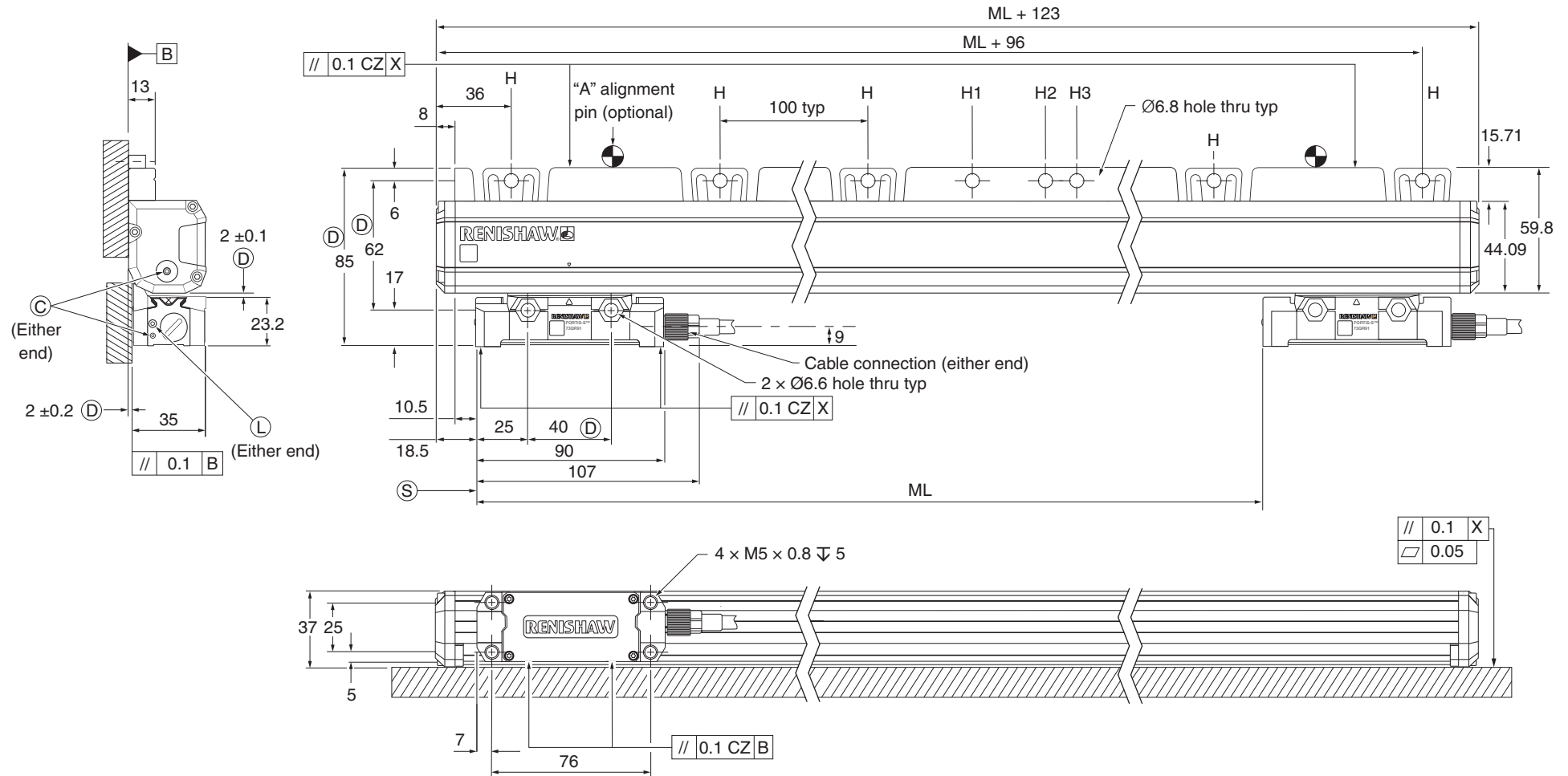
X = Machine guideway/axis datum

#### NOTES:

1. Side elevations show alternative mounting orientations.
2. Screws sizes in brackets are permissible alternatives.

## 5.4 FORTiS system installation drawings

Dimensions and tolerances in mm



### KEY

A = Recommended extrusion alignment pin locations (if required)  
Adjacent to first and last flexure holes plus every 300–500 mm

C = Compressed air inlet fitting

D = Required mounting dimensions

H = Flexure mounting holes

H1 = Fixed mounting hole (preferred)

H2 and H3 = Alternative mounting holes (non-preferred)

L = LED set-up illumination

ML = Measuring length

S = Start of measuring length

X = Machine guideway/axis datum

## 5.5 Mounting holes positions table

Measuring length	Overall length	Recommended thermal datum	Non-preferred thermal datum <sup>1</sup>		Flexure holes, H every 100 mm			
		Static hole H1	Static hole H2	Static hole H3	First flexure hole	Missing flexure hole	Last flexure hole	QTY of flexure holes
140	263	136	171	-	36	136	236	2
240	363	186	221	236	36	236	336	3
340	463	236	271	-	36	236	436	4
440 (shown)	563	286	321	336	36	336	536	5
540	663	336	371	-	36	336	636	6
640	763	386	421	436	36	436	736	7
740	863	436	471	-	36	436	836	8
840	963	486	521	536	36	536	936	9
940	1063	536	571	-	36	536	1036	10
1040	1163	586	621	636	36	636	1136	11
1140	1263	636	671	-	36	636	1236	12
1240	1363	686	721	736	36	736	1136	13
1340	1463	736	771	-	36	736	1436	14
1440	1563	786	821	836	36	836	1563	15
1540	1663	836	871	-	36	836	1636	16
1640	1763	886	921	936	36	936	1736	17
1740	1863	936	971	-	36	936	1836	18
1840	1963	986	1021	1036	36	1036	1936	19
2040	2163	1086	1121	1136	36	1136	2136	21
2240	2363	1186	1221	1236	36	1236	2336	23
2440	2563	1286	1321	1336	36	1336	2536	25
2640	2763	1386	1421	1436	36	1436	2736	27
2840	2963	1486	1521	1536	36	1536	2936	29
3040	3163	1586	1621	1636	36	1636	3136	31

<sup>1</sup> The non-preferred thermal datum holes are only included to provide bolt-hole compatibility with old, obsolete encoders. New machines should be designed to use the recommended thermal datum only.

## 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>	140, 240, 340, 440, 540, 640, 740, 840, 940, 1040, 1140, 1240, 1340, 1440, 1540, 1640, 1740, 1840, 2040, 2240, 2440, 2640, 2840, 3040, 3240
<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 (customer configurable exit direction)
<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 17 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)	< 5 N
<b>Vibration</b> (55 Hz to 2 000 Hz)	Housing: < 300 m/s <sup>2</sup> to IEC 60068-2-6 Readhead: < 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 8.7</a> on page 29 for details
<b>Weight</b>	0.27 kg + 2.0 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.

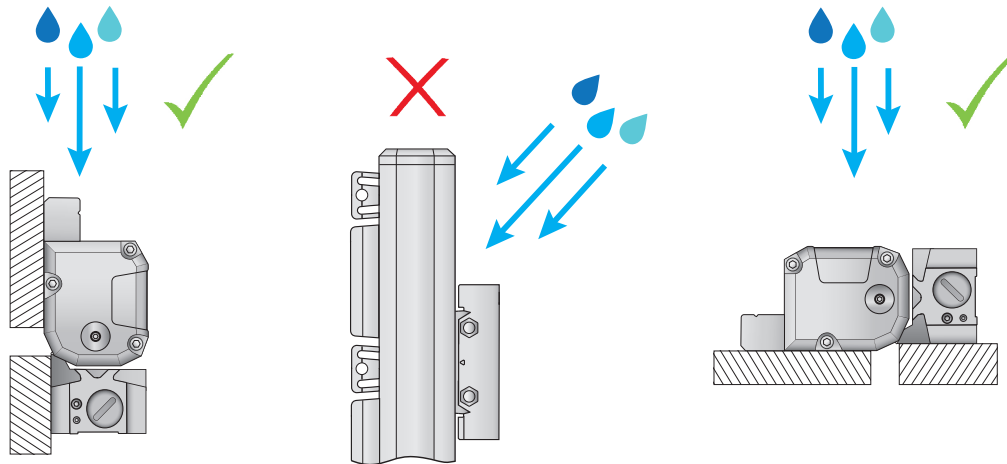
Position word length	Nomenclature code	Accuracy grade	Resolution options (nm)
34 bit	34D	3 µm	1
30 bit	30D	5 µm	10
28 bit	28D	5 µm	50

## 7 Installation procedure – extrusion

### 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 8.7](#) on page 29.

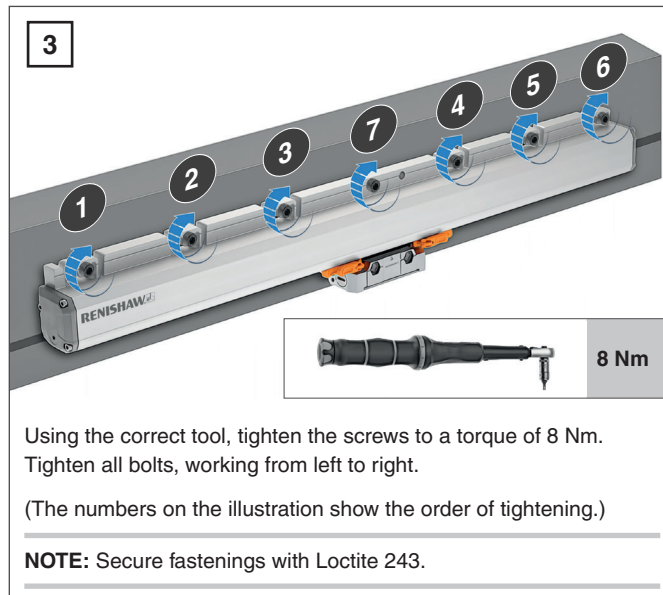
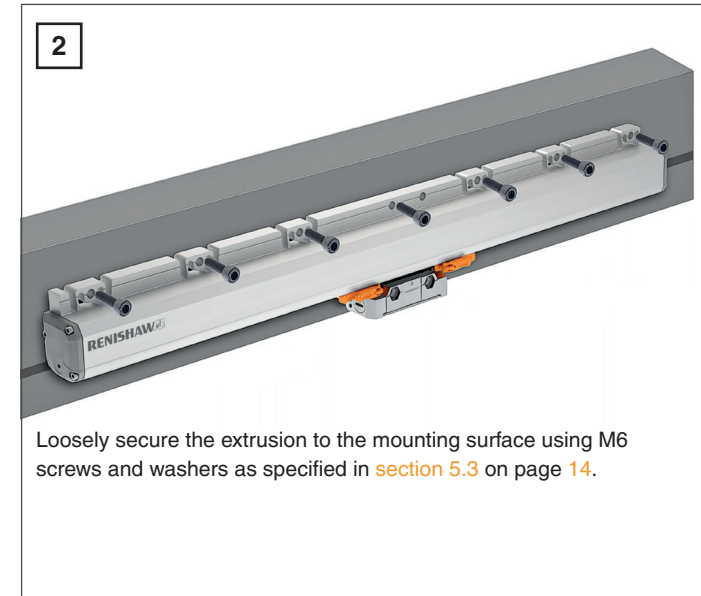
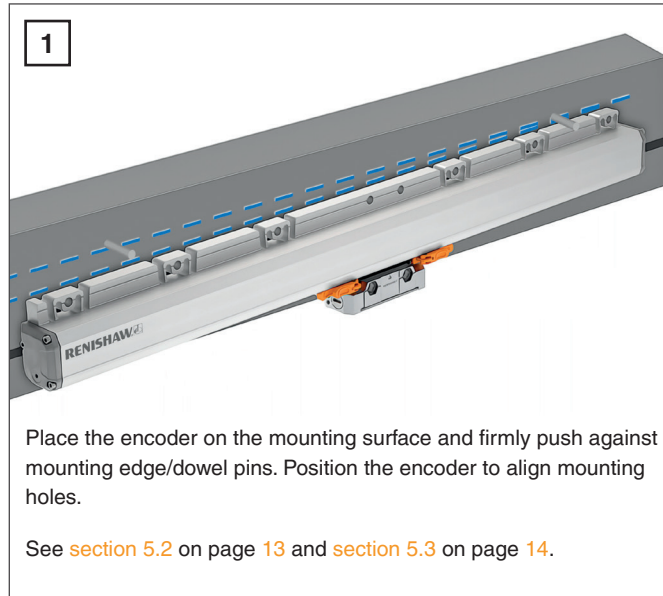


## 7.2 Fitment – general

Please note that fitment of the extrusion is independent of readhead mounting. For illustrative purposes dowel pins are displayed, but the procedure for a datum edge is identical. Where neither an edge or dowel pins are available, begin by aligning extrusion mounting holes.<sup>1</sup>

Ensure the mounting faces are clean before installation.

<sup>1</sup> 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.





## 8 Installation procedure – readhead

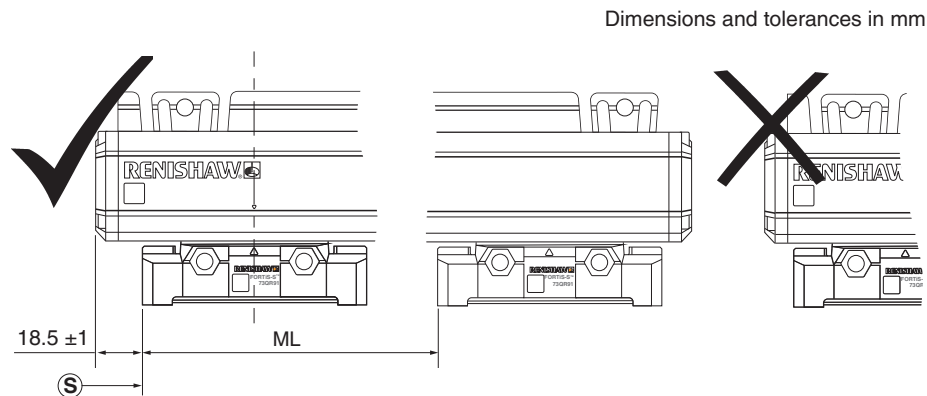
Three different methods may be used to install the readhead, making installation easier for a wide range of machine types and mounting surfaces. These are outlined in the following sections.

**NOTE:** Installation of the extrusion follows the procedure outlined in [section 7](#) on page 19 and is independent of the readhead installation method being used.

### 8.1 Measuring length

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.

#### 8.1.1 Start of measuring length



**KEY**

ML = Measuring length

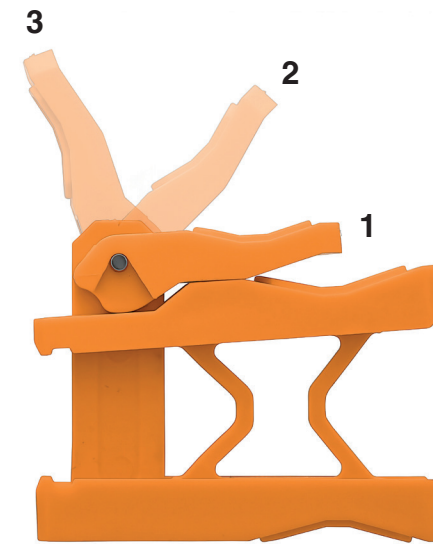
S = Start of measuring length

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

### 8.2 Alignment bracket method

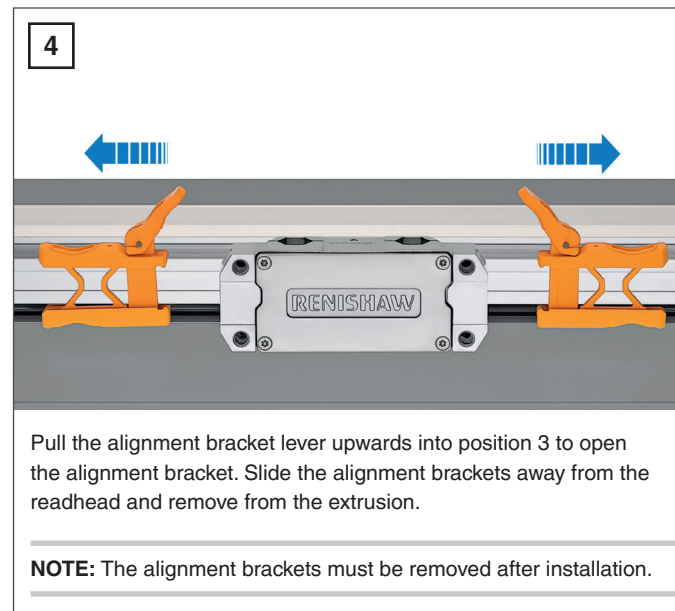
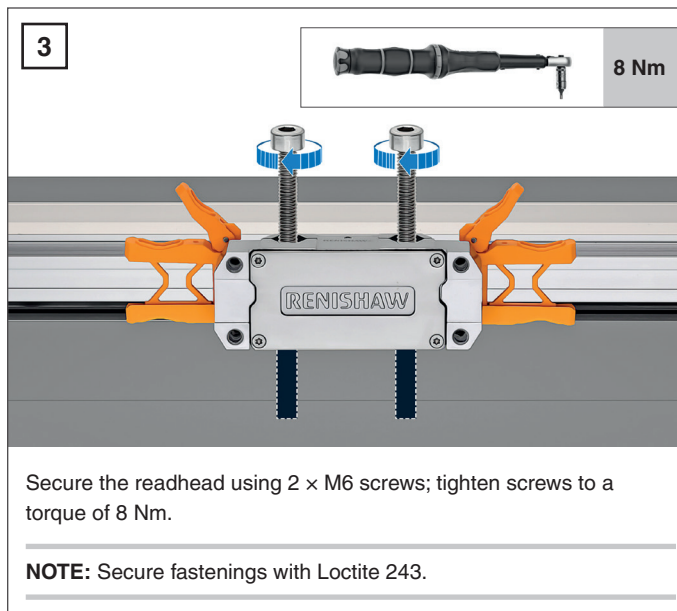
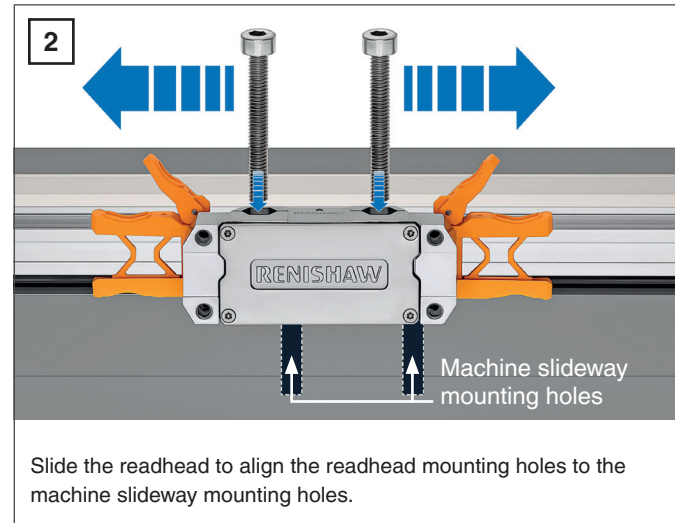
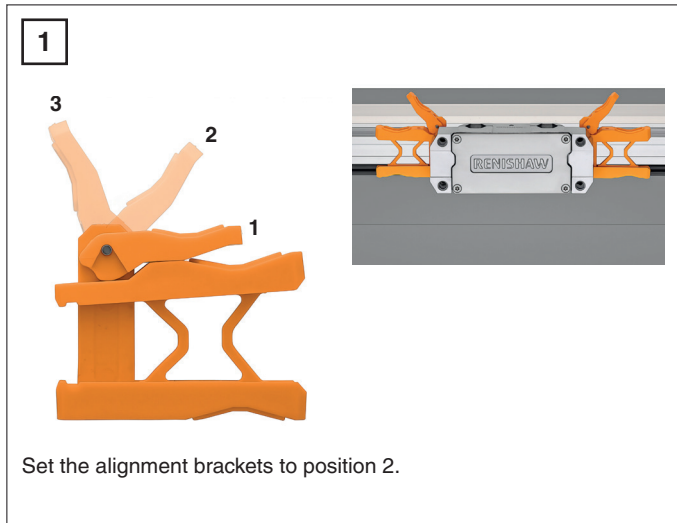
Pre-fitted alignment brackets help protect and secure the readhead to the extrusion during transit. These alignment brackets can also be used to set the readhead at the nominal installation rideheight.

The alignment brackets have three different operating positions which are detailed in the table below.



Position	Status	Description
1	Closed	Alignment bracket locks the readhead to the extrusion for transit
2	Semi-open	Readhead can be moved along the extrusion for alignment purposes, whilst maintaining optimum rideheight
3	Open	Alignment bracket can be removed from the extrusion after installation

## 8.2.1 Installation using the alignment bracket method

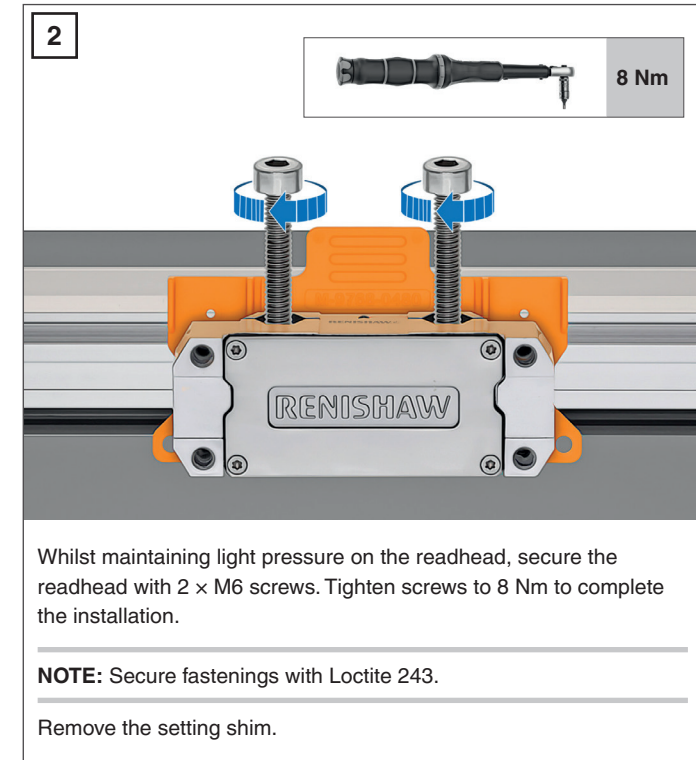
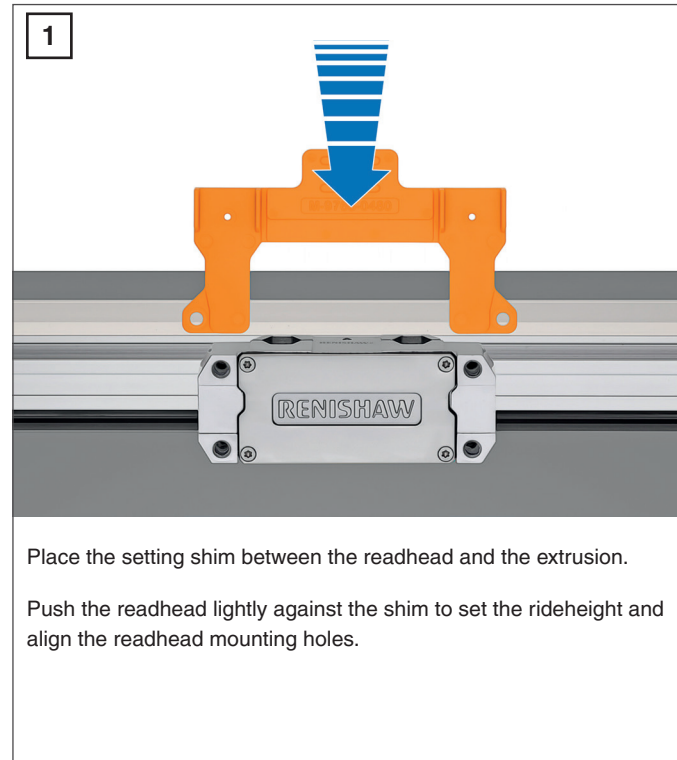


## 8.3 Set-up shim method

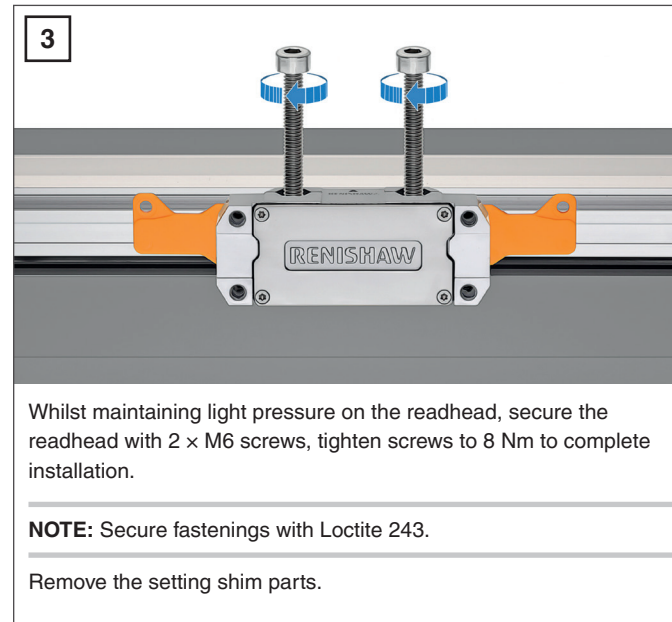
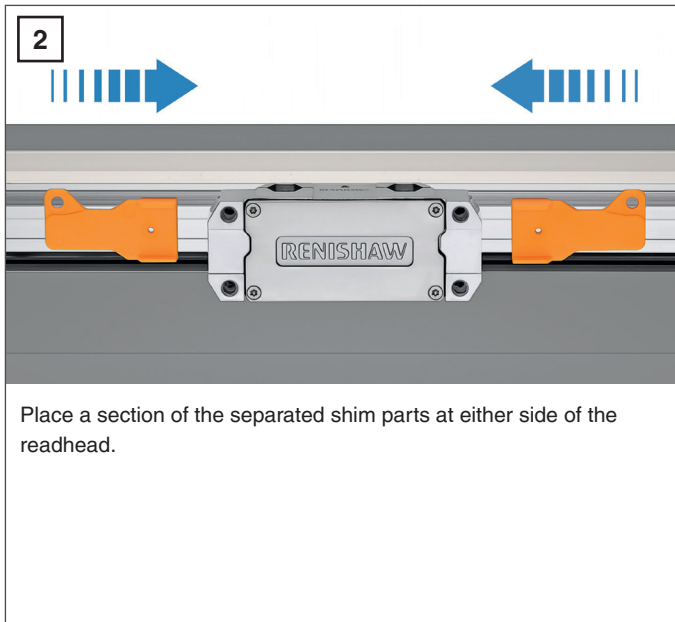
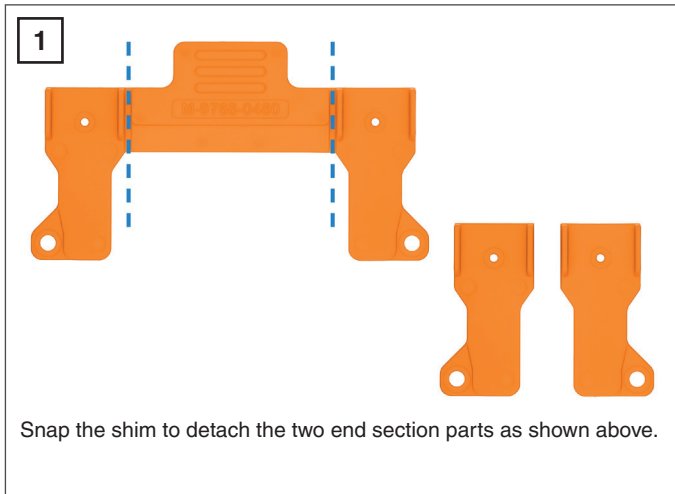
When using this method, remove the alignment brackets (see [section 8.2.1](#) on page 22) just prior to installation.

Where access to the readhead from either side is restricted in the installation position, a setting 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.

### 8.3.1 Front setting shim procedure



### 8.3.2 Side setting shim procedure

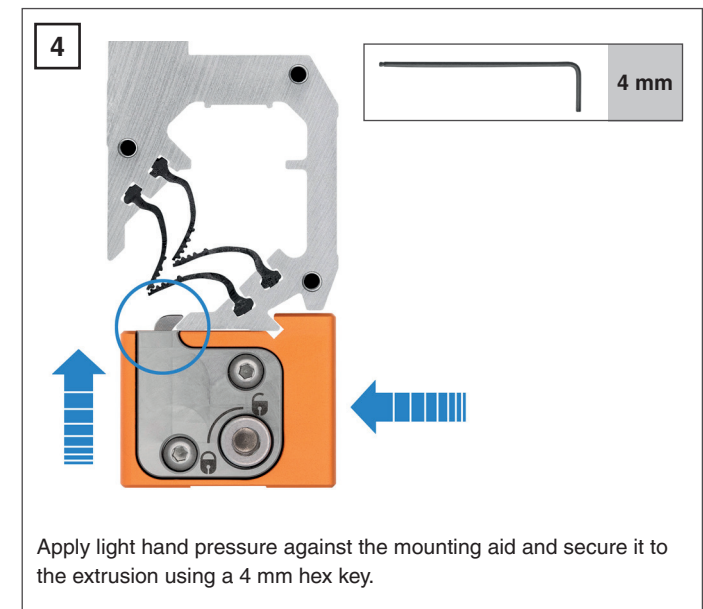
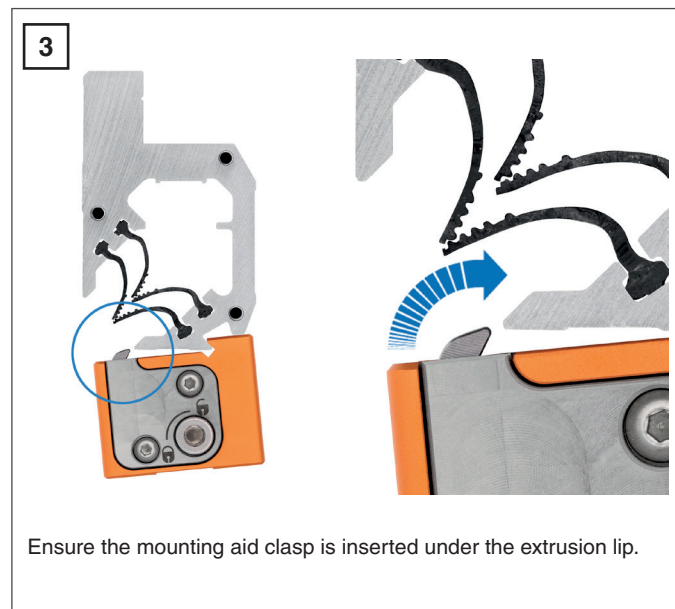
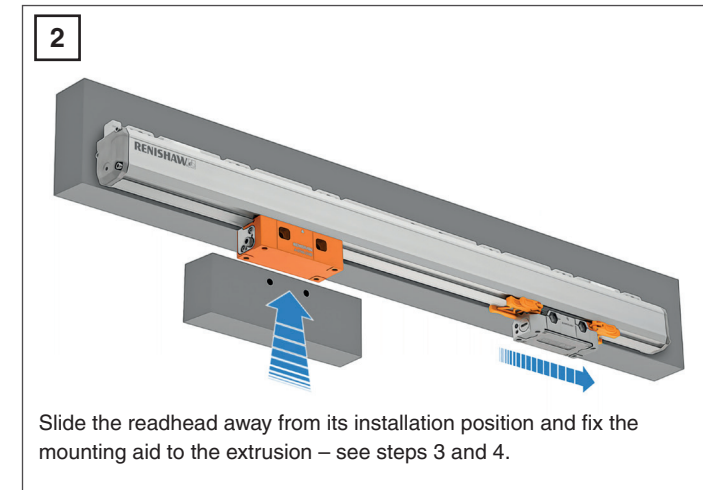
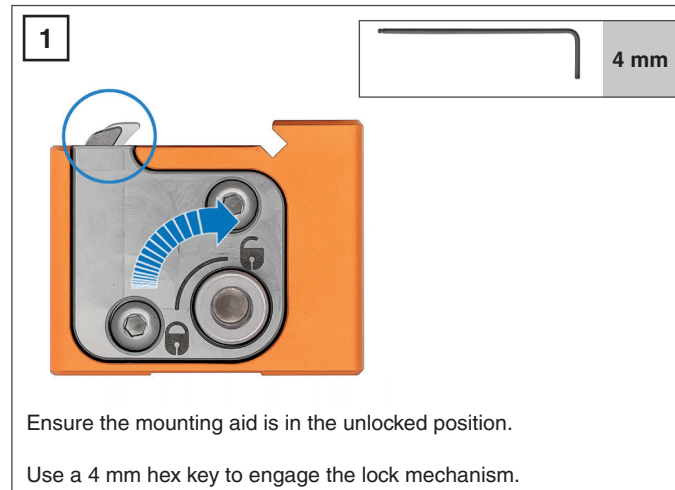


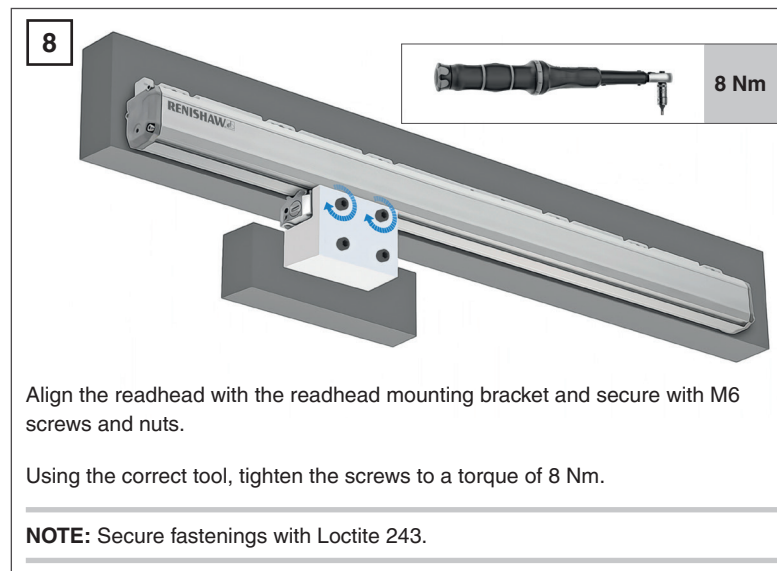
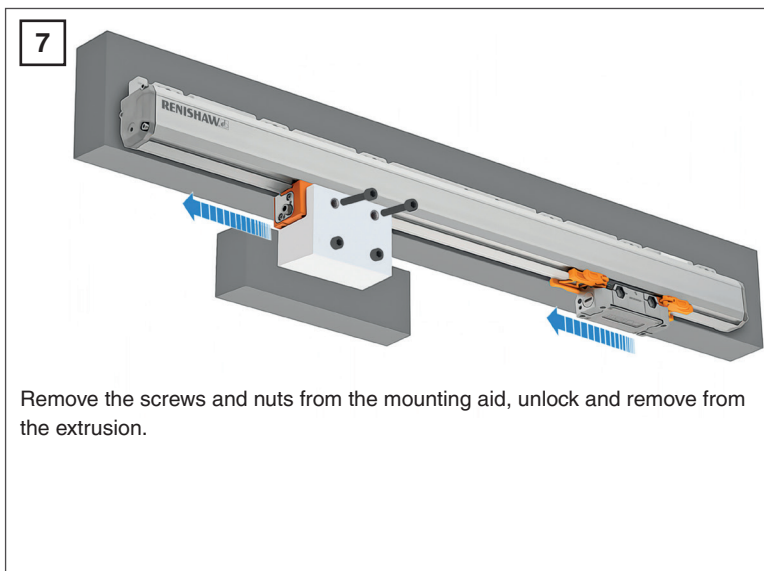
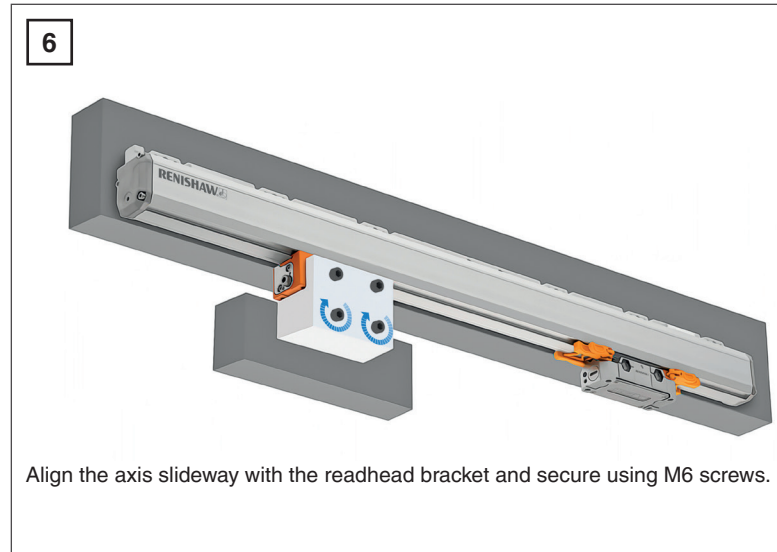
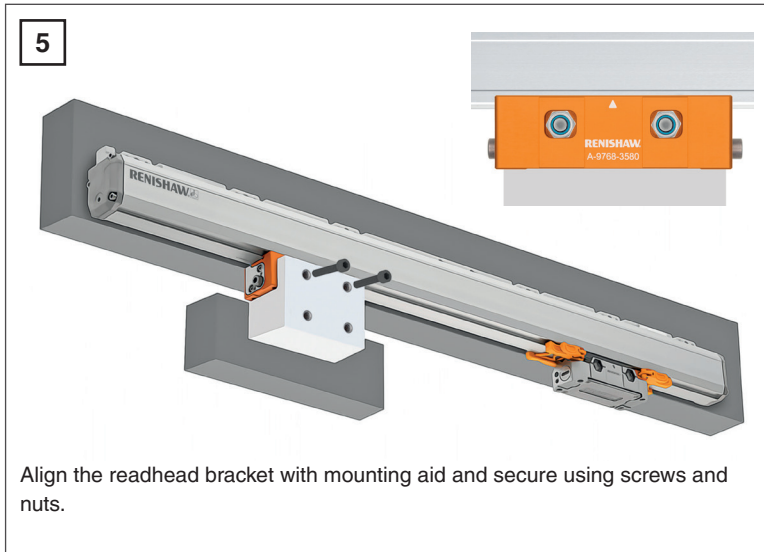
## 8.4 Installation using the mounting aid method

**NOTE:** 37 mm mounting aid and 4 mm hex key required.

Remove the alignment brackets prior to installation using the mounting aid.

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.



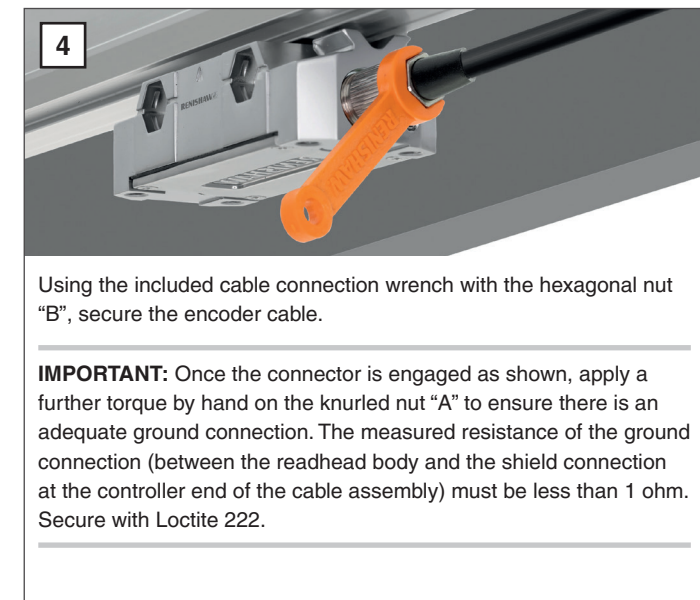
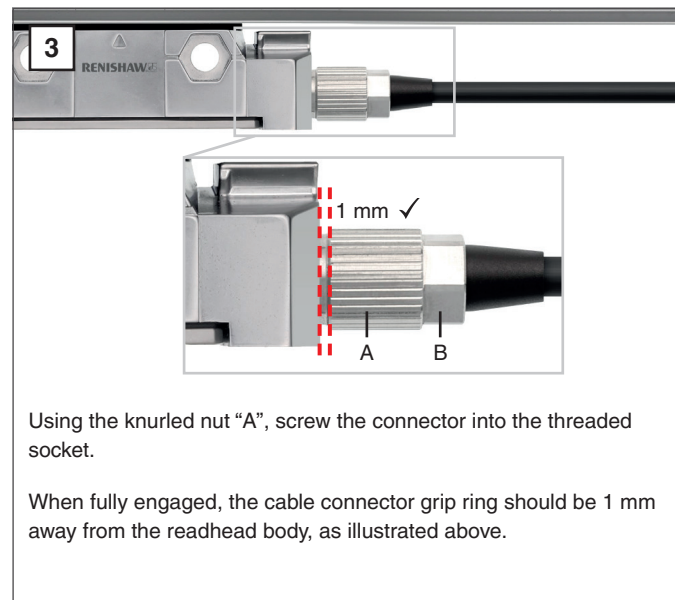
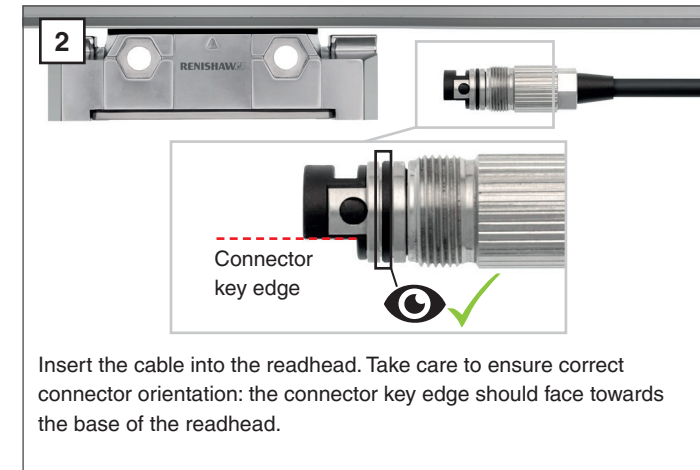
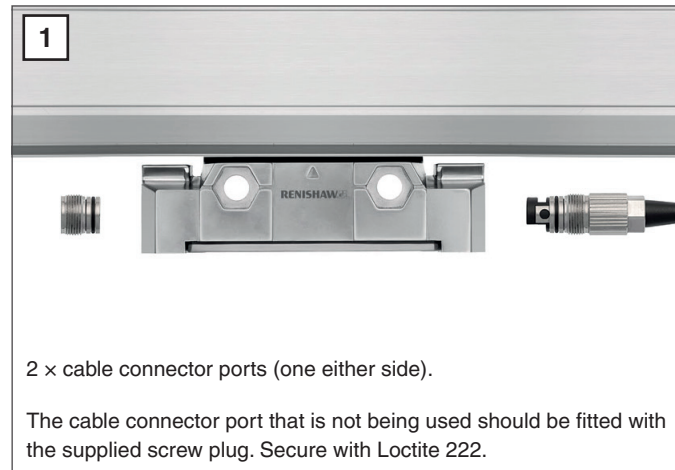




## 8.5 FORTiS cable connection

To assist with cable management the FORTiS-S system has two cable entry ports, allowing the cable to be inserted into either side of the readhead.

**NOTE:** Cable connection thread should be secured with Loctite 222.



## 8.6 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 30 for encoder power supply requirements.

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**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 13) 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	
 <b>FLASHING RED</b>	Unable to determine the position	Readhead not picking up the scale due to contamination or poor installation <hr/> <b>NOTE:</b> Flashing LED indicates scale reading error. Flashing state is latched for some serial interfaces. <hr/> Remove power to reset.



## 8.7 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>Air quality</b>	Particle size 0.1 µm to 0.5 µm 0.5 µm to 1.0 µm 1.0 µm to 5.0 µm	No. of particles per m <sup>3</sup> ≤ 20 000 ≤ 400 ≤ 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> )	
<b>Overpressure</b>	Operating pressure range: Rating 0.7 MPa Maximum 1.0 MPa Minimum 0.3 MPa	

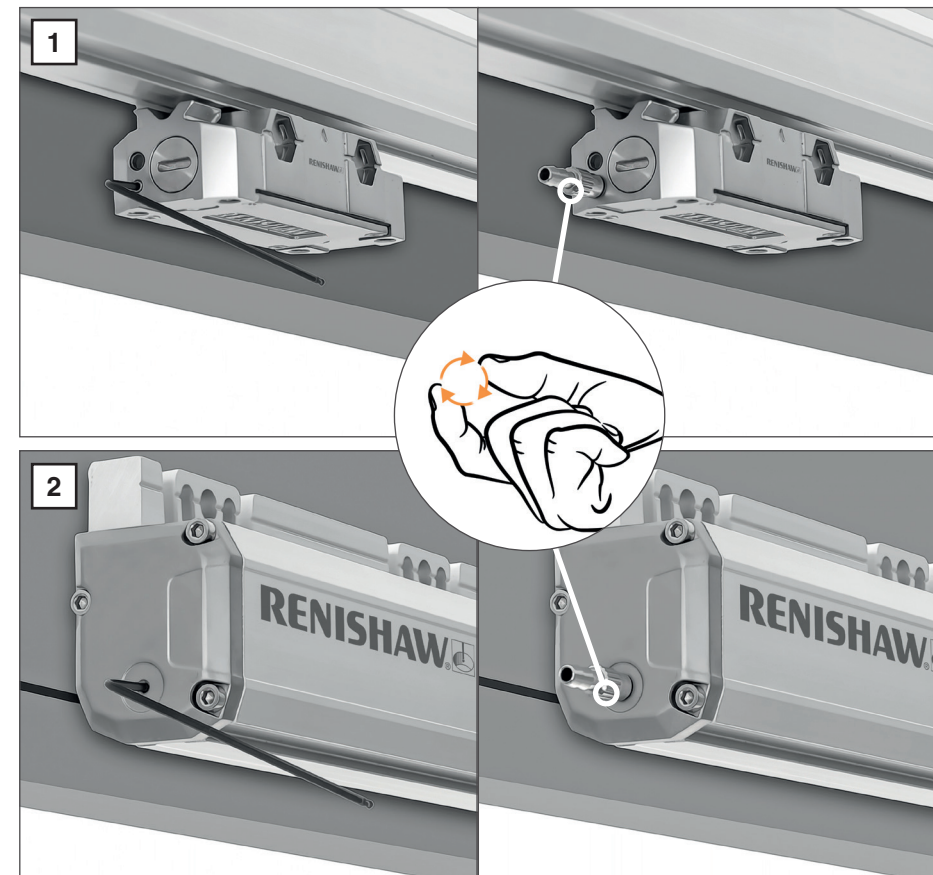
It may be convenient to connect the air purge supply to the system part that will be fixed, i.e., depending on the machine configuration and axis movement, either the extrusion or the readhead may move with the machine slideway.

Air inlets are included on 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).

**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.

**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).

## 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  $\pm$ 5%.
- Operating current: 250 mA.
- Operating power @5 V: 1.25 W.

The system must be earthed as per the image opposite.

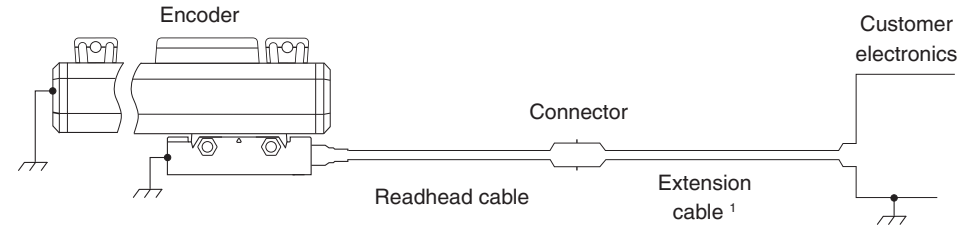
### 9.2 FORTiS grounding and shielding

#### IMPORTANT:

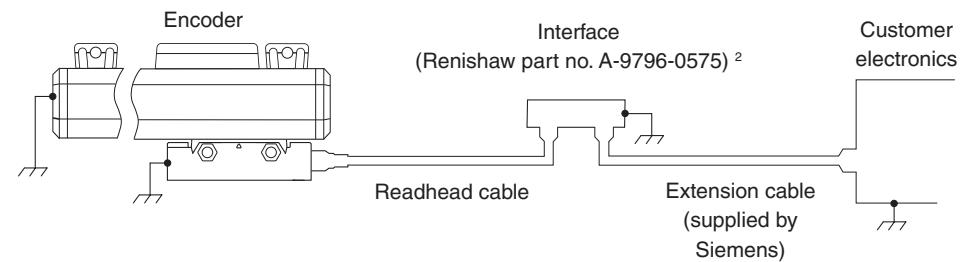
1. The shield should be connected to the machine earth (field ground).
2. If the flying lead variant is used or the connector is modified or replaced, the customer must ensure that both 0 V cores (white and green) are connected to 0 V. In such situations, care should also be taken to ensure that 0 V 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 interface (Renishaw part no. A-9796-0575).

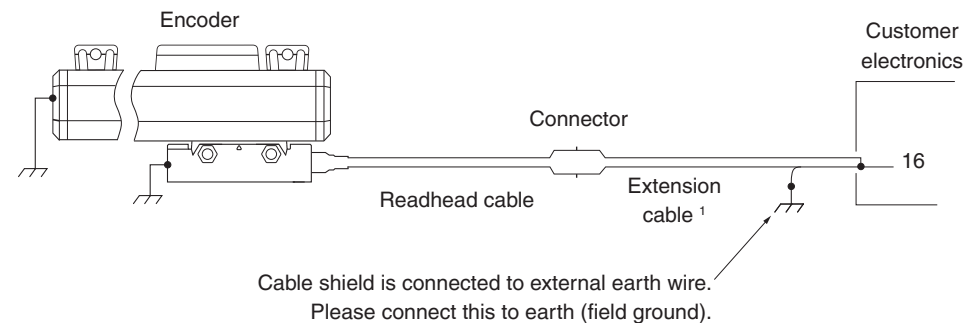
**Figure 1** Standard arrangement.



**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 38 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 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 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 tables in this section, but the combination of readhead cable and extension cable MUST NOT EXCEED 10 m.

Readhead cable length (m)		Extension cable length (m)						
		1	3	6	9	12	15	20
<b>Type A</b>	0.5	✓	✓	✓	✓	✓	✓	✓
	1	✓	✓	✓	✓	✓	✓	✓
	3	✓	✓	✓	✓	✓	✓	✗
	6	✓	✓	✓	✓	✗	✗	✗
	9	✗	✗	✗	✗	✗	✗	✗
<b>Type B</b>	0.5	✓	✓	✓	✓	✓	✓	✓
	1	✓	✓	✓	✓	✓	✓	✓
	3	✓	✓	✓	✓	✓	✓	✓
	6	✓	✓	✓	✓	✓	✓	✓
	9	✓	✓	✓	✓	✓	✓	✗
<b>Type D (armoured)</b>	1	✓	✓	✓	✓	✓	✓	✓
	3	✓	✓	✓	✓	✓	✓	✗
	6	✓	✓	✓	✓	✗	✗	✗
	9	✗	✗	✗	✗	✗	✗	✗

Type B extension cables

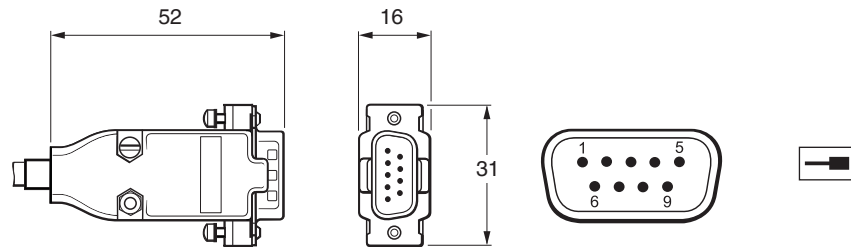
Readhead cable length (m)	Max. extension cable length (m)	
<b>Type A</b>	0.5	55
	1	51
	3	38
	6	20
	9	1
<b>Type B</b>	0.5	56
	1	55
	3	51
	6	45
	9	39

**Type C extension cables**

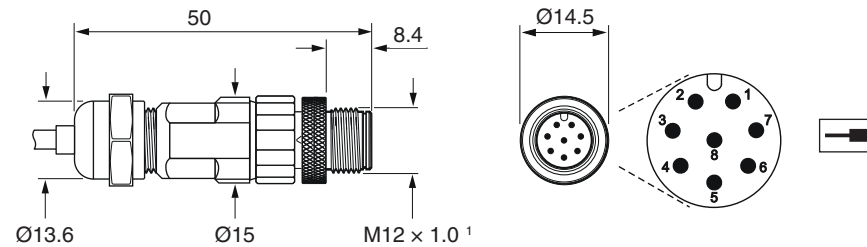
## 10.3 BiSS C serial interface

### 10.3.1 Controller connector

9-way D-type plug Dimensions in mm

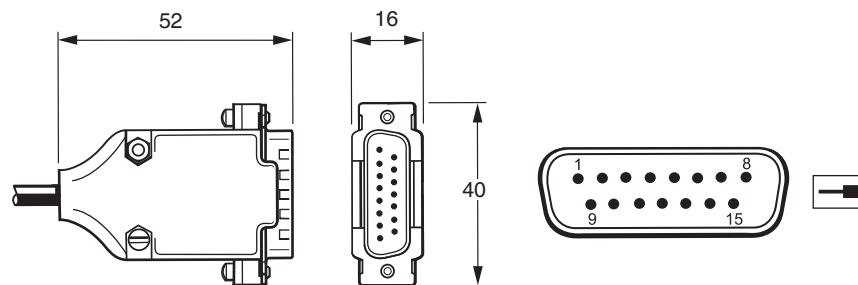


8-way M12 plug



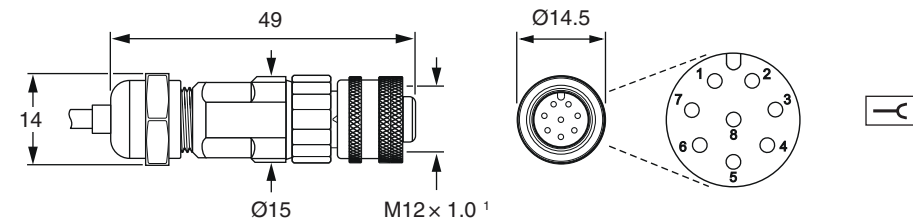
<sup>1</sup> The recommended tightening torque is 4 Nm.

15-way D-type plug



### 10.3.2 In-line connector

8-way M12 socket Dimensions in mm



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

### 10.3.3 Output signals

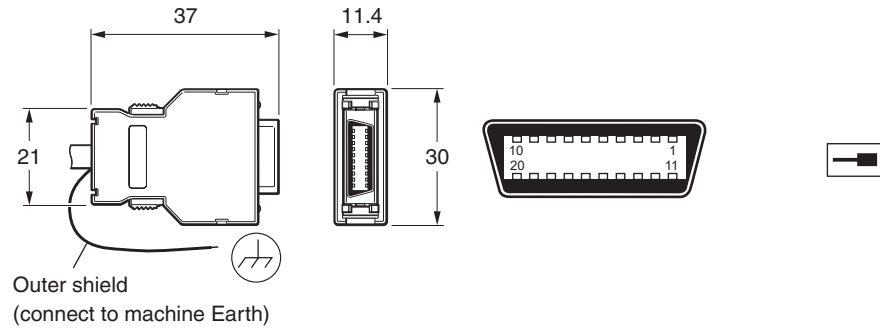
Function	Signal	Flying lead wire colour (F)	Pin-out		
			9-way D-type (A)	8-way M12 (S)	15-way D-type (D)
Power	5 V	Brown	4, 5	2	4, 12
	0 V	White	8, 9	5, 8	2, 10
Serial interface	MA+	Violet	2	3	8
	MA-	Yellow	3	4	15
	SLO+	Grey	6	7	5
	SLO-	Pink	7	6	13
Shield	Shield	Shield	Case	Case	Case

## 10.4 FANUC serial interface

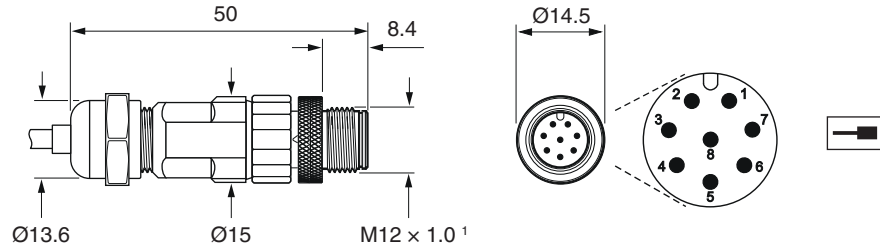
### 10.4.1 Controller connector

Dimensions in mm

#### 20-way plug

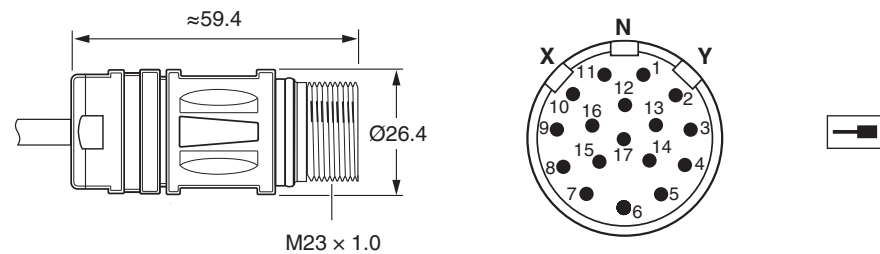


#### 8-way M12 plug



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

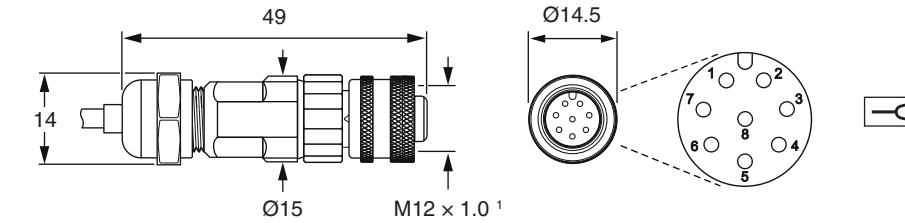
#### 17-way M23 plug



### 10.4.2 In-line connector

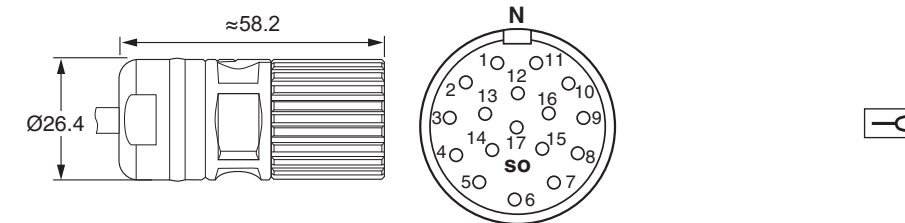
Dimensions in mm

#### 8-way M12 socket



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

#### 17-way M23 socket



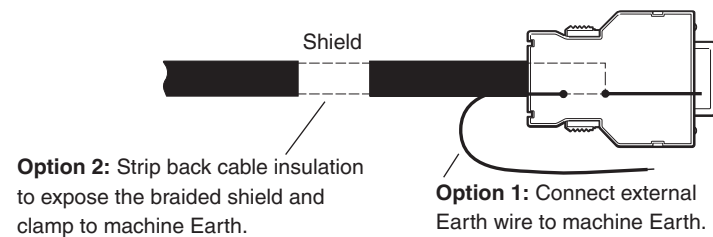
### 10.4.3 Output signals

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.

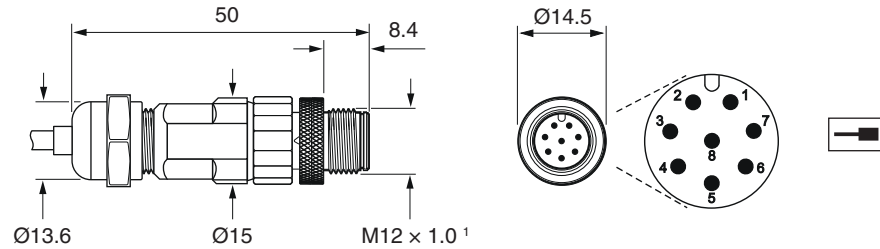


## 10.5 Mitsubishi serial interface

### 10.5.1 Controller connector

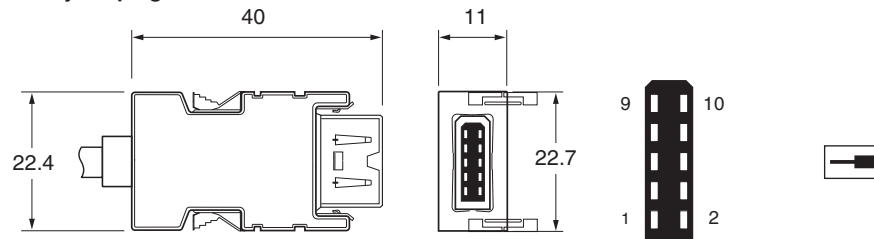
Dimensions in mm

#### 8-way M12 plug

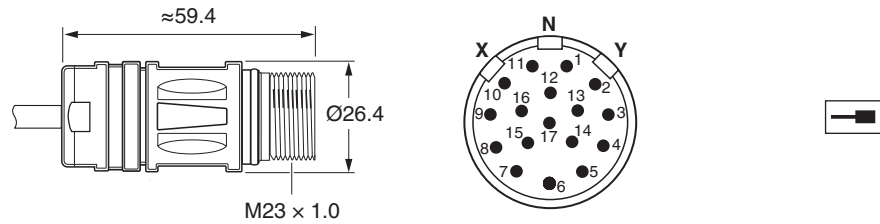


<sup>1</sup> The recommended tightening torque is 4 Nm.

#### 10-way 3M plug



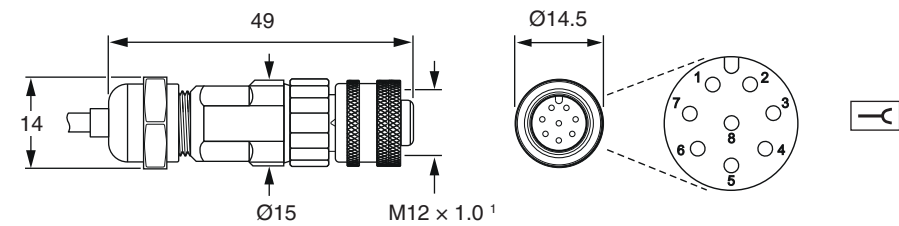
#### 17-way M23 plug



### 10.5.2 In-line connector

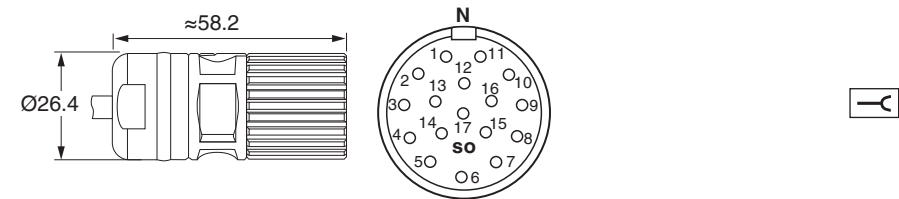
Dimensions in mm

#### 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

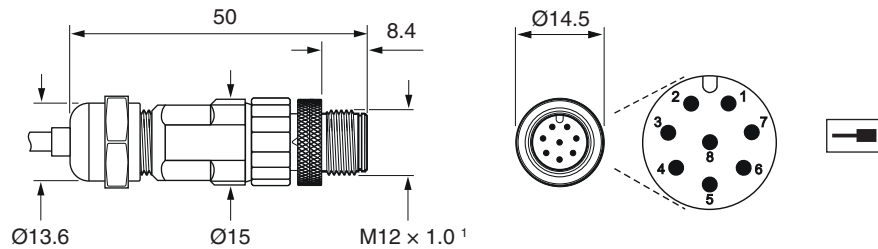


## 10.6 Panasonic serial interface

### 10.6.1 Controller connector

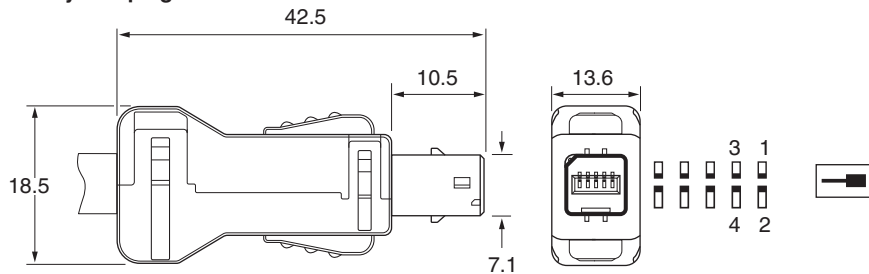
Dimensions in mm

#### 8-way M12 plug



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

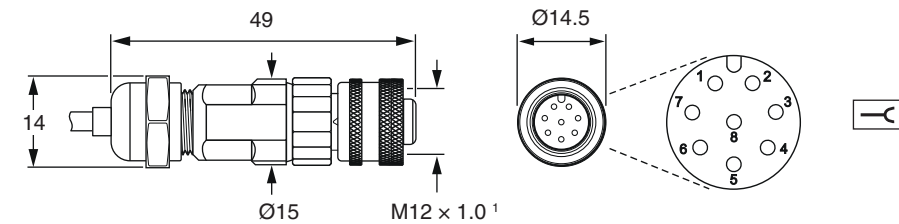
#### 10-way JST plug



### 10.6.2 In-line connector

Dimensions in mm

#### 8-way M12 socket



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

### 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
	$\overline{\text{PS}}$	Yellow	4	4
Reserved	Do not connect	Grey	7	-
		Pink	6	-
Shield	Shield	Shield	Case	Case

## 10.7 Siemens serial interface

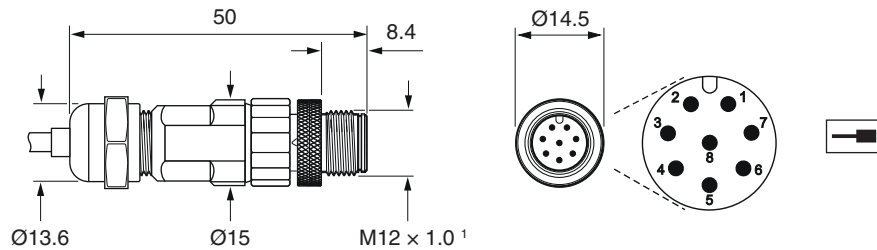
Included with Siemens-only versions of FORTiS.

DRIVE-CLiQ interface connector		
Power supply	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
Maximum total cable length	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	
Connector tightening torque	M12 – 4 Nm	

### 10.7.1 Controller connector

Dimensions in mm

8-way M12 plug

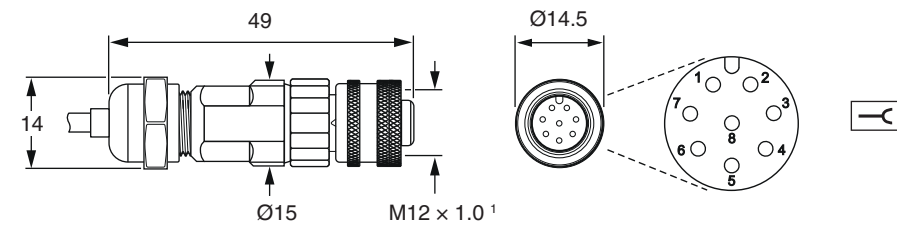


<sup>1</sup> The recommended tightening torque is 4 Nm.

### 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 8.6](#) on page 28 for more details.

## 10.7.5 Siemens DRIVE-CLiQ interface output

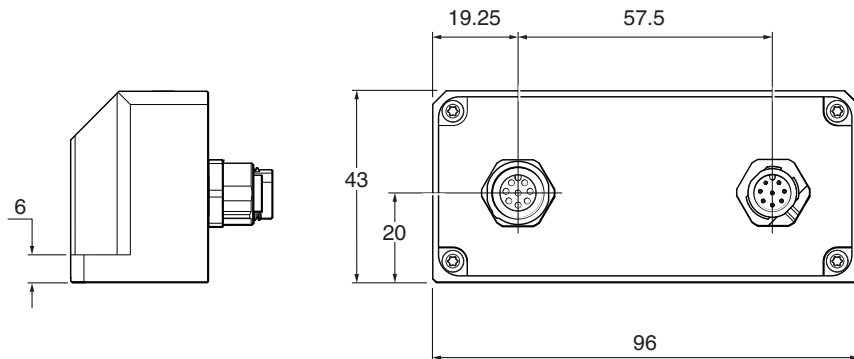
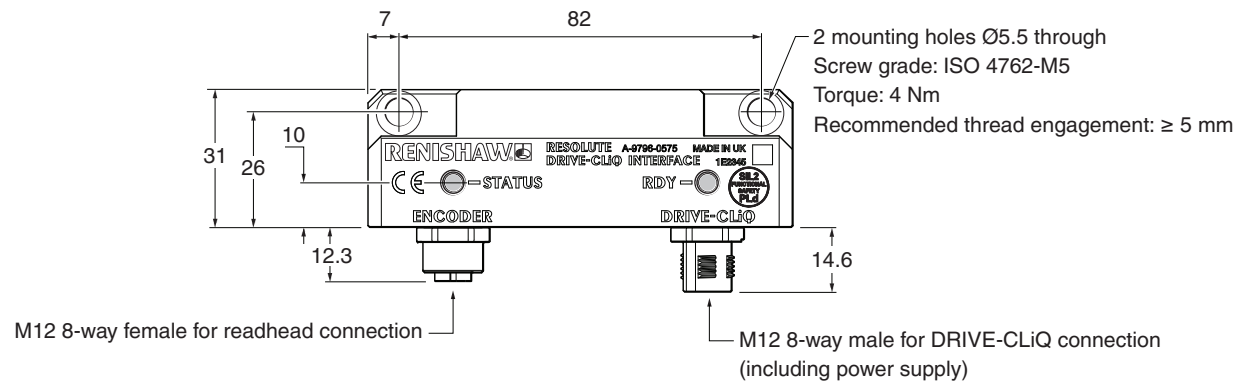
Function	Signal	Pin-out M12
<b>Power</b>	24 V	1
	0 V	5
<b>DRIVE-CLiQ serial interface</b>	RX+	3
	RX-	4
	TX+	7
	TX-	6
<b>Shield</b>	Shield	Case

## 10.7.6 Siemens DRIVE-CLiQ interface installation drawing

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



Dimensions in mm

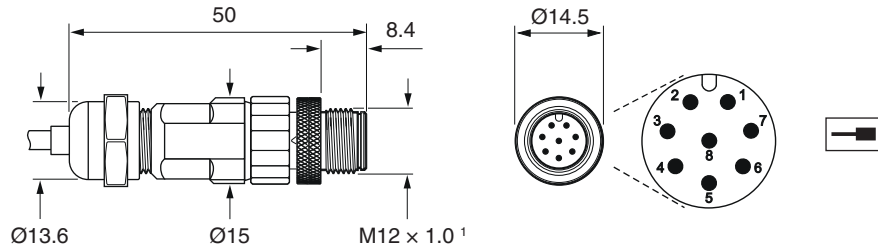


## 10.8 Yaskawa serial interface

### 10.8.1 Controller connector

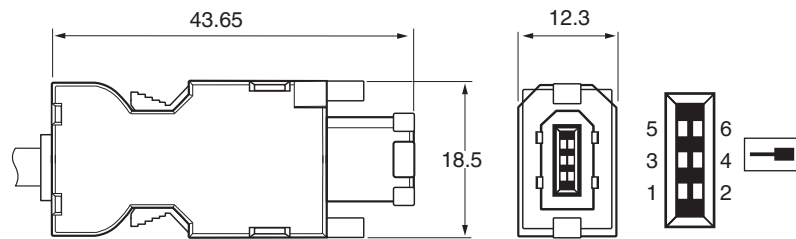
Dimensions in mm

#### 8-way M12 plug



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

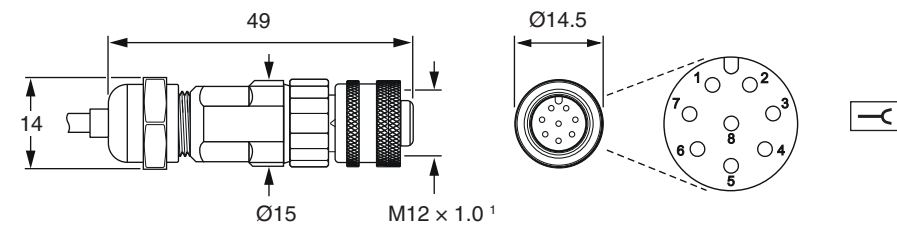
#### 6-way Molex plug



### 10.8.2 In-line connector

Dimensions in mm

#### 8-way M12 socket





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

### 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
	$\overline{S}$	Yellow	4	6
Reserved	Do not connect	Grey	7	-
		Pink	6	-
Shield	Shield	Shield	Case	Case

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

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