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FORTiS-S™ enclosed encoder system



Specification

Measuring standard	Renishaw stainless-steel scale with single track absolute encoding
Coefficient of thermal expansion (at 20 °C)	10.1 ±0.2 µm/m/°C
Thermal datum	At centre position (encoder position of 0.5 × measuring length)
Measuring lengths available (mm)	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, 3440, 3640, 3840, 4040, 4240
Accuracy grades	High grade: ≤ ±3 µm (available in lengths up to 3040 mm only) Standard grade: ≤ ±5 µm
Resolution [1]	0.5 nm, 1 nm, 1.25 nm, 10 nm, 12.5 nm, 25 nm, 50 nm
Sub-Divisional Error (typical)	±40 nm
Jitter (RMS)	10 nm
Absolute position serial interface	BiSS C, FANUC (α/αi), Mitsubishi, Panasonic, Siemens DRIVE-CLiQ (with external interface), Yaskawa
Encoder electrical connection	Cable connector M12 custom (customer configurable exit direction)
Controller electrical connection	8-way M12, FANUC 20-way, 10-way Mitsubishi, 17-way M23, 9-way D-Type, 14-way LEMO, flying lead
Cable length	Up to 100 m (with extension cable)
Power supply	5 V ±10% 1.25 W maximum (250 mA @ 5 V)
Set-up LED	Signal strength indicator LED
Maximum speed	4 m/s
Acceleration (readhead relative to scale)	< 200 m/s² in measuring direction
Moving force (maximum force required to move the readhead through the seals)	< 5 N
Vibration (55 Hz to 2 000 Hz)	Housing: < 300 m/s² to IEC 60068-2-6 Readhead: < 300 m/s² to IEC 60068-2-6
Shock 11 ms half-sine	< 300 m/s² IEC 60068-2-27
Operating temperature	0 °C to 50 °C
Environment protection	IP53 when installed correctly, IP64 with air purge
Air purge requirements	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
Weight	0.27 kg + 2.0 kg/m

[1] See page 2.

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).

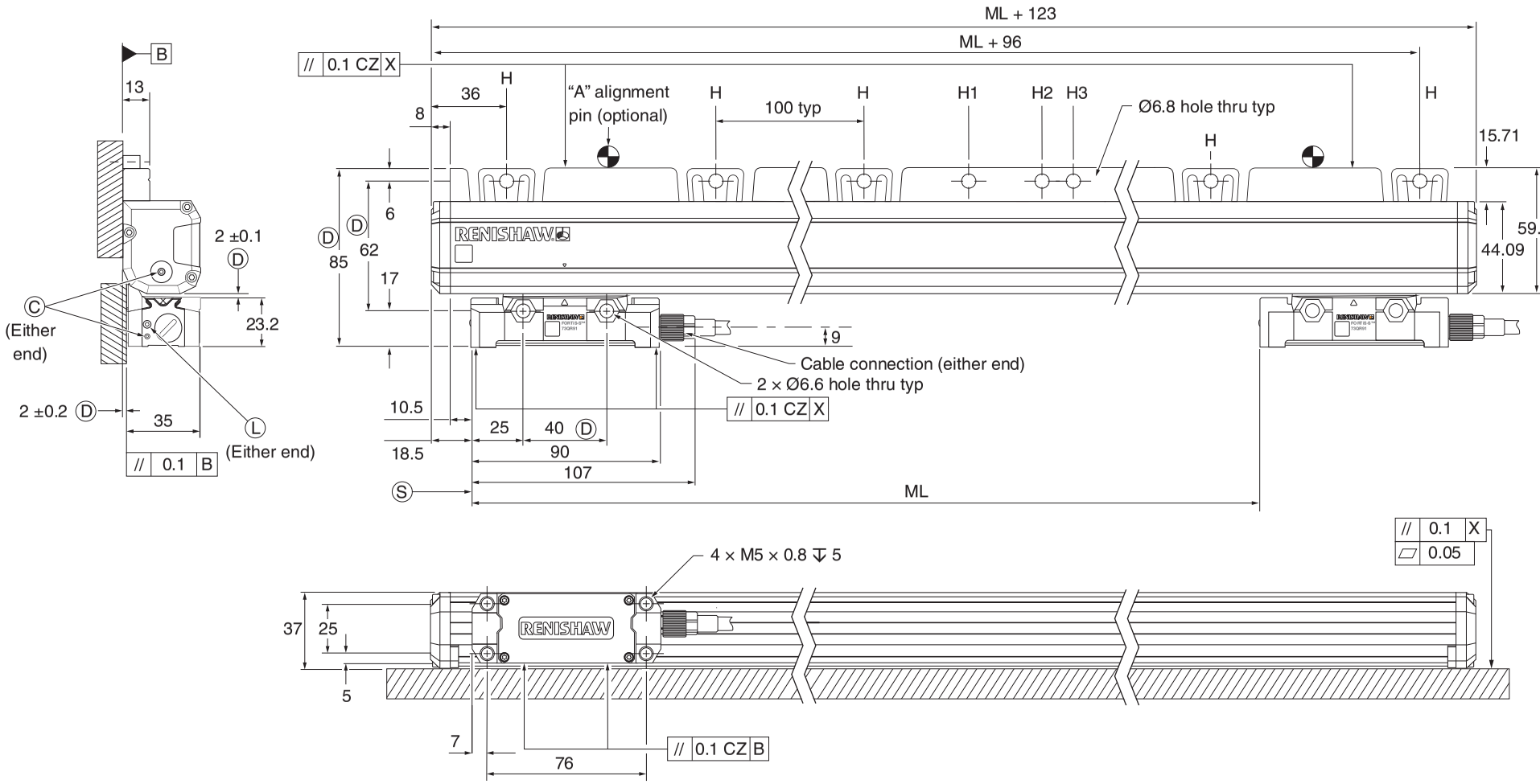
Position word length	Nomenclature code	Accuracy grade	Resolution options (nm)		
			1	10	50
36 bit	36B	3 µm	OK	N/A	N/A
		5 µm	N/A	OK	OK
32 bit	32B		N/A	OK	N/A
26 bit	26B		N/A	N/A	OK

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

System installation drawing

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

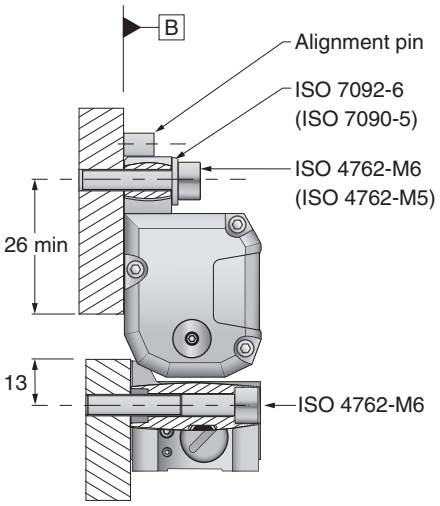
S = Start of measuring length

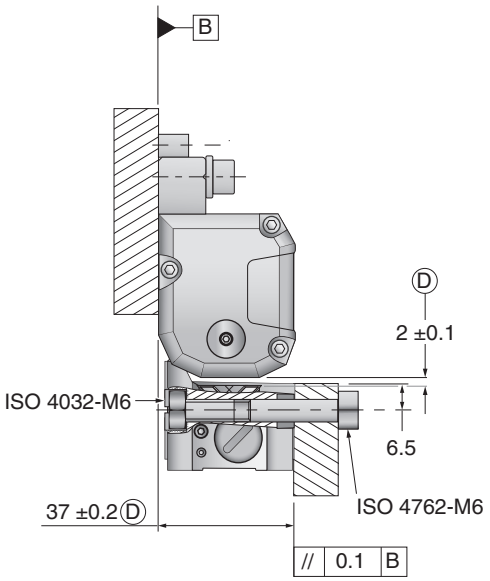
X = Machine guideway/axis datum

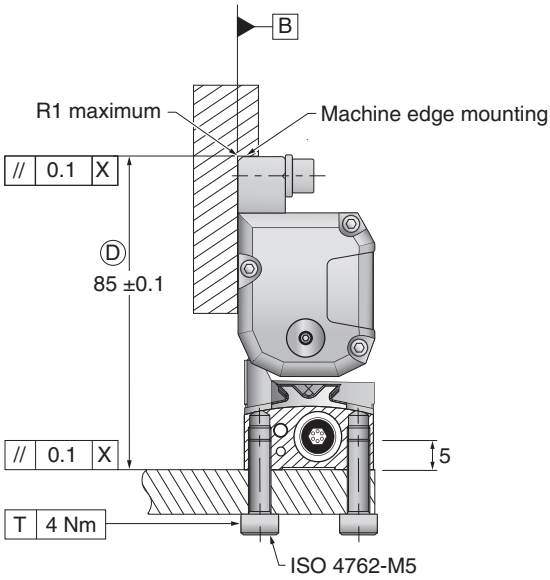
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Mounting orientations

Dimensions and tolerances in mm







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.

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Nomenclature

F S 1 0 0 B 304 S C 36B X 001 X

Product
F - FORTiS

Series
S - Standard (37 mm)
N - Narrow (18 mm)

Encoder type
1 - Absolute

Scale type
0 - 30 µm B code RTLA

End caps
0 - Standard
1 - Small end caps (N type only)

Lip seal configuration
A - DuraSeal™ × 1
B - DuraSeal × 2 (S type only)

Measuring length [1]
FORTiS-S 014 = 140 mm to 424 = 4240 mm
FORTiS-N 007 = 70 mm to 204 = 2040 mm

System accuracy
S - Standard accuracy
H - High accuracy (available in lengths up to 3040 mm only)

Thermal datum position
X - No datum
C - Centrally located [2]

Serial interface
26B - BiSS 26 bit (50 nm only)
32B - BiSS 32 bit (10 nm only)
36B - BiSS 36 bit
37F - 37 bit FANUC α and αi
40N - 40 bit Mitsubishi 4 wire
48P - 48 bit Panasonic
28D - Siemens DRIVE-CLiQ 28 bit (50 nm only)
30D - Siemens DRIVE-CLiQ 30 bit (10 nm only)
34D - Siemens DRIVE-CLiQ 34 bit (1 nm only)
36Y - 36 bit Yaskawa

Functional Safety
X - Standard
S - Functional Safety (BiSS Safety and Siemens DRIVE-CLiQ only)

Resolution
001 - 1 nm (all protocols except FANUC)
010 - 10 nm (all protocols except FANUC)
050 - 50 nm (all protocols except FANUC)
T12 - 1 / 0.5 nm (FANUC only)
108 - 10 / 1.25 nm (FANUC only)
502 - 50 / 25 nm (FANUC only)
504 - 50 / 12.5 nm (FANUC only)

Additional field
X - Standard, no option
D - Standard encoder with one additional readhead [3]

[1] For all permissible measuring length options refer to specification table.

[2] For other datum requirements contact your local Renishaw representative.

[3] For further information see the manual *FORTiS-S enclosed encoder system with multiple readheads* (Renishaw part no. L-6725-9176).

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Part no.: L-9517-9934-02-C
Issued: 09.2024

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FORTiS-S™ Functional Safety enclosed encoder system



Specification

Measuring standard	Renishaw stainless-steel scale with single track absolute encoding
Coefficient of thermal expansion (at 20 °C)	10.1 ±0.2 µm/m/°C
Thermal datum	At centre position (encoder position of 0.5 × measuring length)
Measuring lengths available (mm)	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, 3440, 3640, 3840, 4040, 4240
Accuracy grades	High grade: ≤ ±3 µm (available in lengths up to 3040 mm only) Standard grade: ≤ ±5 µm
Resolution [1]	1 nm, 10 nm, 50 nm
Sub-Divisional Error (typical)	±40 nm
Jitter (RMS)	10 nm
Absolute position serial interface	BiSS Safety, Siemens DRIVE-CLiQ (with external interface)
Encoder electrical connection	Cable connector M12 custom (customer configurable exit direction)
Controller electrical connection	8-way M12, 9-way D-type, flying lead
Cable length	Multiple options available
Power supply	Dependent on protocol
Set-up LED	Signal strength indicator
Maximum speed	4 m/s
Acceleration (readhead relative to scale)	< 200 m/s² in measuring direction
Moving force (maximum force required to move the readhead through the seals)	< 5 N
Vibration (55 Hz to 2 000 Hz)	Housing: < 300 m/s² to IEC 60068-2-6 Readhead: < 300 m/s² to IEC 60068-2-6
Shock 11 ms half-sine	< 300 m/s² IEC 60068-2-27
Operating temperature	0 °C to 50 °C
Storage temperature	–20 °C to 70 °C
Environment protection	IP53 when installed correctly, IP64 with air purge Protection class III Pollution degree II Altitude 2000 m
EMC immunity	IEC 61800-5-2:2016 *Electromagnetic immunity requirement for safety related systems – Annex E, second environment*
Air purge requirements	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
Weight	0.27 kg + 2.0 kg/m

[1] See page 2.

Resolution per accuracy grade and serial interface – standard options

Accuracy grade	Serial interface	Resolution nm
		Single
3 µm	BiSS Safety, Siemens DRIVE-CLiQ	1
5 µm	BiSS Safety, Siemens DRIVE-CLiQ	10
		50

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The FORTiS-S FS enclosed encoder system

FORTiS-S FS encoders are for use in Functional Safety applications and are certified to:

- ISO 13849 Category 3 PLd
- IEC 61508 SIL2
- IEC 61800-5-2 SIL2

The FORTiS-S FS enclosed encoder system is suitable for use in a Category 3 performance level d (PLd) application in compliance with ISO 13849-1 and in a safety integrity level 2 (SIL2) application in compliance with IEC 61508 and IEC 61800-5-2. [1]

The FORTiS-S FS encoder system provides safe position data that supports the following safety sub-functions defined by IEC 61800-5-2:

- Safe stop 1 (SS1) and Safe stop 2 (SS2) [2]
- Safe operating stop (SOS) [2]
- Safe limited acceleration (SLA) ≤ 200 m/s^2
- Safe acceleration range (SAR) ≤ 200 m/s^2
- Safe limited speed (SLS) ≤ 4 m/s
- Safe speed range (SSR) ≤ 4 m/s
- Safely limited position (SLP) [2]
- Safely limited increment (SLI) [2]
- Safe direction (SDI)
- Safe speed monitor (SSM) ≤ 4 m/s

[1] The system must be installed and operated in accordance with the instructions defined in the relevant installation guide. Failure to follow the correct use instructions and failure to heed the limitations may result in PLd and /or SIL2 not being achieved and will invalidate the Functional Safety certification.

[2] See the safety function restrictions for the safe position figure for each FORTiS-S FS encoder system variant.

For further details see the *FORTiS-S FS enclosed encoder system Functional Safety installation guide and safety manual* (Renishaw part no. M-6725-9016). Available from: **www.renishaw.com/fortisdownloads**

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Functional Safety data declaration

Product identification: FORTiS-S FS with BiSS Safety and Siemens DRIVE-CLiQ serial interfaces

IEC 61508 safety data

Safety integrity level		2
Random hardware failures (per hour) – BiSS Safety serial interface		λ_S = 2.60E-07
		λ_D = 4.08E-07
		λ_{DD} = 3.67E-07
		λ_{DU} = 4.08E-08
Random hardware failures (per hour) – Siemens DRIVE-CLiQ serial interface		λ_S = 3.46E-07
		λ_D = 6.02E-07
		λ_{DD} = 5.42E-07
		λ_{DU} = 6.02E-08
PFD_{avg}		Not applicable due to continuous demand mode
PFH (per hour) – BiSS Safety serial interface		λ_{DU} = 4.08E-08
PFH (per hour) – Siemens DRIVE-CLiQ serial interface		λ_{DU} = 6.02E-08
Architectural constraints	Type	B
	HFT	0
	SFF	94%
Hardware safety integrity compliance		Route 1H
Systematic safety integrity compliance		Route 1S
Systematic capability		SC 2
Demand mode		Continuous
Proof test interval		Not required for continuous demand mode

ISO 13849 safety data

$MTTF_D$ – BiSS Safety serial interface	292 years
$MTTF_D$ – Siemens DRIVE-CLiQ serial interface	189 years
Diagnostic coverage	Medium (90%)
Category	3
Performance level	d
Lifetime/replacement limits	20 years

Safety function

The FORTiS-S FS encoder shall provide a safe position when requested by the controller.

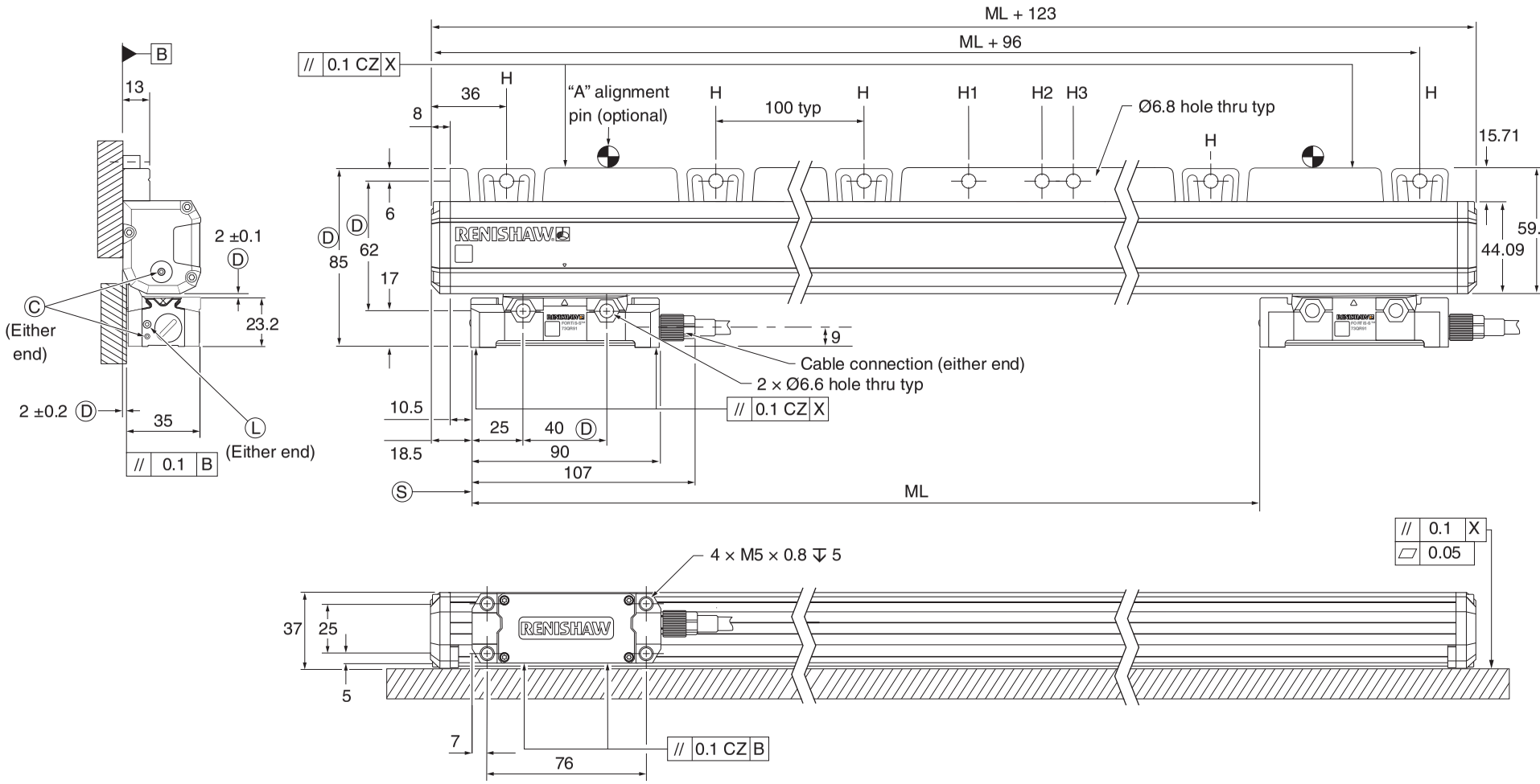
When installed correctly, the FORTiS-S FS encoder has mechanical safe position of ±1 mm.

In addition to any safety requirements defined by the communication protocol, to achieve full system integrity the evaluation unit must continuously monitor the error condition of the FORTiS-S FS encoder system,[1] and in the case of fault detection place the system into a safe state within the process safety time.

[1] Maximum request rate supported is 32 kHz and 16 kHz for DRIVE-CLiQ.

System installation drawing

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

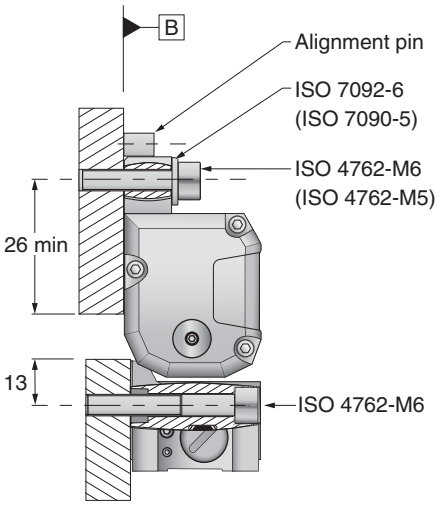
S = Start of measuring length

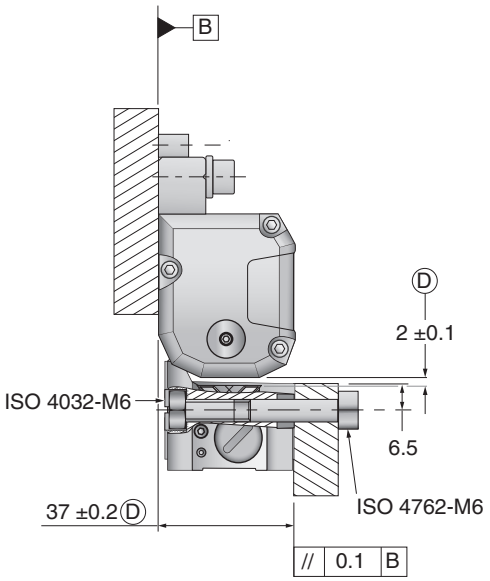
X = Machine guideway/axis datum

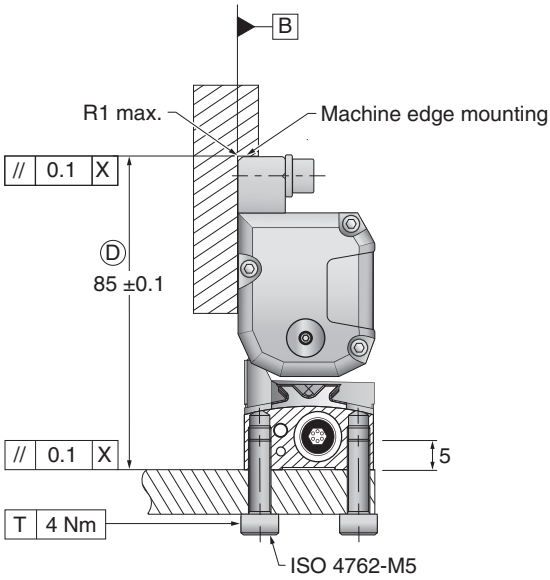
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Mounting orientations

Dimensions and tolerances in mm







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.

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Nomenclature

F	S	1	0	0	B	304	S	C	36B	S	001	X

Product
F - FORTiS

Series
S - Standard (37 mm)
N - Narrow (18 mm)

Encoder type
1 - Absolute

Scale type
0 - 30 µm B code RTLA

End caps
0 - Standard
1 - Small end caps (N type only)

Lip seal configuration
A - DuraSeal™ × 1
B - DuraSeal × 2 (S type only)

Measuring length [1]
FORTiS-S 014 = 140 mm to 424 = 4240 mm
FORTiS-N 007 = 70 mm to 204 = 2040 mm

System accuracy
S - Standard accuracy
H - High accuracy (available in lengths up to 3040 mm only)

Thermal datum position
X - No datum
C - Centrally located [2]

Serial interface
26B - BiSS 26 bit (50 nm only)
32B - BiSS 32 bit (10 nm only)
36B - BiSS 36 bit
37F - 37 bit FANUC α and αi
40N - 40 bit Mitsubishi 4 wire
48P - 48 bit Panasonic
28D - Siemens DRIVE-CLiQ 28 bit (50 nm only)
30D - Siemens DRIVE-CLiQ 30 bit (10 nm only)
34D - Siemens DRIVE-CLiQ 34 bit (1 nm only)
36Y - 36 bit Yaskawa

Functional Safety
X - Standard
S - Functional Safety (BiSS Safety and Siemens DRIVE-CLiQ only)

Resolution
001 - 1 nm (all protocols except FANUC)
010 - 10 nm (all protocols except FANUC)
050 - 50 nm (all protocols except FANUC)
T12 - 1 / 0.5 nm (FANUC only)
108 - 10 / 1.25 nm (FANUC only)
502 - 50 / 25 nm (FANUC only)
504 - 50 / 12.5 nm (FANUC only)

Additional field
X - Standard, no option
D - Standard encoder with one additional readhead [3]

[1] For all permissible measuring length options refer to specification table.

[2] For other datum requirements contact your local Renishaw representative.

[3] For further information see the manual *FORTiS-S FS enclosed encoder system with multiple readheads* (Renishaw part no. L-6725-9188).

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