# HEIDENHAIN

Product Information
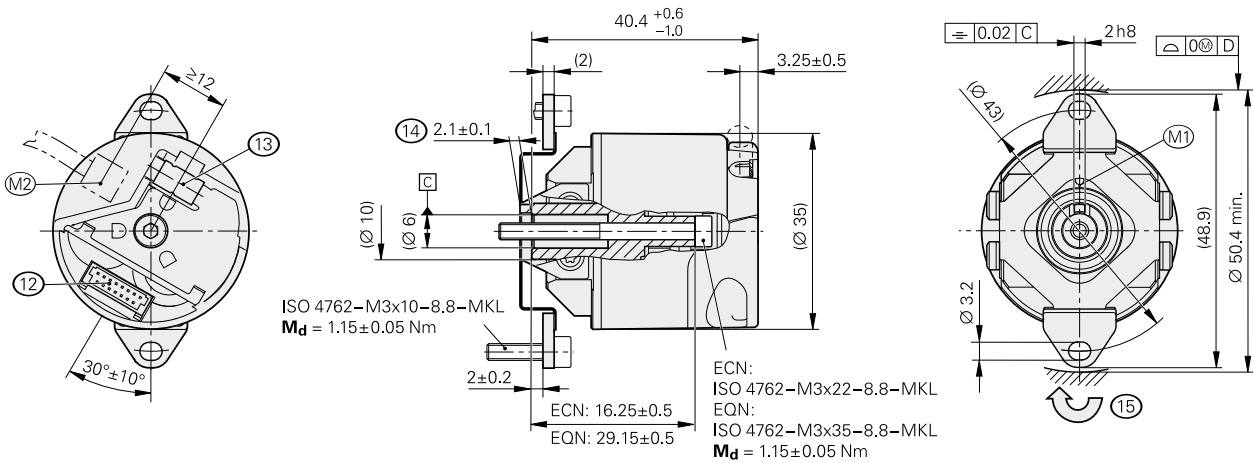
## ECN 1123S
## EQN 1135S

Absolute Rotary Encoders
with DRIVE-CLiQ Interface
for Safety-Related Applications

Firmware 53

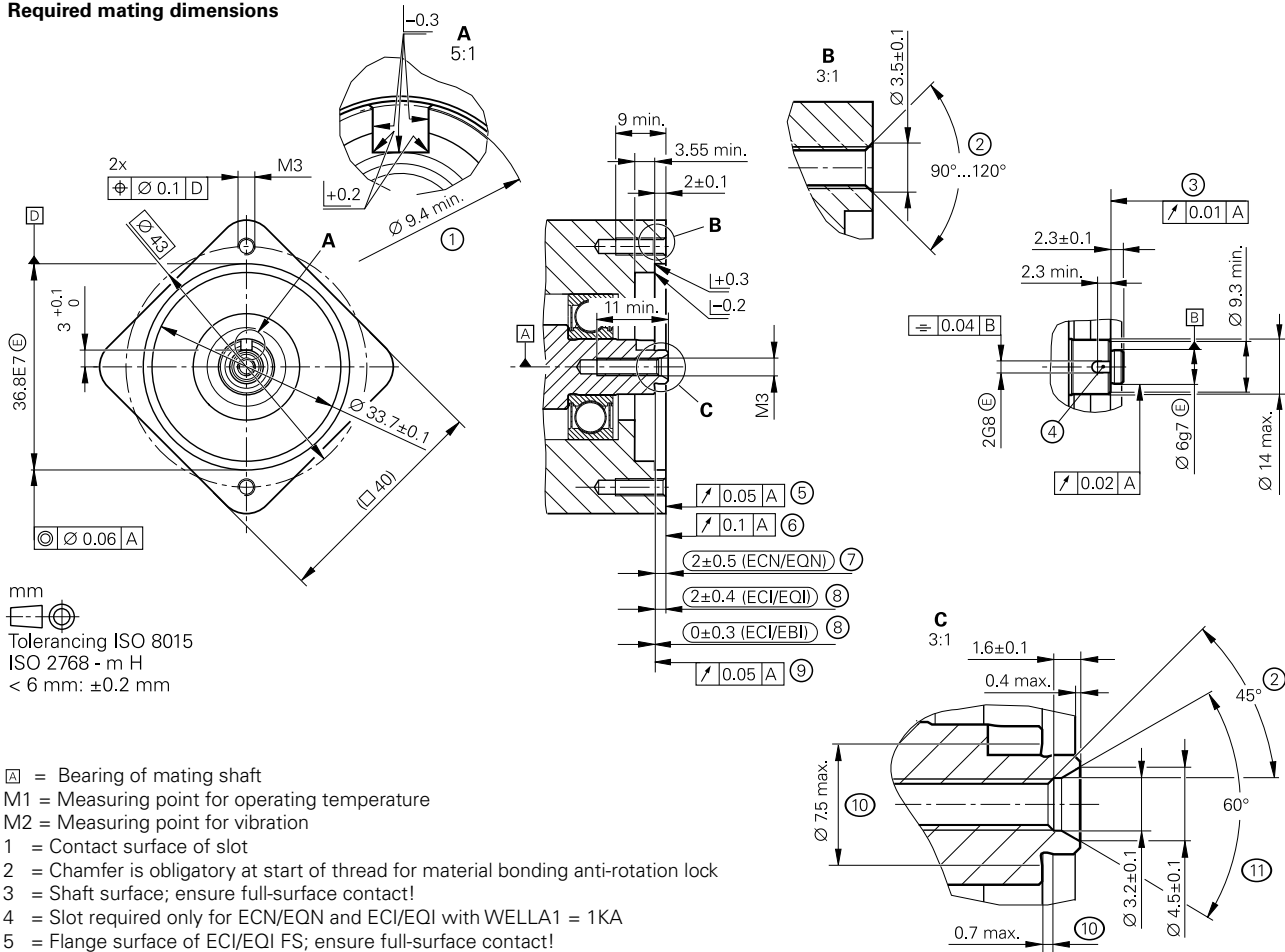Functional
Safety

# ECN 1123S, EQN 1135S

**Rotary encoders for absolute position values with safe singleturn information**

- **75A mounted stator coupling**
- **1KA blind hollow shaft Ø 6 mm for axial clamping**



Functional Safety



40.4 $^{+0.6}_{-1.0}$

(2)

3.25±0.5

2 h8

0.02 C

(Ø 43)

M1

(48.9)

Ø 50.4 min.

Ø 3.2

14  2.1±0.1

Ø 10

Ø 6

C

Ø 35

2±0.2

ECN: 16.25±0.5

EQN: 29.15±0.5

ISO 4762–M3x10–8.8–MKL
**M$_d$** = 1.15±0.05 Nm

ECN:
ISO 4762–M3x22–8.8–MKL
EQN:
ISO 4762–M3x35–8.8–MKL
**M$_d$** = 1.15±0.05 Nm

≥12

M2

13

12

30°±10°

15

## Required mating dimensions

**A** 5:1
−0.3
+0.2
Ø 9.4 min.
①

2x  Ø 0.1 D
M3
⊕

D
Ø 43
3 $^{+0.1}_{0}$
36.8E7
Ⓔ
Ø 33.7±0.1
(□ 40)
Ⓔ
Ø 0.06 A

mm
Tolerancing ISO 8015
ISO 2768 - m H
< 6 mm: ±0.2 mm

9 min.
3.55 min.
2±0.1
**B**
+0.3
−0.2
11 min.
A
**C**
M3

0.05 A ⑤
0.1 A ⑥
2±0.5 (ECN/EQN) ⑦
2±0.4 (ECI/EQI) ⑧
0±0.3 (ECI/EBI) ⑧
0.05 A ⑨

**B** 3:1
Ø 3.5±0.1
②
90°...120°

③
0.01 A
2.3±0.1
2.3 min.
0.04 B
2G8 Ⓔ
Ø 6g7 Ⓔ
Ø 9.3 min.
Ø 14 max.
B
④
0.02 A

**C** 3:1
1.6±0.1
0.4 max.
②
45°
60°
Ø 7.5 max.
⑩
3.2±0.1
4.5±0.1
⑪
0.7 max.
⑩

Ⓐ = Bearing of mating shaft
M1 = Measuring point for operating temperature
M2 = Measuring point for vibration
1 = Contact surface of slot
2 = Chamfer is obligatory at start of thread for material bonding anti-rotation lock
3 = Shaft surface; ensure full-surface contact!
4 = Slot required only for ECN/EQN and ECI/EQI with WELLA1 = 1KA
5 = Flange surface of ECI/EQI FS; ensure full-surface contact!
6 = Coupling surface of ECN/EQN
7 = Maximum permissible deviation between shaft surface and coupling surface. Compensation of mounting tolerances and thermal expansion, of which ±0.15 mm of dynamic axial motion is permitted
8 = Maximum permissible deviation between shaft surface and flange surface. Compensation of mounting tolerances and thermal expansion
9 = Flange surface of ECI/EBI; ensure full-surface contact!
10 = Undercut
11 = Possible centering hole
12 = 15-pin PCB connector
13 = Fastening for cable with crimp sleeve, diameter: 4.3 mm ±0.1 mm; length: 7 mm
14 = Positive-locking element. Ensure correct engagement in slot 4 (e.g., by measuring the device overhang)
15 = Direction of shaft rotation for ascending position values

| Specifications | ECN 1123S – singleturn | EQN 1135S – multiturn |
|---|---|---|
| **Functional safety** for applications with up to | As single-encoder system for monitoring and closed-loop functions • SIL 2 as per EN 61508 (further basis for testing: EN 61800-5-2) • Category 3, PL d as per EN ISO 13849-1:2015 Safe in singleturn operation | |
| PFH [1] | ≤ 27 · $10^{-9}$ (probability of dangerous failure per hour) | |
| Safe position [2] | *Encoder:* ±1.76° (safety-relevant measuring step SM = 0.7°); *mechanical coupling:* ±2° (fault exclusion for the loosening of shaft coupling and stator coupling, designed for accelerations of ≤ 300 m/s$^2$) | |
| **Interface/ordering designation** | DRIVE-CLiQ / DQ01 | |
| Firmware | 01.32.26.53 | |
| Siemens software [3] Firmware 01.32.26.53 | SINAMICS, SIMOTION: ≥ V4.4 HF4; SINUMERIK with safety: ≥ V4.4 SP2; SINUMERIK without safety: ≥ V4.4 SP1 HF3 | |
| Position values per revolution | 8 388 608 (23 bits) | |
| Revolutions | - | 4096 (12 bits) |
| Processing time TIME_MAX_ACTVAL | ≤ 8 µs [4] | |
| **System accuracy** | ±60" | |
| **Electrical connection** | 15-pin PCB connector (with connection for external temperature sensor [5]) | |
| Cable length | ≤ 40 m (see *Cable lengths* in the *Cables and Connectors* brochure) | |
| Supply voltage | DC 24 V (10 V to 28.8 V); up to DC 36.0 V possible without compromising functional safety | |
| Power consumption (max.) | *At 10 V:* ≤ 850 mW; *at 28.8 V:* ≤ 900 mW | *At 10 V:* ≤ 950 mW; *at 28.8 V:* ≤ 1000 mW |
| Current consumption (typical) | *At 24 V:* 32 mA (without load) | *At 24 V:* 35 mA (without load) |
| **Shaft** | 1KA blind hollow shaft Ø 6 mm with positive-locking element | |
| Speed [6] | ≤ 12 000 rpm | |
| Starting torque (typical) | 0.001 Nm (at 20 °C) | 0.002 Nm (at 20 °C) |
| Moment of inertia of rotor | 0.4 · $10^{-6}$ kgm$^2$ | |
| Angular acceleration of rotor | ≤ 1.0 · $10^5$ rad/s$^2$ | |
| Axial motion of measured shaft | ≤ ±0.5 mm | |
| **Natural frequency** of stator coupling | ≥ 1000 Hz | |
| **Vibration** 55 Hz to 2000 Hz **Shock** 6 ms | ≤ 200 m/s$^2$ (EN 60068-2-6); 10 Hz to 55 Hz constant over 3.2 mm peak to peak ≤ 2000 m/s$^2$ (EN 60068-2-27) | |
| **Operating temperature** | –40 °C to 95 °C | |
| **Trigger threshold** of error message for temperature exceedance | 125 °C (measurement accuracy of the internal temperature sensor: ±7 K at 125 °C) | |
| **Relative humidity** | ≤ 93 % (40 °C/21 d as per EN 60068-2-78); without condensation | |
| **Protection** EN 60529 | IP40 (read about "isolation" in the *General mechanical information* chapter of the *Encoders for Servo Drives* brochure; contamination from the ingress of liquids must be prevented) | |
| **Mass** | ≈ 0.1 kg | |
| ID number | 1211015-02 | 1211017-02 |

1) For altitudes of ≤ 1000 m above sea level
2) Further tolerances may apply in subsequent electronics after position value comparison (contact mfr. of subsequent electronics)
3) Information from Siemens as per document "Certified encoders with DRIVE-CLiQ Dependencies on SIMOTION / SINUMERIK and SINAMICS Hardware and Software versions" (version: 12/2018)
4) The calculation time TIME_MAX_ACTVAL specifies the time after which data transfer from the encoder to the control can start within the current-regulator clock time.
5) See *Temperature measurement in motors* in the *Encoders for Servo Drives* brochure
6) At ≥ 2 position requests per revolution

# Mounting

The blind hollow shaft of the rotary encoder is slid onto the measured shaft and fastened with a central screw. It is particularly important to ensure that the positive-locking element of the rotary encoder shaft securely engages the corresponding slot in the measured shaft. Mounting on the stator side is performed without a centering collar on a flat surface with two clamping screws. Use screws with material bonding anti-rotation lock (see *Mounting accessories*).

The following material properties and conditions must be complied with for the customer-side mounting design:

| | Mating stator | Mating shaft |
|---|---|---|
| Material | Aluminum | Steel |
| Tensile strength $R_m$ | ≥ 220 N/mm$^2$ | ≥ 600 N/mm$^2$ |
| Yield strength $R_{p0.2}$ or yield point $R_e$ | - | ≥ 400 N/mm$^2$ |
| Shear strength $\tau_a$ | 130 N/mm$^2$ | ≥ 390 N/mm$^2$ |
| Interface pressure $P_G$ | ≥ 250 N/mm$^2$ | ≥ 660 N/mm$^2$ |
| Young's modulus E (at 20 °C) | 70 kN/mm$^2$ to 75 kN/mm$^2$ | 200 kN/mm$^2$ to 215 kN/mm$^2$ |
| Coefficient of thermal expansion $\alpha_{therm}$ (at 20 °C) | ≤ 25 · 10$^{-6}$ K$^{-1}$ | 10 · 10$^{-6}$ K$^{-1}$ to 17 · 10$^{-6}$ K$^{-1}$ |
| Surface roughness $R_Z$ | ≤ 16 µm | |
| Friction values | Mounting surfaces must be clean and free of grease. Use screws from HEIDENHAIN in their delivery condition. | |
| Tightening procedure | Use a signal-emitting torque wrench as per DIN EN ISO 6789, with an accuracy of ±6 % | |
| Mounting temperature | 15 °C to 35 °C | |
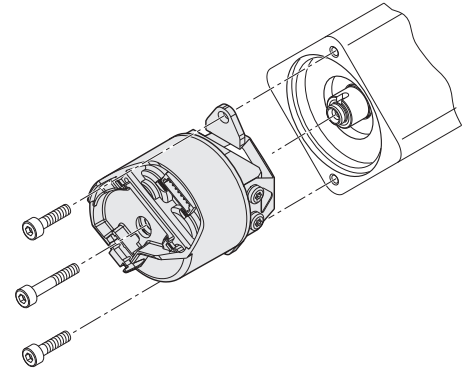
For the design of the mechanical fault exclusion for the shaft connection, the following maximum torque $M_{max}$ must be considered:
$M_{max} = 1.0$ Nm

The customer's mechanical design must ensure that the maximum torque $M_{max}$ occurring in the application can be transmitted.

# Mounting accessories

**Screws**

Screws (central screw, mounting screws) are not included in delivery and can be ordered separately.

| | Screws [1] | | Quantity |
|---|---|---|---|
| **Central screw for ECN 1123** | ISO 4762-**M3×22**-8.8-**MKL** | ID 202264-65 | 10 or 100 pieces |
| **Central screw for EQN 1135** | ISO 4762-**M3×35**-8.8-**MKL** | ID 202264-66 | |
| **Mounting screw** for flange | ISO 4762-**M3×10**-8.8-**MKL** | ID 202264-87 | 20 or 200 pieces |

[1] With coating for material bonding anti-rotation lock

Please note the information on screws from HEIDENHAIN in the *Encoders for Servo Drives* brochure, under *Screws with material bonding anti-rotation lock* in the chapter *General mechanical information*.

**Mounting aid**

To avoid damage to the cable, use the mounting aid to connect and disconnect the cable assembly. Apply the pulling force only to the connector and not to the wires.

ID 1075573-01
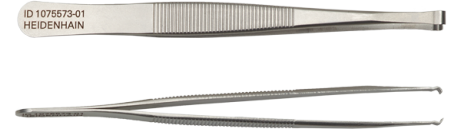
**Mounting aid**

This mounting aid allows the shaft of the rotary encoder to be turned from the rear of the device for easy locating of the positive-locking connection between the rotary encoder and the measured shaft.

ID 821017-03
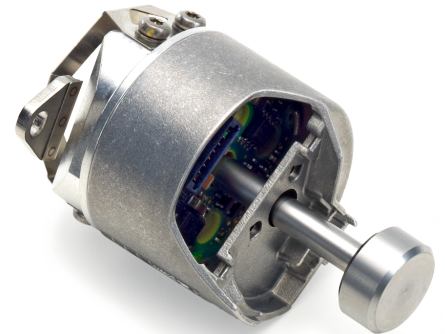
# Integrated temperature evaluation

These rotary encoders feature an internal temperature sensor integrated into the encoder electronics, as well as an evaluation circuit for an external temperature sensor. In both cases, the given digitalized temperature value is transmitted purely serially via the DRIVE-CLiQ interface. Please bear in mind that neither the temperature measurement nor the transmission of the temperature value is "safe" in terms of functional safety.

The temperature measured by the internal temperature sensor is higher by a device- and application-specific amount than the temperature at measuring point M1 as shown in the dimension drawing.

Upon reaching a trigger threshold for the internal temperature sensor, these rotary encoders issue an "Alarm 405" error message. This threshold may vary depending on the encoder and is provided in the specifications. During operation, it is recommended that the temperature be kept adequately below this threshold.

Fulfillment of the encoder's intended use requires compliance with the operating temperature at measuring point M1.

The internal temperature sensor has an accuracy of ±7 K.

**Temperature measurement in motors**

To protect a motor from overloading, the motor manufacturer often installs a temperature sensor in close proximity to the motor winding.

For this purpose, the PT 1000 or, for example, the KTY 84-130 semiconductor sensor is to be used. In the case of the PT 1000, the following values for the accuracy of the evaluation circuit apply:

±4 K at 80 °C to 160 °C
±6 K at –40 °C to 80 °C
±6 K at 160 °C to 200 °C

For the KTY 84-130 semiconductor sensor, the following values for the accuracy of the evaluation circuit apply:

±2 K at 80 °C to 160 °C
±6 K at –40 °C to 80 °C
±6 K at 160 °C to 200 °C

The temperature values are transmitted by means of the DRIVE-CLiQ protocol.

The temperature sensor being used can be configured with parameter 601 in the configuration software of the drive (e.g., Starter software).

# Online diagnostics and firmware version

**Online diagnostics**

For the evaluation of encoder functionality, valuation numbers can be read cyclically from the encoder. The valuation numbers yield information on the current status and function reserves of the encoder. These function reserves are likewise transferred via the DRIVE-CLiQ interface and can be displayed in the higher-level control.
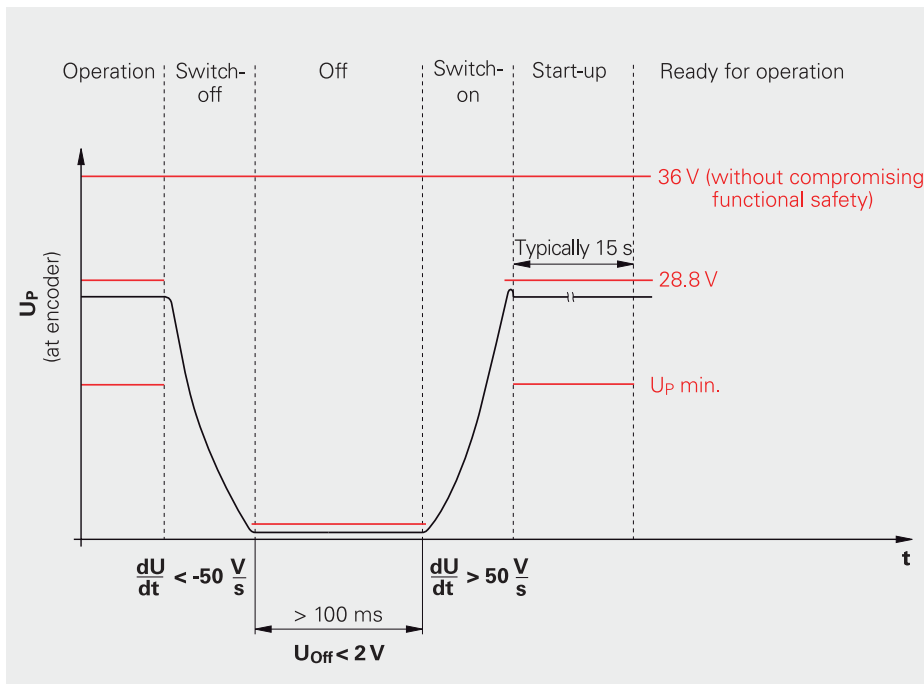
Further information is available from HEIDENHAIN upon request.

**Firmware version**

The firmware version can be read via the DRIVE-CLiQ parameter "Act_FW_Version" (Index 0). The final two digits of the displayed value are decisive.

# Electrical requirements

**Switch-on and switch-off conditions**

| Operation | Switch-off | Off | Switch-on | Start-up | Ready for operation |
|---|---|---|---|---|---|

$U_P$ (at encoder)

36 V (without compromising functional safety)

Typically 15 s

28.8 V

$U_P$ min.

$\frac{dU}{dt} < -50 \frac{V}{s}$

$\frac{dU}{dt} > 50 \frac{V}{s}$

t

> 100 ms

$U_{Off} < 2\,V$
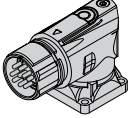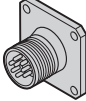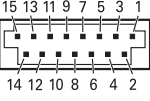
# Electrical connection

## Cables

| EPG output cables inside the motor housing Ø 3.7 mm; 2 × (2 × 0.06 mm $^2$) + 4 × 0.06 mm $^2$; $A_P$ = 0.06 mm $^2$ |
|---|
| with shield crimp Ø 4.3 mm and wires for temperature sensor [1] TPE 2 × 0.16 mm $^2$ |

| With 15-pin PCB connector and 8-pin M12 flange socket [2] (male), PCD28 |  | ID 1217143-xx |
|---|---|---|

1) The electromagnetic compatibility of the complete system must be ensured.
2) The shield connection must be implemented on the motor side

## Pin layout

| 9-pin SpeedTEC M23 angle flange socket |  | 8-pin M12 flange socket |  |
|---|---|---|---|

| 15-pin PCB connector |  |
|---|---|

|  | Power supply | | | | Serial data transfer | | | | Other signals [1] | |
|---|---|---|---|---|---|---|---|---|---|---|
| ◼— M12 | 8 | 2 | 1 | 5 | 3 | 4 | 7 | 6 | / | / |
| ◼— M23 | 3 | 7 | 8 | 4 | 5 | 6 | 1 | 2 | / | / |
| ◼ 15 | – | – | 12 | 14 | 7 | 8 | 9 | 10 | 5 | 6 |
|  | – | – | $U_P$ | 0 V | RXP | RXN | TXP | TXN | T+ [2] | T- [2] |
| ◄ | Brown/ Green | Blue | White | White/ Green | Gray | Pink | Violet | Yellow | Brown | Green |

1) Only for encoder cables within the motor housing
2) Connections for external temperature sensor; evaluation optimized for KTY 84-130/PT 1000 (see *Temperature measurement in motors* in the *Encoders for Servo Drives* brochure)

**Cable shield** connected with housing; **Up** = Power supply
Unused pints or wires must not be assigned!
**Output cable with length of > 0.5 m requires strain relief**

SpeedTEC is a registered trademark of TE Connectivity Industrial GmbH.
DRIVE-CLiQ is a registered trademark of Siemens AG.

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This Product Information document supersedes all previous editions, which thereby become invalid. The basis for ordering from HEIDENHAIN is always the Product Information document edition valid when the order is made.

**Further information:** Comply with the requirements described in the following documents to ensure the correct and intended operation of the encoder:

- Brochure: *Encoders for Servo Drives* — 208922
- Brochure: *Interfaces of HEIDENHAIN Encoders* — 1078628
- Mounting instructions: *ECN 1123S, EQN 1135S* — 1254938
- Brochure: *Cables and Connectors* — 1206103