



# HEIDENHAIN



Product Overview

## **Rotary Encoders** For Potentially Explosive Atmospheres (ATEX)

April 2016

# Rotary encoders for use in potentially explosive areas

## Introduction

There are many types of applications in industry where exposure to potentially explosive atmospheres is virtually unavoidable, for example on paint spray lines, printing machines or silage systems.

The condition of equipment and facilities operated in potentially explosive atmospheres is defined by **ATEX Directive 2014/34/EU**, also known as **ATEX 95** (ATEX derives its name from the French "atmosphères explosibles," which means explosive atmospheres).

This directive has been in effect since February 26, 2014 and has replaced all other existing regulations, which cover the same subjects, within the entire European Union (EU). In the field of explosion protection, national regulations must not contain any diverging requirements and/or any requirements beyond the scope of this directive. Products that are placed on the market or put into service after February 26, 2014 must meet the requirements of the directive.

## Standard

CENELEC (European Committee for Electrotechnical Standardization) prepared the EU standard EN 60079 for explosion protection on the basis of the EU directive.

## Usability (classification into zones and categories)

In potentially explosive areas, the operating conditions must be considered carefully. The installer/operator must therefore assess the explosion risk of production facilities and divide them into zones that reflect the degree of danger based on

- the probability and duration of the occurrence of dangerous potentially explosive atmospheres,
- the probability of the presence, activation and effectiveness of sources of ignition, as well as
- the scope of the expected effects of explosions.

Operating equipment for potentially explosive areas is classified into **three categories** (for Equipment Group II for electrical equipment except mines liable to be endangered by firedamp), depending on its design.

- Category 1 ensures a very high level of safety
- Category 2 ensures a high level of safety
- Category 3 ensures a normal level of safety

## Classification into zones

The composition of the atmosphere is decisive for the classification into zones:

- Potentially explosive atmosphere consisting of a mixture of air and gases, vapors or mists
  - Zone 0: Continuously, for long periods, frequently, majority of the time
  - Zone 1: Occasionally in normal operation
  - Zone 2: Rare, for a short period
- Potentially explosive atmosphere that consists of a mixture of air and dust
  - Zone 20: Continuously, for long periods, frequently, majority of the time
  - Zone 21: Occasionally in normal operation
  - Zone 22: Rare, for a short period

## Designation

All explosion-proof electrical devices are marked using a uniform code.

Gas atmosphere

- II = Equipment group (II = for above-ground applications)
- 2 = Category
- G = Gas
- Ex = Explosion protection
- d = Type of ignition protection (d = flameproof enclosure)
- II = Explosion group gas
- C = Subgroup (C = maximum permitted gap < 0.5 mm)
- T120 °C = Maximum surface temperature
- Gb = High protection level against gas

Dust atmosphere

- II = Equipment group (II = for above-ground applications)
- 2 = Category
- D = Dust
- Ex = Explosion protection
- tb = Type of ignition protection (tb = protection by housing)
- III = Procedure for determining dust proofness (explosion group, dust)
- C = Conductive dust
- T120 °C = Maximum surface temperature
- Db = High protection level against dust



## Equipment Group II (other potentially explosive areas)

| Category        | 1: Very high level of safety                    |          | 2: High level of safety   |         | 3: Normal level of safety       |         |
|-----------------|---|----------|---|---------|---------------------------------|---------|
| Risk level      | Continuous, long-term and frequent risk         |          | Occasional risk   |         | Unlikely and short-term risk    |         |
| Adequate safety | By means of 2 protective measures/with 2 faults |          | In case of frequently occurring equipment faults/with one fault |         | In case of fault-free operation |         |
| Use in          | Zone 0  | Zone 20  | Zone 1  | Zone 21 | Zone 2                          | Zone 22 |
| Atmosphere      | G (gas)   | D (dust) | G   | D       | G                               | D       |

Comparison of equipment groups and categories

HEIDENHAIN produces special rotary encoders for potentially explosive areas. They comply with **equipment group II**, meet the requirements of **category 2** and can be used for the **zones 1 and 21** as well as **2 and 22** (devices of Zone 0 available on request).

### Type of ignition protection

The rotary encoders for potentially explosive areas fulfill the requirements of flameproof enclosures (d) or protection by housing (tb). A **flameproof enclosure d** is designed in such a way that the parts that can ignite a potentially explosive atmosphere are located in a housing that can resist the pressure of an explosion inside the housing, and that prevents a transfer of the explosion to the potentially explosive atmosphere surrounding the housing. The maximum permitted gap is less than 0.5 mm (corresponds to explosion group IIC).

The **protection by housing tb** type of ignition protection means that the ingress of dust is prevented (IP 66 protection). Also, at maximum surface temperature, dust deposition forming conductive dust layers with a thickness of up to 5 mm is considered.

### Maximum surface temperature

The **maximum surface temperature** that a rotary encoder can reach during rated operation and in disturbed operation is **120 °C**. This temperature applies for a **maximum ambient temperature of +60 °C**. Thermal switches in the rotary encoder flange ensure that the maximum surface temperature is not exceeded. At a temperature of 100°C (+5 K) at the thermal switch, they trigger the fault detection signal  $U_{aS}$  ( $U_{aS}$  = low), and at a temperature of 110°C (+5 K) at the thermal switches, they cause the power supply to be switched off.

### Accessories

#### Diaphragm coupling K 17

Shaft coupling with galvanic isolation with 6 mm or 10 mm shaft diameter

⊗ II 2 DG c X

Explosion protection c (constructive)

Ambient temperature X (max. 60 °C)

ID 296746-xx



### Mounting criteria

#### • Power consumption

In order to limit the maximum current in the event of a fault, the power consumption of the rotary encoder must be limited to a maximum of 10 W in the subsequent electronics. Comply with the additional measures for electrical safety described in the catalog *Interfaces*

#### • Voltage supply

Comply with the *General electrical information* in the catalog *Interfaces*

#### • Connecting cable

The connecting cable that is permanently mounted on the rotary encoder must have a **rigid configuration** within the potentially explosive area. The rotary encoders for potentially explosive areas are supplied by HEIDENHAIN with a 10 m connecting cable as a standard feature. The connection must be located **outside of the potentially explosive area** or in an ATEX terminal box.

#### • Shaft sealing ring

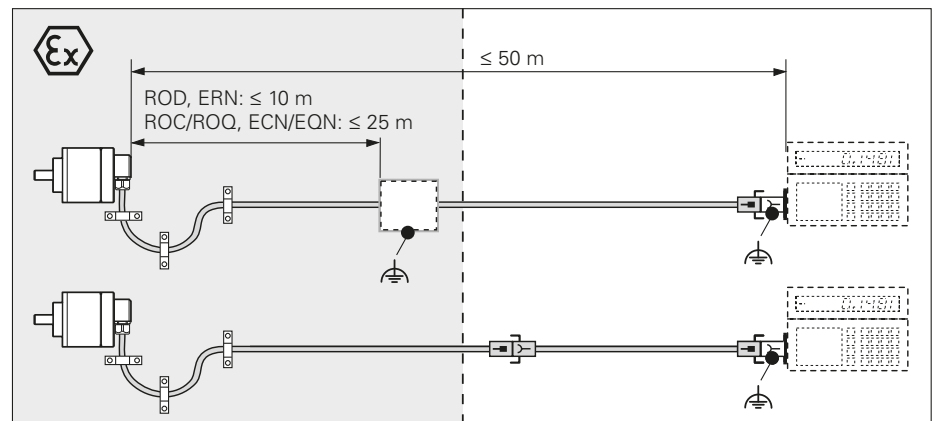
To protect the shaft sealing ring from UV radiation, a rotor coupling (e.g. K17) must be used to install encoders with solid shaft, and a clamping ring for encoders with hollow shaft

### Repair

In case of a defect, repair of the rotary encoders is subject to stringently specified conditions. The rotary encoders must therefore be returned to HEIDENHAIN, Traunreut, because this ensures that the stringent requirements are fulfilled.

### Overview

This Product Overview contains all specifications relevant for selecting HEIDENHAIN rotary encoders for potentially explosive atmospheres. For further specifications, please refer to the respective standard versions described in the *Rotary Encoders* catalog.



### Input circuitry of subsequent electronics

The input circuits of the subsequent electronics for EnDat and SSI are described in detail in the *Interfaces for HEIDENHAIN Rotary Encoders* catalog.

Differences in SSI interfaces:

- No programming inputs
- $t_2$  start with positive edge (12 to 30  $\mu$ s).

The ATEX encoders also provide a fault detection signal in TTL levels over a separate line when the integrated thermal switches measure a temperature greater than 100°C (see *Maximum surface temperature*).

### Dimensioning

$IC_1$  = Recommended differential line receiver

DS 26 C 32 AT

Only for a > 0.1  $\mu$ s:

AM 26 LS 32

MC 3486

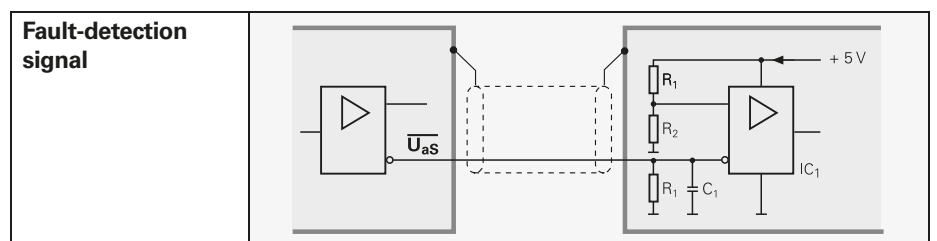
SN 75 ALS 193

$R_1$  = 4.7 k $\Omega$

$R_2$  = 1.8 k $\Omega$

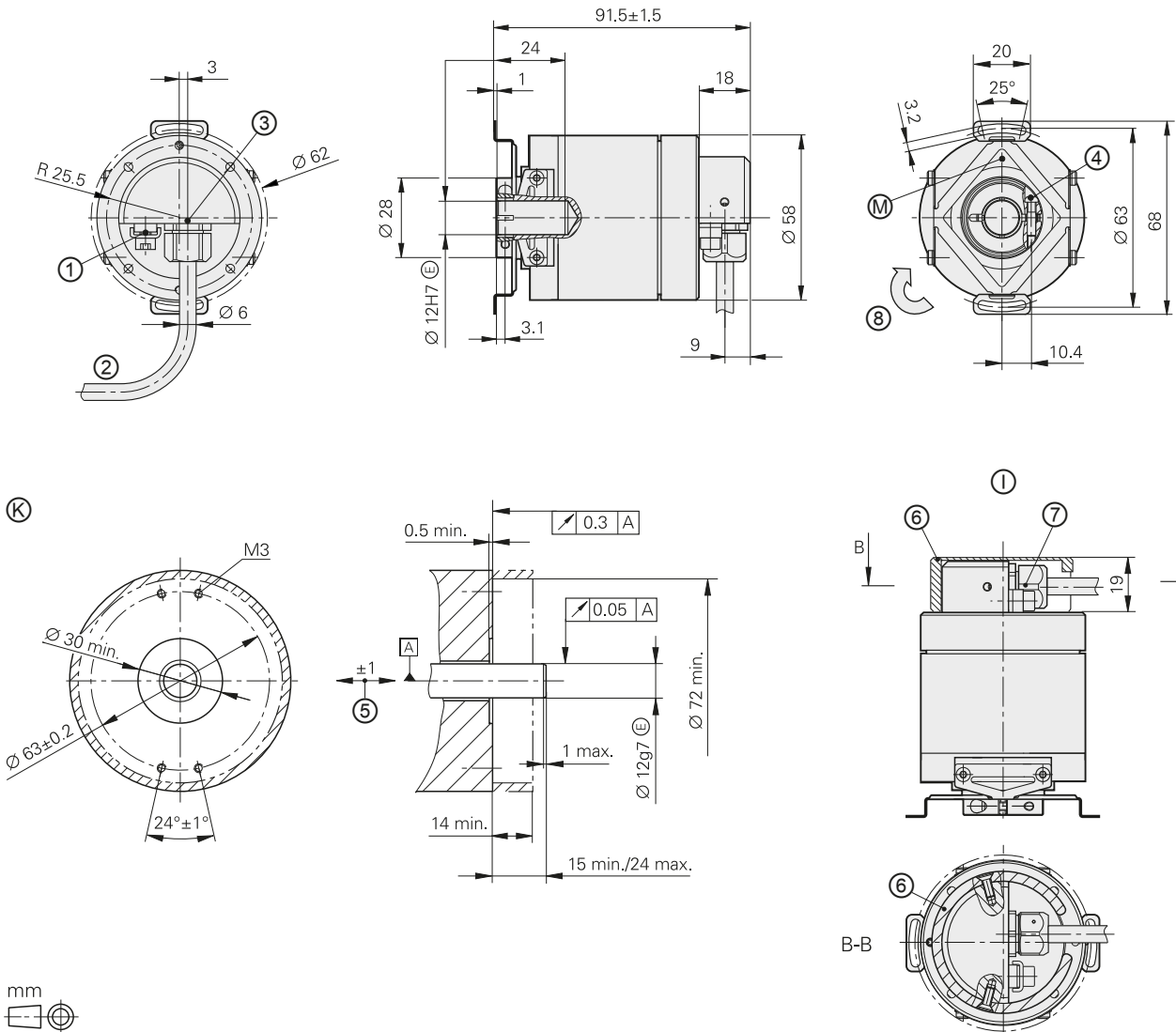
$Z_0$  = 120  $\Omega$

$C_1$  = 220 pF (serves to improve noise immunity)






# ECN/EQN/ERN 400 series

- Absolute and incremental rotary encoders
- Stator coupling for plane surface
- Blind hollow shaft
- For use in potentially explosive atmospheres



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

- ▣ = Bearing of mating shaft
- ⊗ = Required mating dimensions
- Ⓜ = Measuring point for operating temperature on encoder flange
- ① = Connection point for grounding and equipotential bonding as per DIN EN 60079-0
- ② = Provide cable strain relief
- ③ = Entry thread for cable gland M13x0.75
- ④ = Clamping screw with hexalobular socket X8, tightening torque 1.1 Nm±0.1 Nm
- ⑤ = Compensation of mounting tolerances and thermal expansion, no dynamic motion
- ⑥ = Protective cap
- ⑦ = Cable bushing Ø 6
- Ⓢ = Direction of shaft rotation for output signals as per the interface description
- ① = Additional means of protection for cable bushings that may be exposed to external load when the encoder is mounted vertically (Directive 2014/34/EU)

|  | Incremental   |   |   |
|--|---|---|---|
|  | ERN 420   | ERN 430   | ERN 480   |
| <b>Interface</b>   |  TTL     |  HTL |  1 V <sub>PP</sub> <sup>1)</sup> |
| Line counts*   | 1000 1024 1250 2000 2048 2500 3600 4096 5000  |   |   |
| Reference mark   | One   |   |   |
| Cutoff frequency –3 dB<br>Scanning frequency<br>Edge separation a  | –<br>≤ 300 kHz<br>≥ 0.39 μs   |   | ≥ 180 kHz<br>–<br>–   |
| <b>System accuracy</b>   | 1/20 of grating period  |   |   |
| <b>Voltage supply</b><br><b>Current consumption</b><br>without load  | DC 5 V ± 0.5 V<br>≤ 120 mA  | DC 10 V to 30 V<br>≤ 150 mA   | DC 5 V ± 0.5 V<br>≤ 120 mA  |
| <b>Electrical connection</b>   | Cable 10 m with 12-pin M23 coupling (male)  |   |   |
| <b>Shaft</b>   | Blind hollow shaft, D = 12 mm   |   |   |
| <b>Mech. permiss. speed n</b>  | ≤ 5000 rpm  |   |   |
| <b>Starting torque</b>   | ≤ 0.015 Nm (at 20 °C)   |   |   |
| <b>Moment of inertia of rotor</b>  | ≤ 5.1 · 10 <sup>-6</sup> kgm <sup>2</sup>   |   |   |
| <b>Permissible axial motion of measured shaft</b>  | ± 1 mm  |   |   |
| <b>Vibration</b> 55 to 2000 Hz<br><b>Shock</b> 6 ms  | ≤ 100 m/s <sup>2</sup> (EN 60068-2-6)<br>≤ 1500 m/s <sup>2</sup> (EN 60068-2-27)          |   |   |
| <b>Operating temperature</b>   | –20 °C to 80 °C   |   |   |
| <b>Ambient temperature</b>   | –20 °C (stationary cable) to 60 °C  |   |   |
| <b>Surface temperature</b>   | ≤ 120 °C  |   |   |
| <b>Protection</b> EN 60 529  | IP66  |   |   |
| <b>Explosion protection</b> as per   | DIN EN 60079-0; DIN EN 60079-1; DIN EN 60079-31   |   |   |
| Equipment group<br>Category<br>Explosive atmosphere<br>Type of ignition protection<br>Explosion group and subgroup | II<br>2<br>G (gas) and D (dust)<br>d and tb<br>IIC (max. permitted gap < 0.5 mm) and IIIC |   |   |
| <b>Mass</b>  | ≈ 0.7 kg  |   |   |

\* Please select when ordering

<sup>1)</sup> Restricted tolerances: Signal amplitude: 0.8 to 1.2 V<sub>PP</sub>

|  | <b>Absolute</b>  |                          |
|--|--|--------------------------|
|  | <b>Singleturn</b>  |                          |
|  | <b>ECN 413</b>   |                          |
| <b>Interface*</b>  | <b>EnDat 2.2</b>   | <b>SSI</b>               |
| Ordering designation   | EnDat01  | SSI01r1                  |
| Positions per revolution   | 8192 (13 bits)   |                          |
| Revolutions  | –  |                          |
| Code   | Pure binary  | Gray                     |
| Elec. permissible speed<br>Deviations <sup>1)</sup>  | <i>512 lines:</i> ≤ 5000/12 000 rpm<br>± 1 LSB/± 100 LSB<br><i>2048 lines:</i> ≤ 1500/12 000 rpm<br>± 1 LSB/± 50 LSB | ≤ 12 000 rpm<br>± 12 LSB |
| Calculation time $t_{cal}$<br>Clock frequency  | ≤ 9 μs<br>≤ 2 MHz  | ≤ 5 μs<br>–              |
| <b>Incremental signals</b>   | $\sim 1 V_{PP}$ <sup>1)</sup>  |                          |
| Line counts*   | 512 2048   | 512                      |
| Cutoff frequency –3 dB   | <i>512 lines:</i> ≥ 130 kHz; <i>2048 lines:</i> ≥ 400 kHz  |                          |
| <b>System accuracy</b>   | <i>512 lines:</i> ± 60"; <i>2048 lines:</i> ± 20"  |                          |
| <b>Voltage supply</b>  | DC 5 V ± 0.25 V  |                          |
| Power consumption (max.)   | ≤ 625 mW   | ≤ 600 mW                 |
| Current consumption (typical; without load)  | 85 mA  | 70 mA                    |
| <b>Electrical connection</b>   | Cable 10 m with 17-pin M23 coupling (male)   |                          |
| <b>Shaft</b>   | Blind hollow shaft, D = 12 mm  |                          |
| <b>Mech. perm. speed n</b>   | ≤ 5000 rpm   |                          |
| <b>Starting torque</b>   | ≤ 0.015 Nm (at 20 °C)  |                          |
| <b>Moment of inertia of rotor</b>  | ≤ 5.1 · 10 <sup>-6</sup> kgm <sup>2</sup>  |                          |
| <b>Permissible axial motion of measured shaft</b>  | ± 1 mm   |                          |
| <b>Vibration</b> 55 to 2000 Hz<br><b>Shock</b> 6 ms  | ≤ 100 m/s <sup>2</sup> (EN 60068-2-6)<br>≤ 1500 m/s <sup>2</sup> (EN 60068-2-27)                                     |                          |
| <b>Operating temperature</b>   | –20 °C to 80 °C  |                          |
| <b>Ambient temperature</b>   | –20 °C (stationary cable) to 60 °C   |                          |
| <b>Surface temperature</b>   | ≤ 120 °C   |                          |
| <b>Protection</b> EN 60 529  | IP66   |                          |
| <b>Explosion protection</b> as per   | DIN EN 60079-0; DIN EN 60079-1; DIN EN 60079-31  |                          |
| Equipment group<br>Category<br>Explosive atmosphere<br>Type of ignition protection<br>Explosion group and subgroup | II<br>2<br>G (gas) and D (dust)<br>d and tb<br>IIC (max. permitted gap < 0.5 mm) and IIIC                            |                          |
| <b>Mass</b>  | ≈ 0.7 kg   |                          |

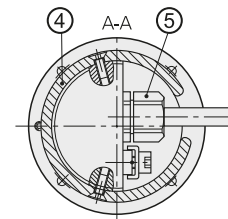
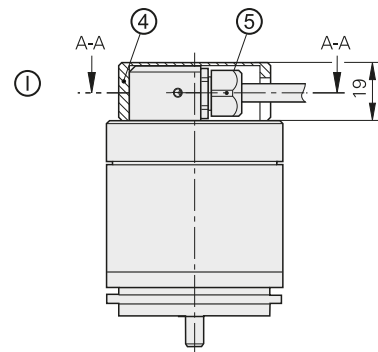
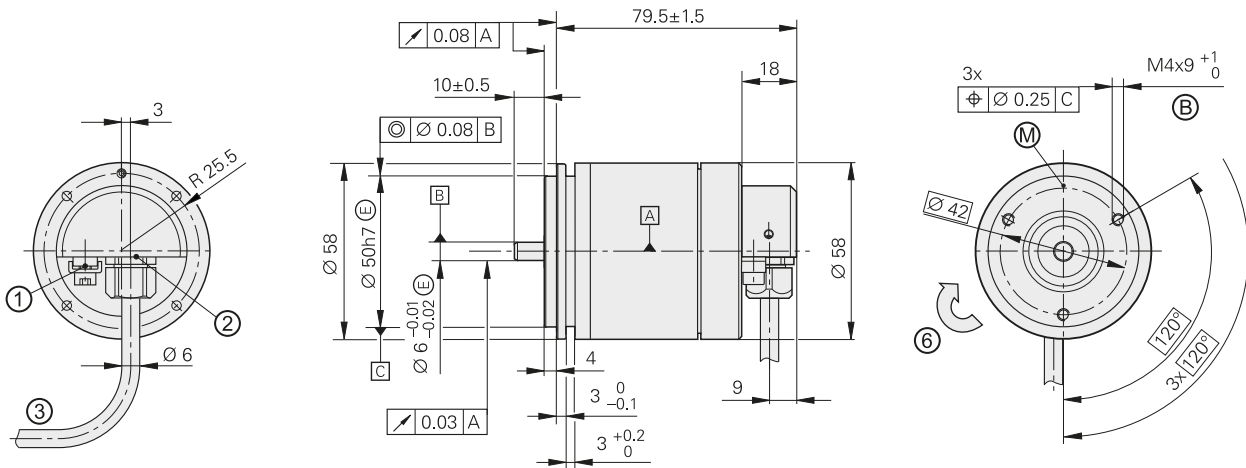
\* Please select when ordering

<sup>1)</sup> Restricted tolerances: Signal amplitude: 0.8 to 1.2 V<sub>PP</sub>



# ROC/ROQ/ROD 400 series

- Absolute and incremental rotary encoders
- Synchro flange
- Solid shaft for separate shaft coupling
- For use in potentially explosive atmospheres



mm






Tolerancing ISO 8015

ISO 2768 - m H

< 6 mm: ±0.2 mm

- ▣ = Encoder bearing
- ⊕ = Threaded mounting hole
- Ⓜ = Measuring point for operating temperature on encoder flange
- ① = Connection point for grounding and equipotential bonding as per DIN EN 60079-0
- ② = Entry thread for cable gland M13x0.75
- ③ = Provide cable strain relief
- ④ = Protective cap
- ⑤ = Cable bushing
- ⑥ = Direction of shaft rotation for output signals as per the interface description
- ① = Additional means of protection for cable bushings that may be exposed to external load when the encoder is mounted vertically (Directive 2014/34/EU)



|  | Incremental   |   |   |
|--|---|---|---|
|  | ROD 426   | ROD 436   | ROD 486   |
| <b>Interface</b>                           |  TTL       |  HTL |  1 V <sub>PP</sub> <sup>1)</sup> |
| Line counts*                               | 1000 1024 1250 1500 1800  | 2000 2048 2500 3600 4096  | 5000  |
| Reference mark                             | One   |   |   |
| Cutoff frequency –3 dB                     | –   |   | ≥ 180 kHz   |
| Scanning frequency                         | ≤ 300 kHz   |   | –   |
| Edge separation a                          | ≥ 0.39 μs   |   | –   |
| <b>System accuracy</b>                     | 1/20 of grating period  |   |   |
| <b>Voltage supply</b>                      | DC 5 V ± 0.5 V  | DC 10 V to 30 V   | DC 5 V ± 0.5 V  |
| <b>Current consumption</b><br>without load | ≤ 120 mA  | ≤ 150 mA  | ≤ 120 mA  |
| <b>Electrical connection</b>               | Cable 10 m with 12-pin M23 coupling (male)  |   |   |
| <b>Shaft</b>                               | Solid shaft D = 6 mm (recommended shaft coupling: K17; see <i>Rotary Encoders</i> ) catalog |   |   |
| <b>Mechanically permissible speed n</b>    | ≤ 10000 rpm   |   |   |
| <b>Starting torque</b>                     | ≤ 0.015 Nm (at 20 °C)   |   |   |
| <b>Moment of inertia</b> of rotor          | ≤ 4.4 · 10 <sup>-6</sup> kgm <sup>2</sup>   |   |   |
| <b>Shaft load</b> <sup>2)</sup>            | <i>Axial</i> : ≤ 40 N; <i>radial</i> : ≤ 60 N at shaft end                                  |   |   |
| <b>Vibration</b> 55 to 2000 Hz             | ≤ 300 m/s <sup>2</sup> (EN 60068-2-6)   |   |   |
| <b>Shock</b> 6 ms                          | ≤ 1500 m/s <sup>2</sup> (EN 60068-2-27)   |   |   |
| <b>Operating temperature</b>               | –20 °C to 80 °C   |   |   |
| <b>Ambient temperature</b>                 | –20 °C (stationary cable) to 60 °C  |   |   |
| <b>Surface temperature</b>                 | ≤ 120 °C  |   |   |
| <b>Protection</b> EN 60 529                | IP66  |   |   |
| <b>Explosion protection</b> as per         | DIN EN 60079-0; DIN EN 60079-1; DIN EN 60079-31   |   |   |
| Equipment group                            | II  |   |   |
| Category                                   | 2   |   |   |
| Explosive atmosphere                       | G (gas) and D (dust)  |   |   |
| Type of ignition protection                | d and tb  |   |   |
| Explosion group and subgroup               | IIC (max. permitted gap < 0.5 mm) and IIIC  |   |   |
| <b>Mass</b>                                | ≈ 0.7 kg  |   |   |

\* Please select when ordering

<sup>1)</sup> Restricted tolerances: Signal amplitude: 0.8 to 1.2 V<sub>PP</sub>

<sup>2)</sup> See also *Mechanical types and mounting* in the *Rotary Encoders* catalog

|  | <b>Absolute</b>   |                        |
|--|---|------------------------|
|  | <b>Singleturn</b>   |                        |
|  | <b>ROC 413</b>  |                        |
| <b>Interface*</b>  | <b>EnDat 2.2</b>  | <b>SSI</b>             |
| Ordering designation   | EnDat01   | SSI01r1                |
| Positions per revolution   | 8192 (13 bits)  |                        |
| Revolutions  | –   |                        |
| Code   | Pure binary   | Gray                   |
| Elec. permissible speed<br>Deviations <sup>1)</sup>  | <i>512 lines:</i> ≤ 5000/12 000 rpm<br>± 1 LSB/± 100 LSB<br><i>2048 lines:</i> ≤ 1500/12 000 rpm<br>± 1 LSB/± 50 LSB                                      | 12 000 rpm<br>± 12 LSB |
| Calculation time $t_{cal}$<br>Clock frequency  | ≤ 9 μs<br>≤ 2 MHz   | ≤ 5 μs<br>–            |
| <b>Incremental signals</b>   | $\sim 1 V_{PP}$ <sup>1)</sup>   |                        |
| Line counts*   | 512 2048  | 512                    |
| Cutoff frequency –3 dB   | <i>512 lines:</i> ≥ 130 kHz; <i>2048 lines:</i> ≥ 400 kHz   |                        |
| <b>System accuracy</b>   | <i>512 lines:</i> ± 60"; <i>2048 lines:</i> ± 20"   |                        |
| <b>Voltage supply</b>  | DC 5 V ± 0.25 V   |                        |
| Power consumption (max.)   | ≤ 625 mW  | ≤ 600 mW               |
| Current consumption (typical; without load)  | 85 mA   | 70 mA                  |
| <b>Electrical connection</b>   | Cable 10 m with 17-pin M23 coupling (male)  |                        |
| <b>Shaft</b>   | Solid shaft D = 6 mm (recommended shaft coupling: K17; see <i>Rotary Encoders</i> ) catalog   |                        |
| <b>Mechanically permissible speed n</b>  | ≤ 10 000 rpm  |                        |
| <b>Starting torque</b>   | ≤ 0.015 Nm (at 20 °C)   |                        |
| <b>Moment of inertia</b> of rotor  | ≤ 4.4 · 10 <sup>-6</sup> kgm <sup>2</sup>   |                        |
| <b>Shaft load</b> <sup>2)</sup>  | <i>Axial:</i> ≤ 40 N; <i>radial:</i> ≤ 60 N at shaft end<br>(see also <i>Mechanical design types and mounting</i> in the <i>Rotary Encoders</i> ) catalog |                        |
| <b>Vibration</b> 55 to 2000 Hz<br><b>Shock</b> 6 ms  | ≤ 300 m/s <sup>2</sup> (EN 60068-2-6)<br>≤ 1500 m/s <sup>2</sup> (EN 60068-2-27)  |                        |
| <b>Operating temperature</b>   | –20 °C to 80 °C   |                        |
| <b>Ambient temperature</b>   | –20 °C (stationary cable) to 60 °C  |                        |
| <b>Surface temperature</b>   | ≤ 120 °C  |                        |
| <b>Protection</b> EN 60529   | IP66  |                        |
| <b>Explosion protection</b> as per   | DIN EN 60079-0; DIN EN 60079-1; DIN EN 60079-31   |                        |
| Equipment group<br>Category<br>Explosive atmosphere<br>Type of ignition protection<br>Explosion group and subgroup | II<br>2<br>G (gas) and D (dust)<br>d and tb<br>IIC (max. permitted gap < 0.5 mm) and IIIC   |                        |
| <b>Mass</b>  | ≈ 0.7 kg  |                        |

\* Please select when ordering

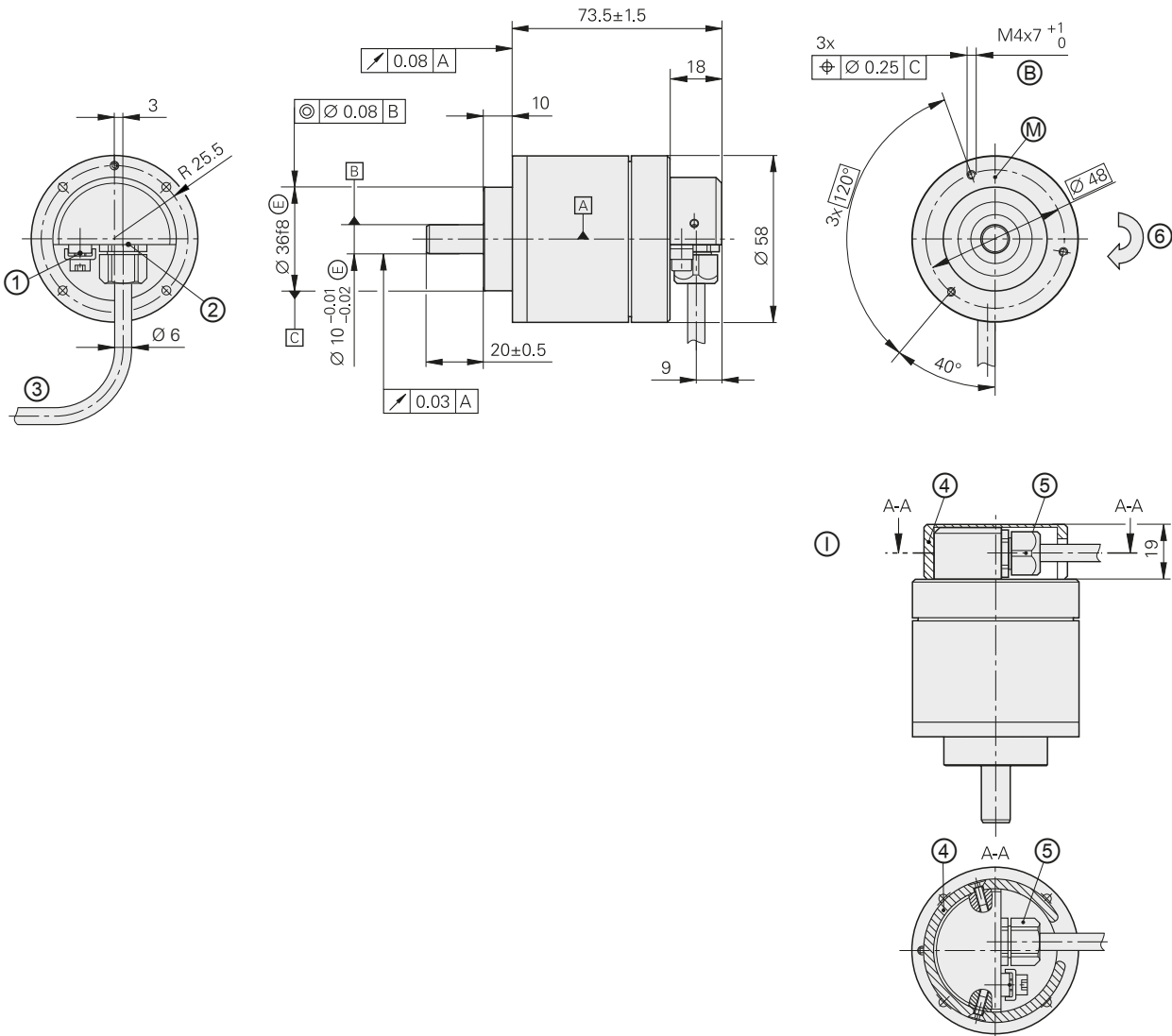
<sup>1)</sup> Restricted tolerances: Signal amplitude: 0.8 to 1.2 V<sub>PP</sub>

<sup>2)</sup> See also *Mechanical types and mounting* in the *Rotary Encoders* catalog






# ROC/ROQ/ROD 400 series

- Absolute and incremental rotary encoders
- Clamping flange
- Solid shaft for separate shaft coupling
- For use in potentially explosive atmospheres



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

- ▣ = Encoder bearing
- ⊕ = Threaded mounting hole
- Ⓜ = Measuring point for operating temperature on encoder flange
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- ⑥ = Direction of shaft rotation for output signals as per the interface description
- ① = Additional means of protection for cable bushings that may be exposed to external load when the encoder is mounted vertically (Directive 2014/34/EU)

|  | Incremental   |   |   |
|--|---|---|---|
|  | ROD 420   | ROD 430   | ROD 480   |
| <b>Interface</b>                           |  TTL       |  HTL |  1 V <sub>PP</sub> <sup>1)</sup> |
| Line counts*                               | 1000 1024 1250 1500 1800  | 2000 2048 2500 3600   | 4096 5000   |
| Reference mark                             | One   |   |   |
| Cutoff frequency –3 dB                     | –   |   | ≥ 180 kHz   |
| Scanning frequency                         | ≤ 300 kHz   |   | –   |
| Edge separation a                          | ≥ 0.39 μs   |   | –   |
| <b>System accuracy</b>                     | 1/20 of grating period  |   |   |
| <b>Voltage supply</b>                      | DC 5 V ± 0.5 V  | DC 10 V to 30 V   | DC 5 V ± 0.5 V  |
| <b>Current consumption</b><br>without load | ≤ 120 mA  | ≤ 150 mA  | ≤ 120 mA  |
| <b>Electrical connection</b>               | Cable 10 m with 12-pin M23 coupling (male)  |   |   |
| <b>Shaft</b>                               | Solid shaft D = 10 mm (recommended shaft coupling: K17; see <i>Rotary Encoders</i> catalog) |   |   |
| <b>Mechanically permissible speed n</b>    | ≤ 10000 rpm   |   |   |
| <b>Starting torque</b>                     | ≤ 0.015 Nm (at 20 °C)   |   |   |
| <b>Moment of inertia</b> of rotor          | ≤ 4.5 · 10 <sup>-6</sup> kgm <sup>2</sup>   |   |   |
| <b>Shaft load</b> <sup>2)</sup>            | <i>Axial</i> : ≤ 40 N; <i>radial</i> : ≤ 60 N at shaft end                                  |   |   |
| <b>Vibration</b> 55 to 2000 Hz             | ≤ 300 m/s <sup>2</sup> (EN 60068-2-6)   |   |   |
| <b>Shock</b> 6 ms                          | ≤ 1500 m/s <sup>2</sup> (EN 60068-2-27)   |   |   |
| <b>Operating temperature</b>               | –20 °C to 80 °C   |   |   |
| <b>Ambient temperature</b>                 | –20 °C (stationary cable) to 60 °C  |   |   |
| <b>Surface temperature</b>                 | ≤ 120 °C  |   |   |
| <b>Protection</b> EN 60 529                | IP66  |   |   |
| <b>Explosion protection</b> as per         | DIN EN 60079-0; DIN EN 60079-1; DIN EN 60079-31   |   |   |
| Equipment group                            | II  |   |   |
| Category                                   | 2   |   |   |
| Explosive atmosphere                       | G (gas) and D (dust)  |   |   |
| Type of ignition protection                | d and tb  |   |   |
| Explosion group and subgroup               | IIC (max. permitted gap < 0.5 mm) and IIIC  |   |   |
| <b>Mass</b>                                | ≈ 0.7 kg  |   |   |

\* Please select when ordering

<sup>1)</sup> Restricted tolerances: Signal amplitude: 0.8 to 1.2 V<sub>PP</sub>

<sup>2)</sup> See also *Mechanical types and mounting* in the *Rotary Encoders* catalog

|  | <b>Absolute</b>   |                        |
|--|---|------------------------|
|  | <b>Singleturn</b>   |                        |
|  | <b>ROC 413</b>  |                        |
| <b>Interface*</b>  | <b>EnDat 2.2</b>  | <b>SSI</b>             |
| Ordering designation   | EnDat01   | SSI01r1                |
| Positions per revolution   | 8192 (13 bits)  |                        |
| Revolutions  | –   |                        |
| Code   | Pure binary   | Gray                   |
| Elec. permissible speed<br>Deviations <sup>1)</sup>  | <i>512 lines:</i> ≤ 5000/12 000 rpm<br>± 1 LSB/± 100 LSB<br><i>2048 lines:</i> ≤ 1500/12 000 rpm<br>± 1 LSB/± 50 LSB                                      | 12 000 rpm<br>± 12 LSB |
| Calculation time $t_{cal}$<br>Clock frequency  | ≤ 9 μs<br>≤ 2 MHz   | ≤ 5 μs<br>–            |
| <b>Incremental signals</b>   | $\sim 1 V_{PP}$ <sup>1)</sup>   |                        |
| Line counts*   | 512 2048  | 512                    |
| Cutoff frequency –3 dB   | <i>512 lines:</i> ≥ 130 kHz; <i>2048 lines:</i> ≥ 400 kHz   |                        |
| <b>System accuracy</b>   | <i>512 lines:</i> ± 60"; <i>2048 lines:</i> ± 20"   |                        |
| <b>Voltage supply</b>  | DC 5 V ± 0.25 V   |                        |
| Power consumption (max.)   | ≤ 625 mW  | ≤ 600 mW               |
| Current consumption (typical; without load)  | 85 mA   | 70 mA                  |
| <b>Electrical connection</b>   | Cable 10 m with 17-pin M23 coupling (male)  |                        |
| <b>Shaft</b>   | Solid shaft D = 10 mm (recommended shaft coupling: K17; see <i>Rotary Encoders</i> ) catalog  |                        |
| <b>Mechanically permissible speed n</b>  | ≤ 10 000 rpm  |                        |
| <b>Starting torque</b>   | ≤ 0.015 Nm (at 20 °C)   |                        |
| <b>Moment of inertia</b> of rotor  | ≤ 4.5 · 10 <sup>–6</sup> kgm <sup>2</sup>   |                        |
| <b>Shaft load</b> <sup>2)</sup>  | <i>Axial:</i> ≤ 40 N; <i>radial:</i> ≤ 60 N at shaft end<br>(see also <i>Mechanical design types and mounting</i> in the <i>Rotary Encoders</i> ) catalog |                        |
| <b>Vibration</b> 55 to 2000 Hz<br><b>Shock</b> 6 ms  | ≤ 300 m/s <sup>2</sup> (EN 60 068-2-6)<br>≤ 1500 m/s <sup>2</sup> (EN 60 068-2-27)  |                        |
| <b>Operating temperature</b>   | –20 °C to 80 °C   |                        |
| <b>Ambient temperature</b>   | –20 °C (stationary cable) to 60 °C  |                        |
| <b>Surface temperature</b>   | ≤ 120 °C  |                        |
| <b>Protection</b> EN 60529   | IP66  |                        |
| <b>Explosion protection</b> as per   | DIN EN 60079-0; DIN EN 60079-1; DIN EN 60079-31   |                        |
| Equipment group<br>Category<br>Explosive atmosphere<br>Type of ignition protection<br>Explosion group and subgroup | II<br>2<br>G (gas) and D (dust)<br>d and tb<br>IIC (max. permitted gap < 0.5 mm) and IIIC   |                        |
| <b>Mass</b>  | ≈ 0.7 kg  |                        |

\* Please select when ordering

<sup>1)</sup> Restricted tolerances: Signal amplitude: 0.8 to 1.2 V<sub>PP</sub>

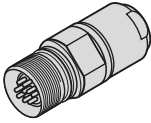


<sup>2)</sup> See also *Mechanical types and mounting* in the *Rotary Encoders* catalog




# Electrical connection

## SSI/EnDat 01 pin layout

**17-pin coupling, M23**

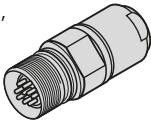

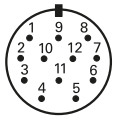
|  | Voltage supply |                 |         |              | Incremental signals |    |    |    | Absolute position values |                          |       |                           | Other signals       |
|--|----------------|-----------------|---------|--------------|---------------------|----|----|----|--------------------------|--------------------------|-------|---------------------------|---------------------|
|  | 7              | 1               | 10      | 4            | 15                  | 16 | 12 | 13 | 14                       | 17                       | 8     | 9                         | 3                   |
|  | $U_P$          | Sensor<br>$U_P$ | 0V      | Sensor<br>0V | A+                  | A- | B+ | B- | DATA                     | $\overline{\text{DATA}}$ | CLOCK | $\overline{\text{CLOCK}}$ | $\overline{U_{aS}}$ |
|  | ● ——— ●        |                 | ● ——— ● |              |                     |    |    |    |                          |                          |       |                           |                     |


**Shield** on housing;  $U_P$  = Power supply

**Sensor:** The sensor line is connected in the encoder with the corresponding power line.

## Pin layout $\sim 1V_{PP}$ / $\square$ TTL / $\square$ HTL

**12-pin coupling, M23, male**

|  | Voltage supply |                 |         |              | Incremental signals |                     |          |                     |          |                     | Other signals       |   |
|--|----------------|-----------------|---------|--------------|---------------------|---------------------|----------|---------------------|----------|---------------------|---------------------|---|
|  | 12             | 2               | 10      | 11           | 5                   | 6                   | 8        | 1                   | 3        | 4                   | 7                   | 9 |
| $\sim 1V_{PP}$   | $U_P$          | Sensor<br>$U_P$ | 0V      | Sensor<br>0V | A+                  | A-                  | B+       | B-                  | R+       | R-                  | /                   | / |
| $\square$ TTL  |                |                 |         |              | $U_{a1}$            | $\overline{U_{a1}}$ | $U_{a2}$ | $\overline{U_{a2}}$ | $U_{a0}$ | $\overline{U_{a0}}$ | $\overline{U_{aS}}$ | / |
| $\square$ HTL  | ● ——— ●        |                 | ● ——— ● |              |                     |                     |          |                     |          |                     |                     |   |

**Shield** on housing;  $U_P$  = Power supply

**Sensor:** The sensor line is connected in the encoder with the corresponding power line.

Vacant pins or wires must not be used.



Connecting cable  $\sim 1 V_{PP}$

TTL  
HTL  
EnDat

12-pin

17-pin

M23

M23

|                                      |  |
|--------------------------------------|--|
| For<br>$\sim 1 V_{PP}$<br>TTL<br>HTL | For<br>EnDat with SSI<br>incremental signals |
|--------------------------------------|--|

|  |   |  |
|--|---|--|
| <b>PUR connecting cables</b>   | <b>12-pin:</b> $[4(2 \times 0.14 \text{ mm}^2) + (4 \times 0.5 \text{ mm}^2)]; A_P = 0.5 \text{ mm}^2$<br><b>17-pin:</b> $[(4 \times 0.14 \text{ mm}^2) + 4(2 \times 0.14 \text{ mm}^2) + (4 \times 0.5 \text{ mm}^2)]; A_P = 0.5 \text{ mm}^2$ | $\varnothing 8 \text{ mm}$<br>$\varnothing 8 \text{ mm}$                         |
| <b>Complete</b> with connector (female) and coupling (male)                          |   | 298401-xx      323897-xx   |
| <b>Complete</b> with connectors (female and male)                                    |   | 298399-xx      -   |
| <b>Complete</b> with connector (female) and D-sub connector (female) for IK 220      |   | 310199-xx      332115-xx   |
| <b>Complete</b> with connector (female) and D-sub connector (male) for IK 115/IK 215 |   | 310196-xx      324544-xx   |
| With <b>one connector</b> , (female)   |   | 309777-xx      309778-xx   |
| <b>Cable without connectors</b> , $\varnothing 8 \text{ mm}$                         |   | 244957-01      266306-01   |
| <b>Mating element on connecting cable to connector on encoder cable</b>              | <b>Connector (female)</b> for cable $\varnothing 8 \text{ mm}$<br>  | 291697-05      291697-26   |
| <b>Connector on connecting cable</b> for connection to subsequent electronics        | <b>Connector (male)</b> for cable $\varnothing 4.5 \text{ mm}$<br>$\varnothing 8 \text{ mm}$<br>$\varnothing 6 \text{ mm}$<br>  | 291697-06      291697-27<br>291697-08<br>291697-07                               |
| <b>Coupling on connecting cable</b>  | <b>Coupling (male)</b> for cable $\varnothing 4.5 \text{ mm}$<br>$\varnothing 6 \text{ mm}$<br>$\varnothing 8 \text{ mm}$<br>   | 291698-14      291698-25<br>291698-03      291698-26<br>291698-04      291698-27 |
| <b>Flange socket</b> for mounting on subsequent electronics                          | <b>Flange socket (female)</b><br>   | 315892-08      315892-10   |
| <b>Mounted couplings</b>   | <b>With flange (female)</b> $\varnothing 6 \text{ mm}$<br>$\varnothing 8 \text{ mm}$<br>  | 291698-17      291698-35<br>291698-07  |
|  | <b>With flange (male)</b> $\varnothing 6 \text{ mm}$<br>$\varnothing 8 \text{ mm}$<br>  | 291698-08      291698-41<br>291698-31      291698-29                             |
|  | <b>With central fastening (male)</b> $\varnothing 6 \text{ mm}$<br>   | 291698-33      291698-37   |

$A_P$ : Cross section of power supply lines

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# HEIDENHAIN

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

### Further Information

- Catalog: *Rotary Encoders*
- Catalog: *Interfaces of HEIDENHAIN Encoders*