HEIDENHAIN

Product Overview

Rotary Encoders
for Potentially Explosive Atmospheres (ATEX)

September 2010

Rotary Encoders for Use in Potentially Explosive Areas

Introduction
There are many types of applications in industry where exposure to potentially explosive atmospheres is 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 **Directive 94/9/EC,** also known as **ATEX 95** (ATEX is named after the French "Atmosphère Explosible," which means explosive atmosphere).

This directive has been in effect since July 1, 2003, 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 July 1, 2003, must meet the requirements of the new 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, and
- Category 3, 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: Not likely, 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: Not likely, for a short period

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

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
C	= Subgroup (C = limit gap width < 0.5 mm)
120 °C	= Maximum surface temperature

II	= Equipment group (II = for above-ground applications)
2	= Category
D	= Dust
Ex	= Explosion protection
tD	= Explosion protection (tD = protection by housing)
A	= Procedure for determining dust proofness
21	= Zone 21
IP 66	= Protection
T120 °C	= Maximum surface temperature

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/2 faults		In case of frequently occurring equipment faults/1 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 **Zones 1 and 21** as well as **2 and 22**.

Type of ignition protection
The rotary encoders for potentially explosive areas fulfill the requirements of the following types of ignition protection: flameproof enclosure (d) or protection by housing (tD). 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 limit gap width is less than 0.5 mm (corresponds to explosion group IIC).

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

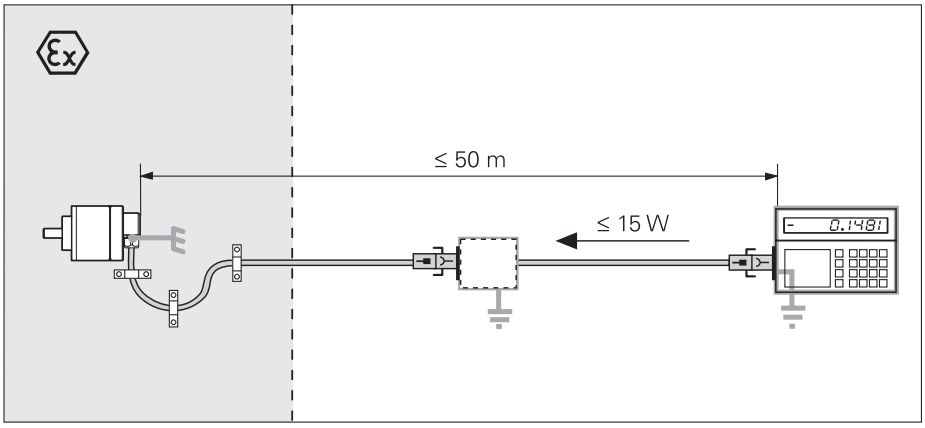
Maximum surface temperature
The **maximum surface temperature** that a rotary encoder can reach during normal and disturbed operation is **120 °C.** This temperature applies for a **maximum ambient temperature of + 60 °C.** Thermal switches in the rotary encoder flange ensure that the maximum surface temperature is not exceeded. At a temperature of 100 °C (+ 5 K) at the thermal switches, 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.

Accessory
Diaphragm coupling K 17
Shaft coupling with galvanic isolation with 6 mm or 10 mm shaft diameter
Ⓔx II 2 DG c X
Explosion protection c (constructive)
Ambient temperature X (max. 60 °C)
ID 296746-xx

Installation 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 15 W in the subsequent electronics.
- **Connecting cable**
  The connecting cable, which 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**.

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 areas. For further specifications, please refer to the respective standard versions described in the *Rotary Encoders* catalog.



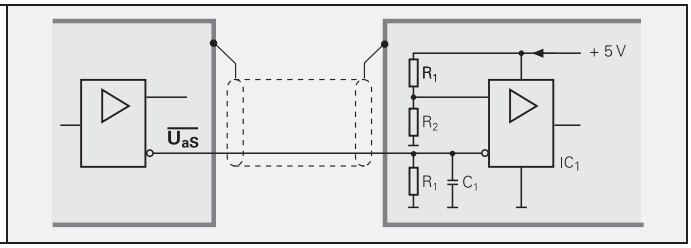
Input circuitry of the subsequent electronics

The input circuits of the subsequent electronics for EnDat and SSI are described in detail in the *Rotary Encoders* catalog. Differences in SSI interfaces:
- No programming inputs
- t_2 start with positive edge (12 to 30 µs).

The ATEX encoders also output 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*).

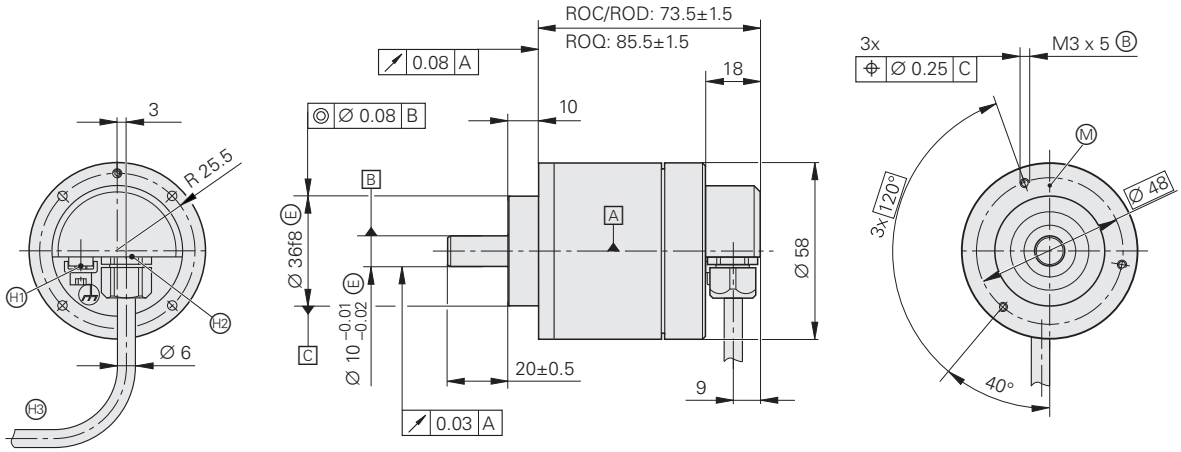
Dimensioning
IC_1 = Recommended differential line receiver
DS 26 C 32 AT
Only for a > 0.1 µs:
AM 26 LS 32
MC 3486
SN 75 ALS 193

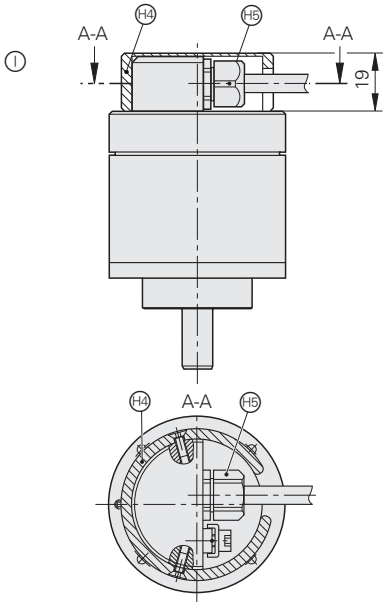
R_1 = 4.7 kΩ
R_2 = 1.8 kΩ
Z_0 = 120 Ω
C_1 = 220 pF (serves to improve noise immunity)

Fault-detection signal	

ROC/ROQ/ROD 400 Series with Clamping Flange

- **Rotary encoders for separate shaft coupling**
- **For use in potentially explosive atmospheres**





Dimensions in 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 = Grounding screw
Ⓗ2 = Lead-in thread for cable gland M13x0.75
Ⓗ3 = Provide cable strain relief
Ⓗ4 = Protective cover
Ⓗ5 = Cable bushing

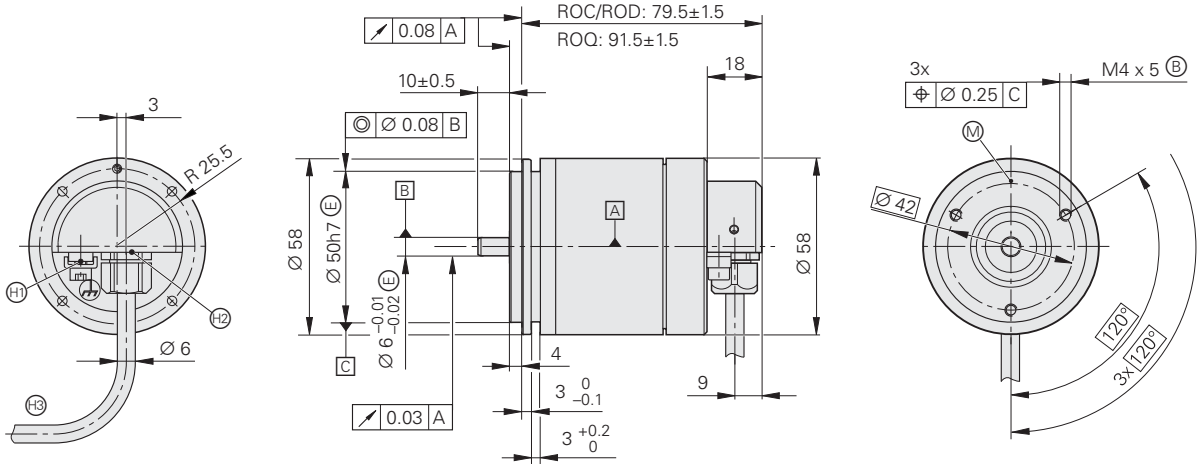
Ⓘ = Additional means of protection for cable bushings that may be exposed to external load when the encoder is mounted vertically (Directive 94/9/EC 12.5)

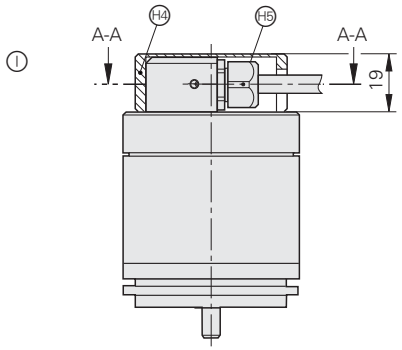
	Absolute				Incremental		
	Singleturn		Multiturn				
	ROC 413		ROQ 425		ROD 420	ROD 430	ROD 480
Absolute position values	**SSI 01**	**EnDat 2.1**	**SSI 07**	**EnDat 2.1**	–		
Ordering designation		**EnDat 01**		**EnDat 01**	–		
Positions per rev	8192 (13 bits)				–		
Revolutions	–		4096		–		
Code	Gray	Pure binary	Gray	Pure binary	–		
Elec. permissible speed	*512 lines:* ≤ 5000 min^{-1}; *2048 lines:* ≤ 1500 min^{-1}				–		
Incremental signals	∿ 1 V_{PP} [1]				⊓⊔ TTL	⊓⊔ HTL	∿ 1 V_{PP} [1]
Line counts*	512	512 2048	512	512 2048	1000 1024 1250 2000 2048 2500 3600 4096 5000		
System accuracy	*512 lines:* ± 60“ *2048 lines:* ± 20“				1/20 of grating period		
Power supply*	5 V + 5 % – 2 %				5 V ± 10 %	10 to 30 V	5 V ± 10 %
Current consumption without load	≤ 200 mA		≤ 260 mA		120 mA	150 mA	120 mA
Electrical connection	Cable 10 m with 17-pin M23 coupling				Cable 10 m with 12-pin M23 coupling		
Shaft [2]	Solid shaft D = 10 mm				Solid shaft D = 10 mm		
Mech. permissible speed n	≤ 10000 min^{-1}				≤ 10000 min^{-1}		
Starting torque	≤ 0.015 Nm (at 20 °C)				≤ 0.015 Nm (at 20 °C)		
Moment of inertia of rotor	≤ 3 · 10^{-5} kgm^2				≤ 3 · 10^{-5} kgm^2		
Shaft load	Axial 10 N/radial 20 N at shaft end				Axial 10 N/radial 20 N at shaft end		
Vibration 55 to 2000 Hz **Shock** 6 ms	≤ 300 m/s^2 (EN 60068-2-6) ≤ 1500 m/s^2 (EN 60068-2-27)				≤ 300 m/s^2 (EN 60068-2-6) ≤ 1500 m/s^2 (EN 60068-2-27)		
Operating temperature	–20 °C to 100 °C				–20 °C to 100 °C		–20 °C to 80 °C
Max. ambient temperature	60 °C				60 °C		
Min. ambient temperature	*For fixed cable:* –20 °C				*For fixed cable:* –20 °C		
Surface temperature	≤ 120 °C				≤ 120 °C		
Protection EN 60529	IP 66				IP 66		
Explosion protection as per	DIN EN 60079-0/DIN EN 60079-1 DIN EN 61241-0/DIN EN 61241-1				DIN EN 60079-0/DIN EN 60079-1 DIN EN 61241-0/DIN EN 61241-1		
Equipment group Category Explosive atmosphere Type of ignition protection Explosion group and subgroup	II 2 G (gas) and D (dust) d and tD IIC (limit gap width < 0.5 mm)				II 2 G (gas) and D (dust) d and tD IIC (limit gap width < 0.5 mm)		
Weight	Approx. 0.7 kg				Approx. 0.7 kg		

***** Please select when ordering
[1] Restricted tolerances: Signal amplitude 0.8 to 1.2 V_{PP}
[2] Recommended shaft coupling: K17 (see *Rotary Encoders* catalog)

ROC/ROQ/ROD 400 Series with Synchro Flange

- **Rotary encoders for separate shaft coupling**
- **For use in potentially explosive atmospheres**





Dimensions in mm

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ISO 2768 - m H
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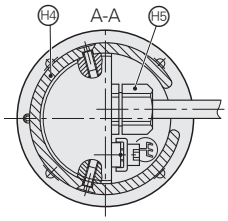

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Absolute position values	**SSI 01**	**EnDat 2.1**	**SSI 07**	**EnDat 2.1**	–		
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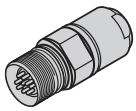
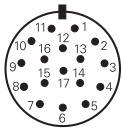
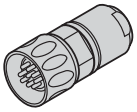
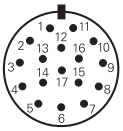
Electrical Connection

SSI/EnDat pin layout

17-pin coupling M23, **male**

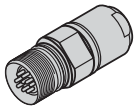
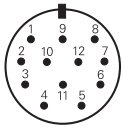





	Power supply				Incremental signals				Absolute position values				Other signals
	7	**1**	**10**	**4**	**15**	**16**	**12**	**13**	**14**	**17**	**8**	**9**	**3**
	U_P	**Sensor** U_P	**0 V**	**Sensor** 0 V	**A+**	**A–**	**B+**	**B–**	**DATA**	**$\overline{DATA}$**	**CLOCK**	**$\overline{CLOCK}$**	**$\overline{U_{aS}}$**
	Brown/ Green	Blue	White/ Green	White	Green/ Black	Yellow/ Black	Blue/ Black	Red/ Black	Gray	Pink	Violet	Yellow	Red

Shield on housing; **U_P** = Power supply voltage
Sensor: The sensor line is connected internally with the corresponding power line.

Pin layout ∿ 1 V_{PP} / ⊓⊔ TTL / ⊓⊔ HTL

12-pin coupling M23, **male**

	Power supply				Incremental signals						Other signals	
	12	**2**	**10**	**11**	**5**	**6**	**8**	**1**	**3**	**4**	**7**	**9**
∿ 1 V_{PP}	**U_P**	**Sensor** U_P	**0 V**	**Sensor** 0 V	**A+**	**A–**	**B+**	**B–**	**R+**	**R–**	**/**	**/**
⊓⊔ TTL					**U_{a1}**	**$\overline{U_{a1}}$**	**U_{a2}**	**$\overline{U_{a2}}$**	**U_{a0}**	**$\overline{U_{a0}}$**	**$\overline{U_{aS}}$**	**/**
⊓⊔ HTL												
	Brown/ Green	Blue	White/ Green	White	Brown	Green	Gray	Pink	Red	Black	Violet	Yellow

Shield on housing; **U_P** = Power supply voltage
Sensor: The sensor line is connected internally with the corresponding power line.
Vacant pins or wires must not be used.

HEIDENHAIN

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For more information
- Catalog: *Rotary Encoders*