



HEIDENHAIN



**Functional
Safety**

Product Information

ECN 425
EQN 437

Absolute Rotary Encoders
with EnDat22 for Safety-
Related Applications

May 2017

ECN 425, EQN 437

Rotary encoders for absolute position values with safe singleturn information

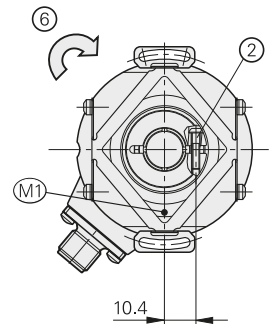
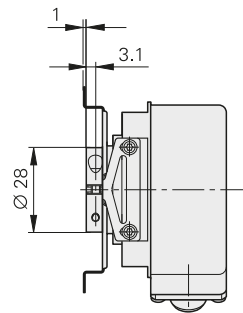
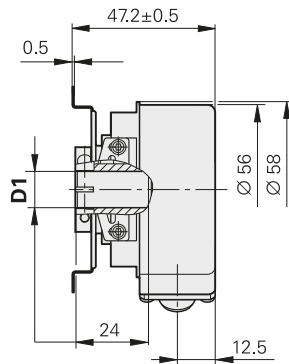
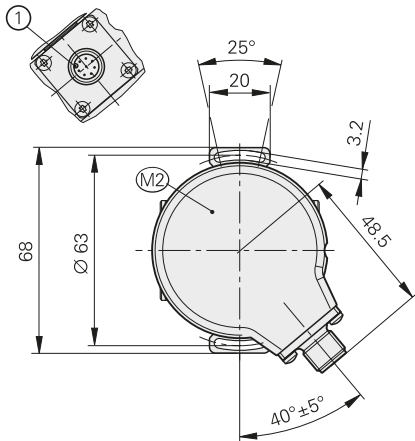
• Blind hollow shaft with steel clamping ring:

Ø 12 mm (68S)

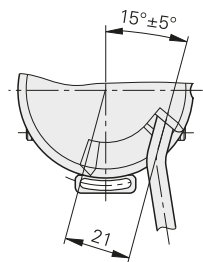
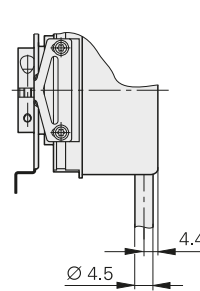
Ø 10 mm (68T)



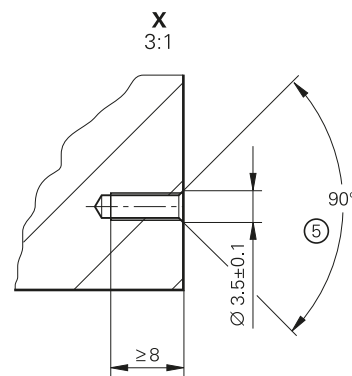
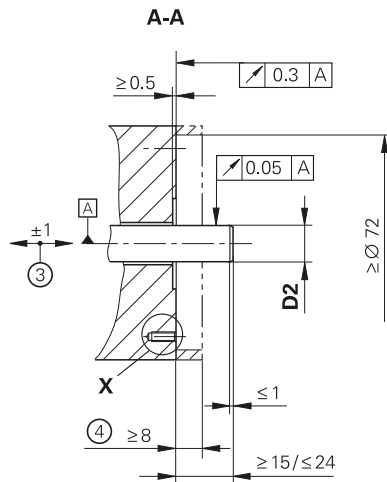
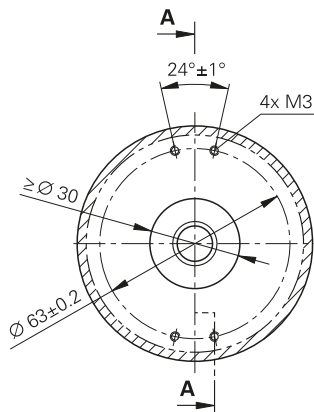
Functional Safety



D1	D2
Ø 10H6 \oplus	Ø 10g7 \ominus
Ø 12H6 \oplus	Ø 12g7 \ominus



Required mating dimensions



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

- ☒ = Bearing of mating shaft
- M1 = Measuring point for operating temperature
- M2 = Measuring point for vibration
- ① = Connector coding
- ② = Clamping screw with hexalobular socket X8, tightening torque 1 Nm ±0.06 Nm
- ③ = Compensation of mounting tolerances and thermal expansion, no dynamic motion permitted
- ④ = Protection against contact as per EN 60529
- ⑤ = Chamfer at start of thread is obligatory for materially bonding anti-rotation lock
- ⑥ = Direction of shaft rotation for output signals as per the interface description

Specifications	ECN 425	EQN 437
Functional safety For applications up to	As single-encoder system for monitoring and closed-loop functions: <ul style="list-style-type: none"> • SIL 2 according to EN 61 508 (further basis for testing: EN 61 800-5-2) • Category 3, PL d as per EN ISO 13849-1:2008 Safe in the singleturn range	
PFH	$\leq 10 \cdot 10^{-9}$ (Probability of dangerous Failure per Hour)	
Safe position ¹⁾	Encoder: $\pm 1.76^\circ$ (safety-related measuring step: SM = 0.7°) Mechanical coupling: $\pm 2^\circ$ (exclusion for loosening of shaft and stator coupling, designed for accelerations of $\leq 150 \text{ m/s}^2$)	
Interface/ordering designation	EnDat 2.2/EnDat22	
Position values/revolution	33554432 (25 bits)	
Revolutions	–	4096 (12 bits)
Calculation time t_{cal} Clock frequency	$\leq 7 \mu\text{s}$ $\leq 8 \text{ MHz}$	
System accuracy at 20 °C	$\pm 20''$	
Voltage supply	DC 3.6 V to 14 V	
Power consumption (max.)	At 3.6 V: $\leq 600 \text{ mW}$ At 14 V: $\leq 700 \text{ mW}$	At 3.6 V: $\leq 700 \text{ mW}$ At 14 V: $\leq 800 \text{ mW}$
Current consumption (typical)	At 5 V: 85 mA (without load)	At 5 V: 105 mA (without load)
Electrical connection	M12 radial flange socket, 8-pin or 1 m cable PUR with M12 coupling (male), 8-pin	
Cable length	$\leq 100 \text{ m}$ (see <i>Interfaces of HEIDENHAIN Encoders</i> brochure)	
Shaft*	Blind hollow shaft D = 12 mm or D = 10 mm	
Permissible speed	$\leq 6000 \text{ rpm}$	
Starting torque at 20 °C	$\leq 0.01 \text{ Nm}$	
Moment of inertia of rotor	$\leq 6 \cdot 10^{-6} \text{ kgm}^2$	
Angular acceleration of rotor	$\leq 4 \cdot 10^4 \text{ rad/s}^2$	
Permissible axial motion of measured shaft	$\leq \pm 1 \text{ mm}$	
Vibration 55 Hz to 2000 Hz ²⁾ Shock 6 ms	$\leq 300 \text{ m/s}^2$; flange socket version: 150 m/s^2 (EN 60068-2-6) $\leq 2000 \text{ m/s}^2$ (EN 60068-2-27)	
Operating temperature ³⁾	–30 °C to 100 °C	
Trigger threshold for error message due to temperature ⁴⁾	125 °C in the scanning ASIC (measuring accuracy of internal temperature sensor $\pm 4 \text{ K}$)	
Relative humidity	$\leq 93 \%$ (40 °C/21 d as per EN 60068-2-78); without condensation	
Protection EN 60529	IP67 at housing; IP64 at shaft inlet (See <i>Isolation</i> under <i>Electrical safety</i> in the <i>Interfaces of HEIDENHAIN Encoders</i> brochure; contamination from the ingress of liquid must be prevented.)	
Mass	$\approx 0.3 \text{ kg}$	
Valid for ID	678920-03 678920-04 678920-05 678920-06	678922-03 678922-04 678922-05 678922-06

* Please select when ordering

Bold: These preferred versions are available on short notice

¹⁾ Further tolerances may occur in subsequent electronics after position value comparison (contact manufacturer of subsequent electronics)

²⁾ 10 Hz to 55 Hz constant over distance 4.9 mm peak to peak

³⁾ For information on operating temperature, shaft speed and supply voltage, see *General mechanical information* in the *Rotary Encoders* brochure

⁴⁾ The internal temperature is not designed for functional safety

Mounting

Mounting

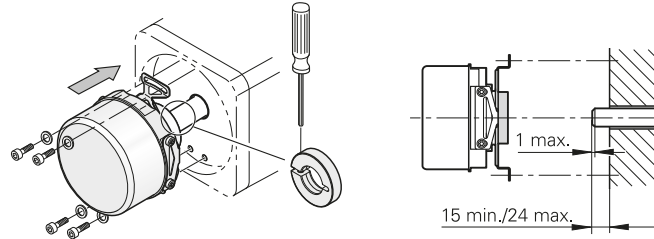
The rotary encoder is slid by its hollow shaft onto the measured shaft and fastened by a screw (tightening torque $1 \text{ Nm} \pm 0.06 \text{ Nm}$). The stator is connected without a centering collar on a flat surface.

For the hollow-shaft connections 68S and 68T, the repetition of fastening reduces the screw force. In order to retain the required safety factor for friction-locked connections, the maximum number of permissible fastening repetitions is limited to four. A mechanical fault exclusion cannot be guaranteed for more repetitions.

In these cases, new clamping rings must be ordered separately.

Clamping ring for 10 mm ID 540741-06
Clamping ring for 12 mm ID 540741-07

With standard stator coupling
Blind hollow shaft



The following maximum torque M_{\max} is to be used when designing the mechanical fault exclusion for the shaft connection:

$M_{\max} = 1 \text{ Nm}$

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

For a safe mechanical coupling, the following prerequisites are to be met by the customer.

	Mating shaft	Mating stator
Material	Steel	Aluminum
Tensile strength R_m	$\geq 600 \text{ N/mm}^2$	$\geq 220 \text{ N/mm}^2$
Interface pressure P_G	$\geq 500 \text{ N/mm}^2$	$\geq 200 \text{ N/mm}^2$
Surface roughness R_z	$\leq 16 \mu\text{m}$	
Coefficient of thermal expansion α_{therm}	$10 \cdot 10^{-6} \text{ K}^{-1}$ to $17 \cdot 10^{-6} \text{ K}^{-1}$	$\leq 25 \cdot 10^{-6} \text{ K}^{-1}$
Minimum shear strength	Not applicable	120 N/mm^2

For further mounting information and help, see the *Rotary Encoders* mounting instructions and the brochure.

Integrated temperature evaluation

This rotary encoder features a temperature sensor integrated in the encoder electronics. The digitized temperature value is transmitted purely serially over the EnDat protocol. Note that temperature measurement and transmission are not secure in the sense of functional safety.

With regard to the internal temperature sensor, the encoder supports two-stage cascaded signaling of excessive temperature. This consists of an EnDat warning and an EnDat error message.

In compliance with the EnDat specification, when the temperature reaches the warning threshold of the internal temperature sensor, it triggers an EnDat warning ("EnDat memory area for operating status," word 1 – warning, bit 2¹ – "temperature exceeded"). This warning threshold for the internal temperature sensor is saved in the EnDat memory area "Operating parameters," word 6 – "Threshold sensitivity warning bit for exceeded temperature," and can be individually adjusted. A product-specific default value is saved before

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

The encoder features a further, but non-adjustable trigger threshold for the EnDat error message for excessive temperature of the internal temperature sensor, which when exceeded triggers an EnDat error message (EnDat memory area for operating status, word 0 – error messages, bit 2² – position and, in the additional datum 2 operating status error sources, bit 2⁶ – temperature exceeded). This threshold sensitivity depends on the device and is shown in the specifications.

HEIDENHAIN recommends setting the warning threshold depending on the application so that it lies sufficiently below the trigger threshold for the EnDat error message. The encoder's intended use requires compliance with the operating temperature at the measuring point M1.

Diagnostic and testing equipment

PWM 20

Together with the ATS adjusting and testing software, the PWM 20 phase angle measuring unit serves for diagnosis and adjustment of HEIDENHAIN encoders.



For more information, see the Product Information document *PWM 20/ATS Software*.


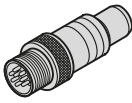

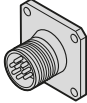


PWM 20	
Encoder input	<ul style="list-style-type: none"> • EnDat 2.1 or EnDat 2.2 (absolute value with or without incremental signals) • DRIVE-CLiQ • Fanuc Serial Interface • Mitsubishi high speed interface • Yaskawa Serial Interface • Panasonic serial interface • SSI • 1 V_{PP}/TTL/11 μA_{PP} • HTL (via signal adapter)
Interface	USB 2.0
Voltage supply	AC 100 V to 240 V or DC 24 V
Dimensions	258 mm x 154 mm x 55 mm

ATS	
Languages	Choice between English and German
Functions	<ul style="list-style-type: none"> • Position display • Connection dialog • Diagnostics • Mounting wizard for EBI/ECI/EQI, LIP200, LIC 4000 and others • Additional functions (if supported by the encoder) • Memory contents
System requirements and recommendations	PC (dual-core processor > 2 GHz) RAM > 2 GB Operating systems: Windows Vista (32-bit), 7, 8, and 10 (32-bit/64-bit) 500 MB free space on hard disk

DRIVE-CLiQ is a registered trademark of SIEMENS AG.

Electrical connection

Pin layout

8-pin flange socket or coupling M12									
									
	Voltage supply				Serial data transmission				
	8	2	5	1	3	4	7	6	
	U_P	Sensor U_P	0V	Sensor 0V	DATA	DATA	CLOCK	CLOCK	
	Brown/Green	Blue	White/Green	White	Gray	Pink	Violet	Yellow	





Cable shield connected to housing; **U_P** = Power supply voltage

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

Vacant pins or wires must not be used.

Note for safety-related applications: Only completely assembled HEIDENHAIN cables are qualified. Exchange connectors or modify cables only after consultation with HEIDENHAIN Traunreut.

Cables with M12 connecting element

PUR connecting and adapter cable \varnothing 6 mm; [(4 x 0.14 mm ²) + (4 x 0.34 mm ²)]; A _P = 0.34 mm ²		
Complete with M12 connector (female) and M12 coupling (male), 8 pins each		1036372-xx
Complete with M12 connector (female), 8-pin, and D-sub connector (female), 15-pin		1036521-xx
Complete with M12 connector (female), 8-pin, and D-sub connector (male), 15-pin		1036526-xx
With one M12 connector (female), 8-pin		634265-xx ¹⁾

A_P = Cross section of power supply lines

¹⁾ Connecting element must be suitable for the maximum clock frequency used.

Note for safety-related applications: Provide bit error rate as per specification 533095!

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 document edition valid when the order is made.



For more information:

Comply with the requirements described in the following documents to ensure the correct operation of the encoder:

- Brochure: *Rotary Encoders* 349529-xx
- Brochure: *Interfaces of HEIDENHAIN Encoders* 1078628-xx
- Mounting Instructions: *ECN 425/EQN 437* 1165780-xx
- Technical Information: *Safety-Related Position Measuring Systems* 596632-xx
- Specification for implementation in a safe control or inverter 533095-xx