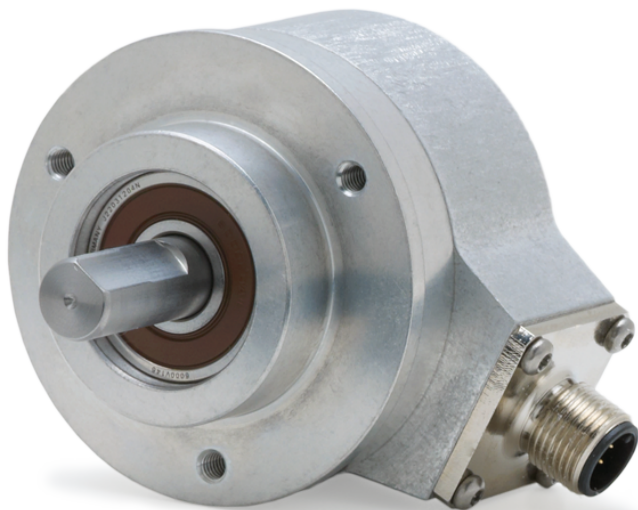




HEIDENHAIN



**Functional
Safety**

Product Information

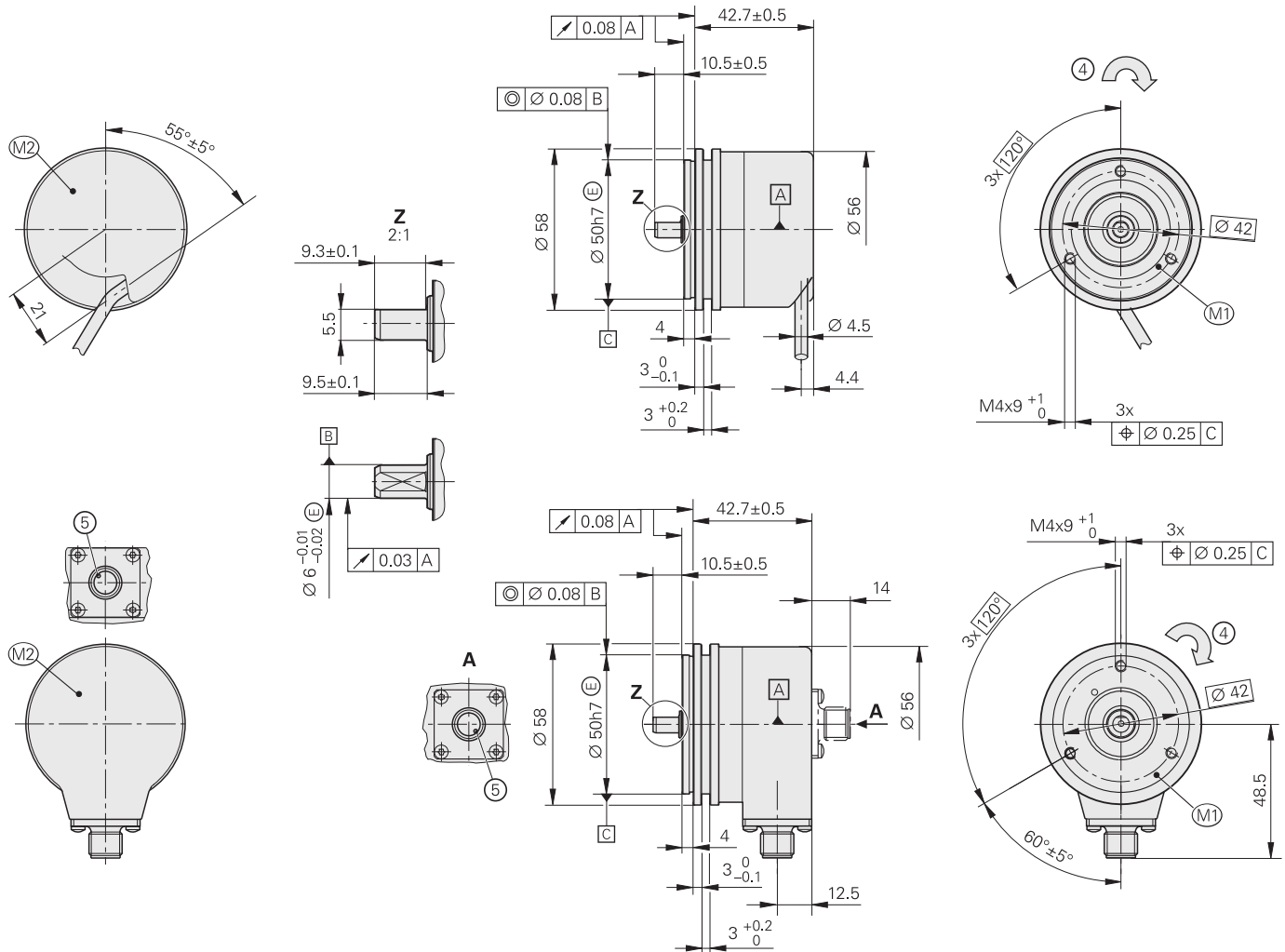
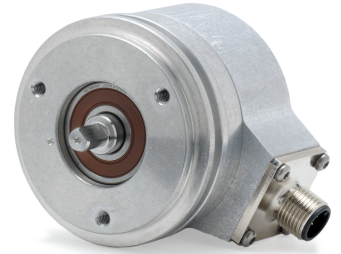
ROC 425 ROQ 437

Absolute Rotary Encoders with
EnDat 2.2 for Safety-Related
Applications

ROC 425, ROQ 437 with synchro flange

Rotary encoders for absolute position values with safe singletum information

- Rotary encoders for separate shaft coupling
- Synchro flange 01C
- Solid shaft with flat 92A



Required mating dimensions

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

⊠ = Encoder bearing

M1 = Measuring point for operating temperature

M2 = Measuring point for vibration, see also D 741714

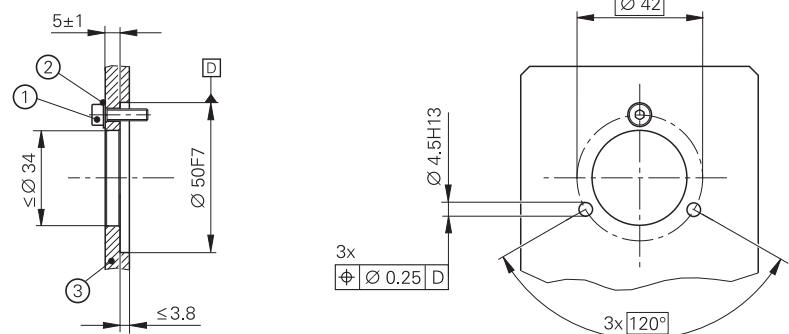
1 = M4 – 8.8 screw with material bonding anti-rotation lock, tightening torque 2.65 Nm ± 0.1 Nm, minimum engagement depth of 6 mm

2 = At permissible interface pressure $P_G \leq 280 \text{ N/mm}^2$, use a washer.

3 = For material characteristics, see table on page "Mounting"

4 = Direction of shaft rotation for output signals according to interface description

5 = Connector coding



Specifications	ROC 425 – Singleturn	ROQ 437 – Multiturn
Functional safety for applications up to	As single-encoder system for monitoring functions <ul style="list-style-type: none"> SIL 1 as per EN 61508 (further basis for testing: EN 61800-5-2) Category 2, PL c according to EN ISO 13849-1:2008 As single-encoder system for closed-loop functions <ul style="list-style-type: none"> SIL 2 as per EN 61508 (further basis for testing: EN 61800-5-2) Category 3, PL d according to EN ISO 13849-1:2008 Safe in the singleturn range	
PFH	$\leq 10 \times 10^{-9}$ (Probability of dangerous Failure per Hour)	
Safe position ¹⁾	<i>Encoder:</i> $\pm 1.76^\circ$ (safety-related measuring step: SM = 0.7°) <i>Mechanical coupling:</i> $\pm 0^\circ$ (fault exclusion for stator coupling and shaft breakage, designed for accelerations $\leq 300 \text{ m/s}^2$)	
Interface	EnDat 2.2	
Ordering designation	EnDat22	
Position values/revolution	33 554 432 (25 bits)	
Revolutions	-	4096 (12 bits)
Calculation time t_{cal} / Clock frequency	$\leq 7 \mu\text{s}$ / $\leq 8 \text{ MHz}$	
System accuracy	$\pm 20''$	
Electrical connection*	M12 flange socket (male), 8-pin, radial or 1 m PUR cable with M12 coupling (male), 8-pin	
Cable length	$\leq 100 \text{ m}$ (see EnDat description in the <i>Interfaces of HEIDENHAIN Encoders</i> catalog)	
Voltage supply	DC 3.6 V to 14 V	
Power consumption ²⁾ (max.)	At 3.6 V: $\leq 60 \text{ mW}$; 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)
Shaft	Solid shaft $\varnothing 6 \text{ mm}$ with flat (92 A)	
Speed	$\leq 15000 \text{ rpm}$	$\leq 12000 \text{ rpm}$
Starting torque	$\leq 0.01 \text{ Nm}$ (at 20°C)	
Moment of inertia of rotor	$2.9 \times 10^{-6} \text{ kgm}^2$	
Angular acceleration of rotor	$\leq 1 \times 10^5 \text{ rad/s}^2$	
Shaft load	<i>Axial:</i> $\leq 40 \text{ N}$; <i>radial:</i> $\leq 60 \text{ N}$ at shaft end	
Vibration 55 to 2000 Hz Shock 6 ms	$\leq 300 \text{ m/s}^2$ (EN 60 068-2-6); 10 to 55 Hz constant over distance 4.9 mm peak to peak $\leq 2000 \text{ m/s}^2$ (EN 60 068-2-27)	
Min. operating temp.	<i>Flange socket or fixed cable:</i> -40°C ; <i>moving cable:</i> -10°C	
Max. operating temperature ³⁾	100°C	
Trigger threshold of error message for excessive temperature	125°C in the scanning ASIC (measuring accuracy of internal temperature sensor: $\pm 4 \text{ K}$)	
Relative humidity	$\leq 93 \%$ ($40^\circ\text{C}/21 \text{ d}$ as per EN 60 068-2-78); without condensation	
Protection ³⁾ EN 60 529	<i>Housing:</i> IP67; <i>shaft inlet:</i> IP64 (see <i>Insulation</i> under <i>Electrical safety</i> in the <i>Interfaces of HEIDENHAIN Encoders</i> catalog; contamination by ingress of liquid must be avoided)	
Mass	$\approx 0.3 \text{ kg}$	
Valid for ID	1042256-01 / 1042256-02	1042255-01 / 1042255-02

Bold These preferred versions are available on short notice

***** Please select when ordering

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

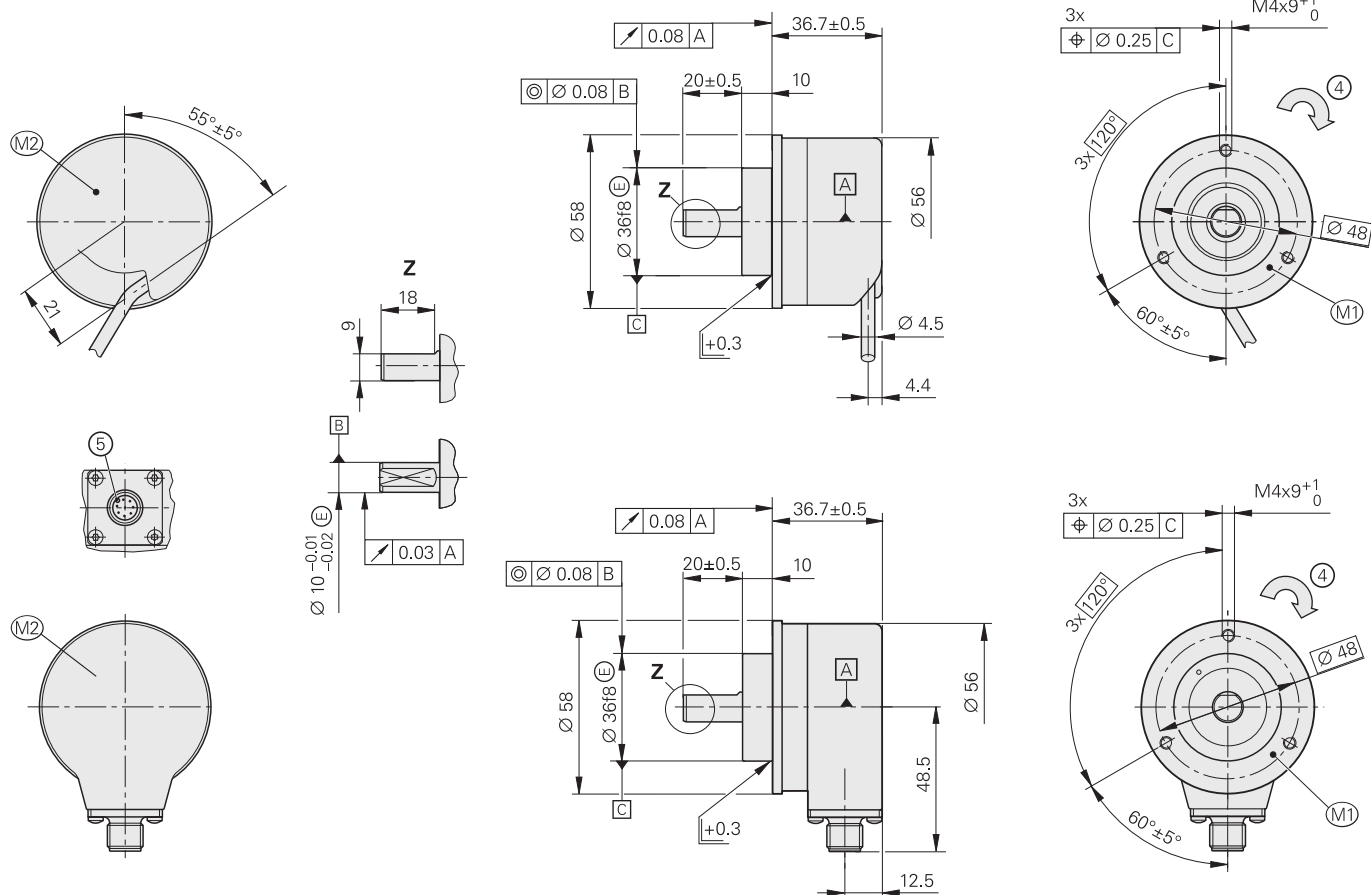
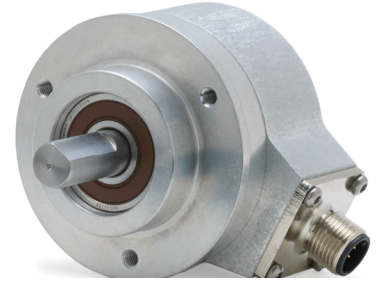
2) See *General electrical information* in the *Interfaces of HEIDENHAIN Encoders* catalog

3) Regarding operating temp./spindle rpm/supply voltage, see *Rotary Encoders* catalog, *General mechanical information*

ROC 425, ROQ 437 with clamping flange

Rotary encoders for absolute position values with safe singletum information

- Rotary encoders for separate shaft coupling
- Clamping flange 03C
- Solid shaft with flat 03D



Required mating dimensions

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

- ▣ = Encoder bearing
- M1 = Measuring point for operating temperature
- M2 = Measuring point for vibration, see also D 741714
- 1 = M4 – 8.8 screw with material bonding anti-rotation lock, tightening torque 2.65 Nm ± 0.1 Nm, minimum engagement depth of 6 mm
- 2 = At permissible interface pressure $P_G \leq 280 \text{ N/mm}^2$, use a washer.
- 3 = For material characteristics, see table on page "Mounting"
- 4 = Direction of shaft rotation for output signals according to interface description
- 5 = Connector coding

Specifications	ROC 425 – Singleturn	ROQ 437 – Multiturn
Functional safety for applications up to	As single-encoder system for monitoring functions <ul style="list-style-type: none"> SIL 1 as per EN 61508 (further basis for testing: EN 61800-5-2) Category 2, PL c according to EN ISO 13849-1:2008 As single-encoder system for closed-loop functions <ul style="list-style-type: none"> SIL 2 as per EN 61508 (further basis for testing: EN 61800-5-2) Category 3, PL d according to EN ISO 13849-1:2008 Safe in the singleturn range	
PFH	$\leq 10 \times 10^{-9}$ (Probability of dangerous Failure per Hour)	
Safe position ¹⁾	<i>Encoder:</i> $\pm 1.76^\circ$ (safety-related measuring step: SM = 0.7°) <i>Mechanical coupling:</i> $\pm 0^\circ$ (fault exclusion for stator coupling and shaft breakage, designed for accelerations $\leq 300 \text{ m/s}^2$)	
Interface	EnDat 2.2	
Ordering designation	EnDat22	
Position values/revolution	33 554 432 (25 bits)	
Revolutions	-	4096 (12 bits)
Calculation time t_{cal} / Clock frequency	$\leq 7 \mu\text{s}$ / $\leq 8 \text{ MHz}$	
System accuracy	$\pm 20''$	
Electrical connection*	M12 flange socket (male), 8-pin, radial or 1 m PUR cable with M12 coupling (male), 8-pin	
Cable length	$\leq 100 \text{ m}$ (see EnDat description in the <i>Interfaces of HEIDENHAIN Encoders</i> catalog)	
Voltage supply	DC 3.6 V to 14 V	
Power consumption ²⁾ (max.)	At 3.6 V: $\leq 60 \text{ mW}$; 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)
Shaft	Solid shaft $\varnothing 10 \text{ mm}$ with flat (03D)	
Speed	$\leq 15000 \text{ rpm}$	$\leq 12000 \text{ rpm}$
Starting torque	$\leq 0.01 \text{ Nm}$ (at 20 °C)	
Moment of inertia of rotor	$2.9 \times 10^{-6} \text{ kgm}^2$	
Angular acceleration of rotor	$\leq 1 \times 10^5 \text{ rad/s}^2$	
Shaft load	<i>Axial:</i> $\leq 40 \text{ N}$; <i>radial:</i> $\leq 60 \text{ N}$ at shaft end	
Vibration 55 to 2000 Hz Shock 6 ms	$\leq 300 \text{ m/s}^2$ (EN 60 068-2-6); 10 to 55 Hz constant over distance 4.9 mm peak to peak $\leq 2000 \text{ m/s}^2$ (EN 60 068-2-27)	
Min. operating temp.	<i>Flange socket or fixed cable:</i> -40 °C; <i>moving cable:</i> -10 °C	
Max. operating temperature ³⁾	100 °C	
Trigger threshold of error message for excessive temperature	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 60 068-2-78); without condensation	
Protection ³⁾ EN 60 529	<i>Housing:</i> IP67; <i>shaft inlet:</i> IP64 (see <i>Insulation</i> under <i>Electrical safety</i> in the <i>Interfaces of HEIDENHAIN Encoders</i> catalog; contamination by ingress of liquid must be avoided)	
Mass	$\approx 0.3 \text{ kg}$	
Valid for ID	1042257-01 / 1042257-02	1042258-01 / 1042258-02

Bold These preferred versions are available on short notice

***** Please select when ordering

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

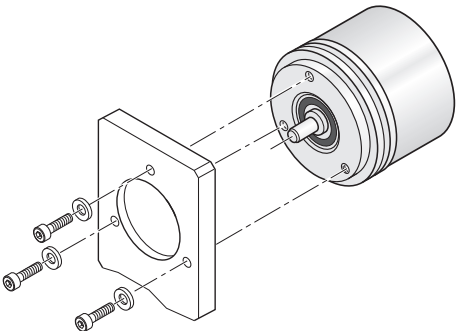
2) See *General electrical information* in the *Interfaces of HEIDENHAIN Encoders* catalog

3) Regarding operating temp./spindle rpm/supply voltage, see *Rotary Encoders* catalog, *General mechanical information*

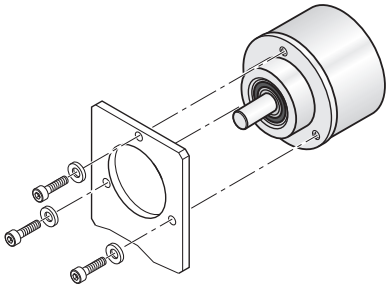
Mounting

The rotary encoders are centered via the centering collar of the synchro or clamping flange and secured with screws at their front. Mechanical fault exclusion can only be ensured when mounting with three M4 screws of strength class 8.8 and a minimum engagement depth of 6 mm in the rotary encoder flange. The mounting screws are not included in delivery. The machine designer is responsible for specifying a material bonding anti-rotation lock for the screws depending on the application.

The fault exclusion was calculated based on a material bonding anti-rotation lock with a thread friction coefficient between 0.1 and 0.16. The through holes for the screws are to be designed according to EN 20273 (medium). The washers must be used for materials with a permissible interface pressure of $\leq 280 \text{ N/mm}^2$.



Rotary encoder with synchro flange



Rotary encoder with clamping flange

Conditions required on the customer's side for a safe mechanical connection:

	Mounting surface on the customer's side	
Material	Steel	Aluminum
Tensile strength R_m	$\geq 600 \text{ N/mm}^2$	$\geq 220 \text{ N/mm}^2$
Interface pressure P_G	$\geq 280 \text{ N/mm}^2$	$\geq 280 \text{ N/mm}^2$
Surface roughness R_z	$\leq 16 \text{ }\mu\text{m}$	$\leq 16 \text{ }\mu\text{m}$
Coefficient of thermal expansion α_{therm}	$(10 \dots 14) \times 10^{-6} \text{ K}^{-1}$	$\leq 25 \times 10^{-6} \text{ K}^{-1}$
Thickness of the mounting flange	4 mm to 20 mm	5 mm ± 1

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

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

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

Connecting cables with a length greater than 0.5 m must be provided with a strain relief.

For further mounting information and mounting aids, refer to the Mounting Instructions and Rotary Encoders catalog.

Integrated temperature evaluation

This rotary encoder features an internal 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 rotary encoder supports two-stage cascaded signaling of excessive temperature. It consists of an EnDat warning and an EnDat error message.

In compliance with the EnDat specification, when the temperature reaches the warning threshold for excessive temperature 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 for 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 trigger threshold depends on the encoder model and is shown in the specifications.

Depending on the application, HEIDENHAIN recommends adjusting the threshold sensitivity so that it lies below the trigger threshold for the EnDat error message “temperature exceeded” by a sufficient value. The encoder’s intended use requires compliance with the operating temperature at the measuring point M1.

Electrical connection

Cable


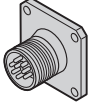
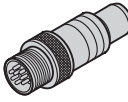



PUR connecting and adapter cable Ø 6 mm; [(4×0.14 mm ²) + (4×0.34 mm ²)]; A _P = 0.34 mm ²		
Complete with M12 connector (female) and M12 coupling (male), 8-pin		ID 368330-xx
Complete with M12 connector (female), 8-pin, and D-sub connector (female), 15-pin		ID 533627-xx
Complete with M12 connector (female), 8-pin, and D-sub connector (male), 15-pin		ID 524599-xx
With one M12 connector (female), 8-pin		ID 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!

Pin layout

8-pin M12 coupling    								
	Voltage supply				Absolute position values			
	8	2	5	1	3	4	7	6
	U_P	Sensor U_P	0 V	Sensor 0 V	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 voltage supply.

Vacant pins and 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.

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.

Related documents: Adhere to the information in the following documents to ensure the correct and intended operation of the encoder:

- *Rotary Encoders* catalog: 249529-xx
- *ROC 425, ROQ 437 Synchro Flange* Mounting Instructions: 1030782-xx
- *ROC 425, ROQ 437 Clamping Flange* Mounting Instructions: 1030781-xx
- Technical Information: *Safety-Related Position Measuring Systems*: 596632
- For implementation in a safe control or inverter: Specification: 533095
- Catalog: *Interfaces of HEIDENHAIN Encoders*: 1078628-xx