



HEIDENHAIN



**Functional
Safety**

Product Information

ROC 425

ROQ 437

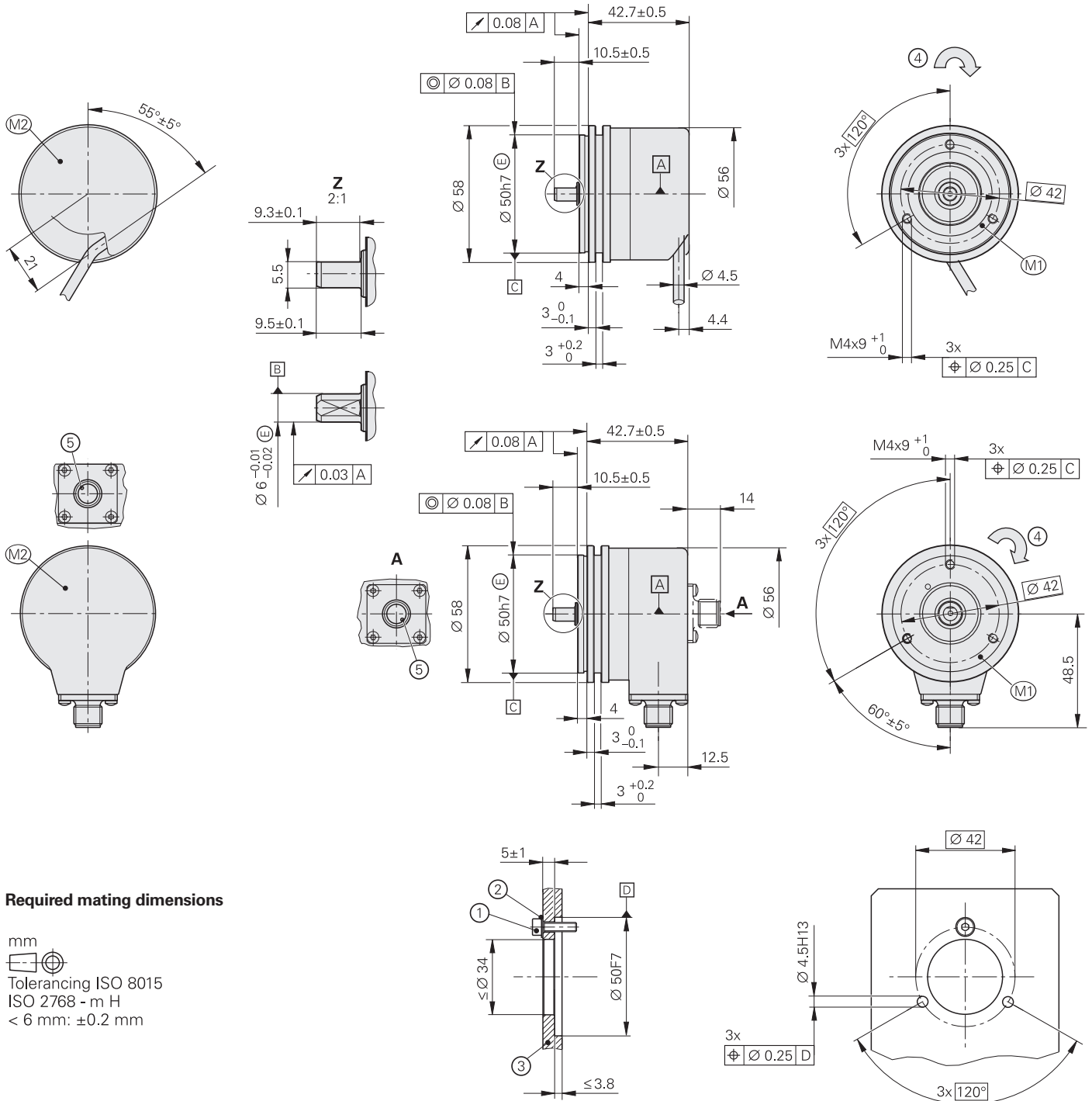
Absolute Rotary Encoders
with EnDat 2.2 for
Safety-Related Applications

05/2019

ROC 425, ROQ 437 with synchro flange

Rotary encoders for absolute position values with safe singletum information

- Rotary encoders for separate shaft coupling
- 01C synchro flange
- 92A solid shaft with flat



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: 6 mm
- 2 = At a permissible interface face pressure PG of ≤ 280 N/mm², use a washer
- 3 = For material characteristics, see the table on the “Mounting” page
- 4 = Direction of shaft rotation for ascending position values
- 5 = Connector coding

Specifications	ROC 425 – singletum	ROQ 437 – multitum
Functional safety for applications with 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 as per EN ISO 13849-1:2015 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 as per EN ISO 13849-1:2015 Safe in the singletum range	
PFH	$\leq 10 \cdot 10^{-9}$ (probability of dangerous failure per hour)	
Safe position ¹⁾	<i>Device:</i> $\pm 1.76^\circ$ (safety-relevant measuring step: SM = 0.7°); <i>mechanical coupling:</i> $\pm 0^\circ$ (fault exclusion for stator coupling and shaft breakage, designed for accelerations of $\leq 300 \text{ m/s}^2$)	
Interface	EnDat 2.2	
Ordering designation	EnDat22	
Position values per revolution	33554432 (25 bits)	
Revolutions	–	4096 (12 bits)
Calc. time t_{cal} /clock frequency	$\leq 7 \mu\text{s} / \leq 8 \text{ MHz}$	
System accuracy	$\pm 20''$	
Electrical connection**	8-pin M12 radial* or axial flange socket (male), or 1 m PUR cable with 8-pin M12 coupling (male) ⁴⁾	
Cable length	$\leq 100 \text{ m}$ (see EnDat description in the <i>Interfaces of HEIDENHAIN Encoders</i> brochure)	
Supply voltage	DC 3.6 V to 14 V	
Power consumption ²⁾ (maximum)	<i>At 3.6 V:</i> $\leq 600 \text{ mW}$; <i>at 14 V:</i> $\leq 700 \text{ mW}$	<i>At 3.6 V:</i> $\leq 700 \text{ mW}$; <i>at 14 V:</i> $\leq 800 \text{ mW}$
Current consumption (typical)	<i>5 V:</i> 85 mA (without load)	<i>5 V:</i> 105 mA (without load)
Shaft	92A solid shaft $\varnothing 6 \text{ mm}$ with flat	
Speed	$\leq 15000 \text{ rpm}$	$\leq 12000 \text{ rpm}$
Starting torque (typical)	0.01 Nm (at 20 °C)	
Moment of inertia of rotor	$2.9 \cdot 10^{-6} \text{ kgm}^2$	
Angular acceleration of rotor	$\leq 1 \cdot 10^{-5} \text{ rad/s}^2$	
Shaft load	<i>Axial:</i> $\leq 40 \text{ N}$; <i>radial:</i> $\leq 60 \text{ N}$ at shaft end	
Vibration 55 Hz to 2000 Hz Shock 6 ms	$\leq 300 \text{ m/s}^2$ (EN 60068-2-6); 10 Hz to 55 Hz constant over 4.9 mm peak to peak $\leq 2000 \text{ m/s}^2$ (EN 60068-2-27)	
Min. operating temperature	<i>Flange socket or fixed cable:</i> $-40 \text{ }^\circ\text{C}$; <i>moving cable:</i> $-10 \text{ }^\circ\text{C}$	
Max. operating temp. ³⁾	100 °C	
Trigger threshold of temperature exceedance error message	125 °C in the scanning ASIC (measuring accuracy of the internal temperature sensor: $\pm 4 \text{ K}$)	
Relative humidity	$\leq 93 \%$ (40 °C/21 d as per EN 60068-2-78), without condensation	
Protection ³⁾ EN 60529	Housing: IP67; shaft inlet: IP64 (read about isolation under <i>Electrical safety</i> in the <i>Interfaces of HEIDENHAIN Encoders</i> brochure; contamination from the ingress of liquids must be avoided)	
Mass	$\approx 0.3 \text{ kg}$	
Valid for ID	1042256-01* / 1042256-02	1042255-01* / 1042255-02

* This preferred version is available on short notice ** Please select when ordering

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

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

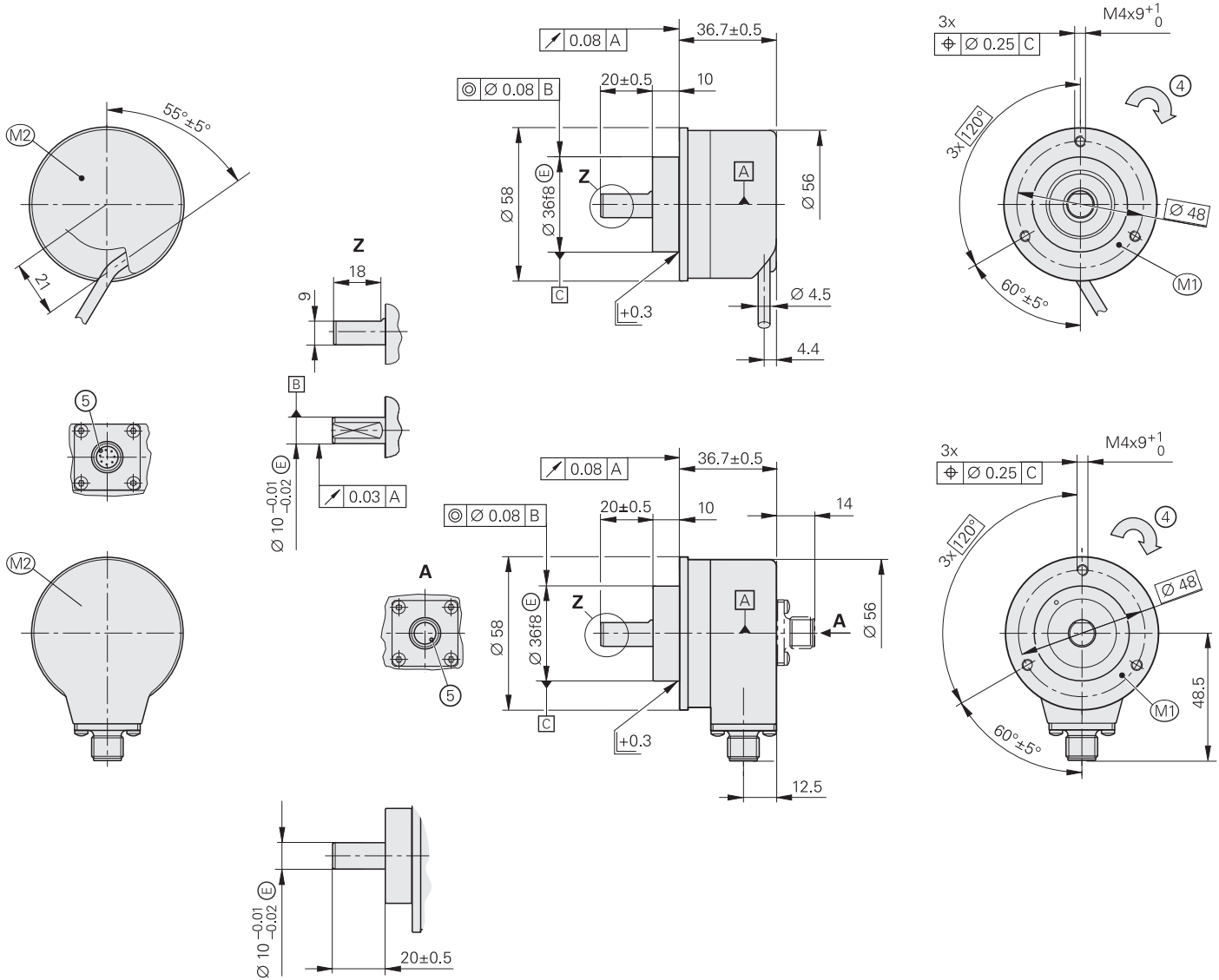
3) For relationship of operating temperature/shaft speed/supply voltage, see *General mechanical information* in the *Rotary Encoders* brochure

4) Cable outlet with cable length of $> 0.5 \text{ m}$ requires strain relief for the cable. Flange socket versions may be used only with plastic-insulated M12 mating connectors

ROC 425, ROQ 437 with clamping flange

Rotary encoders for absolute position values with safe singletum information

- Rotary encoders for separate shaft coupling
- 03C clamping flange
- 03D solid shaft with flat

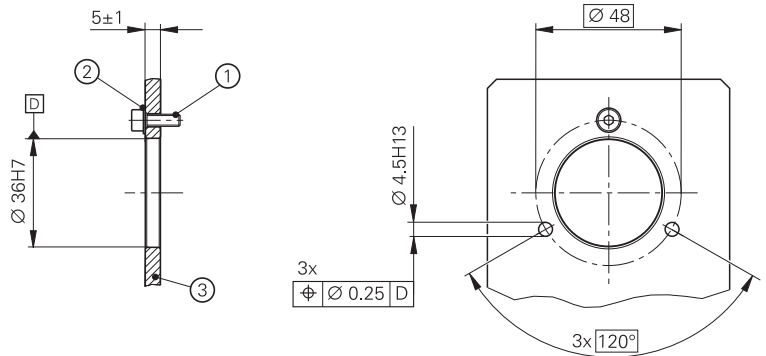


Required mating dimensions

mm

 Tolerancing ISO 8015
 ISO 2768 - m H
 <math>< 6\text{ mm}</math>: $\pm 0.2\text{ mm}$

- ☒ = 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: $2.65\text{ Nm} \pm 0.1\text{ Nm}$; minimum engagement depth: 6 mm
- 2 = At a permissible interface face pressure PG of $\leq 280\text{ N/mm}^2$, use a washer
- 3 = For material characteristics, see the table on the "Mounting" page
- 4 = Direction of shaft rotation for output signals in accordance with the interface description
- 5 = Connector coding



Specifications	ROC 425 – singletum	ROQ 437 – multitum
Functional safety for applications with 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 as per EN ISO 13849-1:2015 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 as per EN ISO 13849-1:2015 Safe in the singletum range	
PFH	$\leq 10 \cdot 10^{-9}$ (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 of $\leq 300 \text{ m/s}^2$)	
Interface	EnDat 2.2	
Ordering designation	EnDat22	
Position values per revolution	33554432 (25 bits)	
Revolutions	–	4096 (12 bits)
Calc. time t_{cal} /clock frequency	$\leq 7 \mu\text{s} / \leq 8 \text{ MHz}$	
System accuracy	$\pm 20''$	
Electrical connection**	8-pin M12 radial* or axial flange socket (male), or 1 m PUR cable with 8-pin M12 coupling (male) ⁴⁾	
Cable length	$\leq 100 \text{ m}$ (see the EnDat description in the <i>Interfaces of HEIDENHAIN Encoders</i> brochure)	
Supply voltage	DC 3.6 V to 14 V	
Power consumption ²⁾ (maximum)	<i>At 3.6 V</i> : $\leq 600 \text{ mW}$; <i>at 14 V</i> : $\leq 700 \text{ mW}$	<i>At 3.6 V</i> : $\leq 700 \text{ mW}$; <i>at 14 V</i> : $\leq 800 \text{ mW}$
Current consumption (typical)	<i>5 V</i> : 85 mA (without load)	<i>5 V</i> : 105 mA (without load)
Shaft	03D solid shaft $\varnothing 10 \text{ mm}$ with flat	
Speed	$\leq 15000 \text{ rpm}$	$\leq 12000 \text{ rpm}$
Starting torque (typical)	0.01 Nm (at 20 °C)	
Moment of inertia of rotor	$2.9 \cdot 10^{-6} \text{ kgm}^2$	
Angular acceleration of rotor	$\leq 1 \cdot 10^{-5} \text{ rad/s}^2$	
Shaft load	<i>Axial</i> : $\leq 40 \text{ N}$; <i>radial</i> : $\leq 60 \text{ N}$ at shaft end	
Vibration 55 Hz to 2000 Hz Shock 6 ms	$\leq 300 \text{ m/s}^2$ (EN 60068-2-6); 10 Hz to 55 Hz constant over 4.9 mm peak to peak $\leq 2000 \text{ m/s}^2$ (EN 60068-2-27)	
Min. operating temperature	<i>Flange socket or fixed cable</i> : $-40 \text{ }^\circ\text{C}$; <i>moving cable</i> : $-10 \text{ }^\circ\text{C}$	
Max. operating temp. ³⁾	100 °C	
Trigger threshold of temperature exceedance error message	125 °C in the scanning ASIC (measuring accuracy of the internal temperature sensor: $\pm 4 \text{ K}$)	
Relative humidity	$\leq 93 \%$ (40 °C/21 d as per EN 60068-2-78), without condensation	
Protection ³⁾ EN 60529	Housing: IP67; shaft inlet: IP64 (read about isolation under <i>Electrical safety</i> in the <i>Interfaces of HEIDENHAIN Encoders</i> brochure; contamination from the ingress of liquids must be avoided)	
Mass	$\approx 0.3 \text{ kg}$	
Valid for ID	1042257-01* / 1042257-02 / 1042257-03	1042258-01* / 1042258-02

* This preferred version is available on short notice ** Please select when ordering

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

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

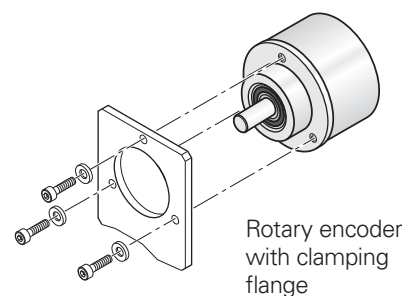
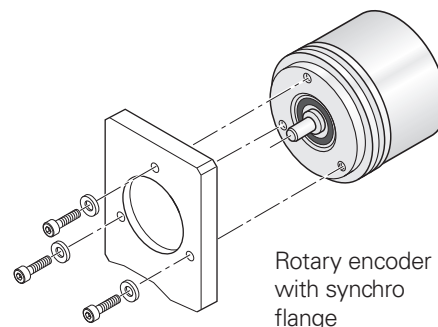
³⁾ For relationship of operating temperature/shaft speed/supply voltage, see *General mechanical information* in the *Rotary Encoders* brochure

⁴⁾ Cable outlet with cable length of $> 0.5 \text{ m}$ requires strain relief for the cable. Flange socket versions may be used only with plastic-insulated M12 mating connectors

Mounting

The rotary encoders are centered by means of the centering collar of the synchro flange or clamping flange and are secured with screws at their front. Mechanical fault exclusion can be ensured only when fastening is accomplished with three M4 screws with strength class 8.8 and at a minimum engagement depth of 6 mm in the rotary encoder flange. The 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.

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



At variance with the standard specifications in the rotary encoders brochure, the following customer-side requirements are permissible for the safe mechanical coupling:

	Steel	Aluminum
Coefficient of thermal expansion α_{therm}	$10 \cdot 10^{-6} \text{ K}^{-1}$ to $14 \cdot 10^{-6} \text{ K}^{-1}$	$\leq 25 \cdot 10^{-6} \text{ K}^{-1}$
Thickness of the mounting flange	4 mm to 20 mm	5 mm \pm 1 mm

For the design of the mechanical fault exclusion for the shaft connection, the following maximum torque M_{max} must be considered:

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

The customer's mechanical design must ensure that the maximum torque M_{max} occurring in the application can be transmitted. Cables with a length of more than 0.5 m must be provided with strain relief.

Further information:

For mounting information and mounting aids, see the mounting instructions in the *Rotary Encoders* brochure.

Integrated temperature evaluation

These rotary encoders feature an internal temperature sensor integrated into the encoder electronics. The digitalized temperature value is transmitted purely serially over the EnDat protocol. Note that the measurement and transfer of the temperature is not performed safely in terms of functional safety.

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

In compliance with the EnDat specification, when the temperature reaches the warning threshold for the temperature exceedance of the internal temperature sensor, an EnDat warning is issued (EnDat memory area for operating status, word 1 – warning, bit 2 1 – temperature exceeded). This warning threshold for the internal





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

The encoder features a further, albeit non-adjustable, trigger threshold of the internal temperature sensor, which, when exceeded, triggers an EnDat error message (EnDat memory area for operating status, word 0 – error messages, bit 2 2 – position, and in additional data 2 operating status error sources, bit 2 6 – temperature exceeded). This trigger threshold depends on the encoder model and is provided in the specifications.

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

Electrical connection

Cables


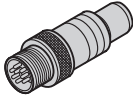



PUR connecting and adapter cables \varnothing 6 mm; $(4 \times 0.14 \text{ mm}^2) + (4 \times 0.34 \text{ mm}^2)$; $A_P = 0.34 \text{ mm}^2$		
8-pin M12 connector (female) and 8-pin M12 coupling (male)		ID 368330-xx
8-pin M12 connector (female) and 15-pin D-sub connector (female)		ID 533627-xx
8-pin M12 connector (female) and 15-pin D-sub connector (male)		ID 524599-xx
8-pin M12 connector (female) and free cable end (stripped)		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 the bit error rate in accordance with specification document 533095!

Pin layout

8-pin M12 coupling								
								
	Power supply				Serial data transfer			
	8	2	5	1	3	4	7	6
	U_P	Sensor U_P	0V	Sensor 0V	DATA	$\overline{\text{DATA}}$	CLOCK	$\overline{\text{CLOCK}}$
	Brown/Green	Blue	White/Green	White	Gray	Pink	Violet	Yellow

Cable shield connected to housing; U_P = Power supply voltage

Sensor: The sense 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. Do not modify cables or exchange their connectors without first consulting with HEIDENHAIN Traunreut!

HEIDENHAIN

DR. JOHANNES HEIDENHAIN GmbH

Dr.-Johannes-Heidenhain-Straße 5

83301 Traunreut, Germany

☎ +49 8669 31-0

☎ +49 8669 32-5061

E-mail: info@heidenhain.de

www.heidenhain.de

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:

To ensure proper and intended use, comply with the specifications in the following documents:

- Brochure: *Rotary Encoders* 249529-xx
- Brochure: *Interfaces of HEIDENHAIN Encoders* 1078628-xx
- Brochure: *Cables and Connectors* 1206103-xx
- Mounting instructions: *ROC 425, ROQ 437 (synchro flange)* 1030782-xx
- Mounting instructions: *ROC 425, ROQ 437 (clamping flange)* 1030781-xx
- Technical Information document: *Safety-Related Position Measurement Systems* 596632-xx
- For implementation in a safe control or inverter: Specification document 533095-xx