



HEIDENHAIN



**Functional
Safety**

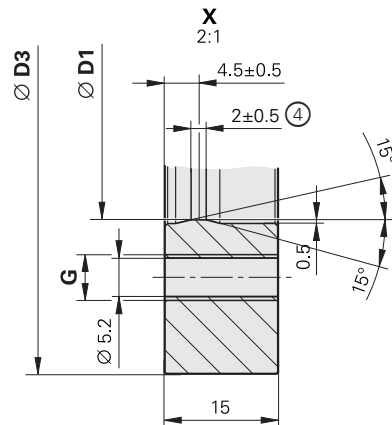
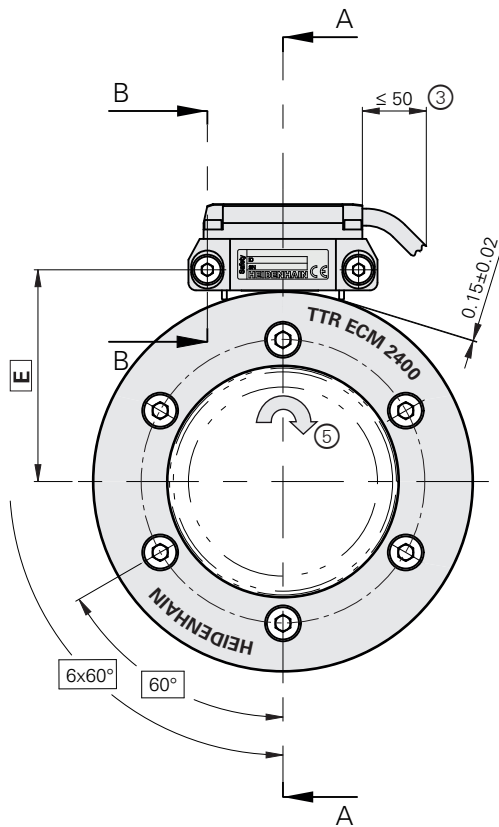
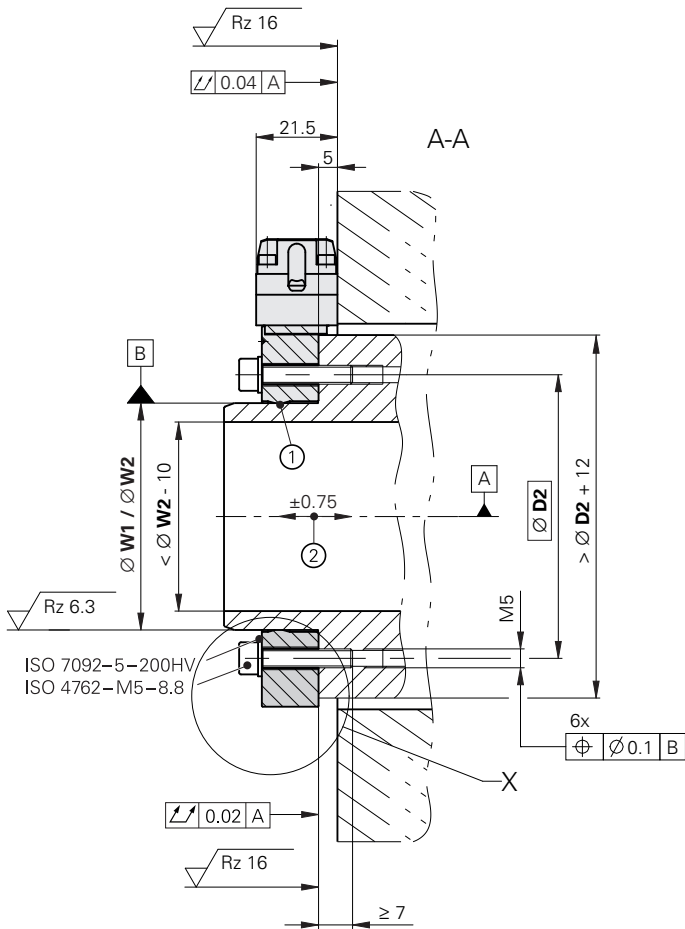
Product Information

ECM 2400 series

Absolute Modular Angle
Encoders for Safety-Related
Applications

ECM 2400

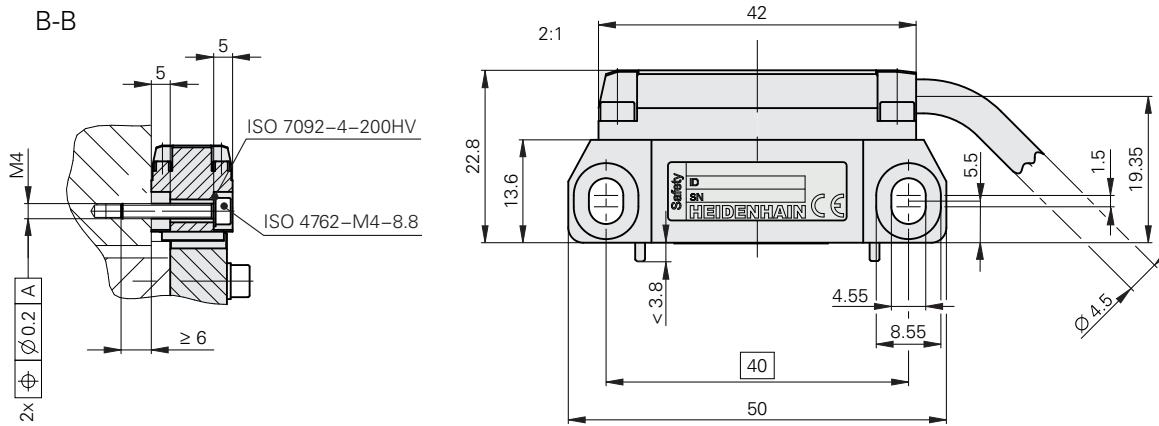
Dimensions



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

W1 = Without mechanical fault exclusion
W2 = With mechanical fault exclusion

- = Bearing of mating shaft
- 1 = Shaft fit; ensure full-surface contact
- 2 = Axial tolerance of mating shaft
- 3 = Cable support
- 4 = Centering collar
- 5 = Direction of shaft rotation for ascending position values



	D1	W1	W2	D2	D3	E	G
TTR ECM 2400	$\varnothing 70 +0/-0.008$	$\varnothing 70 +0.010/+0.002$	$\varnothing 70 +0.019/+0.011$	$\varnothing 85$	$\varnothing 113.16$	62.3	6x M6
	$\varnothing 80 +0/-0.008$	$\varnothing 80 +0.010/+0.002$	$\varnothing 80 +0.022/+0.014$	$\varnothing 95$	$\varnothing 128.75$	70.1	6x M6
	$\varnothing 95 +0/-0.010$	$\varnothing 95 +0.013/+0.003$	$\varnothing 95 +0.029/+0.019$	$\varnothing 110$	$\varnothing 128.75$	70.1	6x M6
	$\varnothing 105 +0/-0.010$	$\varnothing 105 +0.013/+0.003$	$\varnothing 105 +0.031/+0.021$	$\varnothing 120$	$\varnothing 150.88$	81.2	6x M6
	$\varnothing 130 +0/-0.012$	$\varnothing 130 +0.015/+0.003$	$\varnothing 130 +0.041/+0.029$	$\varnothing 145$	$\varnothing 176.03$	93.7	6x M6
	$\varnothing 160 +0/-0.012$	$\varnothing 160 +0.015/+0.003$	$\varnothing 160 +0.049/+0.037$	$\varnothing 175$	$\varnothing 213.24$	112.3	6x M6
	$\varnothing 180 +0/-0.012$	$\varnothing 180 +0.015/+0.003$	$\varnothing 180 +0.055/+0.043$	$\varnothing 195$	$\varnothing 257.50$	134.5	6x M6
	$\varnothing 260 +0/-0.016$	$\varnothing 260 +0.020/+0.004$	$\varnothing 260 +0.082/+0.066$	$\varnothing 275$	$\varnothing 326.90$	169.2	6x M6

ECM 2400 series

Absolute angle encoders with magnetic scanning

- Consists of a scanning head and scale drum
- Also for safety-related applications
- Resistant to contamination



Scanning head

Interface

Ordering designation

Clock frequency

Calculation time t_{cal}

Functional safety

for applications with up to

PFH

Electrical connection

Cable length¹⁾

Supply voltage

Power consumption (max.)

Current consumption (typical)

Vibration 55 Hz to 2000 Hz

Shock 6 ms

With mechanical fault exclusion


Without mechanical fault exclusion

Operating temperature

Protection EN 60529

Mass Scanning head
Cable
Coupling (M12)

¹⁾ With HEIDENHAIN cable;
clock frequency ≤ 8 MHz

	AK ECM 2410 	AK ECM 2490F	AK ECM 2490M
	EnDat 2.2	Fanuc Serial Interface; αi Interface	Mitsubishi high speed interface
	EnDat22	Fanuc05	Mit03-4
	≤ 16 MHz	–	
	≤ 5 μs	–	
	<ul style="list-style-type: none"> • SIL 2 as per EN 61 508 (further basis for testing: EN 61800-5-2) • Category 3, PL “d” as per EN ISO 13849-1:2015 	–	
	≤ 25 · 10 ⁻⁹ (up to 6000 m above sea level)	–	
	Cable (1 m) with 8-pin M12 coupling (male)		
	≤ 30 m		
	DC 3.6V to 14 V		
	At 3.6 V: 1.1 W At 14 V: 1.3 W		
	At 5 V: < 200 mA (without load)		
	≤ 400 m/s ² (EN 60068-2-6) ≤ 400 m/s ² (EN 60068-2-27) ≤ 1000 m/s ² (EN 60068-2-27)		
	-10 °C to 80 °C		
	IP67		
	40 g (without cable) 35 g/m 15 g		

ECM 2400 series

Scale drum	TTR ECM 2400 Grating period $\approx 400 \mu\text{m}$		
Measuring standard Coefficient of expansion	Steel drum $\alpha_{\text{therm}} \approx 10 \cdot 10^{-6} \text{K}^{-1}$		
Signal periods	900	1024	1200
Drum inside diameter*	70 mm	80 mm/95 mm	105 mm
Drum outside diameter*	113.16 mm	128.75 mm	150.88 mm
Accuracy of graduation	$\pm 8''$	$\pm 7''$	$\pm 6''$
Interpolation error per signal period	$\pm 9''$	$\pm 8''$	$\pm 7''$
Position values per rev.	8388608 (23 bits)	16777216 (24 bits)	
Measuring step	0.154''	0.077''	
Safety-relevant measuring step	0.70° (9 bits)	0.35° (10 bits)	
Safe position ¹⁾²⁾	1.76°	0.88°	
Mech. permissible speed	$\leq 14500 \text{ rpm}$	$\leq 13000 \text{ rpm}/12500 \text{ rpm}$	$\leq 10500 \text{ rpm}$
Max. angular acceleration	9000 rad/s^2	6000 rad/s^2 /9000 rad/s^2	4900 rad/s^2
Moment of inertia	$1.5 \cdot 10^{-3} \text{ kgm}^2$	$2.6 \cdot 10^{-3} \text{ kgm}^2/2.1 \cdot 10^{-3} \text{ kgm}^2$	$4.4 \cdot 10^{-3} \text{ kgm}^2$
Permissible axial movement	$\leq \pm 0.75 \text{ mm}$		
Mass	0.69 kg	0.89 kg/0.65 kg	1.0 kg

* Please select when ordering

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

2) Mechanical coupling: fault exclusion for the loosening of the scanning head and scale drum (see page 8)

	1400	1696	2048	2600
	130 mm	160 mm	180 mm	260 mm
	176.03 mm	213.24 mm	257.5 mm	326.9 mm
	±5.5"	±4.5"	±4"	±3.5"
	±6"	±5"	±4"	±3"
			33554432 (25 bits)	
			0.039"	
			0.18° (11 bits)	
			0.44°	
	≤ 9000 rpm	≤ 7000 rpm	≤ 6000 rpm	≤ 4500 rpm
	3300 rad/s ²	1900 rad/s ²	820 rad/s ²	560 rad/s ²
	74 · 10 ⁻³ kgm ²	16 · 10 ⁻³ kgm ²	37 · 10 ⁻³ kgm ²	76 · 10 ⁻³ kgm ²
	1.2 kg	1.8 kg	3.0 kg	3.5 kg

Functional safety

With the ECM 2410 absolute angle encoder, HEIDENHAIN offers an ideal solution for position measurement on rotational axes in safety-related applications. In conjunction with a safe control, the encoders can be used as single-encoder systems in applications with control category SIL 2 (as per EN 61508) or performance level "d" (as per EN ISO 13849).

The reliable transmission of the position is based on two independently generated absolute position values and on error bits provided to the safe control. The functions of the encoder can be used for numerous safety functions of the complete system as per EN 61800-5-2.

Fault exclusion for the loosening of the mechanical connection

The sizing of mechanical connections in a drive system is the task of the machine manufacturer. During the mechanical design phase, the OEM will ideally consider the conditions within the application. Verifying a safe connection, however, is both cost- and time-intensive.

That's why HEIDENHAIN has developed a type-examined mechanical fault exclusion for the ECM 2410 series.

The ECM 2410 angle encoder provides a safe absolute position value at all times—including immediately after switch-on. Purely serial data transmission is performed via the bidirectional EnDat 2.2 interface.

This fault exclusion has been qualified for a wide range of encoder applications and is ensured for the operating conditions listed below. Due to the wide temperature range and numerous material characteristics, as well as the maximum permissible shaft speeds and accelerations, the scale drum requires a press fit. The required size of this press fit, taking all of the safety factors into account, necessitates a shrink fit for the scale drum and directly affects the required fitting temperature.

In addition to the data interface, the mechanical connection of the encoder to the motor is also relevant to safety. Table D16 of the EN 61800-5-2 standard for electric motors defines the loosening of the mechanical connection between the encoder and motor as a fault requiring consideration. Since it cannot be guaranteed that the control will detect such faults, in many cases a fault exclusion for the loosening of the mechanical connection is required.

Mounting with mechanical fault exclusion is optional. If the safety design does not call for a mechanical fault exclusion, then the drum can also be fastened without an interference fit (see **W1** under *Dimensions*).

Both mounting options and their various requirements are described in the documentation.

Mechanical connection	Fastening	Safe position for the mechanical connection ²⁾	Limited specifications ³⁾
Scale drum	Press fit as per the dimension drawing screw connection: ¹⁾ Screws M5 ISO 4762 8.8	±0.025°	See <i>Specifications</i> : <ul style="list-style-type: none"> • Shock • Maximum angular acceleration • Operating temperature See <i>Dimensions</i> : <ul style="list-style-type: none"> • Mounting tolerances • Wall thickness of the measured shaft See mounting information: <ul style="list-style-type: none"> • Usable materials • Mounting conditions
Scanning head	Screw connection: ¹⁾ screws: M4 ISO 4762 8.8		

¹⁾ Friction class B as per VDI 2230

²⁾ Fault exclusions exist only for the explicitly stated mounting conditions

³⁾ Does not apply to ERM/ECM 2xxx without mechanical fault exclusion

Material

For the mating shaft and the mating stator, use materials in accordance with the table.

Mounting temperature

All information on screw connections is based on a mounting temperature of 15 °C to 35 °C.

Mounting the scale drum

An oversize of the shaft is required for fault exclusion. Preferably, the scale drum should be thermally shrunk onto the mating shaft and fastened with screws. For this purpose, the scale drum must be heated slowly before mounting. Using a heat chamber or a heat plate is beneficial (but no induction heating sources may be used). The diagram shows the recommended minimum temperatures for the different drum diameters. The maximum temperature should not exceed 140 °C.

During shrink-fitting, make sure that the hole patterns of the scale drum and mating shaft are properly aligned. Appropriate positioning aids (setscrews) can facilitate mounting. All of the mounting screws must be retightened at the correct torque after the scale drum has cooled. The mounting screws used for the assembly of the scanning head and scale drum may be used only to secure the scanning head and the scale drum. These screws may not be used to additionally fasten other components.

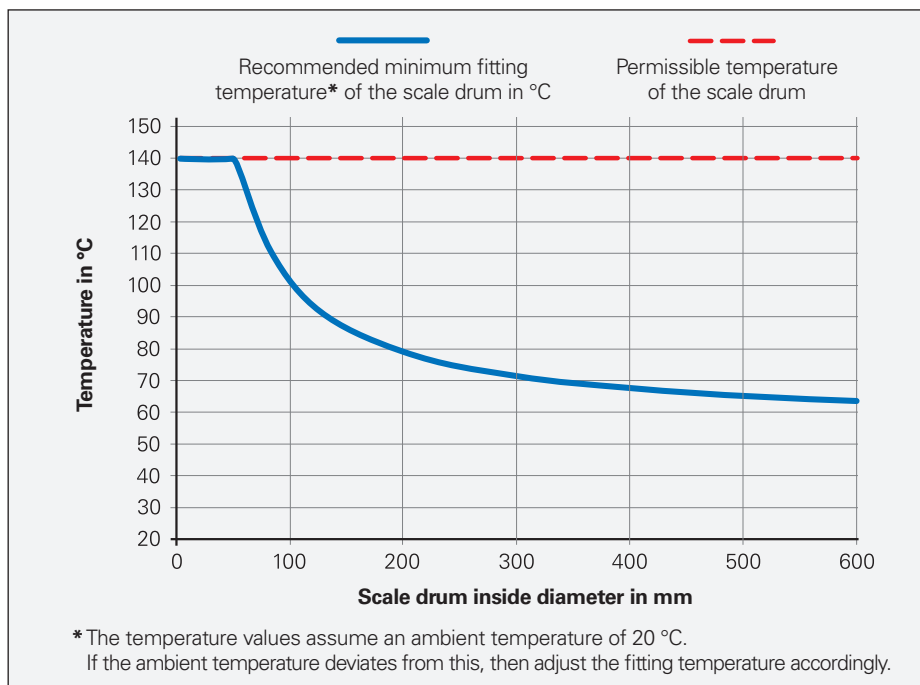
Removing the scale drum

The scale drum is removed using the relevant back-off threads in the drum. To do this, insert greased screws, and tighten them in a row until the scale drum comes off the shaft. Setscrews fastened into the mating shaft are helpful in this regard. The screws in the back-off thread then press against the setscrews.

Mounting of the scanning head

Care must be taken to ensure that a matching scale drum and scanning head are used (size of the grating period and the outer diameter of the scale drum). In order to mount the scanning head, the provided spacer shim is applied to the surface of the circumferential scale drum. The scanning head is pressed against the shim and fastened. The shim is then removed.

	Mating shaft (drum connection)	Mating stator (scanning head connection)
Material	Steel	Steel/cast iron
Tensile strength R_m	$\geq 600 \text{ N/mm}^2$	$\geq 250 \text{ N/mm}^2$
Shear strength τ_m	$\geq 390 \text{ N/mm}^2$	$\geq 290 \text{ N/mm}^2$
Elastic modulus E	200 000 N/mm ² to 215 000 N/mm ²	110 000 N/mm ² to 215 000 N/mm ²
Coefficient of thermal expansion α_{therm}	10 · 10 ⁻⁶ K ⁻¹ to 13 · 10 ⁻⁶ K ⁻¹	



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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 placed.



Further information:

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

- Brochure: *Modular Angle Encoders with Magnetic Scanning* 745168-xx
- Brochure: *Interfaces of HEIDENHAIN Encoders* 1078628-xx
- Brochure: *Cables and Connectors* 1206103-xx
- Technical Information document: *Safety-Related Position Measuring Systems* 596632-xx
- Specification for implementation in a safe control or inverter 533095-xx
- Mounting Instructions: *TTR ECM 2400* 1308375-xx
- Mounting Instructions: *AK ECM 24x0* 1308377-xx