HEIDENHAIN

Encoders for Servo Drives

November 2016

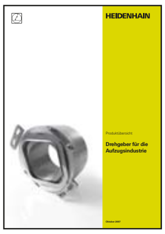
This catalog is not intended as an overview of the HEIDENHAIN product program. Rather it presents a selection of **encoders for use on servo drives.**

In the **selection tables** you will find an overview of all HEIDENHAIN encoders for use on electric drives and the most important specifications. The descriptions of the **technical features** contain fundamental information on the use of rotary, angular, and linear encoders on electric drives.

The **mounting information** and the detailed **specifications** refer to the **rotary encoders** developed specifically for drive technology. Other rotary encoders are described in separate product catalogs.

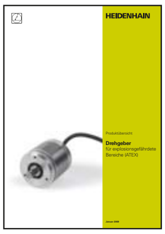
You will find more detailed information on the **linear and angular encoders** listed in the selection tables, such as mounting information, specifications and dimensions in the respective **product catalogs.**

Brochure
Rotary Encoders



Product Overview
Rotary Encoders for the Elevator Industry

Brochure
Angle Encoders With Integral Bearing



Product Overview
Rotary Encoders for Potentially Explosive Atmospheres

Brochure
Angle Encoders Without Integral Bearing

Brochure
Modular Angle Encoders
With Magnetic Scanning

Brochure
Linear Encoders
For Numerically Controlled Machine Tools

Brochure
Exposed Linear Encoders

Comprehensive descriptions of all available interfaces as well as general electrical information are included in the *Interfaces for HEIDENHAIN Encoders* brochure, ID 1078628-xx.

This catalog supersedes all previous editions, which thereby become invalid. The basis for ordering from HEIDENHAIN is always the catalog edition valid when the order is made.

Standards (ISO, EN, etc.) apply only where explicitly stated in the catalog.

Contents

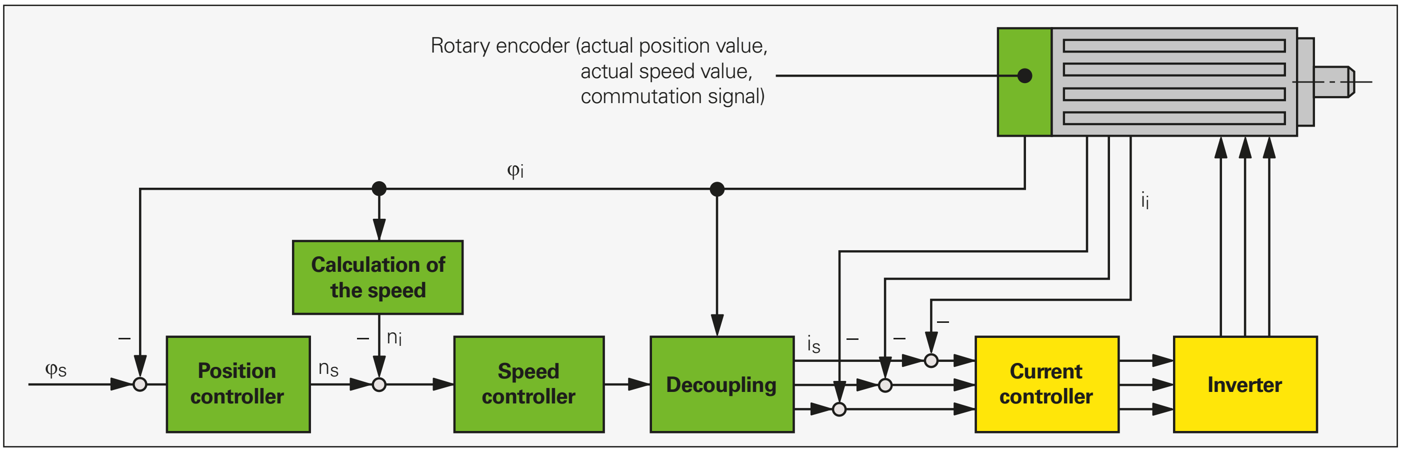
Encoders for servo drives

Controlling systems for servo drives require measuring systems that provide feedback for the position and speed controllers and for electronic commutation.

The properties of encoders have decisive influence on important motor qualities such as:

- Positioning accuracy
- Speed stability
- Bandwidth, which determines drive command-signal response and disturbance rejection capability
- Power loss
- Size
- Noise emission
- Safety

Digital position and speed control



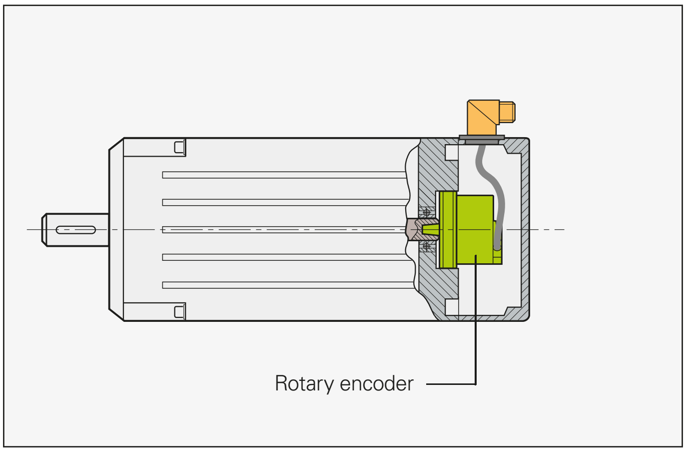
HEIDENHAIN offers the appropriate solution for any of a wide range of applications using both rotary and linear motors:

- Incremental rotary encoders with and without commutation tracks, absolute rotary encoders
- Incremental and absolute angle encoders
- Incremental and absolute linear encoders
- Incremental modular encoders

Rotary encoders

All the HEIDENHAIN encoders shown in this catalog involve very little cost and effort for the motor manufacturer to mount and wire. Encoders for rotary motors are of short overall length. Some encoders, due to their special design, can perform functions otherwise handled by safety devices such as limit switches.

Motor for “digital” drive systems
(digital position and speed control)



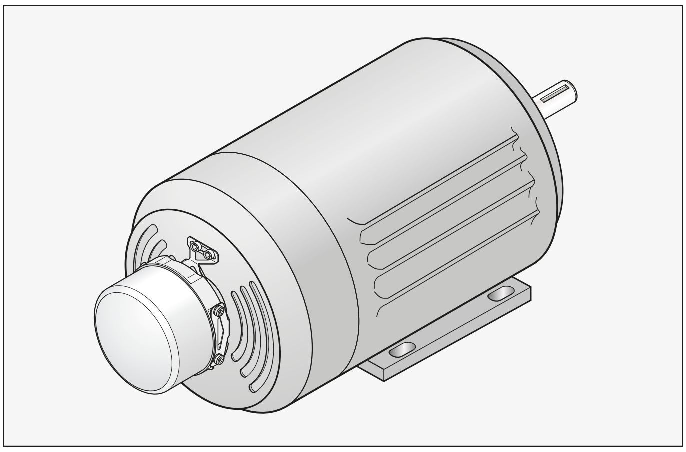
Linear encoders

Angle encoders

Explanation of the selection tables

The tables on the following pages list the encoders suited for individual motor designs. The encoders are available with dimensions and output signals to fit specific types of motors (DC or AC).

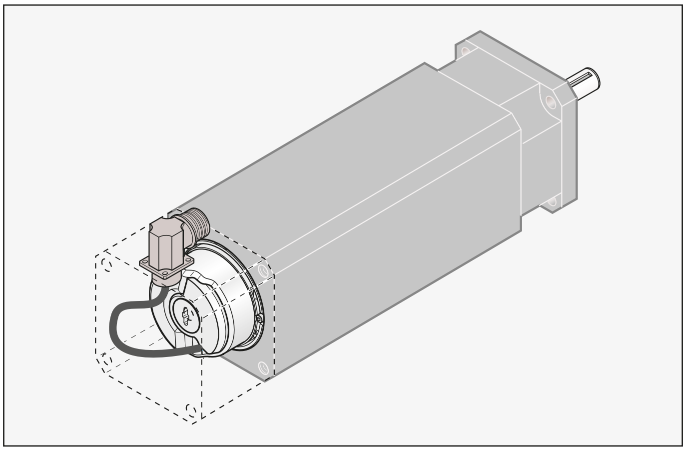
Rotary encoders for mounting on motors
Rotary encoders for motors with forced ventilation are either built onto the motor housing or integrated. As a result, they are frequently exposed to the unfiltered forced-air stream of the motor and must have a high degree of protection, such as IP64 or better. The permissible operating temperature seldom exceeds 100 °C.



In the selection table you will find:
- Rotary encoders with mounted **stator coupling** with high natural frequency—virtually eliminating any limits on the bandwidth of the drive
- Rotary encoders for **separate shaft couplings,** which are particularly suited for **insulated mounting**
- Incremental rotary encoders with high quality **sinusoidal output signals** for digital speed control
- Absolute rotary encoders with purely digital data transfer or complementary sinusoidal TTL or HTL incremental signals
- Incremental rotary encoders with **TTL or HTL compatible output signals**
- Information on rotary encoders that are available as safety-related position encoders under the designation **functional safety**

For selection table see page 10

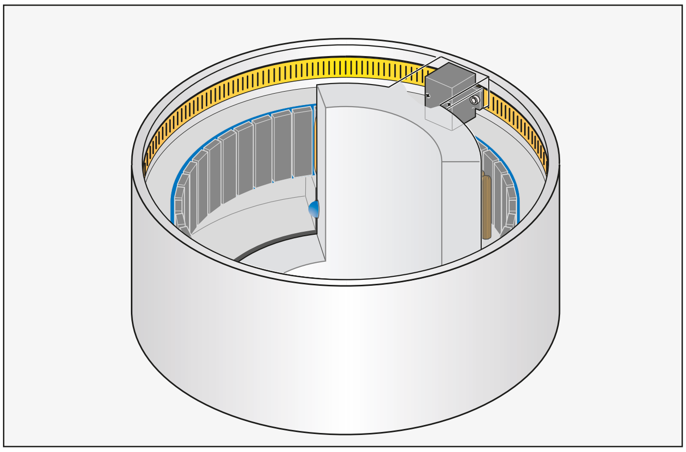
Rotary encoders for integration in motors
For motors without separate ventilation, the rotary encoder is built into the motor housing. This configuration places no stringent requirements on the encoder for a high degree of protection. The operating temperature within the motor housing, however, can reach 100 °C and higher.



In the selection table you will find:
- Incremental rotary encoders for **operating temperatures** up to 120 °C, and absolute rotary encoders for operating temperatures up to 115 °C
- Rotary encoders with mounted **stator coupling** with high natural frequency—virtually eliminating any limits on the bandwidth of the drive
- Incremental rotary encoders for digital speed control with **sinusoidal output signals** of high quality—even at high operating temperatures
- Absolute rotary encoders with **purely digital data transfer**—suited for the **HMC 6** single-cable solutions—or complementary sinusoidal incremental signals
- Incremental rotary encoders with additional **commutation signal** for synchronous motors
- Incremental rotary encoders with **TTL-compatible output signals**
- Information on rotary encoders that are available as safety-related position encoders under the designation **functional safety**

For selection table see page 8

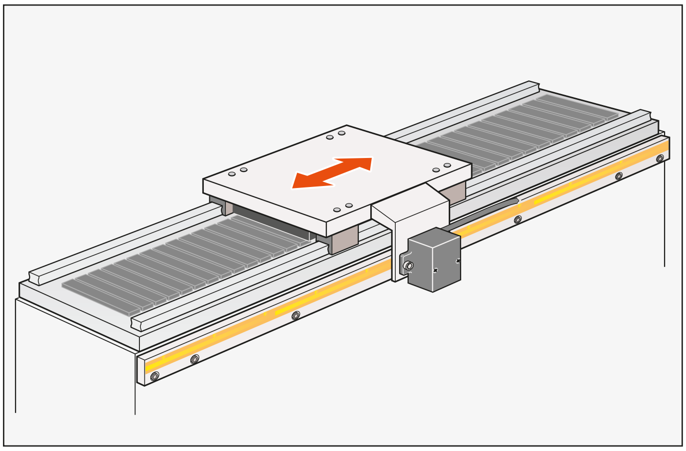
Rotary encoders, modular encoders and angle encoders for integrated and hollow-shaft motors
Rotary encoders and angle encoders for these motors have **hollow through shafts** in order to allow supply lines, for example, to be conducted through the motor shaft—and therefore through the encoder. Depending on the conditions of the application, the encoders must either feature up to IP66 protection or—for example with modular encoders using optical scanning—the machine must be designed to protect them from contamination.



In the selection table you will find:
- Angle encoders and modular encoders with the measuring standard on a steel drum for **shaft speeds up to 42 000 rpm**
- Encoders with integral bearing, with stator coupling or modular design
- Encoders with high quality **absolute and/or incremental output signals**
- Encoders with **good acceleration performance** for a broad bandwidth in the control loop

For selection table see page 16

Linear encoders for linear motors
Linear encoders on linear motors supply the actual value both for the position controller and the velocity controller. They therefore form the basis for the servo characteristics of a linear drive. The linear encoders recommended for this application:



- Have low position deviation during acceleration in the measuring direction
- Have high tolerance to acceleration and vibration in the lateral direction
- Are designed for high velocities
- Provide absolute position information with purely digital data transmission or high-quality sinusoidal incremental signals

Exposed linear encoders are characterized by:
- Higher accuracy grades
- Higher traversing speeds
- Contact-free scanning, i.e., no friction between scanning head and scale

Exposed linear encoders are suited for applications in clean environments, for example on measuring machines or production equipment in the semiconductor industry.

For selection table see page 18

Sealed linear encoders are characterized by:
- A high degree of protection
- Simple installation

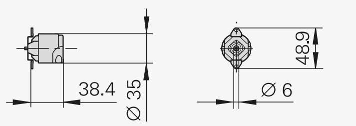
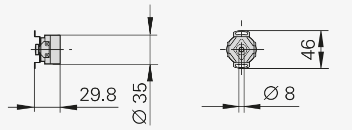
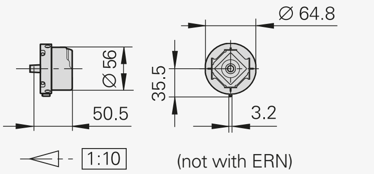
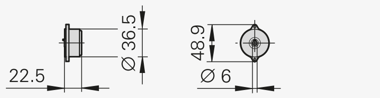
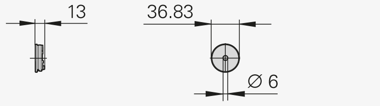
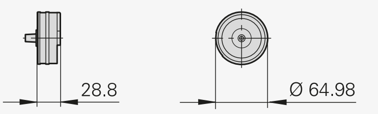
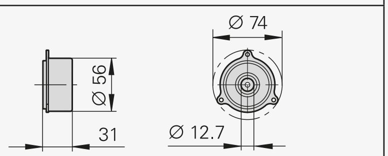
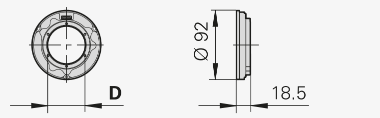
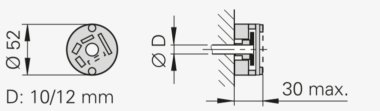
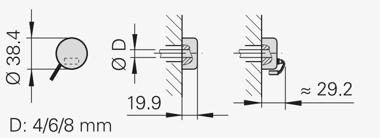
Sealed linear encoders are therefore ideal for applications in environments with airborne liquids and particles, such as on machine tools.

For selection table see page 20

Selection guide

Rotary encoders for integration in motors

Protection: up to IP40 (EN 60529)

Series	Overall dimensions	Mechanically permissible speed	Natural freq. of stator connection	Maximum operating temperature	Voltage supply
Rotary encoders with integral bearing and mounted stator coupling					
ECN/EQN/ERN 1100		≤ 12000 rpm	≥ 1000 Hz	115 °C	DC 3.6 V to 14 V
		≤ 6000 rpm	≥ 1600 Hz	90 °C	DC 5 V ±0.5 V
ECN/EQN/ERN 1300		≤ 15000 rpm/ ≤ 12000 rpm	≥ 1800 Hz	115 °C	DC 3.6 V to 14 V
		≤ 15000 rpm		120 °C *ERN 1381/4096:* 80 °C	DC 5 V ±0.5 V
					DC 5 V ± 0.25 V
					DC 10 V to 28.8 V
Rotary encoders without integral bearing					
ECI/EQI 1100		≤ 15000 rpm/ ≤ 12000 rpm	–	110 °C	DC 3.6 V to 14 V
ECI/EBI 1100				115 °C	
ECI/EQI 1300		≤ 15000 rpm/ ≤ 12000 rpm	–	115 °C	DC 4.75 V to 10 V
					DC 3.6 V to 14 V
ECI 100 **EBI 100**		≤ 6000 rpm	–	115 °C	DC 3.6 V to 14 V
ERO 1200		≤ 25000 rpm	–	100 °C	DC 5 V ± 0.5 V
ERO 1400		≤ 30000 rpm	–	70 °C	DC 5 V ± 0.5 V
					DC 5 V ± 0.25 V
					DC 5 V ± 0.5 V

1) **Functional safety** upon request

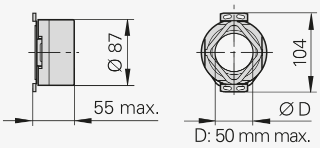
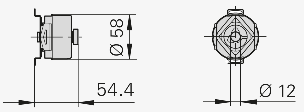
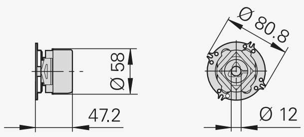
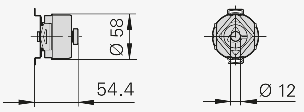
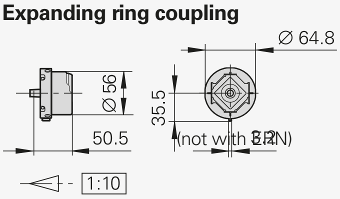
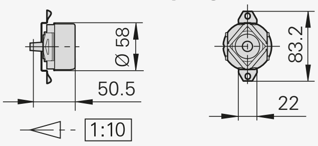
2) After internal 5/10/20/25-fold interpolation

	Signal periods per revolution	Positions per revolution	Distinguishable revolutions	Interface	Model	Further information
	512	8192 (13 bits)	–/4096	EnDat 2.2/01 with ∼ 1 V_{PP}	**ECN 1113/EQN 1125**	**Page 54**
	–	8388608 (23 bits)		EnDat 2.2/22	**ECN 1123[1)]/EQN 1135[1)]**	
	500 to 8192	3 block commutation signals		⊓⊔TTL	**ERN 1123**	**Page 58**
	512/2048	8192 (13 bits)	–/4096	EnDat 2.2/01 with ∼ 1 V_{PP}	**ECN 1313/EQN 1325**	**Page 60**
	–	33554432 (25 bits)		EnDat 2.2/22	**ECN 1325[1)]/EQN 1337[1)]**	
	1024/2048/4096	–		⊓⊔TTL	**ERN 1321**	**Page 66**
		3 block commutation signals			**ERN 1326**	
	512/2048/4096	–		∼ 1 V_{PP}	**ERN 1381**	
	2048	Z1 track for sine commutation			**ERN 1387**	
	–	16777216 (24 bits)	–/4096	DRIVE-CLiQ	**ECN 1324 S/EQN 1336 S**	**Page 62**
	–	524288 (19 bits)	–/4096	EnDat 2.2/22	**ECI 1119[1)]/EQI 1131[1)]**	**Page 72**
		262144 (18 bits)	–/65536[3)]		**ECI 1118/EBI 1135**	**Page 74**
	32	524288 (19 bits)	–/4096	EnDat 2.2/01 with ∼ 1 V_{PP}	**ECI 1319[1)]/EQI 1331[1)]**	**Page 76**
	–			EnDat 2.2/22		**Page 78**
	32	524288 (19 bits)	–	EnDat 2.1/01 with ∼ 1 V_{PP}	**ECI 119**	**Page 80**
	–			EnDat 2.2/22		
			65536[3)]	EnDat 2.2/22	**EBI 135**	
	1024/2048	–		⊓⊔TTL	**ERO 1225**	**Page 82**
				∼ 1 V_{PP}	**ERO 1285**	
	512/1000/1024	–		⊓⊔TTL	**ERO 1420**	**Page 84**
	5000 to 37500[2)]			⊓⊔TTL	**ERO 1470**	
	512/1000/1024			∼ 1 V_{PP}	**ERO 1480**	

3) Multiturn function via battery-buffered revolution counter

Rotary encoders for mounting on motors

Protection: up to IP64 (EN 60529)

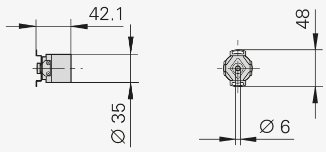
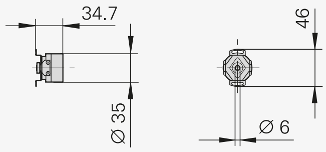
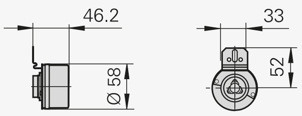
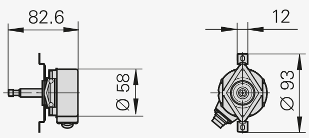
Series	Overall dimensions	Mechanically permissible speed	Natural freq. of stator connection	Maximum operating temperature	Voltage supply
Rotary encoders with integral bearing and mounted stator coupling					
ECN/ERN 100		*D ≤ 30 mm:* ≤ 6000 rpm *D > 30 mm:* ≤ 4000 rpm	≥ 1100 Hz	100 °C	DC 3.6 V to 14 V
					DC 5 V ± 0.5 V
				85 °C	DC 10 V to 30 V
ECN/EQN/ERN 400	**Stator coupling**  **Universal stator coupling** 	≤ 6000 rpm *With two shaft clamps (only for hollow through shaft):* ≤ 12 000 rpm	*Stator coupling:* ≥ 1500 Hz *Universal stator coupling:* ≥ 1400 Hz	100 °C	DC 3.6 V to 14 V
					DC 4.75 V to 30 V
					DC 5 V ± 0.5 V
					DC 10 V to 30 V
				70 °C	
				100 °C	DC 5 V ± 0.5 V
ECN/EQN/ERN 400	**Stator coupling** 	≤ 6000 rpm *With two shaft clamps (only for hollow through shaft):* ≤ 12 000 rpm	*Stator coupling:* ≥ 1500 Hz *Universal stator coupling:* ≥ 1400 Hz	100 °C	DC 10 V to 30 V
					DC 4.75 V to 30 V
					DC 3.6 V to 14 V
					DC 10 V to 28.8 V
ECN/EQN/ERN 400	**Expanding ring coupling**  **Plane-surface coupling** 	≤ 15 000 rpm/ ≤ 12 000 rpm	*Expanding ring coupling:* ≥ 1800 Hz *Plane-surface coupling:* ≥ 400 Hz	100 °C	DC 3.6 V to 14 V
		≤ 15 000 rpm			DC 5 V ± 0.5 V
					DC 5 V ± 0.25 V

1) **Functional safety** on request

	Signal periods per revolution	Positions per revolution	Distinguishable revolutions	Interface	Model	Further information
	2048	8192 (13 bits)	–	EnDat 2.2/01 with ∿ 1 V_{PP}	**ECN 113**	**Catalog:** ***Rotary Encoders***
	–	33 554 432 (25 bits)		EnDat 2.2/22	**ECN 125**	
	1000 to 5000	–		⊓⊔ TTL/∿ 1 V_{PP}	**ERN 120/ERN 180**	
				⊓⊔ HTL	**ERN 130**	
	512/2048	8192 (13 bits)	–/4096	EnDat 2.2/01 ∿ 1 V_{PP}	**ECN 413/EQN 425**	
	–	33 554 432 (25 bits)		EnDat 2.2/22	**ECN 425/EQN 437**	
	512	8192 (13 bits)		SSI	**ECN 413/EQN 425**	
	250 to 5000	–		⊓⊔ TTL	**ERN 420**	
				⊓⊔ HTL	**ERN 430**	
				⊓⊔ TTL	**ERN 460**	
	1000 to 5000			∿ 1 V_{PP}	**ERN 480**	
	256 to 2048	8192 (13 bits)	–/4096	EnDat H ⊓⊔ HTL SSI 41H ⊓⊔ HTL	**EQN 425**	**Catalog:** ***Rotary Encoders***
	512 to 4096			EnDat T ⊓⊔ TTL SSI 41T ⊓⊔ TTL		
	–	αi: 33 554 432 (25 bits)	4096	Fanuc05	**ECN 425 F/EQN 437 F**	
		33 554 432 (25 bits)/ 8 388 608 (23 bits)		Mit03-4	**ECN 425 M/EQN 435 M**	
		16 777 216 (24 bits)		DQ01	**ECN 424 S/EQN 436 S**	
	2048	8192 (13 bits)	–/4096	EnDat 2.2/01 with ∿ 1 V_{PP}	**ECN 413/EQN 425**	**Page 64**
	–	33 554 432 (25 bits)		EnDat 2.2/22	**ECN 425[1]/EQN 437[1]**	
	1024 to 5000	–		⊓⊔ TTL	**ERN 421**	**Product Information**
	2048	Z1 track for sine commutation			**ERN 487**	

Rotary encoders for mounting on motors

Protection: up to IP64 (EN 60529)

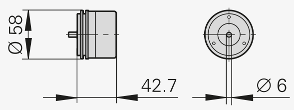
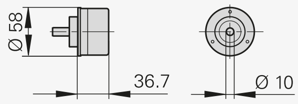
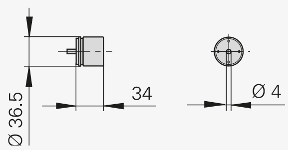
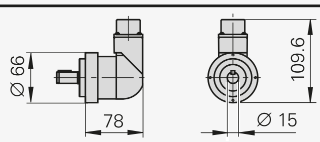
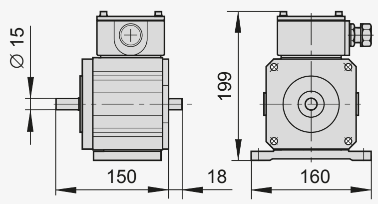
Series	Overall dimensions	Mechanically permissible speed	Natural freq. of stator connection	Maximum operating temperature	Voltage supply
Rotary encoders with integral bearing and mounted stator coupling					
ECN/EQN/ERN 1000		≤ 12000 rpm	≥ 1500 Hz	100 °C	DC 3.6 V to 14 V
					DC 4.75 V to 30 V
					DC 3.6 V to 14 V
	ERN 1023				DC 5 V ± 0.5 V
				70 °C	DC 10 V to 30 V
					DC 5 V ± 0.25 V
		≤ 6000 rpm	≥ 1600 Hz	90 °C	DC 5 V ± 0.5 V
Rotary encoders with integral bearing and torque supports for Siemens drives					
EQN/ERN 400		≤ 6000 rpm	–	100 °C	DC 3.6 V to 14 V
					DC 10 V to 30 V
					DC 5 V ± 0.5 V
					DC 10 V to 30 V
ERN 401		≤ 6000 rpm	–	100 °C	DC 5 V ± 0.5 V
					DC 10 V to 30 V

[1] After internal 5/10/20/25-fold interpolation

	Signal periods per revolution	Positions per revolution	Distinguishable revolutions	Interface	Model	Further information
	512	8192 (13 bits)	–/4096	EnDat 2.2/01 with ∿ 1 V_{PP}	**ECN 1013/EQN 1025**	**Catalog:** ***Rotary Encoders***
				SSI		
	–	8388608 (23 bits)		EnDat 2.2/22	**ECN 1023/EQN 1035**	
	100 to 3600	–		⊓⊔TTL/∿ 1 V_{PP}	**ERN 1020/ERN 1080**	
				⊓⊔ HTLs	**ERN 1030**	
	5000 to 36000[1]			⊓⊔TTL	**ERN 1070**	
	500 to 8192	3 block commutation signals		⊓⊔TTL	**ERN 1023**	**Page 56**
	2048	8192 (13 bits)	4096	EnDat 2.1/01 with ∿ 1 V_{PP}	**EQN 425**	**Page 68**
				SSI		
	1024	–		⊓⊔TTL	**ERN 420**	
				⊓⊔ HTL	**ERN 430**	
	1024			⊓⊔TTL	**ERN 421**	**Page 70**
				⊓⊔ HTL	**ERN 431**	

Rotary encoders for mounting on motors

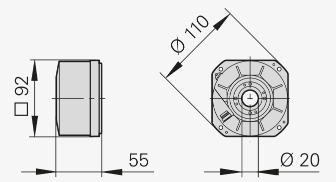
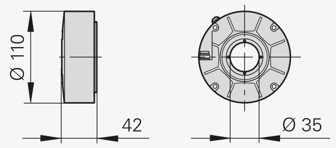
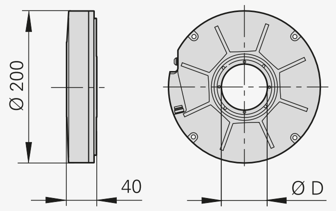
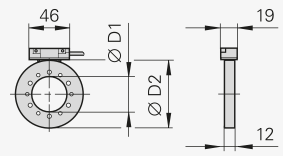
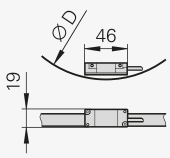
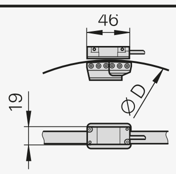
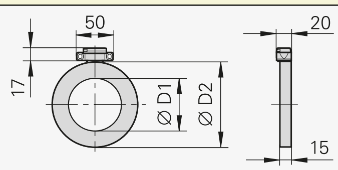
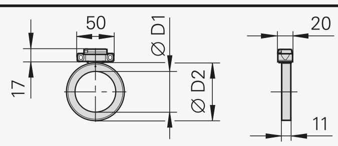
Protection: up to IP64 (EN 60529)

Series	Overall dimensions	Mechanically permissible speed	Natural freq. of stator connection	Maximum operating temperature	Voltage supply
Rotary encoders with integral bearing for separate shaft coupling					
ROC/ROQ/ROD 400 RIC/RIQ	**Synchro flange**  **Clamping flange** 	≤ 12000 rpm	–	100 °C	DC 3.6 V to 14 V
					DC 5 V
					DC 4.75 V to 30 V
					DC 10 V to 30 V
					DC 4.75 V to 30 V
					DC 3.6 V to 14 V
					DC 10 V to 28.8 V
					DC 5 V ± 0.5 V
					DC 10 V to 30 V
				70 °C	
				100 °C	DC 5 V ± 0.5 V
ROC/ROQ/ROD 1000		≤ 12000 rpm	–	100 °C	DC 3.6 V to 14 V
					DC 4.75 V to 30 V
					DC 3.6 V to 14 V
					DC 5 V ± 0.5 V
				70 °C	DC 10 V to 30 V
					DC 5 V ± 0.25 V
ROD 600		≤ 12000 rpm	–	80 °C	DC 5 V ± 0.5 V
ROD 1900		≤ 4000 rpm	–	70 °C	DC 10 V to 30 V

[1] **Functional safety** on request
[2] After integral 5/10-fold interpolation
[3] Only clamping flange

Signal periods per revolution	Positions per revolution	Distinguishable revolutions	Interface	Model	Further information
512/2048	8192 (13 bits)	–/4096	EnDat 2.2/01 with ∼ 1 V_{PP}	**ROC 413/ROQ 425**	**Catalog:** ***Rotary Encoders***
–	33554432 (25 bits)		EnDat 2.2/22	**ROC 425[1]/ROQ 437[1]**	
16	262144 (18 bits)		EnDat 2.1/01	**RIC 418/RIQ 430**	
512	8192 (13 bits)		SSI	**ROC 413/ROQ 425**	
256 to 2048	8192 (13 bits)	–/4096	EnDat H ⊓⊔ HTL SSI 41H ⊓⊔ HTL	**ROQ 425[3]**	
512 to 4096			EnDat T ⊓⊔ TTL SSI 41T ⊓⊔ TTL		
–	αi: 33554432 (25 bits)	4096	Fanuc05	**ROC 425 F/ROQ 437 F**	
	33554432 (25 bits)/ 8388608 (23 bits)		Mit03-4	**ROC 425 M/ROQ 435 M**	
	16777216 (24 bits)		DQ01	**ROC 424 S/EQN 436 S**	
50 to 10000[2]	–	–	⊓⊔ TTL	**ROD 426/ROD 420**	
50 to 5000			⊓⊔ HTL	**ROD 436/ROD 430**	
50 to 10000[2]			⊓⊔ TTL	**ROD 466**	
1000 to 5000			∼ 1 V_{PP}	**ROD 486/ROD 480**	
512	8192 (13 bits)	–/4096	EnDat 2.2/01 with ∼ 1 V_{PP}	**ROC 1013/ROQ 1025**	**Catalog:** ***Rotary Encoders***
			SSI		
–	8388608 (23 bits)		EnDat 2.2/22	**ROC 1023/ROQ 1035**	
100 to 3600	–		⊓⊔ TTL	**ROD 1020**	
			∼ 1 V_{PP}	**ROD 1080**	
			⊓⊔ HTLs	**ROD 1030**	
5000 to 36000[2]			⊓⊔ TTL	**ROD 1070**	
512 to 5000	–		⊓⊔ TTL	**ROD 620**	
			⊓⊔ HTL	**ROD 630**	
600 to 2400	–		⊓⊔ HTL/HTLs	**ROD 1930**	

Rotary encoders and angle encoders for integrated and hollow-shaft motors

Series	Overall dimensions	Diameter	Mechanically permissible speed	Natural freq. of stator connection	Maximum operating temperature
Angle encoders with integral bearing and integrated stator coupling					
RCN 2000		–	≤ 1500 rpm	≥ 1000 Hz	*RCN 23xx:* 60 °C *RCN 25xx:* 50 °C
RCN 5000		–	≤ 1500 rpm	≥ 1000 Hz	*RCN 53xx:* 60 °C *RCN 55xx:* 50 °C
RCN 8000		D: 60 mm and 100 mm	≤ 500 rpm	≥ 900 Hz	50 °C
Modular angle encoders with optical scanning					
ERA 4000 Steel scale drum		D1: 40 mm to 512 mm D2: 76.75 mm to 560.46 mm	≤ 10 000 rpm to ≤ 1500 rpm	–	80 °C
ERA 7000 For inside diameter mounting		D: 458.62 mm to 1146.10 mm	≤ 250 rpm to ≤ 220 rpm	–	80 °C
ERA 8000 For outside diameter mounting		D: 458.11 mm to 1145.73 mm	≤ 50 rpm to ≤ 45 rpm	–	80 °C
Modular angle encoders with magnetic graduation					
ERM 2200 Signal period of approx. 200 µm **ERM 2400** Signal period of approx. 400 µm		D1: 40 mm to 410 mm D2: 75.44 mm to 452.64 mm	≤ 19 000 rpm to ≤ 3000 rpm	–	100 °C
ERM 2400 Signal period of approx. 400 µm		D1: 40 mm to 100 mm D2: 64.37 mm to 128.75 mm	≤ 42 000 rpm to ≤ 20 000 rpm	–	100 °C
ERM 2900 Signal period of approx. 1000 µm		D1: 40 mm to 100 mm D2: 58.06 mm to 120.96 mm	≤ 35 000 rpm/ ≤ 16 000 rpm		

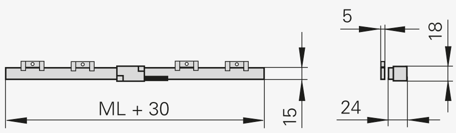
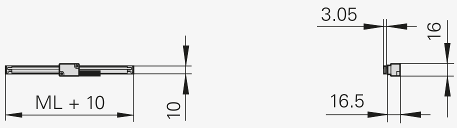
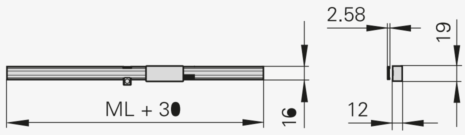
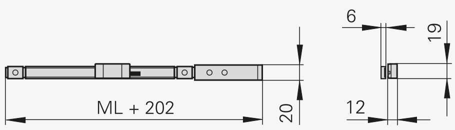
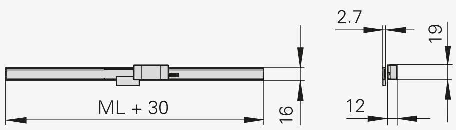
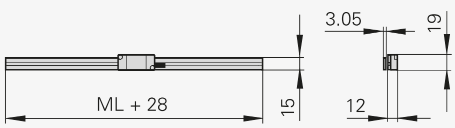
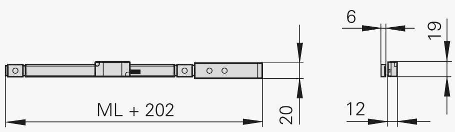
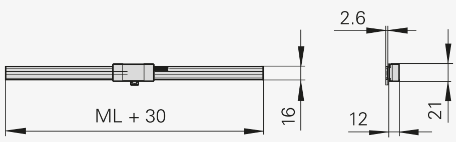
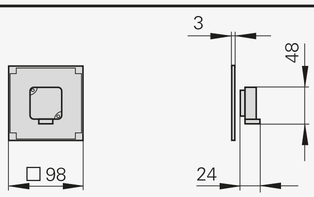
1) Interfaces for Fanuc and Mitsubishi controls upon request

2) Segment solutions upon request

	Voltage supply	System accuracy	Signal periods per revolution	Positions per revolution	Interface[1]	Model	Further information
	DC 3.6 V to 14 V	±5″ ±2.5″	16384	67 108 864 (26 bits) 268 435 456 (28 bits)	EnDat 2.2/02 with ∿ 1 V_{PP}	**RCN 2380** **RCN 2580**	**Catalog:** ***Angle Encoders*** *With Integral Bearing*
		±5″ ±2.5″	–	67 108 864 (26 bits) 268 435 456 (28 bits)	EnDat 2.2/22	**RCN 2310**[3] **RCN 2510**[3]	
	DC 3.6 V to 14 V	±5″ ±2.5″	16384	67 108 864 (26 bits) 268 435 456 (28 bits)	EnDat 2.2/02 with ∿ 1 V_{PP}	**RCN 5380** **RCN 5580**	
		±5″ ±2.5″	–	67 108 864 (26 bits) 268 435 456 (28 bits)	EnDat 2.2/22	**RCN 5310**[3] **RCN 5510**[3]	
	DC 3.6 V to 14 V	± 2″ ± 1″	32 768	536 870 912 (29 bits)	EnDat 2.2/02 with ∿ 1 V_{PP}	**RCN 8380** **RCN 8580**	
		± 2″ ± 1″	–		EnDat 2.2 / 22	**RCN 8310**[3] **RCN 8510**[3]	
	DC 5 V ± 0.5 V	–	12 000 to 52 000	–	∿ 1 V_{PP}	**ERA 4280 C**	**Catalog:** ***Angle Encoders*** *Without Integral Bearing*
			6000 to 44 000			**ERA 4480 C**	
			3000 to 13 000			**ERA 4880 C**	
	DC 5 V ± 0.25 V	–	**Full circle**[2] 36 000 to 90 000	–	∿ 1 V_{PP}	**ERA 7480 C**	
	DC 5 V ± 0.25 V	–	**Full circle**[2] 36 000 to 90 000	–	∿ 1 V_{PP}	**ERA 8480 C**	
	DC 5 V ± 0.5 V	–	600 to 3600	–	⊓⊔TTL	**ERM 2420**	**Catalog** ***Modular Angle Encoders*** *With Magnetic Scanning*
					∿ 1 V_{PP}	**ERM 2280** **ERM 2480**	
	DC 5 V ± 0.5 V	–	512 to 1024	–	∿ 1 V_{PP}	**ERM 2484**	
			256/400	–		**ERM 2984**	

3) **Functional safety** on request

Exposed linear encoders for linear drives

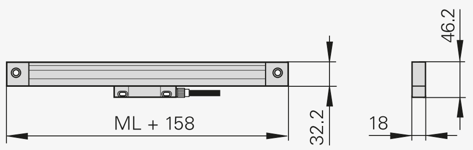
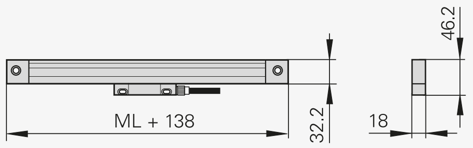
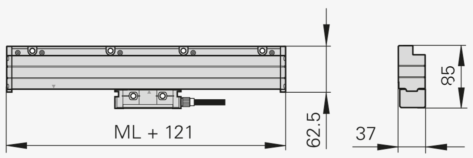
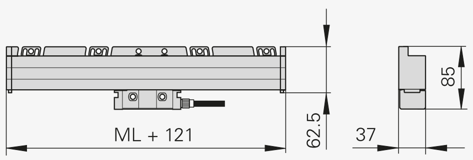
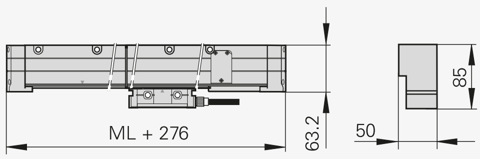
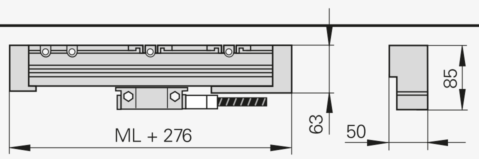
Series	Overall dimensions	Traversing speed	Acceleration in measuring direction	Accuracy grade
LIP 400		≤ 30 m/min	≤ 200 m/s²	To ±0.5 µm
LIF 400		≤ 72 m/min	≤ 200 m/s²	± 3 µm
LIC 2100 Absolute linear encoder		≤ 600 m/min	≤ 200 m/s²	± 15 µm
LIC 4100 Absolute linear encoder		≤ 600 m/min	≤ 500 m/s²	±5 µm
				±5 µm[1)]
LIDA 400		≤ 480 m/min	≤ 200 m/s²	±5 µm
				±5 µm[1)]
LIDA 200		≤ 600 m/min	≤ 200 m/s²	± 30 µm
PP 200 Two-coordinate encoder		≤ 72 m/min	≤ 200 m/s²	± 2 µm

[1)] After linear error compensation

Measuring lengths	Voltage supply	Signal period	Cutoff frequency –3 dB	Switching output	Interface	Model	Further information
70 mm to 420 mm	DC 5 V ± 0.25 V	2 µm	≥ 250 kHz	–	∼ 1 V_{PP}	**LIP 481**	**Catalog:** ***Exposed Linear Encoders***
70 mm to 1020 mm	DC 5 V ± 0.25 V	4 µm	≥ 300 kHz	Homing track Limit switches	∼ 1 V_{PP}	**LIF 481**	
120 mm to 3020 mm	DC 3.6 V to 14 V	–	–	–	EnDat 2.2/22 Resolution 0.05 µm	**LIC 2107**	
140 mm to 27 040 mm	DC 3.6 V to 14 V	–	–	–	EnDat 2.2/22 Resolution 0.001 µm	**LIC 4115**	
140 mm to 6040 mm						**LIC 4117**	
140 mm to 30 040 mm	DC 5 V ± 0.25 V	20 µm	≥ 400 kHz	Limit switches	∼ 1 V_{PP}	**LIDA 485**	
240 mm to 6040 mm						**LIDA 487**	
Up to 10 000 mm	DC 5 V ± 0.25 V	200 µm	≥ 50 kHz	–	∼ 1 V_{PP}	**LIDA 287**	
Measuring range 68 mm x 68 mm	DC 5 V ± 0.25 V	4 µm	≥ 300 kHz	–	∼ 1 V_{PP}	**PP 281**	

Sealed linear encoders for linear drives

Protection: IP53 to IP64[1)] (EN 60 529)

Series	**Overall dimensions**	**Traversing speed**	**Acceleration** in measuring direction	**Natural frequency of coupling**	**Measuring lengths**
Linear encoders with slimline scale housing					
LF		≤ 60 m/min	≤ 100 m/s²	≥ 2000 Hz	50 mm to 1220 mm
LC Absolute linear encoder		≤ 180 m/min	≤ 100 m/s²	≥ 2000 Hz	70 mm to 2040 mm[3)]
Linear encoders with full-size scale housing					
LF		≤ 60 m/min	≤ 100 m/s²	≥ 2000 Hz	140 mm to 3040 mm
LC Absolute linear encoder		≤ 180 m/min	≤ 100 m/s²	≥ 2000Hz	140 mm to 4240 mm
					140 mm to 3040 mm
					140 mm to 4240 mm
					140 mm to 3040 mm
		≤ 120 m/min (180 m/min upon request)	≤ 100 m/s²	≥ 780 Hz	3240 mm to 28 040 mm
LB		≤ 120 m/min (180 m/min upon request)	≤ 60 m/s²	≥ 650 Hz	440 mm to 30 040 mm (up to 72 040 mm upon request)

1) After installation according to mounting instructions
2) Interfaces for Siemens, Fanuc and Mitsubishi controls upon request
3) Measuring lengths from 1340 mm only with spar or clamping elements
4) **Functional safety** on request

Accuracy grade	Voltage supply	Signal period	Cutoff frequency –3 dB	Resolution	Interface[2]	Model	Further information
±5 µm	DC 5 V ± 0.25 V	4 µm	≥ 250 kHz	–	∿ 1 V_{PP}	**LF 485**	**Catalog:** ***Linear Encoders*** *For Numerically Controlled Machine Tools*
±5 µm	DC 3.6 V to 14 V	–	–	To 0.01 µm	EnDat 2.2/22	**LC 415**[4]	
± 3 µm				To 0.001 µm			
±5 µm		20 µm	≥ 150 kHz	To 0.01 µm	EnDat 2.2/02	**LC 485**	
± 3 µm				To 0.05 µm			
±2 µm; ± 3 µm	DC 5 V ± 0.25 V	4 µm	≥ 250 kHz	–	∿ 1 V_{PP}	**LF 185**	**Catalog:** ***Linear Encoders*** *For Numerically Controlled Machine Tools*
±5 µm	DC 3.6 V to 14 V	–	–	To 0.01 µm	EnDat 2.2/22	**LC 115**[4]	
± 3 µm				To 0.001 µm			
±5 µm		20 µm	≥ 150 kHz	To 0.01 µm	EnDat 2.2/02	**LC 185**	
± 3 µm				To 0.05 µm			
±5 µm	DC 3.6 V to 14 V	–	–	To 0.01 µm	EnDat 2.2/22	**LC 211**	
		40 µm	≥ 250 kHz		EnDat 2.2/02 with ∿ 1 V_{PP}	**LC 281**	
To ±5 µm	DC 5 V ± 0.25 V	40 µm	≥ 250 kHz	–	∿ 1 V_{PP}	**LB 382**	

Rotary encoders and angle encoders for three-phase AC and DC motors
General information

Speed stability
To ensure **smooth drive performance,** an encoder must provide a **large number of measuring steps per revolution.** The encoders in the HEIDENHAIN product program are therefore designed to supply the necessary numbers of signal periods per revolution to meet the speed stability requirement.

HEIDENHAIN rotary encoders angle encoders featuring integral bearings and stator couplings provide very good performance: shaft misalignment within certain tolerances (see *Specifications*) does not cause any position error or impair speed stability.

At low speeds, the encoder's **position error within one signal period** affects speed stability. In encoders with purely serial data transmission, the LSB (Least Significant Bit) goes into the speed stability (see also *Measuring accuracy*).

Transmission of measuring signals
To ensure the best possible dynamic performance with digitally controlled motors, the sampling time of the speed controller should not exceed approx. 256 µs. The feedback values for the position and speed controller must therefore be available in the controlling system with the least possible delay.

High clock frequencies are needed to fulfill such demanding time requirements on position-value transfer from the encoder to the controlling system with serial data transmission (see also *Interfaces; Absolute Position Values*). HEIDENHAIN encoders for servo drives therefore provide the position values via the fast, **purely serial EnDat 2.2 interface**, or transmit additional **incremental signals** that are available without delay for use in the subsequent electronics for speed and position control.

For **standard drives,** manufacturers primarily use the especially robust HEIDENHAIN **ECI/EQI** encoders without integral bearing or rotary encoders with **TTL** or **HTL compatible output signals**—as well as additional commutation signals for permanent-magnet DC drives.

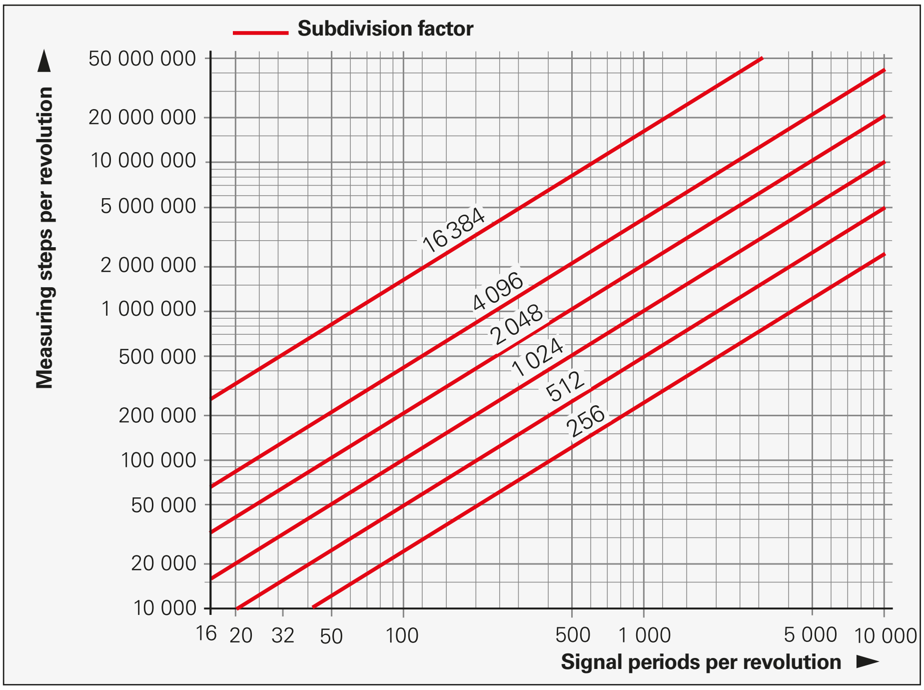
For **digital speed control** on machines with **high requirements for dynamics,** a large number of measuring steps is required—usually above 500 000 per revolution. For applications with standard drives, as with resolvers, approx. 60 000 measuring steps per revolution are sufficient.

HEIDENHAIN encoders for drives with digital position and speed control are therefore equipped with the **purely serial EnDat22 interface**, or they additionally provide **sinusoidal incremental signals** with signal periods of 1 V_{PP} (EnDat01).

The high internal resolution of the **EnDat22** encoders permits resolutions up to 19 bits (524 288 measuring steps) in inductive systems and at least 23 bits (approx. 8 million measuring steps) in photoelectric encoders.

Thanks to their high signal quality, the sinusoidal incremental signals of the **EnDat01** encoders can be highly subdivided in the subsequent electronics (see Figure 1). Even at shaft speeds of 12 000 rpm, the signal arrives at the input circuit of the controlling system with a frequency of only approx. 400 kHz (see Figure 2). 1 V_{PP} incremental signals allow cable lengths up to 150 m (see also *Incremental signals – 1 V_{PP}*).

Figure 1:
Signal periods per revolution and the resulting number of measuring steps per revolution as a function of the subdivision factor



HEIDENHAIN absolute encoders for "digital" drives also supply additional sinusoidal incremental signals with the same characteristics as those described above. Absolute encoders from HEIDENHAIN use the EnDat interface (for Encoder Data) for the **serial data transmission** of absolute position values and other information for **automatic self-configuration, monitoring and diagnosis.** (See *Absolute position values – EnDat*.) This makes it possible to use the same subsequent electronics and cabling technology for all HEIDENHAIN encoders.

Important encoder specifications can be read from the memory of the EnDat encoder for automatic self-configuration, and motor-specific parameters can be saved in the OEM memory area of the encoder. The usable size of the OEM memory in the rotary encoders in the current catalogs is at least 1.4 KB (≙ 704 EnDat words).

Most absolute encoders themselves already subdivide the sinusoidal scanning signals by a factor of 4096 or greater. If the transmission of absolute positions is fast enough (for example, EnDat 2.1 with 2 MHz or EnDat 2.2 with 16 MHz clock frequency), these systems can do without incremental signal evaluation.

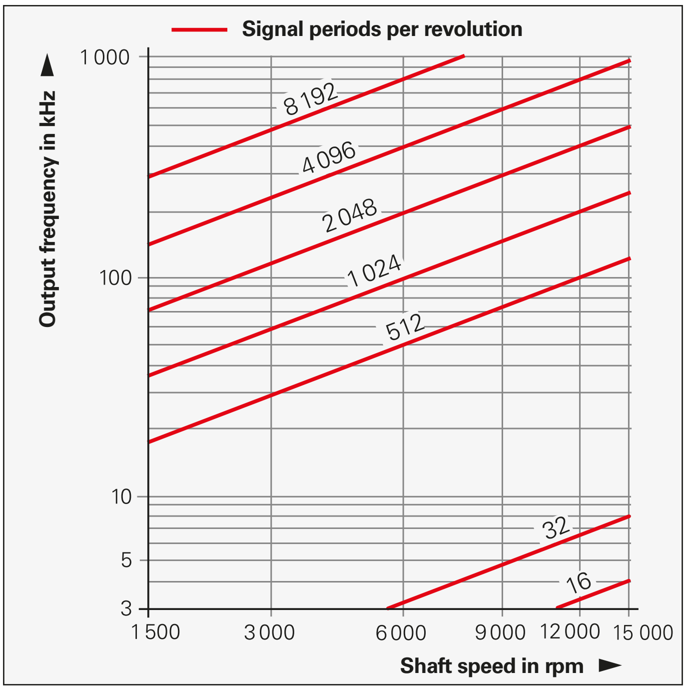
Benefits of this data transmission technology include greater noise immunity of the transmission path and less expensive connectors and cables. Rotary encoders with EnDat 2.2 interface offer the additional feature of being able to evaluate an external temperature sensor, located in the motor coil, for example. The digitized temperature values are transmitted as part of the EnDat 2.2 protocol without an additional line.

Bandwidth

The attainable gain for the position and speed control loops, and therefore the bandwidth of the drives for command response and control reliability, are sometimes limited by the rigidity of the coupling between the motor shaft and encoder shaft as well as by the natural frequency of the stator coupling. HEIDENHAIN therefore offers rotary and angular encoders for high-rigidity shaft coupling.

The stator couplings mounted on the encoders have **high natural frequencies greater than** 1800 Hz. For the modular and inductive rotary encoders, the stator and rotor are firmly screwed to the motor housing and to the shaft (see also *Mechanical design types and mounting*).

Figure 2:
Shaft speed and resulting output frequency as a function of the number of signal periods per revolution



Motor currents

Motors are sometimes subjected to impermissible current from the rotor to the stator. This can result in overheating in the encoder bearing and reduce its service life. HEIDENHAIN therefore recommends encoders without integral bearings or with insulating bearings (hybrid bearings). For more information, please contact HEIDENHAIN.

Fault exclusion for mechanical coupling

HEIDENHAIN encoders designed for functional safety can be mounted so that the rotor or stator fastening does not accidentally loosen.

Size

A higher permissible operating temperature permits a smaller motor size for a specific rated torque. Since the temperature of the motor also affects the temperature of the encoder, HEIDENHAIN offers encoders for **permissible operating temperatures up to 120 °C.** These encoders make it possible to design machines with smaller motors.

Power loss and noise emission

The power loss of the motor, the accompanying heat generation, and the acoustic noise of motor operation are influenced by the position error of the encoder within one signal period. For this reason, rotary encoders with a high signal quality of better than ±1 % of the signal period are preferred (see also *Measuring accuracy*).

Bit error rate

For rotary encoders with purely serial interface for integration in motors, HEIDENHAIN recommends conducting a type test for the bit error rate.

When using functionally safe encoders without closed metal housings and/or with cable assemblies that do not comply with the electrical connection directives (see *General electrical information*) it is always necessary to measure the bit error rate in a type test under application conditions.

HMC 6
Single-cable solution for servo drives

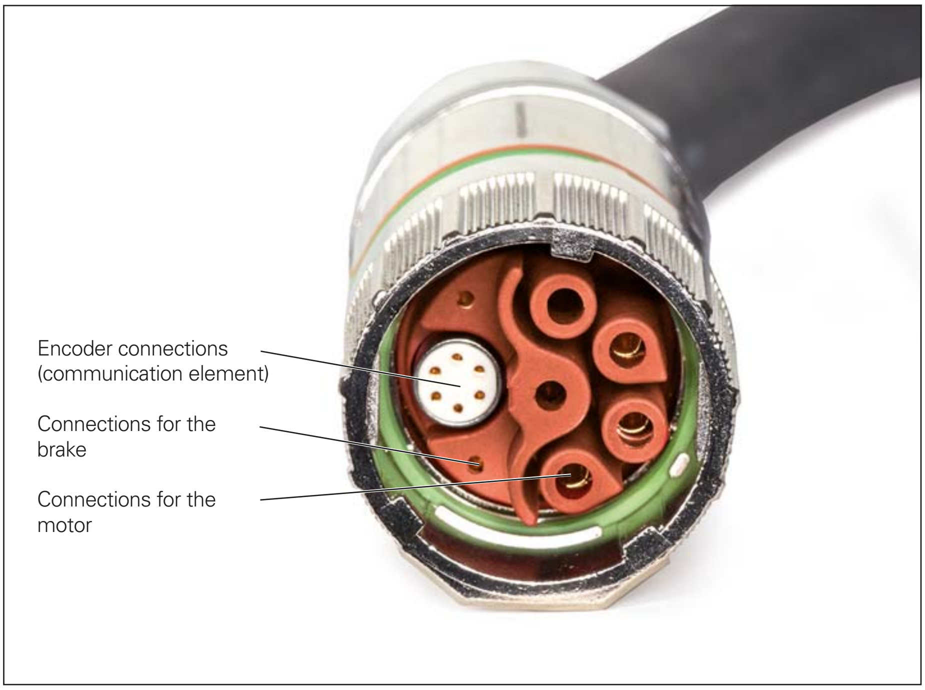
Motors normally need two separate cables:
- One cable for the motor encoder
- One cable for the motor power supply

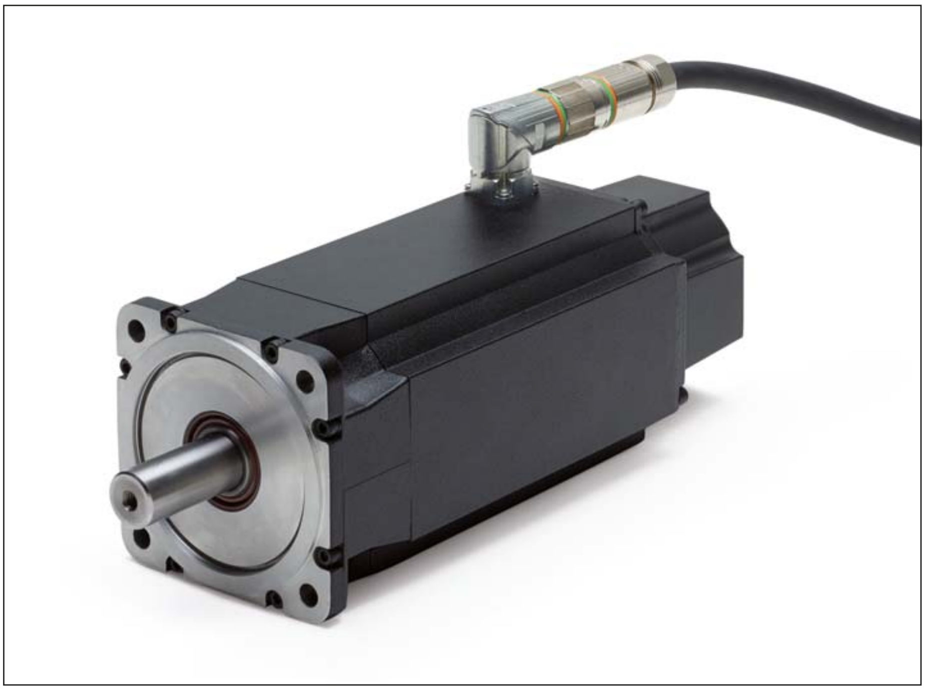
With its Hybrid Motor Cable **HMC 6**, HEIDENHAIN has integrated the encoder lines in the power cable. So now only **one cable** is needed between the motor and electrical cabinet.

The HMC 6 single-cable solution has been specially conceived for the HEIDENHAIN **EnDat22** interface with purely serial transmission over cable lengths up to 100 m. However, all other encoders with purely serial RS-485 interface can also be connected. This makes a broad range of encoders available without having to introduce a new interface.

The HMC 6 integrates the lines for encoders, motors and brakes in only one cable. It is connected to the motor via a special connector. For connection to the inverter, the cable is split into power connections and an encoder connector. This makes it compatible on the control side with all the same components as conventional cables.

If the components are correctly mounted, the connections will have the IP67 degree of protection. Vibration protection against loosening of coupling joints is integrated in the connector, as also is the quick-release lock.





Advantages
The HMC 6 single-cable solution offers a series of cost and quality improvements both for the motor manufacturer and the machine tool builder:
- No need to replace existing interfaces
- Allows smaller drag chains
- A smaller number of cables significantly improves drag chain flexibility
- A wide range of encoders is available for HMC 6 transmission
- There is no assignment of cable contacts in the machine
- Reduces mechanical requirements (flange socket on the motor, cable ducts in the machine housing)
- Lower shipping and storage costs for cables and connectors
- Installation is simpler and faster
- Lower cost of documentation
- Fewer service components are required
- The contour including the cable is smaller, making it easier to integrate the motor in the machine housing
- The combination of power cable and encoder cable has been tested by HEIDENHAIN

The universal design of the HMC 6 provides you—as motor manufacturer or machine tool builder—with the greatest possible flexibility, because you can use standard components—both on the motor and the control side.

A particular advantage: **all HEIDENHAIN encoders with EnDat22 interface** or with purely serial data transfer without battery buffering as per RS-485 are suited for the HMC 6 single-cable solution. They include motor encoders for servo drives in their various sizes, as well as linear and angle encoders used in direct drives. And of course it also includes encoders for **functional safety** up to SIL 3.

But there is no need for acrobatics on the control side either: you can use the same inverter systems or controller units as before. The HMC 6 cable has been designed to be easy for you to wire it to the proper connector systems. And most importantly: there is no reduction in noise immunity.

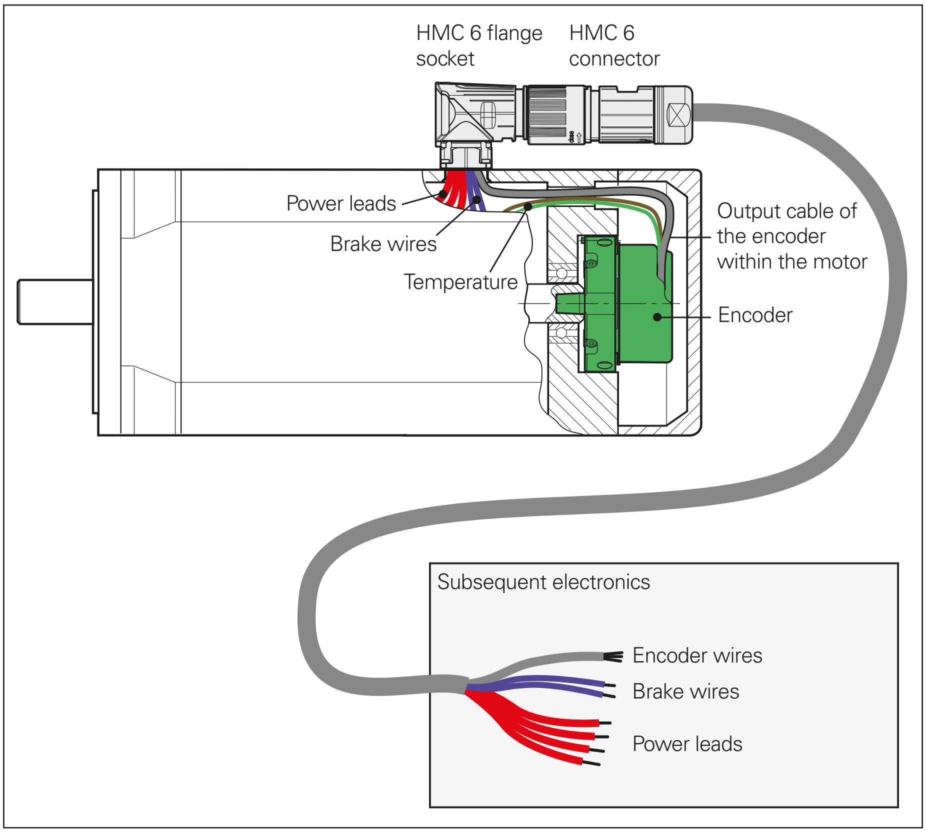
Components
You only need a few components to make your motor ready for the single-cable solution.

Connecting element on the motor
The motor housing must be equipped with a special right-angle flange socket, in which the contacts for the encoder, the motor power and the brake are included.

Crimp tools for the power lines
The crimp contacts for power and brake wires are added using the usual tools.

Cables inside the motor housing
The rotary encoder is connected through the output cable inside the motor: your ready-wired communication element is simply latched to the angle flange socket.

Cable with hybrid connector
Besides the wires to the encoder, the HMC connecting cable with the motor also includes those for the motor power and brake. It is wired at one end with a hybrid connector



For more information on the HMC 6 in the *HMC 6*, see the Product Information document.

Linear encoders for linear drives
General information

Selection criteria for linear encoders
HEIDENHAIN recommends the use of **exposed linear encoders** whenever the severity of contamination inherent in a particular machine environment does not preclude the use of optical measuring systems, and if relatively high accuracy is desired, e.g. for high-precision machine tools and measuring equipment, or for production, testing and inspecting equipment in the semiconductor industry.

Particularly for applications on machine tools that release coolants and lubricants, HEIDENHAIN recommends **sealed linear encoders**. Here the requirements on the mounting surface and on machine guideway accuracy are less stringent than for exposed linear encoders, and therefore installation is faster.

Speed stability
To ensure smooth-running servo performance, the linear encoder must permit a resolution commensurate with the given speed control range:

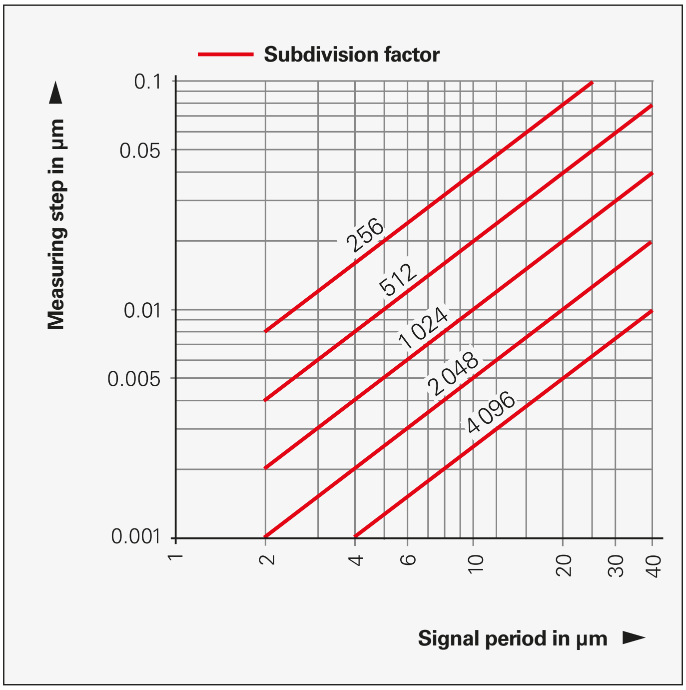
- On handling equipment, resolutions in the range of several microns are sufficient
- Feed drives for machine tools need resolutions of 0.1 µm and finer
- Production equipment in the semiconductor industry requires resolutions of a few nanometers

At low traversing speeds, the **position error within one signal period** has a decisive influence on the speed stability of linear motors (see also *Measuring accuracy*).

Traversing speeds
Exposed linear encoders function without contact between the scanning head and the scale. The maximum permissible traversing speed is limited only by the cutoff frequency (–3 dB) of the output signals.

On sealed linear encoders, the scanning unit is guided along the scale on a ball bearing. Sealing lips protect the scale and scanning unit from contamination. The ball bearing and sealing lips permit mechanical traversing speeds up to **180 m/min**.

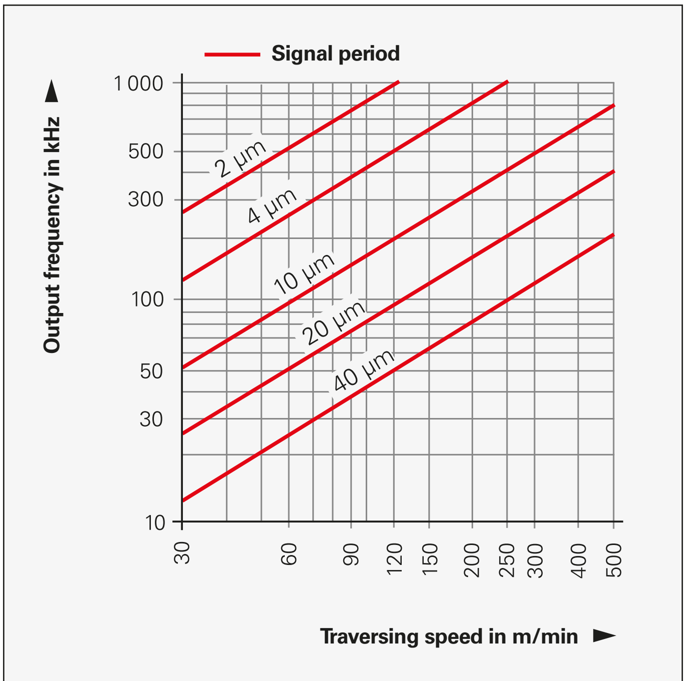
Signal period and resulting measuring step
as a function of the subdivision factor



Transmission of measuring signals
The information given for rotary and angle encoder signal transmission essentially applies also to linear encoders. If, for example, one wishes to traverse at a minimum velocity of 0.01 m/min with a sampling time of 250 µs, and if one assumes that the measuring step should change by at least one measuring step per sampling cycle, then one needs a measuring step of approx. 0.04 µm. To avoid the need for special measures in the subsequent electronics, input frequencies should be limited to less than 1 MHz.
Linear encoders with **sinusoidal output signals** or absolute position values according to **EnDat 2.2** are best suited for high traversing speeds and small measuring steps. Sinusoidal signals with levels of **1 V_{PP}** in particular permit a –3 dB cutoff frequency of approx. 200 kHz and more at permissible cable lengths up to 150 m.

The figure below illustrates the relationship between output frequency, traversing speeds, and signal periods of linear encoders. Even at a signal period of 4 µm and traversing speeds up to 70 m/min, frequencies of only 300 kHz are attained.

Traversing speed and resulting output frequency as a function of the signal period



Bandwidth
On linear motors, a coupling lacking in rigidity can limit the bandwidth of the position control loop. The manner in which the linear encoder is mounted on the machine has a very significant influence on the rigidity of the coupling (see *Design types and mounting*).

On sealed linear encoders, the scanning unit is guided along the scale. A coupling connects the scanning carriage with the mounting block and compensates the misalignment between the scale and the machine guideways. This permits relatively large mounting tolerances. The coupling is very rigid in the measuring direction and is flexible in the perpendicular direction. If the coupling is insufficiently rigid in the measuring direction, it could cause low natural frequencies in the position and velocity control loops and thus limit the bandwidth of the drive.

The sealed linear encoders recommended by HEIDENHAIN for linear motors generally have a **natural frequency of coupling greater than 650 Hz or 2 kHz in the measuring direction,** which in most applications exceeds the mechanical natural frequency of the machine and the bandwidth of the velocity control loop by factors of at least five to ten. HEIDENHAIN linear encoders for linear motors therefore have practically no limiting effect on the position and speed control loops.

For more information on linear encoders for linear drives, refer to our catalogs *Exposed Linear Encoders* and *Linear Encoders For Numerically Controlled Machine Tools.*

Safety-related position measuring systems

The term **functional safety** designates HEIDENHAIN encoders that can be used in safety-related applications. These encoders operate as single-encoder systems with purely serial data transmission via EnDat 2.2 or DRIVE-CLiQ. Reliable transmission of the position is based on two independently generated absolute position values and on error bits, which are then provided to the safe control.

Basic principle
HEIDENHAIN measuring systems for safety-related applications are tested for compliance with EN ISO 13849-1 (successor to EN 954-1) as well as EN 61508 and EN 61800-5-2. These standards describe the assessment of safety-oriented systems, for example based on the failure probabilities of integrated components and subsystems. This modular approach helps manufacturers of safety-oriented systems to implement their complete systems, because they can begin with subsystems that have already been qualified. Safety-related position measuring systems with purely serial data transmission via EnDat 2.2 or DRIVE-CLiQ accommodate this technique. In a safe drive, the safety-related position measuring system is such a subsystem. The **safety-related position measuring system**, e.g. with EnDat 2.2, consists of:

- Encoder with EnDat 2.2 transmission component
- Data transfer line with EnDat 2.2 communication and HEIDENHAIN cable
- EnDat 2.2 receiver component with monitoring function (EnDat master)

In practice, the **complete "safe servo drive" system**, e.g. for EnDat 2.2 consists of:

- Safety-related position measuring system
- Safety-related control (including EnDat master with monitoring functions)
- Power stage with motor power cable and drive
- Mechanical connection between encoder and drive (e.g. rotor/stator connection)

DRIVE-CLiQ is a registered trademark of SIEMENS AG.

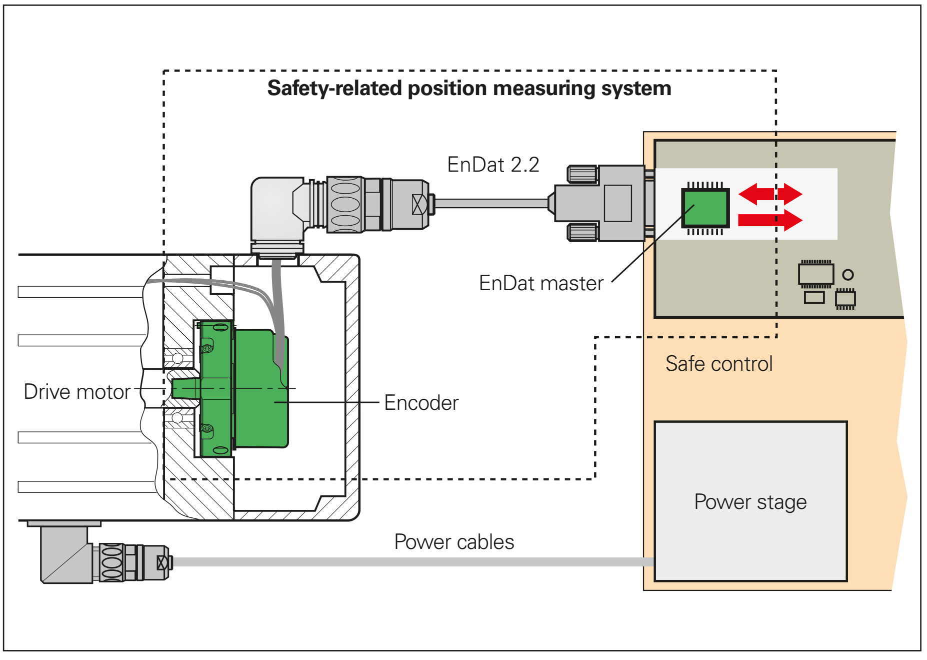
Field of application
Safety-related position measuring systems from HEIDENHAIN are designed so that they can be used as single-encoder systems in applications with control category SIL 2 (according to EN 61 508), performance level "d", category 3 (according to EN ISO 13 849).

Additional measures in the control make it possible to use certain encoders for applications up to SIL 3, PL "e", category 4. The suitability of these encoders is indicated appropriately in the documentation (catalogs/product information documents).

The functions of the safety-related position measuring system can be used for the following safety tasks in the complete system (also see EN 61 800-5-2):

SS1	Safe Stop 1	Safe stop 1
SS2	Safe Stop 2	Safe stop 2
SOS	Safe Operating Stop	Safe operating stop
SLA	Safely Limited Acceleration	Safely limited acceleration
SAR	Safe Acceleration Range	Safe acceleration range
SLS	Safely Limited Speed	Safely limited speed
SSR	Safe Speed Range	Safe speed range
SLP	Safely Limited Position	Safely limited position
SLI	Safely Limited Increment	Safely limited increment
SDI	Safe Direction	Safe direction
SSM	Safe Speed Monitor	Safe report of the limited speed

Safety functions according to EN 61800-5-2



Complete safe-servo-drive system with EnDat 2.2

Function
The safety strategy of the position measuring system is based on two mutually independent position values and additional error bits produced in the encoder and, e.g. for EnDat 2.2, transmitted over the EnDat 2.2 protocol to the EnDat master. The EnDat master assumes various monitoring functions with which errors in the encoder and during transmission can be revealed. For example, the two position values are compared. The EnDat master then makes the data available to the safe control. The control periodically tests the safety-related position measuring system to monitor its correct operation.

The architecture of the EnDat 2.2 protocol makes it possible to process all safety-relevant information and control mechanisms during unconstrained controller operation. This is possible because the safety-relevant information is saved in the additional information. According to EN 61 508, the architecture of the position measuring system is regarded as a single-channel tested system.

Documentation on the integration of the position measuring system
The intended use of position measuring systems places demands on the control, the machine designer, the installation technician, service, etc. The necessary information is provided in the documentation for the position measuring systems.

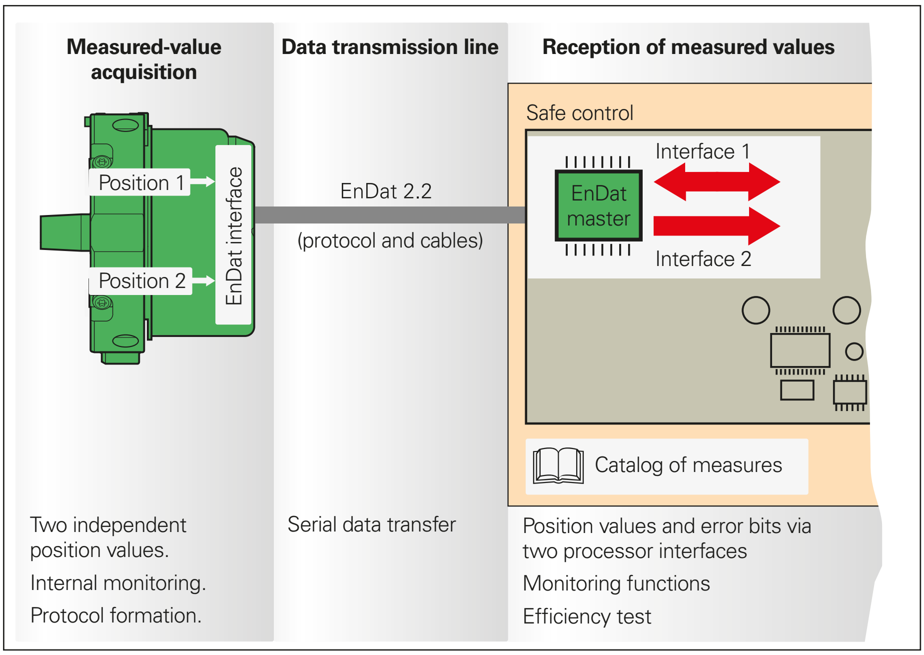
In order to be able to implement a position measuring system in a safety-related application, a suitable control is required. The control assumes the fundamental task of communicating with the encoder and safely evaluating the encoder data.

The requirements for integrating the EnDat master with monitoring functions into the safe control are described in the HEIDENHAIN document 533095. It contains, for example, specifications on the evaluation and processing of position values and error bits, and on electrical connection and cyclic tests of position measuring systems.

Document 1000344 describes additional measures that make it possible to use suitable encoders for applications up to SIL 3, PL "e", category 4.

Machine and plant manufacturers need not attend to these details. These functions must be provided by the control. Product information sheets, catalogs and mounting instructions provide information to aid the selection of a suitable encoder. The **product information sheets** and **catalogs** contain general data on function and application of the encoders as well as specifications and permissible ambient conditions. The **mounting instructions** provide detailed information on installing the encoders.

The architecture of the safety system and the diagnostic possibilities of the control may call for further requirements. **For example, the operating instructions of the control must explicitly state whether fault exclusion is required for the loosening of the mechanical connection between the encoder and the drive.** The machine designer is obliged to inform the installation technician and service technicians, for example, of the resulting requirements.



Safety-related position encoder with EnDat 2.2

Functional Safety

For more information on the topic of functional safety, refer to the technical information documents *Safety-Related Position Measuring Systems* and *Safety-Related Control Technology* as well as the product information document of the functional safety encoders.

Measuring principles
Measuring standard

HEIDENHAIN encoders with optical scanning incorporate measuring standards of periodic structures known as graduations. These graduations are applied to a carrier substrate of glass or steel. The scale substrate for large diameters is a steel tape.

HEIDENHAIN manufactures the precision graduations in specially developed, photolithographic processes.
- AURODUR: matte-etched lines on gold-plated steel tape with typical graduation period of 40 µm
- METALLUR: contamination-tolerant graduation of metal lines on gold, with typical graduation period of 20 µm
- DIADUR: extremely robust chromium lines on glass (typical graduation period of 20 µm) or three-dimensional chromium structures (typical graduation period of 8 µm) on glass
- SUPRADUR phase grating: optically three dimensional, planar structure; particularly tolerant to contamination; typical graduation period of 8 µm and finer
- OPTODUR phase grating: optically three dimensional, planar structure with particularly high reflectance, typical graduation period of 2 µm and less

Magnetic encoders use a graduation carrier of magnetizable steel alloy. A graduation consisting of north poles and south poles is formed with a grating period of 400 µm. Due to the short distance of effect of electromagnetic interaction, and the very narrow scanning gaps required, finer magnetic graduations are not practical.

Encoders using the inductive scanning principle work with graduation structures of copper and nickel. The graduation is applied to a carrier material for printed circuits.

With the **absolute measuring method,** the position value is available from the encoder immediately upon switch-on and can be called at any time by the subsequent electronics. There is no need to move the axes to find the reference position. The absolute position information is read from the **grating on the circular scale,** which is designed as a serial code structure or consists of several parallel graduation tracks.

A separate incremental track or the track with the finest grating period is interpolated for the position value and at the same time is used to generate an optional incremental signal.

Singleturn rotary encoders repeat the absolute position information with each revolution. **Multiturn encoders** can also distinguish between revolutions.

Circular graduations of absolute rotary encoders

With the **incremental measuring method,** the graduation consists of a periodic grating structure. The position information is obtained **by counting** the individual increments (measuring steps) from some point of origin. Since an absolute reference is required to ascertain positions, the circular scales are provided with an additional track that bears a **reference mark.**

The absolute position established by the reference mark is gated with exactly one measuring step.

The reference mark must therefore be scanned to establish an absolute reference or to find the last selected datum.

Circular graduations of incremental rotary encoders

Scanning methods

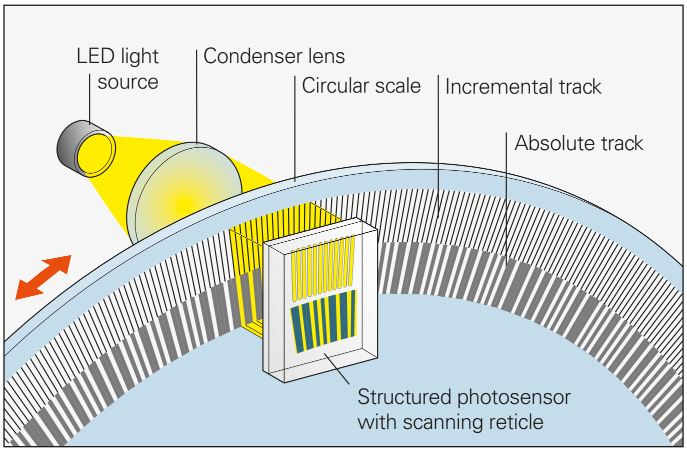
Photoelectric scanning principle
Most HEIDENHAIN encoders operate using the principle of photoelectric scanning. Photoelectric scanning of a measuring standard is contact-free, and as such, free of wear. This method detects even very fine lines, no more than a few micrometers wide, and generates output signals with very small signal periods.

The ERN/ECN/EQN/ERO and ROD/RCN/RQN rotary encoders use the imaging scanning principle.

Put simply, the imaging scanning principle functions by means of projected-light signal generation: two graduations with equal or similar grating periods are moved relative to each other—the scale and the scanning reticle. The carrier material of the scanning reticle is transparent, whereas the graduation on the measuring standard may be applied to a transparent or reflective surface.

When parallel light passes through a grating, light and dark surfaces are projected at a certain distance. An index grating with the same or similar grating period is located here. When the two graduations move in relation to each other, the incident light is modulated: if the gaps are aligned, light passes through. If the lines of one grating coincide with the gaps of the other, no light passes through. A structured photosensor or photovoltaic cells convert these variations in light intensity into nearly sinusoidal electrical signals. Practical mounting tolerances for encoders with the imaging scanning principle are achieved with grating periods of 10 µm and larger.

The ECN and EQN absolute rotary encoders with optimized scanning have a single large photosensor instead of a group of individual photoelements. Its structures have the same width as that of the measuring standard. This makes it possible to do without the scanning reticle with matching structure.



Photoelectric scanning according to the imaging scanning principle

Other scanning principles
Some encoders function according to other scanning methods. ERM encoders use a permanently magnetized MAGNODUR graduation that is scanned with magnetoresistive sensors.

ECI/EQI/EBI and RIC/RIQ rotary encoders operate according to the inductive measuring principle. Here, moving graduation structures modulate a high-frequency signal in its amplitude and phase. The position value is always formed by sampling the signals of all receiver coils distributed evenly around the circumference. This permits large installation tolerances at high resolution.

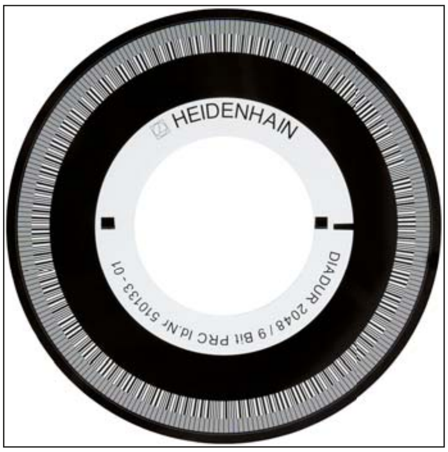
Electronic commutation with position encoders

Commutation in permanent-magnet three-phase motors
Before a permanent-magnet three-phase AC drive starts, the rotor position must be available as an absolute value for electronic commutation. HEIDENHAIN rotary encoders are available with different types of rotor position recognition:

- **Absolute rotary encoders** in singleturn and multiturn versions provide the absolute position information immediately after switch-on. This makes it immediately possible to derive the exact position of the rotor and use it for electronic commutation.
- **Incremental rotary encoders with** a second track—the **Z1 track**—provide one sine and one cosine signal (C and D) for each motor shaft revolution in addition to the incremental signals. For sine commutation, rotary encoders with a Z1 track need only a subdivision unit and a signal multiplexer to provide both the absolute rotor position from the Z1 track with an accuracy of ±5° and the position information for speed and position control from the incremental track (see also *Interfaces—Commutation signals*).
- **Incremental rotary encoders with block commutation tracks** also output three commutation signals U, V and W, which are used to drive the power electronics directly. These encoders are available with various commutation tracks. Typical versions have three signal periods (120° mech.) or four signal periods (90° mech.) per commutation signal and revolution. Independently of these signals, the incremental square-wave signals serve for position and speed control (see also *Interfaces – commutation signals*).

Commutation of synchronous linear motors
Like absolute rotary and angular encoders, absolute linear encoders of the LIC and LC series provide the exact position of the moving motor part immediately after switch-on. This makes it possible to start with maximum holding load on vertical axes even at a standstill.

Keep in mind the switch-on behavior of the encoders (see the *Interfaces of HEIDENHAIN Encoders* brochure, ID 1078628-xx).



Circular scale with serial code track and incremental track

Circular scale with Z1 track

Circular scale with block commutation tracks

Measuring accuracy

The quantities influencing the accuracy of **linear encoders** are listed in the *Linear Encoders For Numerically Controlled Machine Tools* and *Exposed Linear Encoders* catalogs.

The **accuracy of angular measurement** is mainly determined by
- the quality of the graduation,
- the quality of the scanning process,
- the quality of the signal processing electronics,
- the eccentricity of the graduation to the bearing,
- the error of the bearing,
- the coupling to the measured shaft, and
- the elasticity of the stator coupling (ERN, ECN, EQN) or shaft coupling (ROD, ROC, ROQ, RIC, RIQ)

These factors of influence are comprised of encoder-specific error and application-dependent issues. All individual factors of influence must be considered in order to assess the attainable **overall accuracy.**

Error specific to the measuring device

The error that is specific to the measuring device is shown for rotary encoders in the specifications as the **system accuracy**.

The extreme values of the total deviations of a position are—referenced to their mean value—within the system accuracy ±a.

The system accuracy reflects position errors within one revolution as well as those within one signal period and—for rotary encoders with stator coupling—the errors of the shaft coupling.

Position error within one signal period
Position errors within one signal period are considered separately, since they already have an effect even in very small angular motions and in repeated measurements. They especially lead to speed ripples in the speed control loop.

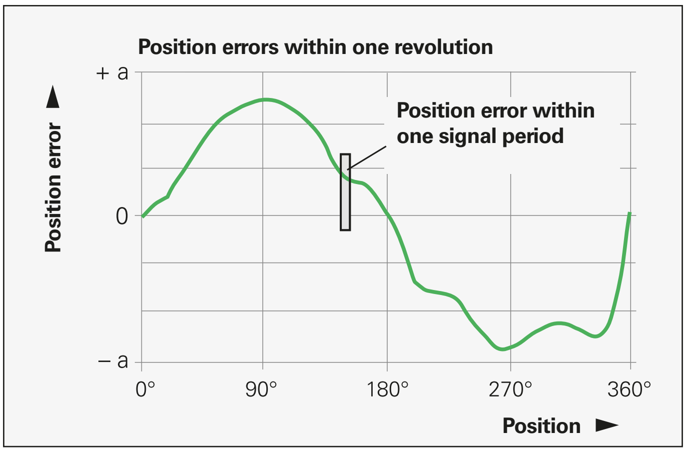
The position error within one signal period ±u results from the quality of the scanning and—for encoders with integrated pulse-shaping or counter electronics—the quality of the signal-processing electronics. For encoders with sinusoidal output signals, however, the errors of the signal processing electronics are determined by the subsequent electronics.

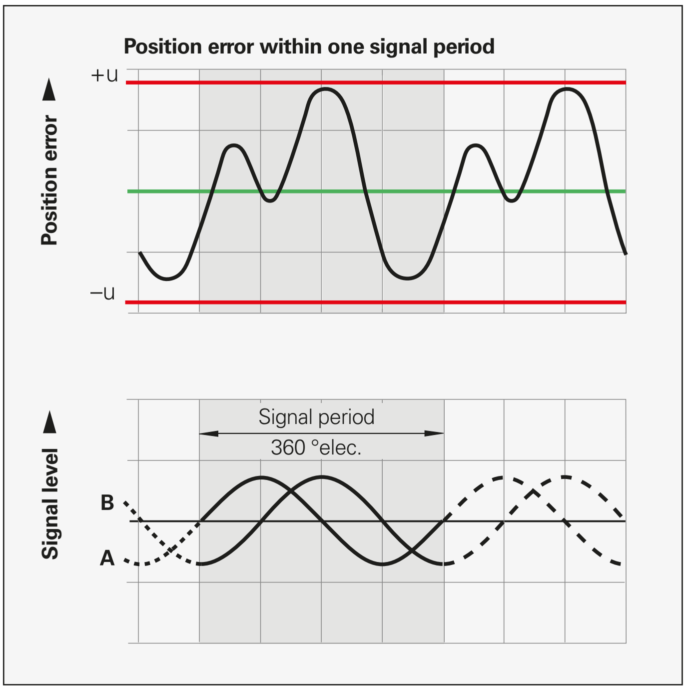
The following individual factors influence the result:
- The size of the signal period
- The homogeneity and period definition of the graduation
- The quality of scanning filter structures
- The characteristics of the sensors
- The stability and dynamics of further processing of the analog signals

These errors are considered when specifying the position error within one signal period. For rotary encoders with integral bearing and sinusoidal output signals it is better than ±1 % of the signal period or better than ±3 % for encoders with square-wave output signals. These signals are suitable for up to 100-fold PLL subdivision.

The position error within one signal period ± u is indicated in the specifications of the rotary encoders.

As the result of increased reproducibility of a position, much smaller measuring steps are still useful.





Application-dependent error

For **rotary encoders with integral bearing**, the specified system accuracy already includes the error of the bearing. For angle encoders with separate **shaft coupling** (ROD, ROC, ROQ, RIC, RIQ), the angle error of the coupling must be added (see *Mechanical design types and mounting*). For angle encoders with **stator coupling** (ERN, ECN, EQN), the system accuracy already includes the error of the shaft coupling.

In contrast, for **encoders without integral bearing**, the mounting, as well as the adjustment of the scanning head, has a decisive influence on the attainable overall accuracy. Of particular importance are the mounting eccentricity of the graduation and the radial runout of the measured shaft. The application-dependent error values for these encoders must be measured and considered individually in order to evaluate the **overall accuracy.**

Rotary encoders with photoelectric scanning

In addition to the system accuracy, the mounting and adjustment of the scanning head normally have a significant effect on the accuracy that can be achieved by rotary encoders without integral bearings with photoelectric scanning. Of particular importance are the mounting eccentricity of the graduation and the radial runout of the measured shaft.

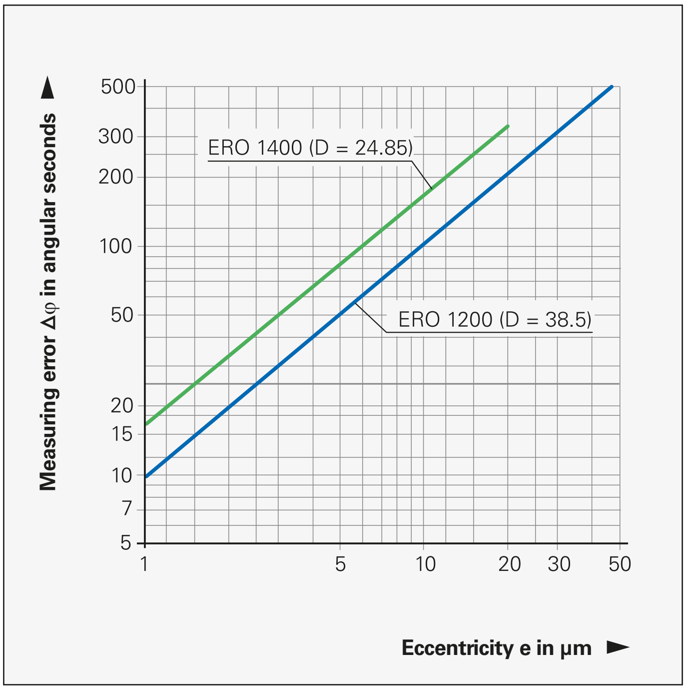
Example
ERO 1420 rotary encoder with a mean graduation diameter of 24.85 mm:
A radial runout of the measured shaft of 0.02 mm results in a position error within one revolution of ± 330 angular seconds.

To evaluate the **accuracy of modular rotary encoders without integral bearing** (ERO), each of the significant errors must be considered individually.

1. Directional deviations of the graduation
ERO: The extreme values of the directional deviation with respect to their mean value are shown in the *Specifications* as the graduation accuracy for each model. The graduation accuracy and the position error within a signal period comprise the system accuracy.

2. Errors due to eccentricity of the graduation to the bearing
Under normal circumstances, the bearing will have a certain amount of radial deviation or geometric error after the disk/hub assembly is mounted. When centering using the centering collar of the hub, please note that, for the encoders listed in this catalog, HEIDENHAIN guarantees an eccentricity of the graduation to the centering collar of under 5 µm. For the modular rotary encoders, this accuracy value presupposes a diameter deviation of zero between the drive shaft and the "master shaft."

If the centering collar is centered on the bearing, then in a worst-case situation both eccentricity vectors could be added together.



Resultant measurement error Δφ for various eccentricity values e as a function of graduation diameter D

The following relationship exists between the eccentricity e, the mean graduation diameter D and the measuring error Δφ (see illustration below):

$$\Delta\varphi = \pm 412 \cdot \frac{e}{D}$$

Δφ = Measurement error in ″ (angular seconds)
e = Eccentricity of the radial grating to the bearing in µm
D = Mean graduation diameter in mm

Model	Mean graduation diameter D	Error per 1 µm of eccentricity
ERO 1420 **ERO 1470** **ERO 1480**	D = 24.85 mm	±16.5″
ERO 1225 **ERO 1285**	D = 38.5 mm	±10.7″

3. Error due to radial runout of the bearing
The equation for the measuring error Δφ is also valid for radial error of the bearing if the value e is replaced with the eccentricity value, i.e. half of the radial error (half of the displayed value).
Bearing compliance to radial shaft loading causes similar errors.

4. Position error within one signal period $\Delta\varphi_u$
The scanning units of all HEIDENHAIN encoders are adjusted so that without any further electrical adjustment being necessary while mounting, the maximum position error values within one signal period will not exceed the values listed below.

Model	Line count	Position error within one signal period $\Delta\varphi_u$	
		TTL	1 V_{PP}
ERO	2048 1500 1024 1000 512	≤ ±19.0″ ≤ ±26.0″ ≤ ±38.0″ ≤ ±40.0″ ≤ ±76.0″	≤ ± 6.5″ ≤ ± 8.7″ ≤ ±13.0″ ≤ ±14.0″ ≤ ±25.0″

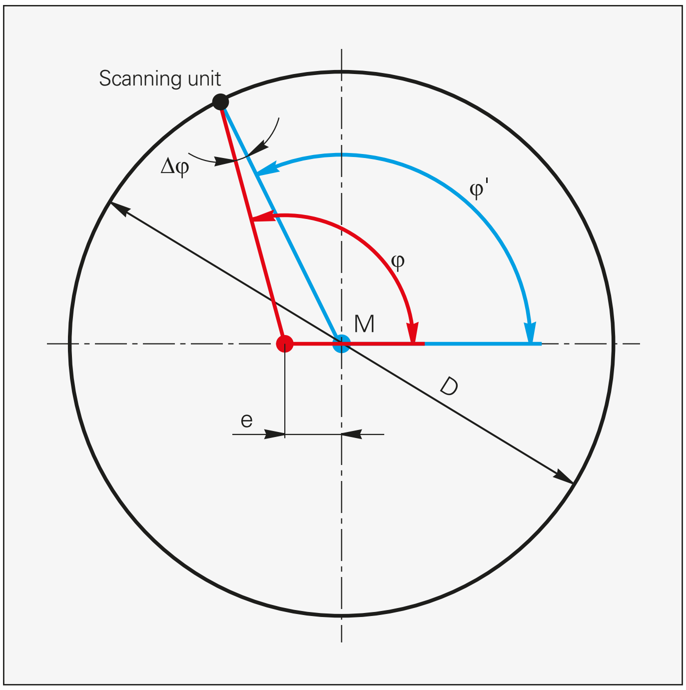
The values for the position errors within one signal period are already included in the system accuracy. Larger errors can occur if the mounting tolerances are exceeded.

Rotary encoders with inductive scanning

As with all rotary encoders without integral bearing, the attainable accuracy for those with inductive scanning depends on the mounting and application conditions. The system accuracy is given for 20 °C and low speed. The exploitation of all permissible tolerances for operating temperature, shaft speed, supply voltage, scanning gap and mounting are to be calculated for the typical total error.

Thanks to the circumferential scanning of the inductive rotary encoders, the total error is less than for rotary encoders without integral bearing but with optical scanning. Because the total error cannot be calculated through a simple calculation rule, the values are provided in the following table.

Model	System accuracy	Total deviation
ECI 1100 **EBI 1100** **EQI 1100** **EnDat22**	±120″	±280″
ECI 1300 **EQI 1300** **EnDat22**	±65″	±120″
ECI 1300 **EQI 1300** **EnDat01**	±180″	±280″
ECI 100 **EBI 100**	±90″	±180″



Measuring error Δφ as a function of the mean graduation diameter D and the eccentricity e

M Center of graduation
φ "True" angle
φ' Scanned angle

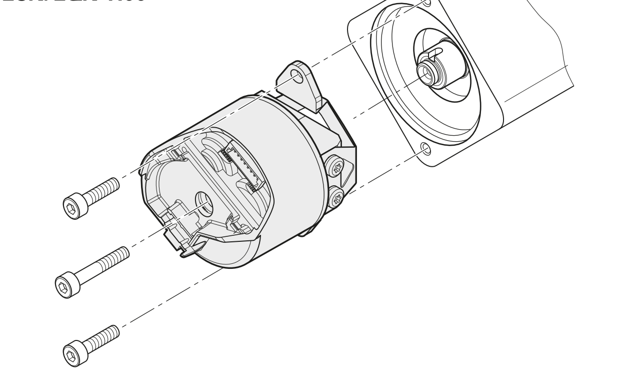
Mechanical design types and mounting
Rotary encoders with integral bearing and stator coupling

ECN/EQN/ERN rotary encoders have integrated bearings and a mounted stator coupling. The encoder shaft is directly connected with the shaft to be measured. During angular acceleration of the shaft, the stator coupling must absorb only that torque resulting from friction in the bearing. ECN/EQN/ERN rotary encoders therefore provide excellent dynamic performance and a high natural frequency.

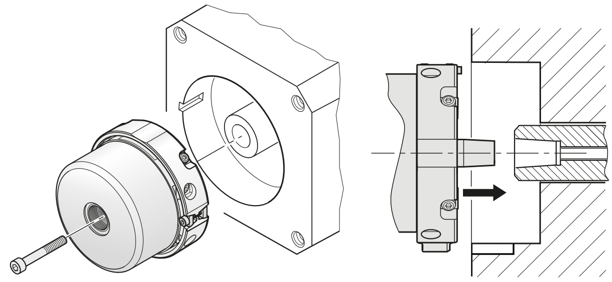
Benefits of the stator coupling:
- No axial mounting tolerances between shaft and stator housing for ExN 1300
- High natural frequency of the coupling
- High torsional rigidity of shaft coupling
- Low mounting or installation space requirement
- Simple axial mounting

Mounting the ECN/EQN 1100 and ECN/EQN/ERN 1300
The blind hollow shaft or the taper shaft of the encoder is connected at its end through a central screw with the measured shaft. The encoder is centered on the motor shaft by the hollow shaft or taper shaft. The stator of the ECN/EQN 1100 is connected without a centering collar to a flat surface with two clamping screws. The stator of the ECN/EQN/ERN 1300 is screwed into a mating hole by an axially tightened screw.

ECN/EQN 1100



ECN/EQN/ERN 1300



Mounting accessories

ECN 1100: mounting aid
For disengaging the PCB connector, see page 42

ECN/EQN/ECI/EQI 1100: mounting aid
For turning the encoder shaft from the rear so that the positive-locking connection between the encoder and measured shaft can be found easily.
ID 821017-03

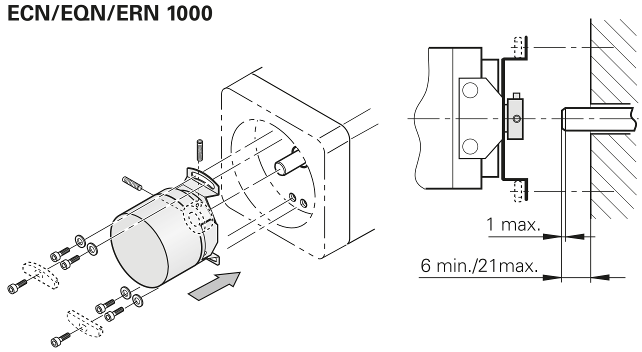
ERN/ECN/EQN 1300: inspection tool
For inspecting the shaft connection (fault exclusion for rotor coupling)
ID 680644-01

HEIDENHAIN recommends inspecting the holding torque of non-positive shaft connections (e.g. tapered shafts, blind hollow shafts).

The inspection tool is screwed into the M10 back-off thread on the rear of the encoder. Due to the low screwing depth it does not touch the shaft-fastening screw. When the motor shaft is locked, the testing torque is applied to the extension by a torque wrench (hexagonal, 6.3 mm width across flats). After any nonrecurring settling, there must not be any relative motion between the motor shaft and encoder shaft.

Mounting the ECN/EQN/ERN 1000 and ERN 1x23
The rotary encoder is slid by its hollow shaft onto the measured shaft and fastened by two screws. The stator is mounted without a centering flange to a flat surface with four cap screws or with two cap screws and special washers.
The ECN/EQN/ERN 1000 encoders feature a blind hollow shaft; the ERN 1123 features a hollow through shaft.

ECN/EQN/ERN 1000

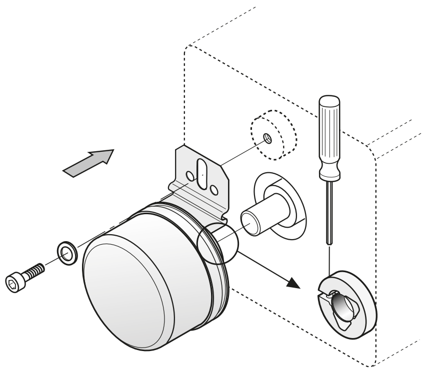


Accessory for ECN/EQN/ERN 1000

Washer
For increasing the natural frequency f_N when mounting with only two screws.
ID 334653-01 (2 pieces)

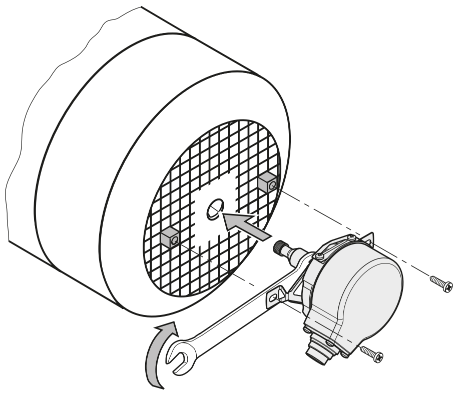
Mounting the EQN/ERN 400
The EQN/ERN 400 encoders are designed for use on Siemens asynchronous motors. They serve as replacement for existing Siemens rotary encoders.

The rotary encoder is slid by its hollow shaft onto the measured shaft and fastened by the clamping ring. On the stator side, the encoder is fixed by its torque support to a plane surface.



Mounting the EQN/ERN 401
The ERN 401 encoders are designed for use on Siemens asynchronous motors. They serve as replacement for existing Siemens rotary encoders.

The rotary encoder features a solid shaft with an M8 external thread, centering taper and SW8 width across flats. It centers itself during fastening to the motor shaft. The stator coupling is fastened by special clips to the motor's ventilation grille.



Rotary encoders without integral bearing – ECI/EBI/EQI

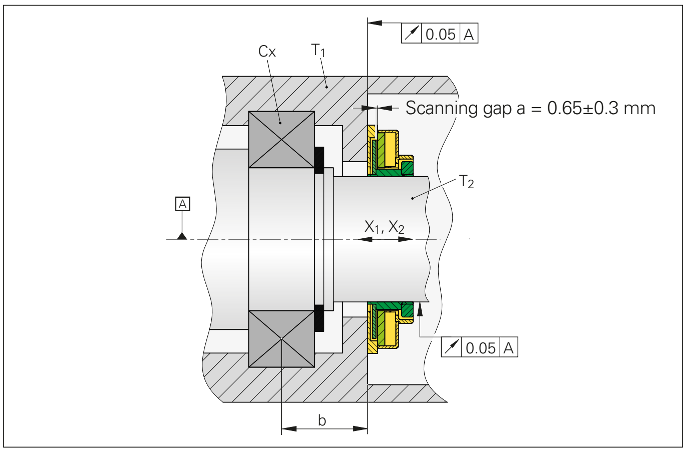
The **ECI/EBI/EQI** inductive encoders have no integral bearings. This means that mounting and operating conditions influence the functional reserves of the encoder. It is essential to ensure that the specified mating dimensions and tolerances (see Mounting Instructions) are maintained in all operating conditions.

The application analysis must result in values within specification for all possible operating conditions (particularly under maximum load and at minimum and maximum operating temperature) and under consideration of the signal amplitude (inspection of scanning gap and mounting tolerance at room temperature). This applies particularly for the measured

- maximum radial runout of the motor shaft
- maximum axial runout of the motor shaft with respect to the mounting surface
- maximum and minimum scanning gap (a), also in combination with e.g.:
  - the length relation between motor shaft and motor housing under the influence of temperature (T_1; T_2; α1; α2) depending on the position of the fixed bearing (b)
  - the bearing play (C_X)
  - nondynamic shaft offsets due to load (X_1)
  - the effect of engaging motor brakes (X_2)

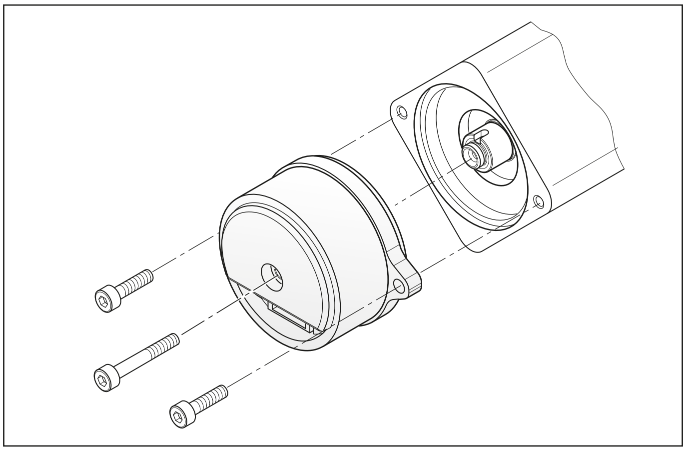
The **ECI/EBI 100** rotary encoders are prealigned on a flat surface and then the locked hollow shaft is slid onto the measured shaft. The encoder is fastened and the shaft clamped by axial screws.

The **ECI/EBI/EQI 1100** inductive rotary encoders are mounted as far as possible in axial direction. The blind hollow shaft is attached with a central screw. The stator of the encoder is clamped against a shoulder by two axial screws.



Schematic representation of **ECI/EBI 100**

Mounting the **ECI 119**



Mounting the **ECI/EQI 1100**

Mounting accessory
Mounting aid for removing the PCB connector, see page 42.

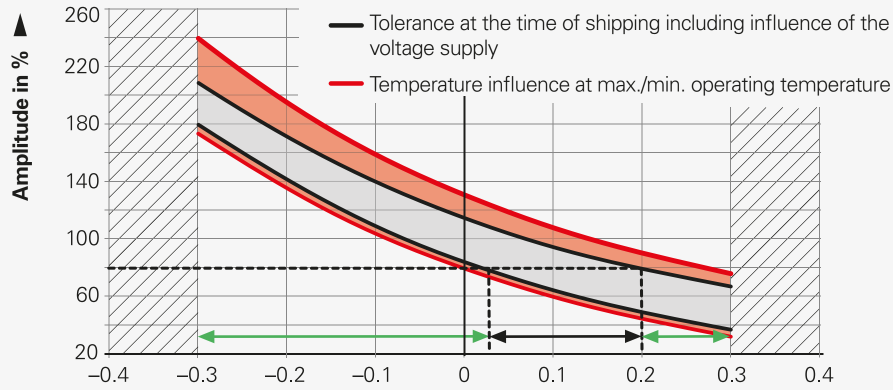
Permissible scanning gap

The scanning gap between the rotor and stator is predetermined by the mounting situation. Later adjustment is possible only by inserting shim rings.

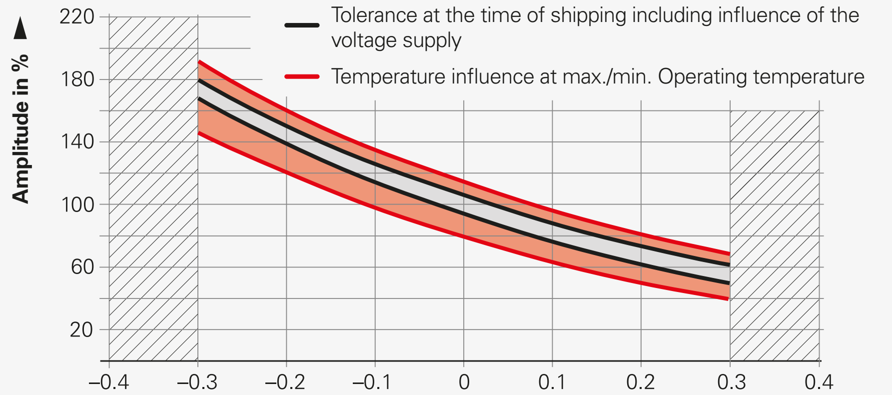
The maximum permitted deviation indicated in the mating dimensions applies to mounting as well as to operation. Tolerances used during mounting are therefore not available for axial motion of the shaft during operation.

Once the encoder has been mounted, the actual scanning gap between the rotor and stator can be measured indirectly via the signal amplitude in the rotary encoder, using the PWM 20 adjusting and testing package. The characteristic curves show the correlation between the signal amplitude and the deviation from the ideal scanning gap, depending on various ambient conditions.

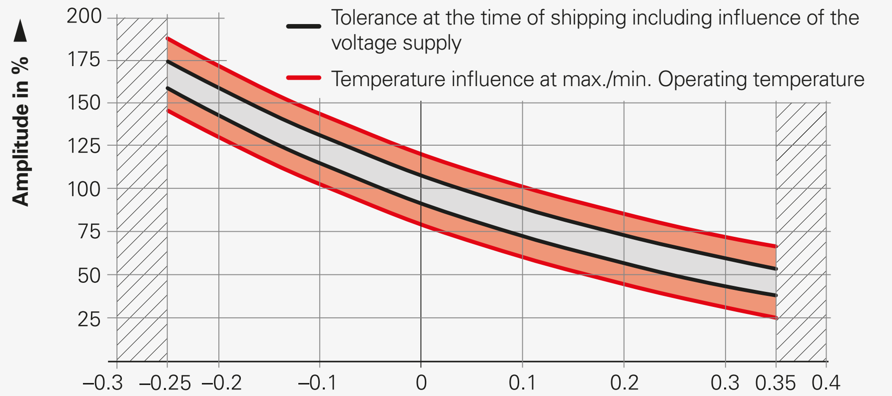
The example for the ECI/EBI 1100 shows the resulting deviation from the ideal scanning gap for a signal amplitude of 80 % at ideal conditions. Due to tolerances within the rotary encoder, the deviation is between +0.03 mm and +0.2 mm. This means that the maximum permissible motion of the drive shaft during operation is between –0.33 mm and +0.1 mm (green arrows).



ECI/EBI 1100 with EnDat 2.2

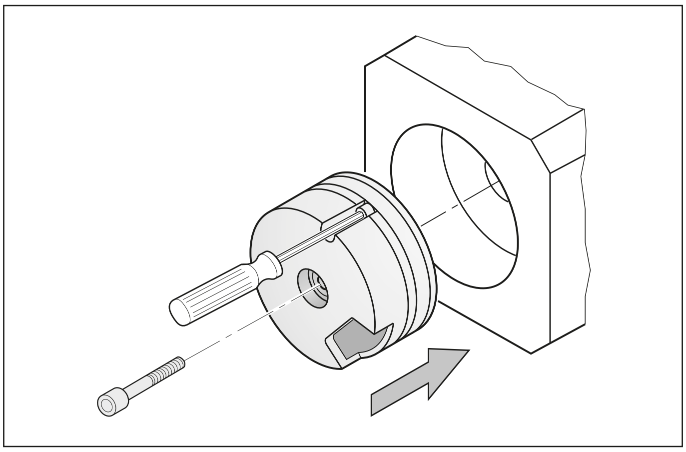


ECI/EBI 100



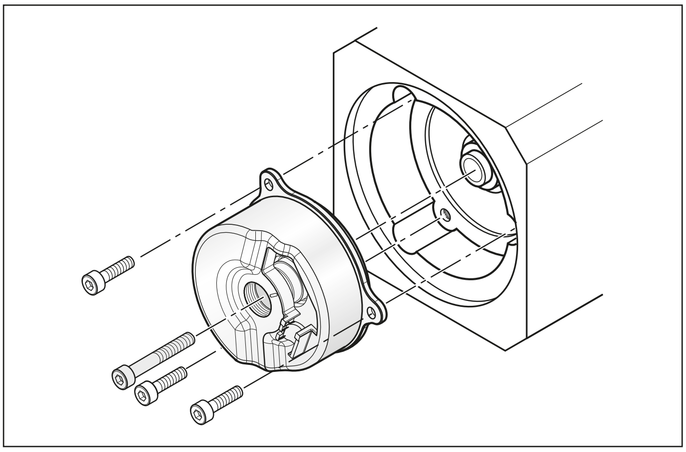
ECI/EQI 1300

The **ECI/EQI 1300** inductive rotary encoders with EnDat01 are mechanically compatible with the ExN 1300 photoelectric encoders. The taper shaft (a bottomed hollow shaft is available as an alternative) is fastened with a central screw. The stator of the encoder is clamped by an axially tightened bolt in the location hole. The scanning gap between rotor and stator must be set during mounting.



Mounting the
ECI/EQI 1300 EnDat01

The **ECI/EQI 1300** inductive rotary encoders with EnDat22 are mounted as far as possible in axial direction. The blind hollow shaft is attached with a central screw. The stator of the encoder is clamped against a shoulder by three axial screws.



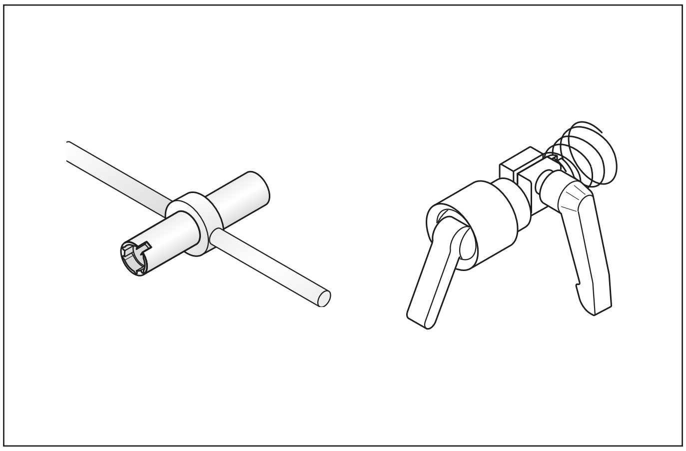
Mounting the
ECI/EQI 1300 EnDat22

Mounting accessories for ECI/EQI 1300
EnDat01

Adjustment aid for setting the gap
ID 335529-xx

Mounting aid for adjusting the rotor position to the motor EMF
ID 352481-02

Accessory for ECI/EQI
For inspecting the scanning gap and adjusting the ECI/EQI 1300



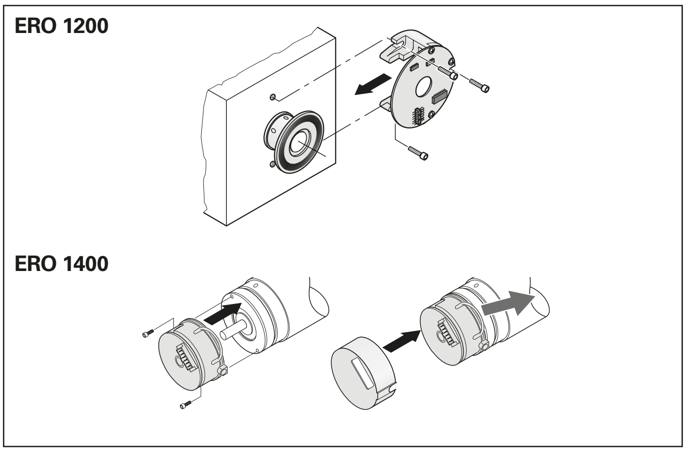
Mounting and adjusting aid for **ECI/EQI 1300** EnDat01

Mounting accessory
Mounting aid for removing the PCB connector, see page 42.

Rotary encoders without integral bearing – ERO

The **ERO** rotary encoders without integral bearing consist of a scanning head and a graduated disk, which must be adjusted to each other very exactly. A precise adjustment is an important factor for the attainable measuring accuracy.

The **ERO** modular rotary encoders consist of a graduated disk with hub and a scanning unit. They are particularly well suited for applications with limited installation space and negligible axial and radial runout, or for applications where friction of any type must be avoided.



Mounting the **ERO**

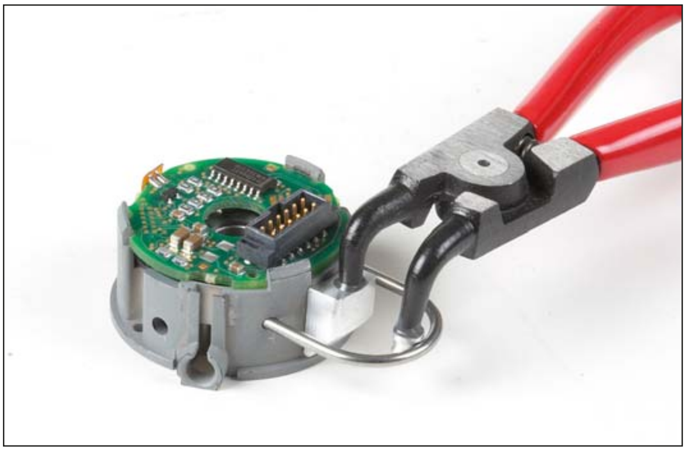
In the **ERO 1200** series, the disk/hub assembly is slid onto the shaft and adjusted to the scanning unit. The scanning unit is aligned on a centering collar and fastened on the mounting surface.

The **ERO 1400** series consists of miniature modular encoders. These rotary encoders have a special built-in **mounting aid** that centers the graduated disk to the scanning unit and adjusts the gap between the disk and the scanning reticle. This makes it possible to install the encoder in a very short time. The encoder is supplied with a cover cap for protection from extraneous light.

Mounting accessory for ERO 1400

Mounting accessory
Aid for removing the clip for optimal encoder mounting.
ID 510175-01

Accessory
Housing for ERO 14xx with axial PCB connector and central hole.
ID 331727-23



Mounting accessory for **ERO 1400**

Information on encoder cables

Mounting and initial operation is permissible only with appropriate ESD protection. Do not engage or disengage any connections while under power. To avoid overstressing the individual wires when disengaging a connector, HEIDENHAIN recommends using the mounting aid to pull the PCB connector.

Accessory
Mounting aid for disengaging the PCB connector. Suitable for all rotary encoders in this brochure, except for the ERO 1200 series.
ID 1075573-01

To avoid damage to the cable, the pulling force must be applied only to the connector, and not to the wires. For other encoders, use tweezers or the mounting aid if necessary.

Mounting aid for PCB connector

Screws
For encoder cables with standard M12 or M23 flange sockets, M2.5 screws are to be used.

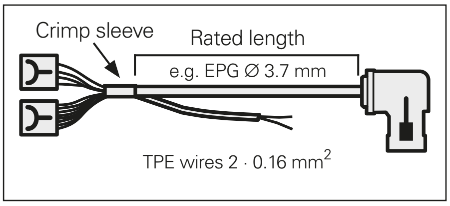
The M2.5 screws are to be fastened with the following torques:

For M12	M_d min.	0.3 Nm
	M_d max.	0.65 Nm
For M23	M_d min.	0.55 Nm
	M_d max.	0.65 Nm

Minimum tensile strength of screws 800 N/mm^2

To prevent the screws from spontaneously loosening, HEIDENHAIN recommends using a materially bonding threadlocker.

Cable length (rated length)
For encoder cables with crimping on the encoder side for strain relief and shield contact, the cable length up to the crimp sleeve is indicated.



For standard encoder cables, the rated wire length for temperature sensors is the same as the rated cable length. Exceptions include encoder cables without crimping on the encoder side or with shield connection clamp. You can receive authorized information (dimension drawing) on request by providing the proper encoder cable ID number (see overview of encoder cables).

Crimp connector
For crimping the wires of the encoder cable for the temperature sensor with the wires of the temperature sensor in the motor.
ID 1148157-01

You will find information on the appropriate crimping tools in the Product Information document for the *HMC 6*.

Strain relief
Avoid torque or strain loading by the mating connector or the encoder cable. Use strain relief if required.

General testing accessories for modular encoders and PWM 20

Testing cable for modular rotary encoders with EnDat22, EnDat01 and SSI interface
Includes three 12-pin adapter connectors and three 15-pin adapter connectors
ID 621742-01

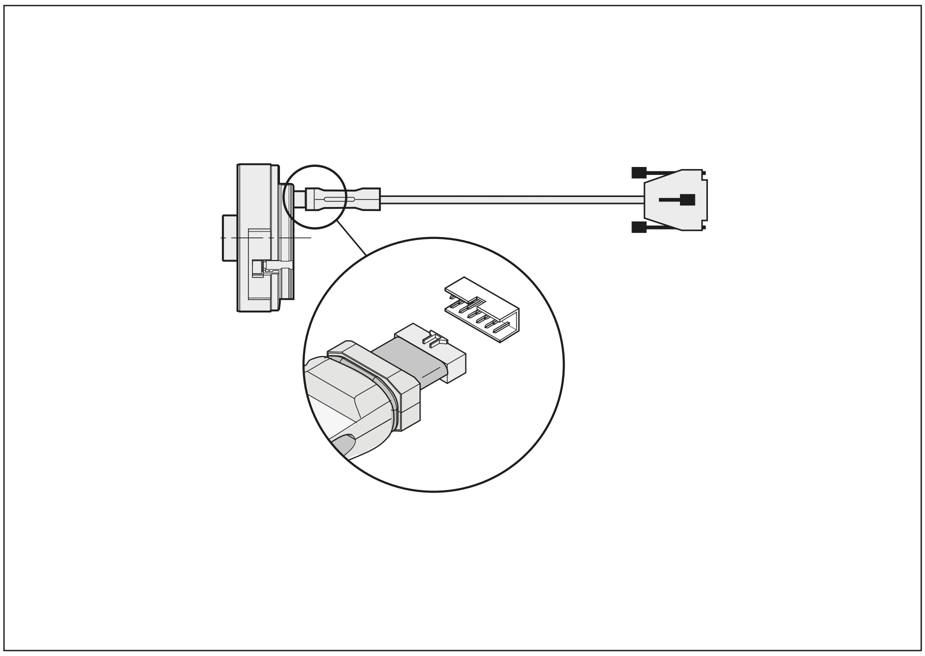
Adapter connectors
Three connectors for replacement
12-pin: ID 528694-01
15-pin: ID 528694-02

Connecting cables
For extending the testing cable.
Complete with D-sub connector (male) and D-sub connector (female), both 15-pin (max. 3 m)
ID 675582-xx

Testing cable for ERN 138xx with commutation signals for sinusoidal commutation
Includes three 14-pin adapter connectors
ID 1118892-02

Adapter connectors
Three connectors for replacement
14-pin: ID 528694-04

Connecting cables
For extending the testing cable.
Complete with D-sub connector (male) and D-sub connector (female), both 15-pin (max. 3 m)
ID 675582-xx



Testing cable

Adapter cable for connecting the flange socket with the motor with the PWM 20

EnDat22 interface
Adapter cable Ø 6 mm
M23 connector (female), 9-pin
M12 coupling (male), 8-pin
ID 745796-xx
(In addition, ID 524599-xx M12 (female) to D-sub connector (male), 15-pin needed

Adapter cable Ø 6 mm
M12 connector (female), 8-pin
D-sub connector (male), 15-pin
ID 524599-xx

DRIVE-CLiQ interface
Adapter cable Ø 6.8 mm
M23 connector (female), 9-pin
Ethernet connector (RJ45) with IP20 metal housing, 6-pin
ID 1117540-xx

Adapter cable Ø 6.8 mm
M12 connector (female), 8-pin
Ethernet connector (RJ45) with IP20 metal housing, 6-pin
ID 1093042-xx

EnDat01, EnDat H, EnDat T or SSI interface with incremental signals
Adapter cable Ø 8 mm
M23 connector (female), 17-pin
D-sub connector (male), 15-pin
ID 324544-xx

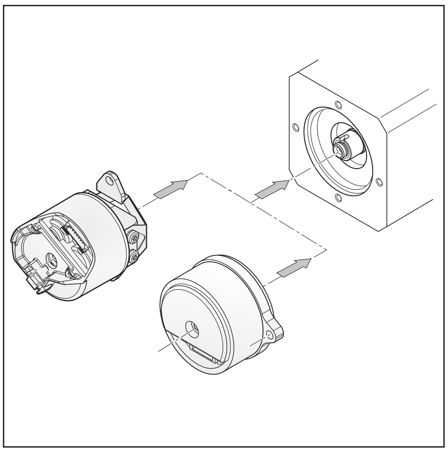
Adapter cable Ø 8 mm
M23 connector (female), 12-pin
D-sub connector (male), 15-pin
ID 310196-xx

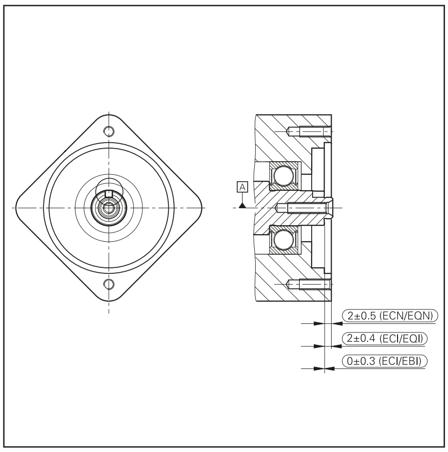
Version for HMC 6
Adapter cable Ø 13.6 mm
M23 SpeedTEC hybrid connector (female), five power wires, two brake wires, six communication wires
D-sub connector (male), 15-pin
ID 1077866-xx

Mating dimensions in common

Mating dimensions and tolerances must be taken into account when mounting rotary encoders. The mating dimensions of some rotary encoders of a series may differ only slightly or may even be identical. As a result, certain rotary encoders are compatible in their mounting dimensions, and can thus be mounted to identical dimensions, depending on the respective requirements.

All dimensions, tolerances, and required mating dimensions are indicated on the dimension drawing of the respective series. Other values for rotary encoders with functional safety (FS) are provided in the corresponding product information documents.

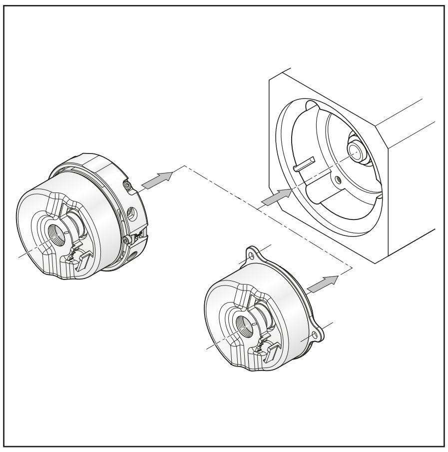




All absolute rotary encoders of the 1100 series are mounting-compatible within the series. There are only slight differences in the respectively permissible deviation between the shaft and coupling surfaces.

Series	Differences
ECN/EQN 1100 FS	Standard, with slot for FS devices
ECI/EQI 1100 FS	Same as ECN/EQN 1100 FS, but with other dimension for the deviation between the shaft and coupling surfaces
ECI/EBI 1100	Same as ECN/EQN 1100 FS, but with other dimension for the deviation between the shaft and coupling surfaces

Some rotary encoders of the 1300 and ECN/EQN 400 series are mounting-compatible, and can therefore be mounted on identical seats. Slight differences, such as the anti-rotation element and the limited tolerance band of the inside diameter, must be taken into account.



Series	Common dimensions				
	ERN 1300	ECN/EQN 1300	ECI/EQI 1300	ECI/EQI 1300 FS	ECN/EQN 400
ERN 1300		✔	✔	✔	✔
ECN/EQN 1300				✔	✔
ECI/EQI 1300					✔
ECI/EQI 1300 FS					
ECN/EQN 400		✔		✔	

Series	Differences
ERN 1300	Standard, usable for taper shaft
ECN/EQN 1300	Same as ERN 1300, with additional ridge as anti-rotation element (stator coupling)
ECI/EQI 1300	Same as ERN 1300, with tolerance for the 65 mm inside diameter limited to 0.02 mm, and available as additional variant for hollow shaft
ECI/EQI 1300 FS	Same as ERN 1300, with additional ridge as anti-rotation element (flange)
ECN/EQN 400	Same as ECN/EQN 1300

Mounting accessory

Screwdriver bit

- For HEIDENHAIN shaft couplings
- For ExN shaft clamps and stator couplings
- For ERO shaft clamps

Width across flats	Length	ID
1.5	70 mm	350378-01
1.5 (spherical head)		350378-02
2		350378-03
2 (spherical head)		350378-04
2.5		350378-05
3 (spherical head)		350378-08
4		350378-07
4 (with dog point)[1]		350378-14
	150 mm	756768-44
TX8	89 mm 152 mm	350378-11 350378-12
TX15	70 mm	756768-42

[1] For screws as per DIN 6912 (low head screw with pilot recess)

Screwdriver

When using screwdrivers with adjustable torque, ensure that they comply with DIN EN ISO 6789 and therefore fulfill the required tolerances for torque values.

Adjustable torque, accuracy ±6 %
0.2 Nm to 1.2 Nm ID 350379-04
1 Nm to 5 Nm ID 350379-05

Screws

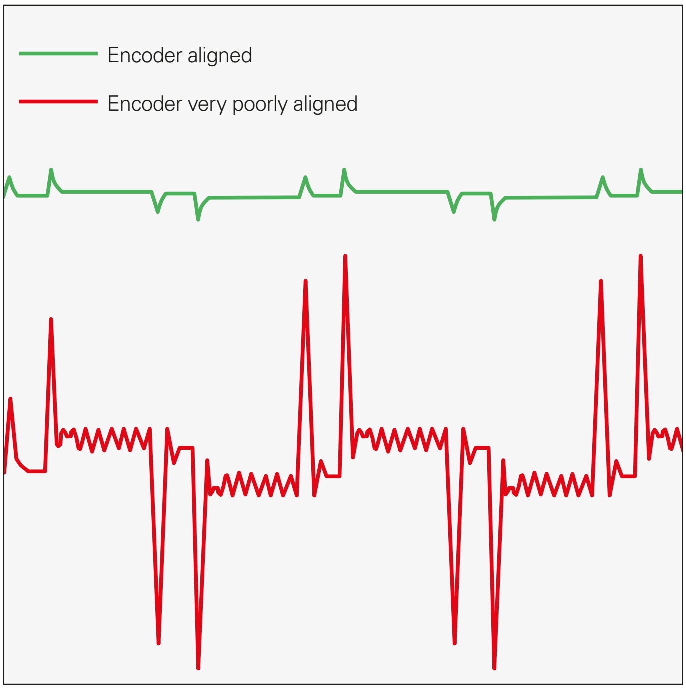
Screw	Securing method	ID
M3x10 A2 ISO 4762 KLF	Self-locking	202264-31
M3x10 A2 ISO 4762 KLF	Materially bonding anti-rotation lock	202264-87
M3x16 A2 ISO 4762 KLF	Self-locking	202264-30
M3x22 A2 ISO 4762 KLF	Self-locking	202264-44
M3x22 8.8 ISO 4762 MKL	Materially bonding anti-rotation lock	202264-65
M3x25 8.8 ISO 4762 MKL	Materially bonding anti-rotation lock	202264-86
M3x35 A2 ISO 4762 KLF	Self-locking	202264-29
M3x35 8.8 ISO 4762 MKL	Materially bonding anti-rotation lock	202264-66
M4x10 8.8 ISO 4762 MKL	Materially bonding anti-rotation lock	202264-85
M5x30 08.8 DIN 6912 MKL	Materially bonding anti-rotation lock	202264-76
M5x50 08.8 DIN 6912 KLF	Self-locking	202264-36
M5x50 08.8 DIN 6912 MKL	Materially bonding anti-rotation lock	202264-54

General information
Aligning the rotary encoders to the motor EMF

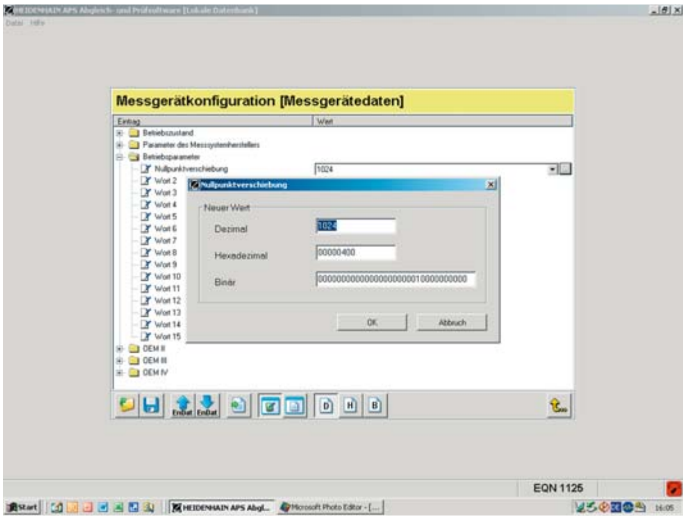
Synchronous motors require information on the rotor position immediately after switch-on. This information can be provided by rotary encoders with additional commutation signals, which provide relatively rough position information. Also suitable are absolute rotary encoders in multiturn and singleturn versions, which transmit the exact position information within a few angular seconds (see also *Electronic commutation with position encoders*). When these encoders are mounted, the rotor positions of the encoder must be assigned to those of the motor in order to ensure the most constant possible motor current. Inadequate assignment to the motor EMF will cause loud motor noises and high power loss.

Rotary encoders with integral bearing
First, the rotor of the motor is brought to a preferred position by the application of a DC current. **Rotary encoders with commutation signals** are aligned approximately—for example with the aid of the line markers on the encoder or the reference mark signal—and mounted on the motor shaft. The fine adjustment is quite easy with a PWM 9 phase angle measuring device (see *HEIDENHAIN measuring and testing devices*): the stator of the encoder is turned until the PWM 9 shows that the distance from the reference mark is about zero. **Absolute rotary encoders** are first mounted as a complete unit. Then the preferred position of the motor is assigned the value zero. The adjusting and testing package (see *HEIDENHAIN measuring and testing devices*) serves this purpose. It features the complete range of EnDat functions and makes it possible to shift datums, set write-protection against unintentional changes to saved values, and use further inspection functions.

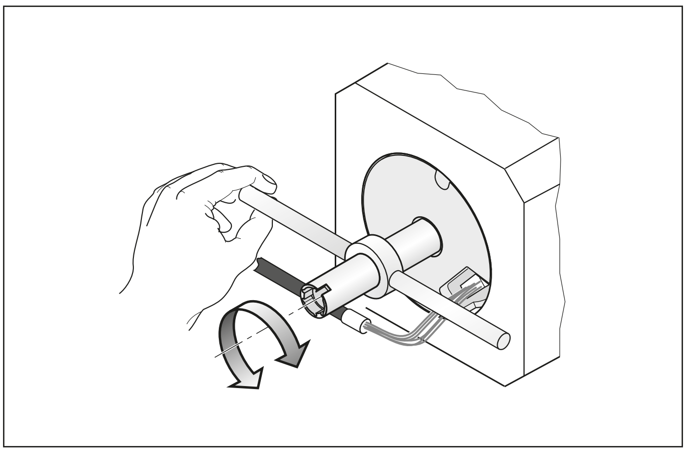
Rotary encoders without integral bearing
ECI/EQI rotary encoders are mounted as complete units and then adjusted with the aid of the adjusting and testing package. For the ECI/EQI with pure serial operation, electronic compensation is also possible: The ascertained compensation value can be saved in the encoder and read out by the control electronics to calculate the position value. ECI/EQI 1300 also permit manual alignment. The central screw is loosened again and the encoder rotor is turned with the mounting aid to the desired position until, for example, an absolute value of approximately zero appears in the position data.



Motor current of a well adjusted and a very poorly adjusted rotary encoder



Aligning a rotary encoder to the motor EMF with the aid of the adjusting and testing software


Manual alignment of the ECI/EQI 1300

General mechanical information

Certified by NRTL (Nationally Recognized Testing Laboratory)
All rotary encoders in this brochure comply with the UL safety regulations for the USA and the CSA safety regulations for Canada.

Acceleration
Encoders are subject to various types of acceleration during operation and mounting.

- **Vibration**
  The encoders are qualified on a test stand to operate with the specified acceleration values at frequencies from 55 Hz to 2000 Hz in accordance with EN 60068-2-6. However, if the application or poor mounting causes long-lasting resonant vibration, it can limit performance or even damage the encoder. **Comprehensive tests of the entire system are therefore required.**
- **Shock**
  The encoders are qualified on a test stand for non-repetitive semi-sinusoidal shock to operate with the specified acceleration values and duration in accordance with EN 60068-2-27. **This does not include continuous shock loads,** which **must be tested in the application.**
- The **maximum angular acceleration** is 10^5 rad/s^2. This is the highest permissible acceleration at which the rotor will rotate without damage to the encoder. The actually attainable angular acceleration lies in the same order of magnitude (for deviating values for ECN/ERN 100 see *Specifications)*, but it depends on the type of shaft connection. A sufficient safety factor is to be determined through system tests.

Other values for rotary encoders with functional safety are provided in the corresponding product information documents.

Humidity
The maximum permissible relative humidity is 75 %. 93 % is permissible temporarily. Condensation is not permissible.

Magnetic fields
Magnetic fields > 30 mT can impair proper function of encoders. If required, please contact HEIDENHAIN in Traunreut, Germany.

RoHS
HEIDENHAIN has tested the products for safety of the materials as per European Directives 2002/95/EC (RoHS) and 2002/96/EC (WEEE). For a Manufacturer's Declaration on RoHS, please refer to your sales agency.

Natural frequencies
The rotor and the couplings of ROC/ROQ/ROD and RIC/RIQ rotary encoders, as also the stator and stator coupling of ECN/EQN/ERN rotary encoders, form a single vibrating spring-mass system.

The **natural frequency of the coupling f_N** should be as high as possible. A prerequisite for the highest possible natural frequency on **ROC/ROQ/ROD/RIC/RIQ rotary encoders** is the use of a diaphragm coupling with a high torsional rigidity C (see *Shaft couplings*).

$$f_N = \frac{1}{2 \cdot \pi} \cdot \sqrt{\frac{C}{I}}$$

f_N: Natural frequency of coupling in Hz
C: Torsional rigidity of the coupling in Nm/rad
I: Moment of inertia of the rotor in kgm2

ECN/EQN/ERN rotary encoders form a vibrating spring-mass system whose **natural frequency of the coupling f_N** should be as high as possible. If radial and/or axial acceleration forces are added, the rigidity of the encoder bearing and the encoder stator is also significant. If such loads occur in your application, HEIDENHAIN recommends consulting with the main facility in Traunreut.

Protection against contact (EN 60529)
After encoder installation, all rotating parts must be protected against accidental contact during operation.

Protection (EN 60529)
The ingress of contamination can impair proper function of the encoder. Unless otherwise indicated, all rotary encoders meet protection standard IP64 (ExN/ROx 400: IP67) according to EN 60 529. This includes housings, cable outlets and flange sockets when the connector is fastened.

The **shaft inlet** provides protection to IP64. Splash water should not contain any substances that would have harmful effects on the encoder's parts. If the protection of the shaft inlet is not sufficient (such as when the encoders are mounted vertically), additional labyrinth seals should be provided. Many encoders are also available with protection to class IP66 for the shaft inlet. The sealing rings used to seal the shaft are subject to wear due to friction, the amount of which depends on the specific application.

Noise emission
Running noise can occur during operation, particularly when encoders with integral bearing or multiturn rotary encoders (with gears) are used. The intensity may vary depending on the mounting situation and the speed.

System tests
Encoders from HEIDENHAIN are usually integrated as components in larger systems. Such applications require **comprehensive tests of the entire system** regardless of the specifications of the encoder.

The specifications shown in this brochure apply to the specific encoder, not to the complete system. Any operation of the encoder outside of the specified range or for any applications other than the intended applications is at the user's own risk.

Mounting
Work steps to be performed and dimensions to be maintained during mounting are specified solely in the mounting instructions supplied with the unit. All data in this catalog regarding mounting are therefore provisional and not binding; they do not become terms of a contract.

All information on screw connections are given with respect to a mounting temperature of 15 °C to 35 °C.

Rotary encoders with functional safety
Mounting screws and central screws from HEIDENHAIN (not included in delivery) feature a coating which, after hardening, provides a materially bonding anti-rotation lock. Therefore the screws cannot be reused. The minimum shelf life is two years (storage at ≤ 30 °C and ≤ 65 % relative humidity). The expiration date is printed on the package.

Screw insertion and application of tightening torque must therefore take no longer than five minutes. The required strength is reached at room temperature after six hours. The curing time increases with decreasing temperature. Hardening temperatures below 5 °C are not permitted.

Screws with materially bonding anti-rotation lock must not be used more than once. In case of replacement, recut the threads and use new screws. A chamfer is required on threaded holes to prevent any scraping off of the adhesive layer.

Changes to the encoder
The correct operation and accuracy of encoders from HEIDENHAIN is ensured only if they have not been modified. Any changes, even minor ones, can impair the operation and reliability of the encoders, and result in a loss of warranty. This also includes the use of additional retaining compounds, lubricants (e.g. for screws) or adhesives not explicitly prescribed. In case of doubt, we recommend contacting HEIDENHAIN in Traunreut.

The following material properties and conditions must be complied with when customers plan and execute installation.

Mating material class	Aluminum	Steel
Material type	Hardenable wrought aluminum alloys	Unalloyed hardened steel
Tensile strength R_m	≥ 220 N/mm^2	≥ 600 N/mm^2
Yield strength $R_{p,0.2}$ or yield point R_e	Not applicable	≥ 400 N/mm^2
Shear strength τ_a	≥ 130 N/mm^2	≥ 390 N/mm^2
Interface pressure p_G	≥ 250 N/mm^2	≥ 660 N/mm^2
Modulus of elasticity E (at 20 °C)	70 kN/mm^2 to 75 kN/mm^2	200 kN/mm^2 to 215 kN/mm^2
Coefficient of thermal expansion α_{therm} (at 20 °C)	$25 \cdot 10^{-6}K^{-1}$	$10 \cdot 10^{-6}K^{-1}$ to $17 \cdot 10^{-6}K^{-1}$
Surface roughness Rz	≤ 16 µm	
Friction values	Mounting surfaces must be clean and free of grease. Use screws and washers in the delivery condition.	
Tightening process	Use a signaling torque tool according to DIN EN ISO 6789; accuracy ±6 %	
Mounting temperature	15 °C to 35 °C	

Conditions for longer storage times
HEIDENHAIN recommends the following in order to make storage times beyond 12 months possible:

- Leave the encoders in the original packaging
- The storage location should be dry, free of dust, and temperature-regulated. It should also not be subjected to vibrations, mechanical shock or chemical influences
- After every 12 months, rotate the shafts of encoders with integral bearings at low speed without axial or radial shaft loading (e.g., as running-in phase), so that the bearing lubrication is distributed evenly

Expendable parts
Encoders from HEIDENHAIN are designed for a long service life. Preventive maintenance is not required. However, they contain components that are subject to wear, depending on the application and manipulation. These include in particular cables with frequent flexing.

Other such components are the bearings of encoders with integral bearing, shaft sealing rings on rotary and angle encoders, and sealing lips on sealed linear encoders.

Service life
Unless specified otherwise, HEIDENHAIN encoders are designed for a service life of 20 years, equivalent to 40 000 operating hours under typical operating conditions.

Insulation
The encoder housings are isolated against internal circuits.
Rated surge voltage: 500 V
Preferred value as per DIN EN 60664-1
Overvoltage category II
Contamination level 2
(no electrically conductive contamination)

Temperature ranges
For the unit in its packaging, the **storage temperature range** is –30 to +65 °C (HR 1120: –30 °C to 70 °C). The **operating temperature range** indicates the temperatures that the encoder may reach during operation in the actual installation environment. The function of the encoder is guaranteed within this range. The operating temperature is measured at the defined measuring point (see dimension drawing) and must not be confused with the ambient temperature.

The temperature of the encoder is influenced by:

- Mounting conditions
- Ambient temperature
- Self-heating of the encoder

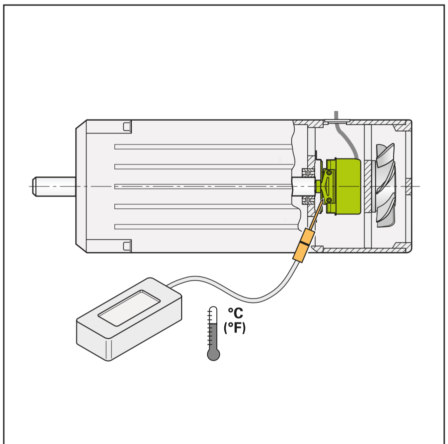
The self-heating of an encoder depends both on its design characteristics (stator coupling/solid shaft, shaft sealing ring, etc.) and on the operating parameters (rotational speed, voltage supply). Temporarily increased self-heating can also occur after very long breaks in operation (of several months). Please take a two-minute run-in period at low speeds into account. Higher heat generation in the encoder means that a lower ambient temperature is required to keep the encoder within its permissible operating temperature range.

This table shows the approximate values of self-heating to be expected in the encoders. In the worst case, a combination of operating parameters can exacerbate self-heating, for example a 30 V supply voltage and maximum rotational speed. Therefore, the actual operating temperature should be measured directly at the encoder if the encoder is operated near the limits of permissible parameters. Then suitable measures should be taken (fan, heat sinks, etc.) to reduce the ambient temperature far enough so that the maximum permissible operating temperature will not be exceeded during continuous operation.

For high speeds at maximum permissible ambient temperature, special versions are available on request with a reduced degree of protection (without shaft seal and its concomitant frictional heat).

Self-heating at shaft speed n_{max}	
Stub shaft/tapered shaft **ROC/ROQ/ROD/ RIC/RIQ/ ExN 400/1300**	≈ + 5 K ≈ +10 K for IP66 protection
ROD 600	≈ + 75 K
ROD 1900	≈ + 10 K
Blind hollow shaft **ECN/EQN/ ERN 400/1300**	≈ + 30 K ≈ + 40 K for IP66 protection
ECN/EQN/ ERN 1000	≈ + 10 K
Hollow through shaft **ECN/ERN 100 ECN/EQN/ ERN 400**	≈ +40 K for IP64 protection ≈ + 50 K for IP66 protection

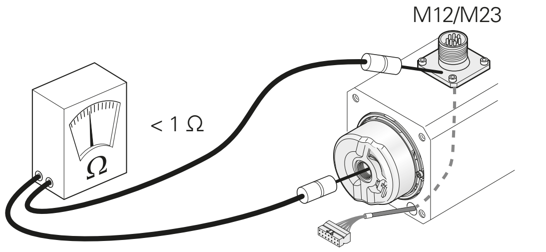
An encoder's typical self-heating values depend on its design characteristics at maximum permissible speed. The correlation between rotational speed and heat generation is nearly linear.



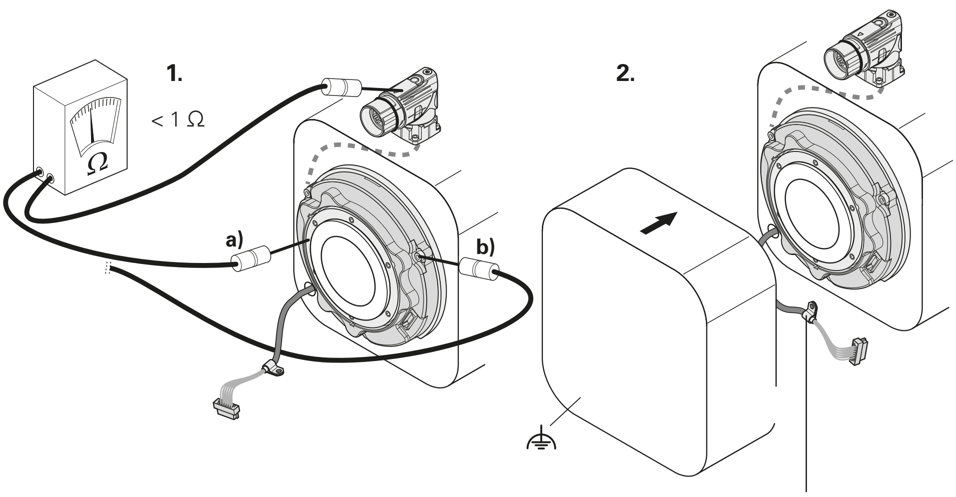
Measuring the actual operating temperature at the defined measuring point of the rotary encoder (see *Specifications*)

Electrical resistance

Encoders with integral bearing, pluggable cable and standard bearing
Check the resistance between the flange socket and the rotor.
Nominal value: < 1 ohm

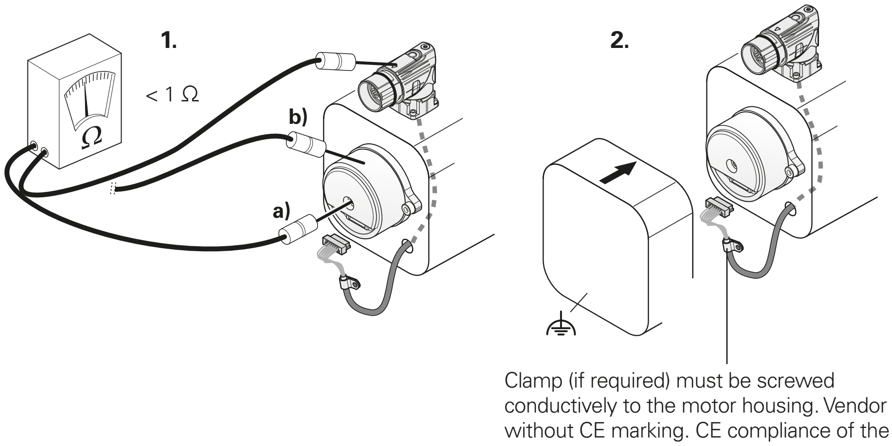


Exposed encoders (ExI 100) without integral bearing and with pluggable cable
Check the resistance between the flange socket, rotor **a)** and stator mounting screw **b)**.
Nominal value: < 1 ohm



Clamp must be screwed conductively to the motor housing. Vendor part without CE marking. CE compliance of the complete system must be ensured.

Exposed encoders (ExI 1100) without integral bearing and with pluggable cable
Check the resistance between the flange socket, rotor **a)** and stator (metal housing) **b)**.
Nominal value: < 1 ohm



Clamp (if required) must be screwed conductively to the motor housing. Vendor part without CE marking. CE compliance of the complete system must be ensured.

Temperature measurement in motors

Transmission of temperature values
To protect the motor from overload, the motor manufacturer usually monitors the temperature of the motor winding. In classic applications, the values from the temperature sensor are led via two separate lines to the subsequent electronics, where they are evaluated. Depending on their version, HEIDENHAIN rotary encoders with EnDat 2.2 interface feature an internal temperature sensor integrated in the encoder electronics as well as an evaluation circuit to which an external temperature sensor can be connected. In both cases, the respective digitized measured temperature value is transmitted purely serially over the EnDat protocol (as a component of the additional datum). This means that no separate lines from the motor to the drive controller are necessary.

Signaling of excessive temperature
With regard to the internal temperature sensor, such rotary encoders can support a dual-level cascaded signaling of exceeded temperature. It consists of an EnDat warning and an EnDat error message. Whether the respective encoder supports these warning and error messages can be read out from the following addresses of the integral memory:

- EnDat warning for *excessive temperature:* EnDat memory area *Parameters of the encoder manufacturer,* word 36 – *Support of warnings,* bit 2^1 – *Temperature exceeded*
- EnDat error message for *excessive temperature:* EnDat memory area *Parameters of the encoder manufacturer for EnDat 2.2,* word 35 – *Support of operating condition error sources,* bit 2^6 – *Temperature exceeded*

Encoder	Interface	Internal temperature sensor[1)]	External temperature sensor Connection
ECI/EQI 1100	EnDat22	✔ (±1 K)	Possible
ECI/EBI 1100	EnDat22	✔ (±5 K)	–
ECN/EQN 1100	EnDat22	✔ (±5 K)	Possible
	EnDat01	–	–
ECN/EQN 1300	EnDat22	✔ (±4 K)	Possible
	EnDat01	–	–
ECN/EQN 400	EnDat22	✔ (±4 K)	Possible
	EnDat01	–	–
ECI/EQI 1300	EnDat22	✔ (±1 K)	Possible
	EnDat01	–	–
ECI/EBI 100	EnDat22	✔ (±4 K)	Possible
	EnDat01	–	–

1) In parentheses: accuracy at 125 °C

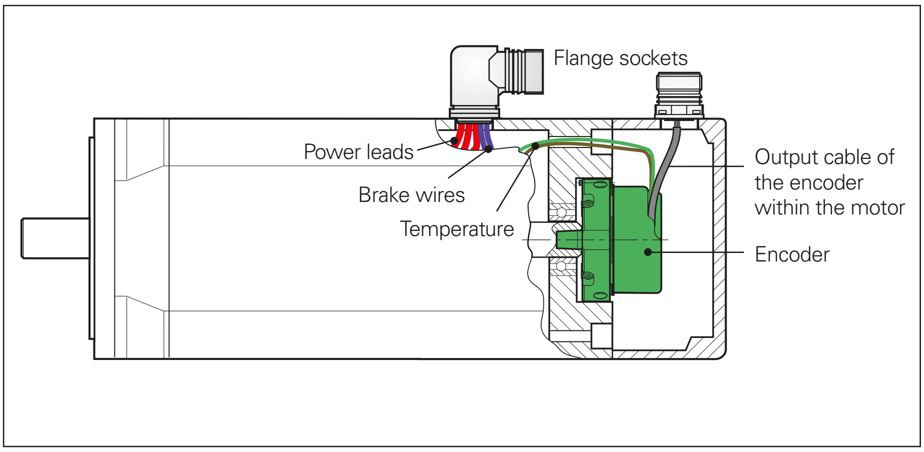
In compliance with the EnDat specification, when the temperature reaches the warning threshold for excessive temperature of the internal temperature sensor, it triggers an **EnDat warning** (EnDat memory area for *operating status*, word 1 – *warning*, bit 2^1 – *temperature exceeded*). This warning 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. At the time the encoder is shipped, a default value corresponding to the maximum permissible operating temperature is stored here (temperature at measuring point M1 as per the dimension drawing). The temperature measured by the internal temperature sensor is higher by a device-specific amount than the temperature at measuring point M1.

The encoder features a further, but 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 the additional datum 2 *operating status error sources*, bit 2^6 – *temperature exceeded*). This threshold sensitivity, if there is one, depends on the device and is shown in the specifications.

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 for the respective application. The encoder's intended use also requires compliance with the operating temperature at the measuring point M1.

Information for the connection of an external temperature sensor

- The external temperature sensor must comply with the following prerequisites as per EN 61800-5-1:
  - Voltage class A
  - Contamination level 2
  - Overvoltage category 3
- Only connect passive temperature sensors
- The connections for the temperature sensor are galvanically connected with the encoder electronics.
- Depending on the application, the temperature sensor assembly (sensor + cable assembly) is to be mounted with double or reinforced insulation from the environment.
- Accuracy of temperature measurement depends on the temperature range.
- Note the tolerance of the temperature sensor
- The transmitted temperature value is not a safe value in the sense of functional safety
- The motor manufacturer is responsible for the quality and accuracy of the temperature sensor, as well as for ensuring that electrical safety is maintained
- Use a crimp connector with a suitable temperature range (e.g. up to 150 °C ID 1148157-01)



Cable configuration of the temperature wires in the motor.

The accuracy of temperature measurement depends on the sensor used and the temperature range.

	KTY84-130	PT1000
–40 °C to +80 °C	±6 K	±6 K
80.1 °C to 160 °C	±3 K	±4 K
160.1 °C to 200 °C	±6 K	±6 K

Specifications of the evaluation	
Resolution	0.1 K (with KTY84-130)
Power supply of sensor	3.3 V over dropping resistor R_V = 2 kΩ
Measuring current typically	1.2 mA at 595 Ω 1.0 mA at 990 Ω
Total delay of temperature evaluation[1)]	160 ms max.
Cable length[2)] with wire cross section of 0.16 mm^2 at TPE or 0.25 mm^2 with cross-linked polyolefin	≤ 1 m

1) Filter time constants and conversion time are included. The time constant/response delay of the temperature sensor and the time lag for reading out data through the device interface are not included here.

2) Limit of cable length due to interference. The measuring error due to the line resistance is negligible.

Connectable temperature sensors

The temperature evaluation within the rotary encoder is designed for a KTY 84-130 PTC thermistor. For other temperature sensors, the output value (value in additional datum 1) must be converted to a temperature value.

Figure 1 shows the relationship between the output value and the resistance of the temperature sensor. For the KTY 84-130, the temperature value equals the output value. The value unit is 0.1 kelvin.

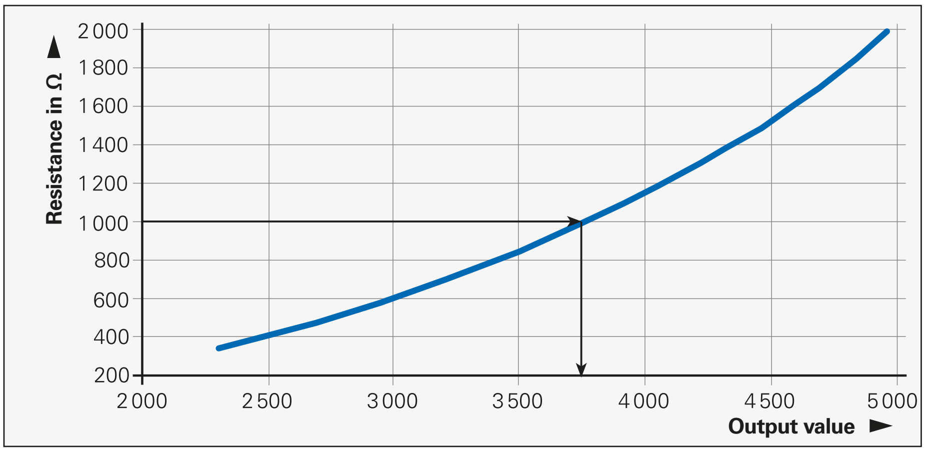


Figure 3.42: Relationship between output value and resistance

Example for KTY 84-130 temperature sensor:
Sensor resistance = 1000 Ω → output value (temperature value) 3751;
which corresponds to 375, 1 K or 102 °C.

Figure 2 shows the relationship between the output value and temperature value for a PT1000. The temperature value for the PT1000 can be found in the graphic from the output value.

For more information, see page 42.

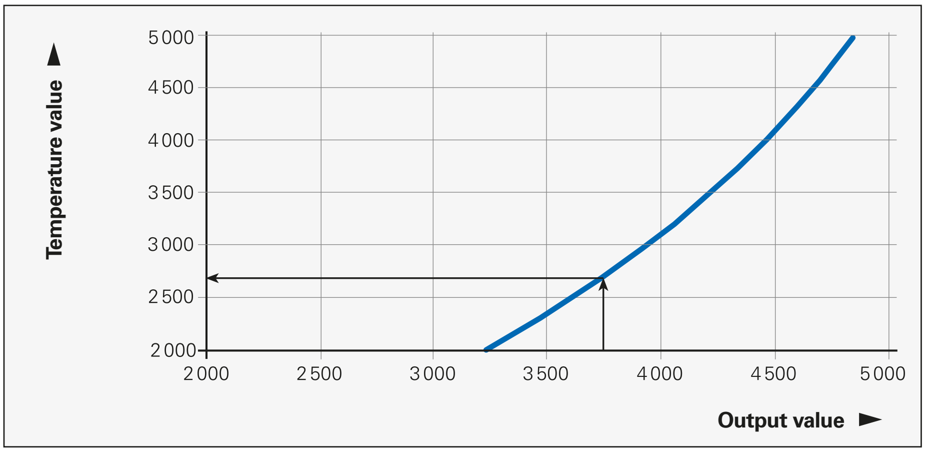


Figure 2: Relationship between output value and temperature value using the example of the PT1000

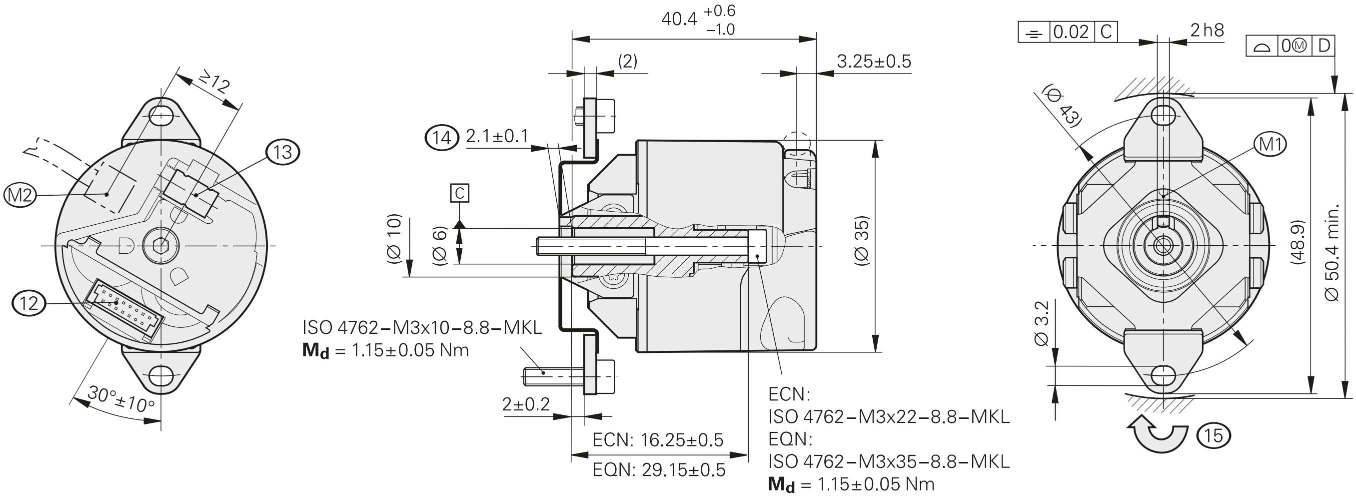
Example with temperature sensor PT1000:
Output value = 3751 → temperature value = 2734 (corresponds to 0.3 °C).
The following polynomial can be used to mathematically calculate the temperature value:

$$\text{Temperature}_{PT1000} = 1.3823 \cdot 10^{-7} \cdot A^3 - 1.2005 \cdot 10^{-3} \cdot A^2 + 4.6807 \cdot A - 5.2276 \cdot 10^3$$

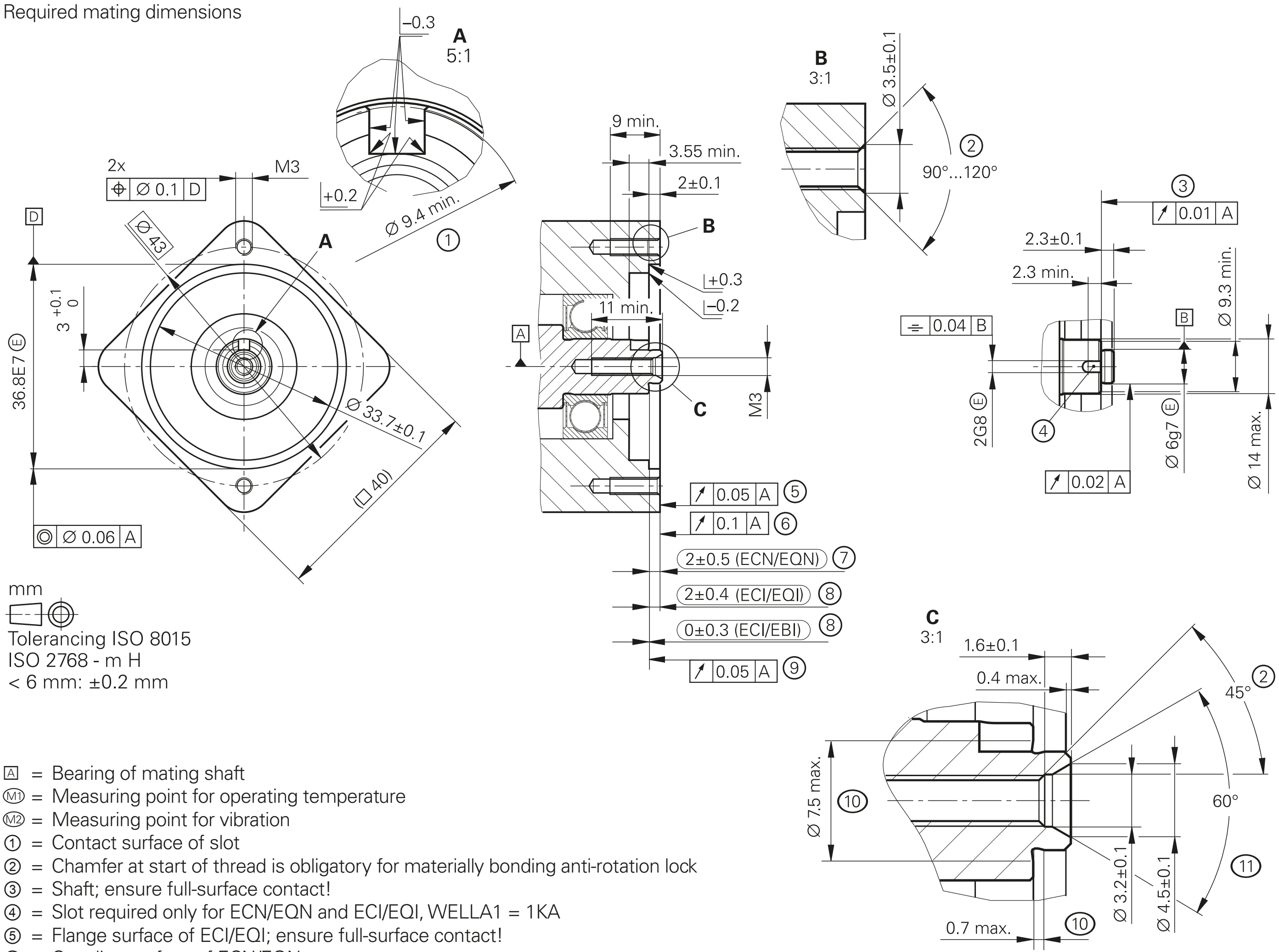
O = Output value. The PT1000 polynomial is value for: $3400 \leq O \leq 4810$.

ECN/EQN 1100 series

Absolute rotary encoders
- **75A stator coupling for plane surface**
- **Blind hollow shaft**
- **Encoders available with functional safety**



Required mating dimensions



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

A = Bearing of mating shaft
M1 = Measuring point for operating temperature
M2 = Measuring point for vibration
① = Contact surface of slot
② = Chamfer at start of thread is obligatory for materially bonding anti-rotation lock
③ = Shaft; ensure full-surface contact!
④ = Slot required only for ECN/EQN and ECI/EQI, WELLA1 = 1KA
⑤ = Flange surface of ECI/EQI; ensure full-surface contact!
⑥ = Coupling surface of ECN/EQN
⑦ = Maximum permissible deviation between shaft and coupling surface. Compensation of mounting tolerances and thermal expansion for which ±0.15 mm of dynamic axial motion is permitted
⑧ = Maximum permissible deviation between shaft and flange surfaces. Compensation of mounting tolerances and thermal expansion
⑨ = Flange surface of ECI/EBI; ensure full-surface contact!
⑩ = Undercut
⑪ = Possible centering hole
⑫ = PCB connector, 15-pin
⑬ = Cable gland with crimp sleeve, diameter 4.3±0.1 – 7 long
⑭ = Positive-fit element. Ensure correct engagement in slot 4, e.g. by measuring the device overhang
⑮ = Direction of shaft rotation for output signals as per the interface description

	Absolute			
	ECN 1113	**ECN 1123** Functional Safety	**EQN 1125**	**EQN 1135** Functional Safety
Interface	EnDat 2.2			
Ordering designation	EnDat01	EnDat22	EnDat01	EnDat22
Position values/revolution	8192 (13 bits)	8388608 (23 bits)	8192 (13 bits)	8388608 (23 bits)
Revolutions	–		4096 (12 bits)	
Elec. permissible speed/ Deviations[1]	4000 rpm/± 1 LSB 12000 rpm/± 16 LSB	12000 rpm (for continuous position value)	4000 rpm/± 1 LSB 12000 rpm/± 16 LSB	12000 rpm (for continuous position value)
Calculation time t_{cal} Clock frequency	≤ 9 µs ≤ 2 MHz	≤ 7 µs ≤ 8 MHz	≤ 9 µs ≤ 2 MHz	≤ 7 µs ≤ 8 MHz
Incremental signals	∿ 1 V_{PP}[1]	–	∿ 1 V_{PP}[1]	–
Line count	512	–	512	–
Cutoff frequency –3 dB	≥ 190 kHz	–	≥ 190 kHz	–
System accuracy	±60"			
Electrical connection	Via 15-pin PCB cnnctr.	Via 15-pin PCB cnnctr.[3]	Via 15-pin PCB cnnctr.	Via 15-pin PCB cnnctr.[3]
Voltage supply	DC 3.6 V to 14 V			
Power consumption (max.)	*3.6 V:* ≤ 0.6 W *14 V:* ≤ 0.7 W		*3.6 V:* ≤ 0.7 W *14 V:* ≤ 0.8 W	
Current consumption (typical)	*5 V:* 85 mA (without load)		*5 V:* 105 mA (without load)	
Shaft	Blind hollow shaft Ø 6 mm with positive fit element			
Mech. permiss. speed n	12000 rpm			
Starting torque	≤ 0.001 Nm (at 20 °C)		≤ 0.002 Nm (at 20 °C)	
Moment of inertia of rotor	≈ $0.4 \cdot 10^{-6}$ kgm^2			
Permissible axial motion of measured shaft	±0.5 mm			
Vibration 55 Hz to 2000 Hz **Shock** 6 ms	≤ 200 m/s^2 (EN 60068-2-6) ≤ 1000 m/s^2 (EN 60068-2-27)			
Max. operating temp.	115 °C			
Min. operating temp.	–40 °C			
Protection EN 60529	IP40 when mounted			
Mass	≈ 0.1 kg			
Valid for ID	803427-xx	803429-xx	803428-xx	803430-xx

1) Restricted tolerances

Signal amplitude:	0.80 V_{PP} to 1.2 V_{PP}
Asymmetry:	0.05
Amplitude ratio:	0.9 to 1.1
Phase angle:	90° ±5° elec.

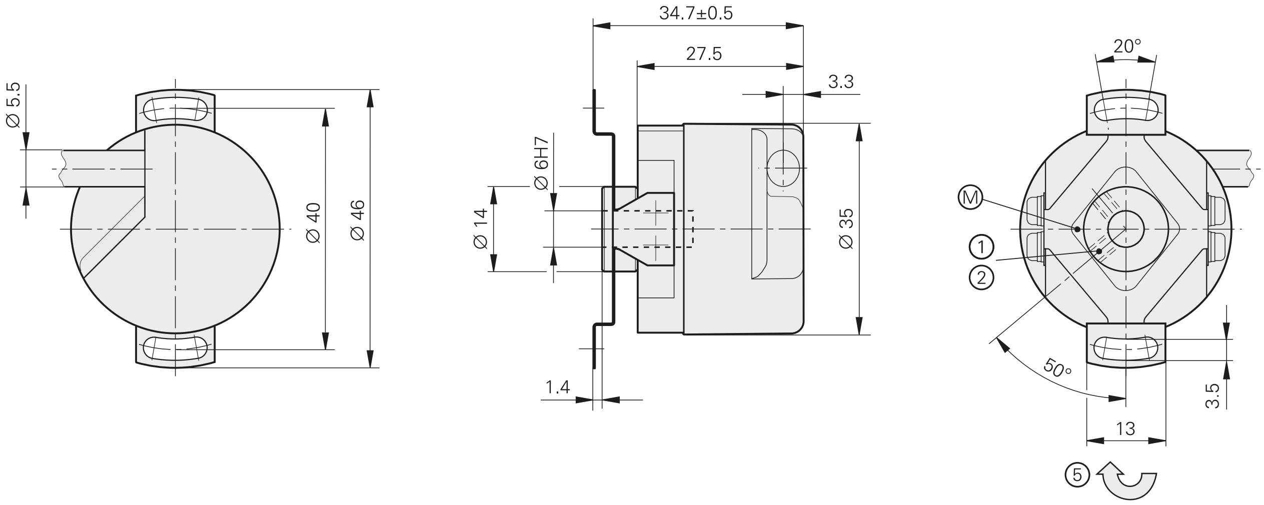
2) Velocity-dependent deviations between the absolute and incremental signals

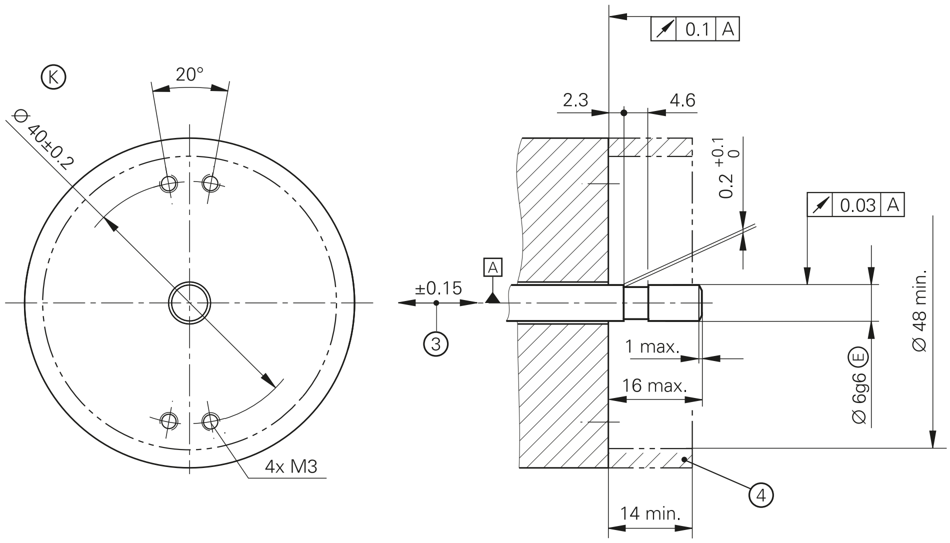
3) With connection for temperature sensor, evaluation optimized for KTY 84-130

Functional safety available for ECN 1123 and EQN 1135. For dimensions and specifications see the Product Information document

ERN 1023

Incremental rotary encoders
- **Stator coupling for plane surface**
- **Blind hollow shaft**
- **Block commutation signals**





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

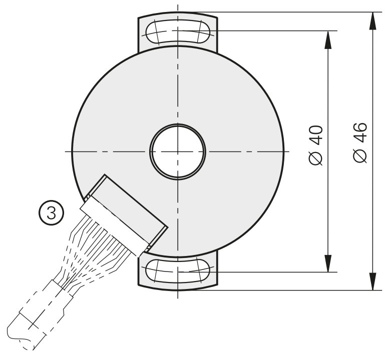
A = Bearing of mating shaft
Ⓚ = Required mating dimensions
Ⓜ = Measuring point for operating temperature
① = 2 screws in clamping ring. Tightening torque: 0.6 Nm ±0.1 Nm, SW1.5
② = Reference mark position ±10°
③ = Compensation of mounting tolerances and thermal expansion, no dynamic motion permitted
④ = Ensure protection against contact (EN 60 529)
⑤ = Direction of shaft rotation for output signals as per the interface description

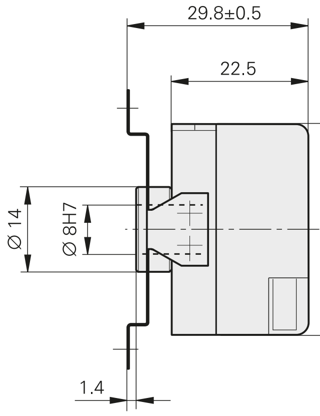
	ERN 1023	
Interface	⊓⊔TTL	
Signal periods/rev*	**500** **512** 600	**1000** **1024** 1250 **2000** **2048** **2500** 4096 5000 8192
Reference mark	One	
Output frequency Edge separation *a*	≤ 300 kHz ≥ 0.41 µs	
Commutation signals[1]	⊓⊔TTL (3 commutation signals U, V, W)	
Width*	2 · 180° (C01); 3 · 120° (C02); **4 · 90° (C03)**	
System accuracy	±260″	±130″
Electrical connection*	Cable **1 m,** 5 m without coupling	
Voltage supply	DC 5 V ±0.5 V	
Current consumption (without load)	≤ 70 mA	
Shaft	Blind hollow shaft ∅ 6 mm	
Mech. permiss. speed n	≤ 6000 rpm	
Starting torque	≤ 0.005 Nm (at 20 °C)	
Moment of inertia of rotor	$0.5 \cdot 10^{-6}$ kgm^2	
Permissible axial motion of measured shaft	±0.15 mm	
Vibration 25 Hz to 2000 Hz **Shock** 6 ms	≤ 100 m/s^2 (EN 60 068-2-6) ≤ 1000 m/s^2 (EN 60 068-2-27)	
Max. operating temp.	90 °C	
Min. operating temp.	*Fixed cable:* –20 °C *Moving cable:* –10 °C	
Protection EN 60 529	IP 64	
Mass	≈ 0.07 kg (without cable)	
Valid for ID	684703-xx	

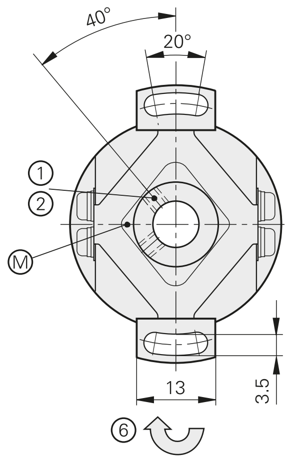
Bold: These preferred versions are available on short notice
* Please select when ordering
1) Three square-wave signals with signal periods of 90°, 120° or 180° mechanical phase shift, see *Commutation signals for block commutation* in the brochure *Interfaces of HEIDENHAIN Encoders*

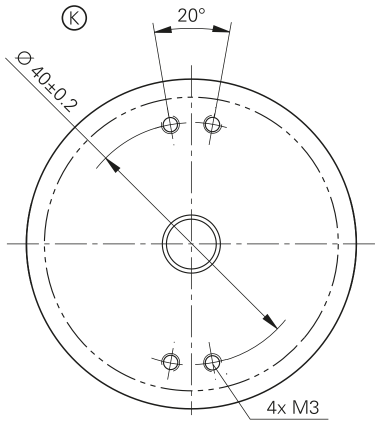
ERN 1123

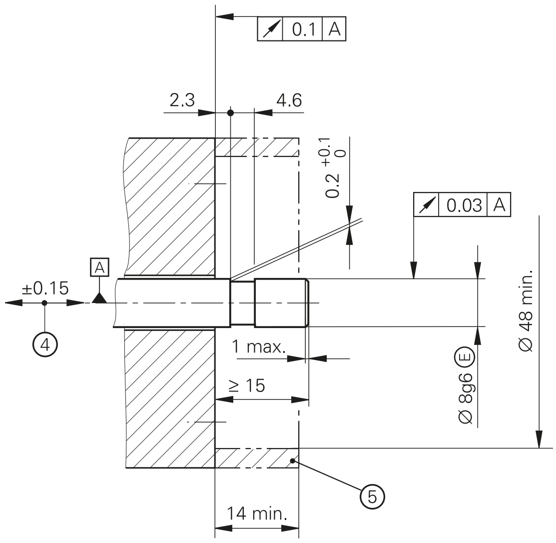
Incremental rotary encoders
- **Stator coupling for plane surface**
- **Hollow through shaft**
- **Block commutation signals**











mm

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

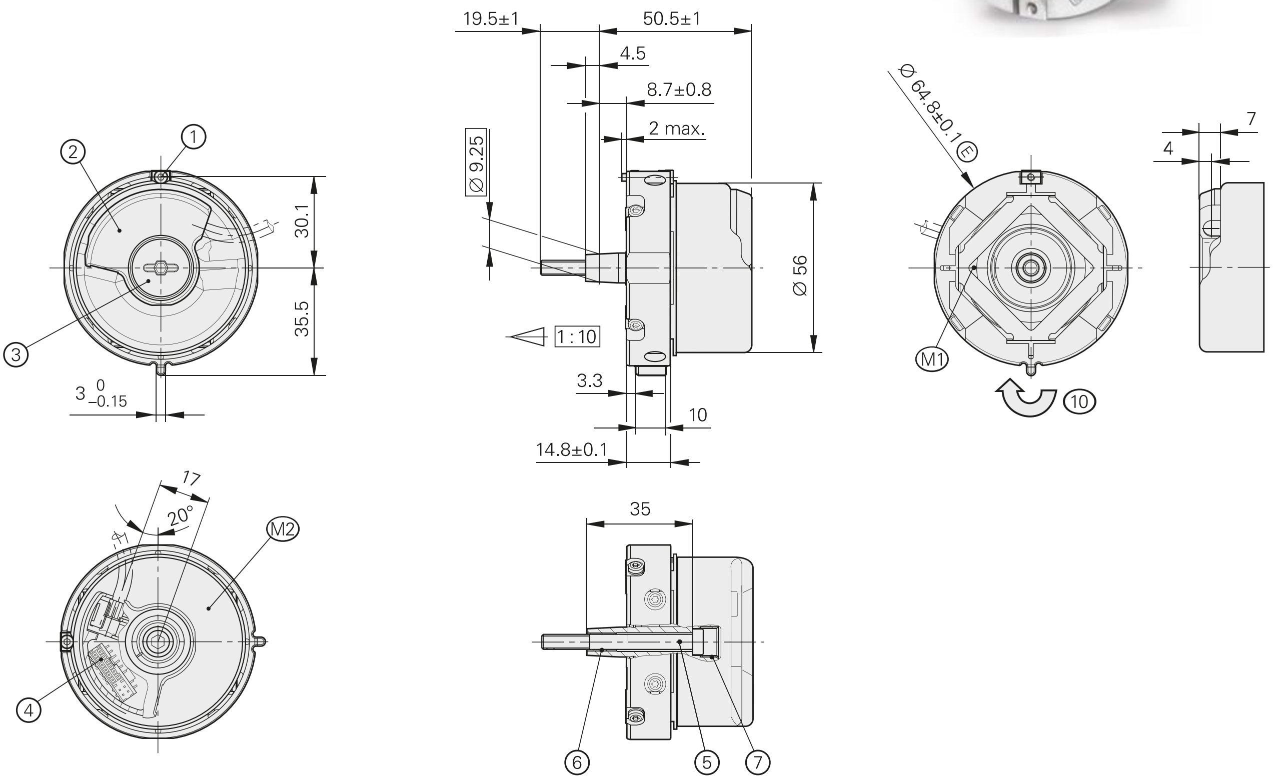
Ⓐ = Bearing of mating shaft
Ⓚ = Required mating dimensions
Ⓜ = Measuring point for operating temperature
① = 2 screws in clamping ring. Tightening torque: 0.6 Nm ±0.1 Nm, SW1.5
② = Reference mark position ±10°
③ = 15-pin JAE connector
④ = Compensation of mounting tolerances and thermal expansion, no dynamic motion permitted
⑤ = Ensure protection against contact (EN 60 529)
⑥ = Direction of shaft rotation for output signals as per the interface description

	ERN 1123	
Interface	⊓⊔TTL	
Signal periods/rev*	**500** **512** 600	**1000** **1024** 1250 **2000** **2048** **2500** 4096 5000 8192
Reference mark	One	
Output frequency Edge separation *a*	≤ 300 kHz ≥ 0.41 µs	
Commutation signals[1]	⊓⊔TTL (3 commutation signals U, V, W)	
Width*	2 · 180° (C01); 3 · 120° (C02); **4 · 90° (C03)**	
System accuracy	±260″	±130″
Electrical connection	Via 15-pin PCB connector	
Voltage supply	DC 5 V ±0.5 V	
Current consumption (without load)	≤ 70 mA	
Shaft	Hollow through shaft ∅ 8 mm	
Mech. permiss. speed n	≤ 6000 rpm	
Starting torque	≤ 0.005 Nm (at 20 °C)	
Moment of inertia of rotor	$0.5 \cdot 10^{-6}$ kgm^2	
Permissible axial motion of measured shaft	±0.15 mm	
Vibration 25 Hz to 2000 Hz **Shock** 6 ms	≤ 100 m/s^2 (EN 60068-2-6) ≤ 1000 m/s^2 (EN 60068-2-27)	
Max. operating temp.	90 °C	
Min. operating temp.	–20 °C	
Protection EN 60 529	IP00[2]	
Mass	≈ 0.06 kg	
Valid for ID	684702-xx	

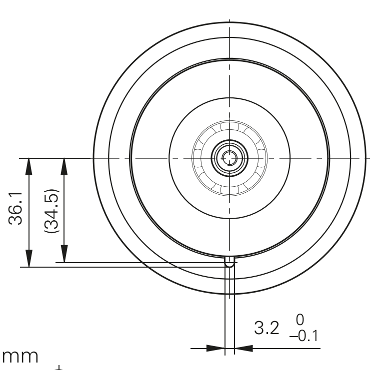
Bold: These preferred versions are available on short notice
* Please select when ordering
1) Three square-wave signals with signal periods of 90°, 120° or 180° mechanical phase shift, see *Commutation signals for block commutation* in the brochure *Interfaces of HEIDENHAIN Encoders*
2) CE compliance of the complete system must be ensured by taking the correct measures during installation.

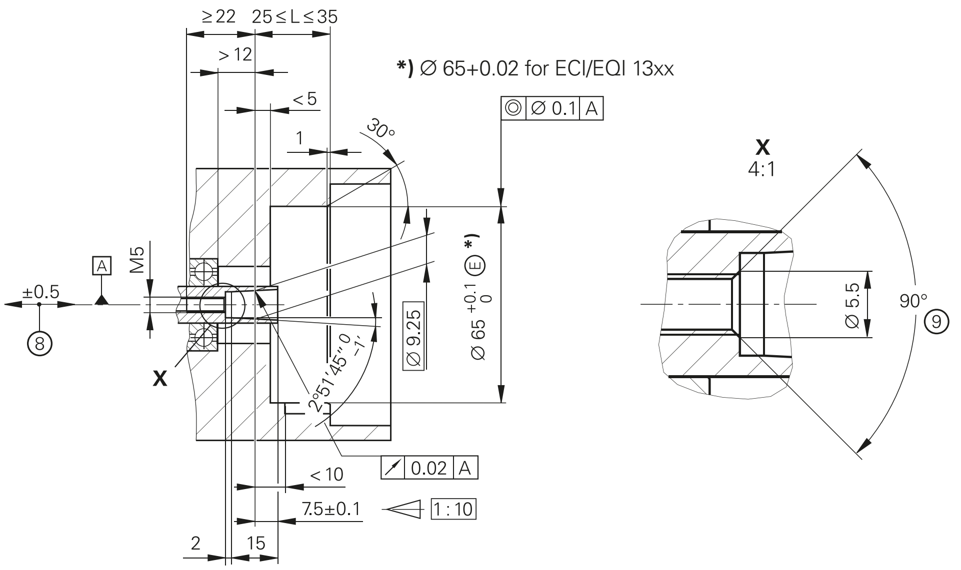
ECN/EQN 1300 series

Absolute rotary encoders
- **07B stator coupling with anti-rotation element for axial mounting**
- **Taper shaft 65B**
- **Encoders available with functional safety**
- **Fault exclusion for rotor and stator coupling as per EN 61800-5-2 possible**



Required mating dimensions





mm

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

A = Bearing of mating shaft
K = Required mating dimensions
M1 = Measuring point for operating temperature
M2 = Measuring point for vibration, see D 741714
① = Clamping screw for coupling ring, width A/F 2, tightening torque 1.25 Nm – 0.2 Nm
② = Die-cast cover
③ = Screw plug width A/F 3 and 4, tightening torque 5 Nm + 0.5 Nm
④ = PCB connector, 12-pin + 4-pin
⑤ = Screw, DIN 6912 – M5x50 – 08.8 – MKL width A/F 4, tightening torque 5 Nm + 0.5 Nm
⑥ = Back-off thread, M6
⑦ = Back-off thread, M10
⑧ = Compensation of mounting tolerances and thermal expansion, no dynamic motion permitted
⑨ = Chamfer at start of thread is obligatory for materially bonding anti-rotation lock
⑩ = Direction of shaft rotation for output signals as per the interface description

	Absolute			
	ECN 1313	**ECN 1325**	**EQN 1325**	**EQN 1337**
Interface	EnDat 2.2			
Ordering designation	EnDat01	EnDat22	EnDat01	EnDat22
Position values/revolution	8192 (13 bits)	33554432 (25 bits)	8192 (13 bits)	33554432 (25 bits)
Revolutions	–		4096 (12 bits)	
Elec. permissible speed/ Deviations[1]	*512 lines:* 5000 rpm/±1 LSB 12000 rpm/±100 LSB *2048 lines:* 1500 rpm/±1 LSB 12000 rpm/±50 LSB	15000 rpm (for continuous position value)	*512 lines:* 5000 rpm/±1 LSB 12000 rpm/±100 LSB *2048 lines:* 1500 rpm/±1 LSB 12000 rpm/±50 LSB	15000 rpm (for continuous position value)
Calculation time t_{cal} Clock frequency	≤ 9 µs ≤ 2 MHz	≤ 7 µs ≤ 16 MHz	≤ 9 µs ≤ 2 MHz	≤ 7 µs ≤ 16 MHz
Incremental signals	∿ 1 V_{PP}[1]	–	∿ 1 V_{PP}[1]	–
Line count*	512 2048	2048	512 2048	2048
Cutoff frequency –3 dB	*2048 lines:* ≥ 400 kHz *512 lines:* ≥ 130 kHz	–	*2048 lines:* ≥ 400 kHz *512 lines:* ≥ 130 kHz	–
System accuracy	*512 lines:* ±60"; *2048 lines:* ±20"			
Electrical connection Via PCB connector	12-pin	*Rotary encoder:* 12-pin *Temperature sensor*[3]*:* 4-pin	12-pin	*Rotary encoder:* 12-pin *Temperature sensor*[3]*:* 4-pin
Voltage supply	DC 3.6 V to 14 V			
Power consumption (max.)	*3.6 V:* ≤ 0.6 W *14 V:* ≤ 0.7 W		*3.6 V:* ≤ 0.7 W *14 V:* ≤ 0.8 W	
Current consumption (typical)	*5 V:* 85 mA (without load)		*5 V:* 105 mA (without load)	
Shaft	Taper shaft ∅ 9.25 mm; taper 1:10			
Mech. permiss. speed n	≤ 15000 rpm		≤ 12000 rpm	
Starting torque	≤ 0.01 Nm (at 20 °C)			
Moment of inertia of rotor	$2.6 \cdot 10^{-6}$ kgm^2			
Natural freq. of stator coupling	≥ 1800 Hz			
Permissible axial motion of measured shaft	±0.5 mm			
Vibration 55 Hz to 2000 Hz **Shock** 6 ms	≤ 300 m/s^2 [4] (EN 60068-2-6) ≤ 2000 m/s^2 (EN 60068-2-27)			
Max. operating temp.	115 °C			
Min. operating temp.	–40 °C			
Protection EN 60529	IP40 when mounted			
Mass	≈ 0.25 kg			
Valid for ID	768295-xx	683643-xx	827039-xx	683645-xx

* Please select when ordering

1) Restricted tolerances
Signal amplitude: 0.8 V_{PP} to 1.2 V_{PP}
Asymmetry: 0.05
Amplitude ratio: 0.9 to 1.1
Phase angle: 90° ±5° elec.
Signal-to-noise ratio E, F: ≥ 100 mV

2) Velocity-dependent deviations between the absolute and incremental signals

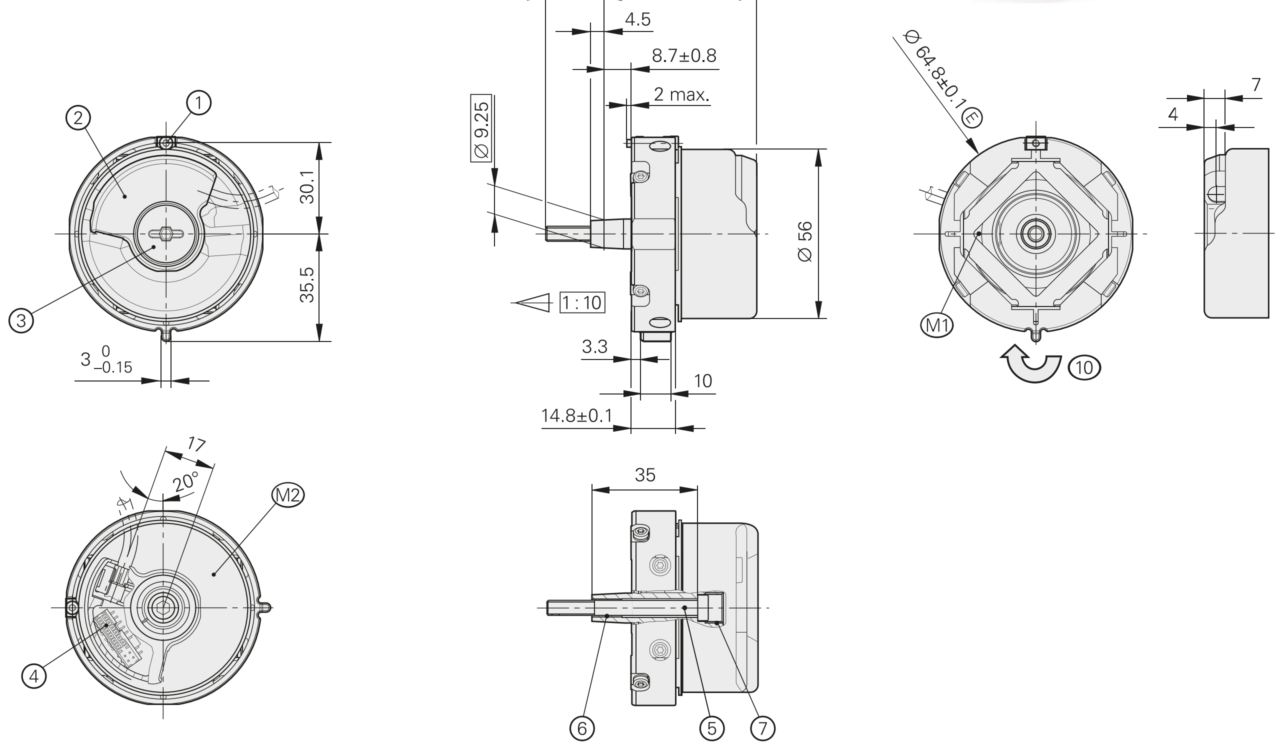
3) Evaluation optimized for KTY 84-130

4) As per standard for room temperature; for operating temperature Up to 100 °C: ≤ 300 m/s^2;
Up to 115 °C: ≤ 150 m/s^2

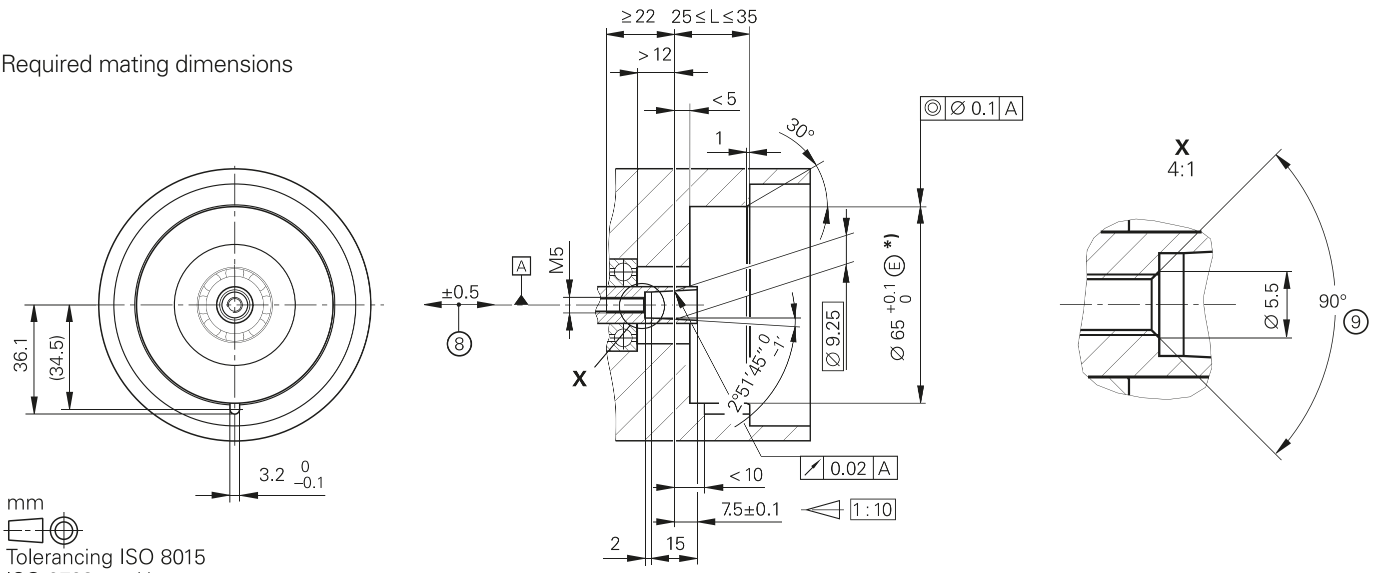
Functional safety available for ECN 1325 and EQN 1337. For dimensions and specifications see the Product Information document

ECN/EQN 1300 S series

Absolute rotary encoders
- **07B stator coupling with anti-rotation element for axial mounting**
- **Taper shaft 65B**
- **Encoders available with functional safety**
- **Fault exclusion for rotor and stator coupling as per EN 61800-5-2 possible**



Required mating dimensions



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

Ⓐ = Bearing of mating shaft
Ⓜ1 = Measuring point for operating temperature
Ⓜ2 = Measuring point for vibration, see D 741714
① = Clamping screw for coupling ring, width A/F 2, tightening torque 1.25 Nm – 0.2 Nm
② = Die-cast cover
③ = Screw plug width A/F 3 and 4, tightening torque 5 Nm + 0.5 Nm
④ = PCB connector, 12-pin + 4-pin
⑤ = Screw, DIN 6912 – M5x50 – 08.8 – MKL width A/F 4, tightening torque 5 Nm + 0.5 Nm
⑥ = Back-off thread, M6
⑦ = Back-off thread, M10
⑧ = Compensation of mounting tolerances and thermal expansion, no dynamic motion permitted
⑨ = Chamfer at start of thread is obligatory for materially bonding anti-rotation lock
⑩ = Direction of shaft rotation for output signals as per the interface description

	Absolute ECN 1324S Functional Safety	EQN 1336S Functional Safety
Interface	DRIVE-CLiQ	
Ordering designation	DC01	
Position values/revolution	16777216 (24 bits)	
Revolutions	–	4096 (12 bits)
Speed[1]	≤ 15000 rpm (at ≥ 2 position requests per revolution)	≤ 12000 rpm (at ≥ 2 position requests per revolution)
Processing$_{TIME_MAX_ACTVAL}$	≤ 8 µs	
Incremental signals	–	
System accuracy	±20"	
Electrical connection Via PCB connector	*Rotary encoder:* 12-pin *Temperature sensor*[1]*:* 4-pin	
Voltage supply	DC 10 V to 28 V	
Power consumption (max.)	*10 V:* ≤ 0.9 W *28.8 V:* ≤ 1 W	*10 V:* ≤ 1 W *28.8 V:* ≤ 1.1 W
Current consumption (typical)	*At 24 V:* 38 mA (without load)	*At 24 V:* 43 mA (without load)
Shaft	Taper shaft ∅ 9.25 mm; taper 1:10	
Starting torque	≤ 0.01 Nm (at 20 °C)	
Moment of inertia of rotor	$2.6 \cdot 10^{-6}$ kgm^2	
Natural frequency of the stator coupling	≥ 1800 Hz	
Permissible axial motion of measured shaft	±0.5 mm	
Vibration 55 Hz to 2000 Hz **Shock** 6 ms	≤ 300 m/s^2 (EN 60068-2-6) ≤ 2000 m/s^2 (EN 60068-2-27)	
Max. operating temp.	100 °C	
Min. operating temp.	–30 °C	
Protection EN 60529	IP40 when mounted	
Mass	≈ 0.25 kg	
Valid for ID	1042274-xx	1042276-xx

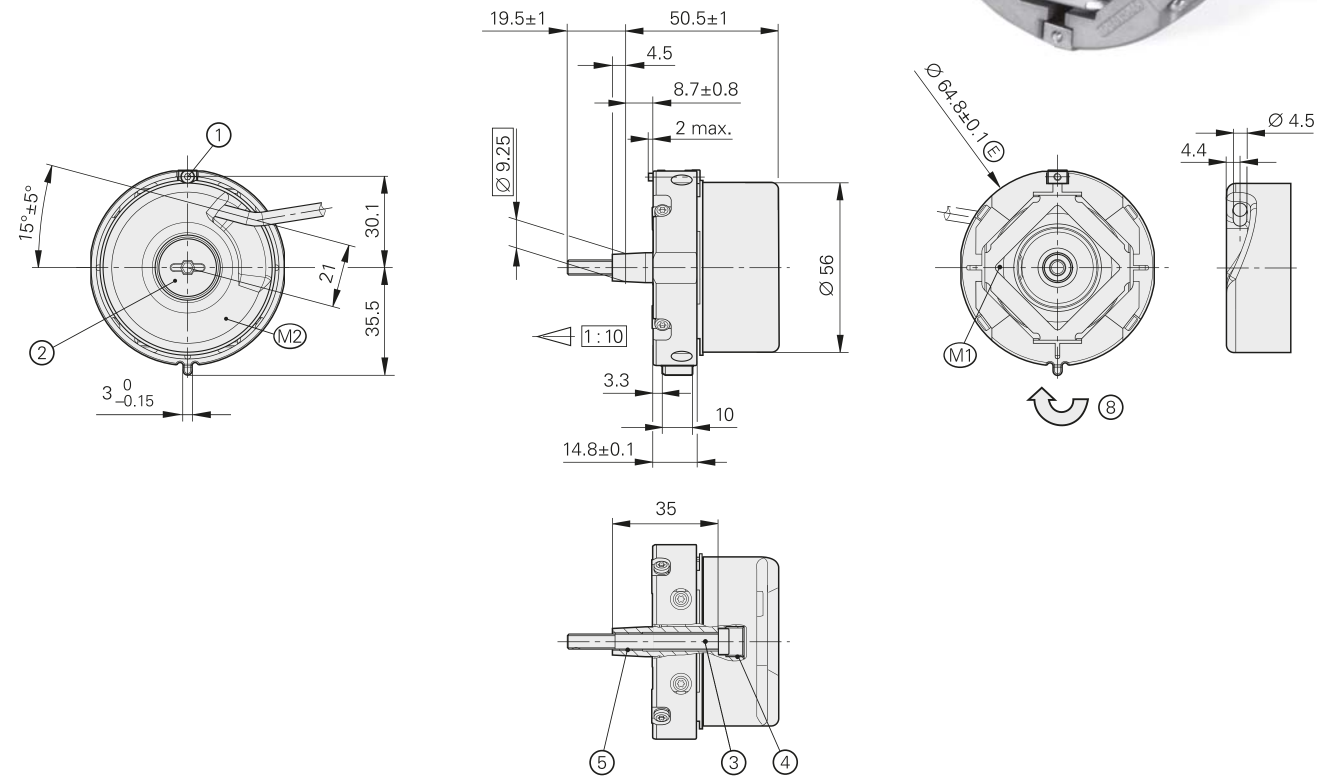
[1] Evaluation optimized for KTY 84-130

Functional safety available for ECN 1324S and EQN 1336S. For dimensions and specifications see the Product Information document

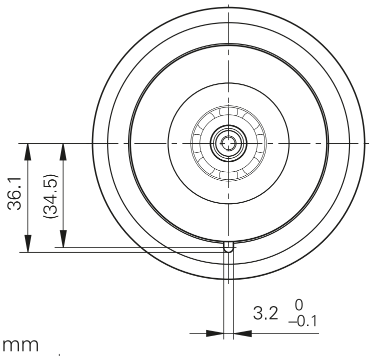
DRIVE-CLiQ is a registered trademark of SIEMENS AG.

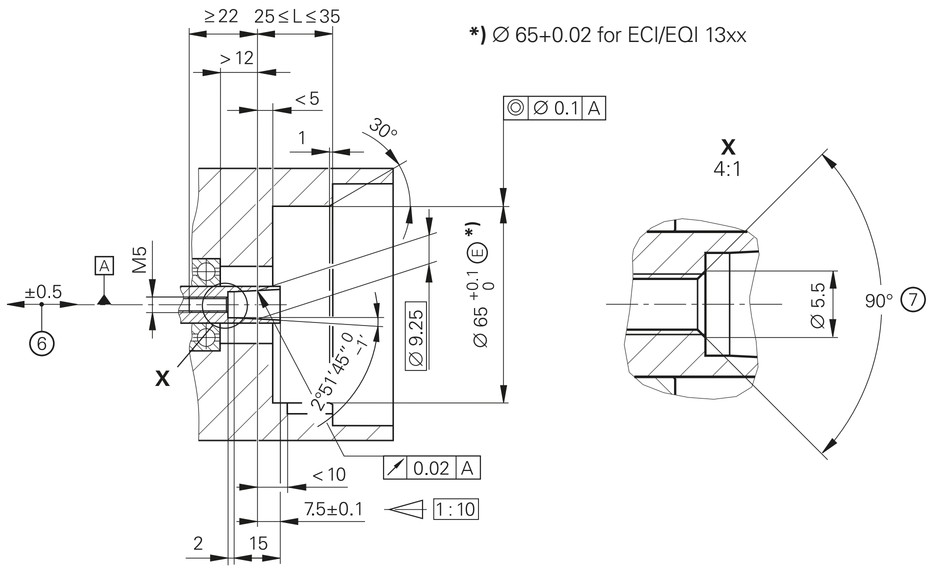
ECN/EQN 400 series

Absolute rotary encoders
- **07B stator coupling with anti-rotation element for axial mounting**
- **Taper shaft 65B**
- **Encoders available with functional safety**
- **Fault exclusion for rotor and stator coupling as per EN 61800-5-2 possible**



Required mating dimensions





***)** Ø 65+0.02 for ECI/EQI 13xx

mm

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

Ⓐ = Bearing of mating shaft
Ⓜ1 = Measuring point for operating temperature
Ⓜ2 = Measuring point for vibration, see D 741714
① = Clamping screw for coupling ring, width A/F 2, tightening torque 1.25 Nm – 0.2 Nm
② = Screw plug width A/F 3 and 4, tightening torque 5 Nm + 0.5 Nm
③ = Screw, DIN 6912 – M5x50 – 08.8 – MKL width A/F 4, tightening torque 5 Nm + 0.5 Nm
④ = Back-off thread, M10
⑤ = Back-off thread, M6
⑥ = Compensation of mounting tolerances and thermal expansion, no dynamic motion permitted
⑦ = Chamfer at start of thread is obligatory for materially bonding anti-rotation lock
② = Direction of shaft rotation for output signals as per the interface description

	Absolute			
	ECN 413	**ECN 425** Functional Safety	**EQN 425**	**EQN 437** Functional Safety
Interface	EnDat 2.2			
Ordering designation	EnDat01	EnDat22	EnDat01	EnDat22
Position values/revolution	8192 (13 bits)	33554432 (25 bits)	8192 (13 bits)	33554432 (25 bits)
Revolutions	–		4096 (12 bits)	
Elec. permissible speed/ Deviations[1]	1500 rpm/±1 LSB 12000 rpm/± 50 LSB	15000 rpm (for continuous position value)	1500 rpm/±1 LSB 12000 rpm/± 50 LSB	15000 rpm (for continuous position value)
Calculation time t_{cal} Clock frequency	≤ 9 µs ≤ 2 MHz	≤ 7 µs ≤ 16 MHz	≤ 9 µs ≤ 2 MHz	≤ 7 µs ≤ 16 MHz
Incremental signals	∿ 1 V_{PP}[1]	–	∿ 1 V_{PP}[1]	–
Line count	2048			
Cutoff frequency –3 dB	≥ 400 kHz	–	≥ 400 kHz	–
System accuracy	±20"			
Electrical connection*	Cable 5 m, with or without M23 coupling	Cable 5 m with M12 coupling	Cable 5 m, with or without M23 coupling	Cable 5 m with M12 coupling
Voltage supply	DC 3.6 V to 14 V			
Power consumption (max.)	*3.6 V:* ≤ 0.6 W *14 V:* ≤ 0.7 W		*3.6 V:* ≤ 0.7 W *14 V:* ≤ 0.8 W	
Current consumption (typical)	*5 V:* 85 mA (without load)		*5 V:* 105 mA (without load)	
Shaft	Taper shaft ∅ 9.25 mm; taper 1:10			
Mech. permiss. speed n	≤ 15000 rpm		≤ 12000 rpm	
Starting torque	≤ 0.01 Nm (at 20 °C)			
Moment of inertia of rotor	$2.6 \cdot 10^{-6}$ kgm^2			
Natural frequency of the stator coupling	≥ 1800 Hz			
Permissible axial motion of measured shaft	±0.5 mm			
Vibration 55 Hz to 2000 Hz **Shock** 6 ms	≤ 300 m/s^2 (EN 60068-2-6) ≤ 2000 m/s^2 (EN 60068-2-27)			
Max. operating temp.	100 °C			
Min. operating temp.	*Fixed cable:* –40 °C *Moving cable:* –10 °C			
Protection EN 60529	IP64 when mounted			
Mass	≈ 0.25 kg			
Valid for ID	1065932-xx	683644-xx	1109258-xx	683646-xx

* Please select when ordering

1) Restricted tolerances

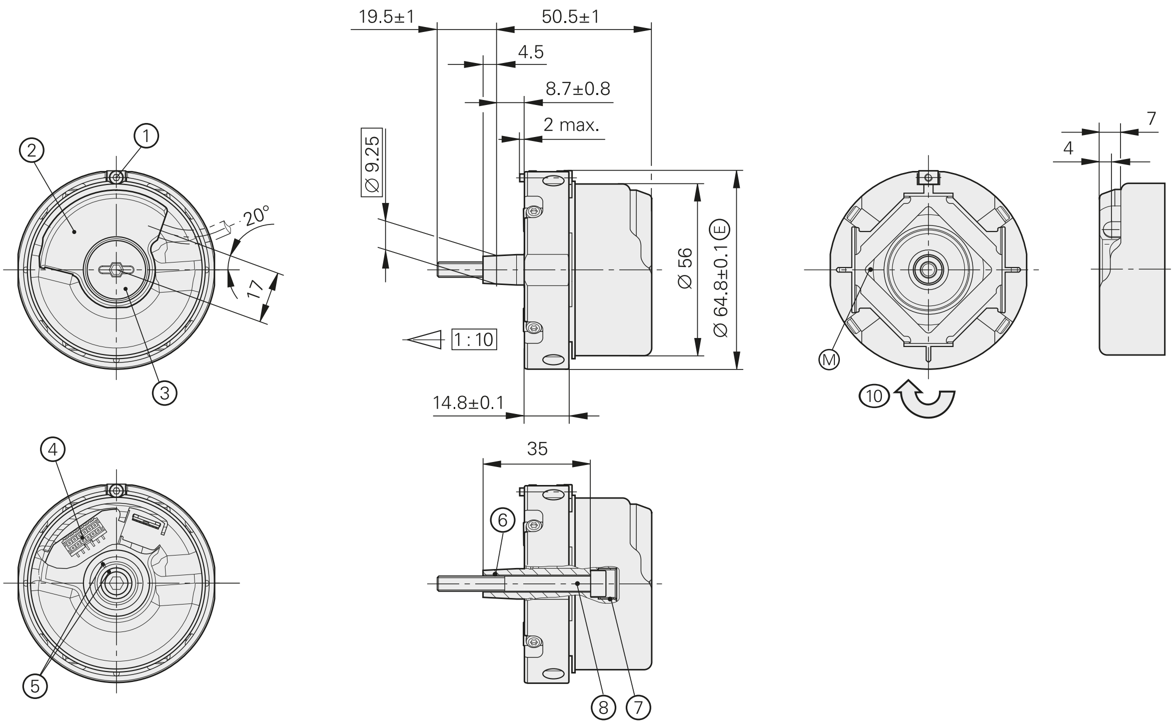
Signal amplitude:	0.8 V_{PP} to 1.2 V_{PP}
Asymmetry:	0.05
Amplitude ratio:	0.9 to 1.1
Phase angle:	90° ±5° elec.

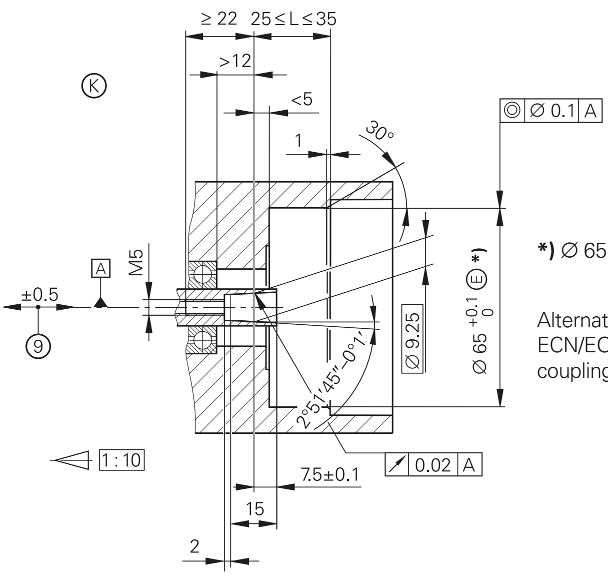
2) Velocity-dependent deviations between the absolute and incremental signals

Functional safety available for ECN 425 and EQN 437. For dimensions and specifications see the Product Information document

ERN 1300 series

Incremental rotary encoders
- **Stator coupling 06 for axis mounting**
- **Taper shaft 65B**





***)** Ø 65+0.02 for ECI/EQI 13xx

Alternative:
ECN/EQN 1300 mating dimensions with slot for stator coupling for anti-rotation element also applicable.

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

Ⓐ = Bearing of mating shaft
Ⓚ = Required mating dimensions
Ⓜ = Measuring point for operating temperature
① = Clamping screw for coupling ring, width A/F 2, tightening torque 1.25 Nm – 0.2 Nm
② = Die-cast cover
③ = Screw plug width A/F 3 and 4, tightening torque 5 Nm + 0.5 Nm
④ = PCB connector 12-pin
⑤ = Reference mark for shaft/cap alignment
⑥ = Back-off thread, M6
⑦ = Back-off thread, M10
⑧ = Self-tightening screw, M5x50 DIN 6912 SW4, tightening torque 5 Nm + 0.5 Nm
⑨ = Compensation of mounting tolerances and thermal expansion, no dynamic motion permitted
⑩ = Direction of shaft rotation for output signals as per the interface description

	Incremental				
	ERN 1321	**ERN 1381**	**ERN 1387**	**ERN 1326**	
Interface	⊓⊔TTL	∼ 1 V_{PP}[1]		⊓⊔TTL	
Line count*/ System accuracy	1024/±64" 2048/±32" 4096/±16"	512/±60" 2048/±20" 4096/±16"	2048/±20"	1024/±64" 2048/±32" 4096/±16"	8192/±16"[5]
Reference mark	One				
Output frequency Edge separation a Cutoff frequency –3 dB	≤ 300 kHz ≥ 0.35 µs –	– ≥ 210 kHz		≤ 300 kHz ≥ 0.35 µs –	≤ 150 kHz ≥ 0.22 µs
Commutation signals	–		∼ 1 V_{PP}[1]	⊓⊔TTL	
Width*	–		Z1 track[2]	3 · 120°; 4 · 90°[3]	
Electrical connection	Via 12-pin PCB connector		Via 14-pin PCB connector	Via 16-pin PCB connector	
Voltage supply	DC 5 V ±0.5 V		DC 5 V ± 0.25 V	DC 5 V ± 0.5 V	
Current consumption (w/o load)	≤ 120 mA		≤ 130 mA	≤ 150 mA	
Shaft	Taper shaft ∅ 9.25 mm; taper 1:10				
Mech. permiss. speed n	≤ 15000 rpm				
Starting torque	≤ 0.01 Nm (at 20 °C)				
Moment of inertia of rotor	$2.6 \cdot 10^{-6}$ kgm^2				
Natural frequency of the stator coupling	≥ 1800 Hz				
Permissible axial motion of measured shaft	±0.5 mm				
Vibration 55 Hz to 2000 Hz **Shock** 6 ms	≤ 300 m/s^2[4] (EN 60068-2-6) ≤ 2000 m/s^2 (EN 60068-2-27)				
Max. operating temp.	120 °C	120 °C *4096 lines:* 80 °C	120 °C		
Min. operating temp.	–40 °C				
Protection EN 60529	IP40 when mounted				
Mass	≈ 0.25 kg				
Valid for ID	385423-xx	534118-xx	749144-xx	574485-xx	

* Please select when ordering

[1] Restricted tolerances

Signal amplitude:	0.8 V_{PP} to 1.2 V_{PP}
Asymmetry:	0.05
Amplitude ratio:	0.9 to 1.1
Phase angle:	90° ±5° elec.
Signal-to-noise ratio E, F: 100 mV	

[2] One sine and one cosine signal per revolution; see the brochure *Interfaces of HEIDENHAIN Encoders*

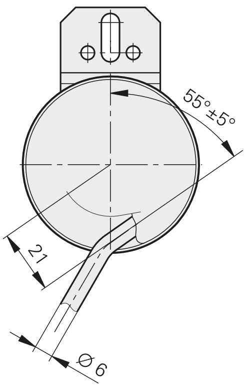
[3] Three square-wave signals with signal periods of 90° or 120° mechanical phase shift; see the brochure *Interfaces of HEIDENHAIN Encoders*

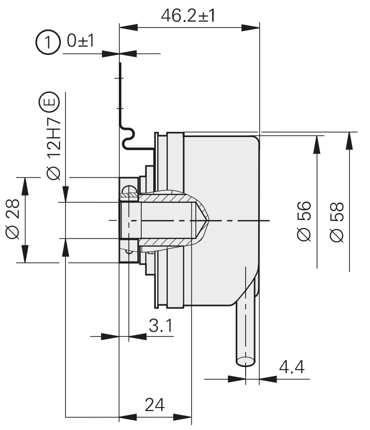
[4] As per standard for room temperature; for operating temperature Up to 100 °C: ≤ 300 m/s^2
Up to 120 °C: ≤ 150 m/s^2

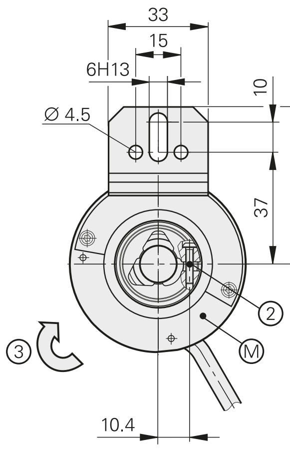
[5] Through integrated signal doubling

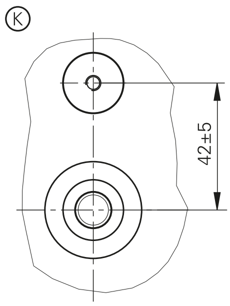
EQN/ERN 400 series

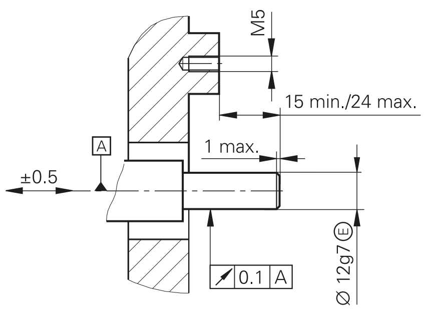
Absolute and incremental rotary encoders
- **Torque support**
- **Blind hollow shaft**
- **Replacement for Siemens 1XP8000**











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

Siemens model	Replacement model		ID	Design
1XP8012-10	ERN 430[1]	HTL	597331-76	Cable 0.8 m with mounted coupling and M23 central fastening, 17-pin
1XP8032-10	ERN 430	HTL		
1XP8012-20	ERN 420[1]	TTL	597330-74	
1XP8032-20	ERN 420	TTL		
1XP8014-10	EQN 425[1]	EnDat	649989-74	Cable 1 m with M23 coupling, 17-pin
1XP8024-10	EQN 425	EnDat		
1XP8014-20	EQN 425[1]	SSI	649990-73	
1XP8024-20	EQN 425	SSI		

[1] Original Siemens encoder features M23 flange socket, 17-pin

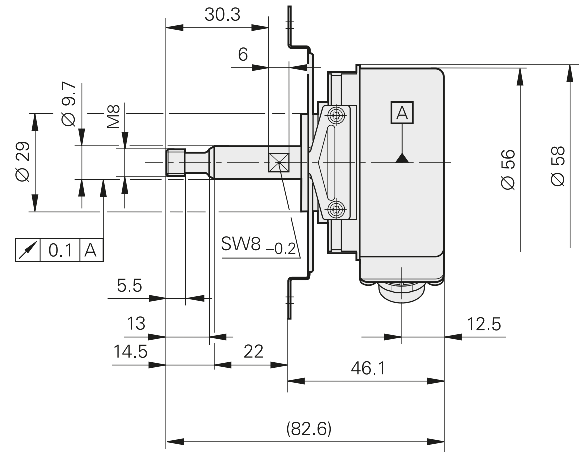
A = Bearing of mating shaft
K = Required mating dimensions
M = Measuring point for operating temperature
① = Distance from clamping ring to coupling
② = Clamping screw with hexalobular socket X8, tightening torque 1.1 Nm ±0.1 Nm
③ = Direction of shaft rotation for output signals as per the interface description

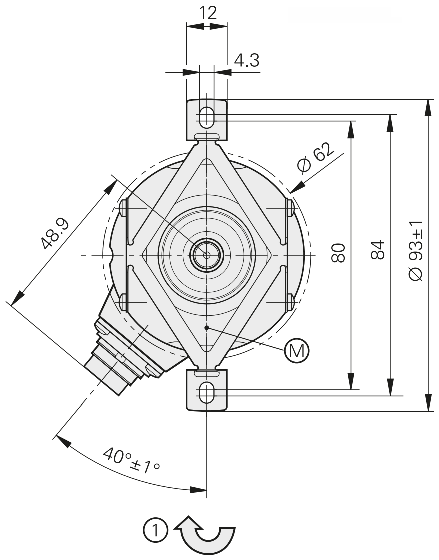
	Absolute		Incremental	
	EQN 425		**ERN 420**	**ERN 430**
Interface*	EnDat 2.2	SSI	⊓⊔ TTL	⊓⊔ HTL
Ordering designation	EnDat01	SSI41r1	–	–
Positions per revolution	8192 (13 bits)		–	–
Revolutions	4096		–	–
Code	Pure binary	Gray	–	–
Elec. permissible speed Deviation[1]	≤ 1500/10000 rpm ±1 LSB/±50 LSB	≤ 12000 rpm ±12 LSB	–	–
Calculation time t_{cal} Clock frequency	≤ 9 µs ≤ 2 MHz	≤ 5 µs –	–	–
Incremental signals	∼ 1 V_{PP}[2]		⊓⊔ TTL	⊓⊔ HTL
Line counts	2048	512	1024	
Cutoff frequency –3 dB Output frequency Edge separation a	≥ 400 kHz – –	≥ 130 kHz – –	– ≤ 300 kHz ≥ 0.39 µs	
System accuracy	±20"	±60"	1/20 of grating period	
Electrical connection	Cable 1 m, with M23 coupling		Cable 0.8 m with mounted coupling and central fastening	
Voltage supply	DC 3.6 V to 14 V	DC 10 V to 30 V	DC 5 V ± 0.5 V	DC 10 V to 30 V
Power consumption (max.)	*3.6 V:* ≤ 0.7 W *14 V:* ≤ 0.8 W	*10 V:* ≤ 0.75 W *30 V:* ≤ 1.1 W	–	–
Current consumption (typical, without load)	*5 V:* 105 mA	*5 V:* 120 mA *24 V:* 28 mA	≤ 120 mA	≤ 150 mA
Shaft	Bottomed hollowed shaft ∅ 12 mm			
Mech. permiss. speed n	≤ 6000 rpm			
Starting torque	≤ 0.05 Nm at 20 °C			
Moment of inertia of rotor	$\leq 4.6 \cdot 10^{-6}$ kgm^2			
Permissible axial motion of measured shaft	±0.5 mm			
Vibration 55 Hz to 2000 Hz **Shock** 6 ms	≤ 300 m/s^2 (EN 60068-2-6) ≤ 1000 m/s^2 (EN 60068-2-27)			
Max. operating temp.	100 °C			
Min. operating temp.	*Fixed cable:* –40 °C *Moving cable:* –10 °C			
Protection EN 60529	IP66			
Mass	≈ 0.3 kg			
Valid for ID	649989-xx	649990-xx	597330-xx	597331-xx

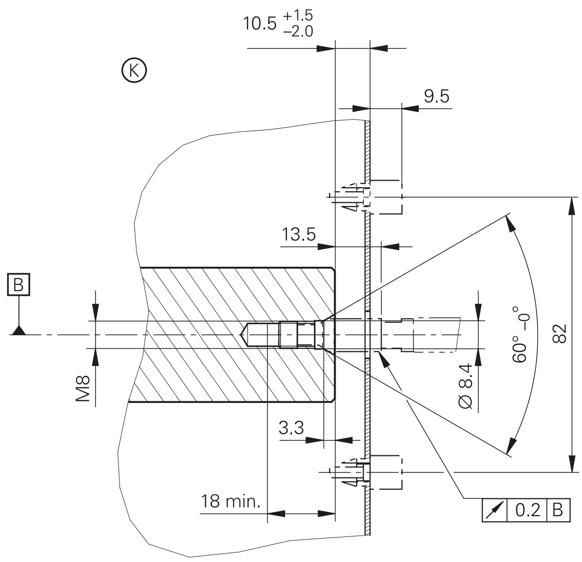
* Please select when ordering
[1] Velocity-dependent deviations between the absolute value and incremental signals
[2] Restricted tolerances Signal amplitudes: 0.8 V_{PP} to 1.2 V_{PP}

ERN 401 series

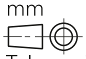
Incremental rotary encoders
- **Stator coupling via fastening clips**
- **Blind hollow shaft**
- **Replacement for Siemens 1XP8000**
- **Includes installation kit with housing**







mm



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

Siemens model	**Replacement model**	**ID**
1XP8001-2	ERN 421	538724-71
1XP8001-1	ERN 431	538725-02

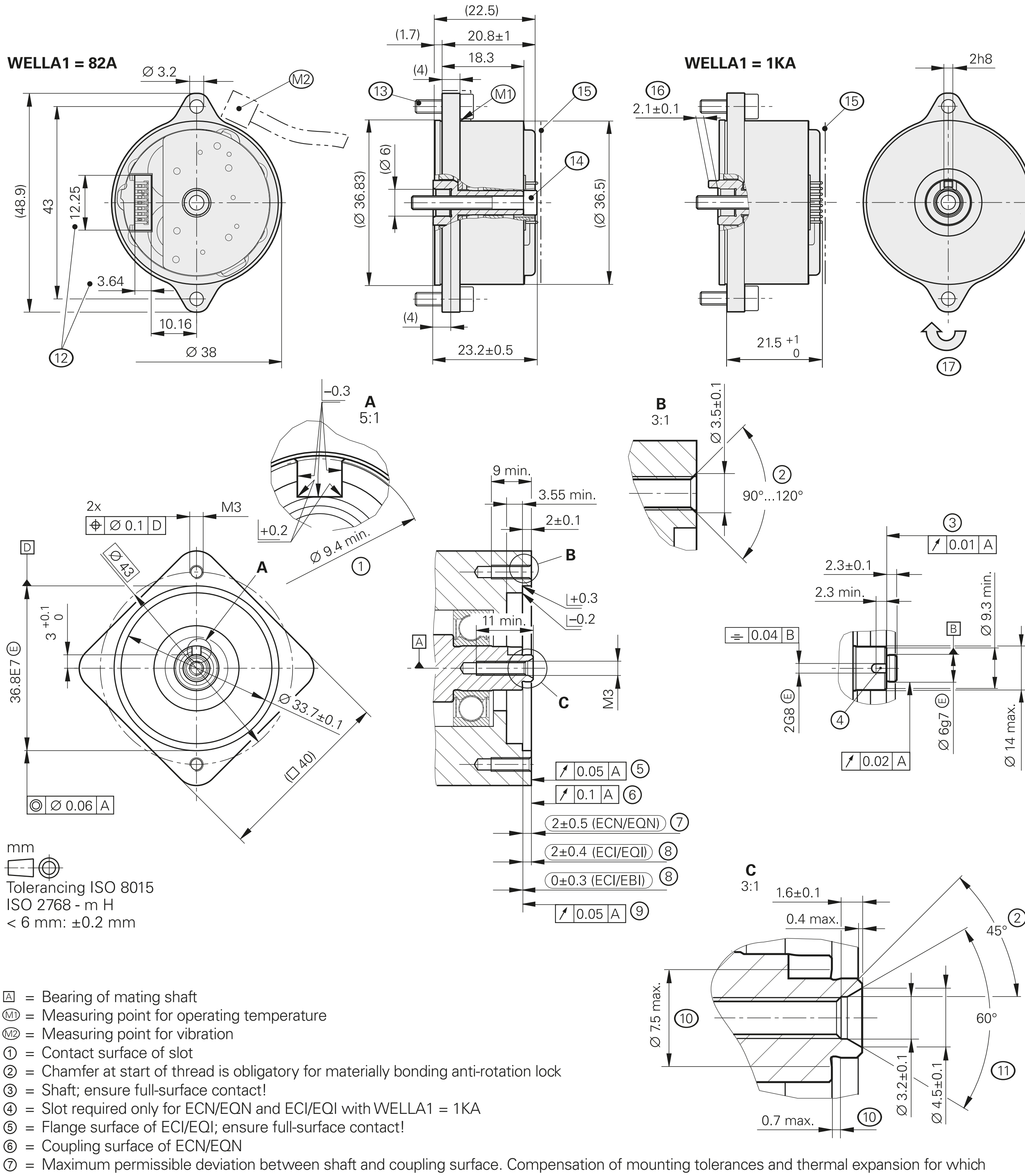
Ⓐ = Encoder bearing
Ⓑ = Bearing of mating shaft
Ⓚ = Required mating dimensions
Ⓜ = Measuring point for operating temperature
① = Direction of shaft rotation for output signals as per the interface description

	Incremental	
	ERN 421	**ERN 431**
Interface	⊓⊔TTL	⊓⊔HTL
Line counts	1024	
Reference mark	One	
Output frequency Edge separation a	≤ 300 kHz ≥ 0.39 µs	
System accuracy	1/20 of grating period	
Electrical connection	Radial Binder **flange socket**	
Voltage supply	DC 5 V ±0.5 V	DC 10 V to 30 V
Current consumption without load	≤ 120 mA	≤ 150 mA
Shaft	Solid shaft with M8 external thread, 60° centering taper	
Mech. permissible speed n[1)]	≤ 6000 rpm	
Starting torque At 20 °C Below –20 °C	≤ 0.01 Nm ≤ 1 Nm	
Moment of inertia of rotor	$\leq 4.3 \cdot 10^{-6}$ kgm^2	
Permissible axial motion of measured shaft	±1 mm	
Vibration 55 Hz to 2000 Hz **Shock** 6 ms	≤ 100 m/s^2 (EN 60068-2-6); higher values upon request ≤ 1000 m/s^2 (EN 60068-2-27)	
Max. operating temp.	100 °C	
Min. operating temp.	–40 °C	
Protection EN 60529	IP66	
Mass	≈ 0.3 kg	
Valid for ID	538724-xx	538725-xx

1) For the correlation between the operating temperature and the shaft speed or supply voltage, see *General mechanical information*

ECI/EQI 1100 series

Absolute rotary encoders
- **Flange for axial mounting**
- **Blind hollow shaft**
- **Without integral bearing**



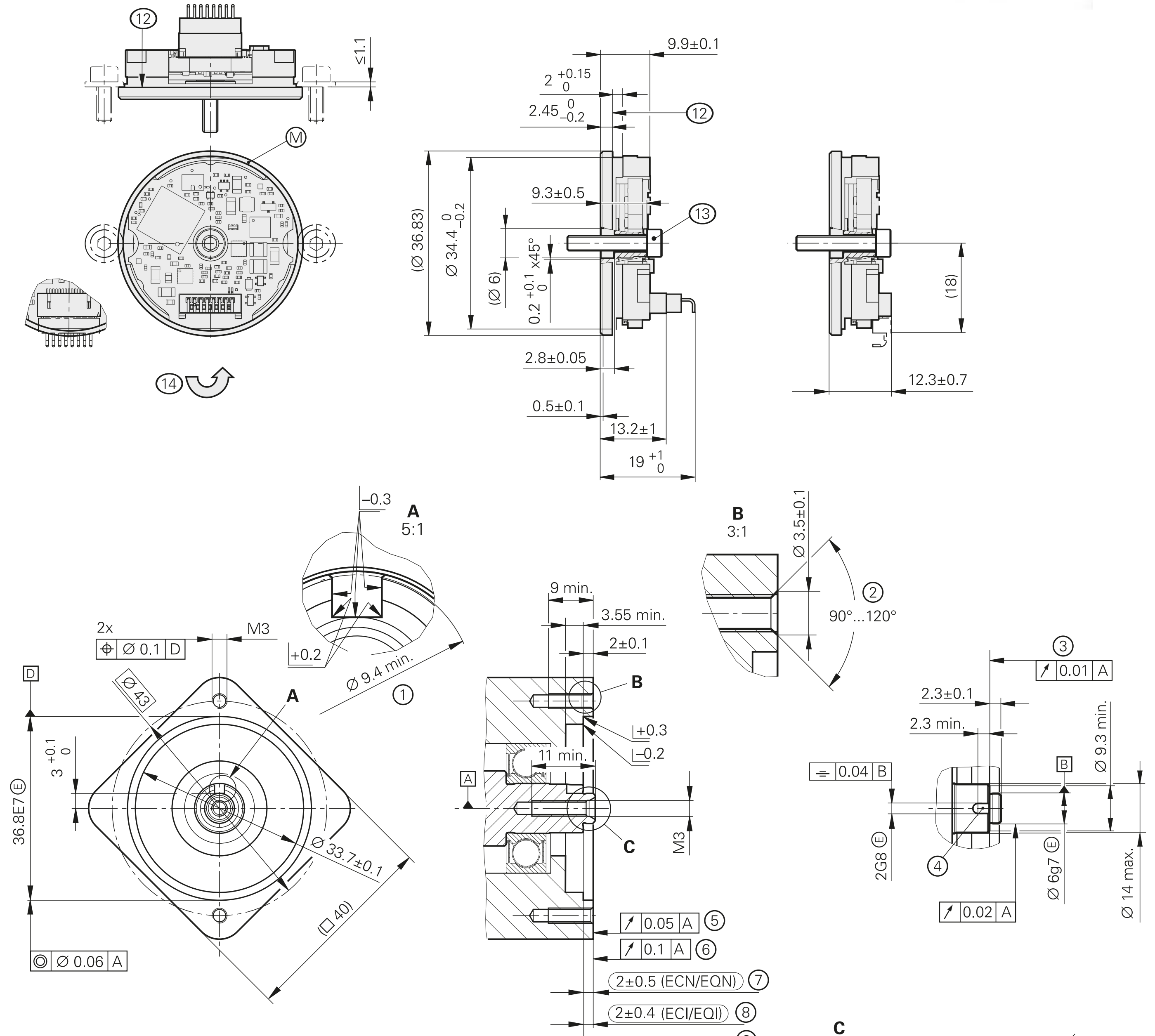
A = Bearing of mating shaft
M1 = Measuring point for operating temperature
M2 = Measuring point for vibration
① = Contact surface of slot
② = Chamfer at start of thread is obligatory for materially bonding anti-rotation lock
③ = Shaft; ensure full-surface contact!
④ = Slot required only for ECN/EQN and ECI/EQI with WELLA1 = 1KA
⑤ = Flange surface of ECI/EQI; ensure full-surface contact!
⑥ = Coupling surface of ECN/EQN
⑦ = Maximum permissible deviation between shaft and coupling surface. Compensation of mounting tolerances and thermal expansion for which ±0.15 mm of dynamic axial motion is permitted
⑧ = Maximum permissible deviation between shaft and flange surfaces. Compensation of mounting tolerances and thermal expansion
⑨ = Flange surface of ECI/EBI; ensure full-surface contact!
⑩ = Undercut
⑪ = Possible centering hole
⑫ = Opening for PCB connector min. 1.5 mm larger all around
⑬ = Screw, ISO 4762 – M3x10 – 8.8 – MKL, tightening torque 1 Nm ±0.1 Nm
⑭ = Screw, ISO 4762 – M3x25 – 8.8 – MKL, tightening torque 1 Nm ±0.1 Nm
⑮ = Maintain a distance of at least 1 mm to the cover. Note the opening for the connector!
⑯ = Positive-locking element. Ensure correct engagement in slot 4
⑰ = Direction of shaft rotation for output signals as per the interface description

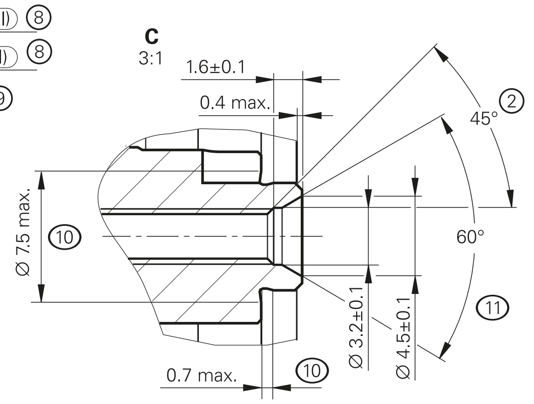
	Absolute	
	ECI 1119 Functional Safety	EQI 1131 Functional Safety
Interface	EnDat 2.2	
Ordering designation	EnDat22	
Position values/revolution	524288 (19 bits)	
Revolutions	–	4096 (12 bits)
Calculation time t_{cal} Clock frequency	≤ 5 µs ≤ 16 MHz	
System accuracy	±120"	
Electrical connection	Via 15-pin PCB connector	
Voltage supply	DC 3.6 V to 14 V	
Power consumption (max.)	*3.6 V:* ≤ 0.65 W *14 V:* ≤ 0.7 W	*3.6 V:* ≤ 0.7 W *14 V:* ≤ 0.85 W
Current consumption (typical)	*5 V:* 95 mA (without load)	*5 V:* 115 mA (without load)
Shaft*	Blind hollow shaft for axial clamping ∅ 6 mm without positive lock (82A) or with positive lock (1KA)	
Mech. permiss. speed n	≤ 15000 rpm	≤ 12000 rpm
Moment of inertia of rotor	$0.3 \cdot 10^{-6}$ kgm^2	
Permissible axial motion of measured shaft	±0.4 mm	
Vibration 55 Hz to 2000 Hz **Shock** 6 ms	≤ 400 m/s^2 (EN 60068-2-6) ≤ 2000 m/s^2 (EN 60068-2-27)	
Max. operating temp.	110 °C	
Min. operating temp.	–40 °C	
Trigger threshold of error message for excessive temperature	125 °C (measuring accuracy of internal temperature sensor: ± 1 K)	
Protection EN 60529	IP00 when mounted	
Mass	≈ 0.04 kg	
Valid for ID	826930-xx	826980-xx

* Please select when ordering
Functional safety available. For dimensions and specifications see the Product Information document

ECI/EBI 1100 series

Absolute rotary encoders
- **Flange for axial mounting**
- **Blind hollow shaft**
- **Without integral bearing**
- **EBI 1135: Multiturn function via battery-buffered revolution counter**





mm

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

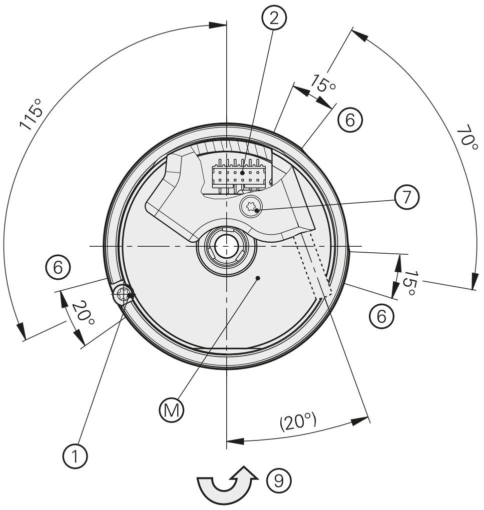
Ⓐ = Bearing of mating shaft
Ⓜ = Measuring point for operating temperature
① = Contact surface of slot
② = Chamfer at start of thread is obligatory for materially bonding anti-rotation lock
③ = Shaft; ensure full-surface contact!
④ = Slot required only for ECN/EQN and ECI/EQI with WELLA1 = 1KA
⑤ = Flange surface of ECI/EQI; ensure full-surface contact!
⑥ = Coupling surface of ECN/EQN
⑦ = Maximum permissible deviation between shaft and coupling surface. Compensation of mounting tolerances and thermal expansion for which ±0.15 mm of dynamic axial motion is permitted
⑧ = Maximum permissible deviation between shaft and flange surfaces. Compensation of mounting tolerances and thermal expansion
⑨ = Flange surface of ECI/EBI; ensure full-surface contact!
⑩ = Undercut
⑪ = Possible centering hole
⑫ = Clamping surface
⑬ = Screw, ISO 4762 – M3x16 – 8.8 with materially bonding anti-rotation lock, tightening torque 1.15 Nm ±0.05 Nm
⑭ = Direction of shaft rotation for output signals as per the interface description

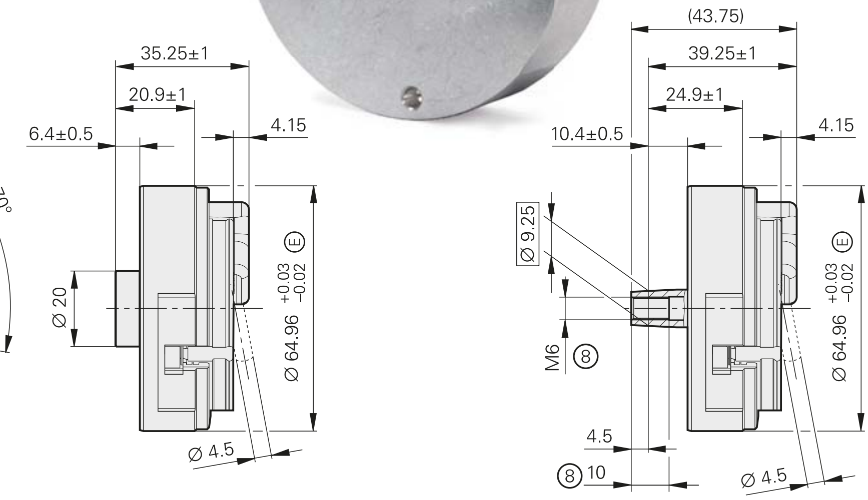
	Absolute	
	ECI 1118	**EBI 1135**
Interface	EnDat 2.2	
Ordering designation	EnDat22[1]	
Position values/revolution	262 144 (18 bits)	262 144 (18 bits; 19-bit data word length with LSB = 0)
Revolutions	–	65 536 (16 bits)
Calculation time t_{cal} Clock frequency	≤ 6 µs ≤ 8 MHz	
System accuracy	±120"	
Electrical connection	Via 15-pin PCB connector	
Voltage supply	DC 3.6 V to 14 V	*Rotary encoder U_P:* DC 3.6 V to 14 V *Backup battery U_{BAT}:* DC 3.6 V to 5.25 V
Power consumption (max.)	*Normal operation at 3.6 V:* 0.52 W *Normal operation at 14 V:* 0.6 W	
Current consumption (typical)	*5 V:* 80 mA (without load)	*Normal operation at 5 V:* 80 mA (without load) *Buffer mode*[2]*:* 22 µA (with rotating shaft) 12 µA (at standstill)
Shaft	Blind hollow shaft ∅ 6 mm, axial clamping	
Mech. permiss. speed n	≤ 15 000 rpm	≤ 12 000 rpm
Mech. permiss. acceleration	≤ 10^5 rad/s^2	
Moment of inertia of rotor	$0.2 \cdot 10^{-6}$ kgm^2	
Permissible axial motion of measured shaft	±0.3 mm	
Vibration 55 Hz to 2000 Hz **Shock** 6 ms	≤ 300 m/s^2 (EN 60 068-2-6) ≤ 1000 m/s^2 (EN 60 068-2-27)	
Max. operating temp.	115 °C	
Min. operating temp.	–20 °C	
Protection EN 60 529	IP00[3]	
Mass	≈ 0.02 kg	
Valid for ID	728563-xx	820725-xx

1) External temperature sensor and online diagnostics are not supported. Compliance with the EnDat specification 297403 and the EnDat Application Notes 722024, Chapter 13, *Battery-buffered encoders,* is required for correct control of the encoder.
2) At T = 25 °C; U_{BAT} = 3.6 V
3) CE compliance of the complete system must be ensured by taking the correct measures during installation.

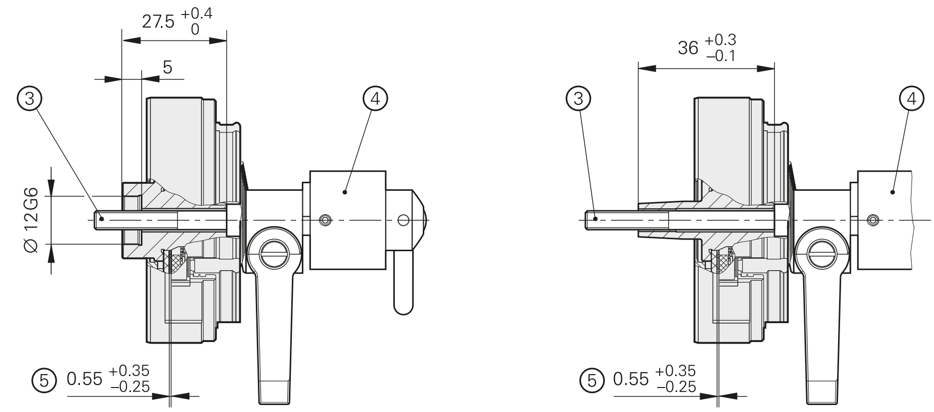
ECI/EQI 1300 series

Absolute rotary encoders
- **Flange for axial mounting; adjusting tool required**
- **Taper shaft or blind hollow shaft**
- **Without integral bearing**

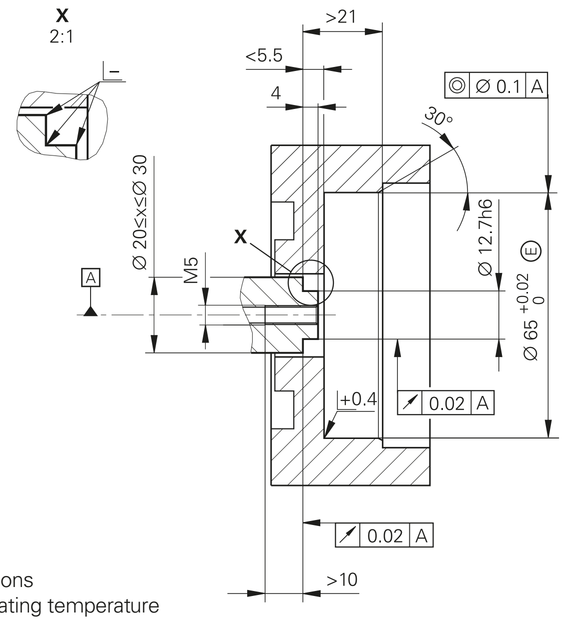


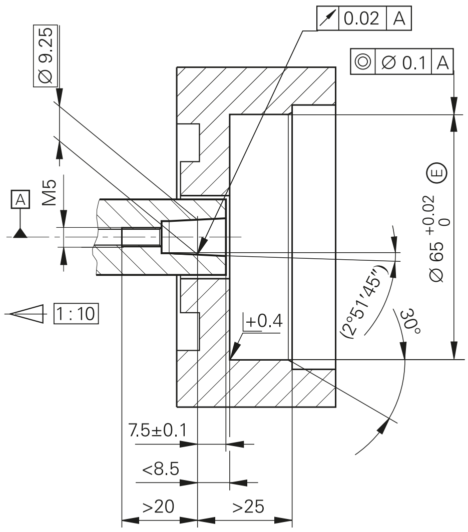


All dimensions under operating conditions



Ⓚ





mm

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

Ⓐ = Bearing
Ⓚ = Required mating dimensions
Ⓜ = Measuring point for operating temperature
① = Eccentric bolt. For mounting: Turn back and tighten with 2–0.5 Nm torque (Torx 15)
② = 12-pin PCB connector
③ = Cylinder head screw: ISO 4762 – M5x35 – 8.8, tightening torque 5 + 0.5 Nm for hollow shaft
= Cylinder head screw: ISO 4762 – M5x50 – 8.8, tightening torque 5 + 0.5 Nm for taper shaft
④ = Setting tool for scanning gap
⑤ = Permissible scanning gap range over all conditions
⑥ = Minimum clamping and support surface; a closed diameter is best
⑦ = Mounting screw for cable cover M2.5 Torx 8, tightening torque 0.4 Nm ±0.1 Nm
⑧ = M6 back-off thread
⑨ = Direction of shaft rotation for output signals as per the interface description

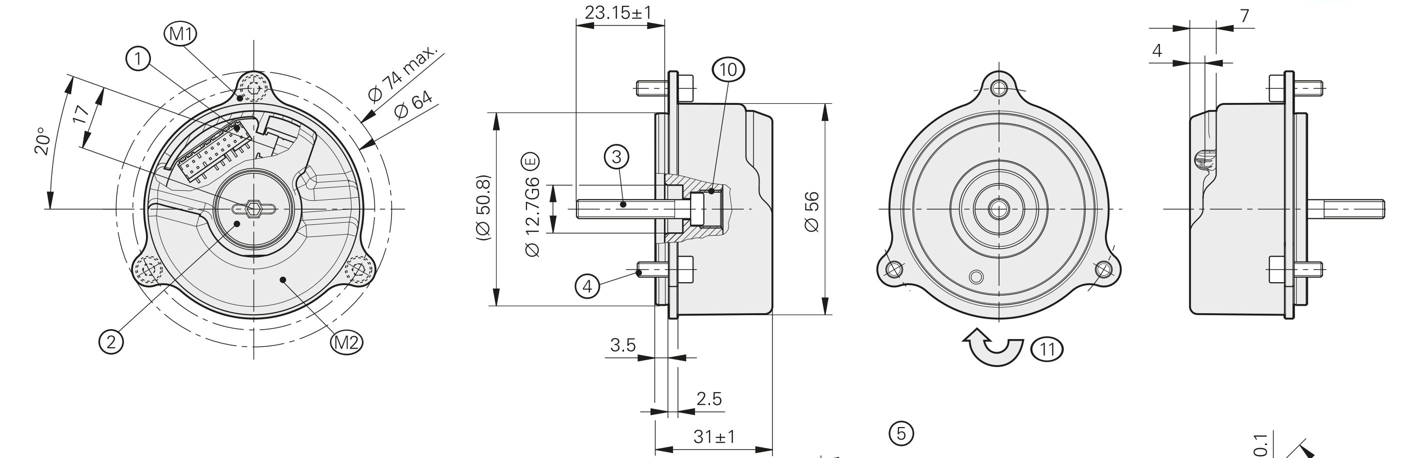
	Absolute	
	ECI 1319	EQI 1331
Interface	EnDat 2.2	
Ordering designation	EnDat01	
Position values/revolution	524288 (19 bits)	
Revolutions	–	4096 (12 bits)
Elec. permissible speed/ Deviation[1]	≤ 3750 rpm/±128 LSB ≤ 15000 rpm/± 512 LSB	≤ 4000 rpm/± 128 LSB ≤ 12000 rpm/± 512 LSB
Calculation time t_{cal} Clock frequency	≤ 8 µs ≤ 2 MHz	
Incremental signals	∿ 1 V_{PP}	
Line count	32	
Cutoff frequency –3 dB	≥ 6 kHz typical	
System accuracy	±180"	
Electrical connection	Via 12-pin PCB connector	
Voltage supply	DC 4.75 V to 10 V	
Power consumption (max.)	*4.75 V:* ≤ 0.62 W *10 V:* ≤ 0.63 W	*4.75 V:* ≤ 0.73 W *10 V:* ≤ 0.74 W
Current consumption (typical)	*5 V:* 85 mA (without load)	*5 V:* 102 mA (without load)
Shaft*	Taper shaft Ø 9.25 mm; Taper 1:10 Blind hollow shaft Ø 12.0 mm; Length 5 mm	
Moment of inertia of rotor	*Tapered shaft:* $2.1 \cdot 10^{-6}$ kgm^2 *Hollow shaft:* $2.8 \cdot 10^{-6}$ kgm^2	
Mech. permiss. speed n	≤ 15000 rpm	≤ 12000 rpm
Permissible axial motion of measured shaft	–0.2/+0.4 mm with 0.5 mm scale-to-reticle gap	
Vibration 55 Hz to 2000 Hz **Shock** 6 ms	≤ 200 m/s^2 (EN 60068-2-6) ≤ 2000 m/s^2 (EN 60068-2-27)	
Max. operating temp.	115 °C	
Min. operating temp.	–20 °C	
Protection EN 60529	IP20 when mounted	
Mass	≈ 0.13 kg	
Valid for ID	811811-xx	811814-xx

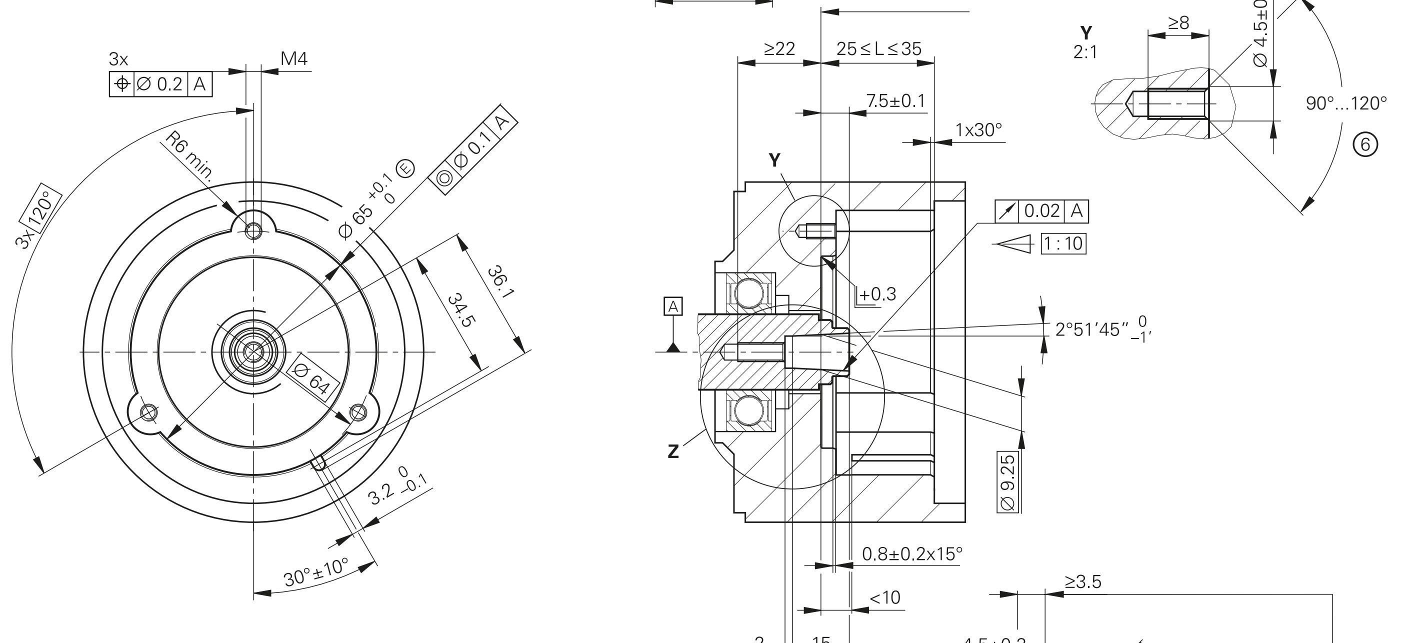
***** Please select when ordering
[1] Velocity-dependent deviations between the absolute and incremental signals

ECI/EQI 1300 series

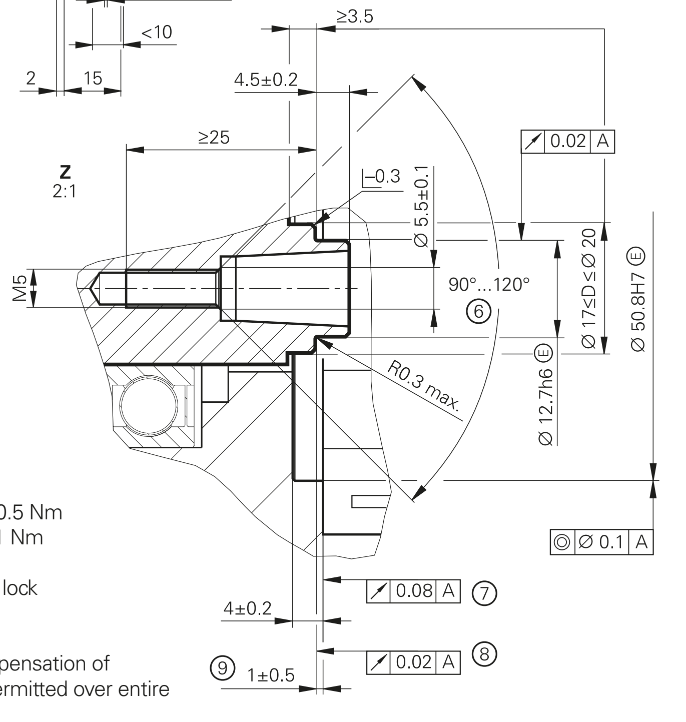
Absolute rotary encoders

- **Mounting-compatible to photoelectric rotary encoders with 07B stator coupling**
- **0YA flange for axial mounting**
- **Blind hollow shaft, Ø 12.7 mm 44C**
- **Without integral bearing**
- **Cost-optimized mating dimensions upon request**





D1	D2
Ø 12.7G6 Ⓔ	Ø 12.7h6 Ⓔ



mm

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

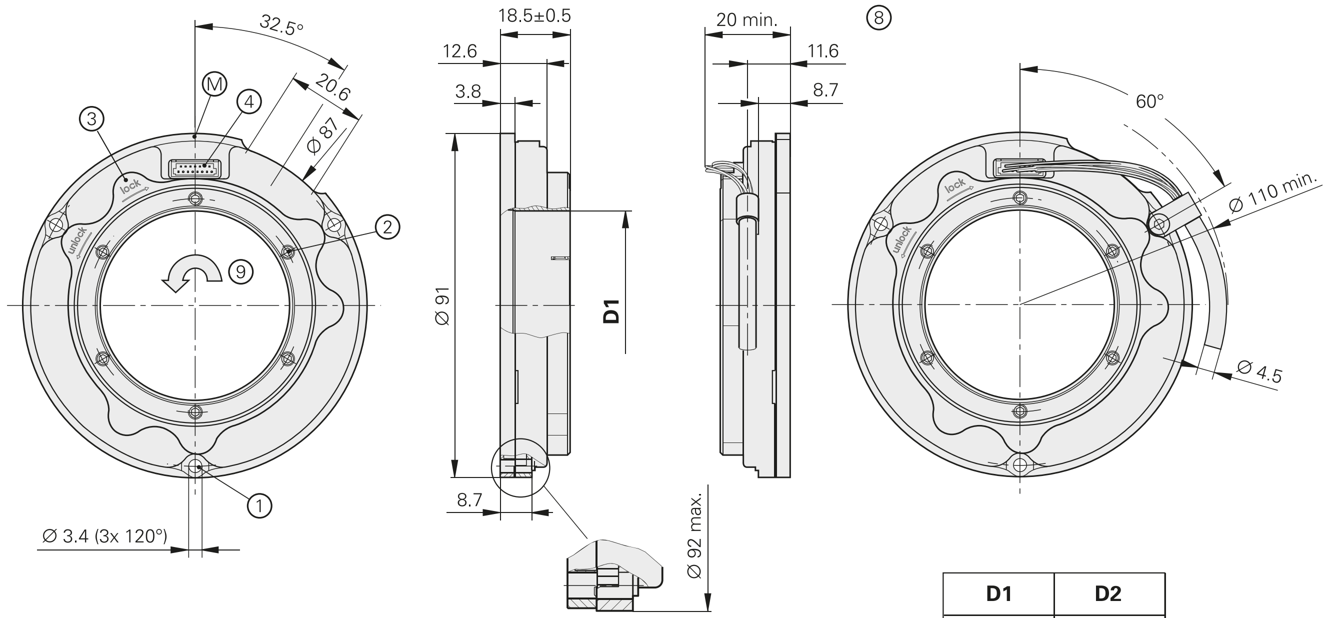
Ⓐ = Bearing of mating shaft
Ⓜ1 = Measuring point for operating temperature
Ⓜ2 = Measuring point for vibration, see also D 741714
① = PCB connector, 12-pin and 4-pin
② = Screw plug width A/F 3 and 4, tightening torque 5 Nm + 0.5 Nm
③ = Screw, ISO 6912 – M5x30 – 08.8 – MKL SW4, tightening torque 5 Nm + 0.5 Nm
④ = Screw, ISO 4762 – M4x10 – 8.8 – MKL SW3, tightening torque 2 Nm ±0.1 Nm
⑤ = Functional diameter of taper for ECN/EQN 13xx
⑥ = Chamfer at start of thread is obligatory for materially bonding anti-rotation lock
⑦ = Flange surface ExI/resolver; ensure full-surface contact!
⑧ = Shaft; ensure full-surface contact!
⑨ = Maximum permissible deviation between shaft and flange surfaces. Compensation of mounting tolerances and thermal expansion. ECI/EQI: Dynamic motion permitted over entire range. ECN/EQN: No dynamic motion permitted
⑩ = M10 back-off thread
⑪ = Direction of shaft rotation for output signals as per the interface description

	Absolute	
	ECI 1319 Functional Safety	**EQI 1331** Functional Safety
Interface	EnDat 2.2	
Ordering designation	EnDat22	
Position values/revolution	524 288 (19 bits)	
Revolutions	–	4096 (12 bits)
Elec. permissible speed/ Deviation[1]	≤ 15 000 rpm (for continuous position value)	
Calculation time t_{cal} Clock frequency	≤ 5 µs ≤ 16 MHz	
System accuracy	±65"	
Electrical connection via PCB connector	*Rotary encoder:* 12-pin *Temperature sensor:*[1] 4-pin	
Cable length	≤ 100 m	
Voltage supply	DC 3.6 V to 14 V	
Power consumption (max.)	*At 3.6 V:* ≤ 0.65 W *At 14 V:* ≤ 0.7 W	*At 3.6 V:* ≤ 0.75 W *At 14 V:* ≤ 0.85 W
Current consumption (typical)	*At 5 V:* 95 mA (without load)	*At 5 V:* 115 mA (without load)
Shaft	Blind hollow shaft for axial clamping ∅ 12.7 mm	
Mech. permiss. speed n	≤ 15 000 rpm	≤ 12 000 rpm
Moment of inertia of rotor	$2.6 \cdot 10^{-6}$ kgm^2	
Permissible axial motion of measured shaft	±0.5 mm	
Vibration 55 Hz to 2000 Hz[2] **Shock** 6 ms	*Stator:* ≤ 400 m/s^2; *Rotor:* ≤ 600 m/s^2 (EN 60 068-2-6) ≤ 2000 m/s^2 (EN 60 068-2-27)	
Max. operating temp.	115 °C	
Min. operating temp.	–40 °C	
Trigger threshold of error message for excessive temperature	130 °C (measuring accuracy of internal temperature sensor: ±1 K)	
Protection EN 60 529	IP20 when mounted	
Mass	≈ 0.13 kg	
Valid for ID	810661-xx	810662-xx

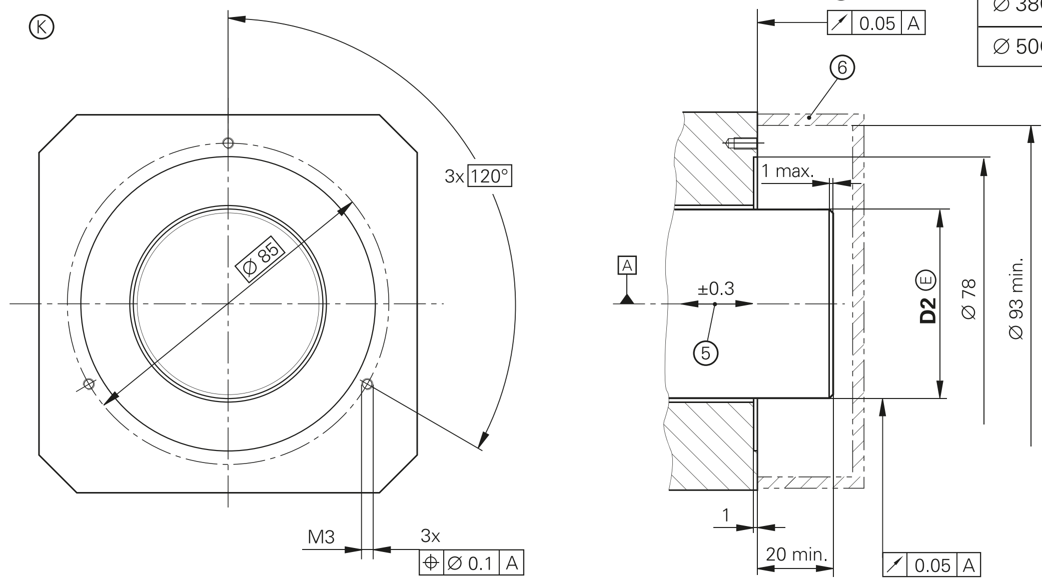
[1] Evaluation optimized for KTY 84-130
[2] 10 Hz to 55 Hz constant over distance 4.9 mm peak to peak
Functional safety available. For dimensions and specifications see the Product Information document

ECI/EBI 100 series

Absolute rotary encoders
- **Flange for axial mounting**
- **Hollow through shaft**
- **Without integral bearing**
- **EBI 135: Multiturn function via battery-buffered revolution counter**



D1	D2
Ø 30G6	Ø 30h7
Ø 38G6	Ø 38h7
Ø 50G6	Ø 50h7



mm

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

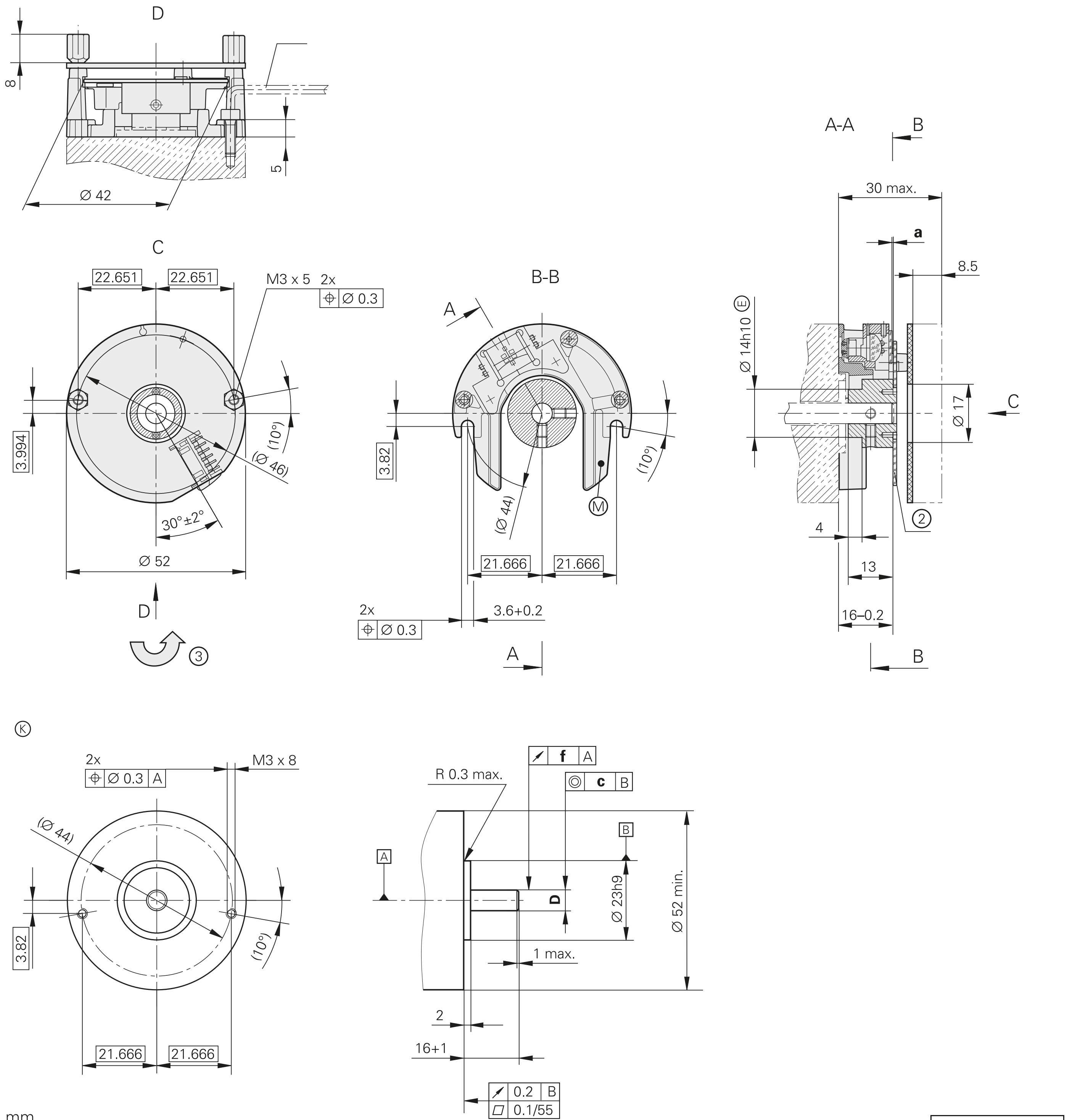
A = Bearing of mating shaft
K = Required mating dimensions
M = Measuring point for operating temperature
① = Cylinder head screw, ISO 4762-M3 with washer ISO 7092 (3x). Tightening torque 0.9 Nm ±0.05 Nm
② = Width A/F 2.0 (6x). Evenly tighten crosswise with increasing tightening torque; final tightening torque 0.5 Nm ±0.05 Nm
③ = Shaft detent: For function, see Mounting Instructions
④ = PCB connector 15-pin
⑤ = Compensation of mounting tolerances and thermal expansion, no dynamic motion
⑥ = Protection against contact as per EN 60 529
⑦ = Required up to max. Ø 92 mm
⑧ = Required mounting frame for output cable with cable clamp (accessory). Bending radius of connecting wires min. R3
⑨ = Direction of shaft rotation for output signals as per the interface description

	Absolute		
	ECI 119		**EBI 135**
Interface*	EnDat 2.1	EnDat 2.2	EnDat 2.2
Ordering designation	EnDat01	EnDat22[1]	EnDat22[1]
Position values/revolution	524 288 (19 bits)		
Revolutions	–		65 536 (16 bits)[2]
Elec. permissible speed/ Deviation[3]	≤ 3000 rpm/±128 LSB ≤ 6000 rpm/±256 LSB	≤ 6000 rpm (for continuous position value)	
Calculation time t_{cal} Clock frequency	≤ 8 µs ≤ 2 MHz	≤ 6 µs ≤ 16 MHz	
Incremental signals	∿ 1 V_{PP}	–	–
Line count	32	–	–
Cutoff frequency –3 dB	≥ 6 kHz typical	–	–
System accuracy	±90"		
Electrical connection via PCB connector	15-pin	15-pin (with connection for temperature sensor[5])	
Voltage supply	DC 3.6 V to 14 V		*Rotary encoders* U_P: DC 3.6 V to 14 V *Buffer battery* U_{BAT}: DC 3.6 V to 5.25 V
Power consumption (max.)	*3.6 V:* ≤ 0.58 W *14 V:* ≤ 0.7 W	*Normal operation at 3.6 V:* 0.53 W *Normal operation at 14 V:* 0.63 W	
Current consumption (typical)	*5 V:* 80 mA (without load)	*5 V:* 75 mA (without load)	*Normal operation at 5 V:* 75 mA (without load) *Buffer mode*[4]: 25 µA (with rotating shaft) 12 µA (at standstill)
Shaft*	Hollow through shaft D = 30 mm, 38 mm, 50 mm		
Mech. permiss. speed n	≤ 6000 rpm		
Moment of inertia of rotor	*D = 30 mm:* $64 \cdot 10^{-6}$ kgm^2 *D = 38 mm:* $58 \cdot 10^{-6}$ kgm^2 *D = 50 mm:* $64 \cdot 10^{-6}$ kgm^2		
Permissible axial motion of measured shaft	±0.3 mm		
Vibration 55 Hz to 2000 Hz[6] **Shock** 6 ms	≤ 300 m/s^2 (EN 60 068-2-6) ≤ 1000 m/s^2 (EN 60 068-2-27)		
Max. operating temp.	115 °C		
Min. operating temp.	–20 °C		
Protection EN 60 529	IP20 when mounted[7]		
Mass	*D = 30 mm:* ≈ 0.19 kg *D = 38 mm:* ≈ 0.16 kg *D = 50 mm:* ≈ 0.14 kg		
Valid for ID	823406-xx	823407-xx	823405-xx

* Please select when ordering
1) Valuation numbers are not supported
2) Compliance with the EnDat specification 297 403 and the EnDat Application Notes 722 024, Chapter 13, *Battery-buffered encoders,* is required for correct control of the encoder.
3) Velocity-dependent deviations between the absolute and incremental signals
4) At T = 25 °C; U_{BAT} = 3.6 V
5) Evaluation optimized for KTY 84-130
6) 10 to 55 Hz constant over distance 4.9 mm peak to peak
7) CE compliance of the complete system must be ensured by taking the correct measures during installation.

ERO 1200 series

Incremental rotary encoders
- **Flange for axial mounting**
- **Hollow through shaft**
- **Without integral bearing**



mm

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

D
Ø 10h6 Ⓔ
Ø 12h6 Ⓔ

	Z	a	f	c
ERO 1225	1024	0.4 ±0.2	0.05	Ø 0.02
	2048	0.2 ±0.05		
ERO 1285	1024 2048	0.2 ±0.03	0.03	Ø 0.02

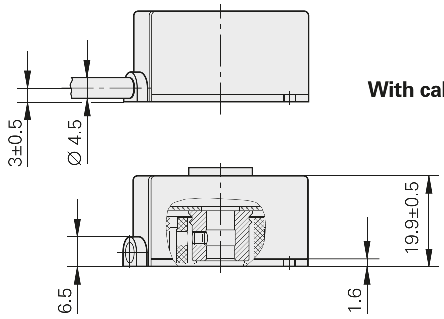
Ⓐ = Bearing
Ⓚ = Required mating dimensions
Ⓜ = Measuring point for operating temperature
① = Circular scale with hub
② = Offset screwdriver, ISO 2936 – 2.5 (l_2 shortened)
③ = Direction of shaft rotation for output signals as per the interface description

	Incremental	
	ERO 1225	**ERO 1285**
Interface	⊓⊔TTL	∿ 1 V_{PP}
Line count*	1024 2048	
Accuracy of graduation[2]	±6"	
Reference mark	One	
Output frequency Edge separation a Cutoff frequency –3 dB	≤ 300 kHz ≥ 0.39 µs –	– – ≥ 180 kHz typical
System accuracy[1]	*1024 lines:* ±92" *2048 lines:* ±73"	*1024 lines:* ±67" *2048 lines:* ±60"
Electrical connection	Via 12-pin PCB connector	
Voltage supply	DC 5 V ±0.5 V	
Current consumption (without load)	≤ 150 mA	
Shaft*	Hollow through shaft D = 10 mm oder D = 12 mm	
Moment of inertia of rotor	*Shaft diameter 10 mm:* 2.2 · 10^{-6} kgm^2 *Shaft diameter 12 mm:* 2.2 · 10^{-6} kgm^2	
Mech. permiss. speed n	≤ 25000 rpm	
Permissible axial motion of measured shaft	*1024 lines:* ±0.2 mm *2048 lines:* ±0.05 mm	±0.03 mm
Vibration 55 Hz to 2000 Hz **Shock** 6 ms	≤ 100 m/s^2 (EN 60068-2-6) ≤ 1000 m/s^2 (EN 60068-2-27)	
Max. operating temp.	100 °C	
Min. operating temp.	–40 °C	
Protection EN 60529	IP00[3]	
Mass	≈ 0.07 kg	
Valid for ID	1037519-xx	1037520-xx

* Please select when ordering
[1] Before installation. Additional errors caused by mounting inaccuracy and inaccuracy from the bearing of the drive shaft are not included
[2] For other errors, see *Measuring accuracy*
[3] CE compliance of the complete system must be ensured by taking the correct measures during installation.

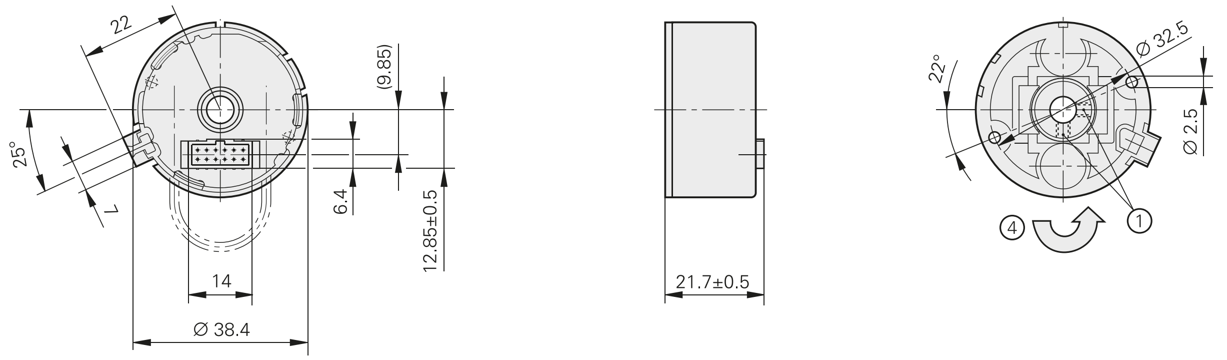
ERO 1400 series

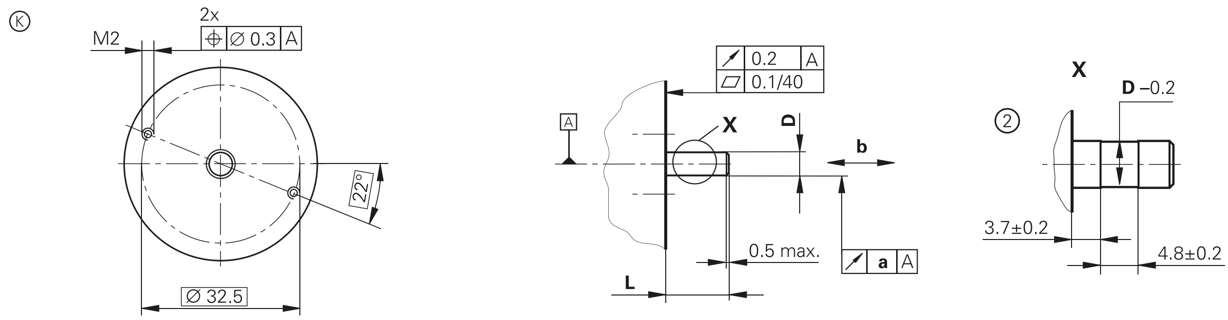
Incremental rotary encoders
- **Flange for axial mounting**
- **Hollow through shaft**
- **Without integral bearing; self-centering**

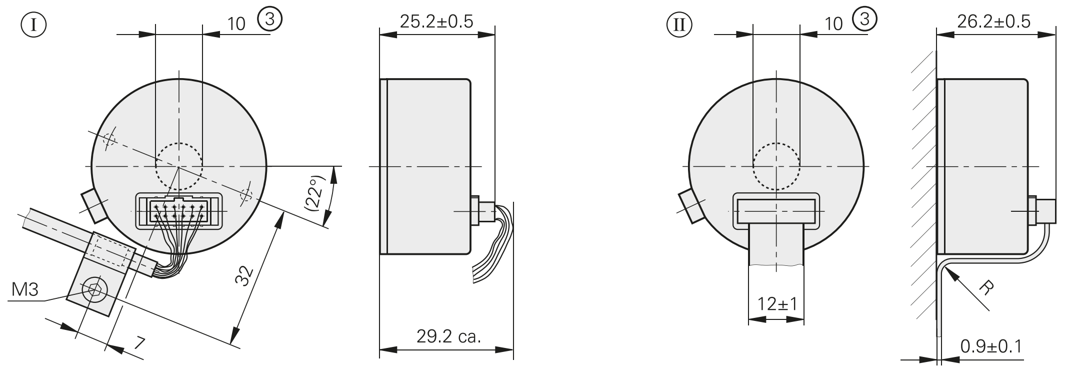


With cable outlet

With axial PCB connector

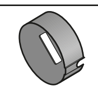
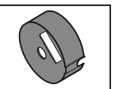






Axial PCB connector and round cable

Axial PCB connector and ribbon cable

		
L	13+4.5/–3	10 min.

mm

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

Bend radius R	**Fixed cable**	**Frequent flexing**
Ribbon cable	R ≥ 2 mm	R ≥ 10 mm

	a	**b**	**D**
ERO 1420	0.03	±0.1	Ø 4h6 Ⓔ
ERO 1470	0.02	±0.05	Ø 6h6 Ⓔ
ERO 1480			Ø 8h6 Ⓔ

Ⓐ = Bearing of mating shaft
Ⓚ = Required mating dimensions
Ⓘ = Accessory: Round cable
Ⓘⓘ = Accessory: Ribbon cable
① = Setscrew, 2x90° offset M3 SW1.5 Md = 0.25 Nm ±0.05 Nm
② = Version for repeated mounting
③ = Version featuring housing with central hole (accessory)
④ = Direction of shaft rotation for output signals as per the interface description

	Incremental					
	ERO 1420	**ERO 1470**				**ERO 1480**
Interface	⊓⊔TTL					∼ 1 V_{PP}
Line count*	512 **1000** **1024**	**1000** 1500				512 **1000** **1024**
Integrated interpolation*	–	5-fold	**10-fold**	20-fold	25-fold	–
Signal periods/revolution	512 1000 1024	5000 7500	10000 15000	20000 30000	25000 37500	512 1000 1024
Edge separation a	≥ 0.39 µs	≥ 0.47 µs	≥ 0.22 µs	≥ 0.17 µs	≥ 0.07 µs	–
Scanning frequency	≤ 300 kHz	≤ 100 kHz		≤ 62.5 kHz	≤ 100 kHz	–
Cutoff frequency –3 dB	–					≥ 180 kHz
Reference mark	One					
System accuracy[1]	*512 lines:* ±139" *1000 lines:* ±112" *1024 lines:* ±112"	*1000 lines:* ±130" *1500 lines:* ±114"				*512 lines:* ±190" *1000 lines:* ±163" *1024 lines:* ±163"
Electrical connection*	Via **PCB connector**, 12-pin, axial[3]					
Voltage supply	DC 5 V ±0.5 V	DC 5 V ± 0.25 V				DC 5 V ± 0.5 V
Current consumption (without load)	≤ 150 mA	≤ 155 mA		≤ 200 mA		≤ 150 mA
Shaft*	**Blind hollow shaft** D= 4 mm; **D = 6 mm** or D= 8 mm or hollow through shaft in housing with bore (accessory)					
Moment of inertia of rotor	*Shaft diameter 4 mm:* $0.28 \cdot 10^{-6}$ kgm^2 *Shaft diameter 6 mm:* $0.27 \cdot 10^{-6}$ kgm^2 *Shaft diameter 8 mm:* $0.25 \cdot 10^{-6}$ kgm^2					
Mech. permiss. speed n	≤ 30000 rpm					
Permissible axial motion of measured shaft	±0.1 mm	±0.05 mm				
Vibration 55 Hz to 2000 Hz **Shock** 6 ms	≤ 100 m/s^2 (EN 60068-2-6) ≤ 1000 m/s^2 (EN 60068-2-27)					
Max. operating temp.	70 °C					
Min. operating temp.	–10 °C					
Protection EN 60529	*With PCB connector:* IP00[2] *With cable outlet:* IP40					
Mass	≈ 0.07 kg					
Valid for ID	360731-xx	360736-xx				360737-xx

Bold: These preferred versions are available on short notice
***** Please select when ordering
1) Before installation. Additional errors caused by mounting inaccuracy and inaccuracy from the bearing of the drive shaft are not included
2) CE compliance of the complete system must be ensured by taking the correct measures during installation.
3) Cable 1 m, radial, without connecting element (not with ERO 1470) upon request

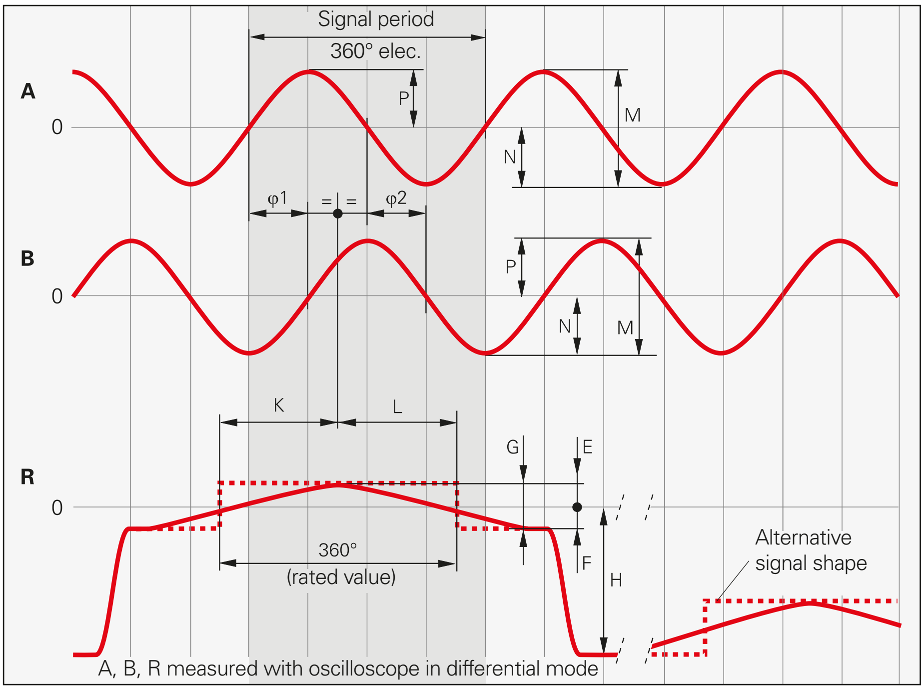
Interfaces
Incremental signals ∿ 1 V_{PP}

HEIDENHAIN encoders with ∿ 1 V_{PP} interface provide voltage signals that can be highly interpolated.

The sinusoidal **incremental signals** A and B are phase-shifted by 90° elec. and have amplitudes of typically 1 V_{PP}. The illustrated sequence of output signals—with B lagging A—applies for the direction of motion shown in the dimension drawing.

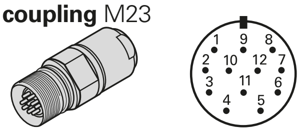
The **reference mark signal** R has an unambiguous assignment to the incremental signals. The output signal might be somewhat lower next to the reference mark.

For comprehensive descriptions of all available interfaces as well as general electrical information, see the *Interfaces of HEIDENHAIN Encoders* brochure, ID 1078628-xx.

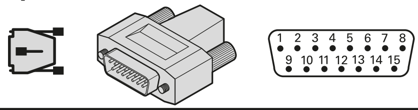


Pin layout

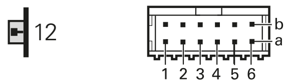
12-pin coupling M23



15-pin D-sub connector for PWM 20



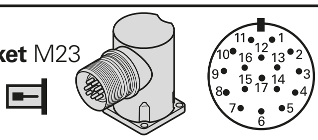
12-pin PCB connector



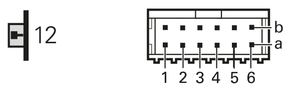
	Voltage supply				Incremental signals						Other signals		
	12	**2**	**10**	**11**	**5**	**6**	**8**	**1**	**3**	**4**	**9**	**7**	**/**
	4	**12**	**2**	**10**	**1**	**9**	**3**	**11**	**14**	**7**	**5/6/8/15**	**13**	**/**
12	**2a**	**2b**	**1a**	**1b**	**6b**	**6a**	**5b**	**5a**	**4b**	**4a**	**3b**	**3a**	**/**
Signal	**U_P**	**Sensor**[1] U_P	**0 V**	**Sensor**[1] 0 V	**A+**	**A–**	**B+**	**B–**	**R+**	**R–**	**Vacant**	**Vacant**	**Vacant**
Wire colour	Brown/ Green	Blue	White/ Green	White	Brown	Green	Gray	Pink	Red	Black	/	Violet	Yellow

Output cable for ERN 1381 in the motor
ID 667343-01

17-pin flange socket M23



12-pin PCB connector



	Voltage supply				Incremental signals						Other signals		
	7	**1**	**10**	**4**	**15**	**16**	**12**	**13**	**3**	**2**	**5**	**6**	**8/9/11/ 14/17**
12	**2a**	**2b**	**1a**	**1b**	**6b**	**6a**	**5b**	**5a**	**4b**	**4a**	**/**	**/**	**3a/3b**
Signal	**U_P**	**Sensor** U_P	**0 V**	**Sensor** 0V	**A+**	**A–**	**B+**	**B–**	**R+**	**R–**	**T+**[2]	**T–**[2]	**Vacant**
Wire colour	Brown/ Green	Blue	White/ Green	White	Brown	Green	Gray	Pink	Red	Black	Brown[2]	White[2]	/

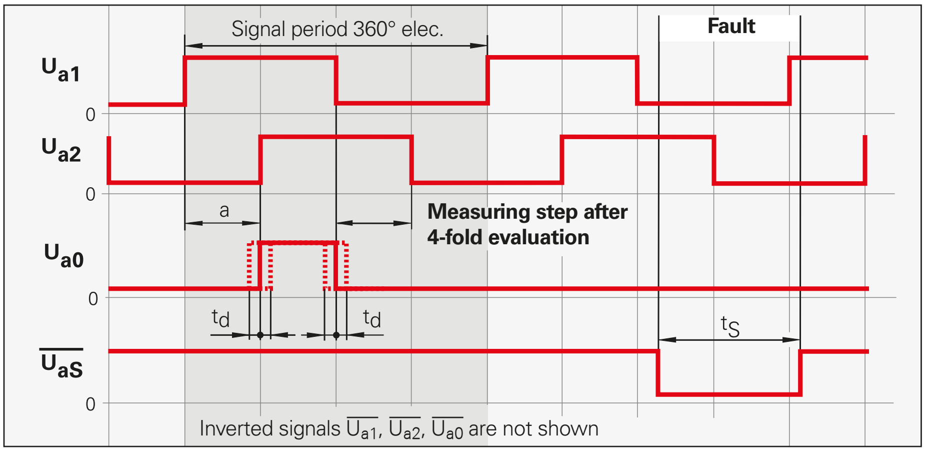
Cable shield connected with housing; **U_P** = Power supply; [1] **LIDA 2xx:** vacant; [2] Only for encoder cable inside the motor housing
Sensor: The sensor line is connected in the encoder with the corresponding power line.
Vacant pins or wires must not be used.

Incremental signals ⊓⊔TTL

HEIDENHAIN encoders with ⊓⊔TTL interface incorporate electronics that digitize sinusoidal scanning signals with or without interpolation.

The **incremental signals** are transmitted as the square-wave pulse trains U_{a1} and U_{a2}, phase-shifted by 90° elec. The **reference mark signal** consists of one or more reference pulses U_{a0}, which are gated with the incremental signals. In addition, the integrated electronics produce their **inverse signals** $\overline{U_{a1}}$, $\overline{U_{a2}}$ and $\overline{U_{a0}}$ for noise-proof transmission. The illustrated sequence of output signals—with U_{a2} lagging U_{a1}—applies to the direction of motion shown in the dimension drawing.

The **fault detection signal** $\overline{U_{aS}}$ indicates fault conditions such as an interruption in the supply lines, failure of the light source, etc.

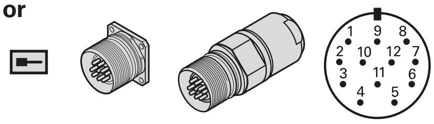


The distance between two successive edges of the incremental signals U_{a1} and U_{a2} through 1-fold, 2-fold or 4-fold evaluation is one **measuring step.**

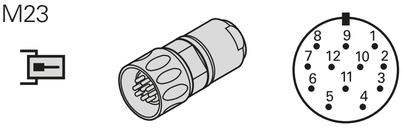
For comprehensive descriptions of all available interfaces as well as general electrical information, see the *Interfaces of HEIDENHAIN Encoders* brochure, ID 1078628-xx.

Pin layout

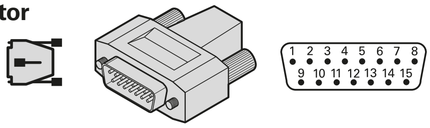
12-pin flange socket or coupling, M23



12-pin connector M23



15-pin D-sub connector
For IK 215/PWM 20



12-pin PCB connector

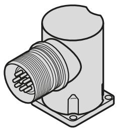
	Voltage supply				Incremental signals						Other signals		
Flange socket / coupling / connector M23	**12**	**2**	**10**	**11**	**5**	**6**	**8**	**1**	**3**	**4**	**7**	**/**	**9**
15-pin D-sub	**4**	**12**	**2**	**10**	**1**	**9**	**3**	**11**	**14**	**7**	**13**	**5/6/8**	**15**
PCB connector 12	**2a**	**2b**[1]	**1a**	**1b**[1]	**6b**	**6a**	**5b**	**5a**	**4b**	**4a**	**3a**	**3b**	**/**
	U_P	**Sensor** U_P	**0 V**	**Sensor** 0 V	**U_{a1}**	**$\overline{U_{a1}}$**	**U_{a2}**	**$\overline{U_{a2}}$**	**U_{a0}**	**$\overline{U_{a0}}$**	**$\overline{U_{aS}}$**[1]	**Vacant**	**Vacant**[2]
Cable	Brown/ Green	Blue	White/ Green	White	Brown	Green	Gray	Pink	Red	Black	Violet	/	Yellow

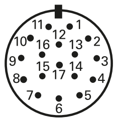
Cable shield connected to housing; **U_P** = Power supply voltage
Sensor: The sensor line is connected in the encoder with the corresponding power line.
Vacant pins or wires must not be used.
[1] **ERO 14xx:** vacant
[2] **Exposed linear encoders:** TTL/11 µAPP switchover for PWT, otherwise vacant

Pin layout

Output cable for ERN 1321 in the motor
ID 667343-01

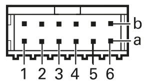
17-pin flange socket M23





12-pin PCB connector

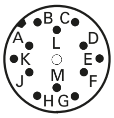
12



	Voltage supply				Incremental signals						Other signals		
	7	**1**	**10**	**4**	**15**	**16**	**12**	**13**	**3**	**2**	**5**	**6**	**8/9/11/ 14/17**
12	**2a**	**2b**	**1a**	**1b**	**6b**	**6a**	**5b**	**5a**	**4b**	**4a**	**/**	**/**	**3a/3b**
	U_P	**Sensor** U_P	**0 V**	**Sensor** 0V	**U_{a1}**	**$\overline{U_{a1}}$**	**U_{a2}**	**$\overline{U_{a2}}$**	**U_{a0}**	**$\overline{U_{a0}}$**	**T+**[1)]	**T–**[1)]	**Vacant**
	Brown/ Green	Blue	White/ Green	White	Brown	Green	Gray	Pink	Red	Black	Brown[1)]	White[1)]	/

ERN 421 pin layout

12-pin Binder flange socket



	Voltage supply				Incremental signals						Other signals	
	M	**B**	**K**	**L**	**E**	**F**	**H**	**A**	**C**	**D**	**G**	**J**
	U_P	**Sensor** U_P	**0 V**	**Sensor** 0 V	**U_{a1}**	**$\overline{U_{a1}}$**	**U_{a2}**	**$\overline{U_{a2}}$**	**U_{a0}**	**$\overline{U_{a0}}$**	**$\overline{U_{aS}}$**	**Vacant**
	Brown/ Green	Blue	White/ Green	White	Brown	Green	Gray	Pink	Red	Black	Violet	Yellow

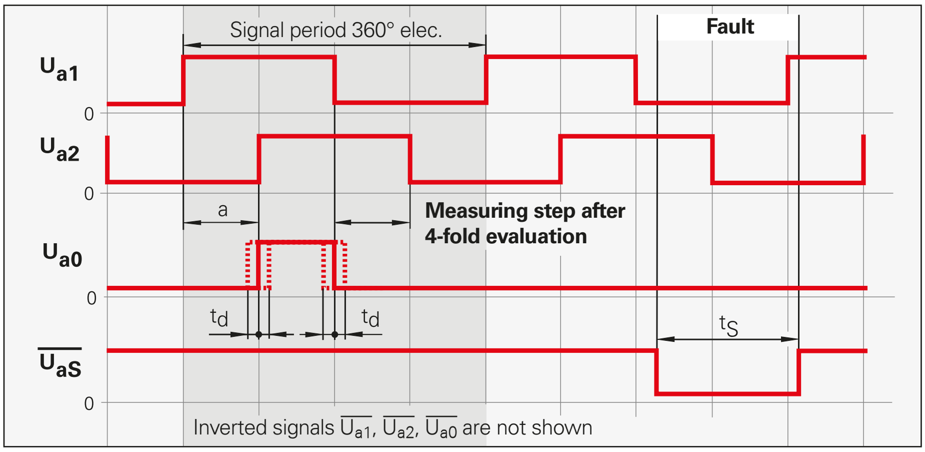
Cable shield connected to housing; **U_P** = Power supply voltage
Sensor: The sensor line is connected in the encoder with the corresponding power line.
Vacant pins or wires must not be used.
1) Only for cables inside the motor housing

Incremental signals ⊓⊔ HTL, HTLs

HEIDENHAIN encoders with ⊓⊔ HTL interface incorporate electronics that digitize sinusoidal scanning signals with or without interpolation.

The **incremental signals** are transmitted as the square-wave pulse trains U_{a1} and U_{a2}, phase-shifted by 90° elec. The **reference mark signal** consists of one or more reference pulses U_{a0}, which are gated with the incremental signals. In addition, the integrated electronics produce their **inverted signals** $\overline{U_{a1}}$, $\overline{U_{a2}}$ and $\overline{U_{a0}}$ for noise-proof transmission (not with HTLs). The illustrated sequence of output signals—with U_{a2} lagging U_{a1}—applies to the direction of motion shown in the dimension drawing.

The **fault detection signal** $\overline{U_{aS}}$ indicates fault conditions, for example a failure of the light source.

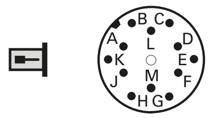


The distance between two successive edges of the incremental signals U_{a1} and U_{a2} through 1-fold, 2-fold or 4-fold evaluation is one **measuring step.**

For comprehensive descriptions of all available interfaces as well as general electrical information, see the *Interfaces of HEIDENHAIN Encoders* brochure, ID 1078628-xx.

ERN 431 pin layout

12-pin Binder flange socket



	Voltage supply				Incremental signals						Other signals	
	M	**B**	**K**	**L**	**E**	**F**	**H**	**A**	**C**	**D**	**G**	**J**
	U_P	**Sensor** U_P	**0 V**	**Sensor** 0 V	**U_{a1}**	**$\overline{U_{a1}}$**	**U_{a2}**	**$\overline{U_{a2}}$**	**U_{a0}**	**$\overline{U_{a0}}$**	**$\overline{U_{aS}}$**	**Vacant**
	Brown/ Green	Blue	White/ Green	White	Brown	Green	Gray	Pink	Red	Black	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.

Commutation signals for block commutation

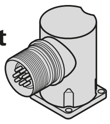
The **block commutation signals U, V and W** are derived from three separate absolute tracks. They are transmitted as square-wave signals in TTL levels.

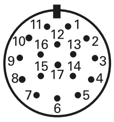
The **ERN 1x23** and **ERN 1326** are rotary encoders with commutation signals for block commutation.

For comprehensive descriptions of all available interfaces as well as general electrical information, see the *Interfaces of HEIDENHAIN Encoders* brochure, ID 1078628-xx.

ERN 1123, ERN 1326 pin layout

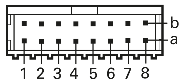
17-pin flange socket
M23





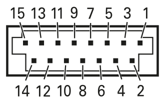
16-pin PCB connector

16



15-pin PCB connector

15



	Voltage supply				Incremental signals					
	7	**1**	**10**	**11**	**15**	**16**	**12**	**13**	**3**	**2**
16	**1b**	**2b**	**1a**	**/**	**5b**	**5a**	**4b**	**4a**	**3b**	**3a**
15	**13**	**/**	**14**	**/**	**1**	**2**	**3**	**4**	**5**	**6**
	U_P	**Sensor** U_P	**0 V**	**Internal shield**	**U_{a1}**	**$\overline{U_{a1}}$**	**U_{a2}**	**$\overline{U_{a2}}$**	**U_{a0}**	**$\overline{U_{a0}}$**
	Brown/ Green	Blue	White/ Green	/	Green/ Black	Yellow/ Black	Blue/ Black	Red/ Black	Red	Black

	Other signals						
	4	**5**	**6**	**14**	**17**	**9**	**8**
16	**2a**	**8b**	**8a**	**6b**	**6a**	**7b**	**7a**
15	**/**	**7**	**8**	**9**	**10**	**11**	**12**
	$\overline{U_{aS}}$	**U**	**$\overline{U}$**	**V**	**$\overline{V}$**	**W**	**$\overline{W}$**
	White	Green	Brown	Yellow	Violet	Gray	Pink

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.

Pin layout for ERN 1023

	Voltage supply		Incremental signals						Other signals					
	U_P	**0 V**	**U_{a1}**	**$\overline{U_{a1}}$**	**U_{a2}**	**$\overline{U_{a2}}$**	**U_{a0}**	**$\overline{U_{a0}}$**	**U**	**$\overline{U}$**	**V**	**$\overline{V}$**	**W**	**$\overline{W}$**
	White	Black	Red	Pink	Olive Green	Blue	Yellow	Orange	Beige	Brown	Green	Gray	Light Blue	Violet

Cable shield connected to housing
U_P = Power supply voltage
Vacant pins or wires must not be used.

Commutation signals for sinusoidal commutation

The **commutation signals C and D** are taken from the Z1 track, and are equal to one sine or cosine period per revolution. They have a signal amplitude of typically 1 V_{PP} at 1 kΩ.

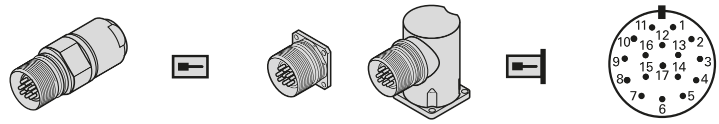
The input circuitry of the subsequent electronics is the same as for the ∼ 1 V_{PP} interface. The required terminating resistance Z_0, however, is 1 kΩ instead of 120 Ω.

The **ERN 1387** is a rotary encoder with output signals for sinusoidal commutation.

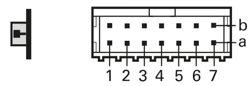
For comprehensive descriptions of all available interfaces as well as general electrical information, see the *Interfaces of HEIDENHAIN Encoders* brochure, ID 1078628-xx.

Pin layout

17-pin coupling or flange socket M23



14-pin PCB connector



	Voltage supply					Incremental signals					
	7	**1**	**10**	**4**	**11**	**15**	**16**	**12**	**13**	**3**	**2**
	1b	**7a**	**5b**	**3a**	**/**	**6b**	**2a**	**3b**	**5a**	**4b**	**4a**
	U_P	**Sensor** U_P	**0 V**	**Sensor** 0 V	**Internal shield**	**A+**	**A–**	**B+**	**B–**	**R+**	**R–**
	Brown/ Green	Blue	White/ Green	White	/	Green/ Black	Yellow/ Black	Blue/ Black	Red/ Black	Red	Black

	Other signals					
	14	**17**	**9**	**8**	**5**	**6**
	7b	**1a**	**2b**	**6a**	**/**	**/**
	C+	**C–**	**D+**	**D–**	**T+**[1)]	**T–**[1)]
	Gray	Pink	Yellow	Violet	Green	Brown

Cable shield connected to housing
U_P = Power supply; **T** = Temperature
Sensor: The sensor line is connected internally with the corresponding power line.
Vacant pins or wires must not be used.
1) Only for cables inside the motor housing

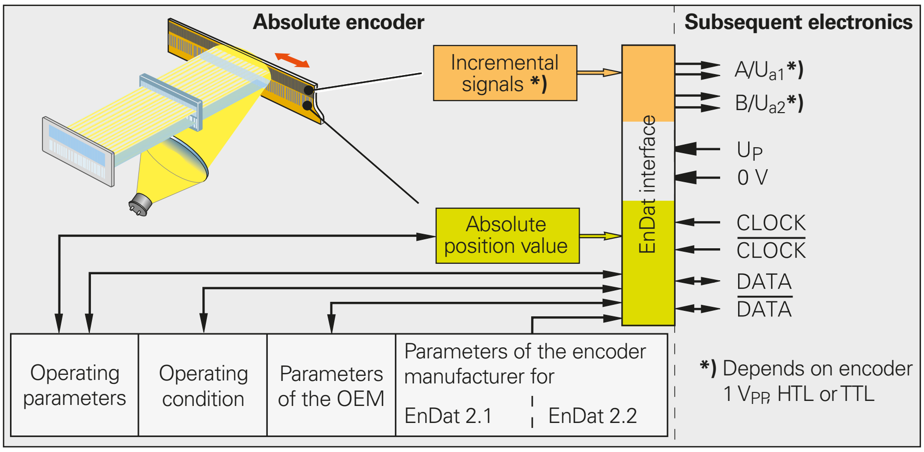
Position values EnDat

The EnDat interface is a digital, **bidirectional** interface for encoders. It is capable of transmitting **position values** as well as transmitting or updating information stored in the encoder, or saving new information. Thanks to the **serial transmission method**, only **four signal lines** are required. The DATA is transmitted in **synchronism** with the CLOCK signal from the subsequent electronics. The type of transmission (position values, parameters, diagnostics ...) is selected by mode commands that the subsequent electronics send to the encoder. Some functions are available only with EnDat 2.2 mode commands.

For comprehensive descriptions of all available interfaces as well as general electrical information, see the *Interfaces of HEIDENHAIN Encoders* brochure, ID 1078628-xx.

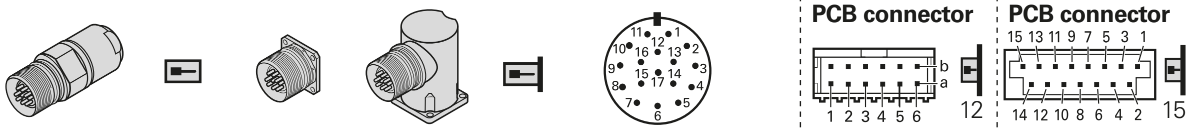
Ordering designation	Command set	Incremental signals
EnDat01 EnDat H EnDat T	EnDat 2.1 or EnDat 2.2	1 V_{PP} HTL TTL
EnDat21		–
EnDat02	EnDat 2.2	1 V_{PP}
EnDat22	EnDat 2.2	–

Versions of the EnDat interface



Pin layout for EnDat01/EnDat02

17-pin coupling or flange socket M23 | **12-pin PCB connector** | **15-pin PCB connector**



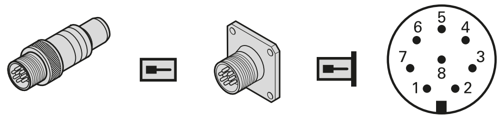
	Power supply voltage					Incremental signals 1)				Position values			
M23	**7**	**1**	**10**	**4**	**11**	**15**	**16**	**12**	**13**	**14**	**17**	**8**	**9**
12	**1b**	**6a**	**4b**	**3a**	**/**	**2a**	**5b**	**4a**	**3b**	**6b**	**1a**	**2b**	**5a**
15	**13**	**11**	**14**	**12**	**/**	**1**	**2**	**3**	**4**	**7**	**8**	**9**	**10**
	U_P	**Sensor** U_P	**0 V**	**Sensor** 0 V	**Internal shield**	**A+**	**A–**	**B+**	**B–**	**DATA**	**$\overline{\text{DATA}}$**	**CLOCK**	**$\overline{\text{CLOCK}}$**
Cable	Brown/ Green	Blue	White/ Green	White	/	Green/ Black	Yellow/ Black	Blue/ Black	Red/ Black	Gray	Pink	Violet	Yellow

	Other signals	
M23	**5**	**6**
12	**/**	**/**
15	**/**	**/**
	T+ 2)	**T–** 2)
Cable	Brown 2)	White 2)

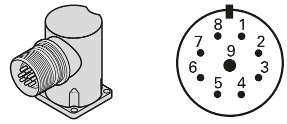
Cable shield connected to housing; **U_P** = Power supply voltage; **T** = Temperature
Sensor: The sensor line is connected in the encoder with the corresponding power line.
Vacant pins or wires must not be used.
1) Only with ordering designations EnDat 01 and EnDat 02
2) Only for cables inside the motor housing

Pin layout for EnDat21/EnDat22

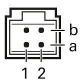
8-pin coupling or flange socket, M12



9-pin flange socket M23

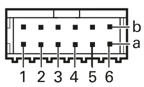


4-pin PCB connector



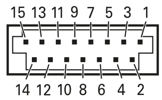
4

12-pin PCB connector



12

15-pin PCB connector



15

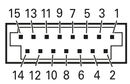
	Power supply voltage				Position values				Other signals	
M12	**8**	**2**	**5**	**1**	**3**	**4**	**7**	**6**	**/**	**/**
M23	**3**	**7**	**4**	**8**	**5**	**6**	**1**	**2**	**/**	**/**
4	**/**	**/**	**/**	**/**	**/**	**/**	**/**	**/**	**1a**	**1b**
12	**1b**	**6a**	**4b**	**3a**	**6b**	**1a**	**2b**	**5a**	**/**	**/**
15	**13**	**11**	**14**	**12**	**7**	**8**	**9**	**10**	**5**	**6**
	U_P	**Sensor** U_P 1)	**0 V**	**Sensor** 0 V 1)	**DATA**	**$\overline{\text{DATA}}$**	**CLOCK**	**$\overline{\text{CLOCK}}$**	**T+** 2)	**T–** 2)
Cable	Brown/ Green	Blue	White/ Green	White	Gray	Pink	Violet	Yellow	Brown	Green

Cable shield connected to housing; **U_P** = Power supply voltage; **T** = Temperature
Sensor: The sensor line is connected in the encoder with the corresponding power line.
Vacant pins or wires must not be used.
1) **ECI 1118 EnDat22:** Vacant 2) Only EnDat22, except ECI 1118

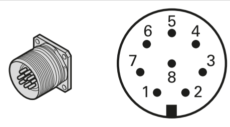
Pin layout of EBI 135/EBI 1135

15-pin PCB connector

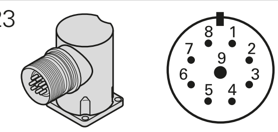
15



8-pin flange socket, M12



9-pin flange socket M23

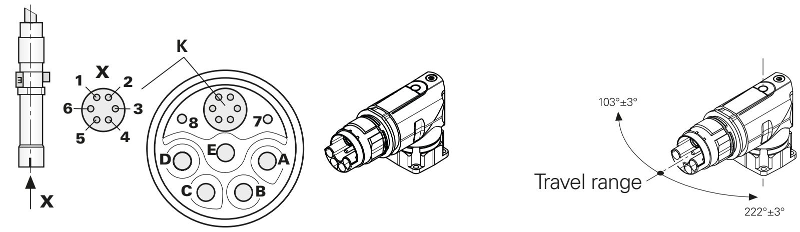


	Power supply voltage				Position values				Other signals 1)	
15	**13**	**11**	**14**	**12**	**7**	**8**	**9**	**10**	**5**	**6**
M12	**8**	**2**	**5**	**1**	**3**	**4**	**7**	**6**	**/**	**/**
M23	**3**	**7**	**4**	**8**	**5**	**6**	**1**	**2**	**/**	**/**
	U_P	**U_{BAT}**	**0 V** 2)	**0 V_{BAT}** 2)	**DATA**	**$\overline{\text{DATA}}$**	**CLOCK**	**$\overline{\text{CLOCK}}$**	**T+**	**T–**
Cable	Brown/ Green	Blue	White/ Green	White	Gray	Pink	Violet	Yellow	Brown	Green

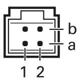
U_P = Power supply; **U_{BAT}** = External buffer battery (false polarity can result in damage to the encoder)
Vacant pins or wires must not be used.
1) Only for EBI 135
2) Connected inside encoder

Pin layout

HMC 6 flange socket

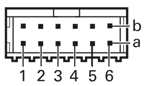


4-pin PCB connector



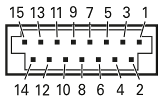
4

12-pin PCB connector



12

15-pin PCB connector



15

	Encoder							
	Power supply voltage		Position values				Other signals	
	1	**2**	**3**	**4**	**5**	**6**	**/**	**/**
4	**/**	**/**	**/**	**/**	**/**	**/**	**1a**	**1b**
12	**1b**	**4b**	**6b**	**1a**	**2b**	**5a**	**/**	**/**
15	**13**	**14**	**7**	**8**	**9**	**10**	**5**	**6**
	U_P	**0 V**	**DATA**	**$\overline{\text{DATA}}$**	**CLOCK**	**$\overline{\text{CLOCK}}$**	**T+** [1]	**T–** [1]
	Brown/Green	White/Green	Gray	Pink	Violet	Yellow	Brown	Green

	Motor						
	Brake		Power				
	7	**8**	**A**	**B**	**C**	**D**	**E**
	BRAKE–	**BRAKE+**	**U**	**V**	**W**	**/**	**PE**
	White	White/Black	Blue	Brown	Black	/	Yellow/ Green

External shield of the encoder output cable on communication element housing **K.**
Vacant pins or wires must not be used.
[1] Except for ECI 1118

DRIVE-CLiQ interface

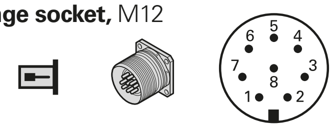
HEIDENHAIN encoders with the code letter S after the model designation are suited for connection to Siemens controls with **DRIVE-CLiQ interface**
- Ordering designation DQ01

For comprehensive descriptions of all available interfaces as well as general electrical information, see the *Interfaces of HEIDENHAIN Encoders* brochure, ID 1078628-xx.

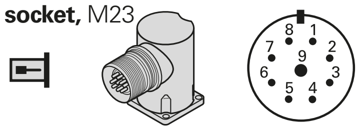
DRIVE-CLiQ is a registered trademark of SIEMENS AG.

Siemens pin layout

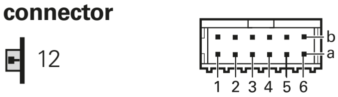
8-pin flange socket, M12



9-pin right-angle socket, M23



12-pin PCB connector



4-pin PCB connector

	Voltage supply		Absolute position values				Other signals[1]	
M12	**1**	**5**	**3**	**4**	**7**	**6**	**/**	**/**
M23	**8**	**4**	**5**	**6**	**1**	**2**	**/**	**/**
12	**3a**	**4b**	**6b**	**1a**	**2b**	**5a**	**/**	**/**
4	**/**	**/**	**/**	**/**	**/**	**/**	**1a**	**1b**
	U_P	**0 V**	**RXP**	**RXN**	**TXP**	**TXN**	**T+**[2]	**T–**[2]
Cable	White	White/Green	Gray	Pink	Violet	Yellow	Brown	Green

Cable shield connected to housing; **U_P** = Power supply voltage
Vacant pins or wires must not be used.
Encoder cables with a cable length > 0.5 m require strain relief of the cable

1) Only for cables inside the motor housing
2) Connections for external temperature sensor; evaluation optimized for KTY 84-130 (see *Temperature measurement in motors* in the *Encoders for Servo Drives* catalog

EBI 135/EBI 1135 – external buffer battery

The multiturn function of the EBI 135 and EBI 1135 is realized through a revolution counter. To prevent loss of the absolute position information during power failure, the EBI must be operated with an external buffer battery.

A lithium-thionyl chloride battery with 3.6 V and 1200 mAh is recommended as buffer battery. The typical service life is over nine years with appropriate conditions (two shifts of ten hours each in normal operation; battery temperature 25 °C; typical self-discharging). To achieve this, the main power supply (U_P) must be connected to the encoder while connecting the backup battery, or directly thereafter, in order for the encoder to become fully initialized after having been completely powerless. Otherwise the encoder will consume a significantly higher amount of battery current until main power is supplied the first time.

Ensure correct polarity of the buffer battery in order to avoid damage to the encoder. HEIDENHAIN recommends operating each encoder with its own backup battery.

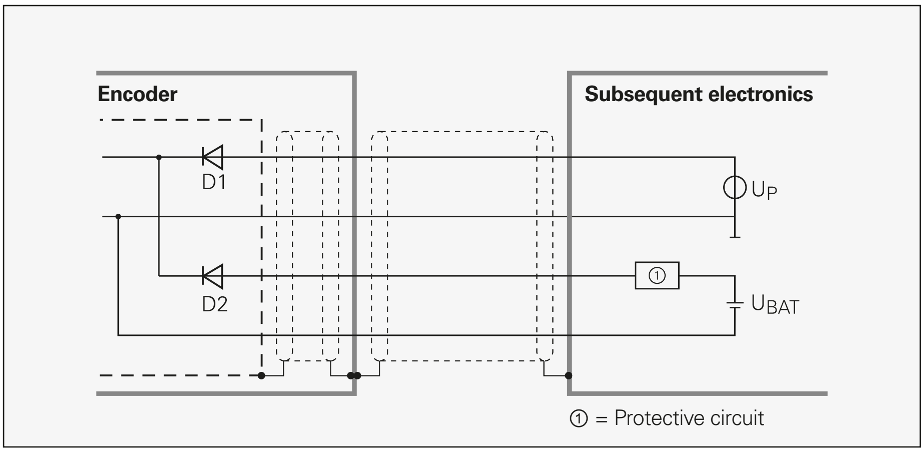
If the application requires compliance with DIN EN 60086-4 or UL 1642, an appropriate protective circuit is required for protection from wiring errors.

If the voltage of the buffer battery falls below certain thresholds, the encoder will set warning or error messages that are transmitted via the EnDat interface:

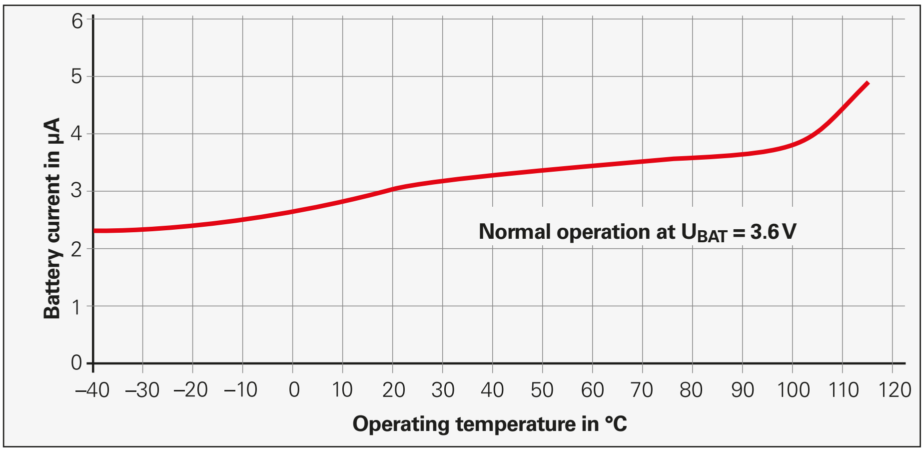
- **"Battery charge" warning**
  ≤ 2.8 V ±0.2 V
  in normal operating mode
- **"M power failure" error message**
  ≤ 2.2 V ±0.2 V
  in battery buffered operating mode
  (encoder must be re-referenced)

The EBI uses low battery current even during normal operation. The amount of current depends on the operating temperature.

Please note:
Compliance with the EnDat specification 297403 and the EnDat Application Notes 722024, Chapter 13, *Battery-buffered encoders,* is required for correct control of the encoder.



Connection to the buffer battery



Typical discharge current in normal operation

SSI position values

The **position value**, beginning with the most significant bit (MSB), is transferred over the data lines (DATA) in synchronism with a CLOCK signal from the control. The SSI standard data word length for singleturn encoders is 13 bits, and for multiturn encoders 25 bits. In addition to the absolute position values, **incremental signals** can also be transmitted. For signal description, see *1 V_{PP} Incremental Signals.*

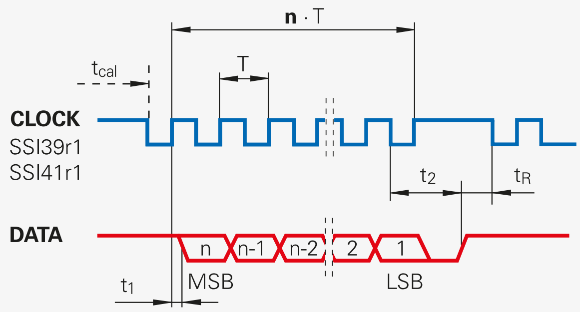
The following **functions** can be activated through programming inputs:

- **Direction of rotation**
- **Zero reset** (setting to zero)

Data transfer

T = 1 to 10 µs
t_{cal} See *Specifications*
$t_1 \leq 0.4$ µs (without cable)
t_2 = 17 to 20 µs
$t_R \geq 5$ µs
n = Data word length 13 bits for ECN/ROC 25 bits for EQN/ROQ

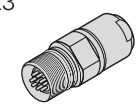
$\overline{\text{CLOCK}}$ and $\overline{\text{DATA}}$ not shown

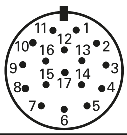


For comprehensive descriptions of all available interfaces as well as general electrical information, see the *Interfaces of HEIDENHAIN Encoders* brochure, ID 1078628-xx.

Pin layout

17-pin coupling, M23





	Voltage supply					Incremental signals				Position values				Other signals	
	7	1	10	4	11	15	16	12	13	14	17	8	9	2	5
	U_P	**Sensor** U_P	**0 V**	**Sensor** 0 V	**Internal shield**[1]	**A+**	**A–**	**B+**	**B–**	**DATA**	**$\overline{\text{DATA}}$**	**CLOCK**	**$\overline{\text{CLOCK}}$**	**Direction of rotation**	**Zero**
	Brown/Green	Blue	White/Green	White	/	Green/Black	Yellow/Black	Blue/Black	Red/Black	Gray	Pink	Violet	Yellow	Black	Green

Shield on housing; **U_P** = Power supply
Sensor: With a 5 V supply voltage, the sensor line is connected in the encoder with the corresponding power line.
[1] Vacant for ECN/EQN 10xx and ROC/ROQ 10xx

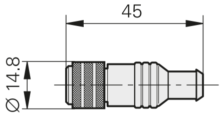
Connecting elements and cables

General information and dimensions

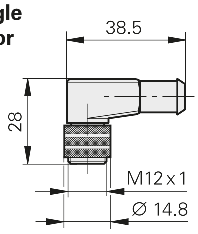
Connector insulated: Connecting element with coupling ring, available with male or female contacts (see symbols).

Symbols

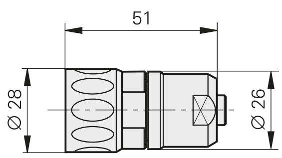
M12



M12 right-angle connector



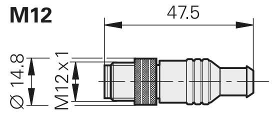
M23



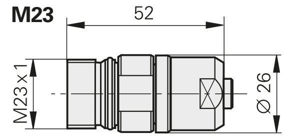
Coupling insulated: Connecting element with outside thread, available with male or female contacts (see Symbols).

Symbols

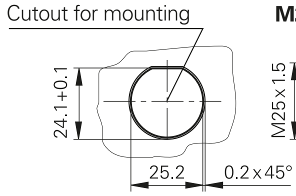
M12



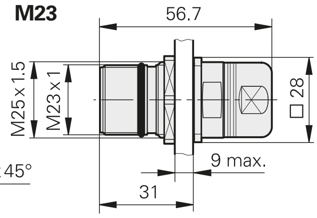
M23



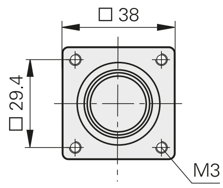
Mounted coupling with central fastening



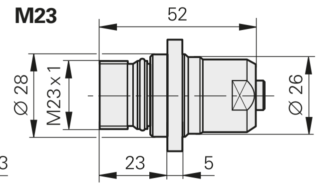
M23



Mounted coupling with flange



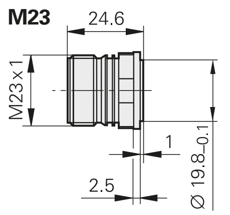
M23

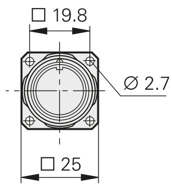


Flange socket: With external thread; permanently mounted on a housing, available with male or female contacts.

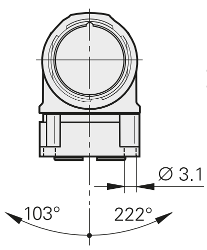
Symbols

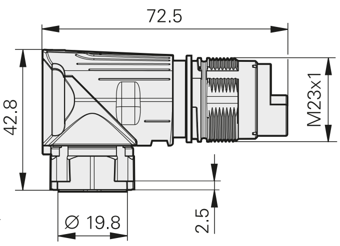
M23

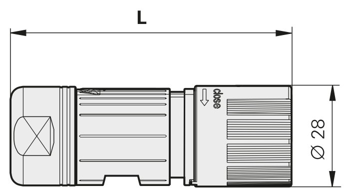




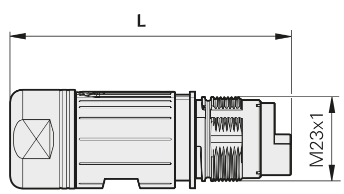
HMC 6





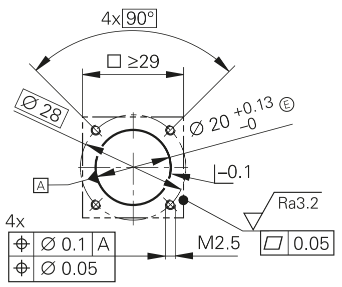


	L
Ø 9.5 mm – Ø 14.5 mm	78
Ø 14 mm – Ø 17 mm	80.5



	L
Ø 9.5 mm – Ø 14.5 mm	78
Ø 14 mm – Ø 17 mm	80.5

Required mating dimensions for flange socket

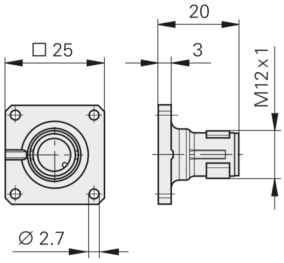


① = At least 4 mm of load-bearing thread length

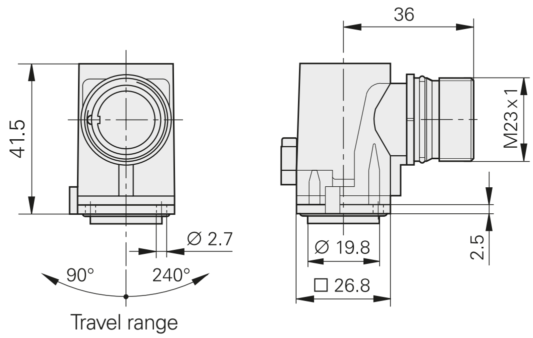
mm

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

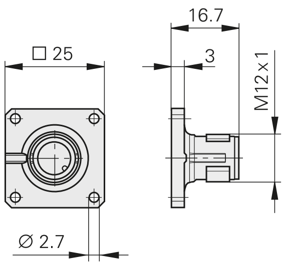
M12 **flange socket**
With motor-internal encoder cable
For EnDat21/22 interface



M23 **right-angle flange socket**
(rotatable) with motor-internal encoder cable

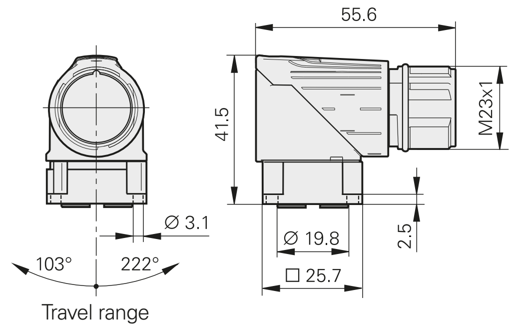


M12 **flange socket**
With motor-internal encoder cable
For DRIVE-CLiQ interface

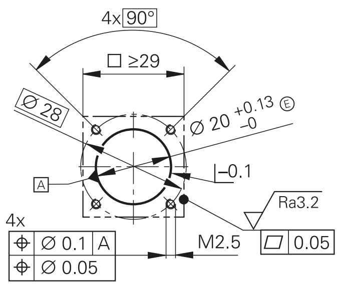


DRIVE-CLiQ is a registered trademark of SIEMENS AG.

M23 SpeedTEC **angle flange socket**
(rotatable) with motor-internal encoder cable



Required mating dimensions for M12 and M23 **flange sockets**



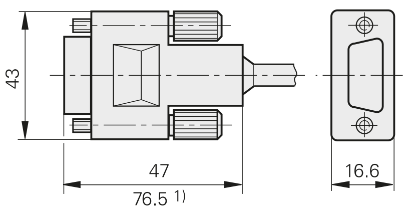
① = At least 4 mm of load-bearing thread length

Encoder cables with SpeedTEC right-angle flange socket are always delivered with a mounted O-ring for vibration protection. This makes it possible to use them for a connecting cable with either a threaded connector (with O-ring) or a SpeedTEC connector (O-ring needs to be removed).

SpeedTEC is a registered trademark of Intercontec Pfeiffer Industriesteckverbindungen GmbH.

D-sub connector for HEIDENHAIN controls, counters and IK absolute value cards.

Symbols

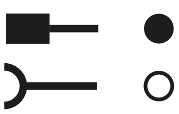


1) Interface electronics integrated in connector

The **pin numbering** on connectors is in the direction opposite to those on couplings or flange sockets, regardless of whether the connecting elements have

male contacts or

female contacts.

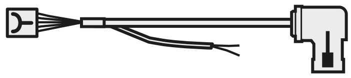


When engaged, the connections provide **protection** to IP67 (D-sub connector: IP50; EN 60529). When not engaged, there is no protection.

Accessories for flange sockets and M23 mounted couplings

Threaded metal dust cap
ID 219926-01

Cables inside the motor housing

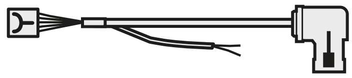
Cables inside the motor housing Cable diameter: 4.5 mm, 3.7 mm or TPE single wire with shrink-wrap or braided sleeving. Cable length: Available in fixed length increments up to the specified maximum length.				**Complete** with PCB connector and angle flange socket, M23, 17-pin; wires for temperature sensor are cross-linked polyolefin 2 · 0.25 mm^2	**Complete** with PCB connector and angle flange socket, M23, 9-pin; wires for temperature sensor are TPE 2 · 0.16 mm^2
Rotary encoder	**Interface**	**PCB connector**	**Crimp sleeve**		
ECI 119	**EnDat01**	**15-pin**	**–**	–	–
ECI 119	**EnDat22**	**15-pin**	**–**	–	1120947-xx[1) 5)] (length ≤ 0.3 m) EPG 1 · (4 · 0.06 mm^2) + 4 · 0.06 mm^2
EBI 135	**EnDat22**	**15-pin**	–	–	
ECI 1119 **EQI 1131**	**EnDat22**	**15-pin**	**–**	–	–
ECI 1118	**EnDat22**	**15-pin**	**–**	–	–
EBI 1135	**EnDat22**	**15-pin**	**–**	–	–
ECI 1319 **EQI 1331**	**EnDat01**	**12-pin**	**Ø 6 mm**	332201-xx (length ≤ 0.3 m) EPG 16 · 0.06 mm^2	–
	EnDat22	**16-pin or** **12-pin plus 4-pin**	**Ø 6 mm**	–	1120948-xx[5)] (length ≤ 0.3 m) EPG 1 · (4 · 0.06 mm^2) + 4 · 0.06 mm^2
ECN 1113 **EQN 1125**	**EnDat01**	**15-pin**	**Ø 4.5 mm**	606079-xx (length ≤ 0.3 m) EPG 16 · 0.06 mm^2	–
ECN 1123 **EQN 1135**	**EnDat22**	**15-pin**	**Ø 4.5 mm**	–	–
ECN 1313 **EQN 1325**	**EnDat01**	**12-pin**	**Ø 6 mm**	332201-xx (length ≤ 0.3 m) EPG 16 · 0.06 mm^2	–

Note: CE compliance in the complete system must be ensured for the encoder cable.
The shielding connection must be realized on the motor.

SpeedTEC is a registered trademark of Intercontec Pfeiffer Industriesteckverbindungen GmbH.

Complete with PCB connector and flange socket, M12, 8-pin (TPC single wires with braided sleeving and without shield; wires for temperature sensor are TPE 2 · 0.16 mm^2 	**With one** PCB connector (free cable end or cable is cut off); wires for TPE temperature sensor 2 · 0.16 mm^2 	**Complete for HMC 6** with PCB connector and communication element; wires for TPE temperature sensor 2 · 0.16 mm^2 
–	640067-xx[1) 3)] (length ≤ 2 m) EPG 16 · 0.06 mm^2	–
–	825855-xx[1) 3)] (length ≤ 2 m) EPG 4 · 2 · 0.14 mm^2	1072652-xx[1)] (length ≤ 0.3 m) EPG 1 · (4 · 0.06 mm^2) + 4 · 0.06 mm^2
–	1116479-xx[1)] (length ≤ 2 m) EPG 1 · (4 · 0.06 mm^2) + 4 · 0.06 mm^2	–
1119952-xx (length ≤ 0.3 m) TPE 8 · 0.16 mm^2	1119958-xx (length ≤ 0.15 m) TPE 8 · 0.16 mm^2	1072652-xx[1)] (length ≤ 0.3 m) EPG 1 · (4 · 0.06 mm^2) + 4 · 0.06 mm^2
805320-xx[3)] (length ≤ 0.3 m) TPE 6 · 0.16 mm^2	735784-xx[2) 3)](length ≤ 0.15 m) TPE 6 · 0.16 mm^2	
804201-xx[3)] (length ≤ 0.3 m) TPE 8 · 0.16 mm^2	640055-xx[2) 3)](length ≤ 0.15 m) TPE 8 · 0.16 mm^2	–
–	332202-xx[3)] (length ≤ 2 m) EPG 16 · 0.06 mm^2	–
1117280-xx (length ≤ 0.3 m) TPE 8 · 0.16 mm^2	1108076-xx (length ≤ 2 m) EPG 1 · (4 · 0.06 mm^2) + 4 · 0.06 mm^2 1100199-xx[3)] (length ≤ 0.3 m) TPE 8 · 0.16 mm^2 1143830-xx (length ≤ 0.3 m) TPE 8 · 0.16 mm^2	1035387-xx (length ≤ 0.3 m) EPG 1 · (4 · 0.06 mm^2) + 4 · 0.06 mm^2
–	605090-xx[3)] (length ≤ 2 m) EPG 16 · 0.06 mm^2	–
1117412-xx (length ≤ 0.3 m) TPE 8 · 0.16 mm^2	1108078-xx (length ≤ 2 m) EPG 1 · (4 · 0.06 mm^2) + 4 · 0.06 mm^2	1035857-xx (length ≤ 0.3 m) EPG 1 · (4 · 0.06 mm^2) + 4 · 0.06 mm^2
–	332202-xx[3)] (length ≤ 2 m) EPG 16 · 0.06 mm^2	–

1) With cable clamp for shielding connection
2) Single wires with heat-shrink tubing (without shielding)
3) Without connections for temperature sensor
4) Note max. temperature, see the brochure *Interfaces of HEIDENHAIN Encoders*
5) SpeedTEC right-angle flange socket with O-ring for vibration protection, male (for threaded connector with O-ring; for SpeedTEC connector, remove O-ring)
6) You can find more information on the HMC 6 in the Product information document *HMC 6*
7) Shield only on one side

Cables inside the motor housing Cable diameter: 4.5 mm, 3.7 mm or TPE single wire with shrink-wrap or braided sleeving. Cable length: Available in fixed length increments up to the specified maximum length.				**Complete** with PCB connector and angle flange socket, M23, 17-pin; wires for temperature sensor are cross-linked polyolefin 2 · 0.25 mm^2	**Complete** with PCB connector and angle flange socket, M23, 9-pin; wires for temperature sensor are TPE 2 · 0.16 mm^2
Rotary encoder	**Interface**	**PCB connector**	**Crimp sleeve**		
ECN 1324 S **EQN 1336 S**	**DRIVE-CLiQ**	**16-pin or** **12-pin plus 4-pin**	**Ø 6 mm**	–	1120945-xx[5)] (length ≤ 0.3 m) EPG 2 · (2 · 0.06 mm^2) + 4 · 0.06 mm^2
ECN 1325 **EQN 1337**	**EnDat22**	**16-pin or** **12-pin plus 4-pin**	**Ø 6 mm**	–	1120948-xx[5)] (length ≤ 0.3 m) EPG 1 · (4 · 0.06 mm^2) + 4 · 0.06 mm^2
ERN 1123	**TTL**	**15-pin**	**–**	–	–
ERN 1321 **ERN 1381**	**TTL** **$1\,V_{PP}$**	**12-pin**	**Ø 6 mm**	667343-xx (length ≤ 0.3 m) EPG 16 · 0.06 mm^2	–
ERN 1326	**TTL**	**16-pin**	**Ø 6 mm**	–	–
ERN 1387	**$1\,V_{PP}$**	**14-pin**	**Ø 6 mm**	332199-xx (length ≤ 0.3 m) EPG 16 · 0.06 mm^2	–
ERO 1225 **ERO 1285**	**TTL** **$1\,V_{PP}$**	**12-pin**	**Ø 4.5 mm**	–	–
ERO 1420 **ERO 1470** **ERO 1480**	**TTL** **TTL** **$1\,V_{PP}$**	**12-pin**	**Ø 4.5 mm**	–	–

Note: CE compliance in the complete system must be ensured for the encoder cable.
The shielding connection must be realized on the motor.

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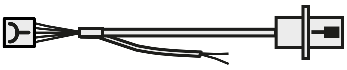
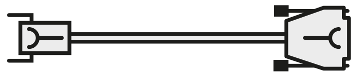
SpeedTEC is a registered trademark of Intercontec Pfeiffer Industriesteckverbindungen GmbH.

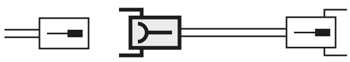
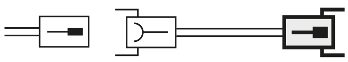
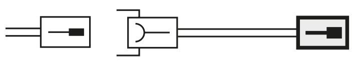
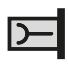
Complete with PCB connector and flange socket, M12, 8-pin (TPC single wires with braided sleeving and without shield; wires for temperature sensor are TPE 2 · 0.16 mm^2 	**With one** PCB connector (free cable end or cable is cut off); wires for TPE temperature sensor 2 · 0.16 mm^2 	**Complete for HMC 6** with PCB connector and communication element; wires for TPE temperature sensor 2 · 0.16 mm^2 
1181373-xx[7] (length ≤ 0.3 m) EPG 2 · (2 · 0.06 mm^2) + 4 · 0.06 mm^2	–	–
1117280-xx (length ≤ 0.3 m) TPE 8 · 0.16 mm^2	1108076-xx (length ≤ 2 m) EPG 1 · (4 · 0.06 mm^2) + 4 · 0.06 mm^2 1100199-xx[3] (length ≤ 0.3 m) TPE 8 · 0.16 mm^2 1143830-xx[3] (length ≤ 0.3 m) TPE 8 · 0.16 mm^2	1035387-xx (length ≤ 0.3 m) EPG 1 · (4 · 0.06 mm^2) + 4 · 0.06 mm^2
–	738976-xx[2] [3] (length ≤ 0.15 m) TPE 14 · 0.16 mm^2	–
–	333276-xx[3] (length ≤ 6 m) EPG 16 · 0.06 mm^2	–
–	341369-xx[3] (length ≤ 6 m) EPG 16 · 0.06 mm^2	–
–	332200-xx[3] (length ≤ 6 m) EPG 16 · 0.06 mm^2	–
–	372164-xx[3] [4] (length ≤ 6 m) PUR [4(2 · 0.05 mm^2) + (4 · 0.14 mm^2)]	–
–	346439-xx[3] [4] (length ≤ 6 m) PUR [4(2 · 0.05 mm^2) + (4 · 0.14 mm^2)]	–

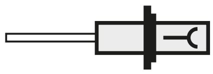
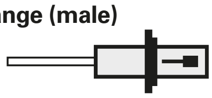
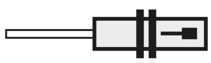
1) With cable clamp for shielding connection
2) Single wires with heat-shrink tubing (without shielding)
3) Without separate connections for temperature sensor
4) Note max. temperature, see the brochure *Interfaces of HEIDENHAIN Encoders*
5) SpeedTEC right-angle flange socket with O-ring for vibration protection, male (for threaded connector with O-ring; for SpeedTEC connector, remove O-ring)
6) You can find more information on the HMC 6 in the Product information document *HMC 6*
7) Shield only on one side

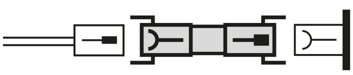
Connecting cables 1 V_{PP}, TTL

12-pin M23

PUR connecting cable	$[4(2 \cdot 0.14\ mm^2) + (4 \cdot 0.5\ mm^2)]$; $A_P = 0.5\ mm^2$ **Ø 8 mm**	~ 1 V_{PP} / ⊓⊔ TTL
Complete with connector (female), and coupling (male)		298401-xx
Complete with connector (female), and connector (male)		298399-xx
Complete with connector (female) and D-sub connector (female), 15-pin, for TNC		310199-xx
Complete with connector (female) and 15-pin D-sub connector (male), for PWM 20/EIB 741		310196-xx
With one connector **(female)**		309777-xx
Cable only		816317-xx

Mating element on connecting cable to connector on encoder cable	**Connector (female)** 	For cable	Ø 8 mm	291697-05
Connector on cable for connection to subsequent electronics	**Connector (male)** 	For cable	Ø 8 mm Ø 6 mm	291697-08 291697-07
Coupling on connecting cable	**Coupling (male)** 	For cable	Ø 4.5 mm Ø 6 mm Ø 8 mm	291698-14 291698-03 291698-04
Flange socket for mounting on subsequent electronics	**Flange socket (female)** 			315892-08

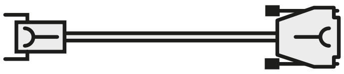
Mounted couplings	**With flange (female)** 	Ø 6 mm Ø 8 mm	291698-17 291698-07
	With flange (male) 	Ø 6 mm Ø 8 mm	291698-08 291698-31
	With central fastening (male) 	Ø 6 mm to 10 mm	741045-01

Adapter ~ 1 V_{PP}/11 μA_{PP} For converting the 1 V_{PP} signals to 11 μA_{PP}; M23 connector (female), 12-pin and M23 connector (male), 9-pin		364914-01

A_P: Cross section of power supply lines

EnDat connecting cables

8-pin M12 | 17-pin M23

PUR connecting cables **8-pin:** $[1(4 \cdot 0.14\ mm^2) + (4 \cdot 0.34\ mm^2)]$; $A_P = 0.34\ mm^2$ **17-pin:** $[(4 \cdot 0.14\ mm^2) + 4(2 \cdot 0.14\ mm^2) + (4 \cdot 0.5\ mm^2)]$; $A_P = 0.5\ mm^2$		**EnDat** without incremental signals		**EnDat** with incremental signals **SSI**
	Cable diameter	6 mm	3.7 mm	8 mm
Complete with connector (female) and coupling (male)		368330-xx	801142-xx	323897-xx *340302-xx*
Complete with right-angle connector (female) and coupling (male)		373289-xx	801149-xx	–
Complete with connector (female) and D-sub connector (female), 15-pin, for TNC (position inputs)		533627-xx	–	332115-xx
Complete with connector (female) and D-sub connector (female), 25-pin, for TNC (speed inputs)		*641926-xx*	–	*336376-xx*
Complete with connector (female) and D-sub connector (male), 15-pin, for IK 215, PWM 20, EIB 741, etc.		524599-xx	801129-xx	324544-xx
Complete with right-angle connector (female) and D-sub connector (male), 15-pin, for IK 215, PWM 20, EIB 741, etc.		722025-xx	801140-xx	–
With one connector **(female)**		634265-xx	–	309778-xx 309779-xx[1)]
With one right-angle connector **(female)**		606317-xx	–	–
Cable only		–	–	816322-xx

Italics: Cable with assignment for "encoder shaft speed" input (MotEnc EnDat)
1) Without incremental signals
A_P: Cross section of power supply lines

EnDat connecting cables

8-pin M12 | 19-pin M23

PUR adapter cable		
PUR adapter cable [1(4 · 0.14 mm^2) + (4 · 0.34 mm^2)]; A_P = 0.34 mm^2		**EnDat** without incremental signals
Complete with M23 connector (female), 9-pin, and M12 coupling (male), 8-pin	Ø 6 mm Ø 8 mm	1136863-xx 1136874-xx
Complete with M23 connector (female), 9-pin, and D-sub connector (female), 15-pin, for PWM 20	Ø 6 mm	1173166-xx

A_P: Cross section of power supply lines

HMC 6 connecting cable

		1.5 mm^2	4 mm^2
PUR connecting cables Communication and supply: 2 · (2 · 0.09 mm^2) + 2 · 0.24 mm^2 Power and PE: 1 · (3 · 1.5 mm^2) + 1 · 1.5 mm^2			
With one Hybrid connecting element with HMC 6 power wires		1034933-xx	1076352-xx

You can find more information on the HMC 6 in the Product Information document *HMC 6*.

Siemens connecting cable

PUR connecting cable Ø 6.8 m; [2 · (2 · 0.17 mm^2) + (2 · 0.24 mm^2)]; A_P = 0.24 mm^2		
Complete with M12 connector (female) and M12 coupling (male), 8 pins each		822504-xx
Complete with 8-pin M12 connector (female) and Siemens RJ45 connector (IP67)		1094652-xx
Complete with 8-pin M12 connector (female) and Siemens RJ45 connector (IP20)		1093042-xx
Complete with 9-pin M23 SpeedTEC connector (female) and Siemens RJ45 connector (IP20)		1121546-xx
Complete with 9-pin M23 connector (female) and Siemens RJ45 connector (IP20)		1117540-xx

A_P: Cross section of power supply lines

Interface electronics

Interface electronics from HEIDENHAIN adapt the encoder signals to the interface of the subsequent electronics. They are used when the subsequent electronics cannot directly process the output signals from HEIDENHAIN encoders, or if additional interpolation of the signals is necessary.

Input signals of the interface electronics
Interface electronics from HEIDENHAIN can be connected to encoders with sinusoidal signals of 1 V_{PP} (voltage signals) or 11 μA_{PP} (current signals). Encoders with the serial interfaces EnDat or SSI can also be connected to various interface electronics.

Output signals of the interface electronics
Interface electronics with the following interfaces to the subsequent electronics are available:
- TTL square-wave pulse trains
- EnDat 2.2
- DRIVE-CLiQ
- Fanuc Serial Interface
- Mitsubishi high speed interface
- Yaskawa Serial Interface
- Profibus

Interpolation of the sinusoidal input signals
In addition to being converted, the sinusoidal encoder signals are also interpolated in the interface electronics. This permits finer measuring steps and, as a result, higher control quality and better positioning behavior.

Formation of a position value
Some interface electronics have an integrated counting function. Starting from the last reference point set, an absolute position value is formed when the reference mark is traversed, and is transferred to the subsequent electronics.

Box design

Plug design

Version for integration

Top-hat rail design

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Outputs		Inputs		Design – degree of protection	Interpolation[1] or subdivision	Model
Interface	Qty.	Interface	Qty.			
⊓⊔TTL	1	∿ 1 V_{PP}	1	Box design – IP65	5/10-fold	**IBV 101**
					20/25/50/100-fold	**IBV 102**
					Without interpolation	**IBV 600**
					25/50/100/200/400-fold	**IBV 660 B**
				Plug design – IP40	5/10/20/25/50/100-fold	**APE 371**
				Version for integration – IP00	5/10-fold	**IDP 181**
					20/25/50/100-fold	**IDP 182**
		∿ 11 μA_{PP}	1	Box design – IP65	5/10-fold	**EXE 101**
					20/25/50/100-fold	**EXE 102**
					Without/5-fold	**EXE 602 E**
					25/50/100/200/400-fold	**EXE 660 B**
				Version for integration – IP00	5-fold	**IDP 101**
⊓⊔TTL/ ∿ 1 V_{PP} Adjustable	2	∿ 1 V_{PP}	1	Box design – IP65	2-fold	**IBV 6072**
					5/10-fold	**IBV 6172**
					5/10-fold and 20/25/50/100-fold	**IBV 6272**
EnDat 2.2	1	∿ 1 V_{PP}	1	Box design – IP65	≤ 16384-fold subdivision	**EIB 192**
				Plug design – IP40	≤ 16384-fold subdivision	**EIB 392**
			2	Box design – IP65	≤ 16384-fold subdivision	**EIB 1512**
DRIVE-CLiQ	1	EnDat 2.2	1	Box design – IP65	–	**EIB 2391 S**
Fanuc Serial Interface	1	∿ 1 V_{PP}	1	Box design – IP65	≤ 16384-fold subdivision	**EIB 192 F**
				Plug design – IP40	≤ 16384-fold subdivision	**EIB 392 F**
			2	Box design – IP65	≤ 16384-fold subdivision	**EIB 1592 F**
Mitsubishi high speed interface	1	∿ 1 V_{PP}	1	Box design – IP65	≤ 16384-fold subdivision	**EIB 192 M**
				Plug design – IP40	≤ 16384-fold subdivision	**EIB 392 M**
			2	Box design – IP65	≤ 16384-fold subdivision	**EIB 1592 M**
Yaskawa Serial Interface	1	EnDat 2.2[2]	1	Plug design – IP40	–	**EIB 3391Y**
PROFIBUS-DP	1	EnDat 2.1; EnDat 2.2	1	Top-hat rail design	–	**PROFIBUS Gateway**

[1] Switchable

[2] Only LIC 4100 with 5 nm measuring step, LIC 2100 with 50 nm and 100 nm measuring steps

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Diagnostic and testing equipment

HEIDENHAIN encoders provide all information necessary for commissioning, monitoring and diagnostics. The type of available information depends on whether the encoder is incremental or absolute and which interface is used.

Incremental encoders mainly have 1 V_{PP}, TTL or HTL interfaces. TTL and HTL encoders monitor their signal amplitudes internally and generate a simple fault detection signal. With 1 V_{PP} signals, the analysis of output signals is possible only in external test devices or through computation in the subsequent electronics (analog diagnostics interface).

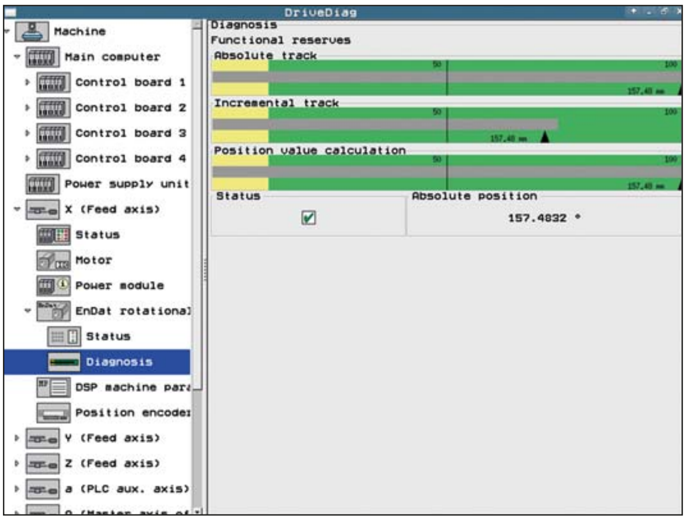
Absolute encoders operate with serial data transfer. Depending on the interface, additional 1 V_{PP} incremental signals can be output. The signals are monitored comprehensively within the encoder. The monitoring result (especially with valuation numbers) can be transferred along with the position values through the serial interface to the subsequent electronics (digital diagnostics interface). The following information is available:

- Error message: Radio connection is not reliable.
- Warning: An internal functional limit of the encoder has been reached
- Valuation numbers:
  - Detailed information on the encoder's functional reserve
  - Identical scaling for all HEIDENHAIN encoders
  - Cyclic output is possible

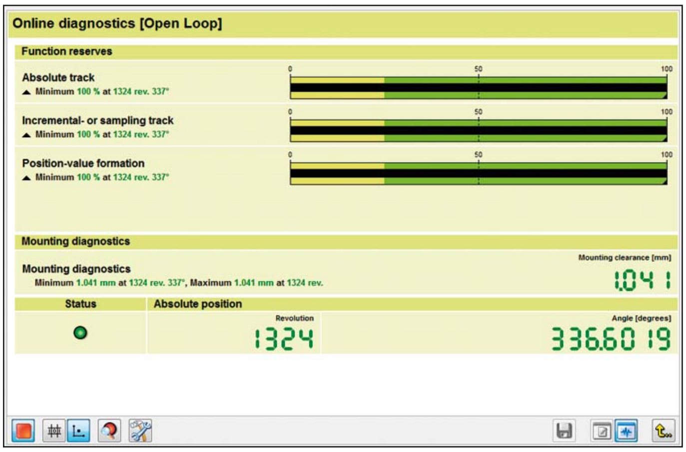
This enables the subsequent electronics to evaluate the current status of the encoder with little effort even in closed-loop mode.

HEIDENHAIN offers the appropriate PWM inspection devices and PWT test devices for encoder analysis. There are two types of diagnostics, depending on how the devices are integrated:

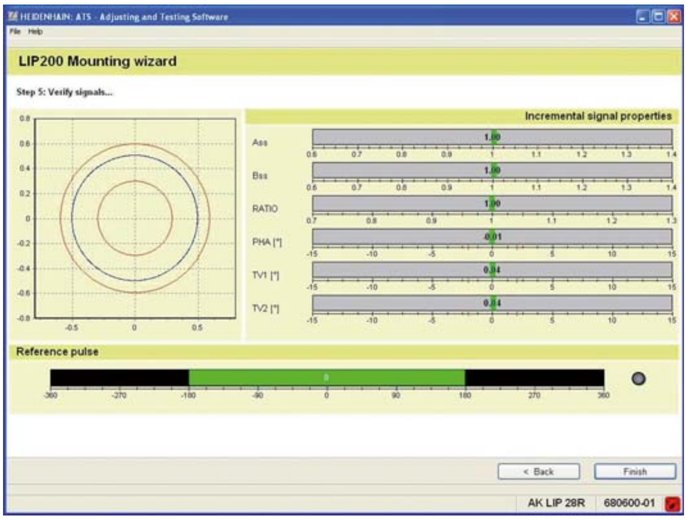
- Encoder diagnostics: The encoder is connected directly to the test or inspection device. This makes a comprehensive analysis of encoder functions possible.
- Diagnostics in the control loop: The PWM phase meter is looped into the closed control loop (e.g. through a suitable testing adapter). This makes a real-time diagnosis of the machine or system possible during operation. The functions depend on the interface.



Diagnostics in the control loop on HEIDENHAIN controls with display of the valuation number or the analog encoder signals



Diagnostics using PWM 20 and ATS software



Commissioning using PWM 20 and ATS software

PWM 20
Together with the included 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 *PWM 20/ ATS Software* Product Information document.

	PWM 20
Encoder input	• 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 × 154 mm × 55 mm

	ATS
Languages	Choice between English and German
Functions	• Position display • Connection dialog • Diagnostics • Mounting wizard for EBI/ECI/EQI, LIP 200, 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.

The **PWM 9** is a universal measuring device for inspecting and adjusting HEIDENHAIN incremental encoders. Expansion modules are available for checking the various types of encoder signals. The values can be read on an LCD monitor. Soft keys provide ease of operation.

	PWM 9
Inputs	Expansion modules (interface boards) for 11 μA_{PP}; 1 V_{PP}; TTL; HTL; EnDat*****/SSI*****/commutation signals * No display of position values or parameters
Functions	• **Measurement** of signal amplitudes, current consumption, operating voltage, scanning frequency • **Graphic display** of incremental signals (amplitudes, phase angle and on-off ratio) and the reference-mark signal (width and position) • **Display symbols** for the reference mark, fault detection signal, counting direction • **Universal counter,** interpolation selectable from single to 1024-fold • **Adjustment support** for exposed linear encoders
Outputs	• Inputs are connected through to the subsequent electronics • BNC sockets for connection to an oscilloscope
Voltage supply	DC 10 V to 30 V, max. 15 W
Dimensions	150 mm × 205 mm × 96 mm

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