HEIDENHAIN

Rotary Encoders

11/2017

Rotary encoders from HEIDENHAIN serve as measuring sensors for rotary motion, angular velocity, and when used in conjunction with mechanical measuring standards such as lead screws, for linear motion. Application areas include electrical motors, machine tools, printing machines, woodworking machines, textile machines, robots and handling devices, as well as various types of measuring, testing, and inspection devices.

The high quality of the sinusoidal incremental signals permits high interpolation factors for digital speed control.

Rotary encoders for separate shaft coupling

Electronic handwheel

Rotary encoder with mounted stator coupling

Information on
- Encoders for servo drives
- Sealed angle encoders
- Modular angle encoders with optical scanning
- Modular angle encoders with magnetic scanning
- Linear encoders for numerically controlled machine tools
- Exposed linear encoders
- Interface electronics
- HEIDENHAIN controls

is available upon request as well as on the Internet at *www.heidenhain.de*.

Further information:

Comprehensive descriptions of all available interfaces as well as general electrical information are included in the *Interfaces of HEIDENHAIN Encoders* brochure.

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

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

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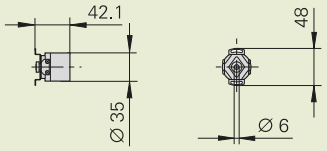
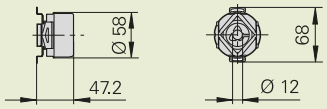
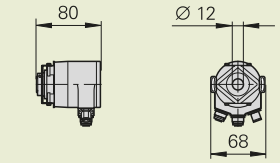
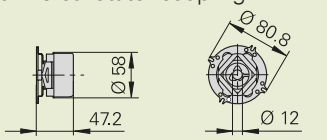
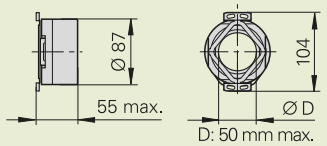
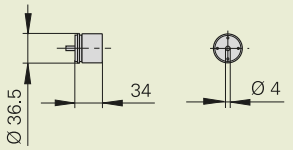
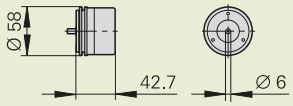
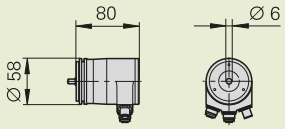
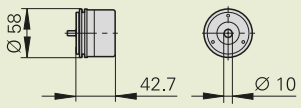
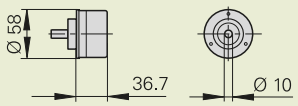
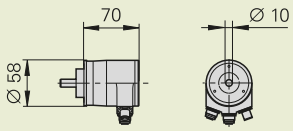
With mounted stator coupling						
ECN/EQN/ERN 1000 series 	**ECN 1023** Positions/rev: 23 bits EnDat 2.2/22 **ECN 1013** Positions/rev: 13 bits EnDat 2.2/01	–	**ECN 1013** Positions/rev: 13 bits	–	**EQN 1035** Positions/rev: 23 bits EnDat 2.2/22 **EQN 1025** Positions/rev: 13 bits EnDat 2.2/01	–
ECN/EQN/ERN 400 series 	**ECN 425** Positions/rev: 25 bits EnDat 2.2/22 Available with **Functional safety** **ECN 413** Positions/rev: 13 bits EnDat 2.2/01	**ECN 425 F** Positions/rev: 25 bits Fanuc αi **ECN 425 M** Positions/rev: 25 bits Mitsubishi **ECN 424 S** Positions/rev: 24 bits DRIVE-CLiQ Available with **Functional safety**	**ECN 413** Positions/rev: 13 bits	–	**EQN 437** Positions/rev: 25 bits EnDat 2.2/22 Available with **Functional safety** **EQN 425**[3] Positions/rev: 13 bits EnDat 2.2/01	**EQN 437 F** Positions/rev: 25 bits Fanuc αi **EQN 435 M** Positions/rev: 23 bits Mitsubishi **EQN 436 S** Positions/rev: 24 bits DRIVE-CLiQ Available with **Functional safety**
ECN/EQN 400 series with fieldbus 	–	–	–	**ECN 413** Positions/rev: 13 bits	–	–
ECN/EQN/ERN 400 series with universal stator coupling 	**ECN 425** Positions/rev: 25 bits EnDat 2.2/22 **ECN 413** Positions/rev: 13 bits EnDat 2.2/01	–	**ECN 413** Positions/rev: 13 bits	–	**EQN 437** Positions/rev: 25 bits EnDat 2.2/22 **EQN 425** Positions/rev: 13 bits EnDat 2.2/01	–
ECN/ERN 100 series 	**ECN 125** Positions/rev: 25 bits EnDat 2.2/22 **ECN 113** Positions/rev: 13 bits EnDat 2.2/01	–	–	–	–	–

[1] Up to 36000 signal periods through integrated 5/10-fold interpolation (higher interpolation on request)
[2] Voltage supply: DC 10 V to 30 V
[3] Also available with TTL or HTL signal transmission
[4] Available with mechanical fault exclusion; for restrictions on specifications and for special mounting information, see the *Fault Exclusion* customer information document

			Incremental			
	SSI	PROFIBUS-DP PROFINET IO	⊓⊔ TTL	⊓⊔ HTL	∿ 1 V_{PP}	
	EQN 1025 Positions/rev: 13 bits	–	**ERN 1020** 100 to 3600 lines **ERN 1070** 1000/2500/[1] 3600 lines	**ERN 1030** 100 to 3600 lines	**ERN 1080** 100 to 3600 lines	 **32**
	EQN 425[3] Positions/rev: 13 bits	–	**ERN 420** 250 to 5000 lines **ERN 460**[2] 250 to 5000 lines	**ERN 430** 250 to 5000 lines	**ERN 480**[4] 1000 to 5000 lines	 **36**
	–	**EQN 425** Positions/rev: 13 bits	–	–	–	 **46**
	EQN 425 Positions/rev: 13 bits	–	**ERN 420** 250 to 5000 lines **ERN 460**[2] 250 to 5000 lines	**ERN 430** 250 to 5000 lines	**ERN 480** 1000 to 5000 lines	 **48**
	–	–	**ERN 120** 1000 to 5000 lines	**ERN 130** 1000 to 5000 lines	**ERN 180** 1000 to 5000 lines	 **52**

Rotary encoders for standard applications

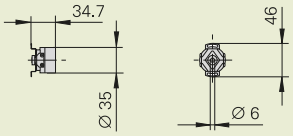
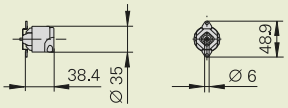
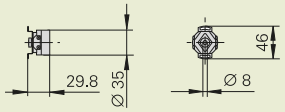
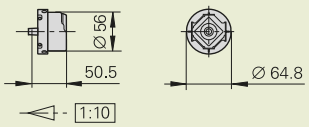
Rotary encoders	**Absolute** **Singleturn**				**Multiturn** 4096 revolutions	
Interface	EnDat	Fanuc Mitsubishi Siemens	SSI	PROFIBUS-DP PROFINET IO	EnDat	Fanuc Mitsubishi Siemens
For separate shaft coupling, with synchro flange						
ROC/ROQ/ROD 1000 series 	**ROC 1023** Positions/rev: 23 bits EnDat 2.2/22 **ROC 1013** Positions/rev: 13 bits EnDat 2.2/01	–	**ROC 1013** Positions/rev: 13 bits	–	**ROQ 1035** Positions/rev: 23 bits EnDat 2.2/22 **ROQ 1025** Positions/rev: 13 bits EnDat 2.2/01	–
ROC/ROQ/ROD 400 **RIC/RIQ 400** series With synchro flange 	**ROC 425** Positions/rev: 25 bits EnDat 2.2/22 Available with **Functional safety** **ROC 413** Positions/rev: 13 bits EnDat 2.2/01 **RIC 418** Positions/rev: 18 bits EnDat 2.1/01	**ROC 425F** Positions/rev: 25 bits Fanuc αi **ROC 425M** Positions/rev: 25 bits Mitsubishi **ROC 424S** Positions/rev: 24 bits DRIVE-CLiQ Available with **Functional safety**	**ROC 413** Positions/rev: 13 bits	–	**ROQ 437** Positions/rev: 25 bits EnDat 2.2/22 Available with **Functional safety** **ROQ 425** Positions/rev: 13 bits EnDat 2.2/01 **RIQ 430** Positions/rev: 18 bits EnDat 2.1/01	**ROQ 437F** Positions/rev: 25 bits Fanuc αi **ROQ 435M** Positions/rev: 23 bits Mitsubishi **ROQ 436S** Positions/rev: 24 bits DRIVE-CLiQ Available with **Functional safety**
ROC/ROQ 400 series With fieldbus 	–	–	–	**ROC 413** Positions/rev: 13 bits	–	–
ROC 425 For high accuracy 	**ROC 425** Positions/rev: 25 bits EnDat 2.2/01	–	–	–	–	–
For separate shaft coupling, with clamping flange						
ROC/ROQ/ROD 400 **RIC/RIQ 400** series With clamping flange 	**ROC 425** Positions/rev: 25 bits EnDat 2.2/22 Available with **Functional safety** **ROC 413** Positions/rev: 13 bits EnDat 2.2/01 **RIC 418** Positions/rev: 18 bits EnDat 2.1/01	**ROC 425F** Positions/rev: 25 bits Fanuc αi **ROC 425M** Positions/rev: 25 bits Mitsubishi **ROC 424S** Positions/rev: 24 bits DRIVE-CLiQ Available with **Functional safety**	**ROC 413** Positions/rev: 13 bits	–	**ROQ 437** Positions/rev: 25 bits EnDat 2.2/22 Available with **Functional safety** **ROQ 425**[4] Positions/rev: 13 bits EnDat 2.2/01 **RIQ 430** Positions/rev: 18 bits EnDat 2.1/01	**ROQ 437F** Positions/rev: 25 bits Fanuc αi **ROQ 435M** Positions/rev: 23 bits Mitsubishi **ROQ 436S** Positions/rev: 24 bits DRIVE-CLiQ Available with **Functional safety**
ROC/ROQ 400 series With fieldbus 	–	–	–	**ROC 413** Positions/rev: 13 bits	–	–

[1] Up to 10000 signal periods through integrated 2-fold interpolation
[2] Up to 36000 signal periods through integrated 5/10-fold interpolation (higher interpolation on request)
[3] Voltage supply: DC 10 V to 30 V
[4] Also available with TTL or HTL signal transmission

			Incremental			
	SSI	PROFIBUS-DP PROFINET IO	⊓⊔ TTL	⊓⊔ HTL	∿ 1 V_{PP}	
	ROQ 1025 Positions/rev: 13 bits	–	**ROD 1020** 100 to 3600 lines **ROD 1070** 1000/2500/ 3600 lines[2]	**ROD 1030** 100 to 3600 lines	**ROD 1080** 100 to 3600 lines	 54
	ROQ 425 Positions/rev: 13 bits	–	**ROD 426** 50 to 5000 lines[1] **ROD 466**[3] 50 to 5000 lines[2]	**ROD 436** 50 to 5000 lines	**ROD 486**[5] 1000 to 5000 lines	 58
	–	**ROQ 425**[4] Positions/rev: 13 bits	–	–	–	 68
	–	–	–	–	–	 70
	ROQ 425 Positions/rev: 13 bits	–	**ROD 420** 50 to 5000 lines	**ROD 430** 50 to 5000 lines	**ROD 480**[5] 1000 to 5000 lines	 72
	–	**ROQ 425** Positions/rev: 13 bits	–	–	–	 78

[5] Mechanical fault exclusion available; for restrictions on specifications and for special mounting information, see the *Fault Exclusion* customer information document

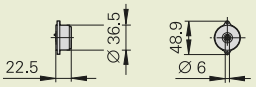
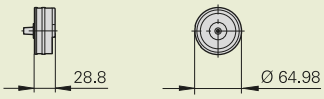
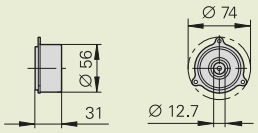
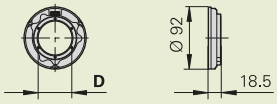
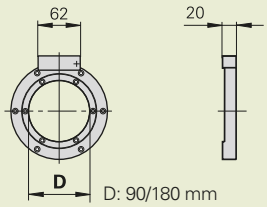
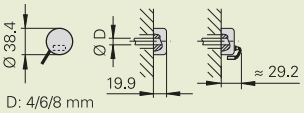
Rotary encoders for motors

Rotary encoders	Absolute Singleturn		Multiturn	
Interface	EnDat		EnDat	
With integral bearing and mounted stator coupling				
ERN 1023 IP64 	–	–	–	–
ECN/EQN 1100 series 	**ECN 1123** Positions/rev: 23 bits EnDat 2.2/22 Available with **Functional safety**	**ECN 1113** Positions/rev: 13 bits EnDat 2.2/01	**EQN 1135** Positions/rev: 23 bits 4096 revolutions EnDat 2.2/22 Available with **Functional safety**	**EQN 1125** Positions/rev: 13 bits 4096 revolutions EnDat 2.2/01
ERN 1123 IP00 	–	–	–	–
ECN/EQN/ERN 1300 series IP40 **ECN/EQN/ERN 400** series IP64 	**ECN 1325** Positions/rev: 25 bits EnDat 2.2/22 Available with **Functional safety** **ECN 425** Positions/rev: 25 bits EnDat 2.2/22 Available with **Functional safety**	**ECN 1313** Positions/rev: 13 bits EnDat 2.2/01 **ECN 413** Positions/rev: 13 bits EnDat 2.2/01	**EQN 1337** Positions/rev: 25 bits 4096 revolutions EnDat 2.2/22 Available with **Functional safety** **EQN 437** Positions/rev: 25 bits 4096 revolutions EnDat 2.2/22 Available with **Functional safety**	**EQN 1325** Positions/rev: 13 bits 4096 revolutions EnDat 2.2/01 **EQN 425** Positions/rev: 13 bits 4096 revolutions EnDat 2.2/01

[1] 8192 signal periods through integrated 2-fold interpolation
[2] Mechanical fault exclusion available; for restrictions on specifications and for special mounting information, see the *Fault exclusion* customer information document

These rotary encoders are described in the ***Encoders for Servo Drives*** brochure.

	Incremental	
	⊓⊔ TTL	∿ 1 V_{PP}
	ERN 1023 500 to 8192 lines 3 signals for block commutation	–
	–	–
	ERN 1123 500 to 8192 lines 3 signals for block commutation	–
	ERN 1321 1024 to 4096 lines **ERN 1326** 1024 to 4096 lines[1] 3 TTL signals for block commutation **ERN 421** 1024 to 4096 lines	**ERN 1381**[2] 512 to 4096 lines **ERN 1387**[2] 2048 lines Z1 track for sine commutation **ERN 487** 2048 lines Z1 track for sine commutation

Rotary encoders	Absolute Singleturn			Multiturn	
Interface	EnDat		Siemens	EnDat	
Without integral bearing					
ECI/EQI/EBI 1100 series  13 with ECI/EBI	**ECI 1118** Positions/rev: 18 bits EnDat 2.2/22	**ECI 1119** Positions/rev: 19 bits EnDat 2.2/22 Available with **Functional safety**	–	**EBI 1135** Positions/rev: 18 bits 65536 revolutions (buffer battery backup) EnDat 2.2/22	**EQI 1131** Positions/rev: 19 bits 4096 revolutions EnDat 2.2/22 Available with **Functional safety**
ECI/EQI 1300 series 	–	**ECI 1319** Positions/rev: 19 bits EnDat 2.2/01	–	–	**EQI 1331** Positions/rev: 19 bits 4096 revolutions EnDat 2.2/01
ECI/EQI 1300 series 	**ECI 1319** Positions/rev: 19 bits EnDat 2.2/22 Available with **Functional safety**	–	–	**EQI 1331** Positions/rev: 19 bits 4096 revolutions EnDat 2.2/22 Available with **Functional safety**	–
ECI/EBI 100 series  D: 30/38/50 mm	**ECI 119** Positions/rev: 19 bits EnDat 2.2/22 or EnDat 2.1/01	–	–	**EBI 135** Positions/rev: 19 bits 65536 revolutions (buffer battery backup) EnDat 2.2/22	–
ECI/EBI 4000 series  D: 90/180 mm	**ECI 4010** Positions/rev: 20 bits EnDat 2.2/22		**ECI 4090S** Positions/rev: 20 bits DRIVE-CLiQ	**EBI 4010** Positions/rev: 20 bits 65536 revolutions (buffer battery backup) EnDat 2.2/22	
ERO 1400 series  D: 4/6/8 mm	–	–	–	–	–

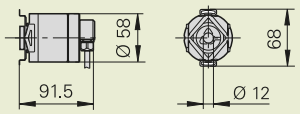
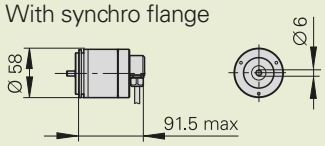
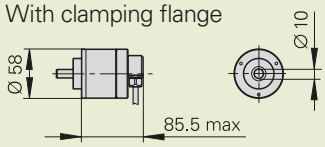
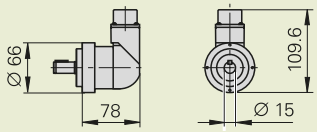
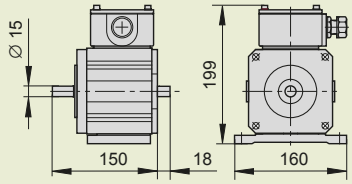
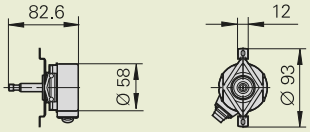
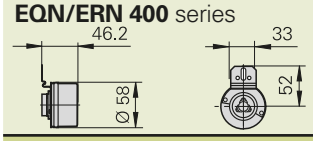
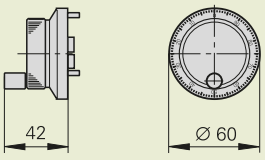
[1] Up to 37500 signal periods through integrated 5/10/20/25-fold interpolation

DRIVE-CLiQ is a registered trademark of SIEMENS AG.

These rotary encoders are described in the ***Encoders for Servo Drives*** brochure.

	Incremental	
	⊓⊔TTL	∿ 1 V_{PP}
	–	–
	–	–
	–	–
	–	–
	ERO 1420 512 to 1024 lines **ERO 1470** 1000/1500 lines [1)]	**ERO 1480** 512 to 1024 lines

Rotary encoders for special applications

Rotary encoders	**Absolute** **Singleturn**		**Multiturn** 4096 revolutions	
Interface	EnDat	SSI	EnDat	SSI
For potentially explosive atmospheres in zones 1, 2, 21 and 22				
ECN/EQN/ERN 400 series 	**ECN 413** Positions/rev: 13 bits EnDat 2.2/01	**ECN 413** Positions/rev: 13 bits	**EQN 425** Positions/rev: 13 bits EnDat 2.2/01	**EQN 425** Positions/rev: 13 bits
ROC/ROQ/ROD 400 series With synchro flange 	**ROC 413** Positions/rev: 13 bits EnDat 2.2/01	**ROC 413** Positions/rev: 13 bits	**ROQ 425** Positions/rev: 13 bits EnDat 2.2/01	**ROQ 425** Positions/rev: 13 bits
ROC/ROQ/ROD 400 series With clamping flange 	**ROC 413** Positions/rev: 13 bits EnDat 2.2/01	**ROC 413** Positions/rev: 13 bits	**ROQ 425** Positions/rev: 13 bits EnDat 2.2/01	**ROQ 425** Positions/rev: 13 bits
For high bearing loads				
ROD 600 	–	–	–	–
ROD 1930 	–	–	–	–
For Siemens asynchronous motors				
ERN 401 series 	–	–	–	–
EQN/ERN 400 series 	–	–	**EQN 425** Positions/rev: 13 bits EnDat 2.1/01	**EQN 425** Positions/rev: 13 bits
Electronic handwheel				
HR 1120 	–	–	–	–

Incremental

	⊓⊔ TTL	⊓⊔ HTL	∿ 1 V_{PP}	
	ERN 420 1000 to 5000 lines	**ERN 430** 1000 to 5000 lines	**ERN 480** 1000 to 5000 lines	
	ROD 426 1000 to 5000 lines	**ROD 436** 1000 to 5000 lines	**ROD 486** 1000 to 5000 lines	
	ROD 420 1000 to 5000 lines	**ROD 430** 1000 to 5000 lines	**ROD 480** 1000 to 5000 lines	
	ROD 620 512 to 5000 lines	**ROD 630** 512 to 5000 lines		 **80**
	–	**ROD 1930** 600 to 2400 lines	–	 **82**
	ERN 421 1024 Lines	**ERN 431** 1024 Lines	–	
	ERN 420 1024 Lines	**ERN 430** 1024 Lines	–	
	HR 1120 100 lines	–	–	 **84**

You will find these rotary encoders in the Product Overview ***Rotary Encoders for Potentially Explosive Atmospheres***

These rotary encoders are described in the ***Encoders for Servo Drives*** brochure.

Measuring principles

Measuring standards

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.

These precision graduations are manufactured in various photolithographic processes. Graduations are produced from
- extremely hard chromium lines on glass
- matte-etched lines on gold-plated steel tape
- three-dimensional structures on glass or steel substrates

The photolithographic manufacturing processes developed by HEIDENHAIN produce grating periods of typically 50 µm to 4 µm.

These processes permit very fine grating periods and are characterized by a high definition and homogeneity of the line edges. Together with the photoelectric scanning method, this high edge definition is crucial for the high quality of the output signals.

The master graduations are manufactured by HEIDENHAIN on custom-built, high-precision dividing engines.

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

Measurement procedure

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 graduated disk**, which is formed from a serial absolute code structure.

A separate incremental track is interpolated for the position value and is simultaneously 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 graduated disks 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

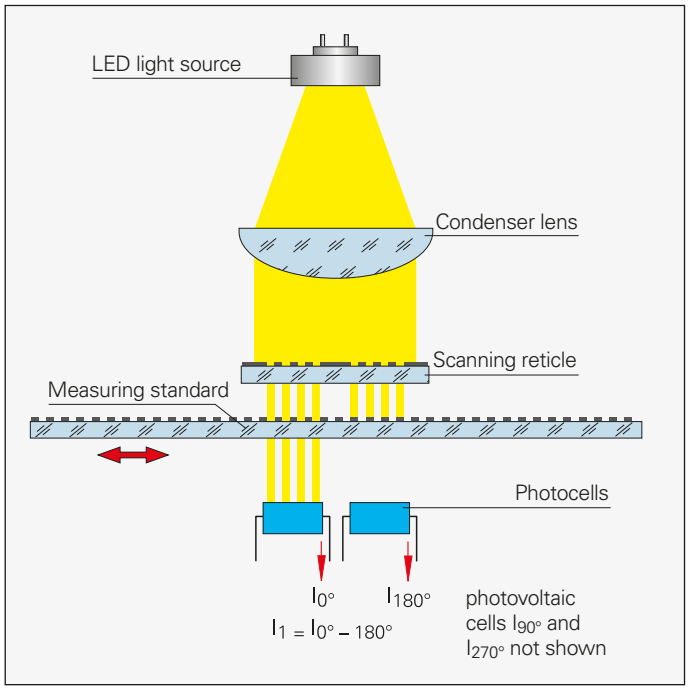
Photoelectric scanning principle
Most HEIDENHAIN encoders operate using the principle of photoelectric scanning. Photoelectric scanning of a measuring standard is contact-free, and as such, free of wear. This method detects even very fine lines, no more than a few micrometers wide, and generates output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

The ECN, EQN, ERN and ROC, ROQ, ROD 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 grating periods—the circular scale and the scanning reticle—are moved relative to each other. The carrier material of the scanning reticle is transparent. The graduation on the measuring standard can likewise be applied to a transparent surface, but also to a 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 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. 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 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.

Other scanning principles
ECI/EBI/EQI and RIC/RIQ rotary encoders operate according to the inductive measuring principle. Here, 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.



Photoelectric scanning according to the imaging scanning principle

Accuracy

The accuracy of position measurement with rotary encoders is mainly determined by
- the directional deviation of the radial grating
- the eccentricity of the graduated disk to the bearing
- the radial runout of the bearing
- The error due to the connection with a shaft coupling—for rotary encoders with stator coupling, this error lies within the system accuracy
- The interpolation errors during further processing of the measuring signals in the integrated or external interpolation and digitizing electronics

For **incremental rotary encoders** with line counts up to 5000:
The maximum direction error at 20 °C ambient temperature and with slow rotation (sampling frequency between 1 kHz and 2 kHz) is within

$$\pm\frac{18° \text{ mech. } \times 3600}{\text{Line count } z} \text{ [angular seconds]}$$

which equals

$$\pm\frac{1}{20} \text{ grating period.}$$

In the case of ROD rotary encoders, the 6000 to 10 000 signal periods per revolution are formed by signal doubling. The line count is important for the system accuracy.

For **absolute rotary encoders**, the accuracy of the absolute position values is given in the specifications of the respective encoder.

For absolute rotary encoders with **complementary incremental signals**, the accuracy depends on the line count:

Line count	Accuracy
16	±480 angular seconds
512	± 60 angular seconds
2048	± 20 angular seconds
2048	± 10 angular seconds (ROC 425 with high accuracy)

The accuracy data are given with respect to the incremental measuring signals at 20 °C ambient temperature and with slow rotation.

Mechanical design types and mounting
Rotary encoders with stator coupling

ECN/EQN/ERN rotary encoders have integrated bearings and a mounted stator coupling. The stator coupling compensates radial runout and alignment errors without significantly reducing the accuracy. The rotary 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. The stator coupling permits axial motion of the measured shaft:

ECN/EQN/ERN 400:	±1 mm
ECN/EQN/ERN 1000:	±0.5 mm
ECN/ERN 100:	±1.5 mm

Mounting
The rotary encoder is slid by its hollow shaft onto the measured shaft, and the rotor is fastened by two screws or three eccentric clamps. Rotary encoders with a hollow through shaft can also be fastened by the housing side. The ECN/EQN/ERN 1300 series rotary encoders with tapered shaft are particularly well-suited for repeated mounting (see the *Encoders for Servo Drives* brochure). The stator is connected without a centering collar on a flat surface. The **universal stator coupling** of the ECN/EQN/ERN400 permits versatile mounting (e.g., by its thread provided for fastening it from the outside to the motor cover).

Mechanical fault exclusion is possible for rotary encoders of the ECN/EQN/ERN 400 series with standard stator coupling and blind hollow shaft.

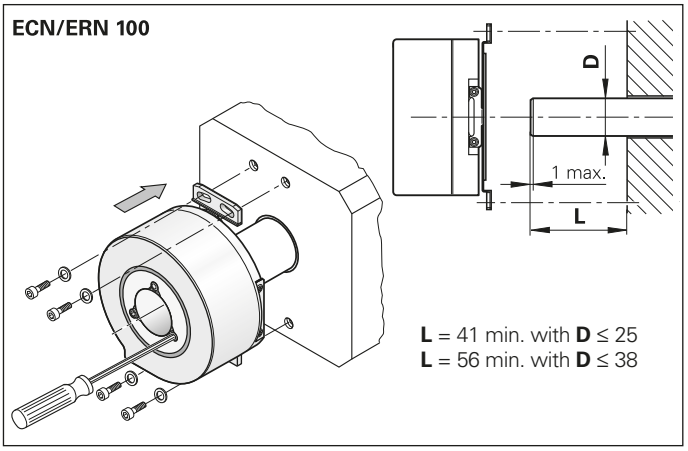
Dynamic applications require the highest possible natural frequencies f_N of the system. (see also *General mechanical information).* These are achieved by connecting the shafts on the flange side and fastening the coupling by four screws or, on the ECN/EQN/ERN 1000, with special washers.

Typical natural frequency f_N with coupling fastened by 4 screws

	Stator coupling	Cable	Flange socket	
			Axial	Radial
ECN/EQN/ERN 400	Standard Universal	1550 Hz 1400 Hz[1)]	1500 Hz 1400 Hz	1000 Hz 900 Hz
ECN/ERN 100		1000 Hz	–	400 Hz
ECN/EQN/ERN 1000		1500 Hz[2)]	–	–

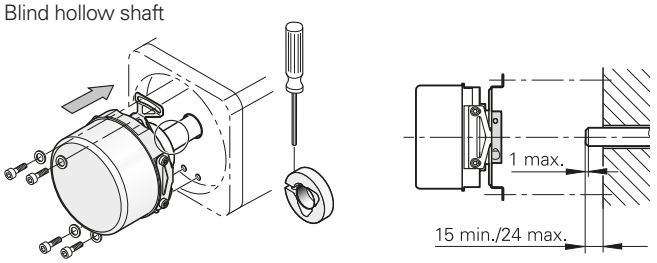
[1)] Also when fastening by two screws
[2)] Also when fastening by 2 screws and washers

ECN/ERN 100

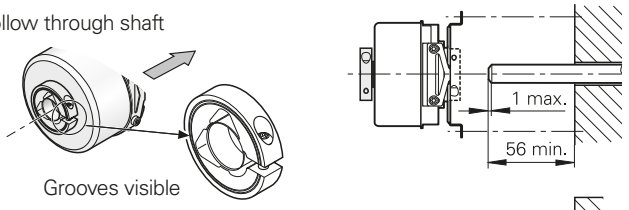


ECN/EQN/ERN 400 with standard stator coupling

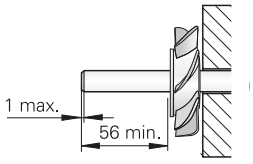
Blind hollow shaft



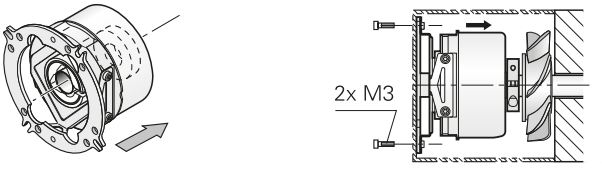
Hollow through shaft



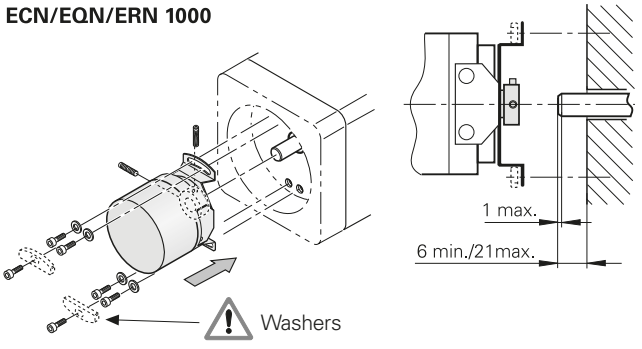
ECN/EQN/ERN 400
With universal stator coupling



Hollow through shaft



ECN/EQN/ERN 1000



Mounting accessories

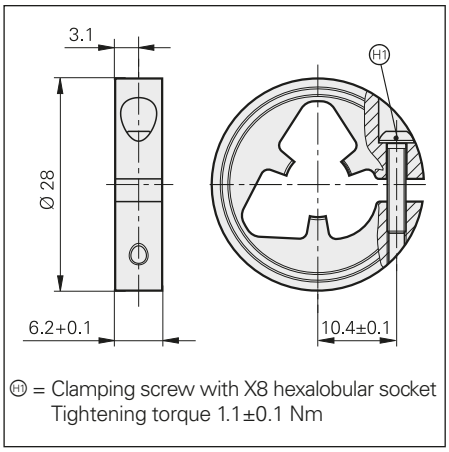
Shaft clamping ring

For ECN/EQN/ERN 400
By using a second shaft clamp ring, the mechanically permissible speed of rotary encoders with hollow through shaft can be increased to a maximum of 12 000 rpm.
ID 540741-xx

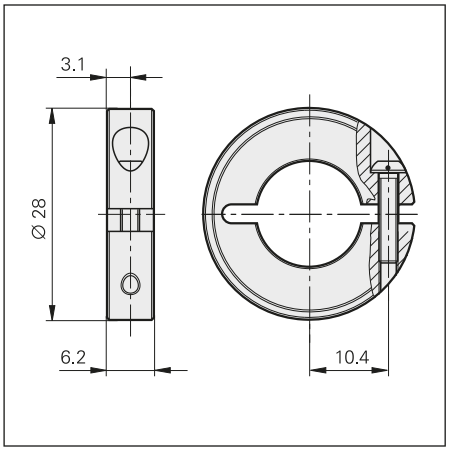
For hollow-shaft connections, the screw force is reduced by repeated fastening. In order to maintain the required safety factor for friction-locked connections, the maximum number of permissible fastening repetitions is limited to four. A mechanical fault exclusion cannot be guaranteed for more repetitions.

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

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



H1 = Clamping screw with X8 hexalobular socket
Tightening torque 1.1±0.1 Nm



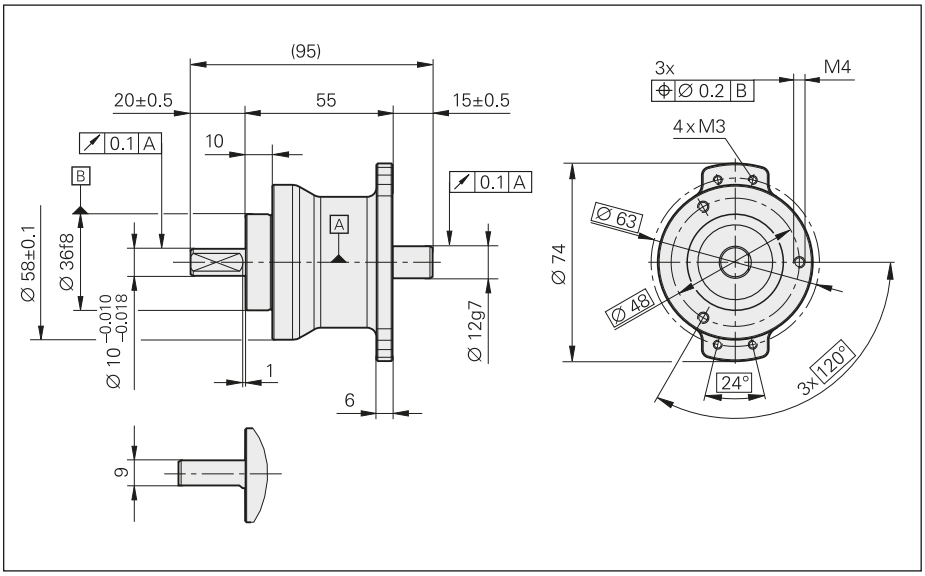
If the encoder is subject to **high shaft loads**, for example from friction wheels, pulleys, or sprockets, then the ECN/EQN/ERN 400 should be mounted with a bearing assembly.

Bearing assembly

For ECN/EQN/ERN 400
With blind hollow shaft
ID 574185-03

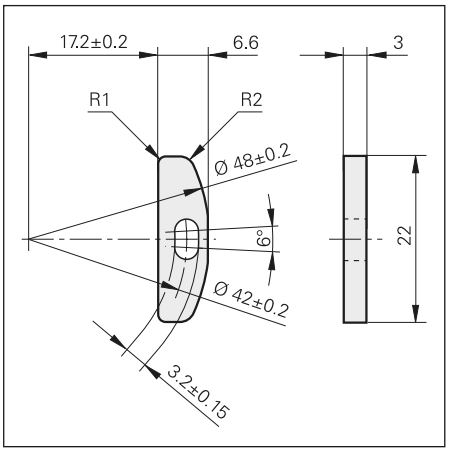
The bearing assembly is capable of absorbing large radial shaft loads. It prevents overload of the encoder bearing. On the encoder side, the bearing assembly has a solid shaft with 12 mm diameter and is well suited for the ECN/EQN/ERN 400 encoders with blind hollow shaft. Also, the threaded holes for fastening the stator coupling are already provided. The flange of the bearing assembly has the same dimensions as the clamping flange of the ROD 420/430 series. The bearing assembly can be fastened through the threaded holes on its face or with the aid of the mounting flange or the mounting bracket (see page 21 for both).

	Bearing assembly
Permissible speed n	≤ 6000 rpm
Shaft load	Axial: 150 N; radial: 350 N
Operating temperature	–40 °C to 100 °C
Protection (EN 60529)	IP64



Mounting accessories

Washer
For ECN/EQN/ERN 1000
For increasing the natural frequency f_N when fastening with only two screws
ID 334653-01



Torque supports for ECN/EQN/ERN 400
For simple applications with the ECN/EQN/ERN 400, the stator coupling can be replaced by torque supports. The following kits are available:

Wire torque support
The stator coupling is replaced by a metal plate to which the provided wire is fastened as coupling.
ID 510955-01

Pin torque support
Instead of a stator coupling, a "synchro flange" is fastened to the encoder. A pin serving as torque support is mounted either axially or radially on the flange. As an alternative, the pin can be pressed in on the customer's surface, and a guide can be inserted in the encoder flange for the pin.
ID 510861-01

General accessories

Screwdriver bits
- For HEIDENHAIN shaft couplings
- For ExN 100/400/1000 shaft couplings
- For ERO shaft couplings

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

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
TX8	89 mm 152 mm	350378-11 350378-12
TX15	70 mm	756768-42

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

Rotary encoders for separate shaft coupling

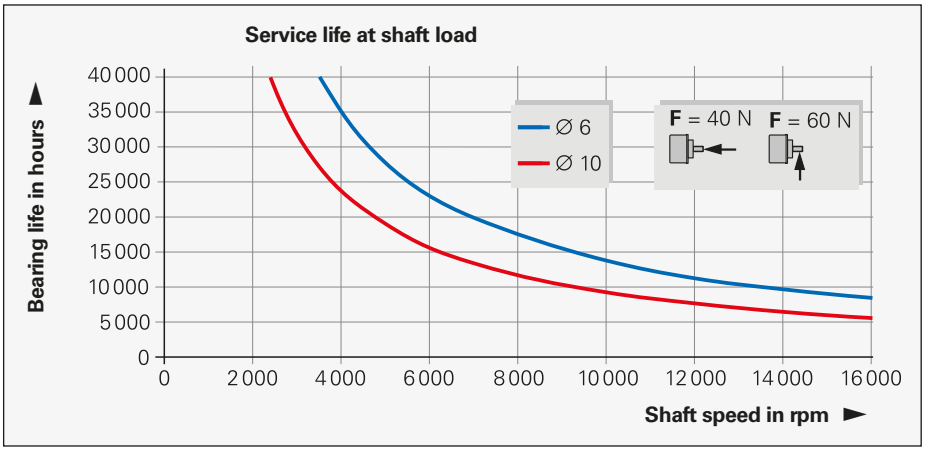
ROC/ROQ/ROD and **RIC/RIQ** rotary encoders have integrated bearings and a solid shaft. The encoder shaft is connected with the measured shaft through a separate rotor coupling. The coupling compensates for axial movements and misalignment (radial and angular misalignment) between the rotary encoder and the drive shaft. In this way, the rotary encoder bearing is free from additional external loads and its service life is not impaired. Diaphragm and metal bellows couplings designed to connect the rotor of the ROC/ROQ/ROD/ RIC/RIQ encoders are available (see *Shaft couplings*).

ROC/ROQ/ROD 400, RIC/RIQ 400 and ROD 600 series rotary encoders permit high bearing loads (see diagram).

If the encoder shaft is subject to relatively high loads, for example from friction wheels, pulleys, or sprockets, HEIDENHAIN recommends mounting the ECN/ EQN/ERN 400 with a bearing assembly. The ROD 1930 is offered for very high bearing loads.

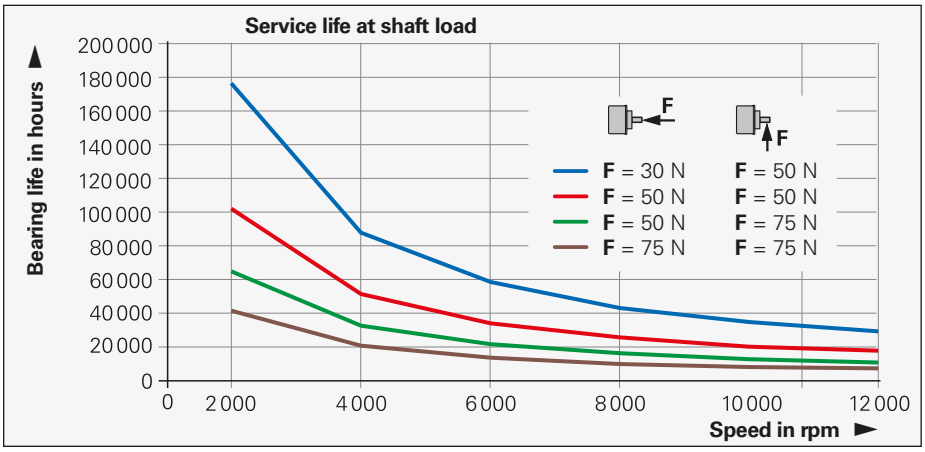
Bearing service life of ROC/ROQ/ ROD 400 and RIC/RIQ 400

The service life to be expected of the bearings depends on the shaft load, the force application point, and the shaft speed. The maximum permissible load of the shaft at shaft end is listed in the *Specifications*. The relationship between bearing life and maximum shaft load is shown in the diagram for 6 mm and 10 mm shaft diameters. With a load of 10 N axially and 20 N radially at the shaft end, the expected bearing service life at maximum shaft speed is more than 40 000 hours.



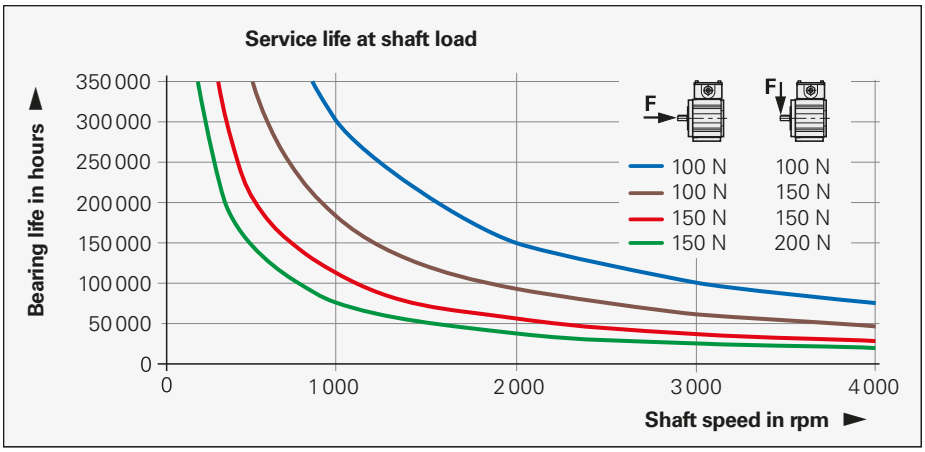
Bearing service life of ROD 600

Rotary encoders of the ROD 600 series are designed for high bearing loads together with long service life.



Bearing service life of ROD 1930

The ROD 1930 is designed for high bearing loads together with a long service life.



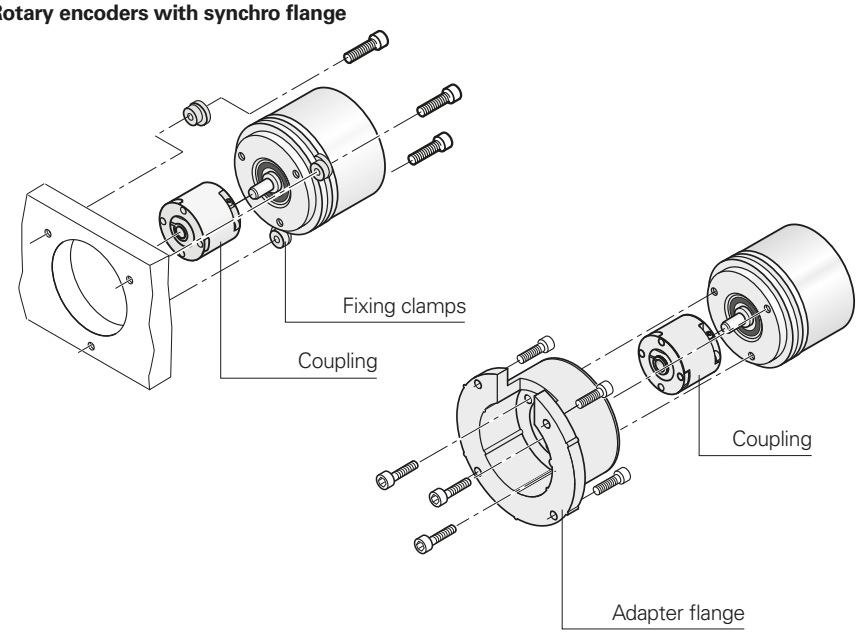
Rotary encoders with synchro flange

Mounting

- By the synchro flange with three fixing clamps, or
- encoder flange to an adapter flange (for ROC/ROQ/ROD 400 or RIC/RIQ 400)

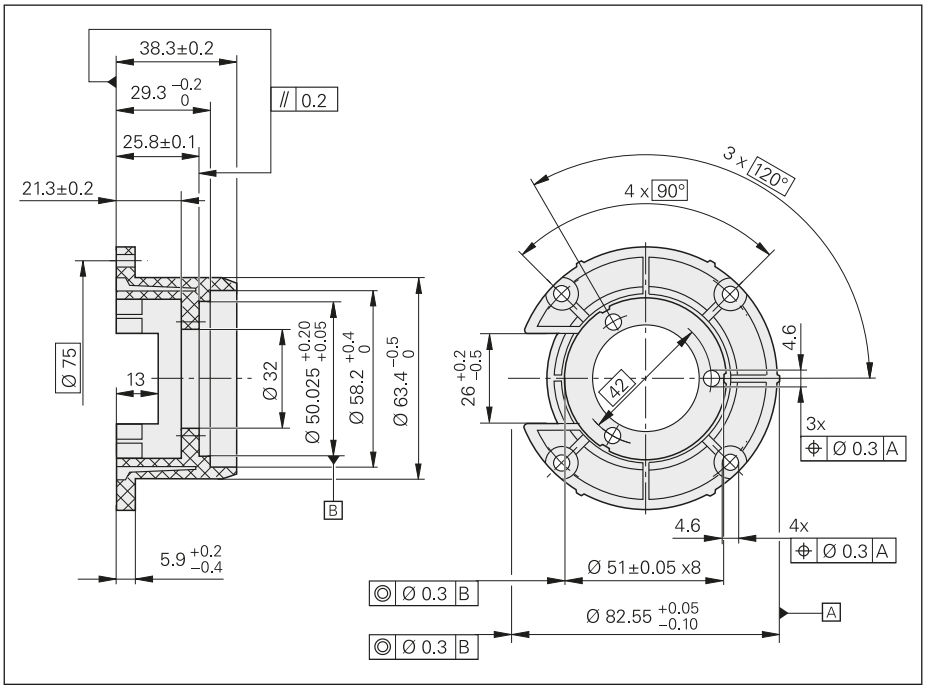
Mechanical fault exclusion is possible after consultation with HEIDENHAIN in Traunreut, Germany.

Rotary encoders with synchro flange

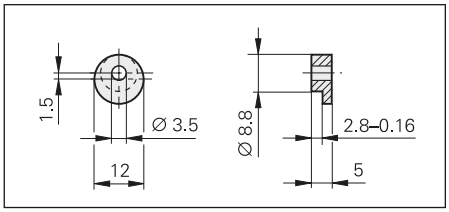


Mounting accessories

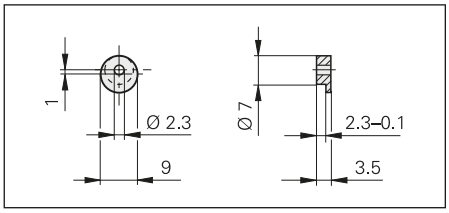
Adapter flange
(electrically non-conductive)
ID 257044-01



Fixing clamps
For ROC/ROQ/ROD 400 and RIC/RIQ 400 series
(3 per encoder)
ID 200032-01



Fixing clamps
For ROC/ROQ/ROD 1000 series
(3 per encoder)
ID 200032-02



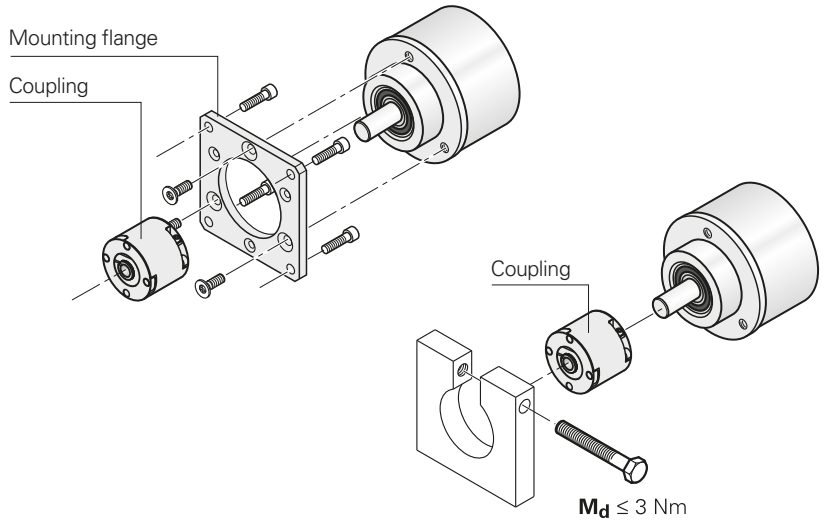
Rotary encoders with clamping flange

Mounting
- By fastening the threaded holes on the encoder flange to an adapter flange or
- by clamping at the clamping flange or
- for encoders with additional slot, by the clamping flange with three fixing clamps

The centering collar on the synchro flange or clamping flange serves to center the encoder.

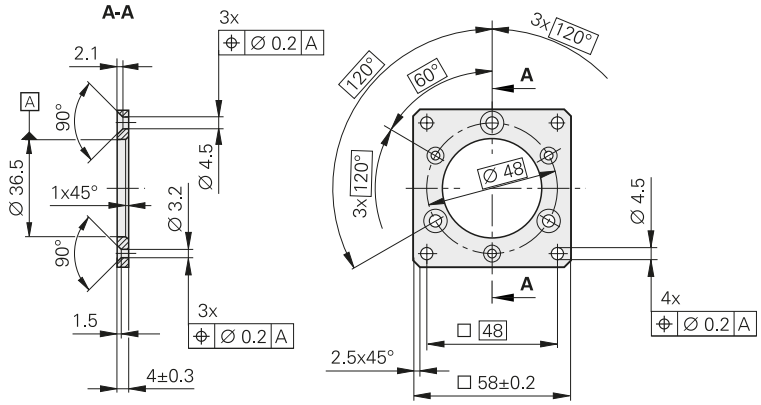
Mechanical fault exclusion is possible after consultation with HEIDENHAIN in Traunreut, Germany.

ROC/ROQ/ROD 400 with clamping flange

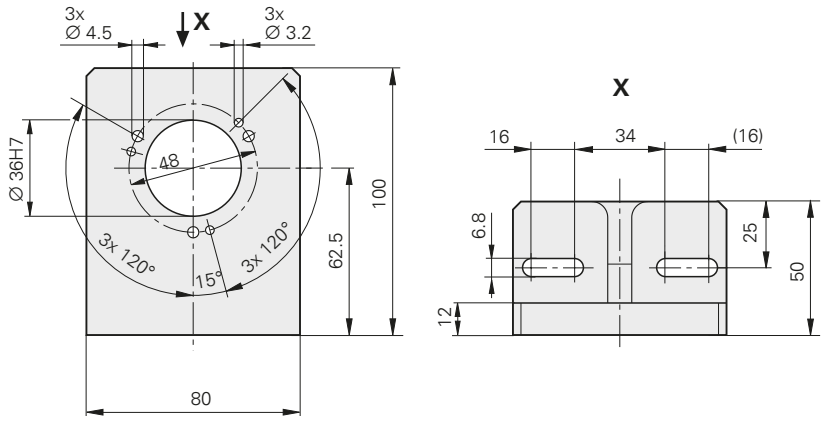


Mounting accessories

Mounting flange
ID 201437-01



Mounting bracket
ID 581296-01



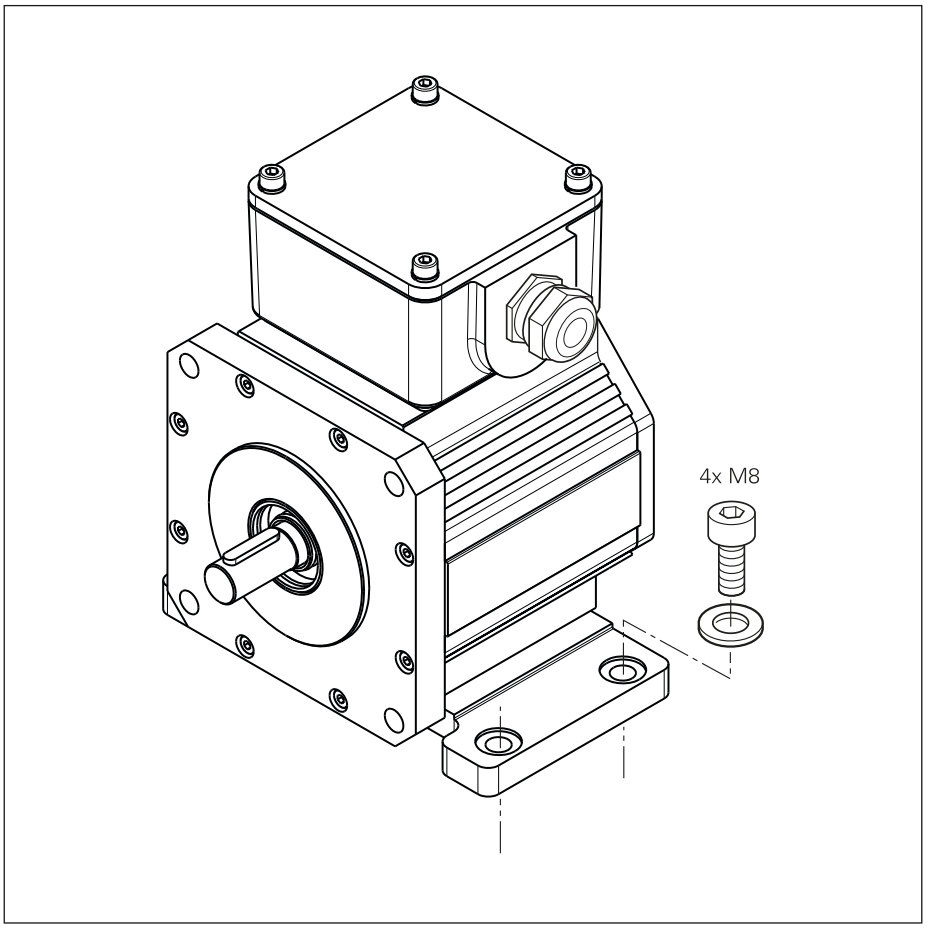
Rotary encoder mounted by flange/base

Mounting
- By the flange, or
- on a base

The encoder is fastened by four M8 screws.

The terminal box can be mounted in 90° offsets.

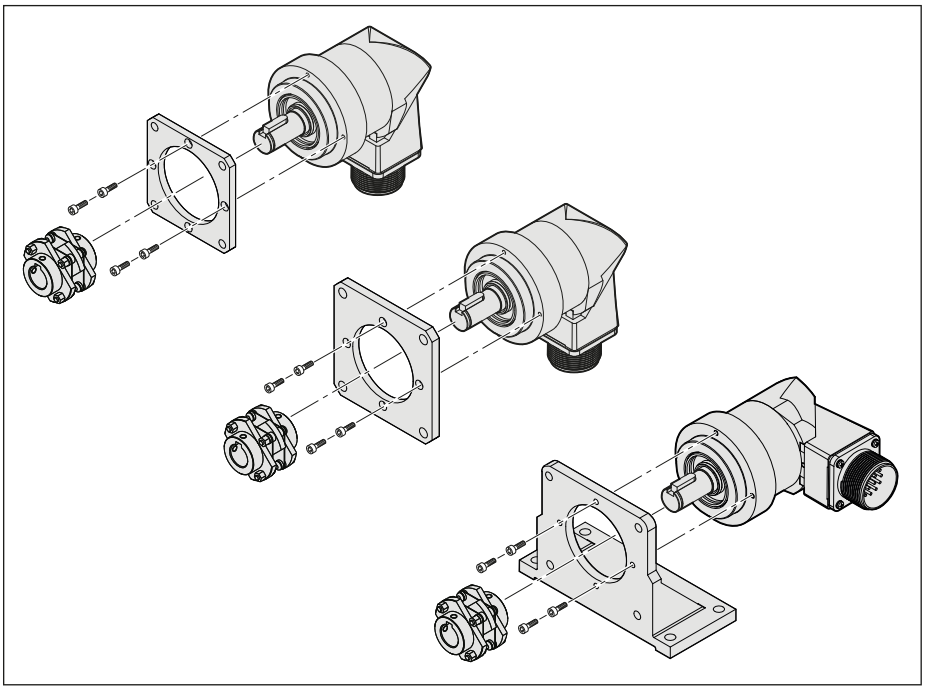
Shaft coupling
The encoder shaft features a machine key for optimum torque transmission. The C19 and C 212 couplings that are provided as accessories feature an appropriate holder.



ROD 600 rotary encoder with clamping flange

Mounting

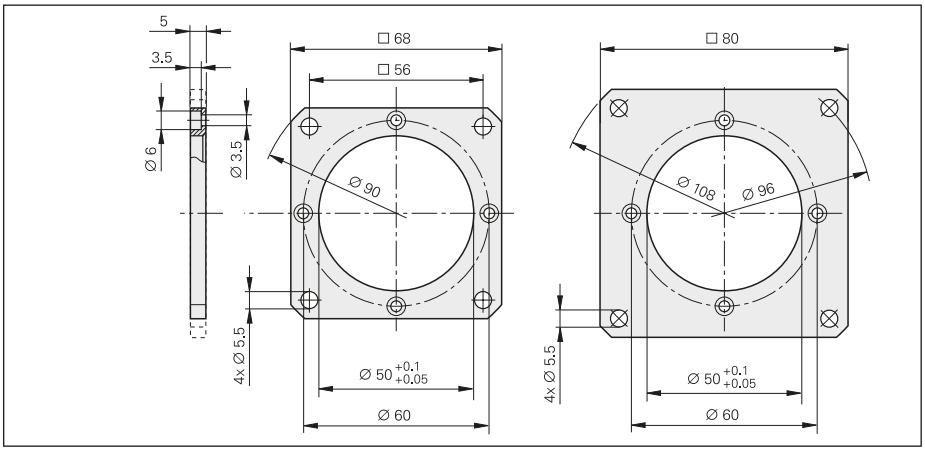
- By fastening the threaded holes on the encoder flange to an adapter flange



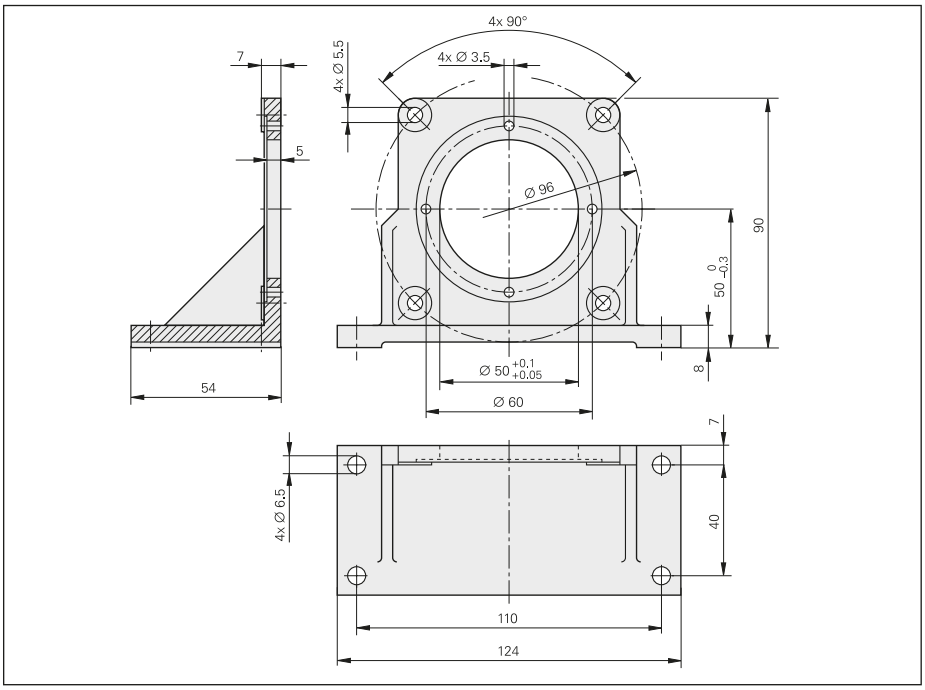
Mounting accessories

Mounting flange, small
ID 728587-01

Mounting flange, large
ID 728587-02



Mounting bracket
ID 728587-03



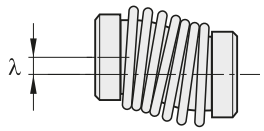
mm
Tolerancing ISO 8015
ISO 2768 - m H
≤ 6 mm: ±0.2 mm

Shaft couplings

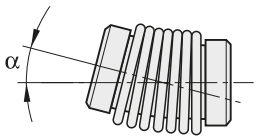
	ROC/ROQ/ROD 400				ROD 1930 ROD 600		ROC/ROQ/ ROD 1000
	Diaphragm coupling				Diaphragm coupling		Metal bellows coupling
	K 14	K 17/01 K 17/06	K 17/02 K 17/04 K 17/05	K 17/03	C 19	C 212	18EBN3
Hub bore	6/6 mm	6/6 mm 6/5 mm	6/10 mm 10/10 mm 6/9.52 mm	10/10 mm	15/15		4/4 mm
Galvanic isolation	–	✓	✓	✓	–	✓	–
Kinematic transfer error*	±6″	±10″			±13″		±40″
Torsional rigidity	500 $\frac{Nm}{rad}$	150 $\frac{Nm}{rad}$	200 $\frac{Nm}{rad}$	300 $\frac{Nm}{rad}$	1700 $\frac{Nm}{rad}$		60 $\frac{Nm}{rad}$
Torque	≤ 0.2 Nm	≤ 0.1 Nm		≤ 0.2 Nm	≤ 3.9 Nm	≤ 5 Nm	≤ 0.1 Nm
Radial offset λ	≤ 0.2 mm	≤ 0.5 mm			≤ 0.3 mm		≤ 0.2 mm
Angular error α	≤ 0.5°	≤ 1°			≤ 1.5°		≤ 0.5°
Axial motion δ	≤ 0.3 mm	≤ 0.5 mm			≤ 1.7 mm		≤ 0.3 mm
Moment of inertia (approx.)	6 x 10^{-6} kgm^2	3 x 10^{-6} kgm^2		4 x 10^{-6} kgm^2	15 x 10^{-6} kgm^2		0.3 x 10^{-6} kgm^2
Permissible speed	16000 rpm				20000 rpm	6000 rpm	12000 rpm
Tightening torque of clamping screws (approx.)	1.2 Nm				1.37 Nm		0.8 Nm
Mass	35 g	24 g	23 g	27.5 g	75 g		9 g

***** With radial misalignment λ = 0.1 mm, angular error α = 0.15 mm over 100 mm ≙ 0.09° to 50 °C

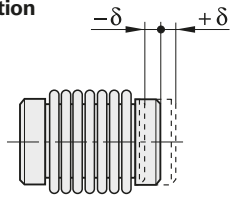
Radial offset



Angular error



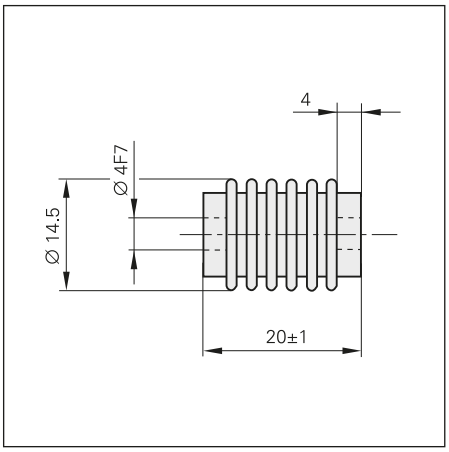
Axial motion



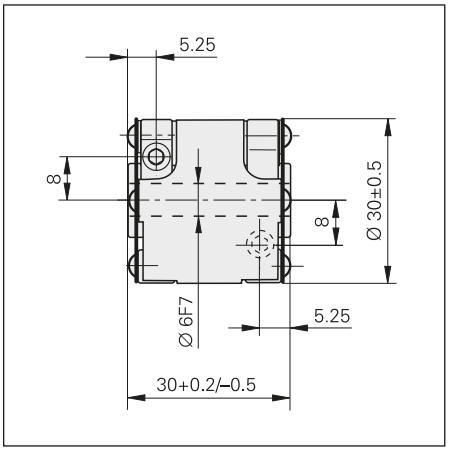
Mounting accessories

Screwdriver bits
Screwdriver
See page 18.

Metal bellows coupling 18 EBN 3
For ROC/ROQ/ROD 1000 series
with **4 mm shaft diameter**
ID 200393-02



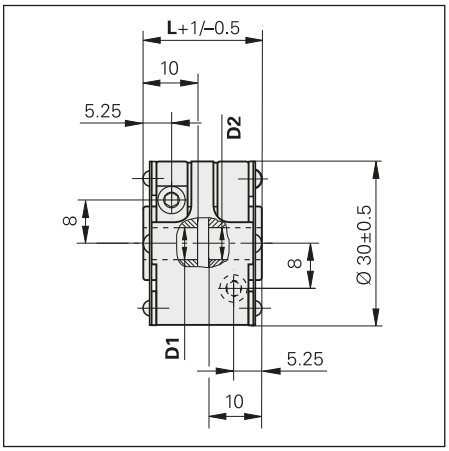
Diaphragm coupling K 14
For ROC/ROQ/ROD 400 and
RIC/RIQ 400 series
with **6 mm shaft diameter**
ID 293328-01



Recommended fit for the mating shaft: h6

Diaphragm coupling K 17 with galvanic isolation
For ROC/ROQ/ROD 400 and
RIC/RIQ 400 series
with **6 or 10 mm shaft diameter**
ID 296746-xx

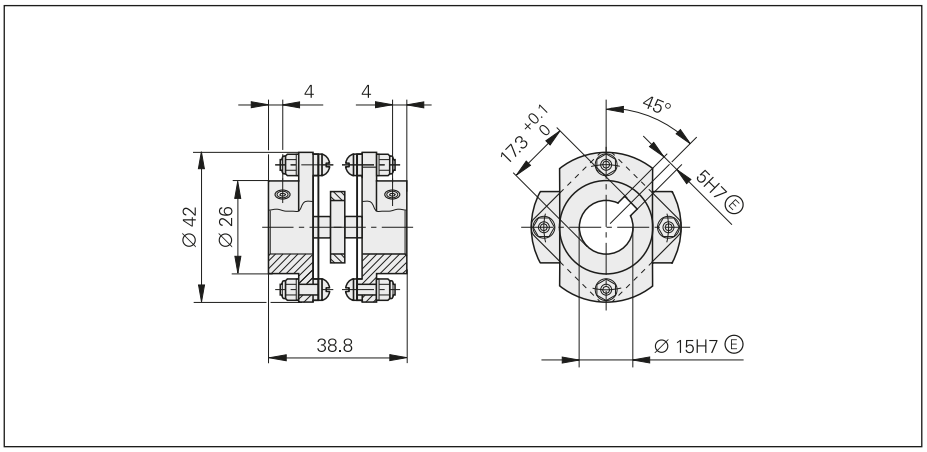
Suitable also for potentially explosive atmospheres in zones 1, 2, 21 and 22



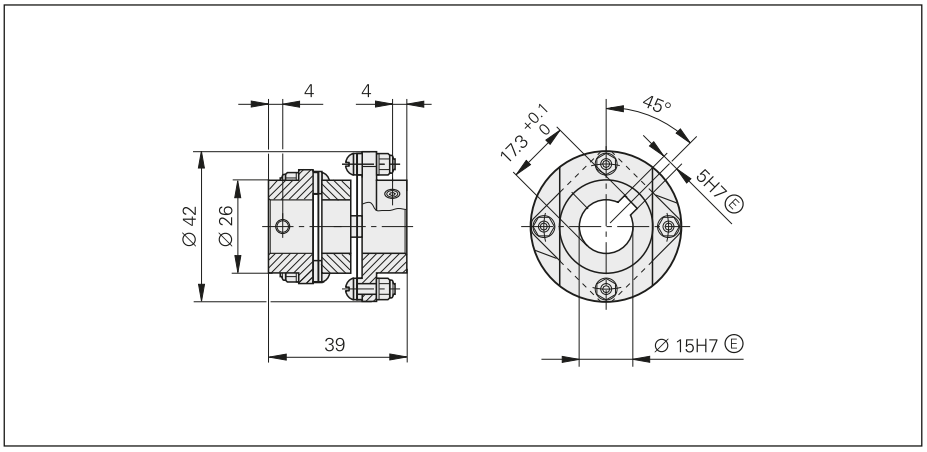
mm
Tolerancing ISO 8015
ISO 2768 - m H
≤ 6 mm: ±0.2 mm

K 17 Variant	D1	**D2**	L
01	Ø 6 F7	**Ø 6 F7**	22 mm
02	Ø 6 F7	**Ø 10 F7**	22 mm
03	Ø 10 F7	**Ø 10 F7**	30 mm
04	Ø 10 F7	**Ø 10 F7**	22 mm
05	Ø 6 F7	**Ø 9.52 F7**	22 mm
06	Ø 5 F7	**Ø 6 F7**	22 mm

Diaphragm coupling C 19
For ROD 1930 and ROD 600 rotary encoders with 15 mm shaft diameter and machine key
ID 731374-01



Diaphragm coupling C 212
With galvanic isolation
For ROD 1930 and ROD 600 rotary encoders with 15 mm shaft diameter and machine key
ID 731374-02



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

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 **permanent 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 max. permissible relative humidity is 75 %. A relative humidity of 93 % is temporarily permissible. Condensation is not permissible.

Magnetic fields
Magnetic fields > 30 mT can impair the proper functioning of encoders. If required, please contact HEIDENHAIN, Traunreut.

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 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*).

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

f_N: Natural frequency of the coupling in Hz
C: Torsional rigidity of the coupling in Nm/rad
I: Moment of inertia of the rotor in kgm^2

ECN/EQN/ERN rotary encoders with their stator couplings form a vibrating spring-mass system whose **natural frequency f_N** should be as high as possible. The specified typical natural frequencies of the stator coupling can vary with different rotary encoder variants (e.g., singleturn or multiturn versions), production tolerances, and mounting conditions. If radial and/or axial acceleration forces are added, the rigidity of the encoder bearings and the encoder stators 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 60 529)
The ingress of contamination can impair the proper functioning of the encoder. Unless otherwise indicated, all rotary encoders meet protection standard IP64 (ExN/ROx 400: IP67) according to EN 60529. 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.

Assembly
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 brochure 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 the 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 decreases 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 x 10^{-6}K^{-1}	10 x 10^{-6}K^{-1} to 17 x 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
- The ambient temperature
- Self-heating of the encoder

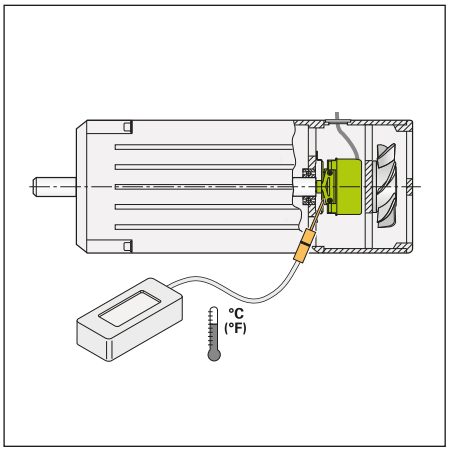
The self-heating of an encoder depends both on its design characteristics (stator coupling/solid shaft, shaft sealing ring, etc.) and on the operating parameters (rotational speed, voltage supply). Temporarily increased self-heating can also occur after very long breaks in operation (of several months). 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 reduced degree of protection (without shaft seal and its concomitant frictional heat).

Self-heating at shaft speed n_{max}	
Solid 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*)

Safety-related position encoders

Under the term **functional safety**, HEIDENHAIN offers 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 61 508 and EN 61 800-5-2. 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. A **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)

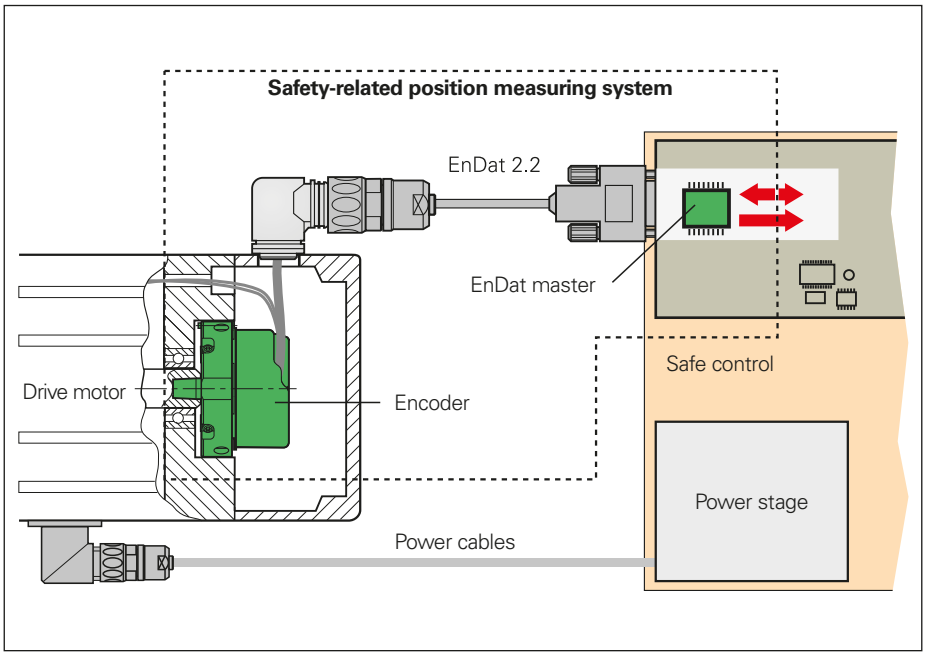
Field of application
Safety-related position measuring systems from HEIDENHAIN are designed so that they can be used as single-encoder systems in applications with control category SIL 2 (according to EN 61 508), performance level "d," category 3 (according to EN ISO 13 849).

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 (brochures / 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 61 800-5-2



Complete safe-servo-drive system with EnDat 2.2

DRIVE-CLiQ is a registered trademark of SIEMENS AG.

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 then 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.

Integration of the position measuring system – the documentation
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.

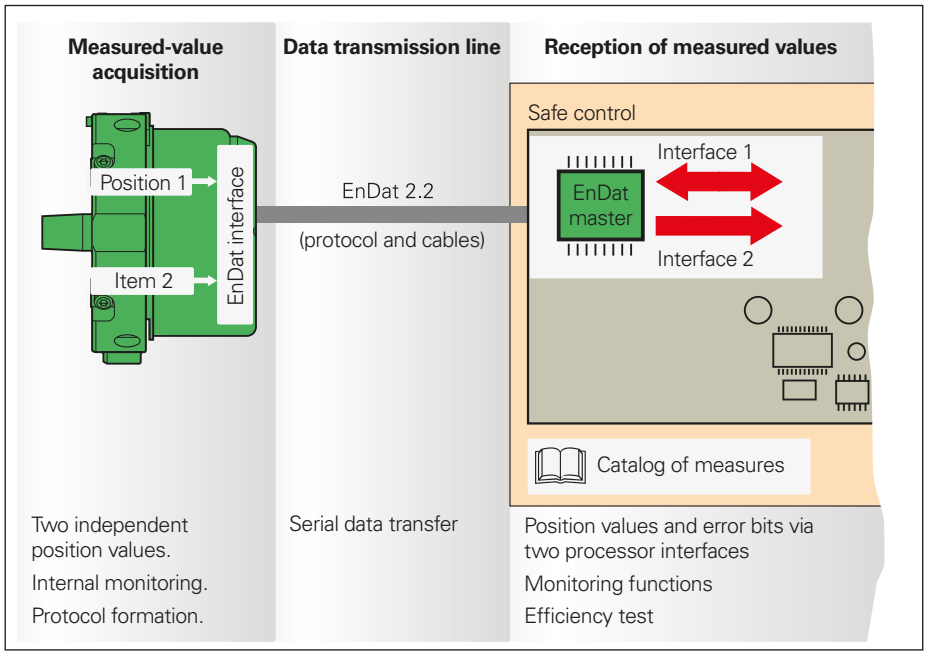
The requirements for integrating the EnDat master with monitoring functions into the safe control are described in the HEIDENHAIN document 533095. It contains, for example, specifications on the evaluation and processing of position values and error bits, and on electrical connection and cyclic tests 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, brochures and mounting instructions provide information to aid in the selection of a suitable encoder. The **product information document** and **brochure** contain general information on the 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.

Fault exclusion for the loosening of the mechanical connection
Regardless of the interface, many safety designs require a safe mechanical connection. The standard for electrical drives, EN 61 800-5-2, defines the loss or loosening of the mechanical connection between the encoder and drive as a fault that requires consideration. Since it cannot be guaranteed that the control will detect such errors, fault exclusion is required in many cases.

Standard encoders
In addition to those encoders explicitly qualified for safety applications, standard encoders (e.g., with 1 V_{PP} signals) can also be used in safe applications. In these cases, the characteristics of the encoders are to be aligned with the requirements of the respective control. HEIDENHAIN can provide additional data on the individual encoders (failure rate, fault model as per EN 61 800-5-2).



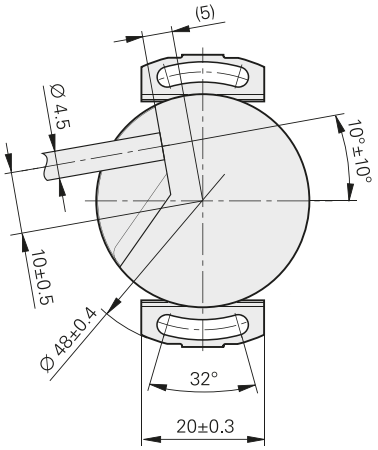
Safety-related position encoder with EnDat 2.2

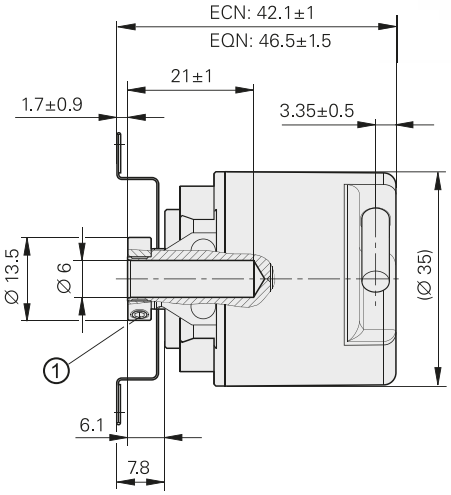
Further information:
For more information on the topic of functional safety, refer to the technical information documents *Safety-Related Position Measuring Systems* and *Safety-Related Control Technology* as well as the product information documents for encoders with functional safety and in the customer information documents on fault exclusion.

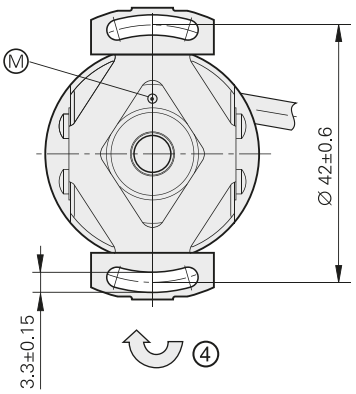
ECN/EQN/ERN 1000 series

Absolute and incremental rotary encoders
- **Stator coupling for plane surface**
- **Blind hollow shaft**

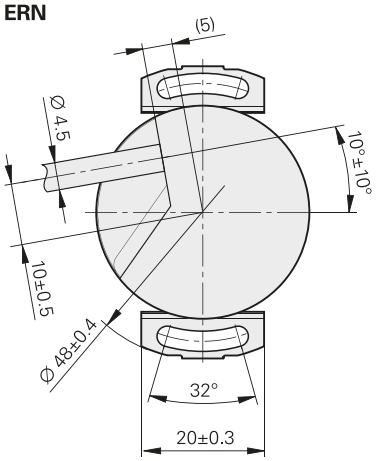
ECN/EQN

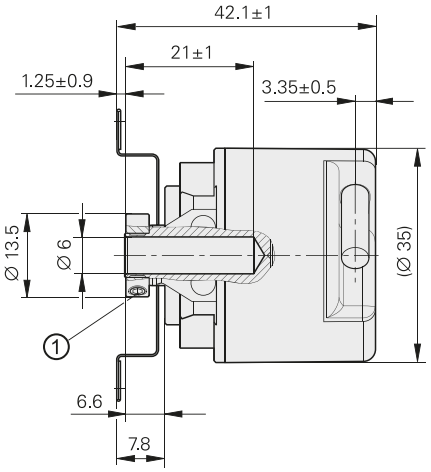


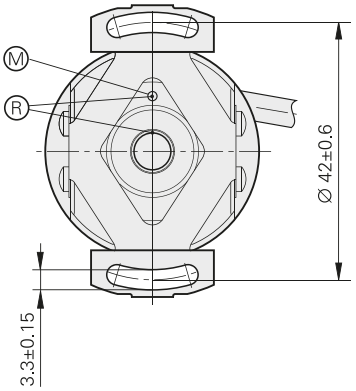




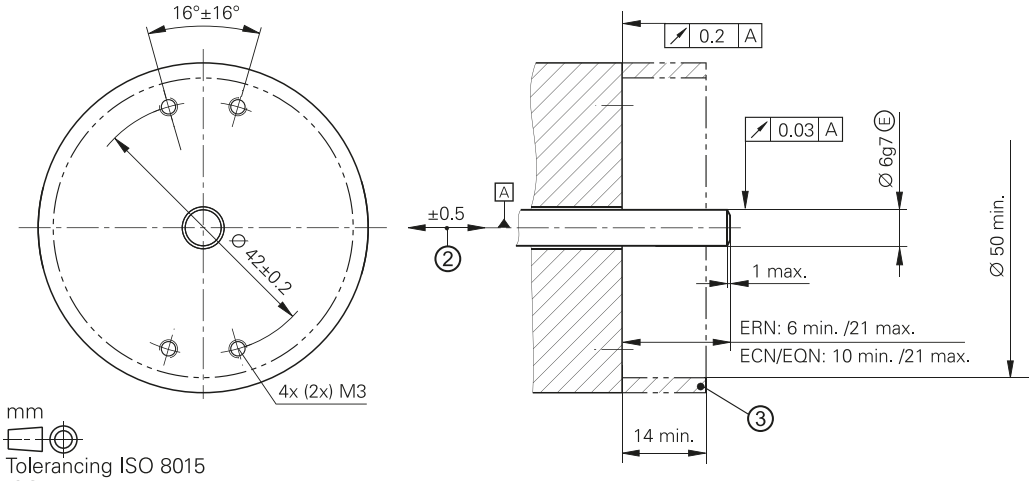
ERN







Required mating dimensions



mm

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

Ⓐ = Bearing of mating shaft
Ⓜ = Measuring point for operating temperature
Ⓡ = Reference mark position ±20°
1 = 2 screws in clamping ring Tightening torque 0.6±0.1 Nm, width across flats 1.5
2 = Compensation of mounting tolerances and thermal expansion; no dynamic motion permitted
3 = Ensure protection against contact (EN 60 529)
4 = Direction of shaft rotation for output signals as per the interface description

	Incremental				
	ERN 1020	**ERN 1030**	**ERN 1080**	**ERN 1070**	
Interface	⊓⊔ TTL	⊓⊔ HTLs	∿ 1 V_{PP}[1)]	⊓⊔ TTL	
Line counts*	100 200 **250** 360 400 **500** 720 900 **1000** **1024** 1250 1500 2000 **2048** **2500** **3600**			**1000** **2500** **3600**	
Reference mark	One				
Integrated interpolation*	–			5-fold	10-fold
Cutoff frequency –3 dB Scanning frequency Edge separation a	– ≤ 300 kHz ≥ 0.39 µs	– ≤ 160 kHz ≥ 0.76 µs	≥ 180 kHz – –	– ≤ 100 kHz ≥ 0.47 µs	– ≤ 100 kHz ≥ 0.22 µs
System accuracy	1/20 of grating period				
Electrical connection*	**Cable 1 m**/5 m, with or **without M23 coupling**			Cable, 5 m, without connecting element	
Voltage supply	DC 5 V ±0.5 V	DC 10 V to 30 V	DC 5 V ±0.5 V	DC 5 V ±0.25 V	
Current consumption without load	≤ 120 mA	≤ 150 mA	≤ 120 mA	≤ 155 mA	
Shaft	Blind hollow shaft Ø 6 mm				
Mechanically permissible speed n	≤ 12 000 rpm				
Starting torque	≤ 0.001 Nm (at 20 °C)				
Moment of inertia of rotor	≤ 0.5 x 10^{-6} kgm^2				
Permissible axial motion of measured shaft	±0.5 mm				
Vibration 55 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 temperature[2)]	100 °C	70 °C	100 °C	70 °C	
Min. operating temp.	*Fixed cable:* –30 °C; *Moving cable:* –10 °C				
Protection EN 60 529	IP64				
Mass	≈ 0.1 kg				
Valid for ID	534909-xx	534911-xx	534913-xx	534912-xx	

Bold: These preferred version are available on short notice.
***** Please select when ordering
1) Restricted tolerances: signal amplitude 0.8 V_{PP} to 1.2 V_{PP}
2) For the correlation between the operating temperature and the shaft speed or supply voltage, see *General mechanical information*

		**Absolute** **Singleturn**		
		ECN 1023	**ECN 1013**	
Interface*		EnDat 2.2	EnDat 2.2	SSI
Ordering designation		EnDat22	EnDat01	SSI39r1
Positions per revolution		8388608 (23 bits)	8192 (13 bits)	
Revolutions		–		
Code		Pure binary		Gray
Elec. permissible speed Deviation[1]		≤ 12000 rpm for continuous position value	≤ 4000 rpm/ ≤ 12000 rpm ±1 LSB/±16 LSB	≤ 12000 rpm ±12 LSB
Calculation time t_{cal} Clock frequency		≤ 7 µs ≤ 8 MHz	≤ 9 µs ≤ 2 MHz	≤ 5 µs ≤ 1 MHz
Incremental signals		–	~ 1 V_{PP}[2]	
Line count		–	512	
Cutoff frequency –3 dB		–	≥ 190 kHz	
System accuracy		±60″		
Electrical connection		Cable 1 m, with M12 coupling	Cable 1 m, with M23 coupling	
Voltage supply		DC 3.6 V to 14 V		DC 4.75 V to 30 V
Power consumption (max.)		*3.6 V:* ≤ 0.6 W *14 V:* ≤ 0.7 W		*4.75 V:* ≤ 0.53 W *30 V:* ≤ 0.86 W
Current consumption (typical, without load)		*5 V:* 85 mA		*5 V:* 70 mA *24 V:* 20 mA
Shaft		Blind hollow shaft Ø 6 mm		
Mech. permiss. speed n		12000 rpm		
Starting torque		≤ 0.001 Nm (at 20 °C)		
Moment of inertia of rotor		≈ 0.5 x 10^{-6} kgm^2		
Permissible axial motion of measured shaft		±0.5 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.		*Stationary cable:* –30 °C; *moving cable:* –10 °C		
Protection EN 60529		IP64		
Mass		≈ 0.1 kg		
Valid for ID		606683-xx	606681-xx	606682-xx

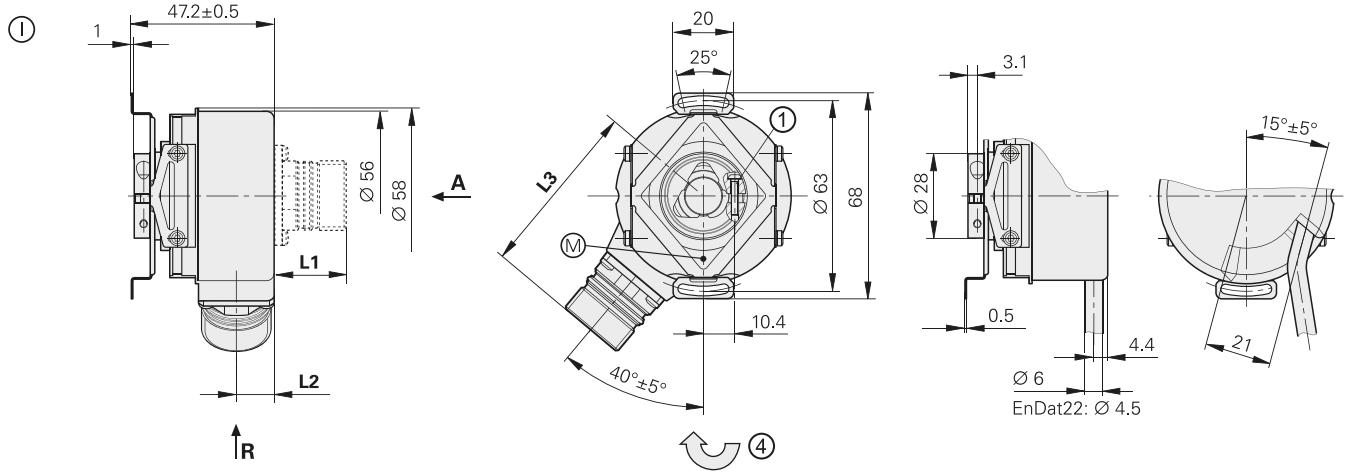
***** Please select when ordering
[1] Velocity-dependent deviations between the absolute and incremental signals
[2] Restricted tolerances: signal amplitude 0.8 V_{PP} to 1.2 V_{PP}

	Multiturn		
	EQN 1035	**EQN 1025**	
	EnDat 2.2	EnDat 2.2	SSI
	EnDat22	EnDat01	SSI41r1
	8388608 (23 bits)	8192 (13 bits)	
	4096 (12 bits)		
	Pure binary		Gray
	≤ 12000 rpm for continuous position value	≤ 4000 rpm/ ≤ 12000 rpm ±1 LSB/±16 LSB	≤ 12000 rpm ±12 LSB
	≤ 7 µs ≤ 8 MHz	≤ 9 µs ≤ 2 MHz	≤ 5 µs ≤ 1 MHz
	–	~ 1 V_{PP} [2)]	
	–	512	
	–	≥ 190 kHz	
	Cable 1 m, with M12 coupling	Cable 1 m, with M23 coupling	
	DC 3.6 V to 14 V		4.75 V DC to 30 V
	3.6 V: ≤ 0.7 W *14 V:* ≤ 0.8 W		*4.75 V:* ≤ 0.65 W *30 V:* ≤ 1.05 W
	5 V: 105 mA		*5 V:* 85 mA *24 V:* 25 mA
	≤ 0.002 Nm (at 20 °C)		
	606688-xx	606686-xx	606687-xx

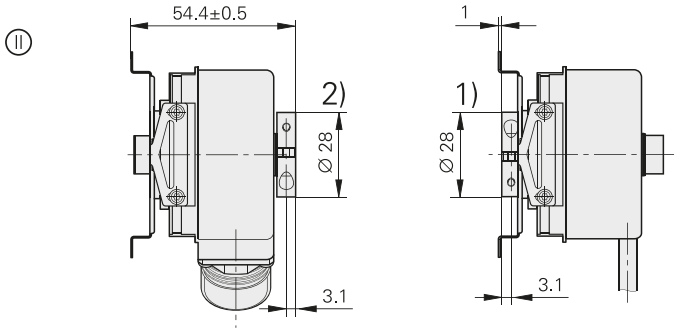
ECN/EQN/ERN 400 series

Absolute and incremental rotary encoders
- **Stator coupling for plane surface**
- **Blind hollow shaft or hollow through shaft**

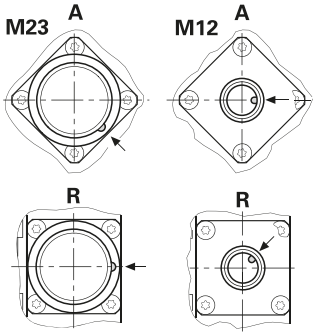
Blind hollow shaft



Hollow through shaft

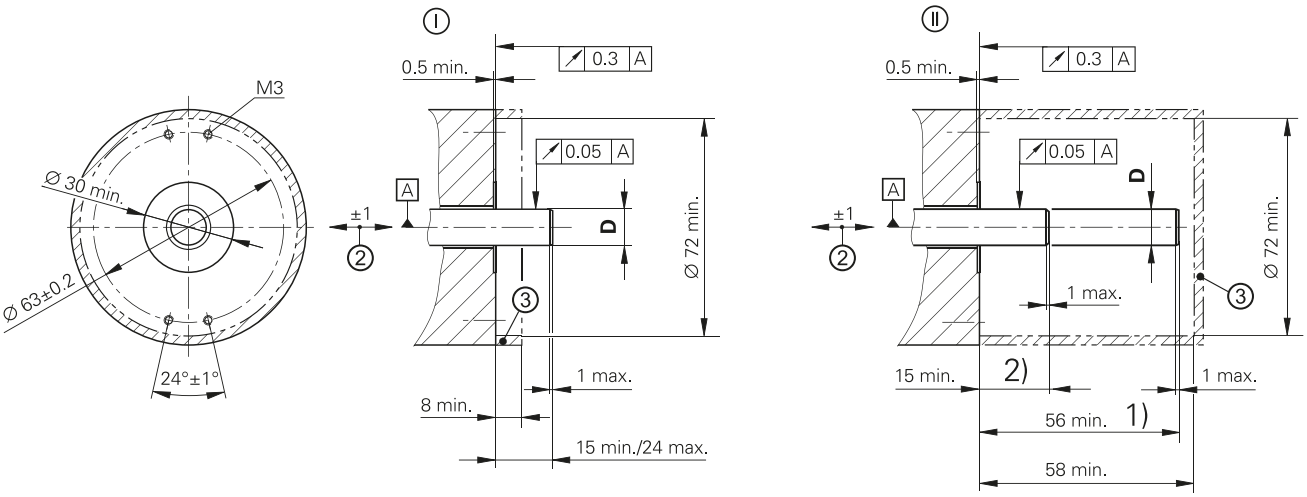


Connector coding
A = axial, **R** = radial



	Flange socket	
	M12	M23
L1	14	23.6
L2	12.5	12.5
L3	48.5	58.1

D
Ø 8g7 Ⓔ
Ø 12g7 Ⓔ



mm

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

Cable radial, also usable axially
Ⓐ = Bearing of mating shaft
Ⓜ = Measuring point for operating temperature
1 = Clamping screw with X8 hexalobular socket
2 = Compensation of mounting tolerances and thermal expansion; no dynamic motion permitted
3 = Ensure protection against contact (EN 60 529)
4 = Direction of shaft rotation for output signals as per the interface description
1) = Clamping ring on housing side (condition upon delivery)
2) = Clamping ring on coupling side (optionally mountable)

	Incremental			
	ERN 420	**ERN 460**	**ERN 430**	**ERN 480**
Interface	⊓⊔ TTL		⊓⊔ HTL	∿ 1 V_{PP}[1]
Line counts*	250 500			–
	1000 1024 1250 2000 2048 2500 3600 4096 5000			
Reference mark	One			
Cutoff frequency –3 dB Output frequency Edge separation a	– ≤ 300 kHz ≥ 0.39 µs			≥ 180 kHz – –
System accuracy	1/20 of grating period			
Electrical connection*	• M23 flange socket, radial and axial (with blind hollow shaft) • Cable 1 m, without connecting element			
Voltage supply	DC 5 V ±0.5 V	DC 10 V to 30 V	DC 10 V to 30 V	DC 5 V ±0.5 V
Current consumption without load	≤ 120 mA	≤ 100 mA	≤ 150 mA	≤ 120 mA
Shaft*	**Blind hollow shaft** or **hollow through shaft; D = 8 mm** or **D = 12 mm**			
Mech. permissible speed n[2]	≤ 6000 rpm/≤ 12 000 rpm[3]			
Starting torque At 20 °C Below –20 °C	*Blind hollow shaft:* ≤ 0.01 Nm *Hollow through shaft:* ≤ 0.025 Nm (for IP66: ≤ 0.075 Nm) ≤ 1 Nm			
Moment of inertia of rotor	≤ 4.3 x 10^{-6} kgm^2			
Permissible axial motion of measured shaft	±1 mm			
Vibration 55 Hz to 2000 Hz **Shock** 6 ms	≤ 300 m/s^2; *flange socket version:* 150 m/s^2 (EN 60 068-2-6); higher values upon request ≤ 2000 m/s^2 (EN 60 068-2-27)			
Max. operating temperature[2]	100 °C	70 °C	100 °C[4]	
Min. operating temp.	*Flange socket or fixed cable:* –40 °C; *moving cable:* –10 °C			
Protection EN 60 529	*At housing:* IP67 (IP66 with hollow through shaft) *At shaft inlet:* IP64 (when D = 12 mm IP66 upon request)			
Mass	≈ 0.3 kg			
Valid for ID	385420-xx	385460-xx	385430-xx	385480-xx[5]

Bold: This preferred version is available on short notice.

* Please select when ordering

1) Restricted tolerances: signal amplitude 0.8 V_{PP} to 1.2 V_{PP}

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

3) With two shaft clamps (only for hollow through shaft)

4) 80 °C for ERN 480 with 4096 or 5000 lines

5) Mechanical fault exclusion available; for restrictions on specifications and for special mounting information, see the *Fault exclusion* customer information document.

	**Absolute** **Singleturn** **ECN 425** Functional Safety	**ECN 413**	
Interface*	EnDat 2.2	EnDat 2.2	SSI
Ordering designation	EnDat22	EnDat01	SSI39r1
Positions per revolution	33554432 (25 bits)	8192 (13 bits)	
Revolutions	–		
Code	Pure binary		Gray
Elec. permissible speed Deviation[1]	≤ 12000 rpm for continuous position value	*512 lines:* ≤ 5000/12000 rpm ±1 LSB/±100 LSB *2048 lines:* ≤ 1500/12000 rpm ±1 LSB/±50 LSB	≤ 12000 rpm ±12 LSB
Calculation time t_{cal} Clock frequency	≤ 7 µs ≤ 8 MHz	≤ 9 µs ≤ 2 MHz	≤ 5 µs –
Incremental signals	Without	~ 1 V_{PP}[2]	
Line counts*	–	**512** 2048	**512**
Cutoff frequency –3 dB Output frequency	– –	*512 lines:* ≥ 130 kHz; *2048 lines:* ≥ 400 kHz –	
System accuracy	±20"	*512 lines:* ±60"; *2048 lines:* ±20"	
Electrical connection*	• **Flange socket** M12, radial • Cable 1 m, with M12 coupling	• **Flange socket** M23, radial • Cable 1 m, with M23 coupling or without connecting element	
Voltage supply	DC 3.6 V to 14 V		DC 4.75 V to 30 V
Power consumption (max.)	*3.6 V:* ≤ 0.6 W *14 V:* ≤ 0.7 W		*5 V:* ≤ 0.8 W *10 V:* ≤ 0.65 W *30 V:* ≤ 1 W
Current consumption (typical, without load)	*5 V:* 85 mA		*5 V:* 90 mA *24 V:* 24 mA
Shaft*	**Blind hollow shaft** or **hollow through shaft; D = 8 mm** or **D = 12 mm**		
Mech. permissible speed n[3]	≤ 6000 rpm/≤ 12000 rpm[4]		
Starting torque At 20 °C Below –20 °C	*Blind hollow shaft:* ≤ 0.01 Nm; *hollow through shaft:* ≤ 0.025 Nm (for IP66: ≤ 0.075 Nm) ≤ 1 Nm		
Moment of inertia of rotor	≤ 4.3 x 10^{-6} kgm^2		
Permissible axial motion of measured shaft	±1 mm		
Vibration 55 Hz to 2000 Hz **Shock** 6 ms	≤ 300 m/s^2; *flange socket version:* ≤ 150 m/s^2 (EN 60068-2-6); higher values upon request ≤ 2000 m/s^2 (EN 60068-2-27)		
Max. operating temp.[3]	100 °C		
Min. operating temp.	*Flange socket or fixed cable:* –40 °C; *moving cable:* –10 °C		
Protection EN 60 529	*At housing:* IP67 (IP66 with hollow through shaft) *At shaft inlet:* IP64 (when D = 12 mm IP66 upon request)		
Mass	≈ 0.3 kg		
Valid for ID	683644-xx[5]	1065932-xx	1132405-xx

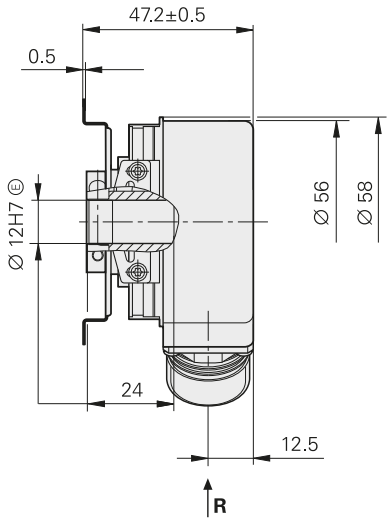
Bold: This preferred version is available on short notice.
***** Please select when ordering
[1] Velocity-dependent deviations between absolute value and incremental signals

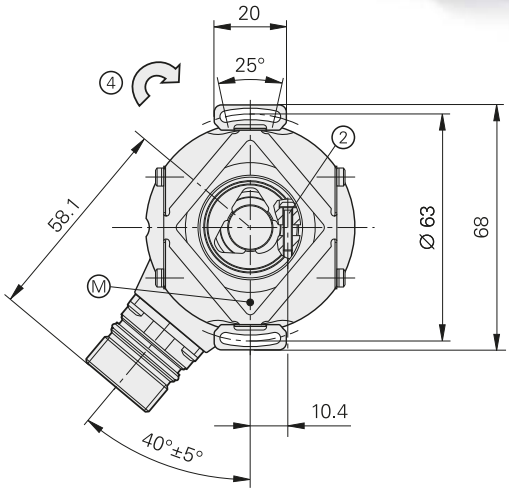
	Multiturn		
	EQN 437 Functional Safety	**EQN 425**	
	EnDat 2.2	EnDat 2.2	SSI
	EnDat22	EnDat01	SSI41r1
	33554432 (25 bits)	8192 (13 bits)	
	4096		
	Pure binary		Gray
	≤ 12000 rpm for continuous position value	*512 lines:* ≤ 5000/10000 rpm ±1 LSB/±100 LSB *2048 lines:* ≤ 1500/10000 rpm ±1 LSB/±50 LSB	≤ 12000 rpm ±12 LSB
	≤ 7 µs ≤ 8 MHz	≤ 9 µs ≤ 2 MHz	≤ 5 µs –
	Without	∿ 1 V_{PP}[2]	
	–	**512** 2048	**512**
	– –	*512 lines:* ≥ 130 kHz; *2048 lines:* ≥ 400 kHz –	
	±20“	*512 lines:* ±60“; *2048 lines:* ±20“	
	• **Flange socket** M12, radial • Cable 1 m, with M12 coupling	• **Flange socket** M23, radial • Cable 1 m, with M23 coupling or without connecting element	
	DC 3.6 V to 14 V	DC 3.6 V to 14 V	4.75 V DC to 30 V
	3.6 V: ≤ 0.7 W *14 V:* ≤ 0.8 W		*5 V:* ≤ 0.95 W *10 V:* ≤ 0.75 W *30 V:* ≤ 1.1 W
	5 V: 105 mA		*5 V:* 120 mA *24 V:* 28 mA
	683646-xx[5]	1109258-xx	1132407-xx

[2] Restricted tolerances: signal amplitude 0.8 V_{PP} to 1.2 V_{PP}
[3] For the correlation between the operating temperature and the shaft speed or supply voltage, see *General mechanical information*
[4] With two shaft clamps (only for hollow through shaft)
[5] Also available with **functional safety**; see the product information document for dimensions and specifications

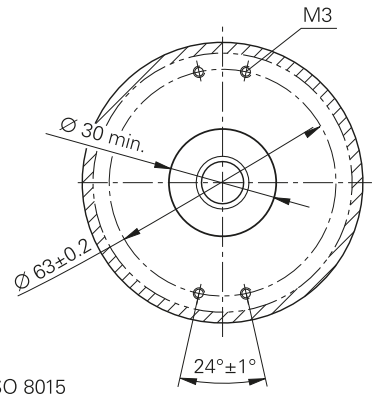
EQN 425

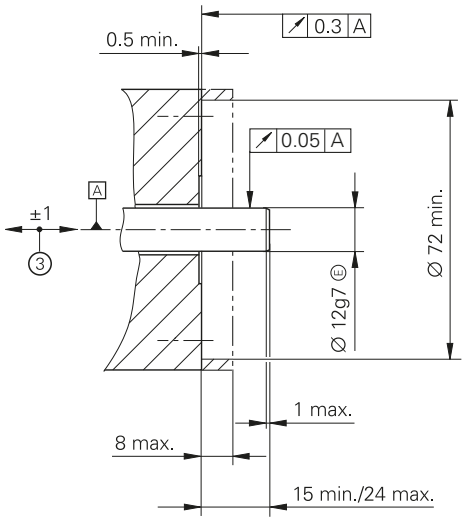
Rotary encoder for absolute position values with blind hollow shaft
- **Stator coupling for plane surface**
- **EnDat interface**
- **Additional incremental signals with TTL or HTL levels**





Required mating dimensions





mm

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

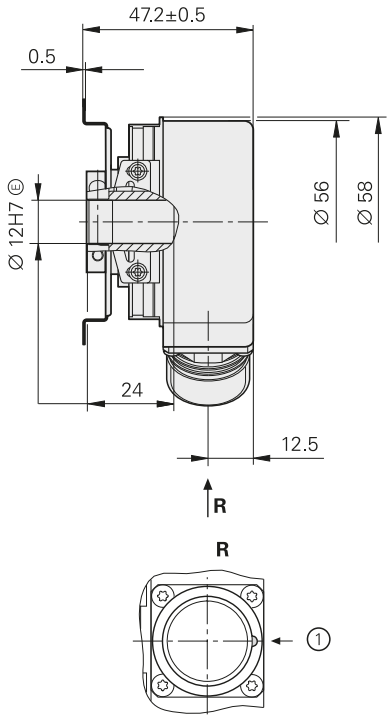
Ⓐ = Bearing of mating shaft
Ⓜ = Measuring point for operating temperature
1 = Connector coding
2 = Clamping screw with X8 hexalobular socket. Tightening torque 1.1±0.1 Nm
3 = Compensation of mounting tolerances and thermal expansion; no dynamic motion permitted
4 = Direction of shaft rotation for output signals as per the interface description

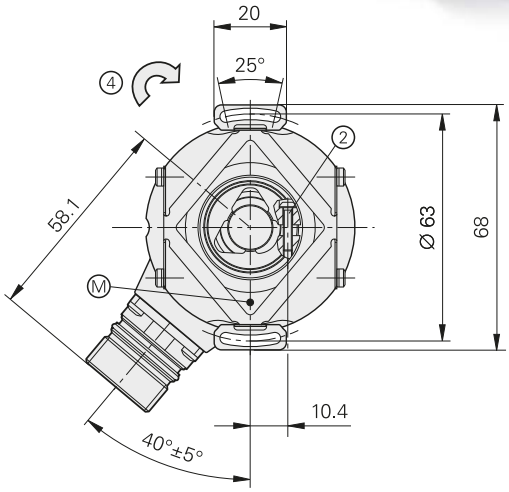
	Absolute **EQN 425 – Multiturn**					
Interface	EnDat 2.2					
Ordering designation*	EnDatH			EnDatT		
Positions per revolution	8192 (13 bits)					
Revolutions	4096 (12 bits)					
Code	Pure binary					
Calculation time t_{cal} Clock frequency	≤ 9 µs ≤ 2 MHz					
Incremental signals	HTL			TTL		
Signal periods *	512	1024	2048	512	2048	4096
Edge separation a	≥ 2.4 µs	≥ 0.8 µs	≥ 0.6 µs	≥ 2.4 µs	≥ 0.6 µs	≥ 0.2 µs
Output frequency	≤ 52 kHz	≤ 103 kHz	≤ 205 kHz	≤ 52 kHz	≤ 205 kHz	≤ 410 kHz
System accuracy[1]	±60“	±60“	±20“	±60“	±20“	±20“
Electrical connection	M23 flange socket (male), 17-pin, radial					
Cable length[2]	≤ 100 m (with HEIDENHAIN cable)					
Voltage supply	DC 10 V to 30 V			DC 4.75 V to 30 V		
Power consumption (max.)[3]	See *Power consumption* diagram			*At 4.75 V:* ≤ 900mW *At 30 V:* ≤ 1100 mW		
Current consumption (typical, without load)	*At 10 V:* ≤ 56 mA *At 24 V:* ≤ 34 mA			*At 5 V:* ≤ 100 mA *At 24 V:* ≤ 25 mA		
Shaft	Blind hollow shaft Ø 12 mm					
Mech. permissible speed n[4]	≤ 6000 rpm					
Starting torque at 20 °C	≤ 0.01 Nm					
Moment of inertia of rotor	4.3 x 10^{-6} kgm^2					
Permissible axial motion of measured shaft	≤ ±1 mm					
Vibration 10 Hz to 2000 Hz[5] **Shock** 6 ms	≤ 150 m/s^2 (EN 60 068-2-6) ≤ 2000 m/s^2 (EN 60 068-2-27)					
Max. operating temperature[4]	100 °C					
Min. operating temp.[4]	–40 °C					
Protection EN 60529	*Housing:* IP67 *Shaft exit:* IP64					
Mass	≈ 0.30 kg					
Valid for ID	1042545-xx			1042540-xx		

* Please select when ordering
1) For absolute position value; accuracy of the incremental signal upon request
2) For HTL signals the maximum cable length depends on the output frequency (see the *Cable length for HTL* diagrams)
3) See *General electrical information* in the *Interfaces of HEIDENHAIN Encoders* brochure
4) For the correlation between the operating temperature and the shaft speed or supply voltage, see *General mechanical information* in the *Rotary Encoders* brochure
5) 10 Hz bis 55 Hz constant over 4.9 mm distance peak to peak

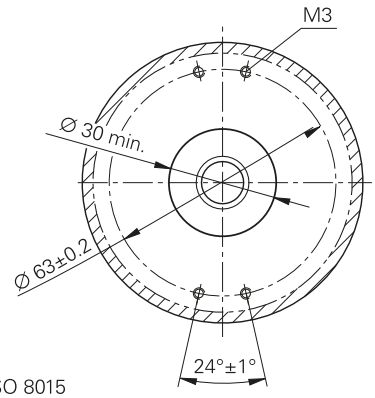
EQN 425

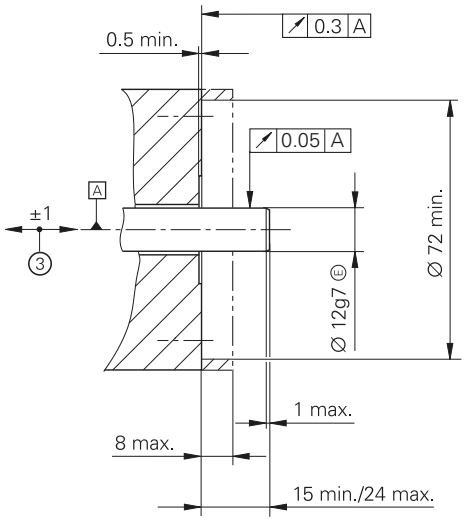
Rotary encoder for absolute position values with blind hollow shaft
- **Stator coupling for plane surface**
- **SSI interface**
- **Additional incremental signals with TTL or HTL levels**





Required mating dimensions





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

Ⓐ = Bearing of mating shaft
Ⓜ = Measuring point for operating temperature
1 = Connector coding
2 = Clamping screw with X8 hexalobular socket. Tightening torque 1.1±0.1 Nm
3 = Compensation of mounting tolerances and thermal expansion; no dynamic motion permitted
4 = Direction of shaft rotation for output signals as per the interface description

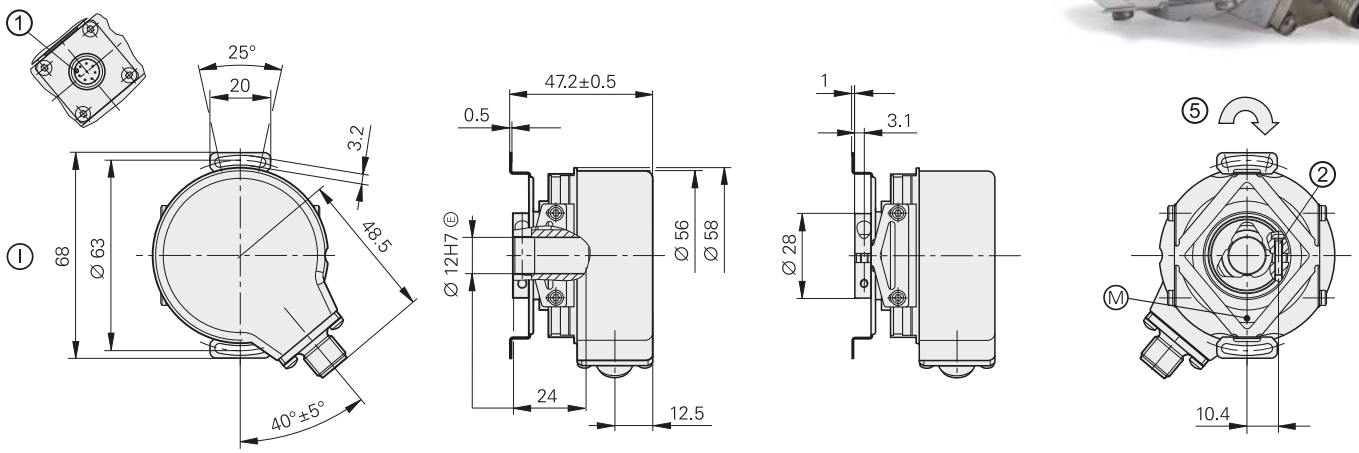
	Absolute **EQN 425 – Multiturn**					
Interface	SSI					
Ordering designation*	SSI41H			SSI41T		
Positions per revolution	8192 (13 bits)					
Revolutions	4096 (12 bits)					
Code	Gray					
Calculation time t_{cal} Clock frequency	≤ 5 µs ≤ 1 MHz					
Incremental signals	HTL[6]			TTL		
Signal periods *	512	1024	2048	512	2048	4096
Edge separation a	≥ 2.4 µs	≥ 0.8 µs	≥ 0.6 µs	≥ 2.4 µs	≥ 0.6 µs	≥ 0.2 µs
Output frequency	≤ 52 kHz	≤ 103 kHz	≤ 205 kHz	≤ 52 kHz	≤ 205 kHz	≤ 410 kHz
System accuracy[1]	±60“	±60“	±20“	±60“	±20“	±20“
Electrical connection	M23 flange socket (male), 12-pin, radial			M23 flange socket (male), 17-pin, radial		
Cable length[2]	≤ 100 m (with HEIDENHAIN cable)					
Voltage supply	DC 10 V to 30 V			DC 4.75 V to 30 V		
Power consumption (max.)[3]	See *Power consumption* diagram			*At 4.75 V:* ≤ 900 mW *At 30 V:* ≤ 1100 mW		
Current consumption (typical, without load)	*At 10 V:* ≤ 56 mA *At 24 V:* ≤ 34 mA			*At 5 V:* ≤ 100 mA *At 24 V:* ≤ 25 mA		
Shaft	Blind hollow shaft, Ø 12 mm					
Mech. permissible speed n[4]	≤ 6000 rpm					
Starting torque at 20 °C	≤ 0.01 Nm					
Moment of inertia of rotor	4.3 x 10^{-6} kgm^2					
Permissible axial motion of measured shaft	≤ ±1 mm					
Vibration 10 Hz to 2000 Hz[5] **Shock** 6 ms	≤ 150 m/s^2 (EN 60 068-2-6) ≤ 2000 m/s^2 (EN 60 068-2-27)					
Max. operating temperature[4]	100 °C					
Min. operating temp.[4]	–40 °C					
Protection EN 60529	*Housing:* IP67 *Shaft exit:* IP64					
Mass	≈ 0.30 kg					
Valid for ID	1065029-xx			1042533-xx		

* Please select when ordering
1) For absolute position value; accuracy of the incremental signal upon request
2) For HTL signals, the maximum calbe length depends on the output frequency (see the *Cable length for HTL* diagrams)
3) See *General electrical information* in the *Interfaces of HEIDENHAIN Encoders* brochure
4) For the correlation between the operating temperature and the shaft speed or supply voltage, see *General mechanical information*
5) 10 Hz bis 55 Hz constant over 4.9 mm distance peak to peak
6) HTLs upon request

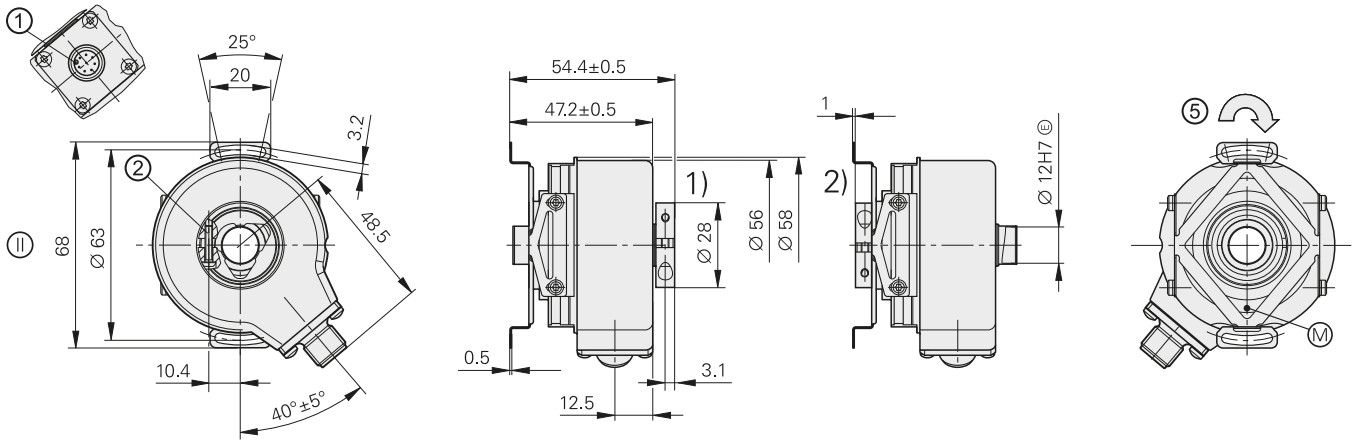
ECN/EQN 400 F/M/S series

Absolute rotary encoders
- **Stator coupling for plane surface**
- **Blind hollow shaft or hollow through shaft**
- **Fanuc Serial Interface, Mitsubishi high speed interface and Siemens DRIVE-CLiQ interface**

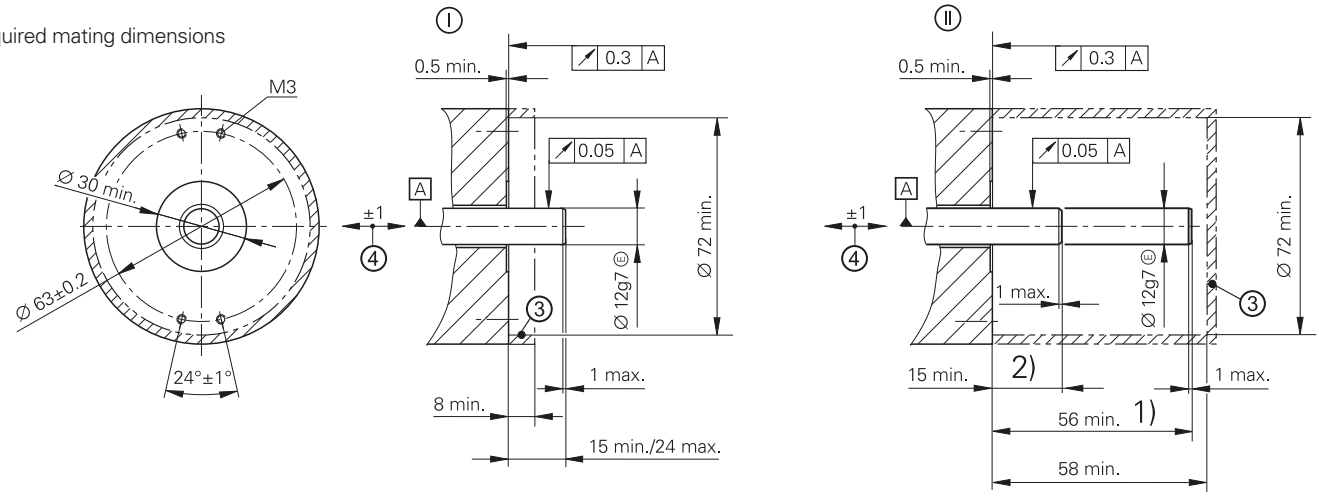
Blind hollow shaft



Hollow through shaft



Required mating dimensions



mm

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

Ⓐ = Bearing of mating shaft
Ⓜ = Measuring point for operating temperature
1 = Connector coding
2 = Clamping screw with X8 hexalobular socket. Tightening torque 1.1±0.1 Nm
3 = Ensure protection against contact (EN 60 529)
4 = Compensation of mounting tolerances and thermal expansion; no dynamic motion permitted
5 = Direction of shaft rotation for output signals as per the interface description
1) = Clamping ring on housing side (condition upon delivery)
2) = Clamping ring on coupling side (optionally mountable)

DRIVE-CLiQ is a registered trademark of SIEMENS AG.

	Absolute					
	Singleturn		Functional Safety	Multiturn		Functional Safety
	ECN 425F	**ECN 425M**	**ECN 424S**	**EQN 437F**	**EQN 435M**	**EQN 436S**
Interface	Fanuc Serial Interface; αi Interface	Mitsubishi high speed interface	DRIVE-CLiQ	Fanuc Serial Interface; αi Interface	Mitsubishi high speed interface	DRIVE-CLiQ
Ordering designation	Fanuc05	Mit03-4	DQ01	Fanuc06	Mit03-4	DQ01
Positions per revolution	α*i:* 33554432 (25 bits) α*:* 8388608 (23 bits)	33554432 (25 bits)	16777216 (24 bits)	33554432 (25 bits)	8388608 (23 bits)	16777216 (24 bits)
Revolutions	8192 via revolution counter	–	–	α*i:* 4096	4096	4096
Code	Pure binary					
Elec. permissible speed	≤ 15000 rpm for continuous position value					
Calculation time t_{cal}	≤ 5 µs	–	≤ 8 µs[4]	≤ 5 µs	–	≤ 8 µs[4]
Incremental signals	Without					
System accuracy	±20"					
Electrical connection	Flange socket M12, radial					
Cable length	≤ 30 m		≤ 95 m[3]	≤ 30 m		≤ 95 m[3]
DC voltage supply	3.6 V to 14 V		10 V to 36 V	3.6 V to 14 V		10 V to 36 V
Power consumption (max.)	*5 V:* ≤ 0.7 W *14 V:* ≤ 0.8 W		*10 V:* ≤ 1.4 W *36 V:* ≤ 1.5 W	*5 V:* ≤ 0.75 W *14 V:* ≤ 0.85 W		*10 V:* ≤ 1.4 W *36 V:* ≤ 1.5 W
Current consumption (typical, without load)	*5 V:* 90 mA		*24 V:* 37 mA	*5 V:* 100 mA		*24 V:* 43 mA
Shaft*	Blind hollow shaft or hollow through shaft D = 12 mm; also available for DRIVE-CLiQ with blind hollow shaft D = 10 mm					
Mech. permissible speed n[1]	≤ 6000 rpm/≤ 12000 rpm [2]					
Starting torque At 20 °C Below –20 °C	*Blind hollow shaft:* ≤ 0.01 Nm *Hollow through shaft:* ≤ 0.025 Nm (for IP66: ≤ 0.075 Nm) ≤ 1 Nm					
Moment of inertia of rotor	≤ 4.6 x 10^{-6} kgm^2					
Permissible axial motion of measured shaft	±1 mm					
Vibration 55Hz to 2000 Hz **Shock** 6 ms	≤ 150 m/s^2 (EN 60068-2-6) ≤ 2000 m/s^2 (EN 60068-2-27)					
Max. operating temp.[1]	100 °C					
Min. operating temp.	–30 °C					
Protection EN 60529	*At housing:* IP67 (IP66 with hollow through shaft) *At shaft inlet:* IP64 (when DQ01 D = 12 mm IP66 upon request)					
Mass	≈ 0.3 kg					
Valid for ID	1081302-xx	1096730-xx	1036798-xx[5]	1081301-xx	1096731-xx	1036801-xx[5]

* Please select when ordering

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

2) With two shaft clamps (only for hollow through shaft)

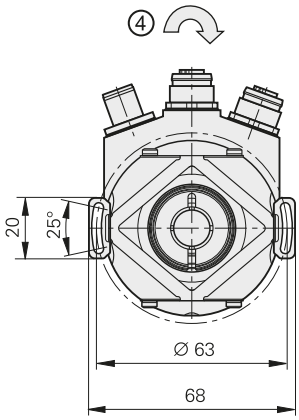
3) See the *Interfaces of HEIDENHAIN Encoders* brochure; with number of encoders = 1 (incl. adapter cable)

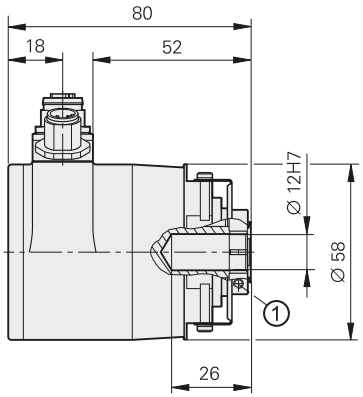
4) Processing time TIME_MAX_ACTVAL

5) Also available with **functional safety**; for dimensions and specifications, see the product information document

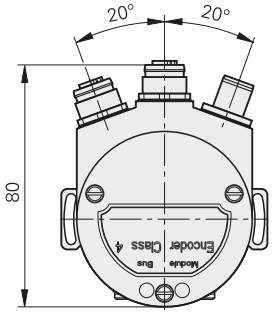
ECN/EQN 400 series

Absolute rotary encoders
- **Stator coupling for plane surface**
- **Blind hollow shaft**
- **Fieldbus interface**

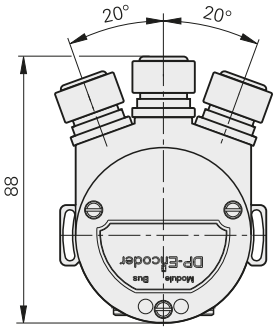




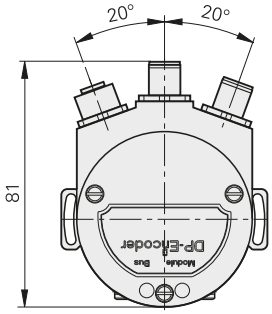
PROFINET IO



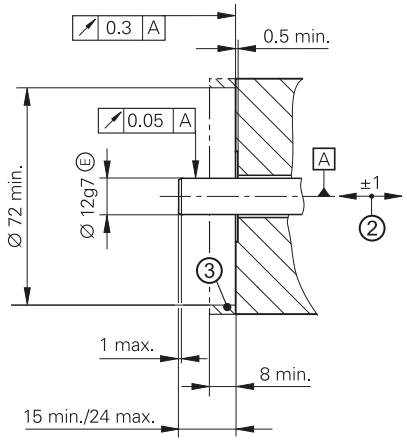
PROFIBUS-DP M16

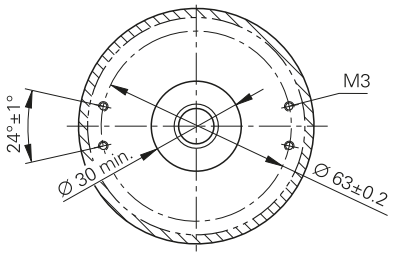


PROFIBUS-DP M12



Required mating dimensions





mm

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

A = Bearing of customer's shaft
1 = Clamping screw with X8 hexalobular socket Tightening torque 1.1±0.1 Nm
2 = Compensation of mounting tolerances and thermal expansion; no dynamic motion permitted
3 = Ensure protection against contact (EN 60 529)
4 = Direction of shaft rotation for output signals as per the interface description

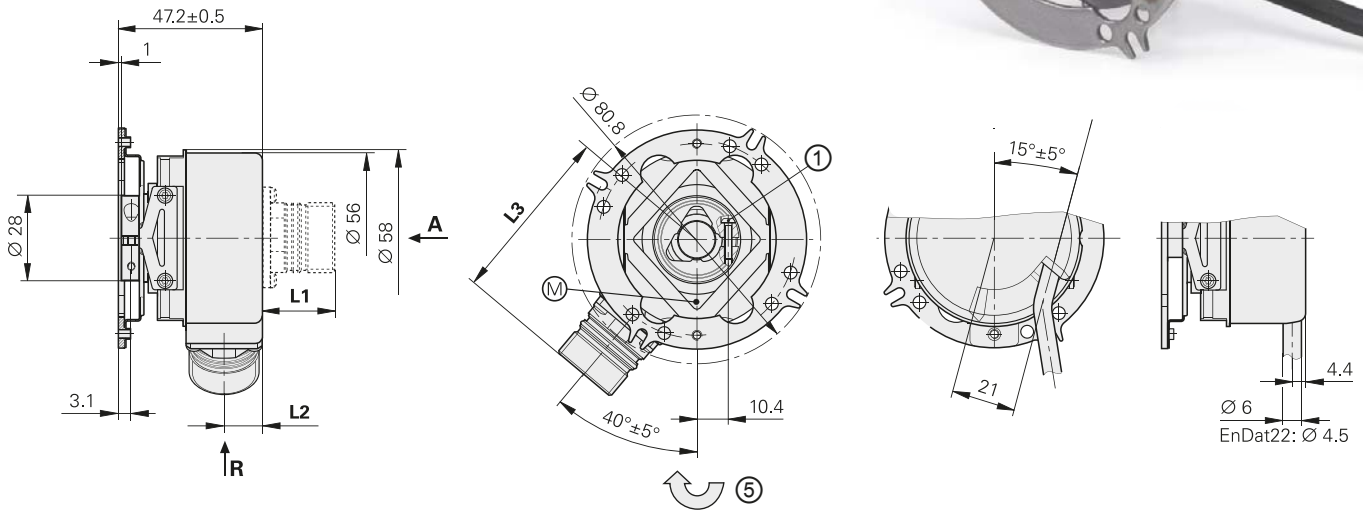
	Absolute			
	Singleturn		**Multiturn**	
	ECN 413		**EQN 425**	
Interface*	PROFIBUS-DP[1]	PROFINET IO	PROFIBUS-DP[1]	PROFINET IO
Positions per revolution	8192 (13 bits)[2]			
Revolutions	–		4096[2]	
Code	Pure binary			
Elec. permissible speed	≤ 15000 rpm for continuous position value		≤ 10000 rpm for continuous position value	
Incremental signals	Without			
System accuracy	±60“			
Electrical connection*	Cable gland M16[4]	Three M12 flange sockets, radial	Cable gland M16[4]	Three M12 flange sockets, radial
Voltage supply	DC 9 V to 36 V	DC 10 V to 30 V	DC 9 V to 36 V	DC 10 V to 30 V
Power consumption (max.)	*9 V:* ≤ 3.38 W *36 V:* ≤ 3.84 W			
Current consumption (typical, without load)	*24 V:* 125 mA			
Shaft	Blind hollow shaft; ∅ 12 mm			
Mech. permissible speed n[3]	≤ 6000 rpm			
Starting torque At 20 °C Below –20 °C	≤ 0.01 Nm ≤ 1 Nm			
Moment of inertia of rotor	≤ 4.3 x 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) ≤ 2000 m/s^2 (EN 60068-2-27)			
Max. operating temp.[3]	70 °C			
Min. operating temp.	–40 °C			
Protection EN 60529	IP67 at housing; IP64 at shaft inlet			
Mass	≈ 0.3 kg			
Valid for ID	1075943-xx	752522-xx	1075945-xx	752523-xx

***** Please select when ordering
1) Supported profiles: DP-V0, DP-V1, DP-V2
2) Programmable
3) For the correlation between the operating temperature and the shaft speed or supply voltage, see *General mechanical information*
4) Variant with three M12 flange sockets available on request

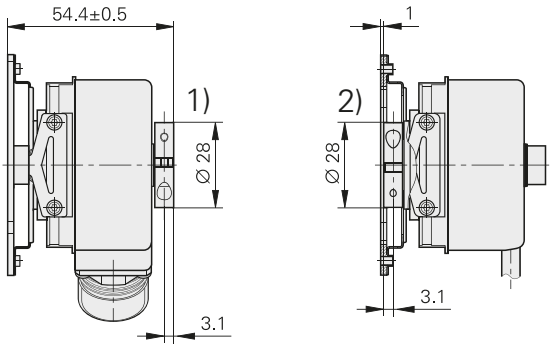
ECN/EQN/ERN 400 series

Absolute and incremental rotary encoders
- **Stator coupling for universal mounting**
- **Blind hollow shaft or hollow through shaft**

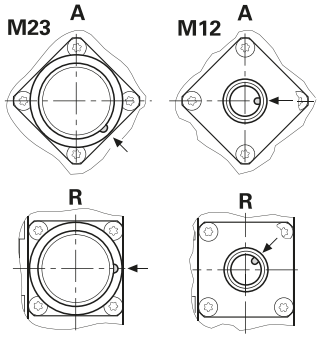
Blind hollow shaft



Hollow through shaft



Connector coding
A = Axial, **R** = Radial

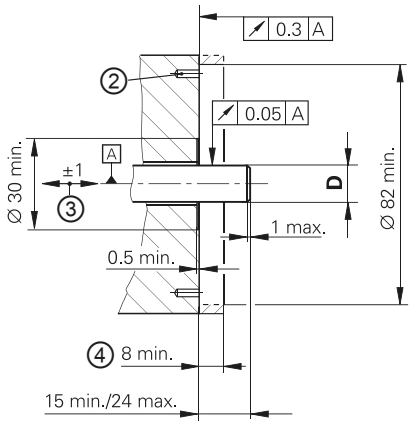


	Flange socket M12	Flange socket M23
L1	14	23.6
L2	12.5	12.5
L3	48.5	58.1

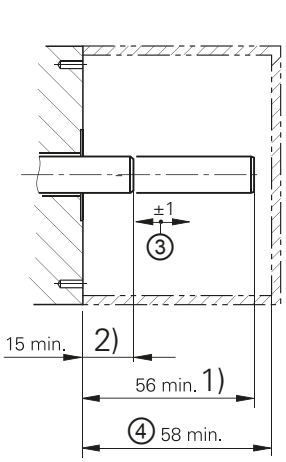
D
Ø 8g7 Ⓔ
Ø 12g7 Ⓔ

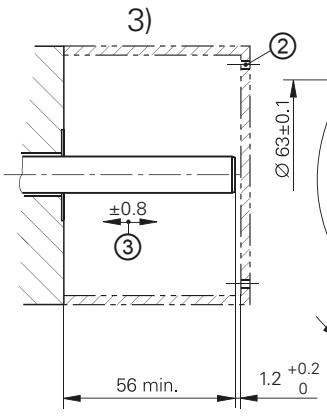
Required mating dimensions

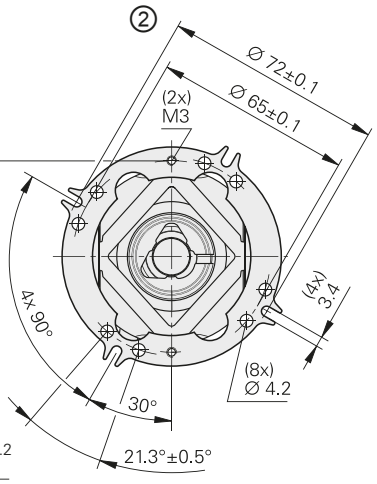
Blind hollow shaft



Hollow through shaft







mm

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

Cable radial, also usable axially
Ⓐ = Bearing of mating shaft
Ⓜ = Measuring point for operating temperature
1 = Clamping screw with X8 hexalobular socket
2 = Hole pattern for fastening; see coupling
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
1) = Clamping ring on housing side (condition upon delivery)
2) = Clamping ring on coupling side (optionally mountable)

	Incremental			
	ERN 420	**ERN 460**	**ERN 430**	**ERN 480**
Interface	⊓⊔ TTL		⊓⊔ HTL	∿ 1 V_{PP}[1]
Line counts*	250 500			–
	1000 1024 1250 2000 2048 2500 3600 4096 5000			
Reference mark	One			
Cutoff frequency –3 dB Output frequency Edge separation a	– ≤ 300 kHz ≥ 0.39 µs			≥ 180 kHz – –
System accuracy	1/20 of grating period			
Electrical connection*	• M23 flange socket, radial and axial (with blind hollow shaft) • Cable 1 m, without connecting element			
Voltage supply	DC 5 V ±0.5 V	DC 10 V to 30 V	DC 10 V to 30 V	DC 5 V ±0.5 V
Current consumption without load	≤ 120 mA	≤ 100 mA	≤ 150 mA	≤ 120 mA
Shaft*	**Blind hollow shaft** or **hollow through shaft; D = 8 mm** or **D = 12 mm**			
Mech. permissible speed n[2]	≤ 6000 rpm/≤ 12 000 rpm[3]			
Starting torque At 20 °C Below –20 °C	*Blind hollow shaft:* ≤ 0.01 Nm *Hollow through shaft:* ≤ 0.025 Nm (for IP66: ≤ 0.075 Nm) ≤ 1 Nm			
Moment of inertia of rotor	≤ 4.3 x 10^{-6} kgm^2			
Permissible axial motion of measured shaft	±1 mm			
Vibration 55 Hz to 2000 Hz **Shock** 6 ms	≤ 300 m/s^2; *flange socket version:* 150 m/s^2 (EN 60 068-2-6); higher values upon request ≤ 2000 m/s^2 (EN 60 068-2-27)			
Max. operating temp.[2]	100 °C	70 °C	100 °C[4]	
Min. operating temp.	*Flange socket or fixed cable:* –40 °C; *moving cable:* –10 °C			
Protection EN 60 529	*At housing:* IP67 (IP66 with hollow through shaft) *At shaft inlet:* IP64 (when D = 12 mm IP66 upon request)			
Mass	≈ 0.3 kg			
Valid for ID	385424-xx	385464-xx	385434-xx	385483-xx

Bold: This preferred version is available on short notice.

* Please select when ordering

1) Restricted tolerances: signal amplitude 0.8 V_{PP} to 1.2 V_{PP}

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

3) With two shaft clamps (only for hollow through shaft)

4) 80 °C for ERN 480 with 4096 or 5000 lines

	**Absolute** **Singleturn**		
	ECN 425	**ECN 413**	
Interface*	EnDat 2.2	EnDat 2.2	SSI
Ordering designation	EnDat22	EnDat01	SSI39r1
Positions per revolution	33 554 432 (25 bits)	8192 (13 bits)	
Revolutions	–		
Code	Pure binary		Gray
Elec. permissible speed Deviation[1]	≤ 12 000 rpm for continuous position value	*512 lines:* ≤ 5000/12 000 rpm ±1 LSB/±100 LSB *2048 lines:* ≤ 1500/12 000 rpm ±1 LSB/±50 LSB	≤ 12 000 rpm ±12 LSB
Calculation time t_{cal} Clock frequency	≤ 7 µs ≤ 8 MHz	≤ 9 µs ≤ 2 MHz	≤ 5 µs –
Incremental signals	Without	~ 1 V_{PP}[2]	
Line counts*	–	**512** 2048	**512**
Cutoff frequency –3 dB Output frequency	– –	*512 lines:* ≥ 130 kHz; *2048 lines:* ≥ 400 kHz –	
System accuracy	±20"	*512 lines:* ±60"; *2048 lines:* ±20"	
Electrical connection*	• **Flange socket** M12, radial • Cable 1 m, with M12 coupling	• **Flange socket** M23, radial • Cable 1 m, with M23 coupling or without connecting element	
Voltage supply	DC 3.6 V to 14 V	DC 3.6 V to 14 V	DC 4.75 V to 30 V
Power consumption (max.)	*3.6 V:* ≤ 0.6 W *14 V:* ≤ 0.7 W		*5 V:* ≤ 0.8 W *10 V:* ≤ 0.65 W *30 V:* ≤ 1 W
Current consumption (typical, without load)	*5 V:* 85 mA		*5 V:* 90 mA *24 V:* 24 mA
Shaft *	**Blind hollow shaft** or hollow through shaft; **D = 8 mm** or **D = 12 mm**		
Mech. permissible speed n[3]	≤ 6000 rpm/≤ 12 000 rpm[4]		
Starting torque At 20 °C below –20 °C	*Blind hollow shaft:* ≤ 0.01 Nm *Hollow through shaft:* ≤ 0.025 Nm (for IP66: ≤ 0.075 Nm) ≤ 1 Nm		
Moment of inertia of rotor	≤ 4.3 x 10^{-6} kgm^2		
Permissible axial motion of measured shaft	±1 mm		
Vibration 55 Hz to 2000 Hz **Shock** 6 ms	≤ 300 m/s^2; *Flange socket version:* 150 m/s^2 (EN 60 068-2-6); Higher values upon request ≤ 2000 m/s^2 (EN 60 068-2-27)		
Max. operating temp.[3]	100 °C		
Min. operating temp.	*Flange socket or fixed cable:*–40 °C; *moving cable:* –10 °C		
Protection EN 60 529	*At housing:* IP67 (IP66 with hollow through shaft) *At shaft inlet:* IP64 (when D = 12 mm IP66 upon request)		
Mass	≈ 0.3 kg		
Valid for ID	683644-xx	1065932-xx	1132405-xx

Bold: These preferred version are available on short notice.
* Please select when ordering
1) Velocity-dependent deviations between the absolute value and incremental signal
2) Restricted tolerances: signal amplitude 0.8 V_{PP} to 1.2 V_{PP}

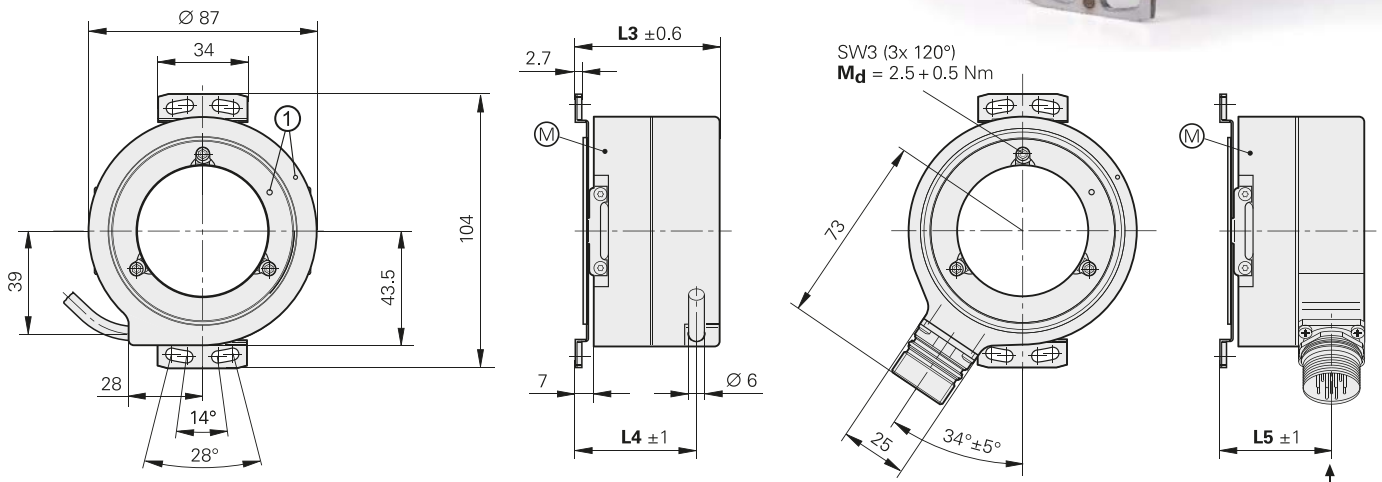
	Multiturn		
	EQN 437	**EQN 425**	
	EnDat 2.2	EnDat 2.2	SSI
	EnDat22	EnDat01	SSI41r1
	33554432 (25 bits)	8192 (13 bits)	
	4096		
	Pure binary		Gray
	≤ 12000 rpm for continuous position value	*512 lines:* ≤ 5000/10000 rpm ±1 LSB/±100 LSB *2048 lines:* ≤ 1500/10000 rpm ±1 LSB/±50 LSB	≤ 12000 rpm ±12 LSB
	≤ 7 µs ≤ 8 MHz	≤ 9 µs ≤ 2 MHz	≤ 5 µs –
	Without	~ 1 V_{PP} [2]	
	–	**512** 2048	**512**
	– –	*512 lines:* ≥ 130 kHz; *2048 lines:* ≥ 400 kHz –	
	±20"	*512 lines:* ±60"; *2048 lines:* ±20"	
	• **Flange socket** M12, radial • Cable 1 m, with M12 coupling	• **Flange socket** M23, radial • Cable 1 m, with M23 coupling or without connecting element	
	DC 3.6 V to 14 V	DC 3.6 V to 14 V	4.75 V DC to 30 V
	3.6 V: ≤ 0.7 W *14 V:* ≤ 0.8 W		*5 V:* ≤ 0.95 W *10 V:* ≤ 0.75 W *30 V:* ≤ 1.1 W
	5 V: 105 mA		*5 V:* 120 mA *24 V:* 28 mA
	683646-xx	1109258-xx	1132407-xx

[3] For the correlation between the operating temperature and the shaft speed or supply voltage, see *General mechanical information*
[4] With two shaft clamps (only for hollow through shaft)

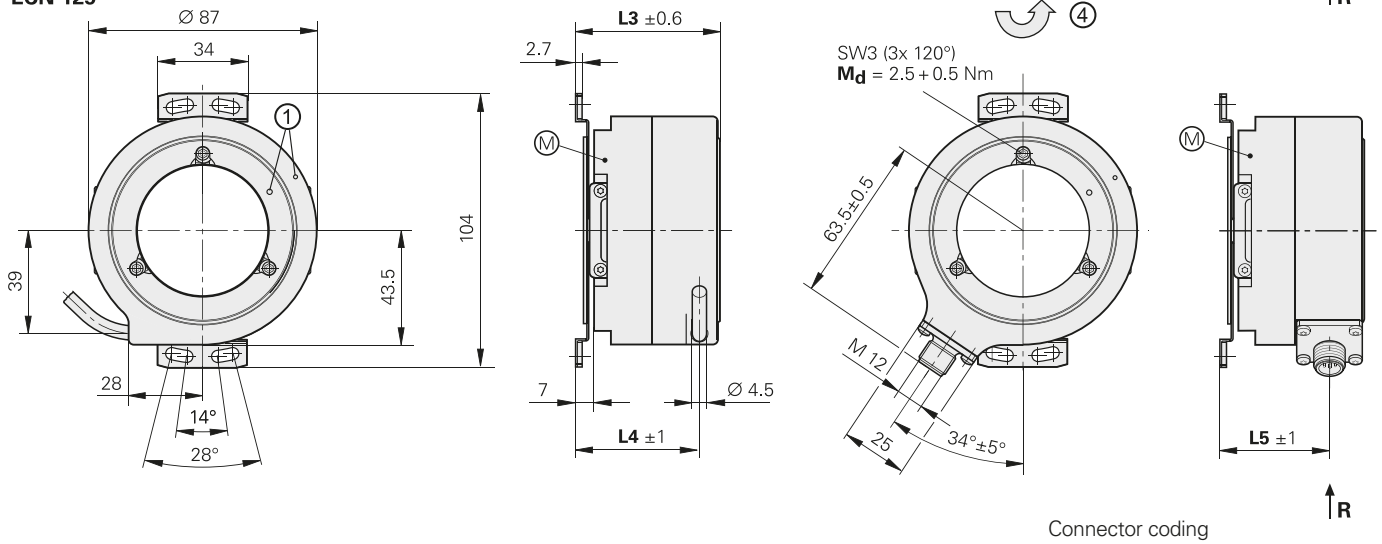
ECN/ERN 100 series

Absolute and incremental rotary encoders
- **Stator coupling for plane surface**
- **Hollow through shaft**

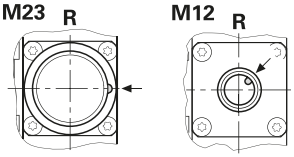
ERN 1x0/ECN 113

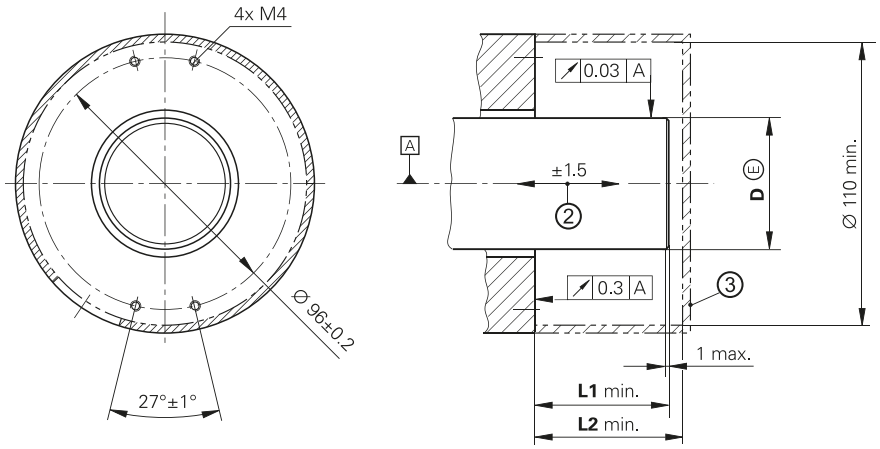


ECN 125



Connector coding
R = Radial





D	L1	L2	L3	L4	L5
Ø 20h7	41	43.5	40	32	26.5
Ø 25h7	41	43.5	40	32	26.5
Ø 38h7	56	58.5	55	47	41.5
Ø 50h7	56	58.5	55	47	41.5

mm

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

Cable radial, also usable axially
Ⓐ = Bearing
Ⓜ = Measuring point for operating temperature
1 = ERN: reference mark position ±15°; ECN: Zero position ±15°
2 = Compensation of mounting tolerances and thermal expansion; no dynamic motion permitted
3 = Ensure protection against contact (EN 60 529)
4 = Direction of shaft rotation for output signals as per the interface description

	Absolute Singleturn		Incremental		
	ECN 125	**ECN 113**	**ERN 120**	**ERN 130**	**ERN 180**
Interface	**EnDat 2.2**	**EnDat 2.2**	⊓⊔ TTL	⊓⊔ HTL	∿ 1 V_{PP}[2]
Ordering designation	EnDat22	EnDat01	–		
Positions per revolution	33 554 432 (25 bits)	8192 (13 bits)	–		
Code	Pure binary		–		
Elec. permissible speed Deviation[1]	n_{max} for continuous position value	≤ 600 rpm/n_{max} ±1 LSB/±50 LSB	–		
Calculation time t_{cal} Clock frequency	≤ 7 µs ≤ 16 MHz	≤ 9 µs ≤ 2 MHz	–		
Incremental signals	Without	∿ 1 V_{PP}[2]	⊓⊔ TTL	⊓⊔ HTL	∿ 1 V_{PP}[2]
Line counts*	–	**2048**	1000 **1024** 2048 2500 3600 **5000**		
Reference mark	–	–	One		
Cutoff frequency –3 dB Output frequency Edge separation a	– – –	≥ 400 kHz typical – –	– ≤ 300 kHz ≥ 0.39 µs		≥ 180 kHz typical – –
System accuracy	±20"		1/20 of grating period		
Electrical connection*	• **Flange socket** M12, radial • Cable 1 m/5 m, with M12 coupling	• **Flange socket** M23, radial • Cable 1 m/5 m, with or without M23 coupling	• **Flange socket** M23, radial • **Cable 1 m**/5 m, with or **without M23 coupling**		
Voltage supply	DC 3.6 V to 14 V		DC 5 V ±0.5 V	DC 10 V to 30 V	DC 5 V ±0.5 V
Power consumption (max.)	*3.6 V:* ≤ 620 mW/*14 V:* ≤ 720 mW		–		
Current consumption (without load)	*5 V:* ≤ 85 mA (typical)		≤ 120 mA	≤ 150 mA	≤ 120 mA
Shaft*	Hollow through shaft D = 20 mm, **25 mm**, 38 mm, **50 mm**				
Mech. permissible speed n[3]	*D > 30 mm:* ≤ 4000 rpm; *D ≤ 30 mm:* ≤ 6000 rpm				
Starting torque At 20 °C	*D > 30 mm:* ≤ 0.2 Nm *D ≤ 30 mm:* ≤ 0.15 Nm				
Moment of inertia of rotor/ angle acceleration[4]	*D = 50 mm* 220 x 10^{-6} kgm^2/≤ 5 x 10^4 rad/s^2; *D = 38 mm* 350 x 10^{-6} kgm^2/≤ 2 x 10^4 rad/s^2 *D = 25 mm* 96 x 10^{-6} kgm^2/≤ 3 x 10^4 rad/s^2; *D = 20 mm* 100 x 10^{-6} kgm^2/≤ 3 x 10^4 rad/s^2				
Permissible axial motion of measured shaft	±1.5 mm				
Vibration 55 Hz to 2000 Hz **Shock** 6 ms	≤ 200 m/s^2; *flange socket version:* ≤ 100 m/s^2 (EN 60068-2-6) ≤ 1000 m/s^2 (EN 60068-2-27)				
Max. operating temp.[3]	100 °C (85 °C for ERN 130)				
Min. operating temp.	*Flange socket or fixed cable:* –40 °C; *moving cable:* –10 °C				
Protection[3] EN 60529	IP64				
Mass	0.6 kg to 0.9 kg depending on the hollow-shaft version				
Valid for ID	810801-xx	810800-xx	589611-xx	589612-xx	589614-xx

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

[1] Velocity-dependent deviations between the absolute value and incremental signals [2] Restricted tolerances: signal amplitude 0.8 V_{PP} to 1.2 V_{PP}

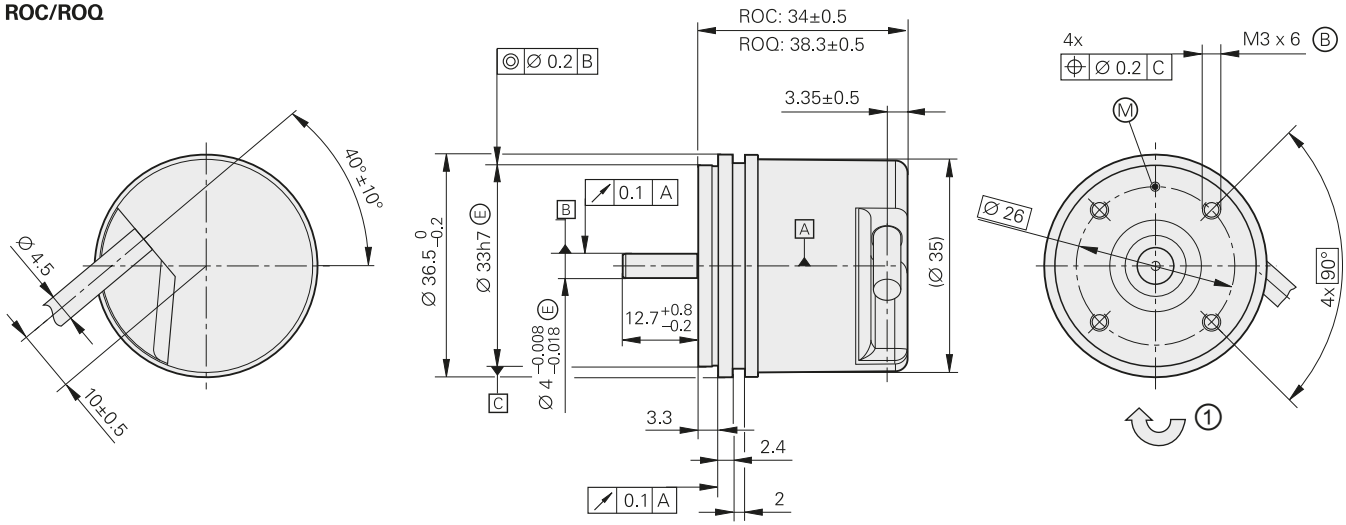
[3] For the correlation between degree of protection, shaft speed and operating temperature, see *General mechanical information*

[4] At room temperature, determined mathematically; material of mating shaft: 1.4104

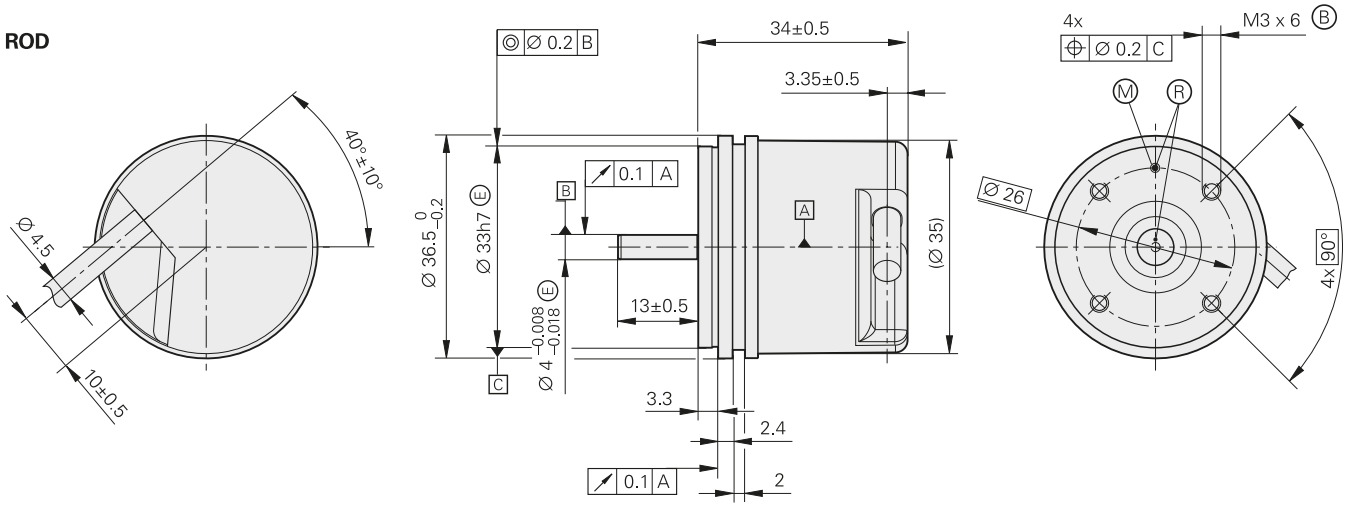
ROC/ROQ/ROD 1000 series

Absolute and incremental rotary encoders
- **Synchro flange**
- **Solid shaft for separate shaft coupling**

ROC/ROQ



ROD



mm

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

Cable radial, also usable axially
Ⓐ = Bearing
Ⓑ = Threaded mounting hole
Ⓜ = Measuring point for operating temperature
Ⓡ = Reference mark position ±20°
1 = Direction of shaft rotation for output signals as per the interface description

	Incremental			
	ROD 1020	**ROD 1030**	**ROD 1080**	**ROD 1070**
Interface	⊓⊔ TTL	⊓⊔ HTLs	∿ 1 V_{PP}[1)]	⊓⊔ TTL
Line counts*	100 200 **250** 360 400 **500** 720 900 **1000** **1024** 1250 1500 2000 **2048** **2500** **3600**			**1000** **2500** **3600**
Reference mark	One			
Integrated interpolation*	–			5-fold / 10-fold
Cutoff frequency –3 dB Scanning frequency Edge separation a	– ≤ 300 kHz ≥ 0.39 µs	– ≤ 160 kHz ≥ 0.76 µs	≥ 180 kHz – –	– ≤ 100 kHz ≥ 0.47 µs / – ≤ 100 kHz ≥ 0.22 µs
System accuracy	1/20 of grating period			
Electrical connection	**Cable, 1 m**/5 m, with or **without** M23 coupling			Cable 5 m, without connecting element
Voltage supply	DC 5 V ±0.5 V	DC 10 V to 30 V	DC 5 V ±0.5 V	DC 5 V ±5 %
Current consumption without load	≤ 120 mA	≤ 150 mA	≤ 120 mA	≤ 155 mA
Shaft	Solid shaft ∅ 4 mm			
Mechanically permissible speed n	≤ 12 000 rpm			
Starting torque	≤ 0.001 Nm (at 20 °C)			
Moment of inertia of rotor	≤ 0.5 x 10^{-6} kgm^2			
Shaft load	*Axial:* 5 N *Radial:* 10 N at shaft end			
Vibration 55 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.[2)]	100 °C	70 °C	100 °C	70 °C
Min. operating temp.	*Fixed cable:* –30 °C; *Moving cable:* –10 °C			
Protection EN 60 529	IP64			
Mass	≈ 0.09 kg			
Valid for ID	534900-x	534901-xx	534904-xx	534903-xx

Bold: This preferred version is available on short notice.

***** Please select when ordering

1) Restricted tolerances: signal amplitude 0.8 V_{PP} to 1.2 V_{PP}

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

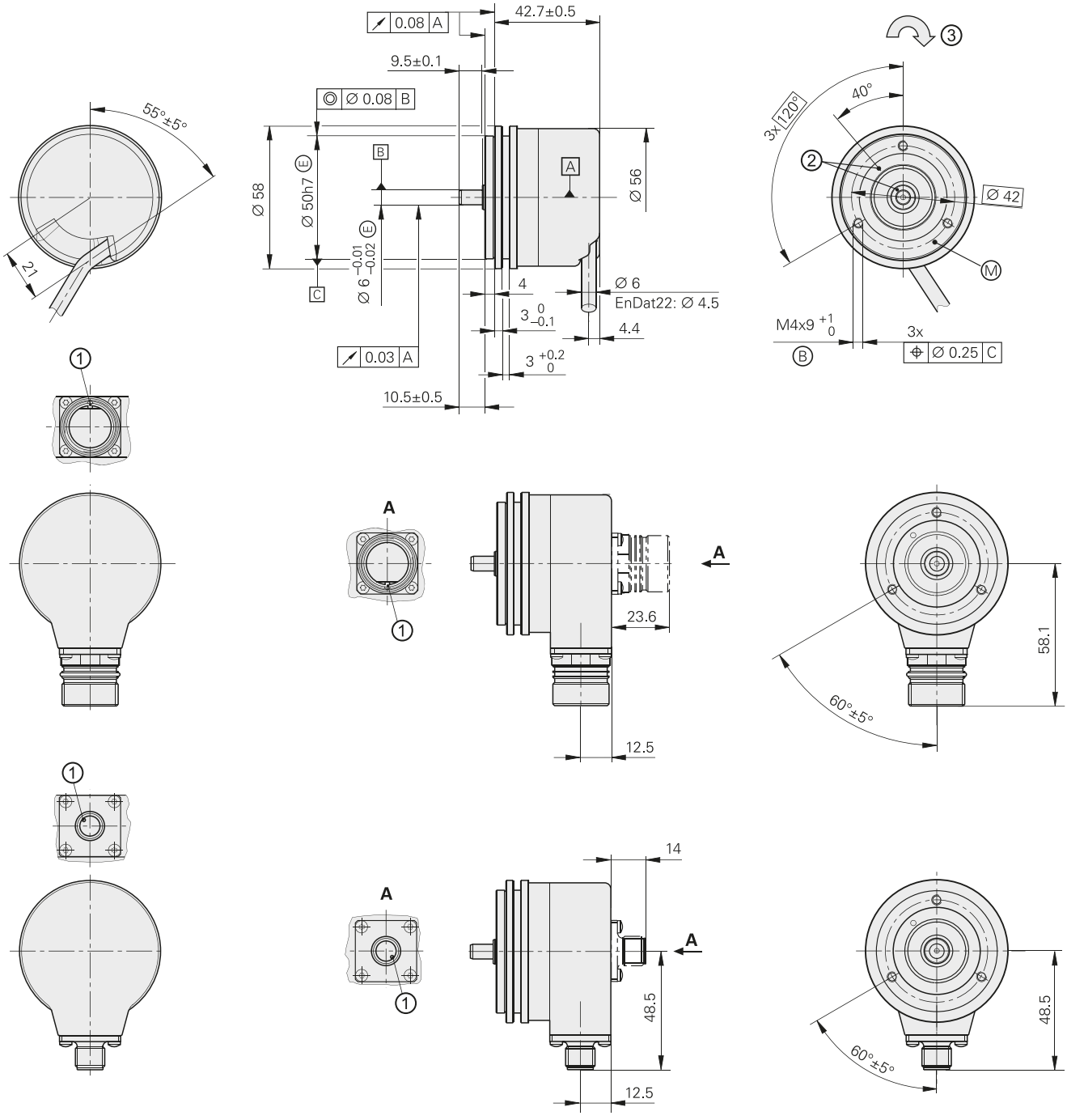
	Absolute Singleturn **ROC 1023**	**ROC 1013**	
Interface*	EnDat 2.2	EnDat 2.2	SSI
Ordering designation	EnDat22	EnDat01	SSI39r1
Positions per revolution	8388608 (23 bits)	8192 (13 bits)	
Revolutions	–		
Code	Pure binary		Gray
Elec. permissible speed Deviation[1)]	≤ 12000 rpm for continuous position value	≤ 4000 rpm/≤ 12000 rpm ±1 LSB/±16 LSB	≤ 12000 rpm ±12 LSB
Calculation time t_{cal} Clock frequency	≤ 7 µs ≤ 8 MHz	≤ 9 µs ≤ 2 MHz	≤ 5 µs ≤ 1 MHz
Incremental signals	–	~ 1 V_{PP}[2)]	
Line count	–	512	
Cutoff frequency –3 dB	–	≥ 190 kHz	
System accuracy	±60″		
Electrical connection	Cable 1 m, with M12 coupling	Cable 1 m, with M23 coupling	
Voltage supply	DC 3.6 V to 14 V		DC 4.75 V to 30 V
Power consumption (max.)	*3.6 V:* ≤ 0.6 W *14 V:* ≤ 0.7 W		*4.75 V:* ≤ 0.53 W *30 V:* ≤ 0.86 W
Current consumption (typical, without load)	*5 V:* 85 mA		*5 V:* 70 mA *24 V:* 20 mA
Shaft	Solid shaft ∅ 4 mm		
Mech. permiss. speed n	12000 rpm		
Starting torque	≤ 0.001 Nm (at 20 °C)		
Moment of inertia of rotor	Approx. 0.5 x 10^{-6} kgm^2		
Shaft load	*Axial:* 5 N *Radial:* 10 N at shaft end		
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.	*Stationary cable:* –30 °C; *moving cable:* –10 °C		
Protection EN 60529	IP64		
Mass	≈ 0.09 kg		
Valid for ID	606693-xx	606691-xx	606692-xx

***** Please select when ordering
1) Velocity-dependent deviations between the absolute and incremental signals
2) Restricted tolerances: signal amplitude 0.8 V_{PP} to 1.2 V_{PP}

	Multiturn		
	ROQ 1035	**ROQ 1025**	
	EnDat 2.2	EnDat 2.2	SSI
	EnDat22	EnDat01	SSI41r1
	8388608 (23 bits)	8192 (13 bits)	
	4096 (12 bits)		
	Pure binary		Gray
	≤ 12000 rpm for continuous position value	≤ 4000 rpm/≤ 12000 rpm ±1 LSB/±16 LSB	≤ 12000 rpm ±12 LSB
	≤ 7 µs ≤ 8 MHz	≤ 9 µs ≤ 2 MHz	≤ 5 µs ≤ 1 MHz
	–	~ 1 V_{PP} [2)]	
	–	512	
	–	≥ 190 kHz	
	Cable 1 m, with M12 coupling	Cable 1 m, with M23 coupling	
	DC 3.6 V to 14 V		4.75 V DC to 30 V
	3.6 V: ≤ 0.7 W *14 V:* ≤ 0.8 W		*4.75 V:* ≤ 0.65 W *30 V:* ≤ 1.05 W
	5 V: 105 mA		*5 V:* 85 mA *24 V:* 25 mA
	≤ 0.002 Nm (at 20 °C)		
	606696-xx	606694-xx	606695-xx

ROC/ROQ/ROD 400 and RIC/RIQ 400 series

Absolute and incremental rotary encoders
- **Synchro flange**
- **Solid shaft for separate shaft coupling**



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

Cable radial, also usable axially
Ⓐ = Bearing
Ⓑ = Threaded mounting hole
Ⓜ = Measuring point for operating temperature
1 = Connector coding
2 = ROD reference mark position on shaft and flange ±30°
3 = Direction of shaft rotation for output signals as per the interface description

	Incremental			
	ROD 426	**ROD 466**	**ROD 436**	**ROD 486**
Interface	⊓⊔ TTL		⊓⊔ HTL	∿ 1 V_{PP}[1]
Line counts*	50 100 150 200 250 360 **500** 512 720			–
	1000 1024 1250 1500 1800 **2000 2048 2500 3600 4096 5000**			
	6000[2] 8192[2] 9000[2] 10000[2]		–	
Reference mark	One			
Cutoff frequency –3 dB Scanning frequency Edge separation a	– ≤ 300 kHz/≤ 150 kHz[2] ≥ 0.39 µs/≥ 0.25 µs[2]			≥ 180 kHz – –
System accuracy	1/20 of grating period			
Electrical connection*	• **Flange socket** M23, radial and axial • **Cable 1 m/**5 m, with or **without M23 coupling**			
Voltage supply	DC 5 V ±0.5 V	DC 10 V to 30 V	DC 10 V to 30 V	DC 5 V ±0.5 V
Current consumption without load	≤ 120 mA	≤ 100 mA	≤ 150 mA	≤ 120 mA
Shaft	Solid shaft Ø 6 mm			
Mech. permiss. speed n	≤ 16000 rpm			
Starting torque	≤ 0.01 Nm (at 20 °C)			
Moment of inertia of rotor	≤ 2.7 x 10^{-6} kgm^2			
Shaft load[3]	*Axial:* ≤ 40 N; *radial:* ≤ 60 N at shaft end			
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.[4]	100 °C	70 °C	100 °C[5]	
Min. operating temp.	*Flange socket or fixed cable:* –40 °C; *moving cable:* –10 °C			
Protection EN 60 529	IP67 at housing, IP64 at shaft inlet (IP66 upon request)			
Mass	≈ 0.3 kg			
Valid for ID	376846-xx	376866-xx	376836-xx	376886-xx[6]

Bold: This preferred version is available on short notice.

* Please select when ordering

1) Restricted tolerances: signal amplitude 0.8 V_{PP} to 1.2 V_{PP}

2) Signal periods; generated by integrated 2-fold interpolation (TTL x 2)

3) See also *Mechanical design types and mounting*

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

5) 80 °C for ROD 486 with 4096 or 5000 lines

6) Mechanical fault exclusion available; for restrictions on specifications and for special mounting information, see the *Fault Exclusion* customer information document

	**Absolute** **Singleturn** **ROC 425** Functional Safety	**ROC 413**		**RIC 418**
Interface*	EnDat 2.2	EnDat 2.2	SSI	EnDat 2.1
Ordering designation	EnDat22	EnDat01	SSI39r1	EnDat01
Positions per revolution	33554432 (25 bits)	8192 (13 bits)		262144 (18 bits)
Revolutions	–			
Code	Pure binary		Gray	Pure binary
Elec. permissible speed Deviation[1]	≤ 15000 rpm for continuous position value	*512 lines:* ≤ 5000/12000 rpm ±1 LSB/±100 LSB *2048 lines:* ≤ 1500/12000 rpm ±1 LSB/±50 LSB	12000 rpm ±12 LSB	≤ 4000/15000 rpm ±400 LSB/±800 LSB
Calculation time t_{cal} Clock frequency	≤ 7 µs ≤ 8 MHz	≤ 9 µs ≤ 2 MHz	≤ 5 µs –	≤ 8 µs ≤ 2 MHz
Incremental signals	Without	~ 1 V_{PP}[2]		~ 1 V_{PP}
Line counts*	–	**512** 2048	**512**	**16**
Cutoff frequency –3 dB	–	*512 lines:* ≥ 130 kHz; *2048 lines:* ≥ 400 kHz		≥ 6 kHz
System accuracy	±20"	*512 lines:* ±60"; *2048 lines:* ±20"		±480"
Electrical connection*	• **Flange socket** M12, radial • Cable 1 m, with M12 coupling	• **Flange socket** M23, axial or radial • Cable 1 m/5 m, with or without M23 coupling		• **Flange socket** M23, radial • Cable 1 m, with M23 coupling
Voltage supply	DC 3.6 V to 14 V	DC 3.6 V to 14 V	DC 4.75 V to 30 V	DC 5 V ±0.25 V
Power consumption (max.)	*3.6 V:* ≤ 0.6 W *14 V:* ≤ 0.7 W		*5 V:* ≤ 0.8 W *10 V:* ≤ 0.65 W *30 V:* ≤ 1 W	*5 V:* ≤ 0.95 W
Current consumption (typical, without load)	*5 V:* 85 mA		*5 V:* 90 mA *24 V:* 24 mA	*5 V:* 125 mA
Shaft	Solid shaft Ø 6 mm			
Mech. permiss. speed n	≤ 15000 rpm			
Starting torque	≤ 0.01 Nm (at 20 °C)			
Moment of inertia of rotor	≤ 2.7 x 10^{-6} kgm^2			
Shaft load	*Axial:* ≤ 40 N; *radial:* ≤ 60 N at shaft end (see also *Mechanical design types and mounting)*			
Vibration 55 Hz to 2000 Hz **Shock** 6 ms	≤ 300 m/s^2 (EN 60068-2-6) *ROC/ROQ:* ≤ 2000 m/s^2; *RIC/RIQ:* ≤ 1000 m/s^2 (EN 60068-2-27)			
Max. operating temp.[3]	100 °C			
Min. operating temp.	*Flange socket or fixed cable:* –40 °C; *moving cable:* –10 °C			
Protection EN 60 529	IP67 at housing, IP64 at shaft inlet[3] (IP66 upon request)			
Mass	≈ 0.35 kg			
Valid for ID	683639-xx[4]	1109254-xx	1131750-xx	642004-xx

Bold: This preferred version is available on short notice.
* Please select when ordering
1) Velocity-dependent deviations between the absolute value and incremental signals

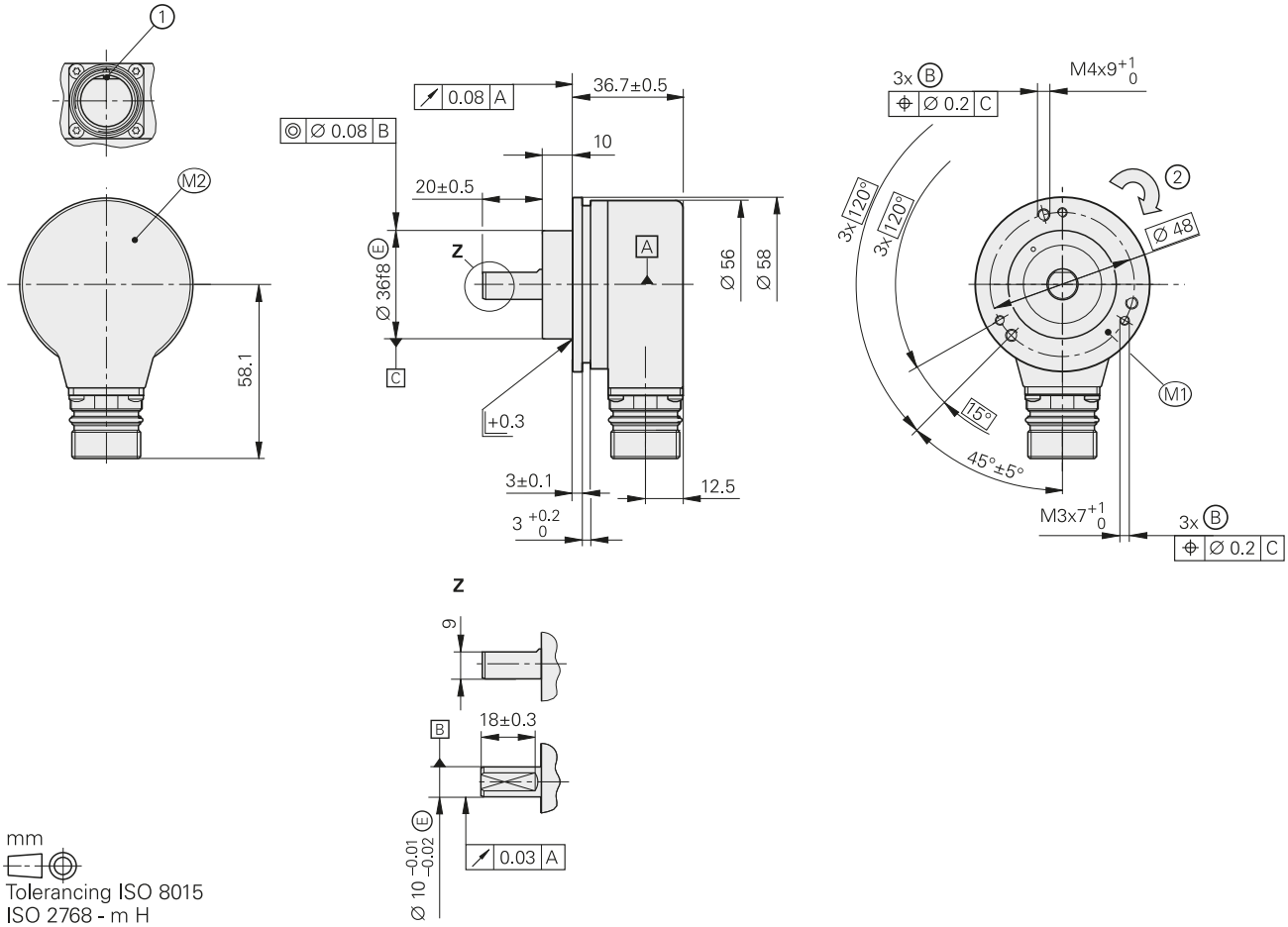
	Multiturn			
	ROQ 437 Functional Safety	**ROQ 425**		**RIQ 430**
	EnDat 2.2	EnDat 2.2	SSI	EnDat 2.1
	EnDat22	EnDat01	SSI41r1	EnDat01
	33554432 (25 bits)	8192 (13 bits)	8192 (13 bits)	262144 (18 bits)
	4096			4096
	Pure binary		Gray	Pure binary
	≤ 15000 rpm for continuous position value	*512 lines:* ≤ 5000/10000 rpm ±1 LSB/±100 LSB *2048 lines:* ≤ 1500/10000 rpm ±1 LSB/±50 LSB	12000 rpm ±12 LSB	≤ 4000/15000 rpm ±400 LSB/±800 LSB
	≤ 7 µs ≤ 8 MHz	≤ 9 µs ≤ 2 MHz	≤ 5 µs –	≤ 8 µs ≤ 2 MHz
	Without	~ 1 V_{PP} [2]		~ 1 V_{PP}
	–	**512** 2048	**512**	**16**
	–	*512 lines:* ≥ 130 kHz; *2048 lines:* ≥ 400 kHz		≥ 6 kHz
	±20"	*512 lines:* ±60"; *2048 lines:* ±20"		±480"
	• **Flange socket** M12, radial • Cable 1 m, with M12 coupling	• **Flange socket** M23, axial or radial • Cable 1 m/5 m, with or without M23 coupling		• **Flange socket** M23, radial • Cable 1 m, with M23 coupling
	DC 3.6 V to 14 V	DC 3.6 V to 14 V	DC 4.75 V to 30 V	DC 5 V ±0.25 V
	3.6 V: ≤ 0.7 W *14 V:* ≤ 0.8 W		*5 V:* ≤ 0.95 W *10 V:* ≤ 0.75 W *30 V:* ≤ 1.1 W	*5 V:* ≤ 1.1 W
	5 V: 105 mA		*5 V:* 120 mA *24 V:* 28 mA	*5 V:* 150 mA
	≤ 12000 rpm			
	683641-xx [4]	1109256-xx	1131752-xx	642000-xx

[2] Restricted tolerances: signal amplitude 0.8 V_{PP} to 1.2 V_{PP}
[3] For the correlation between the operating temperature and the shaft speed or supply voltage, see *General mechanical information*
[4] Also available with **functional safety**; for dimensions and specifications, see the product information document.

ROQ 425

Rotary encoder for absolute position values with solid shaft for separate shaft coupling

- **EnDat interface**
- **Additional incremental signals with TTL or HTL levels**



mm

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

Ⓐ = Bearing
Ⓑ = Threaded mounting hole
M1 = Measuring point for operating temperature
M2 = Measuring point for vibration, see also D 774714
1 = Connector coding
2 = Direction of shaft rotation for output signals as per the interface description

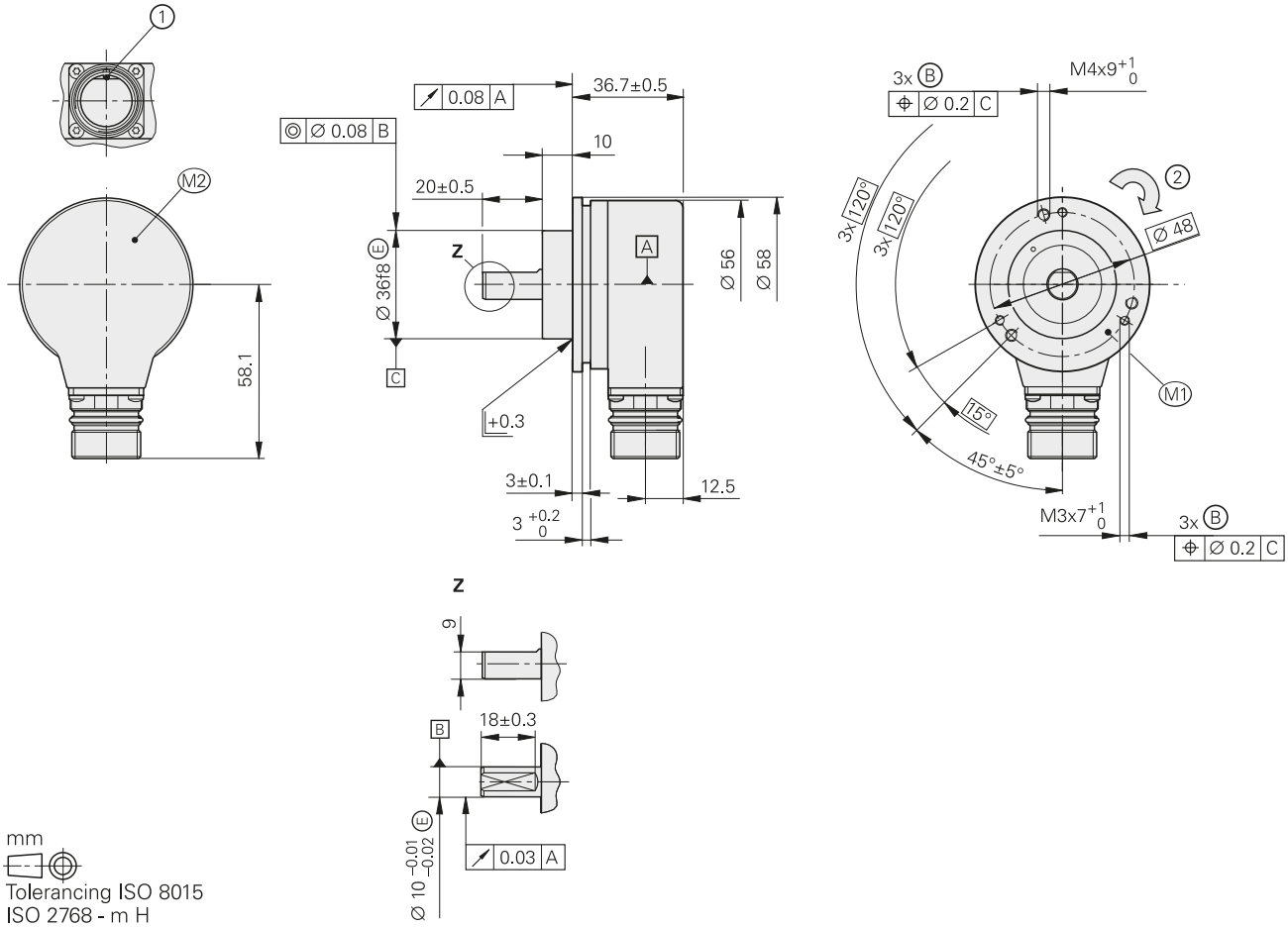
	Absolute **Multiturn** **ROQ 425**					
Interface	EnDat 2.2					
Ordering designation*	EnDatH			EnDatT		
Positions per revolution	8192 (13 bits)					
Revolutions	4096 (12 bits)					
Code	Pure binary					
Calculation time t_{cal} Clock frequency	≤ 9 µm ≤ 2 MHz					
Incremental signals	HTL			TTL		
Signal periods *	512	1024	2048	512	2048	4096
Edge separation a	≥ 2.4 µs	≥ 0.8 µs	≥ 0.6 µs	≥ 2.4 µs	≥ 0.6 µs	≥ 0.2 µs
Output frequency	≤ 52 kHz	≤ 103 kHz	≤ 205 kHz	≤ 52 kHz	≤ 205 kHz	≤ 410 kHz
System accuracy	±60“	±60“	±20“	±60“	±20“	±20“
Electrical connection	M23 flange socket (male), 17-pin, radial					
Cable length[2]	≤ 100 m (with HEIDENHAIN cable)					
Voltage supply	DC 10 V to 30 V			DC 4.75 V to 30 V		
Power consumption (max.)[3]	See *Power consumption* diagram			*At 4.75 V:* ≤ 900 mW *At 30 V:* ≤ 1100 mW		
Current consumption (typical, without load)	*At 10 V:* ≤ 56 mA *At 24 V:* ≤ 34 mA			*At 5 V:* ≤ 100 mA *At 24 V:* ≤ 25 mA		
Shaft	Solid shaft Ø 10 mm with flat					
Mech. permissible speed n[4]	≤ 12000 rpm					
Starting torque at 20 °C	≤ 0.025 Nm					
Moment of inertia of rotor	2.7 x 10^{-6} kgm^2					
Shaft load	*Axial:* ≤ 40 Nm *Radial:* ≤ 60 Nm at shaft end (see also *Mechanical design types and mounting*)					
Vibration 10 Hz to 2000 Hz[5] **Shock** 6 ms	≤ 150 m/s^2 (EN 60068-2-6) ≤ 1000 m/s^2 (EN 60068-2-27)					
Max. operating temp.[4]	100 °C					
Min. operating temp.	–40 °C					
Protection EN 60529	*Housing:* IP67 *Shaft exit:* IP66					
Mass	≈ 0.30 kg					
Valid for ID	1042530-xx			1042529-xx		

* Please select when ordering
1) For absolute position value; accuracy of the incremental signal upon request
2) For HTL signals, the maximum cable length depends on the output frequency (see the *Cable length for HTL* diagrams)
3) See *General electrical information* in the *Interfaces of HEIDENHAIN Encoders* brochure
4) For the correlation between the operating temperature and the shaft speed or supply voltage, see *General mechanical information*
5) 10 Hz to 55 Hz constant over distance 4.9 mm peak to peak

ROQ 425

Rotary encoder for absolute position values with solid shaft for separate shaft coupling

- **SSI interface**
- **Additional incremental signals with TTL or HTL levels**



mm

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

Ⓐ = Bearing
Ⓑ = Threaded mounting hole
M1 = Measuring point for operating temperature
M2 = Measuring point for vibration, see also D 774714
1 = Connector coding
2 = Direction of shaft rotation for output signals as per the interface description

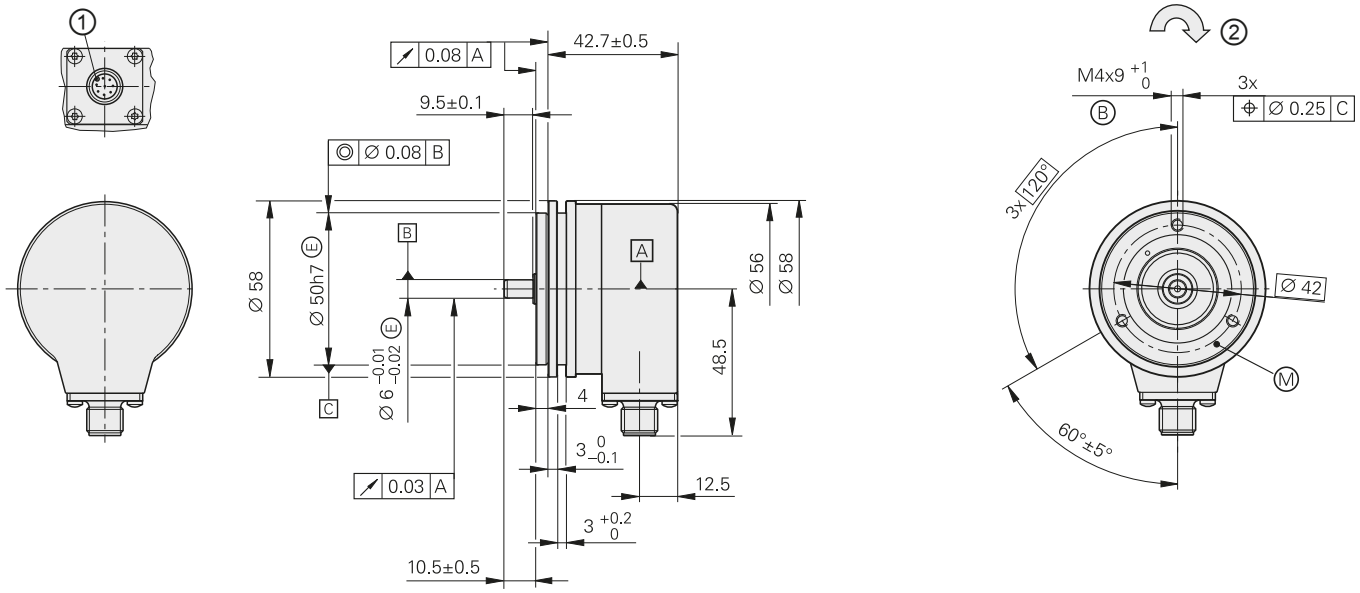
	Absolute **Multiturn** **ROQ 425**					
Interface	SSI					
Ordering designation*	SSI41H			SSI41T		
Positions per revolution	8192 (13 bits)					
Revolutions	4096 (12 bits)					
Code	Pure binary					
Calculation time t_{cal} Clock frequency	≤ 9 µm ≤ 2 MHz					
Incremental signals	HTL[6]			TTL		
Signal periods *	512	1024	2048	512	2048	4096
Edge separation a	≥ 2.4 µs	≥ 0.8 µs	≥ 0.6 µs	≥ 2.4 µs	≥ 0.6 µs	≥ 0.2 µs
Output frequency	≤ 52 kHz	≤ 103 kHz	≤ 205 kHz	≤ 52 kHz	≤ 205 kHz	≤ 410 kHz
System accuracy	±60“	±60“	±20“	±60“	±20“	±20“
Electrical connection	M23 flange socket (male), 17-pin, radial					
Cable length[2]	≤ 100 m (with HEIDENHAIN cable)					
Voltage supply	DC 10 V to 30 V			DC 4.75 V to 30 V		
Power consumption (max.)[3]	See *Power consumption* diagram			*At 4.75 V:* ≤ 900 mW *At 30 V:* ≤ 1100 mW		
Current consumption (typical, without load)	*At 10 V:* ≤ 56 mA *At 24 V:* ≤ 34 mA			*At 5 V:* ≤ 100 mA *At 24 V:* ≤ 25 mA		
Shaft	Solid shaft Ø 10 mm with flat					
Mech. permissible speed n[4]	≤ 12000 rpm					
Starting torque at 20 °C	≤ 0.025 Nm					
Moment of inertia of rotor	2.7 x 10^{-6} kgm^2					
Shaft load	*Axial:* ≤ 40 Nm *Radial:* ≤ 60 Nm at shaft end (see also *Mechanical design types and mounting*)					
Vibration 10 Hz to 2000 Hz[5] **Shock** 6 ms	≤ 150 m/s^2 (EN 60068-2-6) ≤ 1000 m/s^2 (EN 60068-2-27)					
Max. operating temp.[4]	100 °C					
Min. operating temp.	–40 °C					
Protection EN 60529	*Housing:* IP67 *Shaft exit:* IP66					
Mass	≈ 0.30 kg					
Valid for ID	1065028-xx			1042524-xx		

* Please select when ordering
1) For absolute position value; accuracy of the incremental signal upon request
2) For HTL signals, the maximum cable length depends on the output frequency (see the *Cable length for HTL* diagrams)
3) See *General electrical information* in the *Interfaces of HEIDENHAIN Encoders* brochure
4) For the correlation between the operating temperature and the shaft speed or supply voltage, see *General mechanical information*
5) 10 Hz to 55 Hz constant over distance 4.9 mm peak to peak
6) HTLs upon request

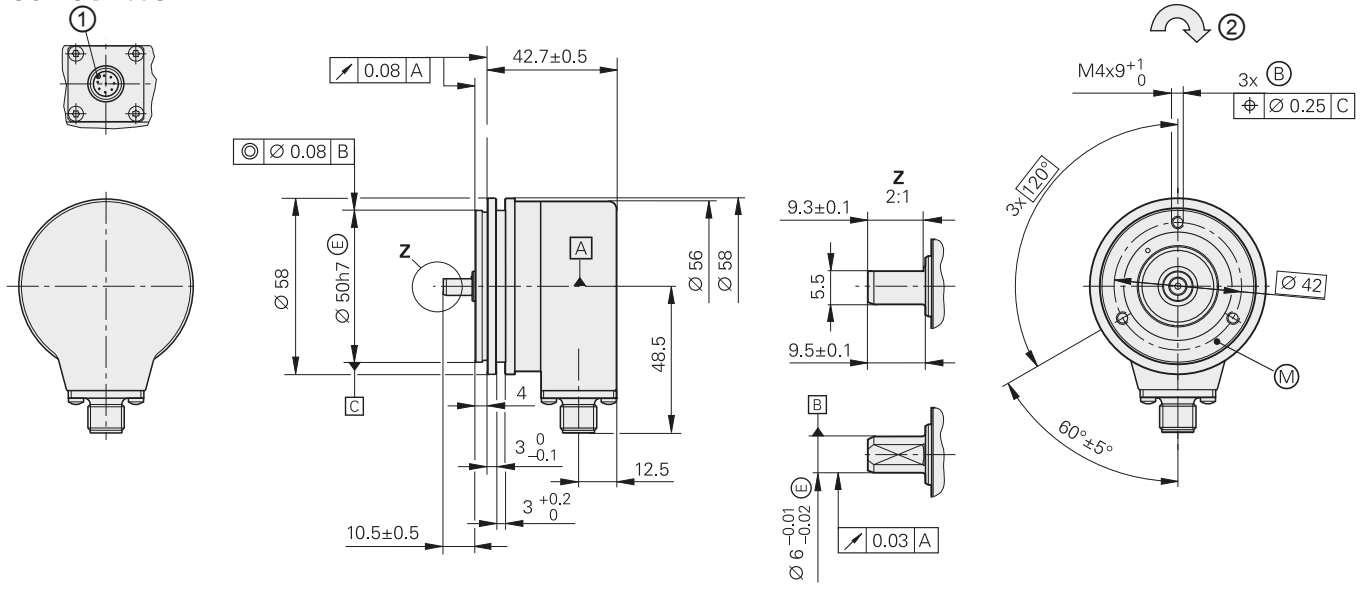
ROC/ROQ 400 F/M/S series

Absolute rotary encoders
- **Synchro flange**
- **Solid shaft for separate shaft coupling**
- **Fanuc Serial Interface, Mitsubishi high speed interface and Siemens DRIVE-CLiQ interface**

ROC/ROQ 400 F/M



ROC/ROQ 400 S



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

Ⓐ = Bearing
Ⓑ = Threaded mounting hole
Ⓜ = Measuring point for operating temperature
1 = Connector coding
2 = Direction of shaft rotation for output signals as per the interface description

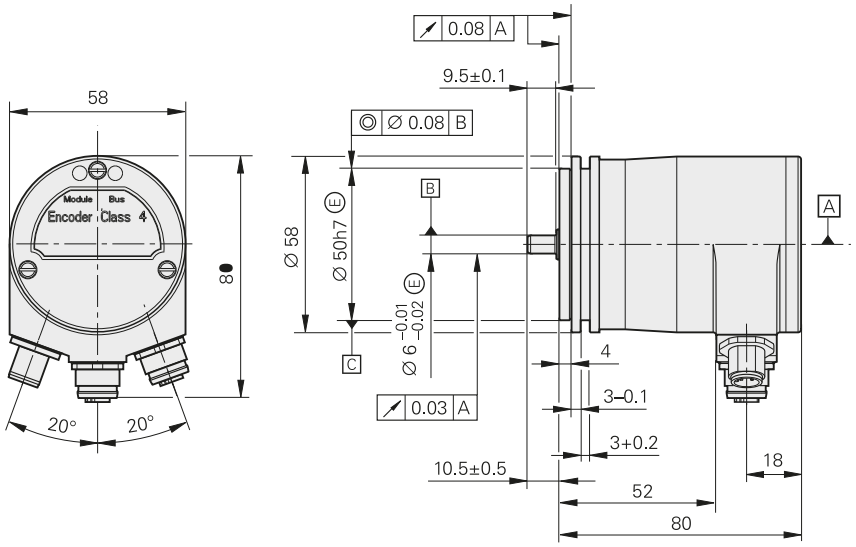
DRIVE-CLiQ is a registered trademark of SIEMENS AG.

	Absolute					
	Singleturn		Functional Safety	Multiturn		Functional Safety
	ROC 425F	**ROC 425M**	**ROC 424S**	**ROQ 437F**	**ROQ 435M**	**ROQ 436S**
Interface	Fanuc Serial Interface; αi Interface	Mitsubishi high speed interface	DRIVE-CLiQ	Fanuc Serial Interface; αi Interface	Mitsubishi high speed interface	DRIVE-CLiQ
Ordering designation	Fanuc05	Mit03-4	DQ01	Fanuc06	Mit03-4	DQ01
Positions per revolution	α*i:* 33554432 (25 bit) α*:* 8388608 (23 bits)	33554432 (25 bits)	16777216 (24 bits)	33554432 (25 bits)	8388608 (23 bits)	16777216 (24 bits)
Revolutions	8192 via revolution counter	–		α*i:* 4096	4096	4096
Code	Pure binary					
Elec. permissible speed	≤ 15000 rpm for continuous position value					
Calculation time t_{cal}	≤ 5 µs	–	≤ 8 µs[3]	≤ 5 µs	–	≤ 8 µs[3]
Incremental signals	Without					
System accuracy	±20"					
Electrical connection	Flange socket M12, radial					
Cable length	≤ 30 m		≤ 95 m[2]	≤ 30 m		≤ 95 m[2]
DC voltage supply	3.6 V to 14 V		10 V to 36 V	3.6 V to 14 V		10 V to 36 V
Power consumption (max.)	*5 V:* ≤ 0.7 W *14 V:* ≤ 0.8 W		*10 V:* ≤ 1.4 W *36 V:* ≤ 1.5 W	*5 V:* ≤ 0.75 W *14 V:* ≤ 0.85 W		*10 V:* ≤ 1.4 W *36 V:* ≤ 1.5 W
Current consumption (typical, without load)	*5 V:* 90 mA		*24 V:* 37 mA	*5 V:* 100 mA		*24 V:* 43 mA
Shaft	Solid shaft Ø 6 mm (for ROC 424S and ROQ 436S with flat)					
Mech. permissible speed n[1]	≤ 15000 rpm			≤ 12000 rpm		
Starting torque	≤ 0.01 Nm (at 20 °C)					
Moment of inertia of rotor	≤ 2.9 x 10^{-6} kgm^2					
Shaft load	*Axial:* 40 N; *radial:* 60 N at shaft end (see also *Mechanical design types and mounting)*					
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.[1]	100 °C					
Min. operating temp.	–30 °C					
Protection EN 60529	IP67 at housing; IP64 at shaft inlet					
Mass	≈ 0.35 kg					
Valid for ID	1081305-xx	1096726-xx	1036789-xx[4]	1081303-xx	1096728-xx	1036786-xx[4]

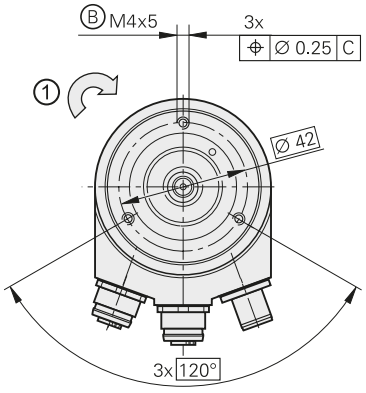
1) For the correlation between the operating temperature and the shaft speed or supply voltage, see *General mechanical information.*
2) See the *Interfaces of HEIDENHAIN Encoders* brochure; with number of encoders = 1 (incl. adapter cable)
3) Processing time TIME_MAX_ACTVAL
4) Also available with **functional safety**; for dimensions and specifications, see the product information document

ROC/ROQ 400 series

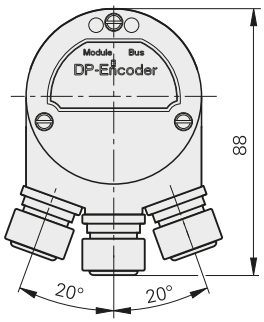
Absolute rotary encoders
- **Synchro flange**
- **Solid shaft for separate shaft coupling**
- **Fieldbus interface**



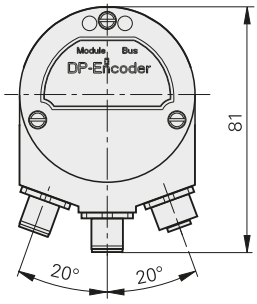
PROFINET IO



PROFIBUS-DP M16



PROFIBUS-DP M12



mm

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

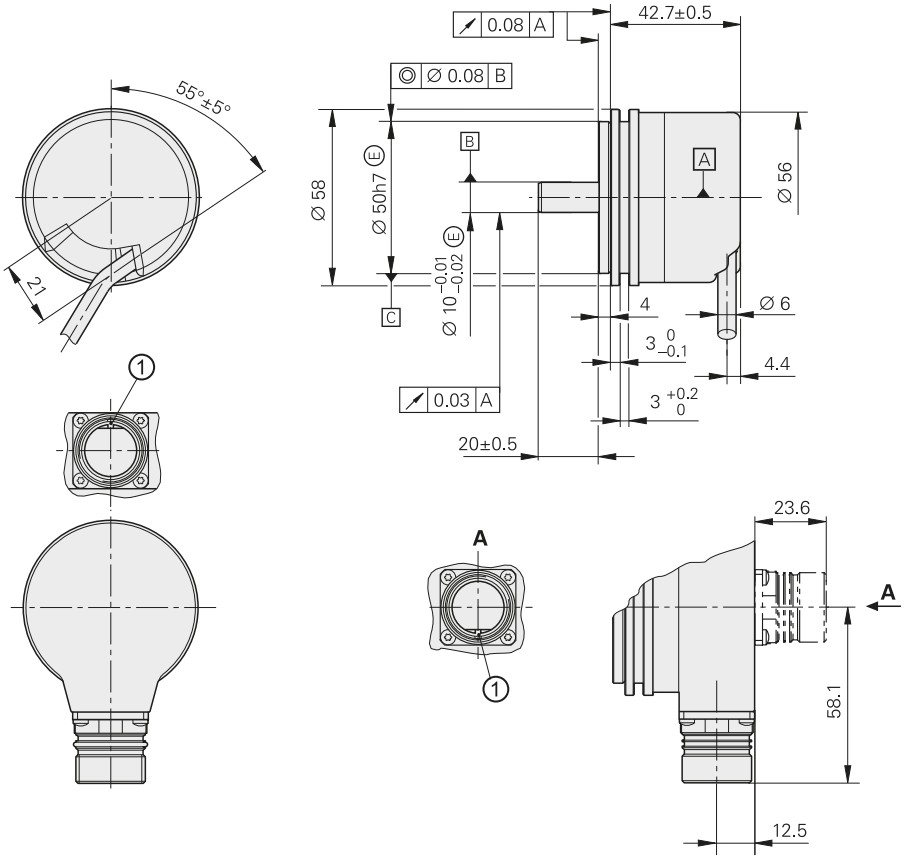
A = Bearing
B = Threaded mounting hole
1 = Direction of shaft rotation for output signals as per the interface description

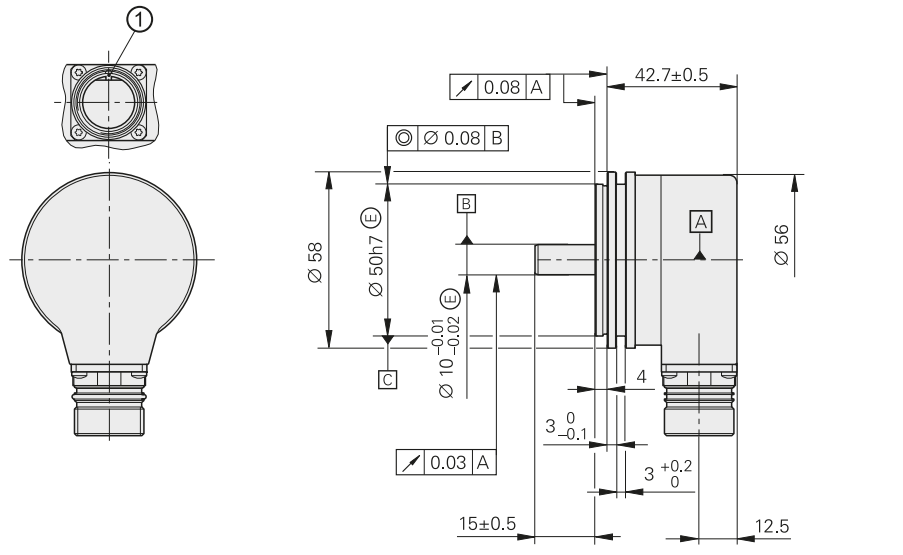
	Absolute			
	Singleturn		**Multiturn**	
	ROC 413		**ROQ 425**	
Interface*	PROFIBUS-DP[1]	PROFINET IO	PROFIBUS-DP[1]	PROFINET IO
Positions per revolution	8192 (13 bits)[2]			
Revolutions	–		4096[2]	
Code	Pure binary			
Elec. permissible speed	≤ 12000 rpm for continuous position value		≤ 10000 rpm for continuous position value	
Incremental signals	Without			
System accuracy	±60"			
Electrical connection*	Cable gland M16[4]	Three M12 flange sockets, radial	Cable gland M16[4]	Three M12 flange sockets, radial
Voltage supply	DC 9 V to 36 V	DC 10 V to 30 V	DC 9 V to 36 V	DC 10 V to 30 V
Power consumption (max.)	*9 V:* ≤ 3.38 W *36 V:* ≤ 3.84 W			
Current consumption (typical, without load)	*24 V:* 125 mA			
Shaft	Solid shaft ∅ 6 mm			
Mech. permiss. speed n	≤ 6000 rpm			
Starting torque	≤ 0.01 Nm (at 20 °C)			
Moment of inertia of rotor	≤ 2.7 x 10^{-6} kgm^2			
Shaft load	*Axial:* ≤ 40 N; *radial:* ≤ 60 N at shaft end (see also *Mechanical design types and mounting)*			
Vibration 55 Hz to 2000 Hz **Shock** 6 ms	≤ 100 m/s^2 (EN 60068-2-6) ≤ 2000 m/s^2 (EN 60068-2-27)			
Max. operating temp.[3]	70 °C			
Min. operating temp.	–40 °C			
Protection EN 60529	IP67 at housing, IP64 at shaft inlet (IP66 upon request)			
Mass	≈ 0.35 kg			
Valid for ID	549882-xx	752518-xx	549884-xx	752520-xx

***** Please select when ordering
[1] Supported profiles: DP-V0, DP-V1, DP-V2
[2] Programmable
[3] For the correlation between operating temperature and the shaft speed or supply voltage, see *General mechanical information*
[4] Variant with three M12 flange sockets upon request

ROC 425 series

Absolute rotary encoders
- **Steel synchro flange**
- **High accuracy**
- **Solid shaft for separate shaft coupling**
- **Version with stainless steel housing**





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

Cable radial, also usable axially
- A = Bearing
- B = Threaded mounting hole
- M = Measuring point for operating temperature
- 1 = Connector coding
- 2 = Direction of shaft rotation for output signals according to interface description

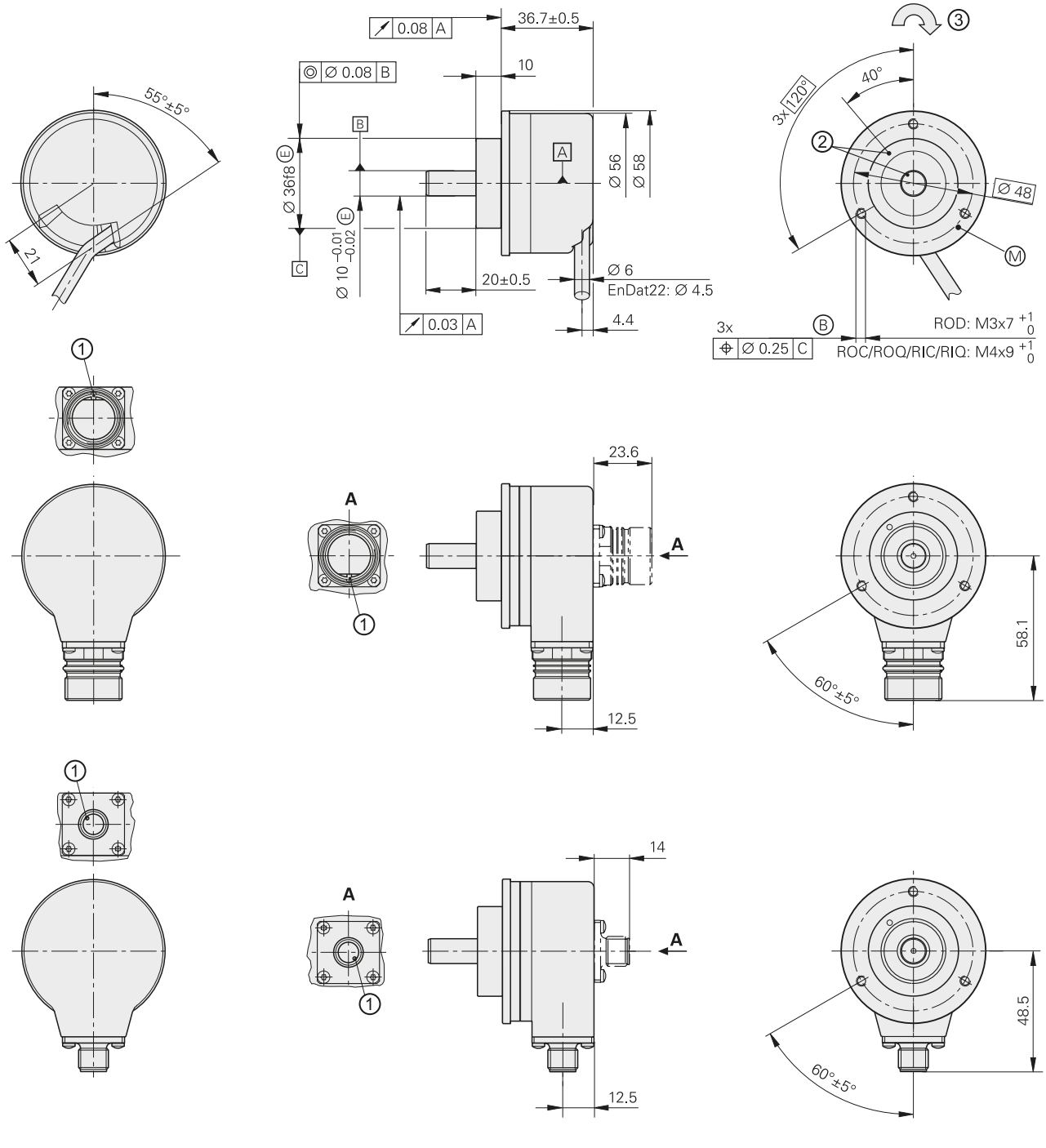
Stainless steel version	Material
Shaft	1.4104
Flange, housing, flange socket	1.4301 (V2A)

	Absolute Singleturn	
	ROC 425, Steel	**ROC 425, stainless steel**
Interface	EnDat 2.2	
Ordering designation	EnDat01	
Positions per revolution	33 554 432 (25 bits)	
Revolutions	–	
Code	Pure binary	
Elec. permissible speed Deviation[1)]	≤ 1500/15 000 rpm ±1200 LSB/±9200 LSB	
Calculation time t_{cal} Clock frequency	≤ 9 µs ≤ 2 MHz	
Incremental signals	⁓ 1 V_{PP}	
Line count	2048	
Cutoff frequency –3 dB	≥ 400 kHz	
System accuracy	±10“	
Electrical connection*	• **Flange socket** M23, axial or radial • Cable 1 m/5 m, with or without M23 coupling	Flange socket M23, radial
Voltage supply	DC 3.6 V to 14 V	
Power consumption (max.)	*3.6 V:* ≤ 0.6 W *14 V:* ≤ 0.7 W	
Current consumption (typical, without load)	*5 V:* 85 mA	
Shaft	Solid shaft Ø 10 mm, length 20 mm	Solid shaft Ø 10 mm, length 15 mm
Mechanically permissible speed n	≤ 12 000 rpm	
Starting torque	≤ 0.025 Nm (at 20 °C) ≤ 0.2 Nm (at -40 °C)	≤ 0.025 Nm (at 20 °C) ≤ 0.5 Nm (at -40 °C)
Moment of inertia of rotor	≤ 2.1 x 10^{-6} kgm^2	
Shaft load	*Axial:* ≤ 40 N; *radial:* ≤ 60 N at shaft end (see also *Mechanical design types and mounting)*	
Vibration 55 Hz to 2000 Hz **Shock** 6 ms	≤ 300 m/s^2 (EN 60 068-2-6) ≤ 2000 m/s^2 (EN 60 068-2-27)	
Max. operating temp.[3)]	80 °C	
Min. operating temp.	*Flange socket or fixed cable:* –40 °C; *moving cable:* –10 °C	
Protection EN 60 529	IP67 at housing; IP66 at shaft inlet	
Mass	≈ 0.50 kg	≈ 0.55 kg
Valid for ID	638726-xx	1080335-xx

Bold: This preferred version is available on short notice.
***** Please select when ordering
1) Velocity-dependent deviations between the absolute value and incremental signals
2) Restricted tolerances: signal amplitude 0.8 V_{PP} to 1.2 V_{PP}
3) For the correlation between the operating temperature and the shaft speed or supply voltage, see *General mechanical information*

ROC/ROQ/ROD 400 and RIC/RIQ 400 series

Absolute and incremental rotary encoders
- **Clamping flange**
- **Solid shaft for separate shaft coupling**



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

Cable radial, also usable axially
Ⓐ = Bearing
Ⓑ = Threaded mounting hole
Ⓜ = Measuring point for operating temperature
1 = Connector coding
2 = ROD reference mark position on shaft and flange ±15°
3 = Direction of shaft rotation for output signals as per the interface description

	Incremental		
	ROD 420	**ROD 430**	**ROD 480**
Interface	⊓⊔ TTL	⊓⊔ HTL	∿ 1 V_{PP} [1]
Line counts*	50 100 150 200 250 360 **500** 512 720		–
	1000 1024 1250 1500 1800 **2000 2048 2500 3600 4096 5000**		
Reference mark	One		
Cutoff frequency –3 dB Output frequency Edge separation a	– ≤ 300 kHz ≥ 0.39 µs		≥ 180 kHz – –
System accuracy	1/20 of grating period		
Electrical connection*	• **Flange socket** M23, radial and axial • **Cable 1 m/**5 m, with or **without M23 coupling**		
Voltage supply	DC 5 V ±0.5 V	DC 10 V to 30 V	DC 5 V ±0.5 V
Current consumption without load	≤ 120 mA	≤ 150 mA	≤ 120 mA
Shaft	Solid shaft ∅ 10 mm		
Mech. permiss. speed n	≤ 16000 rpm		
Starting torque	≤ 0.01 Nm (at 20 °C)		
Moment of inertia of rotor	≤ 2.1 x 10^{-6} kgm^2		
Shaft load [2]	*Axial:* ≤ 40 N; *radial:* ≤ 60 N at shaft end		
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. [3]	100 °C (80 °C for ROD 480 with 4096 or 5000 lines)		
Min. operating temp.	*Flange socket or fixed cable:* –40 °C *Moving cable:* –10 °C		
Protection EN 60 529	IP67 at housing, IP64 at shaft inlet (IP66 upon request)		
Mass	≈ 0.3 kg		
Valid for ID	376840-xx	376834-xx	376880-xx [4]

Bold: This preferred version is available on short notice.

***** Please select when ordering

1) Restricted tolerances: signal amplitude 0.8 V_{PP} to 1.2 V_{PP}

2) See also *Mechanical design types and mounting*

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

4) Mechanical fault exclusion available; for restrictions on specifications and for special mounting information, see the *Fault Exclusion* customer information document

	**Absolute** **Singleturn** **ROC 425** Functional Safety	**ROC 413**		**RIC 418**
Interface*	EnDat 2.2	EnDat 2.2	SSI	EnDat 2.1
Ordering designation	EnDat22	EnDat01	SSI39r1	EnDat01
Positions per revolution	33554432 (25 bits)	8192 (13 bits)		262144 (18 bits)
Revolutions	–			
Code	Pure binary		Gray	Pure binary
Elec. permissible speed Deviation[1]	≤ 15000 rpm for continuous position value	*512 lines:* ≤ 5000/12000 rpm ±1 LSB/±100 LSB *2048 lines:* ≤ 1500/12000 rpm ±1 LSB/±50 LSB	12000 rpm ±12 LSB	≤ 4000/15000 rpm ±400 LSB/±800 LSB
Calculation time t_{cal} Clock frequency	≤ 7 µs ≤ 8 MHz	≤ 9 µs ≤ 2 MHz	≤ 5 µs –	≤ 8 µs ≤ 2 MHz
Incremental signals	Without	~ 1 V_{PP}[2]		~ 1 V_{PP}
Line counts*	–	**512** 2048	**512**	**16**
Cutoff frequency –3 dB	–	*512 lines:* ≥ 130 kHz; *2048 lines:* ≥ 400 kHz		≥ 6 kHz
System accuracy	±20"	±60"		±480"
Electrical connection*	• **Flange socket** M12, radial • Cable 1 m, with M12 coupling	• **Flange socket** M23, axial or radial • Cable 1 m/5 m, with or without M23 coupling		• **Flange socket** M23, radial • Cable 1 m, with M23 coupling
Voltage supply	DC 3.6 V to 14 V	DC 3.6 V to 14 V	DC 4.75 V to 30 V	DC 5 V ±0.25 V
Power consumption (max.)	*3.6 V:* ≤ 0.6 W *14 V:* ≤ 0.7 W		*5 V:* ≤ 0.8 W *10 V:* ≤ 0.65 W *30 V:* ≤ 1 W	*5 V:* ≤ 0.9 W
Current consumption (typical, without load)	*5 V:* 85 mA		*5 V:* 90 mA *24 V:* 24 mA	*5 V:* 125 mA
Shaft	Solid shaft Ø 10 mm			
Mech. permiss. speed n	≤ 15000 rpm			
Starting torque	≤ 0.01 Nm (at 20 °C)			
Moment of inertia of rotor	≤ 2.3 x 10^{-6} kgm^2			
Shaft load	*Axial:* ≤ 40 N; *radial:* ≤ 60 N at shaft end (see also *Mechanical design types and mounting)*			
Vibration 55 Hz to 2000 Hz **Shock** 6 ms	≤ 300 m/s^2; (EN 60068-2-6); higher values upon request *ROC/ROQ:* ≤ 2000 m/s^2; *RIC/RIQ:* ≤ 1000 m/s^2 (EN 60068-2-27)			
Max. operating temp.[3]	100 °C			
Min. operating temp.	*Flange socket or fixed cable:* –40 °C; *moving cable:* –10 °C			
Protection EN 60 529	IP67 at housing; IP64 at shaft inlet[3] (IP66 upon request)			
Mass	≈ 0.35 kg			
Valid for ID	683640-xx[4]	1109255-xx	1131751-xx	642006-xx

Bold: This preferred version is available on short notice.
***** Please select when ordering
[1] Velocity-dependent deviations between the absolute value and incremental signals

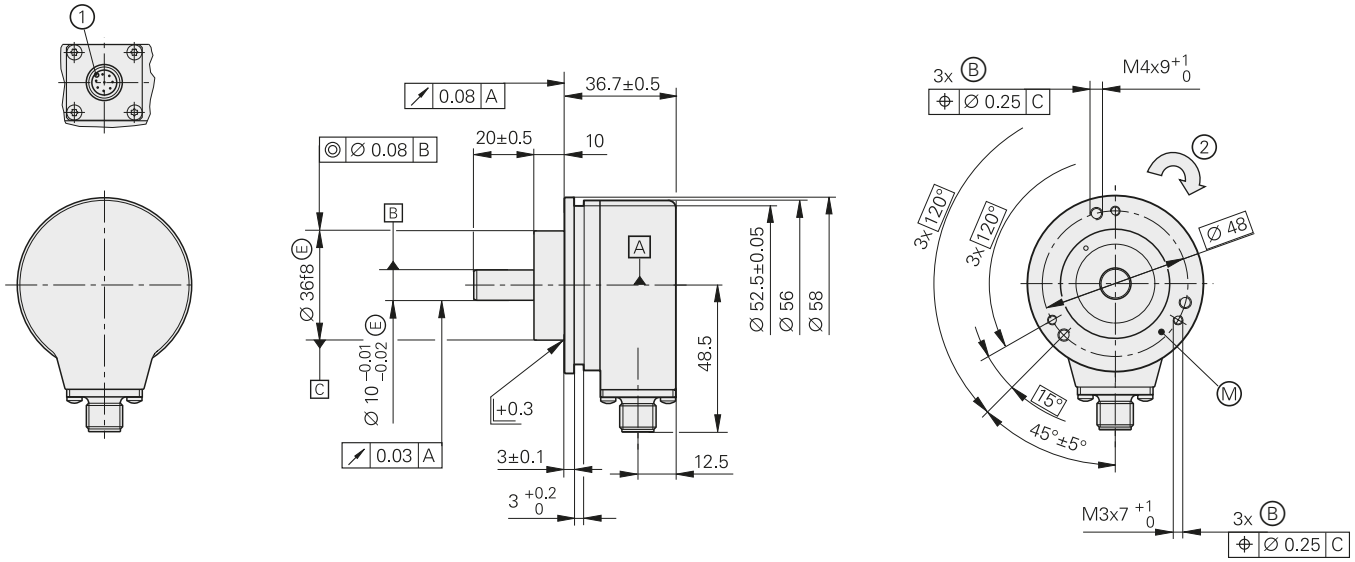
	Multiturn ROQ 437	ROQ 425		RIQ 430
	EnDat 2.2	EnDat 2.2	SSI	EnDat 2.1
	EnDat22	EnDat01	SSI41r1	EnDat01
	33554432 (25 bits)	8192 (13 bits)		262144 (18 bits)
	4096			4096
	Pure binary		Gray	Pure binary
	≤ 15000 rpm for continuous position value	*512 lines:* ≤ 5000/10000 rpm ±1 LSB/±100 LSB *2048 lines:* ≤ 1500/10000 rpm ±1 LSB/±50 LSB	12000 rpm ±12 LSB	≤ 4000/15000 rpm ±400 LSB/±800 LSB
	≤ 7 µs ≤ 8 MHz	≤ 9 µs ≤ 2 MHz	≤ 5 µs –	≤ 8 µs ≤ 2 MHz
	Without	~ 1 V_{PP} [2]		~ 1 V_{PP}
	–	**512** 2048	**512**	**16**
	–	*512 lines:* ≥ 130 kHz; *2048 lines:* ≥ 400 kHz		≥ 6 kHz
	±20"	±60"		±480"
	• **Flange socket** M12, radial • Cable 1 m, with M12 coupling	• **Flange socket** M23, axial or radial • Cable 1 m/5 m, with or without M23 coupling		• **Flange socket** M23, radial • Cable 1 m, with M23 coupling
	DC 3.6 V to 14 V	DC 3.6 V to 14 V	DC 4.75 V to 30 V	DC 5 V ±0.25 V
	3.6 V: ≤ 0.7 W *14 V:* ≤ 0.8 W		*5 V:* ≤ 0.95 W *10 V:* ≤ 0.75 W *30 V:* ≤ 1.1 W	*5 V:* ≤ 1.1 W
	5 V: 105 mA		*5 V:* 120 mA *24 V:* 28 mA	*5 V:* 150 mA
	≤ 12000 rpm			
	683642-xx [4]	1109257-xx	1131753-xx	642002-xx

[2] Restricted tolerances: signal amplitude 0.8 V_{PP} to 1.2 V_{PP}
[3] For the correlation between the operating temperature and the shaft speed or supply voltage, see *General mechanical information*
[4] Also available with **functional safety**; for dimensions and specifications, see the product information document.

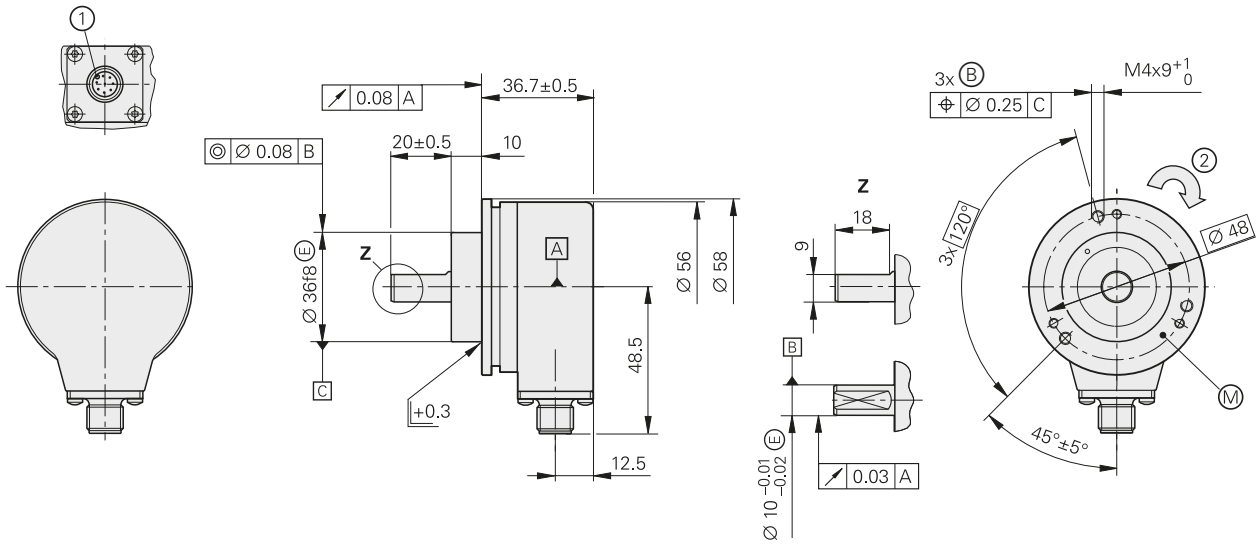
ROC/ROQ 400F/M/S series

Absolute rotary encoders
- **Clamping flange with additional slot for fastening with fixing clamps**
- **Solid shaft for separate shaft coupling**
- **Fanuc Serial Interface, Mitsubishi high speed interface and Siemens DRIVE-CLiQ interface**

ROC/ROQ 400F/M



ROC/ROQ 400S



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

Ⓐ = Bearing
Ⓑ = Threaded mounting hole
Ⓜ = Measuring point for operating temperature
1 = Connector coding
2 = Direction of shaft rotation for output signals as per the interface description

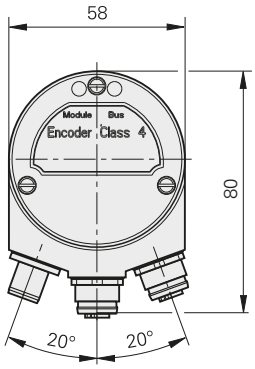
DRIVE-CLiQ is a registered trademark of SIEMENS AG.

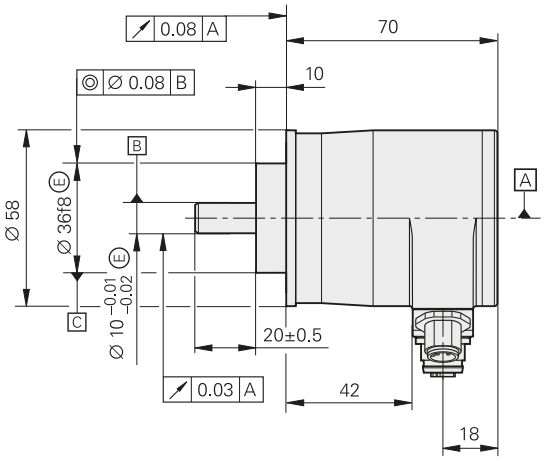
	Absolute					
	Singleturn		Functional Safety	Multiturn		Functional Safety
	ROC 425F	**ROC 425M**	**ROC 424S**	**ROQ 437F**	**ROQ 435M**	**ROQ 436S**
Interface	Fanuc Serial Interface; αi Interface	Mitsubishi high speed interface	DRIVE-CLiQ	Fanuc Serial Interface; αi Interface	Mitsubishi high speed interface	DRIVE-CLiQ
Ordering designation	Fanuc05	Mit03-4	DQ01	Fanuc06	Mit03-4	DQ01
Positions per revolution	α*i:* 33554432 (25 bits) α*:* 8388608 (23 bits)	33554432 (25 bits)	16777216 (24 bits)	33554432 (25 bits)	8388608 (23 bits)	16777216
Revolutions	8192 via revolution counter	–		α*i:* 4096	4096	4096
Code	Pure binary					
Elec. permissible speed	≤ 15000 rpm for continuous position value					
Calculation time t_{cal}	≤ 5 µs	–	≤ 8 µs[3]	≤ 5 µs	–	≤ 8 µs[3]
Incremental signals	Without					
System accuracy	±20"					
Electrical connection	Flange socket M12, radial					
Cable length	≤ 30 m		≤ 95 m[2]	≤ 30 m		≤ 95 m[2]
DC voltage supply	3.6 V to 14 V		10 V to 36 V	3.6 V to 14 V		10 V to 36 V
Power consumption (max.)	*5 V:* ≤ 0.7 W *14 V:* ≤ 0.8 W		*10 V:* ≤ 1.4 W *36 V:* ≤ 1.5 W	*5 V:* ≤ 0.75 W *14 V:* ≤ 0.85 W		*10 V:* ≤ 1.4 W *36 V:* ≤ 1.5 W
Current consumption (typical, without load)	*5 V:* 90 mA		*24 V:* 37 mA	*5 V:* 100 mA		*24 V:* 43 mA
Shaft	Solid shaft Ø 10 mm (with ROC 424S and ROQ 436S with flat					
Mech. permissible speed n[1]	≤ 15000 rpm			≤ 12000 rpm		
Starting torque	≤ 0.01 Nm (at 20 °C)					
Moment of inertia of rotor	≤ 2.9 x 10^{-6} kgm^2					
Shaft load	*Axial:* 40 N; *radial:* 60 N at shaft end (see also *Mechanical design types and mounting)*					
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.[1]	100 °C					
Min. operating temp.	–30 °C					
Protection EN 60529	IP67 at housing; IP64 at shaft inlet					
Mass	≈ 0.35 kg					
Valid for ID	1081306-xx	1096727-xx	1036790-xx[4]	1081304-xx	1096729-xx	1036792-xx[4]

1) For the correlation between the operating temperature and the shaft speed or supply voltage, see *General mechanical information.*
2) See *Interfaces of HEIDENHAIN Encoders* brochure; with number of encoders = 1 (incl. adapter cable)
3) Processing time TIME_MAX_ACTVAL
4) Also available with **functional safety**; for dimensions and specifications, see the product information document.

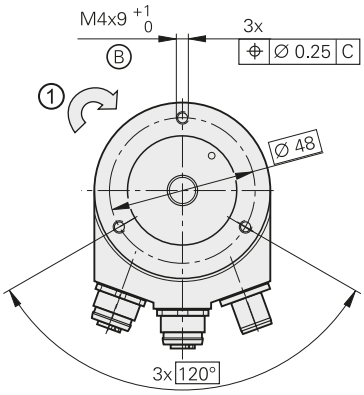
ROC/ROQ 400 series

Absolute rotary encoders
- **Clamping flange**
- **Solid shaft for separate shaft coupling**
- **Fieldbus interface**

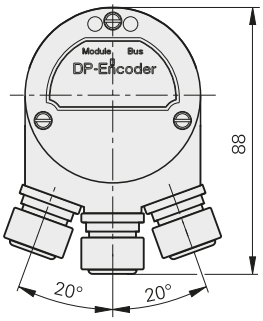




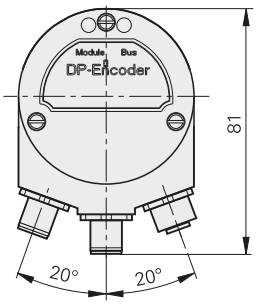
PROFINET IO



PROFIBUS-DP M16



PROFIBUS-DP M12



mm

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

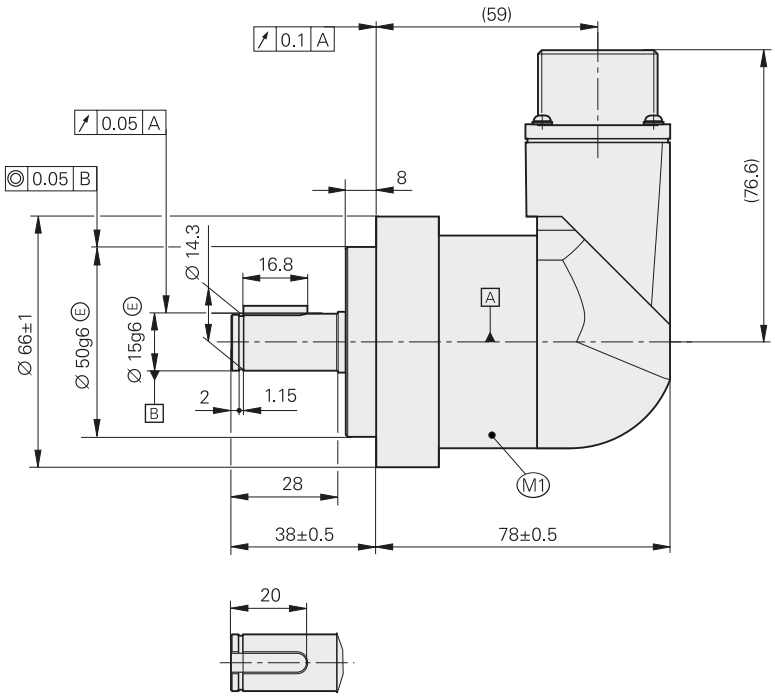
Ⓐ = Bearing
Ⓑ = Threaded mounting hole
1 = Direction of shaft rotation for output signals as per the interface description

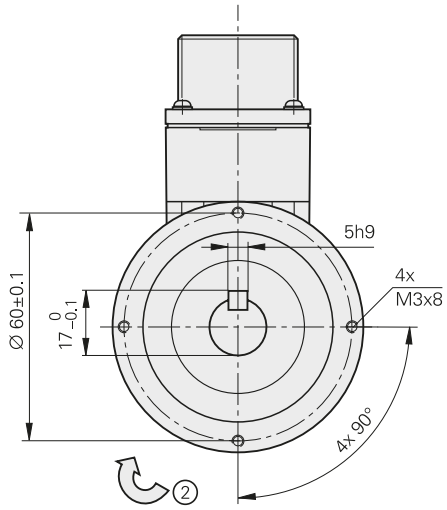
	Absolute			
	Singleturn		**Multiturn**	
	ROC 413		**ROQ 425**	
Interface*	PROFIBUS-DP[1]	PROFINET IO	PROFIBUS-DP[1]	PROFINET IO
Positions per revolution	8192 (13 bits)[2]			
Revolutions	–		4096[2]	
Code	Pure binary			
Elec. permissible speed	≤ 12000 rpm for continuous position value		≤ 10000 rpm for continuous position value	
Incremental signals	Without			
System accuracy	±60“			
Electrical connection*	Cable gland M16[4]	Three M12 flange sockets, radial	Cable gland M16[4]	Three M12 flange sockets, radial
Voltage supply	DC 9 V to 36 V	DC 10 V to 30 V	DC 9 V to 36 V	DC 10 V to 30 V
Power consumption (max.)	*9 V:* ≤ 3.38 W *36 V:* ≤ 3.84 W			
Current consumption (typical, without load)	*24 V:* 125 mA			
Shaft	Solid shaft ∅ 10 mm			
Mech. permiss. speed n	≤ 12000 rpm			
Starting torque	≤ 0.01 Nm (at 20 °C)			
Moment of inertia of rotor	≤ 2.3 x 10^{-6} kgm^2			
Shaft load	*Axial:* ≤ 40 N; *radial:* ≤ 60 N at shaft end (see also *Mechanical design types and mounting)*			
Vibration 55 Hz to 2000 Hz **Shock** 6 ms	≤ 100 m/s^2 (EN 60068-2-6); higher values upon request ≤ 2000 m/s^2 (EN 60068-2-27)			
Max. operating temp.[3]	70 °C			
Min. operating temp.	–40 °C			
Protection EN 60529	IP67 at housing; IP64 at shaft inlet[3] (IP66 upon request)			
Mass	≈ 0.35 kg			
Valid for ID	549886-xx	752519-xx	549888-xx	752521-xx

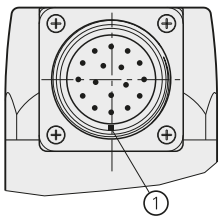
***** Please select when ordering
1) Supported profiles: DP-V0, DP-V1, DP-V2
2) Programmable
3) For the correlation between the operating temperature and the shaft speed or supply voltage, see *General mechanical information*
4) Variant with three M12 flange sockets upon request

ROD 600 series

- **Incremental rotary encoder with sturdy design**
- **Clamping flange**
- **Solid shaft for separate shaft coupling**







mm

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

A = Encoder bearing
M1 = Measuring point for operating temperature
1 = Connector coding
2 = Direction of shaft rotation for output signals as per the interface description

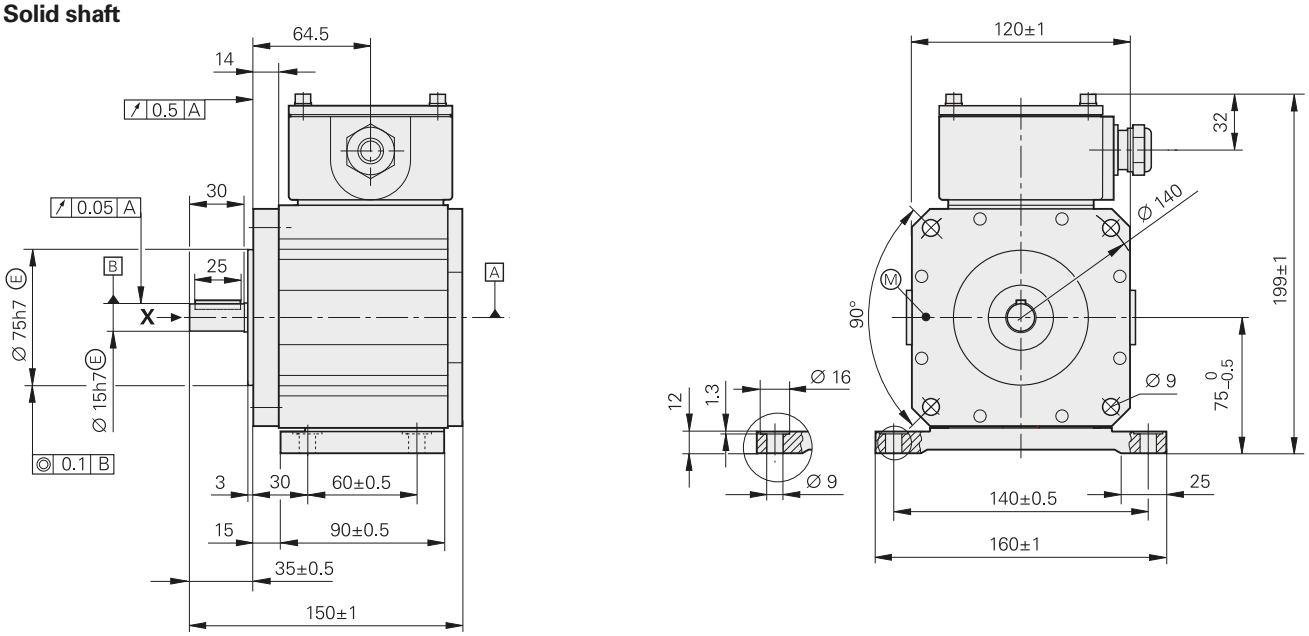
	Incremental	
	ROD 620	**ROD 630**
Incremental signals	⊓⊔TTL	⊓⊔ HTL
Line counts*	512 1000 1024 2048 5000	
Reference mark	One	
Scanning frequency Edge separation a	≤ 300 kHz ≥ 0.39 µs	
System accuracy	±1/20 of grating period	
Electrical connection	Flange socket $1^1/_4$"-18 UNEF, 17-pin, radial[2)]	
Voltage supply **Current consumption** without load	DC 5 V ±0.5 V ≤ 120 mA	DC 10 V to 30 V ≤ 150 mA
Shaft	Solid shaft Ø 15 mm with machine key	
Mech. permiss. speed n	≤ 12000 rpm	
Starting torque	≤ 0.05 Nm (at 20 °C)	
Moment of inertia of rotor	≤ 11 x 10^{-6} kgm^2	
Shaft load	*Axial:* 75 N *Radial:* 75 N at shaft end	
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.[1)]	85 °C	
Min. operating temp.	–20 °C	
Relative humidity	≤ 93 % (40 °C/4 d as per EN 60068-2-78); without condensation	
Protection EN 60 529	IP66	
Mass	≈ 0.8 kg	
Valid for ID	1145260-xx	1145261-xx

***** Please select when ordering
1) Self heating during encoder operation at room temperature and at a max. rotational speed of 6000 rpm is +50 K
2) Fitting mating connector: ID 1094831-01, cable only: ID 816317-xx

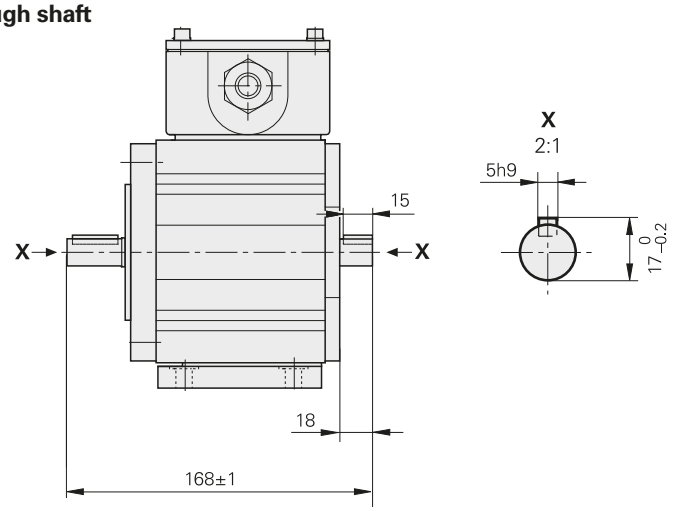
ROD 1930

Incremental rotary encoders
- **For fastening by flange or base**
- **Solid shaft with machine key for separate shaft coupling**

Solid shaft



Solid through shaft



mm

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

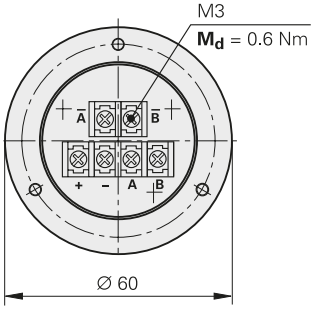
A = Bearing
M = Measuring point for operating temperature

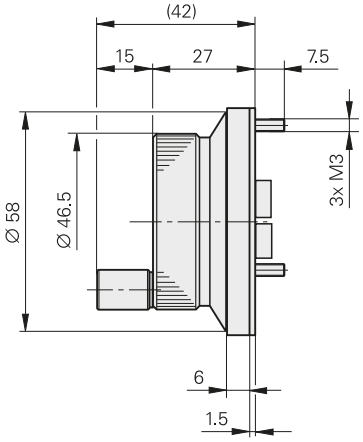
	Incremental ROD 1930	
Interface*	⊓⊔ HTL	⊓⊔ HTLs
Line counts*	600 1024 1200 2400	
Reference mark	Without	One
Output frequency Edge separation a	≤ 160 kHz ≤ 0.76 µs	
System accuracy	±1/10 of grating period	
Electrical connection	Terminal box with screw terminals	
Voltage supply	10 V to 30 V DC	
Current consumption (typical, without load)	*15 V:* 60 mA	
Shaft*	Solid shaft or solid through shaft Ø 15 mm with machine key	
Mech. permissible speed	≤ 4000 rpm	
Starting torque at 20 °C	*Solid shaft:* ≤ 0.05 Nm *Through shaft:* ≤ 0.15 Nm	
Moment of inertia of rotor	2.5×10^{-5} kgm^2	
Permissible angular acceleration	≤ 4×10^4 rad/s^2	
Shaft load[1)]	*Axial:* ≤ 150 N *Radial:* ≤ 200 N at shaft end	
Vibration 25 Hz to 200 Hz **Shock** 6 ms	≤ 100 m/s^2 (EN 60068-2-6) ≤ 1000 m/s^2 (EN 60068-2-27)	
Operating temperature[2)]	–20 °C to +70 °C	
Protection EN 60529	IP66	
Mass	≈ 4.5 kg	
Valid for ID	Solid shaft: 1043373-xx Through shaft: 1043377-xx	

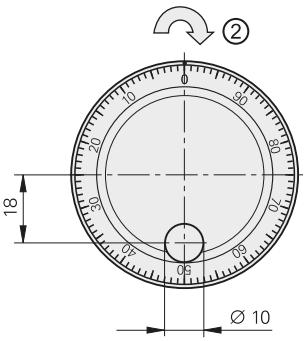
***** Please select when ordering
1) See also *Mechanical design types and mounting*
2) Special versions upon request (e.g., with water jacket)

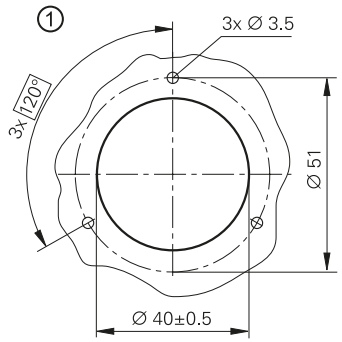
HR 1120

Electronic handwheel
- **Version for integration**
- **With mechanical detent**









mm

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

1 = Cutout for mounting
2 = Direction for output signals as per the interface description

	Incremental HR 1120
Interface	⊓⊔TTL
Line count	100
Output frequency	≤ 5 kHz
Switching times	t_+ / t_- ≤ 100 ns
Electrical connection	Via M3 screw terminals
Cable length	≤ 30 m
Voltage supply	DC 5 V ±0.25 V
Current consumption without load	≤ 160 mA
Detent	Mechanical 100 detent positions per revolution Detent position within the low level of U_{a1} and U_{a2}
Mech. permissible speed	≤ 200 rpm
Torque	≤ 0.1 Nm (at 25 °C)
Vibration (10 Hz to 200 Hz)	≤ 20 m/s^2
Max. operating temp.	60 °C
Min. operating temp.	0 °C
Protection (EN 60529)	IP00; IP40 when mounted No condensation permitted
Mass	≈ 0.15 kg
Valid for ID	687617-xx

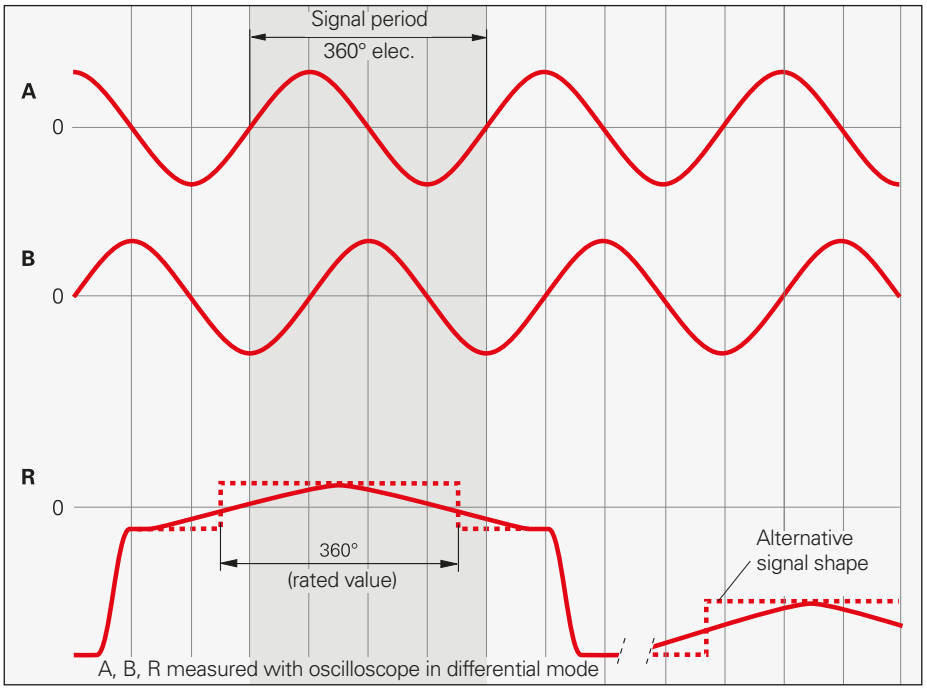
Mounting information
The HR 1120 is designed for mounting in a panel. CE compliance of the complete system must be ensured by taking the correct measures during installation.

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.



Further information:

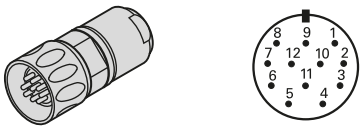
Comprehensive descriptions of all available interfaces as well as general electrical information are included in the *Interfaces of HEIDENHAIN Encoders* brochure.

HEIDENHAIN offers interface electronics to adapt measuring devices to the interface of the subsequent electronics. You can find more detailed information in the *Interface Electronics* product overview.

Pin layout

12-pin coupling, M23

12-pin connector, M23



	Voltage supply				Incremental signals						Other signals		
	12	**2**	**10**	**11**	**5**	**6**	**8**	**1**	**3**	**4**	**9**	**7**	**/**
	U_P	**Sensor**[1] U_P	**0 V**	**Sensor**[1] 0 V	**A+**	**A–**	**B+**	**B–**	**R+**	**R–**	**Vacant**	**Vacant**	**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!

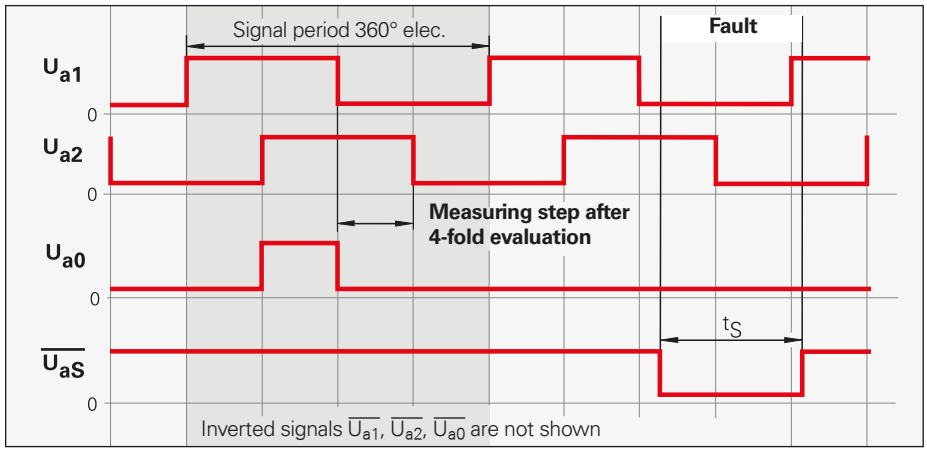
[1] **LIDA 2xx:** Vacant

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.

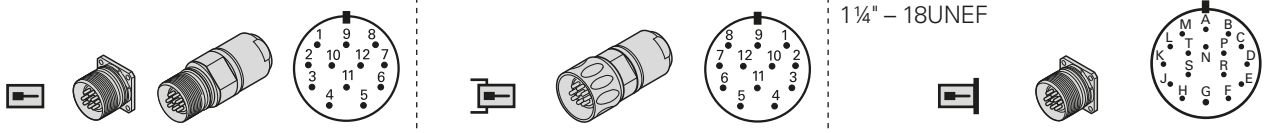


The distance between two successive edges of the incremental signals U_{a1} and U_{a2} through 1-fold, 2-fold or 4-fold evaluation is one **measuring step.**

Further information:
Comprehensive descriptions of all available interfaces as well as general electrical information are included in the *Interfaces of HEIDENHAIN Encoders* brochure.

ERN, ROD pin layout

12-pin flange socket or coupling, M23 | **12-pin connector,** M23 | **17-pin flange socket** 1¼" – 18UNEF



	Voltage supply				Incremental signals						Other signals	
M23	12	2	10	11	5	6	8	1	3	4	7	9
1¼"	H	F	K	M	A	N	C	R	B	P	S	D/E/G/J/L/T
	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 [2]
	Brown/ Green	Blue	White/ Green	White	Brown	Green	Gray	Pink	Red	Black	Violet	Yellow

Shield on housing; U_P = Power supply voltage
Sensor: The sensor line is connected in the encoder with the corresponding power line.
[1] **ERO 14xx:** vacant [2] **Exposed linear encoders:** TTL/11 μA_{PP} switchover for PWT

HR pin layout

Screw-terminal connection

	Voltage supply		Incremental signals			
Connection	+	–	A	$\overline{A}$	B	$\overline{B}$
Signal	U_P 5 V	U_N 0 V	U_{a1}	$\overline{U_{a1}}$	U_{a2}	$\overline{U_{a2}}$

A shielded cable with a cross section of at least 0.5 mm² is recommended when connecting the handwheel to the power supply.

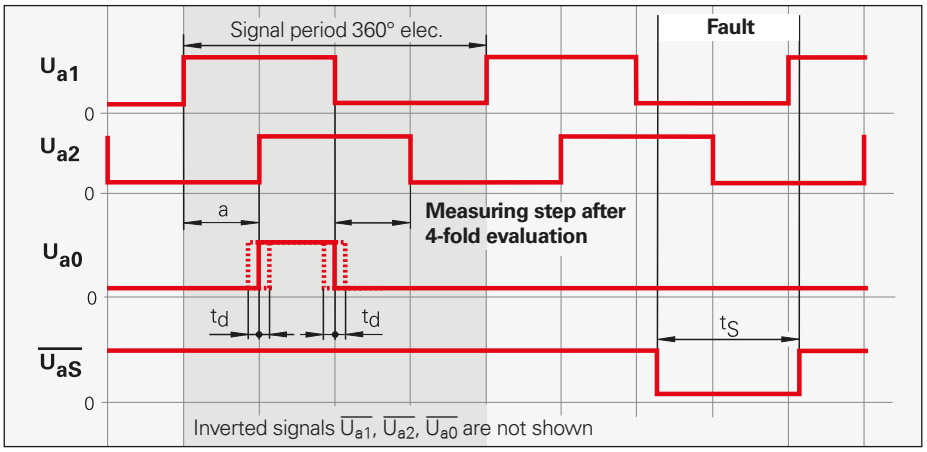
The handwheel is connected electrically via screw terminals. The appropriate wire end sleeves must be attached to the wires.

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.**

Further information:
Comprehensive descriptions of all available interfaces as well as general electrical information are included in the *Interfaces of HEIDENHAIN Encoders* brochure.

Power and current consumption

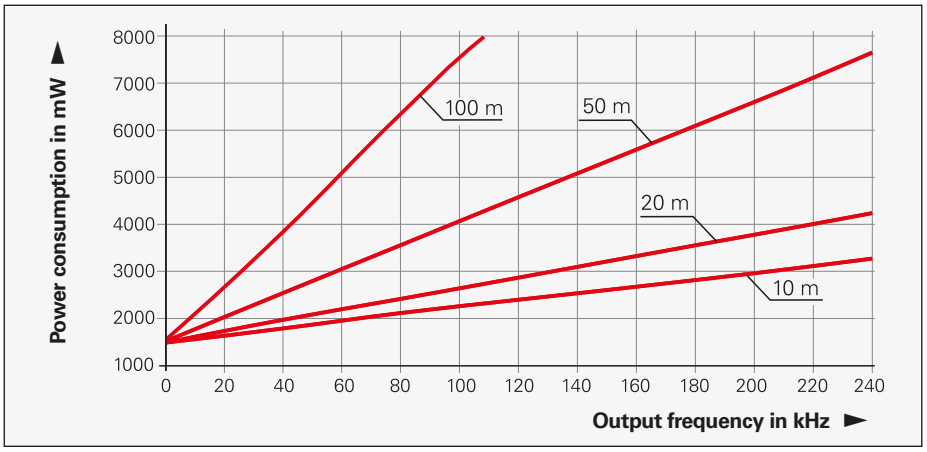
For encoders with a large supply voltage range, the current consumption has a nonlinear relationship with the supply voltage. It is determined using the calculation described in the *Interfaces of HEIDENHAIN Encoders* brochure.

For the rotary encoders with additional HTL output signals, the power consumption also depends on the output frequency and on the cable length. The power consumption values for the HTL or HTLs interface can therefore be taken from the diagrams.

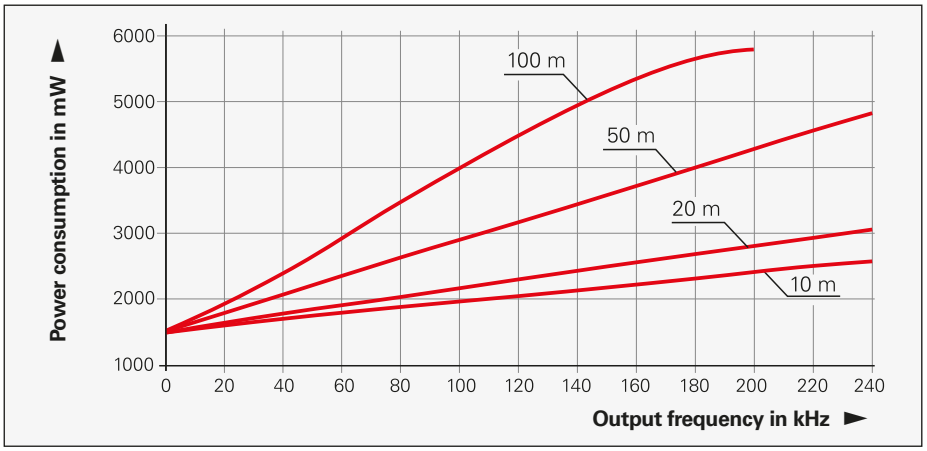
The maximum permissible output frequency is shown in the specifications. It occurs at the maximum permissible shaft speed. The output frequency for any shaft speed is calculated using the following formula:

$f = (n/60) \times z \times 10^{-3}$

With
f = Output frequency in kHz
n = Shaft speed in rpm
z = Number of signal periods per 360°



Power consumption (maximum) for HTL interface and supply voltage U_P = 30 V



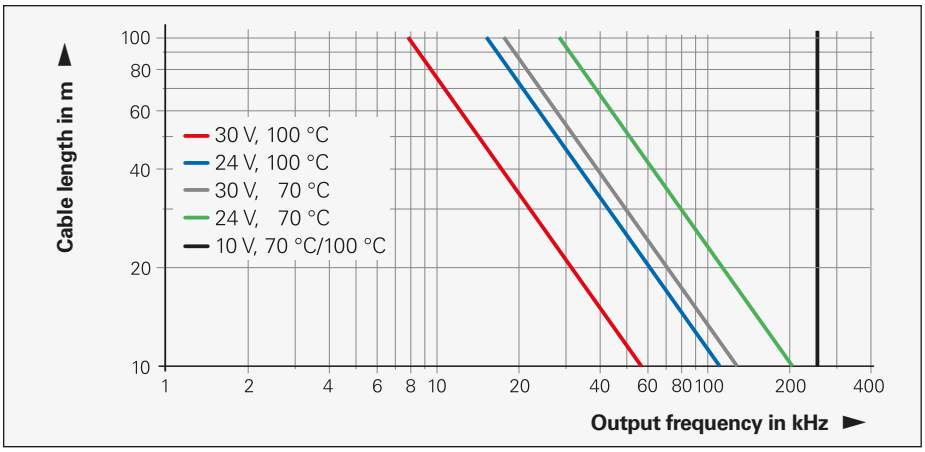
Power consumption (maximum) for HTLs interface and supply voltage U_P = 30 V

Cable length for HTL

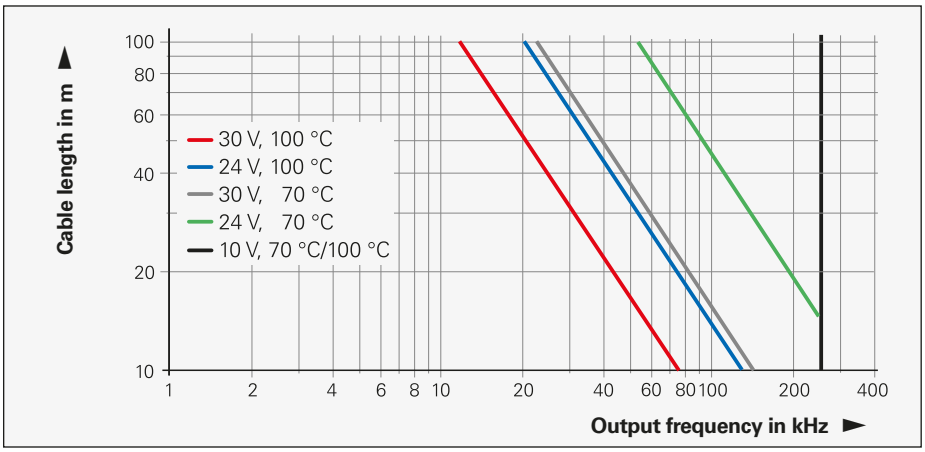
For the rotary encoders with additional HTL output signals, the maximum permissible cable length depends on several criteria:

- Output frequency
- Supply voltage
- Operating temperature

The relationships are shown separately for the HTL and HTLs interface in the diagrams. There are no constraints for a supply voltage of DC 10 V.



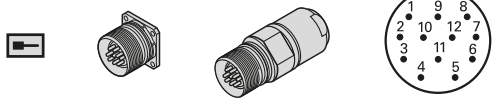
Maximum permissible cable length for HTL interface



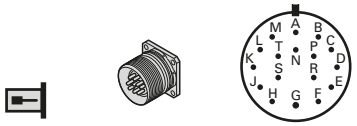
Maximum permissible cable length for HTLs interface

Pin layout

12-pin flange socket or coupling, M23



17-pin flange socket
1¼" – 18UNEF

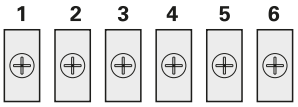


	Voltage supply				Incremental signals						Other signals	
M23	**12**	**2**	**10**	**11**	**5**	**6**	**8**	**1**	**3**	**4**	**7**	**9**
1¼"	**H**	**F**	**K**	**M**	**A**	**N**	**C**	**R**	**B**	**P**	**S**	**D/E/G/J/L/T**
HTL	**U_P**	**Sensor** U_P	0 V	**Sensor** 0 V	**U_{a1}**	**$\overline{U_{a1}}$**	**U_{a2}**	**$\overline{U_{a2}}$**	**U_{a0}**	**$\overline{U_{a0}}$**	**$\overline{U_{aS}}$**	**Vacant**
HTLs*						**0 V**		**0 V**		**0 V**		
	Brown/ Green	Blue	White/ Green	White	Brown	Green	Gray	Pink	Red	Black	Violet	Yellow

Shield on housing; **U_P** = Power supply voltage
Sensor: The sensor line is connected in the encoder with the corresponding power line.
***** Only with 12-pin flange or socket coupling (M23)

ROD 1930 pin layout

Screw-terminal connection



	Voltage supply		Incremental signals			
Connection	**1**	**2**	**3**	**4**	**5**	**6**
HTL	**U_P**	**U_N** 0V	**U_{a1}**	**$\overline{U_{a1}}$**	**U_{a2}**	**$\overline{U_{a2}}$**
HTLs				**U_{a2}**	0 V	**U_{a0}**

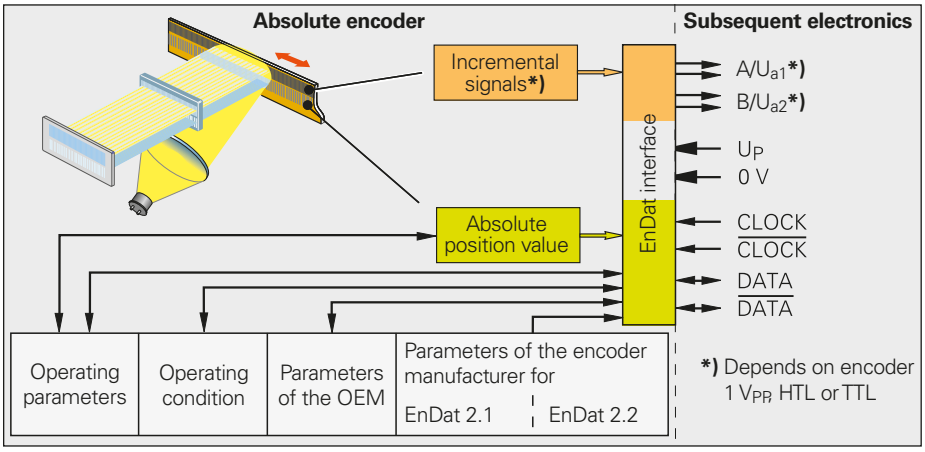
A shielded cable with a cross section of at least 0.5 mm^2 is recommended when connecting to the power supply.
The encoder is connected through screw terminals. The appropriate wire end sleeves must be attached to the wires.

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.

Ordering designation	Command set	Incremental signals
EnDat01 EnDatH EnDatT	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

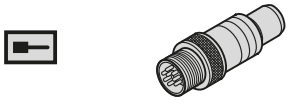


Further information:

Comprehensive descriptions of all available interfaces as well as general electrical information are included in the *Interfaces of HEIDENHAIN Encoders* brochure.

Pin layout

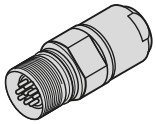
8-pin coupling, M12



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

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

17-pin coupling, M23



	Power supply					Incremental signals [1]				Serial data transfer			
	7	**1**	**10**	**4**	**11**	**15**	**16**	**12**	**13**	**14**	**17**	**8**	**9**
	U_P	**Sensor** U_P	**0 V**	**Sensor** 0 V	**Internal shield**[2]	**A+**	**A–**	**B+**	**B–**	**DATA**	**$\overline{\text{DATA}}$**	**CLOCK**	**$\overline{\text{CLOCK}}$**
	Brown/ Green	Blue	White/ Green	White	/	Green/ Black	Yellow/ Black	Blue/ Black	Red/ Black	Gray	Pink	Violet	Yellow

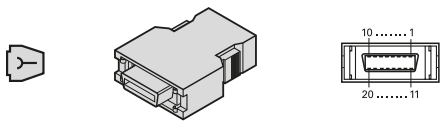
Cable shield connected to housing; **U_P** = Power supply voltage
Sensor: The sensor line is connected in the encoder with the corresponding power line.
Vacant pins or wires must not be used!
[1] Only with EnDat01 and EnDat02 [2] Vacant for ECN/EQN 10xx and ROC/ROQ 10xx

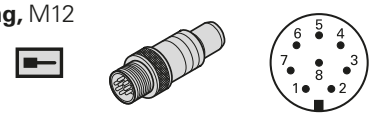
Fanuc, Siemens pin layout

Fanuc pin layout
HEIDENHAIN encoders with the code letter F after the model designation are suited for connection to Fanuc controls with

Fanuc Serial Interface – α Interface
- Ordering designation: Fanuc02
  Normal and high speed, two-pair transmission

Fanuc Serial Interface – αi Interface
- Ordering designation: Fanuc05
  High speed, one-pair transmission
  Contains α interface (normal and high speed, two-pair transmission)
- Ordering designation: Fanuc06
  High speed, one-pair transmission

20-pin Fanuc connector 

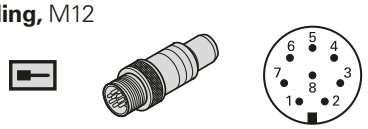
8-pin coupling, M12 

	Power supply					Serial data transfer			
	9	**18/20**	**12**	**14**	**16**	**1**	**2**	**5**	**6**
	8	**2**	**5**	**1**	**–**	**3**	**4**	**7**	**6**
	U_P	**Sensor** U_P	**0 V**	**Sensor** 0 V	**Shield**	**Serial Data**	**$\overline{\text{Serial Data}}$**	**Request**	**$\overline{\text{Request}}$**
	Brown/ Green	Blue	White/ Green	White	–	Gray	Pink	Violet	Yellow

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

Siemens pin layout
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

RJ45 connector 

8-pin coupling, M12 

	Power supply		Serial data transfer			
			Transmit data		Receive data	
	A	**B**	**3**	**6**	**1**	**2**
	1	**5**	**7**	**6**	**3**	**4**
	U_P	**0 V**	**TXP**	**TXN**	**RXP**	**RXN**

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

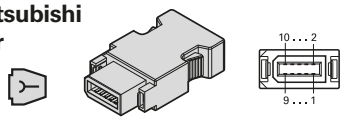
Mitsubishi pin layout

Mitsubishi pin layout
HEIDENHAIN encoders with the code letter M after the model designation are suited for connection to Mitsubishi controls with

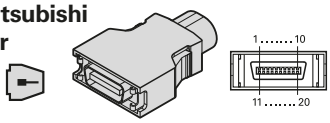
Mitsubishi high speed interface

- Ordering designation: Mitsu01
  Two-pair transmission
- Ordering designation: Mit02-4
  Generation 1, two-pair transmission
- Ordering designation: Mit02-2
  Generation 1, one-pair transmission
- Ordering designation: Mit03-4
  Generation 2, two-pair transmission

10-pin Mitsubishi connector



20-pin Mitsubishi connector



8-pin flange socket, M12

	Voltage supply				Serial data transfer			
10-pin	**1**	**–**	**2**	**–**	**7**	**8**	**3**	**4**
20-pin	**20**	**19**	**1**	**11**	**6**	**16**	**7**	**17**
	8	**2**	**5**	**1**	**3**	**4**	**7**	**6**
	U_P	**Sensor** U_P	**0 V**	**Sensor** 0 V	**Serial Data**	**$\overline{\text{Serial Data}}$**	**Request Frame**	**$\overline{\text{Request Frame}}$**
	Brown/Green	Blue	White/Green	White	Gray	Pink	Violet	Yellow

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

PROFIBUS-DP position values

PROFIBUS-DP
The PROFIBUS is a non-proprietary, open fieldbus according to the international standard EN 50 170. The connecting of sensors through fieldbus systems minimizes the cost of cabling and reduces the number of lines between encoder and subsequent electronics.

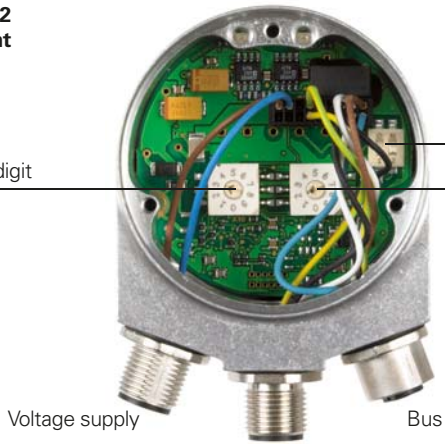
PROFIBUS-DP profile
The PNO (PROFIBUS user organization) has defined standard, nonproprietary profiles for the connection of absolute encoders to the PROFIBUS-DP This ensures high flexibility and simple configuration on all systems that use these standardized profiles.

Encoders with PROFIBUS-DP
The absolute rotary encoders with **integrated PROFIBUS-DP interface** are connected directly to the PROFIBUS.

Accessories
Adapter connector M12 (male) 4-pin, B-coded
Fits 5-pin bus output, with PROFIBUS terminating resistor; required for last participant if the encoder's internal terminating resistor is not to be used.
ID 584217-01

Mating connectors are required for connection via M12 connecting element:
Bus input
M12 connector (female) 5-pin, B-coded
Bus output
M12 coupling (male) 5-pin, B-coded
Voltage supply
M12 connector, 4-pin, A-coded

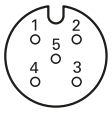
Connection via M12 connecting element



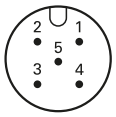
Connection via M16 cable gland

Pin layout of M12 connecting element

Mating connector:
Bus input,
5-pin connector (female)
M12 B-coded



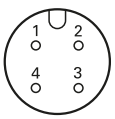
Mating connector:
Bus output,
5-pin coupling (male)
M12 B-coded



	Power supply				Serial data transfer	
	1	**3**	**5**	**Housing**	**2**	**4**
BUS in	**/**	**/**	**Shield**	**Shield**	**DATA (A)**	**DATA (B)**
BUS out	**U**[1)]	**0 V**[1)]	**Shield**	**Shield**	**DATA (A)**	**DATA (B)**

[1)] For supplying the external terminal resistor

Mating connector:
Voltage supply,
4-pin connector (female)
M12 A-coded



	1	3	2	4
	U_P	**0 V**	**Vacant**	**Vacant**

Further information:
Comprehensive descriptions of all available interfaces as well as general electrical information are included in the *Interfaces of HEIDENHAIN Encoders* brochure.

PROFINET IO position values

PROFINET IO
PROFINET IO is the open Industrial Ethernet Standard for industrial communication. It builds on the field-proven function model of PROFIBUS-DP, but uses fast Ethernet technology as physical transmission medium and is therefore tailored for fast transmission of I/O data. It offers the possibility of transmission for required data, parameters and IT functions at the same time.

PROFINET profile
HEIDENHAIN encoders fulfill the definitions as per Profile 3.162, Version 4.1. The device profile describes the encoder functions. Supports the functions of class 4 (full range of scaling and preset functions). More information about PROFINET can be obtained from the PROFIBUS user organization (PNO).

Commissioning
To put an encoder with a PROFINET interface into operation, a general station description (GSD) must be downloaded and imported into the configuration software. The GSD contains the execution parameters required for a PROFINET-IO device.

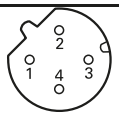
Encoders with PROFINET
The absolute rotary encoders with integrated PROFINET interface are connected directly to the network. Addresses are distributed automatically over a protocol integrated in PROFINET. A PROFINET-IO field device is addressed within a network through its physical device MAC address.

On their rear faces, the encoders feature two double-color LEDs for diagnostics of the bus and the device.

Connection
PROFINET and the power supply are connected via the M12 connecting elements. The necessary mating connectors are:
Ports 1 and 2
M12 coupling (male), 4-pin, D-coded
Voltage supply
M12 connector, 4-pin, A-coded

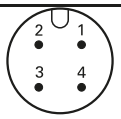
Pin layout

Ports 1 and 2
4-pin connector (female)
M12 D-coded



	Serial data transfer				
	1	**2**	**3**	**4**	**Housing**
PORT 1/2	**Tx+**	**Rx+**	**Tx–**	**Rx–**	**Shield**

Voltage supply
4-pin coupling (male)
M12 A-coded



	1	**3**	**2**	**4**
	U_P	**0 V**	**Vacant**	**Vacant**

Further information:
Comprehensive descriptions of all available interfaces as well as general electrical information are included in the *Interfaces of HEIDENHAIN Encoders* brochure.

SSI position values

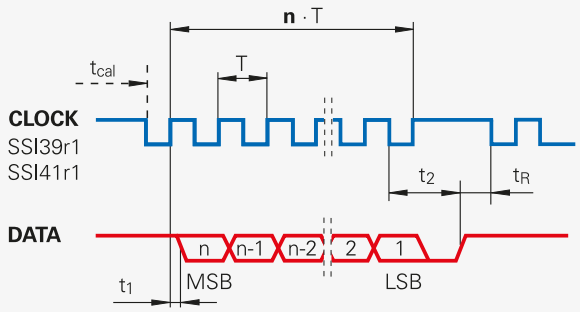
The **position value**, beginning with the most significant bit (MSB), is transferred over the data lines (DATA) in synchronism with a CLOCK signal from the control. The SSI standard data word length for singleturn encoders is 13 bits, and for multiturn encoders 25 bits. In addition to the absolute position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

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

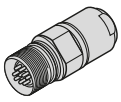


Further information:

Comprehensive descriptions of all available interfaces as well as general electrical information are included in the *Interfaces of HEIDENHAIN Encoders* brochure.

Pin layout

17-pin coupling, M23




	Voltage supply					Incremental signals				Serial data transfer				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**	**$\overline{\text{CLOCK}}$**	**Direc-tion of rotation**	**Zero**
	Brown/ Green	Blue	White/ Green	White	/	Green/ Black	Yellow/ Black	Blue/ Black	Red/ Black	Gray	Pink	Violet	Yellow	Black	Green

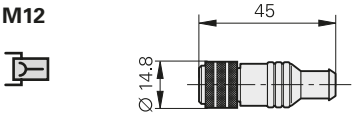
Shield on housing; **U_P** = Power supply voltage
Sensor: With a 5 V supply voltage, the sensor line is connected in the encoder with the corresponding power line.
Vacant pins or wires must not be used!
[1] Vacant for ECN/EQN 10xx and ROC/ROQ 10xx

Connecting elements and cables
General information

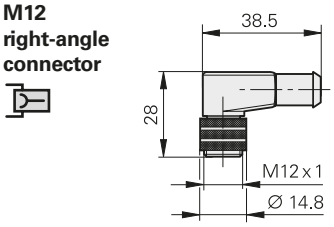
Connector insulated: Connecting element with coupling ring, available with male or female contacts (see symbols).

Symbols

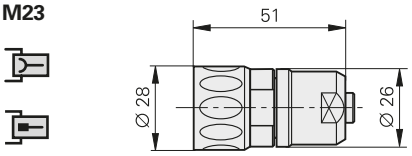
M12



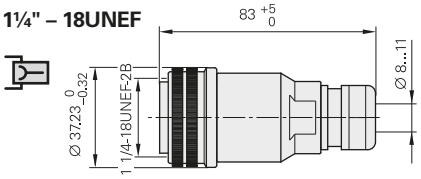
M12 right-angle connector



M23



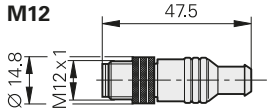
1¼" – 18UNEF



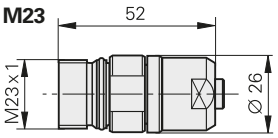
Coupling insulated: Connecting element with outside thread, available with male or female contacts (see Symbols).

Symbols

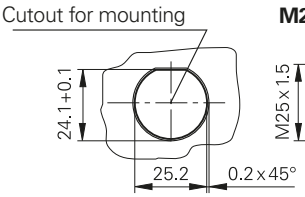
M12



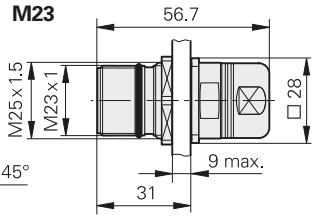
M23



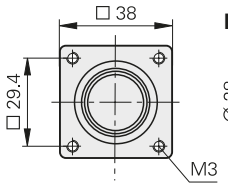
Mounted coupling with central fastening



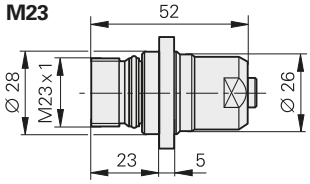
M23



Mounted coupling with flange



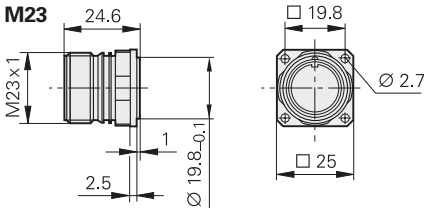
M23



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

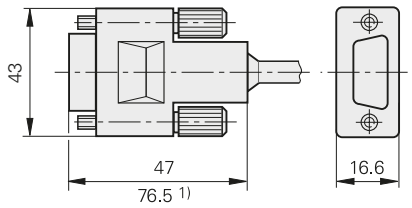
Symbols

M23



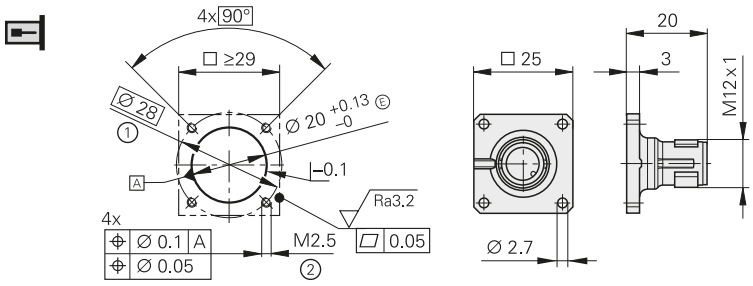
D-sub connector for HEIDENHAIN controls, counters and IK absolute value cards.

Symbols



1) Interface electronics integrated in connector

Flange socket M12 with encoder cable inside the motor housing



① = Bold circle diameter
② = At least 4 mm of load-bearing thread length

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.

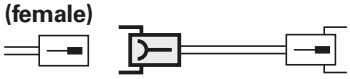
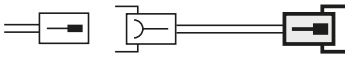
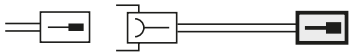
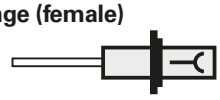
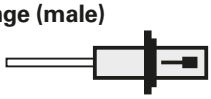
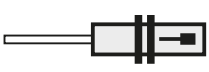
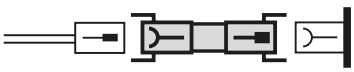
When engaged, the connections provide **protection** to IP67 (D-sub connector: IP50; EN 60529). When not engaged, there is no protection.

Accessories for flange sockets and M23 mounted couplings

Threaded metal dust cap
ID 219926-01

Accessory for M12 connecting element Insulation spacer
ID 596495-01

Connecting cables, 1 V_{PP}, TTL, HTL 12-pin M23

		~ 1 V_{PP}, ⊓⊔ TTL, ⊓⊔ HTL
PUR connecting cables	**12-pin:** [4(2 x 0.14 mm²) + (4 x 0.5 mm²)]; A_P = 0.5 mm²	**Ø 8 mm**
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 D-sub connector (male), 15-pin, for PWM 20/EIB 74x		310196-xx
With one connector (female)		309777-xx
Cable without connectors, Ø 8 mm		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 fastener (male) Ø 6 to 10 mm 	741045-01
Adapter connector ~ 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

		EnDat without incremental signals		**EnDat** with incremental signals **SSI**
PUR connecting cables	**8-pin:** [(4 x 0.14 mm²) + (4 x 0.34 mm²)]; A_P = 0.34 mm² **17-pin:** [(4 x 0.14 mm²) + 4(2 x 0.14 mm²) + (4 x 0.5 mm²)]; A_P = 0.5 mm²			
	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 connector (female), and coupling (male)		373289-xx	801149-xx	–
Complete with connector (female) and D-sub connector (female), 15-pin, for TNC (position input)		533627-xx	–	332115-xx
Complete with connector (female) and D-sub connector (female), 25-pin, for TNC (speed input)		*641926-xx*	–	*336376-xx*
Complete with connector and D-sub connector (male), 15-pin, for IK 215, PWM 20, EIB 74x, etc.		524599-xx	801129-xx	324544-xx
Complete with right-angle connector (female) and D-sub connector (male), 15-pi, for IK 215, PWM 20, EIB 74x 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

Connecting cables Fanuc
Mitsubishi
Siemens

		Cable	Fanuc	Mitsubishi
PUR connecting cable for M23 connecting elements				
Complete With M23 connector (female) 17-pin and Fanuc connector [(2 x 2 x 0.14 mm^2) + (4 x 1 mm^2)]; A_P = 1 mm^2		Ø 8 mm	534855-xx	–
Complete With M23 connector (female), 17-pin and 20-pin Mitsubishi connector [(2 x 2 x 0.14 mm^2) + (4 x 0.5 mm^2)]; A_P = 0.5 mm^2	 20-pin	Ø 6 mm	–	367958-xx
Complete With M23 connector (female), 17-pin and 10-pin Mitsubishi connector [(2 x 2 x 0.14 mm^2) + (4 x 1 mm^2)]; A_P = 1 mm^2	 10-pin	Ø 8 mm	–	573661-xx
Cable only [(2 x 2 x 0.14 mm^2) + (4 x 1 mm^2)]; A_P = 1 mm^2		Ø 8 mm	816327-xx	

		Cable	Fanuc	Mitsubishi
PUR connecting cable for M12 connecting element [(1 x 4 x 0.14 mm^2) + (4 x 0.34 mm^2)]; A_P = 0.34 mm^2				
Complete M12 connector (female), 8-pin and Fanuc connector		Ø 6 mm	646807-xx	–
Complete With M12 connector (female), 8-pin, and 20-pin Mitsubishi connector	 20-pin	Ø 6 mm	–	646806-xx
Complete with M12 connector (female), 8-pin 10-pin Mitsubishi connector	 10-pin	Ø 6 mm	–	647314-xx

		Cable	Siemens
PUR connecting cable for M12 connecting element [2(2 x 0.17 mm^2) + (2 x 0.24 mm^2)]; A_P = 0.24 mm^2			
Complete with M12 connector (female), 8-pin, and M12 coupling (male), 8-pin		Ø 6.8 mm	822504-xx
Complete with M12 connector (female), 8-pin, and Siemens RJ45 connector (IP67), cable length 1 m		Ø 6.8 mm	1094652-01
Complete With M12 connector (female), 8-pin, and Siemens RJ45 connector (IP20)		Ø 6.8 mm	1093042-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

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 3391 Y**
PROFIBUS-DP	1	EnDat 2.1; EnDat 2.2	1	Top-hat rail design	–	**PROFIBUS Gateway**

Switchable

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

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).

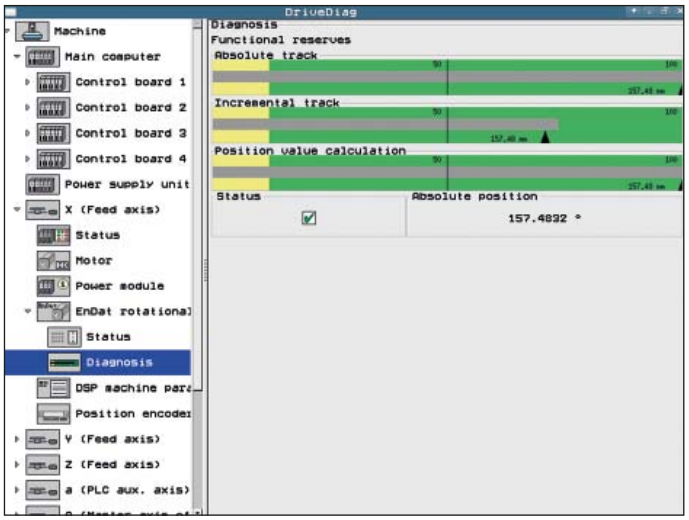
Absolute encoders operate with serial data transfer. Depending on the interface, additional 1 V_{PP} incremental signals can be output. The signals are monitored comprehensively within the encoder. The monitoring result (especially with valuation numbers) can be transferred along with the position values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

- Error message: Position value 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

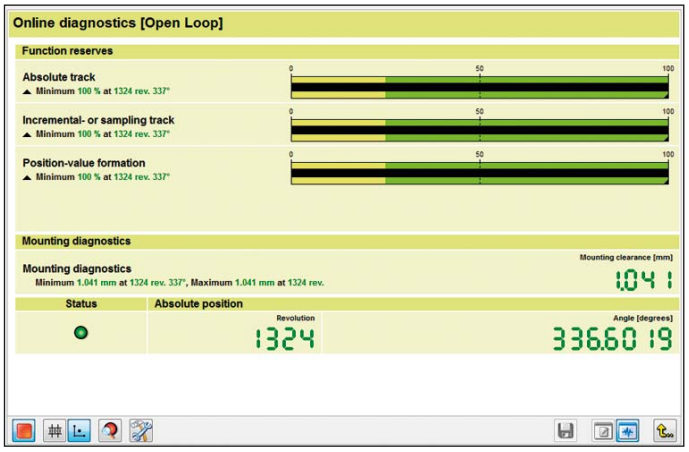
This enables the subsequent electronics to evaluate the current status of the encoder with little effort even in closed-loop mode.

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:

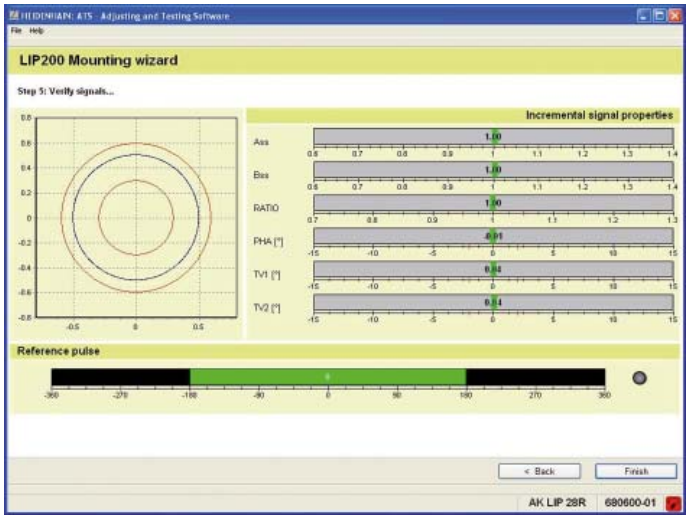
- Encoder diagnostics: The encoder is connected directly to the test or inspection device. This makes a comprehensive analysis of encoder functions possible.
- Diagnostics in the control loop: The PWM phase meter is looped into the closed control loop (e.g., through a suitable testing adapter). This 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 21 and ATS software



Commissioning using PWM 21 and ATS software

PWM 21
The PWM 21 phase angle measuring unit serves together with the provided ATS adjusting and testing software for diagnosis and adjustment of HEIDENHAIN encoders.

For more information, refer to the Product Information document *PWM 21/ ATS Software*.

	PWM 21
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, LIP200, LIC 4000 and others • Additional functions (if supported by the encoder) • Memory contents
System requirements and recommendations	PC (dual-core processor > 2 GHz) RAM > 2 GB Operating systems: Windows Vista (32-bit), 7, 8, and 10 (32-bit/64-bit) 500 MB free space on hard disk

PWT 100
The PWT 100 is a testing device for checking the function and adjustment of incremental and absolute HEIDENHAIN encoders. Thanks to its compact dimensions and robust design, the PWT 100 is ideal for mobile use.

	PWT 100
Encoder input Only for HEIDENHAIN encoders	• EnDat • Fanuc Serial Interface • Mitsubishi high speed interface • Panasonic Serial Interface • Yaskawa Serial Interface • 1 V_{PP} • 11 μA_{PP} • TTL
Display	4.3″ color flat-panel display (touch screen)
Voltage supply	DC 24 V Power consumption (max.): 15 W
Operating temperature	0 °C to 40 °C
Protection EN 60 529	IP20
Dimensions	≈ 145 mm x 85 mm x 35 mm

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