



**HEIDENHAIN**



## **Rotary Encoders**

October 2016

### 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
  - Angle encoders with integral bearing
  - Angle encoders without integral bearing
  - Modular magnetic encoders
  - Linear encoders for numerically controlled machine tools
  - Exposed linear encoders
  - Interface electronics
  - HEIDENHAIN controls
  - Interfaces of HEIDENHAIN Encoders
- is available upon request as well as on the Internet at [www.heidenhain.de](http://www.heidenhain.de).

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

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

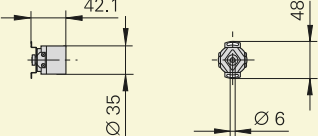
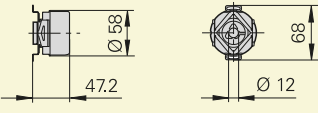
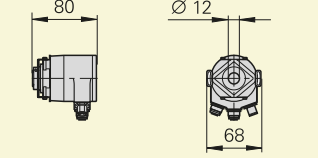
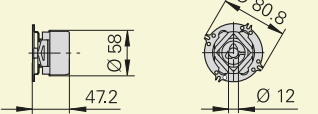
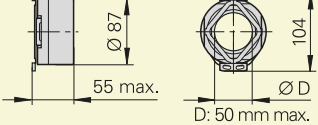
*Standards (ISO, EN, etc.) apply only where explicitly stated in the catalog.*

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# Selection guide

## Rotary encoders for standard applications



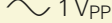
Rotary Encoders	Absolute Singleturn				Multiturn 4096 revolutions	
	Interface	EnDat	Fanuc Mitsubishi Siemens	SSI	PROFIBUS-DP PROFINET IO	EnDat
<b>With mounted stator coupling</b>						
<b>ECN/EQN/ERN 1000 series</b> 	<b>ECN 1023</b> Positions/rev: 23 bits EnDat 2.2/22  <b>ECN 1013</b> Positions/rev: 13 bits EnDat 2.2/01	–	<b>ECN 1013</b> Positions/rev: 13 bits	–	<b>EQN 1035</b> Positions/rev: 23 bits EnDat 2.2/22  <b>EQN 1025</b> Positions/rev: 13 bits EnDat 2.2/01	–
<b>ECN/EQN/ERN 400 series</b> 	<b>ECN 425</b> Positions/rev: 25 bits EnDat 2.2/22  <b>ECN 413</b> Positions/rev: 13 bits EnDat 2.2/01	<b>ECN 425 F</b> Positions/rev: 25 bits Fanuc $\alpha$  <b>ECN 425 M</b> Positions/rev: 25 bits Mitsubishi  <b>ECN 424 S</b> Positions/rev: 24 bits DRIVE-CLiQ	<b>ECN 413</b> Positions/rev: 13 bits	–	<b>EQN 437</b> Positions/rev: 25 bits EnDat 2.2/22  <b>EQN 425<sup>3)</sup></b> Positions/rev: 13 bits EnDat 2.2/01	<b>EQN 437 F</b> Positions/rev: 25 bits Fanuc $\alpha$  <b>EQN 435 M</b> Positions/rev: 23 bits Mitsubishi  <b>EQN 436 S</b> Positions/rev: 24 bits DRIVE-CLiQ
<b>ECN/EQN 400 series with fieldbus</b> 	–	–	–	<b>ECN 413</b> Positions/rev: 13 bits	–	–
<b>ECN/EQN/ERN 400 series with universal stator coupling</b> 	<b>ECN 425</b> Positions/rev: 25 bits EnDat 2.2/22  <b>ECN 413</b> Positions/rev: 13 bits EnDat 2.2/01	–	<b>ECN 413</b> Positions/rev: 13 bits	–	<b>EQN 437</b> Positions/rev: 25 bits EnDat 2.2/22  <b>EQN 425</b> Positions/rev: 13 bits EnDat 2.2/01	–
<b>ECN/ERN 100 series</b> 	<b>ECN 125</b> Positions/rev: 25 bits EnDat 2.2/22  <b>ECN 113</b> Positions/rev: 13 bits EnDat 2.2/01	–	–	–	–	–

<sup>1)</sup> Up to 36000 signal periods through integrated 5/10-fold interpolation (higher interpolation available on request)

<sup>2)</sup> Voltage supply: DC 9 V to 30 V

<sup>3)</sup> Also available with TTL or HTL signal transmission

DRIVE-CLiQ is a registered trademark of SIEMENS AG.

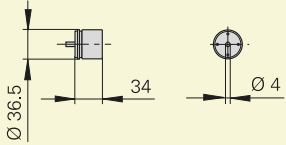
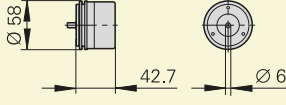
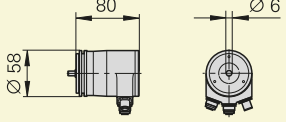
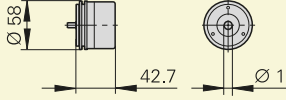
		Incremental		
SSI	PROFIBUS-DP PROFINET IO	 TTL	 HTL	 1 V <sub>PP</sub>

<b>EQN 1025</b> Positions/rev: 13 bits	–	<b>ERN 1020</b> 100 to 3600 lines  <b>ERN 1070</b> 1000/2500( 3600 lines	<b>ERN 1030</b> 100 to 3600 lines	<b>ERN 1080</b> 100 to 3600 lines	 <b>30</b>
<b>EQN 425<sup>3)</sup></b> Positions/rev: 13 bits	–	<b>ERN 420</b> 250 to 5000 lines  <b>ERN 460<sup>2)</sup></b> 250 to 5000 lines	<b>ERN 430</b> 250 to 5000 lines	<b>ERN 480</b> 1000 to 5000 lines	 <b>34</b>
–	<b>EQN 425</b> Positions/rev: 13 bits	–	–	–	 <b>44</b>
<b>EQN 425</b> Positions/rev: 13 bits	–	<b>ERN 420</b> 250 to 5000 lines  <b>ERN 460<sup>2)</sup></b> 250 to 5000 lines	<b>ERN 430</b> 250 to 5000 lines	<b>ERN 480</b> 1000 to 5000 lines	 <b>46</b>
–	–	<b>ERN 120</b> 1000 to 5000 lines	<b>ERN 130</b> 1000 to 5000 lines	<b>ERN 180</b> 1000 to 5000 lines	 <b>50</b>

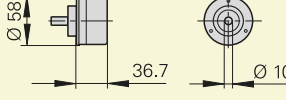
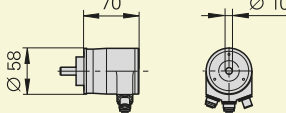
# Rotary encoders for standard applications

Rotary encoders	Absolute Singleturn				Multiturn 4096 revolutions	
	Interface	EnDat	Fanuc Mitsubishi Siemens	SSI	PROFIBUS-DP PROFINET IO	EnDat

## For separate shaft coupling, with synchro flange

<b>ROC/ROQ/ROD 1000 series</b> 	<b>ROC 1023</b> Positions/rev: 23 bits EnDat 2.2/22  <b>ROC 1013</b> Positions/rev: 13 bits EnDat 2.2/01	–	<b>ROC 1013</b> Positions/rev: 13 bits	–	<b>ROQ 1035</b> Positions/rev: 23 bits EnDat 2.2/22  <b>ROQ 1025</b> Positions/rev: 13 bits EnDat 2.2/01	–
Series <b>ROC/ROQ/ROD 400</b> <b>RIC/RIQ 400</b> With synchro flange 	<b>ROC 425</b> Positions/rev: 25 bits EnDat 2.2/22 <b>Functional safety</b> upon request <b>ROC 413</b> Positions/rev: 13 bits EnDat 2.2/01 <b>RIC 418</b> Positions/rev: 18 bits EnDat 2.1/01	<b>ROC 425 F</b> Positions/rev: 25 bits Fanuc $\alpha$ <b>ROC 425 M</b> Positions/rev: 25 bits Mitsubishi <b>ROC 424 S</b> Positions/rev: 24 bits DRIVE-CLiQ <b>Functional safety</b> upon request	<b>ROC 413</b> Positions/rev: 13 bits	–	<b>ROQ 437</b> Positions/rev: 25 bits EnDat 2.2/22 <b>Functional safety</b> upon request <b>ROQ 425</b> Positions/rev: 13 bits EnDat 2.2/01 <b>RIQ 430</b> Positions/rev: 18 bits EnDat 2.1/01	<b>ROQ 437 F</b> Positions/rev: 25 bits Fanuc $\alpha$ <b>ROQ 435 M</b> Positions/rev: 23 bits Mitsubishi <b>ROQ 436 S</b> Positions/rev: 24 bits DRIVE-CLiQ <b>Functional safety</b> upon request
<b>ROC/ROQ 400 series</b> with fieldbus 	–	–	–	<b>ROC 413</b> Positions/rev: 13 bits	–	–
<b>ROC 425</b> For high accuracy 	<b>ROC 425</b> Positions/rev: 25 bits EnDat 2.2/01	–	–	–	–	–

## For separate shaft coupling, with clamping flange

Series <b>ROC/ROQ/ROD 400</b> <b>RIC/RIQ 400</b> With clamping flange 	<b>ROC 425</b> Positions/rev: 25 bits EnDat 2.2/22 <b>Functional safety</b> upon request <b>ROC 413</b> Positions/rev: 13 bits EnDat 2.2/01 <b>RIC 418</b> Positions/rev: 18 bits EnDat 2.1/01	<b>ROC 425 F</b> Positions/rev: 25 bits Fanuc $\alpha$ <b>ROC 425 M</b> Positions/rev: 25 bits Mitsubishi <b>ROC 424 S</b> Positions/rev: 24 bits DRIVE-CLiQ <b>Functional safety</b> upon request	<b>ROC 413</b> Positions/rev: 13 bits	–	<b>ROQ 437</b> Positions/rev: 25 bits EnDat 2.2/22 <b>Functional safety</b> upon request <b>ROQ 425<sup>4)</sup></b> Positions/rev: 13 bits EnDat 2.2/01 <b>RIQ 430</b> Positions/rev: 18 bits EnDat 2.1/01	<b>ROQ 437 F</b> Positions/rev: 25 bits Fanuc $\alpha$ <b>ROQ 435 M</b> Positions/rev: 23 bits Mitsubishi <b>ROQ 436 S</b> Positions/rev: 24 bits DRIVE-CLiQ <b>Functional safety</b> upon request
<b>ROC/ROQ 400 series</b> with fieldbus 	–	–	–	<b>ROC 413</b> 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 available on request)

3) Voltage supply: DC 9V to 30V

4) Also available with TTL or HTL signal transmission

		<b>Incremental</b>		
SSI	PROFIBUS-DP PROFINET IO			

<b>ROQ 1025</b> Positions/rev: 13 bits	–	<b>ROD 1020</b> 100 to 3600 lines  <b>ROD 1070</b> 1000/2500 <sup>1)</sup> 3600 lines <sup>2)</sup>	<b>ROD 1030</b> 100 to 3600 lines	<b>ROD 1080</b> 100 to 3600 lines
<b>ROQ 425</b> Positions/rev: 13 bits	–	<b>ROD 426</b> 50 to 5000 lines <sup>1)</sup>  <b>ROD 466</b> <sup>3)</sup> 50 to 5000 lines <sup>2)</sup>	<b>ROD 436</b> 50 to 5000 lines	<b>ROD 486</b> 1000 to 5000 lines
–	<b>ROQ 425</b> <sup>4)</sup> Positions/rev: 13 bits	–	–	–
–	–	–	–	–



**52**



**56**



**66**



**68**



**70**

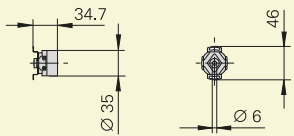
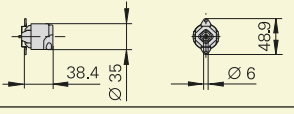
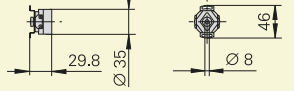
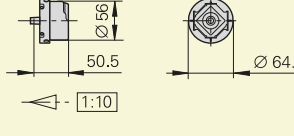
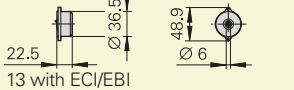
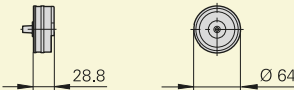
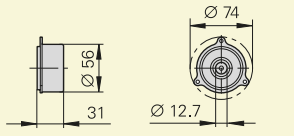
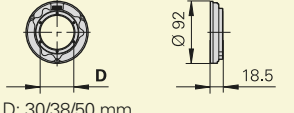
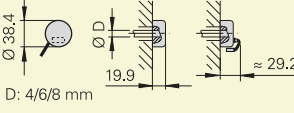


**76**

<b>ROQ 425</b> Positions/rev: 13 bits	–	<b>ROD 420</b> 50 to 5000 lines	<b>ROD 430</b> 50 to 5000 lines	<b>ROD 480</b> 1000 to 5000 lines
–	<b>ROQ 425</b> Positions/rev: 13 bits	–	–	–




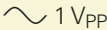
# Rotary encoders for motors

Rotary encoders	Absolute Singleturn		Multiturn	
	Interface	EnDat	EnDat	
<b>With integral bearing and mounted stator coupling</b>				
<b>ERN 1023</b> IP64 	–	–	–	–
<b>ECN/EQN 1100 series</b> 	<b>ECN 1123</b> Positions/rev: 23 bits EnDat 2.2/22 <b>Functional safety</b> upon request	<b>ECN 1113</b> Positions/rev: 13 bits EnDat 2.2/01	<b>EQN 1135</b> Positions/rev: 23 bits 4096 revolutions EnDat 2.2/22 <b>Functional safety</b> upon request	<b>EQN 1125</b> Positions/rev: 13 bits 4096 revolutions EnDat 2.2/01
<b>ERN 1123</b> IP00 	–	–	–	–
<b>ECN/EQN/ERN 1300 series</b> IP40 <b>ECN/EQN/ERN 400 series</b> IP64 	<b>ECN 1325</b> Positions/rev: 25 bits EnDat 2.2/22 <b>Functional safety</b> upon request <b>ECN 425</b> Positions/rev: 25 bits EnDat 2.2/22 <b>Functional safety</b> upon request	<b>ECN 1313</b> Positions/rev: 13 bits EnDat 2.2/01 <b>ECN 413</b> Positions/rev: 13 bits EnDat 2.2/01	<b>EQN 1337</b> Positions/rev: 25 bits 4096 revolutions EnDat 2.2/22 <b>Functional safety</b> upon request <b>EQN 437</b> Positions/rev: 25 bits 4096 revolutions EnDat 2.2/22 <b>Functional safety</b> upon request	<b>EQN 1325</b> Positions/rev: 13 bits 4096 revolutions EnDat 2.2/01 <b>EQN 425</b> Positions/rev: 13 bits 4096 revolutions EnDat 2.2/01
<b>Without integral bearing</b>				
<b>ECI/EQI/EBI 1100 series</b> 	<b>ECI 1118</b> Positions/rev: 18 bits EnDat 2.2/22	<b>ECI 1119</b> Positions/rev: 19 bits EnDat 2.2/22 <b>Functional safety</b> upon request	<b>EBI 1135</b> Positions/rev: 18 bits 65536 revolutions (buffer battery backup) EnDat 2.2/22	<b>EQI 1131</b> Positions/rev: 19 bits 4096 revolutions EnDat 2.2/22 <b>Functional safety</b> upon request
<b>ECI/EQI 1300 series</b> 	–	<b>ECI 1319</b> Positions/rev: 19 bits EnDat 2.2/01	–	<b>EQI 1331</b> Positions/rev: 19 bits 4096 revolutions EnDat 2.2/01
<b>ECI/EQI 1300 series</b> 	<b>ECI 1319</b> Positions/rev: 19 bits EnDat 2.2/22 <b>Functional safety</b> upon request	–	<b>EQI 1331</b> Positions/rev: 19 bits 4096 revolutions EnDat 2.2/22 <b>Functional safety</b> upon request	–
<b>ECI/EBI 100 series</b> 	<b>ECI 119</b> Positions/rev: 19 bits EnDat 2.2/22 or EnDat 2.1/01	–	<b>EBI 135</b> Positions/rev: 19 bits 65536 revolutions (buffer battery backup) EnDat 2.2/22	–
<b>ERO 1400 series</b> 	–	–	–	–

<sup>1)</sup> 8192 signal periods through integrated 2-fold interpolation

<sup>2)</sup> Up to 37500 signal periods through integrated 5/10/20/25-fold interpolation

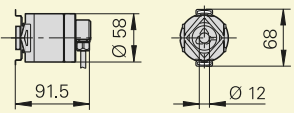
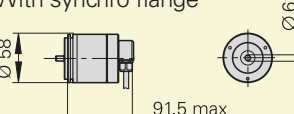
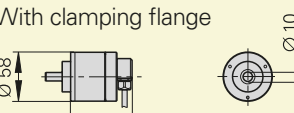
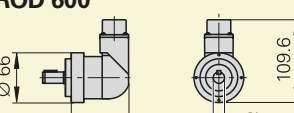
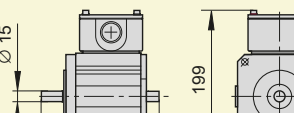
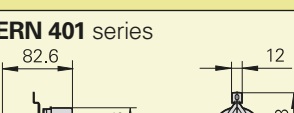
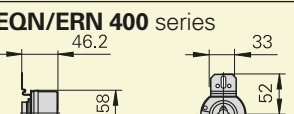
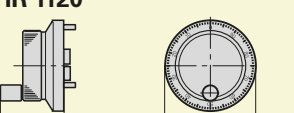




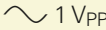
<b>Incremental</b>	
	
<b>ERN 1023</b> 500 to 8192 lines 3 signals for block commutation	-
-	-
<b>ERN 1123</b> 500 to 8192 lines 3 signals for block commutation	-
<b>ERN 1321</b> 1024 to 4096 lines <b>ERN 1326</b> 1024 to 4096 lines <sup>1)</sup> 3 TTL signals for block commutation <b>ERN 421</b> 1024 to 4096 lines	<b>ERN 1381</b> 512 to 4096 lines <b>ERN 1387</b> 2048 lines Z1 track for sine commutation <b>ERN 487</b> 2048 lines Z1 track for sine commutation
-	-
-	-
-	-
-	-
<b>ERO 1420</b> 512 to 1024 lines <b>ERO 1470</b> <sup>2)</sup> 1000/1500 lines	<b>ERO 1480</b> 512 to 1024 lines

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



# Rotary encoders for special applications

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

<b>Incremental</b>			
			
<b>ERN 420</b> 1000 to 5000 lines	<b>ERN 430</b> 1000 to 5000 lines	<b>ERN 480</b> 1000 to 5000 lines	
<b>ROD 426</b> 1000 to 5000 lines	<b>ROD 436</b> 1000 to 5000 lines	<b>ROD 486</b> 1000 to 5000 lines	
<b>ROD 420</b> 1000 to 5000 lines	<b>ROD 430</b> 1000 to 5000 lines	<b>ROD 480</b> 1000 to 5000 lines	
<b>ROD 620</b> 512 to 5000 lines	<b>ROD 630</b> 512 to 5000 lines		
-	<b>ROD 1930</b> 600 to 2400 lines		
<b>ERN 421</b> 1024 Lines	<b>ERN 431</b> 1024 Lines	-	
<b>ERN 420</b> 1024 Lines	<b>ERN 430</b> 1024 Lines	-	
<b>HR 1120</b> 100 lines	-	-	

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



78



80

You will find these rotary encoders in the catalog  
**Encoders for servo drives**



82

# 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 fabricated 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 a precondition 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 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 at the same time is used to generate an optional incremental signal.

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



Circular graduations of absolute rotary encoders

With the **incremental measuring method**, the graduation consists of a periodic grating structure. The position information is obtained **by counting** the individual increments (measuring steps) from some point of origin. Since an absolute reference is required to ascertain positions, the 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

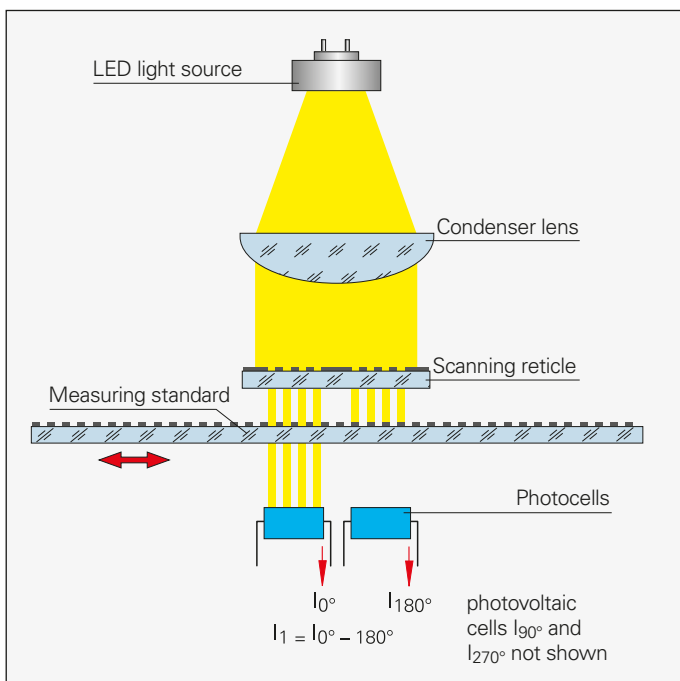
### Photoelectric scanning principle

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 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.



Photoelectric scanning according to the imaging scanning principle

The absolute rotary encoders with optimized scanning have a single large photo-sensor 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.

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

$$\pm \frac{18^\circ \text{ mech.} \cdot 3600}{\text{Line count } z} \text{ [angular seconds]}$$

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 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 encoders with tapered shaft are particularly suitable for repeated mounting (see *Encoders for Servo Drives* catalog). 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 outside to the motor cover.

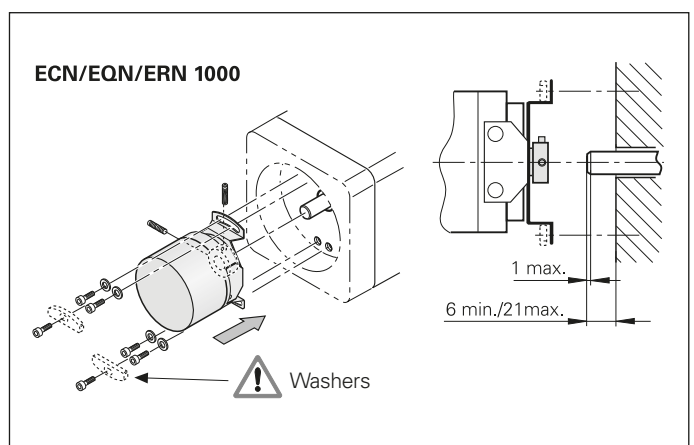
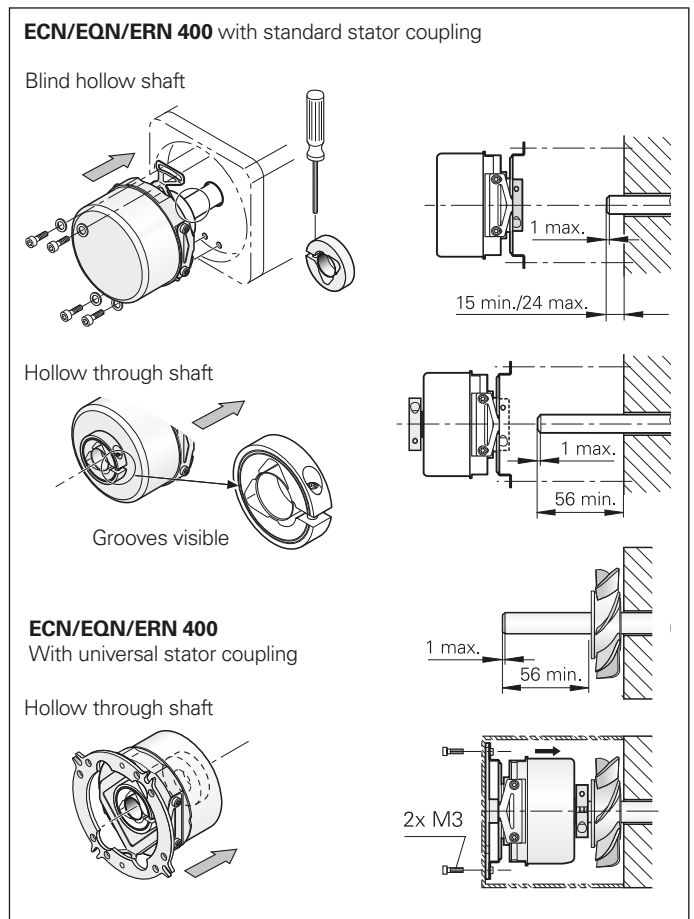
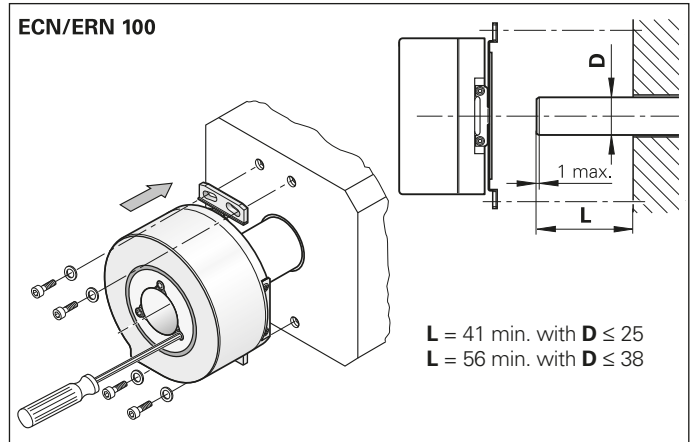
Dynamic applications require the highest possible natural frequencies  $f_N$  of the system. (see also *General mechanical information*). These are achieved by connecting the shafts on the flange side and fastening the coupling by four screws or, on the ECN/EQN/ERN 1000, with special washers.

Natural frequency  $f_N$  with coupling fastened by 4 screws

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

<sup>1)</sup> Also when fastening by two screws

<sup>2)</sup> Also when fastening by two screws and washers

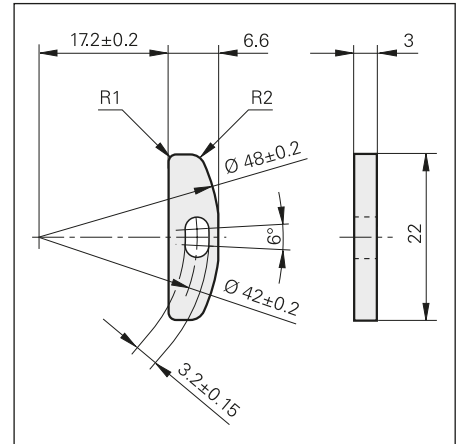




## Mounting accessories

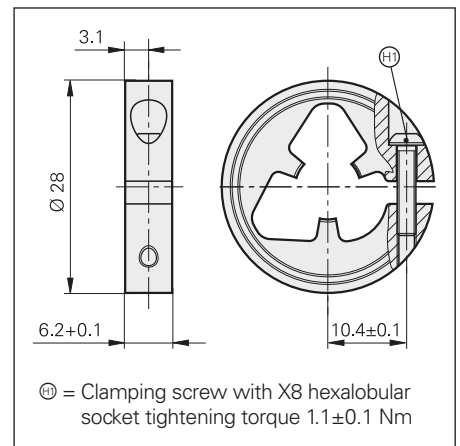
### Washer

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



### Shaft clamp 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



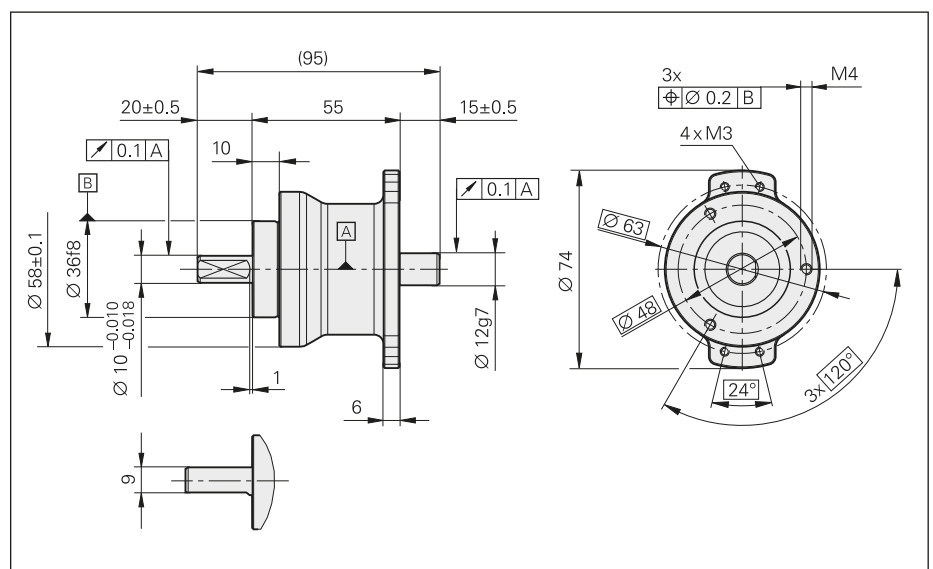
If the encoder shaft is subject to **high loads** for example from friction wheels, pulleys or sprockets, HEIDENHAIN recommends mounting the ECN/EQN/ERN 400 with a bearing assembly.

### Bearing assembly

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

	Bearing assembly
<b>Permissible speed n</b>	≤ 6000 rpm
<b>Shaft load</b>	Axial: 150 N; radial: 350 N
<b>Operating temperature</b>	-40 °C to 100 °C
<b>Protection (EN 60529)</b>	IP 64

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 stub 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 19 for both).





**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  $\pm 6\%$   
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) <sup>1)</sup>	350378-14	
TX8	89 mm	350378-11
	152 mm	350378-12
TX15	70 mm	756768-42



<sup>1)</sup> For screws as per DIN 6912 (low head screw 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*).

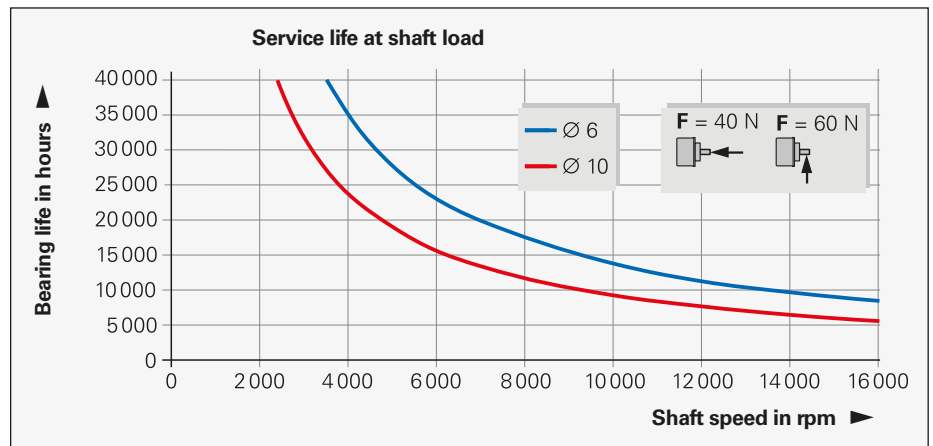
ROC/ROQ/ROD 400, RIC/RIQ 400 and ROD 600 series rotary encoders permit high bearing loads (see diagram).

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.



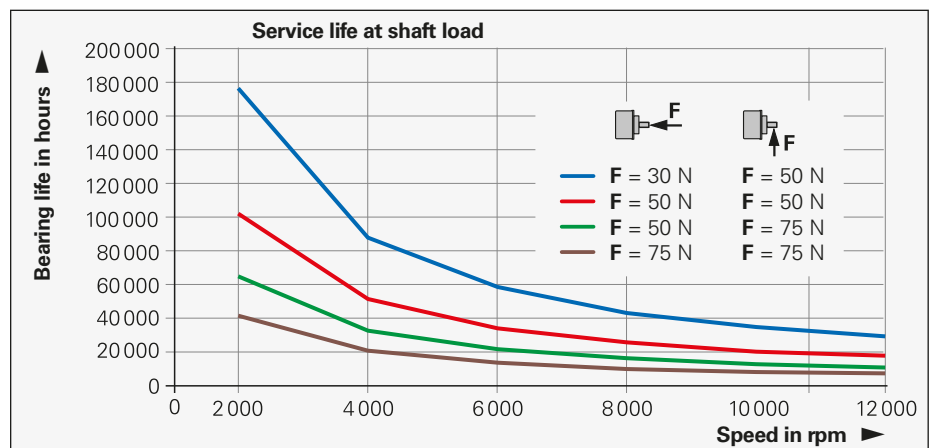
## Bearing service life of ROC/ROQ/ROD 400 and RIC/RIQ 400

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.



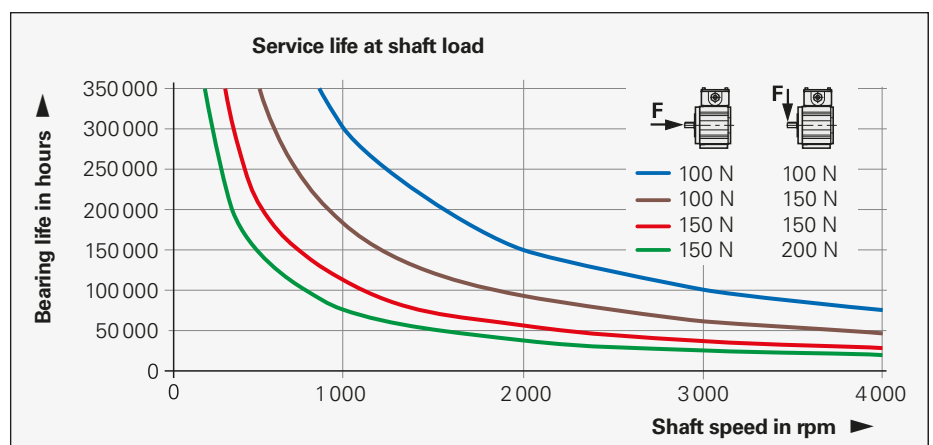
## Bearing service life of ROD 600

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.



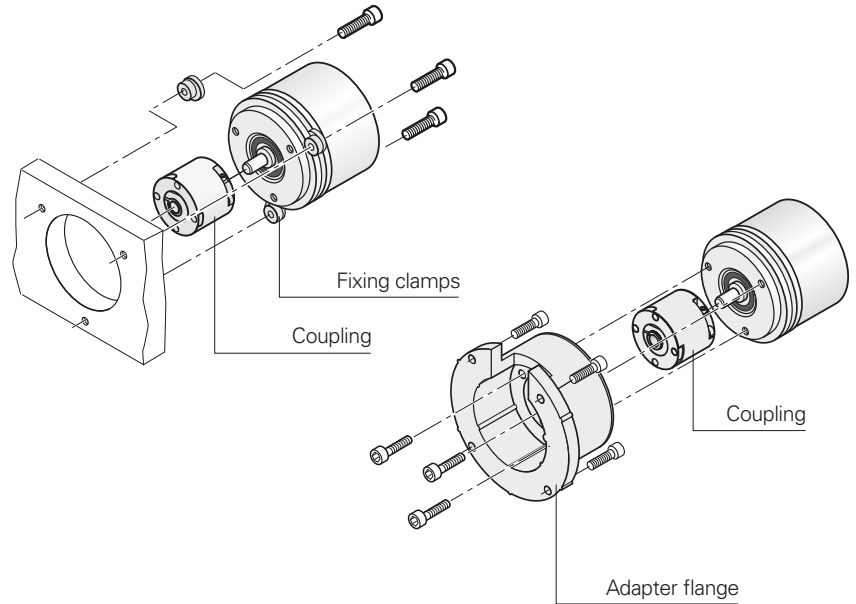
## Rotary encoders with synchro flange

### 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.

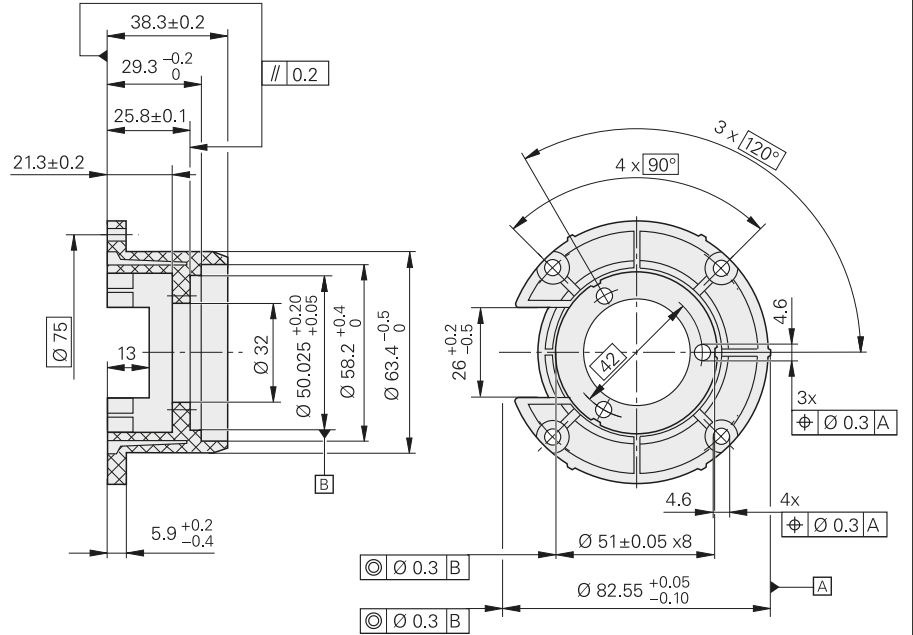
### Rotary encoders with synchro flange



### Mounting accessories

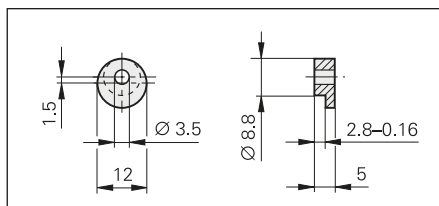
#### Adapter flange

(electrically non-conductive)  
ID 257044-01



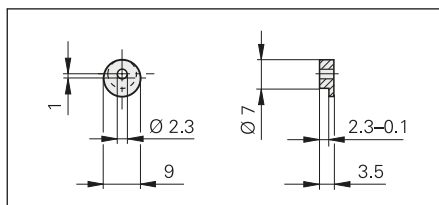
#### Fixing clamps

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

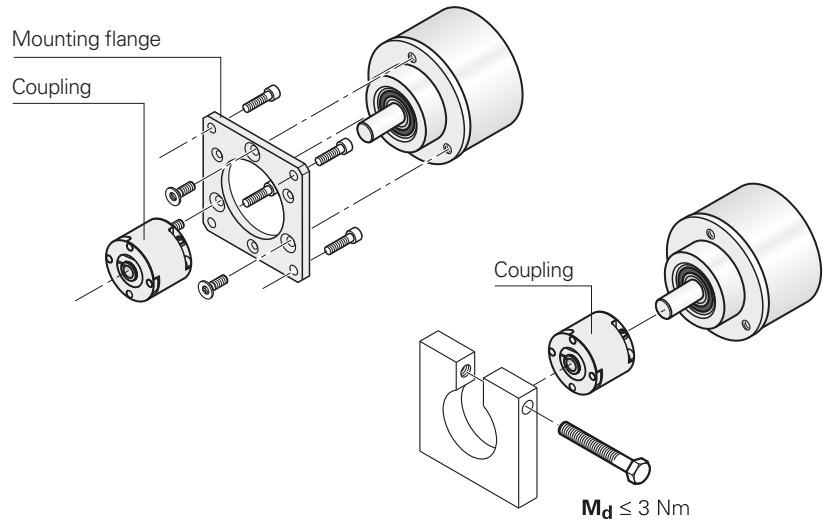
### Mounting

- 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.

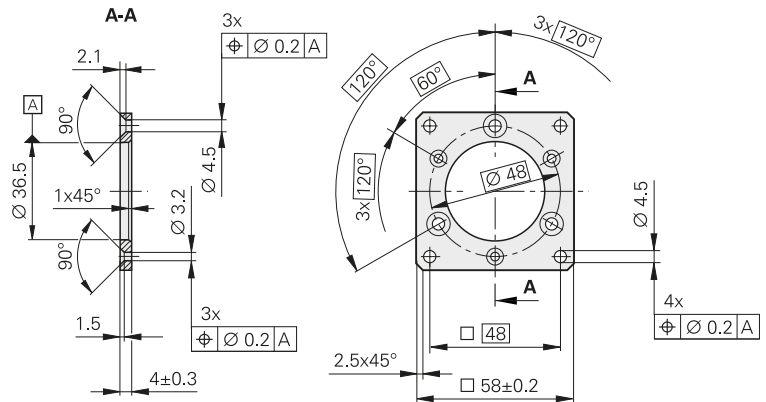
### ROC/ROQ/ROD 400 with clamping flange



### Mounting accessories

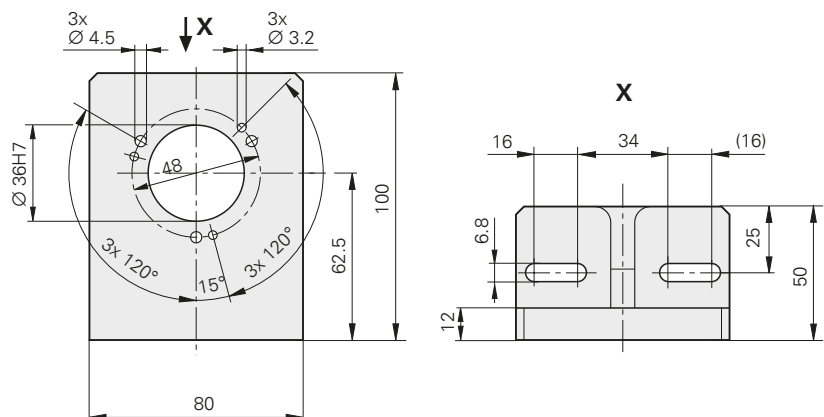
#### Mounting flange

ID 201437-01



#### Mounting bracket

ID 581296-01



## Rotary encoder mounted by flange/base

### Mounting

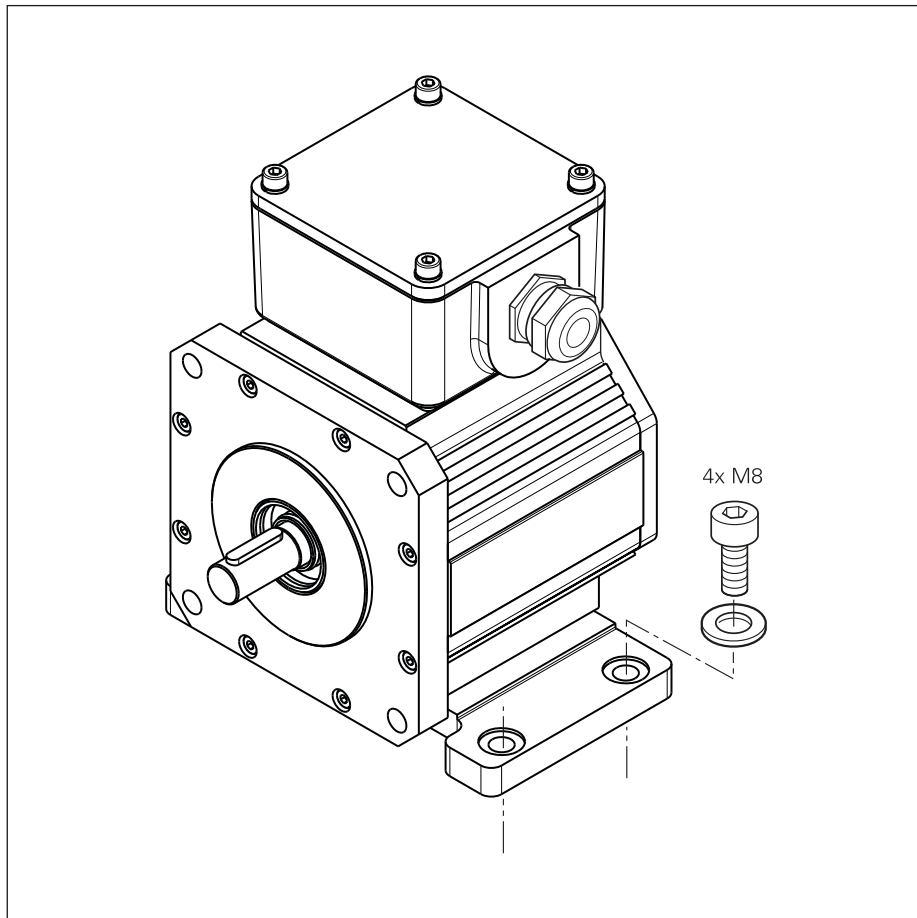
- By the flange, or
- on a base

The encoder is fastened by four M8 screws.

The terminal box can be mounted in 90° offsets.

### Shaft coupling

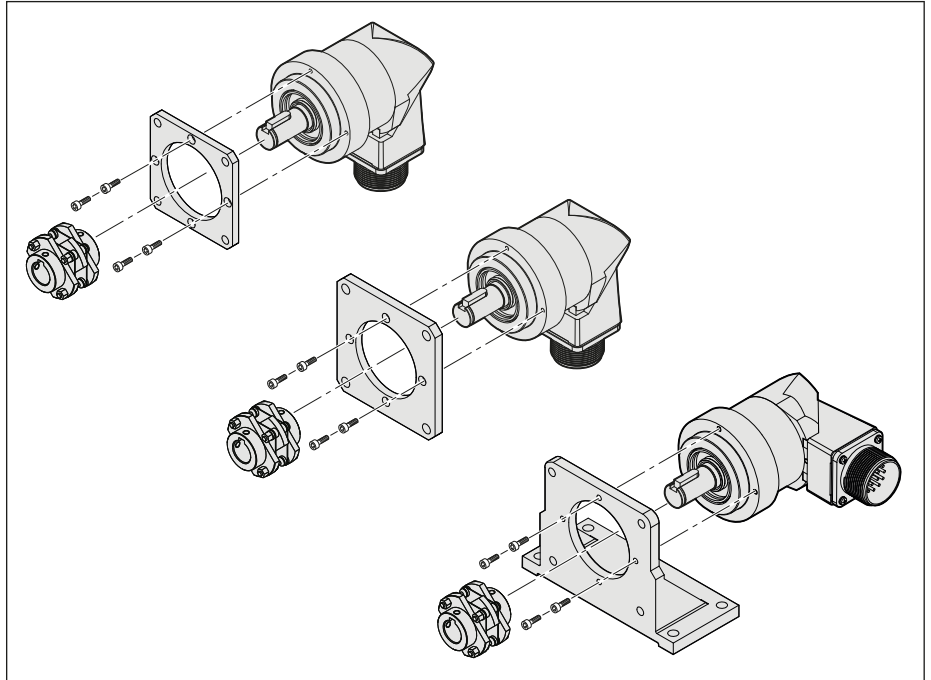
The encoder shaft features a machine key for optimum torque transmission. The C19 and C 212 couplings provided as accessories feature an appropriate holder.



## ROD 600 rotary encoder with clamping flange

### Mounting

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



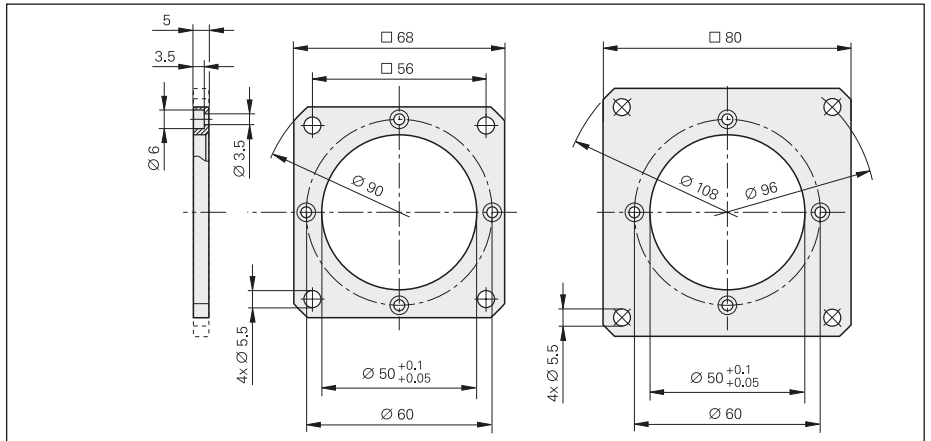
### Mounting accessories

#### Mounting flange, small

ID 728587-01

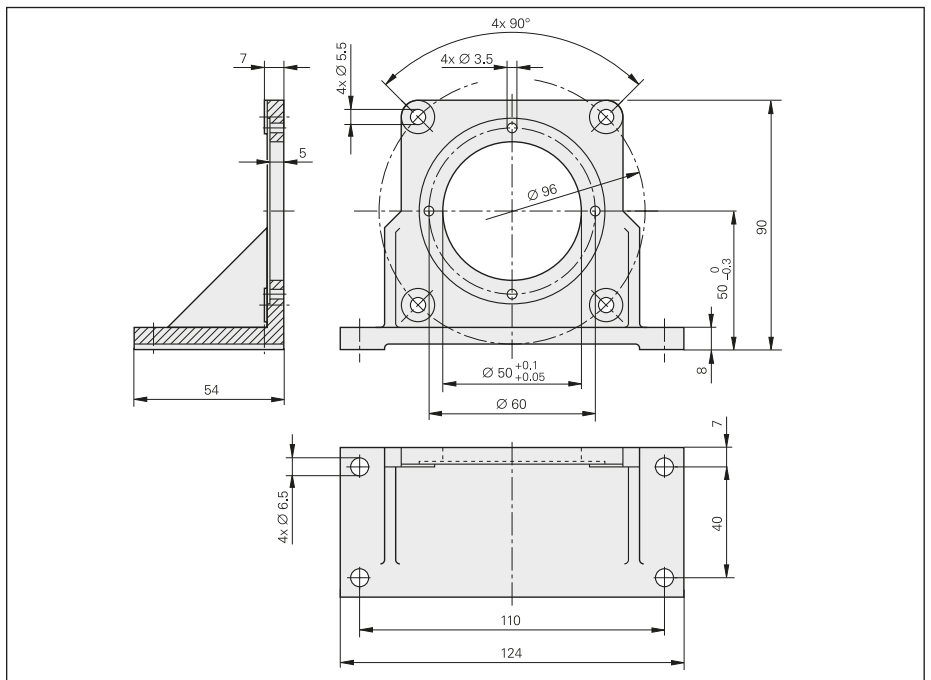
#### Mounting flange, large


ID 728587-02



#### Mounting bracket

ID 728587-03

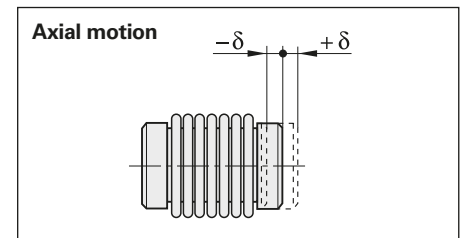
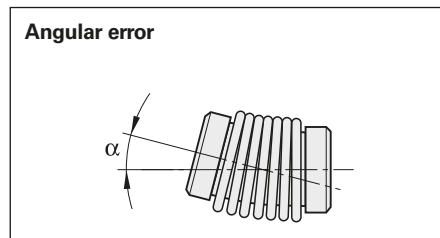
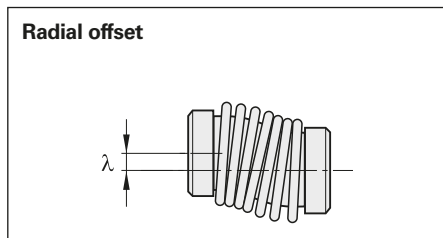


mm  
  
 Tolerancing ISO 8015  
 ISO 2768 - m H  
 < 6 mm: ±0.2 mm

# 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
<b>Hub bore</b>	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
<b>Galvanic isolation</b>	–	✓	✓	✓	–	✓	–
<b>Kinematic transfer error*</b>	±6"	±10"			±13"		±40"
<b>Torsional rigidity</b>	500 $\frac{\text{Nm}}{\text{rad}}$	150 $\frac{\text{Nm}}{\text{rad}}$	200 $\frac{\text{Nm}}{\text{rad}}$	300 $\frac{\text{Nm}}{\text{rad}}$	1700 $\frac{\text{Nm}}{\text{rad}}$		60 $\frac{\text{Nm}}{\text{rad}}$
<b>Torque</b>	≤ 0.2 Nm	≤ 0.1 Nm		≤ 0.2 Nm	≤ 3.9 Nm	≤ 5 Nm	≤ 0.1 Nm
<b>Radial offset <math>\lambda</math></b>	≤ 0.2 mm	≤ 0.5 mm			≤ 0.3 mm		≤ 0.2 mm
<b>Angular error <math>\alpha</math></b>	≤ 0.5°	≤ 1°		≤ 1.5°		≤ 0.5°	
<b>Axial motion <math>\delta</math></b>	≤ 0.3 mm	≤ 0.5 mm		≤ 1.7 mm		≤ 0.3 mm	
<b>Moment of inertia (approx.)</b>	$6 \cdot 10^{-6} \text{ kgm}^2$	$3 \cdot 10^{-6} \text{ kgm}^2$		$4 \cdot 10^{-6} \text{ kgm}^2$	$15 \cdot 10^{-6} \text{ kgm}^2$		$0.3 \cdot 10^{-6} \text{ kgm}^2$
<b>Permissible speed</b>	16000 rpm				20000 rpm	6000 rpm	12000 rpm
<b>Tightening torque of clamping screws (approx.)</b>	1.2 Nm				1.37 Nm		0.8 Nm
<b>Mass</b>	35 g	24 g	23 g	275 g	75 g		9 g

\* With radial misalignment  $\lambda = 0.1 \text{ mm}$ , angular error  $\alpha = 0.15 \text{ mm}$  over  $100 \text{ mm} \hat{=} 0.09^\circ$  to  $50^\circ \text{ C}$



## Mounting accessories

### Screwdriver bits

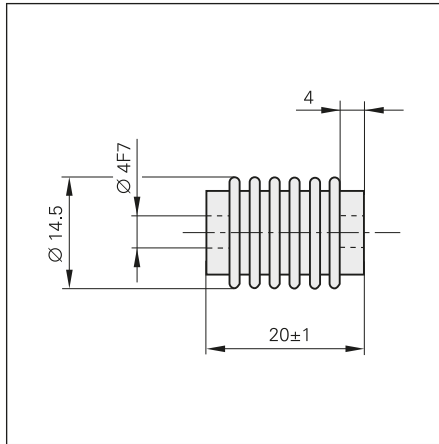
### Screwdriver

See page 16.



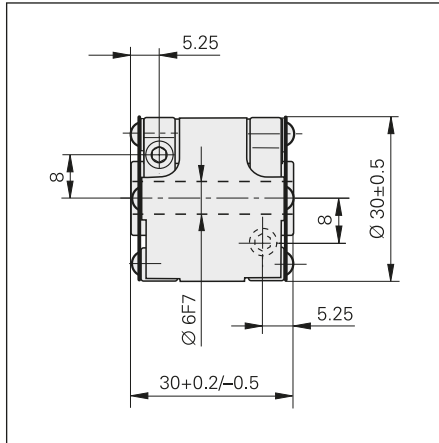
**Metal bellows coupling 18 EBN 3**

For ROC/ROQ/ROD 1000 series  
with **4 mm shaft diameter**  
ID 200393-02



**Diaphragm coupling K 14**

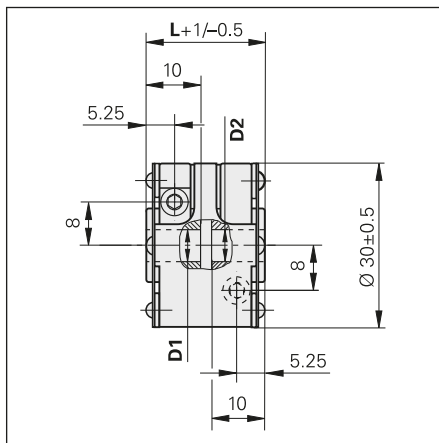
For ROC/ROQ/ROD 400 and  
RIC/RIQ 400 series  
with **6 mm shaft diameter**  
ID 293328-01



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



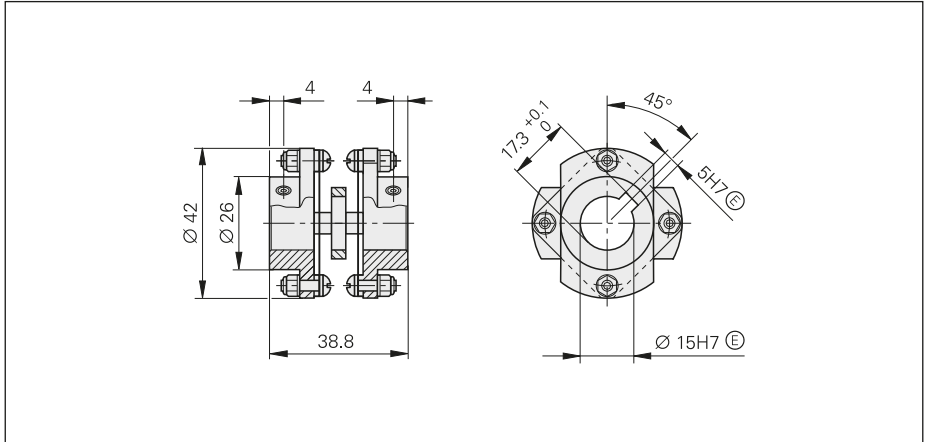
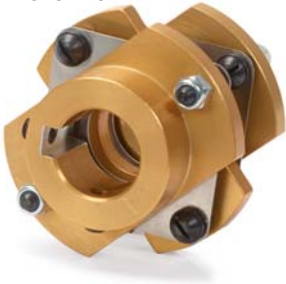
K 17 Variant	D1	D2	L
01	Ø 6 F7	Ø 6 F7	22 mm
02	Ø 6 F7	Ø 10 F7	22 mm
03	Ø 10 F7	Ø 10 F7	30 mm
04	Ø 10 F7	Ø 10 F7	22 mm
05	Ø 6 F7	Ø 9.52 F7	22 mm
06	Ø 5 F7	Ø 6 F7	22 mm

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

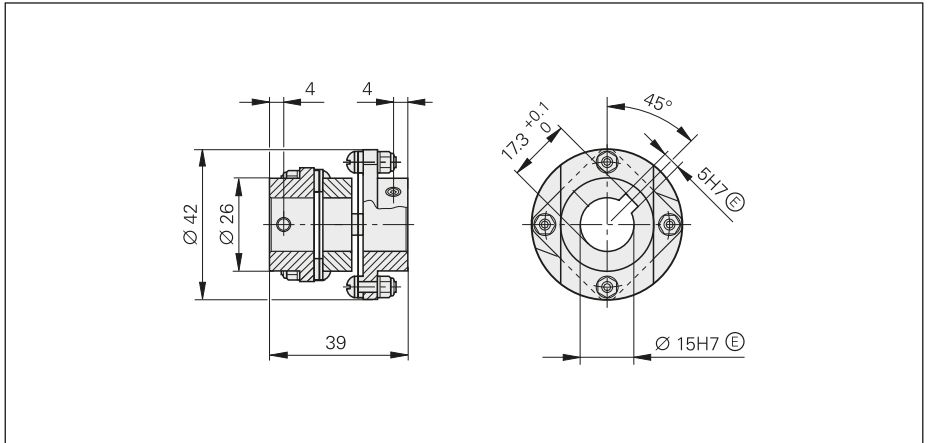
**Diaphragm coupling C 19**


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  $10^5 \text{ rad/s}^2$ . 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 %. 93 % is permissible temporarily. Condensation is not permissible.

## Magnetic fields

Magnetic fields > 30 mT can impair proper function of encoders. If required, please contact HEIDENHAIN, 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*).

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

$f_N$ : Natural frequency of the coupling in Hz  
C: Torsional rigidity of the coupling in Nm/rad

I: Moment of inertia of the rotor in  $\text{kgm}^2$

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

The **shaft inlet** provides protection to IP 64. 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 catalog regarding mounting are therefore provisional and not binding; they do not become terms of a contract.

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

### Rotary encoders with functional safety

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

Screw insertion and application of tightening torque must therefore take no longer than five minutes. The required strength is reached at room temperature after six hours. The curing time 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 $R_m$	$\geq 220$ N/mm <sup>2</sup>	$\geq 600$ N/mm <sup>2</sup>
Yield strength $R_{p,0.2}$ or yield point $R_e$	Not applicable	$\geq 400$ N/mm <sup>2</sup>
Shear strength $\tau_a$	$\geq 130$ N/mm <sup>2</sup>	$\geq 390$ N/mm <sup>2</sup>
Interface pressure $p_G$	$\geq 250$ N/mm <sup>2</sup>	$\geq 660$ N/mm <sup>2</sup>
Modulus of elasticity E (at 20 °C)	70 kN/mm <sup>2</sup> to 75 kN/mm <sup>2</sup>	200 kN/mm <sup>2</sup> to 215 kN/mm <sup>2</sup>
Coefficient of thermal expansion $\alpha_{\text{therm}}$ (at 20 °C)	$25 \cdot 10^{-6} \text{K}^{-1}$	$10 \cdot 10^{-6} \text{K}^{-1}$ to $17 \cdot 10^{-6} \text{K}^{-1}$
Surface roughness $R_z$	$\leq 16$ $\mu\text{m}$	
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 $\pm 6$ %	
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.

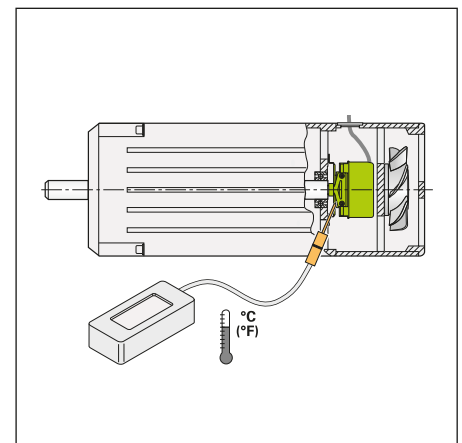
This table shows the approximate values of self-heating to be expected in the encoders. In the worst case, a combination of operating parameters can exacerbate self-heating, for example a 30 V power supply and maximum rotational speed. Therefore, the actual operating temperature should be measured directly 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 $n_{max}$

<i>Stub shaft/tapered shaft</i> <b>ROC/ROQ/ROD/ RIC/RIQ/ ExN 400/1300</b>	$\approx + 5$ K $\approx + 10$ K for IP66 protection
<b>ROD 600</b>	$\approx + 75$ K
<b>ROD 1900</b>	$\approx + 10$ K
<i>Blind hollow shaft</i> <b>ECN/EQN/ ERN 400/1300</b>	$\approx + 30$ K $\approx 40$ K for IP66 protection
<b>ECN/EQN/ ERN 1000</b>	$\approx + 10$ K
<i>Hollow through shaft</i> <b>ECN/ERN 100 ECN/EQN/ERN 400</b>	$\approx + 40$ K for IP64 protection $\approx 50$ 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 measuring systems

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

## Basic principle

HEIDENHAIN measuring systems for safety-related applications are tested for compliance with EN ISO 13849-1 (successor to EN 954-1) as well as EN 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

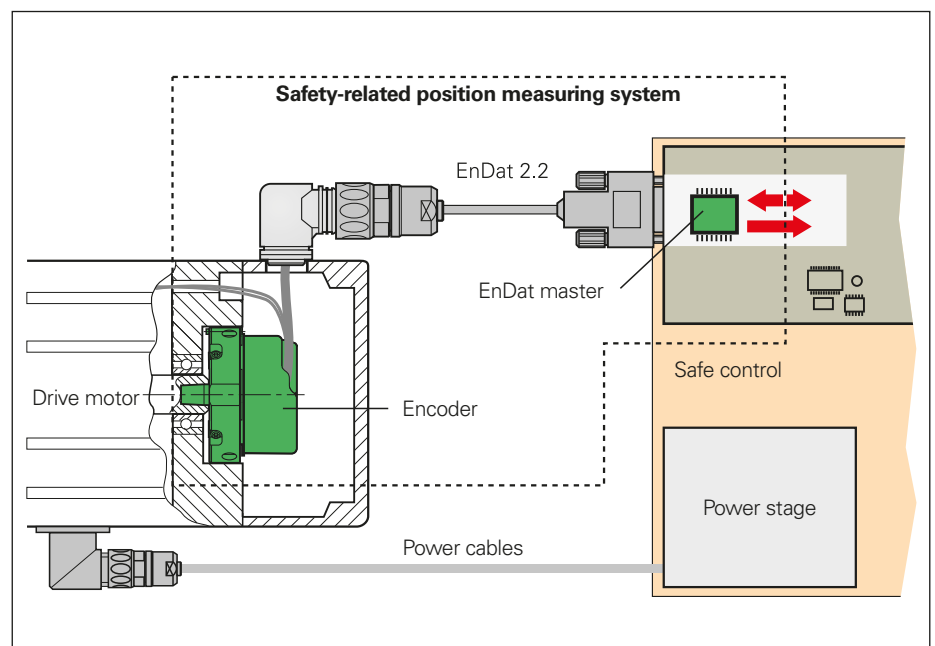
Safety-related position measuring systems from HEIDENHAIN are designed so that they can be used as single-encoder systems in applications with control category SIL 2 (according to EN 61 508), performance level "d", category 3 (according to EN ISO 13 849).

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 (catalogs / product information documents).

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

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

## 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 61508, the architecture of the position measuring system is regarded as a single-channel tested system.

## Integration of the position measuring system – the documentation

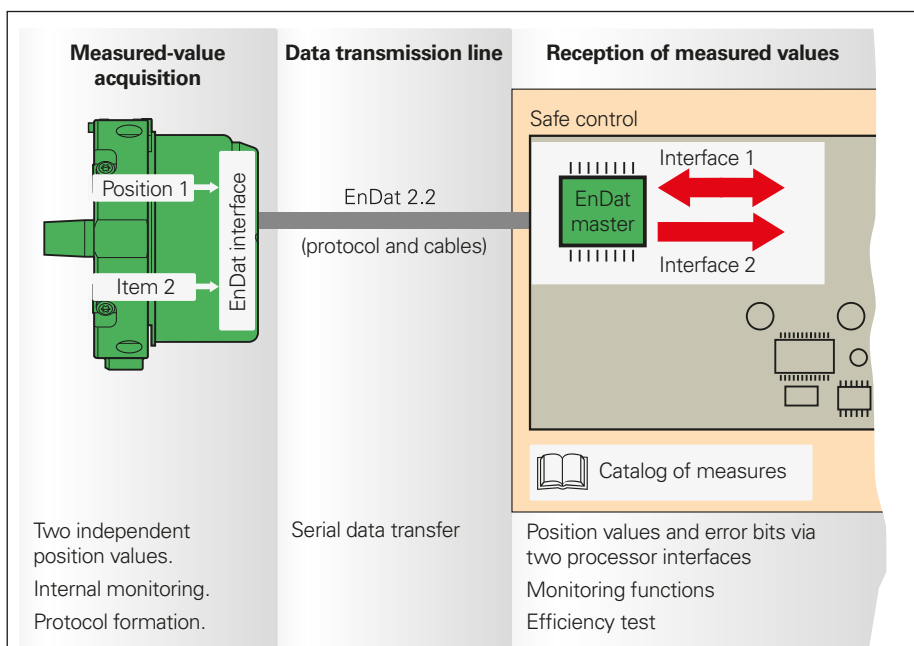
The intended use of position measuring systems places demands on the control, the machine designer, the installation technician, service, etc. The necessary information is provided in the documentation for the position measuring systems.

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, catalogs and mounting instructions provide information to aid the selection of a suitable encoder. The **product information sheets** and **catalogs** contain general data on function and application of the encoders as well as specifications and permissible ambient conditions. The **mounting instructions** provide detailed information on installing the encoders.

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



Safety-related position encoder with EnDat 2.2

**Functional Safety**

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



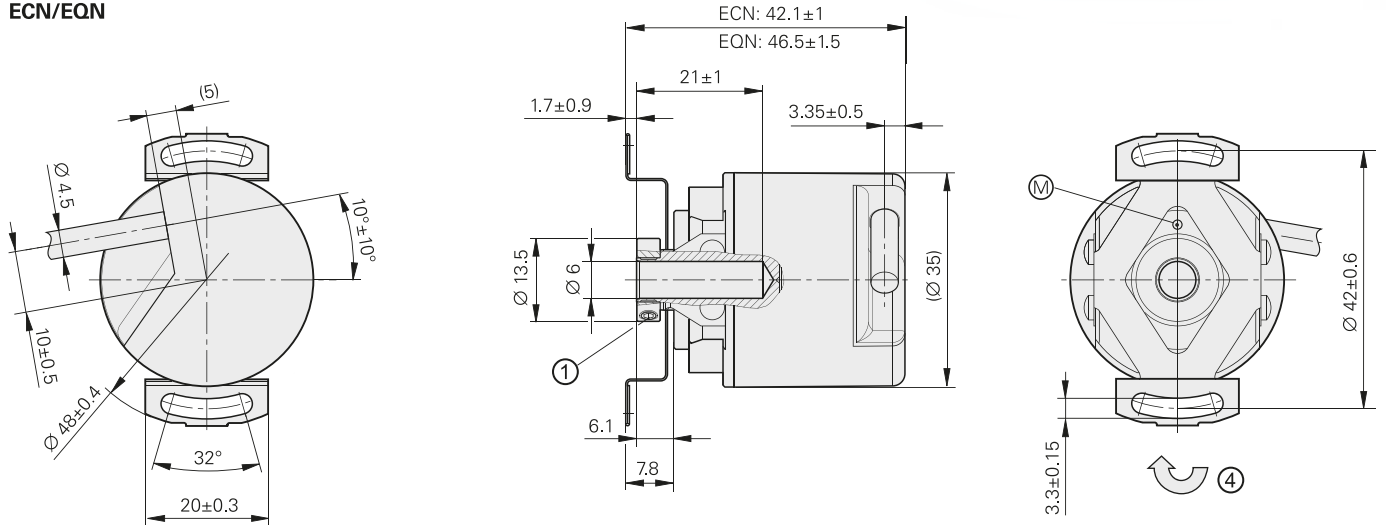
# ECN/EQN/ERN 1000 series

Absolute and incremental rotary encoders

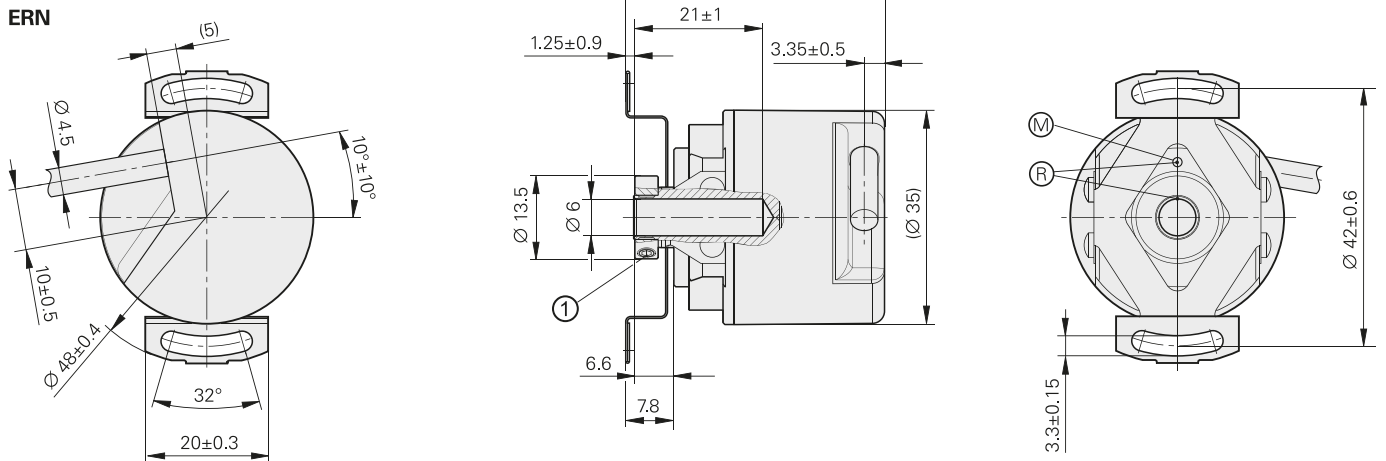
- Stator coupling for plane surface
- Blind hollow shaft



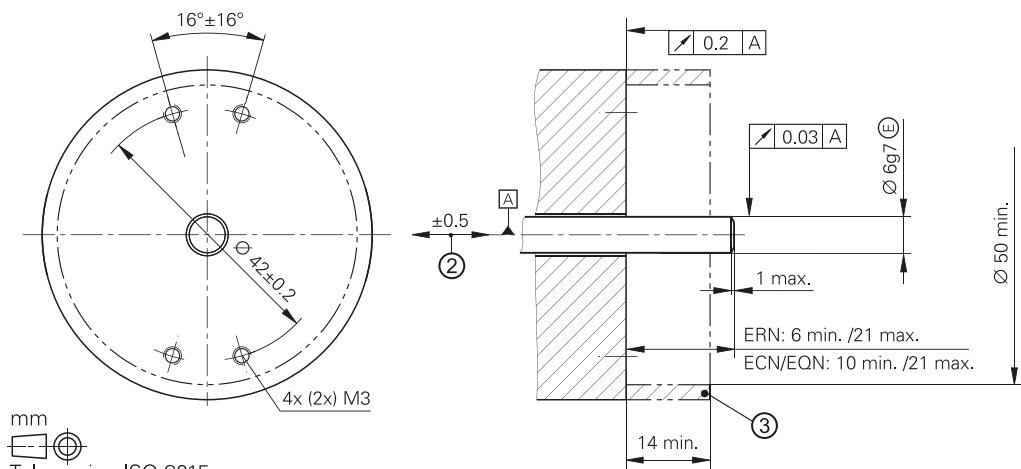
## ECN/EQN



## 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 x screw clamping rings. 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 60529)
- ④ = Direction of shaft rotation for output signals as per the interface description

	Incremental				
	ERN 1020	ERN 1030	ERN 1080	ERN 1070	
<b>Interface</b>	 TTL	 HTLs	 1 V <sub>PP</sub> <sup>1)</sup>	 TTL	
Line counts*	100 200 <b>250</b>	360 400 <b>500</b>	720 900 <b>2048 2500 3600</b>	<b>1000 2500 3600</b>	
Reference mark	One				
Integrated interpolation*	–			5-fold	10-fold
Cutoff frequency –3 dB	–	–	≥ 180 kHz	–	–
Scanning frequency	≤ 300 kHz	≤ 160 kHz	–	≤ 100 kHz	≤ 100 kHz
Edge separation a	≥ 0.39 μs	≥ 0.76 μs	–	≥ 0.47 μs	≥ 0.22 μs
<b>System accuracy</b>	1/20 of grating period				
<b>Electrical connection*</b>	<b>Cable, 1 m/5 m, with or without coupling M23</b>			<b>Cable, 5 m, without connecting element</b>	
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	
<b>Shaft</b>	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 · 10 <sup>–6</sup> kgm <sup>2</sup>				
Permissible axial motion of measured shaft	±0.5 mm				
<b>Vibration</b> 55 Hz to 2000 Hz <b>Shock</b> 6 ms	≤ 100 m/s <sup>2</sup> (EN 60068-2-6) ≤ 1000 m/s <sup>2</sup> (EN 60068-2-27)				
<b>Max. operating temperature</b> <sup>2)</sup>	100 °C	70 °C	100 °C	70 °C	
<b>Min. operating temp.</b>	<i>Stationary cable: –30 °C; moving cable: –10 °C</i>				
<b>Protection</b> EN 60529	IP64				
<b>Mass</b>	≈ 0.1 kg				
<b>Valid for ID</b>	534909-xx	534911-xx	534913-xx	534912-xx	

**Bold:** These preferred versions are available on short notice

\* Please select when ordering

<sup>1)</sup> Restricted tolerances: signal amplitude 0.8 V<sub>SS</sub> to 1.2 V<sub>PP</sub>

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



## Absolute

### Singleturn

#### ECN 1023

#### ECN 1013

<b>Interface*</b>	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 <sup>1)</sup>	≤ 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 <sub>PP</sub> <sup>2)</sup>	
Line count	–	512	
Cutoff frequency –3 dB	–	≥ 190 kHz	
<b>System accuracy</b>	±60''		
<b>Electrical connection</b>	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
<b>Shaft</b>	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 · 10 <sup>-6</sup> kgm <sup>2</sup>		
Permissible axial motion of measured shaft	±0.5 mm		
<b>Vibration</b> 55 Hz to 2000 Hz <b>Shock</b> 6 ms	≤ 100 m/s <sup>2</sup> (EN 60068-2-6) ≤ 1000 m/s <sup>2</sup> (EN 60068-2-27)		
<b>Max. operating temp.</b>	100 °C		
<b>Min. operating temp.</b>	<i>Stationary cable: –30 °C; moving cable: –10 °C</i>		
<b>Protection</b> EN 60529	IP64		
<b>Mass</b>	≈ 0.1 kg		
<b>Valid for ID</b>	606683-xx	606681-xx	606682-xx

\* Please select when ordering

<sup>1)</sup> Velocity-dependent deviations between the absolute and incremental signals

<sup>2)</sup> Restricted tolerances: signal amplitude 0.8 V<sub>PP</sub> to 1.2 V<sub>PP</sub>



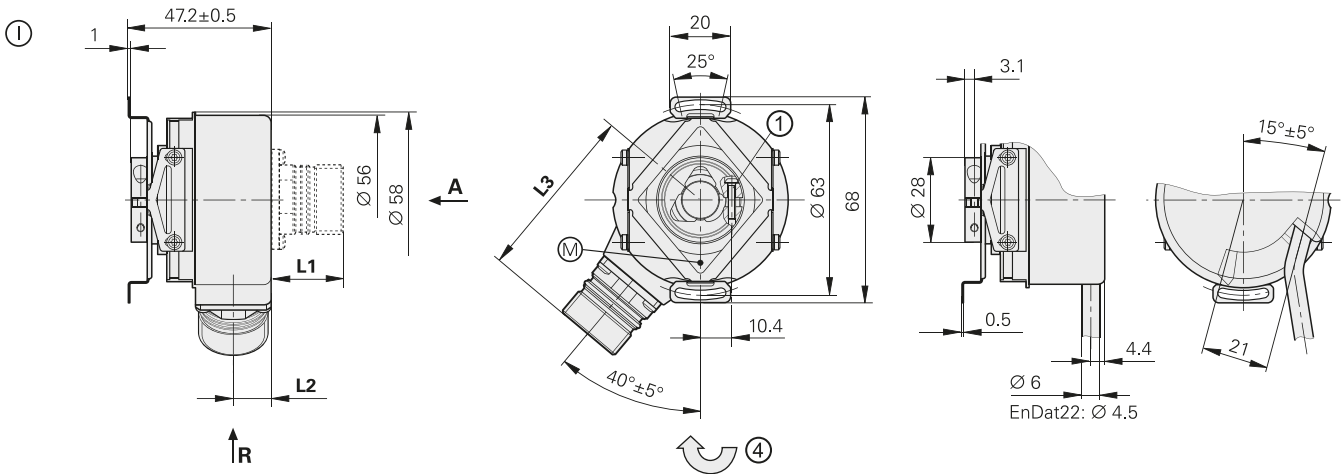
# ECN/EQN/ERN 400 series

Absolute and incremental rotary encoders

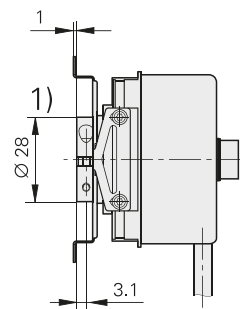
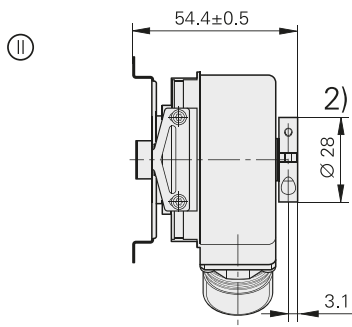
- Stator coupling for plane surface
- Blind hollow shaft or hollow through shaft



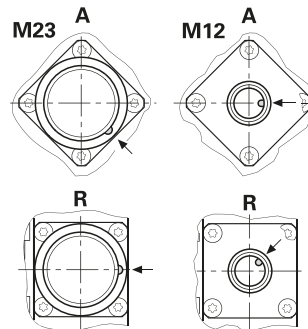
## Blind hollow shaft



## Hollow through shaft

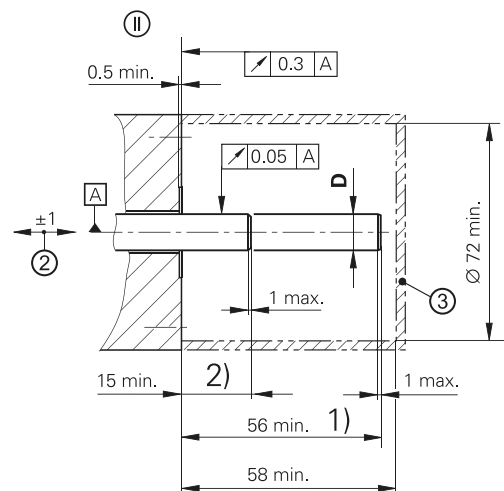
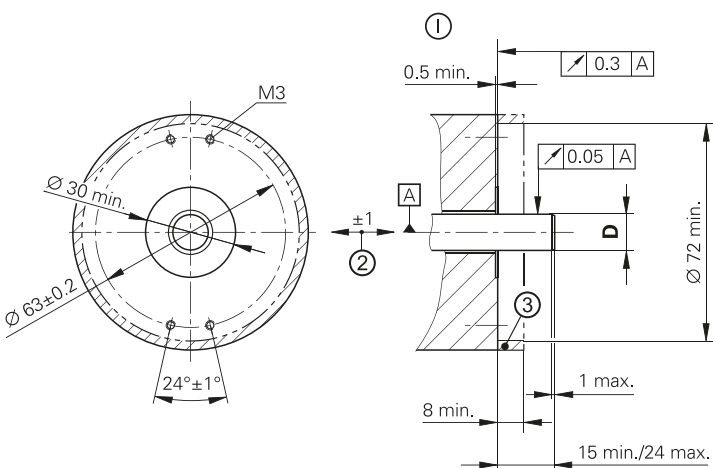


Connector coding  
A = axial, R = radial



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

D
Ø 8g7 $\text{E}$
Ø 12g7 $\text{E}$



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

- Cable radial, also usable axially
- $\square$  = Bearing of mating shaft
- $\text{M}$  = Measuring point for operating temperature
- ① = Clamping screw with X8 hex 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 <sub>PP</sub> <sup>1)</sup>
Line counts*	250 500			-
	<b>1000 1024 1250 2000 2048 2500 3600 4096 5000</b>			
Reference mark	One			
Cutoff frequency -3 dB	-			≥ 180 kHz
Output frequency	≤ 300 kHz			-
Edge separation a	≥ 0.39 μs			-
System accuracy	1/20 of grating period			
Electrical connection*	<ul style="list-style-type: none"> <li>M23 flange socket, radial and axial (with blind hollow shaft)</li> <li>Cable 1 m, without connecting element</li> </ul>			
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*	<b>Blind hollow shaft or hollow through shaft; D = 8 mm or D = 12 mm</b>			
Mech. permissible speed n <sup>2)</sup>	≤ 6000 rpm/≤ 12000 rpm <sup>3)</sup>			
Starting torque	At 20 °C	Blind hollow shaft: ≤ 0.01 Nm Hollow through shaft: ≤ 0.025 Nm (with IP66: ≤ 0.075 Nm)		
	Below -20 °C	≤ 1 Nm		
Moment of inertia of rotor	≤ 4.3 · 10 <sup>-6</sup> kgm <sup>2</sup>			
Permissible axial motion of measured shaft	±1 mm			
Vibration 55 Hz to 2000 Hz	≤ 300 m/s <sup>2</sup> ; Flange socket version: 150 m/s <sup>2</sup> (EN 60068-2-6); higher values upon request			
Shock 6 ms	≤ 2000 m/s <sup>2</sup> (EN 60068-2-27)			
Max. operating temperature <sup>2)</sup>	100 °C	70 °C	100 °C <sup>4)</sup>	
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

**Bold:** This preferred version is available on short notice.

\* Please select when ordering

<sup>1)</sup> Restricted tolerances: signal amplitude 0.8 V<sub>PP</sub> to 1.2 V<sub>PP</sub>

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

<sup>3)</sup> With two shaft clamps (only for hollow through shaft)

<sup>4)</sup> 80 °C for ERN 480 with 4096 or 5000 lines


**Absolute**
**Singleturn**
**ECN 425**
**ECN 413**


<b>Interface*</b>	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 <sup>1)</sup>	≤ 12000 rpm for continuous position value	<i>512 lines:</i> ≤ 5000/12000 rpm ±1 LSB/±100 LSB <i>2048 lines:</i> ≤ 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 <sub>PP</sub> <sup>2)</sup>	
Line counts*	–	<b>512</b> 2048	<b>512</b>
Cutoff frequency –3 dB Output frequency	– –	<i>512 lines:</i> ≥ 130 kHz; <i>2048 lines:</i> ≥ 400 kHz –	
<b>System accuracy</b>	±20"	<i>512 lines:</i> ±60"; <i>2048 lines:</i> ±20"	
<b>Electrical connection*</b>	<ul style="list-style-type: none"> <li>• <b>Flange socket</b> M12, radial</li> <li>• Cable 1 m, with M12 coupling</li> </ul>	<ul style="list-style-type: none"> <li>• <b>Flange socket</b> M23, radial</li> <li>• Cable 1 m, with M23 coupling or without connecting element</li> </ul>	
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
<b>Shaft*</b>	<b>Blind hollow</b> shaft or hollow through <b>shaft; D = 8 mm</b> or <b>D = 12 mm</b>		
Mech. permissible speed $n^{3)}$	≤ 6000 rpm/≤ 12000 rpm <sup>4)</sup>		
Starting torque At 20 °C Below –20 °C	<i>Blind hollow shaft:</i> ≤ 0.01 Nm; <i>Hollow through shaft:</i> ≤ 0.025 Nm (for IP66: ≤ 0.075 Nm) ≤ 1 Nm		
Moment of inertia of rotor	≤ 4.3 · 10 <sup>–6</sup> kgm <sup>2</sup>		
Permissible axial motion of measured shaft	±1 mm		
<b>Vibration</b> 55 Hz to 2000 Hz <b>Shock</b> 6 ms	≤ 300 m/s <sup>2</sup> ; <i>Flange socket version:</i> ≤ 150 m/s <sup>2</sup> (EN 60068-2-6); higher values upon request ≤ 2000 m/s <sup>2</sup> (EN 60068-2-27)		
<b>Max. operating temperature</b> <sup>3)</sup>	100 °C		
<b>Min. operating temp.</b>	<i>Flange socket or fixed cable:</i> –40 °C; <i>moving cable:</i> –10 °C		
<b>Protection</b> EN 60 529	<i>At housing:</i> IP67 (IP66 with hollow through shaft) <i>At shaft inlet:</i> IP64 (when D = 12 mm IP66 upon request)		
<b>Mass</b>	≈ 0.3 kg		
<b>Valid for ID</b>	683644-xx	1065932-xx	1132405-xx

**Bold:** This preferred version is available on short notice.

\* Please select when ordering

<sup>1)</sup> Velocity-dependent deviations between the absolute value and incremental signals



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 <sub>PP</sub> <sup>2)</sup>	
–	<b>512</b> 2048	<b>512</b>
– –	512 lines: ≥ 130 kHz; 2048 lines: ≥ 400 kHz –	
±20"	512 lines: ±60"; 2048 lines: ±20"	
<ul style="list-style-type: none"> <li>• Flange socket M12, radial</li> <li>• Cable 1 m, with M12 coupling</li> </ul>	<ul style="list-style-type: none"> <li>• Flange socket M23, radial</li> <li>• Cable 1 m, with M23 coupling or without connecting element</li> </ul>	
DC 3.6 V to 14 V	DC 3.6 V to 14 V	DC 4.75 V 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

2) Restricted tolerances: signal amplitude 0.8 V<sub>PP</sub> to 1.2 V<sub>PP</sub>

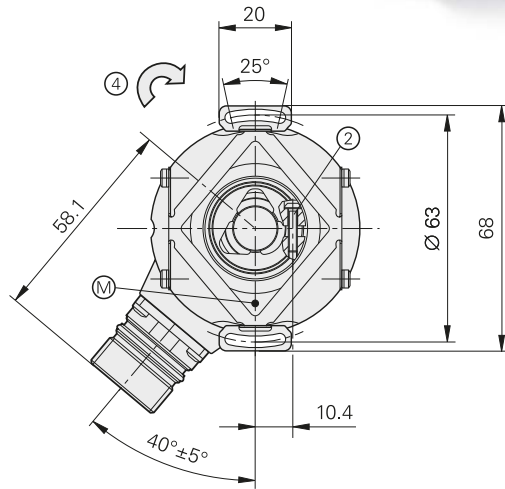
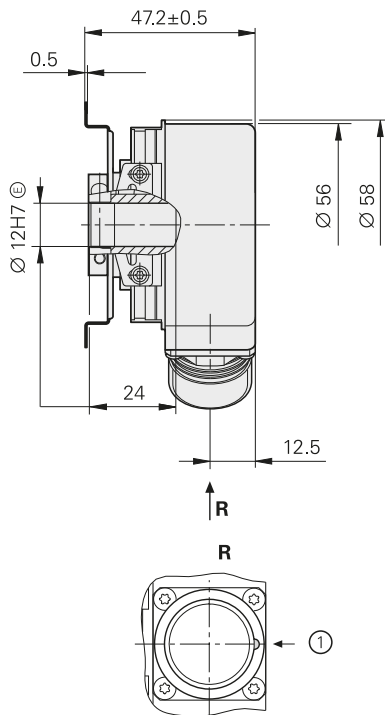
3) For the correlation between the operating temperature and the shaft speed or supply voltage, see *General mechanical information*

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

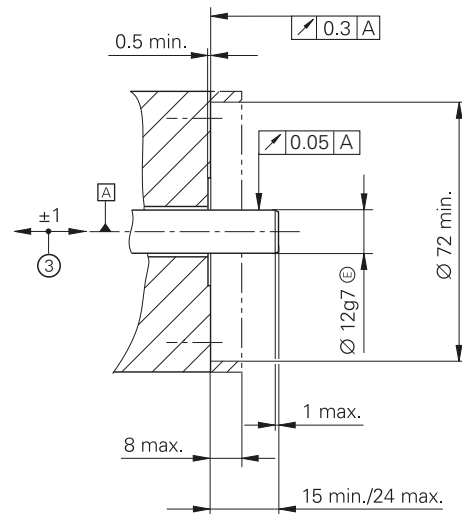
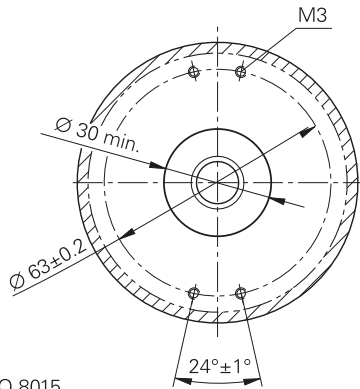
# EQN 425

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 hexalobular socket X8. 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

	<b>Absolute</b>					
	<b>EQN 425 – Multiturn</b>					
<b>Interface</b>	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	$\leq 9 \mu s$ $\leq 2 \text{ MHz}$					
Incremental signals	HTL			TTL		
Signal periods *	512	1024	2048	512	2048	4096
Edge separation a	$\geq 2.4 \mu s$	$\geq 0.8 \mu s$	$\geq 0.6 \mu s$	$\geq 2.4 \mu s$	$\geq 0.6 \mu s$	$\geq 0.2 \mu s$
Output frequency	$\leq 52 \text{ kHz}$	$\leq 103 \text{ kHz}$	$\leq 205 \text{ kHz}$	$\leq 52 \text{ kHz}$	$\leq 205 \text{ kHz}$	$\leq 410 \text{ kHz}$
<b>System accuracy</b> <sup>1)</sup>	$\pm 60''$	$\pm 60''$	$\pm 20''$	$\pm 60''$	$\pm 20''$	$\pm 20''$
<b>Electrical connection</b>	M23 flange socket (male), 17-pin, radial					
Cable length <sup>2)</sup>	$\leq 100 \text{ m}$ (with HEIDENHAIN cable)					
Voltage supply	DC 10 V to 30 V			DC 4.75 V to 30 V		
Power consumption (max.) <sup>3)</sup>	See <i>Power consumption</i> diagram			At 4.75 V: $\leq 900 \text{ mW}$ At 30 V: $\leq 1100 \text{ mW}$		
Current consumption (typical, without load)	At 10 V: $\leq 56 \text{ mA}$ At 24 V: $\leq 34 \text{ mA}$			At 5 V: $\leq 100 \text{ mA}$ At 24 V: $\leq 25 \text{ mA}$		
<b>Shaft</b>	Blind hollow shaft $\varnothing 12 \text{ mm}$					
Mech. permissible speed n <sup>4)</sup>	$\leq 6000 \text{ rpm}$					
Starting torque at 20 °C	$\leq 0.01 \text{ Nm}$					
Moment of inertia of rotor	$4.3 \cdot 10^{-6} \text{ kgm}^2$					
Permissible axial motion of measured shaft	$\leq \pm 1 \text{ mm}$					
<b>Vibration</b> 10 Hz to 2000 Hz <sup>5)</sup> <b>Shock</b> 6 ms	$\leq 150 \text{ m/s}^2$ (EN 60 068-2-6) $\leq 2000 \text{ m/s}^2$ (EN 60 068-2-27)					
<b>Max. operating temperature</b> <sup>4)</sup>	100 °C					
<b>Min. operating temp.</b> <sup>4)</sup>	-40 °C					
<b>Protection</b> EN 60 529	Housing: IP67 Shaft exit: IP64					
<b>Mass</b>	$\approx 0.30 \text{ kg}$					
<b>Valid for ID</b>	1042545-xx			1042540-xx		

\* Please select when ordering

<sup>1)</sup> For absolute position value; accuracy of the incremental signal upon request

<sup>2)</sup> For HTL signals, the maximum cable length depends on the output frequency (see the *Cable length for HTL* diagram)

<sup>3)</sup> See *General electrical information* in the brochure *Interfaces for HEIDENHAIN Encoders*

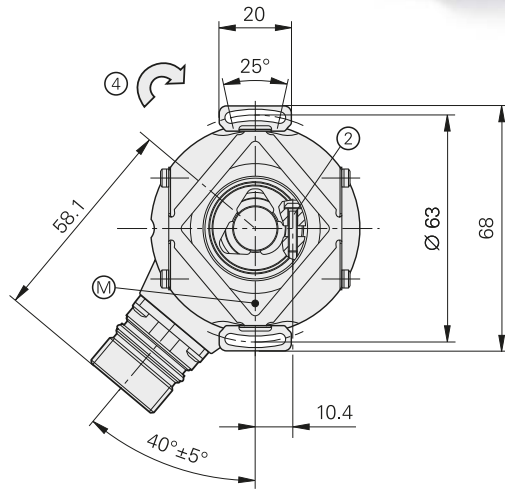
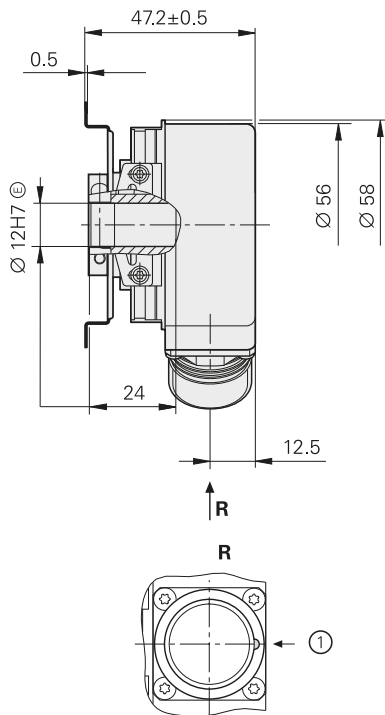
<sup>4)</sup> For the correlation between the operating temperature and the shaft speed or supply voltage, see *General mechanical information* in the *Rotary Encoders* catalog

<sup>5)</sup> 10 Hz to 55 Hz constant over distance 4.9 mm peak to peak

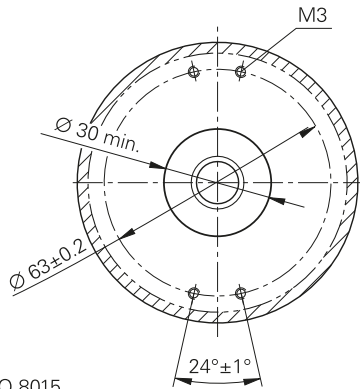
# EQN 425

Rotary encoder for absolute position values with blind hollow shaft

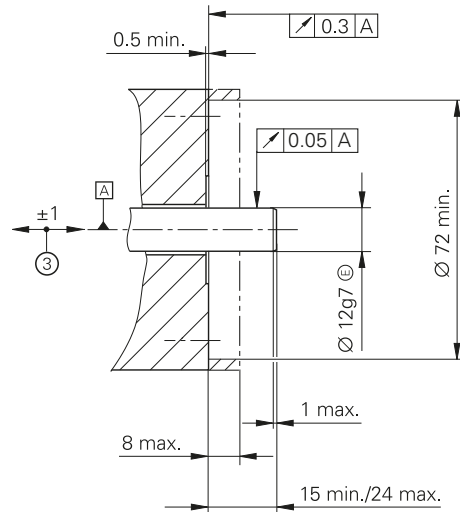
- Stator coupling for plane surface
- SSI interface
- Additional incremental signals with TTL or HTL levels



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 hexalobular socket X8. 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

	<b>Absolute</b>					
	<b>EQN 425 – Multiturn</b>					
<b>Interface</b>	SSI					
Ordering designation*	SSI41H			SSI41T		
Positions per revolution	8192 (13 bits)					
Revolutions	4096 (12 bits)					
Code	Gray					
Calculation time $t_{cal}$ Clock frequency	$\leq 5 \mu s$ $\leq 1 \text{ MHz}$					
Incremental signals	HTL <sup>6)</sup>			TTL		
Signal periods *	512	1024	2048	512	2048	4096
Edge separation a	$\geq 2.4 \mu s$	$\geq 0.8 \mu s$	$\geq 0.6 \mu s$	$\geq 2.4 \mu s$	$\geq 0.6 \mu s$	$\geq 0.2 \mu s$
Output frequency	$\leq 52 \text{ kHz}$	$\leq 103 \text{ kHz}$	$\leq 205 \text{ kHz}$	$\leq 52 \text{ kHz}$	$\leq 205 \text{ kHz}$	$\leq 410 \text{ kHz}$
<b>System accuracy</b> <sup>1)</sup>	$\pm 60''$	$\pm 60''$	$\pm 20''$	$\pm 60''$	$\pm 20''$	$\pm 20''$
<b>Electrical connection</b>	M23 flange socket (male), 12-pin, radial			M23 flange socket (male), 17-pin, radial		
Cable length <sup>2)</sup>	$\leq 100 \text{ m}$ (with HEIDENHAIN cable)					
Voltage supply	DC 10 V to 30 V			DC 4.75 V to 30 V		
Power consumption (max.) <sup>3)</sup>	See <i>Power consumption</i> diagram			At 4.75 V: $\leq 900 \text{ mW}$ At 30 V: $\leq 1100 \text{ mW}$		
Current consumption (typical, without load)	At 10 V: $\leq 56 \text{ mA}$ At 24 V: $\leq 34 \text{ mA}$			At 5 V: $\leq 100 \text{ mA}$ At 24 V: $\leq 25 \text{ mA}$		
<b>Shaft</b>	Blind hollow shaft, $\varnothing 12 \text{ mm}$					
Mech. permissible speed n <sup>4)</sup>	$\leq 6000 \text{ rpm}$					
Starting torque at 20 °C	$\leq 0.01 \text{ Nm}$					
Moment of inertia of rotor	$4.3 \cdot 10^{-6} \text{ kgm}^2$					
Permissible axial motion of measured shaft	$\leq \pm 1 \text{ mm}$					
<b>Vibration</b> 10 Hz to 2000 Hz <sup>5)</sup> <b>Shock</b> 6 ms	$\leq 150 \text{ m/s}^2$ (EN 60 068-2-6) $\leq 2000 \text{ m/s}^2$ (EN 60 068-2-27)					
<b>Max. operating temperature</b> <sup>4)</sup>	100 °C					
<b>Min. operating temp.</b> <sup>4)</sup>	-40 °C					
<b>Protection</b> EN 60 529	Housing: IP67 Shaft exit: IP64					
<b>Mass</b>	$\approx 0.30 \text{ kg}$					
<b>Valid for ID</b>	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 cable length depends on the output frequency (see the *Cable length for HTL* diagram)

3) See *General electrical information* in the brochure *Interfaces for HEIDENHAIN Encoders*

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

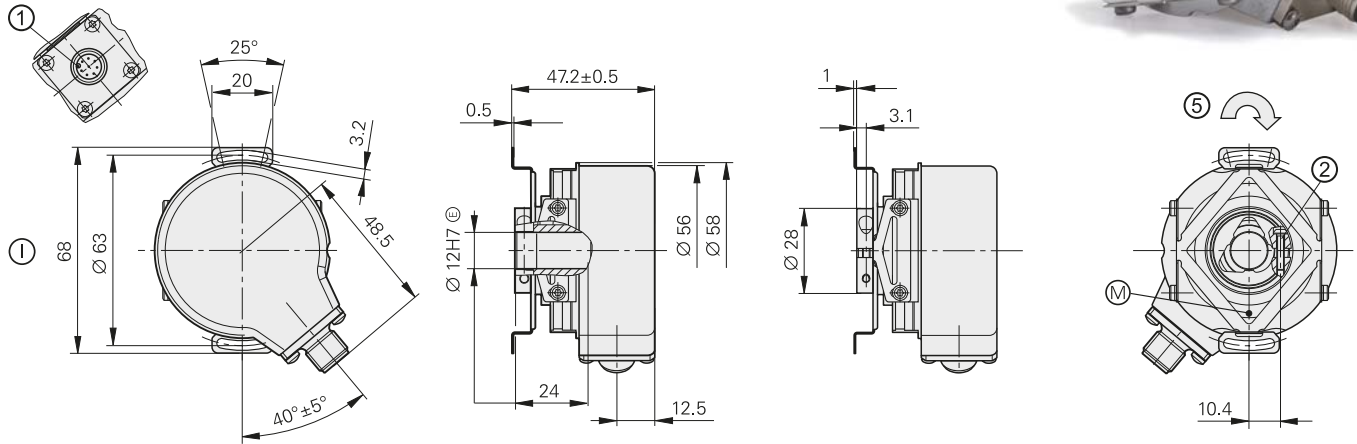
# ECN/EQN 400F/M/S series

## Absolute rotary encoders

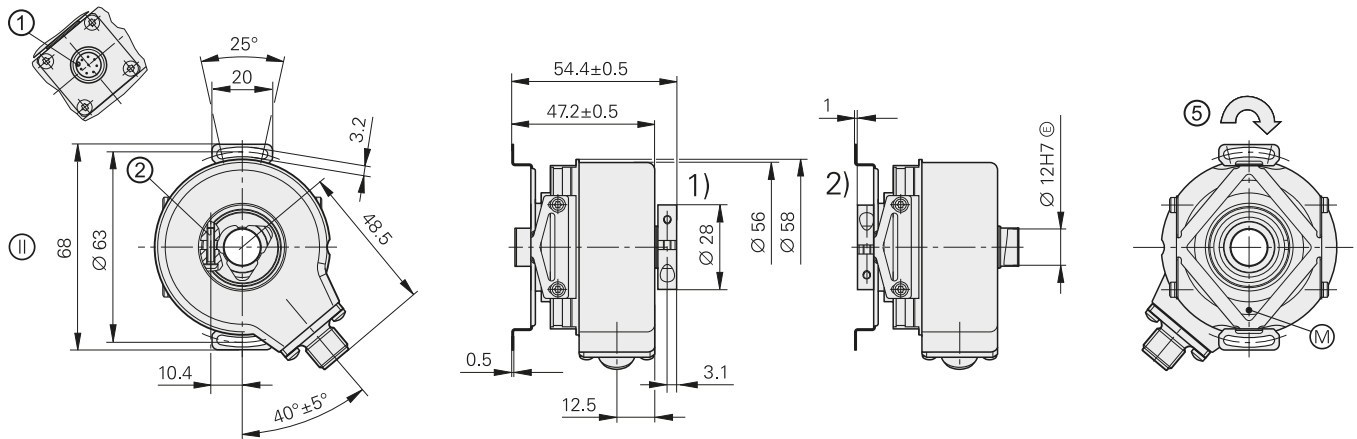
- Stator coupling for plane surface
- Blind hollow shaft or hollow through shaft
- Fanuc Serial Interface, Mitsubishi high speed interface and Siemens DRIVE-CLiQ interface



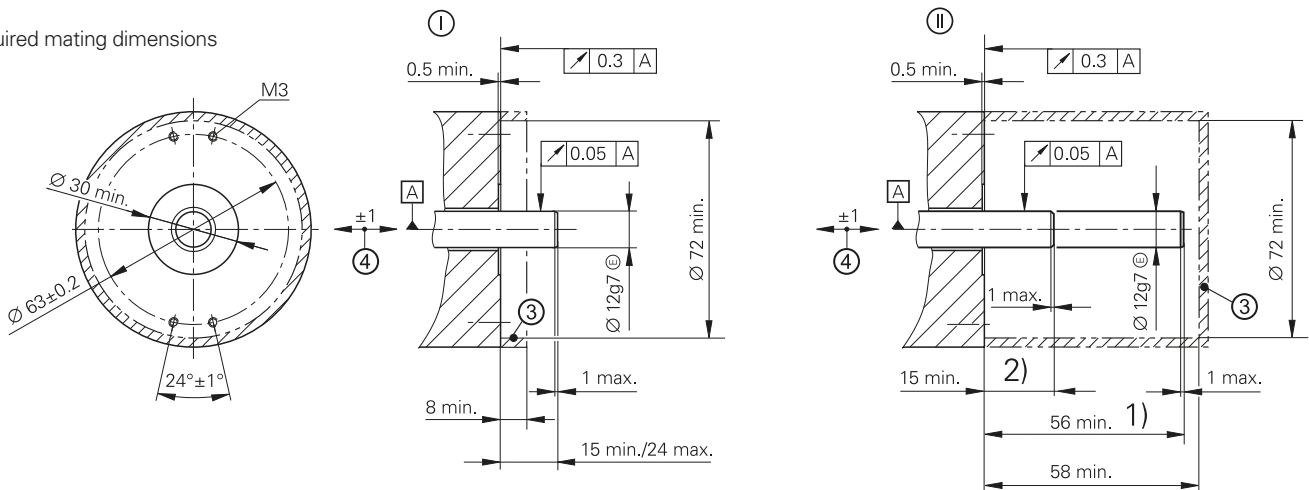
### Blind hollow shaft



### 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 hexalobular socket X8. Tightening torque 1.1±0.1 Nm
- ③ = Ensure protection against contact (EN 60529)
- 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.

	<b>Absolute</b>					
	<b>Singletum</b>			<b>Multitum</b>		
	<b>ECN 425 F</b>	<b>ECN 425 M</b>	<b>ECN 424 S</b>	<b>EQN 437 F</b>	<b>EQN 435 M</b>	<b>EQN 436 S</b>
<b>Interface</b>	Fanuc Serial Interface; $\alpha$ i Interface	Mitsubishi high speed interface	DRIVE-CLiQ	Fanuc Serial Interface; $\alpha$ i Interface	Mitsubishi high speed interface	DRIVE-CLiQ
Ordering designation	Fanuc05	Mit03-4	DQ01	Fanuc05	Mit03-4	DQ01
Positions per revolution	$\alpha$ i: 33554432 (25 bits) $\alpha$ : 8388608 (23 bits)	33554432 (25 bits)	16777216 (24 bits)	33554432 (25 bits)	8388608 (23 bits)	16777216 (24 bits)
Revolutions	8192 via revolution counter	–	–	$\alpha$ i: 4096 $\alpha$ : 2048	4096	4096
Code	Pure binary					
Elec. permissible speed	≤ 15000 rpm for continuous position value					
Calculation time $t_{cal}$	≤ 5 $\mu$ s	–	≤ 8 $\mu$ s <sup>4)</sup>	≤ 5 $\mu$ s	–	≤ 8 $\mu$ s <sup>4)</sup>
Incremental signals	Without					
<b>System accuracy</b>	±20"					
<b>Electrical connection</b>	Flange socket M12, radial					
Cable length	≤ 30 m		≤ 95 m <sup>3)</sup>	≤ 30 m		≤ 95 m <sup>3)</sup>
DC voltage supply	3.6 to 14 V		10 V to 36 V	3.6 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
<b>Shaft*</b>	Blind hollow shaft or hollow through shaft, D = 12 mm		Hollow through shaft, D = 12 mm	Blind hollow shaft or hollow through shaft, D = 12 mm		Hollow through shaft, D = 12 mm
Mech. permissible speed $n^{1)}$	≤ 6000 rpm/≤ 12000 rpm <sup>2)</sup>					
Starting torque	At 20 °C		<i>Blind hollow shaft:</i> ≤ 0.01 Nm <i>Hollow through shaft:</i> ≤ 0.025 Nm (for IP66: ≤ 0.075 Nm)			
	Below –20 °C		≤ 1 Nm			
Moment of inertia of rotor	≤ 4.6 · 10 <sup>–6</sup> kgm <sup>2</sup>					
Permissible axial motion of measured shaft	±1 mm					
<b>Vibration</b> 55Hz to 2000 Hz <b>Shock</b> 6 ms	≤ 150 m/s <sup>2</sup> (EN 60068-2-6) ≤ 2000 m/s <sup>2</sup> (EN 60068-2-27)					
<b>Max. operating temp.</b> <sup>1)</sup>	100 °C					
<b>Min. operating temp.</b>	–30 °C					
<b>Protection</b> EN 60 529	<i>At housing:</i> IP67 (IP66 with hollow through shaft) <i>At shaft inlet:</i> IP64 (when DQ01 D = 12 mm IP66 upon request)					
<b>Mass</b>	≈ 0.3 kg					
<b>Valid for ID</b>	1081302-xx	1096730-xx	1036798-xx	1081301-xx	1096731-xx	1036801-xx

\* Please select when ordering

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

<sup>2)</sup> With two shaft clamps (only for hollow through shaft)

<sup>3)</sup> See *Interfaces of HEIDENHAIN encoders*; catalog with  $n_{MG} = 1$  (incl. adapter cable)

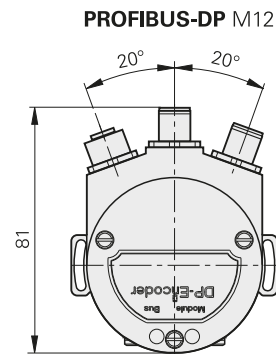
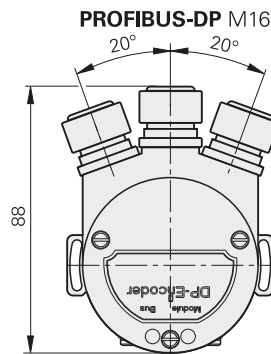
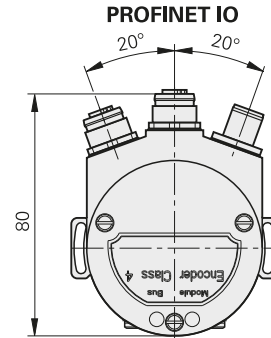
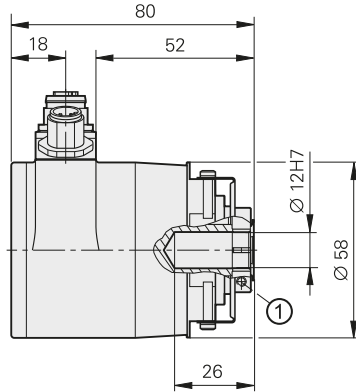
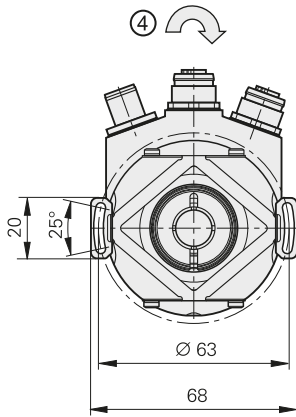
<sup>4)</sup> Processing time  $T_{IME\_MAX\_ACTVAL}$



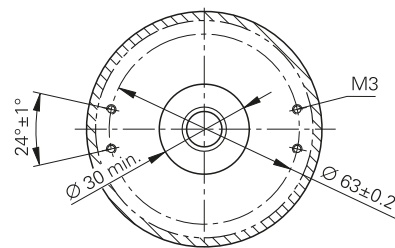
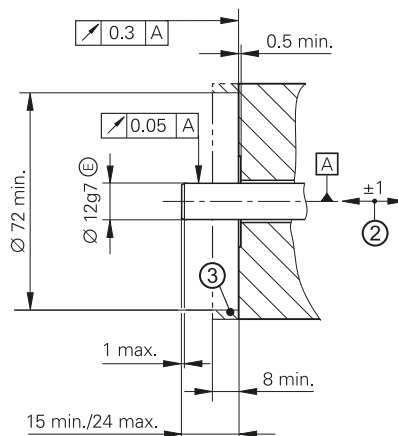
# ECN/EQN 400 series

## Absolute rotary encoders

- Stator coupling for plane surface
- Blind hollow shaft
- Fieldbus interface



## Required mating dimensions



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

- ▢ = Bearing of mating shaft
- ① = Clamping screw with hexalobular socket X8. 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

	<b>Absolute</b>			
	<b>Singletum ECN 413</b>		<b>Multitum EQN 425</b>	
<b>Interface*</b>	PROFIBUS-DP <sup>1)</sup>	PROFINET IO	PROFIBUS-DP <sup>1)</sup>	PROFINET IO
Positions per revolution	8192 (13 bits) <sup>2)</sup>			
Revolutions	–		4096 <sup>2)</sup>	
Code	Pure binary			
Elec. permissible speed	≤ 15000 rpm for continuous position value		≤ 10000 rpm for continuous position value	
<b>Incremental signals</b>	Without			
<b>System accuracy</b>	±60"			
<b>Electrical connection*</b>	Cable gland M16 <sup>4)</sup>	Three M12 flange sockets, radial	Cable gland M16 <sup>4)</sup>	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			
<b>Shaft</b>	Blind hollow shaft; Ø 12 mm			
Mech. permissible speed n <sup>3)</sup>	≤ 6000 rpm			
Starting torque	At 20 °C	≤ 0.01 Nm		
	Below –20 °C	≤ 1 Nm		
Moment of inertia of rotor	≤ 4.3 · 10 <sup>–6</sup> kgm <sup>2</sup>			
Permissible axial motion of measured shaft	±1 mm			
<b>Vibration</b> 55 Hz to 2000 Hz	≤ 100 m/s <sup>2</sup> (EN 60068-2-6)			
<b>Shock</b> 6 ms	≤ 2000 m/s <sup>2</sup> (EN 60068-2-27)			
<b>Max. operating temp.</b> <sup>3)</sup>	70 °C			
<b>Min. operating temp.</b>	–40 °C			
<b>Protection</b> EN 60 529	IP67 at housing; IP64 at shaft inlet			
<b>Mass</b>	≈ 0.3 kg			
<b>Valid for ID</b>	1075943-xx	752522-xx	1075945-xx	752523-xx

\* Please select when ordering

<sup>1)</sup> Supported profiles: DP-V0, DP-V1, DP-V2

<sup>2)</sup> Programmable

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

<sup>4)</sup> Variant with three M12 flange sockets available on request

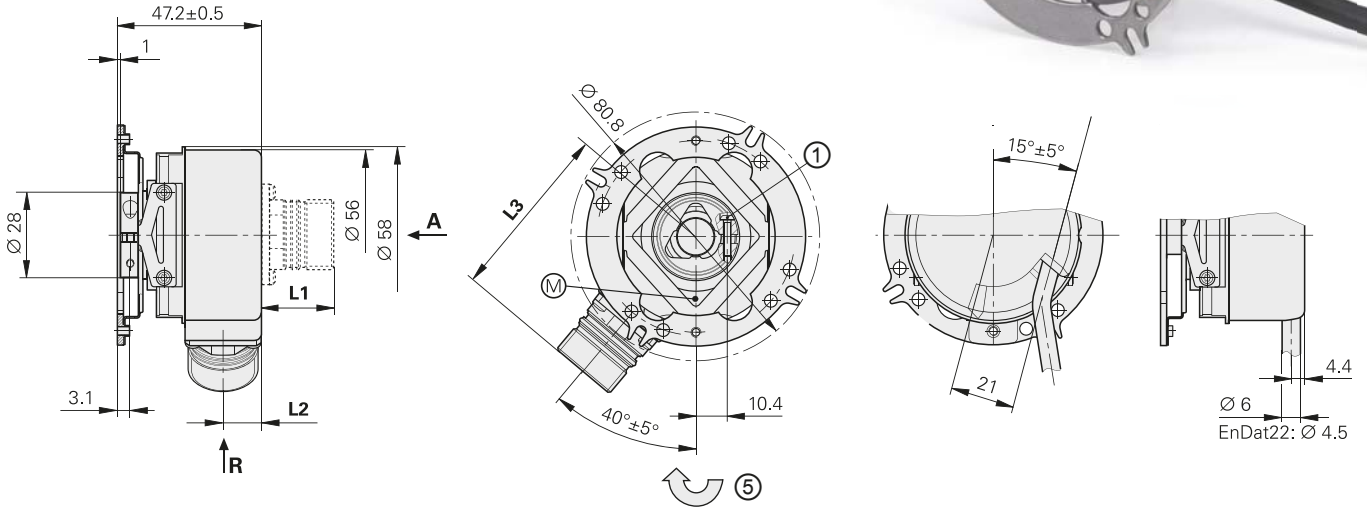
# ECN/EQN/ERN 400 series

Absolute and incremental rotary encoders

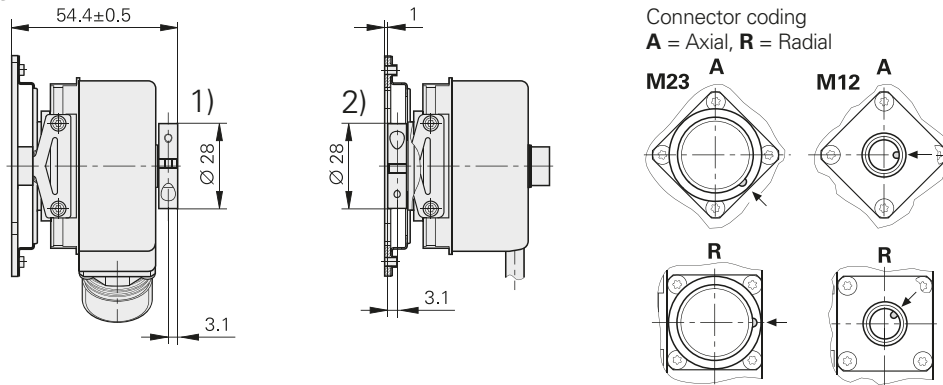
- Stator coupling for universal mounting
- Blind hollow shaft or hollow through shaft



## Blind hollow shaft



## Hollow through shaft

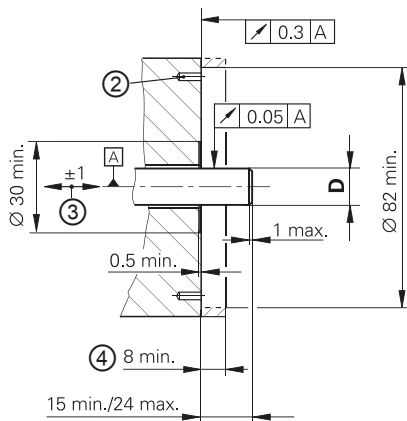


Connector coding  
A = Axial, R = Radial

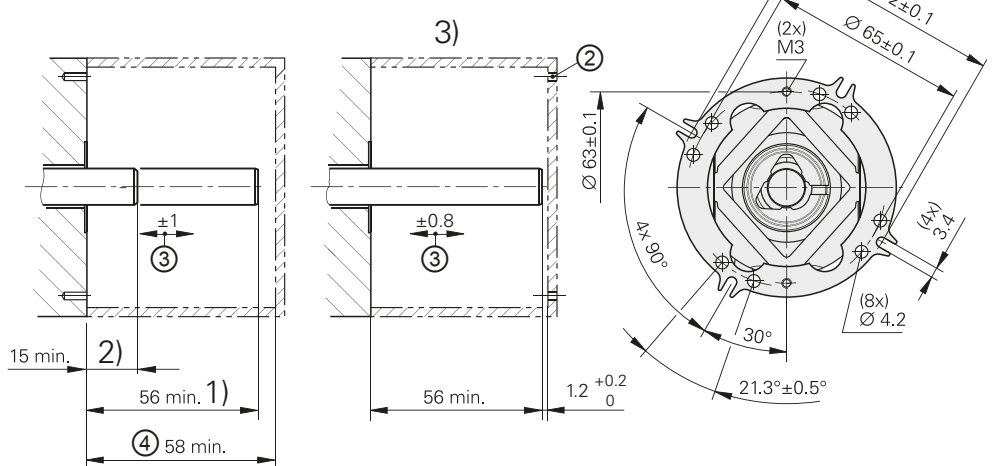
Flange socket		
	M12	M23
L1	14	23.6
L2	12.5	12.5
L3	48.5	58.1
<b>D</b>		
Ø 8g7 $\text{\textcircled{E}}$		
Ø 12g7 $\text{\textcircled{E}}$		

## 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
- $\text{\textcircled{A}}$  = Bearing of mating shaft
  - $\text{\textcircled{M}}$  = Measuring point for operating temperature
  - $\text{\textcircled{1}}$  = Clamping screw with X8 hex socket
  - $\text{\textcircled{2}}$  = Hole pattern for fastening, see coupling
  - $\text{\textcircled{3}}$  = Compensation of mounting tolerances and thermal expansion, no dynamic motion permitted
  - $\text{\textcircled{4}}$  = Ensure protection against contact (EN 60 529)
  - $\text{\textcircled{5}}$  = 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 <sub>PP</sub> <sup>1)</sup>
Line counts*	250 500			-
	<b>1000 1024 1250 2000 2048 2500 3600 4096 5000</b>			
Reference mark	One			
Cutoff frequency -3 dB	-			≥ 180 kHz
Output frequency	≤ 300 kHz			-
Edge separation a	≥ 0.39 μs			-
System accuracy	1/20 of grating period			
Electrical connection*	<ul style="list-style-type: none"> <li>M23 flange socket, radial and axial (with blind hollow shaft)</li> <li>Cable 1 m, without connecting element</li> </ul>			
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*	<b>Blind hollow shaft or hollow through shaft; D = 8 mm or D = 12 mm</b>			
Mech. permissible speed n <sup>2)</sup>	≤ 6000 rpm/≤ 12000 rpm <sup>3)</sup>			
Starting torque	At 20 °C	Blind hollow shaft: ≤ 0.01 Nm Hollow through shaft: ≤ 0.025 Nm (with IP66: ≤ 0.075 Nm)		
	Below -20 °C	≤ 1 Nm		
Moment of inertia of rotor	≤ 4.3 · 10 <sup>-6</sup> kgm <sup>2</sup>			
Permissible axial motion of measured shaft	±1 mm			
Vibration 55 Hz to 2000 Hz	≤ 300 m/s <sup>2</sup> ; Flange socket version: 150 m/s <sup>2</sup> (EN 60068-2-6); higher values upon request			
Shock 6 ms	≤ 2000 m/s <sup>2</sup> (EN 60068-2-27)			
Max. operating temp. <sup>2)</sup>	100 °C	70 °C	100 °C <sup>4)</sup>	
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

<sup>1)</sup> Restricted tolerances: signal amplitude 0.8 V<sub>PP</sub> to 1.2 V<sub>PP</sub>

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

<sup>3)</sup> With two shaft clamps (only for hollow through shaft)

<sup>4)</sup> 80 °C for ERN 480 with 4096 or 5000 lines


**Absolute**
**Singleturn**
**ECN 425**
**ECN 413**

<b>Interface*</b>	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 <sup>1)</sup>	≤ 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 <sub>PP</sub> <sup>2)</sup>	
Line counts*	–	<b>512</b> 2048	<b>512</b>
Cutoff frequency –3 dB Output frequency	– –	512 lines: ≥ 130 kHz; 2048 lines: ≥ 400 kHz –	
<b>System accuracy</b>	±20"	512 lines: ± 60"; 2048 lines: ± 20"	
<b>Electrical connection*</b>	<ul style="list-style-type: none"> <li>• Flange socket M12, radial</li> <li>• Cable 1 m, with M12 coupling</li> </ul>	<ul style="list-style-type: none"> <li>• Flange socket M23, radial</li> <li>• Cable 1 m, with M23 coupling or without connecting element</li> </ul>	
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
<b>Shaft *</b>	<b>Blind hollow shaft</b> or hollow through shaft; <b>D = 8 mm</b> or <b>D = 12 mm</b>		
Mech. permissible speed $n^{3)}$	≤ 6000 rpm/≤ 12000 rpm <sup>4)</sup>		
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 · 10 <sup>–6</sup> kgm <sup>2</sup>		
Permissible axial motion of measured shaft	±1 mm		
<b>Vibration</b> 55 Hz to 2000 Hz <b>Shock</b> 6 ms	≤ 300 m/s <sup>2</sup> ; Flange socket version: 150 m/s <sup>2</sup> (EN 60068-2-6); Higher values upon request ≤ 2000 m/s <sup>2</sup> (EN 60068-2-27)		
<b>Max. operating temp.</b> <sup>3)</sup>	100 °C		
<b>Min. operating temp.</b>	Flange socket or fixed cable: –40 °C; moving cable: –10 °C		
<b>Protection</b> EN 60 529	At housing: IP67 (IP66 with hollow through shaft) At shaft inlet: IP64 (when D = 12 mm IP66 upon request)		
<b>Mass</b>	≈ 0.3 kg		
<b>Valid for ID</b>	683644-xx	1065932-xx	1132405-xx

**Bold:** These preferred versions are available on short notice

<sup>1)</sup> Velocity-dependent deviations between the absolute value and incremental signal <sup>2)</sup> Restricted tolerances: signal amplitude 0.8 V<sub>PP</sub> to 1.2 V<sub>PP</sub>

Multitum		
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	<i>512 lines:</i> ≤ 5000/10000 rpm ±1 LSB/±100 LSB <i>2048 lines:</i> ≤ 1500/10000 rpm ±1 LSB/±50 LSB	≤ 12000 rpm ±12 LSB
≤ 7 μs ≤ 8 MHz	≤ 9 μs ≤ 2 MHz	≤ 5 μs –
Without	~ 1 V <sub>PP</sub> <sup>2)</sup>	
–	<b>512</b> 2048	<b>512</b>
– –	<i>512 lines:</i> ≥ 130 kHz; <i>2048 lines:</i> ≥ 400 kHz –	
±20"	<i>512 lines:</i> ± 60"; <i>2048 lines:</i> ± 20"	
<ul style="list-style-type: none"> <li>• <b>Flange socket</b> M12, radial</li> <li>• Cable 1 m, with M12 coupling</li> </ul>	<ul style="list-style-type: none"> <li>• <b>Flange socket</b> M23, radial</li> <li>• Cable 1 m, with M23 coupling or without connecting element</li> </ul>	
DC 3.6V to 14V	DC 3.6V to 14V	DC 4.75V to 30V
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

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

<sup>4)</sup> With two shaft clamps (only for hollow through shaft)

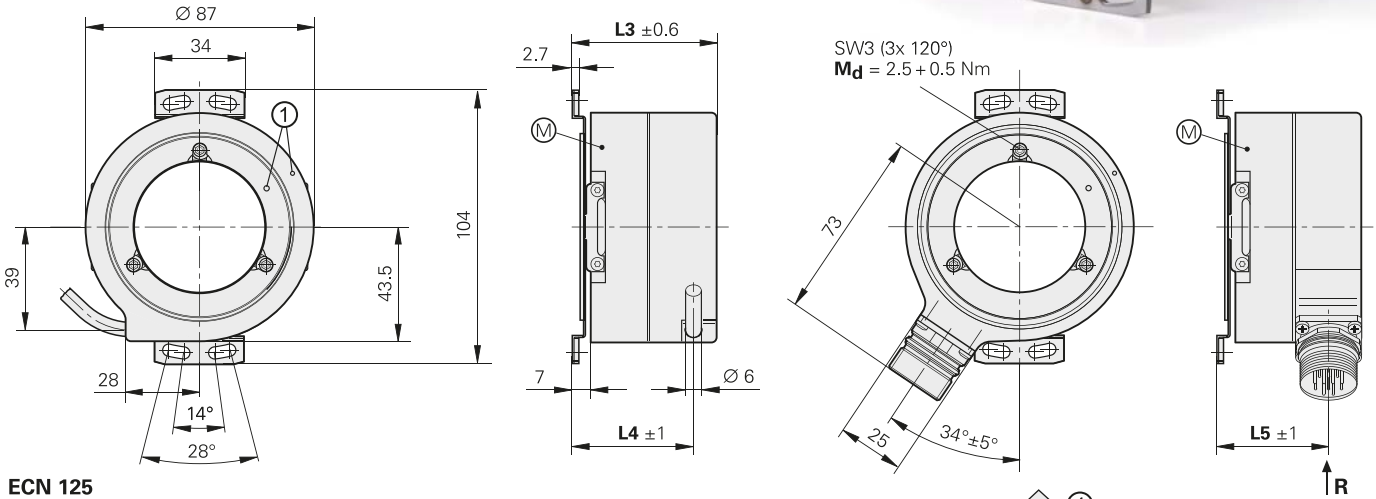
# ECN/ERN 100 series

Absolute and incremental rotary encoders

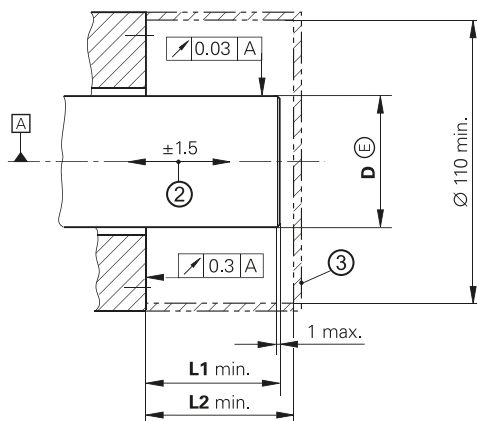
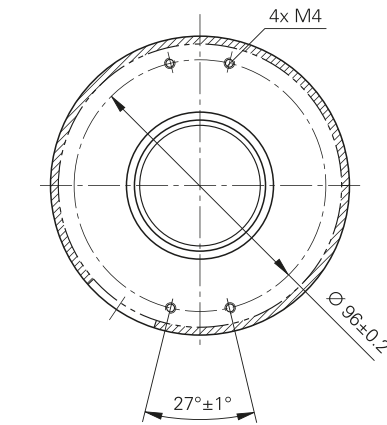
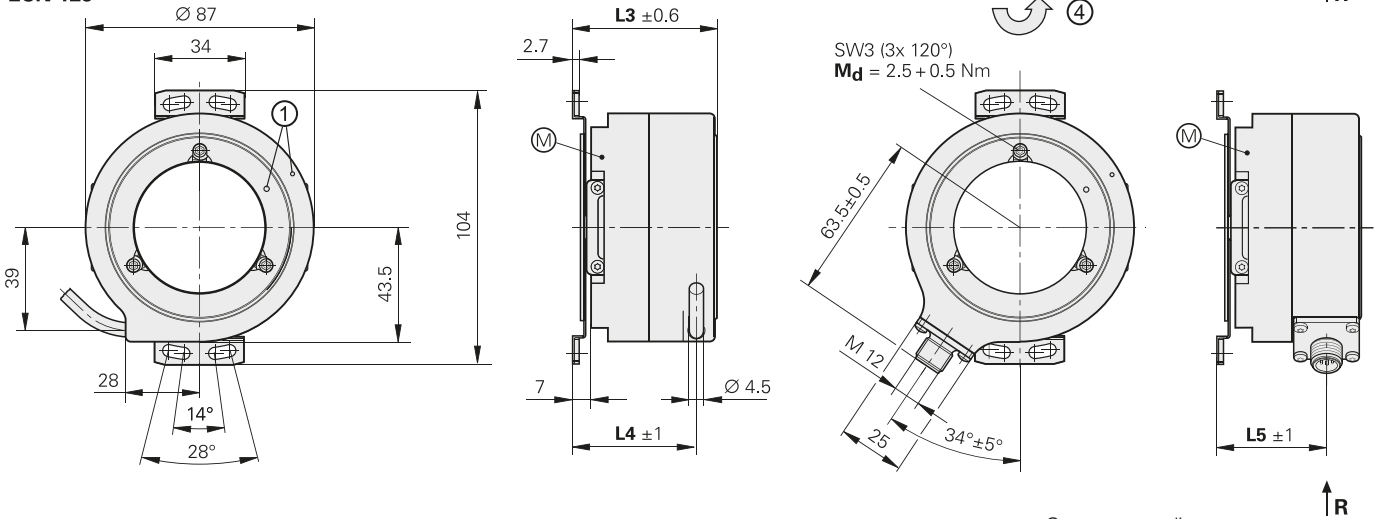
- Stator coupling for plane surface
- Hollow through shaft



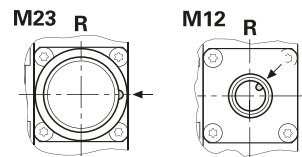
## ERN 1x0/ECN 113



## 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 Singletum		Incremental		
	ECN 125	ECN 113	ERN 120	ERN 130	ERN 180
<b>Interface</b>	<b>EnDat 2.2</b>	<b>EnDat 2.2</b>			1 V <sub>PP</sub> <sup>2)</sup>
Ordering designation	EnDat22	EnDat01	–		
Positions per revolution	33554432 (25 bits)	892 (13 bits)	–		
Code	Pure binary		–		
Elec. permissible speed Deviation <sup>1)</sup>	n <sub>max</sub> for continuous position value	≤ 600 rpm/n <sub>max</sub> ± 1 LSB/± 50 LSB	–		
Calculation time t <sub>cal</sub> Clock frequency	≤ 7 μs ≤ 16 MHz	≤ 9 μs ≤ 2 MHz	–		
Incremental signals	Without	1 V <sub>PP</sub> <sup>2)</sup>			1 V <sub>PP</sub> <sup>2)</sup>
Line counts*	–	<b>2048</b>	1000 <b>1024</b> 2048	2500 3600	<b>5000</b>
Reference mark	–	–	One		
Cutoff frequency –3 dB Output frequency Edge separation a	– – –	≥ 400 kHz typical – –	– ≤ 300 kHz ≥ 0.39 μs	≥ 180 kHz typical – –	
<b>System accuracy</b>	±20"		1/20 of grating period		
<b>Electrical connection*</b>	<ul style="list-style-type: none"> <li>• <b>Flange socket</b> M12, radial</li> <li>• Cable 1 m/5 m, with M12 coupling</li> </ul>	<ul style="list-style-type: none"> <li>• <b>Flange socket</b> M23, radial</li> <li>• Cable 1 m/5 m, with or without coupling M23</li> </ul>	<ul style="list-style-type: none"> <li>• <b>Flange socket</b> M23, radial</li> <li>• <b>Cable, 1 m/5 m, with or without coupling</b> M23</li> </ul>		
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
<b>Shaft*</b>	Hollow through shaft D = 20 mm, <b>25 mm</b> , 38 mm, <b>50 mm</b>				
Mech. permissible speed n <sup>3)</sup>	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 <sup>4)</sup>	D = 50 mm 220 · 10 <sup>-6</sup> kgm <sup>2</sup> /≤ 5 · 10 <sup>4</sup> rad/s <sup>2</sup> ; D = 38 mm 350 · 10 <sup>-6</sup> kgm <sup>2</sup> /≤ 2 · 10 <sup>4</sup> rad/s <sup>2</sup> D = 25 mm 96 · 10 <sup>-6</sup> kgm <sup>2</sup> /≤ 3 · 10 <sup>4</sup> rad/s <sup>2</sup> ; D = 20 mm 100 · 10 <sup>-6</sup> kgm <sup>2</sup> /≤ 3 · 10 <sup>4</sup> rad/s <sup>2</sup>				
Permissible axial motion of measured shaft	±1.5 mm				
<b>Vibration</b> 55 Hz to 2000 Hz <b>Shock</b> 6 ms	≤ 200 m/s <sup>2</sup> ; <i>flange socket version</i> : ≤ 100 m/s <sup>2</sup> (EN 60068-2-6) ≤ 1000 m/s <sup>2</sup> (EN 60068-2-27)				
<b>Max. operating temp.</b> <sup>3)</sup>	100 °C (85 °C for ERN 130)				
<b>Min. operating temp.</b>	<i>Flange socket or fixed cable</i> : –40 °C; <i>moving cable</i> : –10 °C				
<b>Protection</b> <sup>3)</sup> EN 60529	IP 64				
<b>Mass</b>	0.6 kg to 0.9 kg depending on the hollow-shaft version				
<b>Valid for ID</b>	810801-xx	810800-xx	589611-xx	589612-xx	589614-xx

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

<sup>1)</sup> Velocity-dependent deviations between the absolute value and incremental signals

<sup>2)</sup> Restricted tolerances: signal amplitude 0.8 V<sub>PP</sub> to 1.2 V<sub>PP</sub>

<sup>3)</sup> For the correlation between degree of protection, shaft speed and operating temperature, see *General mechanical information*

<sup>4)</sup> At room temperature, calculated by calculation: material of mating shaft 1.4104

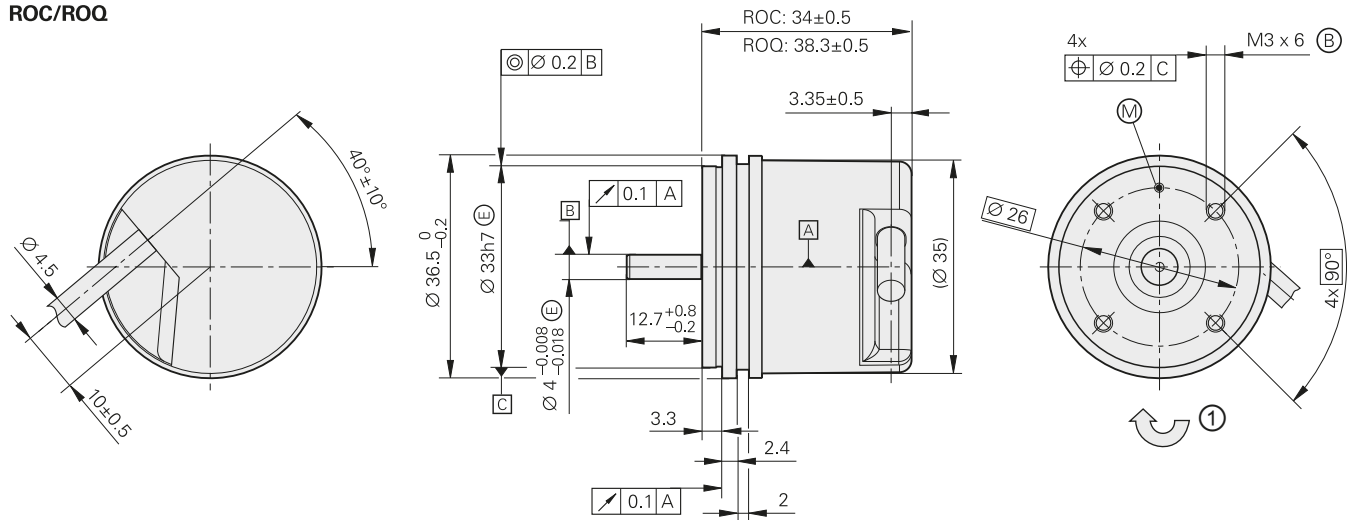
# ROC/ROQ/ROD 1000 series

Absolute and incremental rotary encoders

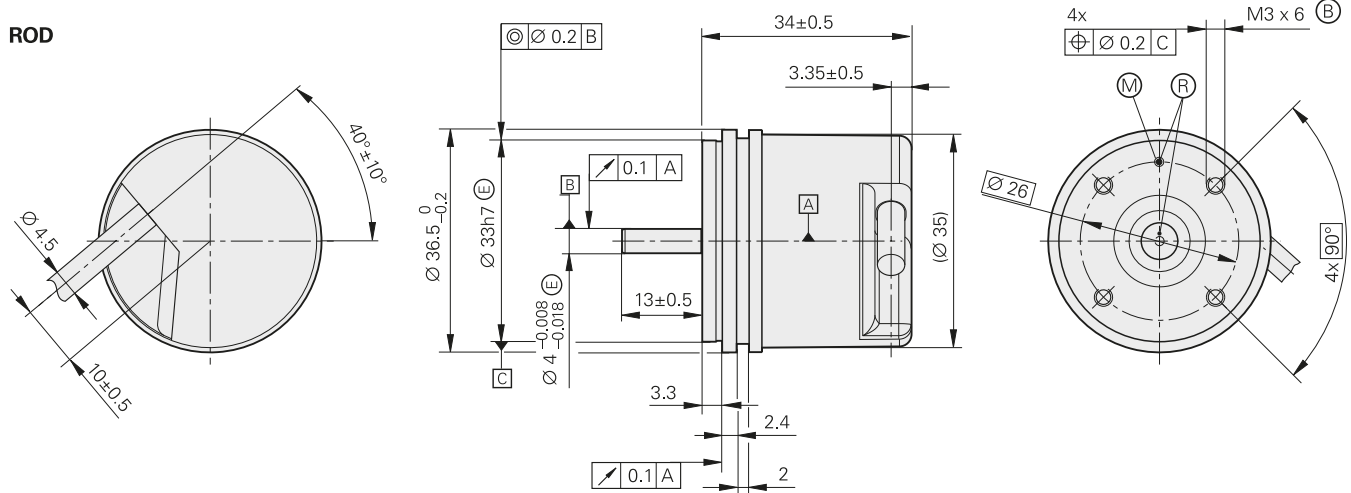
- Synchro flange
- Solid shaft for separate shaft coupling



## 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°  
 Ⓢ = Direction of shaft rotation for output signals as per the interface description

	Incremental			
	ROD 1020	ROD 1030	ROD 1080	ROD 1070
<b>Interface</b>	 TTL	 HTLs	 1 V <sub>PP</sub> <sup>1)</sup>	 TTL
Line counts*	100 200 <b>250</b>	360 400 <b>500</b>	720 900 <b>2048 2500 3600</b>	<b>1000 2500 3600</b>
Reference mark	One			
Integrated interpolation*	–			5-fold 10-fold
Cutoff frequency –3 dB	–	–	≥ 180 kHz	–
Scanning frequency	≤ 300 kHz	≤ 160 kHz	–	≤ 100 kHz
Edge separation a	≥ 0.39 μs	≥ 0.76 μs	–	≥ 0.47 μs
<b>System accuracy</b>	1/20 of grating period			
<b>Electrical connection</b>	<b>Cable, 1 m/5 m, with or without coupling M23</b>			<b>Cable, 5 m, without connecting element</b>
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
<b>Shaft</b>	Stub shaft Ø 4 mm			
Mechanically permissible speed n	≤ 12 000 rpm			
Starting torque	≤ 0.001 Nm (at 20 °C)			
Moment of inertia of rotor	≤ 0.5 · 10 <sup>-6</sup> kgm <sup>2</sup>			
Shaft load	<i>Axial:</i> 5 N <i>Radial:</i> 10 N at shaft end			
<b>Vibration</b> 55 Hz to 2000 Hz <b>Shock</b> 6 ms	≤ 100 m/s <sup>2</sup> (EN 60068-2-6) ≤ 1000 m/s <sup>2</sup> (EN 60068-2-27)			
<b>Max. operating temp.</b> <sup>2)</sup>	100 °C	70 °C	100 °C	70 °C
<b>Min. operating temp.</b>	<i>Stationary cable:</i> –30 °C; <i>moving cable:</i> –10 °C			
<b>Protection</b> EN 60 529	IP 64			
<b>Mass</b>	≈ 0.09 kg			
<b>Valid for ID</b>	534900-x	534901-xx	534904-xx	534903-xx

**Bold:** This preferred version is available on short notice.

\* Please select when ordering

<sup>1)</sup> Restricted tolerances: signal amplitude 0.8 V<sub>SS</sub> to 1.2 V<sub>PP</sub>

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



**Absolute**

**Singleturn**

**ROC 1023**

**ROC 1013**

<b>Interface*</b>	EnDat 2.2	EnDat 2.2	SSI
Ordering designation	EnDat22	EnDat01	SSI39r1
Positions per revolution	8388608 (23 bits)	892 (13 bits)	
Revolutions	–		
Code	Pure binary		Gray
Elec. permissible speed Deviation <sup>1)</sup>	≤ 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 <sub>PP</sub> <sup>2)</sup>	
Line count	–	512	
Cutoff frequency –3 dB	–	≥ 190 kHz	
<b>System accuracy</b>	±60''		
<b>Electrical connection</b>	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	
<b>Shaft</b>	Stub shaft Ø 4 mm		
Mech. permiss. speed n	12000 rpm		
Starting torque	≤ 0.001 Nm (at 20 °C)		
Moment of inertia of rotor	≈ 0.5 · 10 <sup>-6</sup> kgm <sup>2</sup>		
Shaft load	<i>Axial:</i> 5 N <i>Radial:</i> 10 N at shaft end		
<b>Vibration</b> 55 Hz to 2000 Hz <b>Shock</b> 6 ms	≤ 100 m/s <sup>2</sup> (EN 60068-2-6) ≤ 1000 m/s <sup>2</sup> (EN 60068-2-27)		
<b>Max. operating temp.</b>	100 °C		
<b>Min. operating temp.</b>	<i>Stationary cable:</i> –30 °C; <i>moving cable:</i> –10 °C		
<b>Protection</b> EN 60529	IP 64		
<b>Mass</b>	≈ 0.09 kg		
<b>Valid for ID</b>	606693-xx	606691-xx	606692-xx

\* Please select when ordering

<sup>1)</sup> Velocity-dependent deviations between the absolute and incremental signals

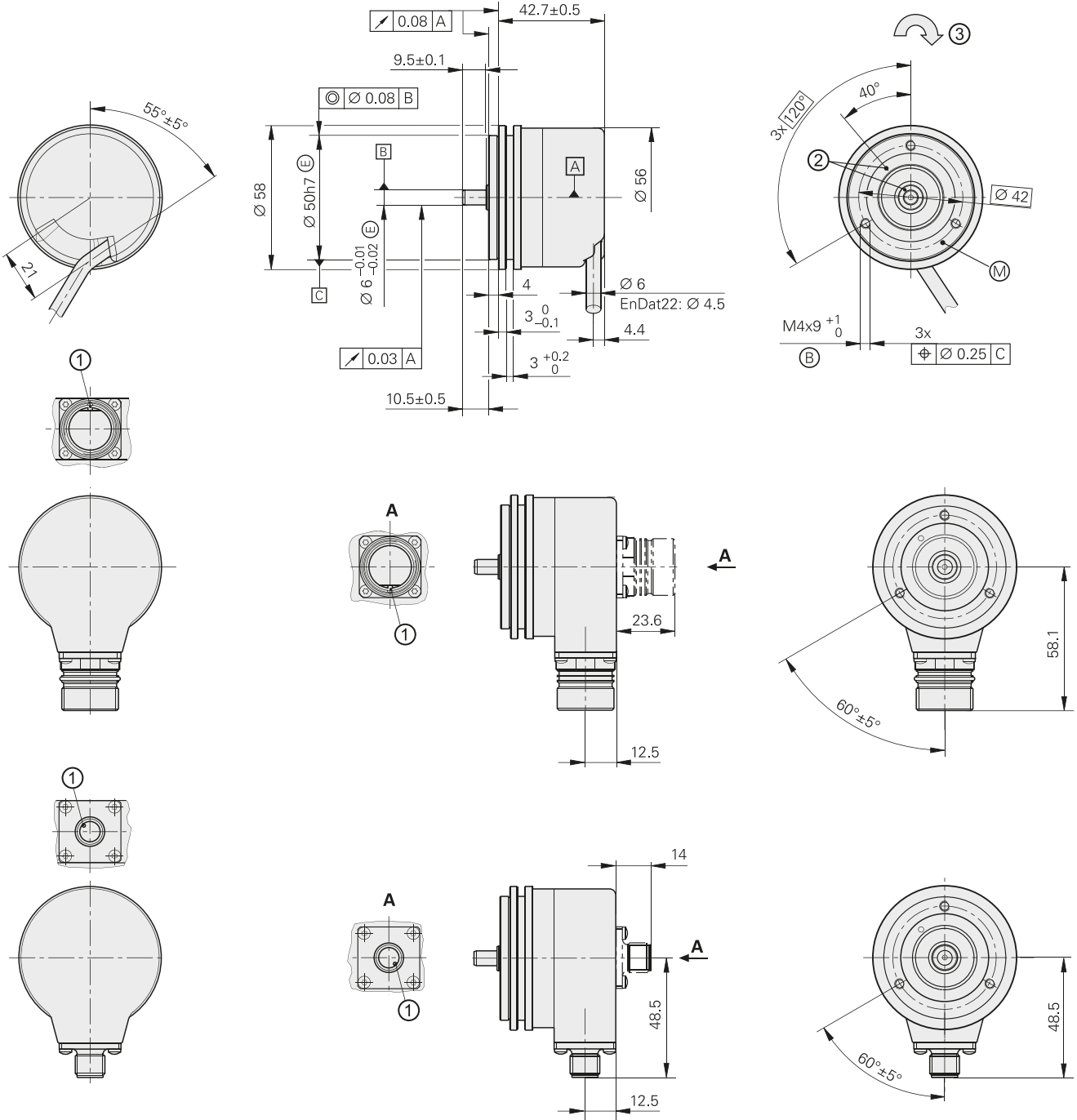
<sup>2)</sup> Restricted tolerances: signal amplitude 0.8 V<sub>PP</sub> to 1.2 V<sub>PP</sub>

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 <sub>PP</sub> <sup>2)</sup>	
–	512	
–	≥ 190 kHz	
Cable 1 m, with M12 coupling		
Cable 1 m, with M23 coupling		
DC 3.6 V to 14 V		DC 4.75 V 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 <sub>PP</sub> <sup>1)</sup>							
Line counts*	50	100	150	200	250	360	<b>500</b>	512	720	-		
	<b>1000</b>	<b>1024</b>	<b>1250</b>	1500	1800	<b>2000</b>	<b>2048</b>	<b>2500</b>	<b>3600</b>	<b>4096</b>	<b>5000</b>	
	6000 <sup>2)</sup>			8192 <sup>2)</sup>			9000 <sup>2)</sup>			10000 <sup>2)</sup>		
Reference mark	One											
Cutoff frequency -3 dB	-									≥ 180 kHz		
Scanning frequency	≤ 300 kHz/≤ 150 kHz <sup>2)</sup>									-		
Edge separation a	≥ 0.39 μs/≥ 0.25 μs <sup>2)</sup>									-		
System accuracy	1/20 of grating period											
Electrical connection*	<ul style="list-style-type: none"> <li>• <b>Flange socket</b> M23, radial and axial</li> <li>• <b>Cable 1 m/5 m</b>, with or <b>without coupling</b> M23</li> </ul>											
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	Stub 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 · 10 <sup>-6</sup> kgm <sup>2</sup>											
Shaft load <sup>3)</sup>	<i>Axial</i> : ≤ 40 N; <i>radial</i> : ≤ 60 N at shaft end											
<b>Vibration</b> 55 Hz to 2000 Hz	≤ 300 m/s <sup>2</sup> (EN 60068-2-6)											
<b>Shock</b> 6 ms	≤ 2000 m/s <sup>2</sup> (EN 60068-2-27)											
<b>Max. operating temp.</b> <sup>4)</sup>	100 °C			70 °C			100 °C <sup>5)</sup>					
<b>Min. operating temp.</b>	<i>Flange socket or fixed cable</i> : -40 °C; <i>moving cable</i> : -10 °C											
<b>Protection</b> EN 60 529	IP 67 at housing, IP 64 at shaft inlet (IP 66 upon request)											
<b>Mass</b>	≈ 0.3 kg											
<b>Valid for ID</b>	376846-xx			376866-xx			376836-xx			376886-xx		

**Bold:** This preferred version is available on short notice.

\* Please select when ordering

1) Restricted tolerances: signal amplitude 0.8 V<sub>SS</sub> to 1.2 V<sub>PP</sub>

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 the operating temperature and the shaft speed or supply voltage, see *General mechanical information*

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




**Absolute**
**Singleturn**
**ROC 425**


**ROC 413**
**RIC 418**

<b>Interface*</b>	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)		262 144 (18 bits)
Revolutions	–			
Code	Pure binary		Gray	Pure binary
Elec. permissible speed Deviation <sup>1)</sup>	≤ 15000 rpm for continuous position value	<i>512 lines:</i> ≤ 5000/12000 rpm ± 1 LSB/± 100 LSB <i>2048 lines:</i> ≤ 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	$\sim 1 V_{PP}$ <sup>2)</sup>		$\sim 1 V_{PP}$
Line counts*	–	<b>512</b> 2048	<b>512</b>	<b>16</b>
Cutoff frequency –3 dB	–	<i>512 lines:</i> ≥ 130 kHz; <i>2048 lines:</i> ≥ 400 kHz		≥ 6 kHz
<b>System accuracy</b>	±20''	<i>512 lines:</i> ±60''; <i>2048 lines:</i> ±20''		±480''
<b>Electrical connection*</b>	<ul style="list-style-type: none"> <li>• <b>Flange socket</b> M12, radial</li> <li>• Cable 1 m, with M12 coupling</li> </ul>	<ul style="list-style-type: none"> <li>• <b>Flange socket</b> M23, axial or radial</li> <li>• Cable 1 m/5 m, with or without coupling M23</li> </ul>		<ul style="list-style-type: none"> <li>• <b>Flange socket</b> M23, radial</li> <li>• Cable 1 m, with M23 coupling</li> </ul>
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.)	<i>3.6 V:</i> ≤ 0.6 W <i>14 V:</i> ≤ 0.7 W	<i>5 V:</i> ≤ 0.8 W <i>10 V:</i> ≤ 0.65 W <i>30 V:</i> ≤ 1 W		<i>5 V:</i> ≤ 0.95 W
Current consumption (typical, without load)	<i>5 V:</i> 85 mA	<i>5 V:</i> 90 mA <i>24 V:</i> 24 mA		<i>5 V:</i> 125 mA
<b>Shaft</b>	Stub 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 · 10 <sup>-6</sup> kgm <sup>2</sup>			
Shaft load	<i>Axial:</i> ≤ 40 N; <i>radial:</i> ≤ 60 N at shaft end (see also <i>Mechanical design types and mounting</i> )			
<b>Vibration</b> 55 Hz to 2000 Hz <b>Shock</b> 6 ms	≤ 300 m/s <sup>2</sup> (EN 60068-2-6) <i>ROC/ROQ:</i> ≤ 2000 m/s <sup>2</sup> ; <i>RIC/RIQ:</i> ≤ 1000 m/s <sup>2</sup> (EN 60068-2-27)			
<b>Max. operating temp.</b> <sup>3)</sup>	100 °C			
<b>Min. operating temp.</b>	<i>Flange socket or fixed cable:</i> –40 °C; <i>moving cable:</i> –10 °C			
<b>Protection</b> EN 60 529	IP 67 at housing, IP 64 at shaft inlet <sup>3)</sup> (IP 66 upon request)			
<b>Mass</b>	≈ 0.35 kg			
<b>Valid for ID</b>	683639-xx	1109254-xx	1131750-xx	642004-xx

**Bold:** This preferred version is available on short notice.

\* Please select when ordering

<sup>1)</sup> Velocity-dependent deviations between the absolute value and incremental signals

Multiturn ROQ 437 		ROQ 425		RIQ 430
EnDat 2.2		EnDat 2.2		EnDat 2.1
EnDat22		EnDat01		EnDat01
33554432 (25 bits)		8192 (13 bits)		262 144 (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		≤ 4000/15000 rpm ± 400 LSB/± 800 LSB
≤ 7 μs ≤ 8 MHz		≤ 9 μs ≤ 2 MHz		≤ 5 μs –
Without		~ 1 V <sub>PP</sub> <sup>2)</sup>		~ 1 V <sub>PP</sub>
–		<b>512</b> 2048		<b>16</b>
–		512 lines: ≥ 130 kHz; 2048 lines: ≥ 400 kHz		≥ 6 kHz
±20"		512 lines: ±60"; 2048 lines: ±20"		±480"
<ul style="list-style-type: none"> <li>• Flange socket M12, radial</li> <li>• Cable 1 m, with M12 coupling</li> </ul>		<ul style="list-style-type: none"> <li>• Flange socket M23, axial or radial</li> <li>• Cable 1 m/5 m, with or without coupling M23</li> </ul>		<ul style="list-style-type: none"> <li>• Flange socket M23, radial</li> <li>• Cable 1 m, with M23 coupling</li> </ul>
DC 3.6 V to 14 V		DC 3.6 V to 14 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		1109256-xx		1131752-xx
				642000-xx

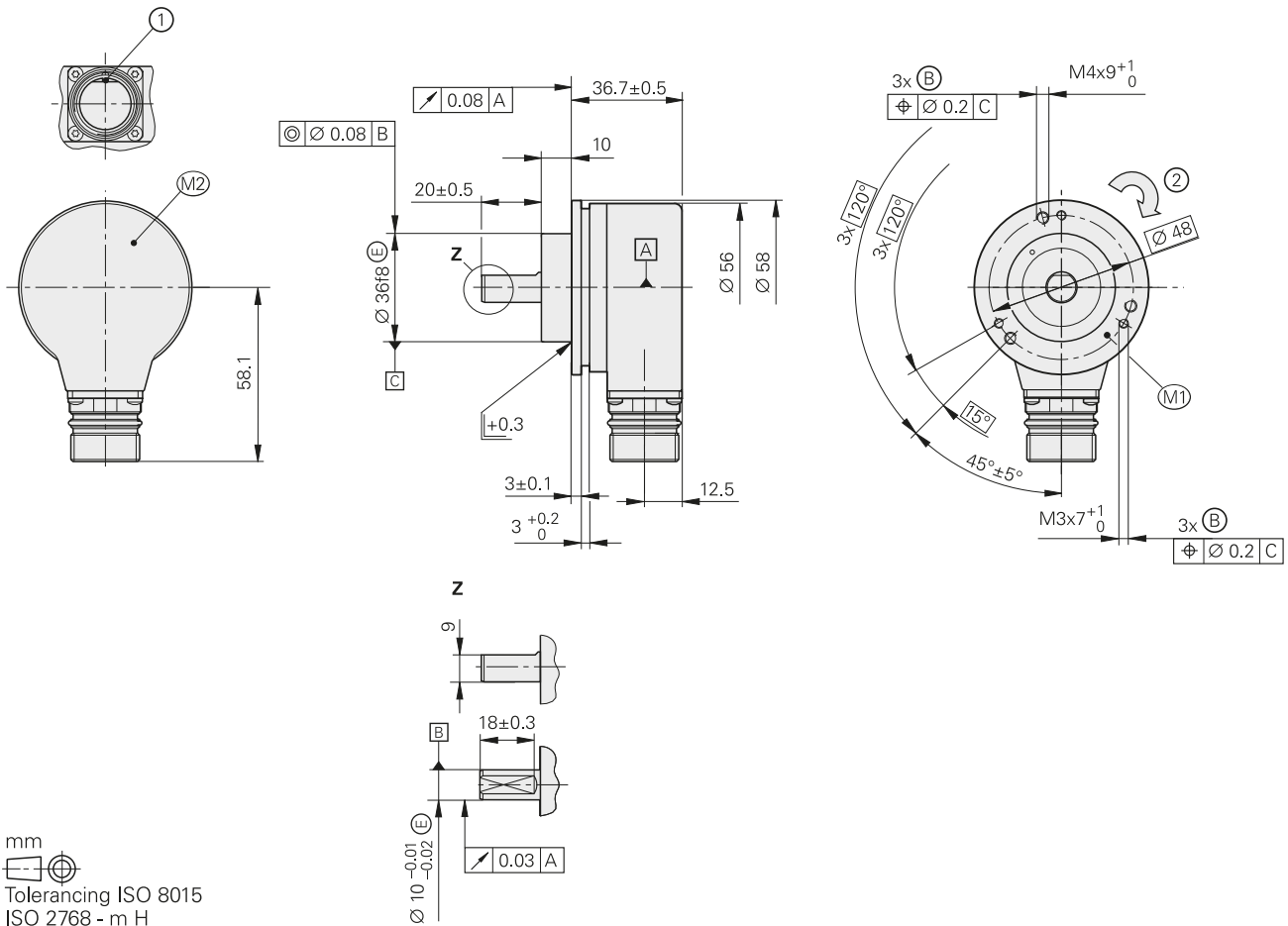
<sup>2)</sup> Restricted tolerances: signal amplitude 0.8 V<sub>PP</sub> to 1.2 V<sub>PP</sub>

<sup>3)</sup> For the correlation between the operating temperature and the shaft speed or supply voltage, see *General mechanical information*  
**Functional safety** available for ROC 425 and ROQ 437. For dimensions and specifications see Product Information

# 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

<b>Absolute Multiturn ROQ 425</b>						
<b>Interface</b>	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	$\leq 9 \mu\text{s}$ $\leq 2 \text{ MHz}$					
Incremental signals	HTL			TTL		
Signal periods *	512	1024	2048	512	2048	4096
Edge separation a	$\geq 2.4 \mu\text{s}$	$\geq 0.8 \mu\text{s}$	$\geq 0.6 \mu\text{s}$	$\geq 2.4 \mu\text{s}$	$\geq 0.6 \mu\text{s}$	$\geq 0.2 \mu\text{s}$
Output frequency	$\leq 52 \text{ kHz}$	$\leq 103 \text{ kHz}$	$\leq 205 \text{ kHz}$	$\leq 52 \text{ kHz}$	$\leq 205 \text{ kHz}$	$\leq 410 \text{ kHz}$
<b>System accuracy</b>	$\pm 60''$	$\pm 60''$	$\pm 20''$	$\pm 60''$	$\pm 20''$	$\pm 20''$
<b>Electrical connection</b>	M23 flange socket (male), 17-pin, radial					
Cable length <sup>2)</sup>	$\leq 100 \text{ m}$ (with HEIDENHAIN cable)					
Voltage supply	DC 10 V to 30 V			DC 4.75 V to 30 V		
Power consumption (max.) <sup>3)</sup>	See <i>Power consumption</i> diagram			At 4.75 V: $\leq 900 \text{ mW}$ At 30 V: $\leq 1100 \text{ mW}$		
Current consumption (typical, without load)	At 10 V: $\leq 56 \text{ mA}$ At 24 V: $\leq 34 \text{ mA}$			At 5 V: $\leq 100 \text{ mA}$ At 24 V: $\leq 25 \text{ mA}$		
<b>Shaft</b>	Stub shaft $\varnothing 10 \text{ mm}$ with flat					
Mech. permissible speed $n^{4)}$	$\leq 12000 \text{ rpm}$					
Starting torque at 20 °C	$\leq 0.01 \text{ Nm}$					
Moment of inertia of rotor	$2.7 \cdot 10^{-6} \text{ kgm}^2$					
Shaft load	Axial: $\leq 40 \text{ Nm}$ Radial: $\leq 60 \text{ Nm}$ at shaft end (see also <i>Mechanical design types and mounting</i> )					
<b>Vibration</b> 10 Hz to 2000 Hz <sup>5)</sup> <b>Shock</b> 6 ms	$\leq 150 \text{ m/s}^2$ (EN 60068-2-6) $\leq 1000 \text{ m/s}^2$ (EN 60068-2-27)					
<b>Max. operating temp.</b> <sup>4)</sup>	100 °C					
<b>Min. operating temp.</b>	-40 °C					
<b>Protection</b> EN 60 529	Housing: IP67 Shaft exit: IP66					
<b>Mass</b>	$\approx 0.30 \text{ kg}$					
<b>Valid for ID</b>	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* diagram)

3) See *General electrical information* in the brochure *Interfaces for HEIDENHAIN Encoders*

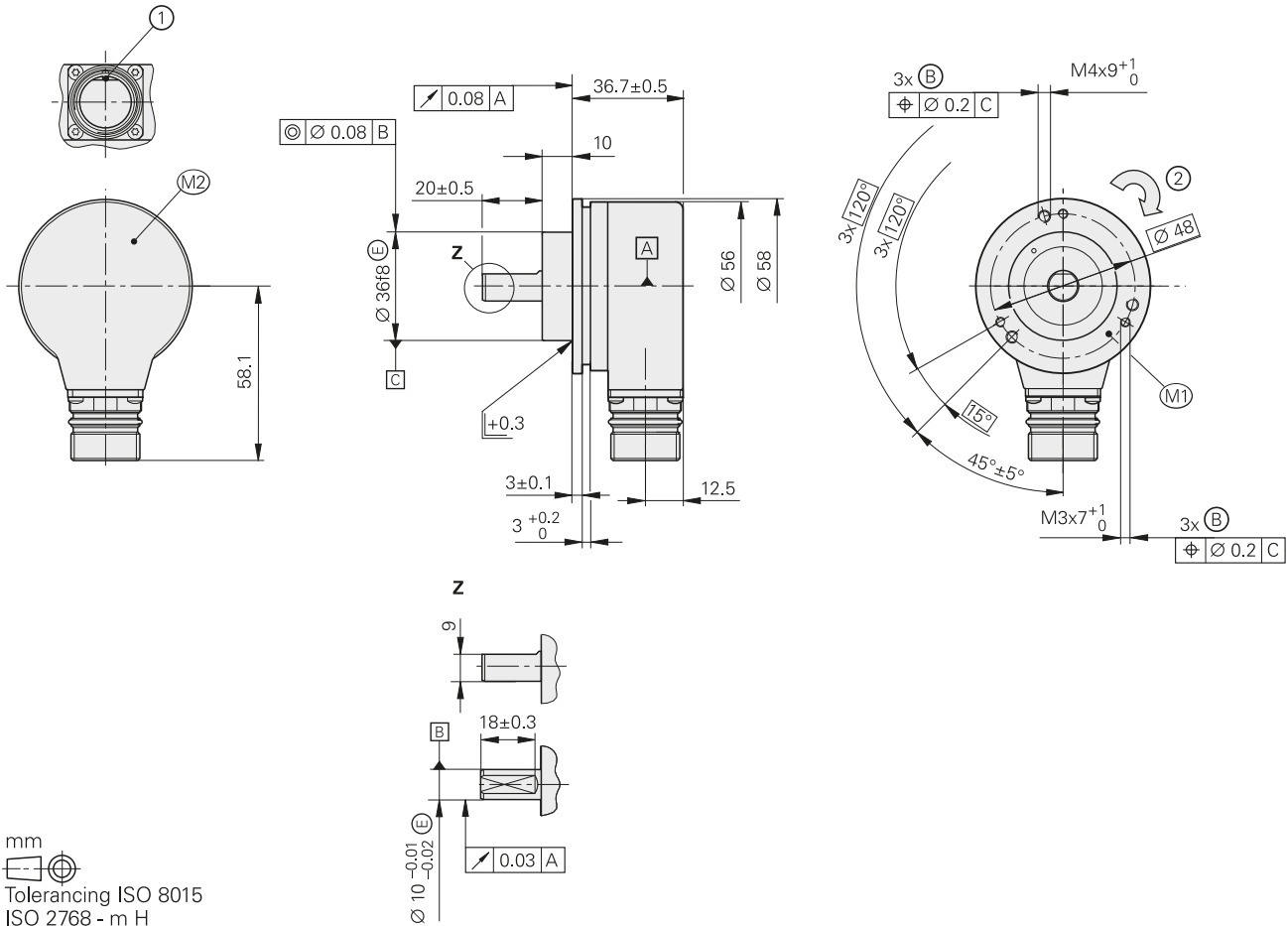
4) For the correlation between the operating temperature and the shaft speed or supply voltage, see *General mechanical information*

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



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

<b>Absolute Multiturn ROQ 425</b>						
<b>Interface</b>	SSI					
Ordering designation*	SSI41H			SSI41T		
Positions per revolution	8192 (13 bits)					
Revolutions	4096 (12 bits)					
Code	Pure binary					
Calculation time $t_{cal}$ Clock frequency	$\leq 9 \mu s$ $\leq 2 \text{ MHz}$					
Incremental signals	HTL <sup>6)</sup>			TTL		
Signal periods *	512	1024	2048	512	2048	4096
Edge separation a	$\geq 2.4 \mu s$	$\geq 0.8 \mu s$	$\geq 0.6 \mu s$	$\geq 2.4 \mu s$	$\geq 0.6 \mu s$	$\geq 0.2 \mu s$
Output frequency	$\leq 52 \text{ kHz}$	$\leq 103 \text{ kHz}$	$\leq 205 \text{ kHz}$	$\leq 52 \text{ kHz}$	$\leq 205 \text{ kHz}$	$\leq 410 \text{ kHz}$
<b>System accuracy</b>	$\pm 60''$	$\pm 60''$	$\pm 20''$	$\pm 60''$	$\pm 20''$	$\pm 20''$
<b>Electrical connection</b>	M23 flange socket (male), 17-pin, radial					
Cable length <sup>2)</sup>	$\leq 100 \text{ m}$ (with HEIDENHAIN cable)					
Voltage supply	DC 10 V to 30 V			DC 4.75 V to 30 V		
Power consumption (max.) <sup>3)</sup>	See <i>Power consumption</i> diagram			At 4.75 V: $\leq 900 \text{ mW}$ At 30 V: $\leq 1100 \text{ mW}$		
Current consumption (typical, without load)	At 10 V: $\leq 56 \text{ mA}$ At 24 V: $\leq 34 \text{ mA}$			At 5 V: $\leq 100 \text{ mA}$ At 24 V: $\leq 25 \text{ mA}$		
<b>Shaft</b>	Stub shaft $\varnothing 10 \text{ mm}$ with flat					
Mech. permissible speed n <sup>4)</sup>	$\leq 12000 \text{ rpm}$					
Starting torque at 20 °C	$\leq 0.01 \text{ Nm}$					
Moment of inertia of rotor	$2.7 \cdot 10^{-6} \text{ kgm}^2$					
Shaft load	Axial: $\leq 40 \text{ Nm}$ Radial: $\leq 60 \text{ Nm}$ at shaft end (see also <i>Mechanical design types and mounting</i> )					
<b>Vibration</b> 10 Hz to 2000 Hz <sup>5)</sup> <b>Shock</b> 6 ms	$\leq 150 \text{ m/s}^2$ (EN 60068-2-6) $\leq 1000 \text{ m/s}^2$ (EN 60068-2-27)					
<b>Max. operating temp.</b> <sup>4)</sup>	100 °C					
<b>Min. operating temp.</b>	-40 °C					
<b>Protection</b> EN 60 529	Housing: IP67 Shaft exit: IP66					
<b>Mass</b>	$\approx 0.30 \text{ kg}$					
<b>Valid for ID</b>	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* diagram)

3) See *General electrical information* in the brochure *Interfaces for HEIDENHAIN Encoders*

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

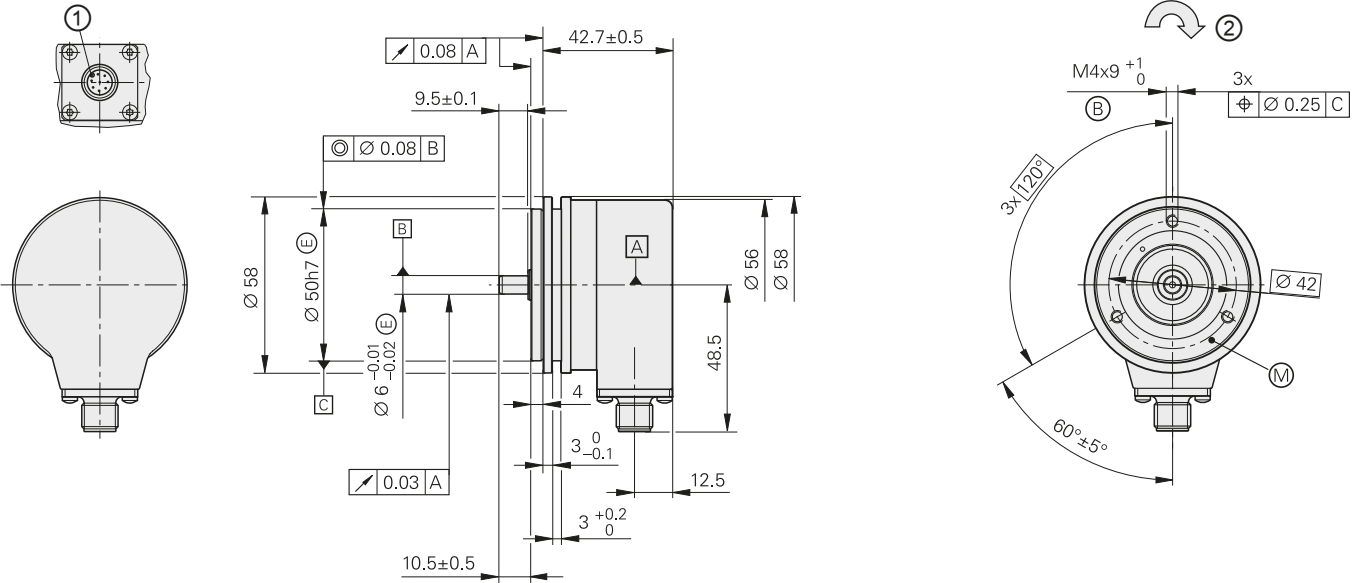
# ROC/ROQ 400F/M/S series

Absolute rotary encoders

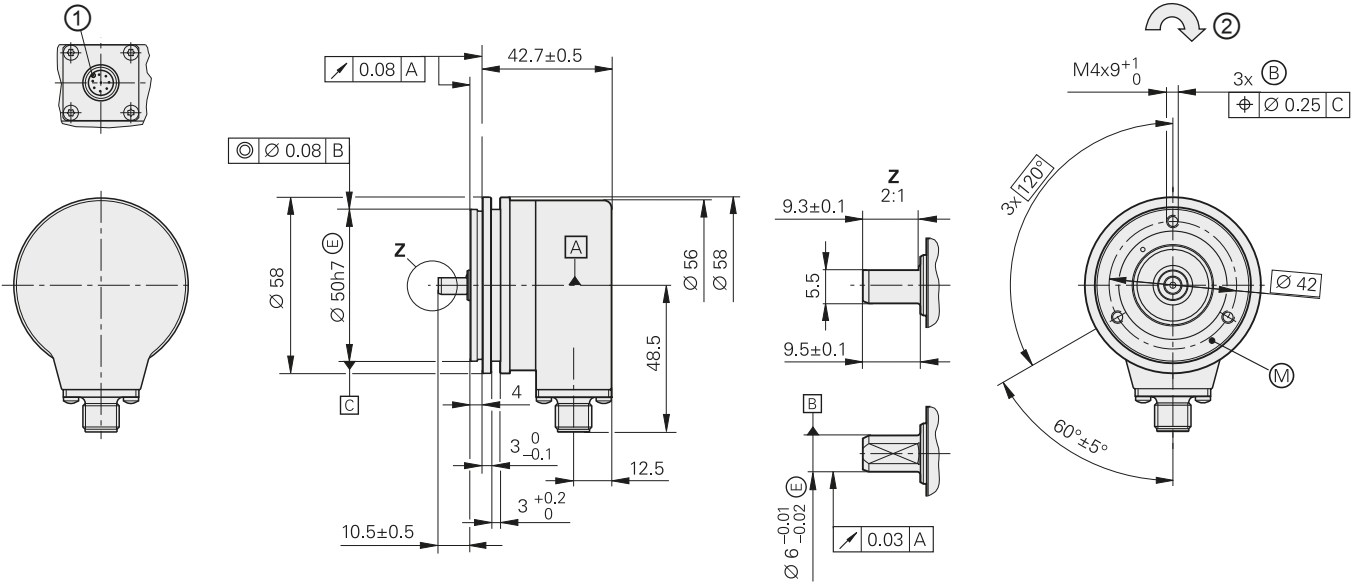
- Synchro flange
- Solid shaft for separate shaft coupling
- Fanuc Serial Interface, Mitsubishi high speed interface and Siemens DRIVE-CLiQ interface



## ROC/ROQ 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.



	<b>Absolute</b>					
	<b>Singletum</b>			<b>Multitum</b>		
	ROC 425 F	ROC 425 M	ROC 424 S 	ROQ 437 F	ROQ 435 M	ROQ 436 S 
<b>Interface</b>	Fanuc Serial Interface; $\alpha$ i Interface	Mitsubishi high speed interface	DRIVE-CLiQ	Fanuc Serial Interface; $\alpha$ i Interface	Mitsubishi high speed interface	DRIVE-CLiQ
Ordering designation	Fanuc05	Mit03-4	DQ01	Fanuc05	Mit03-4	DQ01
Positions per revolution	$\alpha$ i: 33554432 (25 bits) $\alpha$ : 8388608 (23 bits)	33554432 (25 bits)	16777216 (24 bits)	33554432 (25 bits)	8388608 (23 bits)	16777216 (24 bits)
Revolutions	8192 via revolution counter	–		$\alpha$ i: 4096 $\alpha$ : 2048	4096	4096
Code	Pure binary					
Elec. permissible speed	≤ 15000 rpm for continuous position value					
Calculation time $t_{cal}$	≤ 5 $\mu$ s	–	≤ 8 $\mu$ s <sup>3)</sup>	≤ 5 $\mu$ s	–	≤ 8 $\mu$ s <sup>3)</sup>
Incremental signals	Without					
<b>System accuracy</b>	±20"					
<b>Electrical connection</b>	Flange socket M12, radial					
Cable length	≤ 30 m		≤ 95 m <sup>2)</sup>	≤ 30 m		≤ 95 m <sup>2)</sup>
DC voltage supply	3.6 to 14 V		10 V to 36 V	3.6 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
<b>Shaft</b>	Stub shaft $\varnothing$ 6 mm (with ROC 424 S and ROQ 436 S 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 · 10 <sup>-6</sup> kgm <sup>2</sup>					
Shaft load	<i>Axial</i> : 40 N; <i>radial</i> : 60 N at shaft end (see also <i>Mechanical design types and mounting</i> )					
<b>Vibration</b> 55 Hz to 2000 Hz <b>Shock</b> 6 ms	≤ 300 m/s <sup>2</sup> (EN 60068-2-6) ≤ 2000 m/s <sup>2</sup> (EN 60068-2-27)					
<b>Max. operating temp.</b> <sup>1)</sup>	100 °C					
<b>Min. operating temp.</b>	–30 °C					
<b>Protection</b> EN 60 529	IP67 at housing; IP64 at shaft inlet					
<b>Mass</b>	≈ 0.35 kg					
<b>Valid for ID</b>	1081305-xx	1096726-xx	1036789-xx	1081303-xx	1096728-xx	1036786-xx

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

<sup>2)</sup> See *Interfaces of HEIDENHAIN encoders*; catalog with  $n_{MG} = 1$  (incl. adapter cable)

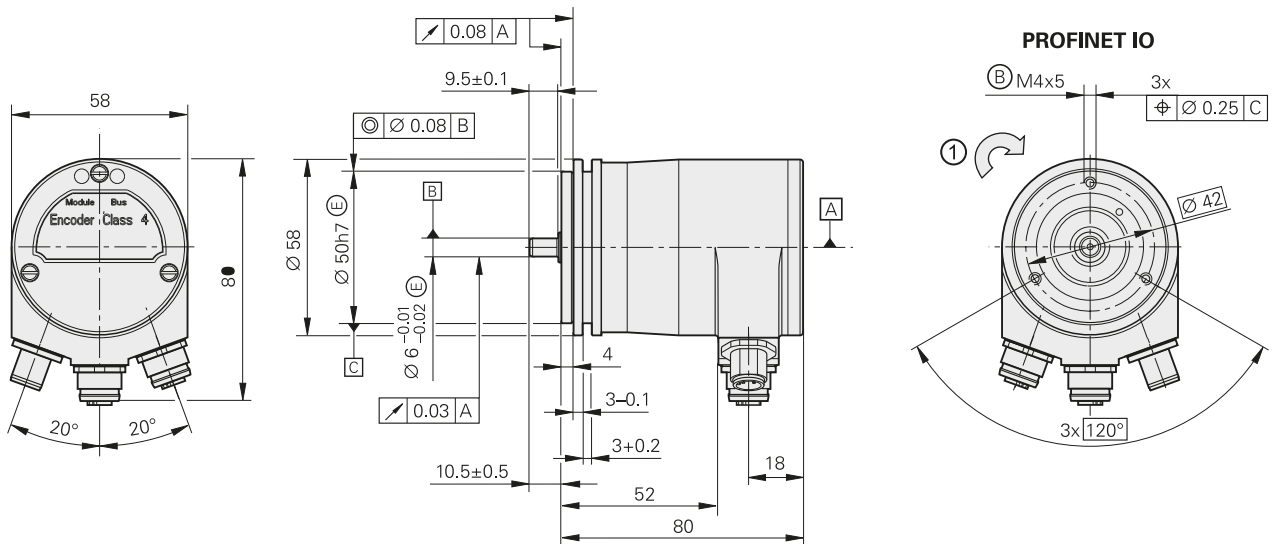
<sup>3)</sup> Processing time  $T_{IME\_MAX\_ACTVAL}$

**Functional safety** for ROC 424 S and ROQ 436 S available, For dimensions and specifications see Product Information

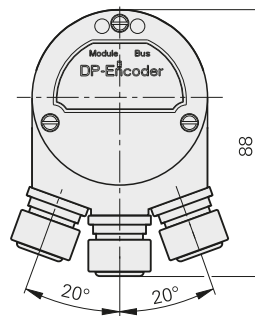
# ROC/ROQ 400 series

## Absolute rotary encoders

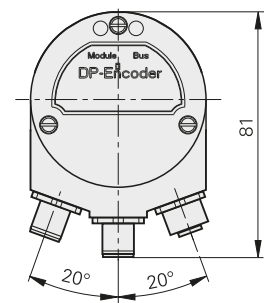
- Synchro flange
- Solid shaft for separate shaft coupling
- Fieldbus interface



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

	<b>Absolute</b>			
	<b>Singletum ROC 413</b>		<b>Multitum ROQ 425</b>	
<b>Interface*</b>	PROFIBUS-DP <sup>1)</sup>	PROFINET IO	PROFIBUS-DP <sup>1)</sup>	PROFINET IO
Positions per revolution	8192 (13 bits) <sup>2)</sup>			
Revolutions	–		4096 <sup>2)</sup>	
Code	Pure binary			
Elec. permissible speed	≤ 12000 rpm for continuous position value		≤ 10000 rpm for continuous position value	
Incremental signals	Without			
<b>System accuracy</b>	±60"			
<b>Electrical connection*</b>	Cable gland M16 <sup>4)</sup>	Three M12 flange sockets, radial	Cable gland M16 <sup>4)</sup>	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			
<b>Shaft</b>	Stub shaft Ø 6 mm			
Mech. permiss. speed n	≤ 6000 rpm			
Starting torque	≤ 0.01 Nm (at 20 °C)			
Moment of inertia of rotor	≤ 2.7 · 10 <sup>-6</sup> kgm <sup>2</sup>			
Shaft load	<i>Axial: ≤ 40 N; radial: ≤ 60 N at shaft end (see also Mechanical design types and mounting)</i>			
<b>Vibration</b> 55 Hz to 2000 Hz <b>Shock</b> 6 ms	≤ 100 m/s <sup>2</sup> (EN 60068-2-6) ≤ 2000 m/s <sup>2</sup> (EN 60068-2-27)			
<b>Max. operating temp.</b> <sup>3)</sup>	70 °C			
<b>Min. operating temp.</b>	–40 °C			
<b>Protection</b> EN 60 529	IP 67 at housing, IP 64 at shaft inlet (IP 66 upon request)			
<b>Mass</b>	≈ 0.35 kg			
<b>Valid for ID</b>	549882-xx	752518-xx	549884-xx	752520-xx

\* Please select when ordering

<sup>1)</sup> Supported profiles: DP-V0, DP-V1, DP-V2

<sup>2)</sup> Programmable

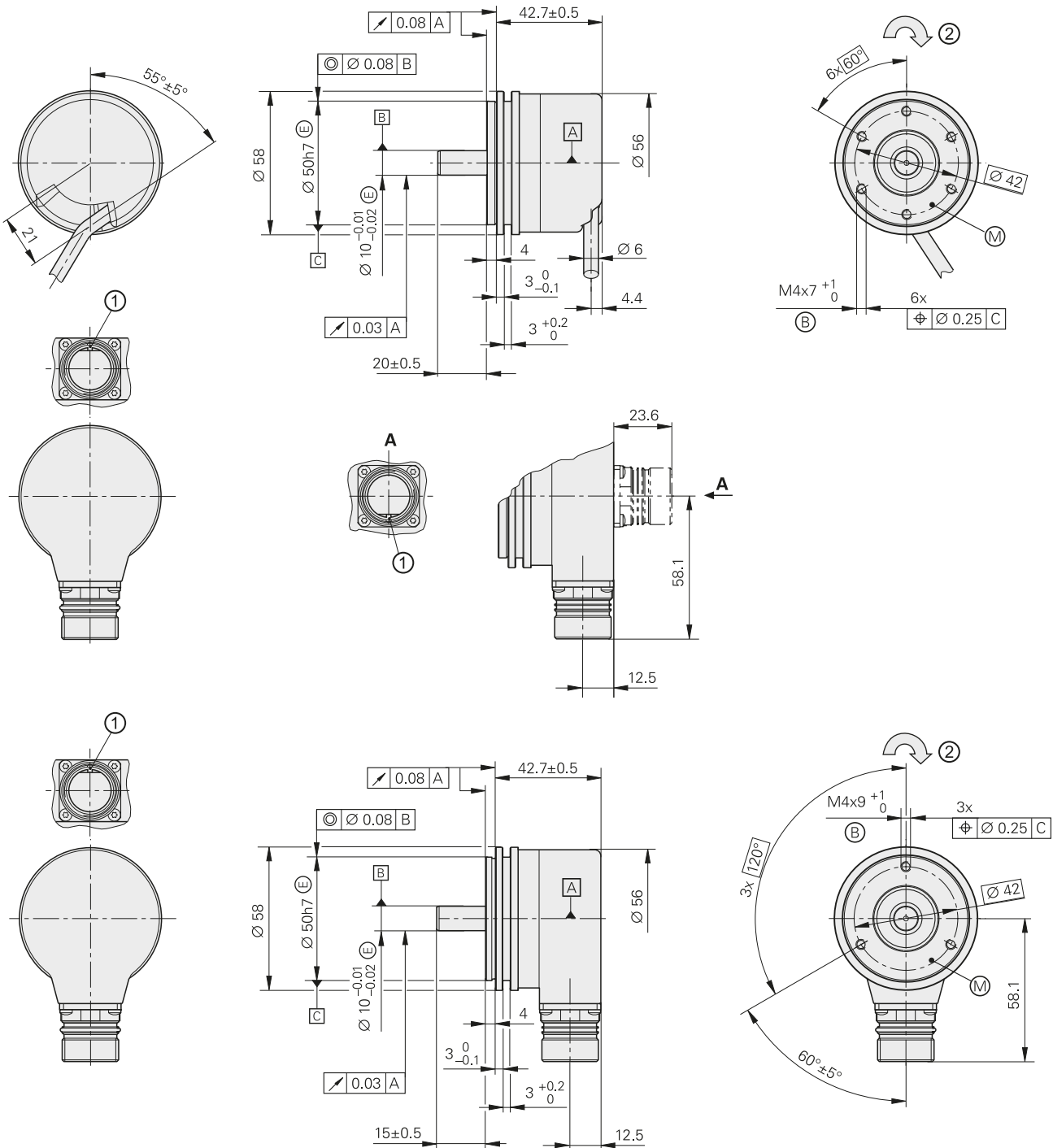
<sup>3)</sup> For the correlation between the operating temperature and the shaft speed or supply voltage, see *General mechanical information*

<sup>4)</sup> 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  
 ▣ = 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

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

	<b>Absolute Singletum</b>	
	<b>ROC 425</b>	<b>ROC 425, stainless steel</b>
<b>Interface</b>	EnDat 2.2	
Ordering designation	EnDat01	
Positions per revolution	33554432 (25 bits)	
Revolutions	–	
Code	Pure binary	
Elec. permissible speed Deviation <sup>1)</sup>	≤ 1500/15000 rpm ± 1200 LSB/± 9200 LSB	
Calculation time $t_{cal}$ Clock frequency	≤ 9 μs ≤ 2 MHz	
Incremental signals	~ 1 V <sub>PP</sub>	
Line count	2048	
Cutoff frequency –3 dB	≥ 400 kHz	
<b>System accuracy</b>	±10"	
<b>Electrical connection*</b>	<ul style="list-style-type: none"> <li>• <b>Flange socket</b> M23, axial or radial</li> <li>• Cable 1 m/5 m, with or without coupling M23</li> </ul>	<ul style="list-style-type: none"> <li>• <b>Flange socket</b> M23, radial</li> </ul>
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	
<b>Shaft</b>	Stub shaft Ø 10 mm, length 20 mm	Stub shaft Ø 10 mm, length 15 mm
Mechanically permissible speed $n$	≤ 12000 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 · 10 <sup>-6</sup> kgm <sup>2</sup>	
Shaft load	<i>Axial: ≤ 40 N; radial: ≤ 60 N at shaft end (see also Mechanical design types and mounting)</i>	
<b>Vibration</b> 55 Hz to 2000 Hz <b>Shock</b> 6 ms	≤ 300 m/s <sup>2</sup> (EN 60068-2-6) ≤ 2000 m/s <sup>2</sup> (EN 60068-2-27)	
<b>Max. operating temp.</b> <sup>3)</sup>	80 °C	
<b>Min. operating temp.</b>	<i>Flange socket or fixed cable: -40 °C; moving cable: -10 °C</i>	
<b>Protection</b> EN 60 529	IP67 at housing; IP66 at shaft inlet	
<b>Mass</b>	≈ 0.50 kg	≈ 0.55 kg
<b>Valid for ID</b>	638726-xx	1080335-xx

**Bold:** This preferred version is available on short notice.

\* Please select when ordering

<sup>1)</sup> Velocity-dependent deviations between the absolute value and incremental signals

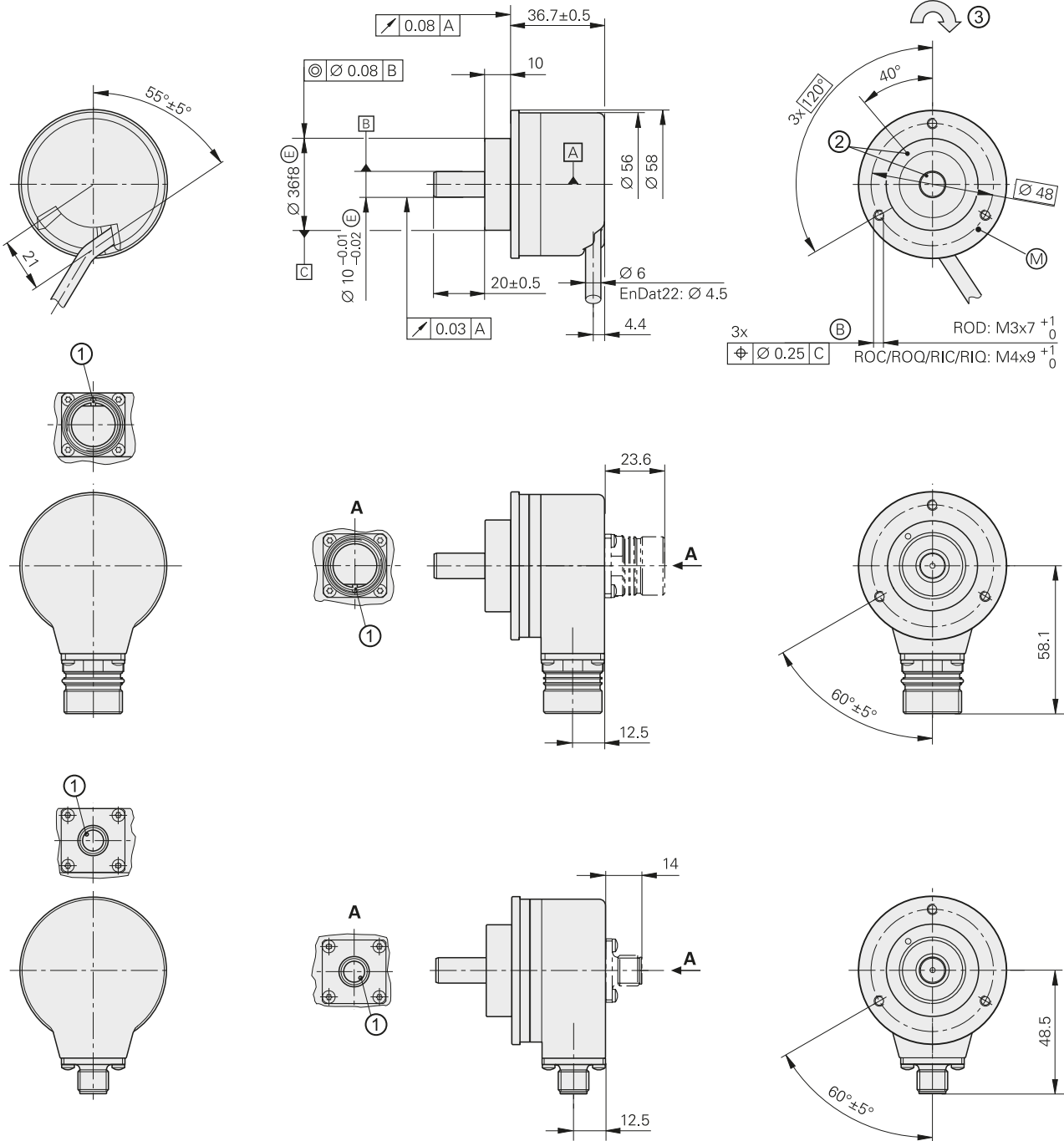
<sup>2)</sup> Restricted tolerances: signal amplitude 0.8 V<sub>SS</sub> to 1.2 V<sub>PP</sub>

<sup>3)</sup> 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
<b>Interface</b>	□□TTL					□□HTL					~ 1 V <sub>PP</sub> <sup>1)</sup>
Line counts*	50	100	150	200	250	360	<b>500</b>	512	720	-	
	<b>1000</b>	<b>1024</b>	<b>1250</b>	1500	1800	<b>2000</b>	<b>2048</b>	<b>2500</b>	<b>3600</b>	<b>4096</b>	<b>5000</b>
Reference mark	One										
Cutoff frequency -3 dB	-									≥ 180 kHz	
Output frequency	≤ 300 kHz									-	
Edge separation a	≥ 0.39 μs									-	
<b>System accuracy</b>	1/20 of grating period										
<b>Electrical connection*</b>	<ul style="list-style-type: none"> <li>• <b>Flange socket</b> M23, radial and axial</li> <li>• <b>Cable 1 m/5 m</b>, with or <b>without coupling</b> M23</li> </ul>										
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
<b>Shaft</b>	Stub shaft Ø 10 mm										
Mech. permiss. speed n	≤ 16000 rpm										
Starting torque	≤ 0.01 Nm (at 20 °C)										
Moment of inertia of rotor	≤ 2.1 · 10 <sup>-6</sup> kgm <sup>2</sup>										
Shaft load <sup>2)</sup>	<i>Axial</i> : ≤ 40 N; <i>radial</i> : ≤ 60 N at shaft end										
<b>Vibration</b> 55 Hz to 2000 Hz	≤ 300 m/s <sup>2</sup> (EN 60068-2-6)										
<b>Shock</b> 6 ms	≤ 2000 m/s <sup>2</sup> (EN 60068-2-27)										
<b>Max. operating temp.</b> <sup>3)</sup>	100 °C (80 °C for ROD 480 with 4096 or 5000 lines)										
<b>Min. operating temp.</b>	<i>Flange socket or fixed cable</i> : -40 °C <i>Moving cable</i> : -10 °C										
<b>Protection</b> EN 60 529	IP 67 at housing, IP 64 at shaft inlet (IP 66 upon request)										
<b>Mass</b>	≈ 0.3 kg										
<b>Valid for ID</b>	376840-xx					376834-xx					376880-xx

**Bold:** This preferred version is available on short notice.

\* Please select when ordering

<sup>1)</sup> Restricted tolerances: signal amplitude 0.8 V<sub>PP</sub> to 1.2 V<sub>PP</sub>

<sup>2)</sup> See also *Mechanical design types and mounting*

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


**Absolute**
**Singleturn**
**ROC 425**

**ROC 413**
**RIC 418**


<b>Interface*</b>	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)		262 144 (18 bits)
Revolutions	–			
Code	Pure binary		Gray	Pure binary
Elec. permissible speed Deviation <sup>1)</sup>	≤ 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	$\sim 1 V_{pp}$ <sup>2)</sup>		$\sim 1 V_{pp}$
Line counts*	–	<b>512</b> 2048	<b>512</b>	<b>16</b>
Cutoff frequency –3 dB	–	512 lines: ≥ 130 kHz; 2048 lines: ≥ 400 kHz		≥ 6 kHz
<b>System accuracy</b>	±20''	±60''		±480''
<b>Electrical connection*</b>	<ul style="list-style-type: none"> <li>• Flange socket M12, radial</li> <li>• Cable 1 m, with M12 coupling</li> </ul>	<ul style="list-style-type: none"> <li>• Flange socket M23, axial or radial</li> <li>• Cable 1 m/5 m, with or without coupling M23</li> </ul>		<ul style="list-style-type: none"> <li>• Flange socket M23, radial</li> <li>• Cable 1 m, with M23 coupling</li> </ul>
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
<b>Shaft</b>	Stub 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 · 10 <sup>-6</sup> kgm <sup>2</sup>			
Shaft load	Axial: ≤ 40 N; radial: ≤ 60 N at shaft end (see also <i>Mechanical design types and mounting</i> )			
<b>Vibration</b> 55 Hz to 2000 Hz <b>Shock</b> 6 ms	≤ 300 m/s <sup>2</sup> ; (EN 60068-2-6); higher values upon request ROC/ROQ: ≤ 2000 m/s <sup>2</sup> ; RIC/RIQ: ≤ 1000 m/s <sup>2</sup> (EN 60068-2-27)			
<b>Max. operating temp.</b> <sup>3)</sup>	100 °C			
<b>Min. operating temp.</b>	Flange socket or fixed cable: –40 °C; moving cable: –10 °C			
<b>Protection</b> EN 60 529	IP67 at housing; IP64 at shaft inlet <sup>3)</sup> (IP66 upon request)			
<b>Mass</b>	≈ 0.35 kg			
<b>Valid for ID</b>	683640-xx	1109255-xx	1131751-xx	642006-xx

**Bold:** This preferred version is available on short notice.

\* Please select when ordering

<sup>1)</sup> Velocity-dependent deviations between the absolute value and incremental signals



Multitum ROQ 437 		ROQ 425		RIQ 430
EnDat 2.2		EnDat 2.2		SSI
EnDat22		EnDat01		SSI41r1
33554432 (25 bits)		8192 (13 bits)		262 144 (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 –
Without		~ 1 V <sub>PP</sub> <sup>2)</sup>		~ 1 V <sub>PP</sub>
–		512 2048		512
–		512 lines: ≥ 130 kHz; 2048 lines: ≥ 400 kHz		16
–				≥ 6 kHz
±20"		±60"		±480"
<ul style="list-style-type: none"> <li>• Flange socket M12, radial</li> <li>• Cable 1 m, with M12 coupling</li> </ul>		<ul style="list-style-type: none"> <li>• Flange socket M23, axial or radial</li> <li>• Cable 1 m/5 m, with or without coupling M23</li> </ul>		<ul style="list-style-type: none"> <li>• Flange socket M23, radial</li> <li>• Cable 1 m, with M23 coupling</li> </ul>
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		1109257-xx		1131753-xx
				642002-xx

<sup>2)</sup> Restricted tolerances: signal amplitude 0.8 V<sub>PP</sub> to 1.2 V<sub>PP</sub>

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

**Functional safety** available for ROC 425 and ROQ 437. For dimensions and specifications see Product Information

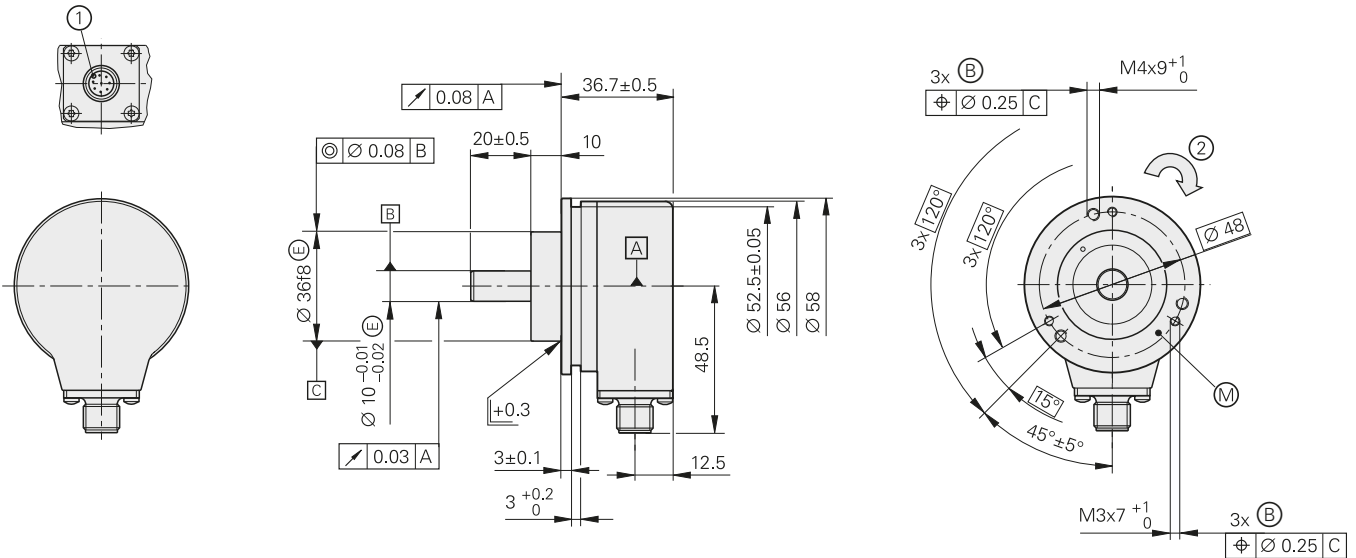
# ROC/ROQ 400F/M/S series

## Absolute rotary encoders

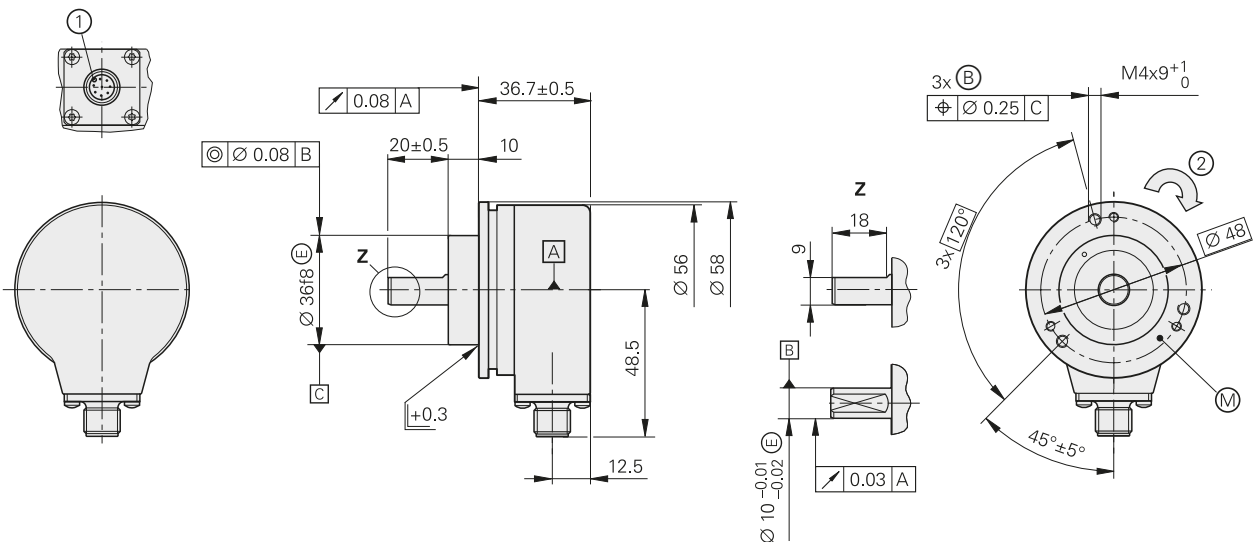
- Clamping flange with additional slot for fastening with fixing clamps
- Solid shaft for separate shaft coupling
- Fanuc Serial Interface, Mitsubishi high speed interface and Siemens DRIVE-CLiQ interface



### 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.

	<b>Absolute</b>					
	<b>Singletum</b>			<b>Multitum</b>		
	<b>ROC 425 F</b>	<b>ROC 425 M</b>	<b>ROC 424 S</b> 	<b>ROQ 437 F</b>	<b>ROQ 435 M</b>	<b>ROQ 436 S</b> 
<b>Interface</b>	Fanuc Serial Interface; $\alpha$ Interface	Mitsubishi high speed interface	DRIVE-CLiQ	Fanuc Serial Interface; $\alpha$ Interface	Mitsubishi high speed interface	DRIVE-CLiQ
Ordering designation	Fanuc05	Mit03-4	DQ01	Fanuc05	Mit03-4	DQ01
Positions per revolution	$\alpha$ : 33554432 (25 bits) $\alpha$ : 8388608 (23 bits)	33554432 (25 bits)	16777216 (24 bits)	33554432 (25 bits)	8388608 (23 bits)	16777216
Revolutions	8192 via revolution counter	–		$\alpha$ : 4096 $\alpha$ : 2048	4096	4096
Code	Pure binary					
Elec. permissible speed	≤ 15000 rpm for continuous position value					
Calculation time $t_{cal}$	≤ 5 $\mu$ s	–	≤ 8 $\mu$ s <sup>3)</sup>	≤ 5 $\mu$ s	–	≤ 8 $\mu$ s <sup>3)</sup>
Incremental signals	Without					
<b>System accuracy</b>	±20"					
<b>Electrical connection</b>	Flange socket M12, radial					
Cable length	≤ 30 m		≤ 95 m <sup>2)</sup>	≤ 30 m		≤ 95 m <sup>2)</sup>
DC voltage supply	3.6 to 14 V		10 V to 36 V	3.6 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
<b>Shaft</b>	Stub shaft $\varnothing$ 10 mm (with ROC 424 S and ROQ 436 S 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 · 10 <sup>-6</sup> kgm <sup>2</sup>					
Shaft load	<i>Axial</i> : 40 N; <i>radial</i> : 60 N at shaft end (see also <i>Mechanical design types and mounting</i> )					
<b>Vibration</b> 55 Hz to 2000 Hz <b>Shock</b> 6 ms	≤ 300 m/s <sup>2</sup> (EN 60068-2-6) ≤ 2000 m/s <sup>2</sup> (EN 60068-2-27)					
<b>Max. operating temp.</b> <sup>1)</sup>	100 °C					
<b>Min. operating temp.</b>	–30 °C					
<b>Protection</b> EN 60 529	IP67 at housing; IP64 at shaft inlet					
<b>Mass</b>	≈ 0.35 kg					
<b>Valid for ID</b>	1081306-xx	1096727-xx	1036790-xx	1081304-xx	1096729-xx	1036792-xx

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

<sup>2)</sup> See *Interfaces of HEIDENHAIN encoders*; catalog with  $n_{MG} = 1$  (incl. adapter cable)

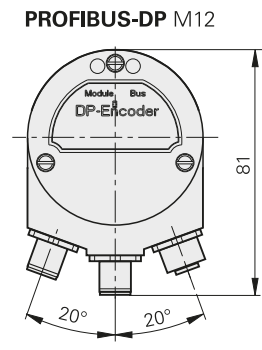
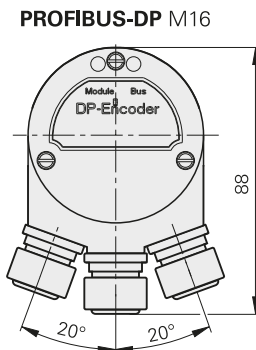
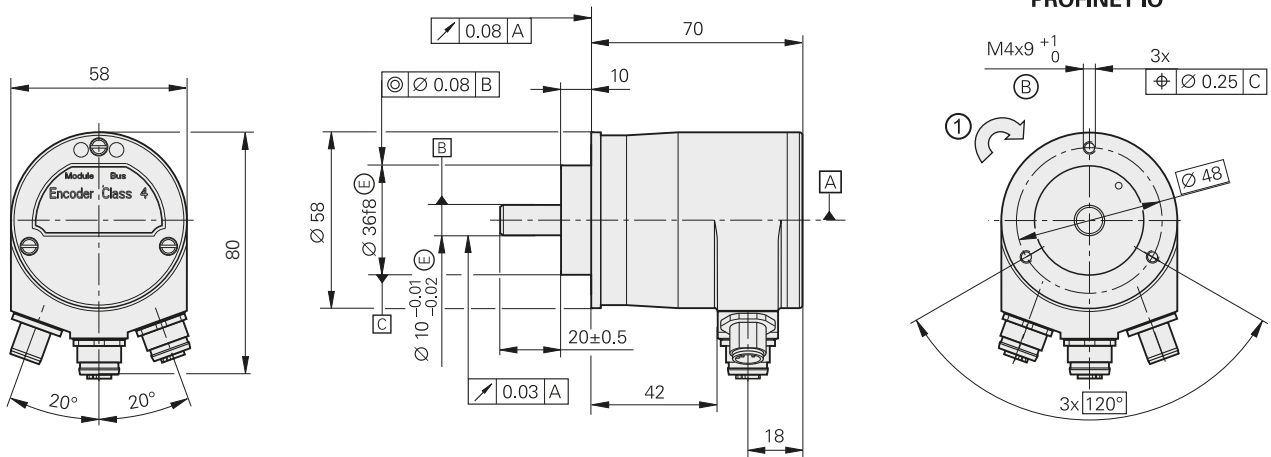
<sup>3)</sup> Processing time  $T_{IME\_MAX\_ACTUAL}$

**Functional safety** for ROC 424 S and ROQ 436 S available, For dimensions and specifications see Product Information

# ROC/ROQ 400 series

Absolute rotary encoders

- Clamping flange
- Solid shaft for separate shaft coupling
- Fieldbus interface



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

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

	<b>Absolute</b>			
	<b>Singletum ROC 413</b>		<b>Multitum ROQ 425</b>	
<b>Interface*</b>	PROFIBUS-DP <sup>1)</sup>	PROFINET IO	PROFIBUS-DP <sup>1)</sup>	PROFINET IO
Positions per revolution	8192 (13 bits) <sup>2)</sup>			
Revolutions	–		4096 <sup>2)</sup>	
Code	Pure binary			
Elec. permissible speed	≤ 12000 rpm for continuous position value		≤ 10000 rpm for continuous position value	
Incremental signals	Without			
<b>System accuracy</b>	±60"			
<b>Electrical connection*</b>	Cable gland M16 <sup>4)</sup>	Three M12 flange sockets, radial	Cable gland M16 <sup>4)</sup>	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			
<b>Shaft</b>	Stub shaft Ø 10 mm			
Mechanically permissible speed n	≤ 12000 rpm			
Starting torque	≤ 0.01 Nm (at 20 °C)			
Moment of inertia of rotor	≤ 2.3 · 10 <sup>-6</sup> kgm <sup>2</sup>			
Shaft load	<i>Axial</i> : ≤ 40 N; <i>radial</i> : ≤ 60 N at shaft end (see also <i>Mechanical design types and mounting</i> )			
<b>Vibration</b> 55 Hz to 2000 Hz <b>Shock</b> 6 ms	≤ 100 m/s <sup>2</sup> (EN 60068-2-6); higher values upon request ≤ 2000 m/s <sup>2</sup> (EN 60068-2-27)			
<b>Max. operating temp.</b> <sup>3)</sup>	70 °C			
<b>Min. operating temp.</b>	–40 °C			
<b>Protection</b> EN 60 529	IP67 at housing; IP64 at shaft inlet <sup>3)</sup> (IP66 upon request)			
<b>Mass</b>	≈ 0.35 kg			
<b>Valid for ID</b>	549886-xx	725519-xx	549888-xx	725521-xx

\* Please select when ordering

1) Supported profiles: DP-V0, DP-V1, DP-V2

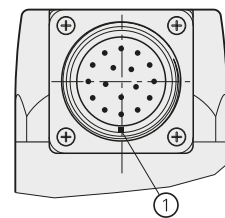
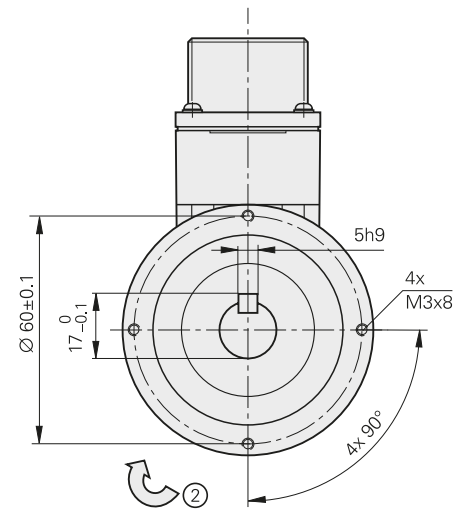
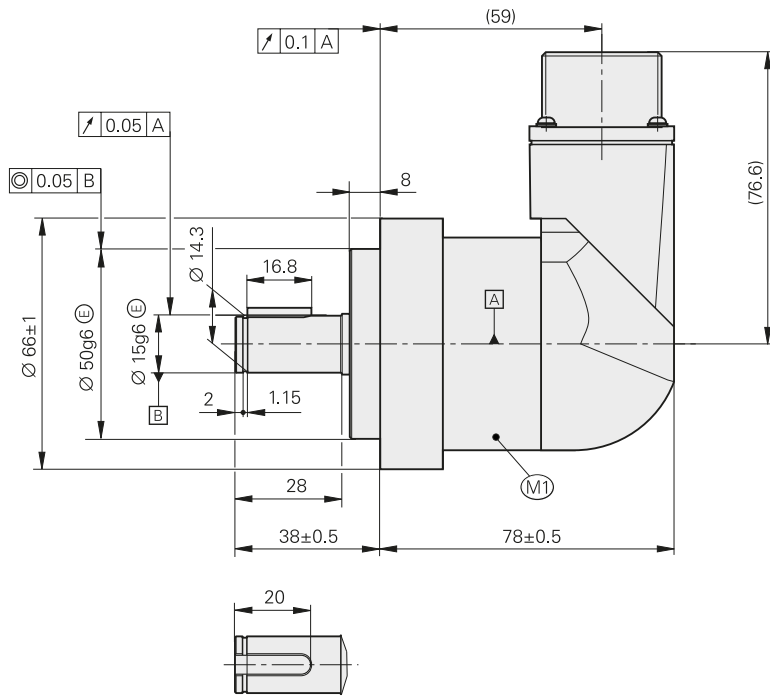
2) Programmable

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

- ▣ = 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
<b>Incremental signals</b>	□□ TTL	□□ HTL
Line counts*	512 1000 1024 2048 5000	
Reference mark	One	
Scanning frequency Edge separation a	≤ 300 kHz ≥ 0.39 μs	
<b>System accuracy</b>	±1/20 of grating period	
<b>Electrical connection</b>	Flange socket 1 1/4"-18 UNEF, 17-pin, radial <sup>2)</sup>	
<b>Voltage supply</b> <b>Current consumption</b> without load	DC 5 V ±0.5 V ≤ 120 mA	DC 10 V to 30 V ≤ 150 mA
<b>Shaft</b>	Stub shaft Ø 15 mm with machine key	
<b>Mech. permiss. speed n</b>	≤ 12000 rpm	
<b>Starting torque</b>	≤ 0.05 Nm (at 20 °C)	
<b>Moment of inertia</b> of rotor	≤ 11 · 10 <sup>-6</sup> kgm <sup>2</sup>	
<b>Shaft load</b>	<i>Axial:</i> 75 N <i>Radial:</i> 75 N at shaft end	
<b>Vibration</b> 55 Hz to 2000 Hz <b>Shock</b> 6 ms	≤ 200 m/s <sup>2</sup> (EN 60068-2-6) ≤ 2000 m/s <sup>2</sup> (EN 60068-2-27)	
<b>Max. operating temp.</b> <sup>1)</sup>	85 °C	
<b>Min. operating temp.</b>	-20 °C	
<b>Relative humidity</b>	≤ 93 % (40 °C/4 d as per EN 60068-2-78); without condensation	
<b>Protection</b> EN 60 529	IP66	
<b>Mass</b>	≈ 0.8 kg	
<b>Valid for ID</b>	1145260-xx	1145261-xx

\* Please select when ordering

<sup>1)</sup> Self heating during encoder operation at room temperature and max. rotational speed is 6000 rpm approx. +50 K

<sup>2)</sup> Fitting mating connector: ID 1094831-01

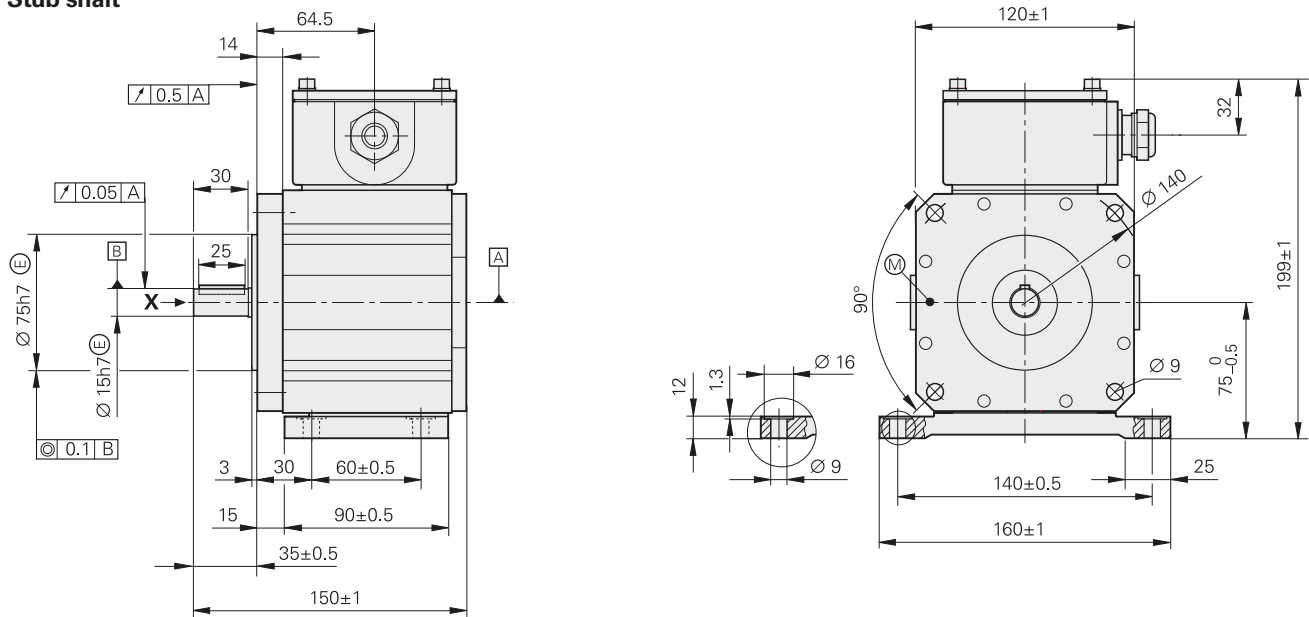
# ROD 1930

## Incremental rotary encoders

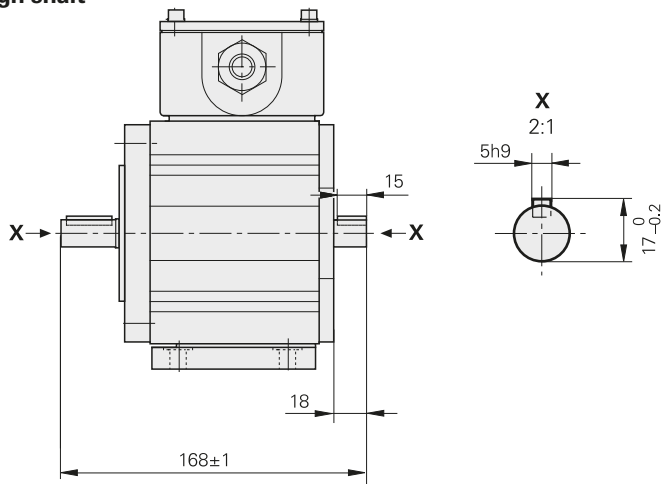
- For fastening by flange or base
- Solid shaft with machine key for separate shaft coupling



### Stub shaft



### Solid through shaft



mm



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

▣ = Bearing

Ⓜ = Measuring point for operating temperature



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

\* Please select when ordering

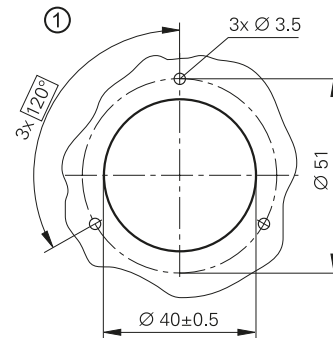
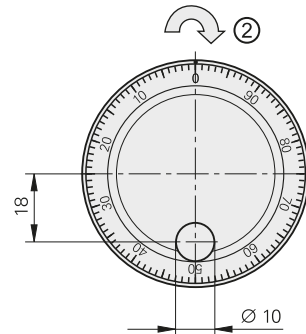
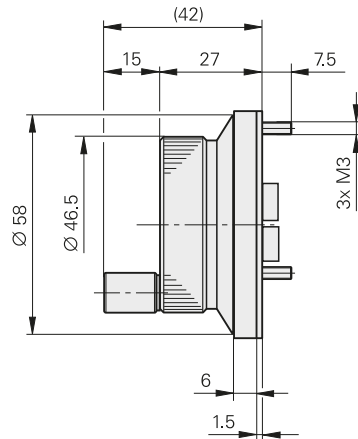
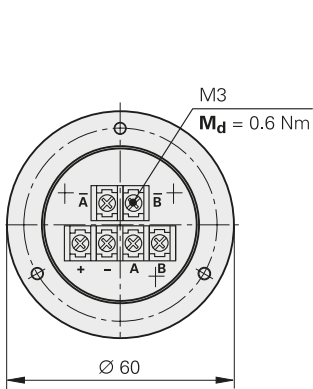
<sup>1)</sup> See also *Mechanical design types and mounting*

<sup>2)</sup> 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:  $\pm 0.2 \text{ mm}$

① = Cutout for mounting

② = Direction of rotation for output signals as per the interface description

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

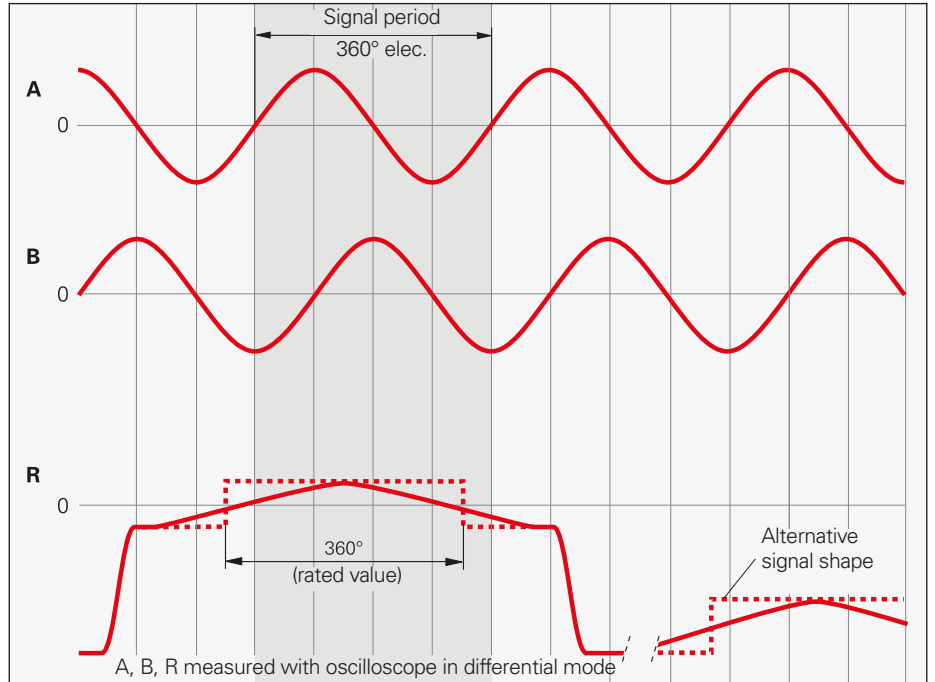
# Interfaces

## Incremental signals $\sim 1 V_{PP}$

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

The sinusoidal **incremental signals** A and B are phase-shifted by  $90^\circ$  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.



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

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 <sup>1)</sup> $U_P$	0V	Sensor <sup>1)</sup> 0V	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.

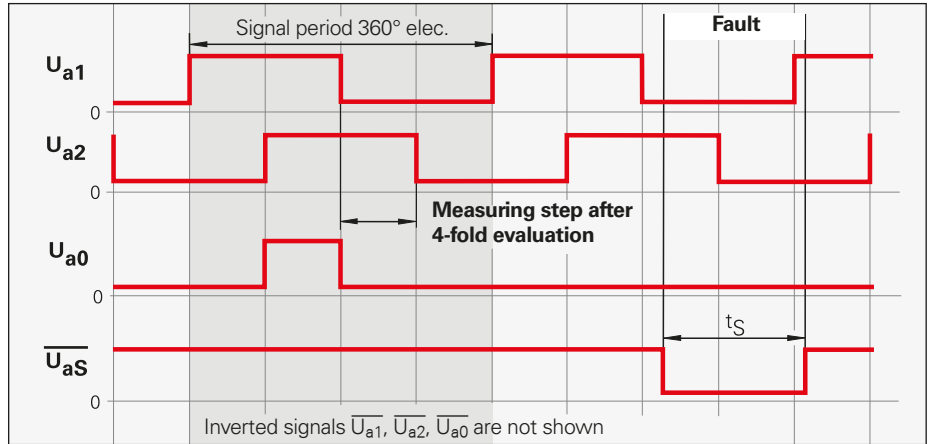
<sup>1)</sup> **LIDA 2xx:** Vacant

# Incremental signals $\square$ TTL

HEIDENHAIN encoders with  $\square$ 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  $90^\circ$  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**.

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

## ERN, ROD pin layout

12-pin flange socket or coupling, M23				12-pin connector, M23				17-pin flange socket 1 1/4" - 18UNE F							
Voltage supply				Incremental signals				Other signals							
M23				5	6	8	1	3	4	7	9				
1 1/4"				H	F	K	M	A	N	C	R	B	P	S	D/E/G/J/L/T
$U_P$		Sensor $U_P$		0V	Sensor 0V		$U_{a1}$	$\overline{U_{a1}}$	$U_{a2}$	$\overline{U_{a2}}$	$U_{a0}$	$\overline{U_{a0}}$	$\overline{U_{aS}}$ <sup>1)</sup>	Vacant <sup>2)</sup>	
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.

<sup>1)</sup> ERO 14xx: Vacant <sup>2)</sup> Exposed linear encoders: TTL/11  $\mu$ App switchover for PWT


## HR pin layout

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

A shielded cable with a cross section of at least  $0.5 \text{ mm}^2$  is recommended when connecting the handwheel to the power supply.

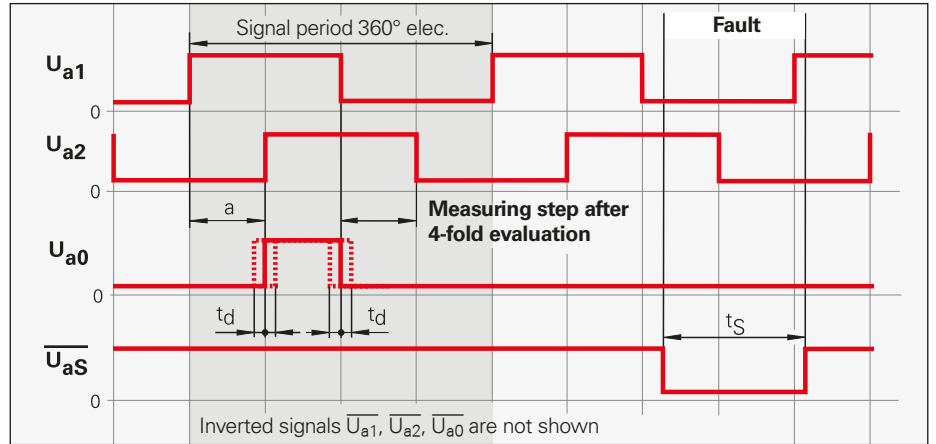
The handwheel is connected electrically via screw terminals. The appropriate wire end sleeves must be attached to the wires.

# 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  $90^\circ$  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**.

Comprehensive descriptions of all available interfaces as well as general electrical information are included in the *Interfaces* catalog ID 1078628-xx.

## 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* catalog.

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

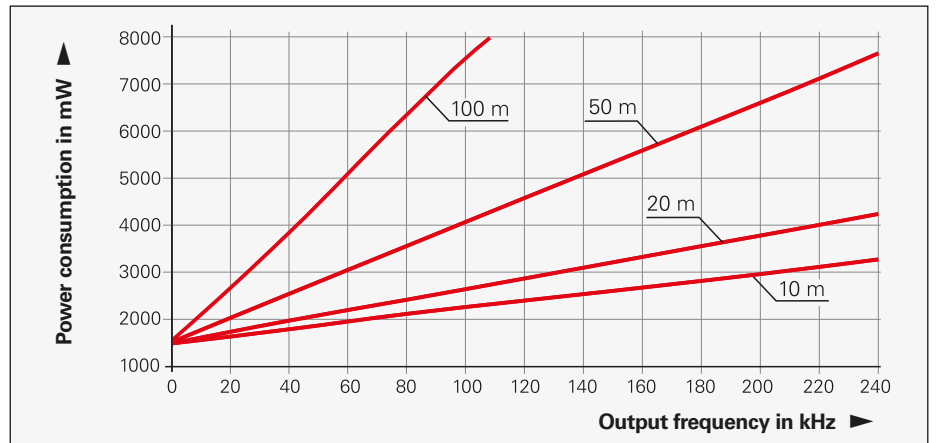
$$f = (n/60) \cdot z \cdot 10^{-3}$$

With

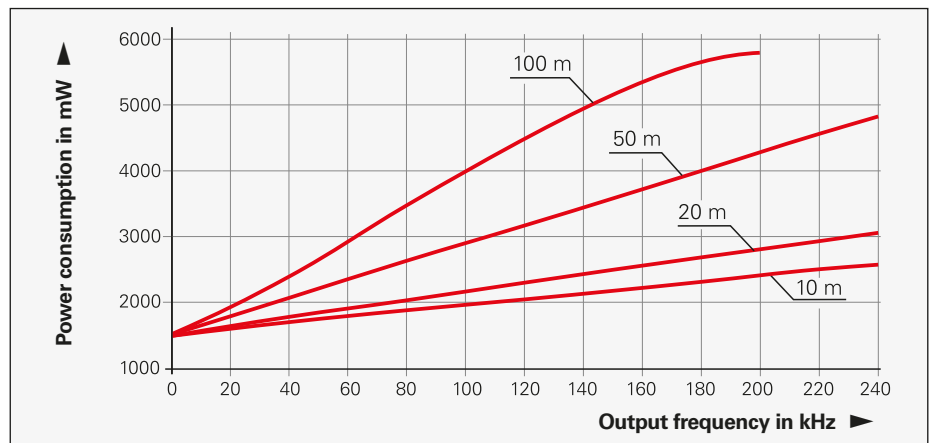
$f$  = Output frequency in kHz

$n$  = Shaft speed in rpm

$z$  = Number of signal periods per  $360^\circ$



Power consumption (maximum) for HTL interface and supply voltage  $U_P = 30\text{ V}$



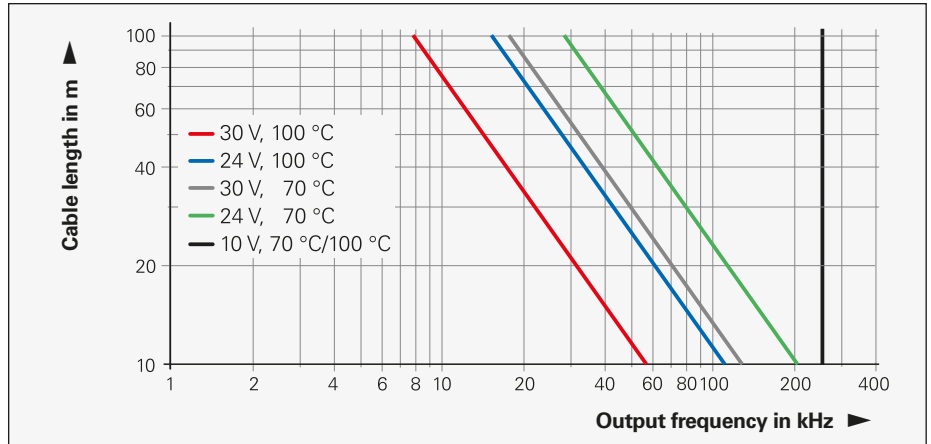
Power consumption (maximum) for HTLs interface and supply voltage  $U_P = 30\text{ V}$

## Cable length for HTL

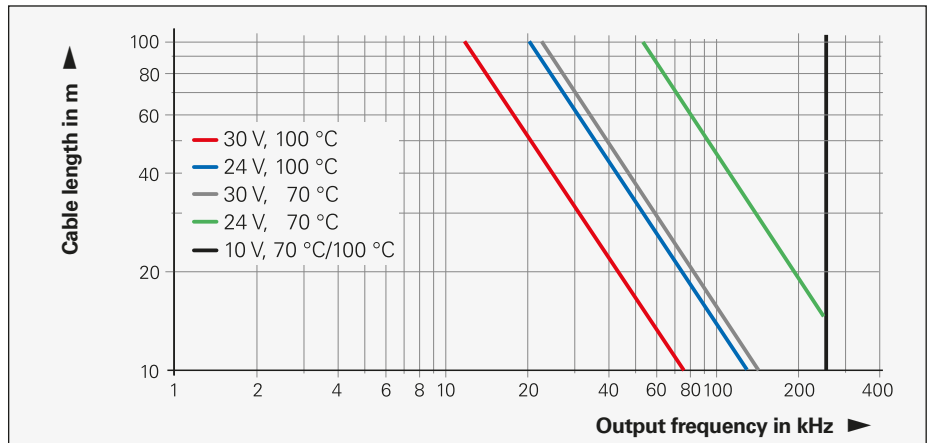
For the rotary encoders with additional HTL output signals, the maximum permissible cable length depends on several criteria:

- 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.



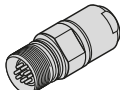
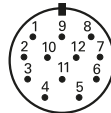


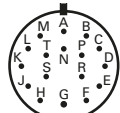







Maximum permissible cable length for HTL interface



Maximum permissible cable length for HTLs interface

## Pin layout







12-pin flange socket or coupling, M23					17-pin flange socket 1 1/4" - 18UNEF								
													
	Voltage supply				Incremental signals						Other signals		
 M23	<b>12</b>	<b>2</b>	<b>10</b>	<b>11</b>	<b>5</b>	<b>6</b>	<b>8</b>	<b>1</b>	<b>3</b>	<b>4</b>	<b>7</b>	<b>9</b>	
 1 1/4"	<b>H</b>	<b>F</b>	<b>K</b>	<b>M</b>	<b>A</b>	<b>N</b>	<b>C</b>	<b>R</b>	<b>B</b>	<b>P</b>	<b>S</b>	<b>D/E/G/J/L/T</b>	
HTL	<b>U<sub>P</sub></b>	<b>Sensor</b> U <sub>P</sub>	0V	<b>Sensor</b> 0V	<b>U<sub>a1</sub></b>	<b>U<sub>a1</sub></b> 0V	<b>U<sub>a2</sub></b>	<b>U<sub>a2</sub></b> 0V	<b>U<sub>a0</sub></b>	<b>U<sub>a0</sub></b> 0V	<b>U<sub>aS</sub></b>	<b>Vacant</b>	
HTLs*													
	Brown/ Green	Blue	White/ Green	White	Brown	Green	Gray	Pink	Red	Black	Violet	Yellow	

**Shield** on housing; **U<sub>P</sub>** = 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						
	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>	<b>6</b>
						
	Voltage supply		Incremental signals			
<b>Connection</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>	<b>6</b>
HTL	<b>U<sub>P</sub></b>	<b>U<sub>N</sub></b> 0V	<b>U<sub>a1</sub></b>	<b>U<sub>a1</sub></b> 0V	<b>U<sub>a2</sub></b>	<b>U<sub>a2</sub></b> 0V
HTLs				<b>U<sub>a2</sub></b>	0V	<b>U<sub>a0</sub></b>

A shielded cable with a cross section of at least 0.5 mm<sup>2</sup> 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.



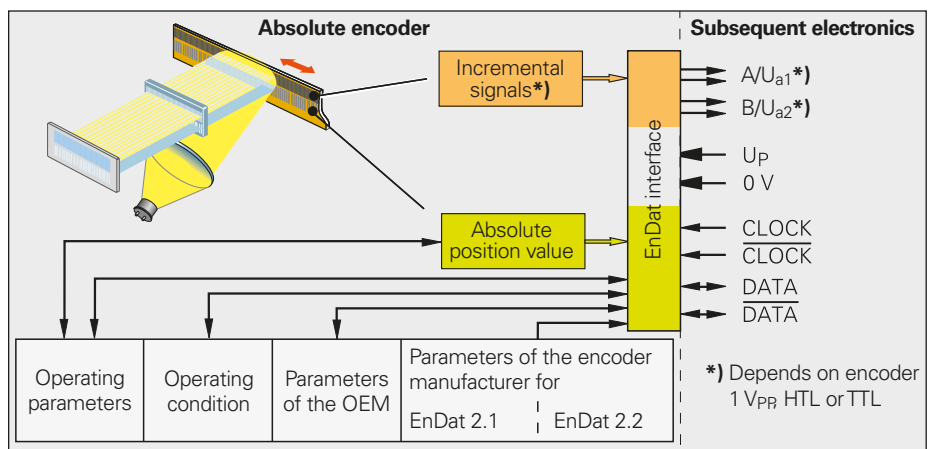
# Position values

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.



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



Ordering designation	Command set	Incremental signals
<b>EnDat01</b> EnDatH EnDatT	EnDat 2.1 or EnDat 2.2	1 V <sub>PP</sub> HTL TTL
EnDat21		–
EnDat02	EnDat 2.2	1 V <sub>PP</sub>
<b>EnDat22</b>	EnDat 2.2	–

Versions of the EnDat interface



## Pin layout

8-pin coupling, M12								
Power supply voltage				Position values				
	<b>8</b>	<b>2</b>	<b>5</b>	<b>1</b>	<b>3</b>	<b>4</b>	<b>7</b>	<b>6</b>
	U <sub>P</sub>	Sensor U <sub>P</sub>	0V	Sensor 0V	DATA	DATA	CLOCK	CLOCK
	Brown/Green	Blue	White/Green	White	Gray	Pink	Violet	Yellow

17-pin coupling, M23													
Power supply voltage					Incremental signals <sup>1)</sup>					Position values			
	<b>7</b>	<b>1</b>	<b>10</b>	<b>4</b>	<b>11</b>	<b>15</b>	<b>16</b>	<b>12</b>	<b>13</b>	<b>14</b>	<b>17</b>	<b>8</b>	<b>9</b>
	U <sub>P</sub>	Sensor U <sub>P</sub>	0V	Sensor 0V	Internal shield <sup>2)</sup>	A+	A-	B+	B-	DATA	DATA	CLOCK	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<sub>P</sub> = 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.

<sup>1)</sup> Only with EnDat01 and EnDat02

<sup>2)</sup> Vacant for ECN/EQN 10xx and ROC/ROQ 10xx

# Fanuc, Siemens pin layout


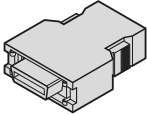
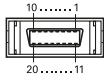

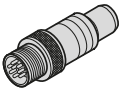




## Fanuc pin layout

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

- **Fanuc Serial Interface –  $\alpha$  Interface**  
Ordering designation: Fanuc02  
Normal and high speed, two-pair transmission

## • Fanuc Serial Interface – $\alpha$ Interface

Ordering designation is Fanuc05, high speed, one-pair transmission contains  $\alpha$  interface (normal and high speed, two-pair transmission)

20-pin Fanuc connector					8-pin coupling, M12				
									
	Power supply voltage					Position values			
	9	18/20	12	14	16	1	2	5	6
	8	2	5	1	–	3	4	7	6
	$U_P$	Sensor $U_P$	0V	Sensor 0V	Shield	Serial Data	Serial Data	Request	Request
	Brown/ Green	Blue	White/ Green	White	–	Gray	Pink	Violet	Yellow


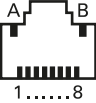

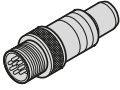



**Cable shield** connected to housing;  $U_P$  = Power supply voltage

**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 voltage		Position values				
			Transmit data		Receive data		
	A	B	3	6	1	2	
	1	5	7	6	3	4	
	$U_P$	0V	TXP	TXN	RXP	RXN	

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

# Mitsubishi pin layout

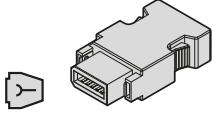

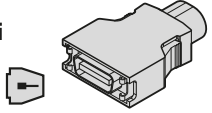




## Mitsubishi pin layout

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

	Power supply voltage				Position values			
<b>10-pin Mitsubishi connector</b>  	1	–	2	–	7	8	3	4
<b>20-pin Mitsubishi connector</b>  	20	19	1	11	6	16	7	17
<b>8-pin flange socket, M12</b>  	8	2	5	1	3	4	7	6
	<b>U<sub>P</sub></b>	<b>Sensor</b> U <sub>P</sub>	<b>0V</b>	<b>Sensor</b> 0V	<b>Serial Data</b>	<b>Serial Data</b>	<b>Request Frame</b>	<b>Request Frame</b>
	Brown/Green	Blue	White/Green	White	Gray	Pink	Violet	Yellow

**Cable shield** connected to housing; **U<sub>P</sub>** = 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 50170. 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

Addressing of tens digit



Terminating resistor

Addressing of ones digit

Voltage supply

Bus output

Bus input

## 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 voltage				Position values	
	1	3	5	Housing	2	4
BUS in	/	/	Shield	Shield	DATA (A)	DATA (B)
BUS out	U <sup>1)</sup>	0V <sup>1)</sup>	Shield	Shield	DATA (A)	DATA (B)

<sup>1)</sup> For supplying the external terminal resistor

Mating connector: Voltage supply 4-pin connector (female) M12 A-coded				
	1	3	2	4
	U <sub>P</sub>	0V	Vacant	Vacant

The Interfaces of HEIDENHAIN Encoders brochure, ID 1078628-xx, provides comprehensive descriptions of all available interfaces as well as general electrical information.

# 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

<b>Ports 1 and 2</b> <b>4-pin connector (female)</b> M12 D-coded					
Position values					
	1	2	3	4	Housing
<b>PORT 1/2</b>	<b>Tx+</b>	<b>Rx+</b>	<b>Tx-</b>	<b>Rx-</b>	<b>Shield</b>

<b>Voltage supply</b> <b>4-pin coupling (male)</b> M12 A-coded				
	1	3	2	4
	<b>Up</b>	<b>0V</b>	<b>Vacant</b>	<b>Vacant</b>

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

# 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<sub>PP</sub>*.

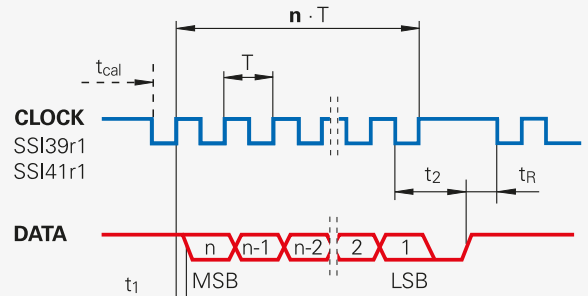
The following **functions** can be activated through programming inputs:

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

### Data transfer

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

CLOCK and DATA not shown



Comprehensive descriptions of all available interfaces as well as general electrical information are included in the *Interfaces* catalog ID 1078628-xx.

## Pin layout

17-pin coupling, M23															
Voltage supply				Incremental signals						Position values				Other signals	
7	1	10	4	11	15	16	12	13	14	17	8	9	2	5	
<b>U<sub>P</sub></b>	<b>Sensor U<sub>P</sub></b>	<b>0V</b>	<b>Sensor 0V</b>	<b>Internal shield<sup>1)</sup></b>	<b>A+</b>	<b>A-</b>	<b>B+</b>	<b>B-</b>	<b>DATA</b>	<b>DATA</b>	<b>CLOCK</b>	<b>CLOCK</b>	<b>Direction of rotation</b>	<b>Zero</b>	
Brown/ Green	Blue	White/ Green	White	/	Green/ Black	Yellow/ Black	Blue/ Black	Red/ Black	Gray	Pink	Violet	Yellow	Black	Green	

**Shield** on housing; **U<sub>P</sub>** = 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.

<sup>1)</sup> Vacant for ECN/EQN 10xx and ROC/ROQ 10xx

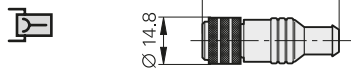
# Connecting elements and cables

## General information

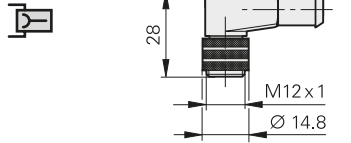
**Connector** insulated: Connecting element with coupling ring, available with male or female contacts (see symbols).

Symbols

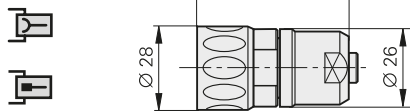
**M12**



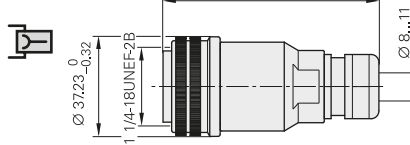
**M12 right-angle connector**



**M23**



**1 1/4" - 18UNEF**

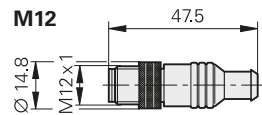


**Coupling** insulated: Connecting element with outside thread, available with male or female contacts (see Symbols).

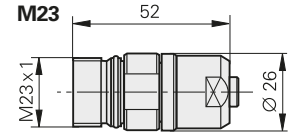
Symbols



**M12**



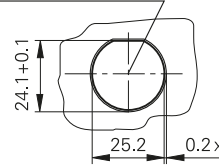
**M23**



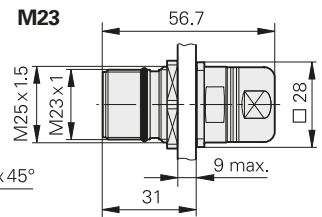
**Mounted coupling with central fastening**



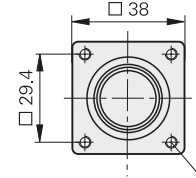
Cutout for mounting



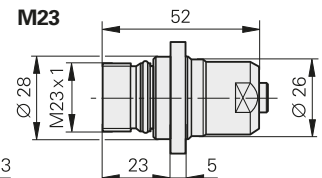
**M23**



**Mounted coupling with flange**



**M23**

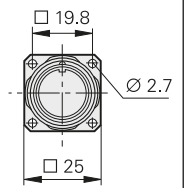
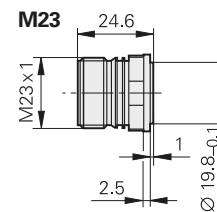


**Flange socket:** with external thread; permanently mounted on a housing, available with male or female contacts.

Symbols

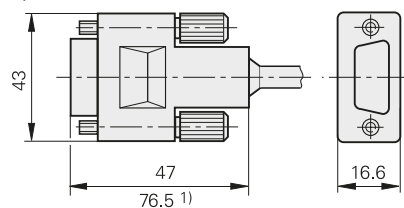


**M23**



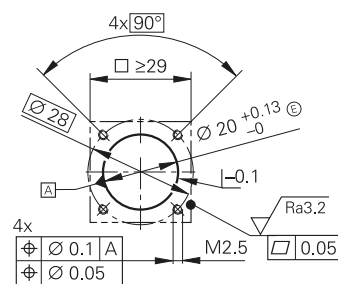
**D-sub connector** for HEIDENHAIN controls, counters and IK absolute value cards.

Symbols



1) Interface electronics integrated in connector

**M12 flange socket** with motor-internal encoder cable



⊙ = Mating mounting holes  
Ⓢ = 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.



**Accessories for flange sockets and M23 mounted couplings**

**Threaded metal dust cap**

ID 219926-01







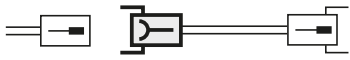
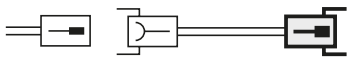
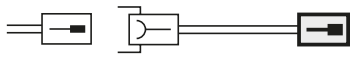

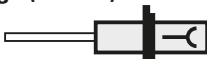

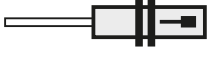
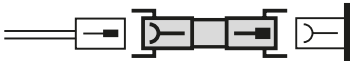
**Accessory for M12 connecting element**

**Insulation spacer**

ID 596495-01

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

~ 1 V<sub>PP</sub> □ TTL, □ HTL

PUR connecting cables		12-pin: [4(2 · 0.14 mm <sup>2</sup> ) + (4 · 0.5 mm <sup>2</sup> )] ; A <sub>P</sub> = 0.5 mm <sup>2</sup>	Ø 8 mm
<b>Complete</b> with connector (female), and coupling (male)			298401-xx
<b>Complete</b> with connector (female), and connector (male)			298399-xx
<b>Complete</b> with connector (female) and D-sub connector (female), 15-pin, for TNC			310199-xx
<b>Complete</b> with connector (female) and D-sub connector (male), 15-pin, for PWM 20/EIB 74x			310196-xx
<b>With one</b> connector (female)			309777-xx
<b>Cable without connectors</b> , Ø 8 mm			816317-xx
<b>Mating element on connecting cable to connector on encoder cable</b>	<b>Connector (female)</b> for cable, Ø 8 mm 		291697-05
<b>Connector on connecting cable</b> for connection to subsequent electronics	<b>Connector (male)</b> for cable, Ø 8 mm Ø 6 mm 		291697-08 291697-07
<b>Coupling on connecting cable</b>	<b>Coupling (male)</b> for cable, Ø 4.5 mm Ø 6 mm Ø 8 mm 		291698-14 291698-03 291698-04
<b>Flange socket</b> for mounting on subsequent electronics	<b>Flange socket (female)</b> 		315892-08
<b>Mounted couplings</b>	<b>With flange (female)</b> Ø 6 mm Ø 8 mm 		291698-17 291698-07
	<b>With flange (male)</b> Ø 6 mm Ø 8 mm 		291698-08 291698-31
	<b>With central fastening</b> Ø 6 mm to 10 mm (male) 		741045-01
<b>Adapter connector</b> ~ 1 V <sub>PP</sub> /11 µA <sub>PP</sub> For converting the 1 V <sub>PP</sub> signals to 11 µA <sub>PP</sub> ; M23 connector (female), 12-pin and M23 connector (male), 9-pin 			364914-01









A<sub>P</sub>: Cross section of power supply lines



# EnDat connecting cables

8-pin  
M12

17-pin  
M23





		EnDat without incremental signals		EnDat with incremental signals <b>SSI</b>
<b>PUR connecting cables</b>		<b>8-pin:</b> $[(4 \cdot 0.14 \text{ mm}^2) + (4 \cdot 0.34 \text{ mm}^2)]; A_P = 0.34 \text{ mm}^2$ <b>17-pin:</b> $[(4 \cdot 0.14 \text{ mm}^2) + 4(2 \cdot 0.14 \text{ mm}^2) + (4 \cdot 0.5 \text{ mm}^2)]; A_P = 0.5 \text{ mm}^2$		
	Cable diameter	6 mm	3.7 mm	8 mm
<b>Complete</b> with connector (female), and coupling (male)		368330-xx	801142-xx	323897-xx 340302-xx
<b>Complete</b> with connector (female), and coupling (male)		373289-xx	801149-xx	–
<b>Complete</b> with connector (female) and D-sub connector (female), 15-pin, for TNC (position input)		533627-xx	–	332115-xx
<b>Complete</b> with connector (female) and D-sub connector (female), 25-pin, for TNC (speed input)		641926-xx	–	336376-xx
<b>Complete</b> with connector (female) and D-sub connector (male), 15-pin, for IK 215, PWM 20, EIB 74x etc.		524599-xx	801129-xx	324544-xx
<b>Complete</b> with right-angle connector (female) and D-sub connector (male), 15-pin, for IK 215, PWM 20, EIB 74x etc.		722025-xx	801140-xx	–
<b>With one</b> connector (female)		634265-xx	–	309778-xx 309779-xx <sup>1)</sup>
<b>With one</b> right-angle connector (female)		606317-xx	–	–
<b>Cable only</b>		–	–	816322-xx




*Italics:* Cable with assignment for “encoder shaft speed” input (MotEnc EnDat)




<sup>1)</sup> Without incremental signals

A<sub>P</sub>: Cross section of power supply lines

# Connecting cables Fanuc Mitsubishi Siemens

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

		Cable	Fanuc	Mitsubishi
<b>PUR connecting cable for M12 connecting element <math>[(1 \cdot 4 \cdot 0.14 \text{ mm}^2) + (4 \cdot 0.34 \text{ mm}^2)]</math>; <math>A_P = 0.34 \text{ mm}^2</math></b>				
<b>Complete</b> With M12 connector (female), 8-pin, and Fanuc connector		Ø 6 mm	646807-xx	–
<b>Complete</b> With M12 connector (female), 8-pin, and Mitsubishi connector, 20-pin	 20-pin	Ø 6 mm	–	646806-xx
<b>Complete</b> With M12 connector (female), 8-pin, and Mitsubishi connector, 10-pin	 10-pin	Ø 6 mm	–	647314-xx

		Cable	Siemens
<b>PUR connecting cable for M12 connecting element <math>[2(2 \cdot 0.17 \text{ mm}^2) + (2 \cdot 0.24 \text{ mm}^2)]</math>; <math>A_P = 0.24 \text{ mm}^2</math></b>			
<b>Complete</b> With M12 connector (female), 8-pin, and M12 coupling (male), 8-pin		Ø 6.8 mm	822504-xx
<b>Complete</b> With M12 connector (female), 8-pin, and Siemens RJ45 connector (IP67) cable length 1 m		Ø 6.8 mm	1094652-01
<b>Complete</b> 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<sub>PP</sub> (voltage signals) or 11 μA<sub>PP</sub> (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 <sup>1)</sup> or subdivision	Model	
Interface	Qty.	Interface	Qty.				
□□TTL	1	~ 1 V <sub>PP</sub>	1	Box design – IP65	5/10-fold	<b>IBV 101</b>	
					20/25/50/100-fold	<b>IBV 102</b>	
					Without interpolation	<b>IBV 600</b>	
					25/50/100/200/400-fold	<b>IBV 660B</b>	
				Plug design – IP40	5/10/20/25/50/100-fold	<b>APE 371</b>	
				Version for integration – IP00	5/10-fold	<b>IDP 181</b>	
		20/25/50/100-fold	<b>IDP 182</b>				
		~ 11 μA <sub>PP</sub>	1	Box design – IP65	1	5/10-fold	<b>EXE 101</b>
						20/25/50/100-fold	<b>EXE 102</b>
						Without/5-fold	<b>EXE 602E</b>
25/50/100/200/400-fold	<b>EXE 660B</b>						
Version for integration – IP00	5-fold			<b>IDP 101</b>			
□□TTL/ ~ 1 V <sub>PP</sub> Adjustable	2	~ 1 V <sub>PP</sub>	1	Box design – IP65	2-fold	<b>IBV 6072</b>	
					5/10-fold	<b>IBV 6172</b>	
					5/10-fold and 20/25/50/100-fold	<b>IBV 6272</b>	
EnDat 2.2	1	~ 1 V <sub>PP</sub>	1	Box design – IP65	≤ 16384-fold subdivision	<b>EIB 192</b>	
				Plug design – IP40	≤ 16384-fold subdivision	<b>EIB 392</b>	
			2	Box design – IP65	≤ 16384-fold subdivision	<b>EIB 1512</b>	
DRIVE-CLiQ	1	EnDat 2.2	1	Box design – IP65	–	<b>EIB 2391 S</b>	
Fanuc Serial Interface	1	~ 1 V <sub>PP</sub>	1	Box design – IP65	≤ 16384-fold subdivision	<b>EIB 192F</b>	
				Plug design – IP40	≤ 16384-fold subdivision	<b>EIB 392F</b>	
			2	Box design – IP65	≤ 16384-fold subdivision	<b>EIB 1592F</b>	
Mitsubishi high speed interface	1	~ 1 V <sub>PP</sub>	1	Box design – IP65	≤ 16384-fold subdivision	<b>EIB 192M</b>	
				Plug design – IP40	≤ 16384-fold subdivision	<b>EIB 392M</b>	
			2	Box design – IP65	≤ 16384-fold subdivision	<b>EIB 1592M</b>	
Yaskawa Serial Interface	1	EnDat 2.2 <sup>2)</sup>	1	Plug design – IP40	–	<b>EIB 3391Y</b>	
PROFIBUS-DP	1	EnDat 2.1; EnDat 2.2	1	Top-hat rail design	–	<b>PROFIBUS Gateway</b>	

Switchable

<sup>2)</sup> Only LIC 4100 with 5 nm measuring step, LIC 2100 with 50 nm and 100 nm measuring steps

DRIVE-CLiQ is a registered trademark of SIEMENS AG.

# 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<sub>PP</sub>, TTL or HTL interfaces. TTL and HTL encoders monitor their signal amplitudes internally and generate a simple fault detection signal. With 1 V<sub>PP</sub> signals, the analysis of output signals is possible only in external test devices or through computation in the subsequent electronics (analog diagnostics interface).

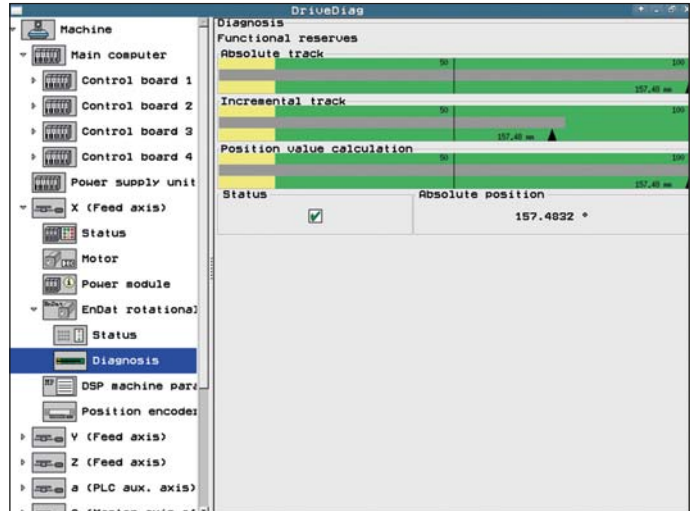
Absolute encoders operate with serial data transfer. Depending on the interface, additional 1 V<sub>PP</sub> incremental signals can be output. The signals are monitored comprehensively within the encoder. The monitoring result (especially with valuation numbers) can be transferred along with the position 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

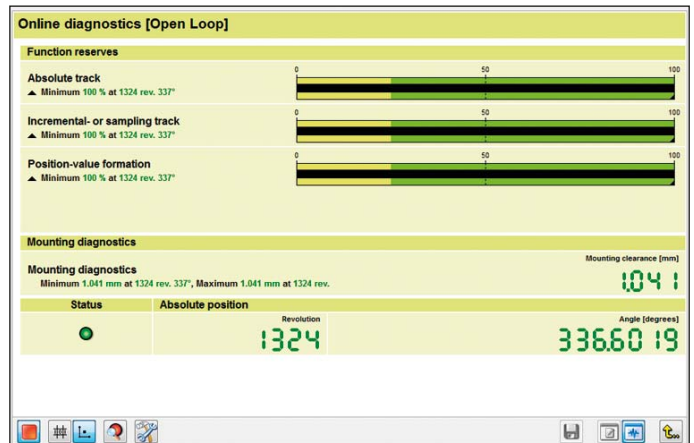
This enables the subsequent electronics to evaluate the current status of the encoder with little effort even in closed-loop mode.

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:

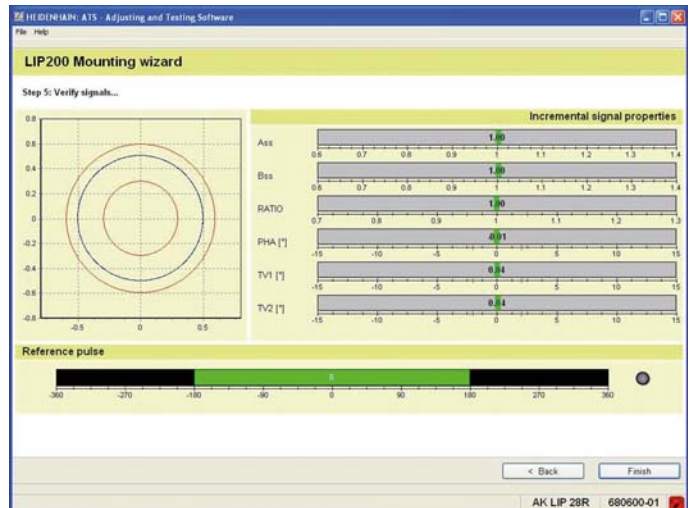
- Encoder diagnostics: The encoder is connected directly to the test or inspection device. This makes a comprehensive analysis of encoder functions possible.
- Diagnostics in the control loop: The PWM phase meter is looped into the closed control loop (e.g. through a suitable testing adapter). This makes 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 20 and ATS software



Commissioning using PWM 20 and ATS software

## PWM 20

Together with the included ATS adjusting and testing software, the PWM 20 phase angle measuring unit serves for diagnosis and adjustment of HEIDENHAIN encoders.



For more information, see the Product Information document *PWM 20/ATS Software*.

	PWM 20
<b>Encoder input</b>	<ul style="list-style-type: none"> <li>• EnDat 2.1 or EnDat 2.2 (absolute value with or without incremental signals)</li> <li>• DRIVE-CLiQ</li> <li>• Fanuc Serial Interface</li> <li>• Mitsubishi high speed interface</li> <li>• Yaskawa Serial Interface</li> <li>• Panasonic serial interface</li> <li>• SSI</li> <li>• 1 V<sub>PP</sub>/TTL/11 μA<sub>PP</sub></li> <li>• HTL (via signal adapter)</li> </ul>
<b>Interface</b>	USB 2.0
<b>Voltage supply</b>	AC 100 V to 240 V or DC 24 V
<b>Dimensions</b>	258 mm × 154 mm × 55 mm

	ATS
<b>Languages</b>	Choice between English and German
<b>Functions</b>	<ul style="list-style-type: none"> <li>• Position display</li> <li>• Connection dialog</li> <li>• Diagnostics</li> <li>• Mounting wizard for EBI/ECI/EQI, LIP200, LIC 4000 and others</li> <li>• Additional functions (if supported by the encoder)</li> <li>• Memory contents</li> </ul>
<b>System requirements and recommendations</b>	PC (dual-core processor > 2 GHz) RAM > 2 GB Operating system Windows Vista (32-bit), 7, 8 and 10 (32-bit/64-bit) 500 MB free space on hard disk

DRIVE-CLiQ is a registered trademark of SIEMENS AG.

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



	PWM 9
<b>Inputs</b>	Expansion modules (interface boards) for 11 μA <sub>PP</sub> ; 1 V <sub>PP</sub> ; TTL; HTL; EnDat*/SSI*/commutation signals * No display of position values or parameters
<b>Functions</b>	<ul style="list-style-type: none"> <li>• <b>Measures</b> signal amplitudes, current consumption, operating voltage, scanning frequency</li> <li>• <b>Graphic display</b> of incremental signals (amplitudes, phase angle and on-off ratio) and the reference-mark signal (width and position)</li> <li>• <b>Displays symbols</b> for the reference mark, fault-detection signal, counting direction</li> <li>• <b>Universal counter</b>, interpolation selectable from single to 1024-fold</li> <li>• <b>Adjustment support</b> for exposed linear encoders</li> </ul>
<b>Outputs</b>	<ul style="list-style-type: none"> <li>• Inputs are connected through to the subsequent electronics</li> <li>• BNC sockets for connection to an oscilloscope</li> </ul>
<b>Voltage supply</b>	DC 10 V to 30 V, max. 15 W
<b>Dimensions</b>	150 mm × 205 mm × 96 mm



# HEIDENHAIN

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