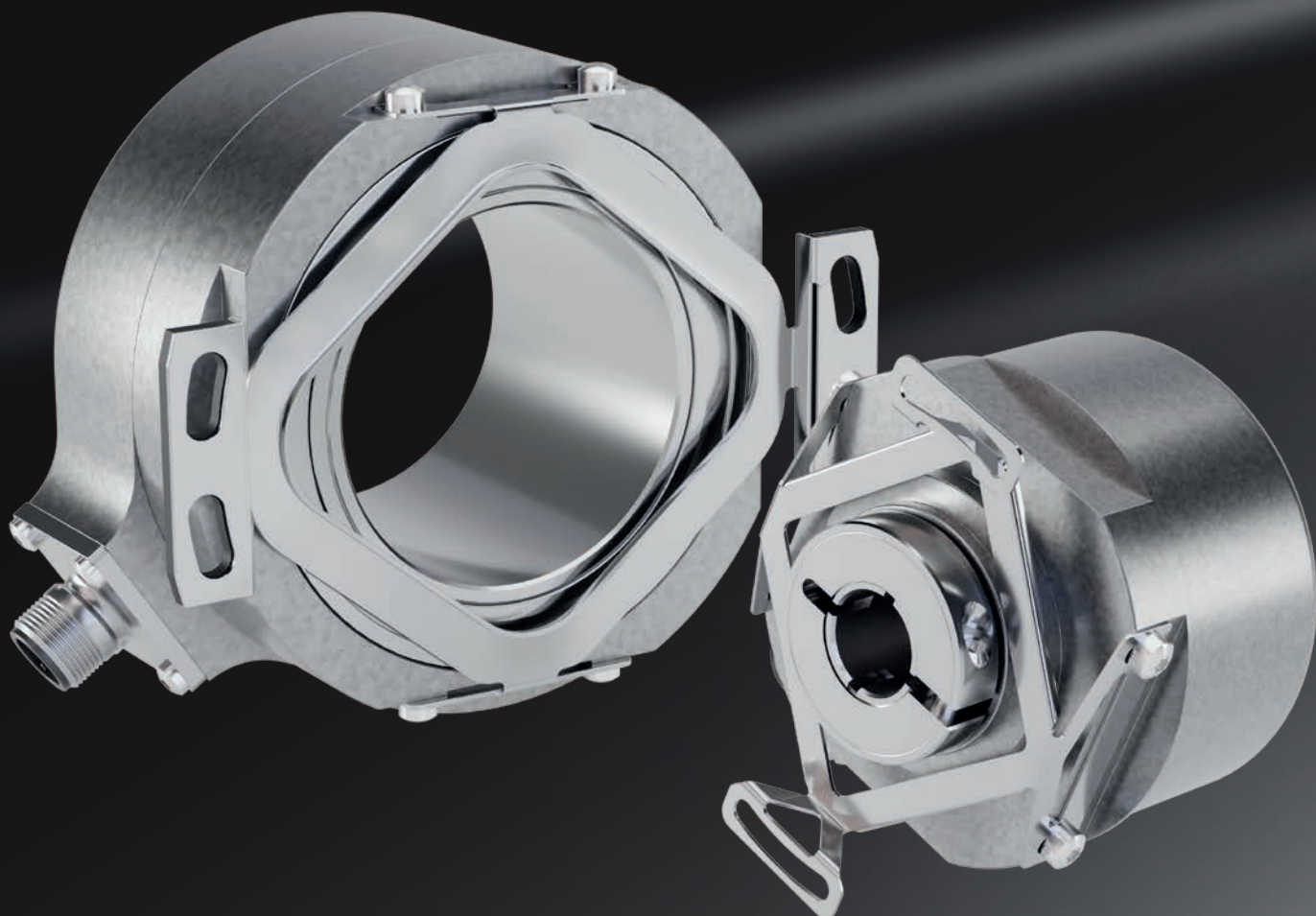




## Rotary Encoders

[www.heidenhain.com/rotary-encoders](http://www.heidenhain.com/rotary-encoders)

### Rotary encoders from HEIDENHAIN

serve as feedback devices for rotary motion and angular speed. When used in conjunction with mechanical measuring standards such as lead screws, they can also measure linear motion. Possible applications include electric motors, machine tools, printing machines, woodworking machines, textile machines, robots, and handling devices, as well as a wide variety of measuring, testing, and inspection units.

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



Rotary encoders for separate shaft coupling



Electronic handwheel



Rotary encoders with mounted stator coupling

Information about the following topics is available upon request or online at [www.heidenhain.com](http://www.heidenhain.com):

- Encoders for servo drives
- Sealed angle encoders
- Modular angle encoders with optical scanning
- Modular angle encoders with magnetic scanning
- Linear encoders for numerically controlled machine tools
- Exposed linear encoders
- Signal converters
- HEIDENHAIN controls
- Cables and connecting elements.



#### Further information:

For detailed descriptions of all available interfaces, as well as general electrical information, please refer to the [Interfaces of HEIDENHAIN Encoders](#) brochure.

This brochure supersedes all previous editions, which thereby become invalid. The basis for ordering from HEIDENHAIN is always the current product documentation at the time the order is placed.

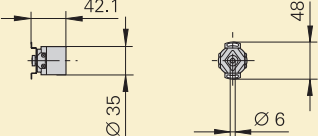
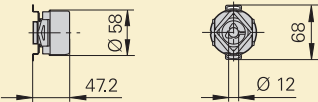
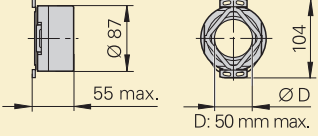
Standards (ISO, EN, etc.) apply only where explicitly stated in this brochure.

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| Mounted stator coupling                              | <b>ECN 1000/EQN 1000 series</b>                          | <b>ERN 1000 series</b>                      | <b>30</b> |
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| Separate shaft coupling;<br>clamping flange          | <b>ROC/ROQ 400 series</b>                                | <b>ROD 400 series</b>                       | <b>62</b> |
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# Selection guide

## Rotary encoders for standard applications

| Rotary encoders                                                                                                     | Absolute Singleturn                                                                                                                                          |                                                                                                                                                                  |                                          | Multiturn (4096 revolutions)                                                                                                                                              |                                                                                                                                                                  |
|---------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                                                                                                     | Interface                                                                                                                                                    | EnDat                                                                                                                                                            | Fanuc Siemens                            | SSI                                                                                                                                                                       | EnDat Fanuc Siemens                                                                                                                                              |
| With mounted stator coupling                                                                                        |                                                                                                                                                              |                                                                                                                                                                  |                                          |                                                                                                                                                                           |                                                                                                                                                                  |
| <b>ECN/EQN/ERN 1000 series</b><br> | <b>ECN 1023</b><br>Positions/rev: 23 bits<br>EnDat 2.2/22<br><br><b>ECN 1013</b><br>Positions/rev: 13 bits<br>EnDat 2.2/01                                   | –                                                                                                                                                                | –                                        | <b>EQN 1035</b><br>Positions/rev: 23 bits<br>EnDat 2.2/22<br><br><b>EQN 1025</b><br>Positions/rev: 13 bits<br>EnDat 2.2/01                                                | –                                                                                                                                                                |
| <b>ECN/EQN/ERN 400 series</b><br>  | <b>ECN 425</b><br>Positions/rev: 25 bits<br>EnDat 2.2/22<br>Available with functional safety<br><br><b>ECN 413</b><br>Positions/rev: 13 bits<br>EnDat 2.2/01 | <b>ECN 425F</b><br>Positions/rev: 25 bits<br>Fanuc $\alpha$ i<br><br><b>ECN 424S</b><br>Positions/rev: 24 bits<br>DRIVE-CLiQ<br>Available with functional safety | <b>ECN 413</b><br>Positions/rev: 13 bits | <b>EQN 437</b><br>Positions/rev: 25 bits<br>EnDat 2.2/22<br>Available with functional safety<br><br><b>EQN 425<sup>3)</sup></b><br>Positions/rev: 13 bits<br>EnDat 2.2/01 | <b>EQN 437F</b><br>Positions/rev: 25 bits<br>Fanuc $\alpha$ i<br><br><b>EQN 436S</b><br>Positions/rev: 24 bits<br>DRIVE-CLiQ<br>Available with functional safety |
| <b>ECN/ERN 100 series</b><br>    | <b>ECN 125</b><br>Positions/rev: 25 bits<br>EnDat 2.2/22<br><br><b>ECN 113</b><br>Positions/rev: 13 bits<br>EnDat 2.2/01                                     | –                                                                                                                                                                | –                                        | –                                                                                                                                                                         | –                                                                                                                                                                |

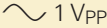
<sup>1)</sup> Up to 36000 signal periods via integrated 5- or 10-fold interpolation (higher interpolation upon request)

<sup>2)</sup> Supply voltage: DC 10 V to 30 V

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

<sup>4)</sup> Available with mechanical fault exclusion; for deviating specifications and special mounting information, see the *Fault Exclusion* Customer Information document

DRIVE-CLiQ is a registered trademark of Siemens AG

|  |                                                       | Incremental                                                                                       |                                                                                   |                                                                                                     |
|--|-------------------------------------------------------|---------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------|
|  | SSI                                                   |                  |  |  1 V <sub>PP</sub> |
|  |                                                       |                                                                                                   |                                                                                   |                                                                                                     |
|  | –                                                     | <b>ERN 1020</b><br>100 to 3600 lines<br><br><b>ERN 1070</b><br>1000/2500/3600 lines <sup>1)</sup> | <b>ERN 1030</b><br>100 to 3600 lines                                              | <b>ERN 1080</b><br>100 to 3600 lines                                                                |
|  | <b>EQN 425<sup>3)</sup></b><br>Positions/rev: 13 bits | <b>ERN 420</b><br>250 to 5000 lines<br><br><b>ERN 460<sup>2)</sup></b><br>250 to 5000 lines       | <b>ERN 430</b><br>250 to 5000 lines                                               | <b>ERN 480<sup>4)</sup></b><br>1000 to 5000 lines                                                   |
|  | –                                                     | <b>ERN 120</b><br>1000 to 5000 lines                                                              | <b>ERN 130</b><br>1000 to 5000 lines                                              | <b>ERN 180</b><br>1000 to 5000 lines                                                                |



30

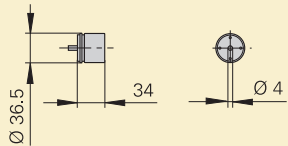
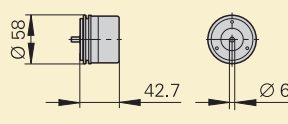
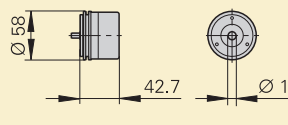
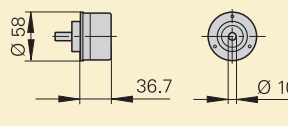


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# Rotary encoders for standard applications

| Rotary encoders                                                                                                                           |                                                                                                                                                              | Absolute Singleturn                                                                                                                                                |                                          |                                                                                                                                                                           | Multiturn (4096 revolutions)                                                                                                                                       |  |
|-------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|
| Interface                                                                                                                                 | EnDat                                                                                                                                                        | Fanuc<br>Siemens                                                                                                                                                   | SSI                                      | EnDat                                                                                                                                                                     | Fanuc<br>Siemens                                                                                                                                                   |  |
| For separate shaft coupling, with synchro flange                                                                                          |                                                                                                                                                              |                                                                                                                                                                    |                                          |                                                                                                                                                                           |                                                                                                                                                                    |  |
| <b>ROC/ROQ/ROD 1000 series</b><br>                       | <b>ROC 1023</b><br>Positions/rev: 23 bits<br>EnDat 2.2/22<br><br><b>ROC 1013</b><br>Positions/rev: 13 bits<br>EnDat 2.2/01                                   | –                                                                                                                                                                  | –                                        | <b>ROQ 1035</b><br>Positions/rev: 23 bits<br>EnDat 2.2/22<br><br><b>ROQ 1025</b><br>Positions/rev: 13 bits<br>EnDat 2.2/01                                                | –                                                                                                                                                                  |  |
| <b>ROC/ROQ/ROD 400 series with synchro flange</b><br>    | <b>ROC 425</b><br>Positions/rev: 25 bits<br>EnDat 2.2/22<br>Available with functional safety<br><br><b>ROC 413</b><br>Positions/rev: 13 bits<br>EnDat 2.2/01 | <b>ROC 425 F</b><br>Positions/rev: 25 bits<br>Fanuc $\alpha$ i<br><br><b>ROC 424 S</b><br>Positions/rev: 24 bits<br>DRIVE-CLiQ<br>Available with functional safety | <b>ROC 413</b><br>Positions/rev: 13 bits | <b>ROQ 437</b><br>Positions/rev: 25 bits<br>EnDat 2.2/22<br>Available with functional safety<br><br><b>ROQ 425</b><br>Positions/rev: 13 bits<br>EnDat 2.2/01              | <b>ROQ 437 F</b><br>Positions/rev: 25 bits<br>Fanuc $\alpha$ i<br><br><b>ROQ 436 S</b><br>Positions/rev: 24 bits<br>DRIVE-CLiQ<br>Available with functional safety |  |
| <b>ROC 425 for high accuracy</b><br>                   | <b>ROC 425</b><br>Positions/rev: 25 bits<br>EnDat 2.2/01                                                                                                     | –                                                                                                                                                                  | –                                        | –                                                                                                                                                                         | –                                                                                                                                                                  |  |
| For separate shaft coupling, with clamping flange                                                                                         |                                                                                                                                                              |                                                                                                                                                                    |                                          |                                                                                                                                                                           |                                                                                                                                                                    |  |
| <b>ROC/ROQ/ROD 400 series with clamping flange</b><br> | <b>ROC 425</b><br>Positions/rev: 25 bits<br>EnDat 2.2/22<br>Available with functional safety<br><br><b>ROC 413</b><br>Positions/rev: 13 bits<br>EnDat 2.2/01 | <b>ROC 425 F</b><br>Positions/rev: 25 bits<br>Fanuc $\alpha$ i<br><br><b>ROC 424 S</b><br>Positions/rev: 24 bits<br>DRIVE-CLiQ<br>Available with functional safety | <b>ROC 413</b><br>Positions/rev: 13 bits | <b>ROQ 437</b><br>Positions/rev: 25 bits<br>EnDat 2.2/22<br>Available with functional safety<br><br><b>ROQ 425<sup>3)</sup></b><br>Positions/rev: 13 bits<br>EnDat 2.2/01 | <b>ROQ 437 F</b><br>Positions/rev: 25 bits<br>Fanuc $\alpha$ i<br><br><b>ROQ 436 S</b><br>Positions/rev: 24 bits<br>DRIVE-CLiQ<br>Available with functional safety |  |

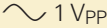
1) Up to 36000 signal periods via integrated 5- or 10-fold interpolation (higher interpolation upon request)

2) Supply voltage: DC 10 V to 30 V

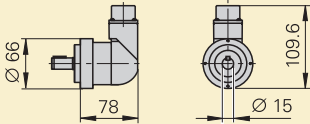
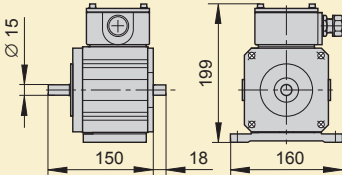
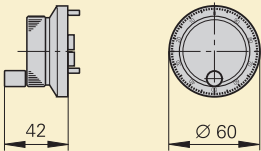
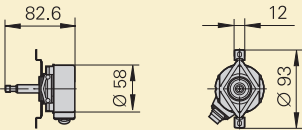
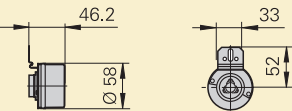
3) Also available with TTL or HTL signal transmission

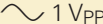
4) Available with mechanical fault exclusion; for deviating specifications and special mounting information, see the *Fault Exclusion Customer Information* document

DRIVE-CLiQ is a registered trademark of Siemens AG

|  |                                          | Incremental                                                                                       |                                                                                   |                                                                                                     |                                                                                                 |
|--|------------------------------------------|---------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------|
|  | SSI                                      |                  |  |  1 V <sub>PP</sub> |                                                                                                 |
|  |                                          |                                                                                                   |                                                                                   |                                                                                                     |                                                                                                 |
|  | –                                        | <b>ROD 1020</b><br>100 to 3600 lines<br><br><b>ROD 1070</b><br>1000/2500/3600 lines <sup>1)</sup> | <b>ROD 1030</b><br>100 to 3600 lines                                              | <b>ROD 1080</b><br>100 to 3600 lines                                                                |  <b>46</b>   |
|  | <b>ROQ 425</b><br>Positions/rev: 13 bits | <b>ROD 426</b><br>50 to 5000 lines<br><br><b>ROD 466<sup>2)</sup></b><br>50 to 5000 lines         | <b>ROD 436</b><br>50 to 5000 lines                                                | <b>ROD 486<sup>4)</sup></b><br>1000 to 5000 lines                                                   |  <b>50</b>   |
|  | –                                        | –                                                                                                 | –                                                                                 | –                                                                                                   |  <b>60</b>  |
|  |                                          |                                                                                                   |                                                                                   |                                                                                                     |                                                                                                 |
|  | <b>ROQ 425</b><br>Positions/rev: 13 bits | <b>ROD 420</b><br>50 to 5000 lines                                                                | <b>ROD 430</b><br>50 to 5000 lines                                                | <b>ROD 480<sup>4)</sup></b><br>1000 to 5000 lines                                                   |  <b>62</b> |

# Rotary encoders for special applications

| Rotary encoders                                                                                                  | Absolute Singleturn |       | Multiturn (4096 revolutions)                             |                                          |
|------------------------------------------------------------------------------------------------------------------|---------------------|-------|----------------------------------------------------------|------------------------------------------|
|                                                                                                                  | Interface           | EnDat | SSI                                                      | EnDat                                    |
| For high bearing loads                                                                                           |                     |       |                                                          |                                          |
| <b>ROD 600</b><br>              | -                   | -     | -                                                        | -                                        |
| <b>ROD 1930</b><br>             | -                   | -     | -                                                        | -                                        |
| Electronic handwheel                                                                                             |                     |       |                                                          |                                          |
| <b>HR 1120</b><br>            | -                   | -     | -                                                        | -                                        |
| For Siemens asynchronous motors                                                                                  |                     |       |                                                          |                                          |
| <b>ERN 401 series</b><br>     | -                   | -     | -                                                        | -                                        |
| <b>EQN/ERN 400 series</b><br> | -                   | -     | <b>EQN 425</b><br>Positions/rev: 13 bits<br>EnDat 2.1/01 | <b>EQN 425</b><br>Positions/rev: 13 bits |

| Incremental |                                                                                  |                                                                                   |                                                                                   |
|-------------|----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|
|             |  |  |  |
|             |                                                                                  |                                                                                   |                                                                                   |
|             | <b>ROD 620</b><br>512 to 5000 lines                                              | <b>ROD 630</b><br>512 to 5000 lines                                               | –                                                                                 |
| –           |                                                                                  | <b>ROD 1930</b><br>600 to 2400 lines                                              | –                                                                                 |
|             |                                                                                  |                                                                                   |                                                                                   |
|             | <b>HR 1120</b><br>100 lines                                                      | –                                                                                 | –                                                                                 |
|             |                                                                                  |                                                                                   |                                                                                   |
|             | <b>ERN 421</b><br>1024 lines                                                     | <b>ERN 431</b><br>1024 lines                                                      | –                                                                                 |
|             | <b>ERN 420</b><br>1024 lines                                                     | <b>ERN 430</b><br>1024 lines                                                      | –                                                                                 |



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For more information, please refer to the respective Product Information document



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For more information, please refer to the respective Product Information document



For more information, please refer to the respective Product Information document

# Measuring principles

## Measuring standards

HEIDENHAIN encoders with **optical scanning** use measuring standards consisting of periodic structures known as graduations. These graduations are applied to a carrier substrate made of glass or steel and are manufactured by means of various photolithographic processes. Graduations are made from the following materials:

- 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 allow for typical grating periods ranging from 50 µm down to 4 µm.

These processes yield fine grating periods characterized by excellent edge definition and high homogeneity. In combination with the photoelectric scanning method, these characteristics are critical for attaining high-quality output signals.

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

Encoders that use the **inductive scanning principle** employ metal graduations or copper/nickel-based graduation structures. These graduation structures are applied to a printed-circuit carrier material.

## Methods of measurement

In the **absolute measuring method**, the position value is available immediately upon encoder switch-on and can be requested by the downstream electronics at any time. There is therefore no need to search for the reference position by jogging the axes. The resulting absolute position information **is read from the circular scale**, which exhibits a code structure.

A separate incremental track is interpolated for the position value and is simultaneously used for generating an optional incremental signal.

In **singleturn encoders**, the absolute position information repeats itself with every revolution. **Multiturn encoders** can distinguish between additional revolutions.



The circular scales of absolute rotary encoders

In the **incremental measuring method**, the graduation is a periodic grating structure. The position information is obtained **through counting** the individual increments (measuring steps) starting at a freely selectable point of origin. Since position ascertainment requires an absolute reference, the circular scales have an additional track containing a **reference mark**.

The absolute position established by the reference mark is assigned to exactly one measuring step.

The reference mark must therefore be traversed before an absolute point of reference can be established or before the most recently selected reference point is refound.



The circular scales of incremental rotary encoders

# Scanning methods

## Photoelectric scanning

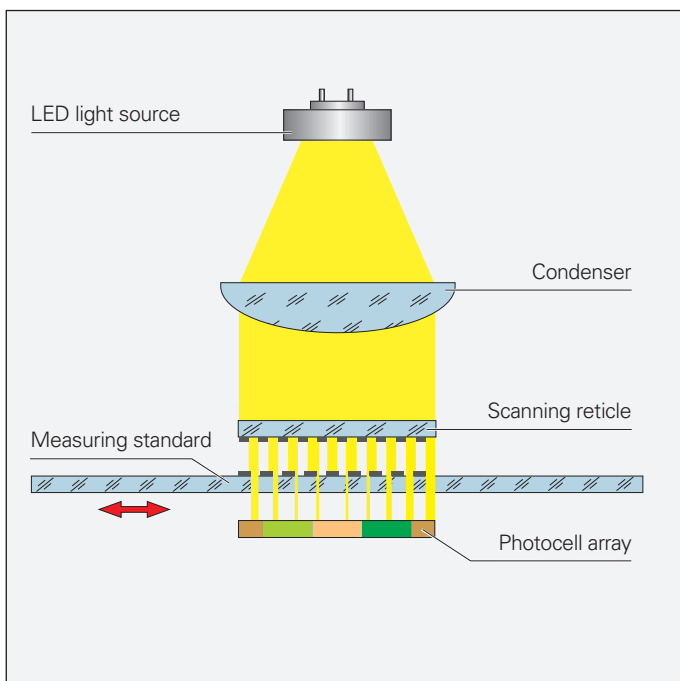
Most HEIDENHAIN encoders utilize the photoelectric scanning principle. Photoelectric scanning is non-contact and therefore does not induce wear. This method detects even extremely fine graduation lines down to a width of only a few micrometers and generates output signals with very small signal periods.

The ECN, EQN, ERN, ROC, ROQ, and ROD rotary encoders utilize the imaging scanning principle.

Put simply, the imaging scanning principle functions by means of projected-light signal generation: two gratings 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 be applied to either a transparent surface or a reflective surface.

When parallel light passes through a grating structure, light and dark fields are projected at a certain distance at which there is an index grating with the same grating period. When these two graduations move relative 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. Photocells convert these light fluctuations into nearly sinusoidal electrical signals. In encoders that use the imaging scanning principle, workable mounting tolerances are attainable starting at a minimum grating period of 10  $\mu\text{m}$ .

The absolute rotary encoders that use this scanning principle have a single, large, and finely structured photosensor as opposed to a group of discrete photocells. The width of the photosensor's structures is identical to the width of the measuring standard's grating structure. A scanning reticle with a matching structure is therefore not needed.



Photoelectric scanning in accordance with the imaging scanning principle

# Accuracy

## Interpolation errors within one signal period

The interpolation errors within one signal period are considered separately because they have an effect even during tiny rotational movements and repeat measurements, causing speed fluctuations especially in the speed control loop.

The interpolation error within one signal period  $\pm u$  results from the scanning quality and, for encoders with integrated pulse-shaping electronics or counter electronics, the quality of the signal-processing electronics. For encoders with sinusoidal output signals, however, the error from the signal processing electronics is dictated by the downstream electronics.

The following factors influence the outcome:

- The size of the signal period
- The homogeneity and period definition of the graduation
- Quality of the filter structures for scanning
- The characteristics of the sensors
- The stability and dynamic performance of the analog signal processing

These errors are taken into account in the information about interpolation error within one signal period. For rotary encoders with integral bearing and sinusoidal output signals, they are better than  $\pm 1\%$  of the signal period or better than  $\pm 3\%$  for encoders with square-wave output signals.

These signals are suitable for up to 100-fold PLL subdivision. Due to the higher reproducibility of a position, much smaller measuring steps are still practical.

Rotary encoder accuracy is primarily determined by the following factors:

- The directional error of the radial grating
- The eccentricity of the circular scale relative to the bearing
- The radial runout of the bearing
- The error arising from connection via a shaft coupling; for rotary encoders with stator coupling, this error lies within the system accuracy
- The interpolation error that arises during signal processing in the integrated or external digitizing and interpolation electronics

The following applies to **incremental rotary encoders** with line counts of up to 5000:

The maximum direction error at 20 °C ambient temperature and slow rotation (sampling frequency between 1 kHz and 2 kHz) is within

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

which equals

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

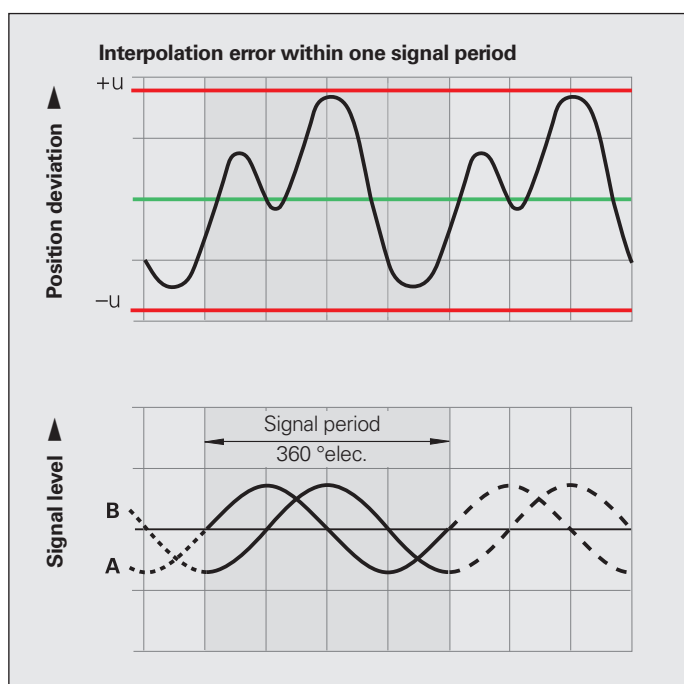
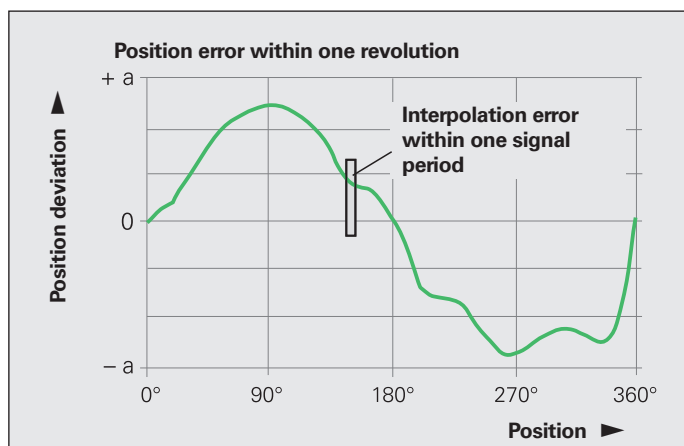
The line count must be considered when determining the system accuracy.

For **absolute rotary encoders**, the accuracy of the absolute position values is stated 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                                             |
|------------|------------------------------------------------------|
| 512        | $\pm 60$ arc seconds                                 |
| 2048       | $\pm 20$ arc seconds                                 |
| 2048       | $\pm 10$ arc seconds<br>(ROC 425 with high accuracy) |

This accuracy information applies to incremental measurement signals at 20 °C ambient temperature and slow rotation.



# Mechanical design types and mounting

## Rotary encoders with stator coupling

The **ECN/EQN/ERN** rotary encoders feature integral bearings and a mounted stator coupling. The stator coupling compensates for radial runout and alignment errors without significantly reducing the accuracy. The rotary encoder shaft is directly connected to the measured shaft. During angular acceleration of the shaft, the stator coupling must absorb only the torque resulting from friction within the bearing. The stator coupling permits a certain amount of axial motion in the measured shaft:

**ECN/EQN/ERN 400:**  $\pm 1$  mm

**ECN/EQN/ERN 1000:**  $\pm 0.5$  mm

**ECN/ERN 100:**  $\pm 1.5$  mm

### Mounting

The hollow shaft of the rotary encoder is slid onto the measured shaft and fastened on the rotor side by two screws or three eccentric clamps. Rotary encoders with a hollow through shaft can be clamped on the housing side as well. Particularly well suited for repeated mounting are the ECN/EQN/ERN 1300 series rotary encoders featuring a tapered shaft (see the *Encoders for Servo Drives* brochure). The stator is connected to a flat surface without a centering collar.

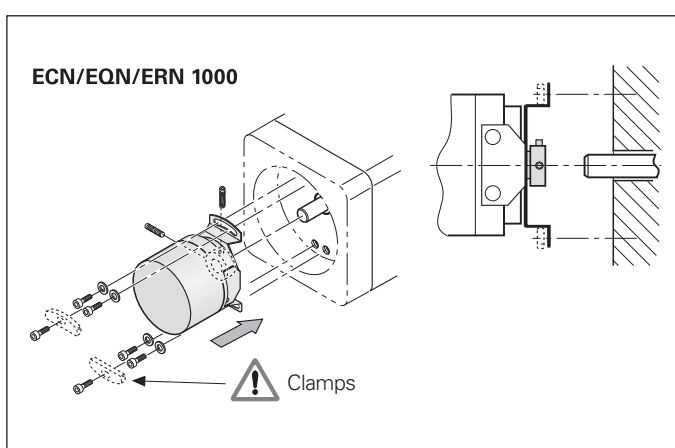
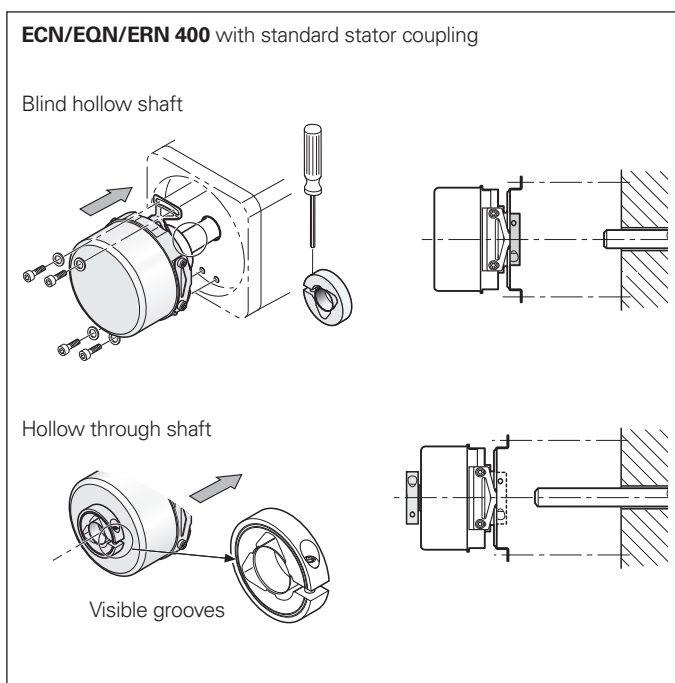
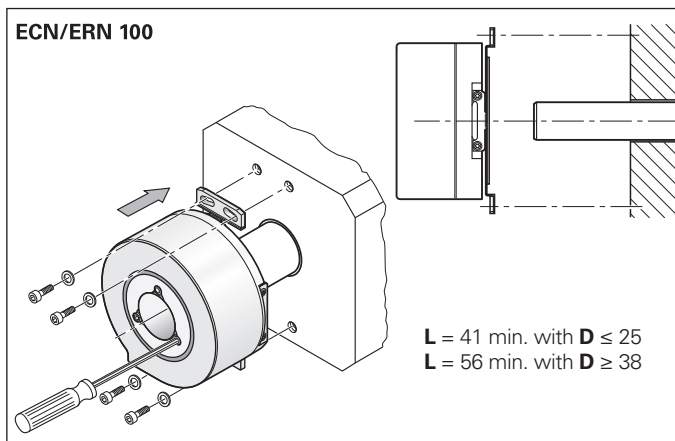
Mechanical fault exclusion is possible for the ECN/EQN/ERN 400 series rotary encoders featuring a standard stator coupling and blind hollow shaft.

Dynamic applications require the highest possible natural frequencies  $f_N$  of the system's coupling (see also "General mechanical information"). These natural frequencies can be attained through the shaft clamping on the flange side and a coupling via four screws or, in the case of the ECN/EQN/ERN 1000 encoders, with clamps.

Typical natural frequency  $f_N$  of the connection with stator-side coupling via four screws:

|                         | Stator coupling | Cable                 | Flange socket |         |
|-------------------------|-----------------|-----------------------|---------------|---------|
|                         |                 |                       | Axial         | Radial  |
| <b>ECN/EQN/ERN 400</b>  | Standard        | 1550 Hz               | 1500 Hz       | 1000 Hz |
| <b>ECN/ERN 100</b>      |                 | 1000 Hz               | —             | 400 Hz  |
| <b>ECN/EQN/ERN 1000</b> |                 | 1500 Hz <sup>1)</sup> | —             | —       |

<sup>1)</sup> Also with fastening via two screws and clamps



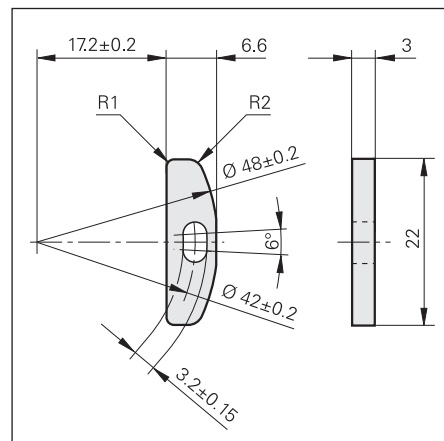


## Mounting accessories

### Washer

For the ECN/EQN/ERN 1000

For increasing the natural frequency  $f_N$  when fastening with only two screws  
ID 334653-01



### Torque supports for ECN/EQN/ERN 400

In simpler applications with the ECN/EQN/ERN 400, the stator coupling can be replaced by torque supports. The following mounting kits are available:

#### Wire torque support

The stator coupling is replaced by a metal plate to which the included wire is fastened as a coupling.

ID 510955-01



#### Pin torque support

In place of a stator coupling, a "synchro flange" is fastened via screws. Torque support is provided by a pin mounted axially or radially on the flange. Alternatively, the pin can be inserted on the customer side. A guide on the encoder's flange is then used for the pin coupling.

ID 510861-01



## General accessories

### Screwdriver bit

- For HEIDENHAIN shaft couplings
- For ExN 100/400/1000 shaft clampings
- For ERO shaft clampings

### Screwdriver

Adjustable torque, with accuracy of  $\pm 6\%$

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<br>152 mm | 350378-11 |
|                                  |                 | 350378-12 |
| TX15                             | 70 mm           | 756768-42 |

<sup>1)</sup> For DIN 6912 screws  
(low head screw with pilot recess)

# Rotary encoders for separate shaft coupling

The **ROC/ROQ/ROD** rotary encoders feature an integral bearing and a solid shaft. The encoder shaft is connected to the measured shaft with a separate shaft coupling. This coupling compensates for axial movement and misalignment (radial and angular misalignment) between the rotary encoder and the drive shaft. Thus, the encoder bearing is not subjected to additional external loads, and its service life remains unaffected. Diaphragm and metal-bellows couplings are available for the rotor-side connection of ROC/ROQ/ROD rotary encoders (see page 21).

The ROC/ROQ/ROD 400 and ROD 600 series rotary encoders permit high bearing loads (see diagrams). The bearing life L<sub>10h</sub> is calculated in accordance with DIN 281.

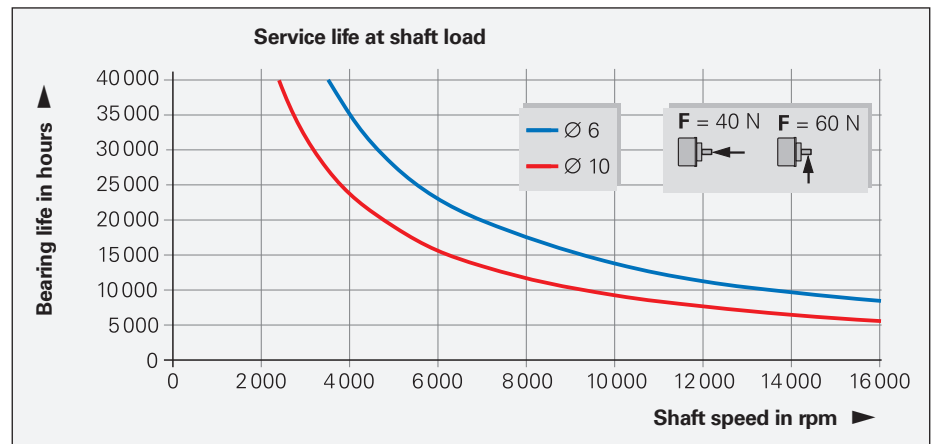
When high loads are involved, such as with friction wheels, pulleys, or sprockets, HEIDENHAIN recommends using an ECN/ EQN/ERN 400 mounted to a bearing assembly. For very high bearing loads, the ROD 1930 is a suitable choice.

The shafts to be connected must be mounted with minimum offset relative to each other. For typical mounting tolerances, see "Kinematic transfer error" on page 21.



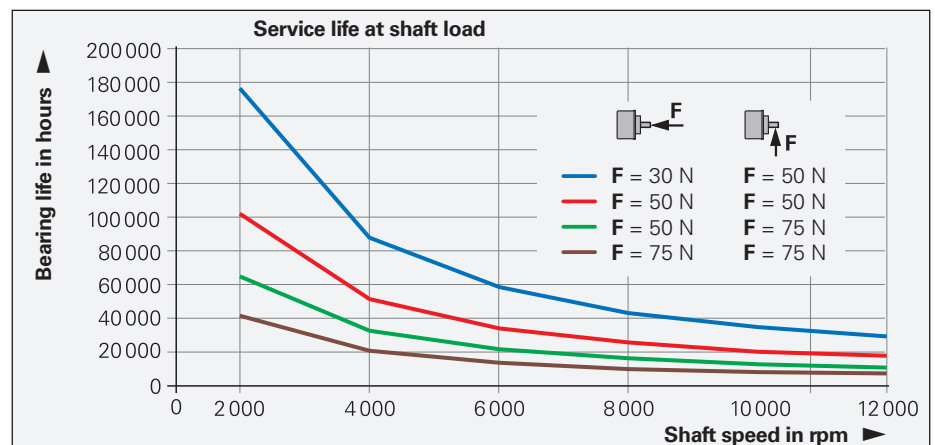
## Bearing life of ROC/ROQ/ROD 400

The service life to be expected of the bearings depends on the shaft load, the force application point and the shaft speed. The specifications state the maximum shaft loads permitted at the end of the shaft. The relationship between bearing life and maximum shaft load is shown in the diagram for 6 mm and 10 mm shaft diameters. Under an axial load of 10 N and a radial load of 20 N at the shaft end, the expected bearing service life at maximum shaft speed is greater than 40 000 hours.



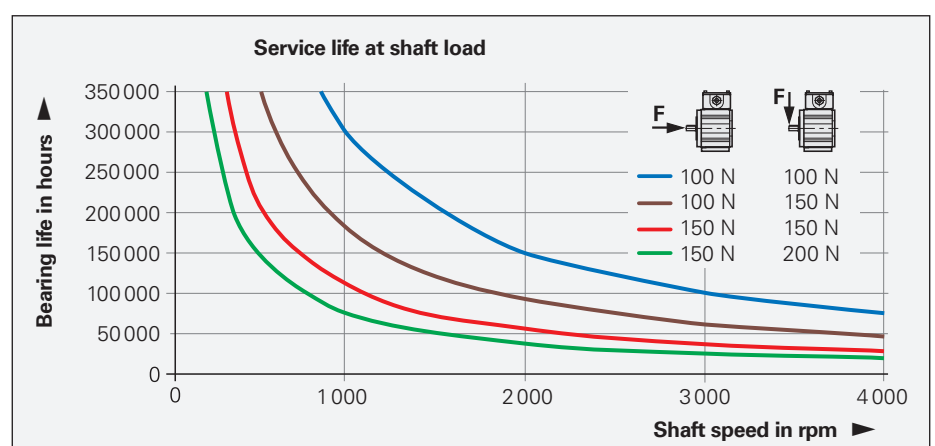
## Bearing life of the ROD 600

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



## Bearing life of the ROD 1930

The ROD 1930 is designed for a long service life under very high bearing loads.



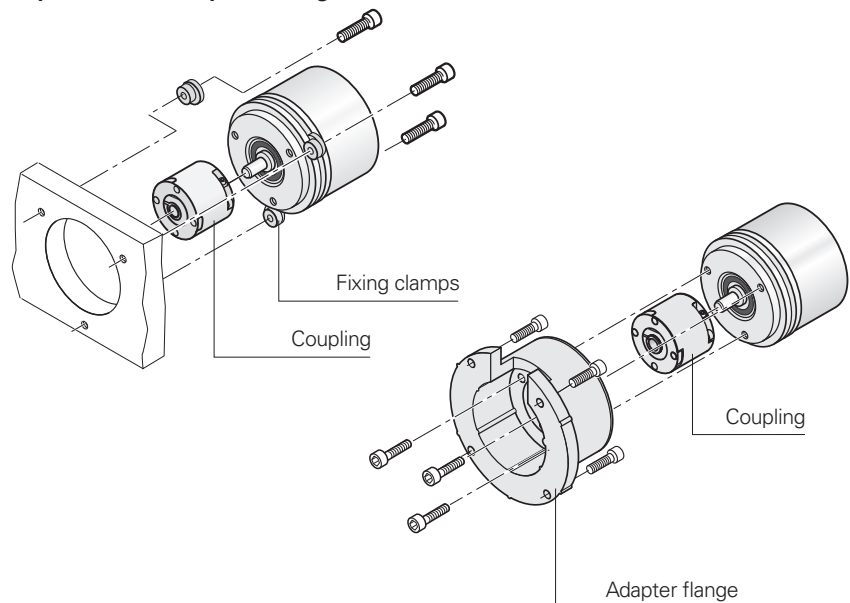
## Rotary encoders with synchro flange

### Mounting

- Via the synchro flange with three fixing clamps, or
- To an adapter flange via the fastening screw threads on the front face (for ROC/ROQ/ROD 400)

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

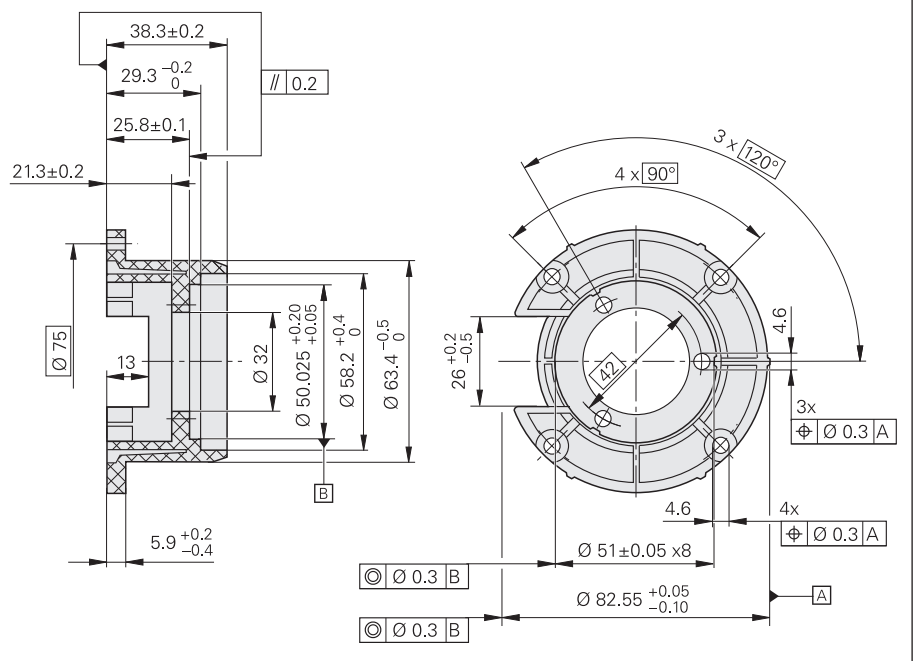
### Rotary encoders with synchro flange



### Mounting accessories

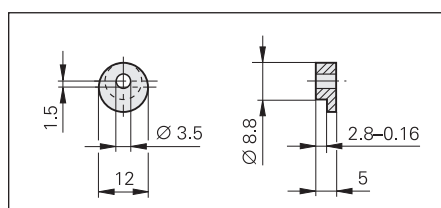
#### Adapter flange

(electrically non-conductive)  
ID 257044-01



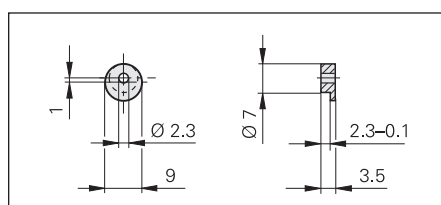
#### Fixing clamps

For the ROC/ROQ/ROD 400 series  
(three per encoder)  
ID 200032-01



#### Fixing clamps

For the ROC/ROQ/ROD 1000 series  
(three per encoder)  
ID 200032-02



## Rotary encoders with clamping flange

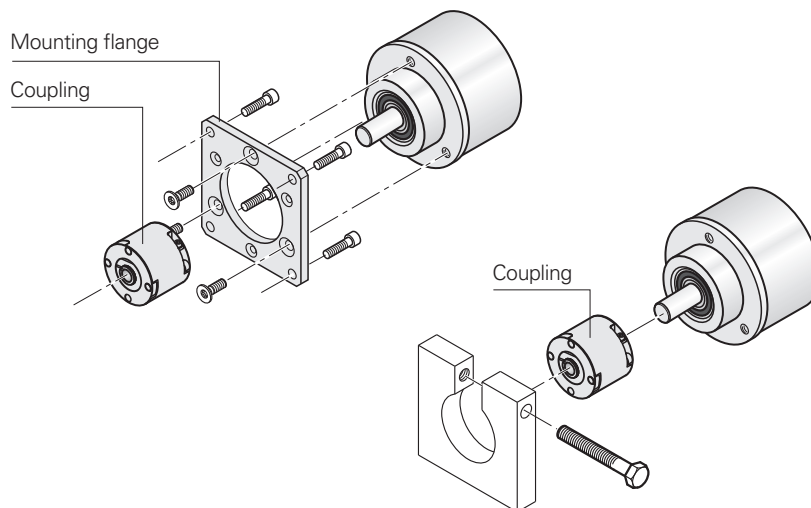
### Mounting

- To a mounting flange via the fastening threads on the front face, or
- Via clamping at the clamping flange, or
- With three fixing clamps (for encoders with an additional groove on the clamping flange)

Centering is performed via the centering collar on the synchro flange or via the clamping flange.

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

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

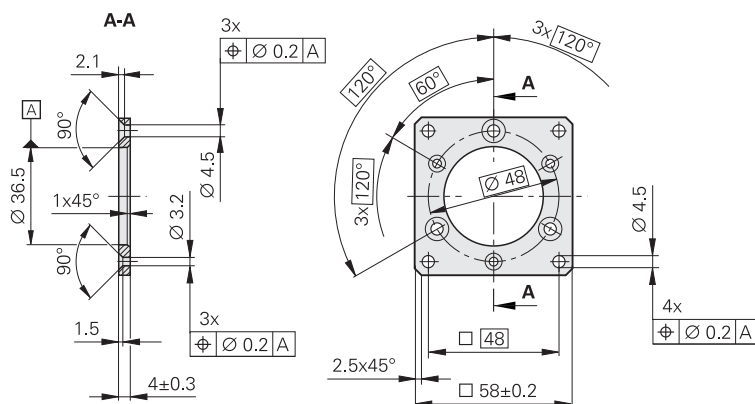


The clamping design must be created by the machine manufacturer.

### Mounting accessories

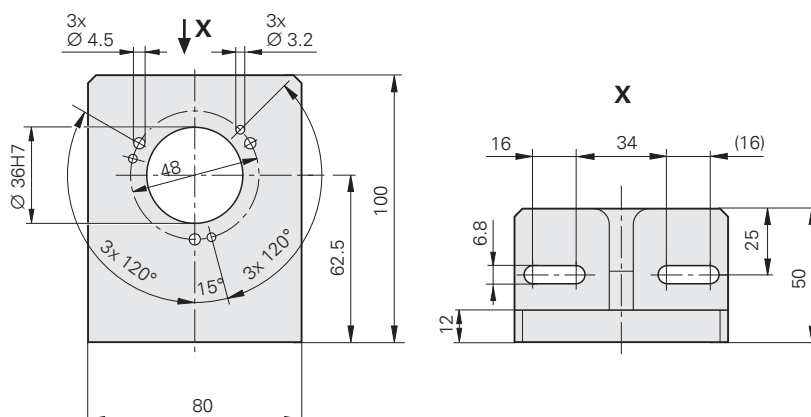
#### Mounting flange

ID 201437-01



#### Mounting bracket

ID 581296-01



## Rotary encoders with flange/base mounting

### Mounting

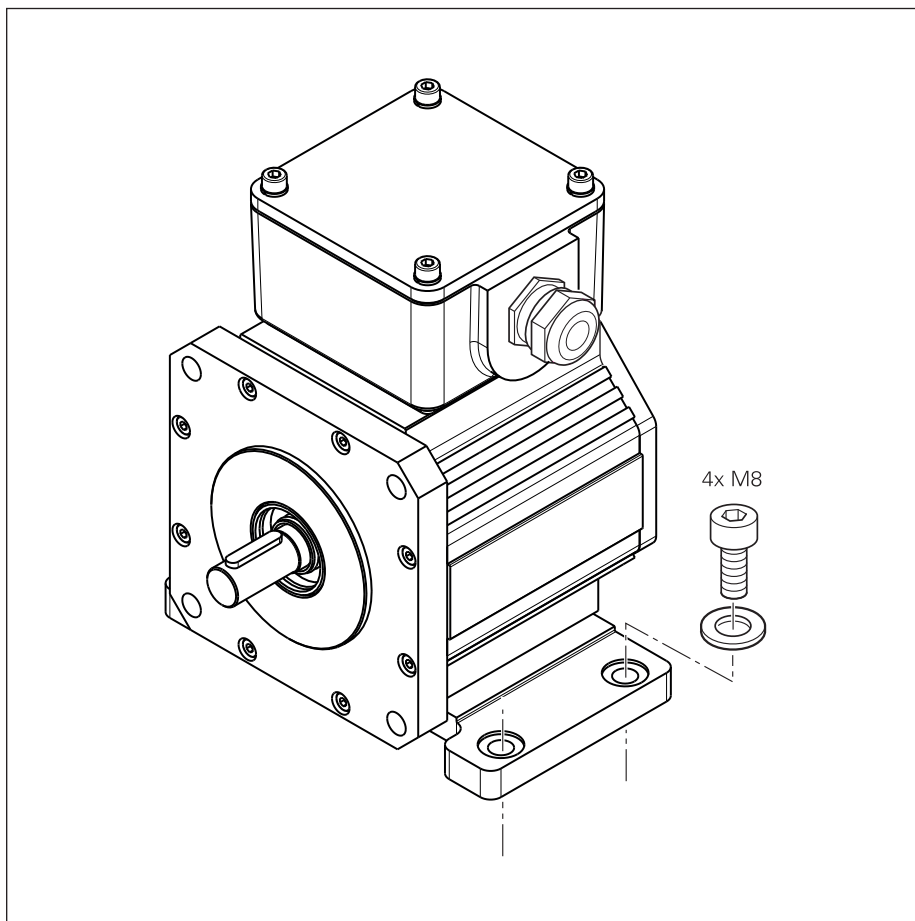
- Via mounting flange, or
- Via base

Fastening is performed with four M8 screws.

The terminal box can be mounted at any 90° orientation.

### Shaft coupling

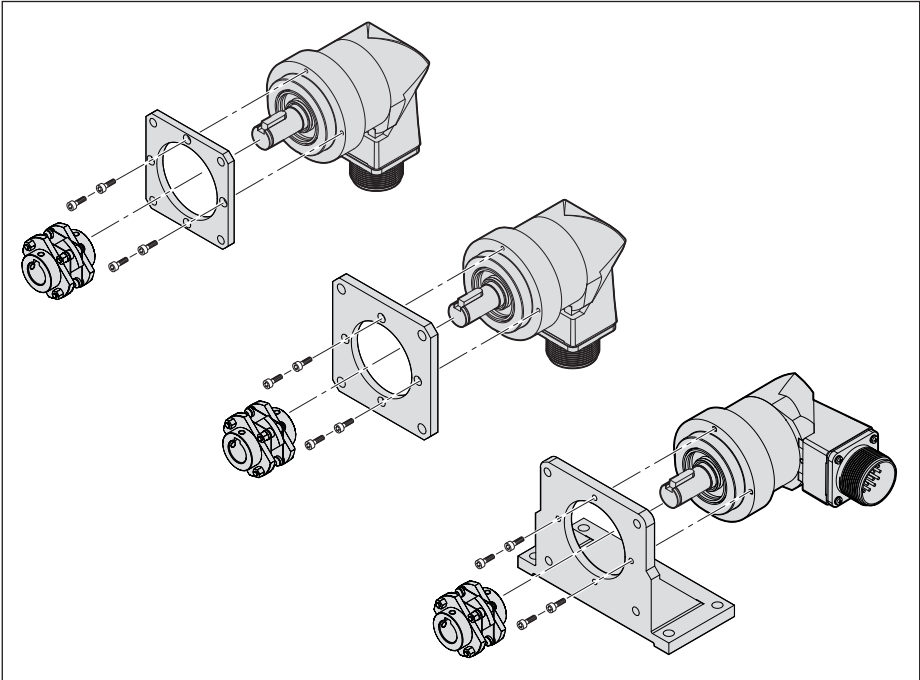
For optimum torque transmission, the encoder shaft is equipped with a key. The C19 and C 212 couplings, which are available as accessories, feature a matching keyway.



# **ROD 600 rotary encoder with clamping flange**

## **Mounting**

- To a mounting flange via the fastening threads on the front face



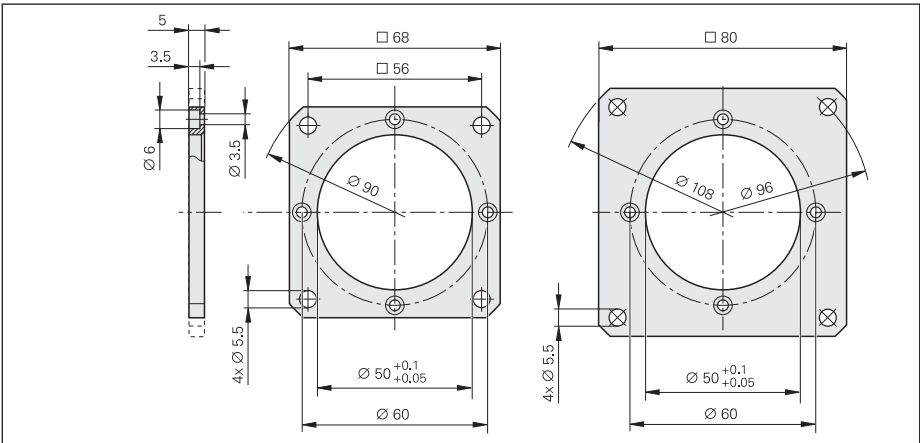
## **Mounting accessories**

### **Mounting flange (small)**

ID 728587-01

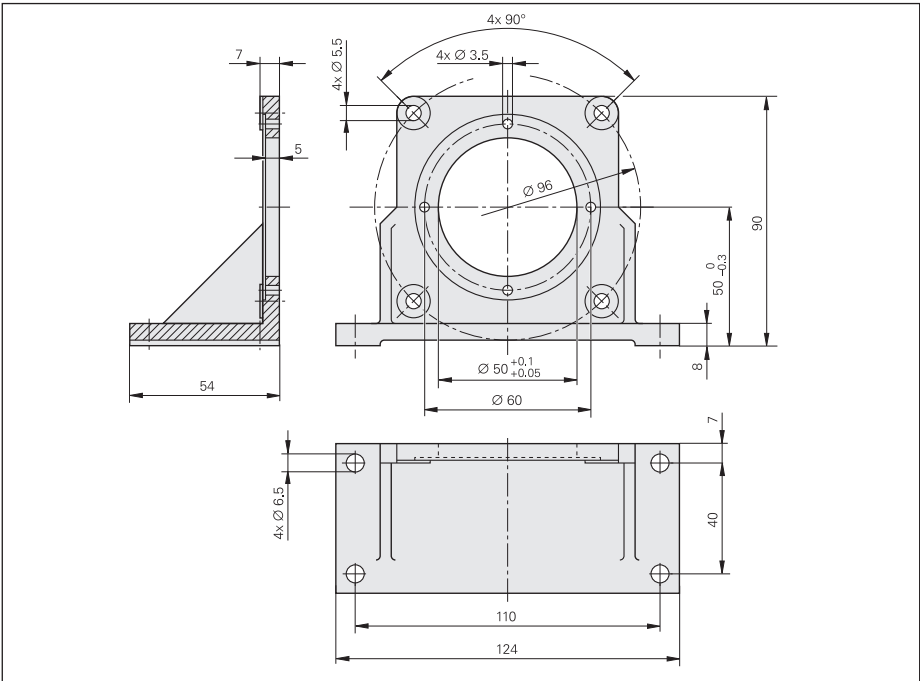
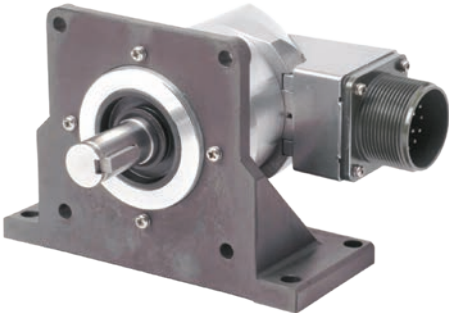
### **Mounting flange (large)**

ID 728587-02



## **Mounting bracket**

ID 728587-03

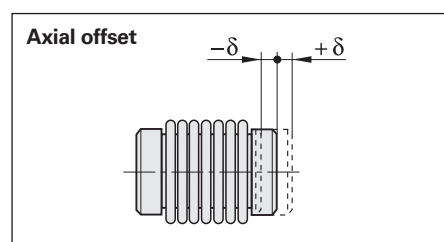
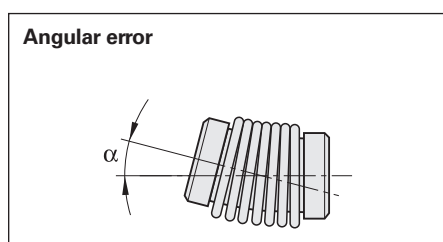
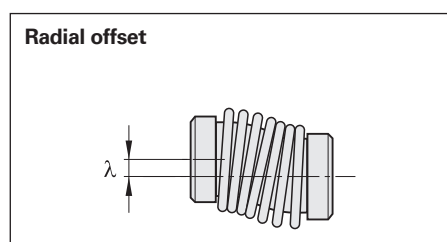


mm  
  
 Tolerancing ISO 8015  
 ISO 2768:1989-mH  
 ≤ 6 mm: ±0.2 mm

# Shaft couplings

|                                                      | ROC/ROQ/ROD 400                       |                                       |                                    |                                       | ROD 1930<br>ROD 600                    |           | ROC/ROQ/<br>ROD 1000                    |
|------------------------------------------------------|---------------------------------------|---------------------------------------|------------------------------------|---------------------------------------|----------------------------------------|-----------|-----------------------------------------|
|                                                      | Diaphragm coupling                    |                                       |                                    |                                       | Diaphragm coupling                     |           | Metal bellows<br>coupling               |
|                                                      | K 14                                  | K 17/01<br>K 17/06                    | K 17/02<br>K 17/04<br>K 17/05      | K 17/03                               | C 19                                   | C 212     | 18 EBN 3                                |
| Hub bore                                             | 6/6 mm                                | 6/6 mm<br>6/5 mm                      | 6/10 mm<br>10/10 mm<br>6/9.52 mm   | 10/10 mm                              | 15/15                                  |           | 4/4 mm                                  |
| Galvanic isolation                                   | –                                     | ✓                                     | ✓                                  | ✓                                     | –                                      | ✓         | –                                       |
| Kinematic transfer<br>error*                         | ±6″                                   | ±10″                                  |                                    |                                       | ±13″                                   |           | ±40″                                    |
| Torsional rigidity                                   | 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 $\frac{\text{Nm}}{\text{rad}}$       |
| Torque                                               | ≤ 0.2 Nm                              | ≤ 0.1 Nm                              |                                    | ≤ 0.2 Nm                              | ≤ 3.9 Nm                               | ≤ 5 Nm    | ≤ 0.1 Nm                                |
| Radial offset λ                                      | ≤ 0.2 mm                              | ≤ 0.5 mm                              |                                    |                                       | ≤ 0.3 mm                               |           | ≤ 0.2 mm                                |
| Angular error α                                      | ≤ 0.5°                                | ≤ 1°                                  |                                    |                                       | ≤ 1.5°                                 |           | ≤ 0.5°                                  |
| Axial offset δ                                       | ≤ 0.3 mm                              | ≤ 0.5 mm                              |                                    |                                       | ≤ 1.7 mm                               |           | ≤ 0.3 mm                                |
| Moment of inertia<br>(approx.)                       | 6 · 10 <sup>-6</sup> kgm <sup>2</sup> | 3 · 10 <sup>-6</sup> kgm <sup>2</sup> |                                    | 4 · 10 <sup>-6</sup> kgm <sup>2</sup> | 15 · 10 <sup>-6</sup> kgm <sup>2</sup> |           | 0.3 · 10 <sup>-6</sup> kgm <sup>2</sup> |
| Permissible shaft speed                              | 16 000 rpm                            |                                       |                                    |                                       | 20 000 rpm                             | 6 000 rpm | 12 000 rpm                              |
| Tightening torque<br>of clamping screws<br>(approx.) | 1.2 Nm                                |                                       |                                    |                                       | 1.37 Nm                                |           | 0.8 Nm                                  |
| Mass                                                 | 35 g                                  | 24 g                                  | 23 g                               | 27.5 g                                | 75 g                                   |           | 9 g                                     |

\* In the case of typical mounting tolerances: Radial offset  $\lambda = 0.1 \text{ mm}$ ; angular error  $\alpha = 0.09^\circ$  (0.15 mm of error over 100 mm)



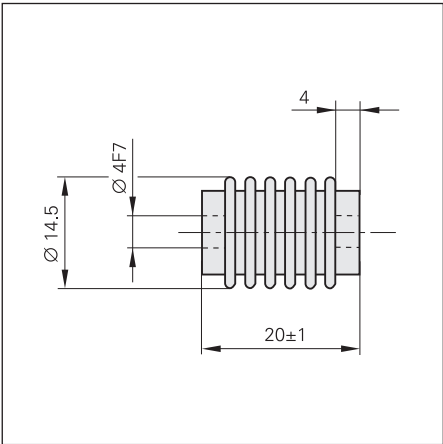
## Mounting accessories

### Screwdriver bit

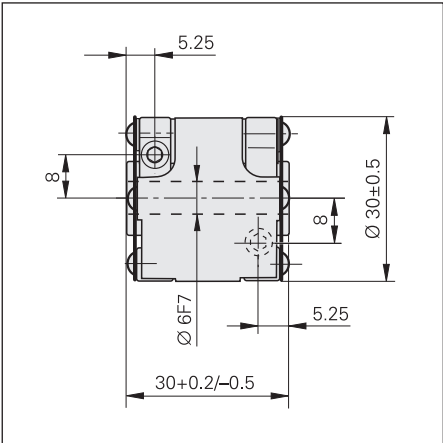
### Screwdriver

See page 18.

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

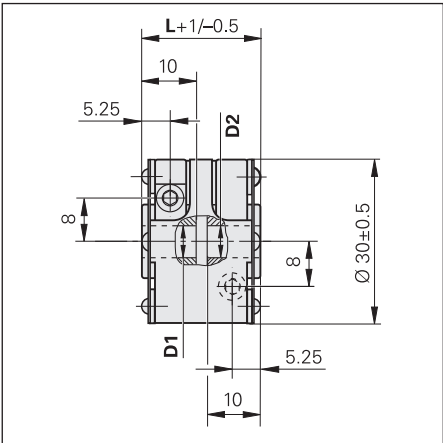


**K 14 diaphragm coupling**  
 For the ROC/ROQ/ROD 400 series  
 with **6 mm shaft diameter**  
 ID 293328-01



Recommended fit for the mating  
 shaft: h6

**K 17 diaphragm coupling**  
 With galvanic isolation  
 For the ROC/ROQ/ROD 400 series  
 with **6 mm or 10 mm shaft diameter**  
 ID 1246841-xx



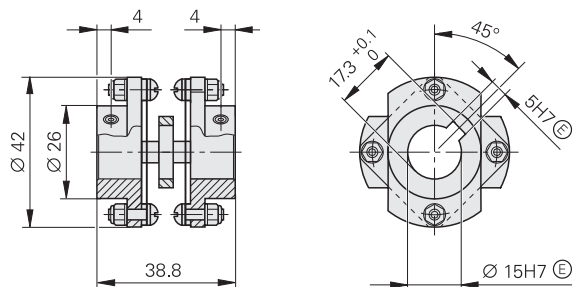
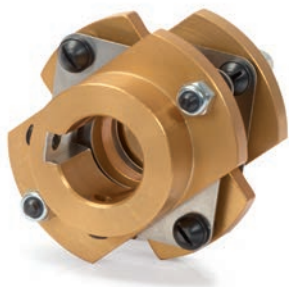
| K 17 Variant | D1      | D2        | L     |
|--------------|---------|-----------|-------|
| 01           | Ø 6 F7  | Ø 6 F7    | 22 mm |
| 02           | Ø 6 F7  | Ø 10 F7   | 22 mm |
| 03           | Ø 10 F7 | Ø 10 F7   | 30 mm |
| 04           | Ø 10 F7 | Ø 10 F7   | 22 mm |
| 05           | Ø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



Tolerancing ISO 8015  
 ISO 2768:1989-mH  
 ≤ 6 mm: ±0.2 mm

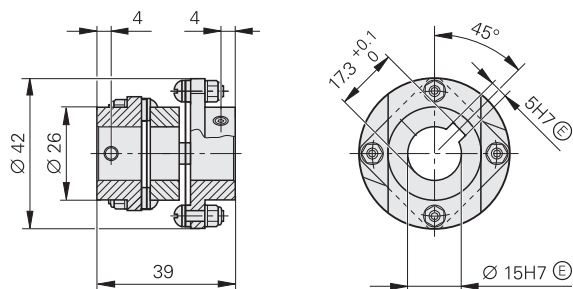
### Diaphragm coupling C 19

For the ROD 1930 and ROD 600 rotary encoders with 15 mm shaft diameter and key ID 731374-01



### Diaphragm coupling C 212

With galvanic isolation  
For the ROD 1930 and ROD 600 rotary encoders with 15 mm shaft diameter and key ID 731374-02



mm



Tolerancing ISO 8015

ISO 2768:1989-mH

$\leq 6 \text{ mm: } \pm 0.2 \text{ mm}$

# General mechanical information

## Certification by an NRTL (Nationally Recognized Testing Laboratory)

All rotary encoders in this brochure comply with the UL safety regulations for the U.S. and the "CSA" safety regulations for Canada.

## Accelerations

During mounting and operation, encoders are subjected to various types of acceleration.

### • Vibration

The encoders are qualified on a test stand under the acceleration values stated in the specifications at frequencies of 55 Hz to 2000 Hz in accordance with EN 60068-2-6. However, if the application or mounting situation causes long-duration resonant vibration, then proper functioning of the encoder may be impaired, or the encoder may incur damage. **Thorough testing of the complete system is therefore required.**

### • Shock

The encoders are qualified on a test stand under the acceleration values stated in the specifications and under the exposure times in accordance with EN 60068-2-27 for non-repetitive, semi-sinusoidal shock. **Continuous shock loads** are therefore not covered and **must be tested in the application.**

- The **maximum angular acceleration** is  $10^5 \text{ rad/s}^2$ . This is the highest permissible rotational acceleration at which the rotor can be accelerated without damage to the encoder. The actual attainable angular acceleration is within the same order of magnitude but can vary depending on the type of shaft connection (for deviating values for the ECN/ERN 100, see the *Specifications*). An adequate safety factor must be determined through system tests.

Deviating values for rotary encoders with functional safety are provided in the corresponding Product Information documents.

## Air humidity

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

## Magnetic fields

Magnetic fields greater than 30 mT can affect proper encoder functioning. Please contact HEIDENHAIN in Traunreut, Germany, as needed.

## Natural frequencies

With the ROC/ROQ/ROD rotary encoders, the rotor and the shaft coupling together form an oscillation-capable spring-mass system. In the case of the ECN/EQN/ERN, this applies to the stator and stator coupling.

The **natural frequency  $f_N$**  should be as high as possible. In order for the highest possible natural frequency to be attained with the **ROC/ROQ/ROD rotary encoders**, a diaphragm coupling with a high torsional rigidity  $C$  must be used (see "Shaft couplings").

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

$f_N$ : Natural frequency of the coupling in Hz

$C$ : Torsional rigidity of the coupling in Nm/rad

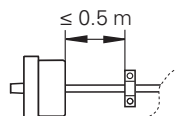
$I$ : Moment of inertia of the rotor in  $\text{kgm}^2$

In conjunction with the stator coupling, the **ECN/EQN/ERN** rotary encoders form an oscillation-capable spring-mass system whose **natural frequency  $f_N$**  of the coupling in the direction of measurement should be as high as possible. The natural frequency of the coupling is influenced by the rigidity of the stator coupling and by the customer-side mounting situation. The stated typical natural frequencies may vary depending on the encoder variant (e.g., singleturn or multiturn), the production tolerances, and the mounting conditions. If radial and/or axial acceleration forces also come into play, then the rigidity of the encoder bearing and of the encoder stator has an effect as well. If such loads occur within your application, HEIDENHAIN recommends consulting with the main facility in Traunreut.

HEIDENHAIN generally recommends determining the natural frequency of the stator coupling within the complete system.

## Strain relief

Provide strain relief for the rotary encoder cable.



## Starting torque and operating torque

The starting torque is the torque required to put the rotor into motion from standstill. If the rotor is already rotating, then a certain operating torque is acting on the encoder. The starting torque and operating torque are influenced by various factors, such as the temperature, prior standstill time and the amount of wear on the bearing and seal.

The typical values stated in the specifications are mean values based on encoder-specific test series performed at room temperature and at a stabilized operating temperature. The typical operating torques are also based on constant shaft speeds. For applications in which the torque has a significant influence, HEIDENHAIN recommends consulting with the main office in Traunreut.

## Protection from contact (EN 60529)

After installation of the encoder, all rotating parts must be protected from accidental contact during operation.

## Protection (EN 60529)

The ingress of contamination can impair proper functioning of the encoder. Unless otherwise indicated, all of the rotary encoders have an IP64 rating (ExN/ROx 400: IP67) in accordance with EN 60529. These specifications apply to the housing, cable outlet, and flange socket versions when engaged.

The **shaft inlet** meets an IP64 rating. Splash water must not contain any substances that would have harmful effects on the encoder's parts. If the protection rating of the shaft inlet is not sufficient (e.g., due to vertical mounting of the encoder), then the encoders should be additionally protected with labyrinth seals. Many rotary encoders are also available with an IP66 rating for the shaft inlet. Depending on the application, the radial shaft seal rings used for sealing are subjected to wear due to friction.

## Acoustic noise

Running noise can occur during operation. This is particularly true of encoders with an integral bearing and of multiturn rotary encoders (with gears). The intensity may vary depending on the mounting situation and shaft speed.

### System tests

Encoders from HEIDENHAIN are usually integrated as components into complete systems. Applications of this type require full-system, **comprehensive testing**, regardless of the encoder's specifications. The specifications provided in this brochure apply only to the encoder and not to the complete system. Any operation of the encoder outside of the specified range or outside of its proper and intended use is solely at the user's own risk.

### Mounting

Only the work steps and dimensions in the mounting instructions available for the encoder are to be followed during mounting. All mounting-related information in this brochure is therefore only provisional and non-binding, and will not become the subject matter of a contract.

In addition, the machine manufacturer must define the other required final mounting information for the given application (e.g., tightening torque, mechanical fault exclusion for screws needed or not). The stated tolerance ranges in the product's dimension drawing and mounting instructions must also be considered.

### Modifications to the encoder

The proper functioning and accuracy of encoders from HEIDENHAIN are ensured only if the encoders have not been modified. Any modification, even a minor one, can impair the proper functioning, reliability and safety of the encoders, and result in a loss of warranty. This also includes the use of any additional or non-prescribed locking varnishes, lubricants (e.g., for screws), or adhesives. If you are in doubt, we recommend that you consult with HEIDENHAIN in Traunreut, Germany.

### Conditions for storage

The specified parameters of the individual products are based on the assumption that steel is used for the mating shaft and that aluminum is used for the mating surface for the stator coupling or stator and that this steel and aluminum have the properties stated in the table below. Any deviations from the information in this table are stated on the respective product page or in separately available Product Information documents. The following material properties and conditions for mounting by the customer are also assumed for the fault exclusion design for functional safety:

|                                                                                       | Aluminum                                                                                                                     | Steel                                                                  |
|---------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|
| <b>Material</b>                                                                       | Hardenable wrought aluminum alloy                                                                                            | Unalloyed hardened steel                                               |
| <b>Tensile strength <math>R_m</math></b>                                              | $\geq 220 \text{ N/mm}^2$                                                                                                    | $\geq 600 \text{ N/mm}^2$                                              |
| <b>Yield strength <math>R_{p0.2}</math> or yield point <math>R_e</math></b>           | Not relevant                                                                                                                 | $\geq 400 \text{ N/mm}^2$                                              |
| <b>Shear strength <math>\tau_a</math></b>                                             | $\geq 130 \text{ N/mm}^2$                                                                                                    | $\geq 390 \text{ N/mm}^2$                                              |
| <b>Interface pressure <math>p_G</math></b>                                            | $\geq 250 \text{ N/mm}^2$                                                                                                    | $\geq 660 \text{ N/mm}^2$                                              |
| <b>Modulus of elasticity <math>E</math> (at 20 °C)</b>                                | 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>                       |
| <b>Coefficient of thermal expansion <math>\alpha_{\text{therm}}</math> (at 20 °C)</b> | $\leq 25 \cdot 10^{-6} \text{ K}^{-1}$                                                                                       | $10 \cdot 10^{-6} \text{ K}^{-1}$ to $17 \cdot 10^{-6} \text{ K}^{-1}$ |
| <b>Surface roughness <math>R_z</math></b>                                             | $\leq 16 \text{ }\mu\text{m}$                                                                                                |                                                                        |
| <b>Friction values</b>                                                                | Mounting surfaces must be clean and free of grease. Screws and washers are assumed to be in the same condition as delivered. |                                                                        |
| <b>Tightening procedure</b>                                                           | Use a signal-emitting torque wrench in accordance with DIN EN ISO 6789, with an accuracy of $\pm 6\%$                        |                                                                        |
| <b>Mounting temperature</b>                                                           | 15 °C to 35 °C                                                                                                               |                                                                        |

Rotary encoders with functional safety may exert a torque of up to 1 Nm on the mating shaft. In addition, other forces and torques (e.g., from vibrational loads and angular acceleration) must be taken into account. The customer's mechanical elements must be designed for these loads (see also EN 61800-5-2 and EN ISO 13849). The respective Product information documents will describe any other requirements.

Supplementary information:  
For rotary encoders of the ECN/EQN/ERN 4xx/13xx series with a hollow shaft, a maximum of 2 Nm is permissible for an operating temperature range of -30 °C to -40 °C.

### Screws with material bonding anti-rotation lock

Mounting screws and central screws from HEIDENHAIN (not included in delivery) feature a coating that, after hardening,

provides a material bonding anti-rotation lock. As a result, these screws cannot be reused. Their minimum shelf life is two years (storage at  $\leq 30 \text{ }^\circ\text{C}$  and  $\leq 65\%$  relative humidity). Their expiration date is printed on the package.

If a replacement becomes necessary, recut the threads and use new screws. On threaded holes, a chamfer is required in order to keep the adhesive coating from being scraped off.

Screw insertion and the application of tightening torque must therefore be completed within five minutes. The required strength is reached at room temperature after six hours. The lower the temperature, the longer the curing process will take. Curing temperatures below 5 °C are not permissible.

### Conditions for longer storage periods

HEIDENHAIN recommends the following in order to make storage periods of at least 12 months possible:

- Leave the encoders in their original packaging
- The storage location should be dry, free of dust and temperature-regulated. It should also be free of vibration, mechanical shock and chemical environmental influences
- Every twelve months, rotate the shafts of the encoders with integral bearing at low speed and without axial or radial shaft loading so that the bearing lubrication becomes evenly redistributed (e.g., such as when first breaking in an encoder)

### Parts subject to wear

Encoders from HEIDENHAIN are designed for a long service life. Preventive maintenance is not required. However, they do contain components that are subject to wear depending on the application and how they are deployed. This especially applies to cables that are subject to frequent flexing.

Other parts subject to wear are the bearings in encoders with integral bearing, the radial shaft seal rings in rotary encoders and angle encoders, and the sealing lips on sealed linear encoders.

In order to avoid damage from current flows, some rotary encoders are available with hybrid bearings. In general, these bearings exhibit greater wear at high temperatures than standard bearings.

### Service life

Unless otherwise specified, HEIDENHAIN encoders are designed for a service life of 20 years, which is equivalent to 40 000 operating hours under typical operating conditions. The encoders' service life may be limited by the bearing service life, depending on the application.

Starting at a continuous use temperature of 75 °C, the service life may be limited by the service life of the grease. Please contact HEIDENHAIN if you have any questions about the service life of the grease.

### Temperature ranges

For an encoder in its packaging, the applicable **storage temperature range** is –30 °C to 65 °C. The **operating temperature range** specifies the temperature of the rotary encoder that is permissible during operation under actual installation conditions. Within this range, proper functioning of the rotary encoder is ensured. 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 rotary encoder is influenced by the following factors:

- The mounting conditions
- The ambient temperature
- The encoder's susceptibility to self-heating

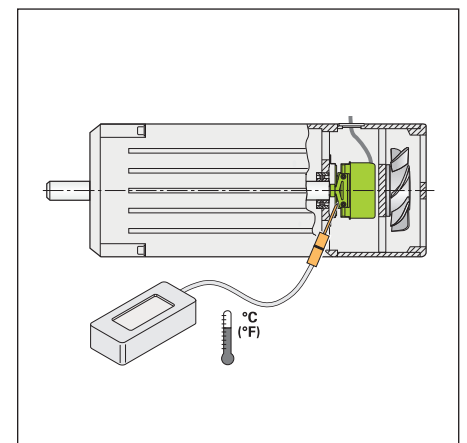
An encoder's susceptibility to self-heating depends both on its design characteristics (stator coupling / solid shaft, shaft sealing ring, etc.) and on its operating parameters (shaft speed, supply voltage). A temporary period of heightened self-heating can also occur after very long breaks in operation (of several months). Please allow for a two-minute break-in period at low shaft speeds. The greater susceptibility to self-heating that an encoder exhibits, the lower the ambient temperature needs to be in order to keep the encoder within its permissible operating temperature range.

This table shows the approximate self-heating values to be expected for the rotary encoders. In the worst case, the amount of self-heating may be affected by multiple operating parameters, such as a 30 V supply voltage and maximum shaft speed. Thus, if an encoder is being operated close to its maximum permissible specifications, then the actual operating temperature should be measured directly at the encoder. Suitable measures must then be taken (fan, heat sinks, etc.) to sufficiently reduce the ambient temperature so that the maximum permissible operating temperature will not be exceeded during continuous operation.

For high shaft speeds at the maximum permissible ambient temperature, special versions with a reduced protection rating are available (without a radial shaft seal ring and its concomitant frictional heat).

| Self-heating at shaft speed $n_{\max}$            |                                         |
|---------------------------------------------------|-----------------------------------------|
| <b>ECN/EQN/ERN 1000</b>                           | ≈ +10 K                                 |
| <b>ROC/ROQ/ROD</b><br>Solid shaft                 | ≈ + 5 K<br>With IP66 rating:<br>≈ +10 K |
| <b>ECN/EQN/ERN 400/1300</b><br>Tapered shaft      | ≈ + 5 K<br>With IP66 rating:<br>≈ +10 K |
| <b>ECN/EQN/ERN 400/1300</b><br>Blind hollow shaft | ≈ +30 K<br>With IP66 rating:<br>≈ +40 K |
| <b>ECN/EQN/ERN 400</b><br>Hollow through shaft    | ≈ +40 K<br>With IP66 rating:<br>≈ +50 K |
| <b>ECN/ERN 100</b><br>Hollow through shaft        | ≈ +40 K<br>With IP64 rating:<br>≈ +50 K |
| <b>ROD 600</b>                                    | ≈ +75 K                                 |
| <b>ROD 1900</b>                                   | ≈ +40 K                                 |

Typical self-heating values of a rotary encoder at maximum permissible shaft speed based on its design characteristics. The relationship between shaft speed and heat generation is nearly linear.



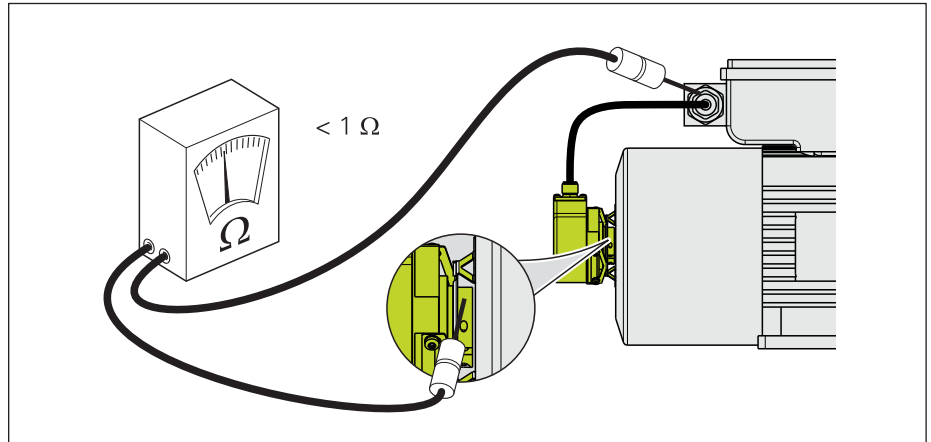
Measuring of the actual operating temperature at the defined measuring point of the rotary encoder (see "Specifications")

# Electrical resistance

## Encoders with an integral bearing and onnector

Check the electrical resistance between the cable gland and the rotor or between the flange socket and the rotor.

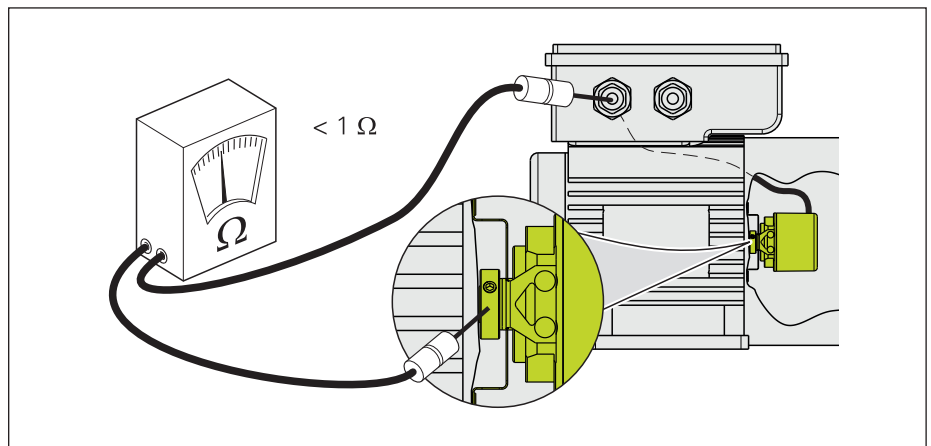
Nominal value: < 1 ohm



## Encoders with an integral bearing and a built-in output cable

Check the electrical resistance between the cable gland and the rotor or between the flange socket and the rotor.

Nominal value: < 1 ohm



### Further information:

Please take into account the information about electromagnetic compatibility under "General electrical information" in the *Interfaces of HEIDENHAIN Encoders* brochure.

# Safety-related position encoders

## Functionally safe axes

Driven axes or moving parts can represent a significant hazard for humans. Particularly if the human interacts with the machine (e.g., during workpiece setup), it must be ensured that the machine does not make any uncontrolled movements. This requires position information about the axes in order for a safety function to be implemented. As an evaluating safety module, the control must be able to detect faulty position information and react accordingly.

Various safety strategies can be pursued depending on the topology of the axis and the evaluation capabilities of the controller. In a single-encoder system, for example, only one encoder per axis is evaluated for the safety function. However, on axes with two encoders, such as a linear axis with a rotary and a linear encoder, the two redundant position values can be compared with each other in the control. Safe fault detection can be ensured only if the two components (the control and encoder) are properly matched to each other. Please note that the safety designs of control manufacturers differ from one another. As a result, the requirements to be fulfilled by the connected encoders may partially differ as well.

## Type-examined encoders

Encoders from HEIDENHAIN are used successfully on a variety of controls in widely differing safety designs. This particularly applies to type-examined encoders with EnDat and DRIVE-CLiQ interfaces. These encoders can be operated as single-encoder systems in conjunction with a suitable control in applications with the control category SIL 3 (according to EN 61508) or Performance Level "e" (of EN ISO 13849). Unlike incremental encoders, absolute encoders always provide a safe absolute position value, including immediately after switch-on or a power failure. Reliable position transmission is based on two independently generated absolute position values and on error bits provided to the safe control. The purely serial data transmission also provides other benefits, including greater reliability, improved accuracy, diagnostic capabilities, and reduced costs through simpler connection technology.

## Standard encoders

In addition to encoders explicitly qualified for safety applications, standard encoders (e.g., with Fanuc interface or 1 V<sub>PP</sub> signals) can also be used in safe axes. In such cases, the characteristics of the encoders must be matched to the requirements of the given controller. For this purpose, HEIDENHAIN can provide additional data about the individual encoders (failure rate, fault model as per EN 61800-5-2).



### Further information:

The safety-related characteristic values are listed in the specifications of the encoders. These characteristic values are explained in the Technical Information document *Safety-Related Position Encoders*.

For the use of standard encoders in safety-related applications, HEIDENHAIN can also provide additional information about individual products (failure rate, fault model as per EN 61800-5-2).

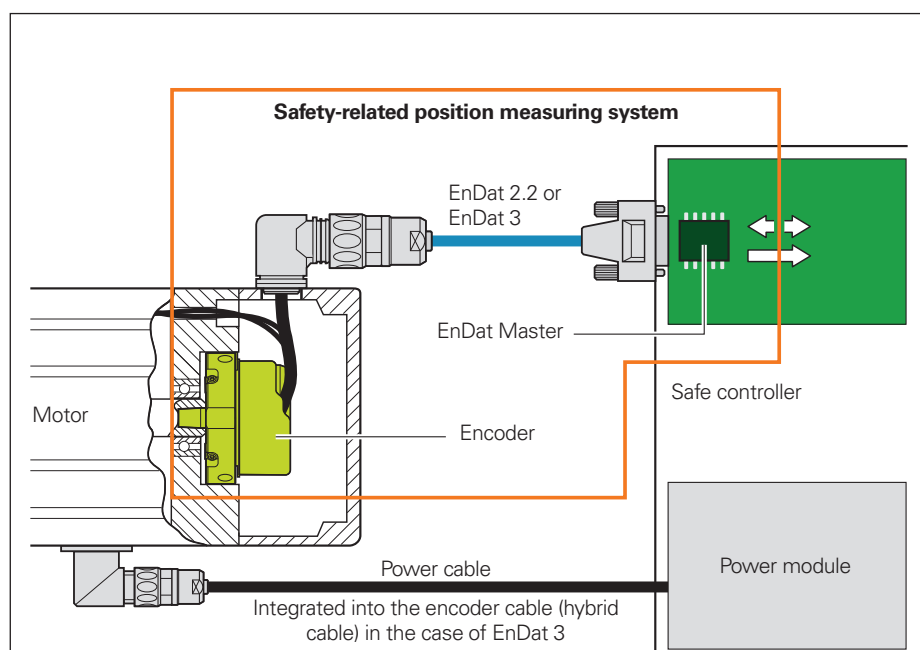
## Service life as per ISO 13849

Unless otherwise specified, HEIDENHAIN encoders are designed for a service life of 20 years (as per ISO 13849), which is equivalent to 40 000 operating hours.

## Bearing life

The bearing life L<sub>10mr</sub> as per ISO/TS 16281 at a temperature of 60 °C and maximum bearing loads (maximum permissible shaft offsets for encoders with an integrated stator coupling) is greater than  $2 \cdot 10^{10}$  revolutions. Starting at a continuous use temperature of 75 °C, the service life of the grease is limited. Please contact HEIDENHAIN if you have any questions about the service life of the grease.

DRIVE-CLiQ is a registered trademark of Siemens AG



Functionally safe drive system with EnDat 2.2 or EnDat 3

### Fault exclusion for the loosening of the mechanical connection

Irrespective of the interface, many safety designs require the safe mechanical connection of the encoder. The standard for electric motors, EN 61800-5-2, requires that the loosening of the mechanical connection between the encoder and the motor be considered as a fault. Because the controller may not be able to detect these errors, fault exclusion is required in many cases. The requirements for fault exclusion can result in additional constraints in the permissible limit values in the

specifications. In addition, fault exclusions for the loosening of the mechanical coupling usually require additional measures during installation of the encoder or in the event of servicing (e.g., anti-rotation lock for screws). These factors must be considered for the selection of a suitable encoder or mounting mode.



#### Further information:

Comply with the requirements described in the following documents to ensure correct and intended operation:

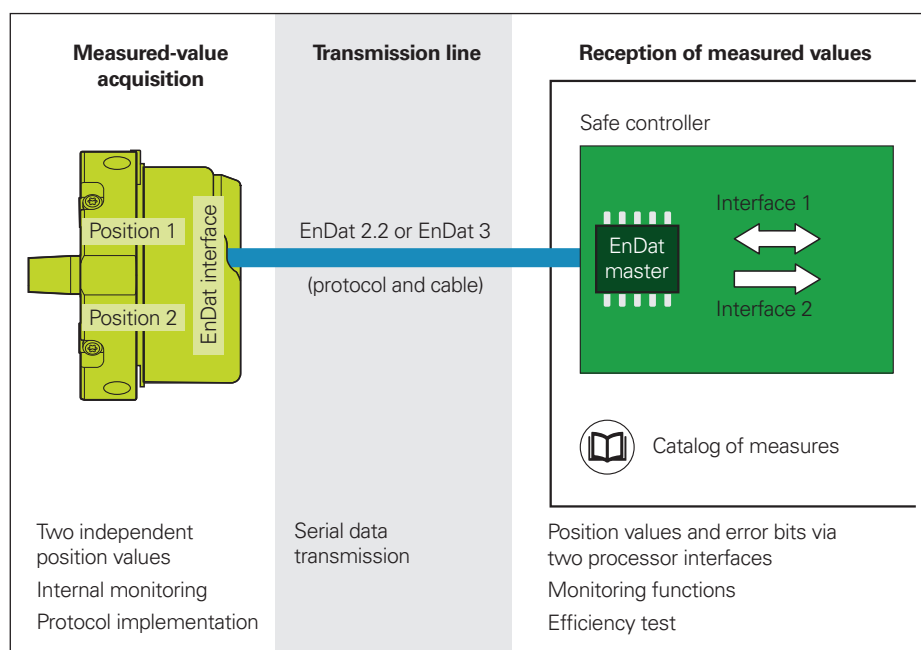
- Mounting instructions
- Operating instructions
- Product Information documents
- Customer information about fault exclusion
- Technical Information: *Safety-Related Position Measuring Systems* 596632

For implementation in a control with EnDat22:

- Specifications for Safe Control 533095

For implementation in a control with EnDat3:

- *Application Conditions for Functional Safety* 3000003



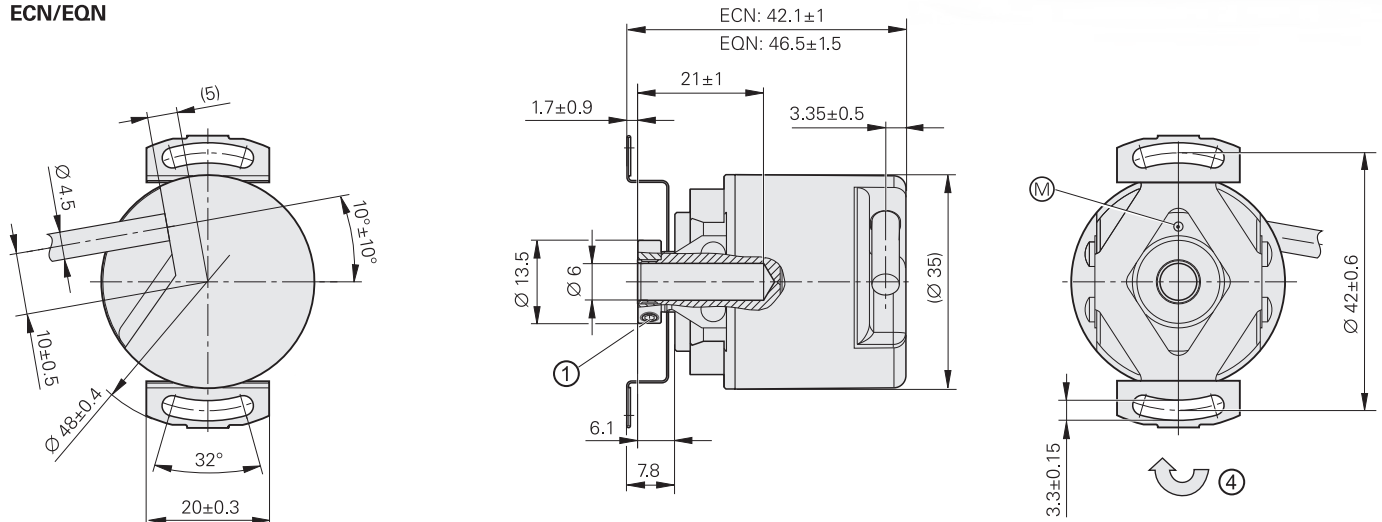
# ECN/EQN/ERN 1000 series

Absolute and incremental rotary encoders

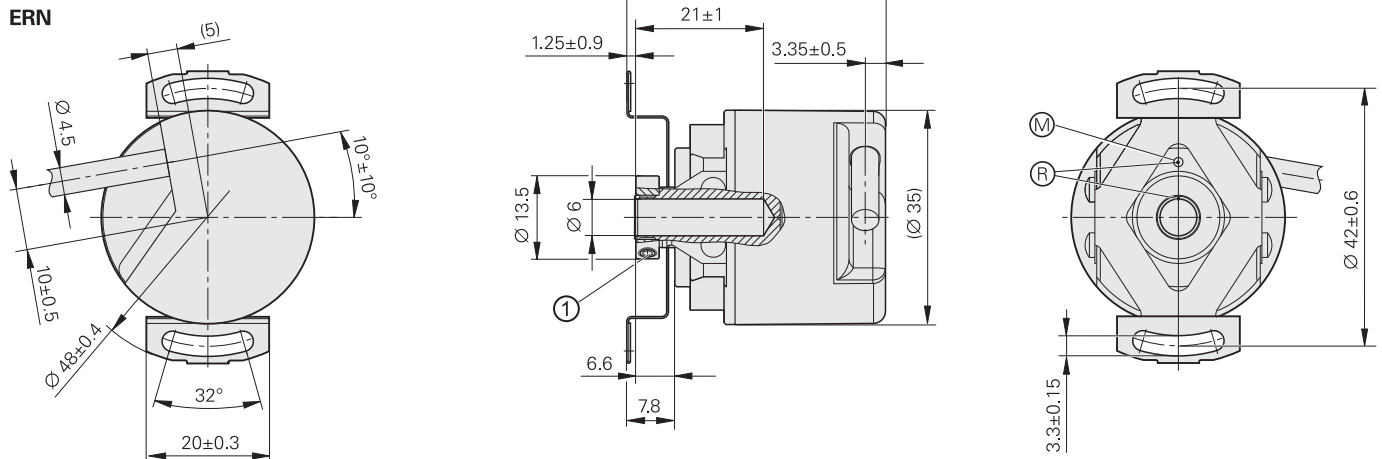
- Stator coupling for plane surface
- Blind hollow shaft



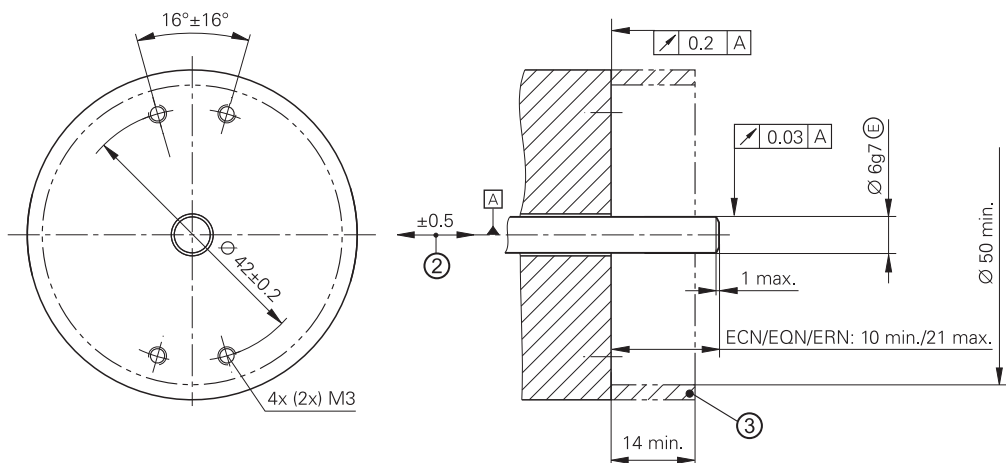
## ECN/EQN



## ERN



## Required mating dimensions



mm  
Tolerancing ISO 8015  
ISO 2768:1989-mH  
≤ 6 mm: ±0.2 mm

- ▣ = Bearing of mating shaft
- Ⓜ = Measuring point for operating temperature
- Ⓟ = Reference mark position ±20°
- 1 = Two screws in clamping ring tightening torque: 0.6 Nm ±0.1 Nm; width A/F: 1.5
- 2 = Compensation of mounting tolerances and thermal expansion; no dynamic motion permitted
- 3 = Ensure protection against contact (EN 60529)
- 4 = Incremental rotary encoders: direction of shaft rotation for output signals as per interface description  
Absolute rotary encoders: direction of shaft rotation for ascending position values

|                                                          | Incremental                                                                           |                    |                    |                                                                                        |             |                           |                                                                                                                   |                    |                                        |                                                                                         |         |
|----------------------------------------------------------|---------------------------------------------------------------------------------------|--------------------|--------------------|----------------------------------------------------------------------------------------|-------------|---------------------------|-------------------------------------------------------------------------------------------------------------------|--------------------|----------------------------------------|-----------------------------------------------------------------------------------------|---------|
|                                                          | ERN 1020                                                                              |                    |                    | ERN 1030                                                                               |             |                           | ERN 1080                                                                                                          |                    |                                        | ERN 1070                                                                                |         |
| Interface                                                |  TTL |                    |                    |  HTLs |             |                           |  1 V <sub>PP</sub> <sup>1)</sup> |                    |                                        |  TTL |         |
| Line counts*                                             | 100<br><b>1000</b>                                                                    | 200<br><b>1024</b> | <b>250</b><br>1250 | 360<br>1500                                                                            | 400<br>2000 | <b>500</b><br><b>2048</b> | 720                                                                                                               | 900<br><b>3600</b> | 1000 2500 3600                         |                                                                                         |         |
| 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 <i>a</i>                                 | ≥ 0.39 μs                                                                             |                    |                    | ≥ 0.76 μs                                                                              |             |                           | –                                                                                                                 |                    |                                        | ≥ 0.47 μs<br>≥ 0.22 μs                                                                  |         |
| System accuracy                                          | 1/20 of grating period                                                                |                    |                    |                                                                                        |             |                           |                                                                                                                   |                    |                                        |                                                                                         |         |
| Electrical connection*                                   | Cable (1 m/5 m) with or <b>without M23 coupling</b>                                   |                    |                    |                                                                                        |             |                           |                                                                                                                   |                    | Cable (5 m) without connecting element |                                                                                         |         |
| Supply voltage                                           | DC 5 V ±0.5 V                                                                         |                    |                    | DC 10 V to 30 V                                                                        |             |                           | DC 5 V ±0.5 V                                                                                                     |                    |                                        | DC 5 V ±0.25 V                                                                          |         |
| Current consumption without load                         | ≤ 120 mA                                                                              |                    |                    | ≤ 150 mA                                                                               |             |                           | ≤ 120 mA                                                                                                          |                    |                                        | ≤ 155 mA                                                                                |         |
| Shaft                                                    | Blind hollow shaft (Ø 6 mm)                                                           |                    |                    |                                                                                        |             |                           |                                                                                                                   |                    |                                        |                                                                                         |         |
| Mech. permiss. speed                                     | ≤ 12 000 rpm                                                                          |                    |                    |                                                                                        |             |                           |                                                                                                                   |                    |                                        |                                                                                         |         |
| Starting torque (typical)                                | 0.001 Nm (at 20 °C)                                                                   |                    |                    |                                                                                        |             |                           |                                                                                                                   |                    |                                        |                                                                                         |         |
| Moment of inertia of rotor                               | ≤ 0.5 · 10 <sup>–6</sup> kgm <sup>2</sup>                                             |                    |                    |                                                                                        |             |                           |                                                                                                                   |                    |                                        |                                                                                         |         |
| Permiss. axial motion of measured shaft                  | ±0.5 mm                                                                               |                    |                    |                                                                                        |             |                           |                                                                                                                   |                    |                                        |                                                                                         |         |
| <b>Vibration:</b> 55 Hz to 2000 Hz<br><b>Shock:</b> 6 ms | ≤ 100 m/s <sup>2</sup> (EN 60068-2-6)<br>≤ 1000 m/s <sup>2</sup> (EN 60068-2-27)      |                    |                    |                                                                                        |             |                           |                                                                                                                   |                    |                                        |                                                                                         |         |
| Max. operating temp. <sup>2)</sup>                       | 100 °C                                                                                |                    |                    | 70 °C                                                                                  |             |                           | 100 °C                                                                                                            |                    |                                        | 70 °C                                                                                   |         |
| Min. operating temp.                                     | Fixed cable: –30 °C; moving cable: –10 °C                                             |                    |                    |                                                                                        |             |                           |                                                                                                                   |                    |                                        |                                                                                         |         |
| Protection EN 60529                                      | IP64                                                                                  |                    |                    |                                                                                        |             |                           |                                                                                                                   |                    |                                        |                                                                                         |         |
| Mass                                                     | ≈ 0.1 kg                                                                              |                    |                    |                                                                                        |             |                           |                                                                                                                   |                    |                                        |                                                                                         |         |
| Valid for ID                                             | 534909-xx                                                                             |                    |                    | 534911-xx                                                                              |             |                           | 534913-xx                                                                                                         |                    |                                        | 534912-xx                                                                               |         |

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

\* Please select when ordering

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

<sup>2)</sup> For the relationship 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                                                                        |                                          |
| Ordering designation                                     | EnDat22                                                                          | EnDat01                                  |
| Positions/revolution                                     | 8388608 (23 bits)                                                                | 8192 (13 bits)                           |
| Revolutions                                              | –                                                                                |                                          |
| Code                                                     | Pure binary                                                                      |                                          |
| Elec. permissible speed<br>Deviations <sup>1)</sup>      | ≤ 12000 rpm<br>for continuous position value                                     | ≤ 4000 rpm/≤ 12000 rpm<br>±1 LSB/±16 LSB |
| Calculation time $t_{cal}$<br>Clock frequency            | ≤ 7 μs<br>≤ 8 MHz                                                                | ≤ 9 μs<br>≤ 2 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            |
| Supply voltage                                           | DC 3.6 V to 14 V                                                                 |                                          |
| Power consumption<br>(maximum)                           | 3.6 V: ≤ 0.6 W<br>14 V: ≤ 0.7 W                                                  |                                          |
| Current consumption<br>(typical, without load)           | 5 V: 80 mA                                                                       |                                          |
| <b>Shaft</b>                                             | Blind hollow shaft (Ø 6 mm)                                                      |                                          |
| Mech. permiss. speed                                     | 12000 rpm                                                                        |                                          |
| Starting torque (typical)                                | 0.001 Nm (at 20 °C)                                                              |                                          |
| Moment of inertia of rotor                               | ≈ 0.5 · 10 <sup>–6</sup> kgm <sup>2</sup>                                        |                                          |
| Permiss. axial motion of<br>measured shaft               | ±0.5 mm                                                                          |                                          |
| <b>Vibration:</b> 55 Hz to 2000 Hz<br><b>Shock:</b> 6 ms | ≤ 100 m/s <sup>2</sup> (EN 60068-2-6)<br>≤ 1000 m/s <sup>2</sup> (EN 60068-2-27) |                                          |
| <b>Max. operating temp.</b>                              | 100 °C                                                                           |                                          |
| <b>Min. operating temp.</b>                              | Fixed cable: –30 °C; moving cable: –10 °C                                        |                                          |
| <b>Protection</b> EN 60529                               | IP64                                                                             |                                          |
| <b>Mass</b>                                              | ≈ 0.1 kg                                                                         |                                          |
| <b>Valid for ID</b>                                      | 1438881-xx                                                                       | 1438880-xx                               |

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

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

| Multiturn                                    |  | EQN 1025                                  |  |
|----------------------------------------------|--|-------------------------------------------|--|
| EQN 1035                                     |  | EQN 1025                                  |  |
| EnDat22                                      |  | EnDat01                                   |  |
| 8388608 (23 bits)                            |  | 8192 (13 bits)                            |  |
| 4096 (12 bits)                               |  |                                           |  |
| ≤ 12000 rpm<br>for continuous position value |  | ≤ 4000 rpm/ ≤ 12000 rpm<br>±1 LSB/±16 LSB |  |
| ≤ 7 μs<br>≤ 8 MHz                            |  | ≤ 9 μs<br>≤ 2 MHz                         |  |
| –                                            |  | ~ 1 V <sub>PP</sub> <sup>2)</sup>         |  |
| –                                            |  | 512                                       |  |
| –                                            |  | ≥ 190 kHz                                 |  |
| Cable (1 m) with M12 coupling                |  | Cable (1 m) with M23 coupling             |  |
| 3.6 V: ≤ 0.7 W<br>14 V: ≤ 0.8 W              |  |                                           |  |
| 5 V: 90 mA                                   |  |                                           |  |
| 0.002 Nm (at 20 °C)                          |  |                                           |  |
| 1438886-xx                                   |  | 1438885-xx                                |  |

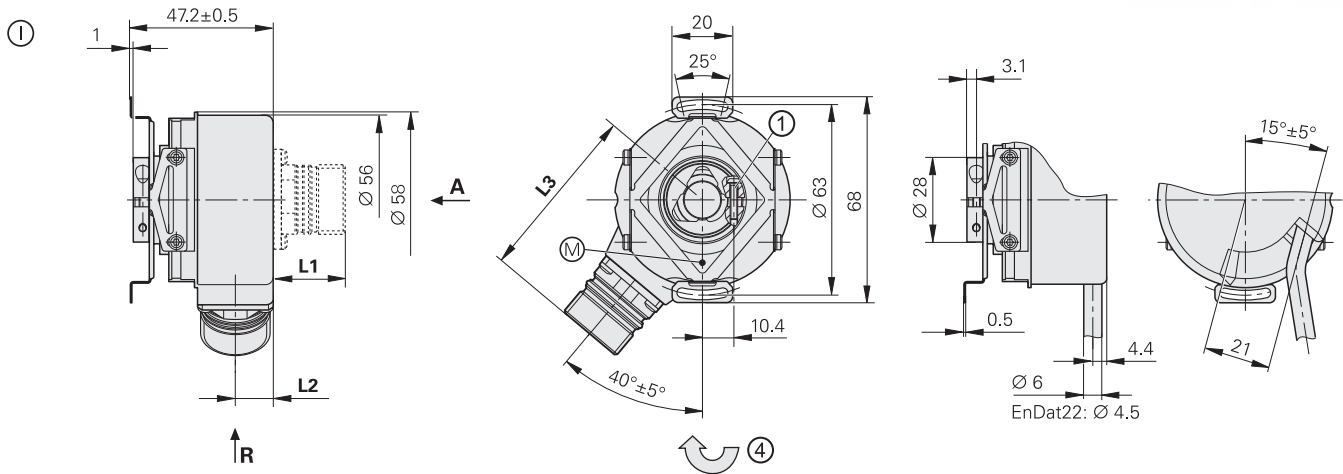
# ECN/EQN/ERN 400 series

## Absolute and incremental rotary encoders

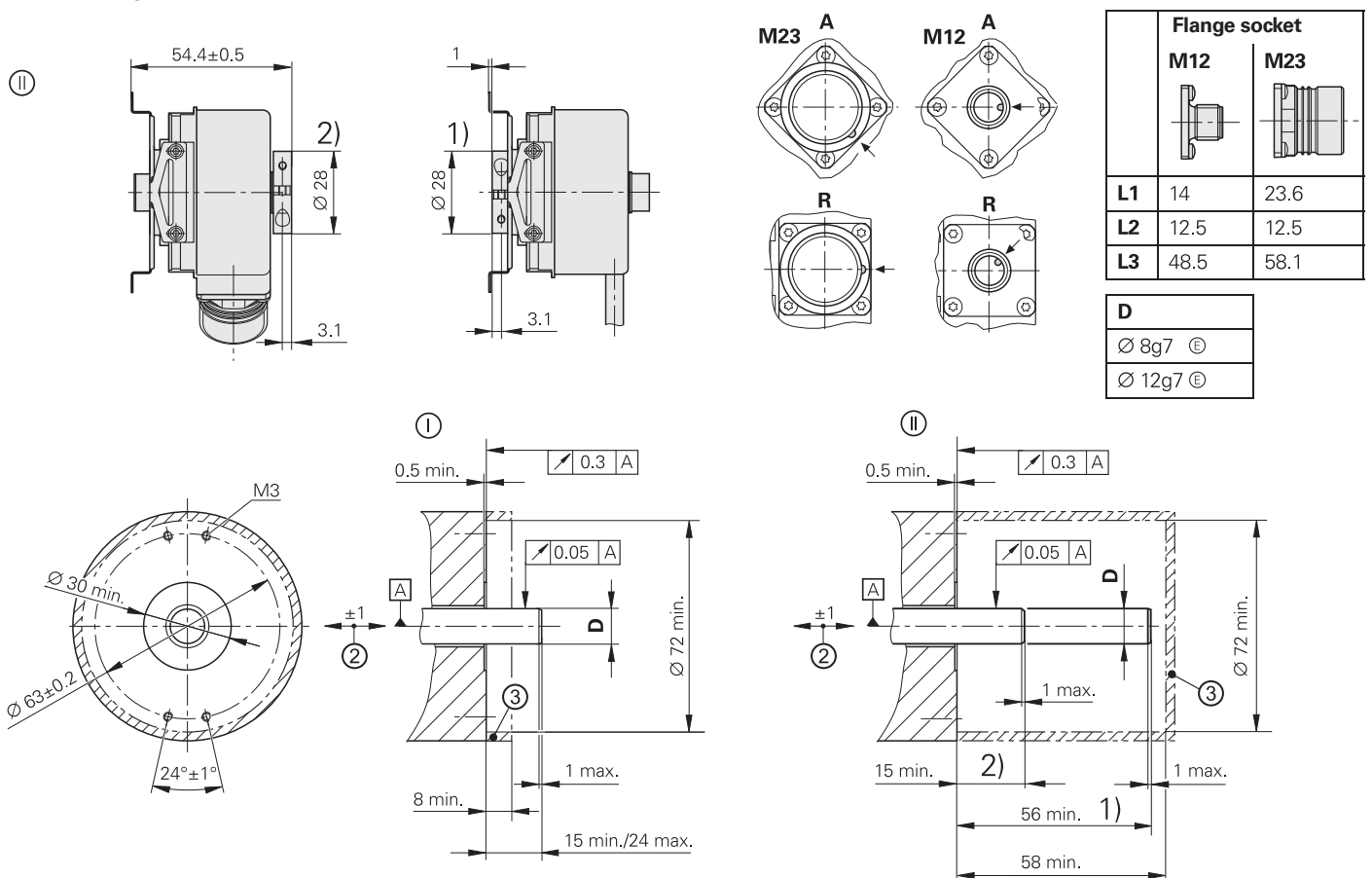
- Stator coupling for plane surface
- Blind hollow shaft or hollow through shaft



### Blind hollow shaft



### Hollow through shaft



mm



Tolerancing ISO 8015  
ISO 2768:1989-mH  
≤ 6 mm: ±0.2 mm

Radial cable (can also be used axially)

▢ = Bearing of mating shaft

Ⓜ = Measuring point for operating temperature

1 = Clamping screw with X8 hexalobular socket

2 = Compensation of mounting tolerances and thermal expansion; no dynamic motion permitted

3 = Ensure protection against contact (EN 60529)

4 = Incremental rotary encoders: direction of shaft rotation for output signals as per interface description

Absolute rotary encoders: direction of shaft rotation for ascending position values

1) = Clamping ring on housing side (delivery condition)

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 <b>500</b>                                                                                                                                                      |                 |                                                                                        | –                                                                                                                   |
|                                                          | <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 <i>a</i>                                 | ≥ 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> |                 |                                                                                        |                                                                                                                     |
| Supply voltage                                           | 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</b> or <b>hollow through shaft</b> (both available in Ø 8 mm or Ø 12 mm)                                                                      |                 |                                                                                        |                                                                                                                     |
| Mech. permiss. speed <sup>2)</sup>                       | ≤ 6000 rpm/≤ 12 000 rpm <sup>3)</sup>                                                                                                                               |                 |                                                                                        |                                                                                                                     |
| Starting torque (typical) at 20 °C                       | Blind hollow shaft: 0.01 Nm (with IP66: 0.05 Nm)<br>Hollow through shaft: 0.025 Nm (with IP66: 0.075 Nm)                                                            |                 |                                                                                        |                                                                                                                     |
| Moment of inertia of rotor                               | ≤ 4.6 · 10 <sup>–6</sup> kgm <sup>2</sup>                                                                                                                           |                 |                                                                                        |                                                                                                                     |
| Permiss. axial motion of measured shaft                  | ±1 mm                                                                                                                                                               |                 |                                                                                        |                                                                                                                     |
| <b>Vibration:</b> 55 Hz to 2000 Hz<br><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<br>≤ 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 60529                                      | At housing: IP67 (IP66 with hollow through shaft)<br>At shaft inlet: IP64 (with Ø 12 mm: IP66 upon request)                                                         |                 |                                                                                        |                                                                                                                     |
| Mass                                                     | ≈ 0.3 kg                                                                                                                                                            |                 |                                                                                        |                                                                                                                     |
| Valid for ID                                             | 385420-xx                                                                                                                                                           | 385460-xx       | 385430-xx                                                                              | 385480-xx <sup>5)</sup>                                                                                             |

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

\* Please select when ordering

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

<sup>2)</sup> For the relationship of operating temperature to shaft speed and supply voltage, see “General mechanical information”

<sup>3)</sup> With two shaft clampings (only with hollow through shaft)

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

<sup>5)</sup> Available with mechanical fault exclusion; for deviating specifications and special mounting information, see the *Fault Exclusion* Customer Information document



## Absolute

### Singleturn

ECN 425



ECN 413

|                                                          |                                                                                                                                                              |                                                                                                                                                             |                                   |
|----------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------|
| <b>Interface*</b>                                        | EnDat 2.2                                                                                                                                                    | EnDat 2.2                                                                                                                                                   | SSI                               |
| Ordering designation                                     | EnDat22                                                                                                                                                      | EnDat01                                                                                                                                                     | SSI39r1                           |
| Positions/revolution                                     | 33554432 (25 bits)                                                                                                                                           | 8192 (13 bits)                                                                                                                                              |                                   |
| Revolutions                                              | –                                                                                                                                                            |                                                                                                                                                             |                                   |
| Code                                                     | Pure binary                                                                                                                                                  |                                                                                                                                                             | Gray                              |
| Elec. permissible speed<br>Deviations <sup>1)</sup>      | ≤ 12000 rpm<br>for continuous position value                                                                                                                 | 512 lines: ≤ 5000/12000 rpm<br>±1 LSB/±100 LSB<br>2048 lines: ≤ 1500/12000 rpm<br>±1 LSB/±50 LSB                                                            | ≤ 12000 rpm<br>±12 LSB            |
| Calculation time $t_{cal}$<br>Clock frequency            | ≤ 7 μs<br>≤ 8 MHz                                                                                                                                            | ≤ 9 μs<br>≤ 2 MHz                                                                                                                                           | ≤ 5 μs<br>–                       |
| Incremental signals                                      | Without                                                                                                                                                      | ~ 1 V <sub>PP</sub> <sup>2)</sup>                                                                                                                           |                                   |
| Line counts*                                             | –                                                                                                                                                            | <b>512</b> 2048                                                                                                                                             | 512                               |
| Cutoff frequency –3 dB<br>Output frequency               | –<br>–                                                                                                                                                       | 512 lines: ≥ 130 kHz; 2048 lines: ≥ 400 kHz<br>–                                                                                                            |                                   |
| <b>System accuracy</b>                                   | ±20"                                                                                                                                                         | 512 lines: ±60"; 2048 lines: ±20"                                                                                                                           |                                   |
| <b>Electrical connection*</b>                            | <ul style="list-style-type: none"> <li>• <b>M12 flange socket</b>, radial</li> <li>• Cable (1 m) with M12 coupling</li> </ul>                                | <ul style="list-style-type: none"> <li>• <b>M23 flange socket</b>, radial</li> <li>• Cable (1 m) with M23 coupling or without connecting element</li> </ul> |                                   |
| Supply voltage                                           | DC 3.6 V to 14 V                                                                                                                                             |                                                                                                                                                             | DC 4.75 V to 30 V                 |
| Power consumption<br>(maximum)                           | 3.6 V: ≤ 0.6 W<br>14 V: ≤ 0.7 W                                                                                                                              |                                                                                                                                                             | 4.75 V: ≤ 0.6 W<br>30 V: ≤ 0.78 W |
| Current consumption<br>(typical, without load)           | 5 V: 80 mA                                                                                                                                                   |                                                                                                                                                             | 5 V: 70 mA<br>24 V: 20 mA         |
| <b>Shaft*</b>                                            | <b>Blind hollow shaft</b> or <b>hollow through shaft</b> (both available in Ø 8 mm or Ø 12 mm)                                                               |                                                                                                                                                             |                                   |
| Mech. permiss. speed <sup>3)</sup>                       | ≤ 6000 rpm/≤ 12000 rpm <sup>4)</sup>                                                                                                                         |                                                                                                                                                             |                                   |
| Starting torque (typical)<br>at 20 °C                    | Blind hollow shaft: 0.01 Nm (with IP66: 0.05 Nm)<br>Hollow through shaft: 0.025 Nm (with IP66: 0.075 Nm)                                                     |                                                                                                                                                             |                                   |
| Moment of inertia of rotor                               | ≤ 4.6 · 10 <sup>–6</sup> kgm <sup>2</sup>                                                                                                                    |                                                                                                                                                             |                                   |
| Permiss. axial motion of<br>measured shaft               | ±1 mm                                                                                                                                                        |                                                                                                                                                             |                                   |
| <b>Vibration:</b> 55 Hz to 2000 Hz<br><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<br>≤ 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 60529                               | At housing: IP67 (IP66 with hollow through shaft)<br>At shaft inlet: IP64 (with Ø 12 mm: IP66 upon request)                                                  |                                                                                                                                                             |                                   |
| <b>Mass</b>                                              | ≈ 0.3 kg                                                                                                                                                     |                                                                                                                                                             |                                   |
| <b>Valid for ID</b>                                      | 1178024-xx <sup>5)</sup>                                                                                                                                     | 1065932-xx                                                                                                                                                  | 1353129-xx                        |

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

\* Please select when ordering

<sup>1)</sup> Speed-dependent deviations between absolute value and incremental signal

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

| 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<br>for continuous position value                   | 512 lines: ≤ 5000/10000 rpm<br>±1 LSB/±100 LSB<br>2048 lines: ≤ 1500/10000 rpm<br>±1 LSB/±50 LSB | ≤ 12000 rpm<br>±12 LSB |         |
| ≤ 7 μs<br>≤ 8 MHz                                              | ≤ 9 μs<br>≤ 2 MHz                                                                                | ≤ 5 μs<br>–            |         |
| Without                                                        | ~ 1 V <sub>PP</sub> <sup>2)</sup>                                                                |                        |         |
| –                                                              | 512 2048                                                                                         | 512                    |         |
| –<br>–                                                         | 512 lines: ≥ 130 kHz; 2048 lines: ≥ 400 kHz<br>–                                                 |                        |         |
| ±20"                                                           | 512 lines: ±60"; 2048 lines: ±20"                                                                |                        |         |
| • M12 flange socket, radial<br>• Cable (1 m) with M12 coupling | • M23 flange socket, radial<br>• Cable (1 m) with M23 coupling or without connecting element     |                        |         |
| 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<br>14 V: ≤ 0.8 W                                | 4.75 V: ≤ 0.68 W<br>30 V: ≤ 0.88 W                                                               |                        |         |
| 5 V: 95 mA                                                     | 5 V: 85 mA<br>24 V: 20 mA                                                                        |                        |         |
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<sup>3)</sup> For the relationship of operating temperature to shaft speed and supply voltage, see “General mechanical information”

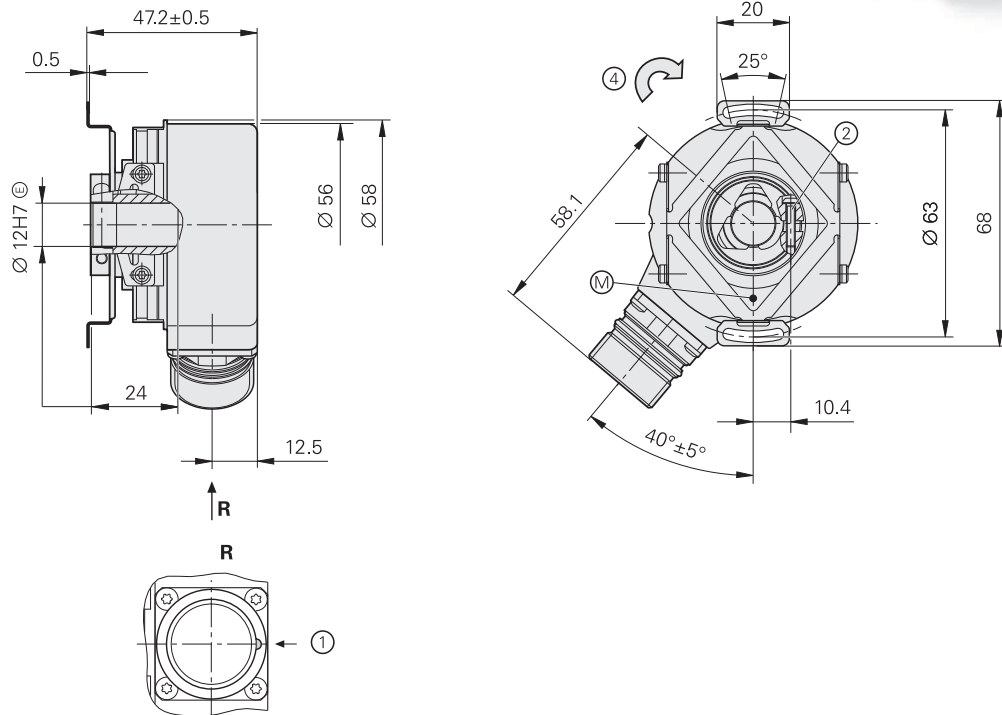
<sup>4)</sup> With two shaft clampings (only with hollow through shaft)

<sup>5)</sup> Also available with functional safety; for dimensions and specifications, see Product Information document

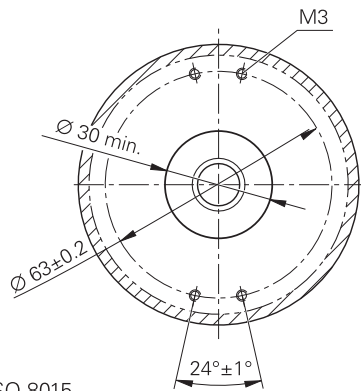
# EQN 425

Rotary encoder for absolute position values with blind hollow shaft

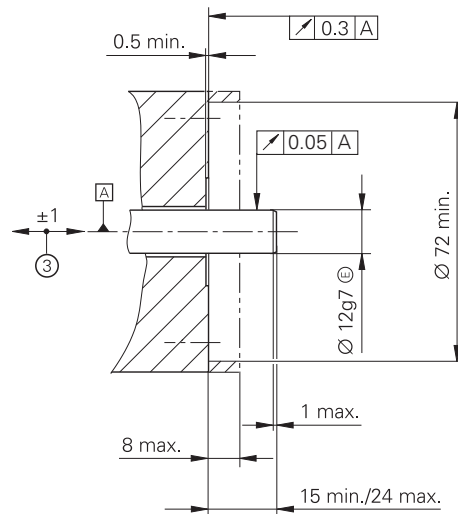
- Stator coupling for plane surface
- EnDat interface
- Additional incremental signals with TTL or HTL levels



Required mating dimensions



mm  
Tolerancing ISO 8015  
ISO 2768:1989-mH  
≤ 6 mm: ±0.2 mm



- ▢ = Bearing of mating shaft
- ⊙ = Measuring point for operating temperature
- 1 = Connector coding
- 2 = Clamping screw with X8 hexalobular socket; tightening torque: 1.1 Nm ±0.1 Nm
- 3 = Compensation of mounting tolerances and thermal expansion; no dynamic motion permitted
- 4 = Direction of shaft rotation for ascending position values

|                                                      | Absolute                                                                         |           |           |                                           |           |           |
|------------------------------------------------------|----------------------------------------------------------------------------------|-----------|-----------|-------------------------------------------|-----------|-----------|
|                                                      | EQN 425 multiturn                                                                |           |           |                                           |           |           |
| Interface                                            | EnDat 2.2                                                                        |           |           |                                           |           |           |
| Ordering designation*                                | EnDatH                                                                           |           |           | EnDatT                                    |           |           |
| Positions/revolution                                 | 8192 (13 bits)                                                                   |           |           |                                           |           |           |
| Revolutions                                          | 4096 (12 bits)                                                                   |           |           |                                           |           |           |
| Code                                                 | Pure binary                                                                      |           |           |                                           |           |           |
| Calculation time t <sub>cal</sub><br>Clock frequency | ≤ 9 μs<br>≤ 2 MHz                                                                |           |           |                                           |           |           |
| Incremental signals                                  | HTL                                                                              |           |           | TTL                                       |           |           |
| Signal periods*                                      | 512                                                                              | 1024      | 2048      | 512                                       | 2048      | 4096      |
| Edge separation <i>a</i>                             | ≥ 2.4 μs                                                                         | ≥ 0.8 μs  | ≥ 0.6 μs  | ≥ 2.4 μs                                  | ≥ 0.6 μs  | ≥ 0.2 μs  |
| Output frequency                                     | ≤ 52 kHz                                                                         | ≤ 103 kHz | ≤ 205 kHz | ≤ 52 kHz                                  | ≤ 205 kHz | ≤ 410 kHz |
| System accuracy <sup>1)</sup>                        | ±60″                                                                             | ±60″      | ±20″      | ±60″                                      | ±20″      | ±20″      |
| Electrical connection                                | 17-pin M23 radial flange socket (male)                                           |           |           |                                           |           |           |
| Cable length <sup>2)</sup>                           | ≤ 100 m (with HEIDENHAIN cable)                                                  |           |           |                                           |           |           |
| Supply voltage                                       | DC 10 V to 30 V                                                                  |           |           | DC 4.75 V to 30 V                         |           |           |
| Power consumption (max.) <sup>3)</sup>               | See “Power consumption” diagram                                                  |           |           | At 4.75 V: ≤ 900 mW<br>At 30 V: ≤ 1100 mW |           |           |
| Current consumption<br>(typical, without load)       | At 10 V: ≤ 56 mA<br>At 24 V: ≤ 34 mA                                             |           |           | At 5 V: ≤ 100 mA<br>At 24 V: ≤ 25 mA      |           |           |
| Shaft                                                | Blind hollow shaft (Ø 12 mm)                                                     |           |           |                                           |           |           |
| Mech. permiss. speed <sup>4)</sup>                   | ≤ 6000 rpm                                                                       |           |           |                                           |           |           |
| Starting torque (typical)                            | 0.01 Nm (at 20 °C)                                                               |           |           |                                           |           |           |
| Moment of inertia of rotor                           | 4.6 · 10 <sup>-6</sup> kgm <sup>2</sup>                                          |           |           |                                           |           |           |
| Permiss. axial motion of<br>measured shaft           | ≤ ±1 mm                                                                          |           |           |                                           |           |           |
| Vibration: 10 Hz to 2000 Hz<br>Shock: 6 ms           | ≤ 150 m/s <sup>2</sup> (EN 60068-2-6)<br>≤ 2000 m/s <sup>2</sup> (EN 60068-2-27) |           |           |                                           |           |           |
| Max. operating temp. <sup>4)</sup>                   | 100 °C                                                                           |           |           |                                           |           |           |
| Min. operating temp. <sup>4)</sup>                   | -40 °C                                                                           |           |           |                                           |           |           |
| Protection EN 60529                                  | Housing: IP67<br>Shaft outlet: IP64                                              |           |           |                                           |           |           |
| Mass                                                 | ≈ 0.30 kg                                                                        |           |           |                                           |           |           |
| Valid for ID                                         | 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" diagrams)

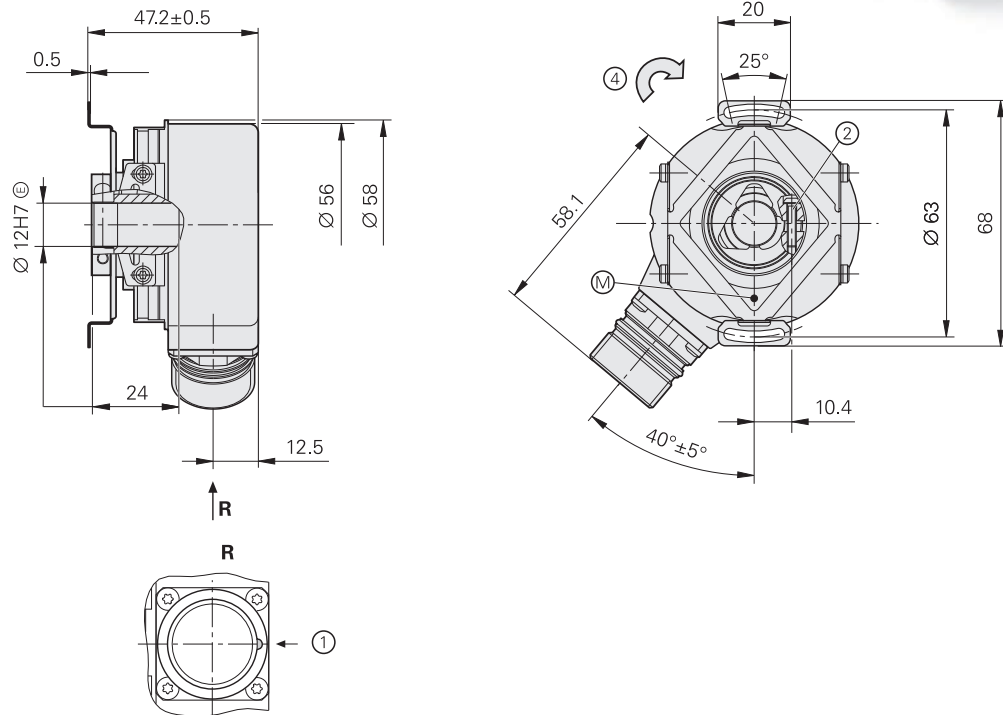
<sup>3)</sup> See "General electrical information" in the *Interfaces of HEIDENHAIN Encoders* brochure

<sup>4)</sup> For the relationship of operating temperature to shaft speed and supply voltage, see "General mechanical information"

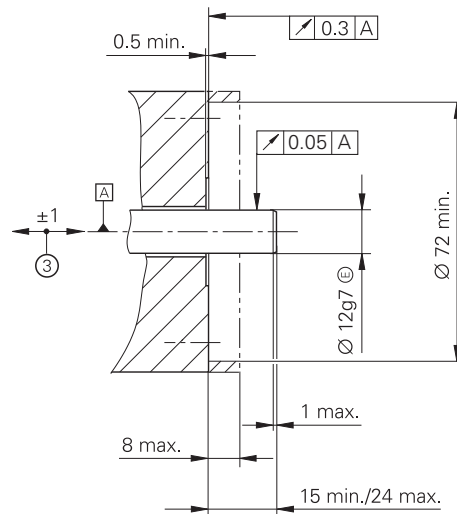
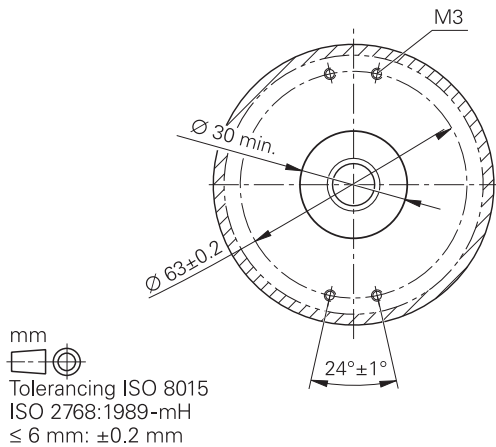
# EQN 425

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



▢ = Bearing of mating shaft

⊙ = Measuring point for operating temperature

1 = Connector coding

2 = Clamping screw with X8 hexalobular socket; tightening torque: 1.1 Nm ±0.1 Nm

3 = Compensation of mounting tolerances and thermal expansion; no dynamic motion permitted

4 = Direction of shaft rotation for ascending position values

|                                                      |                                                                                  |           |           |                                           |           |           |
|------------------------------------------------------|----------------------------------------------------------------------------------|-----------|-----------|-------------------------------------------|-----------|-----------|
|                                                      | Absolute                                                                         |           |           |                                           |           |           |
|                                                      | EQN 425 multiturn                                                                |           |           |                                           |           |           |
| Interface                                            | SSI                                                                              |           |           |                                           |           |           |
| Ordering designation*                                | SSI41H                                                                           |           |           | SSI41T                                    |           |           |
| Positions/revolution                                 | 8192 (13 bits)                                                                   |           |           |                                           |           |           |
| Revolutions                                          | 4096 (12 bits)                                                                   |           |           |                                           |           |           |
| Code                                                 | Gray                                                                             |           |           |                                           |           |           |
| Calculation time t <sub>cal</sub><br>Clock frequency | ≤ 5 μs<br>≤ 1 MHz                                                                |           |           |                                           |           |           |
| Incremental signals                                  | HTL <sup>5)</sup>                                                                |           |           | TTL                                       |           |           |
| Signal periods*                                      | 512                                                                              | 1024      | 2048      | 512                                       | 2048      | 4096      |
| Edge separation <i>a</i>                             | ≥ 2.4 μs                                                                         | ≥ 0.8 μs  | ≥ 0.6 μs  | ≥ 2.4 μs                                  | ≥ 0.6 μs  | ≥ 0.2 μs  |
| Output frequency                                     | ≤ 52 kHz                                                                         | ≤ 103 kHz | ≤ 205 kHz | ≤ 52 kHz                                  | ≤ 205 kHz | ≤ 410 kHz |
| System accuracy <sup>1)</sup>                        | ±60″                                                                             | ±60″      | ±20″      | ±60″                                      | ±20″      | ±20″      |
| Electrical connection                                | 12-pin M23 radial flange socket (male)                                           |           |           | 17-pin M23 radial flange socket (male)    |           |           |
| Cable length <sup>2)</sup>                           | ≤ 100 m (with HEIDENHAIN cable)                                                  |           |           |                                           |           |           |
| Supply voltage                                       | DC 10 V to 30 V                                                                  |           |           | DC 4.75 V to 30 V                         |           |           |
| Power consumption (max.) <sup>3)</sup>               | See “Power consumption” diagram                                                  |           |           | At 4.75 V: ≤ 900 mW<br>At 30 V: ≤ 1100 mW |           |           |
| Current consumption<br>(typical, without load)       | At 10 V: ≤ 56 mA<br>At 24 V: ≤ 34 mA                                             |           |           | At 5 V: ≤ 100 mA<br>At 24 V: ≤ 25 mA      |           |           |
| Shaft                                                | Blind hollow shaft (Ø 12 mm)                                                     |           |           |                                           |           |           |
| Mech. permiss. speed <sup>4)</sup>                   | ≤ 6000 rpm                                                                       |           |           |                                           |           |           |
| Starting torque (typical)                            | 0.01 Nm (at 20 °C)                                                               |           |           |                                           |           |           |
| Moment of inertia of rotor                           | 4.6 · 10 <sup>−6</sup> kgm <sup>2</sup>                                          |           |           |                                           |           |           |
| Permiss. axial motion of<br>measured shaft           | ≤ ±1 mm                                                                          |           |           |                                           |           |           |
| Vibration: 10 Hz to 2000 Hz<br>Shock: 6 ms           | ≤ 150 m/s <sup>2</sup> (EN 60068-2-6)<br>≤ 2000 m/s <sup>2</sup> (EN 60068-2-27) |           |           |                                           |           |           |
| Max. operating temp. <sup>4)</sup>                   | 100 °C                                                                           |           |           |                                           |           |           |
| Min. operating temp. <sup>4)</sup>                   | −40 °C                                                                           |           |           |                                           |           |           |
| Protection EN 60529                                  | Housing: IP67<br>Shaft outlet: IP64                                              |           |           |                                           |           |           |
| Mass                                                 | ≈ 0.30 kg                                                                        |           |           |                                           |           |           |
| Valid for ID                                         | 1065029-xx                                                                       |           |           | 1042533-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" diagrams)

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

<sup>4)</sup> For the relationship of operating temperature to shaft speed and supply voltage, see "General mechanical information"

<sup>5)</sup> HTLs upon request

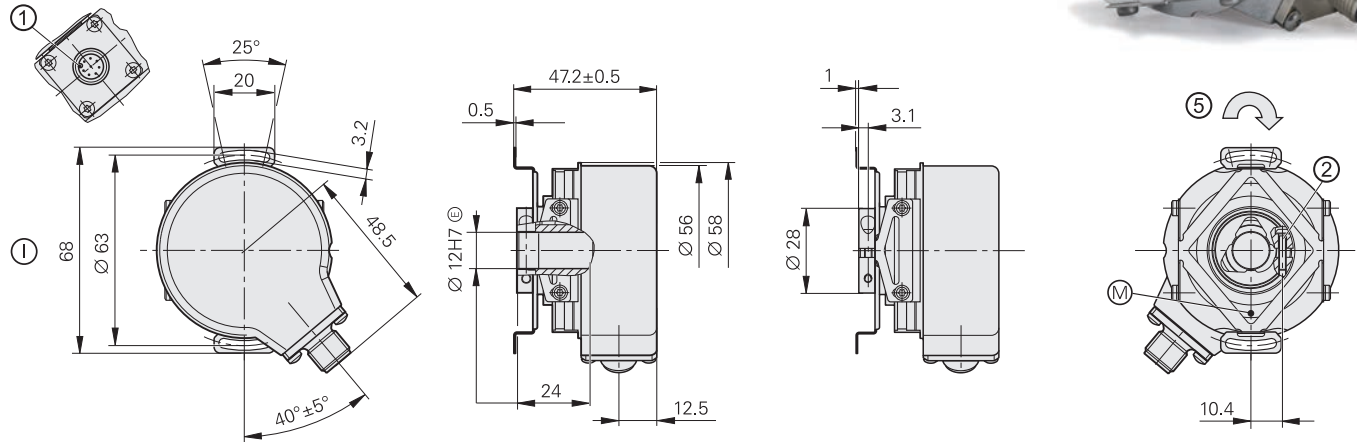
# ECN/EQN 400F/S series

## Absolute rotary encoders

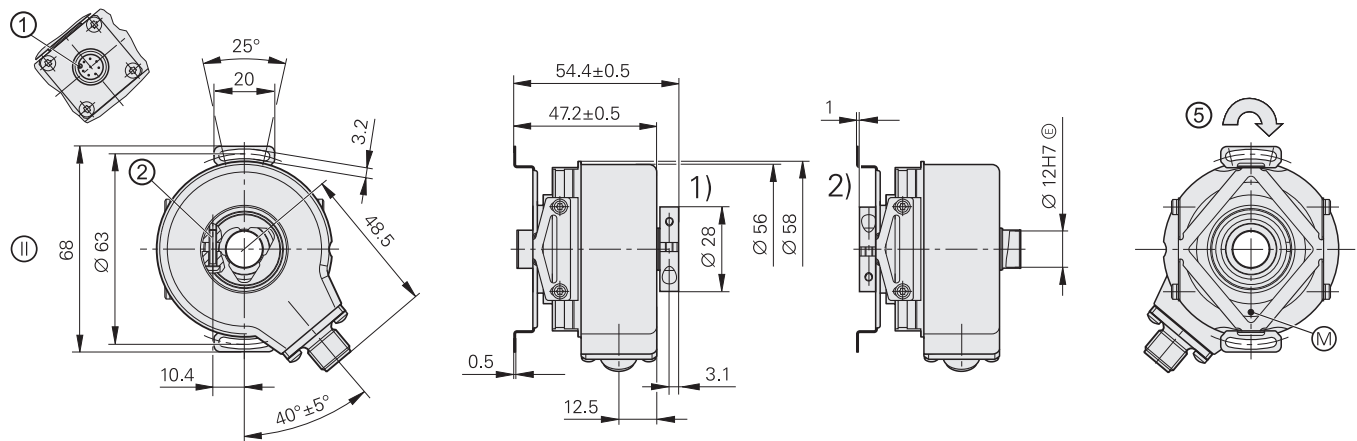
- Stator coupling for plane surface
- Blind hollow shaft or hollow through shaft
- Fanuc Serial Interface or Siemens DRIVE-CLiQ interface



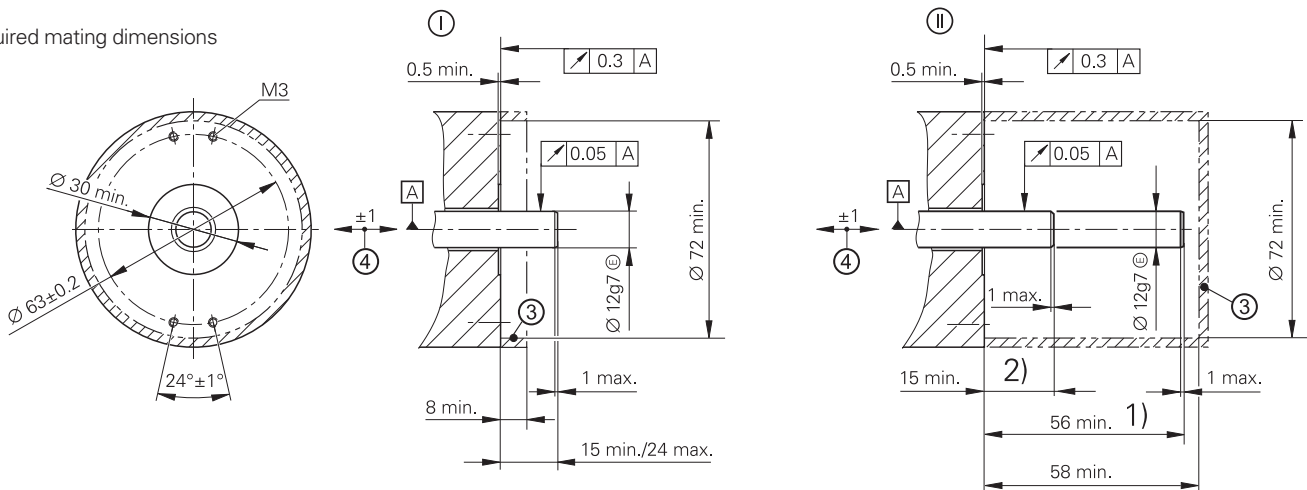
### Blind hollow shaft



### Hollow through shaft



### Required mating dimensions



mm



Tolerancing ISO 8015

ISO 2768:1989-mH

≤ 6 mm: ±0.2 mm

▢ = Bearing of mating shaft

⊙ = Measuring point for operating temperature

1 = Connector coding

2 = Clamping screw with X8 hexalobular socket; tightening torque: 1.1 Nm ±0.1 Nm

3 = Ensure protection against contact (EN 60529)

4 = Compensation of mounting tolerances and thermal expansion; no dynamic motion permissible

5 = Direction of shaft rotation for ascending position values

1) = Clamping ring on housing side (delivery condition)

2) = Clamping ring on coupling side (optionally mountable)

DRIVE-CLiQ is a registered trademark of Siemens AG

|                                                          | <b>Absolute</b>                                                                                                            |                                                                                                    |                                         |                                                                                                      |
|----------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------|-----------------------------------------|------------------------------------------------------------------------------------------------------|
|                                                          | <b>Singletum</b><br><b>ECN 425 F</b>                                                                                       | <b>ECN 424 S</b>  | <b>Multitum</b><br><b>EQN 437 F</b>     | <b>EQN 436 S</b>  |
| <b>Interface</b>                                         | Fanuc Serial Interface;<br>αi Interface                                                                                    | DRIVE-CLiQ                                                                                         | Fanuc Serial Interface;<br>αi Interface | DRIVE-CLiQ                                                                                           |
| Ordering designation                                     | Fanuc05 <sup>1)</sup>                                                                                                      | DQ01                                                                                               | Fanuc06 <sup>1)</sup>                   | DQ01                                                                                                 |
| Positions/revolution                                     | αi: 33554432<br>(25 bits)<br>α: 8388608<br>(23 bit)                                                                        | 16777216<br>(24 bits)                                                                              | 33554432<br>(25 bits)                   | 16777216<br>(24 bits)                                                                                |
| Revolutions                                              | 8192 via revolution<br>counter                                                                                             | –                                                                                                  | αi: 4096                                | 4096                                                                                                 |
| Code                                                     | Pure binary                                                                                                                |                                                                                                    |                                         |                                                                                                      |
| Elec. permissible speed                                  | ≤ 15000 rpm for continuous position values                                                                                 |                                                                                                    |                                         |                                                                                                      |
| Calculation time $t_{cal}$                               | ≤ 5 μs                                                                                                                     | ≤ 8 μs <sup>2)</sup>                                                                               | ≤ 5 μs                                  | ≤ 8 μs <sup>2)</sup>                                                                                 |
| <b>System accuracy</b>                                   | ±20"                                                                                                                       |                                                                                                    |                                         |                                                                                                      |
| <b>Electrical connection</b>                             | M12 flange socket, radial                                                                                                  |                                                                                                    |                                         |                                                                                                      |
| Cable length                                             | ≤ 30 m                                                                                                                     | ≤ 95 m <sup>3)</sup>                                                                               | ≤ 30 m                                  | ≤ 95 m <sup>3)</sup>                                                                                 |
| Supply voltage                                           | DC 3.6 V to 14 V                                                                                                           | DC 10 V to 36 V                                                                                    | DC 3.6 V to 14 V                        | DC 10 V to 36 V                                                                                      |
| Power consumption<br>(maximum)                           | 5 V: ≤ 0.7 W<br>14 V: ≤ 0.8 W                                                                                              | 10 V: ≤ 1.4 W<br>36 V: ≤ 1.5 W                                                                     | 5 V: ≤ 0.75 W<br>14 V: ≤ 0.85 W         | 10 V: ≤ 1.4 W<br>36 V: ≤ 1.5 W                                                                       |
| Current consumption<br>(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 (Ø 12 mm);<br>with DRIVE-CLiQ, also available with blind hollow shaft (Ø 10 mm) |                                                                                                    |                                         |                                                                                                      |
| Mech. permiss. speed <sup>4)</sup>                       | ≤ 6000 rpm/≤ 12000 rpm <sup>5)</sup>                                                                                       |                                                                                                    |                                         |                                                                                                      |
| Starting torque (typical)<br>at 20 °C                    | Blind hollow shaft: 0.01 Nm (with IP66: 0.05 Nm)<br>Hollow through shaft: 0.025 Nm (with IP66: 0.075 Nm)                   |                                                                                                    |                                         |                                                                                                      |
| Moment of inertia of rotor                               | ≤ 4.6 · 10 <sup>-6</sup> kgm <sup>2</sup>                                                                                  |                                                                                                    |                                         |                                                                                                      |
| Permiss. axial motion of<br>measured shaft               | ±1 mm                                                                                                                      |                                                                                                    |                                         |                                                                                                      |
| <b>Vibration:</b> 55 Hz to 2000 Hz<br><b>Shock:</b> 6 ms | ≤ 150 m/s <sup>2</sup> (EN 60068-2-6)<br>≤ 2000 m/s <sup>2</sup> (EN 60068-2-27)                                           |                                                                                                    |                                         |                                                                                                      |
| <b>Max. operating temp.</b> <sup>4)</sup>                | 100 °C                                                                                                                     |                                                                                                    |                                         |                                                                                                      |
| <b>Min. operating temp.</b>                              | –30 °C                                                                                                                     |                                                                                                    |                                         |                                                                                                      |
| <b>Protection</b> EN 60529                               | At housing: IP67 (IP66 with hollow through shaft)<br>At shaft inlet: IP64 (with Ø 12 mm: IP66 upon request)                |                                                                                                    |                                         |                                                                                                      |
| <b>Mass</b>                                              | ≈ 0.3 kg                                                                                                                   |                                                                                                    |                                         |                                                                                                      |
| <b>Valid for ID</b>                                      | 1081302-xx                                                                                                                 | 1036798-xx <sup>6)</sup>                                                                           | 1081301-xx                              | 1036801-xx <sup>6)</sup>                                                                             |

\* Please select when ordering

<sup>1)</sup> Optimized for Fanuc machine tool controls

<sup>2)</sup> Calculation time TIME\_MAX\_ACTVAL

<sup>3)</sup> See the *Interfaces of HEIDENHAIN Encoders* brochure; with  $n_{EN} = 1$  (including adapter cable)

<sup>4)</sup> For the relationship of operating temperature to shaft speed and supply voltage, see "General mechanical information"

<sup>5)</sup> With two shaft clampings (only with hollow through shaft)

<sup>6)</sup> Also available with functional safety; for dimensions and specifications, see Product Information document

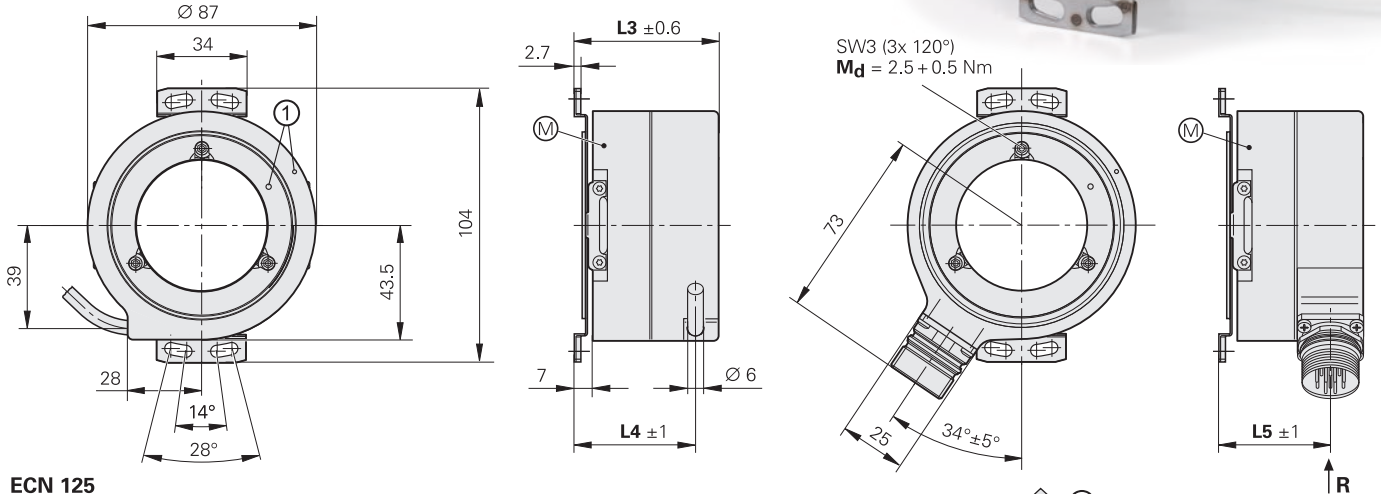
# ECN/ERN 100 series

Absolute and incremental rotary encoders

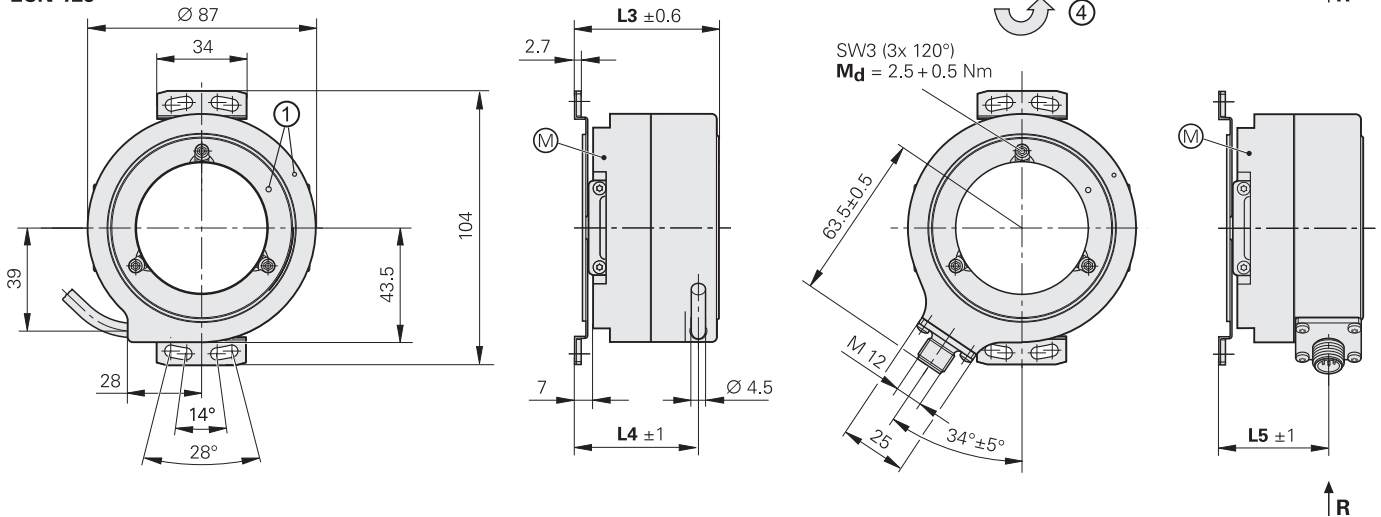
- Stator coupling for plane surface
- Hollow through shaft



ERN 1x0/ECN 113



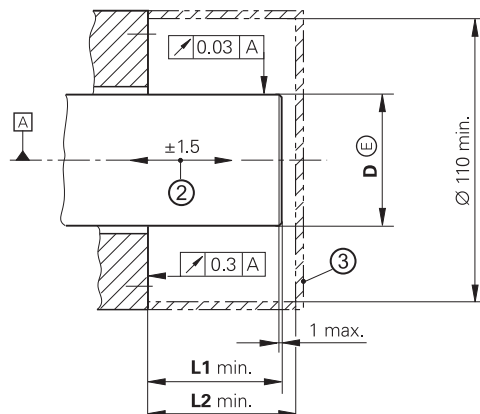
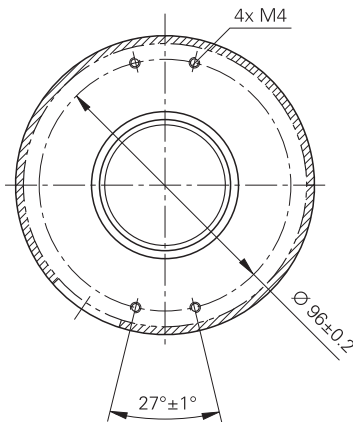
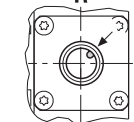
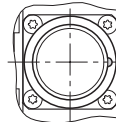
ECN 125



Connector coding  
R = Radial

M23 R

M12 R



| 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 2768:1989-mH  
≤ 6 mm: ±0.2 mm

Radial cable (can also be used axially)

▢ = Bearing

⊗ = Measuring point for operating temperature

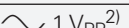
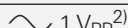
1 = ERN: reference mark position ±15°; ECN: zero position ±15°

2 = Compensation of mounting tolerances and thermal expansion; no dynamic motion permitted

3 = Ensure protection against contact (EN 60529)

4 = Incremental rotary encoders: direction of shaft rotation for output signals as per interface description

Absolute rotary encoders: direction of shaft rotation for ascending position values

|                                                                   | Absolute                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                           | Incremental                                                                                                                                             |                                                                                     |                                                                                                                     |
|-------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------|
|                                                                   | Singleturn                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                           |                                                                                                                                                         |                                                                                     |                                                                                                                     |
|                                                                   | ECN 125                                                                                                                                                                                                                                                                                                                                                                           | ECN 113                                                                                                                                   | ERN 120                                                                                                                                                 | ERN 130                                                                             | ERN 180                                                                                                             |
| Interface                                                         | EnDat 2.2                                                                                                                                                                                                                                                                                                                                                                         | EnDat 2.2                                                                                                                                 |                                                                        |  |  1 V <sub>pp</sub> <sup>2)</sup> |
| Ordering designation                                              | EnDat22                                                                                                                                                                                                                                                                                                                                                                           | EnDat01                                                                                                                                   | –                                                                                                                                                       |                                                                                     |                                                                                                                     |
| Positions/revolution                                              | 33554432 (25 bits)                                                                                                                                                                                                                                                                                                                                                                | 8192 (13 bits)                                                                                                                            | –                                                                                                                                                       |                                                                                     |                                                                                                                     |
| Code                                                              | Pure binary                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                           | –                                                                                                                                                       |                                                                                     |                                                                                                                     |
| Elec. permissible speed<br>Deviations <sup>1)</sup>               | n <sub>max</sub> for continuous position value                                                                                                                                                                                                                                                                                                                                    | ≤ 600 rpm/n <sub>max</sub><br>±1 LSB/±50 LSB                                                                                              | –                                                                                                                                                       |                                                                                     |                                                                                                                     |
| Calculation time t <sub>cal</sub><br>Clock frequency              | ≤ 7 μs<br>≤ 16 MHz                                                                                                                                                                                                                                                                                                                                                                | ≤ 9 μs<br>≤ 2 MHz                                                                                                                         | –                                                                                                                                                       |                                                                                     |                                                                                                                     |
| Incremental signals                                               | Without                                                                                                                                                                                                                                                                                                                                                                           |  1 V <sub>pp</sub> <sup>2)</sup>                         |                                                                        |  |  1 V <sub>pp</sub> <sup>2)</sup> |
| Line counts*                                                      | –                                                                                                                                                                                                                                                                                                                                                                                 | 2048                                                                                                                                      | 1000 <b>1024</b> 2048   2500   3600 <b>5000</b>                                                                                                         |                                                                                     |                                                                                                                     |
| Reference mark                                                    | –                                                                                                                                                                                                                                                                                                                                                                                 | –                                                                                                                                         | One                                                                                                                                                     |                                                                                     |                                                                                                                     |
| Cutoff frequency –3 dB                                            | –                                                                                                                                                                                                                                                                                                                                                                                 | ≥ 400 kHz (typ.)                                                                                                                          | –                                                                                                                                                       |                                                                                     | ≥ 180 kHz (typ.)                                                                                                    |
| Output frequency                                                  | –                                                                                                                                                                                                                                                                                                                                                                                 | –                                                                                                                                         | ≤ 300 kHz                                                                                                                                               |                                                                                     | –                                                                                                                   |
| Edge separation a                                                 | –                                                                                                                                                                                                                                                                                                                                                                                 | –                                                                                                                                         | ≥ 0.39 μs                                                                                                                                               |                                                                                     | –                                                                                                                   |
| System accuracy                                                   | ±20″                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                                                           | 1/20 of grating period                                                                                                                                  |                                                                                     |                                                                                                                     |
| Electrical connection*                                            | <ul style="list-style-type: none"><li>• <b>M12 flange socket</b>, radial</li><li>• Cable (1 m/5 m) with M12 coupling</li></ul>                                                                                                                                                                                                                                                    | <ul style="list-style-type: none"><li>• <b>M23 flange socket</b>, radial</li><li>• Cable (1 m/5 m) with or without M23 coupling</li></ul> | <ul style="list-style-type: none"><li>• <b>M23 flange socket</b>, radial</li><li>• <b>Cable (1 m/5 m)</b> with or <b>without M23 coupling</b></li></ul> |                                                                                     |                                                                                                                     |
| Supply voltage                                                    | DC 3.6 V to 14 V                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                           | DC 5 V ±0.5 V                                                                                                                                           | DC 10 V to 30 V                                                                     | DC 5 V ±0.5 V                                                                                                       |
| Power consumption (max.)                                          | 3.6 V: ≤ 620 mW/14 V: ≤ 720 mW                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                           | –                                                                                                                                                       |                                                                                     |                                                                                                                     |
| Current consumption without load                                  | 5 V: ≤ 85 mA (typical)                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                                           | ≤ 120 mA                                                                                                                                                | ≤ 150 mA                                                                            | ≤ 120 mA                                                                                                            |
| Shaft*                                                            | Hollow through shaft (Ø 20 mm, Ø <b>25 mm</b> , Ø 38 mm, Ø <b>50 mm</b> )                                                                                                                                                                                                                                                                                                         |                                                                                                                                           |                                                                                                                                                         |                                                                                     |                                                                                                                     |
| Mech. permiss. speed <sup>3)</sup>                                | Ø > 30 mm: ≤ 4000 rpm; Ø ≤ 30 mm: ≤ 6000 rpm                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                           |                                                                                                                                                         |                                                                                     |                                                                                                                     |
| Starting torque (typical) at 20 °C                                | Ø > 30 mm: 0.2 Nm<br>Ø ≤ 30 mm: 0.15 Nm                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                           |                                                                                                                                                         |                                                                                     |                                                                                                                     |
| Moment of inertia of rotor/<br>angular acceleration <sup>4)</sup> | Ø 50 mm: 220 · 10 <sup>–6</sup> kgm <sup>2</sup> /≤ 5 · 10 <sup>4</sup> rad/s <sup>2</sup> ; Ø 38 mm: 350 · 10 <sup>–6</sup> kgm <sup>2</sup> /≤ 2 · 10 <sup>4</sup> rad/s <sup>2</sup><br>Ø 25 mm: 96 · 10 <sup>–6</sup> kgm <sup>2</sup> /≤ 3 · 10 <sup>4</sup> rad/s <sup>2</sup> ; Ø 20 mm: 100 · 10 <sup>–6</sup> kgm <sup>2</sup> /≤ 3 · 10 <sup>4</sup> rad/s <sup>2</sup> |                                                                                                                                           |                                                                                                                                                         |                                                                                     |                                                                                                                     |
| Permiss. axial motion of measured shaft                           | ±1.5 mm                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                           |                                                                                                                                                         |                                                                                     |                                                                                                                     |
| Vibration: 55 Hz to 2000 Hz<br>Shock: 6 ms                        | ≤ 200 m/s <sup>2</sup> ; flange-socket version: ≤ 100 m/s <sup>2</sup> (EN 60068-2-6)<br>≤ 1000 m/s <sup>2</sup> (EN 60068-2-27)                                                                                                                                                                                                                                                  |                                                                                                                                           |                                                                                                                                                         |                                                                                     |                                                                                                                     |
| Max. operating temp. <sup>3)</sup>                                | 100 °C (85 °C with ERN 130)                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                           |                                                                                                                                                         |                                                                                     |                                                                                                                     |
| Min. operating temp.                                              | Flange socket or fixed cable: –40 °C; moving cable: –10 °C                                                                                                                                                                                                                                                                                                                        |                                                                                                                                           |                                                                                                                                                         |                                                                                     |                                                                                                                     |
| Protection EN 60529                                               | IP64                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                                                           |                                                                                                                                                         |                                                                                     |                                                                                                                     |
| Mass                                                              | 0.6 kg to 0.9 kg, depending on the hollow-shaft version                                                                                                                                                                                                                                                                                                                           |                                                                                                                                           |                                                                                                                                                         |                                                                                     |                                                                                                                     |
| Valid for ID                                                      | 810801-xx                                                                                                                                                                                                                                                                                                                                                                         | 810800-xx                                                                                                                                 | 589611-xx                                                                                                                                               | 589612-xx                                                                           | 589614-xx                                                                                                           |

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

<sup>1)</sup> Speed-dependent deviations between absolute value and incremental signal   <sup>2)</sup> Limited tolerances: signal amplitude: 0.8 V<sub>pp</sub> to 1.2 V<sub>pp</sub>

<sup>3)</sup> For the relationship between shaft speed and operating temperature, see "General mechanical information"

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

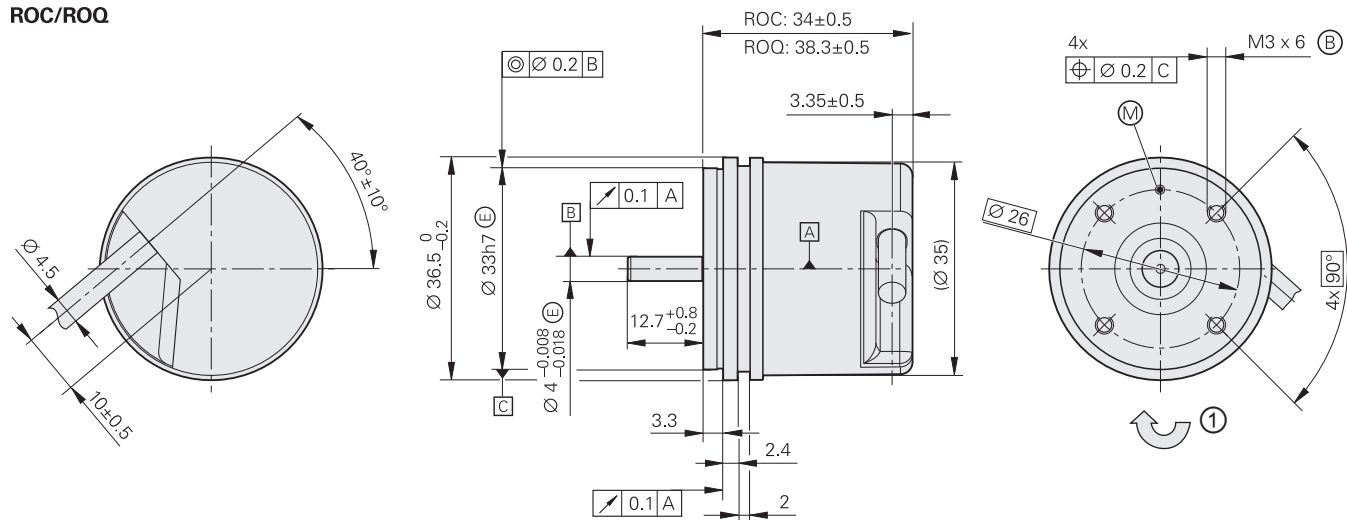
# ROC/ROQ/ROD 1000 series

Absolute and incremental rotary encoders

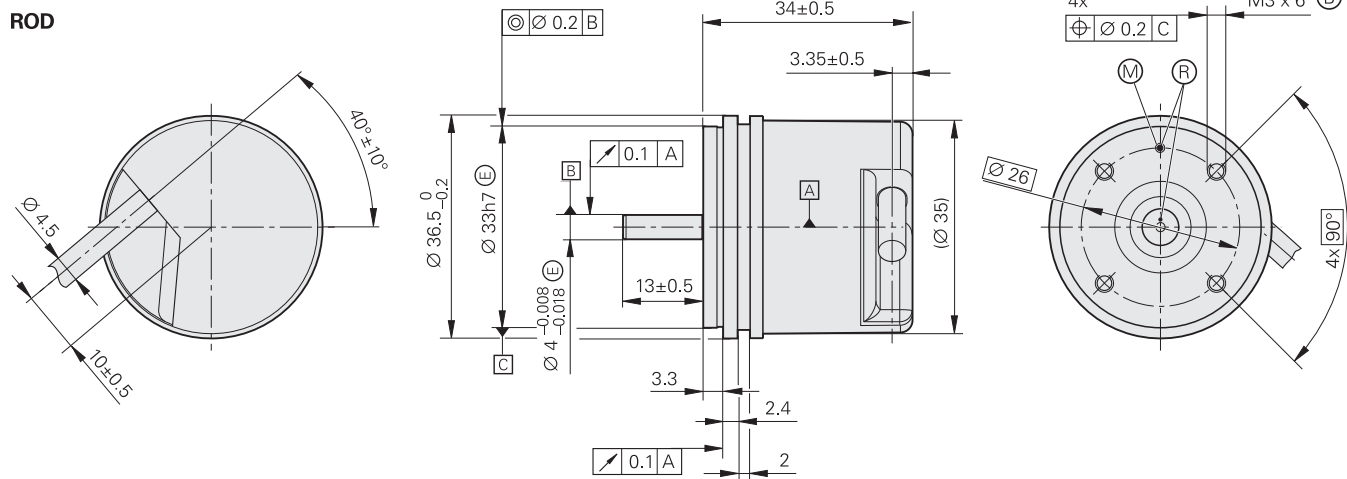
- Synchro flange
- Solid shaft for separate shaft coupling



## ROC/ROQ



## ROD



mm  
  
 Tolerancing ISO 8015  
 ISO 2768:1989-mH  
 ≤ 6 mm: ± 0.2 mm

Radial cable (can also be used axially)

Ⓐ = Bearing

Ⓑ = Fastening thread

Ⓜ = Measuring point for operating temperature

Ⓡ = Reference mark position ± 20°

1 = Incremental rotary encoders: direction of shaft rotation for output signals as per interface description  
 Absolute rotary encoders: direction of shaft rotation for ascending position values

|                                                          | Incremental                                                                           |                    |                                                                                        |             |                                                                                                                   |                           |                                                                                         |                                        |                       |         |
|----------------------------------------------------------|---------------------------------------------------------------------------------------|--------------------|----------------------------------------------------------------------------------------|-------------|-------------------------------------------------------------------------------------------------------------------|---------------------------|-----------------------------------------------------------------------------------------|----------------------------------------|-----------------------|---------|
|                                                          | ROD 1020                                                                              |                    | ROD 1030                                                                               |             | ROD 1080                                                                                                          |                           | ROD 1070                                                                                |                                        |                       |         |
| Interface                                                |  TTL |                    |  HTLs |             |  1 V <sub>PP</sub> <sup>1)</sup> |                           |  TTL |                                        |                       |         |
| Line counts*                                             | 100<br><b>1000</b>                                                                    | 200<br><b>1024</b> | <b>250</b><br>1250                                                                     | 360<br>1500 | 400<br>2000                                                                                                       | <b>500</b><br><b>2048</b> | 720<br><b>2500</b>                                                                      | 900<br><b>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 <i>a</i>                                 | ≥ 0.39 μs                                                                             |                    | ≥ 0.76 μs                                                                              |             | –                                                                                                                 |                           | ≥ 0.47 μs                                                                               |                                        | ≥ 0.22 μs             |         |
| System accuracy                                          | 1/20 of grating period                                                                |                    |                                                                                        |             |                                                                                                                   |                           |                                                                                         |                                        |                       |         |
| Electrical connection                                    | Cable (1 m/5 m) with or <b>without M23 coupling</b>                                   |                    |                                                                                        |             |                                                                                                                   |                           |                                                                                         | Cable (5 m) without connecting element |                       |         |
| Supply voltage                                           | DC 5 V ±0.5 V                                                                         |                    | DC 10 V to 30 V                                                                        |             | DC 5 V ±0.5 V                                                                                                     |                           | DC 5 V ±5 %                                                                             |                                        |                       |         |
| Current consumption without load                         | ≤ 120 mA                                                                              |                    | ≤ 150 mA                                                                               |             | ≤ 120 mA                                                                                                          |                           | ≤ 155 mA                                                                                |                                        |                       |         |
| Shaft                                                    | Solid shaft (Ø 4 mm)                                                                  |                    |                                                                                        |             |                                                                                                                   |                           |                                                                                         |                                        |                       |         |
| Mech. permiss. speed                                     | ≤ 12 000 rpm                                                                          |                    |                                                                                        |             |                                                                                                                   |                           |                                                                                         |                                        |                       |         |
| Starting torque (typical)                                | 0.001 Nm (at 20 °C) <sup>2)</sup>                                                     |                    |                                                                                        |             |                                                                                                                   |                           |                                                                                         |                                        |                       |         |
| Moment of inertia of rotor                               | ≤ 0.5 · 10 <sup>–6</sup> kgm <sup>2</sup>                                             |                    |                                                                                        |             |                                                                                                                   |                           |                                                                                         |                                        |                       |         |
| Shaft load                                               | Axial: 5 N<br>Radial: 10 N at shaft end                                               |                    |                                                                                        |             |                                                                                                                   |                           |                                                                                         |                                        |                       |         |
| <b>Vibration:</b> 55 Hz to 2000 Hz<br><b>Shock:</b> 6 ms | ≤ 100 m/s <sup>2</sup> (EN 60068-2-6)<br>≤ 1000 m/s <sup>2</sup> (EN 60068-2-27)      |                    |                                                                                        |             |                                                                                                                   |                           |                                                                                         |                                        |                       |         |
| Max. operating temp. <sup>3)</sup>                       | 100 °C                                                                                |                    | 70 °C                                                                                  |             | 100 °C                                                                                                            |                           | 70 °C                                                                                   |                                        |                       |         |
| Min. operating temp.                                     | Fixed cable: –30 °C; moving cable: –10 °C                                             |                    |                                                                                        |             |                                                                                                                   |                           |                                                                                         |                                        |                       |         |
| Protection EN 60529                                      | IP64                                                                                  |                    |                                                                                        |             |                                                                                                                   |                           |                                                                                         |                                        |                       |         |
| Mass                                                     | ≈ 0.09 kg                                                                             |                    |                                                                                        |             |                                                                                                                   |                           |                                                                                         |                                        |                       |         |
| Valid for ID                                             | 534900-x                                                                              |                    | 534901-xx                                                                              |             | 534904-xx                                                                                                         |                           | 534903-xx                                                                               |                                        |                       |         |

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

\* Please select when ordering

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

<sup>2)</sup> Version with low starting torque available upon request as the ROD 1170

<sup>3)</sup> For the relationship of operating temperature to shaft speed and supply voltage, see “General mechanical information”



## Absolute

### Singleturn

#### ROC 1023

#### ROC 1013

|                                                          |                                                                                  |                                          |
|----------------------------------------------------------|----------------------------------------------------------------------------------|------------------------------------------|
| <b>Interface</b>                                         | EnDat 2.2                                                                        |                                          |
| Ordering designation                                     | EnDat22                                                                          | EnDat01                                  |
| Positions/revolution                                     | 8388608 (23 bits)                                                                | 8192 (13 bits)                           |
| Revolutions                                              | –                                                                                |                                          |
| Code                                                     | Pure binary                                                                      |                                          |
| Elec. permissible speed<br>Deviations <sup>1)</sup>      | ≤ 12000 rpm<br>for continuous position value                                     | ≤ 4000 rpm/≤ 12000 rpm<br>±1 LSB/±16 LSB |
| Calculation time $t_{cal}$<br>Clock frequency            | ≤ 7 μs<br>≤ 8 MHz                                                                | ≤ 9 μs<br>≤ 2 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            |
| Supply voltage                                           | DC 3.6 V to 14 V                                                                 |                                          |
| Power consumption<br>(maximum)                           | 3.6 V: ≤ 0.6 W<br>14 V: ≤ 0.7 W                                                  |                                          |
| Current consumption<br>(typical, without load)           | 5 V: 80 mA                                                                       |                                          |
| <b>Shaft</b>                                             | Solid shaft (Ø 4 mm)                                                             |                                          |
| Mech. permiss. speed                                     | 12000 rpm                                                                        |                                          |
| Starting torque (typical)                                | 0.001 Nm (at 20 °C)                                                              |                                          |
| Moment of inertia of rotor                               | ≈ 0.5 · 10 <sup>–6</sup> kgm <sup>2</sup>                                        |                                          |
| Shaft load                                               | Axial: 5 N<br>Radial: 10 N at shaft end                                          |                                          |
| <b>Vibration:</b> 55 Hz to 2000 Hz<br><b>Shock:</b> 6 ms | ≤ 100 m/s <sup>2</sup> (EN 60068-2-6)<br>≤ 1000 m/s <sup>2</sup> (EN 60068-2-27) |                                          |
| <b>Max. operating temp.</b>                              | 100 °C                                                                           |                                          |
| <b>Min. operating temp.</b>                              | Fixed cable: –30 °C; moving cable: –10 °C                                        |                                          |
| <b>Protection</b> EN 60529                               | IP64                                                                             |                                          |
| <b>Mass</b>                                              | ≈ 0.09 kg                                                                        |                                          |
| <b>Valid for ID</b>                                      | 1438892-xx                                                                       | 1438891-xx                               |

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

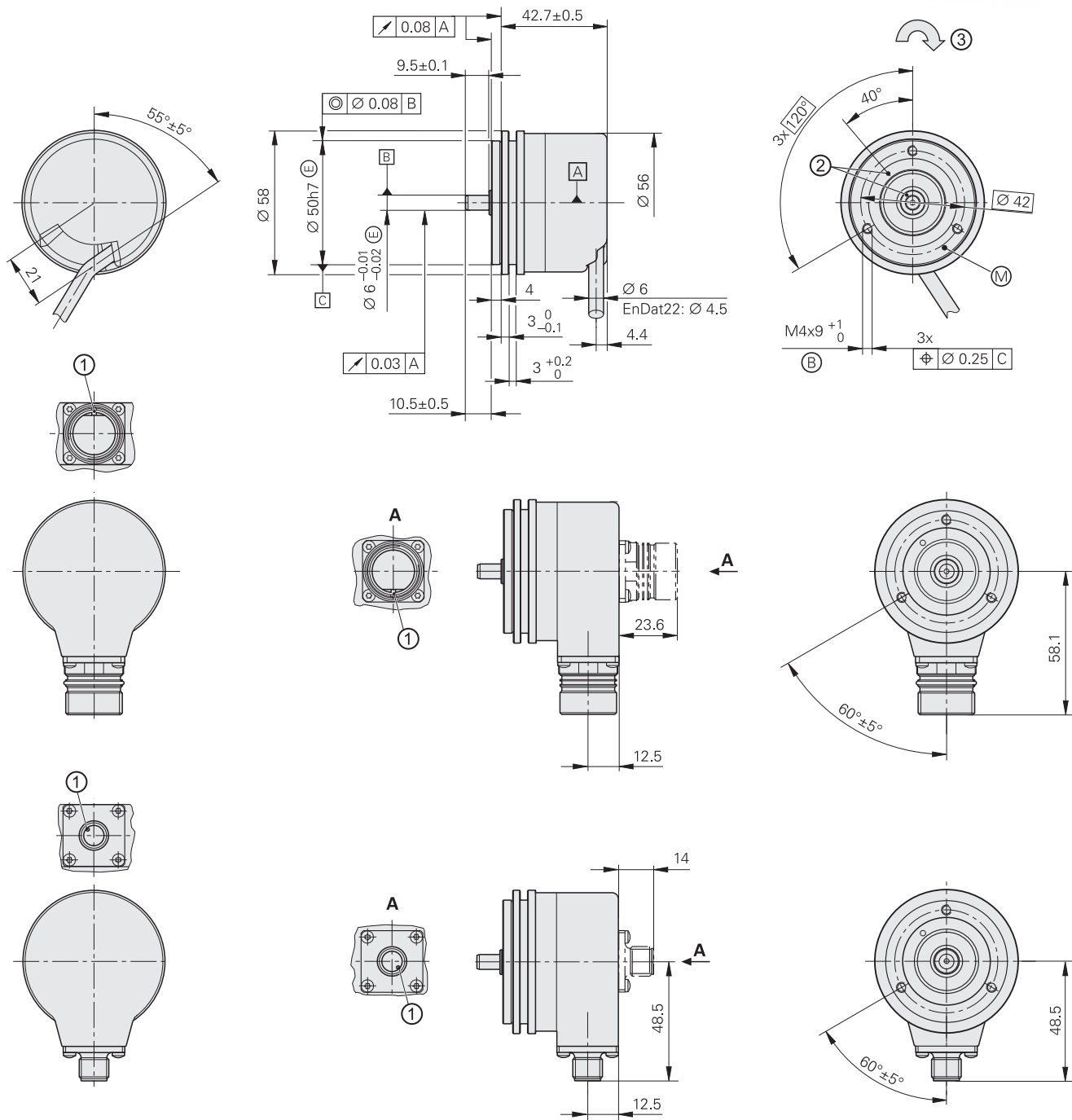
<sup>2)</sup> Limited tolerances: signal amplitude: 0.8 V<sub>PP</sub> to 1.2 V<sub>PP</sub>

[illegible]

# ROC/ROQ/ROD 400 series

Absolute and incremental rotary encoders

- Synchro flange
- Solid shaft for separate shaft coupling



mm



Tolerancing ISO 8015  
ISO 2768:1989-mH  
≤ 6 mm: ±0.2 mm

Radial cable (can also be used axially)

▣ = Bearing

⊙ = Fastening thread

Ⓜ = Measuring point for operating temperature

1 = Connector coding

2 = ROD reference mark position for shaft and flange ±30°

3 = Incremental rotary encoders: direction of shaft rotation for output signals as per interface description  
Absolute rotary encoders: direction of shaft rotation for ascending position values

|                                                          | Incremental                                                                                                                                                       |      |      |      |                 |      |      |      |                                                                                        |      |  |  |                                                                                                                     |  |
|----------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|------|------|-----------------|------|------|------|----------------------------------------------------------------------------------------|------|--|--|---------------------------------------------------------------------------------------------------------------------|--|
|                                                          | ROD 426                                                                                                                                                           |      |      |      | ROD 466         |      |      |      | ROD 436                                                                                |      |  |  | ROD 486                                                                                                             |  |
| Interface                                                |  TTL                                                                             |      |      |      |                 |      |      |      |  HTL |      |  |  |  1 V <sub>PP</sub> <sup>1)</sup> |  |
| Line counts*                                             | 50                                                                                                                                                                | 100  | 250  | 360  | 500             | 512  | 720  |      |                                                                                        |      |  |  | –                                                                                                                   |  |
|                                                          | 1000                                                                                                                                                              | 1024 | 1250 | 1500 | 2000            | 2048 | 2500 | 3600 | 4096                                                                                   | 5000 |  |  |                                                                                                                     |  |
| Reference mark                                           | One                                                                                                                                                               |      |      |      |                 |      |      |      |                                                                                        |      |  |  |                                                                                                                     |  |
| Cutoff frequency –3 dB                                   | –                                                                                                                                                                 |      |      |      |                 |      |      |      |                                                                                        |      |  |  | ≥ 180 kHz                                                                                                           |  |
| Scanning frequency                                       | ≤ 300 kHz/≤ 150 kHz                                                                                                                                               |      |      |      |                 |      |      |      |                                                                                        |      |  |  | –                                                                                                                   |  |
| Edge separation <i>a</i>                                 | ≥ 0.39 μs/≥ 0.25 μs                                                                                                                                               |      |      |      |                 |      |      |      |                                                                                        |      |  |  | –                                                                                                                   |  |
| System accuracy                                          | 1/20 of grating period                                                                                                                                            |      |      |      |                 |      |      |      |                                                                                        |      |  |  |                                                                                                                     |  |
| Electrical connection*                                   | <ul style="list-style-type: none"><li>• <b>M23 flange socket</b>, radial and axial</li><li>• <b>Cable (1 m/5 m)</b> with or <b>without M23 coupling</b></li></ul> |      |      |      |                 |      |      |      |                                                                                        |      |  |  |                                                                                                                     |  |
| Supply voltage                                           | DC 5 V ±0.5 V                                                                                                                                                     |      |      |      | DC 10 V to 30 V |      |      |      | DC 10 V to 30 V                                                                        |      |  |  | DC 5 V ±0.5 V                                                                                                       |  |
| Current consumption without load                         | ≤ 120 mA                                                                                                                                                          |      |      |      | ≤ 100 mA        |      |      |      | ≤ 150 mA                                                                               |      |  |  | ≤ 120 mA                                                                                                            |  |
| Shaft                                                    | Solid shaft (Ø 6 mm)                                                                                                                                              |      |      |      |                 |      |      |      |                                                                                        |      |  |  |                                                                                                                     |  |
| Mech. permiss. speed                                     | ≤ 16000 rpm                                                                                                                                                       |      |      |      |                 |      |      |      |                                                                                        |      |  |  |                                                                                                                     |  |
| Starting torque (typical)                                | 0.01 Nm (at 20 °C) (at IP66: 0.025 Nm)                                                                                                                            |      |      |      |                 |      |      |      |                                                                                        |      |  |  |                                                                                                                     |  |
| Moment of inertia of rotor                               | ≤ 2.7 · 10 <sup>–6</sup> kgm <sup>2</sup>                                                                                                                         |      |      |      |                 |      |      |      |                                                                                        |      |  |  |                                                                                                                     |  |
| Shaft load <sup>2)</sup>                                 | Axial: ≤ 40 N; radial: ≤ 60 N at shaft end                                                                                                                        |      |      |      |                 |      |      |      |                                                                                        |      |  |  |                                                                                                                     |  |
| <b>Vibration:</b> 55 Hz to 2000 Hz<br><b>Shock:</b> 6 ms | ≤ 300 m/s <sup>2</sup> (EN 60068-2-6)<br>≤ 2000 m/s <sup>2</sup> (EN 60068-2-27)                                                                                  |      |      |      |                 |      |      |      |                                                                                        |      |  |  |                                                                                                                     |  |
| Max. operating temp. <sup>3)</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 60529                                      | IP67 at housing; IP64 at shaft inlet (IP66 upon request)                                                                                                          |      |      |      |                 |      |      |      |                                                                                        |      |  |  |                                                                                                                     |  |
| Mass                                                     | ≈ 0.3 kg                                                                                                                                                          |      |      |      |                 |      |      |      |                                                                                        |      |  |  |                                                                                                                     |  |
| Valid for ID                                             | 376846-xx                                                                                                                                                         |      |      |      | 376866-xx       |      |      |      | 376836-xx                                                                              |      |  |  | 376886-xx <sup>5)</sup>                                                                                             |  |

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

\* Please select when ordering

<sup>1)</sup> Limited 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 relationship of operating temperature to shaft speed and supply voltage, see “General mechanical information”

<sup>4)</sup> 80 °C for ROD 486 with 4096 or 5000 lines

<sup>5)</sup> Available with mechanical fault exclusion; for deviating specifications and special mounting information, see the *Fault Exclusion* Customer Information document

|  | Absolute                                                                                                                     |                                                                                                                                                     |                      |
|----------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------|----------------------|
|                                                                                  | Singleturn<br>ROC 425                       | ROC 413                                                                                                                                             |                      |
| Interface*                                                                       | EnDat 2.2                                                                                                                    | EnDat 2.2                                                                                                                                           | SSI                  |
| Ordering designation                                                             | EnDat22                                                                                                                      | EnDat01                                                                                                                                             | SSI39r1              |
| Positions/revolution                                                             | 33554432 (25 bits)                                                                                                           | 8192 (13 bits)                                                                                                                                      |                      |
| Revolutions                                                                      | –                                                                                                                            |                                                                                                                                                     |                      |
| Code                                                                             | Pure binary                                                                                                                  |                                                                                                                                                     | Gray                 |
| Elec. permissible speed<br>Deviations <sup>1)</sup>                              | ≤ 15000 rpm<br>for continuous position value                                                                                 | 512 lines:<br>≤ 5000/12000 rpm<br>±1 LSB/±100 LSB<br>2048 lines:<br>≤ 1500/12000 rpm<br>±1 LSB/±50 LSB                                              | 12000 rpm<br>±12 LSB |
| Calculation time <i>t</i> <sub>cal</sub><br>Clock frequency                      | ≤ 7 µs<br>≤ 8 MHz                                                                                                            | ≤ 9 µs<br>≤ 2 MHz                                                                                                                                   | ≤ 5 µs<br>–          |
| Incremental signals                                                              | Without                                                                                                                      | ~ 1 V <sub>PP</sub> <sup>2)</sup>                                                                                                                   |                      |
| Line counts*                                                                     | –                                                                                                                            | <b>512</b> 2048                                                                                                                                     | 512                  |
| Cutoff frequency –3 dB                                                           | –                                                                                                                            | 512 lines: ≥ 130 kHz; 2048 lines: ≥ 400 kHz                                                                                                         |                      |
| System accuracy                                                                  | ±20"                                                                                                                         | 512 lines: ±60"; 2048 lines: ±20"                                                                                                                   |                      |
| Electrical connection*                                                           | <ul style="list-style-type: none"><li>• <b>M12 flange socket</b>, radial</li><li>• Cable (1 m) with M12 coupling</li></ul>   | <ul style="list-style-type: none"><li>• <b>M23 flange socket</b>, axial, or radial</li><li>• Cable (1 m/5 m) with or without M23 coupling</li></ul> |                      |
| Supply voltage                                                                   | DC 3.6 V to 14 V                                                                                                             | DC 3.6 V to 14 V                                                                                                                                    | DC 4.75 V to 30 V    |
| Power consumption<br>(maximum)                                                   | 3.6 V: ≤ 0.6 W<br>14 V: ≤ 0.7 W                                                                                              | 4.75 V: ≤ 0.6 W<br>30 V: ≤ 0.78 W                                                                                                                   |                      |
| Current consumption<br>(typical, without load)                                   | 5 V: 80 mA                                                                                                                   | 5 V: 70 mA<br>24 V: 20 mA                                                                                                                           |                      |
| Shaft                                                                            | Solid shaft (Ø 6 mm)                                                                                                         |                                                                                                                                                     |                      |
| Mech. permiss. speed                                                             | ≤ 15000 rpm                                                                                                                  |                                                                                                                                                     |                      |
| Starting torque (typical)                                                        | 0.01 Nm (at 20 °C) (at IP66: 0.025 Nm)                                                                                       |                                                                                                                                                     |                      |
| Moment of inertia of rotor                                                       | ≤ 2.7 · 10 <sup>–6</sup> kgm <sup>2</sup>                                                                                    |                                                                                                                                                     |                      |
| Shaft load                                                                       | Axial: ≤ 40 N; radial: ≤ 60 N at shaft end (see also "Mechanical design types and mounting")                                 |                                                                                                                                                     |                      |
| Vibration: 55 Hz to 2000 Hz<br>Shock: 6 ms                                       | ≤ 300 m/s <sup>2</sup> (EN 60068-2-6)<br>ROC/ROQ: ≤ 2000 m/s <sup>2</sup> ; RIC/RIQ: ≤ 1000 m/s <sup>2</sup> (EN 60068-2-27) |                                                                                                                                                     |                      |
| Max. operating temp. <sup>3)</sup>                                               | 100 °C                                                                                                                       |                                                                                                                                                     |                      |
| Min. operating temp.                                                             | Flange socket or fixed cable: –40 °C; moving cable: –10 °C                                                                   |                                                                                                                                                     |                      |
| Protection EN 60529                                                              | IP67 at housing; IP64 at shaft inlet (IP66 upon request)                                                                     |                                                                                                                                                     |                      |
| Mass                                                                             | ≈ 0.35 kg                                                                                                                    |                                                                                                                                                     |                      |
| Valid for ID                                                                     | 1322268-xx <sup>4)</sup>                                                                                                     | 1109254-xx                                                                                                                                          | 1353113-xx           |

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

\* Please select when ordering

<sup>1)</sup> Speed-dependent deviations between absolute value and incremental signal

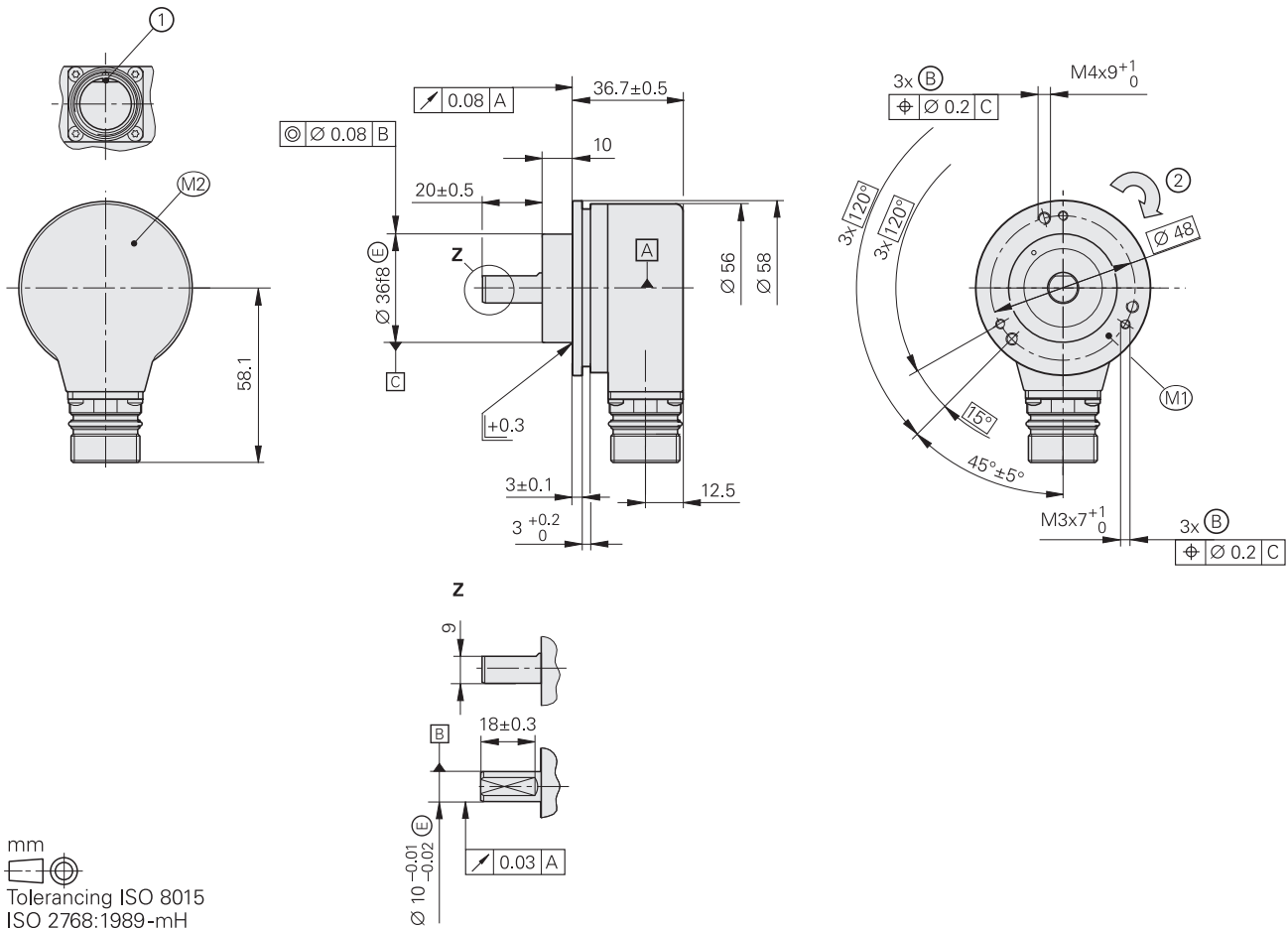
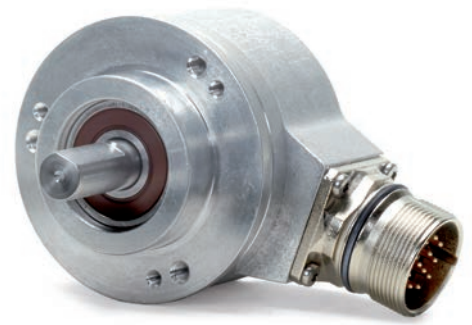
| <div>Multiturn</div> <div>ROQ 437</div> <div>Functional Safety</div> <div>ROQ 425</div> |                                                                                                                               |                                                                                                                                                        |                                              |
|-----------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------|
|                                                                                         | EnDat 2.2                                                                                                                     | EnDat 2.2                                                                                                                                              | SSI                                          |
|                                                                                         | EnDat22                                                                                                                       | EnDat01                                                                                                                                                | SSI41r1                                      |
|                                                                                         | 33 554 432 (25 bits)                                                                                                          | 8192 (13 bits)                                                                                                                                         | 8192 (13 bits)                               |
|                                                                                         | 4096                                                                                                                          |                                                                                                                                                        |                                              |
|                                                                                         | Pure binary                                                                                                                   |                                                                                                                                                        | Gray                                         |
|                                                                                         | $\leq 15\,000$ rpm<br>for continuous position value                                                                           | 512 lines:<br>$\leq 5000/10\,000$ rpm<br>$\pm 1$ LSB/ $\pm 100$ LSB<br>2048 lines:<br>$\leq 1500/10\,000$ rpm<br>$\pm 1$ LSB/ $\pm 50$ LSB             | 12 000 rpm<br>$\pm 12$ LSB                   |
|                                                                                         | $\leq 7$ $\mu$ s<br>$\leq 8$ MHz                                                                                              | $\leq 9$ $\mu$ s<br>$\leq 2$ MHz                                                                                                                       | $\leq 5$ $\mu$ s<br>–                        |
|                                                                                         | Without                                                                                                                       | $\sim 1 V_{PP}^{2)}$                                                                                                                                   |                                              |
|                                                                                         | –                                                                                                                             | <b>512</b> 2048                                                                                                                                        | 512                                          |
|                                                                                         | –                                                                                                                             | 512 lines: $\geq 130$ kHz; 2048 lines: $\geq 400$ kHz                                                                                                  |                                              |
|                                                                                         | $\pm 20''$                                                                                                                    | 512 lines: $\pm 60''$ ; 2048 lines: $\pm 20''$                                                                                                         |                                              |
|                                                                                         | <ul style="list-style-type: none"> <li>• <b>M12 flange socket</b>, radial</li> <li>• Cable (1 m) with M12 coupling</li> </ul> | <ul style="list-style-type: none"> <li>• <b>M23 flange socket</b>, axial, or radial</li> <li>• Cable (1 m/5 m) with or without 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                            |
|                                                                                         | 3.6 V: $\leq 0.7$ W<br>14 V: $\leq 0.8$ W                                                                                     |                                                                                                                                                        | 4.75 V: $\leq 0.68$ W<br>30 V: $\leq 0.88$ W |
|                                                                                         | 5 V: 95 mA                                                                                                                    |                                                                                                                                                        | 5 V: 85 mA<br>24 V: 20 mA                    |
|                                                                                         |                                                                                                                               |                                                                                                                                                        |                                              |
|                                                                                         |                                                                                                                               |                                                                                                                                                        |                                              |
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|                                                                                         |                                                                                                                               |                                                                                                                                                        |                                              |
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|                                                                                         |                                                                                                                               |                                                                                                                                                        |                                              |
|                                                                                         |                                                                                                                               |                                                                                                                                                        |                                              |
|                                                                                         | 1322273-xx <sup>4)</sup>                                                                                                      | 1109256-xx                                                                                                                                             | 1353117-xx                                   |

<sup>2)</sup> Limited tolerances: signal amplitude: 0.8 V<sub>PP</sub> to 1.2 V<sub>PP</sub>  
<sup>3)</sup> For the relationship of operating temperature to shaft speed and supply voltage, see “General mechanical information”  
<sup>4)</sup> Also available with functional safety; for dimensions and specifications, see Product Information document

# ROQ 425

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

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



|                                                |                                                                                                                             |                        |                        |                                                                     |                        |                        |
|------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------|------------------------|------------------------|---------------------------------------------------------------------|------------------------|------------------------|
|                                                | Absolute<br>Multiturn<br>ROQ 425                                                                                            |                        |                        |                                                                     |                        |                        |
| Interface                                      | EnDat 2.2                                                                                                                   |                        |                        |                                                                     |                        |                        |
| Ordering designation*                          | EnDatH                                                                                                                      |                        |                        | EnDatT                                                              |                        |                        |
| Positions/revolution                           | 8192 (13 bits)                                                                                                              |                        |                        |                                                                     |                        |                        |
| Revolutions                                    | 4096 (12 bits)                                                                                                              |                        |                        |                                                                     |                        |                        |
| Code                                           | Pure binary                                                                                                                 |                        |                        |                                                                     |                        |                        |
| Calculation time $t_{cal}$<br>Clock frequency  | $\leq 9 \mu s$<br>$\leq 2 \text{ MHz}$                                                                                      |                        |                        |                                                                     |                        |                        |
| 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                               | $\leq 52 \text{ kHz}$                                                                                                       | $\leq 103 \text{ kHz}$ | $\leq 205 \text{ kHz}$ | $\leq 52 \text{ kHz}$                                               | $\leq 205 \text{ kHz}$ | $\leq 410 \text{ kHz}$ |
| System accuracy <sup>1)</sup>                  | $\pm 60''$                                                                                                                  | $\pm 60''$             | $\pm 20''$             | $\pm 60''$                                                          | $\pm 20''$             | $\pm 20''$             |
| Electrical connection                          | 17-pin M23 radial flange socket (male)                                                                                      |                        |                        |                                                                     |                        |                        |
| Cable length <sup>2)</sup>                     | $\leq 100 \text{ m}$ (with HEIDENHAIN cable)                                                                                |                        |                        |                                                                     |                        |                        |
| Supply voltage                                 | DC 10 V to 30 V                                                                                                             |                        |                        | DC 4.75 V to 30 V                                                   |                        |                        |
| Power consumption (max.) <sup>3)</sup>         | See "Power consumption" diagram                                                                                             |                        |                        | At 4.75 V: $\leq 900 \text{ mW}$<br>At 30 V: $\leq 1100 \text{ mW}$ |                        |                        |
| Current consumption<br>(typical, without load) | At 10 V: $\leq 56 \text{ mA}$<br>At 24 V: $\leq 34 \text{ mA}$                                                              |                        |                        | At 5 V: $\leq 100 \text{ mA}$<br>At 24 V: $\leq 25 \text{ mA}$      |                        |                        |
| Shaft                                          | Solid shaft $\varnothing 10 \text{ mm}$ with flat                                                                           |                        |                        |                                                                     |                        |                        |
| Mech. permiss. speed <sup>4)</sup>             | $\leq 12000 \text{ rpm}$                                                                                                    |                        |                        |                                                                     |                        |                        |
| Starting torque (typical)                      | 0.025 Nm (at 20 °C)                                                                                                         |                        |                        |                                                                     |                        |                        |
| Moment of inertia of rotor                     | $2.7 \cdot 10^{-6} \text{ kgm}^2$                                                                                           |                        |                        |                                                                     |                        |                        |
| Shaft load                                     | Axial: $\leq 40 \text{ N}$<br>Radial: $\leq 60 \text{ N}$ at shaft end<br>(see also "Mechanical design types and mounting") |                        |                        |                                                                     |                        |                        |
| Vibration: 10 Hz to 2000 Hz<br>Shock: 6 ms     | $\leq 150 \text{ m/s}^2$ (EN 60068-2-6)<br>$\leq 1000 \text{ m/s}^2$ (EN 60068-2-27)                                        |                        |                        |                                                                     |                        |                        |
| Max. operating temp. <sup>4)</sup>             | 100 °C                                                                                                                      |                        |                        |                                                                     |                        |                        |
| Min. operating temp.                           | −40 °C                                                                                                                      |                        |                        |                                                                     |                        |                        |
| Protection EN 60529                            | Housing: IP67<br>Shaft outlet: IP66                                                                                         |                        |                        |                                                                     |                        |                        |
| Mass                                           | $\approx 0.30 \text{ kg}$                                                                                                   |                        |                        |                                                                     |                        |                        |
| Valid for ID                                   | 1042530-xx                                                                                                                  |                        |                        | 1042529-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" diagrams)

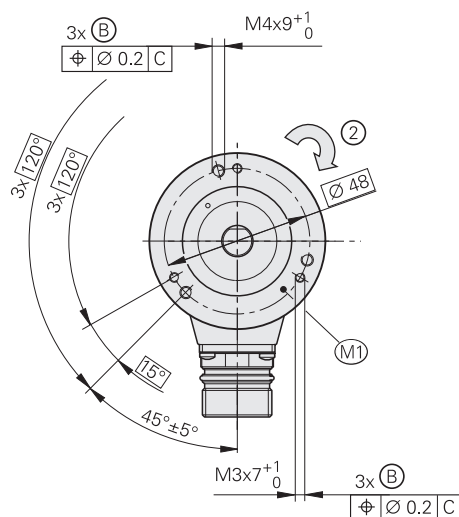
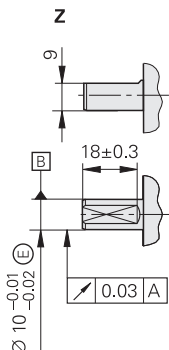
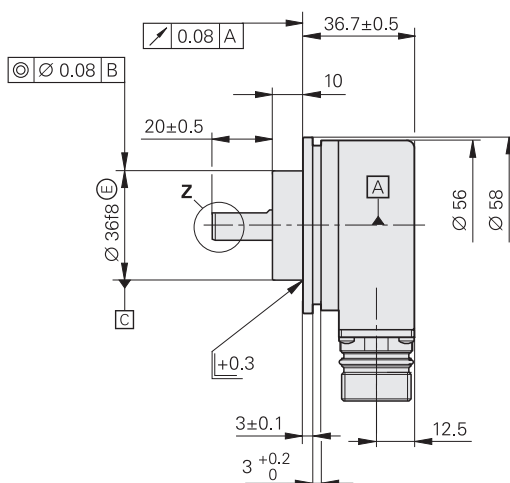
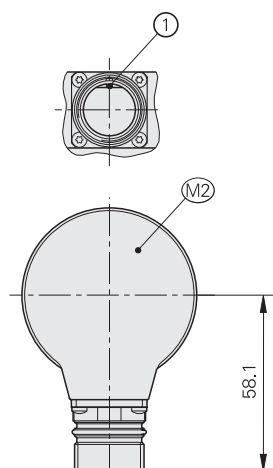
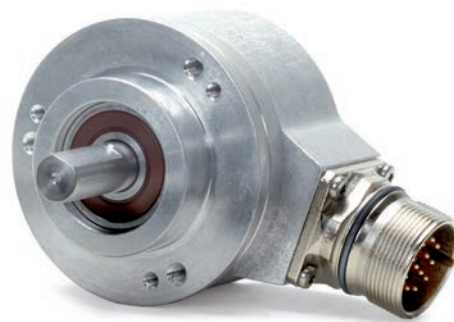
<sup>3)</sup> See "General electrical information" in the *Interfaces of HEIDENHAIN Encoders* brochure

<sup>4)</sup> For the relationship of operating temperature to shaft speed and supply voltage, see "General mechanical information"

# ROQ 425

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

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



mm  
  
 Tolerancing ISO 8015  
 ISO 2768:1989-mH  
 ≤ 6 mm: ±0.2 mm

- [A] = Bearing  
 [E] = Fastening thread  
 M1 = Measuring point for operating temperature  
 M2 = Measuring point for vibration, see also D 774714  
 1 = Connector coding  
 2 = Direction of shaft rotation for ascending position values

|                                                |                                                                                                                             |                        |                        |                                                                     |                        |                        |
|------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------|------------------------|------------------------|---------------------------------------------------------------------|------------------------|------------------------|
|                                                | Absolute<br>Multiturn<br>ROQ 425                                                                                            |                        |                        |                                                                     |                        |                        |
| Interface                                      | SSI                                                                                                                         |                        |                        |                                                                     |                        |                        |
| Ordering designation*                          | SSI41H                                                                                                                      |                        |                        | SSI41T                                                              |                        |                        |
| Positions/revolution                           | 8192 (13 bits)                                                                                                              |                        |                        |                                                                     |                        |                        |
| Revolutions                                    | 4096 (12 bits)                                                                                                              |                        |                        |                                                                     |                        |                        |
| Code                                           | Pure binary                                                                                                                 |                        |                        |                                                                     |                        |                        |
| Calculation time $t_{cal}$<br>Clock frequency  | $\leq 9 \mu s$<br>$\leq 2 \text{ MHz}$                                                                                      |                        |                        |                                                                     |                        |                        |
| Incremental signals                            | HTL <sup>5)</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                               | $\leq 52 \text{ kHz}$                                                                                                       | $\leq 103 \text{ kHz}$ | $\leq 205 \text{ kHz}$ | $\leq 52 \text{ kHz}$                                               | $\leq 205 \text{ kHz}$ | $\leq 410 \text{ kHz}$ |
| System accuracy <sup>1)</sup>                  | $\pm 60''$                                                                                                                  | $\pm 60''$             | $\pm 20''$             | $\pm 60''$                                                          | $\pm 20''$             | $\pm 20''$             |
| Electrical connection                          | 12-pin M23 radial flange socket (male)                                                                                      |                        |                        | 17-pin M23 radial flange socket (male)                              |                        |                        |
| Cable length <sup>2)</sup>                     | $\leq 100 \text{ m}$ (with HEIDENHAIN cable)                                                                                |                        |                        |                                                                     |                        |                        |
| Supply voltage                                 | DC 10 V to 30 V                                                                                                             |                        |                        | DC 4.75 V to 30 V                                                   |                        |                        |
| Power consumption (max.) <sup>3)</sup>         | See "Power consumption" diagram                                                                                             |                        |                        | At 4.75 V: $\leq 900 \text{ mW}$<br>At 30 V: $\leq 1100 \text{ mW}$ |                        |                        |
| Current consumption<br>(typical, without load) | At 10 V: $\leq 56 \text{ mA}$<br>At 24 V: $\leq 34 \text{ mA}$                                                              |                        |                        | At 5 V: $\leq 100 \text{ mA}$<br>At 24 V: $\leq 25 \text{ mA}$      |                        |                        |
| Shaft                                          | Solid shaft $\varnothing 10 \text{ mm}$ with flat                                                                           |                        |                        |                                                                     |                        |                        |
| Mech. permiss. speed <sup>4)</sup>             | $\leq 12\,000 \text{ rpm}$                                                                                                  |                        |                        |                                                                     |                        |                        |
| Starting torque (typical)                      | 0.025 Nm (at 20 °C)                                                                                                         |                        |                        |                                                                     |                        |                        |
| Moment of inertia of rotor                     | $2.7 \cdot 10^{-6} \text{ kgm}^2$                                                                                           |                        |                        |                                                                     |                        |                        |
| Shaft load                                     | Axial: $\leq 40 \text{ N}$<br>Radial: $\leq 60 \text{ N}$ at shaft end<br>(see also "Mechanical design types and mounting") |                        |                        |                                                                     |                        |                        |
| Vibration: 10 Hz to 2000 Hz<br>Shock: 6 ms     | $\leq 150 \text{ m/s}^2$ (EN 60068-2-6)<br>$\leq 1000 \text{ m/s}^2$ (EN 60068-2-27)                                        |                        |                        |                                                                     |                        |                        |
| Max. operating temp. <sup>4)</sup>             | 100 °C                                                                                                                      |                        |                        |                                                                     |                        |                        |
| Min. operating temp.                           | -40 °C                                                                                                                      |                        |                        |                                                                     |                        |                        |
| Protection EN 60529                            | Housing: IP67<br>Shaft outlet: IP66                                                                                         |                        |                        |                                                                     |                        |                        |
| Mass                                           | $\approx 0.30 \text{ kg}$                                                                                                   |                        |                        |                                                                     |                        |                        |
| Valid for ID                                   | 1065028-xx                                                                                                                  |                        |                        | 1042524-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" diagrams)

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

<sup>4)</sup> For the relationship of operating temperature to shaft speed and supply voltage, see "General mechanical information"

<sup>5)</sup> HTLs upon request

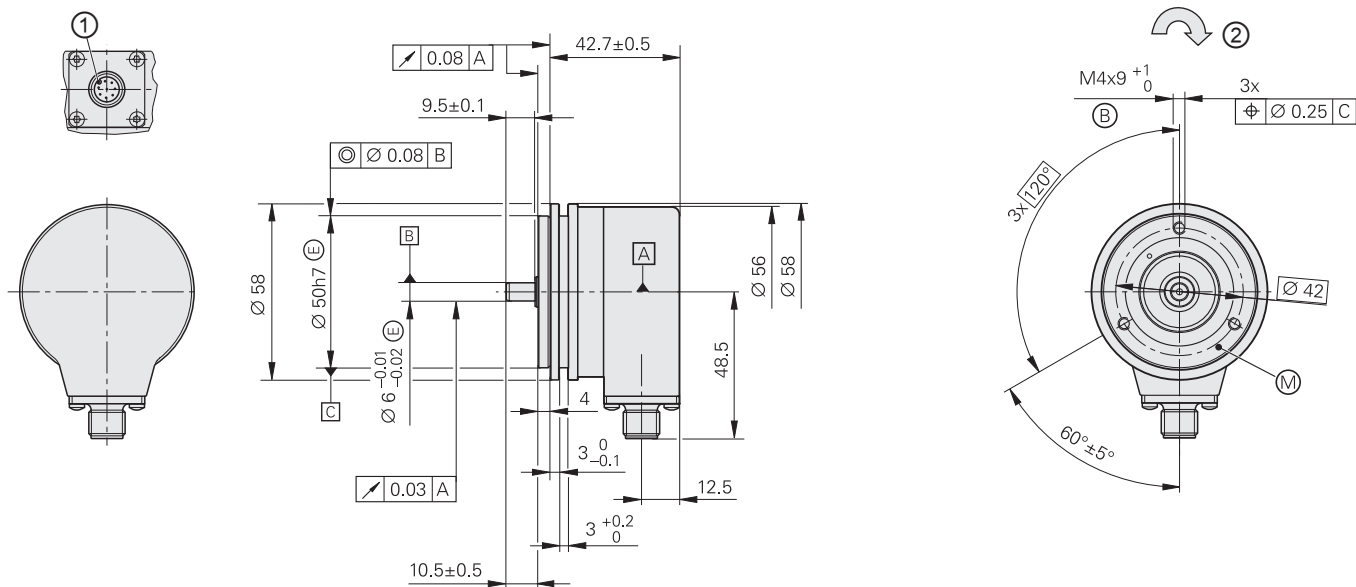
# ROC/ROQ 400F/S series

## Absolute rotary encoders

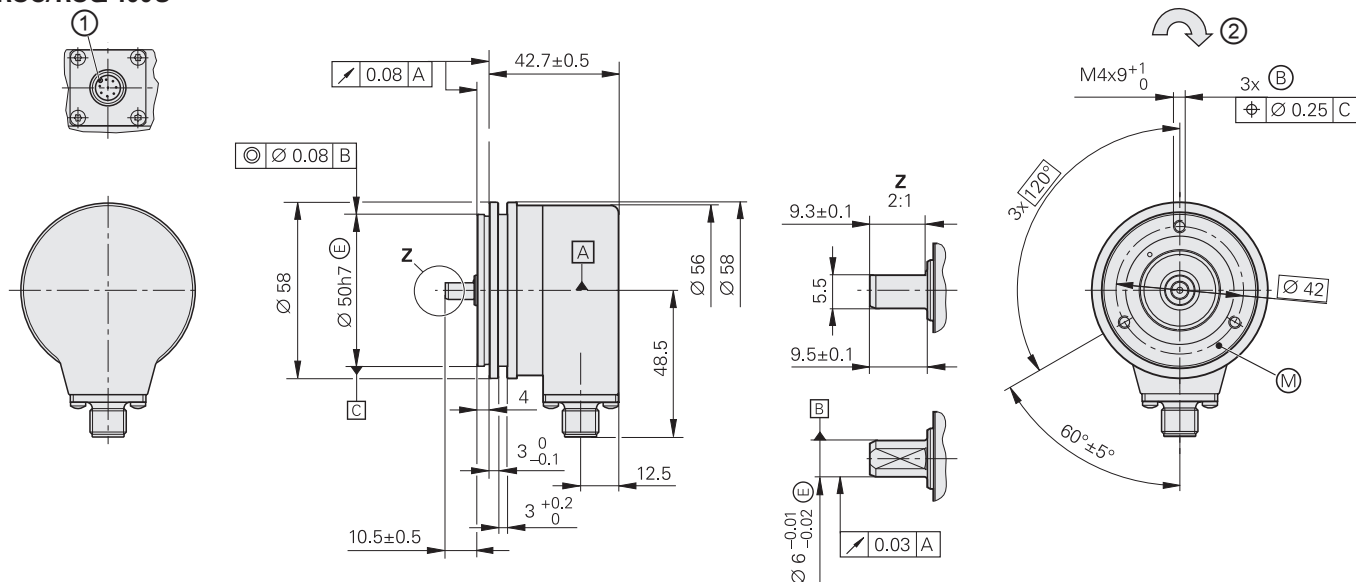
- Synchro flange
- Solid shaft for separate shaft coupling
- Fanuc Serial Interface or Siemens DRIVE-CLiQ interface



### ROC/ROQ 400F



### ROC/ROQ 400S



mm  
 Tolerancing ISO 8015  
 ISO 2768:1989-mH  
 ≤ 6 mm: ±0.2 mm

- ▢ = Bearing  
 Ⓜ = Fastening thread  
 Ⓜ = Measuring point for operating temperature  
 1 = Connector coding  
 2 = Direction of shaft rotation for ascending position values

DRIVE-CLiQ is a registered trademark of Siemens AG

|                                                | Absolute                                                                                 |                                                                                             |                                         |                                                                                               |
|------------------------------------------------|------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------|-----------------------------------------|-----------------------------------------------------------------------------------------------|
|                                                | Singleturn                                                                               |                                                                                             | Multiturn                               |                                                                                               |
|                                                | ROC 425 F                                                                                | ROC 424 S  | ROQ 437 F                               | ROQ 436 S  |
| Interface                                      | Fanuc Serial Interface;<br>αi Interface                                                  | DRIVE-CLiQ                                                                                  | Fanuc Serial Interface;<br>αi Interface | DRIVE-CLiQ                                                                                    |
| Ordering designation                           | Fanuc05 <sup>1)</sup>                                                                    | DQ01                                                                                        | Fanuc06 <sup>1)</sup>                   | DQ01                                                                                          |
| Positions/revolution                           | αi: 33554432<br>(25 bits)<br>α: 8388608<br>(23 bit)                                      | 16777216<br>(24 bits)                                                                       | 33554432<br>(25 bits)                   | 16777216<br>(24 bits)                                                                         |
| Revolutions                                    | 8192 via revolution<br>counter                                                           | –                                                                                           | αi: 4096                                | 4096                                                                                          |
| Code                                           | Pure binary                                                                              |                                                                                             |                                         |                                                                                               |
| Elec. permissible speed                        | ≤ 15000 rpm for continuous position values                                               |                                                                                             |                                         |                                                                                               |
| Calculation time $t_{cal}$                     | ≤ 5 μs                                                                                   | ≤ 8 μs <sup>2)</sup>                                                                        | ≤ 5 μs                                  | ≤ 8 μs <sup>2)</sup>                                                                          |
| System accuracy                                | ±20"                                                                                     |                                                                                             |                                         |                                                                                               |
| Electrical connection                          | M12 flange socket, radial                                                                |                                                                                             |                                         |                                                                                               |
| Cable length                                   | ≤ 30 m                                                                                   | ≤ 95 m <sup>3)</sup>                                                                        | ≤ 30 m                                  | ≤ 95 m <sup>3)</sup>                                                                          |
| Supply voltage                                 | DC 3.6 V to 14 V                                                                         | DC 10 V to 36 V                                                                             | DC 3.6 V to 14 V                        | DC 10 V to 36 V                                                                               |
| Power consumption<br>(maximum)                 | 5 V: ≤ 0.7 W<br>14 V: ≤ 0.8 W                                                            | 10 V: ≤ 1.4 W<br>36 V: ≤ 1.5 W                                                              | 5 V: ≤ 0.75 W<br>14 V: ≤ 0.85 W         | 10 V: ≤ 1.4 W<br>36 V: ≤ 1.5 W                                                                |
| Current consumption<br>(typical, without load) | 5 V: 90 mA                                                                               | 24 V: 37 mA                                                                                 | 5 V: 100 mA                             | 24 V: 43 mA                                                                                   |
| Shaft                                          | Solid shaft (Ø 6 mm) for ROC 424 S and ROQ 436 S with flat                               |                                                                                             |                                         |                                                                                               |
| Mech. permiss. speed <sup>4)</sup>             | ≤ 15000 rpm                                                                              |                                                                                             | ≤ 12000 rpm                             |                                                                                               |
| Starting torque (typical)                      | 0.01 Nm (at 20 °C)                                                                       |                                                                                             |                                         |                                                                                               |
| Moment of inertia of rotor                     | ≤ 2.9 · 10 <sup>−6</sup> kgm <sup>2</sup>                                                |                                                                                             |                                         |                                                                                               |
| Shaft load                                     | Axial: 40 N; radial: 60 N at shaft end (see also “Mechanical design types and mounting”) |                                                                                             |                                         |                                                                                               |
| Vibration: 55 Hz to 2000 Hz<br>Shock: 6 ms     | ≤ 300 m/s <sup>2</sup> (EN 60068-2-6)<br>≤ 2000 m/s <sup>2</sup> (EN 60068-2-27)         |                                                                                             |                                         |                                                                                               |
| Max. operating temp. <sup>4)</sup>             | 100 °C                                                                                   |                                                                                             |                                         |                                                                                               |
| Min. operating temp.                           | −30 °C                                                                                   |                                                                                             |                                         |                                                                                               |
| Protection EN 60529                            | IP67 at housing; IP64 at shaft inlet                                                     |                                                                                             |                                         |                                                                                               |
| Mass                                           | ≈ 0.35 kg                                                                                |                                                                                             |                                         |                                                                                               |
| Valid for ID                                   | 1081305-xx                                                                               | 1036789-xx <sup>5)</sup>                                                                    | 1081303-xx                              | 1036786-xx <sup>5)</sup>                                                                      |

<sup>1)</sup> Optimized for Fanuc machine tool controls

<sup>2)</sup> Calculation time TIME\_MAX\_ACTVAL

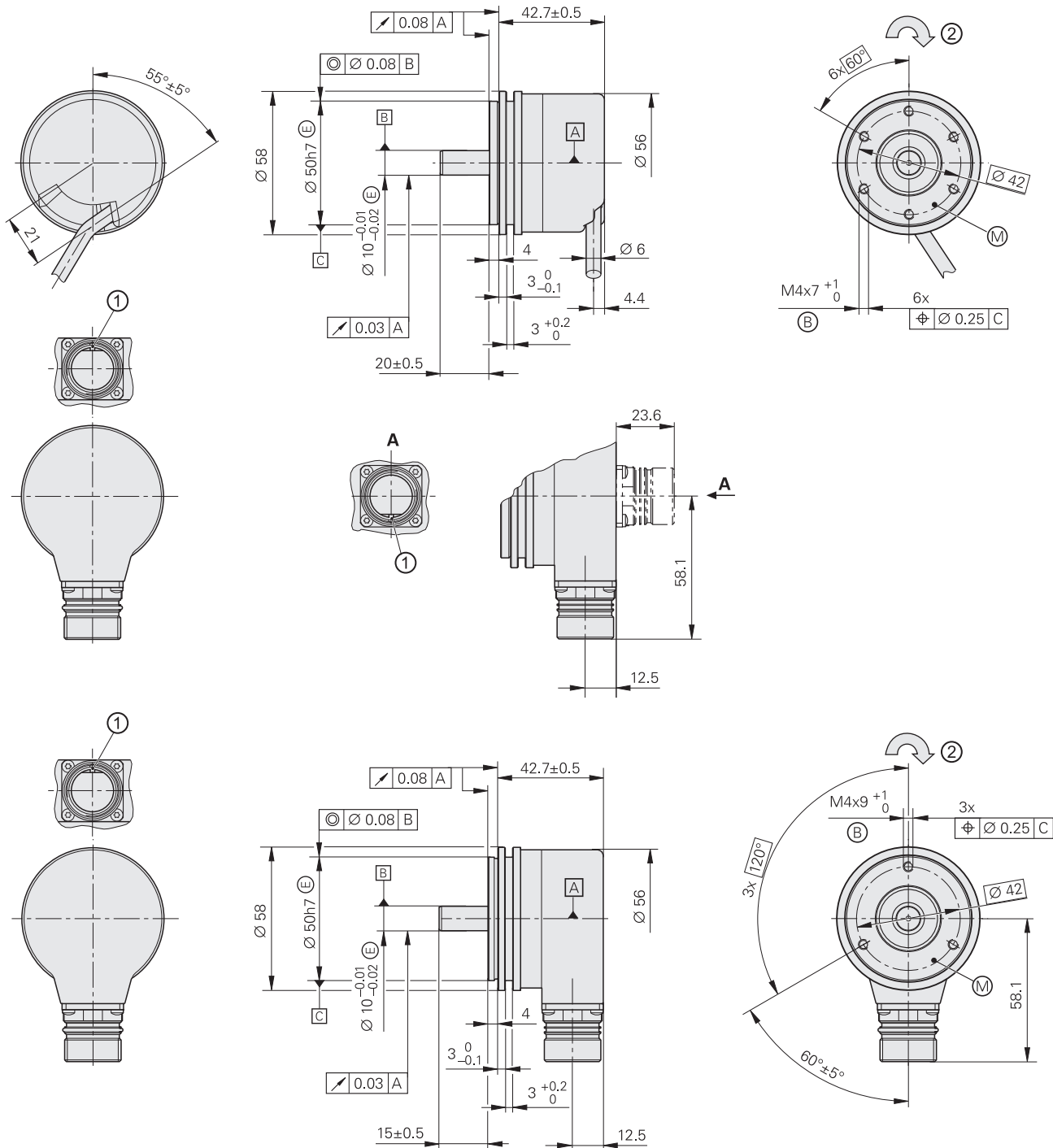
<sup>3)</sup> See the *Interfaces of HEIDENHAIN Encoders* brochure; with  $n_{EN} = 1$  (including adapter cable)

<sup>4)</sup> For the relationship of operating temperature to shaft speed and supply voltage, see "General mechanical information"

<sup>5)</sup> Also available with functional safety; for dimensions and specifications, see Product Information document

# 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 2768:1989-mH  
 ≤ 6 mm: ±0.2 mm

Radial cable (can also be used axially)  
 ▣ = Bearing  
 ⊕ = Fastening thread  
 ⊙ = Measuring point for operating temperature  
 1 = Connector coding  
 2 = Direction of shaft rotation for ascending position values

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

|                                                          | <b>Absolute</b>                                                                                                                                        |                                      |
|----------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------|
|                                                          | <b>Singletum</b>                                                                                                                                       |                                      |
|                                                          | <b>ROC 425, steel</b>                                                                                                                                  | <b>ROC 425, stainless steel</b>      |
| <b>Interface</b>                                         | EnDat 2.2                                                                                                                                              |                                      |
| Ordering designation                                     | EnDat01                                                                                                                                                |                                      |
| Positions/revolution                                     | 33554432 (25 bits)                                                                                                                                     |                                      |
| Revolutions                                              | –                                                                                                                                                      |                                      |
| Code                                                     | Pure binary                                                                                                                                            |                                      |
| Elec. permissible speed<br>Deviations <sup>1)</sup>      | ≤ 1500/15000 rpm<br>±1200 LSB/±9200 LSB                                                                                                                |                                      |
| Calculation time $t_{cal}$<br>Clock frequency            | ≤ 9 μs<br>≤ 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>M23 flange socket</b>, axial, or radial</li> <li>• Cable (1 m/5 m) with or without M23 coupling</li> </ul> | M23 flange socket, radial            |
| Supply voltage                                           | DC 3.6 V to 14 V                                                                                                                                       |                                      |
| Power consumption<br>(maximum)                           | 3.6 V: ≤ 0.6 W<br>14 V: ≤ 0.7 W                                                                                                                        |                                      |
| Current consumption<br>(typical, without load)           | 5 V: 80 mA                                                                                                                                             |                                      |
| <b>Shaft</b>                                             | Solid shaft Ø 10 mm,<br>length 20 mm                                                                                                                   | Solid shaft Ø 10 mm,<br>length 15 mm |
| Mech. permiss. speed                                     | ≤ 12000 rpm                                                                                                                                            |                                      |
| Starting torque (typical)                                | 0.025 Nm (at 20 °C)                                                                                                                                    | 0.025 Nm (at 20 °C)                  |
| Moment of inertia of rotor                               | ≤ 2.1 · 10 <sup>–6</sup> kgm <sup>2</sup>                                                                                                              |                                      |
| Shaft load                                               | Axial: ≤ 40 N; radial: ≤ 60 N at shaft end (see also “Mechanical design types and mounting”)                                                           |                                      |
| <b>Vibration:</b> 55 Hz to 2000 Hz<br><b>Shock:</b> 6 ms | ≤ 300 m/s <sup>2</sup> (EN 60068-2-6)<br>≤ 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>                              | Flange socket or fixed cable: –40 °C; moving cable: –10 °C                                                                                             |                                      |
| <b>Protection</b> EN 60529                               | IP67 at housing; IP66 at shaft inlet                                                                                                                   |                                      |
| <b>Mass</b>                                              | ≈ 0.50 kg                                                                                                                                              | ≈ 0.55 kg                            |
| <b>Valid for ID</b>                                      | 1350876-xx                                                                                                                                             |                                      |

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

\* Please select when ordering

<sup>1)</sup> Speed-dependent deviations between absolute value and incremental signal

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

<sup>3)</sup> For the relationship of operating temperature to shaft speed and supply voltage, see “General mechanical information”



- Clamping flange
- Solid shaft for separate shaft coupling



3 = Incremental rotary encoders: direction of shaft rotation for output signals as per interface description  
Absolute rotary encoders: direction of shaft rotation for ascending position values

|                                            | Incremental                                                                                                                                                       |      |      |      |      |                                                                                       |      |      |      |      |                                                                                                                     |
|--------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|------|------|------|---------------------------------------------------------------------------------------|------|------|------|------|---------------------------------------------------------------------------------------------------------------------|
|                                            | ROD 420                                                                                                                                                           |      |      |      |      | ROD 430                                                                               |      |      |      |      | ROD 480                                                                                                             |
| Interface                                  |  TTL                                                                             |      |      |      |      |  HTL |      |      |      |      |  1 V <sub>PP</sub> <sup>1)</sup> |
| Line counts*                               | 50                                                                                                                                                                | 100  | 250  | 360  | 500  | 512                                                                                   | 720  |      |      |      | –                                                                                                                   |
|                                            | 1000                                                                                                                                                              | 1024 | 1250 | 1500 | 2000 | 2048                                                                                  | 2500 | 3600 | 4096 | 5000 |                                                                                                                     |
| Reference mark                             | One                                                                                                                                                               |      |      |      |      |                                                                                       |      |      |      |      |                                                                                                                     |
| Cutoff frequency –3 dB                     | –                                                                                                                                                                 |      |      |      |      |                                                                                       |      |      |      |      | ≥ 180 kHz                                                                                                           |
| Output frequency                           | ≤ 300 kHz                                                                                                                                                         |      |      |      |      |                                                                                       |      |      |      |      | –                                                                                                                   |
| Edge separation <i>a</i>                   | ≥ 0.39 μs                                                                                                                                                         |      |      |      |      |                                                                                       |      |      |      |      | –                                                                                                                   |
| System accuracy                            | 1/20 of grating period                                                                                                                                            |      |      |      |      |                                                                                       |      |      |      |      |                                                                                                                     |
| Electrical connection*                     | <ul style="list-style-type: none"><li>• <b>M23 flange socket</b>, radial and axial</li><li>• <b>Cable (1 m/5 m)</b> with or <b>without M23 coupling</b></li></ul> |      |      |      |      |                                                                                       |      |      |      |      |                                                                                                                     |
| Supply voltage                             | DC 5 V ±0.5 V                                                                                                                                                     |      |      |      |      | DC 10 V to 30 V                                                                       |      |      |      |      | DC 5 V ±0.5 V                                                                                                       |
| Current consumption without load           | ≤ 120 mA                                                                                                                                                          |      |      |      |      | ≤ 150 mA                                                                              |      |      |      |      | ≤ 120 mA                                                                                                            |
| Shaft                                      | Stub shaft Ø 10 mm                                                                                                                                                |      |      |      |      |                                                                                       |      |      |      |      |                                                                                                                     |
| Mech. permiss. speed                       | ≤ 16000 rpm                                                                                                                                                       |      |      |      |      |                                                                                       |      |      |      |      |                                                                                                                     |
| Starting torque (typical)                  | 0.01 Nm (at 20 °C) (at IP66: 0.025 Nm)                                                                                                                            |      |      |      |      |                                                                                       |      |      |      |      |                                                                                                                     |
| Moment of inertia of rotor                 | ≤ 2.1 · 10 <sup>–6</sup> kgm <sup>2</sup>                                                                                                                         |      |      |      |      |                                                                                       |      |      |      |      |                                                                                                                     |
| Shaft load <sup>2)</sup>                   | Axial: ≤ 40 N; radial: ≤ 60 N at shaft end                                                                                                                        |      |      |      |      |                                                                                       |      |      |      |      |                                                                                                                     |
| Vibration: 55 Hz to 2000 Hz<br>Shock: 6 ms | ≤ 300 m/s <sup>2</sup> (EN 60068-2-6)<br>≤ 2000 m/s <sup>2</sup> (EN 60068-2-27)                                                                                  |      |      |      |      |                                                                                       |      |      |      |      |                                                                                                                     |
| Max. operating temp. <sup>3)</sup>         | 100 °C (80 °C for ROD 480 with 4096 or 5000 lines)                                                                                                                |      |      |      |      |                                                                                       |      |      |      |      |                                                                                                                     |
| Min. operating temp.                       | Flange socket or fixed cable: –40 °C<br>For frequent flexing: –10 °C                                                                                              |      |      |      |      |                                                                                       |      |      |      |      |                                                                                                                     |
| Protection EN 60529                        | IP67 at housing; IP64 at shaft inlet (IP66 upon request)                                                                                                          |      |      |      |      |                                                                                       |      |      |      |      |                                                                                                                     |
| Mass                                       | ≈ 0.3 kg                                                                                                                                                          |      |      |      |      |                                                                                       |      |      |      |      |                                                                                                                     |
| Valid for ID                               | 376840-xx                                                                                                                                                         |      |      |      |      | 376834-xx                                                                             |      |      |      |      | 376880-xx <sup>4)</sup>                                                                                             |

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

\* Please select when ordering

<sup>1)</sup> Limited 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 relationship of operating temperature to shaft speed and supply voltage, see "General mechanical information"

<sup>4)</sup> Available with mechanical fault exclusion; for deviating specifications and special mounting information, see the *Fault Exclusion* Customer Information document

|  | Absolute                                                                                                                                                   |                                                                                                                                                     |                      |
|-----------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------|----------------------|
|                                                                                   | Singleturn<br>ROC 425                                                     | ROC 413                                                                                                                                             |                      |
| Interface*                                                                        | EnDat 2.2                                                                                                                                                  | EnDat 2.2                                                                                                                                           | SSI                  |
| Ordering designation                                                              | EnDat22                                                                                                                                                    | EnDat01                                                                                                                                             | SSI39r1              |
| Positions/revolution                                                              | 33554432 (25 bits)                                                                                                                                         | 8192 (13 bits)                                                                                                                                      |                      |
| Revolutions                                                                       | –                                                                                                                                                          |                                                                                                                                                     |                      |
| Code                                                                              | Pure binary                                                                                                                                                |                                                                                                                                                     | Gray                 |
| Elec. permissible speed<br>Deviations <sup>1)</sup>                               | ≤ 15000 rpm<br>for continuous position value                                                                                                               | 512 lines:<br>≤ 5000/12000 rpm<br>±1 LSB/±100 LSB<br>2048 lines:<br>≤ 1500/12000 rpm<br>±1 LSB/±50 LSB                                              | 12000 rpm<br>±12 LSB |
| Calculation time $t_{cal}$<br>Clock frequency                                     | ≤ 7 µs<br>≤ 8 MHz                                                                                                                                          | ≤ 9 µs<br>≤ 2 MHz                                                                                                                                   | ≤ 5 µs<br>–          |
| Incremental signals                                                               | Without                                                                                                                                                    |  1 V <sub>PP</sub> <sup>2)</sup>                                   |                      |
| Line counts*                                                                      | –                                                                                                                                                          | <b>512</b> 2048                                                                                                                                     | 512                  |
| Cutoff frequency –3 dB                                                            | –                                                                                                                                                          | 512 lines: ≥ 130 kHz; 2048 lines: ≥ 400 kHz                                                                                                         |                      |
| System accuracy <sup>1)</sup>                                                     | ±20"                                                                                                                                                       | 512 lines: ±60"; 2048 lines: ±20"                                                                                                                   |                      |
| Electrical connection*                                                            | <ul style="list-style-type: none"><li>• <b>M12 flange socket</b>, radial</li><li>• Cable (1 m) with M12 coupling</li></ul>                                 | <ul style="list-style-type: none"><li>• <b>M23 flange socket</b>, axial, or radial</li><li>• Cable (1 m/5 m) with or without M23 coupling</li></ul> |                      |
| Supply voltage                                                                    | DC 3.6 V to 14 V                                                                                                                                           | DC 3.6 V to 14 V                                                                                                                                    | DC 4.75 V to 30 V    |
| Power consumption<br>(maximum)                                                    | 3.6 V: ≤ 0.6 W<br>14 V: ≤ 0.7 W                                                                                                                            | 4.75 V: ≤ 0.6 W<br>30 V: ≤ 0.78 W                                                                                                                   |                      |
| Current consumption<br>(typical, without load)                                    | 5 V: 80 mA                                                                                                                                                 | 5 V: 70 mA<br>24 V: 20 mA                                                                                                                           |                      |
| Shaft                                                                             | Stub shaft Ø 10 mm                                                                                                                                         |                                                                                                                                                     |                      |
| Mech. permiss. speed                                                              | ≤ 15000 rpm                                                                                                                                                |                                                                                                                                                     |                      |
| Starting torque (typical)                                                         | 0.01 Nm (at 20 °C) (at IP66: 0.025 Nm)                                                                                                                     |                                                                                                                                                     |                      |
| 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 "Mechanical design types and mounting")                                                               |                                                                                                                                                     |                      |
| Vibration: 55 Hz to 2000 Hz<br>Shock: 6 ms                                        | ≤ 300 m/s <sup>2</sup> ; (EN 60068-2-6); higher values upon request<br>ROC/ROQ: ≤ 2000 m/s <sup>2</sup> ; RIC/RIQ: ≤ 1000 m/s <sup>2</sup> (EN 60068-2-27) |                                                                                                                                                     |                      |
| Max. operating temp. <sup>3)</sup>                                                | 100 °C                                                                                                                                                     |                                                                                                                                                     |                      |
| Min. operating temp.                                                              | Flange socket or fixed cable: –40 °C; moving cable: –10 °C                                                                                                 |                                                                                                                                                     |                      |
| Protection EN 60529                                                               | IP67 at housing; IP64 at shaft inlet (IP66 upon request)                                                                                                   |                                                                                                                                                     |                      |
| Mass                                                                              | ≈ 0.35 kg                                                                                                                                                  |                                                                                                                                                     |                      |
| Valid for ID                                                                      | 1322269-xx <sup>4)</sup>                                                                                                                                   | 1109255-xx                                                                                                                                          | 1353114-xx           |

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

\* Please select when ordering

<sup>1)</sup> Speed-dependent deviations between absolute value and incremental signal

| Multiturn<br>ROQ 437                                           |  |                                                                                                        |  | Functional Safety                  |  | ROQ 425 |  |
|----------------------------------------------------------------|--|--------------------------------------------------------------------------------------------------------|--|------------------------------------|--|---------|--|
| EnDat 2.2                                                      |  | EnDat 2.2                                                                                              |  | SSI                                |  |         |  |
| EnDat22                                                        |  | EnDat01                                                                                                |  | SSI41r1                            |  |         |  |
| 33554432 (25 bits)                                             |  | 8192 (13 bits)                                                                                         |  |                                    |  |         |  |
| 4096                                                           |  |                                                                                                        |  |                                    |  |         |  |
| Pure binary                                                    |  |                                                                                                        |  | Gray                               |  |         |  |
| ≤ 15000 rpm<br>for continuous position value                   |  | 512 lines:<br>≤ 5000/10000 rpm<br>±1 LSB/±100 LSB<br>2048 lines:<br>≤ 1500/10000 rpm<br>±1 LSB/±50 LSB |  | 12000 rpm<br>±12 LSB               |  |         |  |
| ≤ 7 μs<br>≤ 8 MHz                                              |  | ≤ 9 μs<br>≤ 2 MHz                                                                                      |  | ≤ 5 μs<br>–                        |  |         |  |
| Without                                                        |  | ~ 1 Vpp <sup>2)</sup>                                                                                  |  |                                    |  |         |  |
| –                                                              |  | 512 2048                                                                                               |  | 512                                |  |         |  |
| –                                                              |  | 512 lines: ≥ 130 kHz; 2048 lines: ≥ 400 kHz                                                            |  |                                    |  |         |  |
| ±20"                                                           |  | 512 lines: ±60"; 2048 lines: ±20"                                                                      |  |                                    |  |         |  |
| • M12 flange socket, radial<br>• Cable (1 m) with M12 coupling |  | • M23 flange socket, axial, or radial<br>• Cable (1 m/5 m) with or without M23 coupling                |  |                                    |  |         |  |
| 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<br>14 V: ≤ 0.8 W                                |  |                                                                                                        |  | 4.75 V: ≤ 0.68 W<br>30 V: ≤ 0.88 W |  |         |  |
| 5 V: 95 mA                                                     |  |                                                                                                        |  | 5 V: 85 mA<br>24 V: 20 mA          |  |         |  |
|                                                                |  |                                                                                                        |  |                                    |  |         |  |
|                                                                |  |                                                                                                        |  |                                    |  |         |  |
|                                                                |  |                                                                                                        |  |                                    |  |         |  |
|                                                                |  |                                                                                                        |  |                                    |  |         |  |
|                                                                |  |                                                                                                        |  |                                    |  |         |  |
|                                                                |  |                                                                                                        |  |                                    |  |         |  |
|                                                                |  |                                                                                                        |  |                                    |  |         |  |
|                                                                |  |                                                                                                        |  |                                    |  |         |  |
|                                                                |  |                                                                                                        |  |                                    |  |         |  |
|                                                                |  |                                                                                                        |  |                                    |  |         |  |
| 1322274-xx <sup>4)</sup>                                       |  | 1109257-xx                                                                                             |  | 1353118-xx                         |  |         |  |

<sup>2)</sup> Limited tolerances: signal amplitude: 0.8 V<sub>PP</sub> to 1.2 V<sub>PP</sub>  
<sup>3)</sup> For the relationship of operating temperature to shaft speed and supply voltage, see “General mechanical information”  
<sup>4)</sup> Also available with functional safety; for dimensions and specifications, see Product Information document

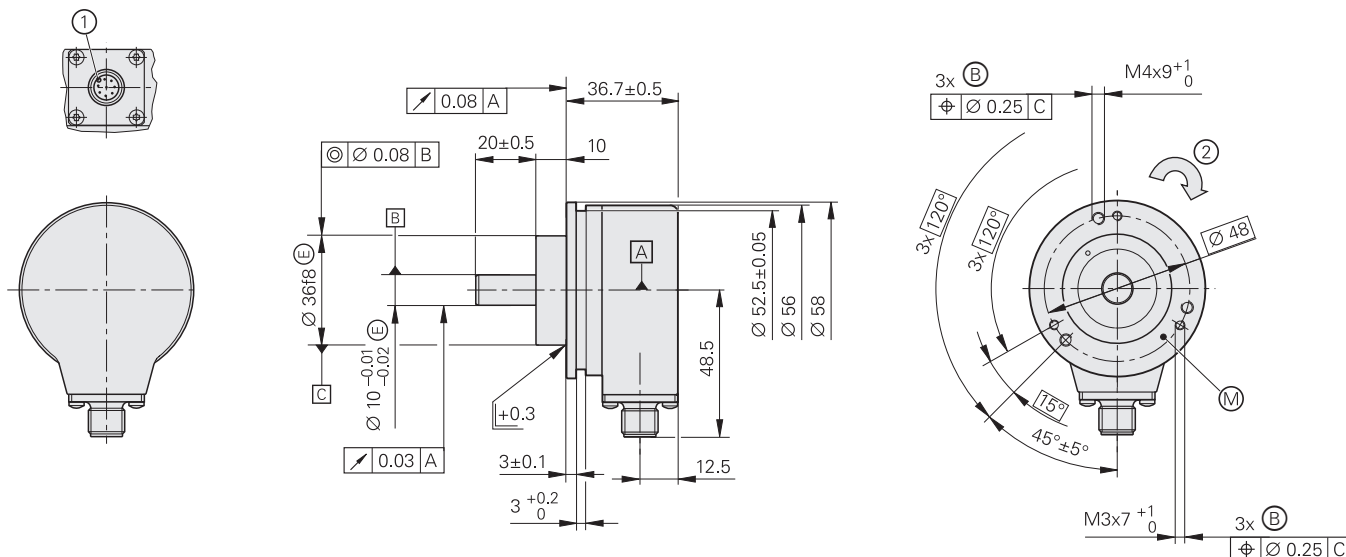
# ROC/ROQ 400F/S series

## Absolute rotary encoders

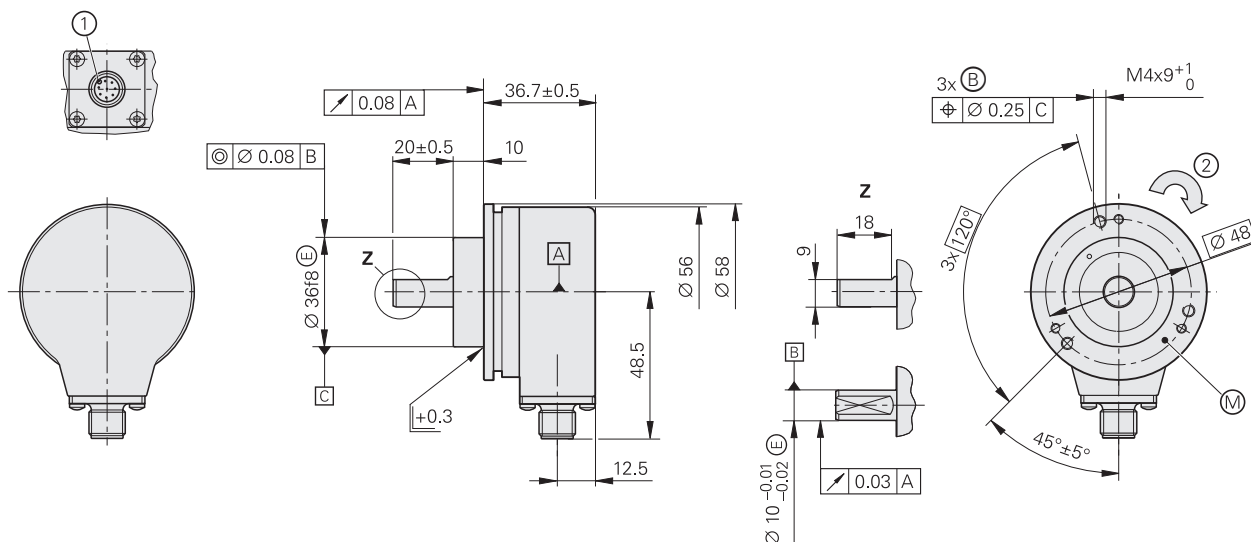
- Clamping flange with additional slot for fastening with fixing clamps
- Solid shaft for separate shaft coupling
- Fanuc Serial Interface or Siemens DRIVE-CLiQ interface



### ROC/ROQ 400F



### ROC/ROQ 400S



mm



Tolerancing ISO 8015  
ISO 2768:1989-mH  
≤ 6 mm: ±0.2 mm

▢ = Bearing

⊕ = Fastening thread

⊗ = Measuring point for operating temperature

1 = Connector coding

2 = Direction of shaft rotation for ascending position values

DRIVE-CLiQ is a registered trademark of Siemens AG

|                                                | Absolute                                                                                 |                                                                                             |                                         |                                                                                               |
|------------------------------------------------|------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------|-----------------------------------------|-----------------------------------------------------------------------------------------------|
|                                                | Singleturn                                                                               |                                                                                             | Multiturn                               |                                                                                               |
|                                                | ROC 425 F                                                                                | ROC 424 S  | ROQ 437 F                               | ROQ 436 S  |
| Interface                                      | Fanuc Serial Interface;<br>αi Interface                                                  | DRIVE-CLiQ                                                                                  | Fanuc Serial Interface;<br>αi Interface | DRIVE-CLiQ                                                                                    |
| Ordering designation                           | Fanuc05 <sup>1)</sup>                                                                    | DQ01                                                                                        | Fanuc06 <sup>1)</sup>                   | DQ01                                                                                          |
| Positions/revolution                           | αi: 33554432<br>(25 bits)<br>α: 8388608<br>(23 bit)                                      | 16777216<br>(24 bits)                                                                       | 33554432<br>(25 bits)                   | 16777216                                                                                      |
| Revolutions                                    | 8192 via revolution<br>counter                                                           | –                                                                                           | αi: 4096                                | 4096                                                                                          |
| Code                                           | Pure binary                                                                              |                                                                                             |                                         |                                                                                               |
| Elec. permissible speed                        | ≤ 15000 rpm for continuous position values                                               |                                                                                             |                                         |                                                                                               |
| Calculation time $t_{cal}$                     | ≤ 5 μs                                                                                   | ≤ 8 μs <sup>2)</sup>                                                                        | ≤ 5 μs                                  | ≤ 8 μs <sup>2)</sup>                                                                          |
| System accuracy                                | ±20"                                                                                     |                                                                                             |                                         |                                                                                               |
| Electrical connection                          | M12 flange socket, radial                                                                |                                                                                             |                                         |                                                                                               |
| Cable length                                   | ≤ 30 m                                                                                   | ≤ 95 m <sup>3)</sup>                                                                        | ≤ 30 m                                  | ≤ 95 m <sup>3)</sup>                                                                          |
| Supply voltage                                 | DC 3.6 V to 14 V                                                                         | DC 10 V to 36 V                                                                             | DC 3.6 V to 14 V                        | DC 10 V to 36 V                                                                               |
| Power consumption<br>(maximum)                 | 5 V: ≤ 0.7 W<br>14 V: ≤ 0.8 W                                                            | 10 V: ≤ 1.4 W<br>36 V: ≤ 1.5 W                                                              | 5 V: ≤ 0.75 W<br>14 V: ≤ 0.85 W         | 10 V: ≤ 1.4 W<br>36 V: ≤ 1.5 W                                                                |
| Current consumption<br>(typical, without load) | 5 V: 90 mA                                                                               | 24 V: 37 mA                                                                                 | 5 V: 100 mA                             | 24 V: 43 mA                                                                                   |
| Shaft                                          | Solid shaft (Ø 10 mm) for ROC 424 S and ROQ 436 S with flat                              |                                                                                             |                                         |                                                                                               |
| Mech. permiss. speed <sup>4)</sup>             | ≤ 15000 rpm                                                                              |                                                                                             | ≤ 12000 rpm                             |                                                                                               |
| Starting torque (typical)                      | 0.01 Nm (at 20 °C)                                                                       |                                                                                             |                                         |                                                                                               |
| Moment of inertia of rotor                     | ≤ 2.9 · 10 <sup>-6</sup> kgm <sup>2</sup>                                                |                                                                                             |                                         |                                                                                               |
| Shaft load                                     | Axial: 40 N; radial: 60 N at shaft end (see also "Mechanical design types and mounting") |                                                                                             |                                         |                                                                                               |
| Vibration: 55 Hz to 2000 Hz<br>Shock: 6 ms     | ≤ 300 m/s <sup>2</sup> (EN 60068-2-6)<br>≤ 2000 m/s <sup>2</sup> (EN 60068-2-27)         |                                                                                             |                                         |                                                                                               |
| Max. operating temp. <sup>4)</sup>             | 100 °C                                                                                   |                                                                                             |                                         |                                                                                               |
| Min. operating temp.                           | –30 °C                                                                                   |                                                                                             |                                         |                                                                                               |
| Protection EN 60529                            | IP67 at housing; IP64 at shaft inlet                                                     |                                                                                             |                                         |                                                                                               |
| Mass                                           | ≈ 0.35 kg                                                                                |                                                                                             |                                         |                                                                                               |
| Valid for ID                                   | 1081306-xx                                                                               | 1036790-xx <sup>5)</sup>                                                                    | 1081304-xx                              | 1036792-xx <sup>5)</sup>                                                                      |

<sup>1)</sup> Optimized for Fanuc machine tools

<sup>2)</sup> Calculation time TIME\_MAX\_ACTVAL

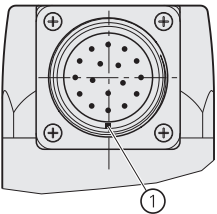
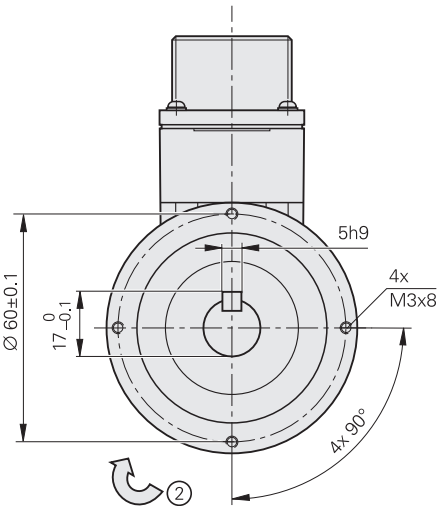
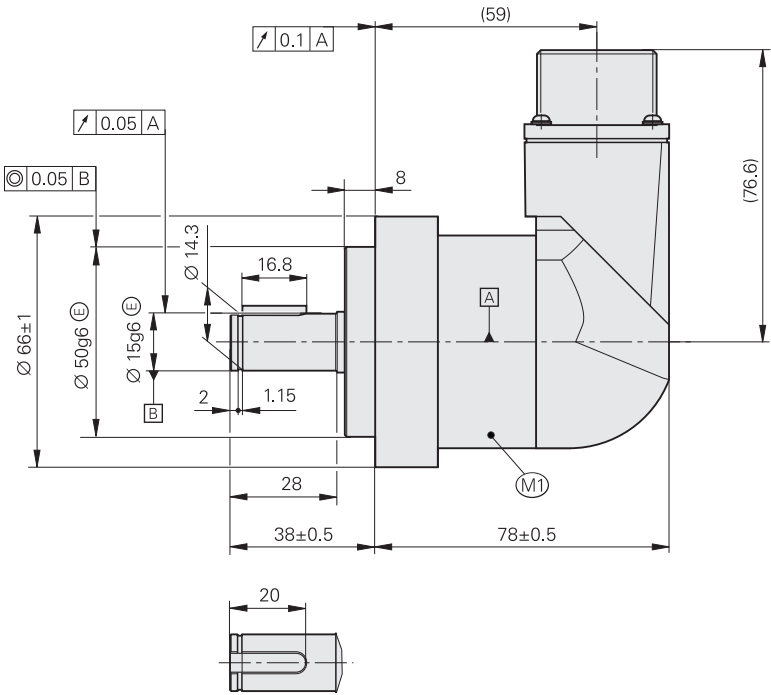
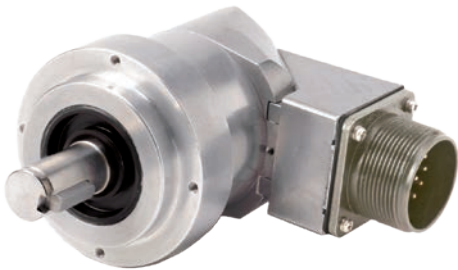
<sup>3)</sup> See the *Interfaces of HEIDENHAIN Encoders* brochure; with  $n_{EN} = 1$  (including adapter cable)

<sup>4)</sup> For the relationship of operating temperature to shaft speed and supply voltage, see "General mechanical information"

<sup>5)</sup> Also available with functional safety; for dimensions and specifications, see Product Information document

# ROD 600 series

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



mm  
Tolerancing ISO 8015  
ISO 2768:1989-mH  
≤ 6 mm: ±0.2 mm

- ▣ = Encoder bearing
- M1 = Measuring point for operating temperature
- 1 = Connector coding
- 2 = Direction of shaft rotation for output signals according to 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<br>Edge separation <i>a</i>           | $\leq 300 \text{ kHz}$<br>$\geq 0.39 \text{ }\mu\text{s}$                             |                                                                                        |
| <b>System accuracy</b>                                   | $\pm 1/20$ of grating period                                                          |                                                                                        |
| <b>Electrical connection</b>                             | Flange socket 1 1/4"; 18UNEF 17-pin, radial <sup>1)</sup>                             |                                                                                        |
| Supply voltage<br>Current consumption<br>without load    | DC 5 V $\pm 0.5 \text{ V}$<br>$\leq 120 \text{ mA}$                                   | DC 10 V to 30 V<br>$\leq 150 \text{ mA}$                                               |
| <b>Shaft</b>                                             | Solid shaft $\varnothing 15 \text{ mm}$ with key                                      |                                                                                        |
| Mech. permiss. speed                                     | $\leq 12000 \text{ rpm}$                                                              |                                                                                        |
| Starting torque (typical)                                | 0.05 Nm (at 20 °C)                                                                    |                                                                                        |
| Moment of inertia of rotor                               | $\leq 11 \cdot 10^{-6} \text{ kgm}^2$                                                 |                                                                                        |
| Shaft load                                               | Axial: 75 N<br>Radial: 75 N at shaft end                                              |                                                                                        |
| <b>Vibration:</b> 55 Hz to 2000 Hz<br><b>Shock:</b> 6 ms | $\leq 200 \text{ m/s}^2$ (EN 60068-2-6)<br>$\leq 2000 \text{ m/s}^2$ (EN 60068-2-27)  |                                                                                        |
| <b>Max. operating temp.</b>                              | 85 °C                                                                                 |                                                                                        |
| <b>Min. operating temp.</b>                              | -20 °C                                                                                |                                                                                        |
| <b>Relative humidity</b>                                 | $\leq 93 \%$ (40 °C/4 d as per EN 60068-2-78); without condensation                   |                                                                                        |
| <b>Protection</b> EN 60529                               | IP66                                                                                  |                                                                                        |
| <b>Mass</b>                                              | $\approx 0.8 \text{ kg}$                                                              |                                                                                        |
| <b>Valid for ID</b>                                      | 1145260-xx                                                                            | 1145261-xx                                                                             |

\* Please select when ordering

<sup>1)</sup> Compatible mating connector: ID 1094831-01, cable only: ID 816317-xx

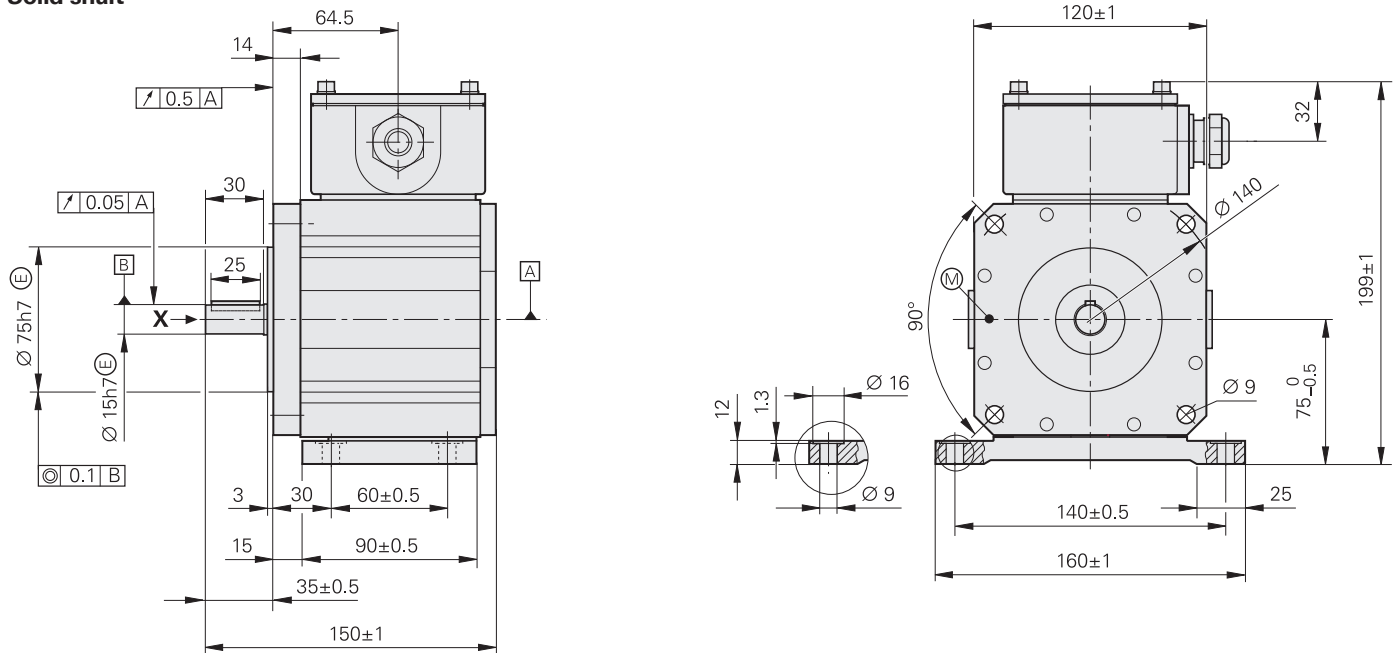
# ROD 1930

## Incremental rotary encoders

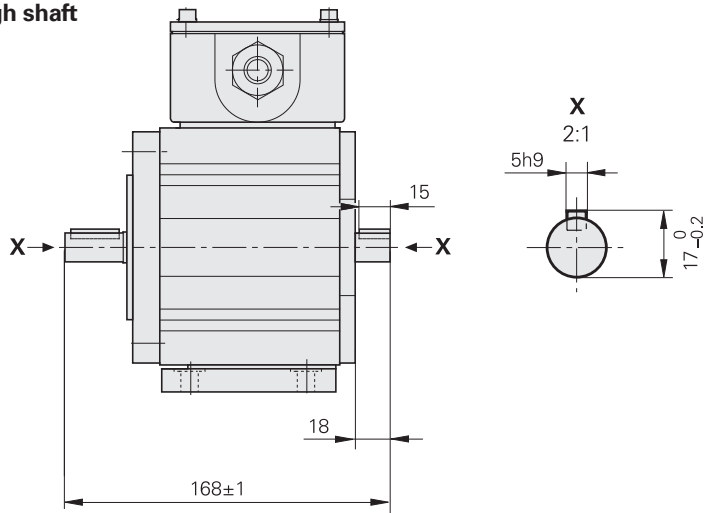
- For fastening with flange or base
- Solid shaft with key for separate shaft coupling



### Solid shaft



### Solid through shaft



Tolerancing ISO 8015  
ISO 2768:1989-mH  
≤ 6 mm: ±0.2 mm

▣ = Bearing

⊙ = Measuring point for operating temperature

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

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

\* Please select when ordering

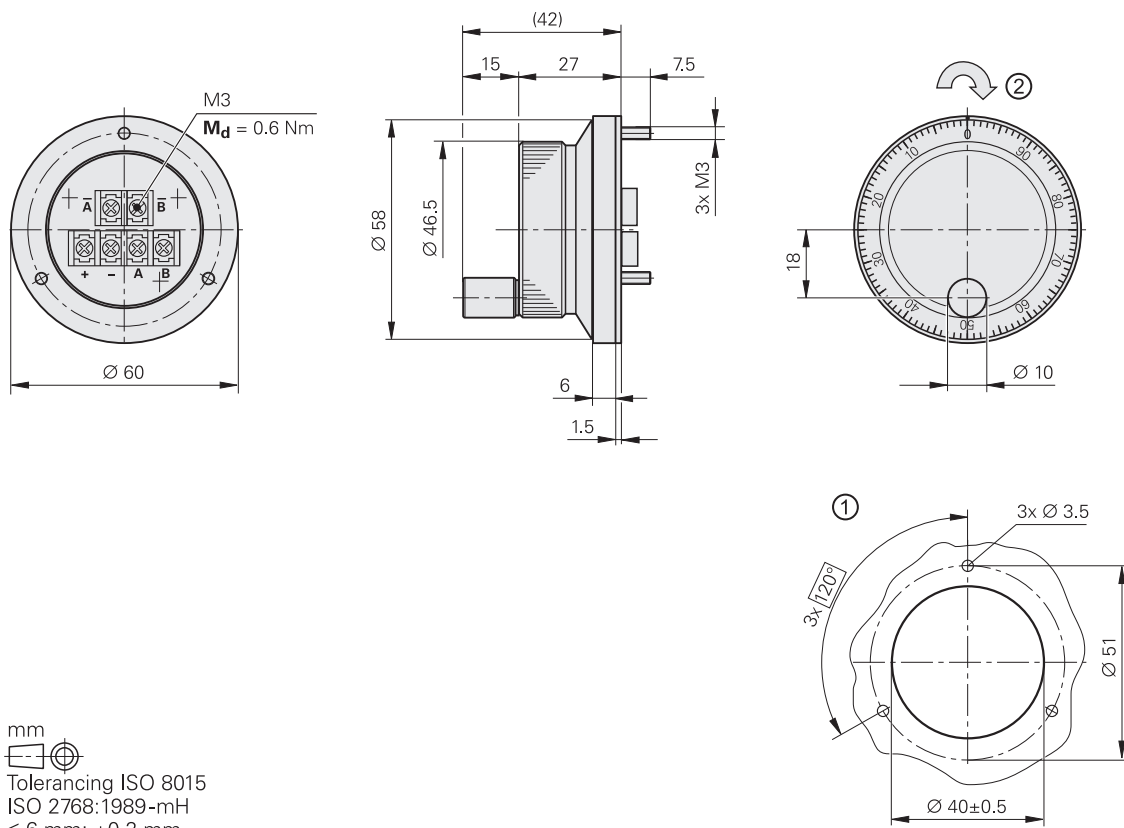
<sup>1)</sup> See also “Mechanical design types and mounting”

<sup>2)</sup> Special versions upon request (e.g., with water jacket)

# HR 1120

## Electronic handwheel

- Version for integration
- With mechanical detent



1 = Cutout for mounting  
2 = Direction of shaft rotation for output signals as per interface description

|                                   | Incremental<br>HR 1120                                                                                                      |
|-----------------------------------|-----------------------------------------------------------------------------------------------------------------------------|
| <b>Interface</b>                  |  TTL                                       |
| Line count                        | 100                                                                                                                         |
| Output frequency                  | $\leq 5 \text{ kHz}$                                                                                                        |
| Switching times                   | $t_r/t_f \leq 100 \text{ ns}$                                                                                               |
| <b>Electrical connection</b>      | Via M3 screw terminals                                                                                                      |
| Cable length                      | $\leq 30 \text{ m}$                                                                                                         |
| Supply voltage                    | DC 5 V $\pm 0.25 \text{ V}$                                                                                                 |
| Current consumption without load  | $\leq 160 \text{ mA}$                                                                                                       |
| <b>Detent</b>                     | Mechanical<br>100 detent positions per revolution<br>Detent positions defined within the LOW level of $U_{a1}$ and $U_{a2}$ |
| <b>Mech. permissible speed</b>    | $\leq 200 \text{ rpm}$                                                                                                      |
| <b>Torque</b>                     | $\leq 0.1 \text{ Nm}$ (at 25 °C)                                                                                            |
| <b>Vibration:</b> 10 Hz to 200 Hz | $\leq 20 \text{ m/s}^2$                                                                                                     |
| <b>Max. operating temp.</b>       | 60 °C                                                                                                                       |
| <b>Min. operating temp.</b>       | 0 °C                                                                                                                        |
| <b>Protection</b> EN 60529        | IP00; IP40 when mounted<br>No condensation permitted                                                                        |
| <b>Mass</b>                       | $\approx 0.15 \text{ kg}$                                                                                                   |
| <b>Valid for ID</b>               | 687617-xx                                                                                                                   |

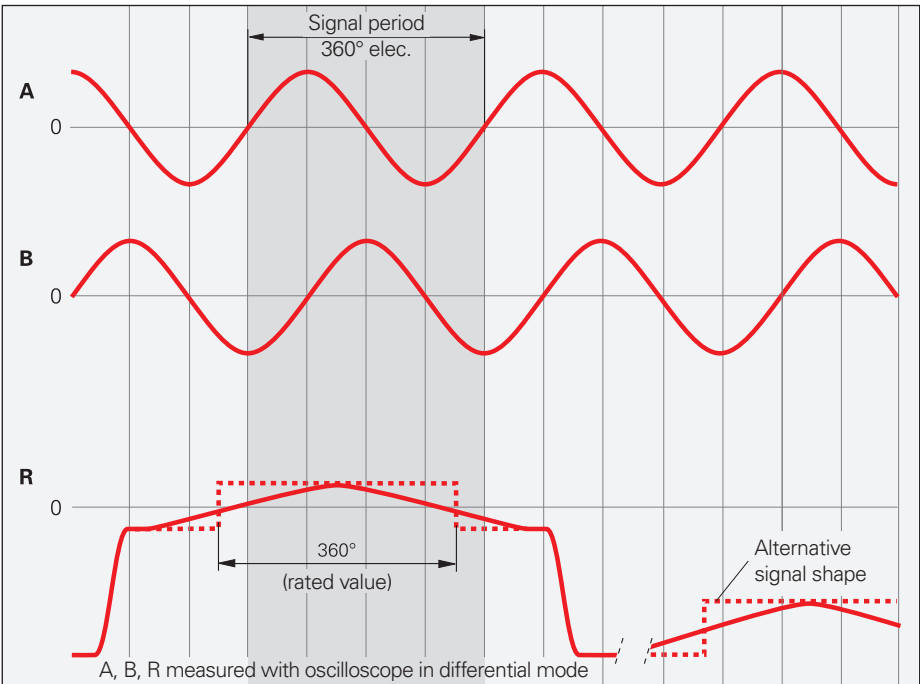
# Interfaces

## ~ 1 V<sub>PP</sub> incremental signals

HEIDENHAIN encoders with the ~ 1 V<sub>PP</sub> interface provide voltage signals that are highly interpolatable.

The sinusoidal **incremental signals** A and B are phase-shifted by 90° elec. and have a typical amplitude of 1 V<sub>PP</sub>. The illustrated sequence of output signals, with B lagging A, applies to the direction of motion shown in the dimension drawing.

The **reference mark signal** R has a unique assignment to the incremental signals. The output signal may be lower next to the reference mark.

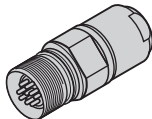
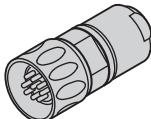
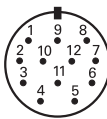
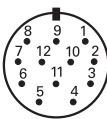


### Further information:

For detailed descriptions of all available interfaces, as well as general electrical information, please refer to the *Interfaces of HEIDENHAIN Encoders* brochure.

To adapt encoders to the interface of the downstream electronics, HEIDENHAIN offers signal converters. For information about this, please refer to the *Signal Converters Product Overview*.

## Pin layout

| 12-pin M23 coupling                                                                                                                                                        |                 |                                        |                 |                            | 12-pin M23 connector                                                                  |       |      |      |     |       |               |        |        |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|----------------------------------------|-----------------|----------------------------|---------------------------------------------------------------------------------------|-------|------|------|-----|-------|---------------|--------|--------|
|                                                                                         |                 |                                        |                 |                            |  |       |      |      |     |       |               |        |        |
|                                                                                         |                 |                                        |                 |                            |  |       |      |      |     |       |               |        |        |
|                                                                                                                                                                            | Supply voltage  |                                        |                 |                            | Incremental signals                                                                   |       |      |      |     |       | Other signals |        |        |
| <br> | 12              | 2                                      | 10              | 11                         | 5                                                                                     | 6     | 8    | 1    | 3   | 4     | 9             | 7      | /      |
|                                                                                                                                                                            | U <sub>P</sub>  | Sensor <sup>1)</sup><br>U <sub>P</sub> | 0V              | Sensor <sup>1)</sup><br>0V | A+                                                                                    | A–    | B+   | B–   | R+  | R–    | Vacant        | Vacant | Vacant |
|                                                                                         | Brown/<br>Green | Blue                                   | White/<br>Green | White                      | Brown                                                                                 | Green | Gray | Pink | Red | Black | /             | Violet | Yellow |

**Cable shield** connected to housing; **U<sub>P</sub>** = Power supply voltage

**Sensor:** The sense line is connected in the encoder with the corresponding power line.

Vacant pins or wires must not be used!

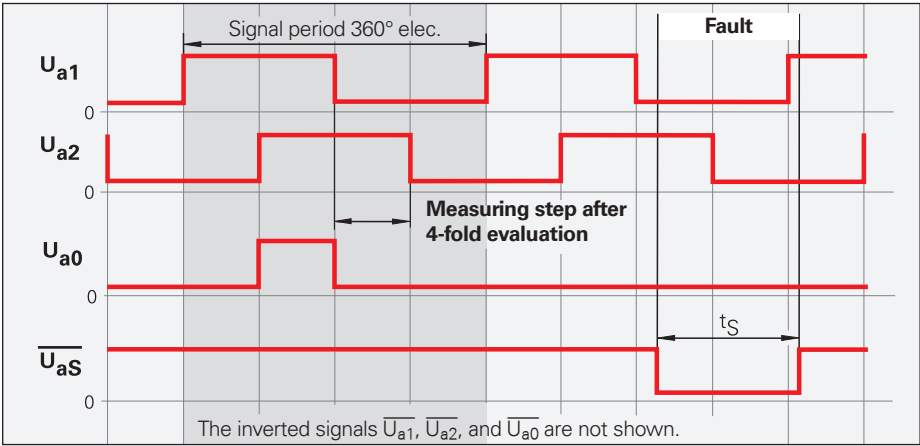
<sup>1)</sup> **LIDA 2xx:** Vacant

TTL incremental signals

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

The **incremental signals** are output as the square-wave pulse trains  $U_{a1}$  and  $U_{a2}$  with a 90° elec. phase shift. 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 generate the **inverted signals**  $\overline{U_{a1}}$ ,  $\overline{U_{a2}}$ , and  $\overline{U_{a0}}$  for noise-immune 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 malfunctions such as supply line breakage, failure of the light source, etc.



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



Further information:

For detailed descriptions of all available interfaces, as well as general electrical information, please refer to the *Interfaces of HEIDENHAIN Encoders* brochure.

ERN and ROD pin layouts

| 12-pin M23 flange socket or coupling |  |  |  |  | 12-pin M23 connector |                     |          |                     |          | 17-pin flange socket<br>1¼" – 18UNEF |                          |                      |
|--------------------------------------|--|--|--|--|----------------------|---------------------|----------|---------------------|----------|--------------------------------------|--------------------------|----------------------|
|                                      |  |  |  |  |                      |                     |          |                     |          |                                      |                          |                      |
| Supply voltage                       |  |  |  |  | Incremental signals  |                     |          |                     |          | Other signals                        |                          |                      |
| M23                                  |  |  |  |  | 5                    | 6                   | 8        | 1                   | 3        | 4                                    | 7                        | 9                    |
| 1¼"                                  |  |  |  |  | A                    | N                   | C        | R                   | B        | P                                    | S                        | D/E/G/J/L/T          |
|                                      |  |  |  |  | $U_{a1}$             | $\overline{U_{a1}}$ | $U_{a2}$ | $\overline{U_{a2}}$ | $U_{a0}$ | $\overline{U_{a0}}$                  | $\overline{U_{aS}}^{1)}$ | Vacant <sup>2)</sup> |
|                                      |  |  |  |  | Brown                | Green               | Gray     | Pink                | Red      | Black                                | Violet                   | Yellow               |

Shield lies on housing;  $U_P$  = Power supply voltage  
Sensor: The sense line is connected in the encoder with the corresponding power line.  
<sup>1)</sup> ERO 14xx: Vacant      <sup>2)</sup> Exposed linear encoders: Switchover: TTL/11 µApp for PWT

HR pin layout

| Screw-terminal connection |              |                     |          |                     |          |                     |
|---------------------------|--------------|---------------------|----------|---------------------|----------|---------------------|
|                           |              |                     |          |                     |          |                     |
| Supply voltage            |              | Incremental signals |          |                     |          |                     |
| Connection                | +            | –                   | A        | A                   | B        | B                   |
| Signal                    | $U_P$<br>5 V | $U_N$<br>0 V        | $U_{a1}$ | $\overline{U_{a1}}$ | $U_{a2}$ | $\overline{U_{a2}}$ |

A shielded cable with a cross section of at least 0.5 mm<sup>2</sup> is recommended when connecting the handwheel to the voltage supply.

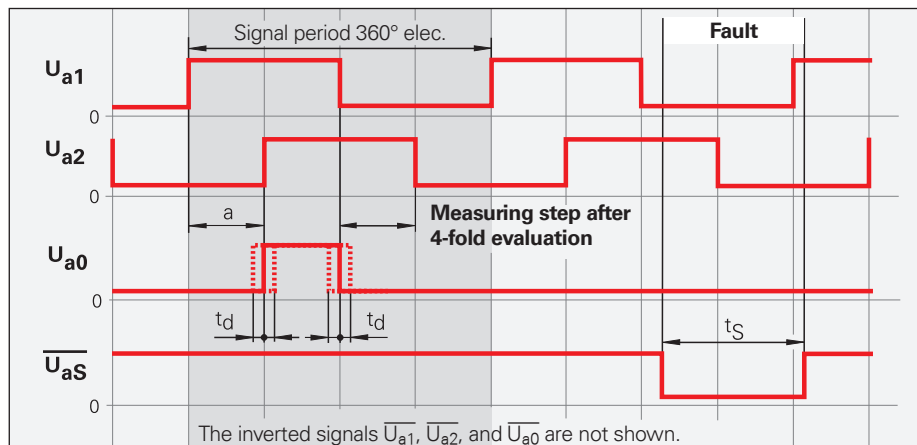
The handwheel is connected via screw terminals. The wires must be provided with the appropriate ferrules.

## □ HTL, HTLs incremental signals

HEIDENHAIN encoders with the □ HTL interface contain electronics that digitize sinusoidal scanning signals with or without interpolation.

The **incremental signals** are output as the square-wave pulse trains  $U_{a1}$  and  $U_{a2}$  with a 90° elec. phase shift. 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 generate the **inverted signals**  $\overline{U_{a1}}$ ,  $\overline{U_{a2}}$ , and  $\overline{U_{a0}}$  for noise-immune 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 a malfunction such as failure of the light source, etc.



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



### Further information:

For detailed descriptions of all available interfaces, as well as general electrical information, please refer to the *Interfaces of HEIDENHAIN Encoders* brochure.

## Power and current consumption

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

For the rotary encoders with additional HTL output signals, the power consumption also depends on the output frequency and cable length. The power consumption values for the HTL and HTLs interfaces therefore be read off separately from the diagrams.

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

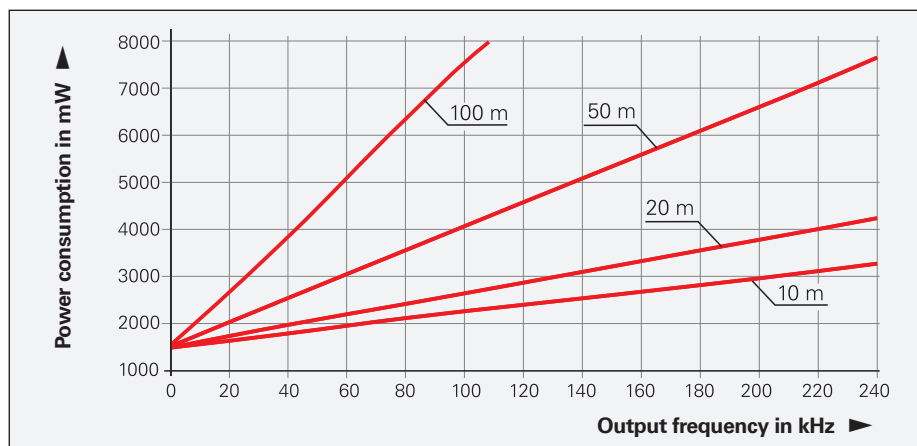
$$f = (n/60) \cdot z \cdot 10^{-3}$$

Where

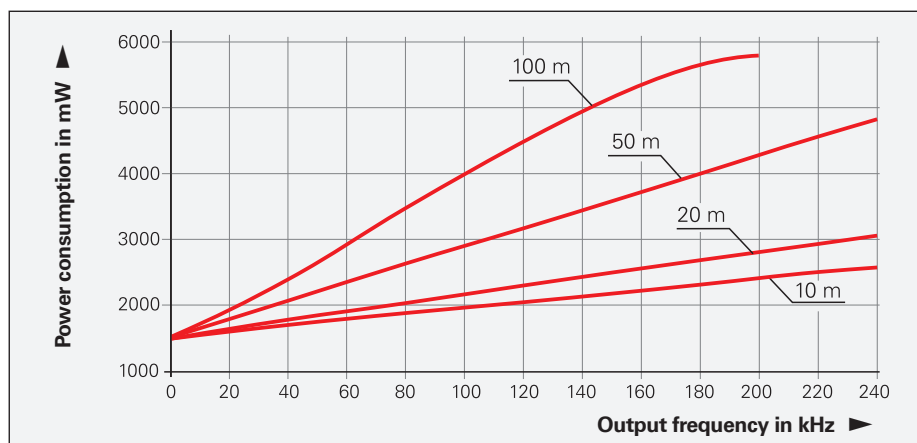
$f$  = Output frequency in kHz

$n$  = Shaft speed in rpm

$z$  = Number of signal periods per 360°



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



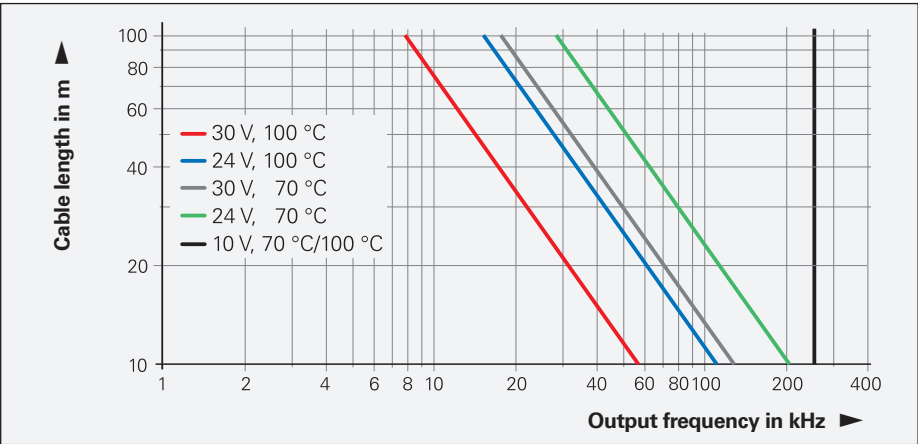
Power consumption (maximum) for the HTLs interface and supply voltage  $U_P = 30\text{ V}$

Cable length for HTL

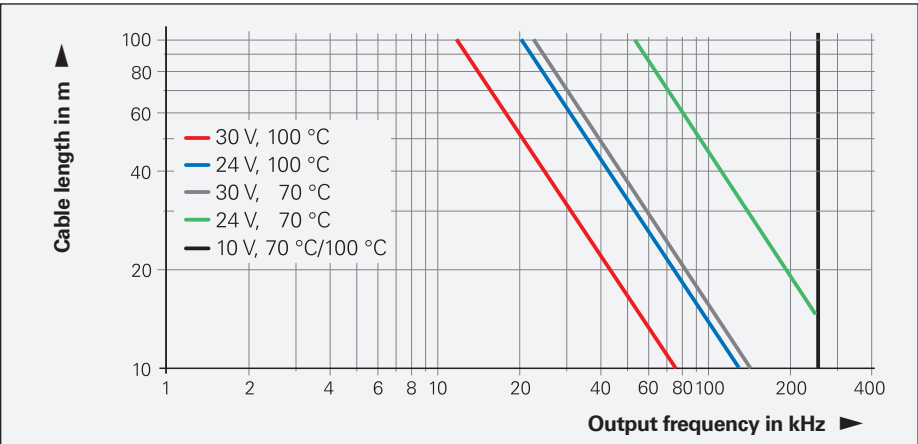
For those rotary encoders with additional HTL output signals, the maximum permissible cable length may vary depending on several criteria:

- Output frequency
- Supply voltage
- Operating temperature

The diagrams show these relationships separately for the HTL and HTLs interfaces. At a supply voltage of DC 10 V, there are no limitations on cable length.

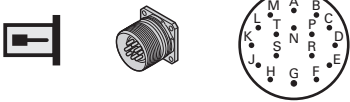


Maximum permissible cable length for the HTL interface



Maximum permissible cable length for the HTLs interface

Pin layout

| 12-pin M23 flange socket or coupling                                                  |                                                                                   |                          |                                                                                   |              | 17-pin flange socket<br>1¼" – 18UNEF                                               |                     |                 |                     |                 |                     |                     |             |
|---------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|--------------------------|-----------------------------------------------------------------------------------|--------------|------------------------------------------------------------------------------------|---------------------|-----------------|---------------------|-----------------|---------------------|---------------------|-------------|
|      |                                                                                   |                          |                                                                                   |              |  |                     |                 |                     |                 |                     |                     |             |
|                                                                                       | Supply voltage                                                                    |                          |                                                                                   |              | Incremental signals                                                                |                     |                 |                     |                 |                     | Other signals       |             |
|  M23 | 12                                                                                | 2                        | 10                                                                                | 11           | 5                                                                                  | 6                   | 8               | 1                   | 3               | 4                   | 7                   | 9           |
|  1¼" | H                                                                                 | F                        | K                                                                                 | M            | A                                                                                  | N                   | C               | R                   | B               | P                   | S                   | D/E/G/J/L/T |
| HTL                                                                                   | U <sub>P</sub>                                                                    | Sensor<br>U <sub>P</sub> | 0V                                                                                | Sensor<br>0V | U <sub>a1</sub>                                                                    | $\overline{U_{a1}}$ | U <sub>a2</sub> | $\overline{U_{a2}}$ | U <sub>a0</sub> | $\overline{U_{a0}}$ | $\overline{U_{aS}}$ | Vacant      |
| HTLs*                                                                                 |  |                          |  |              |                                                                                    | 0V                  |                 | 0V                  |                 | 0V                  |                     |             |
|      | Brown/<br>Green                                                                   | Blue                     | White/<br>Green                                                                   | White        | Brown                                                                              | Green               | Gray            | Pink                | Red             | Black               | Violet              | Yellow      |

**Shield** lies on housing; **U<sub>P</sub>** = Power supply voltage  
**Sensor:** The sense line is connected in the encoder with the corresponding power line.  
\* Only with 12-pin flange socket or M23 coupling

ROD 1930 pin layout

| Screw-terminal connection |                                                                                     |                                                                                     |                                                                                     |                                                                                     |                                                                                     |                                                                                     |
|---------------------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|
|                           | 1                                                                                   | 2                                                                                   | 3                                                                                   | 4                                                                                   | 5                                                                                   | 6                                                                                   |
|                           |  |  |  |  |  |  |
|                           | Supply voltage                                                                      |                                                                                     | Incremental signals                                                                 |                                                                                     |                                                                                     |                                                                                     |
| Connection                | 1                                                                                   | 2                                                                                   | 3                                                                                   | 4                                                                                   | 5                                                                                   | 6                                                                                   |
| HTL                       | U <sub>P</sub>                                                                      | U <sub>N</sub><br>0V                                                                | U <sub>a1</sub>                                                                     | $\overline{U_{a1}}$                                                                 | U <sub>a2</sub>                                                                     | $\overline{U_{a2}}$                                                                 |
| HTLs                      |                                                                                     |                                                                                     |                                                                                     | U <sub>a2</sub>                                                                     | 0V                                                                                  | U <sub>a0</sub>                                                                     |

For connection, a shielded cable with a cross section of at least 0.5 mm<sup>2</sup> is recommended for the power supply. The connection is performed via screw terminals. The wires must be provided with the appropriate ferrules.

# EnDat 2.2 position values

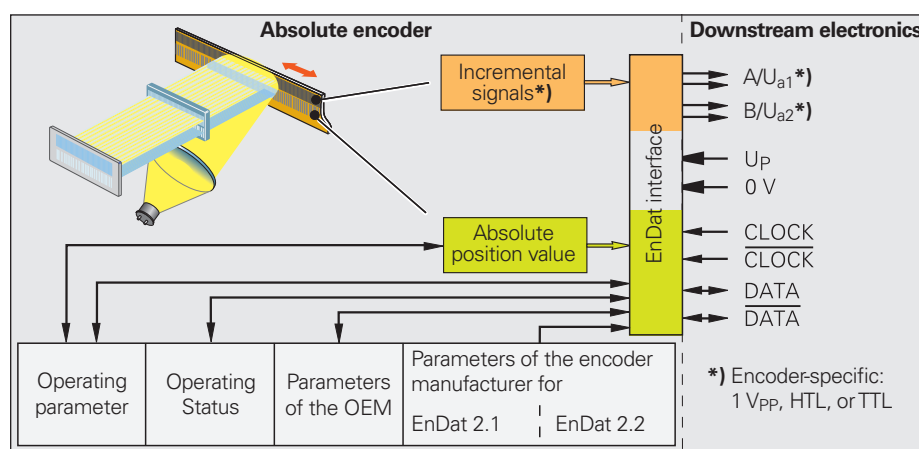
The EnDat interface is a digital, **bidirectional** interface for encoders. It is capable of outputting **position values**, reading information stored in the encoder, updating this information, and storing new information. Because the interface uses **serial transmission**, only **four signal lines** are required. The data (DATA) are transmitted in **synchronism** with the CLOCK signal from the downstream electronics. The type of transmission (position values, parameters, diagnostics, etc.) is selected via mode commands sent to the encoder by the downstream electronics. Some functions are available only in conjunction with EnDat 2.2 mode commands.

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

Versions of the EnDat interface with the EnDat 2.1 and 2.2 command sets

 **Further information:**

For detailed descriptions of all available interfaces, as well as general electrical information, please refer to the *Interfaces of HEIDENHAIN Encoders* brochure.



## Integrated temperature evaluation

Rotary encoders with EnDat 2.2 feature an internal temperature sensor integrated into the encoder electronics. The digitized temperature value is transmitted purely serially via the EnDat protocol. Please bear in mind that this measurement and transmission of the temperature is not safe in terms of functional safety.

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

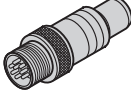
In compliance with the EnDat specification, when the temperature reaches the warning threshold for the temperature exceedance of the internal temperature sensor, an EnDat warning is issued (EnDat memory area "Operating status," word 1 "Warnings," bit 2<sup>1</sup> "Temperature exceeded"). This

warning threshold for the internal temperature sensor is stored in the EnDat memory area "Operating parameters," word 6 "Trigger threshold warning bit for excessive temperature," and can be individually adjusted. A device-specific default value is saved here before shipping. The temperature measured by the internal temperature sensor is higher by a device-specific and application-specific amount than the temperature at measuring point M1, as shown in the dimension drawing.

The rotary encoders feature a further, albeit non-adjustable, trigger threshold of the internal temperature sensor, which, when exceeded, triggers an EnDat error message (the EnDat memory area "Operating status," word 0 "Error messages," bit 2<sup>2</sup> "Position," and in additional data 2 "Operating status error sources," bit 2<sup>6</sup> "Temperature exceeded"). This trigger threshold may vary depending on the encoder and is stated in the specifications.

HEIDENHAIN recommends adjusting the warning threshold based on the application such that this threshold is sufficiently below the trigger threshold for the "Temperature exceeded" EnDat error message. Compliance with the operating temperature at measuring point M1 is required for adherence to the encoder's proper and intended use.

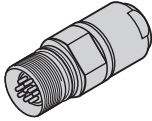
## Pin layout

| 8-pin M12 coupling                                                                                                                                                                                                                                    |                      |                                 |             |                      |                          |             |              |              |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------|---------------------------------|-------------|----------------------|--------------------------|-------------|--------------|--------------|
|    |                      |                                 |             |                      |                          |             |              |              |
|                                                                                                                                                                                                                                                       | Supply voltage       |                                 |             |                      | Serial data transmission |             |              |              |
|                                                                                                                                                                      | 8                    | 2                               | 5           | 1                    | 3                        | 4           | 7            | 6            |
|                                                                                                                                                                                                                                                       | <b>U<sub>P</sub></b> | <b>Sensor</b><br>U <sub>P</sub> | <b>0 V</b>  | <b>Sensor</b><br>0 V | <b>DATA</b>              | <b>DATA</b> | <b>CLOCK</b> | <b>CLOCK</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 sense line is connected in the encoder with the corresponding power line.

Vacant pins or wires must not be used!

| 17-pin M23 coupling                                                                                                                                                                                                                                         |                      |                                 |                 |                      |                                     |                                   |                  |                |               |                          |             |              |              |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------|---------------------------------|-----------------|----------------------|-------------------------------------|-----------------------------------|------------------|----------------|---------------|--------------------------|-------------|--------------|--------------|
|    |                      |                                 |                 |                      |                                     |                                   |                  |                |               |                          |             |              |              |
|                                                                                                                                                                                                                                                             | Supply voltage       |                                 |                 |                      |                                     | Incremental signals <sup>1)</sup> |                  |                |               | Serial data transmission |             |              |              |
|                                                                                                                                                                          | 7                    | 1                               | 10              | 4                    | 11                                  | 15                                | 16               | 12             | 13            | 14                       | 17          | 8            | 9            |
|                                                                                                                                                                                                                                                             | <b>U<sub>P</sub></b> | <b>Sensor</b><br>U <sub>P</sub> | <b>0 V</b>      | <b>Sensor</b><br>0 V | <b>Internal shield<sup>2)</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> |
|                                                                                                                                                                          | Brown/<br>Green      | Blue                            | White/<br>Green | White                | /                                   | Green/<br>Black                   | Yellow/<br>Black | Blue/<br>Black | Red/<br>Black | Gray                     | Pink        | Violet       | Yellow       |

**Cable shield** connected to housing; **U<sub>P</sub>** = Power supply voltage

**Sensor:** The sense line is connected in the encoder with the corresponding power line.

Vacant pins or wires must not be used!

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

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

# EnDat 3

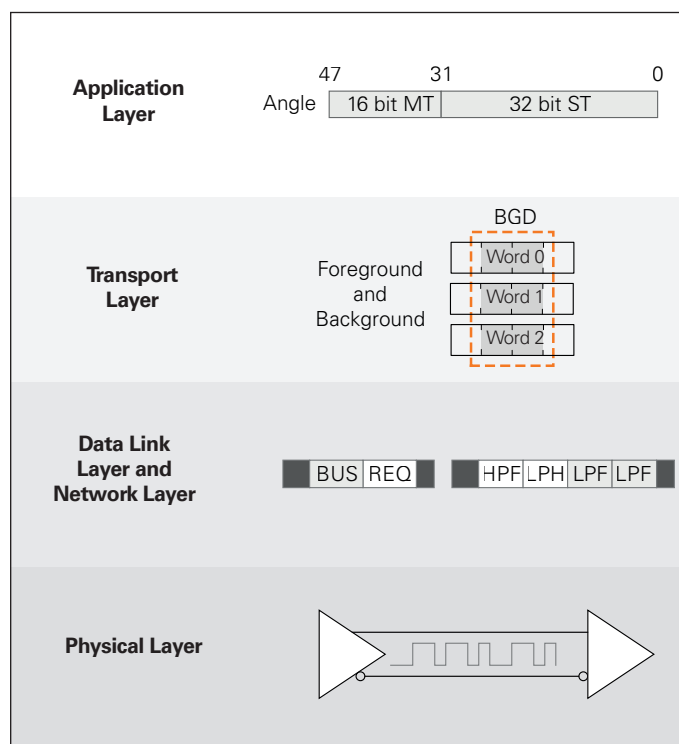
EnDat 3 combines the features and benefits of EnDat in a new architecture and offers interesting enhanced functions for digital production. EnDat 3 requires two wires for communication. Two other wires are generally used with EnDat 3 for supplying power to the encoder. Since the digital data current has no DC component, it is possible to modulate the communication on the supply wires, and so to reduce the number of wires for certain applications (e.g., hybrid motor cables) to a total of just two wires (HMC 2). The EnDat 3 interface specification is based on the standardized OSI layer model.

The encoder-end of the interface is called the slave, and the downstream electronics the master. A communication cycle consists of a request from the master followed by a response from the slave.



## Further information:

Find out more about EnDat at [endat.heidenhain.com](http://endat.heidenhain.com)



## Ordering designations

The ordering designation defines key communication characteristics.

| Supported communication types                   | E30-R2 | E30-R4 | E30-RB |
|-------------------------------------------------|--------|--------|--------|
| Communication modulated onto supply wires       | ✓      | –      | –      |
| Communication + separate supply wires (4 wires) | –      | ✓      | ✓      |
| Bus operation                                   | –      | –      | ✓      |
| Sensor box integration                          | –      | ✓      | ✓      |
| EnDat 3.0 command set                           | ✓      | ✓      | ✓      |

# Fanuc pin layout

### Fanuc pin layout

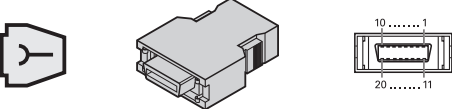
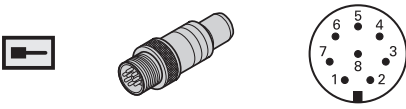
HEIDENHAIN encoders with the code letter F after the model designation are optimized for connection to Fanuc machine-tool controls with the

### Fanuc Serial Interface – α Interface

- Ordering designation: Fanuc02  
normal and high speed, two-pair transmission

### Fanuc Serial Interface – αi Interface

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

| 20-pin Fanuc connector                                                              |                 |           |                 |           |        | 8-pin M12 coupling                                                                 |             |         |         |
|-------------------------------------------------------------------------------------|-----------------|-----------|-----------------|-----------|--------|------------------------------------------------------------------------------------|-------------|---------|---------|
|    |                 |           |                 |           |        |  |             |         |         |
|                                                                                     | Supply voltage  |           |                 |           |        | Serial data transmission                                                           |             |         |         |
|    | 9               | 18/20     | 12              | 14        | 16     | 1                                                                                  | 2           | 5       | 6       |
|    | 8               | 2         | 5               | 1         | –      | 3                                                                                  | 4           | 7       | 6       |
|                                                                                     | Up              | Sensor Up | 0V              | Sensor 0V | Shield | Serial Data                                                                        | Serial Data | Request | Request |
|  | Brown/<br>Green | Blue      | White/<br>Green | White     | –      | Gray                                                                               | Pink        | Violet  | Yellow  |

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

**Sensor:** The sense line is connected in the encoder with the corresponding power line.

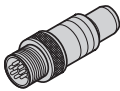
Vacant pins or wires must not be used!

# Siemens pin layout

## Siemens pin layout

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

- Ordering designation: DQ01

| RJ45 connector                                                                    |                |    | 8-pin M12 coupling                                                                                                                                                                                                                                       |     |                   |     |
|-----------------------------------------------------------------------------------|----------------|----|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|-------------------|-----|
|   |                |    |    |     |                   |     |
| Supply voltage                                                                    |                |    | Serial data transmission                                                                                                                                                                                                                                 |     |                   |     |
|                                                                                   |                |    | Send data                                                                                                                                                                                                                                                |     | Data was received |     |
|  | A              | B  | 3                                                                                                                                                                                                                                                        | 6   | 1                 | 2   |
|  | 1              | 5  | 7                                                                                                                                                                                                                                                        | 6   | 3                 | 4   |
|                                                                                   | U <sub>P</sub> | 0V | TXP                                                                                                                                                                                                                                                      | TXN | RXP               | RXN |

Cable shield connected to housing; U<sub>P</sub> = Power supply voltage

## Integrated temperature evaluation

Rotary encoders with the DRIVE-CLiQ interface include an internal temperature sensor integrated into the encoder electronics. The digitized temperature value is transmitted purely serially via the DRIVE-CLiQ interface. Please bear in mind that neither the temperature measurement nor the transmission of the temperature value is safe in terms of functional safety.

The temperature measured by the internal temperature sensor is higher by a device-specific and application-specific amount than the temperature at measuring point M1, as shown in the dimension drawing.

Upon reaching a trigger threshold for the internal temperature sensor, these rotary encoders issue an "Alarm 405" error message. This threshold may vary

depending on the encoder and is stated in the specifications. During operation, it is recommended that the temperature be kept adequately below the error-message threshold.

Compliance with the operating temperature at measuring point M1 is required for adherence to the encoder's proper and intended use.

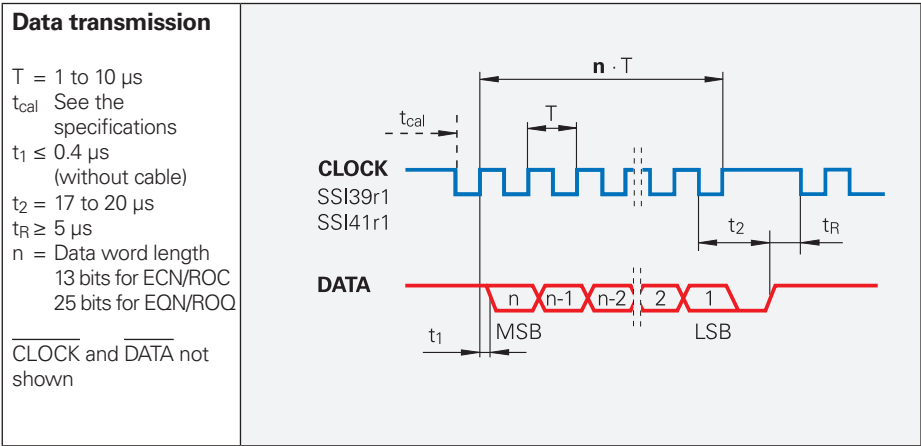
DRIVE-CLiQ is a registered trademark of Siemens AG

# SSI position values

The **position value** is transmitted, starting with the most significant bit (MSB), over the data lines (DATA) in synchronism with a clock signal (CLOCK) provided by 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 be transmitted as well. For a description of the signals, see "1 V<sub>PP</sub> incremental signals".

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

- **Dir. of rotation**
- **Zero reset** (setting to zero)



## Pin layout

| 17-pin M23 coupling |                |                       |             |            |                 |                     |              |            |           |                          |      |        |        |                  |         |
|---------------------|----------------|-----------------------|-------------|------------|-----------------|---------------------|--------------|------------|-----------|--------------------------|------|--------|--------|------------------|---------|
|                     |                |                       |             |            |                 |                     |              |            |           |                          |      |        |        |                  |         |
|                     | Supply voltage |                       |             |            |                 | Incremental signals |              |            |           | Serial data transmission |      |        |        | Other signals    |         |
|                     | 7              | 1                     | 10          | 4          | 11              | 15                  | 16           | 12         | 13        | 14                       | 17   | 8      | 9      | 2                | 5       |
|                     | U <sub>P</sub> | Sensor U <sub>P</sub> | 0 V         | Sensor 0 V | Internal shield | A+                  | A-           | B+         | B-        | DATA                     | DATA | CLOCK  | CLOCK  | Dir. of rotation | Zeroing |
|                     | Brown/Green    | Blue                  | White/Green | White      | /               | Green/Black         | Yellow/Black | Blue/Black | Red/Black | Gray                     | Pink | Violet | Yellow | Black            | Green   |

**Shield** lies on housing; **U<sub>P</sub>** = Power supply voltage

**Sensor:** With a 5 V supply voltage, the sense line is connected in the encoder with the corresponding power line.

Vacant pins or wires must not be used!



### Further information:

For detailed descriptions of all available interfaces, as well as general electrical information, please refer to the *Interfaces of HEIDENHAIN Encoders* brochure.

# Cables and connecting elements

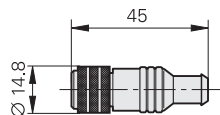
## General information

### Plastic-insulated connector:

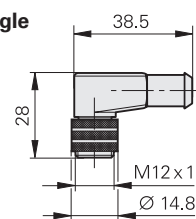
connecting element with coupling ring, available with male or female contacts (see symbols)

#### Symbols

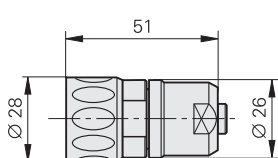
##### M12



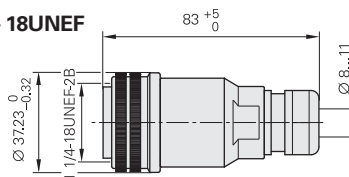
##### M12 right-angle connector



##### M23

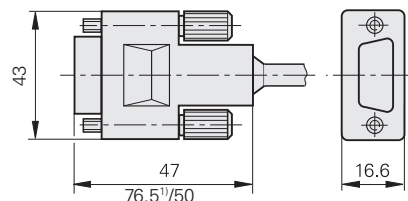


##### 1/4" - 18UNEF



### D-sub connector for HEIDENHAIN controls and evaluation electronics.

#### Symbols



<sup>1)</sup> Interface electronics integrated into the connector

### Plastic-insulated coupling: Connector with external thread; deliverable with male or female contacts(see symbols).

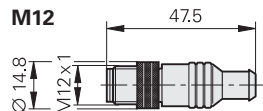
#### Symbols



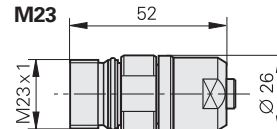
#### Mounted coupling with central fastening



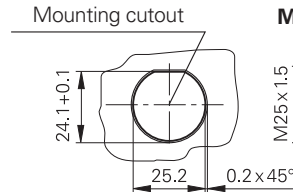
##### M12



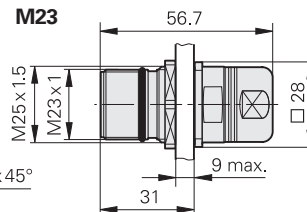
##### M23



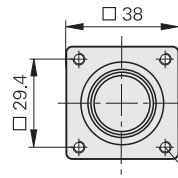
#### Mounting cutout



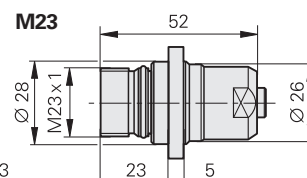
##### M23



#### Mounted coupling with flange



##### M23

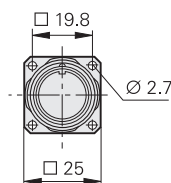
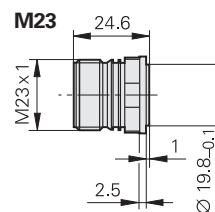


### Flange socket with external thread; is permanently mounted on a housing, available with male or female contacts

#### Symbols



##### M23



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

Male or



Female contacts.



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

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

#### Threaded dust cap made of metal ID 219926-01

#### Accessory for M12 connecting element Insulation spacer ID 596495-01

| $\sim 1 V_{PP}$ , $\square$ TTL, $\square$ HTL                                                                                                                                         |                                                                   |                                     |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------|-------------------------------------|
| <b>PUR connecting cables</b> <b>12-pin:</b> $4(2 \times 0.14 \text{ mm}^2) + (4 \times 0.5 \text{ mm}^2)$ ; $A_P = 0.5 \text{ mm}^2$ <b>Ø 8 mm</b>                                     |                                                                   |                                     |
| With connector (female) and coupling (male)                                                                                                                                            |                                                                   | 298401-xx                           |
| With connector (female) and connector (male)                                                                                                                                           |                                                                   | 298399-xx                           |
| With connector (female) and 15-pin D-sub connector (female) for TNC                                                                                                                    |                                                                   | 310199-xx                           |
| With connector (female) and 15-pin D-sub connector (male) for PWM 20/EIB 74x                                                                                                           |                                                                   | 310196-xx                           |
| With connector (female) and stripped cable end                                                                                                                                         |                                                                   | 309777-xx                           |
| <b>Cable only</b> , Ø 8 mm                                                                                                                                                             |                                                                   | 816317-xx                           |
| <b>Mating element on connecting cable; fits encoder connector</b>                                                                                                                      | <b>Connector (female)</b> for cable Ø 8 mm<br>                    | 291697-05                           |
| <b>Connector on connecting cable</b> for connection to the downstream electronics                                                                                                      | <b>Connector (male)</b> for cable Ø 8 mm<br>Ø 6 mm<br>            | 291697-08<br>291697-07              |
| <b>Coupling on connecting cable</b>                                                                                                                                                    | <b>Coupling (male)</b> for cable Ø 4.5 mm<br>Ø 6 mm<br>Ø 8 mm<br> | 291698-14<br>291698-03<br>291698-04 |
| <b>Flange socket</b> for installation in the downstream electronics                                                                                                                    | <b>Flange socket (female)</b><br>                                 | 315892-08                           |
| <b>Mounted couplings</b>                                                                                                                                                               | <b>With flange (female)</b> Ø 6 mm<br>Ø 8 mm<br>                  | 291698-17<br>291698-07              |
|                                                                                                                                                                                        | <b>With flange (male)</b> Ø 6 mm<br>Ø 8 mm<br>                    | 291698-08<br>291698-31              |
|                                                                                                                                                                                        | <b>With central fastening (male)</b> Ø 6 to 10 mm<br>             | 741045-01                           |
| $\sim 1 V_{PP}/11 \mu A_{PP}$ <b>adapter connector</b><br>For converting 1 V <sub>PP</sub> to 11 μA <sub>PP</sub> ;<br>12-pin M23 connector (female)<br>and 9-pin M23 connector (male) |                                                                   | 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 SSI incremental signals |                                      |  |
|----------------------------------------------------------------------------------------------------------|----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------|--------------------------------------|--|
| PUR connecting cables                                                                                    |                | 8-pin: (4 x 0.14 mm <sup>2</sup> ) + (4 x 0.34 mm <sup>2</sup> ); A <sub>P</sub> = 0.34 mm <sup>2</sup><br>17-pin: (4 x 0.14 mm <sup>2</sup> ) + 4(2 x 0.14 mm <sup>2</sup> ) + (4 x 0.5 mm <sup>2</sup> ); A <sub>P</sub> = 0.5 mm <sup>2</sup> |                                    |                                      |  |
|                                                                                                          | Cable diameter | 6 mm                                                                                                                                                                                                                                             | 3.7 mm                             | 8 mm                                 |  |
| With connector (female) and coupling (male)                                                              |                | 368330-xx                                                                                                                                                                                                                                        | 801142-xx                          | 323897-xx<br>340302-xx               |  |
| With right-angle connector (female) and coupling (male)                                                  |                | 373289-xx                                                                                                                                                                                                                                        | 801149-xx                          | –                                    |  |
| With connector (female) and 15-pin D-sub connector (female) for TNC (position inputs)                    |                | 533627-xx                                                                                                                                                                                                                                        | –                                  | 332115-xx                            |  |
| With connector (female) and 25-pin D-sub connector (female) for TNC (speed inputs)                       |                | 641926-xx                                                                                                                                                                                                                                        | –                                  | 336376-xx                            |  |
| With connector (female) and 15-pin D-sub connector (male), for IK 215, PWM 20, EIB 74x, etc.             |                | 524599-xx                                                                                                                                                                                                                                        | 801129-xx                          | 324544-xx                            |  |
| With right-angle connector (female) and 15-pin D-sub connector (male), for IK 215, PWM 20, EIB 74x, etc. |                | 722025-xx                                                                                                                                                                                                                                        | 801140-xx                          | –                                    |  |
| With connector (female) and stripped cable end                                                           |                | 634265-xx                                                                                                                                                                                                                                        | –                                  | 309778-xx<br>309779-xx <sup>1)</sup> |  |
| With right-angle connector (female) and stripped cable end                                               |                | 606317-xx                                                                                                                                                                                                                                        | –                                  | –                                    |  |
| Cable without connectors                                                                                 |                | –                                                                                                                                                                                                                                                | –                                  | 816322-xx                            |  |

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

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

$A_P$ : Cross section of power supply lines

# Fanuc and Siemens connecting cables

|                                                                                                                                                                             |                                                                                          | Cable  | Fanuc     |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------|--------|-----------|
| <b>PUR connecting cables for M23 connectors</b>                                                                                                                             |                                                                                          |        |           |
| With 17-pin M23 connector (female) and Fanuc connector<br>(2 x 2 x 0.14 mm <sup>2</sup> ) + (4 x 1 mm <sup>2</sup> );<br>A <sub>P</sub> = 1 mm <sup>2</sup>                 |         | Ø 8 mm | 534855-xx |
| With 17-pin M23 connector (female) and 20-pin Mitsubishi connector<br>(2 x 2 x 0.14 mm <sup>2</sup> ) + (4 x 0.5 mm <sup>2</sup> );<br>A <sub>P</sub> = 0.5 mm <sup>2</sup> |  20-pin | Ø 6 mm | –         |
| With 17-pin M23 connector (female) and 10-pin Mitsubishi connector<br>(2 x 2 x 0.14 mm <sup>2</sup> ) + (4 x 1 mm <sup>2</sup> );<br>A <sub>P</sub> = 1 mm <sup>2</sup>     |  10-pin | Ø 8 mm | –         |
| <b>Cable without connectors</b><br>(2 x 2 x 0.14 mm <sup>2</sup> ) + (4 x 1 mm <sup>2</sup> );<br>A <sub>P</sub> = 1 mm <sup>2</sup>                                        |         | Ø 8 mm | 816327-xx |

|                                                                                                                                                     |                                                                                            | Cable  | Fanuc     |
|-----------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------|--------|-----------|
| <b>PUR connecting cable for M12 connectors</b> (1 x 4 x 0.14 mm <sup>2</sup> ) + (4 x 0.34 mm <sup>2</sup> ); A <sub>P</sub> = 0.34 mm <sup>2</sup> |                                                                                            |        |           |
| With 8-pin M12 connector (female) and Fanuc connector                                                                                               |         | Ø 6 mm | 646807-xx |
| With 8-pin M12 connector (female) and 20-pin Mitsubishi connector                                                                                   |  20-pin | Ø 6 mm | –         |
| With 8-pin M12 connector (female) and 10-pin Mitsubishi connector                                                                                   |  10-pin | Ø 6 mm | –         |

|                                                                                                                                                  |                                                                                     | Cable    | Siemens    |
|--------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|----------|------------|
| <b>PUR connecting cable for M12 connectors</b> 2(2 x 0.17 mm <sup>2</sup> ) + (2 x 0.24 mm <sup>2</sup> ); A <sub>P</sub> = 0.24 mm <sup>2</sup> |                                                                                     |          |            |
| With 8-pin M12 connector (female) and 8-pin M12 coupling (male)                                                                                  |  | Ø 6.8 mm | 822504-xx  |
| With 8-pin M12 connector (female) and RJ45 Siemens connector (IP67);<br>cable length: 1 m                                                        |  | Ø 6.8 mm | 1094652-01 |
| With 8-pin M12 connector (female) and RJ45 Siemens connector (IP20)                                                                              |  | Ø 6.8 mm | 1093042-xx |

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

# Signal converters

Signal converters from HEIDENHAIN enable the flexible adaptation of interfaces for encoder signals to the requirements of your application. Depending on the application, additional signals (such as from temperature sensors) may be processed and transmitted to the downstream electronics:

- Adaptation of the interfaces
- Angular measurement with increased accuracy
- Temperature measurement on direct-drive motors
- Computer-aided measured-value acquisition

Incremental signals

~ 1 V<sub>PP</sub> > □ TTL

~ 11 μA<sub>PP</sub> > □ TTL

Incremental signals > position values

~ 1 V<sub>PP</sub> > EnDat

~ 1 V<sub>PP</sub> > Fanuc Serial Interface

~ 1 V<sub>PP</sub> > Mitsubishi high speed Interface

Position values

EnDat > DRIVE-CLiQ

EnDat > Fanuc

EnDat > Yaskawa Serial Interface

## Adaptation of the interfaces

Signal converters from HEIDENHAIN for the adaptation of the encoder signals to the interface increase compatibility with the downstream electronics. Signals can be interpolated, and various versions (e.g., housing version, connector version or cable version) can be selected for greater flexibility in the application.

### IBV 600, IBV 100, IBV 3000, EXE 100 series

In addition to performing signal conversion, the signal converters also interpolate the sinusoidal encoder signals. This permits finer measuring steps, resulting in higher control quality and superior positioning behavior.

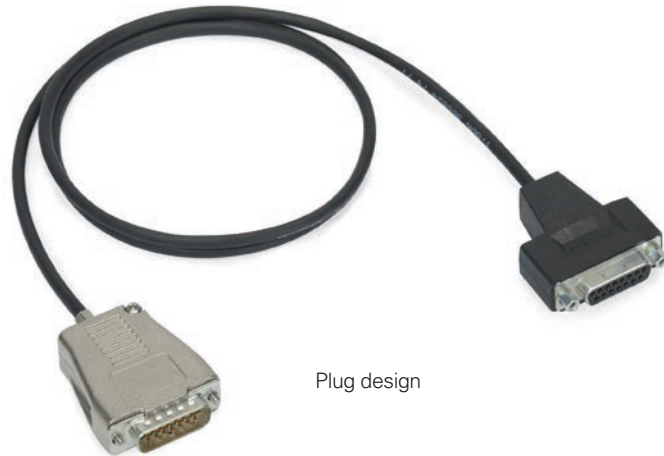
- Incremental interface at the input (1 V<sub>PP</sub> or 11 μA<sub>PP</sub>)
- Incremental interface at the output (TTL)

### IBV 6000 series

- Incremental interface at the input (1 V<sub>PP</sub>)
- Multiple outputs (1 V<sub>PP</sub> or TTL)

Signal converters from HEIDENHAIN are available in various designs:

- Box design
- Plug design
- Cable design
- Version for integration



Plug design

### EIB 100, EIB 3000 series

These signal converters can interpolate the input signals and also feature an integrated counting function. As soon as the reference marks are traversed, an absolute position value is generated and output to the downstream electronics.

- Incremental interface at the input (1 V<sub>PP</sub>)
- Serial interface at the output (EnDat 2.2, Fanuc Serial Interface, Mitsubishi high speed serial interface)

### EIB 2391 S, EIB 3392 S, EIB 3392 F, EIB 3391 Y series

These signal converters adapt the encoder information, such as position, temperature, or diagnostics, to the format of the output interface.

- Serial interface at the input (EnDat 2.2)
- Serial interface at the output (DRIVE-CLiQ/Fanuc/Yaskawa)



### Temperature measurement on direct-drive motors

Monitoring of all three windings for increased cost-effectiveness and protection of the direct-drive motor from overloading: optimized temperature measurement of up to three temperature sensors and compensation of the transmission timing behavior of the temperature measurement for ETEL direct-drive motors.

#### EIB 5000 series

- Fewer cables required
- Protection of the direct-drive motor from overloading
- Faster response behavior in the event of temperature exceedance
- Increased cost efficiency



### Angular measurement with increased accuracy

Position calculation using two scanning heads from rotatory HEIDENHAIN encoders in real time without negative effects on the control loop: deviations such as eccentric mounting of the graduation of a modular angle encoder, or radial runout deviations of the shaft, can be compensated for with the EIB 1500.

#### EIB 1500 series

- Input: Incremental rotatory HEIDENHAIN encoder with two scanning heads and distance-coded reference marks (mounting of the scanning heads relative to each other:  $180^\circ \pm 5^\circ$ )
- Output: EnDat 2.2, Fanuc Serial Interface or Mitsubishi high speed interface



### Computer-aided measured-value acquisition

The signal converters enable the connection of encoders to computer-supported applications that, at the same time, require high resolution of the encoder signals and fast measurement: as an evaluation unit for inspection stations and multi-gauging fixtures.

#### EIB 700 series

- Signal converters for high-resolution encoder signals and fast measurement
- Connection of multiple evaluation units via Ethernet transmission and, for example, WLAN transmission
- Encoder inputs: 1 V<sub>PP</sub>, 11 μA<sub>PP</sub>, EnDat 2.1, EnDat 2.2 or SSI
- Connection of up to four HEIDENHAIN encoders

#### IK 220 series

- Signal converters for high-resolution encoder signals and fast measurement
- PCI counter card
- Encoder inputs: 1 V<sub>PP</sub>, EnDat 2.1, EnDat 2.2 or 11 μA<sub>PP</sub>
- Connectivity for up to two HEIDENHAIN encoders



| Outputs                                                                                                                                                                                                     |          | Inputs                                                                                                |          | Design – IP rating  | Interpolation <sup>1)</sup> or subdivision | Model            |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|-------------------------------------------------------------------------------------------------------|----------|---------------------|--------------------------------------------|------------------|
| Interface                                                                                                                                                                                                   | Quantity | Interface                                                                                             | Quantity |                     |                                            |                  |
|  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-fold                                  | <b>IBV 3171</b>  |
|                                                                                                                                                                                                             |          |                                                                                                       |          |                     | 20/25/50/100-fold                          | <b>IBV 3271</b>  |
|                                                                                                                                                                                                             |          |  11 µA <sub>PP</sub> | 1        | Box design (IP65)   | 5/10-fold                                  | <b>EXE 101</b>   |
|                                                                                                                                                                                                             |          |                                                                                                       |          |                     | 20/25/50/100-fold                          | <b>EXE 102</b>   |
|  TTL/<br> 1 V <sub>PP</sub><br>(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)   | ≤ 16 384-fold subdivision                  | <b>EIB 192</b>   |
|                                                                                                                                                                                                             |          |                                                                                                       |          | Plug design (IP40)  | ≤ 16 384-fold subdivision                  | <b>EIB 3011</b>  |
|                                                                                                                                                                                                             |          |                                                                                                       | 2        | Box design (IP65)   | ≤ 16 384-fold subdivision                  | <b>EIB 1512</b>  |
| DRIVE-CLiQ                                                                                                                                                                                                  | 1        | EnDat 2.2                                                                                             | 1        | Box design (IP65)   | –                                          | <b>EIB 2391S</b> |
|                                                                                                                                                                                                             |          |                                                                                                       |          | Cable design (IP65) | –                                          | <b>EIB 3392S</b> |
| Fanuc Serial Interface                                                                                                                                                                                      | 1        |  1 V <sub>PP</sub> | 1        | Box design (IP65)   | ≤ 16 384-fold subdivision                  | <b>EIB 192F</b>  |
|                                                                                                                                                                                                             |          |                                                                                                       |          | Plug design (IP40)  | ≤ 16 384-fold subdivision                  | <b>EIB 3091F</b> |
|                                                                                                                                                                                                             |          |                                                                                                       | 2        | Box design (IP65)   | ≤ 16 384-fold subdivision                  | <b>EIB 1592F</b> |
|                                                                                                                                                                                                             | 1        | EnDat 2.2                                                                                             | 1        | Cable design (IP65) | –                                          | <b>EIB 3392F</b> |
| Mitsubishi high speed interface                                                                                                                                                                             | 1        |  1 V <sub>PP</sub> | 1        | Box design (IP65)   | ≤ 16 384-fold subdivision                  | <b>EIB 192M</b>  |
|                                                                                                                                                                                                             |          |                                                                                                       |          | Plug design (IP40)  | ≤ 16 384-fold subdivision                  | <b>EIB 3091M</b> |
|                                                                                                                                                                                                             |          |                                                                                                       | 2        | Box design (IP65)   | ≤ 16 384-fold subdivision                  | <b>EIB 1592M</b> |
| Yaskawa Serial Interface                                                                                                                                                                                    | 1        | EnDat 2.2                                                                                             | 1        | Plug design (IP40)  | –                                          | <b>EIB 3391Y</b> |

<sup>1)</sup> Switchable

# Testing and inspection units, and diagnostics

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

Incremental encoders 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, an analysis of the output signals is possible only with external testing units or through the use of computation resources in the downstream electronics (**analog diagnostic interface**).

Absolute encoders employ serial data transmission. Depending on the interface, additional 1 V<sub>PP</sub> incremental signals can be output. The signals are extensively monitored within the encoder. The monitoring results (particularly valuation numbers) can be transmitted to the downstream electronics along with the position values via the serial interface (**digital diagnostic interface**).

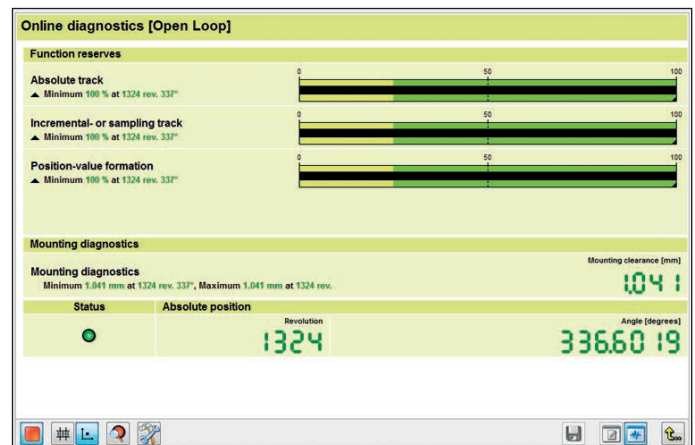
The following information is available:

- Error message: position value is not reliable
- Warning: an internal functional limit of the encoder has been reached
- Valuation numbers:
  - Detailed information about the encoder's function reserve
  - Identical scaling for all HEIDENHAIN encoders
  - Cyclic reading capability

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

For the analysis of these encoders, HEIDENHAIN offers the appropriate PWM inspection units and PWT testing units. Based on how these units are integrated, a distinction is made between two types of diagnostics:

- Encoder diagnostics: the encoder is connected directly to the testing or inspection unit, thereby enabling a detailed analysis of encoder functions.
- Monitoring mode: the PWM inspection unit is inserted within the closed control loop (via suitable testing adapters as needed). This enables real-time diagnosis of the machine or equipment during operation. The available functions depend on the interface.



Diagnostics with the PWM and ATS software



Initial setup with the PWM and ATS software

| Overview                                   |                                             | PWM 21                      |                             | PWT 101                                |
|--------------------------------------------|---------------------------------------------|-----------------------------|-----------------------------|----------------------------------------|
| Interface                                  | Transmission                                | In Encoder Diagnostics mode | In Monitoring mode          | Encoder diagnostics                    |
| EnDat 3                                    | Position value<br>Valuation numbers         | Yes<br>Yes                  | Yes<br>Yes <sup>1)</sup>    | Yes<br>Yes                             |
| EnDat 2.1<br>(with incremental signals)    | Position value<br>Incremental signals       | Yes<br>Yes                  | No<br>Yes                   | Yes<br>Yes                             |
| EnDat 2.2<br>(without incremental signals) | Position value<br>Valuation numbers         | Yes<br>Yes                  | Yes<br>Yes <sup>1)</sup>    | Yes<br>Yes                             |
| DRIVE-CLiQ                                 | Position value<br>Valuation numbers         | Yes<br>Yes                  | No<br>No                    | No <sup>7)</sup><br>No <sup>7)</sup>   |
| Fanuc                                      | Position value<br>Valuation numbers         | Yes<br>Yes                  | Yes<br>Yes                  | Yes <sup>8)</sup><br>Yes <sup>8)</sup> |
| Mitsubishi                                 | Position value<br>Valuation numbers         | Yes<br>Yes <sup>4)</sup>    | Yes<br>Yes <sup>1) 4)</sup> | Yes <sup>8)</sup><br>Yes <sup>8)</sup> |
| Panasonic                                  | Position value<br>Valuation numbers         | Yes<br>Yes                  | Yes<br>Yes <sup>1)</sup>    | Yes <sup>8)</sup><br>Yes <sup>8)</sup> |
| Yaskawa                                    | Position value<br>Valuation numbers         | Yes<br>Yes <sup>5)</sup>    | No<br>No                    | Yes <sup>8)</sup><br>Yes <sup>8)</sup> |
| SSI                                        | Position value<br>Incremental signals       | Yes<br>Yes                  | No<br>Yes                   | No<br>No                               |
| 1 V <sub>PP</sub>                          | Incremental signals                         | Yes                         | Yes                         | Yes                                    |
| 11 µA <sub>PP</sub>                        | Incremental signals                         | Yes                         | Yes                         | Yes                                    |
| TTL                                        | Incremental signals<br>Scanning Signals     | Yes<br>Yes <sup>3)</sup>    | Yes<br>No                   | Yes<br>Yes <sup>3)</sup>               |
| HTL                                        | Incremental signals                         | Yes <sup>2)</sup>           | No                          | No <sup>7)</sup>                       |
| Commutation                                | Block commutation<br>Sinusoidal commutation | Yes <sup>2)</sup><br>Yes    | No<br>Yes                   | Yes <sup>9)</sup><br>Yes               |

<sup>1)</sup> Information must be requested by the control and transmitted

<sup>2)</sup> Via corresponding signal adapters

<sup>3)</sup> If supported by the encoder (PWT function)

<sup>4)</sup> Not available for encoders with the ordering designation Mitsu01

<sup>5)</sup> Not available for the EIB 3391Y

<sup>6)</sup> In planning

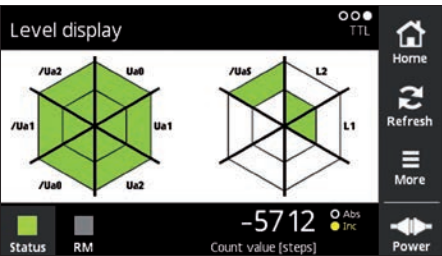
<sup>7)</sup> This function is currently not available

<sup>8)</sup> Two-pair transmission is required (for more information, see the documentation for the PWT 100/PWT 101)

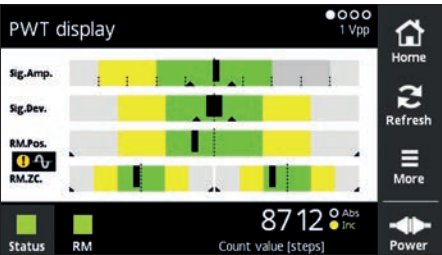
<sup>9)</sup> Only for encoders with block commutation (see encoder documentation)

PWT 101

The PWT 101 is a testing unit for the functional testing and adjustment of absolute and incremental HEIDENHAIN encoders. Thanks to its compact and rugged design, the PWT 101 is ideal for portable use.



Level display



PWT display

SA 1210

Accessory for connecting encoders with the ordering designation E30-R2



|                                               | PWT 101                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|-----------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Area of application                           | <ul style="list-style-type: none"><li>Functional testing of absolute and incremental HEIDENHAIN encoders</li></ul>                                                                                                                                                                                                                                                                                                                                                 |
| Encoder input<br>only for HEIDENHAIN encoders | <ul style="list-style-type: none"><li>EnDat 3<sup>1)</sup></li><li>EnDat 2.1 or EnDat 2.2 (with or without incremental signals)</li><li>DRIVE-CLiQ</li><li>Fanuc Serial Interface</li><li>Mitsubishi high speed interface</li><li>Panasonic Serial Interface</li><li>Yaskawa Serial Interface</li><li>1 V<sub>PP</sub> with Z1 track</li><li>1 V<sub>PP</sub></li><li>11 µA<sub>PP</sub></li><li>TTL</li><li>HTL (signal adapter ID 1093210-01 required)</li></ul> |
| Display                                       | 4.3-inch touchscreen                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| Supply voltage                                | DC 24 V<br>Power consumption: max. 15 W                                                                                                                                                                                                                                                                                                                                                                                                                            |
| Operating temperature                         | 0 °C to 40 °C                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| Protection EN 60529                           | IP20                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| Dimensions                                    | ≈ 145 mm × 85 mm × 35 mm                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| Languages                                     | German, English, French, Italian, Spanish, Japanese, Korean, Chinese (simplified), Chinese (traditional)                                                                                                                                                                                                                                                                                                                                                           |

1) An SA 1210 adapter is required for connecting encoders with the E30-R2 ordering designation.  
The Bus operation function is not supported.

Note:  
The X5 USB connection is currently not supported; there may be country-specific restrictions on plug-in power supplies with regard to the testing standards to be complied with.

A separate version is available for Japan. Consult your contact person at HEIDENHAIN as needed.

DRIVE-CLiQ is a registered trademark of Siemens AG



### PWM 3000

HEIDENHAIN offers an adjusting and testing package for the diagnosis and adjustment of HEIDENHAIN encoders with absolute and incremental interfaces. The following components are needed:

- **PWM 3000:** Inspection unit for connection to a PC via a USB port
- **ATS software:** Adjusting and testing software with integrated local encoder database for automatic encoder identification



To find out more, see the *PWM 3000 with ATS Software* Product Information document.

| Inspection unit                                      | PWM 3000                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
|------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Area of application</b>                           | <ul style="list-style-type: none"> <li>• Functional testing of absolute and incremental HEIDENHAIN encoders</li> <li>• Mounting wizard for HEIDENHAIN encoders</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| <b>Encoder input</b><br>only for HEIDENHAIN encoders | <ul style="list-style-type: none"> <li>• EnDat 3 (ordering designations: E30-R2, E30-R4, E30-RB and E30- RM)*</li> <li>• EnDat 2.2 (EnDat 2.1/EnDat 2.2 without incremental signals; ordering designations: EnDat22, EnDat21)</li> <li>• EnDat 2.1 (EnDat 2.1/EnDat 2.2 with incremental signals; ordering designations: EnDat0x, EnDatHx, EnDatTx)</li> <li>• DRIVE-CLiQ</li> <li>• Fanuc Serial Interface</li> <li>• Mitsubishi high speed interface</li> <li>• Panasonic Serial Interface</li> <li>• Yaskawa Serial Interface</li> <li>• SSI</li> <li>• 1 V<sub>PP</sub> (3 V<sub>PP</sub> for servicing purposes only)</li> <li>• 1 V<sub>PP</sub> with Z1 track</li> <li>• 11 μA<sub>PP</sub> (25 μA<sub>PP</sub> for servicing purposes only)</li> <li>• TTL</li> <li>• HTL (via signal adapter, for servicing purposes only)</li> </ul> |
| <b>Encoder output</b>                                | Monitoring mode for certain interfaces (see the <i>PWM 3000 with ATS Software</i> Product Information document)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| <b>Interface</b>                                     | Ethernet as per IEEE 802.3 (10/100/1000 Mbit/s); network address is assigned either automatically via DHCP or through manual configuration                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| <b>Supply voltage</b>                                | AC 100 V to 240 V (±10 %), 50 Hz to 60 Hz (±2 Hz)<br>Power consumption: max. 60 W                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| <b>Operating temperature</b>                         | 0 °C to 45 °C                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| <b>Protection</b> EN 60529                           | IP20                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| <b>Dimensions</b>                                    | 226 mm × 172 mm × 55 mm                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |

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\* Depending on the ordering designation, an SA 23xx or SA 1210 signal adapter may be required

|                                                | ATS software V4.2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Download</b>                                | <p>The ATS software is part of the uniform adjusting and testing package. The software is not delivered together with the PWM 3000; instead, it can be downloaded from the HEIDENHAIN software filebase at <a href="http://www.heidenhain.com/service/downloads/software">www.heidenhain.com/service/downloads/software</a>. New versions will be released at irregular intervals. Updating to each new version is recommended.</p> <p>For notifications about new ATS software versions, sign up for our newsletter at <a href="http://www.heidenhain.com/newsletter-signup">www.heidenhain.com/newsletter-signup</a>.</p> |
| <b>System requirements and recommendations</b> | <ul style="list-style-type: none"> <li>• PC with dual-core processor &gt; 2 GHz</li> <li>• Main memory &gt; 2 GB</li> <li>• ≈ 500 MB of free memory space</li> <li>• Screen resolution ≥ 1024 × 768</li> <li>• Operating system: Windows 7, 8, 10 (32-bit or 64-bit), Windows 11</li> </ul>                                                                                                                                                                                                                                                                                                                                 |
| <b>Software options available for a fee</b>    | <ul style="list-style-type: none"> <li>• Add or delete product keys</li> <li>• Display the status and validity of product keys</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| <b>Languages*</b>                              | German, English, French, Italian, Spanish, Korean, Chinese (simplified), Chinese (traditional)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |

\* Full availability of the languages depends on the specific version of the ATS V4.2 software

# HEIDENHAIN

Mastering nanometer accuracy



## HEIDENHAIN

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