

## 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 devices. 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 servomotors
- 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, and
- 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.*

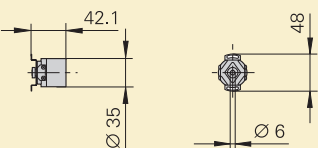
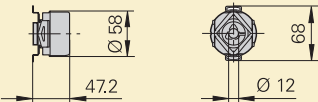
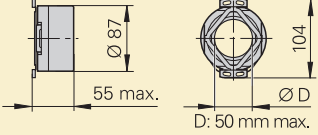
*Standards (ISO, EN, etc.) apply only where explicitly stated in this brochure.*

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|  | <b>ECN 400F/EQN 400F</b> series                        | –   | <b>46</b> |
|  | <b>ECN 400S/EQN 400S</b> series                        | –   |           |
|  | <b>ECN 100</b> series                                  | <b>ERN 100</b> series                       | <b>48</b> |
| <i>Separate shaft coupling;<br/>synchro flange</i>           | <b>ROC/ROQ 1000</b> series                             | <b>ROD 1000</b> series                      | <b>50</b> |
|  | <b>ROC/ROQ 400</b> series                              | <b>ROD 400</b> series                       | <b>54</b> |
|  | <b>ROC 400F/ROQ 400F</b> series                        | –   | <b>62</b> |
|  | <b>ROC 400S/ROQ 400S</b> series                        | –   |           |
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| <i>Separate shaft coupling;<br/>clamping flange</i>          | <b>ROC/ROQ 400 series</b>                              | <b>ROD 400</b> series                       | <b>66</b> |
|  | <b>ROC 400F/ROQ 400F</b> series                        | –   | <b>70</b> |
|  | <b>ROC 400S/ROQ 400S</b> series                        | –   |           |
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# Selection guide

## Rotary encoders for standard applications

| Rotary encoders   | Absolute Singleturn  |  |  | Multiturn (4096 revolutions)  |  |
|---|--|--|--|---|--|
|   | Interface  | EnDat  | Fanuc<br>Siemens                         | SSI   | EnDat  |
| <b>With mounted stator coupling</b>   |  |  |  |   |  |
| <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 425 F</b><br>Positions/rev: 25 bits<br>Fanuc $\alpha$<br><br><b>ECN 424 S</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 437 F</b><br>Positions/rev: 25 bits<br>Fanuc $\alpha$<br><br><b>EQN 436 S</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                                     | –  | –  | –   | –  |



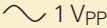
1) Up to 36000 signal periods via integrated 5- or 10-fold interpolation (higher interpolation upon request)

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

|     |   |   |   |  |
|-----|---|---|---|--|
|     |   | <b>Incremental</b>  |   |  |
| SSI |  |  |  |  |

|   |   |                                      |   |
|---|---|--------------------------------------|---|
| -   | <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              |



**34**

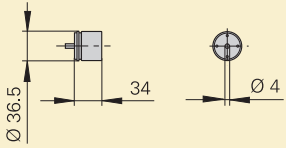
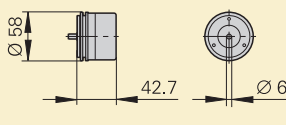
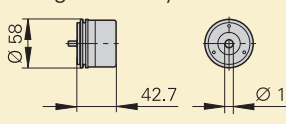
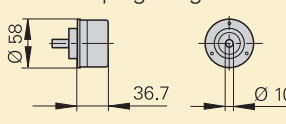


**38**



**48**

# Rotary encoders for standard applications

| Rotary encoders   | Absolute Singleturn  |  |  | Multiturn (4096 revolutions)   |  |
|---|--|--|--|--|--|
|   | Interface  | EnDat  | Fanuc Siemens                            | SSI  | EnDat  |
| <b>For separate shaft coupling, with synchro flange</b>   |  |  |  |  |  |
| <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 $\alpha$<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 $\alpha$<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   | –  | –  | –  | –  |
| <b>For separate shaft coupling, with clamping flange</b>  |  |  |  |  |  |
| <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 $\alpha$<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> <sup>3)</sup><br>Positions/rev: 13 bits<br>EnDat 2.2/01 | <b>ROQ 437 F</b><br>Positions/rev: 25 bits<br>Fanuc $\alpha$<br><br><b>ROQ 436 S</b><br>Positions/rev: 24 bits<br>DRIVE-CLiQ<br>Available with functional safety |



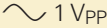
1) Up to 36000 signal periods via integrated 5- or 10-fold interpolation (higher interpolation upon request)

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

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|     |   |   |   |  |
|-----|---|---|---|--|
|     |   | <b>Incremental</b>  |   |  |
| SSI |  |  |  |  |

|  |   |                                      |   |  |
|--|---|--------------------------------------|---|--|
| -  | <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>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 |  |
| -  | -   | -                                    | -   |  |



**50**



**54**



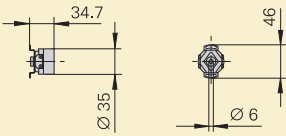
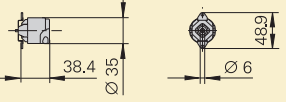
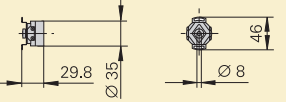
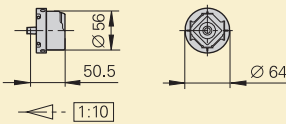
**64**



**66**

|  |                                    |                                    |   |  |
|--|------------------------------------|------------------------------------|---|--|
| <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 |  |
|--|------------------------------------|------------------------------------|---|--|

# Rotary encoders for motors


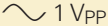
| Rotary encoders   | Absolute Singletum  |   |  | Multitum  |   |
|---|---|---|--|---|---|
| Interface   | EnDat   |   | Siemens  | EnDat   |   |
| <b>With integral bearing and mounted stator coupling</b>  |   |   |  |   |   |
| <b>ERN 1023</b> IP64<br>   | –   | –   | –  | –   | –   |
| <b>ECN/EQN 1100 series</b><br>   | <b>ECN 1123</b><br>Positions/rev: 23 bits<br>EnDat 2.2/22<br>Available with functional safety   | <b>ECN 1113</b><br>Positions/rev: 13 bits<br>EnDat 2.2/01   | –  | <b>EQN 1135</b><br>Positions/rev: 23 bits<br>4096 revolutions<br>EnDat 2.2/22<br>Available with functional safety   | <b>EQN 1125</b><br>Positions/rev: 13 bits<br>4096 revolutions<br>EnDat 2.2/01   |
| <b>ERN 1123</b> IP00<br>  | –   | –   | –  | –   | –   |
| <b>ECN/EQN/ERN 1300 series</b> IP40<br><b>ECN/EQN/ERN 400series</b> IP64<br> | <b>ECN 1325</b><br>Positions/rev: 25 bits<br>EnDat 2.2/22<br>EnDat 3/E30-R2<br>Available with functional safety<br><br><b>ECN 425</b><br>Positions/rev: 25 bits<br>EnDat 2.2/22<br>Available with functional safety | <b>ECN 1313</b><br>Positions/rev: 13 bits<br>EnDat 2.2/01<br><br><b>ECN 413</b><br>Positions/rev: 13 bits<br>EnDat 2.2/01 | <b>ECN 1324S</b><br>Positions/rev: 24 bits<br>DRIVE-CLiQ<br>Available with functional safety | <b>EQN 1337</b><br>Positions/rev: 25 bits<br>4096 revolutions<br>EnDat 2.2/22<br>EnDat 3/E30-R2<br>Available with functional safety<br><br><b>EQN 437</b><br>Positions/rev: 25 bits<br>4096 revolutions<br>EnDat 2.2/22<br>Available with functional safety | <b>EQN 1325</b><br>Positions/rev: 13 bits<br>4096 revolutions<br>EnDat 2.2/01<br><br><b>EQN 425</b><br>Positions/rev: 13 bits<br>4096 revolutions<br>EnDat 2.2/01 |

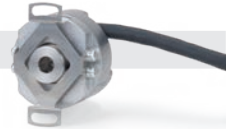
1) 8192 signal periods via integrated 2-fold interpolation

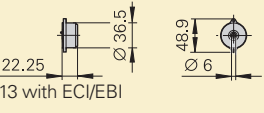
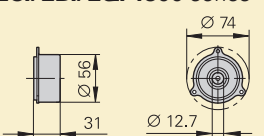
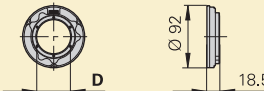
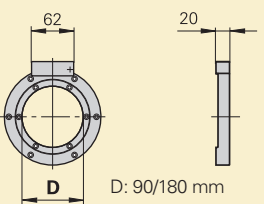
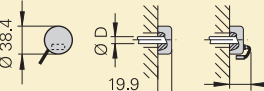
2) Available with mechanical fault exclusion; for deviating specifications and special mounting information, see the *Fault Exclusion* Customer Information document

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


| Incremental  |   |   |                   |
|--|---|---|-------------------|
| Siemens  |    |    | 1 V <sub>PP</sub> |
| -  | <b>ERN 1023</b><br>500 to 8192 lines<br>3 signals for block commutation   | -   | -                 |
| -  | -   | -   | -                 |
| -  | <b>ERN 1123</b><br>500 to 8192 lines<br>3 signals for block commutation   | -   | -                 |
| <b>EQN 1336S</b><br>Positions/rev: 24 bits<br>4096 revolutions<br>DRIVE-CLiQ<br>Available with functional safety | <b>ERN 1321</b><br>1024 to 4096 lines<br><b>ERN 1326</b><br>1024 to 4096 lines <sup>1)</sup><br>3 TTL signals for block commutation<br><b>ERN 421</b><br>1024 to 4096 lines | <b>ERN 1381</b> <sup>2)</sup><br>512 to 4096 lines<br><b>ERN 1387</b> <sup>2)</sup><br>2048 lines<br>Z1 track for sine commutation<br><b>ERN 487</b><br>2048 lines<br>Z1 track for sine commutation | -                 |



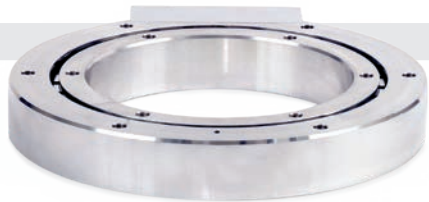
| Rotary encoders  |   | Absolute Singletum   |   | Multitum   |  |
|--|---|--|---|--|--|
| Interface  | EnDat   | Siemens  | EnDat   |  |  |
| <b>Without integral bearing</b>  |   |  |   |  |  |
| <b>ECI/EQI/EBI 1100 series</b><br><br>13 with ECI/EBI | <b>ECI 1118</b><br>Positions/rev: 18 bits<br>EnDat 2.2/22   | <b>ECI 1119</b><br>Positions/rev: 19 bits<br>EnDat 2.2/22,<br>EnDat 3/E30-R2<br>Available with functional safety | –   | <b>EBI 1135</b><br>Positions/rev: 18 bits<br>65536 revolutions<br>(buffer battery backup)<br>EnDat 2.2/22                              | <b>EQI 1131</b><br>Positions/rev: 19 bits<br>4096 revolutions<br>EnDat 2.2/22,<br>EnDat 3/E30-R2<br>Available with functional safety |
| <b>ECI/EBI/EQI 1300 series</b><br>                    | <b>ECI 1319</b><br>Positions/rev: 19 bits<br>EnDat 2.2/22<br>EnDat 3/E30-R2<br>Available with functional safety | <b>ECI 1319</b><br>Positions/rev: 19 bits<br>EnDat 3/E30-R2<br>Available with functional safety                  | <b>ECI 1319 S</b><br>Positions/rev: 19 bits<br>DRIVE-CLiQ<br>Available with functional safety | <b>EQI 1331</b><br>Positions/rev: 19 bits<br>4096 revolutions<br>EnDat 2.2/22<br>EnDat 3/E30-R2<br>Available with functional safety    | <b>EQI 1331</b><br>Positions/rev: 19 bits<br>4096 revolutions<br>EnDat 3/E30-R2<br>Available with functional safety                  |
| <b>ECI/EBI 100 series</b><br><br>D: 30/38/50 mm      | <b>ECI 119</b><br>Positions/rev: 19 bits<br>EnDat 2.2/22 or<br>EnDat 2.1/01                                     | –  | –   | <b>EBI 135</b><br>Positions/rev: 19 bits<br>65536 revolutions<br>(battery backup)<br>EnDat 2.2/22                                      |  |
| <b>ECI/EBI 4000 series</b><br><br>D: 90/180 mm      | <b>ECI 4010</b><br>Positions/rev: 20 bits<br>EnDat 2.2/22<br>Available with functional safety                   | –  | <b>ECI 4090 S</b><br>Positions/rev: 20 bits<br>DRIVE-CLiQ<br>Available with functional safety | <b>EBI 4010</b><br>Positions/rev: 20 bits<br>65536 revolutions<br>(battery backup)<br>EnDat 2.2/22<br>Available with functional safety |  |
| <b>ERO 1400 series</b><br><br>D: 4/6/8 mm           | –   | –  | –   | –  |  |

<sup>1)</sup> Up to 37 500 signal periods via integrated 5-, 10-, 20- or 25-fold interpolation

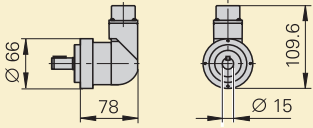
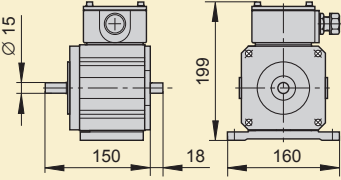
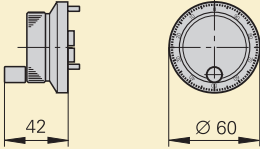
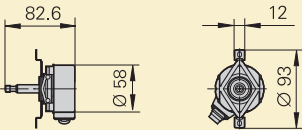
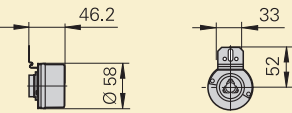
DRIVE-CLiQ is a registered trademark of Siemens AG



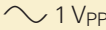
|  |   | Incremental   |                                      |
|--|---|---|--------------------------------------|
|  | Siemens   |  | $\sim 1 V_{PP}$                      |
|  | -   | -   | -                                    |
| <b>EBI 1335</b><br>Positions/rev: 19 bits<br>65536 revolutions<br>EnDat 2.2/22<br>Available with functional safety | <b>EQI 1331 S</b><br>Positions/rev: 19 bits<br>4096 revolutions<br>DRIVE-CLiQ<br>Available with functional safety | -   | -                                    |
|  | -   | -   | -                                    |
|  | -   | -   | -                                    |
|  | -   | <b>ERO 1420</b><br>512 to 1024 lines  | <b>ERO 1480</b><br>512 to 1024 lines |
|  |   | <b>ERO 1470</b><br>1000/1500 lines <sup>1)</sup>                                  |                                      |

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



# Rotary encoders for special applications

| Rotary encoders  | Absolute Singleturn |       | Multiturn (4096 revolutions)                             |  |
|--|---------------------|-------|--|--|
|  | Interface           | EnDat | SSI  | EnDat                                    |
| <b>For high bearing loads</b>  |                     |       |  |  |
| <b>ROD 600</b><br>              | -                   | -     | -  | -  |
| <b>ROD 1930</b><br>             | -                   | -     | -  | -  |
| <b>Electronic handwheel</b>  |                     |       |  |  |
| <b>HR 1120</b><br>            | -                   | -     | -  | -  |
| <b>For Siemens asynchronous motors</b>   |                     |       |  |  |
| <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 |

|  |   |  |   |
|--|---|--|---|
| <b>Incremental</b>   |   |  |   |
|  |  |  |  |
| <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  |  | -   |



72



74

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



76



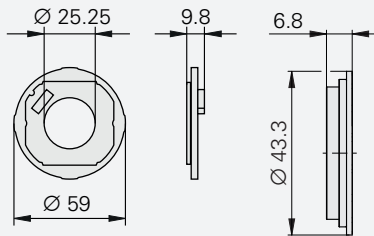
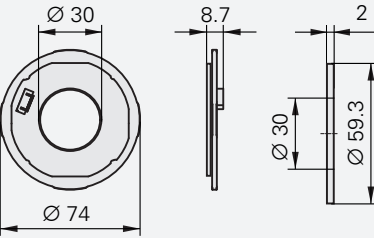
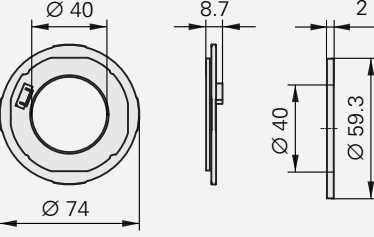
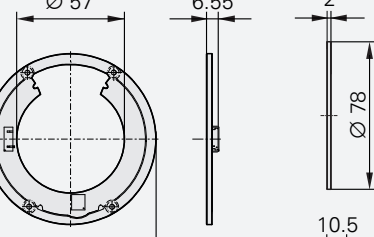
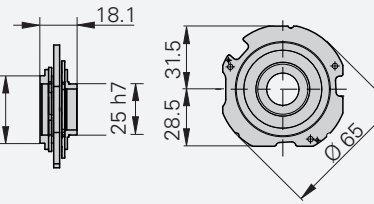
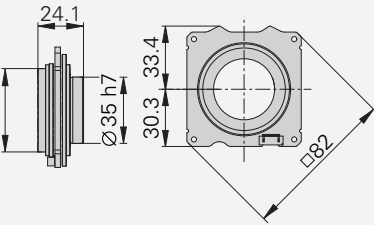
*For more information, please refer to the respective Product Information document*



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

# Rotary encoders for robot drive systems and other motors

Protection rating: IP00 (EN 60529)

| Series   | Main dimensions   | Mechanically permissible shaft speed                               | Natural frequency $f_N$ (typical) of the coupling | Maximum operating temperature | Supply voltage   |
|--|---|--|---|-------------------------------|------------------|
| <b>KCI/KBI 1300</b><br>Hollow shaft<br>diameter: 25 mm |    | $\leq 10000$ rpm   | –   | 115 °C                        | DC 3.6 V to 14 V |
| <b>KCI/KBI 100</b><br>Hollow shaft<br>diameter: 30 mm  |    | $\leq 10000$ rpm   |   |                               |                  |
| <b>KCI/KBI 100</b><br>Hollow shaft<br>diameter: 40 mm  |   | $\leq 10000$ rpm   |   |                               |                  |
| <b>KCI/KBI 100</b><br>Hollow shaft<br>diameter: 55 mm  |  | $\leq 10000$ rpm   |   |                               |                  |
|  |   | $\leq 6000$ rpm  |   |                               |                  |
| <b>KCI/KBI 100 Dplus</b><br>AE 04                      |  | Motor side:<br>$\leq 15000$ rpm<br>Output side:<br>$\leq 6000$ rpm |   |                               |                  |
| <b>KCI/KBI 100 Dplus</b><br>AE 07                      |  | Motor side:<br>$\leq 15000$ rpm<br>Output side:<br>$\leq 6000$ rpm |   |                               |                  |

All variants are available with functional safety

<sup>1)</sup> Multiturn function via battery-buffered revolution counter

| Signal periods per revolution | Positions per revolution  | Distinguishable revolutions <sup>1)</sup> | Interface | Model                | Further information                  |
|-------------------------------|---|---|-----------|----------------------|--------------------------------------|
| –                             | 524288 (19 bits)  | –   | EnDat 2.2 | <b>KCI 1319</b>      | <i>Product Information documents</i> |
|                               |   | 65536 (16 bits)                           |           | <b>KBI 1335</b>      |                                      |
|                               | 1 048576 (20 bits)  | –   |           | <b>KCI 120</b>       |                                      |
|                               |   | 65536 (16 bits)                           |           | <b>KBI 136</b>       |                                      |
|                               | 1 048576 (20 bits)  | –   |           | <b>KCI 120</b>       |                                      |
|                               |   | 65536 (16 bits)                           |           | <b>KBI 136</b>       |                                      |
|                               | 1 048576 (20 bits)  | –   |           | <b>KCI 120</b>       |                                      |
|                               |   | 65536 (16 bits)                           |           | <b>KBI 136</b>       |                                      |
|                               | Motor side:<br>524288 (19 bits)<br>Output side:<br>1 048576 (20 bits) | –   |           | <b>KCI 120 Dplus</b> |                                      |
|                               |   | 65536 (16 bits)                           |           | <b>KBI 136 Dplus</b> |                                      |
|                               | Motor side:<br>524288 (19 bits)<br>Output side:<br>1 048576 (20 bits) | –   |           | <b>KCI 120 Dplus</b> |                                      |

# 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

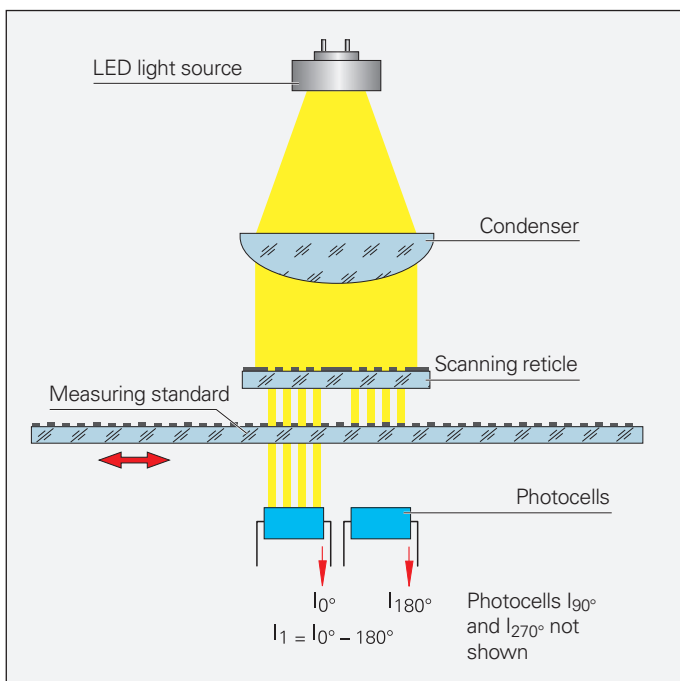
### Photoelectric scanning

Most HEIDENHAIN encoders utilize the photoelectric scanning principle. Photoelectric scanning is touchless 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 µm.



Photoelectric scanning in accordance with the imaging scanning principle

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.

### Other scanning principles

ECI/EBI/EQI rotary encoders operate according to the inductive measuring principle. Here, graduation structures modulate a high-frequency signal in its amplitude and phase. By means of circumferential scanning, the position value is always generated based on the signals from the receiver coils that are evenly distributed along the circumference.

Rotary encoder accuracy is primarily determined by the following factors:

- The directional error of the radial grating
- The eccentricity of the graduated disk 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 in 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        | ±60 arc seconds                                 |
| 2048       | ±20 arc seconds                                 |
| 2048       | ±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:** ±1 mm

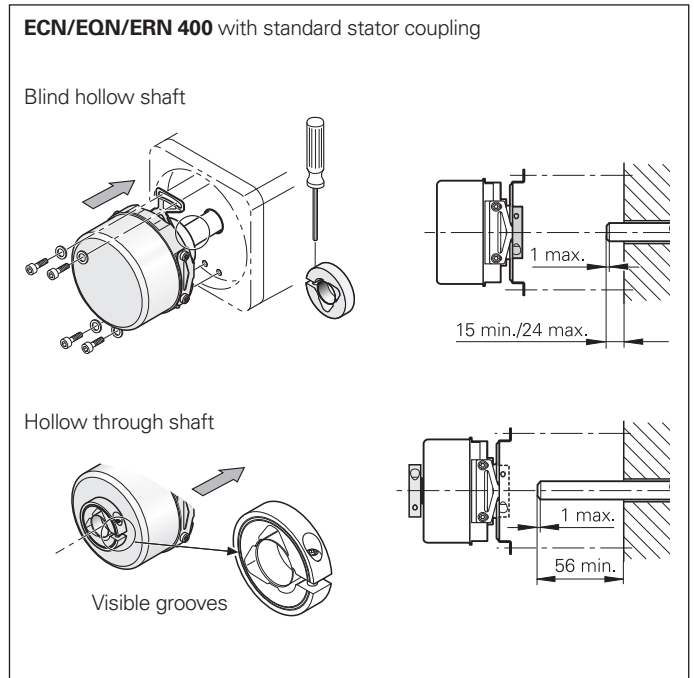
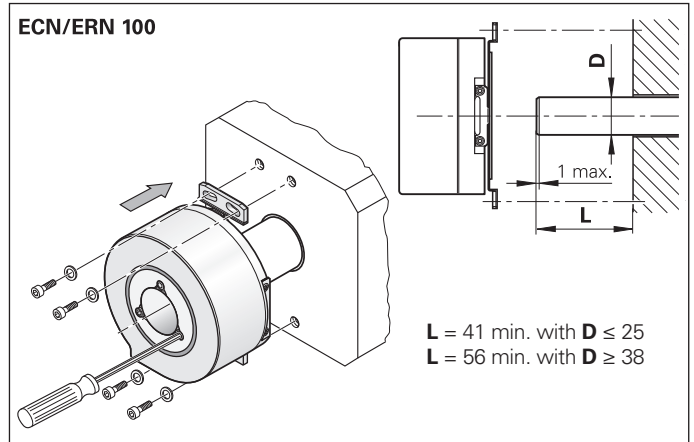
**ECN/EQN/ERN 1000:** ±0.5 mm

**ECN/ERN 100:** ±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.

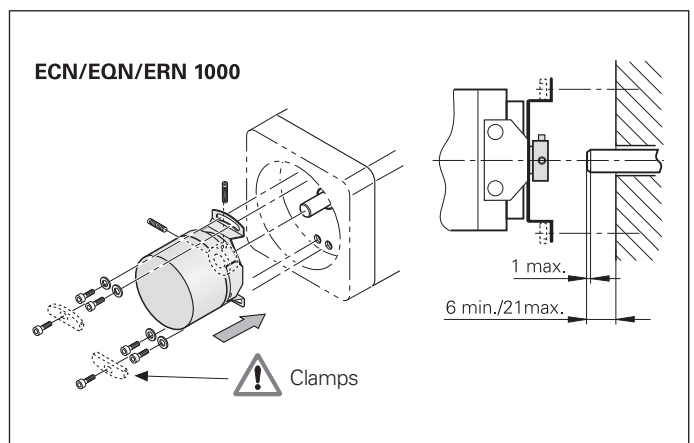


Dynamic applications require the highest possible natural frequencies  $f_N$  of the system's coupling (see also *General mechanical information*). These natural frequencies can be attained through the shaft clamping on the flange side and a coupling via four screws or, in the case of the ECN/EQN/ERN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

### Clamping ring

For ECN/EQN/ERN 400

Through the use of a second clamping ring, the maximum mechanically permissible shaft speed of rotary encoders with a hollow through shaft can be increased up to 12000 rpm.

ID 540741-xx

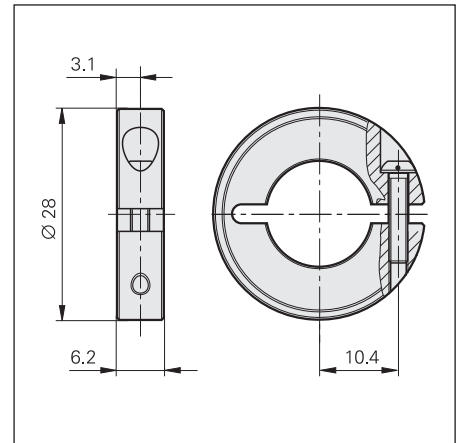
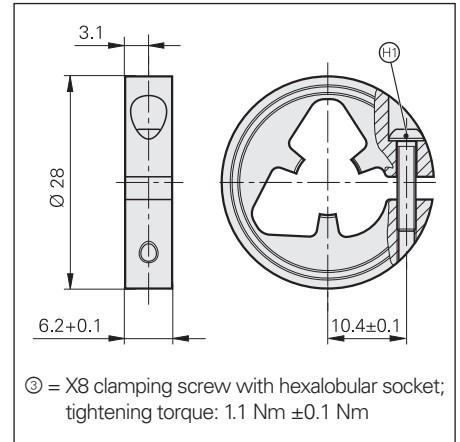
In the case of safe, hollow-shaft connections, repeated fastening reduces the screw force. In order to maintain the required safety factor for friction-locked connections, the maximum permissible number of fastening procedures is limited to four. Beyond this number of repetitions, mechanical fault exclusion cannot be guaranteed. In such cases, new clamping rings must be separately ordered:

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



### Service life

Unless otherwise specified, HEIDENHAIN encoders are designed for a service life of 20 years, equivalent to 40000 operating hours under typical conditions (maximum permissible misalignment and radial runout in accordance with the required mating dimensions).



When **high shaft loads** are involved, such as with friction wheels, pulleys, or sprockets, HEIDENHAIN recommends mounting the ECN/EQN/ERN 400 with a bearing assembly.

### Bearing assembly

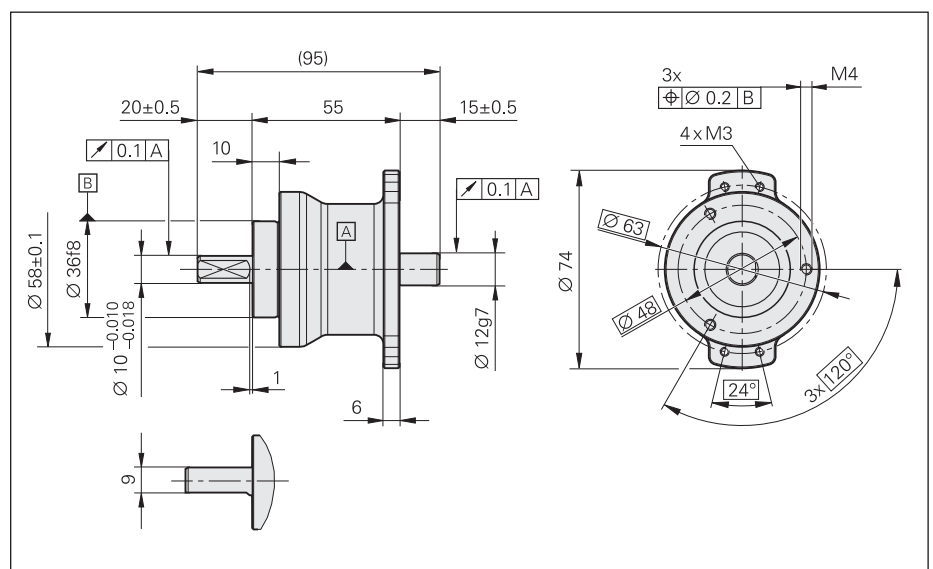
For ECN/EQN/ERN 400

With blind hollow shaft

ID 574185-03

The bearing assembly is able to absorb large radial shaft loads and prevents overloading of the encoder bearing. On the encoder side, the bearing assembly features a shaft stub with a diameter of 12 mm, thus making it suitable for the ECN/EQN/ERN 400 encoders featuring a blind hollow shaft. The threaded holes for fastening the stator coupling are also already provided. The flange of the bearing assembly has the same dimensions as those of the clamping flange for the ROD 420/430 series. The bearing assembly can be fastened via the front-face threaded hole, via the mounting flange or via the mounting bracket. For more information, see page 23.

|  | Bearing assembly            |
|--|-----------------------------|
| <b>Permiss. shaft speed <math>n</math></b> | ≤ 6000 rpm                  |
| <b>Shaft load</b>                          | Axial: 150 N; radial: 350 N |
| <b>Operating temperature</b>               | -40 °C to 100 °C            |
| <b>Protection rating EN 60529</b>          | IP64                        |

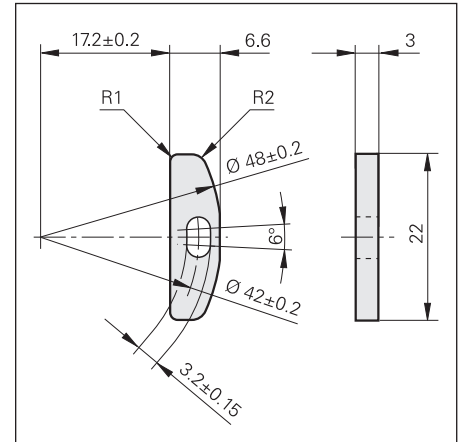


## Mounting accessories

### Clamp

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     | 350378-11 |
|                                  | 152 mm    | 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 26).

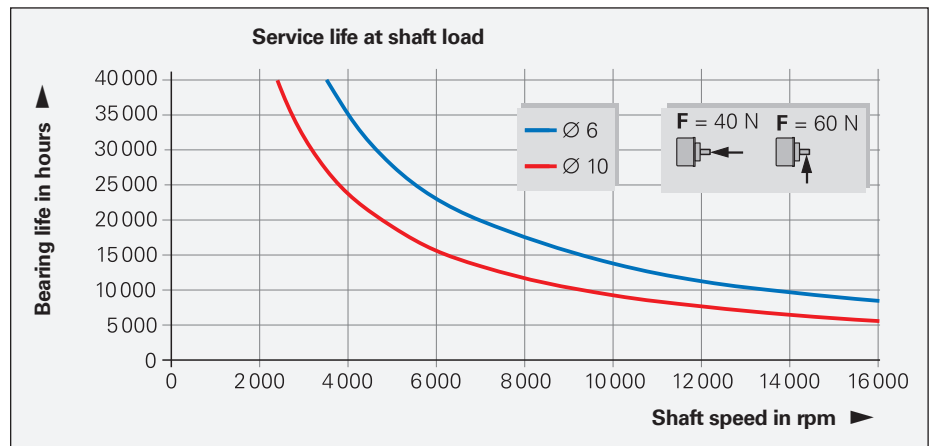
The ROC/ROQ/ROD 400 and ROD 600 series rotary encoders permit high bearing loads (see diagrams). The bearing service life  $L_{10h}$  is calculated in accordance with DIN 281.

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 26.



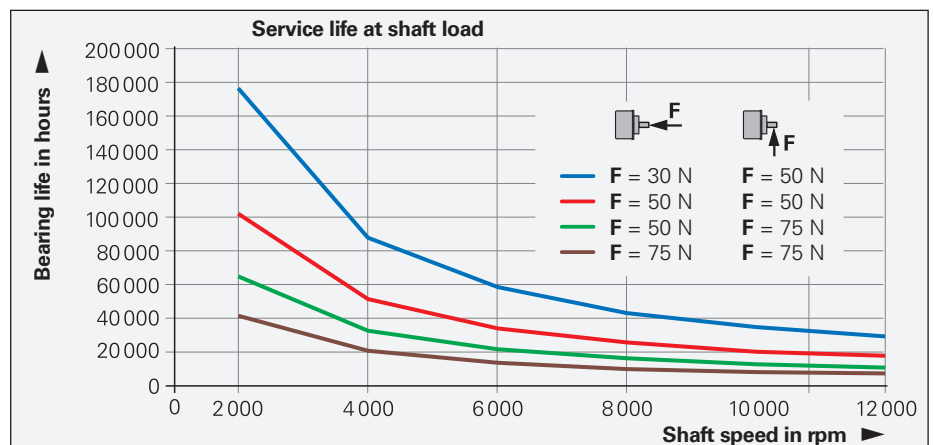
## Bearing lifetime of ROC/ROQ/ROD 400

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 40000 hours.



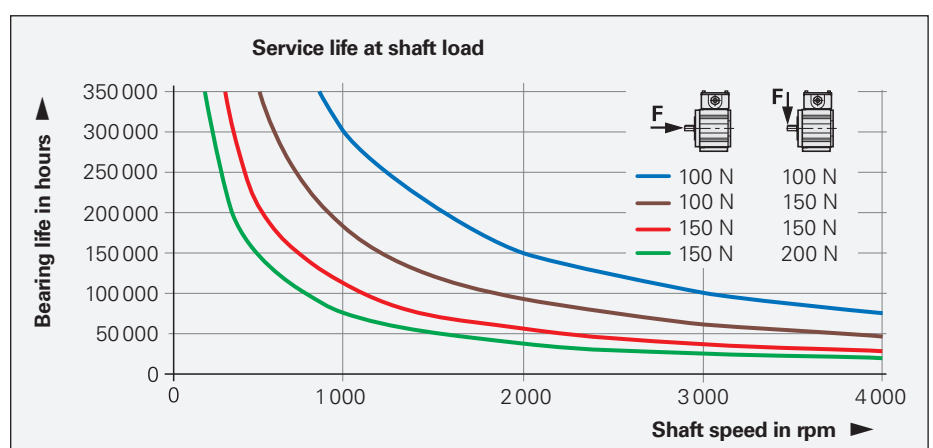
## Bearing life of the ROD 600

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 encoder with clamping flange

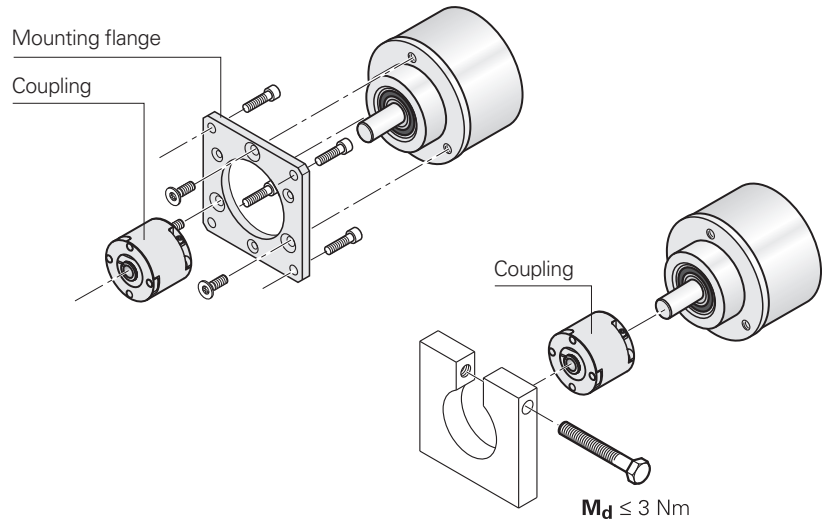
### Mounting

- 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.

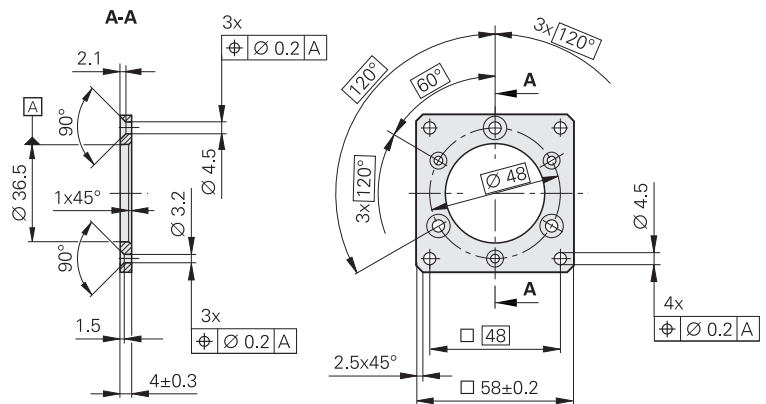
### ROC/ROQ/ROD 400 with clamping flange



### Mounting accessories

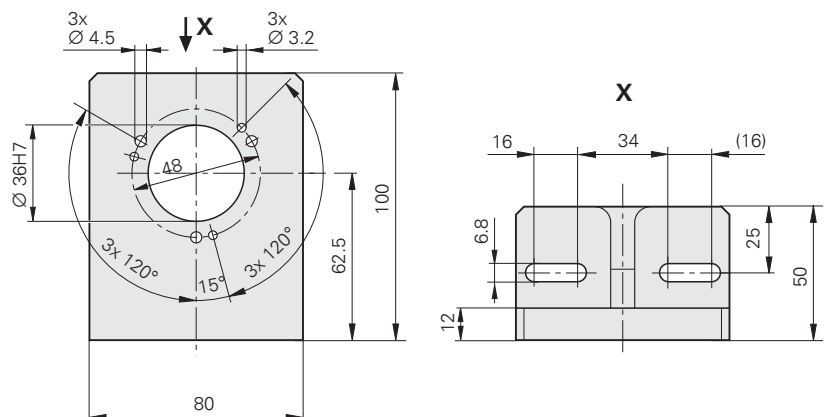
#### Mounting flange

ID 201437-01



#### Mounting bracket

ID 581296-01



## Rotary encoder with flange/base mounting

### Mounting

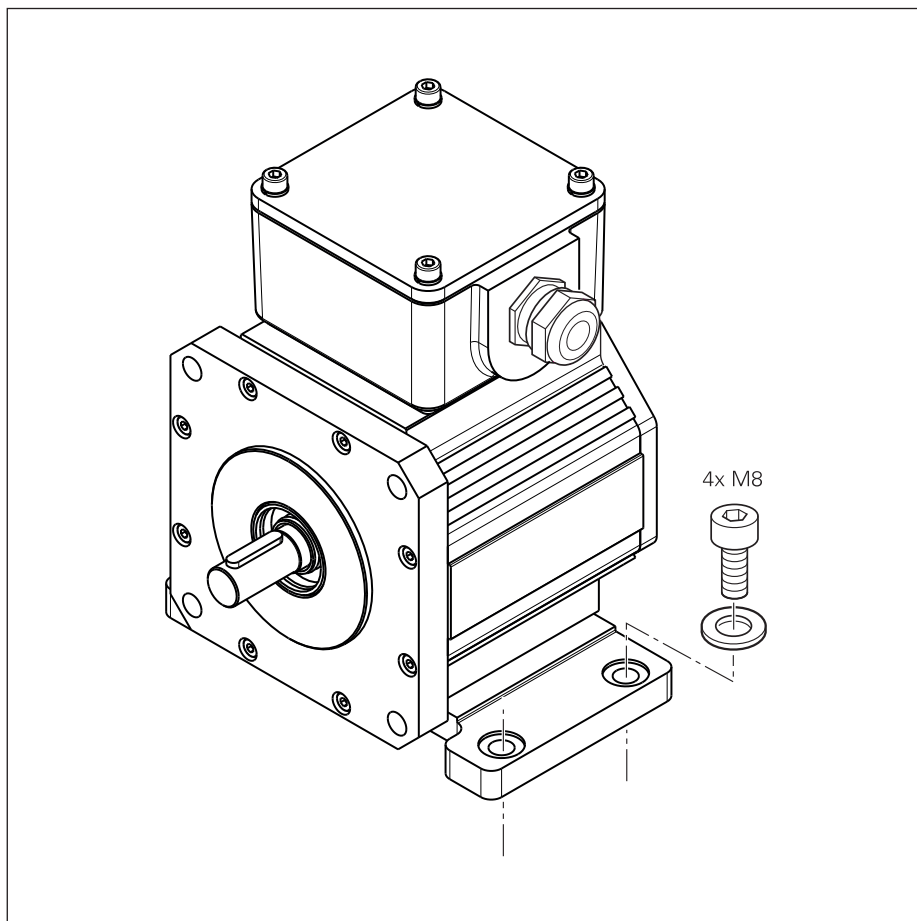
- Via mounting flange, or
- Via base

Fastening is performed with four M8 screws.

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

### Shaft coupling

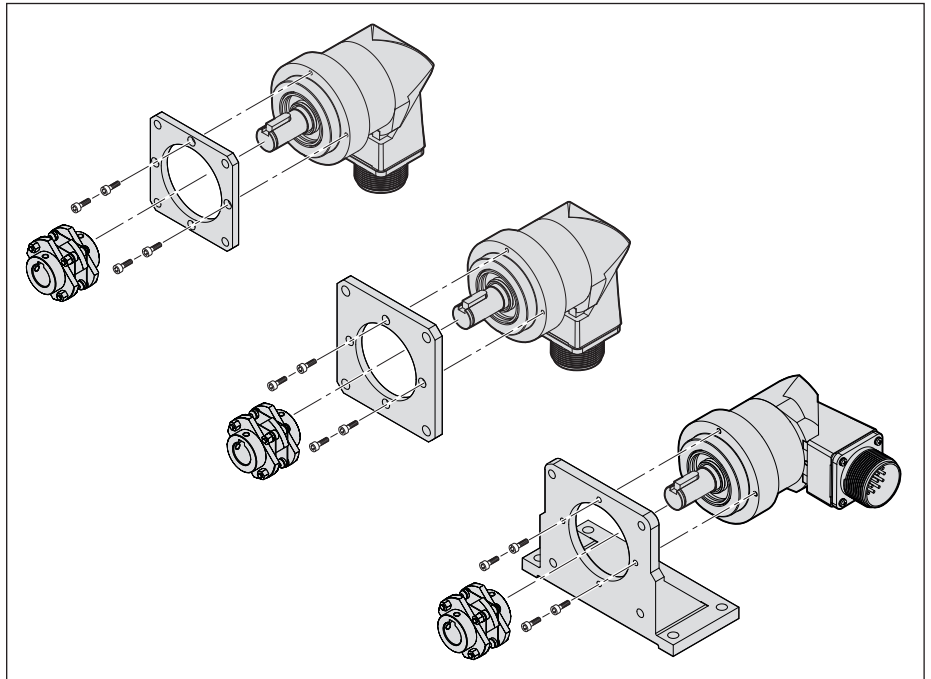
For optimum torque transmission, the encoder shaft is equipped with a key. The C19 and C 212 couplings, which are available as accessories, feature a matching keyway.



## ROD 600 rotary encoder with clamping flange

### Mounting

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



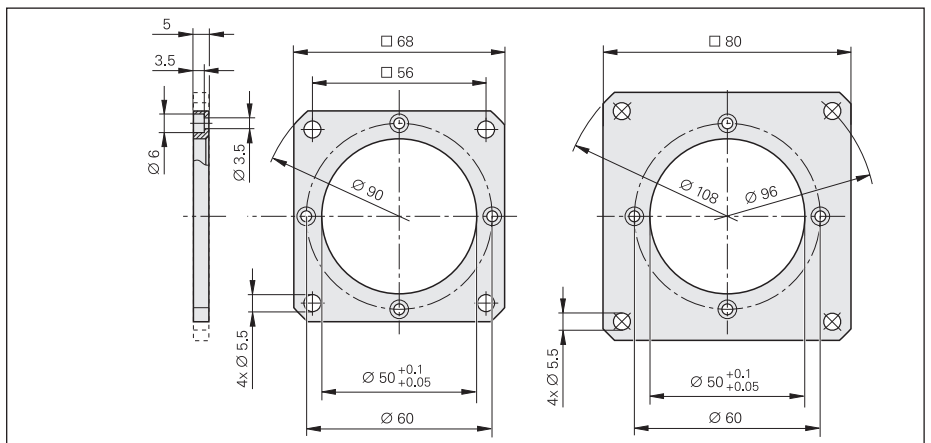
### Mounting accessories

#### Mounting flange (small)

ID 728587-01

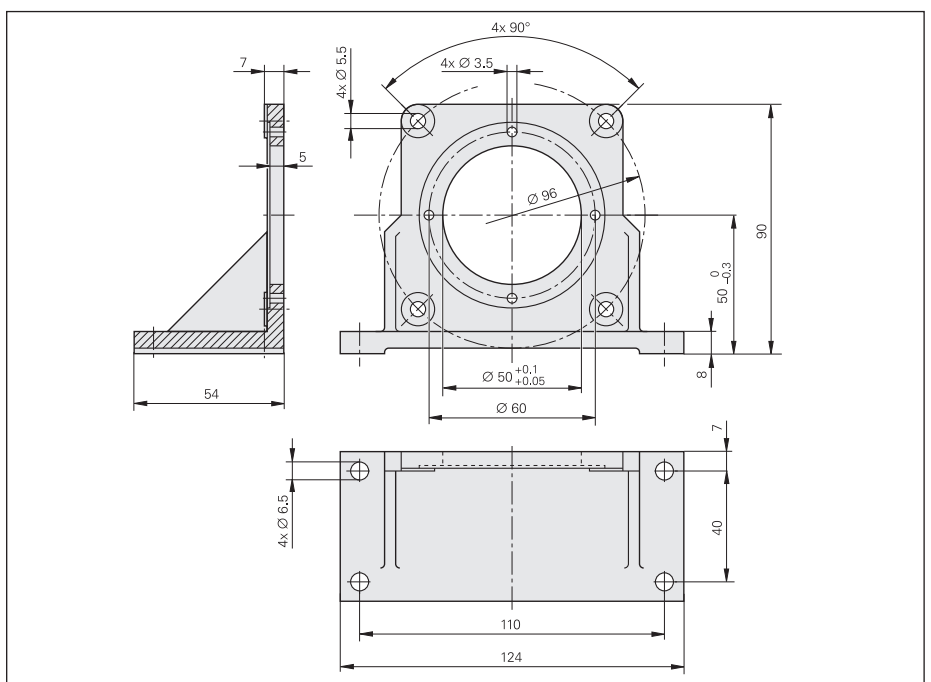
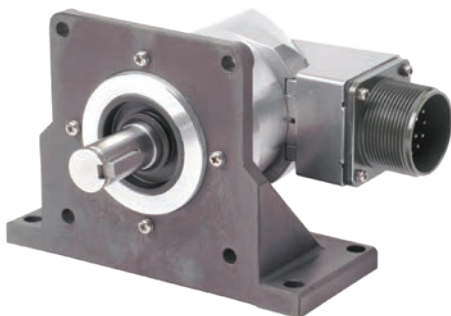
#### Mounting flange (large)

ID 728587-02



### Mounting bracket

ID 728587-03

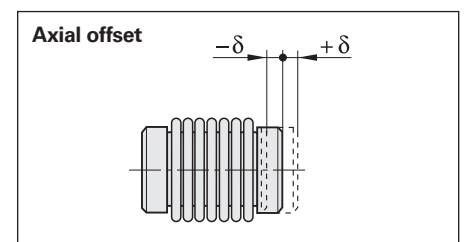
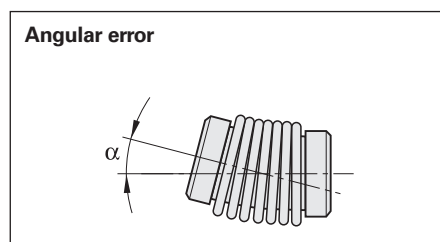
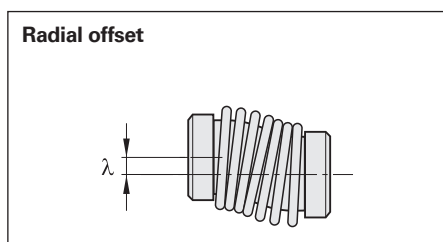


mm  
  
 Tolerancing ISO 8015  
 ISO 2768:1989-mH  
 ≤ 6 mm: ±0.2 mm

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



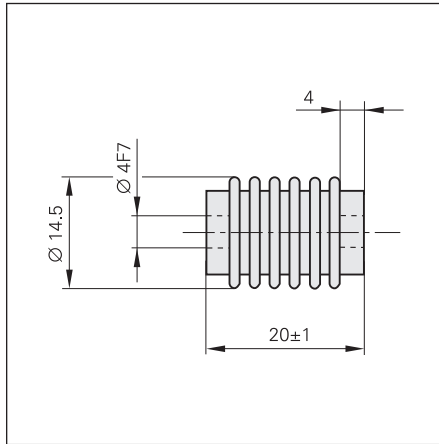
## Mounting accessories

### Screwdriver bit

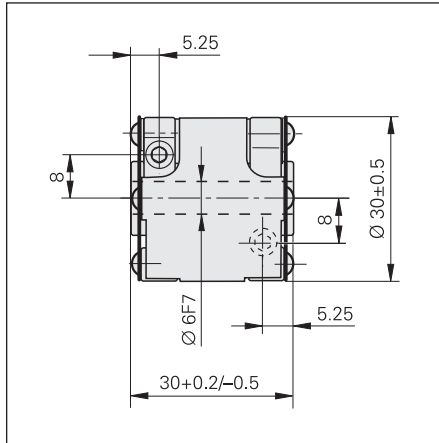
### Screwdriver

See page 18.

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

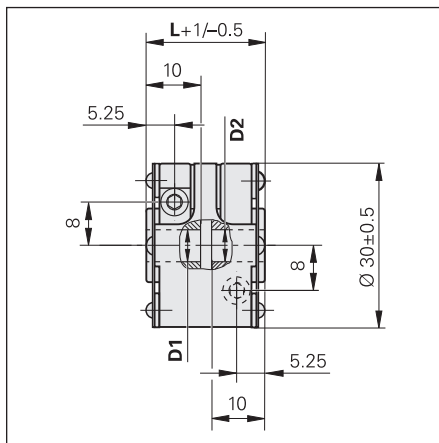


**K 14 diaphragm coupling**  
 For the ROC/ROQ/ROD 400 series  
 with **6 mm shaft diameter**  
 ID 293328-01




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



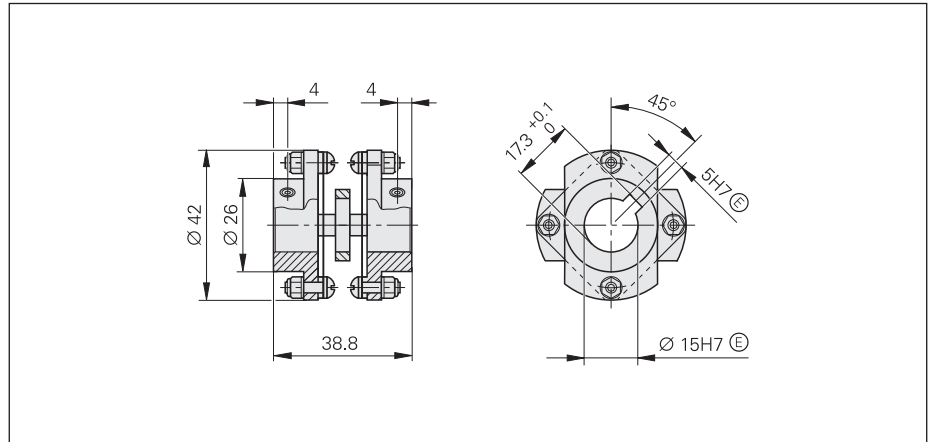
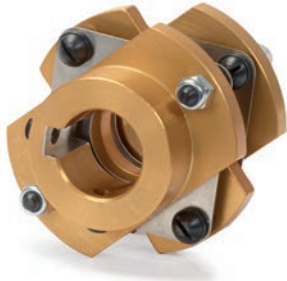
| K 17 Variant | D1      | D2        | L     |
|--------------|---------|-----------|-------|
| 01           | Ø 6 F7  | Ø 6 F7    | 22 mm |
| 02           | Ø 6 F7  | Ø 10 F7   | 22 mm |
| 03           | Ø 10 F7 | Ø 10 F7   | 30 mm |
| 04           | Ø 10 F7 | Ø 10 F7   | 22 mm |
| 05           | Ø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

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

### C 19 diaphragm coupling

For the ROD 1930 and ROD 600 rotary encoders with 15 mm shaft diameter and key

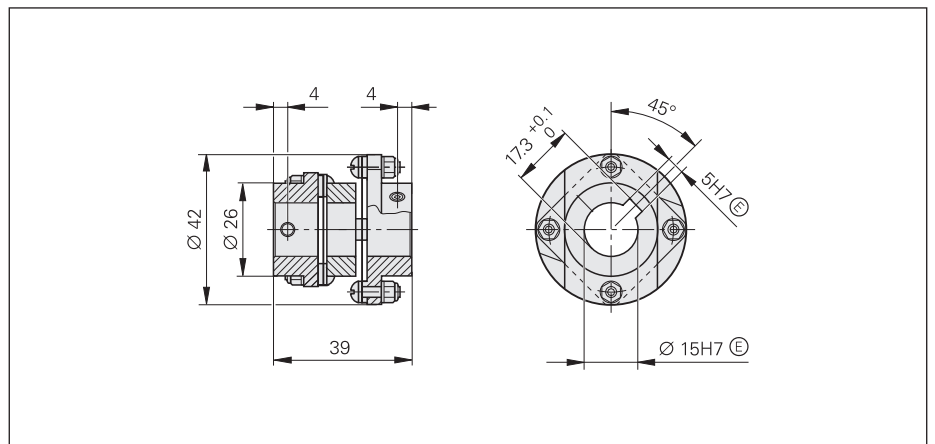
ID 731374-01



### C 212 diaphragm coupling

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  
≤ 6 mm: ±0.2 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

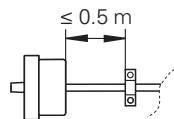
$I$ : Moment of inertia of the rotor in  $\text{kgm}^2$

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 rating (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 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/designer must define the other required final mounting information for the given application (e.g., tightening torque and the necessity for fault exclusion for screws). The stated tolerance ranges in the product's dimension drawing and mounting instructions must also be considered.

All information on screw connections is based on a mounting temperature of 15 °C to 35 °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. The minimum shelf life of these unused screws is two years (storage at  $\leq 30$  °C and  $\leq 65\%$  relative humidity). Their expiration date is printed on the package.

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.

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 the mating surfaces 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>                                      | $\geq 220$ N/mm <sup>2</sup>  | $\geq 600$ N/mm <sup>2</sup>   |
| <b>Yield strength <math>R_{p0.2}</math> or yield point <math>R_e</math></b>   | Not relevant  | $\geq 400$ N/mm <sup>2</sup>   |
| <b>Shear strength <math>\tau_a</math></b>                                     | $\geq 130$ N/mm <sup>2</sup>  | $\geq 390$ N/mm <sup>2</sup>   |
| <b>Interface pressure <math>p_G</math></b>                                    | $\geq 250$ N/mm <sup>2</sup>  | $\geq 660$ N/mm <sup>2</sup>   |
| <b>Modulus of elasticity E (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 expansion <math>\alpha_{\text{therm}}</math> (at 20 °C)</b> | $\leq 25 \cdot 10^{-6}$ K <sup>-1</sup>   | $10 \cdot 10^{-6}$ K <sup>-1</sup> to $17 \cdot 10^{-6}$ K <sup>-1</sup> |
| <b>Surface roughness Rz</b>   | $\leq 16$ $\mu\text{m}$   |  |
| <b>Friction values</b>  | Mounting surfaces must be clean and free of grease. Use screws from HEIDENHAIN in their delivery condition. |  |
| <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  |  |

Screws with material bonding anti-rotation lock must not be used more than once. 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.

Rotary encoders with a bearing and 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.

### 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 longer storage periods

HEIDENHAIN recommends the following in order to make storage periods beyond 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 40000 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 encoders still in their packaging, a **storage temperature range** of -30 °C to 65 °C applies (HR 1120: -30 °C to 70 °C).

The **operating temperature range** specifies the temperatures that a rotary encoder is permitted to reach during operation in the actual installation environment. 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.

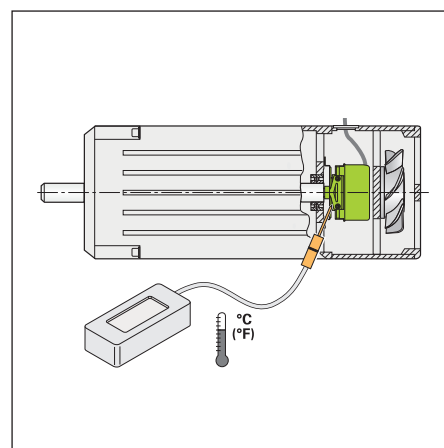
This table shows the approximate self-heating values to be expected for the rotary encoders. In the worst case, the amount of self-heating may be affected by multiple operating parameters, such as a 30 V supply voltage and maximum shaft speed. Thus, if an encoder is being operated close to its maximum 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><i>Solid shaft</i>                 | ≈ + 5 K<br>With IP66 rating:<br>≈ +10 K |
| <b>ECN/EQN/ERN 400/1300</b><br><i>Tapered shaft</i>      | ≈ + 5 K<br>With IP66 rating:<br>≈ +10 K |
| <b>ECN/EQN/ERN 400/1300</b><br><i>Blind hollow shaft</i> | ≈ +30 K<br>With IP66 rating:<br>≈ +40 K |
| <b>ECN/EQN/ERN 400</b><br><i>Hollow through shaft</i>    | ≈ +40 K<br>With IP66 rating:<br>≈ +50 K |
| <b>ECN/ERN 100</b><br><i>Hollow through shaft</i>        | ≈ +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*)

# Safety-related position measuring systems

## Functionally safe axes

Driven axes and 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.

## 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 L10mr 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

## 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

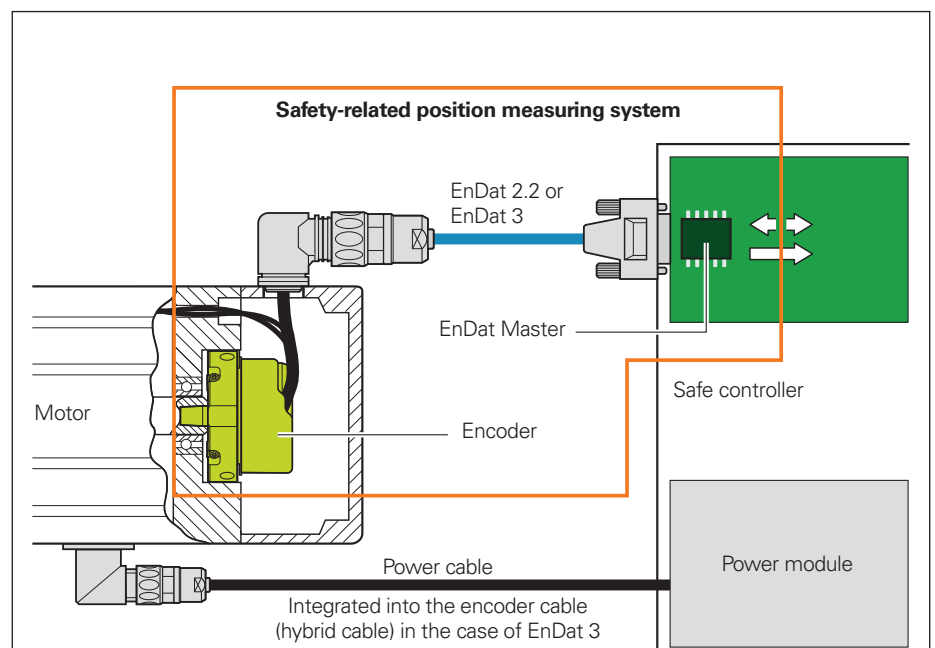
In addition to encoders explicitly qualified for safety applications, standard encoders (e.g., with Fanuc interface or 1 V<sub>PP</sub> signals) can also be used in safe axes. In such cases, the characteristics of the encoders must be matched to the requirements of the given controller. For this purpose, 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).




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.

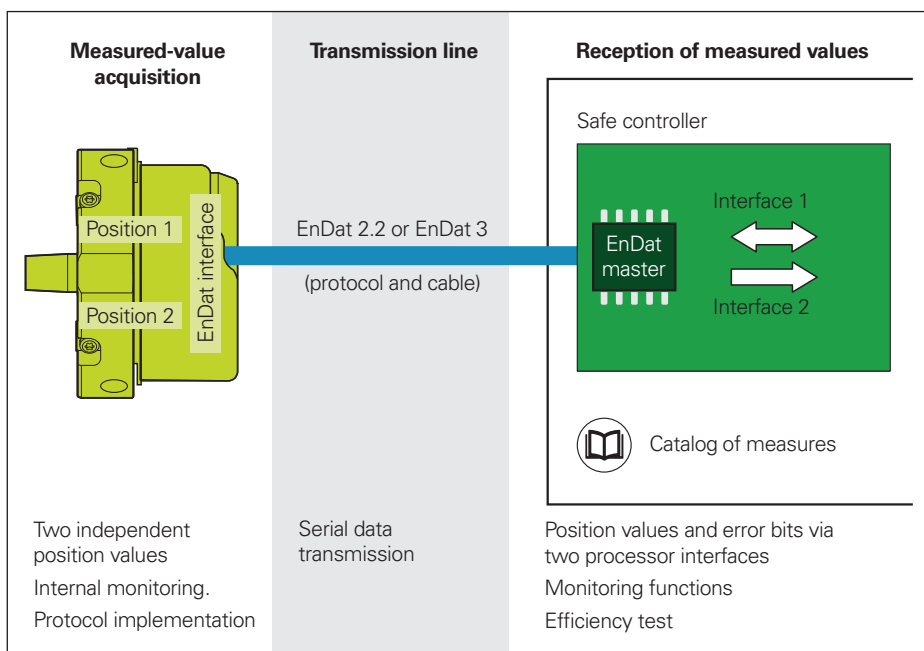
 **Further information:**

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



Safety-related position measurement system with EnDat 2.2 or EnDat 3

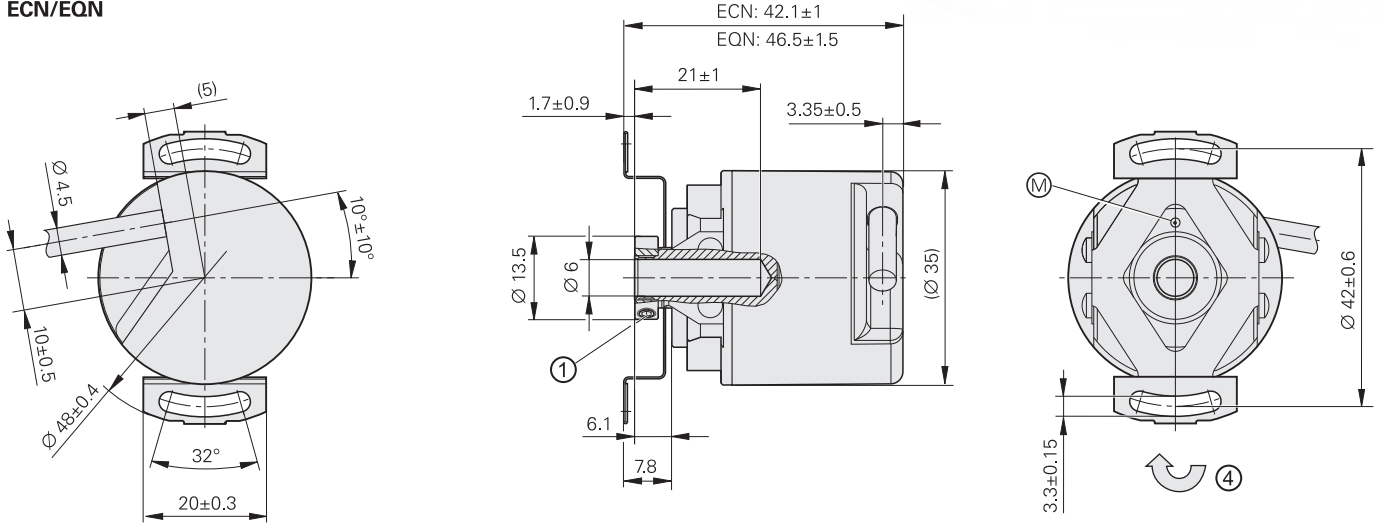
# ECN/EQN/ERN 1000 series

Absolute and incremental rotary encoders

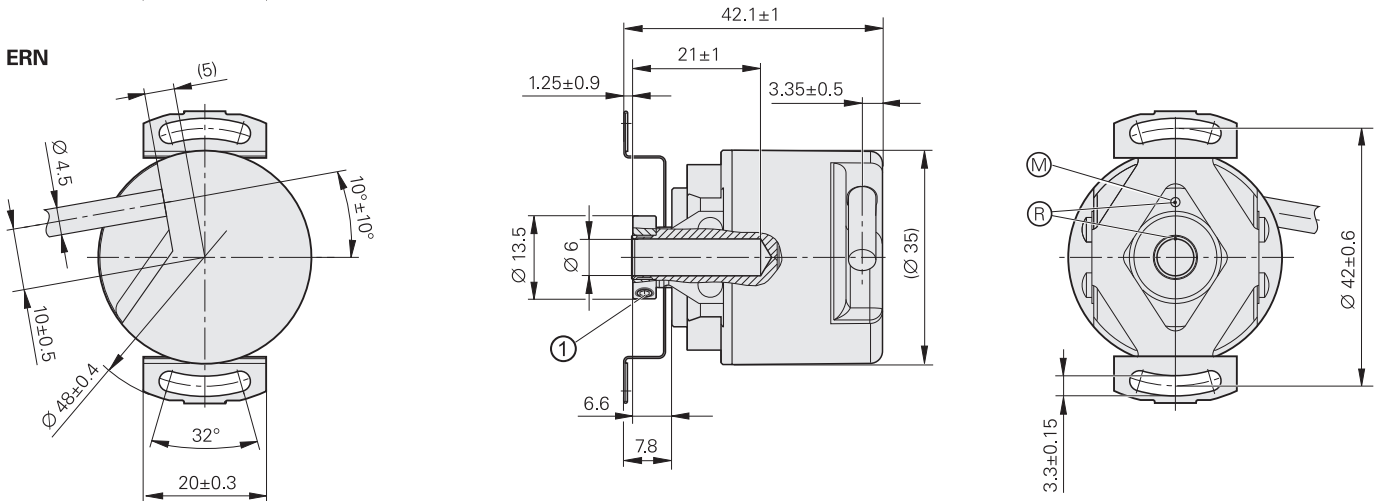
- Stator coupling for plane surface
- Blind hollow shaft



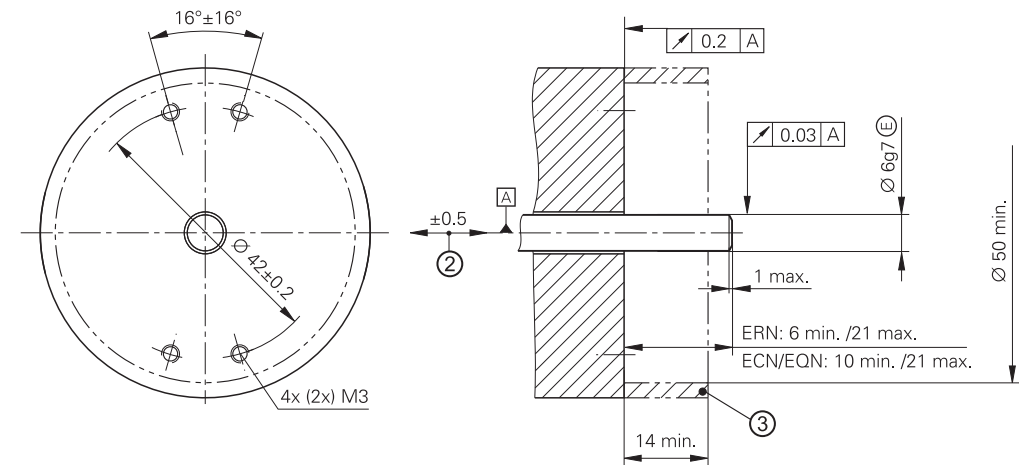
## ECN/EQN



## ERN







## Required mating dimensions



mm  
 Tolerancing ISO 8015  
 ISO 2768:1989-mH  
 $\leq 6$  mm:  $\pm 0.2$  mm

- ▣ = Bearing of mating shaft
- Ⓜ = Measuring point for operating temperature
- Ⓢ = Reference mark position  $\pm 20^\circ$
- 1 = Two screws in clamping ring; tightening torque:  $0.6 \text{ Nm} \pm 0.1 \text{ Nm}$ ; 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  |
| <b>Interface</b>                                       |  |  |  |  |
| Line counts*   | 100 200 <b>250</b><br><b>1000 1024</b>  | 360 400<br>1500 2000  | <b>500</b> 720 900<br><b>2048 2500 3600</b>                                       | 1000 2500 3600  |
| Reference mark   | One   |   |   |   |
| Integrated interpolation*                              | –   |   |   | 5-fold<br>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  |
| <b>System accuracy</b>                                 | 1/20 of grating period  |   |   |   |
| <b>Electrical connection*</b>                          | <b>Cable (1 m/5 m) with or without M23 coupling</b>                               |   |   | Cable (5 m) without connecting element  |
| Supply voltage   | DC 5 V ±0.5 V   | 10 V to 30 V DC   | DC 5 V ±0.5 V   | DC 5 V ±0.25 V  |
| Current consumption without load                       | ≤ 120 mA  | ≤ 150 mA  | ≤ 120 mA  | ≤ 155 mA  |
| <b>Shaft</b>   | Blind hollow shaft Ø 6 mm   |   |   |   |
| Mech. permiss. shaft speed <i>n</i>                    | ≤ 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)  |   |   |   |
| <b>Max. operating temp.</b> <sup>2)</sup>              | 100 °C  | 70 °C   | 100 °C  | 70 °C   |
| <b>Min. operating temp.</b>                            | <i>Fixed cable: –30 °C; moving cable: –10 °C</i>                                  |   |   |   |
| <b>Protection rating</b> EN 60529                      | IP64  |   |   |   |
| <b>Mass</b>  | ≈ 0.1 kg  |   |   |   |
| <b>Valid for ID</b>                                    | 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 correlation between the operating temperature and the shaft speed or supply voltage, see *General mechanical information*


**Absolute**
**Singleturn**
**ECN 1023**
**ECN 1013**

|  |  |  |
|--|--|--|
| <b>Interface</b>   | EnDat 2.2  |  |
| 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: 85 mA   |  |
| <b>Shaft</b>   | Blind hollow shaft Ø 6 mm  |  |
| Mech. permiss. shaft speed $n$                           | 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>                              | <i>Fixed cable:</i> –30 °C; <i>moving cable:</i> –10 °C                          |  |
| <b>Protection rating</b> EN 60529                        | IP64   |  |
| <b>Mass</b>  | ≈ 0.1 kg   |  |
| <b>Valid for ID</b>                                      | 606683-xx  | 606681-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>

|                 |                 |
|-----------------|-----------------|
| <b>Multitum</b> |                 |
| <b>EQN 1035</b> | <b>EQN 1025</b> |

|  |   |
|--|---|
| EnDat22                                      | EnDat01                                     |
| 8388608 (23 bits)                            | 8192 (13 bits)                              |
| 4096 (12 bits)                               |   |
| Pure binary                                  |   |
| ≤ 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 |
| DC 3.6 V to 14 V                |                               |
| 3.6 V: ≤ 0.7 W<br>14 V: ≤ 0.8 W |                               |
| 5 V: 105 mA                     |                               |

|                     |  |
|---------------------|--|
| 0.002 Nm (at 20 °C) |  |
|                     |  |
|                     |  |
|                     |  |
|                     |  |
|                     |  |
|                     |  |
|                     |  |
|                     |  |

|           |           |
|-----------|-----------|
| 606688-xx | 606686-xx |
|-----------|-----------|

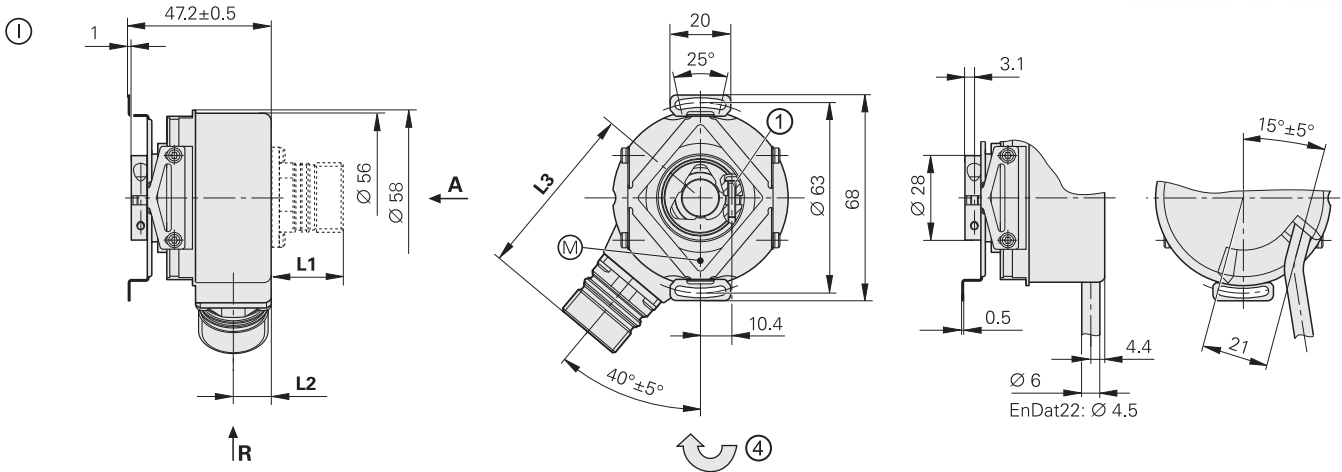
# ECN/EQN/ERN 400 series

Absolute and incremental rotary encoders

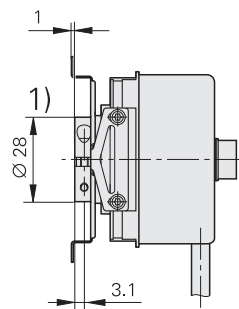
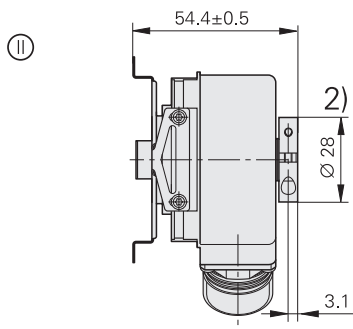
- Stator coupling for plane surface
- Blind hollow shaft or hollow through shaft



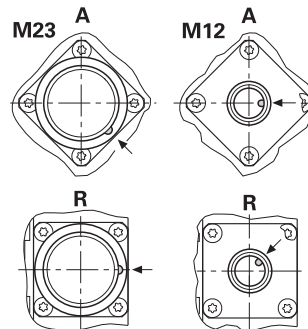
## Blind hollow shaft



## Hollow through shaft

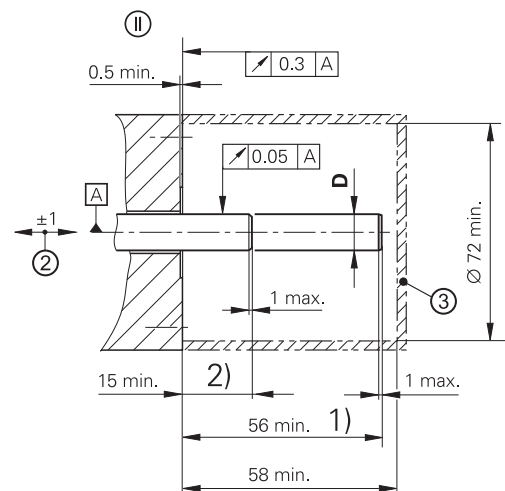
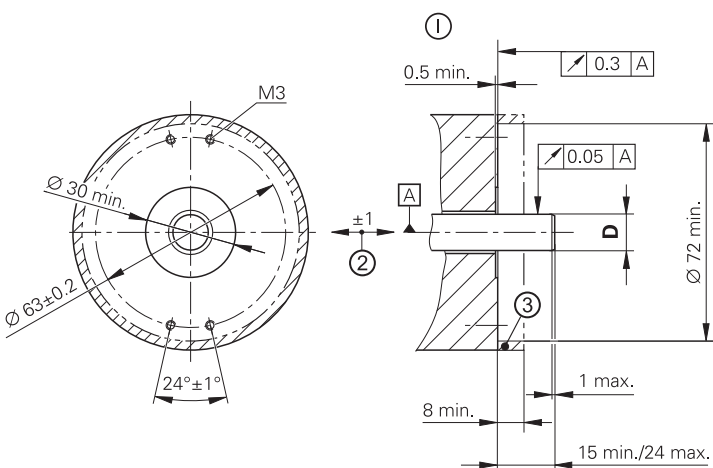


Connector coding  
A = Axial, R = Radial



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

| D        |
|----------|
| Ø 8g7 E  |
| Ø 12g7 E |



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*   | 250 500   |                 |                      | -                                 |
|  | <b>1000 1024 1250 2000 2048 2500 3600 4096 5000</b>   |                 |                      |                                   |
| Reference mark   | One   |                 |                      |                                   |
| Cutoff frequency -3 dB                                   | -   |                 |                      | ≥ 180 kHz                         |
| Output frequency   | ≤ 300 kHz   |                 |                      | -                                 |
| Edge separation a  | ≥ 0.39 μs   |                 |                      | -                                 |
| System accuracy  | 1/20 of grating period  |                 |                      |                                   |
| Electrical connection*                                   | <ul style="list-style-type: none"> <li>• M23 flange socket, radial and axial (with blind hollow shaft)</li> <li>• Cable (1 m) without connecting element</li> </ul> |                 |                      |                                   |
| Supply voltage   | DC 5 V ±0.5 V   | 10 V to 30 V DC | 10 V to 30 V DC      | 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 hollow through shaft (both available in Ø 8 mm or Ø 12 mm)   |                 |                      |                                   |
| Mech. permitt. shaft speed n <sup>2)</sup>               | ≤ 6000 rpm/≤ 12000 rpm <sup>3)</sup>  |                 |                      |                                   |
| Starting torque (typical) at 20 °C                       | <i>Blind hollow shaft:</i> 0.01 Nm<br><i>Hollow through shaft:</i> 0.025 Nm (with IP66: 0.075 Nm)   |                 |                      |                                   |
| Moment of inertia of rotor                               | ≤ 4.3 · 10 <sup>-6</sup> kgm <sup>2</sup>   |                 |                      |                                   |
| Permitt. 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> ; <i>flange socket version:</i> 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.                                     | <i>Flange socket or fixed cable:</i> -40 °C; <i>moving cable:</i> -10 °C  |                 |                      |                                   |
| Protection rating EN 60529                               | <i>At housing:</i> IP67 (IP66 with hollow through shaft)<br><i>At shaft inlet:</i> 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  | <i>512 lines:</i> ≤ 5000/12000 rpm<br>±1 LSB/±100 LSB<br><i>2048 lines:</i> ≤ 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>–  | <i>512 lines:</i> ≥ 130 kHz; <i>2048 lines:</i> ≥ 400 kHz<br>–  |   |
| <b>System accuracy</b>                                   | ±20"  | <i>512 lines:</i> ±60"; <i>2048 lines:</i> ±20"   |   |
| <b>Electrical connection*</b>                            | <ul style="list-style-type: none"> <li>• <b>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 free cable end</li> </ul> |   |
| Supply voltage   | DC 3.6 V to 14 V  |   | 4.75 V to 30 V DC                             |
| Power consumption<br>(maximum)                           | 3.6 V: ≤ 0.6 W<br>14 V: ≤ 0.7 W   |   | 5 V: ≤ 0.8 W<br>10 V: ≤ 0.65 W<br>30 V: ≤ 1 W |
| Current consumption<br>(typical, without load)           | 5 V: 85 mA  |   | 5 V: 90 mA<br>24 V: 24 mA                     |
| <b>Shaft*</b>  | <b>Blind hollow shaft</b> or hollow through shaft (both available in Ø 8 mm or Ø 12 mm)   |   |   |
| Mech. permiss. shaft<br>speed $n^3)$                     | ≤ 6000 rpm/≤ 12000 rpm <sup>4)</sup>  |   |   |
| Starting torque (typical)<br>at 20 °C                    | <i>Blind hollow shaft:</i> 0.01 Nm; <i>hollow through shaft:</i> 0.025 Nm (with IP66: 0.075 Nm)   |   |   |
| Moment of inertia of rotor                               | ≤ 4.3 · 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> ; <i>flange socket version:</i> ≤ 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>                              | <i>Flange socket or fixed cable:</i> –40 °C; <i>moving cable:</i> –10 °C  |   |   |
| <b>Protection rating</b> EN 60529                        | <i>At housing:</i> IP67 (IP66 with hollow through shaft)<br><i>At shaft inlet:</i> 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>

Multitum



EQN 437

EQN 425

|  |  |  |
|--|--|--|
| EnDat 2.2  | EnDat 2.2  | SSI  |
| EnDat22  | EnDat01  | SSI41r1  |
| 33554432 (25 bits)   | 8192 (13 bits)   |  |
| 4096   |  |  |
| Pure binary  |  | Gray   |
| ≤ 12000 rpm<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"  |  |
| <ul style="list-style-type: none"> <li>• M12 flange socket, radial</li> <li>• Cable (1 m) with M12 coupling</li> </ul> | <ul style="list-style-type: none"> <li>• M23 flange socket, radial</li> <li>• Cable (1 m) with M23 coupling or free cable end</li> </ul> |  |
| DC 3.6 V to 14 V   | DC 3.6 V to 14 V   | 4.75 V to 30 V DC                                |
| 3.6 V: ≤ 0.7 W<br>14 V: ≤ 0.8 W  |  | 5 V: ≤ 0.95 W<br>10 V: ≤ 0.75 W<br>30 V: ≤ 1.1 W |
| 5 V: 105 mA  |  | 5 V: 120 mA<br>24 V: 28 mA                       |
| 1178025-xx <sup>5)</sup>   | 1109258-xx   | 1353131-xx                                       |

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

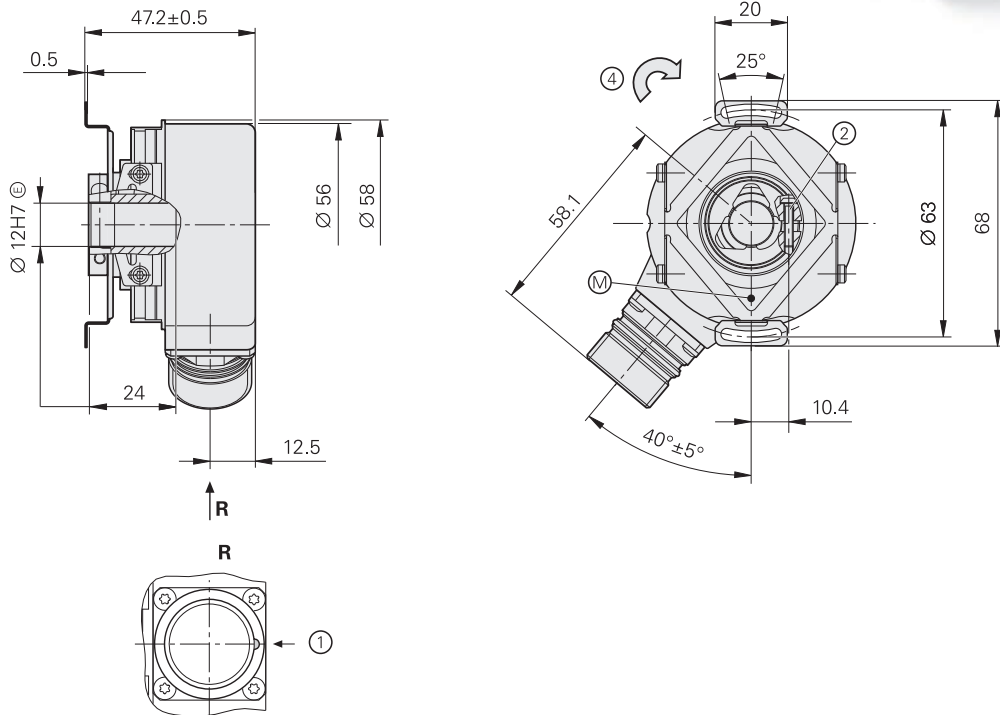
<sup>4)</sup> With two shaft clampings (only with hollow through shaft)

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

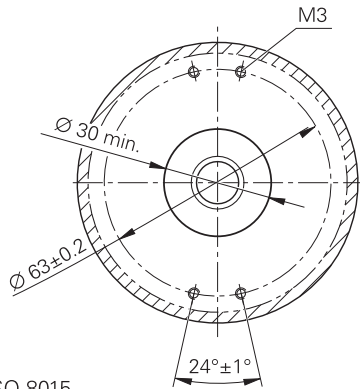
# EQN 425

Rotary encoder for absolute position values with blind hollow shaft

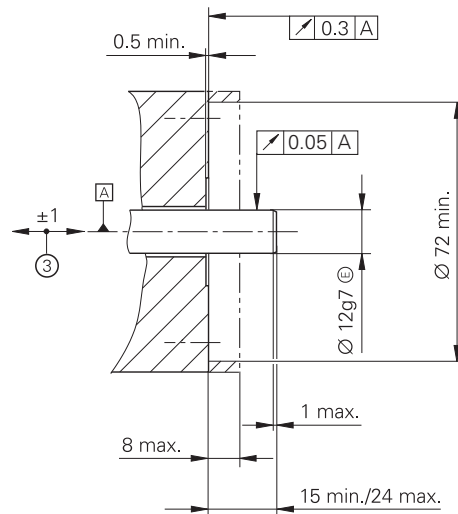
- Stator coupling for plane surface
- EnDat interface
- Additional incremental signals with TTL or HTL levels



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 movement permitted
- 4 = Direction of shaft rotation for ascending position values

|  | <b>Absolute</b>  |                        |                        |   |                        |                        |
|--|--|------------------------|------------------------|---|------------------------|------------------------|
|  | <b>EQN 425 multium</b>   |                        |                        |   |                        |                        |
| <b>Interface</b>   | 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   | $\leq 52 \text{ kHz}$  | $\leq 103 \text{ kHz}$ | $\leq 205 \text{ kHz}$ | $\leq 52 \text{ kHz}$   | $\leq 205 \text{ kHz}$ | $\leq 410 \text{ kHz}$ |
| <b>System accuracy</b> <sup>1)</sup>                     | $\pm 60''$   | $\pm 60''$             | $\pm 20''$             | $\pm 60''$  | $\pm 20''$             | $\pm 20''$             |
| <b>Electrical connection</b>                             | 17-pin M23 radial flange socket (male)   |                        |                        |   |                        |                        |
| Cable length <sup>2)</sup>                               | $\leq 100 \text{ m}$ (with HEIDENHAIN cable)   |                        |                        |   |                        |                        |
| Supply voltage   | 10 V to 30 V DC  |                        |                        | 4.75 V to 30 V DC   |                        |                        |
| Power consumption (max.) <sup>3)</sup>                   | See <i>Power consumption</i> 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: $\leq 25 \text{ mA}$      |                        |                        |
| <b>Shaft</b>   | Blind hollow shaft $\varnothing 12 \text{ mm}$                                       |                        |                        |   |                        |                        |
| Mech. permitt. shaft<br>speed $n$ <sup>4)</sup>          | $\leq 6000 \text{ rpm}$  |                        |                        |   |                        |                        |
| Starting torque (typical)                                | 0.01 Nm (at 20 °C)   |                        |                        |   |                        |                        |
| Moment of inertia of rotor                               | $4.3 \cdot 10^{-6} \text{ kgm}^2$  |                        |                        |   |                        |                        |
| Permitt. axial motion of<br>measured shaft               | $\leq \pm 1 \text{ mm}$  |                        |                        |   |                        |                        |
| <b>Vibration:</b> 10 Hz to 2000 Hz<br><b>Shock:</b> 6 ms | $\leq 150 \text{ m/s}^2$ (EN 60068-2-6)<br>$\leq 2000 \text{ m/s}^2$ (EN 60068-2-27) |                        |                        |   |                        |                        |
| <b>Max. operating temp.</b> <sup>4)</sup>                | 100 °C   |                        |                        |   |                        |                        |
| <b>Min. operating temp.</b> <sup>4)</sup>                | -40 °C   |                        |                        |   |                        |                        |
| <b>Protection rating</b> EN 60529                        | Housing: IP67<br>Shaft outlet: IP64  |                        |                        |   |                        |                        |
| <b>Mass</b>  | $\approx 0.30 \text{ kg}$  |                        |                        |   |                        |                        |
| <b>Valid for ID</b>                                      | 1042545-xx   |                        |                        | 1042540-xx  |                        |                        |

\* Please select when ordering

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

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

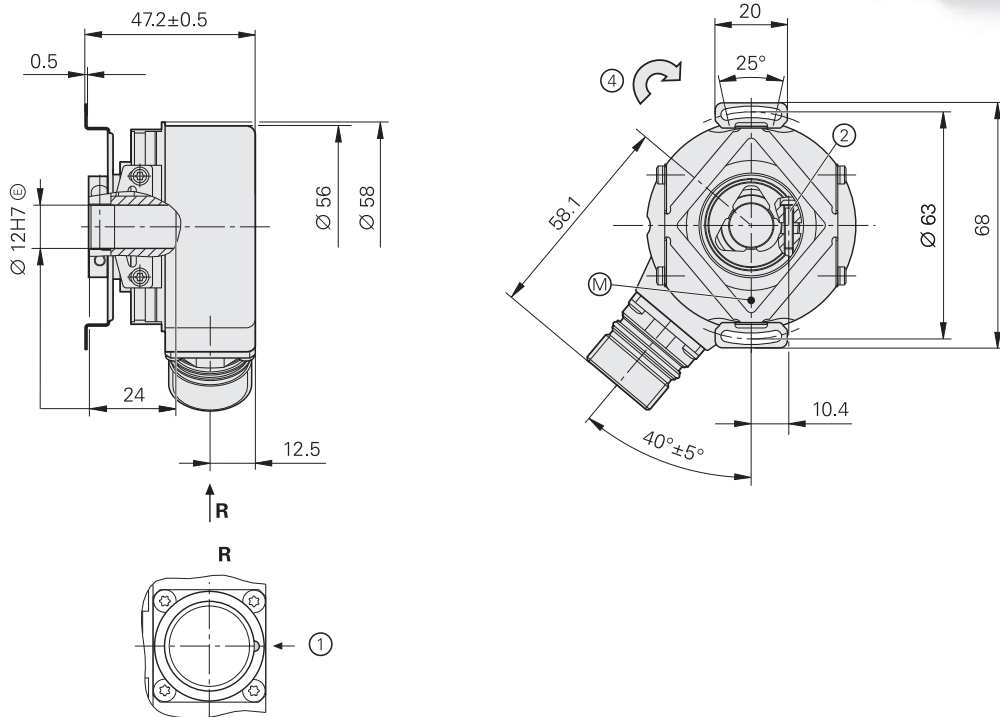
<sup>3)</sup> See *General electrical information* in the *Interfaces of HEIDENHAIN Encoders* brochure

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

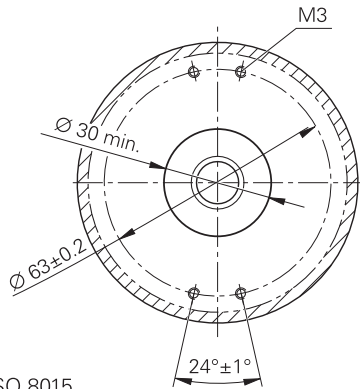
# EQN 425

Rotary encoder for absolute position values with blind hollow shaft

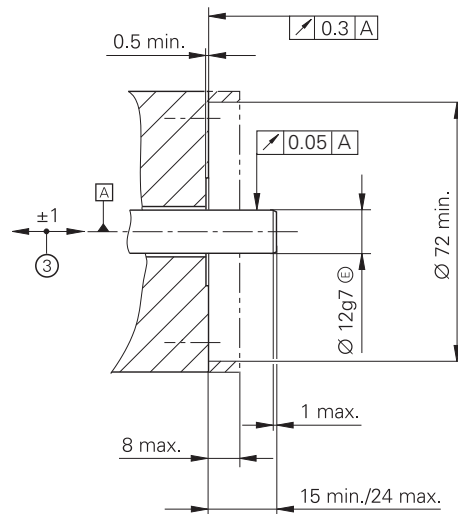
- Stator coupling for plane surface
- SSI interface
- Additional incremental signals with TTL or HTL levels



Required mating dimensions



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 movement permitted
- 4 = Direction of shaft rotation for ascending position values

|  | <b>Absolute</b>  |                        |                        |   |                        |                        |
|--|--|------------------------|------------------------|---|------------------------|------------------------|
|  | <b>EQN 425 multium</b>   |                        |                        |   |                        |                        |
| <b>Interface</b>   | SSI  |                        |                        |   |                        |                        |
| Ordering designation*                                    | SSI41H   |                        |                        | SSI41T  |                        |                        |
| Positions/revolution                                     | 8192 (13 bits)   |                        |                        |   |                        |                        |
| Revolutions  | 4096 (12 bits)   |                        |                        |   |                        |                        |
| Code   | Gray   |                        |                        |   |                        |                        |
| Calculation time $t_{cal}$<br>Clock frequency            | $\leq 5 \mu s$<br>$\leq 1 \text{ MHz}$   |                        |                        |   |                        |                        |
| 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   | $\leq 52 \text{ kHz}$  | $\leq 103 \text{ kHz}$ | $\leq 205 \text{ kHz}$ | $\leq 52 \text{ kHz}$   | $\leq 205 \text{ kHz}$ | $\leq 410 \text{ kHz}$ |
| <b>System accuracy</b> <sup>1)</sup>                     | $\pm 60''$   | $\pm 60''$             | $\pm 20''$             | $\pm 60''$  | $\pm 20''$             | $\pm 20''$             |
| <b>Electrical connection</b>                             | 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   | 10 V to 30 V DC  |                        |                        | 4.75 V to 30 V DC   |                        |                        |
| Power consumption (max.) <sup>3)</sup>                   | See <i>Power consumption</i> 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: $\leq 25 \text{ mA}$      |                        |                        |
| <b>Shaft</b>   | Blind hollow shaft $\varnothing 12 \text{ mm}$                                       |                        |                        |   |                        |                        |
| Mech. perm. shaft<br>speed $n^4)$                        | $\leq 6000 \text{ rpm}$  |                        |                        |   |                        |                        |
| Starting torque (typical)                                | 0.01 Nm (at 20 °C)   |                        |                        |   |                        |                        |
| Moment of inertia of rotor                               | $4.3 \cdot 10^{-6} \text{ kgm}^2$  |                        |                        |   |                        |                        |
| Permiss. axial motion of<br>measured shaft               | $\leq \pm 1 \text{ mm}$  |                        |                        |   |                        |                        |
| <b>Vibration:</b> 10 Hz to 2000 Hz<br><b>Shock:</b> 6 ms | $\leq 150 \text{ m/s}^2$ (EN 60068-2-6)<br>$\leq 2000 \text{ m/s}^2$ (EN 60068-2-27) |                        |                        |   |                        |                        |
| <b>Max. operating temp.</b> <sup>4)</sup>                | 100 °C   |                        |                        |   |                        |                        |
| <b>Min. operating temp.</b> <sup>4)</sup>                | -40 °C   |                        |                        |   |                        |                        |
| <b>Protection rating</b> EN 60529                        | Housing: IP67<br>Shaft outlet: IP64  |                        |                        |   |                        |                        |
| <b>Mass</b>  | $\approx 0.30 \text{ kg}$  |                        |                        |   |                        |                        |
| <b>Valid for ID</b>                                      | 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

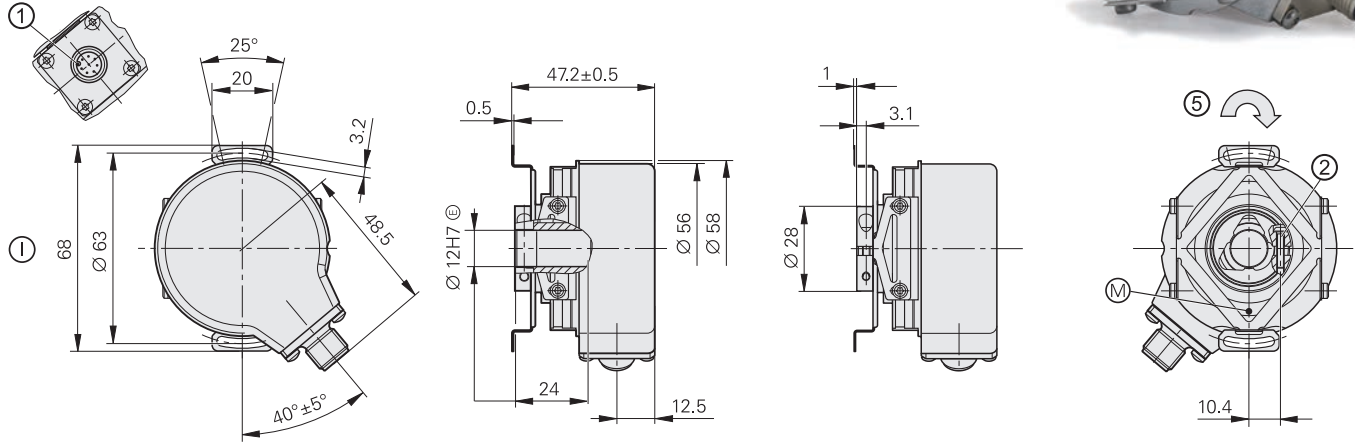
# ECN/EQN 400F/S series

## Absolute rotary encoders

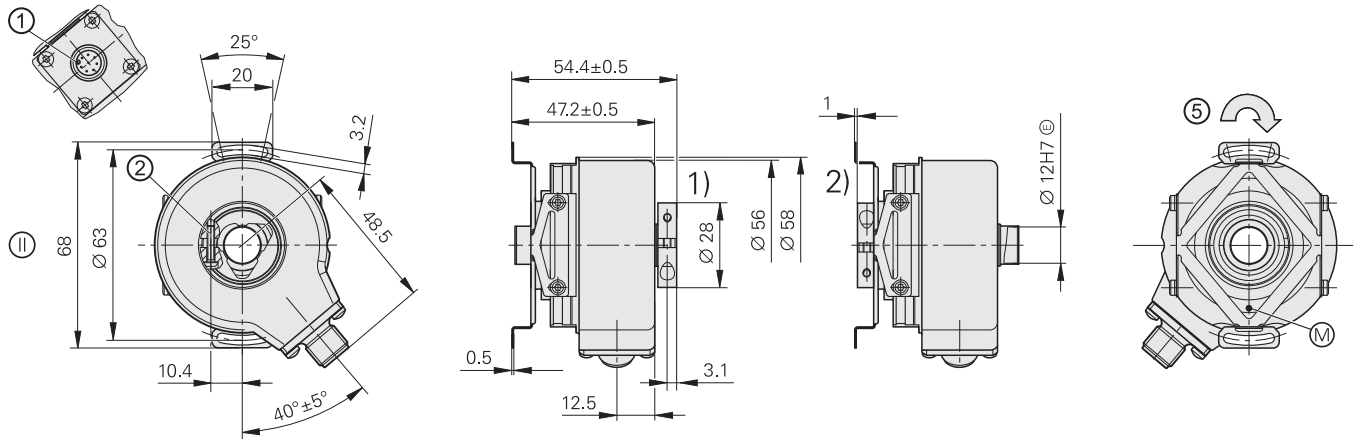
- Stator coupling for plane surface
- Blind hollow shaft or hollow through shaft
- Fanuc Serial Interface or Siemens DRIVE-CLiQ interface



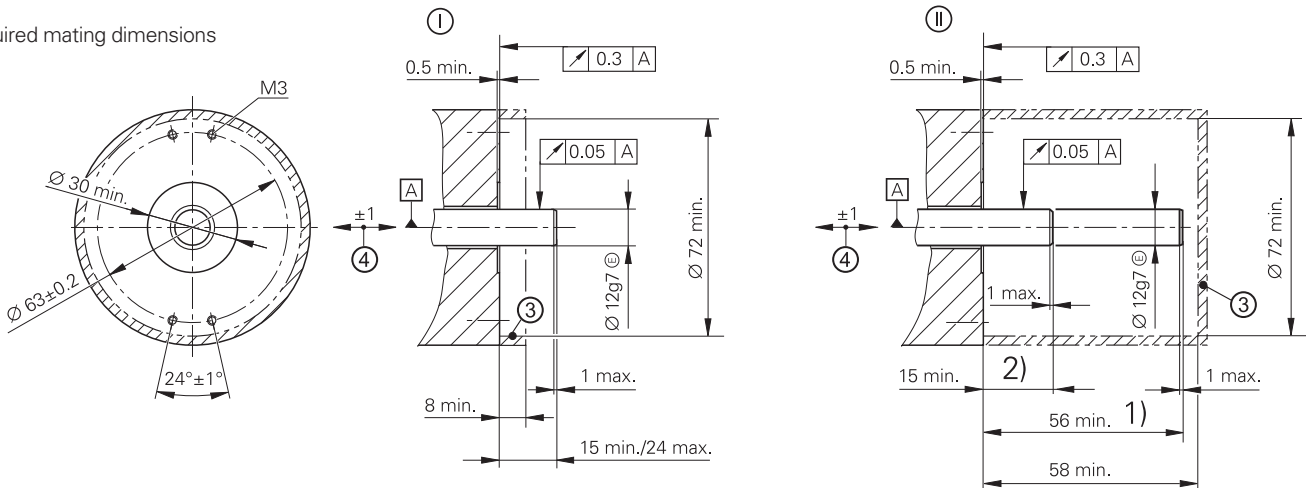
### Blind hollow shaft



### 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>  |  | <b>Multitum</b>                         |  |
|  | <b>ECN 425 F</b>  | <b>ECN 424 S</b>  | <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 bits)  | 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>   |
| DC supply voltage  | 3.6 V to 14 V   | 10 V to 36 V   | 3.6 V to 14 V                           | 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); with DRIVE-CLiQ, also available with blind hollow shaft in Ø 10 mm  |  |   |  |
| Mech. permiss. shaft<br>speed $n^4)$                     | ≤ 6000 rpm/≤ 12000 rpm <sup>5)</sup>  |  |   |  |
| Starting torque (typical)<br>at 20 °C                    | <i>Blind hollow shaft:</i> 0.01 Nm<br><i>Hollow through shaft:</i> 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 rating</b> EN 60529                        | <i>At housing:</i> IP67 (IP66 with hollow through shaft);<br><i>At shaft inlet:</i> IP64 (with DQ01 Ø 12 mm with blind hollow shaft, or with Fanuc06, or with Mit03-4:<br>IP66 is available 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*

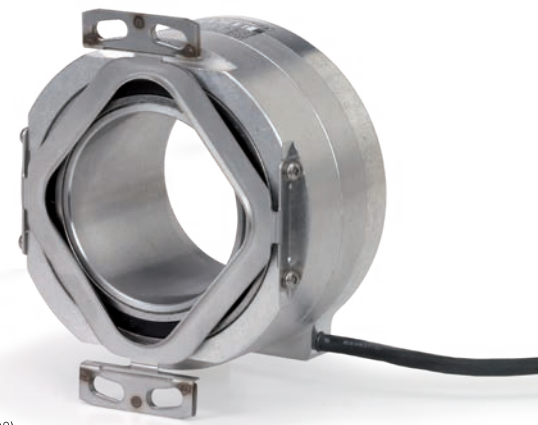
<sup>5)</sup> With two shaft clampings (only with hollow through shaft)

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

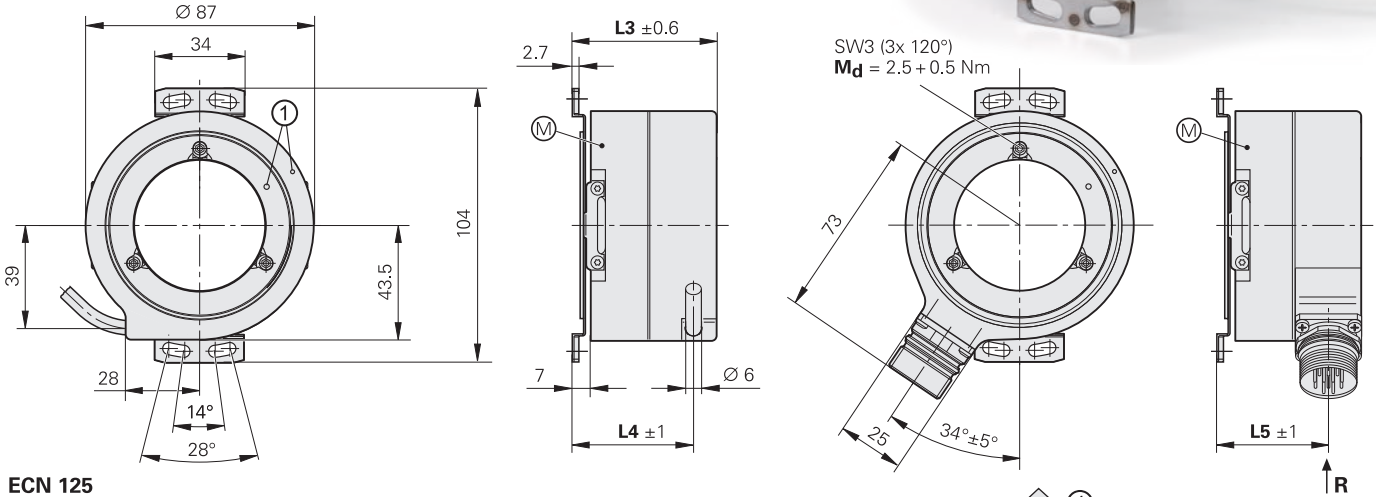
# ECN/ERN 100 series

Absolute and incremental rotary encoders

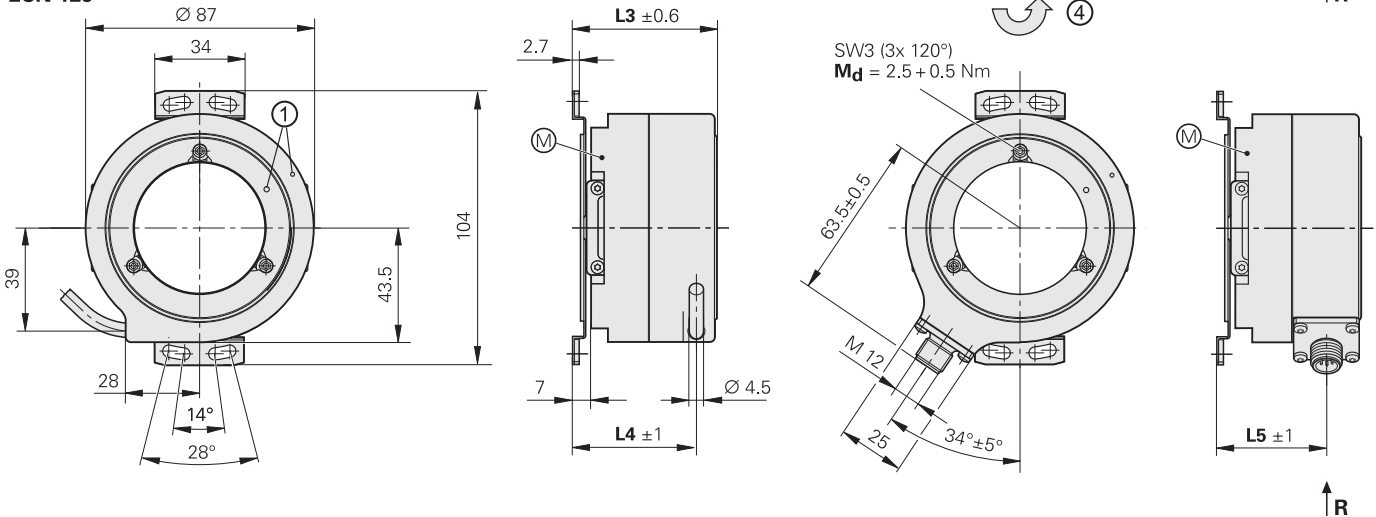
- Stator coupling for plane surface
- Hollow through shaft



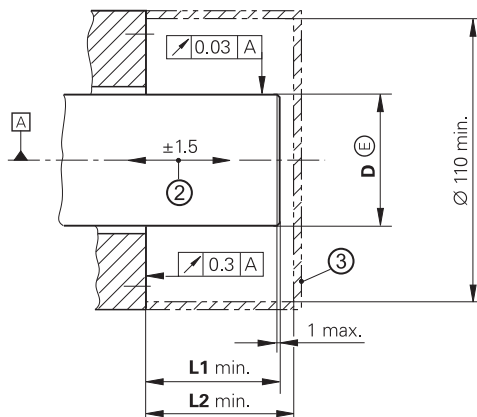
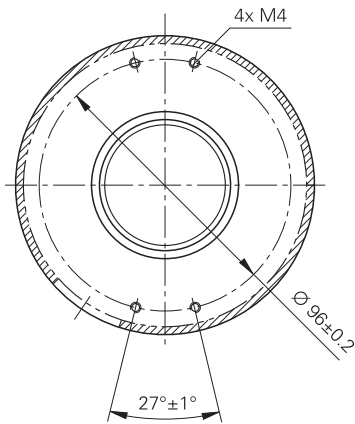
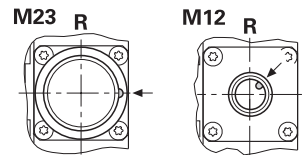
## ERN 1x0/ECN 113



## ECN 125



Connector coding  
R = Radial



| 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



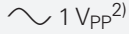
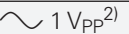



1 = ERN: reference mark position ±15°; ECN: zero position ±15°

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  |   |   |
|---|---|--|--|---|---|
|   | Singletum   |  | ERN 120  | ERN 130   | ERN 180   |
|   | ECN 125   | ECN 113  |  |   |   |
| <b>Interface</b>  | <b>EnDat 2.2</b>  | <b>EnDat 2.2</b>   |   |  |  |
| Ordering designation  | EnDat22   | EnDat01  | –  |   |   |
| Positions/revolution  | 33554432 (25 bits)  | 8192 (13 bits)   | –  |   |   |
| Code  | Pure binary   |  | –  |   |   |
| Elec. permissible speed Deviations <sup>1)</sup>                  | $n_{\max}$ for continuous position value  | $\leq 600 \text{ min}^{-1}/n_{\max}$<br>$\pm 1 \text{ LSB}/\pm 50 \text{ LSB}$   | –  |   |   |
| Calculation time $t_{\text{cal}}$<br>Clock frequency              | $\leq 7 \mu\text{s}$<br>$\leq 16 \text{ MHz}$   | $\leq 9 \mu\text{s}$<br>$\leq 2 \text{ MHz}$   | –  |   |   |
| Incremental signals   | Without   |   |   |  |  |
| Line counts*  | –   | 2048   | 1000 <b>1024</b> 2048  | 2500 3600 <b>5000</b>   |   |
| Reference mark  | –   | –  | One  |   |   |
| Cutoff frequency –3 dB<br>Output frequency<br>Edge separation $a$ | –<br>–<br>–   | $\geq 400 \text{ kHz (typ.)}$<br>–<br>–  | –<br>$\leq 300 \text{ kHz}$<br>$\geq 0.39 \mu\text{s}$   | $\geq 180 \text{ kHz (typ.)}$<br>–<br>–   |   |
| <b>System accuracy</b>  | $\pm 20''$  |  | 1/20 of grating period   |   |   |
| <b>Electrical connection*</b>                                     | <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 $\pm 0.5$ V   | 10 V to 30 V DC   | DC 5 V $\pm 0.5$ V  |
| Power consumption (max.)  | 3.6 V: $\leq 620 \text{ mW}$ /14 V: $\leq 720 \text{ mW}$   |  | –  |   |   |
| Current consumption w/o load                                      | 5 V: $\leq 85 \text{ mA}$ (typical)   |  | $\leq 120 \text{ mA}$  | $\leq 150 \text{ mA}$   | $\leq 120 \text{ mA}$   |
| <b>Shaft*</b>   | Hollow through shaft ( $\varnothing 20 \text{ mm}$ , $\varnothing 25 \text{ mm}$ , $\varnothing 38 \text{ mm}$ , $\varnothing 50 \text{ mm}$ )  |  |  |   |   |
| Mech. permitt. shaft speed $n^3)$                                 | $\varnothing > 30 \text{ mm}$ : $\leq 4000 \text{ rpm}$ ; $\varnothing \leq 30 \text{ mm}$ : $\leq 6000 \text{ rpm}$  |  |  |   |   |
| Starting torque (typical) at 20 °C                                | $\varnothing > 30 \text{ mm}$ : 0.2 Nm<br>$\varnothing \leq 30 \text{ mm}$ : 0.15 Nm  |  |  |   |   |
| Moment of inertia of rotor/<br>angular acceleration <sup>4)</sup> | $\varnothing 50 \text{ mm}$ : $220 \cdot 10^{-6} \text{ kgm}^2/\leq 5 \cdot 10^4 \text{ rad/s}^2$ ; $\varnothing 38 \text{ mm}$ : $350 \cdot 10^{-6} \text{ kgm}^2/\leq 2 \cdot 10^4 \text{ rad/s}^2$<br>$\varnothing 25 \text{ mm}$ : $96 \cdot 10^{-6} \text{ kgm}^2/\leq 3 \cdot 10^4 \text{ rad/s}^2$ ; $\varnothing 20 \text{ mm}$ : $100 \cdot 10^{-6} \text{ kgm}^2/\leq 3 \cdot 10^4 \text{ rad/s}^2$ |  |  |   |   |
| Permitt. axial motion of measured shaft                           | $\pm 1.5 \text{ mm}$  |  |  |   |   |
| <b>Vibration</b> : 55 Hz to 2000 Hz<br><b>Shock</b> : 6 ms        | $\leq 200 \text{ m/s}^2$ ; <i>flange-socket version</i> : $\leq 100 \text{ m/s}^2$ (EN 60068-2-6)<br>$\leq 1000 \text{ m/s}^2$ (EN 60068-2-27)  |  |  |   |   |
| <b>Max. operating temp.</b> <sup>3)</sup>                         | 100 °C (85 °C with ERN 130)   |  |  |   |   |
| <b>Min. operating temp.</b>                                       | <i>Flange socket or fixed cable</i> : –40 °C; <i>moving cable</i> : –10 °C  |  |  |   |   |
| <b>Protection rating</b> EN 60529                                 | IP64  |  |  |   |   |
| <b>Mass</b>   | 0.6 kg to 0.9 kg, depending on the hollow-shaft version   |  |  |   |   |
| <b>Valid for ID</b>   | 810801-xx   | 810800-xx  | 589611-xx  | 589612-xx   | 589614-xx   |

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

<sup>1)</sup> 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

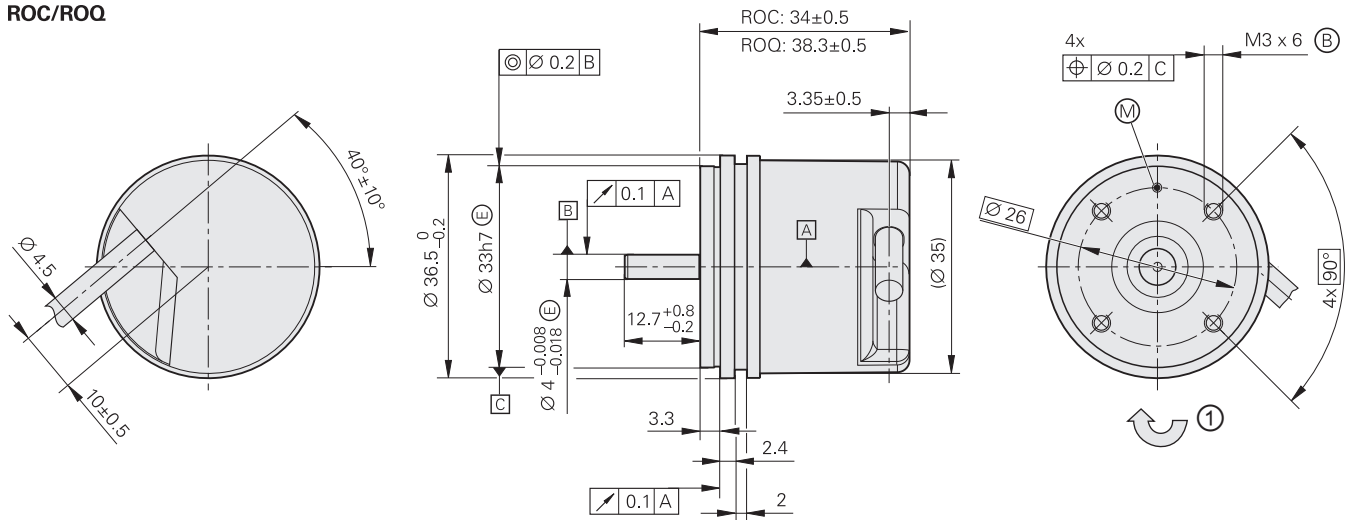
# ROC/ROQ/ROD 1000 series

Absolute and incremental rotary encoders

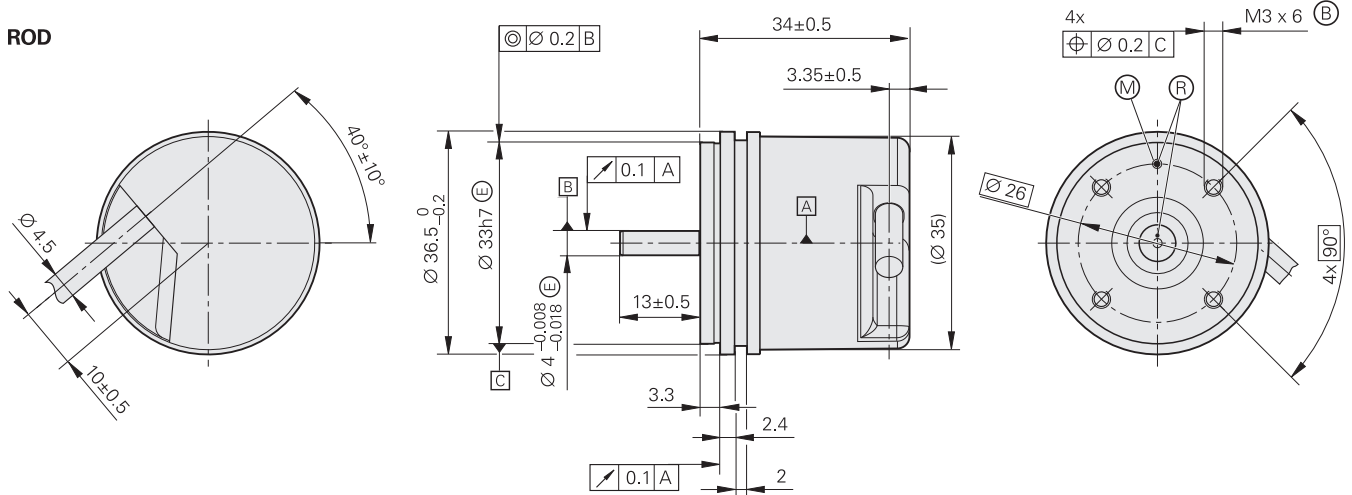
- Synchro flange
- Solid shaft for separate shaft coupling



## ROC/ROQ





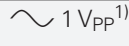

## ROD



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  |
| <b>Interface</b>   |  |  |  |  |
| Line counts*   | 100 200 <b>250</b>  | 360 400 <b>500</b>  | 720 900 <b>2048 2500 3600</b>   | <b>1000 2500 3600</b>   |
| Reference mark   | One   |   |   |   |
| Integrated interpolation*                                | –   |   |   | 5-fold 10-fold  |
| Cutoff frequency –3 dB                                   | –   | –   | ≥ 180 kHz   | –   |
| Scanning frequency                                       | ≤ 300 kHz   | ≤ 160 kHz   | –   | ≤ 100 kHz   |
| Edge separation <i>a</i>                                 | ≥ 0.39 μs   | ≥ 0.76 μs   | –   | ≥ 0.47 μs   |
| <b>System accuracy</b>                                   | 1/20 of grating period  |   |   |   |
| <b>Electrical connection</b>                             | <b>Cable (1 m/5 m) with or without M23 coupling</b>                               |   |   | Cable (5 m) without connecting element  |
| Supply voltage   | DC 5 V ±0.5 V   | 10 V to 30 V DC   | DC 5 V ±0.5 V   | DC 5 V ±5 %   |
| Current consumption without load                         | ≤ 120 mA  | ≤ 150 mA  | ≤ 120 mA  | ≤ 155 mA  |
| <b>Shaft</b>   | Solid shaft Ø 4 mm  |   |   |   |
| Mech. permiss. shaft speed <i>n</i>                      | ≤ 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>   |   |   |   |
| Shaft load   | <i>Axial:</i> 5 N<br><i>Radial:</i> 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> <sup>2)</sup>                | 100 °C  | 70 °C   | 100 °C  | 70 °C   |
| <b>Min. operating temp.</b>                              | <i>Fixed cable:</i> –30 °C; <i>moving cable:</i> –10 °C                           |   |   |   |
| <b>Protection rating</b> EN 60529                        | IP64  |   |   |   |
| <b>Mass</b>  | ≈ 0.09 kg   |   |   |   |
| <b>Valid for ID</b>                                      | 534900-x  | 534901-xx   | 534904-xx   | 534903-xx   |

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

\* Please select when ordering

<sup>1)</sup> 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*


**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: 85 mA   |  |
| <b>Shaft</b>   | Solid shaft Ø 4 mm   |  |
| Mech. permiss. shaft speed $n$                           | 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   | <i>Axial:</i> 5 N<br><i>Radial:</i> 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>                              | <i>Fixed cable:</i> –30 °C; <i>moving cable:</i> –10 °C                          |  |
| <b>Protection rating</b> EN 60529                        | IP64   |  |
| <b>Mass</b>  | ≈ 0.09 kg  |  |
| <b>Valid for ID</b>                                      | 606693-xx  | 606691-xx                                  |

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

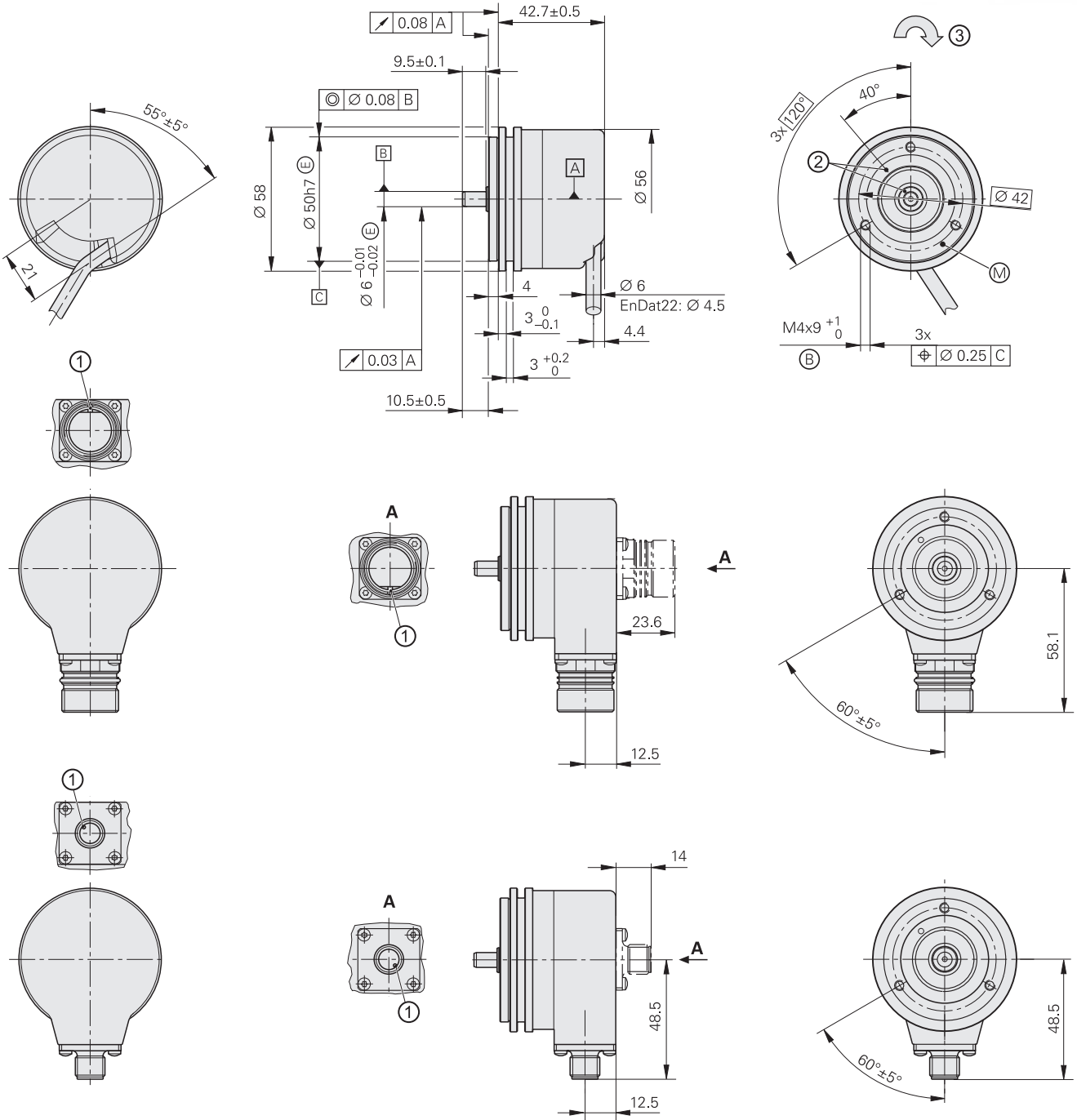
<sup>2)</sup> Limited tolerances: signal amplitude: 0.8 V<sub>PP</sub> to 1.2 V<sub>PP</sub>

| Multiturn<br>ROQ 1035                             |  | ROQ 1025 |
|---|--|----------|
| EnDat22   | EnDat01  |          |
| 8388608 (23 bits)                                 | 8192 (13 bits)   |          |
| 4096 (12 bits)                                    |  |          |
| Pure binary                                       |  |          |
| $\leq 12000$ rpm<br>for continuous position value | $\leq 4000$ rpm/ $\leq 12000$ rpm<br>$\pm 1$ LSB/ $\pm 16$ LSB |          |
| $\leq 7$ $\mu$ s<br>$\leq 8$ MHz                  | $\leq 9$ $\mu$ s<br>$\leq 2$ MHz                               |          |
| –   | $\sim 1 V_{PP}^{(2)}$  |          |
| –   | 512  |          |
| –   | $\geq 190$ kHz   |          |
| Cable (1 m) with M12 coupling                     | Cable (1 m) with M23 coupling                                  |          |
| DC 3.6 V to 14 V                                  |  |          |
| 3.6 V: $\leq 0.7$ W<br>14 V: $\leq 0.8$ W         |  |          |
| 5 V: 105 mA                                       |  |          |
| 0.002 Nm (at 20 °C)                               |  |          |
| 606696-xx   | 606694-xx  |          |

# 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  
 $\leq 6$  mm:  $\pm 0.2$  mm

- Radial cable (can also be used axially)
- $\square$  = Bearing
  - $\odot$  = Fastening thread
  - $\text{M}$  = Measuring point for operating temperature
  - 1 = Connector coding
  - 2 = ROD reference mark position for shaft and flange  $\pm 30^\circ$
  - 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                           |   |  |
| <b>Interface</b>                          | □ TTL  |             |             |                 |             |             | □ HTL                |             |             | ~ 1 V <sub>PP</sub> <sup>1)</sup> |   |  |
| Line counts*                              | 50   | 100         | 250         | 360             | <b>500</b>  | 512         | 720                  |             |             |                                   | - |  |
|   | <b>1000</b>  | <b>1024</b> | <b>1250</b> | 1500            | <b>2000</b> | <b>2048</b> | <b>2500</b>          | <b>3600</b> | <b>4096</b> | <b>5000</b>                       |   |  |
| Reference mark                            | One  |             |             |                 |             |             |                      |             |             |                                   |   |  |
| Cutoff frequency -3 dB                    | -  |             |             |                 |             |             |                      |             |             | ≥ 180 kHz                         |   |  |
| Scanning frequency                        | ≤ 300 kHz/≤ 150 kHz  |             |             |                 |             |             |                      |             |             | -                                 |   |  |
| Edge separation <i>a</i>                  | ≥ 0.39 μs/≥ 0.25 μs  |             |             |                 |             |             |                      |             |             | -                                 |   |  |
| <b>System accuracy</b>                    | 1/20 of grating period   |             |             |                 |             |             |                      |             |             |                                   |   |  |
| <b>Electrical connection*</b>             | <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  |             |             | 10 V to 30 V DC |             |             | 10 V to 30 V DC      |             |             | DC 5 V ±0.5 V                     |   |  |
| Current consumption without load          | ≤ 120 mA   |             |             | ≤ 100 mA        |             |             | ≤ 150 mA             |             |             | ≤ 120 mA                          |   |  |
| <b>Shaft</b>                              | Solid shaft Ø 6 mm   |             |             |                 |             |             |                      |             |             |                                   |   |  |
| Mech. permiss. shaft speed <i>n</i>       | ≤ 16000 rpm  |             |             |                 |             |             |                      |             |             |                                   |   |  |
| Starting torque (typical)                 | 0.01 Nm (at 20 °C)   |             |             |                 |             |             |                      |             |             |                                   |   |  |
| Moment of inertia of rotor                | ≤ 2.7 · 10 <sup>-6</sup> kgm <sup>2</sup>  |             |             |                 |             |             |                      |             |             |                                   |   |  |
| Shaft load <sup>2)</sup>                  | <i>Axial</i> : ≤ 40 N; <i>radial</i> : ≤ 60 N at shaft end   |             |             |                 |             |             |                      |             |             |                                   |   |  |
| <b>Vibration</b> : 55 Hz to 2000 Hz       | ≤ 300 m/s <sup>2</sup> (EN 60068-2-6)  |             |             |                 |             |             |                      |             |             |                                   |   |  |
| <b>Shock</b> : 6 ms                       | ≤ 2000 m/s <sup>2</sup> (EN 60068-2-27)  |             |             |                 |             |             |                      |             |             |                                   |   |  |
| <b>Max. operating temp.</b> <sup>3)</sup> | 100 °C   |             |             | 70 °C           |             |             | 100 °C <sup>4)</sup> |             |             |                                   |   |  |
| <b>Min. operating temp.</b>               | <i>Flange socket or fixed cable</i> : -40 °C; <i>moving cable</i> : -10 °C   |             |             |                 |             |             |                      |             |             |                                   |   |  |
| <b>Protection rating</b> EN 60529         | IP67 at housing; IP64 at shaft inlet (IP66 upon request)   |             |             |                 |             |             |                      |             |             |                                   |   |  |
| <b>Mass</b>                               | ≈ 0.3 kg   |             |             |                 |             |             |                      |             |             |                                   |   |  |
| <b>Valid for ID</b>                       | 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**
**ROC 425**

**ROC 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>      | ≤ 15000 rpm<br>for continuous position value   | <i>512 lines:</i><br>≤ 5000/12000 rpm<br>± 1 LSB/± 100 LSB<br><i>2048 lines:</i><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                                   | –  | <i>512 lines:</i> ≥ 130 kHz; <i>2048 lines:</i> ≥ 400 kHz   |                      |
| <b>System accuracy</b>                                   | ±20"   | <i>512 lines:</i> ±60"; <i>2048 lines:</i> ±20"   |                      |
| <b>Electrical connection*</b>                            | <ul style="list-style-type: none"> <li>• <b>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  | 4.75 V to 30 V DC    |
| Power consumption<br>(maximum)                           | 3.6 V: ≤ 0.6 W<br>14 V: ≤ 0.7 W  | 5 V: ≤ 0.8 W<br>10 V: ≤ 0.65 W<br>30 V: ≤ 1 W   |                      |
| Current consumption<br>(typical, without load)           | 5 V: 85 mA   | 5 V: 90 mA<br>24 V: 24 mA   |                      |
| <b>Shaft</b>   | Solid shaft Ø 6 mm   |   |                      |
| Mech. permiss. shaft speed $n$                           | ≤ 15000 rpm  |   |                      |
| Starting torque (typical)                                | 0.01 Nm (at 20 °C)   |   |                      |
| Moment of inertia of rotor                               | ≤ 2.7 · 10 <sup>-6</sup> kgm <sup>2</sup>  |   |                      |
| Shaft load   | <i>Axial:</i> ≤ 40 N; <i>radial:</i> ≤ 60 N at shaft end (see also <i>Mechanical design types and mounting</i> )                           |   |                      |
| <b>Vibration:</b> 55 Hz to 2000 Hz<br><b>Shock:</b> 6 ms | ≤ 300 m/s <sup>2</sup> (EN 60068-2-6)<br><i>ROC/ROQ:</i> ≤ 2000 m/s <sup>2</sup> ; <i>RIC/RIQ:</i> ≤ 1000 m/s <sup>2</sup> (EN 60068-2-27) |   |                      |
| <b>Max. operating temp.</b> <sup>3)</sup>                | 100 °C   |   |                      |
| <b>Min. operating temp.</b>                              | <i>Flange socket or fixed cable:</i> –40 °C; <i>moving cable:</i> –10 °C   |   |                      |
| <b>Protection rating</b> EN 60529                        | IP67 at housing; IP64 at shaft inlet (IP66 upon request)   |   |                      |
| <b>Mass</b>  | ≈ 0.35 kg  |   |                      |
| <b>Valid for ID</b>                                      | 1322268-xx <sup>4)</sup>   | 1109254-xx  | 1353113-xx           |

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





| <b>Absolute<br/>Multiturn<br/>ROQ 425</b>                |   |                        |                        |   |                        |                        |
|--|---|------------------------|------------------------|---|------------------------|------------------------|
| <b>Interface</b>   | 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   | $\leq 52 \text{ kHz}$   | $\leq 103 \text{ kHz}$ | $\leq 205 \text{ kHz}$ | $\leq 52 \text{ kHz}$   | $\leq 205 \text{ kHz}$ | $\leq 410 \text{ kHz}$ |
| <b>System accuracy<sup>1)</sup></b>                      | $\pm 60''$  | $\pm 60''$             | $\pm 20''$             | $\pm 60''$  | $\pm 20''$             | $\pm 20''$             |
| <b>Electrical connection</b>                             | 17-pin M23 radial flange socket (male)  |                        |                        |   |                        |                        |
| Cable length <sup>2)</sup>                               | $\leq 100 \text{ m}$ (with HEIDENHAIN cable)  |                        |                        |   |                        |                        |
| Supply voltage   | 10 V to 30 V DC   |                        |                        | 4.75 V to 30 V DC   |                        |                        |
| Power consumption (max.) <sup>3)</sup>                   | See <i>Power consumption</i> 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: $\leq 25 \text{ mA}$      |                        |                        |
| <b>Shaft</b>   | Solid shaft $\varnothing 10 \text{ mm}$ with flat   |                        |                        |   |                        |                        |
| Mech. permiss. shaft<br>speed $n^4)$                     | $\leq 12000 \text{ rpm}$  |                        |                        |   |                        |                        |
| 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 <i>Mechanical design types and mounting</i> ) |                        |                        |   |                        |                        |
| <b>Vibration:</b> 10 Hz to 2000 Hz<br><b>Shock:</b> 6 ms | $\leq 150 \text{ m/s}^2$ (EN 60068-2-6)<br>$\leq 1000 \text{ m/s}^2$ (EN 60068-2-27)  |                        |                        |   |                        |                        |
| <b>Max. operating temp.</b> <sup>4)</sup>                | 100 °C  |                        |                        |   |                        |                        |
| <b>Min. operating temp.</b>                              | -40 °C  |                        |                        |   |                        |                        |
| <b>Protection rating</b> EN 60529                        | Housing: IP67<br>Shaft exit: IP66   |                        |                        |   |                        |                        |
| <b>Mass</b>  | $\approx 0.30 \text{ kg}$   |                        |                        |   |                        |                        |
| <b>Valid for ID</b>                                      | 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)

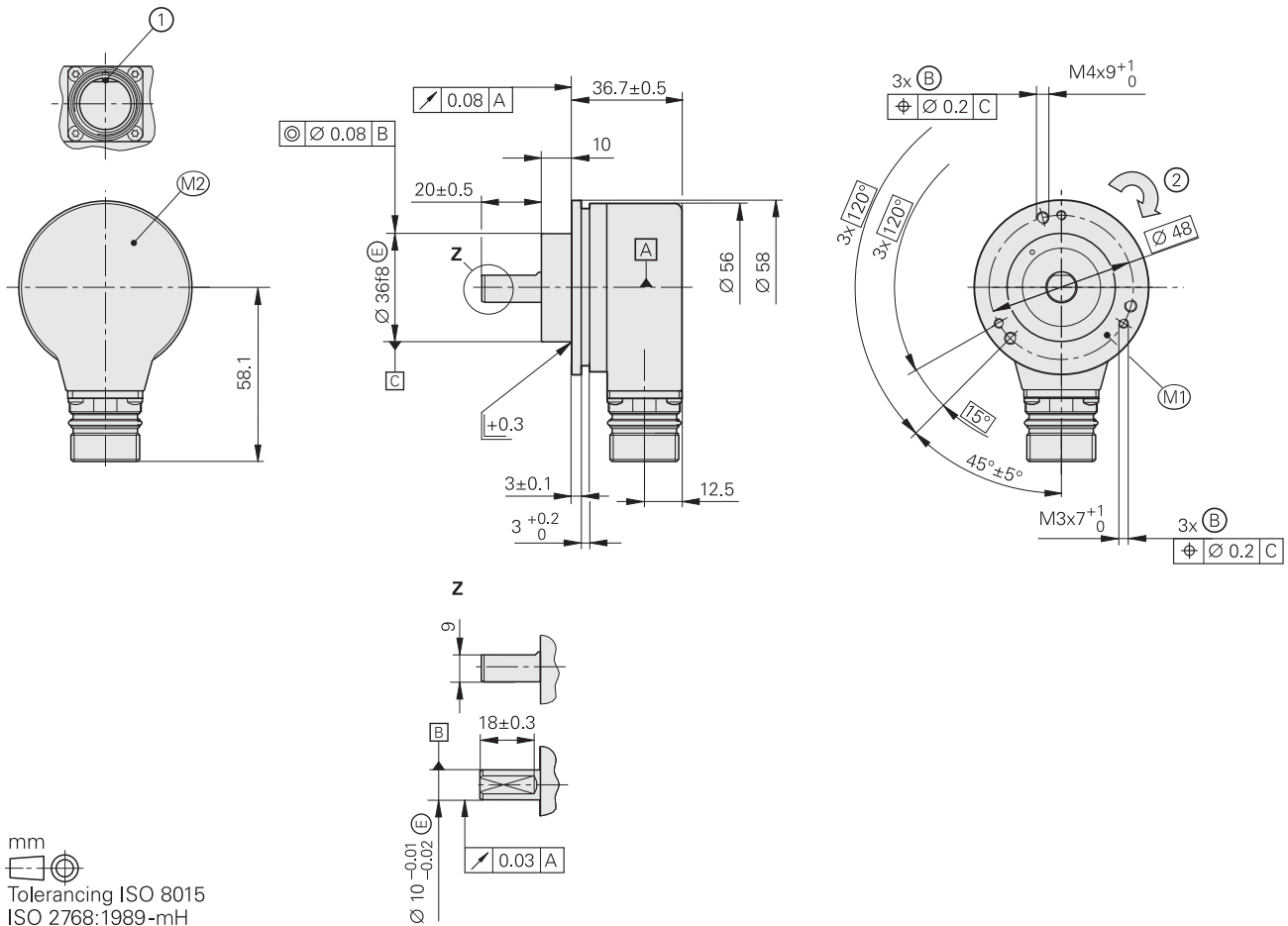
<sup>3)</sup> See *General electrical information* in the *Interfaces of HEIDENHAIN Encoders* brochure

<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

- ▢ = Bearing
- ⊙ = 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

| <b>Absolute<br/>Multiturn<br/>ROQ 425</b>                |   |                        |                        |   |                        |                        |
|--|---|------------------------|------------------------|---|------------------------|------------------------|
| <b>Interface</b>   | 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   | $\leq 52 \text{ kHz}$   | $\leq 103 \text{ kHz}$ | $\leq 205 \text{ kHz}$ | $\leq 52 \text{ kHz}$   | $\leq 205 \text{ kHz}$ | $\leq 410 \text{ kHz}$ |
| <b>System accuracy<sup>1)</sup></b>                      | $\pm 60''$  | $\pm 60''$             | $\pm 20''$             | $\pm 60''$  | $\pm 20''$             | $\pm 20''$             |
| <b>Electrical connection</b>                             | 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   | 10 V to 30 V DC   |                        |                        | 4.75 V to 30 V DC   |                        |                        |
| Power consumption (max.) <sup>3)</sup>                   | See <i>Power consumption</i> 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: $\leq 25 \text{ mA}$      |                        |                        |
| <b>Shaft</b>   | Solid shaft $\varnothing 10 \text{ mm}$ with flat   |                        |                        |   |                        |                        |
| Mech. permiss. shaft<br>speed $n^4)$                     | $\leq 12000 \text{ rpm}$  |                        |                        |   |                        |                        |
| 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 <i>Mechanical design types and mounting</i> ) |                        |                        |   |                        |                        |
| <b>Vibration:</b> 10 Hz to 2000 Hz<br><b>Shock:</b> 6 ms | $\leq 150 \text{ m/s}^2$ (EN 60068-2-6)<br>$\leq 1000 \text{ m/s}^2$ (EN 60068-2-27)  |                        |                        |   |                        |                        |
| <b>Max. operating temp.</b> <sup>4)</sup>                | 100 °C  |                        |                        |   |                        |                        |
| <b>Min. operating temp.</b>                              | -40 °C  |                        |                        |   |                        |                        |
| <b>Protection rating</b> EN 60529                        | Housing: IP67<br>Shaft exit: IP66   |                        |                        |   |                        |                        |
| <b>Mass</b>  | $\approx 0.30 \text{ kg}$   |                        |                        |   |                        |                        |
| <b>Valid for ID</b>                                      | 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

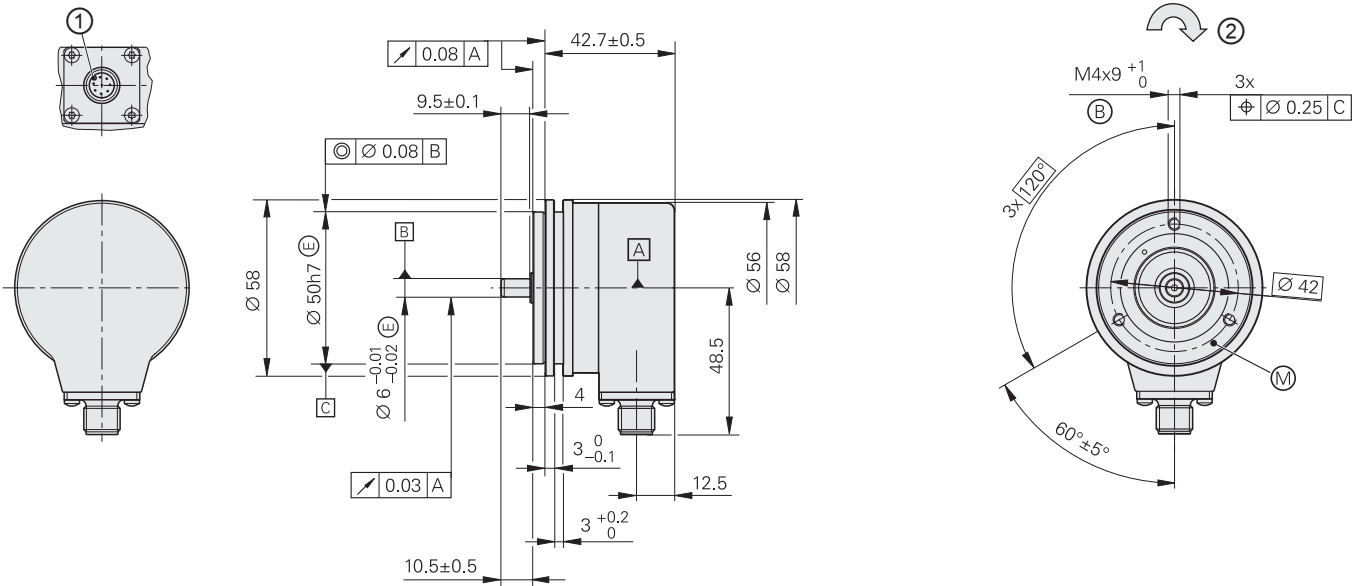
# ROC/ROQ 400F/S series

Absolute rotary encoders

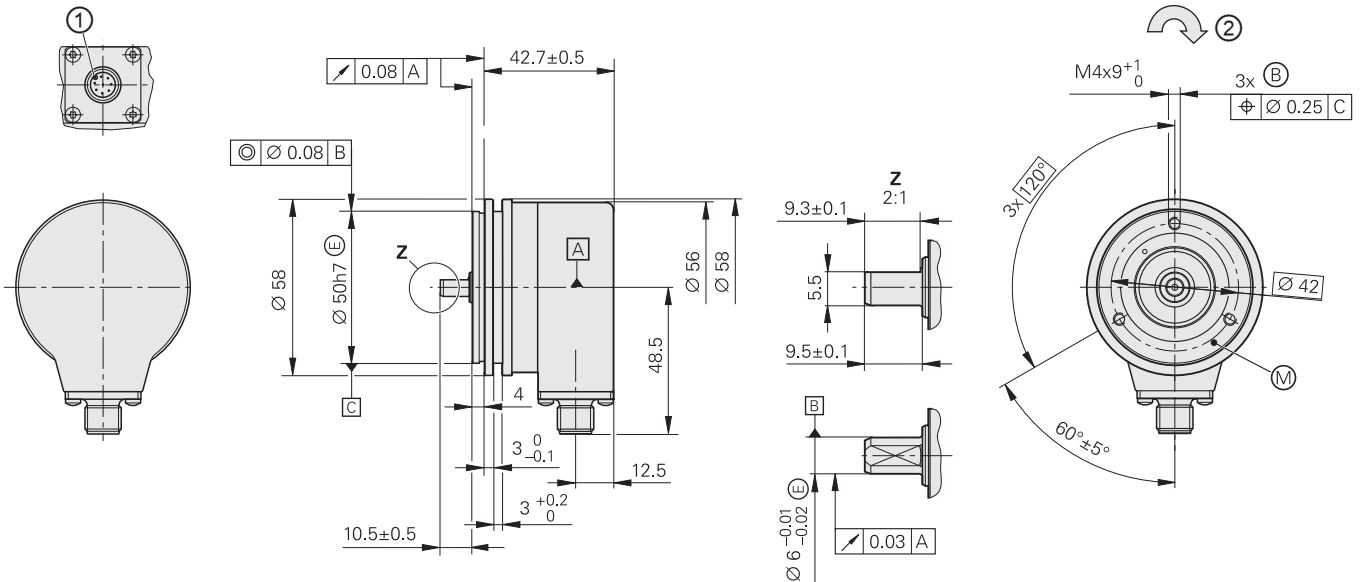
- Synchro flange
- Solid shaft for separate shaft coupling
- Fanuc Serial Interface or Siemens DRIVE-CLiQ interface



## 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

|  | <b>Absolute</b>  |   |   |   |
|--|--|---|---|---|
|  | <b>Singletum</b>   |   | <b>Multitum</b>                         |   |
|  | <b>ROC 425F</b>  | <b>ROC 424S</b>  | <b>ROQ 437F</b>                         | <b>ROQ 436S</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 bits)   | 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>  |
| DC supply voltage  | 3.6 V to 14 V  | 10 V to 36 V  | 3.6 V to 14 V                           | 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>   | Solid shaft (Ø 6 mm) for ROC 424S and ROQ 436S with flat   |   |   |   |
| Mech. permiss. shaft<br>speed $n^4)$                       | ≤ 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   | <i>Axial</i> : 40 N; <i>radial</i> : 60 N at shaft end (see also <i>Mechanical design types and mounting</i> ) |   |   |   |
| <b>Vibration</b> : 55 Hz to 2000 Hz<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>4)</sup>                  | 100 °C   |   |   |   |
| <b>Min. operating temp.</b>                                | –30 °C   |   |   |   |
| <b>Protection rating</b> EN 60529                          | IP67 at housing; IP64 at shaft inlet   |   |   |   |
| <b>Mass</b>  | ≈ 0.35 kg  |   |   |   |
| <b>Valid for ID</b>  | 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)

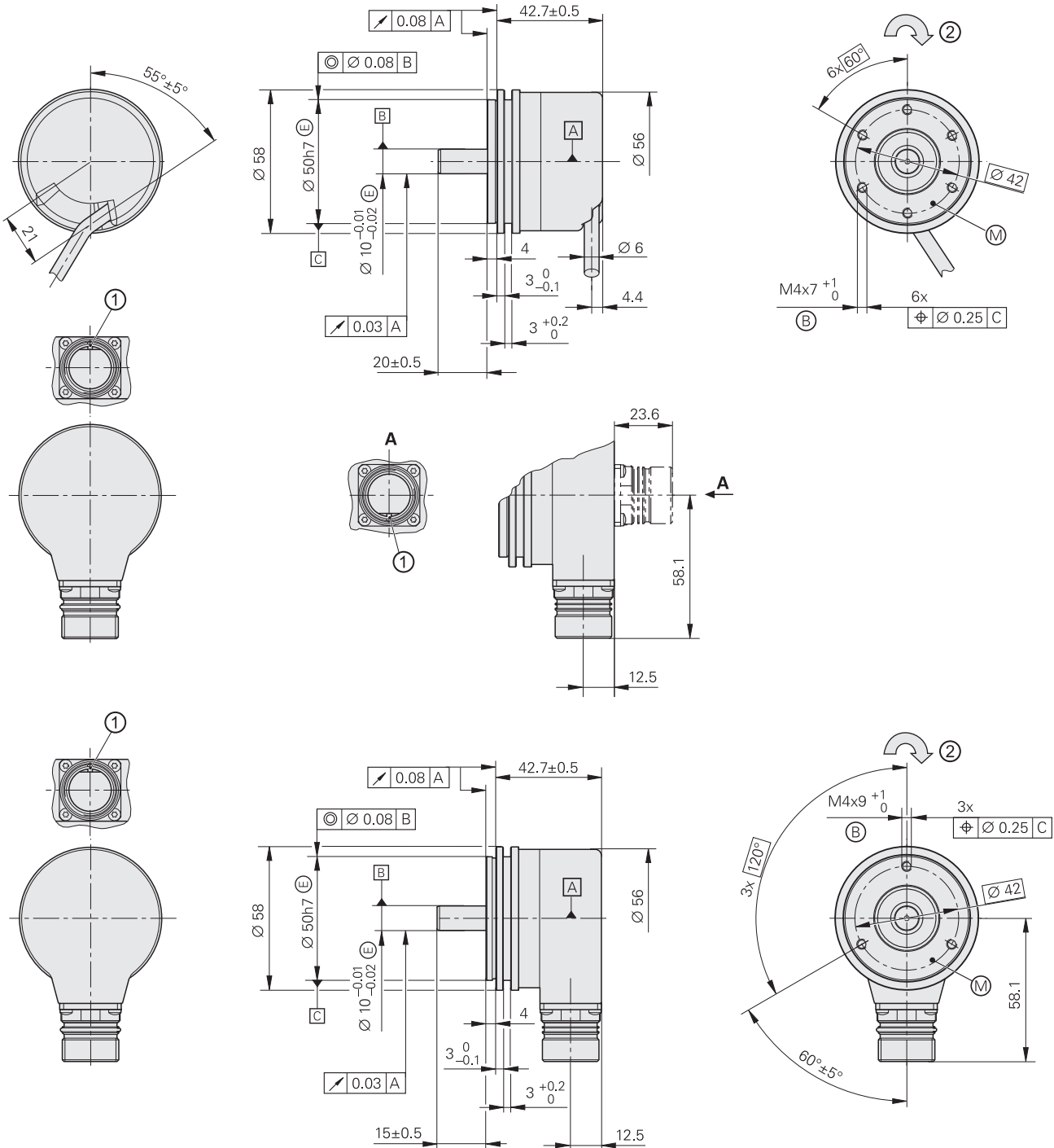
<sup>4)</sup> For the relationship of operating temperature to shaft speed and supply voltage, see *General mechanical information*

<sup>5)</sup> Also available with functional safety; for dimensions and specifications, see the 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  
 ⊗ = Measuring point for position values  
 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 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 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 (maximum)                                | 3.6 V: ≤ 0.6 W<br>14 V: ≤ 0.7 W   |                                   |
| Current consumption (typical, without load)                | 5 V: 85 mA  |                                   |
| <b>Shaft</b>   | Solid shaft Ø 10 mm, length 20 mm   | Solid shaft Ø 10 mm, length 15 mm |
| Mech. permiss. shaft speed $n$                             | ≤ 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   | <i>Axial</i> : ≤ 40 N; <i>radial</i> : ≤ 60 N at shaft end (see also <i>Mechanical design types and mounting</i> )                                    |                                   |
| <b>Vibration</b> : 55 Hz to 2000 Hz<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>                                | <i>Flange socket or fixed cable</i> : –40 °C; <i>moving cable</i> : –10 °C  |                                   |
| <b>Protection rating</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

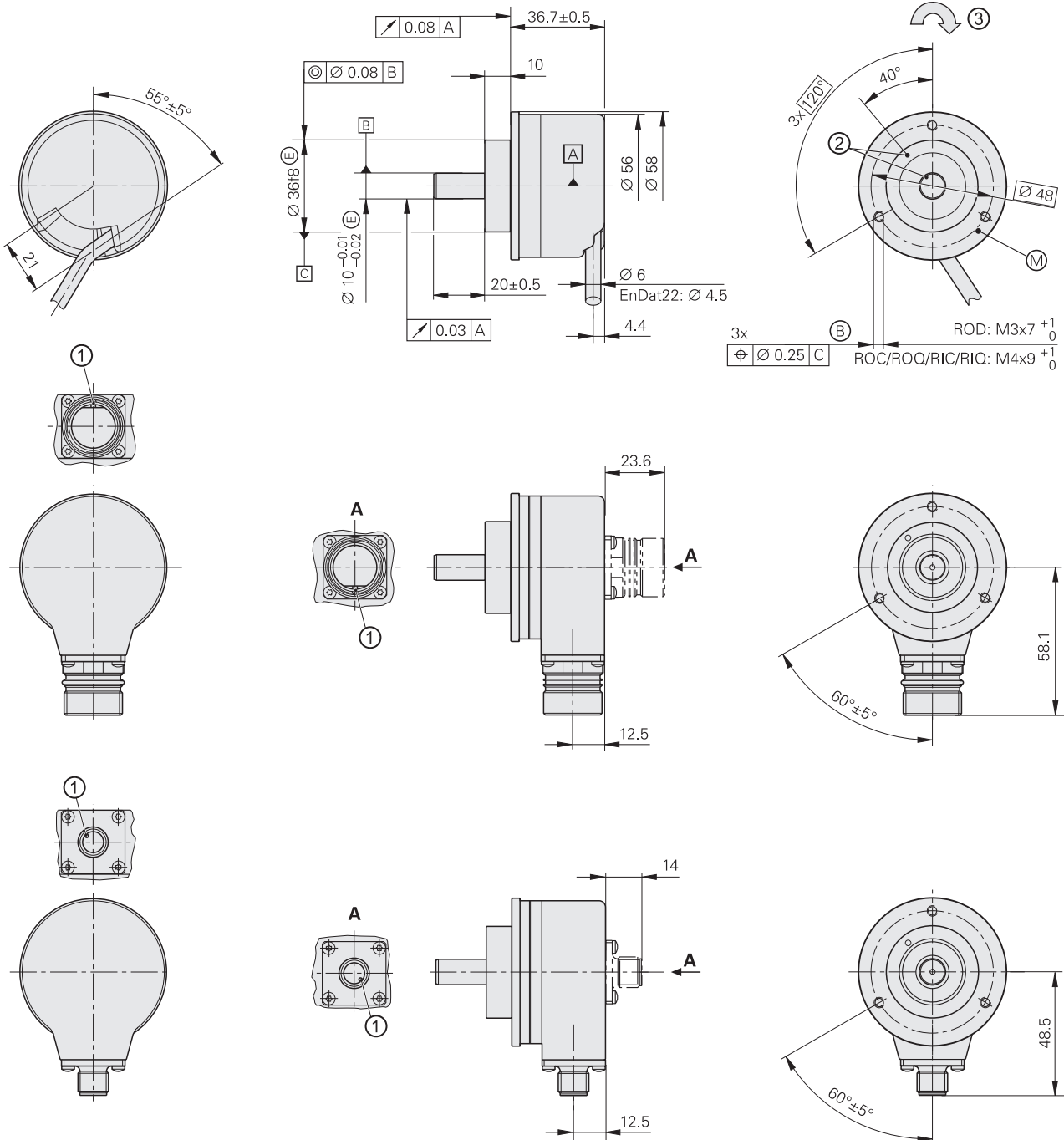
<sup>2)</sup> Limited tolerances: signal amplitude: 0.8 V<sub>PP</sub> to 1.2 V<sub>PP</sub>

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

# ROC/ROQ/ROD 400 series

Absolute and incremental rotary encoders

- Clamping 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 ±15°
- 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                           |  |  |
| <b>Interface</b>                          | □□TTL  |             |             |      |             | □□HTL           |             |             |             | ~ 1 V <sub>PP</sub> <sup>1)</sup> |  |  |
| Line counts*                              | 50   | 100         | 250         | 360  | <b>500</b>  | 512             | 720         |             |             | -                                 |  |  |
|   | <b>1000</b>  | <b>1024</b> | <b>1250</b> | 1500 | <b>2000</b> | <b>2048</b>     | <b>2500</b> | <b>3600</b> | <b>4096</b> | <b>5000</b>                       |  |  |
| Reference mark                            | One  |             |             |      |             |                 |             |             |             |                                   |  |  |
| Cutoff frequency -3 dB                    | -  |             |             |      |             |                 |             |             | ≥ 180 kHz   |                                   |  |  |
| Output frequency                          | ≤ 300 kHz  |             |             |      |             |                 |             |             | -           |                                   |  |  |
| Edge separation <i>a</i>                  | ≥ 0.39 μs  |             |             |      |             |                 |             |             | -           |                                   |  |  |
| <b>System accuracy</b>                    | 1/20 of grating period   |             |             |      |             |                 |             |             |             |                                   |  |  |
| <b>Electrical connection*</b>             | <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  |             |             |      |             | 10 V to 30 V DC |             |             |             | DC 5 V ±0.5 V                     |  |  |
| Current consumption without load          | ≤ 120 mA   |             |             |      |             | ≤ 150 mA        |             |             |             | ≤ 120 mA                          |  |  |
| <b>Shaft</b>                              | Solid shaft Ø 10 mm  |             |             |      |             |                 |             |             |             |                                   |  |  |
| Mech. permiss. shaft speed <i>n</i>       | ≤ 16000 rpm  |             |             |      |             |                 |             |             |             |                                   |  |  |
| Starting torque (typical)                 | 0.01 Nm (at 20 °C)   |             |             |      |             |                 |             |             |             |                                   |  |  |
| Moment of inertia of rotor                | ≤ 2.1 · 10 <sup>-6</sup> kgm <sup>2</sup>  |             |             |      |             |                 |             |             |             |                                   |  |  |
| Shaft load <sup>2)</sup>                  | <i>Axial</i> : ≤ 40 N; <i>radial</i> : ≤ 60 N at shaft end   |             |             |      |             |                 |             |             |             |                                   |  |  |
| <b>Vibration</b> : 55 Hz to 2000 Hz       | ≤ 300 m/s <sup>2</sup> (EN 60068-2-6)  |             |             |      |             |                 |             |             |             |                                   |  |  |
| <b>Shock</b> : 6 ms                       | ≤ 2000 m/s <sup>2</sup> (EN 60068-2-27)  |             |             |      |             |                 |             |             |             |                                   |  |  |
| <b>Max. operating temp.</b> <sup>3)</sup> | 100 °C (80 °C for ROD 480 with 4096 or 5000 lines)   |             |             |      |             |                 |             |             |             |                                   |  |  |
| <b>Min. operating temp.</b>               | <i>Flange socket or fixed cable</i> : -40 °C<br><i>Moving cable</i> : -10 °C   |             |             |      |             |                 |             |             |             |                                   |  |  |
| <b>Protection rating</b> EN 60529         | IP67 at housing; IP64 at shaft inlet (IP66 upon request)   |             |             |      |             |                 |             |             |             |                                   |  |  |
| <b>Mass</b>                               | ≈ 0.3 kg   |             |             |      |             |                 |             |             |             |                                   |  |  |
| <b>Valid for ID</b>                       | 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**
**ROC 425**

**ROC 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>      | ≤ 15000 rpm<br>for continuous position value   | <i>512 lines:</i><br>≤ 5000/12000 rpm<br>± 1 LSB/± 100 LSB<br><i>2048 lines:</i><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                                   | –  | <i>512 lines:</i> ≥ 130 kHz; <i>2048 lines:</i> ≥ 400 kHz   |   |
| <b>System accuracy</b> <sup>1)</sup>                     | ±20"   | <i>512 lines:</i> ±60"; <i>2048 lines:</i> ±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>, 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  | 4.75 V to 30 V DC                             |
| Power consumption<br>(maximum)                           | 3.6 V: ≤ 0.6 W<br>14 V: ≤ 0.7 W  |   | 5 V: ≤ 0.8 W<br>10 V: ≤ 0.65 W<br>30 V: ≤ 1 W |
| Current consumption<br>(typical, without load)           | 5 V: 85 mA   |   | 5 V: 90 mA<br>24 V: 24 mA                     |
| <b>Shaft</b>   | Solid shaft Ø 10 mm  |   |   |
| Mech. permiss. shaft speed $n$                           | ≤ 15000 rpm  |   |   |
| Starting torque (typical)                                | 0.01 Nm (at 20 °C)   |   |   |
| Moment of inertia of rotor                               | ≤ 2.3 · 10 <sup>-6</sup> kgm <sup>2</sup>  |   |   |
| Shaft load   | <i>Axial:</i> ≤ 40 N; <i>radial:</i> ≤ 60 N at shaft end (see also <i>Mechanical design types and mounting</i> )   |   |   |
| <b>Vibration:</b> 55 Hz to 2000 Hz<br><b>Shock:</b> 6 ms | ≤ 300 m/s <sup>2</sup> ; (EN 60068-2-6); higher values upon request<br><i>ROC/ROQ:</i> ≤ 2000 m/s <sup>2</sup> ; <i>RIC/RIQ:</i> ≤ 1000 m/s <sup>2</sup> (EN 60068-2-27) |   |   |
| <b>Max. operating temp.</b> <sup>3)</sup>                | 100 °C   |   |   |
| <b>Min. operating temp.</b>                              | <i>Flange socket or fixed cable:</i> –40 °C; <i>moving cable:</i> –10 °C   |   |   |
| <b>Protection rating</b> EN 60529                        | IP67 at housing; IP64 at shaft inlet (IP66 upon request)   |   |   |
| <b>Mass</b>  | ≈ 0.35 kg  |   |   |
| <b>Valid for ID</b>                                      | 1322269-xx <sup>4)</sup>   | 1109255-xx  | 1353114-xx                                    |

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

\* Please select when ordering

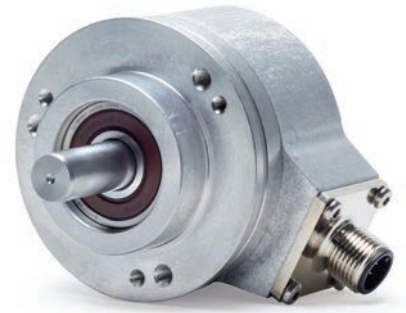
<sup>1)</sup> Speed-dependent deviations between absolute value and incremental signal



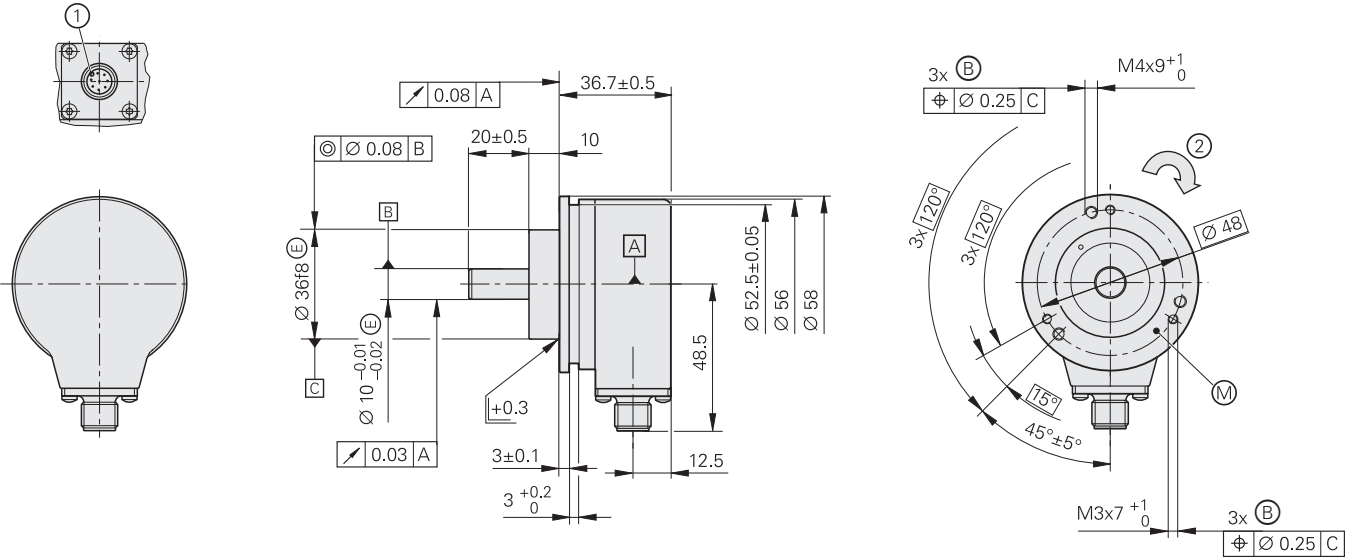
# ROC/ROQ 400F/S series

## Absolute rotary encoders

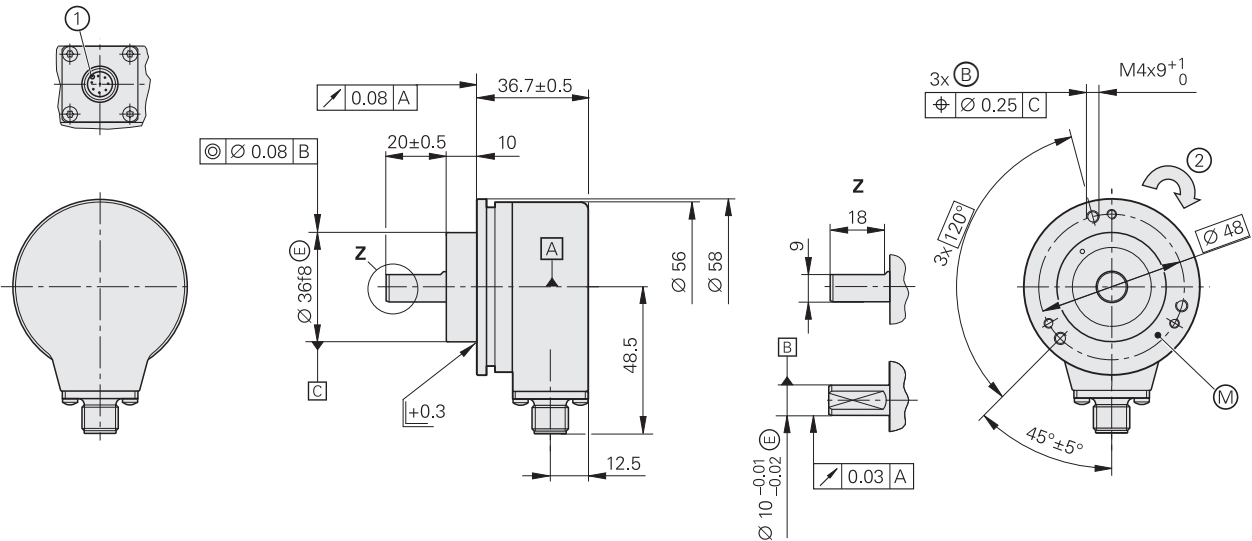
- Clamping flange with additional slot for fastening with fixing clamps
- Solid shaft for separate shaft coupling
- Fanuc Serial Interface or Siemens DRIVE-CLiQ interface



### 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

|  | <b>Absolute</b>  |   |   |   |
|--|--|---|---|---|
|  | <b>Singletum</b>   |   | <b>Multitum</b>                         |   |
|  | <b>ROC 425F</b>  | <b>ROC 424S</b>  | <b>ROQ 437F</b>                         | <b>ROQ 436S</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 bits)   | 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>  |
| <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>  |
| DC supply voltage  | 3.6 V to 14 V  | 10 V to 36 V  | 3.6 V to 14 V                           | 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>   | Solid shaft (Ø 10 mm) for ROC 424S and ROQ 436S with flat  |   |   |   |
| Mech. permiss. shaft<br>speed $n^4)$                       | ≤ 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   | <i>Axial</i> : 40 N; <i>radial</i> : 60 N at shaft end (see also <i>Mechanical design types and mounting</i> ) |   |   |   |
| <b>Vibration</b> : 55 Hz to 2000 Hz<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>4)</sup>                  | 100 °C   |   |   |   |
| <b>Min. operating temp.</b>                                | –30 °C   |   |   |   |
| <b>Protection rating</b> EN 60529                          | IP67 at housing; IP64 at shaft inlet   |   |   |   |
| <b>Mass</b>  | ≈ 0.35 kg  |   |   |   |
| <b>Valid for ID</b>  | 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

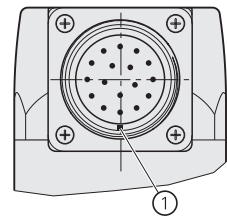
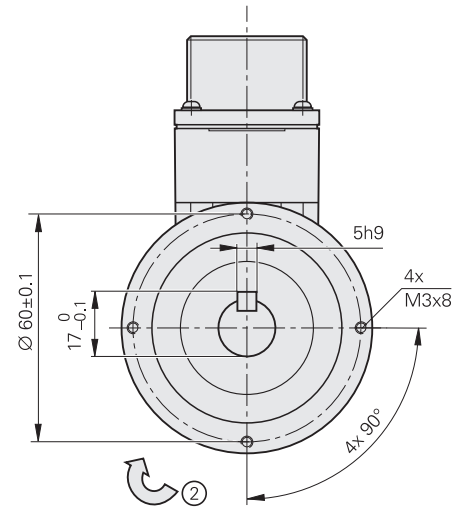
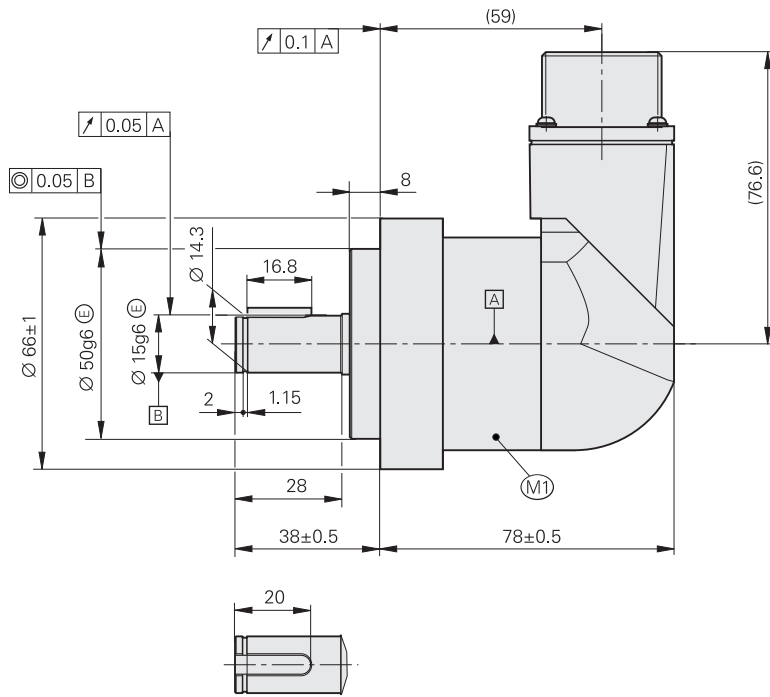
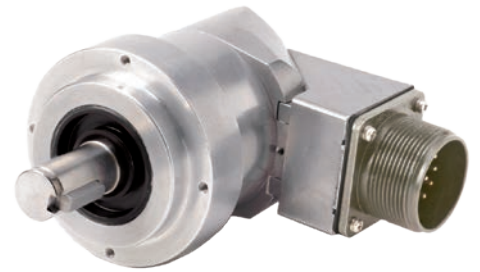
<sup>3)</sup> See the *Interfaces of HEIDENHAIN Encoders* brochure; with  $n_{EN} = 1$  (including adapter cable)

<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 the 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>           | ≤ 300 kHz<br>≥ 0.39 μs   |                             |
| <b>System accuracy</b>                                   | ±1/20 of grating period  |                             |
| <b>Electrical connection</b>                             | Flange socket 1¼"; 18UNEF 17-pin, radial <sup>1)</sup>                           |                             |
| Supply voltage<br>Current consumption<br>without load    | DC 5 V ±0.5 V<br>≤ 120 mA  | 10 V to 30 V DC<br>≤ 150 mA |
| <b>Shaft</b>   | Solid shaft Ø 15 mm with key   |                             |
| Mech. permiss. shaft speed <i>n</i>                      | ≤ 12000 rpm  |                             |
| Starting torque (typical)                                | 0.05 Nm (at 20 °C)   |                             |
| Moment of inertia of rotor                               | ≤ 11 · 10 <sup>-6</sup> kgm <sup>2</sup>   |                             |
| Shaft load   | <i>Axial:</i> 75 N<br><i>Radial:</i> 75 N at shaft end                           |                             |
| <b>Vibration:</b> 55 Hz to 2000 Hz<br><b>Shock:</b> 6 ms | ≤ 200 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>                              | 85 °C  |                             |
| <b>Min. operating temp.</b>                              | -20 °C   |                             |
| <b>Relative humidity</b>                                 | ≤ 93 % (40 °C/4 d as per EN 60068-2-78); without condensation                    |                             |
| <b>Protection rating</b> EN 60529                        | IP66   |                             |
| <b>Mass</b>  | ≈ 0.8 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

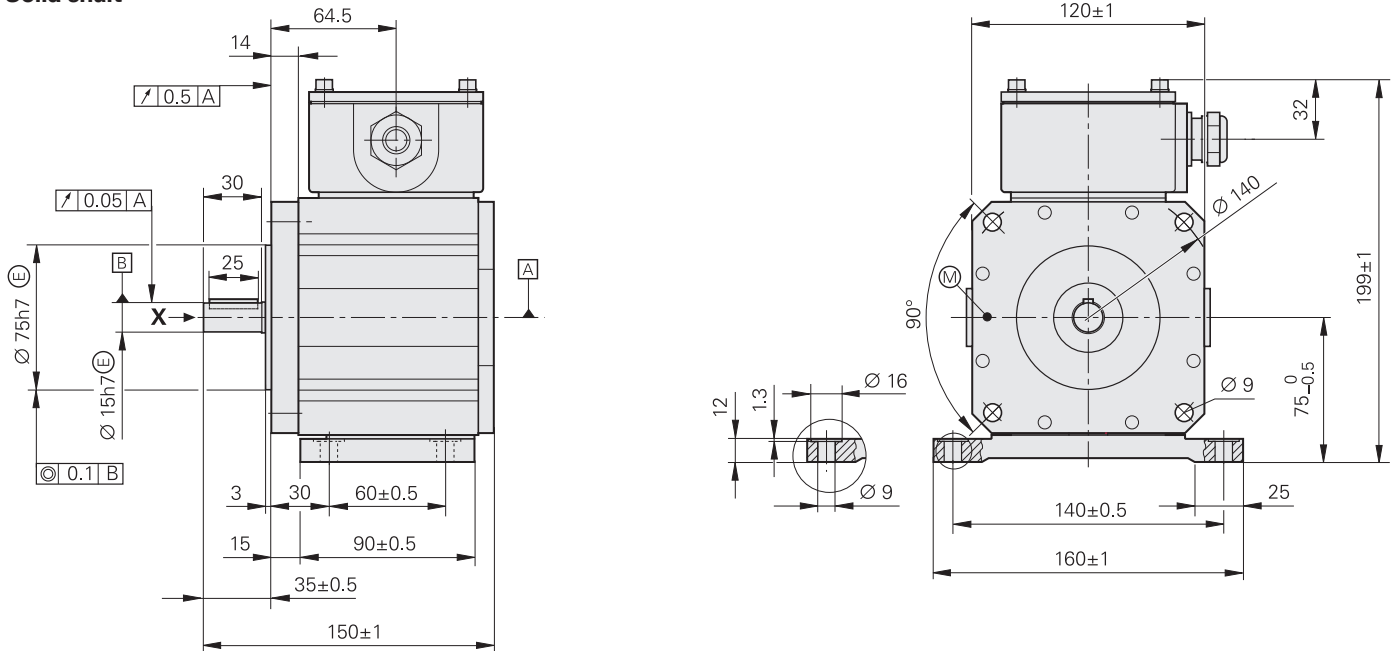
# ROD 1930

## Incremental rotary encoders

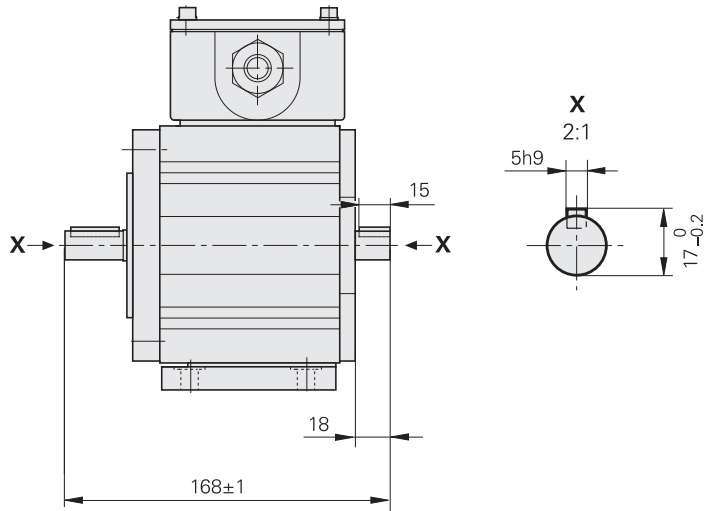
- For fastening with flange or base
- Solid shaft with key for separate shaft coupling



### Solid shaft



### Solid through shaft



mm



mm



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<br/>ROD 1930</b>                         |   |
|---|---|
| <b>Interface*</b>                                       | <input type="checkbox"/> HTL <span style="margin-left: 150px;"><input type="checkbox"/> HTLs</span> |
| Line counts*  | 600 1024 1200 2400  |
| Reference mark  | – <span style="margin-left: 150px;">One</span>  |
| Output frequency<br>Edge separation <i>a</i>            | ≤ 160 kHz<br>≤ 0.76 μs  |
| <b>System accuracy</b>                                  | ±1/10 of grating period   |
| <b>Electrical connection</b>                            | Terminal box with screw terminals   |
| Supply voltage  | 10 V to 30 V DC   |
| 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                   | <i>Solid shaft:</i> 0.05 Nm<br><i>Solid through shaft:</i> 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>                                | <i>Axial:</i> ≤ 150 N<br><i>Radial:</i> ≤ 200 N at shaft end  |
| <b>Vibration:</b> 25 Hz to 200 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>Operating temperature</b> <sup>2)</sup>              | –20 °C to 70 °C   |
| <b>Protection rating</b> EN 60529                       | IP66  |
| <b>Mass</b>   | ≈ 4.5 kg  |
| <b>Valid for ID</b>                                     | <i>Solid shaft:</i> 1043373-xx<br><i>Solid through shaft:</i> 1043377-xx                            |

\* Please select when ordering

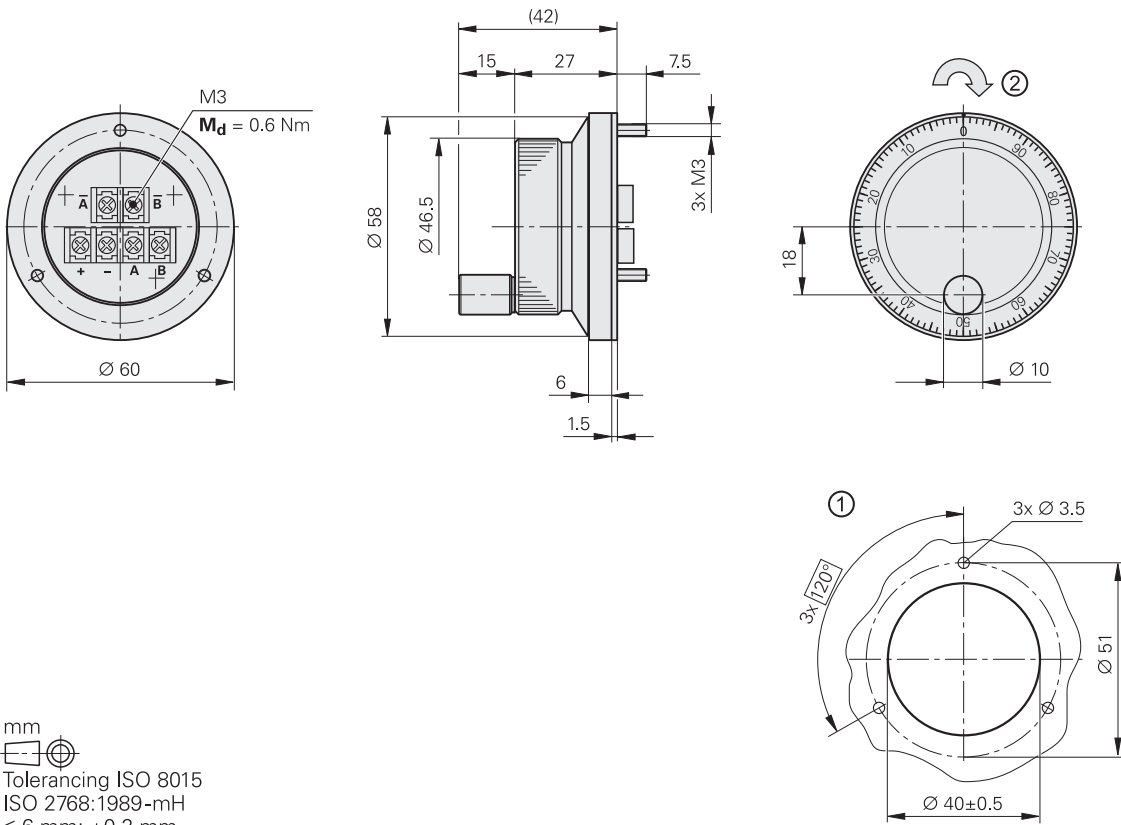
<sup>1)</sup> See also *Mechanical design types and mounting*

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

# HR 1120

## Electronic handwheel

- Version for integration
- With mechanical detent



mm



Tolerancing ISO 8015  
ISO 2768:1989-mH  
 $\leq 6 \text{ mm: } \pm 0.2 \text{ mm}$

1 = Cutout for mounting

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

|                                   | <b>Incremental<br/>HR 1120</b>  |
|-----------------------------------|---|
| <b>Interface</b>                  | □□TTL   |
| Line count                        | 100   |
| Output frequency                  | ≤ 5 kHz   |
| Switching times                   | $t_r/t_f \leq 100$ ns   |
| <b>Electrical connection</b>      | Via M3 screw terminals  |
| Cable length                      | ≤ 30 m  |
| Supply voltage                    | DC 5 V ±0.25 V  |
| Current consumption without load  | ≤ 160 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>    | ≤ 200 rpm   |
| <b>Torque</b>                     | ≤ 0.1 Nm (at 25 °C)   |
| <b>Vibration: 10 Hz to 200 Hz</b> | ≤ 20 m/s <sup>2</sup>   |
| <b>Max. operating temp.</b>       | 60 °C   |
| <b>Min. operating temp.</b>       | 0 °C  |
| <b>Protection rating EN 60529</b> | IP00; IP40 when mounted<br>No condensation permitted  |
| <b>Mass</b>                       | ≈ 0.15 kg   |
| <b>Valid for ID</b>               | 687617-xx   |

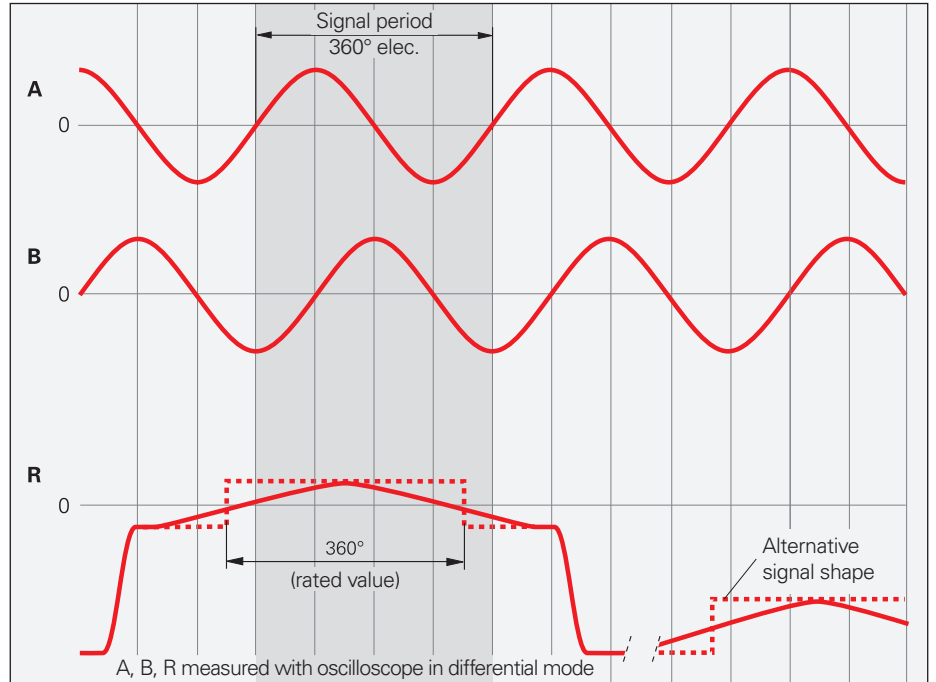
# Interfaces

## ~ 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 |        |        |  |  |  |  |
|                     | 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!

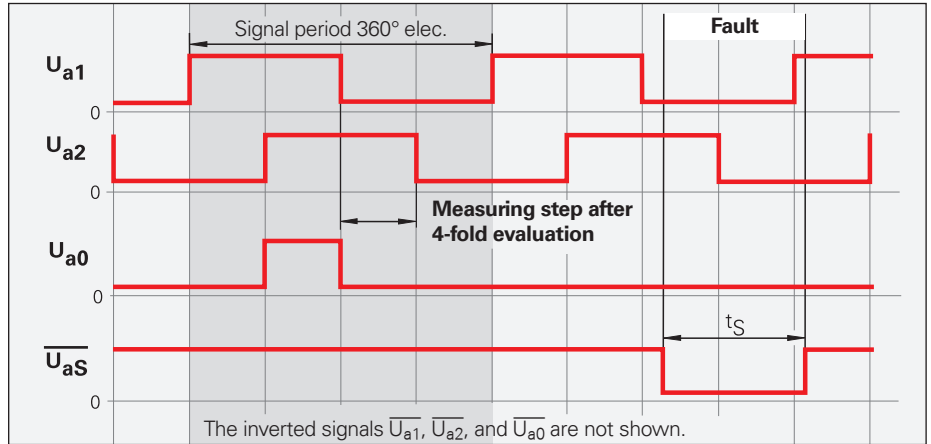
<sup>1)</sup> **LIDA 2xx:** Vacant

# 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         |                           |                       |
| $U_P$                                |  | Sensor<br>$U_P$ |  | 0V              | Sensor<br>0V         |   | $U_{a1}$ | $\overline{U_{a1}}$ | $U_{a2}$                             | $\overline{U_{a2}}$ | $U_{a0}$ | $\overline{U_{a0}}$ | $\overline{U_{aS}}^{(1)}$ | Vacant <sup>(2)</sup> |
| Brown/<br>Green                      |  | Blue            |  | White/<br>Green | White                |   | 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  $\mu$ App for PWT

## HR pin layout

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

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.

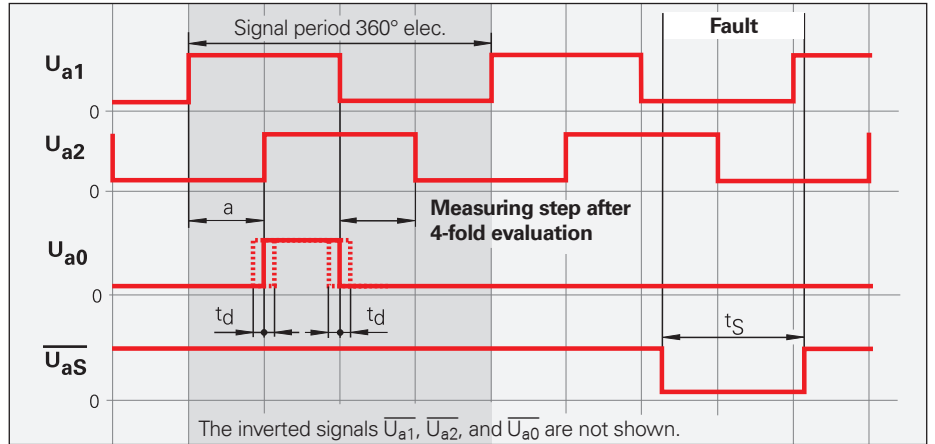
The handwheel is connected via screw terminals. The wires must be provided with the appropriate ferrules.

# 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  $90^\circ$  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 must 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:

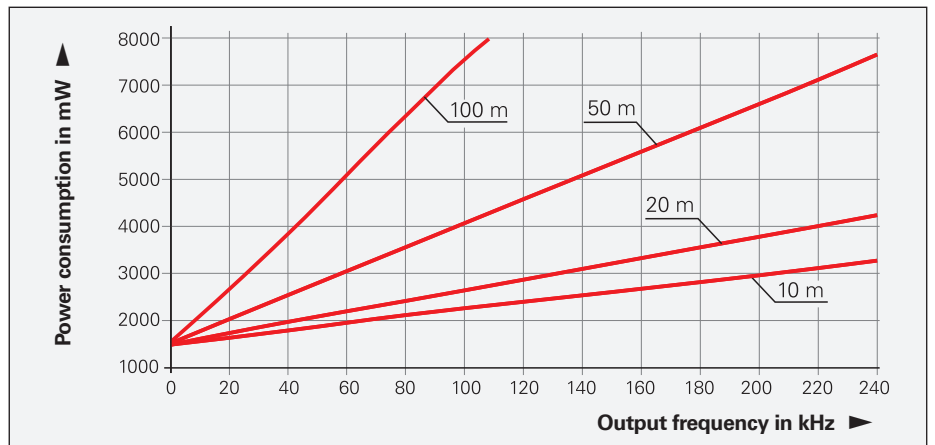
$$f = (n/60) \cdot z \cdot 10^{-3}$$

Where

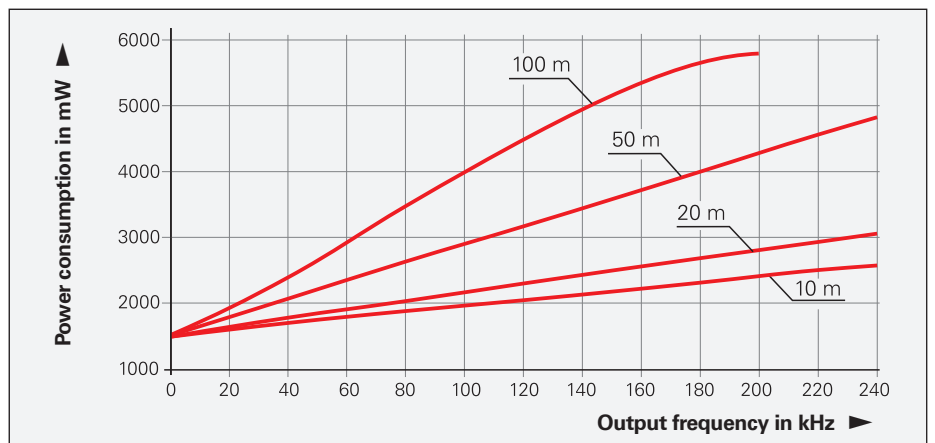
$f$  = Output frequency in kHz

$n$  = Shaft speed in rpm

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



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



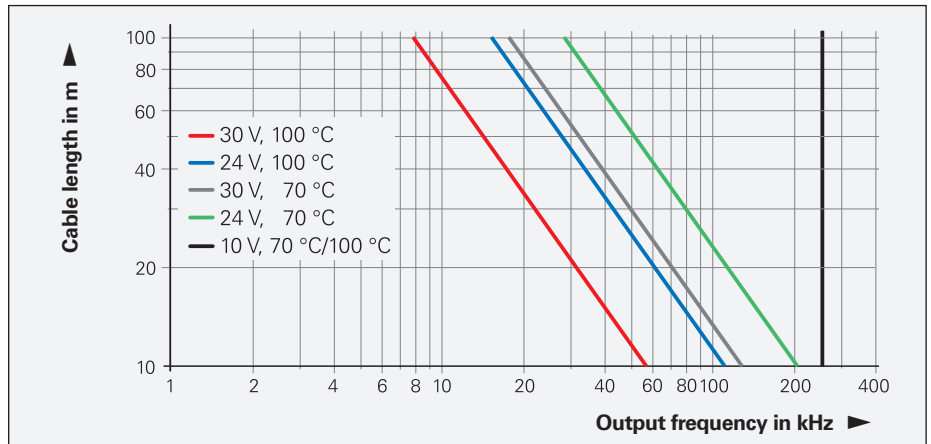
Power consumption (maximum) for the HTLs interface and supply voltage  $U_P = 30$  V

## Cable length for HTL

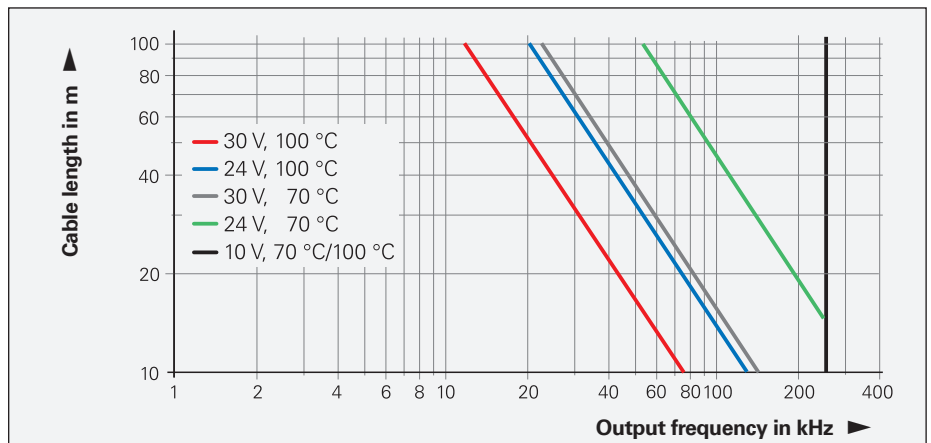
For those rotary encoders with additional HTL output signals, the maximum permissible cable length may vary depending on several criteria:

- 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.




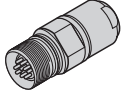
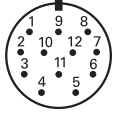


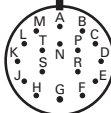







Maximum permissible cable length for the HTL interface



Maximum permissible cable length for 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   | $U_P$   | Sensor<br>$U_P$   | 0V  | Sensor<br>0V  | $U_{a1}$  | $\overline{U}_{a1}$  | $U_{a2}$  | $\overline{U}_{a2}$ | $U_{a0}$ | $\overline{U}_{a0}$ | $\overline{U}_{aS}$ | 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;  $U_P$  = 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   |   |   |   |
| <b>Connection</b>         | 1   | 2   | 3   | 4   | 5   | 6   |
| HTL                       | $U_P$   | $U_N$<br>0V   | $U_{a1}$  | $\overline{U}_{a1}$   | $U_{a2}$  | $\overline{U}_{a2}$   |
| HTLs                      |   |   |   | $U_{a2}$  | 0V  | $U_{a0}$  |

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.

# Position values

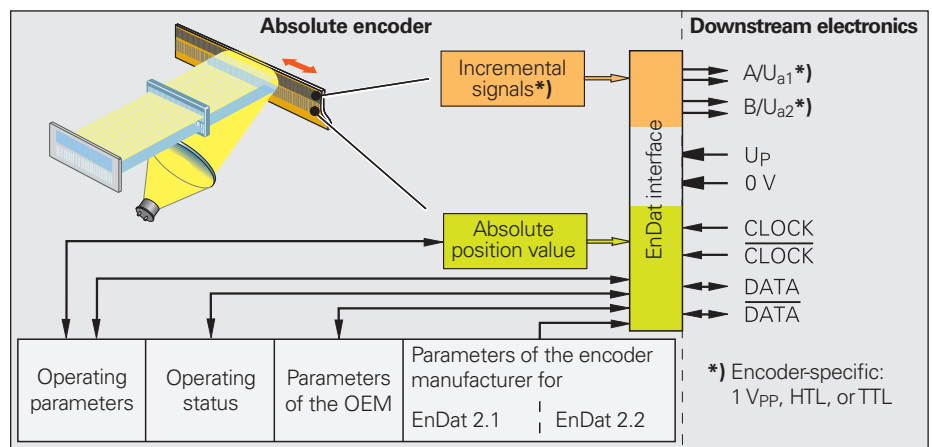
The EnDat interface is a digital, **bidirectional** interface for encoders. It is capable of outputting **position values**, reading information stored in the encoder, updating this information, and storing new information. Because the interface uses **serial transmission**, only **four signal lines** 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             |
|------------------------------------|------------------------|---------------------------------|
| <b>EnDat01</b><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>               |
| <b>EnDat22</b>                     | EnDat 2.2              | –                               |

Versions of the EnDat interface

## 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.


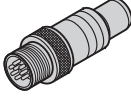



In compliance with the EnDat specification, when the temperature reaches the warning threshold for the temperature exceedance of the internal temperature sensor, an EnDat warning is issued (EnDat memory area "Operating status," word 1 "Warnings," bit 2<sup>1</sup> "Temperature exceeded"). This

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 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.


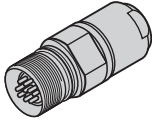



## Pin layout

| 8-pin M12 coupling  |   |   |             |                     |                          |             |              |              |
|---|---|---|-------------|---------------------|--------------------------|-------------|--------------|--------------|
|  |  |  |             |                     |                          |             |              |              |
|   | Supply voltage  |   |             |                     | Serial data transmission |             |              |              |
|  | <b>8</b>  | <b>2</b>  | <b>5</b>    | <b>1</b>            | <b>3</b>                 | <b>4</b>    | <b>7</b>     | <b>6</b>     |
|   | <b>U<sub>P</sub></b>  | <b>Sensor</b><br>U <sub>P</sub>   | <b>0V</b>   | <b>Sensor</b><br>0V | <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 |             |              |              |
|  | <b>7</b>  | <b>1</b>  | <b>10</b>       | <b>4</b>            | <b>11</b>                            | <b>15</b>                         | <b>16</b>        | <b>12</b>      | <b>13</b>     | <b>14</b>                | <b>17</b>   | <b>8</b>     | <b>9</b>     |
|   | <b>U<sub>P</sub></b>  | <b>Sensor</b><br>U <sub>P</sub>   | <b>0V</b>       | <b>Sensor</b><br>0V | <b>Internal shield</b> <sup>2)</sup> | <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

# Fanuc pin layout

## Fanuc pin layout


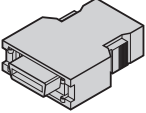
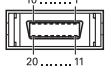

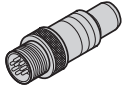




HEIDENHAIN encoders with the code letter F after the model designation are optimized for connection to Fanuc machine-tool controls with the

### 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  |   |                |                |
|   | <b>9</b>  | <b>18/20</b>  | <b>12</b>       | <b>14</b>           | <b>16</b>   | <b>1</b>  | <b>2</b>  | <b>5</b>       | <b>6</b>       |
|   | <b>8</b>  | <b>2</b>  | <b>5</b>        | <b>1</b>            | –   | <b>3</b>  | <b>4</b>  | <b>7</b>       | <b>6</b>       |
|  | <b>U<sub>P</sub></b>  | <b>Sensor</b><br>U <sub>P</sub>   | <b>0V</b>       | <b>Sensor</b><br>0V | <b>Shield</b>   | <b>Serial Data</b>  | <b>Serial Data</b>  | <b>Request</b> | <b>Request</b> |
|  | Brown/<br>Green   | Blue  | White/<br>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.


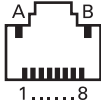

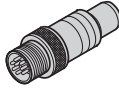



Vacant pins or wires must not be used!

# 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 |            |
|  | <b>A</b>  | <b>B</b>  | <b>3</b>  | <b>6</b>  | <b>1</b>          | <b>2</b>   |
|  | <b>1</b>  | <b>5</b>  | <b>7</b>  | <b>6</b>  | <b>3</b>          | <b>4</b>   |
|   | <b>U<sub>P</sub></b>  | <b>0V</b>   | <b>TXP</b>  | <b>TXN</b>  | <b>RXP</b>        | <b>RXN</b> |

**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.

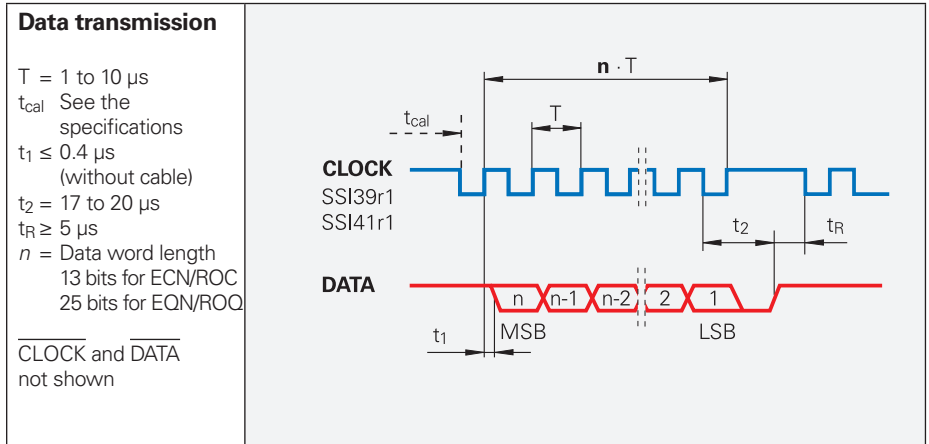
DRIVE-CLiQ is a registered trademark of Siemens AG

# 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  $1 V_{PP}$  incremental signals.

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

- **Direction 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       |  |
|                     | $U_P$           | Sensor $U_P$ | 0V              | Sensor 0V | Internal shield     | A+              | A-               | B+             | B-            | DATA                     | $\overline{DATA}$ | CLOCK  | $\overline{CLOCK}$ | Dir. of rotation | Zeroing |  |
|                     | Brown/<br>Green | Blue         | White/<br>Green | White     | /                   | Green/<br>Black | Yellow/<br>Black | Blue/<br>Black | Red/<br>Black | Gray                     | Pink              | Violet | Yellow             | Black            | Green   |  |

**Shield** lies on housing;  $U_P$  = 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.

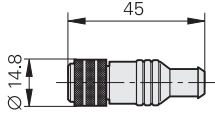
# Cables and connectors

## General information

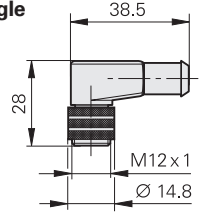
**Plastic-insulated connector:**  
Connecting element with coupling ring, available with male or female contacts (see symbols)

*Symbols*

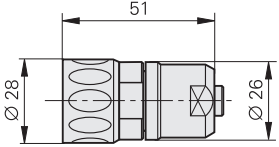
**M12**



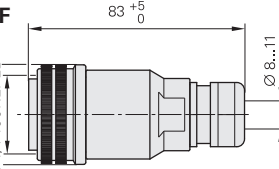
**M12 right-angle connector**



**M23**



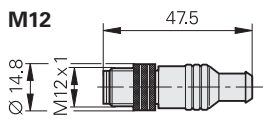
**1 1/4" - 18UNEF**



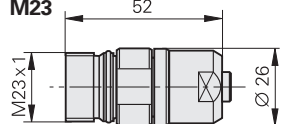
**Plastic-insulated coupling:** Connecting element with external thread; deliverable with male or female contacts (see symbols).

*Symbols*

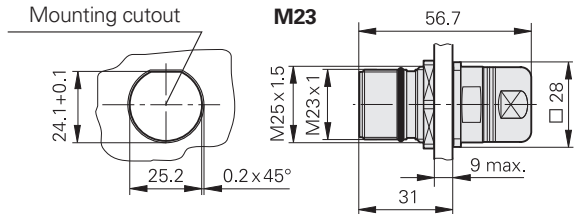
**M12**



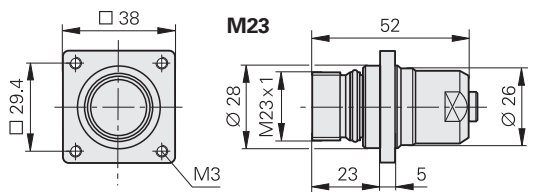
**M23**



**Mounted coupling with central fastening**

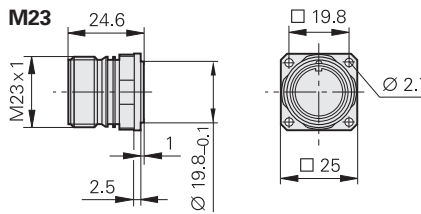


**Mounted coupling with flange**



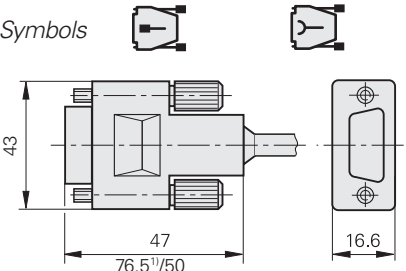
**Flange socket with external thread;** is permanently mounted on a housing, available with male or female contacts

*Symbols*



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

*Symbols*



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

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



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

|  |   | ~ 1V <sub>PP</sub> , □ TTL, □ HTL   |
|--|---|-------------------------------------|
| <b>PUR connecting cables</b>   |   |                                     |
| <b>12-pin:</b> 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> <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                           |
| <b>~ 1V<sub>PP</sub>/11 μA<sub>PP</sub> adapter connector</b><br>For converting 1 V <sub>PP</sub> to 11 μA <sub>PP</sub> ;<br>12-pin M23 connector (female) 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 incremental signals SSI   |
|--|----------------|---|-----------|--------------------------------------|
| <b>PUR connecting cables</b>   |                | <b>8-pin:</b> $(4 \times 0.14 \text{ mm}^2) + (4 \times 0.34 \text{ mm}^2)$ ; $A_P = 0.34 \text{ mm}^2$<br><b>17-pin:</b> $(4 \times 0.14 \text{ mm}^2) + 4(2 \times 0.14 \text{ mm}^2) + (4 \times 0.5 \text{ mm}^2)$ ; $A_P = 0.5 \text{ mm}^2$ |           |                                      |
|  | 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   | –         | –                                    |
| <b>Cable without connectors</b>  |                | –   | –         | 816322-xx                            |


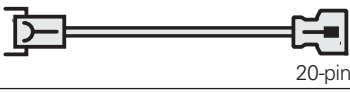

*Italics:* Cable with layout for “speed encoder” input (MotEnc EnDat)




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

$A_P$ : Cross section of power supply lines

# Fanuc and Siemens connecting cables

|   |   | Cables | Fanuc     |
|---|---|--------|-----------|
| <b>PUR connecting cables for M23 connecting elements</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> |  | 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>     |  | 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 |

|  |   | Cables | Fanuc     |
|--|---|--------|-----------|
| <b>PUR connecting cable for M12 connecting elements</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  |  | Ø 6 mm | –         |
| With 8-pin M12 connector (female) and 10-pin Mitsubishi connector  |  | Ø 6 mm | –         |

|   |   | Cables   | Siemens    |
|---|---|----------|------------|
| <b>PUR connecting cable for M12 connecting elements</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.

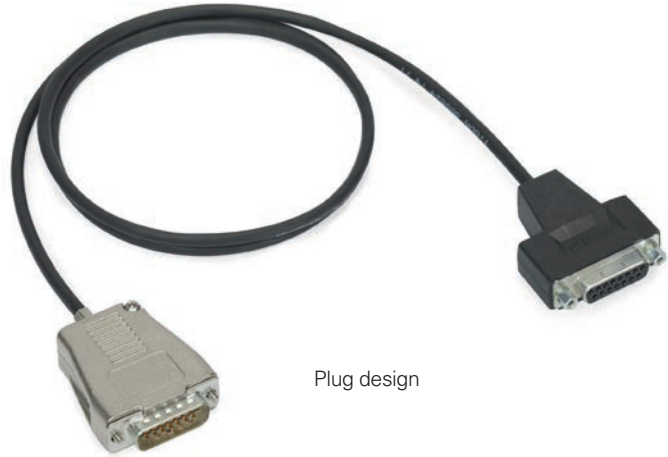
- Incremental interface at the input (1 V<sub>PP</sub> or 11 μA<sub>PP</sub>)
- Incremental interface at the output (TTL)

### 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:  $1 V_{PP}$ ,  $11 \mu A_{PP}$ , 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:  $1 V_{PP}$ , EnDat 2.1, EnDat 2.2 or  $11 \mu A_{PP}$
- Connection of up to two HEIDENHAIN encoders



| Outputs                                       |          | Inputs                |        | Design – IP rating  | Interpolation <sup>1)</sup> or subdivision | Type                      |
|---|----------|-----------------------|--------|---------------------|--|---------------------------|
| Interface                                     | Quantity | Interface             | Status |                     |  |                           |
| □□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 660 B</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<br>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 2391 S</b>         |
|   |          |                       |        | Cable design – IP65 | –  | <b>EIB 3392 S</b>         |
| Fanuc Serial Interface                        | 1        | ~ 1 V <sub>PP</sub>   | 1      | Box design (IP65)   | ≤ 16 384-fold subdivision                  | <b>EIB 192 F</b>          |
|   |          |                       |        | Plug design – IP40  | ≤ 16 384-fold subdivision                  | <b>EIB 3091 F</b>         |
|   |          |                       |        | 2                   | Box design (IP65)                          | ≤ 16 384-fold subdivision |
|   | 1        | EnDat 2.2             | 1      | Cable design – IP65 | –  | <b>EIB 3392 F</b>         |
| Mitsubishi high speed interface               | 1        | ~ 1 V <sub>PP</sub>   | 1      | Box design (IP65)   | ≤ 16 384-fold subdivision                  | <b>EIB 192 M</b>          |
|   |          |                       |        | Plug design – IP40  | ≤ 16 384-fold subdivision                  | <b>EIB 3091 M</b>         |
|   |          |                       | 2      | Box design (IP65)   | ≤ 16 384-fold subdivision                  | <b>EIB 1592 M</b>         |
| Yaskawa serial interface                      | 1        | EnDat 2.2             | 1      | Plug design – IP40  | –  | <b>EIB 3391 Y</b>         |

<sup>1)</sup> Switchable

# Testing and inspection devices, 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 devices 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**).

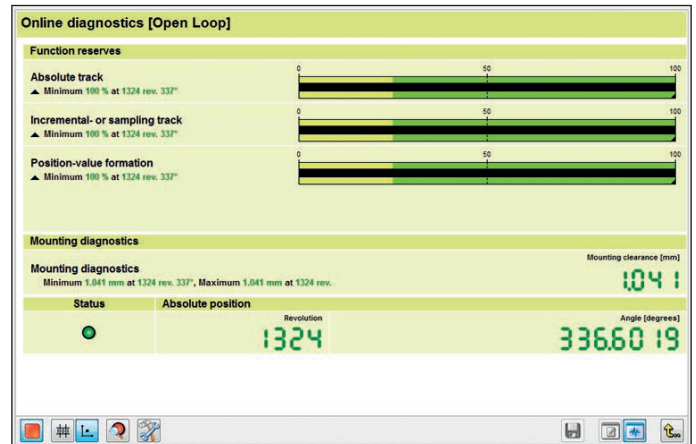
The following information is available:

- 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

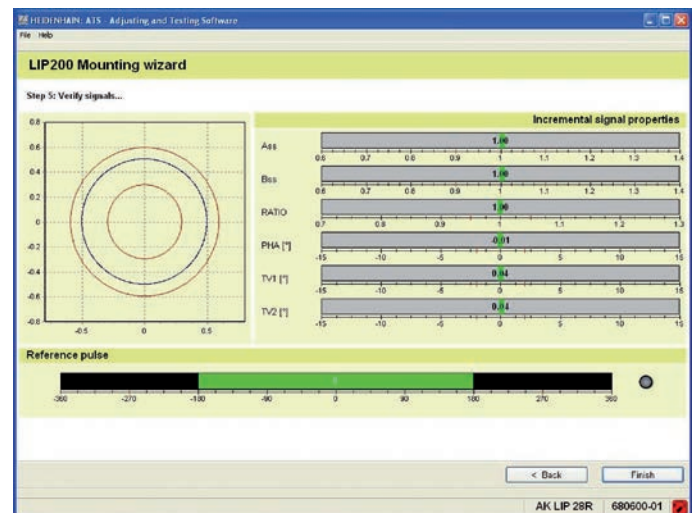
This enables the downstream electronics to evaluate the current status of the encoder with little effort, even in closed-loop mode.

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

- Encoder diagnostics: the encoder is connected directly to the testing or inspection device, thereby enabling a detailed analysis of encoder functions.
- Monitoring mode: the PWM inspection device 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 21 and ATS software



Initial setup with the PWM 21 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               |

1) Information must be requested by the control and transmitted

2) Via corresponding signal adapter

3) If supported by the encoder (PWT function)

4) Not available for encoders with the ordering designation Mitsu01

5) Not available for the EIB 3391Y

6) In planning

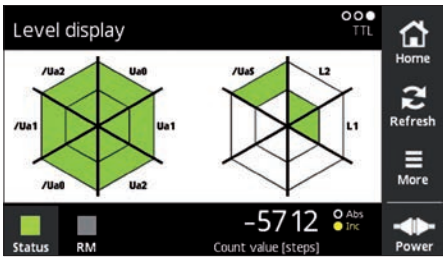
7) This function is currently not available

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

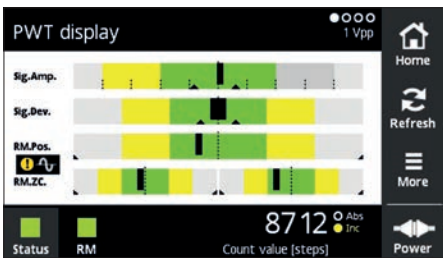
9) Only for encoders with block commutation (see encoder documentation)

### PWT 101

The PWT 101 is a testing device 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 E30-R2 ordering designation



|  | PWT 101   |
|--|---|
| <b>Area of application</b>                           | <ul style="list-style-type: none"> <li>Functional testing of absolute and incremental HEIDENHAIN encoders</li> </ul>  |
| <b>Encoder input</b><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> |
| <b>Display</b>                                       | 4.3-inch touchscreen  |
| <b>Supply voltage</b>                                | DC 24 V<br>Power consumption: max. 15 W   |
| <b>Operating temperature</b>                         | 0 °C to 40 °C   |
| <b>Protection EN 60529</b>                           | IP20  |
| <b>Dimensions</b>                                    | ≈ 145 mm × 85 mm × 35 mm  |
| <b>Languages</b>                                     | German, English, French, Italian, Spanish, Japanese, Korean, Chinese (simplified), Chinese (traditional)  |

<sup>1)</sup> 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.

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## PWM 21

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

- **PWM 21:** inspection device with USB connectability to a PC
- **ATS software:** adjusting and testing software with integrated local encoder database for automatic encoder identification



To find out more, see the *PWM 21/ATS software Product Information document*.

| Inspection device                                    | PWM 21   |
|--|--|
| <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 <i>Diagnostics</i> under <i>Range of functions</i> ); a signal adapter is required for galvanic isolation and EnDat 3 (see <i>Operating modes and signal adapters</i> )  |
| <b>Interface</b>                                     | USB 2.0 (High Speed)   |
| <b>Supply voltage</b>                                | AC 100 V to 240 V (±10 %), 50 Hz to 60 Hz (±2 Hz)<br>Supply voltage: DC 24 V (±2.4 V)<br>Power consumption ≈ 20 W  |
| <b>Operating temperature</b>                         | 0 °C to 45 °C  |
| <b>Protection rating</b><br>EN 60529                 | IP20   |
| <b>Dimensions</b>                                    | 258 mm × 154 mm × 55 mm  |

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

|  | <b>ATS software V3.8</b>   |
|--|--|
| <b>Download</b>                                | The ATS software is not included in delivery and 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> . 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> . |
| <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 x 768</li> <li>• Operating system: Windows 7, 8, 10 (32-bit or 64-bit), Windows 11</li> </ul>  |
| <b>Software options</b>                        | Management of product keys for optional functions  |
| <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 V3.8 software

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