HEIDENHAIN

# General Catalog: Products and Solutions

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DR. JOHANNES HEIDENHAIN GmbH develops and manufactures linear and angle encoders, rotary encoders, evaluation units and numerical controls. HEIDENHAIN supplies its products to manufacturers of machine tools as well as automated machines and systems, especially in the semiconductor and electronics manufacturing industries.

HEIDENHAIN is represented in over 50 countries—mainly through its own subsidiaries. Sales engineers and service technicians assist users on-site with technical information and servicing.


# Contents

# Fundamentals and processes

The high quality of HEIDENHAIN products depends on special production facilities and measuring equipment. Masters and submasters for scale manufacturing are produced in a clean room with special measures for temperature stabilization and vibration insulation. HEIDENHAIN develops and builds most of the machines it needs for the production and measurement of linear and circular scales, including the necessary copying equipment.

30 m long measuring machine for scale tapes

Vacuum machine for application of chromium layers

Competence in the area of linear and angular metrology is reflected by a large number of customized solutions for users. Among other implementations, they include the measuring and test equipment developed and built for standards laboratories and the angle encoders for telescopes and satellite receiving antennas. Of course, the products in the standard HEIDENHAIN product program profit from the knowledge gained.

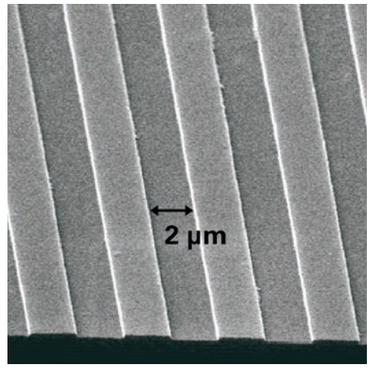
Angle comparator, measuring step approx. 0.001 "

ALMA radio telescope in Chajnantor, Chile (photo courtesy of ESO)



# Precision graduations: the foundation for high accuracy

The heart of a HEIDENHAIN encoder is its measuring standard, usually in the form of a grating with typical line widths of 0.25 µm to 10 µm. These precision graduations are manufactured in a process invented by HEIDENHAIN (e.g. DIADUR or METALLUR) and are a decisive factor in the function and accuracy of encoders. The graduations consist of lines and gaps at defined intervals with very little deviation, forming structures with very high edge definition. These graduations are resistant to mechanical and chemical influences and can tolerate vibration and shock. All measuring standards have a defined thermal behavior.




Phase grating with approx. 0.25 µm grating height

**DIADUR**
DIADUR precision graduations are composed of an extremely thin layer of chromium on a substrate—usually of glass or glass ceramic. The accuracy of the graduation structure lies within the micron and submicron range.

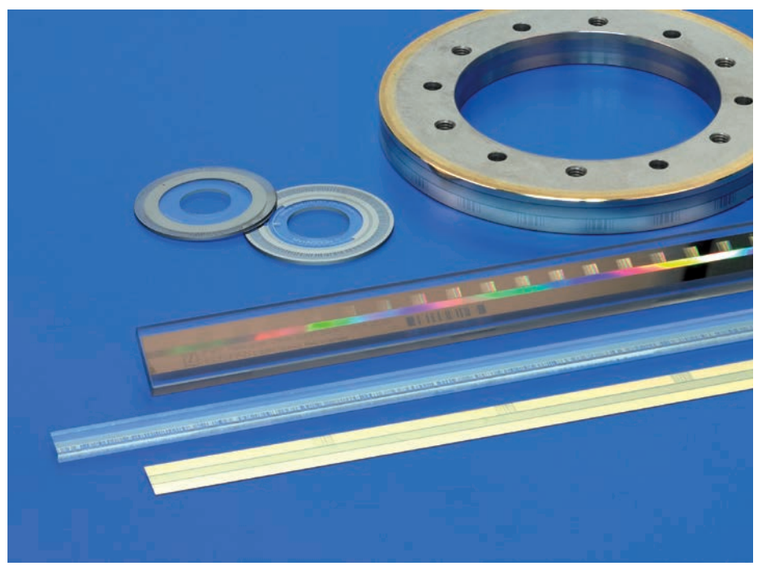
**METALLUR**
With its special optical composition of reflective gold layers, METALLUR graduations show a virtually planar structure. They are therefore particularly tolerant to contamination.

**Phase gratings**
Special manufacturing processes make it possible to produce three-dimensional graduation structures, possessing defined optical characteristics. The structure widths are in the range of a few microns down to quarters of a micron.

**SUPRADUR**
Graduations manufactured with the SUPRADUR process function optically like three-dimensional phase gratings, but they have a planar structure and are therefore particularly insensitive to contamination.

**OPTODUR**
The OPTODUR process produces graduation structures with particularly high reflectance. Its composition as an optically three-dimensional, planar structure is similar to the SUPRADUR graduation.

**MAGNODUR**
Thin magnetically active layers in the micron range are structured for very fine, magnetized graduations.



DIADUR and METALLUR graduations on various carrier materials

# Length measurement

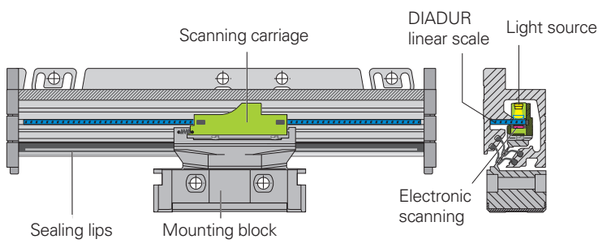
**Sealed linear encoders**
Sealed linear encoders from HEIDENHAIN are protected from dust, chips and splash fluids and are ideal for operation on **machine tools.**

- Accuracy grades as fine as ±2 µm
- Measuring steps of down to 0.001 µm
- Measuring lengths of up to 72 m
- Fast and simple installation
- Large mounting tolerances
- High acceleration loading
- Protection against contamination


Sealed linear encoders are available with

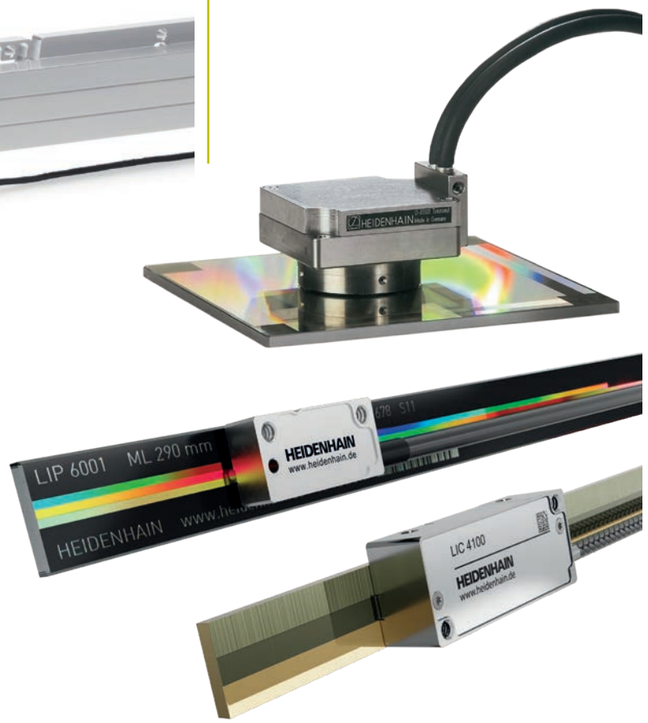
- **Full-size scale housing**
  – For high vibration loading
  – Up to 72 m measuring length
- **Slimline scale housing**
  – For limited installation space
  – Measuring lengths of up to 2040 mm (for measuring lengths starting from 1240 mm, mounting via mounting spar or tensioning elements)

The aluminum housing of a HEIDENHAIN sealed linear encoder protects the scale, scanning carriage and its guideway from chips, dust and fluids. Downward-oriented elastic lips seal the housing. The scanning carriage travels along the scale on a low-friction guide. It is connected to the external mounting block by a coupling that compensates unavoidable misalignment between the scale and the machine guideways.




**Exposed linear encoders**
Exposed linear encoders from HEIDENHAIN operate with no mechanical contact between the scanning head and the scale or scale tape. Typical areas of application for these encoders include **measuring machines, comparators** and other **precision devices,** as well as **production and measuring equipment,** for example in the semiconductor industry.

- Accuracy grades of ±0.5 µm and better
- For measuring steps of down to 0.001 µm (1 nm)
- Measuring lengths of up to 30 m
- No friction between scanning head and scale
- Small dimensions and low mass
- High traversing speeds




**Length gauges**
Length gauges from HEIDENHAIN feature integral guideways for the plunger. They are used to monitor measuring equipment, in industrial metrology, and as position encoders.

- Accuracy grades as fine as ±0.1 µm
- For measuring steps of down to 0.005 µm (5 nm)
- Measuring lengths of up to 100 mm
- High measuring accuracy
- Available with automated plunger drive
- Simple mounting


With **incremental linear encoders**, the current position is determined by starting at a reference point and counting measuring steps, or by subdividing and counting signal periods. Incremental encoders from HEIDENHAIN feature reference marks, which must be scanned after switch-on to reestablish the reference point. This process is especially simple and fast with distance-coded reference marks.

**Absolute linear encoders** from HEIDENHAIN require no previous traverse to provide the current position value. The encoder transmits the absolute value through the **EnDat interface** or another serial interface.

The recommended **measuring steps** listed in the table refer primarily to position measurements. Smaller measuring steps, which are attained through higher interpolation factors of sinusoidal output signals, are useful in particular for applications in rotational speed control, e.g. on direct drives.

Under the designation **functional safety**, HEIDENHAIN offers encoders with purely serial data transmission as single-encoder systems for safety-related machines and systems. The two measured values are already formed independently of each other in the encoder, and are transmitted to the safe control via the EnDat interface.

| Sealed linear encoders | | Series | Page |
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| **With full-size scale housing** | Absolute position measurement | **LC 100** | **8** |
| | Absolute position measurement and long measuring lengths | **LC 200** | |
| | Incremental position measurement | **LS 100** | |
| | Very high repeatability | **LF 100** | |
| | Typically for manual machines | **LS 600** | |
| | Long measuring lengths | **LB 300** | |
| **With slimline scale housing** | Absolute position measurement | **LC 400** | **10** |
| | Incremental position measurement | **LS 400** | |
| | Very high repeatability | **LF 400** | |
| | Typically for manual machines | **LS 300** | |
| **Exposed linear encoders** | Very high accuracy | **LIP** | **12** |
| | Two-coordinate encoders | **LIF, PP** | **13** |
| | For high accuracy and long measuring lengths | **LIDA** | **14** |
| | Absolute position measurement | **LIC** | |
| **Length gauges** | For measuring stations and multipoint inspection apparatuses | **AT, CT, MT, ST** | **16** |

# LC, LF, LS, LB sealed linear encoders
## With full-size scale housing

Linear encoders with **full-size scale housing** are characterized particularly by high tolerance to vibration.

Absolute linear encoders of the **LC 100** and **LC 200** series provide the **absolute position value** without requiring any previous traverse. Depending on the version, incremental signals can be output additionally. The LC 100 can be mounted to the same mating dimensions as the incremental linear encoders of the **LS 100** series and features the same mechanical design. Because of their high accuracy and defined thermal behavior, LC 100 and LS 100 series linear encoders are especially well suited for use on **numerically controlled machine tools.**

The incremental encoders of the **LF** type feature measuring standards with relatively fine grating periods. This makes them particularly attractive for applications requiring very **high repeatability.**

The **LS 600** series incremental linear encoders are used for simple positioning tasks, for example on **manual machine tools.**

The **LC 200** (absolute) and **LB** (incremental) linear encoders were designed for very **long measuring lengths**. Their measuring standard—a steel tape with METALLUR graduation—is delivered as a single piece, and after the housing sections have been mounted, is pulled through the sections, drawn to a defined tension and fixed at both ends to the machine base.

### Absolute position measurement

**LC 100 series**
- Absolute position measurement
- Defined thermal behavior
- High vibration resistance
- Two mounting attitudes
- Single-field scanning

**LC 200 series**
- Absolute position measurement
- For long measuring lengths of up to 28 m[4)]
- Defined thermal behavior
- High vibration resistance
- Two mounting attitudes
- Single-field scanning

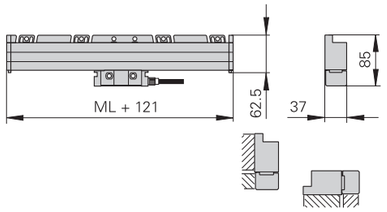
### Incremental position measurement

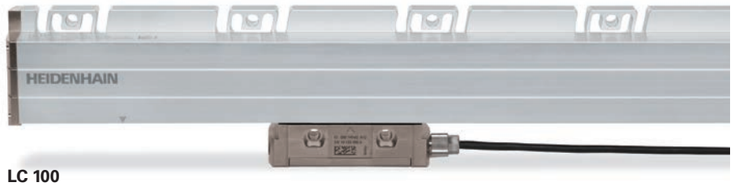
**LS 100 series**
- Incremental position measurement
- Defined thermal behavior
- High vibration resistance
- Two mounting attitudes
- Single-field scanning

**LF 185**
- Incremental position measurement
- Very high repeatability
- Thermal behavior similar to steel or cast iron
- High vibration resistance
- Two mounting attitudes
- Single-field scanning

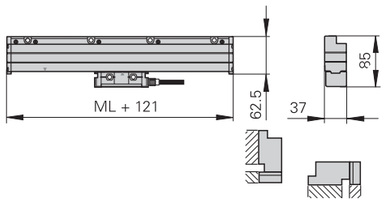
**LB 383**
- Incremental position measurement
- For large measuring lengths of up to 72 m
- Defined thermal behavior
- High vibration resistance
- Two mounting attitudes
- Single-field scanning

**LS 600 series**
- Incremental position measurement
- Typically for manual machines
- Simple mounting



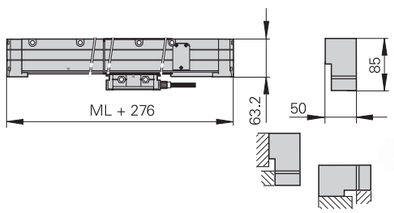




LC 100



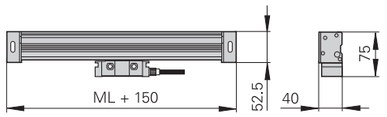


LF 185





LC 200




LS 600

| | *Absolute*<br>**LC 115[1)]/LC 185<br>LC 195F/M/P/S[1)]<br>LC 116/LC 196F/M** | **LC 211/LC 281<br>LC 291F/M** | *Incremental*<br>**LF 185** | **LS 187<br>LS 177** | **LS 683C<br>LS 673C** | **LB 383** |
|---|---|---|---|---|---|---|
| **Measuring standard**<br><br>Grating period | DIADUR glass scale<br><br>20 µm | METALLUR steel scale tape<br><br>40 µm | SUPRADUR phase grating on steel<br>8 µm | DIADUR glass scale<br><br>20 µm | DIADUR glass scale<br><br>20 µm | METALLUR steel scale tape<br><br>40 µm |
| **Interface** | *LC 115/LC 116:* EnDat 2.2<br>*LC 185:* EnDat 2.2 with ~ 1 $V_{PP}$<br>*LC 195:* Fanuc αi/Mitsubishi/ Panasonic/DRIVE-CLiQ<br>*LC 196:* Fanuc αi/Mitsubishi | *LC 211:* EnDat 2.2<br>*LC 281:* EnDat 2.2 with ~ 1 $V_{PP}$<br>*LC 291:* Fanuc αi/Mitsubishi | ~ 1 $V_{PP}$ | *LS 187:* ~ 1 $V_{PP}$<br>*LS 177:* ⊓⊔TTL[2)] | *LS 683C:* ~ 1 $V_{PP}$<br>*LS 673C:* ⊓⊔TTL | ~ 1 $V_{PP}$ |
| Signal period | *LC 185:* 20 µm | *LC 281:* 40 µm | 4 µm | *LS 187:* 20 µm | *LS 683C:* 20 µm | 40 µm |
| **Accuracy grade** | ±5 µm, ±3 µm[3)] | ±5 µm | ±3 µm, ±2 µm | ±5 µm, ±3 µm | ±5 µm | ±5 µm |
| **Measuring lengths ML** | Up to 4240 mm | Up to 28 040 mm[4)] | Up to 3040 mm | Up to 3040 mm | | Up to 72040 mm |
| **Reference mark** | – | | One or distance-coded; *LS 6xxC:* distance-coded | | | |

1) Also available with functional safety
2) 5/10/20-fold integrated interpolation
3) Up to ML 3040 mm
4) Longer measuring lengths with TNC 640 upon request

DRIVE-CLiQ is a registered trademark of SIEMENS AG.

# LC, LF, LS sealed linear encoders
## With slimline scale housing

Sealed linear encoders with **slimline scale housing** are primarily used where installation space is limited.

Absolute linear encoders of the **LC 400** series provide the **absolute position value** without requiring any previous traverse. Like the **LS 400** series incremental linear encoders, their high accuracy and defined thermal behavior make them especially well suited for use on **numerically controlled machine tools.**

The incremental encoders of the **LF** type feature measuring standards with relatively fine grating periods. This makes them particularly attractive for applications requiring very **high repeatability.**

The **LS 300** series incremental linear encoders are used for simple positioning tasks, for example on **manual machine tools.**

### Absolute position measurement

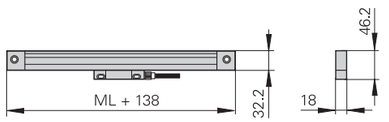
**LC 400 series**
- Absolute position measurement
- Defined thermal behavior
- Single-field scanning

### Incremental position measurement

**LS 400 series**
- Incremental position measurement
- Defined thermal behavior
- Single-field scanning

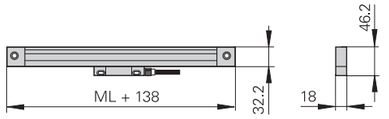
**LF 485**
- Incremental position measurement
- Very high repeatability
- Thermal behavior similar to steel or cast iron
- Single-field scanning

**LS 300 series**
- Incremental position measurement
- Typically for manual machines



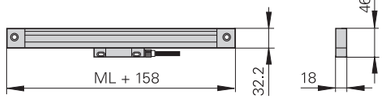


**LC 400**



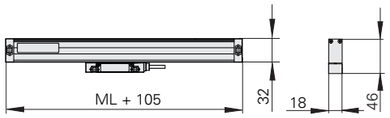


**LS 400**



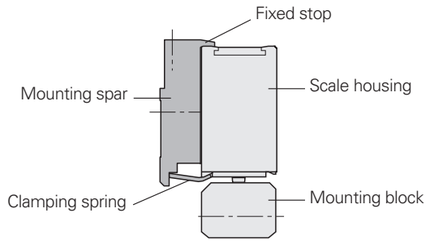


**LF 485**




**LS 300**

**Simple installation with mounting spar**
The use of a mounting spar is of great benefit when mounting slimline linear encoders. It can be fastened as part of the machine assembly process. The encoder is then simply clamped on during final mounting. Easy exchange also facilitates servicing. Moreover, installation with a mounting spar significantly improves the encoder's acceleration behavior.


| | ***Absolute*** **LC 415[1]/LC 485 LC 495 F/M/P/S[1] LC 416/LC 496 F/M** | ***Incremental*** **LF 485** | **LS 487 LS 477** | **LS 383 C LS 373 C** |
|---|---|---|---|---|
| **Measuring standard** | DIADUR glass scale | SUPRADUR phase grating on steel | DIADUR glass scale | Glass scale |
| Grating period | 20 µm | 8 µm | 20 µm | 20 µm |
| **Interface** | *LC 415/LC 416:* EnDat 2.2<br>*LC 485:* EnDat 2.2 with ∿ 1 $V_{PP}$<br>*LC 495:* Fanuc αi/ Mitsubishi/ Panasonic/ DRIVE-CLiQ<br>*LC 496:* Fanuc αi/ Mitsubishi | ∿ 1 $V_{PP}$ | *LS 487:* ∿ 1 $V_{PP}$<br>*LS 477:* ⊓⊔ TTL[2] | *LS 383 C:* ∿ 1 $V_{PP}$<br>*LS 373 C:* ⊓⊔ TTL |
| Signal period | *LC 485:* 20 µm | 4 µm | *LS 487:* 20 µm | 20 µm |
| **Accuracy grade** | ±5 µm, ±3 µm | ±5 µm, ±3 µm | | ±5 µm |
| **Measuring lengths ML** | Up to 2040 mm[3] | Up to 1220 mm | Up to 2040 mm[3] | |
| **Reference mark** | – | One or distance-coded | | One or distance-coded |

[1] Also available with functional safety
[2] 5/10/20-fold integrated interpolation
[3] Over ML 1240 mm with mounting spar or clamping elements

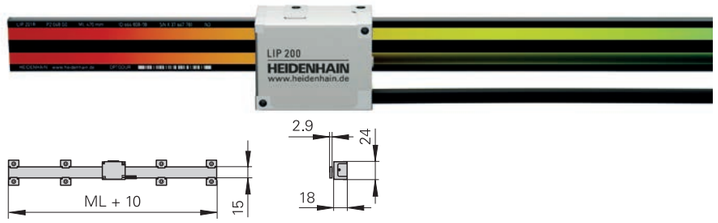
# LIP, LIF exposed linear encoders
## For very high accuracy

The exposed linear encoders of the **LIP** and **LIF** design are characterized by small measuring steps together with high accuracy. The measuring standard is a phase grating applied to a substrate of glass or glass ceramic.

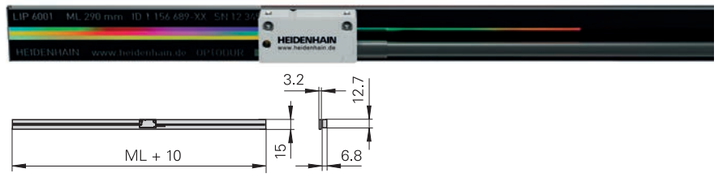
**LIP** and **LIF** encoders are typically used for:
- Measuring machines and comparators
- Measuring microscopes
- Ultra-precision machines such as diamond lathes for optical components, facing lathes for magnetic storage disks, and grinding machines for ferrite components
- Measuring and production equipment in the semiconductor industry
- Measuring and production equipment in the electronics industry

For special **high-vacuum applications**, suitable encoders are the LIF 481V and LIF 471V (for high-vacuum applications down to $10^{-7}$ bar) and the LIF 481 U (for ultrahigh vacuum applications down to $10^{-11}$ bar).

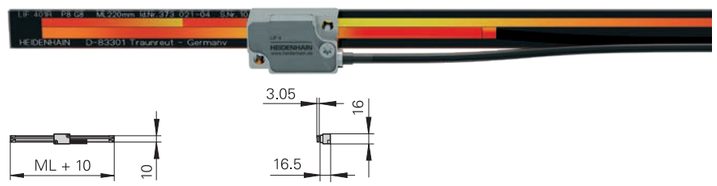
**LIP 200 series**
- Very high repeatability with compact dimensions
- Measuring lengths of up to 3040 mm
- Measuring steps of down to < 1 nm
- Defined thermal behavior thanks to a measuring standard on Zerodur glass ceramic scale




**LIP 6000 series**
- For highly dynamic applications
- For limited installation space
- Measuring steps of down to 1 nm
- Position detection through limit switches and homing track




**LIF 400 series**
- Fast, simple scale fastening with PRECIMET adhesive film
- Insensitive to contamination thanks to SUPRADUR graduation
- Position detection through limit switches and homing track




| | *Incremental*<br>**LIP 281**<br>**LIP 211** | | **LIP 6081**<br>**LIP 6071** | | **LIF 481**<br>**LIF 471** | |
|---|---|---|---|---|---|---|
| **Measuring standard**<br>Grating period | OPTODUR phase grating on Zerodur glass ceramic<br>2.048 µm | | OPTODUR phase grating on glass or Zerodur glass ceramic<br>8 µm | | SUPRADUR phase grating on glass or Zerodur glass ceramic<br>8 µm | |
| **Interface** | *LIP 281:* ⌒ 1 $V_{PP}$<br>*LIP 211:* EnDat 2.2[1] | | *LIP 6081:* ⌒ 1 $V_{PP}$<br>*LIP 6071:* ⊓⊔ TTL | | *LIF 481:* ⌒ 1 $V_{PP}$<br>*LIF 471:* ⊓⊔ TTL | |
| Signal period | *LIP 281:* 0.512 µm | | *LIP 6081:* 4 µm | | *LIF 481:* 4 µm | |
| **Accuracy grade** | ±1 µm | ±3 µm | ±1 µm (only for Zerodur) | ±3 µm | ±1 µm (only for Zerodur) | ±3 µm |
| **Baseline error** | ≤ ±0.125 µm/5 mm | | ≤ ±0.175 µm/5 mm | | ≤ ±0.225 µm/5 mm | |
| **Interpolation error**[2] | ±0.4 nm | | ±4 nm | | ±12 nm | |
| **Measuring lengths ML** | 20 mm to 1020 mm | 370 mm to 3040 mm | 20 mm to 1020 mm | 20 mm to 3040 mm | 70 mm to 1020 mm | 70 mm to 1640 mm |
| **Reference mark** | One | | One | | One | |

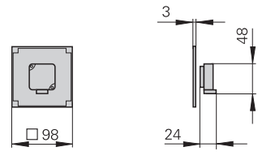
[1] Absolute position value after crossing the reference mark
[2] Only with encoders with the 1 $V_{PP}$ or EnDat 2.2 interface



# PP exposed linear encoders
## Two-coordinate encoders

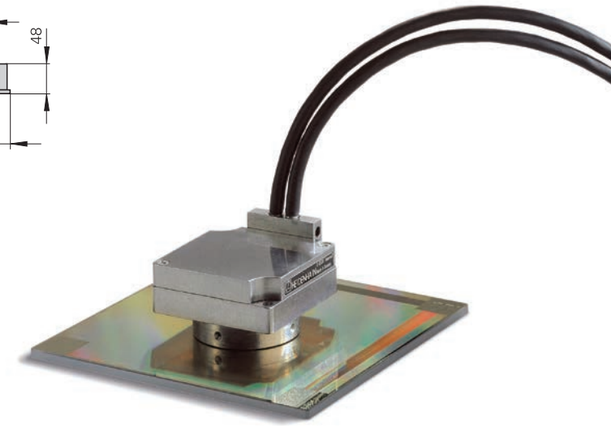
The **PP** two-coordinate encoders feature as measuring standard a planar phase-grating structure on a glass substrate. This makes it possible to measure positions in a plane.

Applications include:
- Measuring and production equipment in the semiconductor industry
- Measuring and production equipment in the electronics industry
- Extremely fast X-Y tables
- Measuring machines and comparators
- Measuring microscopes









| | *Incremental*<br>**PP 281** |
|---|---|
| **Measuring standard**<br>Grating period | DIADUR phase grating on glass<br>8 µm |
| **Interface** | ⌒ 1 $V_{PP}$ |
| Signal period | 4 µm |
| **Accuracy grade** | ±2 µm |
| **Interpolation error** | ±12 nm |
| **Measuring range** | 68 mm x 68 mm,<br>other measuring ranges upon request |
| **Reference mark** | One per coordinate |

# LIC, LIDA exposed linear encoders

## For high accuracy and long measuring lengths

The **LIC** and **LIDA** exposed linear encoders are designed for **high traversing speeds** of up to 10 m/s and **large measuring lengths** of up to 30 m.

The **LIC** encoders make **absolute position measurement** possible over measuring lengths of up to 28 m. In their dimensions, they correspond to LIDA 400 and LIDA 200 incremental linear encoders.

The LIC 4113V and LIC 4193V encoders are suitable for special **high-vacuum applications** (down to $10^{-7}$ bar).

On the **LIC** and **LIDA** linear encoders, steel scale tapes typically serve as substrate for METALLUR graduations. With the LIC 41x3 and LIDA 4x3, graduation carriers of glass or glass ceramics permit **thermal adaptation** thanks to their different coefficients of linear expansion.

LIC and LIDA exposed linear encoders are typically used for:
- Coordinate measuring machines
- Inspection machines
- PCB assembly machines
- PCB drilling machines
- Precision handling devices
- Position and velocity measurement on linear motors

There are **various possibilities for easy mounting** of the LIC and LIDA encoders:

**LIC 41x3, LIDA 4x3**
- Scale of glass or glass ceramic is bonded directly onto the mounting surface

**LIC 41x5, LIDA 4x5**
- One-piece steel scale tape pulled through aluminum extrusions and tensioned at its ends
- The aluminum extrusions can be screwed or bonded onto the mounting surface

**LIC 41x7, LIC 31x7, LIC 21x7, LIDA 4x7, LIDA 2x7**
- One-piece steel scale-tape pulled through aluminum extrusions and fastened at center
- The aluminum extrusions are bonded onto the mounting surface

**LIC 41x9, LIC 31x9, LIC 21x9, LIDA 4x9, LIDA 2x9**
- One-piece steel scale tape is bonded directly to the mounting surface
- Also available with functional safety (LIC 4119)

### Absolute position measurement

**LIC 4100 series**
- Very high accuracy and long measuring lengths
- Various mounting options
- Grating on steel scale tape, glass or glass ceramic
- Also available with functional safety

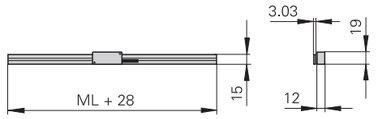
**LIC 3100 series**
- High accuracy and long measuring lengths
- Various mounting options
- Scale tape cut from roll

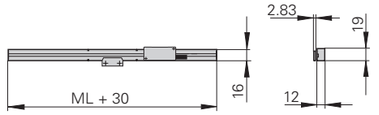
**LIC 2100 series**
- Large mounting tolerance
- For simple applications

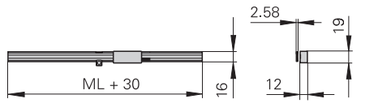
### Incremental position measurement

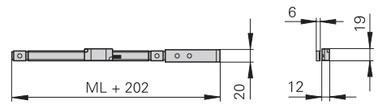
**LIDA 400 series**
- Long measuring lengths of up to 30 m
- Various mounting options
- Limit switches

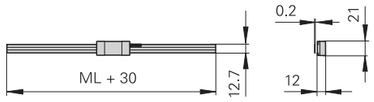
**LIDA 200 series**
- Scale tape cut from roll
- Large mounting tolerance
- For simple applications
- Simple installation through integrated function display





**LIC 4113**


**LIC 3119**


**LIC 2117**


**LIDA 485**


**LIDA 279**

| | ***Absolute*** | | | | | | ***Incremental*** | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **LIC 4113<br>LIC 4193** | **LIC 4115<br>LIC 4195** | **LIC 4117<br>LIC 4197** | **LIC 4119[1]<br>LIC 4199** | **LIC 3117<br>LIC 3197** | **LIC 3119<br>LIC 3199** | **LIC 2117<br>LIC 2197** | **LIC 2119<br>LIC 2199** | **LIDA 483<br>LIDA 473** | **LIDA 485<br>LIDA 475** | **LIDA 487<br>LIDA 477** | **LIDA 489<br>LIDA 479** | **LIDA 287<br>LIDA 277** | **LIDA 289<br>LIDA 279** |
| **Measuring standard**<br><br>Grating period | METALLUR graduation on glass ceramic or glass<br>40 µm | METALLUR steel scale tape<br><br>40 µm | | | Steel scale tape with absolute track and incremental track<br>80 µm | | Steel scale tape<br><br>220 µm | | METALLUR graduation on glass ceramic or glass<br>20 µm | METALLUR steel scale tape<br><br>20 µm | | | Steel scale tape<br><br>200 µm | |
| **Interface** | ***LIC 411x:*** EnDat 2.2<br>***LIC 419x:*** Fanuc αi/Mitsubishi/Panasonic/Yaskawa | | | | ***LIC 311x:*** EnDat 2.2<br>***LIC 319x:*** Fanuc αi/Mitsubishi/ Panasonic/Yaskawa | | ***LIC 211x:*** EnDat 2.2<br>***LIC 219x:*** Fanuc αi/ Mitsubishi/ Panasonic/Yaskawa | | ***LIDA 48x:*** ⌇ 1 $V_{PP}$<br>***LIDA 47x:*** ⊓⊔ TTL[2] | | | | ***LIDA 28x:*** ⌇ 1 $V_{PP}$<br>***LIDA 27x:*** ⊓⊔ TTL[2] | |
| Signal period | – | | | | – | | – | | ***LIDA 48x:*** 20 µm | | | | ***LIDA 28x:*** 200 µm | |
| **Accuracy grade** | ±3 µm;<br>±5 µm | ±5 µm | ±3 µm[3];<br>±5 µm[3];<br>±15 µm | ±3 µm;<br>±15 µm | ±15 µm[6] | | ±15 µm | | ±1 µm[4];<br>±3 µm;<br>±5 µm | ±5 µm | ±3 µm[3];<br>±5 µm[3];<br>±15 µm | ±3 µm;<br>±15 µm | ±15 µm | |
| **Baseline error** | ≤ ±0.275 µm/10 mm | ≤ ±0.750 µm/50 mm | | | ≤ ±0.750 µm/50 mm (typical) | | – | | ≤ ±0.275 µm/10 mm | ≤ ±0.750 µm/50 mm (typical) | | | – | |
| **Interpolation error[5]** | ±20 nm | ±20 nm | | | ±100 nm | | ±1 µm | | ±45 nm | ±45 nm | | | ±2 µm | |
| **Measuring lengths ML** | 240 mm to 3040 mm | 140 mm to 28440 mm | 240 mm to 6040 mm | 70 mm to 1020 mm | Scale tape from the roll<br>3 m/5 m/10 m | | Scale tape from the roll<br>3 m/5 m/10 m | | 240 mm to 3040 mm | 140 mm to 30040 mm | 240 mm to 6040 mm | | Scale tape from the roll<br>3 m/5 m/10 m | |
| **Reference mark** | – | | | | – | | – | | One or distance-coded | One | | | Selectable every 100 mm | |

[1] Also available with functional safety
[2] Up to 100-fold integrated interpolation ( LIDA 47x also 5-fold)
[3] Up to measuring length of 1020 mm or 1040 mm
[4] Only for Robax glass ceramic up to ML 1640 mm
[5] Only with encoders with 1 $V_{PP}$ or EnDat 2.2 interface
[6] ±5 µm after linear length-error compensation in the downstream electronics

# AT, CT, MT, ST length gauges

## For measuring stations and multipoint inspection apparatuses

HEIDENHAIN length gauges are characterized by high accuracy together with large strokes of up to 100 mm. They feature plungers with integral bearings and therefore serve as compact measuring devices.

The **HEIDENHAIN-CERTO** CT length gauges are used predominantly for production quality control of high-precision parts and for the monitoring and calibration of reference standards.

The **HEIDENHAIN-METRO** MT 1200 and MT 2500 length gauges are ideal for precision measuring stations and testing equipment. The ball-bush guided plunger tolerates high radial forces.
The primary applications for the MT 60 and MT 101 are incoming inspection, production monitoring and quality control. They are also used as high-accuracy position encoders, for example on linear slides or X-Y tables.

Thanks to their very small dimensions, the **HEIDENHAIN-ACANTO** AT and **HEIDENHAIN-SPECTO** ST series length gauges are the product of choice for multipoint inspection apparatus and testing equipment.

**Plunger actuation**
The plungers of the length gauges with **motorized** plunger actuation are extended and retracted by an integral motor. They are operated through the associated switch box.

Length gauges with plunger actuation by **coupling** have no plunger drive. The freely movable plunger is connected by a separate coupling with the moving machine element.

The length gauges with plunger actuation **by the measured object** or **with cable-type lifter** feature a spring-loaded plunger that is extended in its resting position.

The MT 1281 and ST 1288 length gauges are available with various gauging forces. Particularly for fragile materials this makes it possible to measure without deformation.

On the length gauges with **pneumatic** plunger actuation, the plunger is retracted by the integral spring at its rest position. It is extended to the measuring position by application of compressed air.

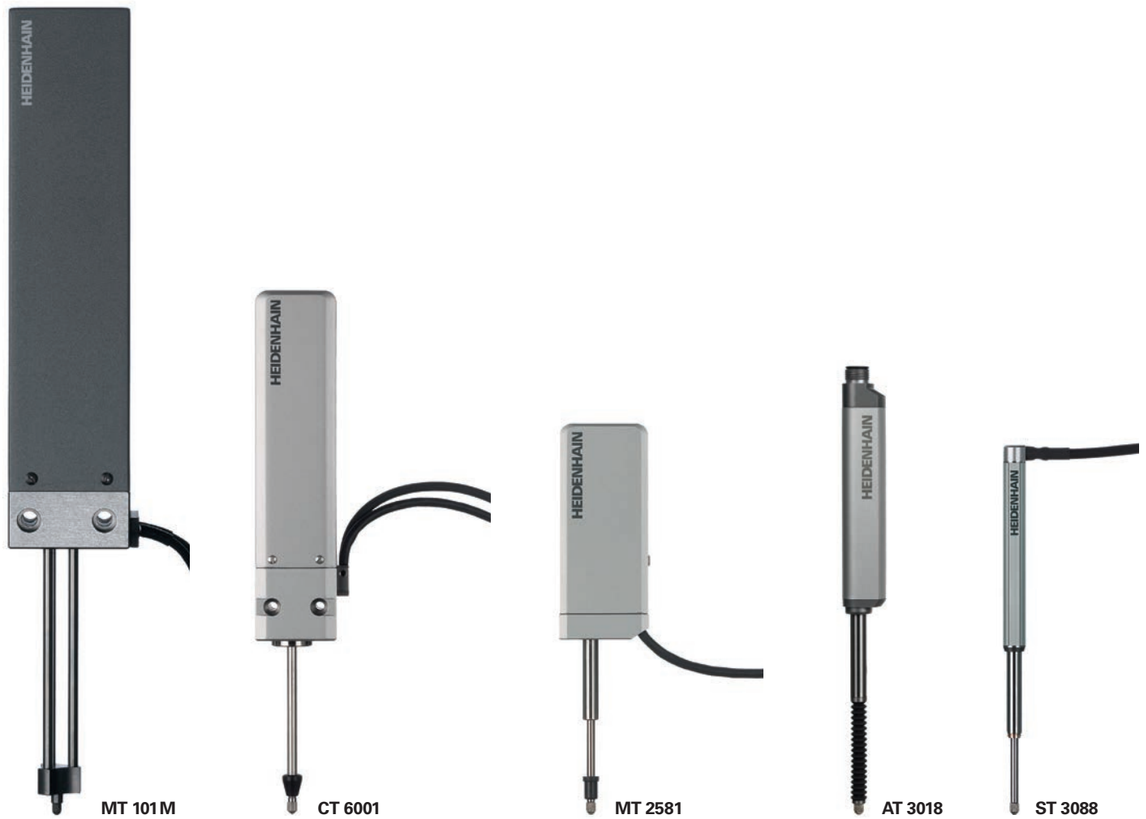
**HEIDENHAIN-ACANTO**
- Online diagnostics
- Protection up to IP67
- Absolute scanning

**HEIDENHAIN-CERTO**
- For highest accuracy
- Low thermal expansion through thermally invariant materials
- High-precision ball bearing guide

**HEIDENHAIN-METRO**
MT 1200 and MT 2500
- High repeatability
- Various gauging force variants
- Various possibilities for plunger actuation

**HEIDENHAIN-METRO**
MT 60 and MT 101
- Large measuring ranges
- Plunger actuation by motor or coupling
- Ball-bush guided plunger

**HEIDENHAIN-SPECTO**
- Exceptionally compact dimensions
- Protection up to IP67
- Especially durable ball-bush guide
- Variant for harsh ambient conditions




MT 101 M | CT 6001 | MT 2581 | AT 3018 | ST 3088

| | ***Absolute*** | | ***Incremental*** | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **AT 1218 AT 1217** | **AT 3018 AT 3017** | **CT 2501 CT 2502** | **CT 6001 CT 6002** | **MT 1281 MT 1287** | **MT 1271** | **MT 2581 MT 2587** | **MT 2571** | **MT 60 M MT 60 K** | **MT 101 M MT 101 K** | **ST 1288 ST 1287** | **ST 1278 ST 1277** | **ST 3088 ST 3087** | **ST 3078 ST 3077** |
| **Measuring standard** | DIADUR glass scale | | DIADUR phase grating on Zerodur glass ceramic<br>Coefficient of linear expansion: $\alpha_{therm} = (0\pm0.1) \cdot 10^{-6}\ K^{-1}$ | | | | | | DIADUR graduation on glass ceramic | | DIADUR glass scale | | | |
| Grating period | 188.4 µm | | 4 µm | | 4 µm | | | | 10 µm | | 20 µm | | | |
| **Interface** | EnDat 2.2 | | ~ 11 $\mu A_{PP}$ | | ~ 1 $V_{PP}$ | ⊓⊔ TTL[3] | ~ 1 $V_{PP}$ | ⊓⊔ TTL[3] | ~ 11 $\mu A_{PP}$ | | ~ 1 $V_{PP}$ | ⊓⊔ TTL[3] | ~ 1 $V_{PP}$ | ⊓⊔ TTL[3] |
| Signal period | – | | 2 µm | | | – | 2 µm | – | 10 µm | | 20 µm | – | 20 µm | – |
| **System accuracy** | ±1 µm | ±2 µm | ±0.1 µm[1]<br>±0.03 µm[2] | ±0.1 µm[1]<br>±0.05 µm[2] | ±0.2 µm | | | | ±0.5 µm | ±1 µm | ±1 µm | | | |
| **Repeatability** | 0.4 µm | 0.8 µm | 0.02 µm | 0.03 µm | | | 0.09 µm | | 0.06 µm | 0.04 µm | 0.25 µm | | 0.7 µm | |
| **Measuring range** | 12 mm | 30 mm | 25 mm | 60 mm | 12 mm | | 25 mm | | 60 mm | 100 mm | 12 mm | | 30 mm | |
| **Plunger actuation** | *AT xx18:* by measured object<br>*AT xx17:* pneumatic | | *CT xx01:* with motor<br>*CT xx02:* by coupling | | *MT xxx1:* cable-type lifter or free<br>*MT xx87:* pneumatic | | | | *MT xxM:* with motor<br>*MT xxK:* by coupling | | *ST xxx8:* by measured object<br>*ST xxx7:* pneumatic | | | |

[1] At 19 °C to 21 °C; permissible temperature fluctuation during measurement: ±0.1 K
[2] With linear length-error compensation in the evaluation unit
[3] 5/10-fold integrated interpolation

# Angle measurement

**Angle encoders**
HEIDENHAIN angle encoders are characterized by high accuracy values in the range of angular seconds and better. These devices are used in applications such as rotary tables and swivel heads of machine tools, indexing heads, high-precision angle measuring tables, precision devices in angular metrology, antennas and telescopes.

- Line counts: typically 9000 to 180 000
- Accuracy: from ±5″ to ±0.4″
- Measuring steps as fine as 0.000 01° or 0.036″ (incremental) or 29 bits, i.e. approx. 536 million positions per revolution (absolute)

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

- Line counts of typically 50 to 5000
- Accuracy grades: to ±10″ (depending on the line count, corresponding to ±1/20 of the grating period)
- Measuring steps: as fine as 0.000 01°. Particularly for photoelectric rotary encoders, the high quality of the sinusoidal incremental signals permits high interpolation factors for digital speed control.

**Absolute angle encoders and rotary encoders** require no previous traverse to provide the current position value. **Singleturn encoders** provide the current angular position value within one revolution, while **multiturn encoders** can additionally distinguish between revolutions. The position values are output, for example, over the purely serial, bidirectional **EnDat** interface. It enables automatic configuration of the higher-level electronics and provides monitoring and diagnostic functions.

Under the designation **functional safety**, HEIDENHAIN offers encoders with purely serial data transmission as single-encoder systems for safety-related machines and systems. The two measured values are already formed independently of each other in the encoder, and are transmitted to the safe control via the data interface.

With **incremental angle encoders and rotary encoders**, the current position is determined by starting at a reference point and counting measuring steps, or by subdividing and counting signal periods. Incremental encoders from HEIDENHAIN feature reference marks to reestablish the reference point.

**Incremental rotary encoders with commutation signals** provide the angular shaft position value—without requiring previous traverse—with sufficient accuracy to correctly control the phases of the rotating field of a permanent-magnet three-phase motor.

**Mounting variants**
In angle encoders and rotary encoders with integral bearing and **stator coupling**, the graduated disk of the encoder is connected directly to the shaft to be measured. The scanning unit is guided on the shaft via ball bearings, supported by the stator coupling. As a result, during angular acceleration of the shaft, the stator coupling must absorb only that torque resulting from friction in the bearing. These angle encoders therefore provide excellent dynamic performance. Thanks to the stator coupling, the system accuracy includes the error of the shaft coupling. Other benefits of the stator coupling are:
- Simple mounting
- Short overall length
- High natural frequency of the coupling
- Hollow through shaft is possible

Angle encoders and rotary encoders with integral bearings for a **separate shaft coupling** are designed with a solid shaft. The recommended coupling to the measured shaft compensates radial and axial tolerances. Angle encoders for separate shaft couplings permit higher shaft speeds.

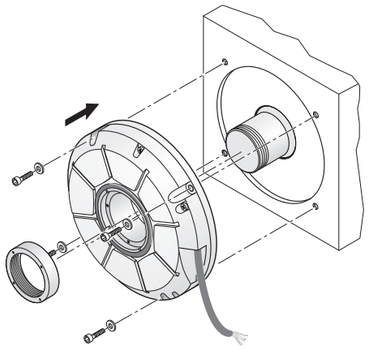
Angle encoders and rotary encoders **without integral bearing** operate without friction. The two components—the scanning head and the scale disk, drum or tape—are adjusted to each other during assembly. The benefits are:
- Little space required
- Large hollow-shaft diameters
- High shaft speeds possible
- No additional starting torque

| Sealed angle encoders | | Series | Page |
|---|---|---|---|
| **With integral bearing and integrated stator coupling** | Absolute (singleturn)/Incremental | **RCN, RON, RPN** | **20** |
| **With integral bearing** | Absolute (singleturn)/Incremental | **ROC, ROD** | **22** |
| **Angle encoder modules** | With precision bearings | **MRP, SRP** | **24** |
| **Modular angle encoders** | | | |
| **Without integral bearing, with optical scanning** | Absolute (singleturn)/Incremental | **ECA, ERA, ERO, ERP** | **26** |
| **Without integral bearing, with magnetic scanning** | Absolute (singleturn)/Incremental | **ECM, ERM** | **32** |
| **Rotary encoders** | | | |
| **With integral bearing, for mounting by stator coupling** | Absolute (singleturn/multiturn) Incremental | **ECN, EQN ERN** | **34** |
| **With integral bearing, for separate shaft coupling** | Absolute (singleturn/multiturn) Incremental | **ROC, ROQ ROD** | **38** |
| **Without integral bearing** | Absolute (singleturn/multiturn) Incremental | **ECI, EQI, EBI ERO** | **40** |
| | | **KCI, KBI** | **44** |

# RCN, RON, RPN sealed angle encoders

## With integral bearing and integrated stator coupling

Because of their high static and dynamic accuracy, the **RCN, RON** and **RPN** angle encoders with integral bearings and integral stator couplings are the preferred encoders for high-precision applications such as rotary tables and tilting axes. The measuring standard is usually a circular scale with DIADUR graduation. For the encoders with stator coupling, the specified accuracy includes the error resulting from mounting. For angle encoders with separate shaft coupling, the coupling error must be added to find the system accuracy.

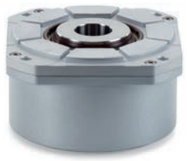


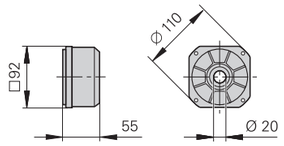
Features of the **RCN 2001, RCN 5001** and **RCN 8001** series angle encoders:

- **High system accuracies** that account for position error within one revolution and within one signal period, as well as errors arising from the coupling, while maintaining wide mounting tolerances
- **Optimized scanning technology,** so that even liquid contamination or condensation droplets barely affect the scanning signal quality and therefore the motor control
- **Simple acquisition of temperature values of direct drive motors** through evaluation of the winding temperatures in the direct drive motors using an EIB 5000
- **High permissible speeds** with purely serial interface: up to 3000 rpm
- Possibility of mechanical fault exclusion against loosening of the encoder-to-drive connection

**RCN 2001, RCN 200 and RON 200 series**

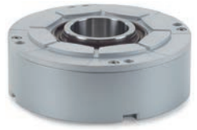
- Compact dimensions
- Sturdy design
- Typically used with rotary tables, tilting tables, for positioning and speed control

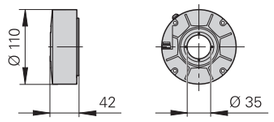





**RCN 5001 series**

- Large hollow shaft and small installation space
- Stator mounting dimensions compatible with RCN 2001

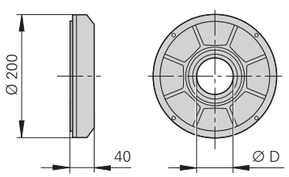





**RCN 8001, RON 700 and RON/RPN 800 series**

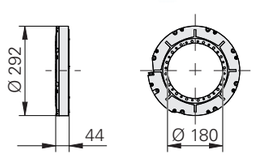
- Large hollow shaft diameters of up to Ø 100 mm
- System accuracies: ±2″ and ±1″
- Typically used on rotary and angle measuring tables, indexing heads, measuring setups, image scanners, etc.

*RCN 8001*
D = 60 mm or 100 mm
*RON 786/886, RPN 886*
D = 60 mm




**RCN 6000 series**

- Very large hollow shaft
- System accuracy: ±2″
- Typically used with rotary tables, tilting tables and direct drive motors




| | *Absolute* | | | | *Incremental* | |
|---|---|---|---|---|---|---|
| | **RCN 2511**[1] **RCN 2311**[1] **RCN 210** | **RCN 2581 RCN 2381 RCN 280** | **RCN 2591 F RCN 2391 F RCN 290 F** | **RCN 2591 M RCN 2391 M RCN 290 M** | **RON 275** | **RON 285 RON 287** |
| **Interface** | EnDat 2.2 | | Fanuc αi | Mitsubishi | ⊓⊔ TTL | ∿ 1 $V_{PP}$ |
| Position values/revolution | *RCN 25x1:* 268 435 456 (28 bits); *RCN 23x1:* 67 108 864 (26 bits)<br>*RCN 2x0:* 33 554 432 (25 bits) | | | | – | |
| Signal periods/revolution | *RCN 2xx1:* 16 384; *RCN 2x0:* 2048 | | | | 90 000/180 000[2] | 18 000 |
| **System accuracy** | *RCN 25x1:* ±2″; *RCN 23x1:* ±4″; *RCN 2x0:* ±6″ | | | | ±5″ | ±5″; ±2.5″ |
| **Mech. permissible speed**[3] | ≤ 3000 rpm | *RCN 2x81:* ≤ 1500 rpm<br>*RCN 280:* ≤ 3000 rpm | ≤ 3000 rpm | | ≤ 3000 rpm | |

| | *Absolute* | | | |
|---|---|---|---|---|
| | **RCN 5511**[1] **RCN 5311**[1] | **RCN 5581 RCN 5381** | **RCN 5591 F RCN 5391 F** | **RCN 5591 M RCN 5391 M** |
| **Interface** | EnDat 2.2 | | Fanuc αi | Mitsubishi |
| Position values/revolution | *RCN 55x1:* 268 435 456 (28 bits); *RCN 53x1:* 67 108 864 (26 bits) | | | |
| Signal periods/revolution | 16 384 | | | |
| **System accuracy** | *RCN 55x1:* ±2″; *RCN 53x1:* ±4″ | | | |
| **Mech. permissible speed**[3] | ≤ 2000 rpm | ≤ 1500 rpm (operating temperature ≤ 50 °C)<br>≤ 1200 rpm (operating temperature > 50 °C) | ≤ 2000 rpm | |

| | *Absolute* | | | | *Incremental* | | |
|---|---|---|---|---|---|---|---|
| | **RCN 8511**[1] **RCN 8311**[1] | **RCN 8581 RCN 8381** | **RCN 8591 F RCN 8391 F** | **RCN 8591 M RCN 8391 M** | **RON 786** | **RON 886** | **RPN 886** |
| **Interface** | EnDat 2.2 | | Fanuc αi | Mitsubishi | ∿ 1 $V_{PP}$ | | |
| Position values/revolution | 536 870 912 (29 bits) | | | | – | | |
| Signal periods/revolution | 32 768 | | | | 18 000, 36 000 | 36 000 | 180 000 |
| **System accuracy** | *RCN 85x1:* ±1″; *RCN 83x1:* ±2″ | | | | ±2″ | ±1″ | |
| **Mech. permissible speed**[3] | ≤ 1500 rpm[4] | ≤ 750 rpm | ≤ 1500 rpm[4] | | ≤ 1000 rpm | | |

| | *Absolute* |
|---|---|
| | **RCN 6310**[1] |
| **Interface** | EnDat 2.2 |
| Position values/revolution | 268 435 456 (28 bits) |
| **System accuracy** | ±2.0″ |
| **Mech. permissible speed** | ≤ 200 rpm[5] |

[1] Also available with functional safety
[2] 5/10-fold integrated interpolation
[3] See *Speeds* in the *Angle Encoders with Integral Bearing* brochure
[4] For 60 mm hollow shaft diameter; for 100 mm hollow shaft diameter: ≤ 1200 rpm
[5] Higher speeds possible depending on the operating temperature

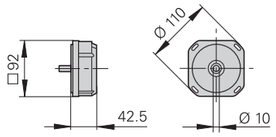
# ROC, ROD sealed angle encoders
## With integral bearing

**ROC** and **ROD** angle encoders with solid shaft for separate shaft coupling are particularly suited to applications where higher shaft speeds and larger mounting tolerances are required. The precision shaft couplings allow up to ±1 mm of axial motion.

ROC and ROD angle encoders feature a DIADUR circular scale as measuring standard. For angle encoders with separate shaft coupling, the angular measuring error caused by the shaft coupling must be added to find the system accuracy.



**For separate shaft coupling: ROC 2000 and ROD 200**
- Compact dimensions
- Sturdy design
- Typically used with rotary tables, tilting tables, for positioning and synchronization monitoring

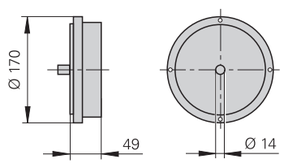



| | *Absolute* ROC 2310 | ROC 2380 | ROC 2390F | ROC 2390M | *Incremental* ROD 270 | ROD 280 |
|---|---|---|---|---|---|---|
| **Interface** | EnDat 2.2[4] | EnDat 2.2[4] ∿ 1 $V_{PP}$ | Fanuc αi | Mitsubishi | ⊓⊔TTL | ∿ 1 $V_{PP}$ |
| Signal periods/revolution | 16384 | | | | 180000[3] | 18000 |
| **System accuracy**[1] | ±5″ | | | | | |
| **Mech. permissible speed** | ≤ 3000 rpm | | | | ≤ 10000 rpm | |

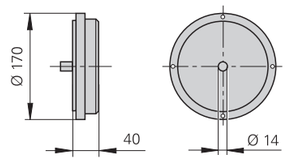
[1] Without shaft coupling
[2] 2-fold integrated interpolation
[3] 10-fold integrated interpolation
[4] DRIVE-CLiQ via EIB

**For separate shaft coupling: ROC 7000, ROD 780 and ROD 880**
- High accuracy
  *ROC 7000, ROD 780:* ±2″
  *ROD 880:* ±1″
- Ideal for angle measurement on high-precision rotary tables, indexing heads or measuring machines






**ROD 780, ROD 880**




**ROC 7000**

| | *Absolute* ROC 7310 | ROC 7380 | ROC 7390F | ROC 7390M | *Incremental* ROD 780 | ROD 880 |
|---|---|---|---|---|---|---|
| **Interface** | EnDat 2.2[2] | EnDat 2.2[2] ∿ 1 $V_{PP}$ | Fanuc αi | Mitsubishi | ∿ 1 $V_{PP}$ | |
| Signal periods/revolution | 16384 | | | | 18000, 36000 | 36000 |
| **System accuracy**[1] | ±2″ | | | | ±2″ | ±1″ |
| **Mech. permissible speed** | ≤ 3000 rpm | | | | ≤ 1000 rpm | |

[1] Without shaft coupling
[2] DRIVE-CLiQ via EIB

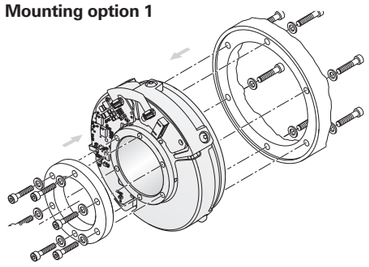
# MRP, SRP angle encoder modules

## Assemblies for high-precision rotary axes

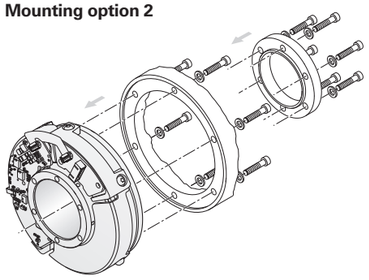
**MRP angle encoder module: combination of angle encoder and bearing**

Angle encoder modules from HEIDENHAIN are optimally matched combinations of angle encoders and high-precision bearings. They boast high measuring and bearing accuracy, very high resolution, exceptional repeatability, and excellent smoothness due to a low starting torque. Their design as specified and tested complete assemblies makes handling and installation easier.

**Mounting option 1**



**Mounting option 2**



**SRP angle encoder module: combination of angle encoder, bearing and motor**

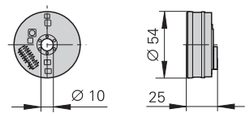
SRP angle encoder modules are additionally equipped with an integrated torque motor. They combine a motor, precision bearing and encoder with very high accuracy in one compact system. The torque motor with its very low cogging torque enables extraordinarily smooth motion control. Neither disruptive cogging torques nor radial forces impair the high guideway accuracy of the bearing.

**MRP 2000 series**

Angle encoder modules with integrated encoder and bearing

- Particularly compact dimensions
- High measuring and bearing accuracy
- Hollow shaft diameter: 10 mm

MRP 2010

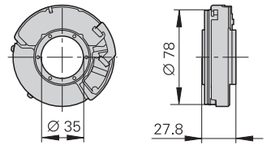



**MRP 5000 series**

Angle encoder modules with integrated encoder and bearing

- Compact dimensions
- High measuring and bearing accuracy
- Hollow shaft diameter: 35 mm

MRP 5010

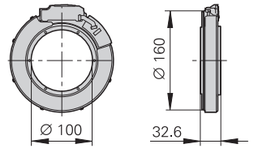



**MRP 8000 / MRP 8100 series**

Angle encoder modules with integrated encoder and bearing

- Compact dimensions
- High measuring and bearing accuracy
- ***MRP 8000:*** 100 mm hollow shaft Ø
  ***MRP 8100:*** 80 mm hollow shaft Ø
- ***MRP 8100:*** axial load of up to 1500 N

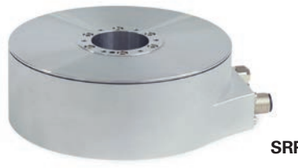
MRP 8010



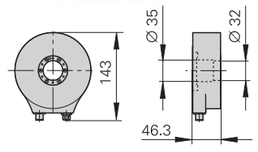

**SRP 5000 series**

Angle encoder modules with integrated encoder, bearing and torque motor

- Compact dimensions
- Torque motor with low cogging torque
- Peak torque: 2.70 Nm
- Rated torque: 0.385 Nm



SRP 5000




| | ***Incremental*** **MRP 2080** | ***Absolute*** **MRP 2010** |
|---|---|---|
| **Interface** | ∿ 1 $V_{PP}$ | EnDat 2.2 |
| Signal periods/revolution | 2048 | |
| **System accuracy** | ±7″ | |
| Maximum permissible axial load | 50 N (centered load, purely static, without additional vibrations or shock loading) | |
| Radial guideway accuracy | ≤ 0.60 µm | |
| Wobble of the axis | 2.5″ | |

| | ***Incremental*** **MRP 5080** | ***Absolute*** **MRP 5010** |
|---|---|---|
| **Interface** | ∿ 1 $V_{PP}$ | EnDat 2.2 |
| Signal periods/revolution | 30000 | 16384 |
| **System accuracy** | ±2.5″ or ±5″ | |
| Maximum permissible axial load | 200 N (centered load, purely static, without additional vibrations or shock loading) | |
| Radial guideway accuracy | ≤ 0.20 µm | |
| Wobble of the axis | 0.7″ | |

| | ***Incremental*** **MRP 8080** | **MRP 8081 D*plus*** | **MRP 8180** | ***Absolute*** **MRP 8010** | **MRP 8110** |
|---|---|---|---|---|---|
| **Interface** | ∿ 1 $V_{PP}$ | 4 x ∿ 1 $V_{PP}$ | ∿ 1 $V_{PP}$ | EnDat 2.2 | |
| Signal periods/revolution | 63000 | | | 32768 | |
| **System accuracy** | ±1″ or ±2″ | ±0.4″ | ±1″ or ±2″ | | |
| Maximum permissible axial load | 300 N | | 1500 N | 300 N | 1500 N |
| Radial guideway accuracy | ≤ 0.15 µm | | ≤ 0.25 µm | ≤ 0.15 µm | ≤ 0.25 µm |
| Wobble of the axis | 0.5″ | | 0.7″ | 0.5″ | 0.7″ |

| | ***Incremental*** **SRP 5080** | ***Absolute*** **SRP 5010** |
|---|---|---|
| **Interface** | ∿ 1 $V_{PP}$ | EnDat 2.2 |
| Signal periods/revolution | 30000 | 16384 |
| **System accuracy** | ±2.5″ or ±5″ | |
| Maximum permissible axial load | 200 N (centered load, purely static, without additional vibrations or shock loading) | |
| Radial guideway accuracy | ≤ 0.20 µm | |
| Wobble of the axis | 0.7″ | |

# ERP, ERO modular angle encoders
## Without integral bearing, with optical scanning

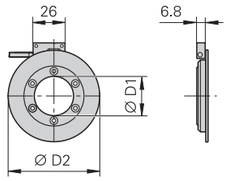
The HEIDENHAIN **ERP** and **ERO** angle encoders without integral bearing operate without friction and use a circular glass scale with hub as the graduation carrier. They are characterized by their low weight and compact dimensions. They thus permit high accuracies and are designed for integration in machine elements or components.

The attainable system accuracy depends on the eccentricity of the graduation to the drive shaft bearing, as well as the radial runout and wobble of the bearing.

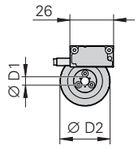
The interferential scanning principle serves as the basis for the high accuracy of the **ERP** encoders. This makes them particularly attractive for high-precision angle measuring tables and precision devices in angular metrology. Additionally, the HSP 1.0 signal stabilization feature makes the encoders highly resistant to environmental factors.

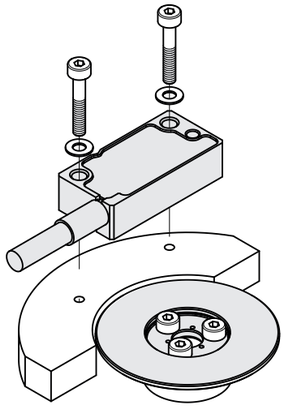
Applications for the **ERO** are found in metrology, in compact rotary tables, and in precise, highly dynamic drives.

**ERP 1000 series**
- Very high resolution and accuracy
- Small mass, low mass moment of inertia
- Very flat design
- Circular scale available as full circle or segment

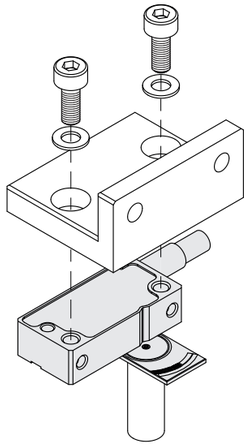



**ERO 2000 series**
- Very compact dimensions
- Small mass, low mass moment of inertia
- For highly dynamic applications



**TKN ERO 2000 (full circle)**



**TKN ERO 2002 (segment)**

| | ***Incremental*** **ERP 1070** **ERP 1080** **ERP 1010** | | | |
|---|---|---|---|---|
| **Interface** | *ERP 1070:* ⊓⊔ TTL; *ERP 1080:* ∿ 1 $V_{PP}$; *ERP 1010:* EnDat 2.2 | | | |
| Signal periods/revolution | 23000 | 30000 | 50000 | 63000 |
| **Accuracy of graduation** | ±4″ | ±3″ | ±1.8″ | ±1.5″; ±0.9″ |
| **Inside diameter D1** | 13 mm | 32 mm | 62 mm | 104 mm |
| **Outside diameter D2** | 57 mm | 75 mm | 109 mm | 151 mm |
| **Mech. permissible speed** | ≤ 2600 rpm | ≤ 2000 rpm | ≤ 1200 rpm | ≤ 950 rpm |

| | ***Incremental*** **ERO 2080** | |
|---|---|---|
| **Interface** | ∿ 1 $V_{PP}$ | |
| Signal periods/revolution | 4096 | 2500 |
| **Accuracy of graduation** | ±8″ | ±10″ |
| **Inside diameter D1** | 5 mm | – |
| **Outside diameter D2** | 30 mm | 18.6 mm |
| **Mech. permissible speed** | ≤ 14000 rpm | ≤ 24000 rpm |

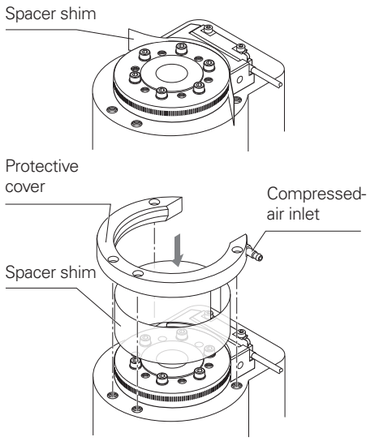
# ECA, ERA modular angle encoders
## Without integral bearing, with optical scanning

The **ECA** and **ERA** HEIDENHAIN angle encoders with solid graduation carrier function without integral bearings. They are intended for integration in machine elements or components.

The attainable system accuracy depends on the eccentricity of the graduation to the drive shaft bearing, as well as the radial runout and wobble of the bearing.

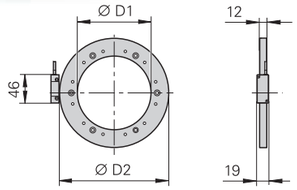
The **ECA** and **ERA** angle encoders feature a sturdy steel scale drum and are suited for high shaft speeds of up to 20000 rpm. They are typically found on fast running spindles, rotary tables and tilting axes.

The ECA 4000 V angle encoders are suitable for vacuum applications in high vacuum (down to $10^{-7}$ bar).

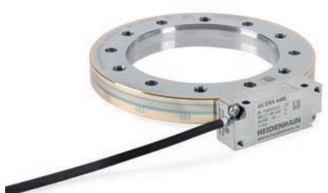


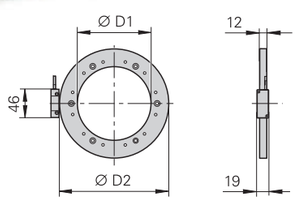

**ERA 4000**
With protective cover

**ECA 4400 series**
- High accuracy
- Sturdy design with steel scale drum and METALLUR graduation
- Various drum versions
  *ECA 4xx0:* with centering collar
  *ECA 4xx2:* with 3-point centering




**ERA 4000 series**
- High shaft speeds of up to 20000 rpm
- Sturdy design with steel scale drum and METALLUR graduation
- Axial motion of measured shaft permissible up to ± 0.5 mm
- The ERA 4480C is available with larger diameters or as versions with protective cover
- Various drum versions
  *ERA 4xx0:* with centering collar
  *ERA 4xx2:* with 3-point centering






| | ***Absolute***<br>**ECA 4410**[1]<br>**ECA 4490F**<br>**ECA 4490M**<br>**ECA 4490P**<br>**ECA 4490Y** | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Interface** | *ECA 4410:* EnDat 2.2; *ECA 4490F:* Fanuc αi; *ECA 4490M:* Mitsubishi; *ECA 4490P:* Panasonic; *ECA 4490Y:* Yaskawa | | | | | | | | |
| Signal periods/revolution | 8195 | 10010 | 11616 | 14003 | 16379 | 19998 | 25993 | 37994 | 44000 |
| **Accuracy of graduation** | ±3″ | ±2.5″ | ±2.8″ | ±2″ | ±1.9″ | ±1.8″ | ±1.7″ | ±1.5″ | ±1.5″ |
| **Inside diameter D1** | 70 mm | 80 mm | 120 mm | 120 mm | 150/185 mm | 180/210 mm | 270 mm | 425 mm | 512 mm |
| **Outside diameter D2** | 104.63 mm | 127.64 mm | 148.2 mm | 178.55 mm | 208.89 mm | 254.93 mm | 331.31 mm | 484.07 mm | 560.46 mm |
| **Mech. permissible speed** | ≤ 8500 rpm | ≤ 6250 rpm | ≤ 5250 rpm | ≤ 4500 rpm | ≤ 4250 rpm | ≤ 3250 rpm | ≤ 2500 rpm | ≤ 1800 rpm | ≤ 1500 rpm |

[1] Also available with functional safety

| | ***Incremental***<br>**ERA 4280C**[1] Signal period: 20 µm<br>**ERA 4480C** Signal period: 40 µm<br>**ERA 4880C** Signal period: 80 µm | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Interface** | ~ 1 $V_{PP}$ | | | | | | | | |
| Signal periods/revolution<br>*ERA 4280C*<br>*ERA 4480C*<br>*ERA 4880C* | 12000<br>6000<br>3000 | 16384<br>8192<br>4096 | 20000<br>10000<br>5000 | 28000<br>14000<br>7000 | 32768<br>16384<br>8192 | 40000<br>20000<br>10000 | 52000<br>26000<br>13000 | –<br>38000<br>– | –<br>44000<br>– |
| **Accuracy of graduation** | ±5″ | ±3.7″ | ±3″ | ±2.5″ | | | | ±2″ | |
| **Inside diameter D1** | 40 mm | 70 mm | 80 mm | 120 mm | 150 mm | 180 mm | 270 mm | 425 mm | 512 mm |
| **Outside diameter D2** | 76.75 mm | 104.63 mm | 127.64 mm | 178.55 mm | 208.89 mm | 254.93 mm | 331.31 mm | 484.07 mm | 560.46 mm |
| **Mech. permissible speed** | ≤ 20000 rpm | ≤ 15000 rpm | ≤ 12250 rpm | ≤ 8750 rpm | ≤ 7500 rpm | ≤ 6250 rpm | ≤ 4750 rpm | ≤ 3250 rpm | ≤ 2750 rpm |

[1] For other drum versions, please refer to the *Modular Angle Encoders with Scale Drum or Scale Tape* brochure

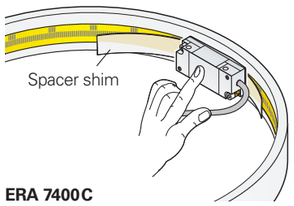
# ERA modular angle encoders

## Without integral bearing, with optical scanning

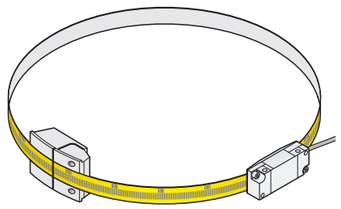
The HEIDENHAIN **ERA** angle encoders with steel scale tape as measuring standard function without integral bearings. They are intended for integration in machine elements or components. They are designed to meet the following requirements:

- Large hollow shaft diameters of up to 10 m
- No additional starting torque caused by rotary shaft seals

The attainable system accuracy depends on the machining accuracy of the scale-tape carrier diameter, on its radial runout and wobble.




**ERA 7400C**



**ERA 8400C**

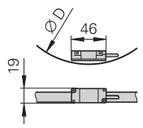
**ERA 7000 and ERA 8000 series**

- For very large diameters of up to 10 m
- METALLUR steel scale tape

**ERA 7000 series**

Scale tape is placed in a slot on the inside circumference of the machine element

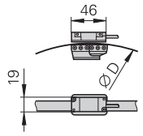
- *ERA 7400C:* full-circle version
- *ERA 7401C:* segment version

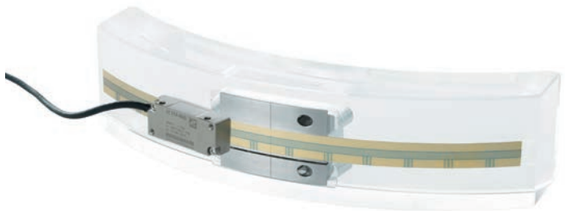



**ERA 8000 series**

Scale tape is fastened on the circumference of the machine element

- *ERA 8400C:* full-circle version
- *ERA 8401C:* segment version, scale tape secured with tensioning elements
- *ERA 8402C:* segment version, scale tape secured without tensioning elements



| | *Incremental*<br>**ERA 7400C** | | |
|---|---|---|---|
| **Interface** | ∿ 1 $V_{PP}$; signal period 40 µm (on circumference) | | |
| Signal periods/revolution | 36000 | 45000 | 90000 |
| **Accuracy of graduation** | ±3.9″ | ±3.2″ | ±1.6″ |
| **Accuracy of the scale tape** | ±3 µm per meter of tape | | |
| **Diameter D1** | 458.62 mm | 573.20 mm | 1146.10 mm |
| **Mech. permissible speed** | ≤ 250 rpm | | ≤ 220 rpm |

| | *Incremental*<br>**ERA 8400C** | | |
|---|---|---|---|
| **Interface** | ∿ 1 $V_{PP}$; signal period 40 µm (on circumference) | | |
| Signal periods/revolution | 36000 | 45000 | 90000 |
| **Accuracy of graduation** | ±4.7″ | ±3.9″ | ±1.9″ |
| **Accuracy of the scale tape** | ±3 µm per meter of tape | | |
| **Diameter D1** | 458.04 mm | 572.63 mm | 1145.73 mm |
| **Mech. permissible speed** | ≤ 50 rpm | | ≤ 45 rpm |

# ECM, ERM modular angle encoders

## Without integral bearing, with magnetic scanning

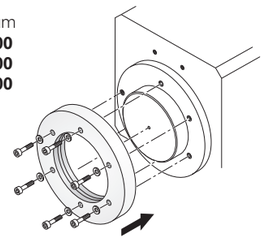
The **ECM and ERM** modular angle encoders from HEIDENHAIN with magnetic scanning consist of a magnetized scale drum and a scanning unit. Their MAGNODUR measuring standard and the magnetoresistive scanning principle make them particularly tolerant to contamination.

The attainable system accuracy depends on the eccentricity of the graduation to the drive shaft bearing, as well as the radial runout and wobble of the bearing.

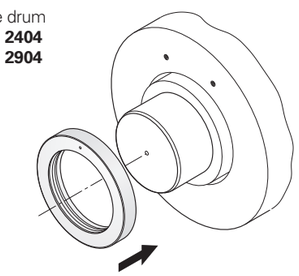
Typical fields of application include machines and equipment with **large hollow shaft diameters** in environments with large amounts of airborne particles and liquids, for example:

- Rotary and tilting axes for ERM 2280 and ECM 2400
- C axes on lathes for ERM 2410, ERM 2420 and ERM 2480
- Main spindles on milling machines for ERM 2484, ERM 2485 and ERM 2984

Scale drum
**ERM 2200**
**ERM 2400**
**ECM 2400**



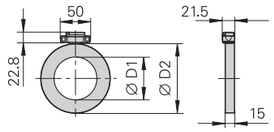
Scale drum
**ERM 2404**
**ERM 2904**



### Absolute position measurement

**ECM 2400 series**

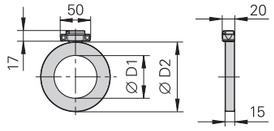
- Drum fastening with screws
- Functional safety with ECM 2410




### Incremental position measurement

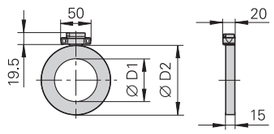
**ERM 2200 series**

- High graduation accuracy
- Distance-coded reference marks
- Drum fastening with screws
- *ERM 2283:* small interpolation error, no reversal error



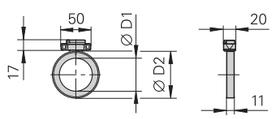

**ERM 2400 series**

- Distance-coded reference marks
- Drum fastening with screws
- Large selection of drum diameters




**ERM 2484 and ERM 2984 series**

- Especially compact dimensions for limited installation space
- High mechanically permissible shaft speeds and therefore particularly well suited for spindles
- Drum fastening by axial clamping




| | ***Absolute*** **ECM 2410**[1] **ECM 2490F** **ECM 2490M** | | | | | | |
|---|---|---|---|---|---|---|---|
| **Interface** | *ECM 2410:* EnDat 2.2; *ECM 2490F:* Fanuc αi; *ECM 2490M:* Mitsubishi | | | | | | |
| Signal periods/revolution | 900 | 1024 | 1200 | 1400 | 1696 | 2048 | 2600 |
| **Accuracy of graduation** | ±8″ | ±7″ | ±6″ | ±5.5″ | ±4.5″ | ±4″ | ±3.5″ |
| **Inside diameter D1** | 70 mm | 80 mm | 105 mm | 130 mm | 160 mm | 180 mm | 260 mm |
| **Outside diameter D2** | 113.16 mm | 128.75 mm | 150.88 mm | 176.03 mm | 213.24 mm | 257.5 mm | 326.9 mm |
| Mech. permissible speed | ≤ 14500 rpm | ≤ 13000 rpm | ≤ 10500 rpm | ≤ 9000 rpm | ≤ 7000 rpm | ≤ 6000 rpm | ≤ 4500 rpm |

| | ***Incremental*** **ERM 2410** (grating period ≈ 400 µm) **ERM 2420** **ERM 2480** **ERM 2280** (grating period ≈ 200 µm) **ERM 2283** | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Interface** | *ERM 2410:* EnDat 2.2[2]; *ERM 2420:* ⊓⊔TTL; *ERM 2480/ERM2280/ERM 2283:* ∿ 1 $V_{PP}$ | | | | | | | | |
| Signal periods/revolution | 600 | 720 | 900 | 1024 | 1200 | 1400 | 2048 | 2600 | 3600 |
| *ERM 2200* | 1200 | 1440 | 1800 | 2048 | 2400 | 2800 | 4096 | 5200 | 7200 |
| **Accuracy of graduation** | ±11″ | ±10″ | ±8″ | ±7″ | ±6″ | ±5.5″ | ±4″ | ±3.5″ | ±3″ |
| *ERM 2280* | ±10″ | ±8.5″ | ±7″ | ±6″ | ±5.5″ | ±5″ | ±3.5″ | ±3″ | ±2.5″ |
| *ERM 2283* | ±6.5″ | ±5.5″ | ±4.5″ | ±4″ | ±3.5″ | ±3″ | ±2″ | ±1.5″ | – |
| **Inside diameter D1** | 40 mm | 55 mm | 70 mm | 80 mm | 105 mm | 130 mm | 180 mm | 260 mm | 380 mm |
| **Outside diameter D2** | 75.44 mm | 90.53 mm | 113.16 mm | 128.75 mm | 150.88 mm | 176.03 mm | 257.5 mm | 326.9 mm | 452.64 mm |
| Mech. permissible speed | ≤ 19000 rpm | ≤ 18500 rpm | ≤ 14500 rpm | ≤ 13000 rpm | ≤ 10500 rpm | ≤ 9000 rpm | ≤ 6000 rpm | ≤ 4500 rpm | ≤ 3000 rpm |

| | ***Incremental*** **ERM 2484** (grating period ≈ 400 µm) | | | | **ERM 2984** (grating period ≈ 1000 µm) | | | |
|---|---|---|---|---|---|---|---|---|
| **Interface** | ∿ 1 $V_{PP}$ | | | | | | | |
| Signal periods/revolution | 512 | 600 | 900 | 1024 | 192 | 256 | 300 | 400 |
| **Accuracy of graduation** | ±17″ | ±14″ | ±10″ | ±9″ | ±68″ | ±51″ | ±44″ | ±33″ |
| **Inside diameter D1** | 40 mm | 55 mm | 80 mm | 100 mm | 40 mm | 55 mm | 60 mm | 100 mm |
| **Outside diameter D2** | 64.37 mm | 75.44 mm | 113.16 mm | 128.75 mm | 58.06 mm | 77.41 mm | 90.72 mm | 120.96 mm |
| Mech. permissible speed | ≤ 42000 rpm | ≤ 36000 rpm | ≤ 22000 rpm | ≤ 20000 rpm | ≤ 47000 rpm | ≤ 35000 rpm | ≤ 29000 rpm | ≤ 16000 rpm |

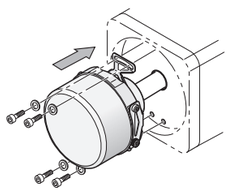
[1] Also available with functional safety
[2] Through integrated counting function after traverse of two reference marks

For other drum versions, please refer to our brochure *Modular Angle Encoders with Magnetic Scanning*

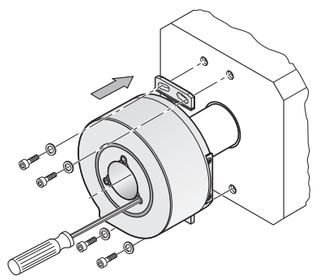
# ECN, EQN, ERN rotary encoders

## With integral bearing and mounted stator coupling
## Up to IP66 protection

HEIDENHAIN **ECN, EQN** and **ERN** rotary encoders with integral bearing and stator-mounted coupling operate by photoelectric scanning. They are characterized by their simple mounting and short overall length. Possible applications range from simple measuring tasks to position and speed control on servo drives. The hollow shaft of these encoders is slid directly onto and fastened to the shaft to be measured. During angular acceleration of the shaft, the stator coupling must absorb only that torque resulting from friction in the bearing. Rotary encoders with stator coupling therefore provide excellent dynamic performance and a high natural frequency.



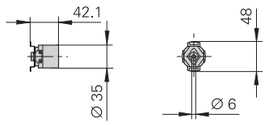
**ECN/EQN/ERN 1000**
**ECN/EQN/ERN 400**



**ECN/ERN 100**

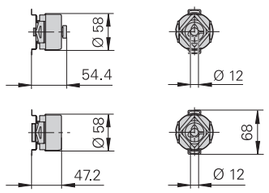
### ECN/EQN/ERN 1000 series

- Miniaturized version
- Blind hollow shaft with 6 mm inside diameter
- Housing outside diameter: 35 mm
- Typical natural frequency $f_N$ of the encoder coupling: 1500 Hz
- Mech. permissible speed: ≤ 12000 rpm



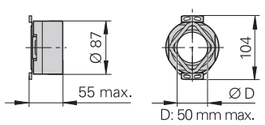

### ECN/EQN/ERN 400 series

- Compact dimensions
- Blind hollow shaft or hollow through shaft with 8 mm, 10 mm or 12 mm inside diameter
- Housing outside diameter: 58 mm
- Protection:
  IP67 at housing (IP66 with hollow through shaft)
  IP64 at shaft inlet (IP66 upon request)
- Typical natural frequency $f_N$ of the encoder coupling: 1550 Hz (cable version)
- Mech. permissible speed: ≤ 12000 rpm
- Fault exclusion of the mechanical coupling for functional safety available




### ECN/ERN 100 series

- For large shaft diameters
- Hollow through shaft with inside diameters D: 20, 25, 38, 50 mm
- Housing outside diameter: 87 mm
- Typical natural frequency $f_N$ of the encoder coupling: 1000 Hz
- Mechanically permissible speed:
  D ≤ 30 mm: ≤ 6000 rpm
  D > 30 mm: ≤ 4000 rpm




| | ***Absolute*** | | | | ***Incremental*** | | | |
|---|---|---|---|---|---|---|---|---|
| | **ECN 1013** | **EQN 1025** | **ECN 1023** | **EQN 1035** | **ERN 1020** | **ERN 1030** | **ERN 1070** | **ERN 1080** |
| **Interface** | EnDat 2.2[1] with ~ 1 $V_{PP}$ | | EnDat 2.2[1] | | ⊓⊔ TTL | ⊓⊔ HTL | ⊓⊔ TTL[2] | ~ 1 $V_{PP}$ |
| Position values/revolution | 8192 (13 bits) | | 8388608 (23 bits) | | – | | | |
| Revolutions | – | 4096 (12 bits) | – | 4096 (12 bits) | – | | | |
| Line count | 512 | | – | | 100 to 3600 | | 1000/2500/3600 | 100 to 3600 |
| **Supply voltage** | DC 3.6 V to 14 V | | DC 3.6 V to 14 V | | DC 5 V | DC 10 V to 30 V | DC 5 V | |

| | ***Absolute*** | | | | ***Incremental*** | | |
|---|---|---|---|---|---|---|---|
| | **ECN 413** | **EQN 425** | **ECN 425[3] ECN 425 F ECN 424 S[3]** | **EQN 437[3] EQN 437 F EQN 436 S[3]** | **ERN 420 ERN 460** | **ERN 430** | **ERN 480** |
| **Interface** | EnDat 2.2[1] with ~ 1 $V_{PP}$; SSI | EnDat 2.2[1] with ~ 1 $V_{PP}$; SSI | EnDat 2.2[1]; Fanuc αi; DRIVE-CLiQ | | ⊓⊔ TTL; ⊓⊔ TTL | ⊓⊔ HTL | ~ 1 $V_{PP}$ |
| Position values/revolution | 8192 (13 bits) | 8192 (13 bits) | *ECN 425, EQN 437:* 33554432 (25 bits) *ECN 424 S, EQN 436 S:* 16777216 (24 bits) | | – | | |
| Revolutions | – | 4096 (12 bits) | – | 4096 (12 bits) | – | | |
| Line count | 512 or 2048 | 512 or 2048 | – | | 250 to 5000 | | 1000 to 5000 |
| **Supply voltage** | 3.6 V to 14 V; 4.75 V to 30 V | 3.6 V to 14 V; 4.75 V to 30 V | 3.6 V to 14 V; 10 V to 28.8 V | | 5 V; 10 V to 30 V | 10 V to 30 V | 5 V |

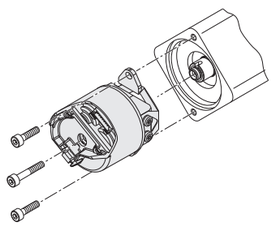
| | ***Absolute*** | | ***Incremental*** | | |
|---|---|---|---|---|---|
| | **ECN 113** | **ECN 125** | **ERN 120** | **ERN 130** | **ERN 180** |
| **Interface** | EnDat 2.2[1] with ~ 1 $V_{PP}$ | EnDat 2.2[1] | ⊓⊔ TTL | ⊓⊔ HTL | ~ 1 $V_{PP}$ |
| Position values/revolution | 8192 (13 bits) | 33554432 (25 bits) | – | | |
| Line count | 2048 | – | 1000 to 5000 | | |
| **Supply voltage** | DC 3.6 V to 14 V | DC 3.6 V to 14 V | DC 5 V | DC 10 V to 30 V | DC 5 V |

[1] Includes EnDat 2.1 command set; PROFIBUS DP via gateway
[2] 5/10-fold integrated interpolation
[3] Also available with functional safety

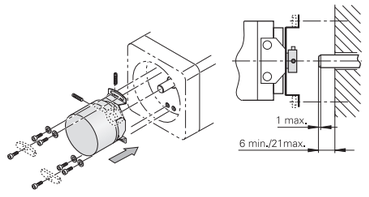
# ECN, EQN, ERN rotary encoders

## With integral bearing and mounted stator coupling
## Up to IP40 protection

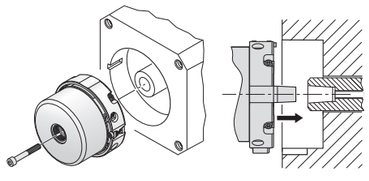
The **ECN, EQN** and **ERN** photoelectric rotary encoders from HEIDENHAIN with IP40 protection are specially designed for integration in motors. Bearings and mounted stator coupling are integrated. Absolute rotary encoders and versions with commutation tracks are available for synchronous motors. The taper shaft or the blind hollow shaft is fastened directly to the shaft to be measured. This ensures an extremely stiff coupling that permits exceptionally high dynamic performance of the drive. The stator coupling is designed to be fastened on a plane surface or a location hole and permits fast, simple mounting.



**ECN/EQN 1100**

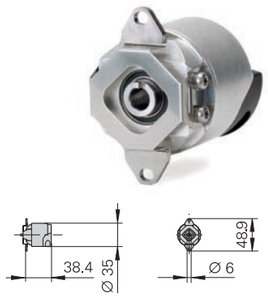



**ERN 1123**

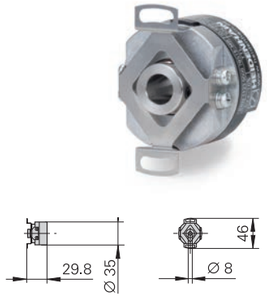


**ECN/EQN/ERN 1300**

**ECN/EQN 1100 series**
- Miniaturized version
- Blind hollow shaft, 6 mm inside diameter with positive-fit element
- Housing outside diameter: 35 mm
- Typical natural frequency $f_N$ of the encoder coupling: 1000 Hz
- Mechanically permissible speed: 12000 rpm
- Fault exclusion of the mechanical coupling for functional safety available




**ERN 1123**
- Blind hollow shaft diameter: 8 mm
- Housing outside diameter: 35 mm
- Stator coupling with bolt-hole circle Ø 40 mm
- Typical natural frequency $f_N$ of the encoder coupling: 1000 Hz
- Mechanically permissible speed: 6000 rpm
- IP00 protection




**ECN/EQN/ERN 1300 series**
- Compact dimensions
- 1:10 taper shaft with 9.25 mm functional diameter for extremely stiff connection
- Housing outside diameter 56 mm. The stator coupling is suited for location holes with 65 mm inside diameter
- Typical natural frequency $f_N$ of the encoder coupling: 1800 Hz
- Mechanically permissible speed:
  *ERN/ECN:* 15000 rpm
  *EQN:* 12000 rpm
- IP40 protection when mounted
- Fault exclusion of the mechanical coupling for functional safety available
- Version with hybrid motor cable with just two wires for power supply and communication (E30-R2)


| | ***Absolute*** **ECN 1113** | **EQN 1125** | **ECN 1123**[2] | **EQN 1135**[2] | ***Incremental*** **ERN 1123** |
|---|---|---|---|---|---|
| **Interface** | EnDat 2.2[1] with ∿ 1 $V_{PP}$ | | EnDat 2.2[1] | | ⊓⊔ TTL |
| Position values/revolution | 8192 (13 bits) | | 8388608 (23 bits) | | – |
| Revolutions | – | 4096 (12 bits) | – | 4096 (12 bits) | – |
| Line count | 512 | | – | | 500 to 8192 |
| **Commutation signals** | – | | | | Block commutation[3] |
| **Supply voltage** | DC 3.6 V to 14 V | | | | DC 5 V |
| **Operating temperature** | ≤ 115 °C | | | | ≤ 90 °C |

[1] Includes EnDat 2.1 command set; PROFIBUS DP via gateway
[2] Also available with functional safety
[3] Three block commutation tracks with 90°, 120° or 180° mech. phase shift

| | ***Absolute*** **ECN 1313** | **EQN 1325** | **ECN 1325**[4] | **EQN 1337**[4] | **ECN 1324S**[4] | **EQN 1336S**[4] | ***Incremental*** **ERN 1321** | **ERN 1326** | **ERN 1381** | **ERN 1387** |
|---|---|---|---|---|---|---|---|---|---|---|
| **Interface** | EnDat 2.2[1] with ∿ 1 $V_{PP}$ | | EnDat 2.2[1], EnDat 3 | | DRIVE-CLiQ | | ⊓⊔ TTL | | ∿ 1 $V_{PP}$ | |
| Position values/revolution | 8192 (13 bits) | | 33554432 (25 bits) | | 16777216 (24 bits) | | – | | | |
| Revolutions | – | 4096 (12 bits) | – | 4096 (12 bits) | – | 4096 (12 bits) | – | | | |
| Line count | 512 or 2048 | | – | | | | 1024 2048 4096 | | 512 2048 4096 | 2048 |
| **Commutation signals** | – | | | | | | – | Block commutation[2] | – | Z1 track[3] |
| **Supply voltage** | DC 3.6 V to 14 V (EnDat2.2); DC 4 V to 14 V (EnDat 3[5]) | | | | DC 10 V to 28.8 V | | DC 5 V | | | |
| **Operating temperature** | ≤ 115 °C | | | | ≤ 100 °C | | ≤ 120 °C; *4096 lines:* ≤ 100 °C | | | |

[1] Includes EnDat 2.1 command set; PROFIBUS DP via gateway
[2] Three block commutation tracks with 90° or 120° mech. phase shift
[3] One sine and one cosine signal with one period per revolution of the encoder shaft
[4] Also available with functional safety
[5] With hybrid motor cable

# ROC, ROQ, ROD rotary encoders

## With integral bearing, for separate shaft coupling

## HR handwheel

The **ROC, ROQ** and **ROD** photoelectric rotary encoders from HEIDENHAIN have integrated bearings and are sealed. The degree of protection is IP64 to IP66, depending on the version. They are robust and compact.

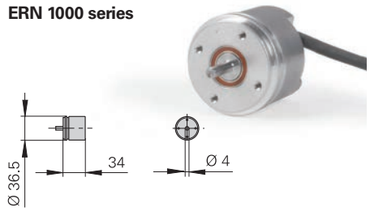
These encoders are coupled by the rotor to the measured shaft through a separate coupling that compensates axial motion and misalignment between the encoder shaft and measured shaft.

**ROC/ROQ/ROD 1000 series**
- Miniaturized dimensions for installation in small devices or in limited installation space
- Mounting by synchro flange
- Shaft diameter: 4 mm

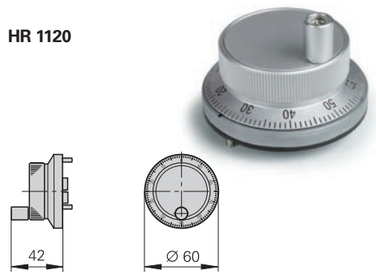
**HR handwheel**
- Compact dimensions
- Sturdy design
- Mechanical detent

**ROC/ROQ/ROD 400 series**
- Industrial standard regarding dimensions and output signals
- IP67 protection at housing, IP64 at shaft inlet (IP66 upon request)
- Mounting via synchro flange or clamping flange
- Shaft diameter
  6 mm with synchro flange
  10 mm with clamping flange
- Preferred types with fast delivery (see *Rotary Encoders* brochure or ask HEIDENHAIN)
- Fault exclusion of the mechanical coupling for functional safety available

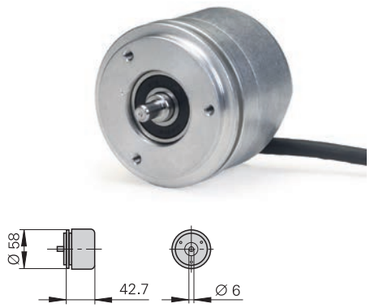
**ERN 1000 series**



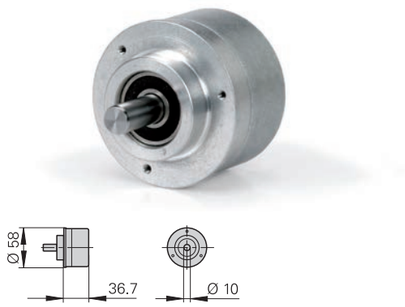

**HR 1120**

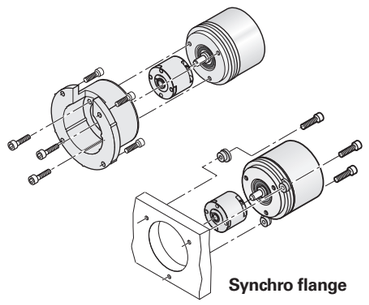



**The 400 series with synchro flange**

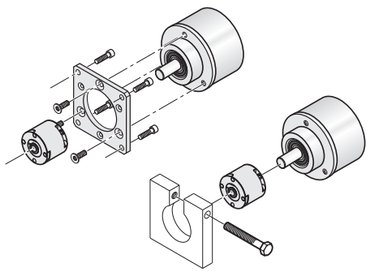



**The 400 series with clamping flange**



**Synchro flange**



**Clamping flange**

The **HR** electronic handwheel features an integral bearing and mechanical detent. It was designed for use in portable or stationary housings, e.g. for positioning units or automation applications.

| | *Absolute* | | | | *Incremental* | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | **ROC 1013** | **ROQ 1025** | **ROC 1023** | **ROQ 1035** | **ROD 1020** | **ROD 1030** | **ROD 1070** | **ROD 1080** | **HR 1120** |
| **Interface** | EnDat 2.2[1] with ∿ 1 $V_{PP}$ | | EnDat 2.2[1] | | ⊓⊔ TTL | ⊓⊔ HTL | ⊓⊔ TTL[2] | ∿ 1 $V_{PP}$ | ⊓⊔ TTL |
| Position values/ revolution | 8192 (13 bits) | | 8388608 (23 bits) | | – | | | | |
| Revolutions | – | 4096 (12 bits) | – | 4096 (12 bit) | – | | | | |
| Line count/ signal periods | 512 | | – | | 100 to 3600 | | Up to 36000[2] | 100 to 3600 | 100 |
| **Supply voltage** | DC 3.6 V to 14 V | | DC 3.6 V to 14 V | | DC 5 V | DC 10 V to 30 V | DC 5 V | | |

[1] Includes EnDat 2.1 command set; PROFIBUS DP via gateway
[2] 5-fold or 10-fold integrated interpolation

| **Synchro flange** | *Absolute* **ROC 413** | **ROQ 425** | **ROC 424S**[1] | **ROQ 436S**[1] | **ROC 425**[1] **ROC 425F** | **ROQ 437**[1] **ROQ 437F** | *Incremental* **ROD 426** | **ROD 466** | **ROD 436** | **ROD 486** |
|---|---|---|---|---|---|---|---|---|---|---|
| **Clamping flange** | | | | | | | **ROD 420** | **–** | **ROD 430** | **ROD 480** |
| **Interface** | EnDat 2.2[2] with ∿ 1 $V_{PP}$; SSI | | DRIVE-CLiQ | | EnDat 2.2[2]; Fanuc αi | | ⊓⊔ TTL | ⊓⊔ TTL | ⊓⊔ HTL | ∿ 1 $V_{PP}$ |
| Position values/revolution | 8192 (13 bits) | | 16777216 (24 bits) | | 33554432 (25 bits) | | – | | | |
| Revolutions | – | 4096 (12 bits) | – | 4096 (12 bits) | – | 4096 (12 bits) | – | | | |
| Line count/signal periods | 512 | | 2048 | | | | 50 to 5000 *ROD 426/466:* up to 10000[3] | | | 1000 to 5000 |
| **Supply voltage** | DC 3.6 V to 14 V; DC 4.75 V to 30 V | | DC 10 V to 28.8 V | | DC 3.6 V to 14 V | | DC 5 V | DC 10 V to 30 V | | DC 5 V |

[1] Also available with functional safety
[2] Includes EnDat 2.1 command set; PROFIBUS DP via gateway
[3] Signal periods over 5000 are generated through signal doubling in the encoder

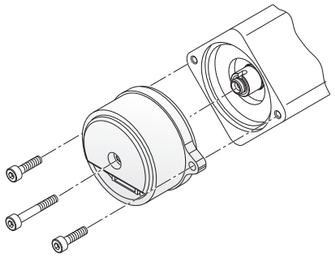
DRIVE-CLiQ is a registered trademark of SIEMENS AG.

# ECI, EQI, EBI rotary encoders
## Without integral bearing

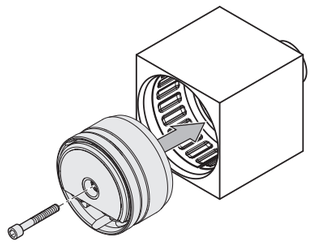
Compared with optical rotary encoders without integral bearings, inductive rotary encoders are particularly robust and have large mounting tolerances.

The **ECI, EQI and EBI 1100** inductive rotary encoders as well as the **ECI, EQI and EBI 1300** are mechanically compatible with the corresponding ExN photoelectric encoders: the shaft is fastened with a central screw. The stator of the encoder is fastened by several screws.

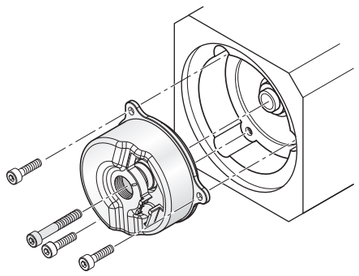
The correct installation of the rotary encoders without integral bearing can be inspected with the HEIDENHAIN PWM 21 or PWT 101 measuring and testing devices.



**ECI/EQI/EBI 1100**

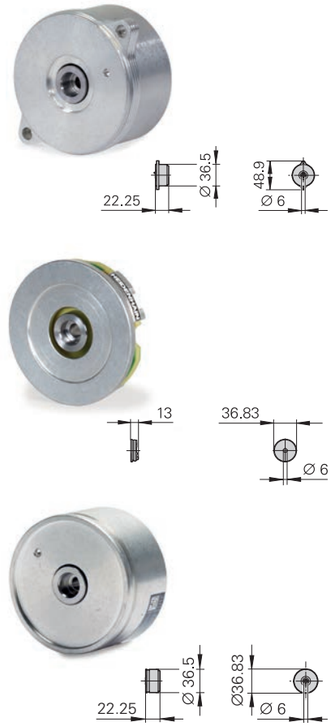


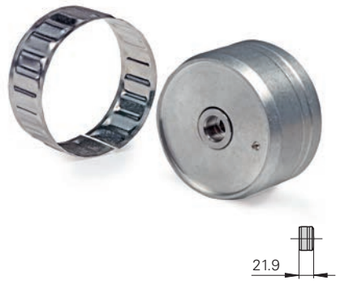
**ECI/EQI 1100 with tolerance sleeve**



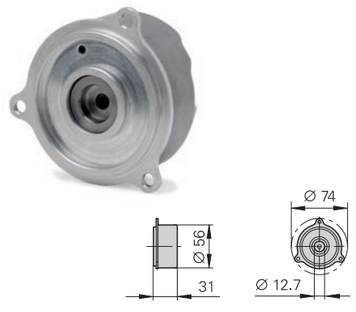
**ECI/EQI/EBI 1300**

**ECI/EQI/EBI 1100 series**
- Miniature size
- Simple mounting without adjustment
- Blind hollow shaft diameter: 6 mm
- *EBI 1135:* multiturn function via battery-buffered revolution counter
- *ECI 1119/EQI 1131:* design with a tolerance sleeve for press-fitting into small motors
- Version available featuring mounting-compatibility with ECN/EQN 1100
- Fault exclusion of the mechanical coupling for functional safety
- Synchro flange for variable mounting




**ECI/EQI/EBI 1300 series**
- Simple mounting without adjustment
- Blind hollow shaft
- *EBI 1335:* multiturn function via battery-buffered revolution counter
- Version featuring mounting-compatibility with ECN/EQN 1300 with tapered shaft or blind hollow shaft available upon request
- Fault exclusion of the mechanical coupling for functional safety




| | ***Absolute***<br>**ECI 1119**[1]<br>**ECI 1319**[1) 3)]<br>**ECI 1118** | **EQI 1131**[1]<br>**EQI 1331**[1) 3)] | **EBI 1135**<br>**EBI 1335** |
|---|---|---|---|
| **Interface** | EnDat 2.2, EnDat 3 | | EnDat 2.2 |
| Position values/revolution | 524 288 (19 bits)<br>***ECI 1118:*** 262 144 (18 bits) | | 524 288 (19 bits)<br>***EBI 1135:*** 262 144 (18 bits) |
| Revolutions | – | 4096 (12 bits) | 65 536 (16 bits)[2] |
| **Mech. permissible speed** | ≤ 15 000 rpm | ≤ 12 000 rpm | ≤ 12 000 rpm |
| **Shaft** | Blind hollow shaft | | |

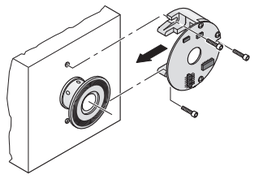
1) Also available with functional safety
2) Multiturn function via battery-buffered revolution counter
3) Also available with DRIVE-CLiQ interface

# ERO, ECI, EBI rotary encoders
## Without integral bearing

The photoelectric **ERO** modular rotary encoders from HEIDENHAIN consist of a graduated disk with hub and a scanning unit. They are particularly well suited for **limited installation space** or for applications where there must be **no friction**.

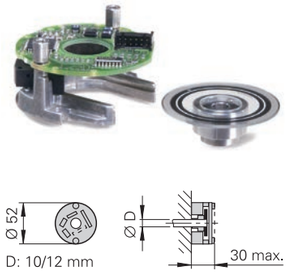
The **ECI/EBI 100** and **ECI/EBI 4000** inductive rotary encoders have a particularly small outside diameter with a large shaft opening. The encoders were conceived for simple axial mounting.

The correct installation of the rotary encoders without integral bearing can be inspected with the HEIDENHAIN PWM 21 or PWT 101 measuring and testing devices.

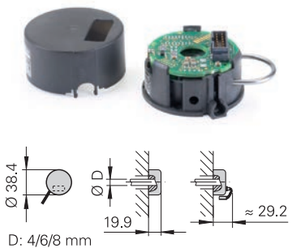


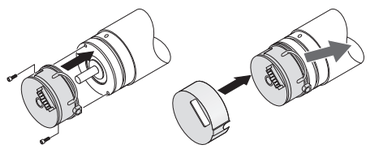
**ERO 1200**

**ERO 1200 series**
- Compact dimensions
- For shaft diameters of up to 12 mm



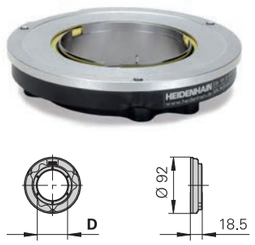

**ERO 1400 series**
- Miniaturized modular rotary encoders for measured shafts of up to 8 mm diameter
- Special integral mounting aid
- With cover cap

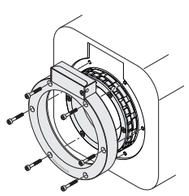


**ERO 1400**

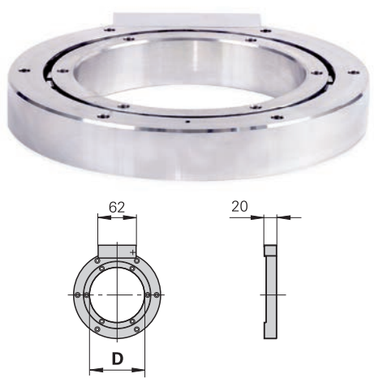
**ECI/EBI 100 series**
- Especially flat design
- Hollow through shaft Ø: 30, 38, 50 mm
- *EBI 135:* multiturn function via battery-buffered revolution counter



**ECI/EBI 4000**

**ECI/EBI 4000 series**
- Flat design
- Hollow through shaft : 90, 180 mm
- *EBI 4010:* multiturn function via battery-buffered revolution counter




| | *Incremental*<br>**ERO 1225** | **ERO 1285** |
|---|---|---|
| **Interface** | ⊓⊔ TTL | ∿ 1 $V_{PP}$ |
| Line count | 1024 2048 | |
| **Mech. permissible speed** | ≤ 25000 rpm | |
| **Shaft diameter D** | 10 mm, 12 mm | |

| | *Incremental*<br>**ERO 1420** | **ERO 1470** | **ERO 1480** |
|---|---|---|---|
| **Interface** | ⊓⊔ TTL | ⊓⊔ TTL[1)] | ∿ 1 $V_{PP}$ |
| Line count/signal periods | 512 1000 1024 | Up to 37500[1)] | 512 1000 1024 |
| **Mech. permissible speed** | ≤ 30000 rpm | | |
| **Shaft diameter D** | 4 mm, 6 mm, 8 mm | | |

[1)] 5/10/20/25-fold integrated interpolation

| | *Absolute*<br>**ECI 119** | **EBI 135** | **ECI 4010**[1)] | **EBI 4010**[1)] | **ECI 4090 S**[1)] |
|---|---|---|---|---|---|
| **Interface** | EnDat 2.1 with ∿ 1 $V_{PP}$ | EnDat 2.2 | | | DRIVE-CLiQ |
| Position values/revolution | 524288 (19 bits) | | 1048576 (20 bits) | | |
| Revolutions | – | 65536 (16 bits)[2)] | – | 65536 (16 bits)[2)] | – |
| Line count | 32 | – | | | |
| **Mech. permissible speed** | ≤ 6000 rpm | | | | |
| **Shaft** | Hollow through shaft : 30, 38, 50 mm | | Hollow through shaft : 90, 180 mm | | |

[1)] Also available with functional safety
[2)] Multiturn function via battery-buffered revolution counter

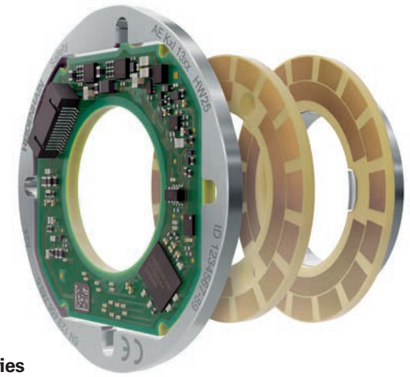
DRIVE-CLiQ is a registered trademark of SIEMENS AG.

# KCI, KBI rotary encoders
## Without integral bearing

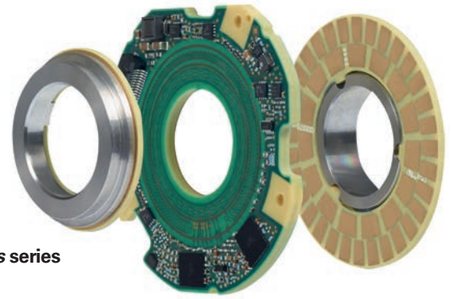
With its KCI 100/KBI 100 and KCI 1300/KBI 1300 series, HEIDENHAIN provides inductive encoders for compact robot motors. The circular scales can be screw-fastened or press-fit onto a motor shaft.

The KCI/KBI inductive rotary encoders are designed for direct installation. Consisting solely of a scale and scanning unit, they do not have a housing. This enclosure-less design saves considerable space and enables easy integration into the application. The KCI/KBI rotary encoders are also available as dual encoders in D*plus* versions, with front and back scanning for two separate circular scales. As a result, these encoders provide position feedback both upstream and downstream from the gearbox with a single encoder.

The KCI 100/KBI 100 D*plus* dual encoders from HEIDENHAIN provide position feedback both upstream and downstream from the gearbox. By providing position feedback downstream from the gearbox, these dual encoders can compensate for inaccuracies inherent in the design of dynamic and highly articulated robots.

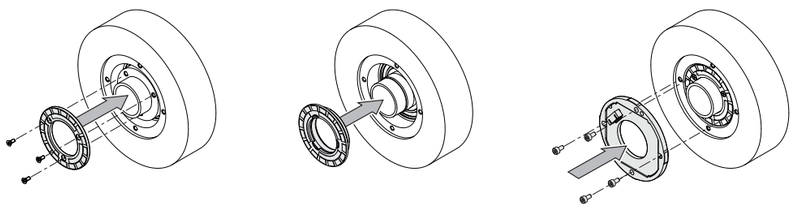


**KCI 1300/KBI 1300 series**

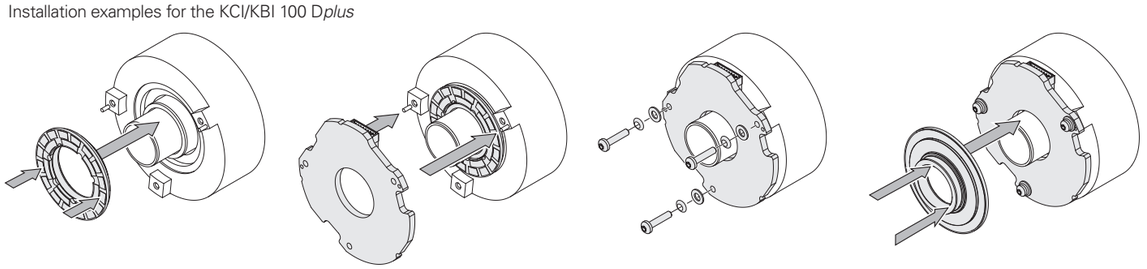


**KCI 100/KBI 100 D*plus* series**

Installation examples for the KCI/KBI 1300



Installation examples for the KCI/KBI 100 D*plus*



Press-fitting the disk/hub assembly | Scanning unit | Scanning unit (mounted) | Press-fitting the disk/hub assembly

| | ***Absolute*** **KCI 1319 HW 25** | **KCI 120 HW 30** | **KCI 120 HW 40** | **KCI 120 HW 55** | **KBI 1335 HW 25** | **KBI 136 HW 30** | **KBI 136 HW 40** | **KBI 136 HW 55** |
|---|---|---|---|---|---|---|---|---|
| **Interface** | EnDat 2.2 | | | | | | | |
| Position values/ revolution | 19 bits | 20 bits | | | | | | |
| Revolutions[1] | – | | | | 16 bits | | | |
| Shaft speed | ≤ 10 000 rpm | | | | | | | ≤ 6000 rpm |
| Inside diameter of hub | 25 mm | 30 mm | 40 mm | 55 mm | 25 mm | 30 mm | 40 mm | 55 mm |

All variants are available with functional safety
[1] Multiturn function via battery-buffered revolution counter

| | ***Absolute*** **KCI 120 D*plus* AE07** | **KCI 120 D*plus* AE04** | **KBI 136 D*plus* AE04** |
|---|---|---|---|
| **Interface** | EnDat 2.2 | | |
| Position values/ rev. at motor side | 19 bits | | |
| Position values/ rev. at output side | 20 bits | | |
| Revolutions[1] | – | | 16 bits |
| Motor-side rotational speed | ≤ 15 000 rpm | | |
| Output-side rotational speed | ≤ 6000 rpm | | |
| Motor-side hollow shaft[2] | 34 mm | 20 mm, 25 mm, 25 mm*, 22.5 mm** | |
| Output-side hollow shaft[2] | 29 mm | 16 mm, 20 mm, 20.5 mm*, 14 mm** | |

* Variant with mechanical fault exclusion for functionally safe applications
** Screw-fastened circular scale without hub, with mechanical fault exclusion
[1] Multiturn functionality via battery-buffered revolution counter on the output side
[2] Circular scale with steel hub (aluminum hub upon request)

# Machine tool control

**Controls for milling machines**
With its TNC controls, HEIDENHAIN offers a complete product line for all common types of machines in the area of milling: from a simple three-axis CNC milling machine to a highly complex machine with up to 23 axes—a TNC control is always the right choice. Thanks to their flexible operational design and practical functions, the TNCs are particularly suitable for the following applications:

- Simple milling, drilling and boring operations
- Machining in a tilted working plane
- Complex 5-axis operations
- High-speed cutting operations
- Milling-turning operations
- Jig grinding
- Gear hobbing or skiving

TNC controls are versatile and offer the right programming function for any task. Thanks to its **HEIDENHAIN Klartext** format, the user need not learn G codes or special programming languages. Instead, the control guides the user with conversational questions and tips. Ease of use is also promoted by clear, **unambiguous key symbols** and names. Each key has only one function. Even if you are used to **G-code programming**, however, the TNC is still the right control—you can simply enter the G codes.

TNC part programs have long lives because they are **upwardly compatible.** Programs from older TNCs can usually also run on the new models. When moving up to a more advanced TNC, the user merely builds on what he already knows.

**Controls for lathes**
Lathe controls from HEIDENHAIN have been proving themselves for years both on standard and complex lathes as well as on turning centers. Many shop-compatible functions support you optimally during:

- Conventional lathe operations
- Machining with driven tools
- Machining with the C and Y axes
- Full-surface machining with dual spindles
- Machining with the B axis

HEIDENHAIN lathe controls are extremely flexible: whether you need only single cycles, short program sequences or complete NC programs—you only need to select the appropriate operating mode.

Program creation with **smart.Turn** is particularly easy and convenient. The straightforward fillable-form input provides graphical support, meaningful dialogs, and a logical check of entries.

You can also reuse NC programs of older HEIDENHAIN lathe controls, such as the CNC PILOT 4290, on the CNC PILOT 640. With a convenient import filter you can simply load the programs into the new control, and then continue using them on the CNC PILOT 640.

**Quickly and easily to the finished part**
The operational design of the milling and lathe controls is tailored to the needs of the user and therefore offers you the greatest possible flexibility in program creation. When **programming at the machine,** all required inputs are guided by practice-oriented prompts and questions while highly expressive help images support you. For standard operations and even complex applications, users can draw on a wide variety of **cycles** for machining, coordinate transformations and machine setup.

HEIDENHAIN controls can be **programmed remotely** equally well on a CAD/CAM system as on a HEIDENHAIN programming station.

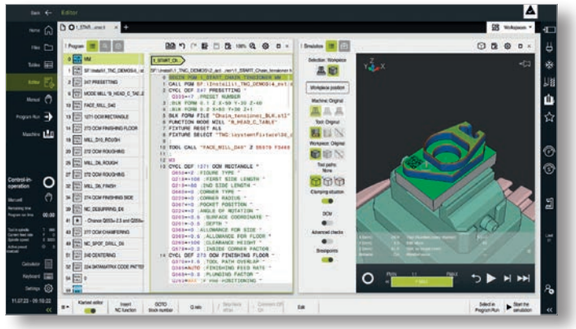
Directly on the control, users can open **DXF, STEP** or **IGES** files created on a separate CAD system. They can then extract contours and machining positions as needed. This not only saves time otherwise spent on programming and testing, but you can also be sure that the adopted data is exactly in accordance with the design engineer's specifications.

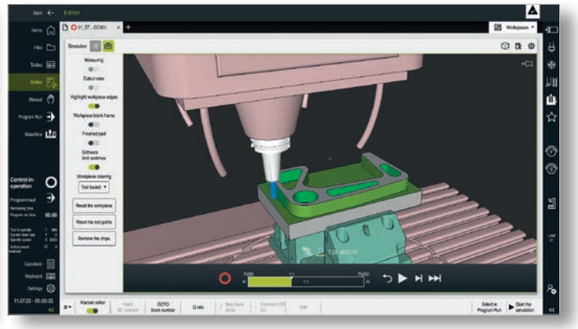
**User-friendly and practical**
Thanks to the robust design optimized for the application, HEIDENHAIN controls are ideally suited for a harsh work-day environment. The intuitive screen displays tips, dialog boxes, program steps, graphical aids and tiles. All texts are available in numerous languages. The 3D illustrations representing the machine, fixtures, tools and workpiece simplify programming and provide valuable aid for verifying the program.


**High quality and productivity**
Thanks to intelligent motion control, HEIDENHAIN controls enable short machining times with perfect workpiece surfaces and very high workpiece accuracy. The bottom line is an increase in productivity: unit costs are reduced without affecting accuracy and surface quality.

**Automating manual operations**
With controls from HEIDENHAIN you can machine your workpieces one step at a time, without having to create an entire machining program. You can switch between manual and automatic positioning as often as desired.

**Manufacturing complex components precisely**
Regardless of whether the workpieces are simple or complex—HEIDENHAIN controls offer the appropriate functions. With them, neither are operations in a tilted plane a challenge, nor is multi-side or full-surface machining. Simultaneous machining with up to five axes is an especially strong point of HEIDENHAIN controls. With special control strategies, functions for process monitoring, and compensation of production-induced disturbances, you can also manufacture components with complex geometries exactly, with process reliability, and efficiently.


Individually customizable workspaces


High resolution simulation graphics

| HEIDENHAIN controls | | Series | Page |
|---|---|---|---|
| **Controls for milling machines** | Contouring control for up to 24 control loops | **TNC7** | **48** |
| | Contouring control for up to 8 control loops | **TNC7 basic** | **50** |
| | Contouring control for up to 24 control loops | **TNC 640** | **52** |
| | Contouring control for up to 8 control loops | **TNC 620** | **54** |
| | Contouring control for up to 6 control loops | **TNC 320** | **54** |
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| **Controls for lathes** | Contouring control for up to 24 control loops | **CNC PILOT 640** | **58** |
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| **Contouring controls** | Digital control design | | **62** |
| **Accessories** | Electronic handwheels | **HR** | **64** |
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| **Tool and workpiece setup and measurement** | Workpiece touch probes | **TS** | **68** |
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# TNC7 contouring control

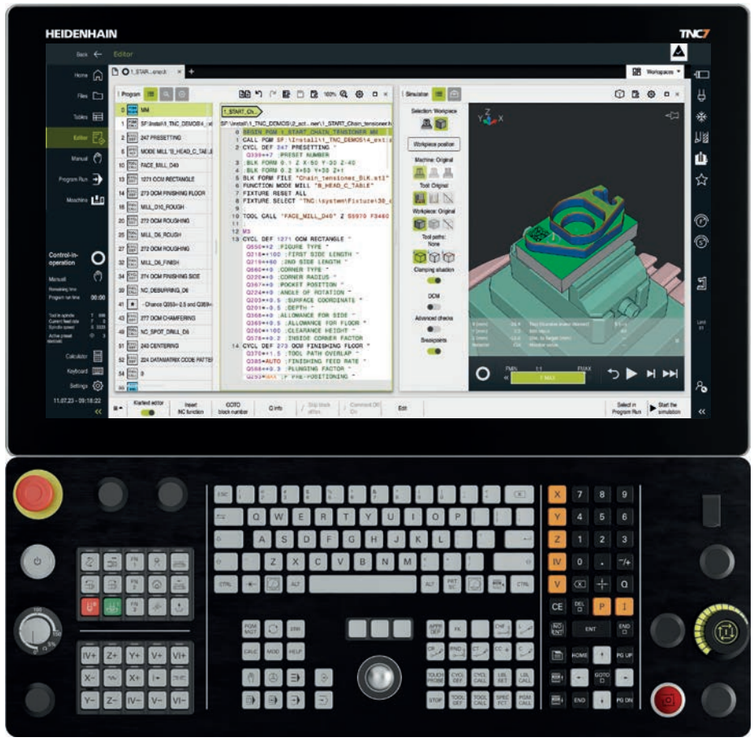
## For milling machines, milling-turning machines and machining centers

The **TNC7** supports you perfectly in your daily work and opens up completely new possibilities. Its optimized operating design ensures highly efficient and ergonomic operation at the machine tool. The control also provides optimal visualization of the workpiece and work envelope for easier programming, setup and machining.

The TNC7 is ideally suited for milling, turning, grinding and 5-axis machining on:
- Universal milling machines
- Boring mills
- High-speed machines
- Machining centers
- Large machines
- Milling-turning machines

Thanks to its optimized motion control, fast block processing and special control strategies, the TNC7 achieves impressive results. As a result, the TNC7 stands for exceptional contour accuracy at very high machining speeds.

The TNC7 supports you from the initial idea to the finished workpiece. Its graphical programming feature allows you to draw contours directly on the touchscreen and then automatically convert them into and save them in the Klartext conversational programming language. For aligning workpiece and fixtures, the TNC7 offers graphically supported probing functions (as a software option). And during machining, a process monitoring software option, that can be fully integrated into the machining process, ensures consistent part quality even during automated manufacturing.




| | TNC7 |
|---|---|
| **Axes** | Up to 24 control loops, of which up to 4 can be configured as spindles |
| **Interpolation** | • Interpolation with more than four axes (with **T**ool **C**enter **P**oint **M**anagement)<br>• Circular in up to 3 axes with tilted working plane<br>• Helical<br>• Cylinder surface[1)]<br>• Rigid tapping[1)] |
| **Program entry** | HEIDENHAIN Klartext format, ISO (G-code programming) |
| **Programming support** | TNCguide provides user information directly on the control |
| **CAD import**[2)] | Loading of contours from 3D models |
| **Storage medium** | SSDR (240 GB) or CFR (CFast: 30 GB or 60 GB) |
| **Position entry** | Nominal positions in Cartesian or polar coordinates, absolute or incremental dimensions, in mm or inches; actual position capture |
| **Input resolution and display step** | Down to 0.1 µm or 0.0001°; optionally down to 0.01 µm or 0.00001° |
| **Block processing time** | < 0.5 ms |
| **Turning functions**[2)] | • Turning tool data management<br>• Tool-tip radius compensation<br>• Constant cutting speed<br>• Switching between milling and turning mode |
| **High-speed cutting** | Motion control with minimum jerk |
| **Graphical programming** | Intuitive graphical contour programming via symbolic gestures on the touchscreen |
| **Coordinate transformations** | • Shifting, rotating, mirroring and scaling (axis-specific)<br>• Tilting the working plane, PLANE function[2)] |
| **Machining cycles** | For drilling, milling, turning[2)], interpolation turning[2)], grinding[2)], hobbing[2)] and cylinder surface machining[2)]; data-input with support from graphical images and forms |
| **Touch probe cycles** | For tool measurement, workpiece alignment, workpiece measurement and presetting |
| **Graphics** | For programming and program verification |
| **Parallel operation** | Program run and programming with graphics |
| **Data interface** | Ethernet 1000BASE-T; USB 3.0 |
| **Remote control and diagnosis** | RemoteAccess |
| **Screen** | 19-inch or 24-inch screen for multitouch operation |
| **Axis feedback control** | • Velocity feedforward control or operation with following error<br>• Integrated digital motor controller, including inverter |
| **Adaptive Feed Control (AFC)**[2)] | Adaptation of the contouring feed rate to the spindle power |
| **Dynamic Collision Monitoring (DCM)**[2)] | Dynamic monitoring of the work envelope for possible collisions with machine components[1)] |
| **Accessories** | • HR electronic handwheels<br>• TS workpiece touch probe and TT or TD tool touch probe |

[1)] This function requires adaptation by the machine manufacturer
[2)] Software option
For further functions and differences between functions, see the product documentation

# TNC7 basic contouring control
## For milling machines

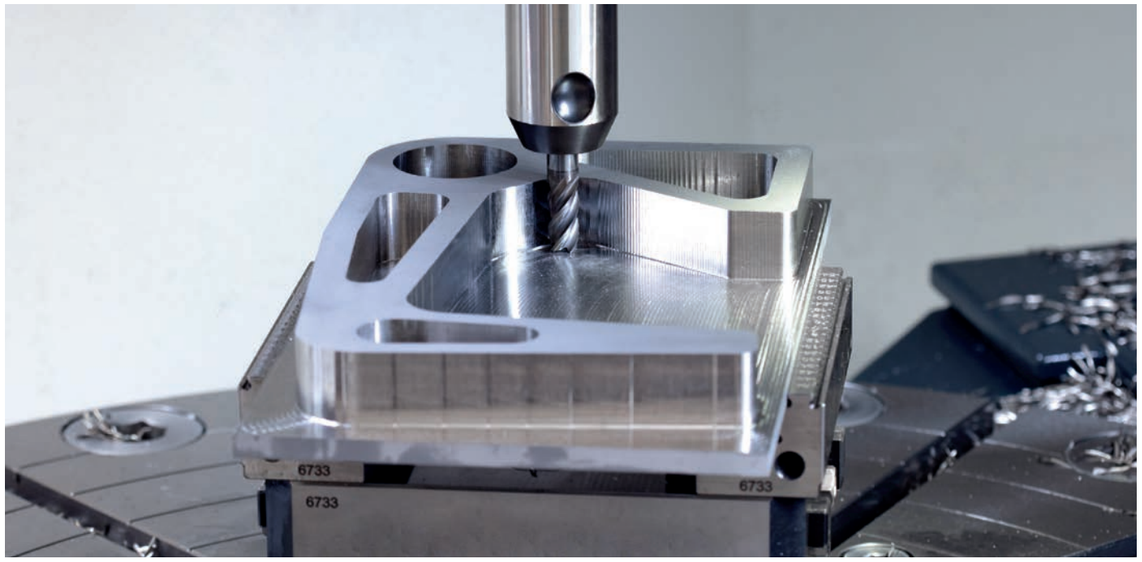
The HEIDENHAIN **TNC7 basic** is a compact and versatile contouring control. Thanks to its optimized user experience and extensive functionality, it is especially well suited for use on universal milling and drilling machines for:

- Serial and single-part production
- Tool making
- Machine building
- Repair departments
- Training and education facilities

With up to eight control loop and an expanded range of options, the TNC7 basic is an ideal solution for simple milling machines, drilling machines and machining centers. The versatile options that can be used with the control include Optimized Contour Milling, collision monitoring and graphically supported setup for fixtures and workpieces. The TNC7 basic provides optimal user support every day on the shop floor.




TNC7 basic with the TE keyboard unit




| | TNC7 basic |
|---|---|
| **Axes** | Up to 8 control loops, of which up to 2 can be configured as spindles |
| **Interpolation** | • Linear in 4 (optionally 5) main axes<br>• Circular in 2 (optionally 3) axes<br>• Helical, superimposition of circular and straight paths<br>• Cylinder surface[1)] |
| **Program entry** | HEIDENHAIN Klartext format, ISO (G-code programming) |
| **Programming support** | TNCguide provides user information directly on the control |
| **CAD import**[2)] | Loading of contours from 3D models |
| **Storage medium** | CFR (CFast: 30 GB or 60 GB) |
| **Position entry** | Nominal positions in Cartesian or polar coordinates, absolute or incremental dimensions, in mm or inches; actual position capture |
| **Input resolution and display step** | Down to 0.1 µm or 0.0001°; optionally down to 0.01 µm or 0.00001° |
| **Block processing time** | < 0.5 ms |
| **Graphical programming** | Intuitive graphical contour programming via symbolic gestures on the touchscreen |
| **Coordinate transformations** | • Shifting, rotating, mirroring and scaling (axis-specific)<br>• Tilting the working plane, PLANE function[2)] |
| **Machining cycles** | For drilling, milling and cylinder surface machining[2)]; data input with graphical support and fillable forms |
| **Touch probe cycles** | For tool measurement, workpiece alignment, workpiece measurement and presetting |
| **Graphics** | For programming and program verification |
| **Parallel operation** | Program run and programming with graphics |
| **Data interface** | Ethernet 1000BASE-T; USB 3.0 |
| **Remote control and diagnosis** | RemoteAccess |
| **Screen** | 16-inch screen for multitouch operation |
| **Axis feedback control** | • Velocity feedforward control or operation with following error<br>• Integrated digital motor controller, including inverter |
| **Dynamic Collision Monitoring (DCM)**[2)] | Dynamic monitoring of the work envelope for possible collisions with machine components[1)] |
| **Accessories** | • HR electronic handwheels<br>• TS workpiece touch probe and TT or TD tool touch probe |

[1)] This function requires adaptation by the machine manufacturer
[2)] Software option
For further functions and differences between functions, see the product documentation

# TNC 640 contouring control

## For milling machines, milling-turning machines and machining centers

Besides milling, the **TNC 640** from HEIDENHAIN is also capable of combined milling and turning operations. It is particularly well suited for milling, turning, high-speed machining and 5-axis machining. The shop-oriented and versatile control features numerous functions.

The TNC 640 is especially well suited for milling, turning, grinding and 5-axis machining on:

- Universal milling machines
- Boring mills
- High-speed machines
- Machining centers
- Large machines
- Milling-turning machines

The TNC 640 features **optimized motion control, short block processing times** and special closed-loop control strategies. Together with its **uniform digital design** and its integrated digital drive control including inverters, it enables you to reach very high machining speeds and the best possible contour accuracy—particularly when machining 3D contours.

You can program **turning contours** with the TNC 640 in the familiar HEIDENHAIN Klartext format. Beyond this, you have typical contour elements for turning (recesses, undercuts, thread undercuts) as well as cycles for complex turning operations.


| | TNC 640 |
|---|---|
| **Axes** | Up to 24 control loops, of which up to 4 can be configured as spindles |
| **Interpolation** | • Interpolation with more than four axes (with **T**ool **C**enter **P**oint **M**anagement)<br>• Circular in up to 3 axes with tilted working plane<br>• Helical<br>• Cylinder surface[1)]<br>• Rigid tapping[1)] |
| **Program entry** | HEIDENHAIN Klartext conversational format, ISO (G codes) |
| **Programming support** | TNCguide provides user information directly on the control |
| **CAD import**[2)] | Loading of contours from 3D models |
| **Storage medium** | SSDR (32 GB or 240 GB) |
| **Position entry** | Nominal positions in Cartesian or polar coordinates, absolute or incremental dimensions, in mm or inches; actual position capture |
| **Input resolution and display step** | Down to 0.1 µm or 0.0001°; optionally down to 0.01 µm or 0.00001° |
| **Block processing time** | < 0.5 ms |
| **Turning functions**[2)] | • Turning tool data management<br>• Tool-tip radius compensation<br>• Constant cutting speed<br>• Switching between milling and turning mode |
| **High-speed cutting** | Motion control with minimum jerk |
| **FK free contour programming** | HEIDENHAIN Klartext conversational format with graphical support |
| **Coordinate transformations** | • Shifting, rotating, mirroring and scaling (axis-specific)<br>• Tilting the working plane, PLANE function[2)] |
| **Machining cycles** | For drilling, milling, turning[2)], interpolation turning[2)], grinding[2)], hobbing[2)] and for cylinder surface machining[2)]; data input with graphical support |
| **Touch probe cycles** | For tool measurement, workpiece alignment, workpiece measurement and presetting |
| **Graphics** | For programming and program verification |
| **Parallel operation** | Program run and programming with graphics |
| **Data interface** | Ethernet 1000BASE-T; USB 3.0 |
| **Remote control and diagnosis** | RemoteAccess |
| **Screen** | 15-inch, 19-inch or 24-inch screen for multitouch operation |
| **Axis feedback control** | • Velocity feedforward control or operation with following error<br>• Integrated digital motor controller, including inverter |
| **Adaptive Feed Control (AFC)**[2)] | Adaptation of the contouring feed rate to the spindle power |
| **Dynamic Collision Monitoring (DCM)**[2)] | Dynamic monitoring of the work envelope for possible collisions with machine components[1)] |
| **Accessories** | • HR electronic handwheels<br>• TS workpiece touch probe and TT or TD tool touch probe |

[1)] This function requires adaptation by the machine manufacturer
[2)] Software option
For further functions and differences between functions, see the product documentation

# TNC 620, TNC 320 contouring controls
## For milling machines

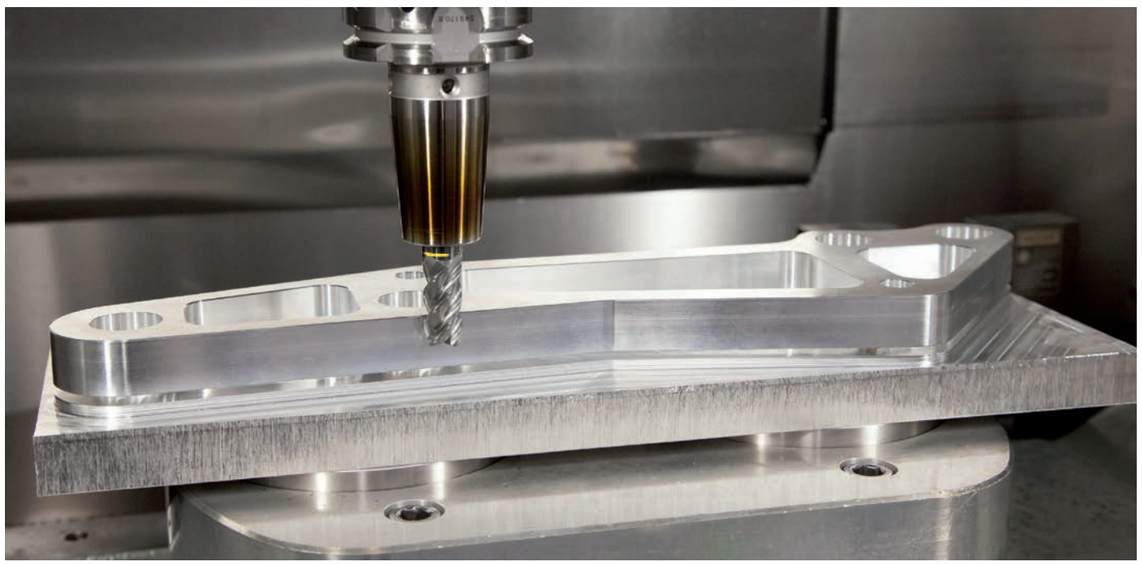
The HEIDENHAIN **TNC 620** and **TNC 320** controls are compact but versatile contouring controls. Thanks to their flexible operation—shop-oriented programmability with the HEIDENHAIN Klartext format or offline programming—and their scope of features, they are especially suited for use on universal milling, drilling and boring machines for the following:

- Serial and single-part production
- Tool making
- Machine building
- Research and development
- Prototypes and pilot plants
- Repair departments
- Training and education facilities

Thanks to its **digital design,** the **TNC 620** has control over the machine's entire drive system. Not only does the field-proven digital drive technology from HEIDENHAIN make high contour fidelity and rapid machining at high speeds possible, but also all control components of the TNC 620 are connected via digital interfaces. The TNC 620 is available in a touch-screen version as well as in a screen and keyboard version.

Because of its analog outputs (which also provide nominal speed values), the **TNC 320** is well suited for retrofitting on machine tools.


TNC 620 touch screen version (only for TNC 620)



| | TNC 620 | TNC 320 |
|---|---|---|
| **Axes** | Up to 8 control loops, of which up to 2 can be configured as spindles | Up to 6 control loops, of which up to 2 can be configured as spindles |
| **Interpolation** | • Linear in 4 (optionally 5) main axes<br>• Circular in 2 (optionally 3) axes<br>• Helical, superimposition of circular and straight paths<br>• Cylinder surface[1)] | • Linear in 4 main axes<br>• Circular in 2 axes<br>• Helical, superimposition of circular and straight paths<br>• Cylinder surface[1)] |
| **Program entry** | • HEIDENHAIN Klartext conversational format<br>• ISO (G codes: input via soft keys or via external USB keyboard)<br>• FK free programming of contours (software option on the TNC 620) | |
| **Programming support** | TNCguide presents user information directly on the TNC | |
| **CAD import**[1)] | Loading of contours from 3D models | |
| **Storage medium** | CFR (CFast: 30 GB) | |
| **Position entry** | • Positions in Cartesian or polar coordinates<br>• Incremental or absolute dimensions<br>• Display and entry in mm or inches<br>• Actual position capture | |
| **Input resolution and display step** | To 0.1 µm or 0.0001°<br>optionally to 0.01 µm or 0.00001° | To 0.1 µm or 0.0001° |
| **Block processing time** | < 1.5 ms | < 6 ms |
| **Coordinate transformations** | • Shifting, rotating, mirroring and scaling (axis-specific)<br>• Tilting the working plane, PLANE function[1)] | |
| **Machining cycles**<br>(some are software options on the TNC 620) | • Drilling, tapping, thread cutting, reaming and boring<br>• Cycles for hole patterns, facing of flat surfaces<br>• Clearance and finishing of pockets, slots and studs | |
| **Touch probe cycles** | For tool measurement, workpiece alignment, workpiece measurement and workpiece presetting (software option on the TNC 620) | |
| **Graphics** | For programming and program verification (software option on the TNC 620); graphic support with cycle programming | |
| **Parallel operation** | Programming during program run, program-run graphics (software option on the TNC 620) | |
| **Data interface** | Ethernet 1000BASE-T; USB 3.0 | |
| **Monitor** | 15-inch (landscape) or 19-inch (portrait) screen for multitouch operation | 15-inch screen with operating keys |
| **Axis feedback control** | Velocity feedforward control or operation with following error | |
| | Integrated digital drive control for synchronous and asynchronous motors | – |
| **Interfacing to the machine** | Via integrated programmable logic controller (PLC) | |
| | Inputs/outputs with PL 6000 | Inputs/outputs expandable with PL 510 |
| **Accessories** | • HR electronic handwheels<br>• TS workpiece touch probe and TT or TD tool touch probe | |

[1)] Software option

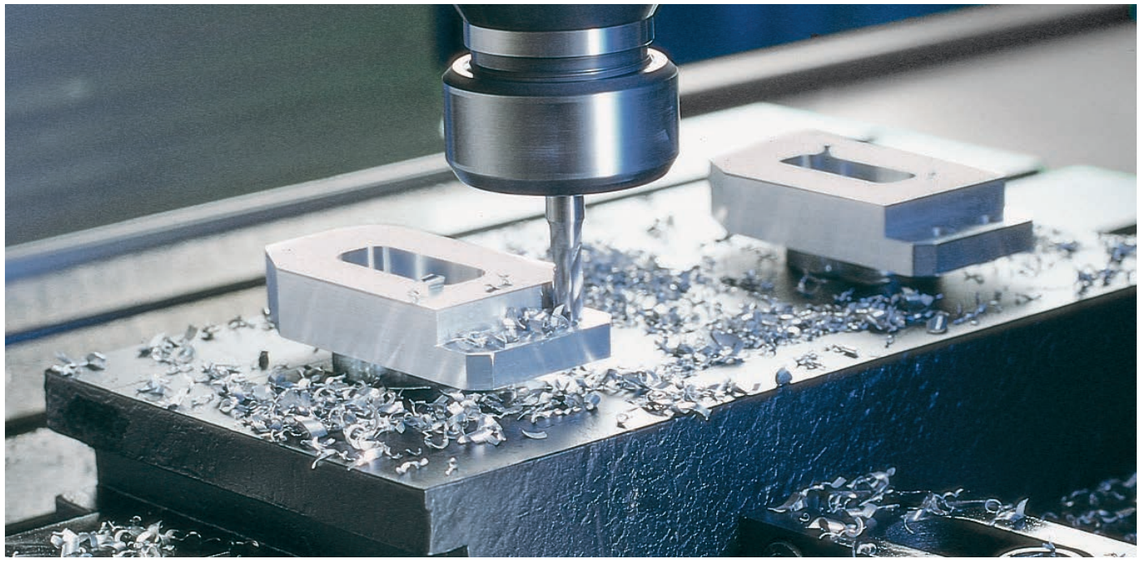
# TNC 128 straight-cut control
## For milling machines

The **TNC 128** from HEIDENHAIN is a compact but versatile straight-cut control for three servo axes and servo spindle. A further servo axis is an option. Thanks to its user-friendly operation and scope of features, it is especially well suited for use on universal milling, drilling and boring machines for the following possibilities:

- Series and single-part production
- Machine building
- Prototypes and pilot plants
- Repair departments
- Training and education facilities

Because of its analog output that also provides nominal speed values, the TNC 128 is well suited for retrofitting on machine tools.


| | TNC 128 |
|---|---|
| **Axes** | Up to 5 control loops, of which up to 2 can be configured as spindles |
| **Program entry** | HEIDENHAIN Klartext conversational format |
| **Storage medium** | CFR (CFast: 30 GB) |
| **Position entry** | • Positions in Cartesian or polar coordinates<br>• Incremental or absolute dimensions<br>• Display and entry in mm or inches |
| **Input resolution and display step** | To 0.1 µm or 0.0001° |
| **Block processing time** | < 6 ms |
| **Coordinate transformations** | Shifting, rotating, mirroring and scaling (axis-specific) |
| **Machining cycles** | • Drilling, tapping, reaming and boring<br>• Cycles for hole patterns, facing of flat surfaces<br>• Pocket, stud and slot milling |
| **Touch probe cycles** | Touch probe calibration and presetting |
| **Graphics** | For programming and program verification; graphic support for cycle programming |
| **Parallel operation** | Program run and programming, program-run graphics |
| **Data interface** | Ethernet 1000BASE-T; USB 3.0 |
| **Monitor** | 12.1-inch screen with operating keys |
| **Axis feedback control** | Velocity feedforward control or operation with following error |
| **Interfacing to the machine** | Via integrated programmable logic controller (PLC); inputs/outputs expandable with PL 510 |
| **Accessories** | • HR electronic handwheels<br>• TS workpiece touch probe and TT or TD tool touch probe |



# CNC PILOT 640 contouring control

## For lathes and turning-milling machines

The **CNC PILOT 640** offers you the right support thanks to its flexible design and versatile programming capabilities — regardless of whether you are manufacturing single parts or batches, simple or complex workpieces. The CNC PILOT 640 is characterized by its simple operation and programming. It is quickly learned and requires minimum training time.

The CNC PILOT 640 was designed for CNC lathes and is ideal for both horizontal and vertical lathes as well as for vertical boring and turning mills.

The CNC PILOT 640 supports lathes with main and counter spindle, one slide (X and Z axis), C axis or positionable spindle, driven tools, and machines with Y and B axes.

Regardless of whether you are turning simple parts or complex workpieces, the CNC PILOT 640 provides you with the benefits of graphical contour input and convenient programming with smart.Turn. With the TURN PLUS software option, you can even create an NC program at the touch of a button. Once you've defined your contour, material and workholding, TURN PLUS automatically handles the rest.

The CNC PILOT 640 also supports multi-channel machining. Different machining steps can then be performed simultaneously using multiple slides.


| | CNC PILOT 640 |
|---|---|
| **Axes** | Up to 24 control loops; up to 8 NC axes per channel; up to 6 spindles in the overall system |
| **Interpolation** | • Straight line: in 2 principal axes, optional in 3 principal axes<br>• Circle: in 2 axes, optional additional linear interpolation in the third axis<br>• C1/C2 axis[1]: interpolation of X and Z linear axes with the C1/C2 axis<br>• B axis[1]: 5-axis interpolation between the X-, Z-, Y-, B- and C axis |
| **Program entry** | smart.Turn, DIN PLUS, Teach-In mode[1] |
| **Programming aids** | TURNguide presents user information directly on the control |
| **DXF import**[1] | Loading of DXF contours |
| **Storage medium** | CFR (CFast: 30 GB) |
| **Position entry** | Nominal positions in Cartesian or polar coordinates, absolute or incremental dimensions, in mm or inches; actual position capture |
| **Input resolution and display step** | X axis: 0.5 µm, diameter: 1 µm<br>U, V, W, Y, Z axes: 1 µm<br>B, C1/C2 axis: 0.001° |
| **Block processing time** | < 1.5 ms |
| **Setup functions** | • Setting the workpiece datum<br>• Defining the tool change point<br>• Defining the protection zone |
| **Interactive contour programming (ICP)** | Contour definition with graphic support |
| **Machining cycles** | Stock removal, recessing, recess turning, engraving, thread cutting, helical slot milling, boring, drilling, tapping, deburring, trochoidal milling, hobbing, eccentric and non-circular turning, simultaneous turning |
| **Touch-probe cycles**[1] | For tool and workpiece measurement as well as presetting |
| **Graphics** | For programming and program verification |
| **Parallel operation** | Program run and programming with graphics |
| **Data interface** | Ethernet 1000BASE-T; USB 3.0 |
| **Remote control and diagnosis** | RemoteAccess |
| **Screen** | 15.6-inch or 24-inch screen for multitouch operation |
| **Axis feedback control** | • Velocity feedforward control or operation with following error<br>• Integrated digital motor controller, including inverter |
| **Multi-channel capability** | • Up to three channels for asynchronous multi-slide machining |
| **Accessories** | • HR electronic handwheels<br>• TS workpiece touch probe and TT tool touch probe |

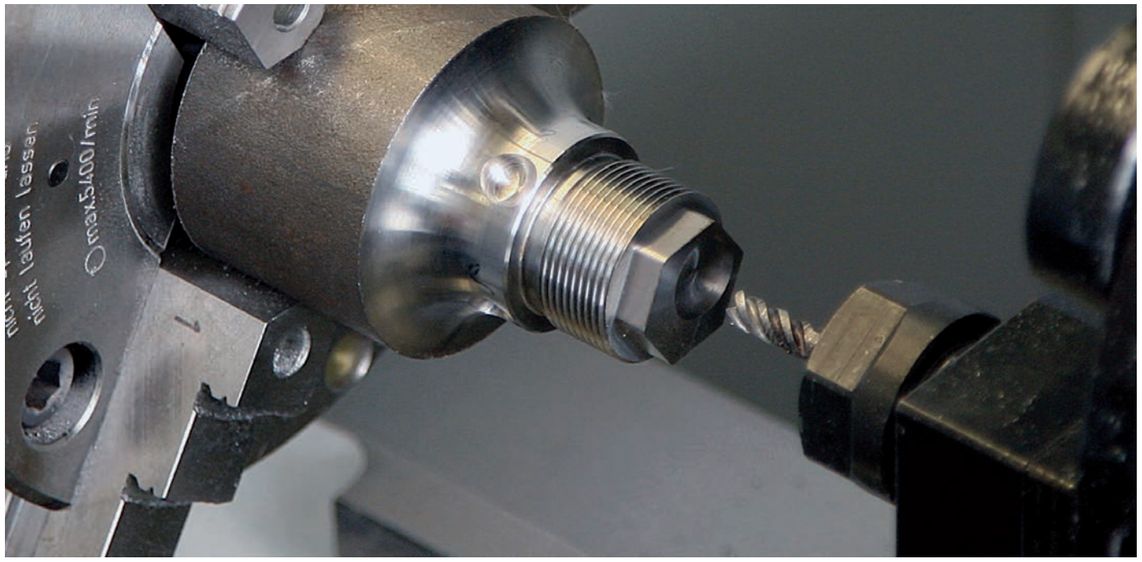
[1] Software option
For further functions and differences between functions, see the product documentation

# MANUALplus 620 contouring control
## For CNC and cycle lathes

The **MANUALplus 620** is a compact and versatile contouring control that is particularly well suited for cycle-controlled lathes. The MANUALplus 620 optimally combines the ease of use of conventional lathes with the advantages of CNC-controlled machines.

Regardless of whether you are manufacturing single parts or batches or whether your workpieces are simple or complex, the control adapts to the needs of your company. The MANUALplus 620 is characterized by its simple operation and programming. It is quickly learned and requires minimum training time.

The MANUALplus 620 supports lathes with main and counter spindle, one slide (X and Z axis), C axis or positionable spindle, and driven tools, as well as machines with Y and B axes.


| | MANUALplus 620 |
|---|---|
| **Axes** | Up to 10 control loops, of which up to 6 can be configured as spindles |
| **Interpolation** | • Straight line: in 2 principal axes, optional in 3 principal axes<br>• Circle: in 2 axes, optional additional linear interpolation in the third axis<br>• C1/C2 axis[1]: interpolation of X and Z linear axes with the C1/C2 axis |
| **Program entry** | Teach-In mode, smart.Turn[1], DIN PLUS |
| **Programming aids** | TURNguide presents user information directly on the control |
| **DXF import**[1] | Loading of DXF contours |
| **Storage medium** | CFR (CFast: 30 GB) |
| **Position entry** | Nominal positions in Cartesian or polar coordinates, absolute or incremental dimensions, in mm or inches; actual position capture |
| **Input resolution and display step** | X axis: 0.5 µm, diameter: 1 µm<br>U, V, W, Y, Z axes: 1 µm<br>B, C1/C2 axis: 0.001° |
| **Block processing time** | < 3 ms |
| **Setup functions** | • Setting the workpiece datum<br>• Defining the tool change point<br>• Defining the protection zone |
| **Interactive contour programming (ICP)** | Contour definition with graphic support |
| **Machining cycles** | Stock removal, recessing, recess turning, engraving, thread cutting, helical slot milling, boring, drilling, tapping, deburring, trochoidal milling, hobbing, eccentric and non-circular turning |
| **Touch-probe cycles**[1] | For tool and workpiece measurement as well as presetting |
| **Graphics** | For programming and program verification |
| **Parallel operation** | Program run and programming with graphics |
| **Data interface** | Ethernet 1000BASE-T; USB 3.0 |
| **Remote control and diagnosis** | RemoteAccess |
| **Screen** | 15.6-Inch screen for multitouch operation (machine operating field in the right part of the screen) |
| **Axis feedback control** | • Velocity feedforward control or operation with following error<br>• Integrated digital motor controller, including inverter |
| **Accessories** | • HR electronic handwheels<br>• TS workpiece touch probe and TT tool touch probe |

[1] Software option
For further functions and differences between functions, see the product documentation

# Contouring controls
## Digital control design

HEIDENHAIN control packages are perfectly matched systems specifically developed for use on machine tools with rigorous requirements. These packages usually consist of the following:
- Software
- Control hardware and real-time hardware
- Drive electronics
- Motors
- Encoders

In this uniformly digital control solution, all components are connected over purely digital interfaces: the control components over **HSCI** (HEIDENHAIN Serial Controller Interface), which is the HEIDENHAIN real-time protocol for Fast Ethernet, and the encoders over **EnDat 2.2,** the bidirectional interface from HEIDENHAIN. This achieves a high degree of availability for the entire system. It can be diagnosed and is immune to noise—from the main computer to the encoder. The outstanding characteristics of the uniform digital solution from HEIDENHAIN guarantee very high accuracy and surface quality, together with high traversing speeds.

**Digital drive control**
High surface quality, high contouring accuracy of the finished workpiece and short machining times—these requirements can be met only with digital control techniques. Here HEIDENHAIN offers NC products with integrated digital drive control.

The following HEIDENHAIN controls are available with HSCI and digital drive control:
- TNC7
- TNC7 basic
- TNC 640
- TNC 620
- CNC PILOT 640
- MANUALplus 620

**Motors for axis and spindle drives**
HEIDENHAIN offers various motors for axis and spindle drives as accessories to its controls with integrated inverters:
- Feed motors with a stall torque of 1.5 Nm to 120 Nm and a power rating ranging from 0.5 kW to 14.4 kW.
- Spindle motors with a power rating ranging from 5.5 kW to 43.2 kW.

**Inverter systems**
Either compact or modular inverters are available, depending on the type of machine. **Compact inverters** contain the power electronics for up to five control loops and a controller unit for up to six motors with an overall system power rating of up to 30 kW. For the **modular inverters,** supply units from 30 kW to 135 kW as well as various power modules for axles and spindles are available. Modular inverters are suitable for machines with up to 24 control loops, of which up to four can be configured as spindles.

**Gen 3 drives**
With the new Gen 3 components, HEIDENHAIN offers a complete system that is based on highly innovative and future-oriented technologies. You profit from state-of-the-art interface technology, improved performance data and increased controller performance. This makes the Gen 3 drive technology a key component for machines that must fulfill stringent requirements regarding availability, surface quality and machining time.

Gen 3

**TNC 640**
With modular inverters, motors and position encoders

# Accessories
## Electronic handwheels and programming stations

With an electronic handwheel from HEIDENHAIN, you can use the feed drive to make very precise movements in the axis slides in proportion to the rotation of the handwheel. As an option, the handwheels are available with mechanical detent.

**HR 510, HR 520 and HR 550 FS portable handwheels**
The axis keys and certain function keys are integrated in the housing. This way you can switch axes or set up the machine at any time—and regardless of where you happen to be standing. The **HR 520** also features a display for the position value, the feed rate, the spindle speed, the operating mode, and other functions, as well as override potentiometers for the feed rate and spindle speed. You can enjoy unlimited freedom of movement with the **HR 550 FS** with radio transmission. Its features correspond to those of the HR 520.

**HR 550 FS** **HR 510**

**HR 130 and HR 180 panel-mounted handwheels**
Panel-mounted handwheels from HEIDENHAIN can be integrated in the machine operating panel or be installed at another location on the machine. With the HRA 180 handwheel adapter, up to three HR 180 electronic panel-mounted handwheels can be connected.

**HR 130** for integration into the machine operating panel

The TNC7, TNC7 basic, TNC 640 and TNC 620/TNC 320 programming stations allow you to create Klartext programs away from all the noise of the shopfloor, just as if you were working at the machine. With the DataPilot CP 640 and the DataPilot MP 620 you can also use smart.Turn, G codes and cycles to create programs for your HEIDENHAIN lathe controls.

**Creating programs**
The programming, testing and optimizing of HEIDENHAIN Klartext or G-code programs with the programming station substantially reduces machine idle time. You do not need to change your way of thinking. At the programming station you program on the same keyboard as at the machine.

**Training with the programming station**
Because the programming stations are based on the respective control software, they are ideally suited for apprentice and advanced training.

**TNC training in schools**
Since they can be programmed with G codes as well as in Klartext conversational format, the programming stations can also be used in schools for TNC programming training.



## VT 121, VT 122 vision systems for tool inspection

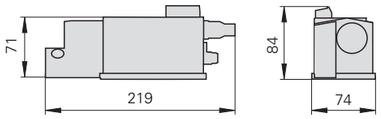
The vision systems for tool inspection consist of two components:
- Camera with two objectives (VT 121, VT 122)
- Touch-operated PC software (VTC)

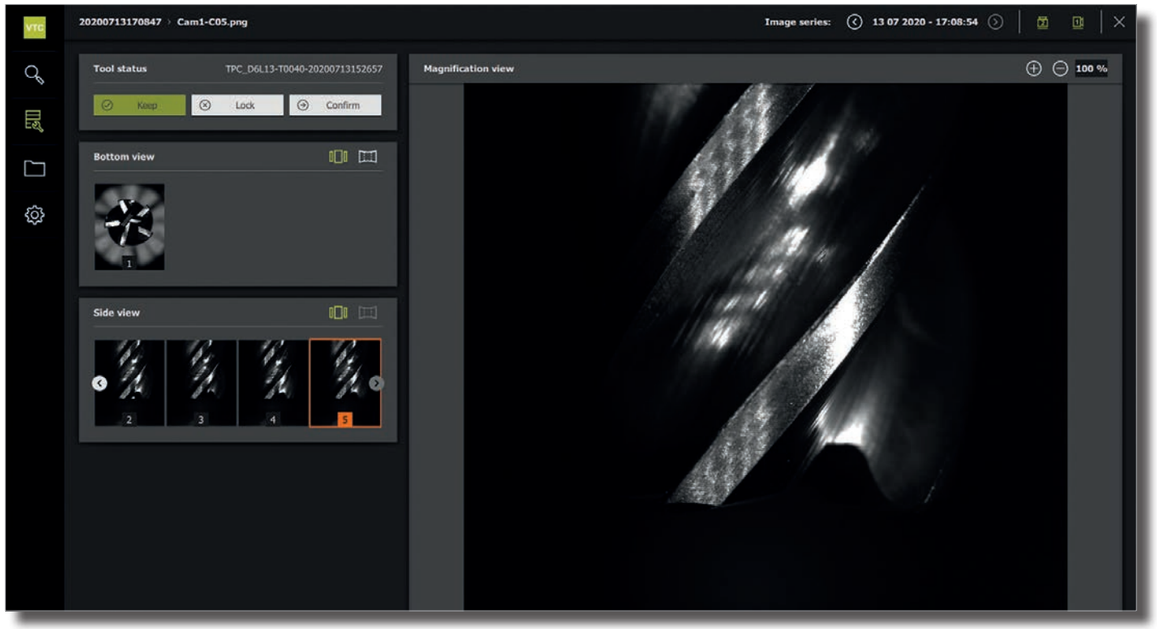
The VT 122 is available in two variants:
- With connections through the base plate for mounting on a prepared machine, or
- With lateral connections for variable cable routing

The vision systems enable tool imaging during machining. Besides documenting tool status and wear, the following applications are possible as well:
- Tool inspection before critical machining steps
- Optimization of cutting parameters
- Optimization of NC programs
- Breakage detection
- Tool inspection after expiration of tool life

Your benefits:
- Automated imaging during machining
- Time savings, since the tool stays in the machine
- Compact system, even usable with very large tools
- Rugged design
- Controlled compressed-air cleaning
- PC software for configuration and evaluation also on the TNC


**VT 122**



# Digital Shop Floor: software solutions

The software solutions of the Digital Shop Floor from HEIDENHAIN are ideal for manufacturing companies that use CNC machine tools. They provide support along the process chain, ensuring improved process quality and enabling sustainable productivity gains.


**Software solutions for your manufacturing operations**

**HEIDENHAIN**
**StateMonitor**

StateMonitor gives you insight into the production processes of your machine tools in real time. It collects and visualizes machine statuses, machine messages, NC program data and many other types of data related to the machine. StateMonitor provides greater insight into production processes, optimizes the use of machines and shortens user response times during malfunctions.

Interfaces:
- HEIDENHAIN DNC
- OPC UA
- MTConnect
- Modbus TCP
- FOCAS

**Machine data collection**
with StateMonitor

**Software options for use with StateMonitor**

**HEIDENHAIN**
**JobTerminal**

JobTerminal enables the machine-based management of machining jobs and of their quantities and nominal/actual times.

**HEIDENHAIN**
**MaintenanceManager**

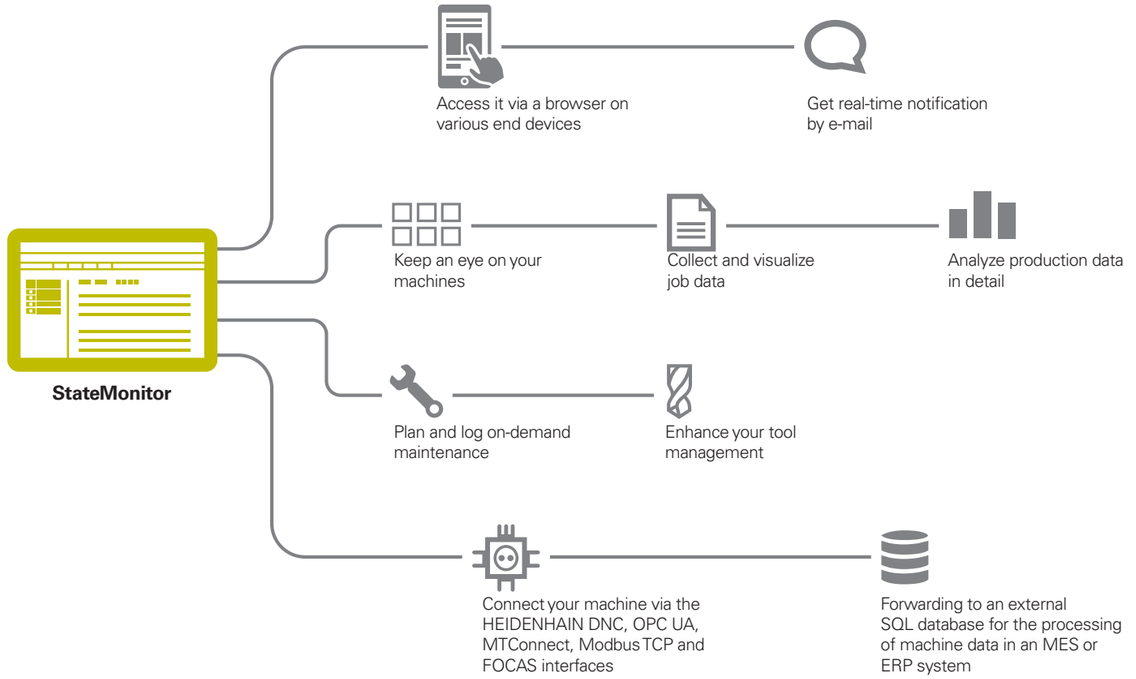
MaintenanceManager displays maintenance and malfunction messages. Maintenance work can be planned based on machining hours, machine messages and intervals of time.

**HEIDENHAIN**
**5 Signals**

5 Signals collects five additional, machine-specific signals.

**HEIDENHAIN**
**5 Machines**

5 Machines allows you to connect an additional five machine tools.



# Tool and workpiece setup and measurement

## TS workpiece touch probes

The **TS workpiece touch probes** from HEIDENHAIN help you perform setup, measuring and inspection functions directly on the machine tool.

The stylus of a TS touch trigger probe is deflected upon contact with a workpiece surface. At that moment the TS generates a trigger signal that, depending on the model, is transmitted either by cable or over an infrared or radio beam to the control.

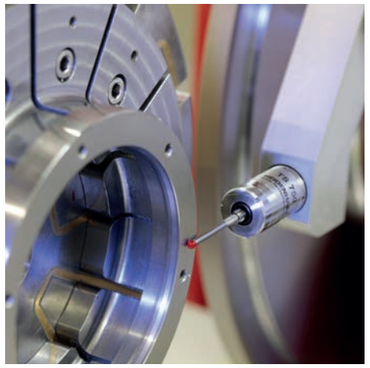
The control simultaneously saves the actual position values as measured by the machine axis encoders, and uses this information for further processing. The trigger signal is generated by means of a wear-free and highly reliable optical sensor or piezoelectric sensor.

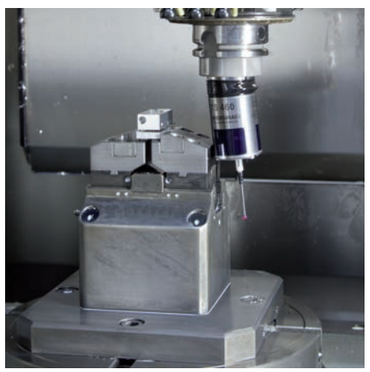
HEIDENHAIN offers probe styli with various ball-tip diameters and stylus lengths.

With a TS touch probe and a KKH calibration sphere from HEIDENHAIN, you can calibrate the rotary axes of your machine and minimize measurement error in the machine's kinematic description. These calibration spheres are also well suited for 3D calibration of the touch probe.

**Benefits of HEIDENHAIN touch probes**

- Idle time reduced through high probing speeds
- High-quality probing saves repeat measurements
- Reliable workpiece cleaning removes chips before probing
- Convenient TNC operation with SE 661 transceiver unit
- With **TS 460:** collision protection adapter (optional) prevents damage to machine and spindle, and reduces heating of the TS through the spindle
- With **TS 260:** direct connection with any downstream electronics; no interface required





Touch probe with **radio and infrared transmission** for machines with automatic tool change:

- **TS 460:** universal touch probe Compact dimensions, energy-saving mode, optional collision protection and thermal decoupling
- **TS 760:** highly accurate touch probe High probing accuracy and repeatability, low probing force

Touch probe with **cable-bound signal transmission** for machines with manual tool change (e.g., grinding, turning and milling machines):

- **TS 750:** highly accurate touch probe, cable-bound, radial or axial cable connection
- **TS 150/TS 260:** cable-bound touch probe, radial or axial cable connection


TS 460


TS 760


TS 260


TS 150/TS 750

| | TS 460 | TS 760 | TS 260 | TS 150 | TS 750 |
|---|---|---|---|---|---|
| **Machine type** | **CNC machine tools for milling, drilling and boring,** as well as **lathes** | | **CNC grinding machines or lathes** | | |
| **Signal transmission** | Radio and infrared | | Cable | | |
| **Transceiver** | *SE 540:* infrared<br>*SE 640:* infrared<br>*SE 660:* radio/infrared<br>*SE 661:* radio/infrared | | – | | |
| **Supply voltage** | Rechargeable or non-rechargeable batteries | | DC 10 V to 30 V | DC 10 V to 30 V[1] | |
| **Switching on/off** | Radio or infrared transmission | | – | | |
| **Interface to control** Signal level | HTL or EnDat via SE transceiver | | HTL | | |
| **Probe repeatability** | 2 σ ≤ 1 µm | 2 σ ≤ 0.25 µm | 2 σ ≤ 1 µm | | 2 σ ≤ 0.25 µm |
| **Probing speed** | ≤ 3 m/min | ≤ 0.1 m/min | ≤ 3 m/min | | ≤ 0.1 m/min |
| **Protection** EN 60529 | IP68 | | | | |

[1] Via UTI 150

# TT and TD tool touch probes

Reduce scrap, minimize rework, cut down on idle time and increase machining accuracy: the TT touch probes and TD 110 tool breakage detector from HEIDENHAIN enable efficient and reliable tool inspection and measurement.

Due to their rugged design and high degree of protection, these tool touch probes can be installed directly within the machine tool's work envelope. Tool inspection is possible at any time: before machining, between two machining steps, or after machining is done.

**Touch probes**
The TT 160 and TT 460 are 3D touch trigger probes for tool measurement and inspection. The disk-shaped probe contact of the TT is deflected during the tactile probing of a tool. In that instant, the TT generates a trigger signal that is transmitted to the control, where it is then processed further. The trigger signal is generated by means of a wear-free and highly reliable optical sensor.

**TT 160, TD 110**
Signal transmission via cable

**TT 460**
- Signal transmission over radio and infrared beam to transceiver
- Via SE 660: a shared transceiver for tool and workpiece touch probes with radio and infrared transmission


TD 110

TT 160

TT 460

| | TD 110 |
|---|---|
| **Type of mounting** | Mounting holes |
| **Electrical connection** | 8-pin M12 flange socket |
| Supply voltage | 10 V to 30 V |
| Output signal | HTL (switching signal S, $\overline{S}$)<br>Floating switch outputs (NC, NO) |
| Cable length | ≤ 30 m |
| **Vibration** 55 Hz to 2000 Hz<br>**Shock** 6 ms | ≤ 200 m/s$^2$ (EN 60068-2-6)<br>≤ 300 m/s$^2$ (EN 60068-2-27) |
| **Operating temperature** | 10 °C to 50 °C |
| **Storage temperature** | –20 °C to 70 °C |
| **Protection rating** | IP66/68 |

| | TT 160 | TT 460 |
|---|---|---|
| **Probing method** | Physical probing in three dimensions: ±X, ±Y, +Z | |
| **Probe repeatability** | 2 σ ≤ 1 µm (probing speed: 1 m/min) | |
| **Permissible deflection of probe contact** | ≈ 5 mm in all directions | |
| **Supply voltage** | DC 10 V to 30 V via NC | Rechargeable or non-rechargeable batteries |
| **Interface to control**<br>Signal level | HTL | *SE 640:* infrared<br>*SE 660:* radio/ infrared<br>*SE 661:* radio/ infrared |
| **Signal transmission** | Via cable | Radio wave and infrared transmission with 360° range |
| **Probe contact** | Ø 40 mm or Ø 25 mm | |
| **Protection** EN 60529 | IP68 | |



# SE transceivers

The following transceivers are available for **wireless signal transmission:**

- **SE 540:** for integration in spindle head; only infrared transmission
- **SE 640:** infrared transmission
- **SE 660:** shared SE for TS and TT; radio and infrared transmission
- **SE 661:** shared SE for TS and TT; radio and infrared transmission, EnDat interface for touch probes

With wireless signal transmission, touch probes are also suited for use on machines with automatic tool change.

The SE 661 transceiver and the TS 460 and TT 460 touch probes are available with the EnDat interface. The EnDat interface from HEIDENHAIN is a digital, bidirectional interface that transmits the trigger status as well as diagnostic information and additional data from the touch probe. Thanks to the interface's serial transmission method, multiple items of data can be transmitted simultaneously.

SE 660

SE 661


SE 540


SE 640

| | SE 660 | SE 661 | SE 540 | SE 640 |
|---|---|---|---|---|
| **TS 460** | Radio/infrared | | Infrared | |
| **TS 760** | Radio/infrared | | Infrared | |
| **TT 460** | Radio/infrared | | Infrared | |

Signal transmission types and combinations of TS, TT and SE

# Measured value acquisition and display

**Digital readouts**
HEIDENHAIN digital readouts for manually operated machine tools have universal application: in addition to standard tasks on milling, drilling and boring machines and lathes, they also offer ideal solutions for many applications on machine tools and special machines—in fact all machines where axis slides are moved. This includes radial drilling machines and rapid radial drilling machines.

Digital readouts for manual machine tools increase your productivity. They save time and increase the dimensional accuracy of the finished workpiece while offering very user-friendly operation.

Practice-oriented functions and cycles are available for various applications. The distance-to-go display feature with graphic positioning aid allows you to approach the next nominal position quickly and reliably simply by traversing to a display value of zero. The digital readouts speed up small-batch production—repetitive machining sequences can be saved as a program.

Precise manufacturing made easy: Together with linear encoders from HEIDENHAIN, the digital readouts measure the axis movements directly. The backlash caused by mechanical transfer elements such as lead screws, racks and gears therefore has no influence.


**Evaluation units**
HEIDENHAIN provides the appropriate evaluation unit for each type of application. They offer numerous functions for measured data acquisition and statistical evaluation of measured values. For automation solutions the results of the measured-data evaluation can be processed further by integrated switching functions. The splash-proof front panel and the sturdy cast-metal housing make evaluation units from HEIDENHAIN impervious to the harshest of everyday shop conditions.


**User-friendly environment**
Digital readouts and evaluation units with integrated display are specially designed for user friendliness. Typical characteristics:
- Optimally readable, graphic flat panel display
- Intuitive operation using touchscreen or keyboard (depending on the product)
- All-in-one device with compact outside dimensions
- Sturdy aluminum housing
- Reference mark evaluation for distance-coded and single reference marks
- Problem-free installation, maintenance-free operation
- Fast payback with economical use

Evaluation units and digital readouts from HEIDENHAIN feature a data interface for further processing in the higher-level electronics or simply to print out the measured values.

**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 temperature-sensor signals) may be processed and transmitted to the down-stream electronics.

# Digital readouts for manually operated machine tools

Applications for digital readouts are on manually operated machine tools, e.g.:
- Milling machines
- Drilling and boring machines
- Lathes
- Radial drilling machines
- Grinding machines

HEIDENHAIN offers the appropriate digital readout for each of these machine types. The splash-proof front panel and the sturdy aluminum housing make digital readouts from HEIDENHAIN impervious to the harshest of everyday shop conditions.


**POSITIP 8000**


**ND 7000**


**ND 5000**

| | POSITIP 8000 | ND 7000 | ND 5000 |
|---|---|---|---|
| **Application** | Milling, drilling and boring machines and lathes | | |
| **Description** | 12.1-inch multitouch screen, program memory, switching inputs and outputs (digital and analog) | 7-inch screen for multitouch operation, switching inputs and outputs (digital and analog, depending on the version) | 7-inch screen with operating keys |
| **Axes** | 6, two of them as software option | 3 | 3 |
| **Encoder inputs** | ⏦ 1 $V_{PP}$, ⏦ 11 $\mu A_{PP}$ or EnDat 2.2 | ⏦ 1 $V_{PP}$, ⏦ 11 $\mu A_{PP}$ or EnDat 2.2 | TTL |
| **Display step** | 10 µm, 5 µm, 1 µm or finer | | 5 µm (with LS 673C), 1 µm (with LS 373C) |
| **Presets** | 100 | | 10 |
| **Tool data** | For 100 tools | | For 16 tools |
| **Programming** | Yes | Software option | No |
| **Functions** | • Manual and MDI operation, graphical positioning aid, variable font size for display of position values<br>• User administration and data management | | |
| | • Touch probe connection<br>• ACTIVE version: NC control of up to three axes (point to point), as software option<br>• Support of machines with central drive | Touch probe connection | – |
| For milling or boring operation | • Hole patterns (circular and linear patterns)<br>• Roughing of rectangular pockets<br>• Probing functions for reference-point acquisition<br>• Switching functions | | • Circle pattern, linear pattern<br>• Diagonal and arc milling |
| | ACTIVE version: controlling the spindle speed | I/O version: controlling the spindle speed | – |
| For turning | • Radius/diameter display<br>• Separate or sum display for Z and $Z_0$<br>• Freezing tool position for back-off/taper calculator<br>• Switching functions | | |
| | ACTIVE version: constant cutting speed | I/O version: constant cutting speed | – |
| **Data interfaces** | Ethernet, USB | | USB |

# Evaluation units for metrology applications
## Measuring and testing tasks

Evaluation units for measuring and testing tasks are ideal for:
- Measurement equipment
- Adjustment and inspection equipment
- SPC inspection stations
- Multi-gauging fixtures
- Mobile data acquisition
- Positioning equipment

The GAGE-CHEK 2000 evaluation unit is an independently operating device with a built-in screen and robust housing. It features special functions for metrological collection and the statistical evaluation of measurements, such as sorting, minimum/maximum value recording and the storage of measurement series. These data make it possible to calculate mean values and standard deviations, as well as graphically display them in histograms or control charts.

The GAGE-CHEK 4000 SW evaluation software is particularly suitable for positioning tasks on measuring and positioning equipment. You can easily load position values to Excel using a LOG function.

GAGE-CHEK 4000 SW is very versatile for multi-gauging fixtures with up to six axes.


| | GAGE-CHEK 2000 | GAGE-CHEK 4000 SW |
|---|---|---|
| **Application** | • Positioning equipment<br>• Measuring fixtures | • Evaluation software for positioning systems<br>• Measuring fixtures |
| **Axes**[1] | 3 | 6 |
| **Encoder inputs** | ∿ 1 $V_{PP}$, ∿ 11 $\mu A_{PP}$, EnDat 2.2 or ⊓⊔ TTL | ∿ 1 $V_{PP}$, ∿ 11 $\mu A_{PP}$ or EnDat 2.2 (via EIB 74x[3]) |
| **Display** | 7-inch screen for multitouch operation | PC monitor |
| **Function** | • Measurement series with minimum and maximum value recording<br>• Touch probe connection for a HEIDENHAIN or Renishaw touch probe<br>• Data transmission via Ethernet or RS-232<br>Manual<br>Touch-probe triggered<br>Continuous<br>Switching-function triggered<br>• User administration<br>• Measurement with reference parts<br>• Management of parts<br>• Dial gage for a graph of the measured value<br>• Diameter/radius display<br>• Relative measurement<br>• Probing functions<br>• Remote access<br>• Position calculations using formulas | • Position calculations using formulas<br>• Dial gage for a graph of the measured value<br>• Configurability of each axis for length or angle display<br>• Measurement series with minimum and maximum value recording<br>• Simple switching of the counting direction<br>• LOG function for Excel |
| **Data interfaces** | Ethernet, USB, RS-232-C[2] | – |

[1] Depending on version
[2] Possible with RS-232 adapter connection via USB port
[3] Must be ordered separately from HEIDENHAIN



# Inspection and testing devices

**Inspection and testing devices from HEIDENHAIN**
HEIDENHAIN encoders provide all of the information needed for setup, monitoring and diagnostics. HEIDENHAIN offers the appropriate PWM inspection devices and PWT testing devices for encoder adjustment and analysis. The PWM inspection devices can be used universally. They have low measuring tolerances and can be calibrated. Testing devices have larger measuring tolerances, fewer available functions, and cannot be calibrated.

HEIDENHAIN encoders can usually be connected either directly or via signal converters to a number of different downstream electronics.

HEIDENHAIN therefore offers encoders and signal converters with various interfaces. The testing and inspection devices from HEIDENHAIN also support various interfaces, which makes their application more flexible (see overview for the PWM 21 and PWT 101).

PWM 21 inspection device with ATS adjusting and testing software


PWT 101 testing device for mobile application

| Encoder input | PWM 21 | PWT 101 |
|---|---|---|
| EnDat 2.1 | ✓ | ✓ |
| EnDat 2.2 | ✓ | ✓ |
| EnDat 3 | ✓ | – |
| DRIVE-CLiQ | ✓ | ✓ |
| Fanuc Serial Interface | ✓ | ✓ |
| Mitsubishi high speed interface | ✓ | ✓ |
| Yaskawa Serial Interface | ✓ | ✓ |
| Panasonic Serial Interface | ✓ | ✓ |
| SSI | ✓ | – |
| 1 $V_{PP}$/TTL/11 $\mu A_{PP}$ | ✓ | ✓ |
| 1 $V_{PP}$ with Z1 track | ✓ | ✓ |
| HTL (via signal adapter) | ✓ | ✓ |

# 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

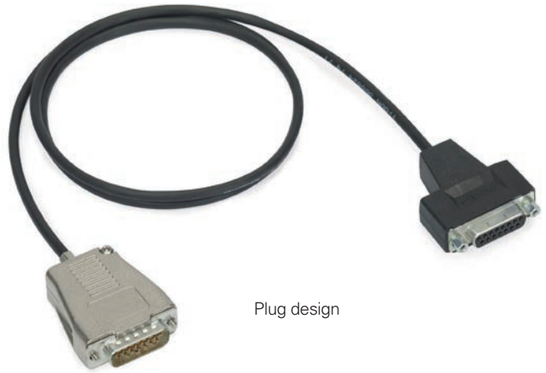
Incremental signals
~ 1 $V_{PP}$ > ⊓⊔TTL
~ 11 $\mu A_{PP}$ > ⊓⊔TTL

Incremental signals > position values
~ 1 $V_{PP}$ > EnDat
~ 1 $V_{PP}$ > Fanuc Serial Interface
~ 1 $V_{PP}$ > Mitsubishi high speed Interface

Position values
EnDat > DRIVE-CLiQ
EnDat > Fanuc
EnDat > Yaskawa Serial Interface

Signal converters from HEIDENHAIN are available in various designs:

- Box design
- Plug design
- Cable design
- Version for integration
- Top-hat rail design



Plug design

**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 $V_{PP}$ or 11 $\mu A_{PP}$)
- Incremental interface at the output (TTL)

*IBV 6000 series*
- Incremental interface at the input (1 $V_{PP}$)
- Multiple outputs (1 $V_{PP}$ or TTL)

*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 $V_{PP}$)
- 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 3391Y 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° ±5°)
- 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

# Sales, consulting and services worldwide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