HEIDENHAIN

Angle Encoders
with Integral Bearing

June 2006

Angle encoders with integral bearing and integrated stator coupling

Angle encoders with integral bearing for separate shaft coupling

Information on
- Angle encoders without integral bearing
- Rotary encoders
- Position encoders for servo drives
- Exposed linear encoders
- Linear encoders for numerically controlled machine tools
- HEIDENHAIN subsequent electronics
- HEIDENHAIN controls

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

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

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

Content

HEIDENHAIN Angle Encoders

The term angle encoder is typically used to describe encoders that have an accuracy of better than ± 5" and a line count above 10000.

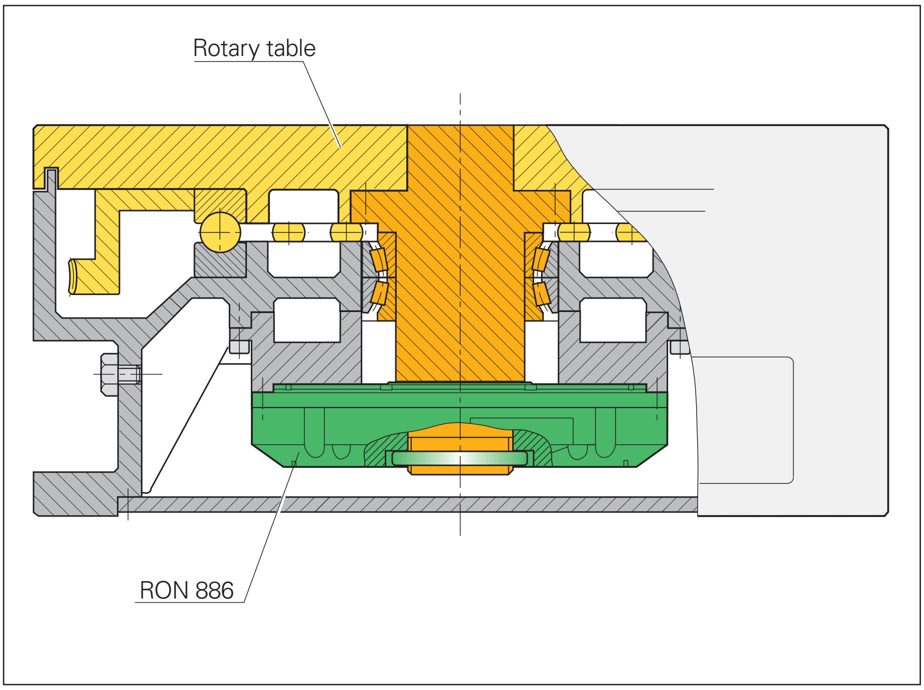
In contrast, rotary encoders are encoders that typically have an accuracy of more than ± 10".

Angle encoders are found in applications requiring precision angular measurement to accuracies within several arc seconds.

Examples:
- Rotary tables on machine tools
- Swivel heads on machine tools
- C axes of lathes
- Measuring machines for gears
- Printing units of printing machines
- Spectrometers
- Telescopes

etc.

The tables on the following pages list different types of angle encoders to suit the various applications and meet different requirements.



The **RON 886** angle encoder mounted onto the rotary table of a machine tool

Angle encoders can have one of the following mechanical designs:

Angle encoders with integral bearing, hollow shaft and integrated stator coupling
Because of the design and mounting of the stator coupling, it must only absorb that torque caused by friction in the bearing during angular acceleration of the shaft. **RCN, RON** and **RPN** angle encoders therefore provide excellent dynamic performance. With an integrated stator coupling, the stated system accuracy also includes the deviations from the shaft coupling.

Other advantages:
- Compact size for limited installation space
- Hollow shaft diameters up to 100 mm for leading power cables, etc.
- Simple installation

Selection Guide
For absolute angle encoders, see pages 6/7.
For incremental angle encoders, see pages 8/9.

RON 886 incremental angle encoder

Angle encoders with integral bearing, for separate shaft coupling
ROD angle encoders with solid shaft are particularly suited to applications where higher shaft speeds and larger mounting tolerances are required. The shaft couplings allow axial tolerances of ± 1 mm.

Selection Guide on pages 8/9

ROD 880 incremental angle encoder with **K 16** flat coupling

Angle encoders without integral bearing
The **ERP** and **ERA** angle encoders without integral bearing (modular angle encoders) are intended for integration in machine elements or apparatuses. They are designed to meet the following requirements:

- Large hollow shaft diameter (up to 10 m with a scale tape)
- High shaft speeds up to 20000 rpm
- No additional starting torque from shaft seals
- Segment angles

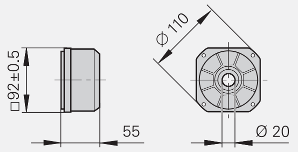
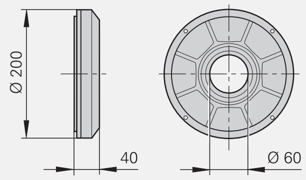
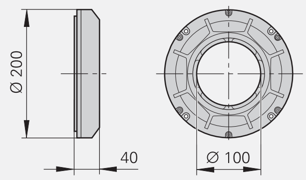
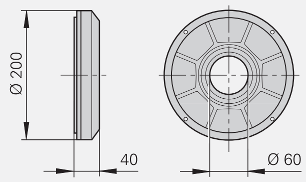
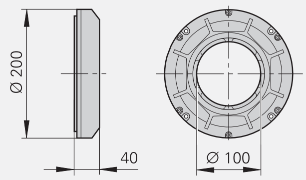
Selection Guide on pages 10/11

ERA 180 incremental angle encoder

You can find more detailed information on HEIDENHAIN angle encoders for integration on the Internet under www.heidenhain.de or in our *Angle Encoders without Integral Bearing* brochure.

Selection Guide

Absolute Angle Encoders with Integral Bearing

Series	Overall dimensions in mm	System accuracy	Recommd. display step[1]	Mechanically perm. speed	Incremental signals	Signal periods/rev
With integrated stator coupling						
RCN 200		± 5“	0.000 1°	3000 rpm	∼ 1 V_{PP}	16 384
					–	–
					–	–
					–	–
		± 2.5“			∼ 1 V_{PP}	16 384
					–	–
					–	–
					–	–
RCN 700		± 2“	0.000 1°	1000 rpm	∼ 1 V_{PP}	32 768
					–	–
					–	–
					–	–
					∼ 1 V_{PP}	32 768
					–	–
					–	–
					–	–
RCN 800		± 1“	0.000 05°	1000 rpm	∼ 1 V_{PP}	32 768
					–	–
					–	–
					–	–
					∼ 1 V_{PP}	32 768
					–	–
					–	–
					–	–

[1] For position measurement

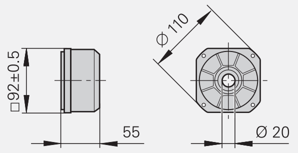
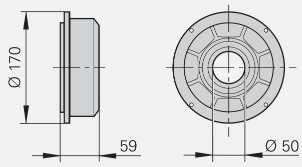
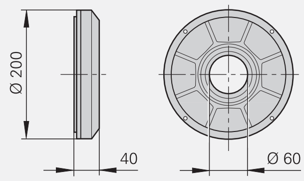
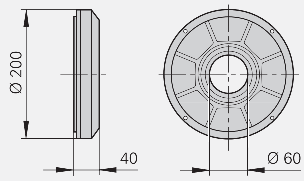
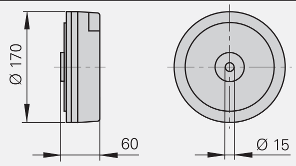
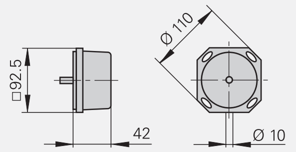
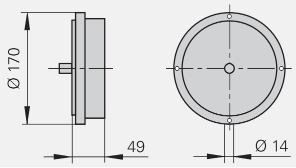
	Absolute position values	Absolute positions per revolution	Model	Page
	EnDat 2.2/02	67 108 864 ≙ 26 bits	**RCN 226**	**24**
	EnDat 2.2/22	67 108 864 ≙ 26 bits	**RCN 226**	
	Fanuc 02	8 388 608 ≙ 23 bits	**RCN 223 F**	
	Mit 02-4	8 388 608 ≙ 23 bits	**RCN 223 M**	
	EnDat 2.2/02	268 435 456 ≙ 28 bits	**RCN 228**	
	EnDat 2.2/22	268 435 456 ≙ 28 bits	**RCN 228**	
	Fanuc 02	134 217 728 ≙ 27 bits	**RCN 227 F**	
	Mit 02-4	134 217 728 ≙ 27 bits	**RCN 227 M**	
	EnDat 2.2/02	536 870 912 ≙ 29 bits	**RCN 729**	**30**
	EnDat 2.2/22	536 870 912 ≙ 29 bits	**RCN 729**	
	Fanuc 02	134 217 728 ≙ 27 bits	**RCN 727 F**	
	Mit 02-4	134 217 728 ≙ 27 bits	**RCN 727 M**	
	EnDat 2.2/02	536 870 912 ≙ 29 bits	**RCN 729**	**32**
	EnDat 2.2/22	536 870 912 ≙ 29 bits	**RCN 729**	
	Fanuc 02	134 217 728 ≙ 27 bits	**RCN 727 F**	
	Mit 02-4	134 217 728 ≙ 27 bits	**RCN 727 M**	
	EnDat 2.2/02	536 870 912 ≙ 29 bits	**RCN 829**	**30**
	EnDat 2.2/22	536 870 912 ≙ 29 bits	**RCN 829**	
	Fanuc 02	134 217 728 ≙ 27 bits	**RCN 827 F**	
	Mit 02-4	134 217 728 ≙ 27 bits	**RCN 827 M**	
	EnDat 2.2/02	536 870 912 ≙ 29 bits	**RCN 829**	**32**
	EnDat 2.2/22	536 870 912 ≙ 29 bits	**RCN 829**	
	Fanuc 02	134 217 728 ≙ 27 bits	**RCN 827 F**	
	Mit 02-4	134 217 728 ≙ 27 bits	**RCN 827 M**	

RCN 200

RCN 700
Ø 60 mm

RCN 800
Ø 100 mm

Selection Guide
Incremental Angle Encoders with Integral Bearing

Series	Overall dimensions in mm	System accuracy	Recommended display step[1]	Mechanically perm. speed
With integrated stator coupling				
RON 200		± 5"	0.005°	3000 rpm
			0.001°/0.0005°	
			0.0001°	
		± 2.5"		
RON 700		± 2"	0.0001°	1000 rpm
				
RON 800 **RPN 800**		± 1"	0.00005°	1000 rpm
			0.00001°	
RON 900		± 0.4"	0.00001°	100 rpm
For separate shaft coupling				
ROD 200		± 5"	0.005°	10000 rpm
			0.0005°	
			0.0001°	
ROD 700		± 2"	0.0001°	1000 rpm
ROD 800		± 1"	0.00005°	1000 rpm

[1] For position measurement
[2] After integrated interpolation

	Incremental signals	Signal periods/rev	Model	Page
	⊓⊔TTL	18000[2)]	**RON 225**	**26**
	⊓⊔TTL	180000/90000[2)]	**RON 275**	
	∼ 1 V_{PP}	18000	**RON 285**	
	∼ 1 V_{PP}	18000	**RON 287**	
	∼ 1 V_{PP}	18000	**RON 785**	**28**
	∼ 1 V_{PP}	18000/36000	**RON 786**	**34**
	∼ 1 V_{PP}	36000	**RON 886**	**34**
	∼ 1 V_{PP}	180000	**RPN 886**	
	∼ 11 μA_{PP}	36000	**RON 905**	**36**
	⊓⊔TTL	18000[2)]	**ROD 220**	**38**
	⊓⊔TTL	180000[2)]	**ROD 270**	
	∼ 1 V_{PP}	18000	**ROD 280**	
	∼ 1 V_{PP}	18000/36000	**ROD 780**	**40**
	∼ 1 V_{PP}	36000	**ROD 880**	

RON 285

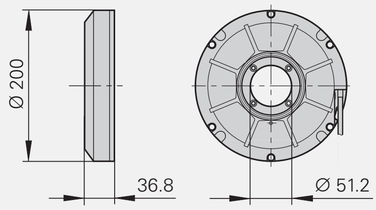
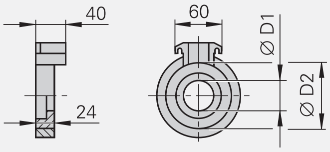
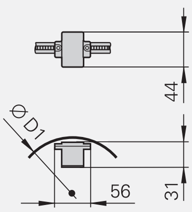
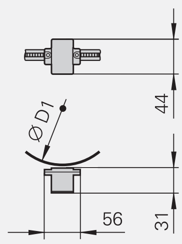
RON 786

RON 905

ROD 280

ROD 780

Selection Guide
Angle Encoders without Integral Bearing

Series	**Overall dimensions** in mm	**Diameter D1/D2**	**Line count/ System accuracy**[1]	**Recommended display step**[3]	**Mechanically perm. speed**
Grating on solid scale carrier					
ERP 880 Glass disk with interferential grating		–	90 000/± 1" (180 000 signal periods)[1]	0.000 01°	≤ 1000 rpm
ERA 180 Steel drum with axial grating		D1: 40 to 512 mm D2: 80 to 562 mm	6 000/± 7.5" to 36 000/± 2.5"[1]	0.001 5° to 0.000 1°	≤ 20 000 rpm to ≤ 3 000 rpm
Grating on steel tape					
ERA 700 For inside diameter mounting		458.62 mm 573.20 mm 1146.10 mm	**Full circle**[1] 36 000/± 3.5" 45 000/± 3.4" 90 000/± 3.2	0.000 2° to 0.000 02°	≤ 500 rpm
		318.58 mm 458.62 mm 573.20 mm	**Segment**[2] 5 000 10 000 20 000		
ERA 800 For outside diameter mounting		458.04 mm 572.63 mm	**Full circle**[1] 36 000/± 3.5" 45 000/± 3.4"	0.000 2° to 0.000 05°	≤ 100 rpm
		317.99 mm 458.04 mm 572.63 mm	**Segment**[2] 5 000 10 000 20 000		

[1] Before installation. Additional error caused by mounting inaccuracy and inaccuracy from the bearing of the drive shaft are not included.
[2] Angular segment from 50° to 200°; see *Measuring Accuracy* for the accuracy
[3] For position measurement

	Incremental signals	Reference marks	Model	For more information
	∼ 1 V_{PP}	One	**ERP 880**	***Angle Encoders without Integral Bearing* brochure**
	∼ 1 V_{PP}	One	**ERA 180**	
	∼ 1 V_{PP}	Distance-coded (nominal increment of 1000 grating periods)	**ERA 780 C** full circle	***Angle Encoders without Integral Bearing* brochure**
			ERA 781 C segment	
	∼ 1 V_{PP}	Distance-coded (nominal increment of 1000 grating periods)	**ERA 880 C** full circle	
			ERA 881 C segment with tensioning elements	
			ERA 882 C segment without tensioning elements	

ERP 880

ERA 180

ERA 780

ERA 880

Measuring Principles
Measuring Standard

HEIDENHAIN encoders incorporate measuring standards of periodic structures known as graduations. These graduations are applied to a glass or steel substrate. Glass scales are used primarily in encoders for speeds up to 10000 rpm. For higher speeds—up to 20000 rpm—steel drums are used. The scale substrate for large diameters is a steel tape.

These precision graduations are manufactured in various photolithographic processes. Graduations are fabricated from:
- extremely hard chromium lines on glass or gold-plated steel drums,
- three-dimensional structures etched into quartz glass, or
- matte-etched lines on gold-plated steel tape.

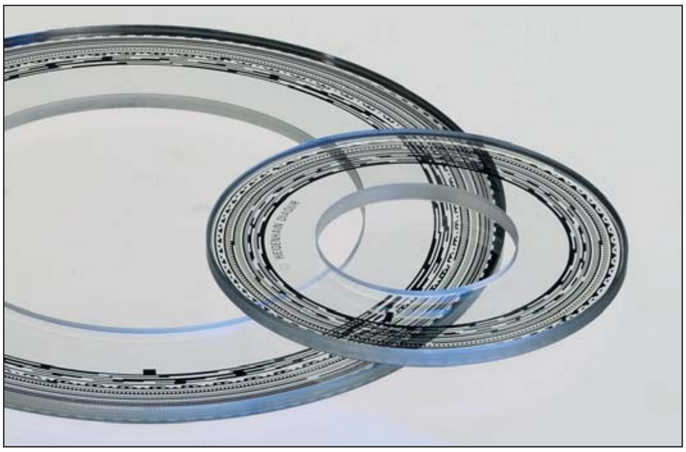
These photolithographic manufacturing processes—DIADUR and AURODUR—developed by HEIDENHAIN produce grating periods of:
- 40 µm with AURODUR
- 10 µm with DIADUR
- 4 µm with etched quartz glass

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

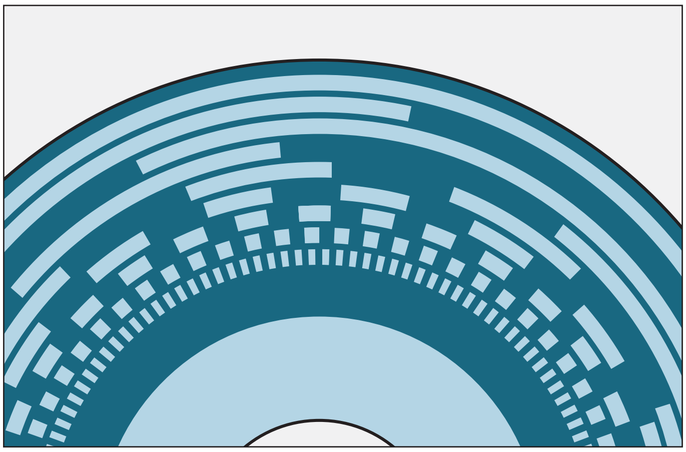
The master graduations are manufactured by HEIDENHAIN on custom-built high-precision ruling machines.

Absolute Measuring Method

Absolute encoders feature multiple coded graduation tracks. The code arrangement provides the absolute position information, which is available immediately after restarting the machine. The track with the finest grating structure is interpolated for the position value and at the same time is used to generate an incremental signal (see *EnDat Interface*).



Circular graduations of absolute angle encoders



Schematic representation of a circular scale with absolute grating

Incremental Measuring Method

With the **incremental measuring method,** the graduation consists of a periodic grating structure. The position information is obtained **by counting** the individual increments (measuring steps) from some point of origin. Since an absolute reference is required to ascertain positions, the scales or scale tapes are provided with an additional track that bears a **reference mark.** The absolute position on the scale, established by the reference mark, is gated with exactly one measuring step. The reference mark must therefore be scanned to establish an absolute reference or to find the last selected datum.

In some cases, however, this may require a rotation up to nearly 360°. To speed and simplify such "reference runs," many encoders feature **distance-coded reference marks**—multiple reference marks that are individually spaced according to a mathematical algorithm. The subsequent electronics find the absolute reference after traversing two successive reference marks—meaning only a few degrees of traverse (see Nominal increment I in the table).

Encoders with distance-coded reference marks are identified with a "C" behind the model designation (e.g. RON 786C).

With distance-coded reference marks, the **absolute reference** is calculated by counting the signal periods between two reference marks and using the following formula:

$$\alpha_1 = (\text{abs } A - \text{sgn } A - 1) \times \frac{I}{2} + (\text{sgn } A - \text{sgn } D) \times \frac{\text{abs } M_{RR}}{2}$$

where:

$$A = \frac{2 \times \text{abs } M_{RR} - I}{GP}$$

and:

α_1 = Absolute angular position of the first traversed reference mark to the zero position in degrees

abs = Absolute value

sgn = Sign function ("+1" or "–1")

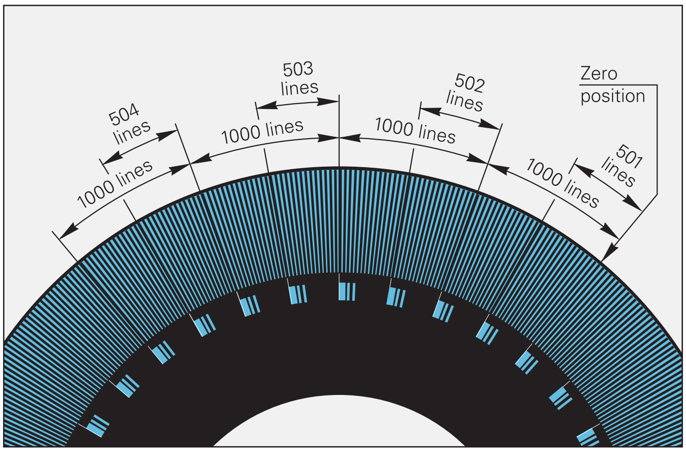
M_{RR} = Measured distance between the traversed reference marks in degrees

I = Nominal increment between two fixed reference marks (see table)

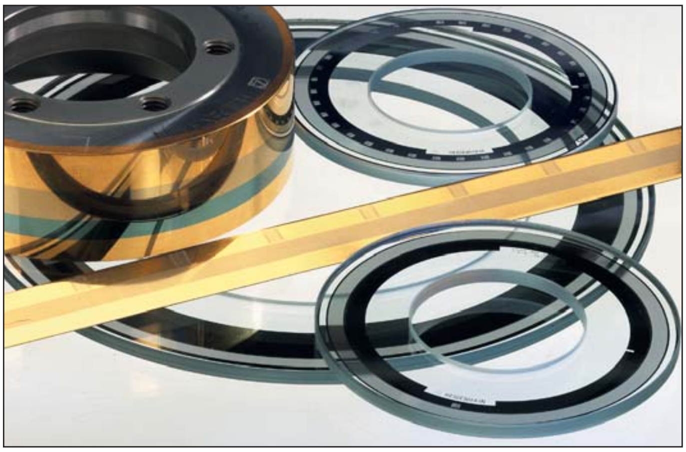
GP = Grating period ($\frac{360°}{\text{Line count}}$)

D = Direction of rotation (+1 or –1) Rotation to the right (as seen from the shaft side of the angle encoder—see Mating Dimensions) gives "+1"

Line count z	Number of reference marks	Nominal increment I
36000	72	10°
18000	36	20°



Schematic representation of a circular scale with distance-coded reference marks



Circular graduations of incremental angle encoders

Scanning the Measuring Standard
Photoelectric Scanning

Most HEIDENHAIN encoders operate using the principle of photoelectric scanning. The photoelectric scanning of a measuring standard is contact-free, and therefore without wear. This method detects even very fine lines, no more than a few microns wide, and generates output signals with very small signal periods.

The finer the grating period of a measuring standard is, the greater the effect of diffraction on photoelectric scanning. HEIDENHAIN uses two scanning principles with angle encoders:

- The **imaging scanning principle** for grating periods from 10 µm to approx. 70 µm.
- The **interferential scanning principle** for very fine graduations with grating periods of 4 µm.

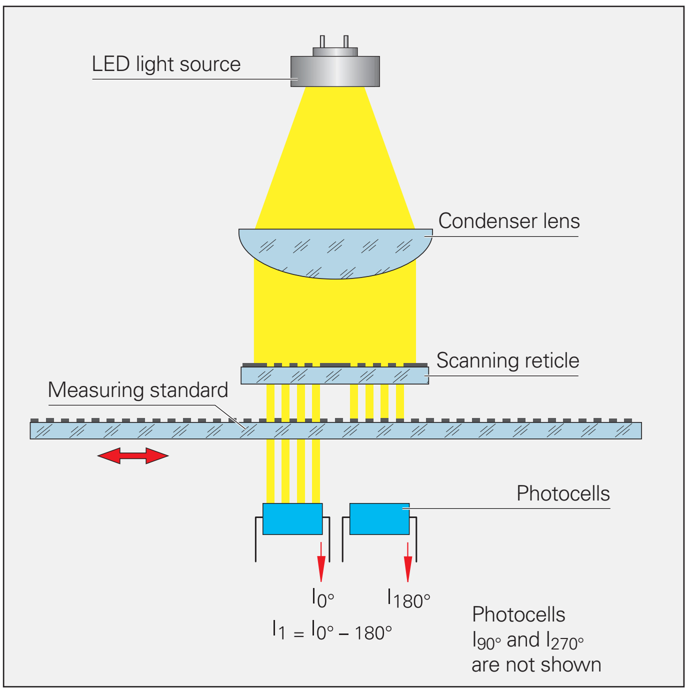
Imaging scanning principle
Put simply, the imaging scanning principle functions by means of projected-light signal generation: two graduations with equal grating periods are moved relative to each other—the scale and the scanning reticle. The carrier material of the scanning reticle is transparent, whereas the graduation on the measuring standard may be applied to a transparent or reflective surface.

When parallel light passes through a grating, light and dark surfaces are projected at a certain distance. An index grating with the same grating period is located here. When the two gratings move relative to each other, the incident light is modulated. If the gaps in the gratings are aligned, light passes through. If the lines of one grating coincide with the gaps of the other, no light passes through.

Photovoltaic cells convert these variations in light intensity into electrical signals. The specially structured grating of the scanning reticle filters the light current to generate nearly sinusoidal output signals. The smaller the period of the grating structure is, the closer and more tightly toleranced the gap must be between the scanning reticle and circular scale. Practical mounting tolerances for encoders with the imaging scanning principle are achieved with grating periods of 10 µm and larger.

The RCN, RON and ROD angle encoders with integral bearing operate according to the imaging scanning principle.

Imaging scanning principle



Interferential scanning principle

The interferential scanning principle exploits the diffraction and interference of light on a fine graduation to produce signals used to measure displacement.
A step grating is used as the measuring standard: reflective lines 0.2 µm high are applied to a flat, reflective surface. In front of that is the scanning reticle—a transparent phase grating with the same grating period as the scale.

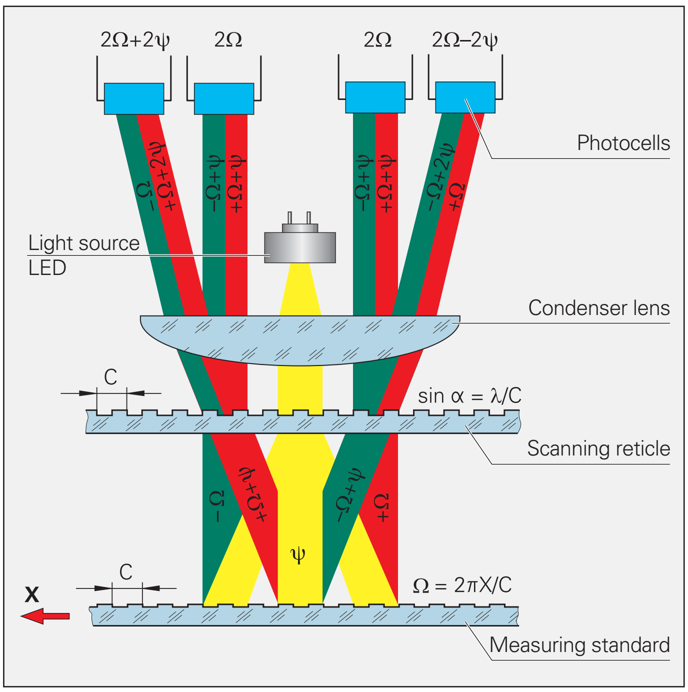
When a light wave passes through the scanning reticle, it is diffracted into three partial waves of the orders –1, 0, and +1, with approximately equal luminous intensity. The waves are diffracted by the scale such that most of the luminous intensity is found in the reflected diffraction orders +1 and –1. These partial waves meet again at the phase grating of the scanning reticle where they are diffracted again and interfere. This produces essentially three waves that leave the scanning reticle at different angles. Photovoltaic cells convert this alternating light intensity into electrical signals.

A relative motion of the scanning reticle to the scale causes the diffracted wave fronts to undergo a phase shift: when the grating moves by one period, the wave front of the first order is displaced by one wavelength in the positive direction, and the wavelength of diffraction order –1 is displaced by one wavelength in the negative direction. Since the two waves interfere with each other when exiting the grating, the waves are shifted relative to each other by two wavelengths. This results in two signal periods from the relative motion of just one grating period.

Interferential encoders function with average grating periods of 4 µm and finer. Their scanning signals are largely free of harmonics and can be highly interpolated. These encoders are therefore especially suited for high resolution and high accuracy. Even so, their generous mounting tolerances permit installation in a wide range of applications.

The RPN 886 angle encoder with integral bearing operates according to the interferential scanning principle.

Interferential scanning principle (optics schematics)
C Grating period
ψ Phase shift of the light wave when passing through the scanning reticle
Ω Phase shift of the light wave due to motion X of the scale



Measuring Accuracy

The accuracy of angular measurement is mainly determined by:

1. The quality of the graduation
2. The quality of the scanning process
3. The quality of the signal processing electronics
4. Eccentricity of the graduation to the bearing
5. Radial runout of the bearing
6. Elasticity of the encoder shaft and its coupling with the drive shaft
7. The elasticity of the stator coupling (RCN, RON, RPN) or shaft coupling (ROD)

In positioning tasks, the accuracy of the angular measurement determines the accuracy of the positioning of a rotary axis. The **system accuracy** given in the *Specifications* is defined as follows:
The extreme values of the total deviations of a position are—referenced to their mean value—within the system accuracy ± a.
The total deviations are ascertained at a constant temperature (22 °C) during the final inspection, and are indicated on the calibration chart.

- For angle encoders with integral bearing and integrated stator coupling, this value also includes the deviation due to the shaft coupling.
- For angle encoders with integral bearing and separate shaft coupling, the angle error of the coupling must be added (see *Mechanical Design Types and Mounting — ROD*).
- For angle encoders without integral bearing, additional deviations resulting from mounting, errors in the bearing of the drive shaft, and adjustment of the scanning head must be expected (see the *Angle Encoders without Integral Bearing* brochure). These deviations are not reflected in the system accuracy.

The system accuracy reflects position errors within one revolution as well as those within one signal period.

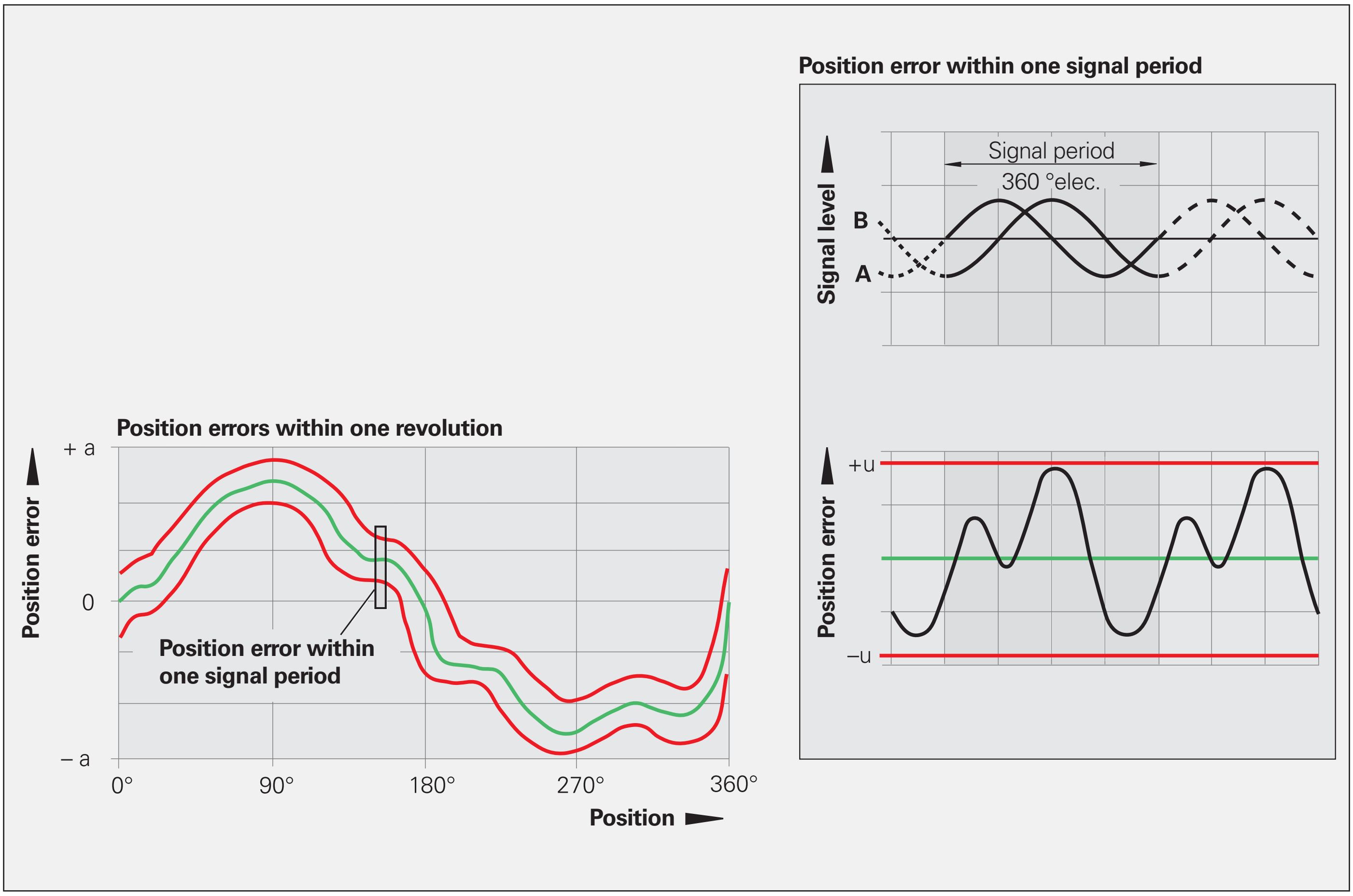
Position errors within one revolution become apparent in larger angular motions.

Position errors within one signal period already become apparent in very small angular motions and in repeated measurements. They especially lead to speed ripples in the speed control loop.
These errors within one signal period are caused by the quality of the sinusoidal scanning signals and their subdivision.
The following factors influence the result:

- The size of the signal period,
- The homogeneity and edge definition of the graduation,
- The quality of the optical filter structures on the scanning reticle,
- The characteristics of the photoelectric detectors, and
- The stability and dynamics during the further processing of the analog signals.

HEIDENHAIN angle encoders take these factors of influence into account, and permit interpolation of the sinusoidal output signal with subdivision accuracies of better than ±1% of the signal period (RPN: ±1.5%). The reproducibility is even better, meaning that useful electric subdivision factors and small signal periods permit small enough measuring steps (see *Specifications*).

Example:
Angle encoder with 36000 sinusoidal signal periods per revolution
One signal period corresponds to 0.01° or 36". At a signal quality of ±1%, this results in maximum position errors within one signal period of approx. ±0.0001° or ±0.36".



For its angle encoders with integral bearings, HEIDENHAIN prepares individual calibration charts and ships them with the encoder.

The calibration chart documents the encoder´s accuracy and serves as a traceability record to a calibration standard. For the RCN, RON and RPN, which feature an integrated coupling, the accuracy specifications already include the error of the coupling. For angle encoders with separate shaft coupling, however, the error caused by the coupling is not included in the encoder specification and must be added to calculate the total error (see *Kinematic error of transfer* under *Mechanical Design Types and Mounting – ROD*).

The accuracy of angle encoders is ascertained through five forward and five backward measurements. The measuring positions per revolution are chosen to determine very exactly not only the long-range error, but also the position error within one signal period.

Calibration chart example: RON 285
1 Graphic representation of error
- Envelope curve
- Mean value curve

2 Results of calibration

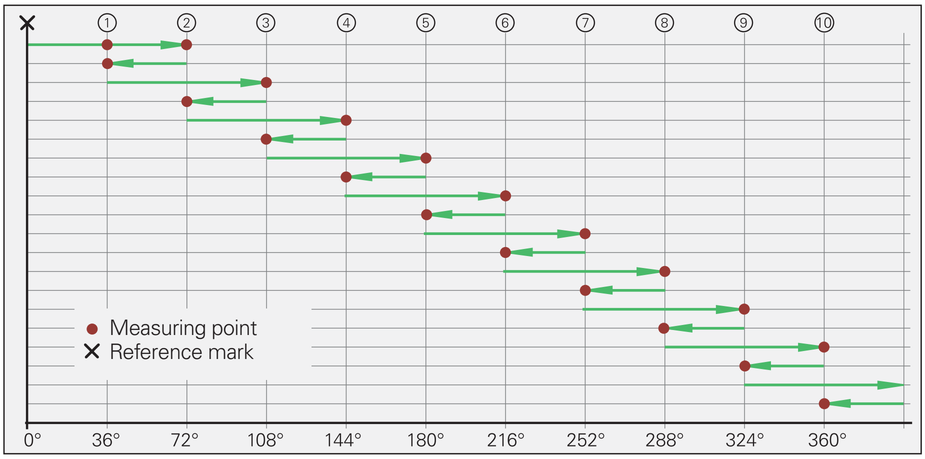
All measured values determined in this manner lie within or on the graphically depicted **envelope curve.** The **mean value curve** shows the arithmetic mean of the measured values, whereby the reversal error is not included.

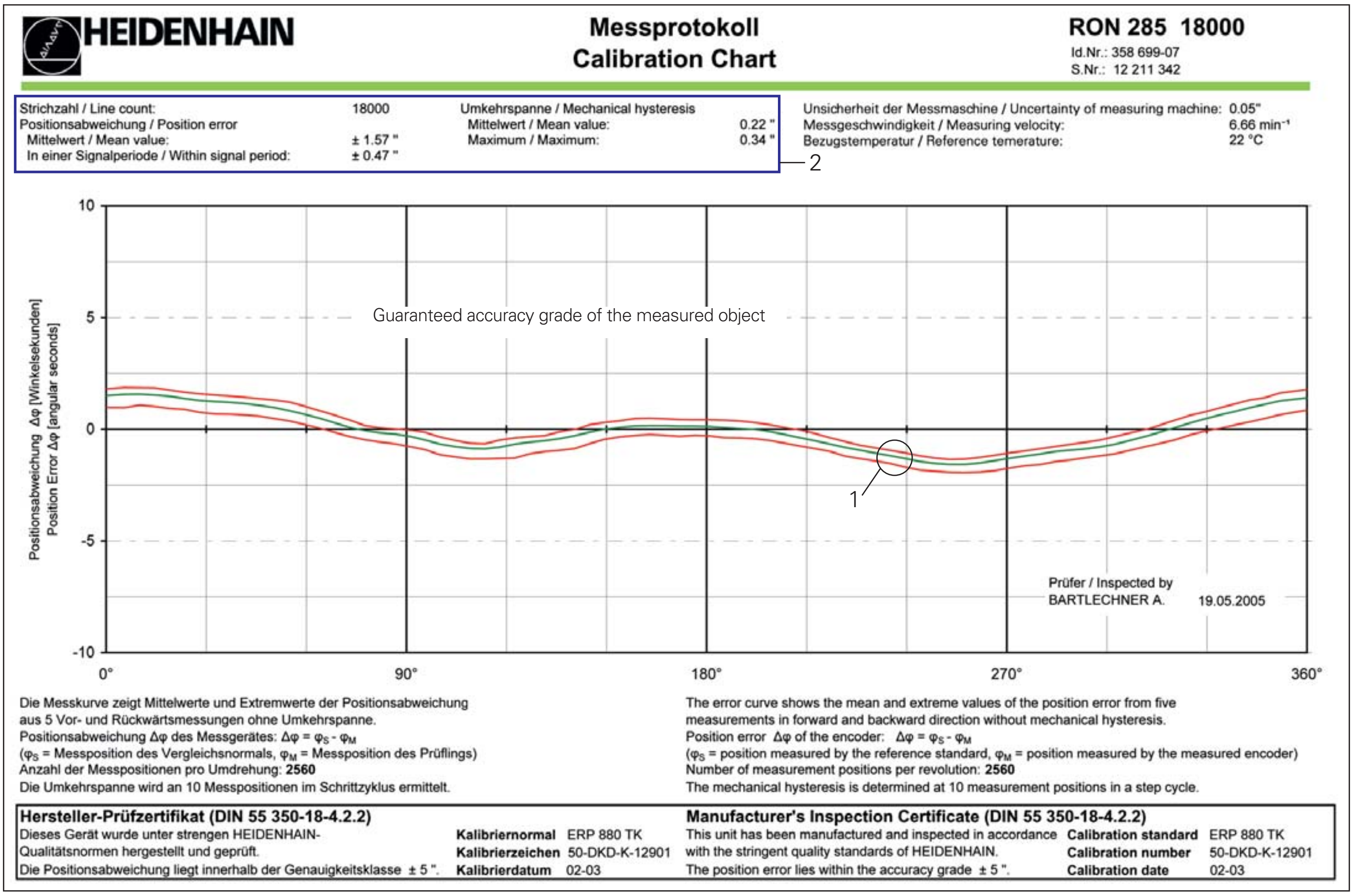
The **reversal error** depends on the shaft coupling. On angle encoders with integral stator coupling it is determined at ten measuring positions in forward and backward steps. The maximum value and arithmetic mean are documented on the calibration chart.

The following limits apply to the reversal error:
RCN/RON 2xx: Max. 0.6“
RCN/RON 7xx: Max. 0.4“
RCN/RON/RPN 8xx: Max. 0.4“

The **manufacturer’s inspection certificate** certifies the accuracy of the encoder. The **calibration standard** is indicated in order to certify the traceability to the national standard.

Determination of the reversal error with forward and backward measurements





Mechanical Design Types and Mounting
RCN, RON, RPN

RCN, RON and **RPN** angle encoders have an integral bearing, hollow shaft and integrated stator coupling. The measured shaft is directly connected with the shaft of the angle encoder. The reference mark can be assigned to a desired angular position of the measured shaft from the rear of the encoder during mounting.

The graduated disk is rigidly affixed to the hollow shaft. The scanning unit rides on the shaft on ball bearings and is connected to the housing with a coupling on the stator side. During angular acceleration of the shaft, the coupling must absorb only that torque caused by friction in the bearing. Angle encoders with integrated stator coupling therefore provide excellent dynamic performance.

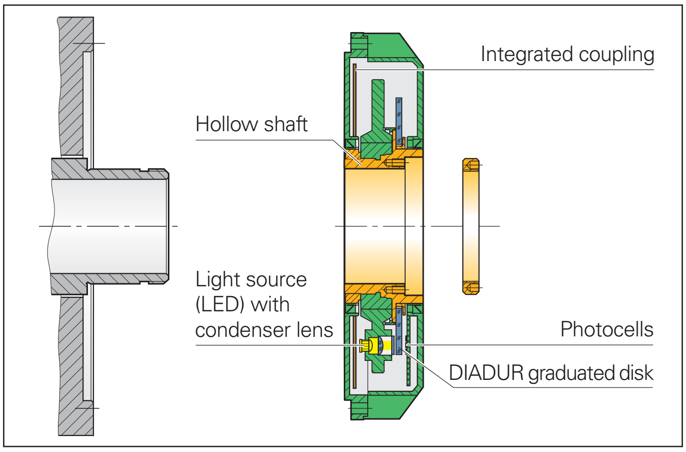
Mounting
The housing of the RCN, RON and RPN is firmly connected to the stationary machine part with an integral mounting flange and a centering collar. Liquids can easily flow away through drainage channels on the flange.

Shaft coupling with ring nut
The RCN, RON and RPN series have a hollow through shaft. For installation, the hollow through shaft of the angle encoder is placed over the machine shaft, and is fixed with a ring nut from the front of the encoder. The ring nut can easily be tightened with the mounting tool.

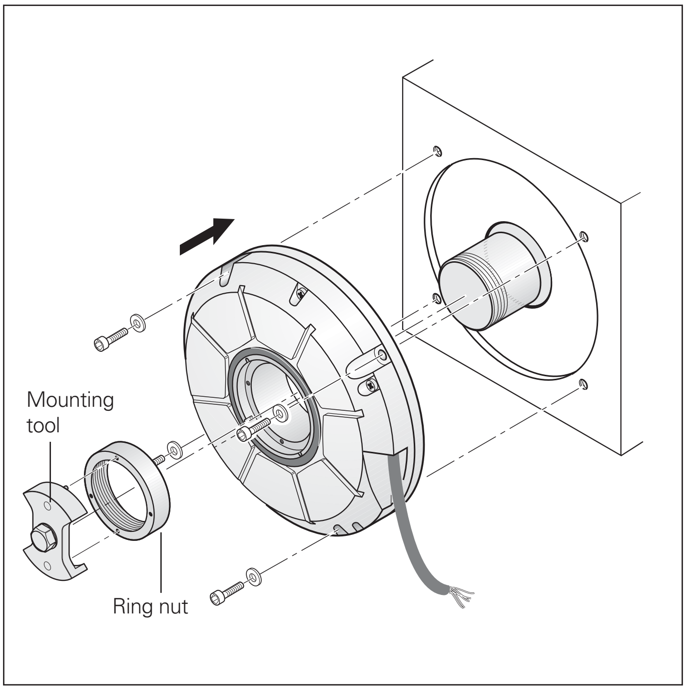
RON 905 shaft coupling
The RON 905 has a bottomed hollow shaft. The shaft connection is made via an axial central screw.

Front end shaft coupling
It is often advantageous, especially with rotary tables, to integrate the angle encoder in the table so that it is freely accessible when the rotor is lifted. This installation from above reduces mounting times, increases the ease for servicing, and improves the accuracy, since the encoder is located nearer to the rotary table bearing and the measuring or machining plane. The hollow shaft is attached with the threaded holes on the face, using special mounting elements fitted to the individual design (not included in delivery).

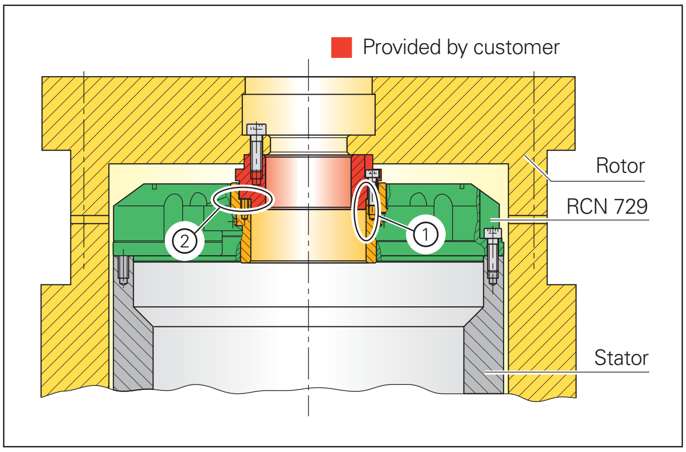
To comply with radial and axial runout specifications, the internal bore ① and the shoulder surface ② are to be used as mounting surfaces for shaft coupling at the face of the encoder.



Cross section of the **RON 886** angle encoder



Mounting an angle encoder with hollow through shaft



Front-end shaft coupling with **RCN 729**

Ring nuts for RCN, RON and RPN
HEIDENHAIN offers special ring nuts for the RCN, RON and RPN angle encoders with integral bearing and hollow through shaft with integrated coupling. Choose the tolerance of the shaft thread such that the ring nut can be tightened easily, with a minor axial play. This guarantees that the load is evenly distributed on the shaft connection, and prevents distortion of the encoder´s hollow shaft.

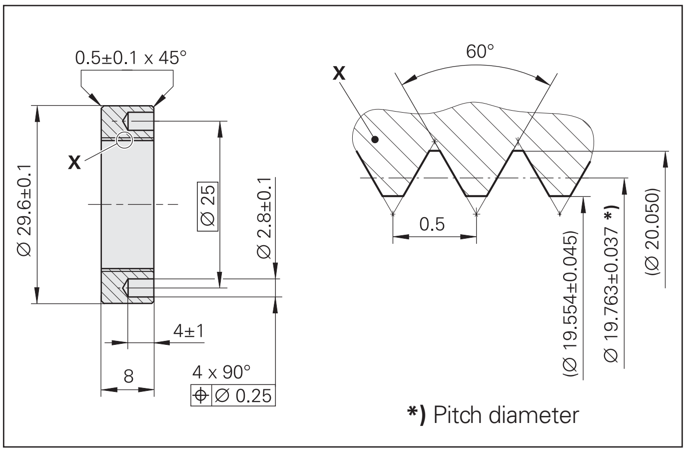
Ring nut for RON/RCN 200
Hollow shaft Ø 20 mm: Id. Nr. 336669-03

Ring nut for RON 785
Hollow shaft Ø 50 mm: Id. Nr. 336669-05

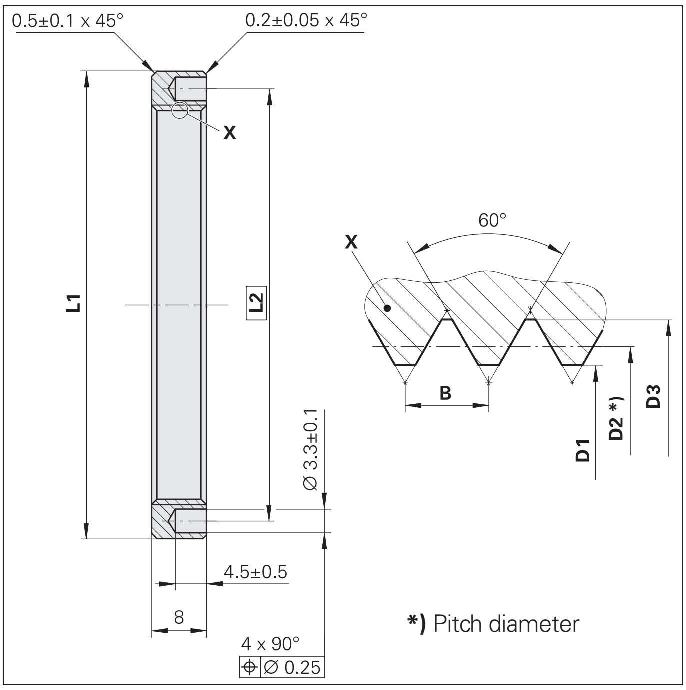
Ring nut for RON 786; RON/RPN 886
RCN 72x/RCN 82x
Hollow shaft Ø 60 mm: Id. Nr. 336669-01

Ring nut for RCN 72x/RCN 82x
Hollow shaft Ø 100 mm: Id. Nr. 336669-06

Ring nut for
RxN 200 series



Ring nut for
RxN 700 / 800 series



Mounting tool for HEIDENHAIN ring nuts
The mounting tool is used to tighten the ring nut. Its pins lock into the bore holes in the ring nuts. A torque wrench provides the necessary tightening torque.

Mounting tool for ring nuts with
Hollow shaft Ø 20 mm Id. Nr. 530334-03
Hollow shaft Ø 50 mm Id. Nr. 530334-05
Hollow shaft Ø 60 mm Id. Nr. 530334-01
Hollow shaft Ø 100 mm Id. Nr. 530334-06

Ring nut for	L1	L2	D1	D2	D3	B
Hollow shaft Ø 50	Ø 62±0.2	Ø 55	(Ø 49.052 ±0.075)	Ø 49.469 ±0.059	(Ø 50.06)	1
Hollow shaft Ø 60	Ø 70±0.2	Ø 65	(Ø 59.052 ±0.075)	Ø 59.469 ±0.059	(Ø 60.06)	1
Hollow shaft Ø 100	Ø 114±0.2	Ø 107	(Ø 98.538 ±0.095)	(Ø 99.163 ±0.07)	(Ø 100.067)	1.5

Mechanical Design Types and Mounting
ROD

Angle encoders of the **ROD** product family require a separate coupling for connection to the drive shaft. The shaft coupling compensates axial movement and misalignment between the shafts, preventing excessive load on the bearing of the angle encoder. It is important that the encoder shaft and the drive shaft be optimally aligned for high measurement accuracies to be realized. The HEIDENHAIN product program includes diaphragm couplings and flat couplings designed for connecting the shaft of the ROD angle encoder to the drive shaft.

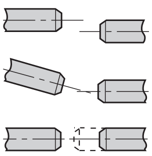
Mounting
ROD angle encoders are provided with an integral mounting flange with centering collar. The encoder shaft is connected to the drive shaft by way of a diaphragm coupling or flat coupling.

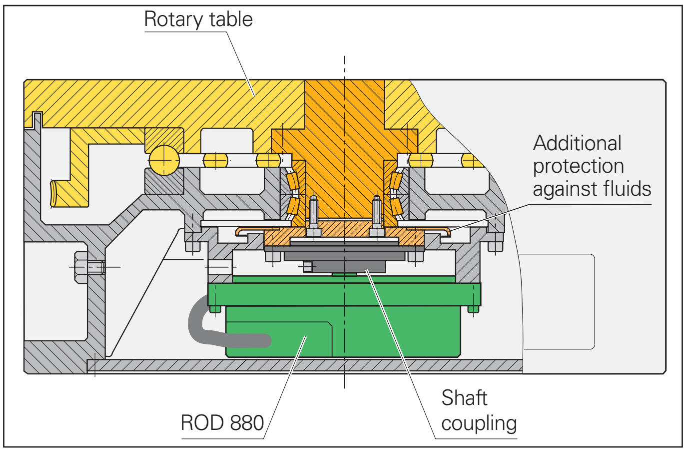
Shaft couplings
The shaft coupling compensates axial movement and misalignment between the encoder shaft and the drive shaft, preventing excessive load on the encoder bearing of the angle encoder.

Radial misalignment λ

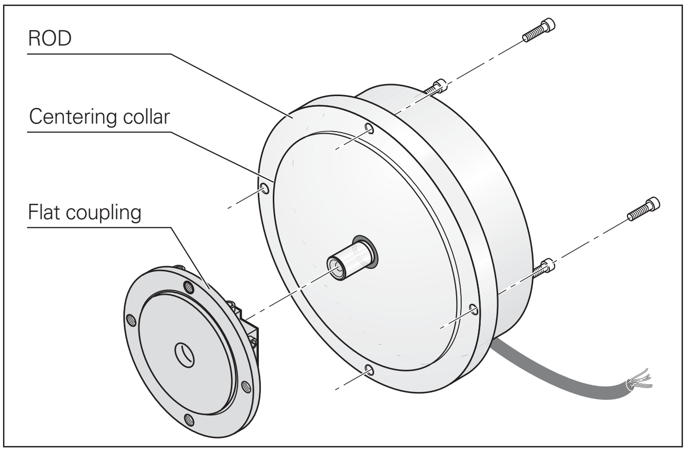
Angular error α

Axial motion δ





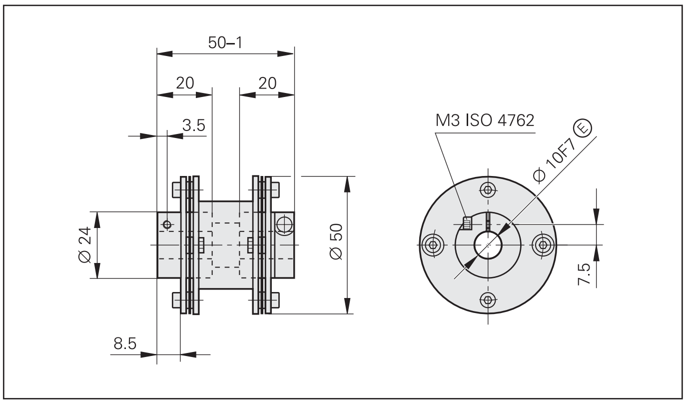
Mounting example ROD 880



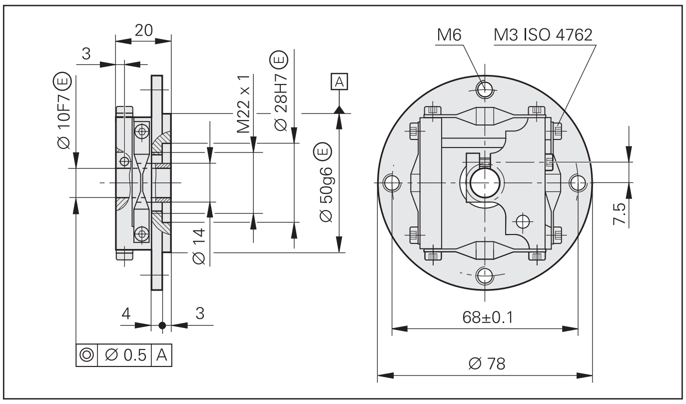
Mounting an ROD

Shaft coupling	ROD 200 series K 03 Diaphragm coupling	 K 18 Flat coupling	ROD 700 series, ROD 800 series K 01 Diaphragm coupling	 K 15 Flat coupling	 K 16 Flat coupling
Hub bore	10 mm		14 mm		
Kinematic transfer error	± 2“ at λ ≤ 0.1 mm and α ≤ 0.09°	± 3“	± 1“	± 0.5“ at λ ≤ 0.05 mm and α ≤ 0.03°	
Torsional rigidity	1500 Nm/rad	1200 Nm/rad	4000 Nm/rad	6000 Nm/rad	4000 Nm/rad
Permissible torque	0.2 Nm	0.5 Nm			
Perm. radial offset λ	≤ 0.3 mm				
Perm. angular error α	≤ 0.5°			≤ 0.2°	≤ 0.5°
Perm. axial offset δ	≤ 0.2 mm			≤ 0.1 mm	≤ 1 mm
Moment of inertia (approx.)	$20 \cdot 10^{-6}$ kgm^2	$75 \cdot 10^{-6}$ kgm^2	$200 \cdot 10^{-6}$ kgm^2		$400 \cdot 10^{-6}$ kgm^2
Permissible speed	10000 rpm	1000 rpm	3000 rpm	1000 rpm	
Torque for locking screws (approx.)	1.2 Nm		2.5 Nm	1.2 Nm	
Weight	100 g	117 g	180 g	250 g	410 g

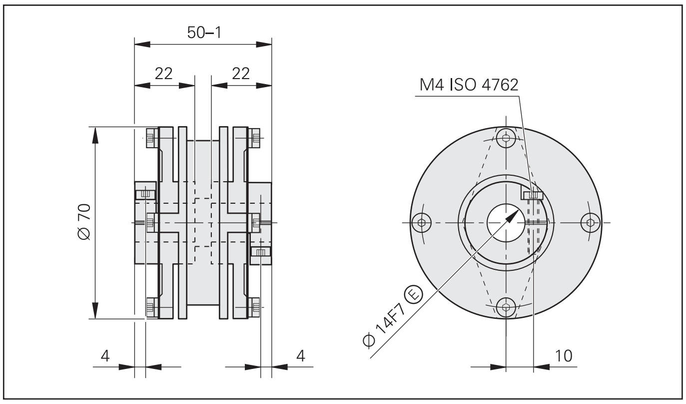
K 03 diaphragm coupling
Id. Nr. 200313-04



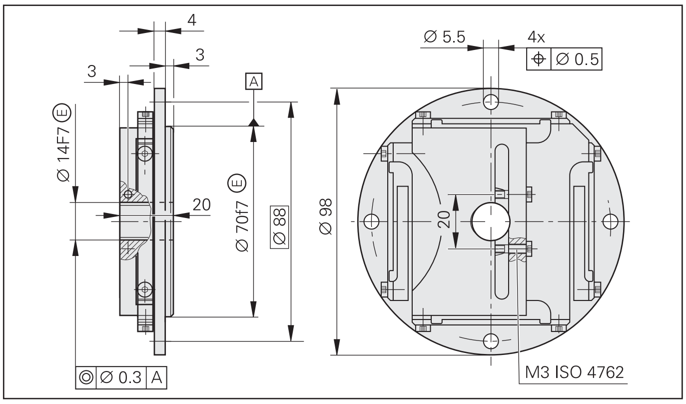
K 18 flat coupling
Id. Nr. 202227-01



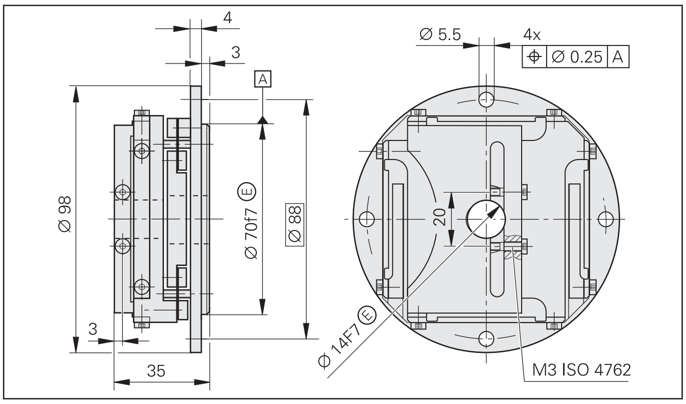
K 01 diaphragm coupling
Id. Nr. 200301-02



K 15 flat coupling
Id. Nr. 255797-01



K 16 flat coupling
Id. Nr. 258878-01



Dimensions in mm

Tolerancing ISO 8015
ISO 2768 - m H

General Mechanical Information

Protection
Unless otherwise indicated, all RCN, RON, RPN and ROD angle encoders meet protection standard IP 67 according to IEC 60529. This includes housings and cable outlets.
The **shaft inlet** provides protection to IP 64.

Splash water should not contain any substances that would have harmful effects on the encoder parts. If protection to IP 64 of the shaft inlet is not sufficient (such as when the angle encoder is mounted vertically), additional labyrinth seals should be provided.

RCN, RON, RPN and ROD angle encoders are equipped with a compressed air inlet. Connection to a source of compressed air slightly above atmospheric pressure provides additional protection against contamination.

For this purpose, HEIDENHAIN offers the **DA 300 compressed air unit** (filter combination with pressure regulator and fittings). The compressed air introduced into the encoder must fulfill the requirements of the following quality classes as per ISO 8573-1:

- Max. particle size and density of solid contaminants:
  Class 4 (max. particle size: 15 µm, max. particle density: 8 mg/m^3)
- Total oil content:
  Class 4 (oil content: 5 mg/m^3)
- Max. pressure dew point:
  (+29 °C at $10 \cdot 10^5$ Pa)
  No classification

The following components are necessary for connection to the RCN, RON, RPN and ROD angle encoders:

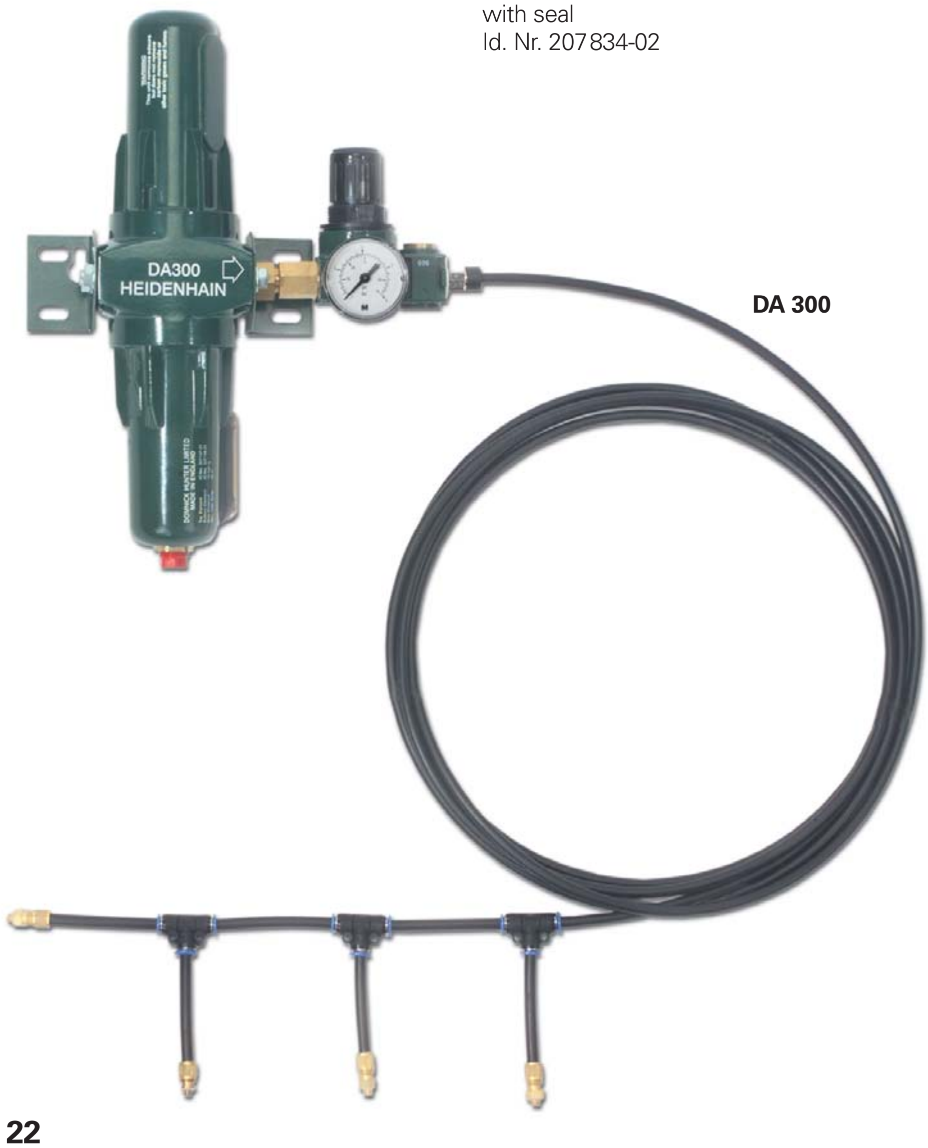
M5 connecting piece for RCN/RON/RPN/ROD
with gasket and throttle ∅ 0.3 mm
for air-flow rate from 1 to 4 l/min
Id. Nr. 207835-04

M5 coupling joint, swiveling
with seal
Id. Nr. 207834-02

Temperature range
The angle encoders are inspected at a **reference temperature** of 22 °C. The system accuracy given in the calibration chart applies at this temperature.

The **operating temperature** indicates the ambient temperature limits between which the angle encoders will function properly.

The **storage temperature range** of –30 °C to +80 °C is valid when the unit remains in its packaging. The storage temperature for the RON 905 may not exceed –30 °C to +50 °C.



DA 300

For more information, ask for our *DA 300* product information sheet.

Protection against contact
After encoder installation, all rotating parts (coupling on ROD, locking ring on RCN, RON and RPN) must be protected against accidental contact during operation.

Acceleration
Angle encoders are subject to various types of acceleration during operation and mounting.

- The **permissible angular acceleration** for all RCN, RON, RPN and ROD angle encoders is over 10^5 rad/s^2.
- The indicated maximum values for **vibration** are valid according to IEC 60068-2-6.
- The maximum permissible acceleration values (semi-sinusoidal shock) for **shock and impact** are valid for 6 ms (IEC 60068-2-27).
  Under no circumstances should a hammer or similar implement be used to adjust or position the encoder.

Natural frequency f_N of coupling
The rotor and shaft coupling of the ROD angle encoders, as well as the stator and stator coupling of the RCN, RON and RPN angle encoders, form a single vibrating spring-mass system.

The **natural frequency f_N** should be as high as possible. For RCN, RON and RPN angle encoders, the frequency ranges given in the respective specifications are those where the natural frequencies of the encoders do not cause any significant position deviations in the measuring direction. A prerequisite for the highest possible natural frequency on **ROD angle encoders** is the use of a **shaft coupling** with a high torsional rigidity C.

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

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

If radial and/or axial acceleration occurs during operation, the effect of the rigidity of the encoder bearing, the encoder stator and the coupling are also significant. If such loads occur in your application, HEIDENHAIN recommends consulting with the main facility in Traunreut.

Expendable parts
HEIDENHAIN encoders contain components that are subject to wear, depending on the application and manipulation. These include in particular the following parts:

- LED light source
- Cables with frequent flexing

Additionally for encoders with integral bearing:

- Bearings
- Shaft sealing rings for rotary and angular encoders
- Sealing lips for sealed linear encoders

System tests
Encoders from HEIDENHAIN are usually integrated as components in larger systems. Such applications require **comprehensive tests of the entire system** regardless of the specifications of the encoder.

The specifications given in the brochure apply to the specific encoder, not to the complete system. Any operation of the encoder outside of the specified range or for any other than the intended applications is at the user´s own risk.
In safety-oriented systems, the higher-level system must verify the position value of the encoder after switch-on.

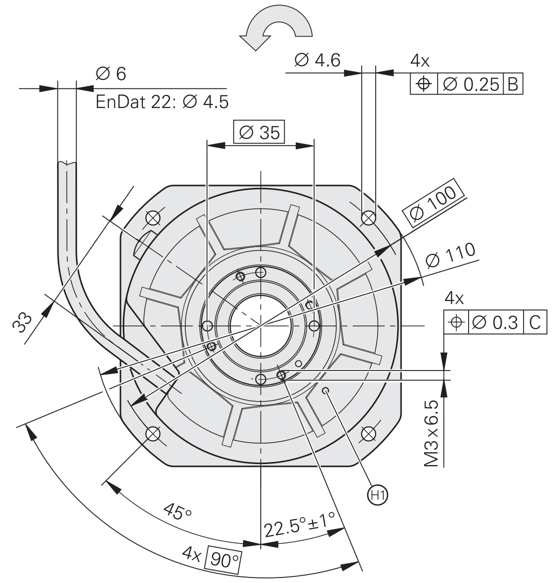
Mounting
Work steps to be performed and dimensions to be maintained during mounting are specified solely in the mounting instructions supplied with the unit. All data in this catalog regarding mounting are therefore provisional and not binding; they do not become terms of a contract.

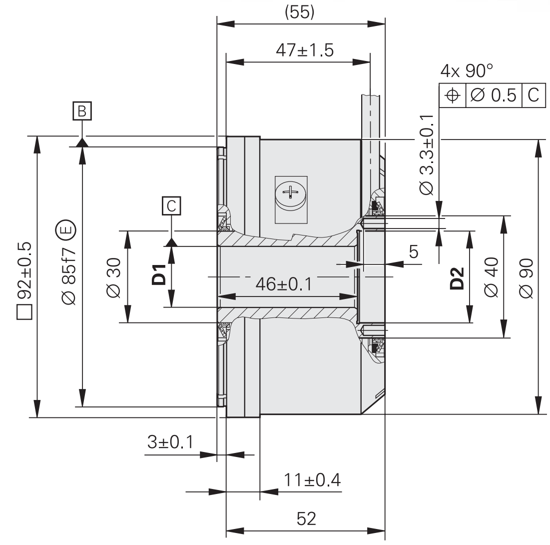
RCN 200 Series

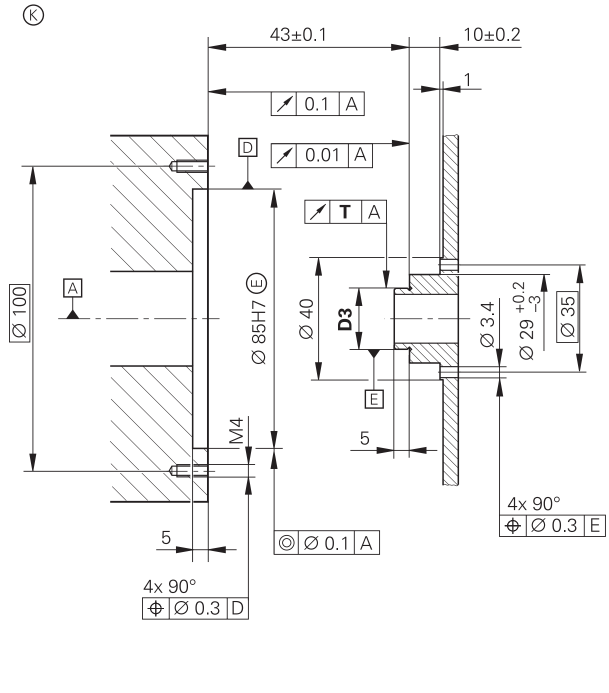
- **Integrated stator coupling**
- **Hollow through shaft, diameter 20 mm**
- **System accuracy ± 5" and ± 2.5"**

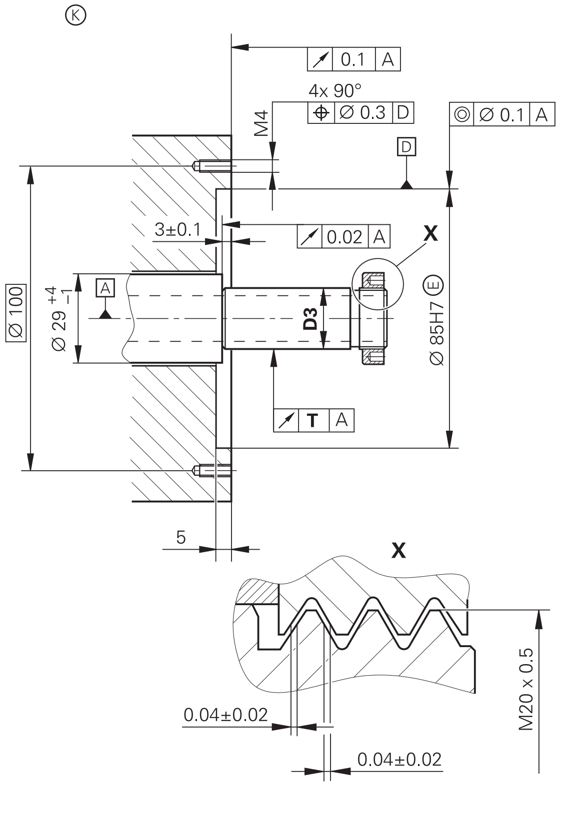
Dimensions in mm

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









Cable radial, also usable axially
A = Bearing
K = Required mating dimensions
H1 = Mark for 0° position (± 5°)
Direction of shaft rotation for output signals as per the interface description

System accuracy	± 2.5"	± 5"
D1	Ø 20H6 E	Ø 20H7 E
D2	Ø 30H6 E	Ø 30H7 E
D3	Ø 20g6 E	Ø 20g7 E
T	0.01	0.02

	Absolute **RCN 228** **RCN 226**		**RCN 227 F** **RCN 223 F**	**RCN 227 M** **RCN 223 M**
Absolute position values	EnDat 2.2	EnDat 2.2	Fanuc serial interface	Mitsubishi high-speed serial interface
Ordering designation*	EnDat 22	EnDat 02	Fanuc 02	Mit 02-4
Positions per revolution	*RCN 228:* 268 435 456 (28 bits) *RCN 226:* 67 108 864 (26 bits)		*RCN 227:* 134 217 728 (27 bits) *RCN 223:* 8 388 608 (23 bits)	
Elec. permissible speed	≤ 1500 rpm			
Clock frequency	≤ 8 MHz	≤ 2 MHz	–	
Calculation time t_{cal}	5 µs		–	
Incremental signals	–	∿ 1 V_{PP}	–	
Line count	–	16 384	–	
Cutoff frequency –3 dB	–	≥ 180 kHz	–	
Recommended meas. step for position capture	0.0001°			
System accuracy*	*RCN 228*: ± 2.5" *RCN 226:* ± 5"		*RCN 227 F:* ± 2.5" *RCN 223 F:* ± 5"	*RCN 227 M:* ± 2.5" *RCN 223 M:* ± 5"
Power supply without load	3.6 V to 5.25 V at encoder/max. 350 mA			
Electrical connection	Cable 1 m, with M12 coupling	Cable 1 m, with M23 coupling	Cable 1 m, with M23 coupling	
Max. cable length[1)]	150 m		30 m	25 m
Shaft	Hollow through shaft D= 20 mm			
Mech. permissible speed	≤ 3000 rpm			
Starting torque	≤ 0.08 Nm at 20 °C			
Moment of inertia of rotor	$73 \cdot 10^{-6}$ kgm^2			
Natural frequency	≥ 1200 Hz			
Permissible axial motion of measured shaft	± 0.1 mm			
Vibration 55 to 2000 Hz **Shock** 6 ms	≤ 100 m/s^2 (IEC 60 068-2-6) ≤ 1000 m/s^2 (IEC 60 068-2-27)			
Operating temperature	*For accuracy of ± 2.5":* 0 to 50 °C *For accuracy of ± 5":* *Moving cable* –10 to 70 °C *Stationary cable* –20 to 70 °C			
Protection IEC 60 529	IP 64			
Weight	Approx. 0.8 kg			

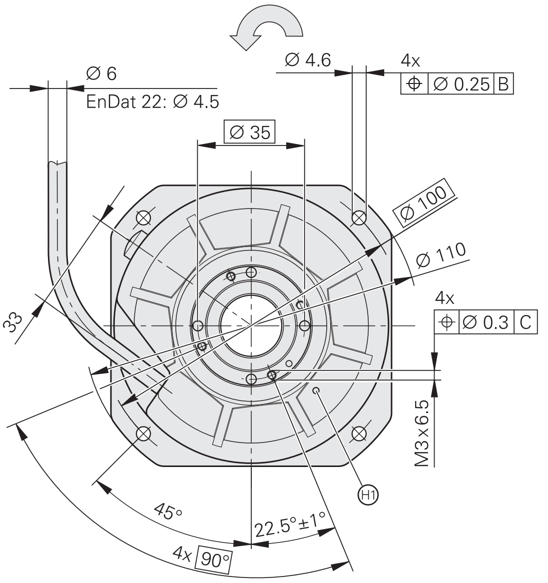
* Please indicate when ordering
1) With HEIDENHAIN cable

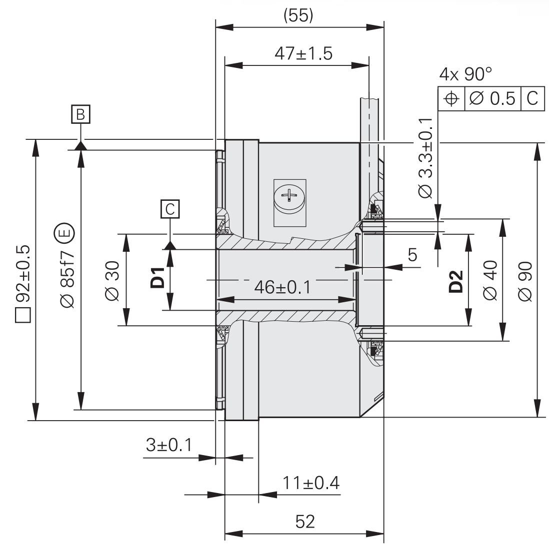
RON 200 Series

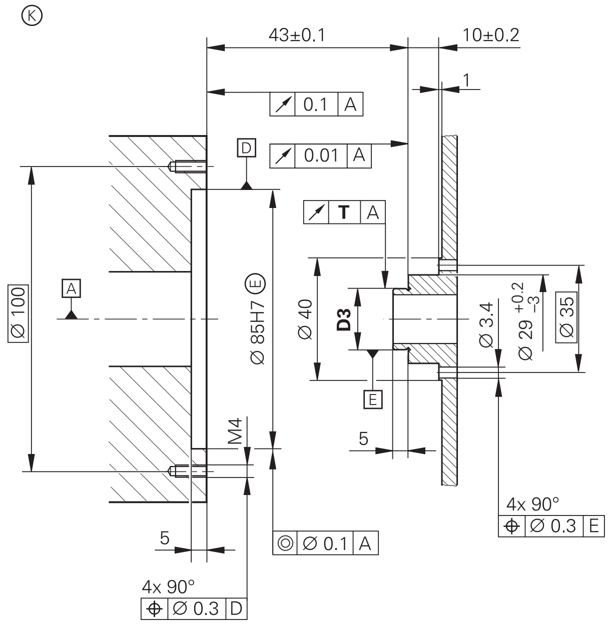
- **Integrated stator coupling**
- **Hollow through shaft, diameter 20 mm**
- **System accuracy ± 5" and ± 2.5"**

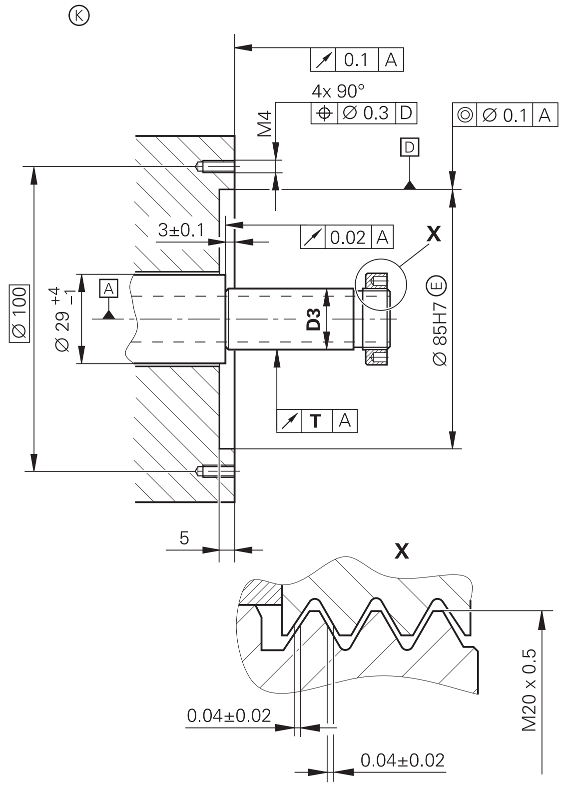
Dimensions in mm

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









Cable radial, also usable axially
A = Bearing
K = Required mating dimensions
H1 = Position of the reference-mark signal (± 5°)
Direction of shaft rotation for output signals as per the interface description

System accuracy	± 2.5"	± 5"
D1	Ø 20H6 E	Ø 20H7 E
D2	Ø 30H6 E	Ø 30H7 E
D3	Ø 20g6 E	Ø 20g7 E
T	0.01	0.02

	Incremental				
	RON 225	**RON 275**	**RON 275**	**RON 285**	**RON 287**
Incremental signals	⊓⊔TTL x 2	⊓⊔TTL x 5	⊓⊔TTL x 10	∼ 1 V_{PP}	
Line count Integrated interpolation* Output signals/rev.	9000 2-fold 18000	18000 5-fold 90000	18000 10-fold 180000	18000	
Reference mark*	One			*RON 2xx:* One *RON 2xx C:* Distance-coded	
Cutoff frequency –3 dB Output frequency Edge separation a	– ≤ 1 MHz ≥ 0.125 µs	– ≤ 250 kHz ≥ 0.96 µs	– ≤ 1 MHz ≥ 0.22 µs	≥ 180 kHz –	
Elec. permissible speed	–	≤ 166 rpm	≤ 333 rpm	–	
Recommended meas. step for position capture	0.005°	0.001°	0.0005°	0.0001°	
System accuracy	± 5"				± 2.5"
Power supply without load	5 V ±10% max. 150 mA				
Electrical connection*	Cable 1 m, with or without M23 coupling				
Max. cable length[1)]	50 m			150 m	
Shaft	Hollow through shaft D= 20 mm				
Mech. permissible speed	≤ 3000 rpm				
Starting torque	≤ 0.08 Nm at 20 °C				
Moment of inertia of rotor	$73 \cdot 10^{-6}$ kgm^2				
Natural frequency	≥ 1200 Hz				
Permissible axial motion of measured shaft	± 0.1 mm				
Vibration 55 to 2000 Hz **Shock** 6 ms	≤ 100 m/s^2 (IEC 60068-2-6) ≤ 1000 m/s^2 (IEC 60068-2-27)				
Operating temperature	*Moving cable:* –10 to 70 °C *Stationary cable:* –20 to 70 °C				0 to 50 °C
Protection IEC 60529	IP 64				
Weight	Approx. 0.8 kg				

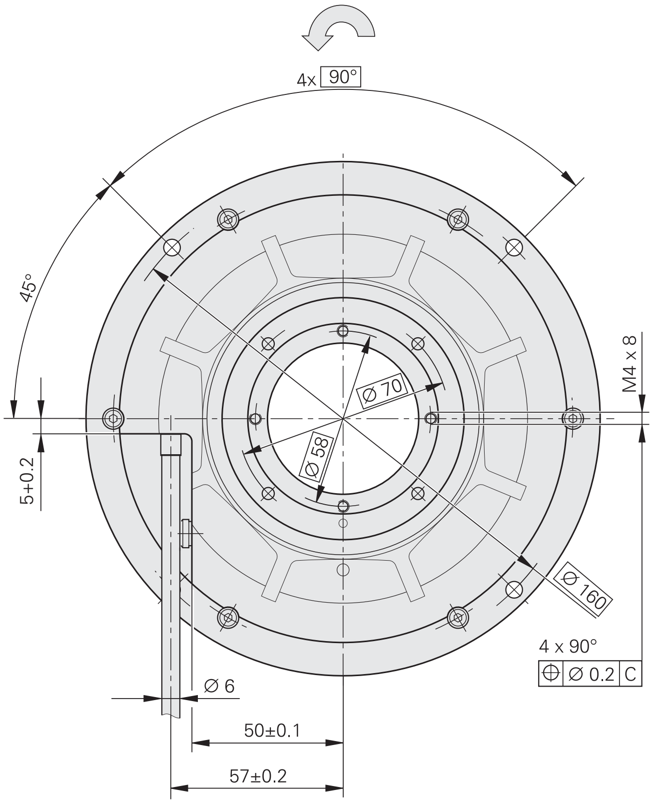
***** Please indicate when ordering
1) With HEIDENHAIN cable

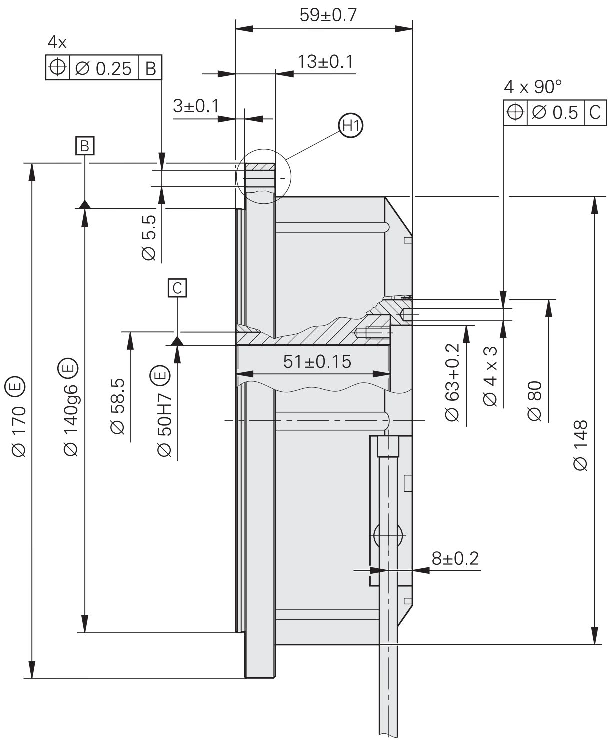
RON 785

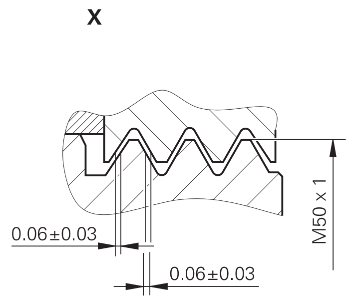
- **Integrated stator coupling**
- **Hollow through shaft, diameter 50 mm**
- **System accuracy ± 2“**

Dimensions in mm

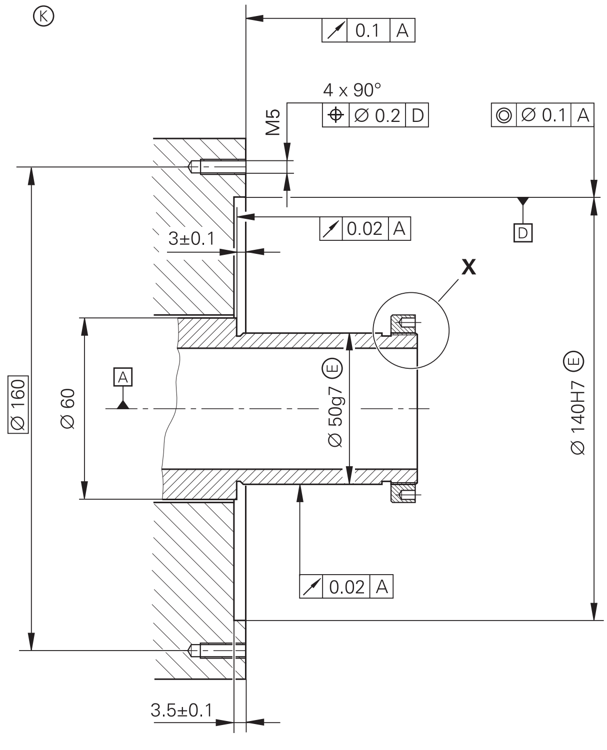
Tolerancing ISO 8015
ISO 2768 - m H
< 6 mm: ±0.2 mm







K



Cable radial, also usable axially
A = Bearing
K = Required mating dimensions
H1 = Shown rotated by 45°
Direction of shaft rotation for output signals as per the interface description

	Incremental **RON 785**
Incremental signals	∿ 1 V_{PP}
Line count	18000
Reference mark*	*RON 785:* One *RON 785 C:* Distance-coded
Cutoff frequency –3 dB	≥ 180 kHz
Recommended meas. step for position capture	0.0001°
System accuracy	± 2“
Power supply without load	5 V ±10% max. 150 mA
Electrical connection*	Cable 1 m, with or without M23 coupling
Max. cable length[1)]	150 m
Shaft	Hollow through shaft D= 50 mm
Mech. permissible speed	≤ 1000 rpm
Starting torque	≤ 0.5 Nm at 20 °C
Moment of inertia of rotor	$1.05 \cdot 10^{-3}$ kgm^2
Natural frequency	≥ 1000 Hz
Permissible axial motion of measured shaft	± 0.1 mm
Vibration 55 to 2000 Hz **Shock** 6 ms	≤ 100 m/s^2 (IEC 60068-2-6) ≤ 1000 m/s^2 (IEC 60068-2-27)
Operating temperature	0 to 50 °C
Protection IEC 60529	IP 64
Weight	Approx. 2.5 kg

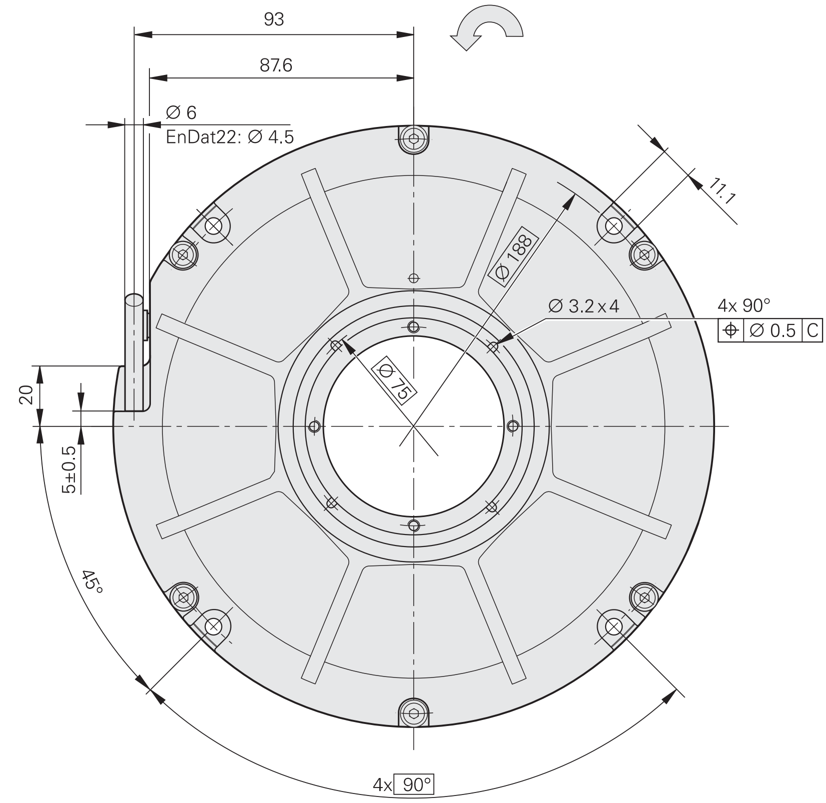
* Please indicate when ordering
1) With HEIDENHAIN cable

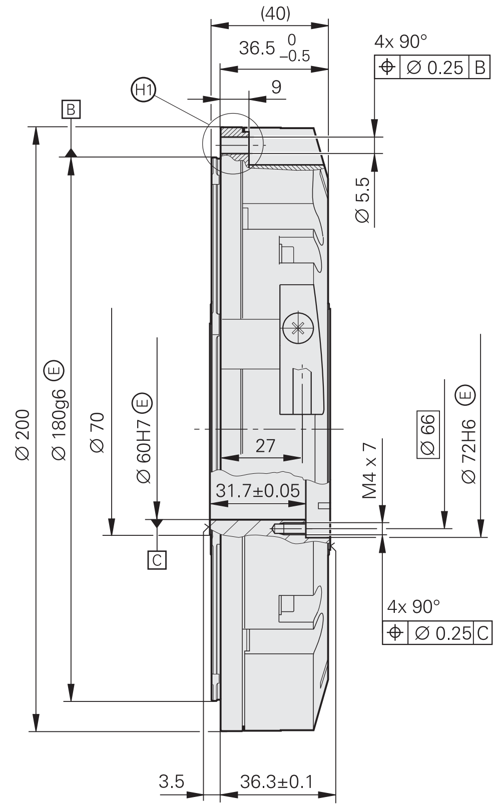
RCN 700/RCN 800 Series

- **Integrated stator coupling**
- **Hollow through shaft, diameter 60 mm**
- **System accuracy ± 2“ or ± 1“**

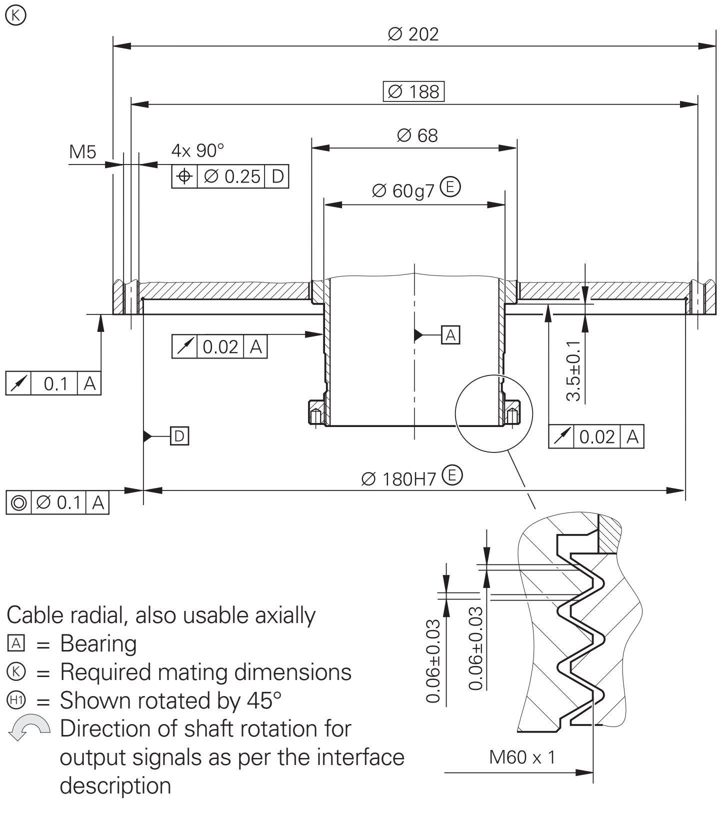
Dimensions in mm

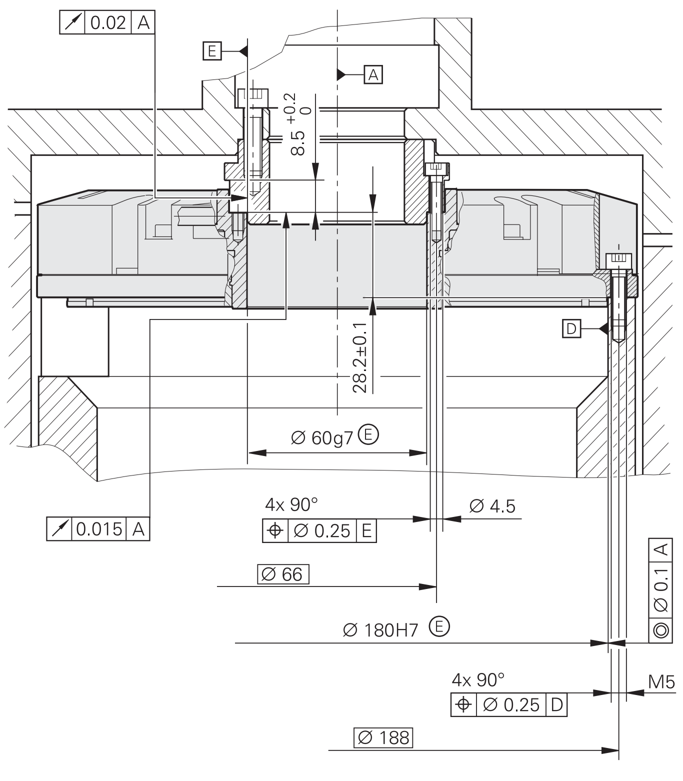
Tolerancing ISO 8015
ISO 2768 - m H
< 6 mm: ±0.2 mm





K





Cable radial, also usable axially
A = Bearing
K = Required mating dimensions
H1 = Shown rotated by 45°
Direction of shaft rotation for output signals as per the interface description

	Absolute			
	RCN 729 **RCN 829**	**RCN 729** **RCN 829**	**RCN 727 F** **RCN 827 F**	**RCN 727 M** **RCN 827 M**
Absolute position values	EnDat 2.2	EnDat 2.2	Fanuc 02 serial interface	Mitsubishi high-speed serial interface
Ordering designation*	EnDat 22	EnDat 02	Fanuc 02	Mit 02-4
Positions per revolution	536 870 912 (29 bits)		134 217 728 (27 bits)	
Elec. permissible speed	≤ 300 rpm (for continuous position value)			
Clock frequency	≤ 8 MHz	≤ 2 MHz	–	
Calculation time t_{cal}	5 µs		–	
Incremental signals	–	∼ 1 V_{PP}	–	
Line count*	–	32 768	–	
Cutoff frequency –3 dB	–	≥ 180 kHz	–	
Recommended meas. step for position capture	*RCN 72x:* 0.000 1° *RCN 82x:* 0.000 05°			
System accuracy	*RCN 72x:* ± 2" *RCN 82x:* ± 1"			
Power supply without load	3.6 to 5.25 V/Max. 350 mA			
Electrical connection*	Cable 1 m, with M12 coupling	Cable 1 m, with or without M23 coupling		
Max. cable length[1]	150 m		30 m	25 m
Shaft	Hollow through shaft D= 60 mm			
Mech. permissible speed	≤ 1000 rpm			
Starting torque	≤ 0.5 Nm at 20 °C			
Moment of inertia of rotor	$1.3 \cdot 10^{-3}$ kgm^2			
Natural frequency	≥ 1000 Hz			
Permissible axial motion of measured shaft	≤ ± 0.1 mm			
Vibration 55 to 2000 Hz **Shock** 6 ms	≤ 100 m/s^2 (IEC 60 068-2-6) ≤ 1000 m/s^2 (IEC 60 068-2-27)			
Operating temperature	0 to 50 °C			
Protection IEC 60 529	IP 64			
Weight	Approx. 2.8 kg			

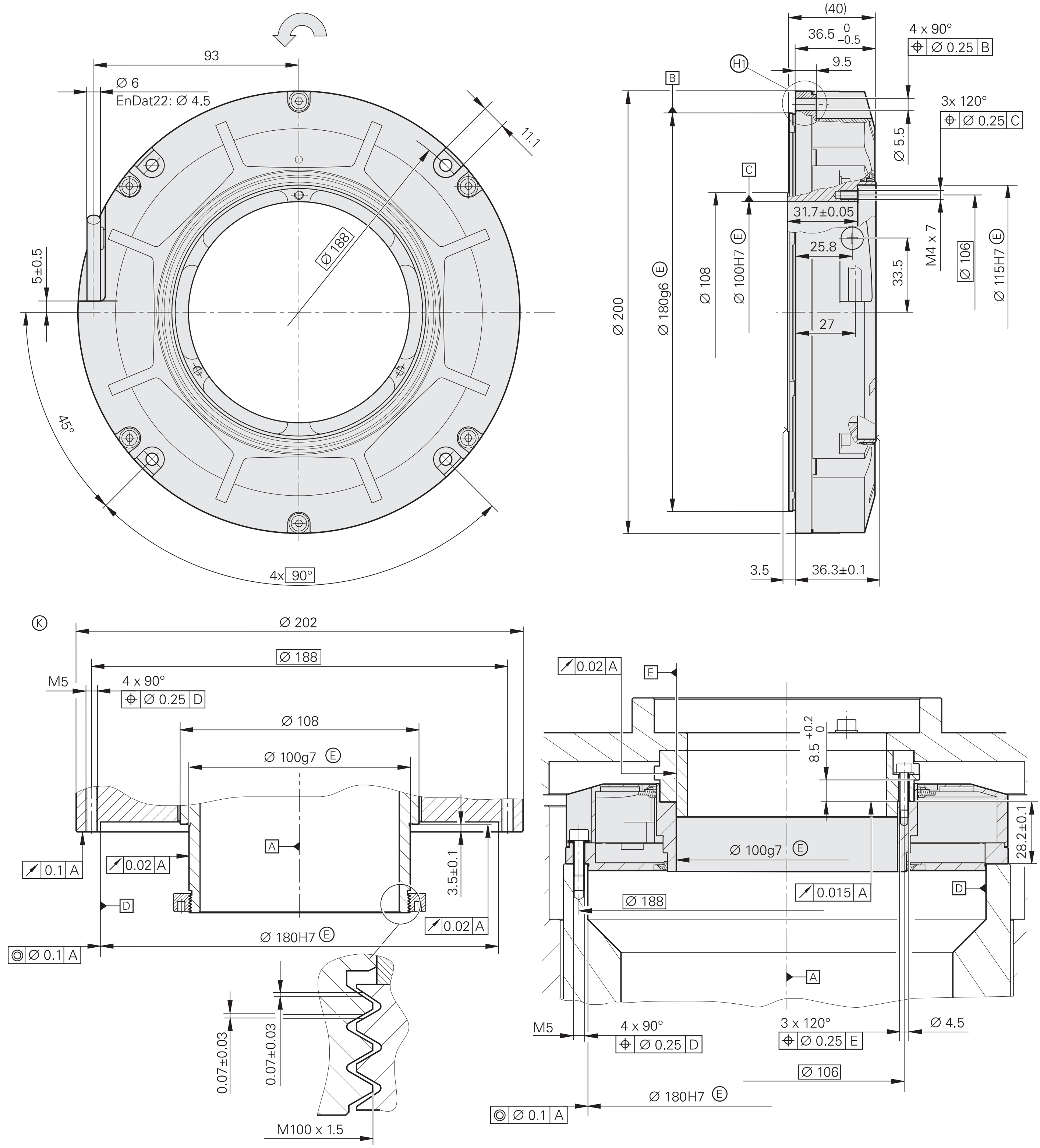
* Please indicate when ordering
[1] With HEIDENHAIN cable

RCN 700/RCN 800 Series

- **Integrated stator coupling**
- **Hollow through shaft, diameter 100 mm**
- **System accuracy ± 2" or ± 1"**

Dimensions in mm

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



Cable radial, also usable axially
A = Bearing
K = Required mating dimensions
H1 = Shown rotated by 45°
Direction of shaft rotation for output signals as per the interface description

	Absolute			
	RCN 729 **RCN 829**	**RCN 729** **RCN 829**	**RCN 727 F** **RCN 827 F**	**RCN 727 M** **RCN 827 M**
Absolute position values	EnDat 2.2	EnDat 2.2	Fanuc 02 serial interface	Mitsubishi high-speed serial interface
Ordering designation*	EnDat 22	EnDat 02	Fanuc 02	Mit 02-4
Positions per revolution	536 870 912 (29 bits)		134 217 728 (27 bits)	
Elec. permissible speed	≤ 300 rpm (for continuous position value)			
Clock frequency	≤ 8 MHz	≤ 2 MHz	–	
Calculation time t_{cal}	5 µs		–	
Incremental signals	–	∼ 1 V_{PP}	–	
Line count*	–	32 768	–	
Cutoff frequency –3 dB	–	≥ 180 kHz	–	
Recommended meas. step for position capture	*RCN 72x:* 0.000 1° *RCN 82x:* 0.000 05°			
System accuracy	*RCN 72x:* ± 2" *RCN 82x:* ± 1"			
Power supply without load	3.6 to 5.25 V/Max. 350 mA			
Electrical connection*	Cable 1 m, with M12 coupling	Cable 1 m, with or without M23 coupling		
Max. cable length[1)]	150 m		30 m	25 m
Shaft	Hollow through shaft D= 100 mm			
Mech. permissible speed	≤ 1000 rpm			
Starting torque	≤ 1.5 Nm at 20 °C			
Moment of inertia of rotor	$3.3 \cdot 10^{-3}$ kgm^2			
Natural frequency	≥ 900 Hz			
Permissible axial motion of measured shaft	≤ ± 0.1 mm			
Vibration 55 to 2000 Hz **Shock** 6 ms	≤ 100 m/s^2 (IEC 60 068-2-6) ≤ 1000 m/s^2 (IEC 60 068-2-27)			
Operating temperature	0 to 50 °C			
Protection IEC 60 529	IP 64			
Weight	Approx. 2.6 kg			

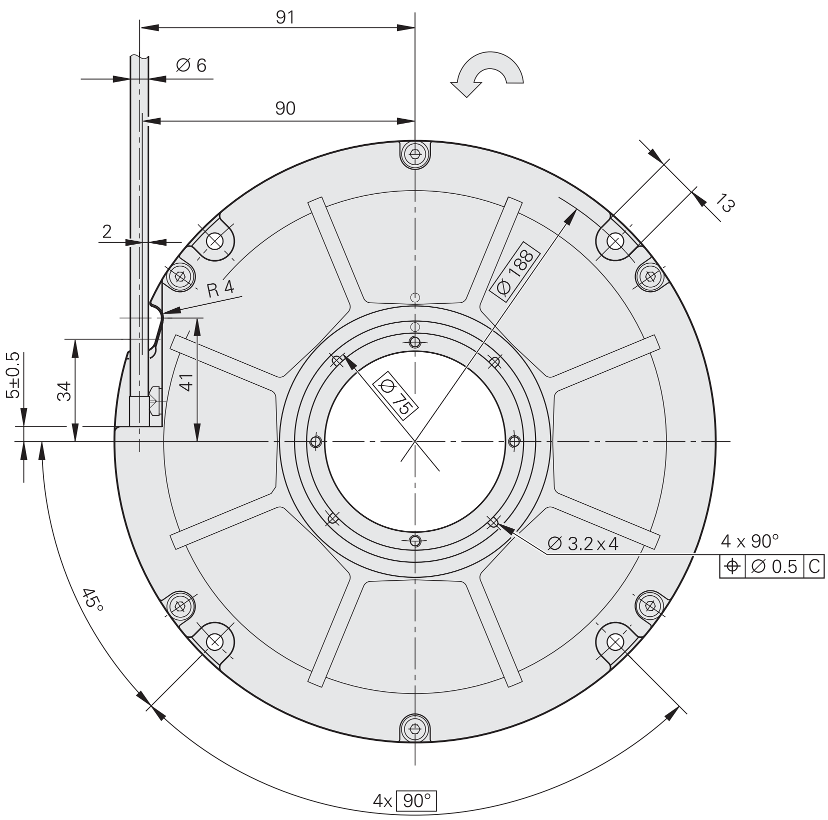
* Please indicate when ordering
1) With HEIDENHAIN cable

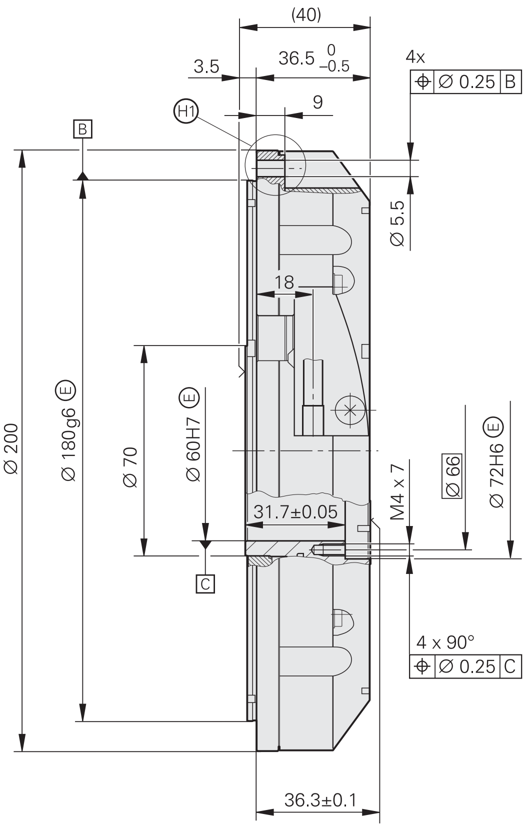
RON 786/RON 886/RPN 886

- **Integrated stator coupling**
- **Hollow through shaft, diameter 60 mm**
- **System accuracy ± 2" or ± 1"**

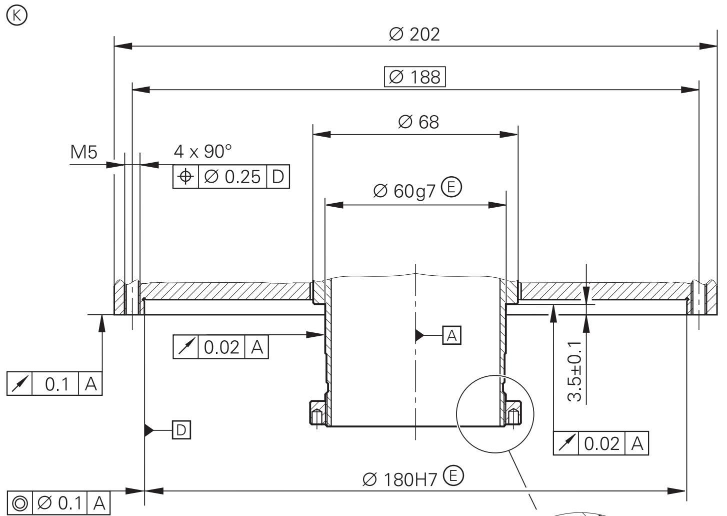
Dimensions in mm

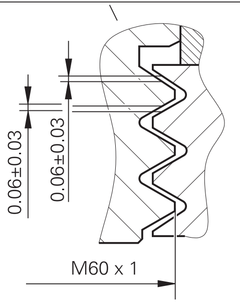
Tolerancing ISO 8015
ISO 2768 - m H
< 6 mm: ±0.2 mm

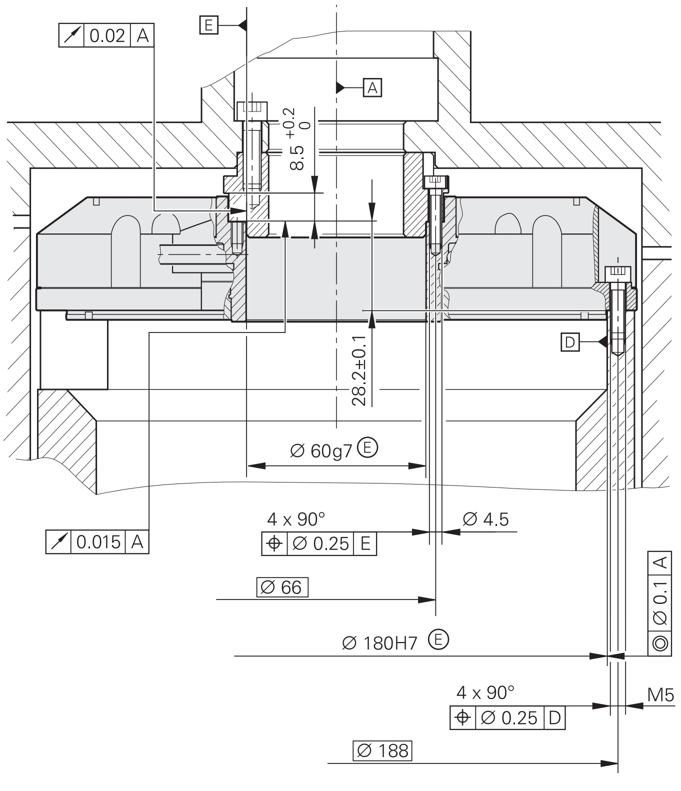




K







Cable radial, also usable axially
A = Bearing
K = Required mating dimensions
H1 = Shown rotated by 45°
Direction of shaft rotation for output signals as per the interface description

	Incremental		
	RON 786	**RON 886**	**RPN 886**
Incremental signals	∼ 1 V_{PP}		
Line count*	18 000 36 000	36 000	90 000 (≙ 180 000 signal periods)
Reference mark*	*RON x86:* One *RON x86 C:* Distance-coded		One
Cutoff frequency –3 dB –6 dB	≥ 180 kHz		≥ 800 kHz ≥ 1300 kHz
Recommended meas. step for position capture	0.0001°	0.000 05°	0.000 01°
System accuracy	± 2"	± 1"	
Power supply without load	5 V ±10% max. 150 mA		5 V ±10% max. 250 mA
Electrical connection*	Cable 1 m, with or without M23 coupling		
Max. cable length[1)]	150 m		
Shaft	Hollow through shaft D= 60 mm		
Mech. permissible speed	≤ 1000 rpm		
Starting torque	≤ 0.5 Nm at 20 °C		
Moment of inertia of rotor	$1.2 \cdot 10^{-3}$ kgm^2		
Natural frequency	≥ 1000 Hz		≥ 500 Hz
Permissible axial motion of measured shaft	≤ ± 0.1 mm		
Vibration 55 to 2000 Hz **Shock** 6 ms	≤ 100 m/s^2 (IEC 60 068-2-6) ≤ 1000 m/s^2 (IEC 60 068-2-27)		≤ 50 m/s^2 (IEC 60 068-2-6) ≤ 1000 m/s^2 (IEC 60 068-2-27)
Operating temperature	0 to 50 °C		
Protection IEC 60 529	IP 64		
Weight	Approx. 2.5 kg		

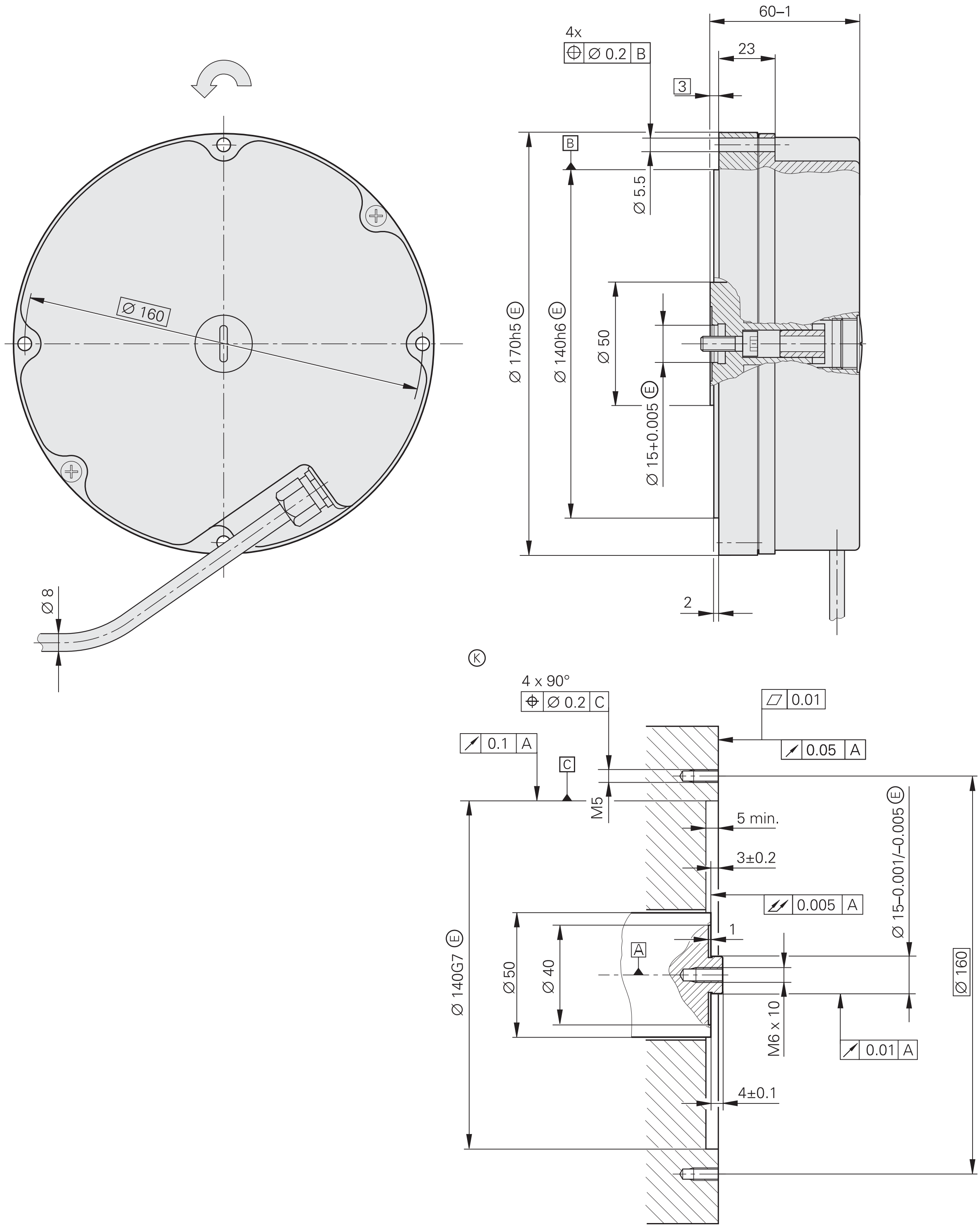
* Please indicate when ordering
1) With HEIDENHAIN cable

RON 905

- **Integrated stator coupling**
- **Blind hollow shaft**
- **System accuracy ± 0.4“**

Dimensions in mm

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



Cable radial, also usable axially
A = Bearing
Ⓚ = Required mating dimensions
Direction of shaft rotation for output signal I_2 lagging I_1

	Incremental RON 905
Incremental signals	∼ 11 µAPP
Line count	36000
Reference mark	One
Cutoff frequency –3 dB	≥ 40 kHz
Recommended meas. step for position capture	0.00001°
System accuracy	± 0.4"
Power supply without load	5 V ± 5% max. 250 mA
Electrical connection	Cable 1 m, with M23 connector
Max. cable length[1)]	15 m
Shaft	Blind hollow shaft
Mech. permissible speed	≤ 100 rpm
Starting torque	≤ 0.05 Nm at 20 °C
Moment of inertia of rotor	$0.345 \cdot 10^{-3}$ kgm^2
Natural frequency	≥ 350 Hz
Permissible axial motion of measured shaft	≤ ± 0,2 mm
Vibration 55 to 2000 Hz **Shock** 6 ms	≤ 50 m/s^2 (IEC 60068-2-6) ≤ 1000 m/s^2 (IEC 60068-2-27)
Operating temperature	10 to 30 °C
Protection IEC 60529	IP 64
Weight	Approx. 4 kg

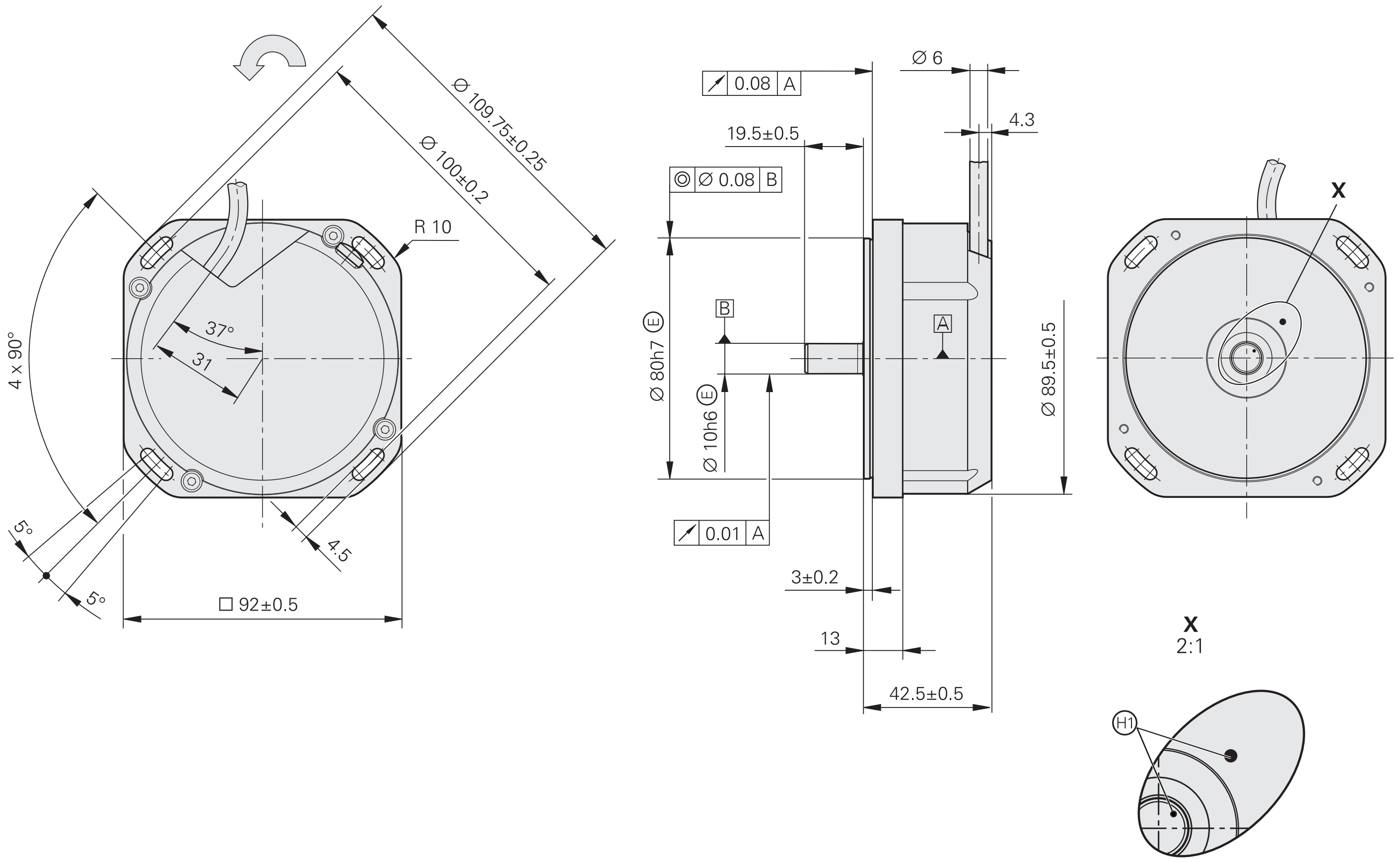
1) With HEIDENHAIN cable

ROD 200 Series

- **For separate shaft coupling**
- **System accuracy ± 5“**

Dimensions in mm

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



Cable radial, also usable axially
A = Bearing
H1 = Position of the reference mark,
ROD 220/270/280: ±10°
ROD 280 C: ±5°
Direction of shaft rotation for output signals as per the interface description

	Incremental		
	ROD 220	**ROD 270**	**ROD 280**
Incremental signals	⊓⊔TTL x 2	⊓⊔TTL x 10	∼ 1 V_{PP}
Line count Integrated interpolation Output signals/revolution	9000 2-fold 18000	18000 10-fold 180000	18000 – 18000
Reference mark*	One		*ROD 280:* One *ROD 280 C:* Distance-coded
Cutoff frequency –3 dB Output frequency Edge separation *a*	– ≤ 1 MHz ≥ 0.125 µs	– ≤ 1 MHz ≥ 0.22 µs	≥ 180 kHz —
Elec. permissible speed	3333 rpm	≤ 333 rpm	–
Recommended meas. step for position capture	0.005°	0.0005°	0.0001°
System accuracy	± 5"		
Power supply without load	5 V ±10% max. 150 mA		
Electrical connection*	Cable 1 m, with or without M23 coupling		
Max. cable length[1]	100 m		150 m
Shaft	Solid shaft D = 10 mm		
Mech. permissible speed	≤ 10000 rpm		
Starting torque	≤ 0.01 Nm at 20 °C		
Moment of inertia of rotor	$20 \cdot 10^{-6}$ kgm^2		
Shaft load	*Axial:* 10 N *Radial:* 10 N at shaft end		
Vibration 55 to 2000 Hz **Shock** 6 ms	≤ 100 m/s^2 (IEC 60068-2-6) ≤ 1000 m/s^2 (IEC 60068-2-27)		
Operating temperature	*Moving cable:* –10 to 70 °C *Stationary cable:* –20 to 70 °C		
Protection IEC 60529	IP 64		
Weight	Approx. 0.7 kg		

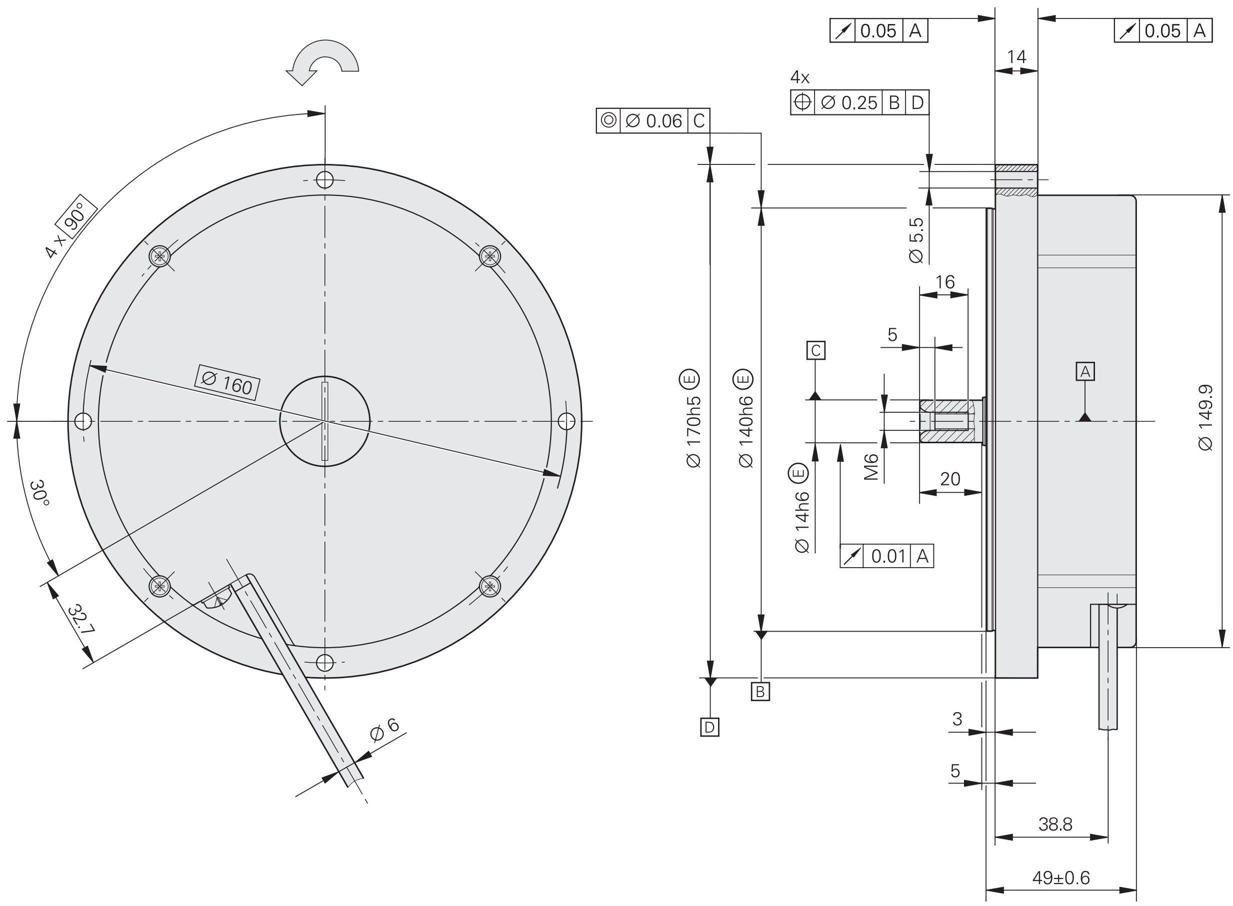
***** Please indicate when ordering
[1] With HEIDENHAIN cable

ROD 780/ROD 880

- **For separate shaft coupling**
- **System accuracy ROD 780: ± 2"**
  ROD 880: ± 1"

Dimensions in mm

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



Cable radial, also usable axially
A = Bearing
Direction of shaft rotation for output signals as per the interface description

	Incremental	
	ROD 780	**ROD 880**
Incremental signals	∿ 1 V_{PP}	
Line count*	18 000 36 000	36 000
Reference mark*	*ROD x80:* One *ROD x80 C:* Distance-coded	
Cutoff frequency –3 dB	≥ 180 kHz	
Recommended meas. step for position capture	0.0001°	0.000 05°
System accuracy	± 2“	± 1“
Power supply without load	5 V ±10% max. 150 mA	
Electrical connection*	Cable 1 m, with or without M23 coupling	
Max. cable length1)	150 m	
Shaft	Solid shaft D = 14 mm	
Mech. permissible speed	≤ 1000 rpm	
Starting torque	≤ 0.012 Nm at 20 °C	
Moment of inertia of rotor	$0.36 \cdot 10^{-3}$ kgm^2	
Shaft load	*Axial:* 30 N *Radial:* 30 N at shaft end	
Vibration 55 to 2000 Hz **Shock** 6 ms	≤ 100 m/s^2 (IEC 60 068-2-6) ≤ 300 m/s^2 (IEC 60 068-2-27)	
Operating temperature	0 to 50 °C	
Protection IEC 60 529	IP 64	
Weight	Approx. 2.0 kg	

***** Please indicate when ordering
1) With HEIDENHAIN cable

Interfaces

Incremental signals ~ 1 V_{PP}

HEIDENHAIN encoders with ~ 1-V_{PP} interface provide voltage signals that can be highly interpolated.

The sinusoidal **incremental signals** A and B are phase-shifted by 90° elec. and have an amplitude of typically 1 V_{PP}. The illustrated sequence of output signals—with B lagging A—applies for the direction of motion shown in the dimension drawing.

The **reference mark signal** R has a usable component *G* of approx. 0.5 V. Next to the reference mark, the output signal can be reduced by up to 1.7 V to a quiescent value *H*. This must not cause the subsequent electronics to overdrive. Even at the lowered signal level, signal peaks with the amplitude G can also appear.

The data on **signal amplitude** apply when the power supply given in the specifications is connected to the encoder. They refer to a differential measurement at the 120-ohm terminating resistor between the associated outputs. The signal amplitude decreases with increasing frequency. The **cutoff frequency** indicates the scanning frequency at which a certain percentage of the original signal amplitude is maintained:

- –3 dB cutoff frequency:
  70 % of the signal amplitude
- –6 dB cutoff frequency:
  50 % of the signal amplitude

Interpolation/resolution/measuring step
The output signals of the 1 V_{PP} interface are usually interpolated in the subsequent electronics in order to attain sufficiently high resolutions. For **velocity control,** interpolation factors are commonly over 1000 in order to receive usable velocity information even at low speeds.

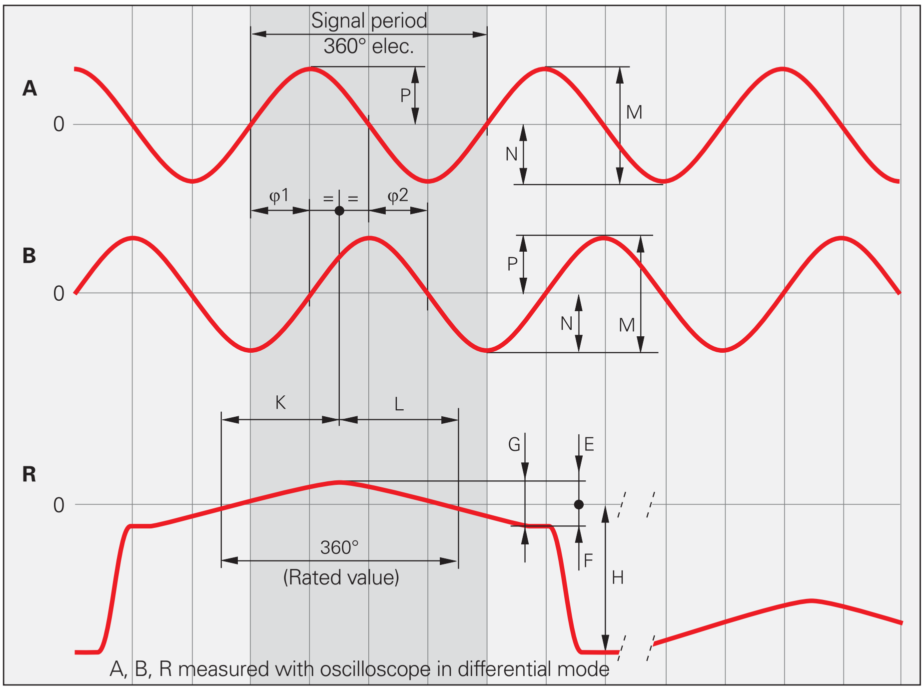
Measuring steps for **position measurement** are recommended in the specifications. For special applications, other resolutions are also possible.

Short-circuit stability
A temporary short circuit of one signal output to 0 V or U_P does not cause encoder failure, but it is not a permissible operating condition.

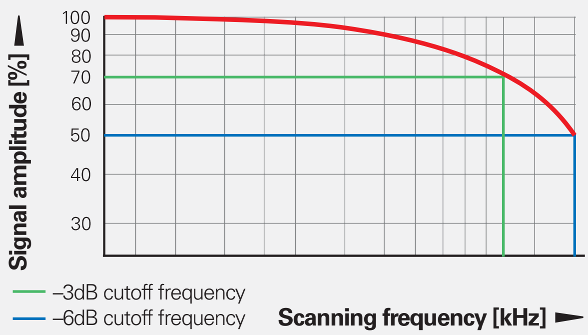
Short circuit at	20 °C	125 °C
One output	< 3 min	< 1 min
All outputs	< 20 s	< 5 s

Interface	Sinusoidal voltage signals ~ **1 V_{PP}**	
Incremental signals	**2 nearly sinusoidal signals A and B**	
	Signal amplitude M:	0.6 to 1.2 V_{PP}; typ. 1 V_{PP}
	Asymmetry $\|P – N\|/2M$:	≤ 0.065
	Signal ratio M_A/M_B:	0.8 to 1.25
	Phase angle $\|\varphi1 + \varphi2\|/2$:	90° ± 10° el.
Reference mark signal	**1 or more signal peaks R**	
	Usable component G:	0.2 to 0.85 V
	Quiescent value H:	0.04 V to 1.7 V
	Switching threshold E, F:	≥ 40 mV
	Zero crossovers K, L:	180° ± 90° elec.
Connecting cable	HEIDENHAIN cable with shielding PUR [4(2 x 0.14 mm^2) + (4 x 0.5 mm^2)]	
Cable length	Max. 150 m distributed capacitance 90 pF/m	
Propagation time	6 ns/m	

Any limited tolerances in the encoders are listed in the specifications.



Cutoff frequency
Typical signal amplitude curve with respect to the scanning frequency



Input circuitry of the subsequent electronics

Dimensioning
Operational amplifier MC 34074
$Z_0 = 120\,\Omega$
$R_1 = 10\,k\Omega$ and $C_1 = 100$ pF
$R_2 = 34.8\,k\Omega$ and $C_2 = 10$ pF
$U_B = \pm 15\,V$
U_1 approx. U_0

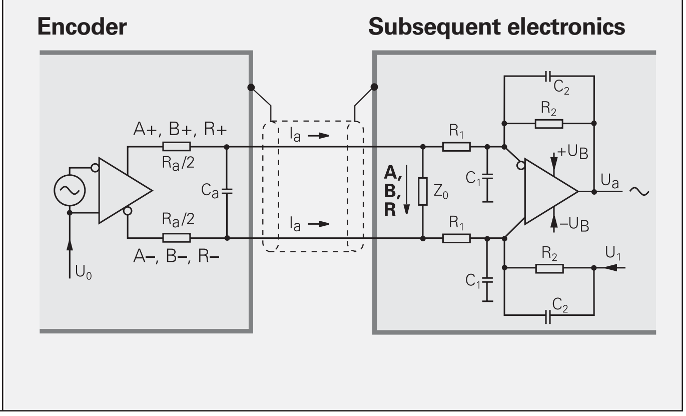
–3dB cutoff frequency of circuitry
Approx. 450 kHz
Approx. 50 kHz and $C_1 = 1000$ pF
and $C_2 = 82$ pF
This circuit variant does reduce the bandwidth of the circuit, but in doing so it improves its noise immunity.

Circuit output signals
$U_a = 3.48\,V_{PP}$ typical
Gain 3.48

Signal monitoring
A threshold sensitivity of 250 mV_{PP} is to be provided for monitoring the 1 V_{PP} incremental signals.

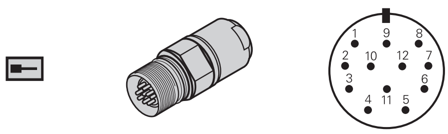
Incremental signals
Reference mark signal

$R_a < 100\,\Omega$, approx. $24\,\Omega$
$C_a < 50$ pF
$\Sigma I_a < 1$ mA
$U_0 = 2.5\,V \pm 0.5\,V$
(relative to 0 V of the power supply)

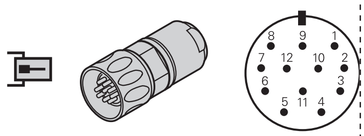


Pin Layout

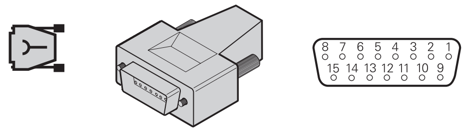
12-pin M23 coupling



12-pin M23 connector



15-pin D-sub connector, female
for HEIDENHAIN controls and IK 220



	Power supply				Incremental signals						Other signals		
M23	12	2	10	11	5	6	8	1	3	4	7/9	/	/
D-sub	1	9	2	11	3	4	6	7	10	12	5/8/13/14/15	/	/
	U_P	Sensor U_P	0 V	Sensor 0 V	A+	A–	B+	B–	R+	R–	Vacant	Vacant	Vacant
Cable	Brown/ Green	Blue	White/ Green	White	Brown	Green	Gray	Pink	Red	Black	/	Violet	Yellow

Shield on housing; U_P = power supply voltage
Sensor: The sensor line is connected internally with the corresponding power line
Vacant pins or wires must not be used!

Incremental signals ⊓⊔TTL

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

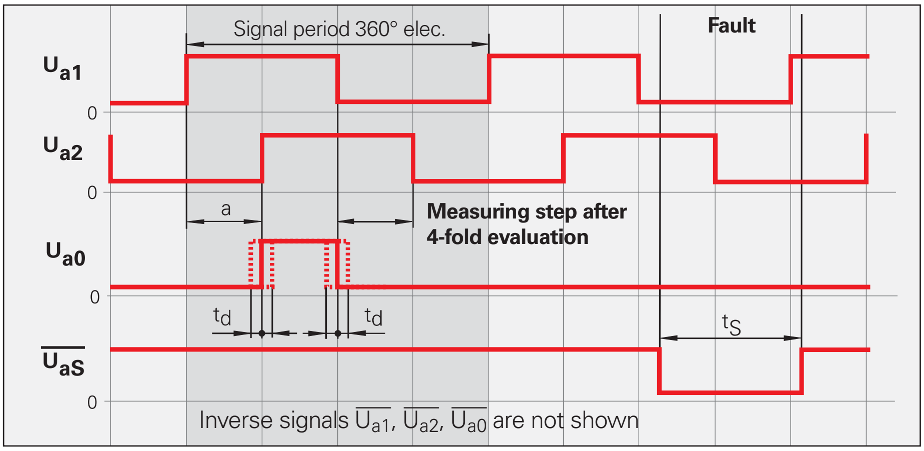
The **incremental signals** are transmitted as the square-wave pulse trains U_{a1} and U_{a2}, phase-shifted by 90° elec. The **reference mark signal** consists of one or more reference pulses U_{a0}, which are gated with the incremental signals. In addition, the integrated electronics produce their **inverse signals** $\overline{U_{a1}}$, $\overline{U_{a2}}$ and $\overline{U_{a0}}$ for noise-proof transmission. The illustrated sequence of output signals—with U_{a2} lagging U_{a1}—applies for the direction of motion shown in the dimension drawing.

The **fault-detection signal** $\overline{U_{aS}}$ indicates fault conditions such as breakage of the power line or failure of the light source. It can be used for such purposes as machine shut-off during automated production.

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

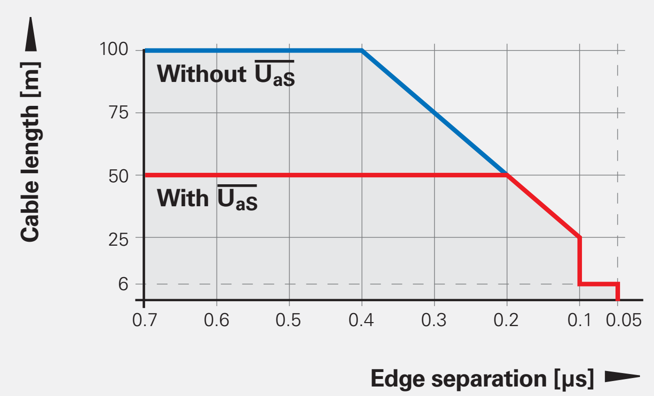
The subsequent electronics must be designed to detect each edge of the square-wave pulse. The minimum **edge separation *a*** listed in the *Specifications* applies for the illustrated input circuitry with a cable length of 1 m, and refers to a measurement at the output of the differential line receiver. Propagation-time differences in cables additionally reduce the edge separation by 0.2 ns per meter of cable length. To prevent counting error, design the subsequent electronics to process as little as 90% of the resulting edge separation. The max. permissible **shaft speed** or **traversing velocity** must never be exceeded.

Interface	Square-wave signals ⊓⊔TTL
Incremental signals	**2 TTL square-wave signals U_{a1}, U_{a2}** and their inverted signals **$\overline{U_{a1}}$, $\overline{U_{a2}}$**
Reference mark signal Pulse width Delay time	**1 or more square-wave pulses U_{a0}** and their inverted pulses **$\overline{U_{a0}}$** 90° elec. (other widths available on request); *LS 323:* ungated $\|t_d\| \leq 50$ ns
Fault detection signal Pulse width	**1 TTL square-wave pulse $\overline{U_{aS}}$** Improper function: LOW (upon request: U_{a1}/U_{a2} high impedance) Proper function: HIGH $t_S \geq 20$ ms
Signal level	Differential line driver as per EIA standard RS 422 $U_H \geq 2.5$ V at $-I_H = 20$ mA $U_L \leq 0.5$ V at $I_L = 20$ mA
Permissible load	$Z_0 \geq 100\ \Omega$ between associated outputs $\|I_L\| \leq 20$ mA max. load per output $C_{load} \leq 1000$ pF with respect to 0 V Outputs protected against short circuit to 0 V
Switching times (10% to 90%)	$t_+ / t_- \leq 30$ ns (typically 10 ns) with 1 m cable and recommended input circuitry
Connecting cable Cable length Propagation time	HEIDENHAIN cable with shielding PUR [4(2 × 0.14 mm^2) + (4 × 0.5 mm^2)] Max. 100 m ($\overline{U_{aS}}$ max. 50 m) distributed capacitance 90 pF/m 6 ns/m



The permissible **cable length** for transmission of the TTL square-wave signals to the subsequent electronics depends on the edge separation *a.* It is max. 100 m, or 50 m for the fault detection signal. This requires, however, that the power supply (see *Specifications*) be ensured at the encoder. The sensor lines can be used to measure the voltage at the encoder and, if required, correct it with an automatic system (remote sense power supply).

Permissible cable length
with respect to the edge separation



Input circuitry of the subsequent electronics

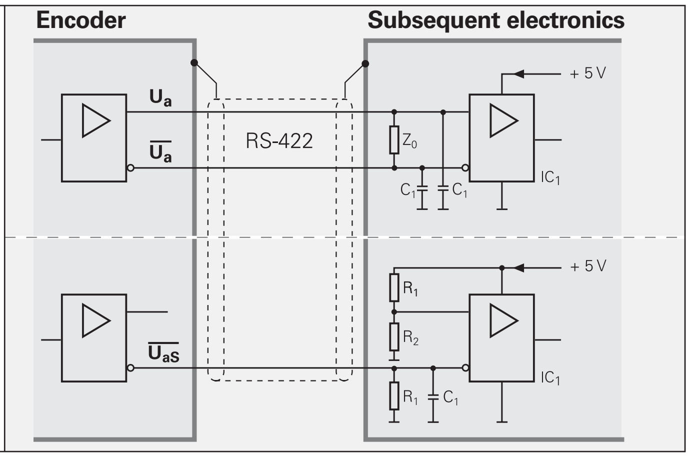
Dimensioning

IC_1 = Recommended differential line receivers
DS 26 C 32 AT
Only for *a* > 0.1 µs:
AM 26 LS 32
MC 3486
SN 75 ALS 193

R_1 = 4.7 kΩ
R_2 = 1.8 kΩ
Z_0 = 120 Ω
C_1 = 220 pF (serves to improve noise immunity)

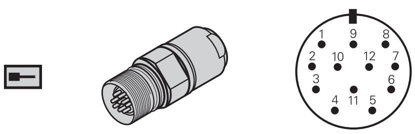
Incremental signals Reference mark signal

Fault detection signal

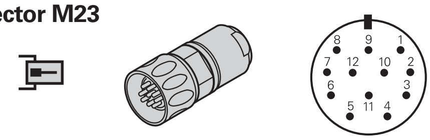


Pin Layout

12-pin flange socket or M23 coupling



12-pin connector M23



	Power supply				Incremental signals						Other signals	
	12	2	10	11	5	6	8	1	3	4	7	9
	U_P	**Sensor** U_P	**0 V**	**Sensor** 0 V	**U_{a1}**	**$\overline{U_{a1}}$**	**U_{a2}**	**$\overline{U_{a2}}$**	**U_{a0}**	**$\overline{U_{a0}}$**	**$\overline{U_{aS}}$** [1]	**Vacant** [2]
	Brown/ Green	Blue	White/ Green	White	Brown	Green	Gray	Pink	Red	Black	Violet	Yellow [2]

Shield on housing; **U_P** = power supply voltage
Sensor: The sensor line is connected internally with the corresponding power line
[1] **LS 323/ERO 14xx:** Vacant [2] **Exposed linear encoders:** TTL/11 µA_{PP} conversion for PWT, otherwise vacant
Vacant pins or wires must not be used!

Interfaces

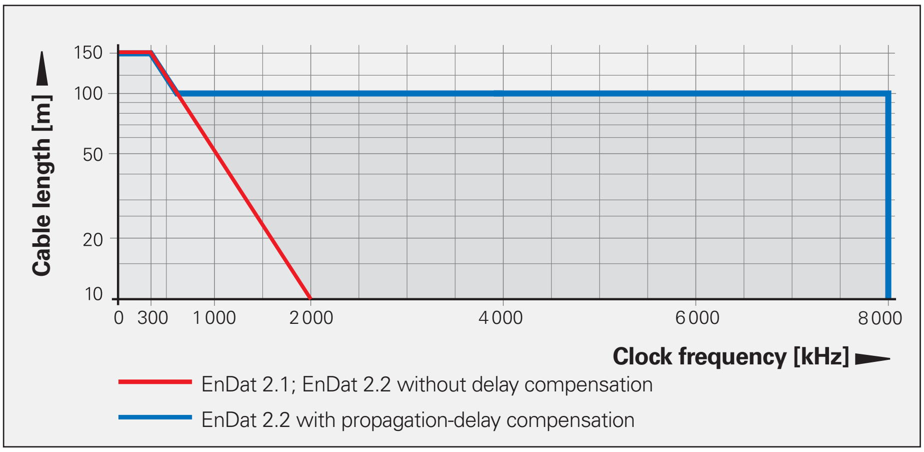
Absolute Position Values EnDat

The EnDat interface is a digital, **bidirectional** interface for encoders. It is capable of transmitting **position values** from both absolute and—with EnDat 2.2—incremental encoders, as well as reading and updating information stored in the encoder, or of saving new information. Thanks to the **serial transmission method** only **four signal lines** are required. The data are transmitted **in synchronism** with the clock signal from the subsequent electronics. The type of transmission (position values, parameters, diagnostics, etc.) is selected by mode commands that the subsequent electronics send to the encoder.

Clock frequency and cable length
Without propagation-delay compensation, the **clock frequency**—depending on the cable length—is variable between **100 kHz** and **2 MHz.**

Because large cable lengths and high clock frequencies increase the signal run time to the point that they can disturb the unambiguous assignment of data, the delay can be measured in a test run and then compensated. With this **propagation-delay compensation** in the subsequent electronics, clock frequencies up to **8 MHz** at cable lengths up to a maximum of 100 m are possible. The maximum clock frequency is mainly determined by the cables and connecting elements used. To ensure proper function at clock frequencies above 2 MHz, use only original ready-made HEIDENHAIN cables.

Interface	**EnDat** serial bidirectional
Data transfer	Absolute position values, parameters and additional information
Data input	Differential line receiver according to EIA standard RS 485 for the CLOCK, $\overline{\text{CLOCK}}$, DATA and $\overline{\text{DATA}}$ signals
Data output	Differential line driver according to EIA standard RS 485 for the DATA and $\overline{\text{DATA}}$ signals
Code	Pure binary code
Position values	Ascending during traverse in direction of arrow (see Dimensions)
Incremental signals	∼ 1 V_{PP} (see *Incremental Signals 1* V_{PP}) depending on unit
Connecting cable With incremental Without signals	HEIDENHAIN cable with shielding PUR [(4 x 0.14 mm^2) + 4(2 x 0.14 mm^2) + (4 x 0.5 mm^2)] PUR [(4 x 0.14 mm^2) + (4 x 0.34 mm^2)]
Cable length	Max. 150 m
Propagation time	Max. 10 ns; approx. 6 ns/m



Input circuitry of the subsequent electronics

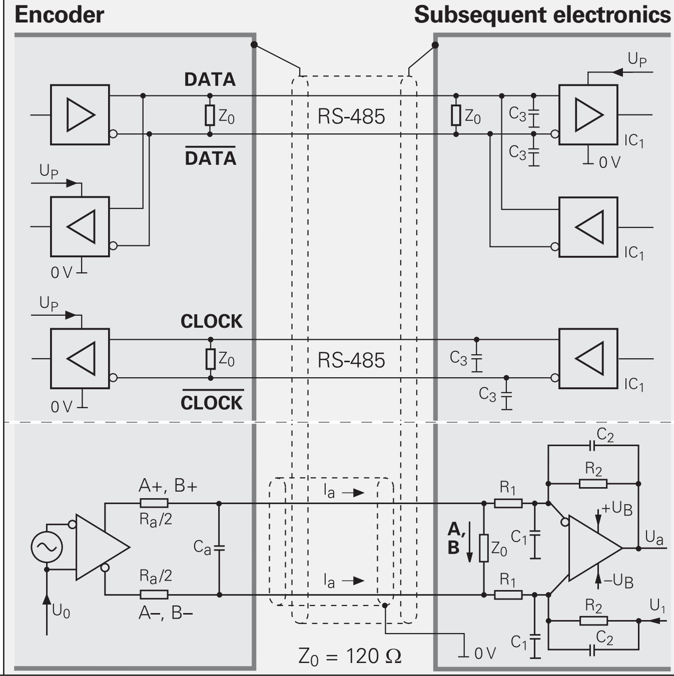
Dimensioning
IC_1 = RS 485 differential line receiver and driver

C_3 = 330 pF
Z_0 = 120 Ω

Data transfer

Encoder **Subsequent electronics**

Incremental signals
Depends on encoder



Versions

The extended EnDat interface version 2.2 is compatible in its communication, command set and time conditions with version 2.1, but also offers significant advantages. It makes it possible, for example, to transfer additional information with the position value without sending a separate request for it. The interface protocol was expanded and the time conditions (clock frequency, processing time, recovery time) were optimized. In addition, encoders with ordering designations EnDat 02 or EnDat 22 have an extended power supply range.

Both EnDat 2.1 and EnDat 2.2 are available in versions with or without incremental signals. EnDat 2.2 encoders feature a high internal resolution. Therefore, depending on the control technology being used, interrogation of the incremental signals is not necessary. To increase the resolution of EnDat 2.1 encoders, the incremental signals are evaluated in the subsequent electronics.

Command set

The command set is the sum of all available mode commands. The EnDat 2.2 command set includes EnDat 2.1 mode commands. When a mode command from the EnDat 2.2 command set is transmitted to EnDat 01 subsequent electronics, the encoder or the subsequent electronics may generate an error message.

EnDat 2.2 command set (includes EnDat 2.1 command set)

- Position values for incremental and absolute encoders
- Additional information on position value
  - Diagnostics and test values
  - Absolute position values after reference run of incremental encoders
  - Parameter upload/download
  - Commutation
  - Acceleration
  - Limit position signal
  - Temperature of the encoder PCB
  - Temperature evaluation of an external temperature sensor (e.g. in the motor winding)

EnDat 2.1 command set

- Absolute position values
- Parameter upload/download
- Reset
- Test command and test values

Interface	Command set	Ordering designation	Version	Clock frequency
EnDat	EnDat 2.1 or EnDat 2.2	EnDat 01	With incremental signals	≤ 2 MHz
		EnDat 21	without incremental signals	
	EnDat 2.2	EnDat 02	With incremental signals	≤ 2 MHz
	EnDat 2.2	EnDat 22	without incremental signals	≤ 8 MHz

Benefits of the EnDat Interface

- **Automatic self-configuration:** All information required by the subsequent electronics is already stored in the encoder
- **High system security** through alarms and messages for monitoring and diagnosis
- **High transmission reliability** through cyclic redundancy checking
- Faster configuration during installation: **Datum shifting** through offsetting by a value in the encoder

Other benefits of EnDat 2.2

- **A single interface** for all absolute and incremental encoders
- **Additional information** (limit switch, temperature, acceleration)
- **Quality improvement:** Position value calculation in the encoder permits shorter sampling intervals (25 µs)

Advantages of purely serial transmission specifically for EnDat 2.2 encoders

- **Simple subsequent electronics** with EnDat receiver chip
- **Simple connection technology:** Standard connecting elements (M12 — 8-pin) single-shielded standard cable and low wiring costs
- **Minimized transmission times** through adaptation of the data word length to the resolution of the encoder
- **High clock frequencies** up to 8 MHz. Position values available in the subsequent electronics after only approx. 10 µs
- **Support for state-of-the-art machine designs** e.g. direct drive technology

Functions

The EnDat interface transmits absolute position values or additional physical quantities (only EnDat 2.2) in an unambiguous time sequence and serves to read from and write to the encoder´s internal memory. Some functions are available only with EnDat 2.2 mode commands.

Position values can be transmitted with or without additional information. The additional information types are selectable via the Memory Range Select (MRS) code. Other functions such as parameter reading and writing can also be called after the memory area and address have been selected. Through simultaneous transmission with the position value, additional information can also be requested of axes in the feedback loop, and functions executed with them.

Parameter reading and writing is possible both as a separate function and in connection with the position value. Parameters can be read or written after the memory area and address is selected.

Reset functions serve to reset the encoder in case of malfunction. Reset is possible instead of or during position value transmission.

Servicing diagnostics make it possible to inspect the position value even at a standstill. A test command has the encoder transmit the required test values.

You can find more information in the *Technical Information* document for EnDat 2.2 or on the Internet at www.endat.de.

Selecting the Transmission Type

Transmitted data are identified as either position values, position values with additional information, or parameters. The type of information to be transmitted is selected by mode commands. **Mode commands** define the content of the transmitted information. Every mode command consists of three bits. To ensure reliable transmission, every bit is transmitted redundantly (inverted or double). If the encoder detects an erroneous mode transmission, it transmits an error message. The EnDat 2.2 interface can also transfer parameter values in the additional information together with the position value. This makes the current position values constantly available for the control loop, even during a parameter request.

Control cycles for transfer of position values

The transmission cycle begins with the first falling **clock edge.** The measured values are saved and the position value calculated. After two clock pulses (2T), to **select the type of transmission** the subsequent electronics transmit the mode command "Encoder transmit position value" (with/without additional information).

After successful calculation of the absolute position value (t_{cal}—see table), the **start bit** begins the data transmission from the encoder to the subsequent electronics. The subsequent **error messages,** error 1 and error 2 (only with EnDat 2.2 commands), are group signals for all monitored functions and serve as failure monitors.

Beginning with the LSB, the encoder then transmits the absolute **position value** as a complete data word. Its length varies depending on which encoder is being used. The number of required clock pulses for transmission of a position value is saved in the parameters of the encoder manufacturer. The data transmission of the position value is completed with the **Cyclic Redundancy Check** (CRC).

In EnDat 2.2, this is followed by additional information 1 and 2, each also concluded with a CRC. With the end of the data word, the clock must be set to HIGH. After 10 to 30 µs or 1.25 to 3.75 µs (with EnDat 2.2 parameterizable recovery time t_m) the data line falls back to LOW. Then a **new data transmission** can begin by starting the clock.

Mode commands

Mode commands		
• Encoder transmit position value • Selection of the memory area • Encoder receive parameters • Encoder transmit parameters • Encoder receive reset[1)] • Encoder transmit test values • Encoder receive test commands	**EnDat 2.1**	**EnDat 2.2**
• Encoder transmit position value with additional information • Encoder transmit position value and receive selection of memory area[2)] • Encoder transmit position value and receive parameters[2)] • Encoder transmit position value and transmit parameters[2)] • Encoder transmit position value and receive error reset[2)] • Encoder transmit position value and receive test command[2)] • Encoder receive communication command[3)]		**EnDat 2.2**

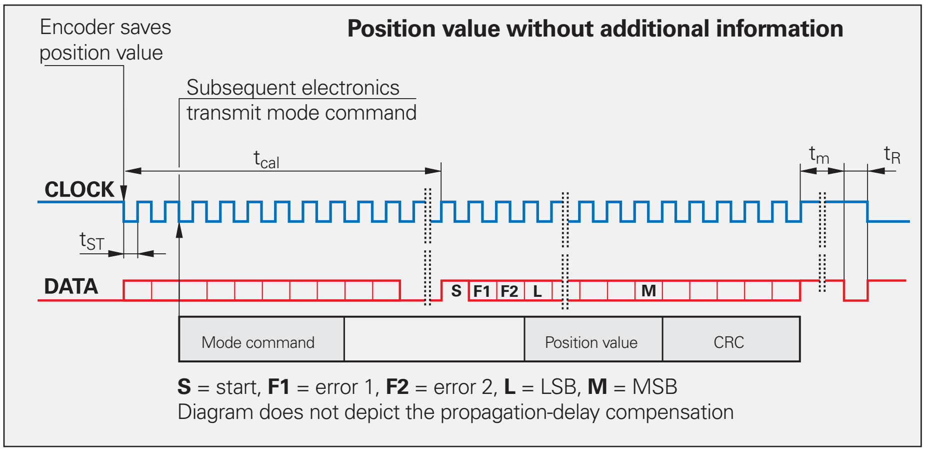
[1)] Same reaction as switching the power supply off and on
[2)] Selected additional information is also transmitted
[3)] Reserved for encoders that do not support the safety system

The time absolute linear encoders need for calculating the position values t_{cal} differs depending on whether EnDat 2.1 or EnDat 2.2 mode commands are transmitted (see *Specifications* in the *Linear Encoders for Numerically Controlled Machine Tools* brochure). If the incremental signals are evaluated for axis control, then the EnDat 2.1 mode commands should be used. Only in this manner can an active error message be transmitted synchronously to the currently requested position value. EnDat 2.1 mode commands should not be used for pure serial position-value transfer for axis control.

		Without delay compensation	**With delay compensation**
Clock frequency	f_c	100 kHz ... 2 MHz	100 kHz ... 8 MHz
Calculation time for **Position value** **Parameters**	 t_{cal} t_{ac}	 See *Specifications* Max. 12 ms	
Recovery time	t_m	*EnDat 2.1:* 10 to 30 µs *EnDat 2.2:* 10 to 30 µs or 1.25 to 3.75 µs ($f_c \geq 1$ MHz) (parameterizable)	
	t_R	Max. 500 ns	
	t_{ST}	–	2 to 10 µs
Data delay time	t_D	(0.2 + 0.01 x cable length in m) µs	
Pulse width	t_{HI} t_{LO}	0.2 to 10 µs 0.2 to 50 ms/30 µs (with LC)	Pulse width fluctuation HIGH to LOW max. 10%

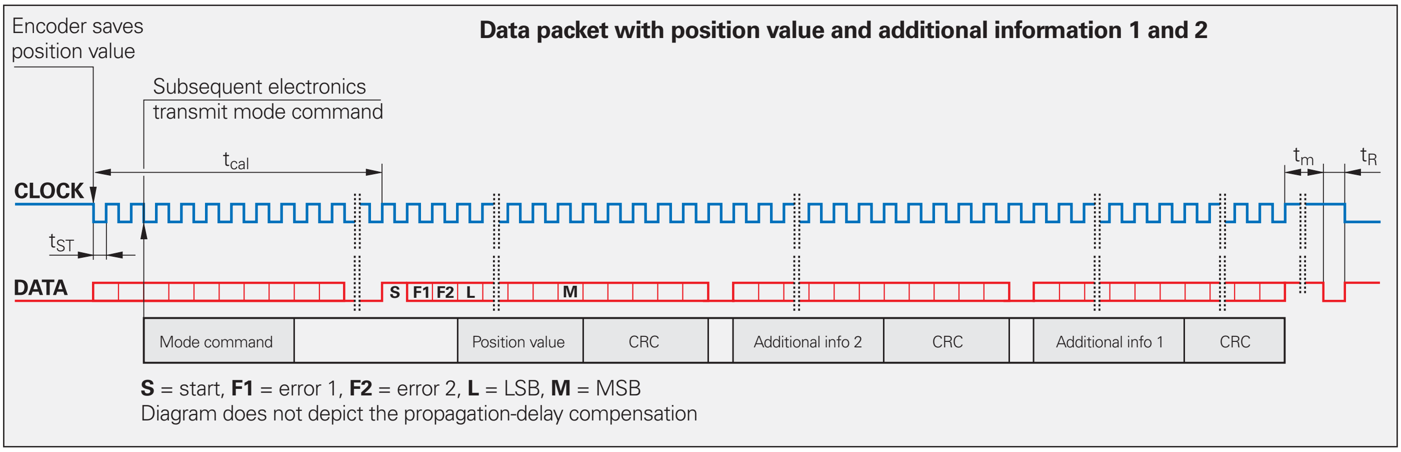
EnDat 2.2 – Transfer of Position Values

EnDat 2.2 can transmit position values with or without additional information.



Position value without additional information

S = start, **F1** = error 1, **F2** = error 2, **L** = LSB, **M** = MSB
Diagram does not depict the propagation-delay compensation



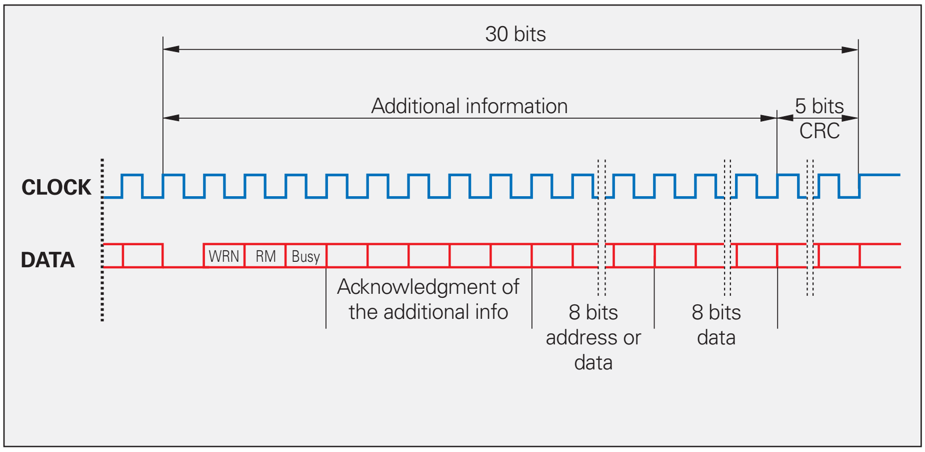
Data packet with position value and additional information 1 and 2

S = start, **F1** = error 1, **F2** = error 2, **L** = LSB, **M** = MSB
Diagram does not depict the propagation-delay compensation

Additional information

With EnDat 2.2, one or two pieces of additional information can be appended to the position value. Each additional information is 30 bits long with LOW as first bit, and ends with a CRC check. The additional information supported by the respective encoder is saved in the encoder parameters.

The content of the additional information is determined by the MRS code and is transmitted in the next sampling cycle for additional information. This information is then transmitted with every sampling until a selection of a new memory area changes the content.



The additional information always begins with:	The additional information can contain the following data:	
Status data Warning – WRN Reference mark – RM Parameter request – Busy **Acknowledgment** of additional information	**Additional information 1** Diagnosis Position value 2 Memory parameters MRS-code acknowledgment Test values Temperature	**Additional information 2** Commutation Acceleration Limit position signals

EnDat 2.1 – Transmission of Position Values

EnDat 2.1 can transmit position values with interrupted clock pulse (as in EnDat 2.2) or continuous clock pulse.

Interrupted clock

The interrupted clock is intended particularly for time-clocked systems such as closed control loops. At the end of the data word the clock signal is set to HIGH level. After 10 to 30 µs (t_m), the data line falls back to LOW. A new data transmission can then begin when started by the clock.

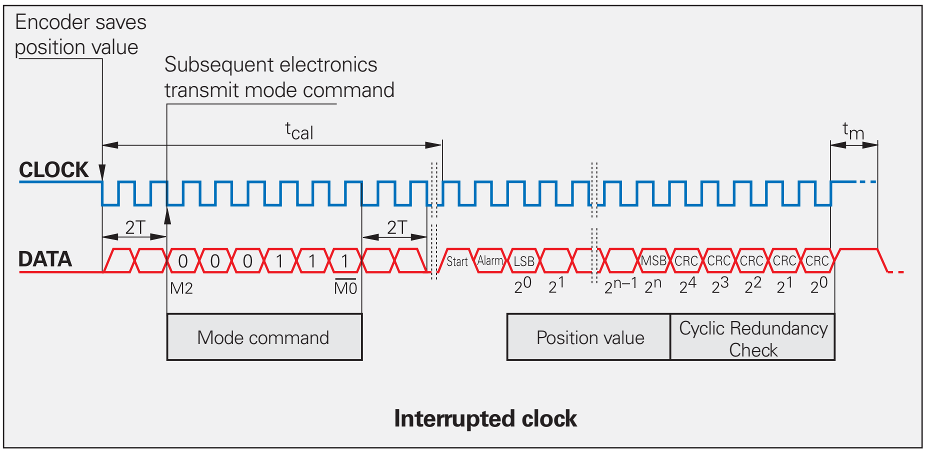
Continuous clock

For applications that require fast acquisition of the measured value, the EnDat interface can have the clock run continuously. Immediately after the last CRC bit has been sent, the data line is switched to high for one clock cycle, and then to low. The new position value is saved with the very next falling edge of the clock and is output in synchronism with the clock signal immediately after the start bit and alarm bit. Because the mode command *Encoder transmit position value* is needed only before the first data transmission, the continuous-clock transfer mode reduces the length of the clock-pulse group by 10 periods per position value.

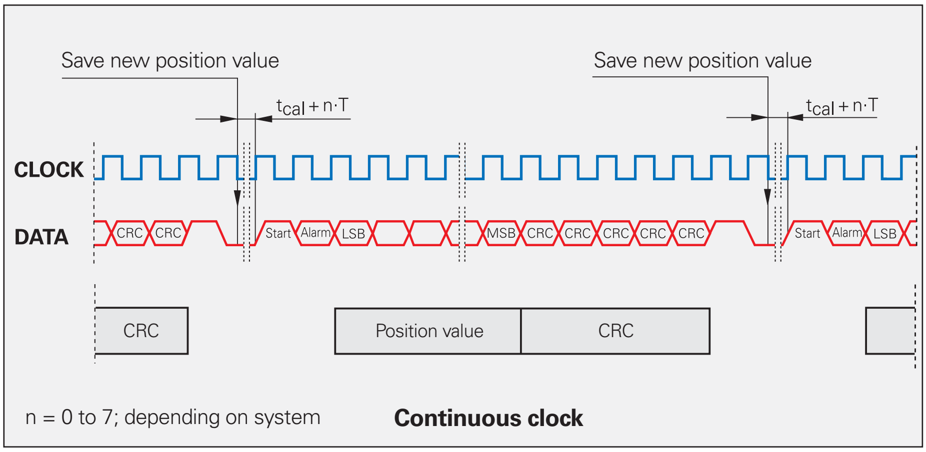
Synchronization of the serially transmitted code value with the incremental signal

Absolute encoders with EnDat interface can exactly synchronize serially transmitted absolute position values with incremental values. With the first falling edge (latch signal) of the CLOCK signal from the subsequent electronics, the scanning signals of the individual tracks in the encoder and counter are frozen, as are the A/D converters for subdividing the sinusoidal incremental signals in the subsequent electronics.

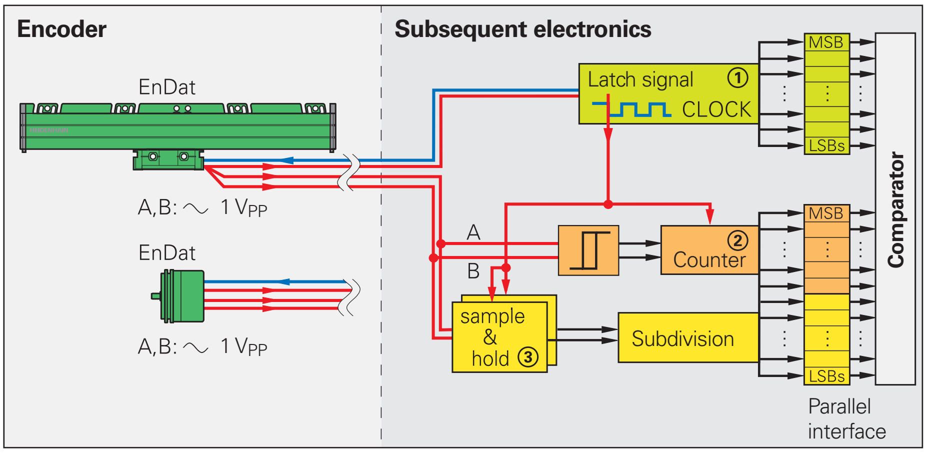
The code value transmitted over the serial interface unambiguously identifies one incremental signal period. The position value is absolute within one sinusoidal period of the incremental signal. The subdivided incremental signal can therefore be appended in the subsequent electronics to the serially transmitted code value.



Interrupted clock



Continuous clock



After power on and initial transmission of position values, two redundant position values are available in the subsequent electronics. Since encoders with EnDat interface guarantee a precise synchronization—regardless of cable length—of the serially transmitted absolute value with the incremental signals, the two values can be compared in the subsequent electronics. This monitoring is possible even at high shaft speeds thanks to the EnDat interface's short transmission times of less than 50 µs. This capability is a prerequisite for modern machine design and safety systems.

Parameters and Memory Areas

The encoder provides several memory areas for parameters. These can be read from by the subsequent electronics, and some can be written to by the encoder manufacturer, the OEM, or even the end user. Certain memory areas can be write-protected.

The parameters, which in most cases are set by the OEM, largely define the function of the encoder and the EnDat interface. When the encoder is exchanged, it is therefore essential that its parameter settings are correct. Attempts to configure machines without including OEM data can result in malfunctions. If there is any doubt as to the correct parameter settings, the OEM should be consulted.

Parameters of the encoder manufacturer

This write-protected memory area contains all **information specific to the encoder,** such as encoder type (linear/angular, singleturn/multiturn, etc.), signal periods, position values per revolution, transmission format of position values, direction of rotation, maximum speed, accuracy dependent on shaft speeds, warnings and alarms, part number and serial number. This information forms the basis for **automatic configuration.** A separate memory area contains the parameters typical for EnDat 2.2: Status of additional information, temperature, acceleration, support of diagnostic and error messages, etc.

Parameters of the OEM

In this freely definable memory area, the OEM can store his information, e.g. the "electronic ID label" of the motor in which the encoder is integrated, indicating the motor model, maximum current rating, etc.

Operating parameters

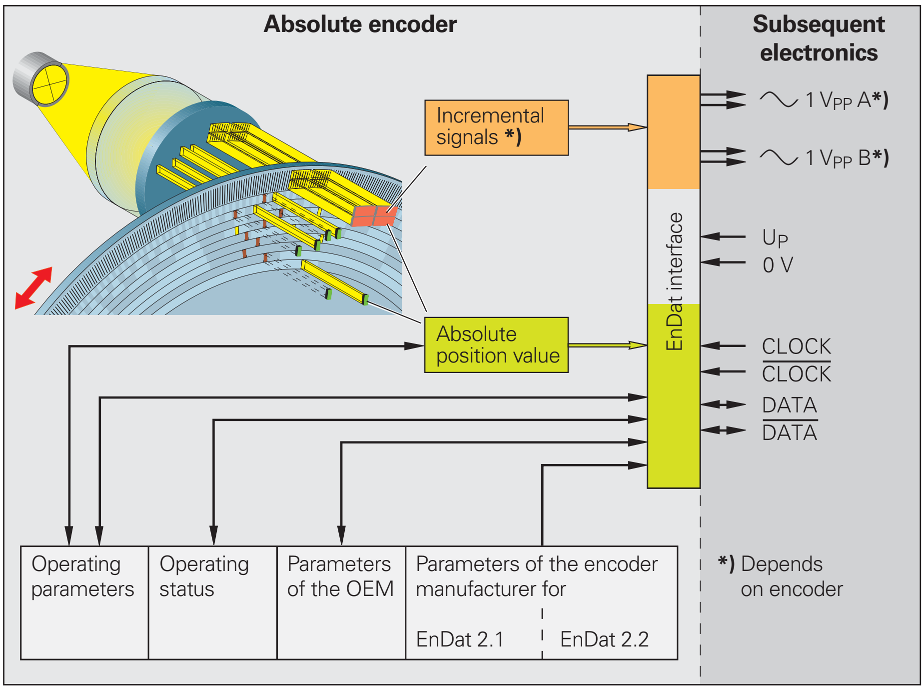
This area is available for a **datum shift** and the configuration of diagnostics. It can be protected against overwriting.

Operating status

This memory area provides detailed alarms or warnings for diagnostic purposes. Here it is also possible to activate write protection for the OEM parameter and operating parameter memory areas, and to interrogate their status. Once **write protection** is activated, it cannot be removed.

Safety System

The safety system is in preparation. Safety-oriented controls are the planned application for encoders with EnDat 2.2 interface. The ISO 13849-1 (previously EN 954-1) and IEC 61508 standards serve as the foundation for this.



Monitoring and Diagnostic Functions

The EnDat interface enables comprehensive monitoring of the encoder without requiring an additional transmission line. The alarms and warnings supported by the respective encoder are saved in the "parameters of the encoder manufacturer" memory area.

Error message

An error message becomes active if a **malfunction of the encoder** might result in incorrect position values. The exact cause of the disturbance is saved in the "operating status" memory and can be interrogated in detail. Errors include, for example,

- Light unit failure
- Signal amplitude too low
- Error in calculation of position value
- Power supply too high/low
- Current consumption is excessive

Here the EnDat interface transmits the error bits, error 1 and error 2 (only with EnDat 2.2 commands). These are group signals for all monitored functions and serve for failure monitoring. The two error messages are generated independently from each other.

Warning

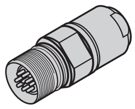
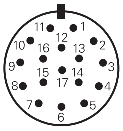
This collective bit is transmitted in the status data of the additional information. It indicates that certain **tolerance limits of the encoder** have been reached or exceeded—such as shaft speed or the limit of light source intensity compensation through voltage regulation—without implying that the measured position values are incorrect. This function makes it possible to issue preventive warnings in order to minimize idle time.

Cyclic Redundancy Check

To ensure **reliability of data transfer,** a cyclic redundancy check (CRC) is performed through the logical processing of the individual bit values of a data word. This 5-bit long CRC concludes every transmission. The CRC is decoded in the receiver electronics and compared with the data word. This largely eliminates errors caused by disturbances during data transfer.

Pin Layout EnDat

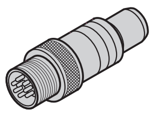
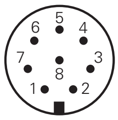
17-pin M23 coupling

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

Shield on housing; **U_P** = power supply voltage
Sensor: The sensor line is connected internally with the corresponding power line
Vacant pins or wires must not be used!
[1] Only with ordering designations EnDat 01 and EnDat 02

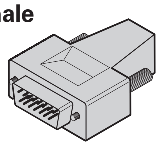
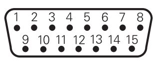
8-pin M12 coupling

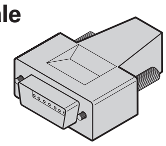
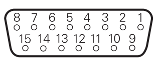
	Power supply				Absolute position values			
	2	8	1	5	3	4	7	6
	U_P[1]	**U_P**	**0 V**[1]	**0 V**	**DATA**	**$\overline{\text{DATA}}$**	**CLOCK**	**$\overline{\text{CLOCK}}$**
	Blue	Brown/Green	White	White/Green	Gray	Pink	Violet	Yellow

Shield on housing; **U_P** = power supply voltage
Vacant pins or wires must not be used!
[1] For parallel supply lines

15-pin D-sub connector, male
for IK 115/IK 215

15-pin D-sub connector, female
for HEIDENHAIN controls
and IK 220

	Power supply					Incremental signals[1]				Absolute position values			
	4	12	2	10	6	1	9	3	11	5	13	8	15
	1	9	2	11	13	3	4	6	7	5	8	14	15
	U_P	**Sensor** U_P	**0 V**	**Sensor** 0 V	**Inside shield**	**A+**	**A–**	**B+**	**B–**	**DATA**	**$\overline{\text{DATA}}$**	**CLOCK**	**$\overline{\text{CLOCK}}$**
	Brown/ Green	Blue	White/ Green	White	/	Green/ Black	Yellow/ Black	Blue/ Black	Red/ Black	Gray	Pink	Violet	Yellow

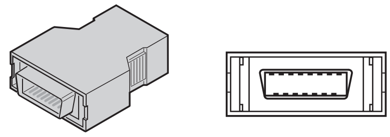
Shield on housing; **U_P** = power supply voltage
Sensor: The sensor line is connected internally with the corresponding power line
Vacant pins or wires must not be used!
[1] Only with ordering designations EnDat 01 and EnDat 02

Interfaces
Fanuc and Mitsubishi Pin Layouts

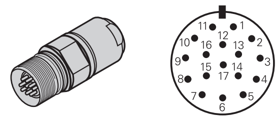
Fanuc pin layout
HEIDENHAIN encoders with the code letter F after the model designation are suited for connection to Fanuc controls with

- **Fanuc 01 serial interface** with 1 MHz communication rate
- **Fanuc 02 serial interface** with 1 MHz or 2 MHz communication rate

15-pin Fanuc connector



17-pin HEIDENHAIN coupling

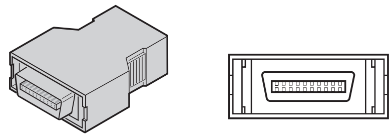


	Power supply					Absolute Position Values			
	9	**18/20**	**12**	**14**	**16**	**1**	**2**	**5**	**6**
	7	**1**	**10**	**4**	**–**	**14**	**17**	**8**	**9**
	U_P	**Sensor** U_P	**0 V**	**Sensor** 0 V	**Shield**	**Serial Data**	**$\overline{\text{Serial Data}}$**	**Request**	**$\overline{\text{Request}}$**
	Brown/ Green	Blue	White/ Green	White	–	Gray	Pink	Violet	Yellow

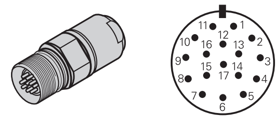
Shield on housing; **U_P** = power supply voltage
Sensor: The sensor line is connected internally with the corresponding power line
Vacant pins or wires must not be used!

Mitsubishi pin layout
HEIDENHAIN encoders with the code letter M after the model designation are suited for connection to controls with the **Mitsubishi high-speed serial interface.**

10 or 20-pin Mitsubishi connector



17-pin HEIDENHAIN coupling



	Power supply				Absolute Position Values			
10-pin	**1**	**–**	**2**	**–**	**7**	**8**	**3**	**4**
20-pin	**20**	**19**	**1**	**11**	**6**	**16**	**7**	**17**
	7	**1**	**10**	**4**	**14**	**17**	**8**	**9**
	U_P	**Sensor** U_P	**0 V**	**Sensor** 0 V	**Serial Data**	**$\overline{\text{Serial Data}}$**	**Request frame**	**$\overline{\text{Request frame}}$**
	Brown/Green	Blue	White/Green	White	Gray	Pink	Violet	Yellow

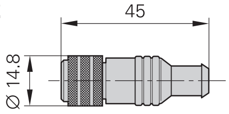
Shield on housing; **U_P** = power supply voltage
Sensor: The sensor line is connected internally with the corresponding power line
Vacant pins or wires must not be used!

Connecting Elements and Cables
General Information

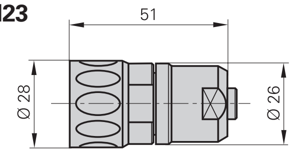
Insulated **connector:** Connecting element with coupling ring; available with male or female contacts.

Symbols 

M12



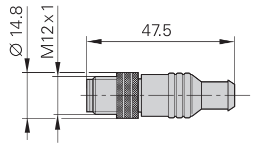
M23



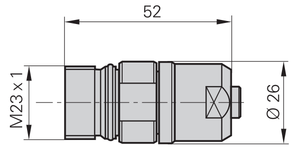
Insulated **coupling:**
Connecting element with external thread; available with male or female contacts.

Symbols 

M12

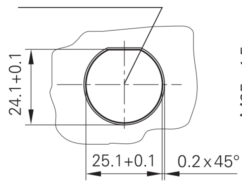


M23

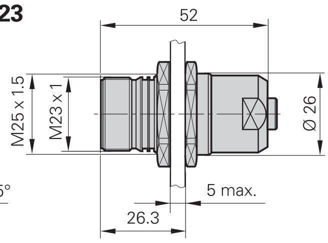


Mounted coupling with central fastening

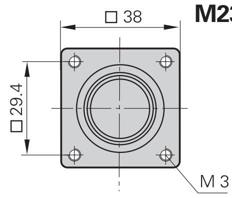
Cutout for mounting



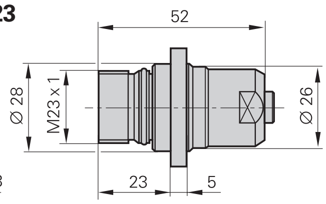
M23



Mounted coupling with flange



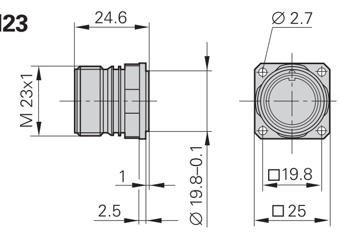
M23



Flange socket: Permanently mounted on the encoder or a housing, with external thread (like the coupling), and available with male or female contacts.

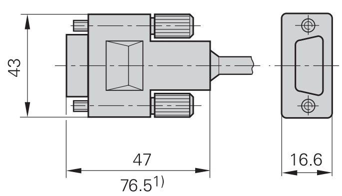
Symbols 

M23



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

Symbols 



1) with integrated interpolation electronics

The pins on connectors are **numbered** in the direction opposite to those on couplings or flange socket, regardless of whether the contacts are

male contacts
or
female contacts.

When engaged, the connections provide **protection** to IP 67 (D-sub connector: IP 50; IEC 60529). When not engaged, there is no protection.

Accessories for flange socket and M23 mounted couplings

Bell seal
Id. Nr. 266 526-01

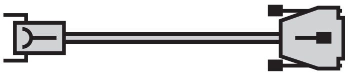
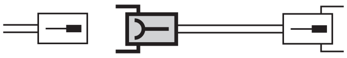
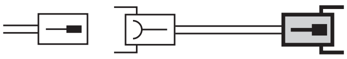
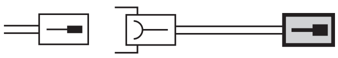
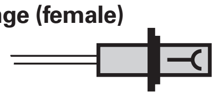
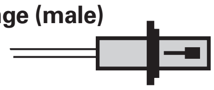
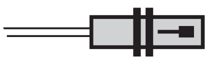
Threaded metal dust cap
Id. Nr. 219 926-01

Connecting Cables ∿ 1 V_{PP} ⊓⊔TTL — 12-pin M23

		∿ 1 V_{PP} ⊓⊔ TTL
PUR connecting cable	**12-pin:** [4(2 × 0.14 mm^2) + (4 × 0.5 mm^2)] **Ø 8 mm**	
Complete with connector (female) and coupling (male)		298 401-xx
Complete with connector (female) and connector (male)		298 399-xx
Complete with connector (female) and D-sub connector (female) for IK 220		310 199-xx
Complete with connector (female) and D-sub connector (male) for IK 115/IK 215		310 196-xx
With one connector (female)		309 777-xx
Cable only, Ø 8 mm		244 957-01
Mating element on connecting cable to connector on encoder cable	**Connector (female)** for cable Ø 8 mm	291 697-05
Connector on cable for connection to subsequent electronics	**Connector (male)** for cable Ø 8 mm Ø 6 mm	291 697-08 291 697-07
Coupling on connecting cable	**Coupling (male)** for cable Ø 4.5 mm Ø 6 mm Ø 8 mm	291 698-14 291 698-03 291 698-04
Flange socket for mounting on the subsequent electronics	**Coupling (female)**	315 892-08
Mounted couplings	**With flange (female)** Ø 6 mm Ø 8 mm	291 698-17 291 698-07
	With flange (male) Ø 6 mm Ø 8 mm	291 698-08 291 698-31
	With central fastening (male) Ø 6 mm	291 698-33
Adapter connector ∿ **1 V_{PP}/11 µA_{PP}** For converting the 1 V_{PP} signals to 11 µA_{PP}; M23 connector (female) 12-pin and M23 connector (male) 9-pin		364 914-01

Connecting Cables EnDat

8-pin M12 | 17-pin M23

		EnDat without Incremental signals	**EnDat** with incremental signals
PUR connecting cable	**8-pin:** [(4 × 0.14 mm^2) + (4 × 0.34 mm^2)] **Ø 6 mm** **17-pin:** [(4 × 0.14 mm^2) + 4(2 × 0.14 mm^2) + (4 × 0.5 mm^2)] **Ø 8 mm**		
Complete with connector (female) and coupling (male)		368330-xx	323897-xx
Complete with connector (female) and D-sub connector (female) for IK 220		530627-xx	332115-xx
Complete with connector (female) and D-sub connector (male) for IK 115/IK 215		524599-xx	324544-xx
With one connector (female)		559346-xx	309778-xx
Cable only, Ø 8 mm		–	266306-01
Mating element on connecting cable to connector on encoder cable	**Connector (female)** for cable Ø 8 mm 	–	291697-26
Connector on cable for connection to subsequent electronics	**Connector (male)** for cable Ø 8 mm Ø 6 mm 	–	291697-27
Coupling on connecting cable	**Coupling (male)** for cable Ø 4.5 mm Ø 6 mm Ø 8 mm 	–	291698-25 291698-26 291698-27
Flange socket for mounting on the subsequent electronics	**Coupling (female)** 	–	315892-10
Mounted couplings	**With flange (female)** Ø 6 mm Ø 8 mm 	**–**	291698-35
	With flange (male) Ø 6 mm Ø 8 mm 	–	291698-41 291698-29
	With central fastening (male) Ø 6 mm 	–	291698-37

Connecting Cables Fanuc
Mitsubishi

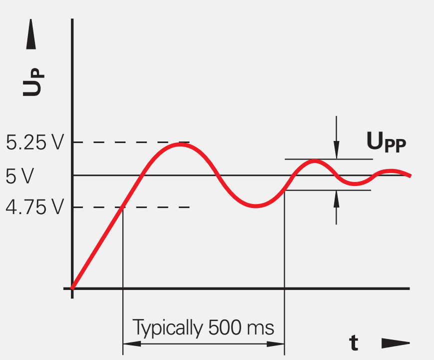
		Cable	Fanuc	Mitsubishi
PUR connecting cable				
Complete with M23 connector (female), 17-pin and Fanuc connector [(2 x 2 x 0.14 mm^2) + (4 x 1 mm^2)]		Ø 8 mm	534 855-xx	–
Complete with M23 connector (female), 17-pin and Mitsubishi connector, 20-pin [(2 x 2 x 0.14 mm^2) + (4 x 0,5 mm^2)]		Ø 6 mm	–	367 958-xx
Complete with M23 connector (female), 17-pin and Mitsubishi connector, 10-pin [(2 x 2 x 0.14 mm^2) + (4 x 1 mm^2)]		Ø 8 mm	–	573 661-xx
Cable only [(2 x 2 x 0.14 mm^2) + (4 x 1 mm^2)]		Ø 8 mm	354 608-01	

General Electrical Information

Power supply

The encoders require a **stabilized dc voltage U_P** as power supply. The respective specifications state the required power supply and the current consumption. The permissible ripple content of the dc voltage is:

- High frequency interference
  $U_{PP} < 250$ mV with $dU/dt > 5$ V/µs
- Low frequency fundamental ripple
  $U_{PP} < 100$ mV



Initial transient response of the supply voltage e.g. 5 V ± 5 %

The values apply as measured at the encoder, i.e., without cable influences. The voltage can be monitored and adjusted with the device´s **sensor lines.** If a controllable power supply is not available, the voltage drop can be halved by switching the sensor lines parallel to the corresponding power lines.

Calculation of the **voltage drop:**

$$\Delta U = 2 \cdot 10^{-3} \cdot \frac{L_C \cdot I}{56 \cdot A_P}$$

where
- ΔU: Line drop in V
- L_C: Cable length in m
- I: Current consumption of the encoder in mA (see *Specifications*)
- A_P: Cross section of power lines in mm^2

HEIDENHAIN cables	**Cross section** of power supply lines A_P			
	1 V_{PP}/TTL/HTL	**11 μA_{PP}**	**EnDat/SSI** 17-pin	**EnDat** 8-pin
Ø 3.7 mm	0.05 mm^2	–	–	–
Ø 4.5/5.1 mm	0.14/0.05[2)] mm^2	0.05 mm^2	0.05 mm^2	–
Ø 6/10[1)] mm	0.19/ 0.14[3)] mm^2	–	0.08 mm^2	0.34 mm^2
Ø 8/14[1)] mm	0.5 mm^2	1 mm^2	0.5 mm^2	1 mm^2

1) Metal armor
2) Only on length gauges
3) Only for LIDA 400

Electrically permissible speed/ Traversing speed

The maximum permissible shaft speed or traversing velocity of an encoder is derived from
- the **mechanically** permissible shaft speed/traversing velocity (if listed in *Specifications*)
  and
- the **electrically** permissible shaft speed or traversing velocity.

For encoders with **sinusoidal output signals,** the electrically permissible shaft speed or traversing velocity is limited by the –3dB/ –6dB cutoff frequency or the permissible input frequency of the subsequent electronics.
For encoders with **square-wave signals,** the electrically permissible shaft speed/ traversing velocity is limited by
- the maximum permissible scanning frequency f_{max} of the encoder
  and
- the minimum permissible edge separation *a* for the subsequent electronics

For angular or rotary encoders

$$n_{max} = \frac{f_{max}}{z} \cdot 60 \cdot 10^3$$

For linear encoders

$$v_{max} = f_{max} \cdot SP \cdot 60 \cdot 10^{-3}$$

where
- n_{max}: Electrically permissible speed in rpm,
- v_{max}: Electrically permissible speed in m/min
- f_{max}: Maximum scanning/output frequency of the encoder or input frequency of the subsequent electronics in kHz,
- z: Line count of the angle or rotary encoder per 360°
- SP: Signal period of the linear encoder in µm

Cables

Lengths
The cable lengths listed in the *Specifications* apply only for HEIDENHAIN cables and the recommended input circuitry of subsequent electronics.

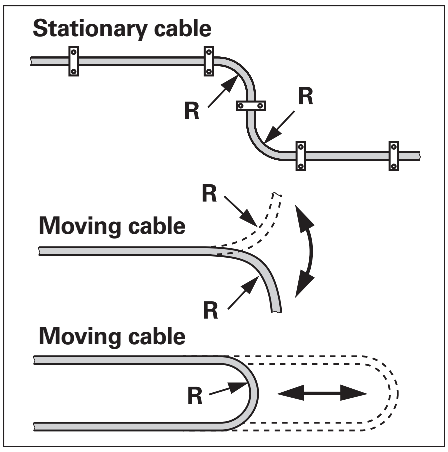
Durability
All encoders have polyurethane (PUR) cables. PUR cables are resistant to oil, hydrolysis and microbes in accordance with **VDE 0472.** They are free of PVC and silicone and comply with UL safety directives. The **UL certification** AWM STYLE 20963 80 °C 30 V E63216 is documented on the cable.

Temperature range
HEIDENHAIN cables can be used:

for rigid configuration	–40 to 85 °C
for moving cables	–10 to 85 °C

Cables with limited resistance to hydrolysis and microbes are rated for up to 100 °C.

Bending radius
The permissible bending radii R depend on the cable diameter and the configuration:



HEIDENHAIN cables	Stationary cable	Moving cable
Ø 3.7 mm	R ≥ 8 mm	R ≥ 40 mm
Ø 4.5 mm **Ø 5.1 mm**	R ≥ 10 mm	R ≥ 50 mm
Ø 6 mm	R ≥ 20 mm	R ≥ 75 mm
Ø 8 mm	R ≥ 40 mm	R ≥ 100 mm
Ø 10 mm[1)]	R ≥ 35 mm	R ≥ 75 mm
Ø 14 mm[1)]	R ≥ 50 mm	R ≥ 100 mm

Reliable Signal Transmission

Electromagnetic compatibility/ CE compliance
When properly installed, HEIDENHAIN encoders fulfill the requirements for electromagnetic compatibility according to 89/336/EEC with respect to the generic standards for:

- **Noise immunity (IEC 61000-6-2)**
  Specifically:
  - ESD EN 61000-4-2
  - Electromagnetic fields EN 61000-4-3
  - Burst EN 61000-4-4
  - Surge EN 61000-4-5
  - Conducted disturbances EN 61000-4-6
  - Power frequency magnetic fields EN 61000-4-8
  - Pulse magnetic fields EN 61000-4-9
- **Interference (EN 61000-6-4):**

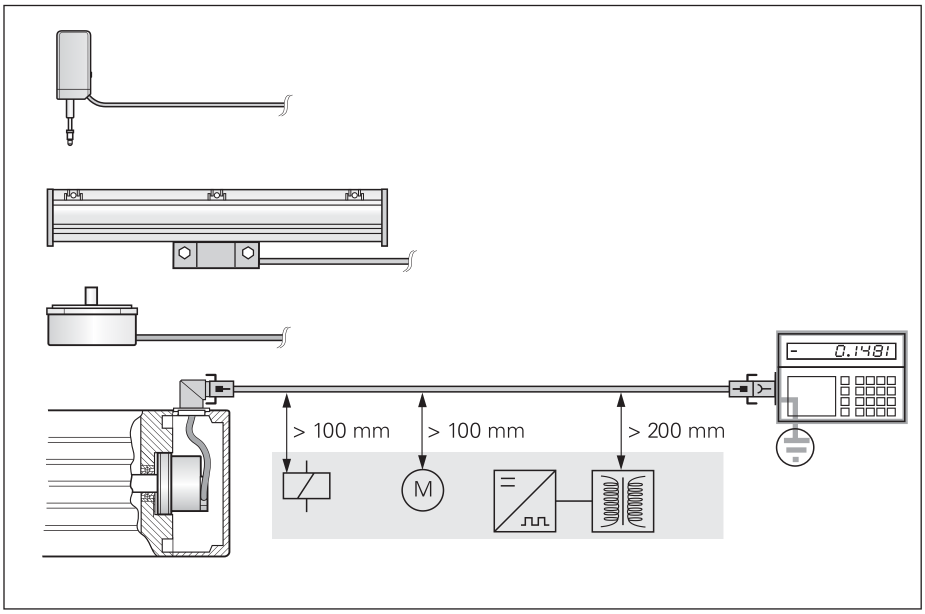
Specifically:
- For industrial, scientific and medical (ISM) equipment EN 55011
- For information technology equipment EN 55022

Transmission of measuring signals—electrical noise immunity
Noise voltages arise mainly through capacitive or inductive transfer. Electrical noise can be introduced into the system over signal lines and input or output terminals.
Possible sources of noise are:
- Strong magnetic fields from transformers and electric motors
- Relays, contactors and solenoid valves
- High-frequency equipment, pulse devices, and stray magnetic fields from switch-mode power supplies
- AC power lines and supply lines to the above devices

Isolation
The encoder housings are isolated against all circuits.
Rated surge voltage: 500 V
(preferred value as per VDE 0110 Part 1)

Protection against electrical noise
The following measures must be taken to ensure disturbance-free operation:
- Use only original HEIDENHAIN cables. Watch for voltage attenuation on the supply lines.
- Use connectors or terminal boxes with metal housings. Do not conduct any extraneous signals.
- Connect the housings of the encoder, connector, terminal box and evaluation electronics through the shield of the cable. Connect the shielding in the area of the cable inlets to be as induction-free as possible (short, full-surface contact).
- Connect the entire shielding system with the protective ground.
- Prevent contact of loose connector housings with other metal surfaces.
- The cable shielding has the function of an equipotential bonding conductor. If compensating currents are to be expected within the entire system, a separate equipotential bonding conductor must be provided. Also see **EN 50178**/4.98 Chapter 5.2.9.5 regarding "protective connection lines with small cross section."
- Connect HEIDENHAIN position encoders only to subsequent electronics whose power supply is generated through double or strengthened insulation against line voltage circuits. Also see **IEC 364-4-41:** 1992, modified Chapter 411 regarding "protection against both direct and indirect touch" (PELV or SELV).
- Do not lay signal cables in the direct vicinity of interference sources (inductive consumers such as contacts, motors, frequency inverters, solenoids, etc.).
- Sufficient decoupling from interference-signal-conducting cables can usually be achieved by an air clearance of 100 mm or, when cables are in metal ducts, by a grounded partition.
- A minimum spacing of 200 mm to inductors in switch-mode power supplies is required. Also see **EN 50178**/4.98 Chapter 5.3.1.1 regarding cables and lines, **EN 50174-2**/09.01, Chapter 6.7 regarding grounding and potential compensation.
- When using **multiturn encoders in electromagnetic fields** greater than 30 mT, HEIDENHAIN recommends consulting with the main facility in Traunreut.

Both the cable shielding and the metal housings of encoders and subsequent electronics have a shielding function. The housings must have the **same potential** and be connected to the main signal ground over the machine chassis or by means of a separate potential compensating line. Potential compensating lines should have a minimum cross section of 6 mm^2 (Cu).



Minimum distance from sources of interference

Evaluation and Display Units

ND 281 B
Position Display Unit
The ND 281 B position display unit contains special display ranges for angle measurement. You can directly connect incremental angle encoders with ~ $1\text{-}V_{PP}$ output signals and any line count up to 999 999 signal periods per revolution. The display value is available via the RS-232-C/V.24 interface for further processing or print-out.

For more information, see the *Numerical Displays for Length and Angle* catalog.

	ND 281 B	
Input signals	~ $1\ V_{PP}$	~ $11\ \mu A_{PP}$
Encoder inputs	Flange socket, 12-pin female	Flange socket, 9-pin female
Input frequency	Max. 500 kHz	Max. 100 kHz
Max. cable length	60 m	30 m
Signal subdivision	Up to 1024-fold (adjustable)	
Display step (adjustable)	*Decimal degrees:* 0.1° to 0.000 002° *Degrees, minutes, seconds:* to 1"	
Display range (adjustable)	0 to 360° –180° .... 0 ..... +180° 0 to ± max. display range	
Features	Sorting and tolerance check mode with two limit values Display freeze Two switching limits REF reference mark evaluation	
External operation	Zero reset, preset and latch command	
Interface	RS-232-C/V.24; max. 38 400 baud	

IBV Series
Interpolation and Digitizing Electronics
Interpolation and digitizing electronics interpolate and digitize the sinusoidal output signals (~ $1\ V_{PP}$) from HEIDENHAIN encoders up to 100-fold, and convert them to TTL square-wave pulse sequences.

IBV 101

For more information, see the *Interpolation and Digitizing Electronics* brochure for IBV 660 as well as the *IBV 100/EXE 100* product overview.

	IBV 101	IBV 102	IBV 660
Input signals	~ $1\ V_{PP}$		
Encoder inputs	Flange socket, 12-pin female		
Interpolation (adjustable)	5-fold 10-fold	25-fold 50-fold 100-fold	25-fold 50-fold 100-fold 200-fold 400-fold
Minimum edge separation	Adjustable from 2 to 0.125 µs, depending on input frequency		Adjustable from 0.8 to 0.1 µs, depending on input frequency
Output signals	• Two TTL square-wave pulse trains U_{a1} and U_{a2} and their inverted signals $\overline{U_{a1}}$ and $\overline{U_{a2}}$ • Reference pulse U_{a0} and $\overline{U_{a0}}$ • Fault detection signal $\overline{U_{aS}}$		
Power supply	5 V ± 5%		

IK 220
Universal PC Counter Card
The IK 220 is an expansion board for AT-compatible PCs for recording the measured values of **two incremental or absolute linear or angle encoders.** The subdivision and counting electronics **subdivide** the **sinusoidal input signals** to generate up to **4096 measuring steps** per input signal period. A driver software package is included in delivery.

For more information, see the *IK 220 Product Information* sheet.

	IK 220			
Input signals (switchable)	∿ 1 V_{PP}	∿ 11 μA_{PP}	EnDat 2.1	SSI
Encoder inputs	Two D-sub connectors (15-pin), male			
Max. input frequency	500 kHz	33 kHz	–	
Max. cable length	60 m		10 m	
Signal subdivision (signal period to meas. step)	Up to 4096-fold			
Data register for measured values (per channel)	48 bits (44 bits used)			
Internal memory	For 8192 position values			
Interface	PCI bus (plug and play)			
Driver software and demonstration program	**For WINDOWS 98/NT/2000/XP** In VISUAL C++, VISUAL BASIC and BORLAND DELPHI			
Dimensions	Approx. 190 mm × 100 mm			

HEIDENHAIN Measuring Equipment
For Incremental Angle Encoders

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

	PWM 9
Inputs	Expansion modules (interface boards) for 11 μA_{PP}; 1 V_{PP}; TTL; HTL; EnDat*/SSI*/commutation signals *No display of position values or parameters
Features	• **Measures** signal amplitudes, current consumption, operating voltage, scanning frequency • **Graphically displays** incremental signals (amplitudes, phase angle and on-off ratio) and the reference-mark signal (width and position) • **Displays symbols** for the reference mark, fault detection signal, counting direction • **Universal counter,** interpolation selectable from single to 1024-fold • **Adjustment support** for exposed linear encoders
Outputs	• Inputs are connected through to the subsequent electronics • BNC sockets for connection to an oscilloscope
Power supply	10 to 30 V, max. 15 W
Dimensions	150 mm × 205 mm × 96 mm

The **PWT** is a simple adjusting aid for HEIDENHAIN incremental encoders. In a small LCD window the signals are shown as bar charts with reference to their tolerance limits.

	PWT 10	PWT 17	PWT 18
Encoder input	∿ 11 μA_{PP}	⊓⊔ TTL	∿ 1 V_{PP}
Features	Measurement of signal amplitude Wave-form tolerance Amplitude and position of the reference mark signal		
Power supply	Via power supply unit (included)		
Dimensions	114 mm x 64 mm x 29 mm		

For Absolute Angle Encoders

The **IK 215** is an adapter card for PCs for inspecting and testing absolute HEIDENHAIN encoders with EnDat or SSI interface. Parameters can be read and written via the EnDat interface.

	IK 215
Encoder inputs	EnDat 2.1 (absolute value or incremental signals) or SSI
Interface	PCI bus, Rev. 2.1
Application software	**Operating system:** Windows 2000/XP **Features:** Display of position value Counter for incremental signals EnDat functions Mounting software for ExI 1100/1300
Signal subdivision for incremental signals	Up to 1024-fold
Dimensions	100 mm x 190 mm

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