



HEIDENHAIN

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Angle Encoders with Integral Bearing

November 2010





Angle encoders with integral bearing
and integrated stator coupling



Angle encoders with integral bearing
for separate shaft coupling

Information on

- Absolute Angle Encoders with Optimized Scanning
- Angle Encoders without Integral Bearing
- Rotary Encoders
- Encoders for Servo Drives
- Exposed Linear Encoders
- Linear Encoders for Numerically Controlled Machine Tools
- Interface Electronics
- HEIDENHAIN controls

is available on request as well as on the Internet at 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.

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Specifications		Series or Model	System Accuracy	
Angle encoders with integral bearing and integrated stator coupling		RCN 200 Series	± 5" / ± 2.5"	24
		RON 200 Series	± 5" / ± 2.5"	26
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		RCN 700/RCN 800 Series	± 2" / ± 1" Ø 60 mm	30
				Ø 100 mm
		RON 786	± 2"	34
		RON 886/RPN 886	± 1"	
		RON 905	± 0.4"	36
Angle encoders with integral bearing for separate shaft coupling		ROD 200 Series	± 5"	38
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			± 1"	
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HEIDENHAIN Angle Encoders

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

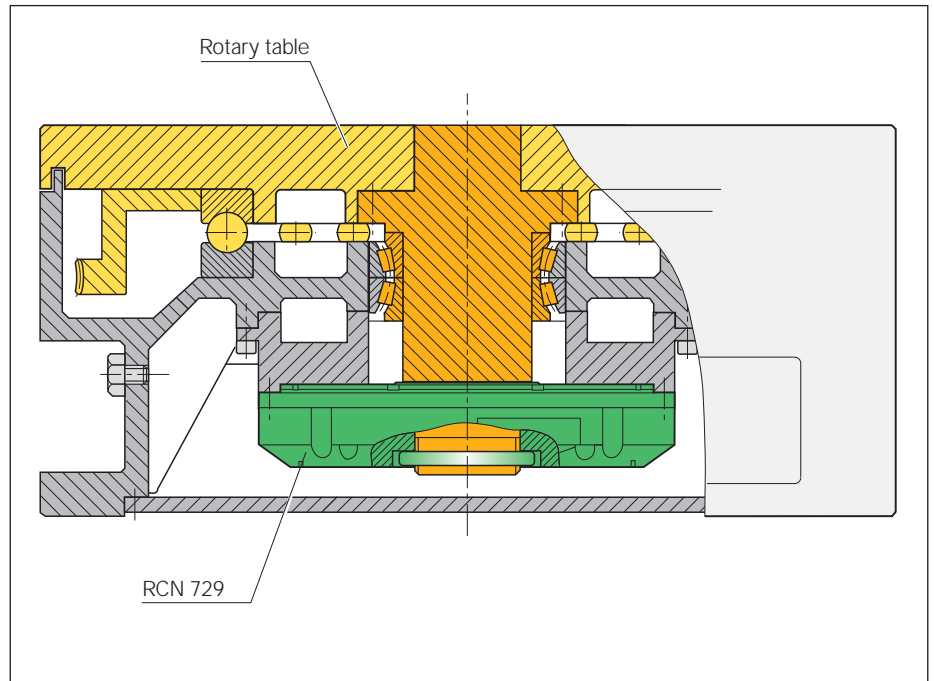
In contrast, rotary encoders are encoders that typically have an accuracy better than $\pm 10''$.

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 various applications and meet different requirements.



The **RCN 729** angle encoder mounted on 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 absorb only 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 deviations from the shaft coupling.

Other advantages:

- Compact size for limited installation space
- Hollow shaft diameters up to 100 mm to provide space for power lines, etc.
- Simple installation

Selection Guide

For Absolute Angle Encoders

see pages 6/7

For Incremental Angle Encoders

see pages 8/9



RCN 729 incremental angle encoder



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

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



ERA 4000 incremental angle encoder

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:

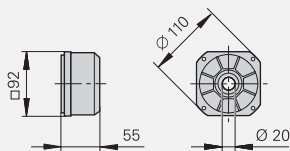
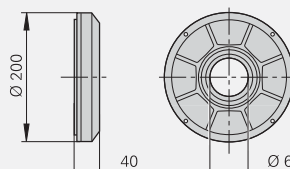
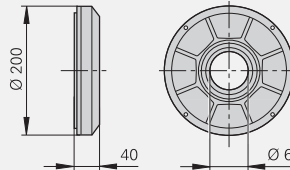
- Large hollow shaft diameters (up to 10 m with a scale tape)
- High shaft speeds up to 20000 min^{-1}
- No additional starting torque from shaft seals
- Segment angles

Selection Guide on pages 10/11

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

Selection Guide

Absolute Angle Encoders with Integral Bearing

Series	Overall dimensions in mm	System accuracy	Recommended measuring step ¹⁾	Mechanically permissible speed	Incremental signals	Signal periods/ revolution
With integrated stator coupling						
RCN 200		± 5"	0.0001°	3000 min ⁻¹	~ 1 V _{pp}	16384
					—	—
					—	—
					—	—
		± 2.5"			~ 1 V _{pp}	16384
					—	—
RCN 700		± 2"	0.0001°	1000 min ⁻¹	~ 1 V _{pp}	32768
					—	—
					—	—
					—	—
					~ 1 V _{pp}	32768
					—	—
RCN 800		± 1"	0.00005°	1000 min ⁻¹	~ 1 V _{pp}	32768
					—	—
					—	—
					—	—
					~ 1 V _{pp}	32768
					—	—

¹⁾ For position measurement

For information about the new absolute angle encoders with optimized scanning, visit www.heidenhain.de or ask for our catalog: *Absolute Angle Encoders with Optimized Scanning*.

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



RCN 200



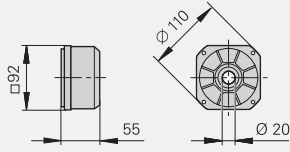
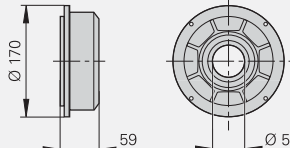
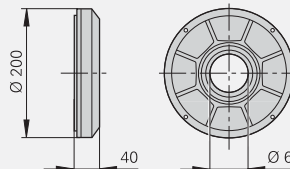
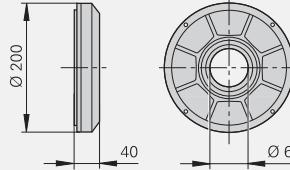
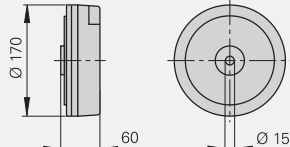
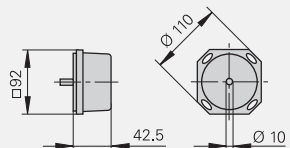
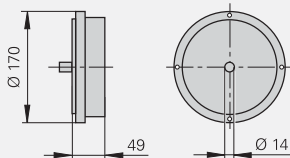
RCN 700
Ø 60 mm

















RCN 800
Ø 100 mm

Selection Guide

Incremental Angle Encoders with Integral Bearing

Series	Overall dimensions in mm	System accuracy	Recommended measuring step ¹⁾	Mech. permissible speed
With integrated stator coupling				
RON 200		± 5"	0.005°	3000 min ⁻¹
			0.001°/0.0005°	
		± 2.5"	0.0001°	
RON 700		± 2"	0.0001°	1000 min ⁻¹
				
RON 800 RPN 800		± 1"	0.00005°	1000 min ⁻¹
			0.00001°	
RON 900		± 0.4"	0.00001°	100 min ⁻¹
For separate shaft coupling				
ROD 200		± 5"	0.005°	10000 min ⁻¹
			0.0005°	
			0.0001°	
ROD 700		± 2"	0.0001°	1000 min ⁻¹
ROD 800		± 1"	0.00005°	1000 min ⁻¹

- ¹⁾ For position measurement
²⁾ After integrated interpolation

	Incremental signals	Signal periods/ revolution	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



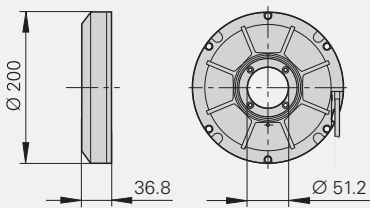
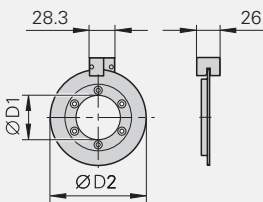
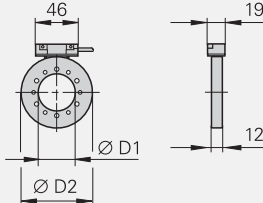
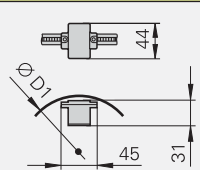
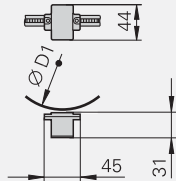
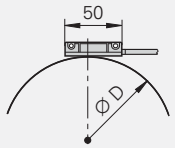
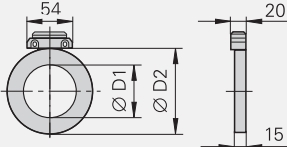
ROD 280



ROD 780

Selection Guide

Angle Encoders and Modular Encoders without Integral Bearing

Series	Overall dimensions in mm	Diameter D1/D2	Line count/System accuracy ¹⁾	Recommended measuring step ²⁾	Mechanically permissible speed
Angle encoders with rigid graduation carrier					
ERP 880 Glass disk with interferential grating		–	90000/± 1" (180000 signal periods)	0.00001°	≤ 1000 min ⁻¹
ERP 8000		D1: 50 mm D2: 108 mm	180000/± 2" (360000 signal periods)	0.000005°	≤ 100 min ⁻¹
ERP 4000		D1: 8 mm D2: 44 mm	65536/± 5" (131072 signal periods)	0.00001°	≤ 300 min ⁻¹
ERA 4x80³⁾ Steel circumferential scale drum with centering collar		D1: 40 mm to 512 mm D2: 76.75 mm to 560.46 mm	3000/± 9.4" to 52000/± 2.3"	0.002° to 0.00005°	≤ 10000 min ⁻¹ to ≤ 1500 min ⁻¹
Angle encoders with steel scale tape					
ERA 700³⁾ For inside diameter mounting		458.62 mm 573.20 mm 1146.10 mm	36000/± 3.5" to 45000/± 3.4" to 90000/± 3.2"	0.0002° to 0.00002°	≤ 500 min ⁻¹
ERA 800³⁾ For outside diameter mounting		458.04 mm 572.63 mm	36000/± 3.5" to 45000/± 3.4"	0.0002° to 0.00005°	≤ 100 min ⁻¹
ERA 6000		159.07 mm 1146.54 mm	2500/± 80" to 18000/± 15"		≤ 200 min ⁻¹ to ≤ 83 min ⁻¹
Modular encoders with magnetic graduation					
ERM 200³⁾		D1: 40 mm to 410 mm D2: 75.44 mm to 452.64 mm	600/± 36" to 3600/± 9"		≤ 19000 min ⁻¹ to ≤ 3000 min ⁻¹

¹⁾ Before installation. Additional error caused by mounting inaccuracy and inaccuracy from the bearing of the measured shaft are not included.

²⁾ For position measurement

³⁾ For further versions, see appropriate catalog

⁴⁾ After integrated interpolation

	Incremental signals/ Grating period	Reference marks	Model	For more information
	$\sim 1 V_{pp}/-$	One	ERP 880	Catalog: <i>Angle Encoders without Integral Bearing</i>
		None	ERP 8080	
			ERP 4080	
	$\sim 1 V_{pp}/20 \mu m$	Distance-coded	ERA 4280C	
	$\sim 1 V_{pp}/40 \mu m$		ERA 4480C	
	$\sim 1 V_{pp}/80 \mu m$		ERA 4880C	
	$\sim 1 V_{pp}/40 \mu m$	Distance-coded (nominal increment of 1 000 grating periods)	ERA 780C full circle	Catalog: <i>Angle Encoders without Integral Bearing</i>
	$\sim 1 V_{pp}/40 \mu m$	Distance-coded (nominal increment of 1 000 grating periods)	ERA 880C full circle	
	$\sim 1 V_{pp}$	Selectable every 100 mm	ERA 6080	ERA 6000 Product Information
	$\square TTL^4)$		ERA 6070	
	$\sim 1 V_{pp}/$ Approx. 400 μm		ERM 280	Catalog: <i>Magnetic Modular Encoders</i>
	$\square TTL$ Approx. 400 μm		ERM 220	



ERP 880



ERP 4080



ERA 4000



ERA 780



ERA 880



ERM 280

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 min^{-1} . For higher speeds—up to 20000 min^{-1} —steel drums are used. The scale substrate for large diameters is a steel tape.

HEIDENHAIN manufactures the precision graduations in specially developed, photolithographic processes.

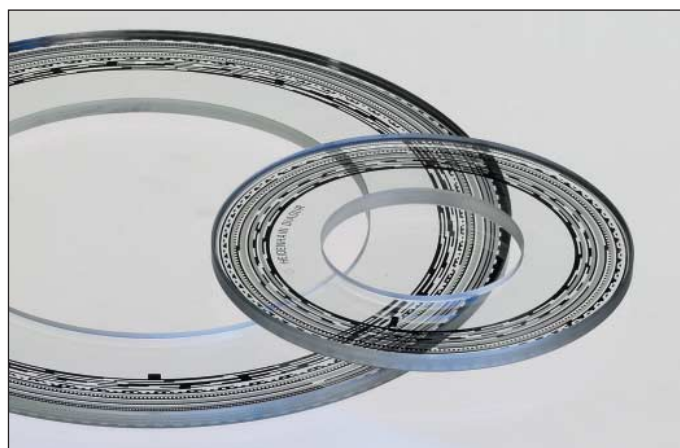
- AURODUR: Matte-etched lines on gold-plated steel tape with grating periods of typically $40 \mu\text{m}$
- METALLUR: Contamination-tolerant graduation of metal lines on gold, with typical graduation period of $20 \mu\text{m}$
- DIADUR: Extremely robust chromium lines on glass (typical graduation period $20 \mu\text{m}$) or three-dimensional chrome structures (typical graduation period of $8 \mu\text{m}$) on glass
- SUPRADUR phase grating: optically three dimensional, planar structure; particularly tolerant to contamination; typical graduation period of $8 \mu\text{m}$ and less
- OPTODUR phase grating: optically three dimensional, planar structure with particularly high reflectance, typical graduation period of $2 \mu\text{m}$ and less.

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.

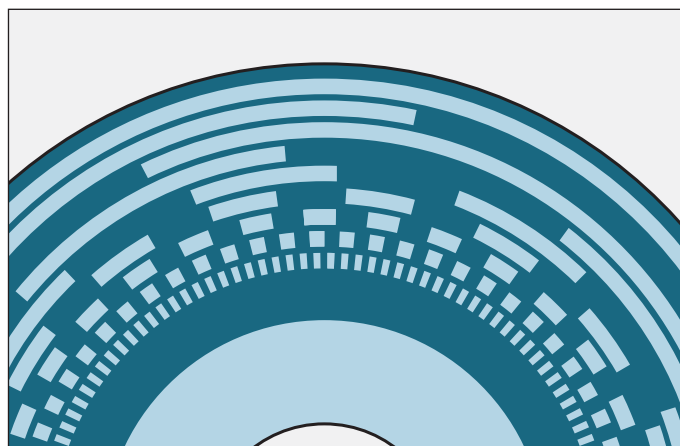
The master graduations are manufactured by HEIDENHAIN on custom-built high-precision ruling machines.

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, 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:

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

where:

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

Where:

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”)

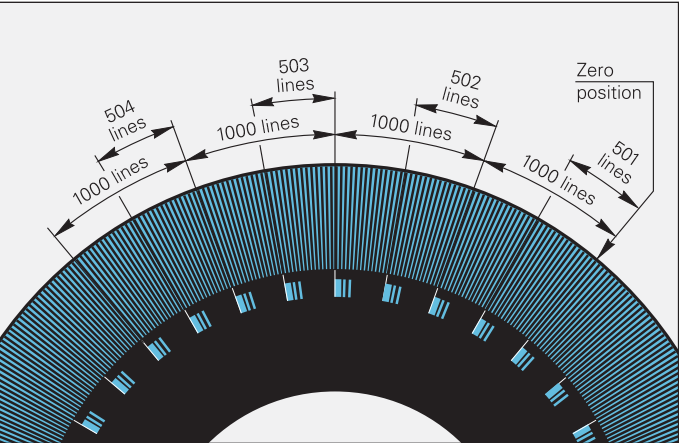
M_{RR} = Measured distance between the traversed reference marks in degrees

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

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

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
36 000	72	10°
18 000	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. Photoelectric scanning of a measuring standard is contact-free, and as such, free of wear. This method detects even very fine lines, no more than a few 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

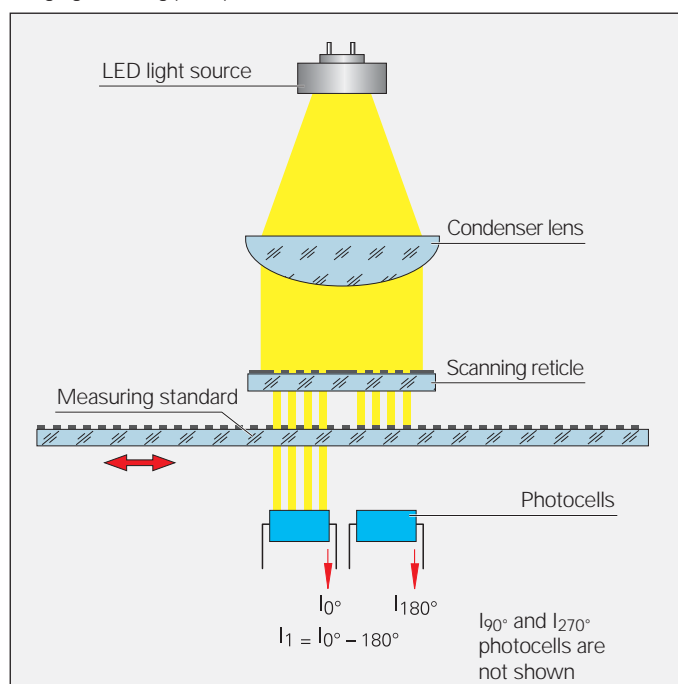
Put simply, the imaging scanning principle functions by means of projected-light signal generation: two graduations with equal grating periods are moved relative to each other—the scale and the scanning reticle. The carrier material of the scanning reticle is transparent, whereas the graduation on the 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 tolerated 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 $0.2\text{ }\mu\text{m}$ 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 $4\text{ }\mu\text{m}$ 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.

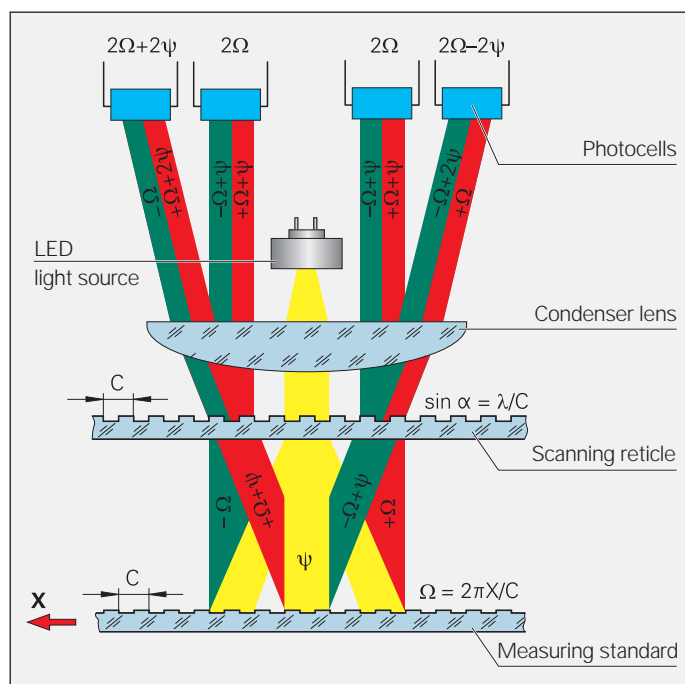
The RPN 886 angle encoder with integral bearing operates according to the interferential scanning principle.

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. the eccentricity of the graduation to the bearing,
5. the radial runout of the bearing,
6. the 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 error of a position—with respect to the mean value—are within the system accuracy $\pm a$.* The total error is ascertained at constant temperatures (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 catalog: *Angle Encoders without Integral Bearing*). 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 error within one revolution becomes apparent in larger angular motions.

Position deviations 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 deviations within one signal period are caused by the quality of the sinusoidal

scanning signals and their subdivision. The following factors influence the result:

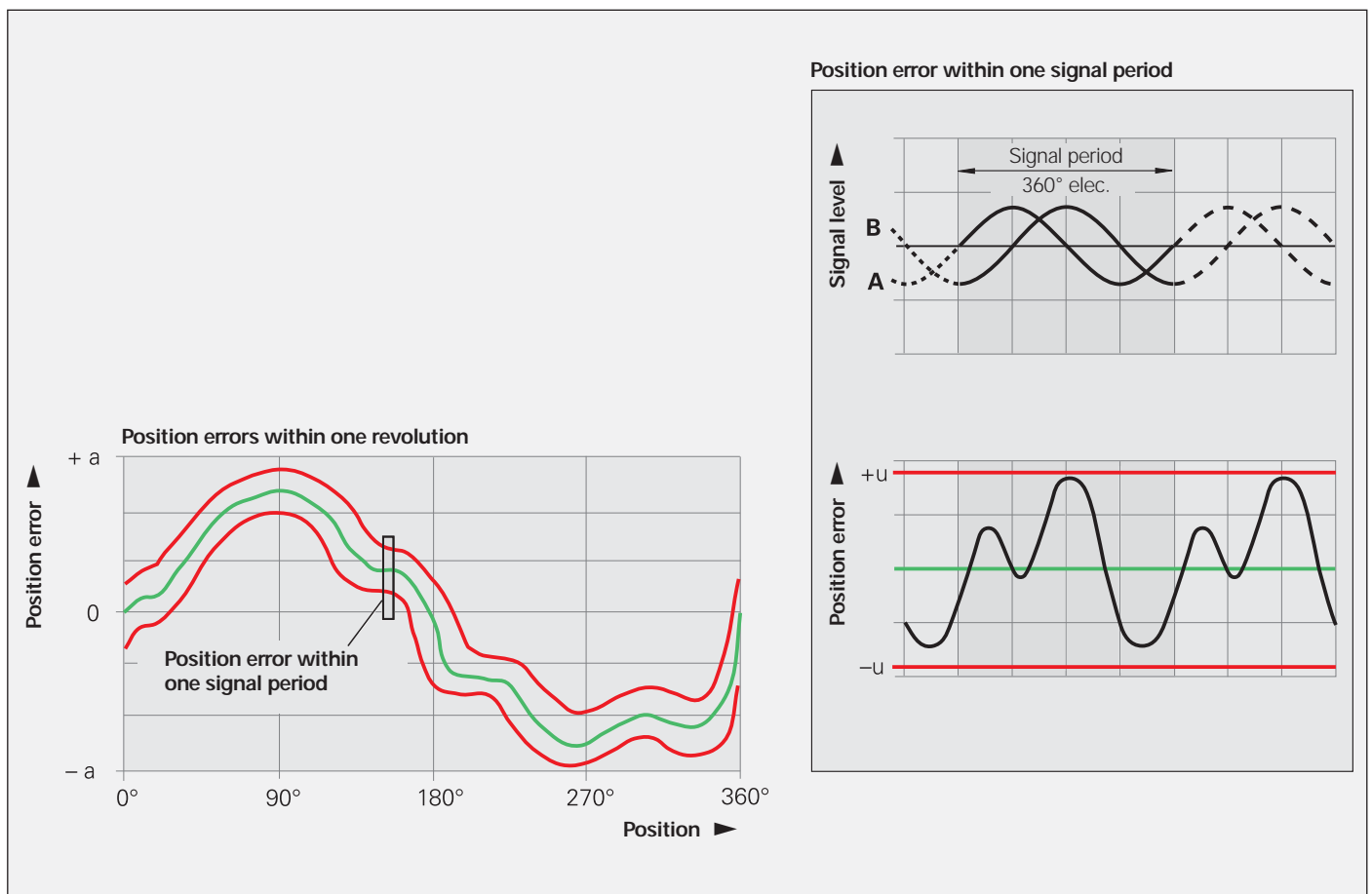
- The size of the signal period
- The homogeneity and edge definition of the graduation
- The quality of the optical filter structures on the scanning reticle
- The characteristics of the photoelectric detectors
- The stability and dynamics during the further processing of the analog signals

HEIDENHAIN angle encoders take these factors of influence into account, and permit interpolation of the sinusoidal output signal with subdivision accuracies of better than $\pm 1\%$ of the signal period (RPN: $\pm 1.5\%$). 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 36 000 sinusoidal signal periods per revolution
One signal period corresponds to 0.01° or $36''$.

With a signal quality of $\pm 1\%$, this results in maximum position error within one signal period of approx. $\pm 0.0001^\circ$ or $\pm 0.36''$.



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 *Mechanical Design Types and Mounting – ROD – Kinematic error of transfer*).

The system 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, in which 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:

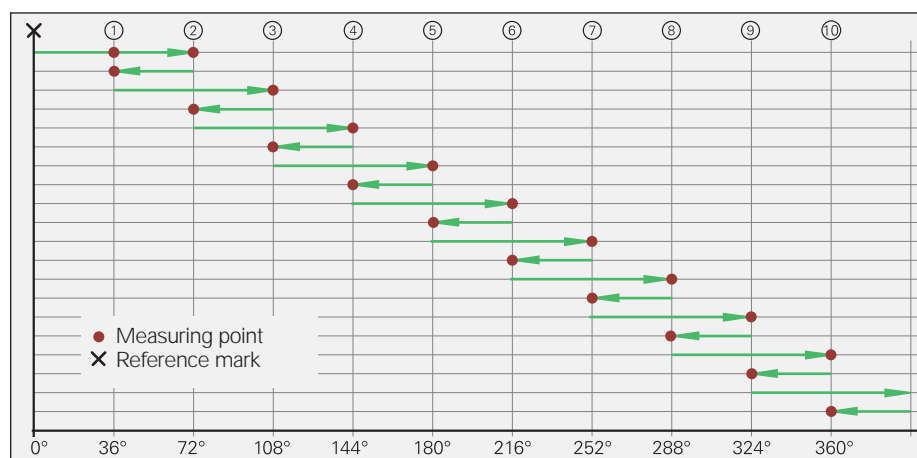
RCN/RON 2xx: Max. 0.6"

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



HEIDENHAIN

Messprotokoll Calibration Chart

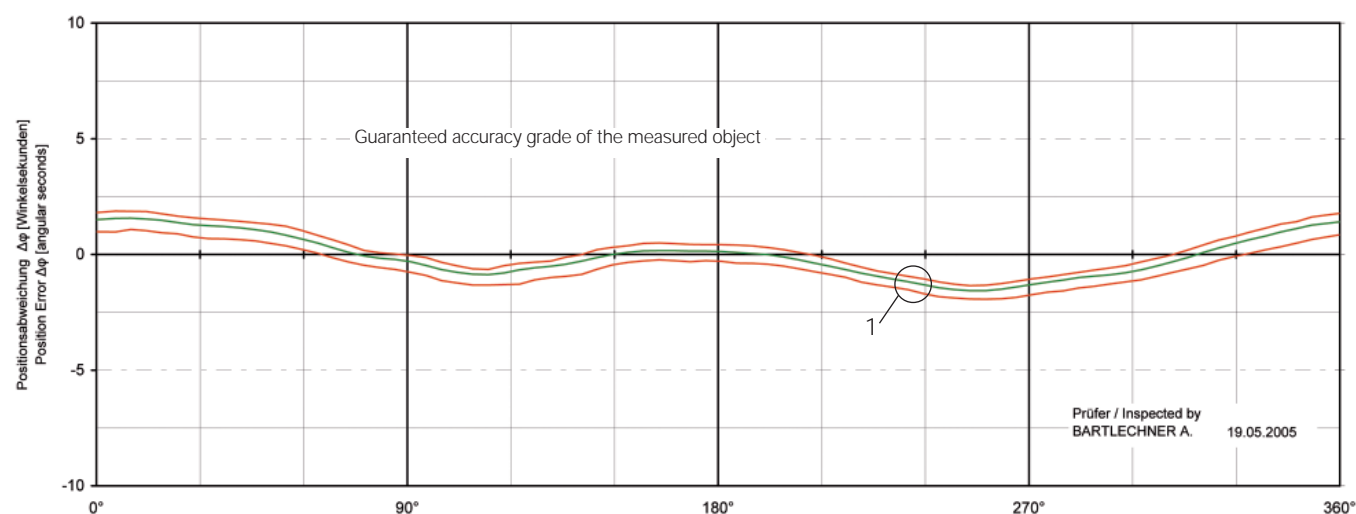
RON 285 18000

Id.Nr.: 358 699-07
S.Nr.: 12 211 342

Strichzahl / Line count: 18000
Positionsabweichung / Position error: Mittelwert / Mean value: $\pm 1.57''$
In einer Signalperiode / Within signal period: $\pm 0.47''$

Umkehrspanne / Mechanical hysteresis: Mittelwert / Mean value: 0.22"
Maximum / Maximum: 0.34"

Unsicherheit der Messmaschine / Uncertainty of measuring machine: 0.05"
Messgeschwindigkeit / Measuring velocity: 6.66 min⁻¹
Bezugstemperatur / Reference temperature: 22 °C



Die Messkurve zeigt Mittelwerte und Extremwerte der Positionsabweichung aus 5 Vor- und Rückwärtsmessungen ohne Umkehrspanne.
Positionsabweichung $\Delta\phi$ des Messgerätes: $\Delta\phi = \phi_S - \phi_M$
(ϕ_S = Messposition des Vergleichsnormals, ϕ_M = Messposition des Prüflings)
Anzahl der Messpositionen pro Umdrehung: 2560
Die Umkehrspanne wird an 10 Messpositionen im Schrittzyklus ermittelt.

The error curve shows the mean and extreme values of the position error from five measurements in forward and backward direction without mechanical hysteresis.
Position error $\Delta\phi$ of the encoder: $\Delta\phi = \phi_S - \phi_M$
(ϕ_S = position measured by the reference standard, ϕ_M = position measured by the measured encoder)
Number of measurement positions per revolution: 2560
The mechanical hysteresis is determined at 10 measurement positions in a step cycle.

Hersteller-Prüfzertifikat (DIN 55 350-18-4.2.2)

Dieses Gerät wurde unter strengen HEIDENHAIN-Qualitätsnormen hergestellt und geprüft.
Die Positionsabweichung liegt innerhalb der Genauigkeitsklasse $\pm 5''$.

Kalibriernormal ERP 880 TK
Kalibrierzeichen 50-DKD-K-12901
Kalibrierdatum 02-03

Manufacturer's Inspection Certificate (DIN 55 350-18-4.2.2)

This unit has been manufactured and inspected in accordance with the stringent quality standards of HEIDENHAIN.
The position error lies within the accuracy grade $\pm 5''$.

Calibration standard ERP 880 TK
Calibration number 50-DKD-K-12901
Calibration date 02-03

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.

Design: 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.

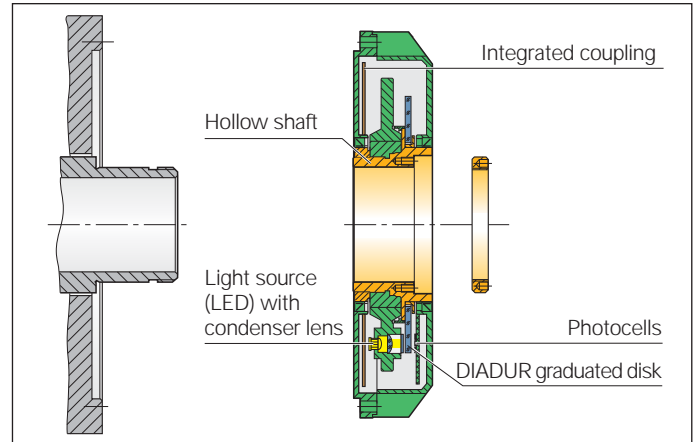
Front end shaft coupling

It is often helpful, 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 connected by threaded holes on the face with the aid of special mounting elements adapted to the respective design (not included in delivery).

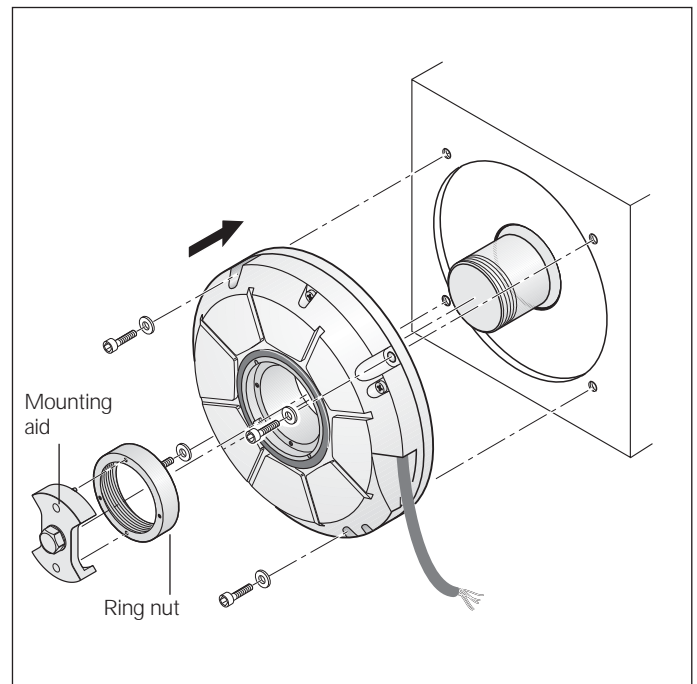
To comply with radial and axial runout specifications, the internal bore ① and the shoulder surface ② are to be used as mounting surfaces for shaft coupling at the face of the encoder.

RON 905 shaft coupling

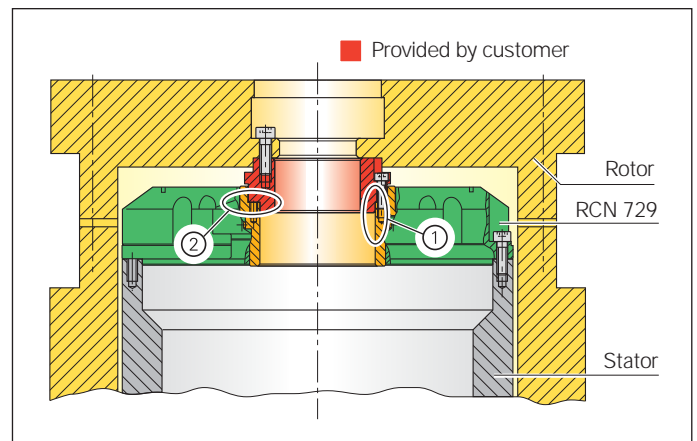
The RON 905 has a blind hollow shaft. The shaft is connected by an axial central screw.



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 \varnothing 20 mm: ID 336 669-03

Ring nut for RON 785

Hollow shaft \varnothing 50 mm: ID 336 669-05

Ring nut for RON 786; RON/RPN 886 RCN 72x/RCN 82x

Hollow shaft \varnothing 60 mm: ID 336 669-11

Ring nut for RCN 72x/RCN 82x

Hollow shaft \varnothing 100 mm: ID 336 669-16

Mounting tool for HEIDENHAIN ring nuts

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

Mounting tool for ring nuts with

Hollow shaft \varnothing 20 mm	ID 530 334-03
Hollow shaft \varnothing 50 mm	ID 530 334-05
Hollow shaft \varnothing 60 mm	ID 530 334-11
Hollow shaft \varnothing 100 mm	ID 530 334-16

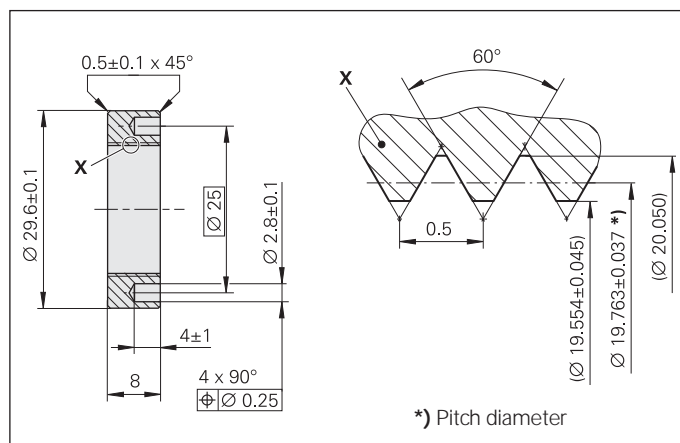
PWW inspection tool for angle encoders

The PWW makes a simple and quick inspection of the most significant mating dimensions possible. The integrated measuring equipment measures position and radial runout regardless of the type of shaft coupling, for example.

PWW for

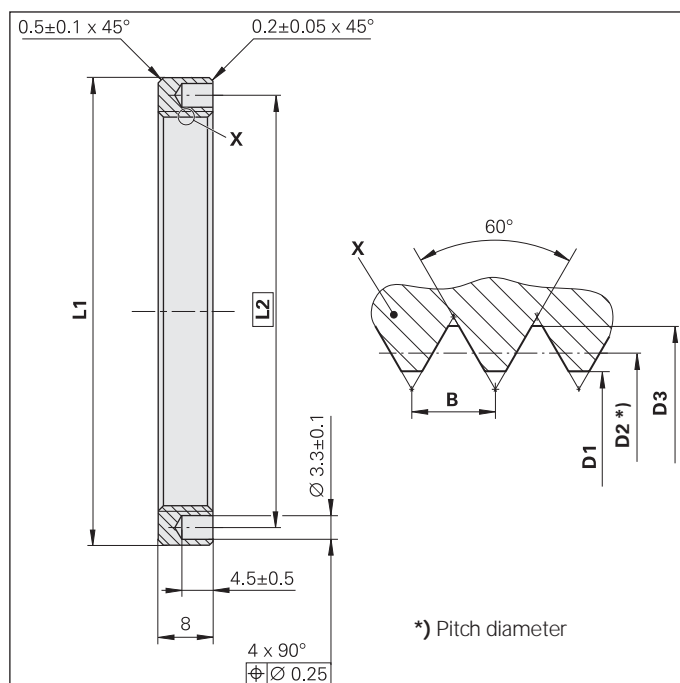
Hollow shaft \varnothing 20 mm:	ID 516 211-01
Hollow shaft \varnothing 50 mm:	ID 516 211-02
Hollow shaft \varnothing 60 mm:	ID 516 211-03
Hollow shaft \varnothing 100 mm:	ID 516 211-05

Ring nut for
Series
RxN 200



*) Pitch diameter

Ring nut for
RxN 700/800 series



*) Pitch diameter

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



Inspection tool
PWW

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.

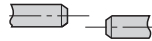
Mounting

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.

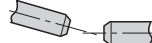
Shaft couplings

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.

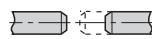
Radial offset λ



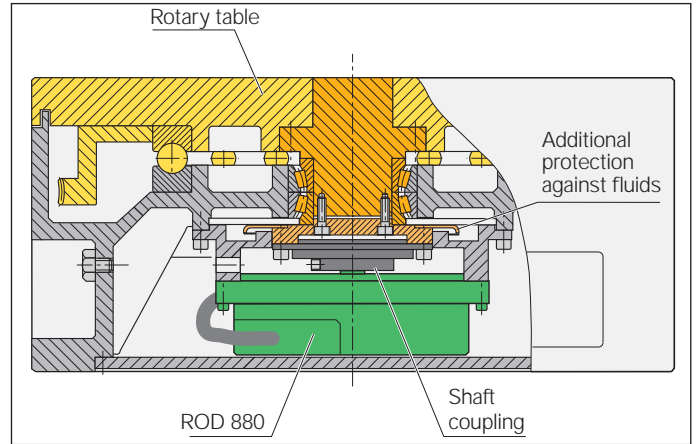
Angular error α



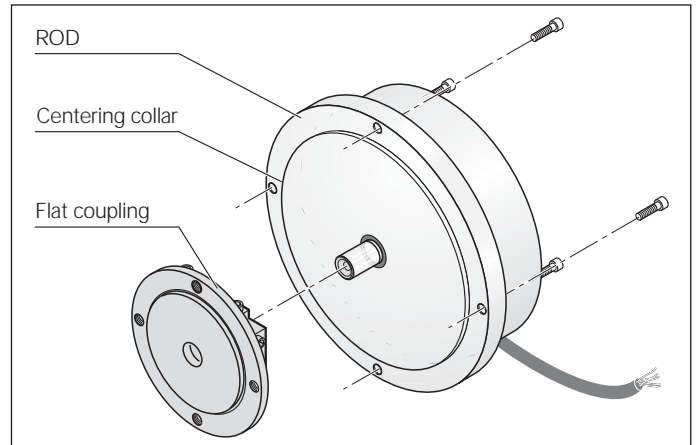
Axial motion δ



Mounting example
ROD 880

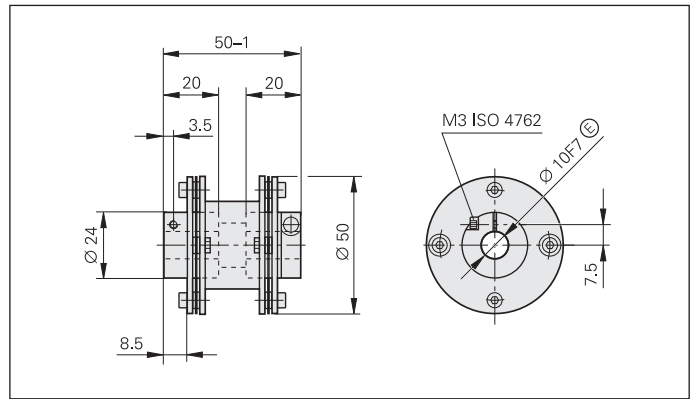


Mounting an
ROD

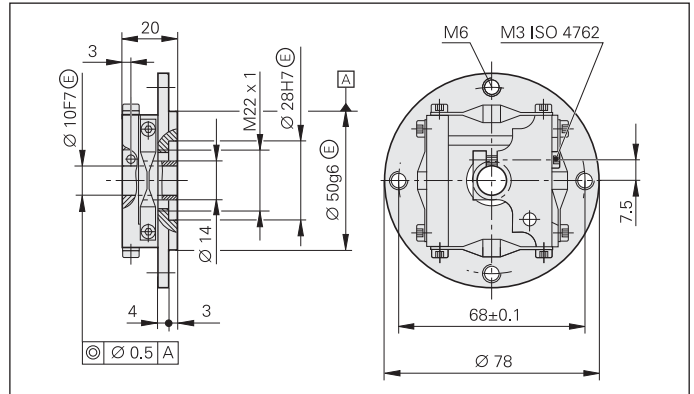


	ROD 200 Series		ROD 700 Series, ROD 800 Series		
Shaft coupling	K 03 Diaphragm coupling	K 18 Flat coupling	K 01 Diaphragm coupling	K 15 Flat coupling	K 16 Flat coupling
Hub bore	10 mm		14 mm		
Kinematic transfer error	± 2" at λ ≤ 0.1 mm and α ≤ 0.09°		± 1"	± 0.5" at λ ≤ 0.05 mm and α ≤ 0.03°	
Torsional rigidity	1 500 Nm/rad	1 200 Nm/rad	4 000 Nm/rad	6 000 Nm/rad	4 000 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 · 10 ⁻⁶ kgm ²	75 · 10 ⁻⁶ kgm ²	200 · 10 ⁻⁶ kgm ²		400 · 10 ⁻⁶ kgm ²
Permissible speed	10 000 min ⁻¹	1 000 min ⁻¹	3 000 min ⁻¹	1 000 min ⁻¹	
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

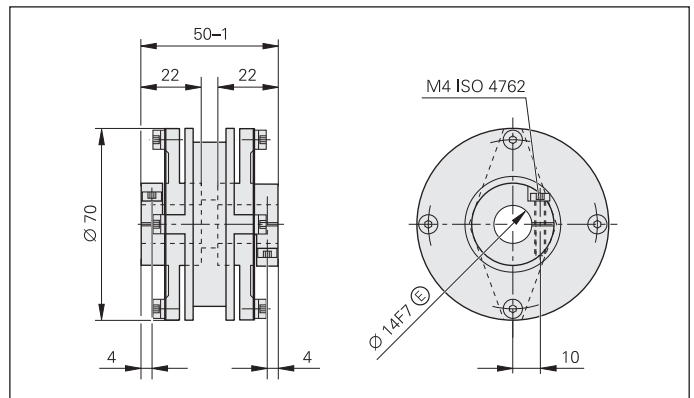
K 03 diaphragm coupling
ID 200 313-04



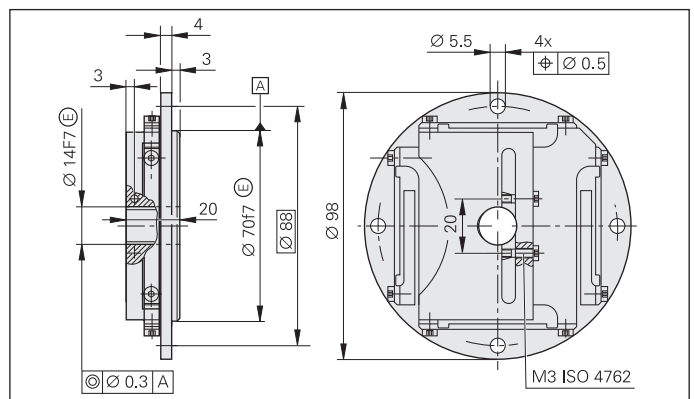
K 18 flat coupling
ID 202 227-01



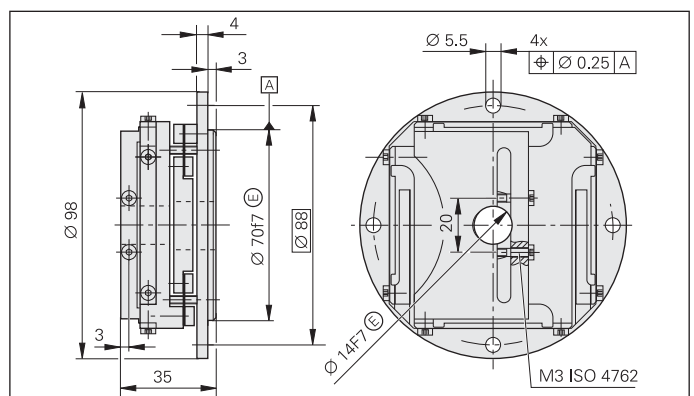
K 01 diaphragm coupling
ID 200 301-02



K 15 flat coupling
ID 255 797-01



K 16 flat coupling
ID 258 878-01



Dimensions in mm

General Mechanical Information

Degree of protection

Unless otherwise indicated, all RCN, RON, RPN and ROD angle encoders meet protection standard IP 67 according to IEC 60529 or EN 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 the 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.

The compressed air introduced directly onto the encoders must be cleaned by a micro filter, and must comply with the following quality classes as per **ISO 8573-1 (2001 edition)**:

- Solid contaminant: Class 1
(max. particle size $0.1\ \mu\text{m}$ and max. particle density $0.1\ \text{mg}/\text{m}^3$ at $1 \cdot 10^5\ \text{Pa}$)
- Total oil content: Class 1
(max. oil concentration $0.01\ \text{mg}/\text{m}^3$ at $1 \cdot 10^5\ \text{Pa}$)
- Maximum pressure dew point: Class 4, but with reference conditions of $+3\ ^\circ\text{C}$ at $2 \cdot 10^5\ \text{Pa}$

For this purpose, HEIDENHAIN offers the **DA 300 compressed air unit** (filter combination with pressure regulator and fittings). The compressed air introduced into the DA 300 must fulfill the requirements of the following quality classes as per ISO 8573-1 (2001 edition):

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

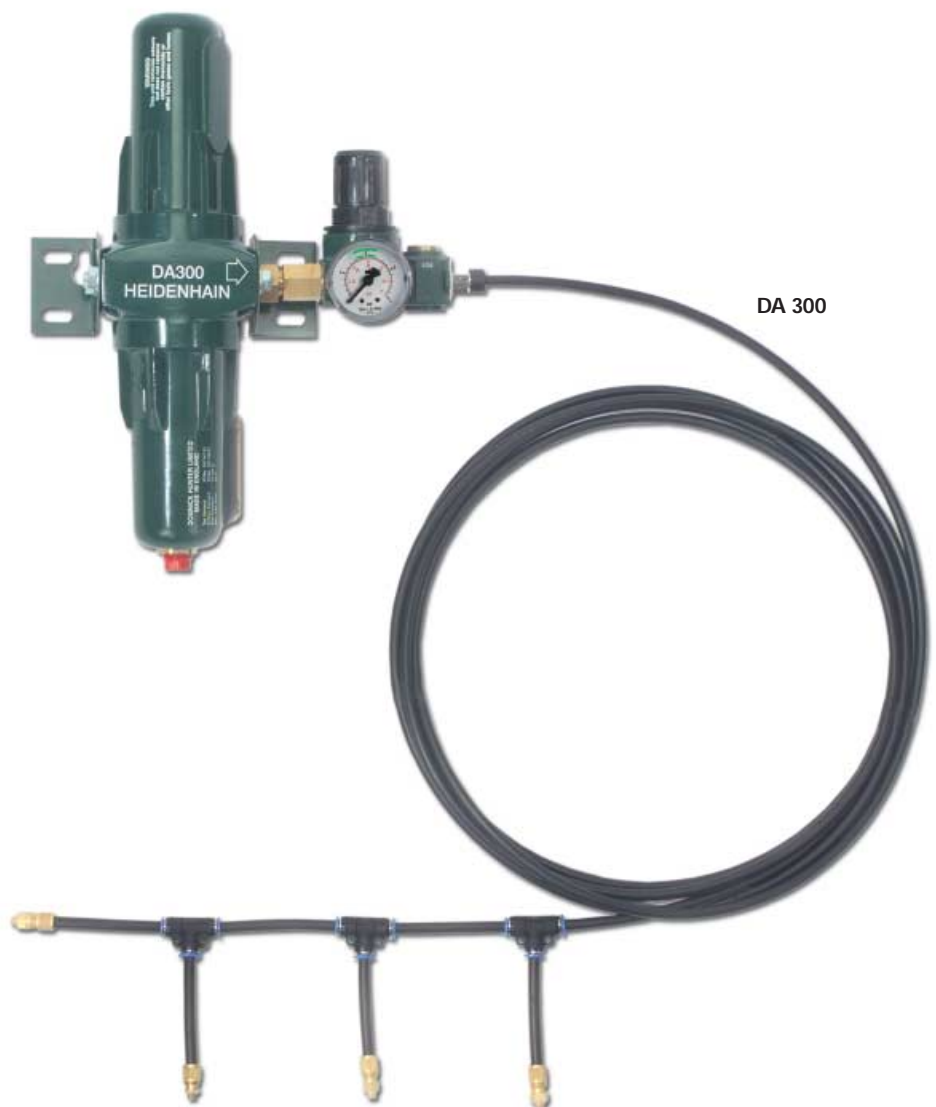
The following components are necessary for connection to the RCN, RON, RPN and ROD angle encoders:

M5 connecting piece for RCN/RON/RPN/ROD

With gasket and throttle $\varnothing 0.3\ \text{mm}$
For air-flow rate from 1 to 4 l/min
ID 207835-04

M5 coupling joint, swiveling

with seal
ID 207834-02



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

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 range

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 RPN 886 may not exceed –10 °C to +50 °C.

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 angle acceleration** for the and encoders
 - RCN/RON 200 series:
1 500 rad/s²
 - RCN/RON 700 series:
3 000 rad/s²
 - RCN/RON/RPN 800 series:
3 000 rad/s²

For the ROD angle encoders, the permissible angular acceleration varies depending on the shaft coupling and the mating shaft (details upon request).

- The indicated maximum values for **vibration** are valid according to EN 60068-2-6.
- The maximum permissible acceleration values (semi-sinusoidal shock) for **shock and impact** are valid for 6 ms (EN 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 kgm²

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 handling. These include in particular the following parts:

- LED light source
 - Cables with frequent flexing
- Additionally for encoders with integral bearing:
- Bearing
 - 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-related 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 $\varnothing 20$ mm
- System accuracy $\pm 5''$ and $\pm 2.5''$

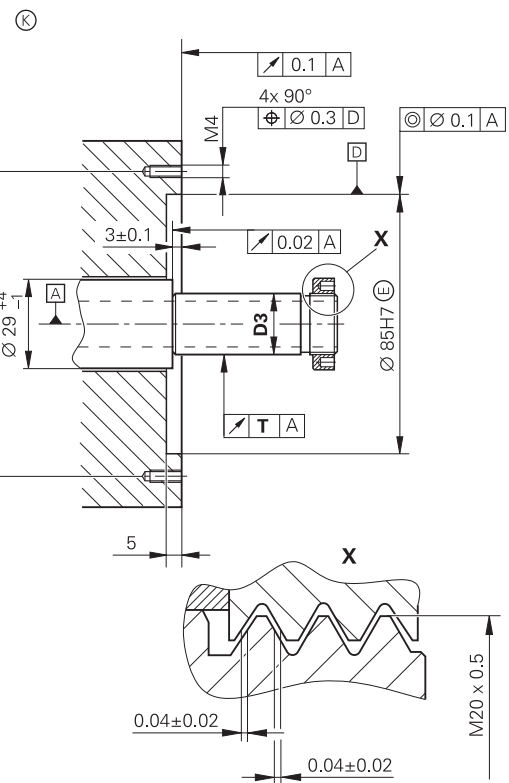
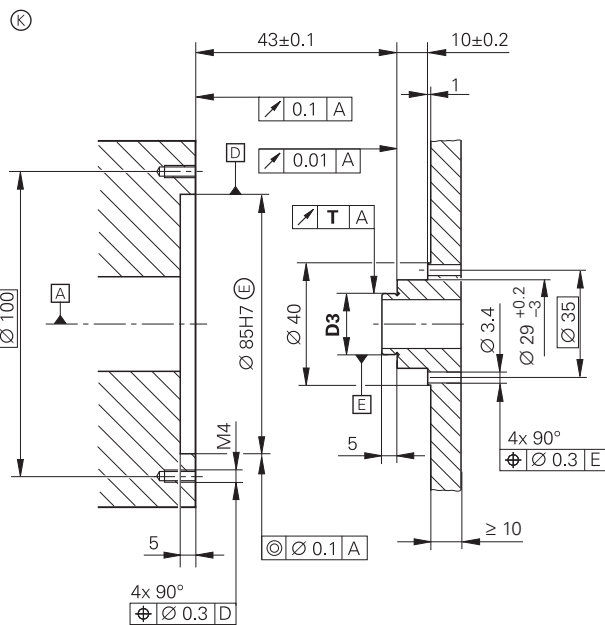
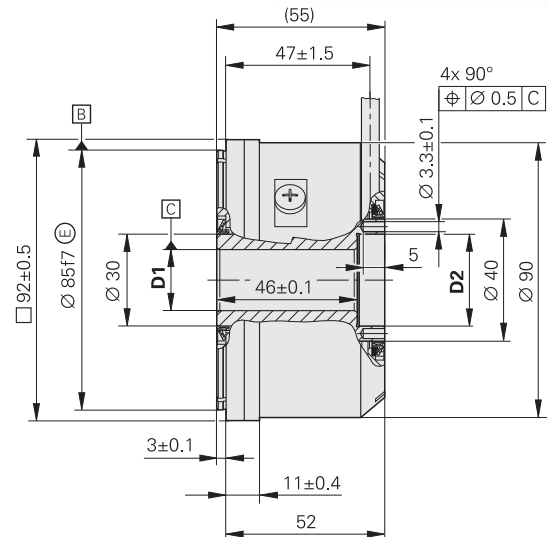
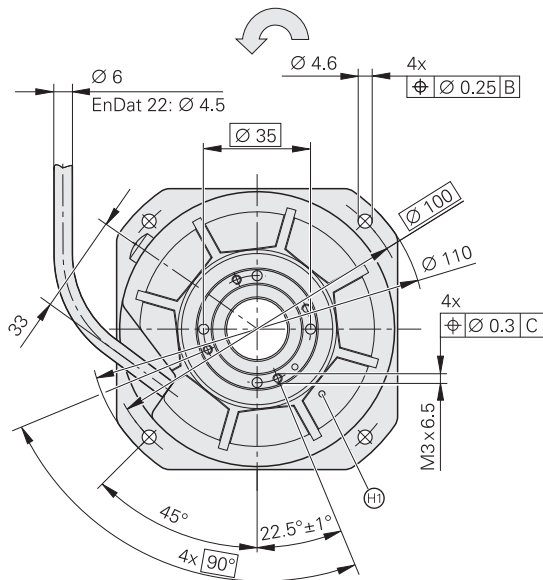
Dimensions in mm



Tolerancing ISO 8015

ISO 2768 - m H

< 6 mm: ± 0.2 mm



Cable radial, also usable axially

▢ = Bearing

⊗ = Required mating dimensions

⊕ = Mark for 0° position ($\pm 5''$)

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

System accuracy	$\pm 2.5''$	$\pm 5''$
D1	$\varnothing 20H6 E$	$\varnothing 20H7 E$
D2	$\varnothing 30H6 E$	$\varnothing 30H7 E$
D3	$\varnothing 20g6 E$	$\varnothing 20g7 E$
T	0.01	0.02

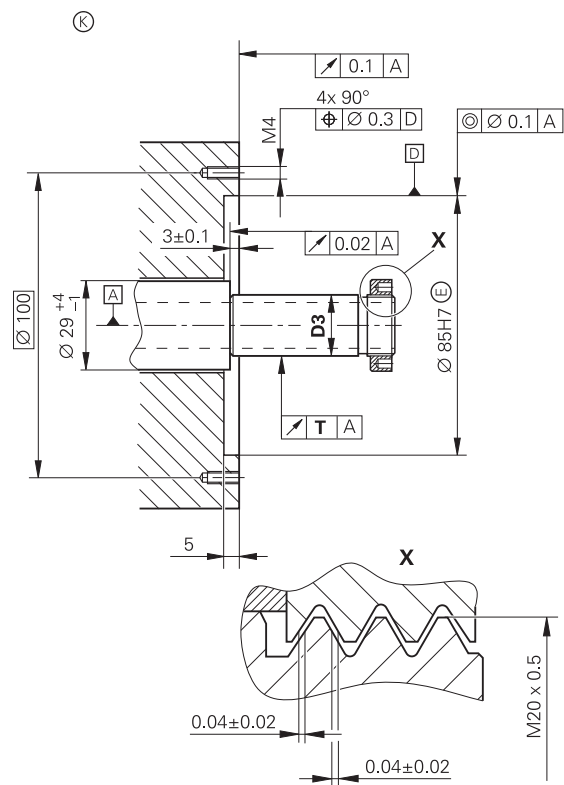
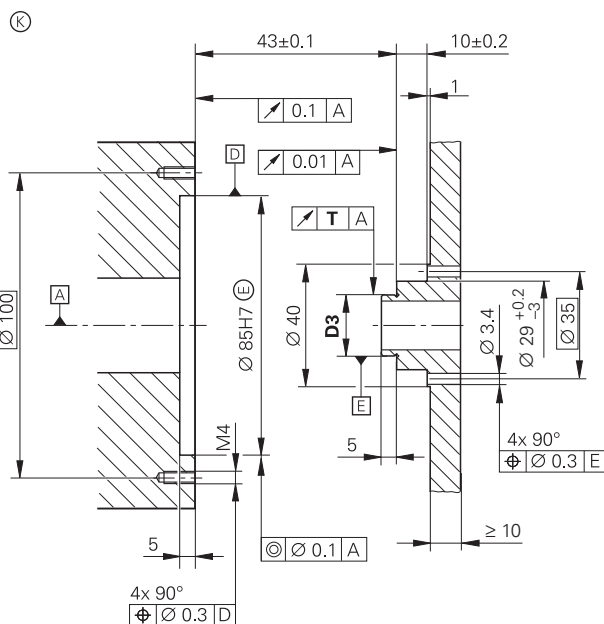
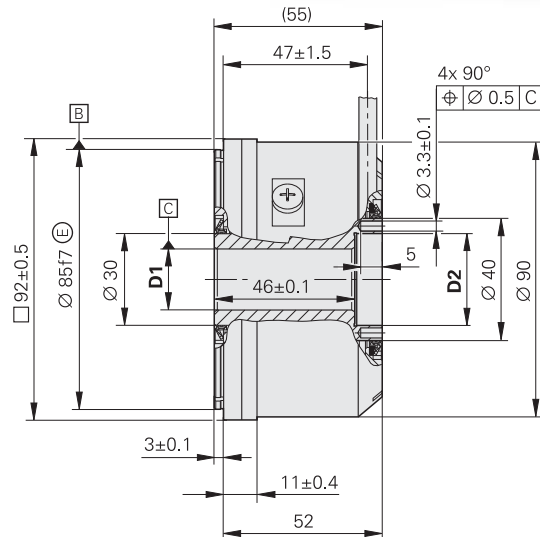
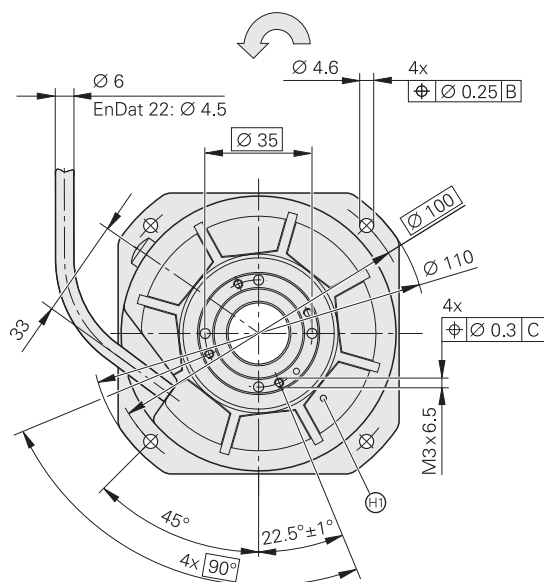
	Absolute			
	RCN 228 RCN 226		RCN 227F RCN 223F	RCN 227M RCN 223M
Absolute position values	EnDat 2.2	EnDat 2.2	Fanuc serial interface	Mitsubishi High Speed Serial Interface
Ordering designation*	EnDat 22	EnDat 02	Fanuc 02	Mit 02-4
Positions per revolution	RCN 228: 268 435 456 (28 bits) RCN 226: 67 108 864 (26 bits)		RCN 227: 134 217 728 (27 bits) RCN 223: 8 388 608 (23 bits)	
Elec. permissible speed	≤ 1500 min ⁻¹			
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 measuring step for position measurement	0.0001°			
System accuracy*	RCN 228: ± 2.5" RCN 226: ± 5"		RCN 227F: ± 2.5" RCN 223F: ± 5"	RCN 227M: ± 2.5" RCN 223M: ± 5"
Power supply Without load	3.6 V to 5.25 V at encoder/max. 350 mA			
Electrical connection	Cable 1 m, with coupling M12	Cable 1 m, with M23 coupling	Cable 1 m, with M23 coupling	
Max. cable length ¹⁾	150 m		30 m	
Shaft	Hollow through shaft D = 20 mm			
Mech. perm. speed	≤ 3000 min ⁻¹			
Starting torque	≤ 0.08 Nm at 20 °C			
Moment of inertia of rotor	73 · 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 (EN 60068-2-6) ≤1000 m/s ² (EN 60068-2-27)			
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 EN 60529	IP 64			
Weight	Approx. 0.8 kg			

* Please select when ordering

¹⁾ With HEIDENHAIN cable





- Integrated stator coupling
- Hollow through shaft Ø 20 mm
- System accuracy $\pm 5''$ and $\pm 2.5''$

< 6 mm: ± 0.2 mm



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

26

	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 2xxC: One	
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 min ^{–1}	≤ 333 min ^{–1}	–	
Recommended measuring step for position measurement	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. perm. speed	≤ 3000 min ^{–1}				
Starting torque	≤ 0.08 Nm at 20 °C				
Moment of inertia of rotor	73 · 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 (EN 60068-2-6) ≤1000 m/s ² (EN 60068-2-27)				
Operating temperature	Moving cable: –10 to 70 °C Stationary cable: –20 to 70 °C				0 °C to 50 °C
Protection EN 60529	IP 64				
Weight	Approx. 0.8 kg				

* Please select when ordering

¹⁾ With HEIDENHAIN cable

RON 785

- Integrated stator coupling
- Hollow through shaft Ø 50 mm
- System accuracy $\pm 2''$

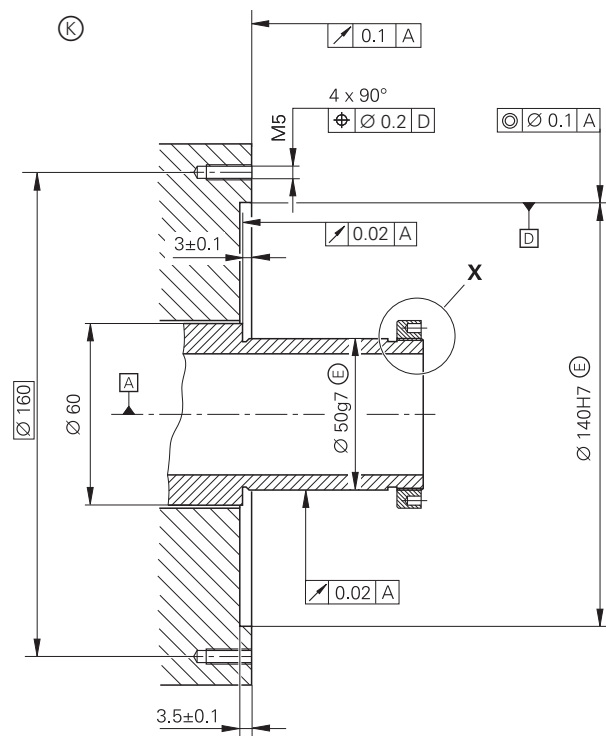
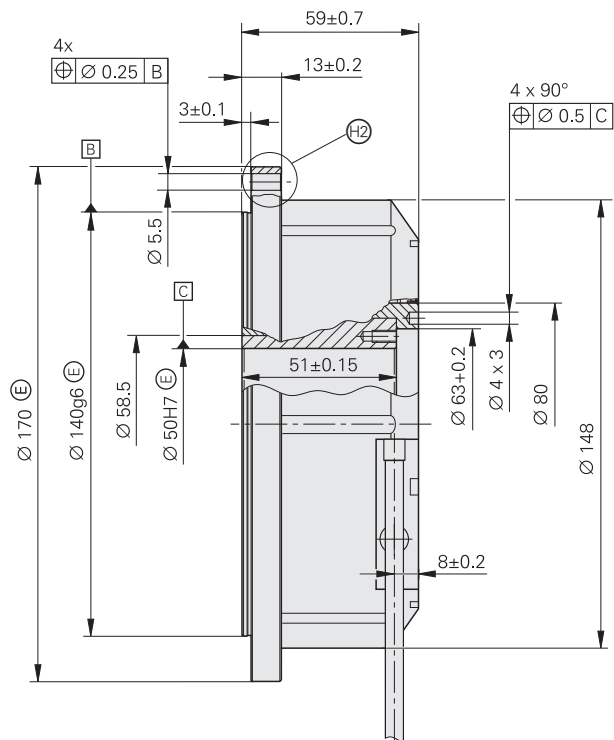
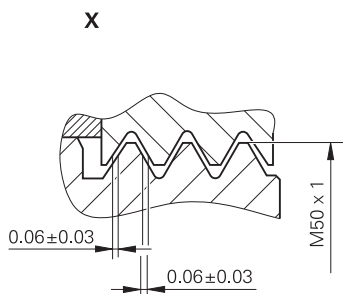
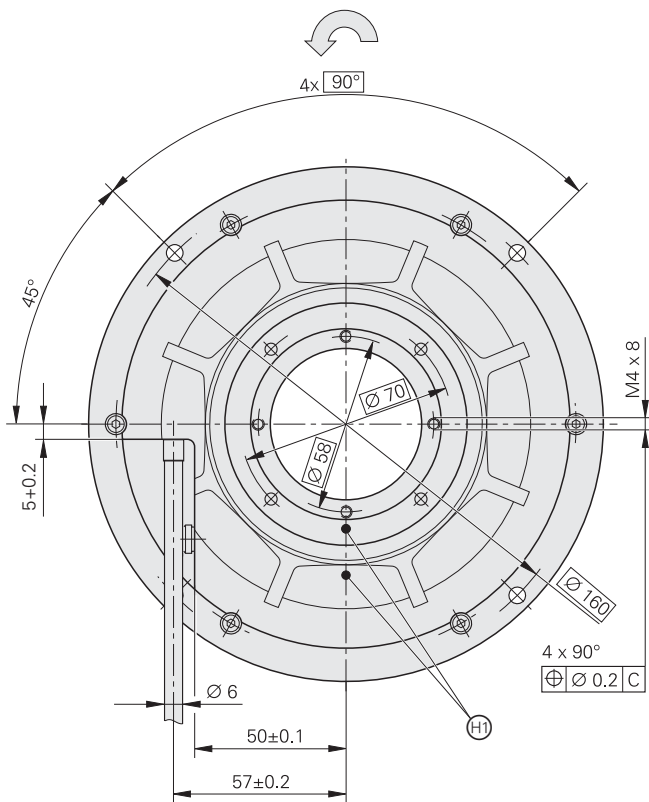
Dimensions in mm



Tolerancing ISO 8015

ISO 2768 - m H

< 6 mm: ± 0.2 mm



Cable radial, also usable axially

A = Bearing

Ⓚ = Required mating dimensions

Ⓜ = Position of the reference-mark signal ($\pm 5^\circ$)

⊙2 = Shown rotated by 45°

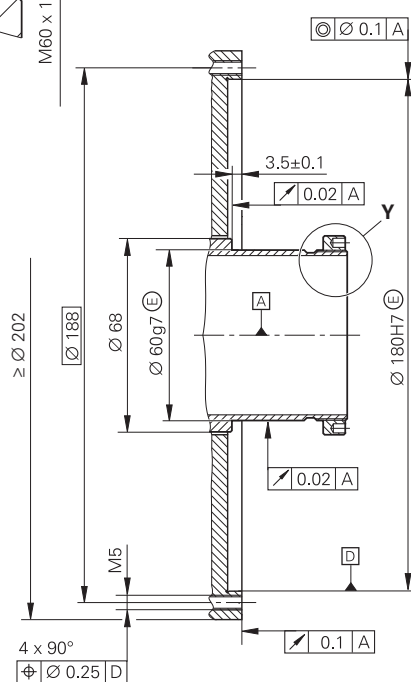
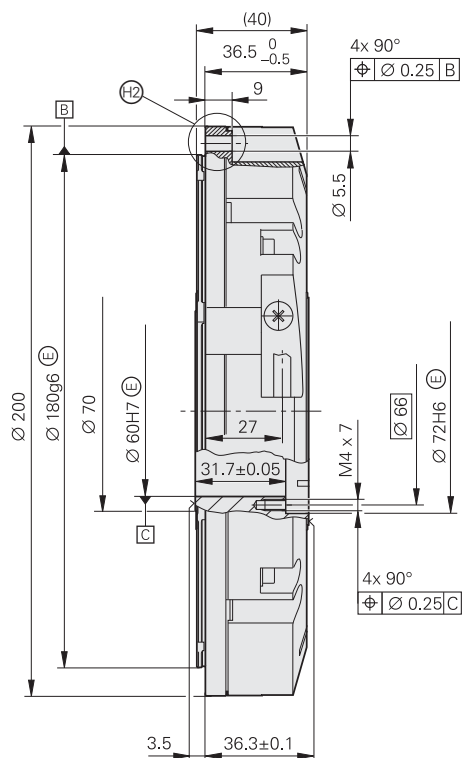
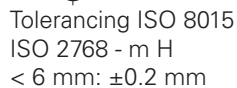
 Direction of shaft rotation for output signals as per the interface description

	Incremental RON 785
Incremental signals	$\sim 1 V_{PP}$
Line count	18 000
Reference mark*	RON 785: One RON 785 C: Distance-coded
Cutoff frequency -3 dB	$\geq 180 \text{ kHz}$
Recommended measuring step for position measurement	0.0001°
System accuracy	$\pm 2''$
Power supply Without load	$5 \text{ V} \pm 10 \%$, max. 150 mA
Electrical connection*	Cable 1 m, with or without M23 coupling
Max. cable length¹⁾	150 m
Shaft	Hollow through shaft D = 50 mm
Mech. perm. speed	$\leq 1000 \text{ min}^{-1}$
Starting torque	$\leq 0.5 \text{ Nm}$ at 20°C
Moment of inertia of rotor	$1.05 \cdot 10^{-3} \text{ kgm}^2$
Natural frequency	$\geq 1000 \text{ Hz}$
Permissible axial motion of measured shaft	$\pm 0.1 \text{ mm}$
Vibration 55 to 2000 Hz Shock 6 ms	$\leq 100 \text{ m/s}^2$ (EN 60068-2-6) $\leq 1000 \text{ m/s}^2$ (EN 60068-2-27)
Operating temperature	0°C to 50°C
Protection EN 60529	IP 64
Weight	Approx. 2.5 kg

* Please select when ordering

¹⁾ With HEIDENHAIN cable

- Integrated stator coupling
- Hollow through shaft Ø 60 mm
- System accuracy $\pm 2''$ or $\pm 1''$



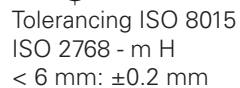
 Direction of shaft rotation for output signals as per the interface description

	Absolute			
	RCN 729 RCN 829	RCN 729 RCN 829	RCN 727F RCN 827F	RCN 727M RCN 827M
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	536870912 (29 bits)		134217728 (27 bits)	
Elec. permissible speed	≤ 300 min ^{−1} 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 measuring step for position measurement	RCN 72x: 0.0001° RCN 82x: 0.00005°			
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 coupling M12	Cable 1 m, with M23 coupling		
Max. cable length ¹⁾	150 m		30 m	
Shaft	Hollow through shaft D = 60 mm			
Mech. perm. speed	≤ 1000 min ^{−1}			
Starting torque	≤ 0.5 Nm at 20 °C			
Moment of inertia of rotor	1.3 · 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 (EN 60068-2-6) ≤1000 m/s ² (EN 60068-2-27)			
Operating temperature	0 °C to 50 °C			
Protection EN 60529	IP 64			
Weight	Approx. 2.8 kg			

* Please select when ordering

¹⁾ With HEIDENHAIN cable

- Integrated stator coupling
- Hollow through shaft Ø 100 mm
- System accuracy $\pm 2''$ or $\pm 1''$



\boxed{A} = Bearing

Ⓚ = Required mating dimensions

Ⓜ = Mark for 0° position ($\pm 5^\circ$)

Ⓜ2 = 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 727F RCN 827F	RCN 727M RCN 827M
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	536870912 (29 bits)		134217728 (27 bits)	
Elec. permissible speed	≤ 300 min ⁻¹ 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 measuring step for position measurement	RCN 72x: 0.0001° RCN 82x: 0.00005°			
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 coupling M12	Cable 1 m, with M23 coupling		
Max. cable length ¹⁾	150 m		30 m	
Shaft	Hollow through shaft D = 100 mm			
Mech. perm. speed	≤ 1000 min ⁻¹			
Starting torque	≤ 1.5 Nm at 20 °C			
Moment of inertia of rotor	3.3 · 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 (EN 60068-2-6) ≤ 1000 m/s ² (EN 60068-2-27)			
Operating temperature	0 °C to 50 °C			
Protection EN 60529	IP 64			
Weight	Approx. 2.6 kg			

* Please select when ordering

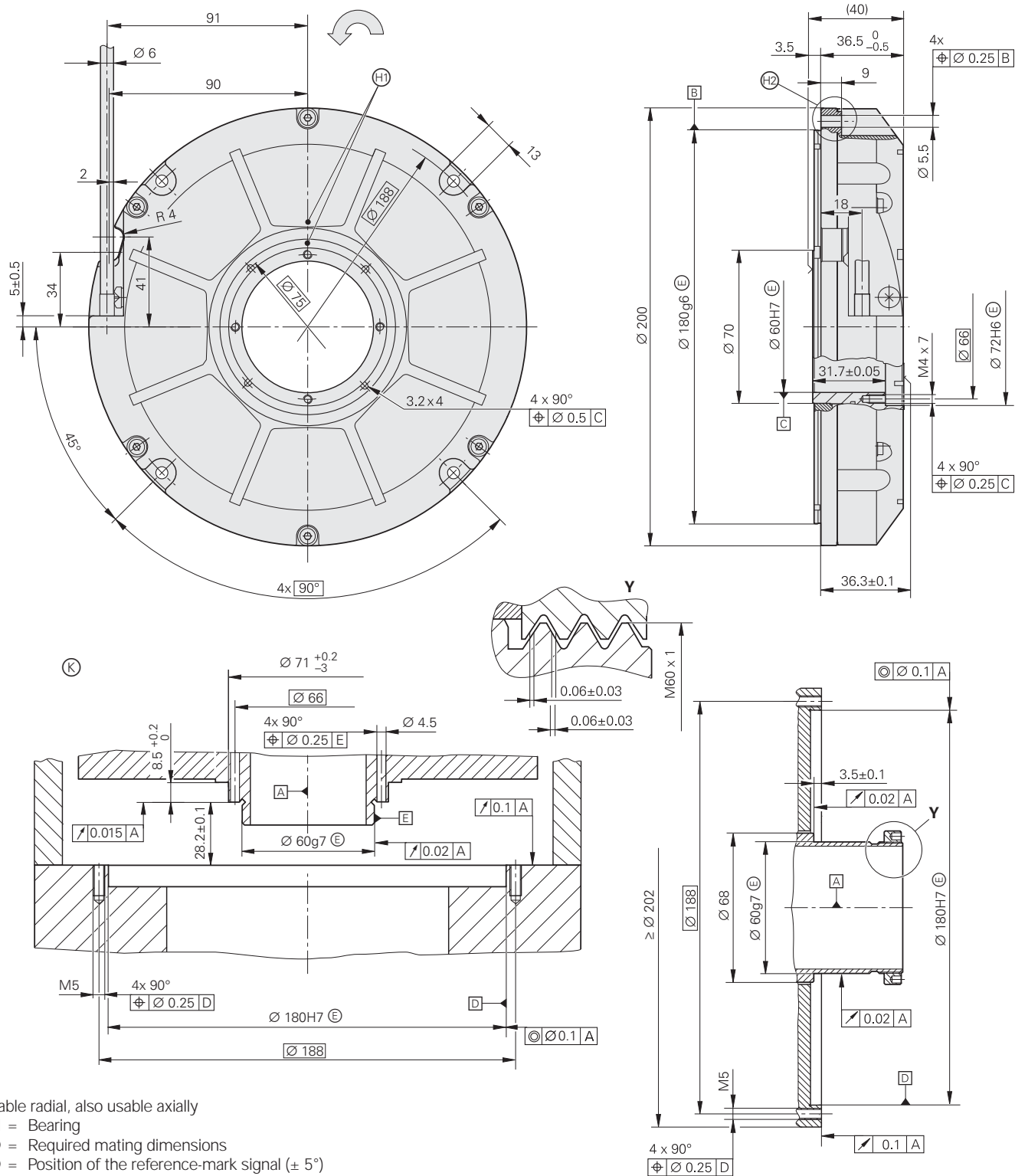
¹⁾ With HEIDENHAIN cable

- Dimensions in mm



ISO 2768 - m H

< 6 mm: ± 0.2 mm



Cable radial, also usable axially


[A] = Bearing

Ⓚ = Required mating dimensions

Ⓜ = Position of the reference-mark signal ($\pm 5^\circ$)

Ⓜ2 = 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 ≥ 1 300 kHz
Recommended measuring step for position measurement	0.0001°	0.00005°	0.00001°
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. perm. speed	≤ 1 000 min ⁻¹		
Starting torque	≤ 0.5 Nm at 20 °C		
Moment of inertia of rotor	1.2 · 10 ⁻³ kgm ²		
Natural frequency	≥ 1 000 Hz		≥ 500 Hz
Permissible axial motion of measured shaft	≤ ± 0.1 mm		
Vibration 55 to 2 000 Hz Shock 6 ms	≤ 100 m/s ² (EN 60068-2-6) ≤ 1 000 m/s ² (EN 60068-2-27)		≤ 50 m/s ² (EN 60068-2-6) ≤ 1 000 m/s ² (EN 60068-2-27)
Operating temperature	0 °C to 50 °C		
Protection EN 60529	IP 64		
Weight	Approx. 2.5 kg		

* Please select when ordering

¹⁾ With HEIDENHAIN cable

RON 905

- Integrated stator coupling
- Blind hollow shaft
- System accuracy $\pm 0.4''$

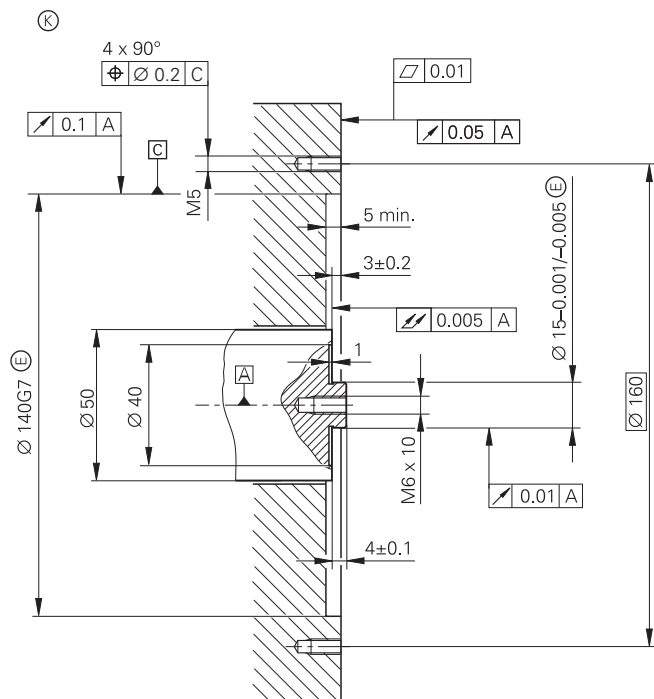
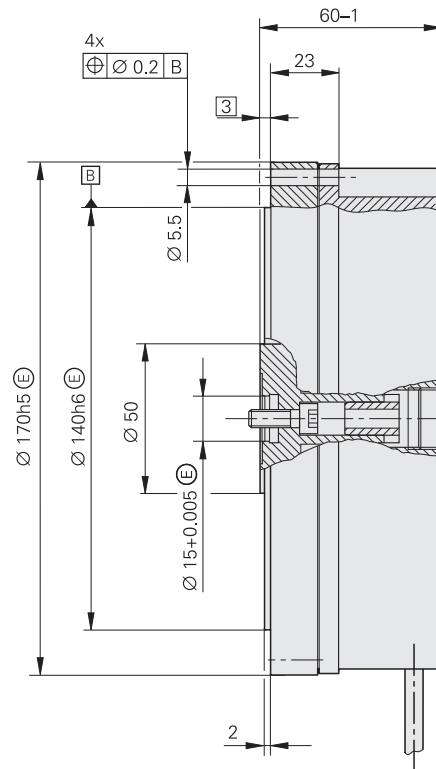
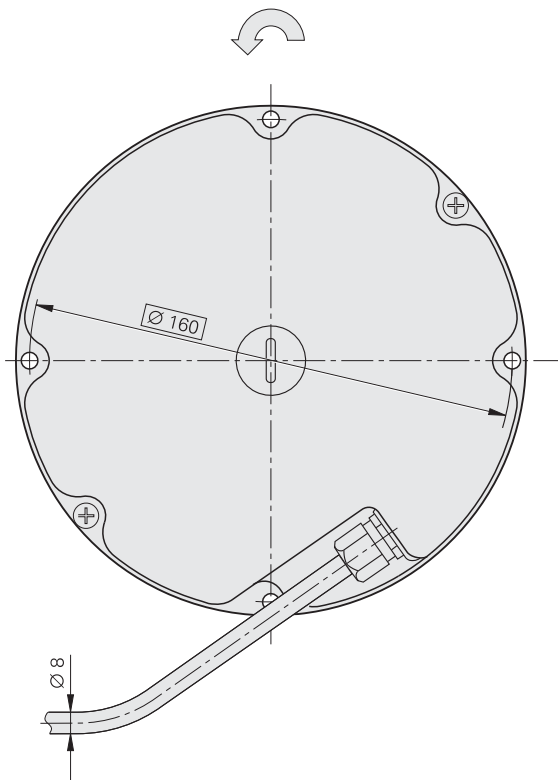
Dimensions in mm



Tolerancing ISO 8015

ISO 2768 - m H

< 6 mm: ± 0.2 mm



Cable radial, also usable axially

▢ = Bearing

⊗ = Required mating dimensions

↻ Direction of shaft rotation for output signal I_2 lagging I_1

	Incremental RON 905
Incremental signals	$\sim 11 \mu A_{PP}$
Line count	36 000
Reference mark	One
Cutoff frequency -3 dB	$\geq 40 \text{ kHz}$
Recommended measuring step for position measurement	0.00001°
System accuracy	$\pm 0.4''$
Power supply Without load	$5 \text{ V} \pm 5 \text{ \%/max. } 250 \text{ mA}$
Electrical connection	Cable 1 m, with M23 connector
Max. cable length ¹⁾	15 m
Shaft	Blind hollow shaft
Mech. perm. speed	$\leq 100 \text{ min}^{-1}$
Starting torque	$\leq 0.05 \text{ Nm at } 20^\circ \text{C}$
Moment of inertia of rotor	$0.345 \cdot 10^{-3} \text{ kgm}^2$
Natural frequency	$\geq 350 \text{ Hz}$
Permissible axial motion of measured shaft	$\leq \pm 0.2 \text{ mm}$
Vibration 55 to 2000 Hz Shock 6 ms	$\leq 50 \text{ m/s}^2 \text{ (EN 60068-2-6)}$ $\leq 1000 \text{ m/s}^2 \text{ (EN 60068-2-27)}$
Operating temperature	10 to 30°C
Protection EN 60529	IP 64
Weight	Approx. 4 kg

¹⁾ With HEIDENHAIN cable

ROD 200 Series

- For separate shaft coupling
- System accuracy $\pm 5''$

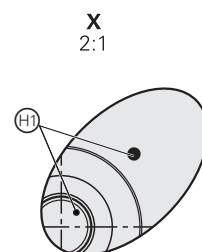
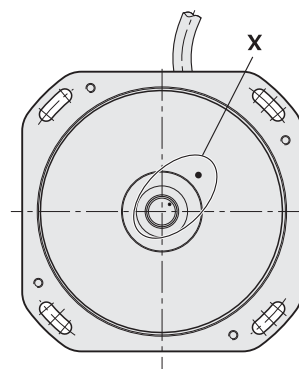
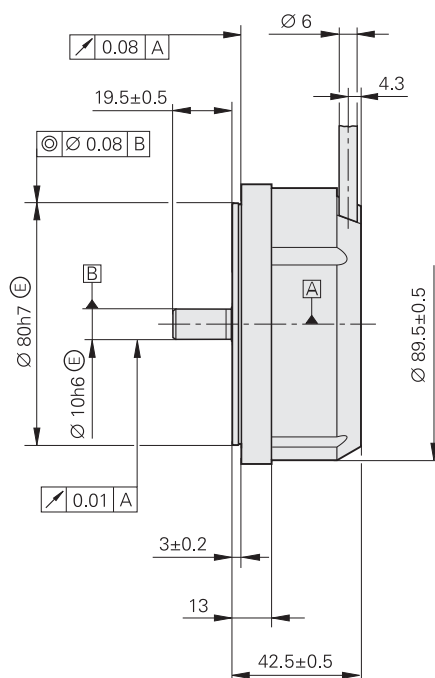
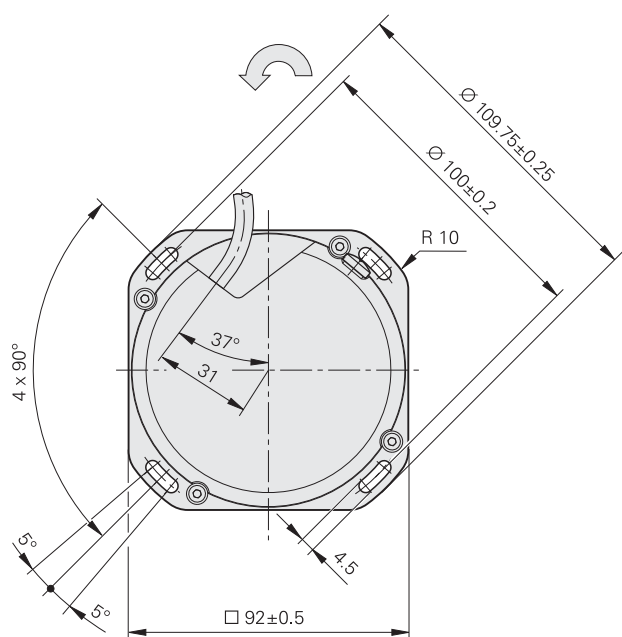
Dimensions in mm



Tolerancing ISO 8015

ISO 2768 - m H

< 6 mm: ± 0.2 mm



Cable radial, also usable axially




▣ = Bearing

⊕ = Position of the reference-mark signal

ROD 220/270/280: $\pm 10^\circ$

ROD 280 C: $\pm 5^\circ$

↻ 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	9000	18000	18000
Integrated interpolation	2-fold	10-fold	–
Output signals/rev	18000	180000	18000
Reference mark*	One		ROD 280: One RON 280C: Distance-coded
Cutoff frequency –3 dB	–	–	≥ 180 kHz
Output frequency	≤ 1 MHz	≤ 1 MHz	–
Edge separation a	≥ 0.125 μs	≥ 0.22 μs	–
Elec. permissible speed	3333 min ^{–1}	≤ 333 min ^{–1}	–
Recommended measuring step for position measurement	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. perm. speed	≤ 10000 min ^{–1}		
Starting torque	≤ 0.01 Nm at 20 °C		
Moment of inertia of rotor	20 · 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 (EN 60068-2-6) ≤ 1000 m/s ² (EN 60068-2-27)		
Operating temperature	Moving cable: –10 to 70 °C Stationary cable: –20 to 70 °C		
Protection EN 60529	IP 64		
Weight	Approx. 0.7 kg		

* Please select when ordering

¹⁾ With HEIDENHAIN cable

ROD 780/ROD 880

- For separate shaft coupling
- System accuracy ROD 780: $\pm 2''$
ROD 880: $\pm 1''$

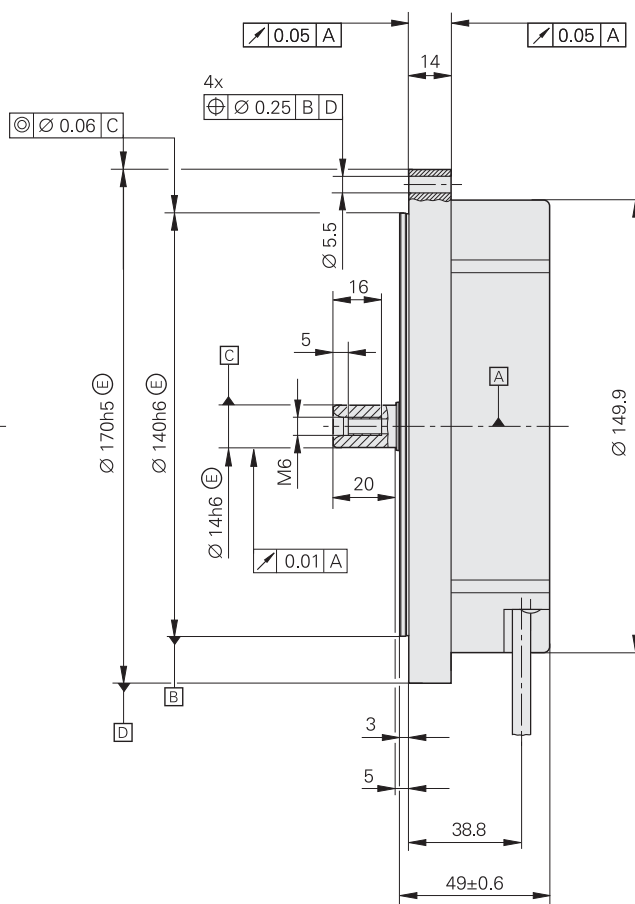
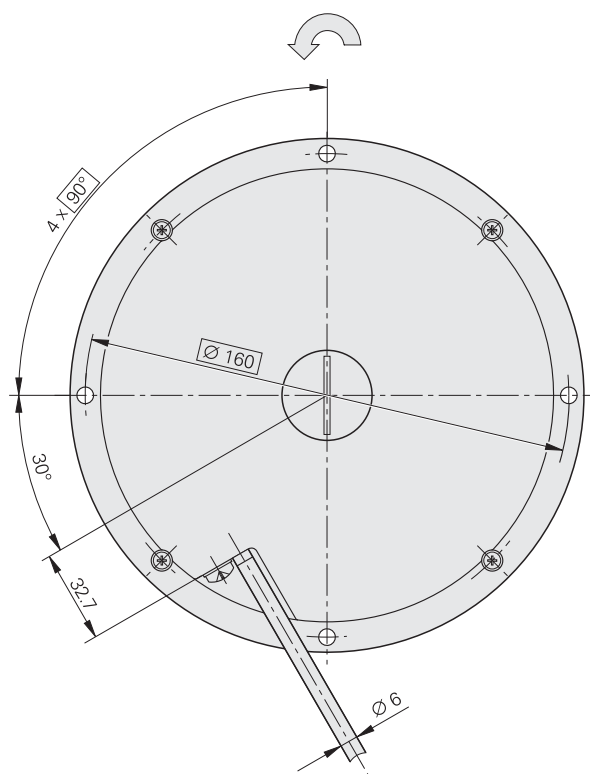
Dimensions in mm



Tolerancing ISO 8015

ISO 2768 - m H

< 6 mm: ± 0.2 mm



Cable radial, also usable axially

△ = Bearing

⊕ = Position of the reference-mark signal ($\pm 5^\circ$)

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

	Incremental	
	ROD 780	ROD 880
Incremental signals	$\sim 1 V_{PP}$	
Line count*	18 000 36 000	36 000
Reference mark*	ROD x80: One RON x80C: Distance-coded	
Cutoff frequency –3 dB	$\geq 180 \text{ kHz}$	
Recommended measuring step for position measurement	0.0001°	0.00005°
System accuracy	$\pm 2''$	$\pm 1''$
Power supply Without load	$5 \text{ V} \pm 10 \%$, max. 150 mA	
Electrical connection*	Cable 1 m, with or without M23 coupling	
Max. cable length ¹⁾	150 m	
Shaft	Solid shaft D = 14 mm	
Mech. permissible speed	$\leq 1000 \text{ min}^{-1}$	
Starting torque	$\leq 0.012 \text{ Nm}$ at 20°C	
Moment of inertia of rotor	$0.36 \cdot 10^{-3} \text{ kgm}^2$	
Shaft load	Axial: 30 N Radial: 30 N at shaft end	
Vibration 55 to 2000 Hz Shock 6 ms	$\leq 100 \text{ m/s}^2$ (EN 60068-2-6) $\leq 300 \text{ m/s}^2$ (EN 60068-2-27)	
Operating temperature	0°C to 50°C	
Protection EN 60529	IP 64	
Weight	Approx. 2.4 kg	

* Please select when ordering

¹⁾ With HEIDENHAIN cable

Interfaces

Incremental Signals $\sim 1 V_{PP}$

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

The sinusoidal **incremental signals** A and B are phase-shifted by 90° 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 level 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:

- $-3 \text{ dB} \triangleq 70 \%$ of the signal amplitude
- $-6 \text{ dB} \triangleq 50 \%$ of the signal amplitude

The data in the signal description apply to motions at up to 20% of the -3 dB cutoff frequency.

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.

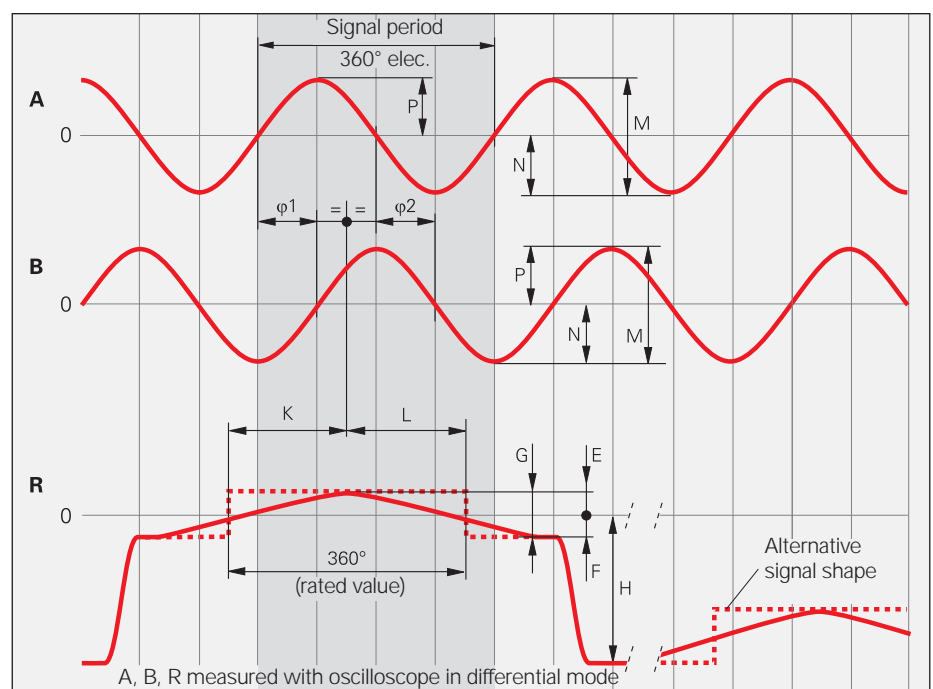
Short-circuit stability

A temporary short circuit of one signal output to $0 V$ or U_P (except encoders with $U_{Pmin} = 3.6 V$) 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

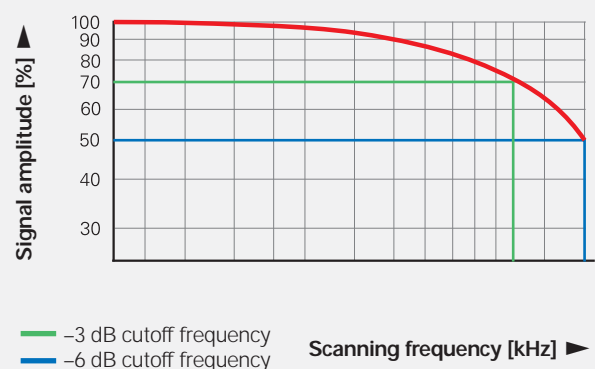
Interface	Sinusoidal voltage signals $\sim 1 V_{PP}$
Incremental signals	2 nearly sinusoidal signals A and B Signal amplitude M: $0.6 \text{ to } 1.2 V_{PP}$; typically $1 V_{PP}$ Asymmetry $ P - N /2M$: ≤ 0.065 Amplitude ratio M_A/M_B : $0.8 \text{ to } 1.25$ Phase angle $ \varphi_1 + \varphi_2 /2$: $90^\circ \pm 10^\circ$ elec.
Reference-mark signal	One or several signal peaks R Usable component G: $\geq 0.2 V$ Quiescent value H: $\leq 1.7 V$ Switching threshold E, F: $0.04 \text{ to } 0.68 V$ Zero crossovers K, L: $180^\circ \pm 90^\circ$ elec.
Connecting cable	Shielded HEIDENHAIN cable PUR $[4(2 \times 0.14 \text{ mm}^2) + (4 \times 0.5 \text{ mm}^2)]$ Max. 150 m with 90 pF/m distributed capacitance 6 ns/m

These values can be used for dimensioning of the subsequent electronics. Any limited tolerances in the encoders are listed in the specifications. For encoders without integral bearing, reduced tolerances are recommended for initial operation (see the mounting instructions).



Cutoff frequency

Typical signal amplitude curve with respect to the scanning frequency



Input circuitry of the subsequent electronics

Dimensioning

Operational amplifier MC 34074

$Z_0 = 120\ \Omega$

$R_1 = 10\ \text{k}\Omega$ and $C_1 = 100\ \text{pF}$

$R_2 = 34.8\ \text{k}\Omega$ and $C_2 = 10\ \text{pF}$

$U_B = \pm 15\ \text{V}$

U_1 approx. U_0

-3 dB cutoff frequency of circuitry

Approx. 450 kHz

Approx. 50 kHz with $C_1 = 1000\ \text{pF}$

and $C_2 = 82\ \text{pF}$

The circuit variant for 50 kHz does reduce the bandwidth of the circuit, but in doing so it improves its noise immunity.

Circuit output signals

$U_a = 3.48\ \text{V}_{\text{PP}}$ typically

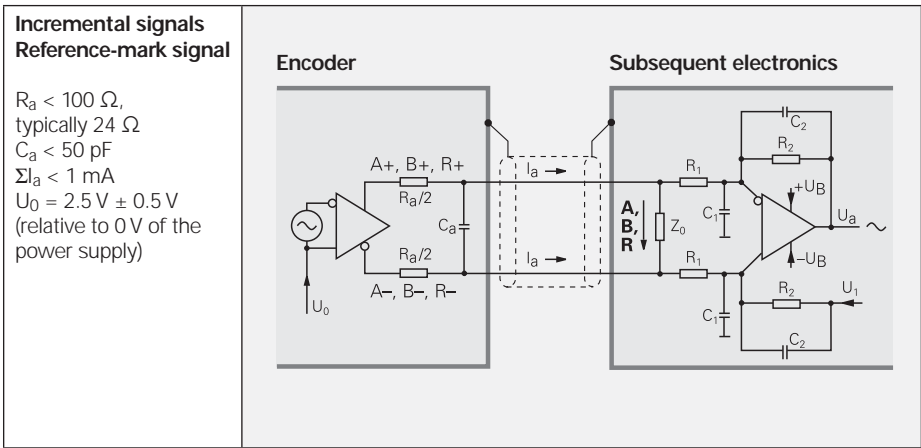
Gain 3.48

Monitoring of the incremental signals


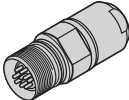


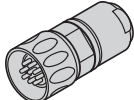
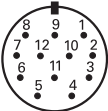

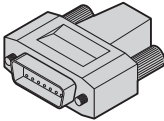
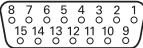

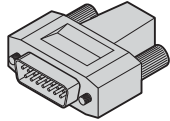
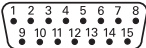




The following thresholds are recommended for monitoring of the signal level M:

Lower threshold: 0.30 V_{PP}

Upper threshold: 1.35 V_{PP}



Pin layout

12-pin coupling M23					12-pin connector M23								
  					  								
15-pin D-sub connector					15-pin D-sub connector								
For HEIDENHAIN controls and IK 220					For encoder or IK 215								
  					  								
	Power supply				Incremental signals						Other signals		
	12	2	10	11	5	6	8	1	3	4	9	7	/
	1	9	2	11	3	4	6	7	10	12	5/8/13/15	14	/
	4	12	2	10	1	9	3	11	14	7	5/6/8/15	13	/
	Up	Sensor Up	0 V	Sensor 0 V	A+	A-	B+	B-	R+	R-	Vacant	Vacant	Vacant
	Brown/ Green	Blue	White/ Green	White	Brown	Green	Gray	Pink	Red	Black	/	Violet	Yellow

Cable shield connected to housing; U_P = power supply voltage

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

Vacant pins or wires must not be used!

Interfaces

Incremental Signals $\square\square$ TTL

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

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

The **fault-detection signal** $\overline{U_{aS}}$ indicates fault conditions such as 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.

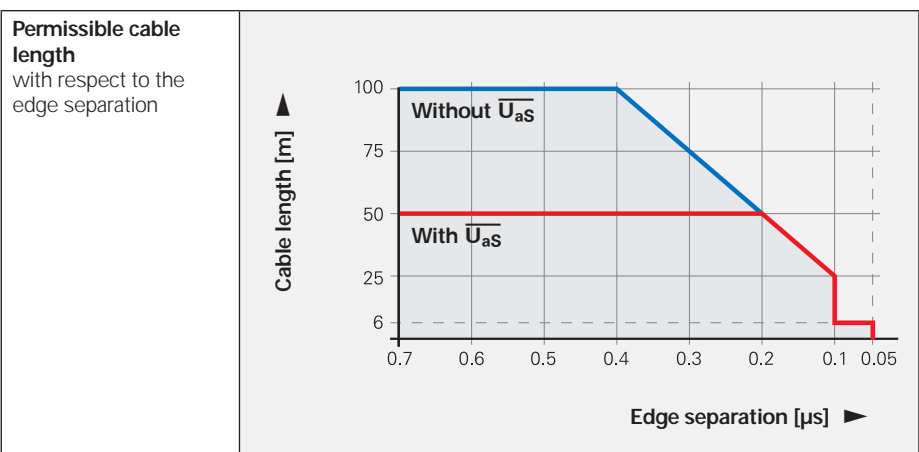
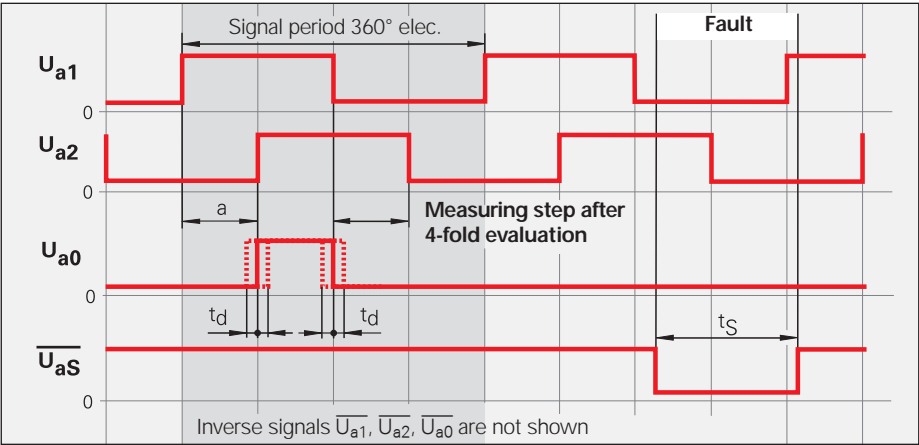
The distance between two successive edges of the incremental signals U_{a1} and U_{a2} through 1-fold, 2-fold or 4-fold evaluation is one **measuring step**.

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 to 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 errors, 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.

The permissible **cable length** for transmission of the TTL square-wave signals to the subsequent electronics depends on the edge separation a. It is at most 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 control system (remote sense power supply).

Interface	Square-wave signals $\square\square$ TTL
Incremental signals	2 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 TTL 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 amplitude	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 cables Cable length Propagation time	Shielded HEIDENHAIN cable PUR $[4(2 \times 0.14 \text{ mm}^2) + (4 \times 0.5 \text{ mm}^2)]$ Max. 100 m ($\overline{U_{aS}}$ max. 50 m) at distributed capacitance 90 pF/m 6 ns/m

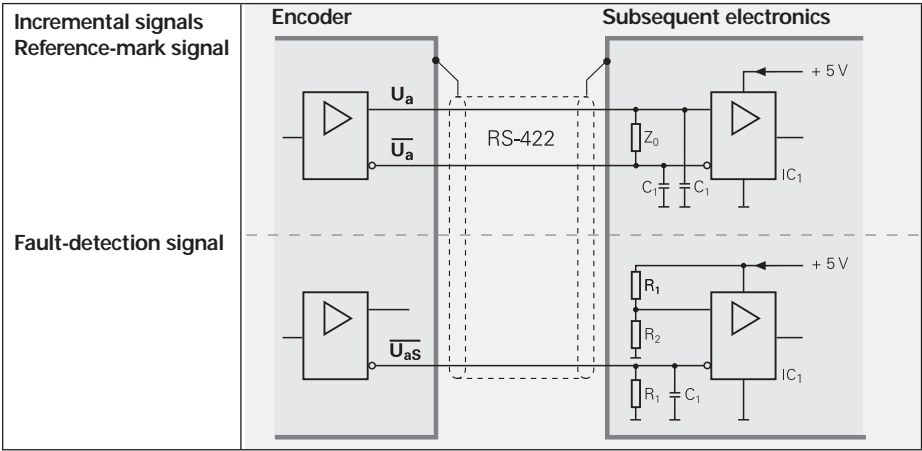


Input circuitry of the subsequent electronics

Dimensioning

IC₁ = Recommended differential line receiver
DS 26 C 32 AT
Only for a > 0.1 μs:
AM 26 LS 32
MC 3486
SN 75 ALS 193

R₁ = 4.7 kΩ
R₂ = 1.8 kΩ
Z₀ = 120 Ω
C₁ = 220 pF (serves to improve noise immunity)



Pin layout

12-pin coupling M23					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	0V	Sensor 0V	U _{a1}	U _{a1}	U _{a2}	U _{a2}	U _{a0}	U _{a0}	U _{aS} ¹⁾	Vacant	Vacant ²⁾
	Brown/ Green	Blue	White/ Green	White	Brown	Green	Gray	Pink	Red	Black	Violet	/	Yellow

Cable shield connected to housing; U_P = power supply voltage
Sensor: The sensor line is connected in the encoder with the corresponding power line.
Vacant pins or wires must not be used!
¹⁾ ERO 14xx: Vacant
²⁾ Exposed linear encoders: Switchover TTL/11 μApp for PWT, otherwise vacant

Interfaces

Absolute Position Values

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

For more information, refer to the *EnDat* Technical Information sheet or visit www.endat.de.

Position values can be transmitted with or without additional information (e.g. position value 2, temperature sensors, diagnostics, limit position signals). Besides the position, additional information can be interrogated in the closed loop and functions can be performed with the EnDat 2.2 interface.

Parameters are saved in various memory areas, e.g.:

- Encoder-specific information
- Information of the OEM (e.g. "electronic ID label" of the motor)
- Operating parameters (datum shift, instructions, etc.)
- Operating status (alarm or warning messages)

Monitoring and diagnostic functions of the EnDat interface make a detailed inspection of the encoder possible.

- Error messages
- Warnings
- Online diagnostics based on valuation numbers (EnDat 2.2)

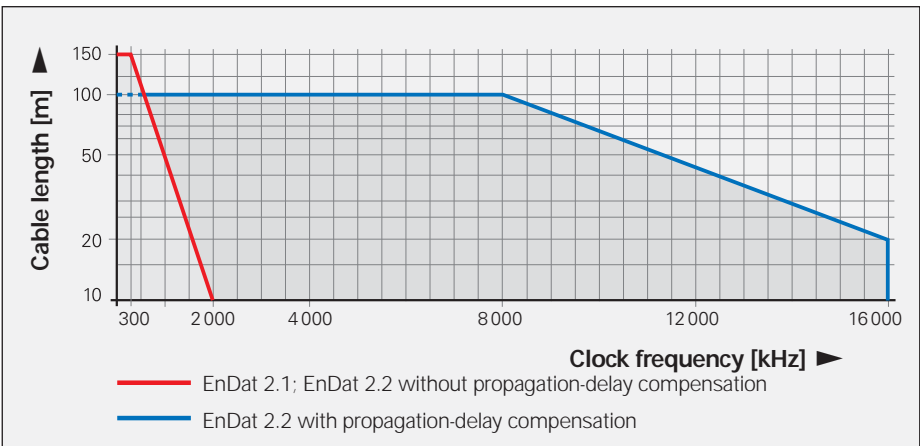
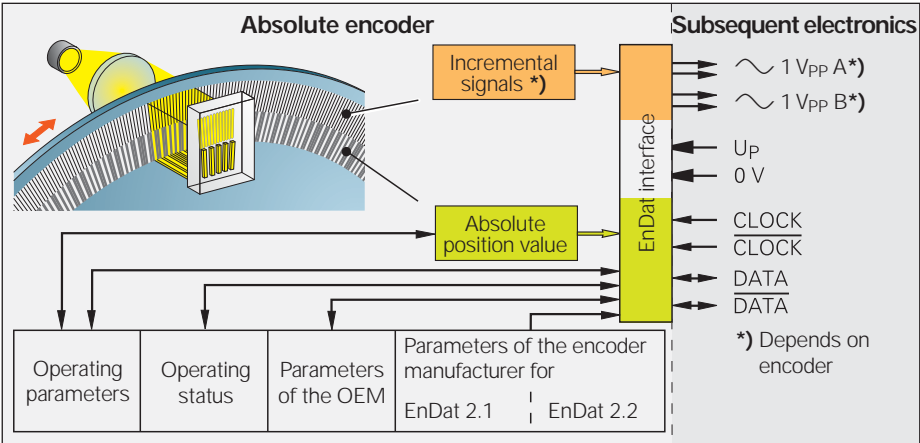
Incremental signals
EnDat encoders are available with or without incremental signals. EnDat 21 and EnDat 22 encoders feature a high internal resolution. An evaluation of the incremental signal is therefore unnecessary.

Clock frequency and cable length
The clock frequency is variable—depending on the cable length (max. 150 m)—between **100 kHz** and **2 MHz**. With propagation-delay compensation in the subsequent electronics, clock frequencies up to **16 MHz** at cable lengths up to 100 m are possible.

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 signals $\overline{\text{CLOCK}}$, CLOCK , $\overline{\text{DATA}}$ and DATA
Data output	Differential line driver according to EIA standard RS 485 for the signals DATA and $\overline{\text{DATA}}$
Position values	Ascending during traverse in direction of arrow (see dimensions of the encoders)
Incremental signals	$\sim 1 V_{PP}$ (see <i>Incremental Signals 1 V_{PP}</i>) depending on the unit

Ordering designation	Command set	Incremental signals	Power supply
EnDat 01	EnDat 2.1 or EnDat 2.2	With	See specifications of the encoder
EnDat 21		Without	
EnDat 02	EnDat 2.2	With	Expanded range 3.6 to 5.25 V or 14 V
EnDat 22	EnDat 2.2	Without	

Versions of the EnDat interface (bold print indicates standard versions)

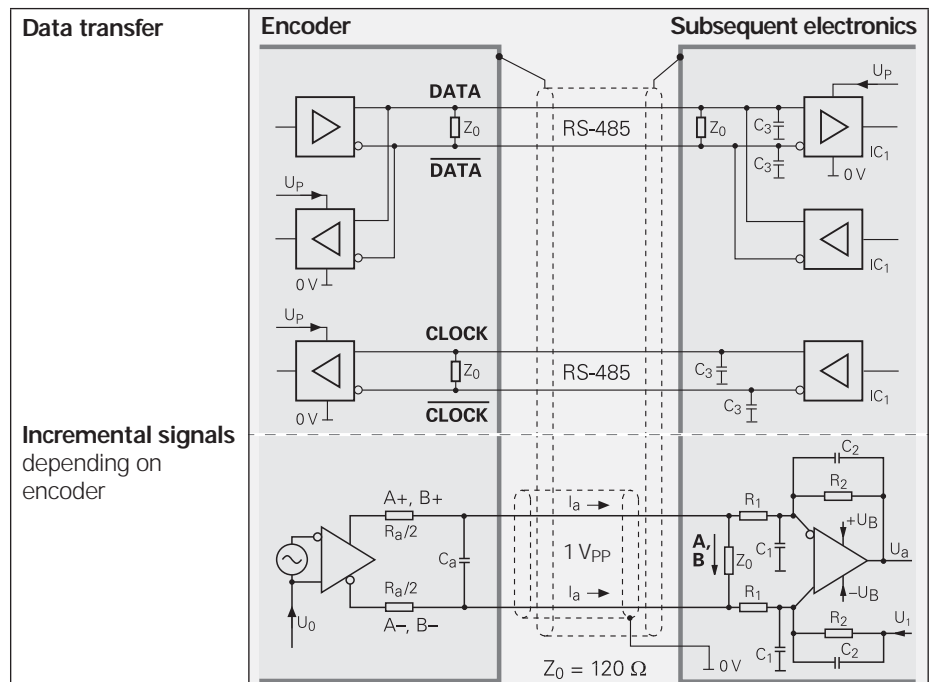


Input circuitry of the subsequent electronics


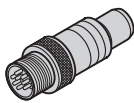
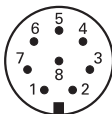
Dimensioning


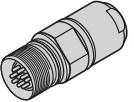
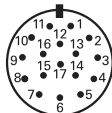

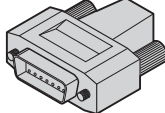
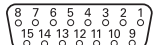
IC₁ = RS 485 differential line receiver and driver

$C_3 = 330 \text{ pF}$
 $Z_0 = 120 \Omega$



Pin layout

8-pin M12 coupling								
  								
	Power supply				Absolute position values			
	8	2	5	1	3	4	7	6
	U _P	Sensor U _P	0V	Sensor 0V	DATA	DATA	CLOCK	CLOCK
	Brown/Green	Blue	White/Green	White	Gray	Pink	Violet	Yellow

17-pin M23 coupling						15-pin D-sub connector							
  						  							
	Power supply					Incremental signals ¹⁾				Absolute position values			
	7	1	10	4	11	15	16	12	13	14	17	8	9
	1	9	2	11	13	3	4	6	7	5	8	14	15
	U _P	Sensor U _P	0V	Sensor 0V	Internal shield	A+	A-	B+	B-	DATA	DATA	CLOCK	CLOCK
	Brown/ Green	Blue	White/ Green	White	/	Green/ Black	Yellow/ Black	Blue/ Black	Red/ Black	Gray	Pink	Violet	Yellow

Cable shield connected to housing; U_P = power supply voltage

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

Vacant pins or wires must not be used!


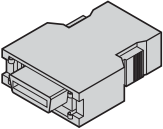
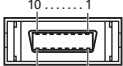

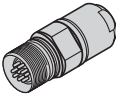
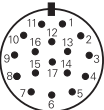



¹⁾ Only with ordering designations EnDat 01 and EnDat 02

Interfaces

Fanuc and Mitsubishi Pin Layouts


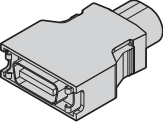
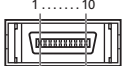

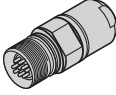
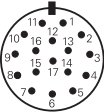



Fanuc pin layout
 HEIDENHAIN encoders with the code letter F after the model designation are suited for connection to Fanuc controls with

- **Serial interface Fanuc 01**
 with 1 MHz communication rate
- **Serial interface Fanuc 02**
 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	0V	Sensor 0V	Shield	Serial Data	Serial Data	Request	Request
	Brown/Green	Blue	White/Green	White	–	Gray	Pink	Violet	Yellow

Cable shield connected to housing; **U_P** = power supply voltage
Sensor: The sensor line is connected in the encoder with the corresponding power line.
 Vacant pins or wires must not be used!

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	0V	Sensor 0V	Serial Data	Serial Data	Request Frame	Request Frame	
	Brown/Green	Blue	White/Green	White	Gray	Pink	Violet	Yellow	

Cable shield connected to housing; **U_P** = power supply voltage
Sensor: The sensor line is connected in the encoder with the corresponding power line.
 Vacant pins or wires must not be used!

HEIDENHAIN Measuring Equipment

For Incremental Angle Encoders

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 μ App; 1 V _{PP} ; TTL; HTL; EnDat*/SSI*/commutation signals *No display of position values or parameters
Functions	<ul style="list-style-type: none"> • 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	<ul style="list-style-type: none"> • 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

For Absolute Angle Encoders

HEIDENHAIN offers an adjusting and testing package for diagnosis and adjustment of HEIDENHAIN encoders with absolute interface.

- **IK 215** PC expansion board
- **ATS** adjusting and testing software



	IK 215
Encoder input	<ul style="list-style-type: none"> • EnDat 2.1 or EnDat 2.2 (absolute value with/without incremental signals) • FANUC serial interface • Mitsubishi High Speed Serial Interface • SSI
Interface	PCI bus, Rev. 2.1
System requirements	<ul style="list-style-type: none"> • Operating system: Windows XP (Vista upon request) • Approx. 20 MB free space on the hard disk
Signal subdivision for incremental signals	Up to 65536-fold
Dimensions	100 mm x 190 mm

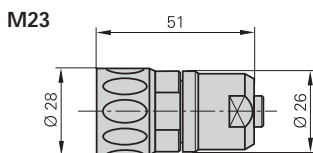
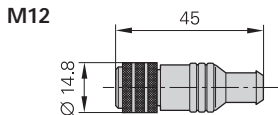
	ATS
Languages	Choice between English or German
Functions	<ul style="list-style-type: none"> • Position display • Connection dialog • Diagnostics • Mounting wizard for ECI/EQI • Additional functions (if supported by the encoder) • Memory contents

Cables and Connecting Elements

General Information

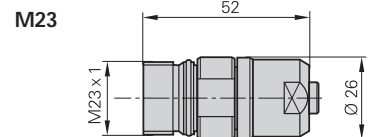
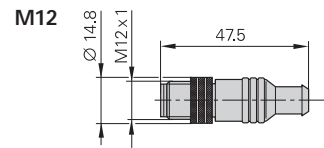
Connector (insulated): A connecting element with a coupling ring. Available with male or female contacts.

Symbols



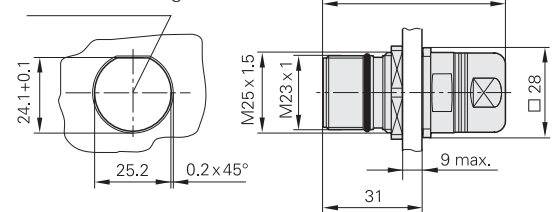
Coupling (insulated): Connecting element with external thread; available with male or female contacts.

Symbols

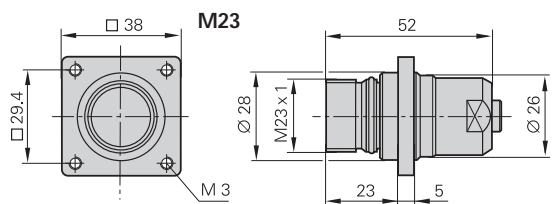


Mounted coupling with central fastening

Cutout for mounting M23

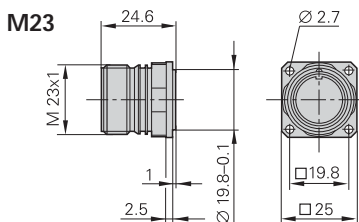


Mounted coupling with flange



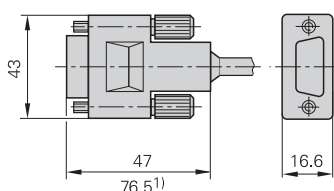
Flange socket: Permanently mounted on the encoder or a housing, with external thread (like a coupling), available with male or female contacts.

Symbols



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 sockets, regardless of whether the connecting elements are

male contacts or



female contacts.



Accessories for flange sockets and M23 mounted couplings

Bell seal

ID 266526-01







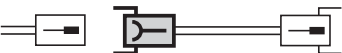
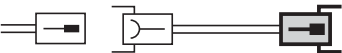
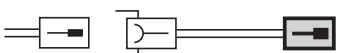

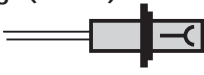
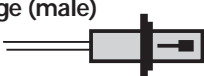
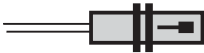

Threaded metal dust cap






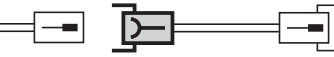
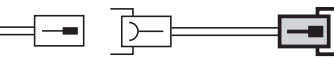
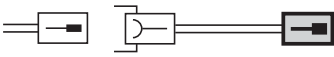

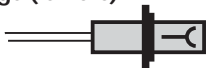
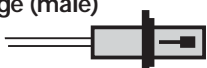
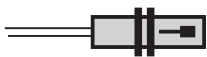
ID 219926-01

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





Connecting Cables $\sim 1 V_{PP}$ TTL

12-Pin M23

		$\sim 1 V_{PP}$ TTL
PUR connecting cables 12-pin: $[4(2 \times 0.14 \text{ mm}^2) + (4 \times 0.5 \text{ mm}^2)] \text{ } \varnothing 8 \text{ mm}$		
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 without connectors , $\varnothing 8 \text{ mm}$		244 957-01
Mating element on connecting cable to connector on encoder cable	Connector (female) for cable $\varnothing 8 \text{ mm}$ 	291 697-05
Connector on connecting cable for connection to subsequent electronics	Connector (male) for cable $\varnothing 8 \text{ mm}$ $\varnothing 6 \text{ mm}$ 	291 697-08 291 697-07
Coupling on connecting cable	Coupling (male) for cable $\varnothing 4.5 \text{ mm}$ $\varnothing 6 \text{ mm}$ $\varnothing 8 \text{ mm}$ 	291 698-14 291 698-03 291 698-04
Flange socket for mounting on subsequent electronics	Flange socket (female) 	315 892-08
Mounted couplings	With flange (female) $\varnothing 6 \text{ mm}$ $\varnothing 8 \text{ mm}$ 	291 698-17 291 698-07
	With flange (male) $\varnothing 6 \text{ mm}$ $\varnothing 8 \text{ mm}$ 	291 698-08 291 698-31
	With central fastening (male) $\varnothing 6 \text{ to } 10 \text{ mm}$ 	741 045-01
Adapter $\sim 1 V_{PP}/11 \mu A_{PP}$ For converting the $1 V_{PP}$ signals to $11 \mu A_{PP}$: 12-pin M23 connector (female) and 9-pin M23 connector (male)		364 914-01

		EnDat without incremental signals	EnDat with incremental signals
PUR connecting cables 8-pin: $[(4 \times 0.14 \text{ mm}^2) + (4 \times 0.34 \text{ mm}^2)]$ Ø 6 mm 17-pin: $[(4 \times 0.14 \text{ mm}^2) + 4(2 \times 0.14 \text{ mm}^2) + (4 \times 0.5 \text{ mm}^2)]$ Ø 8 mm			
Complete with connector (female) and coupling (male)		368 330-xx	323 897-xx
Complete with connector (female) and D-sub connector (female) for IK 220		533 627-xx	332 115-xx
Complete with connector (female) and D-sub connector (male) for IK 115/IK 215		524 599-xx	324 544-xx
With one connector (female)		634 265-xx	309 778-xx
Cable without connectors , Ø 8 mm		–	266 306-01
Mating element on connecting cable to connector on encoder cable	Connector (female) for cable Ø 8 mm 	–	291 697-26
Connector on connecting cable for connection to subsequent electronics	Connector (male) for cable Ø 8 mm Ø 6 mm 	–	291 697-27
Coupling on connecting cable	Coupling (male) for cable Ø 4.5 mm Ø 6 mm Ø 8 mm 	–	291 698-25 291 698-26 291 698-27
Flange socket for mounting on subsequent electronics	Flange socket (female) 	–	315 892-10
Mounted couplings	With flange (female) Ø 6 mm Ø 8 mm 	–	291 698-35
	With flange (male) Ø 6 mm Ø 8 mm 	–	291 698-41 291 698-29
	With central fastening (male) Ø 6 to 10 mm 	–	741 045-02

Connecting Cables Fanuc Mitsubishi

		Cable	Fanuc	Mitsubishi
PUR connecting cables				
Complete with 17-pin M23 connector (female) and Fanuc connector $[(2 \times 2 \times 0.14 \text{ mm}^2) + (4 \times 1 \text{ mm}^2)]$	 Fanuc	Ø 8 mm	534 855-xx	–
Complete with 17-pin M23 connector (female) and 20-pin Mitsubishi connector $[(2 \times 2 \times 0.14 \text{ mm}^2) + (4 \times 0.5 \text{ mm}^2)]$	 Mitsubishi 20-pin	Ø 6 mm	–	367 958-xx
Complete with 17-pin M23 connector (female) and 10-pin Mitsubishi connector $[(2 \times 2 \times 0.14 \text{ mm}^2) + (4 \times 1 \text{ mm}^2)]$	 Mitsubishi 10-pin	Ø 8 mm	–	573 661-xx
Cable without connectors $[(2 \times 2 \times 0.14 \text{ mm}^2) + (4 \times 1 \text{ mm}^2)]$		Ø 8 mm	354 608-01	

General Electrical Information

Power supply

Connect HEIDENHAIN encoders only to subsequent electronics whose power supply is generated from PELV systems (**EN 50178**). In addition, overcurrent protection and overvoltage protection are required in safety-related applications.

If HEIDENHAIN encoders are to be operated in accordance with IEC 61010-1, power must be supplied from a secondary circuit with current or power limitation as per IEC 61010-1:2001, section 9.3 or IEC 60950-1:2005, section 2.5 or a Class 2 secondary circuit as specified in UL1310.

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
 $U_{pp} < 250 \text{ mV}$ with $dU/dt > 5 \text{ V}/\mu\text{s}$
- Low frequency fundamental ripple
 $U_{pp} < 100 \text{ mV}$

The values apply as measured at the encoder, i.e., without cable influences. The voltage can be monitored and adjusted with the encoder'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**:

$$\Delta U = 2 \cdot 10^{-3} \cdot \frac{1.05 \cdot L_C \cdot I}{56 \cdot A_p}$$

where

- ΔU : Voltage attenuation in V
- 1.05: Length factor due to twisted wires
- L_C : Cable length in m
- I : Current consumption in mA
- A_p : Cross section of power lines in mm^2

The voltage actually applied to the encoder is to be considered when **calculating the encoder's power requirement**. This voltage consists of the supply voltage U_p provided by the subsequent electronics minus the line drop at the encoder. For encoders with an expanded supply range, the voltage drop in the power lines must be calculated under consideration of the nonlinear current consumption (see next page).

If the voltage drop is known, all parameters for the encoder and subsequent electronics can be calculated, e.g. voltage at the encoder, current requirements and power consumption of the encoder, as well as the power to be provided by the subsequent electronics.

Switch-on/off behavior of the encoders

The output signals are valid no sooner than after switch-on time $t_{SOT} = 1.3 \text{ s}$ (2 s for PROFIBUS-DP) (see diagram). During time t_{SOT} they can have any levels up to 5.5 V (with HTL encoders up to U_{Pmax}). If an interpolation electronics unit is inserted between the encoder and the power supply, this unit's switch-on/off characteristics must also be considered. If the power supply is switched off, or when the supply voltage falls below U_{min} , the output signals are also invalid. During restart, the signal

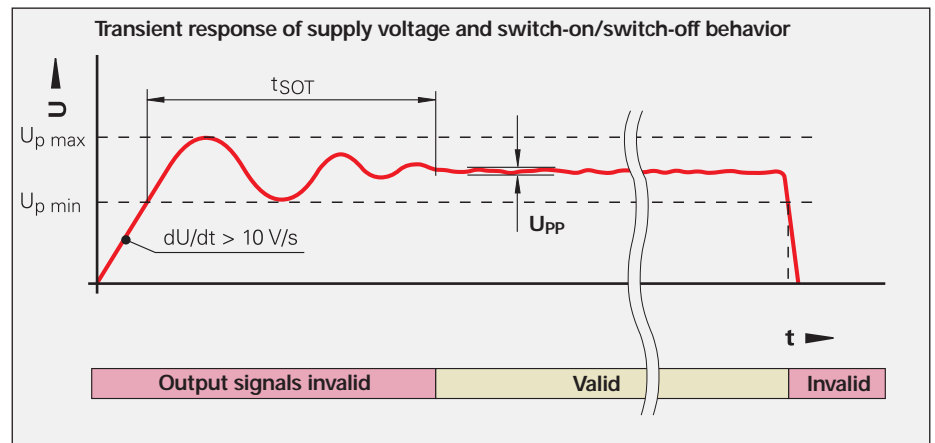
level must remain below 1 V for the time t_{SOT} before power on. These data apply to the encoders listed in the catalog—customer-specific interfaces are not included.

Encoders with new features and increased performance range may take longer to switch on (longer time t_{SOT}). If you are responsible for developing subsequent electronics, please contact HEIDENHAIN in good time.

Isolation

The encoder housings are isolated against internal circuits.

Rated surge voltage: 500 V
(preferred value as per VDE 0110 Part 1, overvoltage category II, contamination level 2)



Cable	Cross section of power supply lines A_p			
	1 V _{PP} /TTL/HTL	11 μ A _{PP}	EnDat/SSI 17-pin	EnDat ⁵⁾ 8-pin
Ø 3.7 mm	0.05 mm ²	–	–	0.09 mm ²
Ø 4.3 mm	0.24 mm ²	–	–	–
Ø 4.5 mm EPG	0.05 mm ²	–	0.05 mm ²	0.09 mm ²
Ø 4.5 mm Ø 5.1 mm	0.14/0.09 ²⁾ mm ² 0.05 ^{2), 3)} mm ²	0.05 mm ²	0.05 mm ²	0.14 mm ²
Ø 6 mm Ø 10 mm ¹⁾	0.19/0.14 ^{2), 4)} mm ²	–	0.08 mm ²	0.34 mm ²
Ø 8 mm Ø 14 mm ¹⁾	0.5 mm ²	1 mm ²	0.5 mm ²	1 mm ²

¹⁾ Metal armor

²⁾ Rotary encoders

³⁾ Length gauges

⁴⁾ LIDA 400

⁵⁾ Also Fanuc, Mitsubishi

Encoders with expanded voltage supply range

For encoders with expanded supply voltage range, the current consumption has a nonlinear relationship with the supply voltage. On the other hand, the power consumption follows a linear curve (see *Current and power consumption diagram*). The maximum power consumption at minimum and maximum supply voltage is listed in the **Specifications**. The power consumption at maximum supply voltage (worst case) accounts for:

- Recommended receiver circuit
- Cable length 1 m
- Age and temperature influences
- Proper use of the encoder with respect to clock frequency and cycle time

The typical current consumption at no load (only supply voltage is connected) for 5 V supply is specified.

The actual power consumption of the encoder and the required power output of the subsequent electronics are measured while taking the voltage drop on the supply lines in four steps:

Step 1: Resistance of the supply lines

The resistance values of the power lines (adapter cable and encoder cable) can be calculated with the following formula:

$$R_L = 2 \cdot \frac{1.05 \cdot L_C \cdot I}{56 \cdot A_P}$$

Step 2: Coefficients for calculation of the drop in line voltage

$$b = -R_L \cdot \frac{P_{E\max} - P_{E\min}}{U_{E\max} - U_{E\min}} - U_P$$

$$c = P_{E\min} \cdot R_L + \frac{P_{E\max} - P_{E\min}}{U_{E\max} - U_{E\min}} \cdot R_L \cdot (U_S - U_{E\min})$$

Step 3: Voltage drop based on the coefficients b and c

$$\Delta U = -0.5 \cdot (b + \sqrt{b^2 - 4 \cdot c})$$

Step 4: Parameters for subsequent electronics and the encoder

Voltage at encoder:

$$U_M = U_P - \Delta U$$

Current requirement of encoder:

$$I_E = \Delta U / R_L$$

Power consumption of encoder:

$$P_E = U_E \cdot I_E$$

Power output of subsequent electronics:

$$P_S = U_P \cdot I_E$$

Where:

$U_{E\max}$,

$U_{E\min}$: Minimum or maximum supply voltage of the encoder in V

$P_{E\min}$,

$P_{E\max}$: Maximum power consumption at minimum or maximum power supply, respectively, in W

U_S : Supply voltage of the subsequent electronics in V

R_L : Cable resistance (for both directions) in ohms

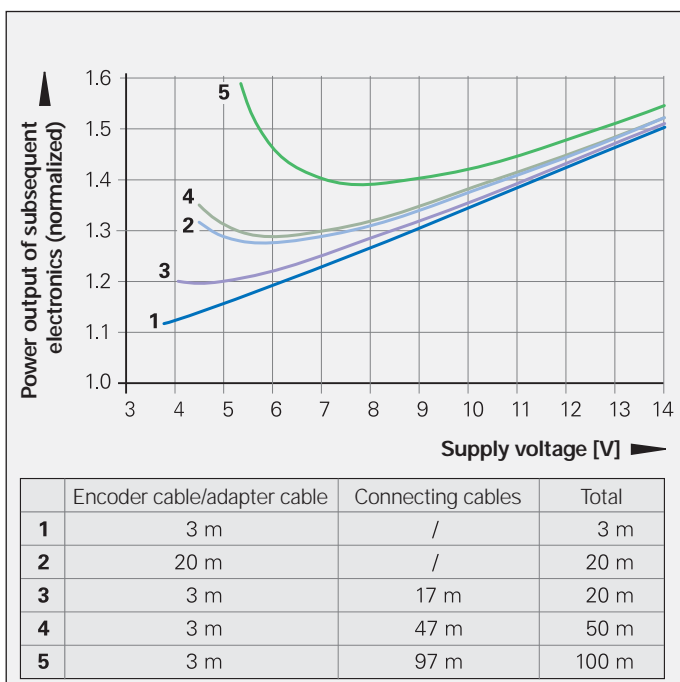
ΔU : Voltage drop in the cable in V

1.05: Length factor due to twisted wires

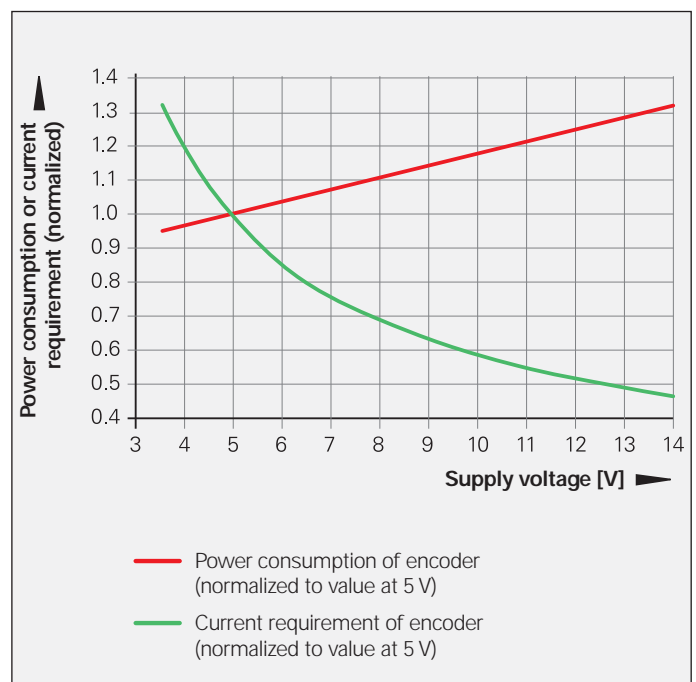
L_C : Cable length in m

A_P : Cross section of power lines in mm^2

Influence of cable length on the power output of the subsequent electronics (example representation)



Current and power consumption with respect to the supply voltage (example representation)



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 the *Specifications*) and
- the **electrically** permissible shaft speed/traversing velocity.

For encoders with **sinusoidal output signals**, the electrically permissible shaft speed/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} : Elec. permissible speed in min^{-1}
 v_{\max} : Elec. permissible traversing velocity in m/min
 f_{\max} : Max. scanning/output frequency of encoder or input frequency of subsequent electronics in kHz
 z : Line count of the angle or rotary encoder per 360°
 SP : Signal period of the linear encoder in μm

Cable

For safety-related applications, use HEIDENHAIN cables and connectors.

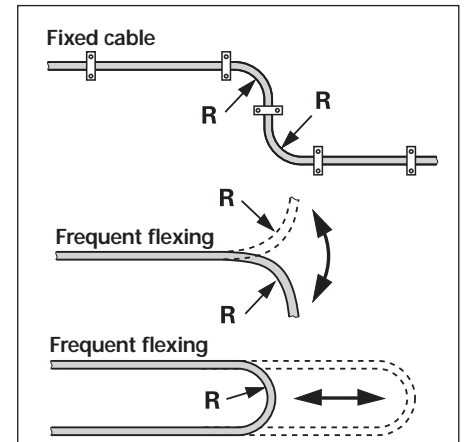
Versions

The cables of almost all HEIDENHAIN encoders and all adapter and connecting cables are sheathed in **polyurethane (PUR cable)**. Most adapter cables for within motors and a few cables on encoders are sheathed in a **special elastomer (EPG cable)**. These cables are identified in the specifications or in the cable tables with "EPG."

Durability

PUR cables are resistant to oil and hydrolysis in accordance with **VDE 0472** (Part 803/test type B) and resistant to microbes in accordance with **VDE 0282** (Part 10). 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.

EPG cables are resistant to oil in accordance with **VDE 0472** (Part 803/test type B) and to hydrolysis in accordance with **VDE 0282** (Part 10). They are free of silicone and halogens. In comparison with PUR cables, they are only conditionally resistant to media, frequent flexing and continuous torsion.



Temperature range

HEIDENHAIN cables can be used for

Rigid configuration (PUR)	–40 to 80 °C
Rigid configuration (EPG)	–40 to 120 °C
Frequent flexing (PUR)	–10 to 80 °C

PUR cables with limited resistance to hydrolysis and microbes are rated for up to 100 °C. If needed, please ask for assistance from HEIDENHAIN Traunreut.

Lengths

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

Cable	Bend radius R	
	Fixed cable	Frequent flexing
Ø 3.7 mm	≥ 8 mm	≥ 40 mm
Ø 4.3 mm	≥ 10 mm	≥ 50 mm
Ø 4.5 mm EPG	≥ 18 mm	–
Ø 4.5 mm Ø 5.1 mm	≥ 10 mm	≥ 50 mm
Ø 6 mm Ø 10 mm ¹⁾	≥ 20 mm ≥ 35 mm	≥ 75 mm ≥ 75 mm
Ø 8 mm Ø 14 mm ¹⁾	≥ 40 mm ≥ 100 mm	≥ 100 mm ≥ 100 mm

¹⁾ Metal armor

Noise-free signal transmission

Electromagnetic compatibility/ CE compliance

When properly installed, and when HEIDENHAIN connecting cables and cable assemblies are used, HEIDENHAIN encoders fulfill the requirements for electromagnetic compatibility according to 2004/108/EC with respect to the generic standards for:

- **Noise immunity EN 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:

- or industrial, scientific and medical equipment (ISM) 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 include:

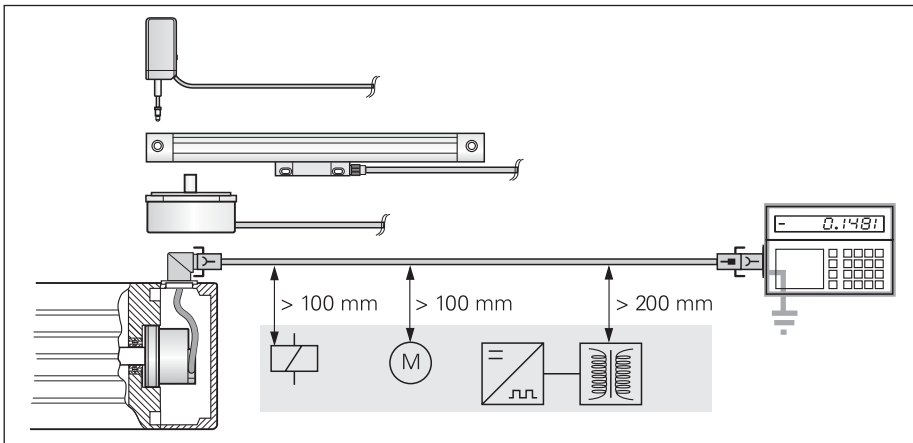
- Strong magnetic fields from transformers, brakes and electric motors
- Relays, contactors and solenoid valves
- High-frequency equipment, pulse devices, and stray magnetic fields from switch-mode power supplies
- AC power lines and supply lines to the above devices

Protection against electrical noise

The following measures must be taken to ensure disturbance-free operation:

- Use only original HEIDENHAIN cables. Consider the voltage attenuation on supply lines.
- Use connecting elements (such as connectors or terminal boxes) with metal housings. Only the signals and power supply of the connected encoder may be routed through these elements. Applications in which additional signals are sent through the connecting element require specific measures regarding electrical safety and EMC.

- Connect the housings of the encoder, connecting elements and subsequent electronics through the shield of the cable. Ensure that the shield has complete contact over the entire surface (360°). For encoders with more than one electrical connection, refer to the documentation for the respective product.
- For cables with multiple shields, the inner shields must be routed separately from the outer shield. Connect the inner shield to 0V of the subsequent electronics. Do not connect the inner shields with the outer shield, neither in the encoder nor in the cable.
- Connect the shield to protective ground as per the mounting instructions.
- Prevent contact of the shield (e.g. connector housing) with other metal surfaces. Pay attention to this when installing cables.
- Do not install 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.
- If compensating currents are to be expected within the overall system, a separate equipotential bonding conductor must be provided. The shield does not have the function of an equipotential bonding conductor.
- Only provide power from PELV systems **(EN 50178) to position encoders.** Provide high-frequency grounding with low impedance **(EN 60204-1 Chap. EMC).**
- For encoders with 11 µApp interface: For extension cables, use only HEIDENHAIN cable ID 244 955-01. Overall length: max. 30 m.



Minimum distance from sources of interference

Evaluation Electronics

IK 220

Universal PC counter card

The IK 220 is an expansion board for 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 up to 4096-fold. A driver software package is included in delivery.



For more information, see the *IK 220* Product Information document as well as the Product Overview of *Interface Electronics*.

	IK 220			
Input signals (switchable)	$\sim 1 V_{PP}$	$\sim 11 \mu A_{PP}$	EnDat 2.1	SSI
Encoder inputs	Two D-sub connections (15-pin) male			
Input frequency	$\leq 500 \text{ kHz}$	$\leq 33 \text{ kHz}$	–	
Cable length	$\leq 60 \text{ m}$		$\leq 50 \text{ m}$	$\leq 10 \text{ m}$
Signal subdivision (signal period : 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			
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			

IBV / APE series

Interpolation and digitizing electronics

Interpolation and digitizing electronics interpolate and digitize the sinusoidal output signals ($\sim 1 V_{PP}$) from HEIDENHAIN encoders up to 400-fold, and convert them to TTL square-wave pulse trains.



IBV 101

For more information, see the *IBV 100*, *IBV 600* and *APE 371* Product Information documents, as well as the *Interface Electronics* Product Overview.

	IBV 101	IBV 102	IBV 660	APE 371
Design	Housing			Connector
Degree of protection	IP 65			IP 40
Input	$\sim 1 V_{PP}$			
Encoder connection	<i>IBV</i> : M23 flange socket, 12-pin, female <i>APE</i> : D-sub connector 15-pin or M23 connector 12-pin female			
Interpolation switchable	5-fold 10-fold	25-fold 50-fold 100-fold	25-fold 50-fold 100-fold 200-fold 400-fold	5-fold 10-fold 20-fold 25-fold 50-fold 100-fold
Output	<ul style="list-style-type: none"> Two \square 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 U_{as} Limit and homing signals H, L (for APE 371) 			
Power supply	5 V ± 5 %			

ND 200

Digital readouts

HEIDENHAIN encoders with 11 μApp or 1 V_{PP} signals and EnDat 2.2 interface can be connected to the digital readouts of the ND 200 series. The **ND 280** readout provides the basic functions for simple measuring tasks. The **ND 287** also features other functions such as sorting and tolerance check mode, minimum/maximum value storage, measurement series storage. It calculates the mean value and standard deviations and creates histograms and control charts. The ND 287 permits optional connection of a second encoder for sum/difference measurement or of an analog sensor. The ND 28x feature serial interfaces for measured value transfer.



For more information, see brochure:
Digital Readouts/Linear Encoders.

	ND 280	ND 287
Input signals¹⁾	1 x \sim 11 μApp , \sim 1 V_{PP} or EnDat 2.2	
Encoder inputs	D-sub 15-pin female	
Input frequency	\sim 1 V_{PP} : \leq 500 kHz; 11 μApp : \leq 100 kHz	
Signal subdivision	Up to 1024-fold (adjustable)	
Display step (adjustable)	<i>Linear axis:</i> 0.5 to 0.002 μm <i>Angular axis:</i> 0.5° to 0.00001° or 00°00'00.1"	
Functions	<ul style="list-style-type: none"> • REF reference mark evaluation • 2 datums 	
	–	<ul style="list-style-type: none"> • Sorting and tolerance checking • Measurement series (max. 10000 measured values) • Minimum/maximum value storage • Statistics functions • Sum/difference display (option)
Switching I/O	–	Yes
Interface	V.24/RS-232-C; USB (UART); Ethernet (option for ND 287)	

¹⁾ Automatic detection of interface

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