HEIDENHAIN

Encoder Technology Ltd
Units 5 & 6 Leatherhead Industrial Estate
Station Rd, Leatherhead,
Surrey, KT22 7AL, UK
Tel: +44 (0)1372 377985
Fax: +44 (0)1372 386973
http://www.encoder-technology.com

Rotary Encoders

April 2002

Rotary encoders with mounted stator coupling

Rotary encoders with separate shaft coupling

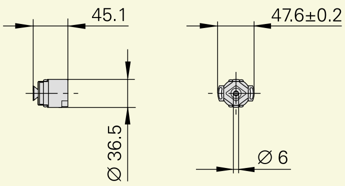
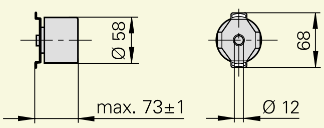
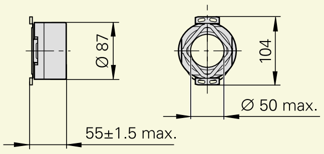
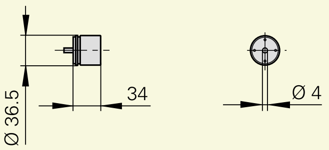
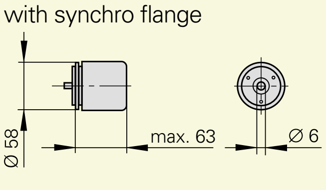
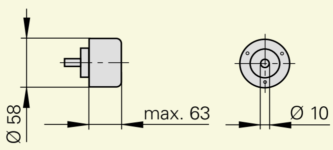
The catalogs for
• Angle encoders
• Exposed linear encoders
• Sealed linear encoders
• Position encoders for servo drives
• HEIDENHAIN subsequent electronics
are available on request.

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

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

Contents

Selection Guide

Rotary Encoders	Incremental				Absolute Singleturn Parallel	 Serial
Interface	⊓⊔ TTL	⊓⊔ TTL	⊓⊔ HTL	∿ 1 V_{PP}	⊓⊔ TTL or ⊓⊔ HTL	SSI
Power supply	5 V	10 to 30 V	10 to 30 V	5 V	5 V or 10 to 30 V	5 V or 10 to 30 V
with mounted stator coupling						
ERN 1000 series 	**ERN 1020** 100 to 3600 lines	–	**ERN 1030** 100 to 3600 lines	**ERN 1080** 100 to 3600 lines	–	–
ERN/ECN/EQN 400 series** 	**ERN 420** 250 to 5000 lines	**ERN 460** 250 to 5000 lines	**ERN 430** 250 to 5000 lines	**ERN 480** 1000 to 5000 lines	–	**ECN 413** Positions/rev: 13 bits
ERN/ECN 100 series 	**ERN 120** 1000 to 5000 lines	–	**ERN 130** 1000 to 5000 lines	**ERN 180** 1000 to 5000 lines	–	**ECN 113** Positions/rev: 13 bits
for separate shaft coupling						
ROD 1000 series 	**ROD 1020** 100 to 3600 lines	–	**ROD 1030** 100 to 3600 lines	**ROD 1080** 100 to 3600 lines	–	–
ROD/ROC/ROQ 400 series** with synchro flange 	**ROD 426** 50 to 10 000 lines	**ROD 466** 50 to 10 000 lines	**ROD 436** 50 to 5000 lines	**ROD 486** 1000 to 5000 lines	**ROC 409/360** **ROC 410** **ROC 412** Positions/rev: 360 Positions/ 10/12 bits	**ROC 410** **ROC 412** **ROC 413** Positions/rev: 10/12/13 bits
ROD/ROC/ROQ 400 series** with clamping flange 	**ROD 420** 50 to 5000 lines	–	**ROD 430** 50 to 5000 lines	**ROD 480** 250 to 5000 lines	–	**ROC 413** Positions/rev: 13 bits

* PROFIBUS-DP via gateway
** Explosion-proof versions upon request

		Multiturn Serial		Programmable Serial	
	EnDat* 5 V	SSI 5 V or 10 to 30 V	EnDat* 5 V	SSI 10 to 30 V	
	–	–	–	–	34
	ECN 413 Positions/rev: 13 bits	**EQN 425** Positions/rev: 13 bits 4096 revolutions	**EQN 425** Positions/rev: 13 bits 4096 revolutions	**EQN 425** Positions/rev: 13 bits 4096 revolutions	36
	ECN 113 Positions/rev: 13 bits	–	–	–	40
	–	–	–	–	42
	ROC 413 Positions/rev: 13 bits	**ROQ 425** Positions/rev: 13 bits 4096 revolutions	**ROQ 425** Positions/rev: 13 bits 4096 revolutions	**ROQ 425** Positions/rev: 13 bits 4096 revolutions	44
	ROC 415 **ROC 417** Positions/rev: 15/17 bits				48
	ROC 413 Positions/rev: 13 bits	**ROQ 425** Positions/rev: 13 bits 4096 revolutions	**ROQ 425** Positions/rev: 13 bits 4096 revolutions	**ROQ 425** Positions/rev: 13 bits 4096 revolutions	50



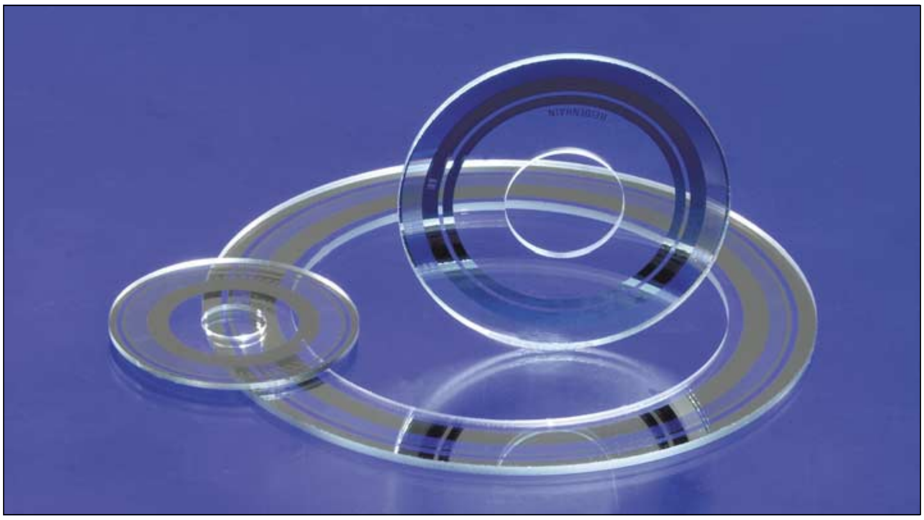



Measuring Standard

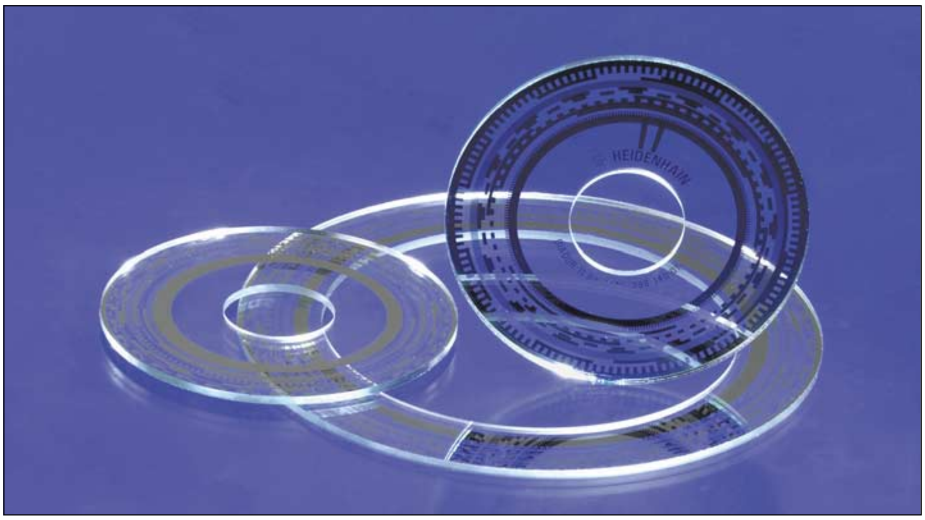
The circular graduations of rotary encoders are manufactured with the DIADUR process developed by HEIDENHAIN. It produces a radial grating of opaque chromium lines with very high edge definition. This high edge definition is a precondition for a high quality of scanning signal.

The glass substrate permits the rotary encoders to operate at high temperatures — as high as 100 °C (212 °F) on some models — without any significant reduction of signal quality.

DIADUR circular graduations form the basis for the accuracy of HEIDENHAIN rotary encoders.



Circular graduations of incremental rotary encoders



Circular graduations of absolute rotary encoders

Accuracy

The accuracy of rotary encoders is influenced mainly by:

- The directional deviation of the radial grating.
- The eccentricity of the graduated disk to the bearing.
- The radial deviation of the bearing.
- The error resulting from the connection with the rotor couplings. On rotary encoders with stator coupling this error lies within the system accuracy.
- The interpolation deviation during signal processing in the integrated or external interpolation and digitizing electronics.

For **incremental rotary encoders** with line counts up to 5000:
The extreme values of directional deviation at 20 °C ambient temperature and slow speed (scanning frequency between 1 kHz and 2 kHz) lie within

$$\pm \frac{18° \text{ mech.} \cdot 3600}{\text{Line count } z} \text{ [angular seconds]}$$

which equals

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

ROD rotary encoders with 6000 to 10 000 signal periods per revolution have a system accuracy of ±12 angular seconds.

The accuracy of the absolute position values from **absolute rotary encoders** is given in the specifications for each model.

For absolute rotary encoders with **additional incremental signals,** the accuracy depends on the line count:

Line count	**Accuracy**
512	± 60 arc seconds
2048	± 20 arc seconds
8192	± 10 arc seconds

The above accuracy data refer to incremental measuring signals at an ambient temperature of 20 °C (68 °F) and at slow speed.

Photoelectric Scanning

HEIDENHAIN rotary encoders operate on the principle of photoelectrically scanning very fine gratings.

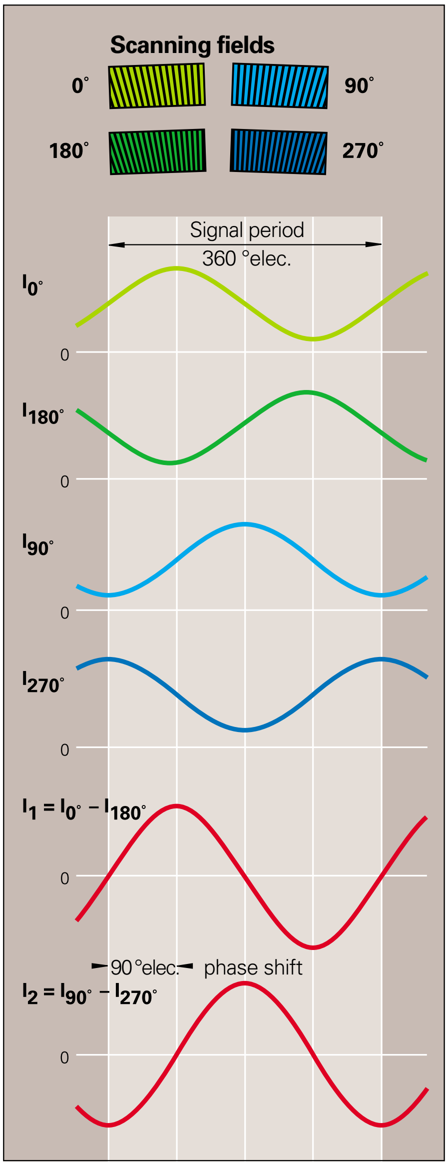
The measuring standard for **incremental rotary encoders** is a graduated glass disk with a radial grating of lines and gaps forming an **incremental track.** A second track carries a **reference mark.**

At a small distance from the rotating graduation is a scanning reticle with a grating in each of four fields, and a fifth field for the reference mark. The four fields on the scanning reticle are phase-shifted to each other by one quarter of the grating period (= 360°/line count).

All these fields are penetrated by a beam of collimated light produced by a light unit consisting of an LED and condenser lens. When the graduated disk rotates, it modulates the beam of light, whose intensity is sensed by silicon photovoltaic cells.

Signal generation
The photovoltaic cells for the incremental track produce four sinusoidal current signals, phase-shifted from each other by 90° (elec.): $I_{0°}$, $I_{90°}$, $I_{180°}$ and $I_{270°}$. The photovoltaic cell for the reference mark outputs a signal peak.

The four sinusoidal signals do not lie symmetrically to the zero line. For this reason the photovoltaic cells are connected in a push-pull circuit, producing two 90° phase-shifted output signals I_1 and I_2 in symmetry to the zero line.



The measuring standard for **singleturn encoders** is a graduated glass disk with several **coded tracks.** At a short distance from the rotating disk surface are one or more scanning reticles with transparent fields for each of the disk's coded tracks.

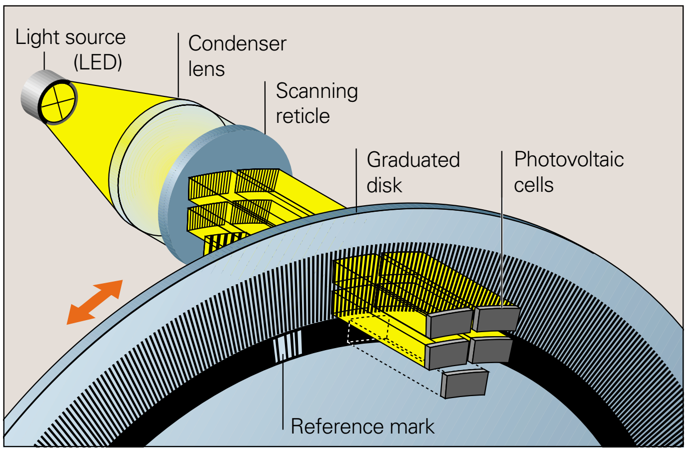
Each scanning reticle masks a beam of collimated light produced by a light unit consisting of an LED and condenser lens. When the graduated disk rotates, it modulates the beam of light, whose intensity is sensed by silicon photovoltaic cells.

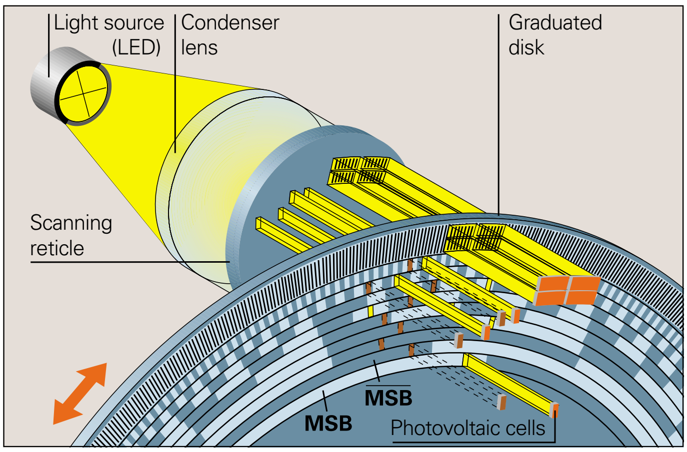
Absolute rotary encoders that also output incremental signals have four scanning fields above the finest track. The four fields on the scanning reticle are phase-shifted relative to each other by one quarter of the grating period (grating period = 360° divided by the line count).

For determining a position within one revolution, **multiturn absolute encoders** function on the same principle as singleturn encoders.

The measuring standard for distinguishing separate revolutions is a series of permanent-magnet circular graduations connected by gears. The transmission is designed for scanning speeds up to 12 000 rpm and temperatures of –40 °C to 120 °C. The graduations are scanned by Hall sensors.

LSB — Least Significant Bit:
In a group of bits representing a number, the bit with the smallest weight by virtue of its position.
MSB — Most Significant Bit:
In a group of bits representing a number, the bit with the greatest weight by virtue of its position.
$\overline{\text{MSB}}$ — Most Significant Bit, inverted:
The inverted signal $\overline{\text{MSB}}$ can be used to reverse the counting direction.





Interfaces
Incremental Signals ⊓⊔ TTL

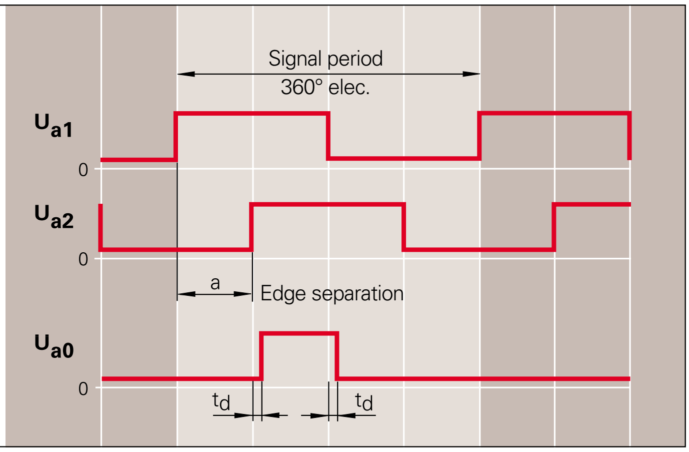
Encoders with TTL square-wave output signals incorporate circuitry that digitizes sinusoidal scanning signals without interpolation, or after 2-fold interpolation. They provide two 90° (elec.) phase-shifted **square-wave pulse trains U_{a1} and U_{a2},** and one **reference pulse U_{a0},** which is gated with the incremental signals. A **fault-detection signal $\overline{U_{aS}}$** indicates fault conditions such as an interruption in the supply lines, failure of the light source, etc. It can be used, for example, in automated production to switch off the machine. The integrated electronics also generate the **inverse signals** of all square-wave pulse trains. The distance between two successive edges of the combined pulse trains U_{a1} and U_{a2} after 1-fold, 2-fold or 4-fold evaluation is **one measuring step.**

To ensure reliable operation, the input circuitry of the subsequent electronics must be designed to detect each edge of the square-wave pulse. To prevent counting errors in the subsequent electronics, the **edge separation** a must never exceed the maximum possible scanning frequency. The minimum edge separation a is guaranteed over the entire operating temperature range.

	ERN 120, ERN 420/460, ERN 1020, ROD 42x, ROD 466, ROD 1020
Output Signals	Square-wave signals ⊓⊔ TTL
Incremental signals	2 TTL square-wave signals U_{a1}, U_{a2} and their inverted signals $\overline{U_{a1}}$, $\overline{U_{a2}}$
Edge separation	a ≥ 0.4 µs at scanning frequency of 400 kHz a ≥ 0.45 µs at scanning frequency of 300 kHz a ≥ 0.8 µs at scanning frequency of 160 kHz a ≥ 1.3 µs at scanning frequency of 100 kHz
Ref. mark signal	1 square-wave pulse U_{a0} and inverted pulse $\overline{U_{a0}}$
Pulse width	90° elec. (other widths available on request)
Delay time	$\lvert t_d \rvert \leq 50$ ns
Fault detection signal	1 square-wave pulse $\overline{U_{aS}}$ (improper function = LOW; proper function: HIGH)
Signal level	Differential line driver as per EIA standard RS 422 $U_H \geq 2.5$ V with $-I_H = 20$ mA $U_L \leq 0.5$ V with $I_L = 20$ mA
Permissible load	R ≥ 100 Ω (between associated outputs) $\lvert I_L \rvert \leq 20$ mA (max. load per output) $C_{load} \leq 1000$ pF with respect to 0 V Outputs protected against short circuit after 0 V
Switching times (10% to 90%)	Rise time $t_+ \leq 50$ ns; Fall time $t_- \leq 50$ ns; with 1 m cable and recommended input circuitry
Connecting cable	HEIDENHAIN shielded cable PUR [4(2 x 0.14 mm²) + (4 x 0.5 mm²)]
Cable length	Max. 100 m ($\overline{U_{aS}}$ max. 50 m) with distributed capacitance 90 pF/m
Propagation time	6 ns/m

Incremental signals

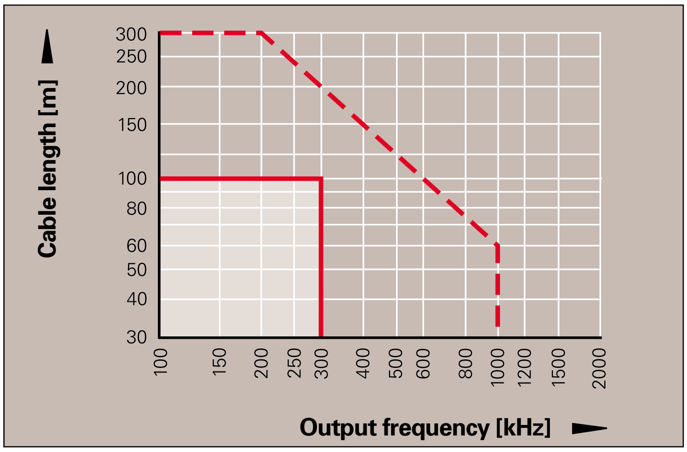
Reference mark signal



Direction of rotation: U_{a1} lags U_{a2} with clockwise rotation (viewed from flange side)

Cable lengths

TTL square-wave signals can be transmitted to the subsequent electronics over cable up to 100 m (329 ft), provided that the specified 5 V ± 10% supply voltage is maintained at the encoder. The sensor lines enable the subsequent electronics to measure the voltage at the encoder and, if required, correct it with a line-drop compensator.



Permissible cable length in relation to output frequencies
(- - - TTL specification)

⊓⊔ TTL: Recommended input circuitry of subsequent electronics

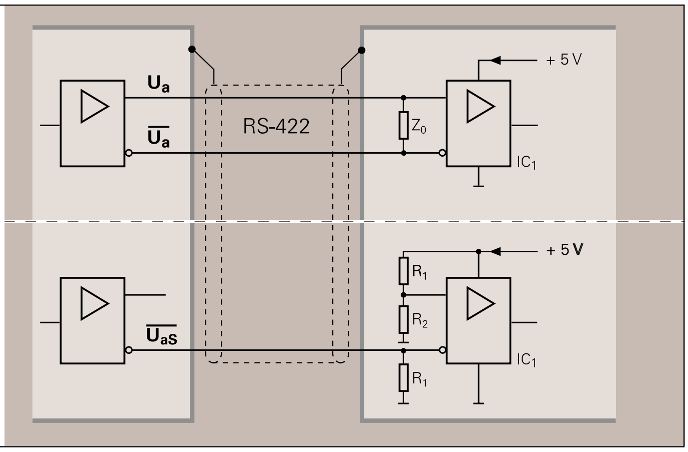
Dimensioning

IC_1 = Recommended differential line receiver
AM 26 LS 32
MC 3486
SN 75 ALS 193

R_1 = 4.7 kΩ
R_2 = 1.8 kΩ
Z_0 = 120 Ω

Incremental signals Reference mark signal

Fault detection signal



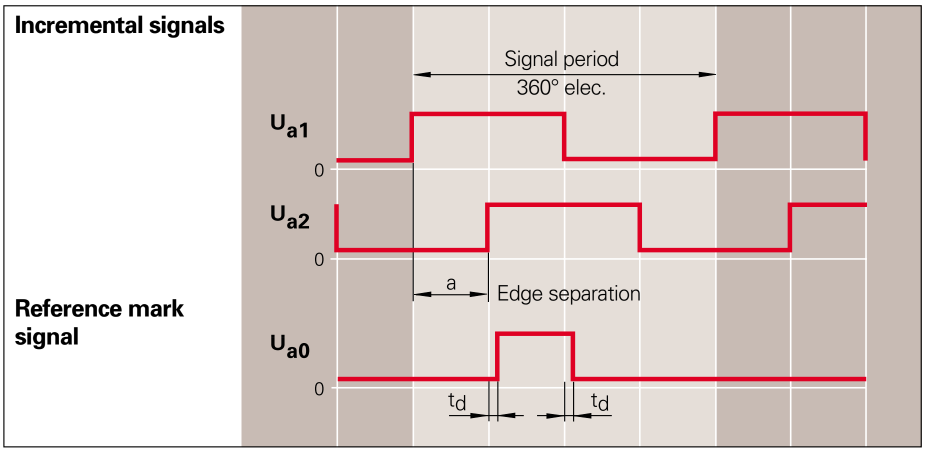
Interfaces
Incremental Signals ⊓⊔ HTL

Encoders with HTL square-wave output signals incorporate circuitry that digitizes sinusoidal scanning signals. They provide two 90° (elec.) phase-shifted **square-wave pulse trains U_{a1} and U_{a2},** and one **reference pulse U_{a0},** which is gated with the incremental signals. A **fault-detection signal $\overline{U_{aS}}$** indicates fault conditions such as an interruption in the supply lines, failure of the light source, etc. The integrated electronics also generate the **inverse signals** of all square-wave pulse trains (not with ERN/ROD 1x30).

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

To ensure reliable operation, the input circuitry of the subsequent electronics must be designed to detect each edge of the square-wave pulse. To prevent counting errors in the subsequent electronics, the **edge separation *a*** must never exceed the maximum possible scanning frequency. The minimum edge separation a is guaranteed over the entire operating temperature range.

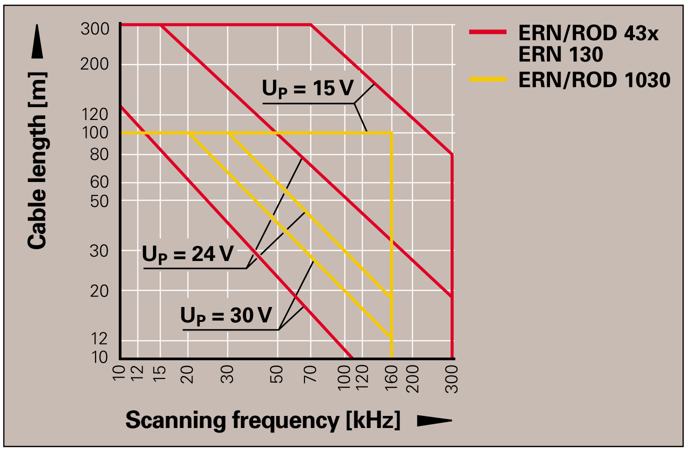
	ERN 130, ERN 430, ERN 1030, ROD 43x,ROD 1030
Output Signals	Square-wave signals ⊓⊔ HTL
Incremental signals	2 HTL square-wave signals U_{a1} , U_{a2} and their inverted signals $\overline{U_{a1}}$, $\overline{U_{a2}}$ (*ERN/ROD 1x30* without $\overline{U_{a1}}$, $\overline{U_{a2}}$)
Edge separation	a ≥ 0.45 µs at scanning frequency of 300 kHz a ≥ 0.8 µs at scanning frequency of 160 kHz a ≥ 1.3 µs at scanning frequency of 100 kHz
Ref. mark signal	1 square-wave pulse U_{a0} and inverted pulse $\overline{U_{a0}}$ (*ERN/ROD 1x30* without $\overline{U_{a0}}$)
Pulse width	90° elec. (other widths available on request)
Delay time	$\|t_d\| \leq 50$ ns with gated reference pulse
Fault detection signal	1 square-wave pulse $\overline{U_{aS}}$ (improper function=LOW; proper function=HIGH)
Signal level	$U_H \geq 21$ V with $-I_H = 20$ mA $U_L \leq 2.8$ V with $I_L = 20$ mA with power supply $U_P = 24$ V, without cable
Permissible load	$\|I_L\| \leq 100$ mA (max. load per output, except $\overline{U_{aS}}$) $C_{load} \leq 10$ nF with respect to 0 V Outputs protected against short circuit after 0 V (except $\overline{U_{aS}}$)
Switching times (10% to 90%)	Rise time $t_+ \leq 200$ ns Fall time $t_- \leq 200$ ns with 1 m cable and recommended input circuitry
Connecting cable	HEIDENHAIN shielded cable PUR [4(2 x 0.14 mm²) + (4 x 0.5 mm²)]
Cable length	Max. 300 m (*ERN/ROD 1x30* max. 100 m)
Propagation time	6 ns/m



Direction of rotation: U_{a1} lags U_{a2} with clockwise rotation (viewed from flange side)

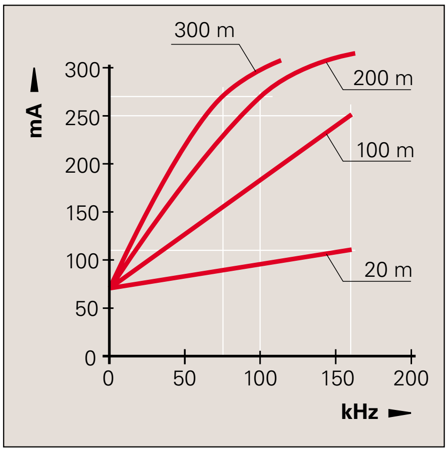
Cable lengths

For incremental rotary encoders with HTL signals, the permissible cable length depends on the scanning frequency and the effective power supply. The limit on cable length ensures the correct switching times and edge steepness of output signals.

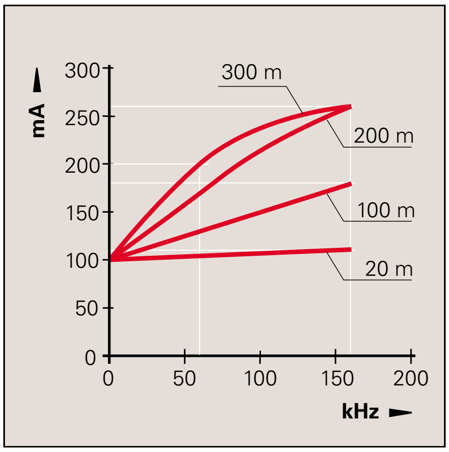


Current consumption

The current consumption for rotary encoders with HTL output signals depends on the output frequency and the cable length of the subsequent electronics. The diagrams at right show typical curves for push-pull signal transmission with a 12-line HEIDENHAIN cable. The maximum current consumption can be 50 mA higher.

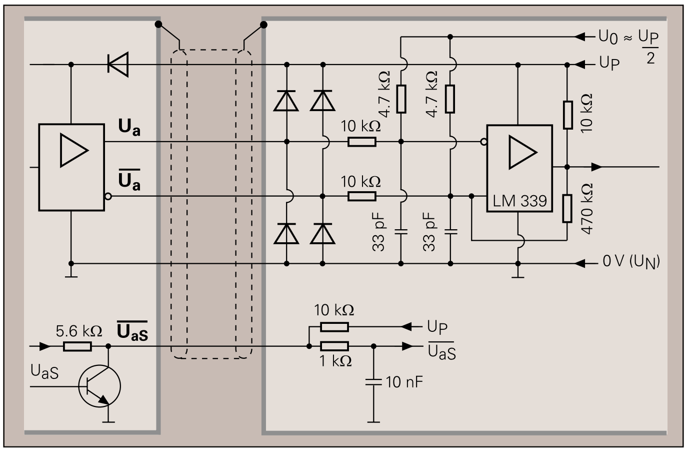


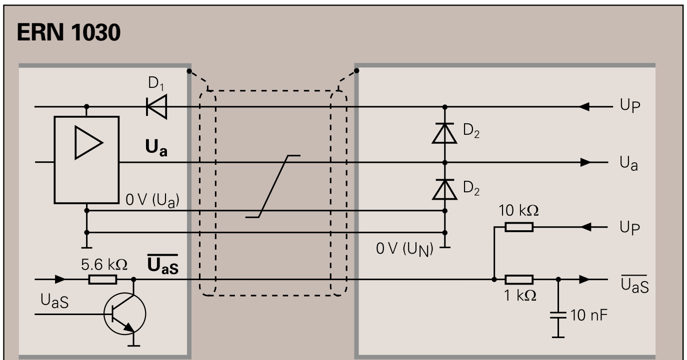
Typical current consumption at Up = 24 V



Typical current consumption at Up = 15 V

⊓⊔ HTL: Recommended input circuitry of subsequent electronics



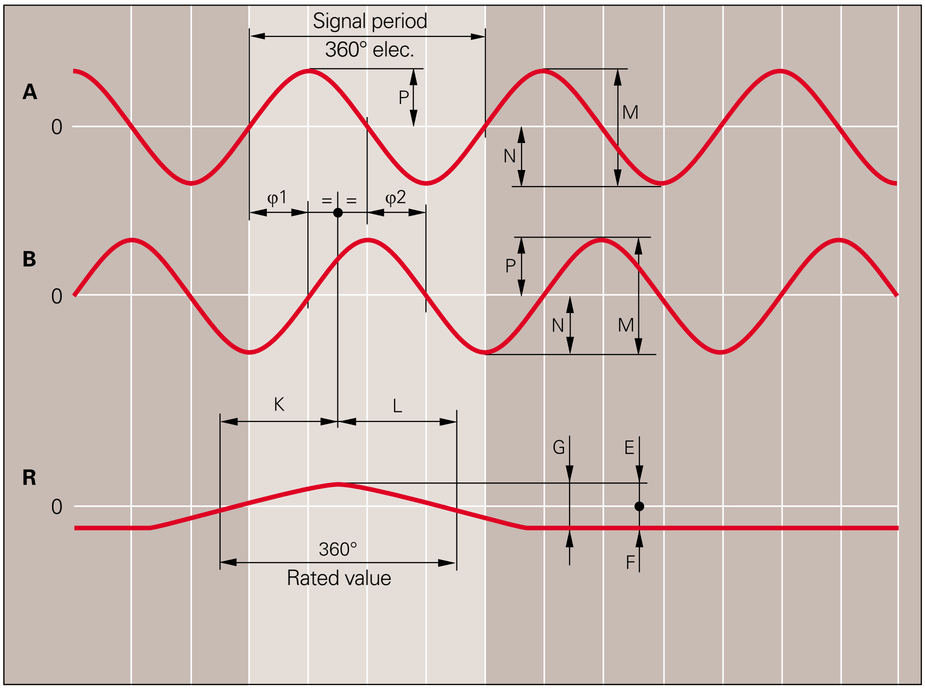


For cable lengths over 50 m, the corresponding 0 V signal lines must be connected with 0 V of the subsequent electronics to increase noise immunity.

Interfaces
Incremental Signals ∿ 1 V_{PP}

The sinusoidal incremental signals A and B are phase-shifted by 90° and have a signal level of approx. 1 V_{PP}. The usable component of the reference mark signal is approx. 0.5 V. Data on signal amplitude apply for U_P (see *Specifications*) at the encoder. The signal amplitude decreases with increasing scanning frequency (see *Explanation of Specifications*). Sensor lines enable the subsequent electronics to measure the voltage at the encoder and, if required, to correct it with a line-drop compensator.

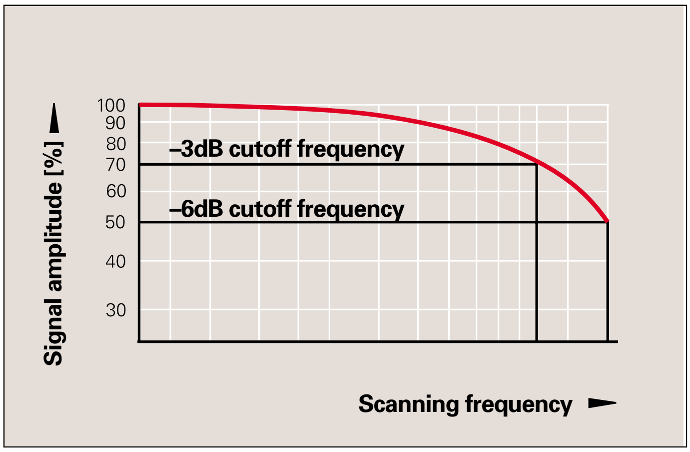
	ERN 180, ERN 480, ERN 1080, ROD 48x, ROD 1080	
Output signals	Sinusoidal voltage signals ∿ 1 V_{PP}	
Incremental signals	**2 sinusoidal signals A and B**	
	Signal level M:	0.8 to 1.2 V_{PP} Typically 1V_{PP}
	Asymmetry |P – N| / 2M:	0.065
	Amplitude ratio M_A/M_B:	0.8 to 1.25
	Phase angle $\|\varphi 1 + \varphi 2\| / 2$:	90° ± 10° elec.
Reference mark signal	Useable component G:	0.2 to 0.85 V
	Signal-to-noise ratio E / F:	Min. 40 mV
	Zero crossovers K, L:	180° ± 90° elec.
Connecting cable	HEIDENHAIN cable with shielding PUR [4(2 × 0.14 mm^2) + (4 × 0.5 mm^2)]	
Cable lengths	Max. 150 m with distributed capacitance of 90 pF/m	
Propagation time	6 ns/m	



A, B, R measured with an oscilloscope in differential mode
Direction of rotation: A lags B with clockwise rotation (viewed from flange side)

Cutoff frequency
The cutoff frequency indicates the frequency at which a certain percentage of the original signal amplitude is maintained.
- –3dB cutoff frequency: 70% of the signal amplitude
- –6dB cutoff frequency: 50% of the signal amplitude

Recommended measuring step
The recommended measuring step for speed control results essentially from the signal period and the quality of the scanning signals.



Typical curve of the signal amplitude as a function of the scanning frequency

∿ 1 V_{PP}: Recommended input circuitry of subsequent electronics

Dimensioning
Operational amplifier e.g. RC 4157
R_1 = 10 kΩ and C_1 = 220 pF
R_2 = 34.8 kΩ and C_2 = 10 pF
Z_0 = 120 Ω
U_B = ± 15 V
U_1 approx. U_0

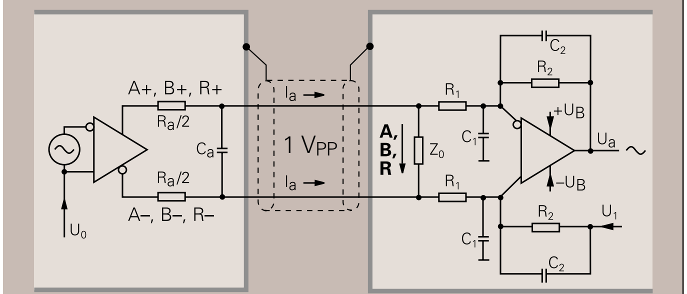
–3dB cutoff frequency of circuitry
Approx. 450 kHz
Approx. 50 kHz with C_1 = 1000 pF
and C_2 = 82 pF

Output signals of circuitry
U_a = 3.48 V_{PP} typical
Gain 3.48-fold

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

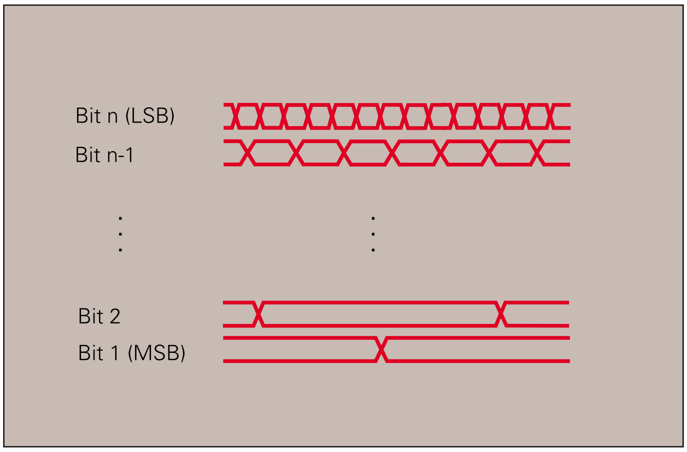
Incremental signals
Reference mark signal

R_a < 100 Ω,
typically 24 Ω
C_a < 50 pF
Sum I_a < 1 mA
U_0 = 2.5 V ± 0.5 V
(relative to 0 V of the power supply)

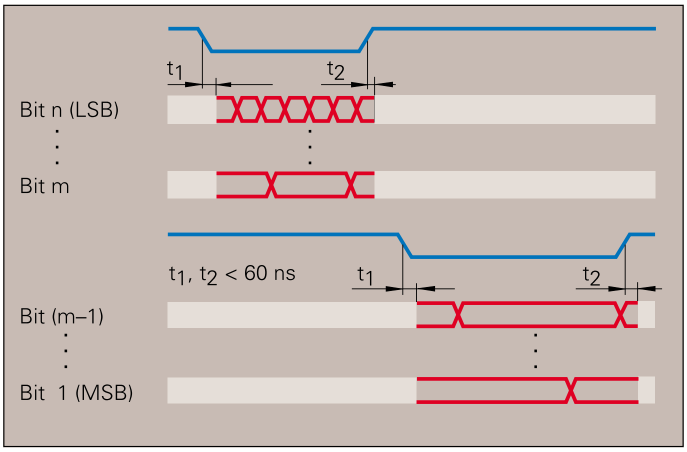


Interfaces
Parallel, TTL and HTL

Parallel data output
For absolute rotary encoders with parallel data output, **each track** has a **separate data line.** The data are available as output upon generation of a release signal (exception: with ROC 412, HTL the data is permanently available). Output signal levels are either HTL compatible or TTL compatible, depending on the model.



Three-state function
If two or more ROC absolute rotary encoders are to be connected to one input of the subsequent electronics, the ROC 409/360, ROC 410, and ROC 412 (TTL) rotary encoders are capable of outputting position values upon request through release lines and a three-state function.

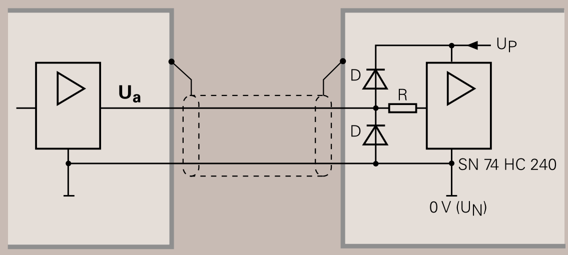


Resolutions
Absolute rotary encoders can be used below their rated resolutions. In such cases the high-resolution tracks are ignored by omitting the corresponding electrical lines.

Data input except ROC 412 HTL	$\overline{\text{Release A}}$ = LOW: Bit *n* (LSB) to bit *m* on the output lines $\overline{\text{Release B}}$ = LOW: Bit (*m–1*) to bit *1* (MSB) on output lines $\overline{\text{Release A}}$ and $\overline{\text{Release B}}$ = LOW: Bit *n* (LSB) to bit *1* (MSB) in the output lines		
Signal level	TTL-compatible control signals U_H: 2 to 5.25 V / U_L: 0 to 0.8 V *ROC 409/410:* $-I_L$ < 2 mA (CMOS input with 3.9 kΩ against 5 V) *ROC 412:* $-I_L$ < 0.55 mA (CMOS input with 10 kΩ against 5 V)		
Data output	Data in Gray code or Gray excess code *(ROC 409/360)* *n* parallel output signals		
	$\overline{\text{Release A}}$ and $\overline{\text{Release B}}$	$\overline{\text{Release A}}$ Bit *n* to bit *m*	$\overline{\text{Release B}}$ Bit (*m–1*) to bit *1*
ROC 409/360	Bit 9 to bit 1	Bit 9 (LSB) to bit 3	Bit 2 to bit 1 + $\overline{\text{bit 1 (MSB)}}$
ROC 410	Bit 10 to bit 1	Bit 10 (LSB) to bit 3	Bit 2 to bit 1 + $\overline{\text{bit 1 (MSB)}}$
ROC 412 TTL	Bit 12 to bit 1	Bit 12 (LSB) to bit 7	Bit 6 to bit 1
ROC 412 HTL	Bit 12 to bit 1 (no release required)		
Direction of rotation	Increasing code values with clockwise rotation (viewed from flange side). When $\overline{\text{MSB}}$ and ($\overline{\text{RELEASE B}}$) is used instead of MSB, the code values decrease. ($\overline{\text{MSB}}$ is not available on the *ROC 412*.)		
Connecting cable	HEIDENHAIN cable with shielding PUR [11(2 x 0.14 mm^2)]; distributed capacitance 90 pF/m		
Propagation time	6 ns/m		

Parallel Data in TTL Levels
Parallel data in TTL levels can be transmitted to the subsequent electronics over distances up to 20 m (66 ft).

TTL: Recommended input circuitry of subsequent electronics

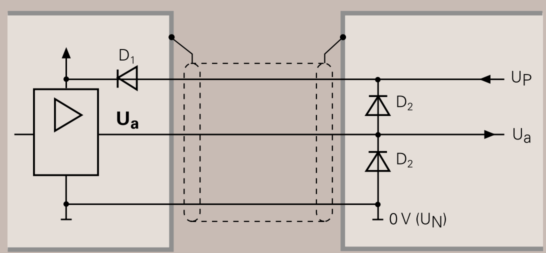


D: e.g. 1N4448
R = 10 kΩ

TTL signal levels	$U_H \geq 3.5$ V at $-I_H \leq 6$ mA $U_L \leq 0.4$ V at $I_L \leq 6$ mA
Load	$-I_H \leq 6$ mA $I_L \leq 6$ mA $C_{load} \leq 1000$ pF
Three-State	I < 5 µA at U = 0 to 5.25 V
Switching times	Rise time: $t_+ \leq 100$ ns Fall time: $t_- \leq 100$ ns

Parallel Data in HTL Levels
Parallel data in HTL levels can be transmitted to the subsequent electronics over distances up to 100 m (329 ft).

HTL: Recommended input circuitry of subsequent electronics



D_1: reverse polarity protection
D_2: e.g. 1N4448

HTL signal levels	$U_H \geq U_P - 3$ V with $-I_H \leq 20$ mA $U_L \leq 2.8$ V with $I_L \leq 20$ mA
Load	$-I_H \leq 20$ mA $I_L \leq 20$ mA $C_{load} \leq 1000$ pF
Three-State	Only for *ROC 409 (HTL)* and *ROC 410 (HTL)*: I < 5 µA at U = 0 to 5.25 V
Switching times	Rise time: $t_+ \leq 300$ ns Fall time: $t_- \leq 300$ ns
Short-circuit stability	Short circuit of all outputs at room temperature permissible

Interfaces
Serial EnDat 2.1

As a **bidirectional** interface, the EnDat (**En**coder **Dat**a) interface for absolute encoders is capable of outputting **absolute position values** as well as requesting or updating information stored in the encoder. Thanks to the **serial data transmission,** only **four signal** lines are required. The type of transmission (i.e., whether position values or parameters) is selected through mode commands transmitted from the subsequent electronics to the encoder. Data is transmitted **in synchronism** with a CLOCK signal from the subsequent electronics.

Advantages of the EnDat Interface

- **One interface** for all absolute encoders, whereby the subsequent electronics can automatically distinguish between EnDat and SSI.
- Complementary **output of incremental signals** (optional use for high speed control loops).
- **Automatic self-configuration** during encoder installation, since all information required by the subsequent electronics is already stored in the encoder.
- **Reduced wiring cost.** For standard applications six lines are sufficient.
- **High system security** through alarms and messages that can be evaluated in the subsequent electronics for monitoring and diagnosis. No additional lines are required.
- **Minimized transmission times** through adaptation of the data word length to the resolution of the encoder and through high clock frequencies.
- **High reliability of transmission** through cyclic redundancy checks.
- **Datum shift** through an offset value in the encoder.
- It is possible to form a **redundant system,** since the absolute value and incremental signals are output independently from each other.

	ROC 41x, ECN 413, ECN 113, ROQ 425, EQN 425
Interface	EnDat (serial bidirectional)
Code signals	
Data input	Differential line receiver according to EIA standard RS-485 for CLOCK and $\overline{\text{CLOCK}}$ as well as DATA and $\overline{\text{DATA}}$ signals
Data output	Differential line driver according to EIA standard RS-485 for DATA and $\overline{\text{DATA}}$ signals
Signal level	Differential voltage outputs > 1.7 V with 120 Ω load*) (EIA standard RS-485)
Code	Pure binary code
Direction of rotation	Code values increase with clockwise rotation (viewed from flange side)
Incremental signals	∿ 1 V_{PP} (see *1 V_{PP} Incremental Signals*)
Connecting cable	HEIDENHAIN cable with shielding PUR [(4 × 0.14 mm^2) + 2(4 × 0.14 mm^2) + (4 × 0.5 mm^2)]
Cable lengths	Max. 150 m with distributed capacitance 90 pF/m
Propagation time	6 ns/m

*) Terminating and receiver input resistor

EnDat interface: Recommended input circuitry of subsequent electronics

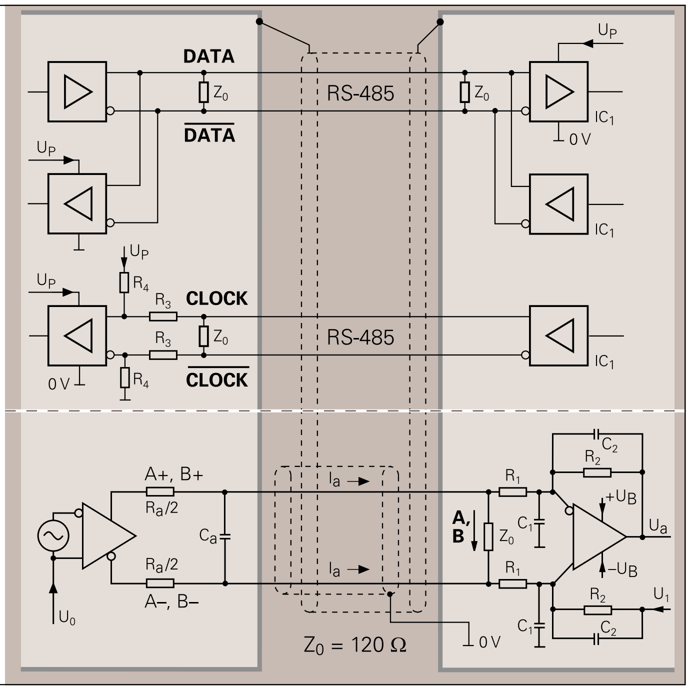
Code signals

IC_1 = Differential line receiver and driver e.g. SN 65 LBC 176 LT 485

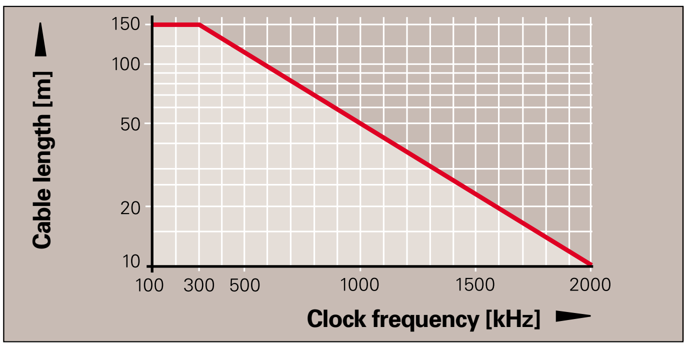
R_3 = 100 kΩ*)
R_4 = 1 kΩ*)
Z_0 = 120 Ω

Incremental signals*

*) Encoder-dependent



Permissible clock frequency with respect to cable lengths



Function of the EnDat Interface

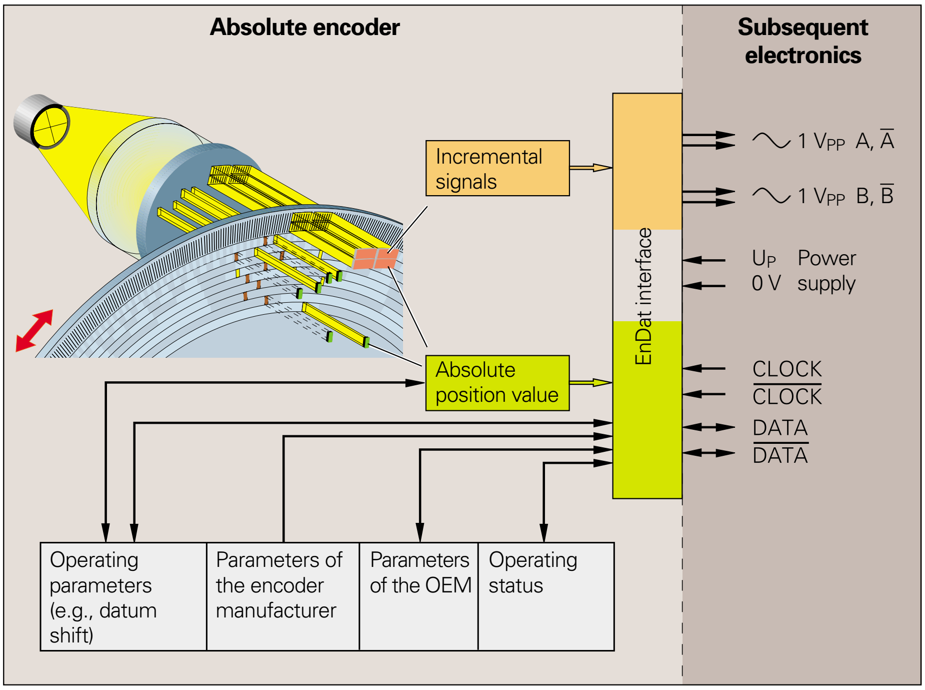
The EnDat interface outputs **absolute position values**, and permits reading from and writing to the **memory in the encoder.** Depending on the encoder, **incremental signals** may additionally be available (see *Specifications*).

Selection of transmission mode
Position values and memory contents are transmitted serially through the DATA lines. The type of transmission is selected through **mode commands** that define the content of the subsequent information. Each mode command consists of 3 bits. To ensure transmission reliability, each bit is also transmitted inverted. If the encoder recognizes a faulty mode transmission, an error message follows. The following mode commands are available:

- Encoder transmit absolute position value
- Select the memory area
- Encoder transmit/receive parameters of the last defined memory area
- Encoder transmit test values
- Encoder receive test command
- Encoder receive RESET

Parameters
The encoder provides several memory areas that can be read from by the subsequent electronics, some of which can be written to by the encoder manufacturer, the OEM, or even the end user. Certain memory areas can be write-protected.

The parameters, which in most cases are set by the OEM, largely define the function of the encoder and the EnDat interface. When an EnDat encoder is exchanged it is therefore essential that the encoder parameter settings be correct. Putting a machine into operation with incorrect parameters can result in malfunctions. If there is any doubt as to the correct parameter settings, the OEM should be consulted.



Block diagram: Absolute encoder with EnDat interface

Encoder Memory Areas

Parameters of the encoder manufacturer
This write-protected memory area contains all **information specific to the encoder** such as encoder type (linear encoder, angle encoder, singleturn/multiturn, etc.), signal periods, number of position values per revolution, transmission format of absolute position values, direction of rotation, maximum permissible speed, accuracy with respect to shaft speed, support through warnings and alarms, part number, and serial number. This information forms the basis for **automatic configuration.**

Parameters of the OEM
In this freely definable memory area the OEM can store his information. A motor manufacturer, for example, can save an "electronic ID label" of the motor in which the encoder in integrated, indicating the motor model, maximum current rating, etc.

Operating parameters
This area is available to the customer for a **datum shift.** It can be protected against overwriting.

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

Monitoring and Diagnostic Functions

Alarms and warnings
The EnDat interface permits extensive monitoring of the encoder without requiring additional transmission lines.

An **alarm** becomes active if there is a malfunction in the encoder that is presumably causing incorrect position values. At the same time, an alarm bit is set in the data word. Alarm conditions include, for example:

- Failure of the light unit
- Insufficient signal amplitude
- Error in calculation of the position value
- Operating voltage too high or too low
- Current consumption too high

Warnings indicate that certain tolerance limits of the encoder have been reached or exceeded — such as shaft speed or the limit of light source intensity compensation through voltage regulation — without implying that the measured position values are incorrect. This function enables preventive maintenance and therefore minimizes machine downtime.

The alarms and warnings supported by the respective encoder are stored in the encoder manufacturer's parameter memory area.

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

Data transfer

The two types of EnDat data transfer are position value transfer and parameter transfer.

Control Cycles for Transfer of Position Values

The **clock** signal is transmitted by the subsequent electronics to synchronize the data output from the encoder. When not transmitting, the clock line is high. The transmission cycle begins with the first falling edge. The encoder saves the measured values and calculates the position value.

After two clock pulses (2T), the subsequent electronics send the **mode command** *encoder transmit position value.*

After the encoder has completed calculation of the absolute position value (t_{cal} — see table), it begins with the **start bit** to transmit data to the subsequent electronics.

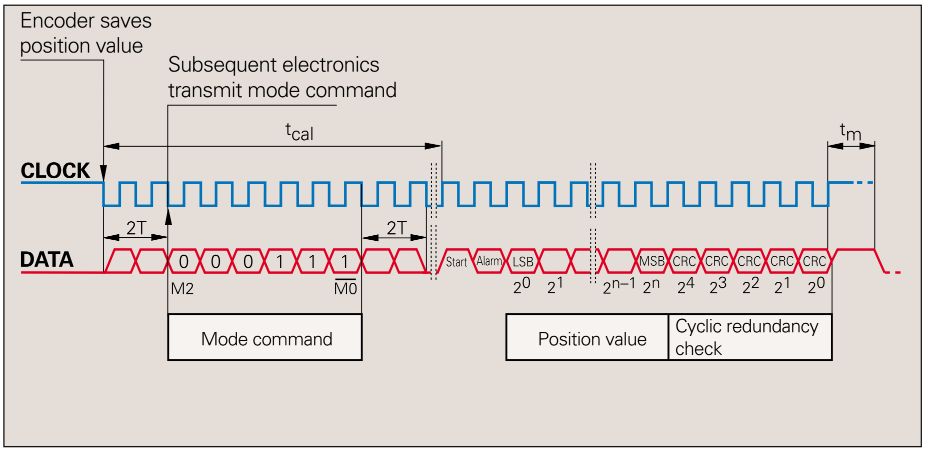
The subsequent **alarm bit** is a common signal for all monitored functions and serves for failure monitoring. It becomes active if there is a malfunction in the encoder that could result in incorrect position values. The exact cause of the alarm is saved in the operating-status memory area where it can be interrogated.

The **absolute position value** is then transmitted beginning with the LSB. Its length depends on the encoder. It is saved in the encoder manufacturer's memory area. Since EnDat does not need to fill superfluous bits with zeros as is common in SSI, the transmission time of the position value to the subsequent electronics is minimized.

Data transmission is concluded with the **cyclic redundancy check** (CRC).

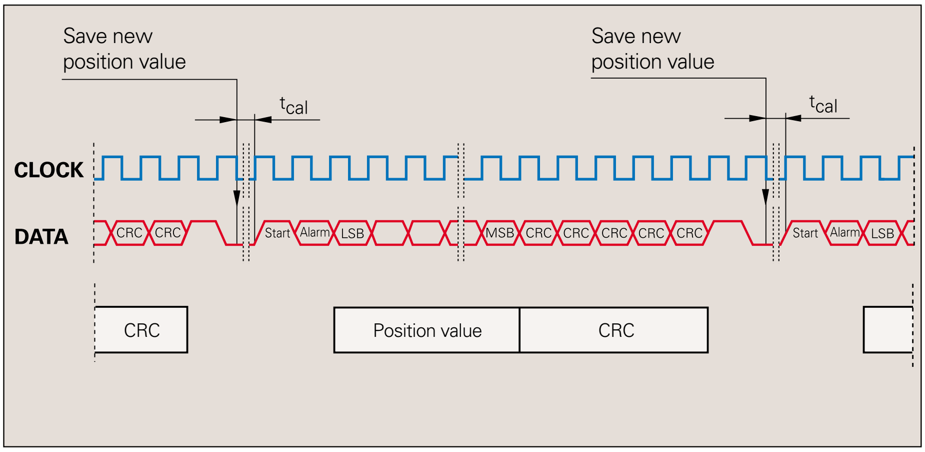
Interrupted clock

The interrupted clock is intended particularly for time-clocked systems such as closed control loops. At the end of the data word the clock signal is set to high level. After the time t_m (10 to 30 µs) the data line returns to low and can begin a new transmission when started by the clock signal.



Continuous clock

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



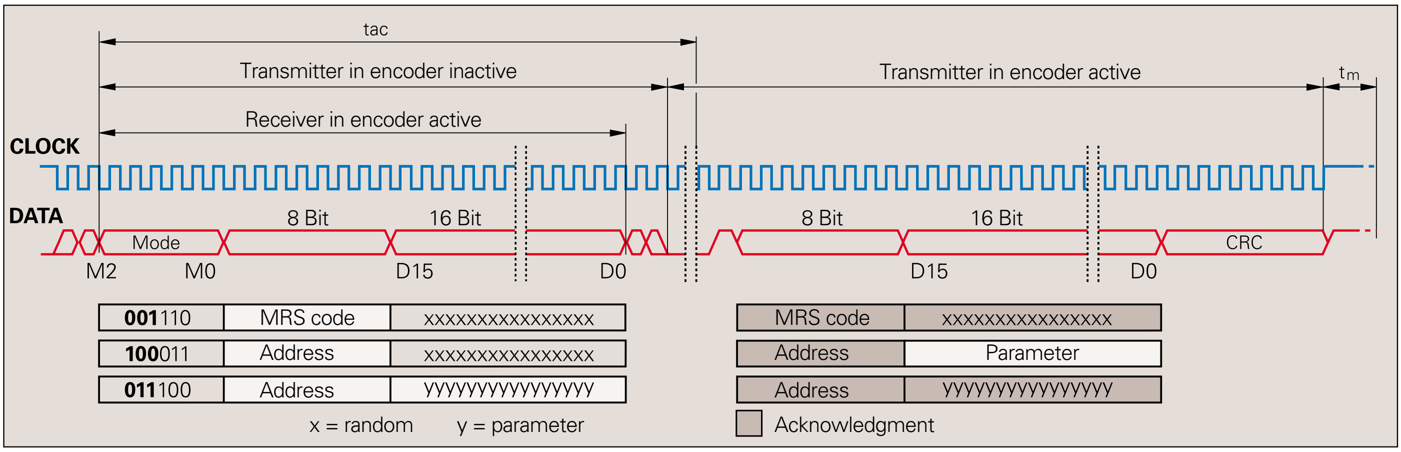
		ROC, ECN, ROQ, EQN	RCN*	LC**
Clock frequency	f_C	100 kHz to 2 MHz		
Calculation time for **– Position value** **– Parameter**	t_{cal} t_{ac}	250 ns Max. 12 ms	10 µs Max. 12 ms	1 ms Max. 12 ms
Recovery Time	t_m	10 to 30 µs		
HIGH pulse width	t_{HI}	0.2 to 10 µs		
LOW pulse width	t_{LO}	0.2 µs to 50 ms		0.2 to 30 µs

*) See ***Angle Encoders*** catalog
) See ***Sealed Linear Encoders* catalog

Control cycles for transfer of parameters (mode command 001110)
Before parameter transfer, the memory area is determined with the mode command *select the memory area* and a subsequent memory-range-select code (MRS). The possible memory areas are stored in the parameters of the encoder manufacturer. Due to the internal access times to the individual memory areas, the calculating time t_{ac} may reach 12 ms.

Reading parameters from the encoder (mode command 100011)
After selecting the memory area, the subsequent electronics transmits a complete communications protocol beginning with the mode command *encoder transmit parameters*, followed by an 8 bit-address and 16 bits with random content. The encoder answers with the repetition of the address and 16 bits with the contents of the parameter. The transmission cycle is concluded with a CRC check.

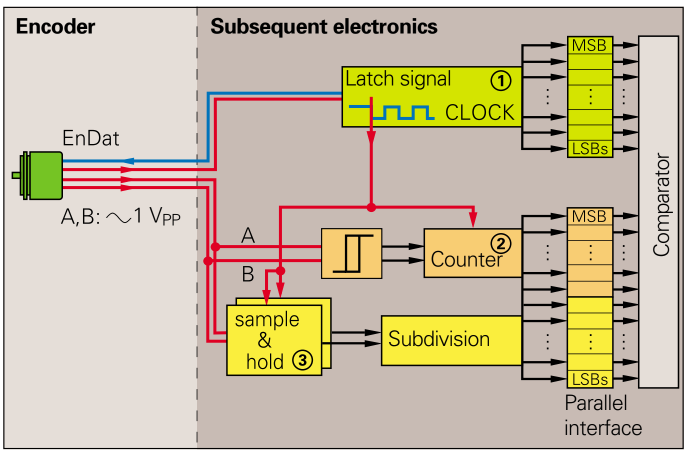
Writing parameters to the encoder (mode command 011100)
After selecting the memory area, the subsequent electronics transmit a complete communications protocol beginning with the mode command *encoder receive parameters*, followed by an 8-bit address and a 16-bit parameter value. The encoder answers by repeating the address and the contents of the parameter. The CRC check concludes the cycle.



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

The code value transmitted over the serial interface unambiguously identifies one incremental signal period. The position value is absolute within one sinusoidal period of the incremental signal. The subdivided incremental signal can therefore be appended in the subsequent electronics to the serially transmitted code value. This makes it possible to increase the resolution of the absolute rotary encoder. For example, a 1024-fold subdivision in the subsequent electronics of 512 signal periods per revolution results in approx. 500 000 absolute measuring steps per revolution (i.e., 19 bits).

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

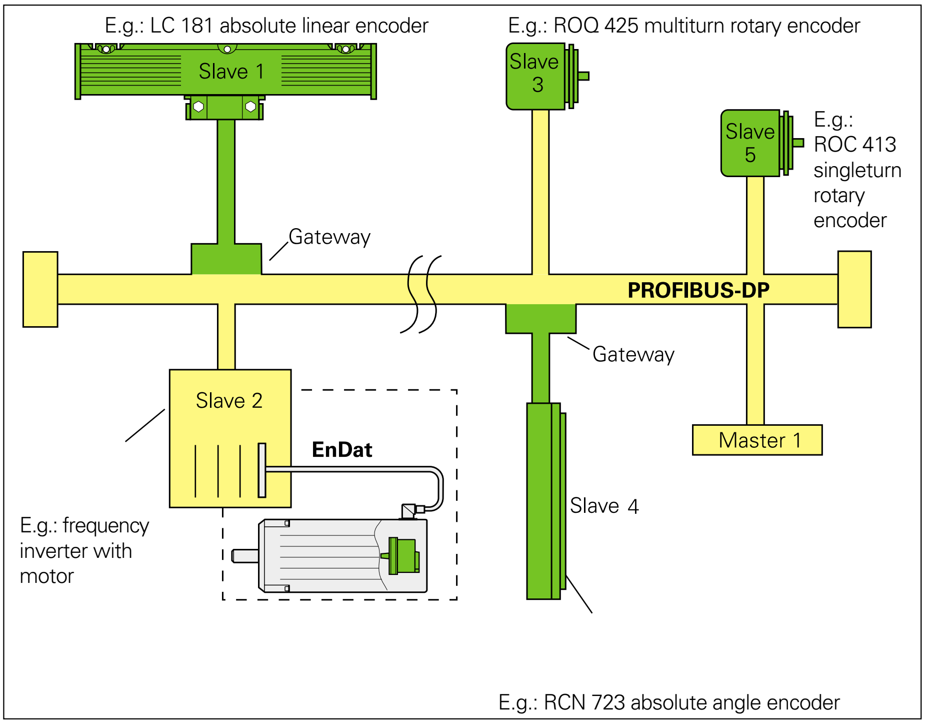


Interfaces
PROFIBUS-DP

PROFIBUS-DP
PROFIBUS is a nonproprietary, open field bus in accordance with the international EN 50 170 standard. The connecting of sensors through field bus systems minimizes the cost of cabling and the number of lines between encoder and subsequent electronics.

Topology and bus assignment
The PROFIBUS-DP has a linear structure permitting stub lines for transfer rates up to 1.5 Mbit/s. Both mono-master and multi-master systems are possible. Each master can serve only its own slaves (polling). The slaves are polled cyclically by the master. Slaves are, for example, sensors such as absolute rotary encoders, linear encoders, or also control devices such as motor frequency inverters.

Physical characteristics
The electrical features of the PROFIBUS-DP comply with the RS-485 standard. The bus connection is a shielded, twisted two-wire cable with active bus terminations at each end.



Bus structure of PROFIBUS-DP

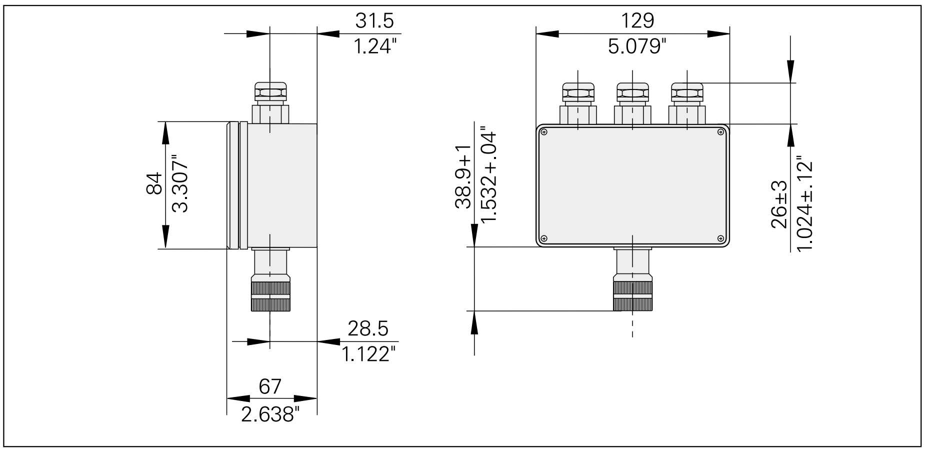
Connection
All absolute encoders from HEIDENHAIN with **EnDat interface** are suitable for PROFIBUS-DP. The encoder is electrically connected through a **gateway.** The complete interface electronics are integrated in the gateway, which offers a number of benefits:

- Simple connection of the field bus cable, since the terminals are easily accessible.
- Encoder dimensions remain small.
- No temperature restrictions for the encoder. All temperature-sensitive components are in the gateway.
- No bus interruption when an encoder is exchanged.

Besides the EnDat encoder connector, the gateway provides two connections for the PROFIBUS and one for the power supply of the encoder and the gateway. In the gateway there are coding switches for addressing and selecting the terminating resistor. The terminating resistor must be activated if the gateway is the last member of the PROFIBUS-DP.

Since the gateway is connected directly to the bus lines, the cable to the encoder is not a stub line, although it can be up to 150 meters (492 ft) long.

	Gateway
Power supply	10 to 30 V/Max. 400 mA
Protection	IP 67
Operating temperature	–40 °C to 80 °C (–40 °F to 176 °F)
Electrical connection EnDat PROFIBUS-DP	 Flange socket, 17-pin terminations PG9 cable exit
Part number	Id. Nr. 325 771-01



Gateway for connecting one absolute position encoder with EnDat interface to the PROFIBUS-DP

PROFIBUS-DP profile
The PNO (PROFIBUS user organization) has defined a standard, nonproprietary profile for the connection of absolute encoders to the PROFIBUS-DP, thus ensuring high flexibility and simple configuration on all systems that use this standardized profile.

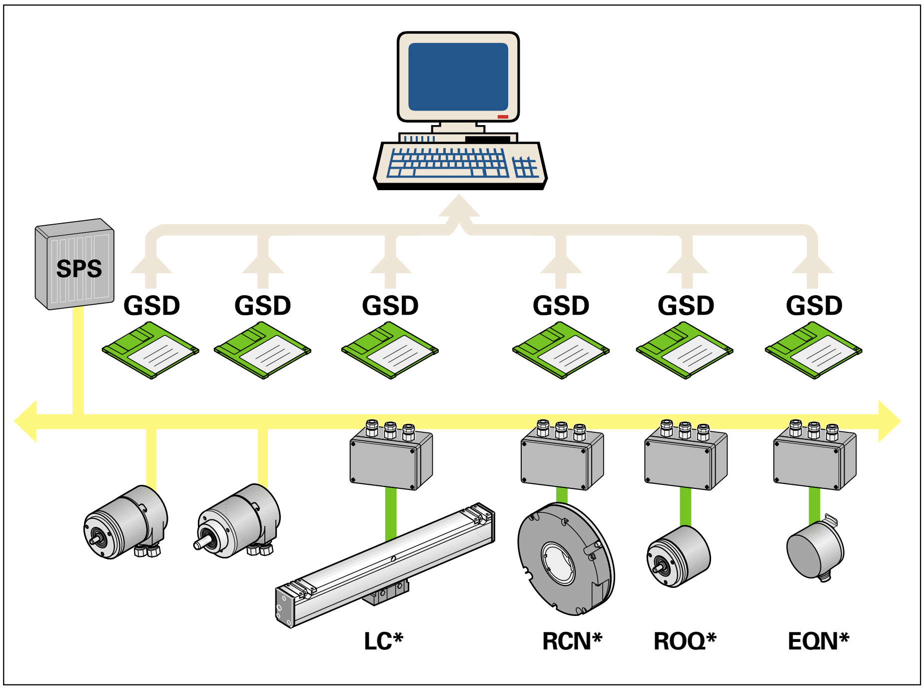
You can request the profile for absolute encoders from the PNO in Karlsruhe, Germany, under the order number 3.062. There are two classes defined in the profile, whereby class 1 provides minimum support, and class 2 allows additional, in part optional functions.

Supported functions
Through the use of the gateway, the PROFIBUS-DP supports all functions of the EnDat interface. Particularly important in decentralized field bus systems are the **diagnostic functions** (e.g. warnings and alarms), and the **electronic ID label** with information on the type of encoder, resolution, and measuring range. But also programming functions such as counting direction reversal, **preset/zero shift** and **changing the resolution (scaling)** are possible. The **operating time** of the encoder can also be recorded.

Characteristic	Class	ECN 113 ECN 413 ROC 413[3]	EQN 425 ROQ 425[3]	ROC 415 ROC 417 RCN 220[1] RCN 723[1]	LC 481[2] LC 181[2]
Position value in pure binary code	1, 2	✓	✓	✓	✓
Data word length	1, 2	16	32	32	32
Scaling function					
Measuring steps/rev	2	✓	✓	✓[4]	–
Total resolution	2	✓	✓	–	–
Reversal of counting direction	1, 2	✓	✓	✓	–
Preset/Datum shift	2	✓	✓	✓	–
Diagnostic functions					
Warnings and alarms	2	✓	✓	✓	✓
Operating time recording	2	✓	✓	✓	✓
Profile version	2	✓	✓	✓	✓
Serial number	2	✓	✓	✓	✓

[1] See ***Angle Encoders*** catalog.
[2] See ***Sealed Linear Encoders*** catalog.
[3] Rotary encoders also with integrated PROFIBUS interface (see *General Catalog*)
[4] Scaling factor in binary steps

Self-configuration
The characteristics of the HEIDENHAIN encoders required for system configuration are included as "electronic data sheets" — also called device identification records (GSD) — in the gateway. These device identification records hold the complete and exact characteristics of a device in a precisely defined format, which permits the simple and application-friendly integration of the devices into the bus system.



*) With EnDat interface

Interfaces
seriell SSI

SSI Interface
The absolute position value, beginning with the Most Significant Bit (MSB first), is transferred in synchronism with a CLOCK signal transmitted by the control. The SSI standard data word length for singleturn absolute encoders is 13 bits, and for multiturn absolute encoders 25 bits.

Incremental Signals
Absolute rotary encoders listed with synchronous-serial interface also provide 1 V_{PP} incremental signals as a complement to the serial transfer of absolute position information. For the signal description, see *1 V_{PP} Incremental Signals*.

	ROC 410, ROC 412, ROC 413, ROQ 424, ROQ 425, ECN 113, ECN 413, EQN 425
Interface	SSI serial
Code signals	
Data input	Differential line receiver according to EIA standard RS-485 for the CLOCK and $\overline{\text{CLOCK}}$ signals
Data output	Differential line driver according to EIA standard RS-485 for DATA and $\overline{\text{DATA}}$ signals
Signal level	Differential voltage output > 1.7 V with 120 Ω load*) (EIA standard RS-485)
Code	Gray code
Direction of rotation	Increasing code values with clockwise rotation, viewed from flange side
Incremental signals	∿ 1 V_{PP} (see *1 V_{PP} Incremental Signals*)
Connecting cable	HEIDENHAIN cable with shielding PUR [(4 × 0.14 mm²) + 2(4 × 0.14 mm²) + (4 × 0.5 mm²)]
Cable lengths	Max. 150 m with distributed capacitance 90 pF/m
Propagation time	6 ns/m

*) Terminating and receiver input resistor

SSI interface: Recommended input circuitry of subsequent electronics

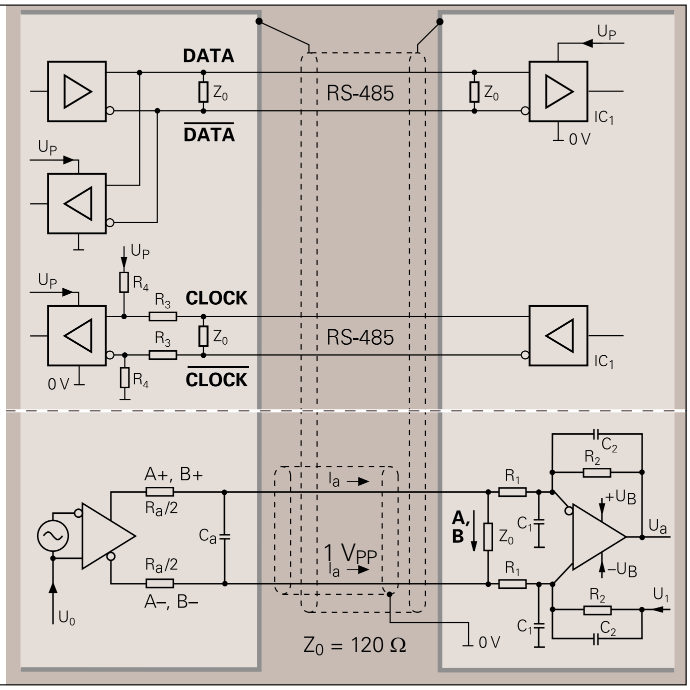
Code signals

IC_1 =
Differential line receiver and driver
e.g. SN 65 LBC 176
LT 485

R_3 = 100 kΩ*)
R_4 = 1 kΩ*)
Z_0 = 120 Ω

Incremental signals

*) Encoder-dependent



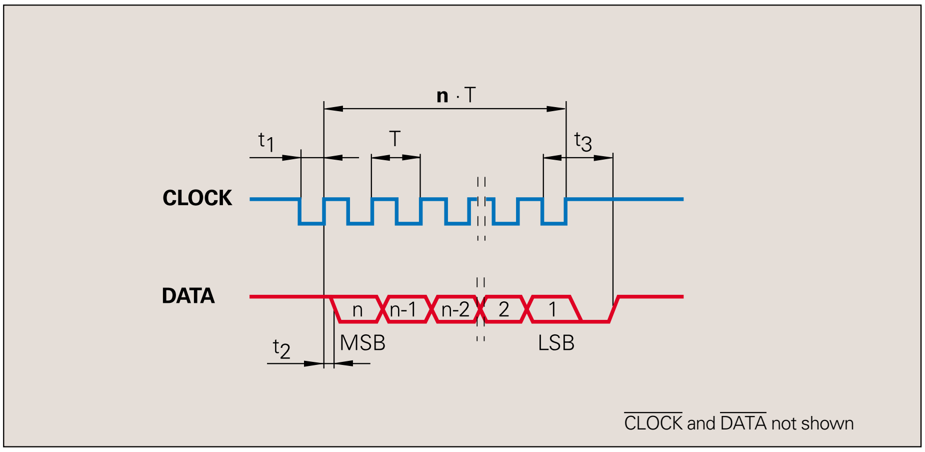
Cable lengths and permissible clock frequencies

Cable lengths	Clock pulse period T	Clock frequency
50 m	0.9 to 11 µs	1100 kHz to 90 kHz
100 m	3.3 to 11 µs	Approx. 300 kHz to 90 kHz

Control cycle for complete data word
When not transmitting, the clock and data lines are high. The current position value is stored on the first falling edge of the clock. The stored data is then clocked out on the subsequent rising edges.

After transmission of a complete data word, the data line remains low for a period of time *(t_3)* until the encoder is ready for interrogation of a new value. If a falling clock edge is received within t_3, the same value will be output once again.

Data output will be interrupted if the clock remains high for longer than t_3. In this case, a new position value will be stored on the next falling edge of the clock, and clocked out on the subsequent rising edges.



T = 0.9 to 11 µs
t_1 > 0.45 µs
$t_2 \leq$ 0.4 µs (without cable)
t_3 = 12 to 35 µs

Data word length *n*

ROC 413 ECN 113 ECN 413	ROC 412	ROC 410	ROQ 424	ROQ 425 EQN 425
13	13	13	25	25

Interfaces

Programmable Serial SSI

Programmable SSI Interface

HEIDENHAIN also offers the ROQ 425 and EQN 425 multiturn rotary encoders in programmable versions. The following parameters and functions can be programmed with the included software:

- Singleturn resolution up to 8192 absolute positions per revolution, e.g., for adaptation to various screw pitches.
- Multiturn resolution up to 4096 distinguishable revolutions, e.g., for adaptation to the ball-screw length.
- Direction of rotation for increasing position values.
- Output format of position values in Gray code or pure binary code.
- Data format synchronous-serial right-aligned or 25-bit tree format (SSI).
- Offset and preset values for zeroing and compensation as required.

Some of these functions can be activated through jumpers on dedicated lines:

- Direction of rotation for increasing code values.
- Setting the preset value through the programming software.

HEIDENHAIN's programmable absolute rotary encoders offer an additional diagnostic function that provides information on the operating status. A fault detection signal, output through a separate line, can be evaluated in the PLC. This reduces the idle time of your system.

	ROQ 425 programmable; EQN 425 programmable
Interfaces	Serial in the SSI (tree) or synchronous-serial right-aligned (programmable) data formats
Code signals	
Data input	Differential line receiver according to EIA standard RS 485 for the CLOCK and $\overline{\text{CLOCK}}$ signals as well as DATA and $\overline{\text{DATA}}$
Data output	Differential line driver according to EIA standard RS 485 for DATA and $\overline{\text{DATA}}$ signals
Signal level	Differential voltage output > 2 V (EIA standard RS-485)
Code	Gray or pure binary code (programmable)
Direction of rotation	Increasing code values with clockwise or counterclockwise rotation, viewed from flange side (programmable)
Incremental signals	∿ 1 V_{PP} (see *1 V_{PP} Incremental Signals*)
Fault detection signal U_{aS}	One square-wave pulse $\overline{U_{aS}}$ (HTL) Improper function: LOW; Proper function: HIGH
Connecting cable	HEIDENHAIN cable with shielding PUR [(4 × 0.14 mm^2) + 2(4 × 0.14 mm^2) + (4 × 0.5 mm^2)]
Cable lengths	Max. 150 m with distributed capacitance 90 pF/m
Propagation time	6 ns/m

Programmable SSI Interface:
Recommended input circuitry of subsequent electronics

Code signals

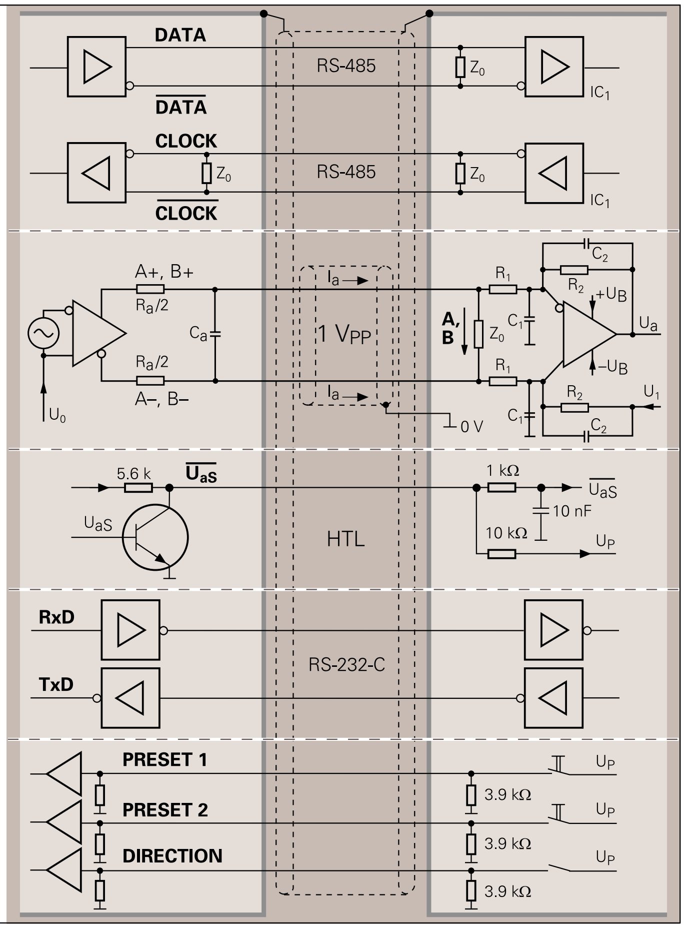
IC_1 =
RS-485 Differential line receiver and driver
Z_0 = 120 Ω

Incremental signals

Fault detection signal

Programming interface

Programming via connecting element



Serial Data Transfer

Transmission of the absolute position values is always synchronized with the CLOCK signal generated by the subsequent electronics, beginning with the most significant bit (MSB). The data word length of the programmable rotary encoders is 25 bits if they are used as multiturn encoders and 13 bits as singleturn encoders, regardless of whether the SSI (tree) or the right-aligned data format was selected. With the first falling edge of the clock, the scaled position value is saved in the transfer register: Data transfer begins with the next rising clock edge.

Fault detection

With synchronous-serial data-word transfer there is no error control (parity bits, CRC bits, etc.). Rather, the encoders have their own fault detection signal $\overline{U_{aS}}$, which is output over a separate line. The $\overline{U_{aS}}$ fault detection signal reports errors such as breaks in the power lines, failure of the light source, etc. This signal can then be evaluated by the PLC through a separate input.

Incremental signals

Incremental signals corresponding to the line count are output in 1 V_{PP} level as a complement to the serial transfer of the absolute position value.

Non-binary scaling

The resolution or measuring range corresponds exactly to the defined value, even when it does not equal the square of a number.

SSI (tree) format

With SSI transfer of the position values in tree format, a distinction is always made between the multiturn partition (12 bits = 4096 revolutions) and the singleturn partition (13 bits = 8192 positions per revolution). Thus data bits are always transferred in 25 clocks pulses, the content of which however can vary. A reduced resolution of the multiturn partition due to scaling is filled in with preceding zeros. If the singleturn resolution is reduced, the zeros are filled in at the end.

Example:
Singleturn 12 bits; multiturn 9 bits (Gray code)

Pulse	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	
4096	U12	U11	U10	U9	U8	U7	U6	U5	U4	U3	U2	U1	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P13	**8192**
2048	0	U11	U10	U9	U8	U7	U6	U5	U4	U3	U2	U1	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	0	**4096**
1024	0	0	U10	U9	U8	U7	U6	U5	U4	U3	U2	U1	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	0	0	**2048**
512	0	0	0	U9	U8	U7	U6	U5	U4	U3	U2	U1	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	0	0	0	**1024**
⋮												⋮														⋮
8	0	0	0	0	0	0	0	0	0	U3	U2	U1	P1	P2	P3	P4	0	0	0	0	0	0	0	0	0	**16**
4	0	0	0	0	0	0	0	0	0	0	U2	U1	P1	P2	P3	0	0	0	0	0	0	0	0	0	0	**8**
2	0	0	0	0	0	0	0	0	0	0	0	U1	P1	P2	0	0	0	0	0	0	0	0	0	0	0	**4**
Multiturn Number of revolutions													**Singleturn** Positions per revolution													

Example of non-binary scaling:
Singleturn 360 positions; multiturn 5 revolutions (pure binary code)

Pulse	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	
	0	0	0	0	0	0	0	0	0	2^2	2^1	2^0	2^8	2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0	0	0	0	0	
	0	0	0	0	0	0	0	0	0	Values from 1 to 5			Values from 0 to 359									0	0	0	0	
Multiturn Number of revolutions													**Singleturn** Positions per revolution													

Right-aligned data format

As with the SSI/tree format, in right-aligned format the encoder also transmits data bits in 25 clock pulses. If the output is scaled, however, all of the filled-in zeros precede the data bits of the total position information (= multiturn positions x singleturn positions).

Example:
Singleturn 12 bits; multiturn 9 bits (pure binary code)

Pulse	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
	0	0	0	0	2^{20}	2^{19}	2^{18}	2^{17}	2^{16}	2^{15}	2^{14}	2^{13}	2^{12}	2^{11}	2^{10}	2^9	2^8	2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
	0	0	0	0	Values from 0 to 2 097 151 Positions per revolution x Number of revolutions																				

Example of non-binary scaling:
Singleturn 360 positions; multiturn 5 revolutions (pure binary code)

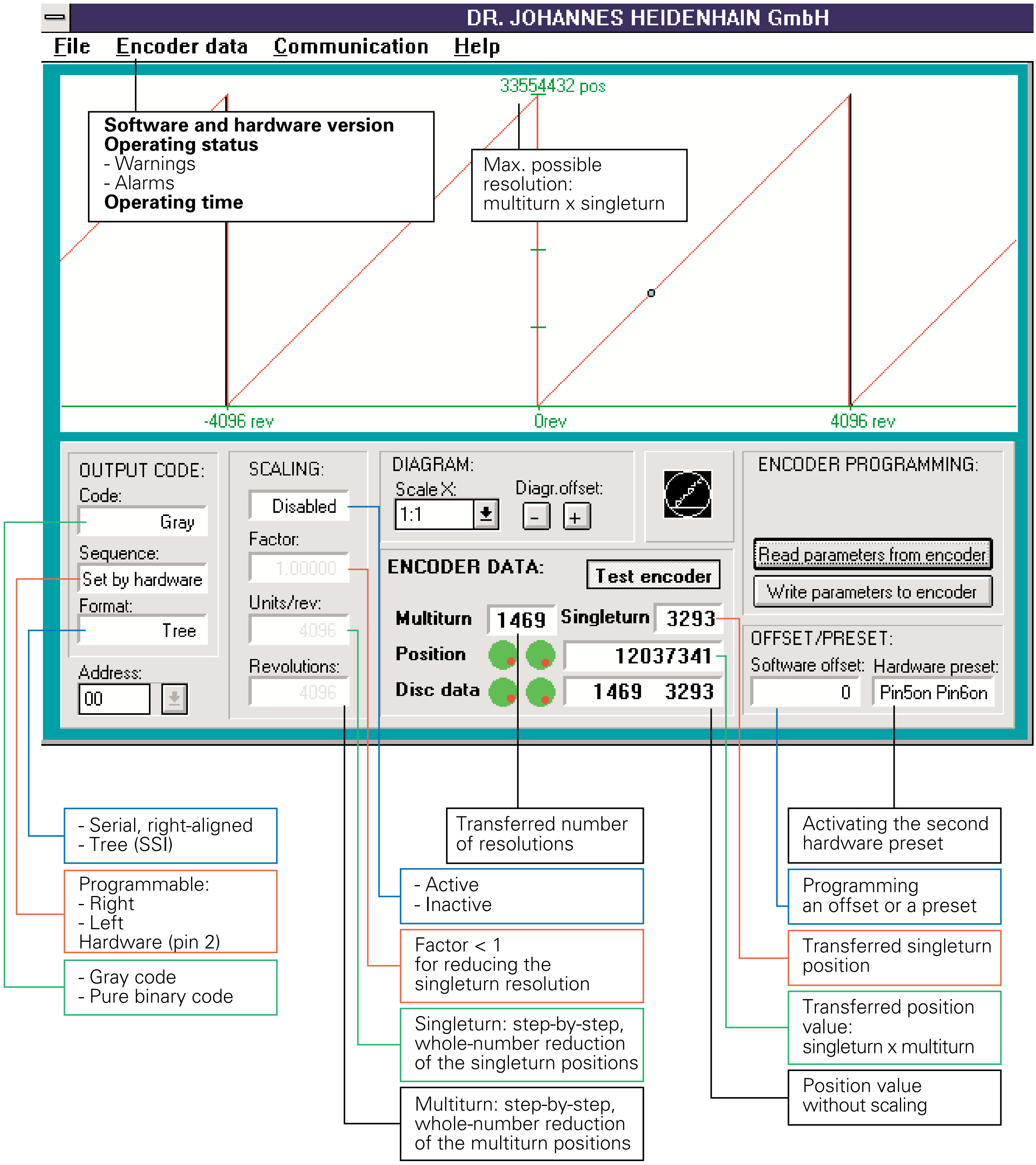
Pulse	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2^{10}	2^9	2^8	2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Values from 0 to 1799 Positions per revolution x Number of revolutions										

Programming
The rotary encoders are programmed with HEIDENHAIN software on a standard personal computer.

Programming software
Besides enabling programming of the encoder, the programming software can also serve for checking the parameter settings. This is particularly important when exchanging encoders.

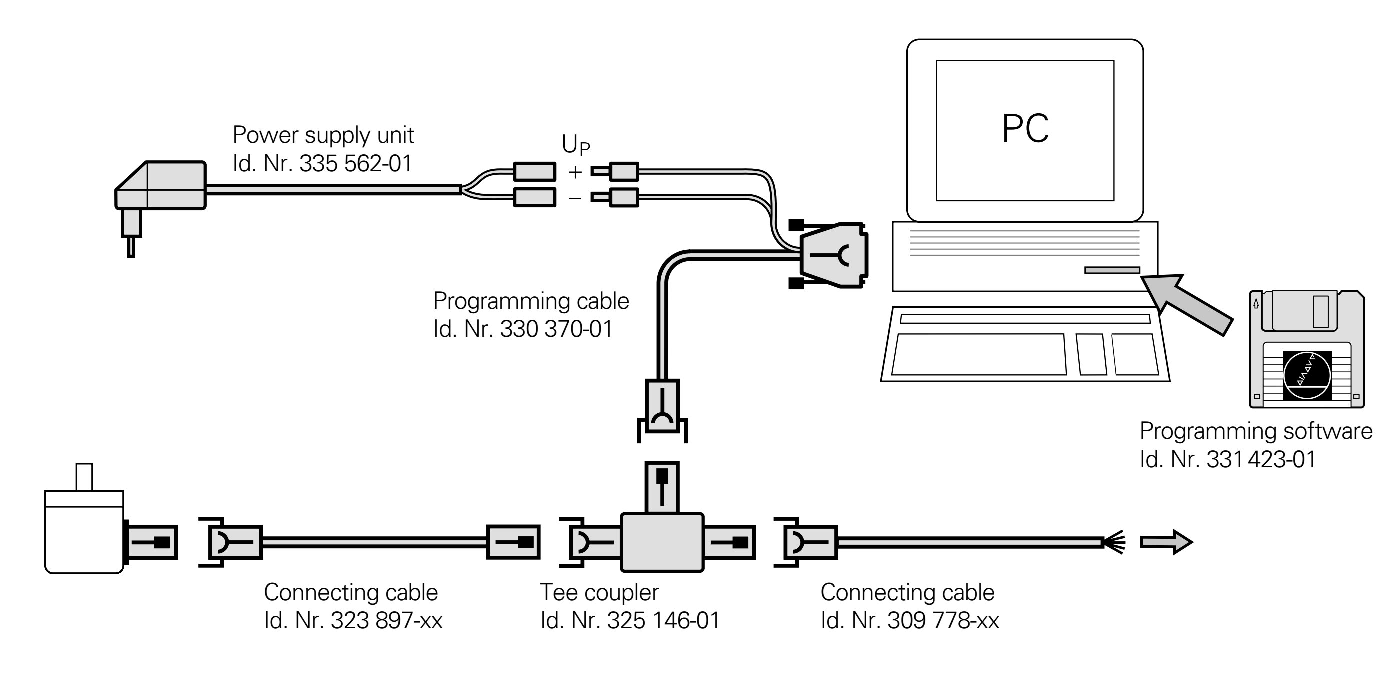
System prerequisites
A PC is required with at least a 486 microprocessor and the operating system Windows 3.1, Windows 95/98 or Windows NT.

The function of programmable encoders is defined by programming. They are normally programmed by the OEM. Before installing a programmable rotary encoder, always check it for the proper settings. The unadapted factory default setting can cause dangerous malfunctions in the system!



Connection
The programming cable, available as an accessory, connects the encoder directly or through a tee coupler with the COM interface of the PC. It conducts the power supply (U_P = 10 to 30 V) if no control is connected.

The encoder can be programmed or inspected through the tee coupler while it is in the control loop.



Programming through switches on dedicated lines
Some functions that have no influence on the interface configuration can also be activated directly through dedicated lines by applying the operating voltage U_P:

- Reversal of rotational direction:
  The direction of rotation for increasing position values can be reversed.
- Preset 1
  Any desired position value defined through the software can be accepted. This value is preset in relation to the zero position of the encoder.
- Preset 2
  Any desired position defined through the software can be accepted. This value is preset in relation to the end position of the encoder.

Mounting of Rotary Encoders with Stator Coupling

ERN/ECN/EQN absolute rotary encoders have integral bearings and externally mounted stator couplings. Their shaft is directly connected to the shaft to be measured. During angular acceleration of the shaft, the stator coupling carries only that torque resulting from friction in the bearing. In this way, the stator coupling compensates radial runout and misalignment without significantly reducing accuracy. The externally mounted stator coupling tolerates axial motion in the drive shaft up to:

ERN/ECN/ EQN 400	± 1 mm
ERN 1000	± 0.5 mm
ERN/ ECN 100	± 1.5 mm

Rotary encoders of the **ERN 400** series

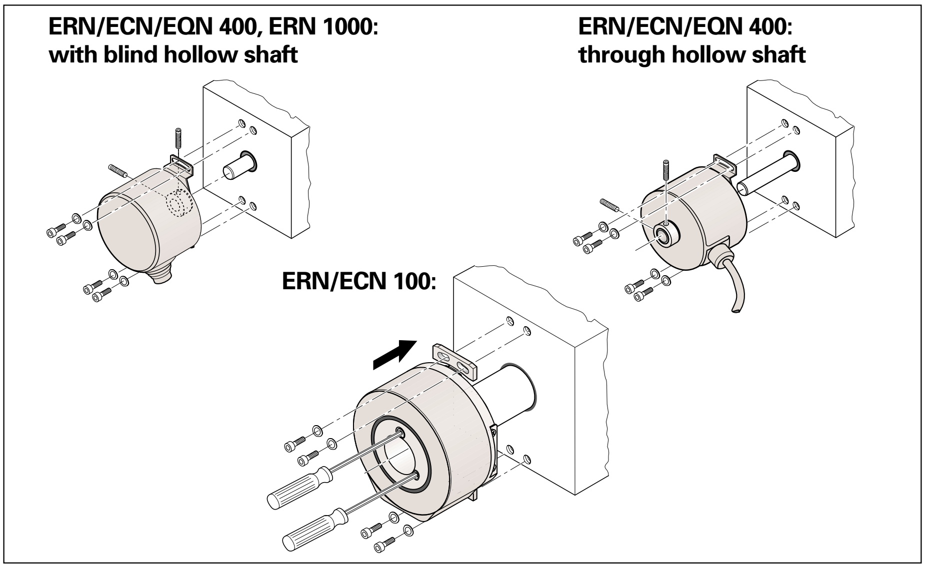
Mounting Procedure
The mounting procedure is very simple: The encoder shaft is slid onto the drive shaft and fastened with two screws and eccentric clamps on the flange side of the encoder. Short shaft ends can be fastened on the flange side of the encoder; with hollow-shaft encoders and long shaft ends, the shaft can be fastened on the housing side.

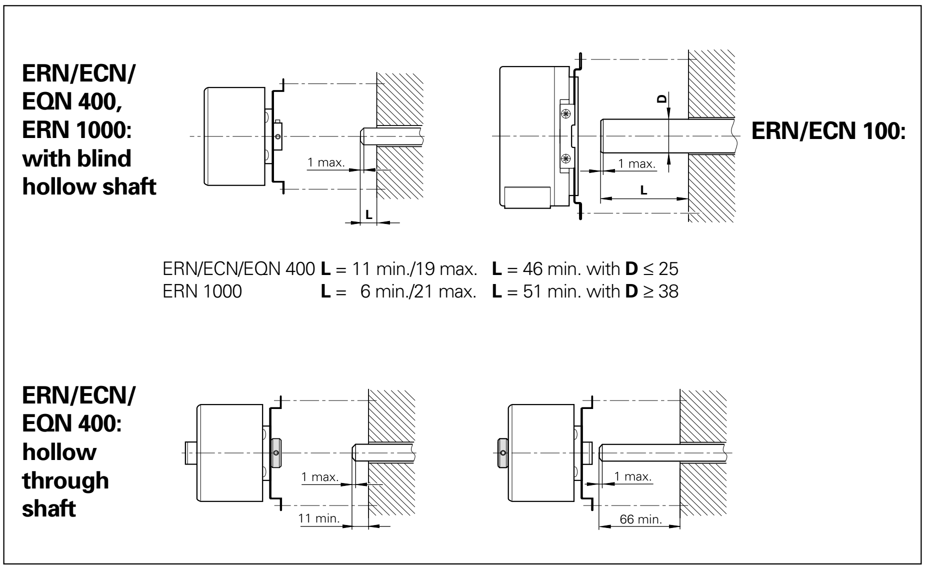
Rotary encoders of the ERN/ECN/EQN 1300 series with mounted stator coupling and taper shaft are particularly well suited for repeated mounting (see brochure entitled *Position Encoders for Servo Drives*). The stator is connected without a centering collar on a flat surface. For dynamic applications such as servo motors, it is recommended that the shaft be fastened at the flange and the coupling be fastened with four cap screws or, for the ERN 1000, with special washers (see *Mounting Accessories)* to attain the highest possible natural frequency f_N of the system.

	Natural frequency f_N* when coupling is fastened by via 2 screws	4 screws
ERN/ECN/ EQN 400	600 Hz	1250 Hz
ERN 1000	750 Hz	950 Hz
ERN/ ECN 100	–	1100 Hz

* When fastened with special washers (*accessory*)

If the encoder shaft is subject to high loads from friction wheels, pulleys, or sprockets, HEIDENHAIN recommends mounting the ERN/ECN/EQN 400 with a bearing assembly (see *Mounting Accessories*).





Mounting of Rotary Encoders for Separate Shaft Coupling

Rotary encoders of the **ROD/ROC/ROQ 400 series** have an integral bearing capable of withstanding up to 60 N (radially at shaft end) at speeds up to 6000 rpm. They can therefore be connected directly to mechanical transfer elements such as gears or friction wheels.

Should the load exceed these values, HEIDENHAIN recommends the use of a shaft coupling. If high shaft loads are expected, for example when using belt gears or sprockets, HEIDENHAIN recommends mounting the ERN/ECN/EQN 400 with the bearing assembly.

The coupling compensates axial motion and misalignment (radial and angular offset) between encoder shaft and drive shaft to prevent additional, external loads that would otherwise shorten the service life of the encoder bearing.

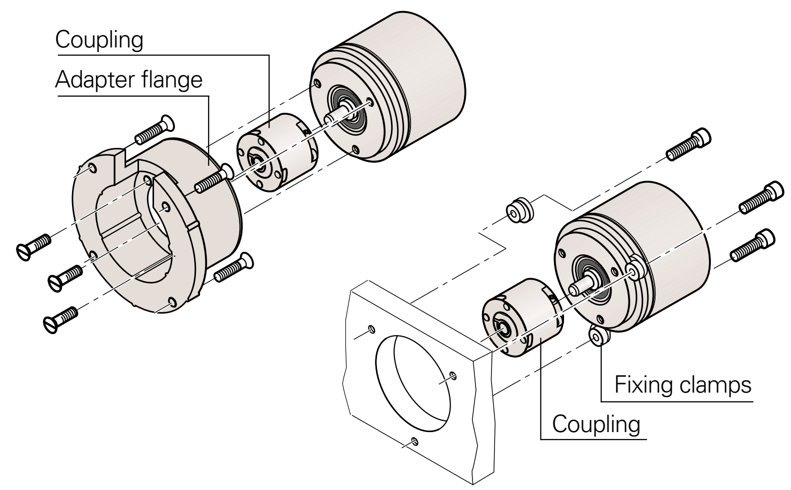
The HEIDENHAIN product program includes diaphragm couplings and metal bellows couplings for rotor connection of the ROD/ROC/ROQ rotary encoders.

Rotary Encoder of the **ROD 400 Series, with Synchro Flange**

Mounting Options

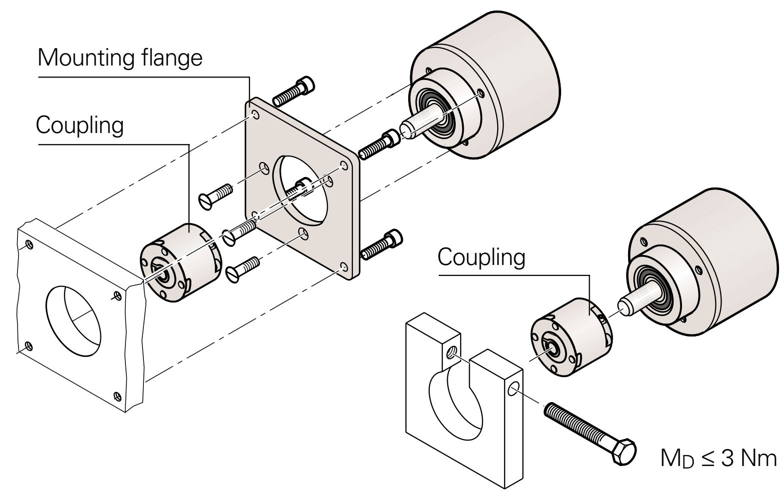
Rotary encoders with synchro flange
- Mounting by threaded mounting holes and an adapter flange (see *Accessories*)
- Mounting by synchro flange and three fixing clamps (see *Accessories*)

In both cases, the encoder is centered with the collar on the flange.



ROD rotary encoders with clamping flange
- Mounting by threaded mounting holes and an adapter flange (see *Accessories*)
- Mounting by the clamping flange itself

In both cases, the encoder is centered with the clamping flange.

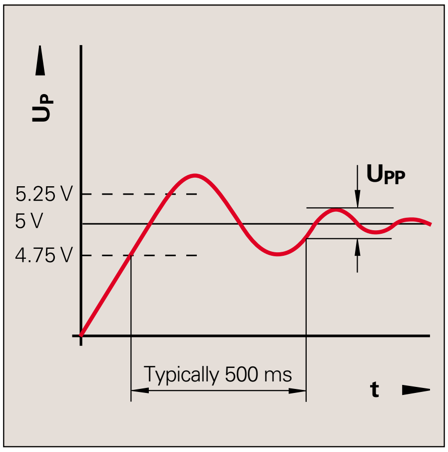


Explanations of Specifications
Electrical Data

Power supply

A **stabilized dc voltage** is required as the power supply for the encoders. The voltage and current consumption are given in the individual specifications.
The permissible ripple amplitude of the dc voltage is:
- High-frequency interference
  $U_{PP} < 250$ mV with $dU/dt > 5$ V/µs
- Low-frequency fundamental ripple
  $U_{PP} < 100$ mV

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



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

The **voltage drop** for HEIDENHAIN cable is calculated as:

$$\Delta U[V] = 2 \cdot 10^{-3} \cdot \frac{L_C\,[m] \cdot I\,[mA]}{56 \cdot A_P\,[mm^2]}$$

Where L_C: Cable length
I: Current consumption of angle encoder (see Specifications)
A_P: Cross section of power line

Cable External diameter	**Cross-section** of the power supply wires Incremental	Absolute
Ø 4,5 mm (Ø .18 in.)	0.14 mm^2 (AWG 26)	0.05 mm^2 (AWG 30)
Ø 6 mm (Ø .24 in.)	0.19 mm^2 (AWG 24)	0.08 mm^2 (AWG 28)
Ø 8 mm (Ø .31 in.)	0.5 mm^2 (AWG 20)	0.5 mm^2 (AWG 20)

Reverse-polarity protection
The power lines of the encoders with U_P = 10 to 30 V are protected against reverse polarity.

Electrically permissible speed

The maximum **permissible speed** of an angle encoder is derived from
- the **mechanically permissible speed** (see Specifications)
  and
- the **electrically permissible speed.**
  For **encoders with sinusoidal signals** the electrically permissible speed is limited by the –3 dB and –6 dB cutoff frequency of the encoder and by the input frequency f_{max} of the subsequent electronics.
  For **encoders with square-wave signals** the electrically permissible speed is limited by
  – the maximum permissible output frequency f_{max} of the encoder and
  – the **minimum edge separation** a for the subsequent electronics.

$$n_{max} = \frac{f_{max}\,[kHz]}{z} \cdot 10^3 \cdot 60 \text{ rpm}$$

where n_{max}: Maximum electrically permissible speed
f_{max}: Maximum scanning frequency of the encoder or input frequency of the subsequent electronics
z: Line count of the rotary encoder

Cable

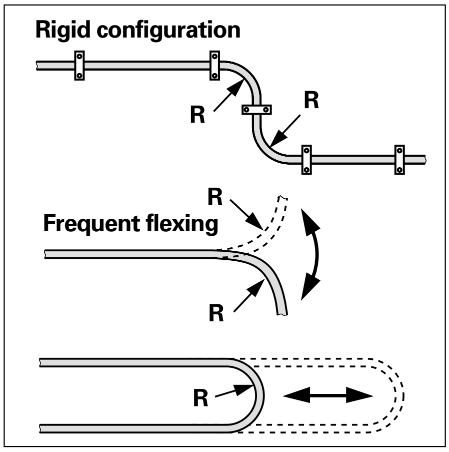
Durability
All angle encoders use polyurethane (PUR) cables that are resistant to oil, hydrolysis and microbes in accordance with **VDE 0472.** They are free of PVC and silicone and comply with UL safety directives. The **UL certification** AWM STYLE 20963 80 °C 30V E63216 is documented on the cable.

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

Cable diameter 4.5 mm (0.18 in.)
Rigid configuration R ≥ 10 mm (0.4 in.)
Frequent flexing R ≥ 50 mm (2 in.)

Cable diameter 6 mm (0.24 in.)
Rigid configuration R ≥ 20 mm (0.8 in.)
Frequent flexing R ≥ 75 mm (3 in.)

Cable diameter 8 mm (0.31 in.)
Rigid configuration R ≥ 40 mm (1.6 in.)
Frequent flexing R ≥ 100 mm (4 in.)



Temperature range
HEIDENHAIN cable can be used in the following temperature ranges:
for stationary configuration –40 to 85 °C (–40 to 185 °F)
for frequent flexing –10 to 85 °C (14° to 185 °F)

Cables with limited resistance to hydrolysis and microbes are rated for up to 100 °C (212 °F).

Reliable Signal Transmission

Electromagnetic compatibility (EMC)
When properly installed, HEIDENHAIN encoders fulfill the requirement for electromagnetic compatibility according to 89/336/EWG.
Compliance with the regulations of the EMC Guidelines is based on conformance to the following standards:

- **IEC 61000-6-2**
  Electromagnetic compatibility — Immunity for industrial environments
  Specifically:

– ESD	IEC 61 000-4-2
– Electromagnetic fields	IEC 61 000-4-3
– Burst	IEC 61 000-4-4
– Surge	IEC 61 000-4-5
– Conducted disturbances	IEC 61 000-4-6
– Power frequency magnetic fields	IEC 61 000-4-8
– Pulse magnetic fields	IEC 61 000-4-9

- **EN 50 081-1**
  Electromagnetic compatibility — Generic emission standard
  Specifically:

– for industrial, scientific and medical (ISM) equipment	EN 55 011
– for information technology equipment	EN 55 022

Protection against electrical noise

- Use only the recommended **HEIDENHAIN cable** for signal lines.
- To connect signal lines, use only **HEIDENHAIN connectors.**
- The shielding should conform to **EN 50178**.
- Do not lay signal cable in the direct vicinity of interference sources (air clearance > 100 mm (4 in.).
- A minimum spacing of 200 mm (8 in.) to inductors is usually required, for example in switch-mode power supplies.
- HEIDENHAIN encoders should be connected only to subsequent electronics whose power supplies comply with **EN 50178** (protective low voltage).
- Configure the signal lines for minimum length and avoid the use of intermediate terminals.
- In metal cable ducts, sufficient decoupling of signal lines from interference signal transmitting cable can usually be achieved with a grounded partition.
- For applications using **multiturn rotary encoders in electromagnetic fields** stronger than 10 mT , we recommend consulting with HEIDENHAIN in Traunreut.

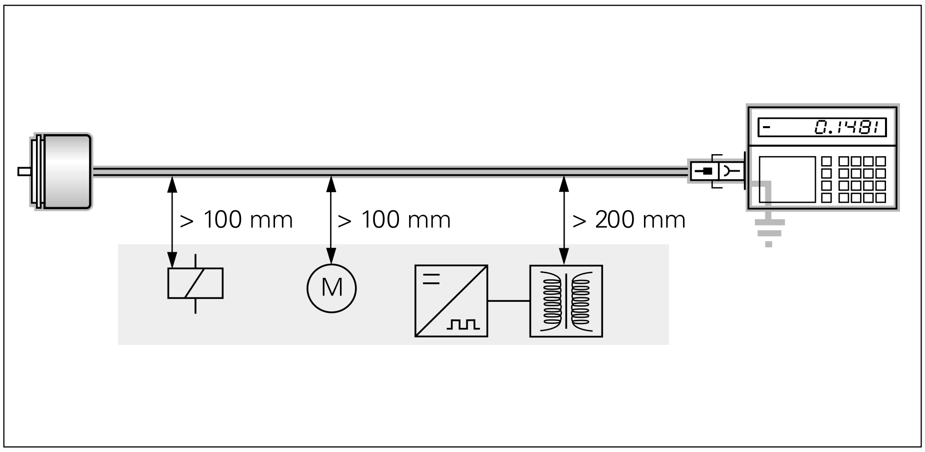
Both the cable shielding and the metal housings of encoders and subsequent electronics have a shielding function. The housing must have the **same potential** and be connected to the main signal ground over the machine chassis or by means of a separate potential compensating line. Potential compensating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

Transmission of measuring signals — electrical noise immunity
Noise voltages arise mainly through capacitive or inductive transfer. Electrical noise can be introduced into the system over signal lines and input or output terminals. Possible sources of noise are:

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

Isolation
The encoder housings are isolated from the electronics.

Dielectric strength	500 V/50 Hz for max. 1 minute
Air clearance and leakage distance	> 1 mm
Insulation resistance	> 50 MΩ



Minimum distance from sources of interference

Mechanical Data

UL certification
All rotary encoders and cables shown in this brochure comply with UL safety standards. They are listed under file no. **E205635.** Certification is valid in the USA for "cULus" and in Canada for "CSA."

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

- The maximum values for **vibration** apply at frequencies from 55 to 2000 Hz **(IEC 60068-2-6).** If resonance due to the application and mounting exceed the permissible acceleration values, it might damage the encoder. **Thorough testing of the entire system is therefore required.**
- The values for **shock and impact** (semi-sinusoidal shock) are valid at 6 ms **(IEC 60068-2-27).** Under no circumstances should a hammer or similar implement be used to adjust or position the encoder.
- The **permissible angular acceleration** is greater than 10^5 rad/s^2.

The maximum values for vibration and shock loading indicate the limits up to which the encoder will operate without failure. To ensure maximum accuracy, ensure compliance with the ambient and operating conditions described under *Measuring Accuracy.* For applications in which high shock and vibration loads are expected, contact HEIDENHAIN for more specific information.

Natural frequencies
The rotor and the coupling of ROD/ROC/ROQ rotary encoders, as also the stator and stator coupling of ERN/ECN/EQN rotary encoders, form a single vibrating spring-mass system. The **natural frequency f_N** should be as high as possible. A prerequisite for the highest possible natural frequency on **ROD/ROC/ROQ rotary encoders** is the use of a **diaphragm coupling** with a high torsional rigidity C (see *Shaft Couplings*).

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

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

The **ERN/ECN/EQN** rotary encoders with their stator couplings form a vibrating spring-mass system whose **natural coupling frequency f_N** should be as high as possible. If radial and/or axial acceleration forces are added, the stiffness of the encoder bearings and the encoder stators are also significant. If such loads occur in your application, we recommend closer consultation with HEIDENHAIN in Traunreut.

Shaft couplings
Couplings compensate axial motion and misalignment between the encoder shaft and the drive shaft, thereby preventing excessive bearing load on the encoder. A selection of suitable couplings for the ROD/ROC/ROQ rotary encoders is shown under *Accessories*.

Protection against contact (IEC 60529)
After encoder installation, all rotating parts must be protected against accidental contact during operation.

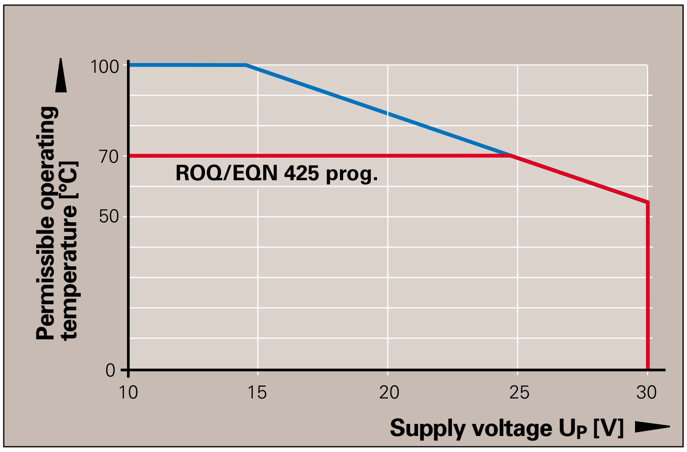
Protection (IEC 60529)
Unless otherwise indicated, all rotary encoders meet protection standard IP 67 according to IEC 60529. This includes housings, cable outlets, and flange sockets when the connector is fastened.

The **shaft inlet** provides protection to IP 64 or IP 65. Splash water should not contain any substances that would have harmful effects on the encoder parts. If the standard protection for the shaft inlet is not sufficient (such as when the encoders are mounted vertically), additional labyrinth seals should be provided. Many encoders are also available with protection to class IP 66 for the shaft inlet. The sealing rings used to seal the shaft are subject to wear due to friction, the amount of which depends on the specific application.

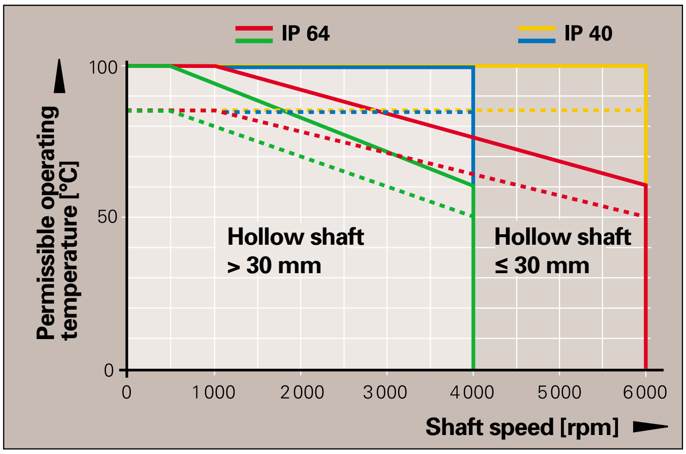
For rotary encoders of the ERN/ECN 100 series, the maximum mechanically permissible speed is subject to constraints from the actual **operating temperature** (see diagram). A special version with IP 40 **reduced protection** is available for high shaft speeds at maximum operating temperature.

Temperature range
The **operating temperature range** indicates the ambient temperatures within which the rotary encoders can be operated (DIN 32878). The range can be constricted by heat generated by the specific application (see diagram). The storage temperature range of –30° to +80° is valid when the unit remains in its packaging.

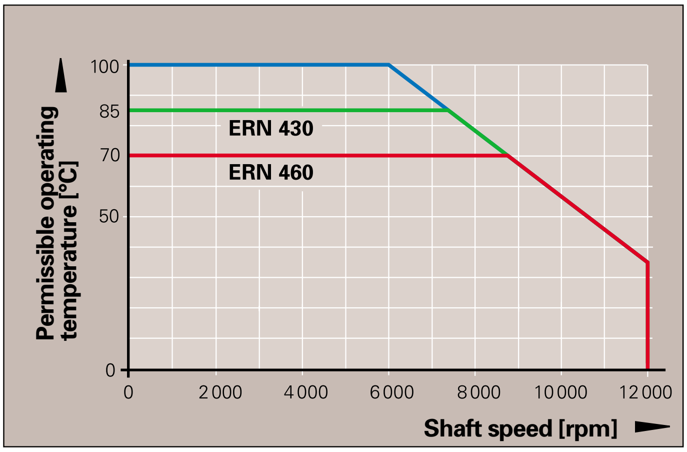
ROC/ECN 413; ROQ/EQN 425:
Permissible operating temperature for a power supply of 10 to 30 V



ERN/ECN 100:
Operating temperature as a function of shaft speed at 5 V (—) or 10 to 30 V (- - - -)

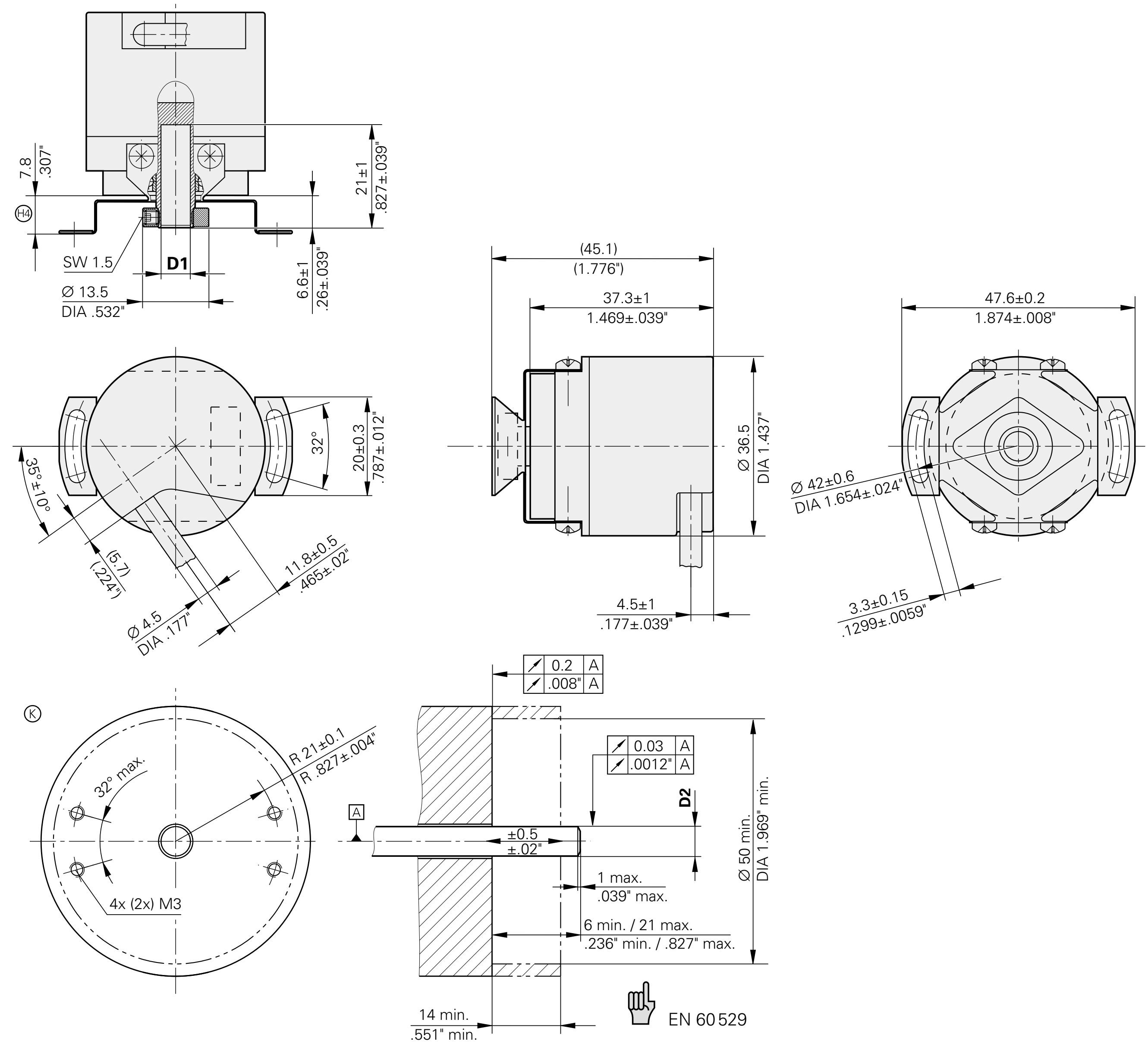


ERN/ECN/ EQN 400 with blind hollow shaft: operating temperature as a function of shaft speed



ERN 1000 Series

- **Rotary encoders with mounted stator coupling**
- **Compact dimensions**
- **Blind hollow shaft, Ø 6 mm**



Dimensions
in mm/inches

DIN ISO 8015
ISO 2768 - m H

Ⓐ = Bearing
Ⓚ = Required mating dimensions
Ⓗ = Variable depending on the coupling

D1	D2
Ø 6 DIA .23622	Ø 6g7 Ⓔ DIA .23622–.00016/–.00063"

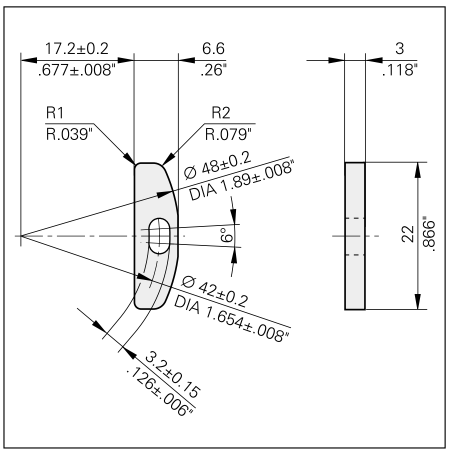
	Incremental		
	ERN 1020	**ERN 1030**	**ERN 1080**
Incremental signals	⊓⊔ TTL	⊓⊔ HTL	∼ 1 V_{PP}
Line counts*	100 200 **250** 360 400 **500** 720 900 **1000** **1024** 1250 1500 2000 **2048** **2500** **3600**		
Cutoff frequenz (–3 dB) (–6 dB) **Scanning frequency**	– – Max. 300 kHz	– – Max. 160 kHz	≥ 180 kHz typical ≥ 450 kHz typical –
Power supply **Max. current consumption** (without load)	5 V ± 10% 150 mA	10 V to 30 V 150 mA	5 V ± 10% 150 mA
Electrical connection* **Cable**	**1 m**/5 m, Radial, with or **without coupling**		
Max. cable length[1]	100 m		150 m
Mech. perm. speed *n*	Max. 10 000 rpm		
Starting torque	≤ 0.001 Nm (at 20 °C)		
Moment of inertia of rotor	$0.5 \cdot 10^{-6}$ kgm^2		
Permissible axial motion of drive shaft	± 0.5 mm		
Vibration (55 to 2000 Hz) **Shock** (6 ms)	≤ 100 m/s^2 (EN 60 068-2-6) ≤ 1000 m/s^2 (EN 60 068-2-27)		
Max. operating temp.	100 °C	70 °C	100 °C
Min. operating temp.	*Stationary cable:* –40 °C *Moving cable:* –10 °C		
Protection (IEC 60 529)	IP 64		
Weight	Approx. 0.1 kg (3.5 oz)		

Bold: These preferred versions are available on short notice.
***** Please indicate when ordering.
[1] with HEIDENHAIN cable and recommended input circuitry of subsequent electronics (see *Interfaces/Incremental signals*)

Mounting Accessory

for ERN 1000 Series

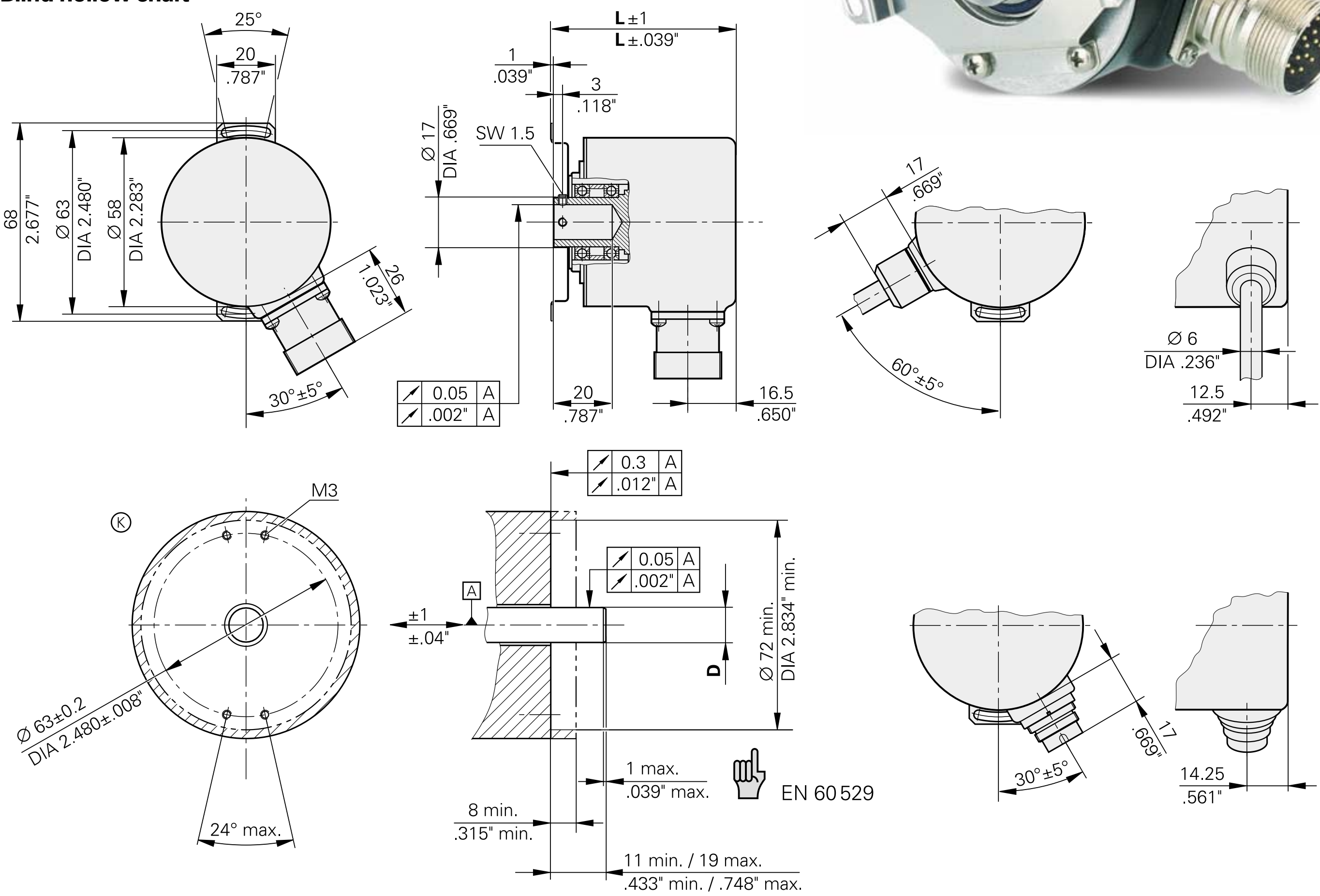
Washer
For increasing the natural frequency f_N and mounting with only two screws.
Id. Nr. 334 653-01



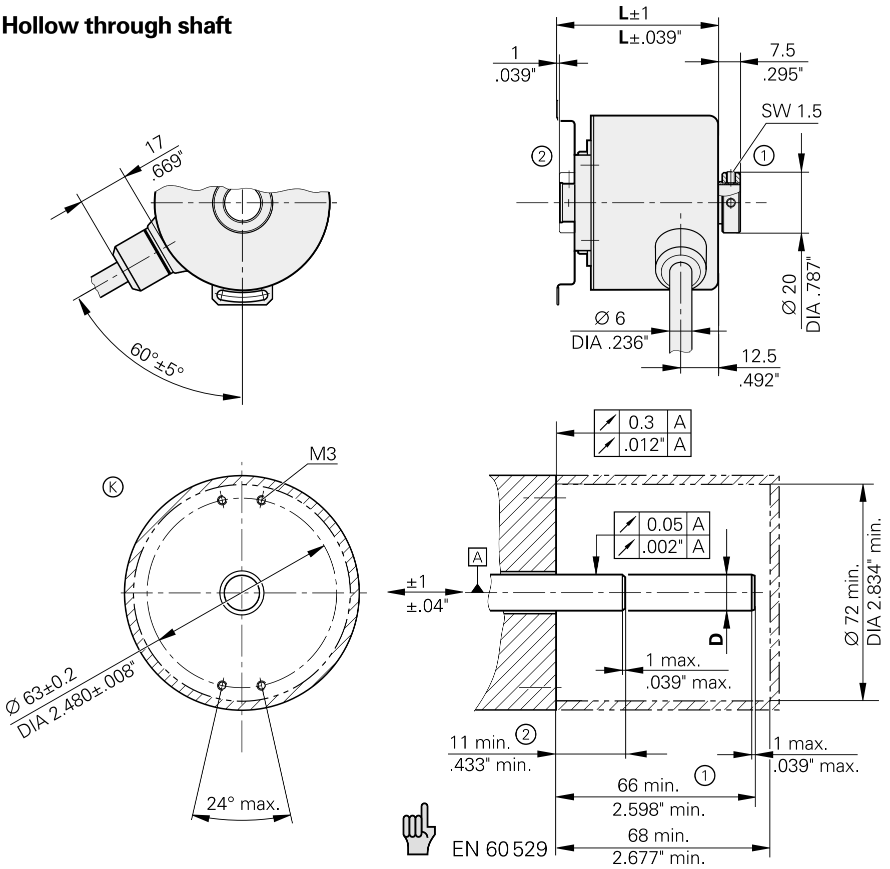
ERN/ECN/EQN 400 Series

- **Rotary encoders with mounted stator coupling**
- **Blind hollow shaft or Hollow through shaft (available with ERN 4x0)**

Blind hollow shaft



Hollow through shaft



Dimensions
in mm/inches

DIN ISO 8015
ISO 2768 - m H

Ⓐ = Bearing
Ⓚ = Required mating dimensions
① = Clamping ring on housing side
② = Clamping ring on flange side

Shaft diameter D	Ø12g7 DIA .4724 –.00023"/–.00094"	
Overall length L	Flange socket	Cable
ERN 4x0	46.2 1.8189"	46.2 1.8189"
ECN 413 5 V *10 to 30 V*	56.2 2.2126" 56.2 2.2126"	46 1.8110" 52 2.0472"
EQN 425	63 2.4803"	–
EQN 425 programmable	73 2.874"	–

	Incremental				Absolute				
					Multiturn		Programmable	Singleturn	
	ERN 420	**ERN 460**	**ERN 430**	**ERN 480**	**EQN 425**	**EQN 425**	**EQN 425**	**ECN 413**	**ECN 413**
Data interface*	–				**EnDat**[4]	SSI	SSI or serial Right justified [3]	**EnDat**[4]	SSI
Positions per rev	–				8192 (13 bits)		8192 (13 bits) [3]	8192 (13 bits)	
Resolvable revolutions	–				4096		4096[3]	–	
Code	–				Pure binary	Gray	Pure binary/ Gray[3]	Pure binary	Gray
Electrically permissible speed[1]	–				*512 lines:* 5000 rpm (± 1 bit accuracy) 10000 rpm (± 100 bits accuracy) *2048 lines:* 1500 rpm (± 1 bit accuracy) 10000 rpm (± 50 bits accuracy)		Updating time 500 µs	*512 lines:* 5000 rpm (± 1 bit accuracy) 12000 rpm (± 100 bits accuracy) *2048 lines:* 1500 rpm (± 1 bit accuracy) 12000 rpm (± 50 bits accuracy)	
Incremental signals	⊓⊔ TTL		⊓⊔ HTL	∼ 1 V_{PP}	∼ 1 V_{PP}			∼ 1 V_{PP}	
Line counts*	250 500 **1000** **1024** 1250 **2000** **2048** **2500** 3600 4096 **5000**			**1000** **1024** **2000** 2048 **2500** 3600 4096 **5000**	**512** 2048	**512**		**512** 2048	**512**
Cutoff frequenz (–3 dB) (–6 dB) **Scanning frequency**	– – Max. 300 kHz			≥ 180 kHz typical ≥ 450 kHz typical –	*512 lines:* ≥ 100 kHz typical; *2048 lines:* ≥ 200 kHz typical – –			*512 lines:* ≥ 100 kHz typical; *2048 lines:* ≥ 200 kHz typical – –	
Power supply*	5 V ± 10 %	10 to 30 V		5 V ± 10 %	5 V ± 5 %	5 V ± 5 % or **10 to 30 V**	10 to 30 V	5 V ± 5 %	5 V ± 5 % or **10 to 30 V**
Max. current consumption (without load)	150 mA	150 mA		150 mA	250 mA	250 mA	300 mA	150 mA	150 mA
Electrical connection* **Flange socket**	**Radial** (Binder); only with blind hollow shaft version				**Radial**		Radial	**Radial**	
Cable	1 m radial, **without connecting element** or with coupling				1 m radial with coupling or without connecting element		–	1 m radial with coupling or without connecting element	
Max. cable length[2]	100 m		300 m	150 m	150 m	100 m		150 m	100 m
Hollow shaft* **Inside diameter**	**Blind hollow shaft** or through shaft **D = 12 mm**[5]				Blind hollow shaft **D = 12 mm**[5]			Blind hollow shaft **D = 12 mm**[5]	
Mech. perm. speed *n*	Max. 12000 rpm				Max. 10000 rpm			Max. 12000 rpm	
Starting torque (at 20 °C)	*Blind hollow shaft:* ≤ 0.01 Nm *Hollow through shaft:* ≤ 0.025 Nm				≤ 0.01 Nm			≤ 0.01 Nm	
Moment of inertia of rotor	*Blind hollow shaft:* $3.1 \cdot 10^{-6}$ kgm^2 with shaft inside diameter D = 12 mm *Hollow through shaft:* $3.2 \cdot 10^{-6}$ kgm^2 with shaft inside diameter D = 12 mm				$4.6 \cdot 10^{-6}$ kgm^2			$4.4 \cdot 10^{-6}$ kgm^2	
Permissible axial motion of drive shaft	± 1 mm				± 1 mm			± 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)				≤ 100 m/s^2 (EN 60068-2-6) ≤ 1000 m/s^2 (EN 60068-2-27)			≤ 100 m/s^2 (EN 60068-2-6) ≤ 1000 m/s^2 (EN 60068-2-27)	
Max. operating temp.[6]	100 °C	70 °C	85 °C (100 °C at U_P < 15 V)	100 °C	*U_P = 5 V:* 100 °C *U_P = 10 to 30 V:* 85 °C		70 °C	*U_P = 5 V:* 100 °C *U_P = 10 to 30 V:* 85 °C	
Min. operating temp.	*Flange socket or stationary cable:* –40 °C *Moving cable:* –10 °C				*Flange socket or stationary cable:* –40 °C *Moving cable:* –10 °C		–20 °C	*Flange socket or stationary cable:* –40 °C *Moving cable:* –10 °C	
Protection (IEC 60529)	IP 67 at housing; IP 64 at shaft inlet				IP 67 at housing; IP 64 at shaft inlet			IP 67 at housing; IP 64 at shaft inlet	
Weight	Approx. 0.25 kg (8.8 oz)				Approx. 0.30 kg (11 oz)			Approx. 0.30 kg (11 oz)	

Bold: These preferred versions are available on short notice.
***** Please indicate when ordering.

1) for absolute position value
2) with HEIDENHAIN cable and recommended input circuitry of subsequent electronics (see *Interfaces*)
3) These functions are programmable.
4) PROFIBUS-DP via gateway
5) Other shaft inside diameters upon request
6) For correlation between operating temperture and shaft speed or supply voltage, see *Mechanical Data*

Mounting Accessories

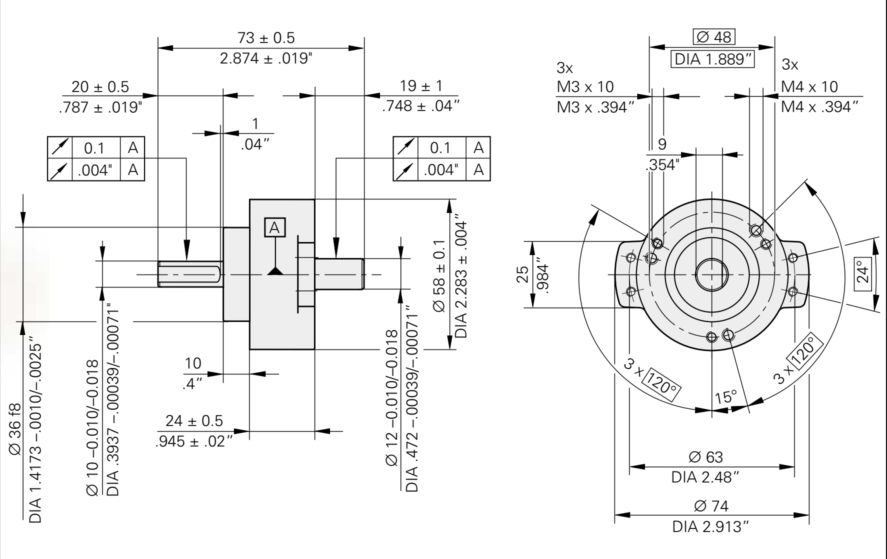
for the ERN/ECN/EQN 400 Series

Screwdriver
Adjustable torque

Screwdriver bit
Width across flats 1.5
See *Accessories*

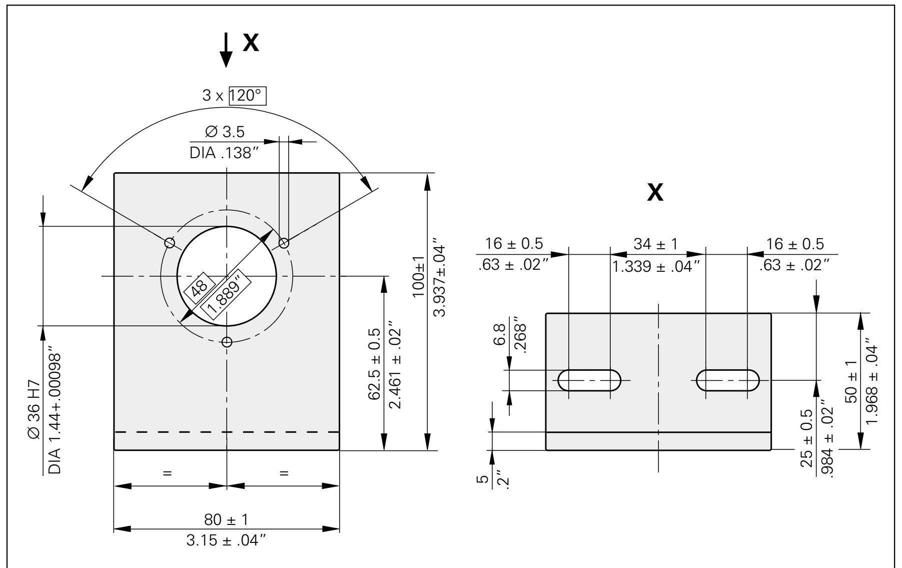
Bearing assembly
for ERN/ECN/EQN 400 series
with blind hollow shaft
Id. Nr. 324320-01

The bearing assembly is capable of absorbing large radial shaft loads that would otherwise overload the encoder bearing. It is therefore particularly recommended for use in applications with friction wheels, pulleys, or sprockets. On the encoder side, the bearing assembly has a stub shaft with 12-mm diameter and is well suited for the ERN/ECN/EQN 400 encoders with blind hollow shaft. Also, the threaded holes are already provided for fastening the stator coupling. The flange of the bearing assembly has the same dimensions as the clamping flange of the ROD 420/430 series. The bearing assembly can be fastened through the threaded holes on its face or with the aid of the mounting flange or the mounting bracket (see *Mounting Accessories*).



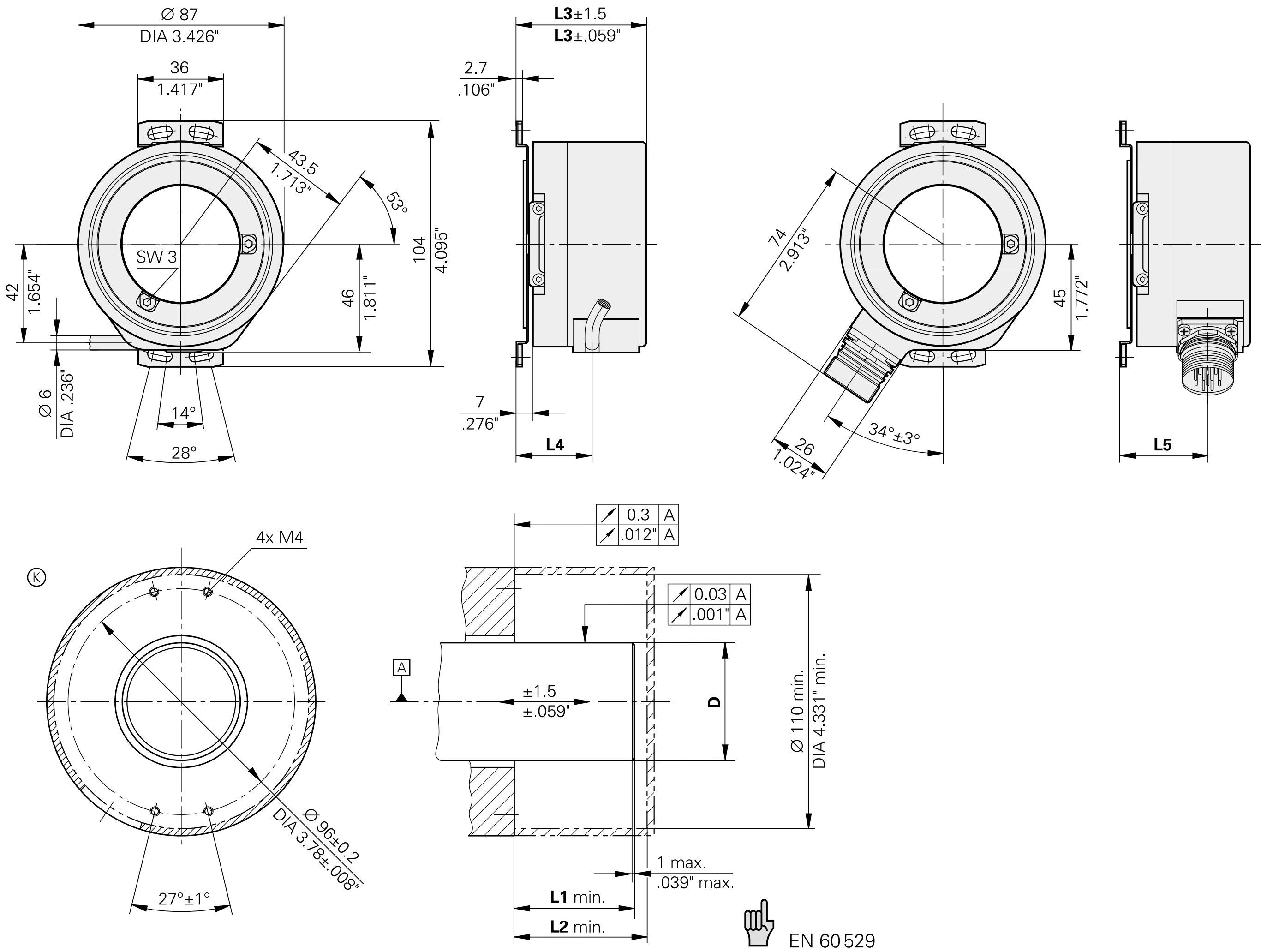
	Bearing assembly
Permissible speed *n*	Max 6000 rpm
Shaft load	Axial 200 N Radial 200 N
Calculated service life at max. permissible speed	84000 h at load of 100 N radial; 100 N axial 79000 h at load of 100 N radial; 50 N axial 11000 h at load of 200 N radial; 200 N axial
Operating temperature	–40 to 100 °C

Mounting bracket
for bearing assembly
Id. Nr. 324322-01



ERN/ECN 100 Series

- **Rotary encoders with mounted stator coupling**
- **Hollow through shaft with diameters up to Ø 50 mm**



Dimensions
in mm/inches

DIN ISO 8015
ISO 2768 - m H

Ⓐ = Bearing
Ⓚ = Required mating dimensions

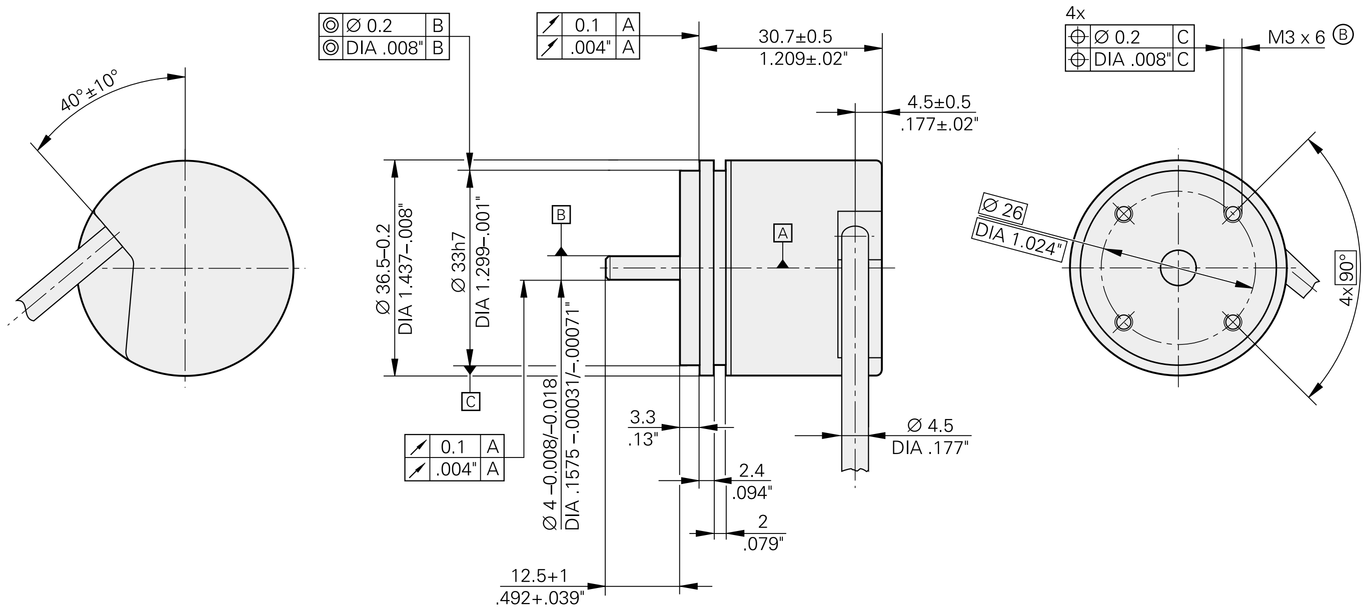
D	L1	L2	L3	L4	L5
Ø 20h7 DIA .78740 –.00083"	46 1.81102"	48,5 1.90945"	45 1.77165"	22,5 .88583"	27,5 1.08268"
Ø 25h7 DIA .98425 –.00083"	46 1.81102"	48,5 1.90945"	45 1.77165"	22,5 .88583"	27,5 1.08268"
Ø 38h7 DIA 1.49606 –.00098"	56 2.20472"	58,5 2.30315"	55 2.16535"	32 1.25984"	37 1.45669"
Ø 50h7 DIA 1.96850 –.00098"	56 2.20472"	58,5 2.30315"	55 2.16535"	32 1.25984"	37 1.45669"

	Incremental			Absolute	
				Singleturn	
	ERN 120	ERN 130	ERN 180	ECN 113	ECN 113
Data interface*	–			**EnDat**[4]	SSI
Positions per rev	–			8192 (13 bits)	
Code	–			Pure binary	Gray
Electrically permissible speed[1]	–			660 rpm (accuracy ± 1 bit) 6000 rpm (accuracy ± 50 bits)	
Incremental signals	⊓⊔ TTL	⊓⊔ HTL	∿ 1 V_{PP}	∿ 1 V_{PP}	
Line counts*	1000 **1024** 2048 2500 3600 **5000**			2048	
Cutoff frequency (–3 dB) **Scanning frequency**	– Max. 300 kHz		≥ 180 kHz typical	≥ 200 kHz typical –	
Power supply* **Max. current consumption** (without load)	5 V ± 10 % 150 mA	10 to 30 V 200 mA	5 V ± 10 % 150 mA	5 V ± 5 % 180 mA	5 V ± 5 % or **10 to 30 V** 180 mA
Electrical connection* **Flange socket**	**Radial**			**Radial**	
Cable	**1 m**/5 m, radial, with or **without coupling**			**1 m**/5 m, radial, with or **without coupling**	
Max. cable length[2]	100 m	300 m	150 m	150 m	100 m
Mech. perm. speed *n*[3]	*D > 30 mm:* max. 4000 rpm *D ≤ 30 mm:* max. 6000 rpm			*D > 30 mm:* max. 4000 rpm *D ≤ 30 mm:* max. 6000 rpm	
Starting torque (at 20 °C)	*D > 30 mm:* ≤ 0.2 Nm *D ≤ 30 mm:* ≤ 0.15 Nm			*D > 30 mm:* ≤ 0.2 Nm *D ≤ 30 mm:* ≤ 0.15 Nm	
Moment of inertia of rotor	*D = 50 mm:* $240 \cdot 10^{-6}$ kgm^2 *D = 38 mm:* $350 \cdot 10^{-6}$ kgm^2 *D = 25 mm:* $80 \cdot 10^{-6}$ kgm^2 *D = 20 mm:* $85 \cdot 10^{-6}$ kgm^2			*D = 50 mm:* $240 \cdot 10^{-6}$ kgm^2 *D = 38 mm:* $350 \cdot 10^{-6}$ kgm^2 *D = 25 mm:* $80 \cdot 10^{-6}$ kgm^2 *D = 20 mm:* $85 \cdot 10^{-6}$ kgm^2	
Hollow shaft* **Inside diameter**	Through shaft D = 20 mm, **25 mm,** 38 mm, **50 mm**			Through shaft D = 20 mm, **25 mm,** 38 mm, **50 mm**	
Permissible axial motion of drive shaft	± 1.5 mm			± 1.5 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)			≤ 100 m/s^2 (EN 60068-2-6) ≤ 1000 m/s^2 (EN 60068-2-27)	
Max. operating temp.[3]	100 °C	85 °C (100 °C at U_P < 15 V)	100 °C	100 °C	*U_P = 5 V:* 100 °C *U_P = 10 to 30 V:* 85 °C
Min. operating temp.	*Flange socket or stationary cable:* –40 °C *Moving cable*: –10 °C			*Flange socket or stationary cable:* –40 °C *Moving cable*: –10 °C	
Protection[3] (IEC 60529)	IP 64 (IP 40 upon request)			IP 64 (IP 40 upon request)	
Weight	0.6 kg to 0.9 kg (21 to 32 oz) depending on hollow shaft dimensions			0.6 kg to 0.9 kg (21 to 32 oz) depending on hollow shaft dimensions	

Bold: These preferred versions are available on short notice.
***** Please indicate when ordering.
[1] for absolute position value
[2] with HEIDENHAIN cable and recommended input circuitry of subsequent electronics (see *Interfaces*)
[3] For description of relationships between degree of protection, shaft speed and operating temperature, see *Mechanical Data*.
[4] PROFIBUS-DP via gateway

ROD 1000 Series

- Rotary encoder for separate shaft coupling
- Compact dimensions
- Synchro flange



Dimensions
in mm/inches

DIN ISO 8015
ISO 2768 - m H

A = Bearing
B = Threaded mounting hole

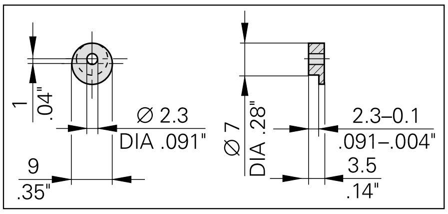
	Incremental		
	ROD 1020	**ROD 1030**	**ROD 1080**
Incremental signals	⊓⊔ TTL	⊓⊔ HTL	∼ 1 V_{PP}
Line counts*	100 200 **250** 360 400 **500** 720 900 **1000** **1024** 1250 1500 2000 **2048** **2500** **3600**		
Cutoff frequenz (–3 dB) (–6 dB) **Scanning frequency**	– – Max. 300 kHz	– – Max. 160 kHz	≥ 180 kHz typical ≥ 450 kHz typical –
Power supply **Max. current consumption** (without load)	5 V ± 10% 150 mA	10 V to 30 V 150 mA	5 V ± 10% 150 mA
Electrical connection* **Cable**	**1 m**/5 m, Radial, optional axial, with or **without coupling**		
Max. cable length[1)]	100 m		150 m
Mech. perm. speed ***n***	Max. 10 000 rpm		
Starting torque	≤ 0.001 Nm (at 20 °C)		
Moment of inertia of rotor	$0.45 \cdot 10^{-6}$ kgm^2		
Shaft load	Axial 5 N Radial 10 N shaft end		
Vibration (55 to 2000 Hz) **Shock** (6 ms)	≤ 100 m/s^2 (EN 60 068-2-6) ≤ 1000 m/s^2 (EN 60 068-2-27)		
Max. operating temp.	100 °C	70 °C	100 °C
Min. operating temp.	*Stationary cable:* –40 °C *Moving cable:* –10 °C		
Protection (IEC 60 529)	IP 64		
Weight	Approx. 0.09 kg (3 oz)		

Bold: These preferred versions are available on short notice.
***** Please indicate when ordering.
1) with HEIDENHAIN cable and recommended input circuitry of subsequent electronics (see *Interfaces*)

Mounting Accessory

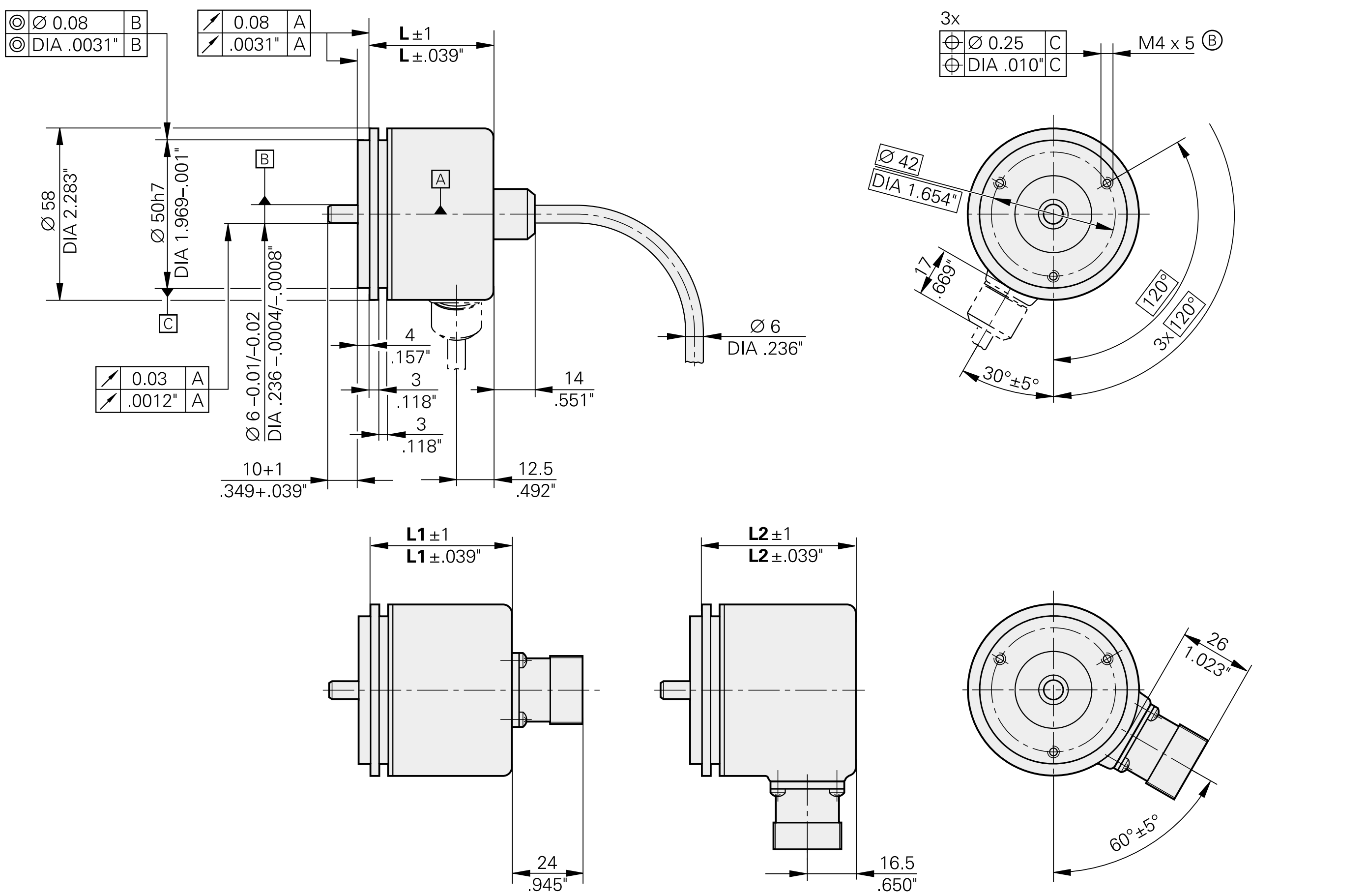
Fixing clamps for ROD 1000 series
(3 per encoder)
Id. Nr. 200 032-02

Shaft coupling
See *Accessories*



ROD/ROC/ROQ 400 with Synchro Flange

Rotary encoder for separate shaft coupling



Dimensions
in mm/inches

DIN ISO 8015
ISO 2768 - m H

A = Bearing
B = Threaded mounting hole

	L	L1	L2
ROD **ROC/5 V**	42 1.654"	48 1.890"	52 2.047"
ROC/10 to 30 V	48 1.890"	48 1.890"	52 2.047"
ROQ	59 2.323"	59 2.323"	59 2.323"
ROQ 425 programmable	63 2.480"	63 2.480"	63 2.480"

	Incremental				Absolute										
					Multiturn			Pro-grammable	Singleturn						
	ROD 426	ROD 466	ROD 436	ROD 486	ROQ 425	ROQ 424	ROQ 425	ROQ 425	ROC 413	ROC 410	ROC 412	ROC 413	ROC 409/360	ROC 410	ROC 412
Data interface*	–				**EnDat**[4]	SSI		SSI or serial Right justified[3]	**EnDat**[4]	SSI			Parallel TTL or **HTL**		
Positions per rev	–				8192 (13 bits)	4096 (12 bits)	8192 (13 bits)	8192 (13 bits)[3]	8192 (13 bits)	1024 (10 bits)	4096 (12 bits)	8192 (13 bits)	360	1 024 (10 bits)	4096 (12 bits)
Resolvable revolutions	–				4096			4096[3]	–				–		
Code	–				Pure binary	Gray		Pure bin./Gray[3]	Pure binary	Gray			Gray excess	Gray	
Electrically permissible speed[1]	–				*512 lines:* 5 000 rpm at ± 1 bit accuracy 10 000 rpm at ± 100 bits accuracy *2 048 lines:* 1500 rpm at ± 1 bit accuracy 10 000 rpm at ± 50 bits accuracy			Updating time 500 µs	*512 lines:* 5 000 rpm at ± 1 bit accuracy 12 000 rpm at ± 100 bits accuracy *2048 lines:* 1500 rpm at ± 1 bit accuracy 12 000 rpm at ± 50 bits accuracy				6000 rpm		1500 rpm
Incremental signals	⊓⊔ TTL		⊓⊔ HTL	∼ 1 V_{PP}	∼ 1 V_{PP}				∼ 1 V_{PP}				–		
Line counts/ signal periods*	50 100 150 200 **250** 360 400 **500** 512 600 720 900 **1000** **1 024** **1 250** 1 500 1 800 **2 000** 2 048 **2 500** 3 000 **3 600** 4 096 4 500 **5 000**			**1000** **1024** **2000** **2048** **2500** **3600** 4096 **5000**	**512** 2048	512			**512** 2048	512			–		
Signal periods[7]*****	6 000 8192 9000 10 000		–												
Cutoff frequenz (–3 dB) (–6 dB) **Scanning frequency**	– – Max. 300 kHz			≥ 180 kHz typ. ≥ 450 kHz typ. –	*512 lines:* ≥ 100 kHz typical; *2048 lines:* ≥ 200 kHz typical – –				*512 lines:* ≥ 100 kHz typical; *2048 lines:* ≥ 200 kHz typical – –				– – –		
Power supply*/ Max. current consumption (without load)	5 V ± 10 %/ 150 mA	10 to 30 V/ 150 mA		5 V ± 10 %/ 150 mA	5 V ± 5 %/ 250 mA	5 V ± 5 % or **10 to 30 V**/ 250 mA		10 to 30 V/ 300 mA	5 V ± 5 % 150 mA	5 V ± 5 % or **10 to 30 V**/ 150 mA			*TTL:* 5 V ± 5 %/150 mA (*ROC 412:* 180 mA) *HTL:* **10 to 30 V**/150 mA (*ROC 412:* 270 mA)		
Electrical connection* **Flange socket**	**Axial** or **radial**				**Axial** or **radial**			Radial	**Axial** or **radial**				**Axial** or **radial**		
Cable	**1 m**/5 m, **axial** or **radial,** with or **without coupling**				1 m/5 m, axial or radial, with or without coupling			–	1 m/5 m, axial or radial, with or without coupling				1 m/5 m, axial or radial, without connecting element		
Max. cable length[2]	100 m		300 m	150 m	150 m	100 m			150 m	100 m			*TTL:* 20 m; *HTL:* 100 m		
Mech. perm. speed ***n***	Max. 12 000 rpm				Max. 10 000 rpm				Max. 12 000 rpm				Max. 10 000 rpm		
Starting torque	≤ 0.01 Nm (at 20 °C)				≤ 0.01 Nm (at 20 °C)				≤ 0.01 Nm (at 20 °C)				≤ 0.01 Nm (at 20 °C)		
Moment of inertia of rotor	$1.45 \cdot 10^{-6}$ kgm^2				$3.8 \cdot 10^{-6}$ kgm^2				$3.6 \cdot 10^{-6}$ kgm^2				$1.6 \cdot 10^{-6}$ kgm^2		
Shaft load	*n ≤ 6000 rpm:* axial 40 N/radial 60 N at shaft end *n > 6000 rpm:* axial 10 N/radial 20 N at shaft end				*n ≤ 6000 rpm:* axial 40 N/radial 60 N at shaft end *n > 6000 rpm:* axial 10 N/radial 20 N at shaft end				*n ≤ 6000 rpm:* axial 40 N/radial 60 N at shaft end *n > 6000 rpm:* axial 10 N/radial 20 N at shaft end				Axial 10 N/radial 20 N at shaft end		
Vibration (55 to 2000 Hz) **Shock** (6 ms)	≤ 300 m/s^2 [5] ≤ 5000 m/s^2	≤ 100 m/s^2 (EN 60 068-2-6) ≤ 1000 m/s^2 (EN 60 068-2-27)			≤ 100 m/s^2 (EN 60 068-2-6) ≤ 1000 m/s^2 (EN 60 068-2-27)				≤ 100 m/s^2 (EN 60 068-2-6) ≤ 1000 m/s^2 (EN 60 068-2-27)				≤ 100 m/s^2 (EN 60 068-2-6) ≤ 1000 m/s^2 (EN 60 068-2-27)		
Max. operating temp.	100 °C	70 °C	85 °C (100 °C at U_P < 15 V)	100 °C	100 °C	*U_P = 5 V:* 100 °C *U_P = 10 to 30 V:* 85 °C		70 °C	100 °C	*U_P = 5 V:* 100 °C *U_P = 10 to 30 V:* 85 °C			*TTL:* 85 °C *HTL:* 70 °C		
Min. operating temp.	*Flange socket or stationary cable:* –40 °C *Moving cable*: –10 °C				*Flange socket or stationary cable:* –40 °C *Moving cable*: –10 °C			–20 °C	*Flange socket or stationary cable:* –40 °C *Moving cable*: –10 °C				*Stationary cable:* –20 °C *Moving cable*: –10 °C		
Protection (IEC 60 529)	IP 67 at housing; IP 64 at shaft inlet[6]				IP 67 at housing; IP 64 at shaft inlet[6]				IP 67 at housing; IP 64 at shaft inlet[6]				IP 67 at housing; IP 65 at shaft inlet		
Weight	Approx. 0.25 kg (8.8 oz)				Approx. 0.35 kg (12 oz)				Approx. 0.35 kg (12 oz)				Approx. 0.35 kg (12 oz)		

Bold: These preferred versions are available on short notice.
***** Please indicate when ordering.

[1] for absolute position value
[2] with HEIDENHAIN cable and recommended input circuitry of subsequent electronics (see *Interfaces*)

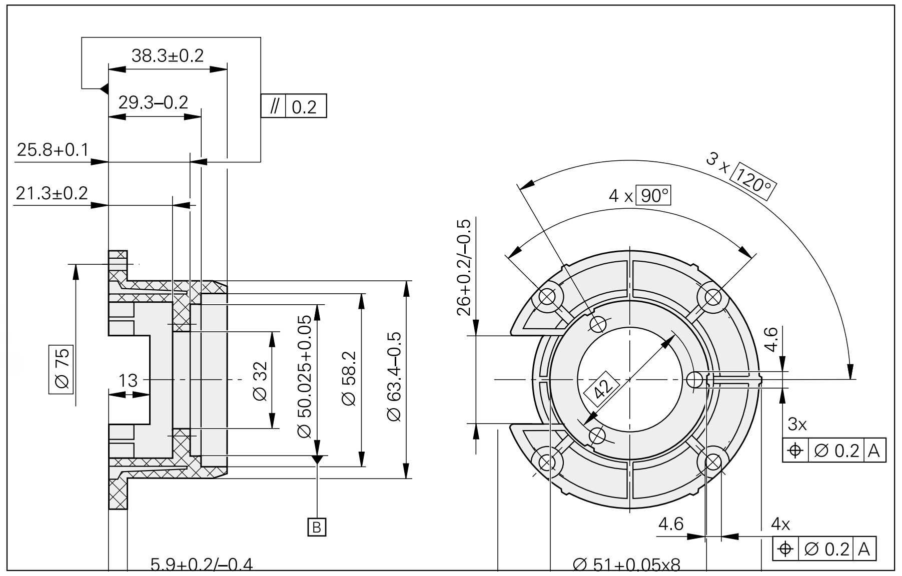
[3] These functions are programmable.
[4] PROFIBUS-DP via gateway

[5] Only for cable version. For flange socket version see specifications of ROD 466.
[6] IP 66 upon request
[7] through integrated signal doubling

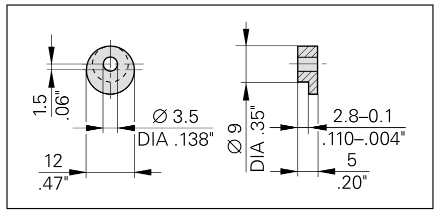
Mounting Accessories

for ROD/ROC/ROQ 400 with synchro flange

Adapter flange
(non-conducting)
Id. Nr. 257 044-01



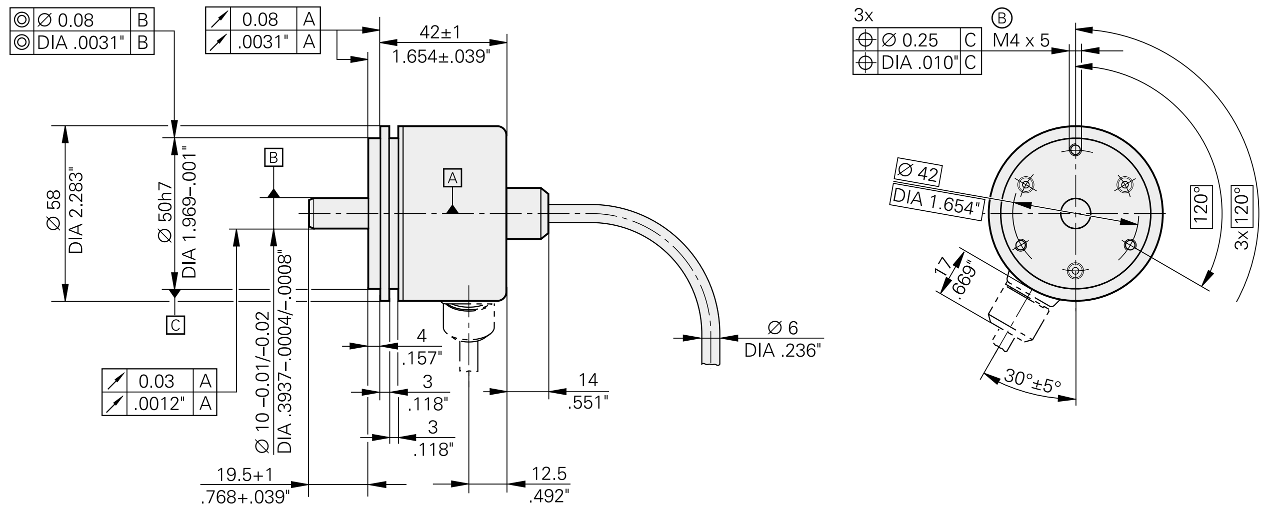
Fixing clamps
(3 per encoder)
Id. Nr. 200 032-01

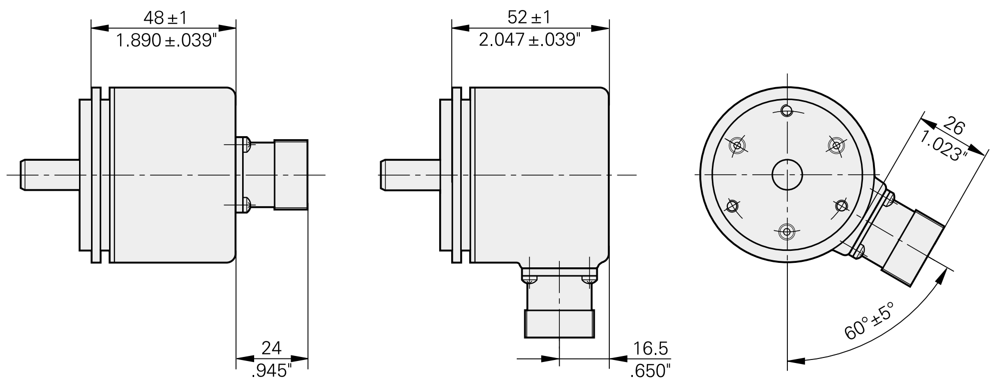


Shaft coupling
See *Accessories*

ROC 415, ROC 417

- **Rotary encoder for separate shaft coupling**
- **Synchro flange**
- **High absolute resolution**
  32 768 position values per revolution (15 bits) or
  131 072 position values per revolution (17 bits)





Dimensions
in mm/inches

DIN ISO 8015
ISO 2768 - m H

Ⓐ = Bearing
Ⓑ = Threaded mounting hole

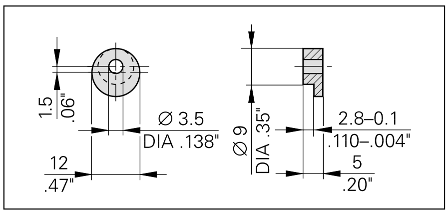
	Absolute Singleturn ROC 415	ROC 417
Data interface	**EnDat**[2]	
Positions per rev	32 768 (15 bits)	131 072 (17 bits)
Code	Pure binary	
Elec. perm. speed for absolute position value	60 rpm at ± 2 bits accuracy 200 rpm at ± 50 bits accuracy	
Incremental signals	∿ 1 V_{PP}	
Line count	8192	
Cutoff frequency (–3 dB)	≥ 100 kHz	
Power supply **Max. current consumption** (without load)	5 V ± 5 % 250 mA	
Electrical connection* **Flange socket**	Axial or radial	**Axial** or **radial**
Cable	1 m/5 m, axial or radial, with or without coupling	
Max. cable length[1]	150 m	
Mech. perm. speed	Max. 10 000 rpm	
Starting torque	≤ 0.025 Nm (at 20 °C)	
Moment of inertia of rotor	$3.6 \cdot 10^{-6}$ kgm^2	
Shaft load	Axial 10 N Radial 20 N shaft end	
Vibration (55 to 2000 Hz) **Shock** (6 ms)	≤ 100 m/s^2 (EN 60 068-2-6) ≤ 1000 m/s^2 (EN 60 068-2-27)	
Max. operating temp.	80 °C	
Min. operating temp.	*Flange socket or stationary cable:* –40 °C *Moving cable*: –10 °C	
Protection (IEC 60 529)	IP 67 at housing IP 66 at shaft inlet	
Weight	Approx. 0.4 kg (14 oz)	

Bold: These preferred versions are available on short notice.
***** Please indicate when ordering.
[1] with HEIDENHAIN cable and recommended input circuitry of subsequent electronics (see *Interfaces*)
[2] PROFIBUS-DP via gateway

Mounting Accessory

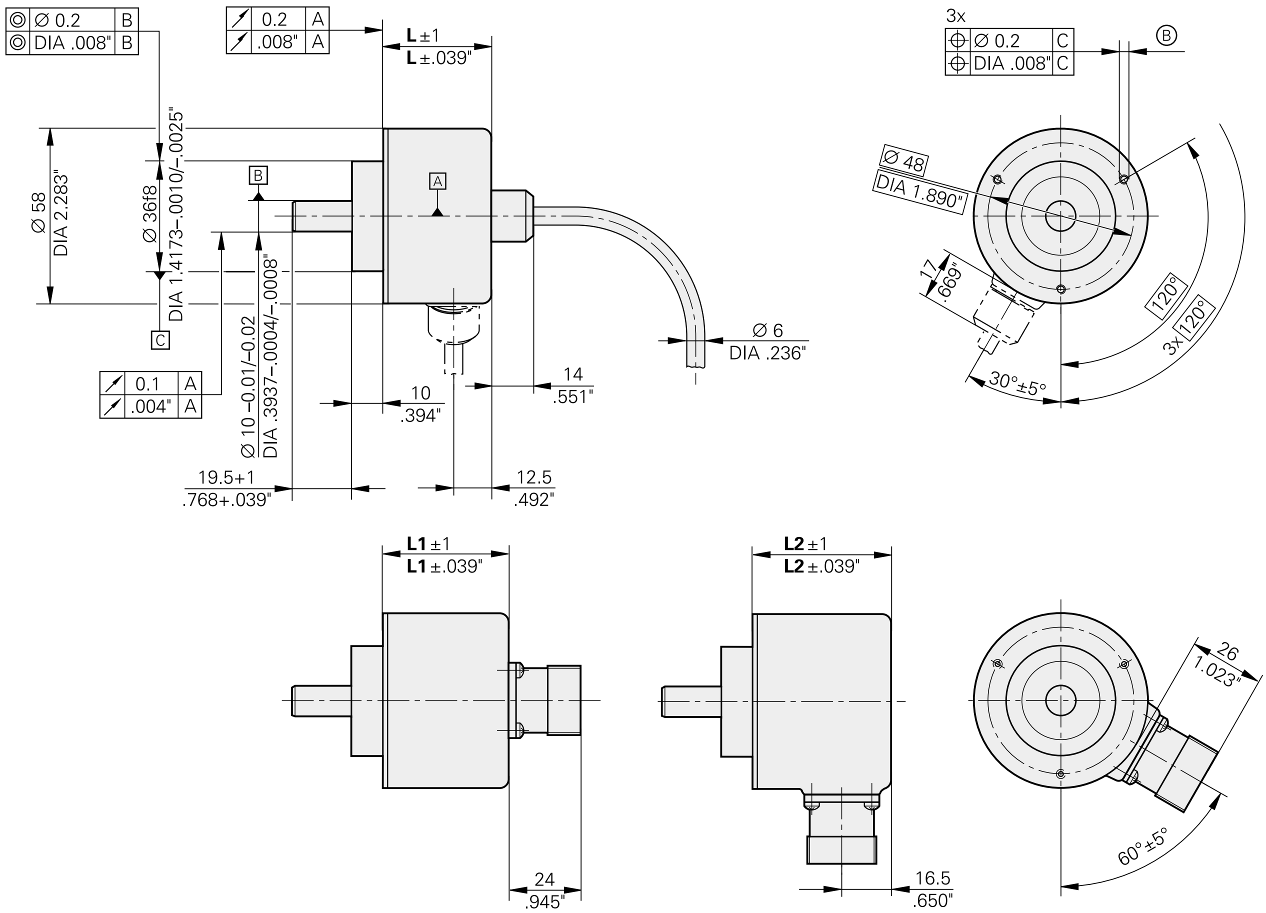
Fixing clamps
(3 per encoder)
Id. Nr. 200 032-01

Shaft coupling
See *Accessories*



ROD/ROC/ROQ 400 with Clamping Flange

Rotary encoder for separate shaft coupling



Dimensions
in mm/inches

DIN ISO 8015
ISO 2768 - m H

Ⓐ = Bearing
Ⓑ = Threaded mounting hole ROD: M3 x 5
ROC/ROQ: M4 x 5

	L	L1	L2
ROD **ROC/5V**	36 1.417"	42 1.654"	46 1.811"
ROC 10 to 30 V	42 1.654"	42 1.654"	46 1.811"
ROQ	53 2.087"	53 2.087"	53 2.087"
ROQ 425 **programmable**	63 2.480"	63 2.480"	63 2.480"

	Incremental			Absolute					
				Multiturn			Pro- grammable	Singleturn	
	ROD 420	ROD 430	ROD 480	ROQ 425	ROQ 424	ROQ 425	ROQ 425	ROC 413	ROC 413
Data interface*	–			**EnDat**[4]	SSI		SSI or serial Right justified [3]	**EnDat**[4]	SSI
Positions per rev	–			8192 (13 bits)	4096 (12 bits)	8192 (13 bits)	8192 (13 bits) [3]	8192 (13 bits)	
Resolvable revolutions	–			4096			4096[3]	–	
Code	–			Pure binary	Gray		Pure binary/ Gray[3]	Pure binary	Gray
Electrically permissible speed[1]	–			*512 lines:* 5000 rpm at ± 1 bit accuracy 10000 rpm at ± 100 bits accuracy			Updating time 500 µs	*512 lines:* 5000 rpm at ± 1 bit accuracy 12000 rpm at ± 100 bits accuracy	
Incremental signals	⊓⊔ TTL	⊓⊔ HTL	∼ 1 V_{PP}	∼ 1 V_{PP}				∼ 1 V_{PP}	
Line counts*	50 100 150 200 **250** 360 400 **500** 512 600 720 **900** **1000** **1024** **1250** 1500 1800 **2000** **2048** 2500 3000 **3600** 4096 4500 **5000**		**1000** **1024** **2000** **2048** **2500** 3600 4096 **5000**	512				512	
Cutoff frequenz (–3 dB) **Cutoff frequenz** (–6 dB) **Scanning frequency**	– – Max. 300 kHz		≥ 180 kHz typical ≥ 450 kHz typical –	≥ 100 kHz typical – –				≥ 100 kHz typical – –	
Power supply*	5 V ± 10 %	10 to 30 V	5 V ± 10 %	5 V ± 5 %	5 V ± 5 % or **10 to 30 V**		10 to 30 V	5 V ± 5 %	5 V ± 5 % or **10 to 30 V**
Max. current consumption (without load)	150 mA	150 mA	150 mA	250 mA	250 mA		300 mA	150 mA	150 mA
Electrical connection* **Flange socket**	**Axial** or **radial**			**Axial** or **radial**			Radial	**Axial** or **radial**	
Cable	**1 m**/5 m, **axial** or **radial,** with or **without coupling**			1 m/5 m, axial or radial, with or without coupling			–	1 m/5 m, axial or radial, with or without coupling	
Max. cable length[2]	100 m	300 m	150 m	150 m	100 m			150 m	100 m
Mech. perm. speed *n*	Max. 12000 rpm			Max. 10000 rpm				Max. 12000 rpm	
Starting torque	≤ 0.01 Nm (at 20 °C)			≤ 0.01 Nm (at 20 °C)				≤ 0.01 Nm (at 20 °C)	
Moment of inertia of rotor	$1.45 \cdot 10^{-6}$ kgm^2			$3.8 \cdot 10^{-6}$ kgm^2				$3.6 \cdot 10^{-6}$ kgm^2	
Shaft load at shaft end	*n ≤ 6000 rpm:* axial 40 N/radial 60 N *n > 6000 rpm:* axial 10 N/radial 20 N			*n ≤ 6000 rpm:* axial 40 N/radial 60 N *n > 6000 rpm:* axial 10 N/radial 20 N				*n ≤ 6000 rpm:* axial 40 N/radial 60 N *n > 6000 rpm:* axial 10 N/radial 20 N	
Vibration (55 to 2000 Hz) **Shock** (6 ms)	≤ 100 m/s^2 (EN 60068-2-6) ≤ 1000 m/s^2 (EN 60068-2-27)			≤ 100 m/s^2 (EN 60068-2-6) ≤ 1000 m/s^2 (EN 60068-2-27)				≤ 100 m/s^2 (EN 60068-2-6) ≤ 1000 m/s^2 (EN 60068-2-27)	
Max. operating temp.	100 °C	85 °C (100 °C at U_P < 15 V)	100 °C	*U_P = 5 V:* 100 °C *U_P = 10 to 30 V:* 85 °C			70 °C	*U_P = 5 V:* 100 °C *U_P = 10 to 30 V:* 85 °C	
Min. operating temp.	*Flange socket or stationary cable:* –40 °C *Moving cable:* –10 °C			*Flange socket or stationary cable:* –40 °C *Moving cable:* –10 °C			–20 °C	*Flange socket or stationary cable:* –20 °C *Moving cable:* –10 °C	
Protection (IEC 60529)	IP 67 at housing; IP 64 at shaft inlet[5]			IP 67 at housing; IP 64 at shaft inlet[5]				IP 67 at housing; IP 64 at shaft inlet[5]	
Weight	Approx. 0.25 kg (8.8 oz)			Approx. 0.35 kg (12 oz)				Approx. 0.35 kg (12 oz)	

Bold: These preferred versions are available on short notice.
***** Please indicate when ordering.

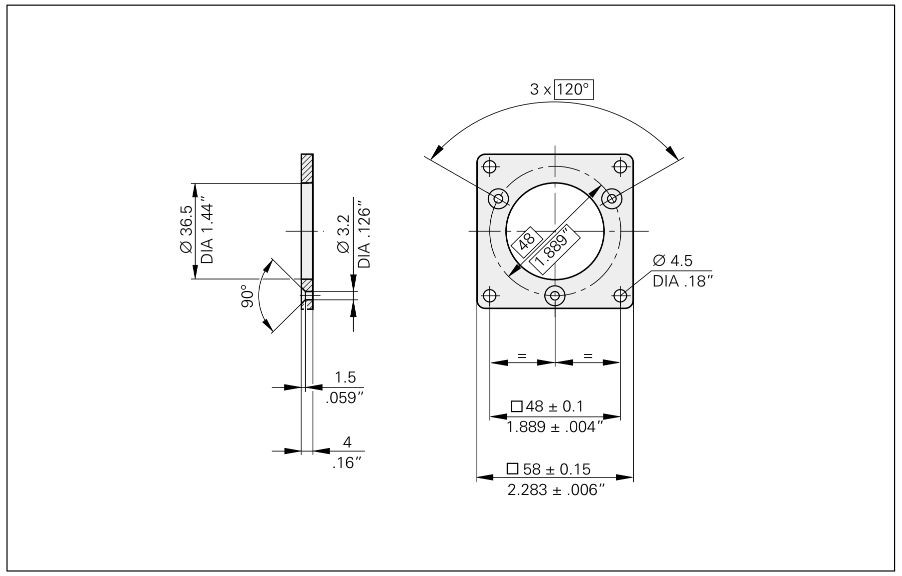
1) for absolute position value
2) with HEIDENHAIN cable and recommended input circuitry of subsequent electronics (see *Interfaces*)
3) These functions are programmable.
4) PROFIBUS-DP via gateway
5) IP 66 upon request

Mounting Accessories

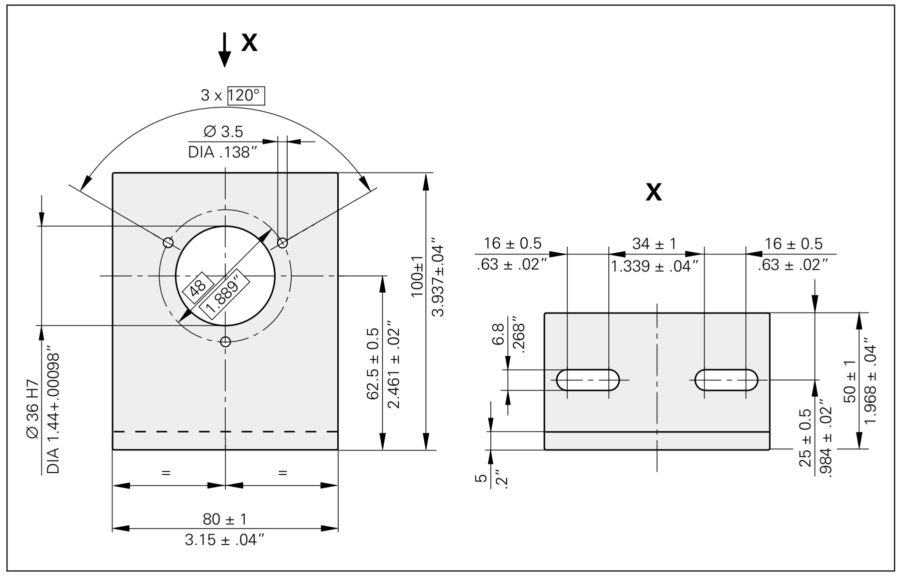
For ROD/ROC/ROQ 400 series with clamping flange

Shaft coupling
See page 54

Mounting flange
Id. Nr. 201 437-01



Mounting bracket
Id. Nr. 324 322-01

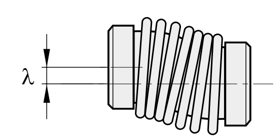


HEIDENHAIN Shaft Couplings

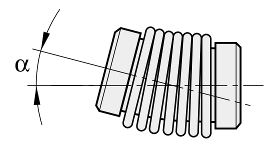
	ROD/ROC/ROQ 400				ROD 1000	ROC 417, ROC 415	
	Diaphragm couplings	with metallic isolation			Metal bellows coupling	Diaphragm coupling	Flat coupling
	K 14	K 17/01 K 17/06	K 17/02 K 17/04	K 17/03	18EBN3	K 03	K 18
Hub bores	6 mm	6 mm 6/5 mm	6/10 mm 10 mm	10 mm	4/4 mm	10 mm	10 mm
Kinematic error of transfer*	± 6″	± 10″			± 40″	± 2″	± 3″
Torsional rigidity	500 $\frac{Nm}{rad}$	150 $\frac{Nm}{rad}$	200 $\frac{Nm}{rad}$	300 $\frac{Nm}{rad}$	60 $\frac{Nm}{rad}$	1500 $\frac{Nm}{rad}$	1200 $\frac{Nm}{rad}$
Max. torque	0.2 Nm	0.1 Nm		0.2 Nm	0.1 Nm	0.2 Nm	0.5 Nm
Max. radial misalignment λ	≤ 0.2 mm	≤ 0.5 mm			≤ 0.2 mm	≤ 0.3 mm	
Max. angular error α	≤ 0.5°	≤ 1°			≤ 0.5°	≤ 0.5°	
Max. axial motion δ	≤ 0.3 mm	≤ 0.5 mm			≤ 0.3 mm	≤ 0.2 mm	
Mmt. of inertia (approx.)	$6 \cdot 10^{-6}$ kgm^2	$3 \cdot 10^{-6}$ kgm^2		$4 \cdot 10^{-6}$ kgm^2	$0.3 \cdot 10^{-6}$ kgm^2	$20 \cdot 10^{-6}$ kgm^2	$75 \cdot 10^{-6}$ kgm^2
Permissible speed	16 000 rpm	16 000 rpm			12 000 rpm	10 000 rpm	1000 rpm
Torque for locking screws (approx.)	1.2 Nm				0.8 Nm	1.2 Nm	
Weight	35 g	24 g	23 g	27.5 g	9 g	100 g	117 g

*With radial misalignment λ = 0.1 mm, angular error α = 0.15 mm over 100 mm ≙ 0.09° to 50 °C

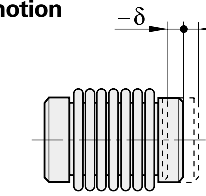
Radial misalignment



Angular error



Axial motion



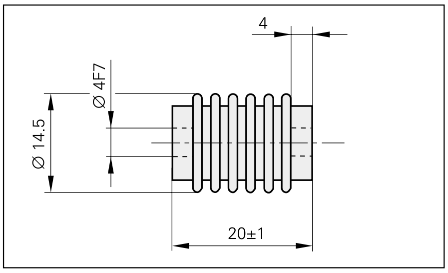
Mounting Accessories

Screwdriver bit
For HEIDENHAIN shaft couplings and for ExN 100/400 shaft clamps

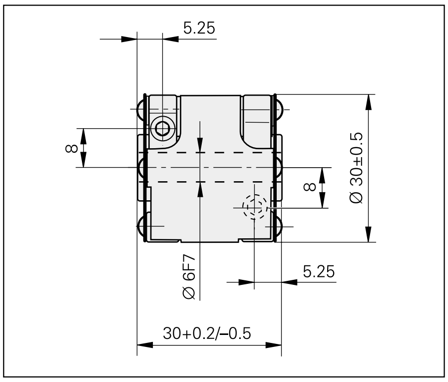
Width across flats 1.5
Length 70 mm
Id. Nr. 350 378-01

Screwdriver
Adjustable torque
0.2 Nm to 1 Nm Id. Nr. 350 379-01
0.5 Nm to 5 Nm Id. Nr. 350 379-02

Metal bellows coupling 18 EBN 3
for rotary encoders of the ROD 1000
series with **4 mm shaft diameter**
Id. Nr. 200 393-02

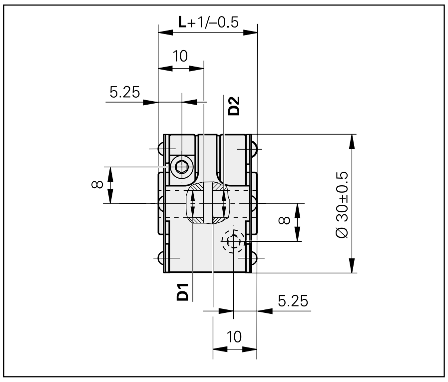


Diaphragm coupling K 14
for ROD/ROC/ROQ 400 series
with **6 mm shaft diameter**
Id. Nr. 293 328-01



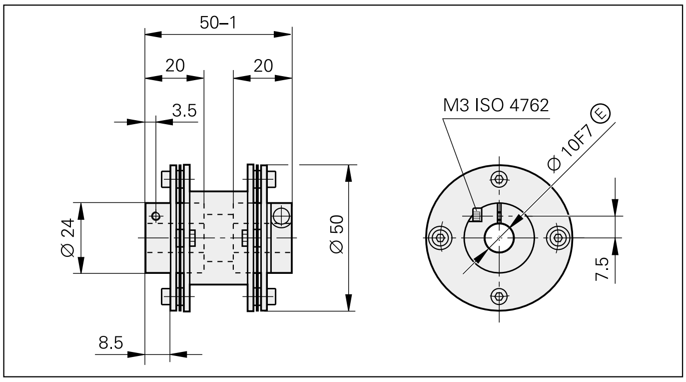
The recommended fit for the customer shaft is h6.

Diaphragm coupling K 17 with metallic isolation
for ROD/ROC/ROQ 400 series
with **6 or 10 mm shaft diameter**
Id. Nr. 296 746-xx

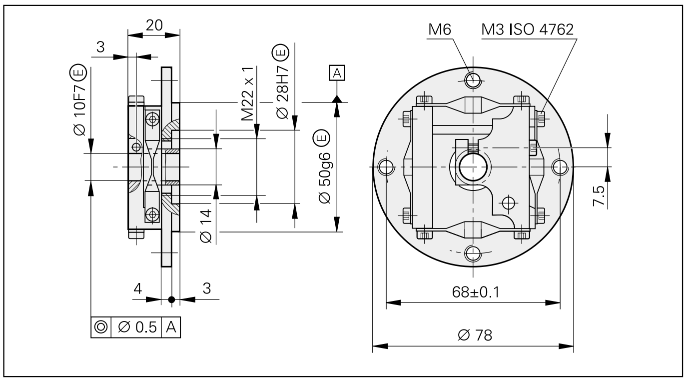


K 17 Version	D1	**D2**	L
01	Ø 6 F7	**Ø 6 F7**	22 mm
02	Ø 6 F7	**Ø 10 F7**	22 mm
03	Ø 10 F7	**Ø 10 F7**	30 mm
04	Ø 10 F7	**Ø 10 F7**	22 mm
06	Ø 5 F7	**Ø 6 F7**	22 mm

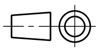
Diaphragm coupling K 03
Id. Nr. 200313-04
for
ROC 417
ROC 415



Flat coupling K 18
Id. Nr. 202 227-01
for
ROC 417
ROC 415



Dimensions
in mm



DIN ISO 8015
ISO 2768 - m H

A = Bearing

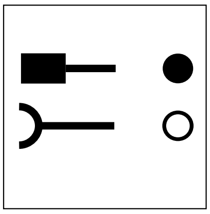
Connecting Elements
General Information

Pin numbering
The pins on connectors are numbered in directions opposite to those on couplings, regardless of whether the contacts are male or female. Couplings and flange sockets, both with external threads, have the same pin-numbering direction.

Contacts:

Male contact

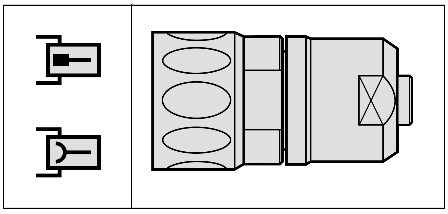
Female contact

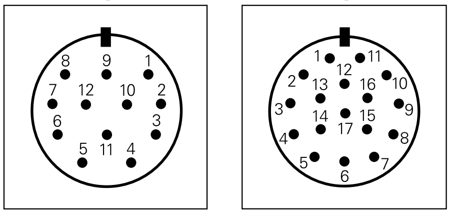


View of contact end:

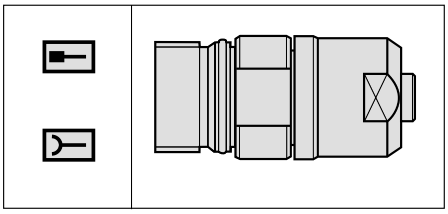
12-pin **17-pin**

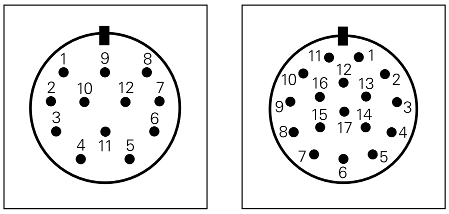
Connector: A connecting element with a knurled coupling ring, regardless of whether the contacts are male or female.



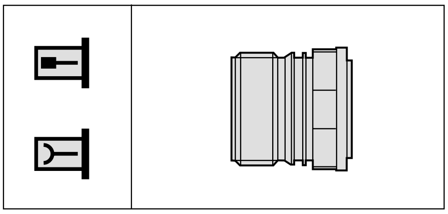


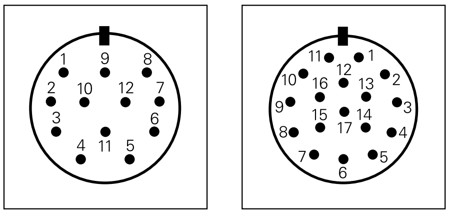
Coupling: A connecting element with external thread, regardless of whether the contacts are male or female. A coupling on mounting base features a flange with mounting holes.



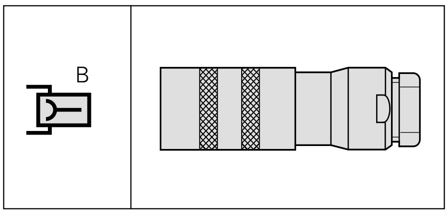


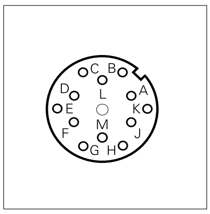
Flange socket: A flange socket is permanently mounted on the encoder or machine housing, has an external thread and is available with male or female contacts.



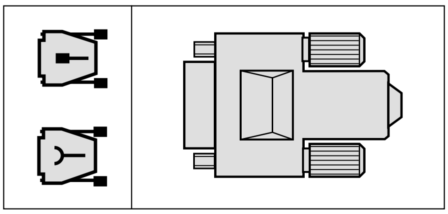


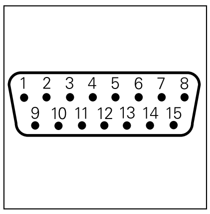
Binder connector:
Compact, round connector with coupling ring for encoders with Binder flange socket.





D-sub connector:
The D-sub connector connects the encoder to the PC counter card or absolute value card.



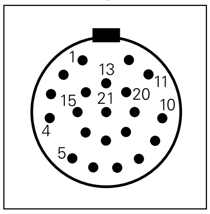


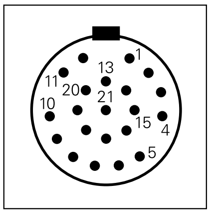
15-pin

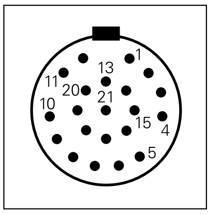
Protection:
When engaged, connections provide protection to IP 67 (D-sub connector: IP 30) as per IEC 529/IEC 144/EN 60 529. When not engaged, there is no protection (IP 00).

Overall Dimensions

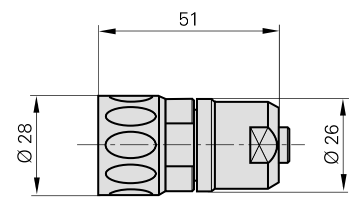
21-pin



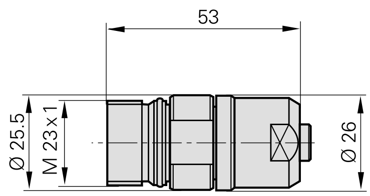




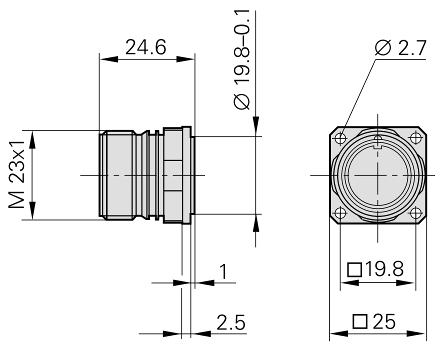
HEIDENHAIN connector
insulated



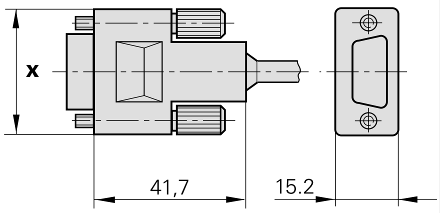
HEIDENHAIN coupling
insulated



HEIDENHAIN flange socket

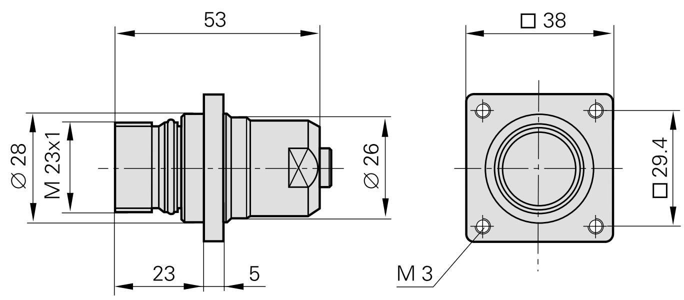


D-sub connector

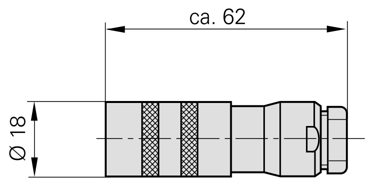


x: 42.7 15-pin

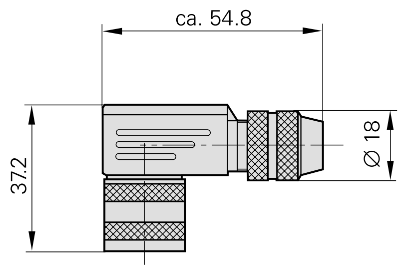
HEIDENHAIN coupling on mounting base insulated



Binder connector

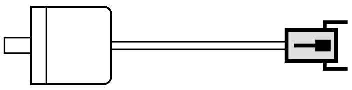
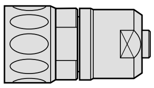


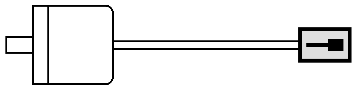
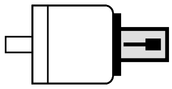
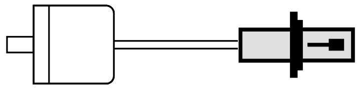
Binder connector
Right-angled version,
adjustable in 45° increments



Connecting Elements and Cables (12-pin)
Standard Versions

⊓⊔ TTL, ⊓⊔ HTL and ∿ 1 V_{PP}

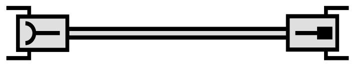
Connector on encoder cable 	**Connector (male),** 12-pin, shield on housing 
for encoder cable dia. 6 mm dia. 4.5 mm	291 697-07 291 697-06

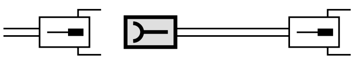
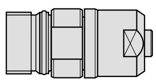
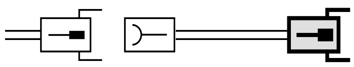
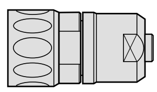
Coupling on encoder cable 	**Coupling (male),** 12-pin, shield on housing
for encoder cable dia. 6 mm dia. 4.5 mm	291 698-03 291 698-14
Flange socket on encoder 	**Flange socket (male),** 12-pin, shield on housing 200 722-02
Coupling on mounting base 	**Coupling on mounting base (male),** shield on housing
for encoder cable dia. 6 mm	291 698-08

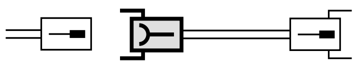
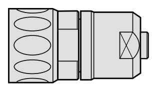
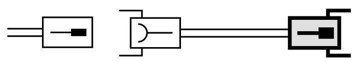
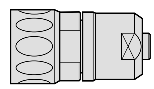
Polyurethane (PUR) connecting cable dia. 8 mm
[4(2 × 0.14 mm^2) + (4 × 0.5 mm^2)] Shield on housing
for encoders with connector

Complete with coupling (female) and connector (male) 	298 400-xx
With one coupling (female) 	298 402-xx

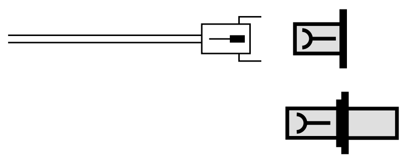
Polyurethane (PUR) connecting cable dia. 8 mm
[4(2 × 0.14 mm^2) + (4 × 0.5 mm^2)] Shield on housing
for encoders with coupling or flange socket

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
With one connector (female) 	309 777-xx

Mating element on connecting cable to connector on encoder cable 	**Coupling (female),** 12-pin, shield on housing 
for connecting cable dia. 8 mm	291 698-02
Connector on connecting cablel for connection to subsequent electronics 	**Connector (male),** 12-pin, shield on housing 
for connecting cable dia. 8 mm	291 697-08

Mating element on connecting cable to coupling or flange socket on encoder 	**Connector (female),** 12-pin, shield on housing 
for connecting cable dia. 8 mm	291 697-05
Connector on connecting cable for connection to subsequent electronics 	**Connector (male),** 12-pin, shield on housing 
for connecting cable dia. 8 mm	291 697-08

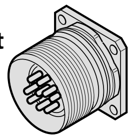
Cable only 	244 957-01

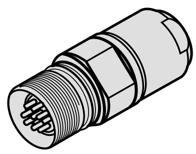
for subsequent electronics 	**Flange socket (female),** 12-pin: 200 722-01 **Coupling on mounting (female),** for cable dia. 8 mm, 12-pin: 291 698-07

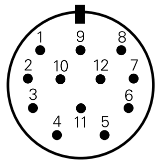
Pin Layout

TTL

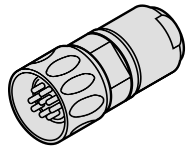
12-pin HEIDENHAIN flange socket or coupling

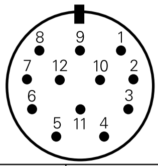






12-pin HEIDENHAIN connector



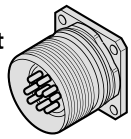


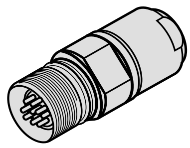
5	6	8	1	3	4	12	10	2	11	7	9	/
U_{a1}	$\overline{U_{a1}}$	U_{a2}	$\overline{U_{a2}}$	U_{a0}	$\overline{U_{a0}}$	**5 V*** (U_P)	**0 V** (U_N)	**5 V*** Sensor	**0 V** Sensor	$\overline{U_{aS}}$	**Vacant**	**Vacant**
Brown	Green	Gray	Pink	Red	Black	Brown/ Green	White/ Green	Blue	White	Violet	/	Yellow
						EN 50 178						

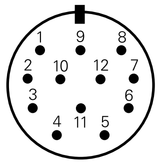
The sensor lines are connected internally to the respective supply lines.
Shield on housing.
* ROD 466 and ERN 460 have a power supply of 10 to 30 V.

HTL

12-pin HEIDENHAIN flange socket or coupling





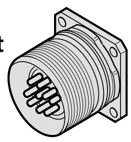


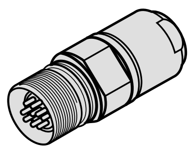
5	6	8	1	3	4	12	10	2	11	7	9	/
U_{a1}	$\overline{U_{a1}}$	U_{a2}	$\overline{U_{a2}}$	U_{a0}	$\overline{U_{a0}}$	**10 to 30 V** (U_P)	**0 V** (U_N)	**10 to 30 V** Sensor	**0 V** Sensor	$\overline{U_{aS}}$	**Vacant**	**Vacant**
Brown	Green	Gray	Pink	Red	Black	Brown/ Green	White/ Green	Blue	White	Violet	/	Yellow
						EN 50 178						

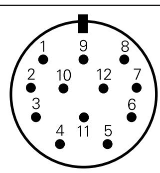
The sensor lines are connected internally to the respective supply lines.
ROD 1030/ERN 1030 without inverse signals $\overline{U_{a1}}$, $\overline{U_{a2}}$ and $\overline{U_{a0}}$.
Shield on housing.

1 V_{PP}

12-pin HEIDENHAIN flange socket or coupling







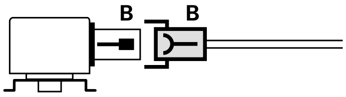
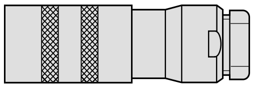
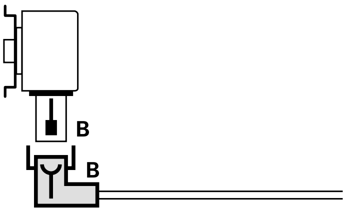
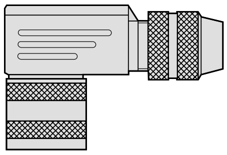
5	6	8	1	3	4	12	10	2	11	7	9	/
A		**B**		**R**		**5 V** (U_P)	**0 V** (U_N)	**5 V** Sensor	**0 V** Sensor	**Vacant**	**Vacant**	**Vacant**
+	−	+	−	+	−							
Brown	Green	Gray	Pink	Red	Black	Brown/ Green	White/ Green	Blue	White	Violet	/	Yellow
						EN 50 178						

The sensor lines are connected internally to the respective supply lines.
Shield on housing.

Binder Connecting Elements (12-pin)

for ERN 400 with blind hollow shaft and Binder model radial flange socket

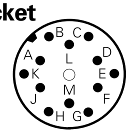
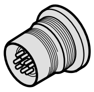
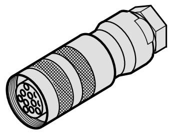
⊓⊔ TTL, ⊓⊔ HTL and ∼ 1 V_{PP}

Mating element on connecting cable to encoder flange socket	
	**Binder connector (female)** 12-pin, straight, shield on housing 
for connecting cable dia. 6 mm to dia. 8 mm	292 275-02
	**Binder connector (female),** 12-pin, right-angled, shield on housing 
for connecting cable dia. 6 mm to dia. 8 mm	298 541-01

Polyurethane (PUR) connecting cable dia. 6 mm [6(2 × 0.19 mm^2)] Shield on housing **for encoders with Binder model flange socket**	
With one connector (Binder model), female 	329 306-xx
Cable only dia. 6 mm 	291 639-01

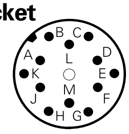
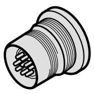
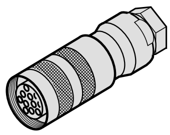
Pin Layout

TTL

12-pin Binder flange socket  						12-pin Binder connector, straight or right-angled  						
E	**F**	**H**	**A**	**C**	**D**	**M**	**K**	**B**	**L**	**G**	**J**	**/**
U_{a1}	$\overline{U_{a1}}$	U_{a2}	$\overline{U_{a2}}$	U_{a0}	$\overline{U_{a0}}$	**5 V*** (U_P)	**0 V** (U_N)	**5 V*** Sensor	**0 V** Sensor	$\overline{U_{aS}}$	**Vacant**	**Vacant**
Brown	Green	Gray	Pink	Red	Black	Brown/ Green	White/ Green	Blue	White	Violet	/	Yellow
						EN 50 178						

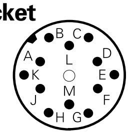
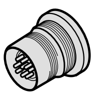
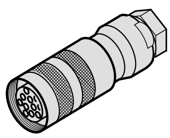
The sensor lines are connected internally to the respective supply lines.
Shield on housing.
* ERN 460 and ROD 466 have a power supply of 10 to 30 V.

HTL

12-pin Binder flange socket  						12-pin Binder connector, straight or right-angled  						
E	**F**	**H**	**A**	**C**	**D**	**M**	**K**	**B**	**L**	**G**	**J**	**/**
U_{a1}	$\overline{U_{a1}}$*	U_{a2}	$\overline{U_{a2}}$*	U_{a0}	$\overline{U_{a0}}$*	**10 to 30 V** (U_P)	**0 V** (U_N)	**10 to 30 V** Sensor	**0 V** Sensor	$\overline{U_{aS}}$	**Vacant**	**Vacant**
Brown	Green	Gray	Pink	Red	Black	Brown/ Green	White/ Green	Blue	White	Violet	/	Yellow
						EN 50 178						

The sensor lines are connected internally to the respective supply lines.
Shield on housing.
* 0 V for ROD/ERN 1030.

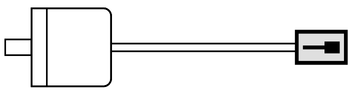
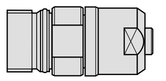
$1\ V_{PP}$

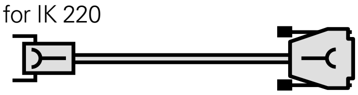
12-pin Binder flange socket  						12-pin Binder connector, straight or right-angled  						
E	**F**	**H**	**A**	**C**	**D**	**M**	**K**	**B**	**L**	**G**	**J**	**/**
A		**B**		**R**		**5 V** (U_P)	**0 V** (U_N)	**5 V** Sensor	**0 V** Sensor	**Vacant**	**Vacant**	**Vacant**
+	–	+	–	+	–							
Brown	Green	Gray	Pink	Red	Black	Brown/ Green	White/ Green	Blue	White	Violet	/	Yellow
						EN 50 178						

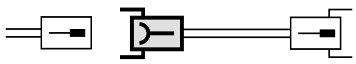
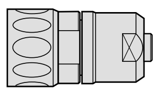
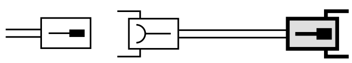
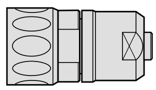
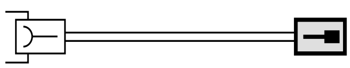
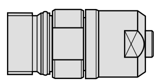
The sensor lines are connected internally to the respective supply lines.
Shield on housing.

Connecting Elements and Cables (17-pin)

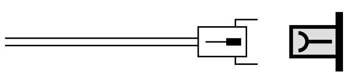
Serial Interface

Connecting element on encoder cable 	**Coupling (male),** 17-pin 
for encoder cable dia. 6 mm dia. 4.5 mm	291 698-25 291 698-26

Polyurethane (PUR) connecting cable dia. 8 mm	$[(4 \times 0.14\ mm^2) + 4(2 \times 0.14\ mm^2) + (4 \times 0.5\ mm^2)]$		
Complete with connector (female) and coupling (male) 	323 897-xx	**Complete** with connector (female) and D-sub connector (male) for IK 115 	324 544-xx
With one connector (female) 	309 778-xx	**Complete** with connector (female) and D-sub connector (male) for IK 220 	332 115-xx

Mating element on connecting cable to connecting element on encoder cable 	**Connector (female),** 17-pin 
for connecting cable dia. 8 mm	291 697-26
Connector on connecting cable to the subsequent electronics 	**Connector (male),** 17-pin 
for connecting cable dia. 8 mm	291 697-27
Coupling on extension cable 	
for extension cable dia. 8 mm	291 698-27

Cable only 	266 306-01

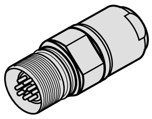
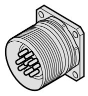
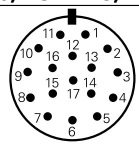
Flange socket for connecting the cable to the subsequent electronics	
	**Flange socket (female),** 17-pin: 315 892-10

Pin Layout

Serial Interface

Pin assignments for ROC 417, ROC 415, ROC 413, ROC 412, ROC 410, ECN 113, ECN 413, ROQ 424, ROQ 425 and EQN 425

17-pin HEIDENHAIN coupling or flange socket

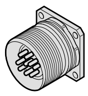
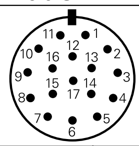
	15	16	12	13	14	17	8	9	7	10	11
	A		**B**		**DATA**	$\overline{\textbf{DATA}}$	**CLOCK**	$\overline{\textbf{CLOCK}}$	**(U_P)**	**0 V** (U_N)	**Internal shield**
	+	–	+	–							
	Green/ Black	Yellow/ Black	Blue/ Black	Red/ Black	Gray	Pink	Violet	Yellow	Brown/ Green	White/ Green	/
									EN 50178		

	1	4	3	2	5	6
	U_P Sensor*	**0 V** Sensor*	**Vacant**	**Vacant**	**Vacant**	**Vacant**
	Blue	White	Red	Black	Green	Brown

U_P = Power supply voltage.
External shield on housing.
Vacant pins or wires must not be used!
*The sensor lines are not used when U_P = 10 to 30 V.

Pin assignments for ROC 425 programmable and EQN 425 programmable

17-pin HEIDENHAIN flange socket

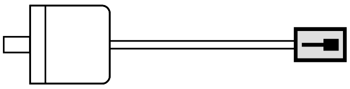
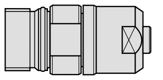



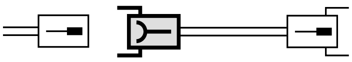
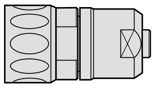
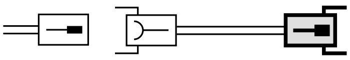
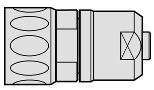
	15	16	12	13	14	17	8	9	7	10	11
	A		**B**		**DATA**	$\overline{\textbf{DATA}}$	**CLOCK**	$\overline{\textbf{CLOCK}}$	**10 to 30 V** (U_P)	**0 V** (U_N)	**Internal shield**
	+	–	+	–							
	Green/ Black	Yellow/ Black	Blue/ Black	Red/ Black	Gray	Pink	Violet	Yellow	Brown/ Green	White/ Green	/

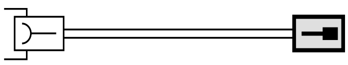
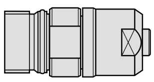
	1	4	3	2	5	6
	RxD	**TxD**	$\overline{U_{aS}}$	**Direction of rotation**	**Preset 1**	**Preset 2**
	Blue	White	Red	Black	Green	Brown

Connecting Elements and Cables (21-pin)

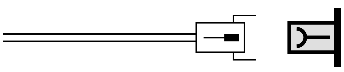
Parallel Interface

Connecting element on encoder cable 	**Coupling (male),** 21-pin 
for encoder cable dia. 8 mm	291 698-30

Polyurethane (PUR) connecting cable dia. 8 mm [11(2 x 0.14 mm^2)]	
With one connector (female) 	269 165-xx
Mating element on connecting cable to connecting element on encoder cable 	**Connector (female),** 21-pin 
for connecting cable dia. 8 mm	291 697-30
Connector on connecting cable to the subsequent electronics 	**Connector (male),** 21-pin 
for connecting cable dia. 8 mm	291 697-31

Coupling on extension cable 	
for extension cable dia. 8 mm	291 698-30

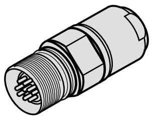
Cable only 	262 360-01

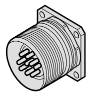
Flange socket for connecting the cable to the subsequent electronics	
	**Flange socket (female)**, 21-pin: 315 892-12

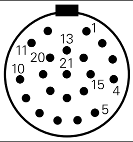
Pin Layout

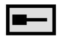
Parallel Interface **ROC 412, ROC 410, ROC 409/360**

21-pin
HEIDENHAIN coupling
or flange socket









1	2	3	4	5	6	7	8	9	10	11
0 V (UN)	**(UP)***	**RELEASE A** **	**RELEASE B** **	**Bit 10**[2]	**Bit 9**[3]	**Bit 8**	**Bit 7**	**Bit 6**	**Bit 5**	**Bit 4**
White	Brown	Green	Yellow	Gray	Pink	Blue	Red	Black	Violet	Gray/Pink
EN 50 178										

12	13	14	15	16	17	18	19	20	21
Bit 3	**Bit 2**	**Bit 1** (MSB)	**0 V** Sensor	**UP** Sensor*	**Bit 1** MSB ***	**Bit 11**	**Bit 12**[1]	**Vacant**	**Vacant**
Red/ Blue	White/ Green	Brown/ Green	White/ Yellow	Yellow/ Brown	White/ Gray	Gray/ Brown	White/ Pink	Pink/ Brown	White/ Blue

* ⊓⊔ TTL: UP = 5 V
⊓⊔ HTL: UP = 10 V to 30 V

** RELEASE A/B not with ROC 412 (HTL version)

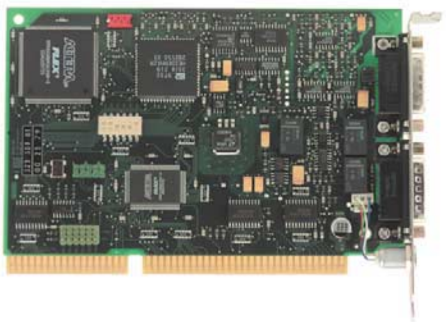
*** Bit 1 (MSB) only for ROC 410, ROC 409/360 (TTL and HTL)

[1] Bit 12 – LSB for ROC 412
[2] Bit 10 – LSB for ROC 410
[3] Bit 9 – LSB for ROC 409/360

Vacant pins or wires must not be used!
External shield on housing.

HEIDENHAIN Measuring and Testing Equipment

The **IK 115** is an adapter card for PCs for inspecting and testing absolute HEIDENHAIN encoders with EnDat or SSI interface. The user can read out all parameters of the encoder over the EnDat interface and write to all encoder memory areas that are not write-protected.



	IK 115
Encoder input	EnDat or SSI (absolute value and incremental signals)
Interface	ISA bus
Application software	Operating system: Windows 95/98 Functions: Position value display Counter for incremental signals EnDat functions
Dimensions	158 mm x 107 mm

The **PWM 8** is a universal measuring device for inspecting and adjusting HEIDENHAIN incremental encoders. Several adapters are provided for the various encoder signals.
The display is a small LCD screen with easy-to-use soft keys.

	PWM 8
Encoder inputs	11 µA_{PP}/1 V_{PP}/TTL/HTL signals via adapters
Functions	• Measuring the signal amplitudes, current consumption, power supply • Display of phase angle, on-off ratio, scanning frequency • Display symbols for reference signal, disturbance signal, count direction • Integrated universal counter
Outputs	Incremental signals for subsequent electronics Incremental signals for oscilloscope via BNC sockets
Power supply	10 to 30 V, max. 15 W
Dimensions	150 mm × 205 mm × 96 mm

Counter Cards

IK 220
PC counter card
The IK 220 is an adapter card for AT compatible PCs for measured value acquisition of **two incremental or absolute linear and angular encoders.** The subdivision and counting electronics **subdivide** the **sinusoidal input signals** up to **4096 fold.** Driver software is included.

	IK 220			
Input signals (switchable)	∼ 1 V_{PP}	∼ 11 μA_{PP}	EnDat	SSI
Encoder inputs	Two D-sub ports (15-pin) male			
Input frequency (max.)	500 kHz	33 kHz	–	
Cable length (max.)	60 m		10 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 (plug and play)			
Driver software and demonstration program	**For WINDOWS NT/95/98** in VISUAL C++, VISUAL BASIC and BORLAND DELPHI			
Dimensions	Approx. 190 mm × 100 mm			

IK 410V
Counter card with 16-bit microcomputer interface
The IK 410V is an interpolation and counter PCB for incremental encoders with additional input for commutation signals (one sine/cosine per revolution). It is inserted directly onto the PCB of the customer's electronics.

	IK 410V
Encoder inputs	Incremental signals: 1 × ∼ 1 V_{PP} Commutation signals: 1 x sine/cosine (V_{PP})
Signal subdivision (signal period : meas. step)	Up to 1024-fold
Input frequency	Max. 350 kHz
Counter	32 bits
Interface	16-bit microcomputer interface
Driver software	BORLAND C and C++, TURBO PASCAL
Data format	MOTOROLA or INTEL format
Dimensions	100 mm × 65 mm

Sales and Service — Worldwide

HEIDENHAIN is represented in sales and service subsidiaries in all important industrial nations. In addition to the addresses listed here, there are many service agencies located worldwide. For more information, visit our Internet site or contact HEIDENHAIN in Traunreut,

DR. JOHANNES HEIDENHAIN GmbH
Dr.-Johannes-Heidenhain-Straße 5
83301 Traunreut, Deutschland
☏ (0 86 69) 31-0
FAX (0 86 69) 50 61
E-Mail: info@heidenhain.de

www.heidenhain.de

Europe

AT **HEIDENHAIN**
Dr.-Johannes-Heidenhain-Straße 5
83301 Traunreut, Deutschland
☏ (+49 86 69) 31 13 37
FAX (+49 86 69) 50 61
E-Mail: tba@heidenhain.de

LACKNER & URNITSCH Präzisionsmaschinen und Werkzeuge Ges.m.b.H.
Bahnhofgürtel 37
8020 Graz, Österreich
☏ (03 16) 71 14 80-0
E-Mail: heidenhain@urnitsch.at

LACKNER & URNITSCH Präzisionsmaschinen und Werkzeuge Ges.m.b.H.
Gewerbestraße 13
IZ-Süd 2
2351 Wiener Neudorf, Österreich
☏ (0 22 36) 6 12 20-0
E-Mail: Lackner.Urnitsch@netway.at

BE **HEIDENHAIN NV/SA**
Pamelse Klei 47,
1760 Roosdaal-Pamel, Belgium
☏ (0 54) 34 31 58
FAX (0 54) 34 31 73
E-Mail: sales@heidenhain.be

CH **HEIDENHAIN (SCHWEIZ) AG**
Post Box; Vieristrasse 14
8603 Schwerzenbach, Switzerland
☏ (01) 8 06 27 27
FAX (01) 8 06 27 28
E-Mail: hch@heidenhain.ch

CZ
SK **HEIDENHAIN s.r.o.**
Stremchová 16
106 00 Praha 10, Czech Republic
☏ (02) 72 65 81 31
FAX (02) 72 65 87 24
E-Mail: heidenhain@heidenhain.cz

DK **TP TEKNIK A/S**
Korskildelund 4
2670 Greve, Denmark
☏ (70) 10 09 66
FAX (70) 10 01 65
E-Mail: tp-gruppen@tp-gruppen.dk

ES **FARRESA ELECTRONICA S.A.**
c/Simon Bolivar, 27 – Dpto. 11
48013 Bilbao (Vizcaya), Spain
☏ (94) 4 41 36 49
FAX (94) 4 42 35 40
E-Mail: farresa@farresa.es

FI **HEIDENHAIN AB**
Mikkelänkallio 3
02770 Espoo, Finland
☏ (09) 8 67 64 76
FAX (09) 86 76 47 40
E-Mail: info@heidenhain.fi

FR **HEIDENHAIN FRANCE sarl**
2, Avenue de la Cristallerie
92316 Sèvres, France
☏ 01 41 14 30 00
FAX 01 41 14 30 30
E-Mail: info@heidenhain.fr

GB **HEIDENHAIN (G.B.) Limited**
200 London Road, Burgess Hill
West Sussex RH15 9RD, Great Britain
☏ (0 14 44) 24 77 11
FAX (0 14 44) 87 00 24
E-Mail: sales@heidenhain.co.uk

GR **D. PANAYOTIDIS – J. TSATSIS S.A.**
6, Pireos St.
183 46 Moschato, Athens, Greece
☏ (01) 4 81 08 17
FAX (01) 4 82 96 73
E-Mail: ptgr@otenet.gr

HU
RO **HEIDENHAIN Kereskedelmi Képviselet**
Hrivnák Pál utca 13.
1237 Budapest, Hungary
☏ (1) 4 21 09 52
FAX (1) 4 21 09 53
E-Mail: info@heidenhain.hu

IT **HEIDENHAIN ITALIANA srl**
Via Asiago 14
20128 Milano, Italy
☏ (02) 2 70 75-1
FAX (02) 2 70 75-2 10
E-Mail: heidenhain@heidenhain.it

NL **HEIDENHAIN NEDERLAND B.V.**
Postbus 107; Landjuweel 20
3900 AC Veenendaal, Netherlands
☏ (03 18) 54 03 00
FAX (03 18) 51 72 87
E-Mail: verkoop@heidenhain.nl

NO **KASPO MASKIN AS**
Hoeggvn. 66
7036 Trondheim, Norway
☏ (0 73) 96 96 00
FAX (0 73) 96 96 01
E-Mail: kaspo@kaspo.no

PL **PATEH**
ul. Zelazna 67
00-871 Warszawa, Poland
☏ (22) 6 20 23 69
FAX (22) 6 20 29 73
E-Mail: pateh@pateh.com.pl

PT **FARRESA ELECTRÓNICA LDA.**
Rua do Outeiro, 1315 1º M
4470 Maia, Portugal
☏ (22) 9 47 81 40
FAX (22) 9 47 81 49
E-Mail: farresapo@mail.telepac.pt

SE **HEIDENHAIN AB**
Fittjavägen 23
14553 Norsborg, Sweden
☎ (08) 53 19 33 50
FAX (08) 53 19 33 77
E-Mail: sales@heidenhain.se

TR **ORSEL LTD.**
Kusdili Cad. No. 43
Toraman Han, Kat 3
81310 Kadiköy/Istanbul, Turkey
☎ (2 16) 3 47 83 95
FAX (2 16) 3 47 83 93
E-Mail: orsel@turk.net

Africa

ZA **DIGITAL READOUT SERVICES C.C.**
16 Piet Retief Street, Alberton
North, P.O. Box 167233
Brackendowns 1454, South Africa
☎ (0 11) 9 07 17 08
FAX (0 11) 8 69 83 08

Asia

CN **HEIDENHAIN**
Technical Office Beijing
Room 808, Exchange Beijing
Tower 4,2 Dong Hua Nan Lu
Chaoyang District
100022 Beijing
☎ (10) 65 67-32 38
FAX (10) 65 67-27 89
E-Mail: beijing@heidenhain.com.cn

HK **HEIDENHAIN LTD**
Unit 2, 15/F, APEC Plaza
49 Hoi Yuen Road
Kwun Tong
Kowloon, Hong Kong
☎ (8 52) 27 59 19 20
FAX (8 52) 27 59 19 61
E-Mail: service@heidenhain.com.hk

IL **NEUMO VARGUS**
Post Box 57057
34-36, Itzhak Sade St.
Tel-Aviv 61570, Israel
☎ (3) 5 37 32 75
FAX (3) 5 37 21 90
E-Mail: neumoil@netvision.net.il

IN **ASHOK & LAL**
Post Box 5422
12 Pulla Reddy Avenue
Chennai – 600 030, India
☎ (0 44) 6 26 72 89
FAX (0 44) 6 47 82 24
E-Mail: ashoklal@satyam.net.in

JP **HEIDENHAIN K.K.**
Kudan Center Bldg. 10th Floor
Kudankita 4-1-7, Chiyoda-ku
Tokyo 102-0073 Japan
☎ (03) 32 34-77 81
FAX (03) 32 62-25 39
E-Mail: sales@heidenhain.co.jp

KR **HEIDENHAIN LTD.**
Suite 1415, Family Tower Building
958-2 Yeongtong-Dong, Paldal-Gu, Suwon
442-470 Kyeonggi-Do, Republic of Korea
☎ (82) 3 12 01 15 11
FAX (82) 3 12 01 15 10
E-Mail: info@heidenhain.co.kr

SG **HEIDENHAIN PACIFIC PTE LTD**
50, Lorong 21, Geylang
Singapore 388465
☎ 67 49-32 38
FAX 67 49-39 22
E-Mail: hdhsin@singnet.com.sg

TW **HEIDENHAIN Co., Ltd.**
No. 12-5, Gong 33rd Road
Taichung Industrial Park
Taichung 407, Taiwan, R.O.C.
☎ (8 86-4) 23 58 89 77
FAX (8 86-4) 23 58 89 78
E-Mail: info@heidenhain.com.tw

America

AR **NAKASE Asesoramiento Tecnico**
de Carlos Klug
Calle 49 Nr. 5764/66
1653 Villa Ballester,
Provincia de Buenos Aires, Argentina
☎ (11) 47 68 36 43
FAX (11) 47 68 24 13
E-Mail: nakase@usa.net

BR **DIADUR Indústria e Comércio Ltda.**
Rua Sérvia, 329, Santo Amaro
04763-070 – São Paulo – SP, Brazil
☎ (0 11) 55 23-67 77
FAX (0 11) 55 23-14 11
E-Mail: assistenciatec@diadur.com.br

CA **HEIDENHAIN CORPORATION**
Canadian Regional Office
11-335 Admiral Blvd.
Mississauga, Ontario L5T2N2, Canada
☎ (9 05) 6 70-89 00
FAX (9 05) 6 70-44 26
E-Mail: heidcan@netcom.ca

MX **HEIDENHAIN CORPORATION MEXICO**
Calle San Juan de los Lagos Nte. 904 Altos
Fracc. Jardines de la Concepción
20120 Aguascalientes, Ags., Mexico
☎ (4) 9 14 37 38
FAX (4) 9 12 57 33
E-Mail: rnohl@infosel.net.mx

US **HEIDENHAIN CORPORATION**
333 State Parkway
Schaumburg, IL 60173-5337, U.S.A.
☎ (8 47) 4 90-11 91
FAX (8 47) 4 90-39 31
E-Mail: info@heidenhain.com

HEIDENHAIN

DR. JOHANNES HEIDENHAIN GmbH
Dr.-Johannes-Heidenhain-Straße 5
83301 Traunreut, Deutschland
☎ (0 86 69) 31-0
FAX (0 86 69) 50 61
E-Mail: info@heidenhain.de

www.heidenhain.de

Germany – Application Support

Technisches Büro Baden-Württemberg
Eichachstraße 20
72131 Ofterdingen
☎ (0 74 73) 2 27 33
FAX (0 74 73) 2 17 64
E-Mail: tbbw@heidenhain.de

Technisches Büro Berlin
Rhinstraße 134
12681 Berlin
☎ (030) 5 47 05-2 40
FAX (030) 5 47 05-2 00
E-Mail: tbbln@heidenhain.de

Technisches Büro Chemnitz
Kaltes Feld 22
08468 Heinsdorfergrund
☎ (0 37 65) 6 95 44
FAX (0 37 65) 6 96 28
E-Mail: tbchz@heidenhain.de

Technisches Büro Hamburg
Bahnhofstraße 50
22880 Wedel
☎ (0 41 03) 74 38
FAX (0 41 03) 1 62 03
E-Mail: tbhbg@heidenhain.de

Technisches Büro Hessen
Wilhelm-Leuschner-Straße 17
61231 Bad Nauheim
☎ (0 60 32) 7 16 55
FAX (0 60 32) 17 96
E-Mail: tbhss@heidenhain.de

Technisches Büro Nordbayern
Birkenstraße 18
95503 Hummeltal
☎ (0 92 01) 79 62 65
FAX (0 92 01) 79 63 24
E-Mail: tbnby@heidenhain.de

Technisches Büro Nordrhein-Westfalen
Bandstahlstraße 2
58093 Hagen
☎ (0 23 31) 95 79-0
FAX (0 23 31) 95 79-49
E-Mail: tbnrw@heidenhain.de

Technisches Büro Südbayern
Dr.-Johannes-Heidenhain-Straße 5
83301 Traunreut
☎ (0 86 69) 31 13 45
FAX (0 86 69) 50 61
E-Mail: tbsby@heidenhain.de

Germany – Sales and Service

KLEIN & MISTELE GmbH
Brandstücken 35
22549 Hamburg
☎ (040) 80 10 57
E-Mail: klein-mistele@t-online.de

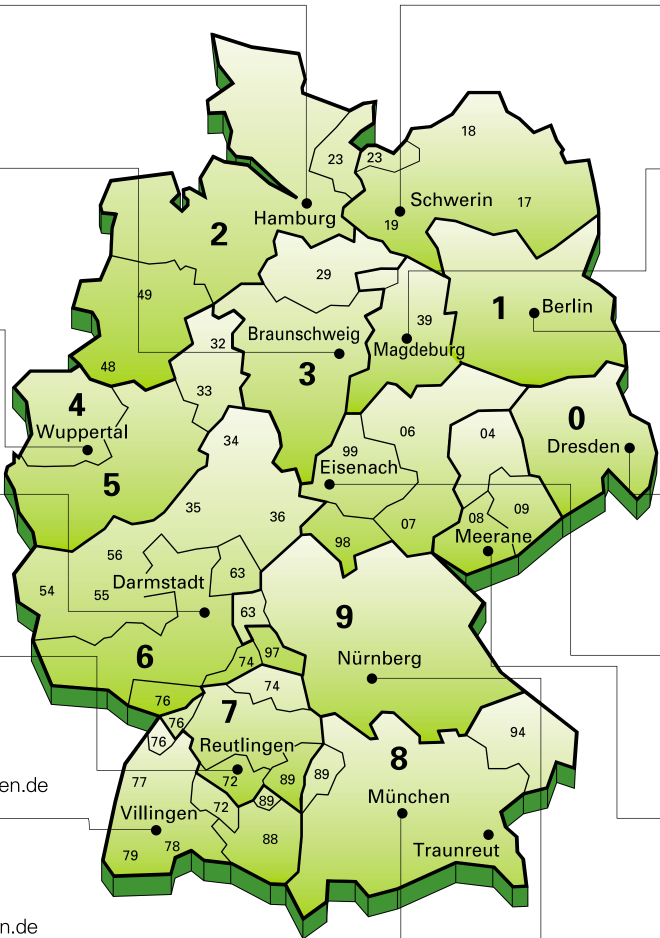
RHEINWERKZEUG KG
Gablonzstraße 8
38114 Braunschweig
☎ (05 31) 2 56 59-0
E-Mail: info@rheinwerkzeug.de

FRIEDR. STRACK GmbH
Buchenhofener Straße 19
42329 Wuppertal
☎ (02 02) 38 50
E-Mail: verkauf@strack-maschinen.de

Walter BAUTZ GmbH
Mess- und Spanntechnik
Mühlenweg 8
64347 Griesheim
☎ (0 61 55) 84 22-0
E-Mail: info@walterbautz-gmbh.de

BRAUN Werkzeugmaschinen Vertrieb und Service GmbH
Industriestraße 41
72585 Riederich
☎ (0 71 23) 93 43-0
E-Mail: info@braun-werkzeugmaschinen.de

HAAS Werkzeugmaschinen GmbH
Heinrich-Hertz-Straße 16
78052 VS-Villingen
☎ (0 77 21) 95 59-0
E-Mail: info@haas-werkzeugmaschinen.de



TEDI Technische Dienste GmbH
Werkstraße 113
19061 Schwerin
☎ (03 85) 6 17 21-0
E-Mail: schwerin@tedi-online.de

TEDI Technische Dienste GmbH
Liebknechtstraße 65
39110 Magdeburg
☎ (03 91) 73 25 29-0
E-Mail: magdeburg@tedi-online.de

MOSER Industrie-Elektronik GmbH
Genestraße 7/8
10829 Berlin
☎ (030) 7 51 57 37
E-Mail: mosergmbh.berlin@t-online.de

GLM-NEUMANN GmbH & Co. KG
Geblerstraße 11
01139 Dresden
☎ (03 51) 8 47 31-30
E-Mail: andreas.klinger@glm-neumann.de

WWZ-Vertrieb GmbH
Werkzeugmaschinen
An der Allee 9
99848 Wutha-Farnroda
☎ (03 69 21) 2 30
E-Mail: j.wellendorf@wwz.vertrieb.de

HEMPEL Werkzeugmaschinen
Pestalozzistraße 58
08393 Meerane
☎ (0 37 64) 30 64
E-Mail: info@hempel-wzm.de

BRAUN Werkzeugmaschinen Vertrieb und Service GmbH
Anton-Pendele-Straße 3
82275 Emmering
☎ (0 81 41) 97 14
E-Mail: albert@braunemm.de

GLM-NEUMANN GmbH & Co. KG
Im Gewerbegebiet 4
91093 Heßdorf
☎ (0 91 35) 6 06-0
E-Mail: ralph.schubert@glm-neumann.de

Fold here for filing!

349 529-23 · 100 · 4/2002 · F&W · Printed in Germany · Subject to change without notice