Magnetic incremental encoder
GEL 293
for heavy duty applications

LENORD +BAUER
... automates motion.

Technical Information ***Version 04.14***

General information

- High-resolution magnetic incremental rotary encoder with robust mechanical design
- Worldwide proven technology in various applications, suitable for harsh industrial environments
- Hollow shaft encoder with integrated, highly flexible and torsionally rigid hollow shaft coupling for shaft diameters of 16 mm
- High reliability and long service life characterizes the magnetic incremental encoders.

Features

- High resolution up to 266240 pulses per revolution
- Interpolation up to 1024-fold
- Additional current output
  0 to 20 mA, 4 to 20 mA, -20 to + 20 mA
- Reference signal
- High electromagnetic compatibility (EMC)

Advantages

- Absolute operational reliability even in case of high humidity (dewing) and frequent change of ambiant temperature
- Withstands extreme impacts and vibration
- Resistant to dirt, humidity and oil
- No ageing of the magnetic sensor technology

Field of application

- Heavy industry
- Vibration motors
- Shipbuilding
- Offshore engineering

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Description

Design and construction

The magnetic incremental rotary encoders GEL 293 are based on contactless magnetic scanning of an integrated ferromagnetic precision target wheel. The resilent housing with a flange size of 115 mm is available with radial connector or cable outlet.
The integrated flexible hollow shaft coupling of the encoder is mounted on the drive shaft with a diameter of 16 mm. By mounting the encoder with the aid of DS 290 pressure plate a frictional connection between the hollow shaft and the drive shaft is ensured. In this case the preload of the hollow shaft coupling must be observed. It is recommended to perform the drive shaft with a driver fitting the groove of the hollow shaft, in order to avoid slippage of the encoder shaft.
Optional designs include a condensate outlet or additional protection measures against moisture and vibration for harsh environmental conditions.
If the flange side of the encoder should be dust and water-protected, mounting with a intermediate flange or shaft adapter or mounting flange is recommended.

Sensing principle

The rotary encoders work with differential, magnetic- field-dependent sensors and a precision target wheel. The sensors scan without contact the tooth structure of the target wheel and output a sine and cosine voltage. The integrated evaluation electronics converts the analog sensor signals into incremental output signals.

Output signals

Rectangular signals are output with different signal patterns which provide a clear direction detection and a high data reliability. Additionally, an optional reference pulse can be supplied.
For display and control purposes, a measuring current of 0 to 20 mA, 4 to 20 mA or -20 to + 20 mA can be obtained from the pulse frequency. The current depends on the rotational speed and can be direction-dependent if necessary. Therefore the measuring pulses are integrated and converted into a speed dependent output current. There is a strictly linear interrelation between measuring current and pulse frequency (see current outputs).
The polarity of the current can be reversed by the connection assignment. For encoders with signal pattern S, by reversing the measuring current the direction-dependent S-signal is also reversed.

Possible pulse numbers

The GEL 293 is a high-resolutuion rotary encoder with pulse numbers of up to 266,240 pulses per revolution and is available in the following standard pulse numbers:

40	60	90	100	120
125	150	180	200	250
256	300	360	400	500
512	600	720	750	800
900	1000	1024	1200	1250
1500	1800	2000	2048	2500
3000	3500	3600	4000	4096
5000	6000	7000	7200	8000
8192	9000	10000	12000	12500
15000	16384	18000	20000	25000
30000	32768	36000	40000	50000
60000	65536	70000	80000	90000
100000	120000	125000	131072	262144

Other possible pulse numbers are available on the Internet at www.lenord.de or can be ordered upon request.

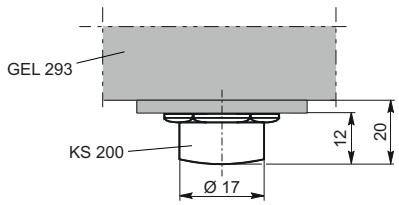
Additional protection measures

Moisture protection

The encoder electronics is coated with a highly effective protection against humidity, salt-water atmosphere and corrosive vapours. During years, proper functioning even in harsh environments is ensured.

Condensate outlet

By multiple dewing condensed water may gather in the encoder housing. This water can drain through the condensate outlet. When mounting the encoder make sure that the outlet points down. The protection class drops to IP 64.



The position of the condensate outlet must be specified upon the order.

Vibration protection

The additional fixing of mechanical parts with special plastic prevents the electronics and the connections inside the encoder from vibrating. Thus, the proper and continuous operation of the encoder even under extreme vibration and shock loading is guaranteed.

Current output – options

A: 

Direction dependent measuring current
nominal range: -20 to + 20 mA
(reversible)

B: 

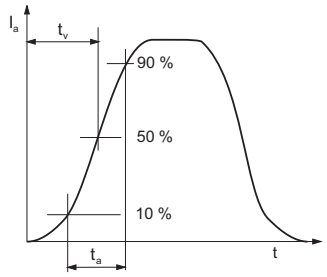
Direction independent measuring current
nominal range: 0 to + 20 mA

C: 

Direction independent measuring current
nominal range: +4 ... +20 mA.

General information

Due to the high resolution (direction of rotation dependent pulses per revolution) a DC output current is obtained which shows a low harmonic content even at a very low speed range (e.g. 0 to 0.5 min^{-1}). The harmonic content depends on the pulse frequency and the determined attenuation, latter influencing the rising and trailing edge times as well as the delay time in case of erratic changes of the speed.

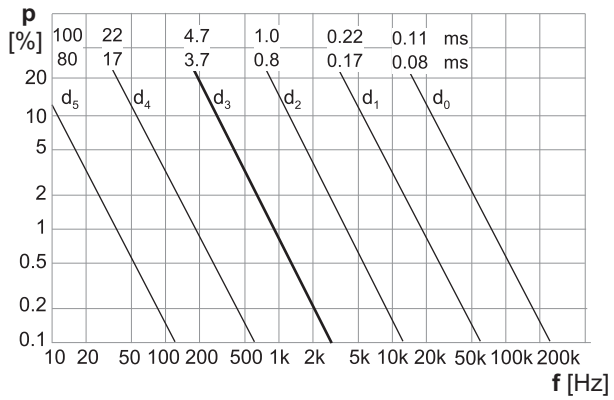


Rise time t_a and delay time t_v after a erratic change in speed

I_a Output current

Attenuation

The attenuation is adjusted according to the diagram below. The desired factory default setting must be specified in the order, default is set to d_3.
The speed for the maximum current of 20 mA, which was specified in the order is indicated on the ID-plate (eg, “4000 min^{-1}”). The attenuation is factory set so that the harmonic content p at rated speed is ≤ 1%, it is also indicated on the ID-plate (eg 'd5').



Harmonic content of the output current as a function of on the pulse frequency (f) and the selectable attenuation (d_n)

d attenuation
f effective pulse frequency
p harmonic content
t_a rise time
t_v delay time

Technical data

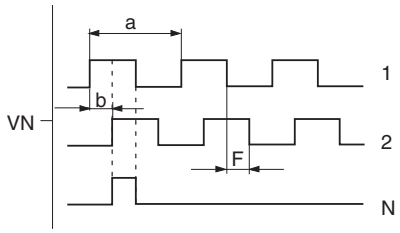
Current output		
Max. apparent ohmic resistance	R_a	550 Ω
Measuring device class	K	1
Rated current tolerance		< 1 %
Linearity error		< 1 %
Repeatability	r	100 %
Temperature drift	ΔI_{aT}	< ±3 µA/1 °K
Min. RPM (for attenuation d_5)	$n_{min\ electrical}$	1,5 x 10^3/i min^{-1}
Max. RPM	$n_{max\ electrical}$	6 x 10^6/i min-1

i = rated pulse number

Output signals

Signal pattern V, VN

The "V" signal pattern refers to two tracks with square-wave signals offset by 90°. On the third track N a reference signal of defined length is output once per turn.



a 360° electrical

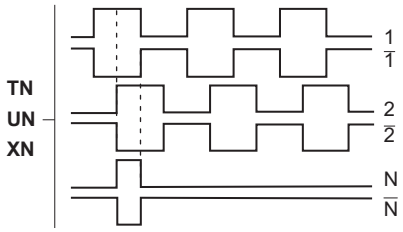
b 90° phase offset

F Time between edges(1)

	V_S(2)	V_{out}(3)
V, VN	10 to 30 V DC	HTL

Signal pattern T, TN, U, UN, X, XN

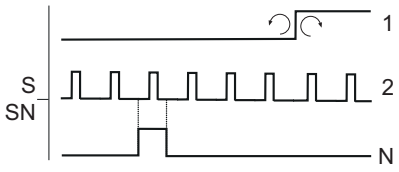
The two pulse outputs and the reference signal are output as inverse signals.



	V_S(2)	V_{out}(3)
T, TN	+ 5 V DC ± 5 %	TTL
U, UN	10 to 30 V DC	TTL
X, XN	10 to 30 V DC	HTL

Signal pattern S, SN

Pulses independent of the direction of rotation and of constant duration are derived from the square-wave signals as per signal pattern V and output on the 2nd track. In addition, a signal dependent on the direction of rotation is obtained from the signal pattern (counting direction); it is output on the 1st track. On the third track N (option) a reference signal is output once per turn.
The pulses follow a possible change in the direction of rotation with a short delay so that any downstream counting circuit can be set to the counting direction prior to the pulse.
The signal dependent on the direction of rotation can be inverted using a switch accessible from the exterior (switch 1).



	V_S(2)	V_{out}(3)
S, SN	10 to 30 V DC	HTL

Output singal level

The signal patterns S, SN, V, VN, X and XN have HTL levels, the signal patterns T, TN, U and UN have TTL levels. All outputs have a push-pull power amplifier and have sustained short circuit-protection.
The peak output current for discharging the cable capacitance is 100 mA.

Maximum cable lengths

The following stated data for each signal pattern refer to cable type LiYCY 6 (10) × 0.25 mm² between encoder and subsequent electronics.

Maximum cable lengths

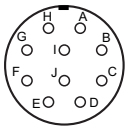
Signal pattern		**at output frequency f of**						
		5	**10**	**20**	**50**	**100**	**200**	**[kHz]**
T, TN, U, UN	TTL (V_S = 5 V) (4)	200	200	200	200	145	72	[m]
S, SN, V, VN	HTL (at V_S = 20 V)	200	200	200	80	40	20	[m]
X, XN	HTL (at V_S = 20 V)	200	200	100	40	20	10	[m]

(1) At an output frequency of 200 kHz the time between the edges is F > 0.6 µs
(2) Supply voltage
(3) Signal voltage
(4) The given lengths are only valid for a power supply with Sense control.

	S, SN	V, VN	X, XN	U, UN	T, TN
General					
Measuring range	9° to 0.0074°				
Resolution (pulses per revolution)	40 to 266,240				
Error limit	0.07°				
Incremental deviation	0.01°				
Accuracy	0.005°				
Electrical data					
Supply voltage V_S	10 to 30 V DC				5 V DC ± 5%
Power consumption	≤ 1.3 W, without load				
Output signals	square-wave signals option: reference signal (N)				
Output level	HTL			TTL	
Output level high	≥ V_S - 1.00 V at I = 10 mA; ≥ V_S - 1.20 V at I = 30 mA	≥ 4.00 V at I = 10 mA; ≥ 3.85 V at I = 30 mA	≥ V_S - 1.80 V at I = 10 mA; ≥ V_S - 2.20 V at I = 30 mA		
Output level low	≤ 0.75 V at I = 10 mA; ≤ 1.00 V at I = 30 mA		≤ 1.15 V at I = 10 mA; ≤ 1.55 V at I = 30 mA		
Mechanical data					
Moment of inertia of rotor	8 ×10^{-5} kgm^2				
Max. operating speed (r.p.m.)	8,000 min^{-1}				
Weight	0,7 kg				
Admissible coupling offset axial radial	 ±1.0 mm ±0.5 mm				
Bearing life cycle	> 15.000 revolutions				
Housing material	Polyamide, glass fibre reinforced				
Flange material	Aluminium nickel plated, stainless steel X12CrMoS17-1,4104 (upon request)				
Ambient data					
Working temperature range	0 °C to +70 °C (standard) -20 °C to +85 °C (option) -40 °C to +85 °C (option)				
Operating temperature range	-40 °C to +85 °C				
Storage temperature range	-40 °C to +105 °C				
Protection class (EN 60529)	IP 66				
Vibration protection (DIN EN 60068-2-6)	100 m/s^2, 10 to 2000 Hz				
Shock protection (DIN EN 60068-2-27)	1000 m/s^2, 11 ms				
Electromagnetic compatibility (EMC)	EN 61000-6-1 to 4				
Insulation strength (DIN EN 60439-1)	Ri > 1 MΩ at 500 V AC testing voltage				

Connection assignment

Anschlussbelegung

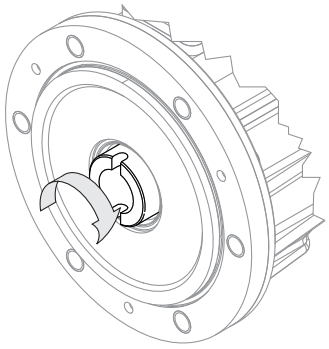
Signal	with connector type L	with cable outlett type I	Description
	10 pole 	10 cores	
V_S	F	red	Supply voltage
GND	A	blue	Ground
1	C	ehite	Track 1
/1	H	brown	Track 1, inverted
2	B	pink	Track 2
/2	G	black	Track 2, inverted
N	D	violet	Reference signal
/N	I	yellow	Reference signal, inverted
A/B/C	E	grey	Current output
	J	green	Direction reversal

Direction reversal

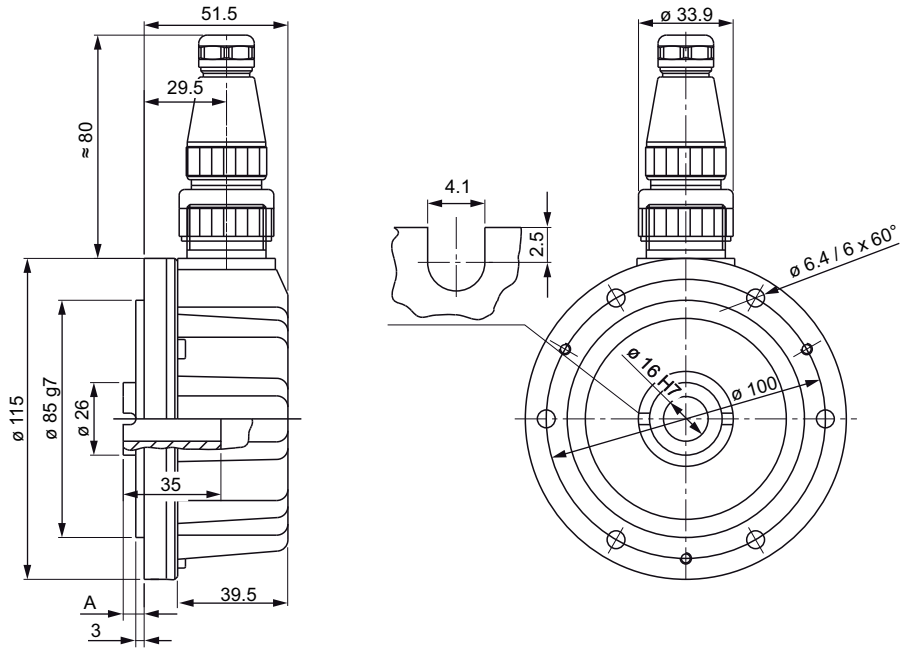
The polarity of the current output option A can be reversed by the connection of pin J or green core. For encoders with signal pattern S, by reversing the measuring current the direction-dependent S-signal is also reversed.

Polarity of the measuring current when shaft rotates clockwise

Pin J / green core wired with		Polarity of current output A	S signal (track 1)
Low level or not connected	standard	positive	High
High level	direction reversal	negative	Low



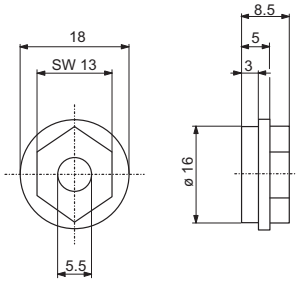
Dimensional drawing – GEL 293



Dimension A(1)

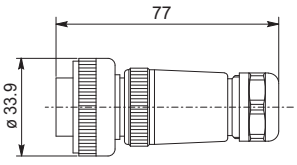
Max. axial shaft motion [mm]	Min. dimension A [mm]
1	7.5
2	8.5
3	9.5

Pressure plate **DS 290**
(included in the scope of supply)

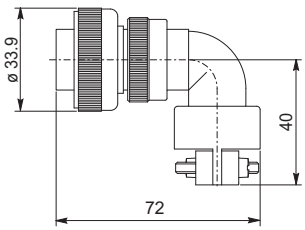


Dimensional drawing – mating connector

GG 106 10 pole, straight
(included in the scope of supply)



GW 106 10 pole, angled

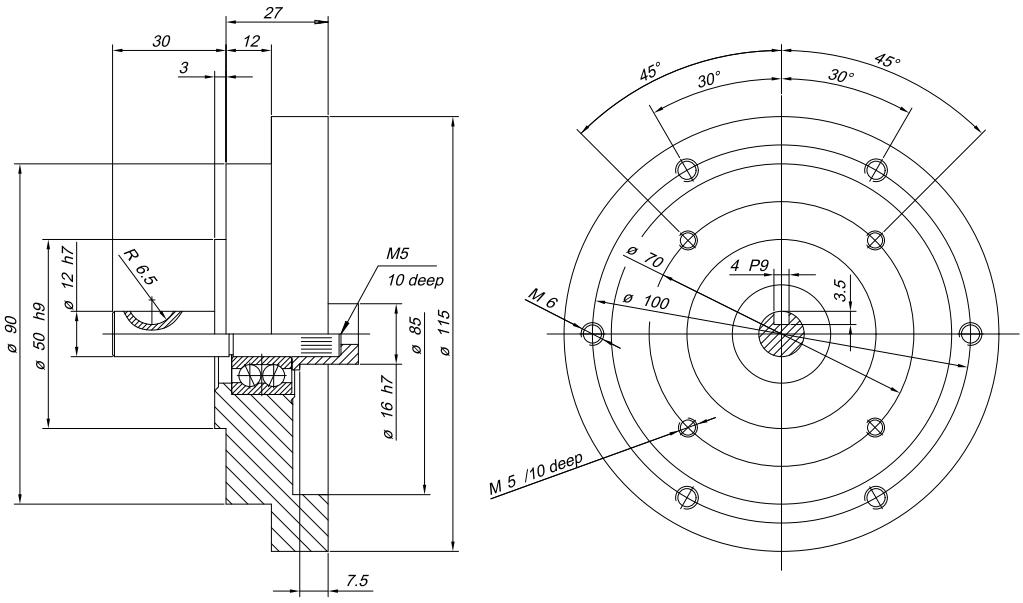


(1) Dimension A includes the minimum pre-load on the coupling of 1.5 mm with an axial shaft motion of 1 mm.

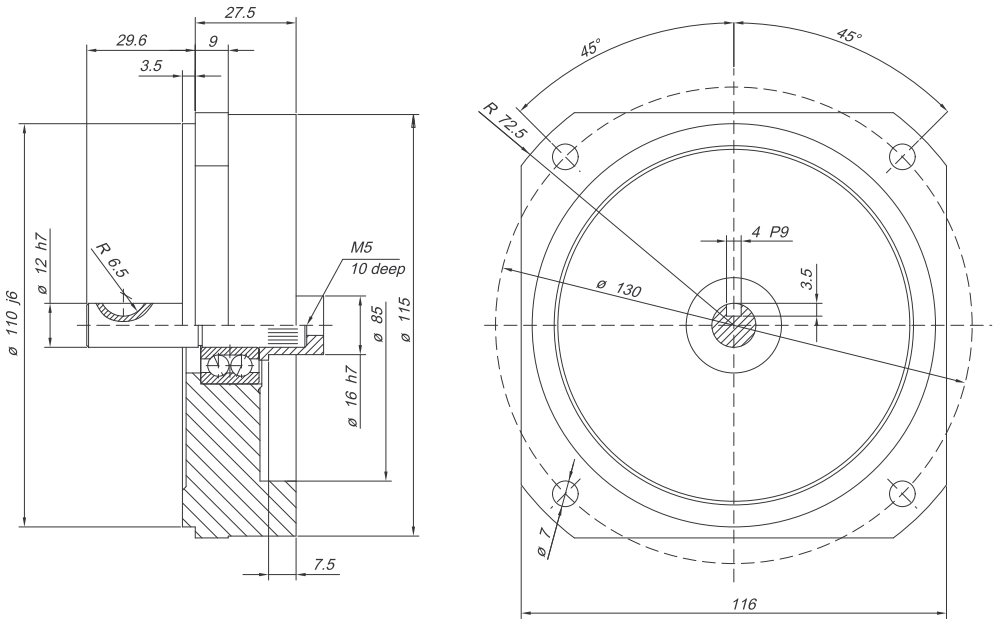
Dimensional drawings

Dimensional drawing – mounting accessories

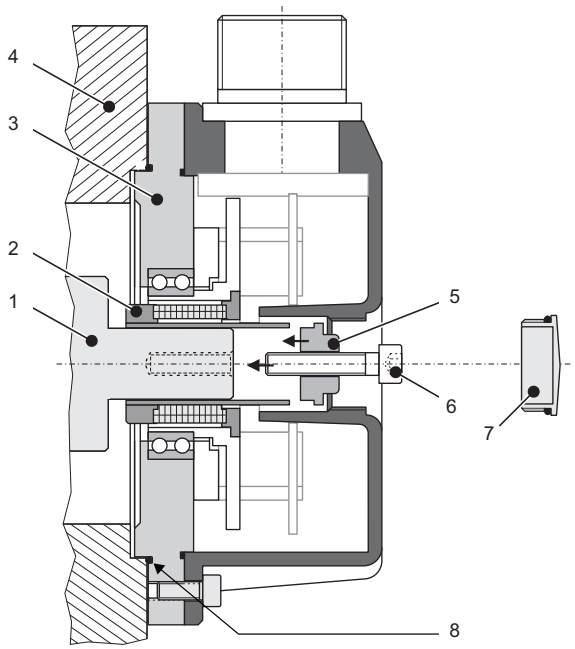
Mounting flange, round **BF 292**



Mounting flange, square **BR 292**



Mounting sketch – stepped drive shaft



1 Drive shaft(1)
connection shank 16 mm
2 Flexible hollow shaft coupling
3 Encoder flange
4 Mounting device with centring (85 ^{H7})
e.g. bearing cap, motor flange
5 Pressure plate DS 290
6 Set screw
7 Blind plug
8 Sealing ring

The mounting to other drive shafts is in principle possible.
When mounting with aid of pressure plate DS 290 the position of the zero signal is adjustable at the rear side.
Various mounting accessories such as shaft adapters and mounting flanges are available.
When mounting on shaft preload the coupling (see dimensional drawing of GEL 293).

(1) It is recommended to perform the drive shaft with a driver, fitting with the groove of the hollow shaft, in order to avoid slippage of the encoder shaft.

Type code

	Current output								
	– without								
	A -20 mA to + 20 mA								
	B 0 mA to + 20 mA								
	C +4 mA to + 20 mA								
		Signal pattern							
		S Output of constant pulses independent of the direction of rotation and a signal for counting direction (HTL)							
		V 2 square-wave signals shifted by 90° (HTL)							
		X 2 square-wave signals shifted by 90° and their inversed signals (HTL)							
		U 2 square-wave signals shifted by 90° and their inversed signals (TTL)							
		T 2 square-wave signals shifted by 90° and their inversed signals (TTL)							
			Reference signal						
			– without						
			N with reference signal						
				Pulse numbers per revolution					
				00000	**00040** … **266240**				
					Connector / cable outlet				
					L 10-pole connector, straight				
					I 10-core cable, radial (1 m standard cable length, specify other cable lengths when ordering)				
						Shaft design			
						0 Standard (16 mm hollow shaft)			
							Protection of electronics		
							0 no additional protection		
							1 moisture protection		
							2 vibration protection		
							3 moisture and vibration protection		
							4 moisture protection with condensate outlet		
							5 moisture and vibration protection with condensate outlet		
								Temperature range	
								1 0 °C to +70 °C	
								3 -20 °C to +85 °C	
293	_	_	_	_ _ _ _ _	_	_	_	_	

Customer-specific designs

Customer-specific modifications to mechanical and electrical features are in principle possible.

Accessories

Description	Item number
Pressure plate[1], 18 mm	DS 290
Mating connector [1], 1 1/8-18UNEF-2A thread, 10 pole, straight, IP 65	GG 106
Mating connector, 1 1/8-18UNEF-2A thread, 10 pole, angled, IP 65	GW 106
Mounting flange, round [2]	BF 292
Mounting flange, square [2]	BR 292
Bearing pedestal	LB 206.1
Measuring block for position measurement using toothed belt	MB 292
Intermediate flange, for mounting a bearing pedestal or measuring pedestal Shaft adapter, for intermediate flange ZF 206	ZF 206 WA 206
Measuring arm for mounting on the mounting flange BR 292, BF 292	MA 262
Measuring wheel with collet chuck SP 12, hard anodised, circumference 500 mm	MRM 500
Measuring wheel with collet chuck SP 12, rubberised, circumference 500 mm	MRG 500

[1] Included in the scope of supply
[2] Mounting with measuring ar MA 262 or measuring wheel MRG 500/MRM 500 possible.

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