THE COUPLING.

R+W®
A POPPE + POTTHOFF COMPANY

INDUSTRIAL COUPLINGS

Sizing and selection

Proper sizing of couplings is crucial to ensuring smooth and efficient power transmission. This involves taking the specific requirements and operating conditions of the application into account. Various factors such as torque, speed, temperature and shock loads must be considered when selecting the correct coupling type and size.

According to DIN 740 part 2

Legend guide book industrial couplings

T_{AR}	=	Disengagement torque of the coupling (Nm)
K	=	Service factor
T_{max}	=	Maximum torque of the drive system (Nm)
T_{AN}	=	Rated torque of the motor (Nm)
P_{Drive}	=	Drive power (kW)
n	=	Drive speed (min^{-1})
α	=	Angular acceleration (rad/s^2)
t	=	Acceleration time (s)
ω	=	Angular velocity (rad/s)
J_L	=	Moment of inertia of load (kgm^2)
J_A	=	Moment of inertia of drive (kgm^2)
T_{AS}	=	Peak motor torque (Nm)
S	=	Number of safety elements
F	=	Tangential force (kN)
r	=	Radius to element (m)
s	=	Spindle pitch (mm)
F_V	=	Feed force (N)
η	=	Spindle efficiency
d_0	=	Pitch diameter (mm)
C_T	=	Torsional stiffness of coupling (Nm/rad)
J_{Masch}	=	Total load inertia (kgm^2) (e.g. shaft + sprocket + chain + roller + 1/2 of coupling)
$J_{Mot.}$	=	Total driving inertia (kgm^2) (e.g. motor shaft + 1/2 of coupling)
f_e	=	Resonant frequency of the two mass system (Hz)
f_{er}	=	Exitation frequency of the drive (Hz)
T_{KN}	=	Rated torque of coupling (Nm)
T_{AS}	=	Peak torque (Nm) e.g. maximum acceleration peak torque or maximum braking torque from the load
φ	=	Angle of twist (degree)
S_A	=	Load factor
N	=	Length to flexture (mm)

Formulas

Shock / load factor S_A		
uniform load	non-uniform load	heavy shock load
1	2	3
For many crushing and shredding applications load factors are commonly S_A = 2-3		

According to disengagement torque

Safety couplings are normally selected according to the required disengagement torque, which must be greater than the maximum torque required for start-up and operation.

$$T_{AR} \geq K \cdot T_{max}\ (Nm)$$

or

$$T_{AN} \geq 9{,}550 \cdot \frac{P_{Drive}}{n}\ (Nm)$$

Disengagement torque values are often determined from the drive data and are typically a multiple of the nominal torque at the operating drive speed (TAN). In addition to a start-up torque (Tmax.), the following values are used as further safety factors, depending on the load conditions:

K = 1.3 uniform harmonious load
K = 1.5 non-uniform load
K = 1.8 heavy shock load

According to torque

1. Calculate the drive torque T_{AN}.

$$T_{AN} \geq 9{,}550 \cdot \frac{P_{Drive}}{n}\ (Nm)$$

2. Base the coupling rated torque T_{KN} on the drive torque T_{AN} multiplied by the application factors.

$$T_{KN} \geq T_{AN} \cdot S_A \cdot S_u \cdot S_Z$$

Couplings are normally sized for the highest torque to be regularly transmitted. The peak torque of the application should not exceed the rated torque of the coupling. The following calculation provides an approximation of the minimum required coupling size, and allows for the maximum rated speed and misalignment to exist in the application.

$$T_{KN} \geq 1.5 \cdot T_{AS}\ (Nm)$$

Formulas

According to acceleration (Start-up with no load)

$$T_{AR} \geq \alpha \cdot J_L \geq \frac{J_L}{J_A + J_L} \cdot T_{As} \cdot S_A \,(Nm)$$

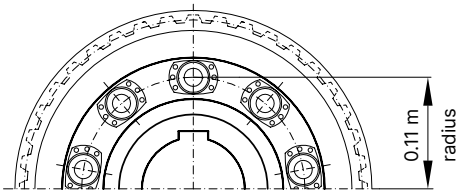
$$\alpha = \frac{\omega}{n} = \frac{\pi \cdot n}{t \cdot 30}$$

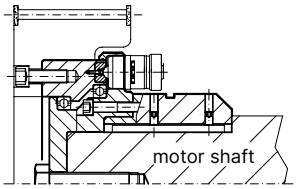
According to acceleration (Start-up with load)

$$T_{AR} \geq \alpha \cdot J_L + T_{AN} \geq \left[\frac{J_L}{J_A + J_L} \cdot (T_{AS} - T_{AN}) + T_{AN} \right] \cdot S_A \,(Nm)$$

According to the number of safety elements

$$T_{AR} = S \cdot F \cdot r$$





According to linear feed force

Srew drive

$$T_{AN} = \frac{s \cdot F_v}{2{,}000 \cdot \pi \cdot \eta} \quad (Nm)$$

Rack and pinion drive

$$T_{AN} = \frac{d_0 \cdot F_v}{2{,}000} \quad (Nm)$$

Formulas

According to resonant frequency

The torsional natural frequency of the coupling must be significantly higher or lower than that of the equipment. For the mechanical substitution model the two mass system applies.

$$f_e = \frac{1}{2 \cdot \pi} \sqrt{C_T \cdot \frac{J_{Masch} + J_{Mot}}{J_{Masch} \cdot J_{Mot}}} \quad (Hz)$$

According to accleration torque

A more detailed calculation takes acceleration and the driving and driven moments of inertia into account. A strong inertia ratio diminishes the effect of the load factor in the sizing calculation.

$$T_{KN} \geq T_{AS} \cdot S_A \cdot \frac{J_L}{J_A + J_L} \quad (Nm)$$

According to torsional deflection

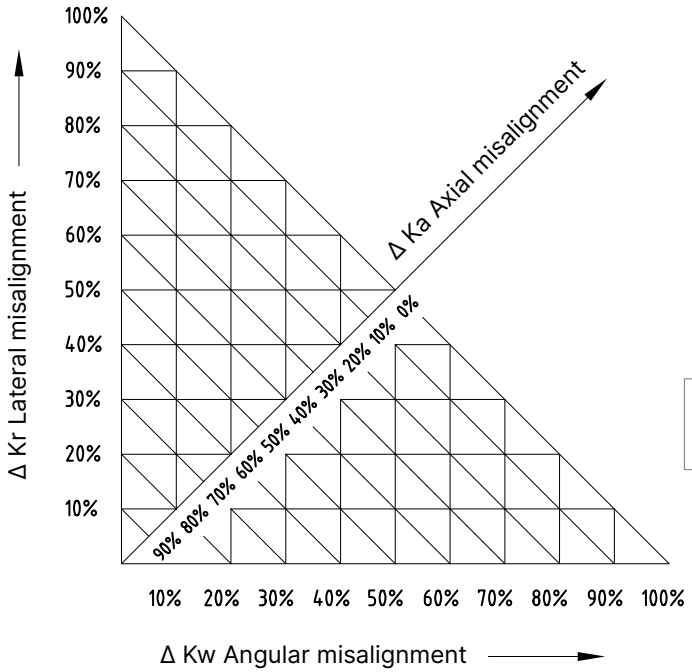
To calculate transmission error as a result of torsional stress:

$$\varphi = \frac{180}{\pi} \cdot \frac{T_{AS}}{C_T} \quad (degree)$$

Design disc pack couplings

Taking into account the friction drive principle of the R+W disc coupling design, torque is transfered without micro-movements or backlash.

Misalignment comensation



$$\Delta K_{total} = \Delta K_r + \Delta K_w + \Delta K_a \leq 100\%$$

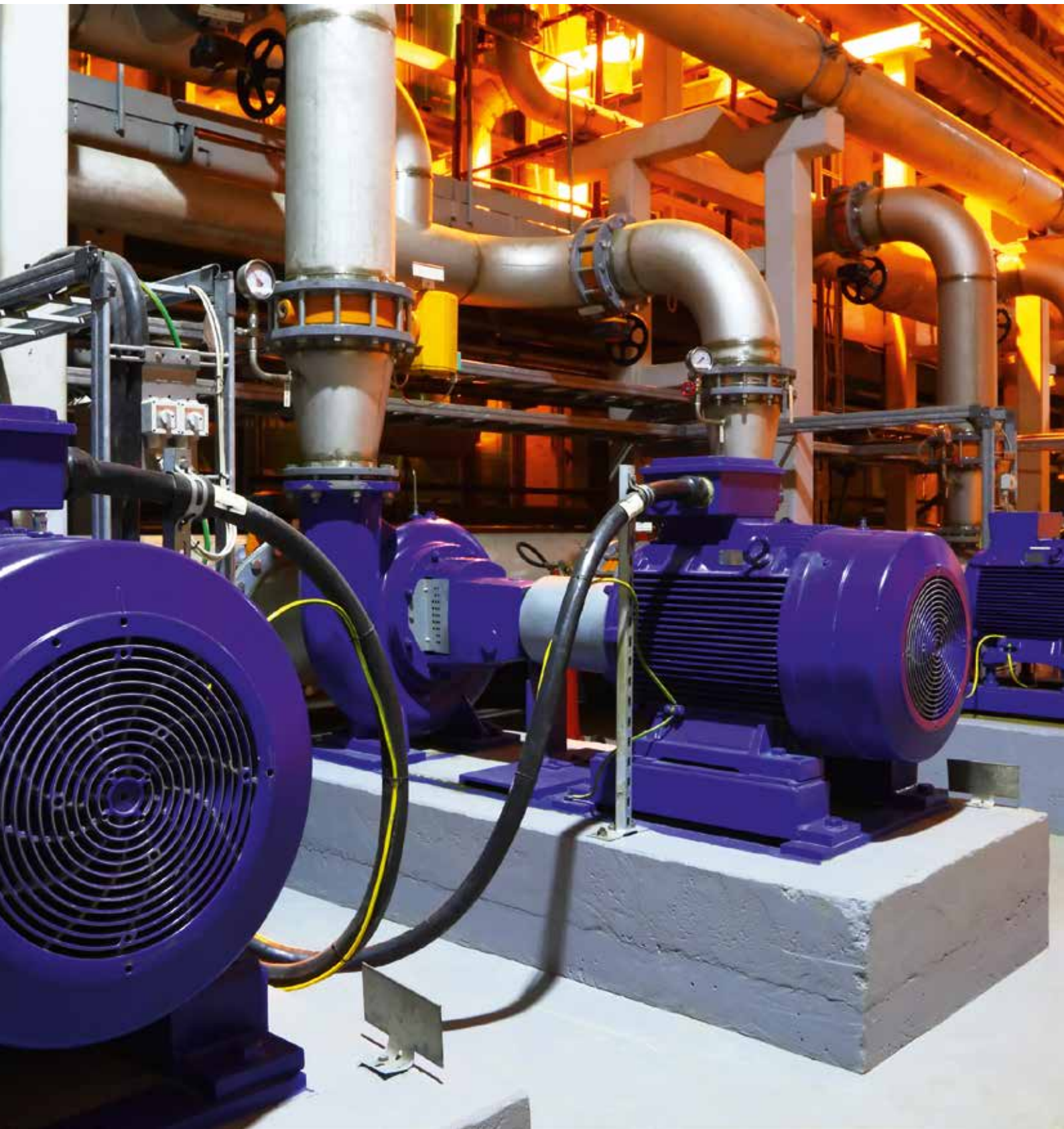
The maximum total misalignment of the disc coupling should not exceed 100% of the combined percentages of the maximum axial, angular and lateral values as shown in the product data tables.

Example: pump skid

axial misalignment:	20%
lateral misalignment:	40%
angular misalignment:	40%

$$\Delta K_{total} = 20\% + 40\% + 40\% \leq 100\%$$

» coupling is fatigue resistant



BZ

Crowned gear couplings

1,900 – 2,080,000 Nm

Areas of application
+ Mixers
+ Rolling mills
+ Conveyors
+ Crushers
+ Shredders
+ Levelers
+ Wherever high torque and low cost meet

Fit clearance
Overall shaft / hub clearance of 0.01 - 0.05 mm

Temperature range
-30 to +100° C; higher temperatures on request

Ordering Example	BZ1	50	60	50	XX
Model	●				Special designation only (e.g. special bore tolerance).
Size		●			
Bore Ø D1 H7			●		
Bore Ø D1 H7				●	

For custom features place an XX at the end of the part number and describe the special requirements (e.g. BZ1 / 50 / 60 / 50 / XX)

BZ

Crowned **gear couplings**
1,900 – 2,080,000 Nm

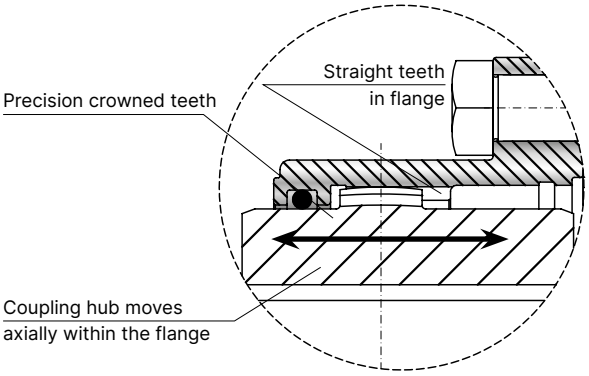
Model		Features	Page
BZ1		**With keyway mounting or cylindrical bore for interference fit** 1,900 – 2,080,000 Nm • High power density • Very low backlash • Economically priced • Low maintenance due to special crowned tooth design	62-63
BZA		**With keyway mounting or cylindrical bore for interference fit** 1,900 – 2,080,000 Nm • For spanning larger shaft distances • High power density • Very low backlash • Low maintenance due to special crowned tooth design	64-65

Crowned gear couplings

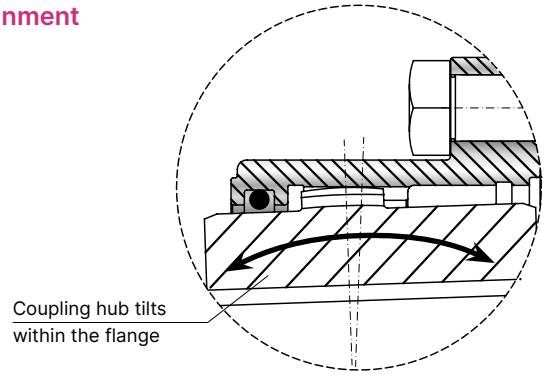
Function of the gear coupling

The precise integration of the coupling hub and intermediate flange allow for low backlash and highly rigid torque transmission, while compensating for lateral, axial and angular shaft misalignment. The crowned geometry of the gearing allows for a long life, even without the presence of misalignment.

Axial misalignment



Angular and lateral misalignment



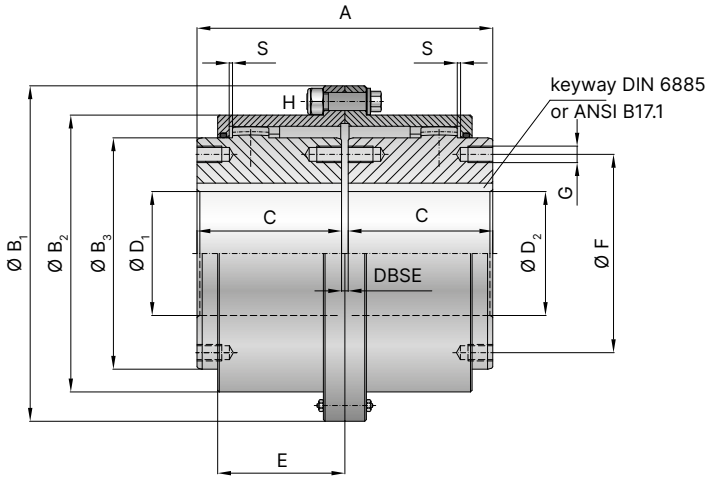
BZ1

With keyway mounting

Features
- High power density
- Very low backlash
- Economically priced
- Low maintenance due to special
- Crowned tooth design

Material
- **Coupling:** high strength steel

Design
Hubs with keyway mounting or high precision cylindrical bore for interference fitting. Optional DIN 916 set screw for locking down onto shaft key.



Size 450 and up with axial threads in hubs.

Model BZ1 | Size 10–2,000

Size			10	25	50	100	150	200	300	450	600	800	1,500	2,000
Rated torque	(kNm)	T_{KN}	1.9	2.9	5.7	9	14.5	22	34	45	70	85	150	200
Max. torque	(kNm)	T_{Kmax}	4.2	6.8	14	21.5	35	54	83	110	170	205	360	480
Installed length	(mm)	A	89	103	127	157	185	216	246	278	308	358	388	450
Outside diameter	(mm)	B_1	111	142	168	200	225	265	300	330	370	406	438	505
Flange diameter	(mm)	B_2	82.5	104.6	130.5	158.4	183.4	211.5	245.5	275.5	307	335	367	423
Hub diameter	(mm)	B_3	68	86	105	132	151	179	209.5	234	255	280	306	356
Hub fit length	(mm)	C	43	50	62	76	90	105	120	135	150	175	190	220
Max bore diameter H7 with 1 / 2 keyways*	(mm)	$D_{1/2}$	48 / 52	62 / 62	72 / 78	90 / 98	105 / 112	122 / 132	144 / 156	160 / 174	175 / 190	192 / 210	210 / 233	245 / 280
Bore diameters from Ø to Ø H7 with interference fit	(mm)	$D_{1/2}$	12-52	18-62	30-78	32-98	42-112	45-132	50-156	60-174	70-190	90-210	110-233	120-280
Distance between shaft ends	(mm)	DBSE	3	3	3	5	5	6	8	8	8	8	8	10
Hub length	(mm)	E	39	46	59	78.5	92.5	108	123	139	154	179	194	225
Hole circle diameter	(mm)	ØF	61	73	91	115	132	154	180	204	220	240	268	316
Thread size		G	M5	M6	M8	M10	M12	M12	M16	M16	M20	M20	M24	M24
Bolt		H	M8	M10	M10	M12	M12	M16	M16	M16	M18	M22	M22	M24
Tightening torque	(Nm)		18	36	36	65	65	150	150	150	220	400	400	520
Moment of inertia at Dmax	(10^{-3}kgm^2)		3.9	11.6	28.7	70.6	135.3	326.7	605.6	1,021	1,745.5	2,963	4,147.2	7,982
Weight at Dmax	(Kg)		2.5	4.8	8.4	14.2	21.4	36.0	51.5	71	99	144	165	234.5
Max. speed	(1/min)		6,000	4,550	4,000	3,900	3,700	3,550	3,000	2,750	2,420	2,270	1,950	1,730
Axial misalignment	(mm)	S	1.5	1.5	1.5	2.5	2.5	3	4	4	4	4	4	5
Angular misalignment	(degree)		2×0.35	2×0.35	2×0.35	2×0.35	2×0.35	2×0.35	2×0.35	2×0.35	2×0.35	2×0.35	2×0.35	2×0.35

* Larger maximum bore possible with 2 keyways, due to increased stress distribution versus wall thickness.

BZ1

With keyway mounting

Features

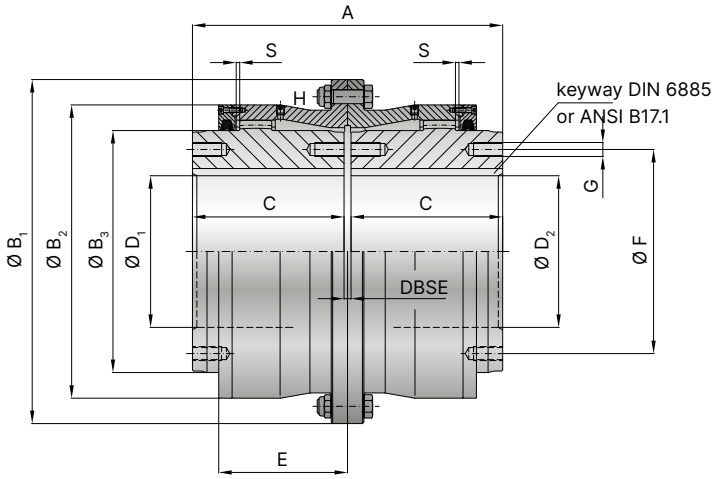
- High power density
- Very low backlash
- Economically priced
- Low maintenance due to special
- Crowned tooth design

Material

- **Coupling:** high strength steel

Design

Hubs with keyway mounting or high precision cylindrical bore for interference fitting. Optional DIN 916 set screw for locking down onto shaft key. Size 450 and up with axial threads in hubs.



Model BZ1 | Size 3,000 – 10,000

Size			3,000	4,000	5,000	7,000	8,000	10,000
Rated torque	(kNm)	T_{KN}	290	402	518	693	882	1,040
Max. torque	(kNm)	T_{Kmax}	580	804	1,036	1,386	1,764	2,080
Installed length	(mm)	A	532	592	652	712	772	820
Outside diameter	(mm)	B_1	590	639	702	769	834	894
Flange diameter	(mm)	B_2	503	553	597	657	722	763
Hub diameter	(mm)	B_3	415	464	490	545	620	660
Hub fit length	(mm)	C	260	290	320	350	380	400
Bore diameter H7		$D_{1/2}$	160-325	180-370	200-400	200-430	230-475	250-510
Bore diameters from Ø to Ø H7 with interference fit	(mm)	$D_{1/2}$	160-325	180-370	200-400	200-430	230-475	250-510
Distance between shaft ends	(mm)	DBSE	12	12	12	12	12	20
Hub length	(mm)	E	221	245.5	262	280	292	315
Hole circle diameter	(mm)	ØF	350	400	430	490	560	580
Thread size		G	M24	M24	M30	M30	M24	M36
Bolt		H	M24	M24	M30	M30	M30	M36
Tightening torque	(Nm)		670	670	1,250	1,250	1,250	2,170
Moment of inertia at Dmax	(10^{-3}kgm²)		18,781	28,323	44,986	71,329	113,616	150,801
Weight at Dmax	(Kg)		406	503	670	904	1,201	1,403
Max. speed	(1/min)		1,100	990	890	785	700	645
Axial misalignment	(1/min)	S	6	6	6	6	6	10
Angular misalignment	(degree)		2×0.35	2×0.35	2×0.35	2×0.35	2×0.35	2×0.35

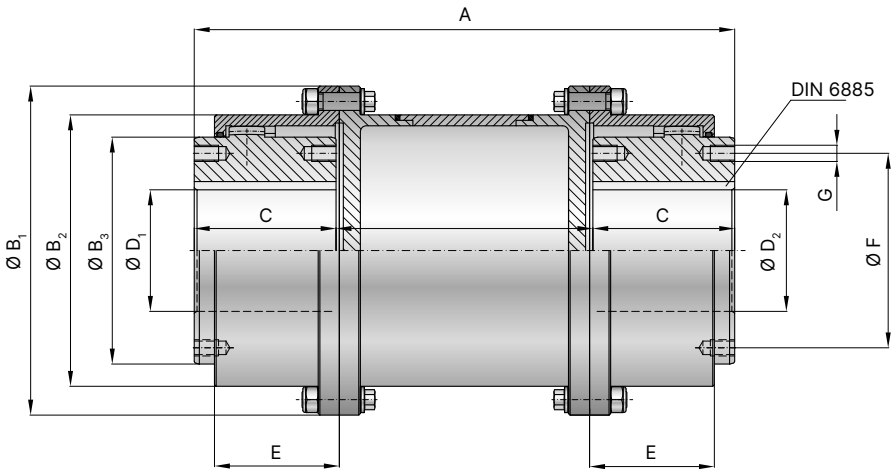
BZA

With keyway mounting

Features
- For spanning larger shaft distances
- High power density
- Very low backlash
- Low maintenance due to special crowned
- Tooth design

Material
- **Coupling:** high strength steel

Design
Hub with keyway connection or cylindrical
bore for shink disc. Optional set screw for keyway DIN 916.
Customer specified intermediate length also available.



Model BZA | Size 10–2,000

Size			10	25	50	100	150	200	300	450	600	800	1,500	2,000
Rated torque	(kNm)	T_{KN}	1.9	2.9	5.7	9	14.5	22	34	45	70	85	150	200
Max. torque	(kNm)	T_{Kmax}	4.2	6.8	14	21.5	35	54	83	110	170	205	360	480
Installed length	(mm)	A	89	103	127	157	185	216	246	278	308	358	388	450
Outside diameter	(mm)	B_1	111	142	168	200	225	265	300	330	370	406	438	505
Flange diameter	(mm)	B_2	82.5	104.6	130.5	158.4	183.4	211.5	245.5	275.5	307	335	367	423
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Thread size		G	M5	M6	M8	M10	M12	M12	M16	M16	M20	M20	M24	M24
Bolt		H	M8	M10	M10	M12	M12	M16	M16	M16	M18	M22	M22	M24
Tightening torque	(Nm)		18	36	36	65	65	150	150	150	220	400	400	520
Axial misalignment	(mm)	S	1.5	1.5	1.5	2.5	2.5	3	4	4	4	4	4	5
Angular misalignment	(degree)		2×0.35	2×0.35	2×0.35	2×0.35	2×0.35	2×0.35	2×0.35	2×0.35	2×0.35	2×0.35	2× 0.35	2× 0.35

* Larger maximum bore possible with 2 keyways, due to increased stress distribution versus wall thickness.

BZA

With keyway mounting

290,000 – 2,080,000 Nm

Features

- For spanning larger shaft distances
- High power density
- Very low backlash
- Low maintenance due to special crowned
- Tooth design

Material

- **Coupling:** high strength steel

Design

Hub with keyway connection or cylindrical
bore for shink disc. Optional set screw for keyway DIN 916.
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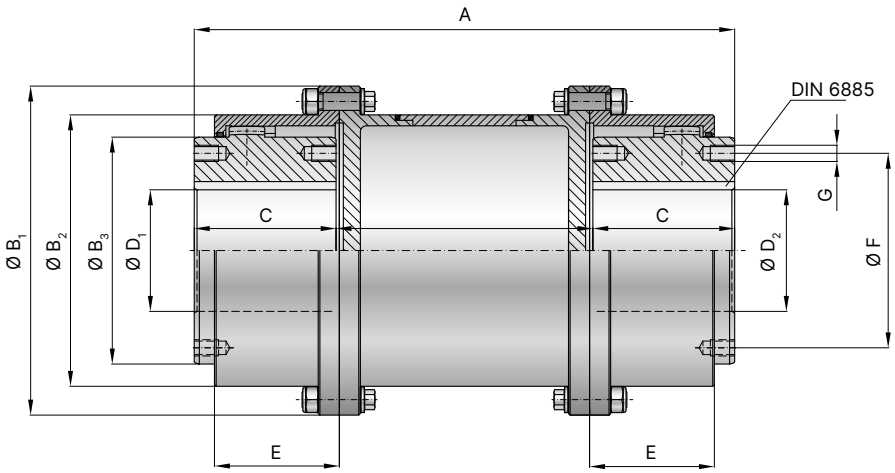

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Thread size		G	M24	M24	M30	M30	M24	M36
Bolt		H	M24	M24	M30	M30	M30	M36
Tightening torque	(Nm)		670	670	1,250	1,250	1,250	2,170
Axial misalignment	(mm)	S	6	6	6	6	6	10
Angular misalignment	(degree)		2×0.35	2×0.35	2×0.35	2×0.35	2×0.35	2×0.35

Notes