Metal bellows couplings

Product information / Design

Typical characteristics of metal bellows couplings

- Backlash-free transmission of torque
- High torsional stiffness, precision of transmission of rotational angle
- Different torsional stiffness
- Backlash-free shaft connection
- Small dimensions, low moment of inertia
- Compensation for radial, axial, and angular misalignment
- Free of wear, maintenance-free, no standstill period
- Not sensitive to temperatures between -30 °C and +100 °C, higher temperature ranges available on demand
- Simple and operationally safe assembly
- Economical and user-friendly due to modular system
- Nominal moments between 0.4 - 5000 Nm

Backlash-free, torsionally stiff metal bellows couplings are ready to install when delivered. The metal bellows are made of anti-corrosive steel, all other parts are manufactured from aluminum or steel and partly have an environmental friendly protective coating.

As a standard, the boreholes are equipped with a fitting in accordance with ISO-H7. For the shafts, we recommend an transition, e.g. H7/g6. When selecting other shaft fitting, the fitting should not exceed a maximum of 0.03 mm.

The power transmission between the coupling hub and the shaft occurs through compression and friction between the contact surfaces. Special attention must be paid to the tightening torque of the retaining screws as well as the perfect condition of the contact surfaces.

The contact surfaces must be free of oil and grease. Types with a keyway are available. The torques indicated in the lists of Technical Data can only be safely transferred if these points are complied with. Otherwise it would be necessary to make compromises.

The dimensioning in accordance with the torque

Metal bellows couplings are generally designed according to the nominal torque stated in the lists of the Technical Data below. The nominal torque must always be higher than the regularly transferred torque. This generally applies to the use of servo motors, whose acceleration moment in positive and negative directions is much higher than the nominal moment.

The use of metal bellows couplings which are put in controlled, high dynamic drives, the following dimensioning values have proven to be reliable in practice:

K = 1,5	for evenly shaped movements
K = 2	for unevenly shaped movements
K = 2,5 – 4	for jerky movements

For Servo drives within tool making machines, the values for K of 1.5 - 2 should be used.

In general, the following relationships apply:

$$T_{KN} \geq K \times T_{AS} \times \frac{J_{Mach}}{J_{Mot} + J_{Mach}} = [Nm]$$

Design

Design with consideration for dynamic torsional stiffness.

Although metal bellows couplings are backlash-free and torsion-rigid, it should not be overlocked that they link two rotating masses. In disadvantageous cases like torsion springs the couplings can effect a high stiffness. The hunting of the drives and the harmonic oscillation in the armature current of the motor, e.g. thyristor industrial drives with low pulse number must therefore never be within the range of the mechanical resonance frequency.

$$f_{res} = \frac{1}{2\pi}\sqrt{C_{T\,dyn} \times \frac{J_{Mot} + J_{Mach}}{J_{Mot} \times J_{Mach}}} = [Hz]$$

In practice the resonance frequency "f_{res}" must be twice as large as the excitation frequency of the drive.

For most normal drives, e.g. NC-machine tool, this will be between 150 and 350 Hz.

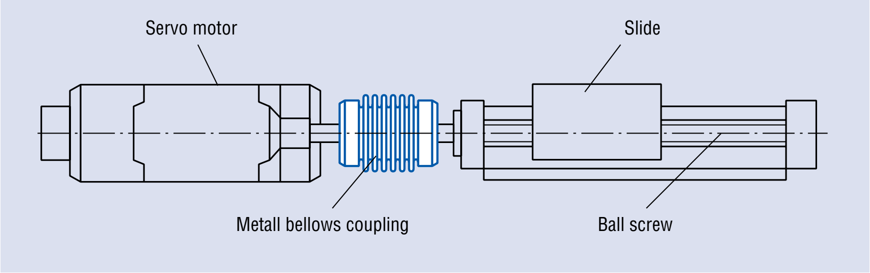
In the development of metal bellows couplings this factor was given special consideration. The dynamic torsional stiffness $C_{T\,dyn}$ was selected so that it would not be within the range of clearance diameter from most applications. Various levels of torsional stiffness are available as standard versions.

We would be pleased to design your metal bellows couplings for you. Feel free to use our experience and know-how for your success.

Speak to us.

Sample calculation

Application of a metal bellows coupling in a machine tool drive



Drive related data

Servo motor 1 FT 5104

Maximum torque T_{AS} = 160 Nm
Moment of inertia
$J_{Mot} = 18.3 \times 10^{-3}$ kgm²

Output-data

Machine tool

Moment of inertia of ball screw and slide $J_{Mach} = 17 \times 10^{-3}$ kgm²

The low moment of inertia of the metal bellows coupling is disregarded. K = Load factor, impulse factor selected for this drive K = 2

Design according to torque:

$$T_{KN} \geq K \times T_{AS} \times \frac{J_{Mach}}{J_{Mot} + J_{Mach}} = 2 \times 160\ Nm \times \frac{17 \times 10^{-3}\ Kgm^2}{(18{,}3 + 17) \times 10^{-3}\ Kgm^2} = 154\ Nm$$

Coupling selection: AKD 200, T_{KN} = 200 Nm, $C_{T\,dyn} = 116 \times 10^3$ Nm/rad.

The metal bellows coupling is sufficiently dimensioned, since 200 Nm ≥ 154 Nm.

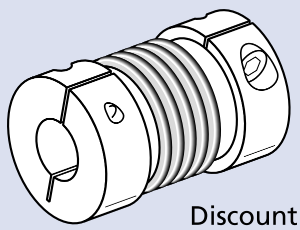
Design according to resonance frequency:

$$f_{res} = \frac{1}{2\pi} \times \sqrt{C_{T\,dyn} \times \frac{J_{Mot} + J_{Mach}}{J_{Mot} \times J_{Mach}}} = \frac{1}{2\pi} \times \sqrt{116000\ Nm/rad \times \frac{0{,}0183 + 0{,}017\ Kgm^2}{0{,}0183 \times 0{,}017\ Kgm^2}} = 578\ Hz$$

The arithmetic calculation is clearly much higher than the expected resonance frequency.

Summary of type series

Series DK – miniature



Discountinued model

To connect two shafts, backlash-free shaft-hub connection using collet clamps. For torques between 0.10 – 10 Nm.

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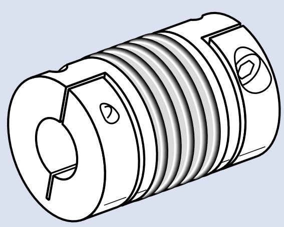
Technical data and dimensions

Series DKN – miniature



To connect two shafts, backlash-free shaft-hub connection using collet clamps. For torques between 0.40 – 10 Nm.

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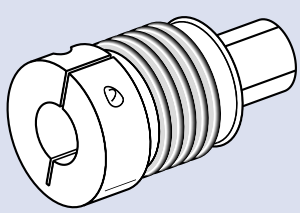
Technical data and dimensions

Series DK/S – miniature



To connect two shafts, backlash-free shaft-hub connection using a collet clamp and an expanding clamp.
For torques between 0.40 – 10 Nm.

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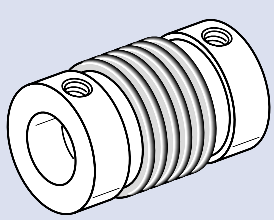
Technical data and dimensions

Series EK – miniature



To connect two shafts, backlash-free shaft-hub connection using set screws.
For torques between 0.10 – 10 Nm.

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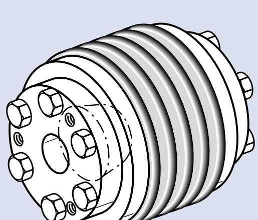
Technical data and dimensions

Series AK



Inner conical hub

To connect two shafts, backlash-free shaft-hub connection using conical hubs. For torques between 30 – 5000 Nm.

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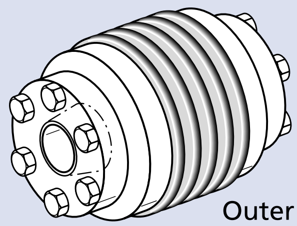
Technical data and dimensions

Summary of type series

Series AK/SB

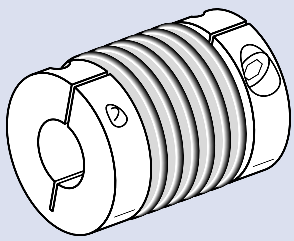


Outer conical hub

To connect two shafts, backlash free shaft-hub connection using outer conical hubs, contracting disc, no releasing screw required, release during dismantling. For torques between 18 – 5000 Nm.

Technical data and dimensions **Page 13**

Series AKD



To connect two shafts, backlash free shaft-hub connection using collet clamps. For torques between 18 – 500 Nm.

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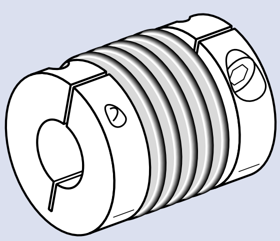
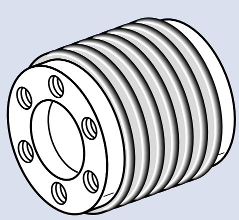
Series AKN



Same as Series AKD but with shorter length and higher torsional stiffness. For torques between 18 – 500 Nm.

Technical data and dimensions **Page 15**

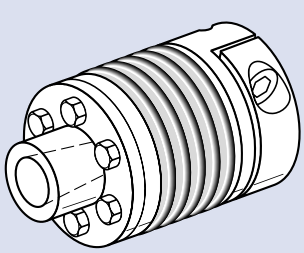
Series CK



Variable installation element for mounting of hubs, flanged shafts, flanges, etc. For torques between 18 – 5000 Nm.

Technical data and dimensions **Page 16**

Series AKD-Fanuc



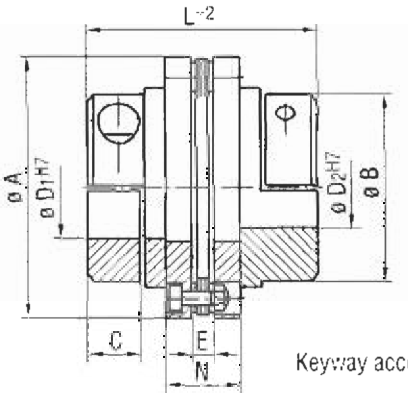
Appropriate coupling for Fanuc AC motors. Shorter installation models available. For torques between 18 – 60 Nm.

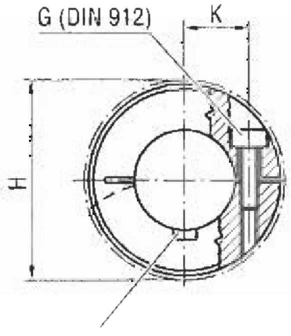
Technical data and dimensions **Page 17**

User-friendly solutions **Page 18**

Flexible disc couplings

Series FSD with clamping hub





Keyway according to DIN 6885[1] on demand

Ordering data

FSD 150 — 30^{H7} — 35^{H7} — XX

- FSD 150: Type
- 30^{H7}: Bore diameter D_1
- 35^{H7}: Bore diameter D_2
- XX: Further details, e.g. special material, keyway 3)

Technical Data – Series FSD

Available from Peter GmbH (see address on the back page)

TYPE	18	30	60	80	150	200	300	500
Nominal moment (Nm) T_{KN}	18	30	60	80	150	200	300	500
Torsional stiffness (10^3 Nm/rad) $C_{T\,dyn}$	5	12	48	48	85	85	160	339
Axial force during max. axial misalignment (N) F_a	76	98	116	116	166	166	232	586
Moment of inertia (10^{-3} Kgm²) J	0.1	0.2/0.25	0.5/0.6	2/3.2	2.7/4	4/5.5	7/8	18
Tightening torque for retaining screws (Nm) M_A	6/6	15/12	40/30	60/50	80/50	100/80	110/90	145
Weight (ca. kg) m	0.25	0.4/0.5	0.7/0.8	2.6/3.3	3/3.5	4/4.5	5/5.2	8
Allowed axial misalignment (mm) ΔK_a	0.3	0.4	0.7	0.7	0.8	0.8	0.9	1.2
Allowed angular misalignment (degree) ΔK_w	1	1	1	1	1	1	1	1
Max. rotating speed at V = 30 m/s (rpm) n_{max}	11250	8430	7165	7165	6050	6050	5120	4100

Dimensions (mm) – Series FSD

Available from Peter GmbH (see address on the back page)

TYPE	18	30	60	80	150	200	300	500
$L^{\pm2}$	63	79	82.5	91.5	94	102	103	114
Ø A	50	68	80	80	95	95	110	140
Ø B	45	47/56	57/66	68/84	68/84	80/90	90/96	110
Ø D_1^{H7} / Ø D_2^{H7} 2) - min. - max.	10/20 20/25	10/20 20/25	14/23 23/35	20/28 28/40	20/28 28/40	25/32 32/42	32/40 40/45	40 60
E	8	9	6.5	6.5	7.5	7.5	6.2	7.4
N	24	30	24.5	24.5	25.5	25.5	26	30
C	11	15	19.5	21.5	21.5	25.5	26	28
G	M5	M6	M8	M10	M10	M12	M12	M12
K	17.5	16/20	20/24	24/28	24/28	26/31	32/35	40
H (clearance diameter)	48	56	70	84	84	93	102	108

Hubs 18 to 60 made of aluminum, Hubs 80 to 500 made of steel, other materials available on request.

1) Tolerance of keyway: Standard JS9.

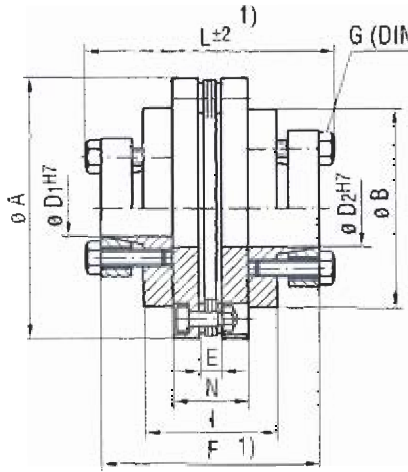
2) Smaller ø possible for lower torque of transmission.

3) Stainless steel version also available.

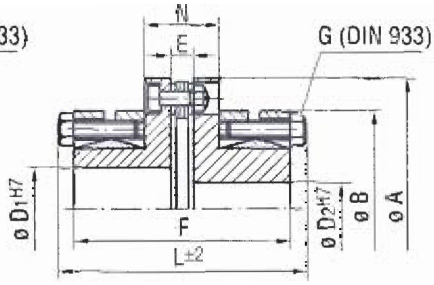
Flexible disc couplings

Series FSS with outer conical hub – self-loosening while dismantling

Type 18-300



Type 500-5000



Ordering data

FSS 150 — 30H7 — 35H7 — XX

- Type
- Bore diameter D1
- Bore diameter D2
- Further details, e.g. special material 2)

Technical Data – Series FSS

Available from Peter GmbH (see address on the back page)

TYPE			18	30	60	150	200	300	500	800	1400	3000	5000
Nominal moment	(Nm)	T_{KN}	18	30	60	150	200	300	500	800	1400	3000	5000
Torsional stiffness	(10^3 Nm/rad)	$C_{T\,dyn}$	5	12	48	85	85	160	339	570	877	2459	3450
Axial force during max. axial misalignment	(N)	F_a	76	98	116	166	166	232	586	1236	1768	2498	4140
Moment of inertia	(10^{-3} Kgm^2)	J	0.15	0.3	0.9	1.8	3.1	7.5	12	35.5	37	67	195
Tightening torque of retaining screws	(Nm)	M_A	5.9	5.9	8.7	15	15	25	12	30	30	30	59
Weight	(Kg)	m	0.5	0.7	1.4	2.0	3	4.5	5.7	10	11	20	33
Allowed axial misalignment	(mm)	ΔK_a	0.3	0.4	0.7	0.8	0.8	0.9	1.2	1.3	1.5	1.9	2.1
Allowed angular misalignment	(degree)	ΔK_w	1	1	1	1	1	1	1	1	1	1	1
Max. rotating speed at V = 30 m/s	(rpm)	n_{max}	11250	8430	7165	6050	6050	5210	4100	3900	3310	2550	2300

Dimensions (mm) – Series FSS

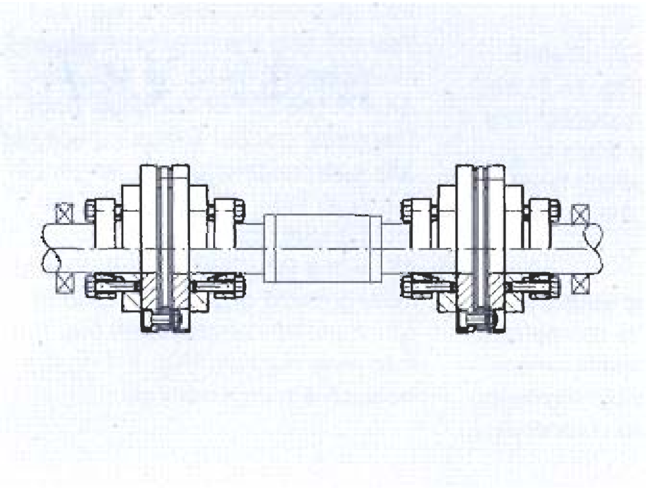
Available from Peter GmbH (see address on the back page)

TYPE	18	30	60	150	200	300	500	800	1400	3000	5000
L±2	65	74	83.5	100	100	108	101	109	115	139	167
Ø A	50	68	80	95	95	110	140	147	170	220	250
Ø B	45	52	65	80	85	110	115	145	145	155	185
Ø D_1^{H7} / Ø D_2^{H7} - min.	9	12	15	20	20	25	35	50	50	55	60
- max.	15	20	32	35	42	50	55	70	70	75	85
E	8	9	6.5	7.5	7.5	6.3	7.6	7.5	9	11.8	11.8
N	24	30	24.5	25.5	25.5	26	32	33.5	39	50	54
F	58	67	76.5	91.5	91.5	97	93	98.5	104	128	154
I	38	45	40.5	51.5	51.5	53	–	–	–	–	–
G	4 x M5	6 x M5	6 x M5	6 x M6	6 x M6	6 x M8	10 x M6	7 x M8	7 x M8	10 x M8	9 x M10

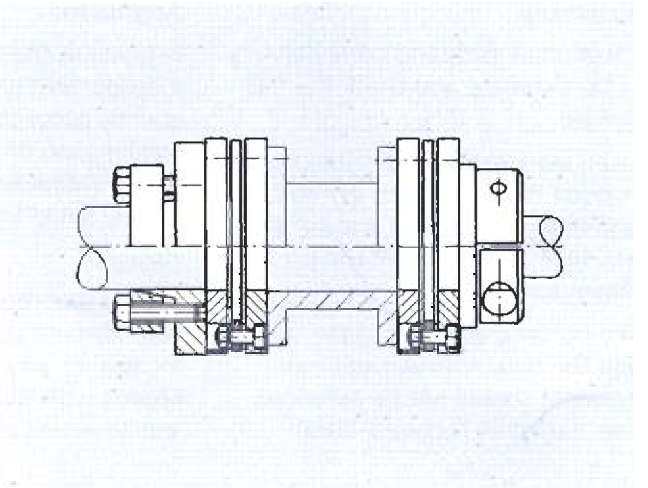
1) Keep space for releasing the retaining screws. 2) Stainless steel version also available.

Flexible disc couplings

Example applications

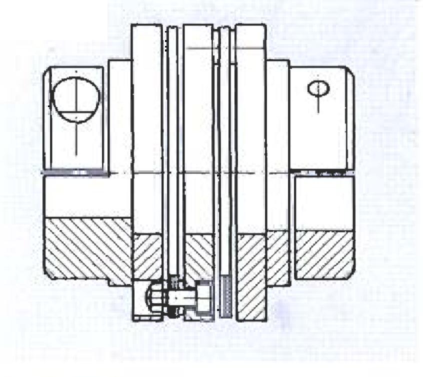


Series FSS
With outer conical hub, used in printing and packaging machines.

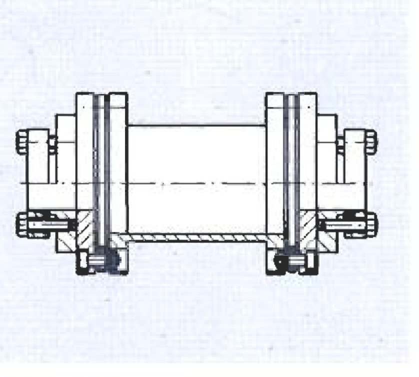


Series FSS/FSD
With inner flange, used in testing equipment.

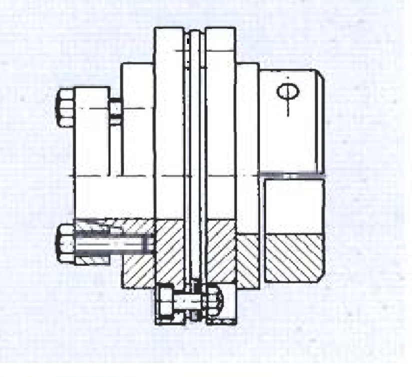
Modular design series



Series FSD
Short version with two-sided collet clamps.
Radial flexibility due to two flexible elements.



Series FSS
With outer conical hub and inner flange; for linking larger shaft gaps.



Series FSS/FSD
With outer conical hub and collet clamp.
Simple connection between two shafts.

Flexible disc couplings

Assembly instructions

Assembly

Clean shaft ends and boreholes in hubs, degrease and check the tolerances.

Insert both shafts trunks into the hubs of the flexible disc coupling, and firmly tighten the screws, after examining the axial installation dimensions.

The tightening torque of the screws and the maximum allowed misalignment should not be exceeded (see the list of Technical Data).

Alignment

In practice, the three illustrated misalignment types (Fig. 12.1) frequently occur simultaneously. The combination of these leads to a total misalignment, which must be compensated for by the coupling.

Caution!

Flexible disc couplings with a flexible element can only compensate for axial or angular misalignment. Models with two flexible elements and an inner case also compensate for radial misalignments (Fig. 12.1). You will find the maximum allowed misalignment values for ΔK_a and ΔK_w in the lists of Technical Data. The radial compensation capacity of ΔK_r is dependent on the length of the inner case. The following formula is used to calculate this: $\Delta K_r = b \times \tan 1° = [mm]$. If an axial misalignment exists, then ΔK_w or ΔK_r must be compensated for. The following diagram (Fig. 11) illustrates such a compensation.

Figure 11: Compensating for misalignment

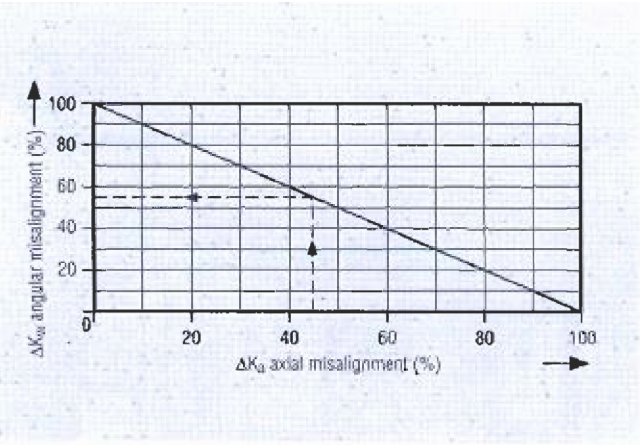


Figure 12: Flexible disc coupling

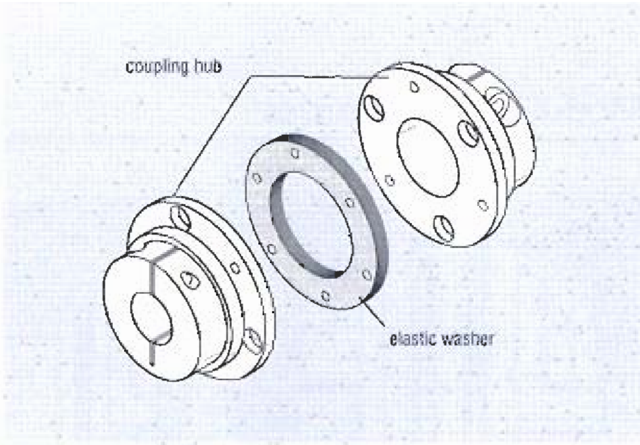
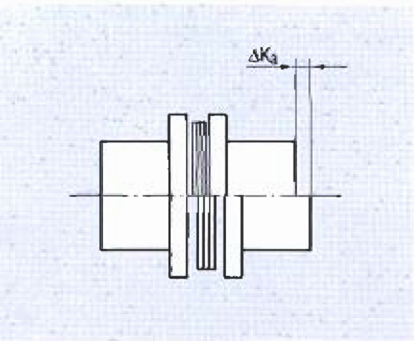
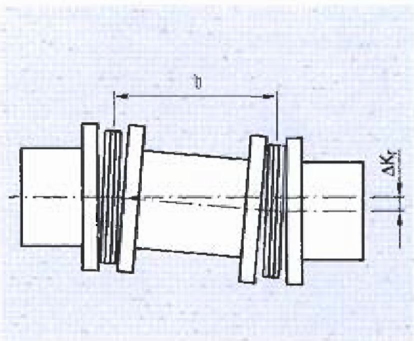


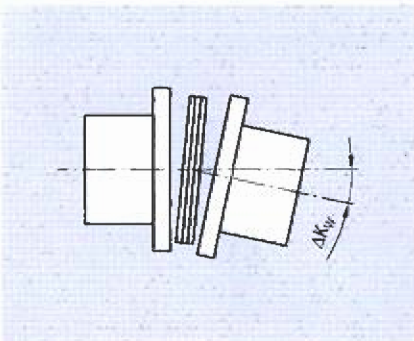
Figure 12.1: Types of misalignment



axial



radial



angular

Flexible disc couplings

Assembly instructions

Assembly

The installed flexible disc coupling must now be aligned.

The more precise the alignment, the more reserves are available to handle additional misalignments during operation. This will have an advantageous effect on the service life, balance quality, and the precision of transmission.

Dismantling

After releasing the backlash-free shaft-hub connections, the drive can be pulled apart and the flexible disc coupling can be removed.

Conical bushings for series AK are forced off with a hexagonal socket screw.

Please ask for our detailed assembly instructions.

Calculating the existing axial force Fa = [N]

We have indicated the maximum allowed values for ΔKa and ΔKw in the lists of Technical Data. We have summarized these values once again in the following table and have also plotted the coordinates as a curve on the graph.

The individual diagrams are illustrated in the graph. You can use this to define the corresponding axial force Fa for each axial misalignment ΔKa.

Example:

Flexible disc coupling, Size 500

max. ΔK_a = 1.2 mm
max. F_a = 586 N

Existing axial misalignment:

ΔK_a = 0,6 mm ≙ 50 %
F_a = 27 % of F_a max.
F_a = 158 N

Size	max. axial misalignment K_a (mm)	max. axial stiffness F_a (N)	Curve
18	0,3	76	A
30	0,4	98	A
60	0,7	116	A
80	0,7	116	A
150	0,8	166	B
200	0,8	166	B
300	0,9	232	B
500	1,2	586	B
800	1,3	1236	B
1400	1,5	1768	C
3000	1,9	2498	D
5000	2,1	4140	B

Table: Coupling characteristic values ΔK_a + F_a

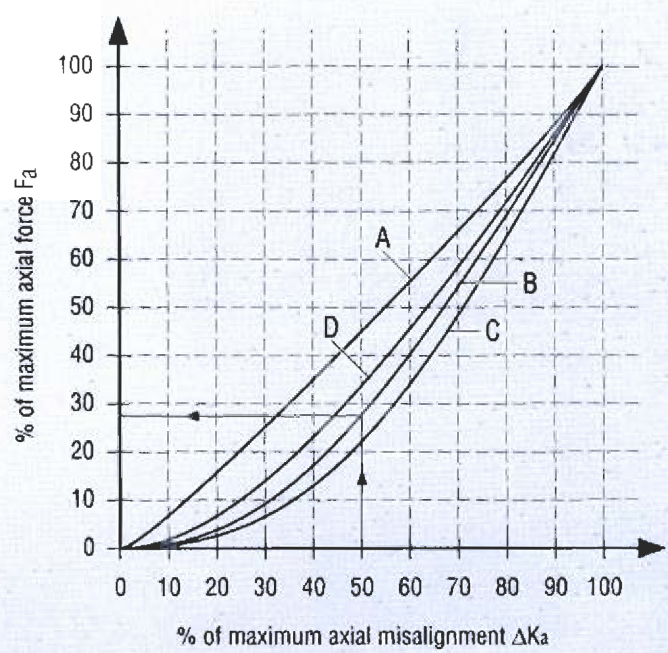


Diagram: dependent on characteristic values