Servo Couplings I General

Definition - Servo Couplings:

Servo couplings are compensating couplings with a backlash free and conformal torque transfer providing high torsional stiffness and a low moment of inertia.
According to these requirements, JAKOB metal bellows couplings can be regarded as the ideal solution. For more than 40 years, they have proven themselves in numerous servo drives as an excellent choice. Elastomer couplings with a flexible polyurethane spider can also represent a perfect alternative for different applications because of their product-specific advantages.

All JAKOB servo couplings are backlash-free and flexible to allow for compensation of shaft misalignments. Because of the unique characteristics of the different series, the designer will most likely find the best solution within the large-scale JAKOB coupling program. The area of application ranges from highly dynamic feed drives of the axes in machine tools to high performance drives in machine tool design.

Characteristics - JAKOB Servo Couplings:

- absolutely backlash-free, precise torque transfer
- low moment of inertia / high balancing quality
- excellent operational characteristics / high speed
- compensation of shaft misalignments / low restoring forces
- frictional, easy-to-fit shaft-hub-connection
- metal bellows: max. torsional stiffness, wear-free, up to 350°C
- elastomer spider: plug-in, oscillation dampening, up to 120°C
- compact dimensions, flexible areas of applications
- large number of types and sizes available (modular system)
- precise production / best quality / long life

The JAKOB Modular System:

As flexible compensating parts, stainless steel bellows are used in different forms as well as polyurethane spiders with different shore hardnesses, oldham-type spacer as polyacetal and stainless steel membrane hubs. Another important aspect is the kind of connection between the drive shafts or the primary shafts and the coupling hubs. Several versions of backlash-free frictional clamping hubs or conical hubs are available.

In this catalog, the most important and widely used series of compensating elements and kinds of hubs, derived from the numerous possibilities of combinations, are described. A well-contrived modular system, which provides multiple uses for many parts, enables production in cost-effective batch sizes and very short delivery periods.

The JAKOB coupling program is devided into the following four main groups:

- metal bellows couplings
- elastomer couplings
- miniature couplings
- distance couplings

For decades, the center of the JAKOB coupling program has been a large variety of different metal bellows couplings.

Safety Couplings I General

Definition – Safety Couplings:

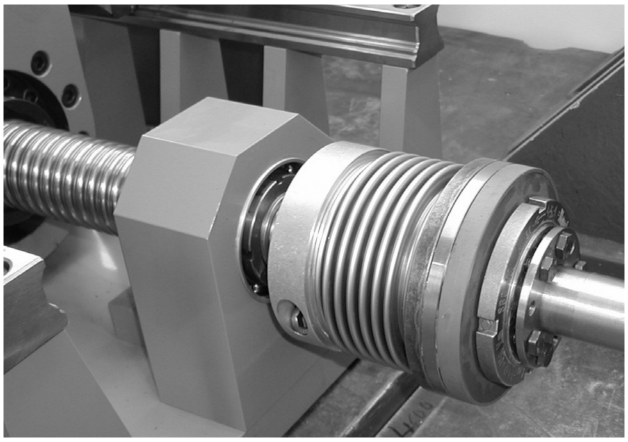
Due to the constantly increasing automation and dynamics of modern work processes, the devices which protect the complex and expensive units against damages in case of errors are becoming more important. JAKOB safety couplings reduce expensive machine damages, repairs and downtime by acting as torque limiters and overload protection absolutely reliably. JAKOB safety couplings are the life insurance for your machines, no matter whether the error occurs due to incorrect operation, programming error, material overload or tool breakage.

JAKOB safety couplings are the result of decades of continuous research and development as well as the experience gained from numerous different applications worldwide.
Unique design aspects, high-quality materials, precision machining of the individual components are some of the factors which make JAKOB couplings some of the leading couplings today. The safety couplings are used in all areas of the machine tool industry, ranging from critical servo drive applications to overload protection in conveyor systems.

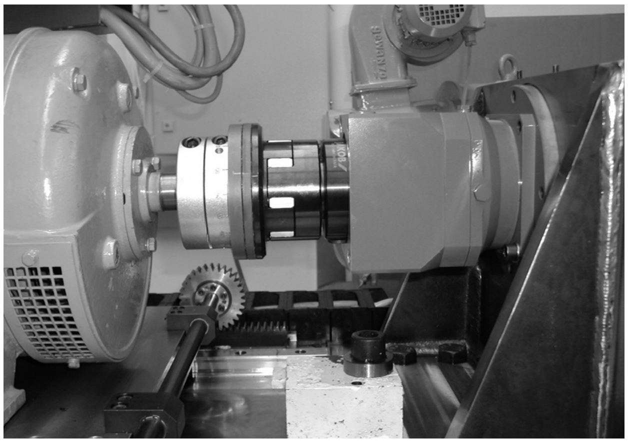
Performance Characteristics – JAKOB Safety Couplings:

- optimal overload and crash protection
- backlash-free, precise torque transfer
- stepless disengagement torque adjustment
- fixed point reengagement (360° synchronised position)
- automatic reengaging (optional feature)
- degressive spring characteristic / precise disengagement function
- excellent dynamic functional characteristics
- low moments of inertia / high-speed
- large selection of types (modular system)
- integral fitting of pulleys or gear wheels
- stop-signal (emergency stop) by use of a proximity switch

Application examples:



Collision protection of a drive spindle with safety coupling series SKB-K with bellows attachment



Safety coupling series SKB-E with elastomer attachment for overload protection of a planetary gearbox

Couplings I Dimensioning

Technical Information - Definitions / Details:

Nominal torque of the coupling: T_N - [Nm]
The nominal torque of the coupling defines the max. load of the prolonged alternating-stress strength. If in normal operation, T_N is not exceeded, an infinite number of operation cycles can be carried out (see d „durability“).

Moment of inertia: J_K - [10^{-3}kgm^2]
The values for the moment of inertia are defined for medium hub-bores in the given diameter range Dmin/Dmax. Conversion: [kgcm^2] = [10^{-4}kgm^2]

Torsional stiffness: C_{TK} - [Nm/arc min]
The values for the specific torsional stiffness of all couplings are converted from the existing values [103 Nm/rad] to “Newton meter per angular minute”. This enables the constructor to determine the torsion angle failure quite easily (see b below) under consideration of the operating torque. 60 angular minutes (resp. arc minutes) correspond to one angular degree. This defines the conversion factor 1 rad = 57,3° = 3438 arcmin.

Conversion: [103Nm/rad = 0,291 Nm/arcmin] resp. [1Nm/arcmin = 3438 Nm/rad=3,44 kNm/rad]
Example: Size KM 170: 17,5 Nm/arcmin= 60 kNm/rad

Max. misalignment of shafts: [mm]
The maximum misalignment of shafts is the largest allowed misalignment between drive and output shaft, which results from the calculation of the prolonged alternating-stress strength for compensating elements. If the allowed misalignment values are not exceeded, an infinite number of load alternations can be carried out. In exceptional cases (e.g. during fixing) particularly at reduced numbers of load alternations, the misalignment values may be considerably higher (please contact for further consultation).

- **axial misalignment:** usually without problems (expansion due to temperature)
- **angular misalignment:** usually without problems - allowed max. value: 1 to 2 degrees
- **lateral or parallel misalignment:** If the admissible values are considerably exceeded, permanent distortion at the bellows and higher wear of the elastomer spider can occur. Special care must be taken during fitting!

Spring stiffness - axial / lateral: [N/mm]
Restoring forces of metal bellows or elastomer spiders, caused by shaft misalignments.

Dimensioning of the coupling

a) according to torque:

Usually, the size of the coupling is chosen according to the required torque. For exact determination of the necessary drive torque, difficult calculations are neccessary (see formularies). If the size of the motor is fixed, the necessary nominal torque of the coupling T_{KN} can be calculated as follows:

$$T_N > 1,25 \cdot T_A \max \cdot i$$

T_A max = peak torque of the motor
i = transmission / reduction of the toothed belt drive or the spur-toothed wheel

b) according to torsional stiffness:

For applications with very precise requirements (position control, transmitter), transfer errors due to high elastic deformation can be an important criterion for selection of the coupling. The torsional angle “αT” is calculated as follows:

$$\alpha T = \frac{T_A}{C_{TK}}$$

[arc minutes] with T_A= drive torque [Nm] C_{TK}= torsional stiffness of the coupling [Nm/arcmin]

Very seldomly, metal bellows couplings may have resonance sounds (e.g. a whistling or a humming), when coupling types with a higher torsional stiffness or vibration reducing elastomer couplings are recommended.

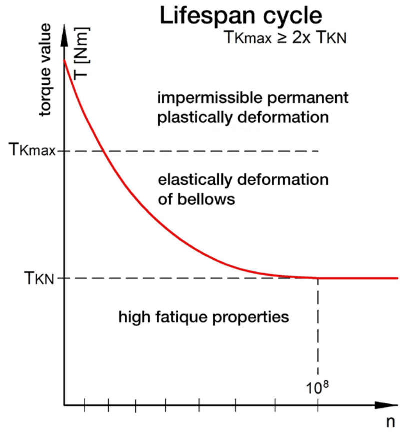
c) according to shaft diameter:

After selecting the coupling type, it must be checked whether the requested shaft diameter corresponds with the allowed diameter (Dmin / Dmax) of the hub bores. Another coupling type or size must be chosen, if the shaft diameter is overdimensioned in relation to the torque, which means it is larger than Dmax of the hub.

note: hub bores which are smaller than “Dmin” are possible, but an optimal transfer of the nominal torque cannot be guaranteed in this case, so a reduction of the drive torque is necessary.

d) durability:

The durability of JAKOB compensating couplings is basically determined by the peak torque and the existing shaft misalignment. If the admissible maximum values for the axial, lateral and angular misalignment are not exceeded and the operating torque is below the nominal torque T_{KN}, then the coupling is within the range of fatigue limit. An infinite number of start-stop-cycles or accelerations and decelerations can be carried out without having to expect a breakdown of the coupling during operation.

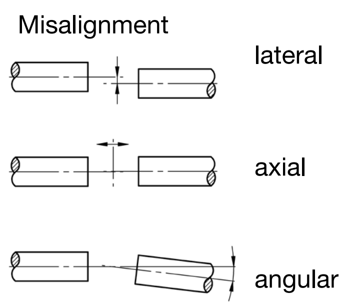


e) max. load:

In special cases, couplings can be overloaded for a short time with twice the nominal torque (2 x T_{KN}). This applies unless otherwise stated on the data sheet for the respective series. The shaft-hub-connection, however, must then be calculated seperately.

f) bearing load:

Due to the flexibility of the compensating couplings in all directions, considerable bearing loads are prevented, in spite of possible axial, lateral or angular misalignment from drive to output shaft. Therefore, an early breakdown or higher wear of the rolling bearing can be prevented. This means less difficult and expensive repairs.



g) operating temperatures:

Metal bellows couplings are, as whole metal couplings, extremely insensitive to temperature. Series with aluminum clamping hubs can be used without restriction from -40 ° C to + 150 ° C, short-term up to + 200 ° C. For models with welded steel or stainless steel hubs, the application temperature is a maximum of 350 ° C. The temperature limits of the elastomer spider are at 90°C (98 Sh-A) and 120°C (72 Sh-D).

h) speeds:

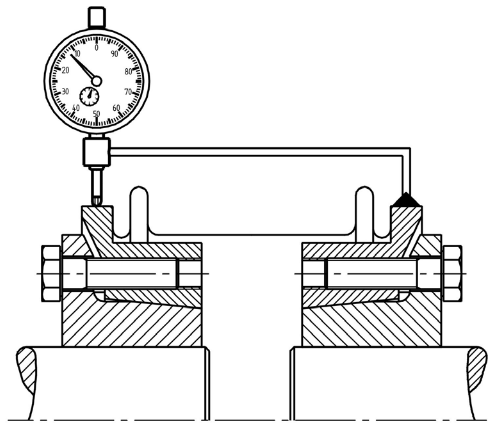
Due to precision machining, the rotation symmetry, and the additional balance pin, the compensating couplings are generally suitable for high speeds up to 20,000 min-1 even without additional balancing. The standard balancing quality is approx. Q6.3 to Q16. Couplings with conical hubs or hubs with tapered ring can be operated with speeds of over 25,000 min-1 (please contact us for further information). The low moment of inertia also has a positive effect.

i) maintenance and wear:

Compensating couplings are maintenance and wear free under normal conditions. The polyurethane spiders of the elastomer couplings should be changed in suitable periods, if critical operation parameters are given.

Alignment of shafts:

Axial and angle misalignment are usually without problems and also simple to measure. To obtain the lateral misalignment, it is recommended to proceed as follows: Fit a dial gauge with an appropriate holding device on one shaft end or on one hub of the coupling and bring the feeler onto the second shaft end or onto the second coupling half (sketch). Now the shafts are turned with the dial gauge and the deflection is read. One half of the total deflection is the lateral misalignment. The admissible value for the shaft misalignments must be taken from the technical data sheets of the appropriate series.



Shaft-hub connection

The couplings are generally supplied with finished bores, in exceptional cases they are also supplied prebored. The seat shaft / hub is to be selected as a transitional seat (example: hub bore diameter 28 G6 - shaft diameter 28 k6). Prior to mounting, the finished bore shaft end conical sleeve should be oiled to prevent fretting corrosion. The coupling is then ready for assembly between the two shafts. An existing keyway in the shaft will not affect the frictional connection.

a) lateral clamping hub

Admissible seat clearance shaft hub: **min. 0,01mm / max. 0,04mm**. Very simple fitting by tightening only one laterally arranged clamping screw (DIN 912). The value for the relevant tightening torques can be found in the data sheets. One hole in the housing is sufficient to tighten the clamping screw (see EASY-clamp sytem).

b) conical hub / conical ring hub

Admissible seat clearance shaft-hub: **max. 0,02 mm.** Assembly of the conical bush or of the conical clamping ring with several, concentrically arranged mounting screws (as a rule 6x DIN 933). One side of the coupling is fit onto the shaft end by evenly tightening the screws crosswise (to prevent uneven draw-on). The drive or output is now turned by a few revolutions, so that the shaft pinion turns in the second hub and the hub can move on the shaft for axial release. Now the six screws of the second hub are also evenly tightened.

c) split-hub

Admissible seat clearance shaft-hub: **min. 0,01mm / max. 0,04mm.** Two lateral clamping screws (DIN 912) are arranged oppositely. The hubs or couplings are split and consist of two loose halves. One of the split-hubs can be put onto the aligned shaft. Tighten clamping screws evenly, alternating between both sides (note specified tightening torques). A larger opening must be provided in the housing for easy installation.

d) disassembly

After releasing the six retaining screws, the hubs are released with three push-off threads each. In axially tight space conditions, it is advisable to screw in and secure the push-off-screws before fitting. For disassembly an opening in the housing should be provided. Disassembly of lateral clamping hub: see EASY-clamp System page 7!

e) special notes

- As the metal bellows consist of thin stainless steel sheeting, special care during fitting and disassembly is necessary. Damages to the bellows can render the coupling useless
- **hub bores which are smaller than “Dmin”** are possible, but an optimal transfer of the nominal torque cannot be guaranteed in this case
- at smaller shaft diameters, the conical hub (larger section thickness) is slotted additionally
- you will find further type specific technical details and characteristics in the data sheets