

Items to Consider when Choosing Shaft Misalignment Couplings:

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Rotating shaft-driven mechanical components are ubiquitous in all forms of machinery that perform the various processes and functions of the modern world. In designing these systems, engineers idealize perfect alignment of shafts and rotating components, but out in the real world, building a machine in which adjacent shaft ends align perfectly is near impossible. Shaft ends can be radially or angularly misaligned, exhibit axial displacement or experience a combination of all three.

Misalignment will place stresses on shafts and related parts of the assembly such as bearings, which can result in early failure of both and potential costly repair. Including couplings which compensate for misalignment is part of the design process and in some cases intentional shaft misalignment will be part of the design. In selecting shaft misalignment couplings when designing a system, there are essential points to consider in choosing the correct coupling for the application.

Careful consideration of these points is key to choosing a coupling that is mechanically as well as economically correct. While Computer Aided Design and Finite Element Analysis software packages have improved the design process of individual components and assemblies, a sound knowledge of the different characteristics of components that perform a seemingly similar

function is critical. This is especially true in choosing misalignment couplings, where there is a large variety of configurations and materials available that will perform the same basic function.

The following represents a guideline that will help identify the correct coupling for a particular application. Depending on the nature of your project, other considerations may affect the choice.

1. RPM The first of these points is: at what rotational speed will the coupling operate? Knowing the shaft RPM will narrow down the choice of coupling that will be viable in the application. Higher rpm will dictate a different choice than a low operating rpm. Choose from among Servo-Beam™, Bellows, Step-Beam™, Multibeam, Membrane or Jaw style for higher rpm, or Universal Joint or Oldham style for lower rpm usage.

In high speed applications balancing of the coupling must be considered. Some coupling styles can be supplied dynamically balanced, but jaw couplings will provide the highest rpm in unbalanced form as well as torsional damping. In very dynamic systems consideration of the resonant frequency of the couplings is required. RPM, acceleration, torsional stiffness, and other system characteristics combine to form the resonant frequency of the system and will determine

whether a particular coupling choice is correct.

2. Torque Transmitted torque is the next consideration in the selection process, and will enable selection by size of a particular style of coupling. For this requirement, you must consider Peak Torque, which is generally at startup, Operating Torque at steady state operation and Reversing or Braking Torque, which can match or exceed peak startup torque under certain conditions.

Applications that transmit power at high rates of acceleration, or rapidly change direction exhibit the latter characteristic and will require special attention to Service Factor adjustments, in which there is a reduction in rated torque transmission capacity resulting from a demanding motion profile. In this type of application, system inertia is high, and maximum torque and therefore coupling selection will be defined by whether the braking is applied by the motor or the load.

3. Backlash Will the coupling be used in a reversing and/or motion control application, in which accurate positioning is essential? In this case, low or zero backlash couplings must be selected in order to provide the necessary precision. Backlash is the angular measure of the compliance of a coupling system, resulting from the torsional properties of the components, combined with any other mechanical clearance between individual pieces.

While no backlash is ultimately desirable, a less precise application or one with constant rotation will enable specification of a lower precision, lower cost unit. For accurate, highly repeatable positioning applications use Servo-Beam™, Bellows, Aluminum Step-Beam™, disc coupling or zero backlash universal joints. For non-critical

applications: Beam, Plastic Step-Beam™, Oldham, Jaw (Spider), Universal Joints or Double Loop couplings. Ondrives Oldhams are specified as backlash free to 100,000,000 cycles.

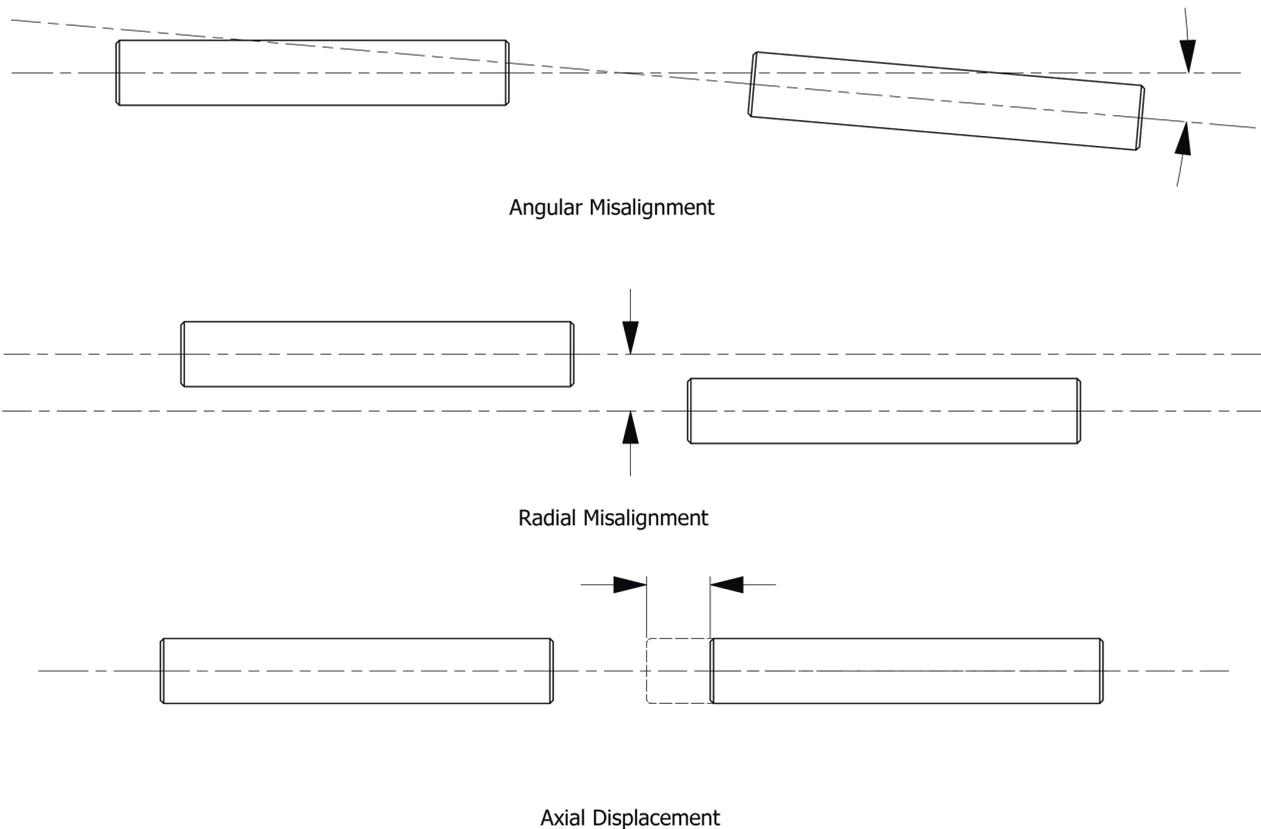
4. Misalignment This is the primary reason for designing a misalignment coupling into your system. Angular, radial or axial misalignment between shafts will almost certainly occur in an assembly and the expected magnitude of each type and how they combine to create larger total misalignment should be understood for each individual application. This will further narrow down the choice, as some couplings are more effective in one misalignment mode than any other.

Beam and Bellows offer good angular compliance and limited radial compensation, Servo-Beam™ style offer similar angular, radial as beam style while providing axial compensation similar to bellows couplings. Oldham style offer large radial compensation and less angular. High magnitude shaft misalignment or shaft movement compensation can be achieved by the use of telescoping double universal joints.

Other higher magnitude compensation can be handled with the use of 2 stage Bellows couplings connected by a shaft. In cases where the clearance between misaligned shaft ends is low, the use of through bored Oldham couplings will allow large radial compliance in a short distance as well as provide a small amount of angular and axial compensation.

Beam couplings with relieved bores or bellows couplings can also accommodate very short gaps between the coupled shaft ends. In the case of very close shaft ends, care must be made that the shafts will not make contact when there is high angular or axial misalignment.





5. Duty Cycle Is the system in constant, 24 hour use or in 8 hour shifts with start/stop cycles? One hundred percent duty cycles with rapid start/ stop or reversing needs will require a different coupling selection than a less demanding application. Pay careful attention to Service Factor needs when evaluating the duty cycle in very demanding applications. Failure due to material fatigue is a possibility under extreme conditions and must be prevented in applications where failure can result in injury.

6. Environmental Are there special environmental conditions, such as contact with acids or solvents? Proper selection of coupling material will eliminate concerns of destructive environments. A clean room environment eliminates the use of several coupling materials. If is it a food processing application with special material requirements, there are available selections that can be specified that meet food service industry requirements.

A great many industrial processes will expose various components to highly corrosive chemicals in the form of vapors or direct contact. Coupling materials can be chosen which can minimize or in some cases eliminate susceptibility to corrosive action. In a marine application with exposure to saltwater, a material can be selected that eliminates galvanic action. Some coupling styles are made of materials that break down quickly if there is exposure to ultraviolet light or other types of radiation.

In critical medical or industrial applications where this may be true, materials with a resistance to this type of environmental degradation must be chosen to ensure the integrity of the design and safety of operators and patients. Couplings in high vacuum environments like space or certain semiconductor manufacturing processes will need to be made of materials with low vapor pressures, ensuring their stability in such an application.

7. Temperature What temperature range will the coupling be exposed to? Temperature extremes will have an effect on choice of coupling style and material. Temperatures above the melting point of plastics would prohibit their use.

Applications in which the difference between operating temperature is much different from assembly temperature, consideration of expansion and contraction of the system will dictate the suitability of a particular coupling choice, depending on the anticipated type and magnitude of final operating misalignment.



8. Conductivity Is electrical or RF isolation desirable? If so, couplings with appropriate properties may be chosen from several styles which are manufactured largely of plastic. Examples are: Servo-Beam™, Jaw, Oldham, Molded Step-Beam™ and Double Loop couplings. It must be remembered that a high voltage isolation requirement may rule out the use of jaw style as a result of small clearance between the conductive tenons and its opposing hub, which could result in current “jumping the gap”. Elastomeric couplings also are able to provide electrical isolation since the center section is non-conductive.

Other highly technical industrial or medical applications may require the consideration of a coupling’s non-magnetic properties as well. Here again, appropriate

materials are available in several styles of couplings that will provide the necessary mechanical characteristics

9. Size constraint Clearance diameter; length; shaft to shaft clearance. After using all the above to choose a particular coupling, will the unit fit in the space available? If not, a custom unit may need to be designed. In the initial design stage, it is wise to evaluate the size of the possible coupling to be considered versus the space available, as these two parameters are frequently in conflict.

When choosing a coupling, inquire as to whether there is a CAD drawing or 3D model available to fit into your assembly so that conflict issues can be solved early in the design process. If space cannot be made to accommodate a standard coupling, most manufacturers will modify standard units to meet the requirement.

10. Fastening What is the distance between mountings and what are the bore sizes and mounting styles needed? Two very common methods for connecting shafts to couplings are clamp and set screw style hubs that are integral to the coupling. Most couplings are available in both of these fixing methods as a standard configuration; with the option of custom bore diameters available in almost all couplings. Some applications will require one or more custom machined ends.

High integrity drives which require no slippage, a possibility in clamp or set screw fastening, are provided by keys, splines or D-bores, which eliminate the possibility of slippage and are appropriate in very high precision motion control. Permanent installation is often achieved by pinning the coupling to the hub with a dowel through the shaft.

11. Safety and Maintenance

In machinery where there is direct operator interaction, injury protection is one more parameter of design. Shaft Couplings are manufactured that consist of Oldham Coupling/Clutch combinations which provide overload protection as well as misalignment compensation. This can reduce the risk of injury in the event of machine misuse or accident. Oldham couplings are also useful in a breakdown or jam up situation, where breakable discs can function as mechanical circuit breakers that will protect upstream components from overload damage. Oldhams are also useful in this regard since in the event of a jam up or breakdown event, the coupling disc can be replaced without moving adjacent components that may require costly disassembly and reassembly. Both Oldham style and "Finger" style afford easy disassembly due to their unconnected elements, facilitating scheduled maintenance.



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It is clear that in modern machine design, a coupling is not just a means of simply connecting rotating pieces of a driven system. Properly chosen couplings can enhance system performance, protect the investment in machinery by preventing damage to expensive components like gearboxes and motors and provide a safer working environment by preventing dangerous failures. This adds up to more economical operation and greater profitability over the life cycle of the machine.

When designing any complex mechanical system, knowledge of the individual components' range of characteristics and how to choose among them is often as great a challenge as designing the system itself. Coupling choice is one such situation due to the large variety of coupling styles and materials available. While designing your system your team should engage in the design process a knowledgeable manufacturer or supplier that offers expert advice in selecting a full range of couplings and who will suggest units based on comprehensive product knowledge and familiarity with related components such as gearboxes, clutches, motors and shafting.

As with any mechanical device, extensive testing in your application will determine which coupling will work best for all of your operating parameters.

Beam	Step-Beam™	Servo-Beam™	Jaw or Spider	Disc Coupling
				
<p>General purpose one-piece coupling. Options are single, 3 or 6 beam, with material options as stainless steel, aluminum.</p>	<p>Similar to Beam style but with a beam geometry that affords less backlash, no windup and greater flexibility. Material options include stainless steel, aluminum, and plastic.</p>	<p>Unique, low backlash, high performance, and high torque coupling. Optional plastic center section affords electrical isolation.</p>	<p>The most commonly specified coupling. Shock absorbing and fail-safe operation are among its attributes. Urethane spiders give electrical isolation and come in different durometers.</p>	<p>Very high precision coupling with excellent high RPM characteristics. Can be built up into one or two stage units with tailored kinematic properties.</p>
Bellows	Oldham	Oldham/Clutch	U-Joint	Metal U-Joint
				
<p>Precision coupling that gives compliance radially, angularly and axially. Each property can be tailored by varying bellows materials and dimensional characteristics.</p>	<p>Simple, robust general purpose 3 piece coupling. Excellent radial compensation with axial compliance as well. Commonly used in blind assemblies or as a mechanical “fuse” due to the breakable element.</p>	<p>Combines the alignment advantages of Oldham couplings with the torque control performance of a slip clutch. Useful where drag and overload protection are important.</p>	<p>Light duty u-joints are corrosion resistant and can be utilized with extended teleshafts. Use where steel u-joints would be underutilized or electrical isolation is necessary.</p>	<p>Instrument-quality U-Joints give extreme precision for applications requiring the utmost in performance, such as test and metrology equipment. Can be specified with a telescoping center section.</p>
Uni-Lat	Flex/K Coupling	Cardan Jaw	Elastomeric	Finger
				
<p>General purpose coupling that gives a high degree of radial and angular compliance. Generally used in lighter duty uses.</p>	<p>Highly flexible in all types of misalignment. Used primarily in light duty drives, pump and small generators.</p>	<p>Two stage jaw coupling that gives the smooth operation of cardans with the shock absorbing qualities of jaw</p>	<p>Shock absorbing, low backlash, general purpose coupling. Urethane center provides electrical isolation as well.</p>	<p>Two piece metal coupling with generous angular compliance. The engagement “fingers” facilitate disassembly</p>

Engineer's Guide to Misalignment Coupling Specification:

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Coupling Type:

Beam _____ Step-Beam™ _____ Bellows _____ Oldham _____ Oldham-Clutch _____ Uni-Lat _____
Elastomeric _____ U-Joint _____ Servo-Beam™ _____ Double Loop _____ Jaw _____ Cardan Jaw _____

- Rpm (Maximum) _____
- Torque (in-Lb. or N-m) _____
- Backlash (Degrees) _____
- Acceleration (rad/sec²) _____
- Start-Stop/ Reverse _____
- Misalignment Type and Amount: _____
 - a) Radial (in. or mm) _____
 - b) Angular (Degrees) _____
 - c) Axial (in. or mm) _____
- Torsional Stiffness (N-m/rad or in.-lb./rad) _____
- Overload Protection (in.-lb. or N-m.) _____
- Duty Cycle (min./hr.) _____
- Balanced (To: rpm) _____

Environment:

Temperature Range From _____ To _____ (Degrees C or F) Vacuum _____ (psi or Pa) Radiation _____
Electrical Isolation _____ Non-Magnetic _____ Corrosive _____ Other _____

Application:

Industrial _____ Manufacturing _____ Medical _____ FDA _____
Military _____ Aerospace _____ Naval/Marine _____ Clean Room _____

Dimensions:

Maximum Diameter _____ Maximum Length _____ Narrow Shaft End Clearance _____
Bore #1: Diameter _____ Clamp _____ Setscrew _____ Key _____ D-Bore _____ Pin _____
Bore #2: Diameter _____ Clamp _____ Setscrew _____ Key _____ D-Bore _____ Pin _____
Description of Application: _____

