# Cablecraft Linkage Technical/Application Data

Cablecraft Motion Control's (CMC) engineering staff possesses the expertise to provide advice and guidelines regarding nearly all motion transmission applications.

There are several factors pertaining to engineering application, including correct installation, that should be taken into consideration to insure optimum performance of your chosen linkage components.

1. When mounting ball studs, the hex mounting portion should be properly tightened and flat against its mating surface. Adequate countersinks, counterbores or washers may be necessary to provide a tight, flush joint. Installation torque values for tightening must be within the capacity of the linkage component or breakage may occur from over-tightening. Consult CMC's engineering staff or refer to an appropriate engineering standard for mounting nut torque values associated with each grade of threaded fastener. Looseness in the threaded joint or mounting surface may cause abnormal wear and early failure of the linkage component.

2. When mounting rod ends, care should be used in tightening a fastener against the ball to prevent distortion. The same torque requirements that apply to threaded fasteners also apply to securing the rod end spherical ball. The plated ball may become chipped or distorted by excessive clamping pressure, resulting in increased torque, wear, and premature failure of the rod end.

3. In applications involving vibration where loosening of the linkage components may occur, self-locking nuts or lockwashers should be used to secure the components and prevent loosening. Looseness in the threaded joint or mounting surface may cause abnormal wear and early failure of the linkage component.

4. Ball joints and rod end bearings should be mounted in such a way as to best utilize the design of the joint with respect to gravitational force. For example, a ball joint should be mounted with the housing member on top of the ball stud. Mounting the housing component with it's weight and linkage hanging from the ball or ball stud could accelerate wear and lead to detachment of linkage components and sudden loss of control.

5. It is recommended that a separate stop be incorporated in the linkage system to eliminate the possibility of exceeding the misalignment capability of the ball joint or rod end bearing. An overtravel condition of this type may result in breakage and detachment of the ball joint or rod end components and sudden loss of control.

6. CMC ball joints and rod end bearings are manufactured to commercial standards. If you have questions concerning a particular product for your application, CMC can offer assistance; however, it is the end user's responsibility to determine if the chosen part is suitable for a specific application (especially true where safety is a factor).

7. To determine a part's useful life for a particular application, you should test sample parts under actual operating conditions.

## Load Definitions

### Ultimate Radial Static Load Capacity (Rod Ends)

**These loads are the maximum amount of force the part can sustain before complete failure. All loads listed in the catalog are based on rod ends without grease fittings. Due to the removal of material for the fitting, the load rating for such a part is substantially lower. Consult CMC engineering for assistance on these parts.**

### Radial Static Load Capacity (Spherical Bearings)

**These loads are the maximum amount of force the part can sustain before a 2% permanent set occurs in the part. Consult CMC engineering if these numbers don't fit your application.**

### Static Limit Load (Spherical Bearings)

**Static limit load is the allowable load that can be applied to a bearing without adversely affecting its performance capabilities.**

## Calculations for Misalignment of Rod Ends & Spherical Bearings

B = Bore of ball

C = Chamfer on outer race

D = Head diameter or diameter of outer race

E = Ball diameter

H = Housing width

S = Shoulder diameter (neck ball)

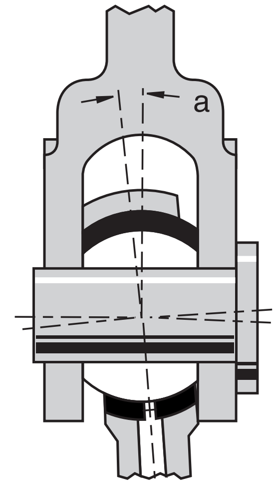
V = $\sqrt{(D - 2C)^2 + H^2}$

W = Ball width

The angle of misalignment in a rod end is controlled by the outside diameter of the head. The maximum degree of misalignment is obtained when the head contacts the side of the fork or clevis in which it is mounted.

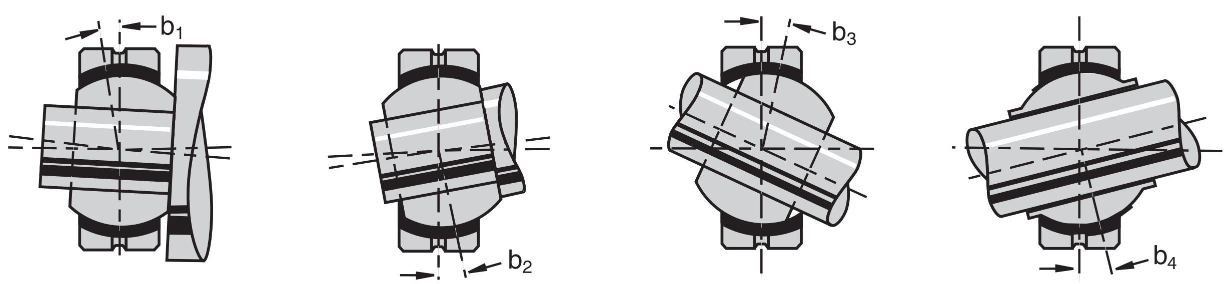
The angle of misalignment in a spherical bearing is calculated somewhat differently from that of the rod end because the housing is not spherical. There are four different types of mountings in which these bearings may be used as shown, and the angle of misalignment is governed by the type of mounting adopted.

Shown below are the common mountings for spherical bearings and the corresponding formula for calculating the angle of misalignment.




Rod End Angle:

$a = \sin^{-1}\frac{W}{D} - \sin^{-1}\frac{H}{D}$




$b_1 = \sin^{-1}\frac{W}{V} - \sin^{-1}\frac{H}{V}$

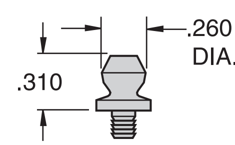
$b_2 = \sin^{-1}\frac{W}{E} - \sin^{-1}\frac{H}{E}$

$b_3 = \cos^{-1}\frac{B}{E} - \sin^{-1}\frac{H}{E}$

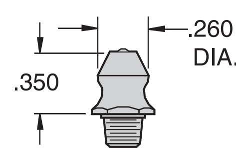
$b_4 = \cos^{-1}\frac{S}{E} - \sin^{-1}\frac{H}{E}$

*Standard zerk locations on male and female rod ends*

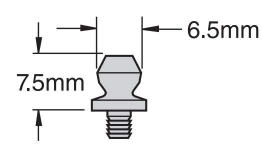
**Standard Drive Fit Zerk**
Specify by adding suffix "Z" to part number.
Example: MSF8Z



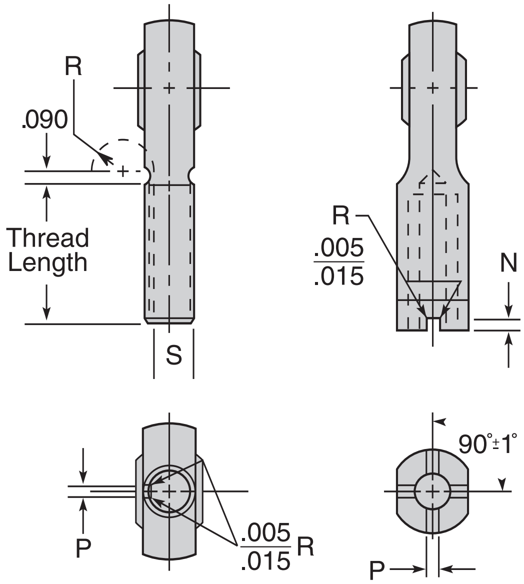

**Standard Threaded Zerk**
Specify by adding suffix "-28" to part number.
Example: MSF8Z-28




**Metric Zerk**
Specify by adding suffix "ZM" to part number.
Example: MSF8ZM



## Rod End Keyway (Ref NAS 559)




| THREAD OD REF | N MAX. | P MIN. | N MAX. | P MIN. |
|---|---|---|---|---|
| | Dimensions in Inches | | | |
| .2500 | .056 | .062 | .201 | .255 |
| .3125 | .056 | .062 | .260 | .255 |
| .3750 | .056 | .093 | .311 | .255 |
| .4375 | .069 | .093 | .370 | .255 |
| .5000 | .069 | .093 | .436 | .255 |
| .5620 | .077 | .125 | .478 | .255 |
| .6250 | .077 | .125 | .541 | .255 |
| .7500 | .077 | .125 | .663 | .255 |
| .8750 | .086 | .156 | .777 | .318 |
| 1.0000 | .094 | .156 | .900 | .318 |
| 1.1250 | .094 | .094 | 1.010 | .382 |
| 1.2500 | .116 | .187 | 1.136 | .382 |
| 1.3750 | .116 | .187 | 1.236 | .445 |
| 1.5000 | .116 | .250 | 1.361 | .445 |
| 1.6250 | .129 | .250 | 1.477 | .445 |
| 1.7500 | .129 | .250 | 1.589 | .508 |
| 1.8750 | .129 | .312 | 1.714 | .508 |
| 2.0000 | .129 | .312 | 1.839 | .508 |
| 2.1250 | .129 | .312 | 1.955 | .508 |
| 2.2500 | .129 | .312 | 2.080 | .508 |

## Rod Ends/Ball Joints: Specifying Tips

Each of our products are specifically designed to perform in even the most extreme conditions. Through this technical guide and the advice of our sales and engineering staff, our goal is to help you identify the most appropriate Cablecraft product suited to your application.
First, a few key considerations…

While the applications are almost limitless, the conditions that the different linkages witness are often very similar. **When designing a linkage solution, keep in mind everything from environmental conditions (humidity, dust & temperature) to the range of motion required.**

- For example: Rod ends and ball joints are not designed for high rate rotational applications such as holding rotating shafts. However, when repetitive motion is present, one of CMC's many **self-lubricated bearings (such as nylon, bronze or PTFE race bearings)** should be considered. Our comprehensive catalog provides individual product pages that identify key features such as temperature restraints and descriptions of strength for each product.
- **When environmental conditions involving excessive dirt exist,** our **nylon race bearings** help keep the cavity free of excessive dirt build-up (a great alternative to the "tough to reach linkage and often-neglected grease fitting" applications).
- Additionally CMC provides many **specialty alloy designs** to prevent corrosion and increase strengths.

**Why choose a ball joint instead of a rod end?** While ball joints are often considered the more economical solution, there are also many cases in which a ball joint is better suited for performance and geometry-based applications. CMC ball joints come in many forms aside from designs in the catalog. A popular and flexible design option includes our 1-piece solid and bent linkages (as seen on many draglinks and tie rods in the lawn and garden industry). The integral ball joint placed directly in the connecting rod creates a low profile linkage that is optimal for minimal clearance applications such as steering and other internal machine controls.

**What sets CMC apart from other rod end and ball joint manufacturers?** CMC not only designs all of our rod ends, ball joints and sphericals, but also manufactures them in the USA. Since 1920, we have been creating and developing many of the critical and revolutionary methods to manufacture linkages. This has put us in the forefront of product offerings, and to this day we continue to strive to offer the best product, the best delivery and the best value to our customers.

*Call us at 260-749-5105 when you need product/technical engineering support.*

### WARNING!

***Since the manufacturer is unable to determine all applications in which a part may be placed, it is the user's responsibility to determine the suitability of the part for its intended use. This is especially true where safety is a factor. Incorrect application or installation may result in property damage, bodily injury, or death. For technical assistance, call 260-749-5105.***

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