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Exclusion of Warranty

The items in this catalog are intended for use in motorsport competition, i.e. AUTO RACING. No warranty of these components, express or implied, is offered by Woodward Machine Corporation or its subsidiaries, for the following reasons, among others:

(1) Motorsport is inherently dangerous. The conditions of end use of the components are normally hazardous and unpredictable, and are entirely beyond our control; and

(2) The decision as to the suitability of said components for a particular manner of use, or in a particular installation, is made by the user and is likewise beyond our control; and

(3) The application of said components is therefore understood to be experimental.

Liability of Woodward Machine Corporation is therefore limited to the replacement or repair, at our option, of any of our products that we find, upon our inspection, to be defective in materials or workmanship, specifically excluding items damaged as a result of collision, misuse, or neglect.

Warning: The approval of your state department of motor vehicles or your country's Ministry of Transport or other relevant authority, for the use of racing equipment on the public highways should not be assumed. Woodward Machine Corporation does not support nor participate in efforts to obtain such approval. The end user is reponsible for not utilizing Woodward racing components in any manner which may contravene local law. Original Equipment Manufacturers installing Woodward components in vehicles licensed for use on the public highways are responsible for complying with all applicable safety standards. Purchasers of Woodward equipment for use in race cars subject to homologation by a sanctioning body, e.g. FIA, NASCAR, IMSA, etc. are responsible for ensuring that the equipment does in fact conform to current rules.

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Surcharges, previously necessitated by unpredictable and exorbitant fees charged by the credit card brands for processing sales across international borders, no longer apply.

Credit card sales are invoiced and shipped by our subsidiary Racor, Inc.

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Please note that any customs duties or clearance fees imposed by the destination country are the responsibility of the recipient. We will gladly include your VAT registration number on the shipping documents but we do not collect or remit taxes.

PACKAGING FOR INTERNATIONAL SHIPMENT:

In some cases, international air freight imposes more stringent requirements for packaging. Should this be necessary, any extra cost will be included in our freight quote.

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OUR STANDARD FREIGHT CARRIERS AND INSURANCE:

We ship via Federal Express or United Parcel Service, FOB our plant in Mills, Wyoming. Next Day Air and Early AM delivery are available at extra cost for most ZIP codes in the continental US, as is Saturday delivery. Freight insurance is provided free by the carrier up to USD100.00 value, and rises on a very reasonable sliding scale. We ship everything insured for its full value. We can also ship freight collect on your FedEx or UPS account. *We do not ship via Postal Service, as delivery cannot be guaranteed and if your parcel is lost or undelivered it is difficult or impossible to obtain compensation.*

Orders for parts in stock will generally ship the same day if received before noon Mountain Standard Time.

USING OTHER CARRIERS:

Alternatively, we can hold for pickup by the carrier of your choice. However, in these cases we cannot create waybills or submit the export declaration electronically. If your carrier requires that we manually complete their shipping documents we will have to charge for the time. Also, you should be aware that freight companies not having a base of operations in the US will subcontract the pickup to UPS or FedEx and sometimes this can add a week or more before the parcel can actually be placed in transit.

RETURNS OF MERCHANDISE, DOMESTIC:

Returned parts may be subject to a charge of up to 20% to defray the cost of inspection, restocking, and repackaging. Returned merchandise must be unused, unmarked and not over 30 days old. We will make adjustment via exchange or credit only. Special order parts, damaged or rusted parts, or “basket cases” are not returnable except in connection with repair orders.

RETURNS OF MERCHANDISE, INTERNATIONAL:

Make absolutely sure to specify in the customs declaration that you are returning goods *manufactured in the U.S.* If this is not done and we receive a bill for import duties, it will be charged to your account.

SPECIAL ORDER PARTS:

In this catalog, many categories of parts are only manufactured on a made-to-order basis. Please note that parts built or assembled to customer specifications are generally specialized enough to be otherwise unsalable, and consequently these are not returnable.

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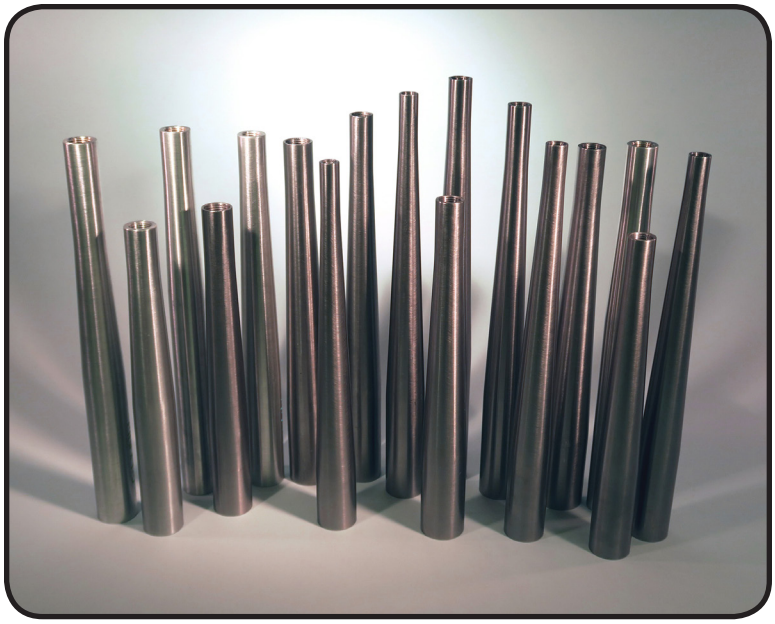
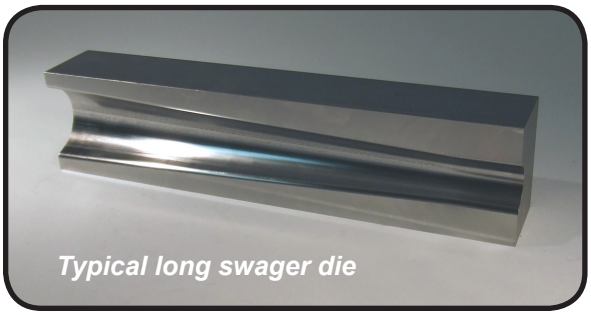
HIGH-STIFFNESS TUBULAR COMPONENTS via ROTARY SWAGING



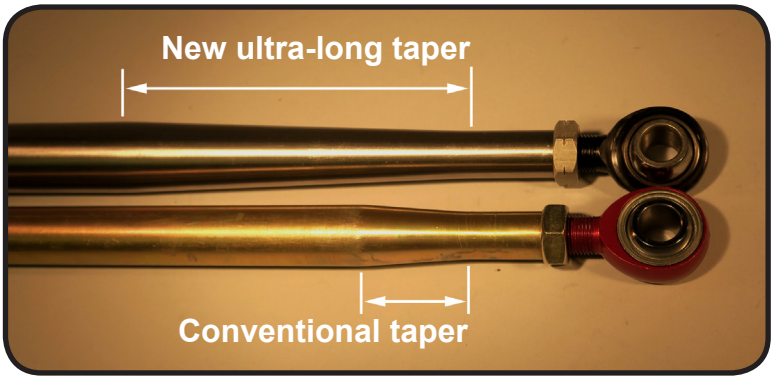
The rotary swaging process reduces the diameter of a tubular part while thickening its wall. This allows a suspension link to be made from a single piece of lightweight thinwall tubing instead of heavy wall tubing or welded inserts that would otherwise be necessary to support internal threads. Most importantly, a swaged tube has its largest diameter in the middle where it is most effective against buckling under compression. The thickened ends of a rotary swaged tube are not produced by a hydraulic crimping or squeezing operation, but are hammered to shape in rotating dies which progressively cold-forge the tubing at up to 3,000 blows per minute. This process develops maximum strength in the material, and the cross section of the finished part has a very gradual transition that is free of stress concentration.

Many sizes made to order

We have an extensive array of dies for our swaging machines and we can manufacture small or large quantities of tubular struts to accept all the common rod end sizes, including extreme reductions such as 1.5 OD x .065 wall tubing tapered all the way down to 1/2-20 thread.

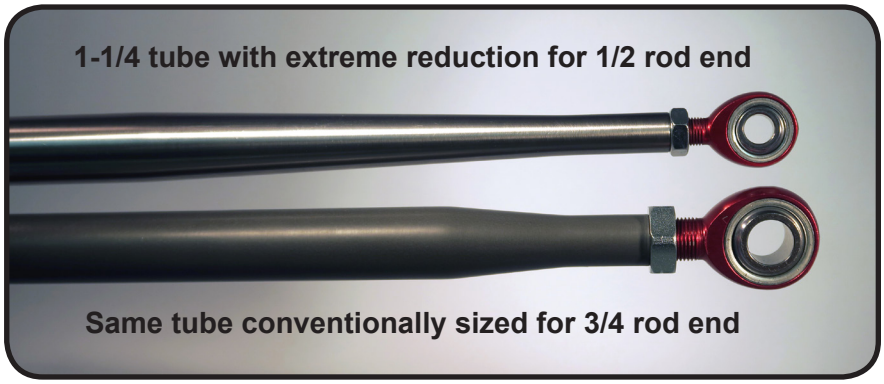


Typical long swager die



Smaller rod ends can be used with larger diameter tubes

Greater reductions enable the use of smaller and lighter high-strength rod ends, an important design advantage in cases where the rod end will constitute unsprung weight—in other words, the moving end of just about any suspension or steering link. Here a 1-1/4 diameter .065 wall steel tube reduced for a 1/2 inch rod end is compared to the same tube more conventionally sized for a 3/4 inch rod end. The difference in weight outward from the beginning of the taper is obvious.



Versatility for the designer

Various combinations can be made from a single OD and wall, for example 5/8-18 at one end and 14mm x 1.5 at the other end, in right or left hand as required. The large number of possible combinations of diameter and length allows the chassis designer to maximize the stiffness factor, or the ratio of diameter to wall thickness. Since at a given weight the stiffness of the tube increases with its diameter, we suggest that when specifying a swaged tube for use in a race car the builder aim for the maximum diameter practical for the available space—that is, consider the load limit of the tube in *buckling* (as with a pushrod) as opposed to its load limit in *tension.* Remember: you can pull a rope, but you can't push a rope. And, to carry the foregoing "rope" analogy a bit further, *unlike a resin-and-fiber composite, a metal tube will never turn into a piece of rope if struck by track debris.*

Aluminum or Steel

Woodward aluminum tubes are made exclusively from cold-drawn seamless 6061-T6 material rather than from cheap extruded water pipe. Consequently they are not "weak link" sacrificial elements, but full-strength structural members of premium quality and reliability.

Woodward steel tubes are manufactured from cold-drawn 1026 DOM and are in most cases half the wall thickness of their aluminum counterparts. They are the lightest steel parts of this kind available in the USA. In the shorter lengths, the weight penalty compared with aluminum is negligible.

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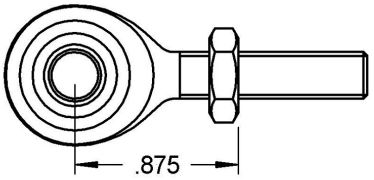
How to calculate the length required for a swaged tube:

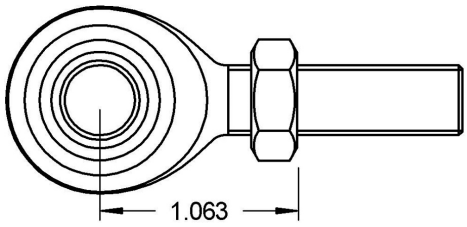
Given the distance between spherical centers of the assembled link, subtract the *distance from the center of the rod end ball to the contact side of the jam nut* as illustrated below. Although the machined features may vary somewhat among rod end manufacturers, these drawings represent the average, and will allow a reasonable range of adjustment while giving priority to maximum thread engagement in the tube using standard-thickness jam nuts.

US Commercial Grade Rod Ends

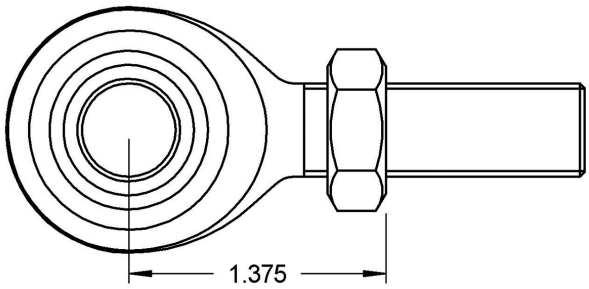
The dash numbers indicate the bore and threaded shank diameters in sixteenths of an inch, e.g. -8 means 8/16 or 1/2 inch.



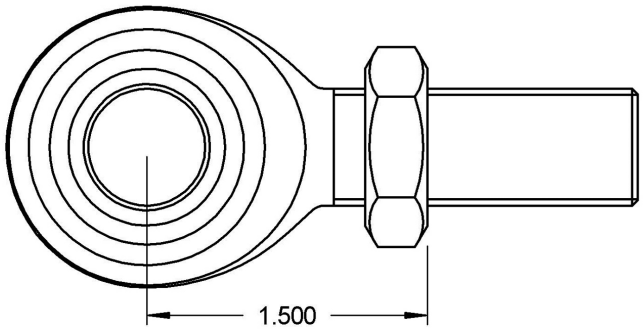
-4 (1/4 bore x 1/4-28 thread)



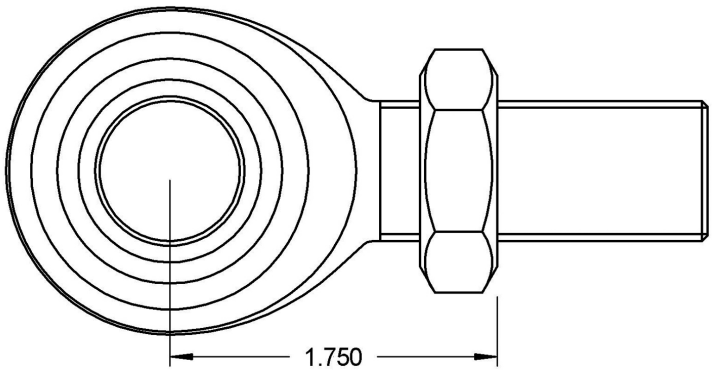
-6 (3/8 bore x 3/8-24 thread)



-8 (1/2 bore x 1/2-20 thread)



-10 (5/8 bore x 5/8-18 thread)



-12 (3/4 bore x 3/4-16 thread)

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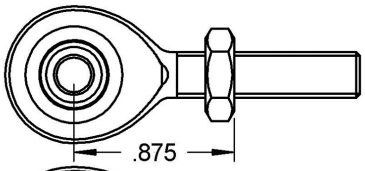
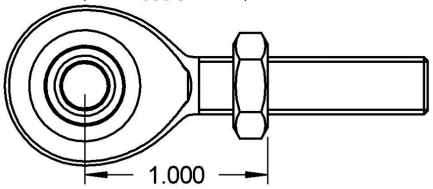
US High Strength and High Misalignment rod ends

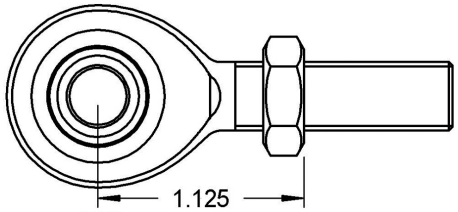
These types have larger bodies and shanks in proportion to their bearing bores; their dash number indicates bore diameter only.



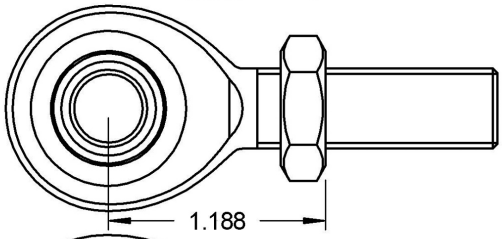
-3 (3/16* bore x 1/4-28 thread)
*actually .190 to fit #10 screw)



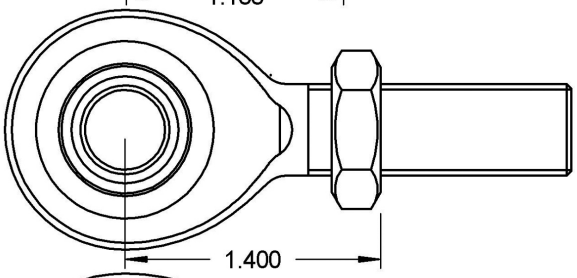
-4 (1/4 bore x 5/16-24 thread*)
*also available with 3/8-24 thread



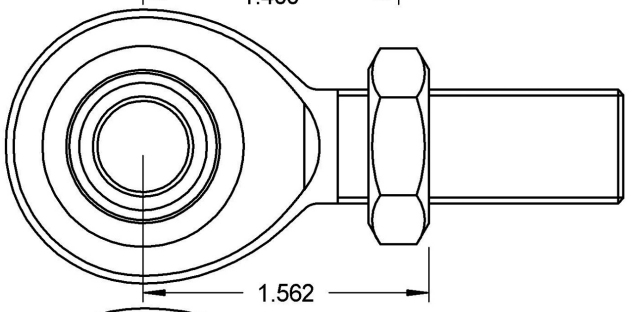
-5 (5/16 bore x 3/8-24 thread)



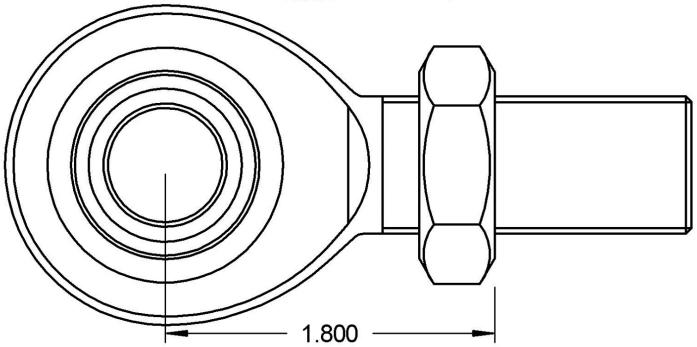
-6 (3/8 bore x 7/16-20 thread)



-7 (7/16 bore x 1/2-20 thread)



-8 (1/2 bore x 5/8-18 thread)



-10 (5/8 bore x 3/4-16 thread)

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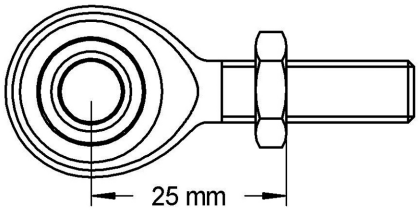
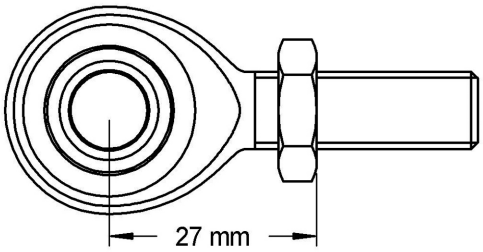
Metric rod ends

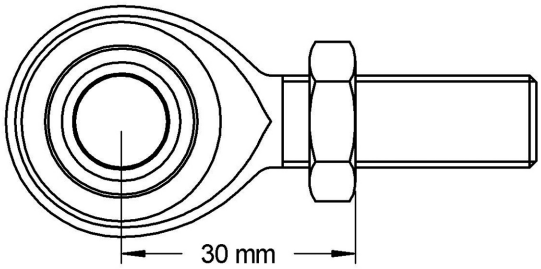
The examples shown below have identical bore and shank diameters and are fairly typical. Note: Whereas practically all US rod ends are furnished with UNF (fine) threads, metric rod ends worldwide do not all conform to the fine thread series used on metric bolts and screws. Some diameters have metric fine threads and others have coarse or intermediate threads. Depending on the country of manufacture, other thread pitches may be standard which are not shown here. If you have an odd size please inquire; we may be able to accommodate it, as we are constantly making new tooling. In general—given a choice—finer pitches are more compatible with lighter-wall tubing.



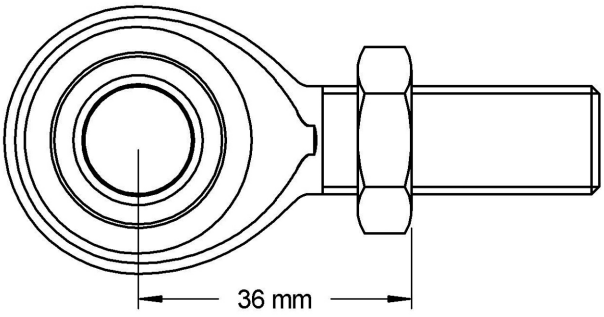
M8 (8mm bore, 8 x 1.25 thread*)
*also available with 8 x 1 thread



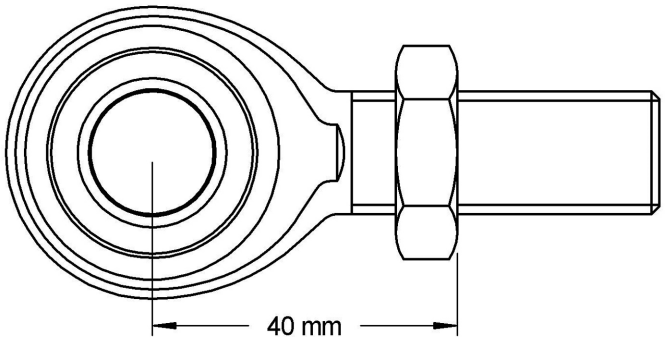
M10 (10mm bore, 10 x 1.25 thread*)
*also available with 10 x 1.5 thread



M12 (12mm bore, 12 x 1.25 thread*)
*also available with 12 x 1.75 thread



M14 (14mm bore, 14 x 1.5 thread*)
*also available with 14 x 2 thread



M16 (16mm bore, 16 x 1.5 thread*)
*also available with 16 x 2 thread

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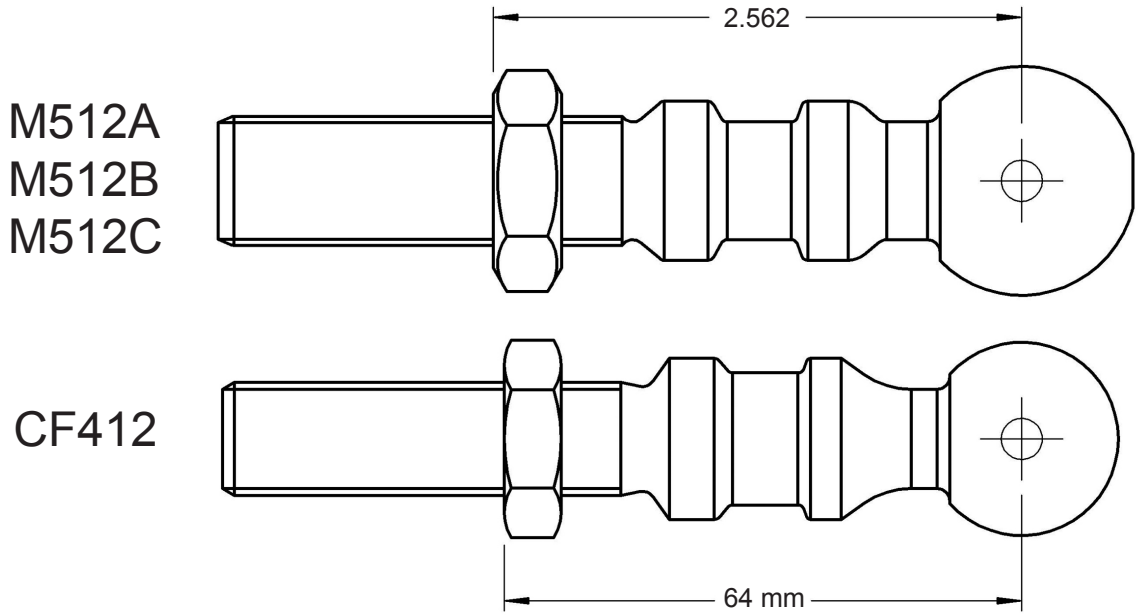
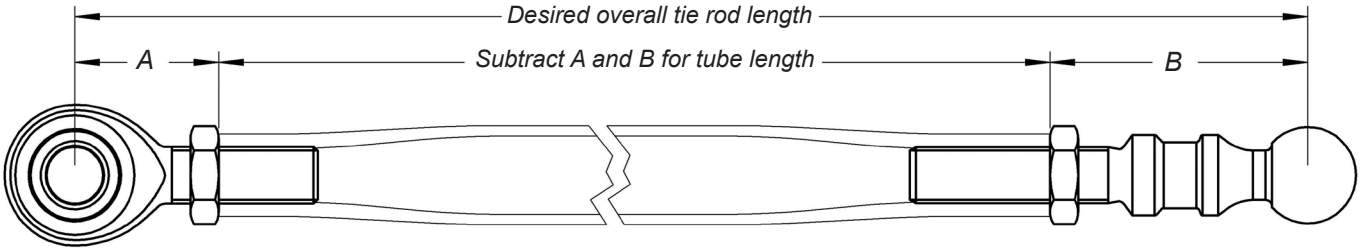
Woodward monoball rack ends

CF412 ball studs are furnished on type CF racks and are threaded 14mm x 1.5. M512 ball studs are furnished on type JL/JLR and GE/HE racks and are available in 14mm x 1.5, 5/8-18, or 3/4-16. ALL WOODWARD BALL STUDS ARE RIGHT HAND THREAD. The dimensions shown will allow a reasonable range of adjustment while giving priority to maximum thread engagement in the tube using standard-thickness jam nuts. Note that the balls are the “spherical centers” or “pivot points” of the rack.



Determining your tube length:



To find your tube length, get the A and B dimensions for your rod ends (and/or ball studs) from the charts on pages 4-7 and subtract A and B from your desired overall tie rod length. If you have ball studs other than Woodward, estimate B as closely as possible.

SHORT TIE ROD SLEEVES

As explained above, swaging from large diameter tubing is mainly advantageous where stiffness is needed in a relatively long link. Since a certain minimum length is used for creating the tapered section, lengths shorter than about 9 inches (230mm) are not practical to swage. However, we can provide shorter sleeves from solid bar stock in any combination of the thread sizes listed on the following pages.

MACHINED SLEEVES
9 inch maximum length, specify thread each end.....35.00 up
(Shown at left: Combination 5/8-18 RH x 3/4-16 LH, made from 1” Ø aluminum)

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STEEL SWAGED TUBES
Diameter and thread combinations currently available:

Diameter and wall thickness	Thread
1-1/2 OD x .065	3/4-16
1-1/2 OD x .065	M16 x 1.5
1-1/2 OD x .065	5/8-18
1-1/2 OD x .065	1/2-20
1-3/8 OD x .065	3/4-16
1-3/8 OD x .065	M16 x 1.5
1-3/8 OD x .065	5/8-18
1-1/4 OD x .065	3/4-16
1-1/4 OD x .065	M16 x 1.5
1-1/4 OD x .065	M16 x 2
1-1/4 OD x .065	5/8-18
1-1/4 OD x .065	M14 x 1.5
1-1/4 OD x .065	M14 x 2
1-1/4 OD x .065	1/2-20
1-1/4 OD x .049	M10 x 1.25
1-1/4 OD x .049	M10 x 1.5
1-1/4 OD x .049	3/8-34
1 OD x .065	M16 x 1.5
1 OD x .065	5/8-18
1 OD x .065	M14 x 1.5
1 OD x .065	1/2-20
1 OD x .065	M12 x 1.25
1 OD x .065	M12 x 1.75
1 OD x .065	7/16-20
1 OD x .065	M10 x 1.25
1 OD x .065	3/8-24
7/8 OD x .049	M10 x 1.25
7/8 OD x .049	M10 x 1
7/8 OD x .049	3/8-24
7/8 OD x .035	M8 x 1.25
7/8 OD x .035	M8 x 1
7/8 OD x .035	5/16-24

NOTE: Suspension links using a rod end at both ends generally need a right hand thread in one end and a left hand thread in the other, so that turning the tube will adjust both ends in or out simultaneously. The exception is a **steering tie rod where one end is a ball stud** (such as a monoball rack end). Since that end is free to rotate, the two threads can be of the same hand.

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ALUMINUM SWAGED TUBES
Diameter and thread combinations currently available:

Diameter and wall thickness	Thread
1-1/4 OD x .125	3/4-16
1-1/4 OD x .125	M16 x 1.5
1-1/4 OD x .125	M16 x 2
1-1/4 OD x .125	5/8-18
1-1/4 OD x .125	M14 x 1.5
1-1/4 OD x .125	M14 x 2
1-1/4 OD x .125	1/2-20
1-1/8 OD x .125	M16 x 1.5
1-1/8 OD x .125	5/8-18
1-1/8 OD x .125	M14 x 1.5
1-1/8 OD x .125	M14 x 2
1-1/8 OD x .095	1/2-20
1-1/8 OD x .095	M12 x 1.25
1 OD x .125	1/2-20
1 OD x .125	M12 x 1.25
1 OD x .125	M12 x 1.75
1 OD x .125	7/16-20
1 OD x .125	M10 x 1.25
1 OD x .125	M10 x 1.5
1 OD x .125	3/8-24
1 OD x .095	M8 x 1.25
1 OD x .095	M8 x 1
1 OD x .095	5/16-24
1 OD x .065	M10 x 1.25
1 OD x .065	3/8-24
7/8 OD x .095	M10 x 1.25
7/8 OD x .095	M10 x 1.5
7/8 OD x .095	3/8-24
3/4 OD x .083	M8 x 1.25
3/4 OD x .035	M8 x 1
3/4 OD x .035	5/16-24

NOTE: Suspension links using a rod end at both ends generally need a right hand thread in one end and a left hand thread in the other, so that turning the tube will adjust both ends in or out simultaneously. The exception is a **steering tie rod where one end is a ball stud** (such as a monoball rack end). Since that end is free to rotate, the two threads can be of the same hand.