

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's 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 never be assumed. Woodward Machine Corporation does not support nor participate in efforts to obtain such approval. The end user is responsible 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.

DOMESTIC AND INTERNATIONAL PRICING:

The prices published in this catalog are in US Dollars and apply to all purchases made with Visa, Mastercard, Discover, or American Express cards, whether issued by US or foreign banks.

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.

Business-to-business purchases arranged directly with Woodward Machine Corporation are payable by bank wire transfer.

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 nor 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.

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 nor 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. ***In general, Type JL racks are considered Made to Order.***

Type JL LHD Front Steer/RHD Rear Steer, lengths 19.75 to 31.50 inches Type JLR RHD Front Steer/LHD Rear Steer, lengths 19.75 to 31.50 inches

Heavy duty **manual** or **powered column** applications, **longer rack centers**, **monoball ends**

The housings for racks longer than those on the preceding page are built to the required length to properly support the rackshaft, using a 1-1/2OD x .083 wall precision DOM tube. These units feature the heavy-duty hard-chromed rackshaft, extra long rack bushings, and a four-ball-bearing pinion. The large 1.25 (31,75mm) diameter rackshaft is more than 2.4 times stiffer in bending than a 1.0 (25,4mm) shaft and has correspondingly wider gear teeth, making it capable of handling the amplified input from a gearmotor-powered steering column. Three ratios are available: 2.09 (53mm), 2.36 (60mm), and 2.62 (67mm) per turn. All three gearsets are interchangeable in the housing.

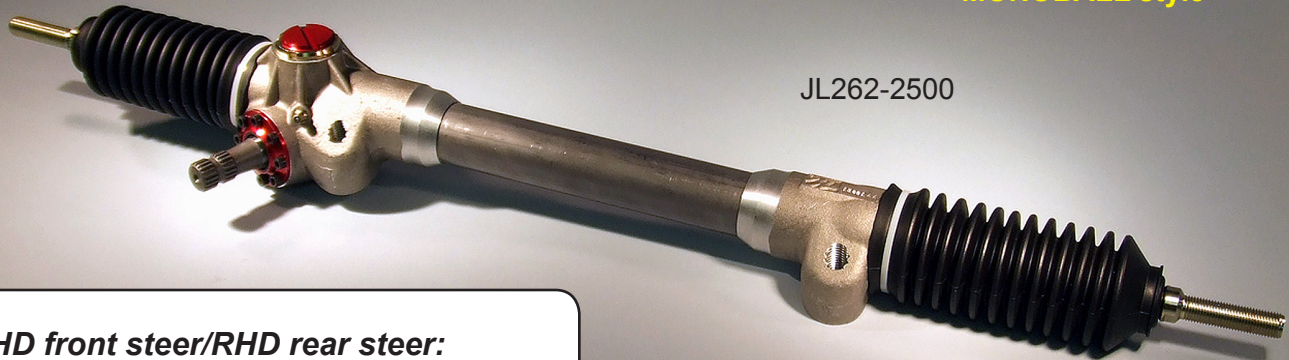
JL series rack housings do not have mounting provisions for hydraulic assist and consequently can fit in tighter spaces than the GE design. They use larger M14 mounting bolts. These racks are supplied standard with the new design Woodward monoball rack ends with adjustable preload, which are available in thread sizes of 14mm x 1.5, 5/8-18, or 3/4-16.

MONOBALL style



JL262R-2425

MONOBALL style



JL262-2500

LHD front steer/RHD rear steer:

JL209-1975 through -3150	1383.75
JL236-1975 through -3150	1383.75
JL262-1975 through -3150	1383.75

RHD front steer/LHD rear steer:

JL209R-1975 through -3150	1383.75
JL236R-1975 through -3150	1383.75
JL262R-1975 through -3150	1383.75

In their normal configuration, long-style JL racks with monoballs have 6+ inches of rack travel. The rack travel can be reduced either with stop spacers or by specifying a longer housing than the standard one for that rack. Racks built with a longer housing are identified by a two-part number, e.g. a rack 25.00 long with a travel reduced to 5 inches would use a housing made for a 26.00 rack; its part number suffix would be -2500/2600.

Lengths are standard in 1/4-inch increments. Odd lengths or racks longer than those listed are available on special order for an additional charge.

The two-bolt rack mounting method of the JL series is extremely fabricator-friendly; the chassis bracket can be a simple 1/4 flat bar with 14mm (9/16) holes.

RACK LENGTH: Note that the "length" of a rack is the distance between its spherical centers, i.e., the centers of the inner tie rod ends or monoball studs. This is a critical dimension, as the arc of movement of the tie rods must conform to the movement of the suspension links—otherwise suspension travel will steer the front wheels, a condition known as "bump steer."

To order a custom JL or JLR rack, print the last two pages of this section OR go to the **Detailed Tech Info** section of the website and download **link #6a, "Type JL Design Worksheets."** Fill in your numbers and email the document to tech@woodwardsteering.com.

Important:

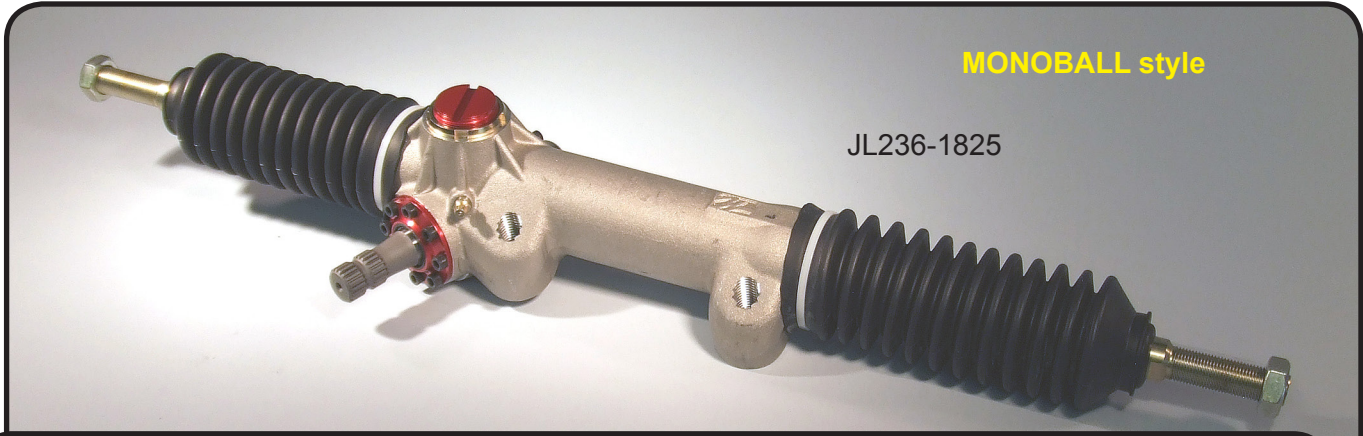
FRONT OR REAR STEER: Page 7 of this catalog section illustrates the important difference in operation between a rack placed ahead of the front wheel centerline and one placed behind it.

Type JL LHD Front Steer/RHD Rear Steer, lengths 16.25 to 18.25 inches Type JLR RHD Front Steer/LHD Rear Steer, lengths 16.25 to 18.25 inches

Heavy duty **manual** or **powered column** applications, **shorter rack centers**, **monoball ends**

New design one-piece housing with heavy-duty hard-chromed rackshaft, extra long rack bushings, and a four-ball-bearing pinion. The large 1.25 (31,75mm) diameter rackshaft is more than 2.4 times stiffer in bending than a 1.0 (25,4mm) shaft and has correspondingly wider gear teeth, making it capable of handling the amplified input from a gearmotor-powered steering column. Three ratios are available: 2.09 (53mm), 2.36 (60mm), and 2.62 (67mm) per turn. All three gearsets are interchangeable in the housing.

JL series rack housings do not have mounting provisions for hydraulic assist and consequently can fit in tighter spaces than the GE design. They also use larger M14 mounting bolts. These racks are equipped with the new design Woodward monoball rack ends with adjustable preload, which are available in thread sizes of 14mm x 1.5, 5/8-18, or the extra-large 3/4-16 for off-road use.



MONOBALL style

JL236-1825



MONOBALL style

JL236R-1825

LHD front steer/RHD rear steer:

JL209-1625, -1725, or -1825	1121.25
JL236-1625, -1725, or -1825	1121.25
JL262-1625, -1725, or -1825	1121.25

RHD front steer/LHD rear steer:

JL209R-1625, -1725, or -1825	1121.25
JL236R-1625, -1725, or -1825	1121.25
JL262R-1625, -1725, or -1825	1121.25

An 18.25 monoball rack has 6+ inches travel; a 17.25 rack has 5+ inches travel; a 16.25 rack has 4+ inches travel.

Rack lengths other than those listed are available on special order for an additional charge. Rackshafts exceeding 18.25 will be equipped with travel stops to prevent the pinion from colliding with the end of the rack teeth.

The maximum monoball rack length that can be installed in the short one-piece housing is 19.50 inches.

The two-bolt rack mounting method of the JL series is extremely fabricator-friendly; the chassis bracket can be a simple 1/4 flat bar with 14mm (9/16) holes.

RACK LENGTH: Note that the "length" of a rack is the distance between its spherical centers, i.e., the centers of the inner tie rod ends or monoball studs. This is a critical dimension, as the arc of movement of the tie rods must conform to the movement of the suspension links—otherwise suspension travel will steer the front wheels, a condition known as "bump steer."

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Important:

FRONT OR REAR STEER: Page 7 of this catalog section illustrates the important difference in operation between a rack placed ahead of the front wheel centerline and one placed behind it.

Type JLC LHD Front Steer/RHD Rear Steer, lengths 19.75 to 31.50 inches Type JLRC RHD Front Steer/LHD Rear Steer, lengths 19.75 to 31.50 inches

Heavy duty **manual** or **powered column** applications, **longer rack centers**, **CLEVIS ends**

The housings for racks longer than those on the preceding page are built to the required length to properly support the rackshaft, using a 1-1/2OD x .083 wall precision DOM tube. These units feature the heavy-duty hard-chromed rackshaft, extra long rack bushings, and a four-ball-bearing pinion. The large 1.25 (31,75mm) diameter rackshaft is more than 2.4 times stiffer in bending than a 1.0 (25,4mm) shaft and has correspondingly wider gear teeth, making it capable of handling the amplified input from a gearmotor-powered steering column. Three ratios are available: 2.09 (53mm), 2.36 (60mm), and 2.62 (67mm) per turn. All three gearsets are interchangeable in the housing.

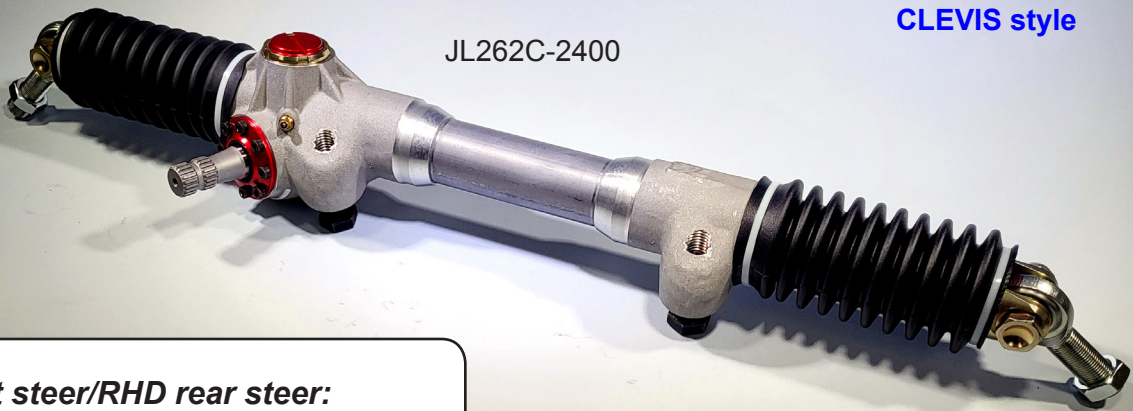
JLC series rack housings do not have mounting provisions for hydraulic assist and consequently can fit in tighter spaces than the GE design. They use larger M14 mounting bolts. These racks are supplied standard with the new Woodward clevises, complete with 5/8 (-10) rod ends and close-fitting bolts in double shear.

CLEVIS style



JL262RC-2400

CLEVIS style



JL262C-2400

LHD front steer/RHD rear steer:

JL209C-1975 through -3250	1383.75
JL236C-1975 through -3250	1383.75
JL262C-1975 through -3250	1383.75

RHD front steer/LHD rear steer:

JL209RC-1975 through -3250	1383.75
JL236RC-1975 through -3250	1383.75
JL262RC-1975 through -3250	1383.75

In their normal configuration, "long" style JL clevis racks have 6+ inches of rack travel. The rack travel can be reduced either with stop spacers or by specifying a longer housing than the standard one for that rack. Racks built with a longer housing are identified by a two-part number, e.g. a rack 25.00 long with a travel reduced to 5 inches would use a housing made for a 26.00 rack; its part number suffix would be -2500/2600.

Lengths are standard in 1/4-inch increments. Odd lengths or racks longer than those listed are available on special order for an additional charge.

The two-bolt rack mounting method of the JL series is extremely fabricator-friendly; the chassis bracket can be a simple 1/4 flat bar with 14mm (9/16) holes.

RACK LENGTH: Note that the "length" of a rack is the distance between its spherical centers, i.e., the centers of the inner tie rod ends or monoball studs. This is a critical dimension, as the arc of movement of the tie rods must conform to the movement of the suspension links—otherwise suspension travel will steer the front wheels, a condition known as "bump steer."

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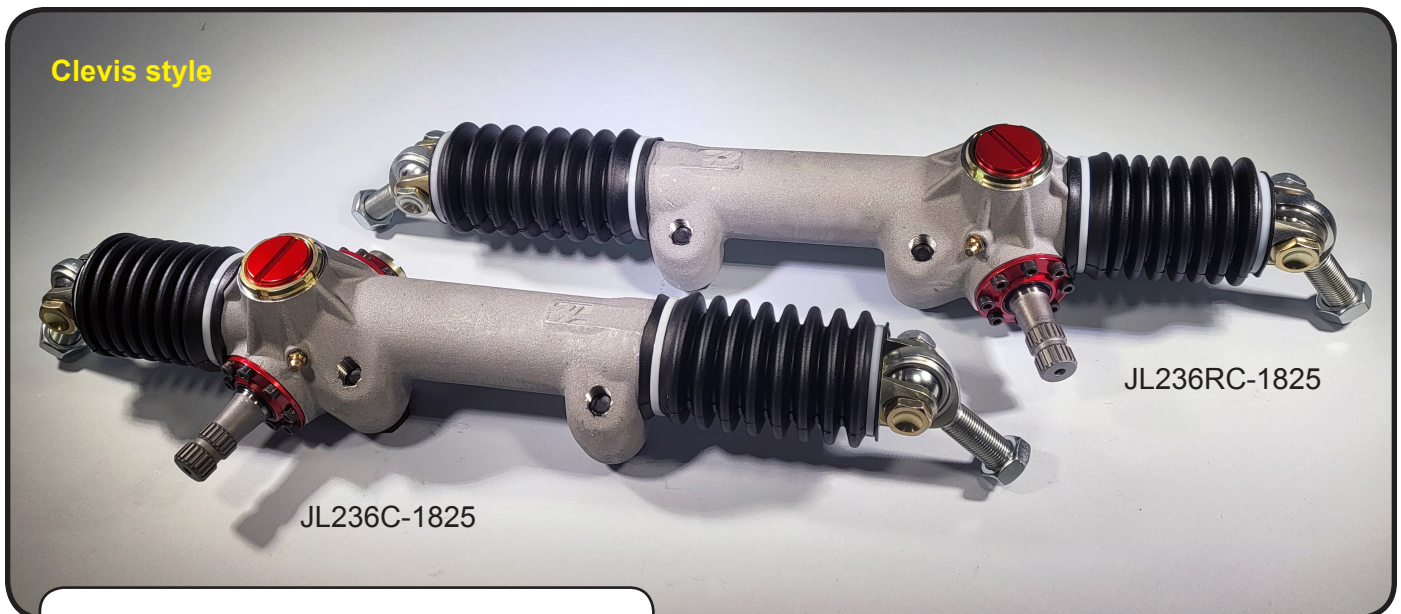
FRONT OR REAR STEER: Page 7 of this catalog section illustrates the important difference in operation between a rack placed ahead of the front wheel centerline and one placed behind it.

Type JLC LHD Front Steer/RHD Rear Steer, lengths 17.25 to 19.50 inches Type JLRC RHD Front Steer/LHD Rear Steer, lengths 18.25 to 19.50 inches

Heavy duty **manual** or **powered column** applications, **shorter** rack centers, **CLEVIS** ends

New design one-piece housing with heavy-duty hard-chromed rackshaft, extra long rack bushings, and a four-ball-bearing pinion. The large 1.25 (31,75mm) diameter rackshaft is more than 2.4 times stiffer in bending than a 1.0 (25,4mm) shaft and has correspondingly wider gear teeth, making it capable of handling the amplified input from a gearmotor-powered steering column. Three ratios are available: 2.09 (53mm), 2.36 (60mm), and 2.62 (67mm) per turn. All three gearsets are interchangeable in the housing.

JLC series rack housings do not have mounting provisions for hydraulic assist and consequently can fit in tighter spaces than the GE design. They use larger M14 mounting bolts. These racks are supplied standard with the new Woodward clevises, complete with 5/8 (-10) rod ends and close-fitting bolts in double shear.



Clevis style

JL236C-1825

JL236RC-1825

LHD front steer/RHD rear steer:

JL209C-1725, -1825, -1925 or -1950	1121.25
JL236C-1725, -1825, -1925 or -1950	1121.25
JL262C-1725, -1825, -1925 or -1950	1121.25

RHD front steer/LHD rear steer:

JL209RC-1725, -1825, -1925 or -1950	1121.25
JL236RC-1725, -1825, -1925 or -1950	1121.25
JL262RC-1725, -1825, -1925 or -1950	1121.25

On "short" style one-piece racks, clevises reduce the available rack travel relative to rack length. A 19.50 clevis rack has about 5.75 inches travel, an 18.25 clevis rack has about 4.3 inches travel; a 17.25 clevis rack has only 3.3 inches travel.

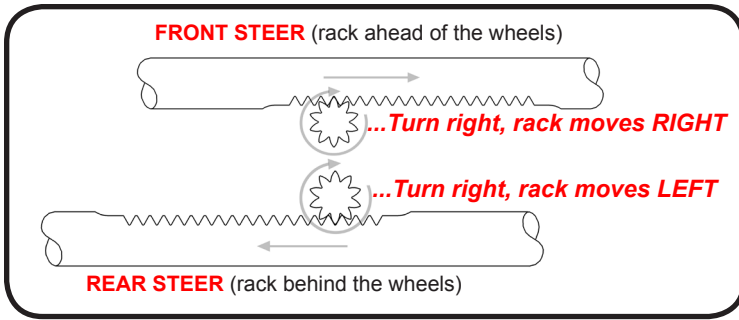
Rack lengths other than those listed are available on special order for an additional charge.
The maximum clevis rack length that can be installed in the short one-piece housing is 19.75 inches.

The two-bolt rack mounting method of the JL series is extremely fabricator-friendly; the chassis bracket can be a simple 1/4 flat bar with 14mm (9/16) holes.

RACK LENGTH: Note that the "length" of a rack is the distance between its spherical centers, i.e., the centers of the inner tie rod ends or monoball studs. This is a critical dimension, as the arc of movement of the tie rods must conform to the movement of the suspension links—otherwise suspension travel will steer the front wheels, a condition known as "bump steer."

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NOTE: Page 7 of this catalog section illustrates the important difference in operation between a rack placed ahead of the front wheel centerline and one placed behind it.



What's the difference between "front steer" and "rear steer?"

In the illustration at left, note that the pinion engages the rack from *underneath* in the case of front steer, and from *above* in the case of rear steer.

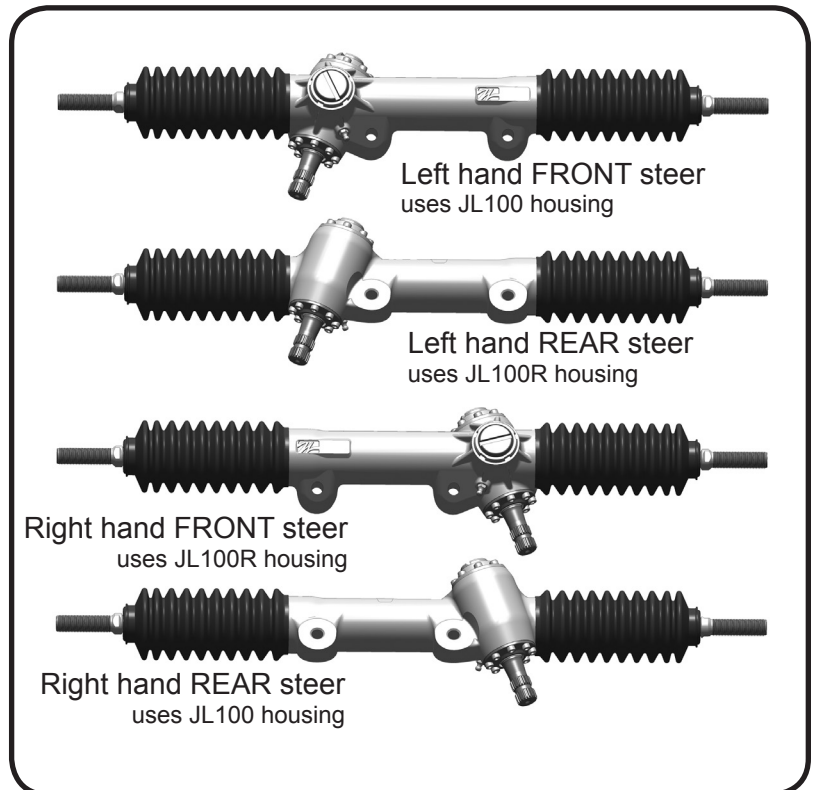
Note that if this condition is not met, the steering linkage will operate in reverse.

Mounting a rear steer rack:

Many car projects have been delayed when, after the fabrication has been finished and the chassis is powder-coated, it is suddenly discovered that the steering wheel turns backward, like a fork lift.

Since the vast majority of steering racks in existence are front steer, it is not uncommon for a front steer rack to have been mounted behind the wheels without realizing what would happen.

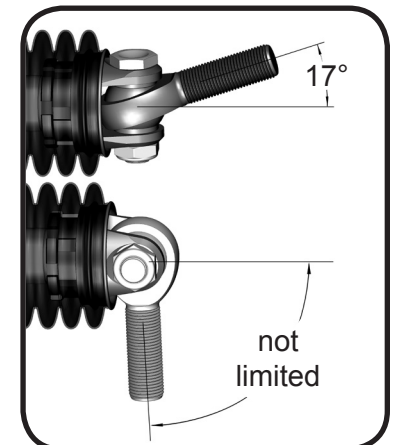
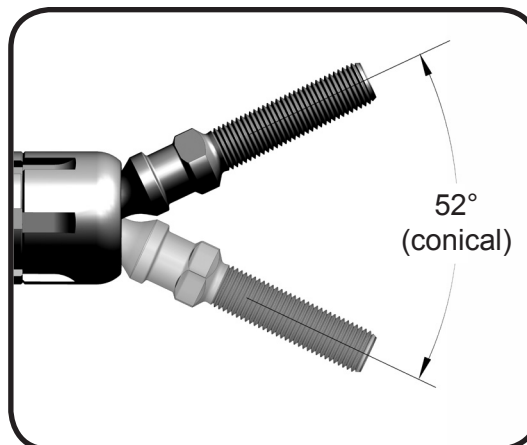
To operate in rear steer mode, it is not enough to simply invert a front steer rack to put the pinion on top, as that will also flip it end for end and convert it from left hand drive to right hand drive (or vice versa). For example, to obtain a Left Hand Rear Steer configuration, you must invert a Right Hand Front Steer rack. At right is shown how, regardless of drive hand, a rear steer mounting plate is *above* the rack.



Angular misalignment capacity of monoball versus clevis:

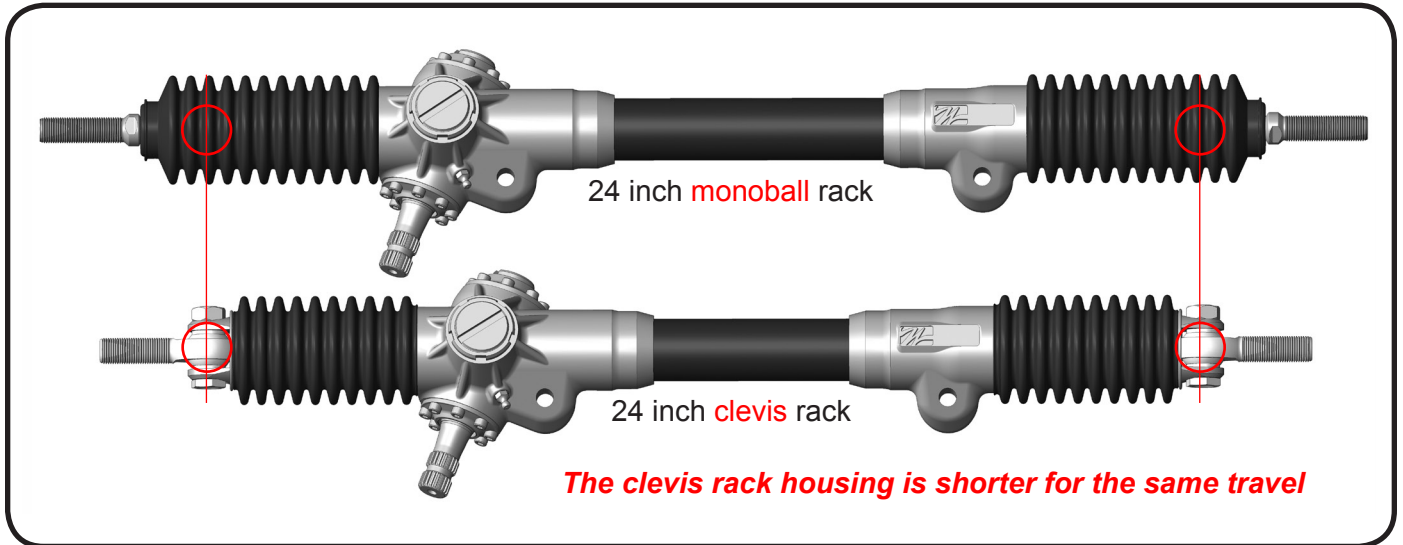
Monoballs are the obvious choice for the vast majority of racing and performance applications. However, **off-roading** involves quite extreme angles of suspension droop, which requires more tie-rod travel in the vertical plane.

The clevises can be oriented to allow extra vertical misalignment and are locked in place with spanner wrenches.



The effect of rack end type on JL housing dimensions:

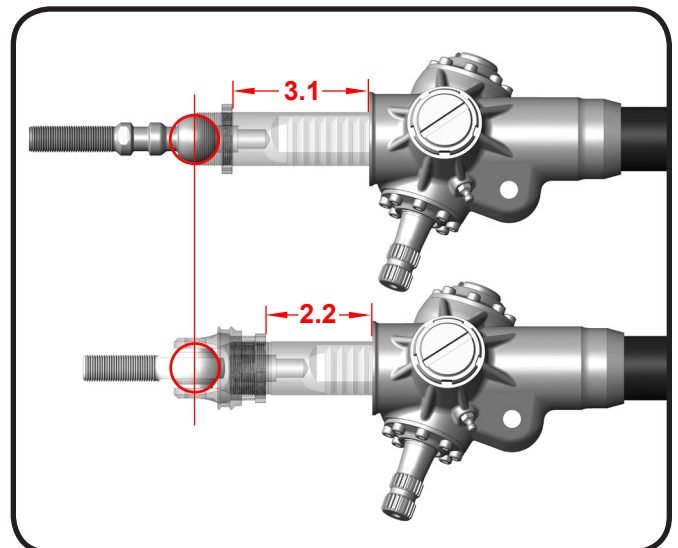
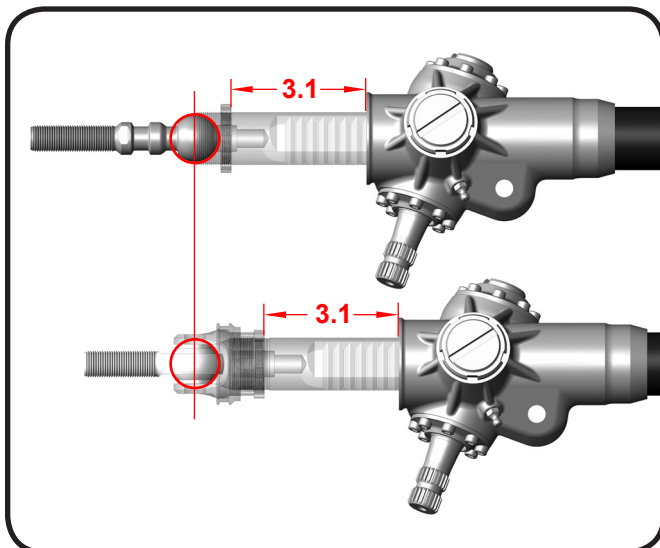
Unless otherwise specified, a long-style JL rack housing will allow 6+ inches of rack travel. Because the spherical center of a clevis end extends .89 inch farther from the rackshaft than a monoball end, the housing of a clevis rack must be shortened by twice that amount in order to allow the same travel as a monoball rack of equivalent length. The illustration below shows two JL racks, both 24 inches between spherical centers:



Both racks above are the same length (that is, they have the same spherical center distance). On the clevis rack the housing is made shorter to prevent loss of travel. This incidentally moves the pinion inboard by .89 inch. Note that to simply install clevis ends on a monoball rack would widen the rack's center distance by 1.78 inch, thus destroying its compatibility with a 24-inch front end. For any given rack length, the rackshaft and housing are machined to the specific length required for *either* monoballs or clevises but not both.

How the rack travel is affected by the housing length:

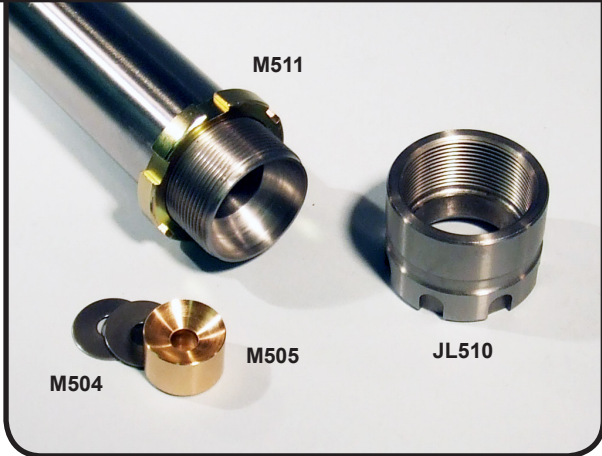
If the spherical center distance *and* the housing length of the two 24-inch racks were identical, the added overhang of the clevises would reduce the travel as illustrated below. While this is easily enough compensated for by shortening the housing, that compensation is only available on a "long" style rack with a tube in the middle. The "short" one-piece casting cannot be shortened any further. Therefore, the use of clevises on "short" style racks will always reduce the travel by the aforementioned 1.78 inch, or .89 per side.



Heavy-duty monoballs with adjustable preload

All new Woodward monoball racks now include Belleville spring washers and a solid bronze preloader. The rackshaft is machined internally for the preloader and spring washers. *Note: these parts will not fit into older plain monoball rackshafts.*

Monoball adjusting nut ("Swivel nut") JL510	54.68
Monoball locking nut ("Jam nut") M511	16.66
Preloader M505	24.94
Belleville spring washer (pair) M504	10.98
Complete adjustable-preload monoball kit for one end:	
Monoball unit including all above parts and 14mm stud M501A	150.00
Monoball unit including all above parts and 5/8-18 stud M501B	150.00
Monoball unit including all above parts and 3/4-16 stud M501C	150.00



High strength BALL STUDS are now available in three thread sizes.

Ball stud with 14mm x 1,5 threads **M512A** **51.05**
 Ball stud with 5/8-18 UNF threads **M512B** **51.05**
 Ball stud with 3/4-16 UNF threads **M512C** **51.05**

Woodward ball studs feature a contoured "bumper" that stops against the adjusting nut at the limit of angular misalignment. In crashes with thread sizes of 5/8 and smaller this feature has been proven over many years to confine breakage to the ball stud itself, leaving the spherical race of the adjusting nut untouched and reusable.

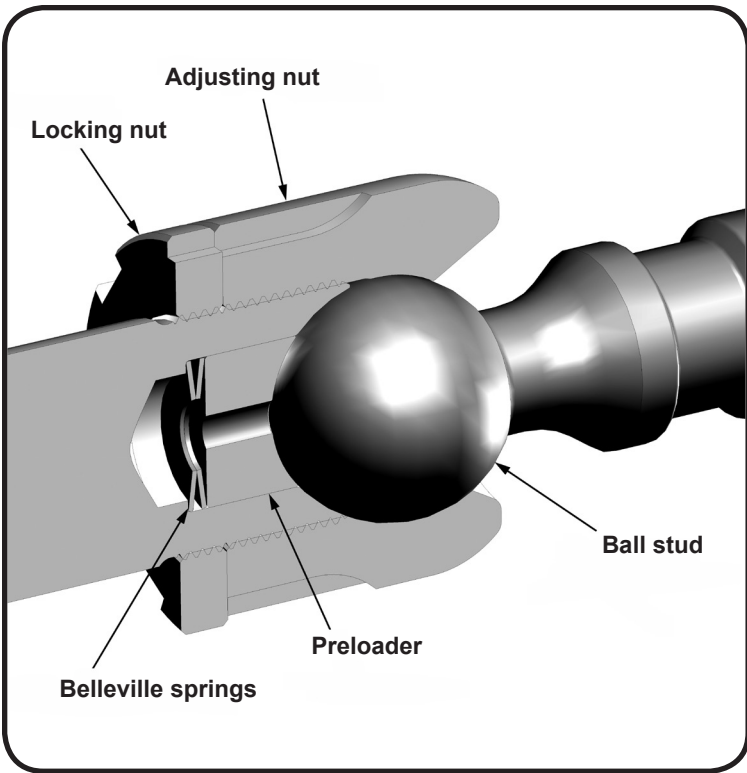
Easy, precise adjustment

Belleville springs provide a high spring rate over a very short range and can be adjusted to allow free movement with no perceptible play in the steering, according to the mechanic's preference. The stiffness can be further altered with optional spring washers of different thickness.

Both nuts take the M600-160 hook spanner. One nut has 6 slots and the other 7, which allows two wrenches to be positioned for a powerful "squeeze" without applying any turning force to the rack itself. Wrenches and sets are shown on the next page.

Always tighten (or loosen) the locking nut and adjusting nut AGAINST EACH OTHER.

NEVER TURN THE MONOBALL OR LOCK NUT WITH A SINGLE WRENCH AGAINST THE RESISTANCE OF THE PINION!

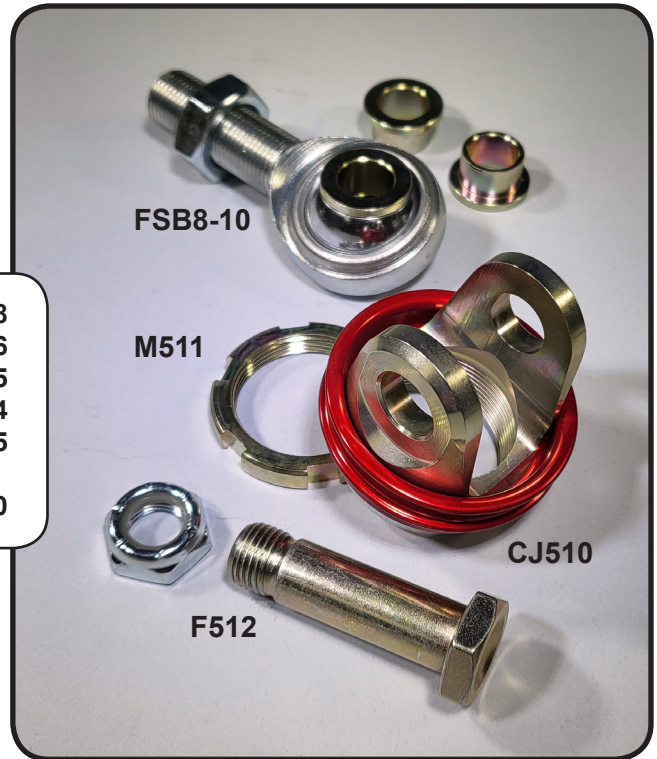


Clevises for use with spherical rod ends

Type JR and JL racks are now available with clevis ends. These include a close-fitting half-inch bolt in double shear and a 5/8 rod end equipped with misalignment spacers. The bolt shank passes through both sides and does not bear on the threads. At .938 wide, the clevis will also directly accept a -8 rod end of the high misalignment type.

Clevis F510	54.68
Locking nut ("Jam nut") M511	16.66
Close-fitting bolt w/elastic stop nut F512	18.95
Rod end with hat spacers FSB8-10	34.94
Hat spacers (pair) for standard 5/8 rod end F515	12.25
Complete clevis kit for one end CJ501A	125.00

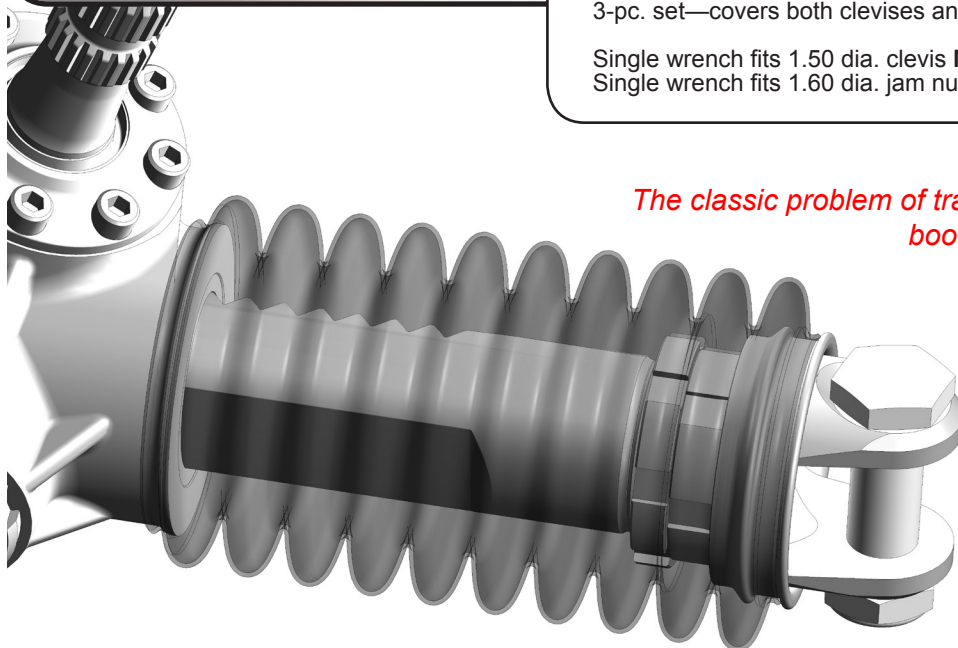
The clevis is locked in position using an M600-160 hook spanner in a slotted jam nut, just like a monoball—except in this case one of the hook spanners used is the smaller M600-150 which fits the diameter of the clevis. The locking nut has six notches and the clevis seven (alternatively, the clevis can be kept from turning by putting a half-inch rod through the bolt holes).



Hook-type spanner wrenches and sets

These wrenches fit perfectly and provide a more positive grip than general-purpose jointed hook spanners. The overall length of about 9 inches (228mm) provides plenty of leverage—no need to use a hammer and screwdriver. Heat treated 4130 alloy steel.

2-pc. set for monoballs M601 (pair of M600-160)	61.50
2-pc. set for clevises M602 (one M600-160 and one M600-150)	61.50
3-pc. set—covers both clevises and monoballs M603	90.35
Single wrench fits 1.50 dia. clevis M600-150	32.75
Single wrench fits 1.60 dia. jam nut or monoball M600-160	32.75



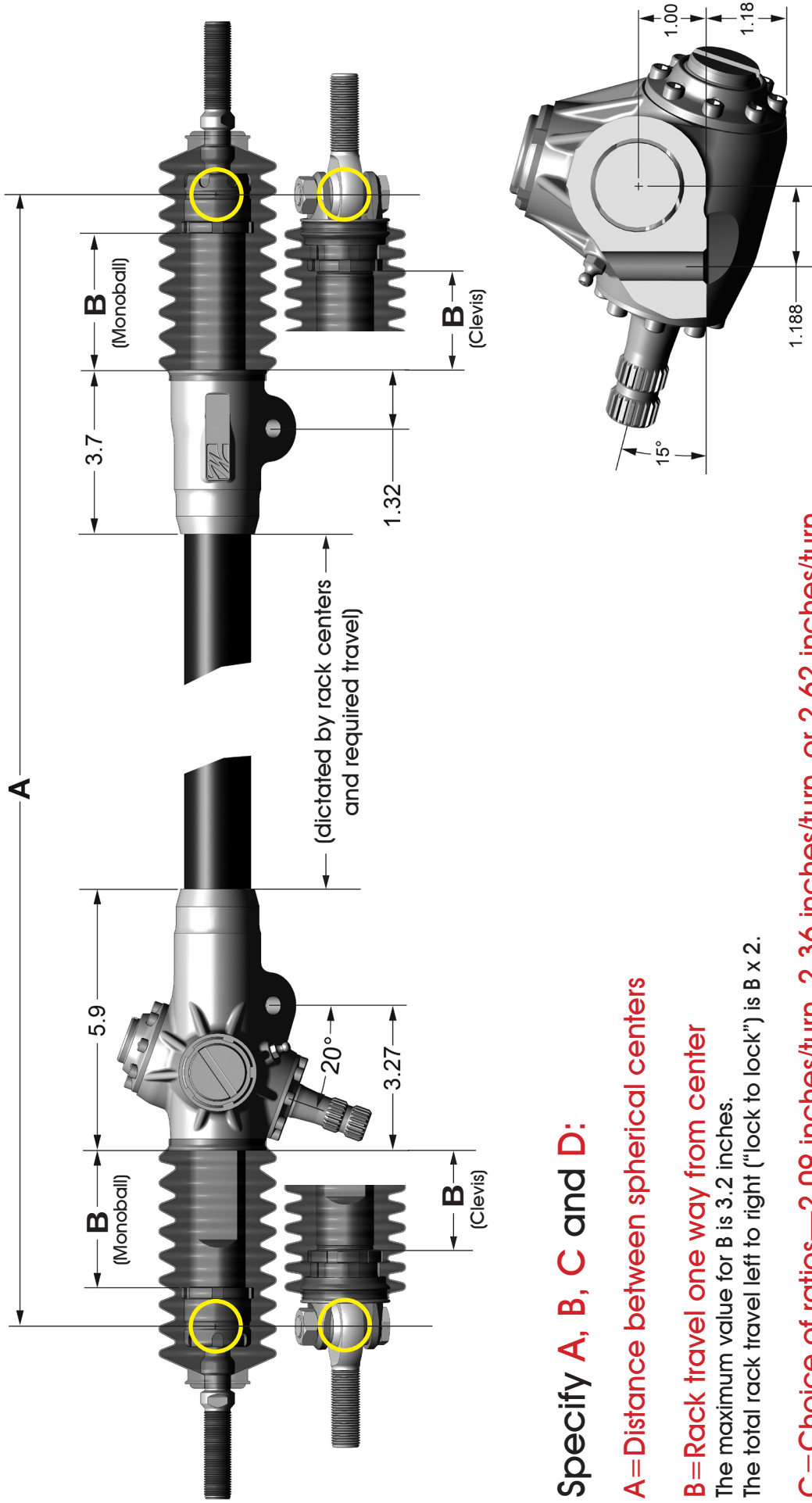
The classic problem of travel interference from stacking the boot solid has been largely eliminated by recessing most of the clevis body inside the boot.

The pressed-on, machined aluminum lip extends the boot well beyond the point where the clevis contacts the end of the rack housing.

Data needed to build a “long” type JL Rack and Pinion

Applies to right or left hand drive, front or rear steer (LHD front steer is shown)

Note: Dimensions already shown in the drawing are provided for reference and cannot be changed.



Specify A, B, C and D:

A = Distance between spherical centers

B = Rack travel one way from center

The maximum value for B is 3.2 inches.

The total rack travel left to right (“lock to lock”) is $B \times 2$.

C = Choice of ratios—2.09 inches/turn, 2.36 inches/turn, or 2.62 inches/turn

For reference, to obtain the number of turns lock to lock divide your total rack travel by the ratio, e.g. $6.0 \div 2.09 = 2.87$ turns. Note that the number of “turns lock to lock” is NOT the steering ratio. The ratio, or quickness, is the distance a rack can travel IN ONE TURN.

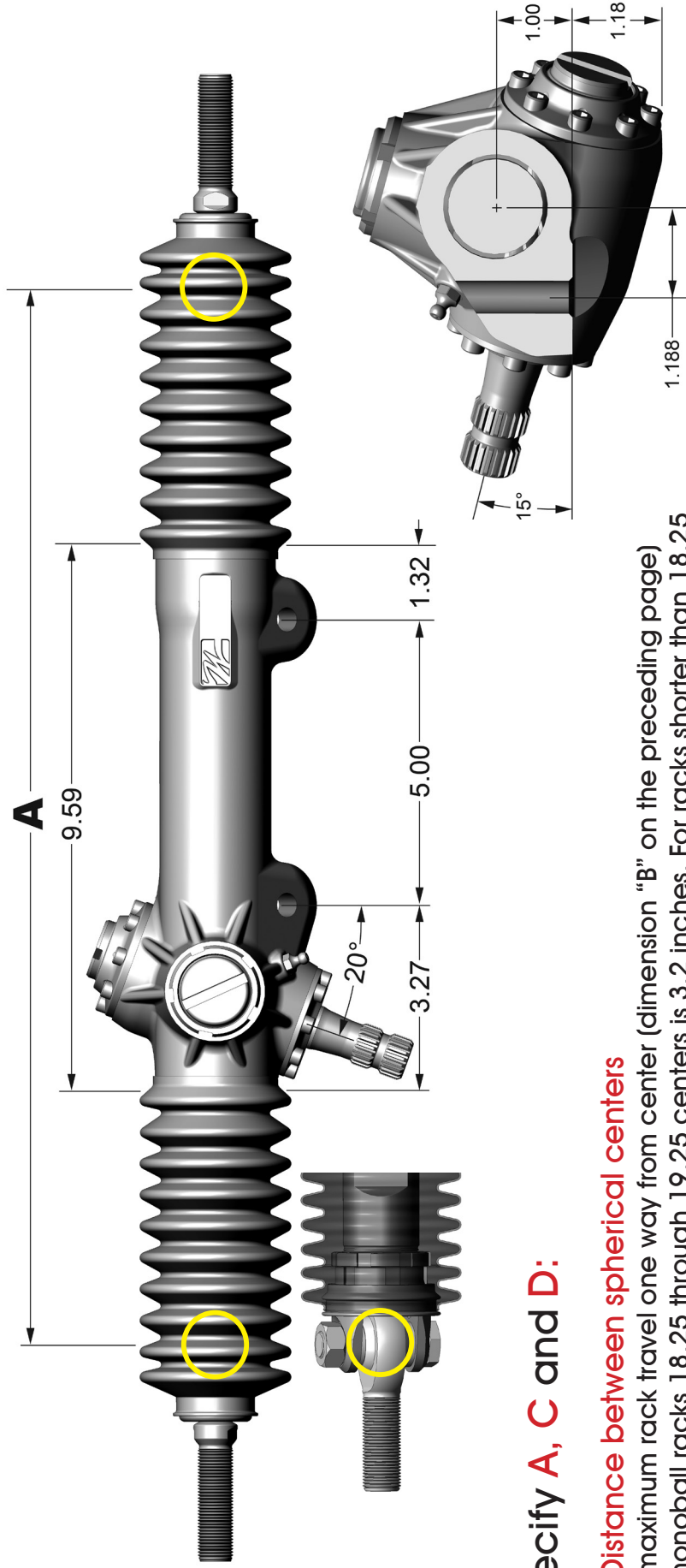
D = Choice of monoball stud threads—14mm x 1.5, 5/8-18, or 3/4-16

To find the length of the required tie rod adjuster sleeve, refer to the tables in Catalog section 9, “Suspension Links and Tie Rods.”

Data needed to build a “short” type JL Rack and Pinion

Applies to right or left hand drive, front or rear steer (LHD front steer is shown)

Note: Dimensions already shown in the drawing are provided for reference and cannot be changed.



Specify A, C and D:

A=Distance between spherical centers

The maximum rack travel one way from center (dimension “B” on the preceding page) for monoball racks 18.25 through 19.25 centers is 3.2 inches. For racks shorter than 18.25 the travel will be correspondingly shorter. *Note that clevises will reduce travel by .89 per side over monoballs, which cannot be compensated for by shortening the one-piece housing.*

C=Choice of ratios—2.09 inches/turn, 2.36 inches/turn, or 2.62 inches/turn

For reference, to obtain the number of turns lock to lock divide your total rack travel by the ratio; for example, $6.0 \div 2.09 = 2.87$ turns. *Note that “turns lock to lock” is NOT the steering ratio. The ratio, or quickness, is the distance a rack can travel IN ONE TURN.*

D=Choice of monoball stud threads—14mm x 1.5, 5/8-18, or 3/4-16

To find the length of the required tie rod adjuster sleeve, refer to the tables in Catalog section 9, “Suspension Links and Tie Rods.”