

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 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 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.

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.

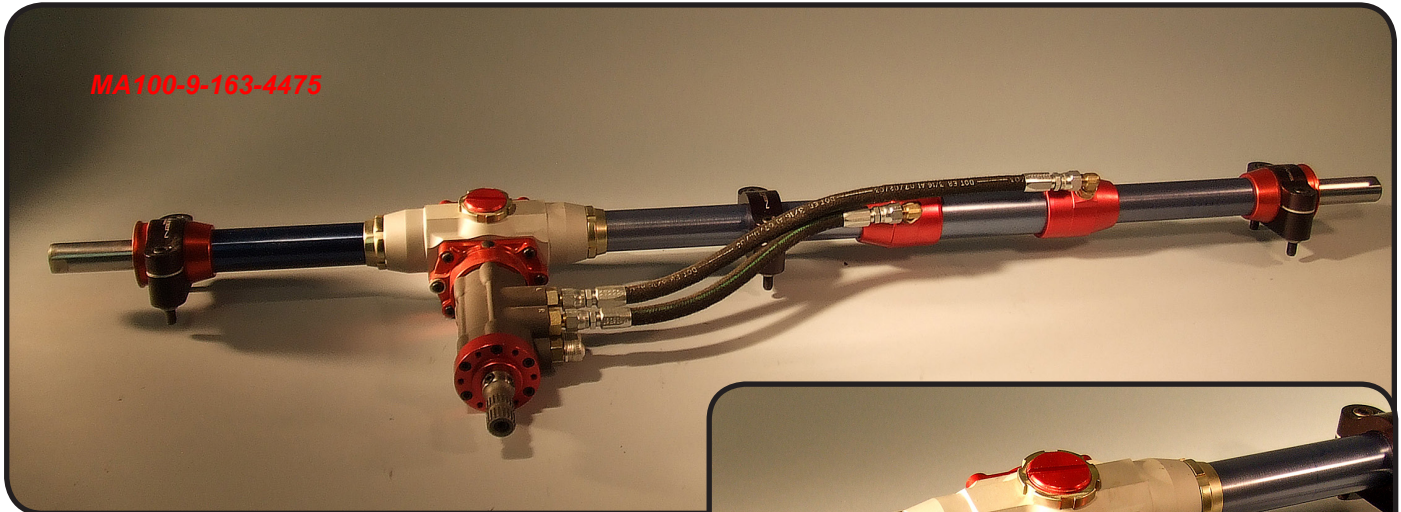
SPECIAL ORDER PARTS:

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.

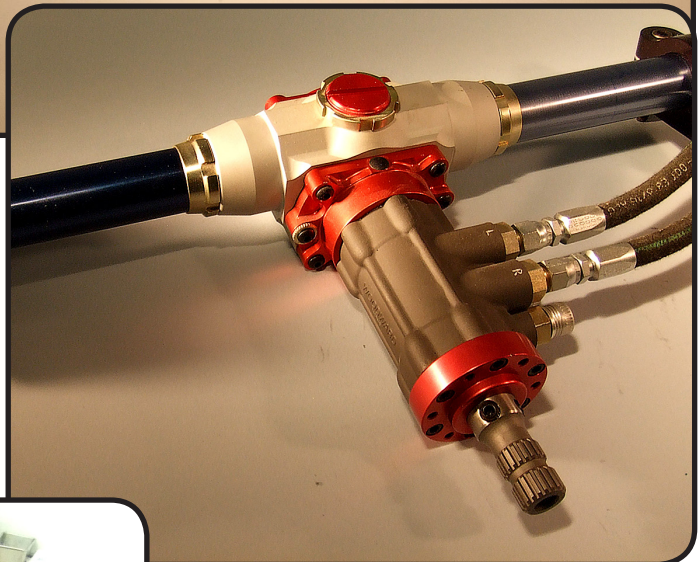
Type MR Power Racks

Power steering with **integral cylinder and servo**, for road racing and proprietary supercars

For installations requiring relatively long pivot centers. The straight-cut spur pinion has only rolling action and develops no end thrust. Elimination of end thrust means elimination of the sliding action common to angled pinions with helical teeth, a major source of frictional losses. With the extra thrust-bearing structure rendered unnecessary, the MR is vastly lighter in weight than any production-car power rack. It is especially suited to mid-engined race cars where the pinion can be directly aligned with the driver.



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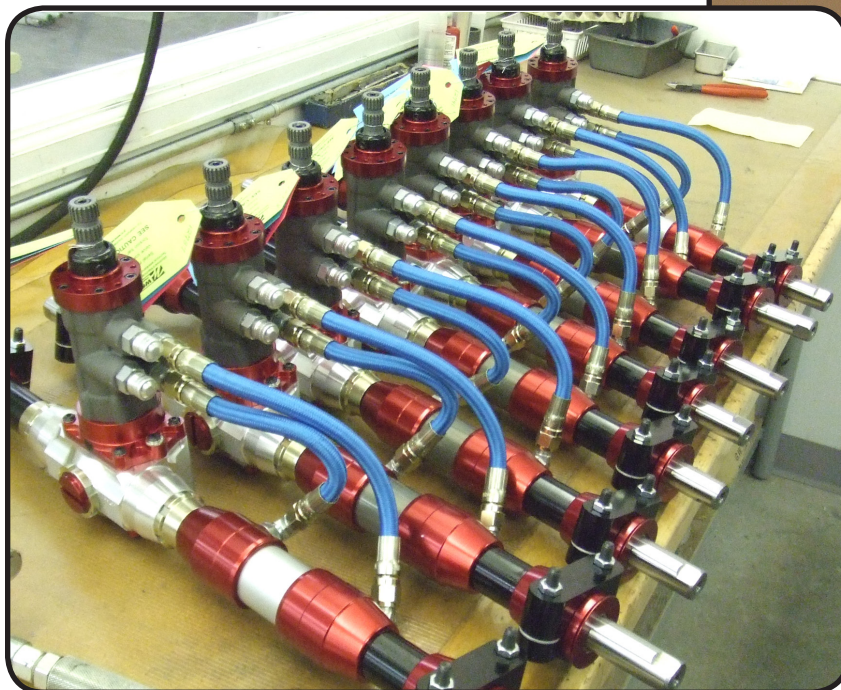


Steering Ratios and Rack Travel

MR racks are available in ratios of 2.02 (51mm), 2.24 (57mm) per turn. They can be furnished as left or right hand, front or rear steer, offset or centered, and with a maximum travel of 5.38 inches.

Rack Length

In its most popular application (mid-engined supercars) the MR is installed on a level with the upper control arm pivots, which means it will be fairly long as in the example above. Very short racks are also possible; some of these are shown in the picture below. The minimum length possible to build generally depends on the rack stroke and the pinion location.



Cost and Lead Time

An MR rack prototype typically costs US\$4400 with a 4 week lead time following customer approval of the 3D CAD model. To obtain a design proposal and a quote please specify the following details so we can determine how one can be manufactured to fit your application:

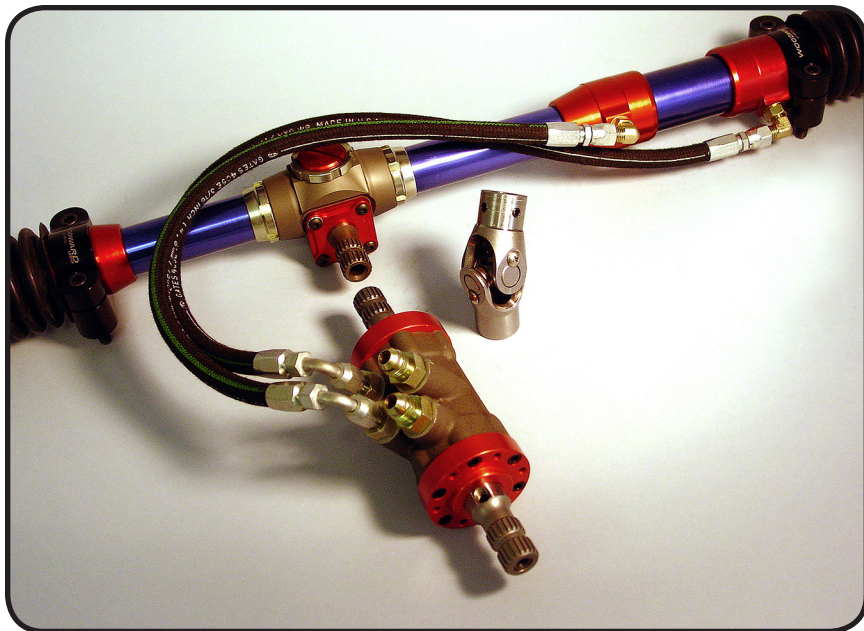
- (1) Distance between spherical centers
- (2) Total rack travel required L to R
- (3) Ratio (rack travel per revolution)
- (4) Pinion location relative to center
- (5) Front or rear steer (i.e. whether the rack is to be located ahead of or behind the front wheels)

Please bear in mind that not all dimensional combinations are possible. For example, the MR rack has an integral hydraulic cylinder. What is often overlooked is that the rack teeth must move the full travel without entering the cylinder. This fact imposes a definite minimum on the length of the rack housing, which dictates a minimum length for the rackshaft, which must protrude from the housing at each end by a distance equal to half the travel.

Type MRC Power Racks

Power steering with **integral cylinder and inline servo**, same applications as MR series

For type MR applications where severe space conflicts exist in the area of the pinion housing, or where the lightest possible weight is the primary concern. MRC racks use the much smaller housing of the MC manual rack. With this setup the servo is mounted independently and is connected to the pinion through an intermediate shaft and/or universal joints. Like the MR, these racks can be made left or right hand, front or rear steer, offset or centered, with a maximum stroke of 5.38 inches (136mm) depending on pinion location. While functionally identical to the integral-servo MR, separating the servo from the pinion removes some dimensional constraints and incidentally enables the use of some additional gear ratios. The hollow pinion is extremely light. Its straight rolling contact with the rack develops only radial loads which are taken by three ball bearings. The absence of end thrust enables the housing to be miniaturized. It has been described as "a scale model rack and pinion, but with an output of 1800 lb-force (8,2kN)." Although there are no functional limitations on its distance from the rack, the servo should not be mounted within the driver's compartment in a way that could directly expose the driver to the radiant heat of operation or to hot fluid.



Steering Ratios

MRC racks are available in ratios of 2.02 (51mm), 2.24 (57mm), 2.69 (68mm), and 3.14 (80mm) per turn.

Clevis Rack Ends

MR, and MRC racks are equipped with heat treated alloy steel clevises which accept high-misalignment rod ends in 5/16 and 8 mm bolt sizes.

Cost and Lead Time

The typical cost of a prototype MRC rack is USD\$4600 with 4-5 week delivery after approval of a 3D CAD model. In order to quote an MRC we must have the following information:

- (1) Distance between spherical centers
- (2) Total rack travel required L to R
- (3) Ratio (rack travel per revolution)
- (4) Pinion location relative to center
- (5) Front or rear steer (i.e. whether the rack is to be located ahead of or behind the front wheels)

When considering the MRC design, please bear in mind that some dimensional combinations may be impossible. Like the MR, the MRC is normally built with an integral hydraulic cylinder. The part of the shaft which slides in the cylinder obviously cannot occupy the same space as the rack teeth. In most cases, the smaller pinion housing of the MRC rack will permit offsetting the pinion somewhat farther to one side than is possible with the MR, making it possible to package a shorter rack.

The MRC is as close to a pure racing component as has ever been produced, and is rapidly becoming the go-to solution for all kinds of prototype race car projects.

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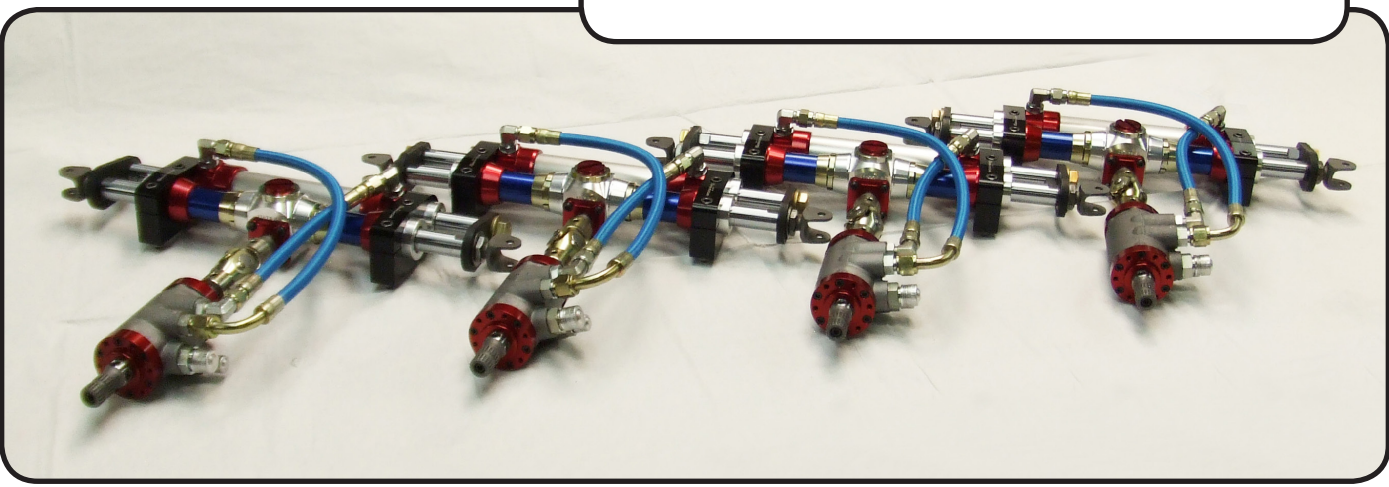
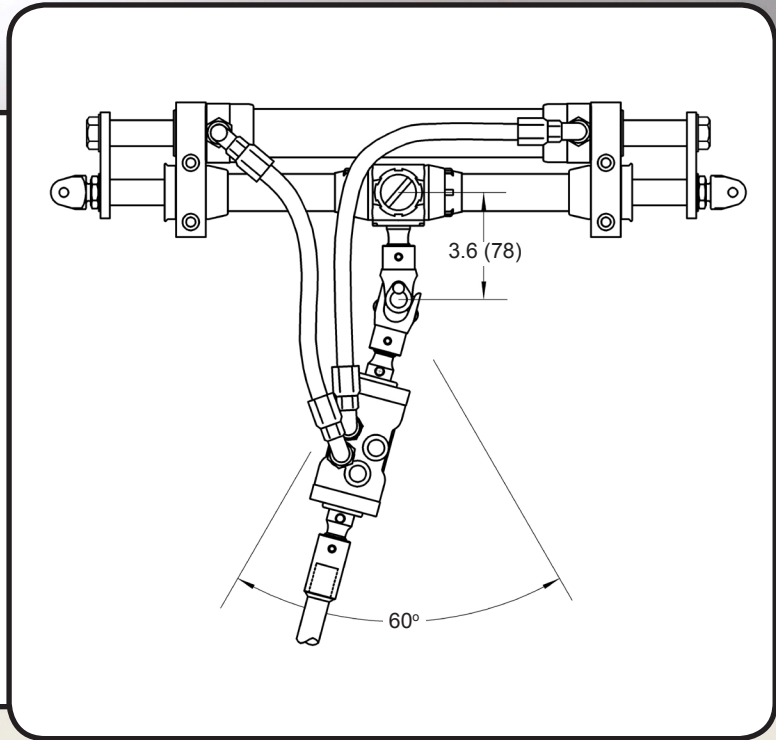


Extreme Packaging Solutions

In cases where a very short rack needs power assist (or one with a centered pinion, as in many single- or two-seater race cars) the hydraulic cylinder can be fixed parallel to the rack as shown on this page. This eliminates interference with the rack teeth and opens the possibility of longer rack travel than ordinarily possible with an integral cylinder. This construction is quite robust and in fact has been retrofit into a number of Porsche 911s.

Lightest Weight

It's also worth mentioning that an MRC power rack is a much lighter total assembly than a manual rack driven by an electric gearmotor. Since in hydraulically assisted steering the power is amplified on the OUTPUT side, all the components (gear teeth, housing structure, etc) can be made much lighter than if they had to transmit amplified INPUT. In this system the gears are essentially relieved of all but the very low torque used to open the servovalve, and the rack is practically immune to the play which commonly develops after a few laps with an electric column drive.



Remote Air Bleed Option Available on MR and MRC steering racks

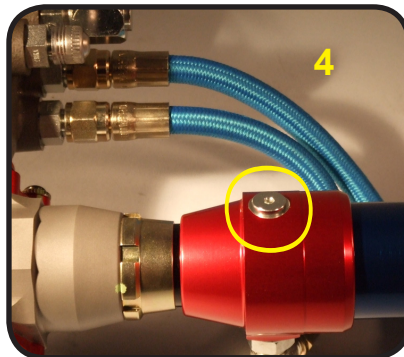
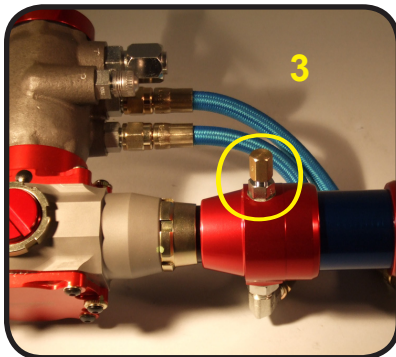
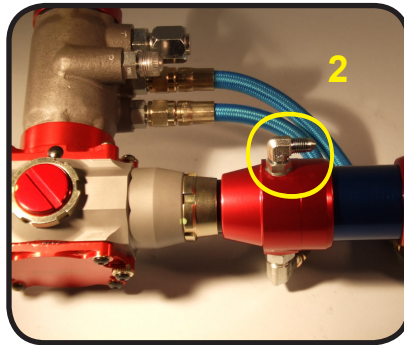
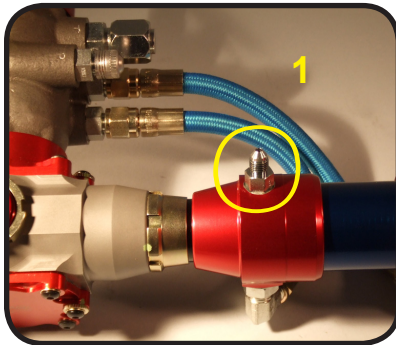
Air is a compressible medium. If present in the fluid it will create weak, chattering, and generally non-positive steering. In order to allow air to escape from the cylinder, its fluid ports must be located within the upper 45 degrees (between 10:30 and 1:30 as installed in the car). Where this is not possible because of interference by other components, the cylinder ends can be machined for a remote bleeder system. This is least expensive if done at the time the rack is originally manufactured, but can be added later in conjunction with a teardown and rebuild.

Instead of installing brake bleeders directly in the cylinder (in what is usually one of the least accessible places on a race car) the cylinder is connected through ordinary AN-3 brake hoses to a block containing the bleeders. This light, compact block is fastened to the chassis in a location easily reached by the mechanic with a 5/16 or 8mm box-end wrench. The bleeders are equipped with internal check valves which prevent air from being drawn back into the cylinder as it reverses direction. This allows each side to be quickly and easily purged of air with the steering under pressure, without dismantling or disassembly.



REMOTE BLEEDER KIT includes bolt-down block, bleeders with internal check valves, all hose adapters, and AN/JIC-3 O-ring ports machined in the rack at time of order.

V375 **215.00**
Retrofits quoted separately or as part of rebuild



Typical use on type MR Rack:

In this case the pressure lines had to pass through a hole in the front bulkhead of an FIA monocoque which is not permitted to be enlarged or modified. To get through the hole they were forced to connect on the bottom side of the cylinder. This type of connection is guaranteed to trap air, and means the rack must be removed and inverted in order to bleed it.

The remote bleeder option offers a variety of solutions to cope with obstructions. Fittings supplied with the kit are (1) O-ring boss to AN/JIC straight male flare, (2) O-ring boss to orientable 90 degree AN/JIC male flare, (3) hex cap for male flare, and (4) O-ring 140 barflush plug. Hoses are supplied by the customer to fit the car. Any -3 high-pressure hose (such as race car brake line) may be used provided it has a working pressure rating of 2000PSI (140 bar).

NOTE: while it is possible, although somewhat messy, to use the hex cap (3) as a makeshift bleeder, the flush plug (4) is threaded *directly into aluminum* and should never be loosened under pressure.