

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. The lead time to build a type MC steering rack is typically one week (excluding holidays).

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:

Parts in this catalog section are not stocked but are 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 MC Manual Racks

Manual steering for FSAE and F/Student projects and lightweight formula cars

The MC rack uses the same mounting clamps as the MR power racks as well as the same clevises. Like the power racks, the mounting points are located a fixed distance from the ends of the housing, which is calculated to result in the minimum possible shaft overhang and the greatest tie-rod stability. Like all Woodward racks these units have the .750-20 pinion spline, which provides a substantially more positive engagement than the .562-36 usually found on small steering racks. To achieve equivalent light weight, the pinion is hollow. The MC incorporates the same level of engineering as the steering racks we make for high-end race cars, and delivers the most function per dollar of anything offered for Formula SAE and Formula Student projects, with **quick delivery at reasonable cost**. To make that possible, we do not incorporate ion-implanted unobtainium or other exotic materials, nor do we offer any student discount.

Custom MC Racks

To obtain a quote for a custom MC rack to fit your project, please provide the following data:

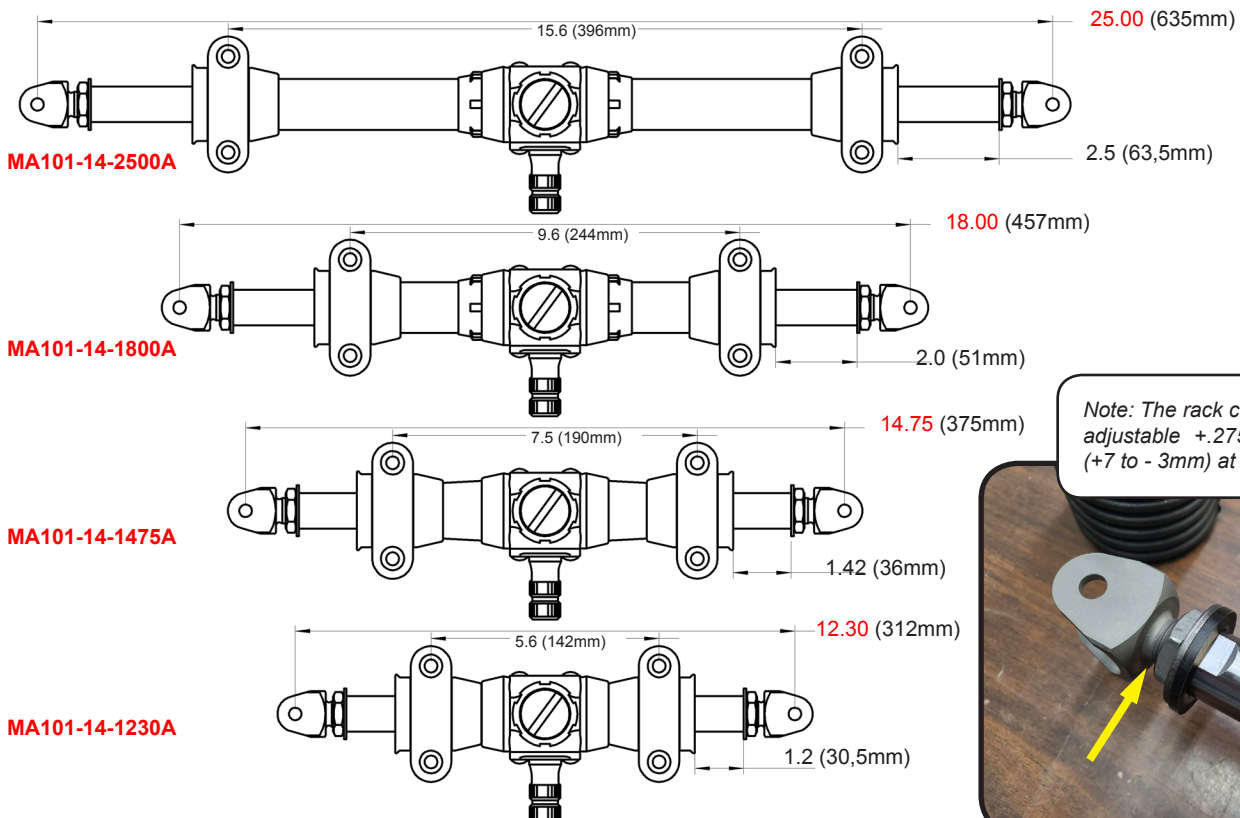
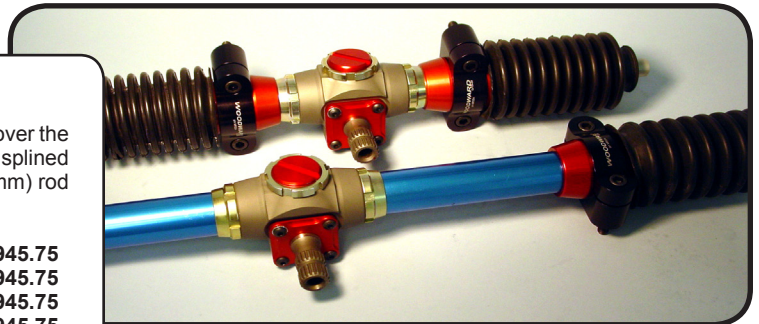
- (1) Pivot center distance (2) Total rack travel required L to R
- (3) Ratio (rack travel per revolution) (4) Pinion location relative to center (5) Front or rear steer (i.e. whether the rack is to be located ahead of or behind the front wheels)



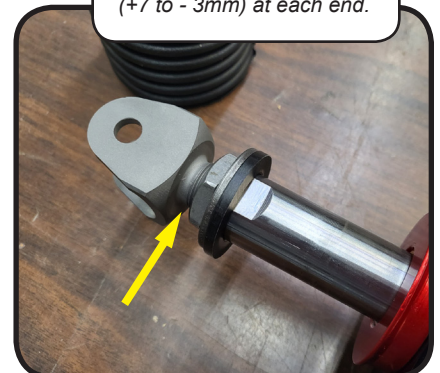
Standard MC Racks

The most popular dimensions for FSAE and F/Student over the past few decades, all 3.14 (80mm) per turn. Includes weld-on splined coupler, mounting clamps, rubber boots and clevises for 5/16 (8mm) rod ends.

MA101-14-2500A	945.75
MA101-14-1800A	945.75
MA101-14-1475A	945.75
MA101-14-1230A	945.75

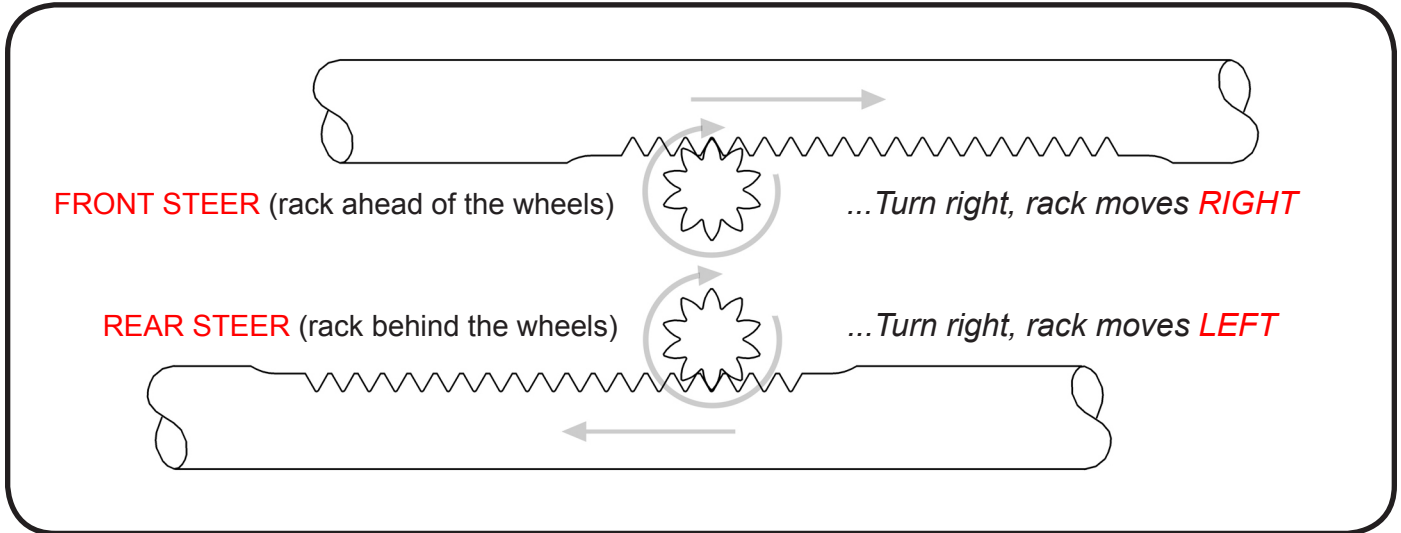


Note: The rack clevises are adjustable +.275 to -.120 (+7 to -3mm) at each end.



Basic Steering Rack Configurations

FRONT STEER vs. REAR STEER



Note that the pinion engages the rack from *underneath* in the case of front steer, and from *above* in the case of rear steer. If this condition is not met, the steering linkage will operate in reverse. This very fundamental error has been made countless times when building a race car for the first time.

Fortunately, any center-pinion type MC steering rack can be converted between front and rear steer by simply inverting it in its mounting clamps. An offset-pinion MC rack can be converted the same way but also requires unscrewing the housing tubes and exchanging left and right.

Basic Steering Rack Configurations

STEERING RATIO

The “gear ratio” of a rack and pinion conventionally means the *linear distance traveled by the rack-shaft in one turn of the pinion*. The larger the pinion, the more teeth it has. The linear pitch (spacing) of the rack teeth is the same as the circular pitch of the pinion teeth at .2244 inch. Multiplying this pitch by the number of teeth on the pinion gives the linear distance traveled per turn, e.g. 9 teeth x .2244 = 2.02 inches, 12 teeth x .2244 = 2.69 inches, and so forth. MC racks are available in gear ratios of 2.02, 2.24, 2.47, 2.69, 2.92 and 3.14 ratios.

The *overall steering ratio* of the assembled car refers to the angle the steering wheel is turned (example: 180 degrees) divided by the resulting steered angle of the tire (example: 30 degrees)—in this case the ratio is 6:1.

The gear ratio of the rack and pinion is only one factor, the other being the length of the steering arm on the spindle or upright (also known as the Ackermann Arm, Lever Arm, or Toe Link). A long arm requires a longer stroke of the rack to achieve a given steered angle than does a short arm, and thereby produces a slower overall steering ratio.

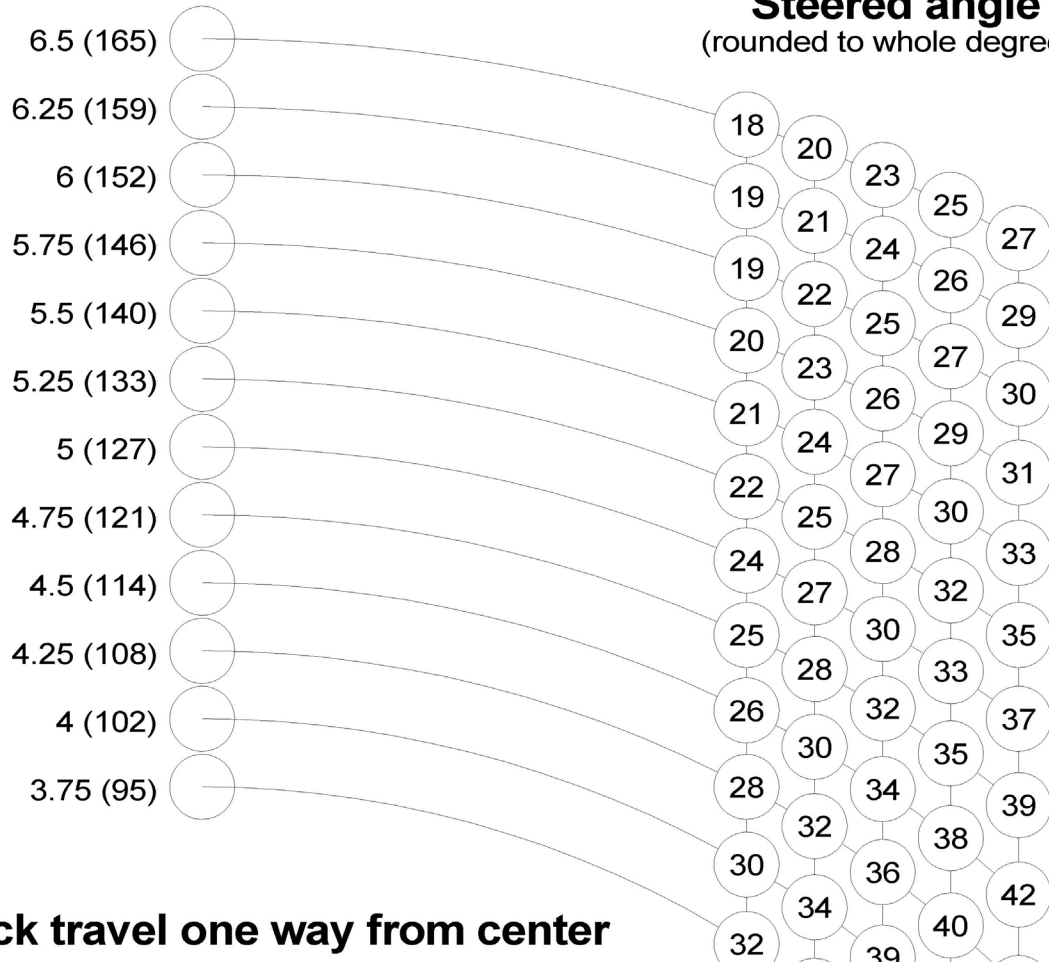
The “cheat sheet” on the following page shows the approximate steered angle produced by various combinations of steering arm and rack travel. Applying the rack ratio, simple arithmetic will translate the linear travel into the number of turns of the steering wheel needed to achieve the steered angle.

Steering arm

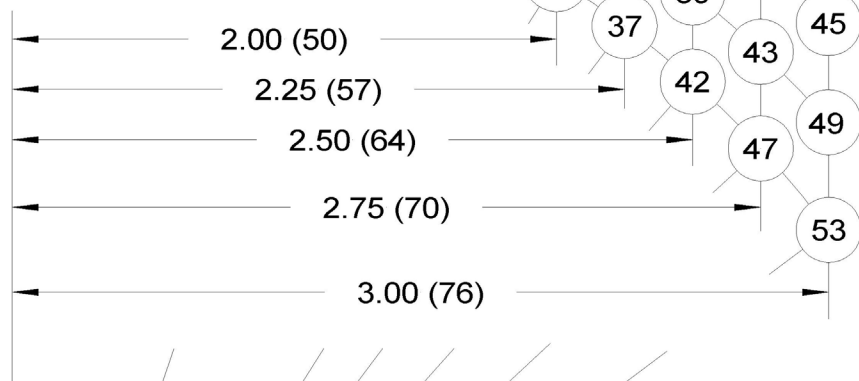
inches (mm)

Steered angle

(rounded to whole degrees)

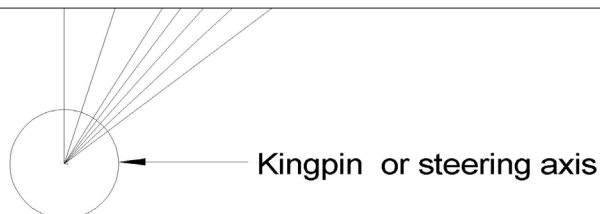


Rack travel one way from center



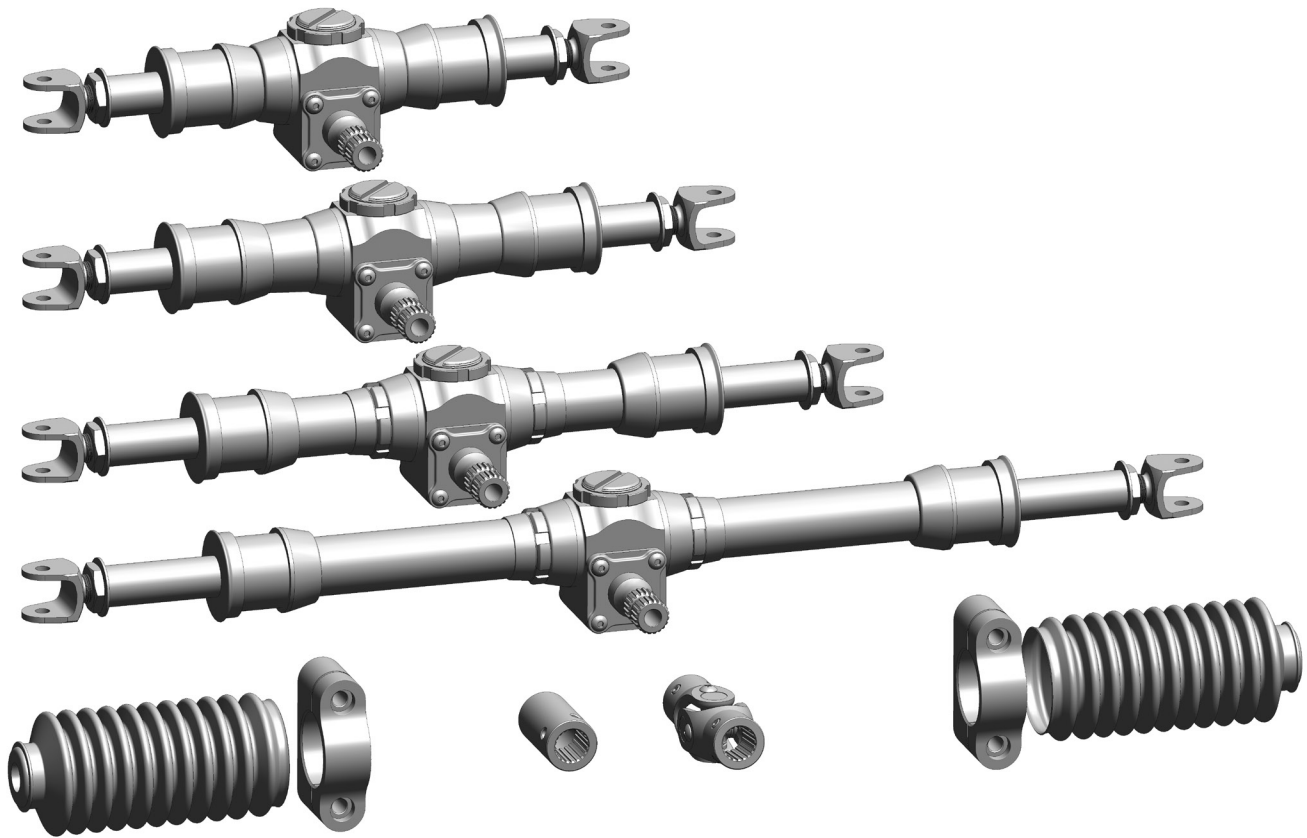
Approximate full-lock turning angles given steering arm length and rack travel

NOTE: For simplicity, this diagram assumes the outer tie rod end moves parallel to the rack axis, which is actually only true of the inner end. This diagram also does not take into account positive Ackerman geometry built into the steering arm, which accelerates the steering of the outside wheel while retarding the steering of the inside wheel.



FSAE/Formula Student 3D CAD MODELS AVAILABLE ON REQUEST:

MA101-14-1230A Steering Rack
MA101-14-1475A Steering Rack
MA101-14-1800A Steering Rack
MA101-14-2500A Steering Rack
MR35A Mounting Clamp
MR360 Boot
C201 Weld-on Splined Coupler
UA201201 Splined Universal Joint



E-mail request to tech@woodwardsteering.com; specify file format:
Solid Works (.sldprt)
Parasolid (.x_t)
STEP (.stp)
IGES (.igs)

Request must include contact name, phone number and physical address including ZIP or postal code