

Wheel Alignment Guide - DIY Alignment

WITH A FEW BASIC TOOLS AND THE KNOW-HOW SHARED HERE, YOU'LL NEVER AGAIN BE AT THE MERCY OF AN ALIGNMENT SHOP

Photography by Matt King, Randy Lorentzen/Planet R

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Most gearheads understand the basic definitions of caster, camber, and toe, but when it comes to actually measuring or setting these wheel-alignment specs, the easy solution is to bring the car to a professional shop. For cruisers where an alignment is a set-it-and-forget-it proposition, that's probably OK. But if you enjoy the satisfaction of knowing how to do it yourself, or if you expect to be making enough alignment changes that taking your car to a shop every time would be expensive and impractical, you'll benefit from adding alignment skills to your mental toolbox.



Aligning a car may seem like one of those voodoo sciences that makes no sense if you've never actually seen it done, but as we learned by doing in preparing this article, the process is really quite straightforward if approached logically. The most difficult and time-consuming part of the process is setting up your equipment to get accurate, repeatable results. Most critical is having a flat, level spot to work from, and as you'll read, we've come up with a simple way to accomplish that so you can set alignment in your garage, shop, or even at the racetrack.

Although a bit more advanced and requiring more expensive tools than a basic alignment, we've also included information on measuring and adjusting bumpsteer and scaling and corner-weighting a car—techniques that are critical to properly setting up any race car or high-performance street machine for optimum handling.

Even if you're not racing, having all your car's wheels pointed in the right directions is a good idea, and you might be surprised at how much better your car drives after being aligned, not to mention the fact that your tires will probably last longer once you learn how to do your own alignments. Even if you just want to set it and forget it.

Scaling and Cross-Weighting

Knowing your car's weight is handy, but knowing how that weight is balanced is critical for a race car and can be measured easily with the Longacre Accuset scale system, which costs about \$1,100. If you don't need this advanced data, you can still use the information here about how to level the scales before moving on to the basic at-home alignment procedure in the following pages.



For accurate corner weights, all four



We used floor tiles and sheetmetal



A set of corner scales is helpful when setting up the weight distribution and balance of a

scale pads must be on a level plane because variance

squares to shim each scale pad until all four sat at the



The digital readout on our Longacre Accuset computer scales displays individual corner weight

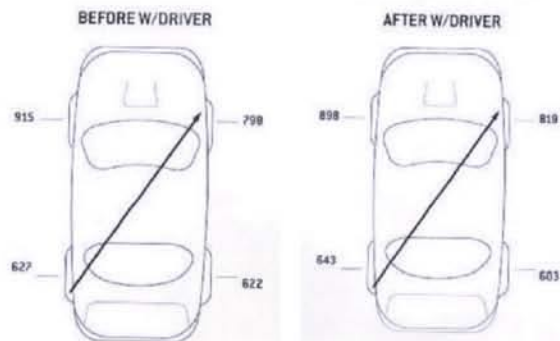


Weight is jacked around the car by adjusting the ride height at each corner. It's better to



We raised the ride height of our Mustang's left-rear corner by 1/2 inch using a pair of polyurethane spring isolators (arrow), which is about the maximum change you'd like to make at any corner.

These diagrams show the before-and-after results of corner-weighting our Mustang. Making a 1/2-inch ride height adjustment to the left rear resulted in a 1.1 percent increase in cross-weight to 49.2 percent, which represents 0.8 percent of reverse wedge. Notice that the left, rear, and total weights did not change. For more information on balancing the car's weight per wheel, see Marlan Davis' story "The Science of Scaling Your Car" in the Sept. '03 issue, or on the This Month page of HOTROD.com right now.



Left weight: 1,541, 52.0% Rear weight: 1,249, 42.1% Cross-weight: 1,425, 48.1% Total weight

Left weight: 1,541, 52.0% Rear weight: 1,246, 42.1% Cross-weight: 1,462, 49.2% Total weight

Scaling Tips

* Always measure cross-weights with the car in race-ready condition with all fluids full and driver weight accounted for.

* Develop a settling routine to use after each weight adjustment, either by rolling the car back and forth onto the scales or jouncing the suspension. Verify your procedure by weighing the car, jacking up one corner, and rechecking the corner-weights after settling. If the corner-weights vary, there is still some bind in the suspension. Refine your settling procedure until your results are repeatable before making any changes.

* Disconnect front and rear sway bars to eliminate the effect of sway-bar bind.

* Remember that weight jacking cannot shift weight from front-to-back or left-to-right. Only physically moving or adding weight can change the distribution within the car. (Small differences are the result of rounding.)

Your First Alignment

With some patience, it's actually very easy and cheap to set your wheel alignment at home. This page introduces you to the tools and basic terms you'll need to know. Refer to the previous section about scaling and cross-weighting to learn how to level all your wheel pads before you begin your alignment.



A set of jackstands, a few loose floor tiles, some heavy fishing line and weights, a steel



The key to accurate alignments is starting with a level surface. To accomplish that, we built



For the best accuracy, the car should be aligned in ready-to-race condition, with a full l

Alignment Terms

Ackerman Effect: Also called toe-out on turns, this occurs when the steering angle of the inside tire is greater than that of the outside tire when the wheels are turned. Ackerman is desirable because it helps the front end turn in to the corner.

Camber: The degree of deviation between the top edge of the tire and a true vertical line running through the center of the wheel. If the top of the tire tilts inward as seen from the front, camber is negative; if it tilts outward, camber is positive. A tire's traction is always greatest when the largest part of its contact patch is in contact with the road surface, and static camber can be dialed in to keep the tire perpendicular as the chassis rolls in a turn. Excessive camber results in accelerated wear on the inner or outer shoulders of the tires, but most street cars can benefit from up to 1-1.5 degrees of negative camber.

Caster: The deviation in degrees between an imaginary line running through the upper and lower ball joints and a vertical line running through the center of the wheel hub to the center of the tire's contact patch on the ground. If the imaginary line tilts to the back of the vehicle as viewed from the side, caster is positive; if it tilts forward, caster is negative. High amounts of positive caster cause the wheels to try to center themselves as the vehicle moves forward resulting in higher steering effort.

Cross-Camber: A side-to-side difference in camber settings. Many circle-track cars are set up to make lefthand turns with positive camber on the inside wheel and negative camber on the outside wheel.

Cross-Caster: A side-to-side difference in caster settings. Up to a half-degree more positive caster on the passenger side is often used on production vehicles to compensate for the effect of crowned pavement and keeps the vehicle from pulling to the outside edge of the road. Many oval-track racers run even higher amounts of cross-caster on the outside wheel to help the car turn down to a lefthand corner.

Toe Angle: Toe angle is the difference in track widths between the leading and trailing edges of the tires. If the track is wider at the front, the wheels are toed-out; if the track is narrower at the front, the wheels are toed in. Toe-in is used on most drag and production cars to compensate for slack in the steering components so the front wheels track straight ahead under forward thrust. Toe-out is often used on road-race cars to improve corner-entry turn-in, but excessive toe-out can cause dartiness on straightaways and tire wear.

Measuring Toe With the String Method

Very accurate toe measurements can be achieved by the string method, which involves stretching a perfectly squared rectangle of string around it to create a known point from which to measure. The simple-to-build rig consists of two lengths of 3/4-inch electrical conduit cut about 6 inches wider than the track width of the car, with holes drilled for the string to pass through on each end. The conduit is supported at each end of the car by a set of adjustable jackstands (we use screwdrivers to keep the conduit from rolling off, as seen in the photos) and a length of 60-pound-test fishing line is strung along each side of the car at the same height as the hubs. The string is squared by using a steel ruler to take measurements from fixed points on the chassis, such as the center of the wheel hubs or a machined flat on a wheel, and then sliding the conduit side-to-side until the string is an equal distance from the reference point on each side of the car. Note that the front and rear measurements may be different due to variations in track width, but the conduit ensures that the strings always remain parallel to each other. It will take several minutes of walking around the car making smaller and smaller adjustments until you get the string square. Record the measurements to speed up the process the next time. This will also help identify bent chassis parts in the future.



The exact length of each conduit isn't important, but the holes must be drilled the same d



The string method measures the toe angle of the wheels relative to the centerline of the vehicle.

Once the strings are parallel to each side of the car, center the steering wheel and use the



To find total toe, add the results from each side. We used the millimeter scale on the ruler.

Tips on Setting Alignment

* The effects of the various alignment settings interact, so adjust caster and camber first. Toe must be set last.

* If you run out of adjustment range, you may have to make compromises on caster and camber to get the specs equal side-to-side.

* Always work from a level surface to avoid introducing error into your measurements. For example, tilting the front or rear of the car up or down can affect caster measurements. Tilting it side to side can affect the camber readings.

* Center the steering wheel before measuring and setting the toe, and make all adjustments without moving it.

Measuring Camber

Camber measurements are easy with this inexpensive, yet highly accurate, caster/camber gauge from Maximum Motorsports, available for about \$60. To use it, steer the wheels straight ahead (which is easy to get perfect if you have strung the car), then hold the gauge firmly against each wheel and turn the knob until the bubble level is centered. Each mark on the knob represents 1/8 degree of camber (clockwise for positive camber, counterclockwise for negative). That's it. Our road-race Mustang is set up with about 3 3/4 degrees of negative camber per side.



Measuring Caster To measure caster, you must steer the wheels right and left to record the



The Maximum Motorsports caster/camber gauge is designed to make caster measurements at 20



With the wheel in the straight-ahead position, mark a line on the floor along the edge of



Hold the straightedge against the tire and turn the wheel until the 20-degree gauge lines



Caster is measured by calculating the change in camber from when the wheel is steered 20 d



Changing Settings Depending on the make and model of the car, alignment adjustments are m



On many muscle-era GM and Ford vehicles, alignment adjustments are made with shims placed

Bumpsteer

Caused by the control arms and steering linkage traveling through arcs with unequal radiuses, bumpsteer results in the undesirable effect of the front wheels steering themselves without driver input as the suspension compresses and rebounds. The result forces the driver to make additional steering inputs to keep the car turning in the desired direction, especially in tight corners as the car's suspension rolls while cornering. The problem is noticeable on stock-suspended cars that have been lowered, but it's prevalent on street rods with fabricated front suspension.



Measuring and correcting bumpsteer is relatively simple if you have the right tools, such



Begin by measuring the height of the hub above the floor at ride height. You'll need this



Remove the spring from the front suspension. The ease of this procedure varies with differ



With the brake caliper and bracket removed, attach the gauge board to the hub with a couple



Use a jack under the lower control arm to raise the hub to the predetermined ride height.



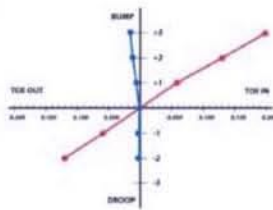
Set the baseplate against the gauge board with the fixed pointer at the rear and the dial



...recording the movements of the gauge board as the suspension moves through bump and dro



Bumpsteer is corrected by using a set of adjustable tie-rods ends that accept shims to alt



This graph illustrates the before and after plots of our Mustang's bumpsteer curves. In th

Bumpsteer Tips

*Always set toe and caster prior to bumpsteering a car because caster affects the height of the steering arms, which in turn affects the bumpsteer measurements.

*Shoot for zero toe-in and no more than 0.015-0.020 inch of toe-out on bump, especially in the first inch of travel.

*Some toe-out on the inside tire in rebound can help corner entry by creating an Ackerman-like effect as the car turns in.

Big Thanks To:

We couldn't have written this article without expert help and advice from Maximum Motorsports owner Chuck Schwynoch, who trained us during several phone conversations and trips to local racetracks. Although primarily known as late-model Mustang suspension specialists, Maximum Motorsports also sells several inexpensive alignment tools, including the caster/camber and bumpsteer gauges we used.