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C4 Autocross Alignment

By: Matt Kaufer

Autocross is a form of racing that is not only a lot of fun, but is also low risk and can be low budget. If you race within the stock classes, you are not allowed to make many modifications to your car and therefore you can stay competitive without shelling out large amounts of extra cash. One "modification" you can perform to your car, though, is to set the suspension alignment to any point within the car's factory range of adjustment. It's a common belief that you can't adjust suspension alignment without thousands of dollars of specialty equipment, especially on a car with independent rear suspension, such as a Corvette. In reality, however, with a few dollars worth of simple parts and tools, and a few hours of work (and patience), you can perform an accurate alignment on your Corvette that will give you a noticeable competitive edge on the track.

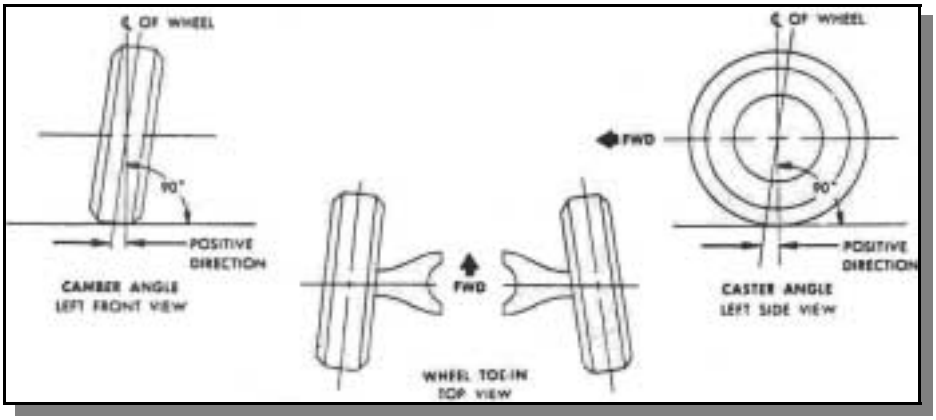

Figure #1: An illustration of camber, toe, and caster.

Before you start measuring and adjusting, it's important to understand exactly what a suspension alignment is comprised of. What you will be doing is adjusting the caster, camber, and toe of the wheels on your car. Caster is the tilting of the upper, front steering axis either forward (positive) or rearward (negative) from vertical. Think of a wheel on a grocery cart. The wheel axle is offset from where it is mounted on the cart and will fall in behind as you push the cart forward. As you drive your car forward, caster helps the steering to snap back to center and point straight in the direction you're heading. With any luck, your car wheels won't be wobbling like the ones on the grocery cart.

Camber is the tilting of the wheels either into or away from the side of the car. If the top of the wheel is tilting away from the car, the camber is positive. If the top of the wheel tilts toward the car, the camber is negative. When aligning a car for daily driving, you generally want the wheels straight up and down (0 degrees camber). When aligning a car for autocross or track driving, you want to dial in negative camber. While this may cause faster tire wear, it allows the tire to sit flat on the pavement as you go through a corner. This gives you a bigger tire footprint, better traction, and better cornering response.

Toe describes the direction the tires are pointing in relationship to the car. If the tires are toed in, then the front of the tires are pointing in toward the car. Toe out indicates the front of the tires are pointing away from the center of the car. Zero toe would have the wheels parallel to the car and to each other.

For a graphical representation of these terms, check out Figure #1. Also note that rear caster is not adjustable on a C4 Corvette, and the front caster is determined by shims in the front control arms. Since an autocross setup calls for a fair amount of negative camber, you'll end up taking out all the shims and you'll be left with whatever caster you get.

This article assumes that your Corvette's suspension is in top-notch shape. If your car has worn ball joints, bushings, etc., you will have a hard time maintaining an alignment whether it is done professionally or not. Now with that disclaimer out of the way, the first step to performing your own alignment is to establish a level surface for your Corvette to sit on. I performed the alignment on my '86 Corvette in my garage. At first glance, the floor appeared fairly level, but I found out there was about a 2" height difference from the front to the back. As you can see in the pictures, my rear leveling pads are considerably thicker than those in the front. The pads were constructed of various materials including 1/8" thick masonite, 7/16" and 1/2" particle board, and 1 1/2" thick 2x10's. The masonite and particle board pieces were cut

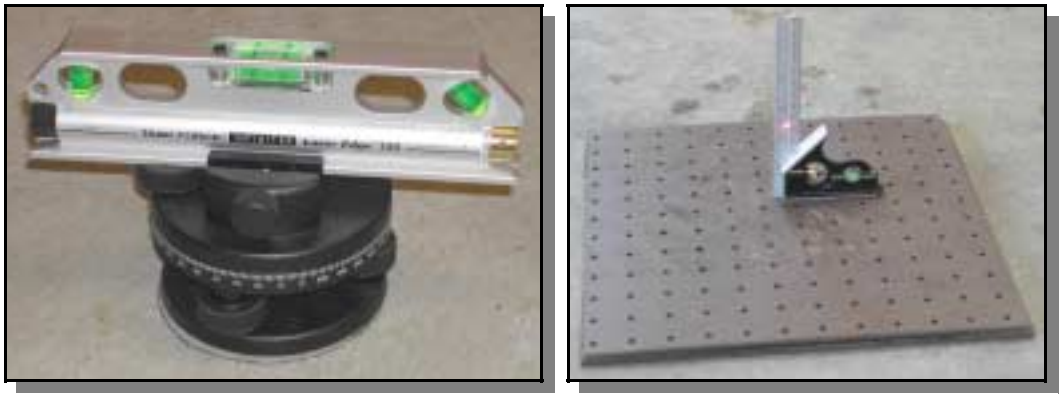

Figure #2: A laser level is one way to set up your leveling pads.

Figure #3: The pad heights may differ considerably.

1 foot square, while the 2x10's were cut slightly larger to make them easier to drive on to. I chose to use a laser level (purchased at Lowe's Home Improvement) to determine how many pads I needed at each corner of the car. Figure #2 shows how I used a small combination square to check the height of the pads against the laser level. When you get to adjusting the toe on the car (more on that later), the tires will have to pivot on the ground. Since rubber tires tend to stick to concrete pretty well, you should make sure that all tires have a minimum of two pads underneath them (i.e. two pieces of 1/8" masonite) to allow the tires to turn easier during adjustments.

Once you have a level surface, and your Corvette is in position, you can begin by adjusting the camber. The first step is to determine your current baseline values. There are several types of camber gauges on the market, which generally range from about $100 on up. I chose to go the inexpensive route and made my own. I started with a small plastic level, which had a metric ruler on one side. I cut the level down to allow it to match the diameter of the Corvette's wheel. I also cut a small notch to allow a metal scale to be positioned at a particular spot on the level (437 mm for my 16" wheels). I chose to take my measurements in metric units since it makes the math much easier. Many sources still specify alignment measurements in English units (such as the chart in Table #1), so you may have to do some conversions for comparison.

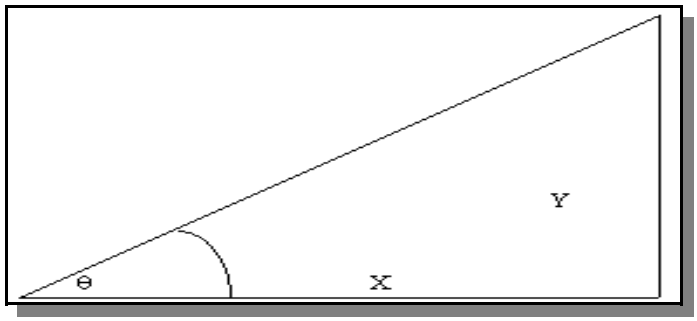

Figure #4: A quick trigonometry refresher

Θ = Camber angle
X = Length of level
Y = Distance from level to wheel rim

Θ = Atan (Y/X)

Since measuring camber is measuring the angle at which the wheel is tilting, you can use some basic trigonometry to calculate the angle from the measurements with the level and scale … and you told your high school teacher you'd never need to use this stuff! Figure #4 shows the relationships graphically. Just divide the scale measurement by the length of the level and use a scientific calculator to take the inverse tangent (arctangent) of the result. This will give you the camber angle. Repeat this measurement for all four wheels.

Figure #5: The components of an inexpensive camber gauge.

Figure #6: The camber gauge in action.

Adjusting camber on the front wheels is performed by changing the number of shims on the upper control arms. These shims are shown in Figure #7. When setting up a C4 for autocross, you'll want to remove all of these shims. While -1.5 degrees of camber would be nice in the front, the most you'll be able to achieve by removing the shims is about -1.0 degrees. Modifications can be made to allow more adjustment, but these will bump you out of the stock classes at the races.

While the front camber adjustment can be made with the car on the ground, the rear camber adjustment requires you to jack up the vehicle. Take your initial measurements on the ground and figure out what adjustment

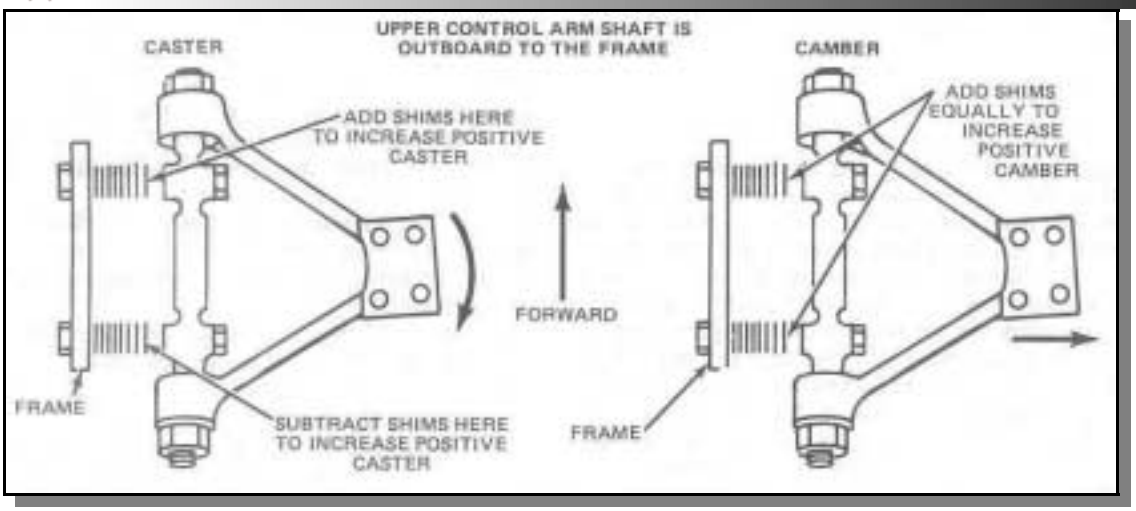

Figure #7: Shims can be added or removed to adjust front caster & camber.

Once you have the bolts tight and put the car back on the ground, you'll need to settle the suspension before taking any more measurements. I do this by backing the car out into the driveway and performing a few quick stops. After settling the suspension, pull the car back onto the leveling pads and re-measure the rear camber. If it's where you wanted it, then you did a great job. If you're like me, you'll get to adjust it again. It took me three iterations of the whole process to get the camber where I wanted it.

The final part of the alignment is to adjust the toe. Making any adjustments to the caster or camber can (and probably will) affect your toe settings, so you want to do this last. In order to adjust the toe, you need a reference to measure to. The professional shops use lasers; I use string. Figures #10 and #11 show how I do it. The goal is to get two parallel pieces of string, one on either side of the car, to use as a measuring reference. I use two 8-foot pieces of 1 1/2" aluminum angle as cross pieces to serve as attachment points for the string. Each cross piece has grooves cut in it, so the string can be located accurately. The cross pieces are supported on adjustable jack stands. Once the strings are roughly parallel, the cross pieces should be clamped in place. The jack stands are used to adjust the height of the string, which should be as close to the center of the car's wheels as possible (see Figure #12).

Ideally you would adjust the strings to be a given distance from the centerline of the car, but there isn't a practical way to locate the centerline. As a compromise, you can measure from the center of the wheels; I use the center point of the center caps on the wheels. The front and rear tracks of the car (the width between the right

you want to make. Raise the rear of the car, support it securely on jack stands, and take another camber measurement. The suspension will droop when you raise the car, so the camber measurement you took on the ground will be different. I have found, though, that if you make an adjustment to the wheels in the air, it will be relatively the same as the adjustment you want when the car is on the ground. In order to adjust the rear camber, you need to loosen up the cam bolts on the rear spindle rods (see Figure #8). When you loosen the nut on the back of the bolt, you can turn the bolt to adjust the camber angle of the wheel. It's a good idea to mark the position of the bolt prior to adjustment so you can see which way and how far you moved (see Figure #9). Adjust the bolt, take another measurement, and repeat until you get the desired results. When you think you have it adjusted right, you need to make sure the nut on the cam bolt is tight. The service manual calls for 180 ft-lbs of torque. A base 2002 Chevy Cavalier 4-cylinder engine has a maximum torque output of 135 ft-lbs. This is pretty snug. My torque wrench only goes up to 150 ft-lbs, so I tightened the bolt until the wrench clicked, and then I gave it another push … with my foot. If you don't get these bolts tight, they will move. It's also a good idea to re-mark the cam bolt position when you're all done so you can tell at a glance if the camber has moved.

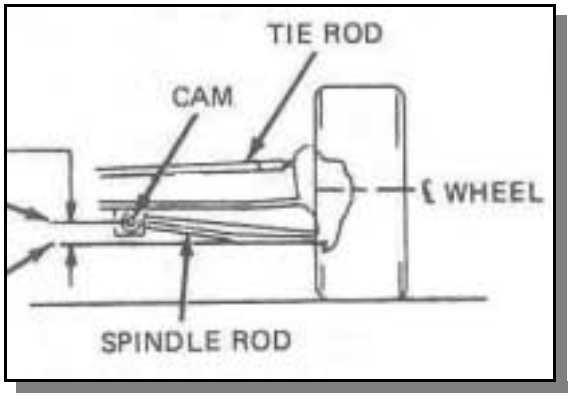

Figure #8: Rear camber and toe adjustments

Figure #9: Cam bolt marks help gauge adjustments.

Figure #10: Parallel strings can be used to measure toe.

Figure #11: Jack stands hold the cross pieces.

and left wheels) are different, so you can't use the same values front and rear. As I shifted the jack stand / angle assemblies back and forth, I ended up with a 93 mm string-to-wheel spacing in the rear, and 111 mm in the front. Your numbers will depend on your particular car and the distance between the strings on the cross pieces. Using these parallel strings, you can now measure the distance between the string and the front and rear edges of the wheel rims (Figure #13), which is your toe. The toe is adjusted (both front and rear) by turning the sleeves on the tie rods (Figure #14). A word of advice: once you have the strings set up, don't bump them. If you do, you need to start the setup all over. Don't ask how I know.

Once you have the toe adjusted, you're all set. The whole process takes a while and is somewhat tedious, but it will give you an excellent, repeatable alignment that will yield immediate benefits on the street and the track. I checked my toe measurements one year after performing these steps and verified the settings within 0.5 mm. While it requires a small initial investment in equipment, it's cheaper than a professional job and you can easily experiment with different settings as you get a chance to try them out. You also get the intangible benefit of understanding your car's setup a little better and knowing you did it yourself. **TC**

Figure #12: Center the strings vertically on the wheels.

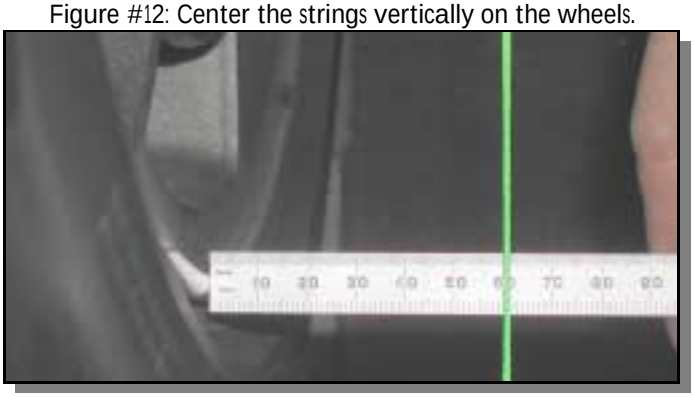

Figure #13: Measure toe from the wheel rim to the string.

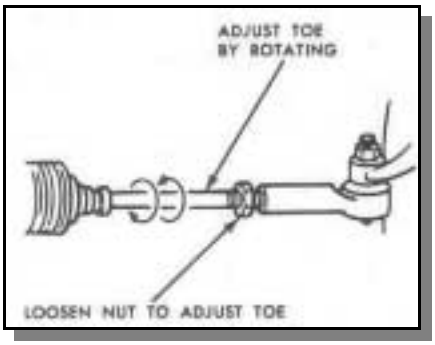

Figure #14: Toe adjustments are made with the tie rods.

C4 Autocross Alignment - Alignment Setting Suggestions

	Daily Driver	Advanced Street	Autocross Baseline
Front (1984-96 Corvette)			
Toe	1/32" in	0"	3/16" out
Camber	0º	0.25º neg	1.5 - 3.0º neg
Caster	5.0 - 7.0º pos	5.0 - 7.0º pos	4.0 - 5.0º pos
Rear (1984-96 Corvette)			
Toe	1/8" in	1/8" in	1/16" in
Camber	0º	0.50º neg	0.75 - 2.5º neg

Table #1: Vette Brakes & Products, Inc. (www.vettebrakes.com) suggests the above alignment settings for C4 Corvettes. These numbers are a starting point and can be modified as your experience dictates. Note: while this table recommends toe out as an autocross setup, toe out will make a car act very "nervous" on the street, so use caution. I personally aim for zero toe on my car.