# ALIGNING A 2007 CADILLAC CTS-V

I'll describe a four-wheel alignment of a 2007 Cadillac CTS-V in this document using homemade alignment tools. I described the tools in a previous document. The alignment steps are basically the same as you can find described in instructions for alignment tools that can be purchased. You will need some super-low friction devices during your alignments to put under each wheel. You can buy 8- ¼ inch thick polyethylene cutting boards for $15 or so at a discount home-goods store and they are perfect. Put 2 under each wheel. Your alignment location needs to be perfectly level. I use my 4 post lift, but you may have to add some sheets of plywood under the cutting boards to achieve level if you do it on the floor.

Before starting the alignment, let's take a few quick measurements that will be needed during the alignment. These data are recorded on the ALIGNMENT MEASUREMENTS sheet at the back of this document.

**The wheel diameters are: front: 18", rear: 18"**

**The Front ground to C/L: 12 ¾ "  rear ground to C/L is 13"** (this measurement is needed to set the toe measuring bar and is the floor to hub centerline measure)

**The Hub C/L to C/L left side is 114 ¼ " the right side is 113 7/8"** (the easy way to take this measurement is to pull a tape measure from the back edge of the rear wheel at the hub C/L to the back edge of the front wheel). A big side-to-side difference may indicate accident damage and you may find a tolerance for this dimension in the service manual. We may want to look around the suspension and see if there is a bushing out causing this.)


You are wondering what we need these measurements for. Well, the measurements we take during our alignment checks are dimensions and we have to use a little math to convert them to angles so we can compare to the car's written specifications.

The factory alignment specs are:

**Front:**

Caster: 5.3°+/- 0.6°   Camber: -0.6°+/- 0.6°
Toe: 0.2°+/-0.2°

**Rear:**

Thrust angle: 0°+/- 0.2°  Camber: -1.2°+/- 0.6°
Toe: 0.2°+/-0.2° (Individual side: -0.10° to 0.0°)

A note is in order regarding sign convention Positive Toe means the front of the tire points inward. Positive Camber means the top of the wheel points outward.

The proper way to conduct a four-wheel alignment with hand-held tools is to begin with measurements at the rear of the car. Start with thrust angle, solve that, then set the rear camber to specification, then re-check thrust angle. Finally the toe is set. To complicate things, thrust angle is corrected with toe adjustments, but is also affected somewhat by camber. Further, the measurements will change a little and this is because the suspension components have running tolerances, and there may be some minor wear of some renewable parts.

**THRUST ANGLE**

The principle of checking thrust angle is to determine if both rear wheels are aimed parallel to the direction of travel of the car. A solid axle car can only have an unacceptable thrust angle if the rear axle is not mounted correctly or the frame has been damaged and the frame of the car is not square. A car such as the CTS-V has an independent rear suspension, and the toe of each wheel can be set such that both wheels aim off-axis, yet have the toe setting to spec. This is easy to see on sophisticated alignment machines, but those of us with hand-held alignment tools also have a way.

The hand held camber/caster gage I built has a laser pointer built into the device and the gage frame is adjusted so that the beam is parallel to the frame. If the gage is centered over the rear hub, then the laser will shoot a beam parallel to the rear wheel. Now the gage offsets the beam path from the rear wheel about 4 ½ inches or so, and to measure thrust angle, we measure the distance from the beam to the center of the front hub. Then perform the same measure on the other side.

Here is the gage attached to the rear wheel:

Now here is the front wheel. I used a try-square and touched the hub edge with the blade, then split the beam with the square; sliding the stock along the blade to take the measure:

On the left side of the car the measurement was 5-13/32 inches, and on the right side 5-20/32 inches. So, this is a difference of 7/32 inches. Now let's calculate the thrust angle. The math (trigonometry) equation is:

$\text{Arctan } y/x=\theta$

Arctan is trig shorthand for "the angle whose tangent is (y÷x)"

We want "θ" in degrees so we can compare to the angle in the factory spec. So, the value for y is 7/32 and the value for x is the hub-to-hub distance or 114 ¼. Since you are going to use your cell phone calculator for this little division exercise, you can compare to my calculation for the tangent of the angle θ. I get 0.00191

Next, go to the attached table of tangents and find the tangent value for 0.00191. It is about 0.11°. That is within spec, so we really do not have to fix a thrust angle problem. Should you have to, that will be the first adjustment to make, so you will have to use the tie rods for adjusting toe and increase toe on the side showing the smallest measure, and decrease a corresponding amount on the other side. The best way to do this is to rotate each turnbuckle the same amount but in different directions, counting revolutions or flats. The CTS-V has right hand/left hand coupling nut, so you will need to figure out which way to turn each side.

I will be describing toe measurements shortly, but if you are off with thrust angle, it is a good idea to check toe each time you make an incremental thrust change to make sure you do not get the alignment badly out of whack. Toe is still the last adjustment you make.

**CAMBER**

Rear camber and front camber are measured the same way. The gage is placed on the wheel and leveled with the cross-level bubble (the little red dealie stuck to the bottom of the gage frame). I put a small piece of white electrician's tape where the gage pins contact the wheel so the wheel is not scratched. For the front measurements, I make a mark where each gage pin contacts the wheel (on the tape) when the wheel is at the straight-forward position. Then, later when the gage is used to measure caster, the gage can be placed in the correct location on the wheel.

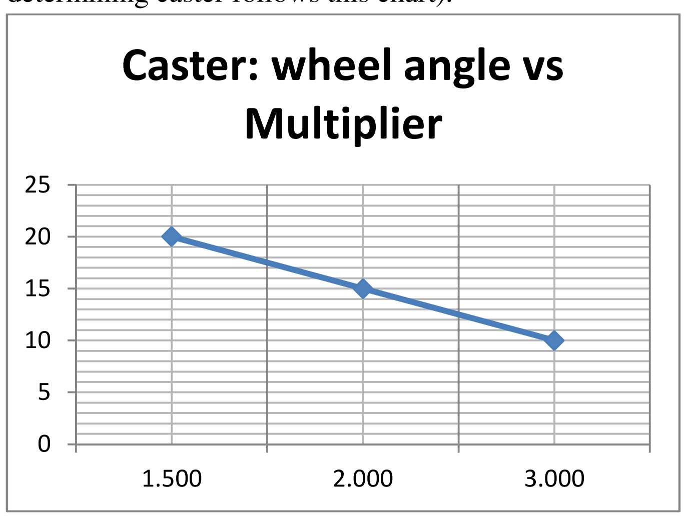
You don't have to use bungee cords, just hold to the wheel and read the measurement from the digital level. This style level only reads 0° to 90°, so you have to subtract the reading from 90° to get the camber reading, and you have to also determine if the camber is negative or positive (remember, negative camber means the bottom of the wheel tilts outward)

**CASTER**

Caster is the angle of the pivot line for the front spindle. The CTS-V and most all other autos on the planet have positive caster. This means the pivot line angles to the front of the car at its lowest point (Google caster for a better description). Now caster does some interesting things to tire position when the steering wheel is turned. It causes the tires to "lean" when turned. On the track in a turn when you are really loading the car, positive caster will aid in maintaining a large contact patch and help your tire grip.

Caster adjustment on a CTS-V is very limited. The camber adjustment affects caster, and so you have to go back and forth between caster and camber to make sure you don't get the cross-caster (the difference between caster reading from side to side) out of spec.

Caster measurements for one wheel is a pair of camber readings when the wheel is turned first to the right and second to the left. The difference between the two measurements multiplied by a factor. For example, taking caster measurements on the left wheel the wheel will have positive camber when turned to the right, and more negative camber when turned to the left. The greater the angle of the turn, the greater the difference in camber from left to right. The normal convention is to perform this measurement at a wheel angle of 20°. However, this measure is tough to achieve and reproduce. So, here's an easier and consistent way to perform this measure. The steering ratio for a CTS-V is 16.4 to 1. So 16.4° of turn of the steering wheel gives you 1° of turn of the wheel. Turning the steering wheel 180° will produce just a tad under 11° change in the front wheel. So, to measure caster, it I turn the steering wheel 180° I can use a multiplier of 2.66 (the math for determining caster follows this chart).




Here's the drill for measuring caster: Since you used the white electrician's tape and marked the 3 gage pin locations you are ready to take caster measurements. You will take two measurements on each wheel.

1. Starting with the steering wheel in the straight-ahead position, rotate it 180° degrees making a

right-hand turn (OK, you set your wheels on something slippy-slidey like poly cutting boards, right?)

2. Measure and record the left wheel camber and right wheel camber placing the gage on the marks on the tape (you know the tape you put there and marked when measuring camber) This should be a positive camber number
3. Measure and record the right wheel camber and right wheel camber placing the gage on the marks on the tape. This should be a negative camber number and greater that the straight-ahead camber.
4. Now rotate the steering wheel one full turn to the left (360°, now your wheels will be pointed left a tad less than 11°)
5. Measure and record right and left wheel camber.
6. Now to calculate camber. This is an absolute value calculation, so the total camber change is the sum of absolute values (for example, if for the right wheel, you measured +1.6° and -0.8° the absolute value is 2.4°)
7. Now multiply the absolute value by 2.66 the 10.97° factor from the graph above.

So, if you had 2.4 x2.66 for the right side, the caster would be 6.4°

The only way to change caster on a CTS-V is to move the two camber adjustments on the lower control arm. It will be impossible to increase caster and still get a reasonable camber so the car will behave correctly. The caster for these cars might vary one degree from side to side, and what you want to strive for is to get the caster of the two sides as close to each other as possible. All this will be affected by wear of suspension components and repairs from wrecks, if the frame or suspension was involved. The other complication is that the lower control arm is not symmetrical, so you can't move them both an equal distance without impacting other measurements.

**MEASURING TOE**

A sentence or two about the convention of describing toe. Positive toe means the tires point slightly inward for the forward direction of the car. Negative toe means they point out. The CTS-V street specifications have a slightly positive toe (TOE IN) both front and rear, and the tolerance allows it to be zero. If you are tracking the car, you will probably change this a bit as you increase negative camber.

The device for measuring toe measures TOTAL TOE, and cannot precisely tell you which wheel might be toed on more. The professional alignment machines and their operators can tell you individual toe, but in the end, their adjustments will get you exactly the same place the homemade devices will, and here's why:

If toe meets spec for the rear, then any thrust angle correction to bring thrust angle within spec followed by a final toe correction will produce a total AND individual toe within spec.

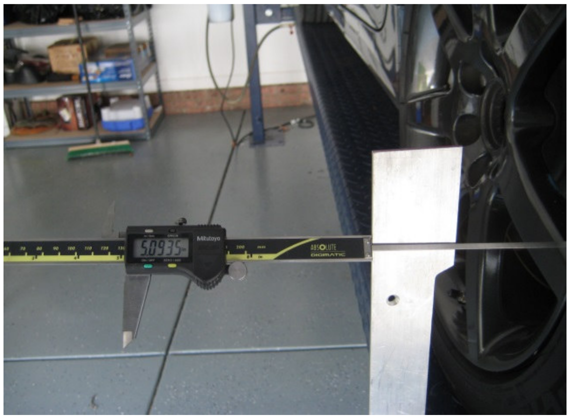
If toe meets spec for the front, but both wheels are, say aiming to the left, then a driving test will show the steering wheel to be off to the right, you must put right-turn correction to make the wheels drive straight with respect to the car. If you are going down the road STRAIGHT and the steering wheel is straight, both total toe and individual toe are correct, if your total toe measurement is within spec.

OK enough stuff, let's measure. The toe measuring device is basically a giant caliper (refer to the tool making document for a pic).

The first thing to do is to set the brass stair guide at the floor to hub center height. Also mark the other

Blade of the toe gage for hub center height. Then slide the gage under the car and set the brass stair guide on the rear of the wheel.

Next, go to the other side, and place a measuring tool against the blade of the gage and contact the wheel to take a measurement.



I used a digital caliper for this, but you do not need this precision. All you need is to be able to measure to the nearest 1/32. However, I'm old and can't see well, so this digital display is easy to read. Now this all takes a light touch. You need to hold the whole gage just firm enough to keep good contact with the wheel. This measure is 5.09 inches. (forget the rest of the places).

Move the gage to the front of the same pair of wheels and take a second measurement. The measure I got at the front of this axle was 4.88 inches. The difference (5.09 minus 4.88) is 0.21 inches.

If you think of this as an angle, the "x" leg is 18 inches (the diameter of the wheel) and the "y" leg is this difference, 0.21 inches. Dividing x by gives us the tangent of the angle, 0.1167 (forget significant figures for the moment that's what the calculator on my PHONE says).

Now, we can go to the table of tangents and find out our toe angle is close to 0.09° so we are toed IN, but within spec. If this is the rear and our thrust angle and camber are in spec, we're done. If this is the front, and caster, camber and the steering wheel is straight, we're done.

**FINAL COMMENTS**

Feel free to take issue with my methods, won't bother me a bit. I am a layman when it comes to alignments and have had over the years less than satisfying experiences with professional alignments. Yea you get lots of paper with green and red squares, but what does it mean. Your butt-O-meter, and notice of tire wear are far more refined than any setting you get from a pro.

The methods described will take probably four hours of your time to complete, and if you don't have the time, and aren't curious about the relationship of the alignment to drivability, then you shouldn't bother trying to do your own.

If you are tracking or autocrossing, this might be a way to increase contact time with your car and learn why it behaves the way it does.

| TABLE OF TANGENTS | | | | |
|---|---|---|---|---|
| **ANGLE(DEG)** | **Tangent** | | **ANGLE(DEG)** | **Tangent** |
| 0.01 | 0.00017 | | 0.31 | 0.00541 |
| 0.02 | 0.00035 | | 0.32 | 0.00559 |
| 0.03 | 0.00052 | | 0.33 | 0.00576 |
| 0.04 | 0.00070 | | 0.34 | 0.00593 |
| 0.05 | 0.00087 | | 0.35 | 0.00611 |
| 0.06 | 0.00105 | | 0.36 | 0.00628 |
| 0.07 | 0.00122 | | 0.37 | 0.00646 |
| 0.08 | 0.00140 | | 0.38 | 0.00663 |
| 0.09 | 0.00157 | | 0.39 | 0.00681 |
| 0.10 | 0.00175 | | 0.40 | 0.00698 |
| 0.11 | 0.00192 | | 0.41 | 0.00716 |
| 0.12 | 0.00209 | | 0.42 | 0.00733 |
| 0.13 | 0.00227 | | 0.43 | 0.00751 |
| 0.14 | 0.00244 | | 0.44 | 0.00768 |
| 0.15 | 0.00262 | | 0.45 | 0.00785 |
| 0.16 | 0.00279 | | 0.46 | 0.00803 |
| 0.17 | 0.00297 | | 0.47 | 0.00820 |
| 0.18 | 0.00314 | | 0.48 | 0.00838 |
| 0.19 | 0.00332 | | 0.49 | 0.00855 |
| 0.20 | 0.00349 | | 0.50 | 0.00873 |
| 0.21 | 0.00367 | | 0.51 | 0.00890 |
| 0.22 | 0.00384 | | 0.52 | 0.00908 |
| 0.23 | 0.00401 | | 0.53 | 0.00925 |
| 0.24 | 0.00419 | | 0.54 | 0.00943 |
| 0.25 | 0.00436 | | 0.55 | 0.00960 |
| 0.26 | 0.00454 | | 0.56 | 0.00977 |
| 0.27 | 0.00471 | | 0.57 | 0.00995 |
| 0.29 | 0.00506 | | 0.58 | 0.01012 |
| 0.30 | 0.00524 | | 0.59 | 0.01030 |

Note: calculate the tangent (y/x) and determine the angle from the table above. For Toe measurements divide the difference in toe measurements by the diameter of the wheel which gives you the TANGENT of the angle. For thrust angle measurement, divide the difference in thrust measurements by the distance between axles.

| ALIGNMENT MEASUREMENTS | | | | | | | |
|---|---|---|---|---|---|---|---|
| CAR: | | | | DATE: | | | |
| Front Wheel Dia: | | | | Rear wheel Dia: | | | |
| Front Ground to C/L: | | | | Rear Ground to C/L: | | | |
| Left Hub C/L to C/L: | | | | Right Spindle/Spindle: | | | |
| Rear Axle Measurements | | | | | | | |
| THRUST MEASURE | 1st L | 1st R | 2nd L | 2nd R | 3rd L | 3rd R | Final |
| | | | | | | | |
| THRUST ANGLE | | | | | | | |
| Camber | 1st L | 1st R | 2nd L | 2nd R | 3rd L | 3rd R | |
| | | | | | | | |
| REAR TOTAL TOE | 1st Fr | 1st Rr | 2nd Fr | 2nd Rr | 3rd Fr | 3rd Rr | |
| | | | | | | | |
| TOE ANGLE: | | | | | | | |
| | | | | | | | |
| Front Axle Measurements | | | | | | | |
| CAMBER | 1st L | 1st R | 2nd L | 2nd R | 3rd L | 3rd R | |
| | | | | | | | |
| CASTER | 1st L | 1st R | 2nd L | 2nd R | 3rd L | 3rd R | |
| | | | | | | | |
| FRONT TOTAL TOE | 1st Fr | 1st Rr | 2nd Fr | 2nd Rr | 3rd Fr | 3rd Rr | |
| | | | | | | | |
| TOE ANGLE: | | | | | | | |
| | | | | | | | |