# FCM SUSPENSION CHARACTERIZATION PROCEDURE

NOTE: These measurements will help us determine where the bump stop is at rest, how much total travel your suspension currently has available and if it needs to be adjusted to suit your needs.

**ONLY USE METRIC VALUES FOR THIS PROCEDURE!**

1. Vehicle YR ____ Make _____ Model _____ Approx curb weight _____ lb Wt distr ___/ ___
2. Measure the **static ride height front and rear.** Usually we go from the center of the wheel to the lip on the fender above the wheel. You can see my Cardomain page for more details:

http://www.cardomain.com/ride/742393/2

**Required / highly-recommended tools:**

**6' metric tape measure, digital calipers, camber gauge, low-profile floor jack, 4 jack stands, stopwatch/timer**

**Estimated time to complete full procedure: 3-4 hours**

## 1 -Measure bounce frequencies

You will now test the physical bounce frequencies to see how the car actually responds to a given installed spring rate.

1. Tools – terry cloths or soft towels to protect any painted surfaces. To avoid damaging/crinkling any painted body panels, it's best to press at the shock tower in the front and along the trunk seam in the rear. Be sure the vehicle is as empty as possible. Note if any extra, heavy options have been added to alter its expected curb weight.

Added items(weight): _____ (  ) , _____ (  ), _____ (  ), _____ (  )

2. Best done with three people. Two to bounce at each corner of the car, one as the timer

3. The purpose is to determine the relationship between the theoretical spring rate and how the car actually responds to the springs. If the test is done with two different sets of springs, the motion ratio can be empirically determined, which we've found to be more accurate for handling purposes than a mechanical leverage (which is best for noting suspension travel / bump stop sizing / shock body lengths). Note that for the most accurate results, the shocks should be set to full soft on low-speed (if adjustable). Because the system is not fully degassed/drained of oil, the results will be off a few percent but for setup purposes this is a minor offset. The expediency of the method and the consistent results prove its efficacy.

4. Begin with the front. Both 'bouncers' should push down in unison as close to the shock towers as possible while not bending any sheet metal. The suspension has its natural frequency which the bouncers will find by pushing down in unison. On stiff cars it may not deflect much so some

force is required to clearly see a full cycle. Once a rhythm is found, the timer should start watching the stopwatch. At t=10 seconds the timer should say 'start'.

5. For the next thirty seconds each bouncer should count, silently, each time they push down. It's best that the timer simply focus on the watch. At the end of the 30 second period, at t=40 second, timer says 'stop'.

6. The two bouncers should compare their counts. If they agree within 1 cycle, the result is valid. If not, it should be repeated. You can expect results of 40 cycles for a softly-sprung vehicle to 70 or more for a very stiff suspension.

**7. It is important to prevent the bump stops from being compressed while the suspension is cycling during this test! <u>This is the case if the height in step 10 if greater than step 2! The car is resting on the bump stops!</u> For this test, we recommend raising the ride height (if possible) to prevent contact between bump stop and primary steel spring for the bounce frequency test. Otherwise the result will be skewed by the bump stop.**

a. In some cases the bump stop spring rate may be characterized (e.g. on a spring test or shock dyno set for that function).

8. Once the results are agreed upon for the first test, it should be repeated. All cycles need to be recorded for accuracy –

a. Front suspension
b. Bouncer 1, Test 1 ____ Bouncer 1, Test 2____
c. Bouncer 2, Test 1 ____ Bouncer 2, Test 2 ____
d. Average of Test 1____ Average of test 2 ____

e. Rear suspension
f. Bouncer 1, Test 1 ____ Bouncer 1, Test 2____
g. Bouncer 2, Test 1 ____ Bouncer 2, Test 2 ____
h. Average of Test 1____ Average of Test 2 ____

## 2 - Measure wheel and shock travel

**<u>NOTE</u>: All ride height measurements for this procedure are done from the center of the wheel or hub to the center of the fender arch above the tire.**

These steps apply to both front and rear suspension but read through the procedure before performing the test.

**3. With the car on level ground, measure the front and rear static (resting) ride height.**

**Front static ride height: _____ mm**
**Rear static ride height: _____ mm**

4. Jack up the entire car and support it securely on stands. Measure the full droop height as the wheel hangs down:

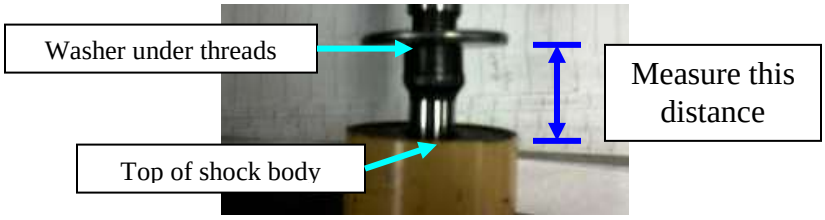
   **Front full droop ride height: _____ mm**
   **Rear full droop ride height: _____ mm**

NOTES for testing front bump travel: On the front suspension, remove a wheel and the shock assembly at that corner. Remove the spring and dust boot (if any).

NOTES for testing rear bump travel: Follow the same procedure for the rear. You will need to remove the rear shock from the vehicle to measure the shock shaft travel. In cases where the spring is not coaxial to the shock, it still needs to be removed or disconnected to allow suspension articulation. Be careful to not jack anything up so far that it messes with the rear axles so use your judgment here. Watch the CV joints/axles to make sure their angle doesn't go far from horizontal.

5. Compress the front shock fully in and note the distance from where a washer will sit on the threads to the top of the shock body. This distance must be accounted for with bump stop length or packers to prevent damage to the shock at full compression.

   **Top of body to washer height of compressed front shock _____ mm**
   **Top of body to washer height of compressed rear shock _____ mm**




6. Allow the shock to extend and note the distance from top of body to washer position.

   **Top of body to washer height of extended front shock _____ mm**
   **Top of body to washer height of extended rear shock _____ mm**

7. The difference in these last two measurements is the available shock travel:

   **Front shock travel _____ mm**
   **Rear shock travel _____ mm**

8. Examine the front and rear bump stops. Take photos of them with a ruler for scale.

   Measure the **front bump stop free length _____ mm**
   Measure the **rear bump stop free length _____ mm**

9. Return the bump stop to the shaft along with all shock mount hardware. You will reinstall the 'spring-less' shock assembly and compress the suspension to find three more data points,

   1. the ride height where the bump stop first touches,

2. the point where the bump stop is compressed enough to lift the corner off the jack stand
3. the height where the chassis or suspension can travel no further (even from tire-to-fender or metal-on-metal contact).

10. Reinstall the front shock assembly but without the spring. Find a solid location for your jack under the control arm. Jack the control arm up until the bump stop begins to be compressed:

    **Ride height at front bump stop initial contact: _____ mm**
    **Ride height at rear bump stop initial contact: _____ mm**

11. Continue jacking, being sure the jack is well-placed under the control arm, until the jack stand has no weight on it (rattle it slightly by hand). This point is the theoretical **maximum travel allowed by the bump stop and shock body length, provided there is nothing to limit travel.**

    **Ride height at front bump stop full compression/lift-off height: _____ mm**
    **Ride height at rear bump stop full compression/lift-off height: _____ mm**

**NOTE: REMOVE THE BUMP STOPS front and rear for this next step. We will be measuring the physical compression limit of the tire/wheel to see if/how much the suspension travel is being limited by the bump stops. OE stops are usually 'stealing' about 1"+ of available wheel travel.**

**12.** Now, fit the wheel - if needed, lower the control arm and reposition the jack until you can. Carefully move the control arm up while rotating the tire/wheel to look for the point where it starts to rub. Also observe the suspension to ensure it is not physically binding on the chassis. Measure the ride height where the tire starts to touch the fender liner. It's probably before the point where the bump stop went fully compressed. This is the **practical limit of the travel.**

**Ride height at front physical tire/wheel height limit**
**(tire to fender contact or suspension arm to frame contact): _____ mm**
**Ride height at rear physical tire/wheel height limit**
**(tire to fender contact or suspension arm to frame contact): _____ mm**

**CAUTION! IMPORTANT APPLICATION NOTE!**

**If the values from Step 12 are HIGHER than Step 11, it means the tire contacts before the bump stop bottoms (ride height @ 12 > ride height @11). This is potentially very bad!**

**It means the bump stop is TOO SHORT or the tire too wide/offset too low. We recommend adding bump stop length or adjusting tire clearance / offset (wheel spacers/ etc) so the bump stop and NOT the tire is the limiter of suspension travel.**

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## 3 – Front and Rear Spring / Shock motion ratios

Pick solid reference points (mark w/ permanent pen, blue racer tape, etc.). Jacking under the control arm/hub w/ wheel off, t**ake the following measurements at a minimum of 5 ride heights to get accurate shock / spring motion ratios and camber curve.**

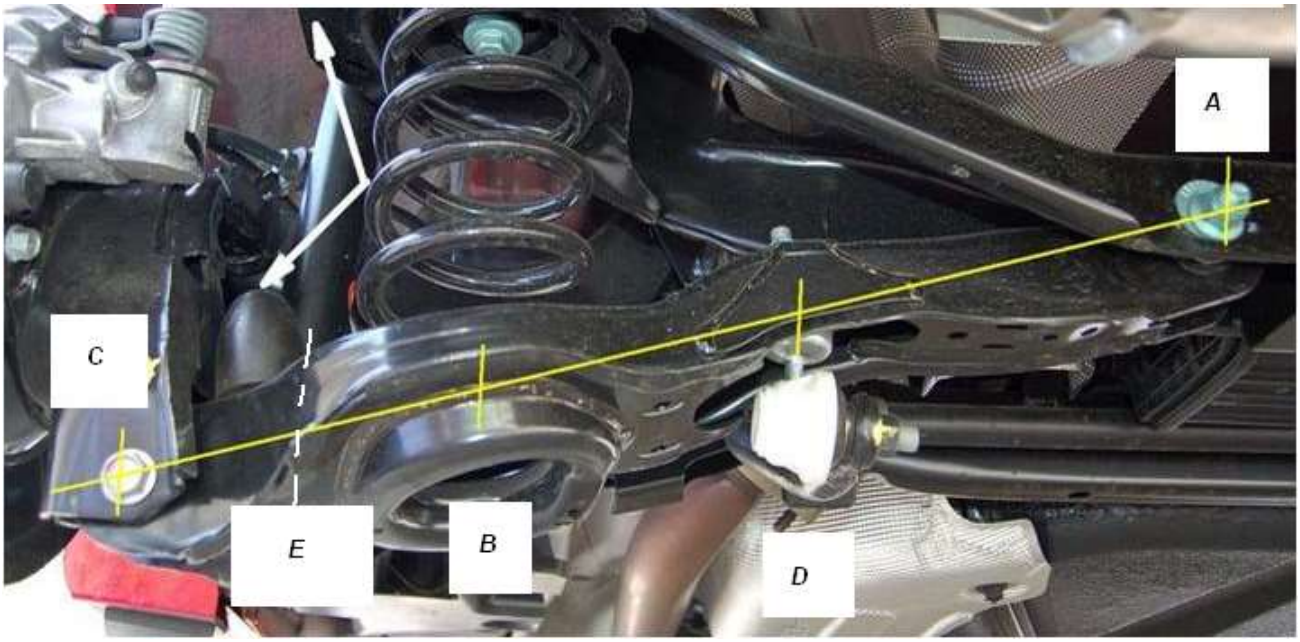
**!!!!! USE MILLIMETERS NOT INCHES!!!!!**

| Meas | Ride height (mm) | | Shock travel left to bstop touch (mm) | | Spring travel (mm){only if spr separate from shock!} | | Camber (deg) | |
|---|---|---|---|---|---|---|---|---|
| | Fr | Rr | Fr | Rr | Fr | Rr | Fr | Rr |
| 1 | | | | | | | | |
| 2 | | | | | | | | |
| 3 | | | | | | | | |
| 4 | | | | | | | | |
| 5 | | | | | | | | |
| 6 | | | | | | | | |
| 7 | | | | | | | | |
| 8 | | | | | | | | |

(refer to image next page for rough spring shock and sway bar motion ratio measurements)

| | Front | Rear | |
|---|---|---|---|
| AB = | _____ | _____ | (spring to inner pivot) |
| AC = | _____ | _____ | (rear lower control arm) |
| AD = | _____ | _____ | (sway bar end link to inner pivot) |
| AE = | _____ | _____ | (shock to inner pivot) |

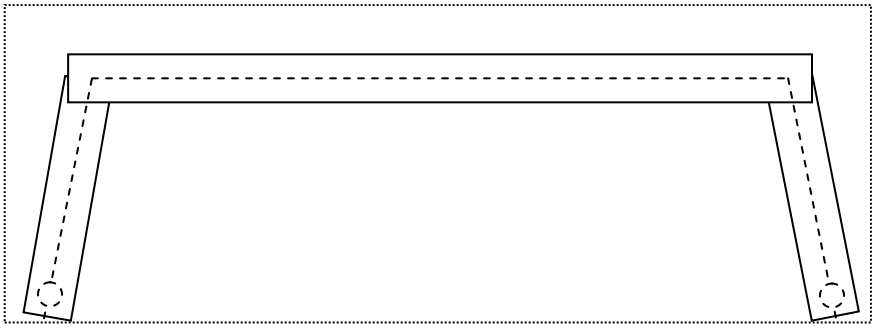
| | Front | Rear | |
|---|---|---|---|
| AB / AC = | _____ | _____ | (spring motion ratio) |
| AE / AC = | _____ | _____ | (shock motion ratio) |
| AD / AC = | _____ | _____ | (sway bar motion ratio) |



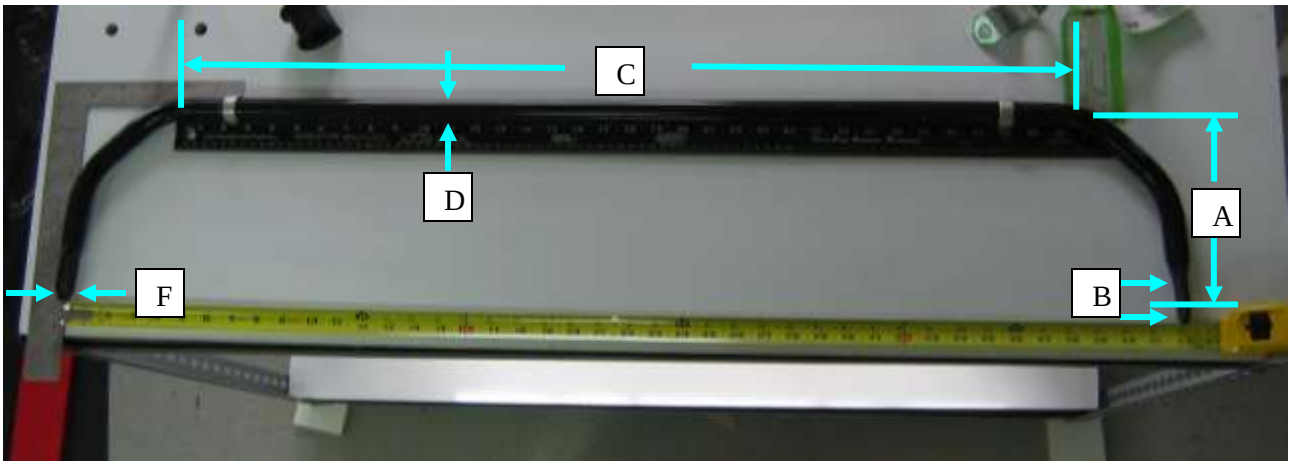

**The ratio of AB / AC gives the approximate spring motion ratio. Typically it will be between 0.5 to 0.8 for a rear suspension.**

## 4 - Measure sway bar dimensions / motion ratios

1. Remove the front and rear sway bar and obtain measurements of dimensions as shown. To get the arm length, measure from the mounting hole along the axis of the arm to the axis of the bar. Do the same for measuring the bar length:
2. If there are multiple mounting locations, measure the distance between holes (usually it is constant)



| | Front (mm) | Rear (mm) |
|---|---|---|
| A. Arm length (to inner hole): | _____ | _____ |
| B. Distance between mounting holes: | _____ | _____ |
| Number of holes | _____ | _____ |
| C. Bar length: | _____ | _____ |
| D. Bar diameter | _____ | _____ |
| E. Bar wall thickness (if known): | _____ | _____ |
| F. Thickness of flats at mounting tabs | _____ | _____ |




3. Reinstall the front and rear spring/dust boot and complete shock assembly to the car.