Duntov Motor Company

Corvette Differentials and Handling

How the 63-82 Corvette Differential Affects your Car's Handling

To start, it might be helpful to consider the tire patch. Under normal circumstances, this is the only area where your Corvette meets the road. It's the most important real estate in your car's world. The problem is it changes shape and size dramatically as the car accelerates, brakes and turns. The two rear tire patches provide resistance to the engine torque, and any dissimilarity in the size or effectiveness of the two driven tire patches will dramatically affect handling.

Visualize the static tire patch as the contact area of an inflated balloon pressed gently onto a glass topped table. Looking up at the contact patch from below the glass, imagine this as your Corvette's rear tire contact patch at rest. By pushing down slightly harder on the balloon, the contact patch grows, just like the outside tire patch will grow when weight is transferred onto it in a turn. By reducing the pressure slightly on the balloon you will observe a reduction of the contact patch just as the tire patch is reduced when weight is pulled off the inside tire in a turn by weight transfer, braking action or by a rear sway bar or a combination of all three.

In road racing, the engineer and driver must manage these dynamic tire patches to maximize the performance potential of the car. In a production based car like the Corvette, it is illegal to make wholesale changes to the suspension attachment points. Aerodynamic changes are also prohibited, so to improve our Corvette's handling, we are limited to the following:

1. Weight and the center of gravity
2. Frame stiffness
3. Tire size and brand
4. Ride height and alignment specs
5. Suspension bushing materials
6. Spring rates
7. Shocks
8. Stabilizer bars
9. Differential

To understand how the differential affects handling, we need to review how the Corvette Positrac differential works. As you know, both the Eaton 65-79 and the Dana 80-82 Corvette differentials use springs to preload the clutch pack that transfers torque to the unloaded tire. The Eaton system uses four coil springs, while the Dana utilizes a conical Belleview spring to preload the clutch pack.

The clutch discs and their preload springs upgrade an 'open' differential to a Positrac unit**.** It may be helpful to compare the Positrac system to two alternatives on either side of the Corvette 'limited slip' Positrac differential.

The Open Differential:

In an open differential, as long as the car is moving forward in a stable state, driven by the pinion gear (engine power), both tires are being driven, and the spider gears in the differential are stationary in relation to the side gears. Resistance torque from the tire patches is transferred to the differential by the stub axles. As long as this resistance is equal, the spider gears are stationary within the differential carrier. When this torque is unequal, the engine torque, through the pinion gear, drives ***only the wheel with the least resistance***, which causes the spider gears to spin in relation to the speed differential.

When your car 'turns in' to a corner, resistance on the inside wheel is reduced because it has to roll a shorter distance due to the difference between the inside and outside turn radiuses. On the front axle this difference is accommodated by Ackerman steering geometry that causes the inside tire to turn more sharply than the outside tire.

In a turn taken at speed, the inside rear tire patch is reduced in size as the car's center of gravity causes the car to lean. This lean plants the outside tire while lifting the inside, causing the engine torque to drive only the inside wheel, the one with the least resistance. In a high speed-high horsepower situation the inside tire tends to break traction. Bottom line: It turns in great, but you can only put the power down on the unloaded wheel and you end up accomplishing nothing but tattooing the racetrack with a single black stripe.

The Locked Differential:

In a locked differential, the spider gears are locked to the side gears at all times, as if they are welded together. The differential's only job is to equally split engine torque and redirect it to the rear wheels. You could never use a locked differential on a street driven car, as slow speed tight turns would break the axles in short order. You can use a locked differential on high speed racetracks if you can successfully accommodate the handling problems inherent with this setup.

With a locker, it doesn't matter whether one tire is on a wet spot and the other on dry pavement; both wheels get equal torque all the time. When you get to a turn, the front tires don't want to turn at all because the rear wheels are tracking equally and the only way the car is going to turn is for something to slip. Since nothing can slip inside the differential, either the inside rear tire must be induced to slip, or the front tires are going to slide, or there is going to be a combination of both.

Here is where a rear stabilizer will help. A rear stabilizer bar lifts the inside tire, which, along with the natural roll of the car on its suspension, causes the

inside tire patch to further shrink which helps to induce slippage in the inside rear tire, which helps reduce front tire slippage (understeer).

The Corvette Positrac Differential:

The limited slip Corvette Positrac differential is an open differential with a spring loaded clutches that limit the speed differential between driven axles, thereby theoretically giving us the best of both worlds. It allows the car to turn in well, and the inside tire is discouraged from spinning wildly on corner exit. The clutches transfer the torque through the spider gears to help equalize the torque split.

There are three different preload spring sets available for the Eaton differentials, but only the one 200 lb. conical Belleville spring on the Dana. The higher the spring rate the more torque can be transferred across the spider gears. There are also two different clutch pack materials available for the Eaton.

On the Eaton differential, the 200 lb preload kit with steel clutch plates is the standard set up. It works just fine for a street car.

Eaton makes an optional carbon fiber clutch pack that uses 400 lb springs that works much better. You can't get by with anything over 200 lbs of preload on a street car with steel clutch plates because low speed maneuvering (as in a parking lot) causes the clutches to 'clunk' and chatter. You can use the 400 lb. preload springs with the carbon fiber clutch discs on street driven cars because the natural lubrication (graphite) of the carbon fiber clutch discs allows smooth low speed operation. The 400 lb springs allow more transfer of torque, but with the carbon fiber discs there is another quality that enhances hook-up: When they get hot they expand and really hook up. We have used the 400 lb preload springs with the carbon fiber discs in racing with up to 700 hp, and it worked fine. They also work really well in street applications.

The 800 lb preload kit is a racing only set up, and is the greatest for hook up, but it may cause your car to push, but not nearly as much as would a locker. The choice of differential preload springs comes down to how much power you have, the size of the tire you run, how your car handles, how tight is the racetrack, etc. If you only have 400 horsepower, you probably don't need 800 lb. springs. If you are ordering a racing differential from us and would rather have the carbon fiber clutch pack with 400 pound springs, just indicate that in the notes section of the check-out sheet. The change won't affect the price.

To set up for a new racetrack, we used to station our crew chief at the most important turn at the track so he could observe the tire tracks on exit. If the inside was heavier than the outside, we put in heavier preload springs. At Atlanta, that is turn 7, the slowest turn on the track, and the one leading to the longest straight.

If your car is already pushing (understeer), using heavier differential clutch preload springs will make it worse. If you need the additional traction out of a corner that you will get with the 800 lb springs, you might want to address that push by one or more of the following: soften the front bar, soften the front springs, or try a rear sway bar. Remember, a little rear sway bar goes a long way. A stock rear bar may be all you need.