

TWEAKING AND TUNING FOR TWISTIES



Hitting the track hard with a well-setup road-course suspension is an adrenalin rush!

How to Tune a Coilover Suspension System for the Street and the Track PART III

BY KEVIN DIOSI

PHOTOGRAPHY BY THE AUTHOR,
JUSTIN CESLER, SCOTT PARKER,
AND COURTESY OF GM

If you've been following along with our suspension build on our '05 GTO, then you're probably anticipating the performance results. However, if you're just joining us, good news! This story will discuss the fundamentals of suspension tuning for any vehicle with adjustable suspension, not just our '05 GTO.

OUR GOAT

With our LS2-powered GTO injected with a healthy dose of performance, we were eager to test it around Gainesville Raceway's circuit.

Before we even touch the car, however, we need to know what each adjustment does so we will have a better idea how to tune.

SHOCK TUNING

The KW V3 system we installed on our '05 GTO came with independent two-way damping adjustability for compression (aka bump) and rebound. Looking at these shocks on paper, there are an overwhelming amount of possibilities for suspension tuning, with 19 settings for rebound on the top of the shock and 14 settings for compression on the bottom. This leaves us with 266 possible combinations for each shock—wow!

But we don't want to think about it that way. We want to tune for the car's behavior,

and we're going to explain how to do this by discussing the fundamentals of rebound and compression, their effects on handling, and the feeling that each of these elements transfers to the vehicle.

REBOUND—SHOCK EXTENDING

According to KW Automotive, generally a soft rebound adjustment provides a comfortable ride at low vehicle speeds, but less stability at higher speeds, especially the front-end. The vehicle will tend to float if the rebound is set too soft. A hard rebound adjustment offers more stability at higher speeds, but it could reduce vehicle grip and the car will tend to skip across road imperfections, reducing traction. Adjustments to rebound are made on the top of the shock.

COMPRESSION/BUMP—SHOCK COMPRESSING

Bump and compression are interchangeable terms, but most of us are familiar with compression, therefore we will also call it compression throughout this article. According to KW, compression damping plays a larger roll in controlling dive and turn-in, since hydraulic resistance of the damper reacts faster than the springs in a dynamic situation. This helps a tire dig-in when you turn, brake or accelerate, and supports the chassis so that it doesn't move excessively. However, too much low-speed compression can reduce grip as it overpowers the tires. Having adjustable compression damping is a great tool if you have to set up for different tire compounds. Setting of the compression is done from the bottom of the shock case on KW shocks.

The KW V3 kit we installed was designed to deal with imperfections in the road and curbs on a racetrack without adversely affecting suspension response, something very important for vehicles that see extensive track use, because the shocks can be tuned specifically for handling without having to worry about eating a wall when riding over a pebble on the track. And it's also a great benefit when the car is driven on the road. This speaks to KW's race-inspired design and is only available on a select number of its kits.

SHOCK SETTINGS

Though, KW offered us a good starting point via its out-of-the-box settings, every car will like different shock tuning. When changing settings, to get consistent damping forces between two sides, you should first zero the rebound and compression by turning them full clockwise while counting the clicks. This will "stiffen" them as much as possible and reset the damping adjustment check valve. Then dial back the setting, counting the clicks, to your next

desired position and keep a log to document the car's behavior. Adjust by one or two clicks to rebound OR compression at a time. This is the most accurate way to make changes and document them.

Our '05 GTO has adjustable Hotchkis sway bars, and Jay Chen of KW suggested that we back them down to their lowest settings and tune the shocks independently of the sway bars. If they were left at the previous, stiffer settings, the car would push through corners. We set the front at 1 of 3 and the rear at 2 of 4. We left them at these throughout the testing because the car exhibited near perfect bodyroll and didn't hit the tires too hard or soft.

OUT-OF-THE-BOX SETTINGS

LF		RF	
Rebound	10	Rebound	10
Compression	6	Compression	6
LR		RR	
Rebound	13	Rebound	13
Compression	4	Compression	4

TUNING FOR THE TRACK

Our initial track time was completed with our Nitto NT05 street tires to get a feel for the car and an idea of what we wanted to change. Out of the box, Jay suggested that we start with the settings seen in the chart.

We initially put Greg Lovell from Anti Venom behind the wheel to get his opinion on the car. With his extensive background in Corvettes and heavily-modified cars, we were pleased to hear him say, "Man that was fun! I can't believe how good this GTO feels. The brakes feel great, it was stable as hell in the corners—it just needed more grip." This thing is the real deal.

▼ Believe it or not, this is a picture of our GTO under full brake pressure! The Lovells front radius rod bushings and strut top mounts provided by Kollar Racing eliminate strut deflection, and the KW V3 shocks handled the increased brunt with little-to-no brake dive. This makes the car feel incredible under braking. Brake application is more precise and you feel the speed scrub away.



► The amount of speed that can be carried through the corners is impressive—everything was working well together, thanks to the precise bushings from Lovells, tires from Nitto, alignment, and KW V3 coilovers. Bodyroll is impressively low as the car ducks into each corner.



To achieve more grip, Nitto NT01 R-compound tires were bolted on. From there, we added more rebound by zeroing the shocks out and adding a single click at a time until the car started experiencing some high speed bouncing. This meant that there was too much rebound. We returned the shocks to full hard to close the check valve and softened the rebound by one click from the previous setting. This cleaned the car up and reduced its tendency to hop. Our final settings were 8 in the front and 12 in the rear.

With these settings made, we wanted to increase steering feel and response by adding compression. We didn't notice any improvement when clicks were added to the rear, but the front benefited from the increased compression by giving the front-end more positive steering. When it was pushed too far, the suspension forced the car into understeer; we backed it off. Our final settings were 4 in the front and 4 in the rear.

TUNING ON THE STREET

While the same theories are applied to street tuning as track tuning, usually street tuning means you're tuning for comfort rather than performance. Ride quality and comfort is designed into the stock suspension via geometry, spring rates, dampening, and bushing hardness.

Our KW V3s came with 550-lb/ft springs up front and a proprietary progressive spring rate in the rear. These rates were calculated specifically for the GTO on KW's chassis dyno system, which tests chassis and suspension characteristics.

FINAL TRACK SETTINGS *(will vary track-to-track)*

Nitto NT01 245/40R18 at 32 psi hot

LF		RF	
Rebound	8	Rebound	8
Compression	4	Compression	4
LR		RR	
Rebound	12	Rebound	12
Compression	4	Compression	4

FINAL STREET SETTINGS

Nitto NT01 245/40R18 at 32 psi

LF		RF	
Rebound	11	Rebound	11
Compression	4	Compression	4
LR		RR	
Rebound	14	Rebound	14
Compression	4	Compression	4

KW claims these rates provide the best compromise between street use and racing for the V3.

The main force you'll notice impacting ride quality is rebound. This is the force that makes itself evident on brick roads and the like. To best tune for this, we again zeroed the shock and returned to the settings suggested by Jay Chen. From there, we were able to determine what was needed to increase on-road comfort. Whenever a raised manhole or pothole was encountered, the KW V3s dealt with them rather nicely. But, with all of the tunability built into these shocks, we wanted to see if we could make the car feel better.

By reducing rebound even further, we found the GTO would ride smoother on the highways, yet we didn't experience the "float" that KW was referring to. The compression settings were left the same because it didn't noticeably compromise the comfort on the street, but when it was reduced, the car felt a little softer in turns. This could be considered "comfortable" to some drivers, but I preferred the dialed-in feeling of



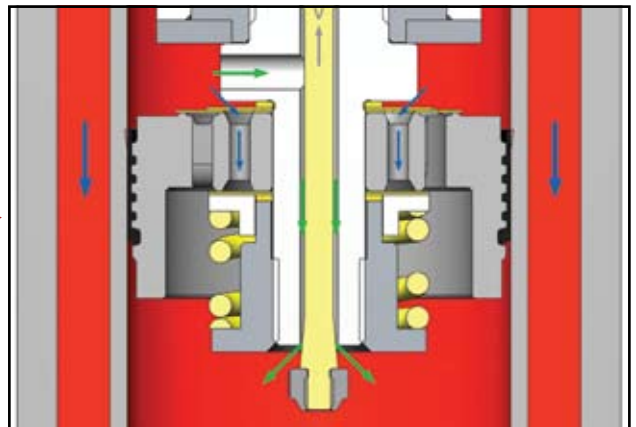
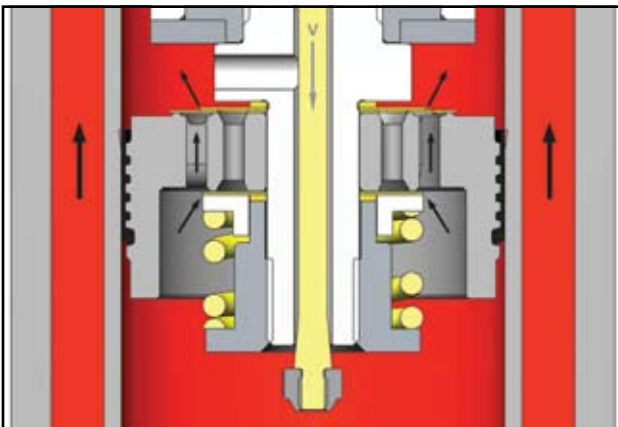
As we tweaked our settings on the shocks, we focused on stability and turning characteristics. It's suggested that you tune each aspect of the suspension one at a time. Once you figure out the shocks, you can then move on to tire pressure and swaybar settings. To isolate the shock's performance, tire pressure and swaybar settings remained constant.



Under heavy acceleration, the GTO has only the required amount of weight transfer to the back, as shown. With the suspension set this way, corner exit feels more responsive. Since brake dive is almost entirely eliminated, corner entry has become a hassle-free scenario because you don't have to manage the previously excessive weight transfer.

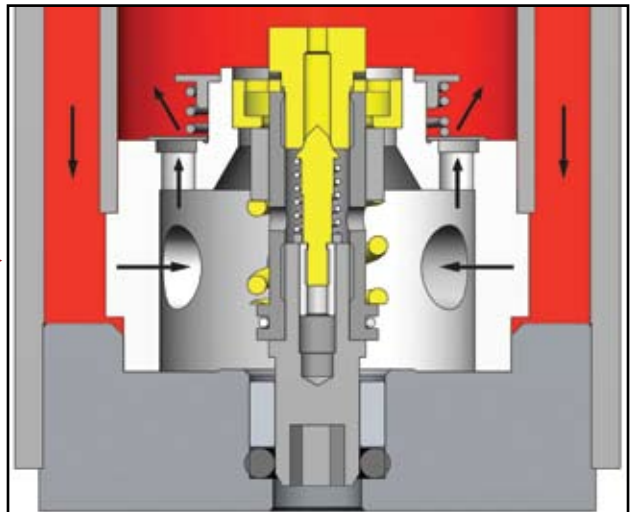
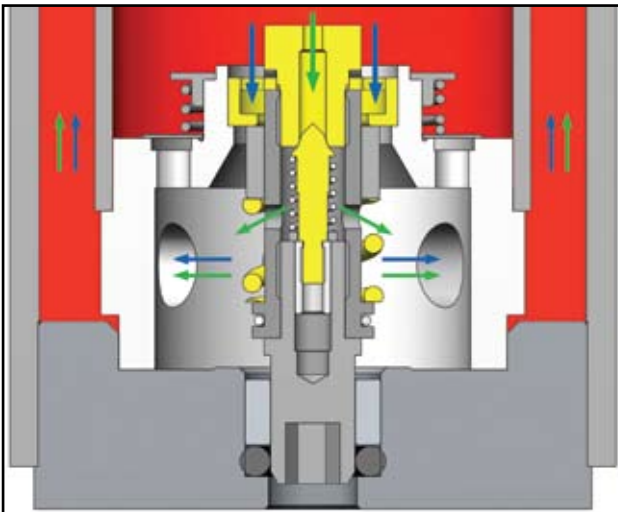


Around the skidpad, our GTO pulled away from our previous record with over 1 x the force of gravity—in a street car.



Here are the KWs in action. Internal oilflow during bump/compression.

Internal oilflow during rebound.



Internal oilflow valve during bump/compression.

Internal oilflow valve during rebound.

ILLUSTRATIONS COURTESY OF KW AUTOMOTIVE

the increased compression—with it the car felt planted on on-ramps and lane changes.

TESTING RESULTS

Lap Times

All testing was done with Nitto NT01 tires. For the baseline, the aftermarket additions were tires and Hotchkis swaybars. Under modified, the car now benefits from a gamut of Lovells bushings from Kollar Racing and KW V3 coilover shocks.

Let's keep in mind that this road course is only 1.1 miles. To shave off one second on such a short course is very impressive. With the car now properly set up, our times were noticeably more consistent, as we have listed

TEST RESULTS LAP TIMES

Session	Baseline (Seconds)	Modified (Seconds)
1.	1:07:87	1:06:29
2.	1:08:40	1:05:89
3.	1:06:85	1:05:67
4.	1:07:75	1:05:29
5.	1:07:24	1:05:95
AVERAGE	1:07:62	1:05:81

Difference of 1:81 seconds per lap average

Difference of 1:56 seconds in best time comparison

our best five laps as they came. When it was all said and done, the GTO was lapping the track nearly two seconds quicker than our baseline passes.

Best of all, I felt like a track star because the car responded better and was easier to control. Its handling limits were actually so hard to reach that I feel with more track time another second or two could be taken off. It was very satisfying to experience such a large improvement in both stability and cornering speed.

200-Foot Skidpad Testing

With the addition of our suspension components, the car certainly felt more controllable right on the edge of grip. That's very good

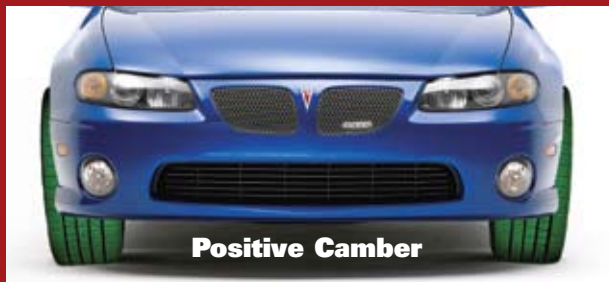
ALIGNMENT

Some debate may be raised because everyone thinks differently when it comes to alignment. Our alignment suggestions came from three sources: Andy Kollar, Jay Chen, and members of LS1gto.com who are actually out there open-track racing their GTOs.

After talking with all three parties, the initial thought was to run as much camber as possible, as everyone boasted about how impactful

an ultra-aggressive camber setup would be on the cornering. But an alignment such as this can chew up tires fast, so we backed off the camber and toe settings.

Alignment settings will be different for each car type, but our setup shows a good compromise for a street car that sees the track on the weekends.



▲ Here's the difference between negative and positive camber. For the cornering benefits, we went with approximately 2 degrees of negative camber. Most avid racers love to go with 3 degrees or more, but this car is also a street car so 2 degrees is used. The KW shock body is narrower than the factory struts and allow for camber adjustment. The factory struts don't allow for any camber adjustment. As a matter of fact, the tire-to-strut tolerances are so close from the factory that when the strut mount bushings collapse, like ours, the tire will rub the strut. We replaced our strut top mounts with Lovells polyurethane mounts, which won't collapse on us. Having excessive negative camber will wear tires irregularly on the street but help the tire bite-in during cornering. For the rear, we went with slightly less camber than the front, because the IRS naturally increases negative camber under load. The rear Lovells bushings provided by Kollar Racing allow us to adjust rear camber; the factory ones had no adjustment.



▲ This diagram shows the dramatic differences between having a lot of positive or negative caster. Caster is the angle in which the steering pivot axis is tilted forward or rearward from 90-degree vertical, as viewed from the side. Andy and everyone on the LS1gto site were keen on dialing in a lot of positive caster on our late-model GTO. Since Andy provided us with adjustable radius rod bushings, we were able to increase our positive caster to 9.5 degrees on both sides. Having this much caster not only increases straight-line stability, but also steering effort. This is something that should be kept in mind for older Pontiacs without power steering because it can make it difficult to steer. It's also important that both sides are equal -- it will cause the car to track left or right if they are offset.

news because it's what most drivers want. If a car can be taken to the edge of its grip and it still gives good feedback, it feels incredible. The combination of our dialed-in suspension and the brilliant R-compound NT01 tires was excellent.

Lateral grip is calculated by averaging our best pass clockwise and counterclockwise. This

200-FOOT SKIDPAD TESTING

PASS

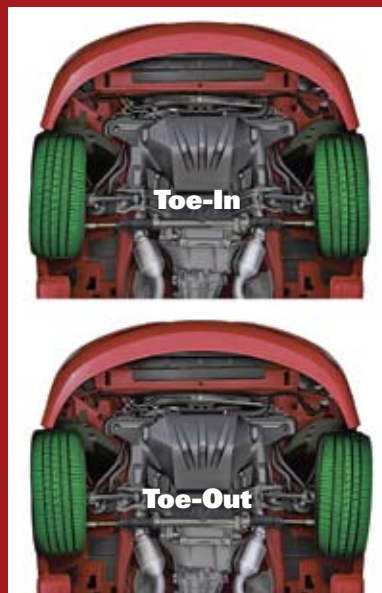
LATERAL GRIP

Baseline

0.965 g

Modified

1.030 g



▲ Toe settings affect three major areas of performance: tire wear, straight-line stability, and corner-entry handling characteristics. This is an area that can completely change the way a car handles, and at the same time, will eat through tires faster than you could imagine. Having excessive toe-in or toe-out will cause the tires to scrub because they are always turned relative to the direction of travel. Toe-in causes accelerated wear on the outboard edges of the tire, and toe-out wears the inboard edges. We have our GTO set to a very small amount of toe-out, it's actually within the factory alignment tolerances. Having toe-out will cause the inner wheel to steer in a tighter turn radius than the outer wheel. This makes the vehicle always want to enter a turn, rather than maintain a straight line of travel. Toe-out encourages the initiation of a turn, while toe-in discourages it.

time around our goal was to exceed 1.0g. Well how does 1.01g clockwise and 1.05g counterclockwise sound? That's an average of 1.03g in a street car/vehicle.

CONCLUSION

With our new Lovells bushings from Kollar Racing ensuring us that there wasn't any unnecessary flex from the factory rubber parts, our KW V3 coilovers were able to work precisely and we were able to tune the suspension more accurately. The end result is a GTO with a precisely tuned suspension and greatly increased cornering speed potential that will require more seat time to fully exploit.

It goes to show that adding a good combination of suspension parts, tires, brakes, and tuning them accordingly will transform a street car into something completely wild and fun to drive. Best of all, taking the time to tune the settings for your new suspension will help you get the most enjoyment out of your new parts and the best results.

These are the final suspension items we will add to the car before we take the Goat out for a three-day jaunt on the track at Sebring International Raceway. Stay tuned to find out

how to get involved in events similar to this one, and see how to get yourself and your car ready before you endure extended on-track sessions on a large open track. 🏁

SOURCES

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Summit Racing

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Adding a good combination of suspension parts, tires, brakes, and tuning them accordingly will transform a street car into something completely wild and fun to drive

Pontiac : GTO : 2004-06		
	Left	Right
Front		
Camber	-1.6°	-1.9°
Cross Camber		0.2°
Caster	9.5°	9.6°
Cross Caster		-0.1°
SAI	15.0°	15.7°
Cross SAI		-0.7°
Toe	0.15°	0.16°
Total Toe		0.31°
Rear		
Camber	-1.6°	-1.4°
Cross Camber		-0.2°
Toe	0.20°	0.19°
Total Toe		0.40°
Thrust Angle		0.01°

Save the "before" alignment measurements.

Show VirtualView® Show Secondary Measurements Save "Before" Measurements

Here is our alignment. The camber is different on the lefthand side to counter for driver weight. It evened out with me in the car.