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Praxis WRX Suspension

AIR SUSPENSION FOR THE TRACK

BY DAVE COLEMAN • PHOTOGRAPHY BY KEN NOTHAM

Air springs. Say it, and you automatically think show car, self-leveling motorhomes, or hittin' the streets in your '64. Use "air springs" in a sentence with "WRX track suspension," and you're an instant comedian.

Stop laughing. This isn't funny.

About two years ago, someone in the vast Bridgestone/Firestone rubber empire realized a lot of the people who want their street cars to be fast on track day don't want a street ride that causes kidney failure. This same person, presumably, realized the Bridgestone/Firestone empire could combine its tires, air springs, and vast engineering resources to find a solution.

The solution, for reasons nobody can explain, is called Praxis, and it's good.

The idea, in a nutshell, is to combine air springs and adjustable shocks to make a suspension that can switch between three distinct modes in a matter of seconds. The first mode mimics the stock suspension, preserving your family's internal organs. The second, Sport mode, lowers the car about an inch, and cranks up the spring rates and damping for a performance setup that can still handle a bump or two. And the third, Track mode, is exactly that. Ride height drops 2 inches, spring rates approximately double, with the rears getting significantly stiffer, and damping increases to match.

A prototype system debuted at the SEMA show last year, and we managed to destroy it with five simple words: "Cool! Where's the rallycross setting?" At the time, there was no way to set the suspension tall, with soft springs and stiff damping, but a week later, there was a new rallycross course at Bridgestone's test track. That led to some important changes.

The struts are now inverted H&R units, with the more rigid shock body on top, instead of the shock shaft. All rally struts, and most performance WRX struts, are built this way. Inverting the strut moved the adjuster to the bottom however, putting the stepper motor, which made the shock adjustments automatic, in harm's way. Combined with most customers' desires to adjust things themselves, the final system adopted manually adjustable shocks.

To switch between modes, you now push a button on the dash to change ride height and spring rates, and run around the car adjusting shocks at all four corners. The adjusters are at the bottom of each strut behind the tires and are easily reached with your butt firmly on the ground. If you're worried about soiling your precious little white tennis pants, throw an extra floor mat or towel in the trunk and quit crying. There are recommended shock settings for each mode based on the work of engineers, test drivers, computerized kinematics and compliance rigs and racetracks. If you're smarter than all that, there are plenty of other shock settings you could try yourself. And, of course, you can now concoct your own rallycross setting.

HOW IT WORKS

Each stock spring/strut assembly is replaced with an adjustable, inverted H&R damper wrapped in an air spring and topped with a specially tuned rubber top mount. Wheel position sensors attach to the suspension at each corner to send ride height information back to an ECU that gets mounted in the left rear fender. A small, rubber-mounted air compressor in the left front fender supplies air to a tank mounted to the back of the rear seat or simply hanging out in the cargo area on a wagon. When the ECU wants to make height adjustments, it signals the valve block, which can let air into or out of each air spring individually.

Touring mode is stock ride height, track mode is 2 inches lower. Changing them means pushing a button and twisting a knob under each strut.

Changing the spring rate when the car is lowered is automatic. Air springs already have a non-linear spring rate, meaning they get stiffer as their volume decreases. Air spring stiffness also depends on the diameter of the piston, which determines how much volume gets displaced for a given amount of suspension travel. A bigger piston means a stiffer spring. The Praxis piston is tapered, so it starts out small and soft in Touring mode, is tapered through the section used in Sport mode, and is largest in Track mode.

The front springs, for example, start in Touring mode at a cushy 165 lb/in., increase to around 255 lb/in. in Sport mode, and jump all the way to 380 lb/in. in Track mode. Of course, when the suspension compresses in touring mode, it doesn't stay at 165 lb/in like a coil spring does, it stiffens somewhat as it passes through the Sport and Track zones of the suspension travel. But now we're getting geeky. For more than you ever wanted to know about air springs, go read "Technobabble" on page 16.

DETAILS

The detail work on the kit is impressive. The air spring, for example, is mounted at a severe angle relative to the strut, much like the stock springs are on most strut cars. This reduces friction in the strut, making the suspension smoother and more responsive to tuning changes. If you look at the way a strut mounts, you can see that the force applied to hold the car up is in a straight line from the top of the strut to the middle of the contact patch, rather than straight down the strut. This puts a side load on the strut, making it want to bend in the middle. This is why strut shafts are so much thicker than shock shafts, and why inverted struts, with their larger load-bearing surfaces, are even better.

Even with an inverted strut, though, this side load causes friction at the piston and strut bearing. Bridgestone's tests showed a conventional WRX coil-over, with the spring in line with the strut, had about 250 pounds of binding force pushing sideways on the middle of the strut. Depending on the frictional characteristics of the strut bearings and piston, this could mean about 30 or 40 pounds of static friction that has to be overcome before the strut can begin to move.

Angling the spring toward the centerline of the tire pushes on the strut in the opposite direction, reducing or even completely canceling this binding force. The stock Subaru strut, for example, only has 60 pounds of binding force. The shape of the air spring gives a little more mounting flexibility than a coil spring, so it was able to be mounted at an even steeper angle, completely eliminating this binding force.

We haven't tried installing a Praxis system yet, but much of the work went into making installation simple is evident. The struts come fully assembled, for example,

complete with top hats, so there's no need for a spring compressor to disassemble the stock units. The wiring harness and mounting brackets are all made specifically for the WRX, so the wires are the right length and everything mounts with existing factory holes.

The self-leveling feature automatically corner weights the car every time it adjusts ride height, and there's an accelerometer to ensure it doesn't try leveling to compensate for brake dive or acceleration squat.

And perhaps the coolest feature of all: There's an extra fitting on the air tank and an optional hose available so you can fill your tires at the track.

THE ALIGNMENT COMPROMISE

But what about the alignment? If lowering your car is supposed to screw with your alignment, how can you get away with raising and lowering the car all the time without the alignment changing? You can't. The alignment will be different in each height setting, so the suspension comes with a single recommended Touring mode alignment setting that balances the need for stability, performance and tire wear as the car gets lowered into Sport and Track modes.

As a WRX is lowered, both front and rear camber increase slightly, with rear camber increasing more quickly, the front wheels toe-out, and the rears toe-in. Praxis recommends setting the Touring alignment to –1.6 degrees of camber and .06 inches of toe-in up front, and –0.5 degrees and .04 inches of toe-out in the rear. The very slight toe-out in the rear is unusual for a street setup, but is necessary to prevent excessive toe-in when set to Track mode, a condition that would cause severe understeer. Pushing the button to lower the car 2 inches into Track mode results in more camber all around (-2.3 degrees up front, -1.4 in the rear), a bit of toe-out up front (0.12 inches), which sharpens steering response, and 0 toe in the rear.

THE VERDICT

In Touring mode, the ride is as good as stock, and body motion control is better than stock, though still cushy. The car can still be flung around and drop throttle oversteer is still your friend, perhaps even more than it is in stock form. Driven aggressively, however, it washes out quickly. Our lap time around a mid-length configuration at the Streets of Willow Springs on stock STi tires (Bridgestone RE070) was 1:21.35.

The Sport mode still rides reasonably well, though the steeply progressive spring rate makes it fairly harsh on large bumps. Steering response improves, and the wallowiness of the Touring mode over high-speed bumps disappears completely. Lap times dropped slightly to 1:21.16 and smiles increased.

Steering response in Track mode is dramatically improved, as is grip. Good tires are a must to get the most from this setup. We tried it on milder tires and found it dull and unresponsive. On RE070s, though, it works brilliantly, turning in sharply and offering substantial grip and good adjustability. Clipping corners and climbing race-curbing works well in this setting, though still not as well as an EVO VIII. Lap times dropped to 1:20.61, and this setting was by far the most rewarding to drive.

The track setting feels about as good as we expect any coil-over setup to be, but as with any set of coil-overs, the WRX still needs a few more suspension parts to be perfectly dialed. We'd recommend a larger rear anti-roll bar, stiffer steering rack bushings, and perhaps some adjustable rear control arms pre-marked for ideal street and track toe settings. Praxis engineers also suggested more aggressive front camber settings for those willing to sacrifice a little tire wear.

With these few tweaks this could be a dominant track setup, and the drive home could still be civilized.

MSRP will be around $3,695, with a weight penalty of about 30 pounds for the pump, tank and control hardware. The system is available from the Tire Rack.■

The strut comes completely pre-assembled, including the top mount, so there's no need for a spring compressor to remove the stock top mount. Also, note the tapered aluminum piston on the bottom responsible for the different spring rates in each mode.

The struts mount like conventional struts, except for the air line and the wheel position sensor (on the right).

The kit is as complete as it is extensive. All this stuff adds 30 pounds to the car, but it's well hidden in various nooks and crannies, so the only visible parts are the switch to change ride height and the air tank in the trunk.

The valve block, hidden in the rear fender, takes commands from the Praxis ECU to distribute air pressure to each air spring. During the leveling process, the system automatically corner weights the car. The big red thing is a dryer to remove moisture from the compressed air.

The wiring harness is completely pre-assembled, designed specifically to fit the WRX, and comes complete with water-tight connectors labeled for easy assembly.

Quick Take

WHAT WE LIKE

- Touring mode is as comfortable as stock, Sport mode is as good as any street suspension, Track mode is as good as any coil-over. Having all three at once is unprecedented.
- Warranty includes all forms of amateur competition, including rallycross.

WHAT WE DON'T LIKE:

- It's expensive, at around $3,500.
- Alignment is a bit of a compromise.
- 30 pounds of extra weight.

THE VERDICT

- If you want a track car that's civilized on the street, we can't think of a better solution. Even the best coil-over isn't a complete solution, though. We'd still add a bigger rear bar, steering rack bushings and maybe some adjustable rear links for quick rear toe adjustments.