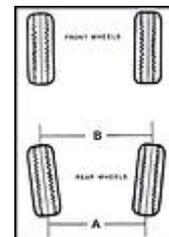




## Rex On Rails - Part One

How to extract the best possible handling from your Subaru WRX's standard suspension...

Words by Michael Knowing, Pix by Michael Knowing and Mellissa Taylor



Grip, grip and more grip - that's what enables the Subaru Impreza WRX to blast its way from corner to corner with enough speed to gobsmack its rivals. Its AWD chassis is s-o stable, even the most mundane driver can drive *fast* without teetering on the edge of death. Get over the user-friendliness of the chassis, though, and you'll realise the WRX doesn't offer a lot of handling finesse; it is nowhere near as finely balanced as, say, a Peugeot 206 GTi or Mazda MX-5 (Miata).

In this series of articles we'll take a look at the GC8-series WRX's suspension, investigate the standard handling characteristics and then progress through various stages of cost effective modifications. Get ready for a complete suspension and handling 'journey'...

## Standard WRX Suspension

Under the front of the WRX you'll find independent MacPherson struts with cylindrical double-acting oil dampers and coil springs. The top of the strut is mounted to the body using a rubber cushion, which reduces the amount of vibration through to the cabin. The lower section of the strut is mounted to the body via an L-shaped control arm, which Subaru claims increases steering stability and reduces road noise. The control arm is anchored at three points - to the front cross-member, the chassis rail and the front hub assembly (via a ball joint). Note that STis and current model WRX sedans come equipped with lightweight alloy control arms, rather than the steel items used in lesser models.

A swaybar is attached to the front cross-member (using a pair of rubber D-shape bushes) and each end of the 'bar is bolted to a plastic swaybar link. The swaybar link connects each end of the swaybar to the front control arms. In terms of geometry adjustment, front camber and toe angle can be altered but castor is fixed.

The rear suspension of the WRX is officially described as "an independent dual link strut type." The rear strut assembly, like the front, comprises double-acting oil dampers and coil springs. The top of the strut is mounted to the body using a rubber cushion, while the lower section of the strut is mounted to the vehicle's underside by parallel lateral links and a trailing arm. Lateral cornering forces are channelled from the hub assembly to the rear cross-member through the parallel lateral links (a pair can be found on each side of the vehicle). Fore-aft loads - such as when braking or accelerating - are channelled from the hub assembly to the body through a trailing link found on either side of the vehicle. The front of the trailing arm is anchored to the body by a metal bracket.

A rear swaybar is mounted to the body using D-shape metal brackets and bushes, while each end of the 'bar connects to the rear-most lateral link. Again, a plastic link adjoins the swaybar to the rear lateral link. The geometry of the rear suspension is fixed except for adjustment of toe angle.

## Standard WRX Handling

Like any major car manufacturer, Subaru has a responsibility to ensure the vehicles it produces can be driven safely in all conditions by the layperson. Understeer (where the front of the car runs wide of the angle being steered) is regarded as a safer and easier handling characteristic to manage than oversteer (where the rear of the car steps outward from the direction being steered). The average driver will instinctively hit the brakes during any kind of 'moment' - during an understeer motion this will cause the car to rapidly slow and, depending on conditions, front-end grip will soon be regained. In contrast, if a driver hit the brakes during an oversteer motion the chassis is further destabilised - the already limited rear-end grip is reduced, creating a possibility of spinning out of control.

Not surprisingly, Subaru engineers have erred on the side of understeer with the WRX chassis - but to what degree and at what stage of cornering? After racking up a few kilometres in the AutoSpeed MY94 WRX (and after owning the similar-handling Liberty RS turbo) we've taken some careful notes on the standard handling...

At the very first stage of a corner - turn-in - the WRX chassis can understeer quite badly. If you go in too fast or are ham-fisted with the steering input, the car will plough understeer and you'll run wide of the corner apex. In some instances, a slight throttle lift-off - or perhaps a gentle dab on the brake - is required during the early stages of turn-in. This serves to transfer weight forwards, thereby improving front-end grip.

Assuming you've entered a corner with a fairly neutral balance, the chassis will typically remain secure. Once again, however, understeer can appear if you continue toward the apex with too much power or you're too ragged with steering inputs. Assuming you're carrying more than about 3500 rpm through the corner (so the engine is developing enough torque to allow chassis balance to be altered), the WRX's chassis attitude is reasonably throttle-controllable.

A balanced car - where you're maintaining just the right amount of throttle to hold the desired line and handling attitude through a corner - is the aim. In some instances, though, you may need to alter the car's attitude mid-corner - easing off the throttle or easing on the brake pedal helps the front-end 'tuck in' and can encourage an oversteer motion. This kind of throttle and brake modulation is particularly useful in tight, relatively low-speed corners where the WRX tends to overload its outside front tyre and hunt for front-end grip. This photo clearly illustrates the massive lateral load applied to the outside front tyre during tight corners.

It's the exit of the corner where the standard WRX performs at its finest - assuming you've set up the right exit line. If you've created a cornering line that allows a good exit, the WRX will accept early application of full throttle and you'll be accelerated to the next corner without wheelspin or any need for steering corrections. This is where the Super Subie really leaves its two-wheel-drive rivals in its wake.

If, however, if you accelerate aggressively while the front wheels are still coping with lots of cornering forces you will encourage power understeer. Power understeer is caused by weight transfer away from the front wheels during acceleration - less weight over the loaded tyres means less grip. Once the WRX starts power understeering the only way to stop it is to unwind some steering lock and/or ease off the accelerator - both measures simply ease the load

on the front tyres. Note, however, you *can* apply power while the front tyres are laterally loaded so long as you're very gentle - you should ease the throttle open as more front-end grip becomes available throughout the stages of the corner.

The basic rule of thumb for the standard WRX is as for most constant four-wheel drive cars: a relatively slow turn-in, balance the car at the mid-point on the throttle, then hammer it as early as possible on the way out. Because of the turbo lag that you'll get when moving on and off the throttle, it's normal to be on the power a touch before the apex - by the time torque builds you'll be past it and blasting out with that all-paw traction.

## How To Make No/Low Cost Handling Improvements

### Tyre Pressures

Before you spend any money on aftermarket handling hardware - and even if you already have, for that matter - it's important to configure the appropriate tyre pressures.

The WRX's tyre placard recommends cold tyre pressures of 33 psi in the front and 32 psi in the rear - note, however, these are only suggested pressures for "the best balance between fuel economy, tyre life, ride comfort and handling." For performance street applications you shouldn't venture below the recommended inflation pressure (all you'll do is increase tyre wear and the steering slip angle), but there is scope to add a couple more psi. The maximum tyre pressure we'd recommend is that quoted to achieve your given tyres' maximum load rating (as indicated on their sidewall). In the case of most performance street tyres this is somewhere around 43 psi.

On our MY94 WRX - which is fitted with Toyo Proxes T1-Ss on the front and Toyo Proxes FZ4s on the rear - we found the best handling balance is achieved with a considerable difference in front-to-rear tyre pressures. After testing in two psi increments, we settled on 37 psi in the front tyres and 32 psi in the rears. The increased front pressures improve turn-in sharpness and reduces the amount of understeer - particularly noticeable through tight roundabouts. The downside, however, is ride comfort - front-end impact harshness is much increased and the front-to-rear ride is imbalanced. In the longer term, the higher front tyre pressure might also cause accelerated wear through the centre of the tread; offsetting this, though, there is **dramatically** less wear on the outside edge of the front tyres when the car is cornering hard.

#### Accuracy of Tyre Pressure Measurements

Tyre pressure varies greatly depending upon temperature. The pressure you measure at the service station after 20 kilometres of driving has little resemblance to the manufacturer's recommended cold inflation pressure. To prove the point, we measured the pressure of our WRX's front tyres after they'd sat overnight and again after a driving in urban traffic for an hour. Amazingly, the cold pressure was 37 psi and the 'up to temperature' reading was 41 psi - a 10 percent increase after only commuting!

Like all other car manufacturers, Subaru's recommended tyre inflation pressure should be set only while cold. According to the owner's handbook, "cold means that the vehicle has been parked for three hours or has been driven less than 1.6 kilometres (1 mile)." That can be regarded the official definition of the term 'cold tyre pressure'.

Another consideration when setting tyre pressures is the inaccuracy of many of the gauges found at service stations. We compared the indicated tyre pressures from seven different service station air hoses against a quality hand-held tyre pressure gauge. Interestingly, the servo pumps read as much as 4 psi above and 4 psi below our hand-held gauge - given tyre pressures of 37 psi, that's a total inaccuracy of over 20 percent! Certainly, it's a good idea to keep a trustworthy tyre pressure gauge in the glovebox...

### Wheel Alignment

A proper wheel alignment - not just the usual toe check after fitting a new set of tyres - is the next step to optimising the handling of the standard car. The 'correct' alignment specs depend very much on your given application - someone chucking the car around in an urban environment has different alignment requirements to someone that regularly sits on 200 km/h (in the Northern Territory, of course).

The following table compares the factory wheel alignment to two different performance alignment specs as recommended by Australia's Whiteline Suspension.

	Factory Recommendation	Whiteline Recommendation - 'Touring' Use	Whiteline Recommendation - 'Sport' Use

<b>Front Toe</b>	Zero (+/- 3mm)	Zero	Zero
<b>Front Camber</b>	Zero (+/- zero degrees, 3 minutes)	-1.0 degrees	-1.5 degrees*
<b>Rear Toe</b>	Zero (+/- 3mm)	1mm toe-out per side	1 to 2mm toe-out per side
<b>Rear Camber</b>	-1.0 degrees (+/- zero degrees, 45 minutes)	As factory	-1.0 to -1.25 degrees*

\*Aftermarket camber adjustment kit required

So what application are each of these alignments best suited for, you ask?

Well, with only slight negative camber on the rear only, the factory alignment has been devised to deliver even tyre wear under typical driving conditions. Front and rear toe - set at zero degrees - ensures good straight-line tracking (important for high-speed cruising stability) and predictable, non-twitchy handling.

The Whiteline Touring alignment offers improved front-end grip during cornering thanks to some slight negative front camber. Negative front camber serves to keep the outside front tyre sitting more squarely on its tread when you're cornering fast - this provides improved grip. Another benefit is reduced wear on the outside edge of the front tyres.

The only other change is the adoption of a slight toe-out attitude on the rear (as illustrated in this drawing). This reduces the lateral stability of the rear-end, which improves turn-in and - by encouraging the rear-end to adopt an oversteer attitude - offsets some of the WRX's standard understeer.

Note, however, there are a couple of trade-offs with this alignment - albeit not particularly severe. First, the negative front camber will cause reduced longitudinal (accelerative and braking) grip and slightly more wear on the inside edge of the front tyres - particularly if you use the car mainly for everyday commuting. Second, the rear toe-out attitude slightly increases wear on the outer edge of the tyres and makes the car more nervous - given that 1mm toe-out per side is still within the range recommended by Subaru, though, we can only guess there's minimal adverse affect.

The Whiteline Sport alignment is largely another step in the same direction as the Touring specs - it adds further negative front camber and rear toe-out, while also introducing more negative rear camber. Note that Whiteline suggests these particular specs only for vehicles equipped with significant suspension upgrades and that are regularly used for motorsport.

Of course, by setting 1.5 degrees of negative front camber (possible only with the fitment of an aftermarket kit), you can expect further sharpened turn-in and even greater cornering grip. On the other hand, the effect on longitudinal grip and wear on the front tyres will both be more pronounced. The 1.0 to 2.0mm of rear toe-out encourages further rear-end activity than the Touring spec but, depending on the exact toe angle you adopt, you'll be venturing beyond the range recommended by Subaru. The rear camber adjustment (again, possible only with an aftermarket kit) serves to enhance lateral rear grip - this is desirable only when the front-end lateral grip has been enhanced. Note that the front toe angle remains the same for the factory, Touring and Sports alignment settings.

Okay, now let's translate some of this alignment theory into practice...

The alignment specs we chose for the AutoSpeed Rex are the Whiteline Touring. Why? Well, we wanted to maintain reasonably even tyre wear and stability at cruise and, furthermore, we didn't want to install any aftermarket camber kits (not yet, anyhow).

The workshop that we took the car to - who just happened to have a new cutting-edge alignment rig - adjusted the front and rear toe exactly to Whiteline's Touring specification. The car had arrived running around 1mm toe-out on the front left and 1mm toe-in on the front right, while the rears were set at zero and 0.8mm toe-out respectively.

Interestingly, front camber on the AutoSpeed MY94 WRX could be adjusted to a maximum of only negative 0.5 degrees - 0.5 shy of the full 1 degree recommended in the Whiteline Touring set-up. We can only assume there's a car-to-car variation in the amount of scope for negative camber. The car had previously been running virtually zero front camber.

Out on the road, the new alignment made another considerable improvement in addition to our optimised tyre pressures. Most noticeably, the increased negative front camber has improved front-end cornering grip after the early stage of turn-in. Wear on the outside edges of the front tyres is also visibly reduced. At the opposite end - the rear - the adoption of toe-out has perhaps slightly improved turn-in but it has certainly created more lift-off oversteer, though not to a dangerous level. The only negatives associated with our alignment specs are increased nervousness at cruise and, while not yet apparent, wear on the inside edge of the front tyres will almost certainly be increased. Overall, though, our fiddling with tyre pressures and the alignment has yielded a bigger improvement than we'd

thought possible.

Next, in Part Two of Rex On Rails, we'll install the two bits of aftermarket gear that provide the biggest bang-for-buck handling improvement...

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