# Gaining Traction

## *Managing Tire Heat and Pressure to Get a Performance Advantage*

Text by Cameron Parsons // Photos by Aaron Eusebi and Cameron Parsons

**WHEN FLYING AT MORE THAN 2,100 MPH, FRICTION AND HEAT FROM AIR** ramming into the SR-71 Blackbird caused the titanium-alloy body to expand, so much so that the aircraft reportedly leaked fuel when it was on the ground as the body panels shrunk at a resting temperature. Although fuel leaks often point to an error, this was a planned design for the Blackbird. Anticipating the heat generated from the supersonic flight speeds, engineers had to account for every detail, including how much expansion the metals of the plane's body would experience, and develop panels and components to fit loosely when the plane sat on the ground. In most cases, heat can be dangerous, but gaining an understanding of its properties can yield an advantage.



**"THE FIRST THING TO KNOW ABOUT TIRES IS THAT THERE ARE NO END-ALL, UNIVERSAL SETTINGS THAT ENSURE PEAK PERFORMANCE FOR EVERYONE.**

## Know Your Rubber

The first thing to know about tires is that there are no end-all, universal settings that ensure peak performance for everyone. Engineered designs in tread patterns, sidewall stiffness, compound, size and overall construction differs drastically between different manufacturers and models. Adding to these variables, age, number of heat cycles, temperature history and pressure history all affect the characteristics of the rubber that holds you to the road. Therefore, the key to unlocking the performance that is in your tires resides in actual track testing, not in a magical PSI that an Internet know-it-all tells you.

## Crank Up the Heat

Many of the most important car components change their characteristics in response to different temperatures. From pistons and cylinder walls, to gears and shafts, to tires and the road, friction occurs in many essential areas and generates heat. No matter how smooth your driving may be, a paved road surface in its tiny details is inconsistent and rough, and the tire rubber that rolls over it attempts to conform to all the tiny pits and cracks. The flex of the rubber, mixed with the abrasion against asphalt, builds temperature that the tire absorbs and in turn transfers to ambient air.

As the air inside a tire heats up, the air molecules move around in an attempt to move down the temperature gradient. But since the air is constrained within the set volume of the tire, the rubber stretches and conforms to accommodate the hot air's attempt to expand instead, what is realized is an increase in pressure. Although many variables come into play when estimating how much the pressure increases, there is a good rule of thumb to go by. For every 10-degree Fahrenheit increase or decrease, the pressure changes by approximately 1.9%.

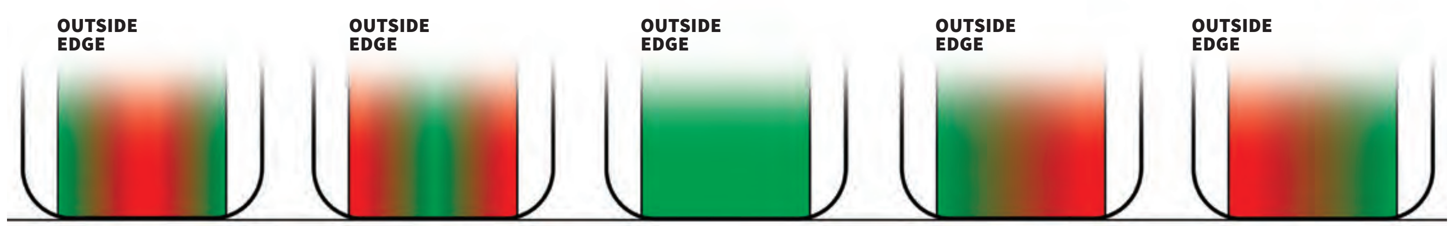
## Know Your Limits

Why do tire pressure changes matter so much? From purpose-built racing slicks to treaded street tires, the answer lies in how heat and air pressure change the characteristics and performance of the tire. Higher pressures stiffen the tire sidewall, preventing it from folding and flexing in high-force corners. Higher temperatures on the other hand, aid in softening the tire rubber, helping to grab onto the road for better turn-in and corner speeds. Ideally, street tires should reach 140- to 170-degrees Fahrenheit, while race tires may see temperatures upwards of 200-degrees.

High pressures and high temperatures may sound like a positive goal, but as with any other component of car tuning, excessive settings in one direction will quickly reduce performance and potentially cause damage. While heat and friction tend to increase tire pressure, the inverse is also true. Setting too high of a cold pressure before getting on track often results in too high of a hot pressure, effectively contributing to overheating the rubber, reducing performance, causing blisters on the surface and shortening the life of the tire.

### Reading Tire Temperatures

Logging the inner, middle and outer surface temperatures of your tire tread can greatly simplify the process of discovering the optimal pressure and alignment settings of your vehicle. Ideally, street tires should fall within the 140- to 170-degree Fahrenheit range, with a variance no greater than 20-degrees across any individual tire on a street setup, or 20- to 30-degrees on an aggressively-tuned setup. The following guide can be used as a rule of thumb, however always consider that suspension, alignment, tire construction and driving style affect the temperature gradient of the tire.




**HOT CENTER:** The tire is likely overinflated, raising the center and reducing friction and traction on the outside and inside. This can lead to overheating the rubber and excessive sliding.

**HOT EDGES:** The tire pressure was set too low, feeding most of the traction area to the inside and outside, contributing to sidewall flex and weakened response.

**OPTIMUM:** Temperatures across the tire are very close if not the same, showing an even level of wear and grip that maximizes the contact patch for optimum performance.

**HOT INSIDE:** More than 20- to 30-degrees variance spanning from a hotter inside to cooler outside of the tire shows an excess of negative camber. If this pattern shows similarly on both tires side-to-side, this may also point to toe-out, which improves turn-in response but reduces higher speed straight line stability (generally not recommended, as it can make the vehicle difficult to control in corners).

**HOT OUTSIDE:** More than 20- to 30-degrees variance spanning from a hotter outside to a cooler inside of the tire shows an excess of positive camber. If this pattern shows similarly on both tires side-to-side, this may also point to toe-in, which can improve higher speed straight line stability but reduces turn-in response.

**HIGHER PRESSURES STIFFEN THE TIRE SIDEWALL, PREVENTING IT FROM FOLDING AND FLEXING IN HIGH-FORCE CORNERS. HIGHER TEMPERATURES ON THE OTHER HAND, AID IN SOFTENING THE TIRE RUBBER.**

**AS WITH ANY OTHER COMPONENT OF CAR TUNING, EXCESSIVE SETTINGS IN ONE DIRECTION WILL QUICKLY REDUCE PERFORMANCE AND POTENTIALLY CAUSE DAMAGE.**

## Putting the Pieces Together

Air pressure, heat and tire softness all go hand in hand, and there's no better place to test these effects than at the race track. During a recent trip to Buttonwillow Raceway, we set out to collect some data. Turning laps in a Ford Fiesta ST on its stock Bridgestone Potenza RE050A tires, we experimented with some different tire pressures to test the effects.

Before starting the session, our durometer read all four tires in the mid-60s for softness out of a scale of 100, 100 being hard as a rock. Outside ambient temperature sat at a comfortable 70-degrees Fahrenheit, while the track surface climbed into the 90s with the help of sunlight in a cloudless sky. We started the Fiesta ST with 32 psi of compressed air in the front tires and 29 psi in the rear, filling the tires of the driving wheels with higher pressure in hopes of maximizing front-end grip.

***(LEFT) Sometimes the best tool to use is your vision. Visual inspection between runs can often give indication of the rubber's condition.***

**NOTE:** Nitrogen is a popular alternative to compressed air, as air contains moisture and other contaminants that make its pressure changes more sensitive to heat. Nitrogen still fluctuates in pressure in response to heat, but experiences less change than compressed air.


*Analytical tools such as Intercomp's Tire/Brake Pyrometer are extremely useful to measure, store and analyze tire temperatures. This particular tool allows for readings up to 1,500-degrees Fahrenheit, average temps of four tires, and storage for up to 10 sets of tires.*

**THE DUROMETER READINGS DROPPED FROM THE 60S TO THE 50S, SHOWING THAT THE RUBBER SOFTENED UP FOR BETTER GRIP.**

We were off to a good start, as the car drove well and laid down a 2'12.54" lap time. The tires heated up after a set of laps and pressures increased to approximately 44 psi in front and 36 psi in the rear, helping the tires break into the 140-degree and higher range that we were aiming for. The durometer readings dropped from the 60s to the 50s at all four corners, showing that the rubber softened up for better grip as well.

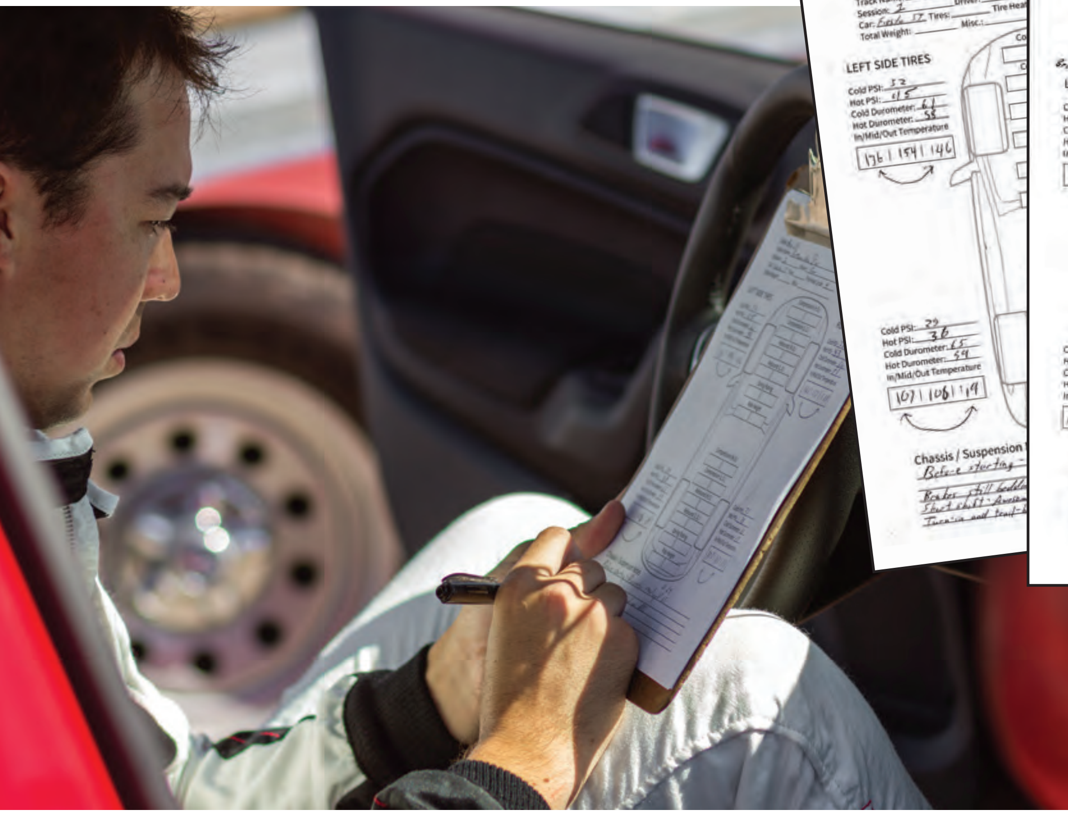
## Over the Edge

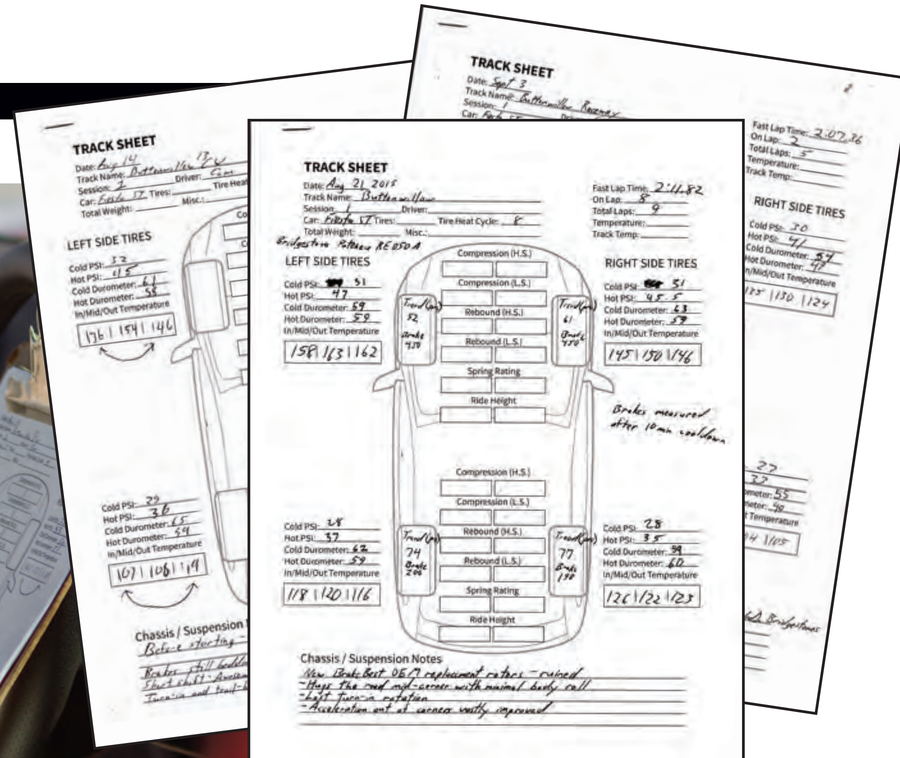
After some experimenting, we found ourselves going backwards. We tried running variations of cold pressures in the mid-to-high 20s, which slowed down the lap times to approximately 2'13. Giving too much flex in the tires, the temperatures were borderline too high and reduced the fast lap time by nearly a second. Testing the waters in the other direction, we tested with pressures in the cold mid-to-high 30s range. The fast lap of the session came early on just lap three, as the tire pressures and temperatures shot up quickly, exceeding 40 psi and approaching 200-degrees Fahrenheit on the tire surface. The car never got back into the 2'12s on this run and traction became increasingly worse throughout.

**DIALING IN THE RIGHT SETUP TAKES TIME AND PATIENCE, AND REQUIRES A METHODICAL APPROACH IN ORDER TO PULL OUT THE MOST PERFORMANCE.**

## Getting it Right

Ultimately, we were close to the optimal cold pressure with the first session on track. In the fastest session of the day, we ran a similar but higher tire pressure setup. With 34 psi cold in front and 32 psi in the rear, we found






*Once a few measurements were made of cold and hot tires pressures, it was possible to start estimating the tire's characteristics under varying conditions.*

**THIS ENDED THE DAY WITH A LAP TIME VARIANCE OF AN ENTIRE SECOND DUE TO NOTHING MORE THAN CHANGES IN TIRE PRESSURES.**

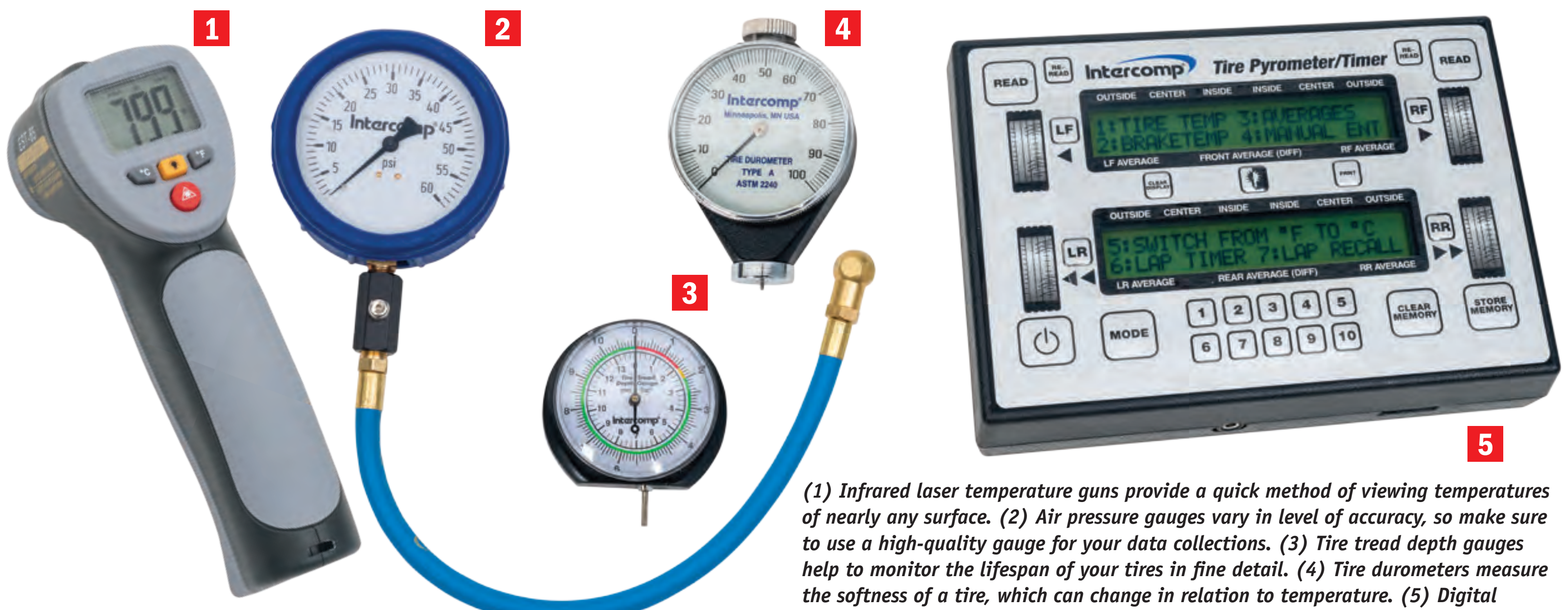
the sweet spot. Tire temperatures were ideal at about 150-degrees Fahrenheit, pressures increased by six to seven psi and the durometer readings of 56 showed the softest tire rubber we saw all day. On this setup, we were knocking on the door of 2'11s as we hit a 2'12.11. This ended the day with a lap time variance of an entire second and a difference of one-tenth of a lateral G in corners due to nothing more than tire pressures.

## The Right Tools

Dialing in the right setup takes time and patience, and requires a methodical approach in order to pull out the most performance. Reading and recording data plays a key role in finding where an extra couple tenths of a second might hide. Take advantage of tire pressure gauges, durometers and pyrometers to record the data while the car is cold and immediately after the car comes off track while hot. No matter the car or tire, there's a good chance that the ideal setup will turn out different from competitors' setups on the same track. Whoever comes out on top weighs heavily on who familiarized themselves with their equipment and learned to accurately predict the effects of heat on their tires.

**HOOK UPS** *Support DSPORT, tell them we sent you.*

Intercomp Company
800.328.3336




*(1) Infrared laser temperature guns provide a quick method of viewing temperatures of nearly any surface. (2) Air pressure gauges vary in level of accuracy, so make sure to use a high-quality gauge for your data collections. (3) Tire tread depth gauges help to monitor the lifespan of your tires in fine detail. (4) Tire durometers measure the softness of a tire, which can change in relation to temperature. (5) Digital gauges allow you to quickly measure and store information in an organized manner.*