

HIGH-PERFORMANCE **BRAKE SYSTEMS** *DESIGN, SELECTION AND INSTALLATION*

JAMES WALKER, JR.



CarTech[®]

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Front Cover:

There is more to upgrading your brake system than just shopping for the best looking parts. While aesthetics certainly are important, consideration must also be given to system-level performance. Picking the right parts is usually more complicated than physically bolting them on—they have to work together. (Randall Shafer)

Title Page:

During track use, rotors are squeezed with thousands of pounds of clamp force, twisted by thousands of foot-pounds of torque, and heated to over 1,200 degrees F. Heavy cars with large engines such as these only make the demands that much more intense. (Wayne Flynn/pdxsports.com)

Back Cover, Top:

Designing a hot rod brake system from scratch may seem intimidating at first, but the fundamental concepts of gain and balance still apply. What really differentiates these brake systems are unique design and operating requirements that may require different compromises than would be appropriate for an all-out racecar. (Randall Shafer)

Middle:

Because experience is the best teacher, the final four chapters of this book are dedicated to sharing our years of upgrade know-how with you. Whether you are upsizing your front rotors for track use or converting your muscle car from rear drum brakes to rear disc brakes, grab your wrenches and head out to the garage with us. Just be sure to wear your safety glasses! (Randall Shafer)

Bottom:

Motorsports can place extreme demands on your brake system, and if your hardware is not up to the task, performance can suffer dramatically. A solid understanding of brake system fundamentals greatly increases your likelihood of ending up in the winner's circle on race day. (Wayne Flynn/pdxsports.com)



SPORTS CAR BRAKE UPGRADE

Now that you've read and understand everything about brakes (right?), it's time to explore four different brake improvement projects. In other words, it's time to grab the wrenches and head out to the garage to bolt on some high-performance brake hardware. Each upgrade scenario has its own set of unique conditions and constraints, but by

referencing these four chapters, you'll be better prepared to address any challenges your own vehicle may throw at you.

To kick things off, we're going to get our hands dirty (literally) walking through the installation of two-piece rotors, high-performance brake pads, four-piston fixed calipers, and stainless steel brake hoses

behind the front wheels of a modern sports sedan—the quintessential *big brake upgrade*. It's important to note that these same steps and considerations apply to practically any vehicle going through a front disc brake upgrade. Whether you are working on a late-model Camaro, an Acura Integra, an Audi A6, or a Ford GT,



While most brake upgrades can be performed by the average enthusiast, remember that you're tinkering with one of your vehicle's most important safety systems. For this reason, you need not only your tools, jack, and jack stands, but also a healthy dose of experience and common sense. If you question your abilities in the least, enlist the services of a professional. (Randall Shafer)

the fundamental sequence of events remains the same.

However, in parallel with selecting and installing the upgraded components, we also take the time to address system-level characteristics such as gain, balance, and pedal feel. For this reason, we frequently reference equations from Chapters 1 through 4 in order to juggle these sometimes conflicting requirements while optimizing overall brake system performance.

The Vehicle

Representative of many compact sports cars on the market today, the BMW 330i is a competent performance machine. Like several other vehicles of this nature, this particular example is used primarily for commuting and driving around town, but on weekends it is driven to the limit at high-speed driving schools and racetrack lapping events. Consequently, a high-performance brake system upgrade was desired that would balance the needs of street and track use.

The Objective

Although its six-cylinder engine produces only a modest 235 hp, this car's 3,300-pound curb weight contributes to significant brake system temperatures when driven

aggressively. Being a BMW, there is certainly autobahn DNA in the brake system design, but like any production passenger vehicle, its stock brake system hardware is biased toward high-speed cruising more than toward generating fast lap times around a road course.

In fact, that last statement is true for practically *any* street-driven vehicle. Whether you drive a turbocharged sport compact, a high-performance V-12 exotic, a or a modern muscle machine, brake systems designed for street use simply don't cut it when driven hard on track.

Although increasing the BMW's brake system thermal capacity quickly became the primary objective, we wanted to make this improvement without making any sacrifices when driving around town. In other words, a dedicated, race-only solution with dual master cylinders and aggressive brake pads was not a viable option.

Therefore, the plan was to replace the brake rotors and calipers with pieces more suited toward high-performance driving while retaining the stock apply system hardware. An equally important objective was to accomplish this task while maintaining stock brake system gain and brake balance. Without the constraints of sanctioning body rules and regulations, our only limiting factor was our checkbook.



Removing the wheels and supporting the vehicle on suitable jack stands is usually the most safety-critical step in any brake system installation. Once you have the vehicle safely in the air, you have easy access to its stock brake system components. Regardless of which make and model you're working on, the stock front brakes probably look a lot like this. (Randall Shafer)

Picking the Right Parts

Even though the vehicle's front-to-rear weight distribution is a respectable 50/50 at rest, under 1.05g of deceleration, the weight distribution shifts to approximately 80/20. Typical of most production-based vehicles, this suggests that the rear brakes are probably not the primary area of concern. As a result, we elected to focus on the thermal mass and performance of the front brakes while leaving the rear brakes alone.

Fortunately, a complete front big brake upgrade kit is available for this vehicle from StopTech. While the kit consists of upgraded front rotors, calipers, brake hoses, and brake pads (smart parts), the icing on top is that the individual components are designed to be compatible from a gain and balance perspective as well (smart system).

Front Rotors

As with any thermal mass upgrade, the most important step is to select and install new front rotors. The stock 330i rotors measure 12.8 inches in diameter and 1.0 inch



The objective of this project was to select and install a brake system that's capable of great around-town driving while being able to sustain the abuse of weekend track events. For this reason, we decided to focus on the front brake system components, as they were the limiting factor for the brake system's thermal performance. (Randall Shafer)