

## Solving Brake Fade in Performance Brake Systems.

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**Brake fade is** a reduction or total absence of stopping power in your brake system that occurs as a result of overheated brake pads. Simply put it's when you push on pedal, the pedal is high and firm, and the vehicle doesn't slow like you planned. No amount of additional foot pressure can make you stop quicker. While it is most commonly associated with race cars and heavy trucks that put high demands on the braking system, as you'll read below, it can occur on any vehicle that uses brake pads and rotors for deceleration.

It's a particularly significant issue compared to other system failures because once the driver has hit the brakes - they've already committed to stopping their vehicle within a certain distance and there isn't much time to correct when it goes awry. Brake fade manifests itself with a very firm yet ineffective brake pedal. *So if you're reading this paper and your braking issue is not accompanied by a firm or hard brake pedal - you don't have brake fade. You will need to look deeper for your issue and I can help.*

It is important to distinguish brake fade from brake failure. Brake failure is a mechanical condition where something in the system has malfunctioned. Brake fade is a condition where the brake system doesn't work even though the brake system may be largely in good mechanical order. It is often temporary or transient .



### ***Here is how you know if you've experienced brake fade:***

- Your brake pedal is firm (soft pedal is a different condition),
- Your brakes are not effective enough,
- Pumping the brake pedal does not help and
- Once your brakes have cooled, performance usually returns, but not to 100%. (I'll tell you why later.)

Let's begin by discussing the cause of brake fade and I will show you a simple and effective method to solve it.

## The Cause of Brake Fade.

**Brake fade occurs** when the temperature of the brake pad exceeds its designed temperature envelope. Brake pads are designed to work within a certain temperature range. This temp range is determined by a number of features such as the pad material, the compounds used in construction, and even the thickness of the pad itself. It takes an incredible amount of energy to slow a fast moving car. To give you a sense - here is how you calculate that energy:  $ENERGY (lb/ft) = 0.335 \times [(mph\ max)^2 (mph\ min)^2] \times gross\ weight(lb)$

So your average 3500 lb car braking from 85 to 25 MPH requires 773,850 ft/lbs of energy to accomplish this. This amount of energy is translated into friction and then heat in a very short amount of time. That's what your brakes do every day.



***That rapid outgassing creates a very thin layer of high-temperature gas barrier between the pad and the brake Rotor***

If the transfer of heat into the pads from hard braking exceeds the design tolerances, the brake pad compounds are overheated and the pad material itself begins to melt. As it melts the binding components of the pad material begin to outgas. ***That rapid outgassing creates a very thin layer of a high-temperature gas barrier between the pad and the brake disc.*** When there is no contact, there is no friction. No friction = No braking. This is also why your pedal remains firm. All other components of the brake system are working perfectly, only ***your pad can't fully contact the rotor.***

While modern brake pads reduce the amount of outgassing compared to older versions and features like slots and holes provide an escape route for these gasses, they do not eliminate this problem they only attempt to manage it.

To be clear, brake fade is the brake pad sliding on a film of very high-pressure gas, which prevents full contact with the rotor. This does not always mean a poor quality brake pad has been chosen and, even with performance use, they can fade due to overloading the brake pad compared to its design targets. This often results in a distinctive smell much like a "burning clutch" in a manual car.

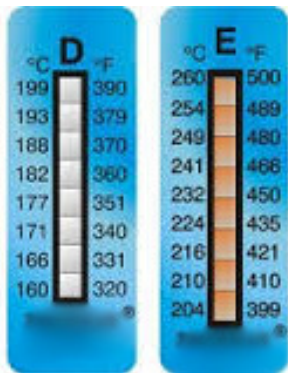
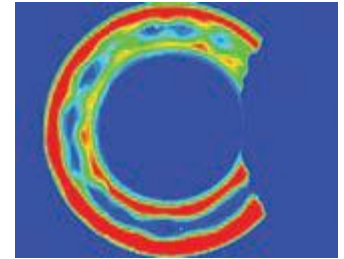
Eventually that melted compound also changes chemical properties and much like the initial pad bedding process, begins to deposit itself into the surface of the rotor. Because it has melted it will often have shiny or "glazed" appearance or even feel slightly pulsing in the pedal (often misread as warped rotors). This surface has a much lower coefficient of friction. Future stops after pad overheating and glazing will not be as effective. After overheating occurs, you have to keep pressing the pedal harder even after the system cools off. This generates more heat leading to a vicious circle of lowered performance. Time for replacement parts.

On the next page, I talk about how to solve the Brake Fade issue that plagues every performance driver, street, track or race.

## Solving Brake Fade.

**Solving brake fade** means addressing all the issues identified above. You must address each issue completely in order to rid yourself of this problem permanently. But you can do it and I can help.

First you must find a brake pad that is designed to function in the heat range that you are operating in. This means **you must know the peak temperature that the system is reaching**. It makes no difference if you are a spirited street driver, track driver or hard core racer, this can and needs to be addressed. There are many expensive infrared devices and cameras that the manufacturers use to assess this. They generate heat maps of the brake systems in action and figure out what pad temperature range they need. For most this is complicated and not practical. The image to the right shows a heat map of a brake rotor so that max temps, and other information, can be assessed. Champions know that this is important.



For the driving enthusiast there are much more practical ways to assess max brake temp without resorting to expensive scientific equipment. Hand held temp-guns are okay but only indicate temp after a period of cooling. I like temp strips and heat paint. They are low cost and provide quality results for the average driver. Brake temp strips can be stuck onto the caliper or flat surface and will indicate the peak temperature reached. Brake temperature paint changes colors to show the maximum temperature achieved. In both instances, you know the max temp reached from your own driving – That is the first step.

In the picture to the left you can see an unused (Left side) and used (Right side) brake temp strip for a street/autocross driver. You can clearly see that the driver has exceeded the maximum 480 degree Fahrenheit temperature recommended for street pad and should look for a dual-use brake pad. Knowing the max temperature of your brakes is critical to solving your fade issues.

Once you have installed the brake pads that fit your driving style, you need to remove the glazing from your brake rotors or replace the rotors completely and bed the new brake pads. To remove the glazing, take 200 grit garnet sandpaper wrapped around a sanding block and lightly sand both sides of the rotor in a circular motion. **NOTE: GARNET sandpaper only must be used. Standard oxide sandpaper will impregnate the surface with unwanted compounds and may make the problem worse than before. DO NOT USE STANDARD SANDPAPER.** Once you see the shiny glazing removed, you are ready to bed your new brake pads per the manufacturer's recommendations and you have solved your brake fade!

Below is a chart of common temperature ranges and pad materials that help define that performance envelope.

Type	Effective Range	Typical Material
Street Pads	50-250°C ( 120-480 °F)	Organic - Ceramic
Dual Use	250-500°C ( 480-930 °F)	Organic - Ceramic - Semi Metallic
Race	450-700°C ( 840-1300 °F)	Semi Metallic - Sintered