

# THE HOWS AND WHYS OF THE ELECTRONIC STABILITY PROGRAM

## THE BEST SAFETY SYSTEM SINCE SEATBELTS

**M**ercedes-Benz has been at the forefront of safety technology pretty much forever, priding itself on delivering the very best modern engineering can provide for the benefit of owners. In this article, we'll look at one safety system that used to be novel, and is now close to ubiquitous: Electronic Stability Program (ESP) known generically as dynamic stability control. The system made its first appearance in the 1995 S500 sedan, slowly permeating the whole M-B line and has been the focus of constant testing and improvement for the past 15 years. We'll look at the evolution of the system, how it works, and the benefits it provides.

### A Brief History of ESP Systems

Mercedes-Benz and Robert Bosch GmbH have worked together for decades. Many of the safety systems first introduced by Mercedes have their roots in Bosch technology, and ESP does as well. Stability control is really made up of several "building blocks", the first of which is the Anti-Lock Braking System (ABS).

While the first Bosch patent for a form of ABS systems dates to 1936, it wasn't until 1978 that the system appeared in a production vehicle. The October introduction in the S-Class sedans (W116) beat BMW by just months, with ABS being introduced into the BMW 7 series in December of that year. As a testament to just how advanced this introduction was, it's worthy of noting that it was a full seven years later, in 1985, that ABS systems first appeared in US manufactured cars. One can only wonder how many lives might have been saved if the technology had been more quickly launched.

ABS systems use wheel speed sensors to detect the onset of wheel lock-up. If lock-up is imminent or has occurred, the system releases brake-line pressure, on a wheel by wheel basis, so that maximum braking efficacy is maintained. Because most drivers just slam on the brakes in a panic situation, even early ABS systems

resulted in decreased emergency stopping distances. (Yes, it's true that some expert drivers can stop a car in a shorter distance than ABS systems, but the advantage continues to shrink, and can only be achieved in ideal situations.)

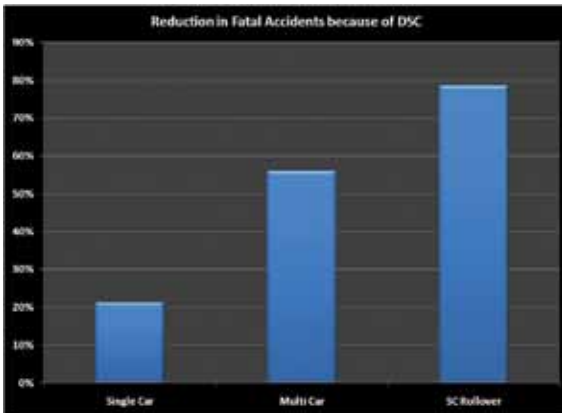
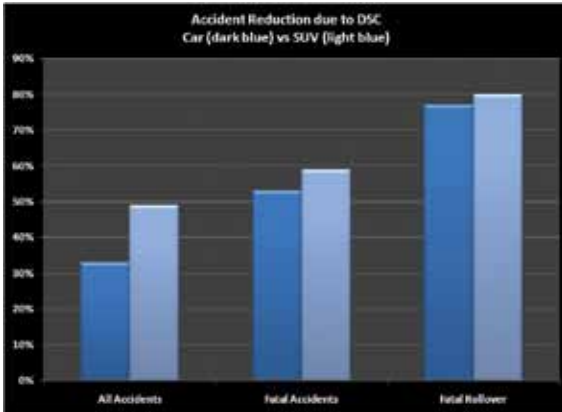
An interesting byproduct of ABS system function is the pulsing brake pedal. This is caused by the ABS pumps when they have to quickly modulate pressure to a wheel or wheels that are about to lock up. When the systems were first introduced, this behavior scared many a driver and they'd take their foot off the brake pedal. Now we're all used to it and just keep the pedal down in a panic stop.

One item worth noting here is that ABS is also the first example of automatic systems that can do more than any driver can, independent of skill. The system works on an individual wheel basis in contrast to the brake pedal that works on all four at once. This ability to keep each tire slowing the car independently is why you can steer the car during a panic stop compared to when the wheels are locked up and you just keep going in the direction you were going, no matter what you do. (If you've never seen how well this works, next time you have a chance to play in an empty snow-covered parking lot, stomp on your brakes so the ABS kicks in, and then steer the car! It really is an amazing system). But anyway, ABS is the first "building block" of modern braking systems. But enough with ABS systems, it's time to look at the next building block: Traction Control.

Traction control also came out of Bosch technology. Called Automatic Slip Regulation, this is a system that looks at relative wheel speed to see if one wheel is starting to spin, and if so, cuts engine power. First introduced just one year after ABS in the 1979 S-class (W126), it wasn't available in the US until 1990 in the 560 SEL. While similar in concept to ABS (monitoring of wheels and computer intervention) early ASR systems have had their share of problems. With no on-board diagnostics, problems with the early systems are difficult to diagnose and have caused many a headache. Teething issues aside, ASR is the second building block of stability control systems. (But this time M-B wasn't first; Buick had introduced its own traction control system in 1971 called MaxTrac!)

These two systems act (mostly) on fore and aft motion. To get the rest of the information required to control cars in turns, a few more sensors have to be added: a steering wheel angle sensor to tell where the driver wants the car to go; and a yaw sensor to measure how fast the car is actually turning. (Lateral or sideways acceleration, and roll sensors, may be included in the system as well.) When the ESP system determines that the car isn't going where the driver wants it to, it intervenes. Intervention modes include individual wheel braking to change weight balance (transferring weight to the wheel that is about to slide) as well as cutting engine power to keep the rear end planted.

First introduced in the W140 S-Class in 1996, ESP systems are now common in many makes of cars and are standard in all Mercedes-Benz cars. Because of the



Source: Insurance Institute for Highway Safety, 2006

magnitude of accident reduction, many regions will be mandating ESP adoption in most or all of the new car fleet in the very near future. In the U.S., all passenger vehicles must have ESP by 2012; Canada, 2011; Australia, 2011; and the EU has a proposal that all vehicles have it as standard by 2014.

Modern systems have many settings for the systems. Sporting modes can allow for an increased drift angle for faster track work (a loose car is a fast car is a common statement in racing), and modes for snow and ice exist as well.

### Safety: the Numbers.

Early on when ESP was first introduced, numbers on benefits were subject to large uncertainties. But now with almost 15 years of accrued data, the benefits are definite and incontrovertible. I personally think that ESP systems are the most significant safety item since seat belts! According to an IIHS study released in 2006, ESP reduced all fatal accidents by 43 percent and fatal single vehicle accidents by about 56 percent. If you look at the numbers by vehicle class, the higher the center of gravity, the better the numbers. SUV rollovers are reduced by a massive 80 percent!

As with all numbers, one should wonder if they are "statistically significant." The answer is, without a doubt, yes. One study by the National Traffic Highway Safety Administration took a particularly close look at this very issue and found that using every possible way to look at the data lent statistical significance to the safety en-

## When to Turn the Nanny Off

If these systems are so good, why do cars come with buttons to turn them off? There is one good answer, but the side effect is that it means we can also defeat the system when we shouldn't. There is a very bad reason I often hear: "I can drive my car just fine and I don't need any computerized nanny to take care of me." The statistics on accident reduction are so compelling that anyone should be able to see the folly of this statement. In the AMG Driving Academy, one of the standard exercises asks the student to drive a fast slalom course with ESP on. This usually goes reasonably well, with lots of interesting noises coming from various corners of the car as the brakes intermittently slow individual wheels to keep the car on the student's intended course. This is followed by asking the student to drive the same course with ESP turned off. It's a rare student who can manage more than two turns before slewing wildly off course.

So, what's a good reason to turn it off?

The only one that makes any sense is when the stability system isn't programmed for how the car is being used. As the systems get better and better, these opportunities become more and more rare.

One of the few examples is when the car is caught in a snow bank and has to be rocked and skidded to get it out. After regular efforts have failed, turning the stability control off is sometimes the only way to gain enough traction to get out. However, the newest cars even have a program in the ESP system for snow and ice that changes the braking action if a wheel spins when the vehicle is moving slower than 20 mph to overcome just such a problem.

It's true that advanced stability control systems may slow an expert driver down a bit on a race track. But running the car with the system off comes with a massive increase in risk. So unless the particular system on your car isn't well-suited to your particular driving situation, or you are Michael Schumacher, just leave it on.

hancement. Since all Mercedes Benz passenger cars and SUVs have the feature as standard, the decision about buying or not buying is a simple one. If you buy a MB, you get the system! But this isn't true of all new cars yet, and the older a car bought the less likely it is to have ESP. So now that you know how well the systems work, it just makes sense to think about whether the car you're buying does have ESP.



**Matt Richter, of Woodside, California, owns a company that manufactures electronic control systems for high-performance automobiles, and contributes to several car magazines. He has a doctorate in applied physics from Stanford University.**