ACTIVE SAFETY: COLLISION WARNING & AUTOMATIC BRAKING

By Larry Carley

Brakes have been a safety feature on cars since day one. Anything that goes under its own power also has to stop. Over the years, technical innovations such as Antilock Brakes (ABS) have improved the ability to stop with minimal skidding on wet or slick surfaces. The addition of Stability Control allowed each wheel to be braked individually to reduce understeer and oversteer when cornering or swerving from one lane to another. Then came braking systems that "precharged" the brakes the instant the driver lifted their foot from the accelerator pedal to reduce brake reaction time and stopping distance.

The latest innovation is braking systems that anticipate the need to brake (collision warning) and actually apply the brakes (autonomous braking) to avoid or reduce the damage caused by a collision. These technologies combine elements of "brake assist" with "adaptive cruise control" to take braking safety to the next level.

Automatic braking can react to emergencies when a driver does not.

A growing number of import applications for the U.S. market currently offer some type of automatic braking as standard or optional equipment. These include certain Acura, Audi, BMW, Lexus, Mercedes, Toyota, Volvo and VW models, plus the 2015 Nissan Infiniti and Hyundai Genisys.

The technology is still evolving so currently there are systems that simply warn the driver with a flashing light and/or audible alarm, others that warn the driver and apply partial braking to slow the vehicle ("collision mitigation" systems) if the driver fails to react in time, and various degrees of automatic braking that will actually apply full braking and either slow the vehicle or bring it to a complete halt depending on the speed and circumstances.

The ongoing evolution in braking technology arises from the fact that tens of thousands of people are killed and injured every year in motor vehicle accidents. In theory, many if not most of these accidents could be prevented or reduced in severity by autonomous braking. Although some accidents are weather-related or the result of mechanical failure, the majority of accidents are caused by driving under the influence of alcohol or drugs, driver inattention, driver fatigue or driver error (such as misjudging when to brake and how hard to brake).

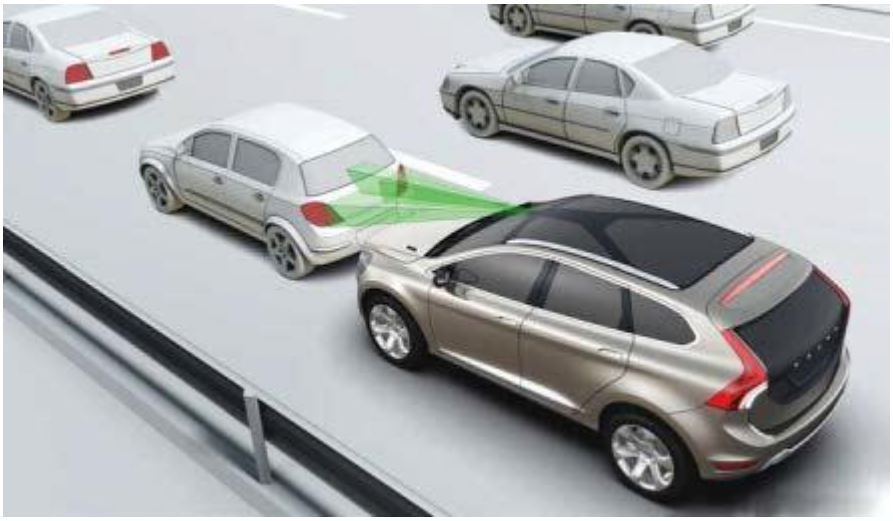
There are laws to discourage people from driving under the influence (which many people ignore) and laws that make it illegal to text or use a hand-held cell phone while driving (which people also ignore). There are also devices that can prevent an intoxicated person from starting their car. But currently there is no technology that can force a driver to keep their eyes on the road or their brain fully engaged while driving the vehicle.

Automatic braking is designed to function as a backup co-pilot who is always paying attention even if the driver is not. It doesn't assume the responsibility for driving and braking the vehicle (at least not yet) but it can intervene if the driver is distracted or fails to react quickly enough when traffic suddenly slows or stops, or an obstacle appears in the road ahead.

Distractions such as texting, yaking on a cell phone, eating, lighting a cigarette, fiddling with the radio, climate controls or navigation system, yelling at the kids in the back seat can shift a driver's attention away from the road. An automatic braking system isn't distracted by any of these things because it is constantly monitoring the road ahead of the vehicle.

HOW THEY WORK

Automatic braking systems may use a combination of short and long range radar sensors mounted in the bumper or grille to detect what's going on in front of a vehicle, or Lidar (laser range detection) sensors and/or optical cameras mounted between the rearview mirror and windshield to "see" what's going on ahead of a vehicle. Radar-based systems will typically sense objects in the road ahead up to a distance of about 80 to 100 yards (the length of a football field). Some systems will look further ahead (up to 200 meters or more) depending on the speed of the vehicle and the maximum speed it is designed to remain active (some systems only work at speeds of 30 to 50 mph or less).

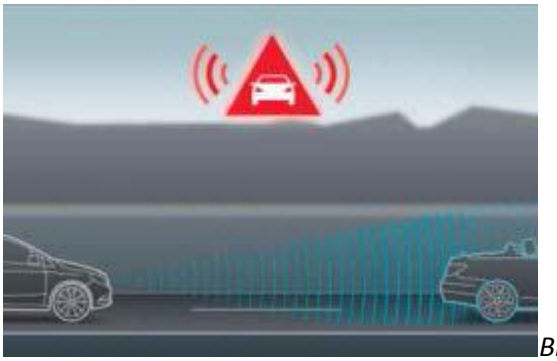


Radar, lasers or camera keep an eye on traffic ahead.

Collision warning systems have been around for a number of years, including those introduced in 2006 on the Acura RL, and 2007 Mercedes S-Class and CLS-Class models with "PRE-SAFE" braking. These early systems did not apply the brakes, but only warned the driver and precharged the brakes so they would be ready when the driver finally reacted.

One of the first production applications of fully automatic braking was in 2010 on the Volvo XC60. Volvo's "City Safety" system only operates at speeds below 30 km/h (about 18 mph) to prevent low

speed rear-end collisions and parking lot accidents which account for nearly half of all accidents. The system uses an infrared laser camera mounted behind the windshield to monitor the road ahead. The same camera is also used for adaptive cruise control and lane departure warning. The camera can pick up vehicles easily enough, but may not always detect low-reflective objects such as animals or pedestrians. If the rate of closure indicates a collision is imminent unless the brakes are applied, it will flash a visual warning and sound an alarm. If the driver reacts in time and hits the brakes, the system does not intervene. But if the driver fails to react, it takes over and automatically applies the brakes to stop the car.


Brake warning icon

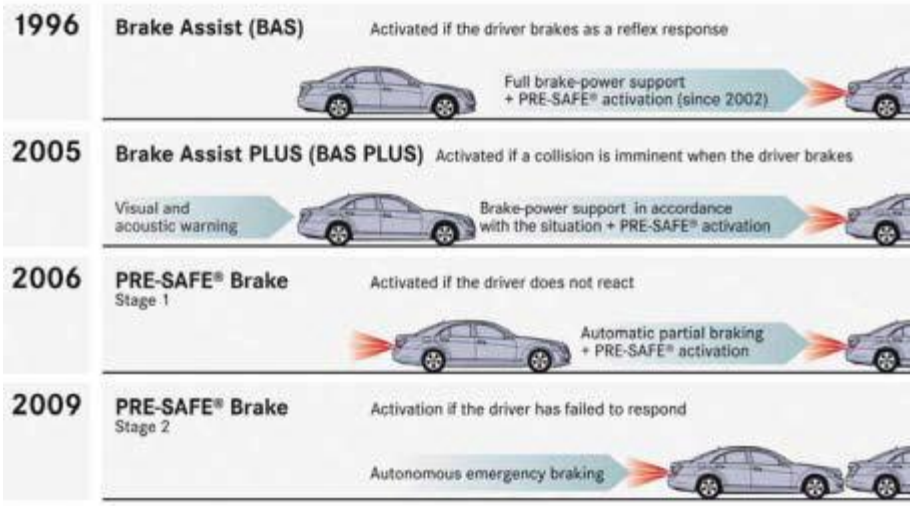
The system has its limitations. It only look ahead about 10 meters in front of the vehicle, and only avoids a collision if the relative speed between the car and object is less than 15 km/h. At higher speeds (up to 31 mph), it will slow the car but not bring it to a complete halt. The system can also be deactivated by the driver, but will revert back to active mode the next time the vehicle is driven.

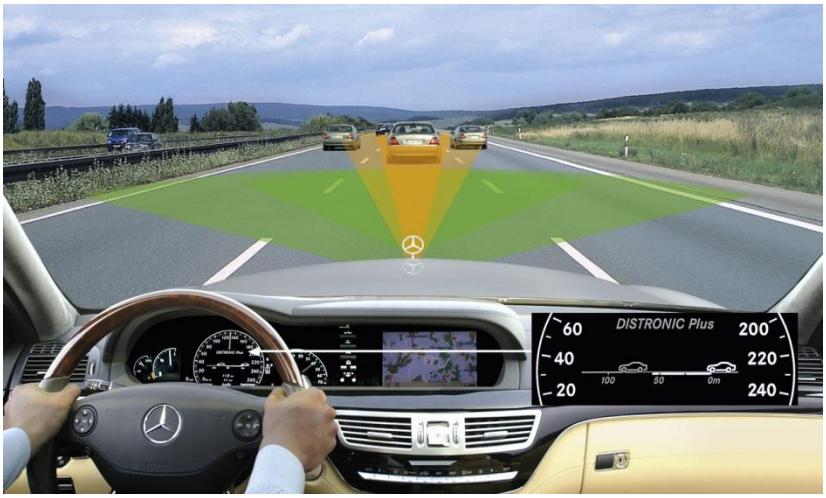
Since the introduction of the City Safety automatic braking system on the Volvo XC60, accident claims have dropped 20 percent compared to comparable vehicles that are not equipped with any type of brake alert or automatic braking system according to a study by the Insurance Institute for Highway Safety.

On the 2015 Hyundai Genesis, the "Automatic Emergency Braking" (AEB) system uses both cameras and radar sensors. In fog, rain or other extreme conditions, it can see what's happening in the road ahead to alert the driver if a crash seems imminent. If the driver does not react, the system will brake automatically and stop the vehicle from speeds from 5 to 50 mph.

On the 2012 Audi A6, a "PreSense" automatic braking system is used. Like the Volvo XC60 system, it will fully brake at speeds up to about 30 km/h in an emergency situation. Above 30 km/h, it will precharge the brakes and apply partial braking as needed to reduce the severity of a collision. It will also tap the brake momentarily to wake up a driver who may be ignoring the visual and audible warnings. The Audi system uses front-mounted radar and a windshield-mounted camera that sees ahead about 80 meters. The Audi system can be switched off by the driver, and will remain off until it is turned back on by the driver (no automatic reset). The same system is used on certain VW models, and is called "Front Assist."

Mercedes "Pre-Safe Braking" system, which uses radar and dates back to 2006, precharges the brakes and provides optimum braking assist when the driver applies the brakes. If the driver fails to react, it will apply partial braking to reduce the speed of the vehicle and hopefully mitigate the damage caused by a collision.





Mercedes Distronic

Mercedes "Distronic Plus with Pre-Safe Braking" system combines the features of Pre-Safe braking with adaptive cruise control. Distronic Plus uses short and long range radar sensors to monitor traffic conditions up to 600 yards ahead of the vehicle from speeds of 20 to 120 mph. Like Pre-Safe braking it will partially apply the brakes in an emergency if the driver isn't paying attention an fails to apply the brakes. On 2014 M-Class SUV, the system is called "Collision Prevention Assist."

Most of the automatic braking systems that are currently on the road revert full control to the driver if the driver hits the brakes when a warning is received -- which may or may not prevent an accident depending on how fast the vehicle is traveling, how hard the brakes are applied and the distance to the vehicle or object in the road ahead. In other words, if the driver does not brake soon enough, their vehicle may not slow fast enough to prevent a collision even with brake assist. That's one of the downsides of current automatic braking systems.

Another drawback is that some systems may apply the brakes autonomously when braking really isn't necessary, as when suddenly changing lanes and cutting in behind another vehicle. As software and hardware continue to improve, most of these bugs will go away (we hope, anyway) allowing smarter braking and fewer accidents.

Another drawback with automatic braking is that some systems (like Volvo XC60) only apply full braking at slow speeds. Systems that use automatic braking with adaptive cruise control can slow a

vehicle traveling at highway speeds to maintain safe spacing as traffic slows down and speeds up, but at highway speeds it can't be relied on to fully stop the car if the driver is distracted or asleep at the wheel.

Auto makers are very cautious about fully autonomous braking systems for obvious liability reasons. If a car that is supposed to brake itself doesn't and hits something, who gets sued? The auto maker? The supplier who provided the braking system? The vehicle owner? Or all of the above?

DIAGNOSIS & REPAIR ISSUES

For diagnostics and repair, access to the factory service information is absolutely essential. We searched through one of the leading online providers of OEM service information for the aftermarket and could not find much service information or any technical service bulletins for 2014 or 2015 import collision warning or autonomous braking systems. The information will likely be added as time goes on, but for now you will have to go to the OEM service information websites for detailed service procedures. Most of these systems are still under new car warranty and will be for several years, so dealers will likely handle any initial problems and software updates

Diagnosis also requires using an OEM scan tool or a professional grade scan tool that can access the various safety systems -- which means if your scan tool lacks such coverage or is not up-to-date if such coverage is available you can't really diagnose these systems.

By intuition, you may be able to figure out where a fault is if there is a warning light and the system is not functioning. Loss of a vital sensor (forward radar or camera, or even a vehicle speed sensor) will affect adaptive cruise control as well as the collision warning and braking system.

A fault within the brake system itself such as a bad ABS solenoid, pump or relay, or a leaky high pressure accumulator, may prevent the system from precharging or applying the brakes. Electronic faults in control modules and/or wiring may also prevent the system from working normally.

To date, we have not heard of any specific faults or recalls with any of the current applications. This doesn't mean the technology is working flawlessly or that failures have not occurred. It only means we haven't seen any pattern failures to report -- yet. However, Volvo has issued software updates for 2011 and 2012 models to reduce the sensitivity of the system due to reports of false braking applications in certain driving situations or for no apparent reason.

The same factors that affect conventional brakes still apply to automatic braking systems. The pads and rotors need to be in good condition, the brake likes and hydraulics need to be leak-free, and the control electronics (wheel speed sensors, brake pedal switch, ABS solenoids, pump and module) all needs to be functioning perfectly. Something as simple as a misadjusted brake pedal switch may upset the operation of the system.

With radar based systems, mud and snow usually have no effect on the sensors. But with laser and camera based optical systems, the optics need a clear view of the road ahead. Mud, dirt or even inspect splatter on the windshield may obscure the view of the road ahead preventing the system from successfully analyzing distances or anticipating closure rates. The windshield wipers should keep the windshield clean, which means if the wipers are not in good condition they need to be replaced.

Another problem that may be encountered with these systems is that of driver training. A driver may not fully understand how their collision warning/automatic braking system is supposed to operate, what it can and can't do, and what they should or should not do in an emergency situation. If they think the system is supposed to brake automatically for them, and it doesn't, they may think something is wrong and needs to be fixed. Your vehicle owners manual should spell out the functions of the system and its capabilities. As with ABS brakes, you should generally apply the brakes normally and not pump the brakes. If you have the bad habit of resting your left foot on the brake pedal while driving, it may confuse the system and prevent it from reacting in an emergency situation.