

BRAKE OVERRIDE (SMART STOP TECHNOLOGY)

It's a typically busy weekday morning on your drive to work.

You come to a stop at a red light with a

line of cars

behind you. As you stop

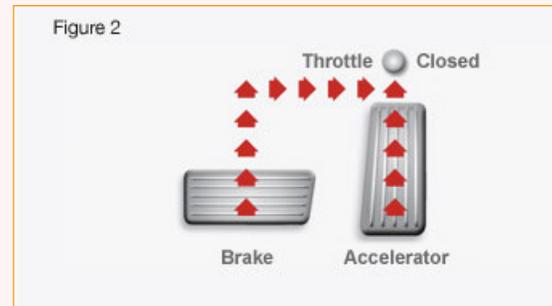
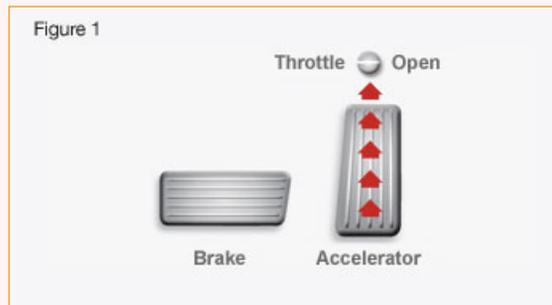
you notice an empty water bottle roll from the backseat of your car to the front seat. The light turns green before you can reach down to pick it up, but you know that it's there so you decide that picking it up can wait until the next red light. Suddenly, you hear plastic crinkling around your foot. You look down, and see that the water bottle has lodged itself under your gas pedal, causing the pedal to stay pushed down after you take your foot off. Instinctively, you press down on the brake pedal, but with the gas pedal also stuck down, you are unable to slow your vehicle's forward motion.

It's the stuff of nightmares: realizing that you are in the driver's seat of a vehicle that is out of your control. Human and/or mechanical failures can lead to a frightening situation like the one just described. Fortunately, more and more vehicles are being equipped with brake override, a vehicle safety feature that can act as a failsafe measure in the event of an electronic or driver malfunction that results in unintended acceleration.

WHAT IS BRAKE OVERRIDE?

Brake override is an active vehicle safety feature designed to work as a failsafe measure in the event that your vehicle's powertrain receives mixed signals (i.e., the gas and brake are pushed down simultaneously) or that something goes wrong with other electronics on the vehicle. In vehicles that have brake override, the brake pedal is enhanced with "smart" technology. This means that it is programmed to recognize when something abnormal

is occurring and to take action by safely bringing the vehicle to a stop. To illustrate, brake override can detect if the driver is pushing the accelerator and the brake at the same time. The safety system recognizes that this is not how people normally drive, and proceeds to initiate corrective action. Brake override is designed to override accelerator commands when appropriate, and will not override the brake.



Brake override is called by several other names, including "smart pedal", and "smart stop technology". Despite terminological differences, all the systems share the same purpose and work in fundamentally similar ways.

WHEN WOULD BRAKE OVERRIDE BE USEFUL?

Brake override is designed to be useful in cases of unintended accelerations. Unintended acceleration is defined by the National Highway Traffic Safety Administration (NHTSA) as "the occurrence of any degree of acceleration that the driver did not purposely cause to occur" (NHTSA 2012). In other words, brake override is designed to engage whenever it senses that your car is accelerating against your will. There are a variety of reasons why this could happen, and therefore a variety of situations where brake override would be useful:

- An object or accessory in your vehicle becomes entangled with the accelerator pedal, causing it to stay pushed down even after you release your foot.
- Your foot is still on the accelerator but you push down the brake so that both pedals are being pushed simultaneously.
- A malfunction in some other electrical component in your vehicle causes the acceleration command to continue after you have released your foot from the gas.

The underlying principle behind brake override is that if the driver is pushing the brake but their vehicle is still accelerating, then something is going wrong and the vehicle should be brought to a stop as safely and quickly as possible.

Driving a vehicle that is accelerating beyond your control can be a frightening experience. The vehicle's brakes are expected to work and when this expectation proves false, panic, fear, and confusion can set in. If a vehicle without brake override experiences an unintended acceleration, many

Your brain is your vehicle's most important safety feature.

drivers tend to “ride the brakes”, i.e., apply constant, moderate force to the brake pedal. This reaction is typical but unfortunately does not guarantee that your vehicle will stop. Riding the brakes wears them down, reducing their overall effectiveness and eventually ruining the brakes (NHTSA 2012). Applying very firm, consistent force to the brake pedal will likely stop an unintended acceleration, however it is unlikely that the majority of drivers will actually apply the amount of force required to stop a runaway vehicle, since this method necessitates drivers to “fight” the vehicle’s desire to accelerate. Brake override can remedy these situations by automatically overriding the acceleration commands.

HOW DOES BRAKE OVERRIDE WORK?

Brake override technology is possible because modern vehicles are controlled by a fully integrated electronic system. This allows various sensors in your vehicle to transmit information to a single, overarching electronic control unit (ECU) which sends customized commands to different parts of the vehicle.

Prior to the invention of ECUs, vehicles relied exclusively on mechanical or hydraulic controls, which complicated the installation and integration of additional features and limited the ways in which different aspects of vehicle performance could be connected. In the case of brake override, the ECU receives information from the sensors at the brake and gas pedals, decides whether there is a problem occurring (e.g., the driver is holding the brake but the vehicle is speeding up), and initiates the appropriate corrective actions.

Brake override is a function of the ECU and works by continuously checking the position of the brake and accelerator pedals for potential conflicts, for

example, if the accelerator pedal was pushed down as well as the brake pedal. If a conflict is detected, the brake override function engages and the ECU either ignores the accelerator pedal completely or significantly reduces the effects of having the accelerator pushed down. Different brake override setups accomplish this in different ways. For example, in some vehicles, the accelerator commands are overridden by partially closing the accelerator throttle. Other systems reduce fuel flow to the engine, while brake override setups on hybrid vehicles weaken the force of the electronic current driving the vehicle (NHTSA 2012).

HOW DOES BRAKE OVERRIDE KNOW IF MY VEHICLE IS OUT OF CONTROL?

Brake override systems are designed to identify cases where a vehicle is accelerating beyond what the driver intends. Technology developers have done their best to ensure that brake override identifies these situations correctly and does not slow down a vehicle where the acceleration is intended.

The basic brake setups activate when the position sensors for the gas and brake pedals show that both are being pressed down. Brake override is programmed to recognize that this is not the way people normally drive, and to override the accelerator command. Other manufacturers brake override programs are more complicated. Many require that the accelerator pedal be pushed before the brake pedal in order for brake override to engage. This means that if you push down on the brake pedal with one foot and then push the accelerator with the other, brake override will not prevent you from accelerating. This is to allow for occasional “two-footed” driving that might be necessary when starting on a steep hill or positioning a trailer.

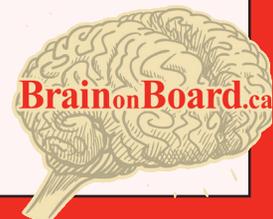
In addition to including sequential information like the order that the gas and brake pedals were pushed, some brake override systems also operate according to time specifications. For example, the activation of Toyota’s brake override system (called “Smart Stop Technology”) requires that the accelerator is pushed down first and the brakes are applied firmly for longer than one half second at speeds greater than approximately eight kilometers per hour.

All of these measures are designed to ensure that the brake override technology quickly and correctly identifies dangerous unintended accelerations and engages to safely stop your vehicle.

IS BRAKE OVERRIDE EFFECTIVE?

There is little data available on the exact number of crashes that could be mitigated or prevented with brake override. Nevertheless, estimates of the potential benefits of brake override are encouraging. For example, NHTSA has identified thousands of complaints of unintended acceleration over the past ten years (NHTSA 2012). As a result, NHTSA estimates that brake override would prevent most crashes where a stuck or entangled accelerator pedal was to blame (NHTSA 2012).

It is difficult to know how many crashes occur or almost occur every year as a result of unintended accelerations. Many incidents relevant to brake override may be unreported, since establishing a historical record of unintended accelerations is dependent on reports from drivers or other involved persons, who may be reluctant to report cases of unintended accelerations. However, leading traffic safety organizations including NHTSA has



concluded that the possibility of a stuck accelerator is serious enough to present a significant traffic safety issue, even if the exact number of cases is presently undetermined.

DOES BRAKE OVERRIDE HAVE ANY LIMITATIONS?

Yes. Like the majority of other vehicle safety features, brake override has important design and functional limitations that may influence its performance in a variety of contexts.

Brake override acts as a failsafe measure in certain cases of simultaneous brake and gas pedal application. It is not designed to help you stop sooner or to take over the job of maintaining a safe vehicle speed. Speed, road conditions, and driver input (i.e., your steering commands) can all affect your stopping distance and overall safety. Excessive speed can exacerbate unintended accelerations and result in your vehicle achieving a dangerous rate of speed faster than it otherwise would have. Slippery road conditions may also limit the effectiveness of your brakes and result in longer stopping distances. When driving conditions are poor, you are encouraged to reduce your speed, leave more distance between other vehicles, and take extra precautions.

Unintended accelerations are by definition not controlled. As such, it is hard to say how far you will travel or how fast you will go before you can come to a safe stop, even on dry roads. To reduce the risk of a collision before brake override can help you to stop, you are encouraged to always maintain a safe speed; to leave plenty of distance between yourself and other vehicles; and to remain alert and attentive to the road ahead.

The best course of action to is to prevent unintended accelerations from happening in the first place.

While you may not be able to do anything about unintended accelerations that result from electronic malfunctions, there are many easily controlled variables that can help reduce your risk. First, you can reduce the likelihood of accidentally pressing both pedals down at once by driving with one foot, alternating between the gas and the brake. While two-footed driving may be preferable in vehicles with standard transmissions and in certain driving conditions (e.g., starting on a steep hill), one-footed driving limits the possibility of pushing both pedals down. Wearing appropriate driving footwear can also decrease the likelihood of accidentally pushing both the gas and brake pedals. Sandals and other loose footwear could catch under the gas pedal as you attempt to move your foot from the gas to the brake.

Unintended accelerations can also be the result of items becoming wedged around the gas pedal, increasing the risk that it becomes stuck in the depressed position. To avoid this, ensure that the area around your feet is clear, and that objects cannot accidentally roll around near the pedals. If you have purchased floor mats, make sure that they are designed for your vehicle's make and model, and that they are secured firmly in place.

CAN I TURN BRAKE OVERRIDE OFF?

Many brake override systems can be turned off. Disabling the safety feature usually involves pushing the brake pedal and the accelerator while the car is in a parked position for a certain amount of time. If the brake override feature on your vehicle can be turned off, you can find more information about how to disable it in your owner's manual.

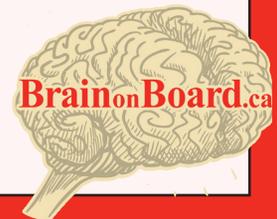
It is important to keep in mind, however, that it is unlikely that you would want brake override to be disabled. Normally, the only driving activity

that brake override disrupts are certain types of racing where the driver maintains pressure on the accelerator and feathers the brake in order to achieve maximum speed. This type of racing is extremely dangerous and should never be performed on public roads. As such, there is virtually no situation where brake override would get in the way of safe driving, and therefore no need to disable this safety feature.

HOW MANY VEHICLES TODAY HAVE BRAKE OVERRIDE?

Brake override was first introduced in the late 1980s as a performance enhancement for certain racing styles. Its potential as a safety feature was soon recognized, and many vehicle manufacturers have installed brake override on all their vehicles for over a decade. Since brake override is simple to install on modern drive-by-wire vehicles (i.e., vehicles that are controlled by an ECU), its prevalence on today's cars has increased substantially over the years. To find out if your vehicle has brake override or is eligible to be fitted for brake override, please consult your owner's manual.

Although brake override is not required on all new vehicles, its mandatory installation has been suggested by prominent public figures and research organizations including the President of the United States, Barak Obama and NHTSA. Earlier this year, NHTSA initiated a proposed change in the laws mandating what safety features must be included on all new vehicles, suggesting that brake override's demonstrated ability to mitigate against unintended accelerations warrants its requirement on all new



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vehicles (NHTSA 2012). In addition, this year the Obama administration also recommended that car-makers install brake override systems on all new cars (New York Times, March 2012).

While brake override is currently not a mandatory safety feature on all new vehicles Canada, many manufacturers install it on all their vehicles anyway. For example, Lexus, Toyota, Hyundai, and Scion currently use brake override on their vehicles.

HOW MUCH DOES BRAKE OVERRIDE COST?

Installing brake override is only possible in a vehicle that operates with an ECU. This is because brake override is essentially electronic and cannot be modified to work on a vehicle that contains only mechanical and hydraulic mechanisms. Most modern vehicles have an ECU. If you are unsure of whether your vehicle has an ECU or not, you can consult your owner's manual.

Installing brake override on a vehicle with an ECU is a relatively simple, low-cost initiative. NHTSA's cost projections estimate that the additional cost for a car-buyer would be slight (NHTSA 2012). Brake override is usually bundled into a safety package that car-buyers can purchase for around \$1000.

REFERENCES

Visit www.brainonboard.ca/program_resources/references.php for a full list of references.

WANT TO LEARN MORE?

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- Active Safety Features
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The advertisement graphic features a textured, light brown background with the text "DRIVING TAKES MORE TAL EFFORT THAN YOU TH" in large, bold, orange and black letters. Below the text are icons of two men in suits, a car, and a brain. A red banner at the bottom contains the text "64.8% of Canadians think it's important to pay careful attention to driving, even with advanced safety features like brake assist." and "Your brain is your vehicle's most important safety feature." Below this is a call to action: "Visit BrainonBoard.ca to give it a tune-up." and logos for TIRE, Toyota Foundation, and AGART.