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 under the front seat of your car. 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 the water bottle has wrapped around your gas pedal, causing the pedal to stay pushed down after you remove your foot. 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 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 your vehicle's powertrain receives mixed signals (i.e., the gas and brake are pushed down simultaneously) or something goes wrong with other electronics in the vehicle. With brake override, the brake pedal is enhanced with *smart* technology. This means it is programmed to recognize when something abnormal is occurring and 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 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.

Figure 1

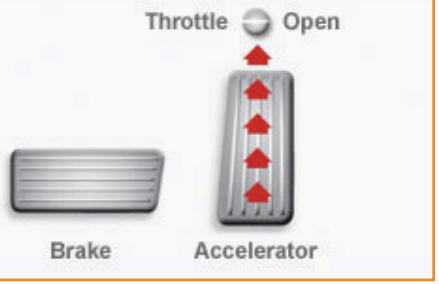
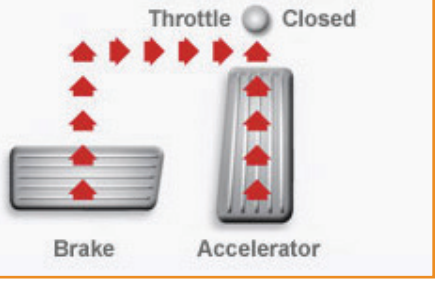


Figure 2



Brake override is called by several other names, including *smart pedal* and smart stop technology. Despite terminology 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 acceleration. 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 your car is accelerating against your will.

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

There are a variety of reasons why this could happen, and therefore a variety of situations when 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 remove your foot.
- Your foot is still on the accelerator, but you push down the brake so both pedals are pushed simultaneously.
- A malfunction in some other electrical component in your vehicle causes the acceleration command to continue after you have removed 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 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 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 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.

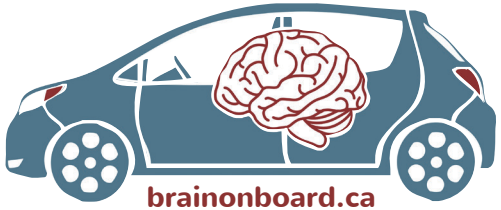
Prior to the invention of ECUs, vehicles relied exclusively on mechanical or hydraulic controls, which complicated the installation and integration of additional features and limited the ways in which different aspects of vehicle performance could be connected. In the case of brake override, the ECU 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 brake override identifies these situations correctly and does not slow down a vehicle when acceleration is intended.

The basic brake setups activate when the position sensors for the gas and brake pedals show both are being pressed down. Brake override is programmed to recognize this is not the way people normally drive, and to override the accelerator command. Other manufacturers' brake override programs are more complicated. Many require 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 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 the accelerator be pushed down first and the brakes applied firmly for longer than one-half second at speeds greater than approximately eight kilometres per hour.

All of these measures are designed to ensure 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 which 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 have concluded 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 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. 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 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 which 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 the area around your feet is clear, and objects cannot accidentally roll around near the pedals. If you have purchased floor mats, make sure they are designed for your vehicle's make and model, and 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 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 in 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.

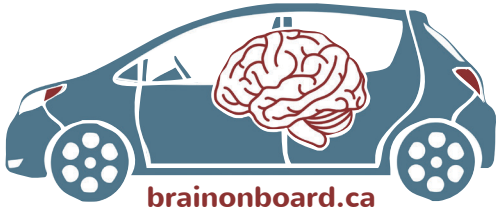
Although brake override is not required on all new vehicles, its mandatory installation has been suggested by prominent public figures and research organizations, including President of the United States, Barack Obama and NHTSA. In 2012, NHTSA initiated a proposed change in the laws mandating what safety features must be included on all new vehicles, suggesting brake override's demonstrated ability to mitigate against unintended accelerations warrants its requirement on all new vehicles (NHTSA, 2012). In addition, the Obama administration also recommended that carmakers 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 in 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 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 $1,000.



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