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| Research Article

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Modern Abs Systems

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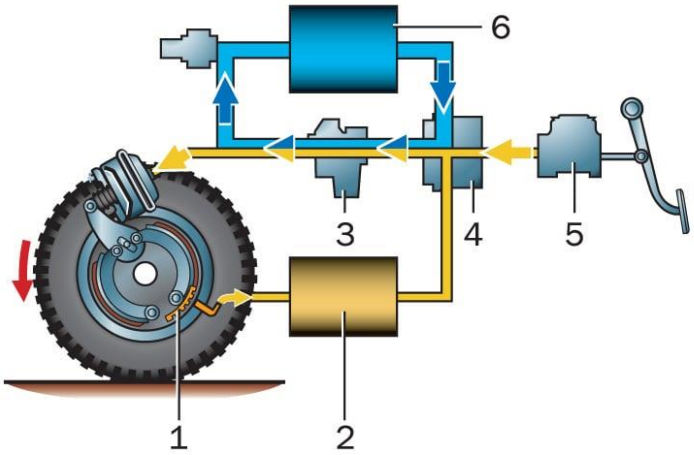
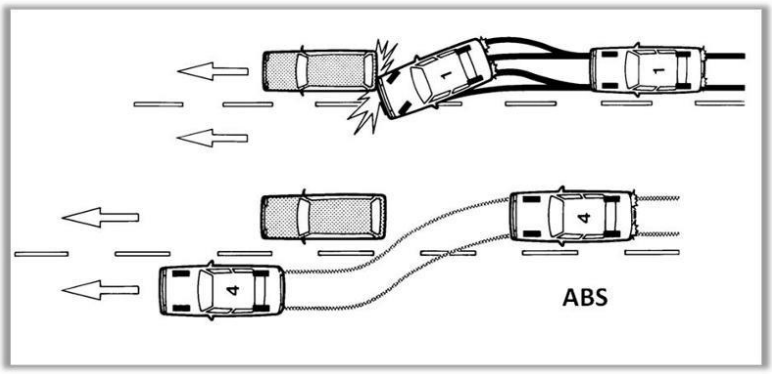
Annotation
The article discusses the basic principles of ABS, its evolution since its introduction into the automotive industry, and modern technological improvements. Particular attention is paid to the integration of ABS with other active safety systems such as ESP (Electronic Stability Program) and TCS (Traction Control System), which helps to improve the safety and stability of the car on the road. The advantages and disadvantages of modern ABS systems, their role in reducing the number of accidents, as well as prospects for further development of technologies in the field of automotive safety are discussed.

Keywords: Anti-lock braking system, control, function, car, controllability, safety, surface, brake, load.

Introduction. Modern ABS (Anti-lock braking system) systems are a key safety element in cars, preventing wheel locking during emergency braking and providing better vehicle control. Anti-lock braking system (ABS) is a technology designed to prevent the wheels from locking during braking, allowing the driver to maintain control of the car. Modern ABS systems have many improvements and additional features that improve the safety and controllability of cars. Let's consider the main types of modern ABS systems:



The main part. Standard ABS is the basic version of the system, which prevents the wheels from locking by monitoring the braking force and adjusting it if necessary. Standard ABS allows the car to remain controlled on slippery surfaces.

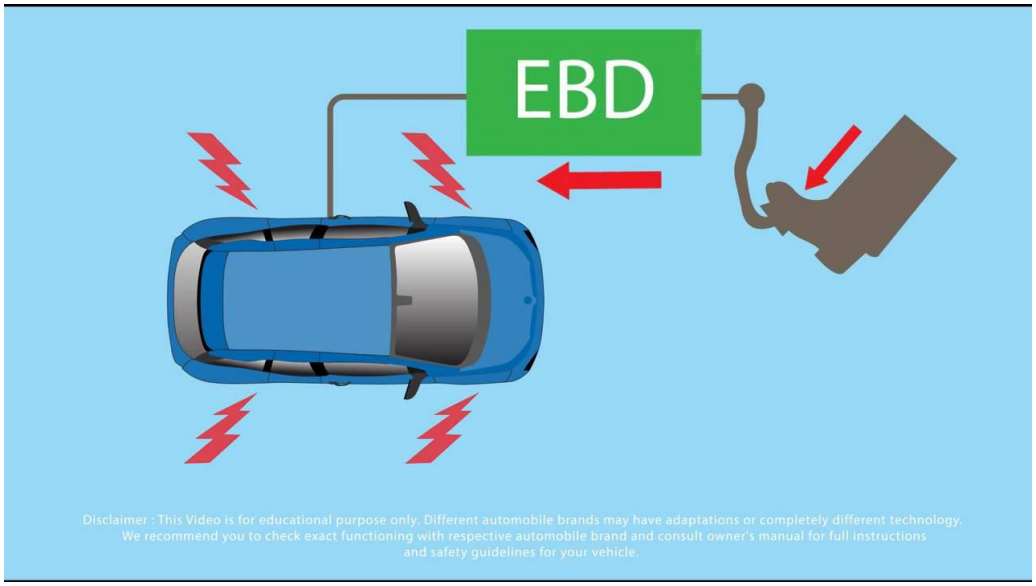


EBD works together with ABS and is responsible for the automatic distribution of braking force between the front and rear wheels depending on the load and driving conditions. This improves the stability of the car when braking, especially under various conditions (for example, when loaded). The fundamental difference between EBD and other systems from the basic ABS is that they help the driver control the car constantly, and not only during emergency braking, when the driver hits the brake pedal. When braking sharply on an uneven surface, the car begins to turn. This happens because the degree of adhesion of the wheels to the road is different, and the braking force transmitted to the wheels is the same. The EBD system, using ABS sensors, analyzes the position of each wheel during braking and strictly individually doses the braking force on it. Also, engineers noticed that during braking, the bulk of the load falls on the front wheels, while the pressure on the rear wheels weakens, while it is necessary to take into account the load of the car. This can lead to the rear wheels locking. This problem can be solved in two ways: by automatically adjusting the pressure of the pads on the discs and by reducing the size of the rear brake discs.

In some cars, this system is used to maintain directional stability when braking in a turn, when the center of mass of the car is transferred to the side of the wheels moving along the outer radius. In this case, the braking forces are distributed not only between the axles, but also between the wheels. The distribution depends on calculations based on data from various sensors.

EBD helps maintain the trajectory, reduces the likelihood of skidding or understeer when braking in a turn and on mixed surfaces. The electronics determine by the difference in rotation speeds that the wheels have entered areas with a different surface, and will reduce the braking forces on

the wheels that have the worst grip. By the way, the intensity of deceleration in this case will decrease and will be determined by the friction force of the wheel (wheels) with the worst grip.



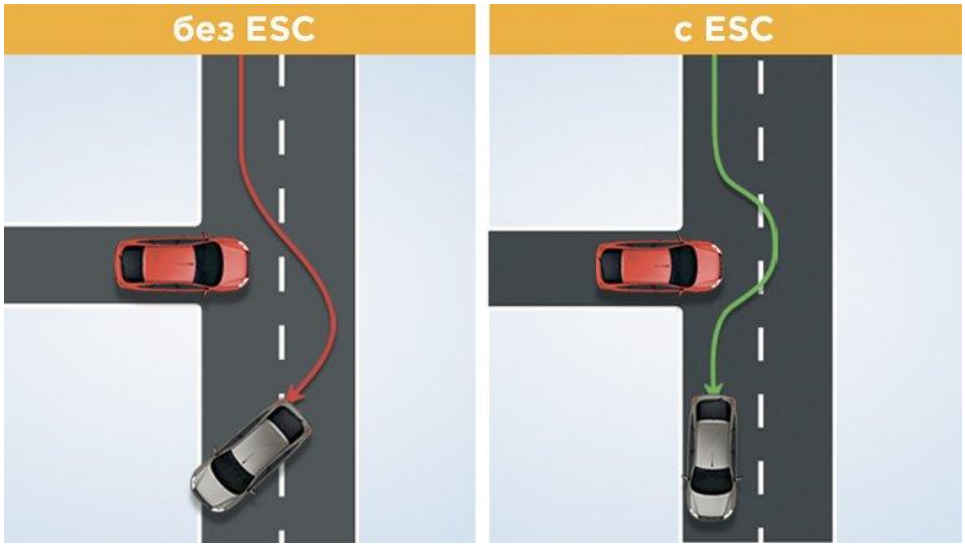
Traction control system (TCS) works in tandem with ABS to prevent wheel spin during starting and acceleration. It regulates braking force and engine power to provide better traction.

Traction control system (TCS) is typically (but not necessarily) a secondary function of Electronic Stability Control (ESC) on production vehicles, designed to prevent loss of traction (i.e. slippage) of the driven road wheels. TCS is activated when throttle input and engine power and torque delivery are not appropriate for road surface conditions. The intervention consists of one or more of the following actions:

- Brake force applied to one or more wheels
- Reduction or suppression of the firing sequence in one or more cylinders
- Reduction of fuel delivery to one or more cylinders
- Closing the throttle if the vehicle has a drive-by-wire throttle
- In turbocharged vehicles, actuating the boost control solenoid reduces boost and therefore engine power.

Typically, traction control systems use an electro-hydraulic brake actuator (which does not use a conventional master cylinder and servo) and wheel speed sensors with ABS. The basic idea behind the need for a traction control system is that loss of traction can compromise the steering and stability of the vehicles. This is the result of differences in traction between the drive wheels. The difference in slip can be due to the vehicle turning or different road conditions for the different wheels. When a car turns, its outer and inner wheels rotate at different speeds; this is usually controlled by a differential. A further improvement on the differential is the use of an active differential, which can vary the power sent to the outer and inner wheels as needed. For example, if outside slip is sensed while turning, the active differential can send more power to the outer wheel to minimize yaw (essentially the amount of movement of the front and rear wheels of the car). The active differential is in turn controlled by a set of electromechanical sensors that interact with the traction control unit. The electronic stability control (ESC) system further monitors the stability of the car, preventing it from skidding when cornering. If necessary, the ESC can use the ABS to brake individual wheels, which helps maintain stability and control. Electronic stability control (ESC), also called electronic stability program (ESP) or dynamic stability control (DSC), is a computerized technology that improves vehicle stability by detecting

and reducing loss of traction (skidding). When the ESC system detects a loss of control, it automatically applies the brakes to steer the vehicle in the direction the driver wants.



Braking is automatically applied to individual wheels, such as the outside front wheel to counteract skidding or the inside rear wheel to counteract understeer. Some ESC systems also reduce engine power until control is regained. ESC does not improve the car's handling when cornering; instead, it helps reduce the likelihood of the driver losing control of the car.

Many modern cars are equipped with active safety systems that include ABS, EBD, TCS, and ESC. These systems work together to provide maximum safety in a variety of road conditions. Hybrid and electric cars use systems that not only brake, but also recuperate energy during braking. They can work in conjunction with ABS to improve braking efficiency.

AEB automatically applies the brakes if the system detects a potential collision. This technology, when paired with ABS, significantly increases safety. Modern versions of ABS may include improved sensors and algorithms that make them more sensitive and faster. This provides more precise brake control and improves the overall efficiency of the system.

Conclusion. Modern ABS systems and their additions provide a high level of safety and control of the car in various conditions. Constant development of technologies allows car manufacturers to improve the characteristics of ABS, which makes driving safer and more comfortable.

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