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STUDY OF SENSOTRONIC BREAK CONTROL SYSTEM

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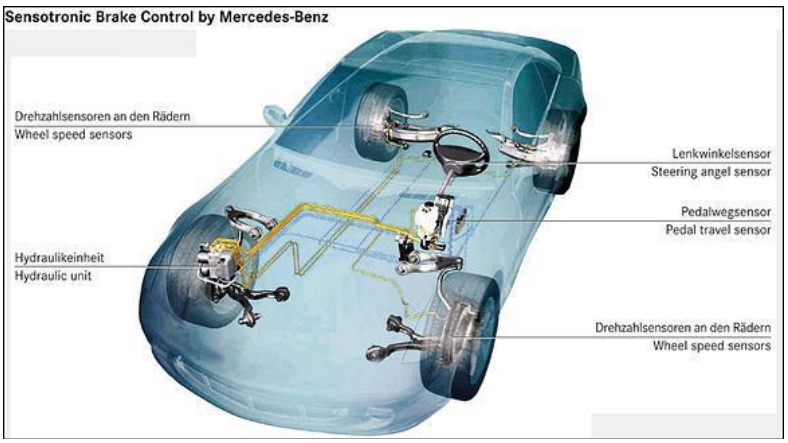
ABSTRACT

Sensotronic Brake Control- also known as Brakes of the future is appellation given by Mercedes to an innovative electrically controlled brake system which operates more precisely than a conventional hydraulic braking system. Within no time you press the brake pedal and the sensor identify situation in hand, the microcontroller makes an exact calculation of brake force necessary and distributes it between the wheels as per the current scenario. This allows SBC to critically reduce stopping distances.

With Sensotronic Brake Control electric impulses are used to pass the driver's braking commands onto a microcomputer which processes various sensor signals simultaneously and, depending on the particular driving situation, calculates the optimum brake pressure for each wheel. The factor causing burgeon in SBC demand is that it plays a significant role in offers even greater active safety than conventional brake systems when braking in a corner or on a slippery surface. With the help of a high-pressure reservoir and electronically controllable valves it is ensured that maximum brake pressure is available much sooner. Moreover, the system offers innovative additional functions to reduce the driver's workload which include Traffic Jam Assist, which brake's the vehicle automatically in stop-and-go traffic once the driver takes his or her foot off the accelerator resulting in a comfortable driving experience even for long distances. The Soft-Stop function – another first – allows particularly soft and smooth stopping in town traffic. Taking into account additional safety conditions Mercedes has a backup hydraulic only braking system if due to some malfunctioning SBC fails.

I. INTRODUCTION



When drivers hit the brake pedal today, their foot moves a piston rod which is linked to the brake booster and the master brake cylinder. Depending on the pedal force, the master brake cylinder builds up the appropriate amount of pressure in the brake lines which - in a tried and tested interaction of mechanics and hydraulics - then presses the brake pads against the brake discs via the wheel cylinders.

By contrast, in the Mercedes-Benz Sensotronic Brake Control, a large number of mechanical components are simply replaced by electronics. The brake booster will not be needed in future either. Instead sensors gauge the pressure inside the master brake cylinder as well as the speed with which the brake pedal is operated, and pass these data to the SBC computer in the form of electric impulses. To provide the driver with the familiar brake feel, engineers have developed a special simulator which is linked to the tandem master cylinder and which moves the pedal using spring force and hydraulics. In other words: during braking, the actuation unit is completely disconnected from the rest of the system and serves the sole purpose of recording any given brake command. Only in the event of a major fault or power failure does SBC automatically use the services of the tandem master cylinder and instantly establishes a direct hydraulic link between the brake pedal and the front wheel brakes in order to decelerate the car safely.

The central control unit under the bonnet is the centrepiece of the electrohydraulic brake. This is where the interdisciplinary interaction of mechanics and electronics provides its greatest benefits - the microcomputer, software, sensors, valves and electric pump work together and allow totally novel, highly dynamic brake management:

In addition to the data relating to the brake pedal actuation, the **SBC computer** also receives the sensor signals from the other electronic assistance systems. For example, the anti-lock braking system (ABS) provides information about wheel speed, while Electronic Stability Program (ESP®) makes available the data from its steering angle, turning rate and transverse acceleration sensors. The transmission control unit finally uses the data highway to communicate the current driving range. The result of these highly complex calculations is rapid brake commands which ensure optimum deceleration and driving stability as appropriate to the particular driving scenario. What makes the system even more sophisticated is the fact that SBC calculates the brake force separately for each wheel.

II. METHODOLOGY

The bonnet is the central control unit known as the centerpiece of the electrohydraulic brake which mainly consists of-microcomputer, software, sensors, valves and electric pumps with all together lead to a high dynamic brake management. In order to improve this data to a greater extent the electronic assistance systems like antilock braking system(ABS) provides information about the wheel speed with electronic stability program(ESP) providing the data from its steering angle, turning rate and transverse acceleration sensors to SBC computer in the form of sensor signals. The complex calculations made in order to calculate the current driving range leads to perfect driving stability and optimum deceleration. Further briefing about the system comes the high pressure reservoir which contains brake fluid that enters the system at pressure from 140 to 172 bar. The SBC computer controls the electric pump which is connected to the reservoir and results in a shorter response time than conventional breaking system.

III. FEATURES OF SENSOTRONIC BRAKE CONTROL

3.1 Emergency braking

The main performance characteristics of Sensotronic Brake Control include the extremely high dynamics during pressure build-up and the exact monitoring of driver and vehicle behaviour using sophisticated sensors. Mercedes-Benz is thus moving into new dimensions of driving safety. Take the example of the emergency brake movement from the accelerator onto the brake pedal as a clue to an imminent emergency stop and responds automatically: with the aid of the high-pressure reservoir, the system increases the pressure inside the brake lines and instantly presses the pads onto the brake discs so that they can get a tight grip the moment the driver steps onto the brake pedal. As a result of this so-called prefilling of the brake system, the stopping distance of an SBC-equipped sports car from a speed of 120 km/h is cut by around three per cent compared to a car featuring conventional braking technology.

Due to electrohydraulic back-up, the performance of Brake Assist is also improved further. If this system issues the command for an automatic emergency stop, the quick pressure build-up and the automatic prefilling of the wheel brakes leads to a shorter braking distance.

3.2 Driving stability

It is not just in emergency braking that Sensotronic Brake Control proves its worth, but also in other critical situations –for example, when there is a risk of swerving. Under such conditions, the system interacts with the Electronic Stability Program (ESP®) which keeps the vehicle safely on course through precise braking impulses at all wheels and/or by reducing engine speed. SBC once again offers the benefits of greater dynamics and precision: thanks to the even faster and more accurate braking impulses from the SBC high-pressure reservoir, ESP® is able to stabilise early and comfortably a vehicle which is about to break away.

This is evident, for example, from the results of the VDA lane-change test which suspension engineers use to simulate a quick obstacle-avoidance manoeuvre and to demonstrate the high capabilities of the Electronic Stability Program. In conjunction with SBC, ESP® works even more effectively and significantly reduces vehicle swerving through quick and precise braking impulses.

At the same time the driver's steering effort is reduced. Due to SBC and ESP® he or she will have even less difficulty keeping the car on course with Sensotronic there is no need for ESP intervention when braking in a curve.

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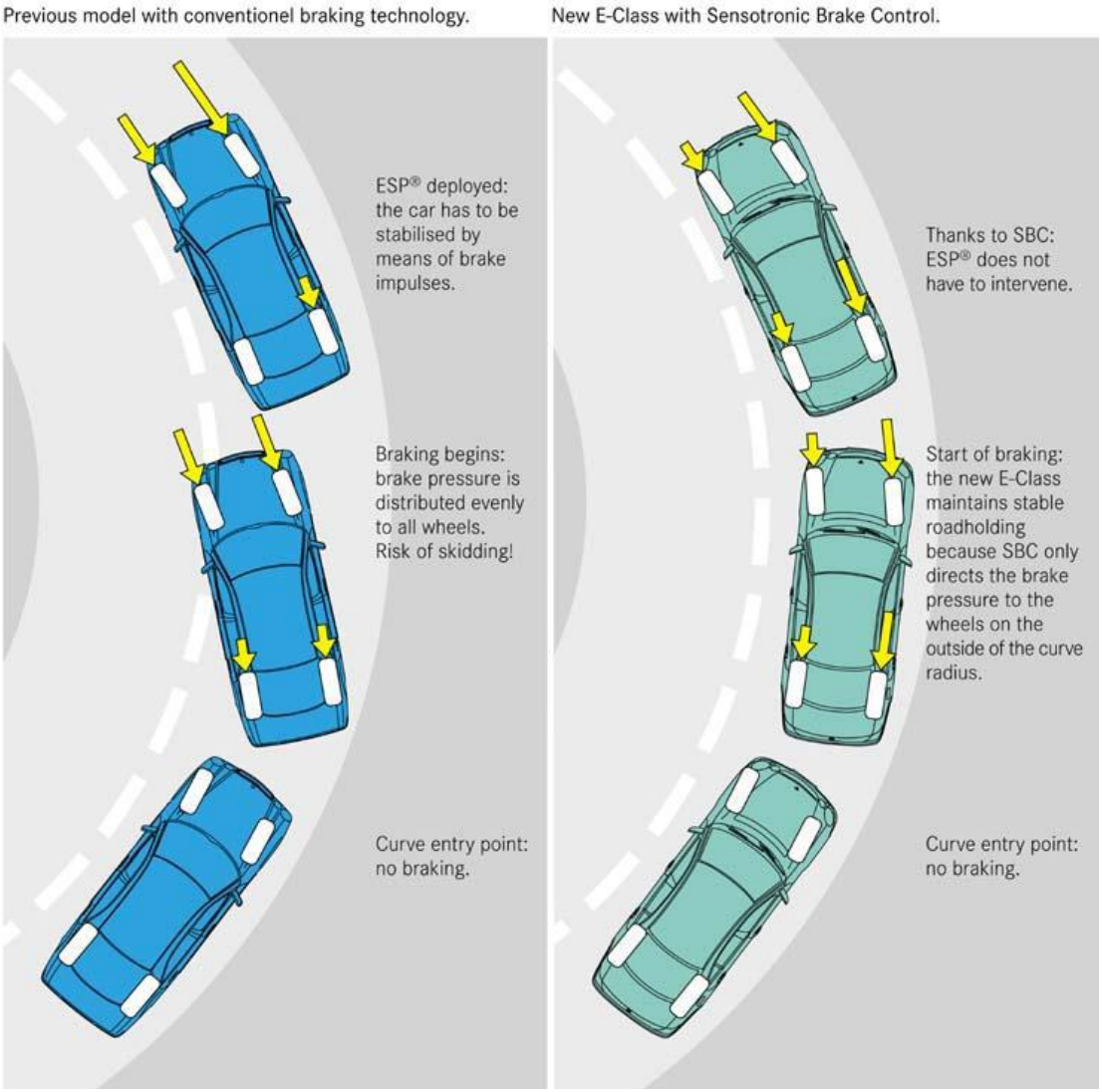
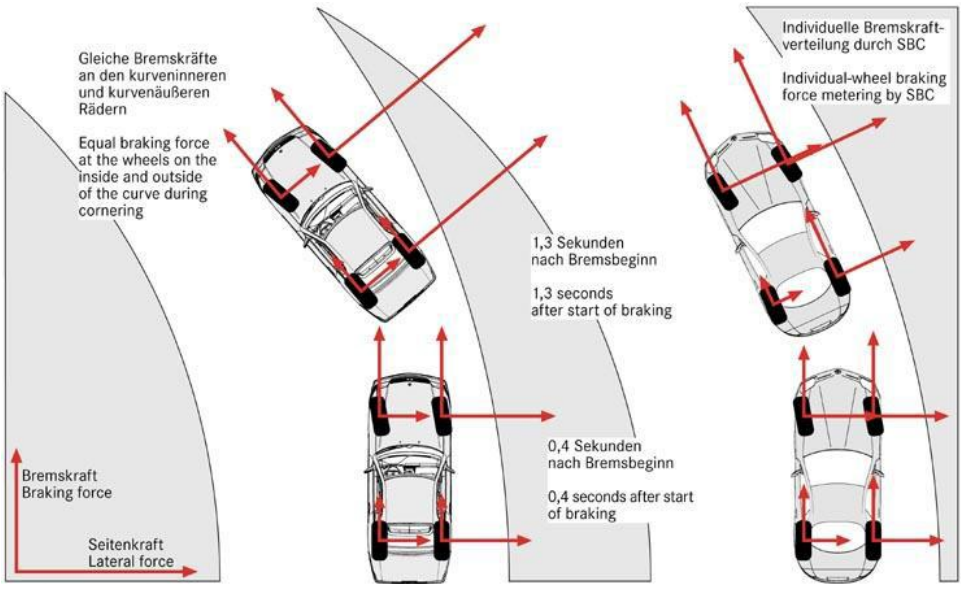


3.3 Braking in corners



Braking in a curve. Left: conventional. Right: with SBC.

Notice the unequal braking force, smaller lateral force, better stability and alignment with SBC. Even when braking in corners, SBC also offers more safety than a conventional brake system. This is where the variable and targeted brake force distribution is of particular advantage to actively influence the car's compliance steer. While conventional brake systems always mete out the brake pressure equally to the inner and outer wheels, SBC offers the possibility of assigning brake forces in a way appropriate to the situation. Hence the system will automatically increase the brake pressure at the outer wheels because the higher vertical forces also allow them to transfer greater brake forces. At the same time the brake forces at the inner wheels are reduced to provide the higher cornering forces needed to stay on course. The result is a more stable braking behaviour along with optimum deceleration values. With the innovative Sensotronic Brake Control Mercedes engineers still stick to the proven principle of a variable brake force control for the front and rear axles. They program the system in such a way that, when slowing down from a high speed, the larger part of the brake force continues to act on the front axle. This prevents a potentially hazardous over braking of the rear axle. Again SBC is capable of adapting to the prevailing situation. At low speeds or during partial braking, the system automatically increases the brake force share at the rear axle to improve brake system response and achieve even wear and tear of the brake pads.

3.4 Comfort

Both the separation of the SBC pedal from the rest of the brake system and the proportional pressure control using mechatronics serve to increase brake comfort – particularly during sharp deceleration or when the anti-lock braking system is operational. The usual vibration of the brake pedal when ABS sets in does not occur, which, Mercedes engineers have found, is not only a comfort feature of the new system but also offers measurable safety benefits. Their research in DaimlerChrysler's Berlin driving simulator has revealed that almost two thirds of all drivers are startled when ABS pulsation sets in: they do not increase the brake force further and are even prone to taking their foot off the brake pedal for a short while, thereby lengthening the stopping distance of their vehicle – in the driving simulator by an average of 2.10 metres - 7 feet - during ABS braking from 60 km/h - 37 MPH - on a snow-covered road surface.

IV. FUTURE SCOPE

Mechatronics – a new term is gaining popularity within the automotive industry and is rapidly developing into the catchword of a quiet technological revolution which in many fields stands century-old principles on their head. Mechatronics brings together two disciplines which in many cases were thought to be irreconcilable, namely mechanics and electronics.

Hence automobile functions which hitherto worked purely mechanically and partly with hydraulic assistance will in future be controlled by high-performance microcomputers and electronically controllable actuators. These either replace the conventional mechanical components or else enhance their function. The mechatronic interplay therefore opens up hitherto inconceivable possibilities to further raise the safety and comfort levels of modern passenger cars. For example: it was only possible through mechatronics that an electronically controlled suspension system which instantly adapts to prevailing conditions when driving off, braking or cornering -- thus providing a totally new driving experience -- became a reality. In 1999 Mercedes-Benz launched this system

under the name Active Body Control (ABC) in the flagship CL coupé, thereby signalling the advent of a new era of suspension technology.

The advent of electronics in brake technology opens up new and promising opportunities to Mercedes engineers - and not only in the disciplines of safety and comfort. By means of SBC they have also moved a considerable way closer to the realisation of their long-term objective, namely to be able to automatically guide the cars of the future along the roads with the aid of video cameras, proximity radar and advanced telematics. For such autonomous vehicle guidance, the experts need a computer-controlled brake system which automatically acts on the instructions of an electronic autopilot and stops the car safely.

V. CONCLUSION

Sensotronic Brake Control (SBC) is the name given to an innovative electronically controlled brake system which Mercedes-Benz will fit to future passenger car models. Following on from the Mercedes innovations ABS, ASR, ESP® and Brake Assist, this system is regarded as yet another important milestone to enhance driving safety. With Sensotronic Brake Control electric impulses are used to pass the driver's braking commands onto a microcomputer which processes various sensor signals simultaneously and, depending on the particular driving situation, calculates the optimum brake pressure for each wheel. As a result, SBC offers even greater active safety than conventional brake systems when braking in a corner or on a slippery surface. A high-pressure reservoir and electronically controllable valves ensure that maximum brake pressure is available much sooner. Moreover, the system offers innovative additional functions to reduce the driver's workload. These include Traffic Jam Assist, which brakes the vehicle automatically in stop-and-go traffic once the driver takes his or her foot off the accelerator. The Soft-Stop function – another first – allows particularly soft and smooth stopping in town traffic.

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