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Sensotronic Brake Control System

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Abstract: ***Sensotronic Brake Control (SBC™) works electronically, and thus faster and more precisely, than a conventional hydraulic braking system. As soon as you press the brake pedal and the sensors identify the driving situation in hand, the computer makes an exact calculation of the brake force necessary and distributes it between the wheels as required. This allows SBC™ to critically reduce stopping distances. SBC™ also helps to optimise safety functions such as ESP®, ASR, ABS and BAS.***
Keywords: SBC, ABS. BAS, TCS, ESP

I. INTRODUCTION

When drivers hit the brake pedal, 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 4number of mechanical components are simply replaced by electronics (Mechatronics).Instead of using Brake boosters, 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 braking experience, 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 uses the services of the tandem master cylinder(TMC) 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 center piece of the electrohydraulic brake. It is the brain of the entire system. This is where the interdisciplinary interaction of mechanics and electronics (also information technology) provides its greatest benefits - the microcomputer, control units, software, sensors, valves and electric pump work together and allow totally novel, highly dynamic brake management

II. ABOUT SBC

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. 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. 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 even if the driver takes his or her foot off the accelerator or brake pedal. **The Soft-Stop** function, which particularly allows soft and smooth stopping in town traffic.

III. LITERATURE REVIEW

Sensotronic Brake Control is an innovative electronically controlled brake system that is faster and more precise than the conventional braking system. SBC is the name given to an innovative electronically controlled brake system which will fit to future passenger car models. With Sensotronic Brake Control electric signals 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

Mr Atul B. Takle et al [1] expresses his need of mechatronics in the field of autobile industry. Sensotronic brake control system helps in efficient braking and it is has dynamic braking management. The features offered like emergency braking, driving stability, soft stopping, etc. ease the driving efforts and the braking efficient. The fact cannot be neglected that the additional advantages of Sensotronic braking system provide high and advanced quality, stability as well as longevity.

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Combination of manage ride and handling with driving safety provided by the braking system in a sustainable and calculable way differentiates it with other braking system in a affirmative way. This technology by Mercedes and Bosch has taken braking to a new level, which is very essential.

Mercedes Benz Sensotronic Brake Control –SBC et al [2] states the various advantages like Dry Braking, Emergency Braking, no pedal vibration ABS, Steering assist etc. SBC Incorporates these Functions: ABS (Anti-lock Brakes 1984), ASR (Automatic Slip Regulation 1991), ETS (Electronic Traction System 1995), ESP (Electronic Stability Program 1996) and BAS (Brake Assist System 1998) .

IV. WORKING

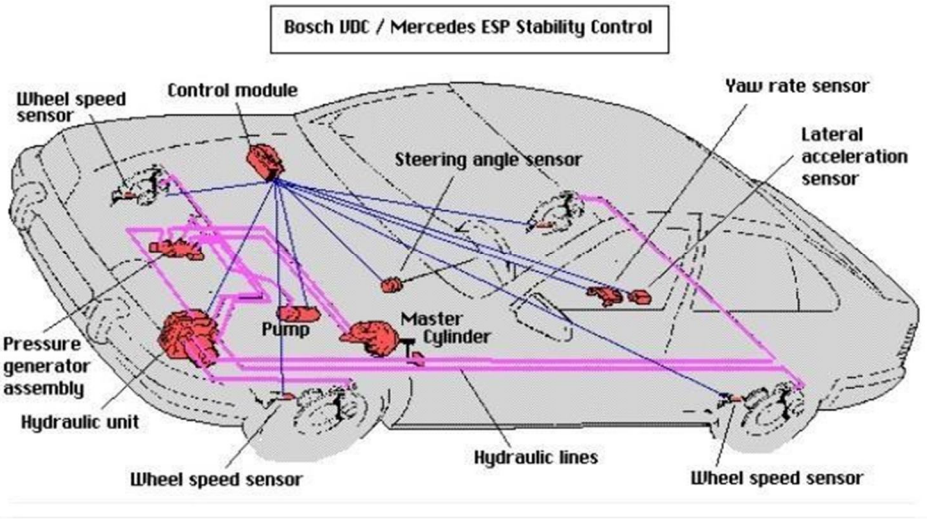
A. Components In SBC

1) High Pressure Accumulator: - High pressure accumulator contains the brake force each wheel individually.

2) Hydraulic Unit: - They meter the brake pressure according to requirements and pass it to the brake callipers.

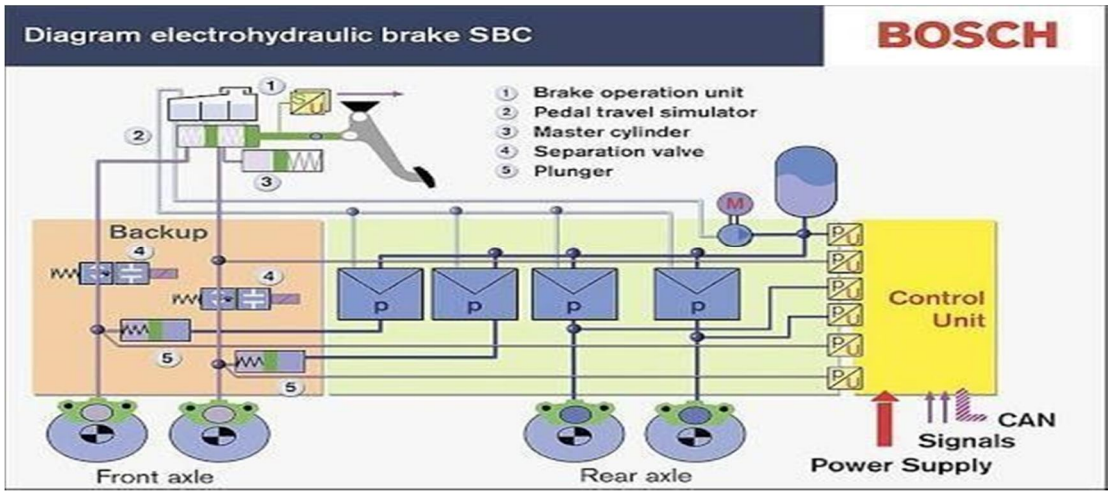
3) Wheel Speed Sensor: - Generating signals representative of the wheel speed in RPM.

4) Pressure Sensor: - It converts the amount of pressure into electrical value using piezoresistive elements.



V. FEATURES OF SBC

Although the working and development of a Sensotronic braking system may seem to be a bit complicated from the below fig, since it is an adaptation of mechatronics- a terms gaining its importance in automobile industry now a days, which brings it together two different disciplines which in many cases were thought can never be fused together, namely mechanics and electronics. The features and how they work of the components will explain it in detail.



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A. Brake Pedal: Electronics Instead of a Vacuum

In the Mercedes-Benz's SBC, a large number of mechanical components are simply replaced by electronics. The pressure inside the master brake cylinder in a addition to the speed with which the brake pedal is operated and is recorded and this data is passed to the SBC microcomputer in the form of electric impulses with the help of sensor gauges. In other words: during braking, the actuation unit is completely disengaged from the rest of a system and serves as the sole purpose of recording any given brake command. Only in the event of a major responsibility or power failure does SBC automatically use the services of the Tandem master cylinder and instantly SBC establishes a direct hydraulic link between the brake pedal and the front wheel brake callipers in order to decelerate the car safely. The control unit is the cardinal part of an SBC. This is where the interaction of mechanics and electronics provide its greater benefits. The microcomputer, software, sensors, valves and electric pump all work together and it allow total dynamic brake management (DBM).

B. Emergency Braking

The Performance of the SBC includes the precise monitoring of driver and vehicle behaviour using various sensors. To increase the driver safety, Mercedes Benz has an eitome that is Emergency brake. SBC already recognizes the driver's rapid movement from the accelerator on the brake pedal as a clue to an imminent emergency stop and responds automatically. As a result of this, the stopping distance of a SBC equipped car from a speed of 120km/hr is cut by around 3 % as compared to a car featuring and conventional braking technology. Reducing engine speed, offering the benefits of greater dynamics and precision. ESP is able to stabilize early and comfortably a vehicle which is about to break away. Despite the functions of a typical SBC which it already provides, the Mercedes - Benz has installed other additional functions which tend to reduce the driver strain as much as possible, due to its electronic brake.

C. SBC Traffic Assist

In stop-and-start traffic the vehicle applies brakes automatically, when the foot is lifted off the accelerator pedal ("traffic jam assist"). It can be engaged under 10 mph. It remains active under 40 mph. Driver can also activate it on downhill slopes as per his convenience, so the as car won't speed over the set limit. Hence, SBC's traffic assist feature makes things a easier whilst dealing with an traffic signals or traffic jams in densely populated cities.

D. SBC Soft Stop

SBC gently brakes to a stop below 6 km/h by briefly reducing the brake pressure, soft stop reduces the jolt which occurs when braking immediately upon reaching a standstill, which often irked the driver. Thus, this soft stop function increases the comfort level of the vehicle by circumventing this problem often faced by a many.

E. SBC Hold

A "drive-away assistant" can prevents the vehicle from rolling backwards or forward when starting on a hill or steep incline. A stiff can push onto the brake pedal, and the car remains at one place, even when the brake pedal is released, until the driver accelerates and the vehicle begins to roll. Mercedes drivers usually tend to enjoy this feature.

F. Dry Brake

There is the dry brake function. It can remain always activated when the windshield wipers run. The system then identifies, that it rains and, with short brake pulses unnoticed by the driver, keeps the brake discs always dry and fully functional.

G. Sensors and Electronic Unit

Field of mechatronics has created a promising opportunities to the Mercedes engineers not only in terms of a comfort and safety as well as in a considerable way to the realization of their long term objectives. In order to replace the mechanical components and to enhance to the braking, high performance microcontroller and actuators are required.

To achieve these factors it is necessary to conceive a silicon micro machined & piezoresistive pressure sensor chip with higher and lower sensitivities each having a specified pressure range. To check if all the components and sensors are working, there is function of self-testing in these microcontrollers.

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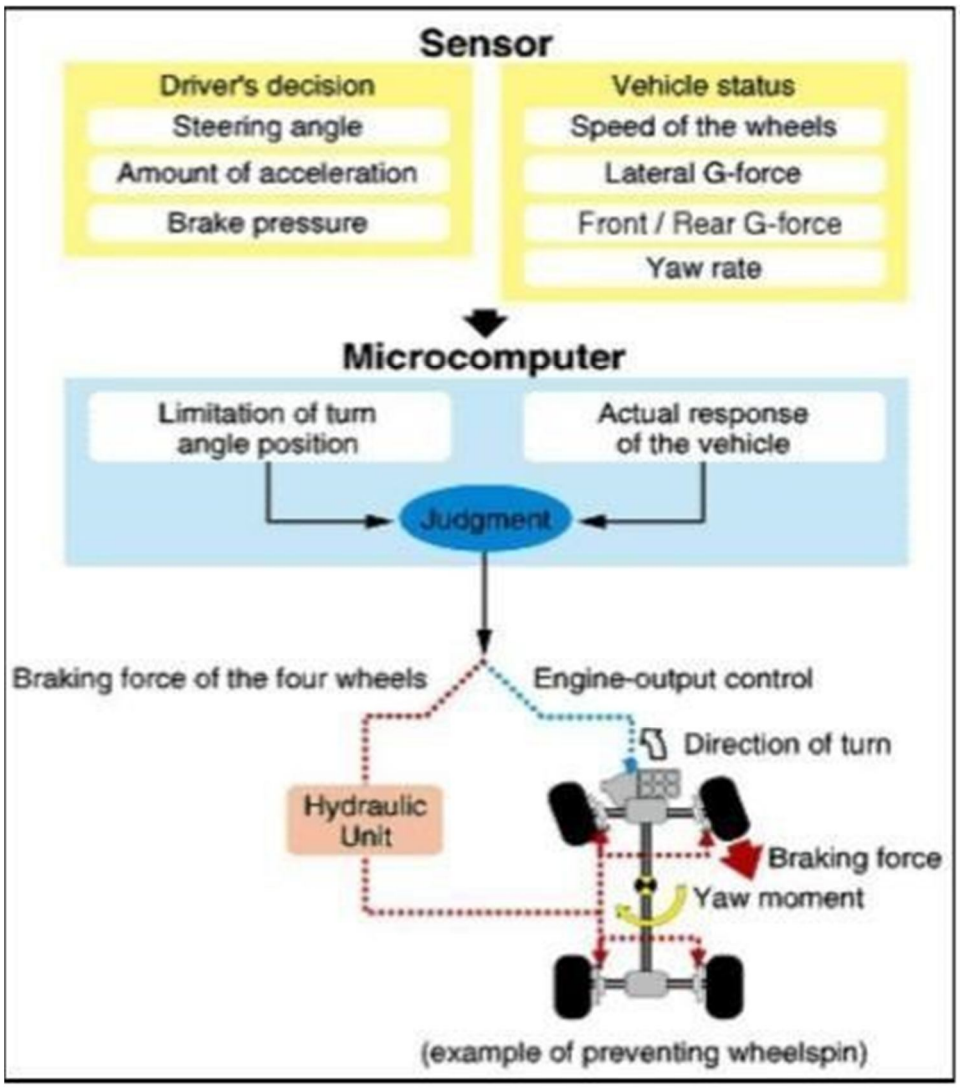

VI. ADVANTAGES AND LIMITATIONS OF SBC

It can improve metering of necessary brake pressure, and each wheel can be precisely controlled

1) Reduction of stopping distance in particular during an emergency stop.
2) It can Increase the active vehicle dynamics safety as the vehicle Dynamics control system ABS and ESP can be used in an optimized manner.
3) It can also leads to timelier and more comfortable stabilization of the vehicle during ESP control.
4) The Use of the brake force reserve at the rear axle due to growing the brake force and share in the partial braking range and when braking from a low speed.
5) Consequences in more stable braking performance with optimal deceleration values when cornering as a result of braking forces being shifted to the outer wheels.
6) There is No reaction (vibration) on the brake pedal during ABS.

A. *Limitations*

1) The Maintenance is high
2) Electronics parts are costly to replace
3) Some people don't like the noise of SBC
4) Poor implementation and poor design ultimately leading to its downfall
5) Mercedes decides to stop the technology due to its costly maintenance.

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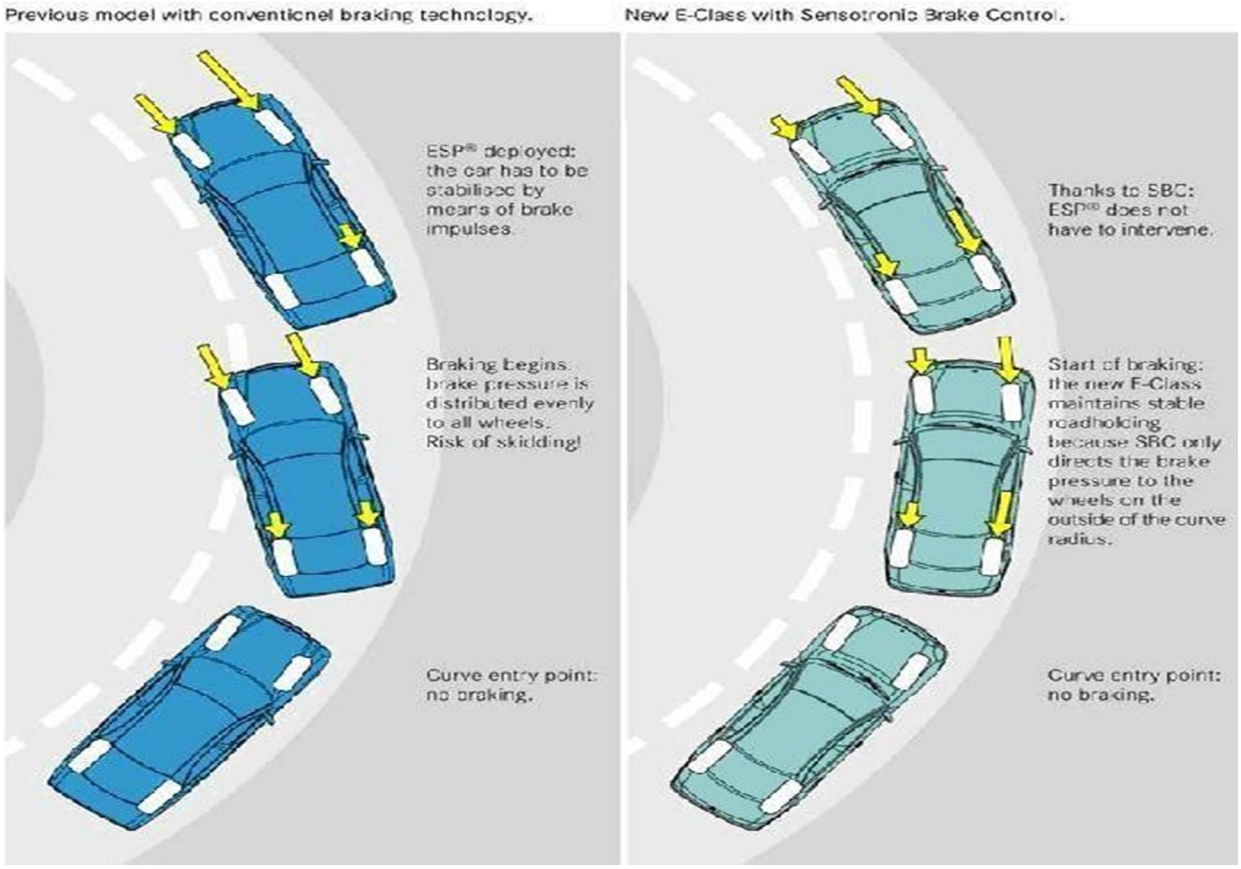
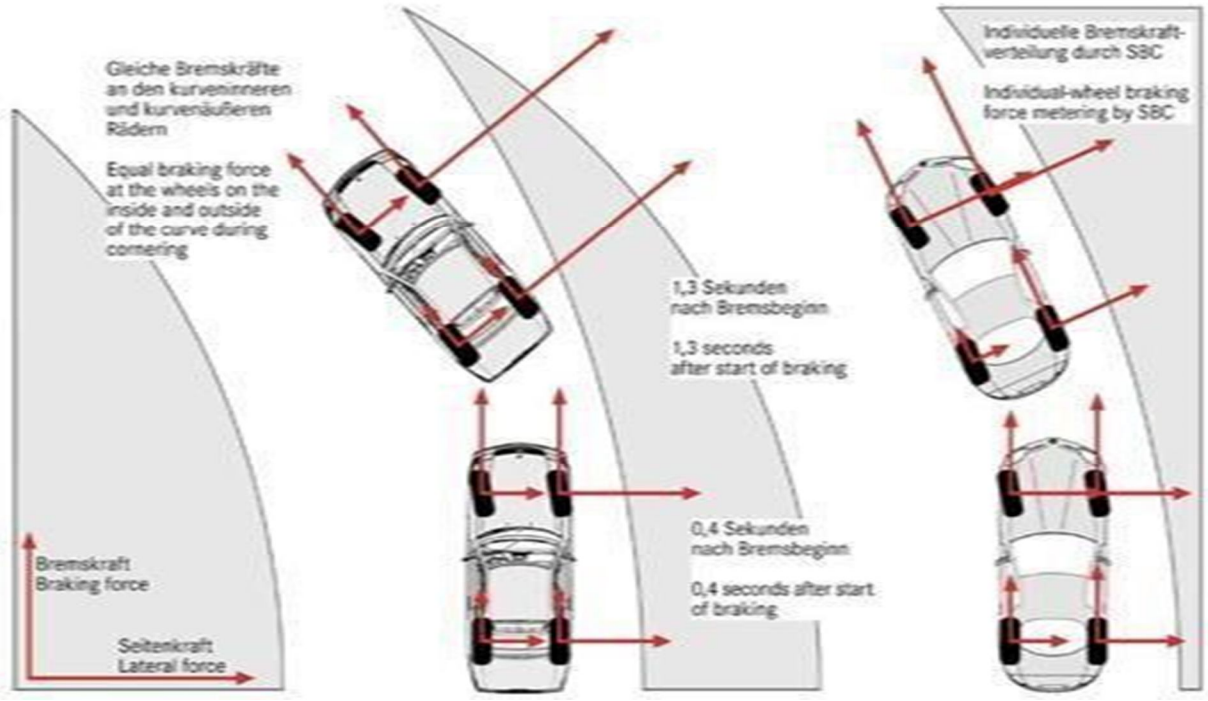
VII. CASE STUDY



Conventional Braking v/s SBC for steering 3



Forces on the car during braking

A. Left is Conventional Braking sys and right is Sensotronic Brake Control

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.[2]

At the same time the driver's steering effort is reduced. Thanks 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.Notice the unequal braking force, smaller lateral force, better stability and alignment with SBC.

B. Braking In Corners: Greater Safety Thanks To Variable Brake Force Distribution

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.

C. Comfort: No Pedal Vibrations During ABS Operation

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.[3]

VIII. CONCLUSION:

In simple words, Sensotronic Brake Control is a braking system developed by an interdisciplinary approach. Mechanical components along with electronic components build an SBC system. The sensor, software, electric pumps, SBC microcomputer together allows a highly dynamic brake system. . The basis of development in the field of braking system the Sensotronic braking control system has proved that the foothold in automobile engineering due to its efficiency and reliability over conventional systems.[1] Sensotronic braking system provide uncompromising quality, stability and longevity. Combination of manage ride and handling with driving safety provided by the braking system in a sustainable and calculable way differentiates it with other braking system in a lucrative way. Mercedes engineers are exploring new and promising avenues beyond just comfort and safety. Although if there is a small malfunctioning in the electronic part of the SBC system, no repair is available and the part has to be replaced completely. Taking into consideration the future needs Mercedes will try to drop the SBC system and will substitute with an Adaptive brake new system which is the first facelift model [2]. Hence the system maintenance costs a lot. The basis of development in the field of braking system the sensotronic braking control system has proved that the foothold in automobile engineering due to its efficiency and reliability over conventional systems[1]

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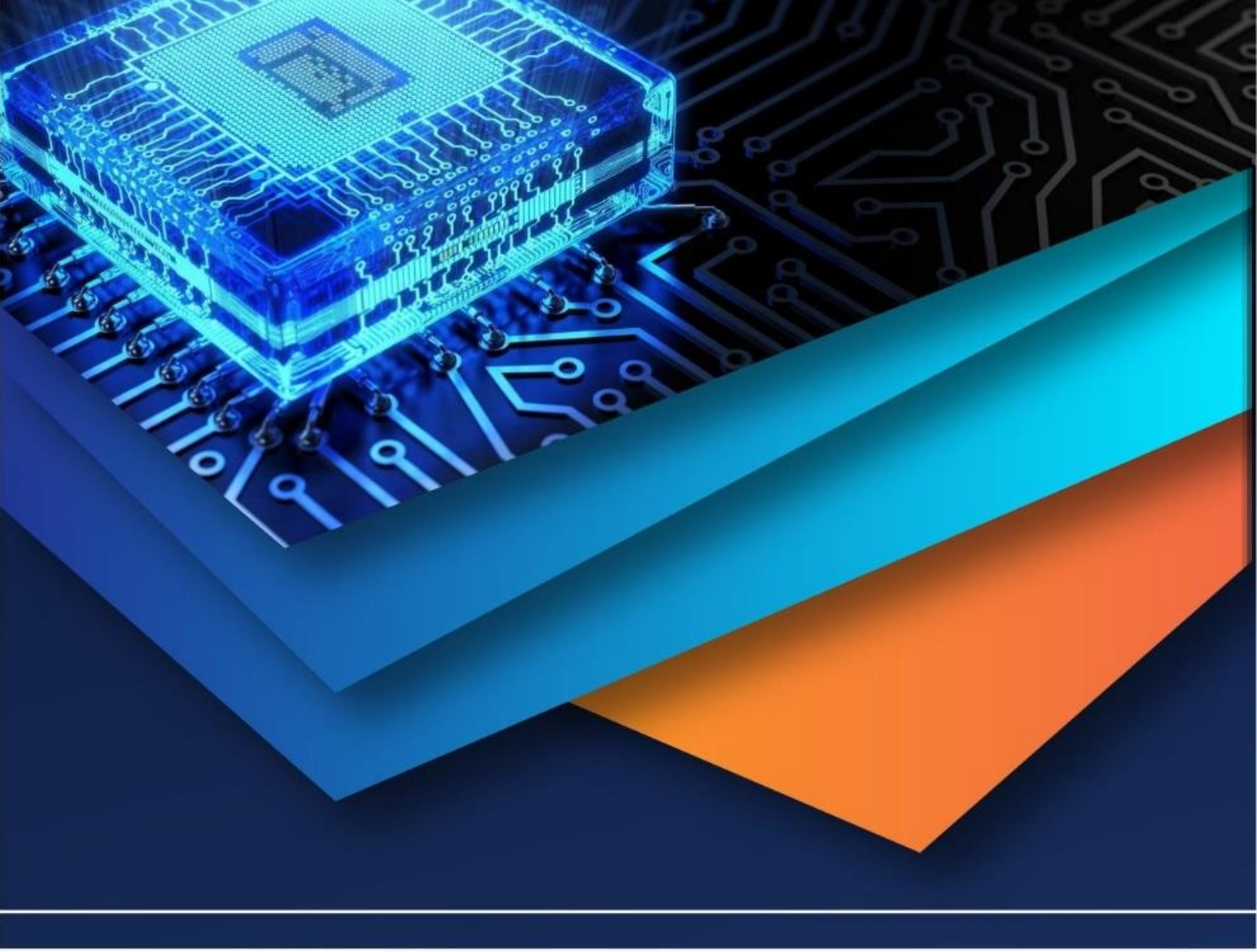

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