Distributed Brake Systems: Greater Efficiency Through Intelligent Redundancy

True by-wire brake systems offer advantages over conventional vacuum booster or eBooster-based solutions. By translating the driver’s brake request into electrical signals, they enable exceptionally fast and precise brake actuation, resulting in very short stopping distances. Hydraulic fallback systems are eliminated completely to achieve greater design freedom for vehicle architecture. However, brake systems without a hydraulic fallback must meet particularly stringent requirements in terms of redundancy and functional safety. Distributed Brake Systems address this challenge by turning redundancy into a functional advantage.

AUMOVIO has 120 years of experience in vehicle safety, most recently in tried-and-tested electrohydraulic actuation in One Box Brake Systems of the MK Cx series which sold over 15 million times since its premiere in 2016. All this knowledge went into the development of the concept for a true brake-by-wire application that combines the strengths of hydraulic brakes with an electromechanical brake system architecture. The result is the best of both worlds: high performance and efficient use of resources, such as energy, installation space and costs in regard to development, manufacturing, and over lifetime.

Intelligent redundancy: two systems working as one

Although One Box HAD Brake Systems with a second extension unit consist of two actuators, only one of them is used during normal operation, the other one being a fallback solution. **Distributed Brake Systems** are the next step in AUMOVIO’s Brake System Roadmap: In their architecture, two independent brake actuators are permanently active and work together to generate the braking force. Both systems – one with advantage in quick fluid volume spending the other in pressure generation – are functionally coordinated with each other and contribute simultaneously during normal operation.

The advantage of this concept: Because neither actuator has to provide the full braking force on its own under normal conditions, they can be downsized and designed to be more compact, lighter and more energy efficient compared to a One Box solution, while providing a more powerful braking performance. At the same time, full safety is maintained.

Each of the two brake systems is designed to function in fallback independently. The fallback mode of AUMOVIO’s true brake-by-wire system after single electric failure provides outstanding braking performance and short stopping distances. The reason: While most other braking systems act on two or three wheels, Distributed Brake Systems can still access all four wheels in the fallback mode. Performance exceeds Full-Dry Brake System fallback performance as well.

The **E/E architecture** in modern vehicles is essential for the design of Distributed Brake Systems. In the case of true brake-by-wire systems, it includes multiple power supply points and redundant electrical networks, fulfilling the requirements for systems without hydraulic fallback to be equipped with a redundant system with its own circuit. Since not only electric vehicles but also many modern combustion engine vehicles come equipped with redundant E/E architectures (starter batteries, high-voltage batteries, DC/DC converters and, where applicable, buffer capacitor units), Distributed Brake Systems are not limited to battery-electric vehicles.

The result: Excellent braking performance in every situation, which makes Distributed Brake Systems particularly suitable for highly automated driving functions – combined with more efficiency through reduced size, lower weight and lower product costs.

True brake-by-wire: freedom in vehicle design

Because the driver’s brake request is transmitted electrically and no hydraulic fallback with mechanical push-through is required, almost all brake system components – with the exception of the electronic brake pedal – can be positioned freely in the vehicle’s front end. This flexibility supports new vehicle concepts and optimized use of installation space, for example by using larger batteries that increase the range of vehicles.

Economical e-pedal concept instead of numerous variants

Without a mechanical-hydraulic coupling between the brake pedal and the brake system, a single ePedal brake system can be used across a wide range of vehicle architectures. Instead of having slightly different options, e.g. for left-hand drive or right-hand drive, combustion engine or electric vehicle, all vehicles can be equipped with the same ePedal brake system solution. This significantly reduces variant diversity and helps lower development, manufacturing, and logistics costs for both suppliers and OEMs.

Efficiency in everyday driving

Vehicle range and efficiency are becoming increasingly important, especially in electric vehicles. Every component must contribute to this in terms of optimal design and function. In Distributed Brake Systems, for example, the reduced residual friction torque plays a big role. It is achieved by a larger air gap between brake disc and caliper. Compared to hydraulic brake systems, the gap can be increased, because the driver is mechanically decoupled from the brake system. Pedal force is converted into precise brake pressure generation within less than 150 milliseconds – much faster than any conventional hydraulic system and independent from the driver’s physical strength. The increased air clearance enables significantly lower unwanted friction during driving, reducing energy losses.

Outlook: Systematic further development of the brake-by-wire concept

By combining intelligent redundancy with true brake-by-wire principles, Distributed Brake Systems reduce weight and complexity while enabling excellent braking performance. They are predestined for future vehicle architectures, as they allow for increasingly required flexibility in the arrangement of vehicle functions and support energy efficiency. AUMOVIO draws from many decades of experience in designing driving safety technologies, to take this next step in the Brake System Roadmap.

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| 01\_AUMOVIO\_BSR\_Distributed\_Products | It’s all about interplay: in the Distributed Brake System, two downsized actuators work together, helping to increase high performance and safety standards whilst lowering weight, space and materials. |
| 02\_AUMOVIO\_BSR\_Portfolio | After One Box Brake Systems, Distributed Brake Systems are the next step in AUMOVIO’s Brake System Roadmap, based on 120 years of experience in designing driving safety technologies. |
| 03\_AUMOVIO\_BSR\_Distributed\_Highres\_EN | Smart redundancy: the brake command from the e-pedal is sent electronically to both actuators, which together generate high braking force for all four wheels. |