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## Safe Parking: Further Development EPB +

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## SAFE PARKING: FURTHER DEVELOPMENT EPB +

### Technical task:

The task of the technical innovation is to realize additional brake and ESC functions with the parking brake.

### Initial situation:

The subject of redundancy of systems becomes more and more important with increasing automation of the driving operation. So it is inevitable to turn off a vehicle safely, even if the driver is not in the vehicle. In almost all vehicles with automatic transmissions, an electronic parking brake (EPB) and a parking brake are already installed in the transmission, providing a very good starting point for this. This ensures that, in the event of a fault, at least two wheels, ie one axle, can always be detected. The parking brake is also used as a redundant brake in low speed ranges (below 15 km / h) to bring the vehicle to a halt and then immediately secure against rolling away.

However, the known from automatic transmissions parking lock is not able to close at speeds above about 3km / h, without taking any damage. Thus, the parking brake can only be used in a very limited speed range.

Also, in electrified drive with more than one engine and thus more than one gear more than a parking brake to lock two wheels to integrate, with appropriate requirements for space, weight and cost.

A control topology for a redundant parking brake is known, in which each parking brake actuator is controlled by one control unit each. There is a connection between these controllers, e.g. over the vehicle bus, over which the coordination of the two sides takes place. In the event of a fault, this system only ensures the locking of a wheel. The braking effect of dynamic braking is manageable with the remaining brake.

### Solution:

The parking brake remains in its current, non-redundant form. An EPB control unit, currently standard in the Electronic Stability Program (ESC), controls both parking brakes. The gear-own parking brake is replaced by two additional parking brake calipers. These can be installed on the front or rear axle and controlled directly via the parking brake control unit.

As a result, the redundancy already described above persists when parking.

The operating concept parking brake / parking lock, signaling, tuning, connection to the holding management system, functional safety considerations does not change, the logic for opening and closing the parking brake can still be used. Only the execution is taken over by the two additional parking brakes. This would allow the concept to be integrated retrospectively into existing vehicle projects with little effect on the overall vehicle. The gearboxes can be designed without a parking lock. If several transmissions are used in a vehicle project, the „new parking lock“, ie the additional parking brake, will only be developed once. The parking brake is fail-safe as an existing and proven technology.

The additional parking brake (with 4 parking brakes instead of the previous 2) could be used in emergency stop situations, e.g. in automated parking, the braking performance by simultaneous closing the parking brake and the parking brake are improved at speeds below 15 km / h. In particular, if at each wheel a parking brake caliper is installed.

Figures 1, 2 and 3 show a possible implementation. Shown are the controlling ECUs (XY STG), the power lines (red or blue lines) to the Parkbremsaktuatoren and the Park brake actuators (red or blue boxes).

Figure 1 shows a variant in which the actuators of both „brake circuits“ are installed on one axle. Similar to the EPB control unit, the transmission control unit integrates the power amplifiers and the EPB software for opening and closing in the ESC.

Figure 2 shows a variant in which the actuators of the EPB „circle“ on the rear axle and those of the transmission „circle“ are installed on the front axle. Similar to the EPB control unit, the transmission control unit integrates the power amplifiers and the EPB software into the ESC.

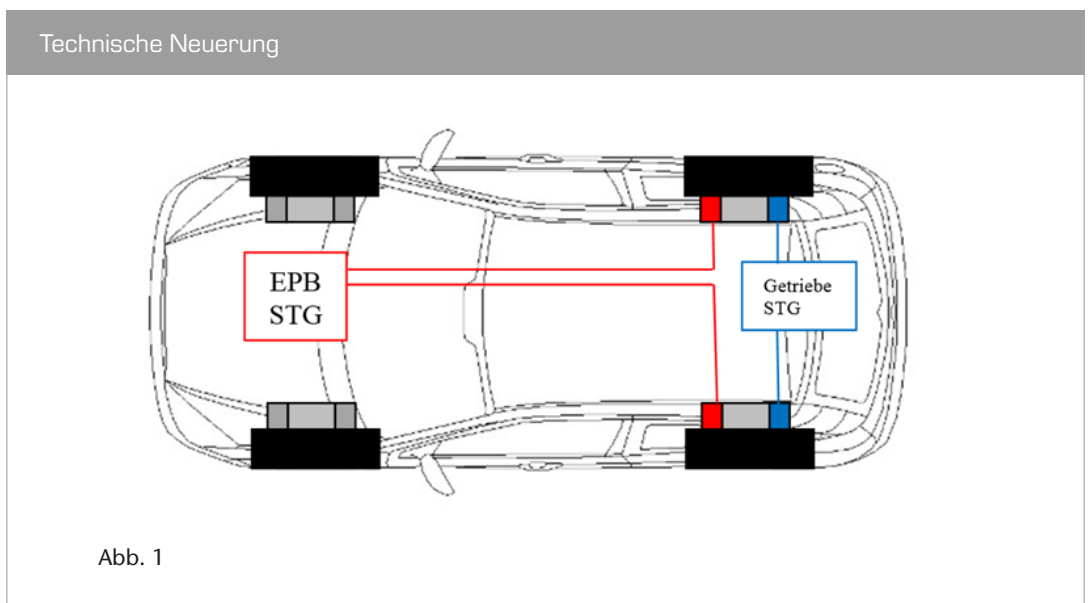
Figure 3 shows a variant in which the actuators of the EPB „circle“ on the rear axle and the transmission „circle“ are installed on the front axle. The transmission control unit controls the EPB via an additional EPB control unit or via smart actuators (control units integrated in the EPB actuator), which contain the power amplifiers and the EPB software for opening and closing. With this expansion stage, the modification effort for the transmission control unit would be minimal. The open or close command, which originally controlled the parking brake, could be simply communicated via private-bus communication to the intermediate EPB controller, which then executes it.

**Advantages:**

- Transmissions can be designed without integrated parking locks.
- Additional EPB enables the use of multiple (parking-barrier-free) single transmissions.
- Saving space and weight.
- 4-way EPB enables low-speed ESC functions.

**Possible application:**

- All vehicles with automatic transmission and EPB.



Technische Neuerung

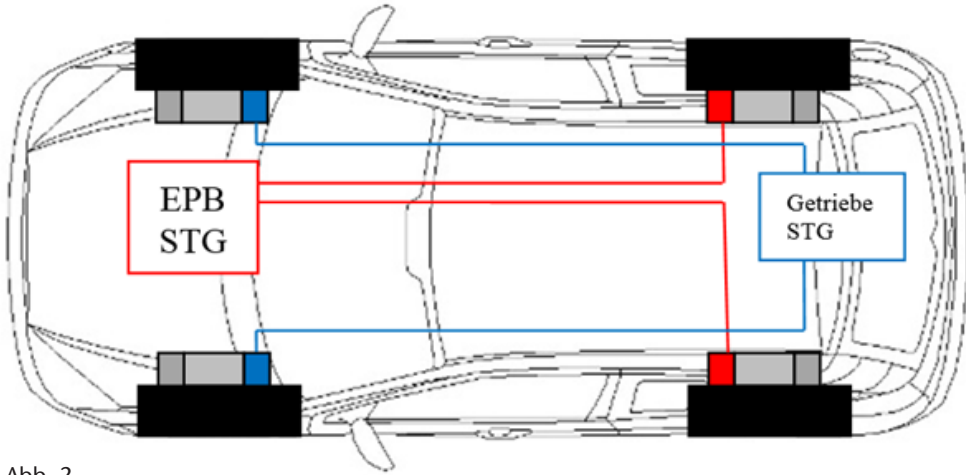


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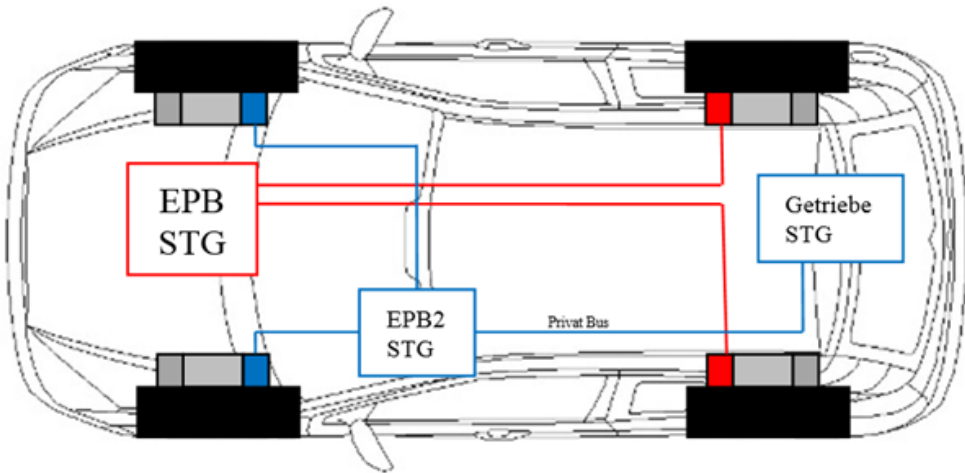


Abb. 3