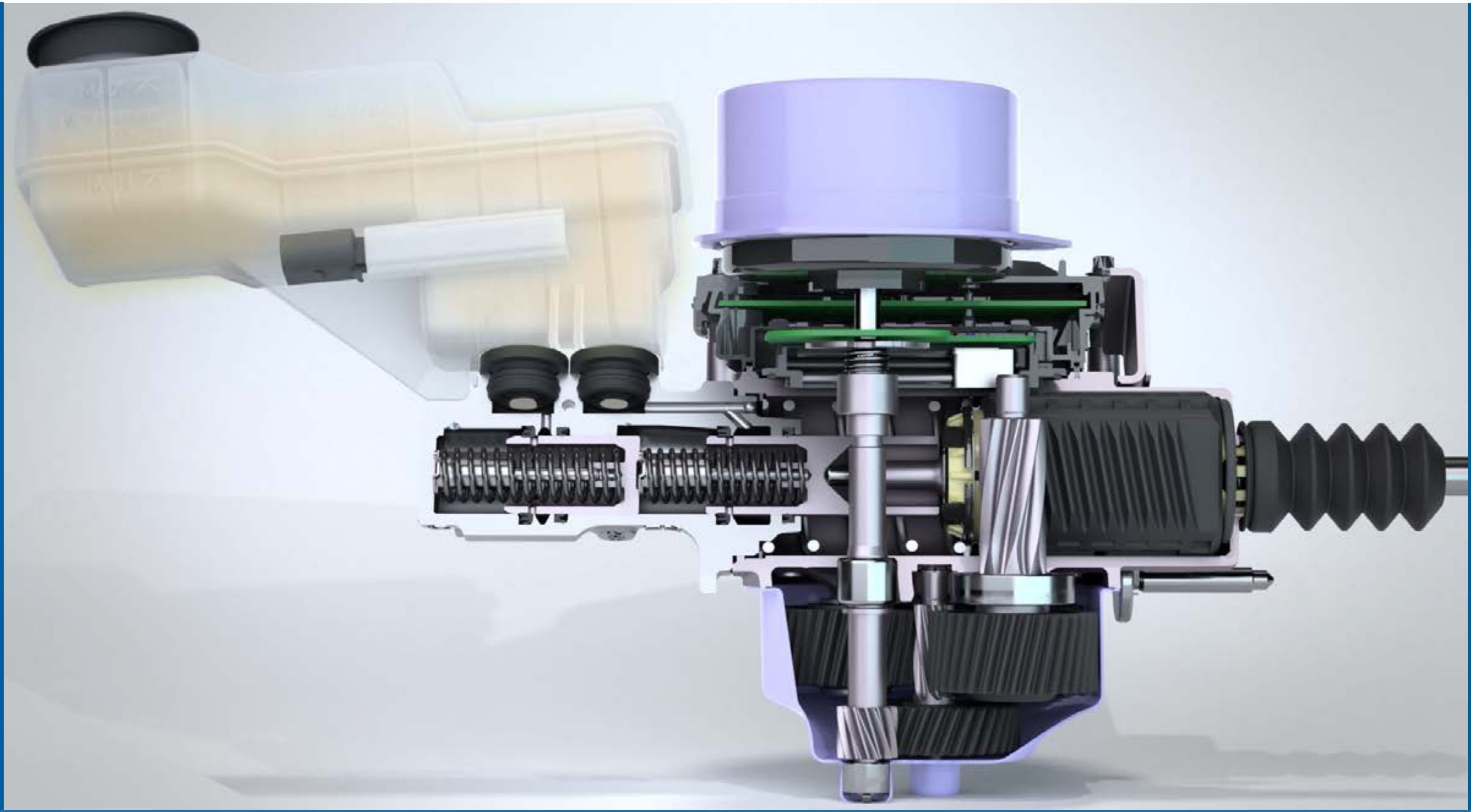
Self Study Program 861213

The ID.4 Electromechanical Brake Servo (eBKV)

Tablet Format



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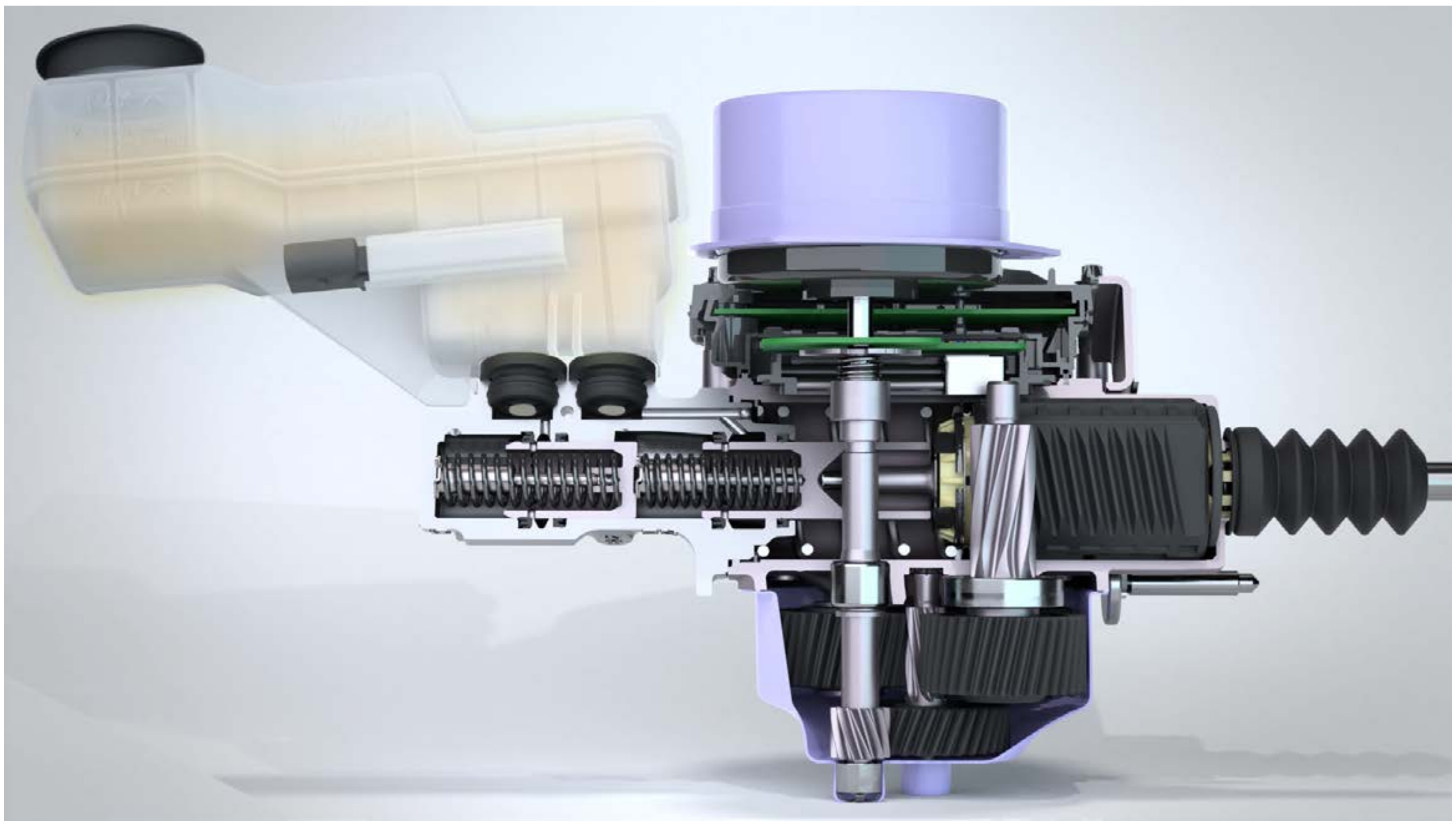
Introduction

Due to the increasing number of electric vehicles and the low vacuum produced in the intake manifolds on modern combustion engines, a method to enhance braking force is needed. The Electromechanical Brake Servo (eBKV) provides a solution to these concerns.

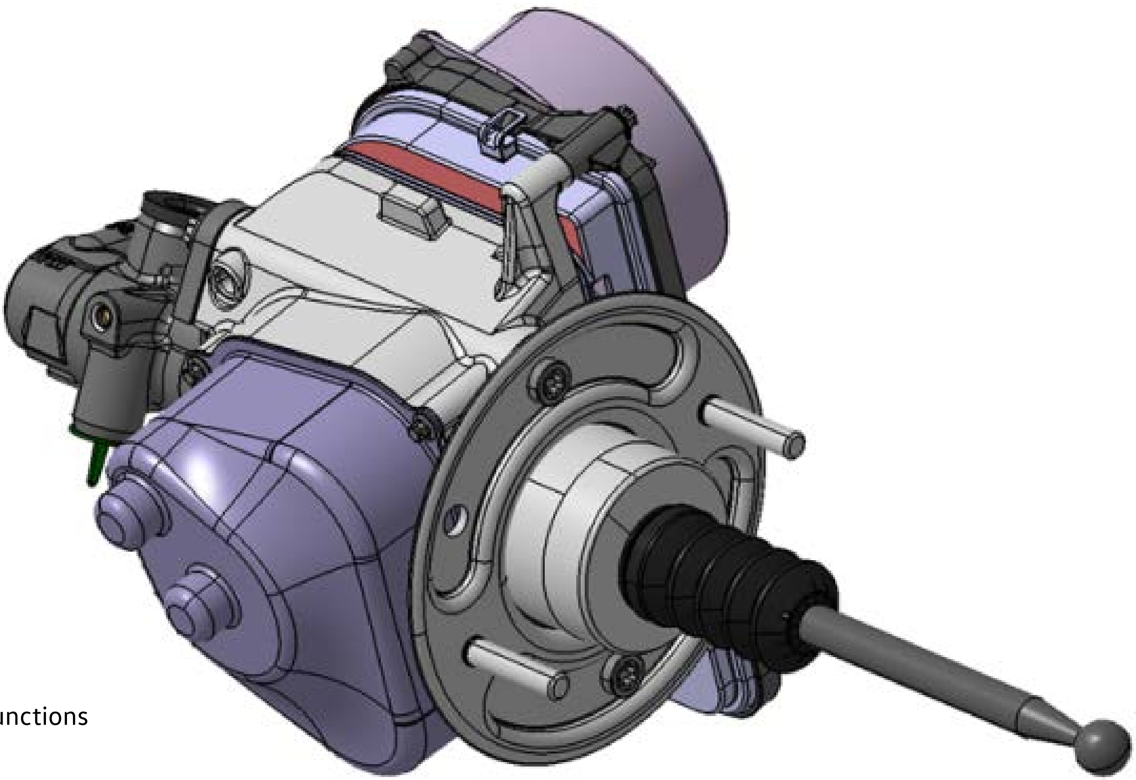
In addition to enhancing braking force, this system also reduces the total weight of the brake system, allowing further CO_2 emission reduction for vehicles with combustion engines.



Introduction

Technical features of the Electromechanical Brake Servo (eBKV):

- Parallel axis electric drive
- Weight-saving gear unit
- Weight saving control unit housing
- Vacuum-free brake force boosting
- No additional pressure accumulator
- Up to 5.3 kN power assistance
- Weight of approx. 9.7 lb (4.4 kg)
- Motor output 370 W
- Voltage range 9.8–16 V
- Maximum torque of 2.4 lb/ft (3.3 Nm)



Advantages of the eBKV

- Particularly fast brake pressure build-up for driver assist functions
- High safety advancement
- Reduced wheel brake drag torque
- Comfortable pedal feel
- CO_2 savings due to weight reduction and omission of vacuum pump
- Long service life
- Redundant brake system for Electronic Stability Control (ESC)

Safety Increases due to the eBKV

The eBKV increases the effectiveness of driver assist systems, such as Front Assist, in potential accident conditions that require extremely high pressure braking increases. This cannot be performed using conventional vacuum-based systems.

This results in a shorter stopping distances than conventional systems:

- A reduced emergency braking distance of up to 4.2 ft (1.3 m) with deceleration from 18.5 mph (30 km/h) to a stop
- Collision speeds can be reduced by approximately 1.8 mph (3 km/h) due to the shorter stopping distance

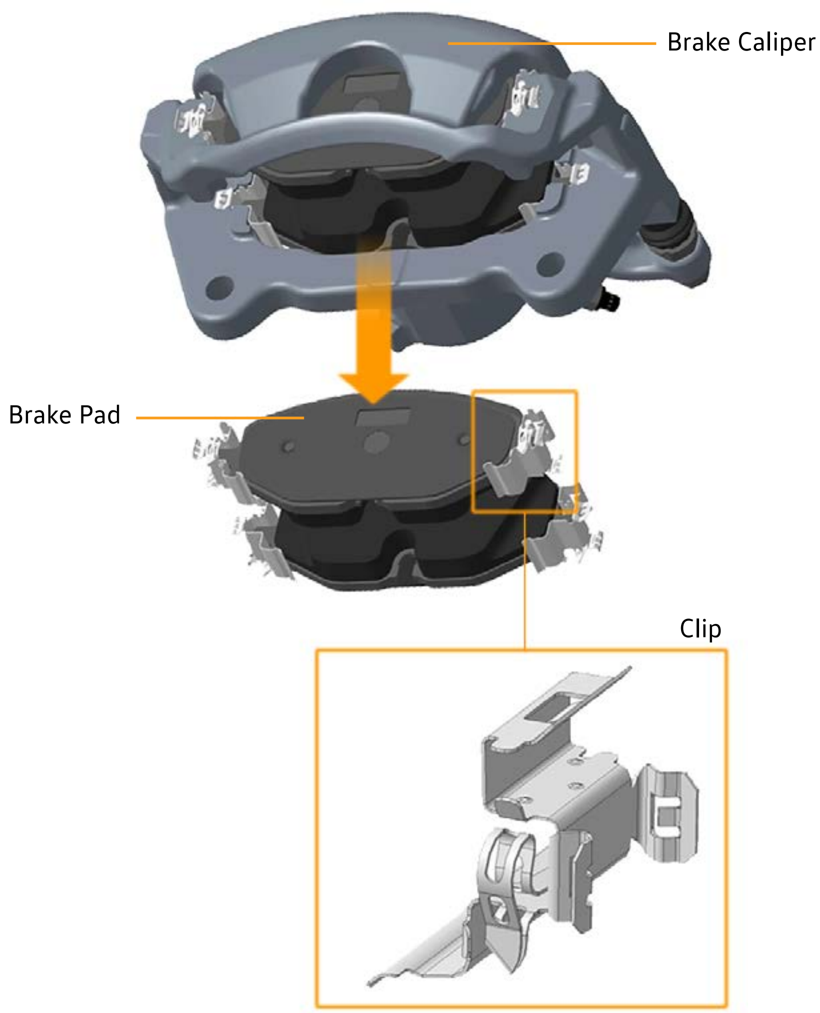
This also allows pedestrian accident avoidance to be improved by 10%.

Reducing collision speed decreases the energy that the body has to absorb during the impact, improving occupant protection.

What is Reduced Brake Drag Torque?

Brake drag torque occurs with disc brakes after a braking event. Brake drag torque leads to higher fuel consumption and increased CO_2 emissions.

After a braking event, the brake pads retract to their starting position as brake pressure decreases. Due to slight wobbling of the brake disc in relation to the brake caliper, combined with tight clearance, the whole brake pad does not immediately lose contact with the brake disc. There is still transitional frictional contact between the brake disc and the brake pad. By using a clip in the brake caliper, the pads can be mechanically retracted faster.



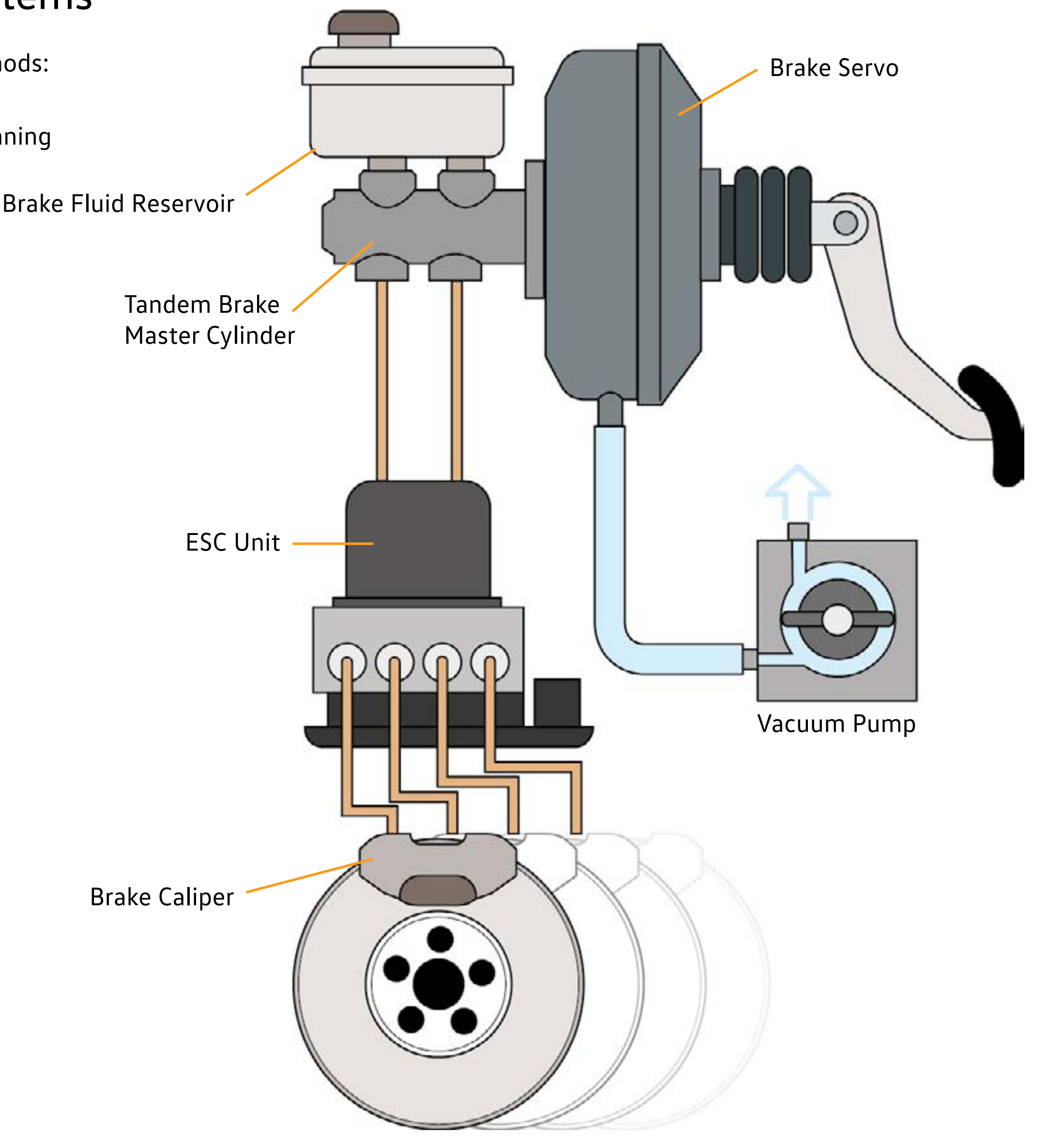
Conventional, Vacuum-based Brake Systems

Vacuum-based brake systems create vacuum using multiple methods:

- Intake manifold evacuation while the combustion engine is running
- A mechanical vacuum pump
- An electric vacuum pump

These methods have some partial disadvantages:

- Poor CO_2 figures
- Heavy weight
- High production costs



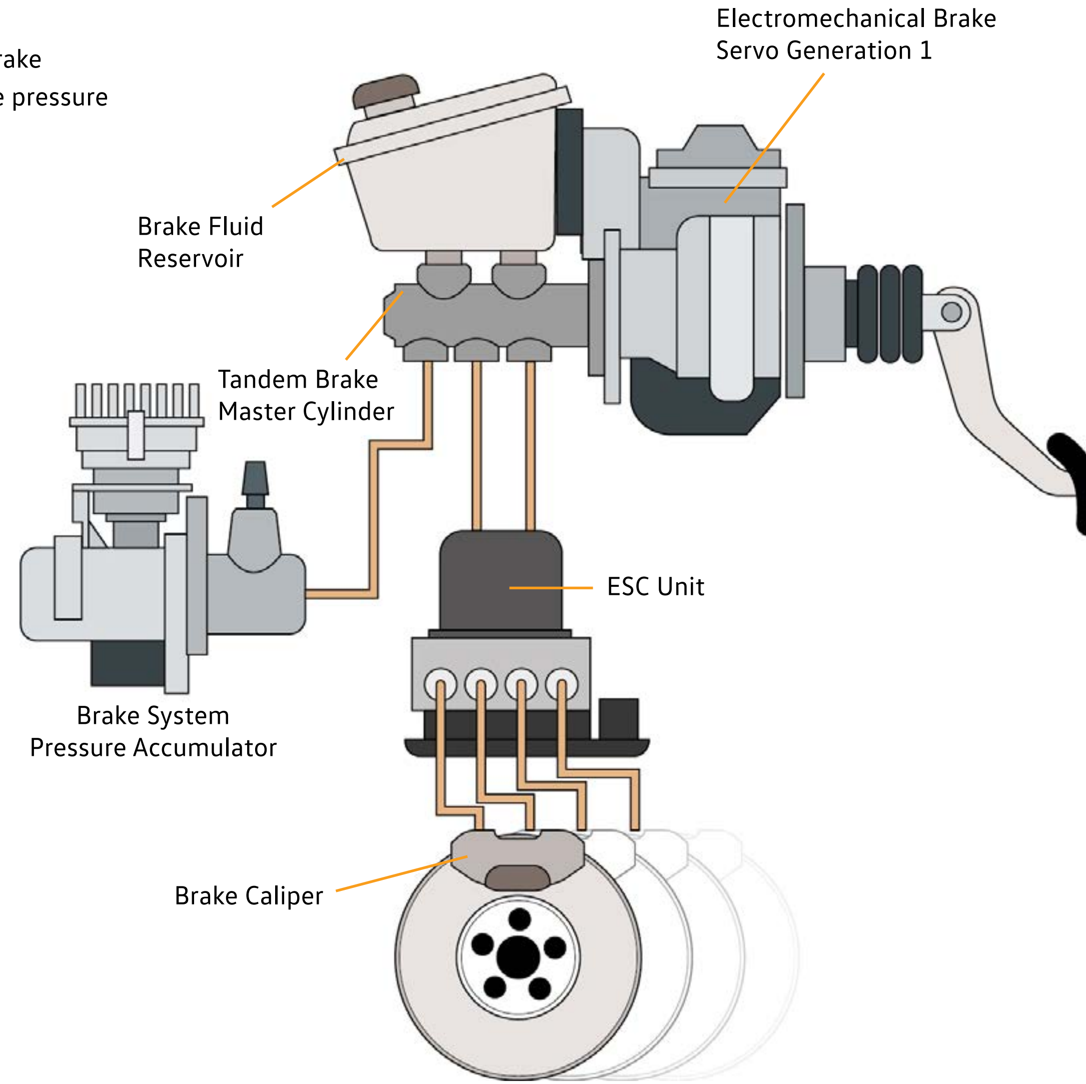
Current Brake Systems for Electric Vehicles

This is the 1st Generation eBKV. It is used in high-voltage vehicles.

Its distinguishing feature is a special pressure accumulator for the brake system. It stores brake fluid during recuperation, reducing the brake pressure in the system.

The disadvantages are:

- The space required
- The separate drive for the active accumulator
- Its weight

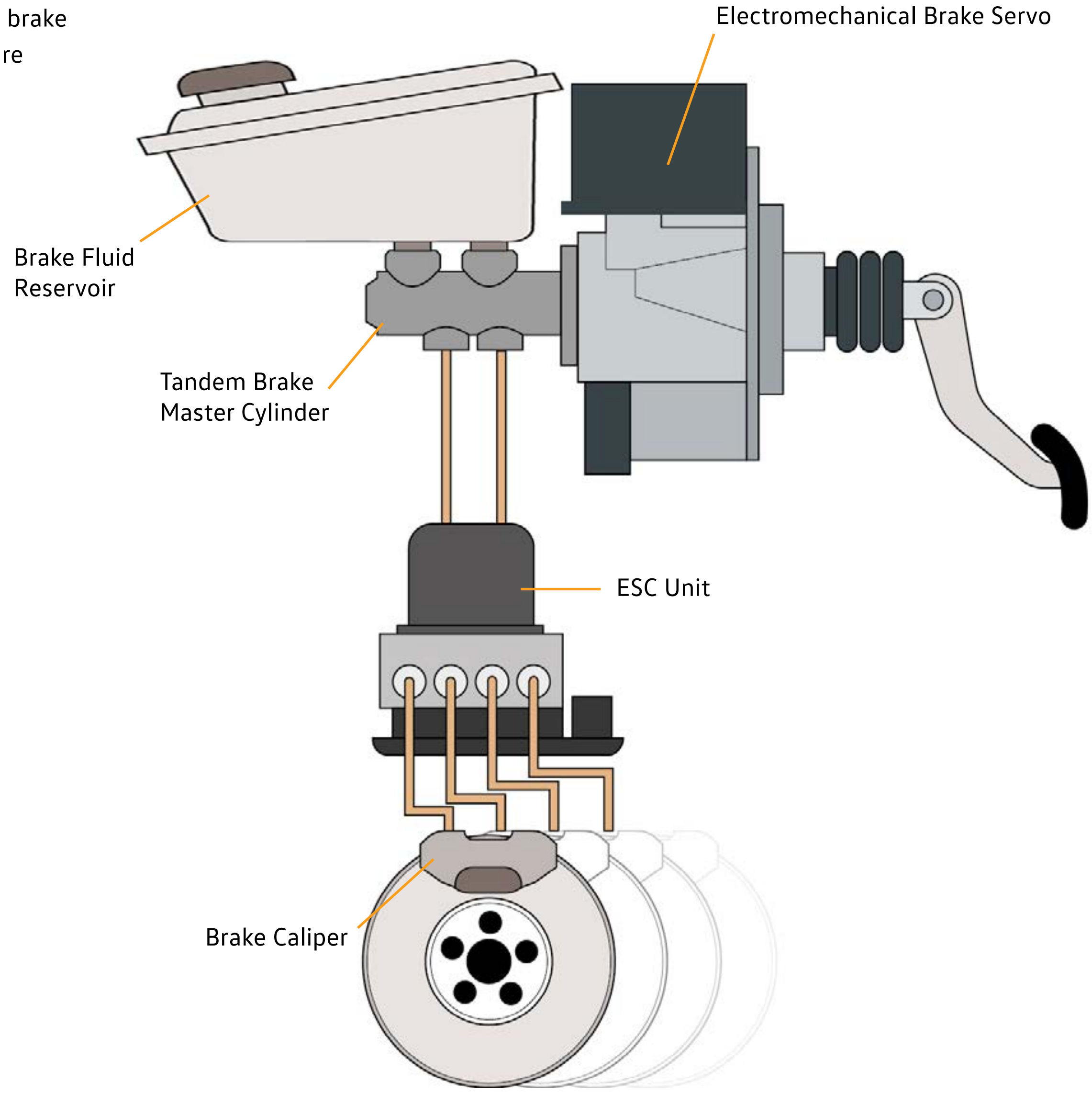


Electronic Brake Servo

The eBKV has an accumulator integrated into the ESC unit that holds brake fluid during recuperation, instead of an external brake system pressure accumulator.

The advantages of this system are:

- No additional space required for additional components
- Weight reduction
- Lower CO_2 emissions
- Reduced costs

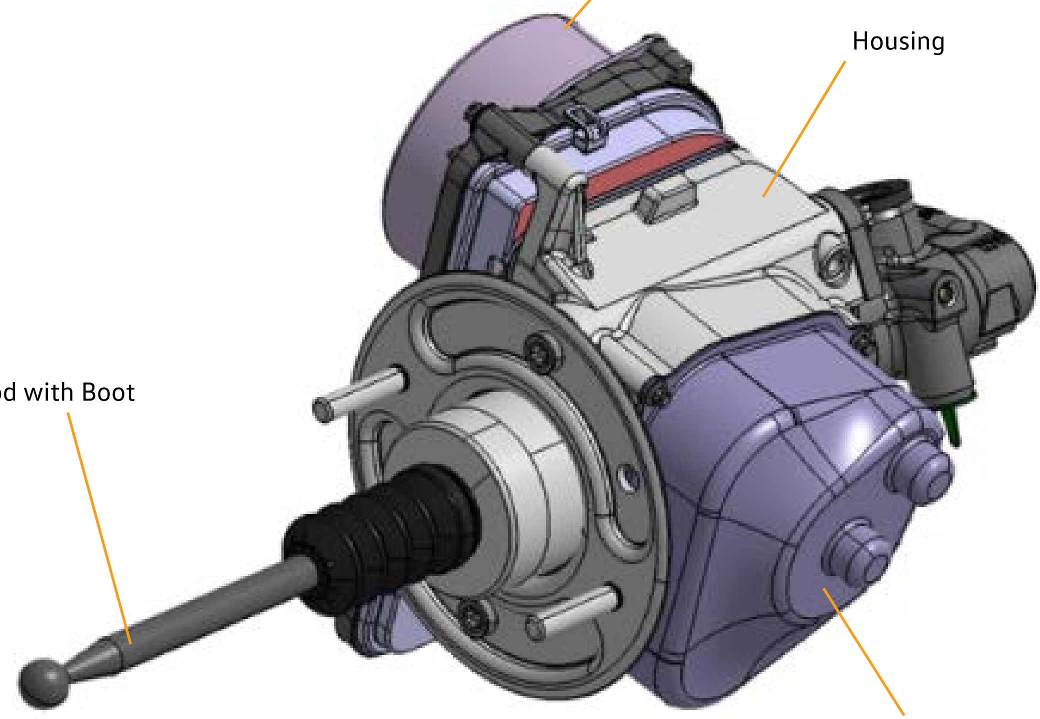


Design of the eBKV

Exterior Design

The eBKV has the following components:

- The housing
- The push rod with boot
- The motor/gear unit
- J539 Brake Booster Control Module
- The brake fluid reservoir
- The tandem brake master cylinder



Design of the eBKV

Function

When the driver presses on the brake pedal, the push rod introduces this movement into the assembly. This movement is sensed by the transferred by the Brake Pedal Position Sensor G100, which is part of the Brake Booster Control Module J539.

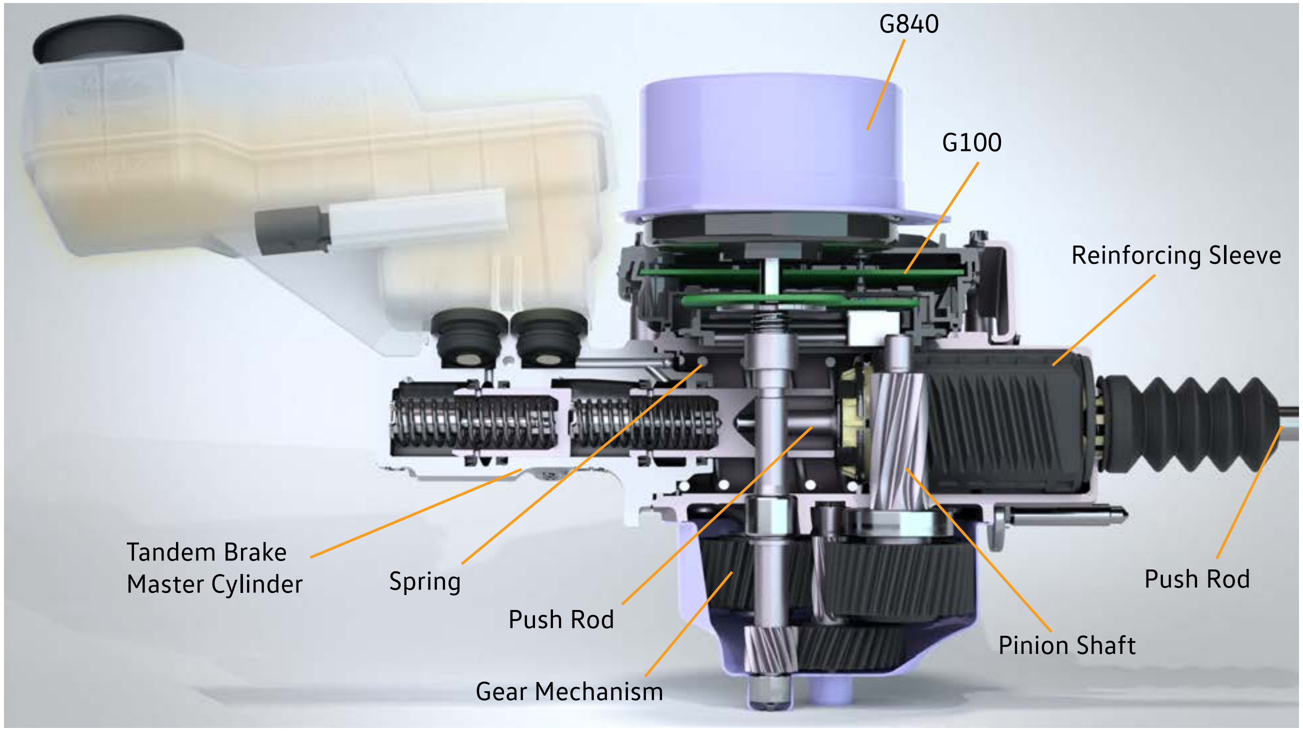
The G840 Brake Booster Motor Position Sensor is also intgral to the J539, and relays the current motor position.

The J539 uses the information about the driver's brake request and the motor position to calculate the brake servo movement required.

To initiate movement, the reinforcing sleeve is moved to the left by the pinion shafts, located on either side of the reinforcing sleeve.

As the reinforcing sleeve moves, the push rod also moves. The braking force is increased by seven to eight times when the electromechanical brake servo is used.

When the braking request is removed, the spring located between the master cylinder and the reinforcing sleeve pushes the reinforcing sleeve/push rod back to its original position.



Released and Engaged Positions

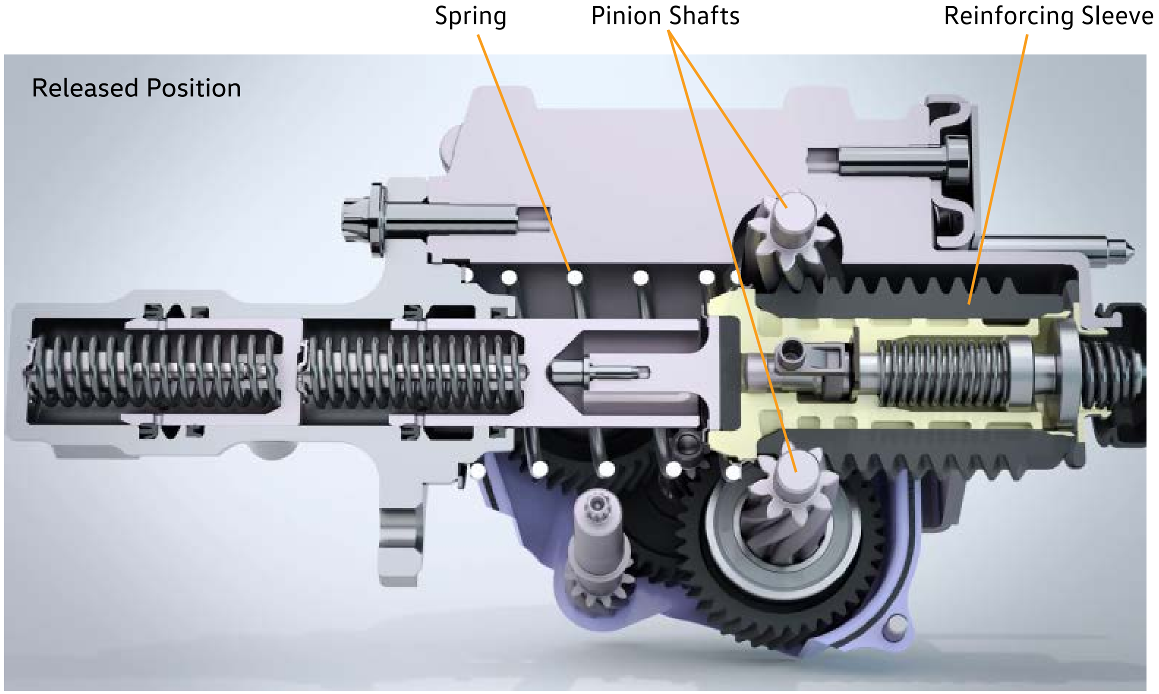
These overhead images illustrate the released and engaged positions as described on the previous page.

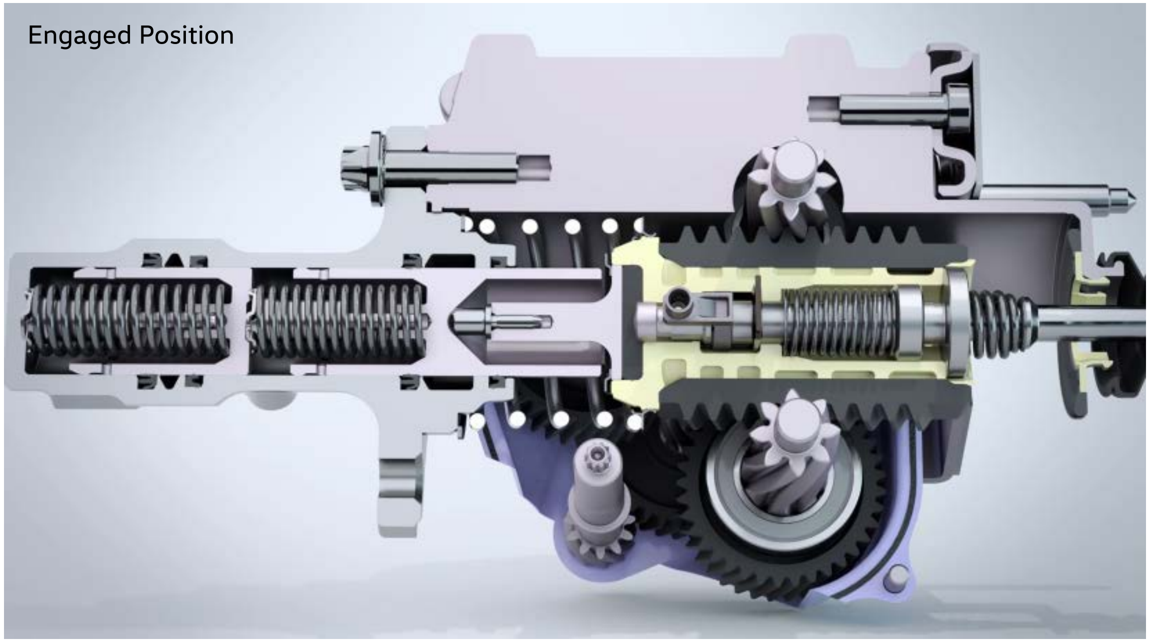
Released position:

- The spring is relaxed
- The parallel pinion shafts are on the left side of the reinforcing sleeve

Engaged position

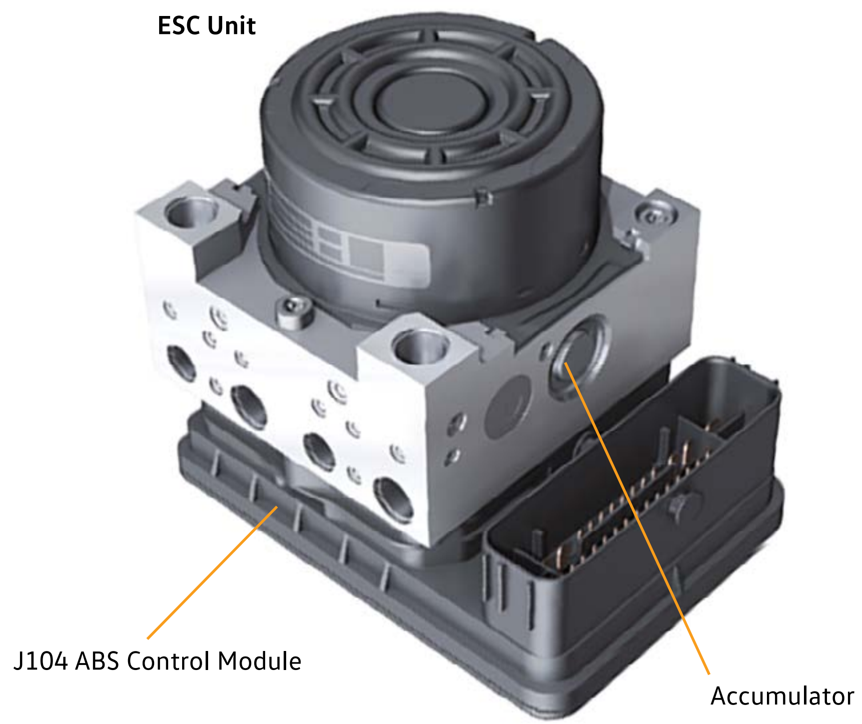
- The reinforcing sleeve has moved the left
- The spring is compressed





Design in Detail - Pressure Accumulator in the ESC Unit

When compared to the 1st Generation eBKV, the active pressure accumulator has been removed. The pressure accumulator function is now integrated into the ESC unit. The ESC unit has a larger volume to accommodate this function.

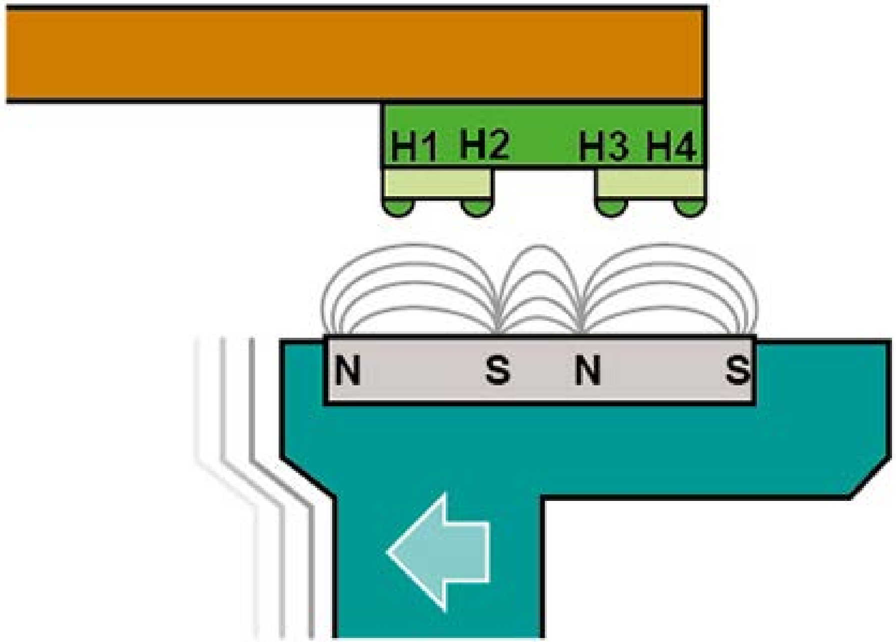


G100 Brake Pedal Position Sensor - Design and Failure Effects

Design

The brake pedal position sensor has two Hall sensor elements on the boost body and a slide with four Hall magnets. The magnets are connected to the input push rod.

When the driver presses the brake pedal, the Hall magnets move over the Hall sensors. This movement is interpreted as a braking request by the brake servo system

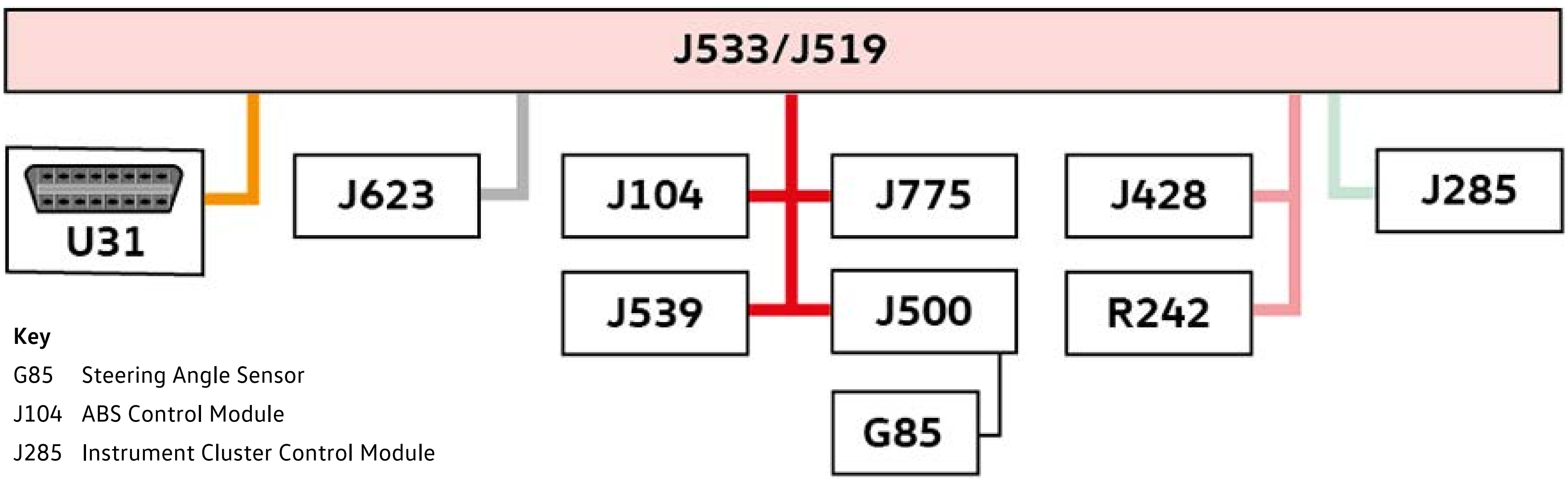


Failure Effects

If the G100 fails, the brake function is taken over by the ESC unit. If the electromechanical brake servo and ESC fail at the same time, purely mechanical braking is still possible.

Network System

The eBKV is connected to the engine and transmission control modules using CAN-Bus.



Key

G85	Steering Angle Sensor
J104	ABS Control Module
J285	Instrument Cluster Control Module
J428	Control Module for Adaptive Cruise Control
J500	Power Steering Control Module
J519	Vehicle Electrical System Control Module
J533	Data Bus On Board Diagnostic Interface
J539	Brake Booster Control Module
J623	Engine/Motor Control Module
J775	Drivetrain Control Module
R242	Driver Assistance Systems Front Camera
U31	Diagnostic Connection

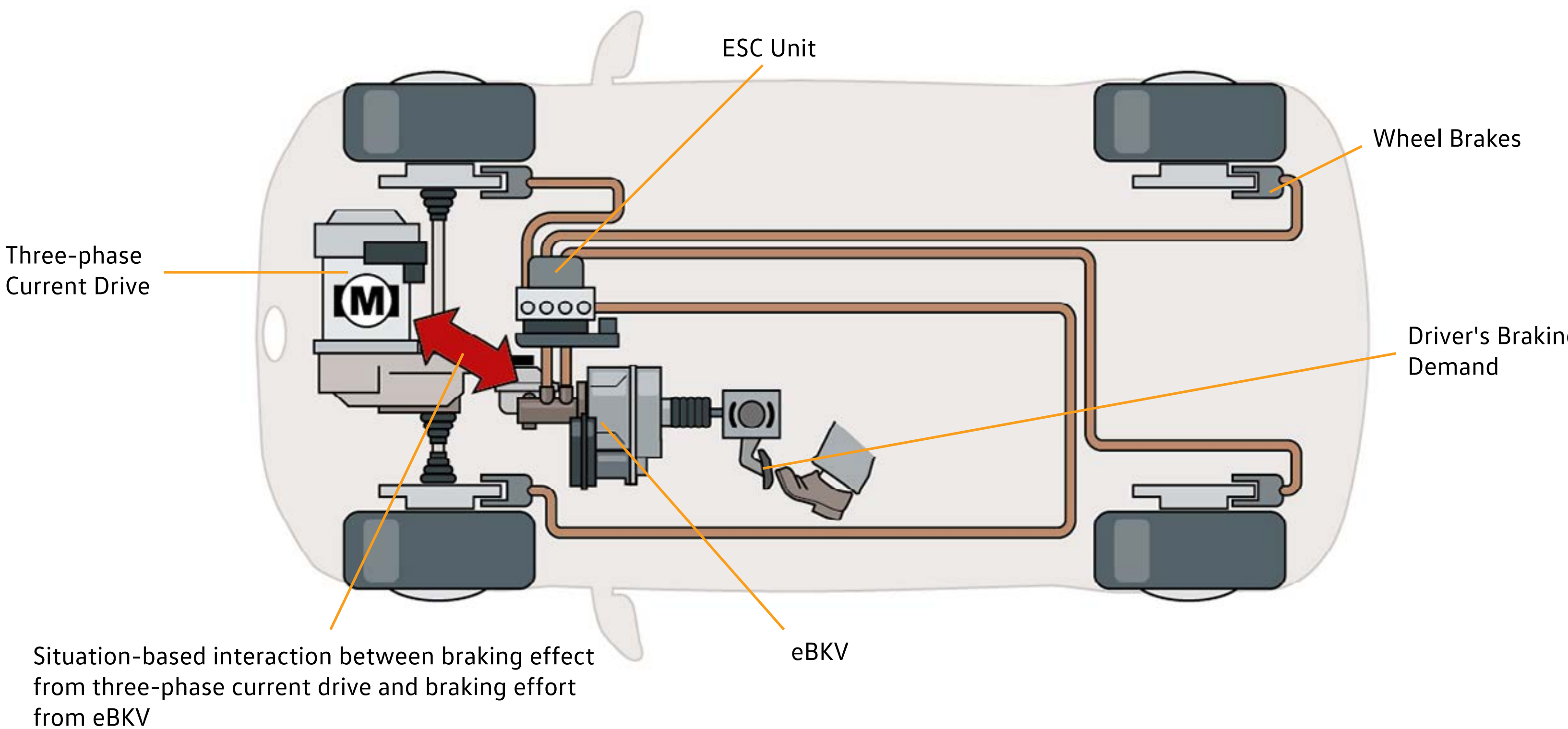
Powertrain CAN-bus
Running Gear CAN-bus
Drivers Assist System CAN-bus
Convenience CAN-bus
Diagnostic CAN-bus
Analogue Connection

What is Brake Blending?

The term "brake blending" comes from high-voltage vehicles. The three phase current drive of a high-voltage vehicle can be used in regenerative mode to brake (decelerate) the vehicle speed. Part of the vehicle's kinetic energy is converted into electrical energy and thermal energy during the process and the vehicle speed decreases.

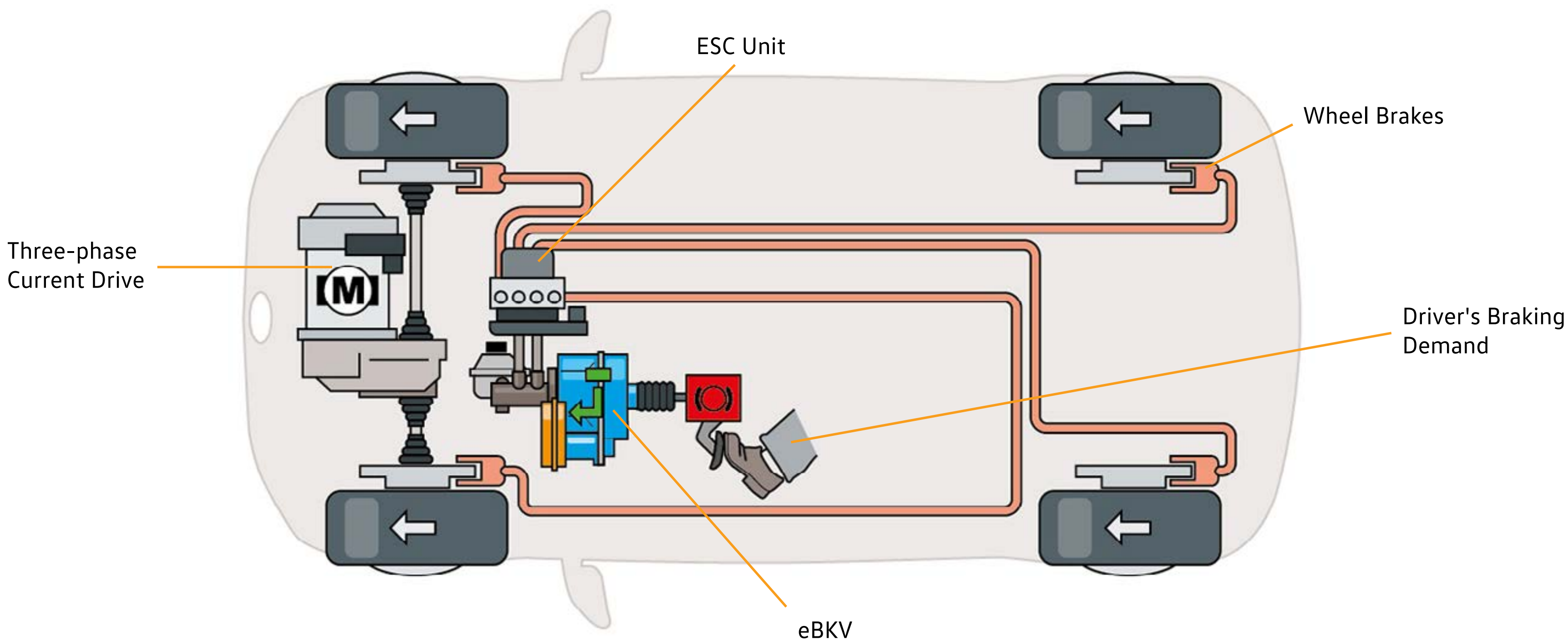
Depending on the battery charge level and the temperature of the high-voltage battery, it is not always possible to use the high-voltage system for deceleration. Any fluctuations in deceleration are covered by the hydraulic brake system.

Since the eBKV responds much faster than vacuum-based systems, this collaboration between hydraulic braking and high-voltage braking is very efficient.



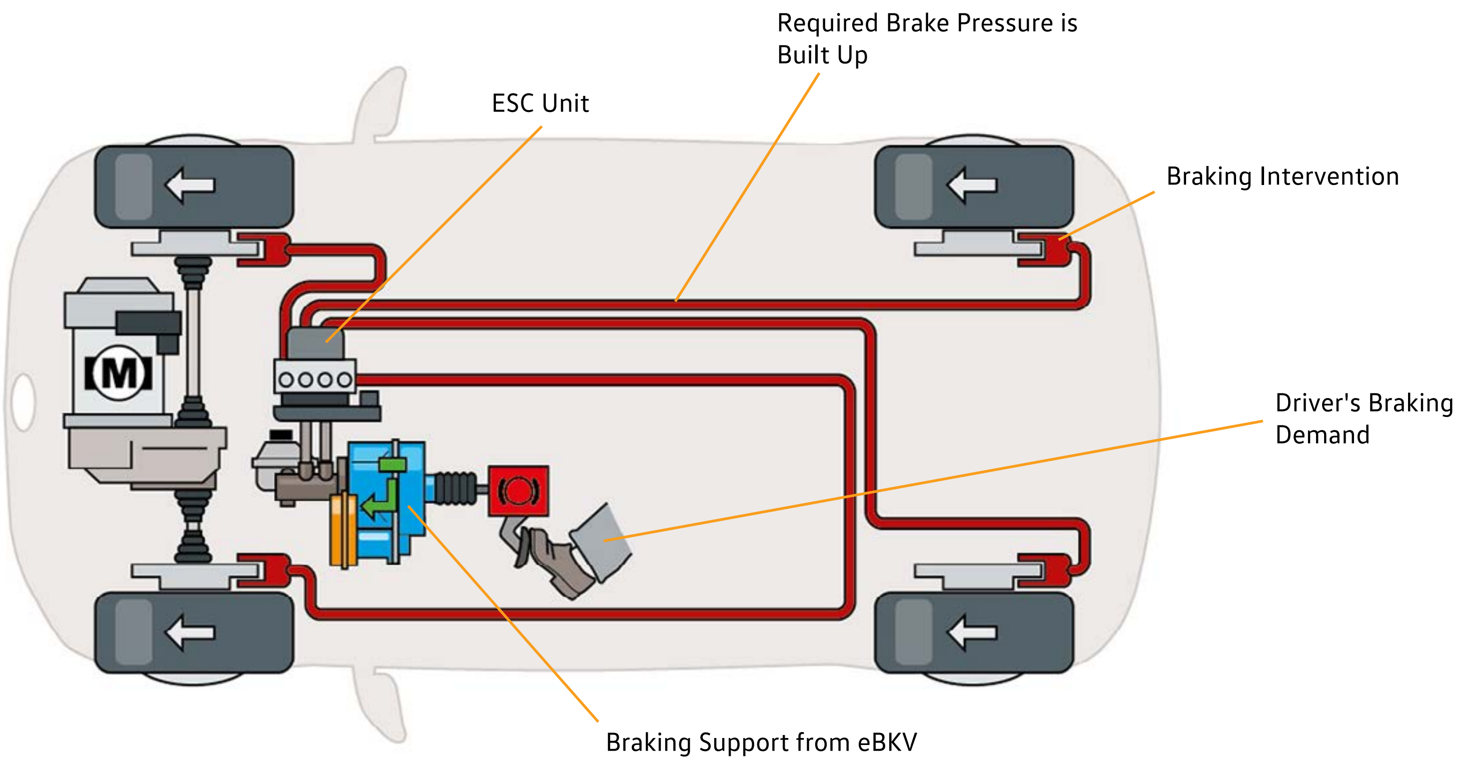
Brake Blending Process - Deceleration Requirement

When brake pedal actuation occurs, which is detected by the J539 Brake Booster Control Module, the eBKV will build up pressure.



Brake Blending Process - Frictional Deceleration

The brake pressure built up in the hydraulic brake system presses the brake pads against the brake disc. Due to the resulting friction, part of the vehicle's kinetic energy is converted into thermal energy and radiated. This energy is lost.

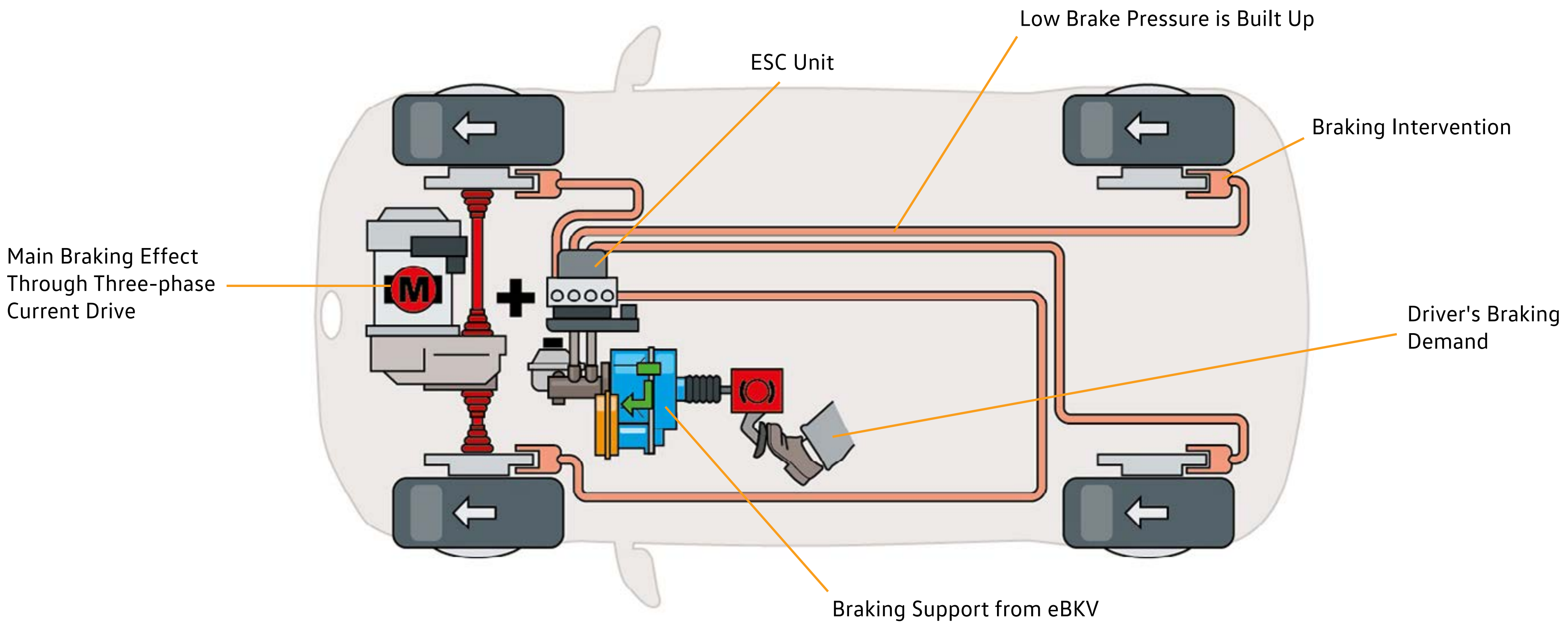


Brake Blending Process - Recuperative Deceleration

If the charge level of the high-voltage battery and its temperature are suitable, a large part of the frictional deceleration can happen using the regenerative mode of the three-phase current drive.

The vehicle's kinetic energy is converted into electrical energy, stored in the high-voltage battery and can be used for acceleration. In this process, which is known as recuperation, a small amount is lost as thermal energy due to bearing friction and the heat occurring during induction.

Since the braking effect happens using the high-voltage drive, brake pressure in the hydraulic system and the electrical brake force boosting are reduced. Electrical energy is saved by the not using the hydraulic brake system.

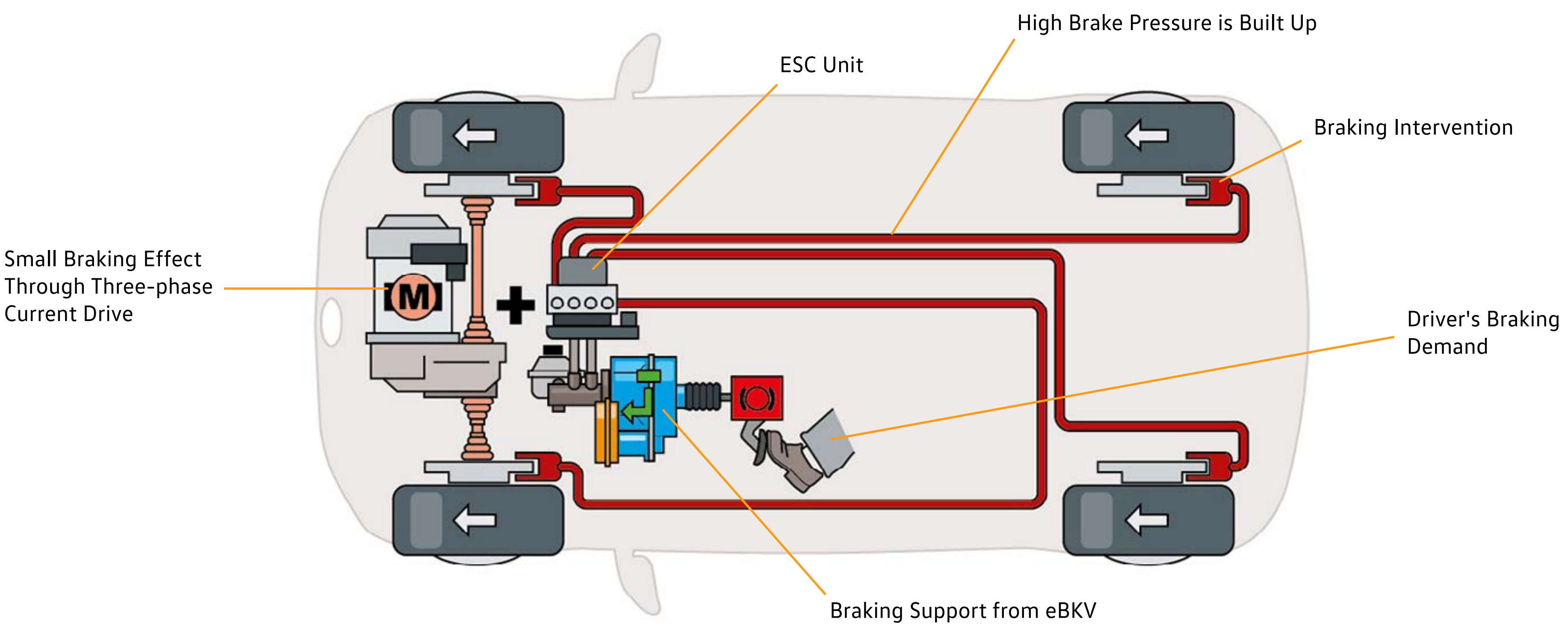


Brake Management

Brake Blending Process - Supporting Deceleration

If the charge level of the high-voltage battery and its temperature do not allow recuperative deceleration to be used, hydraulic braking must be used to slow the vehicle. The eBKV and the hydraulic brake system intervenes and supplies the required braking force using the wheel brake cylinders.

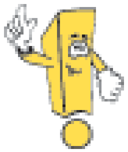
The driver does not notice any of this interaction since the eBKV acts autonomously and will automatically build up the brake pressure without driver intervention.



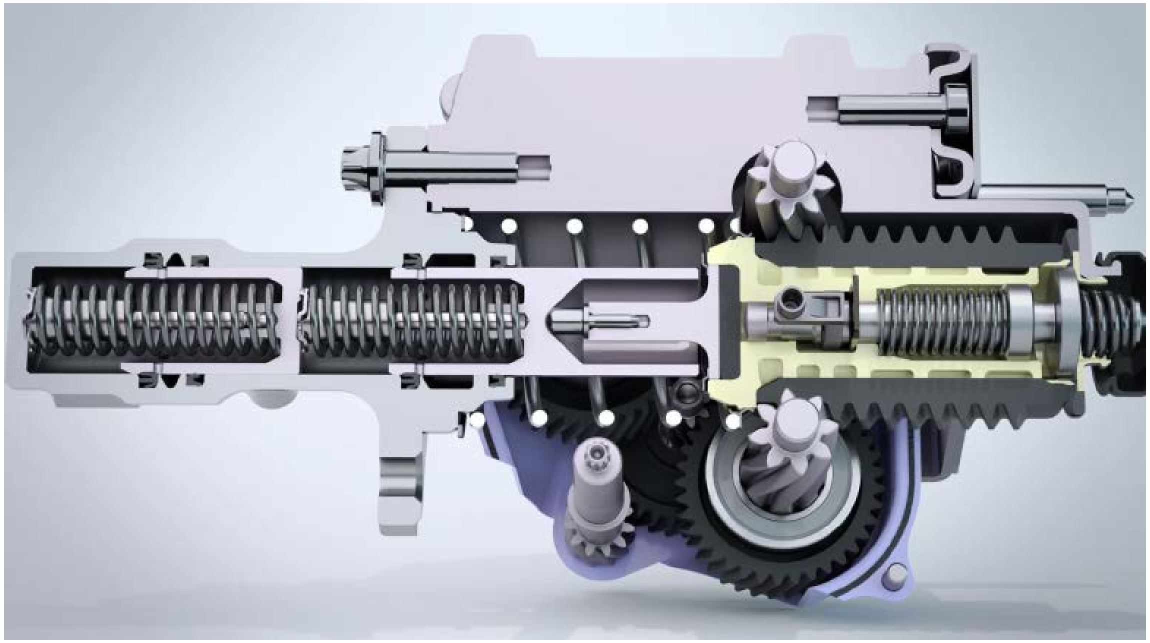
Service - Work After the Electromechanical Brake Servo is Replaced

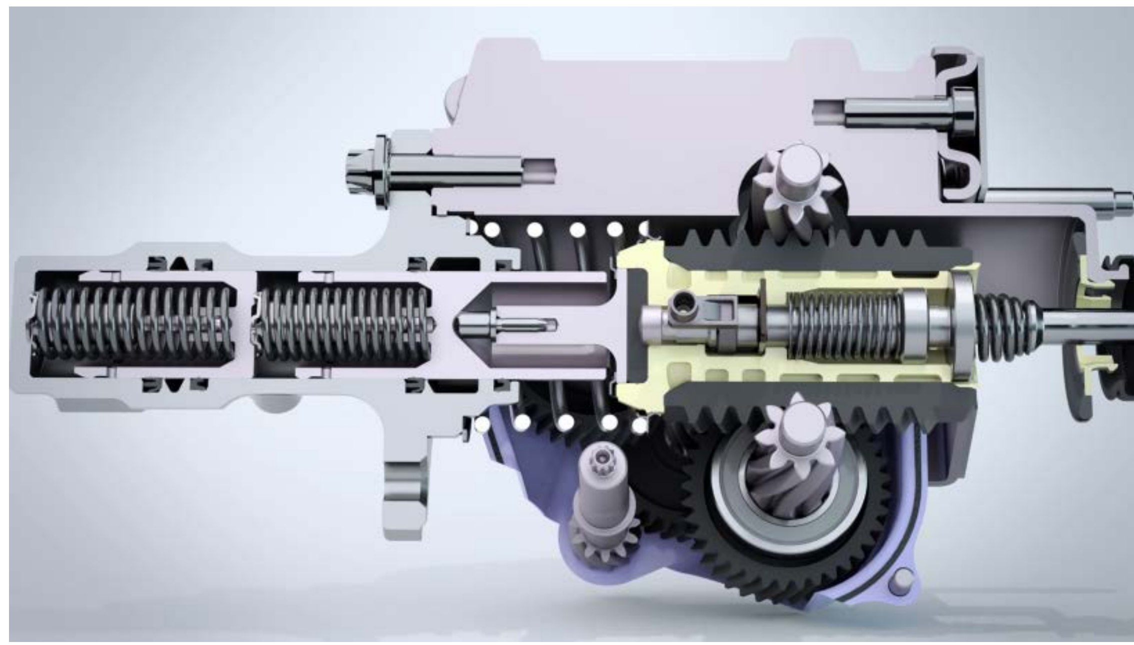
If defective, eBKV must be replaced as a complete unit. Once the new eBKV has been installed, the brake system needs to be checked for free movement and also bled by means of a pressure test:

- A free movement test is performed first. This involves testing the mechanical functions of the brake servo
- The pressure test is then performed with the vehicle diagnostic tester using “Guided Functions”



The individual steps for changing a new electromechanical brake servo vary according to model.





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