Hella: ELECTRIC PARKING BRAKE

Here you will find useful information and important tips relating to the electric/electromechanical parking brake in vehicles

Electric parking brakes are being used in an increasing number of vehicles. In addition to stopping the vehicle rolling away, they also allow for additional comfort functions. On this page we will explain how two system variants work. You will also find out what to do in the event of a fault, as well as the key points that experts must note when performing repair work on the wheel brake.

Important safety note: Technical information and practical tips have been compiled by HELLA in order to provide professional support to vehicle workshops in their day-to-day work.

1. ELECTROMECHANICAL PARKING BRAKE (EPB): BASIC PRINCIPLES

Electromechanical parking brakes (EPB) are increasingly being used as an “electronic hand-brake” in the latest generation of passenger cars. Alongside increasing comfort, they also offer numerous additional functions. We will examine the system installed in the BMW 7 Series (E65) and Audi A8 (4E..) here by way of example.

Tasks of the electromechanical parking brake
When the vehicle is at a standstill, the electromechanical parking brake is responsible for stopping it rolling away unintentionally. It also fulfils the legal requirement for a second, independent brake system in the vehicle as well as additional safety and comfort functions.

Distinction
The systems used for BMW and Audi differ in terms of their fundamental design. On the Audi A8, the EPB acts directly on the rear axle’s brake pads by means of an electric motor and a spindle.
On BMW vehicles, an electromechanical actuator operates the ca-

2.DESIGN FOR AUDI

The parking brake mechanism on Audi vehicles comprises a DC motor, a wobble plate gear, and a spindle. The components are attached directly to the rear brake calipers and enable the rotation of the motor to be converted into small brake piston lifting movements. The DC motor powers the wobble plate gear via a belt drive.

The drive motor speed is reduced for the first time here. Due to the belt drive ratio, the speed is reduced to 1:3. The wobble plate gear then reduces the speed further. The speed at the gear output has been reduced by a factor of 147 relative to the drive speed of the DC motor. A spindle directly powered by the wobble plate gear converts the rotation into a lifting movement.

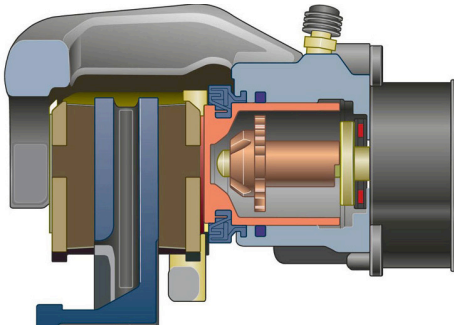
The brake piston houses a cylinder that can move back and forth inside the piston. In order to prevent the cylinder in the piston from turning, it is surface-ground in two locations. A nut is press-fitted to the cylinder front end, and the nut moves on the spindle thread as soon as the spindle rotates. A Hall generator measures the number of DC motor revolutions and passes it on to the control unit, which uses the information to calculate the lift path.

When the parking brake is applied, the rotation of the spindle moves the nut forward. The cylinder then presses the brake pads to the brake disc via the brake piston.

When the parking brake is released, the nut on the spindle is turned back and the brake piston is relieved. As the sealing ring recovers its shape, the brake piston is moved back as is the case after regular braking.

The overall system also comprises a control unit with integrated tilt angle sensor, the indicator lamps, and the switch in the center console.

The parking brake is activated by pulling the switch and released by pressing the switch. The indicator lamp in the instrument panel and switch indicates that the parking brake has been activated. Please note that the parking brake can also be activated with the ignition switched off. However, it can only be released with the ignition switched on.



Functions:
The electromechanical parking brake provides the following functions:

- Parking brake
- Dynamic emergency brake function
- Adaptive hill-start assistant
- Brake pad wear control

1. The parking brake
When the vehicle is parked and the parking brake is activated, the system automatically activates the required clamping force in order to stop the vehicle rolling away unintentionally. When parking the vehicle at an inclination of more than 30%, the instrument panel emits a warning. As the brake discs cool down when the vehicle is at a standstill, the control unit automatically re-tensions the brake. This occurs via a simulation model in the control unit, which determines the current brake disc temperature.

2. The dynamic emergency brake function
This function is activated by pressing the switch. In this context, the function of the switch corresponds to that of a normal hand-brake lever. The vehicle is braked for as long as the switch is pressed. The braking action is interrupted as soon as the switch is released. The maximum deceleration is 8 m/s. The parking brake only brakes the vehicle at speeds of less than 8 km/h. At higher speeds the braking is provided by the ESP system, which distributes the brake pressure to all four wheel brakes.

At the same time, the engine torque is reduced if the accelerator pedal is pressed. If the cruise control system is activated, it is turned off. In order to avoid operating errors (function triggered by passenger), the emergency braking is deactivated if the driver accelerates again.

3. The adaptive hill-start assistant
When the vehicle is on an incline, this function enables the driver to move off without jolts and without rolling back. In order to optimally use the hill-start assistant, the control unit requires additional information. As a result, information on the engaged drive position, the accelerator pedal position, and the engine torque, as well as the tilt angle sensor integrated into the control unit, is taken into account via the CAN bus. The parking brake is released depending on this information. It is not possible for the driver to switch off this function.

4. The brake pad wear control
The pad thickness is checked at intervals of around 500 km. For this, the vehicle must be at a standstill, the parking brake must be released, and the ignition must be switched off. The control unit moves the brake pad from the final position (zero position) against the brake disc. Based on the value measured by the Hall generator, the control unit calculates the distance covered by the brake pad and, in turn, the pad thickness. On vehicles where the parking brake is only used rarely, the brake pad wear control may be more precise than on vehicles where the parking brake is used regularly.

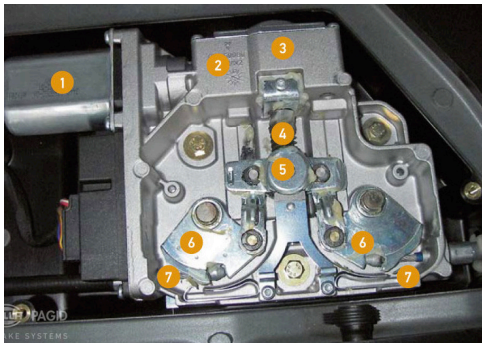
3. DESIGN FOR BMW

The parking brake mechanism on the BMW 7 Series does not act on the rear brake pads directly as is the case for Audi. Instead, it acts on the duo-servo drum brake. This is located inside the rear brake discs. The actuation unit can be found in the trunk floor, between the recess for the spare wheel and the rear wall, behind the rear seat bench.

The actuation unit comprises the following components:
The electric motor, a spindle, the wrap spring, the balance beam, the cable deflection pulleys, the plastic gear wheels, and the cables.

When the parking brake is activated, the electric motor drives the spindle via the plastic gear wheels. As a result of the thread on the spindle, the balance beam – which is used for left/right compensation – is moved forward and back on the spindle depending on whether the brake needs to be applied or released. The pulleys are fastened to the balance beam by connection levers. The cables for the left and right sides are mounted in the pulleys. When applying the parking brake, the balance beam moves on the spindle and the pulleys rotate inward and operate the cables, which then apply the duo-servo drum brake.

When the parking brake is released, the electric motor turns the spindle in the other direction. The balance beam is moved back and the pulleys rotate outward. The cables are pulled back and the parking brake is released. The restoring force is provided by the return springs in the duo-servo drum brake.



A wrap spring is installed to ensure that the entire holding force of the parking brake (when applied) is not exerted entirely on the plastic gear wheels. The wrap spring is attached to the spindle. If the parking brake has been applied and the spindle has reached the holding position, the restoring force attempts to turn the spindle in the opposite direction. Due to this rotation in the opposite direction, the first windings of the wrap spring are pressed outward against the surrounding housing. This holds the spindle in position and the restoring forces are absorbed by the wrap spring. When the parking brake is released, the spindle is driven by the electric motor and takes the opposite end of the wrap spring with it. As a result, the spring is turned inward and released from the housing.

To prevent corrosion at the brake drums and pads and ensure an optimal braking effect is achieved at all times, the system initiates braking while the vehicle is being driven. This braking routine takes place around once a month or every 1000 km. The system carries out the braking routine automatically, and it goes unnoticed by the driver. During the braking routine, the parking brake is applied with around 20% of the maximum positioning force. The wear caused by this braking routine is extremely low – during around 300 braking routines, a maximum of 0.5 mm is removed from the brake pads.

The BMW 7 Series also comes with additional functions that assist the driver in certain situations.

This includes:

- The hill-hold function, which helps the driver to move off when the vehicle is on an incline. The vehicle parking brake is applied and released to stop the vehicle rolling back on the incline.
- The auto-stop function, which applies the vehicle parking brake when it is stationary at traffic lights, to stop the vehicle creeping forward when idling, for example. This relieves the burden on the driver as they do not always need to press the foot brake.

The difference to Audi is that these functions are carried out by the DSC (Dynamic Stability Control). The electromechanical parking brake is only active when the engine is switched off.

4. THE EMERGENCY RELEASE: PRACTICAL TIPS

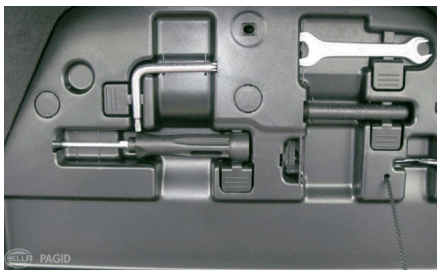
Both vehicles have an emergency release enabling the driver or the workshop to unlock the brake in the case of system failure.

In Audi vehicles, a special Torx wrench is included for this in the on-board toolkit. In an emergency, remove the wheel. You can use one side of the Torx wrench to unscrew the electric motor, together with the wobble plate gear, from the brake caliper. The other side can then be used to turn the spindle back.

BMW vehicles also come with an unlocking rod in the on-board toolkit. This needs to be guided through a guide tube, to a gear wheel, into the actuator. To release the brake, turn the unlocking rod counter-clockwise with the aid of an open-end wrench and the screwdriver handle.

Important:
If there is no power supply (because the battery is flat), it may not be possible to move the vehicle even though the brake is released. If this occurs, the parking brake of the automatic transmission is still engaged. It can also be released using an emergency release. For this purpose, open the cover of the emergency release in the left-hand footwell. Pull on the red strap – a lever folds out and locks. The parking brake is now unlocked.

To put the electromechanical parking brake back into service after having used the emergency release, proceed as follows:
The vehicle should be at a standstill and the ignition must be switched on. Press the switch for the electromechanical parking brake three times at intervals of approx. 5 seconds. The system starts the initialisation procedure. The release position is initialised. Then the brake is applied and the brake position is initialised. The indicator lamp in the display lights up red. The brake is then released and is ready for operation again. The indicator lamp in the display goes out.



5. MAINTENANCE AND REPAIRS: WORKSHOP TIP

To replace the rear brake pads on the Audi A8, a suitable diagnostic unit is required. Before the brake pads can be removed, the cylinder needs to be completely moved back with the diagnostic unit using the “basic setting” function.

Only then is it possible to press the brake piston back. After replacing the brake pads, move the cylinder to the brake piston using the “basic setting” function again. Using the “adjustment” function, enter the thickness of the new brake pads as the final step.

On BMW vehicles, it is possible to replace the brake shoes without using a diagnostic unit.

IMPORTANT
Please note that, after replacing the brake shoes or the rear brake discs, the basic setting must be carried out. For this purpose, unscrew a wheel bolt on each side. Turn the right wheel such that the wheel bolt thread is at the “7 o’clock position” and the left wheel is at the “5 o’clock position”.

Using a suitable screwdriver, turn the adjusting screw through the bore hole until it is no longer possible to turn the wheel. Then release the adjusting screw by 10 detents. Repeat the procedure on the other side. Screw the wheel bolts back in and tighten them to the prescribed torque.

6. CHECKING THE FUNCTION ON THE BRAKE TEST STAND: CHECKING

In order to check the braking effect of the electromechanical parking brake, it must be possible to test it on a brake test stand.

CAUTION!
In the process, the vehicle can jump out of the test rollers.

The Audi A8 independently recognizes this test. As soon as the rear wheels are turning on the test stand at a constant speed of 3 - 9 km/h, the control unit detects the test mode after 3 seconds. In this regard, it is important that terminal 15 (the ignition) is switched on. The control unit changes the closing behaviour of the parking brake in that each time the switch is pressed, the piston is moved out a little further and the brake closes a little more.

On the BMW 7 Series, it is only possible to test the parking brake when the engine is not running and the ignition is switched on. When you press the switch, the parking brake closes relatively quickly and cannot be applied slowly and continuously as is the case for a manually operat-

7. FAULT IN THE ELECTRIC PARKING BRAKE: TROUBLESHOOTING

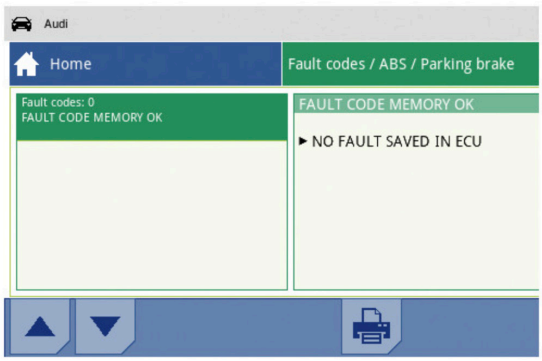
If faults occur in the electromechanical parking brake, the first step must always be to test the brake on the brake test stand. On the test stand you can find out whether the braking function is merely restricted or not provided at all. If the tests on the test stand reveal that the brake is not working properly, conduct a visual inspection.

In the process, pay particular attention to the brake pads/brake shoes, the brake cables (BMW), and any leaks (Audi). If the brake pads/brake shoes are OK and no leaks or damage to the brake cables can be identified, check the mechanics next.

If you press the parking brake switch when the vehicle is stationary and the engine is not running, the closing process is audible. On BMW vehicles, it is possible to observe the closing process after opening the actuation unit. If the visual inspection and check of the mechanics have not revealed any faults, or if the actuation unit/the actuator motors are not actuated, a suitable diagnostic unit is required to conduct further tests.

As is the case for many other electrical systems, the diagnostic unit can be used to read out the fault memory. Depending on the diagnostic unit being used, the function/switched state of individual components can be depicted using measured value blocks (actual values), or the actuator diagnostics can be used to actuate the components and check that they are working.

If repair work is being carried out, always observe the repair instructions, test values, and tightening torques specific to the vehicle manufacturer. Once repair work is complete, clear the fault memory and check the function on the brake test stand.



IPORTANT NOTE
The function of the electromechanical parking brake can only be checked on a roller test bench. A plate test bench is unsuitable for this task.