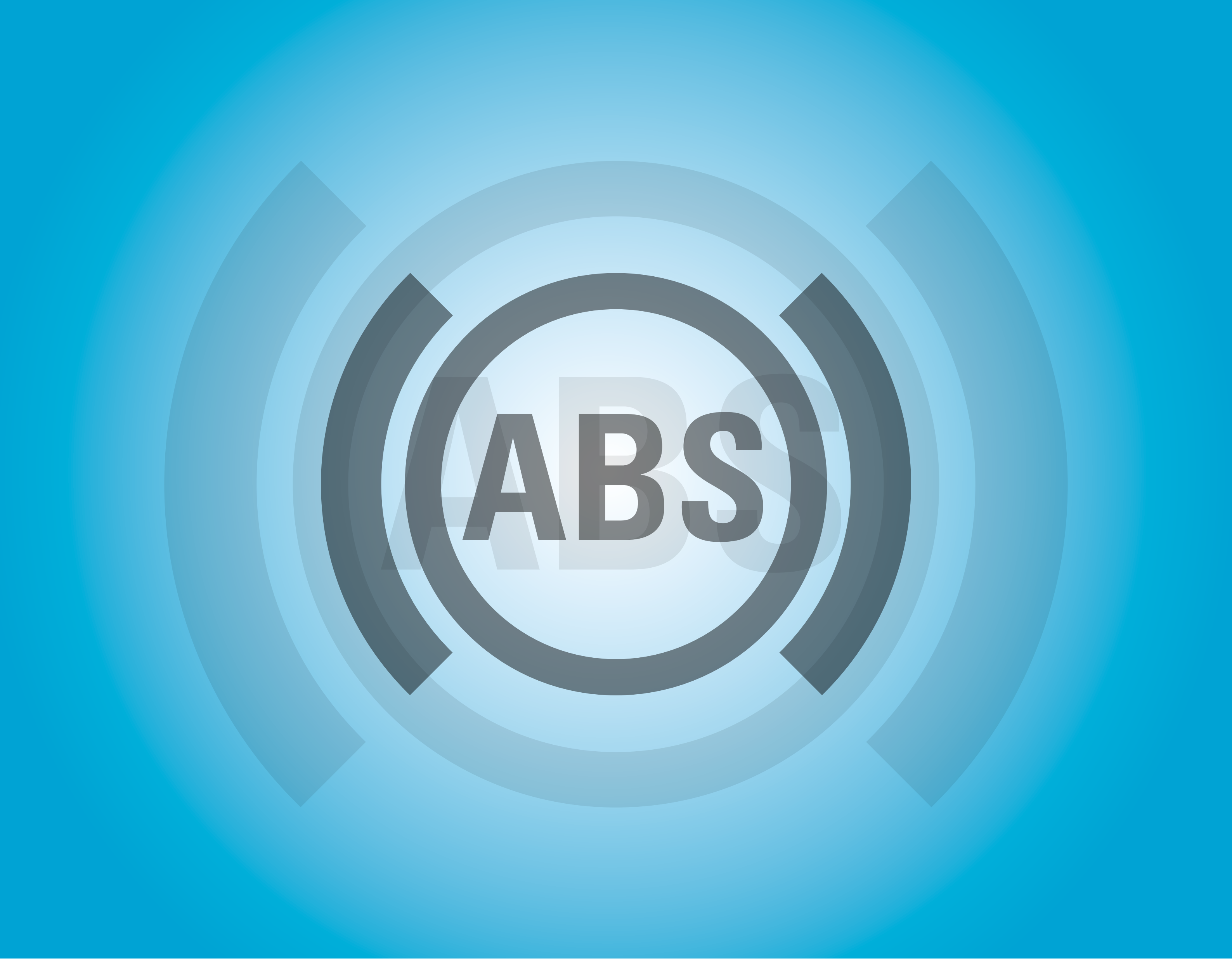
HELLA PAGID

BRAKE SYSTEMS

BRAKE DISCS AND WHEEL SPEED SENSORS IN ABS SYSTEMS

www.hella-pagid.com



The advent of the anti-lock braking system (ABS) made it possible to improve safety during critical braking situations. Different road conditions (wet and slippery roads, for example) or suddenly appearing obstacles caused the wheels of vehicles without ABS to lock up and skid during emergency braking. This, in turn, makes it impossible for the driver to continue steering the vehicle. Vehicles equipped with ABS, on the other hand, do not lock up their wheels and the vehicle remains steerable even during emergency or critical braking.

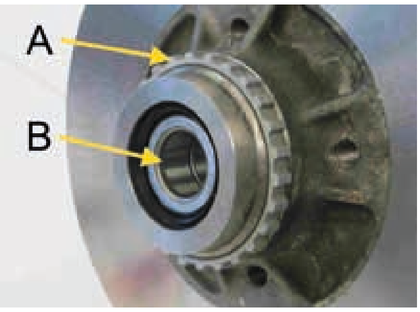
The information about the wheel speed is received by the control unit from the wheel speed sensors. Based on this information, the brake slip and wheel deceleration or wheel acceleration can be derived. "Wheel speed" signals are prepared by the impulse ring mounted on the brake disc or drive shaft and the corresponding wheel speed sensor. Later on in this brochure, we will go into greater detail on the brake disc, impulse ring and wheel speed sensor components.

BRAKE DISCS WITH IMPULSE RING

Different variants can be installed due to the wide range of axle designs from vehicle manufacturers. Depending on the model of the ABS braking system, the design of the brake disc and the type of pulse wheel can vary.

Variants

Brake disc without wheel bearing but with permanently fixed impulse ring and vertically positioned toothed segments (A).



Brake disc with wheel bearing (B) and with permanently fixed impulse ring and horizontally positioned toothed segments (A).

Brake disc with wheel bearing and multipole ring (C).

A multipole ring can also be used as a pulse wheel (encoder wheel) that is integrated separately or simultaneously into the sealing ring of the wheel bearing. Magnets with changing polarity are inserted in this sealing ring.

Purpose of the impulse ring

The impulse ring attached to the brake disc serves as a signalling device for the wheel speed sensor. The sensors are positioned over the impulse wheel. The rotation of the impulse wheel and the resulting switching from tooth to tooth space brings about a change in the magnetic flow. Such a varying magnetic field is then forwarded to the control unit as a signal via the wheel speed sensor. The frequency and amplitude of this signal are in relation to the wheel speed.

Purpose of the wheel bearing

The wheel bearing is a constituent part of the chassis. Its function is to guide and support the axles and the shafts. The bearings also simultaneously bear the axial and radial forces exerted upon it. The radial forces brought about by the rotary movement have an effect on the bearing at right angles to the longitudinal axis. Axial forces, in contrast, have an effect on the wheel bearing towards the longitudinal axis, for example, when bends are being taken. In this situation, a very high level of strain is placed on the wheel bearing.

Notes on carrying out brake repair work

When preparing to carry out brake repairs, it is always important to check the construction of the wheel brake as there are so many different models on the market. Wheel bearings and impulse rings are not always integral parts of the brake disc or they are not always included in the purchased parts package. In such a case, the necessary parts can be taken from the old brake disc and reworked on the new one. Or, if required, such components can be ordered and then used as replacements.

CAUSES OF FAILURE

In addition to the typical damage patterns for brake discs, such as wear and radial runout, the following damage patterns must also be taken into account for wheel bearings and impulse rings.

Causes of failure and effects for impulse rings

The following are signs that damage has occurred:
- → The ABS warning light illuminates
- → Error code is stored
- → ABS system is inoperative

Cause:
Contamination by environmental influences (e.g. water, salt and dirt)
Effect:
Rust accumulation on the surfaces of the toothed segments can damage the ring gear, thus leading to incorrect speed information from the wheel speed sensor.

Cause:
Incorrect installation due to improper use of tools (hammer, screwdriver, etc.)
Effect:
Incorrectly applied installation forces can damage the bearing or impulse ring

Cause:
Excessive use of lubricants
Effect:
Too much lubricant leads to an accumulation of dirt and abrasion

Cause:
Use of metallic-based lubricants (e.g. copper paste)
Effect:
The metallic particles contained can chemically react with water and salt, thereby increasing oxidation levels and causing sensor failure and system malfunctions.

Installation instructions

Such brake disc models require a great deal of extra care and precision when repairs are being carried out by the mechanic. Any incorrect installation can lead to damage being caused to the bearing and impulse ring.

Installation errors influence the length of a wheel bearing's service life or they can cause malfunction of the anti-lock braking system. Therefore, the installation instructions of the brake manufacturer and those of the vehicle manufacturer always have to be observed in each individual case.

Causes of failure and effects for wheel bearings

The following are signs that damage has occurred:
→ Droning or grinding running noises
→ Axial clearance of the wheel

Cause:
Tightening torque of hub nut too low
Effect:
The axial clearance of the wheel bearings is excessive and causes bearing damage

Cause:
Tightening torque too high
Effect:
The wheel bearing becomes twisted or deformed/distorted. This, in turn, increases temperature levels to the point that the bearing surfaces start to run in. The grease can also lose its lubricative properties.

WHEEL SPEED SENSORS

Wheel speed sensors can be designed as active or passive sensors, depending on how they operate.
A clear and precise way of distinguishing or categorising them has not been defined.

The following strategy has therefore proven useful in day-to-day garage activities:

→ If a sensor is only "activated" when a supply voltage is applied and then generates an output signal, this is an "active" sensor.
→ If a sensor operates without additional supply voltage applied, this is a "passive" sensor.

INDUCTIVE-PASSIVE SENSORS

Signal processing

The wheel speed sensors are positioned directly above the impulse wheel, which is connected to the wheel hub or drive shaft. The pole pin, surrounded by a winding, connects to a permanent magnet whose magnetic effect extends to the pole wheel. The rotation of the impulse wheel and the resulting switching from tooth to tooth space brings about a change in the magnetic flow caused by the pole pin and winding. This changing magnetic field induces a quantifiable, or measurable alternating voltage in the winding (Figure 1).

The frequency and amplitudes of this alternating voltage are in relation to the wheel speed. Inductive-passive sensors do not require a separate power supply from the control unit. Since the signal range for signal detection is defined by the control unit, the amplitude level must be within a specific voltage range. Gap (A) between sensor and impulse wheel is provided by way of the axle design (Figure 2).

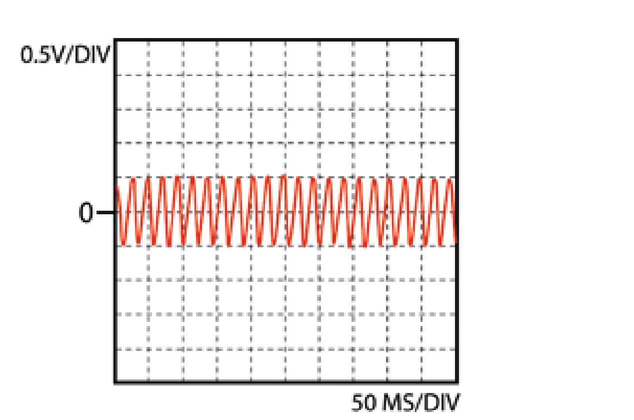


Figure 1

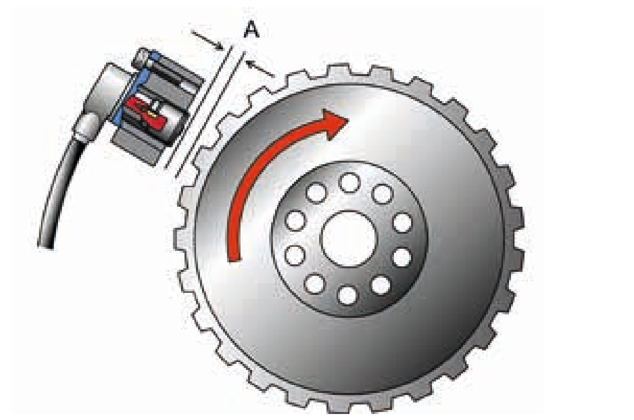


Figure 2

ACTIVE SENSORS

How it works

The active sensor is a proximity sensor with integrated electronics that is supplied with a defined voltage from the ABS control unit. A multipole ring can be used as an impulse wheel while at the same time being integrated in a sealing ring of a wheel bearing. Inserted in this sealing ring are magnets with alternating pole directions (Figure 1). The magneto-resistive resistors integrated in the electronic circuit of the sensor detect an alternating magnetic field when the multipole ring rotates. This sinusoidal signal is converted by the electronics in the sensor into a digital signal (Figure 2). The signal is transmitted to the control unit as a current signal in pulse width-modulated fashion.

The sensor is connected to the control unit via a two-pole electric connecting cable. The sensor signal is also transmitted at the same time over a power supply line. The other line is used as a sensor ground.

In addition to magneto-resistive sensor elements, Hall sensor elements are also fitted that permit a larger air gap and respond to the smallest of changes in the magnetic field. If a steel impulse wheel is installed in a vehicle in place of a multipole ring, a magnet is also affixed to the sensor element. When the impulse wheel turns, the constant magnetic field in the sensor changes. The signal processing and IC are identical to the magneto-resistive sensor.

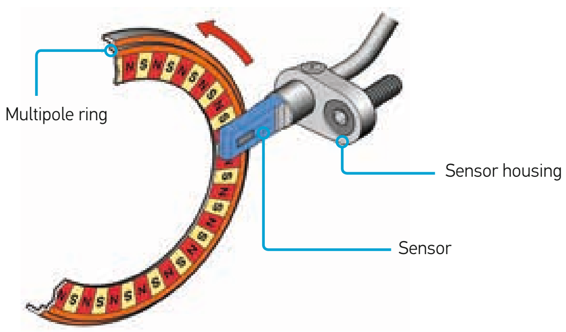


Figure 1

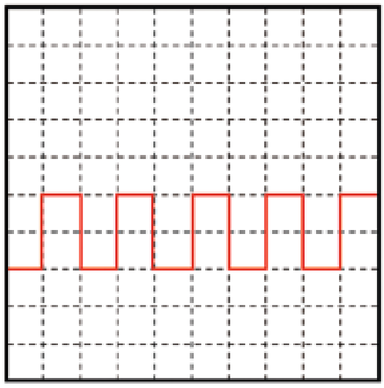


Figure 2

Advantages of active sensors:

- → Wheel speed detection from standstill. This facilitates speed measurements down to 0.1 km/h, which is relevant to acceleration skid control systems (ASRs) as soon as the vehicle accelerates from a stop.
- → The Hall sensors detect forwards and backwards movements.
- → The sensor is smaller and lighter in design.
- → The lack of impulse wheels simplifies the power transfer linkage.
- → Sensitivity to electromagnetic interference is less pronounced.
- → Changes in the air gap between the sensor and magnetic ring have no direct impact on the signal.
- → Virtual insensitivity to vibrations and fluctuations in temperature.

Effects of ballast failure

The following system characteristics can be recognised when wheel speed sensors fail:

- → The ABS warning light illuminates
- → Error code is stored
- → The wheels locks during braking
- → Incorrect or pseudo regulation interventions
- → Failure of further systems

Causes of failure

- → Breaks in wiring
- → Internal short-circuits
- → External damage
- → Heavy contamination
- → Increased wheel bearing clearance
- → Mechanical damage to the encoder wheel

Check sensor installation point and impulse ring

TESTING OPTIONS

Generally speaking, a malfunction of the ABS/ASR/ESP braking system occurs before the wheel speed sensors are tested.

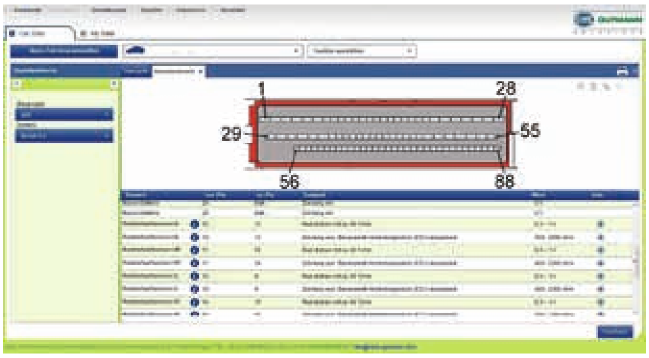
After the warning light illuminates, the following options are available for troubleshooting and diagnosis:
- → Readout the stored fault code
- → Check the supply voltages and signals using a multimeter and oscilloscope
- → Visually inspect the wiring and mechanical assemblies

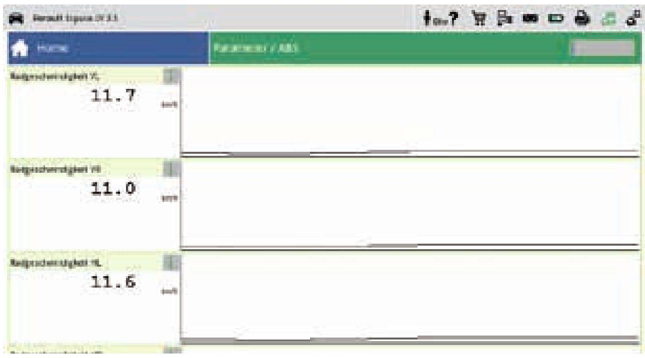
Diagnostic tool
- → Read out fault memory
- → Evaluate parameters
- → Compare and evaluate signals from individual wheel speed sensors

Multimeter
- → Voltmeter
- → Check voltage supply

Ohmmeter
- → Check internal resistance
- → The internal resistance cannot be measured if the sensors are active

Oscilloscope
- → Display/depict signal
- → Evaluate signal path

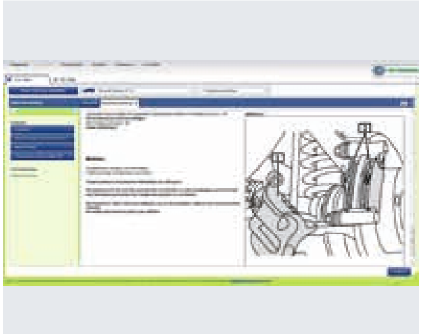




Note:

Troubleshooting wheel speed sensors can be difficult when it comes to differentiating between active and passive sensors as these sensors cannot always be easily distinguished by appearance. Here, specific manufacturers' specifications and the specifications of the respective vehicle manufacturer must be consulted. Due to their advantageous technical characteristics such as accuracy and low structural size, vehicle manufacturers have mainly installed active wheel sensors since 1998.

Requirements for a reliable diagnosis:



- → Proper documentation in the form of technical data
- → A suitable diagnostic unit, multimeter or oscilloscope
- → Sufficient technical know-how of the technician and targeted employee training

When diagnosing complex systems, the best technology alone cannot help repair the vehicle. Only well-trained personnel can prevent the random replacement of system components, avoid malfunctions in garage processes and strengthen the trusting relationship with the customer.

Observe the following general repair notes:

Repair work to brake systems may only be carried out by qualified specialists.

When carrying out any repairs on the brake system, you must follow the maintenance and safety instructions of the vehicle manufacturer and the product-specific assembly instructions

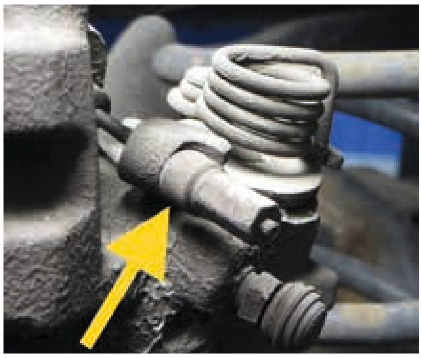
- → Brake discs must always be replaced in pairs.
- → Always replace brake discs together with new brake pads.
- → Observe the respective tightening torques.

PRACTICAL EXAMPLE IN DAY-TO-DAY GARAGE WORK

Brake discs with integrated wheel bearing and ABS impulse ring (magnetic coder)
Later on, we will explain how to replace brake discs with integrated wheel bearings and the ABS impulse ring on the rear axle. The repair procedure will be explained using a Renault Espace IV fitted with an electric parking brake. The schematic illustrations, pictures and descriptions are for explanation of the document text only and cannot be used as the basis for carrying out the installation and repair.

Prepare vehicle for repair
- → Drive vehicle onto lifting platform
- → Remove rear wheels
- → Carry out a visual inspection
- → Before carrying out the repair, check all relevant components near the axle and wheel brake such as the tyres, transverse control arms and brake hoses for damage
- → Read out the fault memory of the electric parking brake

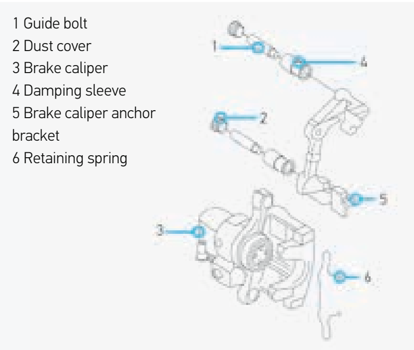
Deactivate the electric parking brake
Carry out the following steps for deactivation or emergency release:
- → Switch on the ignition
- → Put automatic transmission in "P" position
- → Release parking brake
- → To do this, press release button and actuate release pushbutton switch
- → Switch off ignition and withdraw Renault chip card
- → Open centre flap between the front seats
- → Forcefully pull emergency release (yellow lever)
- → Slackening of the cables produces an audible sound



- → Unhook control cables at the brake calipers
- → Avoid placing mechanical loads on the cables by the tools

Vehicle-specific repair notes

- The vehicle is equipped with an electric parking brake
- Before the repair work is carried out, this brake must be deactivated
- Brake discs may not be reworked
- If they show signs of heavy wear or grooves, they must be replaced



Remove brake discs

- Remove retaining spring of brake caliper
- Remove protective plugs from guide bolts
- Inspect protective plugs and damping sleeves for damage
- Undo and remove guide bolts (fixing screws)
- Remove brake caliper from brake anchor plate and hang on spring using suitable hook
- Avoid twisting the brake hose
- Remove brake pads
- Slacken and unscrew the fixing screws of the caliper anchor bracket
- Remove brake caliper anchor bracket
- Remove wheel hub cap
- Slacken and unscrew hub nut
- Remove brake disc with wheel hub.

NOTE
To avoid damage, do not leave the brake caliper hanging from the brake hose!

Cleaning and inspecting

Clean and inspect the following components for damage prior to installation

- Brake caliper anchor bracket:
  Remove any corrosion from the contact surfaces of the linings using a wire brush
- Brake caliper:
  Check the dust protection boot of the piston for damage
- Clean the guide bolt and check for damage:
  Then apply a thin coat of silicone-based grease to the contact surfaces
- ABS sensor:
  Check for correct seating and for signs of damage
- Axle journals should generally be free of burrs, flat and rust-free:
  After cleaning, coat the axle journal with a little calibrating oil and spread evenly using a clean cloth

NOTE
Only clean using brake cleaner, a brush and a lint-free cloth. It is essential to avoid mechanical damage to the guide surfaces.

Preparing for installation:

- Compare new brake disc to the one that has been removed
- Check the ABS impulse ring (magnetic coder) installed on the brake disc prior to installation
- Clean brake disc with brake cleaner if necessary
- Check level of brake fluid in expansion tank
- If at the MAX. mark, unscrew cover from brake fluid tank and extract a little fluid.

INSTALLING THE BRAKE DISC:

- → Position brake disc with integrated wheel bearing centrally on the axle journal and slide on
- → Loosen hub nut and tighten to specified torque
- → Fit hub cap
- → Install brake caliper anchor bracket
- → Tighten fixing screws to specified torque
- → Push brake piston right back using reset tool
- → At the same time, turn the piston to the right
- → Please note the brake fluid level in the expansion tank

Insert the piston-side inner brake pad with spring

- → When doing so, note that all three brackets of the retaining spring are inserted into the piston groove
- → Fit external brake pad
- → Position and mount brake caliper
- → Screw in guide bolt and tighten with specified torque
- → Clean the sliding surfaces of the bolts and apply a thin coat of silicone-based grease
- → Place dust covers onto the damping sleeves
- → Insert brake caliper retaining spring
- → Check clamping force of retaining spring and replace if necessary
- → Hook in hand-brake cables
- → Ensure that the cables are correctly positioned and engaged
- → Depress the brake pedal several times to move the brake pads to the required working position

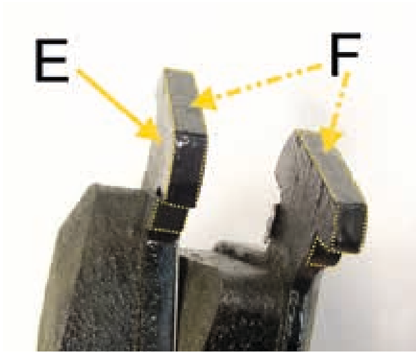
- → Check the brake fluid level in the expansion tank and fill up to the "MAX" mark if necessary
- → Replace brake fluid if necessary
- → Activate parking brake
- → Actuate parking brake several times (pull up, release)
- → When the parking brake is released and the lever is pulled up again, there must be a play, or clearance of 1 to 2 mm at the end of the cable by the brake caliper.

Additional information on tightening torque

Sample vehicle: Renault Espace IV
Tightening torque at the wheel brake for the rear axle
- → Bolt on brake anchor plate (105 Nm)
- → Brake caliper guide bolt (28 Nm)
- → Wheel bolt (130 Nm)
- → Fastening nut on wheel hub (280 Nm)

- → Carry out subsequent check with diagnostic unit
- → Read out fault memory and delete if necessary
- → Mount wheels
- → Before mounting the wheel, clean the contact surfaces of the rims

- → Carry out a functional check and take a test drive
- → Run in brake discs and brake pads
- → Comply with the run-in instructions from the brake pad and vehicle manufacturers
- → Carry out a functional check on the brake test stand



Installation notes on using lubricants
- → Apply a thin coat of non-metallic, long-lasting lubricant to the brake pad contact surfaces (F) at the hammer head (E) and the brake caliper contact surfaces

CAUTION
The dust protection boot of the brake piston and the protective plugs and damping sleeves of the caliper guide must not come into contact with mineral oil-based oils or greases. They could be damaged due to swelling of the elastomers.

HELLA Asia Singapore Pte Ltd
Regional Headquarters Asia Pacific
Independent Aftermarket
2 International Business Park
#02-12 The Strategy
Singapore 609930
Tel: +65 6854 7300
Fax: +65 6854 7302
E-mail: singapore@hella.com
Internet: www.hellaasia.com

HELLA PAGID GmbH
Lüschershofstraße 80
45356 Essen, Germany
www.hella-pagid.com

9Z2 999 138-543   J01007/KB/07.16
Subject to technical and price modifications
Printed in Germany