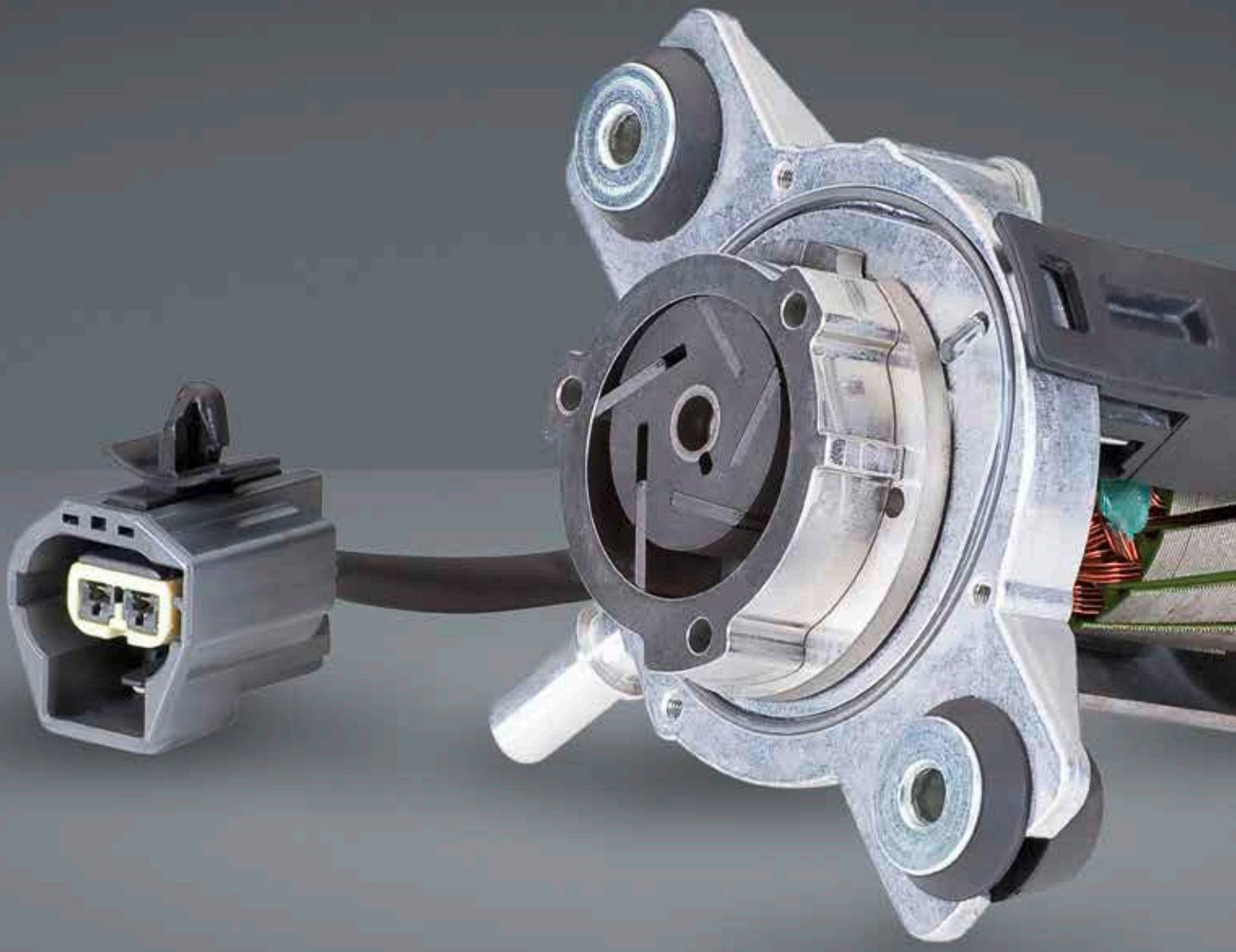
ELECTRIC VACUUM PUMPS



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GENERAL INFORMATION

Because the brake system is one of the most important systems in every vehicle, it is imperative to ensure that a constant and effective brake force is present at all times. The majority of brake boosters uses the vacuum generated by the internal combustion engine's intake section. But under certain operating conditions, for example during the cold start and warm-up phase or when driving at extreme altitudes, the vacuum produced by the engine is no longer sufficient. In such cases, an additional vacuum pump is required in order to generate an alternative or an extra vacuum.

For vehicles whose engine geometry means that they have too little or no vacuum at all to operate the brake system, electric vacuum pumps are used in order to ensure the reliable operation of the brake booster. The electric vacuum pump guarantees that the reliable operation of a brake system functioning with pneumatic brake boost is maintained.

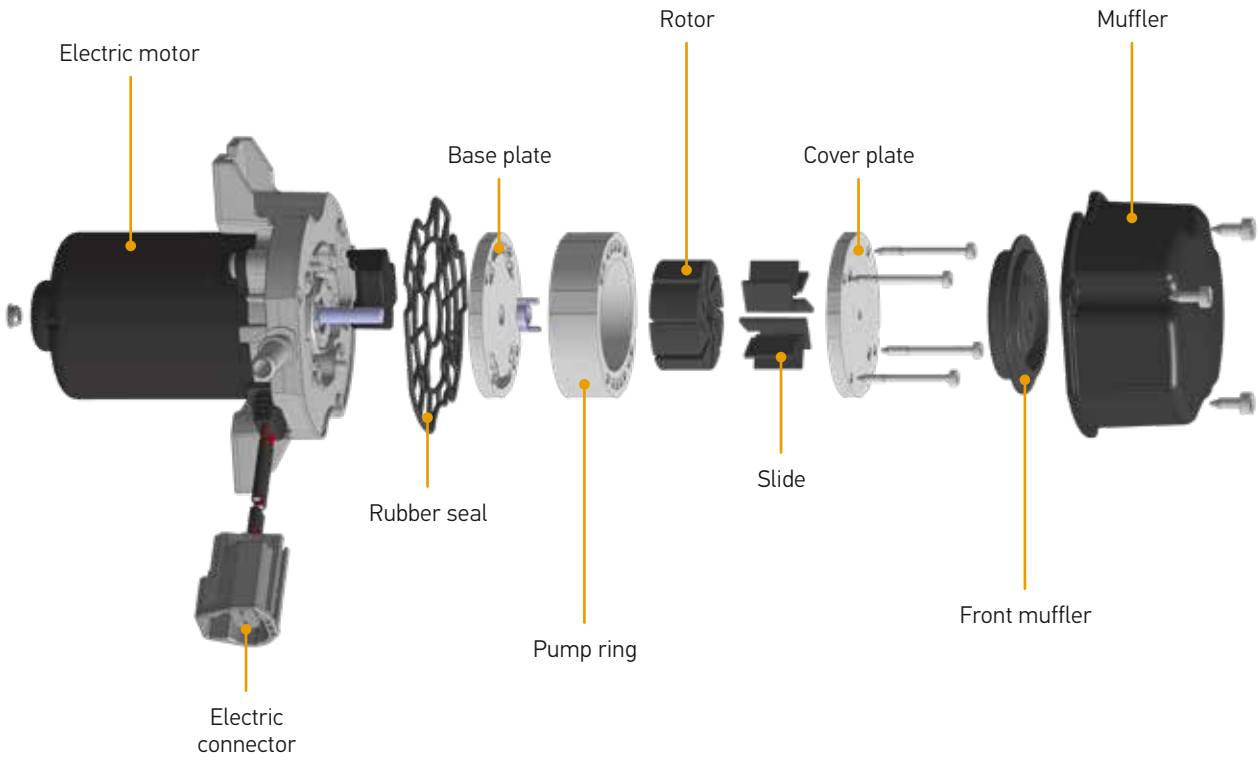
Vacuum pumps can be used in the following engine types

- → Gasoline engine with direct injection
- → Diesel vehicles
- → Hybrid and electric vehicles
- → Fuel cell/electric vehicles
- → Vehicles with or without turbocharger, automatic transmission or STOP-START system.

Advantages of an additional electric vacuum pump

- → Supports all engine types
- → Reduces energy requirements thanks to on-demand pump operation
- → Supports the reduction of CO_2 emissions
- → Functions independently of combustion engine technology
- → Maintenance-free (dry running and self-lubrication require no connection to the oil circuit)
- → Electrically driven vacuum pumps support a flexible vehicle platform concept

DESIGN OF AN ELECTRIC VACUUM PUMP

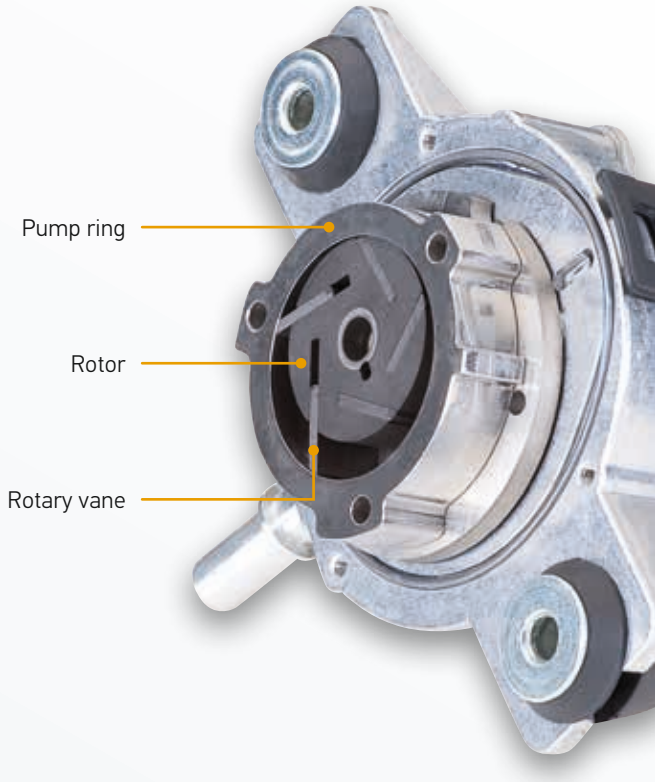


DESIGN AND FUNCTION OF THE ROTARY VANE PUMP

The rotary vane pump, sometimes called a vane pump, is a positive displacement pump, which is designed for suction and pressure tasks. The vacuum pump operates according to the rotary vane compressor principle.

The pump contains a rotor off-centre to the pump chamber. One or several movable slides can be incorporated in this rotor. The electric motor enables the pump shaft and thus the rotor to be rotated. The movable slides are pressed against the inner wall of the pump chamber by means of the centrifugal force and they seal the cells. The result is that the air in the cells, which are formed by the housing wall and by each of the two slides, is displaced from the suction side to the pressure side.

This change in the chamber volume generates a vacuum causing air to be sucked in by the brake booster through the vacuum pump via the pneumatic brake line system.



INSTALLATION POSITION IN THE VEHICLE

The chassis area in the engine compartment is usually the place of installation for the vacuum pump. Depending on the vehicle, the pump can be fixed on the left or on the right next to the engine or on the lower supporting frame (engine mount). For acoustic reasons (transmission of structure-borne noise and vibration), the pumps are secured on a support with appropriate isolating elements (vibration dampers).

PNEUMATIC CONNECTION

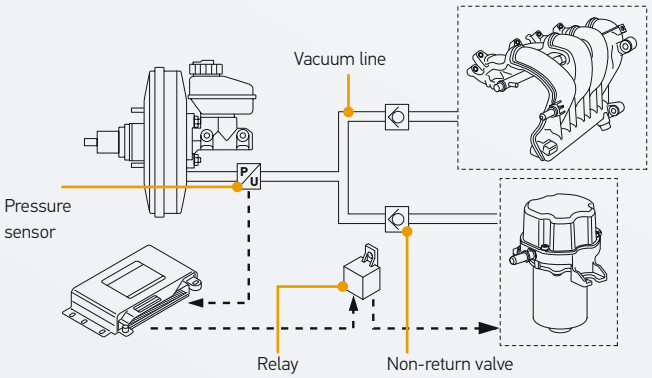
The electric vacuum pump is connected to the flexible pneumatic brake line system via a suction nozzle. The sucked-in air is filtered and moves from the passenger compartment to the vacuum pump via the brake booster and the flexible line system.

The pneumatic lines, valves and the brake booster must be free of particles and all types of contamination which, if drawn in, can lead to pump damage.

CONNECTION VARIANTS / SYSTEM OVERVIEW

Depending on the type of vehicle and on the required use, there are two kinds of vacuum pump variants which can be installed. This is where we differentiate between controlled and regulated electric vacuum pumps.

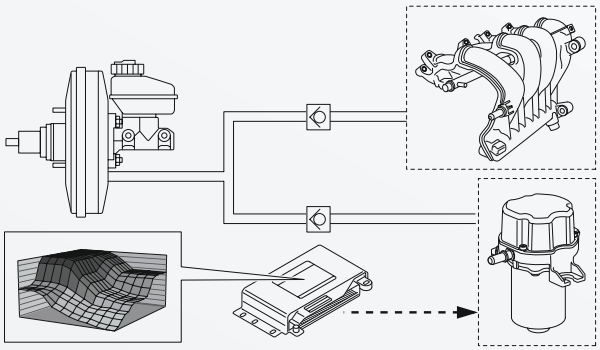
Regulated variant



In the case of the regulated variant, a pressure sensor is installed in the vacuum line to the brake booster. The pressure sensor permanently registers the actual pressure in the system and conveys this value to a higher-level electronic control unit (e. g. an engine control unit).

The control unit compares the sensor data with the set values and regulates, as required, the duty cycle of the vacuum pump. The electric control resulting from the control unit is performed by means of the pump's relay being connected upstream.

Controlled variant



This variant operates without a pressure sensor and is controlled via induction pipe pressure characteristic maps deposited in the engine control unit. Induction pipe pressure is calculated from the input variables, the engine speed, the engine load, the throttle valve position and the stop-lamp switch.
The engine control unit compares the pressure deposited in the characteristic map with the calculated induction pipe pressure for the brake booster and then uses this information in order to control the pump. The switching on and off of the electric vacuum pump is carried out in a defined pressure range which is determined by means of the difference between start-up and shut-down pressure.

Ambient pressure serves as a benchmark for the electronic control unit. Depending on the system, this value can be calculated or determined by means of a pressure sensor installed in the electronic control unit.

EFFECTS AND CAUSES

The following effects can result when failure of an electric vacuum pump occurs

- → Vacuum in the brake booster too small
- → Poor braking function
- → Increased effort needed when brake pedal is activated
- → Fault lamp lights up (system-dependent)

The following causes can be responsible for the failure of the electric vacuum pump

- → Voltage supply faulty
- → External damage
- → Defective electric motor
- → Vacuum lines damaged or contaminated

TESTING AND FAULT DIAGNOSIS

Pressure sensor in the vacuum line on the brake booster

Driver information on the display of the instrument cluster

The diagnostics will now be illustrated by using the example of an Opel Cascada 1.4i 16V Turbo, model year 2013 with a mega macs 77 diagnostic unit. This example, however, also covers vehicle models which are identical in construction. This vehicle with a turbocharger and STOP-START system has a HELLA UP28 vacuum pump with a pressure sensor on the brake booster installed.

The electric vacuum pump, or rather its functioning, is monitored by the relevant higher-level electronic control unit. Any occurring errors are stored in the control unit's error memory and can be read by using a suitable diagnostic unit. Furthermore, the driver is warned about a system error by way of the display on the instrument cluster.

However, before control unit diagnostics are undertaken, it is first of all advisable to carry out a visual check on the individual system components as part of initial troubleshooting activities. In conjunction with this inspection, the pneumatic and electric connections of the vacuum pump and the condition of all other vacuum lines to the brake booster should be checked. In this way some errors can be eliminated during the control unit diagnostics.

A simple functional check of the electric vacuum pump can be performed in the vehicle as follows.

- → Park vehicle in a safe location
- → Put the parking brake on
- → Switch on the ignition. Start the engine and allow it to run in idling mode. The engine temperature should be > 40° Celsius
- → Operate the brake pedal several times in order to reduce the pressure in the brake booster

If everything in the system is in good working order, at the same time it should be possible to hear the vacuum pump temporarily running up in order to increase the required vacuum in the brake booster or alternatively balance it out.

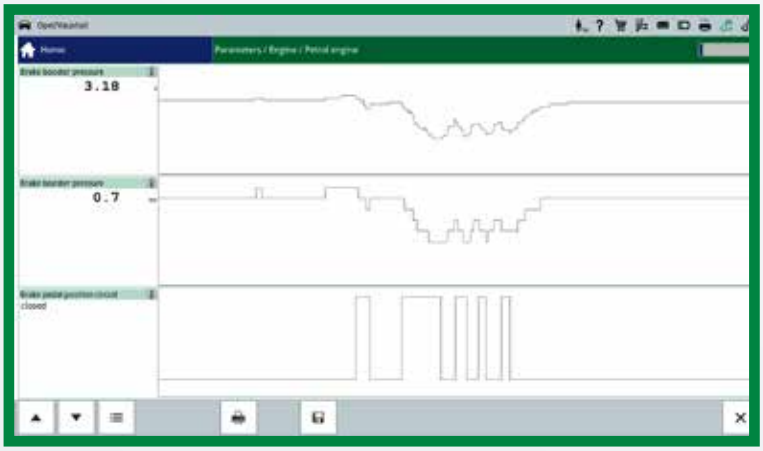
If necessary, another option would be to connect a diagnostic unit so as to show the pressure gradient in the brake booster using the "Parameter" function.

CONTROL UNIT DIAGNOSTICS

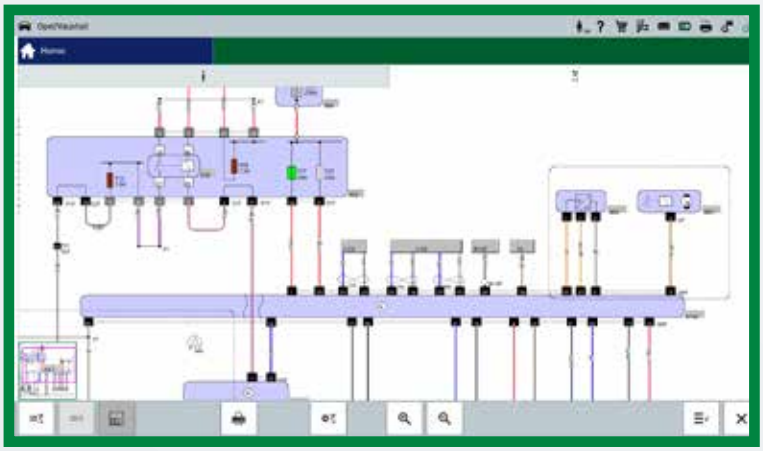
As part of control unit diagnostics, it is possible to employ the help of various functions and vehicle information as and when needed.

Fault code
With this function, the fault codes stored in the error memory can be read.
For all subsequent troubleshooting, general information regarding possible effects and causes is presented in the error code descriptions.

Reading parameters
This function enables current measured values from the electronic control unit, such as brake booster pressure or brake pedal position, to be selected and shown.



Circuit diagrams
System-specific circuit diagrams can be taken from vehicle information and used for troubleshooting purposes. This is where the PIN assignment on the control unit plug or the cable colours can be read and used for further testing on the electric vacuum pump or on the brake booster pressure sensor.



Important!
The actual extent of testing and the variety of functions may differ depending on the vehicle manufacturer and all this depends on the individual system configuration of the control unit.

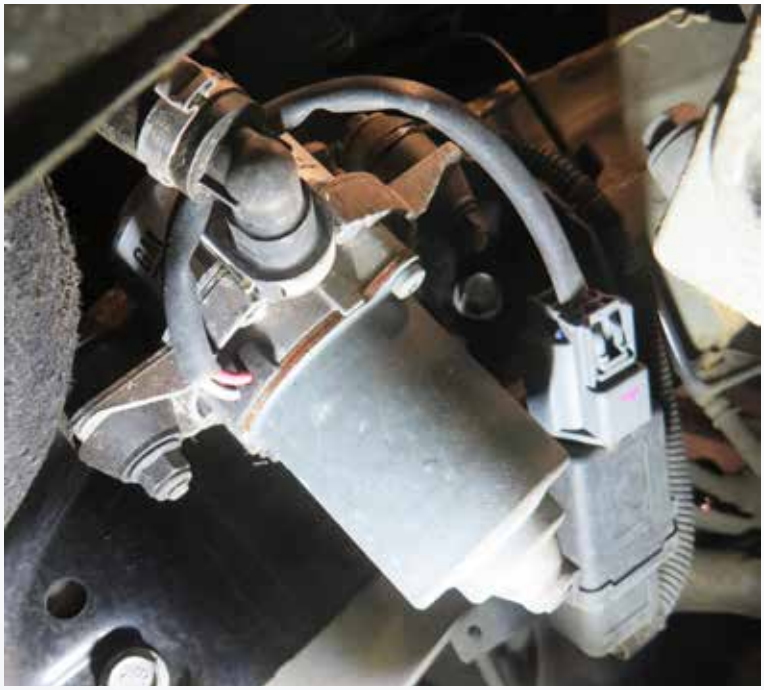
REMOVAL AND INSTALLATION NOTES

Because of the mounting position, removal of the electric vacuum pump is carried out on this vehicle model from the underside and can be completed without the need for any special tools.

Procedure

- → Drive vehicle onto a lifting platform.
- → Switch off engine. Switch off the ignition.
- → Raise vehicle to working height.
- → Disconnect electrical plug connectors and vacuum hose from the pump.
- → Slacken and unscrew the fixing screws of the pump support.
- → Remove the vacuum pump with its support from the vehicle.

Then, if necessary, the vacuum pump can be replaced with a new one. Installation is carried out in the reverse order. Finally the functioning of the electric vacuum pump is to be tested.



REPAIR NOTES

When carrying out repairs on the brake system, please pay careful attention to the following information:

- → The brake system is a safety system.
- → Repair work on brake systems should be carried out exclusively by trained specialists.
- → Repair work that is carried out incorrectly can lead to system failure and to severe personal injuries.
- → For all repair work performed on the brake system, please observe the safety and assembly instructions provided by the system or vehicle manufacturer in question.

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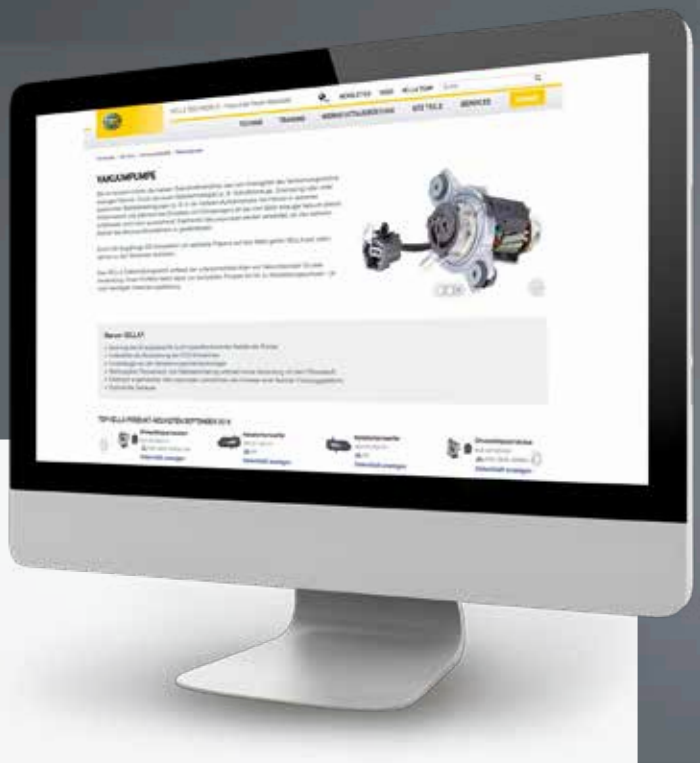

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