Service Training

Self-study Programme 450

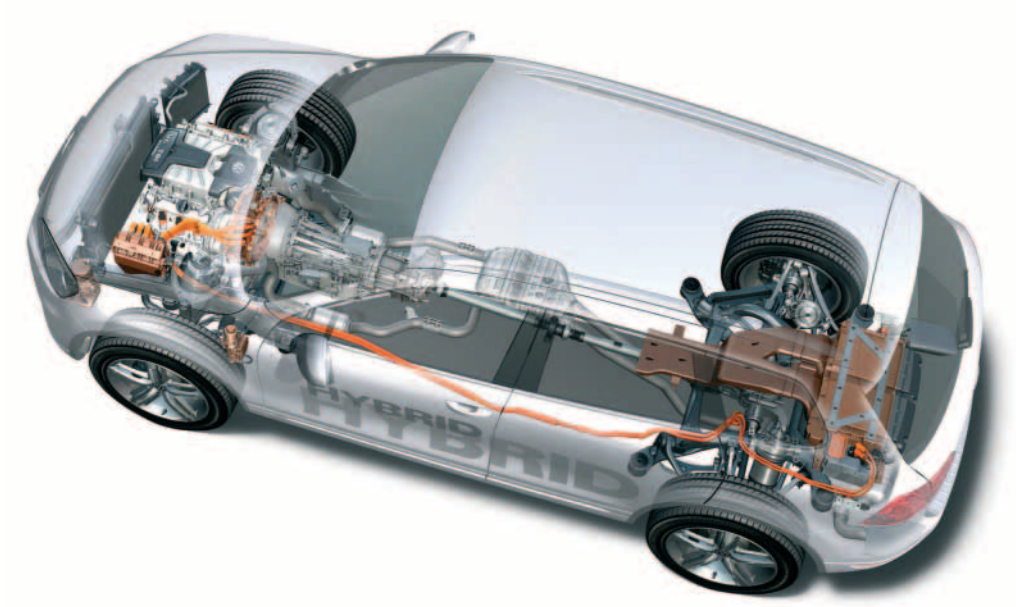
The Touareg Hybrid

Design and Function

For the first time at Volkswagen, an electric hybrid drive, i.e. a combination of a combustion engine and an electric motor, will be available for use in of production in the Touareg 2011.

The Touareg Hybrid is a conventional vehicle concept which has been "hybridised". The hybrid system can be classified as existing, tried-and-tested technology. During vehicle development, focus was placed on employee safety when handling the high-voltage systems.
Numerous shut-off functions and back-up facilities in the hybrid system prevent undesired dangers for workshop employees.

The combination of new high-voltage components and tried-and-tested technology from Volkswagen means that the Touareg Hybrid is leading the way into an increasingly electrified future.



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Urgent warning
Please note that work which is carried out in the vicinity of, or on, the high-voltage components in the hybrid vehicle must only be undertaken by qualified and therefore authorised Volkswagen high-voltage technicians.
Improper handling of the high-voltage systems may lead to life-threatening situations due to an electric shock.

The self-study programme portrays the design and function of new developments!
The contents will not be updated.

For current testing, adjustment and repair instructions, refer to the relevant service literature.

Attention Note

Contents

Introduction

As part of the discussion surrounding CO_2 and the increasing scarcity of fossil fuels, hybrid drives in SUV class vehicles are becoming extremely important in terms of acceptance.

This hybrid technology information deals with the hybridisation of the Touareg's drive train by presenting you with a description of the parallel hybrid drive from the definition of the requirements and concept determination to the portrayal of the hybrid components.

Retention of the driving performance of the conventional drive train in combination with the extensively available technical components from series production was an essential criterion on selection of the parallel hybrid concept.

The standard Touareg's familiar characteristics are retained.
These include
- its gradability,
- its off-road capability,
- its trailed load,
- its high-powered drive and
- occupant comfort.

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The parallel hybrid is a combination of a combustion engine with an electric motor/generator.
In technical circles, this combination is referred to as an "electric hybrid drive".
The following objectives were defined by Volkswagen for the hybrid system in the Touareg.

The values of the Touareg Hybrid

- Integration of the hybrid components without body shell modifications
- Extensive use of standard components
- Extended use of new components within the Touareg platform
- Minimisation of the hybrid-specific production costs

→ These criteria enable a moderate surcharge for the innovative high-voltage technology.

- Maintenance-free hybrid components
- Full hybrid functionality, i.e. implementation of purely electric driving
- Achievement of consumption reduction in conformity with the market
- Same level of comfort as comparable hybrid systems from competitors
- Simultaneous retention of the Touareg's familiar comfort
- Robustness of the hybrid drive
- No reduction in driving performance on- or off-road
- Hybrid-related, integrated start-stop function
- Preference given to electric driving in the event of an adequate operating condition
- Brake energy recovery for charging the high-voltage battery
- Trailed load identical to that of the conventionally driven Touareg
- No limitation of permanent gradability
- Better driving performance in the drive-off range than a conventional drive

→ The combustion engine is only started as required.

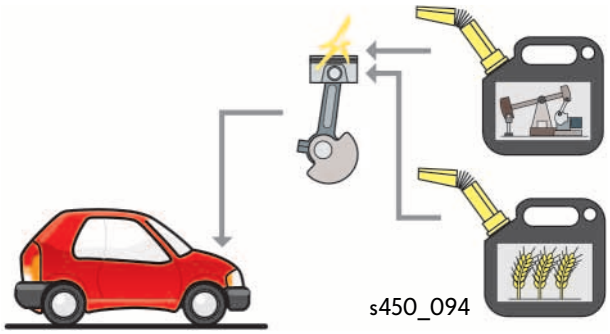
Basics of hybrid technology

What does hybrid technology mean?

The term hybrid is derived from the Latin word "hybrida", and means something crossed or mixed.
In technological terms, hybrid refers to a system in which two different technologies are combined with each other.

In connection with drive concepts, the term hybrid technology is used in two ways:
- The bivalent drive and
- The hybrid drive technology

The bivalent drive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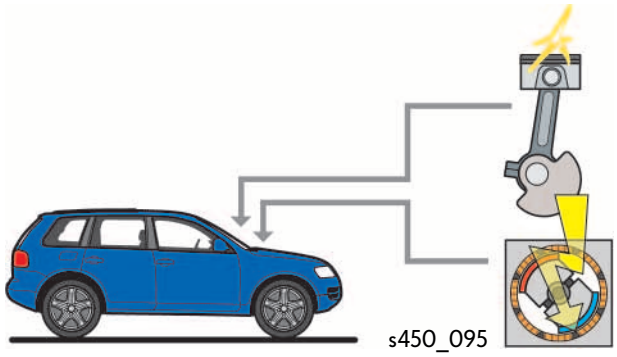
A bivalent drive refers to vehicles in which a combustion engine is able to combust different types of fuel in order to provide drive energy. Systems which use fossil and replenishable fuels (diesel/biodiesel) or liquid and gaseous fuels (petrol/natural gas/LPG), for example, are familiar and are increasingly found on the market.

The hybrid drive technology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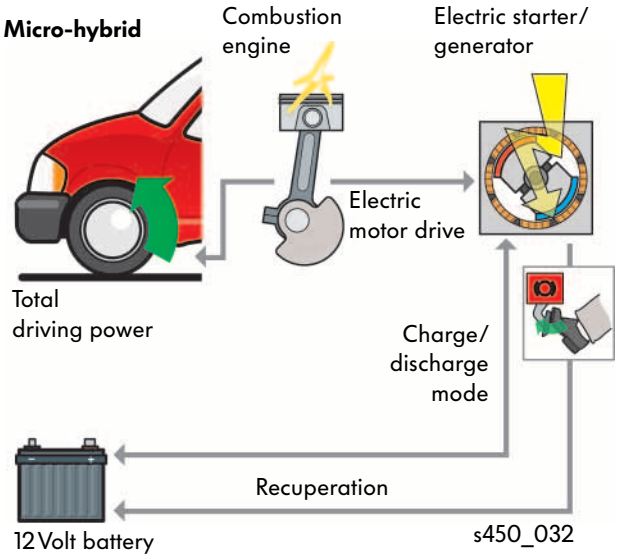
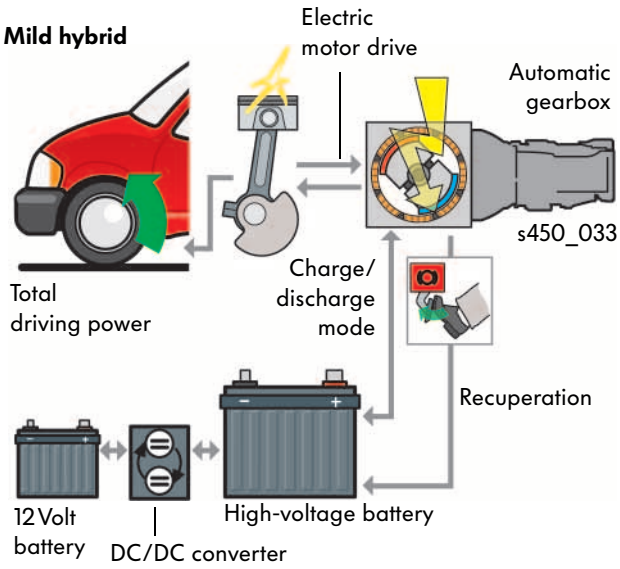
Hybrid drives refer to a combination of two different engines, which operate according to different functional principles. The present understanding of hybrid technology is the combination of a combustion engine and an electric motor/generator. It can be used as a generator for generating electrical energy, as a motor for driving the vehicle and as a starter for the combustion engine. Depending on the direction taken by this basic design, a distinction is made between three types of hybrid drive:
- The micro-hybrid drive,
- The mild hybrid drive,
- The full hybrid drive.



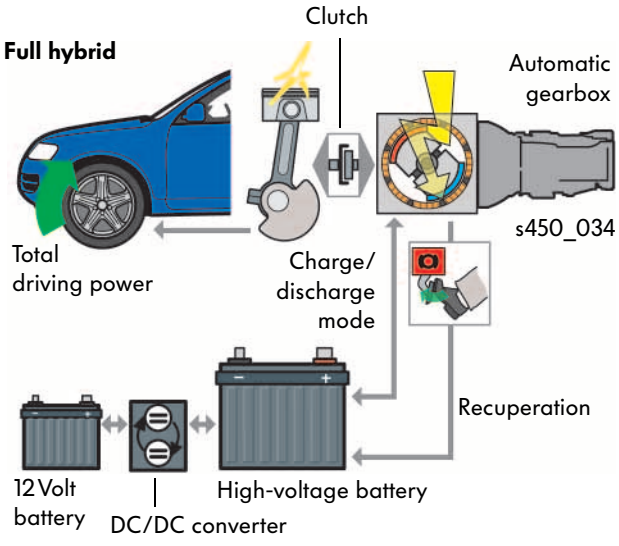
The micro-hybrid drive

In this drive concept, the electric component (electric starter/generator) is merely used to implement a start-stop function. On braking, part of the kinetic energy can be reused as electrical energy (recuperation). Purely electric driving is not intended.
The characteristics of the 12 Volt absorbent mat battery are adapted to the frequent engine starts.



The mild hybrid drive

The electric drive supports the combustion engine. Driving the vehicle purely electrically is not possible. In the mild hybrid drive, a larger part of the kinetic energy is recovered on braking and is stored as electrical energy in the high-voltage battery. The high-voltage battery and the electrical components are designed for a higher voltage and therefore a higher output. Thanks to the support provided by the electric motor, the combustion engine's operating point can be shifted to the optimal efficiency range.
This is referred to as load point shifting.



The full hybrid drive

A higher-performance electric motor/generator is combined with a combustion engine. Purely electric driving is possible. As soon as conditions permit, the electric motor supports the combustion engine. Slow journeys are carried out purely electrically.
A combustion engine start-stop function is implemented. Recuperation is used to charge the high-voltage battery.
The two systems can be decoupled thanks to a clutch between the combustion engine and the electric motor. The combustion engine is only engaged as required.

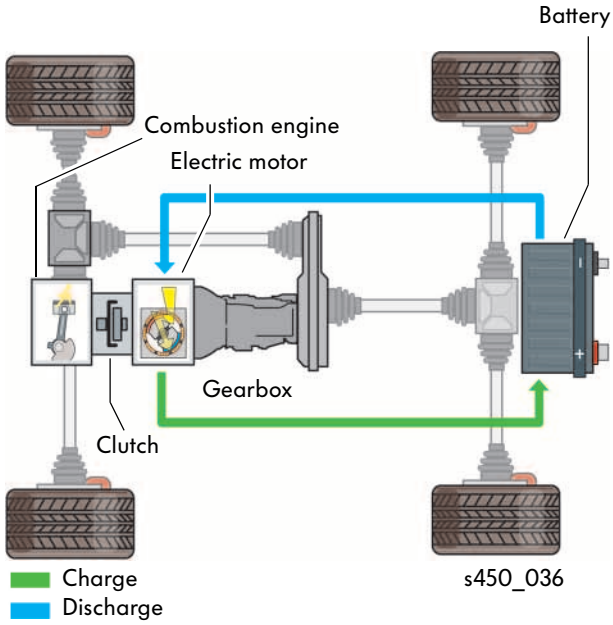
Basics of hybrid technology

The full hybrid drives are sub-divided into three sub-groups:
- Parallel hybrid drives
- Power-split hybrid drives
- Serial hybrid drives

The parallel hybrid drive

The parallel design is characterised by its simplicity. It is used when an existing vehicle is to be "hybridised". The combustion engine, electric motor and gearbox are seated on a single shaft. The parallel hybrid usually has an electric motor. The total of the combustion engine's and the electric motor's individual outputs corresponds to the total output. This concept achieves a high level of carry-over parts from the original vehicle.
In parallel hybrid design in four-wheel drive vehicles, the drive to all four wheels is achieved via a Torsen differential and a transfer box.

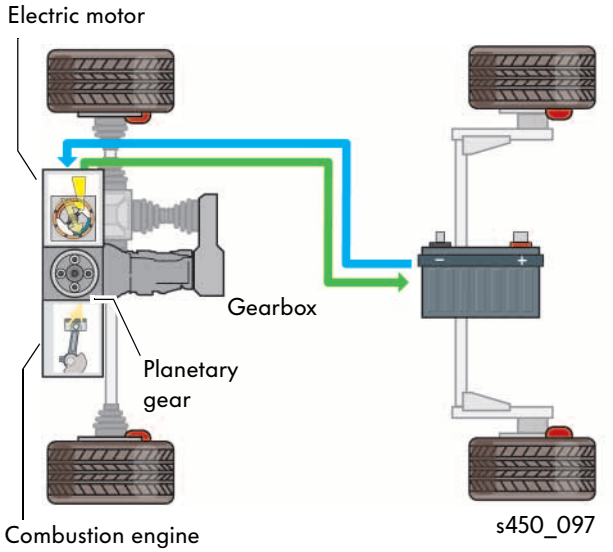
Parallel hybrid



The power-split hybrid drive

In addition to a combustion engine, the power-split hybrid drive also has an electric motor/generator. Both are located on the front axle.
Drive power is provided from both the combustion engine and the electric motor to the vehicle's gearbox via a planetary gear. In contrast to the parallel hybrid design, the sum of the two drive types' individual outputs cannot therefore be picked up at the wheel. Part of the output which is generated is used to drive the vehicle and the other part is stored as electrical energy in the high-voltage battery.

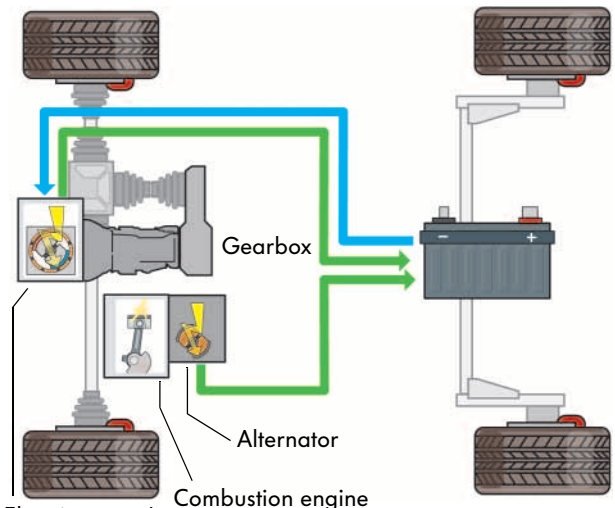
Power-split hybrid



The serial hybrid drive

The vehicle has a combustion engine, an alternator and an electric motor. However, the difference in comparison with the two concepts described above is that the combustion engine has no possibility of moving the vehicle itself via a shaft or a gearbox. No output from the combustion engine arrives at the wheel. The electric motor acts as the vehicle's main drive. If the capacity of the high-voltage battery is low, the combustion engine is started. The combustion engine charges the high-voltage battery via an alternator.
The electric motor/generator is again able to draw energy from the high-voltage battery.

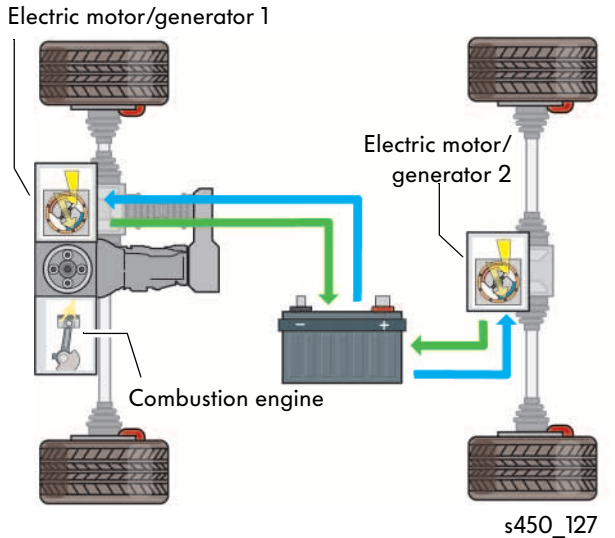
Serial hybrid



The power-split, serial hybrid drive

The power-split, serial hybrid drive is a mixed form of the two above described hybrid drives. The vehicle has a combustion engine and two electric motor/generators. The combustion engine and electric motor/generator 1 are located on the front axle. Electric motor/generator 2 is located in the rear axle. This concept applies to a four-wheel drive vehicle. The combustion engine and electric motor/generator 1 are able to actuate the vehicle's gearbox via a planetary gear. Again, the individual outputs of the drive variants cannot be picked up as total output at the wheel in this case. Electric motor/generator 2 in the rear axle is activated as required. Due to the design, the high-voltage battery is located between the vehicle's two axles.

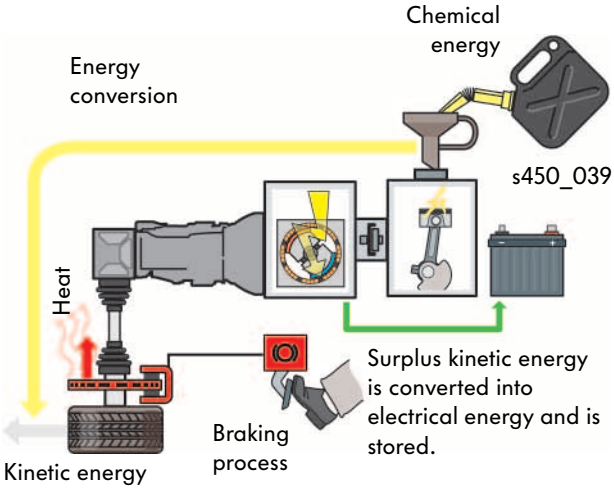
Power-split serial hybrid



Further terms

Further terms which are frequently used in connection with hybrid technology will be briefly explained at this point.

Recuperation



In technology, this term generally refers to an energy recovery process.
During recuperation, an existing form of energy is converted into another, reusable form of energy.
The chemical energy bound in the fuel is converted into kinetic energy in the drive train. If the vehicle is now braked using conventional brakes, surplus kinetic energy generated via brake friction is converted into thermal energy. The heat which is created is released into the environment and cannot therefore be reused.
If, in contrast, a generator is used as a motor brake in addition to the classic brakes, as in the case of hybrid technology, part of the kinetic energy can be recovered in the form of electrical energy and is therefore available for use again. The vehicle's energy balance improves. This is also referred to as regenerative braking.

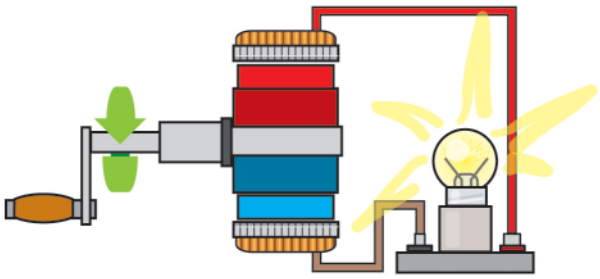
During overrun, as soon as the vehicle

- reduces its speed via braking with the brake pedal
  or
- rolls to a stop
  or
- drives downhill

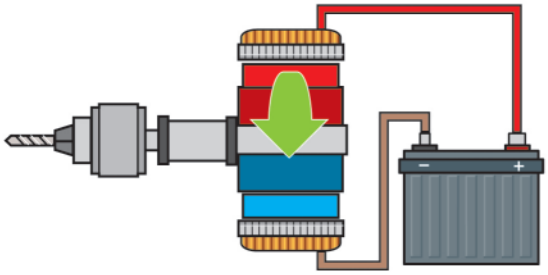
the hybrid system switches the electric motor over and uses it as an alternator. It then charges the high-voltage battery. During overrun, it is therefore possible to "top up" an electric hybrid with electrical energy.
When the vehicle rolls to a stop, only that amount of kinetic energy which the 12 Volt vehicle electrical system requires to operate is converted via the electric motor, as the alternator.

Electric motor/generator

Electric motor as a generator



Electric motor as a drive motor



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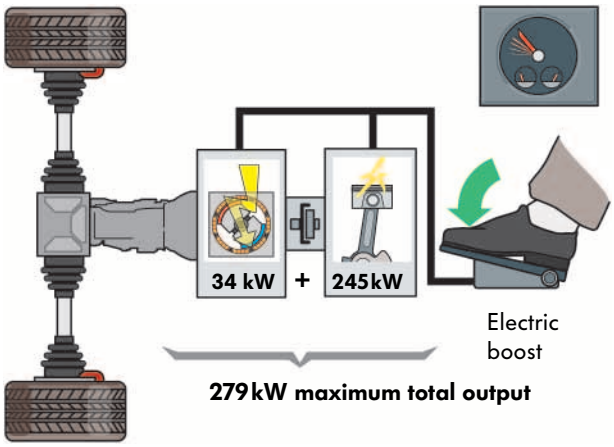
The term electric motor/generator is used instead of generator, motor and starter. Every electric motor can always additionally be used as a generator. If the electric motor's shaft is driven externally, it supplies electrical energy as a generator. If electrical energy is supplied to the electric motor/generator, it functions as a motor.

An electric hybrid's electric motor/generator therefore replaces the combustion engine's conventional starter and the conventional alternator.

Electric boost



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Along the lines of the kick-down function in combustion engines, which makes the maximum engine power available, the hybrid drive offers an electric boost function. If it is carried out, the electric motor and the combustion engine supply their maximum outputs, which therefore add up to a higher total value. The total of the individual outputs of both drive types corresponds to the total output of the drive train.

Due to the technical power loss within the electric motor/generator, however, the generator output is less than the driving power.
The driving power or the mechanical output of the electric motor is 34kW. The alternator output or the electrical output of the electric motor is 31kW.

In the Touareg Hybrid, the combustion engine has an output of 245kW and the electric motor, as an alternator, has an output of 31kW. As a motor, the electric motor has an output of 34kW. Together, the combustion engine and the electric motor have an output of 279kW.

Basics of hybrid technology

Start-stop function

Due to the hybrid technology, a start-stop function can be integrated into this vehicle design. In a conventional vehicle with a start-stop system, the vehicle has to be stationary in order to deactivate the combustion engine (example: Passat BlueMotion).

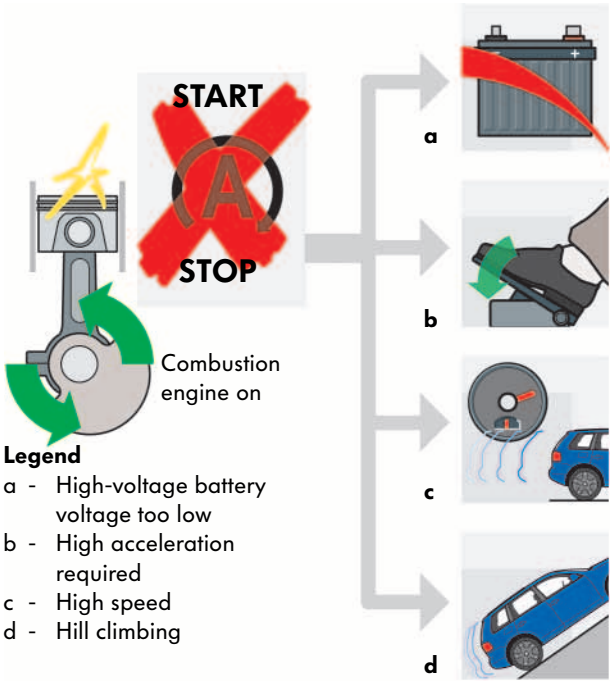
In a full hybrid vehicle, however, the vehicle can be driven electrically. This characteristic enables the start-stop function to deactivate the combustion engine even when the vehicle is driving or rolling. The engine is actuated as required. This may be the case in the event of high acceleration, high speed, high load or a low high-voltage battery charge. If the charge of the high-voltage battery is low, the hybrid system is able to use the combustion engine, with the electric motor/generator as a generator, to charge the high-voltage battery.

In other cases, the full hybrid vehicle can be driven electrically. The combustion engine is then stopped. This is also true in slowly flowing traffic, when stationary at a red traffic light, during overrun when descending hills or when the vehicle is rolling to a stop.

When the combustion engine is not running, it does not consume any fuel and does not generate any emissions.

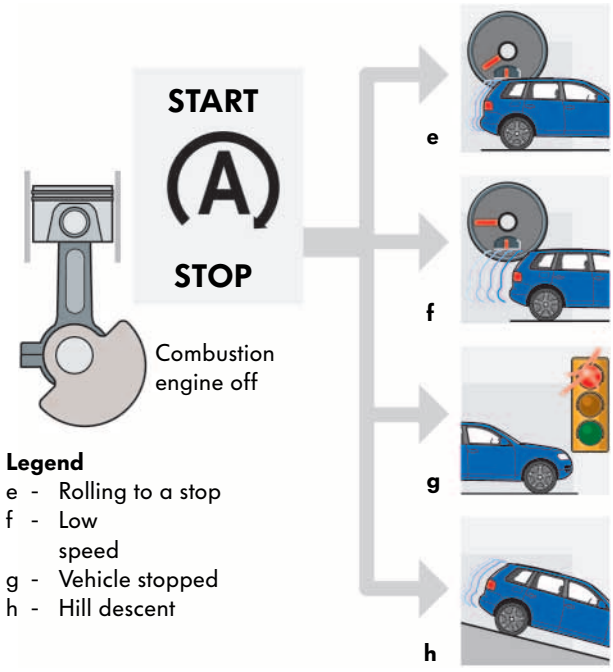
The start-stop function integrated into the hybrid system increases the vehicle's efficiency and therefore its environmental friendliness.

Whilst the combustion engine is stopped, the air conditioner can continue to be operated. The air conditioner compressor forms part of the high-voltage system.



Legend

a - High-voltage battery voltage too low
b - High acceleration required
c - High speed
d - Hill climbing



Legend

e - Rolling to a stop
f - Low speed
g - Vehicle stopped
h - Hill descent

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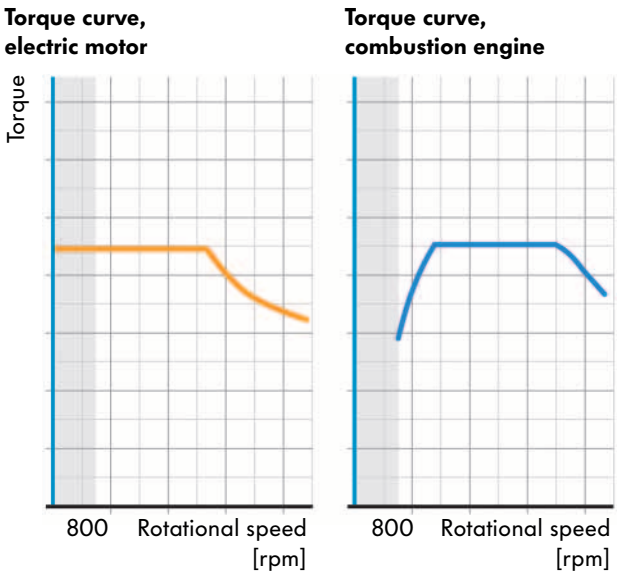
The arguments in favour of hybrid technology



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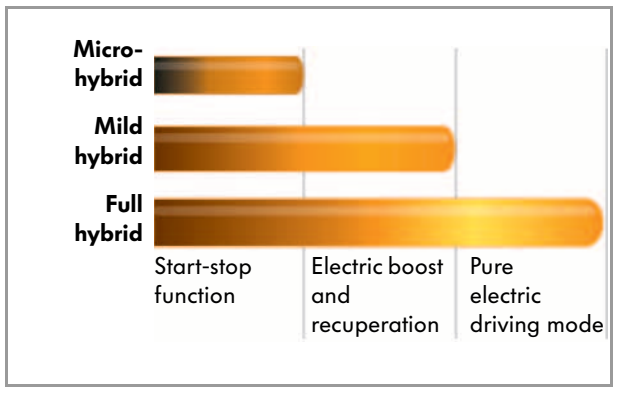
Why do we combine an electric motor/generator with a combustion engine?

The combustion engine requires an idling speed to output a torque. The engine cannot output any torque when it is stationary. When the combustion engine's rotational speed is increased, its torque is increased. The electric motor reaches its maximum torque as of its first revolution. It does not require any idling speed. As its rotational speed increases, its torque decreases.

The electric motor supports the combustion engine wherever this reveals weaknesses due to its concept: below the idling speed.
Thanks to the support provided by the electric motor, the combustion engine can be used in the optimal efficiency range. This load point shift increases the efficiency of the drive concept.



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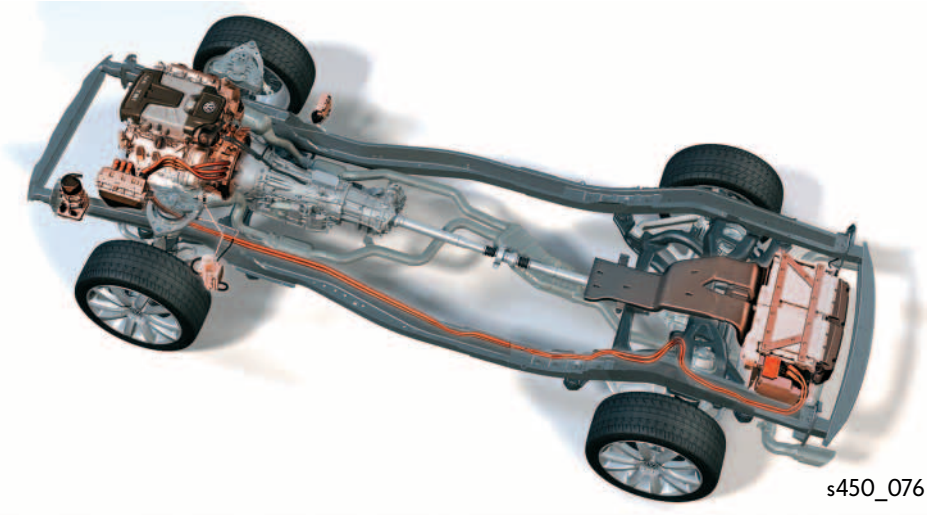
Why a full hybrid drive?

In comparison with the other hybrid drives, the full hybrid drive combines the function of the integrated start-stop system, electric boost, recuperation and purely electric driving (electric driving mode).

The hybrid concept from Volkswagen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The hybrid concept developed at Volkswagen, which will initially be launched in the Touareg, is based on the parallel hybrid drive. The electric motor and the combustion engine are therefore used for mechanical propulsion via a common drive train. Both drive types are seated on a single shaft. The hybrid concept from Volkswagen therefore requires significantly fewer hybrid components than is the case in the power-split or serial hybrid system.

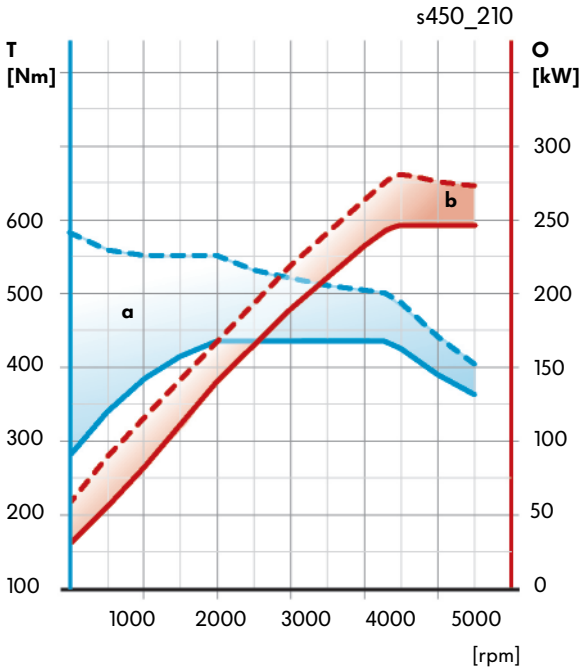
Thanks to the option of using the electric motor as both a drive motor, a generator and a starter, it has been possible to omit the starter, the alternator and a poly V-belt. Electric driving using the electric motor/generator makes it necessary to equip components which are supplied by the rotating combustion engine in conventional vehicle concepts with electric drives.
These include:

- Electric coolant pumps,
- Electric power steering,
- Electric vacuum pump for the brake servo,
- Electric air conditioner compressor,
- Electric pressure pump for the oil pressure in the automatic gearbox.

The combustion engine and electric motor are separated from each other by a hydraulically actuated single-plate dry clutch.
The hybrid vehicle's operating modes and therefore actuation of the clutch are controlled by the hybrid system. The driver has no direct influence on actuation of the single-plate dry clutch.
It is controlled by an electric clutch actuator.
The clutch is closed when the combustion engine is running. It is open when the combustion engine is not running.

Technical data on the Touareg Hybrid

Combustion engine	3.0 l V6 TSI engine with supercharging
Combustion engine output	245 kW
Electric motor/generator	3-phase AC motor/generator
Electric motor/generator output	31 kW generator output (electrical output) 34 kW motor output (mechanical output)
Maximum output during E boost	279 kW
Maximum torque during E boost	550 Nm
High-voltage battery voltage	288 V (2 x 144 V)
High-voltage battery capacity	6.5 Ah corresponding to 1.87 kW/h
Top speed	240 km/h
Acceleration from 0 to 100 km/h	6.6 seconds
Additional weight due to the hybrid components	175 kg



Total torque
Torque, combustion engine
Total output
Output, combustion engine
a Torque increase, e.g. during electric boost
b Output increase due to electric motor/generator

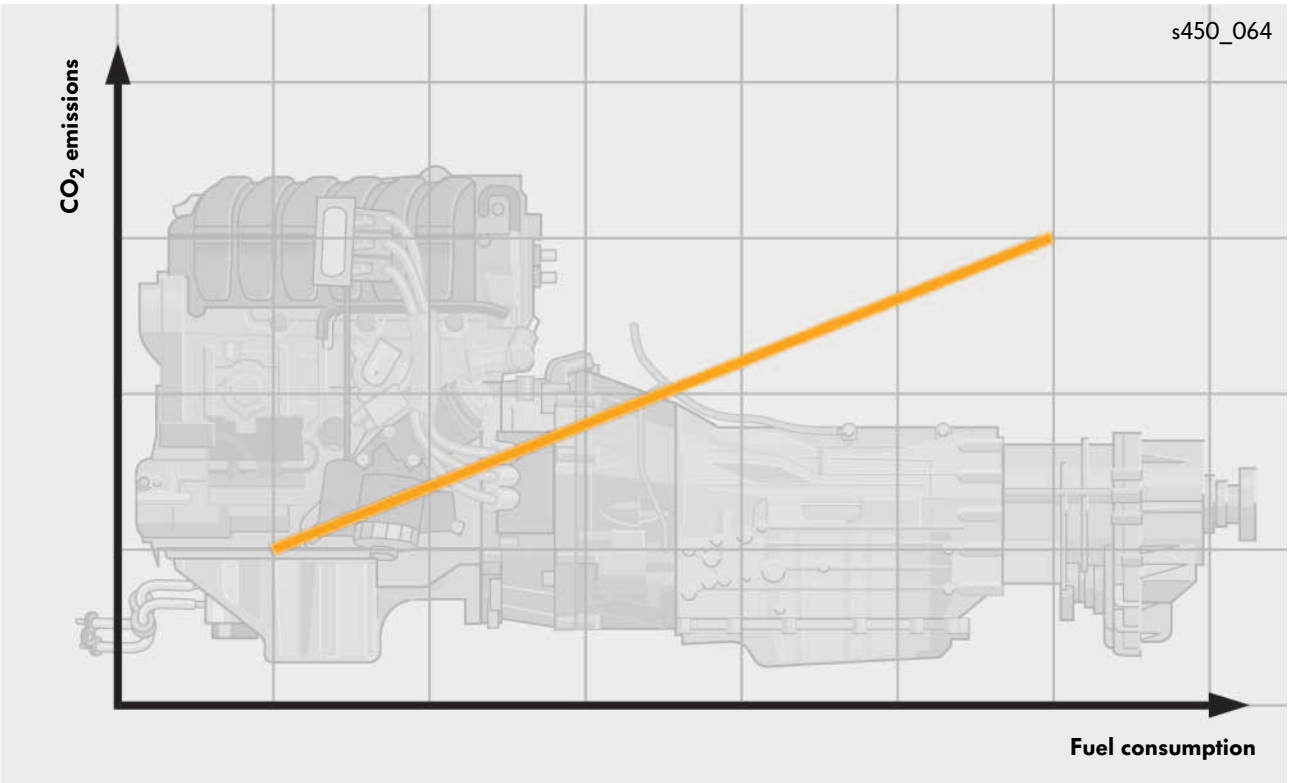
Torque/output graph

Particularly in the lower speed range, the electric motor compensates the combustion engine's slow torque increase. For its weight class, the Touareg Hybrid therefore offers unusually high acceleration from stationary.
In the output curve, the driving power of the combustion engine and the electric motor add up to a maximum total output of 279 kW.
This means that the output curve is increased by the amount of the electric motor's driving power, 34 kW. This occurs over almost the entire speed range. Whilst the combustion engine is running, a mixed mode occurs.

As a result of this, the combustion engine's optimal efficiency range can be controlled. This load point shift increases the efficiency of the full hybrid vehicle.

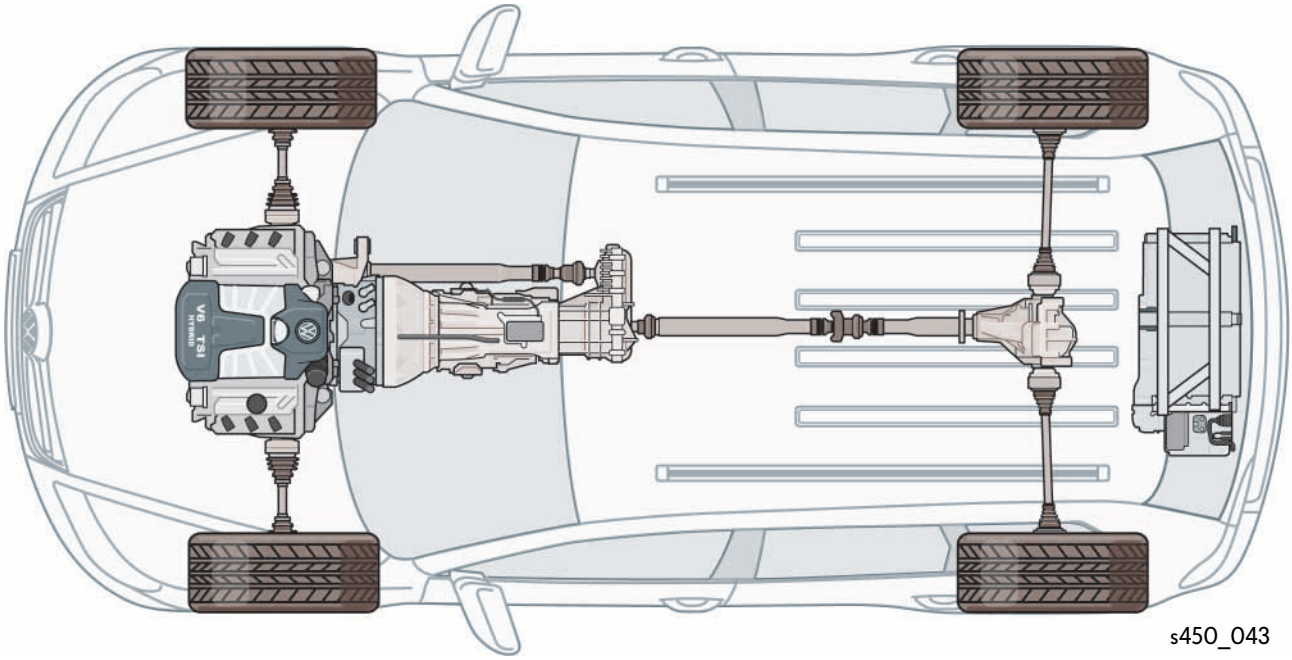
Legal CO_2 emission limitation

A vehicle's CO_2 emissions and consumption are almost proportionately connected.
The higher the fuel consumption, the more CO_2 which is emitted into the environment.
The legal specifications for limiting CO_2 emissions are therefore aimed particularly at high-volume vehicles with high outputs.
The hybrid technology enables vehicles to remain below the legal limit values, even with high outputs, as the value for the CO_2 which is emitted is formed as a mean value in grams of CO_2 per kilometre which is covered.
On integration of the kilometres covered in pure electric driving mode, the mean CO_2 value per kilometre is reduced.



The CO_2 emissions increase as fuel consumption rises.

Overview of the drive train



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The drive train on the Touareg Hybrid consists of:

- The 3.0l 245 kW TSI engine with supercharging,
- A disengagement clutch between the combustion engine and the electric motor/generator,
- The electric motor/generator,
- The automatic 8-speed gearbox 0C8 from Aisin,
- The drive shafts,
- The transfer box on the rear and front axles,
- The Torsen differential.

The combustion engine, the clutch, the electric motor/generator and the automatic gearbox are located behind one another on a common shaft. This method enabled installation space and weight caused by additional hybrid components to be saved. Adaptation of the propshaft tunnel from the standard Touareg was not necessary.

The mechanical components will be briefly explained in the following.

Further information on the combustion engine, the gearbox and the vehicle can be found in the self-study programmes:
449 "The Touareg 2011",
452 "The 3.0 l 245kW TSI Engine with Supercharging",
466 "The 8-speed Automatic Gearbox 0C8" and
469 "The Touareg 2011 Running Gear and Four-wheel Drive Concept".

Mechanical design

The 3.0l 245kW TSI engine with supercharging

The engine is a 3.0l V6 TSI with a supercharger.
The supercharger is driven using a belt. The second belt on the engine drives the engaged water pump. It forms part of the entire drive train's thermal management system.

Thanks to the electric motor/generator, the starter and the generator for the 12Volt vehicle electrical system have been omitted.
The TSI engine does not therefore have a belt for the alternator.

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The disengagement clutch K0 to the combustion engine

This single-plate dry clutch is located between the engine and the electric motor/generator. The clutch actuator (pressure regulator for disengagement clutch N511) for this clutch is located behind the left front wheel housing liner. It is controlled by the hybrid system.
The driver has no direct influence on this clutch. The hydraulic fluid is made available from the brake fluid reservoir.

The clutch is closed when the combustion engine is running. When the vehicle is driven electrically, is in recuperation mode or is stationary, the combustion engine is deactivated and the clutch is open. When the high-voltage battery's charge is low, the hybrid system allows the combustion engine to run in order to charge the high-voltage battery. In this case, the clutch is closed.


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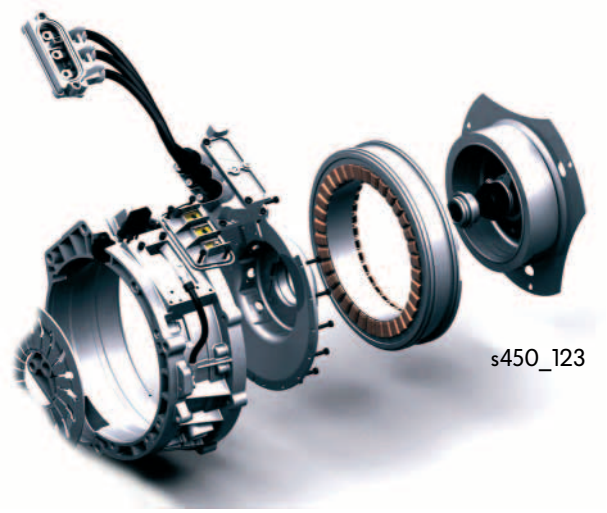
The electric motor/generator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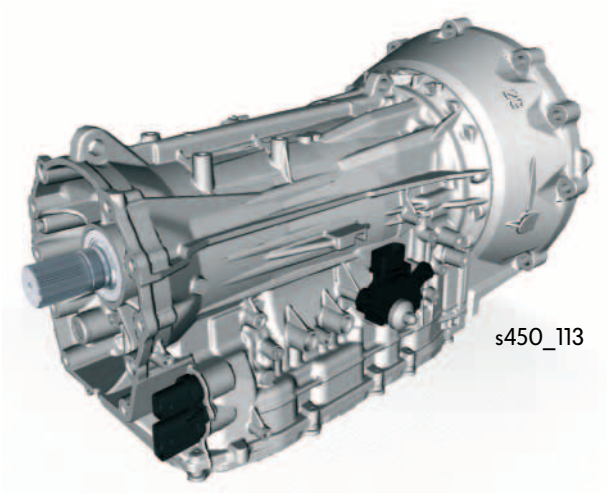
The core element of the hybrid drive is the electric motor/generator. This performs three essential tasks in the hybrid system:

1. Combustion engine starter,
2. Generator for charging the high-voltage battery,
3. Electric motor for moving the vehicle.

The rotor runs, without contact, in the stator.
In generator mode, the electric motor has an output of 38kW. As a motor, the electric motor/generator has an output of 34kW. This difference arises from the power loss, which every electric motor/generator displays due to its design.
The Touareg Hybrid can be driven purely electrically up to approx. 50km/h over flat terrain.
The maximum speed is dependent on motion resistance and the high-voltage battery's state of charge. The K0 clutch is located in the electric motor/generator's housing.

The 8-speed automatic gearbox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This gearbox extensively corresponds to the 6-speed automatic gearbox 09D which is already available on the market. An additional friction element and a pressure control valve are used to implement the eight gears.

The gearbox is equipped with an electric pressure pump, which maintains the oil pressure when the vehicle is stationary or is driving in electric mode. A conventional mechanical pressure pump is installed in the gearbox to provide pressure in combustion engine mode.

Mechanical design

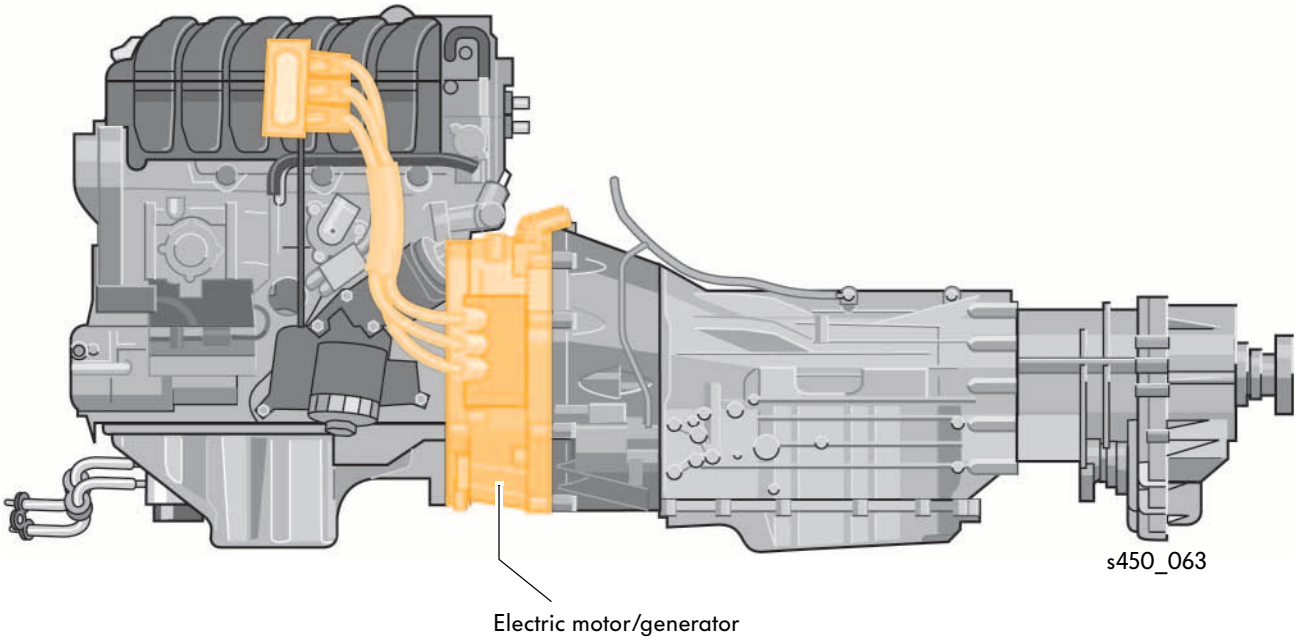
Torsen differential, differential and drive shafts

These components are carry-over parts from the Touareg. They are used without modifications for the hybrid drive.

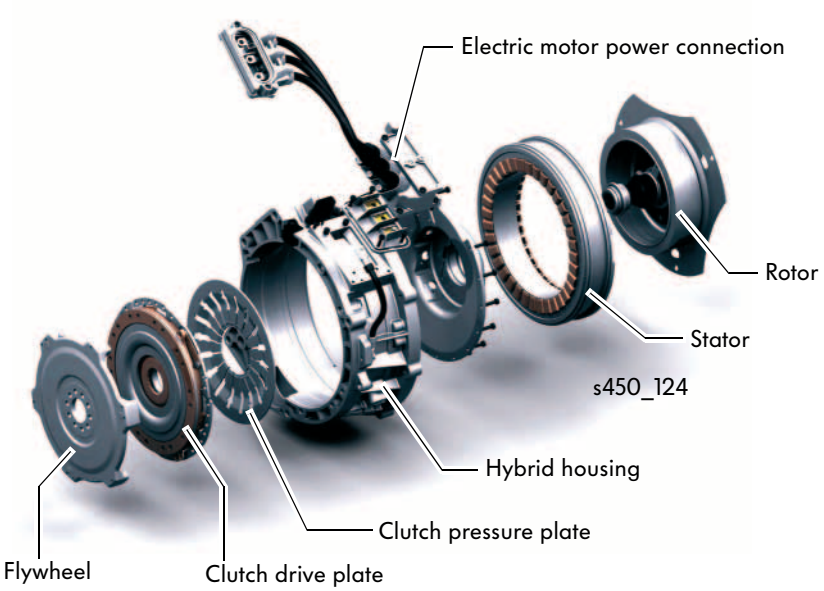
In principle, the Touareg is available with two drive train layouts: "4motion" and "4Xmotion".
The Touareg Hybrid is exclusively available in the "4motion" version.
This means that it is equipped with a self-locking Torsen transfer box.
The drive shafts are weight-optimised and have a splined connection to the gearbox.
The drive shaft splines for transmitting the torque are self-centring.

More detailed information on the drive train can be found in the self-study programmes:
449 "The Touareg 2011",
452 "The 3.0 l 245kW TSI Engine with Supercharging",
466 "The 8-speed Automatic Gearbox 0C8" and
469 "The Touareg 2011 Running Gear and Four-wheel Drive Concept".

The electric motor/generator



The electric motor/generator is located between the combustion engine and the automatic gearbox.
It is an AC induction motor and is driven by a 3-phase field.
The power electronics convert the 288V DC voltage to AC voltage with three phases.
These 3 phases build up an electromagnetic 3-phase field in the electric motor/generator.
In the service literature, the electric motor/generator is described as "electric drive motor V141".



Electrical components

Tasks

Depending on the driving situation and operating mode, the electric motor/generator performs different tasks. On switching from electric drive to combustion mode, the electric motor/generator operates as a starter for the combustion engine. During continued combustion mode, the electric motor/generator is switched over by the hybrid system to act as the generator.
The electrical energy which is generated in this case is used, via voltage converters, to charge the high-voltage battery (288V) and the 12Volt vehicle electrical system battery.

When the vehicle is braked, the electric motor/generator supplies electrical energy to the high-voltage battery by means of recuperation, and thereby recovers part of the surplus kinetic energy in the form of electrical energy. The pedal travel sensor is located on the brake pedal. If slight braking is detected, the hybrid system switches the electric motor/generator over so that it acts as a generator and charges the high-voltage battery.

Energy which is converted into heat in conventional hydraulic brakes can now be stored in the high-voltage battery. This energy is subsequently used to drive the vehicle. During recuperation, at least the amount of energy which the 12Volt vehicle electrical system requires is converted. During this process, the combustion engine is deactivated. The electric motor/generator thus implements the concept of a start-stop system for the hybrid drive.

During electric driving mode, the electric motor/generator switches back from functioning as a generator to functioning as an electric motor.
When the combustion engine is decoupled, the electric motor is then used to drive the vehicle. Depending on motion resistance (aerodynamic drag, rolling, slope, frictional resistance), the electric motor is able to drive the vehicle up to approximately 50km/h. If, however, the driver requires greater acceleration, the electric motor's output is no longer sufficient to implement the driver's command. The hybrid system therefore independently starts the combustion engine.

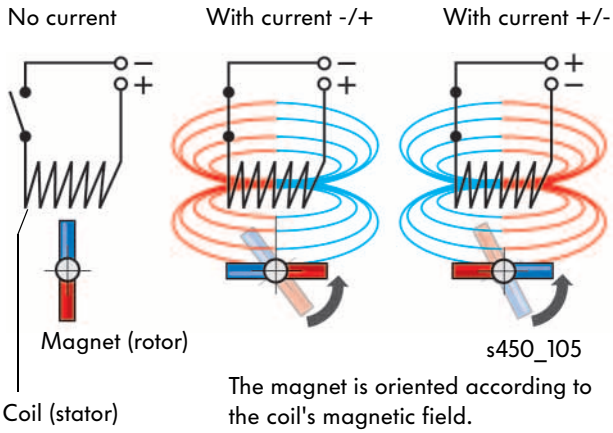
The electric motor/generator is supplied via a three-phase cable from the power electronics.

Design

The electric motor consists of:

- The diecast aluminium housing,
- The internal, magnetic rotor,
- The stator with solenoids,
- An intermediate plate for connecting to the automatic gearbox's torque converter,
- The main electric motor bearing,
- The high-voltage connection with three phases.

On the engine side, the clutch to the combustion engine connects with a flywheel. The three phase connections are routed to the solenoids in such a way that three adjacent solenoids are each connected to different phases.



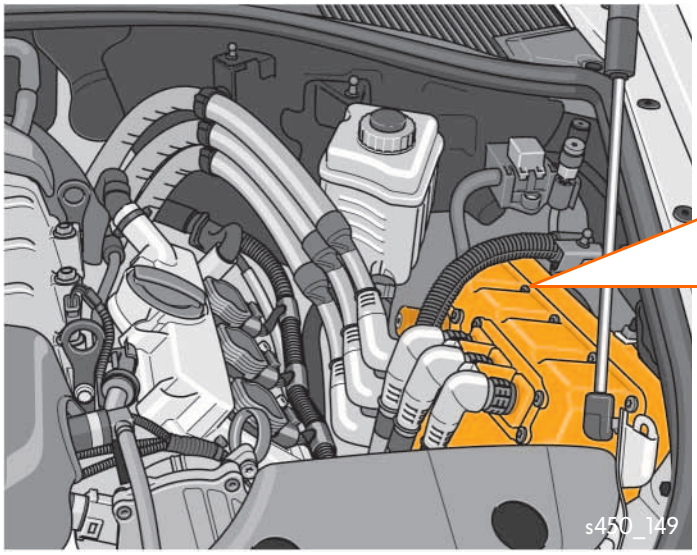
The magnet is oriented according to the coil's magnetic field.

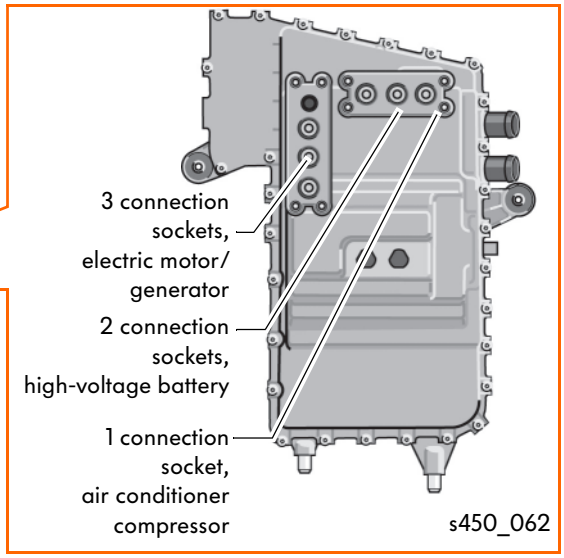
How it works

The electric motor/generator is equipped with a wound stator coil, which generates a rotating magnetic field as a motor.
When the electric motor/generator operates as a motor, the stator coil generates a rotating magnetic field.
The rotor is fitted with permanent magnets for field generation. The speed of the induction motor is precisely specified via the frequency of the AC current which is supplied. A frequency inverter is used to enable infinitely variable synchronous motor speed regulation. The rotor position sensors constantly measure the position of the rotor. From this, the control electronics determine the actual rotational speed.

If the electric motor/generator operates as a generator, the rotor is driven externally by the gearbox. As the rotor's magnetic field runs past the stator's coils, a voltage is induced in the coils for each phase. The rotor's magnetic field runs through the coils in sequence. The power electronics convert the electrical energy which is obtained into a DC charging current of 288V for the high-voltage battery.

The power and control electronics for electric drive





To make the system easier to understand, the power and control electronics for electric drive JX1 will be shortened to the term "power electronics" in the following.

The power electronics are the electric drive's energy converter. The aluminium housing, which is mounted on the driver side between the engine and the wheel housing, contains various high-voltage system and electric drive components.
They are:

- The control unit for power electronics,
- The temperature sender for power electronics,
- A 288 Volt DC/12 Volt DC voltage converter,
- A bi-directional DC/AC voltage converter for the electric motor/generator,
- The high-voltage network distributor,
- The two high-voltage connections for the lines from the high-voltage battery,
- The three high-voltage connections for the lines to the electric motor,
- One high-voltage connection for the line to the air conditioner compressor,
- The low-voltage connection to the 12 Volt vehicle electrical system,
- A cooling system integrated into the housing, with a connection to the low-temperature cooling circuit,
- The safety line with safety connector.

The power electronics must not be opened, and are exchanged completely in the event of damage. They can be obtained as an exchange part at a later point in time.

The voltage converters

Two voltage converters are integrated into the power electronics. They process the high-voltage battery's 288 Volt DC voltage for the electric motor and the 12 Volt vehicle electrical system.

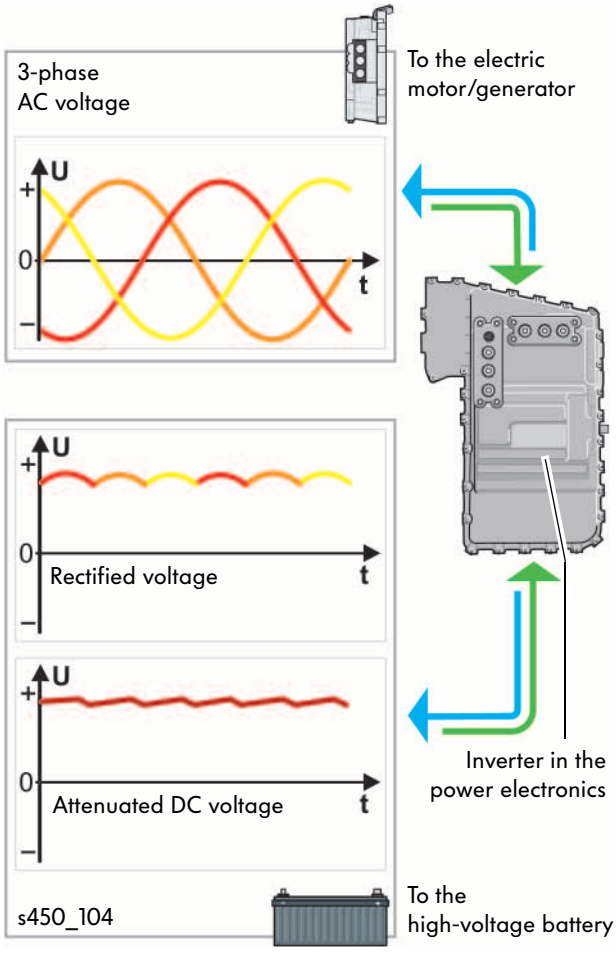
Voltage converter A19

This voltage converter is the interface between the vehicle's high-voltage system and 12 Volt system.

Task

As the alternator has been omitted, the vehicle electrical system's 12 Volt battery can only be charged via the electric motor/generator. To achieve this, the 288 Volt DC voltage from the high-voltage system has to be converted into a charging voltage for the 12 Volt vehicle electrical system battery. The 12 Volt vehicle electrical system battery is located, as in the basic Touareg vehicle, beneath the driver seat.

Inverter for drive motor A37



As the electric motor/generator is a three-phase synchronous alternator, but batteries are only able to store DC voltage, a DC/AC voltage converter is also integrated into the power electronics.

Task

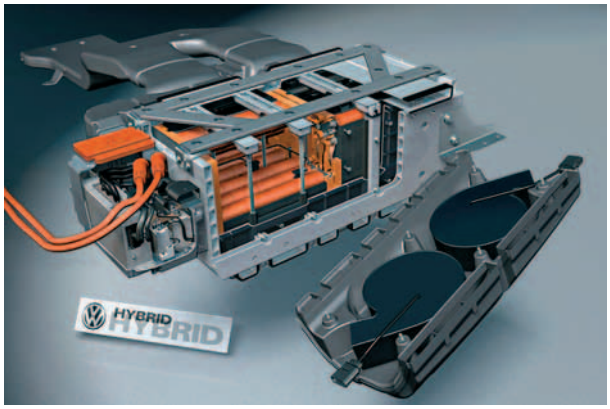
This voltage converter transforms the high-voltage battery's 288 Volt DC voltage for supplying the electric motor/generator into AC voltage with three phases.

When the electric motor/generator is operated as a generator, it converts the AC voltage into 288 Volt DC voltage for charging the high-voltage battery. The rectified voltage is attenuated via the high-voltage battery for the high-voltage system, and for the 12 Volt vehicle electrical system, via the 12 V battery beneath the driver seat and the capacitors in the power electronics.

The high-voltage battery

The high-voltage battery is deceased via the luggage compartment floor cover. It is designed as a module and contains various components belonging to the Touareg's high-voltage system. The entire high-voltage battery module weighs 85kg and may only be exchanged completely.

In the service literature, the high-voltage battery is referred to as "hybrid battery A38".



s450_058

Warning
Even AC voltages of 25Volts and DC voltages of 60Volts are hazardous to persons.
It is therefore vital to observe the safety instructions in the service literature and in guided fault finding plus the warnings on the vehicle. Only qualified personnel who are aware of the hazards of high voltage may carry work out on high-voltage vehicles.

The high-voltage battery cannot be compared with a conventional 12 Volt battery. During regular operation, the high-voltage battery is operated between the loose charge boundaries of 20% and 85%. A 12Volt battery would be unable to tolerate this load over a long period of time.
The high-voltage battery therefore has to be regarded as a short-term store for the electric drive. Like a capacitor, it is able to absorb energy and emit it again. Recuperation, or energy recovery, can therefore essentially be viewed as an option for fuelling the vehicle whilst driving.

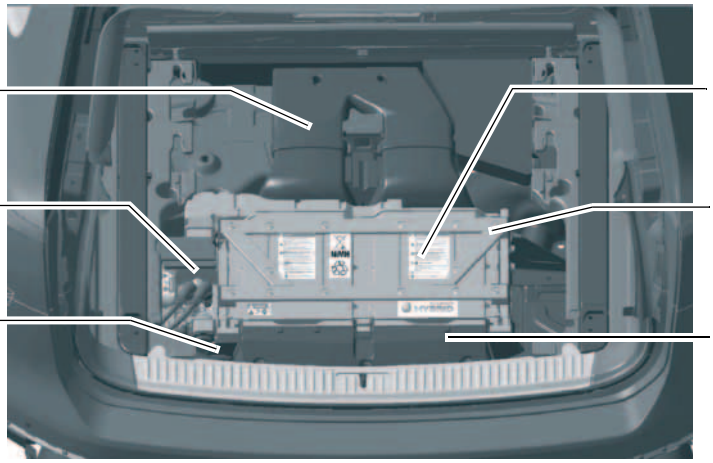
Use of the high-voltage battery in a hybrid vehicle is characterised by alternately charging the high-voltage battery (recuperation) and discharging it (electric driving).

Example:
If the high-voltage battery's energy is compared with the energy which is released when fuel is combusted, the energy which the battery is able to supply corresponds to approx. 200 ml fuel.
This shows that the battery still has scope for optimisation on the road to a purely electric vehicle in terms of its energy storage capability.

Design

The high-voltage battery module consists of:

- The 288 Volt high-voltage battery,
- The battery box,
- The connection and distribution box (electronics box),
- The air inlet and outlet ducts,
- The fan housing with two electric fans (12 V).



s450_150

The high-voltage battery is a nickel-metal hydride battery. The battery acid has the form of a gel. No fluid would escape even in the event of large holes in the battery housing.
The battery consists of two battery banks, each with a voltage of 144 V.
These two battery banks are connected via safety switches and, together, supply 288 V.

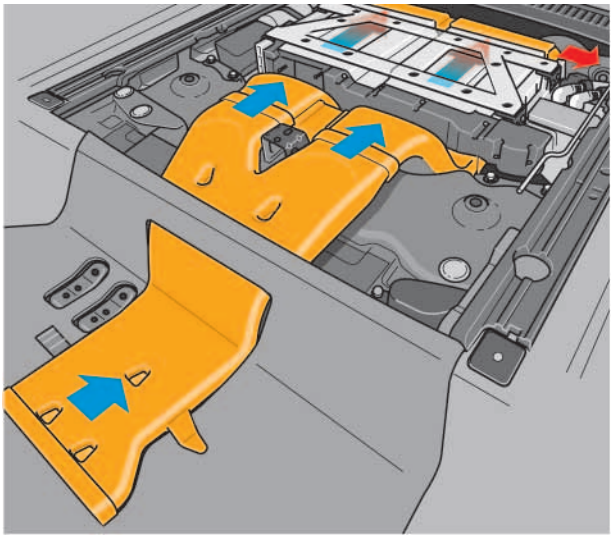
With a charge level of 75%, the high-voltage battery has a voltage of approx. 288 V.
The electrical charge is approx. 6.5 Ah. This means that the charged energy content of the high-voltage battery is 1.87 kWh.
The high-voltage battery is air cooled. Two fans draw in a small amount of the air from the interior of the vehicle. Heated air discharge is ensured via a forced ventilation system in the rear bumper.

The electronics box is flanged onto the high-voltage battery.

The battery cooling system

Task

When charging a battery, the chemical processes which occur spontaneously during discharge are reversed. Heat is released during this thermodynamically forced process, leading to battery heating. If the heat cannot be adequately dissipated to the environment, the risk of destroying the battery is run. As the high-voltage battery in the Touareg is subject to constant charging and discharging, significant volumes of heat can also develop here. In addition to possible damage to the battery, this particularly results in increased electrical resistance on the part of the involved conductors. This leads to the fact that the electrical energy is not converted into power but is emitted as heat. The high-voltage battery therefore has a separate electric cooling system.



s450_151

Design

Two electric cooling fans, which are actuated by the battery management control unit, are the core element of this cooling system. The two fans form part of the high-voltage battery module and intake part of the air from the interior via the battery. They operate with the 12 Volt vehicle electrical system voltage.

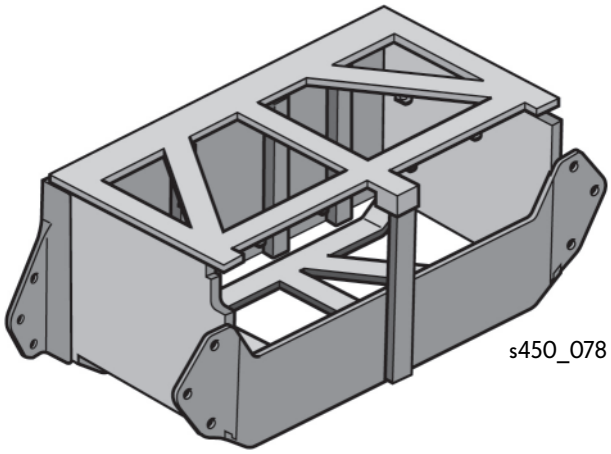
The fans are referred to as:
- Battery fan 1 V457 and
- Battery fan 2 V458

in the service literature.

How it works

If the battery management control unit determines an excessively high battery temperature via the sensor cluster on the battery connection terminal, it actuates the two cooling fans.
The air is drawn in through the intake duct, which is located beneath the rear seats, and is supplied to the high-voltage battery. The high-voltage battery's cells have small intermediate spaces between each other, through which the air is able to flow.
The two fans then force the heated air laterally into the luggage compartment.

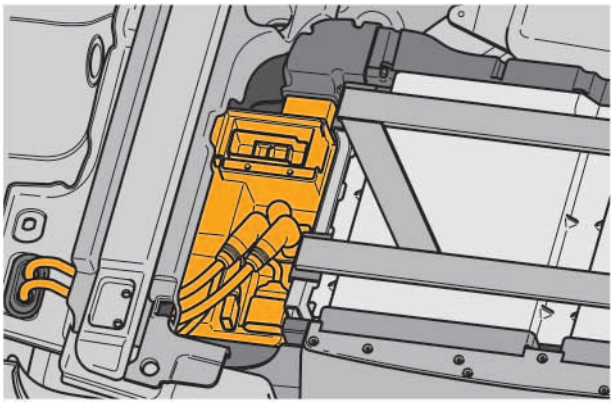
The battery box



s450_078

In order to protect the high-voltage battery, particularly in the event of a rear impact, both battery banks are surrounded by a battery box. The frame consists of welded and bolted aluminium profiles. These transmit the impact energy into the vehicle structure.
The frame can also be used to lift the entire battery out of the luggage compartment floor using workshop equipment.

The connection and distribution box SX1



s450_057

The connection and distribution box, shortened to electronics box in the following, is flanged onto the left of the high-voltage battery.

Task

The electronics box is used to connect the high-voltage battery to the vehicle's 288 Volt system. It contains part of the safety systems for the high-voltage system and the monitoring facility for the high-voltage battery.

Design

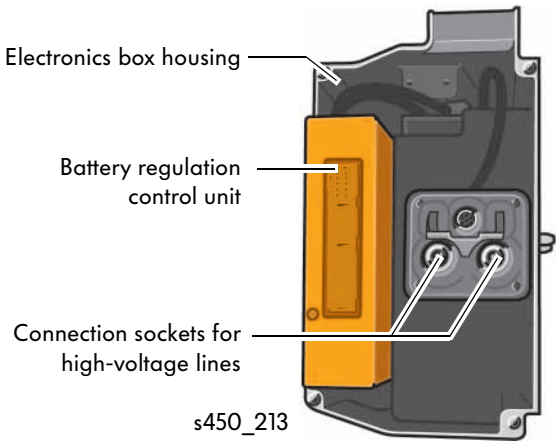
The connection and distribution box (electronics box) contains:

- The battery regulation control unit J840,
- The safety connector 1 TV44,
- The maintenance connector for high-voltage system TW,
- The protective relays (contactors),
- The connections for the two high-voltage lines from the high-voltage battery to the power electronics.

Electrical components

Battery regulation control unit J840

The control unit is located on the left-hand side in the electronics box.



Task

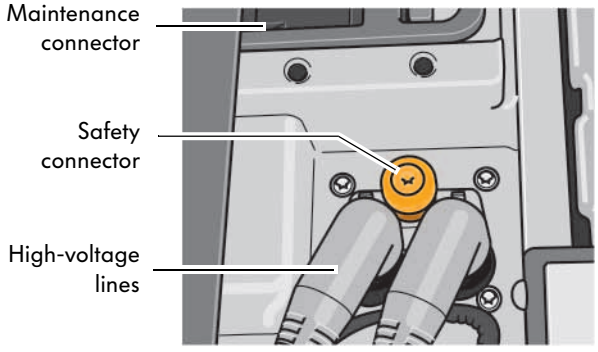
The battery regulation control unit monitors the battery's charge and operating status.
The control unit determines values for the high-voltage battery's charge, discharge and temperature. It registers the battery temperature and regulates battery cooling via the electric cooling fans. For vehicle diagnosis purposes, it stores faults which occur on the battery or in the electronics box in its fault memory.

All battery-relevant data are stored by the control unit as protection against tuning. High-voltage battery deep discharge or overheating can therefore also be determined at a later point in time.

Safety connector 1 TV44

The safety connector is located between the maintenance connector and the connection elements for the two high-voltage lines to the power electronics.

s450_202

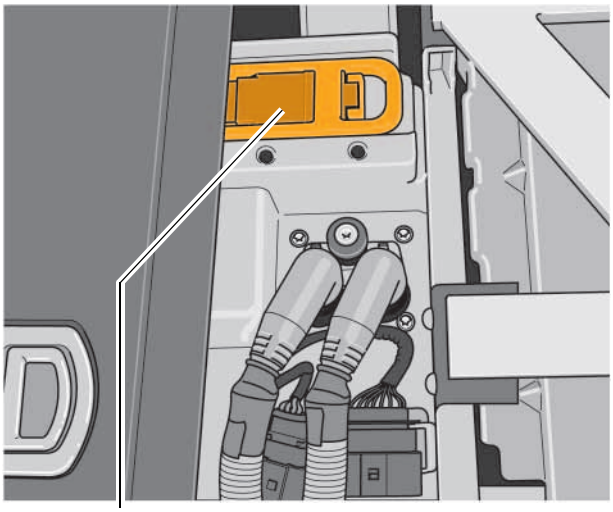


Task

The safety connector functions as a switch which is located in an electrical circuit. If the safety connector is disconnected, the switch is opened and the safety line is interrupted.
The high-voltage system is now deactivated.
If the safety connector is connected, the switch and therefore the safety line are closed.
The monitoring system assumes that the two high-voltage lines are connected to the high-voltage battery. The hybrid system is able to run.

The safety connector is mechanically connected to the high-voltage lines' locking detents.
If the lines have to be disconnected, the safety connector has to be removed.

The maintenance connector for high-voltage system TW



The maintenance connector on the electronics box

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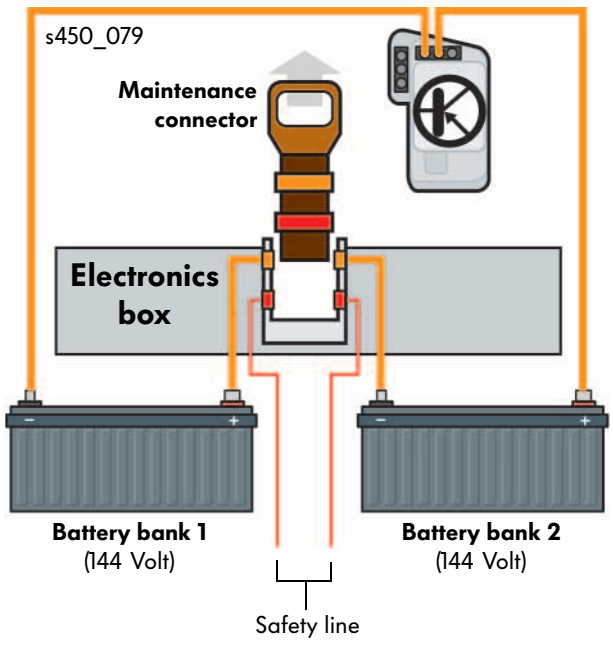
This is located beneath the orange-coloured cover in the electronics box.

Task

The maintenance connector is an electrical bridge between the high-voltage battery's two battery banks. If the connector is removed, the connection is separated. The residual voltage in the high-voltage system dissipates. The high-voltage system is then de-energised.
The maintenance connector is always disconnected when work has to be carried out on high-voltage components or in the vicinity of high-voltage components with metal-removing, deforming or sharp-edged tools.

High-voltage line to the power electronics



How it works

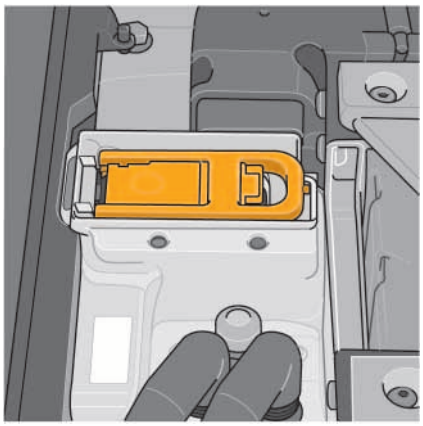
Remove the orange-coloured rubber cover on the electronics box.
The maintenance connector is now exposed. Release the maintenance connector by pulling the upper section to the side. Then fold the upper side of the connector upwards. The maintenance connector is now released and can be removed.

To recommission the high-voltage system, reposition the maintenance connector. Precise information on carrying out measurements for recommissioning can be found in guided fault finding.

Electrical components

Removal of the maintenance connector

One way of deactivating the high-voltage system is to actuate the maintenance connector, because it acts as an electric bridge between the two halves of the battery. The process is carried out with two defined switching positions.



Maintenance connector connected

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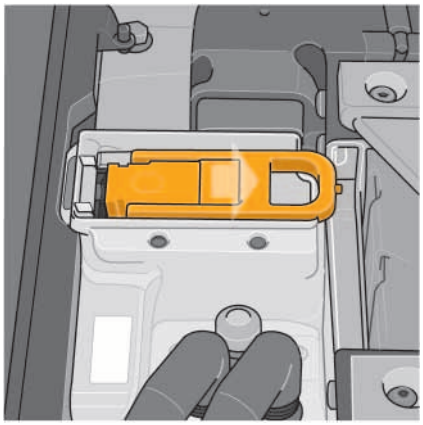
In the first position, the safety line is separated. The protective relays (contactors) are then opened as an emergency shut-off facility. The safety line is used primarily to protect against arcs.



Maintenance connector in position 1

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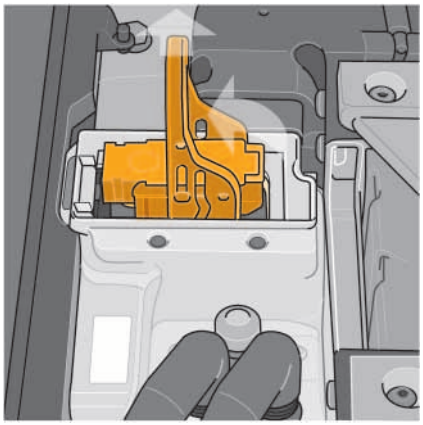
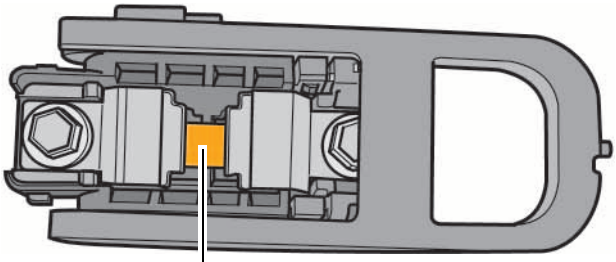
In the second position, the series connection between the two halves of the battery is separated.
The maintenance connector can now be removed from the retainer. The high-voltage system is now deactivated and must be checked to determine whether it is de-energised.



Maintenance connector in position 2

s450_186

Warning:
Only qualified high-voltage technicians may remove this maintenance connector to de-energise the system.



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Blow-out fuse in the maintenance connector

The fuse in the maintenance connector

A blow-out fuse for the high-voltage system is integrated into the maintenance connector. The system is usually fused to 125 A.
In order to exchange the fuse, the cover on the top of the maintenance connector has to be released.

Warning:
Only qualified high-voltage technicians may remove this maintenance connector to de-energise the system.

The protective relays

In addition to the battery regulation control unit, the electronics box also contains the protective relays, also called the contactors.
The contactors are technical devices from the field of electrical engineering, and are used to protect the high-voltage system and therefore the vehicle electrical system from faults in individual sections of the system.
If a fault is ascertained by the hybrid monitoring system, the contactors are opened.
This is necessary, for example, in the event of an accident involving the hybrid vehicle. In this case, the airbag control unit triggers the contactors.

Task

The two protective relays connect the high-voltage battery to the high-voltage system. In addition to the maintenance connector, they serve to separate the two areas from each other.

Electrical components

Design

Each relay is an electromagnetically actuated switch via which a high operating current can be switched on and off using a low control current. If the relay coil is supplied with current by the control unit, an armature is pulled into the coil. As a result of this movement, a mechanical switch for the operating current is closed.
If the coil is not supplied with current, the switch for the operating current remains open.

How it works

When the Touareg's vehicle electrical system is activated, the battery regulation control unit actuates the protective relays and therefore switches on the 288 Volt system. If the ignition (terminal 15) is not activated, the contactors are open.
If the ignition is switched on, the contactors are closed.
Shutting off the 12 Volt vehicle electrical system opens the contactors.

Effects in the event of failure

If the contactors cannot be closed after switching on the ignition, the high-voltage system cannot be activated. Firstly, the "Ready" lettering in the instrument cluster does not light up. Secondly, the combustion engine will not start, as the electric motor cannot be switched on.

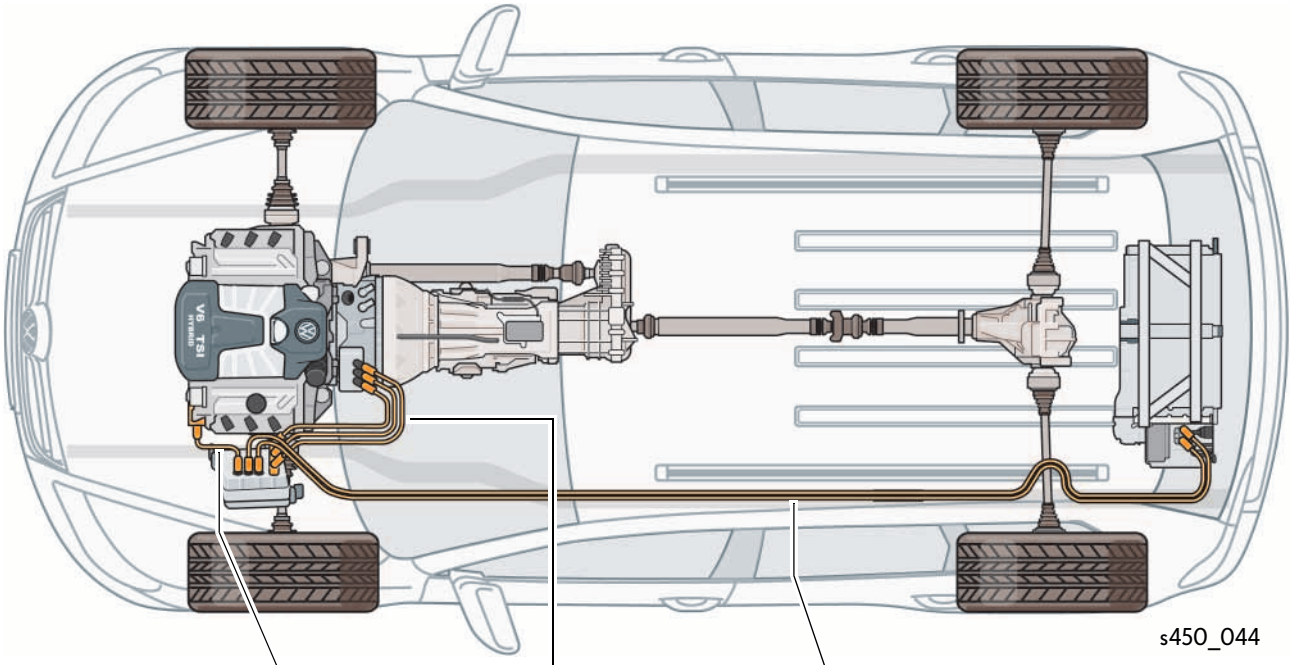
If the contactors cannot be opened, the high-voltage system cannot be de-energised.
One possible cause may be the protective relays' 288 Volt switch contacts "sticking".
This is the only case in which the vehicle cannot be de-energised.

The high-voltage lines

The high-voltage system's electrical lines differ significantly from the lines in the rest of the vehicle electrical system and the 12 Volt vehicle electrical system. Due to the high voltage and current strengths, they have a significantly larger cross-section and are connected via special connectors.
Unlike the 12 Volt vehicle electrical system, the high-voltage system has no electrical potential to the body.

In order to draw attention to the danger of high voltage, all of the high-voltage system's cables are coloured orange throughout. All manufacturers of electric vehicles have agreed to colour all lines which conduct high-voltage orange. The high-voltage lines are secured to prevent polarity reversal.
They cannot be incorrectly installed, as they are colour and mechanically coded.
The high-voltage system has a potential equalisation line. This line is monitored by the hybrid system.

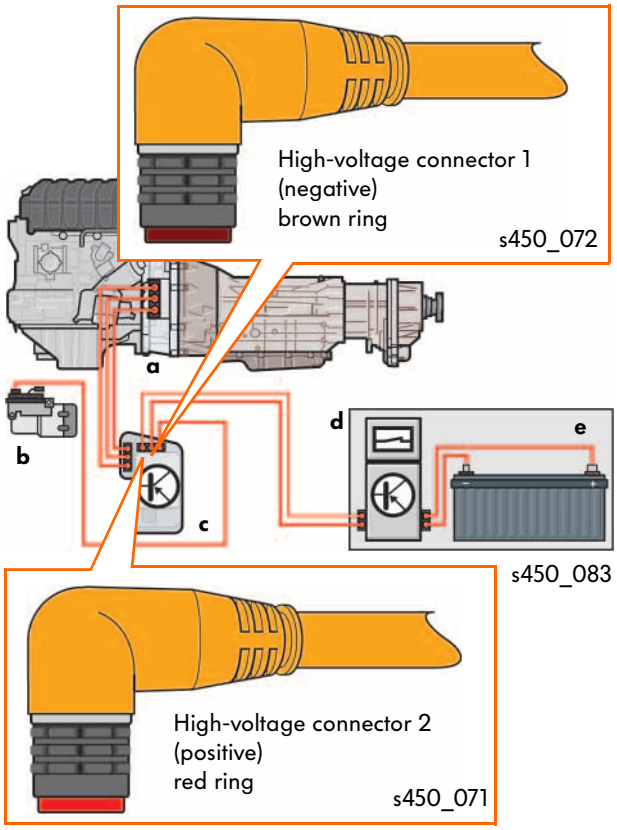
The following line sections are formed in the high-voltage system:
- Two high-voltage lines from the high-voltage battery to the power electronics,
- Three high-voltage lines from the power electronics to the electric motor/generator,
- One two-wire high-voltage line from the power electronics to the air conditioner compressor.



Electrical components

From the high-voltage battery to the power electronics

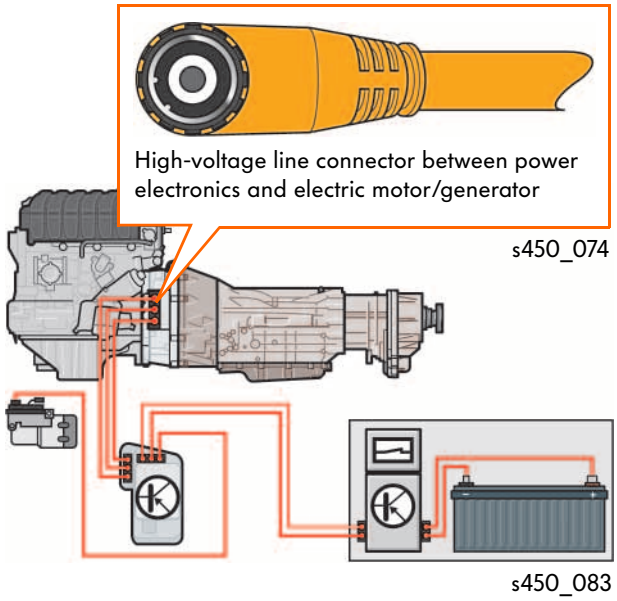
Between the high-voltage battery and the power electronics, the electrical charges are transmitted via two orange-coloured high-voltage lines. Both lines conduct a potential.
A DC voltage of 288 Volt is present.
The 1-pin lines are designed with a screen.



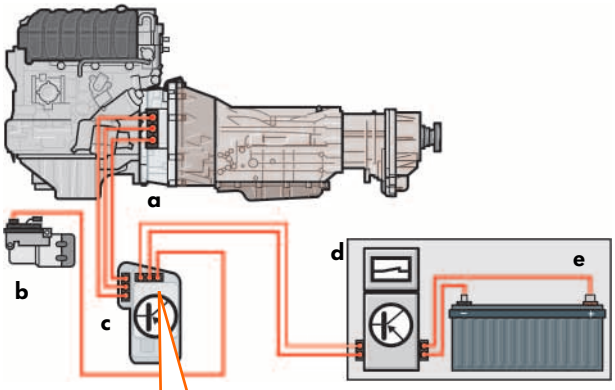
From the power electronics to the electric motor/generator

In the power electronics, the high-voltage battery's 288 Volt DC voltage is converted by a DC/AC voltage converter into a three-phase AC voltage (alternating current) for operating the electric motor. The electric motor is connected to the power electronics via three short high-voltage cables. Like all of the others, the three-phase lines are colour and mechanically marked and coded so that they cannot be interchanged with each other.

For the corresponding designations of the lines in the service literature, please refer to the parts catalogue.



From the power electronics to the air conditioner compressor



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s450_073

Connector for connecting the air conditioner compressor to the power electronics

Legend

a - Electric drive motor V141 (electric motor)
b - Electric air conditioner compressor V470
c - Power and control electronics for electric drive JX1
d - Connection and distribution box SX1 (electronics box)
e - High-voltage battery

Due to the air conditioner compressor, the air conditioner forms part of the Touareg Hybrid's high-voltage system.
This innovative actuation of the compressor has the advantage that the climate inside the vehicle can be controlled when the combustion engine is switched off. The air conditioner remains active depending on the battery's state of charge. If the high-voltage battery's charge declines further, the system automatically starts the combustion engine.

The air conditioner compressor is connected to the power electronics via a line. Thanks to colour and mechanical coding, it is not possible to interchange the high-voltage lines.

This two-pin line is designed with screening and the safety line's line. If one of this line's two connectors is disconnected, this corresponds to removing a safety connector.
The high-voltage system is deactivated.

The safety concept

In the event of improper handling, the high-voltage current system poses a danger due to its high voltage of 288 Volts. In order to reduce the potential danger and to avoid improper work on the system or unintentional contact with high voltage, the Touareg Hybrid is equipped with an extensive safety concept.

The safety concept components include:

- The electric safety line with safety connector,
- The ignition lock,
- The protective relays in the electronics box,
- The airbag control unit,
- The maintenance connector,
- The battery regulation control unit.

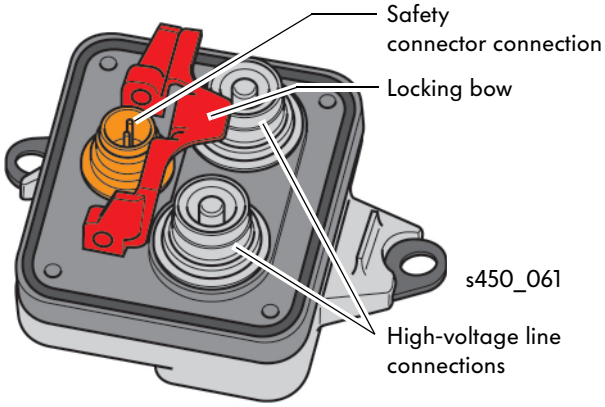
The electric safety line with safety connector

The safety line is a safety concept which contains a mechanical and an electric component.

Task

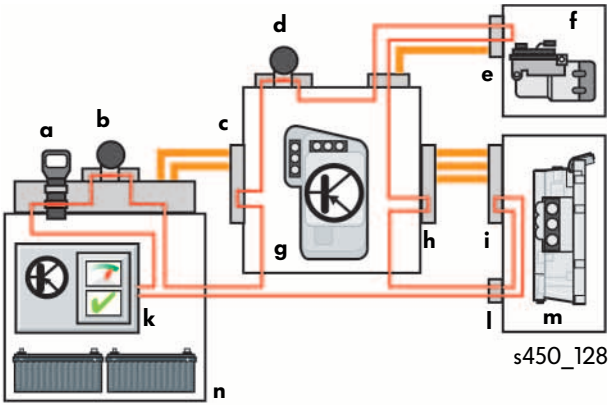
The safety line guarantees that the entire high-voltage system's voltage is switched off as soon as a high-voltage component is disconnected from the system. Together with a locking bow, the safety connector additionally forms a mechanical lock, which prevents the high-voltage lines from being disconnected whilst conducting voltage.

The safety line is like an electrical circuit which is closed by its safety connectors. If this circuit is opened by removing the safety connectors, the high-voltage system shuts off.
The safety connectors have to be removed before high-voltage lines can be disconnected from the high-voltage components. This guarantees that the system is not conducting voltage when the lines are disconnected.



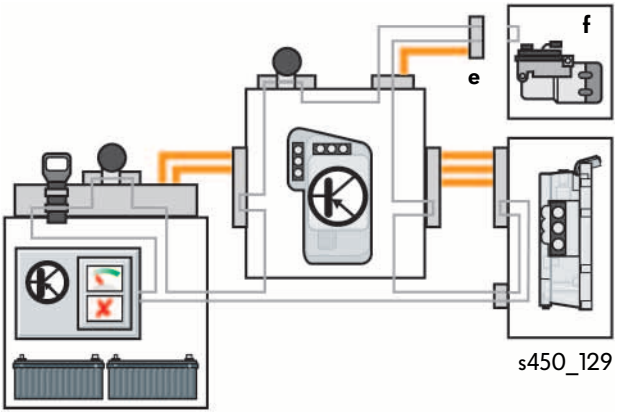
The safety connector bracket with the mechanical locking bow (red) on the electronics box with the safety connector removed and high-voltage lines disconnected

Safety line closed



All high-voltage components are ready to operate.

Safety line interrupted



Example: Disconnection of the high-voltage line from the compressor

Legend

a - Maintenance connector
b - Safety connector 1
c - Traction system distributor cover
d - Safety connector 2
e - Air conditioner compressor connector
f - Air conditioner compressor
g - Power electronics
h - Power electronics 3-phase cover
i - Electric motor connection box
k - Battery regulation control unit
l - 14-pin connector for motor/generator wiring sensors
m - Electric motor/generator
n - High-voltage battery with electronics box

How the safety line works

All of the high-voltage system's components are connected to each other via a separate low-voltage line in a loop.
In this case, the component's connection with the safety line is designed as a contact breaker point. When all components are ready to operate, the contact breaker points are closed. If voltage is now applied to the safety line, current is able to flow because the line is not interrupted. The measurable current is therefore an indication of the fact that all of the safety line's components are ready to operate. The function of the safety line is comparable with cold monitoring in the case of bulbs.

If a contact breaker point is opened because a component is not ready to operate or because the safety connector has been removed, the safety line is interrupted. No current is able to flow on application of a voltage. This is an indication of the fact that the high-voltage system is not ready to operate.

The check to determine whether the safety line is closed or interrupted is carried out by the battery regulation control unit in the electronics box. If the control unit ascertains that the line is interrupted, it does not actuate the protective relays and therefore interrupts the high-voltage battery's connection to the high-voltage system.

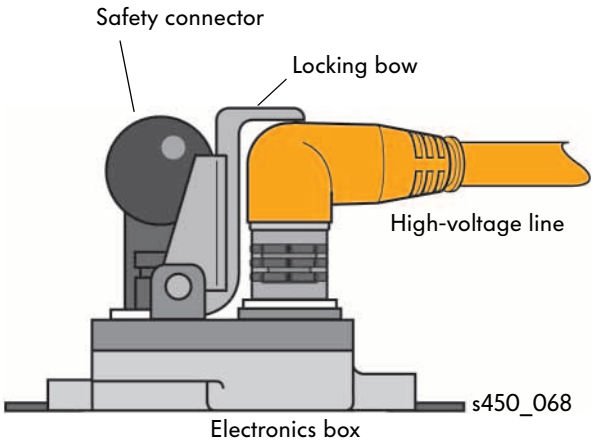
Electrical components

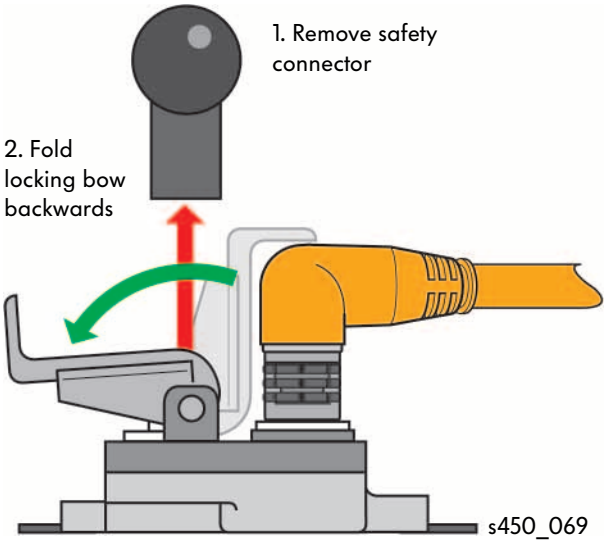
How the mechanical lock with the safety connector works

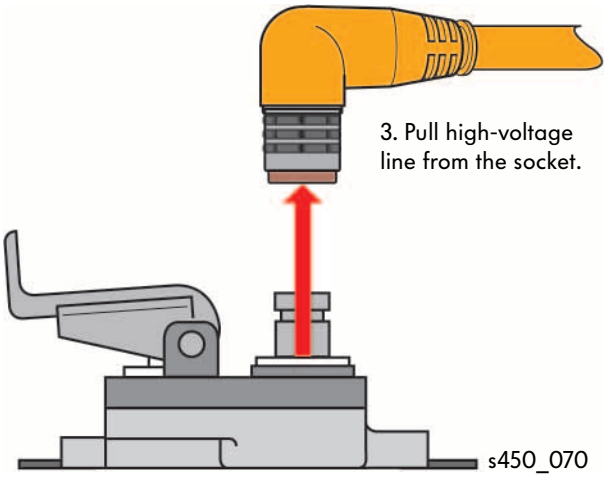
At the start of this work, it is vital to remove the maintenance connector.
This work must only be carried out by a high-voltage technician qualified by Volkswagen.
If the high-voltage line to the power electronics is connected to the electronics box, a locking bow must be swiveled over the two connectors before the safety connector can be inserted.
In connection with the safety line, this means that the high-voltage system is only supplied with current when the safety connector is connected.
The high-voltage connections are therefore always inserted when no current is flowing.

In turn, the high-voltage line can be disconnected from the electronics box only if the safety connector has been removed beforehand. Only then can the locking bow be swivelled back to disconnect the high-voltage line's connectors.

As the safety connector has had to be removed beforehand, the safety line is interrupted and the battery management control unit has decoupled the high-voltage battery via the protective relays.
No further voltage is therefore present at the contacts for the high-voltage line, and no electric shocks can occur when disconnecting the high-voltage line.







Attention!
This work must only be carried out by a qualified Volkswagen high-voltage technician.

The ignition lock

Via the information "Ignition key is inserted", the ignition lock requests the high-voltage system to switch to drive readiness mode. For the battery management control unit, the information "Ignition key is inserted" is a condition which has to be met so that the control unit actuates the protective relays for coupling the high-voltage battery to the high-voltage current system. If the ignition key is removed, the control unit automatically separates the high-voltage battery from the high-voltage system.

Battery regulation control unit shut-off measures

The battery regulation control unit closes the contactors as soon as terminal 15 (ignition on) has been switched on. If the voltage supply for the battery regulation control unit is disconnected, the contactors are opened.
Vehicle electrical system off means that the high-voltage system is off. Fire brigades can introduce measures for deactivating the high-voltage system on-site.
The contactors are opened by the battery regulation control unit J840 when:

- The ignition is deactivated
- The safety line is separated
- The seat belt pre-tensioners have triggered
- The airbags have triggered
- The 12 V battery is disconnected from the vehicle electrical system

The airbag control unit

To reduce the danger posed to occupants and rescue services by the high-voltage system in the event of a crash, the crash detection signal from the airbag control unit is also evaluated by the battery regulation control unit J840. If a crash is detected, the battery regulation control unit disconnects the high-voltage battery from the high-voltage current system via the protective relays.
In the first crash stage, in which only the seat belt pre-tensioners have triggered, the protective relays are opened. This process is reversible. This means that the protective relays can be closed again following a new ignition cycle. If the seat belt pre-tensioners and the airbags have been triggered in the second crash stage, disconnection of the high-voltage battery from the high-voltage system is irreversible. This means that the protective relays can not be closed again via a new ignition cycle. This process must be carried out using the workshop tester.
The triggered airbags therefore indicate to the rescue services that the contactors have been opened in the event of a crash and that the high-voltage system has therefore been disconnected from the high-voltage battery.

The electric motor sensor system

The rotor position senders

As the combustion engine with its speed senders is mechanically decoupled from the electric motor in electric mode, the electric motor requires a separate sensor system to determine the rotor position and the rotor speed. Three speed sensors are integrated into the electric motor for this purpose.
They are:

- Drive motor rotor position sender 1 G713
- Drive motor rotor position sender 2 G714
- Drive motor rotor position sender 3 G715

Signal use

Based on the signals from this total of three individual sensors the engine and gearbox management system receives information regarding whether, and the speed at which, the electric motor is rotating. The signal is used to control the following high-voltage drive components:

- Electric motor/generator as a generator
- Electric motor/generator as a motor
- Electric motor/generator as a combustion engine starter

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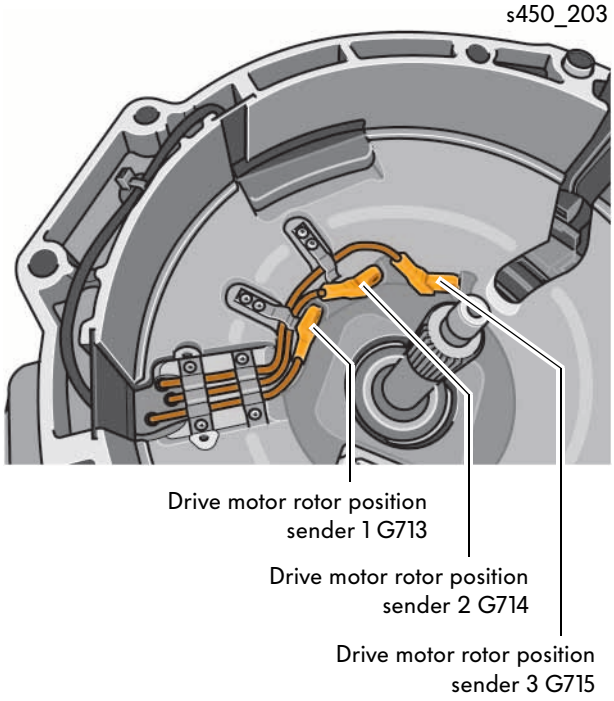
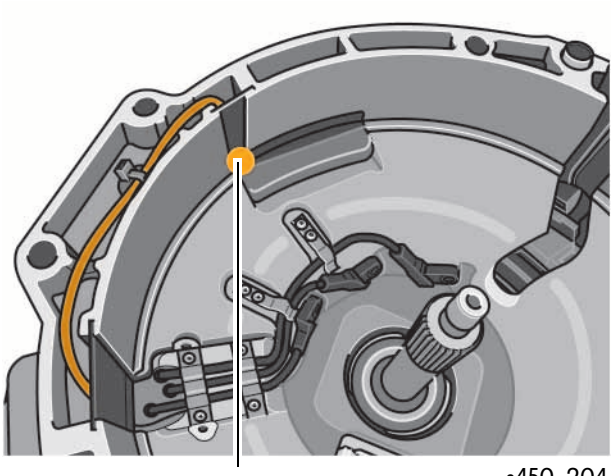


Effects in the event of failure

In the event that the sensors fail, the warning lamp for the hybrid system appears in the instrument cluster.
The nearest workshop must be visited.
Starting the engine again is no longer possible.
The request not to switch off the combustion engine then appears in the instrument cluster. This is to ensure that the vehicle can still reach a workshop.

Drive motor temperature sender G712

This sensor is cast into synthetic resin in the electric motor's housing.



Drive motor temperature sender G712, cast into the electric motor's housing

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Signal use

It detects the temperature of the electric motor. The cooling circuits form part of the innovative thermal management system. The electric motor temperature sensor signal is used to control the high-temperature circuit's cooling capacity. Via an electric auxiliary coolant pump and the combustion engine's engaged water pump, the cooling capacity can be regulated from standing coolant to maximum.

Effects in the event of failure

In the event that the sensor fails, the warning lamp for the hybrid system appears in the instrument cluster.
The nearest workshop must be visited.
The vehicle remains able to drive, but hybrid drive operation is very limited.

Warning
Even AC voltages of 25 Volts and DC voltages of 60 Volts are hazardous to persons.
It is therefore vital to observe the safety instructions in the service literature and in guided fault finding plus the warnings on the vehicle. Only qualified personnel who are aware of the hazards of high voltage may carry work out on high-voltage vehicles.

The electrical components in the hybrid technology

Because the combustion engine is decoupled and deactivated during electric driving with the electric motor/ generator, the components which perform comfort- and safety-relevant tasks for vehicle operation must be driven electrically. In the Touareg Hybrid, all functions which are guaranteed by a rotating combustion engine in a conventionally driven vehicle are carried out by means of electric motors and pumps.
This is necessary to adequately supply e.g. the brake system, the power steering system, the gearbox hydraulics and the vacuum system with the required pressures even in electric mode. Depending on the ancillary units' power requirements and power consumption, these are assigned either to the 12 Volt vehicle electrical system or the 288 Volt high-voltage system.

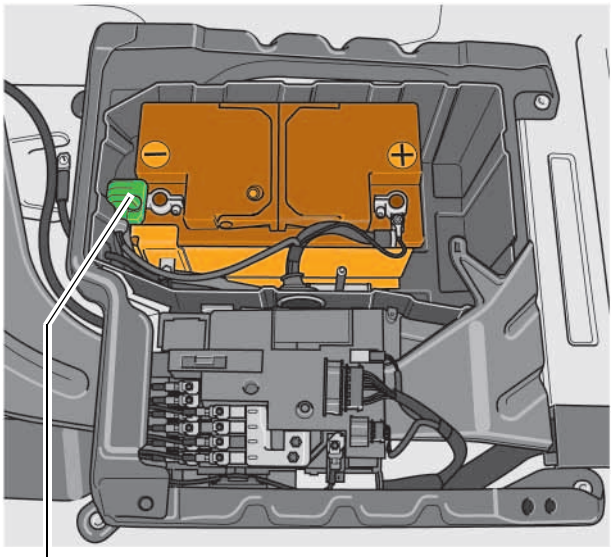
12 Volt components

All electrically driven ancillary units are assigned to the 12 Volt vehicle electrical system.
Only the air conditioner compressor is connected to the high-voltage system. All electrically driven ancillary units are capable of diagnosis.

The 12 V battery

This is installed beneath the driver seat and supplies the 12 V vehicle electrical system with electrical energy. The hybrid vehicle has no conventional 12 V alternator.
The 12 Volt vehicle electrical system supply is made available by the high-voltage battery via a DC/DC converter in the power electronics.
Battery monitoring is carried out via the battery monitor control unit J367 with battery sensor. This is located on the negative terminal of the 12 V battery cable.

If the 12 V battery is discharged, it can be charged via the jump-starting points in the engine compartment. The battery charge is used to activate the control units, close the high-voltage protective relays and make the ignition available for the combustion engine.



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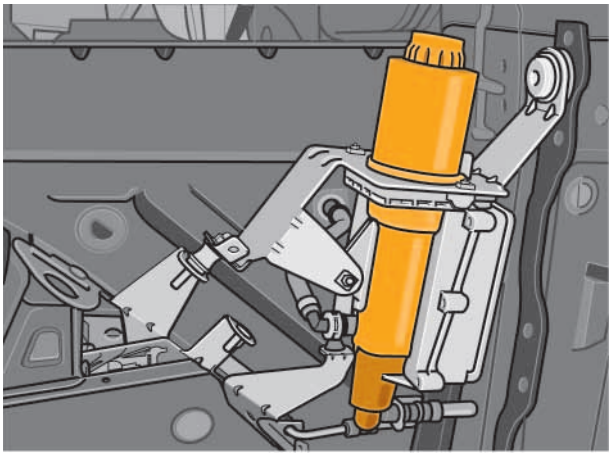
J367 battery monitor control unit with battery sensor



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Effects in the event of failure

Without the pressure which the electric pump builds up, the combustion engine and the electric motor cannot be mechanically decoupled. Driving the vehicle purely electrically is no longer possible. Only the combustion engine can be used to drive the vehicle.

A hybrid warning lamp is displayed on the instrument cluster display. The request not to switch off the combustion engine additionally appears in the instrument cluster display, as restarting is not possible.

A workshop must be visited.

The pressure regulator for disengagement clutch K0 N511

The pressure regulator is installed in the front left wheel housing above the wheel housing liner. In a conventional Touareg, this is the location of the auxiliary heater.

Task

The pressure regulator supplies the release bearing of the single-plate disengagement clutch between the combustion engine and the electric motor with the necessary hydraulic pressure. The hydraulic fluid reservoir is the brake fluid expansion tank.
When the ignition is deactivated, the clutch is closed. The electric motor is therefore immediately able to rotate the combustion engine when the combustion engine is started.
The clutch is always closed when the combustion engine is running.

Design

The pressure regulator is a spindle actuator. The "brake fluid" is pressed to the clutch release bearing via an electric motor.
The pressure regulator can be diagnosed and learnt values can be set via the tester.

The fluid in the pressure line also has to be changed when the brake fluid is changed.

Electrical components

The electrical power steering pump V466

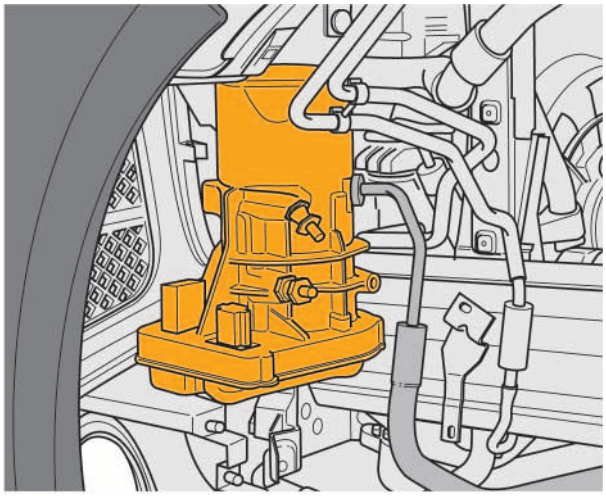
The power steering pump for the electrohydraulic power steering is mounted on a bracket on the front left wheel housing beneath the headlight.

Task

It supplies the requirement-controlled working pressure for the power steering's hydraulic system. Regulation is carried out depending on the vehicle speed, the steering angle and the speed with which the steering wheel is moved.

Effects in the event of failure

No steering assistance is available in the event that the power steering pump fails. However, the steering can continue to be actuated with an increased level of force.



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The coolant pump for high-temperature circuit V467

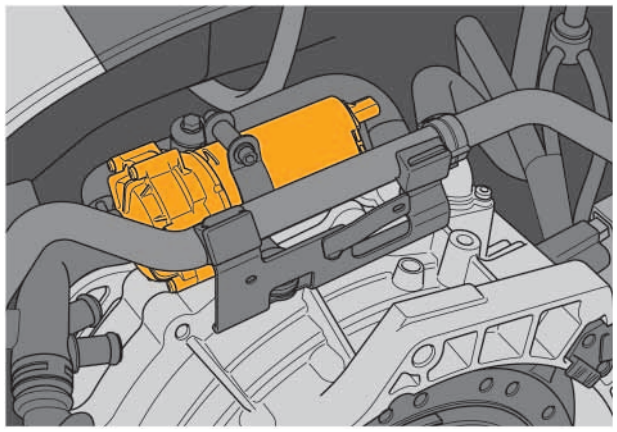
This forms part of the innovative thermal management (ITM) system.

Task

This electrical pump pumps the coolant in the high-temperature cooling circuit system. It ensures that an adequate supply of coolant and therefore adequate heat transport to the radiators is guaranteed even in electric mode.

Effects in the event of failure

If the pump fails, a fault entry is written to the fault memory. The heat output to the interior is reduced but still functional. All of the high-temperature circuit's valves are opened and the main water pump on the combustion engine is activated. Hybrid operation is possible to a limited degree.



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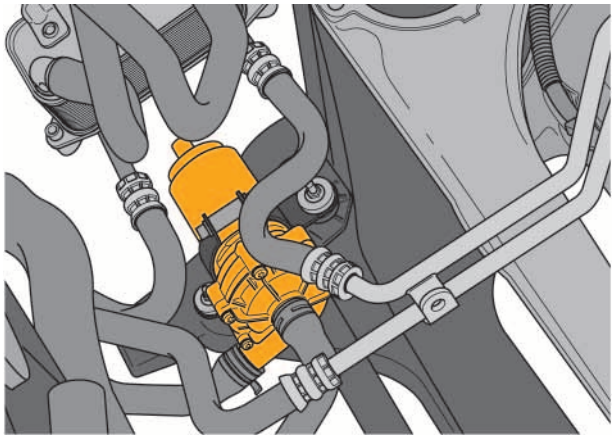

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Effects in the event of failure

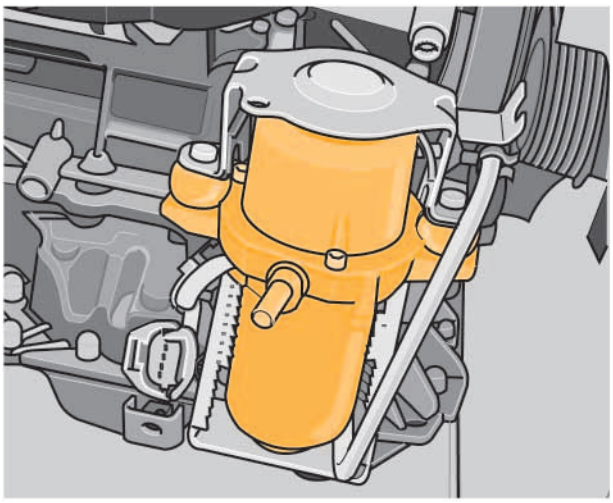
If the pump fails and the power electronics overheat, a warning message appears in the instrument cluster. Hybrid operation is possible to a limited degree. A workshop must be visited.

Coolant pump for low-temperature circuit V468

The coolant pump is mounted on the right-hand longitudinal member in the area of the vehicle's engine.

Task

This electrical pump pumps the flow of coolant in the low-temperature circuit. The low-temperature circuit passes through the power electronics and the combustion engine's charge air cooler.



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Effects in the event of failure

In the event of a defective vacuum pump, the combustion engine starts. Driving electrically is no longer possible.

The brake servo vacuum pump V469

This is bolted to the front right of the engine from below.

Task

During electric mode, the brake servo vacuum pump alone is responsible for generating vacuum. It therefore also ensures the vacuum required for the brake servo. On starting and during combustion engine operation, it is able to run to provide support. The vacuum pump additionally supplies the vacuum for controlling the shutter for the on-demand coolant pump on the combustion engine.
An internal pressure accumulator ensures a pulsation-free, constant vacuum.

Electrical components

Auxiliary hydraulic pump 1 for gearbox oil V475

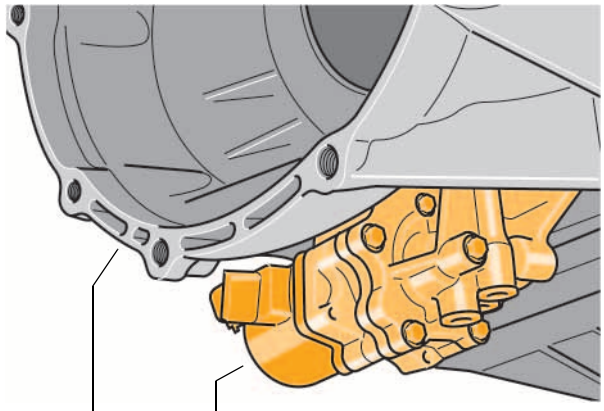
This is mounted beneath the gearbox torque converter bell housing.

Task

The auxiliary hydraulic pump supplies the gearbox with oil pressure during electric driving. Depending on operating conditions, it can also start up during engine operation to support the ATF pump.

Design

It consists of an electric motor which drives the hydraulic pump. The electric motor is a brushless DC motor. It consists of a stator and a rotor.



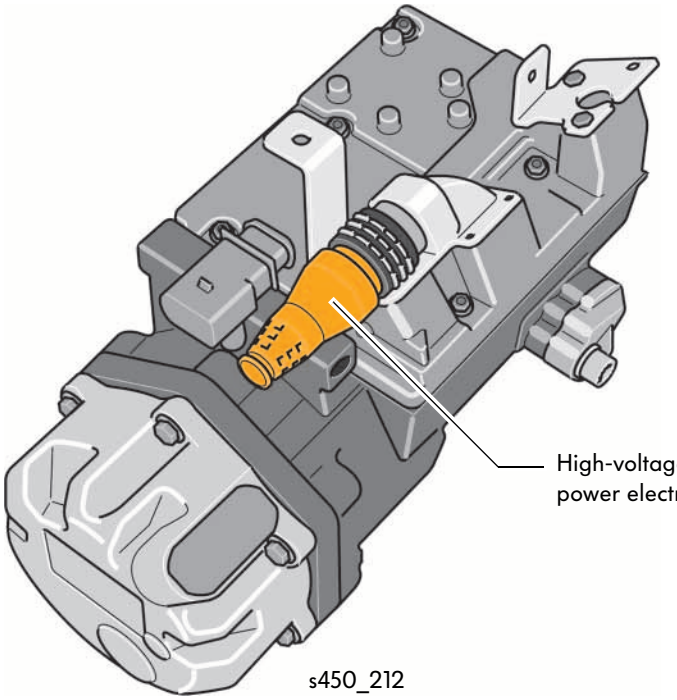
Effect in the event of failure

Position sensors in the auxiliary hydraulic pump detect whether a malfunction is present based on the rotational speed of the DC motor. The malfunction is reported to the gearbox control unit. The automatic gearbox control unit J217 requests the engine control unit to start up the mechanical ATF pump via the combustion engine or the electric motor.

Further information on the auxiliary hydraulic pump can be found in self-study programme 466 "The 8-speed Automatic Gearbox 0C8".

288 Volt components

The air conditioner compressor in the Touareg Hybrid is supplied with 288 V DC voltage by the power electronics.



The electrical air conditioner compressor V470

Due to its connection to the high-voltage system, the air conditioner compressor can also be operated during purely electric driving.

The interior can also be air conditioned when the vehicle is stationary, i.e. when the combustion engine is deactivated. This is always carried out depending on the high-voltage battery's state of charge.
The 288 Volt DC voltage is converted into an AC voltage via a voltage converter integrated into the compressor.

Warning
When working on the air conditioner compressor, the high-voltage system must be de-energised by a Volkswagen high-voltage technician. Always refer to the workshop manual or guided fault finding to determine the work during which the high-voltage system has to be deactivated, i.e. its voltage has to be de-energised.

Electrical components

Design

The compressor is driven by an asynchronous DC motor. A DC/AC voltage converter is integrated into the compressor.
The heat which is created in the voltage converter, the air conditioner compressor and the DC motor is dissipated via the connection to the vehicle's coolant system.

The compressor's connection to the high-voltage system is mechanically and colour coded so that the cables and connectors cannot be interchanged.
By removing the high-voltage line connector at the air conditioner compressor, the safety line routed in the cable is interrupted and the high-voltage system is deactivated.

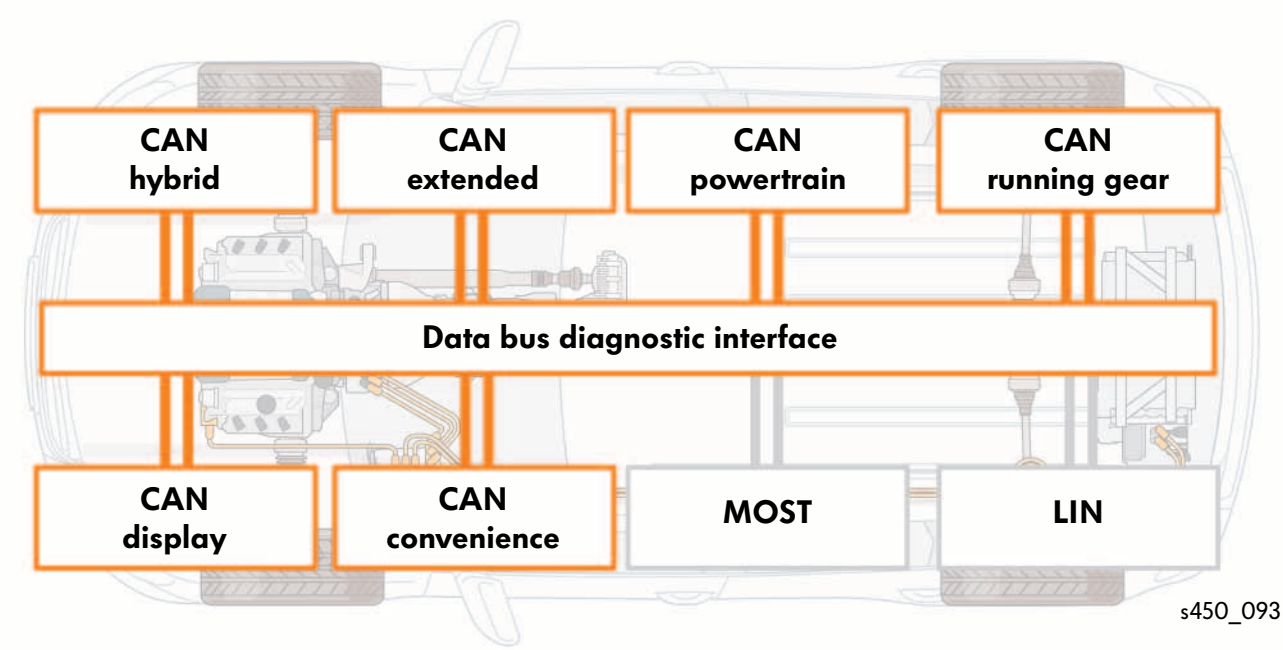
Effects in the event of failure

In the event that the air conditioner compressor fails, no climate control is possible for the interior.
The yellow hybrid warning lamp appears in the instrument cluster, together with the request to visit the nearest workshop.

Data bus communication

A high number of different pieces of vehicle information have to be registered, evaluated and exchanged between the different vehicle systems for the control processes when switching between the Touareg Hybrid's different operating modes.
In addition to the familiar powertrain, convenience and infotainment CAN data bus networks, further CAN data bus networks such as e.g. CAN running gear, CAN extended, CAN display and CAN hybrid are also available for this purpose.

Information from the MOST and LIN networks is additionally processed.
The common interface for all of these networks is the data bus diagnostic interface (gateway).



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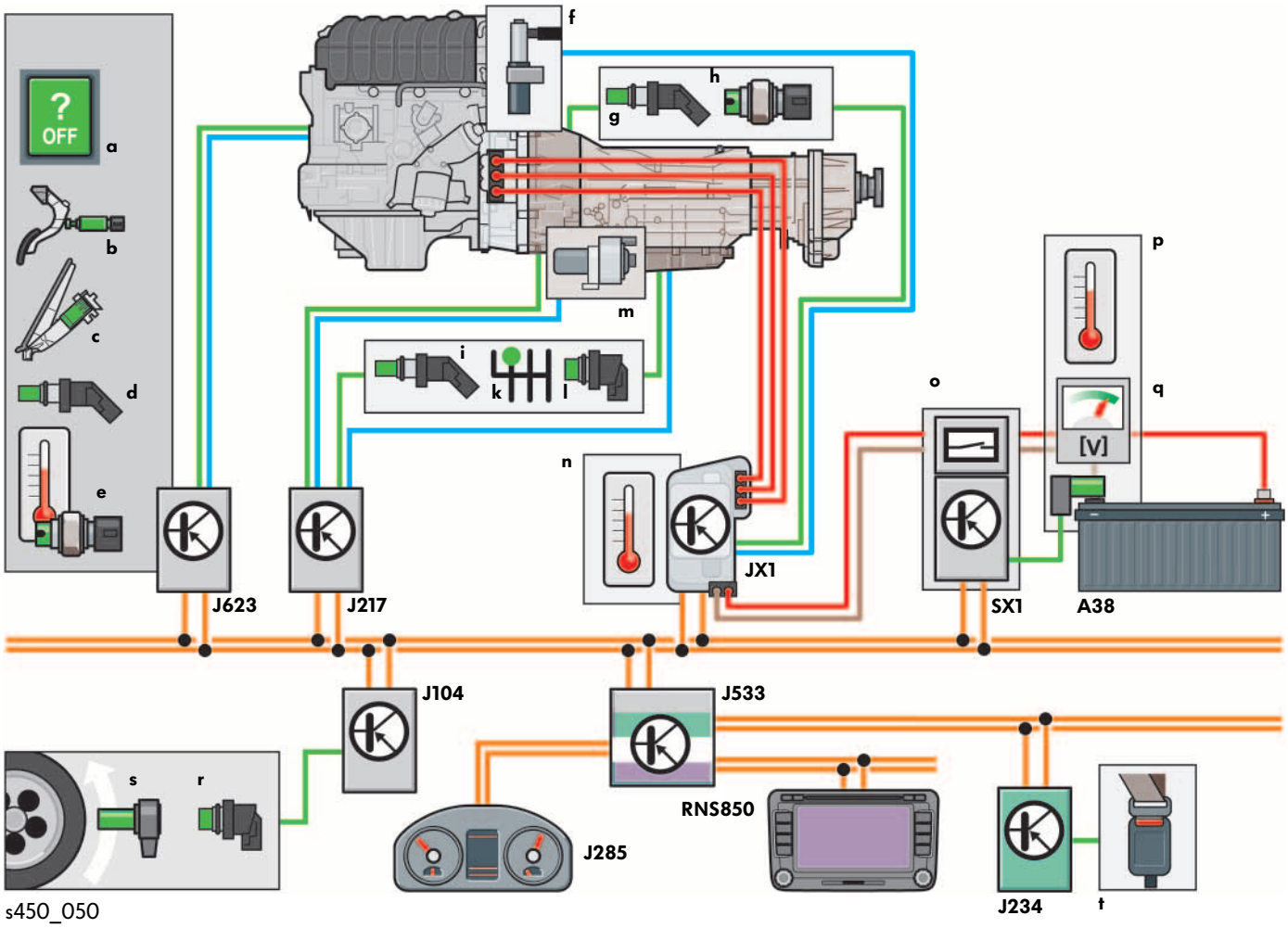
Legend

CAN powertrain	-	Communication among engine management system, gearbox management system, airbag system, etc.
CAN convenience	-	Communication among seat memory, trailer detection, immobiliser, etc.
CAN running gear	-	Communication among ABS/ESP, shock absorber regulation and self-levelling suspension, electric parking brake, steering angle sensor, etc.
CAN extended	-	Communication among air conditioner compressor, headlight range control, electrohydraulic power steering, etc.
CAN display	-	Communication among instrument cluster, Park Assist system, climate control, etc.
CAN hybrid	-	Communication among engine control unit, spindle actuator, power electronics, electric motor/generator, etc.
MOST	-	Communication among radio/navigation system, instrument cluster, audio system, etc.
LIN	-	Communication among seat occupied recognition system, PTC regulation, blower regulation, etc.

System layout



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Input signals
Output signal
CAN data bus
High-voltage system positive
High-voltage system earth

Legend for input and output signals

a Electric mode on/off
b Brake actuation signal
c EPC signal
d Engine speed
e Engine temperature
f Clutch actuation, combustion engine/ electric motor/generator
g Electric motor/generator rotational speed
h Electric motor/generator temperature
i Gearbox rotational speed
k Gear recognition
l Gearbox hydraulics temperature
m Clutch hydraulic pump, gearbox hydraulic pressure, gear selector
n Power electronics temperature
o High-voltage line monitoring
p Battery temperature
q Voltage monitoring
r Brake system hydraulic pressure, brake pressure
s Wheel speed detection
t Seat belt recognition

The depicted system layout shows a selection of components and signals which are required for driving mode with the electric motor. As described above, a multitude of other input and output signals are actually exchanged between all vehicle systems involved in driving mode, e.g. to operate the heater and air conditioning system, the power steering system, the brake system, etc.
Co-ordination of the vehicle systems is particularly important when switching from electric mode to the combustion engine and vice-versa, so that related changes in drive torque do not impact negatively on driving comfort. This means that the engine management system, the gearbox management system and the hybrid regulation system, in particular, are precisely co-ordinated to each other.

When switching between electric mode and combustion mode, the priority also switches between the engine control unit and the power electronics. In combustion mode, the engine control unit is the dominant control unit. In electric mode, the power electronics take precedence over the engine control unit.

The hybrid drive's system management communicates with the driver via four methods:

- The radio/navigation system's touch screen (RNS 850)
- Hybrid-specific warning lamps in the dash panel insert
- Text messages in the dash panel insert display
- Vehicle status descriptions in the dash panel insert display

Legend for electrical components

A38	High-voltage battery
J623	Engine control unit
J217	Automatic gearbox control unit
JX1	Power and control electronics for electric drive
SX1	Connection and distribution box (electronics box)
J104	ABS control unit
J285	Control unit in dash panel insert
J533	Data bus diagnostic interface
J234	Airbag control unit
	Radio/navigation system RNS 850

The innovative thermal management system

The introduction of the new engine control unit generation MED 17.1.6 with triple processor also enabled the implementation of the innovative thermal management system. Its objective is to further reduce consumption and CO_2 emissions via optimised vehicle thermal management. Optimised thermal management means that all thermally strained components and assemblies which are connected to the cooling system, such as the engine or gearbox, are kept within a temperature range which is optimal for their efficiency. In the Touareg Hybrid, the cooling system is divided into a low-temperature and a high-temperature circuit. Besides the additional electrical coolant pumps, the innovative thermal management system is also equipped with a on-demand main coolant pump, via which the delivery flow can be adapted to the required cooling capacity.

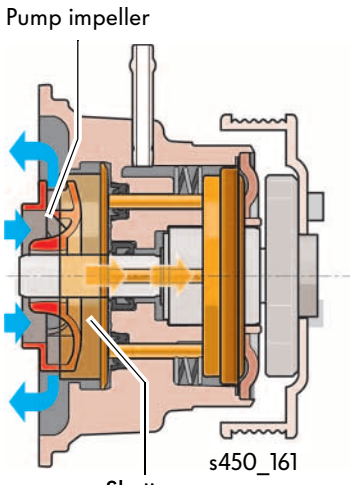
The on-demand coolant pump on the combustion engine

Task

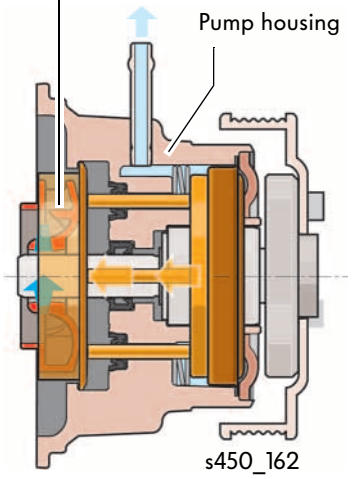
The on-demand coolant pump can be used to influence the coolant delivery flow in the high-temperature circuit irrespective of the engine speed.

Design

The on-demand coolant pump differs from the regular coolant pump in that it has a shutter which can be moved over the pump's impeller with the aid of a vacuum unit. The coolant delivery flow is therefore set according to the requirements. Volumetric flows from stationary coolant up to and including full delivery rate can be generated in the coolant circuit.



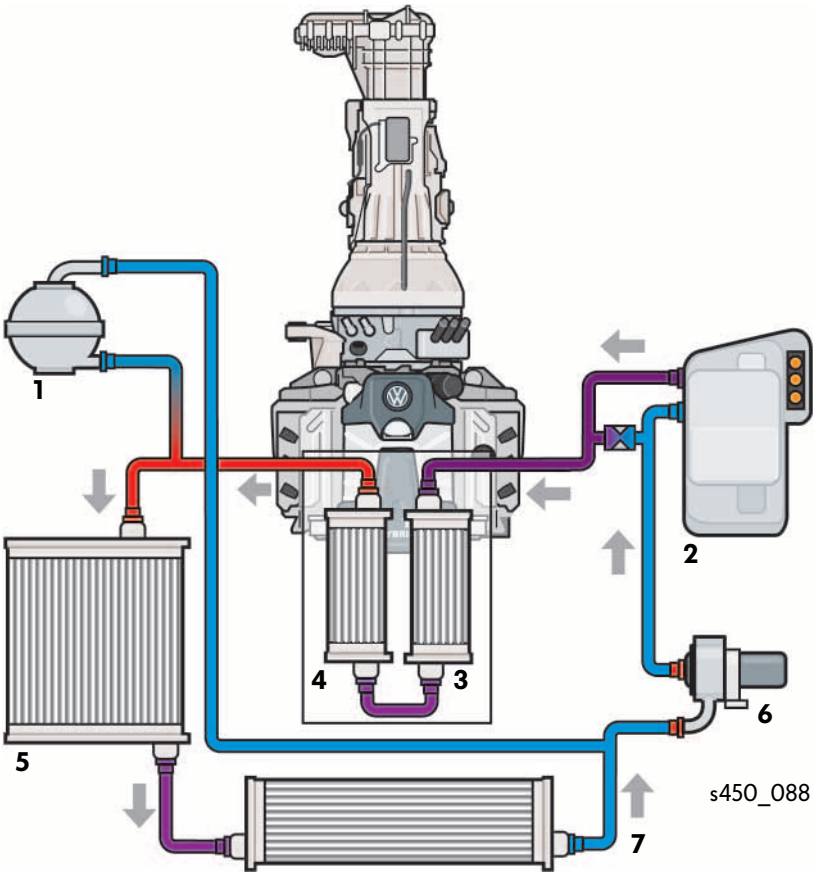
Pump in delivery mode
The shutter releases the running pump impeller. The delivery flow is able to flow unimpeded.



Pump not in delivery mode
The shutter shields the running pump impeller and therefore blocks the delivery flow.

Further information on the on-demand coolant pump can be found in self-study programme No. 452 "The 3.0l V6 245kW TSI Engine with Supercharging in the Touareg Hybrid".

The low-temperature cooling circuit



Legend

1 Coolant expansion tank
2 Power electronics
3 Charge air cooler 1
4 Charge air cooler 2
5 Low-temperature radiator 1
6 Electrical low-temperature coolant pump
7 Low-temperature radiator 2

Task

The low-temperature cooling circuit passes through those components which do not require or tolerate a high temperature during operation.

Design

In the Touareg Hybrid, the combustion engine's two charge air coolers and the housing of the 288 Volt system's power electronics are integrated into this cooling circuit. Heat output to the environment is carried out via two low-temperature cooling elements as heat exchangers.

How it works

In this circuit, the temperature is also regulated by the innovative thermal management system in the engine control unit. However, this is carried out independently of regulation in the high-temperature cooling circuit. The delivery flow in this coolant circuit is maintained exclusively by the electrical low-temperature coolant pump.
The low-temperature cooling circuit operates with the same coolant as the high-temperature cooling circuit.

The high-temperature cooling circuit

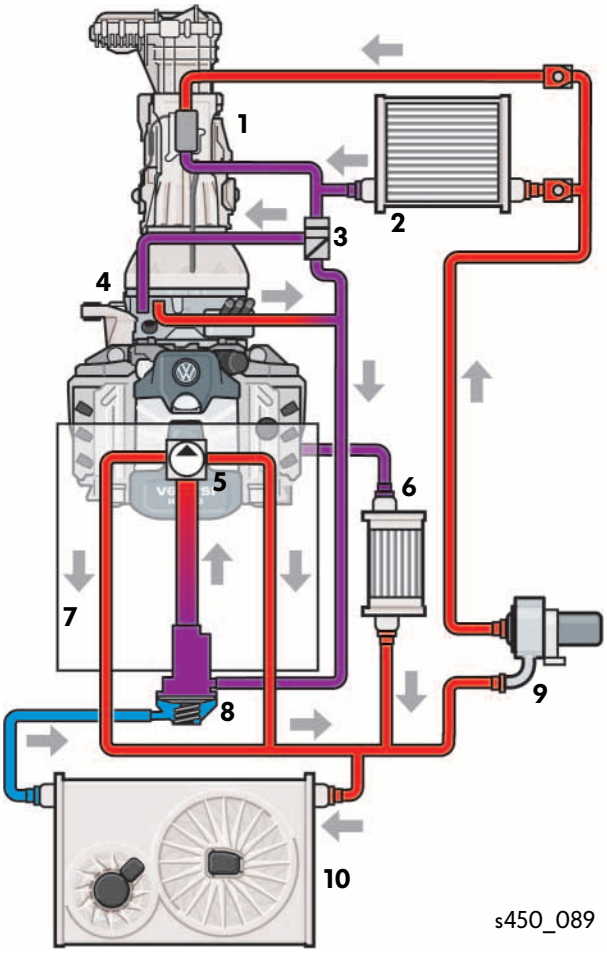
The high-temperature cooling circuit encompasses the engine and gearbox cooling, electric motor/generator cooling, and engine oil cooling systems as well as the heat exchanger for the heater and air conditioner.

Design

To achieve the high functionality of the innovative thermal management system, this cooling circuit is equipped with an electrical auxiliary coolant pump and a switching valve in addition to the on-demand main coolant pump on the combustion engine.

How it works

Depending on operating conditions, the coolant volumetric flow is reduced in order e.g. to heat the cylinder head more quickly. In this case, the volumetric flow of the main coolant pump is blocked. If, in contrast, a higher volume of heat has to be transported away to the radiator, the volumetric flow of the main coolant pump is increased by engaging the electrical auxiliary coolant pump. With the aid of the switching valve, the electric motor can be decoupled or coupled from or to the cooling circuit until its optimal operating temperature is reached. When the main coolant pump is shut off, it may also occur that only the electrical pump initially delivers until the permissible temperature limit values, e.g. in the cylinder head, are exceeded. Only then does the main coolant pump begin to deliver again.
The innovative thermal management system therefore reacts very flexibly to the temperature requirements and temperature conditions in the vehicle.



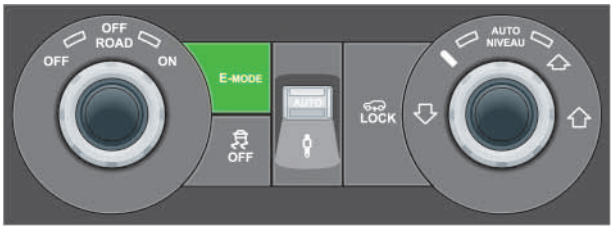
Legend

1 Gearbox pre-heating
2 Heater heat exchanger
3 Switching valve
4 Electric motor/generator
5 Switchable coolant pump
6 Engine oil cooler
7 Engine cooling circuit
8 Coolant thermostat
9 Electrical high-temperature coolant pump
10 Radiator

The displays and controls for driving in hybrid mode

The Touareg Hybrid is equipped with the following displays and controls for driving in electric mode:

- The display in radio/navigation system RNS 850
- The display in the dash panel insert
- The button for extended electric drive mode



s450_106

Effects in the event of failure

Failure has no effect on the hybrid drive. Only the additional function of extended electric driving is no longer possible.

Button for extended electric drive mode E709

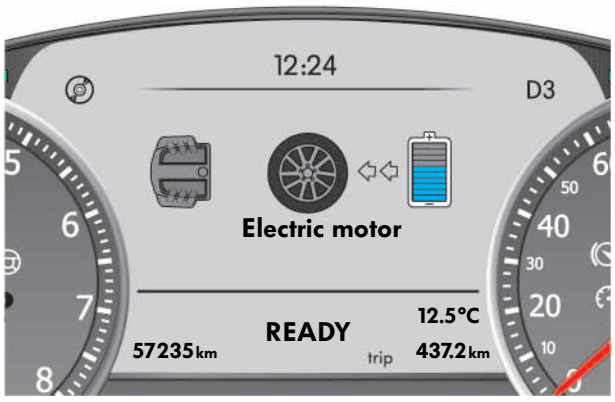
The electric drive button (electric mode button) is located in the button module between the two rotary switches for suspension regulation on the centre console. The size and position of the button within the button module varies depending on the vehicle's equipment, e.g. with or without air suspension.

Signal use

The driver can use this button to extend the limits of electric driving. The idea behind this is that hybrid drivers can leave their residential areas without making a noise in the morning when they are on their way to work. The combustion engine's minimum temperature threshold is lowered using the electric drive button. This enables electric driving with the hybrid vehicle to be carried out earlier.

The display in the dash panel insert

Electric driving mode (electric driving) is also displayed in the dash panel insert. The symbol for the high-voltage battery and arrows pointing to the wheels indicate that the vehicle is being driven via the high-voltage battery and the electric motor.
The display in the dash panel insert also indicates all other driving statuses. The portrayals are merely adapted according to the driving status.



s450_163

If a fault occurs in the high-voltage system, a warning lamp is output. This warning lamp may light up in the colours in orange, red or black. Depending on the type of fault in the high-voltage system, the corresponding colour and a request text are displayed.

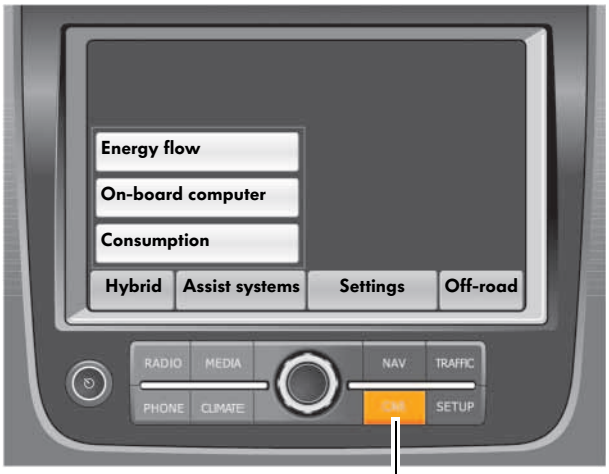
s450_164

If the high-voltage system detects that the electric motor's output of 34kW is sufficient to drive the vehicle, the combustion engine is switched off.
The driver only notices this process due to the fact that the rev. counter drops to zero.
The combustion engine may be shut off during vehicle operation irrespective of speed.
The rev. counter may therefore drop to zero even at a speed of 110km/h, for example.

Symbol	Message	Meaning
 s450_165	Hybrid system not currently available. Electric mode not currently available. Start the combustion engine.	Driving can be continued in combustion mode.
 s450_166	Hybrid system fault: stop vehicle in a safe location!	The vehicle is no longer driveable.
 s450_167	Hybrid system fault: workshop!	The vehicle is still driveable.

The display in radio/navigation system RNS 850

The Touareg Hybrid is supplied with radio/navigation system RNS 850.
This offers the option of having information on driving with the combustion engine or the electric motor displayed via the system's touch screen.



s450_191

"CAR" push button

Operating mode display

Pressing the "CAR" button on the RNS 850 takes the user to the display mode, which shows the current operating mode. The information provided there refers to:

- The flow of energy in the drive train
- The high-voltage battery's state of charge ("On-board computer" button)
- The combustion engine's probable range depending on the fuel tank content

The charge control system

The system display shows a battery symbol, via which the high-voltage battery's state of charge is displayed.

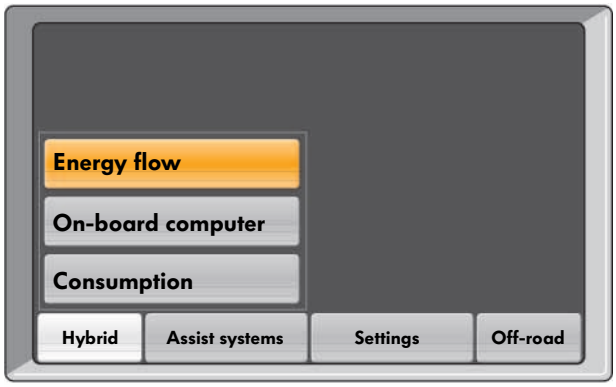
High-voltage battery fully charged
Following a long braking phase, the high-voltage battery may have been charged to this value, e.g. via regenerative braking.

State of charge half charged
Due to electric driving or operation of the electrical air conditioner compressor, e.g. the high-voltage battery may be discharged. This discharge is displayed via a reduction in the high-voltage battery's state of charge.

State of charge at the lower limit
If the high-voltage battery has been discharged, the combustion engine starts automatically when this display is shown, in order to recharge the high-voltage battery. This case may occur e.g. when electric driving is carried out for a long time or if the vehicle is parked for a long time with the air conditioner running.

s450_116
s450_117
s450_118

Pressing on the "Hybrid" text field and selecting the "Energy flow" entry shows the relevant, current energy flow display on the touch screen.

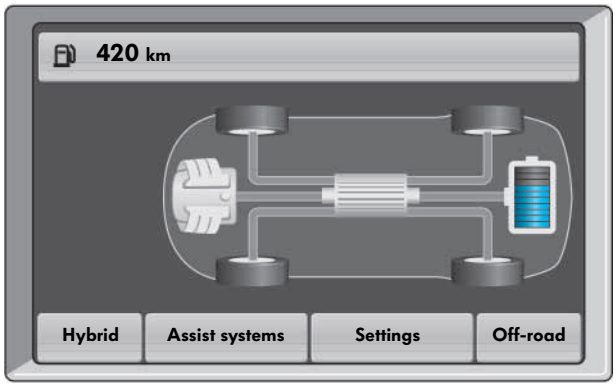


s450_207

Vehicle active and air conditioning system on

Situation

When the ignition is switched on, the user can have this screen displayed on the RNS 850 screen. The vehicle is driveable but stationary. The READY lamp is activated. The air conditioning system can be activated as desired by the vehicle occupants.



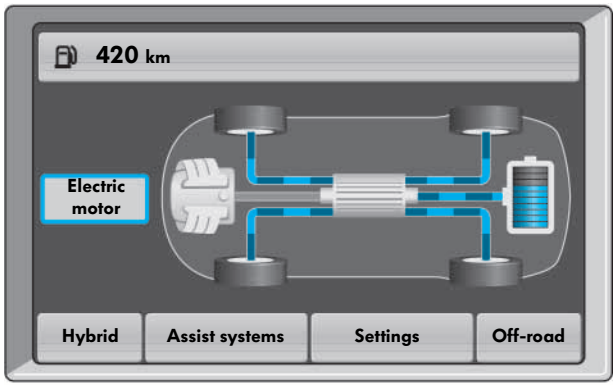
s450_192

System display

Only the high-voltage battery is emphasised in colour on the display; this indicates the high-voltage battery's state of charge.

Primary system conditions

- The high-voltage battery's state of charge is sufficient.
- The vehicle is stationary.
- The ignition key is inserted.
- The vehicle can be driven electrically -> the green READY lettering lights up in the display in the dash panel insert.



s450_194

Driving with the electric motor only

Situation

If the high-voltage battery's state of charge is sufficient, and the motion resistance and the accelerator pedal value are low, the vehicle drives in electric mode.

The vehicle is only driven using the electric motor. The combustion engine is mechanically decoupled via the disengagement clutch.

Primary system conditions

- The high-voltage battery's state of charge is sufficient.
- The vehicle can be driven electrically
  -> the green READY lettering lights up in the display in the dash panel insert.
- The vehicle doors are closed.
- The seat belts are engaged.
- The electronic parking brake is switched off.
- The gear selector lever is set to the R, D, S or Tiptronic position.
- Motion resistance is low
  -> Low rolling resistance
  Vehicle is not excessively laden
  -> Low climbing resistance
  Vehicle is driving on a level surface
  -> Low aerodynamic drag
  Vehicle speed is relatively low.
- Combustion engine coolant temperature is approx. 30°C or
- The button for extended electric drive mode has been actuated.

System display

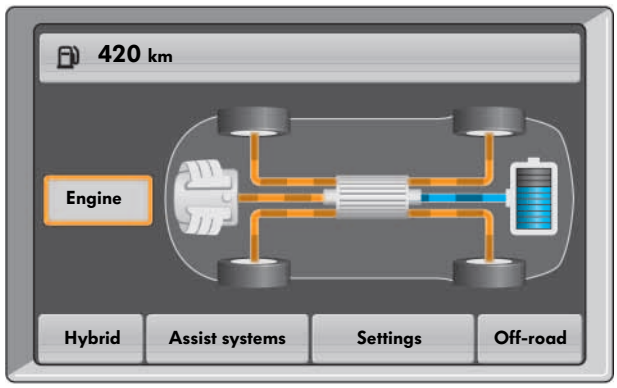
The high-voltage battery's state of charge is displayed. Blue lines running to the drive wheels and a blue outlined text field with electric motor indicate that the vehicle is in electric mode.

System management

Driving with the combustion engine only

Situation

If the hybrid system recognises that the 34kW provided by the electric motor/generator, as a motor, are no longer sufficient to meet the driver's acceleration requirement, the combustion engine is started automatically.
The vehicle is now driven exclusively via the combustion engine. The combustion engine's surplus torque is used to charge the high-voltage battery via the electric motor/generator, which now runs as a generator.



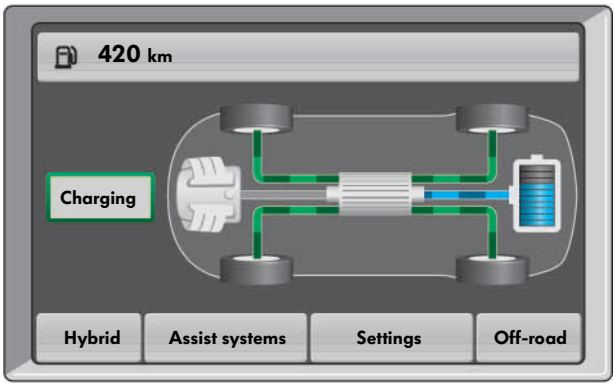
s450_195

System display

The high-voltage battery's state of charge is displayed. Orange coloured lines running to the drive wheels and an orange outlined text field indicate that the vehicle is running with the combustion engine.

Primary system conditions

- The vehicle can be driven electrically.
  -> the green READY lettering lights up in the display in the dash panel insert.
- The vehicle doors are closed.
- The seat belts are engaged.
- The electronic parking brake is switched off.
- The accelerator pedal is actuated.



s450_197

Recuperation

Situation

If the hybrid system recognises that the vehicle is in overrun mode, the combustion engine is deactivated. Depending on the degree to which the brake pedal is actuated, the electric motor/generator, as a generator, generates a stronger field. In order to maintain this field, the automatic gearbox must provide more energy to the electric motor/generator. In this manner, the automatic gearbox and thus the vehicle are braked. The voltage which is generated is converted by the AC/DC converter in the power electronics and is stored in the high-voltage battery.

Primary system conditions

- The vehicle can be driven electrically.
  -> the green READY lettering lights up in the display in the dash panel insert.
- The vehicle doors are closed.
- The seat belts are engaged.
- The electronic parking brake is switched off.

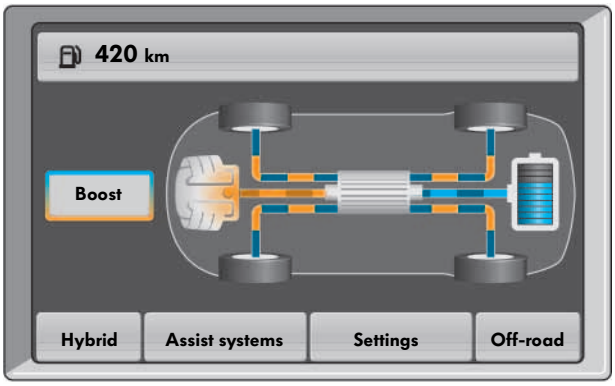
System display

The high-voltage battery's state of charge is displayed.
Green lines move from the wheels to the electric motor.
A green outlined text field labelled "Charging" indicates that the high-voltage battery is being charged. A blue line additionally runs from the electric motor to the high-voltage battery.

Driving with the electric motor and the combustion engine (electric boost)

Situation

The driver causes out a kick-down.
The combustion engine and electric motor combine their maximum output to achieve the maximum possible vehicle acceleration.



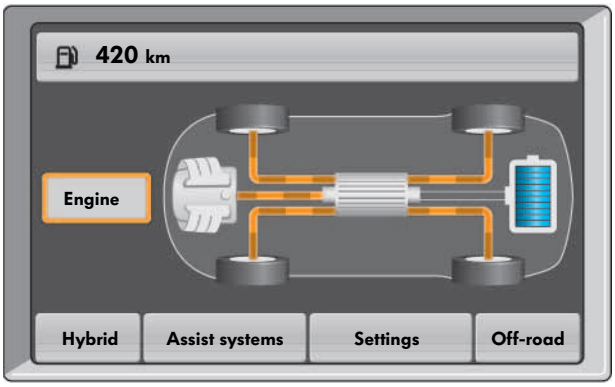
s450_196

System display

The high-voltage battery's state of charge is displayed. Orange and blue lines running to the drive wheels and an orange/blue outlined text field indicate that the vehicle is being driven by the combustion engine and the electric motor.

Primary system conditions

- The high-voltage battery's state of charge is sufficient.
- The vehicle can be driven electrically.
  -> the green READY lettering lights up in the display in the dash panel insert.
- The vehicle doors are closed.
- The seat belts are engaged.
- The electronic parking brake is switched off.
- The accelerator pedal is actuated.



s450_198

Pure combustion mode without high-voltage battery charging

Situation

If the high-voltage battery is fully charged and driving is continued, for example, at a constantly high speed, charging is ended. Only the combustion engine continues to drive the vehicle.

As soon as the high-voltage system detects that the electric motor/generator's output of 34kW is sufficient, the combustion engine is deactivated again.

Primary system conditions

- The vehicle can be driven electrically.
  -> the green READY lettering lights up in the display in the dash panel insert.
- The electronic parking brake is switched off.
- The seat belts are engaged.
- The doors are closed.
- The accelerator pedal is actuated.

System display

On the display, the orange coloured lines run from the combustion engine to the individual wheels. The electric motor's connection to the high-voltage battery remains grey.

Further display modes

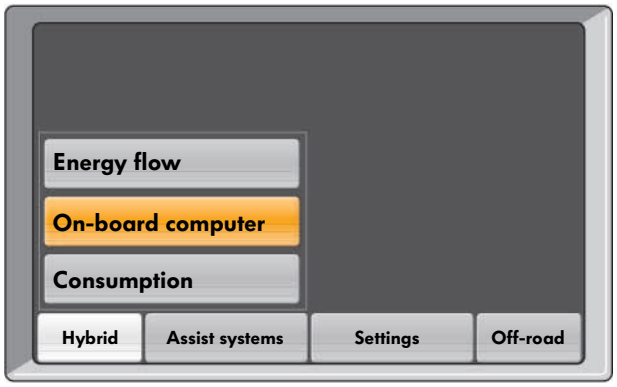
By pressing the "Hybrid" text field on the display screen, the user can choose between the following entries in a selection field:

- Energy flow,
- On-board computer and
- Consumption.

The options for displaying the energy flow have already been described.

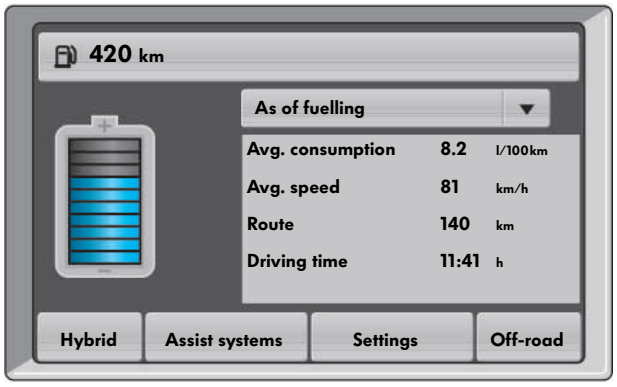
On-board computer

The "On-board computer" selection displays vehicle values such as average consumption, average speed, driving route and time.

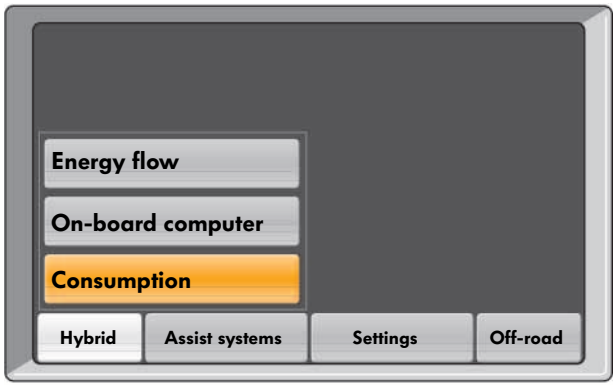


s450_193

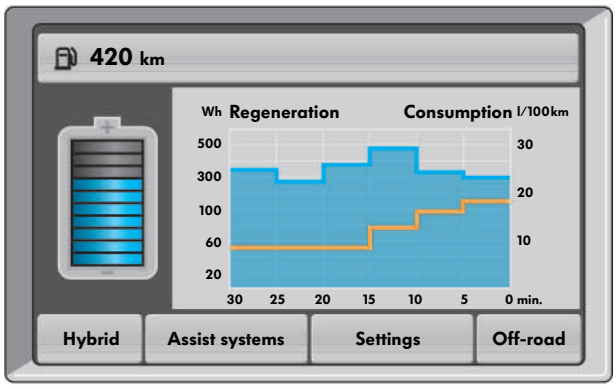
In the upper function on this screen, the user can select the values determined as of the last fuelling stop, the start of the journey or a long-term analysis.



s450_199



s450_206



s450_200

Blue line:
Regeneration energy in watt-hours [Wh]
Orange line:
Fuel consumption in litres per 100km [l/100km]

Consumption

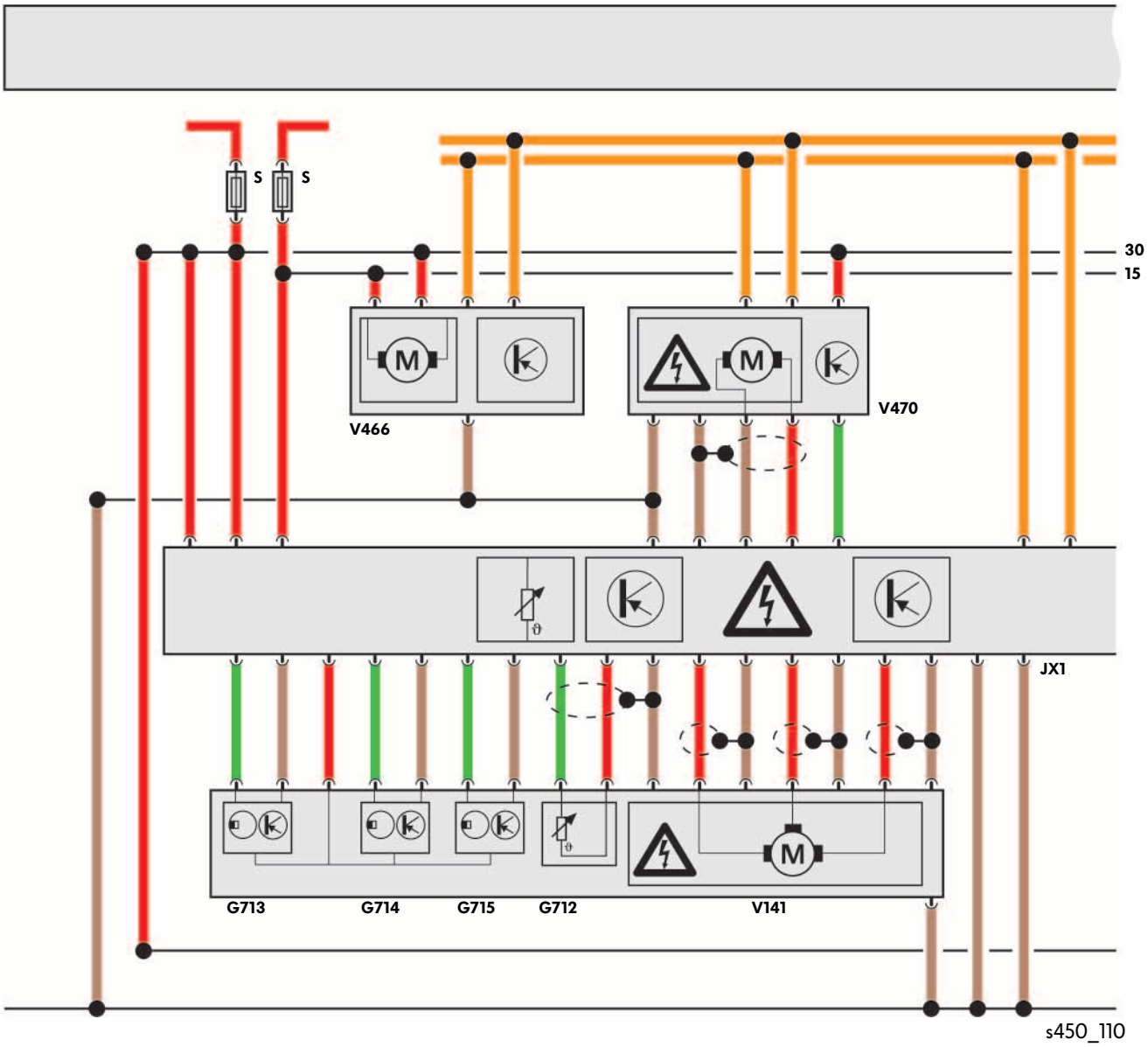
The "Consumption" selection in the Touareg Hybrid is comparable with an electrocardiogram (ECG) for a person. The time since the start of the journey runs from right to left on the chart.

Regeneration in watt-hours [Wh] is shown on the vertical blue axis on the left. The vertical orange axis on the right describes the consumption in litres per 100 km [l/100km].

The objective for the Touareg Hybrid driver is to drive with foresight. This driving style reduces consumption (orange) and increases regeneration (blue). For example, the Touareg Hybrid is braked when driving up to a red traffic light. The longer the overrun or braking process takes, the more energy is stored in the high-voltage battery.
The combustion engine is usually deactivated throughout the entire process.

The kilometres shown at the top left of the display refer exclusively to the vehicle's anticipated range with the corresponding content in the fuel tank. However, the vehicle's anticipated range can be extended by increasingly driving electrically and regenerative braking.
The displayed kilometre value is therefore reduced more slowly.

The high-voltage functional diagram

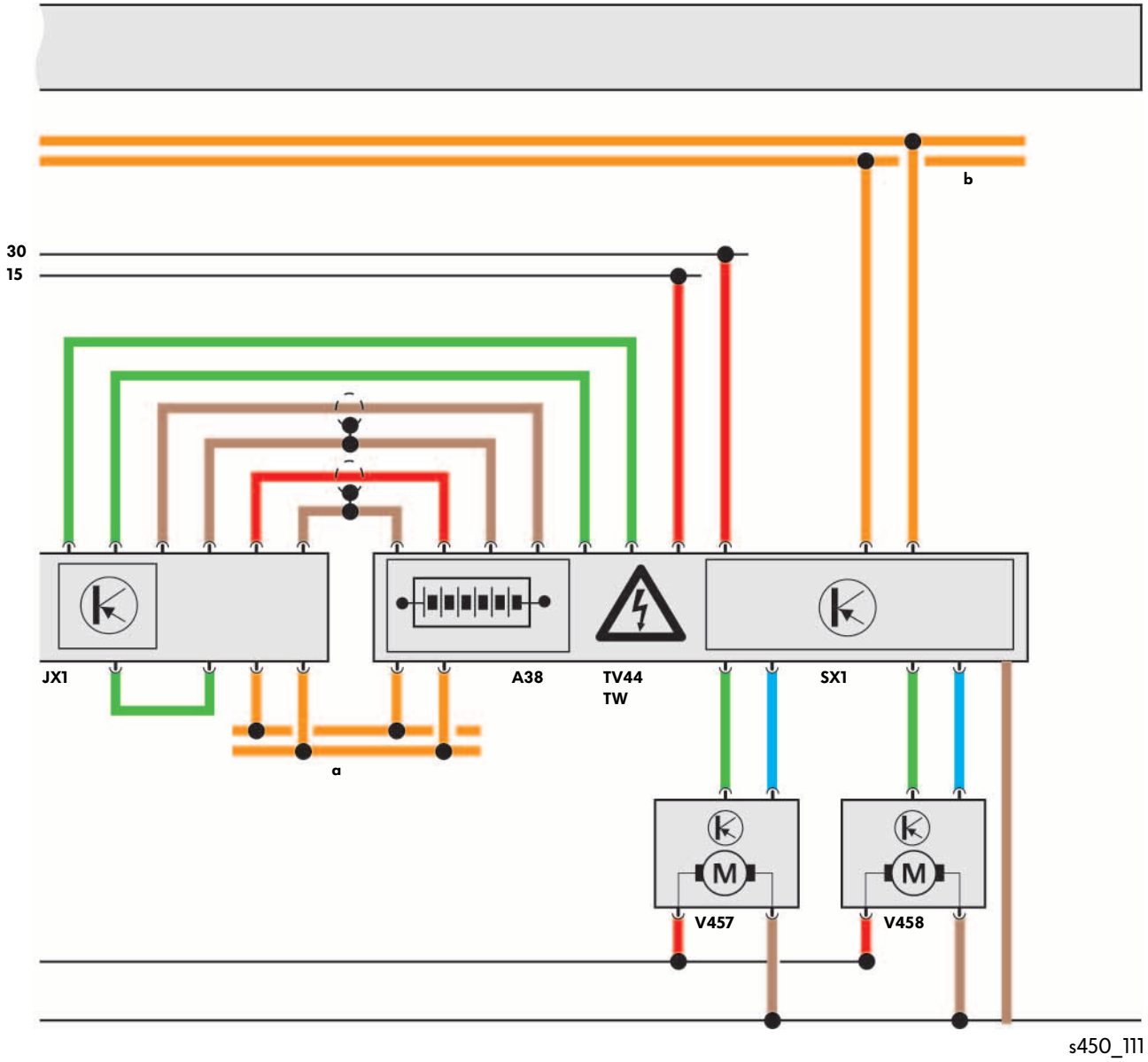


G712 Drive motor temperature sender
G713 Drive motor rotor position sender 1
G714 Drive motor rotor position sender 2
G715 Drive motor rotor position sender 3

JX1 Power and control electronics for electric drive

S Fuse

V141 Electric drive motor (electric motor)
V466 Electrical power steering pump
V470 Electrical air conditioner compressor



A38 High-voltage battery

JX1 Power and control electronics for electric drive
J840 Battery regulation control unit

SX1 Connection and distribution box (electronics box)

TV44 Safety plug 1
TW Maintenance connector for high-voltage system

V457 Battery fan 1
V458 Battery fan 2

a Hybrid CAN data bus
b Powertrain CAN data bus

Special notes

VDE electrical engineering safety regulations

(VDE - Association for Electrical, Electronic and Information Technologies, Registered Association)

It is assumed that the following five safety regulations based on the DIN VDE 0105 series of standards are familiar to every domestic system electrician. This also applies to the responsible person qualified for high-voltage systems in motor vehicles: the high-voltage technician.
These must be applied in the specified sequence prior to work on electrical systems.

These steps are always carried out by the high-voltage technician.

1. **De-energise the system**
2. **Secure the system to prevent re-energising**
3. **Determine that the system is de-energised**

These steps are not relevant for high-voltage vehicles.

4. **Earth and short-circuit the system**
5. **Cover or prevent access to neighbouring parts which are energised**

Attention!
Work on the high-voltage system must only be carried out by a qualified Volkswagen high-voltage technician.

Distinguishing features and warning identification

How can a hybrid Touareg be distinguished from a Touareg with combustion engine?

Hybrid lettering on the designer cover in the engine compartment s450_208

An initial indication that a Touareg Hybrid is involved and therefore a vehicle with a high-voltage system is provided by the model identification on the vehicle. These are:

- The hybrid lettering on the designer cover in the engine compartment
- Hybrid lettering on the front and rear ends of the vehicle
- Hybrid lettering on the chrome strips on the sides of the vehicle

Hybrid lettering in the radiator grille next to the left headlight s450_170

Hybrid lettering on the rear end beneath the right tail light s450_169

How can the location of parts conducting high-voltage be determined?

In order to rule out as far as possible dangers posed by the high-voltage system for the user, service and workshop personnel as well as technical and medical rescue service personnel, numerous warning and notice stickers are affixed in the Touareg Hybrid.

Basically, two types of warning stickers are used:
- Yellow warning stickers with the warning symbol for electrical voltage
- Warning sticker labelled "Danger" on a red background

The yellow stickers indicate high-voltage components which are installed in the vicinity or are concealed beneath covers.
The warning stickers labelled "Danger" identify components conducting high-voltage.

These warning symbols indicate high-voltage components which are installed in the vicinity or e.g. are concealed beneath covers.

Warning regarding hazardous electrical voltage according to DIN 4844-2 (BGV A8)

Warning regarding a danger point according to DIN 4844-2 (BGV A8)

Warning regarding touching parts conducting voltage

s450_108

Warning regarding hazardous electrical voltage according to DIN 4844-2 (BGV A8)

Instruction signs: Observe operating instructions according to DIN 4844-2 (BGV A8)

These warning signs identify high-voltage components or components conducting high-voltage.

s450_107

Warning regarding hazardous electrical voltage according to DIN 4844-2 (BGV A8)

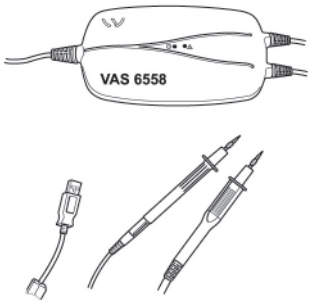
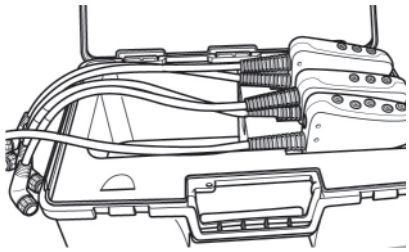
Instruction signs: Observe operating instructions according to DIN 4844-2 (BGV A8)

Warning regarding touching parts conducting voltage

Special high-voltage battery identification
This sticker, in English and the relevant national language, is affixed to the top of the high-voltage battery.

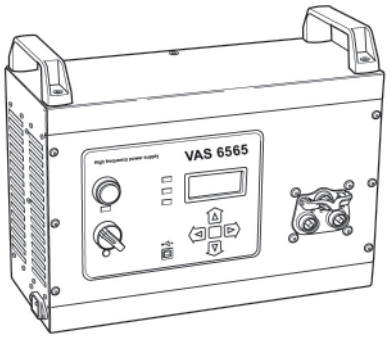
s450_168

Special tools

Designation	Tool	Application
VAS 6558	 s450_181	Hybrid test module This is used to generate a measurement voltage of up to 1000 V with a very low current. With the aid of a test adapter, the hybrid test module can be used to measure whether the system is de-energised. The hybrid test module can also be used to determine the insulation resistance. The hybrid test module is compatible with the VAS 5051B, VAS 5052A and VAS 6150 diagnostic units.
VAS 6558/1-1 VAS 6558/1-2 VAS 6558/1-3	 s450_188	Hybrid test adapter (tester for de-energised state) (VAS 6558/1-1) Hybrid test adapter (insulation resistance) (VAS 6558/1-2) Hybrid test adapter (air conditioner compressor) (VAS 6558/1-3) The adapters are part of the VAS 6558/1 set and are used to measure insulation resistance and test for de-energised state in the high-voltage system. All test adapter high-voltage connection lines are mechanically and optically coded. They only fit into a specific socket. Remove and insert the test adapter high-voltage connections carefully, as the sockets may otherwise be damaged. This results in the loss of contact protection.

Attention!
Work on the high-voltage system must only be carried out by a qualified Volkswagen high-voltage technician.

Adherence to the specifications in the workshop manuals is vital to use the special high-voltage tools properly and safely.

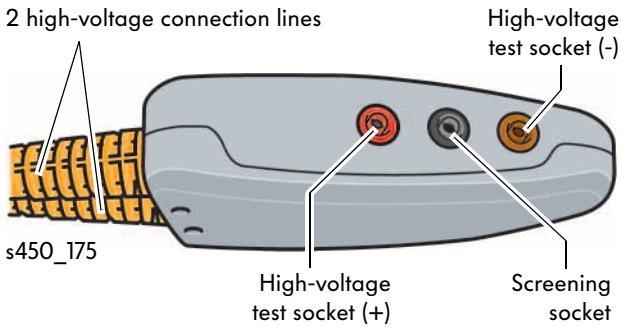
Designation	Tool	Application
VAS 6565	 s450_187	Hybrid charger unit If the high-voltage battery is completely discharged, it can be charged using the hybrid charger unit. The entire charging process is monitored using the VAS tester. The tester starts and ends the charging process. The charger unit can store up to 20 characteristic charging curves. After updating the software, it can therefore be used for future high-voltage vehicles.

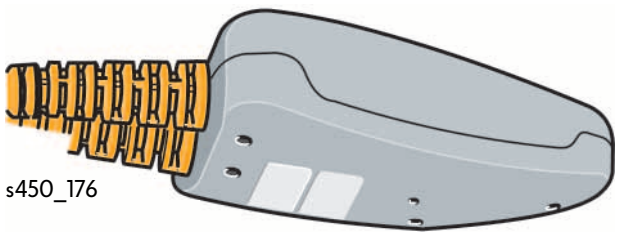
Attention!
Work on the high-voltage system must only be carried out by a qualified Volkswagen high-voltage technician.

Adherence to the specifications in the workshop manuals is vital to use the special high-voltage tools properly and safely.

Special features of the VAS 6558/1 hybrid test adapters

VAS 6558/1-1



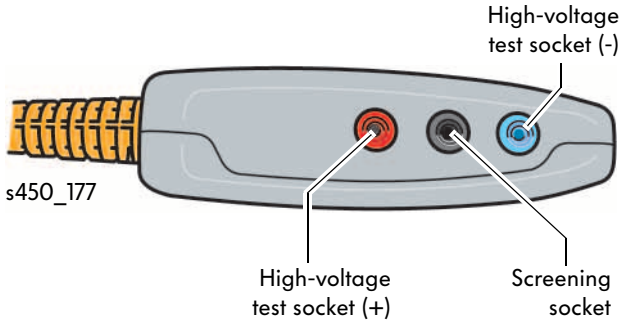


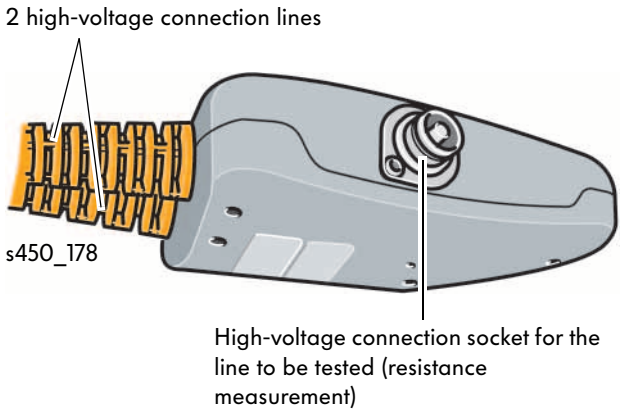
Hybrid test adapter (tester for de-energised state**) VAS 6558/1-1**

The hybrid test adapter (tester for de-energised state) is connected directly to the two voltage sources, the high-voltage battery and the power electronics. High-impedance resistors are installed in the hybrid test adapter. These ensure that only a low current is present in the test sockets in the event of a fault.

Checking the hybrid test adapters each time before testing whether the system is de-energised is mandatory.

VAS 6558/1-2





Hybrid test adapter (insulation resistance) VAS 6558/1-2

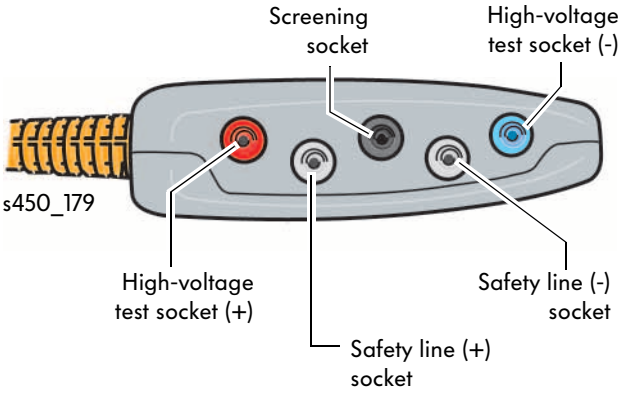
The hybrid test adapter's two high-voltage connection lines fit on the electronics box and the power electronics connections.
The hybrid test adapter's high-voltage connection socket fits on the high-voltage lines of the electronics box, the power electronics and the electric motor/ generator.

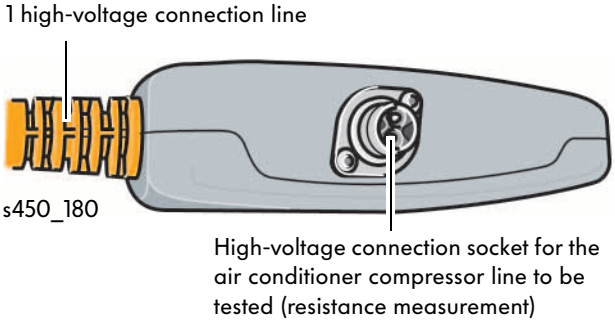
This hybrid test adapter enables the insulation resistance to be measured throughout the entire high-voltage system (not in the air conditioner compressor).

Hybrid test adapter
(air conditioner compressor) VAS 6558/1-3

The hybrid test adapter's high-voltage connection line only fits into the air conditioner compressor socket in the power electronics and the air conditioner compressor itself.
The high-voltage connection socket can be used to determine the insulation resistance in the high-voltage line to the air conditioner compressor.
Due to the integration of the safety line into the air conditioner compressor's high-voltage connection, this hybrid test adapter can additionally be used to check the safety line.

VAS 6558/1-3

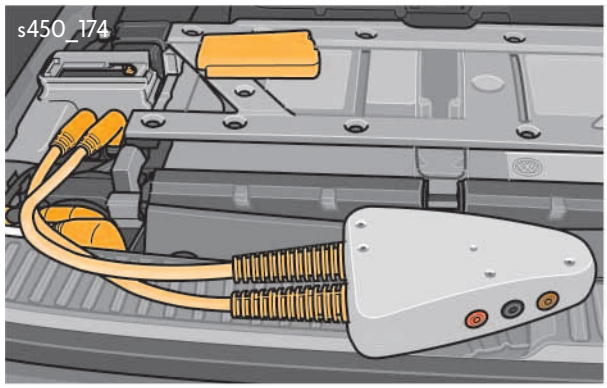


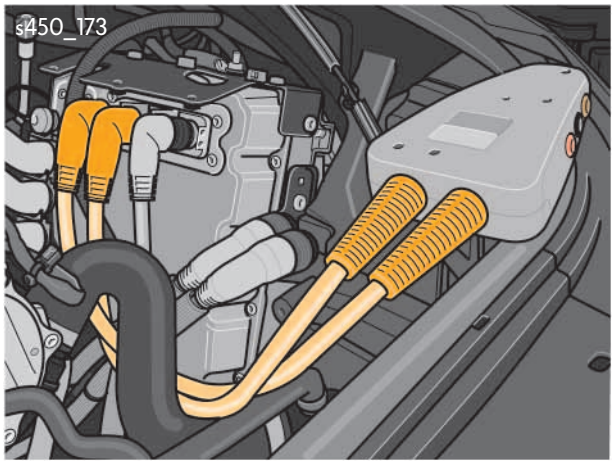


Usage examples

According to the definition of the measurement to determine whether the system is de-energised, measurement must always be carried out at the voltage source. This means that the high-voltage battery and the power electronics must be checked to ascertain whether they are de-energised. The power electronics have intermediate circuit capacitors, whose discharge has to be measured.

During the measurement to ascertain that the electronics box is de-energised, a check is carried out to determine whether the protective relays have opened properly. If approximately zero Volts is measured on the HV(+) and HV(-) sides, the protective relays have opened.





Adherence to the specifications in the workshop manuals is vital to use the special high-voltage tools properly and safely.

Which answers are correct?

One or several of the given answers may be correct.

1. What voltage do the power electronics supply to the air conditioner compressor?

☐ a. 288V AC

☐ b. 188V DC

☐ c. 288V DC

☐ d. 12V DC

2. With the ignition "Off": Which statement is correct?

☐ a. The clutch between the electric motor/generator and the combustion engine is open. The clutch is only closed when the ignition is switched "On".

☐ b. The clutch is closed again when the ignition is switched "Off", so that the hybrid system immediately has the possibility of starting the combustion engine on restarting.

3. Can a Touareg Hybrid be towed away?

☐ a. No, as the hybrid technology will otherwise be destroyed.

☐ b. Yes, but the usual restriction of 50km at a maximum of 50km/h applies.

☐ c. Yes, if necessary.

4. Does the high-voltage system have to be de-energised to remove the air conditioner compressor?

☐ a. Under all circumstances, as the compressor forms part of the high-voltage system.

☐ b. Not in this case, as the air conditioner compressor is supplied with 12 Volts.

☐ c. Depending on the damage case.

Test yourself

5. Can the Touareg Hybrid be slave-started?

☐ a. Yes, if the 12 Volt battery is discharged.

☐ b. Yes, as the 12 Volt battery supplies the starter for the combustion engine with voltage.

☐ c. No, as the high-voltage battery starts the combustion engine even if the 12 Volt battery is discharged.

6. How can the Touareg Hybrid be recognised from the outside?

☐ a. By the lightning symbols on the doors.

☐ b. By the "Hybrid" lettering on the radiator grille and roof.

☐ c. By the "Hybrid" lettering on the radiator grille, the tailgate and the chrome strips at the sides.

7. What options are available to the driver for recognising that the combustion engine has been deactivated by the hybrid system during driving?

☐ a. The rev. counter decreases to zero rpm during driving.

☐ b. The power steering system is deactivated and the steering wheel has to be moved using greater force.

☐ c. The displays in the instrument cluster or in the RNS 850 provide corresponding information.

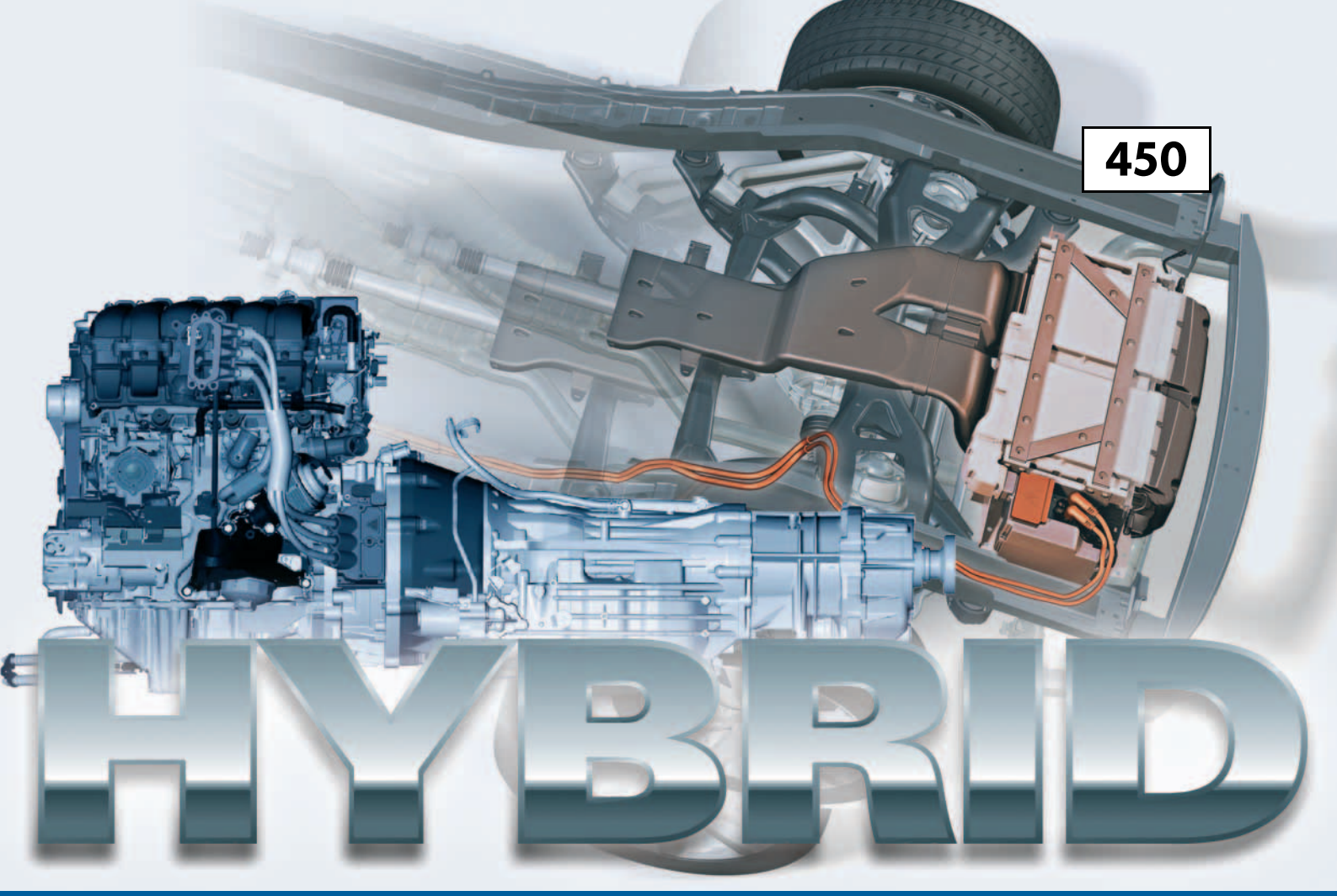
8. What characterises the Touareg Hybrid in comparison with its competitors?

☐ a. The Touareg Hybrid is capable of off-road driving with the same gradability as the conventional Touareg without hybrid.

☐ b. The Touareg Hybrid can pull up to 3500kg.

☐ c. Its wading depth is less than that of the competition.

Answers
1. c); 2. b); 3. b); 4. a); 5. a); 6. c); 7. a), c); 8. a), b)



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