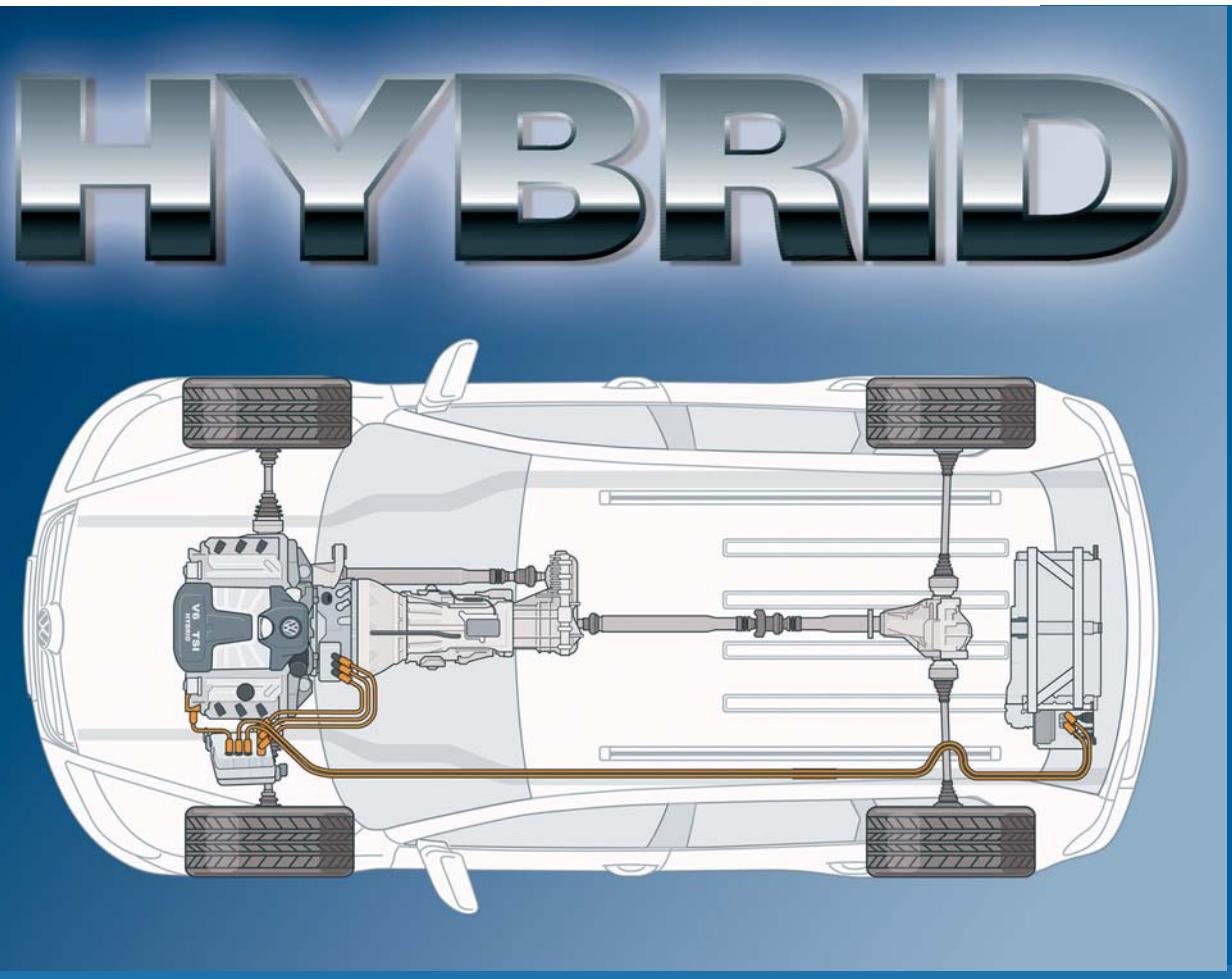
Service Training

Self Study Program 890203

The Touareg Hybrid



Volkswagen Group of America, Inc.
Volkswagen Academy
Printed in U.S.A.
Printed 08/2010

Course Number 890203

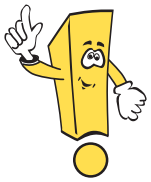
Always check Technical Bulletins and the latest electronic repair information for information that may supersede any information included in this booklet.

Contents

This Self-Study Program provides information regarding the design and function of new models.
This Self-Study Program is not a Repair Manual.

This information will not be updated.
For maintenance and repair procedures, always refer to the latest electronic service information.

Note



Important!

Page intentionally left blank

Introduction

The 2011 Touareg will be the first Volkswagen vehicle to be equipped with a hybrid powertrain.

The Touareg Hybrid is a conventional vehicle that has been converted into a hybrid. This blends the hybrid technology with the already proven Touareg technology. During vehicle development, special emphasis was placed on employee safety when handling and servicing the high voltage technology.

Numerous shut-off and redundant functions in the hybrid system prevent danger to dealership employees.

The 2011 Touareg Hybrid is moving Volkswagen into an electrified future.

S450_133

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 performed by trained high voltage and hybrid Volkswagen technicians.

Improper service of the high voltage system can result in life-threatening situations due to electrical shock.

Personnel with electronic life-sustaining devices should not work on high-voltage systems!

Introduction

This hybrid technology information covers the hybridization of the Touareg's drive train by beginning with a description of the parallel hybrid drive and continuing through to component function and operation.

It was essential that the characteristics of the Touareg were retained, even though hybrid components were introduced. These characteristics are:

- its off-road capability
- its towing capacity
- its high-power and
- occupant comfort.

S450_133

Introduction

The parallel hybrid is a combination of a combustion engine with a 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 objectives 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

These criteria enable a moderate cost increase for high-voltage technology.

- Hybrid-specific production cost control
- Maintenance-free hybrid components
- Full hybrid functionality, ex. implementation of purely electric driving
- Reduction in fuel consumption
- Same level of comfort as comparable hybrid systems from competitors
- Retention of the Touareg's familiar comfort
- Hybrid drive strength
- No reduction in driving performance on or off road
- Hybrid-related, integrated start-stop function
- Electric driving whenever possible

The combustion engine is only started as required.

- Brake energy recovery for charging the high voltage battery
- Towing capacity identical to that of the conventionally-driven Touareg
- Long-term reliability
- Better initial acceleration than with a conventional engine

Basics of Hybrid Technology

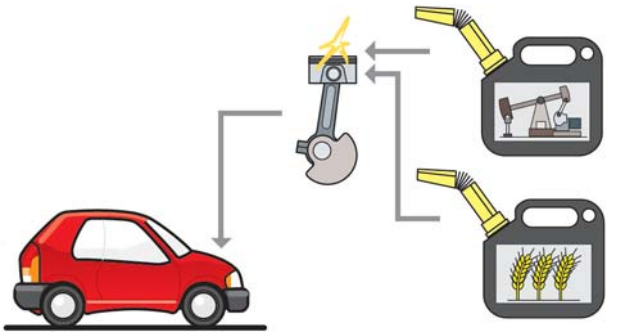
What Does Hybrid Technology Mean?

The term hybrid is derived from the Latin word "hybrida", and means something that is crossed or mixed. In technical 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

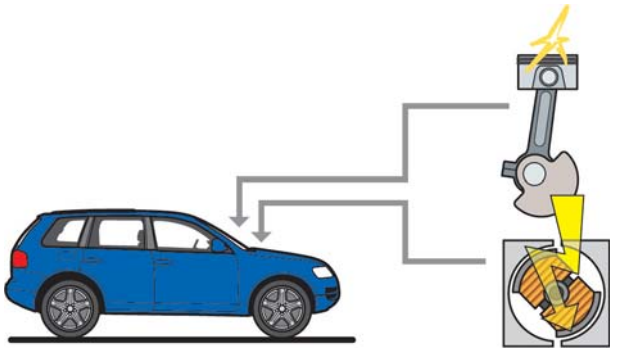
The Bivalent Drive



S45_094

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 (gasoline/ natural gas/LPG), are becoming more popular.

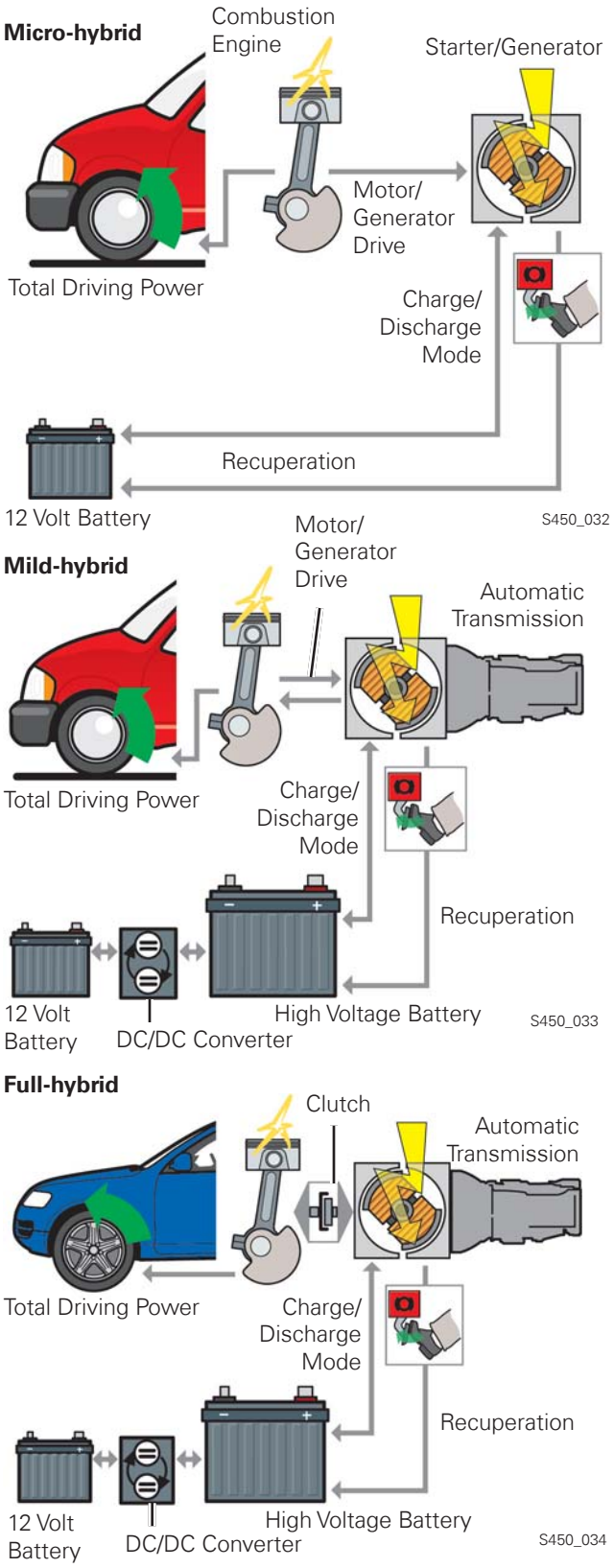
The Hybrid Drive Technology



S45_095

Hybrid drives refer to a combination of two different tractive assemblies, which operate according to different principles. The current understanding of hybrid technology is the combination of a combustion engine and an electric drive. Depending on the direction taken by this basic design, a distinction is made between three types of hybrid drives:

- The micro-hybrid drive,
- The mild hybrid drive,
- The full hybrid drive.



The Micro-Hybrid Drive

In this drive concept, the electric component (starter/ generator) is only used for a start-stop function. On braking, part of the kinetic energy can be reused as electrical energy (recuperation). Purely electric driving is not possible. The 12 volt absorbent mat battery is larger and designed for frequent engine starts.

The Mild Hybrid Drive

The electric drive only 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 a higher output. Due to the support provided by the electric motor, the combustion engine's operating strategy can be shifted to the optimal efficiency range.

The Full Hybrid Drive

A higher-performance electric motor is combined with a combustion engine. Pure 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 using a clutch between the combustion engine and the electric motor/ generator. The combustion engine is only engaged as needed.

Basics of Hybrid Technology

Full hybrid drives can be divided into three groups:

- Parallel hybrid drives
- Power-split hybrid drives
- Serial hybrid drives

The Parallel Hybrid Drive

The parallel design is the simplest design. It can be used when an existing vehicle is to be "hybridized". The combustion engine, motor/generator and transmission are aligned on a single virtual shaft. The total power of the combustion engine and the electric motor can be combined for a higher total output. This drive configuration can use many carry-over parts from the original vehicle.

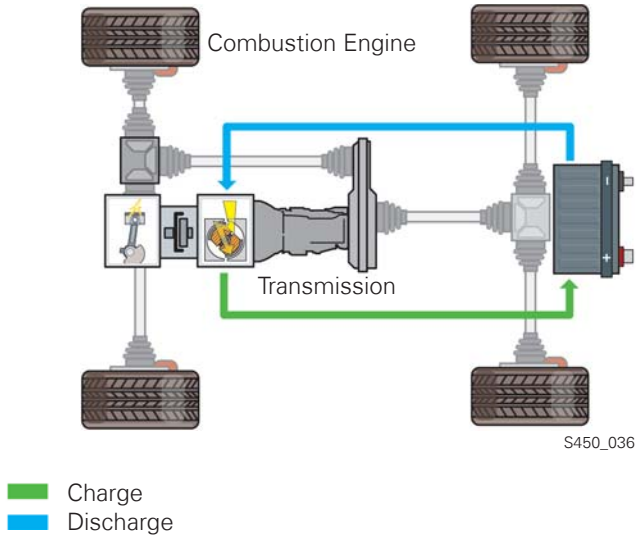
In the Touareg four-wheel drive parallel hybrid design, a Torsen center differential and transfer case are used to distribute power to the wheels.

The Power-Split Hybrid Drive

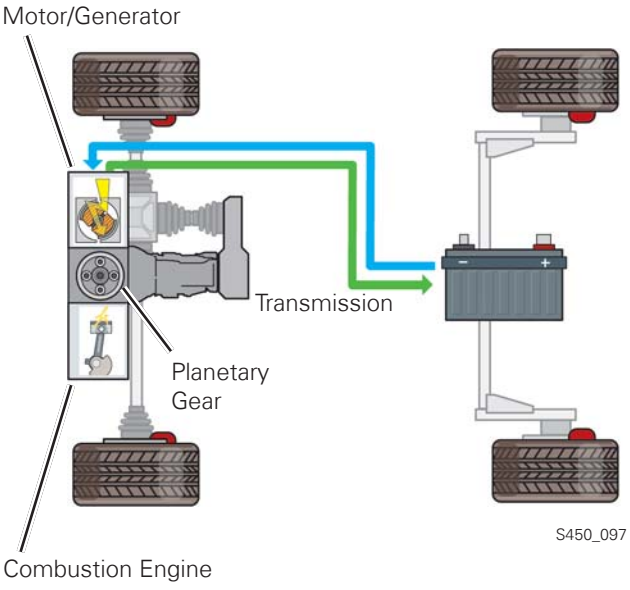
In addition to a combustion engine, the power-split hybrid drive also has an electric motor/generator. Both are located on the front axle.

A planetary drive is used to supply power from both the combustion engine and the electric motor to the transmission. Unlike the parallel hybrid design, the power of the combustion engine and electric motor cannot be combined for a higher total output. Only part of the combustion engine's output is used to drive the vehicle. The other part is used to power the generator for electricity generation.

Parallel hybrid

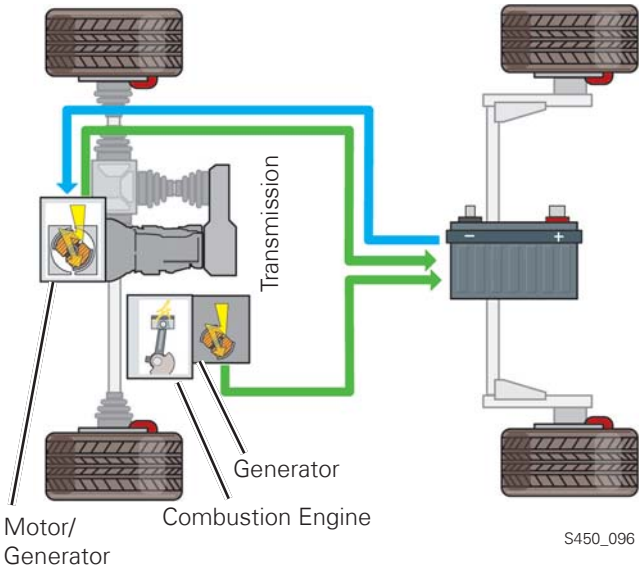


Power-split hybrid



The Serial Hybrid Drive

Serial hybrid

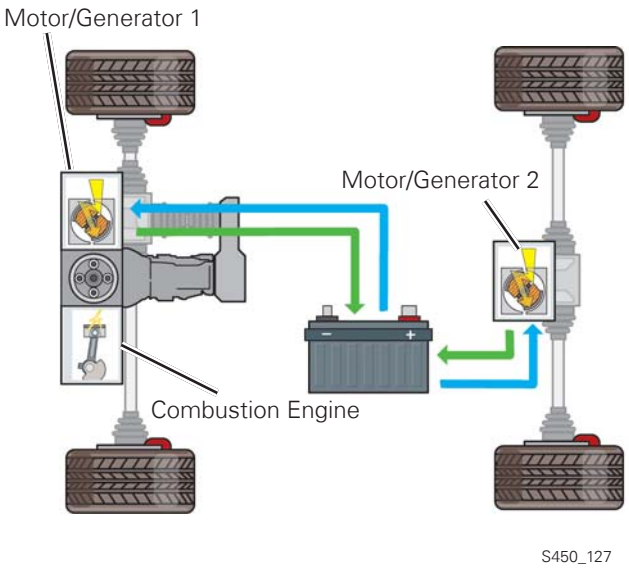


The vehicle has a combustion engine, a generator and a motor/generator. However, the engine power cannot directly power the wheels. The motor/generator acts as the vehicle's main drive. If the capacity of the high voltage battery is low, the combustion engine is started. The only purpose of the combustion engine is to charge the high voltage battery through the generator.

A separate electric motor is used to draw energy from the high voltage battery and drive the vehicle.

The Power-Split, Serial Hybrid Drive

Power-split serial hybrid



The power-split, serial hybrid drive has a combustion engine and two motor/generators. The combustion engine and motor/generator 1 are located on the front axle.

The motor/generator 2 is located on the rear axle.

The pictured image is for a four-wheel drive vehicle. The combustion engine and motor/generator 1 are able to send power to the transmission using a planetary gear.

Again, the output of the separate motors/engines cannot be combined for a higher total output at the wheel.

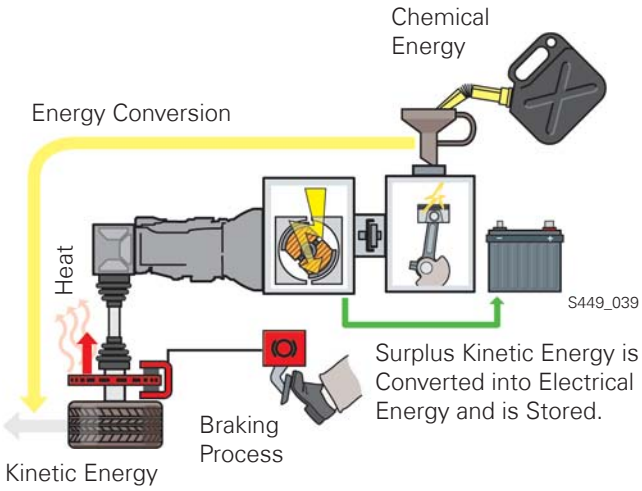
The motor/generator 2 in the rear axle is activated as needed. Due to the design, the high voltage battery is located between the vehicle's two axles.

Terminology

Recuperation

This term generally refers to the process of recovering energy.

During recuperation, one form of energy is converted into another form of energy. Initially, the chemical energy in the fuel is converted into kinetic energy in the drivetrain to move the vehicle. Upon braking with conventional brakes, surplus kinetic energy generated by the brake friction is converted into thermal energy. The heat which is created is released into the environment and cannot be reused. If, in contrast, a generator is used as an engine 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 be re-used.

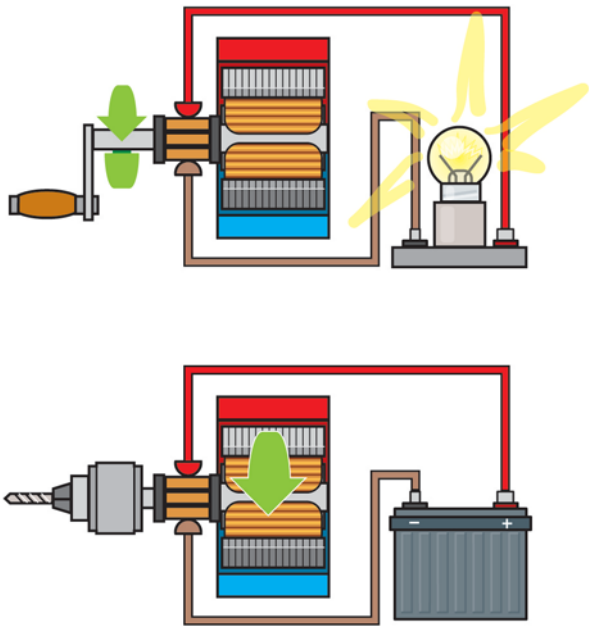


During overrun, as soon as the vehicle:

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

The hybrid system switches the motor/generator to its generator function. It then charges the high voltage battery. During this overrun, the battery can be "topped-off" with electrical energy.

When the vehicle rolls to a stop, only the amount of kinetic energy required to operate the 12 volt vehicle electrical system will be converted into electricity by the motor/generator.



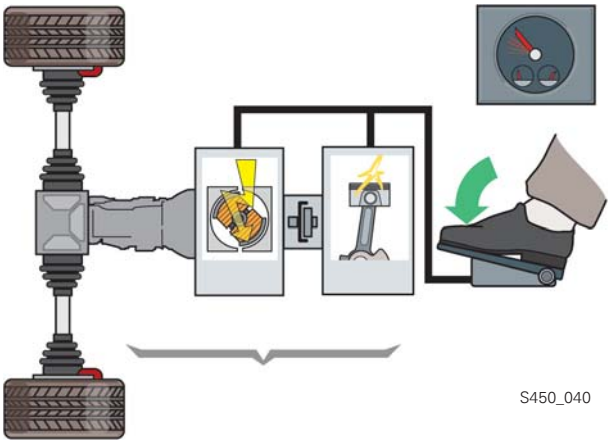
S450_038

Motor/Generator

The term motor/generator is used instead of electric motor, generator and starter. Every electric motor can also be used as a generator.

If the motor/generator's shaft is externally driven, it supplies electrical energy as a generator. If electrical energy is supplied to the motor/generator, it functions as a motor.

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



S450_040

Electric Boost

An electric boost function is available, which has a similar effect of the kick-down function in combustion engines. In this mode, the electric motor and the combustion engine supply their maximum outputs, which add up to a higher total output.

Due to the technical power loss within the electric motor, the driving power is slightly less than the generator output.

The driving power or the mechanical output of the electric motor is 46 hp (34kW). The generator output or the electrical output of the motor/generator is 51 hp (38kW).

In the Touareg Hybrid, the combustion engine has an output of 329 hp (245kW) and the motor/generator has an output of 46 hp (34kW). Together, the combustion engine and the motor/generator have an output of 375 hp (279kW).

Start-Stop Function

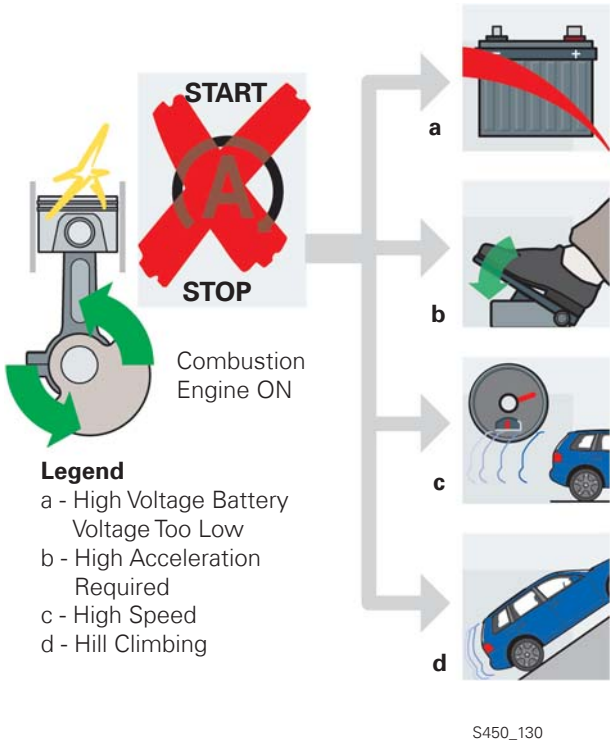
Due to the hybrid technology, a start-stop function can be used in the vehicle. In a conventional vehicle with a start-stop system, the vehicle has to be stationary in order to deactivate the combustion engine.

However, a full hybrid vehicle can be driven electrically. This enables the start-stop function to deactivate the combustion engine even when the vehicle is driving or rolling. The engine is only used as it is needed. Usually, this is a result of high acceleration, high speed, high load or a low charge on the high voltage battery. If the charge of the high voltage battery is low, the hybrid system is able to use the combustion engine, with the motor/generator working as a generator, to charge the high voltage battery.

In other situations, the vehicle can be driven electrically without the combustion engine running. This can happen in slowly flowing road traffic, when stationary at a red traffic light, during overrun when descending hills or when the vehicle is rolling to a stop.

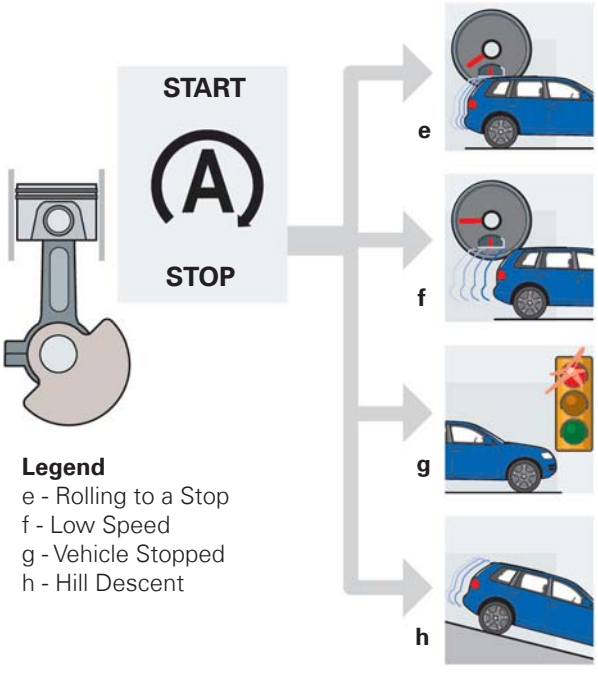
When the combustion engine is not running, it does not consume any fuel and cannot generate any emissions. This start-stop function increases the vehicle's efficiency and environmental friendliness.

While the combustion engine is stopped, the air conditioner can continue to be operated because the A/C compressor is driven by the high voltage system and not the engine.



Legend
a - High Voltage Battery Voltage Too Low
b - High Acceleration Required
c - High Speed
d - Hill Climbing

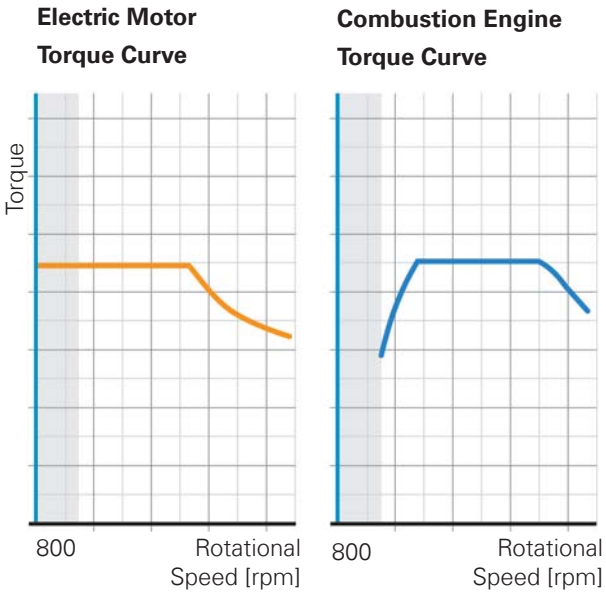
S450_130



Legend
e - Rolling to a Stop
f - Low Speed
g - Vehicle Stopped
h - Hill Descent

S450_131

The Arguments in Favor of Hybrid Technology



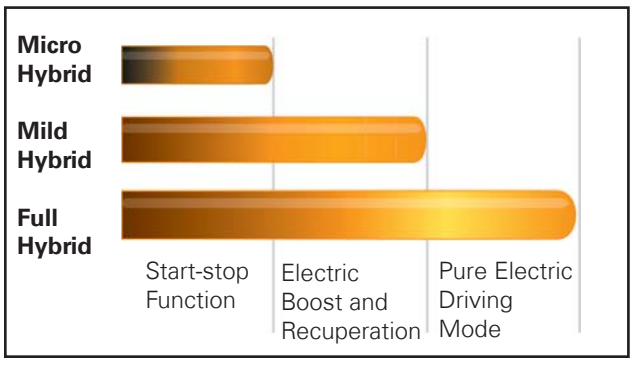
S450_102

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

A combustion engine has internal moving parts that produce torque. When fuel is added, the torque increases. When no fuel is added, the parts become stationary and no torque is produced.

The electric motor reaches its maximum torque on 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 below idling speed.

Thanks to the support provided by the electric motor, the combustion engine can be utilized in its optimal efficiency range. This shift in the loads between the combustion engine and electric motor increases the efficiency of the drive concept.

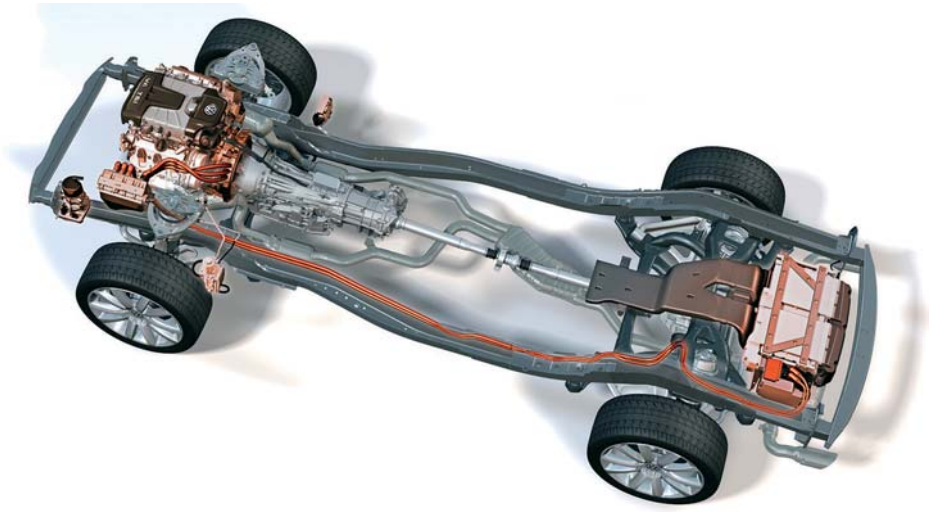


S450_132

Why a Full Hybrid Drive?

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

The Hybrid Concept from Volkswagen



S450_076

The hybrid concept developed for the 2011 Touareg is based on the parallel hybrid drive. The electric motor and the combustion engine are used for mechanical propulsion by a common drive train. Both drive elements are located on a shaft. This concept requires significantly fewer hybrid components than power-split or serial hybrid systems.

The starter and alternator have been eliminated because the motor/generator replaces their functions. When the combustion engine is deactivated, some components still need to operate.

These include:

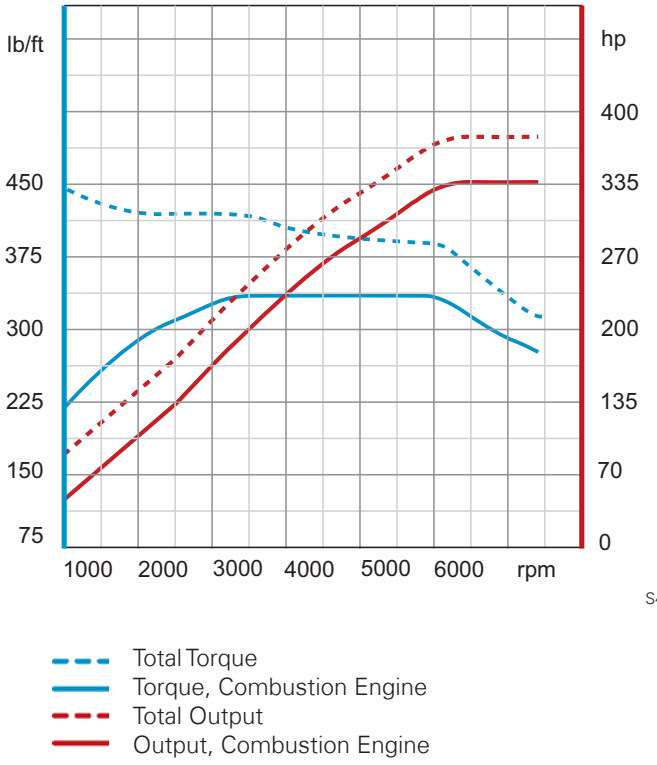
- Electric coolant pumps
- Electric power steering
- Electric vacuum pump for the brake servo
- Electric air conditioner compressor
- Electric pressure pump for the oil pressure in the automatic transmission

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 actuation of the clutch are controlled by the hybrid system. The driver has no direct influence on actuation of the single-plate dry clutch.

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	3.0L Supercharged V6 TSI Engine
Combustion engine output	329hp (245 kW)
Electric motor/generator	3-phase AC motor/generator
Electric motor/generator output	51 hp (38 kW) generator output (electrical output) 45 hp (34 kW) motor output (mechanical output)
Maximum output during electric boost	375 hp (279 kW)
Maximum torque during electric boost	405 lb/ft (550 Nm)
High-voltage battery voltage	288 V (2x144V)
High-voltage battery capacity	6 Ah corresponding to 1.87 kW/h
Additional weight due to the hybrid components	386 lb (175 kg)



Torque/Output Graph

The electric motor assists the combustion engine's slow torque increase during low rpm conditions. This allows the Touareg hybrid to offer unusually high acceleration from a stop.

When joined together and at their maximum combined power, the driving power of the combustion engine and the electric motor add up to 375 hp (279kW).

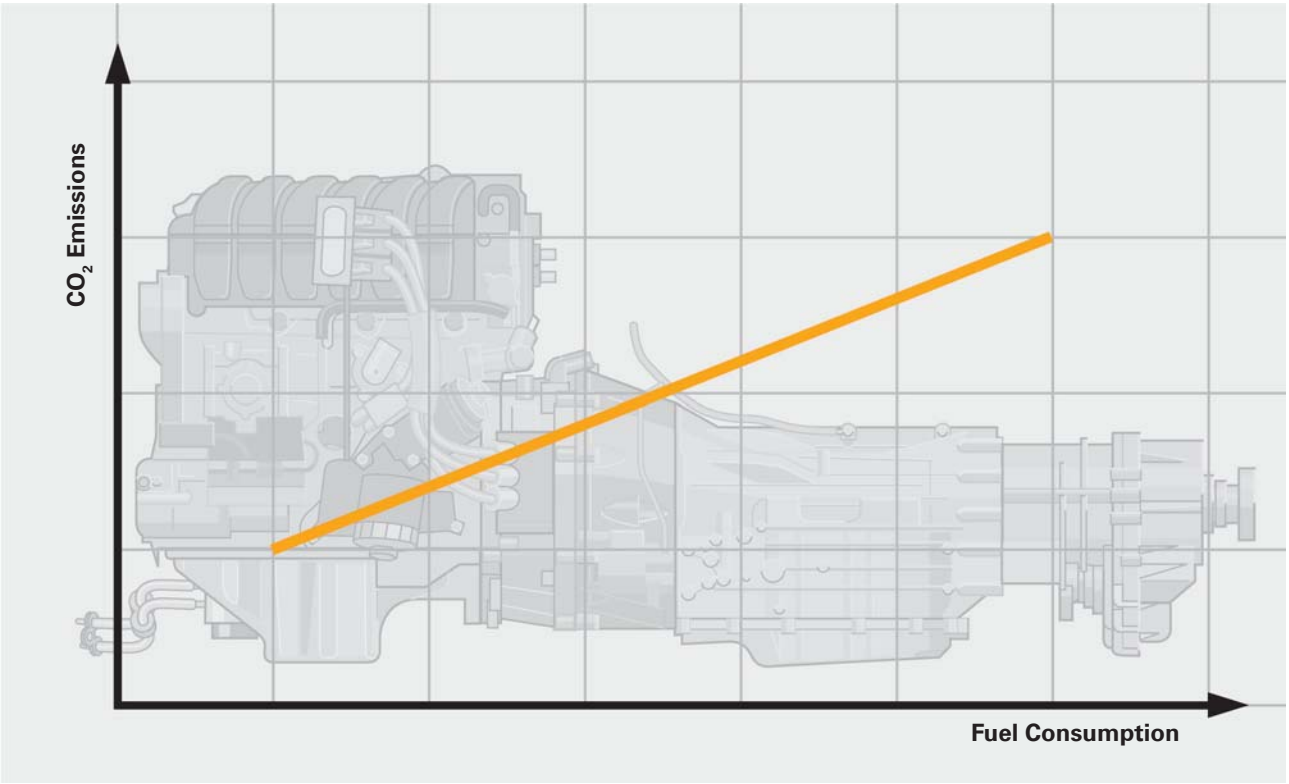
Throughout almost all of the speed range, the output curve can be increased by approximately 45 hp (34 kW) due to the assistance of the electric motor.

This allows the combustion engine to be regulated within its optimal efficiency range.

CO2 Emission Limits

A vehicle's Carbon Dioxide (CO_2) emissions and consumption are almost directly proportional. The higher the fuel consumption, the more CO_2 is created. There are no current CO_2 emissions regulations in the USA, but it is a subject of common concern. It is well-known that larger vehicles that consume more fuel put out larger volumes of CO_2.

Hybrid technology enables vehicles to emit low levels of CO_2 per mile. The electric motor assists the combustion engine, resulting in lower CO_2 emissions. When the Touareg is running on the electric motor alone, there are zero CO_2 emissions.

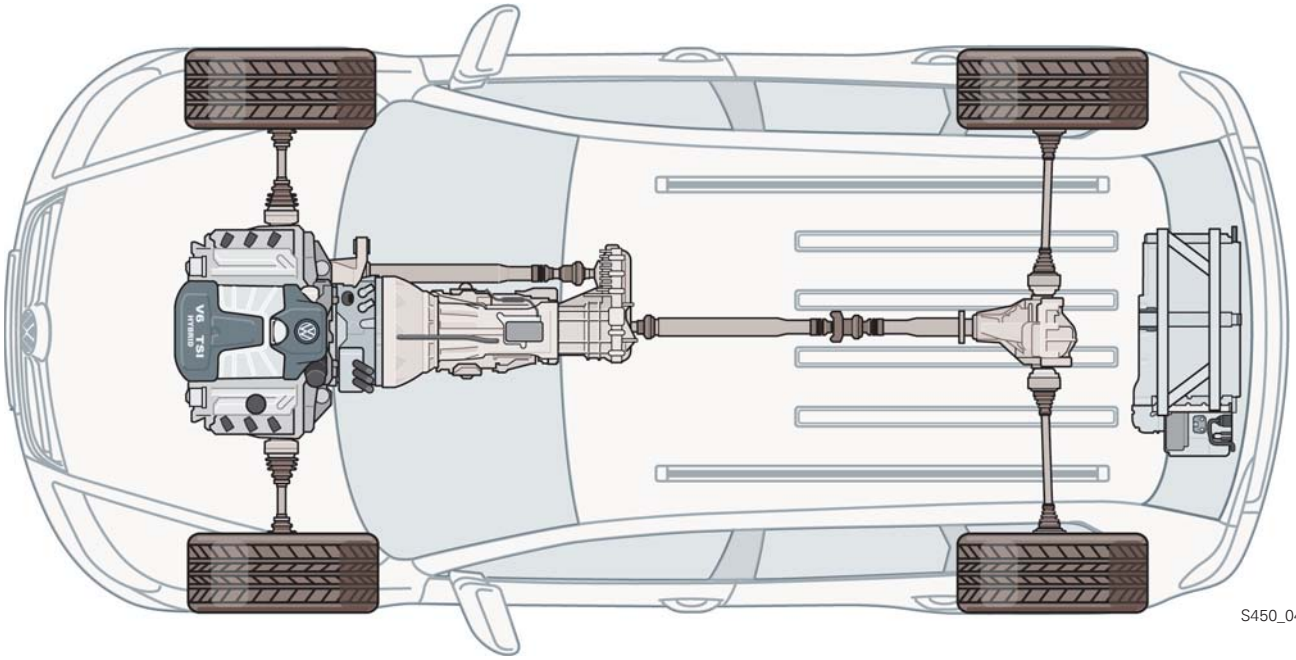


S450_064

Page intentionally left blank

Mechanical Design

Drivetrain

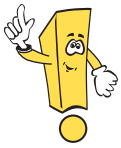


S450_043

The drivetrain on the Touareg Hybrid consists of:

- The 3.0L supercharged TSI engine
- A separating clutch between the combustion engine and the motor/generator
- The motor/generator
- The automatic 8-speed transmission
- The drive shafts
- The transfer case on the front and rear axles
- The Torsen differential

The combustion engine, the clutch, the motor/generator and the automatic transmission are located in line with each other on a common shaft. This method enables conservation of both installation space and component weight.



Further information on the engine, transmission and vehicle can be found in the SSPs:

890103 The Touareg Overview

820103 The 3.0L Supercharged TSI Engine

850103 The 8-speed Automatic Transmission 0C8

The 3.0L Supercharged TSI Engine

The combustion engine for all 2011 Touareg Hybrids is the 3.0L Supercharged V6 TSI. This engine has two belts. One drives the supercharger. The other drives the water pump. The water pump is a part of the thermal management system.

The electric motor/generator functions as a starter and generator. These components were removed from the engine, along with the belt that drove the alternator.

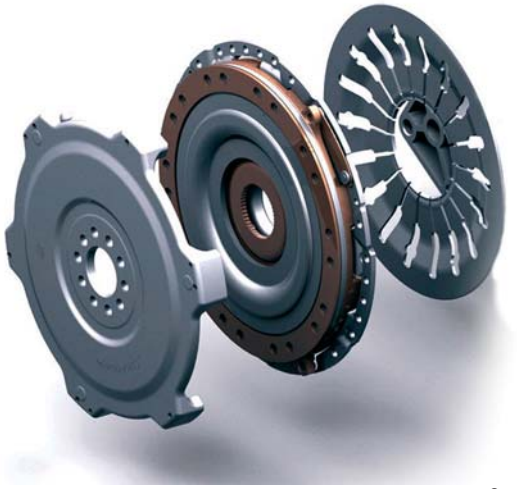
S450_092

The K0 Clutch

This single-plate dry clutch is located between the combustion engine and the motor/generator. The clutch actuator (Decoupler Pressure Actuator N511) for this clutch is located behind the left front wheel housing liner. It is controlled by the hybrid system. The fluid to actuate this clutch comes from the brake fluid reservoir.

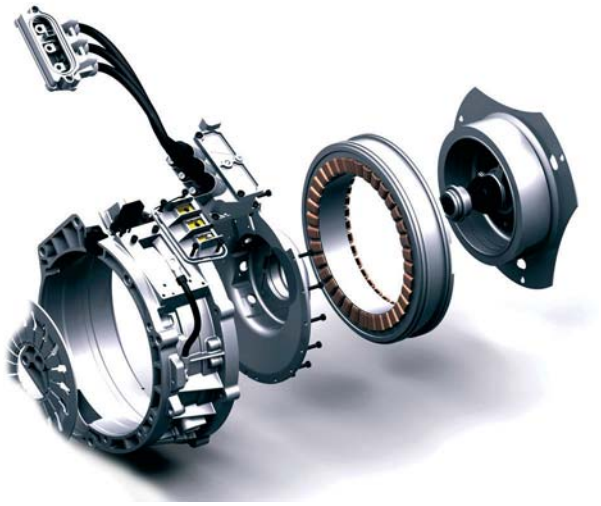
The driver has no direct influence on this clutch.

The clutch is closed when the combustion engine is running or when the ignition is OFF. When the vehicle is driven electrically, as 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 will run the combustion engine and close the clutch to charge the high voltage battery.



S450_122

Mechanical Design



S450_123

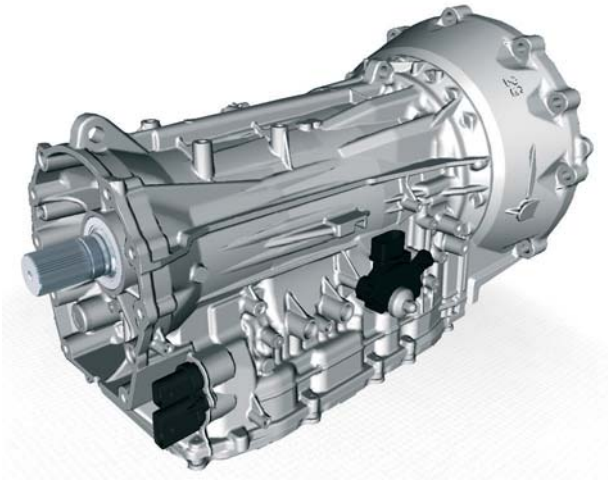
The Motor/Generator

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

1. Starter for the combustion engine
2. Generator for charging the high voltage battery
3. Electric motor for moving the vehicle

The brushless rotor rotates in the stator. In generator mode, the motor/generator has an output of 51 hp (38kW). As a motor, the motor/generator has an output of 45 hp (34kW). This power output difference is due to the basic design losses from an electric motor.

The Touareg Hybrid can be driven purely electrically up to approximately 30 mph (50km/h) over flat terrain. The maximum speed of purely electric driving is dependent on road and wind resistance as well as the state of the high voltage battery's charge.



S450_113

8-speed Automatic Transmission

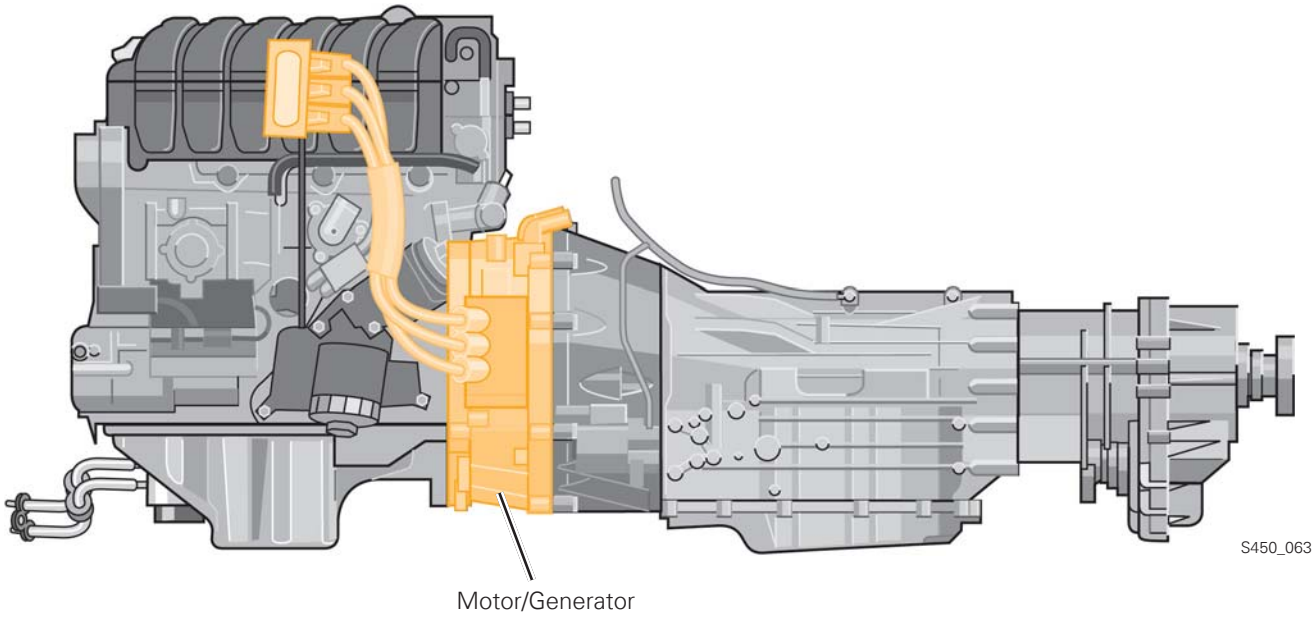
This transmission is based upon the previous 09D 6-speed automatic transmission. An additional friction element and pressure control valve are used to create the eight forward gears.

The transmission is equipped with an electric pressure pump, which maintains the oil pressure when the vehicle is stationary and in electric mode. A conventional mechanical pressure pump is in the transmission to provide pressure when the vehicle is moving (transmission input shaft turning).

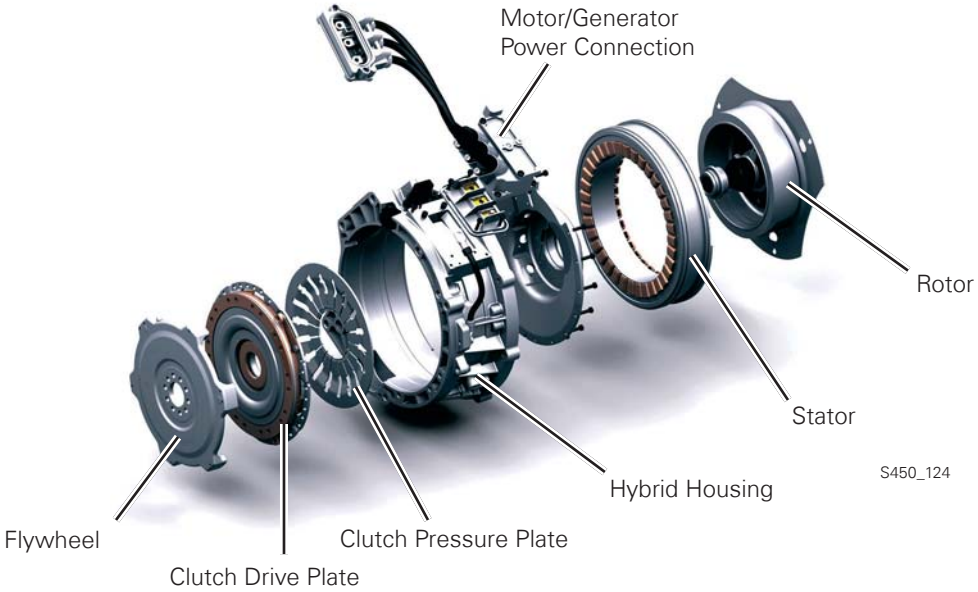
Page intentionally left blank

Electrical Components

Electro-Drive Drive Motor V141



- The motor/generator is located between the combustion engine and the automatic transmission.
- It is a three-phase induction motor driven by a three-phase field.
- The power electronics convert the 288V DC voltage to three-phase AC voltage.
- These three phases create an electromagnetic three-phase field in the electric motor.



Tasks

Depending on the driving situation and operating mode, the motor/generator performs different tasks. When switching from electric drive to combustion mode, the motor operates as a starter for the combustion engine. During continued combustion mode, the motor/generator acts as a generator.

The generated electrical energy generated is used to charge the high voltage battery (288V) and the 12 volt vehicle electrical system battery.

When the vehicle is braked, the motor/generator recuperates the surplus kinetic energy from the braking system and supplies electrical energy. This is controlled by sensing the requirements of the driver using a pedal travel sensor on the brake pedal. If slight braking is detected, the hybrid system switches the motor/generator over so that it acts as a generator and charges the high voltage battery. This creates drivetrain drag and kinetic energy can that be generated for storage. This energy will be used to drive the vehicle. Recuperation recovers at least the amount of energy necessary to operate the 12 volt electrical system's needs. During recuperation, the combustion engine is deactivated.

In electric driving mode, the motor/generator switches back from a generator to an electric motor. When the combustion engine is decoupled, the electric motor is 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 35 mph (50 km/h). If, however, the driver requires greater acceleration, the output of the electric motor is no longer sufficient. The hybrid system will then start the combustion engine.

When driving the vehicle, electricity travels from the high voltage battery, to the power electronics where it is converted to three-phase power. It is then and supplied to the electric motor to drive the vehicle.

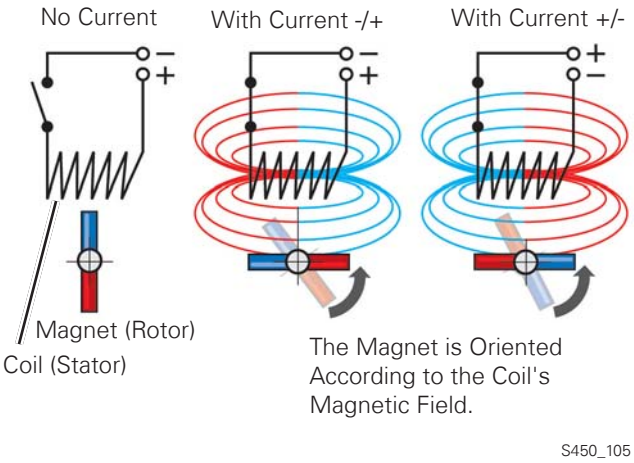
Electrical Components

Design

The motor/generator consists of:

- The die-cast aluminium housing
- The internal magnetic rotor
- The stator with coils
- An intermediate plate for connecting to the automatic transmission's torque converter
- The main motor/generator bearing
- The high voltage connection with three phases

The clutch to the combustion engine and a flywheel are connected on the engine side of the assembly. The three phase connections are routed to the coils so that the three adjacent coils are each connected to different phases.

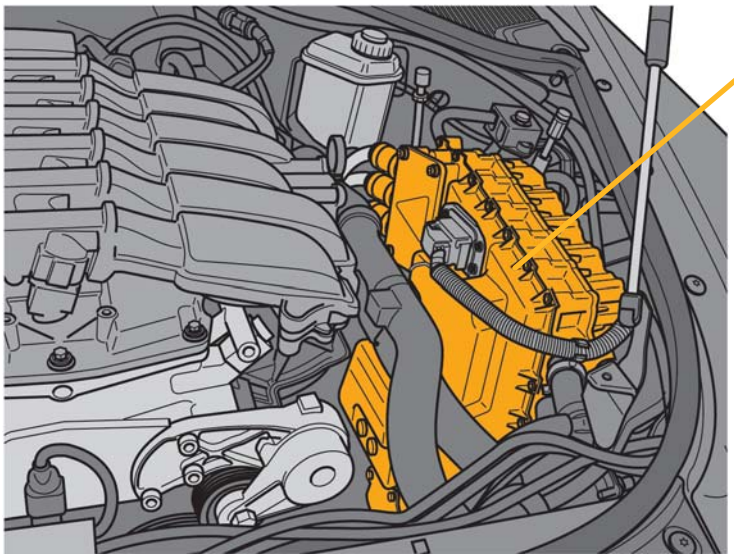


How it works

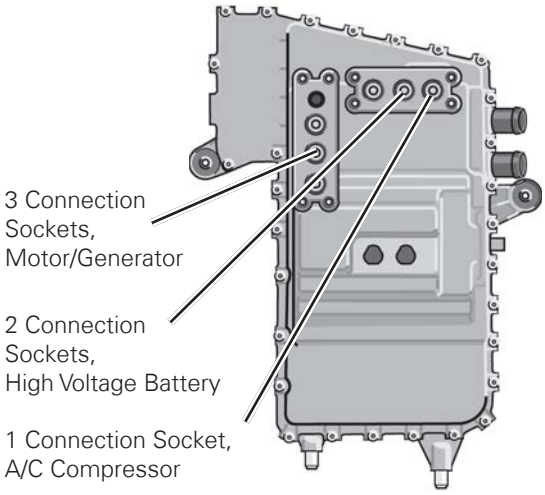
The motor/generator is equipped with a stator coil, which generates a rotating magnetic field as a motor. When the motor/generator operates as a generator, the stator coil induces an electrical voltage. The rotor is fitted with permanent magnets for field generation. The speed of the induction motor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

If the motor/generator operates as a generator, the rotor is set in motion by the transmission. As the rotor's magnetic field runs past the stator's coils, a voltage is induced in each of the phase coils. The rotor's magnetic field runs through the coils in sequence. The power electronics convert the electrical energy into 288V direct current for charging the high voltage battery.

Electric Drive Power and Control Electronics JX1



S450_059



S450_062

To make the system easier to understand, Electric Drive Power and Control Electronics JX1 will be shortened to the term "voltage converter" in the following.

The voltage converter is the electric drive's energy converter. The aluminium housing, which is mounted on the driver's side of the engine compartment between the engine and the wheel housing, contains various high voltage system and electric drive components.

They are:

- The control module for power electronics
- The temperature sensor for power electronics
- A 288 volt DC/12 volt DC voltage converter
- A 288 volt DC/288 volt AC voltage converter for the motor/generator
- The high voltage system distributor
- The two high voltage connections for the lines from the high-voltage battery
- The three high voltage connections for the lines to the motor/generator
- One high voltage connection for the line to the A/C 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 the voltage converter must not be opened or repaired! In the event of failure or damage it must be replaced as a complete unit.

Electrical Components

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.

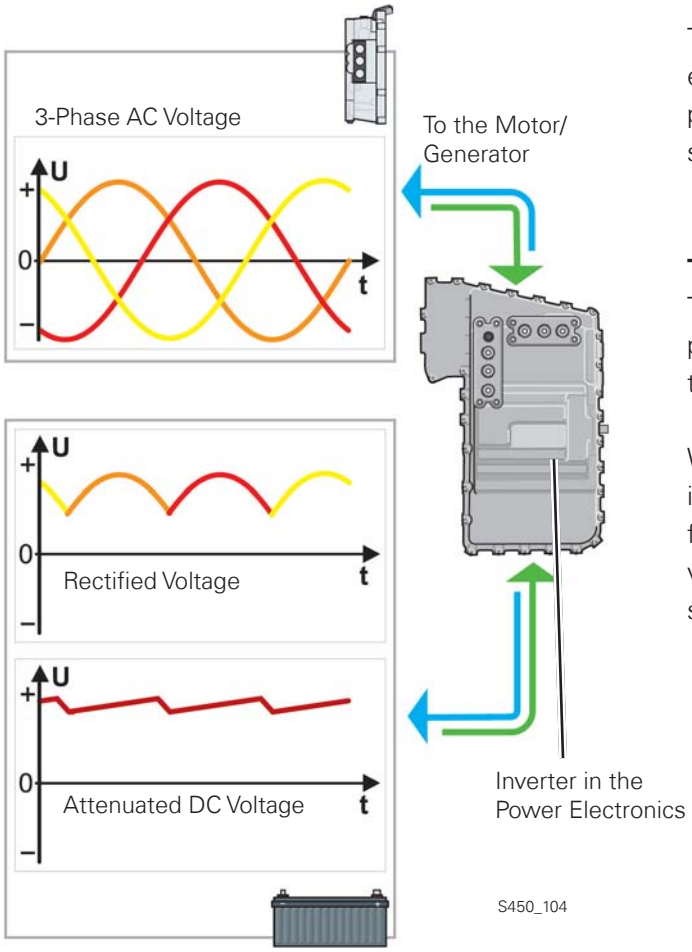
Voltage Converter A19

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

Task

Due to the removal of the traditional alternator, the motor/generator must be used to charge the 12 volt battery. This requires the 288 volt DC voltage from the high voltage system to be converted into charging voltage for the 12 volt vehicle electrical system battery. The 12 volt vehicle electrical system battery is located under the driver's seat.

Drive Motor Inverter A37



The DC/AC converter is integrated into the power electronics because the electric motor is a three-phase induction motor, but batteries are only able to store DC voltage.

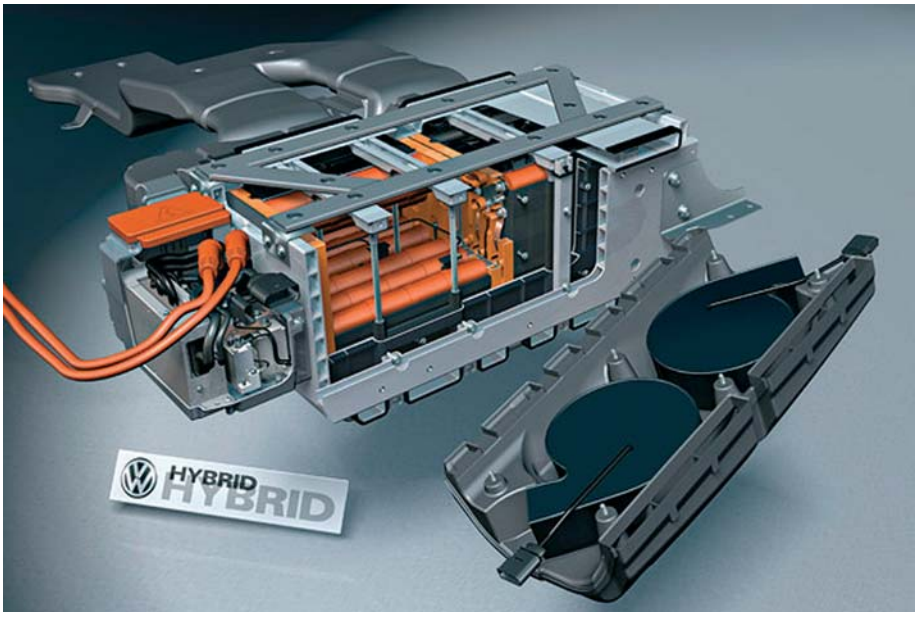
Task

This voltage converter transforms the 288 volt DC power from the high voltage battery into 288 volt three-phase AC voltage.

When the motor/generator operates as a generator, it converts the AC voltage into 288 volt DC voltage for charging the high voltage battery. The rectified voltage is attenuated by the 12 volt vehicle electrical system battery.

The Hybrid Battery A38

The high voltage battery is located under the luggage compartment floor. It is a single module and contains various components of the Touareg's high voltage system. The entire high voltage battery module weighs 188 lb (85kg) and can only be replaced as a complete unit.



S450_058

Example:

If the high voltage battery's energy is compared with the energy released when fuel is combusted, the energy that the battery can supply is equivalent of approx. 0.2 qt (200 ml) fuel. Imagine how far the vehicle could drive on 0.2 qt (200 ml) of fuel and you can understand the power that can be stored in the battery.

The battery is a short-term storage device that acts like a capacitor. It absorbs energy and releases it when required. Recuperation while driving can be viewed as refueling the battery.

Through the various cycles, the hybrid system alternately charges the high voltage battery (recuperation) and discharges it (electric driving).

Electrical Components

Design

The high voltage battery module consists of:

- The 288 volt battery
- The protective box
- The connection and distribution box
- The air intake and outlet ducts
- The fan housing
- Two electric fans (12V)

The high voltage battery is a nickel-metal hybrid battery that uses a gel electrolyte. No fluid escapes even if there are large holes in the battery housing.

The battery ,module has two battery banks, each with a voltage of 144V.

These two battery banks are connected by safety switches. When connected, they supply 288V.

At a charge level of 75%, the high-voltage battery has approximately. 288V.

The electrical charge is approximately. 6.5Ah. This means that the charged energy content of the high-voltage battery is 1.87kWh.

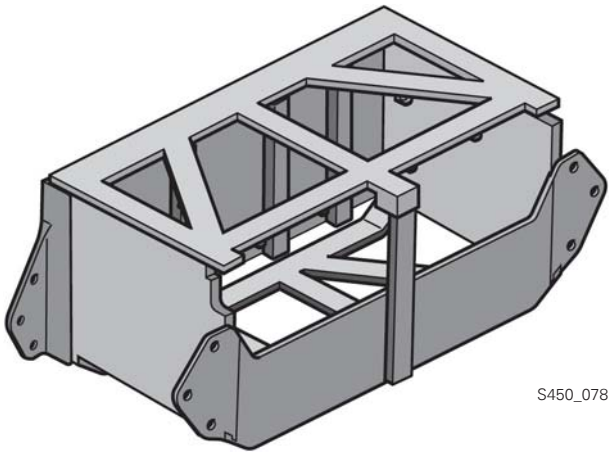
The high voltage battery is air cooled. Two fans draw in a small amount of the air from the interior of the vehicle and heated air is discharged through the rear bumper.

Warning
AC voltages of 25 volts and DC voltages of 60 volts are hazardous. It is vital to read, understand and follow the safety instructions in the Repair Information, Guided Fault Finding and the vehicle warnings. Only personnel trained to work on the high voltage system of the Touareg can work on the high voltage system components.

The Protective Box

In order to protect the high voltage battery, particularly in the event of a rear impact, both battery banks are surrounded by a protective box. The frame consists of welded and bolted aluminium. These will transfer the impact energy into the vehicle structure.

If replacement of the assembly is required, the frame can be used to lift the entire battery out of the luggage compartment floor.



S450_078

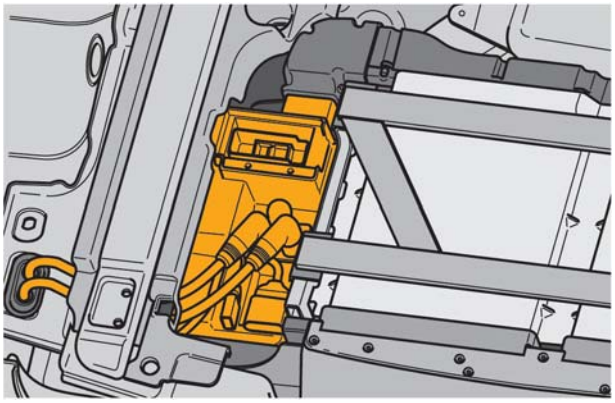
The Connection and Junction Box 1 SX1

The SX1 Connection and Junction Box 1, shortened to “electronics box” for this section, is attached to the left side of the high voltage battery assembly.

Task

The electronics box connects 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 components for the high voltage battery.



S450_057

Design

The SX1 (electronics box) contains:

- The Battery Regulation Control Module J840
- The Safety Connector 1 TV44
- High Voltage System Maintenance Connector TW
- The protective relay (contactor)
- The connections for the two high voltage lines from the high voltage battery to the power electronics

Electrical Components

Battery Regulation Control Module J840

The J840 Battery Regulation Control Module is located on the left-hand side of the electronics box.

Task

The J840 monitors the charge and operating status of the battery. The J840 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 for the battery and electronics box.

Data regarding discharging cycles are stored as well. This tracks tuning characteristics, which are generally deep battery discharge or overheating.

Safety Connector 1 TV44

The TV44 Safety Connector 1 is located between the maintenance connector and the two high voltage power cable connectors.

Task

The TV44 functions as a switch in an electrical circuit. If the TV44 is disconnected, the switch is opened and the safety line is interrupted.

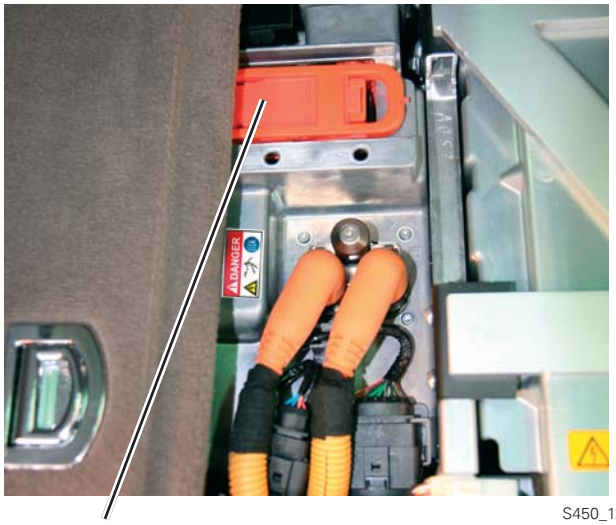
When open, the high voltage system is deactivated.

When the TV 44 is connected, the switch and 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 TV44 is mechanically connected to the high voltage lines' locking detents. If the lines have to be disconnected, the safety connector has to be removed.

High Voltage System Maintenance Connector TW

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



S450_125

The Maintenance Connector on the Electronics Box

Task

The TW High Voltage System Maintenance Connector is an electrical bridge between the two high voltage battery banks. If the TW is removed, the connection is separated. The residual voltage in the high voltage system dissipates.

The TW must always be disconnected when work is necessary for the high voltage components. It must also be disconnected when working near high voltage components with metal-removing, deforming or sharp-edged tools.

How it works

Remove the orange-colored rubber cover on the electronics box.

Using a tool, release the TW by pulling the upper section to the side. This opens the safety line.

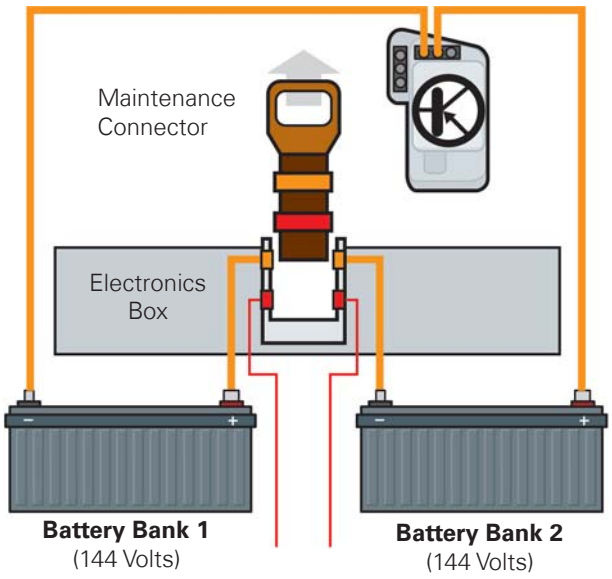
Then pull the TW up into a perpendicular position. The TW can now be pulled up and off, separating the two batteries.

To re-energize the high voltage system, install the TW. The procedures for measuring the system and components, as well as re-energizing the system can be found in Guided Fault Finding.

Warning:

Only qualified high voltage technicians may remove this maintenance connector to deactivate the voltage. The system must be tested to assure that the voltage is indeed disconnected.

High Voltage Line to the Power Electronics



S450_079

Electrical Components

The Protective Relays

The electronics box also contains the protective relays, sometimes referred to as contactors. The contactors are technical devices from the electrical engineering field, and are used to protect the high voltage system and the vehicle's electrical system from faults in individual sections of the system. If a fault is detected by the hybrid monitoring system, the contactors are opened. This will happen if the hybrid vehicle gets in an accident. The airbag control module will also trigger the contactors.

Task

The two protective relays connect and separate the high voltage battery to and from the high-voltage system.

Design

Each relay is an electromagnetically actuated switch. Low current switches the high current on or off. If the relay coil is supplied with current by the control module, 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 module actuates the protective relays, switching 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 hybrid system will not be activated. One sign is that "Ready" will not display in the instrument cluster. Another sign is that the combustion engine will not start and the electric motor will not operate.

If the contactors cannot be opened, the high voltage system stays on. This can be caused by the 200 volt relay contact sticking.

The Cooling Fans for the High Voltage Battery

Task

The two fans for the high voltage battery are located directly on the battery. They draw part of the cool air from the interior through the battery.

The air which is heated up by the high voltage battery is discharged under the luggage compartment floor and through the ventilation flaps to the outside air.

The fans are referred to as:

- Battery Fan 1 V457 and
- Battery Fan 2 V458 in the service literature.

How it works

The air is drawn in through an intake duct located beneath the rear seats.

Air flows from the duct through the high voltage battery's plates. The cells have small spaces between each other, through which the air is able to flow. The two fans then force the heated air laterally away from the high voltage battery.

If the battery sets a fault code for overheating, check these ducts to make sure they are no clogged.

Electrical Components

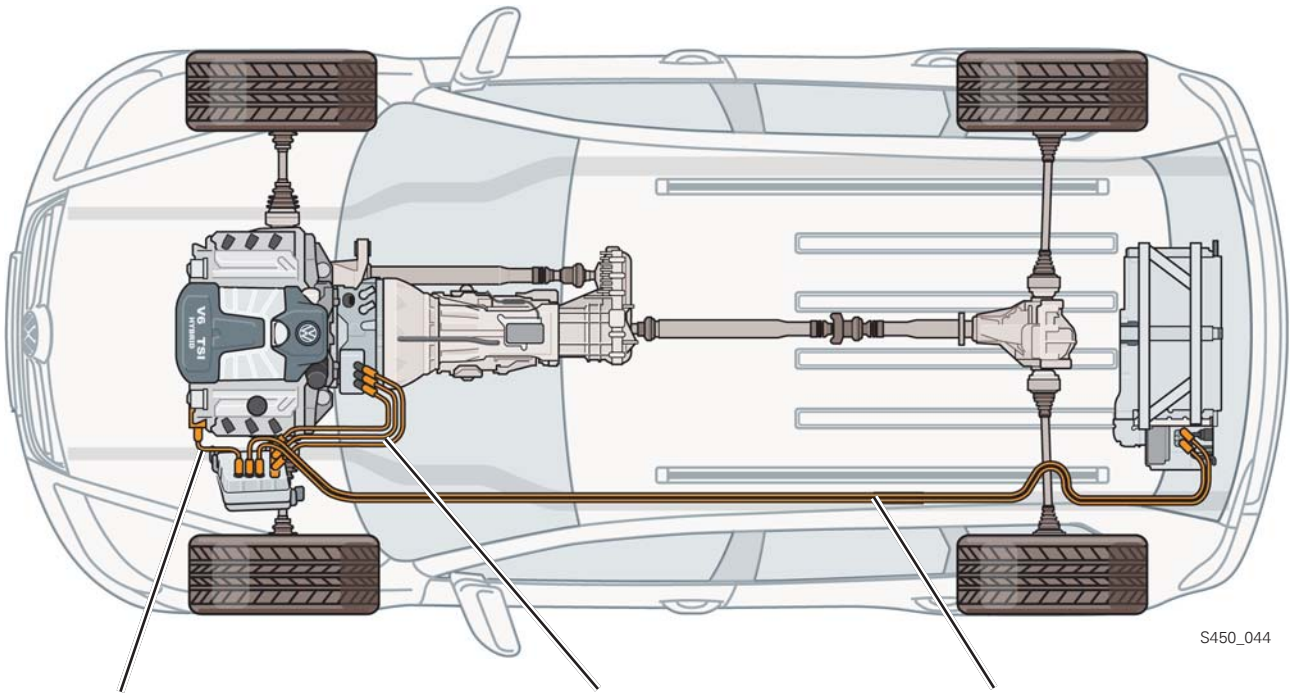
The High Voltage Lines

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 is completely isolated and 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 colored orange throughout. All manufacturers of electric vehicles have agreed to color 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 color 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:

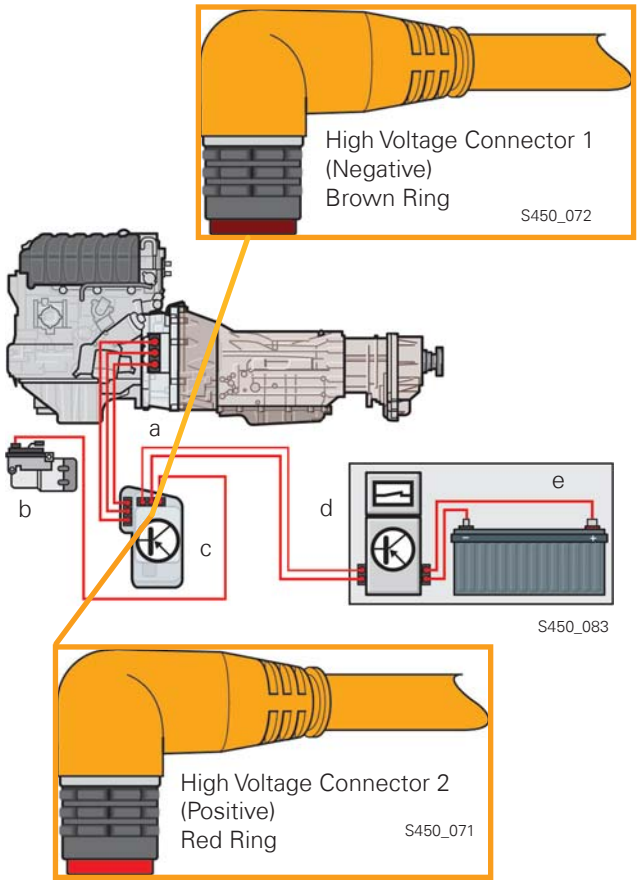
- Two high voltage lines from the high voltage battery to the voltage converter
- Three high voltage lines from the voltage converter to the motor/generator
- One high voltage line from the voltage converter to the air conditioning compressor



From the High Voltage Battery to the Voltage Converter

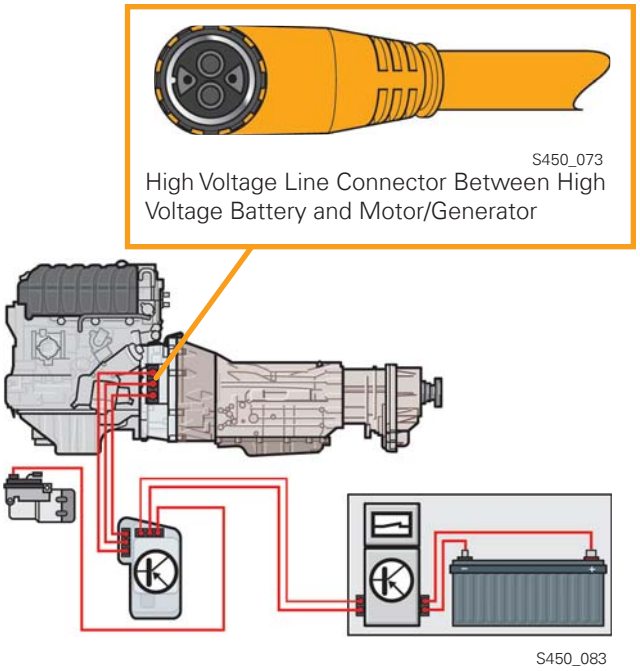
The electrical charges are exchanged via two orange-colored high voltage lines between the high voltage battery and the voltage converter. Both lines conduct a potential.

A DC voltage of 288 volt is present. The 1-pin lines are designed with a screen.



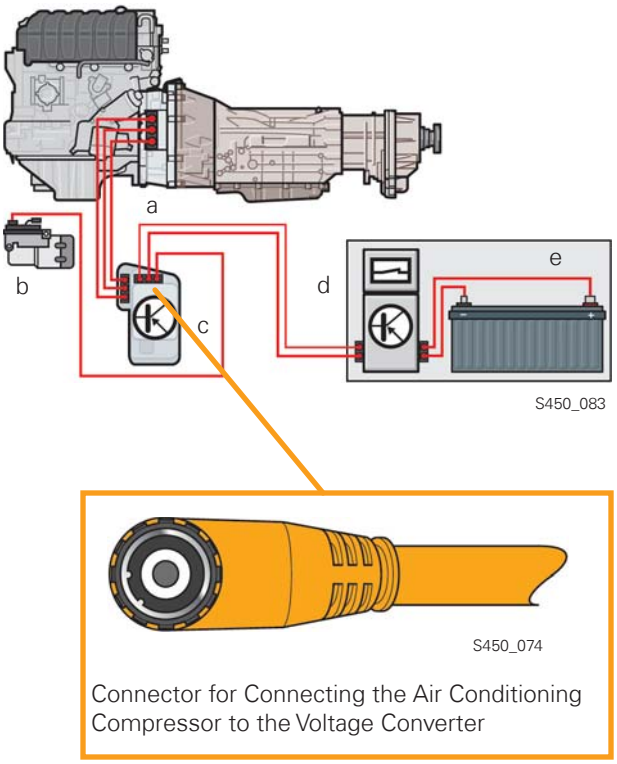
From the Voltage Converter to the Motor/Generator

The voltage converter converts the high voltage battery's single-phase 288 volt DC voltage using a DC/AC voltage converter to create three-phase AC voltage (alternating current) that operates the electric motor. The electric motor is connected to the voltage converter via three short high voltage cables. Like all of the others, the three-phase lines are color and mechanically marked and coded so that they cannot be interchanged with each other.



Electrical Components

From the Voltage Converter to the Air Conditioner Compressor



Connector for Connecting the Air Conditioning Compressor to the Voltage Converter

Legend

a - Electro-Drive Drive Motor V141 (Motor/Generator)
b - Electrical A/C Compressor V470
c - Electric Drive Power and Control Electronics JX1
d - Connection and Junction Box 1 SX1 (electronics box)
e - High voltage battery

The air conditioning compressor is part of the Touareg Hybrid's high voltage system.

The air conditioning can remain active even when the combustion engine is not running. The air conditioner remains active depending on the battery's state of charge. If the high-voltage battery's charge declines, the system automatically starts the combustion engine.

The air conditioner compressor is connected to the voltage converter by a line. Thanks to color and mechanical coding, it is not possible to interchange the high voltage lines.

This two-pin cable is designed with a shielding wire for the safety line. If one of this cable's two connectors is disconnected, it is the equivalent of 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 extensive safety measures.

The safety measures include:

- The electric safety line with safety connector
- The ignition lock
- The battery regulation control unit relay
- The airbag control module
- The maintenance connector

The Electric Safety Line with Safety Connector

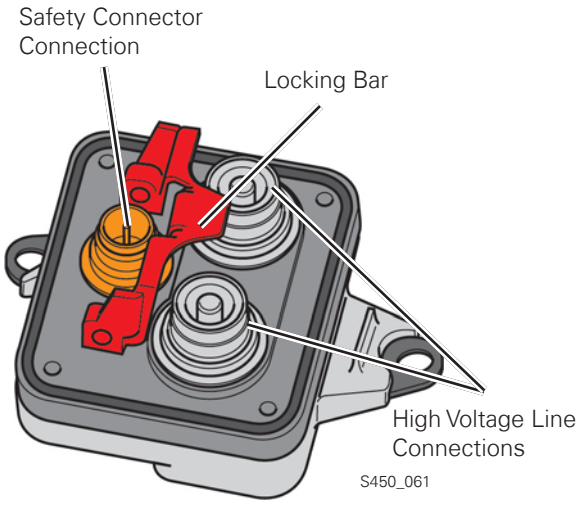
The safety line contains a mechanical and an electric component.

Task

The safety line guarantees that the entire high voltage system's voltage is turned off as soon as a high voltage component is disconnected from the system. Together with a locking bar, the safety connector forms a mechanical lock, which prevents the high voltage lines from being disconnected while voltage is present.

The safety line is an electrical circuit that is closed by safety connectors. If this circuit is opened by removing the safety connectors, the high voltage system shuts off.

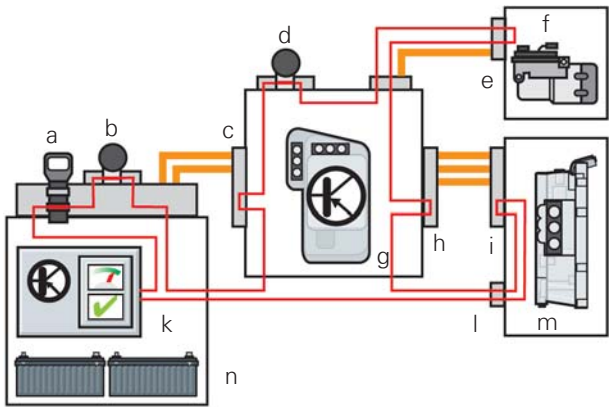
The safety connectors have to be removed before high voltage lines can be disconnected from the high voltage components. This guarantees that the system is not conducting voltage when the lines are disconnected.



The safety connector fitting with the mechanical locking bar (red) on the electronics box with the safety connector removed and high voltage lines disconnected

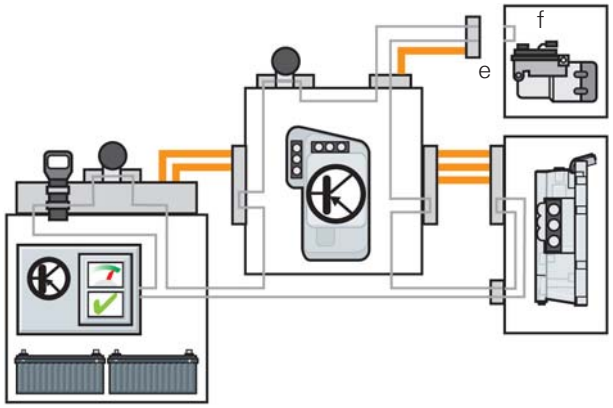
Electrical Components

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 - Motor/generator connection box
k - Battery regulation control unit
l - 14-pin engine wiring sensor connector
m - 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 by a separate low voltage loop line.

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 presence of current indicates 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. This indicates 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 voltage converter. If the control unit determines that the line is interrupted, it actuates the protective relays and interrupts the high voltage battery's connection to the high voltage system.

How the Mechanical Lock with the Safety Connector Works

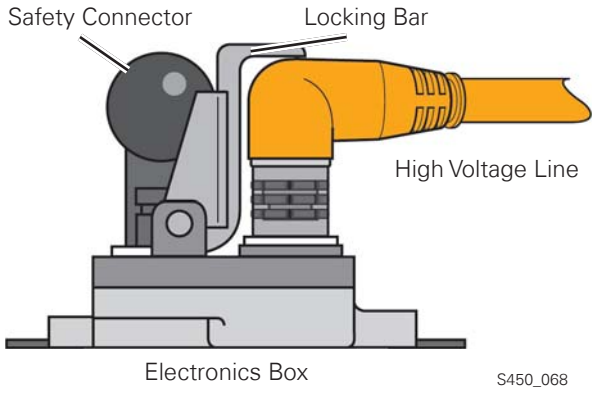
Before starting any work on the vehicle, it is vital to remove the maintenance connector. This can only be performed by a Volkswagen High Voltage Technician.

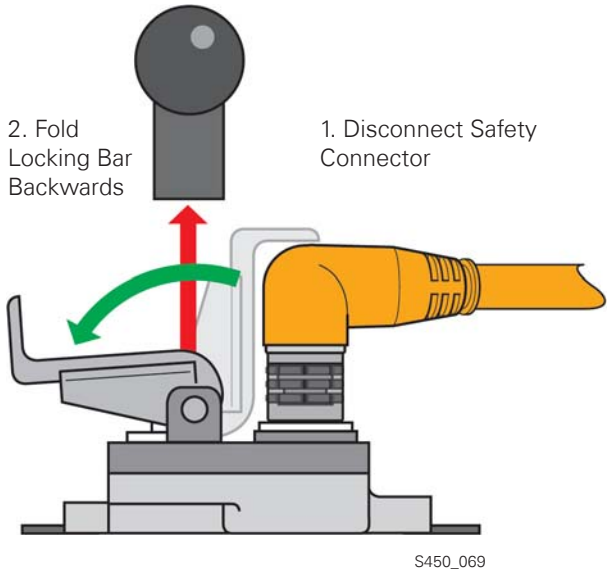
If the high voltage line to the voltage converter is connected to the electronics box, a locking bar must be swiveled over the two connectors before the safety connector can be inserted.

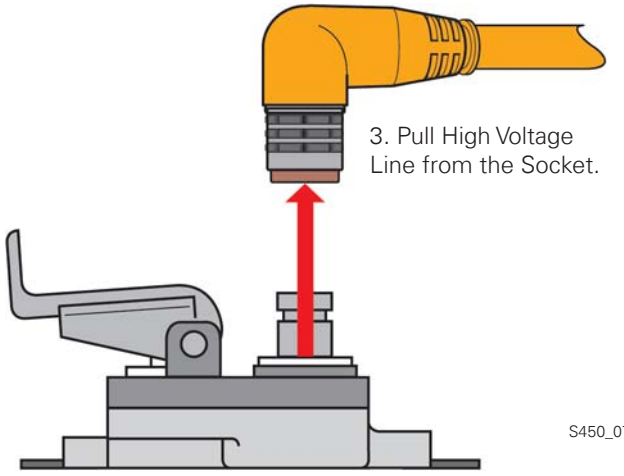
This means that the high voltage system is only supplied with current when the safety connector is connected. This assures that the high voltage connections are always inserted when no current is flowing.

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

As soon as the safety connector is removed, the safety line is interrupted and the battery management control unit decouples the high voltage battery through the protective relays. No voltage is 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.

Page intentionally left blank

Page intentionally left blank

Page intentionally left blank

Knowledge Assessment

An on-line Knowledge Assessment (exam) is available for this Self-Study Program.

The Knowledge Assessment may or may not be required for Certification.

You can find this Knowledge Assessment at:

www.vwwebsource.com

For Assistance, please call:

Volkswagen Academy

Certification Program Headquarters

1-877-791-4838

(8:00 a.m. to 8:00 p.m. EST)

Or, E-Mail:

concierge@volkswagenacademy.com

Volkswagen Group of America
2200 Ferdinand Porsche Drive
Herndon, VA 20171
August 2010