Self-Study Program 990123C

Audi Q5 hybrid quattro

Audi Academy

Audi of America, LLC
Service Training
Printed in U.S.A.
Printed 6/2012
Course Number 990123

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

Table of Contents

Table of Contents

Note

Alternating current (AC) voltage as low as 25 volts, and direct current (DC) voltage as low as 60 volts are hazardous to humans. It is therefore important to pay strict attention to the safety instructions in current technical literature, Guided Fault Finding, and warnings displayed on the vehicle.

All work on the high voltage system must be performed by a qualified high voltage technician. Only qualified high voltage technicians are allowed to disconnect the maintenance connector to de-energize the vehicle.

To ensure the proper and safe use of high voltage special tools, guidelines in current technical literature must also be strictly followed.

The Self-Study Program provides introductory information regarding the design and function of new models, automotive components, or technologies.

The Self-Study Program is not a Repair Manual!
All values given are intended as a guideline only.

For maintenance and repair work, always refer to current technical literature.

Reference

Note

Hybrid Vehicles at Audi

AUDI AG can look back at over 20 years of experience with hybrid technology. The first generation of the Audi duo, a hybrid concept car based on the Audi 100 Avant, made its European debut in 1989. A five-cylinder gasoline engine drove the front wheels and a part-time electric motor developing 12 hp (9 kW) drove the rear wheels. Rechargeable nickel-cadmium batteries provided the energy source.

Another duo variant based on the Audi 100 Avant quattro followed two years later.

In 1997, AUDI AG became the first European manufacturer to build a limited edition hybrid production vehicle. It was based on the Audi A4 Avant.

Drive for this A4 was provided by a 1.9 liter TDI engine developing 90 hp (66 kW), and a water-cooled electric motor developing 29 hp (21 kW). This front-wheel drive vehicle used an electric motor powered by a lead-gel battery that could be recharged by plugging into an electrical outlet.

The A4 Avant duo electric motor could also recover energy during deceleration. In electric mode, the duo attained a top speed of 50 mph (80 km/h) and a maximum speed of 105 mph (170 km/h) with TDI power.

Further development in hybrid technology was showcased in the Audi R18 e-tron quattro prototype race cars at the 2012 24 Hours of Le Mans. Audi dominated the competition, taking first and second place, becoming the first manufacturer to win the legendary race with hybrid technology. The winning cars featured a TDI turbo diesel engine powering the rear wheels, and an electric motor powering the front axle for greater acceleration coming out of corners.

In addition to hybrids, Audi is also developing a new family of electrically powered vehicles (e-tron) capable of driving long distances.

The Audi A1 e-tron, designed for congested city driving conditions, always operates electrically. No additional gasoline or TDI engine is used to extend driving range.

489_020

489_021

489_022

The Q5 hybrid quattro is the first Audi hybrid model with twin drive systems. Its 2.0L TFSI engine develops 211 hp (155 kW), operating in tandem with a water-cooled electric motor developing 54 hp (40 kW). The electric motor is powered by a compact lithium-ion battery.

489_023

Hybrid Technology

The word “hybrid” comes from the Latin word “hibrida”, which means the offspring of a mixed union. In vehicles, a hybrid is a system which combines two different technologies.

Automotive hybrid powertrain technology can be either:

- Bivalent drive
- Hybrid drive

Bivalent Drive

Vehicles with bivalent drive technology have an internal combustion engine which can burn different types of fuel to provide drive power.

These vehicles can run on fossil and renewable fuels (diesel and biodiesel) or liquid and gaseous fuels (gasoline, natural gas, and liquid propane gas), and are gaining market share.

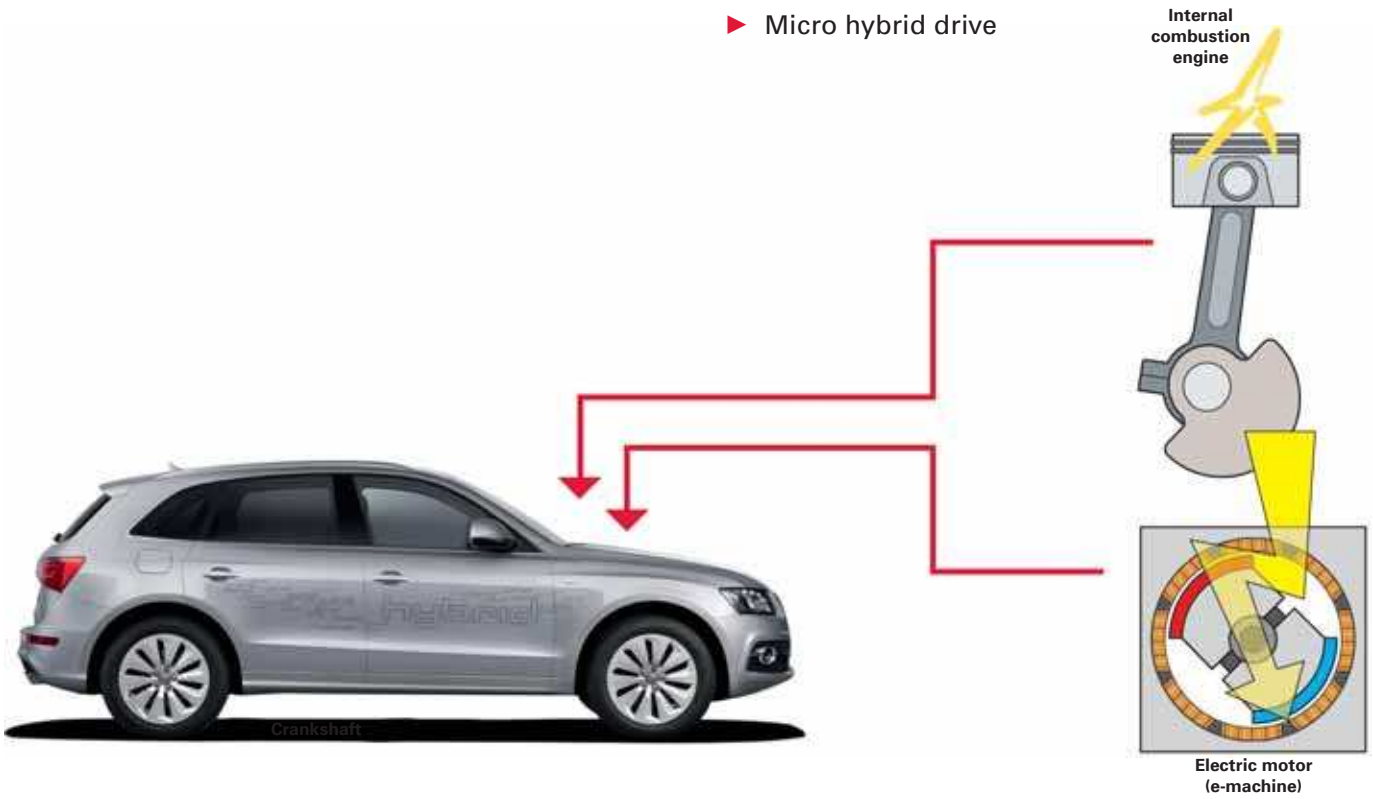
Hybrid Drive

A combination of two different drive units, hybrid drive technology is an internal combustion engine working with an electric motor (e-machine).

Hybrid drive can generate electrical energy from kinetic energy (for instance, brake energy recuperation), serve as a motor for driving the vehicle, and act as a starter for the internal combustion engine.

There are three types of hybrid drives:

- Full hybrid drive
- Mild hybrid drive
- Micro hybrid drive



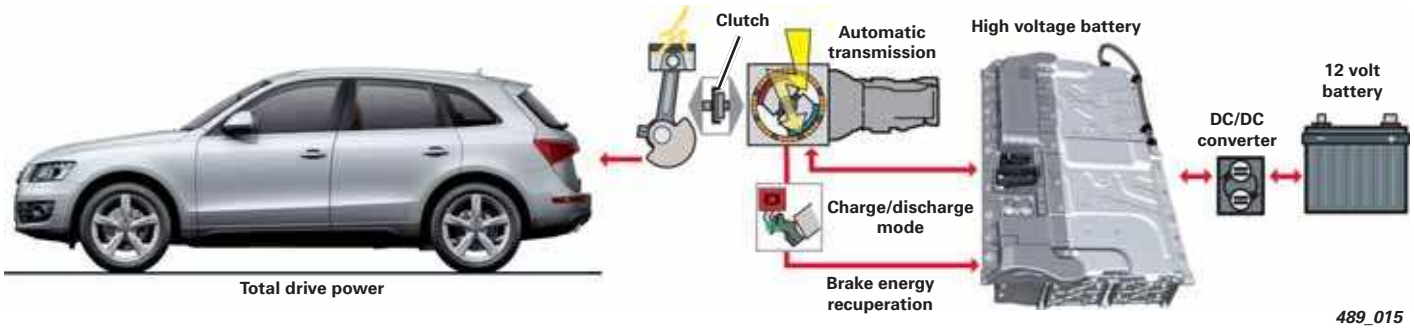
489_075

Full Hybrid Drive

This is the system used in the Audi Q5 hybrid quattro and will be used on other Audi models.

For this drive, a powerful e-machine capable of electric-only, low speed driving is combined with an on-demand internal combustion engine, which is used for longer distances and higher drive speeds.

Additional features include an e-machine start-stop function that automatically shuts down and restarts the internal combustion engine during idling situations, such as when the vehicle is stopped at a traffic light, in stop and go city driving, or when it is coasting. This improves fuel economy and reduces emissions.



Mild Hybrid Drive

While mild hybrid drive is identical to full hybrid drive with regard to technology and components used, this system is not capable of electric-only operation. Via the start-stop function, a smaller e-machine is activated in select situations, such as when the car is coasting, braking, or stopped.

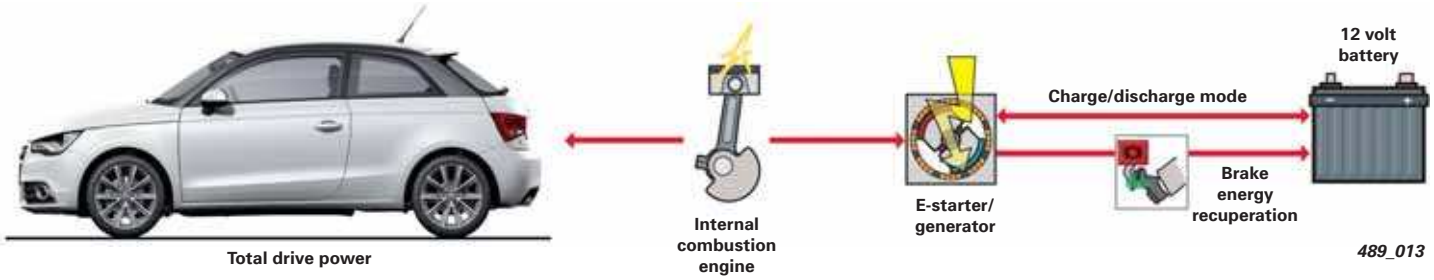
This system also uses brake energy recuperation to charge the high voltage battery.

Micro Hybrid Drive

In this drive design, which is not capable of electric-only driving, the electrical components (e-starter/generator) are used only to implement the start-stop function.

This system does have some capacity for brake energy recuperation to charge the high voltage battery. Characteristics of the 12 volt battery are adapted for frequent engine starting.

This system is used in the Audi A1 (not offered in the North American market at this time).



Types of Full Hybrid Drives

Full hybrid drives are subdivided into four subgroups:

- Parallel hybrid drive
- Power-branched hybrid drive
- Serial hybrid drive
- Power-branched serial hybrid drive

Parallel Hybrid Drive

The parallel configuration is noted for its simplicity. This solution is used for “hybridizing” existing model lines.

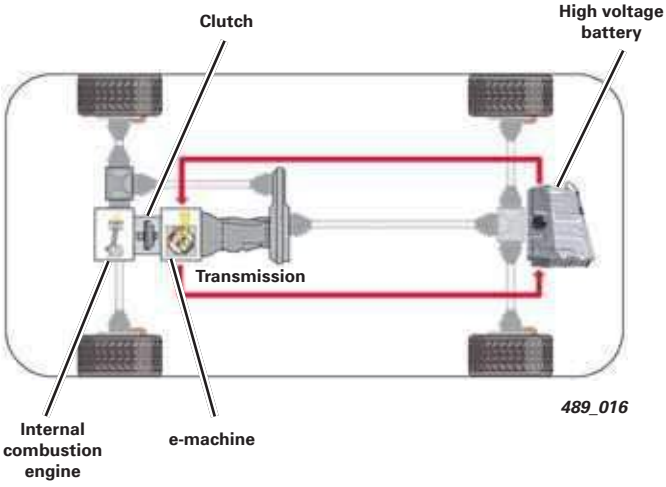
The internal combustion engine, e-machine, and transmission are mounted on a shaft. The individual power output of both drives is transferred directly to the wheels.

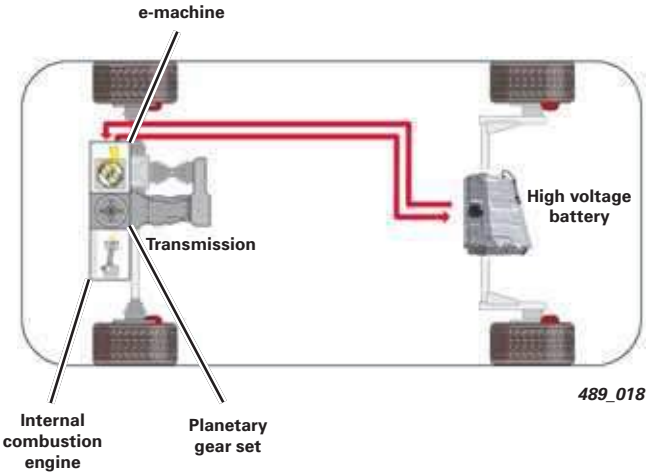
This design uses many carry-over parts from the original vehicle. In quattro models, the drive power is distributed to all four wheels in a parallel hybrid configuration.

Power-Branched Hybrid Drive

The power-branched configuration has an e-machine and an internal combustion engine mounted on the front axle. Drive is provided by both the internal combustion engine and e-machine, and is transmitted through a planetary gear set to the vehicle transmission.

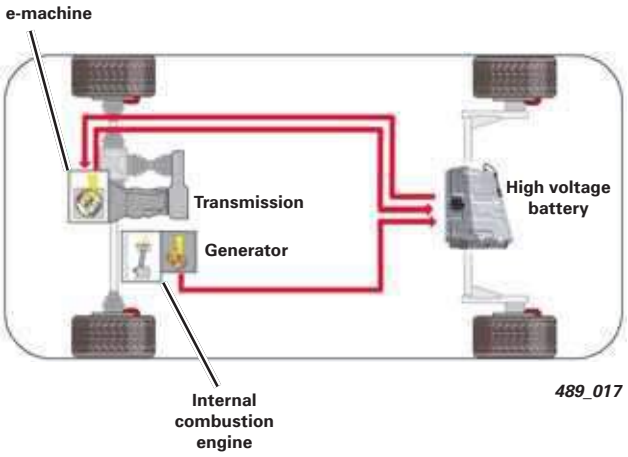
Unlike the parallel hybrid configuration, the individual power output of both drives is not transmitted entirely to the wheels. The generated power is partly used to drive the vehicle, while the remainder is stored as electrical energy in the high voltage battery.





Serial Hybrid Drive

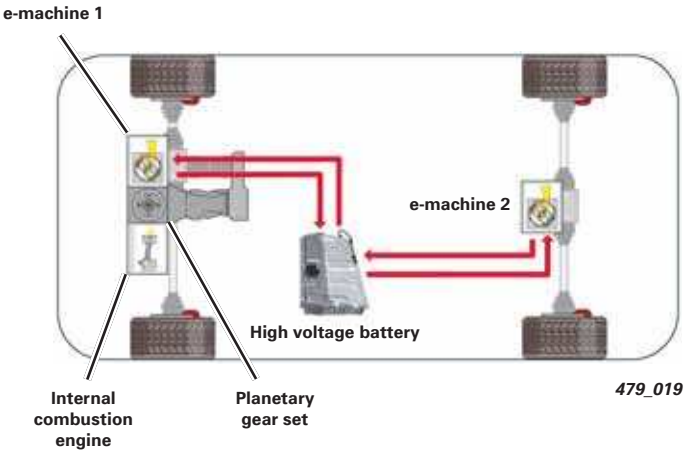
With this configuration, the vehicle is driven by the e-machine only, with the internal combustion engine having no mechanical connection to the drive axle. The internal combustion engine drives an electrical generator which supplies the e-machine with electrical power or charges the high voltage battery during vehicle operation.



Power-Branched Serial Hybrid Drive

This configuration is a cross between the previously described hybrid drive types, and is designed for all-wheel drive vehicles.

The vehicle is equipped with an internal combustion engine and two e-machines. The internal combustion engine and e-machine 1 are mounted on the front axle, while e-machine 2 is mounted on the rear axle and is activated only as required. The internal combustion engine and e-machine 1 can drive the vehicle's transmission through a planetary gear set. A high voltage battery is mounted between the two vehicle axles.



Other Terminology

Plug-In Hybrid

This term describes a hybrid drive vehicle that can have its high voltage battery externally charged via a charging station or a household power outlet.

A cross between a pure hybrid and an electric car, plug-in hybrid vehicles combine the advantages of both internal combustion engine-equipped vehicles and battery powered vehicles.

Brake Energy Recuperation

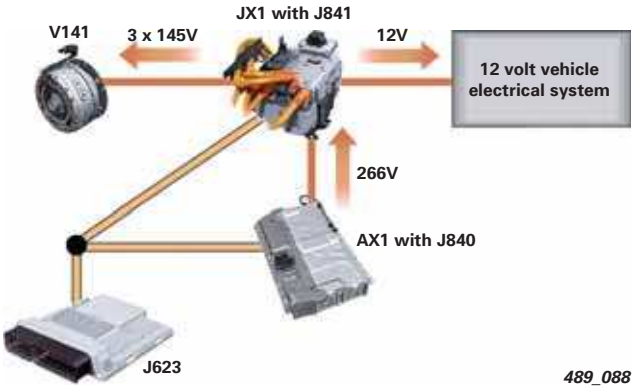
The word “recuperation” comes from the Latin “recuperare,” meaning to recover or restore. In hybrid vehicles, it means the recovery of kinetic energy during deceleration. Kinetic energy is recovered when a vehicle is braking or coasting, and is then stored in the vehicle battery.

Recuperation is a key component of the vehicle’s electrical energy management system.

Energy Flows Between the High Voltage Components

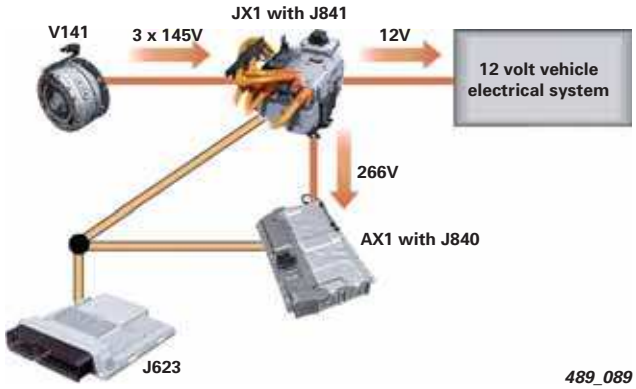
Electric Motor Operation: High Voltage Battery is Discharged

When driving under electric power, power is drawn from the high voltage battery, which also supplies power for the 12 volt vehicle electrical system.



Recuperation: High Voltage Battery is Recharged

During vehicle deceleration, the vehicle is braked electrically by the e-machine, which recharges the high voltage battery. A portion of the energy is recovered as soon as the driver takes his foot off the accelerator, with the amount recovered increasing during vehicle braking. The 12 volt vehicle electrical system is supplied with power from the e-machine.



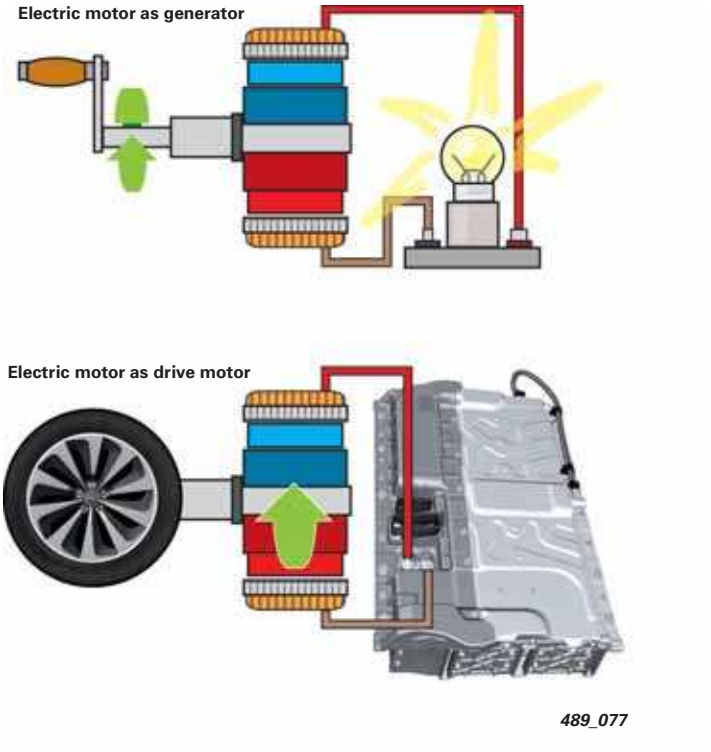
Key:

	High voltage wires
	Hybrid CAN
AX1	Hybrid Battery Unit
JX1	Electric Drive Power and Control Electronics
V141	Electro-Drive Drive Motor
J623	Engine Control Module
J840	Battery Regulation Control Module
J841	Electrical Drive Control Module

Electric Drive Motor (e-machine)

The term “e-machine” is used instead of generator, electric motor, or starter. Any electric motor can be used as a generator. When the e-machine motor shaft is driven externally, it delivers electrical power as a generator. When the e-machine is supplied with electrical power, it functions as a motor.

The e-machine of a hybrid replaces the conventional starter and generator (alternator) of an internal combustion engine.



Electrical Boost (e-boost)

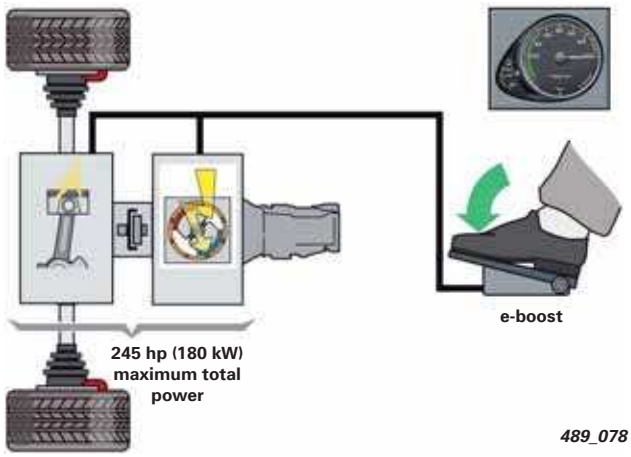
Like the kickdown function in internal combustion engines, which delivers maximum engine power, hybrid drive offers an electrical boost (e-boost) function. When this function is activated, the e-machine and internal combustion engine deliver their maximum power.

The total of the individual power outputs of both types of drive corresponds to the total power output of the driveline.

Due to technical power loss within the e-machine, the generator function produces less power than its electric motor function.

In the Audi Q5 hybrid quattro, the 2.0L TFSI engine develops 211 hp (155 kW), while the e-machine develops 41 hp (31 kW) as a generator and 54 hp (40 kW) as an electric motor.

The internal combustion engine and the e-machine (as an electric motor) have a combined power output of 245 hp (180 kW).



Coasting

The vehicle is not actively driven during coasting. In these instances, the internal combustion engine is turned OFF and the e-machine supplies the 12 volt vehicle electrical system via brake energy recuperation. No current is drawn from the high voltage battery during this phase.

Introduction to the Q5 hybrid quattro

Identifying Features

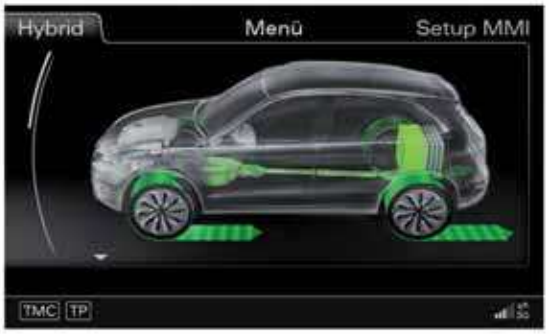
The Audi Q5 hybrid quattro can be distinguished from a standard Audi Q5 with internal combustion by the features illustrated here.

Instrument cluster with power meter and hybrid displays

hybrid logo on the engine cover

hybrid logo on the fenders

MMI Navigation Plus
with hybrid display



hybrid logo on
the rear trunk lid

EV mode switch and shift
control with tip-S function

hybrid logo on
the sill panels

489_024

Design Overview

The 2.0 TFSI and e-machine of the Audi Q5 hybrid quattro are mounted directly behind one another as a parallel hybrid system.

Electric Drive Power and Control Electronics JX1 is a pulse controlled inverter that connects the high voltage battery and the e-machine. It is some times referred to as “power electronics module” or shortened further to “power electronics.” This module serves as a controller between the battery, which outputs direct current (DC), and the e-machine that operates on alternating current (AC).

JX1 includes a DC/DC converter that provides 12 volt power for the electric consumers on the 12V electrical system.

Located in the plenum chamber of the engine compartment, it requires high voltage cabling that is both compact and lightweight.

The cooling circuit of the internal combustion engine also provides cooling for the e-machine. JX1 is cooled via a separate low-temperature coolant circuit.

A permanently excited synchronous motor functions as a starter, and during deceleration, as a generator.

The quattro drive applies the power of both the internal combustion engine and e-machine efficiently to the road in any situation. In normal driving conditions, drive is directed more to the rear axle, or to the axle with better traction.

The sophisticated running gear includes many aluminum components for reduced weight.

The Climatronic system of the Audi Q5 hybrid quattro was adapted to the requirements of electric driving. A high voltage, demand controlled electric A/C compressor is used for high efficiency.

The A/C compressor ensures operation even when the combustion engine is not running.

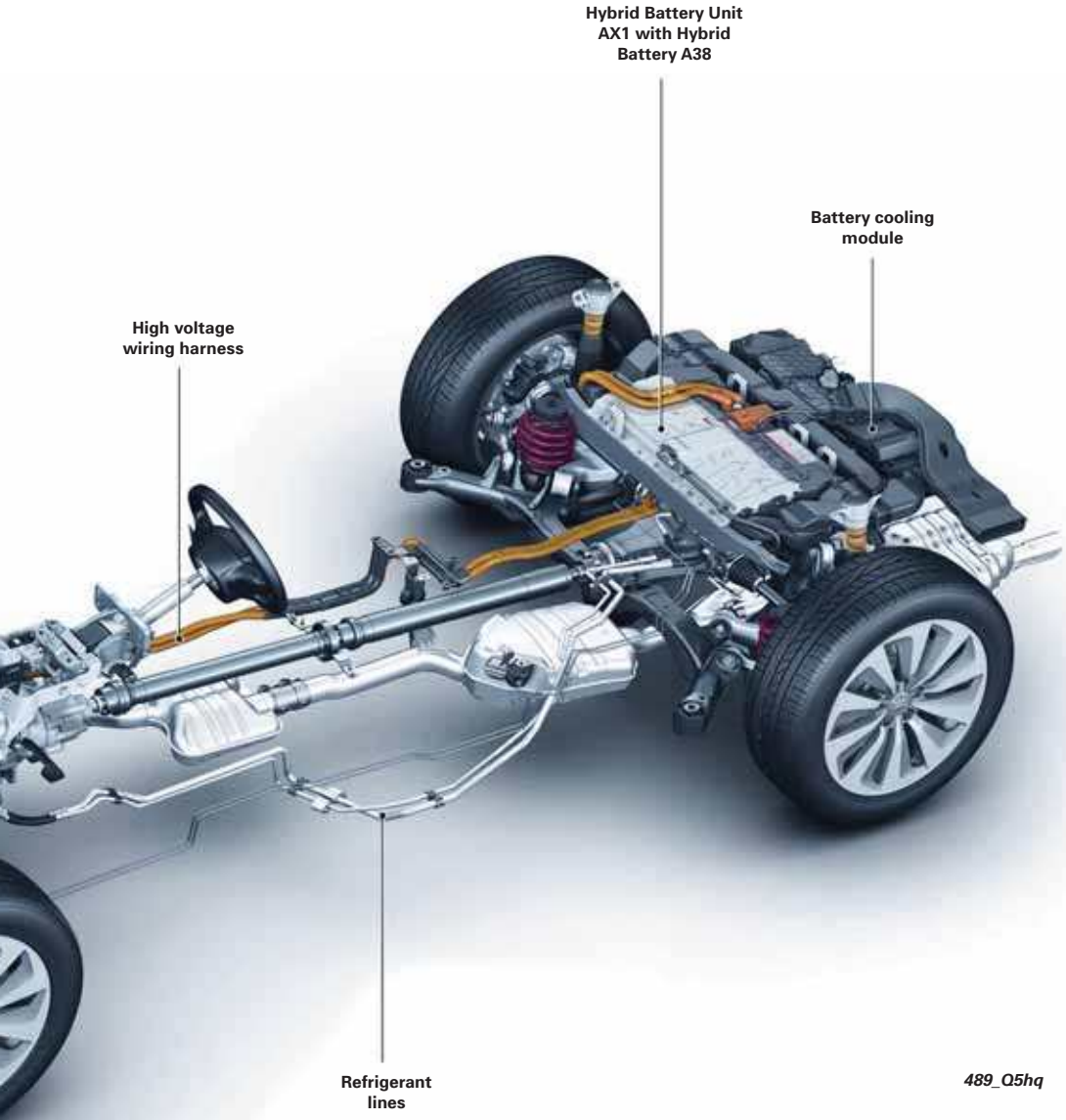
An electric auxiliary heater supports the interior heating system.

A lightweight lithium-ion battery system weighing 83.7 lb (38 kg) stores and provides the energy for the e-machine. This compact unit is positioned in a crash-safe area under the trunk floor, and does not reduce luggage compartment volume.

The battery consists of 72 cells. At 266 volts, its nominal energy is 1.3 kWh, with output being 39 kW.

The battery is cooled in two ways, depending on load requirements. At low-temperature load, it draws temperate air from the vehicle interior via a fan. If its temperature exceeds a certain limit, a separate refrigerant circuit is activated.

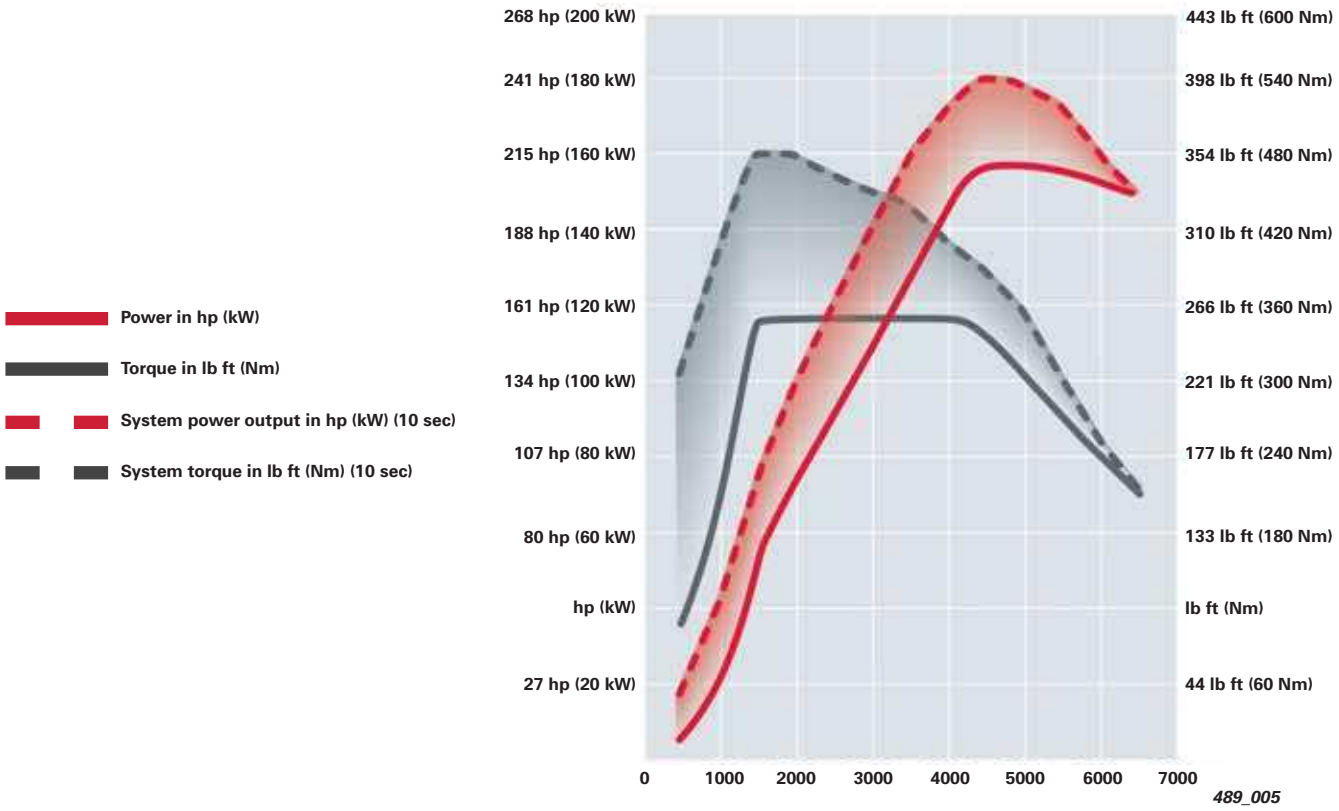
The battery cooling module is coupled to the main climate control system of the vehicle and has its own evaporator.



489_Q5hq

2.0L TFSI Engine

Specifications



Engine Code	CHJA
Engine type	Four-cylinder inline with three-phase AC motor/generator
Displacement	121 cu in (1984 cm^3)
Power output (internal combustion engine)	211 hp (155 kW) @ 4300–6000 rpm
System power output	245 hp (181 kW)
Torque (internal combustion engine)	258 lb ft (350 Nm) @ 1500–4200 rpm
System torque	354 lb ft (480 Nm)
Top speed (electric drive only)	62 mph (100 km/h)
Range (electric drive only)	1.8 miles (3 km) at 37 mph (60 km/h)
Number of valves per cylinder	4
Bore	3.24 in (82.5 mm)
Stroke	3.65 in (92.8 mm)
Compression ratio	9.6 : 1
Powertrain type	8-speed quattro automatic transmission
Engine management	MED 17.1.1
Fuel	Premium unleaded 91 AKI
Emissions standard	Federal Tier II BIN 5 / CA LEV II ULEV
Additional hybrid component weight	less than 287 lb (130 kg)

2.0L TFSI Engine Modifications

Drive Belt Elimination for Auxiliary Units

The conventional belt drive system of the 2.0L TFSI engine was eliminated and replaced with a new mounting design to accommodate the new electrical (non-belt driven) A/C compressor.

The engine features revised bearing materials for the crankshaft and balance shafts to ensure smooth start-stop operation. The crankshaft pulley is still designed to function as a vibration damper.

Modified Use of Secondary Air Injection

- Cylinder heads with additional secondary air channels
- Secondary Air Injection Pump Relay J299
- Secondary Air Injection Pump Motor V101
- Secondary Air Injection Solenoid Valve N112
- Secondary Air Injection Sensor 1 G609

Coolant Circuit and Thermal Management System

The cooling system is subdivided into low and high temperature circuits. It includes an additional low temperature cooling circuit for Electric Drive Power and Control Electronics JX1.

When the internal combustion engine is at a standstill, the coolant is circulated by an electric coolant pump.

The introduction of the MED 17.1.1 engine control module (ECM) with a triple-core processor also made it possible to implement an innovative thermal management system. The result was improved fuel economy and reduced CO_2 emissions via heat balance optimizing in the vehicle. This was accomplished by keeping all parts and assemblies (for instance, the engine and transmission) under thermal load (connected to the cooling system) within their optimal temperature range for greatest efficiency.

High Temperature Circuit Components

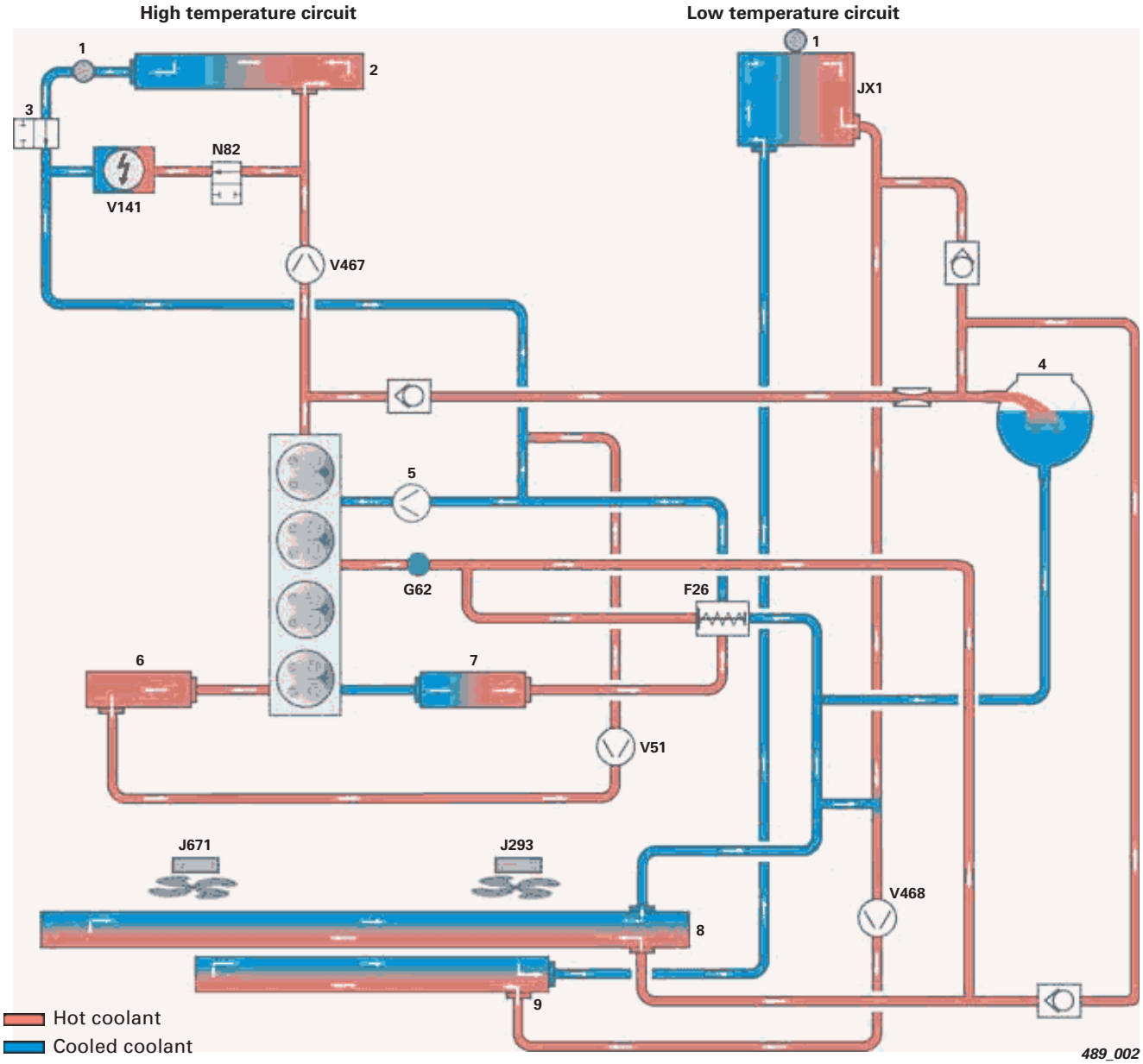
- Passenger compartment heat exchanger
- Coolant Shut-Off Valve N82
- Electro-Drive Motor V141
- High Temperature Circuit Coolant Pump V467
- Coolant pump
- Exhaust turbocharger
- Engine oil cooler
- Engine Coolant Temperature Sensor G62
- Map Controlled Engine Cooling Thermostat F265
- After-Run Coolant Pump V51
- High temperature circuit coolant radiator
- Transmission oil cooler

Low Temperature Circuit Components

- Electric Drive Power and Control Electronics JX1
- Low Temperature Circuit Coolant Pump V468
- Coolant cooler for low temperature circuit

Note

Electric Drive Power and Control Electronics JX1 will be damaged if its temperature goes over 185°F (85°C).



Legend:

1 Bleeder screw
2 Passenger compartment heat exchanger
3 Coolant shutoff valve*
4 Coolant expansion tank
5 Engine coolant pump
6 Turbocharger
7 Engine oil cooler
8 High temperature circuit coolant cooler (including transmission cooler)
9 Coolant cooler for low temperature circuit

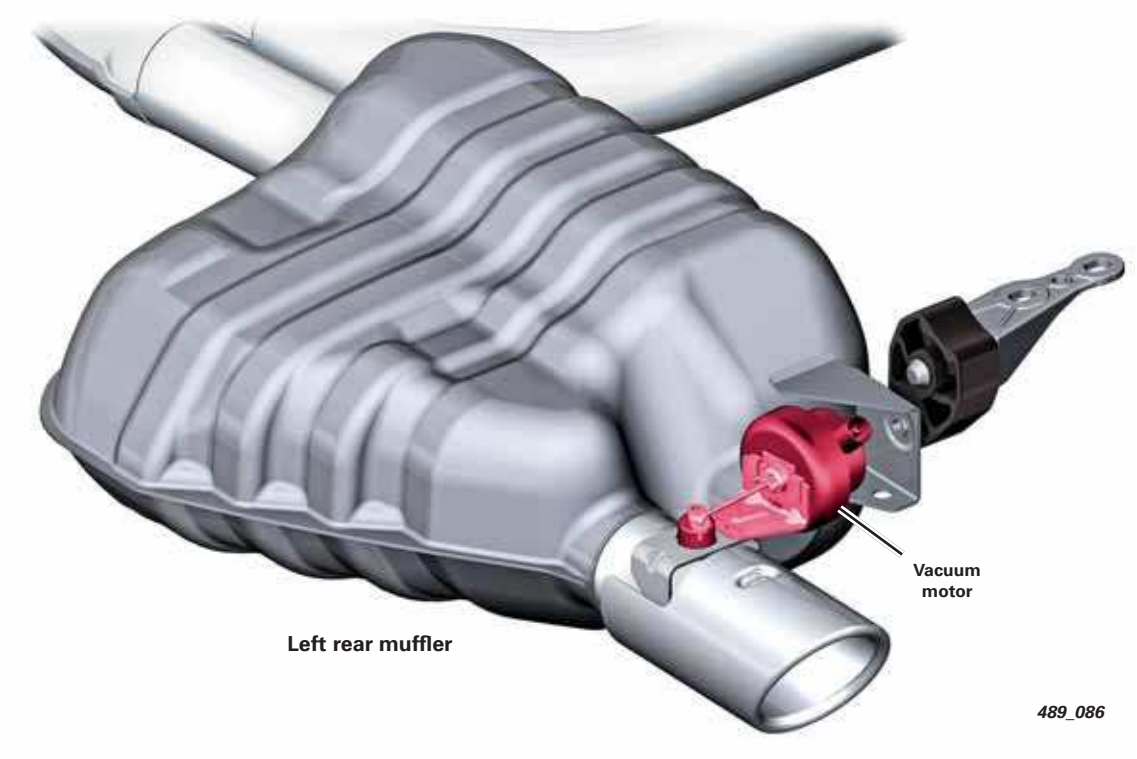
F265 Map Controlled Engine Cooling Thermostat**
G62 Engine Coolant Temperature Sensor
J293 Coolant Fan Control Module**
J671 Coolant Fan Control Module**
JX1 Electric Drive Power and Control Electronics
N82 Coolant Shut-Off Valve**
V51 Coolant After-Run Pump**
V141 Electro-Drive Drive Motor***
V467 High Temperature Circuit Coolant Pump**
V468 Low Temperature Circuit Coolant Pump***

*Activated by Climatronic Control Module J255 via Climatronic Refrigerant Shut-Off Valve N422
**Activated by Engine Control Module J623
***Activated by Electric Drive Power and Control Electronics

Active Exhaust Flap in Rear Muffler

An active exhaust flap is installed only in the left rear muffler, and is controlled by Exhaust Door Valve 1 N321. It is closed when vacuum is present, and is open when vacuum is not present, such as when the engine is not running.

This flap closes at up to 220 lb ft (300 Nm) torque and 1800 rpm and during charging of the battery in idle mode.



Engine Control Module J623

ECM Functions

- Internal combustion engine control
- Thermal management control
- Hybrid manager

The ECM decides when to use electric drive and informs Electric Drive Power and Control Electronics JX1 of the driver's torque requirement.

J623 controls the thermal management of all coolant circuits.

The internal combustion engine can be engaged to run continuously for diagnostic purposes by doing the following:

- Activating the kick-down in "P" will run the internal combustion engine continuously until a gear is selected

Whenever the vehicle is being driven in electric mode, the cruise control system is active.

489_072

Transport Mode

In this mode, the e-machine is used only as a generator. Therefore, no electric drive, e-boost, start-stop function, or brake energy recuperation are available in this mode.

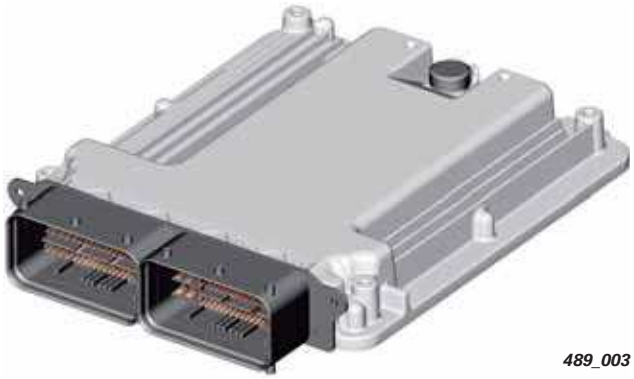
In transport mode, the high voltage battery is charged whenever the internal combustion engine is running. Top speed is limited to 22 mph (35 km/h) or 3500 rpm. If transport mode is not deactivated using the VAS Scan Tool, it is deactivated during the next "terminal 15" cycle after the vehicle has covered a distance greater than 62 miles (100 km).

Service Mode

This mode is activated by J623 via the VAS Scan Tool using the adaptation function. Minimum engine coolant temperature must be 77°F (25°C). When in service mode, both Malfunction Indicator Lamp K83 and Engine Electronics Indicator Lamp K149 are activated.

In this mode, the e-machine can only be used as a generator, with the high voltage battery being charged whenever the internal combustion engine is running. No electric drive, e-boost, start-stop function, or brake energy recuperation are available. The internal combustion engine is started using the 12 volt auxiliary starter.

If the service mode adaptation is not cancelled, it will be deactivated at the next "terminal 15" cycle after the vehicle has been driven a distance greater than 31 miles (50 km).

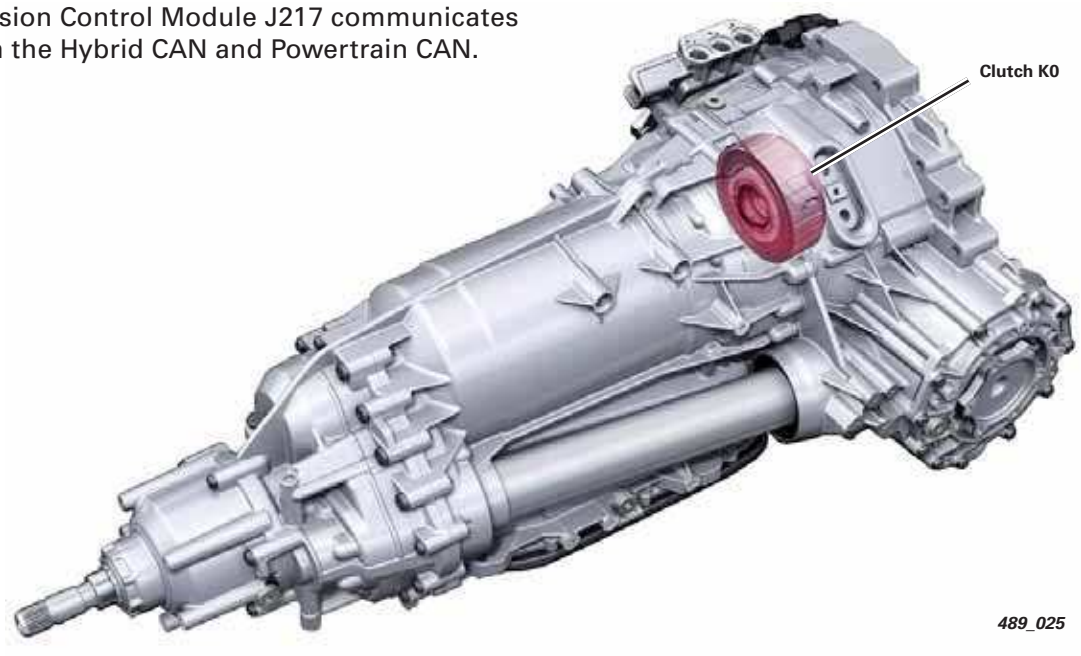


489_003

Notes

Eight-Speed Automatic Transmission with Hybrid Module

Transmission Control Module J217 communicates over both the Hybrid CAN and Powertrain CAN.



The e-machine is installed with a multi-plate clutch (K0) as a single module in the automatic transmission. It takes the place of the torque converter and requires no additional space. Running in an oil bath, it connects or disconnects the internal combustion engine to the e-machine.

Since the torque converter has been eliminated, clutch K1 is used as a starting component.

Transmission Fluid Auxiliary Hydraulic Pump 1 V475 lubricates the transmission and creates the oil pressure required for hydraulic actuation when the e-machine is at a standstill.

Driving State	Clutch K0	Clutch K1
Engine start	closed	open
All-electric driving	open	closed
Brake energy recuperation	open	closed
Internal combustion engine running	closed	closed
Internal combustion engine idling	closed	open
e-boost	closed	closed
Coasting without brake energy recuperation	open	open
Coasting with brake energy recuperation	open	closed

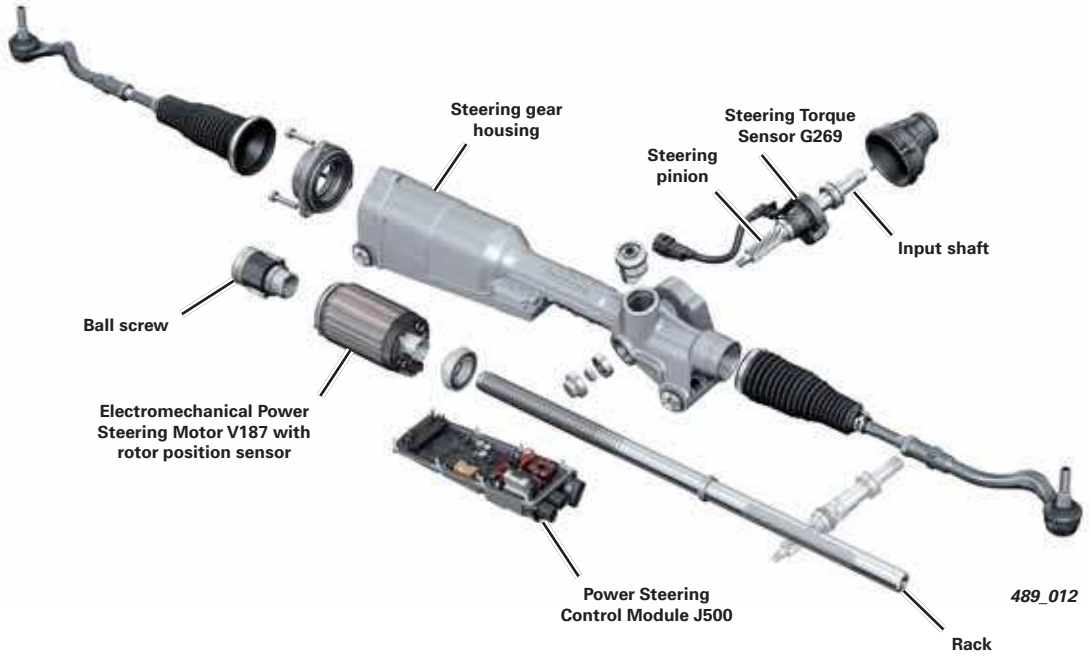
Note

As with other automatic transmission equipped vehicles, a disabled vehicle should be transported by flat bed towing. If this is not possible, it must be flat towed (front or rear axles must not be raised) and a towing speed of 31 mph (50 km/h) must not be exceeded.

Electromechanical Steering

An electromechanical steering system is used in the Audi Q5 hybrid quattro instead of hydraulic power steering.

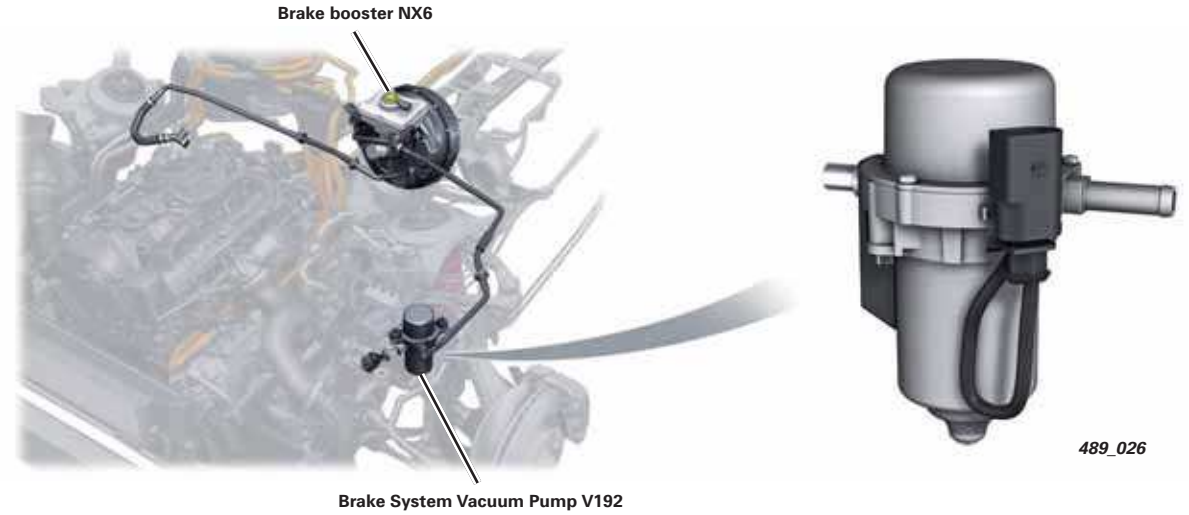
Power Steering Control Module J500 communicates over the DPI/running gear CAN bus.



Brake System Vacuum Pump V192

V192 is mounted on the ABS Control Module on the left side of the engine compartment. It provides a vacuum source when the internal combustion engine is not running.

The vacuum pump is controlled by Engine Control Module J623 via Vacuum Pump Relay J318, based on signals from Brake Booster Pressure Sensor G294.



Reference

For more detailed information about the design and function of the electromechanical power steering system, refer to Self-Study Program 990303, *The 2012 Audi A7 Running Gear and Suspension Systems.*

ABS/ESP Control Module J104

The ABS/ESP module of the Audi Q5 hybrid quattro is identical in design to that in the standard Q5. The software has been revised to include a hybrid engine drag torque control (MSR) function.

This was necessary because brake pressure cannot be reduced for stabilization purposes during electrical braking (brake energy recuperation). During the recuperation phase, the ECM is instructed to reduce and adapt engine drive torque.

If the ESP is deactivated or Downhill Assist is activated while the gear selector is in the "D" position, the internal combustion engine runs continuously.

Hybrid Engine Drag Torque Control (MSR)

The MSR system prevents the drive wheels from locking up under engine braking on a smooth road surface.

This occurs when the driver takes his foot quickly off the accelerator pedal or quickly shifts down a gear. The drive wheels may slip due to the braking effect of the engine, briefly losing traction and making the vehicle unstable. The MSR system maintains driving stability and safety in these situations.

The MSR system control module receives necessary information from the ABS wheel speed sensors and the engine or transmission control modules. If the control module detects slip at the drive wheels, the MSR system sends a signal across the data bus to the ECM. Engine speed is slightly increased until the drive wheels are again rotating at the same speed as the vehicle.

The vehicle thus remains steerable and driving stability is preserved. The engine drag torque control system functions across the entire engine speed range.

Brake Pedal Position Sensor G100

G100 communicates with the Engine Control Module.

It is used for controlling the electrical braking function (brake energy recuperation) via the ECM and ABS/ESP Control Module J104.

The brake pedal has approximately 0.3 in (9 mm) of idle travel at the brake booster. This allows only electrical braking and helps ensure a smooth transmission to hydraulic braking when the brake pedal is depressed.

After replacing the brake pedal position sensor or the ECM, G100 must be adapted using the VAS Scan Tool.

High Voltage System

The high voltage electrical system has an IT network configuration. The “I” in “IT network” stands for the insulated transmission of electrical energy through separate positive and negative wires or lines that are insulated from the vehicle body.

The “T” in “IT network” means that all devices are connected to the body by equi-potential bonding. This electrical line is monitored by Battery Regulation Control Module J840 during the insulation test, where insulation faults and short circuits can be detected.

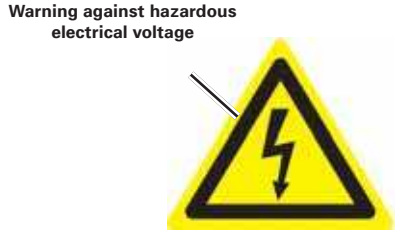
Warning Signs

To minimize high voltage system risks to users, service and repair personnel, and medical emergency first responders, numerous warning and information labels are provided on the Audi Q5 hybrid quattro.

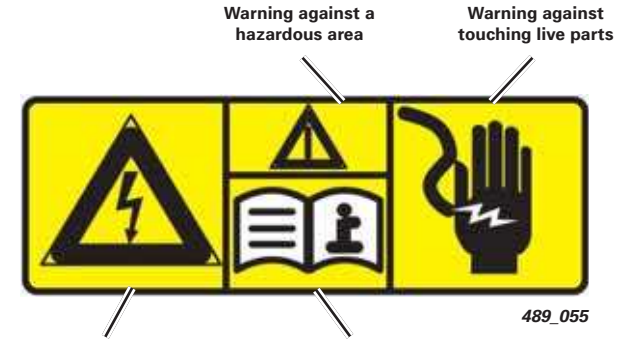
Two types of warning labels are used:

- Yellow warning label with warning symbol for electrical voltage
- Warning label marked “Danger” against a red background

The following yellow labels indicate high voltage conducting components or high voltage components installed in the immediate vicinity, for example, at-risk components not visible under protective covers.



489_054



489_055

Warning labels marked “Danger” identify high voltage components or high voltage conducting components.

489_056

489_057

Special high voltage identification label affixed to the top of the battery in English and in the import country’s national language

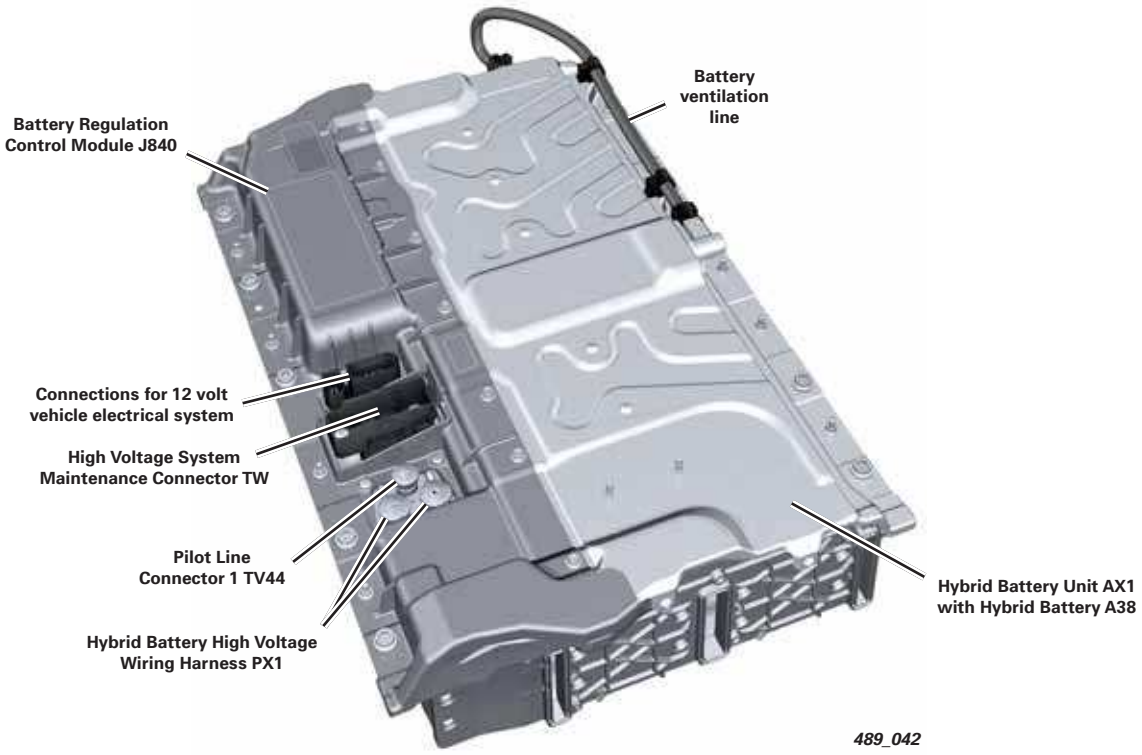
Hybrid Battery Unit AX1

AX1 is located in the spare tire well of the luggage compartment and includes the following components:

- Hybrid Battery A38
- Battery Regulation Control Module J840
- High Voltage System Maintenance Connector TW
- Pilot Line Connector 1 TV44
- Hybrid Battery High Voltage Wiring Harness PX1
- Connections for 12 volt vehicle electrical system

The housing is connected to the vehicle by equi-potential bonding (joined metalwork that is grounded).

Cooling air connections are integrated into the battery housing. A ventilation line is attached to the battery housing to discharge gas released from a faulty cell.



Hybrid Battery A38 Specifications	
Rated voltage	266V
Cell voltage	3.7V
Number of cells	72 (connected in series)
Capacitance	5Ah
Operating temperature	15–131°F (15–55°C)
Energy content	1.3 kWh
Usable energy content	0.8 kWh
Power output	maximum 53 hp (40 kW)
Weight	84 lb (38 kg)

Components of Hybrid Battery Unit AX1

Battery Regulation Control Module J840

J840 is integrated on the left side of Hybrid Battery Unit AX1 and communicates on both the Hybrid and Powertrain CAN buses.

J840 monitors the temperature of the high voltage battery and regulates battery temperature via the battery cooling module. It acquires and evaluates information on charge level, cell voltage, and battery voltage. This information is relayed on the Hybrid CAN to the ECM.

A safety line is looped through all high voltage components and is monitored by J840, which uses an electrical current signal supplied in the safety line by Electric Drive Power and Control Electronics JX1.

All battery-related data is stored in History Data by J840, which makes it possible to track inefficient charging/discharging or overheating of the high voltage battery.

Hybrid Battery A38

A38 is also integrated into AX1. A sensor monitors the electrical current during the charging and discharging cycles. Additional sensors monitor voltage upstream and downstream of the high voltage contacts.

As noted earlier, the high voltage contacts are closed when “terminal 15” is switched ON, and opened when “terminal 15” is switched OFF or a crash signal is received.

The charge level of the high voltage battery is maintained between 30% and 80%. The limited charge range extends the life of this battery. The battery charge indicator in the instrument cluster displays the available range as 0% to 100%. Charge level information is communicated over the Hybrid CAN.

If starting capacity is limited (less than 25% charge in the high voltage battery) or the engine fails to start, the following message is displayed: “Vehicle cannot be started at this time. See owner’s manual“. If the battery charge level drops below 20%, Battery Regulation Control Module J840 prevents the high voltage contacts from closing except for charging of the high voltage battery. This prevents further discharge of the battery.

When driving under electric power only, the high voltage battery supplies both the high voltage and 12 volt systems.

High Voltage Contacts

The high voltage battery is connected to other high voltage components, and is disconnected via high voltage contacts labeled “positive” and “negative”.

J840 closes the high voltage contacts as soon as “terminal 15” is activated. If the 12 volt power supply to J840 is disconnected, the high voltage contacts are opened. When the 12 volt battery power supply is OFF, the high voltage system is also OFF.

Charging the High Voltage Battery

If the instrument cluster display reads, “Vehicle cannot be started at this time. Refer to owner’s manual“, the high voltage battery must be charged.

To do this, switch the ignition OFF and connect a battery charger of at least 30A to the jump start lugs. After the 12V battery has been successfully charged, switch the ignition ON. The following message is displayed: “Preparing to start vehicle. Please wait...“.

If no charge current is consumed by the high voltage battery within one minute, the following message is displayed: “Charging cycle aborted. Cannot start engine“, meaning the charger does not have enough power. A fault is indicated via a red hybrid warning lamp.

If a charging current is detected, the high voltage battery is charged to 35%. A green charging connector symbol appears in the instrument cluster display. During this process, the 12 volt battery is partially discharged. If the charge level of the high voltage battery has dropped below 5%, the battery can no longer be charged.

High Voltage System Maintenance Connector TW

This connector, sometimes referred to as the service disconnect or service connector, can be used to isolate the two halves of the high voltage battery.

It must be removed before working on high voltage components or if you are in the vicinity of high voltage components when using metal cutting, shaping, or sharp edged tools.

The Scan Tool must be used to de-energize the high voltage system.

489_028

Locking and Unlocking the Maintenance Connector

First, switch the ignition system OFF. High Voltage System Maintenance Connector TW is located under the service flap of the high voltage system in the luggage compartment. It is under a removable orange colored rubber cover on Hybrid Battery Unit AX1.

Maintenance connector inserted

489_031

Removing the Maintenance Connector

The removal process for the maintenance connector involves two defined switch positions. Sliding the connector in the direction of the arrow moves it to its first position. In the first position, the safety line is disconnected.

Maintenance connector in position 1 before lifting it to position 2

Lifting the maintenance connector after sliding into the first position moves it into the second defined position.

489_030

In the second position, the series connection between the two battery halves is opened. The maintenance connector can now be removed from the mounting and the high voltage system is now deactivated.

You must always check for the presence of voltage before continuing work.

Maintenance connector in position 2

489_032

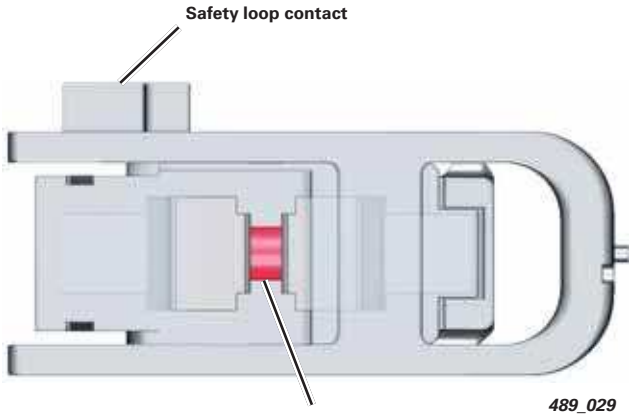
Lock for Service Disconnect T40262

To safeguard the high voltage system against unintentional reactivation during maintenance work, the plastic cover is locked using the maintenance connector padlock.

489_045

Fuse in Maintenance Connector

A fuse for the high voltage system is integrated in the maintenance connector. The fuse is rated for 125A.



489_029

Restarting

To restart the high voltage system, move the maintenance connector back into position in the reverse sequence.

Use Guided Fault Finding to perform the restart procedures.

Note

Only qualified high voltage technicians are allowed to disconnect the maintenance connector to de-energize the vehicle.

Battery Cooling

When charging a battery, the chemical processes which take place during discharging are reversed. Heat is released during this thermodynamic process, causing the battery to heat up.

Because the high voltage battery of the Audi Q5 hybrid quattro is subject to continuous discharge and charge cycles, there can be considerable heat build-up. This not only depreciates and ages the battery, it also increases electrical resistance in the conductors, with the result being that electrical energy is not converted for work but is instead dissipated and lost as heat.

For this reason, the high voltage battery has a cooling module with a separate evaporator, and is connected to the cooling circuit of the A/C compressor. This cooling module operates on the 12 volt onboard power supply.

In addition, there are six temperature sensors between the Hybrid Battery Unit AX1 housing and the two halves of the battery. Single temperature sensors are located in each of the cooling module air intake and outlet ducts.

If Battery Regulation Control Module J840 detects excessively high temperatures from either Temperature Sensor Before Hybrid Battery Evaporator G756 or Temperature Sensor After Hybrid Battery Evaporator G757, it activates Battery Fan 1 V457.

A cooling function model is programmed in the control module. Depending on the temperature, the system switches from fresh air mode to air recirculation mode with active evaporator.

There are three cooling demand levels for Climatronic Control Module J255. The blower speed is controlled by Battery Regulation Control Module J840 via the LIN bus.

In fresh air mode, V457 draws air out of the spare tire well, channels it through the evaporator and into the battery, and discharges the warm air into the atmosphere below the bumper at rear left.

In air recirculation mode, Hybrid Battery Recirculation Door Positioning Motor 1 V479 and Hybrid Battery Recirculation Door Positioning Motor 2 V480 are closed and no fresh air is inducted.

If necessary, Battery Regulation Control Module J840 sends a request to activate Electrical A/C Compressor V470 to Climatronic Control Module J255 via the CAN bus.

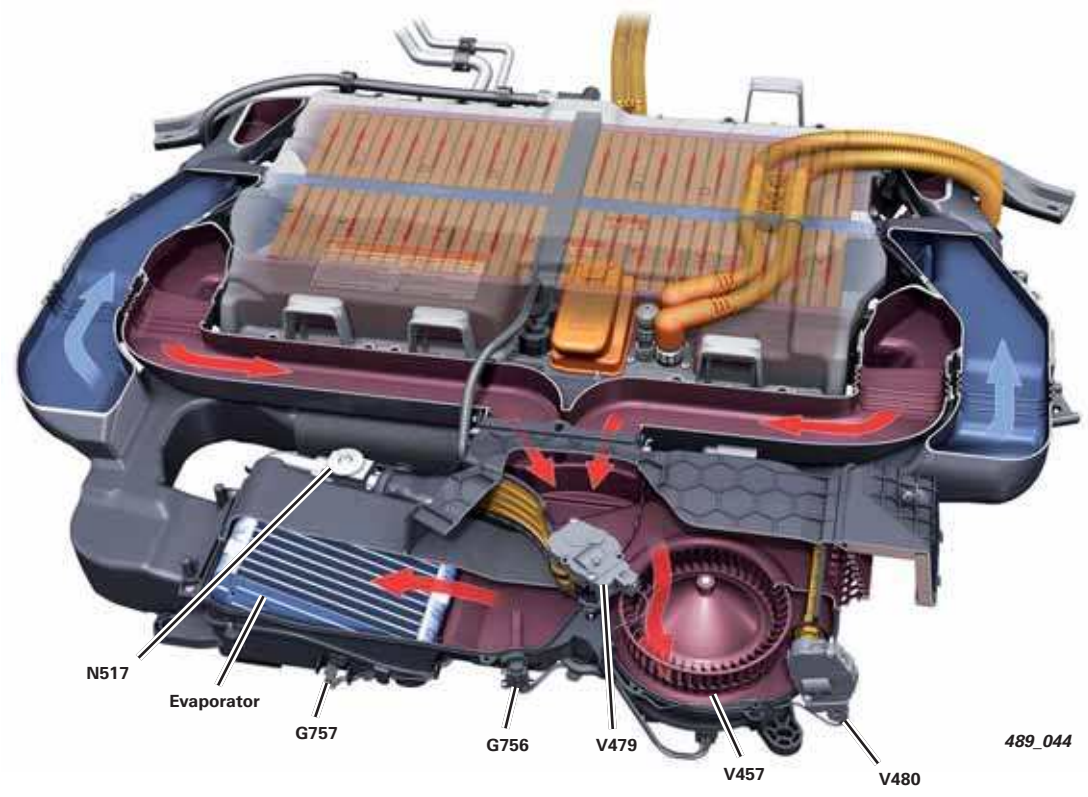
Battery Fan 1 V457, Hybrid Battery Recirculation Door Positioning Motor 1 V479, and Hybrid Battery Recirculation Door Positioning Motor 2 V480 are regulated by Battery Regulation Control Module J840 via the LIN bus. Positioning Motors V479 and V480 are connected in series.

Hybrid Battery Refrigerant Shut-Off Valve 2 N517 is normally closed and controls the refrigerant flow to the air conditioner from the hybrid battery. Hybrid Battery Refrigerant Shut-Off Valve 1 N516 is normally open and controls the refrigerant flow to the passenger compartment. It is located in the engine compartment.

The cooling module has a service position which can be used for accessing the 12 volt battery installed below it.

The components of the cooling module are:

- Battery Fan 1 V457
- Hybrid Battery Recirculation Door Positioning Motor 1 V479
- Hybrid Battery Recirculation Door Positioning Motor 2 V480
- Temperature Sensor Before Hybrid Battery Evaporator G756
- Temperature Sensor After Hybrid Battery Evaporator G757
- Hybrid Battery Refrigerant Shut-Off Valve 1 N516 (mounted in the engine compartment)
- Hybrid Battery Refrigerant Shut-Off Valve 2 N517



Electric Drive Power and Control Electronics JX1

Electric Drive Power and Control Electronics JX1 consists of Electrical Drive Control Module J841, Drive Motor Inverter A37, Voltage Converter A19, and Intermediate Circuit Capacitor 1 C25. Electrical Drive Control Module J841 communicates on both the Hybrid CAN and Powertrain CAN.

Drive Motor Inverter A37 (bidirectional pulse inverter) converts the direct current of the high voltage battery to a three-phase A/C voltage for the e-machine. In brake energy recuperation and generator modes, DC voltage for charging the high voltage battery is generated from the alternating current.

Speed is controlled by modulating the frequency. At a speed of approximately 1000 rpm, the electrical frequency is about 267 Hz. Torque is controlled by pulse width modulation.

Voltage Converter A19 converts the DC voltage from the high voltage battery (266 volts) to the low DC voltage (12 volts) of the vehicle electrical system.

Intermediate Circuit Capacitor C25 serves as an energy storage device for the e-machine. The intermediate circuit capacitor is actively discharged when “terminal 15” is switched OFF or if the high voltage system is deactivated due to a crash signal.

As the DC/DC converter is bidirectional, it can also convert the low voltage (12 volts) of the vehicle electrical system to the high voltage (266 volts) of the high voltage battery. This function is used for jump starting (charging) the high voltage battery.

The A/C compressor is connected directly to the high voltage current of Electric Drive Power and Control Electronics JX1. Because the wires from the A/C compressor have a smaller cross-section than the wires from the high voltage battery to JX1, a 30A fuse is integrated in the power electronics for the A/C compressor.

JX1 has its own low temperature cooling circuit, which is connected to the coolant reservoir of the engine cooling circuit. Coolant is recirculated as required by Low Temperature Circuit Coolant Pump V468.

The low temperature circuit is a component part of the thermal management system. The engine control module controls pump activation. The ECM supplies the power electronics with information on brake energy recuperation, generator operation, and driving speed when driving under electric power.

JX1 checks the speed and position of Drive Motor Rotor Position Sensor 1 G713, as well as coolant temperature of Electro-Drive Drive Motor V141 using Drive Motor Temperature Sensor G712.

Electric Drive Power and Control Electronics JX1 Specifications	
DC/AC	$266V_{nom}$ in $189V_{eff}$ AC
Continuous AC current	$240A_{eff}$
Peak AC current	$395A_{eff}$
AC/DC	$189V_{eff}$ AC to $266V_{nom}$
e-machine drive	0–215V
DC/DC	266V to 12V and 12V to 266V (bidirectional)
DC/DC power output	2.6 kW
Weight	19.8 lb (9.3) kg
Coolant capacity	6.3 quarts (6.0 liters)

Operating States

Ignition OFF:

- "terminal 15 OFF"
- Hybrid manager (ECM) in sleep mode
- No operating current

Ignition ON Without Brake Depressed:

- "terminal 15 ON"
- Hybrid manager (ECM) in standby mode
- High voltage contacts are closed and the power electronics are supplied with a voltage of 266V by the high voltage battery. However, there is no operating current

Ignition ON With Brake Depressed:

- "terminal 15 ON", "terminal 50 ON"
- Message displayed: "Hybrid Ready"
- Operating current now flows:
  - From the high voltage battery to the power electronics
  - From the power electronics to the electric drive motor
  - From the high voltage battery to the 12 volt onboard power supply

489_036

Electro-Drive Drive Motor V141 (e-machine)

Electro-Drive Drive Motor V141 Specifications	
Power output	54 hp (40 kW) @ 2300 rpm
Torque	154 lb ft (210 Nm)
Weight of module	23 lb (31 kg)
Weight of e-machine	57 lb (26 kg)
Voltage	AC 3 ~ 145V

V141 (e-machine) is used for starting the internal combustion engine and, in generator mode, for charging the high voltage battery and 12 volt battery. The 12 volt battery is charged via a DC/DC converter in Electric Drive Power and Control Electronics JX1.

The e-machine allows the vehicle to operate solely under electric power but with limited speed and range. It also assists the internal combustion engine during acceleration (e-boost).

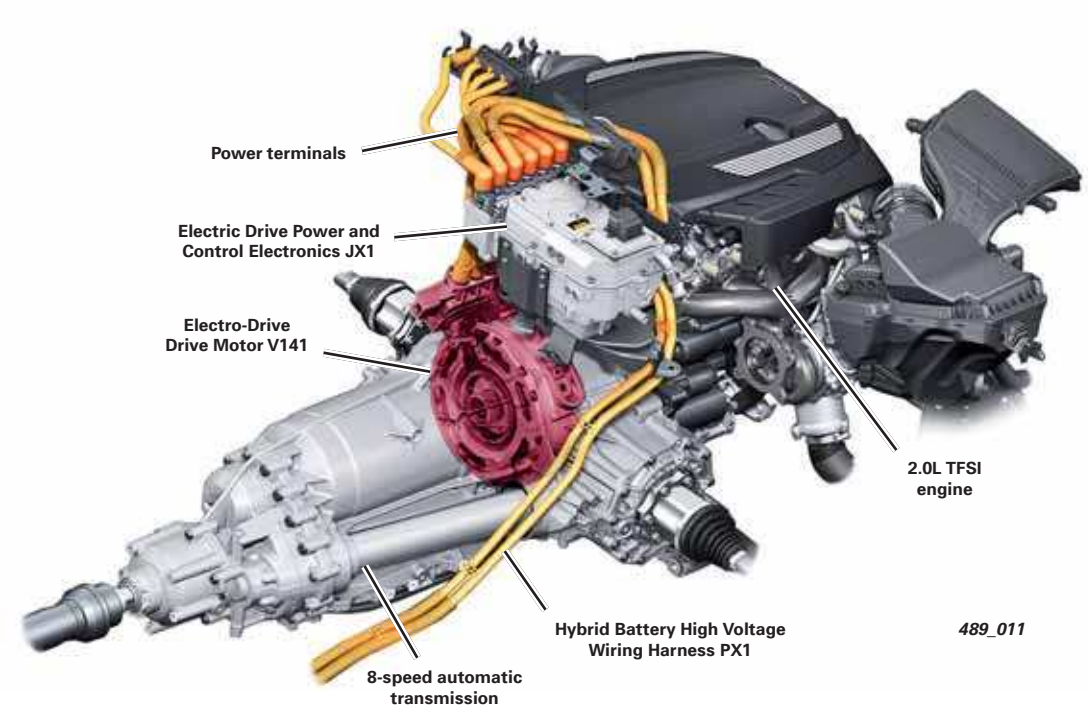
If the hybrid manager (ECM) determines the e-machine has enough power to drive the vehicle, the internal combustion engine is shut OFF.

As noted earlier, in the Audi Q5 hybrid quattro the e-machine is installed between the 2.0L TFSI engine and the 8-speed automatic transmission. It takes the place of the transmission torque converter but does not require additional installation space.

It is a permanently excited synchronous machine and is driven by a three-phase field source. The rotor has neodymium iron boron (NdFeB) permanent magnets.

J841 and JX1 control the operation of the e-machine. Torque is controlled by pulse width modulation (PWM) of frequency and speed.

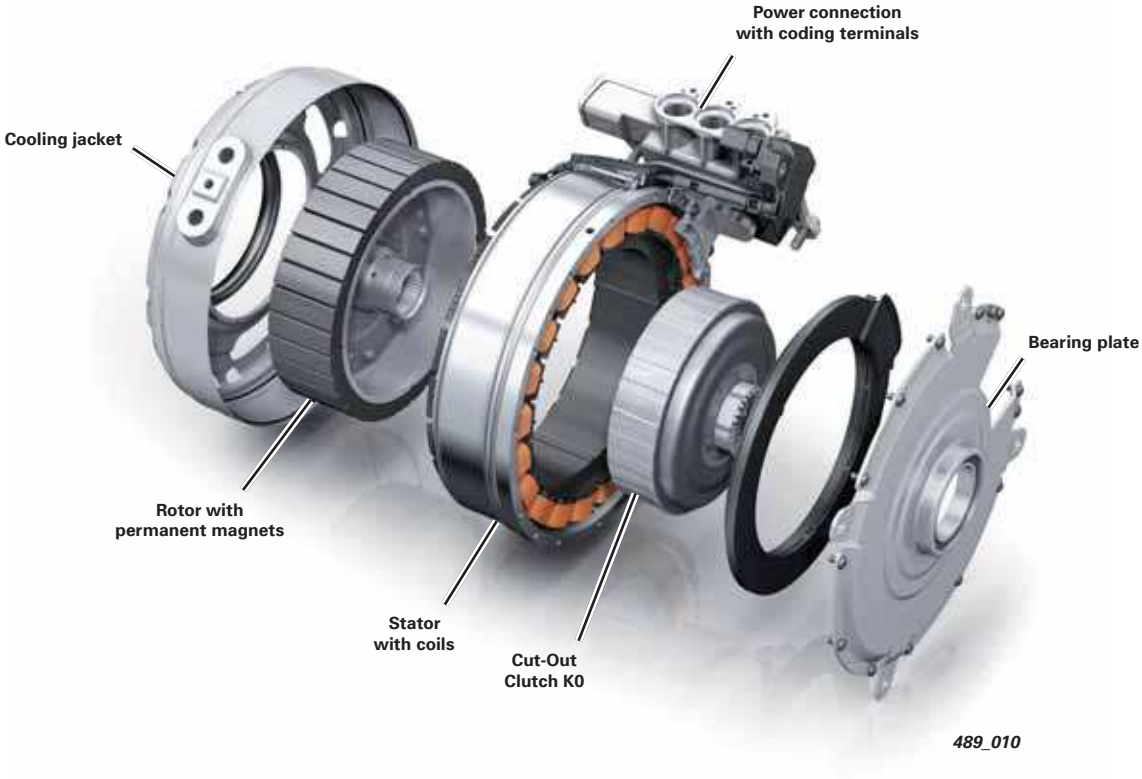
The 266 volt DC voltage is converted to three-phase AC voltage via JX1. This creates an electromagnetic three-phase field in the e-machine.



Components

The electric drive motor consists of:

- Die-cast aluminum housing
- Inner rotor with neodymium iron boron (NdFeB) permanent magnets
- Stator with magnetic coils
- Bearing plate for attachment
- Cut-out clutch
- Three-phase power connection



Cooling

The e-machine is water-cooled through an integrated high temperature cooling circuit of the internal combustion engine. Engine coolant is circulated by High Temperature Circuit Coolant Pump V467 in three stages as required. V467 is controlled by Engine Control Module J623.

Drive Motor Temperature Sensor G712 is an NTC resistor that measures the temperature between the two coils of the electric drive motor.

If the temperature exceeds a range of 356–392°F (180–200°C), the power output of the electric drive motor is reduced to zero (in generator mode and when driving under electric power). If the temperature of the electric drive motor is too high, the internal combustion engine can be re-started by the 12 volt starter.

Drive Motor Rotor Position Sensor 1 G713 records the actual speed and angular position of the rotor.

Drive Motor Temperature Sensor G712

This sensor records the temperature of the electric drive motor between two coils. The hottest point in the electric drive motor is determined by a temperature model. The signal from this temperature sensor is used to control the cooling output of the high temperature circuit.

The cooling circuits are an integral part of the innovative thermal management system. Coolant flow can be adjusted from stationary coolant to full cooling capacity via an electrical auxiliary coolant pump and the active coolant pump of the internal combustion engine.

Effect of Failure

If this signal fails, a red warning lamp in the instrument cluster is lit. The vehicle cannot be restarted but will continue to run by internal combustion engine until the 12 volt battery is completely discharged.

489_074

G712 and G713

Drive Motor Rotor Position Sensor 1 G713

Because the internal combustion engine with its speed sensors is mechanically isolated from the e-machine in EV mode, the e-machine has its own sensors to determine rotor position and rotor speed.

Based on the signal from this sensor, the ECM and transmission control module (TCM) determine if, and how fast, the e-machine is running. The signal is used to control the following functions of the high voltage drive:

- e-machine as generator
- e-machine as motor
- e-machine as internal combustion engine starter

Effect of Failure

If this sensor fails, a red warning lamp in the instrument cluster is lit:

- e-machine is deactivated and the vehicle coasts to a stop
- Vehicle cannot be driven electrically
- Generator mode is not possible
- Internal combustion engine cannot be started
- Vehicle must be taken to an Audi dealership for service

Air Conditioning System

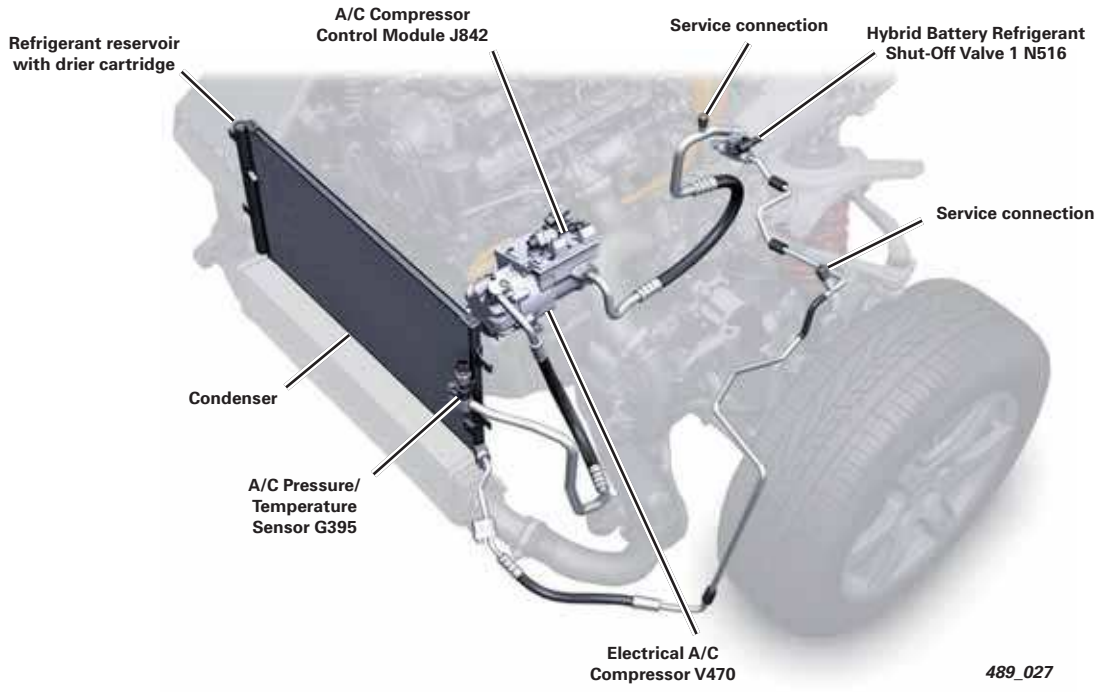
Electrical A/C Compressor V470 Specifications	
Electric motor	Brushless asynchronous motor
Power consumption	up to 6 kW
Voltage supply	266V DC
Current consumption	up to 17A
Speed	800 — 8600 rpm
Cooling	by refrigerant
Weight	15.4 lb (7 kg)

An electric A/C compressor is used instead of a conventional belt-driven A/C compressor. It is powered by the high voltage battery and is connected to Electric Drive Power and Control Electronics JX1. A/C Compressor Control Module J842 is integrated into the A/C compressor.

The control module communicates over the Extended CAN bus. Compressor speed is regulated by a pulse width modulated (PWM) signal between 0–100%.

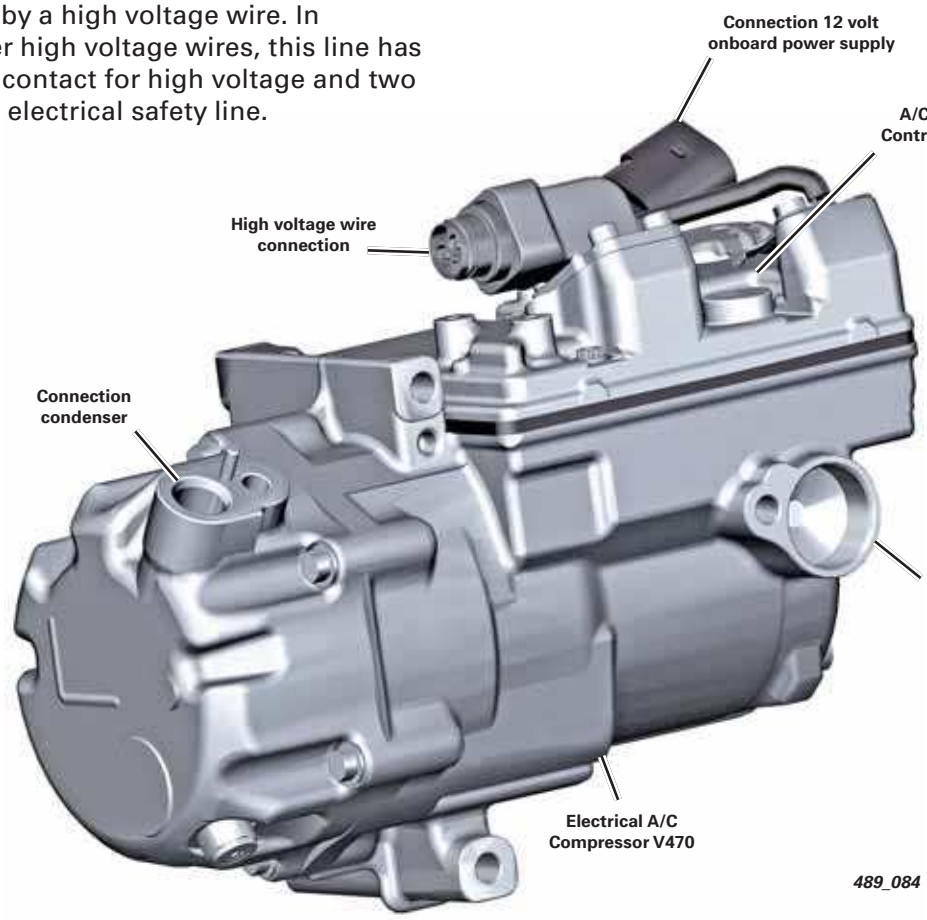
The A/C compressor is activated by Climatronic Control Module J255 to cool the passenger compartment and the high voltage battery.

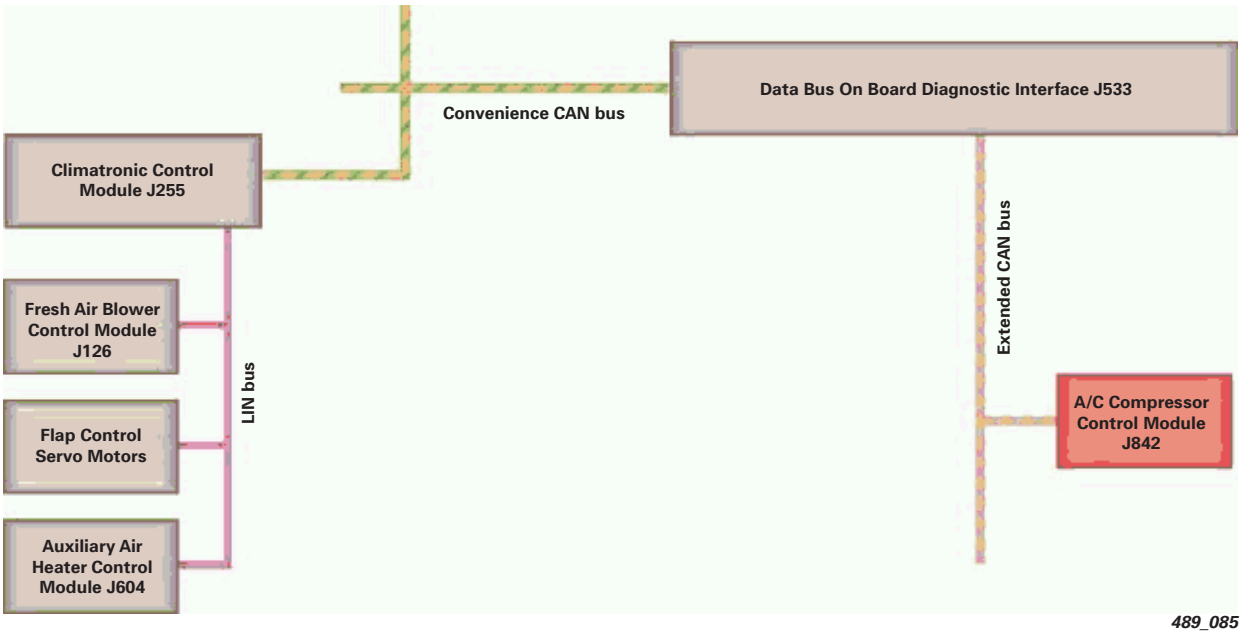
Positive temperature coefficient (PTC) Auxiliary Heater Heating Element Z35 is also installed. Auxiliary Air Heater Control Module J604 controls both Low Heat Output Relay J359 and High Heat Output Relay J360.



Electrical A/C Compressor V470

V470 is mounted to the engine block and connected to Electric Drive Power and Control Electronics JX1 by a high voltage wire. In contrast to other high voltage wires, this line has a double round contact for high voltage and two contacts for the electrical safety line.





High Voltage Wires

The electrical lines of the high voltage system differ considerably from the other lines in the 12 volt vehicle electrical system. Due to higher voltage and current levels, high voltage electrical lines have a significantly larger cross section and are connected by special plug-in contacts.

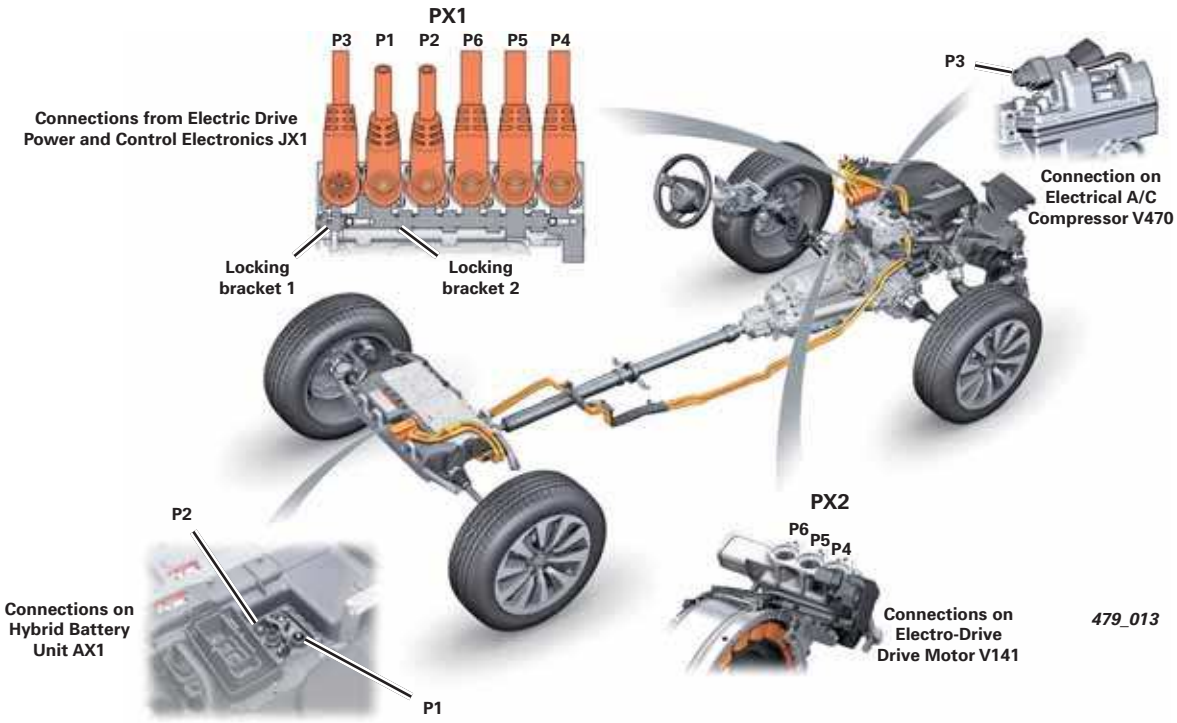
To draw attention to the danger of high voltage, all wires of the high voltage system are color coded orange.

To avoid incorrect assembly, the high voltage connectors are mechanically coded and identified by a colored ring under the bayonet ring.

High voltage wires are also mechanically coded at the round contacts. In a high voltage system, all shock-proofed plug-in connections and high voltage wires are protected against chafing by a thick layer of insulation and additional corrugated tube sheathing.

The high voltage system has the following line sections:

- Two high voltage wires from the high voltage battery to the power electronics (P1, P2)
- Three high voltage wires from the power electronics to the e-machine (P4, P5, P6)
- Two-wire high voltage wire from the power electronics to the A/C compressor (P3)



Connection	Number	Ring and Point Color	Title
Power electronics — high voltage battery High voltage cable set for PX1	P1	red	T+ (HV positive)
	P2	brown	T– (HV negative)
Power electronics — AC compressor	P3	red	—
Power electronics — electric drive motor High voltage cable set for PX2	P4	blue	U
	P5	green	V
	P6	violet	W

Safety Design

Insulation Monitoring

Every 30 seconds, an insulation measurement is made in the high voltage system. This is accomplished by applying system voltage, which will detect insulation faults throughout the high voltage circuit: in the high voltage battery, traction current lines, power electronics, three-phase lines connected to the electric drive motor, in the line to the A/C compressor, and the A/C compressor itself.

Electrical Safety Line

The safety line is a safety device designed to monitor and actuate the open or closed state of the high voltage system. It has an electrical and mechanical component.

Electrically, it is a line that runs through all high voltage components. If high voltage wires are disconnected, the safety line is interrupted and the high voltage system deactivated. It is like a series electrical circuit which is closed by its safety connectors. If this circuit is opened by removing the safety connector, the high voltage system is de-energized.

Pilot Line Contact 1 TV44 is the mechanical component of the safety line. To remove this line, a bayonet ring of the connector must first be lifted. This is combined with a locking bracket which prevents high voltage wires from being disconnected when voltage is present.

The safety connectors must be removed before disconnecting high voltage wires from high voltage components. This ensures that the system is not powered when lines are disconnected.

Note

Other commonly used terms or names for the safety line are: pilot line and HV Interlock.

Safety Line Closed

All component parts of the high voltage system are interconnected as a ring circuit by a separate low voltage wire. The component connection to the safety line is configured as a normally closed (NC) contact system.

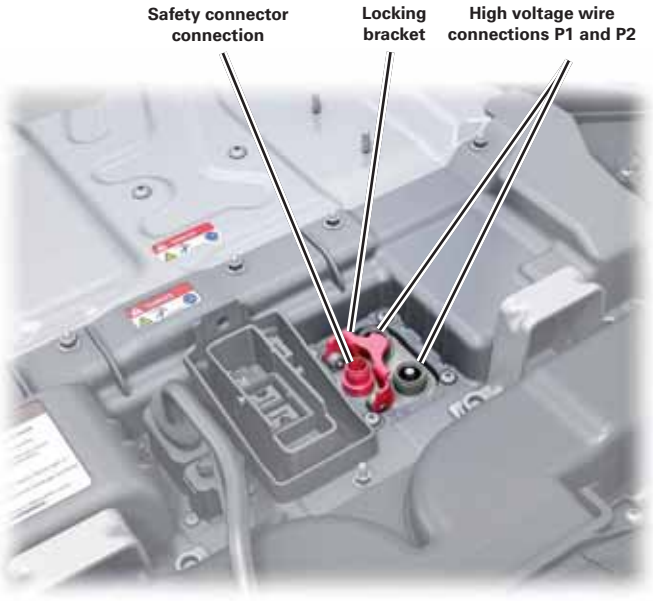
If all components are ready for operation, the contacts are closed. If a voltage is applied to the safety line, current can flow because the line is closed.

A measurable current indicates that all components of the safety line are ready for operation.

Safety Line Open

If a normally closed (NC) contact is opened because a component is not ready for operation, or because the safety connector has been removed, the safety line is now open. No current can flow when a voltage is applied. This is a sign that the high voltage system is not ready for operation.

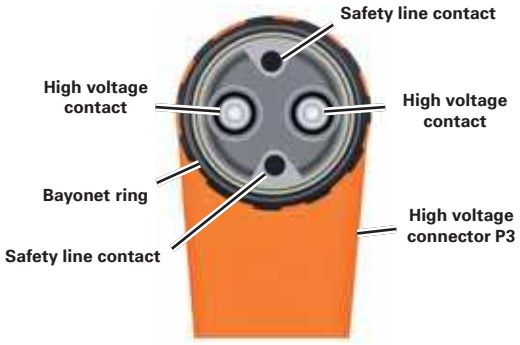
A check is made by Battery Regulation Control Module J840 in the Hybrid Battery Unit to determine if the safety line is closed or open. If the control module determines the line is open, it does not activate the high voltage contact, thus breaking the connection between the high voltage battery and the high voltage system.



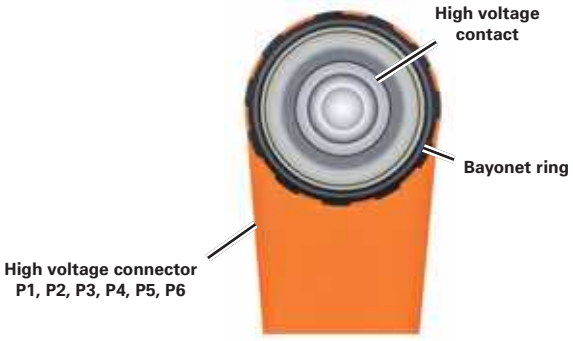
489_037

High Voltage Connector Contacts

High voltage line P3 for the A/C compressor system differs from other high voltage lines. It has two wires, two double round contacts, and two contacts for the electrical safety lines.



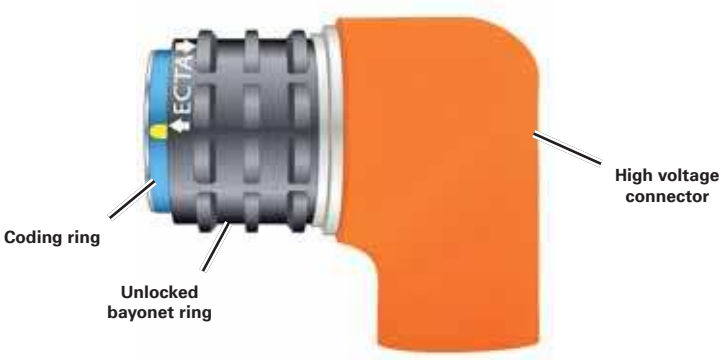
489_092



489_091

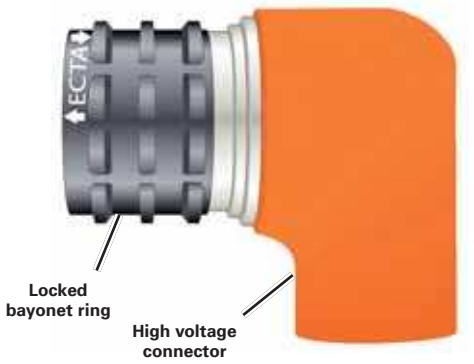
Coding Ring

If the bayonet ring is pulled up and thus unlocked, the color of the coding ring is visible.



489_095

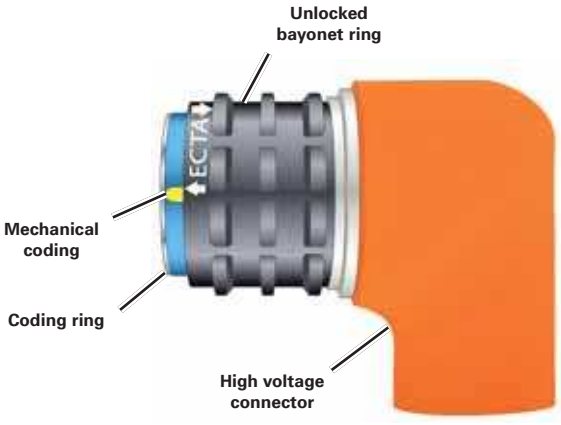
After connecting the terminal, the bayonet ring must be pushed down until it audibly engages. The connection is then closed.



489_093

Mechanical Coding

In addition to color ring codings, the high voltage connector and terminals are mechanically coded. The position of the coding is indicated by a yellow mark.



489_095

High voltage connector of terminal P4

Pilot Line Connector 1 TV44

Mechanical Locking of the Safety Line Connector

Before working on the system, be sure that the maintenance connector has been removed (page 29).

489_038

The high voltage wire can only be disconnected from the Hybrid Battery Unit if Pilot Line Connector 1 TV44 has already been removed. To remove the line, the bayonet ring must be pulled up. The safety line is now open and Battery Management Control Module J840 has isolated the high voltage battery via the high voltage contacts.

Pilot Line Connector TV44

489_039

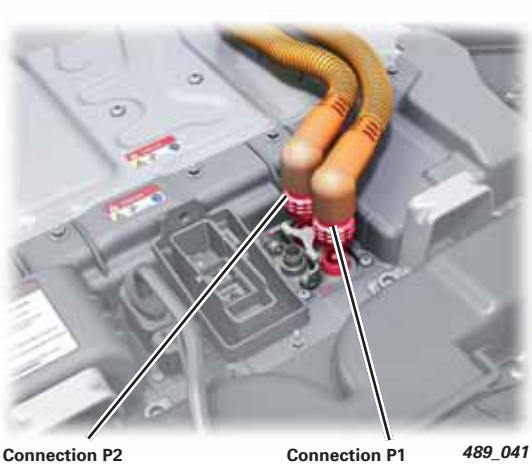
The plug-in contacts of the high voltage wire can only be removed if the locking bracket has been swivelled back. Because the safety line is open, voltage is no longer present at the high voltage wire contacts and there is no danger of electric shock when disconnecting the high voltage wire.

Locking bracket

489_040

Conversely, the high voltage wire to JX1 can only be connected to the Hybrid Battery Unit if the locking bracket has been swivelled over the two plug-in contacts. Only then can the safety connector be inserted.

The high voltage system is not energized until the safety connector has been inserted.



Connection P2

Connection P1

489_041

Note

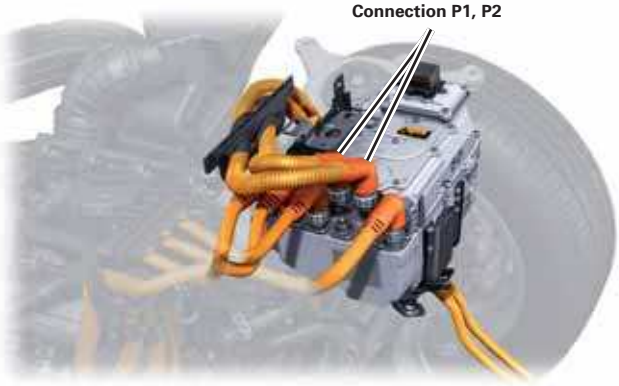
Only qualified high voltage technicians are allowed to disconnect this safety connector to de-energize the vehicle.

Terminals of Electric Drive Power and Control Electronics JX1

P1, P2 — From the High Voltage Battery to JX1

Hybrid Battery High Voltage Wiring Harness PX1

The high voltage battery and JX1 are electrically connected by two orange colored high voltage wires. The lines are of shielded, single pole design.



489_036

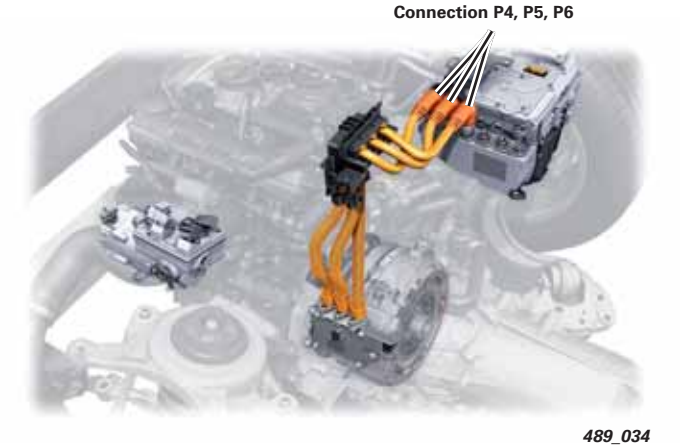
P4, P5, P6 — From JX1 to the e-machine

Drive Motor High Voltage Wiring Harness PX2

In JX1, the 266 volt DC voltage from the high voltage battery is converted to three-phase AC by a DC/AC voltage converter for operating the e-machine.

The e-machine is connected to JX1 via three high voltage cables. These lines are of shielded, single pole design and, like the other high voltage lines, are marked, color coded, and mechanically coded so that they cannot be interchanged.

Refer to current technical literature for more details on line designations.



489_034

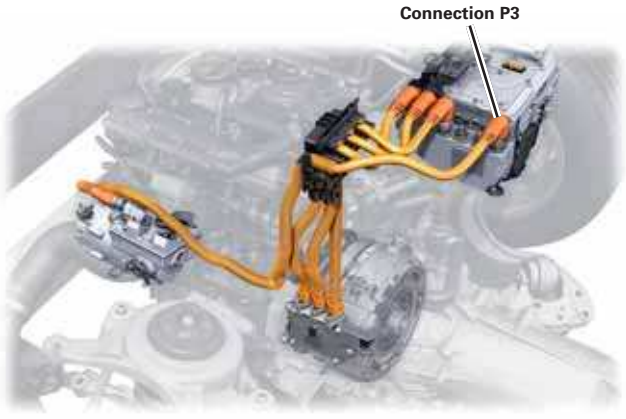
P3 — From JX1 to the A/C Compressor

Through to the A/C compressor, the air conditioning system is an integral part of the Audi Q5 hybrid quattro high voltage system. This new system of activating the compressor means that the vehicle interior can be air conditioned even when the internal combustion engine is at a standstill.

Depending on battery charge level, the air conditioning system remains active. If the charge level of the high voltage battery drops, the system starts the internal combustion engine automatically to charge the high voltage battery.

The A/C compressor is connected to JX1 by a two-wire line. To ensure a proper connection, these high voltage wires are colored orange and feature yellow mechanical markings, making them difficult to interchange.

This two-wire line is of a shielded, two pole design. If either of the two connectors of this line are disconnected, it is the equivalent of removing a safety connector, deactivating the entire high voltage system.



489_035

12 Volt Onboard Power Supply

The following hybrid quattro modifications have been incorporated into the standard Audi Q5 design:

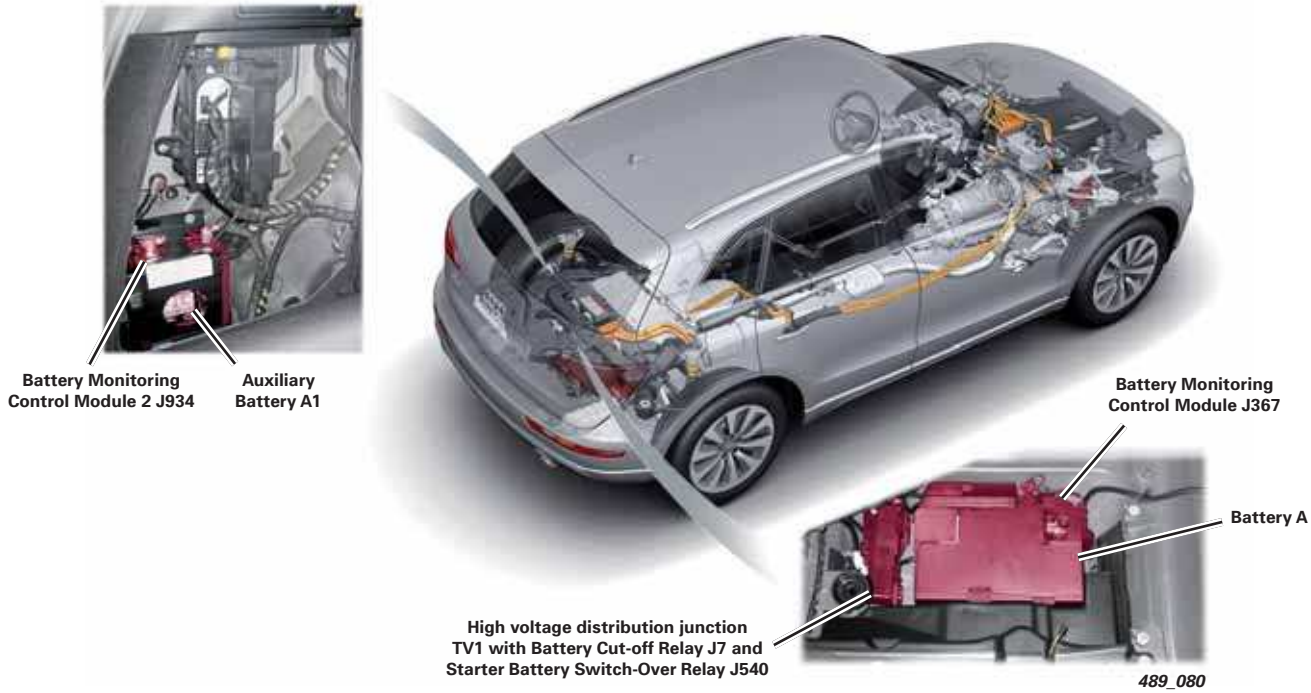
12 Volt Onboard Power Supply

- Alternator C has been eliminated. This function is now performed by Electro-Drive Drive Motor V141 (e-machine)
- 12 volt onboard power supply does not have brake energy recuperation
- 12 volt onboard power supply is supplied by the DC/DC converter of Electric Drive Power and Control Electronics JX1
- In addition, a second 12Ah battery (Auxiliary Battery A1) is installed in the side section at the rear left. Battery Monitoring Control Module 2 J934 is connected to Data Bus On Board Diagnostic Interface J533 via the LIN bus
- Auxiliary Battery A1 is activated by Battery Cut Out Relay J7 when “terminal 15” is switched ON
- Voltage Stabilizer J532 has been eliminated. Its function is now performed by the Auxiliary Battery. No electrical current is drawn from the Auxiliary Battery when “terminal 15” has been switched OFF

12 Volt Auxiliary Starter

The auxiliary starter is used only for starting the internal combustion engine under certain operating conditions. When this occurs, 68Ah Battery A is disconnected from the 12V electrical system by Engine Control Module J623 via Starter Battery Switch-Over Relay J580. This makes the full capacitance of the battery available to the starter motor.

The onboard power supply is then supplied via Auxiliary Battery A1 and the DC/DC converter. The temperature of the Auxiliary Battery must be at least 32°F (0°C) before the 12 volt auxiliary starter is enabled. It the high voltage system is not ready for operation, 12 volt starting is not possible.



Note

Both 12 volt batteries must be disconnected before servicing the 12 volt onboard power supply.

Electronic Ignition Lock

The ignition lock uses the information “ignition key is inserted” to instruct the high voltage system to make the vehicle ready for operation.

For Battery Management Control Module J840, the information “ignition key is inserted” is a condition which must be met so that the control module activates the high voltage contacts for coupling the high voltage battery to the high voltage system.

If the ignition key is removed, the control module disconnects the high voltage battery automatically from the high voltage system.

- “terminal 15 OFF”
- Hybrid manager (ECM) in sleep mode
- No operating current

The terminals have the following status:

Ignition ON With Brake Not Depressed:

- “terminal 15 ON”

Ignition ON With Brake Depressed:

- “terminal 15 ON”
- “terminal 50 ON”
- “Hybrid Ready”

The vehicle can now be driven electrically, with the internal combustion engine starting at a low high voltage battery charge.

Airbag Control Module J234

To ensure that occupants and emergency responders are not endangered by the high voltage system in the event of a crash, the crash detection signal from Airbag Control Module J234 is also evaluated by Battery Regulation Control Module J840. If a crash is detected, J840 isolates the high voltage battery from the high voltage system via the high voltage contacts.

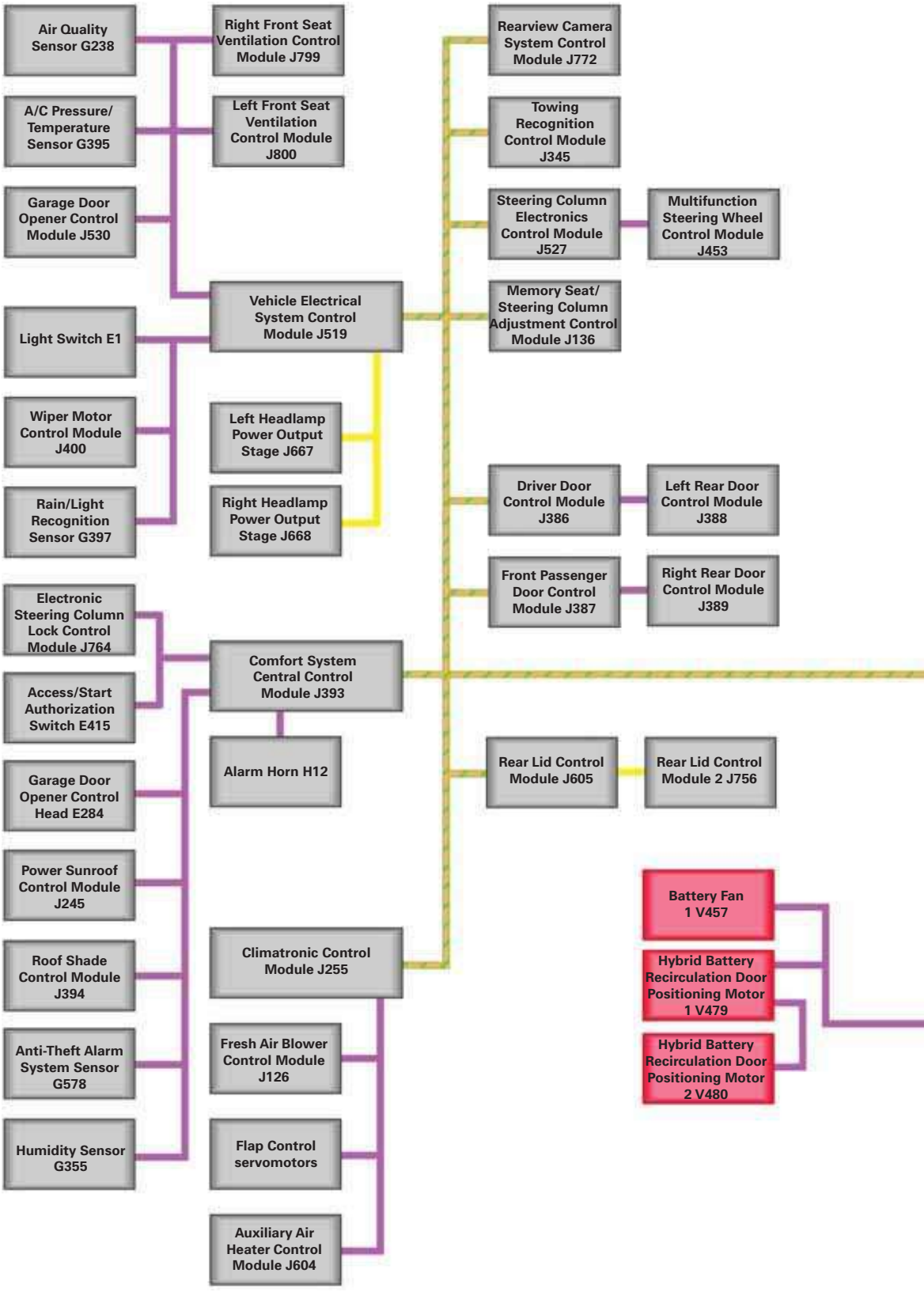
In the first crash phase, only the belt tensioners deploy and the high voltage contacts are opened. If the airbags do not deploy, J840 can be reset by switching the ignition OFF and back ON again. This will allow the high voltage contacts to be closed again, and the vehicle to be restarted.

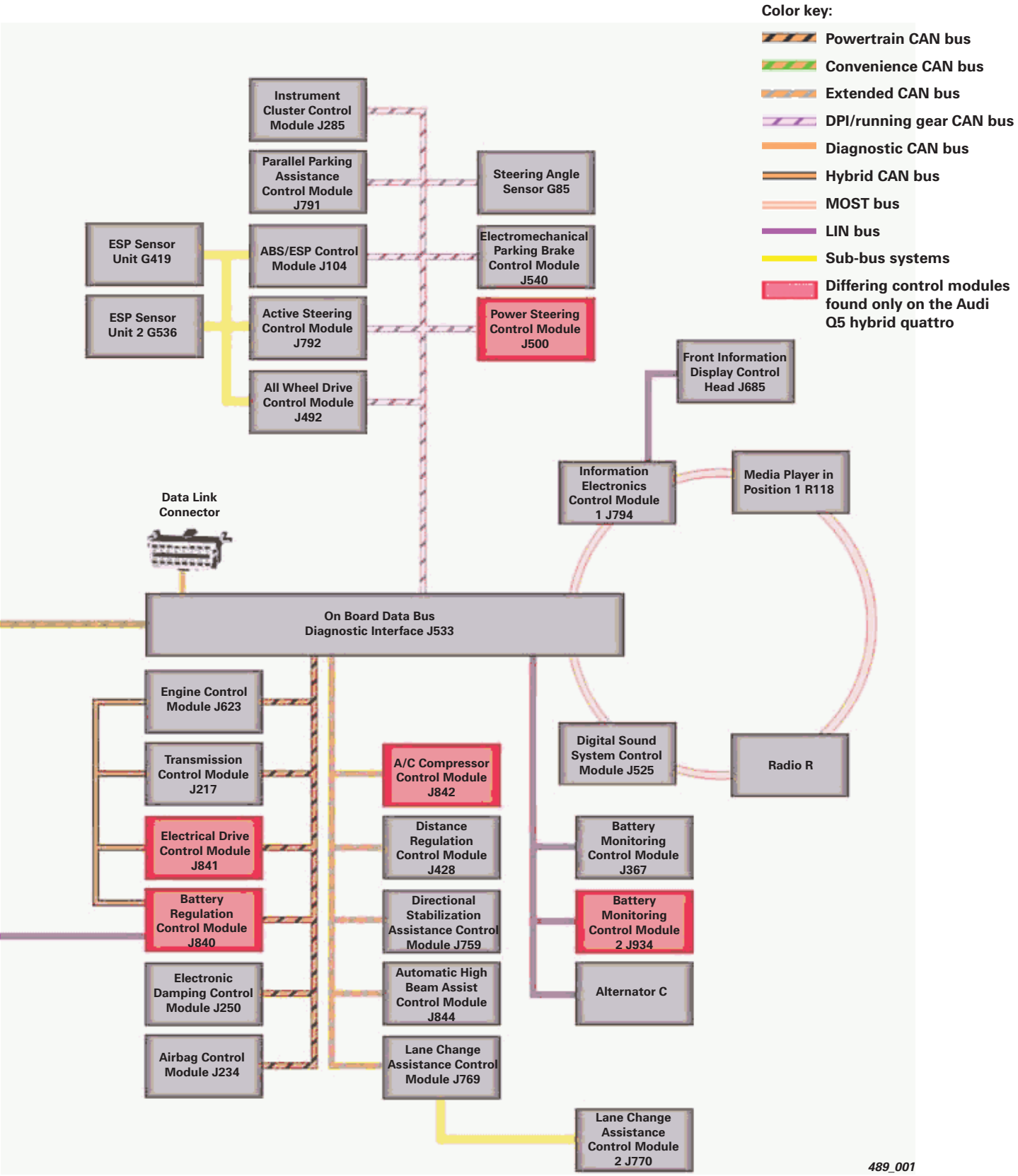
If the belt tensioners and airbags have deployed in the second crash phase, the high voltage contacts cannot be reset by cycling the ignition OFF and back ON. Battery Regulation Control Module J840 can only be reset using the VAS Scan Tool.

The deployed airbags serve the emergency responders as an indicator that the high voltage contacts have been opened in a crash and the high voltage system has been disconnected from the high voltage battery.

489_083

Network Topology



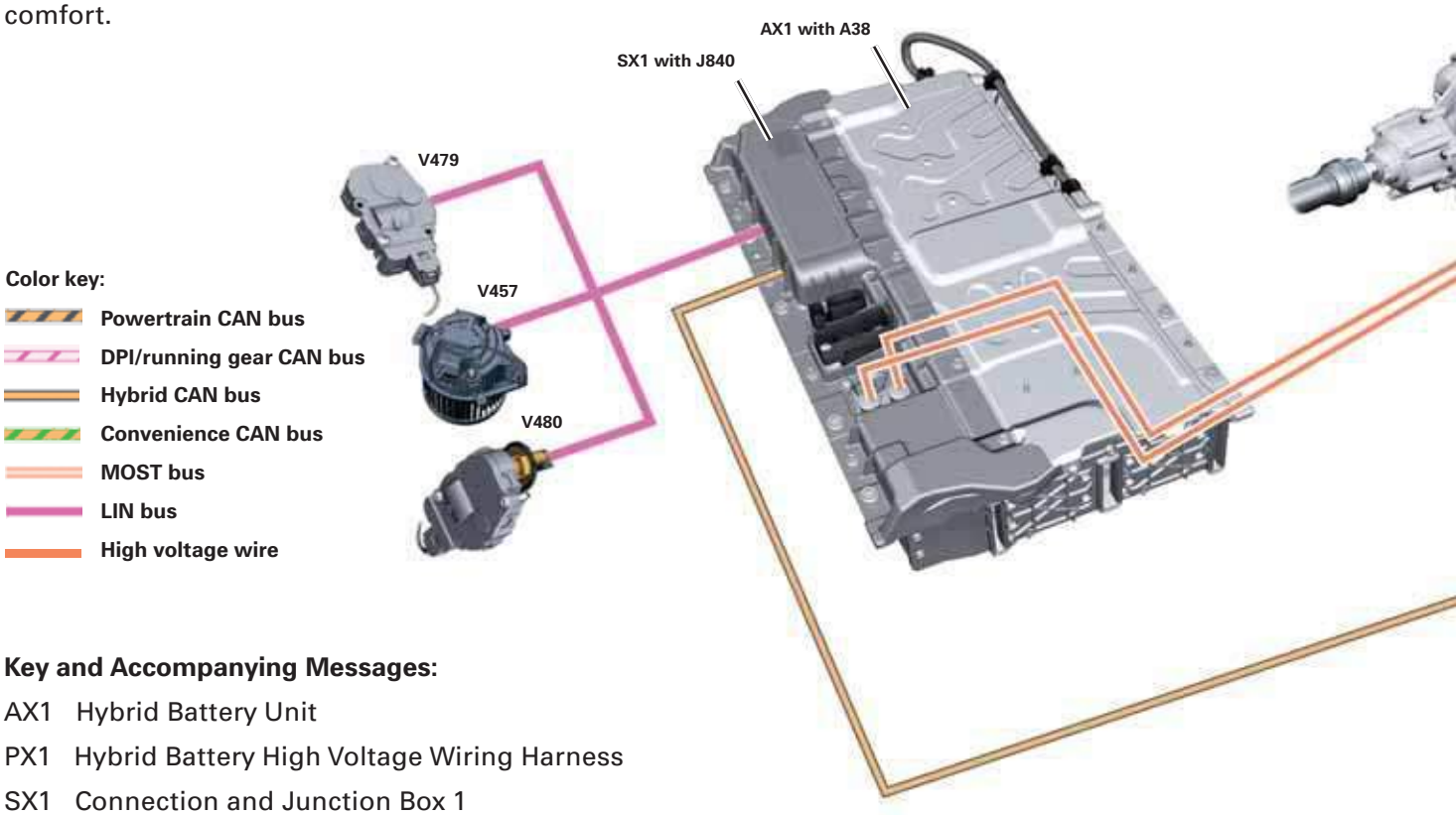

Color key:
Powertrain CAN bus
Convenience CAN bus
Extended CAN bus
DPI/running gear CAN bus
Diagnostic CAN bus
Hybrid CAN bus
MOST bus
LIN bus
Sub-bus systems
Differing control modules found only on the Audi Q5 hybrid quattro
Instrument Cluster Control Module J285
Parallel Parking Assistance Control Module J791
Steering Angle Sensor G85
ESP Sensor Unit G419
ABS/ESP Control Module J104
Electromechanical Parking Brake Control Module J540
ESP Sensor Unit 2 G536
Active Steering Control Module J792
Power Steering Control Module J500
All Wheel Drive Control Module J492
Front Information Display Control Head J685
Information Electronics Control Module 1 J794
Media Player in Position 1 R118
Data Link Connector
On Board Data Bus Diagnostic Interface J533
Engine Control Module J623
Transmission Control Module J217
A/C Compressor Control Module J842
Digital Sound System Control Module J525
Radio R
Electrical Drive Control Module J841
Distance Regulation Control Module J428
Battery Monitoring Control Module J367
Battery Regulation Control Module J840
Directional Stabilization Assistance Control Module J759
Battery Monitoring Control Module 2 J934
Electronic Damping Control Module J250
Automatic High Beam Assist Control Module J844
Alternator C
Airbag Control Module J234
Lane Change Assistance Control Module J769
Lane Change Assistance Control Module 2 J770
489_001

System Management

This schematic shows the components required by the e-machine. Additional input and output signals are interchanged between all vehicle systems: for example, for the operation of the heating and air conditioning systems, power steering, and brake system.

The data exchange between the vehicle systems is extremely important, given the back and forth changeovers from electric drive to internal combustion operation when driving. The changes in drive torque must be virtually transparent to preserve optimum driving comfort.

The engine management system, transmission system, and hybrid control system must be coordinated. In the Audi Q5 hybrid quattro, the ECM is the higher level (master) control module for the internal combustion engine and electric operation.



Key and Accompanying Messages:

AX1 Hybrid Battery Unit

PX1 Hybrid Battery High Voltage Wiring Harness

SX1 Connection and Junction Box 1

- High voltage wire monitoring

A38 Hybrid Battery Unit

J104 ABS/ESP Control Module

- Brake system hydraulic pressure, brake pressure
- Wheel speed measurement

J217 Transmission Control Module

- Transmission speed
- Gear recognition
- Transmission hydraulics temperature
- Electrical hydraulic pump, transmission hydraulic pressure, gear shifting
- Clutch control mechanism for internal combustion engine, electric drive motor

J234 Airbag Control Module

- Crash signal

J255 Climatronic Control Module

- A/C compressor activation

J285 Instrument Cluster Control Module

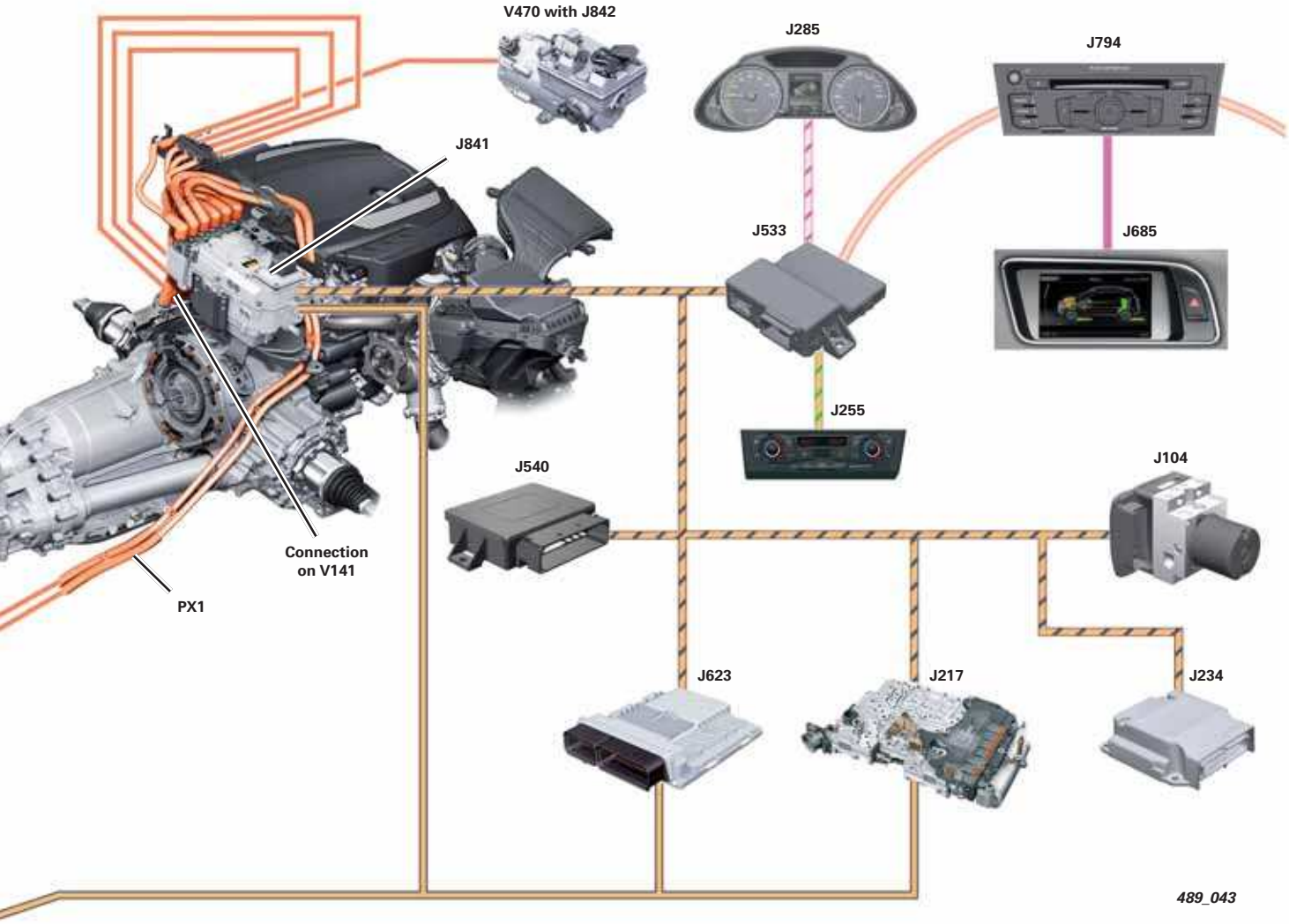
- Textual messages and vehicle operating state descriptions on the instrument cluster display

J533 On Board Data Bus Diagnostic Interface

- Data transfer between the various bus systems

J540 Electromechanical Parking Brake Control Module

- Driver exit detection



J623 Engine Control Module

- EV mode ON/OFF
- Brake application signal
- Drive-by-wire signal
- Engine speed
- Engine temperature
- Driver absence detection
- Electric drive motor coolant temperature
- Drive-by-wire signal
- Engine speed

J685 Front Information Display Control Head

- Animated vehicle operating state descriptions

J794 Information Electronics Control Module 1

- Display information transfer

J840 Battery Regulation Control Module

- Battery temperature
- Control of high voltage contacts

J841 Electrical Drive Control Module

- Electric drive motor speed
- Electric drive motor temperature
- JX1 temperature
- Voltage monitoring

J842 A/C Compressor Control Module

- Compressor speed

V141 Electro-Drive Drive Motor

V457 Battery Fan 1

V470 Electrical A/C Compressor

V479 Hybrid Battery Recirculation Door Positioning Motor 1

V480 Hybrid Battery Recirculation Door Positioning Motor 2

Drive Programs

The Audi Q5 hybrid quattro has three customer selectable drive programs:

Gear Selector Position	Program	Possible Effects
"EV"	Extended electrical drive operation	▶ Driving under electric power down to a high voltage battery charge level of 30% ▶ All electric driving up to 62 mph (100 km/h) ▶ Coasting ▶ Start-stop ▶ No e-boost function ▶ Brake energy recuperation
"D"	Fuel-optimized configuration with moderate e-boost function	▶ Driving under electric power down to a high voltage battery charge level of 30% ▶ Coasting ▶ Start-stop ▶ Moderate e-boost function ▶ Brake energy recuperation
"S" and "tip" gates	Enhanced e-boost function of the electric drive	▶ Start-stop ▶ Intensive e-boost function ▶ Brake energy recuperation ▶ No electrically powered driving

Driver Detection

The status of the driver's door and brake signal are monitored. A driver is recognized as "detected" if:

- Driver's door is closed
- Vehicle is ready for operation (hybrid ready) or the internal combustion engine is running
- Vehicle is currently traveling at less than 4.3 mph (7 km/h)
- "D", "R", "S", or "tip" is selected
- Brake pedal is not depressed

If the driver's door is now opened, a driver exit is detected and the electromechanical parking brake is automatically engaged.

To reactivate the driver exit detection function, the vehicle must again exceed a speed of 4.3 mph (7 km/h).

In gear selector positions "N" (vehicle in car wash) or "P" (mechanical lock in automatic transmission), the parking brake is not engaged automatically.

Driver Absence Detection

A "driver presence" is recognized if the following conditions have been met:

- "Hybrid Ready"
- Driver's presence has been detected (driver's door is closed and safety belt fastened)

  OR
- Driver's door is closed and a selector lever position has been selected

If the driver's door is opened or if the safety belt is unfastened with the gear selector in position "P", a "driver absence" is detected:

- If this happens while the internal combustion engine is running, the engine continues to run without interruption
- If this happens while the internal combustion engine is at a standstill, the hybrid manager (ECM) enters standby mode. No electric current flows from the high voltage battery and the internal combustion engine can no longer start. Without a 12 volt charger, the 12 volt batteries now become discharged

Reference

For more detailed information about the design and function of the electromechanical parking brake, refer to Self-Study Program 999703, *The 2008 Audi A5 Running Gear.*

Display and Operating Elements for Driving in Hybrid Mode

For operation and display of the electric drive, the Audi Q5 hybrid quattro has the following features:

- Power meter instead of tachometer
- Special display in the instrument cluster
- Animated display on MMI screen
- High voltage battery charge indicator instead of coolant temperature display
- Extended Electric Driving Mode Button E709

Display in Power Meter

The power meter displays various vehicle operating states and the power output or charging capacity of the hybrid system during the trip.

1 Vehicle ready “Hybrid Ready“, “terminal 15 ON“ and “terminal 50 ON“

2 Electrically powered driving (engine starting is possible) or hybrid driving

3 Limit for engine starting in EV mode

4 Economical driving (partial throttle range)

5 Full throttle range

6 Internal combustion engine 100%

7 e-machine provides assistance in addition to maximum engine torque (e-boost)

8 “terminal 15 OFF “ or “terminal 15 ON” and “terminal 50 OFF “

9 Hydraulic braking in addition to energy recovery by recuperation

10 Energy recovery by recuperation (under braking and during acceleration)

11 Charge level of high voltage battery

Instrument Cluster

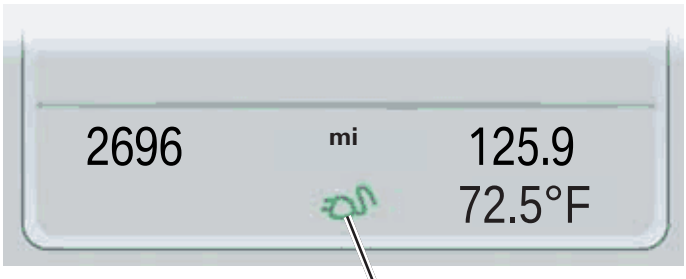
Display — Fault Message

If a fault occurs in the high voltage system, it is indicated by a yellow or red warning lamp on the instrument cluster. Depending on the type of fault, the applicable color and message text are displayed.

Display	Textual Message	Definition
	Hybrid drive: system malfunction. Please take vehicle in for servicing.	The vehicle can still be driven. You can continue driving in internal combustion mode.
	Hybrid drive: malfunction: Possible failure of power steering and brake booster.	The vehicle cannot be driven.

Display — Charging the High Voltage Battery

If a charging current is detected, a green charging connector appears on the instrument cluster.



489_102

The detected charging current appears on the display in the instrument cluster

Display — Instrument Cluster

Electric drive mode (e-drive) is indicated on the display of the instrument cluster. The high voltage battery symbol and the arrows pointing away from the wheels indicate that drive is currently being provided by the high voltage battery and electric drive motor.

The display also indicates all other driving states, and are adapted to current driving status.

Display — Hybrid Ready

The hybrid system is ready for operation.

489_058

Display — Drive by Electric Motor Only (e-machine)

The high voltage battery symbol and the green arrows pointing away from the wheels indicate that drive is currently being provided by the high voltage battery and the electric drive motor.

489_059

Display — Drive by Internal Combustion Engine Only

The symbols for the internal combustion engine, high voltage battery, and the yellow arrows pointing away from the wheels indicate that drive is currently being provided by the internal combustion engine.

489_060

Display — Drive by e-machine and Internal Combustion Engine (e-boost)

The symbols for the internal combustion engine, high voltage battery, and the yellow green arrows pointing away from the wheels indicate that drive is currently being provided by the internal combustion engine, high voltage battery, and electric drive motor.

489_061

Display — Recuperation in Overrun Phase; Speed Less than 99.4 mph (160 km/h)

The high voltage battery symbol and the green arrows pointing towards the wheels indicate that brake energy recuperation is currently in progress and the high voltage battery is being charged.

489_062

Display — Status and Internal Combustion Engine

The symbols for the internal combustion engine and the high voltage battery indicate that the internal combustion engine is currently running and the high voltage battery is being charged.

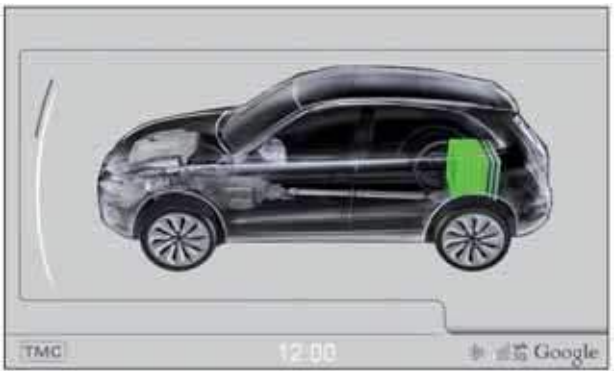
489_064

MMI Screen

The Audi Q5 hybrid quattro comes with the MMI Navigation plus system. Information on current internal combustion engine operation, electric drive motor operation, and high voltage battery charge level can be displayed on the MMI screen.

Display — Hybrid Ready

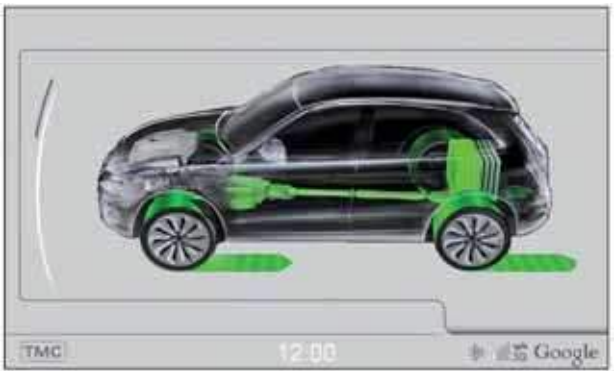
The hybrid system is ready for operation.



489_065

Display — Drive by Electric Motor Only (e-machine)

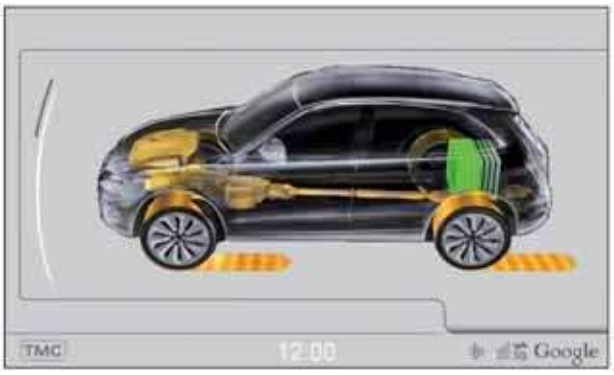
The high voltage battery symbol and the green arrows pointing away from the wheels indicate that drive is currently being provided by the high voltage battery and the electric drive motor.



489_066

Display — Drive by Internal Combustion Only

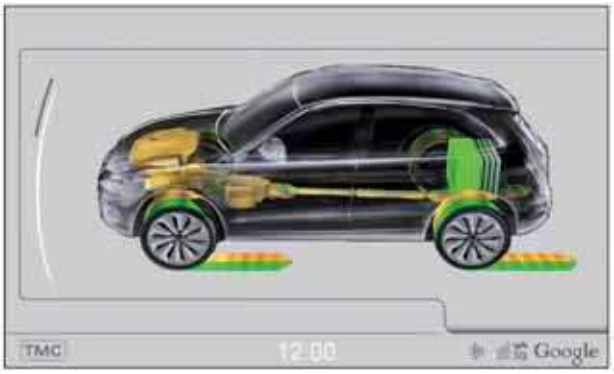
The symbols for the internal combustion engine, high voltage battery, and the yellow arrows pointing away from the wheels indicate that drive is currently being provided by the internal combustion engine.



489_067

Display — Drive by e-machine and Internal Combustion Engine (e-boost)

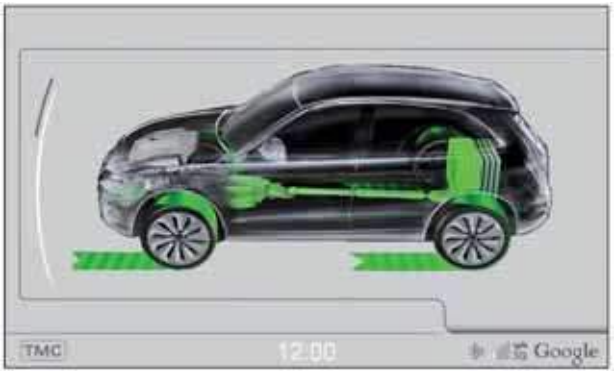
The symbols for the internal combustion engine, high voltage battery, and the yellow green arrows pointing away from the wheels indicate that drive is currently being provided by the internal combustion engine, high voltage battery, and e-machine.



489_068

Display — Recuperation in Overrun Phase Speed Less than 99.4 mph (160 km/h)

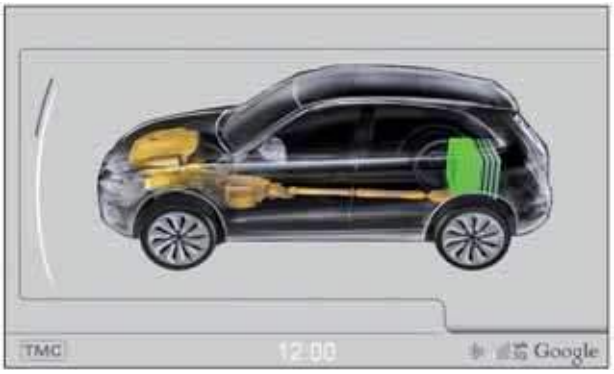
The high voltage battery symbol and the green arrows pointing towards the wheels indicate that brake energy recuperation is currently in progress and that the high voltage battery is being charged.



489_069

Display — Status and Internal Combustion Engine

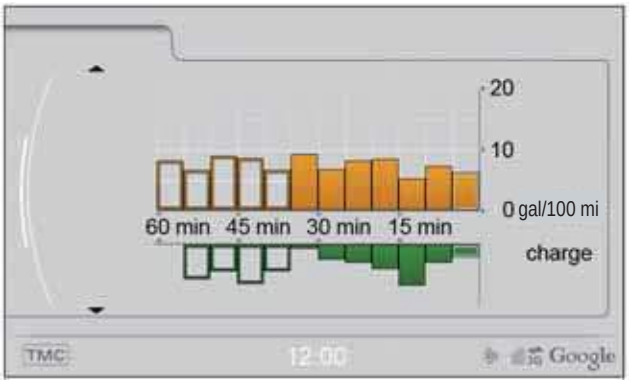
The symbols for the internal combustion engine and the high voltage battery indicate that the internal combustion engine is currently running and the high voltage battery is being charged.



489_071

Display — Consumption Statistics

Consumption statistics, fuel economy, and energy recuperation are updated and displayed every five minutes. This data shows the previous 60 minutes in the form of a bar chart. The filled-in bars are those of the current trip and not the previous trip.



489_096

Operating Elements

By pressing the Extended Electric Driving Mode Button E709 (EV mode), the driver can extend the limits of all-electric driving, using the overall power of the e-machine.

Requirements for driving in EV mode:

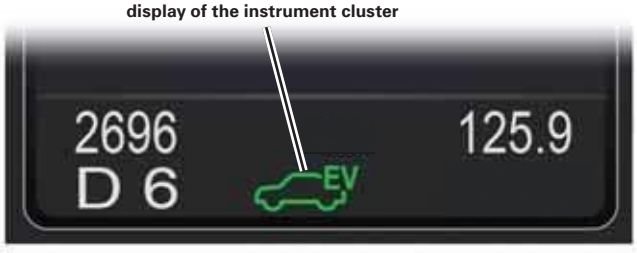
- Speed less than 62 mph (100 km/h)
- Charge level of the high voltage battery > 30%
- Temperature of the high voltage battery greater than 50°F (10°C)
- Coolant temperature of the internal combustion engine between 41°F (5°C) and 122°F (50°C)
- Ambient temperature equal to or greater than 50°F (10°C)
- No DTCs in 12 volt starter system
- Altitude less than 13123 ft (4000 m)
- Not in tiptronic mode
- System capability electrically equal to or greater than 15 kW
- Stop enabling signals are present (from Start/Stop System)

E709

489_006

When EV mode is activated, it is indicated by a green symbol in the instrument cluster and by a green bar below the EV mode button.

Display of activated EV mode in the display of the instrument cluster



489_008

Effect of Failure

Failure of EV mode has no effect on hybrid operation, though extended electrically powered driving is not possible.

Service

Special Tools

Lock for Service Disconnect T40262

To safeguard the high voltage system against unintentional reactivation during service work, the plastic cover is locked using the maintenance connector padlock.

489_045

Adapter T40259

This tool set consists of three eyelets and matching clevises for installing and removing the high voltage battery.

489_046

Release Tool T40258

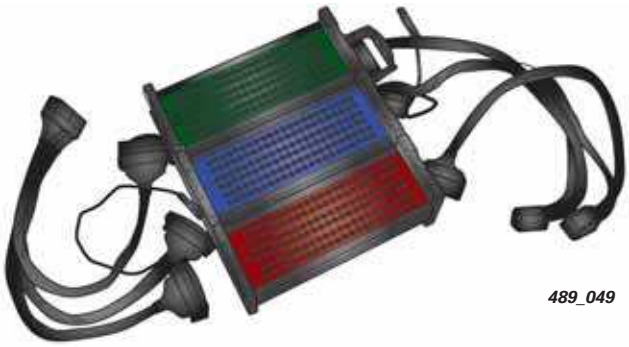
The release tool is used for removing the high voltage connector.

489_047

Other Service Tools

Test Adapter VAS 6606/10

Electric Drive Power and Control Electronics JX1 can be tested using the isolating box test adapter VAS 6606.



489_049

Hybrid Warning Sign VAS 6649

Before beginning service work, warning signs which read “Caution: Hazardous Voltage” must be visibly displayed within the vehicle. Further guidelines can be found in Guided Fault Finding.

489_100

Hybrid Warning Sign VAS 6650

Before beginning service work, warning signs which read “Do not activate switch. Work in progress.” must be visibly displayed within the vehicle. Further guidelines can be found in Guided Fault Finding.

489_101

12 Volt Charger

If the high voltage battery does not have enough charge to start the vehicle (as indicated by the instrument cluster display), it can be charged with a 12 volt charger with a minimum rating of 30A.

Note

All work on the high voltage system must be performed by a qualified high voltage technician. Only qualified high voltage technicians are allowed to disconnect the safety connector to de-energize the vehicle.

Note

To ensure the proper and safe use of high voltage special tools, the guidelines in current technical literature must be strictly followed.

Hybrid Measurement Module VAS 6558

This measurement module is used for generating a measurement voltage of 500V (up to a maximum of 1000V) with a minimum of current. Voltage is supplied via a USB 2.0 port.

Voltage-OFF measurements can be made using the tester and a measuring adapter. The test box can also be used to measure insulation resistance.

This tester is compatible with Scan Tools VAS 5051B, VAS 5052A and VAS 6150.

489_050

Hybrid Test Adapter VAS 6558/1A

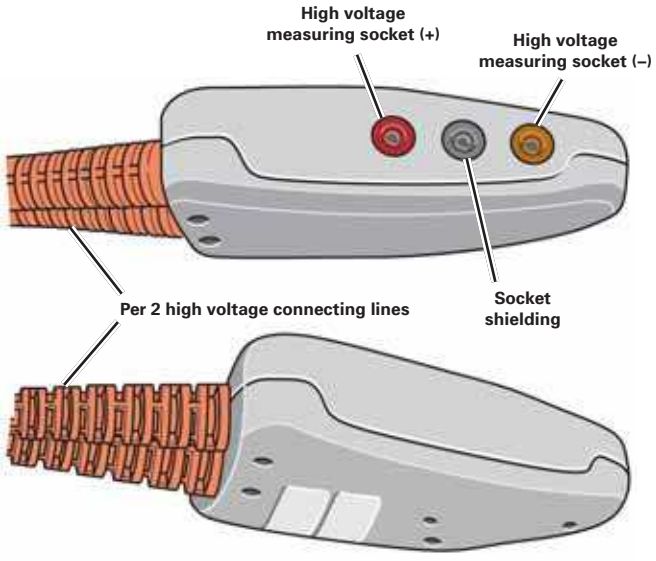
Adapters are a part of set VAS 6558/1A and are used both for voltage-OFF measurement and by insulating resistors in the high voltage system in conjunction with VAS 6558.

All high voltage wires in the measuring adapters are coded mechanically and visually. They are designed to fit only a specific socket type.

Carefully disconnect and connect the high voltage terminals of the measuring adapter, otherwise the sockets could be damaged, resulting in a loss of shock protection.

Voltage-OFF Measurement Adapter VAS 6558/1-1

The voltage-OFF measurement adapter is connected directly to voltage sources, high voltage battery, and power electronics. High ohmic resistors are integrated in the measuring adapter. They ensure that only a low current is present in the measuring sockets in the event of a fault.



489_051

Note

The measuring adapter must be checked prior to every voltage-OFF measurement.

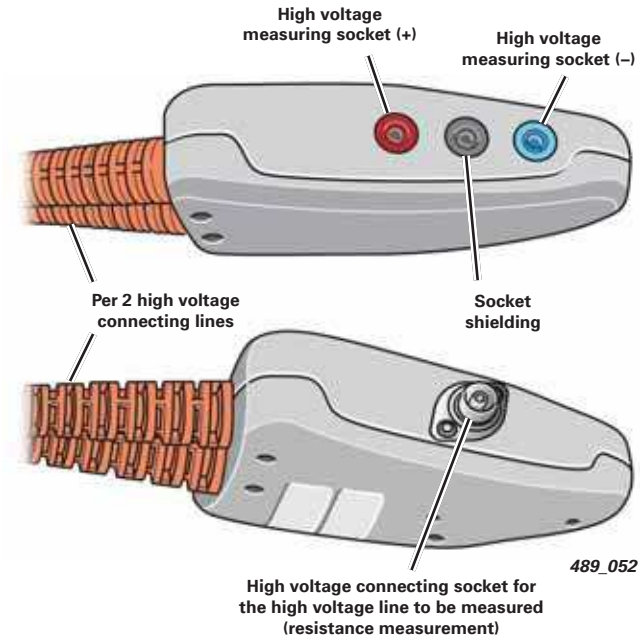
Note

All work on the high voltage system must be performed by a qualified high voltage technician. Only qualified high voltage technicians are allowed to disconnect the safety connector to de-energize the vehicle.

Adapter for Insulation Resistance Measurement in High Voltage System VAS 6558/1-2

The two high voltage connecting lines of the measuring adapter fit the terminals of the hybrid battery unit and the power electronics. The high voltage connecting socket of the measuring adapter fits the high voltage wires of the hybrid battery unit and the power electronics.

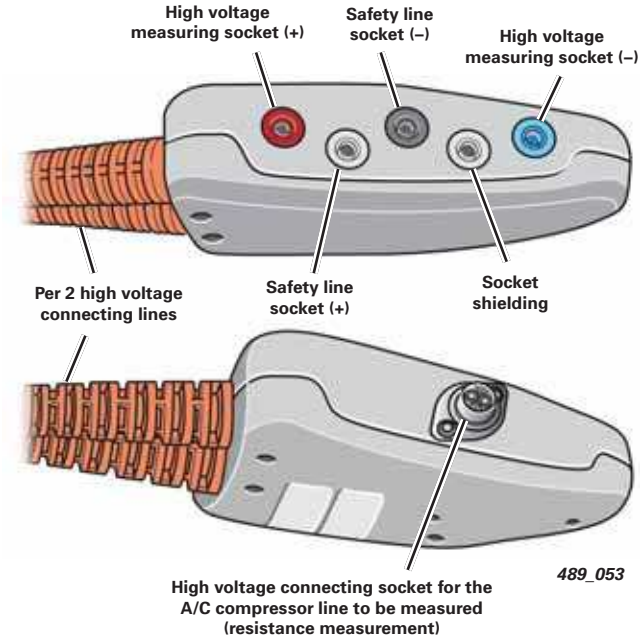
This measuring adapter can be used to measure the insulation resistance in the high voltage system.



Adapter for Measuring Insulation Resistance in the A/C Compressor and Safety Line VAS 6558/1-3A

A high voltage connecting line of the measuring adapter fits only the socket of the A/C compressor in the power electronics and of the A/C compressor itself.

The insulation resistance in the high voltage wire to the A/C compressor can be measured via the high voltage connecting socket. Due to the safety line being integrated into the high voltage connection of the A/C compressor, the safety line can also be checked using this measuring adapter.



Note

Adapters VAS 6558/1-2 and VAS 6558/1 3A may only be used if the absence of high voltage has been established. To ensure the proper and safe use of high voltage special tools, the guidelines in current technical literature must be strictly followed.

Frequently Asked Questions (FAQs)

Extreme care should be taken when working on hybrid vehicles. You must always follow relevant regulations and guidelines. This information will help you recognize hazards, enabling you to respond promptly and correctly in the event of an accident.

Q: Can the Audi Q5 hybrid quattro be washed in an automatic car wash?

A: Yes, the Audi Q5 hybrid quattro can be washed in an automatic car wash without any special restrictions.

Q: Can you perform an engine wash on the Audi Q5 hybrid quattro?

A: You can perform an engine wash on the Audi Q5 hybrid quattro as long as you observe accepted environmental rules. If using a high pressure sprayer, do not aim it directly at high voltage components.

Q: What should I do if the vehicle needs to be towed?

A: The vehicle should be transported by flat bed towing. If this is not possible, it must be flat towed (front or rear axles must not be raised) and a towing speed of 31 mph (50 km/h) must not be exceeded.

Q: Can the Audi Q5 hybrid quattro be driven without a high voltage battery?

A: Any malfunction in the high voltage battery will trigger defined error mechanisms in the system. In the event of a more serious defect, the high voltage system will usually shut down. If this happens, the vehicle can only be driven until the 12V battery is discharged.

Q: What do I need to know about raising the vehicle on a car lift, wheel alignment platform, or brake test platform?

A: There are no special instructions for the Audi Q5 hybrid quattro that differ from the standard Audi Q5. Important: if the ignition is switched ON, the combustion engine may start.

Q: Does the customer require special training for the Audi Q5 hybrid quattro?

A: The customer does not need any special training. However, the information in the owner's manual specific to hybrid technology should be noted.

Q: What service work can be done by the customer?

A: All non-high voltage system service work can be done by the customer, as with any other Audi vehicle. However, work on the high voltage system should only be done by a trained high voltage technician at an authorized service center in accordance with Audi guidelines.

Q: What additional tasks should be performed as part of PDI?

A: No additional preparations are needed for high voltage components during the PDI of the Audi Q5 hybrid quattro. In transport mode, the electric motor is used solely as a generator, which means that electric driving, boost, start-stop, and recuperation are not possible. In this mode, the high voltage battery is continually charged as long as the combustion engine is running.

Q: What needs to be kept in mind when the Audi Q5 hybrid quattro is parked or stored?

A: Please refer to the standard checklist for vehicles in stock and in storage. This list describes what activities need to be carried out and when.

Q: What should be done in the event of an accident?

A: First, either someone in the car or a rescue worker should switch OFF the ignition. This process is the same as in any Audi vehicle. The high voltage system in the Audi Q5 hybrid quattro is automatically shut down when the belt tensioners or airbags are activated. There is no need for emergency responders to isolate it. Details are provided in a separate manual for emergency services.

Q: What type of voltage and current are there in the high voltage system of the Audi Q5 hybrid quattro?

A: When the high voltage system is active, direct current (DC) voltage flows through the electric A/C compressor, high voltage battery, and power electronics. The electric motor operates with alternating current (AC) voltage. An extra capacitor is fitted in the power electronics to serve as a power reserve. This capacitor is discharged when the ignition is switched OFF.

Q: What levels of voltage and currents are dangerous?

A: Alternating voltage of 25V or above and direct voltage of 60V or above are dangerous. Maximum contact voltage must not exceed 50V for alternating current (AC) voltage or 120V for direct current (DC) voltage. A current of approximately 5mA or more can be recognized by the human body, with a current of approximately 10mA or more representing a serious safety hazard.

Q: What are the effects of alternating current (AC) and direct current (DC) if a person comes in direct bodily contact with these currents?

A: Alternating current (AC):

Direct contact with this current will add a harmful disruptive electrical current to the human body that can trigger involuntary vibrations in the muscles and heart. The lower the frequency, the more dangerous the voltage. Ventricular fibrillation (heartbeat alteration and/or heart stoppage) can result. Without prompt first aid, this can prove fatal.

Direct current (DC):

Direct contact with this current can break down (liquify) body tissues through electrolytic dissolution, resulting in tissue poisoning. This damage will only be noticeable several days after the DC direct contact, and if left untreated, can be fatal.

Q: What are the effects and after effects of electrical accidents?

A: Shock effect: Risk of injury from uncontrolled movements and loss of balance.

Thermal effect: Burns and carbonizations at the entry and exit points of the current, as well as internal burns. Resulting stress to the kidneys may be fatal.

Chemical effect: Blood and cell fluids are broken down by electrolysis. The result is serious poisoning that becomes noticeable after several days.

Effect on muscles: Muscle contractions and impairment of controlling brain functions. Consequences may include loss of movement, contraction of the lung muscles (breathing stops), and arrhythmia (ventricular fibrillation, heart stops pumping).

Q: What should I do if a person is touching and/or is in direct contact with electrical voltage?

A: It is important to follow these instructions:

1. Consider your own safety first.
2. Do not touch someone who is in direct contact with electrical voltage.
3. If possible, de-energize the electrical system. Immediately switch OFF the vehicle's ignition or unplug the service connector for the high voltage system.
4. Separate the person or electrical conductor from the power source with a non-conductive object (for example, a wooden plank or broom handle).

Q: What first aid should be given following an electrical accident?

A: If the person is verbally unresponsive:

1. Check pulse and breathing.
2. Call 911 or arrange for someone else to make the call without delay.
3. Perform artificial respiration and CPR until EMS arrives.
4. If it appears that the person has stopped breathing or their heart is in distress, use an automated external defibrillator (AED) to quickly diagnose and treat them. AEDs are simple to use, with their proper use taught in first aid and CPR classes.

   The AED will only supply a shock to the patient if it detects an abnormal or no heartbeat, and can return the patient to a normal heartbeat. Even when the AED is successful, the patient should still be treated by a first responder team.

If the person is verbally responsive:

1. Cool any burns and cover with a sterile lint-free dressing.
2. The person must be examined by a doctor to help prevent after effects.

Q: What should I do in the event of an accident involving batteries or battery contents?

A: It is important to follow these instructions:

1. If skin contact occurs, rinse well with water.
2. In the case of gas inhalation, move the person to fresh air.
3. If eye contact occurs, rinse with plenty of water (for at least 10 minutes).
4. If battery contents are swallowed, the person should drink plenty of water, but not so much that vomiting is induced.
5. Seek medical treatment.

Self-Study Programs for the Audi Q5 hybrid quattro

SSP 994803 The 2009 Audi Q5 Vehicle Introduction

- Body
- Occupant Protection
- Running Gear
- Electrical System
- Infotainment
- Service

SSP 922903 The 2.0L 4V TFSI Engine with AVS

- Secondary Air System

SSP 990303 The 2012 Audi A7 Running Gear

- Electromechanical Steering

Knowledge Assessment

In order to receive credit for this self study program, you are required to complete the online Knowledge Assessment (990123CB) which is located on the Certification Resource Centre.

For assisstance:

Audi Canada Academy Concierge
Hours: 8am - 8pm ET
Phone: 1-877-826-7918
Email: AudiConcierge@audicanadaacademy.com

Notes

Audi
Truth in Engineering

990123

Audi of America, LLC
2200 Ferdinand Porsche Drive
Herndon, VA 20171