

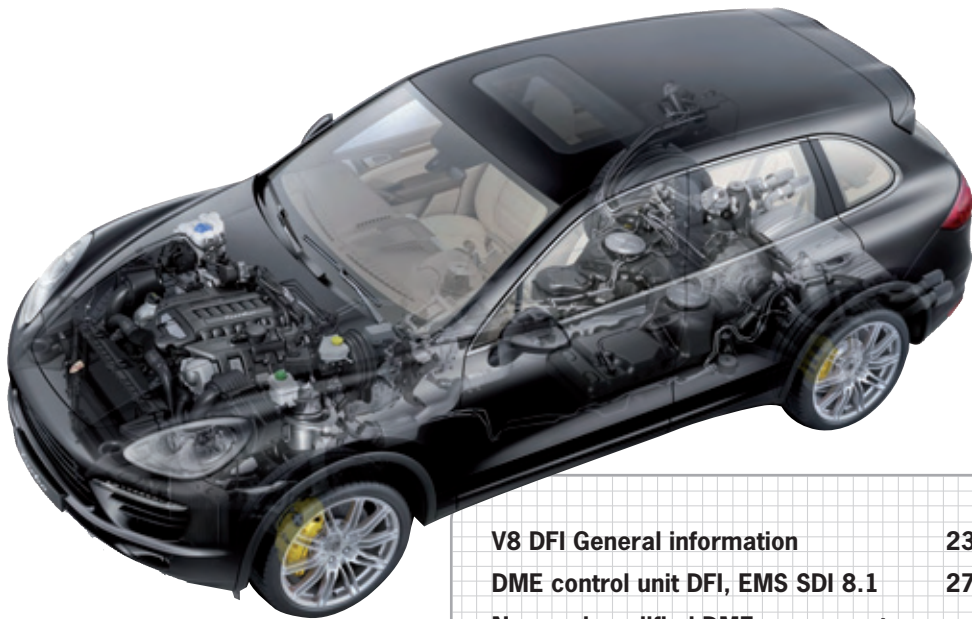
## 2 Fuel and ignition system (DME)

### V8 DFI General

An enhanced engine generation based on the engines familiar from the previous models is used for the new Cayenne models. Thanks to improved efficiency and the use of the latest engine technology, it was possible to significantly reduce the fuel consumption values for all engines compared with the previous models.

The completely revamped family of V8 engines comprises the performance-enhanced 4.8 l V8 naturally aspirated engine for the new Cayenne S, which now develops 400 hp and a torque of 500 Nm, and a turbocharged version with 500 hp and 700 Nm torque for the new Cayenne Turbo. A targeted joint engineering process permitted use of many identical parts in the naturally aspirated and turbo engines.

In addition to direct fuel injection (DFI), which was introduced with the second generation of Cayenne models and which already allowed improvements in fuel economy compared with the previous models, the new V8 engines of the Cayenne S and Cayenne Turbo also feature the new technologies mentioned above. All emission limits are satisfied or exceeded.



|                                                      |           |                                             |           |
|------------------------------------------------------|-----------|---------------------------------------------|-----------|
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### Development goals

- High engine power
- High maximum torque
- Low fuel consumption
- Low emissions

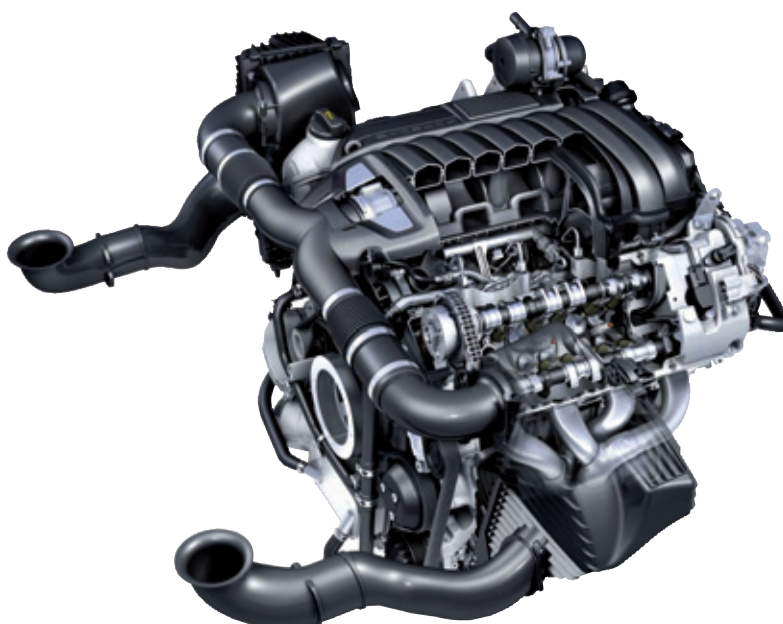
### Enhancements

- Dethrottling of the intake system
- Thermal management
- Start Stop system
- Variable deceleration fuel cutoff
- Vehicle electrical system recuperation
- Reduced component weight

### Cayenne S

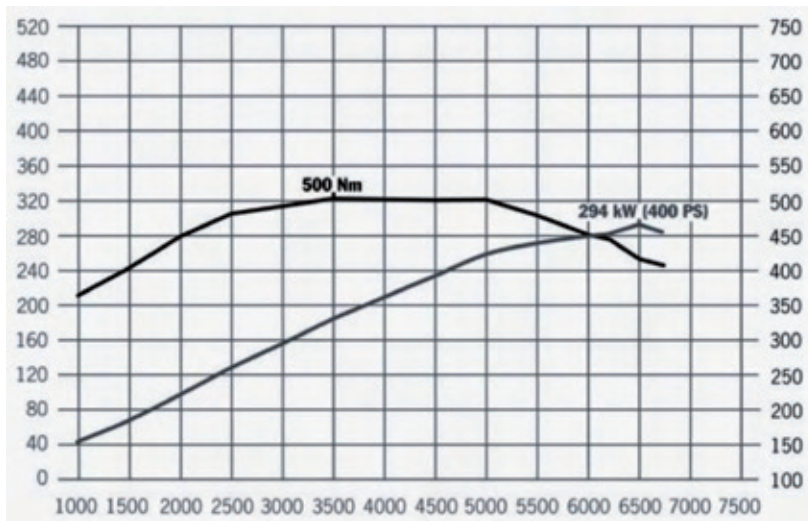
With the new intake system featuring a larger throttle valve diameter (electronic throttle), a pressure sensor on the intake manifold for load detection and modified intake camshafts (for optimum power and torque characteristics), the Cayenne S now develops 400 hp at 6,500 rpm.

In conjunction with the above systems designed to enhance fuel economy, the new Cayenne S now has lower fuel consumption in spite of improved performance values. This corresponds to a reduction of approx. 23 % compared with the previous model. The CO<sub>2</sub> emissions have been reduced by 26 % to only 245 g/km.



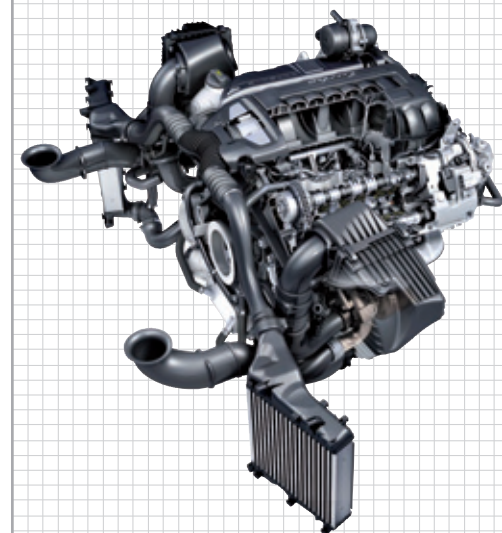
### Engine specifications - V8 naturally aspirated engine for Cayenne S:

|                           |                     |
|---------------------------|---------------------|
| DME control unit          | Siemens EMS SDI 8.1 |
| Displacement              | 4.8 liters          |
| Power                     | 94 kW (400 hp)      |
| Torque                    | 500 Nm              |
| Compression ratio         | 12.5 (-0.5)         |
| Idle speed                | 600 rpm             |
| Max. engine speed         | 6,700 rpm           |
| VarioCamPlus              | 0 - 50° crank angle |
| Firing order              | 1-3-7-2-6-5-4-8     |
| CO <sub>2</sub> emissions | 245 g/km            |



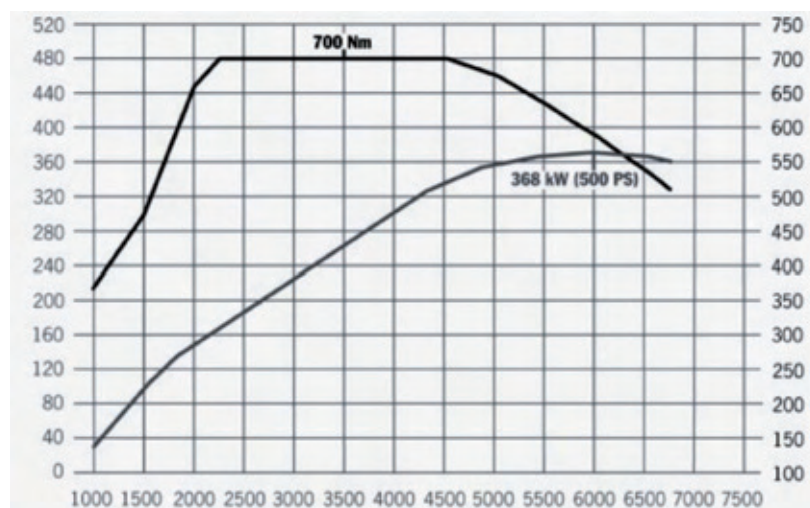
### Cayenne Turbo

The V8 biturbo engine of the Cayenne Turbo is characterized by its high power output and a high torque with low fuel consumption. Weight savings, use of the latest engine technology with systems to reduce fuel consumption as well as the intake manifold with pressure sensor for load detection combine to make the 4.8 l V8 twin turbo engine of the Cayenne Turbo even more efficient. As a result, the Cayenne Turbo has lower fuel consumption than the previous model and CO<sub>2</sub> emissions of 270 g/km (25 % less than the previous model. At the same time, the performance was improved: the top speed is now 173 mph (278 km/h) and the new Cayenne Turbo accelerates from 0 to 62 mph (100 km/h) in just 4.7 s.



### Cayenne Turbo engine specifications

|                           |                     |
|---------------------------|---------------------|
| DME control unit          | Siemens EMS SDI 8.1 |
| Displacement              | 4.8 liters          |
| Power                     | 368 kW (500 hp)     |
| Torque                    | 700 Nm              |
| Boost pressure            | 1.75 bar absolute   |
| Compression ratio         | 10.5                |
| Idle speed                | 600 rpm             |
| Max. engine speed         | 6,700 rpm           |
| VarioCamPlus              | 0 - 50° crank angle |
| CO <sub>2</sub> emissions | 270 g/km            |



## DME control unit DFI, EMS SDI 8.1

The high-performance electronic engine control unit EMS SDI 8.1 is used for the V8 engines. This control unit has been specially designed to meet the requirements relating to direct fuel injection and VarioCam Plus. Of particular significance here is control of the injectors, since these are the central elements of the direct fuel injection system.

The engine control also controls the throttle valve position (electronic throttle), as this is also a prerequisite for the Porsche Stability Management (PSM) system installed as standard.

The modern DME control unit EMS SDI 8.1 allows sequential injection of fuel into the combustion chamber for each cylinder at precisely defined time intervals. This contributes to minimizing fuel consumption and reducing emissions, even in dynamic driving operation. Each cylinder receives precisely the amount of fuel that corresponds to the engine load condition in order to realize the optimum air/fuel ratio.

In addition, the DME control unit also controls functions such as thermal management, Auto Start Stop and variable deceleration fuel cutoff.

### New functions

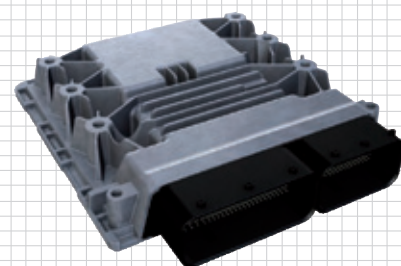
Thermal management  
Auto Start Stop function  
Variable deceleration fuel cutoff  
Vehicle electrical system recuperation

### New components

Differential Hall sensor on the crankshaft  
Pressure sensor on the intake manifold  
Control unit for electric fuel pump



Fuel and ignition system



**The DME control unit EMS SDI 8.1 controls the following functions and communicates with the corresponding components, for example:**

- Thermal management
- Auto Start Stop function
- Variable deceleration fuel cutoff
- Vehicle electrical system recuperation
- Direct fuel injection (DFI)
- Low-pressure fuel supply
- Returnless Fuel System
- High-pressure fuel supply
- Electronic accelerator pedal
- Electronic throttle with idle speed control
- VarioCam Plus
- Demand-controlled variable oil pump
- Intake system with variable intake manifold
- Stereo lambda control circuits
- Static high-voltage ignition distribution with individual ignition coils
- Cylinder-selective knock control (with 2 knock sensors)
- Differential Hall sensor (detects engine speed, reference mark and engine direction of rotation)
- Pressure sensor on the intake manifold (detects intake manifold pressure and intake air temperature)
- On-board diagnosis for monitoring the emission control system

### DME diagnosis options with the PIWIS Tester

The DME diagnostic options largely correspond to those of the DFI control unit EMS SDI 6.1 for the Panamera engines with adaptation to current components/functions (e.g. new sensors/systems) and extension by functions such as Start Stop system, thermal management, etc.

### Fault memory

Adaptation to current legal requirements (e.g. USA: Permanent fault memory = Mode A, via Scan Tool).

For the DFI control unit EMS SDI 8 also, a corresponding code comprising letters and numbers is specified in front of every actual value for each actual value filter. This simplifies assignment in the case of different languages. The explanation for individually selected values is also displayed by way of the Help key ( ? ).

### Fault deletion counter

40 warm-up phases have to be completed to delete a sporadic fault in order to decrement the deletion counter from 40 to 0.

### Actual values

- Mixture adaptations are preserved in the event of an interruption in the power supply
- Extension of actual values (e.g. Start Stop system, thermal management)



#### Note!

For the DFI control unit EMS SDI 8 also, a corresponding code comprising letters and numbers is specified in front of every actual value for each actual value filter. This simplifies assignment in the case of different languages. The explanation for individually selected values is also displayed by means of the Help key ( ? ).

### Drive links

New drive links ( e.g. for Start Stop system) etc.



## New and modified DME components and functions

### Differential Hall sensor V8 DFI

- New differential Hall sensor for detection of the
  - engine speed
  - reference mark and
  - engine direction of rotation
- 3 Hall elements in the sensor
- 1 rotor on the crankshaft
- PWM signal
- Temperature-insensitive
- Suitable for high engine speeds

A new Hall sensor is used in the new V8 engines for determination of the engine speed instead of the previous inductive pick-up. In addition to detecting the engine speed and reference mark, the new multiple Hall sensor also detects the direction of rotation of the engine. This function means that the engine starting operation is very fast. The speed sensor has 3 integrated Hall sensors (A - B - C). Only 1 rotor with 60 - 2 teeth is needed on the crankshaft to generate the corresponding PWM signal. The speed sensor is installed on the left behind the engine at the bottom of the transmission bell housing viewed in driving direction.

### Function

The sensor calculates two signal channels from three Hall signals.

2 signal channels are generated based on Hall technology in 1 sensor with 3 Hall elements (A, B, and C) :

Channel 1 = Engine speed channel (A - B)

Channel 2 = Direction of rotation channel (B - C)

The sensor switches "low" when the speed channel passes through the zero line.

The offset between the tooth center and falling edge in the signal is constant and can be adapted in the DME software.

Detection of the direction of rotation takes place on the basis of the phase displacement between the speed channel and direction of rotation channel.

## Differential Hall sensor signal

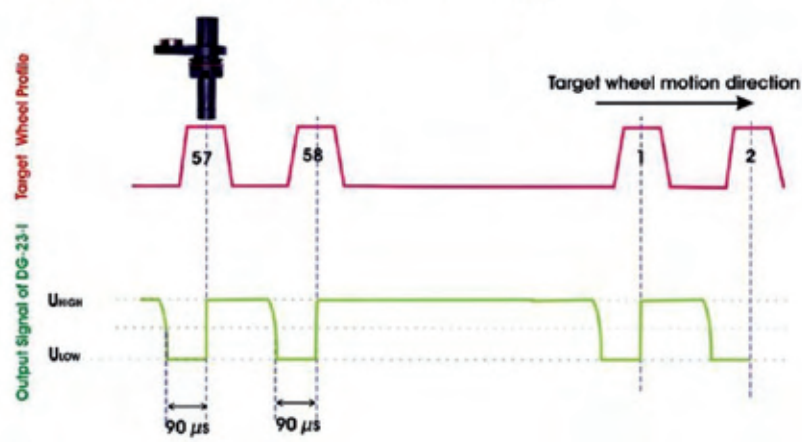
Direction of rotation forward (upper figure), channel 2 leads channel 1

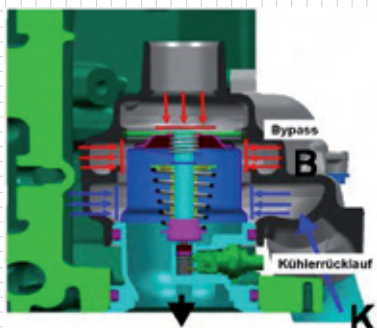
### DG-23-i ECU Interface (forward)



Direction of rotation backward (lower figure), channel 1 leads channel 2

### DG-23-i ECU Interface (backward)





## Thermal management

The thermal management function controlled by the DME control unit covers 3 main areas, namely temperature control and heat distribution between:

- Combustion engine
- Passenger compartment
- and Tiptronic S

Map-controlled coolant temperature control takes place by suppressing the coolant flow in the warm-up phase. This means that the thermostat is a hot thermostat that would open slowly and the engine would heat up quickly. The heating element heats up the wax pellet in the thermostat and opens the thermostat faster allowing the engine management to control the engine temperature. The operating temperature is regulated between 201° F. (94° C.) and 221° F. (105° C.) when the engine is warm.

## Goals

- Bringing components to the optimum operating temperature quickly (reduced friction)
- Reduced engine and transmission friction through map-based control of the operating temperature
- Meeting the comfort requirements of passengers

The new thermal management system for engine and Tiptronic S is used for the Cayenne, Cayenne S and Cayenne Turbo. The cooling system ensures that the engine run at a favorable operating temperature for optimum and permanent high performance. A further advantage is provided by the low fuel consumption and emission values, since all components reach the optimum operating temperature more quickly. The new closed-loop-controlled thermal management system in the Cayenne models controls thermal processes in the vehicle with the aim of achieving optimum efficiency for the overall system and bringing all components to their optimum operating temperature quickly.

The three main areas of the thermal management system in the Cayenne, Cayenne S and Cayenne Turbo are heat distribution between combustion engine, transmission and passenger compartment. The basic goal is to ensure that all components reach their optimum operating temperature as quickly as possible and to also meet the comfort demands of passengers by heating up the cabin quickly. At low temperatures and for cold engine starts in particular, it is important to manage the low amount of available heat in the best possible way. Efficient use of the available heat helps to save fuel, reduced CO<sub>2</sub> emissions and comply with strict emission regulations.

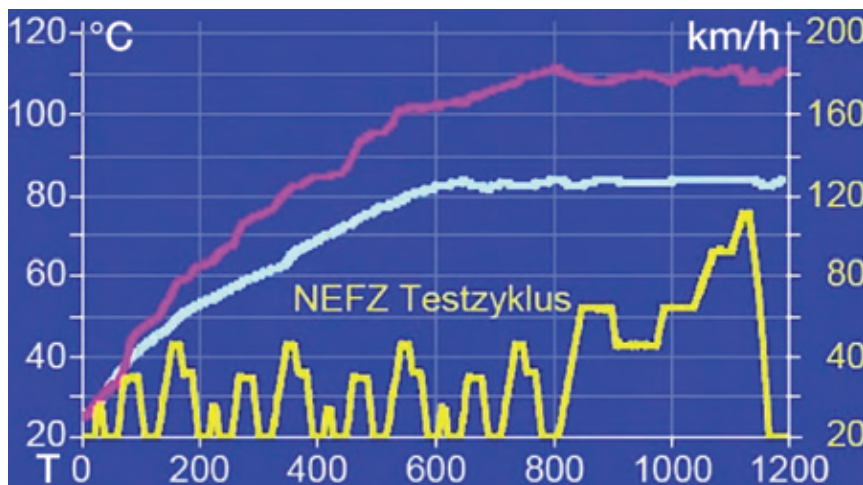
All new Cayenne models with Tiptronic S (optional for Cayenne) are equipped with thermal management for the transmission. Here also, the aim is to reach the optimum operating temperature as quickly as possible in order to minimize friction losses. For this purpose, the heat exchanger of the cooling system for the new 8-speed Tiptronic S is connected to the engine cooling system. If necessary, this allows the heat of the engine coolant, which is heated up more quickly, to be used to bring the transmission up to its operating temperature.

#### Advantages of thermal management with electric control of the coolant thermostat by the DME control unit

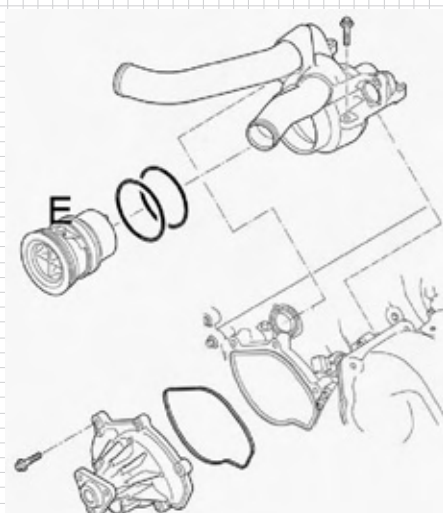
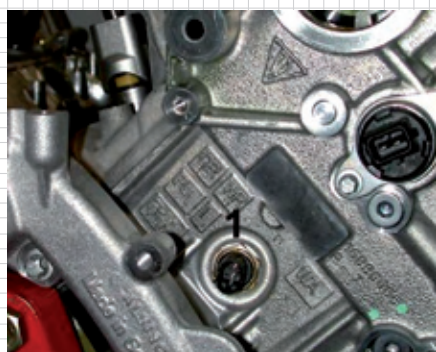
- Map-controlled coolant temperature regulation by suppressing coolant flow in the warm-up phase
- Faster warming-up of engine and transmission
- Reduced engine and transmission friction
- Lower fuel consumption (-1.5 % in the NEDC)
- Reduced emissions

The cooling system is part of the thermal management system and has two circuits which can be regulated depending on the coolant temperature. This is done by an electric, map-controlled and deactivatable thermostat.

The thermostat permits automatic, demand-based suppression of the coolant flow when the engine is cold (cold start). As a result, the engine heats up more quickly (Start Stop operating condition is reached more quickly) and friction, fuel consumption and pollutant emissions are reduced in the warm-up phase.



|            |                                        |
|------------|----------------------------------------|
| NEDC       | New European Driving Cycle (yellow)    |
| Pink       | New Cayenne with thermal management    |
| Light blue | Old Cayenne without thermal management |
| °C         | Coolant temperature                    |
| T          | Time in seconds                        |
| km/h       | Vehicle speed                          |



Depending on the increase in engine temperature, the coolant flow through the engine (small circuit) is then activated during warming up.

After this, the coolant radiator is activated (large circuit) depending on the engine operating point and based on a map stored in the engine control. The map control of the thermostat then regulates the coolant temperature between 201° F. (94° C.) and 221° F. (105° C.), depending on load, and thus ensures optimum friction conditions in the engine that are adapted to the respective load point.

This thermal management system made it possible to reduce fuel consumption by up to 1.5 %.

### Two temperature sensors are used in the engine cooling system to control the thermal management system

#### Figure 1 from top:

1 - The coolant temperature sensor is installed on the cylinder head at the rear right.

#### Figure 2 from top:

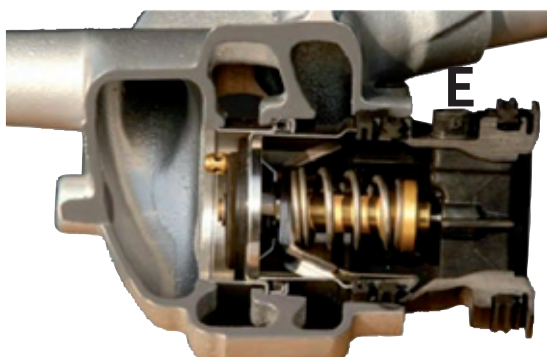
2 - A further temperature sensor is located on the left coolant hose of the radiator outlet.

#### Lower figures:

E - Electrical connection on the coolant thermostat.

As a result of the standing coolant after the cold start, the engine heats up more quickly in the warm-up phase.

Demand-based electrical map control of the thermostat allows the coolant temperature to be regulated between 201° F. (94° C.) and 221° F. (105° C.), depending on load.



## Thermal management

The main advantage of the map-controlled thermostat, which is electrically heated by the DME control unit, is that it is possible to regulate a specific temperature.

The three figures show the different opening positions of the coolant thermostat.

B - Bypass

K - Radiator return line

### Top figure, thermostat fully closed

The thermostat is fully closed when the engine is cold.

### Center figure, bypass open

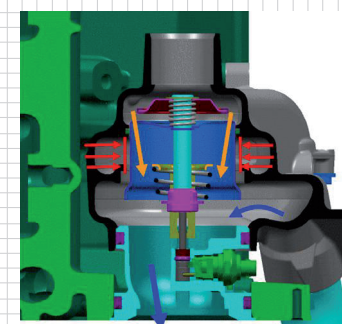
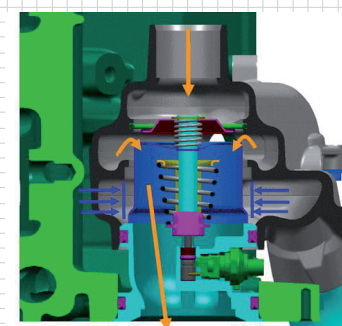
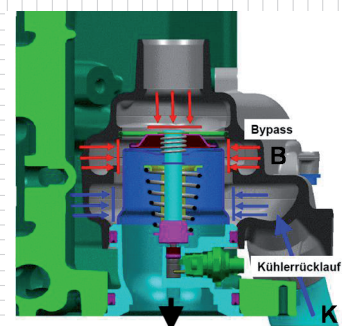
Electrical preheating makes it possible to quickly open the bypass for the small engine circuit in a controlled manner during the warm-up phase. This is achieved by providing more or less electrical heating close to the wax elements. The controlled bypass circulation in the small engine circuit allows the engine to reach operating temperature more quickly and in a uniform way.

### Bottom figure, thermostat fully open

The 2nd temperature sensor on the coolant hose permits early detection of when the thermostat starts to open and allows the necessary corrective action if necessary in order to achieve the setpoint temperature.

The DME control unit adapts the opening behaviour of the thermostat in order to compensate for tolerances and aging.

The setpoint temperature in normal operation is 221° F. (105° C.); the setpoint temperature is reduced to 201° F. (94° C.) in Sport mode and in the event of certain faults.





Further operation-specific and country-specific information is provided in the Owner's Manual.

## Auto Start Stop function

### Coordination takes place in the DME control unit

- On all new Cayenne models with 8-speed Tiptronic S (optional for Cayenne), the Auto Start Stop function can be activated and deactivated by way of a button in the center console.
- This function is available as soon as the engine has reached a coolant temperature of 113° F. (45° C.) and an oil temperature of 68° F. (20° C.)
- The combustion engine is switched off under defined conditions shortly after the vehicle comes to a stop.
- Fuel consumption and emissions are reduced above all in urban driving; fuel consumption in the NEDC is reduced by up to 5 %.
- Increased comfort for passengers, the noise level falls to zero during the stop phase.

All new Cayenne models with the 8-speed Tiptronic S (optional for Cayenne) are equipped with the Auto Start Stop function. This switches off the combustion engine under defined conditions when the vehicle is at a standstill and therefore exploits potential fuel savings, e.g. unnecessary engine idling while waiting at a traffic light is prevented.

The Auto Start Stop function can be deactivated and activated by way of a button in the center console.

If the boundary conditions are met, the function is available as soon as the engine and battery have reached the corresponding temperature and the speed threshold of 1.2 mph (2 km/h) has been exceeded for at least 1.5 seconds. If the vehicle is stopped by brake operation and the brake pedal is held, the Auto Start Stop function switches off the engine after approx. 1 second.

The driver is informed about this by the green Auto Start Stop symbol in the instrument cluster. The tachometer reading falls to zero. The selector lever can remain in position D or M. The engine remains stopped even if the lever is shifted to P and N.

If the engine cannot be switched off automatically, the driver is informed about this by a yellow Auto Start Stop symbol in the instrument cluster.

**For the driver, use of the Auto Start Stop function does not mean that he has to change his driving behaviour.**

The driver does not have to perform any additional activities for an engine stop and restart. Depending on country, the Auto Start Stop function is either switched on automatically when the ignition is switched on or must be activated each time the ignition is switched on.

When the Start Stop system is switched off, the indicator light in the button lights up “red”.

### **Auto Start Stop function**

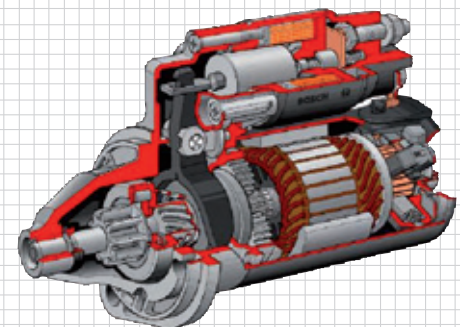
- Optimized criteria for frequent engine switch-off.
- The position of the crankshaft is detected by the differential Hall sensor on the crankshaft to permit fast starting.
- Battery monitoring (voltage, current, temperature).
- The starter is reinforced (for the increased number of starting operations).
- Maintains the vacuum for the brake booster. A pressure sensor on the brake booster measures the vacuum:
  - the engine is started again by way of a veto if the pressure falls below an applicable pressure threshold.
  - there is no other way of maintaining the vacuum when the engine is stopped.

The criteria described were optimized and adjusted in order to ensure that the engine is switched off automatically in as many cases as possible during regular driving operation. The goal was to exploit the fuel-saving potential of the Auto Start Stop function for the driver.

In order to permit realisation of the Auto Start Stop function, the starter was reinforced and designed for the increased number of engine starting operations. In addition, the battery charge and aging condition as well as temperature are monitored in order to ensure the restart capability.

The vehicle assists the driver when the engine is switched off by maintaining the brake pressure on uphill slopes. This was integrated as an additional function in Porsche Stability Management (PSM). This prevents the vehicle from rolling away opposite to the driving direction when the engine is switched off.

The most important comfort and safety functions continue to operate even when the engine is switched off. For example, the audio and communication systems still operate and the lighting, airbag systems and PSM remain available.





These functions are supplied with power from the battery for this purpose. Voltage changes when the engine stops and restarts are partially compensated for and their effects reduced. The air conditioning ensures temperature comfort. For this purpose, it uses the residual heat of the engine for heating or the residual cooling energy in the cooling system to cool the passenger compartment. If there is a risk of the passenger compartment temperature deviating significantly from the preselected value, the engine is automatically restarted in order to guarantee continued climate comfort for the passengers.

### Automatic engine stop

If the prerequisites are met, the engine is stopped as soon as the vehicle comes to a stop.

- 1. Brake vehicle to a stop with the footbrake
- 2. Keep footbrake depressed
- or move selector lever to position **P**

### Automatic engine stop and restart readiness (function indication)

If the engine was automatically switched off under the corresponding conditions, the indicator light in the multi-function display of the instrument panel lights up **“green”**.

### The Auto Start Stop system starts the engine:

- In selector lever position **D**, **N** or manually selected transmission range **1** or **2**
- **Release footbrake**
- or **press accelerator pedal**
- or move selector lever to position **R**

### Automatic engine stop

If the vehicle is stopped by brake operation and the brake pedal is held, the Auto Start Stop function switches off the engine after approx. 1 -2 seconds. The driver is informed about this by the green Auto Start Stop symbol in the instrument cluster. The tachometer reading falls to zero. The selector lever can remain in position **D** or **M**. The engine remains stopped even if the lever is shifted to **P** and **N**.



## Engine start

The engine is restarted when the driver releases the brake. The starting operation is supported by the direct fuel injection and ignition systems so that it can take place quickly and in a way that saves energy and protects the battery. To achieve this, the engine was supplemented by a sensor that detects the position of the crankshaft and therefore makes the information available as to which cylinder can be charged and ignited early. As a result, the engine power required for driving away is already available again after a short time.

### No engine stop or restart readiness (function indication)

If the automatic engine stop function is not possible, the indicator light in the multi-function display of the instrument panel lights up "yellow".

### The Auto Start Stop system has detected that:

- at least one prerequisite is not met
- or at least one exception condition is present
- or e.g. the following faults are present:
  - generator fault
  - battery fault
  - DC/DC converter fault, etc.

**If the engine cannot be switched off automatically**, the driver is informed about this by a "yellow" Auto Start Stop symbol in the instrument cluster.

The engine is not switched off or restarted again:

- if the engine has not yet reached its operating temperature
- if "Sport" mode is activated
- if PSM was switched off
- if manoeuvring or a parking operation has been detected (large steering angle), i.e. reverse gear has been engaged or the steering wheel has been turned by a large angle
- if the height adjustment function of the adaptive air suspension has been selected or is active
- if the vehicle stops on steep uphill or downhill gradients
- if the climate control/heating with residual heat function cannot guarantee that the set temperature can be maintained without a running engine, e.g. at very low and very high outside temperatures



Further operation-specific information is provided in the Owner's Manual.



The DC/DC converter compensates for voltage dips during the starting operation.





- if the total energy requirement of the vehicle systems from the battery cannot be met (charge condition)
- if the rear fog light is activated
- if internal vehicle operations are taking place that must not be interrupted, e.g. flushing operations in the fuel system via the tank vent due to high loading of the active carbon filter
- if trailer operation has been detected

#### Restarting is also prevented

- if the presence of the driver is not guaranteed, i.e. driver's door is open or driver's seat belt is not fastened
- if the hood is open

#### Diagnosis options of the Auto Start Stop system in the DME control unit

##### Actual values:

ST010\_**Status** Start Stop Manager

ST020\_ to ST026\_**Request** (by .... system)

ST030\_**Start Stop system active**

ST041\_**Stop prohibition** by vehicle systems

ST042\_**Stop prohibition** by DME control unit

ST051\_ to ST061\_**Restart request** by (.... system)

ST071\_**Stop request** by vehicle systems

ST072\_**Stop request** by DME control unit

ST081\_Deactivation by vehicle systems

ST082\_Deactivation by DME control unit

ST083\_Deactivation by drive link activation

ST101\_ to ST120\_**Stop prohibition 1 to 20** (1 was the last stop prohibition)

ST201\_ to ST220\_**Restart request 1 to 20** (1 = last request)

ST301\_ to ST320\_**Deactivation 1 to 20** (1 = last deactivation)

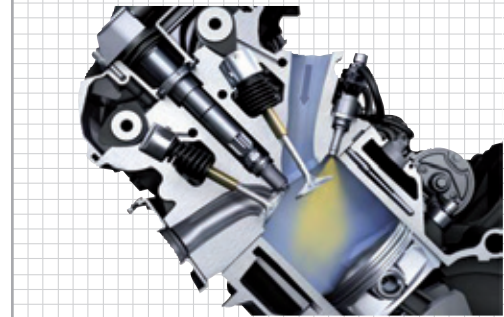
##### Drive links:

- Request stop
- Request restart
- Deactivate system for one ignition cycle

### Variable deceleration fuel cutoff

- Enhancement of conventional deceleration fuel cutoff.
- Controlled interruption of fuel supply in deceleration condition, e.g. when driving downhill.
- After a phase with deceleration fuel cutoff, fuel injection is resumed variably depending on the driving situation, which may correspond to an even lower engine speed.
- The relevant input variables for controlling variable deceleration fuel cutoff are: engine temperature, engine speed, engine speed gradient (change in rpm), as well as transmission fluid temperature and transmission gear.
- The goal is to drive as long as possible in deceleration condition with fuel cutoff. Deceleration fuel cutoff is maintained even in the deceleration coasting phase with downshifts. Deceleration fuel cutoff mode is ended only in the event of significant deceleration.
- The resumption speed after deceleration fuel cutoff is 850 rpm to 950 rpm.

Variable deceleration fuel cutoff is an enhancement of conventional deceleration fuel cutoff. It involves controlled interruption of the fuel supply in driving situations where the combustion engine is not required to output any power but is kept moving by the inertia mass of the vehicle (deceleration, e.g. when driving downhill). Compared with the usual deceleration fuel cutoff systems, which resume fuel injection as from a fixed engine speed, variable deceleration fuel cutoff systems resume fuel injection flexibly depending on the driving situation, which may correspond to an even lower engine speed. Depending on the driving situation, fuel injection can resume even later, thereby saving fuel.





Detailed information is provided in the section Electrics “Gateway”.

### Vehicle electrical system recuperation in communication with gateway control unit

- This control operation includes the DME control unit, the gateway control unit, the brake pedal sensor, starter battery with battery sensor, the generator and the vehicle electrical system.
- Vehicle electrical system recuperation helps to reduce fuel consumption.
- Some of the kinetic braking energy is converted into electrical energy via the generator during vehicle deceleration phases and is fed into the starter battery.
- As a result, the combustion engine has to supply less power to charge the battery through generator operation in acceleration phases.
- Depending on the battery condition, the vehicle voltage is raised and lowered correspondingly and varies between 12.5 and 15.5 V.

The Cayenne, Cayenne S and Cayenne Turbo feature the new function of vehicle electrical system recuperation as a further fuel-saving measure. Here, some of the kinetic braking energy can be converted into electrical energy via the generator during vehicle deceleration phases and stored in the starter battery. As a result, the combustion engine has to supply less power to charge the battery through generator operation in acceleration phases in particular, which directly results in lower fuel consumption.

The starter battery is preferably charged by the usually otherwise lost braking energy during the braking operation. During braking, the generator output is increased in a targeted manner by the generator regulator and the recuperated energy is fed into the starter battery. The voltage is then lowered again and the energy can be fed into the vehicle electrical system in order to supply the loads. The increased generator power acts with a low braking torque on the crankshaft of the combustion engine via a drive belt. This leads to vehicle deceleration and therefore supports the conventional brake system.

A new intelligent algorithm in the energy management system evaluates various input variables of the components involved, thereby allowing active coordination of every recuperation operation based on the battery charge condition and driver request. This control operation includes, among others, the engine control, brake pedal sensor, starter battery with sensor system, generator and the vehicle electrical system. The powerful AGM battery meets all requirements with respect to battery life in view of the increased number of cycles due to frequent charging and discharge.

## Other DME functions

### Sport button as standard

The Sport button is standard for all Cayenne models. This is located in the middle of the center console on the side of the gearshift lever or Tiptronic S selector lever facing the driver. This allows the driver to choose between a setup with optimized comfort and consumption or a sporty setup in the new Cayenne models.

### Standard setting

In Normal mode, the electronic engine management system restricts the engine torque in order to optimise fuel consumption (except during kickdown).

- Optimized comfort and fuel consumption
- Dynamically comfortable accelerator characteristic

### Sport mode

When the Sport button is activated, a "SPORT" symbol lights on the instrument cluster. A sportier vehicle setup is obtained when Sport mode is switched on.

- Auto Start Stop function deactivated
- Sporty engine setup
- Accelerator reacts more quickly, more spontaneous throttle response
- Throttle open further for same pedal travel
- Coolant temperature is reduced

The electronic engine management system controls the engine with more bite. The dynamic response of the engine then becomes even more direct. On vehicles with 8-speed Tiptronic S, upshifts take place later and downshifts earlier in automatic mode. The Auto Start Stop function is also deactivated.

In addition, the chassis control systems Porsche Active Suspension Management (PASM) and the optional Porsche Dynamic Chassis Control (PDCC) are switched to Sport mode. This makes damping sportier and the steering behavior in bends is more direct. This in turn leads to improved road contact. Activation of the Sport button influences the areas DME, Tiptronic S, PTM, PASM and PDCC.

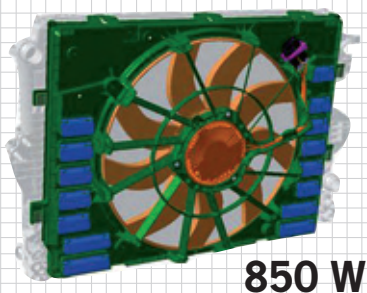
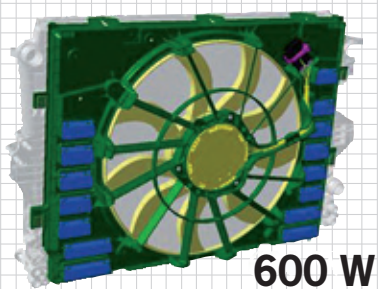
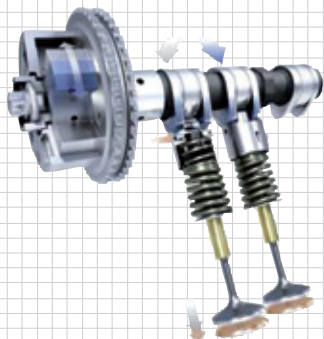
### Off-road mode

- In off-road mode, the accelerator pedal characteristic is very flat at low speed in order to ensure precise throttle control when driving off-road.
- At faster speeds, the accelerator pedal characteristic becomes increasingly more responsive for better handling on sand dunes.



Fuel and ignition system





When removing the electric radiator fan, the fan must not be held by the fan blades as this can lead to imbalance.



Diagnostic information is described in Guided Fault Finding.

### Control of VarioCam Plus

The DME control unit also controls the VarioCam Plus system (stepless control of the intake camshafts from 0 to 50° crank angle) and valve lift adjustment of the intake valves (large/small lift).

This system for adjusting the intake camshafts is also used in the new Cayenne engines. Apart from continuous adjustment of the valve timing, the system also enables adjustment of the valve lift for the intake valves. In conjunction with direct fuel injection, this allows high power output and torque values together with low fuel consumption. A new feature of the new generation of V8 engines is a fully aluminum, lightweight camshaft adjuster. This lightweight design measure reduces the weight by approx. 3.7 lbs (1.7 kg) and also reduces the rotating masses, thereby achieving a more agile engine response.

### Activation of the demand-controlled variable oil pump

The DME control unit also activates the control valve of the demand-controlled variable oil pump. Another measure designed to achieve high efficiency is use of a variable oil pump with demand-based control. The pump is designed as an external gear pump with an integrated turbocharger extraction stage for the V8 twin turbo engine. Demand-based control is performed by the DME control unit, while adjustment is hydraulic. The engine management system uses the engine speed, oil temperature and torque as input variables. Based on this information, the engaged gear wheel width and thus the geometric displacement volume of the gear wheel set are changed through the axial movement of a gear wheel (moved hydraulically) and this in turn changes the oil pressure.

### 1 steplessly controlled radiator fan

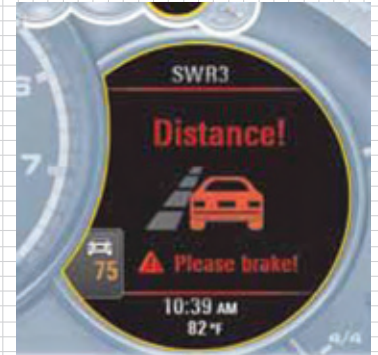
|               |                                |
|---------------|--------------------------------|
| Cayenne V6    | MT- 0 to 600 W, AT- 0 to 850 W |
| Cayenne S     | 0 to 850 W                     |
| Cayenne Turbo | 0 to 850 W                     |

### **Increase in idle speed to increase the charging current**

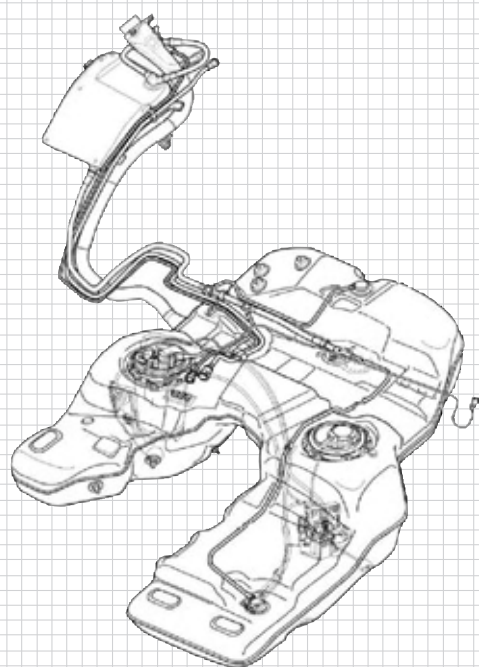
The idle speed can be increased in three stages after a corresponding request from the gateway. The charging current of the generator is increased as a result. The field current is regulated in the gateway. To increase the generator output, the idle speed can be increased in three stages when the engine is warm (e.g. V8 engines 640, 740 and 850 rpm).

### **Communication with Adaptive Cruise Control (ACC)**

In communication with the control unit of the adaptive cruise control, it is possible to perform acceleration or deceleration via the electronic throttle and where appropriate braking, also to vehicle stop.



Further information on ACC is provided in the Owner's Manual.



## Fuel supply, low-pressure side

### Fuel quality

The engines are designed for unleaded premium fuel 93 octane ( $\frac{R+M}{2}$ ). If fuel with a lower number is used, corresponding adaptation is performed by the knock control.

### Fuel tank

Depending on the engine variant, a fuel tank with a filling capacity of 22.4 gal. (85 l) or 26.4 gal. (100 l) is installed. The tank bladder is identical. In the fuel tank with a filling capacity of 22.4 gal. (85 l), the roll-over valve is positioned lower down in the fuel tank by way of an adapter, with the result that the fuel nozzle is then switched off earlier.

- Cayenne V6/Cayenne S - filling quantity 22.4 gal. (85 l), reserve 3.9 gal. (15 l)
- Cayenne Turbo - filling quantity 26.4 gal. (100 l), reserve 3.9 gal. (15 l) (option for V6/S)

The active carbon filter is located behind the wheel housing liner of the right rear wheel. On USA vehicles, a leak detection pump (LDP) is used for the tank leakage test, as previously in the Cayenne vehicles. This pump is installed directly at the fresh-air connection of the active carbon filter.

### ReturnLess Fuel System - RLFS

The low-pressure side of the fuel supply system consists of a returnless fuel system (**RLFS - ReturnLess Fuel System**). The speed-regulated electric fuel pump delivers the fuel via the fuel filter and fuel-pressure regulator (in the fuel tank) to the quantity control valve on the high-pressure pump with a pressure of approx. 82 psi (5.7 bar). The sucking jet pumps in the fuel tank are also operated with the low-pressure side. The 2 fuel-level sensors are installed in the fuel tank for measurement of the fuel level.

1 demand-controlled electric fuel pump as well as the fuel filter (lifetime filter) and the fuel-pressure regulator (rel. fuel pressure approx. 82 psi/5.7 bar) are located in the fuel tank.

## Control unit for electric fuel pump

### Operating principle

The control unit of the electric fuel pump is installed at the rear above the right side of the fuel tank (top figure: access via the wheel housing liner at the rear right). The control unit for the electric fuel pump is used for stepless demand-based control of the fuel delivery rate. This control unit receives the setpoint speed of the fuel pump from the DME control unit via a bidirectional PWM interface and sends back diagnostic information.

### Power supply

- The control unit is supplied with power via the main relay.
- Terminal 31 represents the connection to vehicle ground.
- Control by the DME control unit takes place via a bidirectional PWM interface.

### Electric fuel pump

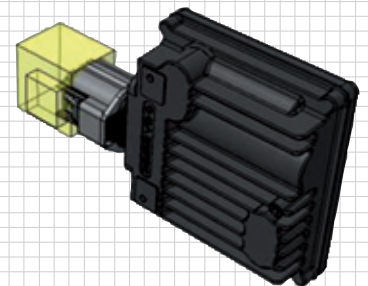
The delivery rate is regulated by the speed of the electric fuel pump by way of the specified frequency (with limitation of the phase current).

### Control

The output of the fuel pump is controlled by the DME control unit by a PWM control signal. This bidirectional PWM interface is also used for diagnosis of the control unit for the electric fuel pump. The speed of the electric fuel pump is regulated by means of the specified frequency within the power limits of the fuel pump (with limitation of the phase current) and independently of the vehicle electrical system voltage (voltage compensation). The pump motor is a brush-less three-phase synchronous motor.



The electric fuel pump must be operated only with the electric control unit.



Further diagnostic information on the PWM signal and diagnosis is described in Guided Fault Finding.

### **Via the door contact**

Cayenne V8: After the DME control unit switches to Sleep mode, it is woken again via a CAN wakeup signal when the driver's door is opened. The electric fuel pump is then operated with a significantly reduced speed for a period of 2 seconds. The electric fuel pump cannot be activated as long as the DME is now active (without ignition on). After the DME has switched back to Sleep mode again, this process can take place a maximum of three times without the ignition being switched on. This limit is designed to protect the vehicle electrical system management. Door contact activation can be activated again for a further three times with ignition On/Off.

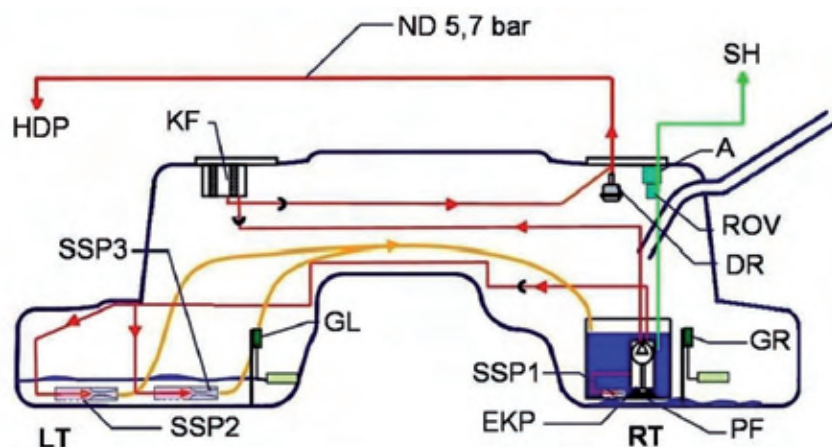
### **When ignition is switched on**

Cayenne V8: In contrast to door contact activation, the electric fuel pump is activated at maximum speed for 1 second after ignition on. This ensures rapid pressure build-up for a possible fast start-off.

### **Note on Cayenne V6**

On these vehicles and depending on the fuel requirement, the delivery rate can be reduced to such an extent that the fuel pressure falls from approx. 82 psi (5.7 bar) to 58 psi (4 bar).

## Internal design of the fuel tank RLFS



- RT Right tank chamber
- LT Left tank chamber
- PF Pump filter
- EKP Electric fuel pump (demand-controlled)
- KF Fuel filter (lifetime filter)
- DR Fuel-pressure regulator (approx. 82 psi/5.7 bar rel.)
- ND Low-pressure line (approx. 82 psi/5.7 bar) to the high-pressure pump
- HDP To the quantity control valve on the fuel high-pressure pump
- SSP1 Sucking jet pump, right (1.0 mm), for filling the electric fuel pump
- SSP2 Sucking jet pump, left (0.42 mm, 82 psi/5.7 bar), fills the pump chamber
- SSP3 Sucking jet pump, left (0.42 mm, 82 psi/5.7 bar), fills the pump chamber
- ROV Roll-over valve (also used for tank venting and fuel level limitation)
- A Adapter in the tank to lower the ROV valve (only for 22.4 gal./85 l tank)
- SH Auxiliary heater
- GR Fuel level sensor, right
- GL Fuel level sensor, left

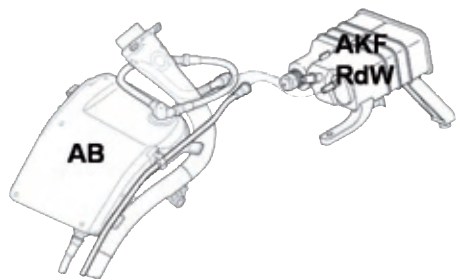
## Fuel and ignition system

2



The procedures for checking the fuel pressure, holding pressure and delivery rate of the electric fuel pump are described in the PIWIS information system Group 2.

The safety instructions in the PIWIS information system Group 2 must be observed when working on the fuel system.

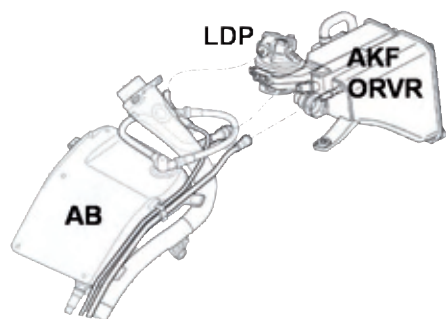


Top figure - Tank ventilation Rest of World:

|         |                                    |
|---------|------------------------------------|
| AB      | Degassing tank                     |
| AKF RoW | Active carbon filter Rest of World |

Bottom figure - Tank ventilation ORVR  
(USA vehicles with tank leakage diagnosis):

|          |                          |
|----------|--------------------------|
| AB       | Degassing tank           |
| AKF ORVR | Active carbon filter USA |
| LDP      | Leak detection pump      |



## Fuel tank ventilation

### Tank ventilation

The fuel tank is aerated and vented exclusively via the active carbon filter, which acts as an intermediate storage device for any HC emissions. Regeneration of the active carbon filter takes place via the tank vent valve when the engine is running.

The active carbon filter is installed behind the wheel housing liner at the rear right. The tank vent valve is located in the engine compartment (on the right next to the electronic throttle in V8 engines).

When the engine is running, the fuel tank is vented by the tank vent valve, which is controlled by the DME control unit, to the intake system of the engine.

- On the turbo engine, a check valve closes the connection to the intake manifold when boost pressure is present.

### Leak detection pump (LDP), for USA vehicles only

The functional principle for tank leakage diagnosis (LDP) is identical to that of the previous Cayenne vehicles. The complete fuel tank system is checked for possible leaks using the positive pressure method. This takes place only when the engine is running. The LDP is an electro-pneumatic diaphragm pump which is supplied with a vacuum. Evaluation by means of a reed contact switch located on the diaphragm takes place after the pumping phase.

### Crankcase ventilation

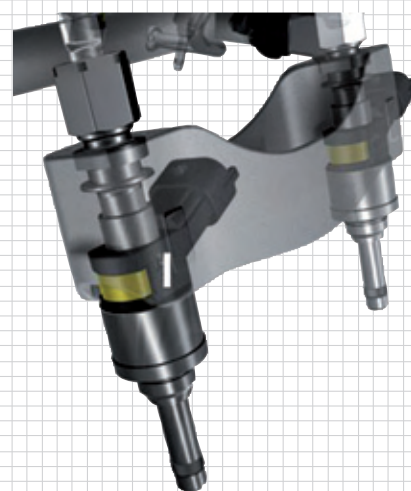
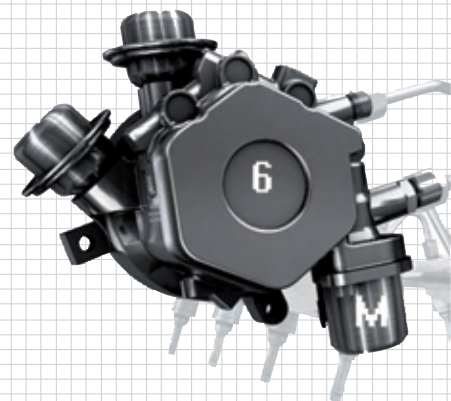
Crankcase ventilation also takes place into the intake system.

- On the naturally aspirated engine, this takes place on the left of the electronic throttle directly into the intake manifold (and on the turbo engine if no boost pressure is present).
- On the turbo engine with boost pressure, ventilation takes place to the intake side of the left turbocharger.

The entry point directly on the intake manifold has an electric heater to prevent freezing at corresponding temperatures and to therefore avoid the risk of excess pressure in the crankcase.

## Fuel supply, high-pressure side DFI

The high-pressure fuel system (from the high-pressure pump to the injectors) corresponds to that of the previous Cayenne V8 DFI engines. The direct fuel injection is optimally matched to the characteristics of the V8 naturally aspirated engine and V8 biturbo engine. A radial piston pump is used in both engines. This is driven by the left intake camshaft. In the V8 naturally aspirated engine, the fuel high pressure is built by up 3 pistons. In the V8 twin turbo engine, this is done by 6 pistons. Fuel is distributed in both engines via a central high-pressure fuel rail in the inner-V of the engine with separate lines leading to the fuel injectors. When the engine is running, the high pressure measured by the pressure sensor is regulated to a pressure of between approx. 580 psi (40 bar) and 1740 psi (120 bar) by the quantity control valve (at the inlet of the high-pressure pump).



- M Quantity control valve
- 3 Radial piston pump, naturally-aspirated engine (3 pistons)
- 6 Radial piston pump Turbo (6 pistons)
  - Engine-specific high-pressure rails
  - Pressure sensor on high-pressure rail and engine-specific injectors
- I Swirl injector Turbo

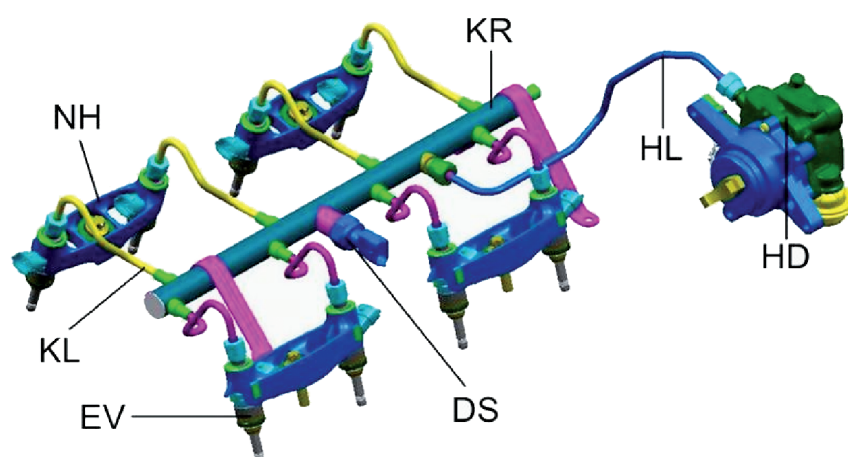
Fuel and ignition system

2

### High-pressure pump

The high-pressure pump provides the high pressure of approx. 580 psi (40 bar) to 1740 psi (120 bar) which is needed for injection. The pump is driven via the intake camshaft of the left cylinder bank.

- Naturally aspirated engine: 3-piston high-pressure pump (HD) with quantity control valve and 1 damper
- Turbo engine: 6-piston high-pressure pump with quantity control valve and 2 dampers



### Quantity control valve

The quantity control valve installed at the inlet of the high-pressure pump on the V8 engines regulates the fuel high pressure.

### High-pressure rail

The central high-pressure rail (KR) is located within the inner-V of the engine, from where the fuel is supplied to the injectors via individual lines. The volume of the high-pressure rail differs for the naturally aspirated and turbo engines. The high-pressure rail provides the same pressure for all injectors.

### Pressure sensor

The pressure sensor (DS) on the high-pressure rail detects the fuel high pressure (pressure measurement from approx. 580 psi/40 bar to 1740 psi/120 bar).

### Swirl injectors

The injectors are solenoid-operated and are positioned beneath the intake ducts of each cylinder. They inject the fuel under high pressure directly into the combustion chamber. To open an injector, the activation voltage is briefly raised to up to 75 V by way of a voltage booster in the DME control unit. Fuel injection quantity for V8 naturally aspirated engine 210 g/min, V8 Turbo 349 g/min.

### Characteristics of direct fuel injection

- High cylinder charging
- Low knock sensitivity
- High compression ratio
- High-pressure stratified charge injection
- Multiple injection possible
- Homogeneous operation with engine at operating temperature

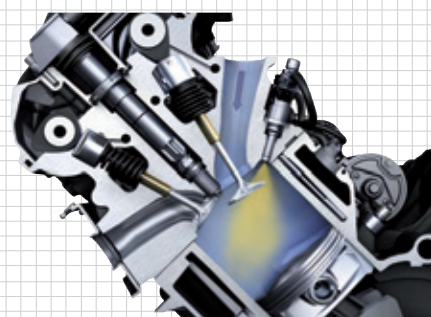
In the case of direct fuel injection, the fuel is injected directly into the combustion chamber, so that the mixture formation takes place almost entirely within the combustion chamber.

The direct fuel injection system used in the Cayenne DFI engines is based on homogeneous operation when the engine is at operating temperature. The mixture of fuel and air is distributed as evenly as possible in the combustion chamber, thereby enabling optimal combustion. In this process, the fuel is injected directly in the combustion chamber at a pressure of up to 1740 psi (120 bar). The jet and cone angles of the injectors have been optimized to achieve optimum homogenization across the entire operating range. Within the injector, the fuel jet is swirled (rotated about the longitudinal axis). This rotation forms a cone-shaped cloud of fuel. This results in fine atomisation which in turn enables quicker evaporation of the fuel.

The heat energy required for this is removed from the air by the fuel evaporation and this cools the air as a result. This reduces the cylinder charge volume and additional air is drawn in through the open intake valve, which in turn improves cylinder filling. The reduced temperature level also helps to create the prerequisites for the high compression ratio in all Cayenne engines, since knock sensitivity and engine efficiency have been improved. The high compression ratio of 12.5:1 for the V8 naturally aspirated engine and 10.5:1 for the V8 twin turbo engine realized through DFI serves to optimize both engine power and fuel consumption.



Fuel and ignition system



## Injection strategies

The piston recesses are important for the injection strategies of single, dual or triple injection. They allow late injection of fuel in order to create an ignitable air/fuel mixture around the spark plug for late ignition.

### Engine start

Different injection strategies are used for the engine start, depending on the start temperature.

### Triple injection

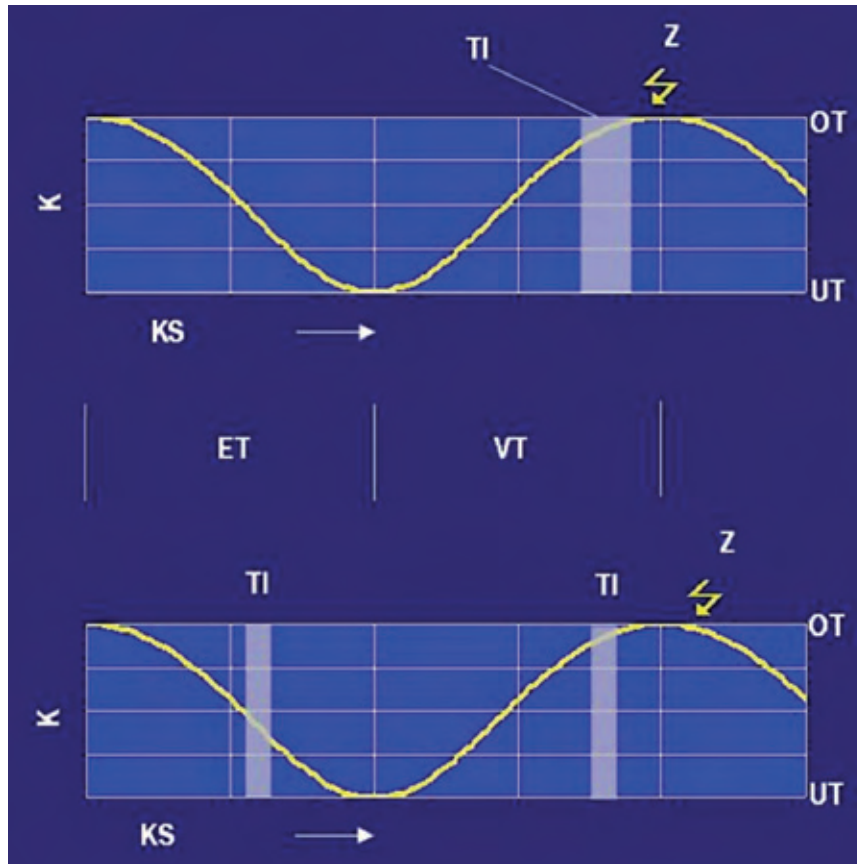
Generally, triple injection is used in the start phase for start temperatures with a coolant temperature of less than 140° F. (60° C.). Triple injection in the start phase offers a very great potential for reduction of the fuel injection quantity. The first two injection pulses occur early in the compression stroke with a small interval between injections, while the third injection pulse takes place at the end of the compression strokes. Triple injection made it possible to reduce the total injection quantity by up to 40 % in the temperature range from -22° F. (-30° C.) to 32° F. (0° C.) and also to shorten the starting times compared with the previous V8 DFI engines. The advantages of multiple injection are achieved primarily due to the fact that the evaporation surface area is increased by dividing the injection quantity between several injection pulses, thereby allowing more fuel to evaporate in the same time. This reduces the wall deposits of fuel for a cold start.

### Single injection

Starting takes place by means of single injection as from a coolant temperature of 140° F. (60° C.). With this so-called high-pressure stratified-charge injection, injection takes place very late and just before the end of the compression stroke. Here, fuel is injected once into the specially molded piston recess in a targeted manner. This creates stratification around the spark plug, which in turn produces an ignitable mixture. The piston recess ensures that the injected fuel is channelled directly to the spark plug. This reduces both the amount of fuel required and the emissions compared with intake manifold injection.

### Engine start with single and triple injection

The top part of the figure shows an engine start with single injection and the bottom part shows catalytic converter heating with dual injection.



- OT Top dead center (TDC)
- UT Bottom dead center (BDC)
- KS Crankshaft position
- K Piston position
- TI Injection
- Z Ignition
- ET Intake stroke
- VT Compression stroke

### Catalytic converter heating with duel injection

After engine starting by high-pressure stratified-charge ignition, the engine management system switches to the catalytic converter heating phase. In this operating state, dual injection helps to bring the catalytic converter to the temperature required for optimal conversion as quickly as possible by increasing the exhaust-gas temperature. For this purpose, the first injection of fuel takes place during the intake stroke and the second injection occurs into the piston recess when the intake valves are closed, just before the end of the compression stroke. The fuel-air mixture is ignited very late, thereby increasing the exhaust-gas temperature. This reduces the emissions during the starting phase.

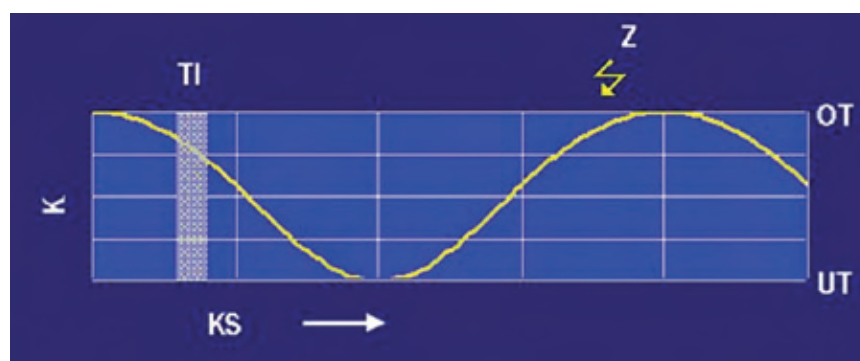
OT Top dead center (TDC)  
UT Bottom dead center (BDC)  
KS Crankshaft position  
K Piston position  
TI Injection  
Z Ignition

## Engine at operating temperature (homogeneous operation)

### Single injection at idle speed and partial load up to 3,500 rpm

When the engine is at operating temperature, injection into the cylinder takes place only during the intake stroke. In this so-called **homogeneous operation**, there is uniform mixture formation for the entire cylinder charging process.

At speeds close to idle speed and in the lower partial-load range, the engine is operated with a single injection in the intake stroke since this relatively short injection time cannot be divided up.



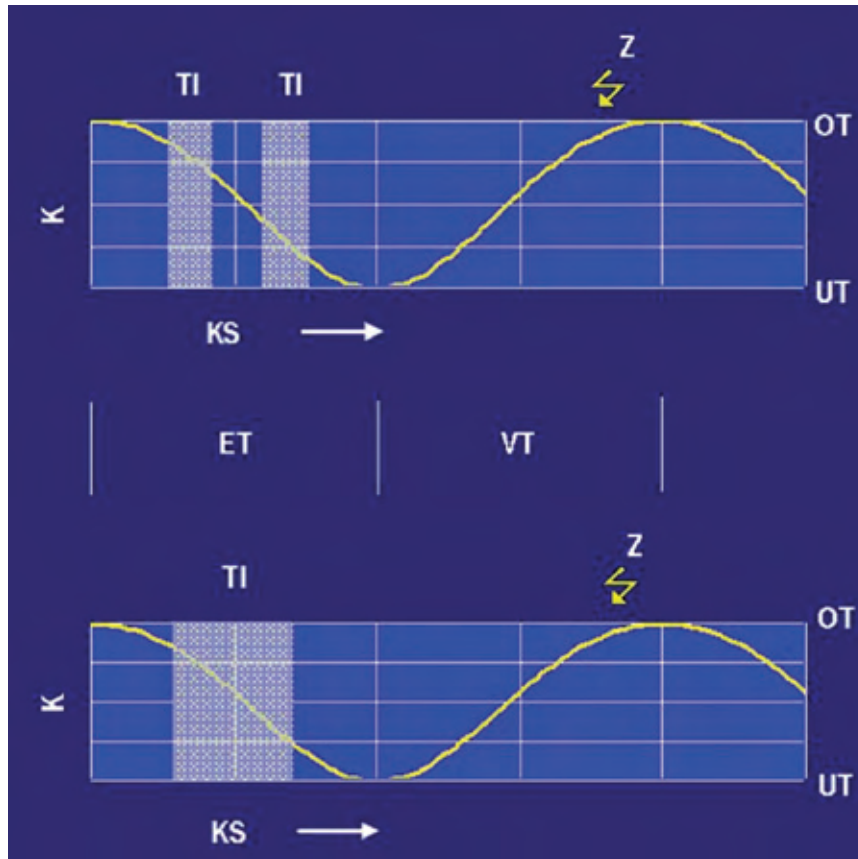
### Dual injection

Under conditions with high load (e.g. large valve lift), a dual injection takes place up to an engine speed of 3,500 rpm. The quantity of fuel required for combustion is shared between two successive injections. In the upper load range, both injections take place during the intake stroke (synchronous intake injection) with open intake valves, thereby ensuring better homogenization (spatial distribution in the combustion chamber) in order to save fuel and increase power output.



Fuel and ignition system

## Dual injection, full load up to 3,500 rpm



- OT Top dead center (TDC)
- UT Bottom dead center (BDC)
- KS Crankshaft position
- K Piston position
- TI Injection
- Z Ignition
- ET Intake stroke
- VT Compression stroke

## Single injection, full load above 3,500 rpm

At high load and with an engine speed of over 3,500 rpm, injection takes place only once in the intake stroke, since there is not enough time to divide up the injection time at high engine speeds.

## Fuel and ignition system

2



## Ignition system

The aluminum fastening screws of the individual ignition coils are secured on the magnesium valve cover. In order to prevent consequential damage, it is essential to observe the new tightening method in accordance with the PIWIS information system.

- 1 Individual ignition coils with integral driver
- 2 Aluminum screws
- 3 Engine compartment temperature sensor

## Intake system / Turbocharging

### Air routing / Air cleaner

As a result of omission of the hot-film mass air flow sensor, air routing of the intake air from the air cleaner to the electronic throttle has been dethrottled in the V8 engines.



The engine-specific service intervals of the spark plugs and the air cleaner elements are specified in the maintenance schedules.

### **New pressure sensor on the intake manifold V8 DFI (naturally aspirated and turbo engines)**

Like on the Panamera engines, the new pressure sensor on the intake manifold replaces the previous hot-film mass air flow (MAF) sensor. In order to ensure that the correct mixture composition is always present in the combustion chambers, the actual intake air mass is continuously measured using a pressure sensor for measuring the mass air flow. As a result, the correct mixture is always available in the combustion chambers, and any changes in the atmospheric pressure (due to changes in altitude) and outside temperature are compensated. This new pressure sensor replaces the previously installed hot-film mass air flow measurement system and also contributes to increased performance by dethrottling the intake section.

The pressure sensor detects the intake manifold pressure (at the rear of the intake manifold). On the basis of this information, the DME control unit determines the respective air mass and intake temperature from different maps.

### **Advantages of the pressure sensor**

- Power increase through dethrottling of the intake section
- Higher precision for small air flows
- High resistance to soiling
- Lightweight design (the pressure sensor replaces 2 MAF sensors)

### **Intake air temperature sensor**

The integrated temperature sensor measures the intake air temperature on both naturally aspirated and turbo engines.



The load signal of the pressure sensor and the intake air temperature can be found under the DME actual values.

### Modified intake system for V8 naturally aspirated engine

The new intake manifold is provided with a mounting at the rear for the new pressure sensor (2) for load detection.

Like the previous Cayenne GTS, the new Cayenne S is equipped with a throttle valve (electronic throttle) with a diameter of 82 mm (1) (previous Cayenne S 76 mm).

The intake system with variable intake manifold combines the advantage of a long intake manifold – higher torque at low rpm – with that of a short manifold, namely high specific output in the upper rpm range. For this purpose, the resonance intake system uses the air mass oscillations in the intake tract, dependent on the engine speed, to achieve better volumetric efficiency of the engine. Depending on the position of the intake manifold flap, this permits realization of a high torque curve in conjunction with the optimized intake duct geometry.

The DME control unit controls the electro-pneumatic switching valve, which switches a vacuum to the diaphragm cell in order to switch to the long intake manifold length at low engine speeds (538 mm torque position). Switching to the short intake manifold takes place as from 4,150 rpm (284 mm power position).



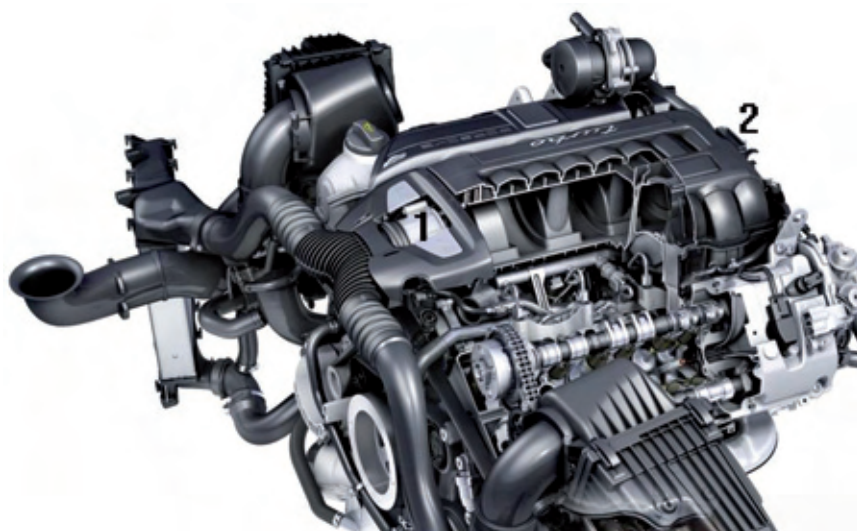


## Cayenne Turbo intake system

The new intake manifold of the Cayenne Turbo is also provided with a mounting at the rear for the new pressure sensor (2) for load detection.

In the turbo engine, the intake air is routed from the air-cleaner housing via the separate air ducts on the left and right directly to the intake side of the respective turbocharger. Downstream of the compressor, the compressed and heated air is cooled in the charge air coolers on the left and right and then routed together again upstream of the electronic throttle. Cooling of the charge air ensures high cylinder charging and reduced component temperatures.

The intake system of the Cayenne Turbo does not require any flaps since the charge effect is produced by the two turbochargers. The short intake manifold lengths are therefore effective across the entire map.



## Deceleration air control

Deceleration air control ensures better engine response for acceleration after an deceleration phase since the turbocharger speed does not drop to the same extent. In addition, the mechanical loads and noise are reduced.

Deceleration air control is activated in deceleration mode. For this purpose, a connection is produced between the pressure side and suction side of the intake air on each turbocharger. Activation takes place when the DME control unit switches the electric switching valve (installed below the intake manifold). The vacuum then opens the diaphragm cells for overrun air control on the left and right.

### Cayenne Turbo boost pressure control

Boost pressure control takes place ahead of the throttle valve. The pressure sensor for detecting the boost pressure (1) is installed directly before the throttle valve.

The intake air temperature is detected by the pressure sensor for the engine load at the rear of the intake manifold (like on the Cayenne S).

The DME control unit regulates the boost pressure by activating the electric boost pressure control valve (2 - installed on the left next to the electronic throttle). This modulates a corresponding control pressure for activating the wastegate valves on the turbochargers. The boost pressure is therefore regulated to the boost pressure setpoint calculated in the DME control unit upstream of the electronic throttle.



- 1 Pressure sensor (boost pressure)
- 2 Electric valve for boost pressure control
- 3 Crankcase ventilation
- 4 Tank vent valve

### Crankcase ventilation

The entry point directly on the intake manifold has an electric heater to prevent freezing at corresponding temperatures and to therefore avoid the risk of excess pressure in the crankcase.

## Exhaust system / Emission control

The exhaust system not only ensures that pollutants are cleaned from combustion exhaust gases, it also has a significant effect on the acoustics of the vehicle. The main function of the exhaust system is after-treatment of the exhaust gas.

### Cayenne S exhaust system

#### Twin-branch exhaust system with branch coupling connection

- 1 Exhaust manifold, bank 1/2
- 2 Wideband oxygen sensor LSU 4.9 ahead of catalytic converter, bank 1/2
- 3 Primary catalytic converter (ceramic substrate), bank 1/2
- 4 Step oxygen sensor LSF 4.2 behind catalytic converter, bank 1/2
- 5 2 main catalytic converters (metal substrate), bank 1/2
- 6 Branch coupling connection for torque optimization

### Cayenne S emission control

USA: ULEV

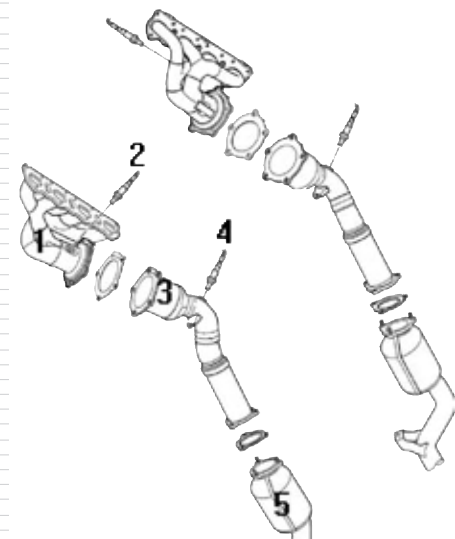
EU: EURO 5 (with secondary-air injection)

As a result of combustion of the fuel-air mixture, small quantities of pollutants (nitrogen oxides (NO<sub>x</sub>), hydrocarbons (HC), carbon monoxide (CO) and soot particles) are produced in addition to CO<sub>2</sub> and water vapor.

In order to ensure compliance with all the globally valid emission regulations, all Cayenne models have an exhaust system that is specially adapted to the respective engine unit. All exhaust systems are made of long-life stainless steels.

To keep emissions low in the cold start phase in particular, it is important that the catalytic converter reaches its optimal operating temperature quickly. For this reason, the exhaust manifolds of all V8 Cayenne models are designed very short so that the high exhaust temperature can be used to heat the catalytic converters. This allows the highly-efficient primary and main catalytic converters to heat up quickly and guarantee effective emission control.

The cylinder bank-specific LSU oxygen sensors ahead of the catalytic converter and LSF oxygen sensors behind the catalytic converter signal the exhaust gas composition to the DME control unit. The DME control unit can then use this information for targeted intervention in bank-specific mixture control. This ensures that the strictest emission standards are met or even bettered.



Tailpipe cover

### Cayenne Turbo exhaust system

There are a number of differences in the exhaust system of the V8 turbo engine compared with the exhaust system of the V8 naturally aspirated engine. For example, the pipes of the twin-branch exhaust system of the Cayenne Turbo have larger cross-sections compared with the exhaust system of the V8 naturally aspirated engine and there is also no branch coupling connection. The larger cross-sections result in comparable exhaust gas speeds in both exhaust systems.

### Twin-branch exhaust system

- 1 Primary catalytic converter, bank 1/2 (ceramic substrate)
- 2 Main catalytic converters, bank 1/2 (metal substrate)
- 3 Muffler
- 4 Dual tailpipe cover, left/right



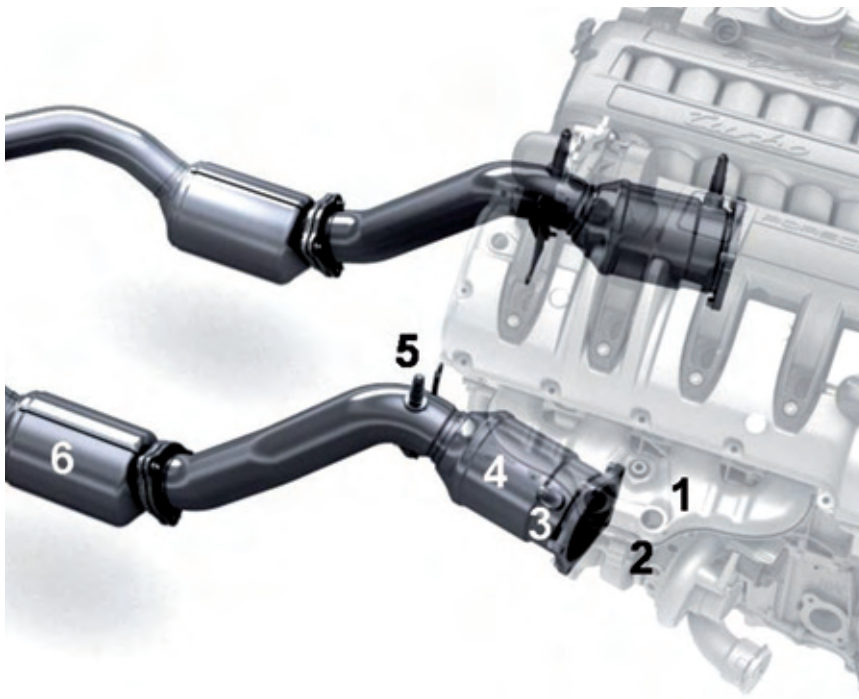
Tailpipe cover

### Exhaust manifold / Turbocharger / Catalytic converter

The exhaust manifolds of the Cayenne Turbo are air-gap insulated. The water-cooled turbochargers with wastegate valve are flanged on.

The cylinder bank-specific LSU oxygen sensors ahead of the catalytic converter and LSF oxygen sensors behind the catalytic converter signal the exhaust gas composition to the DME control unit. The DME control unit can then use this information for targeted intervention in bank-specific mixture control.

This ensures that the strictest emission standards are satisfied or exceeded.



- 1 Air-gap insulated exhaust manifold, with flanged-on turbocharger
- 2 Water-cooled turbocharger (boost pressure control with wastegate valve)
- 3 Wideband oxygen sensor LSU 4.9 ahead of catalytic converter
- 4 Primary catalytic converter (ceramic substrate)
- 5 Step oxygen sensor LSF 4.2 behind catalytic converter
- 6 Main catalytic converter (metal substrate)



## DME engine electronics 3.6 I V6 DFI engine

The main changes in the new Cayenne 3.6 I V6 DFI compared with the previous model are described on the following pages.

### Contents

- General
- DME control unit V6 DFI, Bosch MED 17.1.6
- New and modified DME components and functions
- Fuel supply, low-pressure side
- Fuel supply, high-pressure side
- Ignition system
- Intake system / Hot-film mass air flow sensor HFM 7
- Exhaust system / Emission control

### General

An enhanced V6 naturally aspirated engine with direct fuel injection (DFI) is used for the new Cayenne. Thanks to improved efficiency and the use of the latest engine technology, it was possible to significantly reduce the fuel consumption compared with the previous model and ensure that all world-wide emission standards are met.

### Development goals

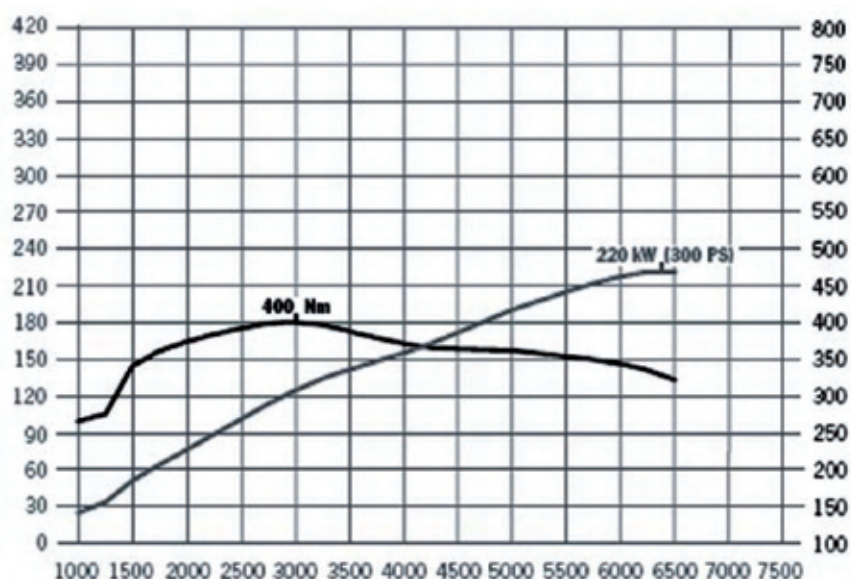
- High engine power
- High maximum torque
- Low fuel consumption
- Low emissions

### Enhancements

- Thermal management
- Auto Start Stop system (Tiptronic S)
- Variable deceleration fuel cutoff
- Vehicle electrical system recuperation
- Dethrottling of the intake system

## Engine specifications for Cayenne 3.6 I V6 DFI naturally aspirated engine (10.6° V)

|                           |                                 |
|---------------------------|---------------------------------|
| DME control unit          | Bosch MED 17.1.6                |
| Displacement              | 3.6 liters                      |
| Power                     | 300 hp/6,300 rpm                |
| Torque                    | 400 Nm/3,000 rpm                |
| Compression ratio         | 11.65 (-0.5)                    |
| Idle speed                | 650 rpm                         |
| Max. engine speed         | 6,700 rpm                       |
| VarioCam                  | Int. 52° / Exh. 32° crank angle |
| Firing order              | 1-5-3-6-2-4                     |
| CO <sub>2</sub> emissions | 236 g/km (Tiptronic S)          |



The engine is based on the 3.6 I V6 DFI naturally aspirated engine familiar from the previous model. The focus of development was not just on optimizing fuel consumption and performance, but also on detailed measures designed to enhance running smoothness and comfort during operation. In addition to the requirement of complying with all worldwide emission regulations and significantly reducing fuel consumption, the development goal for the 3.6 I engine was to increase both power output and torque. The increase in power by 10 hp to an total output of 220 kW/300 hp at 6,300 rpm and the higher maximum torque of 400 Nm (+15 Nm) at 3,000 rpm were achieved by a number of different measures.

Fuel and ignition system

2



Function descriptions for the specified DME functions can be found in the part of this section dealing with the V8 engines.

## DME control unit V6 DFI, Bosch MED 17.1.6

**The DME control unit MED 17.1.6 was adapted for the following new functions of the V6 engine:**

- Thermal management
- Auto Start Stop function (in combination with Tiptronic S)
- Variable deceleration fuel cutoff
- Vehicle electrical system recuperation
- Differential Hall sensor on the crankshaft
- Control unit for electric fuel pump

The high-performance electronic engine control unit MED 17.1.6 from Bosch is used for the 3.6 l V6 engine. This control unit has been specially designed to meet the requirements relating to direct fuel injection and VarioCam. Of particular significance here is control of the injectors, since these are the central elements of the direct fuel injection system. The engine control also controls the throttle valve position (electronic throttle) - this is a prerequisite for the Porsche Stability Management (PSM) system installed as standard.

The modern DME control unit allows sequential injection of fuel into the combustion chamber for each cylinder at precisely defined time intervals. This contributes to minimising fuel consumption and reducing emissions, even in dynamic driving operation. Each cylinder receives precisely the amount of fuel that corresponds to the engine load condition in order to realize the optimum air/fuel ratio.

The newly implemented thermal management, variable deceleration fuel cutoff and realisation of the Auto Start Stop function in combination with the new 8-speed Tiptronic S also contribute to further-enhanced efficiency.

As a result, the new Cayenne with standard manual transmission achieves a combined fuel consumption improvement of approx. 10% compared with the previous model. In combination with the optional Tiptronic S, the fuel consumption is approx. 20% lower than the previous model.



## New and modified DME components and functions

### Thermal management

The three main areas of thermal management are temperature control and heat distribution between:

- Combustion engine
- Passenger compartment and
- Tiptronic S

### Goals

- Bringing components to the optimum operating temperature quickly (reduced friction)
- Reduced engine and transmission friction through map-based control of the operating temperature
- Meeting the comfort requirements of passengers

### Function

The main parts of the coolant system that have been modified for thermal management are a water pump that can be switched off by way of a split ring slide valve, a variable-flow coolant after-run pump as well as shut-off valves in the water guide to the heating heat exchanger and to the transmission oil/water heat exchanger.

Two temperature sensors are installed in the engine cooling system to control the thermal management system, one is installed in the cylinder head at the front left in the direction of travel and the other is located in the coolant collector on the engine block.

### Auto Start Stop function

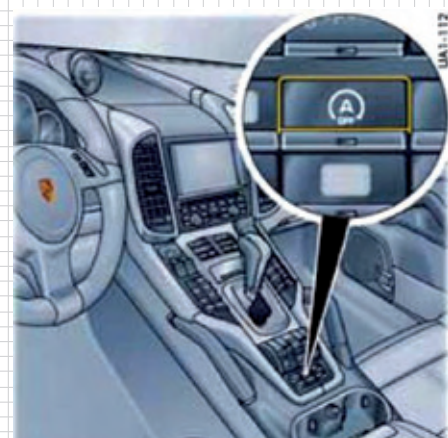
On all new Cayenne models with 8-speed Tiptronic S (optional for Cayenne), the Auto Start Stop function can be activated and deactivated by way of a button in the center console.

### Variable deceleration fuel cutoff

- Enhancement of conventional deceleration fuel cutoff
- Interruption of fuel supply in deceleration condition, e.g. when driving downhill
- After a phase with deceleration fuel cutoff, fuel injection is resumed variably depending on the driving situation, which may correspond to an even lower engine speed.

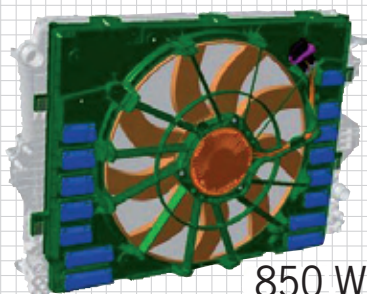


Further function descriptions for the specified DME functions can be found in the part of this section dealing with the V8 engines.





A function description is provided in the part of this section on V8 engines and in the section Electrics "Gateway".



850 W

## Vehicle electrical system recuperation in communication with gateway control unit

Among other things, this control operation includes the DME control unit, the gateway control unit, the brake pedal sensor, starter battery with battery sensor, the generator and the vehicle electrical system.

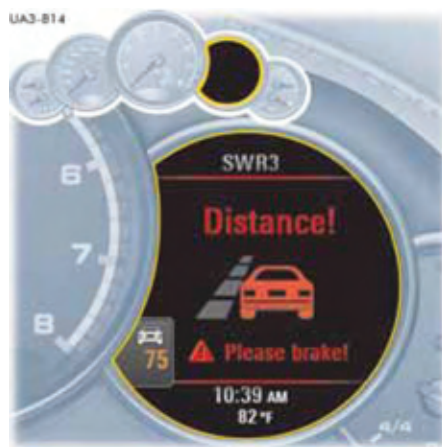
### Differential Hall sensor V6

The new Cayenne V6 also has a new differential Hall sensor for detection of the:

- engine speed
- reference mark and
- direction of rotation of the engine

**The function descriptions for the specified DME functions can be found in the part of this section dealing with the V8 engines.**

- Sport button as standard
- Off-road mode
- Control of VarioCam intake and exhaust camshaft
- 1 steplessly controlled radiator fan Cayenne V6 - MT- 0 to 600 W, AT- 0 to 850 W
- Communication with control unit of adaptive cruise control (ACC), acceleration or deceleration via electronic throttle and where appropriate braking, also to vehicle standstill



- Increase in idle speed

The idle speed can be increased when the engine is warm if a request is received from the gateway in order to increase the charging current of the generator. The field current is regulated in the gateway.

## Fuel supply, low-pressure side V6 DFI

### Fuel quality

The engines are designed for unleaded premium fuel 93 octane ( $\frac{R+M}{2}$ ). If fuel with a lower number is used, corresponding adaptation is performed by the knock control.

### Fuel tank

Cayenne V6/Cayenne S - Filling capacity 22.4 gal. (85 l), reserve 3.9 gal. (15 l)

### Function descriptions

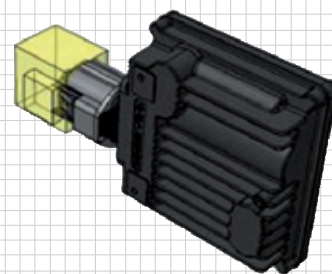
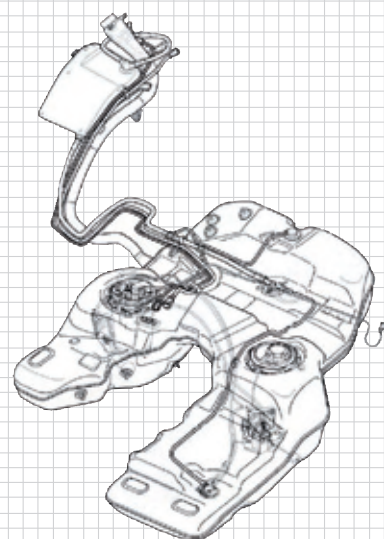
The function descriptions for following three items can be found in the part of this section dealing with the V8 engines.

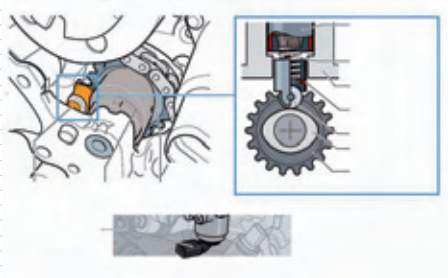
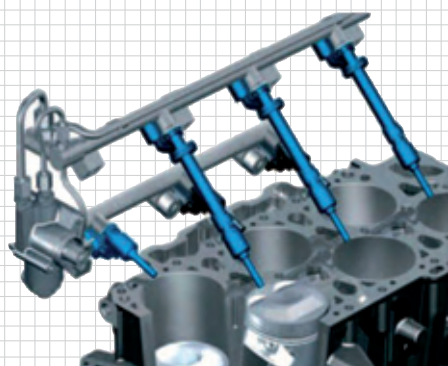
- Internal design of the fuel tank for RLFS and
- Tank ventilation and
- Control unit for electric fuel pump

### Control unit for electric fuel pump

Compared with the function described for the V8 models, the control function has the following changes:

- On the Cayenne V6 DFI the delivery rate can be reduced to such an extent that the fuel pressure falls from approx. 82 psi (5.7 bar) to 58 psi (4 bar), depending on the fuel requirement. The low pressure is detected by a pressure sensor for this. The low pressure sensor is installed on the left bulkhead in the engine compartment.
- This control function differs from the V8 engines, which have a constant fuel low pressure of approx. 82 psi (5.7 bar).





The engine-specific service intervals and heat ratings of the spark plugs are specified in the maintenance schedules.

### Fuel supply, high-pressure side V6 DFI

The fuel supply on the high-pressure side from the 1-piston high-pressure pump with quantity control valve via the fuel high-pressure rail with high-pressure sensor to the injectors corresponds to that for the previous Cayenne V6 DFI engine.

The direct fuel injection is optimally coordinated to the characteristics of the new V6 engine. The axial-piston pump is camshaft-driven with a double cam. When the engine is running, the high pressure measured by the pressure sensor is regulated to a pressure of between approx. 507 psi (35 bar) and 1522 psi (105 bar) by the quantity control valve.

In the case of direct fuel injection, the fuel is injected directly into the combustion chamber, so that the mixture formation takes place almost entirely within the combustion chamber.

The direct fuel injection system of the V6 engine is based on homogeneous operation when the engine is at operating temperature. The mixture of fuel and air is distributed as evenly as possible in the combustion chamber, thereby enabling optimal combustion. In this process, the fuel is injected directly in the combustion chamber at a pressure of up to 1522 psi (105 bar).

The injection strategies for direct fuel injection with single and multiple injection also correspond to those of the previous model.

### Ignition system V6 DFI

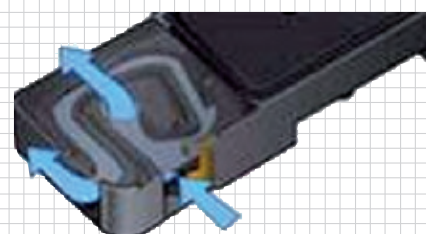
The individual ignition coils with integral driver were adopted from the previous model.

## Intake system V6 DFI

Air routing from the air cleaner to the electronic throttle was dethrottled for the new 3.6 I V6 DFI engine by use of the new mass air flow sensor HFM 7. This optimized hot-film mass air flow sensor improves the air throughput of the intake system by reducing the intake air resistance. This results in improved cylinder charging.

### Hot-film mass air flow sensor HFM 7

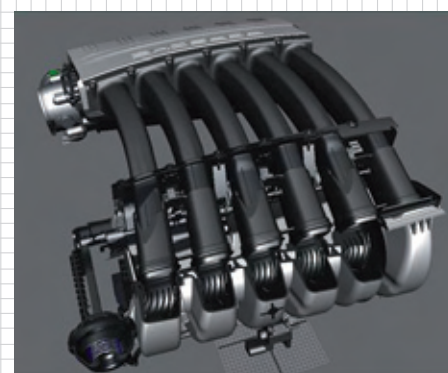
- In the measuring tube on the right next to the MAF sensor there is a special air guide element to optimize air flow.
- The flow characteristics of the bypass duct have been optimized compared to the previous HFM 5 model. The vacuum behind the deflection edge draws the partial air flow required to measure the mass air flow into the bypass duct.
- The inert dirt particles are left behind by this fast motion and are returned to the intake air via an elimination bore.
- This means that the dirt particles cannot falsify the measurement result and damage the sensor element.



### Variable intake manifold

Like in the previous model, a variable intake manifold is installed in the new Cayenne V6. The intake system with variable intake manifold combines the advantage of a long intake manifold – higher torque at low rpm – with that of a short manifold, namely high specific output in the upper rpm range. For this purpose, the resonance tube uses the air mass oscillations in the intake tract, dependent on the engine speed, to achieve better volumetric efficiency of the engine. Depending on the position of the intake manifold flap, this permits realization of a high torque curve in conjunction with the optimised intake duct geometry.

The DME control unit controls the electro-pneumatic switching valve, which switches a vacuum to the diaphragm cell in order to switch to the long intake manifold length at low engine speeds. Switching to the short intake manifold takes place as from 4,200 rpm.





Two exhaust manifolds  
Two wideband oxygen sensors  
(LSU ahead of catalytic converter)  
Two main catalytic converters  
(3-way catalytic converter,  
ceramic substrate)  
Two oxygen sensors LSF  
(behind catalytic converter)  
One center muffler  
One rear muffler  
Individual tailpipes on left and right



Tailpipe cover

## Exhaust system / Emission control V6 DFI

### Exhaust system

The exhaust system has two branches over a long distance. The exhaust gases are routed through two branches from the 2 exhaust manifolds via the 2 wideband oxygen sensors (LSU ahead of catalytic converter) to the 2 main catalytic converters. The gases then flow via the 2 LSF oxygen sensors to the center muffler and then through the rear muffler to the individual tailpipes on the left and right.



### Emission control

The exhaust system of the V6 engine was adapted in order to achieve compliance with the strict worldwide emission standards. The previous system with primary and main catalytic converters was changed to 2 close-coupled main catalytic converters. The close-coupled arrangement of the 2 main catalytic converters achieves faster heating up to the optimum operating temperature as well as a lower heat loss during start-stop phases.

The Cayenne V6 meets all globally valid emission standards without secondary-air injection: For USA - ULEV, for Europe - EURO 5.

## Auto Start Stop function

### Operating principle

The Auto Start Stop function switches off the combustion engine under defined conditions when the vehicle is stopped and therefore contributes to reducing fuel consumption when the vehicle is stationary.

The Auto Start Stop function can be manually deactivated and activated by way of the Start/Stop switch in the center console.

The Start Stop function is available only after the engine, transmission and battery have reached operating temperature.

If the vehicle is stopped by brake operation and the brake pedal is held, the Auto Start Stop function switches off the engine after approx. 1 - 2 seconds.

In Stop mode, the energy supply is provided by the vehicle battery. Energy forms that can otherwise be used only with running engine are buffered where necessary (hydraulic impulse oil storage), replaced (electric oil pump for transmission) or lead to Stop mode being terminated if power is requested (e.g. power steering). All systems remain functional, the ignition remains switched on and communication systems remain active.

Stop mode is ended by an active driver request "Restart" and may also be ended by a request from the DME control unit, e.g.:

- if the total energy requirement of the vehicle systems for the battery cannot be covered (charge condition of the battery, too many loads switched on)
- if the automatic air conditioning/heating with residual heat function cannot guarantee that the set temperature can be maintained without running the engine, e.g. at very low and very high outside temperatures

The restart must also be possible in the engine run-out phase without the starter having to be engaged (by pre-injection of the engine). Otherwise a restart must be initiated only after engine run-out.

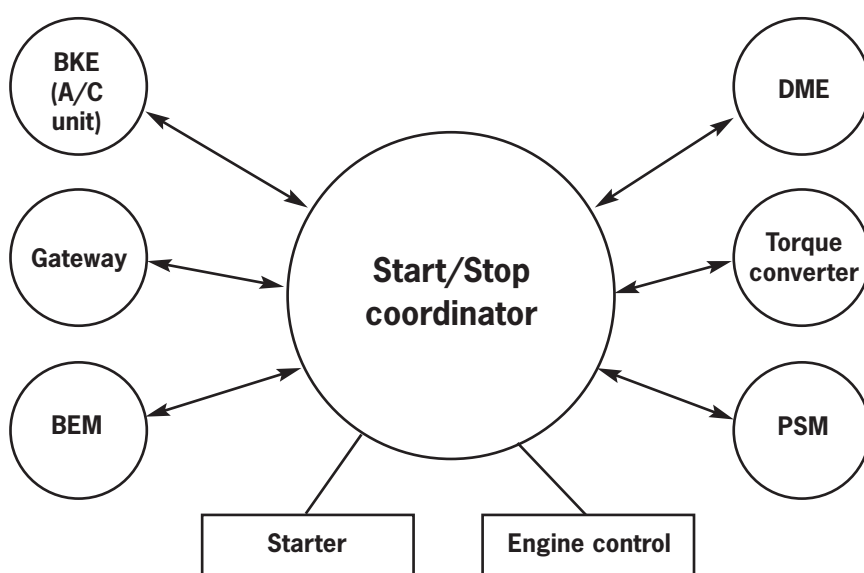
Restarting is also prevented:

- if the presence of the driver is not guaranteed, i.e. driver's door is open or driver's seat belt is not fastened,
- if the hood is open.



## Start Stop coordinator

The Start Stop coordinator processes the input data of the management functions shown in the following illustration and outputs the data for controlling the engine and starter.



### Enabling transition to Stop mode:

- Vehicle standstill with depressed brake. The selector lever must be in one of the selector lever positions D, N, P or in the manually selected driving position 1 or 2
- The driver is detected in the sense of the safety strategy, i.e. the seat belt on the driver's side is fastened, the driver's door is closed and the brake is depressed
- The hood is closed
- The engine, battery and transmission have reached operating temperature
- The vehicle has been driven for at least 1.5 seconds and at a speed of more than 1.2 mph (2 km/h) since the last automatic engine stop
- The engine stop is possible up to a downhill or uphill gradient of 10 %. During an engine stop on uphill gradients, the vehicle is held by maintaining the brake pressure (PSM)
- No Sport mode active
- ESP-OFF not active
- Auto Start Stop function is not deactivated by way of the deactivation button
- A/C max is not active
- No Defrost mode active
- Vehicle is not in Off-road mode
- Level control is not taking place
- Rear fog light is not switched on
- No trailer detected
- Manoeuvring mode not detected

**Start requests (restart):**

- Vehicle moves
- Manoeuvring mode is detected
- Selector lever R is engaged
- Activation of Sport mode
- Shift to a gear that is not permitted in Start Stop mode
- Restart in selector lever position D or N or manually selected driving position 1 or 2 by
- Releasing the footbrake or
- Pressing the accelerator
- Activation of the function ESP-OFF, A/C- Max, Defrost, Off-road mode or level adjustment
- Falling brake pressure
- Energy level falls below the maximum permitted energy that can be tapped from the vehicle battery for each engine stop

If no Stop enable signal is provided by the coordinator before a maximum time since vehicle standstill is exceeded, i.e. speed = 0 mph, Stop operation is prohibited for this standstill phase.

Unfastening the seat belt or opening of the driver's door during an engine stop prevent an automatic start until all safety conditions have been met again and the footbrake is pressed.

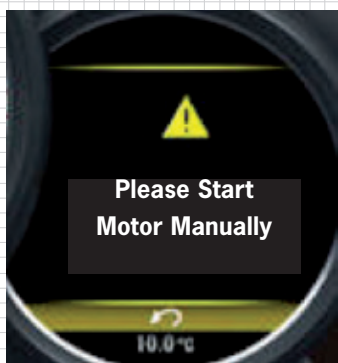
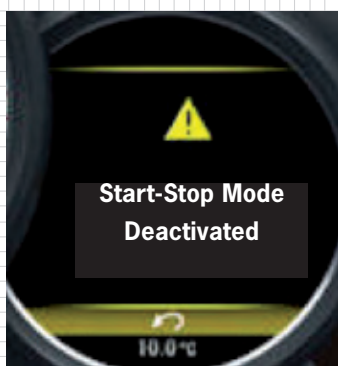
**Restricted Auto Start Stop function, e.g if**

- the battery charge is insufficient
- non vehicle-internal test processes are taking place, e.g. automatic engine diagnosis



**Note!**

Automatic engine restart is possible if one of these states occurs after the engine has been switched off automatically.



Displays:

If the engine has been switched off automatically by the Auto Start Stop function and the driver has been detected in the vehicle (safety strategy), the indicator light in the multi-function display on the instrument panel lights up green.

Start-Stop indicator on the instrument cluster:

The Stop function is displayed on the TFT display by a green pictogram which goes out after restart.

If a stop is not possible, this is indicated by a yellow Start Stop icon on the TFT display. This case applies if the Start Stop function detects that:

- at least one prerequisite for the Stop function is not met,
- or
- at least one exemption condition of the Auto Start Stop function is present.

If the Start Stop function fails, the display shows the message “Start/stop mode deactivated”. This message must be acknowledged once in each ignition cycle.

Unfastening the seat belt or opening the driver’s door with subsequent release of the brake lead to deactivation of the Auto Start Stop function since driver absence in the sense of the safety strategy is then assumed. The engine must be started manually.



## Control units involved

| Master                 | Slave & veto-authorized control units                     | Level 2                         | Level 3                        |
|------------------------|-----------------------------------------------------------|---------------------------------|--------------------------------|
| Start Stop coordinator | Gateway, PASM, BKE (A/C unit), torque converter, PSM, DME | BCM 1 (front)                   | EZS (electronic ignition lock) |
|                        |                                                           | BCM 2 (rear)                    | Slide/tilt roof/Panoramic roof |
|                        |                                                           | Battery sensor                  |                                |
|                        |                                                           | BKE (A/C unit), front           |                                |
|                        |                                                           | Level & PASM                    |                                |
|                        |                                                           | Trailer                         |                                |
|                        |                                                           | Driver's door                   |                                |
|                        |                                                           | Instrument cluster              |                                |
|                        |                                                           | PCM/CDR                         |                                |
|                        |                                                           | Auxiliary heater                |                                |
|                        |                                                           | Combined steering column module |                                |
|                        |                                                           | Airbag                          |                                |
|                        |                                                           | PLG                             |                                |
|                        |                                                           | Passenger door                  |                                |
|                        |                                                           | Driver's seat                   |                                |
|                        |                                                           | Passenger seat                  |                                |
|                        |                                                           | DC/DC converter                 |                                |

## Bus systems involved

|                         |                                                                                                                  |
|-------------------------|------------------------------------------------------------------------------------------------------------------|
| CAN Drive               | Gateway, BDE (DFI), torque converter, airbag, PSM                                                                |
| CAN Comfort             | Gateway, BCM 1 (front), BCM 2 (rear), driver's door, passenger door, trailer, PLG, driver's seat, passenger seat |
| CAN MMI                 | Gateway, instrument cluster, PCM/CDR, auxiliary heater, front operating and air-conditioning unit                |
| CAN Chassis             | Gateway, level & PASM, combined steering column module                                                           |
| LIN bus (BCM 1 (front)) | EZS (electronic ignition system)                                                                                 |
| LIN bus (BCM 2 (rear))  | Slide/tilt roof/Panoramic roof                                                                                   |
| LIN bus (gateway)       | Battery sensor                                                                                                   |

## Involved components

| Name                            | Connected control unit/<br>component | Type        |
|---------------------------------|--------------------------------------|-------------|
| Sport button                    | BKE (A/C unit), front                | Switch      |
| Start/Stop button               | BKE (A/C unit), front                | Switch      |
| Outside temperature sensor      | BKE (A/C unit), front                | Sensor      |
| Air-conditioning compressor     | BKE (A/C unit), front                | Engine      |
| PSM button                      | BKE (A/C unit), front                | Switch      |
| Defrost button                  | BKE (A/C unit), front                | Switch      |
| FSH (windscreen heating) button | BKE (A/C unit), front                | Switch      |
| Sound generator, front          | Instrument cluster                   | Loudspeaker |
| Display                         | Instrument cluster                   | Display     |
| Brake vacuum sensor             | BDE (DFI)                            | Sensor      |
| Crankshaft speed sensore        | BDE (DFI)                            | Sensor      |
| Engine compartment switch       | BCM 1 (front)                        | Switch      |
| Starter relay                   | BCM 1 (front)                        | Relay       |
| DC/DC converter                 | Starter relay                        | Converter   |
| Solenoid starter                | Starter relay                        | Switch      |
| Starter                         | Starter relay                        | Engine      |
| Electric oil pump               | Torque converter                     | Engine      |



