

## 2 Fuel and Ignition System

### General

The newly developed 4.5-liter V8 naturally aspirated and V8 turbo engines in the Cayenne were specially designed for maximum specific power, as well as high torque over a broad rev band. The engine develops its power effortlessly and loves to rev, accompanied by a typical Porsche sound. It has outstanding emissions and fuel consumption characteristics and meets all applicable exhaust emission and noise legislation world-wide. It combines great reliability with a low need for service. Control of the electronic fuel injection using Motronic control module ME 7.1.1 permits continuously variable camshaft adjustment (VarioCam) or feedback with broad-band O2 sensors.



2\_26\_03

### Development Objectives for the Cayenne

- High specific output
- Outstanding torque curve
- Reliable compliance with all legislative emissions requirements
- Low specific fuel consumption
- Porsche-specific note from the exhaust system

## Cayenne

### Table of Contents

|                                                         |    |
|---------------------------------------------------------|----|
| General                                                 | 1  |
| Motronic (DME) ME 7.1.1                                 | 3  |
| DME Power Supply                                        | 6  |
| Fuel Supply                                             | 7  |
| Ignition System                                         | 13 |
| Air Flow                                                | 18 |
| HFM 5 CL Hot-Film Mass Air-Sensor                       | 20 |
| Accelerator Pedal                                       | 22 |
| Intake Manifold                                         | 24 |
| Electrically Heated Crankcase Ventilation               | 25 |
| Fuel Tank Ventilation                                   | 27 |
| Vacuum Pump to Assist the Brake Booster (Cayenne Turbo) | 29 |
| Exhaust System                                          | 30 |
| Exhaust Emission Control                                | 33 |
| Secondary Air System                                    | 35 |
| Stereo Closed Loop Control                              | 36 |
| Exhaust Turbocharging                                   | 39 |
| Boost Pressure Control                                  | 40 |
| Electric Fans 1 and 2 for the Cooling System            | 44 |
| VarioCam                                                | 46 |

## Cayenne

### The following engineering content was implemented in the Cayenne S and the Cayenne Turbo:

- Use of Motronic 7.1.1
- Return-less fuel system
- VarioCam with continuous adjustment of the intake camshafts
- Strong visual appearance to the tail pipes
- OBD II or EOBD adapted to different legislation world-wide
- New individual coils for static high-voltage distribution (single-spark ignition module)
- Electronic throttle valve positioning (E-Gas)
- Engine drag torque control (MSR)
- Air-gap insulated exhaust system up to the primary catalytic converter
- Broad-band LSU O2 sensors ahead of the catalytic converters
- O2 sensors LSF behind the catalytic converters
- CAN networking
- Country-specific fuel tank
- Immobilizer with transponder system

### Cayenne S

- Maximum power 250 kW (340 hp) at 6000 rpm
- Maximum torque 420 Nm at 2500 – 5500 rpm
- Idle speed 580 rpm
- Engine rpm limited to 6500 rpm with Tiptronic S (6700 rpm with manual transmission) through E-Gas and fuel cutoff.
- Intake manifold with variable induction charging
- Special spark plugs

## Cayenne Turbo

- Maximum power 331 kW (450 hp) at 6000 rpm
- Maximum torque 620 Nm at 2250 – 4750 rpm
- Idle speed 580 rpm
- Engine speed limited to 6500 rpm by E-Gas and fuel cutoff
- Special platinum spark plugs with 1 ground electrode
- Exhaust gas turbocharging
- Water-cooled turbocharger
- Supplementary turbocharger oil scavenging

## 24 Motronic (DME) ME 7.1.1

Electronic control of the Cayenne engine is by handled by the Motronic ME 7.1.1  
The DME control module is located on the right side of the cowl.

The DME control module carries out the following tasks:

- Optimal fuel mixture under all operating conditions
- Reduction of fuel consumption
- Combustion control
- Monitoring and regulation of exhaust gas readings



2\_35\_03

## Cayenne



A distinction is made between Cayenne S and Cayenne Turbo when programming the control module.

The following data sets are offered:

LEV – for U.S. vehicles.

EU4 – for Europe, and RoW vehicles with comparable exhaust gas limits.

An additional data set is offered for RoW countries with less strict exhaust gas limits; a description was not finalized at the time of going to press.



You can find the description of the diagnostic possibilities in the Technical Manual or in binder DME 7.1.1.

### **The Motronic control module was adapted to the specific requirements of the V8 engine and contains the following functions or controls:**

- Static high-tension ignition distribution with individual ignition coils
- Knock control with automatic adaptation of the ignition map to fuel quality
- Newly developed software to actuate the vane-type camshaft adjuster (position control)
- Throttle valve controlled by electric motor (E-Gas)
- Engine idle speed control (via E-Gas)
- Cruise control system regulation (Tempostat standard USA)
- Engine drag torque control (MSR)
- Hot-film mass air flow sensing using 2 HFM 5 CL air flow sensors
- Sequential fuel injection
- Fuel tank leak testing with leak diagnosis pump (LDP) for U.S. vehicles
- Two-channel O2 sensor feedback for independent control of the fuel-air mixture for both cylinder banks
- On Board Diagnostics (world-wide – adapted to different legislation in Europe and the U.S.)
- Actuation of radiator fans
- Torque interface (via CAN) to Tiptronic S and PSM
- Actuation of secondary air injection

### **Cayenne Turbo Additional**

- Absolute pressure-controlled boost pressure regulation
- Actuation of the electric run-on coolant pump
- Actuation of the vacuum pump to back up the brake pressure booster

## Check-Engine Warning Light

The Check Engine warning light is used to monitor emissions (on vehicles for the U.S. it is also activated in the event of leaks in the fuel tank system). Emissions monitoring provides early detection of malfunctions, which can result in increased output of pollutants or subsequent damage to the catalytic converters. This is indicated by the Check Engine warning light and a message in the multi-function display in the instrument cluster. These malfunctions are stored in the trouble code memory of the DME control module.

As a functional check, the warning light illuminates when the ignition is switched on and goes out about 4 seconds after the engine is started.

Check Engine warning light comes on steady – emissions related error

Check Engine light flashes – error leading to catalytic converter damage



2\_19\_02

## CAN Networking of the Motronic Control Module (in CAN drive)

Electronic networking allows the exchange of data and electronic information between the control modules. Data exchange in the drivetrain takes place over the two copper wires of the high-speed CAN. This CAN data bus combines the individual control modules into a total system. The K-wire is used for diagnosis.

The DME control module corresponds with the following systems over the CAN data bus:

- ABS/PSM control module
- Steering angle sensor
- Tiptronic control module
- Airbag control module
- Air-conditioning control module
- Instrument cluster
- Rear control module (immobilizer) etc.



Additional information about networking can be found in Section 9.

## Cayenne



Additional information about the immobilizer can be found in Section 9.



Additional information on crash shut-off can be found in Section 9.

## Immobilizer

The DME control module obtains the relevant information for arming the immobilizer over the CAN from the control module for convenience systems, which is installed in the right rear.

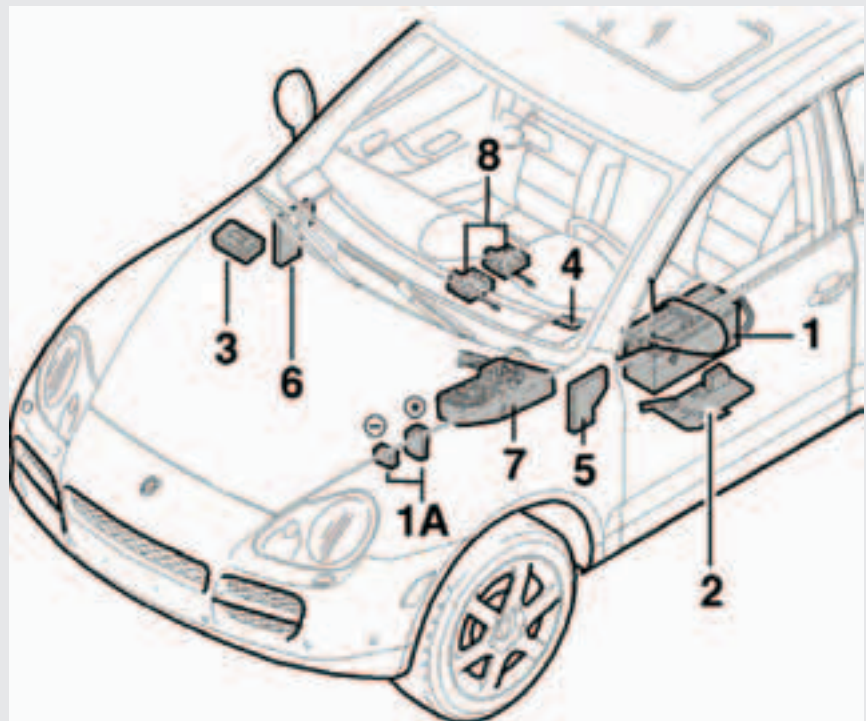
## Crash Shut-Off

Depending on the impact angle and the impact speed, the airbag control module sends a signal whereby either the fuel pump is shut off by the DME control module (re-start possible), or the cutoff relay is opened directly (re-start possible only after reactivating the relay).

## 27 DME Power Supply

### Overview of Component Locations

- 1 – Battery under the driver's seat
- 1A – Positive and negative connections in the engine compartment
- 2 – Current distributor with cut-off relay, under the driver's seat
- 3 – DME control module in the right cowl
- 4 – Diagnostic connection under the instrument panel in the left footwell
- 5 – Fuse carrier instrument panel left
- 6 – Fuse carrier instrument panel right
- 7 – E-Box in the cowl with fuse carrier, relay carrier 1, relay carrier 2
- 8 – Relay carrier 1 and 2 as needed (depending on equipment) below the instrument panel



2\_46\_03

**Safety Caution: Cut-Off Relay**

The cut-off relay separates the battery from the electrical system in the event of an accident. After it is triggered, it must be re-set manually.

**Starter**

The DME control module interrupts actuation of the starter interlock relay and thus terminal 50 actuation to the solenoid if an RPM threshold is exceeded. A possible second start is performed manually by the DME control module not automatically terminating actuation.

**20 Fuel Supply**

The use of the most up-to-date engine technology makes possible fuel consumption, which is low in relation to the performance potential and weight of the vehicle. In order not to compromise operation of the catalytic converters and O2 sensors, unleaded fuel must be used exclusively.

The engines were designed optimally for ROZ 98/MOZ 88 fuel with respect to power and fuel consumption. If ROZ 95/MOZ 85 fuel is used, ignition timing is automatically adjusted by the knock sensor.

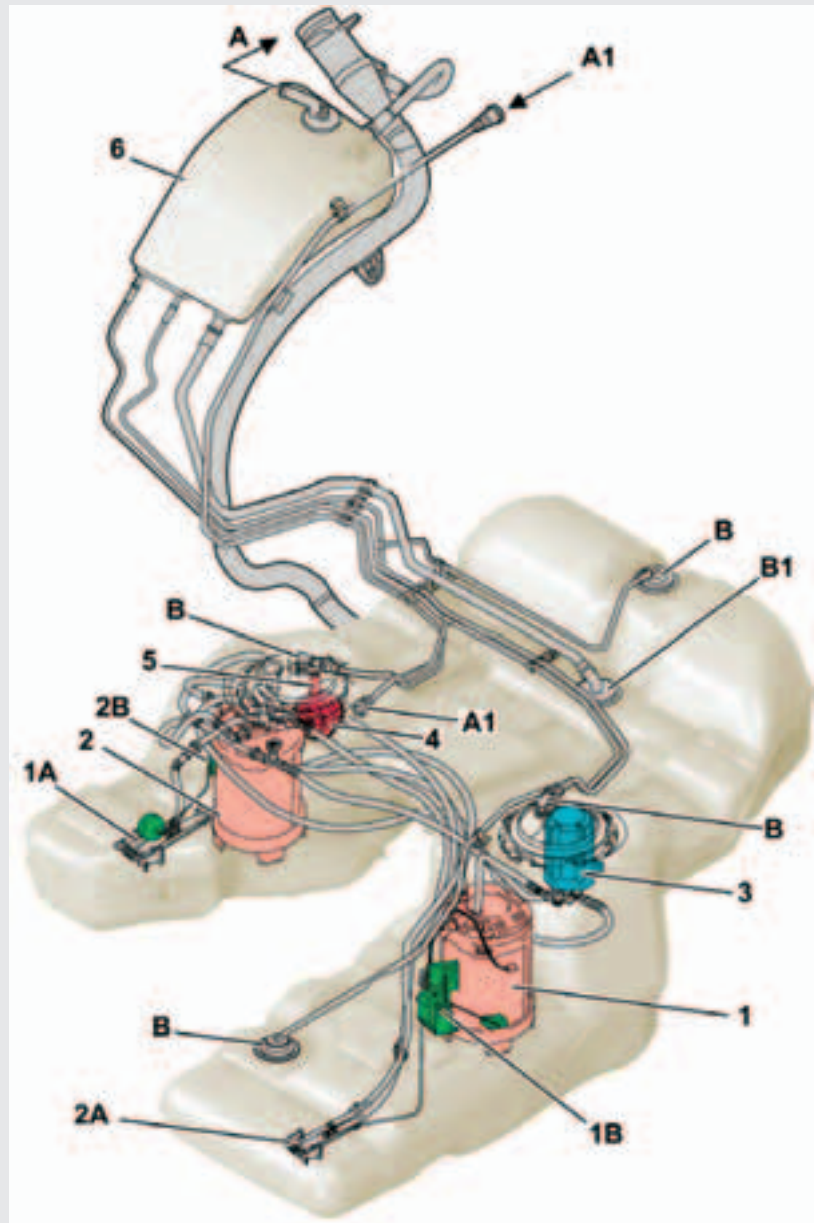
**2010 Fuel tank**

The fuel tank is located ahead of the rear axle and is additionally protected from below by high-strength plastic covers. For the Cayenne, there are three different country-specific saddle tanks (USA, RoW and countries with leaded fuel) made of high-density, multi-layer polyethylene with a capacity of approximately 100 liters (of which approximately 15 liters is reserve). There are differences in the areas of fuel tank ventilation and the diameter of the filler neck. RoW and U.S. versions have the same diameter filler neck, for countries with leaded fuel it is larger in diameter. The filler opening is located on the right side (facing forward) in the quarter panel above the rear wheel.

## Cayenne

- 1 – Left fuel pump
- 1A – Vacuum booster pump for the left fuel pump
- 1B – Left fuel tank sender
- 2 – Right fuel pump
- 2A – Vacuum booster pump for the right fuel pump
- 2B – Right fuel tank sender
- 3 – Fuel filter
- 4 – Fuel pressure regulator
- 5 – Fuel pressure line to the engine
- 6 – Percolation tank (for ventilation lines B and B1)
- A – to activated charcoal filter
- A1 – from activated charcoal filter to the fuel tank ventilation valve in the engine compartment
- B – Operating ventilation (4 with roll-over valve)
- B1 – Refueling ventilation (with fill level restriction)

## Component Location in the Fuel Tank



2\_36\_03



Absolute cleanliness is imperative when working on the fuel system or opening the fuel tank.

A returnless fuel system (**RLFS = Return Less Fuel System**) is used on the Cayenne. In this system the fuel pressure regulator as well as the fuel filter is integrated into the fuel tank. As a result, no return line from the fuel distributor in the engine compartment to the fuel is required with this system. Only the quantity of fuel injected by the fuel injectors is pumped to the fuel distributor in the engine compartment. Doing away with the return line has the benefit that no fuel heated in the engine compartment is returned to the fuel tank to increase fuel temperature there. This further reduces the formation of fuel vapor in the tank.

### **2066    Fuel Pump (Left-side and Right-Side)**

Two electric fuel pumps with integral pressure-side operated vacuum booster pumps are installed. Fuel pump 2 comes into operation depending on need and fill level of the tank.

The operating principle is the same as that of the sports cars. In each case, a two-stage full-flow pump is combined in one, with a pre-stage for charging and a main stage for pressure build-up. The vacuum booster pump for fuel pump (1) is located in the right half of the fuel tank, the one for fuel pump (2) in the left half. So fuel is picked up at four different locations in the tank. This ensures a supply of fuel even in difficult terrain. With this cross-over delivery, the tank can be drained on a level road by each pump.

When the driver's door is first opened, the signal from the door contact switch (via CAN) is additionally used to briefly activate the fuel pump. Fuel pressure is already built up before the engine is started. In the event of an accident with airbag deployment, the fuel pumps are switched off.

# Cayenne



Test procedures such as checking fuel pressure, holding pressure and flow capacity, and any required special tools are described in the Technical Manual.

## Regulation of Fuel Quantity

As a result of the on-demand regulation of fuel flow capacity, fuel heating in the tank is reduced. This is achieved by the DME control module switching on fuel pump 2 only as required, while fuel pump 1 is always activated. With the following switching criteria, fuel pump 2 is additionally switched on to increase flow capacity. At engine start and then 2 seconds run-on (with a hot start 5 seconds run-on). With a calculated fuel consumption of > 50 liters/hour the pump is switched on, and at < 45 liters/hour switched off again. With a fill level of < 10 liters in the tank, it is switched on and with > 15 liters it is switched off again.

## 2060 Fuel Filter

The fuel filter does not need to be changed. It is integrated into the left-side tank flange. The connections at the fuel filter for the left-side and right-side fuel pumps are different in diameter.

## 2458 Fuel Pressure Regulator

The pressure regulator is also built into the fuel tank below the right-side tank flange. Fuel pressure, which is present right up to the fuel injectors, is about 4.0 bar from idle to wide-open throttle. The quantity injected is thus dependent on intake manifold pressure, which is measured by the DME control module when calculating injection duration.

## 2015 Fuel Supply Sender

The information from the two senders for the fuel supply is reported to the instrument cluster to calculate the fuel supply. To prevent corrosion and poor contact, the potentiometer sliding contacts are gold-plated.

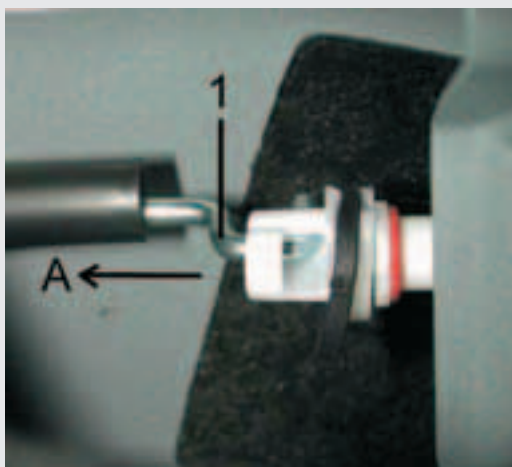
## Fuel Gage

With the ignition switched off, fuel tank contents are displayed. If the amount of fuel falls below about 15 liters, the reserve warning light is activated.

## Emergency Unlocking of the Fuel Filler Flap

If the power locking system should fail, the fuel filler flap can still be unlocked mechanically.

Open the rear hatch, remove the cover from the right-side storage bin in the baggage compartment and pull the emergency release (1) in the direction of the arrow (A), the filler flap will pop open.



2\_48\_03

1 – Emergency unlocking

A – Direction for unlocking

## 2440 Fuel injector (EV-6)

This fuel injector is characterized by small external dimensions and low weight. The risk of vapor lock with hot fuel is very low. As a result, it is well suited for use with returnless fuel systems, since fuel temperature in the fuel injector compared with systems with a return is higher.

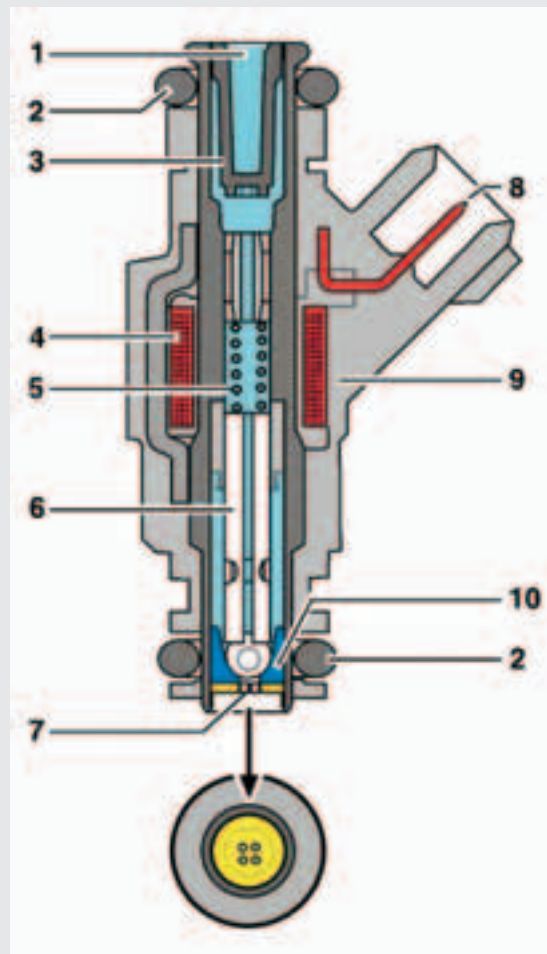
## Cayenne

Fuel is atomized with a perforated disk (4 holes). The stamped injection orifices provide great consistency in the quantity of injected fuel as well as insensitivity to fuel deposits. Good tightness in the area of the injector seat is ensured through the cone/sphere sealing.

In the Cayenne S, the fuel injectors are designed for a maximum injection volume of 210 g/min. In the Cayenne Turbo, this volume was adapted to 349 g/min because of the increased engine performance.

The DME control module activates each fuel injector sequentially. This allows injection of the fuel for each cylinder in a precisely defined time interval, even when driven in a sporting manner, which contributes to reducing fuel consumption and the emission of pollutants.

- 1 – Hydraulic connection
- 2 – Seal ring (O-rings)
- 3 – Filter screen
- 4 – Winding
- 5 – Spring
- 6 – Needle valve with solenoid armature and sealing ball
- 7 – Perforated injection disk
- 8 – Electrical connection
- 9 – Injector housing
- 10 – Injector seat



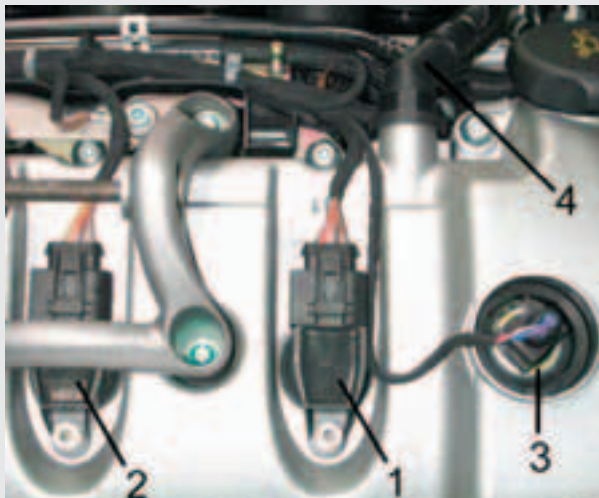
2\_01\_02

The Cayenne has static high-tension ignition distribution with individual coils, which are mounted directly to the spark plugs. The benefits of this system are:

- Highly reliable ignition
- Minimal electromagnetic interference with other electronic components
- No need for spark plug wires and distributor

### **2820 Ignition Coil**

The Motronic ME 7.1.1 assumes control of the individual coils with the firing order 1-3-7-2-6-5-4-8. Through the steps described and with the benefits of the ignition system, reliable ignition is achieved, maximizing performance and minimizing emissions and fuel consumption.



2\_49\_03

- 1 – Ignition coil cylinder 1 (Bank 1 right front)
- 2 – Ignition coil cylinder 2
- 3 – VarioCam valve bank 1
- 4 – Crankcase ventilation

With this newly developed part, all the components are installed as a complete unit in a specific ignition module housing. The housing is connected electrically and mechanically by the short high-voltage connector to the spark plug in the plug recess.

## Cayenne



The coil must not be tipped when it is removed because the coil body extends right into the plug recess.

- A – Mounting eye
- B – Connector terminal
- C – Plug recess gasket
- D – High-voltage connector to spark plug
- 1 – Power output stage
- 2 – Cooling plate for power output stage
- 3 – Electronics board with integral diagnostic function and current limiter)
- 4 – Magnetic core
- 5 – Secondary winding
- 6 – Primary winding
- 7 – Electrical resistance

There is a supplementary mechanical attachment through a threaded connector. The ignition coil is sealed at the 4-pin connector as well as in the plug recess against water.

Ignition coil pin-out.

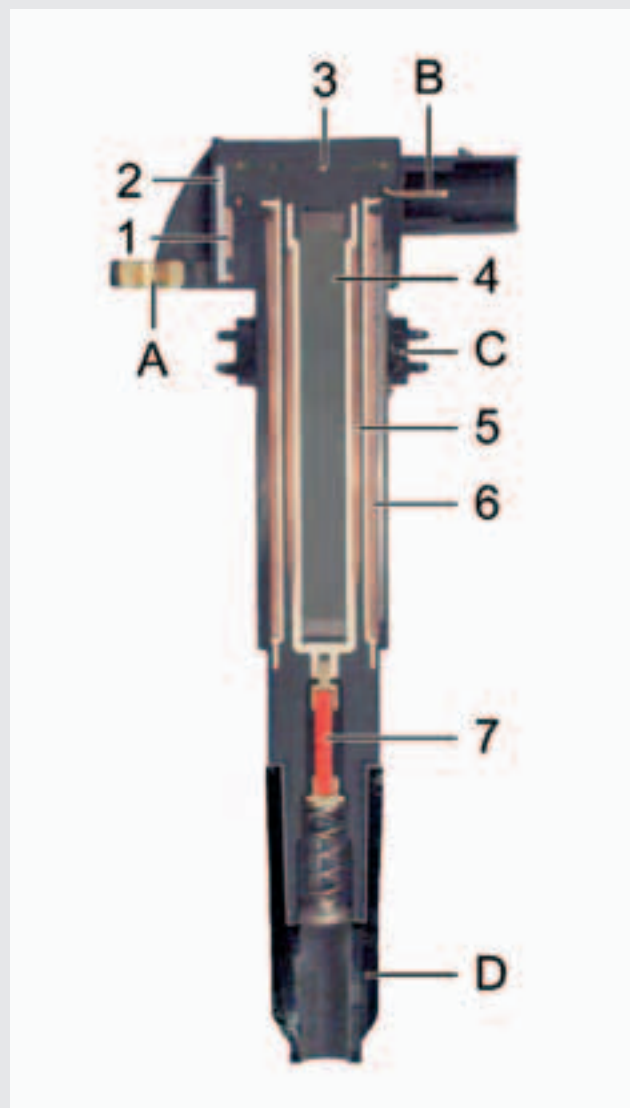
Pin 1 – Body ground

Pin 2 – Engine ground

Pin 3 – B+ terminal 15

Pin 4 – Ignition signal (trigger input)

### Ignition Coil Construction



2\_16\_03

## Operation of Electrical Components in the Ignition Coil

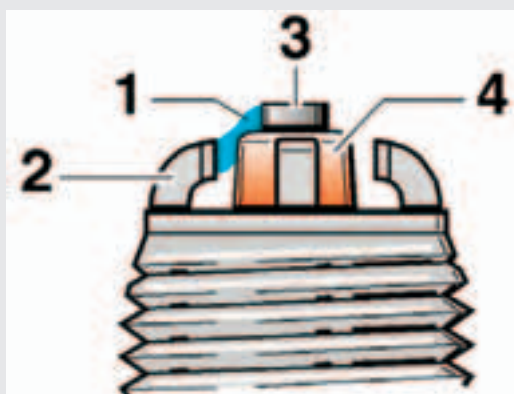
The ignition coil ensures optimal combustion of the air-fuel mixture in the engine combustion chamber. If the coil is triggered for an excessive time, the primary current in the coil is driven down, so that spark-free engine shut-down is ensured.

Diagnostic functions are also integrated. When an error is detected, pin 4 (trigger input) is switched to high impedance. This is detected in turn by the DME and the error is entered in the trouble code memory.

## 2870 Cayenne S Spark Plugs

With these glide spark plugs the 4 ground electrodes are located to the side of the ceramic insulator. As a result, the sparks (1) always glide over the surface of the insulator (4) and jump through a small gas path to the ground electrode (2), producing better ignition properties. The primary benefit of the glide spark plug lies in the self-cleaning effect of the insulator tip since any shunts occurring between the center electrode and ground electrode are eliminated through the sliding sparks, particularly during cold starts. These spark plugs make possible a change interval of 90,000 km or 4 years in the Cayenne S.

### Construction of the Cayenne S Glide Spark Plug



2\_05\_02

- 1 – Glide spark path
- 2 – Ground electrode
- 3 – Center electrode
- 4 – Insulator

## Cayenne



2\_20\_03

### 2870 Cayenne Turbo Spark Plugs

Special platinum spark plugs with one ground electrode are used in the Cayenne Turbo, allowing a change interval of 60,000 km or 4 years. Through the use of a very thin center electrode, voltage requirements are correspondingly reduced, to ensure adequate voltage reserves for the ignition system over its entire service life. The use of glide spark plugs is not possible especially with turbocharged engines, since ceramic nicks can be caused on the insulator tip by higher combustion pressures, which in turn can result in reduced change intervals or premature failure of the spark plug.

### 2873 Engine Speed Sensor

The engine speed sensor at the crankshaft registers engine RPM and the current position of the crankshaft by means of the 60 minus 2 notches (reference mark) on the crankshaft shield and transmits the reading to the DME control module.

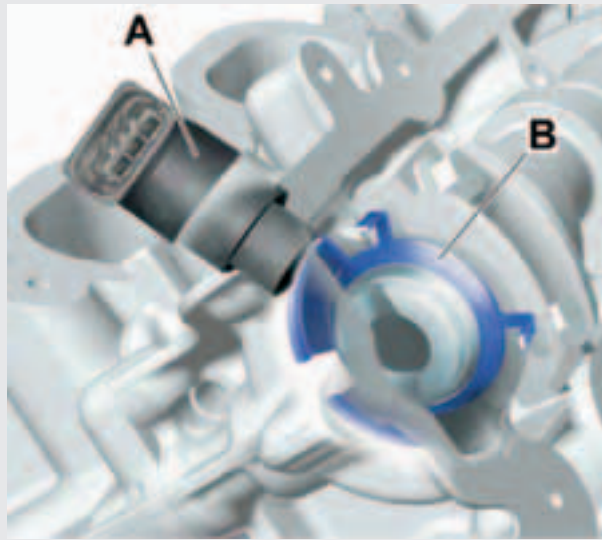


2\_50\_03

A modified rotor is mounted on the intake camshafts for both banks of cylinders. Based on the rotor position, the Hall sensor determines the current position of the intake camshaft 4 times per camshaft revolution and passes this value on to the control module. Thus the exact position of both intake camshafts is determined, which is the precondition for continuous camshaft adjustment.



Using the Porsche System Tester 2 in the "Actual Values" function the deviation, the required angle and the actual angle of the intake camshafts can be read.



2\_17\_03

A – Hall sensor

B – Camshaft rotor

## 2872 Knock Sensor Bank 1 and 2

The knock sensors are mounted on the crankcase below the intake manifold. They detect the structural acoustic oscillations of the crankcase. The mechanical vibrations are transmitted with the help of the piezoelectric effect as electrical voltage signals to the DME control module. If the DME control module detects "knock," the ignition timing at the cylinder in question (cylinder-selective) is retarded. Retardation takes place in steps of 3° CA (crankshaft angle) and can be advanced again in stages of 0.75°, which takes place within 10 to 20 seconds. Maximum retardation of ignition timing is 18° of crankshaft angle up to 1600 RPM, over 1600 RPM 15°.

## Cayenne

If a knock sensor, Hall sensor or engine speed sensor fails, adjustment goes to retarded for safety. In this case, ignition timing up to 4400 RPM is reduced by 15° of crankshaft angle. Above 4400 RPM up to 6000 RPM retardation is reduced to 12° of crankshaft angle.

- 1 – Knock sensor Bank 1
- 2 – Knock sensor Bank 2
- A – Starter



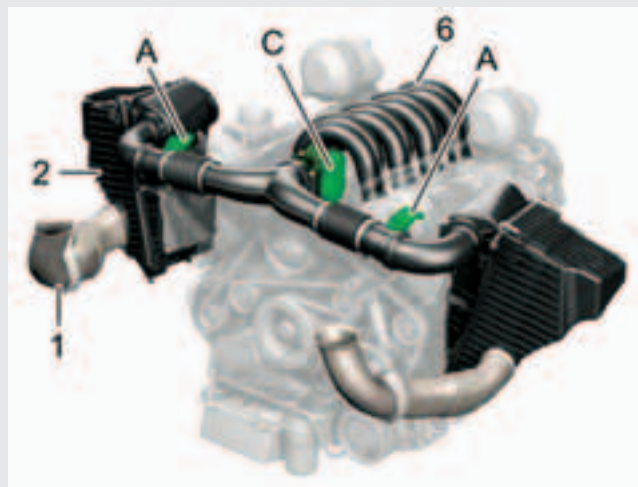
2\_44\_03

## 24 Air Flow

### Cayenne S

Air flow from the air duct (intake pipe) behind the front end, through an air filter on the left and right to the two mass air sensors. Then the intake air flows together ahead of the throttle valve control unit (E-Gas) and is delivered to the engine through the intake manifold.

- 1 – Air duct (intake pipe)
- 2 – Air filter housing with filter insert
- 6 – Composite intake manifold
- A – Hot-film mass air flow sensor
- C – Throttle valve control unit (E-Gas)



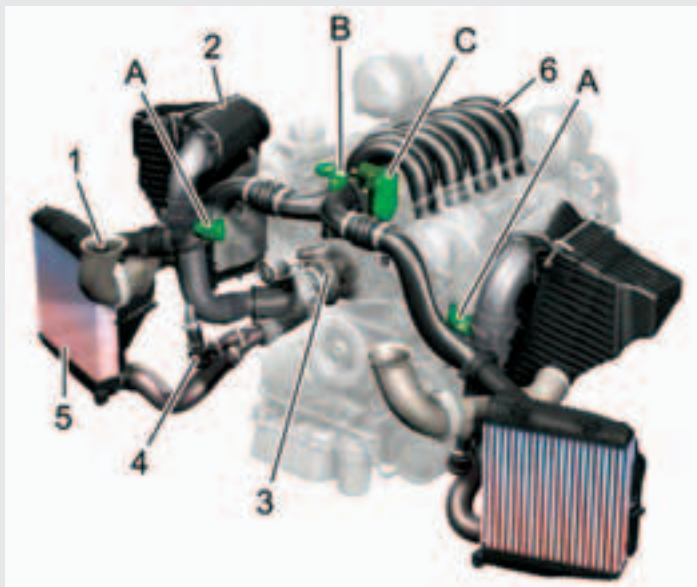
2\_18\_03

The two air filter elements for the Cayenne S and Cayenne Turbo must be changed every 120,000 km or 4 years.

In dusty areas, the air filter elements should be cleaned more frequently and replaced if necessary.

## 24 Air Flow Cayenne Turbo

Air flows from the air duct (intake pipe) behind the front end, through an air filter on the left and right to the two mass air sensors. Then the intake air is delivered to the compressors of the two turbochargers. Then the compressed and heated charge air is re-cooled by means of a charge intercooler located in each of the wheel housings. Boost pressure and charge air temperature at which the intake air is being taken to the engine is registered in the combined airflow ahead of the throttle valve control unit. Cooling the compressed charge air achieves good cylinder filling and low component temperatures. You can find a description of boost pressure control in the Turbocharger section.



2\_19\_03



Fording depth is 500 mm. It means that when driving through water, a water depth of 500 mm must not be exceeded, otherwise there is a risk of damaging the engine and the accessories due to induction or entry of water.

- 1 – Air duct (intake pipe)
- 2 – Air filter housing with filter insert
- 3 – Exhaust turbocharger
- 4 – Deceleration air recirculation valve
- 5 – Charge air intercooler
- 6 – Composite intake manifold
- A – Hot-film mass air flow sensor
- B – Charge air/intake air temperature sensor
- C – Throttle valve control unit (E-Gas)

## Cayenne

### 2445 HFM 5 CL Hot-Film Mass Air Sensor

The venturi mass air sensors on the left and right are supplied as a replacement part with the measuring venturi. The mass air sensor must not be removed from the measuring venturi, since these parts were matched on a flow bench. The diameters of the measuring venturis are different based on the different air throughput between Cayenne S (low) and Cayenne Turbo (high). On the Cayenne S the signal from the intake air temperature sensor is sent to the DME control module by a mass air sensor.

On the Cayenne Turbo the mass air sensors and measuring venturis are matched to the high air throughput. Air temperature is registered by the boost pressure- charge air sensor, which is mounted ahead of the throttle valve. The values measured are made available to the DME control module.

#### Venturi Mass Air Sensor



2\_22\_03

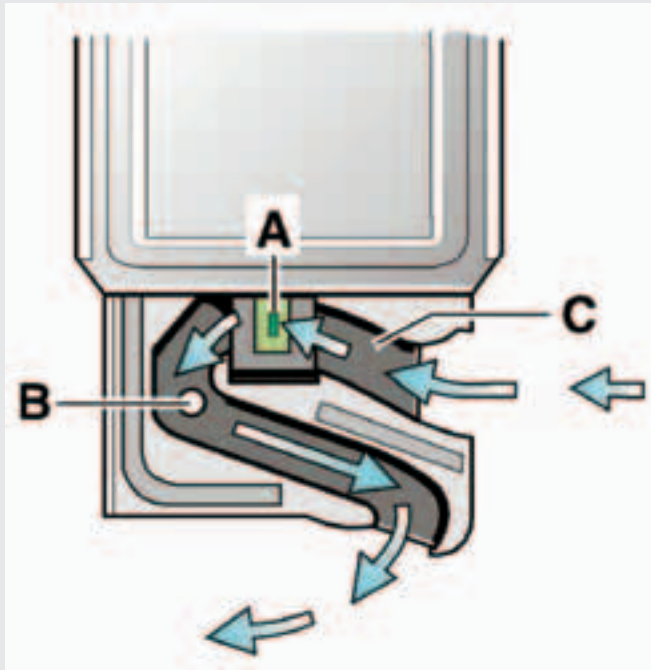
S – Cayenne S (small diameter)

T – Cayenne Turbo (large diameter)



2\_21\_03

As a result of the C-shaped air duct, these mass air sensors are less sensitive to dirt particles and water drops, since they reach the sensor element only after a reversal of the air stream. A transverse hole through the air passage serves to reduce pulsation errors. A transverse hole through the air passage serves to reduce pulsation errors.



A – Sensor element

B – Cross drilling

C – C-shaped air passage

2\_13\_02

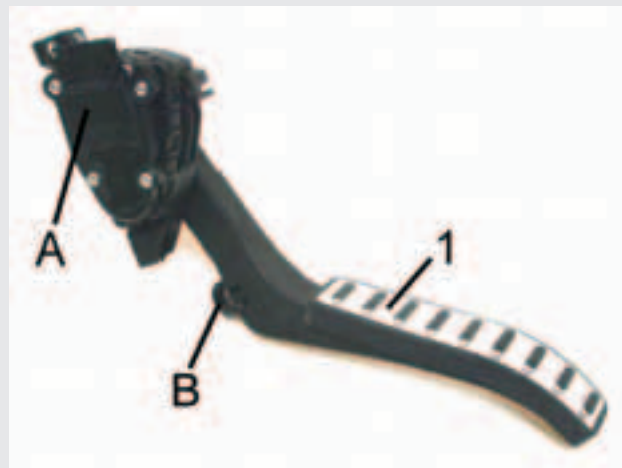
To calculate the total air mass, which serves as the primary load signal, the air mass from the left and right mass air sensors are added together in the control module. Should one or both mass air sensors fail (for example, as the result of an open or short circuit), or if the total air mass (sum of the two mass air sensors) deviates from a tolerance range calculated in the control module, an error is stored and a substitute value is created from throttle valve angle and engine speed.

## Cayenne

### 2080 Accelerator Pedal

With the newly developed accelerator pedal in the Cayenne, the accelerator position sensor is integrated into the control module. Thus no throttle cable is required. The characteristic curves of the two integral potentiometers are comparable with those of the ME 7.2 systems and act as an input signal (driver request) to calculate the torque-oriented operational construct, which triggers the throttle valve control unit accordingly.

- 1 – Accelerator pedal
- A – Pedal potentiometer
- B – Spring-pressure unit



2\_23\_03

- A1 – Potentiometer 1 and 2  
(must not be opened)
- A2 – Sliding contacts for  
potentiometer 1 and 2
- B – Spring-pressure unit



2\_24\_03

On vehicles with Tiptronic, Kickdown is recognized electrically by way of the characteristic curve of the potentiometers. A spring-pressure unit is installed for driver feedback.

### Learning Kickdown Adaptation

In order to achieve reliable conformance between electrical recognition of Kickdown and the increase in power when the pedal is operated, adaptation must be carried out. The result of this adaptation is stored in the EEPROM of the DME control module and as a result it is retained even after disconnecting the battery terminals.

### 2442 Throttle Valve Control Unit (E-Gas)

The range of operation of E-Gas corresponds basically to the operation described for vehicles with Motronic ME 7.2 and ME 7.8. In the case of the electronic throttle valve control unit (E-Gas), the throttle valve is adjusted by an electric motor over a two-stage gear. Thus electronic control of the air inducted by the engine is possible over the entire load range.

Operating characteristics (relationship between engine torque and accelerator pedal position) are clearly established with E-Gas, which offers the following benefits:

- Increased driver comfort
- Engine speed can be better controlled and limited
- Reduction of engine emissions
- Improved cruise control operation
- Improved shift comfort with Tiptronic S
- Assistance for the suspension control systems (e.g. PSM, MSR)
- Engine protection in the event of failures in the area of boost pressure control (Cayenne Turbo)



Kickdown adaptation is necessary under the following circumstances:

- Initial vehicle start-up at the end of the line
- Service replacement of the engine control module (ECM)
- Service replacement of accelerator pedal module (part with different tolerances)

Kickdown adaptation can be performed as a short test using the Porsche System 2 Tester.

## Cayenne



### Throttle valve control unit (E-Gas)

adaptation must be performed under the following circumstances:

- Following a reset (e.g. disconnecting the battery terminals)
- If the connectors at the DME control module were separated
- Following replacement of the throttle valve control unit (or disconnecting the connectors)

As the result of active intervention by the throttle valve control unit (E-Gas), the following functions are made possible:

- On deceleration, with unacceptably high slip and when downshifting, engine drag torque control (MSR) prevents all the drive wheels from locking on a slippery road by slightly opening the throttle valve.
- If braking functions are not sufficient to stabilize the vehicle when PSM is activated, E-Gas intervenes in engine control. A change in engine torque is initiated by changing the ignition timing and intervening in throttle valve adjustment.

To perform adaptation, switch on the ignition for 1 minute (do not start the engine and do not operate the accelerator pedal), then switch off the ignition for at least 10 minutes. The throttle valve stop (close) is re-adapted.

### Cruise Control (standard USA)

The Motronic control module implements this function by positioning the throttle valve control unit (E-Gas) accordingly. Cruise control is operated through the lower left lever on the steering column to select a speed between about 40 and 210 km/h.

### 2447 Intake Manifold

The principle of pulse manifold charging was followed when designing the intake manifold. Through proper layout of the intake runner lengths and intake runner diameters, in conjunction with optimized intake port geometry as well as continuous adjustment of the intake camshafts, it was possible to achieve a generous torque curve.

The benefits of the plastic intake manifold, manufactured in several steps (multi-process technology) are:

- Minimization of pressure losses
- Equal intake runner length
- High component rigidity with low weight

This manufacturing process brings benefits in pulse tuning and acoustics resulting from component rigidity. In addition, the optimal surface finish inside the intake manifold lowers pressure losses and improves torque.



2\_25\_03

- 1 – Composite intake manifold
- 2 – Vacuum reservoir (at the rear integrated in the intake manifold)
- 3 – Throttle valve control unit (E-Gas)
- 4 – Heating element for crankcase ventilation
- 5 – Connection for measuring fuel pressure
- 6 – Fuel injector

A two-piece vacuum reservoir (which has a pre-stage with a calibration drilling as a buffer) is integrated in the rear section of the intake manifold. It is needed in the Turbo to activate the overrun recirculation air valves and in all U.S. vehicles to activate the leak diagnosis pump.

### Electrically Heated Crankcase Ventilation

The crankcase ventilation on the Cayenne engines has an electric heating element which prevents icing of condensate in this area. This heating element is integrated in the connecting pipes for the crankcase ventilation. The connecting pipe is installed behind the throttle valve control unit.

## Cayenne

- 1 – Connector for electric heating
- A – From engine ventilation (bank 2 left)
- B – From fuel tank ventilation valve
- C – Connection to composite intake manifold



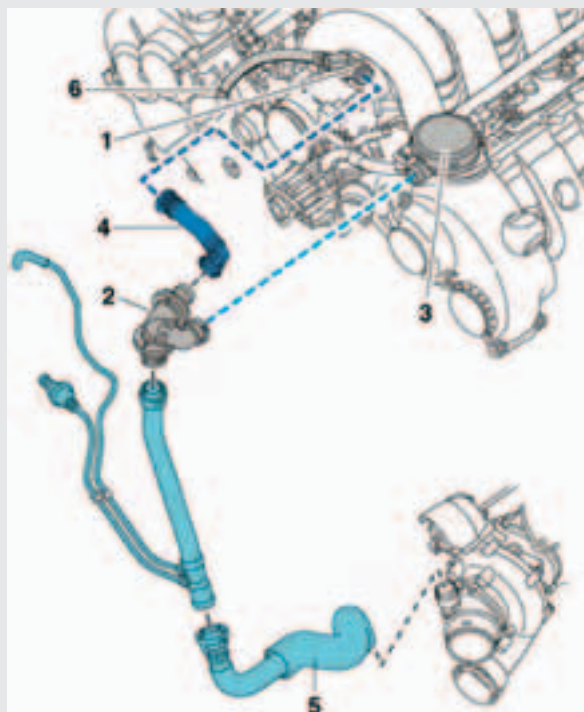
2\_41\_03

Fuel tank ventilation, as well the ventilation system for the turbocharger oil catch tank on the Turbo is taken to the intake system via the connecting pipe for the heated crankcase ventilation.

Through the arrangement of the non-return valves, the airflow on the Cayenne Turbo reaches the intake manifold at idle and under boost pressure it reaches the intake side of the left turbocharger.

### Cayenne Turbo Crankcase Ventilation

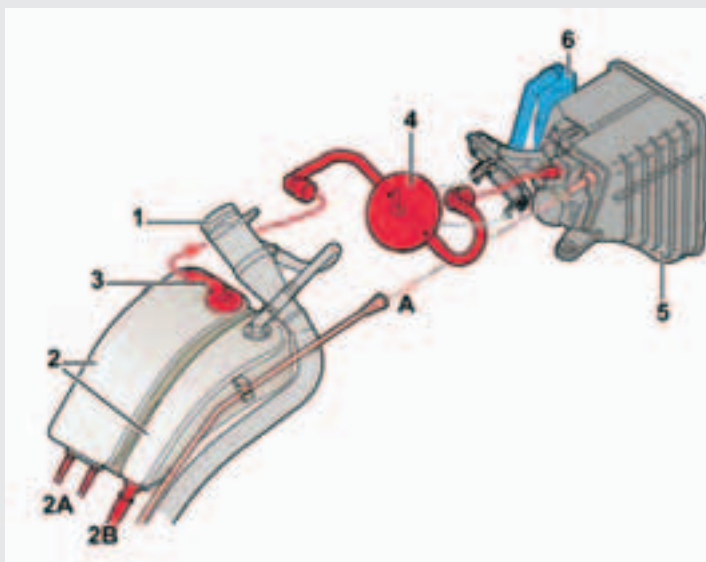
- 1 – Heating element for crankcase ventilation
- 2 – Non-return valves intake side/pressure side
- 3 – Oil vapor separator
- 4 – Tube to intake manifold
- 5 – Hose to intake side of the left turbocharger
- 6 – Connection for fuel tank ventilation



2\_11\_03

**RoW Vehicles**

The fuel vapors accumulated in the activated charcoal filter are taken to the engine when the vehicle is running (the activated charcoal filter is purged) by activating (cycling) the fuel tank ventilation valve. The ventilation valve is next to the throttle valve control unit. Metering the quantity of fuel vapor is carried out through the DME control module depending on air mass throughput and the loading of the charcoal filter.



2\_47\_03

- 1 – Filler neck
- 2 – Percolation tank (RoW two-piece)
- 2A – Fuel tank operating ventilation
- 2B – Refueling ventilation
- 3 – Connection to activated charcoal filter
- 4 – Pressure holding valve
- 5 – Activated charcoal filter (RoW version)
- 6 – Water separator with fresh air induction
- A – to fuel tank ventilation valve (in engine compartment)

**ORVR Vehicles (USA)**

Fuel tank ventilation itself is identical to the RoW vehicles.

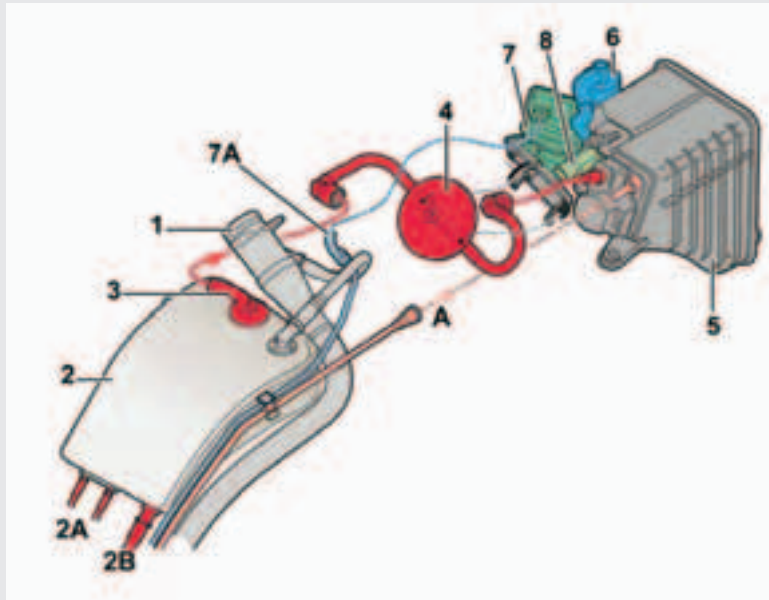
A leak diagnosis pump and a shut-off valve are additionally installed in vehicles for the U.S.

As a result of the legal provisions in the U.S. (component ORVR and OBD II), different activated charcoal filters are used for the models sold there.

The ORVR system (**O**n-Board **R**efueling **V**apor **R**ecovery) ensures that the resulting HC vapors are directed into the activated charcoal filter during refueling and do not escape into the atmosphere.

## Cayenne

- 1 – Filler neck
- 2 – Percolation tank (ORVR one-piece)
- 2A – Fuel tank operating ventilation
- 2B – Refueling ventilation
- 3 – Connection to activated charcoal filter
- 4 – Pressure holding valve
- 5 – Activated charcoal filter (ORVR with flange for leak diagnosis pump)
- 6 – Water separator with filter element and fresh air induction
- 7 – Leak diagnosis pump
- 7A – Vacuum line from intake manifold to leak diagnosis
- 8 – Shut-off valve
- A – to fuel tank ventilation valve (in engine compartment)



2\_37\_03

### 2048 Leak Diagnosis Pump (USA)

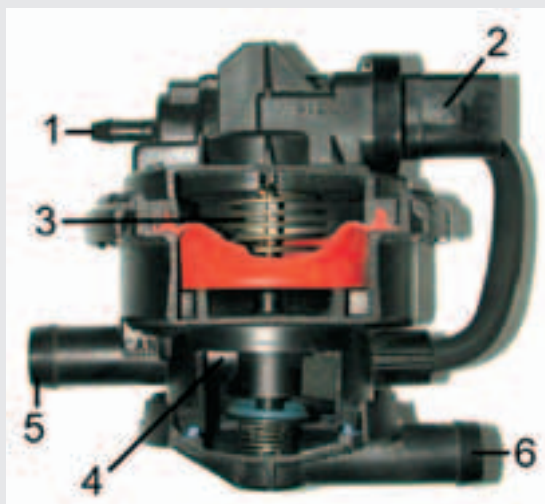
The leak diagnosis pump consists of a diaphragm pump and an electrical frequency valve. Intake manifold vacuum from the vacuum reservoir integrated at the rear in the intake manifold reaches the vacuum side of the diaphragm pump through the electrically cycled valve, and positive pressure in the millibar range is created. Depending on how quickly this positive pressure is built up, and the fuel tank provides counter-pressure, a reed switch on the diaphragm provides feedback to the DME. By evaluating the time differentials and pump strokes, the integrity of the fuel system or the size of the leak is recognized. Leakages less than 0.5 mm in diameter are recognized as a minor leak and displayed through the "Check Engine" light after the leak is confirmed. Larger leakages, as well as an open fuel filler cap, are diagnosed as a gross leak.



Testing for extreme small leaks (> 0.5 mm) takes place less often due to system restrictions and can be performed using a short test.

Following a lengthy shut-down phase (so that fuel temperature is as low as possible) the diagnostic sequence is started under constant driving conditions (e.g. interstate highway driving). Leak diagnosis can be performed once or twice each day during operation if conditions are met (differential of starting temperature to engine shut-down temperature > 42 °C).

### Cross Section Leak Diagnosis Pump



2\_42\_03

- 1 – Vacuum connection (from vacuum reservoir in intake manifold)
- 2 – Electric frequency valve for the diaphragm pump
- 3 – Vacuum side of the diaphragm pump
- 4 – Pressure side of the diaphragm pump
- 5 – Connecting pipe to the activated filter charcoal filter (pressure side)
- 6 – Connecting pipe to the water separator/filter element

### 2071 Shut-Off Valve

The shut-off valve sits in a by-pass to the leak diagnosis pump and voltage is only applied during diagnosis, closing the by-pass. At the conclusion of diagnosis, the valve is opened again to dissipate the positive pressure built up in the fuel tank.

### Vacuum Pump to Assist the Brake Booster (Cayenne Turbo)

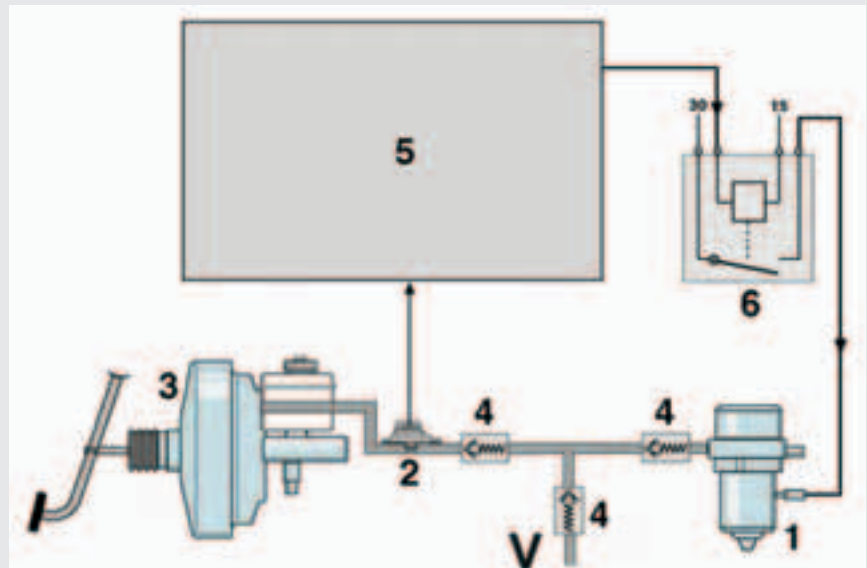
On the Cayenne Turbo an electric vacuum pump is installed to improve brake boost. It is located in the engine compartment on the right strut tower under the styled cover. Under engine operating conditions with reduced vacuum supply (e.g. catalytic converter heating following a cold start, parking maneuvers, driving at high altitudes), the vacuum pump is activated by the DME control module.

## Cayenne



A quick test to diagnose the pump and the pressure sensor can be carried out using the Porsche System Tester 2.

- 1 – Electric vacuum pump
- 2 – Pressure sensor
- 3 – Vacuum brake booster
- 4 – Non-return valves
- 5 – DME control module
- 6 – Relay
- V – Vacuum to engine



4\_47\_03

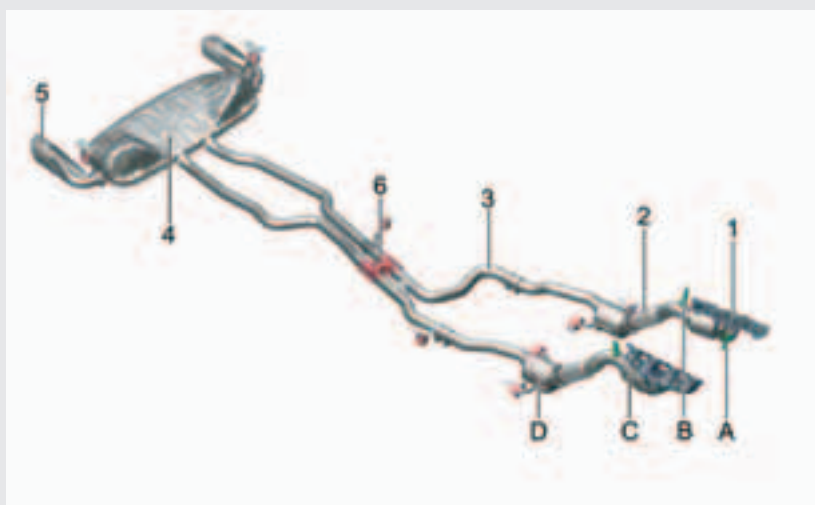
## 26 Exhaust System

The Cayenne S and Cayenne Turbo underscore the engine note through a typical Porsche load-dependent exhaust note, which was tuned through the rear mufflers and tail pipes and satisfies all applicable legal requirements. To achieve long life and long-term attractive appearance, the entire exhaust system is made of stainless steel, which has particularly good corrosion resistance. The exhaust system consists of two exhaust tracts. Exhaust gases are taken through air-gap insulated exhaust headers with the shortest possible pipe length to the preliminary catalytic converters. The short pipe lengths not only speed up heating of the catalytic converters, but also reduce energy losses in the exhaust gases.

By arranging the multi-layer decoupling elements between the pre-catalytic converters attached to the engine and the main catalytic converters attached to the body, the transmission of engine vibration to the body was effectively eliminated. The left and right exhaust tracts come together again in the rear muffler.

## Cayenne S Exhaust System

By means of a cross-connection (cross-over point only on Cayenne S), that is, a pipe which connects both exhaust tracts, the two exhaust tracts, or the oscillating exhaust gas columns, are linked together after the primary catalytic converters. This positively influences the torque curve in the lower RPM range.



2\_27\_03



2\_29\_03

The rear muffler in the Cayenne S has individual tail pipe tips on the left and right.

- 1 – Exhaust header
- 2 – Decoupling element
- 3 – Exhaust pipe
- 4 – Rear muffler
- 5 – Tail pipe enclosure
- 6 – Cross connection  
(cross-over, only Cayenne S)
- A – LSU O2 sensor  
(ahead of catalytic converter)
- B – LSF O2 sensor  
(after the catalytic converter)
- C – Preliminary catalytic converter
- D – Main catalytic converter

## Cayenne

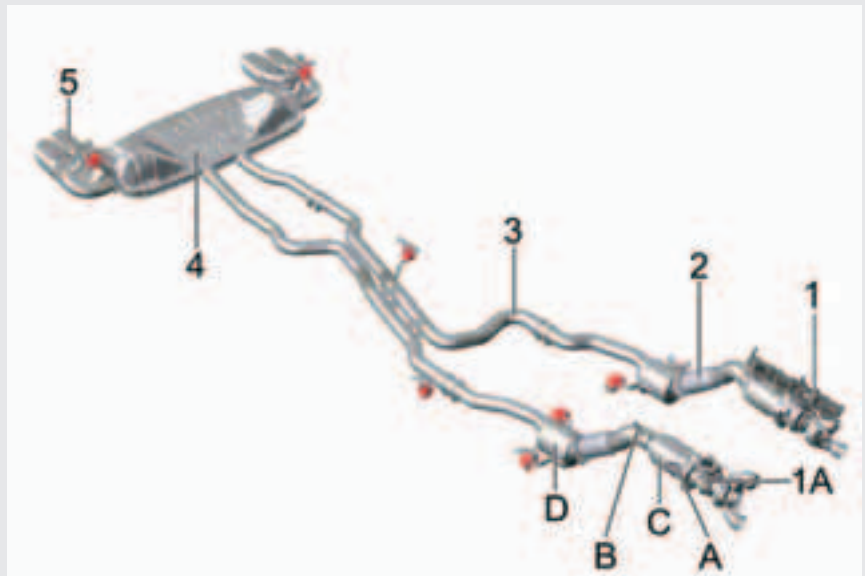
### Cayenne Turbo Exhaust System

The exhaust system on the Cayenne Turbo was matched to the increased requirements and different exhaust gas velocities and exhaust gas pulsations through exhaust pipes with a larger cross section.

As a result of the smoothing of the exhaust gas pulsations in the turbochargers, the demands on the rear muffler are different than with the Cayenne S. An optimal exhaust note is achieved through specific damping and pipe routing inside the rear muffler together with the tail pipes.

Differing from the Cayenne S, the exhaust pipes for the Cayenne Turbo do not have a cross-over point.

- 1 – Exhaust header
- 1A – Exhaust turbocharger
- 2 – Decoupling element
- 3 – Exhaust pipe
- 4 – Rear muffler
- 5 – Tail pipe enclosure
- A – LSU O2 sensor ahead of converter
- B – LSF O2 sensor after the converter
- C – Preliminary catalytic converter
- D – Main catalytic converter



2\_28\_03

The rear muffler on the Cayenne Turbo is also installed as a visible design element. Exhaust gases leave the Cayenne Turbo through two tail pipe tips on the outer left and right, whose design differs from the Cayenne S.



2\_30\_03

**Exhaust Treatment**

Contributing factors to the excellent emissions numbers for the Cayenne include the modern control concept of the DME, the On-Board Diagnostic System (OBD II and EOBD) as well as the exhaust system with metallic catalytic converters and two-channel O2 sensor feed back. Monitoring of exhaust gases and functional monitoring of the catalytic converters is handled by two O2 sensors per cylinder bank. They provide the information to the DME control module for regulating exhaust gas figures. The lowest possible emission of pollutants is achieved through this two-channel O2 sensor feedback. To reduce pollutants during warm-up, the catalytic converters are heated up rapidly as the result of measures in the engine management system, such as, retarded ignition and injection of secondary air in the exhaust tract for afterburning. The associated reduction in torque is compensated for by the corresponding opening of the throttle valve control unit.

**Emissions Standard**

In Europe the Cayenne S and Cayenne Turbo are classified as Stage 4 (EU4) and in the U.S. as an LEV I (Low Emissions Vehicle). Both Cayenne engines are substantially below the threshold values of the EU4 guideline, which goes into effect in 2005 as well as all other applicable legislative directives.

EU4 – Europe: These vehicles meet EOBD (European On Board Diagnosis) and have four O2 sensors (the O2 sensors downstream of the catalytic converter run the control system), 3-way catalytic converter systems with two preliminary and two primary catalytic converters, as well a secondary air system for each cylinder bank.

LEV I – USA: Unlike EU4 these vehicles satisfy OBD II (On Board Diagnostics II) and ORVR (on-board recovery of vapors during refueling)

**2673/2676 Preliminary and Primary Catalytic Converters**

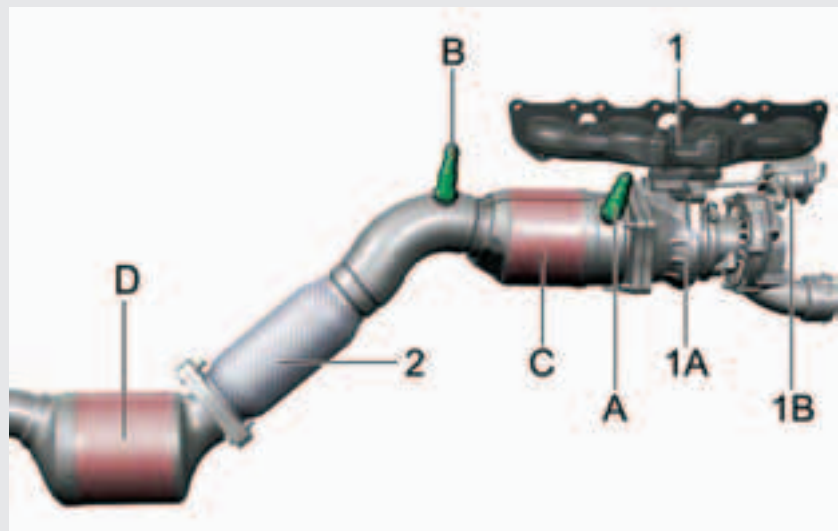
The preliminary and primary catalytic converters are made of metal. This allowed the coated inner walls to be of a thinner design than, for example, ceramic catalytic converters and the result is a greater total surface area for the catalyzing passages. This ensures faster warm-up, long life and greater efficiency in the conversion of pollutants.

## Cayenne

Metallic converter substrates have only about 1/3 the wall thickness of ceramic substrates. They are more compact and have more active surface to convert pollutants. In the warm-up phase, the operating temperature for exhaust gas treatment is reached more quickly. In addition, a metallic catalytic converter is less sensitive to heat, impacts and ages more slowly. Because of lower exhaust gas pressure, increased engine performance is achieved.

### Cayenne Turbo

- A – LSU O2 sensor (ahead of preliminary catalytic converter)
- B – LSF O2 sensor (after the preliminary catalytic converter)
- C – Preliminary catalytic converter
- D – Main catalytic converter
- 1 – Exhaust header
- 1A – Exhaust turbocharger
- 1B – Boost pressure control valve
- 2 – Decoupling element



2\_38\_03

Because of the high temperatures that a catalytic converter needs to effectively begin the process of exhaust gas treatment as quickly as possible after a cold start, the exhaust gases are delivered to the pre-catalytic converters through double-walled, airgap insulated exhaust headers with the shortest possible pipe lengths for rapid heating. As far as the main catalytic converter, which is designed as an underfloor converter, all exhaust pipes are air-gap insulated to reduce heat losses. In addition, heating of the pre-catalytic converters after a cold start is improved by means of secondary air injection.

The V8 engines in the Cayenne have separate secondary air systems for the left and right cylinder bank, mounted at the rear of the appropriate cylinder head.

The secondary air blower for banks 1 and 2 are activated through relays by the DME control module. This builds up pressure over the connecting hoses up to the secondary air valves. At about 80 mbar delivery pressure from the blower, the diaphragm in the secondary air valves is opened; as a result, the injected secondary air arrives behind the exhaust valves through the distribution pipe in the appropriate cylinder head. The injection of secondary air after the exhaust valves results in a reduction of CO and HC, which are generated in greater amounts in the cold start phase with  $\lambda < 1$ .

Additionally, the catalytic converters reach their light-off temperature of about 350 °C as a result of the heat released during afterburning. During the first cold start, the condition for air injection is reached when coolant temperature is between – 10 °C and 30 °C. In the range close to idle, secondary air injection runs for up to about 100 seconds, at part throttle this is reduced to about 40 seconds. If the inducted volume of air of about 340 kg/h is exceeded during secondary air injection, secondary air injection is switched off. A supplementary non-return valve is integrated in the secondary air valve of the Cayenne Turbo, which prevents opening as the result of pressure spikes in the exhaust system.

End stage diagnostics monitors the relays, the operation of the secondary air system is monitored by closed loop O2 sensor control.

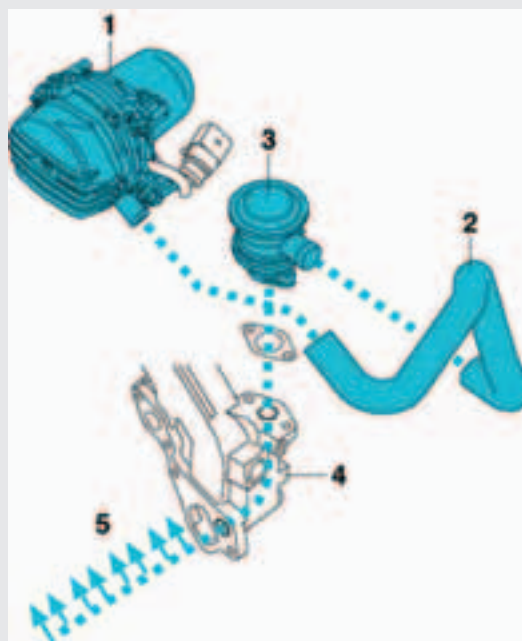


In contrast to the sports cars, no electro-pneumatic valve is required.



### Fire Hazard Around the Exhaust System

Do not park or operate vehicles in places where combustible materials such as dry grass or leaves can come into contact with the hot exhaust system. Do not apply additional undercoating or rust protection to or in the vicinity of the exhaust headers, exhaust pipes, catalytic converters or heat shields. The protective material could become too hot while driving and catch fire.



- 1 – Secondary air blower (left and right)
- 2 – Connecting hose
- 3 – Secondary air valve
- 4 – Flange with air passage
- 5 – Air flow behind the exhaust valves

2\_10\_03

### Two-Channel Closed Loop Control

Both banks of cylinders have a separate O2 sensor control loop, through which the optimal mixture composition is determined for each one individually. The left and right exhaust tracts are equipped with two O2 sensors for monitoring the operation of the catalytic converters. In addition to the conventional jump O2 sensors (LSF), which are installed after the pre-catalytic converters, the more sensitive broad-band O2 sensors (LSU) are installed ahead of the pre-catalytic converters. This keeps fuel consumption and exhaust emissions as low as possible under all operating conditions.

### 2473 LSF O2 Sensor after the Pre-Catalytic Converters

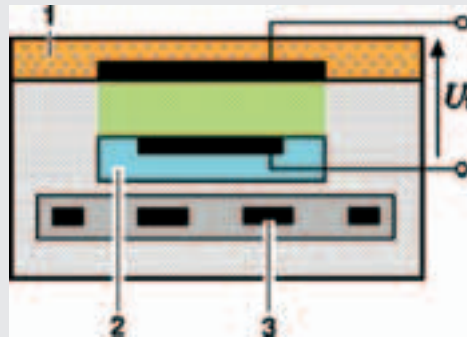
The planar LSF O2 sensor is a further development of the heated O2 sensor. Functionally it corresponds to the LSH heated O2 sensor, with a jump curve from 0 to 0.9 volts at lambda 1. In contrast to the LSH, ceramic films form the solid body electrolyte in the LSF O2 sensor.

**LSF** means **F**lat **O**xygen **S**ensor

Special properties of the LSF O2 sensor:

- Reaches operational status quickly
- Low heating requirements
- Stable control characteristics
- Small size, low weight

The sensor element of the planar O2 sensor is constructed from ceramic films and has the shape of an elongated plate with a rectangular cross section. The individual functional layers (electrodes, protective layers, etc.) are produced using the silk-screen process. Laminating the different printed films on top of each other allows for the integration of a heating element in the sensor element.



2\_11\_02

- 1 – Exhaust
- 2 – Reference air passage
- 3 – Heating element
- Us – O2 sensor voltage

## 2469 Broad-Band O2 Sensor Ahead of the Pre-Catalytic Converters

On the Cayenne S and Cayenne Turbo a broad-band LSU O2 sensor is installed ahead of the pre-catalytic converters for each cylinder bank. (LSU means: Universal O2 Sensor). Vehicles with this broad-band O2 sensor are already operating shortly after a cold start from idle all the way up to wide-open throttle with closed-loop control. The broad-band LSU O2 sensor is a further development of the LSF O2 sensor.

### Benefits of the Broad-Band LSU O2 Sensor

- Precise measurements from  $\lambda > 0.7$  (rich mixture) to  $\lambda < 4$  (pure air) are possible.
- The LSU provides a constant signal, which is evaluated in the DME control module.
- Under all conditions controlled operation with closed loop control is possible.
- The broad-band O2 sensor is operational very quickly.
- Closed loop control reacts more quickly to a discrepancy in the mixture.
- Better control characteristics with increased dynamics.



You can find additional information on the LSU O2 sensor in the Technical Service Information GT2 or in the Corporate Porsche Academy.

## Construction of the Broad-Band LSU O2 Sensor

- The LSU is built up in different planar operational layers.
- The actual sensor element of the broad-band O2 sensor consists of the combination of a Nernst concentration cell (sensor cell) and an oxygen-ion transporting pump cell.
- The broad-band O2 sensor requires special electronics as an evaluation circuit (AWS) in the DME control module.
- The AWS contains the internal control electronics for the pump cell and the sensor cell to generate the sensor signal.
- Through the control current from the electronic pump cell lambda 1 is always generated in the measurement cell.
- This is continuously monitored via the voltage from the sensor cell (450 mV).
- From the deviation of the current from the pump cell ( $0 \text{ mA} \pm 1 \text{ mA}$ ) the AWS calculates the precise lambda value of the exhaust gas.
- The temperature control of the LSU is also integrated in the AWS.

A – Drilling for exhaust gas

B – Heater current

C – Pump current

D – O2 sensor voltage/reference voltage

1 – Nernst concentration cell  
(for generating voltage)

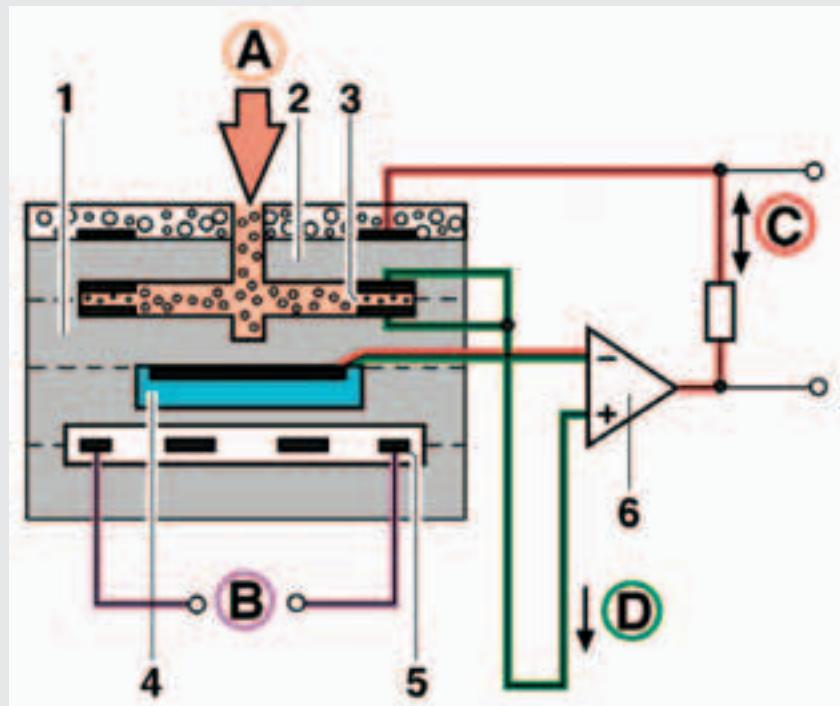
2 – Oxygen pump cell

3 – Measurement cell (diffusion slot)

4 – Reference air passage

5 – O2 sensor heater

6 – Closed loop circuit  
(in the DME control module)

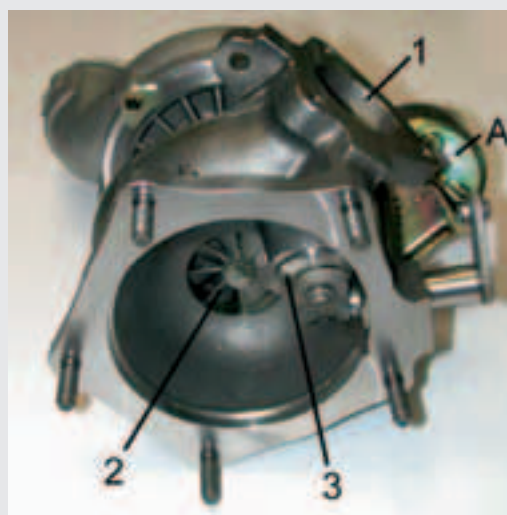


2\_67a\_03

The two turbochargers, which are arranged in parallel, provide effortless power with the appropriate boost pressure control. Air flows into these turbochargers (manufactured by IHI), which have a so-called Mixed Flow Turbine, at a radial and an axial angle, and they have a low moment of inertia. As the result of low intake manifold volume, short exhaust headers and the Mixed Flow Turbines excellent response characteristics are achieved. These turbochargers are designed for a maximum speed of 160,000 RPM (continuous operation). So that the maximum RPM is not exceeded, the DME control module reduces boost pressure as needed above an altitude of 2,200 meters.

A cast steel turbine housing was used to achieve high turbine entry temperatures and consequently optimal wide open throttle consumption. By water cooling the turbochargers, increasing aging of the oil (caused by so-called oil coking) in the turbine bearing housing under high thermal loads is prevented. To cool the turbochargers while the engine is not running, the electric coolant circulation pump, which is installed behind the wheel house cover at the left front, can be switched on. The electric coolant circulation pump is switched on as needed in run-on operation together with the electric cooling fans by the DME control module.

Oil supply and oil scavenging from the turbochargers on the Cayenne Turbo was designed for universal operating conditions (e.g. up to a 45° slope) for the vehicle.



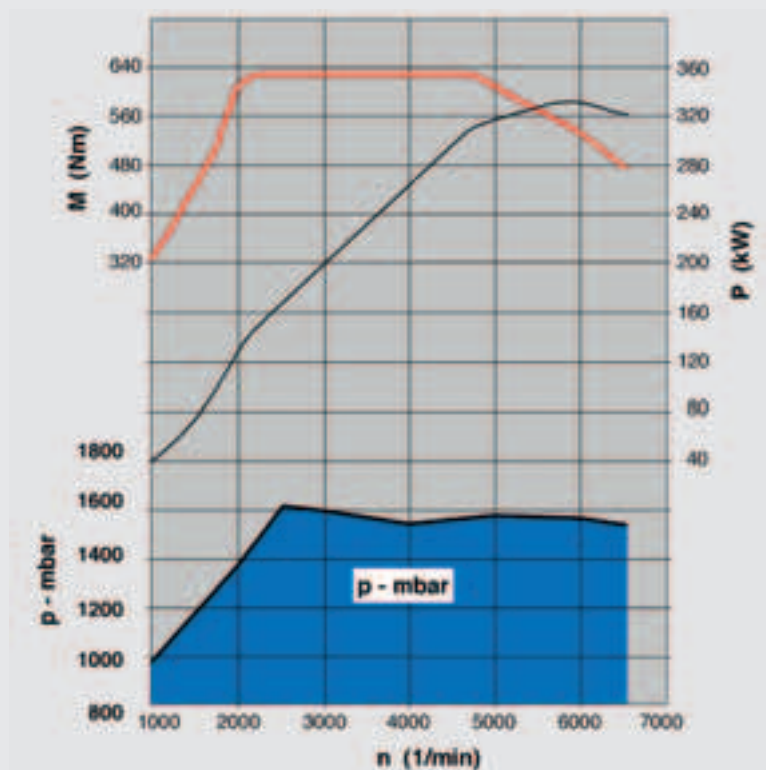
2\_31\_03

- 1 – Flange to exhaust header
- 2 – Exhaust turbine
- 3 – Bypass valve (wastegate)

A – Pressure unit  
for boost pressure control

Depending on driving style, the boost pressure is regulated ahead of the throttle valve. With a steady or not very lively driving style, engine tuning at part throttle is constantly optimized in the direction of low fuel consumption by permitting only low pressure ahead of the throttle valve. It is opened correspondingly wide to bring about a low pressure drop. With a very brisk driving style, a higher boost pressure is set ahead of the throttle valve. The effect is that when the throttle valve is opened at part-throttle operation, the turbochargers are already running at higher speed and thus full-throttle boost pressure is attained very quickly. This principle can minimize "turbo lag." The required engine torque of the engine is calculated depending on the accelerator pedal potentiometer (driver request), engine RPM and other factors in the torque-oriented operational construct in the DME control module. Boost pressure in the Cayenne Turbo is controlled by absolute pressure. Maximum torque can be kept constant for a long period with respect to geographical altitude and temperature. The diagnostic capability of the system was expanded to include leak detection in the intake system. The engine charge required for a particular torque is determined through the calculation of mass air and implemented by specifying and controlling boost pressure.

- p – Boost pressure in mbar absolute (pressure)
- n – Engine speed (rpm)
- M – Torque in Nm
- P – Power in kW

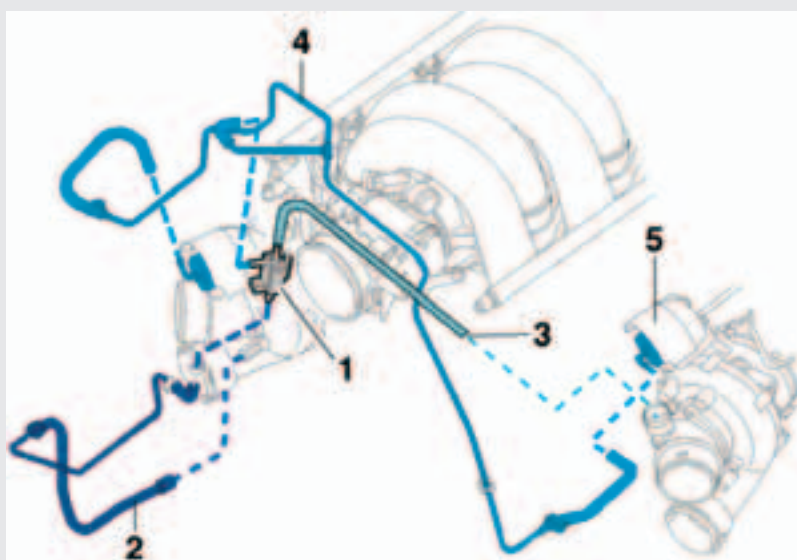


2\_32\_03

The graph applies to 98 ROZ fuel and sea level at average temperatures.

In the Cayenne Turbo, boost pressure is registered by the pressure sensor and controlled to the required boost pressure calculated by the DME control module. The electric frequency valve for boost pressure control is activated by an appropriate duty cycle, by which pressure is applied to the boost pressure control valves on the turbochargers, and the bypass valves (waste gate) in the turbochargers open. Turbocharger RPM is reduced, and boost pressure is limited. The electric frequency valve is activated by the DME control module when accelerating at a maximum 95 % and a steady state at about a 60 % to 80 % duty cycle. Maximum boost pressure at wide-open throttle is up to about 1650 mbar and is already reached at a speed of 2500 RPM. In the remainder of the RPM curve, boost pressure is cut back and at rated power (331 kW/6000 RPM) it is about 1500 mbar. (The values given correspond to absolute pressure.)

## Boost Pressure Control Components



2\_13\_03

- 1 – Frequency valve for boost pressure right control
- 2 – Pressure side (boost pressure from right turbocharger)
- 3 – Vacuum (from the intake side of the left turbocharger)
- 4 – Regulated control pressure to the boost pressure control valves
- 5 – Pressure unit on the turbochargers



In open-loop, the error Leak ahead of the throttle valve is entered.

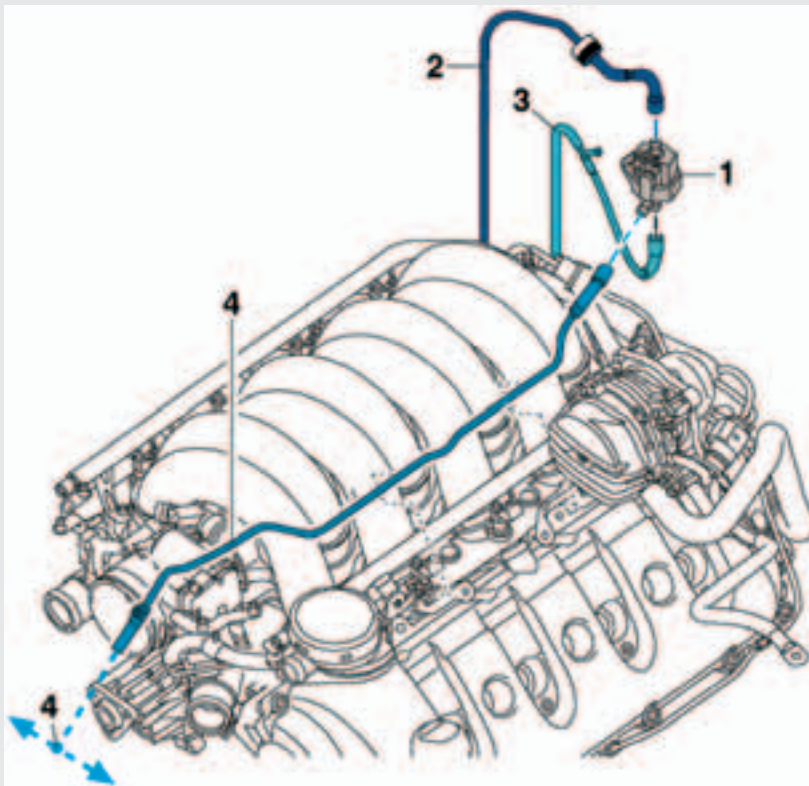
The cross sectional opening of the frequency valve for boost pressure control is dependent on the boost pressure requested. The frequency valve for boost pressure control changes its opening time to atmospheric pressure in accordance with its activation (duty cycle) through the DME control module. From boost pressure and atmospheric pressure, a control pressure is modulated, which actuates the pressure units of the boost pressure control valves accordingly and thereby opens the waste gates on the turbochargers. In a de-energized state, the frequency valve for boost pressure control is switched so that boost pressure acts directly on the pressure units and thus the boost pressure control valves open the waste gates at a low boost pressure.

## 21 Boost Pressure Adaptation

The Cayenne Turbo has adaptive boost-pressure control. For diagnosis the adapted value among the actual values of the DME can be read out as “boost pressure adaptation.” The adaptation range of boost pressure control is  $0 \pm 25\%$ . Above a deviation of more than about 25 % the switch to open-loop is made and a trouble code is stored. In open-loop, boost pressure is lowered by about 20 %, reaching a maximum of 1400 mbar. Should the frequency valve for boost control fail, basic boost pressure is reduced even further for safety reasons. The consequence is a noticeable lack of power and performance.

### 2138 Electrical Switching Valve for Recirculating Air on Deceleration

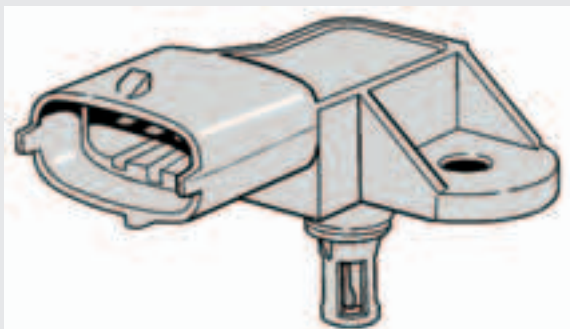
To prevent the turbochargers from pumping on a sudden transition from high load to deceleration, an electrical switching valve is used to control recirculating air. The DME can activate this electric switching valve, which actuates the recirculating air valves independently of intake manifold pressure. Controlled opening of the recirculating air valves reduces noise in the induction system and has positive effects on fuel consumption. Through the electric recirculating air valve in conjunction with the vacuum reservoir, operation of the recirculating air valves independently of intake manifold pressure can be achieved. The system is designed so that if the electric switching valve should fail, the decel recirculating air valves can continue to be opened through manifold pressure.



2\_12\_03

## 2190 Pressure Sensor with Temperature Sensor

The pressure sensor registers pressure and air temperature ahead of the throttle valve control unit and makes these signals available to the DME control modules.



2\_58\_00



You can find a detailed description of operation in the Technical Service Information 911 GT2 or in the Corporate Porsche Academy.

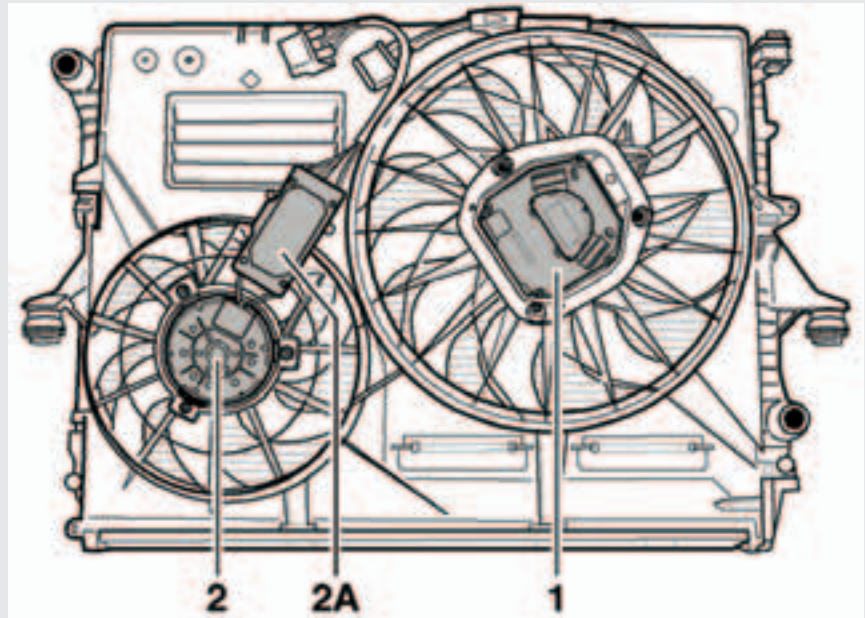
### Coolant Temperature Gage/Coolant Warning Light

The coolant temperature sensor (NTC), which is threaded into the coolant distribution pipe at the right rear of the engine, sends its signal to the DME control module, which passes on this information over CAN. The temperature is displayed in the instrument cluster by the coolant temperature gage. At a coolant temperature of  $> 124^{\circ}\text{C}$  the coolant warning light is additionally switched on and switched off again at  $< 119^{\circ}\text{C}$ .

### 1908 Electric Fans 1 and 2 for the Cooling System

Electric fan 1 has a maximum power of 600 watts, electric fan 2 of 300 watts. For continuous control, the duty cycle for the end stages of fans 1 and 2 is changed by the DME control module.

- 1 – Electric fan 1  
(with integral output stage)
- 2 – Electric fan 2  
(with external output stage)
- 2A – Output stage for electric fan 2



2\_33\_03

Control of fan speed is dependent

- on coolant and ambient temperature.

The coolant thermostat begins to open at about 83 °C coolant temperature and reaches its maximum opening at about 98 °C. The two stepless fans 1 and 2 are activated at about 93 °C and reach their full performance at about 105 °C.

- on the status of the air-conditioning system..

With the air-conditioning switched on, the fans are also activated, above a pressure of about 20 bar in the air-conditioning system maximum fan demand is reached. Above a coolant temperature of > 118 °C the air-conditioning compressor is switched off (zero delivery).

Above 125 km/h, the speed of both fans is reduced and at 140 km/h they are completely switched off, however whenever coolant temperature rises above 116 °C, they are switched on again and off again at below 105 °C.

### **Fan Run-On**

To cool the engine compartment the fans are switched on with the ignition OFF, depending on coolant temperature and the last driving cycle (map on fuel consumption). The switch-on threshold is between 90 °C and 93 °C and running time is between 15 seconds and a maximum of 13 minutes. Once fan run-on is concluded, the fans will not start again with "Engine OFF."

In the Cayenne Turbo, the electric coolant run-on pump, which provides cooling for the turbocharger (to prevent oil coking), is activated through this function. The run-on pump is located behind the left front wheel wheelhouse liner. In addition, this pump is activated on the Cayenne S and Cayenne Turbo by the air-conditioning control module to utilize residual engine heat.



1\_26\_03

### VarioCam

To reduce fuel consumption and increase maximum torque, a continuous variable, stepless camshaft adjuster (VarioCam) is used on the intake camshafts. The DME control module regulates the position of the intake camshafts under the control of a map. The vane-type adjusters can shift the intake camshafts for cylinder banks 1 and 2 between 0° to 50° crankshaft angle (25° camshaft angle). The variable position of the camshaft can be regulated from high torque at low RPM up to maximum power at high RPM, which also achieves a reduction in fuel consumption.

Vane-type VarioCam adjuster on the intake camshaft

### 1537 Activation of the Hydraulic Solenoid Valves for Stepless Adjustment of Valve Timing

The control module determines the current position of the intake camshafts (actual angle) to the crankshaft from the RPM sensor signal and the Hall sensor signal. The position control in the control module receives the desired specified angle via the programmed map values (rpm, load, engine temperature). If there is a difference between the specified angle and the actual angle, the electronic controls in the control module activate the hydraulic solenoid valve to actuate the positioner for the intake camshaft in accordance with the direction requested. Actuation of the valve is carried out through a pulse-width modulated square signal. Voltage is switched between 0 volts and 12 volts in a 4ms cycle (250 Hz), with the ratio of on-time and off-time being changed. Depending on conditions, a control current is set which determines piston position in the hydraulic solenoid valve (and thus opens the different oil lines), allowing a range of adjustment from 0° to about 50° of crankshaft angle.

The stepless VarioCam system with the vane-type adjuster provides the following benefits:

- Higher torque in the lower RPM range for better pulling performance
- Reduction of raw emissions for better exhaust gas numbers
- Maximization of catalytic converter heating for better exhaust gas numbers

### **Idle**

The engine runs with small valve overlap. This provides great idle stability at low RPM. This idle stability is achieved through good cylinder charging and associated even combustion. Valve overlap means that intake and exhaust valves are open together. The effect is that fresh gases flow in while exhaust gases flow out at the same time.

### **Part Throttle**

At part throttle, operation with high residual gas content in the combustion chamber, meaning already burned air-fuel mixture, is optimal for reducing charge cycle losses and for improving combustion uniformity.

Besides reducing fuel consumption this results in better emissions characteristics.

In the part-throttle range the engine is load-dependent, that is, it is operated with different degrees of valve overlap depending on engine RPM and accelerator pedal position. Combustion is promoted by the movement of the charge, which provides good turbulence in the cylinders.

### **Wide-Open Throttle**

With the throttle valve fully open, the optimal closing timing for the intake valves is permanently set for any RPM with the continuously adjustable intake camshaft (vane-type VarioCam). This prevents the backflow of fresh gases from the combustion chamber. At medium RPM and at wide-open throttle, the engine is running with the greatest valve overlap and early closing of the intake valve.

## Cayenne

At high RPM and at wide-open throttle, the engine is operating with small valve overlap and late closing of the intake valve. It is imperative not to permit any discrepancies in valve timing between the two intake camshafts on both banks of cylinders.

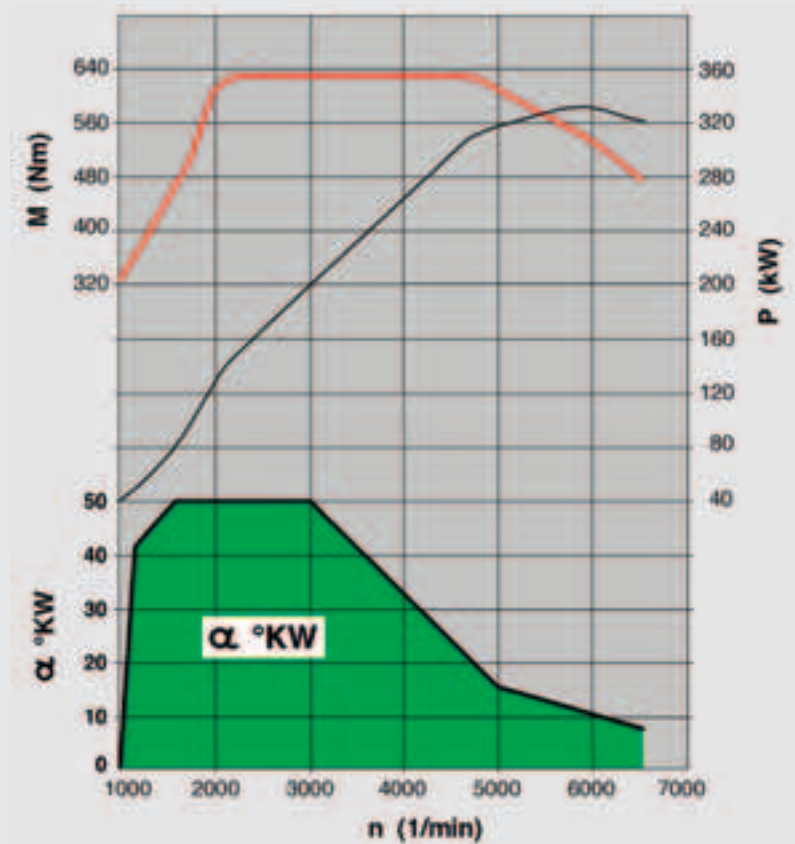
### Cayenne Turbo VarioCam Shift Graph

a – VarioCam adjustment angle  
in ° KW crankshaft rotation

n – Engine speed in rpm

M – Torque in Nm

P – Power in kW



2\_34\_03