2 Fuel and ignition system

General

The further development of the 3.6 litre 911 GT3 naturally-aspirated engine was specially designed for the highest specific performance and high torque over a wide engine speed band. The engine has spontaneous power development with immense liveliness and a typical Porsche sound. It has excellent emission and consumption performance and complies with all exhaust and noise emission requirements world-wide. High reliability is achieved with low service requirements. The electronic mixture preparation control through the Motronic engine management system ME 7.8 also allows the continuous variable timing of the inlet camshafts (VarioCam), and gear-dependent control of the maximum engine speed.

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Contents

Development aims of the 911 GT3

- Increasing the performance potential of the new 6-cylinder, 3.6 litre Boxer engine
- Well-rounded torque curve over the entire engine speed spectrum
- Maximum speed concept with reduced moving masses of the valve gear
- Gear-dependent control of the maximum speed to above 8000 rpm to increase performance
- Compliance with all exhaust and noise emission requirements worldwide

Engine performance and torque

The 911 GT3 engine reaches a maximum engine power of 280 kW (381 PS) at 7400 rpm and a max. torque of 385 Nm at 5000 rpm.

24 ME 7.8 Motronic system

- The Motronic control unit is adapted to the specific requirements of the 911 GT3.
- Engine charge control through electric throttle valve adjuster (E-Throttle)
- Control of gear-dependent maximum speed
- Continuous adjustment of the inlet camshafts (VarioCam) through axial adjusters
- Stereo oxygen sensor control with oxygen sensors up- and downstream of catalytic converters
- Hot film air mass measurement through a hot film air mass measurement meter specially adapted to the 911 GT3
- Actuation of the resonance flap integrated in the intake system
- Actuation of the secondary-air injection to reduce exhaust-gas emission
- Electric actuation of the oil-to-water heat exchanger to cool the gearbox oil
- On-board diagnosis for worldwide use
- Solid-state HT distribution with separate ignition coils for each cylinder

- Knock control with automatic adjustment of ignition timing with varying fuel quality
- Sequential manifold injection with EV-6 injection valves
- Actuation of radiator fans
- Immobiliser with transponder system
- CAN interface to other control units

Additionally, on USA versions:

- ORVR system with tank leak-tightness test
- Pressure sensor to measure tank leak-tightness
- Shut-off valve for locking during leak-tightness test
- 2-chamber activated charcoal fuel tank vent filter with a capacity of 2 litres

The diagnostic functions of the Motronic control unit correspond largely with those of the 911 Carrera (996) as of model year 2002 or the Boxster as of model year 2003.
As of software version 16 of the Porsche System Tester 2 the following functions are available.

For further information see the Technical Manual 911 Carrera (996) or the On-Board Diagnosis Manual (OBDII) DME 7.8.

OBD II and EOBD

The driver is informed worldwide by a visual warning (check engine lamp) in the instrument cluster, through the on-board diagnosis system or Europe on-board diagnosis system, as soon as an emission or engine-related fault occurs.
The functions are adapted to the different worldwide legal regulations.

Check Engine lamp

A permanently lit "Check Engine" lamp indicates an emission-related fault.

A flashing "Check Engine" lamp indicates a combustion fault which may damage the catalytic converter.

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Data records

To program the Motronic control unit, the following data records are available:

LEV — for USA models (Low Emission Vehicle)

EU4 — for Europe (Euro 4) and RoW vehicles with similar emission limit values

EU2 — RoW countries with less strict emission limit values (Euro 2)

JAPAN — for Japan

Australia — for Australia

Motronic control unit

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Exhaust emission standard

The 911 GT3 satisfies all environmental requirements worldwide. By using the most up-to-date engine-control and emission-control systems, a reduction of exhaust-gas emissions has been achieved, despite increased performance, whereby the vehicles comply with exhaust emission standards as per the above mentioned data records.

Noise / Acoustics

The 911 GT3 engine has unmistakable acoustics with the characteristic load-dependent sound. It was possible, with focused acoustic engineering, to retain this typical GT3 sound and develop it further, both inside and outside. All worldwide legal requirements have been met, despite stricter legislation. The dominant intake roar at medium and high engine speeds becomes an even more emotional high-light through the raised engine speed level und underlines the sporty character through accentuation of the engine acoustics.

High-speed concept

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The maximum engine speed has been raised to 8200 rpm to increase the gear-dependent performance in the lower and medium speed range (1st to 4th gear). In 5th and 6th gear it is 8000 rpm.

Improved vehicle acceleration was achieved through the respective transmission ratios. Gear recognition takes place through a map in the Motronic control unit, which calculates the selected gear from the vehicle speed (from the ABS control unit) and the engine speed.

20 Fuel

The engine has been designed to provide optimum performance and fuel consumption with unleaded fuel with 98 RON/88 MON. If unleaded fuel with an octane rating of at least 95 RON/85 MON is used, an adjustment is made through the knock control, whereby the ignition point is retarded and the engine power consequently reduced.

2010 Fuel tank

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The fuel tank has been adopted from the GT2. By utilising the additional space (occupied by the front-axle differential on the 911 Carrera 4), left-hand drive vehicles (except USA) have a usable tank volume (max. refill capacity) of 89 litres.

Owing to different regulations stipulated by the respective legislative bodies with regard to diagnosis and the physical arrangement of vehicle components, a fuel tank with a usable tank volume of 64 litres is fitted in the following vehicles:

- Due to licensing regulations, USA models have the 911 Carrera (996) MY 03 tank with ORVR system (On-board Refueling Vapor Recovery).
- Right-hand drive vehicles have the tank of the 911 Carrera 4 (996) MY 03.

Please refer to the technical manual for the fuel filter change interval.

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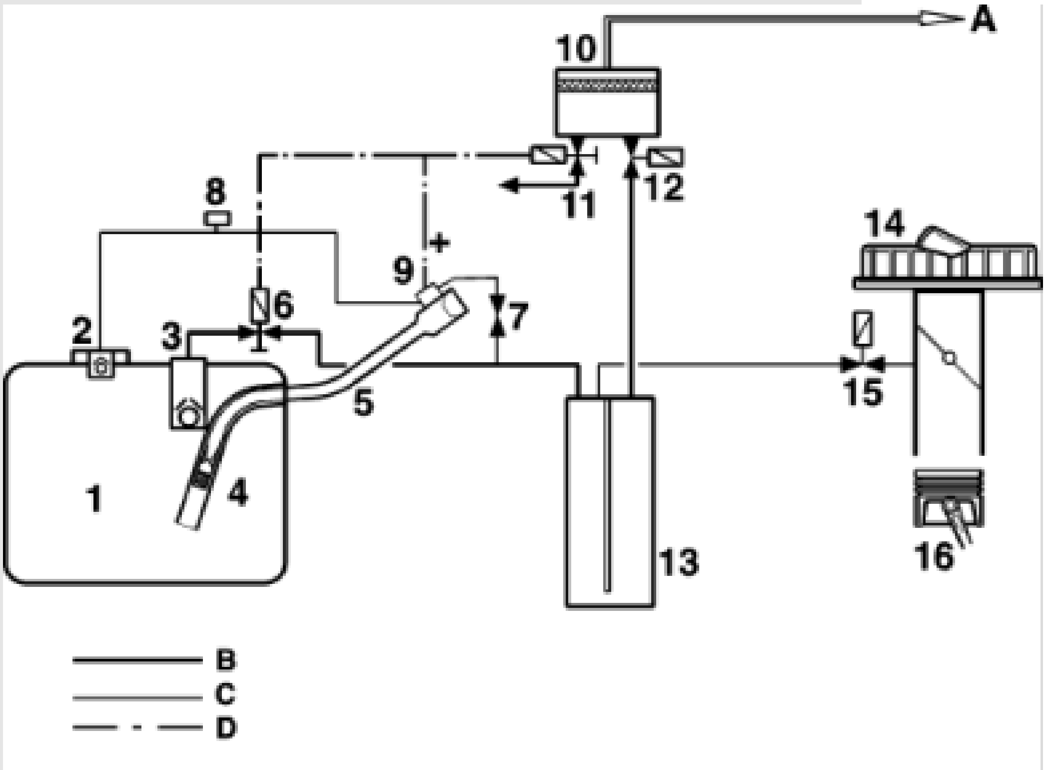
20 Fuel supply

The 911 GT3 has a fuel system with a return line from the pressure regulator on the engine to the fuel tank. A sucking jet pump feeds the fuel to the main pump. The fuel pump (in the tank) feeds the fuel along the inlet line and through the fuel filter to the injection valves. The pressure regulator sets the required operating pressure of approx. 3.8 bar (at full load). The unused fuel flows through the return line back into the tank.

2440 Injection valve (EV-6)

A feature of this injection valve is its small overall size, low weight and the very low risk of vapour lock with hot fuel. The atomisation of the fuel is carried out by a spray-hole disk with 4 holes. The punched injection holes achieve low fuel injection rate tolerance, as well as insensitivity to fuel deposits. Good valve sealing in the valve seat area is ensured by the cone/ball sealing principle.

USA models have a system whereby the fuel vapours occurring during refuelling of the vehicle are directed into the activated charcoal filter.
ORVR stands for: On-board Refueling Vapor Recovery System, i.e. an (On-board) system, fitted into the vehicle, whereby during refuelling (Refueling) the fuel vapours (Vapor) are recovered (Recovery).



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1 - Fuel tank
2 - Rollover valve
3 - Fluid level limiting valve
4 - Spitback valve
5 - Filler neck
6 - ORVR valve
7 - Vacuum limiting valve
8 - Pressure sensor
9 - Operational vent valve
10 - Filter housing
11 - Fresh-air valve
12 - Shut-off valve
13 - Activated charcoal fuel tank vent filter
14 - Air cleaner
15 - Tank breather valve
16 - Engine

A - Purge line to rear
B - Vent pipe during refuelling
C - Operational vent line
D - Positive feed for ORVR and Fresh-air valve

Function

When refuelling the vehicle, a reed contact (9), fitted in the fuel filler neck below the sealing flap, which is opened by the filling nozzle, is switched. This applies positive potential to the ORVR valve (6) and to the fresh-air valve (11). As these valves are permanently connected to earth, they open. While the tank is filling, the space where the HC vapours collect becomes smaller as the fuel volume in the tank increases. The HC vapours building up or already present in the tank are directed via the fuel level limiting valve (3) and the ORVR valve (6) to the activated charcoal fuel tank vent filter (13). The necessary pressure equalisation is carried out via the electric fresh-air valve (11). When the engine is next started, the activated charcoal fuel tank vent filter (13) is evacuated and regulated via the tank breather valve (15) by the DME control unit according to certain criteria and elapsed times.

Activated charcoal fuel tank vent filter

Due to the OVRV system, the volume of activated charcoal fuel tank vent filter is increased to approx. 2 litres. Because the USA models must fulfil the Shed-Test requirements, the activated charcoal fuel tank vent filter is divided into two chambers. As before, the activated charcoal fuel tank vent filter is located in the front right wheel arch. (During the Shed-Test, the gas emission of the fuel vapours is recorded in a measuring chamber).

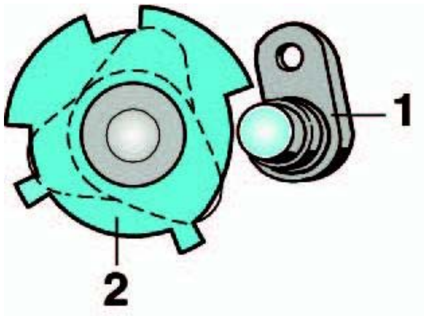
20 Tank leak-tightness test

The description can also be found under TI 1/97 in the Technical Manual 911 Carrera (996) group 2.

The tank leak-tightness test, which is only carried out on USA models, is described in detail on the 911 Carrera MY '98 as part of group 2.

2839 Hall sensor and camshaft rotor

A modified rotor is fitted to the intake camshafts of both cylinder banks. Using the rotor position, the Hall sensor determines the current position of the inlet camshaft 4 times per camshaft revolution and relays this value to the DME control unit. This determines precisely the position of the inlet camshafts.



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1 - Hall sensor

2 - Camshaft rotor

Knock control

Depending on engine load, the knock control can retard the ignition timing up to max. 12° crankshaft angle at engine speeds of between 2600 and 8200 rpm, at lower engine speeds of between 1000 and 2600 rpm the max. retardation is 10° crankshaft angle. Using fuel with an octane value of 95 RON/85 MON results in a significant retardation of the ignition timing under load with a consequential reduction in power output.

24 Air ducting

The newly designed air inlets integrated in the luggage compartment lid for intake air and engine compartment venting lie directly in the air path and thereby reduce the suction effort of the engine. This positively influences the initial response and performance especially at higher speeds due to the improved induction. The air is directed to the air cleaner casing from the inside of the luggage compartment lid, thereby achieving an optimal fresh-air supply.

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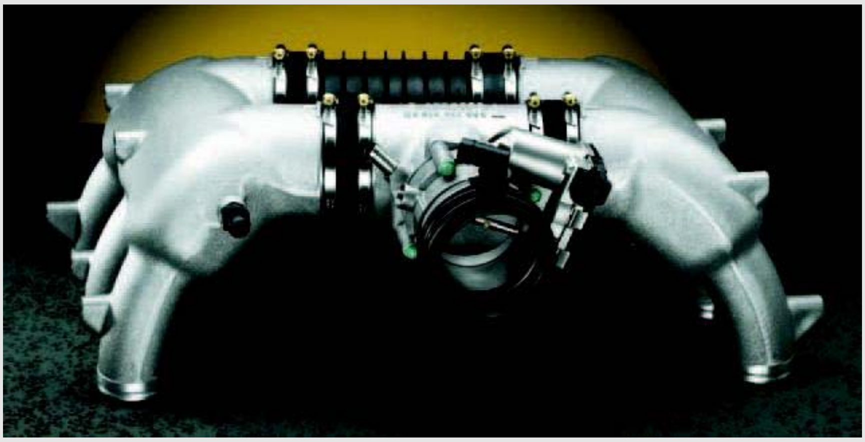
2425 Air cleaner

2_03_04

Please refer to the technical manual for the air cleaner change interval.

24 Intake system

The air is drawn in via the air cleaner, it flows through the connected hot film air mass flow sensor and after the throttle control unit is distributed via a distribution pipe into the two air collection chambers. Straight suction pipes lead from the air collection chambers to the inlet ports. The large volume of the intake duct contributes to the high specific power output and also produces a powerful intake roar. The 2-stage ram air intake system of the 911 GT3 is a light-alloy casting. The air collection chambers lying above the two cylinder banks are connected together via two connecting pipes. The inlet ports and air collection chambers are elaborately surface machined to optimise the gas flow and adapted regarding inlet manifold sizing to the inlet port geometry. The resonance tube is mounted between the two air collection chambers in front of the distribution pipe in direction of travel. This component, made of plastic for weight reasons, houses the resonance flap.



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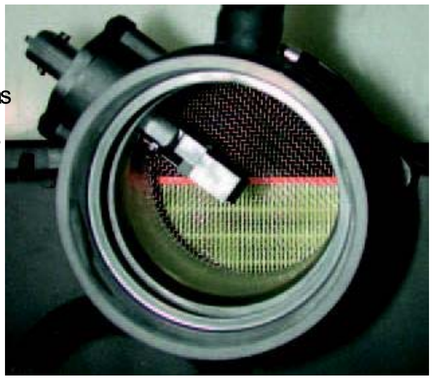
The resonance flap is operated via an electro-pneumatic valve, which is actuated by the Motronic control unit. This control amplifies the gas-column vibration in the inlet manifold through deliberate resonance generation. This achieves better induction. At an intake-air temperature of 0 °C, the resonance flap remains open until 2280 rpm. Between 2280 and 5040 rpm, it is closed to optimise torque and it is opened again above this engine speed to optimise performance.

In overrun condition, the gearshift speed is 4960 rpm and 2120 rpm. The gearshift speed is changed depending on the intake-air temperature to achieve optimum induction. If intake air is hot, the gearshift speed is raised (by max. 10% at + 60 °C), if intake air is cold, it is reduced (by max. 5% at - 20 °C).

2445 Hot film air mass flow sensor (HFM 5)

The so-called tube air mass sensor must not be removed from its measuring tube, as these components are matched to each other on a flow bench. The special air mass flow sensor of the 911 GT3 is designed for a nominal air flow of up to 970 kg/h.



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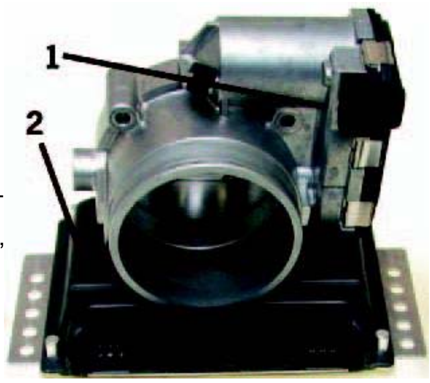
2442 Throttle control unit (E-Throttle)

The use of E-Throttle on the 911 GT3 offers the following advantages:

- Sport ratios (direct response) with high driving comfort
- Improved idling quality
- Torque-orientated control of engine induction
- Reduction of engine emissions and fuel consumption



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1 - Throttle control unit (E-Throttle)

2 - Motronic control unit

On the electronic engine induction control with E-Throttle, the throttle valve is adjusted by an electric motor via a two-stage gear on the throttle valve spindle. As a result, the volume of air drawn in by the engine can be controlled electronically across the entire load and engine speed range. The accelerator pedal has two potentiometers integrated and generates the input signal for the throttle valve control. The accelerator pedal travel is converted into an electrical signal by the potentiometers and sent to the Motronic control unit. The control unit evaluates and prioritises the signals through the torque-orientated functional structure. Using the resulting value, the throttle valve is controlled by an electromotor and the respective position is detected and monitored through 2 potentiometers.

Further information on the topic E-Throttle can be found in the Corporate Porsche Academy.

In order to reduce the emission of pollutants while the engine is warming up, special engine management measures, i.e. retarded ignition and secondary air injection into the exhaust tract for afterburning, ensure that the catalytic converter is heated up more rapidly. The associated reduction in torque can be compensated using the electronic throttle control function. Comfort is increased by a engine temperature-dependent accelerator pedal travel characteristic. This characteristic (the correlation between engine torque and accelerator pedal position) is determined entirely by the E-Throttle function and is independent of the engine's operating state. The engine speed limitation through E-Throttle and the possibility of dispensing with selective fuel injection reduces emissions, lowers thermal catalytic converter loads and increases comfort.

Continuous VarioCam system

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An axial camshaft adjuster is used to adjust the inlet camshafts, which can adjust the inlet camshafts from 0 to 45° crankshaft angle. This continuous variable timing of the two inlet camshafts requires elaborate synchronisation and consequently puts high demands on the DME control unit. The increased adjustment range allows even finer harmonisation of the engine characteristics regarding power, torque and exhaust emission.

1537 Actuation of solenoid hydraulic valves to adjust the inlet camshafts

The Motronic control unit determines the current position of the inlet camshafts in relation to crankshaft (actual angle) using the engine speed signal and Hall sensor signal. The position control in the control unit receives the desired angle via the programmed map values (engine speed, load, engine temperature). If the desired angle and actual angle differ, the control electronics in the control unit actuates the solenoid hydraulic valve to move the control element for inlet camshaft in the desired direction.

Actuation of the valve takes place via a pulse-width-modulated square-wave signal. The voltage is switched between 0 volts and 12 volts in 4ms cycles (250 Hz), while the proportion of switch-on and switch-off time is changed. A control current adjusts itself according to this proportion, which sets the piston position in the solenoid hydraulic valve and thereby releases the different oil lines, facilitating a crankshaft angle adjustment range of 0° to approx. 45°.

The following improvements were implemented through the use of the continuous VarioCam system:

- High torque at low and medium engine speeds for better traction power
- Optimum engine performance
- Reduced raw emissions for improved emission levels
- Stable idling speed (800 ± 40 rpm)
- Catalytic converter heating strategy optimised for improved emission levels

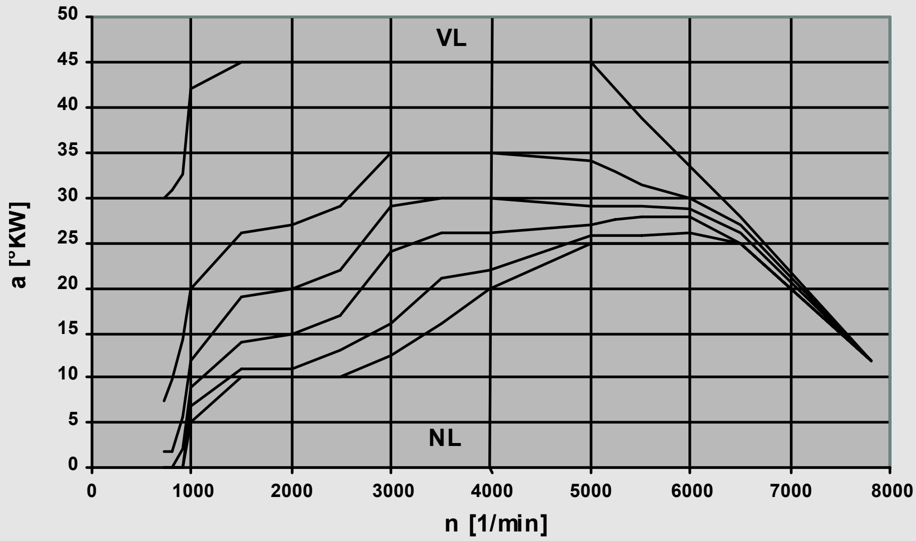
Idling

The engine runs with slight valve overlap, which makes a low idling speed of 800 ± 40 rpm with high idling stability possible. This is due to a good regular combustion pattern. Valve overlap means that inlet and exhaust valves are open together. This results in fresh mixture flowing in while exhaust gases simultaneously flow out.

Part load

To reduce the charge-exchange losses and to improve the combustion stability when under partial load, operation with high residual-gas levels, i.e. burnt fuel/air mixture, is ideal. This results in both reduced fuel consumption and improved emission values. In part-load range, the engine is run load-dependent, i.e. with different amounts of valve overlap depending on engine speed and accelerator pedal position.

Continual adjustment of inlet camshafts



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n - Engine speed in rpm

a - VarioCam adjustment angle (advanced) in °crankshaft angle

NL - No load

VL - Full load

Full load

When the throttle valve is fully open, the continuous inlet camshaft control system Vario-Cam permanently sets the optimum closing time of the inlet valves for every engine speed. This not only prevents backflow of the fresh mixture from the combustion chamber but also allows optimum induction of fresh mixture into the combustion chamber. At medium engine speeds and full load, the engine runs with the largest valve overlap and early closing of the inlet valves. At high engine speeds and full load, the engine runs with the less valve overlap and late closing of the inlet valves. Therefore, it is absolutely essential that there is no deviation in the ignition timing between the camshafts of the cylinder banks.

Adaption of the camshaft control

A deviation of the camshafts up to 10° crankshaft angle can be compensated for through the Motronic control unit. A deviation greater than that results in an entry in the fault memory.

26 Exhaust system

The exhaust system is a 2-stream arrangement, i.e. the exhaust flow of the left and right cylinder banks is separate. Each exhaust system branch has an oxygen sensor fitted up- and downstream of the catalytic converter (double stereo oxygen sensor control). Exhaust manifolds with a pipe diameter of 45 mm and metal catalytic converters result in a minimum exhaust back pressure. This is a prerequisite for an improved volumetric efficiency of the cylinders and the high specific engine performance strived for.

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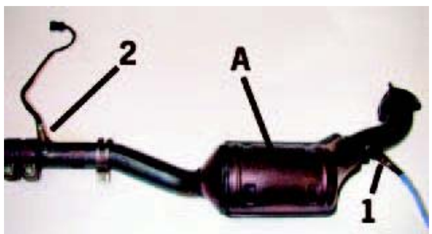
2673 Catalytic converter

The catalytic converter mounts of the exhaust system on left and right are made of metal. The coated inner walls were designed thinner and achieve a larger overall surface of the catalysing channels through the increased number of cells. This ensures quicker warming, a high durability and higher effectiveness when converting the pollutants. Metal catalytic converter mounts have only 1/3 of the wall thickness of ceramic mounts.

A - Catalytic converter

1 - Oxygen sensor LSF (upstream of catalytic converter)

2 - Oxygen sensor LSF (downstream of catalytic converter)



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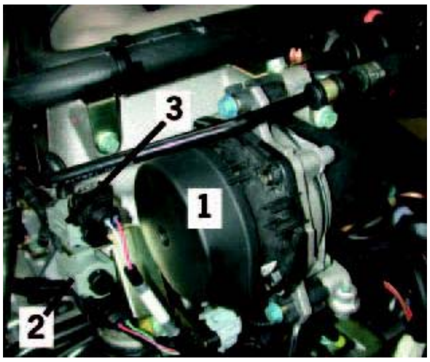
Therefore, they are more compact, have a more active surface for pollutant conversion and reach the operating temperature for exhaust emission control sooner during the warm-up phase. Additionally, heating of the catalytic converters after a cold start is improved through secondary air injection. Furthermore, a metal catalytic converter is less sensitive to heat, impacts and ages slower. Higher engine performance is achieved due to the decreased exhaust back-pressure. The metal catalytic converters of the 911 GT3 are 120 mm long, have a volume of 1312 cm^3 and are each coated with approx. 4.6 grams of precious metal (14 parts palladium, 1 part rhodium).



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2665 Secondary-air injection

1 - Secondary air blower

2 - Switching valve for secondary air

3 - Switching valve for resonance flap

The Motronic control unit actuates the secondary air blower via a relay, at the same time the electro-pneumatic combination valve is actuated. The air delivered by the secondary air blower travels along the lines through the combination valve behind the exhaust valves of the corresponding cylinder head. The injection of secondary air results in the lowering of the CO and HC pollutants which increasingly occur through operation with Lambda < 1 in the cooling down phase. Moreover, the catalytic converters reach their starting temperature of approx. 350 °C faster due to the heat released during afterburning. During the initial coldstart process, the switch-on condition is reached when the coolant temperature lies between -10 °C and + 42 °C. When in idle speed range, the secondary air injection runs for up to approx. 60 seconds, at part load up to 80 seconds. If, during the secondary air injection, the air volume drawn in exceeds approx. 250 kg, the secondary air injection switches off.

The function of the secondary air blower system is controlled through the oxygen sensor control. The relay and combination valve are monitored by the output stage diagnosis.

2_11_04

1 - Combination valve

24 Oxygen sensing

The 911 GT3 has stereo oxygen sensing with 2 oxygen sensors per cylinder bank. Each cylinder bank has one oxygen sensor upstream and one oxygen sensor downstream of the catalytic converter. The Motronic uses the signal of the oxygen sensor upstream of the catalytic converter to control the fuel/air mixture. The signal of the oxygen sensor downstream of the catalytic converter is used to monitor the function of the catalytic converter, as well as to correct the oxygen sensing control. This system ensures that the engine is run with a stoichiometric air/fuel mixture (Lambda 1) as far as the operating behaviour of the engine and the temperature of the components allow. At Lambda=1, efficient pollutant conversion is achieved in the catalytic converter.

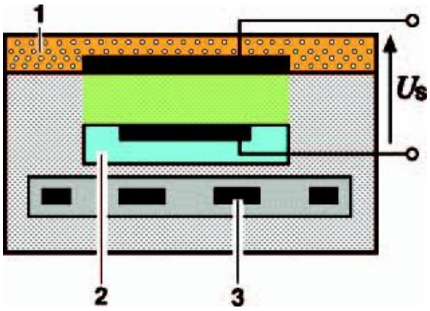
2469/2473 Oxygen sensor LSF

An oxygen sensor LSF (LSF = oxygen sensor, flat design) is fitted up and downstream of the catalytic converters. This planar oxygen sensor is a further development of the heated oxygen sensor. Functionally it equates to the heated oxygen sensor LSH with a step map of 0 to 0.9 volts at Lambda 1. Unlike the LSH, on the oxygen sensor LSF, the solid-state electrolyte is made up of ceramic sheets, thereby allowing a very flat design (planar) The oxygen sensors up and downstream of the catalytic converter have different part numbers.

Special characteristics of the oxygen sensor LSF:

- Quickly operational
- Low heating power demand
- Stable regulating characteristics
- Small overall size, low weight

The sensor element of the oxygen sensor LSF is made up of ceramic sheets and has the form of a rectangular wafer with rectangular cross section. The individual function layers (electrodes, protective layers, etc.), are produced with screen printing technique. The laminating of various printed sheets on top of each other allows for a heater to be integrated in the sensor element.



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1 - Exhaust gas

2 - Reference air channel

3 - Heating element

U_S - Oxygen sensor voltage

If an incorrect signal is sent by the transmission oil temperature sensor, a pneumatic fault occurs at the coolant shut-off valve of the transmission oil cooler or the coolant thermostat is defective, a coolant temperature sensor fault may be stored (on the basis of a temperature model stored in the control unit).

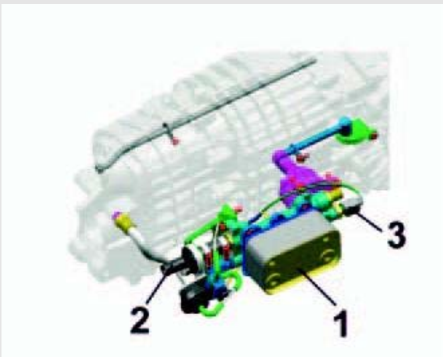
Transmission oil temperature sensor

On the gearbox of 911 GT3 a transmission oil temperature sensor is screwed into the bracket support of the transmission oil/coolant heat exchanger, which sends the transmission oil temperature to the Motronic control unit. The coolant shut-off valve on the heat exchanger to cool the transmission oil is actuated according to the incoming transmission oil and coolant temperature.

The switching points are:

- Coolant circuit open (de-energised):
  coolant temperature >100 °C, or transmission oil temperature >105 °C.
- Cooling circuit closed (energised):
  coolant temperature < 90 °C and transmission oil temperature < 95 °C.

Information on the topic Voltage Supply of the Motronic Systems can be found in the chapter Electrical system.



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1 - Oil-to-water heat exchanger

2 - Coolant shut-off valve

3 - Temperature sensor