AfterSales Training

911 Turbo/GT2/GT3 Engine Repair

P10T

Porsche AfterSales Training

Student Name: ____

Training Center Location: ____

Instructor Name: ____

Date: _________________

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Part Number - PNA P10 T02 Edition - 9/06

Engine Number Identification

Digit: **1 2 3 4 5 6 7 8**

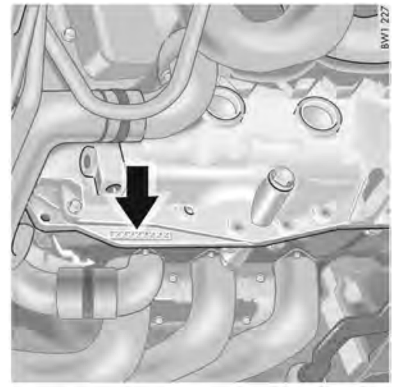
Example: 6 5 V 0 0 1 3 6

Engine Type: (6 = 6 Cyl. Engine)

Engine Version:

Model Year:

Serial Number:



Engine number is stamped on the bottom of the crankcase.

911 and Boxster Engine Type Designations Since Model Year 1984

Model Year	Engine Type	Displ. Liters	Engine Power kW / HP	Installed In
1984	930.20	3.2	170/231	911 Carrera - RoW
	930.21	3.2	152/207	911 Carrera - USA/Canada/Japan
	930.66	3.3	221/300	911 Turbo - Worldwide
1985	930.20	3.2	170/231	911 Carrera - RoW
	930.21	3.2	152/207	FRG/USA/Canada/Japan (with catalytic converter)
	930.26	3.2	170/231	Sweden /Switzerland /Australia
	930.66	3.3	221/300	911 Turbo - Worldwide
1986	930.20	3.2	170/231	911 Carrera - RoW
	930.21	3.2	152/207	911 Carrera USA/Canada/Japan
	930.26	3.2	170/231	911 Carrera Sweden./Switzerland/Australia
	930.66	3.3	221/300	R0W/Canada
	930.68	3.3	208/282	911 Turbo - USA (with catalytic convverter)
1987	930.20	3.2	170/231	911 Carrera - RoW
	930.25	3.2	160/217	USA / Japan
	930.26	3.2	170/231	Sweden
	930.66	3.3	221/300	RoW/Canada
	930.68	3.3	210/282	USA (with catalytic converter)
1988	930.20	3.2	170/231	911 Carrera - RoW
	930.25	3.2	160/217	USA/Japan/Canada/Australia/RoW (with catalytic conv.)
	930.26	3.2	170/231	Sweden
	930.66	3.3	221/300	Turbo RoW
	930.68	3.3	210/282	Turbo USA/Canada
1989	930.20	3.2	170/231	911 Carrera - RoW
	930.25	3.2	160/217	USA/Canada/Japan/Australia/RoW (with catalytic conv.)
	930.66	3.3	221/300	911 Turbo - RoW
	930.68	3.3	210/282	911 Turbo - USA
	M 64.01	3.6	184/250	911 Carrera 4 (964) - Worldwide
1990	M 64.01	3.6	184/250	911 Carrera (964) 2/4 with manual transmission - Worldwide
	M 64.02	3.6	184/250	911 Carrera (964) 2 with tiptronic transmission - Worldwide

Engine Type Designations

Model Year	Engine Type	Displ. Liters	Engine Power kW / HP	Installed In
1991	M64.01	3.6	184/250	911 Carrera (964) 2/4
	M64.02	3.6	184/250	911 Carrera (964) 2
	M30.69	3.3	235/320	911 Turbo (964)
1992	M64.01	3.6	184/250	911 Carrera (964) 2/4
	M64.02	3.6	184/250	911 Carrera (964) 2
	M64.03	3.6	191/260	911 Carrera (964) RS
	M30.69	3.3	235/320	911 Turbo (964)
1993	M64.01	3.6	184/250	911 Carrera (964) 2/4
	M64.02	3.6	184/250	911 Carrera (964) 2
	M64.03	3.6	191/260	911 Carrera (964) RS
	M64.50	3.6	265/360	911 Turbo (964)
1994	M64.01	3.6	184/250	911 Carrera (964) 2/4 USA
	M64.02	3.6	184/250	911 Carrera (964) 2 USA
	M64.05	3.6	200/272	911 Carrera (964) RoW
	M64.06	3.6	200/272	911 Carrera (964) RoW & Taiwan with Tiptronic
	M64.50	3.6	265/355	911 Turbo USA/CDN
1995	M64.05	3.6	200/272	911 Carrera (964) RoW
	M64.06	3.6	200/272	911 Carrera (964) RoW
	M64.20	3.7	220/300	911 Carrera (993) RS RoW
	M64.07	3.6	200/272	911 Carrera (993) USA
	M64.08	3.6	200/272	911 Carrera (993) USA
1996	M64.21	3.6	210/285	911 Carrera (993) /C4 /C4S RoW
	M64.22	3.6	210/285	911 Carrera (993) RoW Tiptronic
	M64.23	3.6	210/285	911 Carrera (993) /C4/C4S USA
	M64.24	3.6	210/285	911 Carrera (993) USA Tiptronic
	M64.60	3.6	300/408	911 Turbo (993) RoW and USA/CDN
1997	M64.21	3.6	210/285	911 Carrera (993) /C4 /C4S RoW
	M64.22	3.6	210/285	911 Carrera (993) RoW Tiptronic
	M64.23	3.6	210/285	911 Carrera (993) /C4/C4S USA
	M64.24	3.6	210/285	911 Carrera (993) USA Tiptronic
	M64.60	3.6	300/408	911 Turbo (993) RoW and USA/CDN
	M96.20	2.5	150/204	Boxster
1998	M64.21	3.6	210/285	911 Carrera (993) /C4/C4S RoW
	M64.22	3.6	210/285	911 Carrera (993) RoW Tiptronic
	M64.23	3.6	210/285	911 Carrera (993) /C4 & C4S USA/CDN
	M64.24	3.6	210/285	911 Carrera (993) USA/CDN Tiptronic
	M64.60	3.6	300/408	911 Turbo (993) RoW and USA/CDN
	M96.20	2.5	150/204	Boxster
1999	M96.01	3.4	220/296	911 Carrera (996)
	M96.20	2.5	150/204	Boxster
2000	M96.01	3.4	220/296	911 Carrera (996)
	M96.02	3.4	220/296	911 Carrera (996) 4
	M96.04	3.4	220/296	911 Carrera (996) 2/4
	M96.22	2.7	162/217	Boxster
	M96.21	3.2	185/250	Boxster S

Model Year	Engine Type	Displ. Liters	Engine Power kW / HP	Installed In
2001	M96.01	3.4	220/296	911 Carrera (996)
	M96.02	3.4	220/296	911 Carrera (996) 4
	M96.04	3.4	220/296	911 Carrera (996) 2/4
	M96.22	2.7	162/217	Boxster
	M96.21	3.2	185/250	Boxster S
	M96.70	3.6	309/414	911 Turbo (996)
	M96.70S	3.6	340/456	911 GT2 (996)
2002	M96.03	3.6	232/310	911 Carrera (996) 2/4/4S
	M96.22	2.7	162/217	Boxster
	M96.21	3.2	185/250	Boxster S
	M96.70	3.6	309/414	911 Turbo (996)
	M96.70S	3.6	340/456	911 GT2 (996)
2003	M96.03	3.6	235/315	911 Carrera (996) 2/4/4S
	M96.23	2.7	168/225	Boxster
	M96.24	3.2	191/256	Boxster S
	M96.70	3.6	309/414	911 Turbo (996)
	M96.70S	3.6	340/456	911 GT2 (996)
2004	M96.03	3.6	235/315	911 Carrera (996) 2/4/4S
	M96.03S	3.6	254/340	911 Carrera (996) 2/4/4S (Special Model - 40 Year)
	M96.23	2.7	168/225	Boxster
	M96.24	3.2	191/256	Boxster S
	M96.70	3.6	309/414	911 Turbo (996)
	M96.70SL	3.6	355/476	911 GT2 (996)
	M96.79	3.6	284/381	911 GT3 (996)
2005	M96.03	3.6	235/315	911 Carrera (996) 2/4/4S
	M96.05	3.6	239/325	911 Carrera (997)
	M97.01	3.8	261/355	911 Carrera S (997)
	M96.25	2.7	176/240	Boxster (987)
	M96.26	3.2	206/280	Boxster S (987)
	M96.70	3.6	309/414	911 Turbo (996)
	M96.70S	3.6	340/456	911 GT2 (996)
	M96.79	3.6	280/381	911 GT3 (996)
2006	M96.05	3.6	239/325	911 Carrera 2/4 (997)
	M97.01	3.8	261/355	911 Carrera 2/4 S (997)
	M96.25	2.7	176/240	Boxster (987)
	M96.26	3.2	206/280	Boxster S (987)
	M97.21	3.4	217/295	Cayman S (987)
2007	M96.05	3.6	239/325	911 Carrera 2/4 (997)
	M97.01	3.8	261/355	911 Carrera 2/4 S (997)
	M97.20	2.7	180/245	Boxster (987)
	M97.21	3.4	217/295	Boxster S (987)
	M97.20	2.7	180/245	Cayman (987)
	M97.21	3.4	217/295	Cayman S (987)
	M97.70	3.6	353/480	911 Turbo (997)
	M97.76	3.6	305/415	911 GT3 (997)

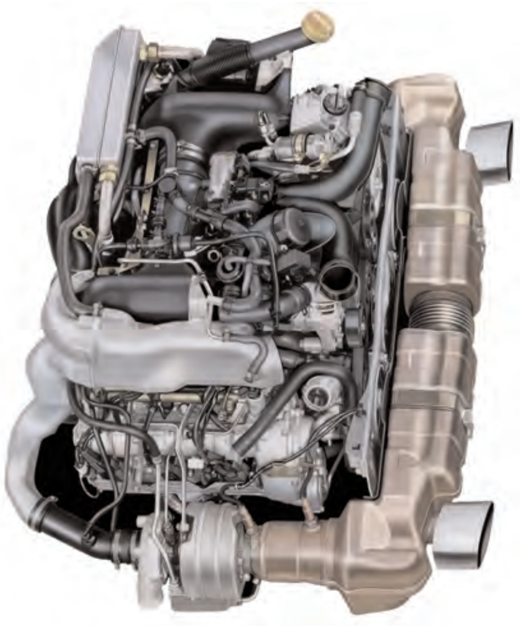
***** The HP number over the years has been listed in SAE or DIN. (Kw to SAE HP factor is x 1.34, SAE HP to DIN HP factor is x 1.014)

Notes:


S MU 5766

Notes:

Engine



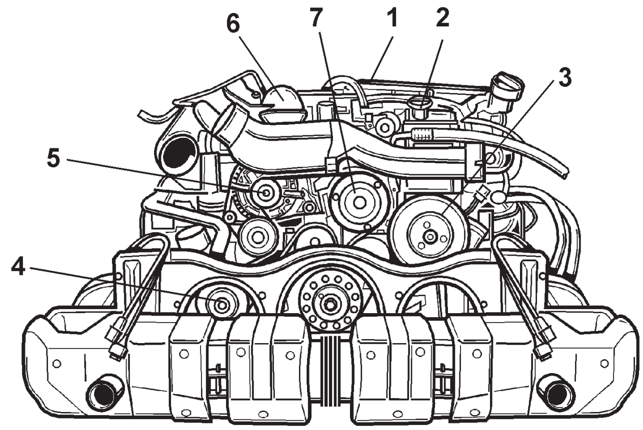
General

M96.70

The engine of the 911 Turbo is an evolution of the 6-cylinder Boxer engine from the 911 GT1. During development of this new turbo engine, special attention was directed at reducing fuel consumption while simultaneously increasing the power output of the engine.

The outstanding features of the engine are:

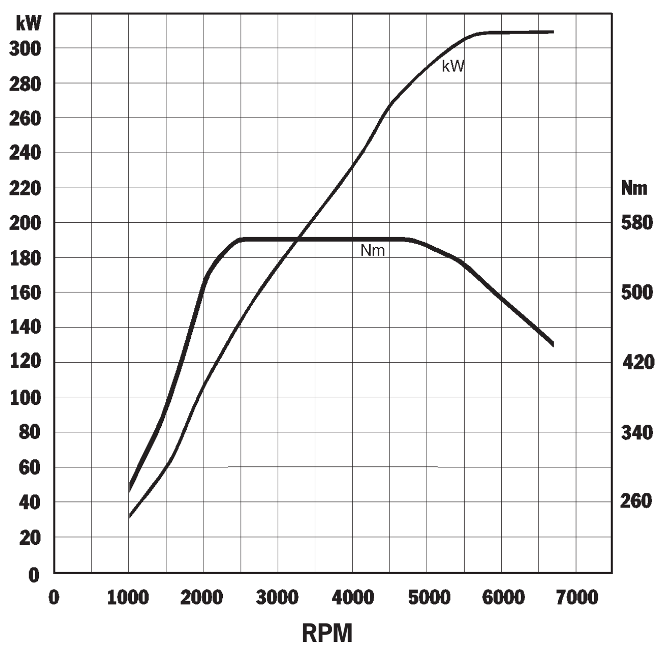
- Two-piece crankcase
- Crankcase with 8 bearing points
- Four-valve technology
- Valve stroke control on inlet side with axial camshaft adjustment (VarioCam Plus)
- Flat-base tappets with hydraulic valve clearance compensation
- Solid-state HT distribution with separate ignition coils for each cylinder
- Dry-sump lubrication with oil reservoir attached to engine, oil returned via two suction pumps per cylinder head, and one central oil return pump
- On-board diagnostic system world-wide
- Reduction of fuel consumption



Component Location

1 - Oil reservoir
2 - Servo reservoir
3 - Steering hydraulics pump
4 - Coolant pump
5 - AC generator
6 - Oil filter housing
7 - Air conditioning compressor

Power/Torque Diagram

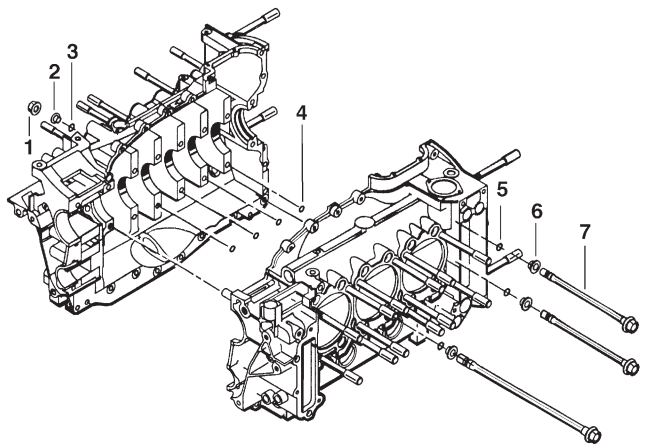


Engine Data:

Displacement	3.6 l
Bore	100 mm
Stroke	76.4 mm
Power output	309 kW/414 HP
at engine speed	6000 rpm
Max. torque	413 ft lbs (560 Nm)
at engine speed	2700 - 4600 rpm
Compression ratio	9.4 : 1
Governed speed	6750 rpm
Fuel grade	93 Octane (Premium Unleaded)

Crankcase

The crankcase is divided into two sections and is made of an aluminum/silicon alloy. The two halves of the crankcase are machined together. It is, therefore, important to ensure that the pairing numbers match when the crankcase is assembled.



Crankcase Components

A ring groove has been cut into the hole for the through bolt of main bearing seat 7. It is a relief groove and prevents oil from being discharged from the joint between the two crankcase halves. It is important to ensure that this groove is free of sealing compound and dirt particles.

The crankcase is bolted together with through bolts (7) which are sealed by means of round seals (3 and 5) and sealing washers (2 and 6). In addition, O-rings (4) are also attached to the lower part of main bearing seats 2, 3, 4 and 5 in order to reduce vibration along the through bolts.

Crankshaft

The crankshaft is drop-forged. The shaft has full bearing support, i.e. every connecting rod pin is supported by 2 main bearings, resulting in 8 main bearing points. Main bearing 1 (flywheel end) is configured as a thrust bearing so that it can absorb the axial forces acting on the crankshaft. The structural design restricts the axial clearance to 0.11...0.20 mm.

The main bearings are supplied with lubricating oil directly from the main oil gallery of the crankcase, whereas connecting rod bearings 4, 1 and 5 are supplied with oil from main bearing 1 and connecting rod bearings 3, 6 and 2 from main bearing 8 via a channel in the crankshaft. This ensures a continuous supply of oil to the connecting rod bearings.

After machining, the crankshaft is plasma-nitrided. This elaborate surface treatment technique gives the main and connecting rod bearing pins excellent surface properties. The crankshaft has a stroke of 76.4 mm.

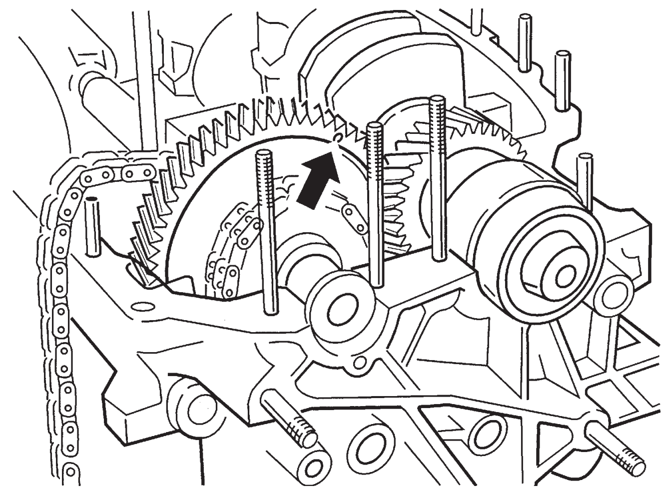
Torsional Vibration Damper

The torsional vibration damper is attached to the crankshaft cone and is also designed as a belt pulley. Its task is to absorb the torsional vibrations of the engine which are produced by inertia and gas forces.

This is achieved by means of a rotating mass which is attached to the steel hub via a torsionally resilient element. The characteristic vibrations of the torsional vibration damper counter and thus absorb the vibrations along the crankshaft.

Intermediate Shaft

The intermediate shaft is driven by the crankshaft via spur gears. In order to ensure that the engine runs smoothly and to reduce wear, the gears are made of steel and manufactured in pairs. The chain sprockets on the intermediate shaft which drive the camshafts are made of sintered steel.



Location of Intermediate Shaft Code

The code on the intermediate shaft gear (arrow) and on the left half of the crankcase indicate tolerance group 0 or 1 (eccentricity in the crankcase). At the end of the intermediate shaft is an intermediate part which is linked to and drives the oil pump. When the intermediate shaft and the oil pump are fitted, it is important to ensure that the intermediate part has axial clearance. As with the 911 Turbo (993), the double oil pump for the turbocharger is driven via TORX gearing.

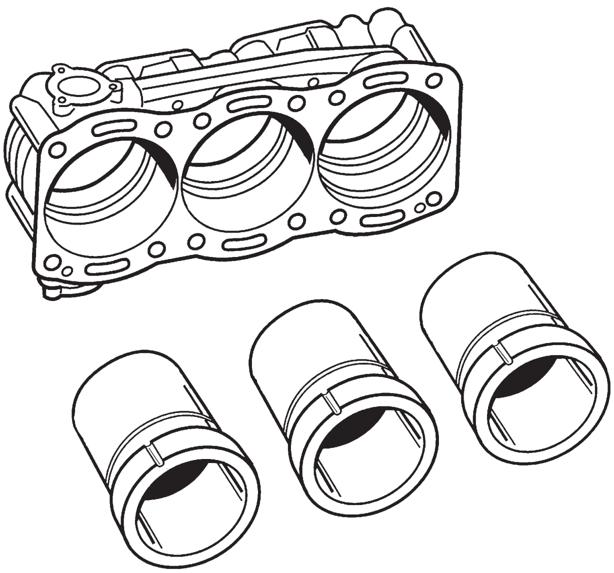
Notes:

Connecting Rods

The connecting rods are the same as those used in the 911 Turbo (993).

Cylinders

In order to increase torsional rigidity, the two cylinder banks (each with 3 cylinders) are housed in a single cylinder case. In contrast to the previous model, these cylinder cases are separate components and are not joined to the crankcase.



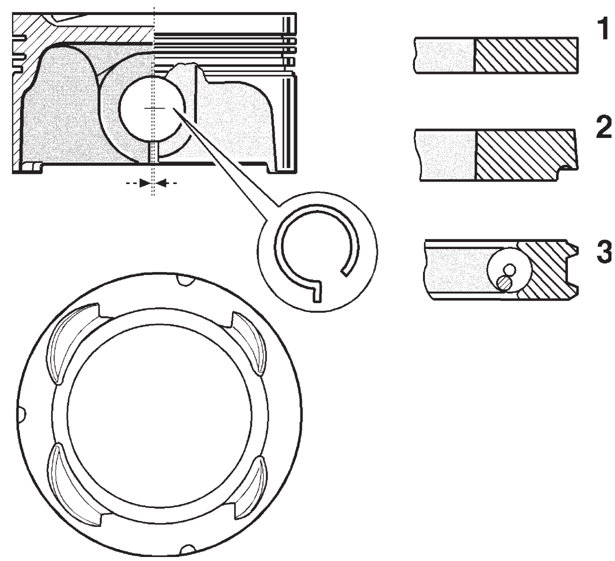
Cylinder Case and Sleeves

Cylinder sleeves made of aluminum and coated with Nikasil are used in the light-alloy cylinder cases. The coolant chamber between the cylinder sleeves and cylinder case is sealed by means of O-rings. The joint between the crankcase and cylinder case is sealed using coated triple-layer sheet-metal gaskets.

Notes:

Pistons

The molded light-alloy pistons have a diameter of 100 mm. The fire land of the pistons is not smooth but rather grooved in order to increase its surface area and thus to reduce the thermal load on the fire land. Furthermore, the bearing surface of the pistons is coated with graphite to reduce the level of noise. The piston pin is on a full-floating bearing and oil spray is used for lubrication. The piston-pin circlip is twist-locked.



Ring 1 - Taper-face ring 100 x 1.75mm
Ring 2 - Stepped taper-face ring 100 x 1.75mm
Ring 3 - Bevel-edged ring with spiral-type expander (SSF ring)

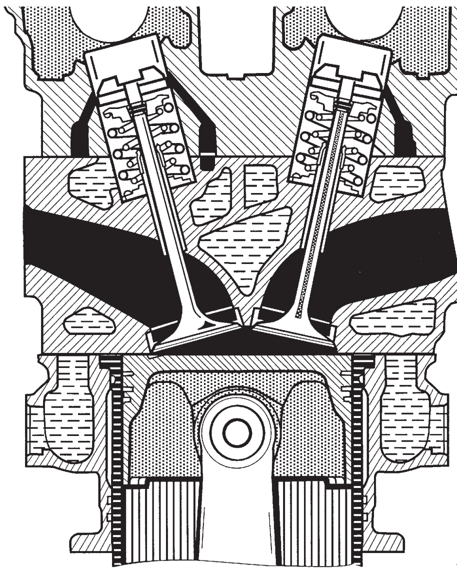
Notes:

Piston Cooling

Oil spray jets are fitted in the crankcase to reduce the temperature of the pistons. The jets have an opening pressure of approx. 1.8 bar to ensure that the engine oil pressure is maintained at low engine speeds and high engine oil temperatures.

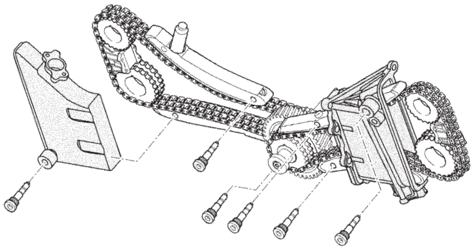
Cylinder Head

The cylinder heads are made of the extremely heat resistant light alloy RR350. The inlet and exhaust ports are machined to improve the charge cycle and thus power output. The combustion chambers are designed as spherical cups.



Cylinder Head Cut-out

The two inlet and two exhaust valves serving each cylinder have a diameter of 41 mm and 35 mm respectively around the valve disc. They are arranged in a “V” at an angle of 27.4°. The diameter of the valve stem is 6 mm in order to keep the moving masses of the valve gear as low as possible. The exhaust valve stem is hollow and filled with sodium to improve heat dissipation. Due to the power-oriented valve timing and the associated high forces, double valve springs are used to close the inlet and exhaust valves. This also safeguards the engine speed stability of the 911 Turbo engine which is designed for high engine speeds.



VarioCam Plus System Layout

A separate inlet and exhaust camshaft is used for each cylinder bank. These camshafts are driven directly by a double roller chain. The chains are guided by plastic guide rails and hydraulic chain tensioners located at the untensioned end of the chain. The inlet camshafts in the new 911 Turbo also have a valve stroke control on the inlet side in addition to the VarioCam Plus system (the system is described in a separate section). This optimizes the compromise between maximum power output and maximum torque while simultaneously reducing fuel consumption and improving running smoothness. A driving flange for the oil suction pump is attached on the input side of each exhaust camshaft.

Cylinder Head Gasket

The multi-layer steel gasket is completely covered with high-temperature resistant plastic in order to enhance the sealing quality of its surface. The advantage of this steel gasket is that heat can be dissipated from the cylinder head very efficiently.

Notes:

Camshaft Housing

The light-alloy camshaft housing is attached to the cylinder head. The inlet and exhaust camshafts are held in the camshaft housing by means of bearing brackets. The bearing brackets and camshaft housing are machined together and have pairing numbers.

Camshafts

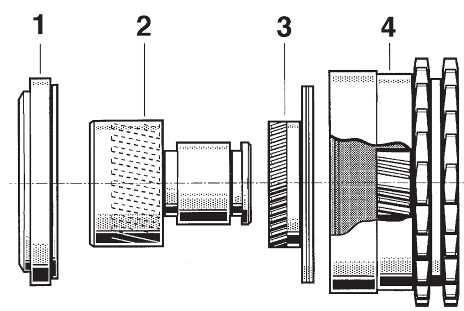
The camshafts are hard-chilled components and hollow-cast to reduce weight. The shank diameter of all camshafts is 26.6 mm. The inlet valve stroke is variable (3.0 mm or 10.0 mm).

Camshaft adjustment with valve stroke control (VarioCam Plus)

The demands placed on the design of an engine, i.e. increased performance, improved driving comfort, observance of legal emission limits and reduced fuel consumption, result in contradictory construction criteria.

The idea behind the development of the VarioCam Plus was to create a variable engine which can be optimized both for maximum performance and for frequent use in urban traffic or on country roads. A system to adjust the inlet camshaft to vary the opening and closing time combined with a valve stroke adjustment system is the solution to this problem.

Functional description of camshaft adjuster

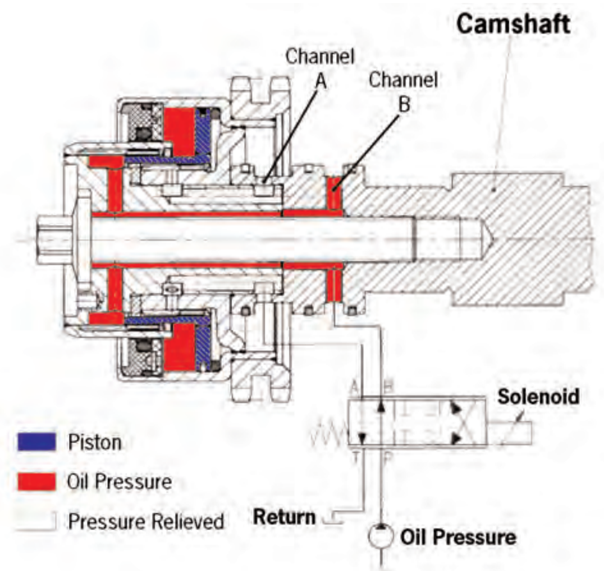


The camshaft adjustment system is based on the principle of a helical sliding gear which has a cylindrical component (3) between the camshaft gear and camshaft stub. The cylindrical component has helical gearing both inside and outside. The inner gearing engages with matching gearing on the inside of the camshaft gear (4). The outer gearing engages with gearing (2) mated to the camshaft stub. At the same time, the cylinder (3) forms a piston on the side facing away from the camshaft. This piston can be moved by oil pressure. A number of teeth have been removed from the gearing to ensure that the oil pressure can act on the piston instantaneously without loss. The component is sealed with a sealing ring (1) and cannot be disassembled. The oil pressure is regulated on both sides by means of a 4/3-way valve.

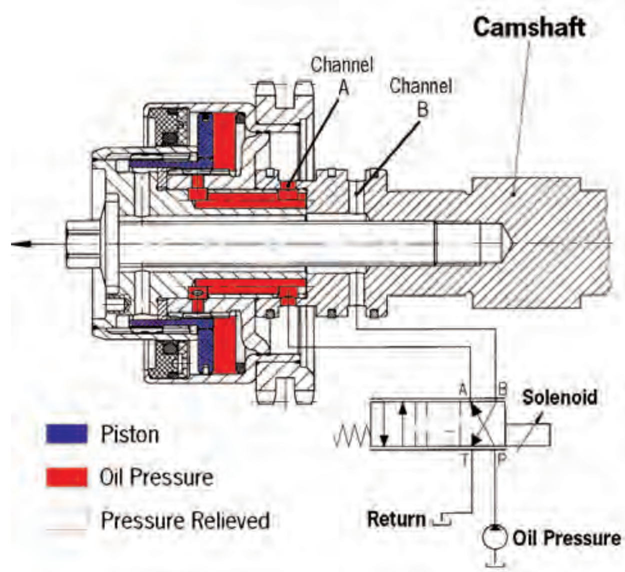
Solenoid Valve

The solenoid valve is configured as a 4/3-way valve. It is actuated by the DME control unit.

Piston position: retarded
(minor valve overlapping)



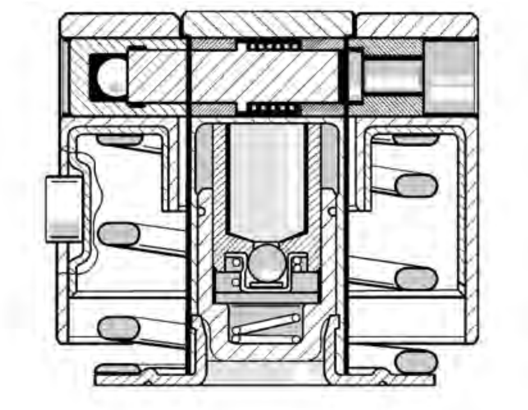
Piston position: advanced
(major valve overlapping)



Notes:

Functional description of valve stroke adjustment

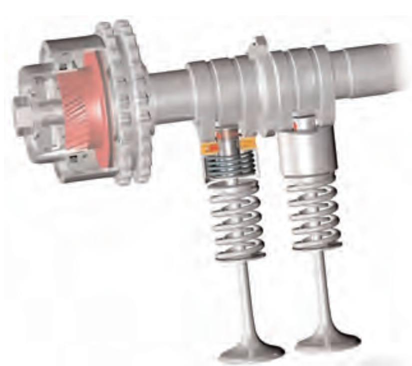
The valve stroke adjustment system consists of switchable flat-base tappets which are actuated by means of an electrohydraulic 3/2-way valve. Since two different cam shapes are used on the camshaft, it is possible to select the different cams (switching the flat-base tappets) so that their respective valve stroke characteristics act on the engine. These flat-base tappets are mounted on the inlet side of the engine. The flat-base tappets consist of two nested tappets which can be interlocked hydraulically by means of a pin. Once interlocked, the inner tappet comes into contact with the small cam and the outer tappet with the large cam. An element for compensating the valve clearance is always integrated in the power flow of the tappet.



Flat-base Tappet Cutout

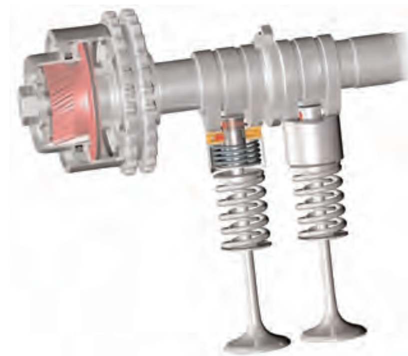
Switching strategy of VarioCam Plus

In **idle speed range**, the valve stroke is switched to a small cam of 3.0 mm and the cam timing is set to minor valve overlap to optimize engine efficiency. This results in reduced friction due to the small valve stroke; a greater charge movement due to the short opening times, and reduced exhaust gas scavenging into the combustion chamber. These measures result in reduced fuel consumption and lower exhaust emissions while simultaneously improving idle speed quality.



VarioCam Plus shown in idle speed range – inner tappet controls valve stroke (3mm valve lift) and camshaft adjuster unit is in "retard" position (minor overlap).

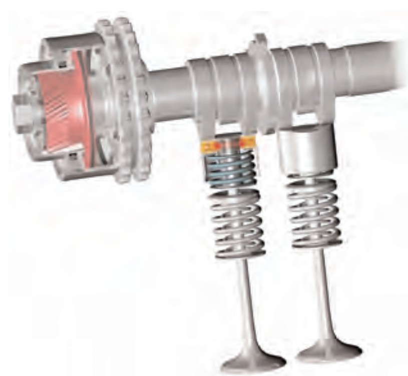
In the **part-load range**, the small valve stroke remains, but engine timing is set to major valve overlap. As a result, a large volume of exhaust gas is drawn back for very smooth combustion and a reduction in consumption.



VarioCam Plus shown in part-load range – inner tappet controls valve stroke (3mm valve lift) and camshaft adjuster unit is in "advance" position (major overlap).

In the **upper full-load range**, the system is switched over to both the large valve stroke and major valve overlap which results in an uncompromising high torque and peak power output.

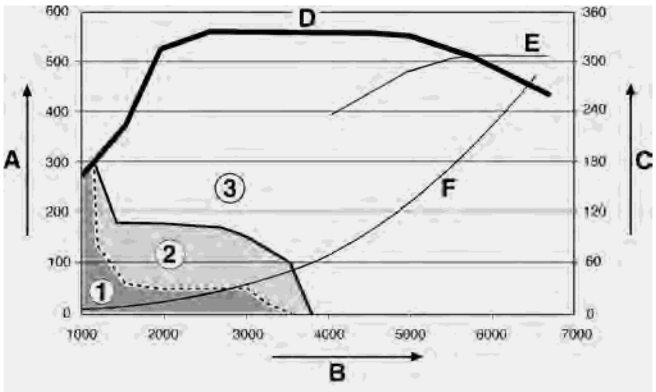
The two individual systems of the VarioCam Plus (camshaft adjustment and valve stroke control) are activated by the DME 7.8 engine control unit.



VarioCam Plus shown in upper full-load range – tappet is interlocked (10mm valve lift) and camshaft adjuster unit is in "advance" position for peak torque and power.

Notes:

The ME 7.8 engine control unit has been specially developed for the requirements of the VarioCam Plus system. The input variables (engine speed, position of accelerator pedal, engine oil temperature, coolant temperature and gear detection) are needed to control the VarioCam Plus. The driver's torque and power requirements are compared with the control unit maps and then a decision is made as to whether the VarioCam Plus system has to be switched and, if so, which configuration is necessary.



VarioCam Plus Operation Chart

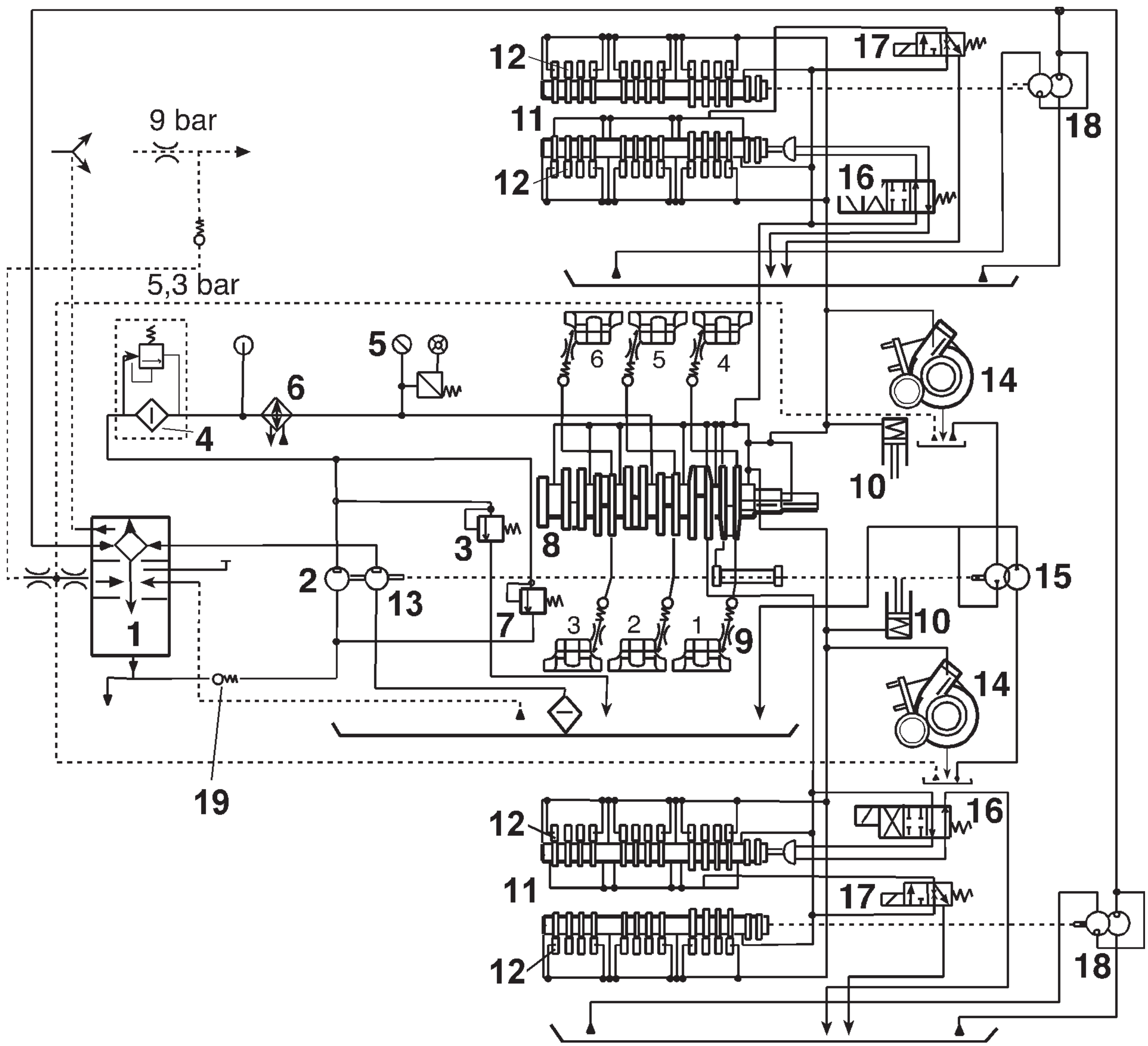
1 - Idle-speed range
2 - Part-load range
3 - Full-load range

A - Torque (Nm)
B - Engine speed (rpm)
C - Power output (kW)
D - Torque curve
E - Power output curve
F - Road resistance in top gear

To ensure that the engine runs smoothly during a switching operation, major adjustments are required in the engine control system. The engine is designed in such a way that maximum vehicle speeds of approx. 150 km/h (90 mph) are possible with the small valve stroke. In the case of the large valve stroke with power-oriented engine timing, speeds of over 300 km/h (180 mph) are possible.

The switching operation inside the engine must, however, go unnoticed by the driver, despite the major change in configuration. This is only possible with modern control units and powerful processor technology. In addition, an electronic accelerator pedal is also required.

Notes:



Oil Circuit

1 - Oil reservoir
2 - Pressure pump
3 - Safety valve
4 - Oil filter
5 - Oil pressure sensor
6 - Oil-to-water heat exchanger
7 - Pressure limiting valve
8 - Crankshaft
9 - Piston spray jet
10 - Chain tensioner
11 - Camshaft
12 - Flat-base tappet
13 - Suction pump
14 - Turbocharger
15 - Double suction pump
16 - Camshaft adjuster
17 - Valve stroke adjuster
18 - Oil return pump
19 - Non-return valve

The 911 Turbo engine has a dry-sump lubrication system with separate oil reservoir (1). A double oil pump, which is driven by the intermediate shaft, is fitted in the crankcase. The pressure pump (2) draws the oil out of the oil reservoir (1) and supplies oil to all bearing points, chain tensioners (10), cam surfaces, hydraulic flat-base tappets, camshaft adjusters (16) and the piston spray jets (9) used to cool the pistons. The suction pump (13) is fitted in the same housing as the pressure pump (2). It draws the foaming oil out of the crankcase via two suction snorkels and feeds it back to the oil reservoir (1).

Since the pump has a low level of efficiency (on account of the air in the oil that it pumps), it must be dimensioned accordingly. A double suction pump (15), which draws oil out of the two turbochargers and is driven via the intermediate shaft, is fitted in the coolant pump housing.

The engine oil is filtered before it enters the engine by means of a filter (4) fitted on top of the engine in the main oil gallery. For safety reasons, a pressure relief valve (7) and safety valve (3) are fitted in the main oil gallery. The pressure relief valve (7) is located in the right-hand half of the crankcase, opens at 5.3 bar and then allows the oil to pass into the inlet port until the pressure drops again. The safety valve is fitted in the oil circuit immediately downstream of the pressure pump outlet. Its task is to function as a safety valve if the pressure relief valve should fail. The opening pressure is 9 bar in order to prevent damage to the sealing rings, oil-to-water heat exchanger (6) and the oil circuit.

Non-return Valve

Due to the extremely low position of the turbochargers, an additional non-return valve (19) has been integrated in the engine oil circuit to prevent the oil in the oil reservoir from emptying into the crankcase. This ensures that the turbochargers are not flooded with oil from the crankcase when the vehicle is parked on an incline. The non-return valve is located in the intake pipe of the engine.

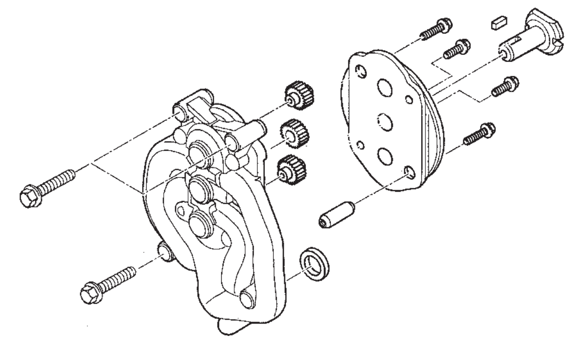
Engine Oil Change Interval

The change interval for the engine oil is 20,000 km (12,000 miles). The change interval for the filter is 40,000 km (25,000 miles).

Notes:

Oil Pumps

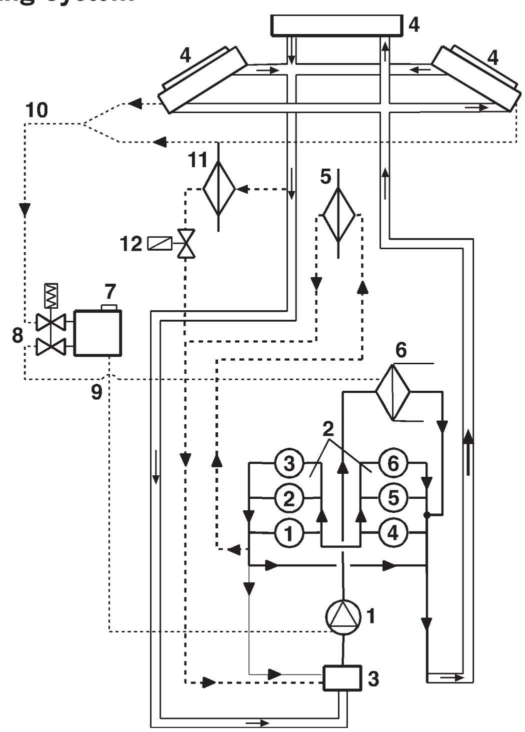
Due to the design of the engine, a large quantity of oil could collect in the cylinder head during extreme cornering manoeuvres. To prevent this, each cylinder head has its own non-return pump (18) to draw off any excess oil.



Oil Pump Construction

The principle of cross-flow cooling is implemented to ensure uniform distribution of the coolant. This prevents a difference in temperature between the individual cylinders.

Cooling System



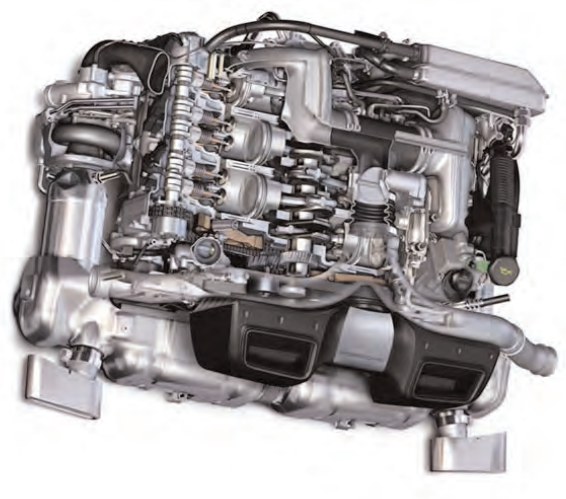
1 - Coolant pump
2 - Crankcase
3 - Thermostat
4 - Radiator
5 - Heat exchanger
6 - Oil-to-water heat exchanger
7 - Expansion tank
8 - Shut-off valve
9 - Bleeder pipe (engine)
10 - Bleeder pipe (radiator)
11 - Oil-to-water heat exchanger (Tiptronic only)
12 - Shut-off valve (Tip.only)

The coolant expansion tank is located on the left-hand side of the engine compartment.

Notes:

Notes:

Engine



General

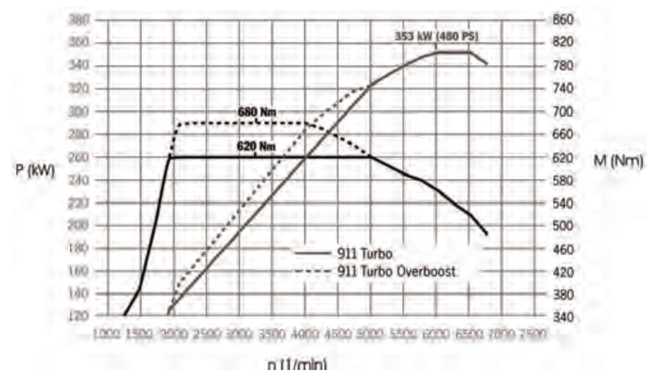
M97.70

The engine of the new 911 Turbo, with its 3.6 liter displacement, is a further development based on the 911 Turbo (996). Porsche used a variable-geometry turbocharger for the first time with this engine. This technology permits extremely fast boost pressure build-up with good response characteristics, high torque values even at low engine speeds and over a wide rpm range, as well as high maximum power combined with low fuel consumption.

Summary of Modifications

- Variable-geometry turbocharger
- Higher power and torque values
- Component reinforcement
- Overboost function in conjunction with the “Sport Chrono Package Turbo” option
- Advanced VarioCam Plus
- Further developed dry sump lubrication with 9 oil pumps
- Increased cooling performance, including 2-stage oil cooling
- Enhanced charge air cooling

Power/Torque Diagram



Engine Data:

Displacement	3,600 cm^3
Bore	100 mm
Stroke	76.4 mm
Power output	480 bhp (353 kW)
At engine speed	6,000 rpm
Max. torque	460 ft lb. (620 Nm)
At engine speed	1,950 - 5,000 rpm
Max. torque (Overboost)	505 ft lb. (680 Nm)
At engine speed	2,100 - 4,000 rpm
Compression ratio	9.0 : 1
Governed speed	6,750 rpm (6th gear 6,800 rpm)
Idling speed	740 +/- 40 rpm

Crankshaft

A reduction in weight was achieved through a deeper central bore in the crankshaft on the pulley side.

Connecting Rod Bearings

"Sputtered bearings" are mounted on the rod side as connecting-rod bearings. Sputtered bearings are high-performance bearings. Higher engine output powers require materials with a significantly higher fatigue strength, lower wearing rate, and good corrosion resistance at high temperatures, particularly for the connecting-rod bearings.

These complex requirements are met by way of cathode sputtering. Micro-particles are ejected from a donor material in a high vacuum. These particles are applied uniformly to the part which is to be coated using electromagnetic fields. These magnetron layers are characterized by extremely fine distribution of the individual structural elements. The basis is the already known three-component bearing. The sputtered bearing has a conventional bearing structure, with the top plated layer replaced with a sputtered lining.

Note:
Two lugs are provided for the twist lock in order to ensure that the sputtered bearings are mounted on the rod side. In addition, the identification "Sputter" is provided on the rear of the bearing.

Connecting Rods

The connecting rods have been left practically unchanged, apart from the fact that two grooves have been incorporated on the rod side for the sputtered bearing twist lock.

Pistons

The pistons are of a symmetrical design; arrows are provided on the piston crown to indicate the installation position. When installing the pistons, it must be ensured that these arrows point in driving direction.

Piston Rings

Three-part rail rings are used as oil scraper rings on the new 911 Turbo in order to reduce the "blow by" gases, which results in a reduction of oil consumption. These very thin rings are able to adapt themselves optimally to the cylinder shape, thereby optimizing sealing quality.

Cylinder Base Seal

A three-part cylinder base seal is used here in order to improve the sealing quality between the crankcase and the cylinder housing. The seal of the new 911 Turbo is 0.3 mm thicker than the seal used in the past.

Cylinder Housing

The cylinder housing and cylinder sleeves have been shortened by 0.3 mm in order to maintain the same overall cylinder height and compression ratio.

Valve Drive

The new 911 Turbo uses a rotary-vane vane actuator, familiar from the 911 Carrera, for continuous adjustment of the intake camshaft. The adjustment range of the actuator is 40° crank angle.

The small valve lift was increased from 3.0 mm to 3.6 mm in order to make more efficient use of the advantages of VarioCam Plus with continuous camshaft adjustment and a larger adjustment range compared with the 911 Turbo (996) with respect to consumption, output and exhaust emissions. The large valve lift was left at 10.0 mm.

Valve Springs

The exhaust backpressure is also increased as a result of the increase in the boost pressure in order to achieve higher torque and power output in the middle rev range. The valve spring assembly was modified in order to ensure that the exhaust valves are reliably closed.

This was achieved by a progressive design without increasing the friction losses or producing excessive pressure at the contact point between the cam and tappet.

Flat-base Tappets

The shape of the hydraulic tappets on the exhaust side has been optimized by providing them with a reinforced base while leaving the overall weight unchanged in order to guarantee the service life of the tappets.

Camshafts

The camshafts and timing have been optimized for the new engine.

Timing in retarded setting at 1 mm valve lift and zero play:

Intake opens, large stroke . . . . .20° before TDC
Intake closes, large stroke . . . . .50° after BDC
Intake opens, small stroke . . . . .30° after TDC
Intake closes, small stroke . . . . .30° before BDC
Exhaust opens . . . . .40° before BDC
Exhaust closes . . . . .9° before TDC

Chain Drive

The timing chains have been lengthened by two chain links compared with the previous engine in order to compensate for the thermal expansion of the engine. As a result, it was also necessary to adapt the guide rails and chain tensioners.

Vacuum Pump

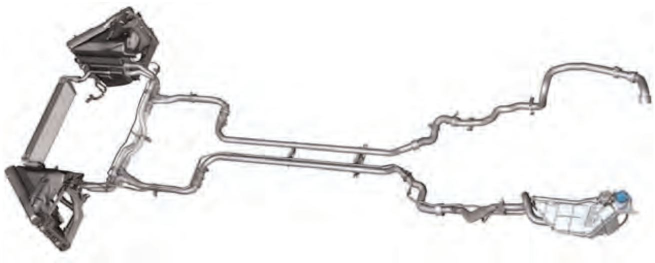
Similar to the current 911 generation, the new 911 Turbo also has a mechanically driven vacuum pump that uses rotary vane technology. This replaces the conventional vacuum amplifier to provide the vacuum for the brake booster and for activating various switching valves. It is located on the cylinder head of cylinder bank 1-3 and is driven by the corresponding exhaust camshaft.

Oil Supply

The oil supply of the new 911 Turbo is provided by way of the familiar and proven dry sump lubrication. An additional oil extraction pump is installed in the front area of the crankcase since the extreme deceleration values of this vehicle can result in oil collecting in this area.

Notes:

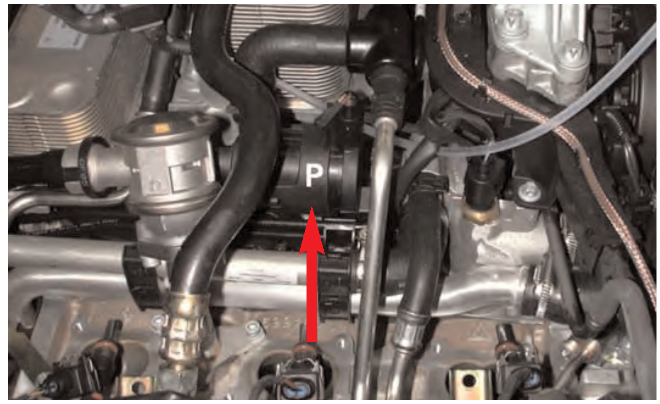
Cooling



In order to take into account the higher cooling requirement of the engine oil on the new 911 Turbo, the waste heat is now dissipated into the coolant by way of two oil-water heat exchangers instead of one (996 Turbo). As a result, it was possible to increase the cooling performance by more than 15 %.

The second heat exchanger is located in the return line to the oil tank. This arrangement reduces any possibility of increased resistance from the second heat exchanger, and ensures that the engine is adequately supplied with oil. In addition, heat transfer to the coolant and therefore also the cooling performance is increased since the temperature in the return line is higher than in the oil pressure line. Routing of the coolant lines ensures optimum distribution to the heat exchangers and other fluid-cooled components.

The heat from the coolant is dissipated to the environment by way of side radiator modules located on the left and right in front of the front wheels, as well as a center radiator in the front end. During aerodynamic development of the front end, particular attention was paid to increasing the cooling air throughput in order to permit dissipation of the additional heat produced by the increased engine power while keeping the radiator dimensions unchanged.



For the first time the bearing housings of the turbochargers on the new 911 Turbo are cooled with coolant . This takes place by way of a separate electrically operated pump, which is mounted on the engine behind the secondary air pump (see illustration below, red arrow "P"). This increases coolant throughput at low engine speeds in accordance with the cooling requirement, and also permits efficient cooling of the highly loaded turbochargers when the engine is stopped after the vehicle has been driven with high power demands.

Notes:

Fuel & Ignition System

General

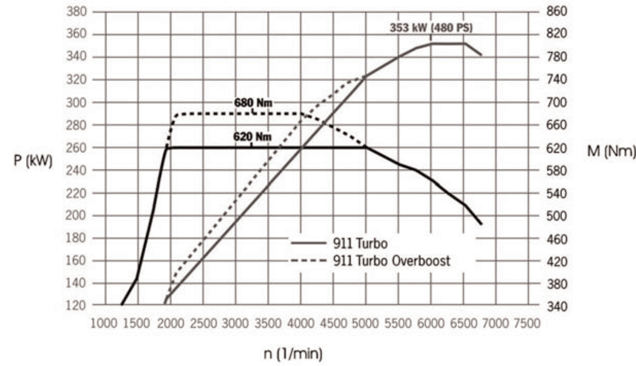
With the new 911 Turbo, Porsche is using a turbocharger with variable turbine geometry on an gasoline fueled engine for the first time. The new 911 Turbo demonstrates once again the pioneering expertise of Porsche, particularly in engine and drive engineering. Exhaust-gas turbocharging is the characteristic feature of a 911 Turbo. The new 911 Turbo sets new standards in the competitive arena with a turbocharging technology for gasoline engines which represents a new development for Porsche. The focus here is on new developments and modifications compared with the 911 Turbo (996). Additional detailed information can be found in the Service Information Technik booklets for the 911 Turbo (996), 911 Carrera (997) and 911 Carrera 4 (997).

Development Objectives

The goal for the new 911 Turbo was to maintain the leading position against the competition, particularly in the areas of Porsche's expertise.

The following modifications were made in Group 2 compared with the 911 Turbo (996):

- Use of a turbocharger with variable turbine geometry to improve response.
- Fuller torque curve, particularly in the lower rpm range.
- Increased maximum torque + 45 ft lb. (60 Nm) and + 90 ft lb. (120 Nm) with Overboost in conjunction with the option Sport Chrono Package Turbo).
- Increased engine power (+ 60 bhp).
- Significantly improved driving performance.
- Reduced fuel consumption.
- Low exhaust emissions (environment).



Engine Data:

n – Engine speed (rpm)
P – Engine power (kW)
M – Engine torque (Nm)

Max. power:	480 bhp (353 kW) at 6000 rpm
Max. torque:	460 ft lb. (620 Nm) at 1950 to 5000 rpm
with Overboost *:	505 ft lb. (680 Nm) at 2100 to 4000 rpm
Max. engine speed:	6750 rpm (6th gear 6800 rpm)
Idling speed:	740 +/– 40 rpm

* Only in conjunction with the "Sport Chrono Package Turbo" option

Motronic Control Unit ME 7.8.1

The further-developed Motronic control unit ME 7.8.1 is used worldwide. It is based on the ME 7.8 of the 911 Turbo (996) and the further development of the current 911 generation. The new Motronic control unit features a processor speed of 40 MHz with a memory capacity of 1 MB.

Electronic Accelerator Pedal Unit

The 911 Turbo (997) is provided with an electronic accelerator pedal unit from the current 911 (997) series.

DME Power Supply

The power supply of the DME control unit is the same as in the current 911 (997) series. The assignment of the fuse carrier, as well as relay carriers 1 and 2, can be found in the circuit diagram on the PIWIS Tester.

Starting The Engine

In order to start the engine it is necessary, after the ignition key has been identified, to fully depress the clutch pedal (vehicles with manual gearbox) or the brake pedal (Tiptronic vehicles). In Tiptronic vehicles, the selector lever must additionally be set to either “P” or “N”.

CAN Networking

As in current (987/997) models, electronic networking in the new 911 Turbo facilitates the exchange of data and electronic information between the various control units throughout the vehicle via the internal high-speed network, the CAN bus (Controller Area Network).

CAN Communication For The Motronic Control Unit (DME)

On the 911 Turbo (997), diagnosis of the DME control unit is performed for the first time via CAN.

The DME control unit communicates with the following control units via CAN:

- Gateway control unit
- Driver authorization control unit
- Tiptronic control unit
- PSM control unit
- PTM control unit
- Steering angle sensor
- Yaw velocity sensor
- Airbag control unit
- Air conditioning control unit

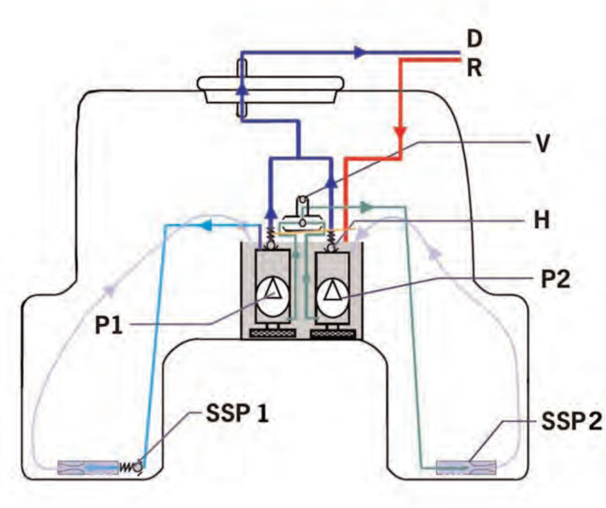
Fuel Supply

Fuel

The engine is designed for operation with unleaded Premium Plus fuel (RON 98), (RON 95 with restricted performance).

Fuel Tank

The tank of the new 911 Turbo corresponds to that of the current 911 Carrera 4 models. With a refill volume of approx. 17.6 gals. (67 liter), this has a capacity of approx. .75 gal. (3 liter) more than the tank of the 911 Turbo (996). The fuel level for the fuel reserve is 2.6 gals. (12 liters). The 911 Turbo (997) still has a return line from the pressure regulator in the engine compartment to the fuel tank. The battery and the battery tray must be removed in order to access the new position of the return line connection.



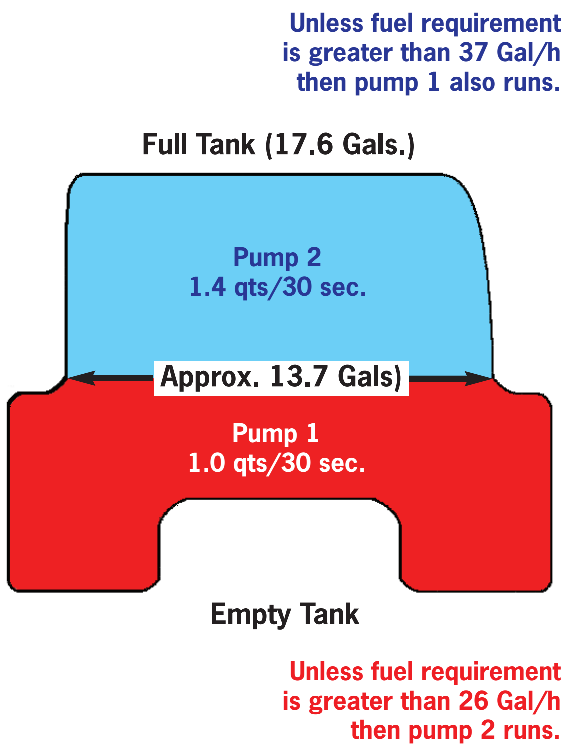
P1	Fuel pump 1
P2	Fuel pump 2
SSP1	Sucking jet pump, right
SSP2	Sucking jet pump, left
H	Pressure holding valve
V	Distributor valve
D	Pressure side to engine
R	Return line from pressure regulator

Fuel Pumps

The fuel tank of the 911 Turbo (997) has 2 fuel pumps which are integrated into the common pump chamber (tandem pump). The fuel pump 1 delivers 1 qt. (1.1 liters) in 30 seconds, and fuel pump 2 delivers 1.4 qts. (1.5 liters) in 30 seconds. The two fuel pump relays are activated as required by way of switching points in the DME control unit.

Fuel pump 1 runs with a tank content of less than 13.7 gal. (52 liters). Fuel pump 2 is activated when a computed fuel requirement of greater than 26 gal/h (100 l/h).

Fuel pump 2 runs with a tank content of greater than 13.7 gal (52 liters). Fuel pump 1 is activated when a computed fuel requirement of greater than 37 gal/h (140 l/h).
The fuel is pumped out of the tank pockets by the two sucking jet pumps. The high-pressure sucking jet pump on the right side of the vehicle is supplied only by fuel pump 1. The low-pressure sucking jet pump on the left side of the vehicle is operated by one or both pumps depending on the fuel level and load condition. The quantity of fuel delivered by both fuel pumps can be checked as described in the Technical Manual.



Fuel Filter

The fuel filter is located on the left-hand side of the engine compartment and must be changed every 60,000 miles (90,000 km) or after 6 years.

Fuel Pressure Regulator

The fuel pressure regulator is installed on the fuel distributor rail on the right (cylinder row 4 - 6 or bank 2) in the engine compartment. A return line runs from the fuel pressure regulator to the fuel tank. The Technical Manual describes how to check the fuel pressure. The holding pressure should be > 29 psi (2 bar) after 1 hour.

Notes:

New EV-14 ST Injection Valve

The advanced EV 14 ST Extended Tip injection valve from the EV series is used. This new 6-hole injection valve has another injection point located in the intake pipe, which results in an even better mixture preparation and therefore a reduction in emissions.

Tank Ventilation System

The compact tank vent valve (TEV-5) in the engine compartment is designed for a higher throughput, especially in the case of small pressure differences compared with the previously installed valve (TEV-2). The tank vent line is routed directly from the tank vent valve into the intake pipe.

Carbon Canister

The functionality of the tank vent systems/carbon canister corresponds to that of the 987/997 vehicles. USA vehicles have a carbon canister with tank leakage diagnostic module (DM-TL) which is located in the front luggage compartment.

Ignition System

The individual ignition coils and spark plug connectors are the same as for the previous model.

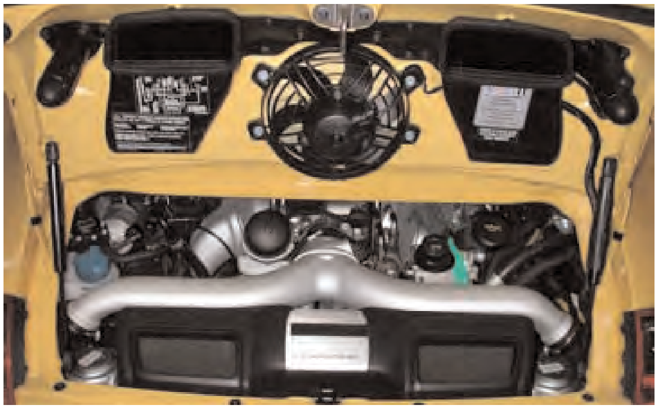
Spark Plugs

New spark plugs are installed. These double-platinum spark plugs (center and ground electrodes are made of platinum) operate in accordance with the air gap principle. The change interval for the spark plugs is 40,000 miles (60,000 km) or after 4 years.

Notes:

Intake Air Side, Air Routing

Rear Lid



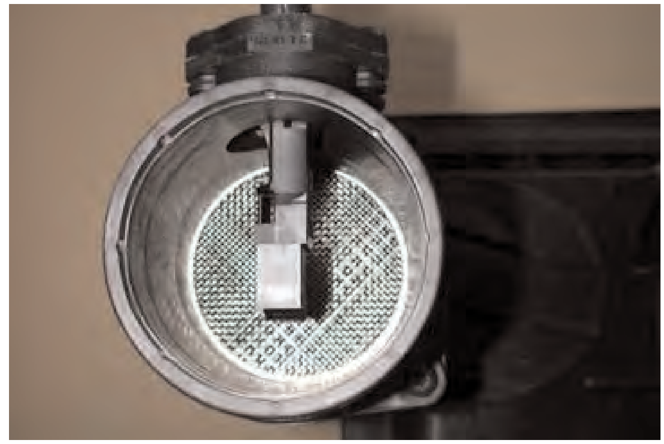
The inner part of the lid has two separate intake ducts which are routed to the air cleaner housing.

Air Cleaner

The air cleaner housing and the air cleaner element were newly developed for the new 911 Turbo. The air cleaner housing was lined inside with foam in order to obtain an optimum intake sound. It was possible to reduce the intake resistance and optimize the charge cycle by way of the 2-channel intake via the rear lid, the new air cleaner element and two separate intake pipes to the turbochargers on the left and right.

In addition, it was also possible to reduce the frequency of cleaner replacement. The air cleaner element now has to be replaced only every 40,000 miles (60,000 km) or after 4 years. The top part of the new air cleaner (housing) has been provided with a design cover made of aluminium to visually upgrade the engine compartment. This cover is embossed with the logo “VARIABLE TURBINE GEOMETRY”.

2 Hot-film Mass Air Flow Sensors HFM 5-6.4



One hot-film mass air flow sensor HFM 5-6.4 is located in each of the turbocharger intake pipes on the left and right behind the air cleaner. The mass air flow sensors are matched to the overall air mass of the engine. Each of the two mass air flow sensors can measure an air mass of up to 800 kg/h.

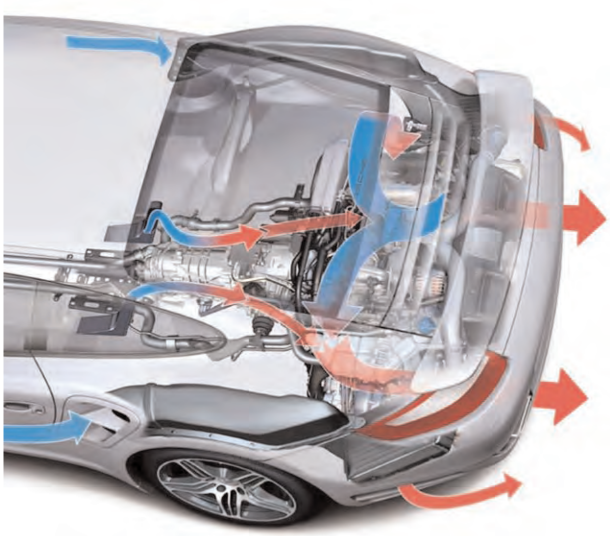
Diverter Control

When the throttle is closed quickly (deceleration), the boost pressure increases in the pressure system in front of the throttle because the compressor of the turbocharger continues running. The new 911 Turbo (997) is also equipped with a diverter valve for each cylinder bank to blow off the excess boost pressure. In contrast to the 911 Turbo (996), however, this is not accommodated separately, but is integrated in a space-saving and compact manner in the compressor housing of the turbocharger. The Motronic control unit activates the electro-pneumatic switching valve, which then opens the diverter valve by means of a vacuum.

Charge Air Cooling

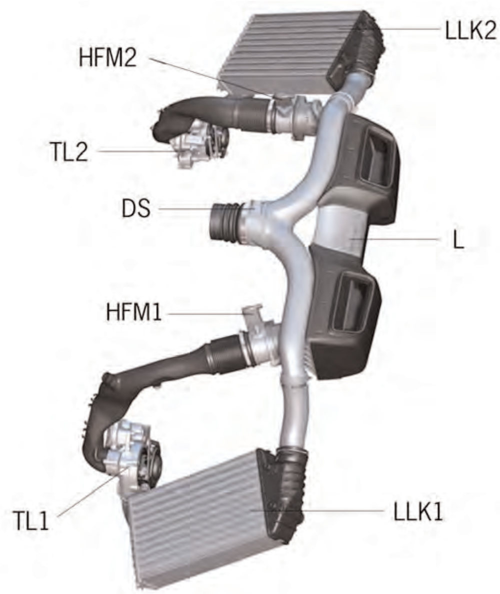
Flow Duct To Charge Air Cooler

The inlet trim elements in the rear side panels were modified. These possess a characteristic design for the new 911 Turbo, including an additional bar in the middle of the inlet duct. The form and position of this bar were specially designed, and the bar does not hamper air flow into the flow duct in spite of the slight reduction in the cross-section of the inlet. In addition, the manufacturing method for the plastic parts was modified to achieve an increased duct cross-section with lower production tolerances. The result is a reduction in flow resistance by approx. 10 % combined with a higher air throughput.



Charge Air Coolers

The charge air coolers have been further developed compared with the 911 Turbo (996) and the air flow onto the cooler surfaces improved. The result is more efficient charge air cooling and therefore higher power and torque values.



L - Air cleaner
HFM 1 - Mass air flow sensor, left
HFM 2 - Mass air flow sensor, right
TL 1 - Turbocharger, left
TL 2 - Turbocharger, right
LLK 1 - Charge air cooler, left
LLK 2 - Charge air cooler, right
DS - Boost pressure sensor

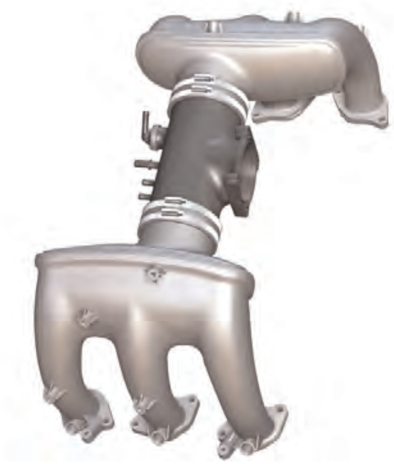
Outgoing Air Routing Through The Rear Apron

The outlet openings for the outgoing air of the charge air coolers were provided with a new design in the completely newly developed rear apron.

Boost Pressure Sensor/Intake Air Temperature Sensor

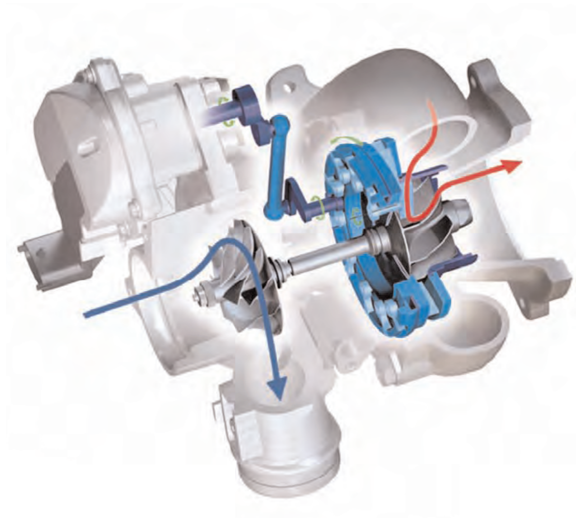
The boost pressure sensor measures the pressure upstream of the throttle adjusting unit (electronic throttle) as well as the air temperature before the air enters the intake system, and supplies this information to the DME control unit. The boost pressure is controlled by way of the position of the vanes in the turbocharger. Throttle adjusting unit (electronic throttle) The throttle adjusting unit (electronic throttle) has a diameter of 74 mm.

Intake System



Both the intake pipes from the air cleaner to the turbocharger and the pressure pipes from the turbocharger to the throttle were modified with respect to their flow properties and the flow resistances reduced. The intake distributor is still made of plastic and is now produced in one piece. Compared with the intake distributor of the 911 Turbo (996) with a separate intake pipe support made of aluminium, the one-piece design offers weight advantages and improved flow transitions to the cylinder head. In addition, the dimensioning of the intake distributors was adapted to the new turbocharger concept. The intake distributor of the new 911 Turbo has a silver paint finish to improve the engine compartment design. A weight saving of approx. 4.4 lbs. (2 kg) was achieved for the intake system compared with the 911 Turbo (996).

Turbocharger With Variable Turbine Geometry



The exceptional driving performance is due above all to the newly developed turbocharger technology of the six-cylinder engine. By using extremely high-temperature resistant materials, it was possible to develop an exhaust turbocharger with variable turbine geometry which is capable of withstanding the high exhaust temperatures produced by gasoline fueled engines of up to 1832° F (1000° C). A turbocharger with variable turbine geometry combines the respective advantages of small and large turbochargers, and permits optimum utilization of the exhaust energy for charging at any engine operating point; in addition, there is no longer any need for wastegate valves.

The result of the new technology is a significant increase in torque and performance: the opposed cylinder engine delivers 480 bhp (353 kW) at 6,000 rpm, 60 bhp (44 kW) more than the engine of the previous model, and this with an unchanged displacement of 3.6 l. At the same time, the nominal torque increases from 415 ft lbs (560 Nm) to 460 ft lbs (620 Nm) in a much wider rpm range: On the new Turbo, the maximum value is now in the range between 1,950 and 5,000 rpm.

Variable Turbine Geometry

The greatest development potential for exhaust turbochargers is solving the conflict between good response at low engine speeds and high specific performance values at high engine speeds. Variable turbine geometry with variable vane adjustment in front of the turbine wheel has shown itself to be the optimum solution for further improving turbocharger response and thereby the response of the turbocharged engine.

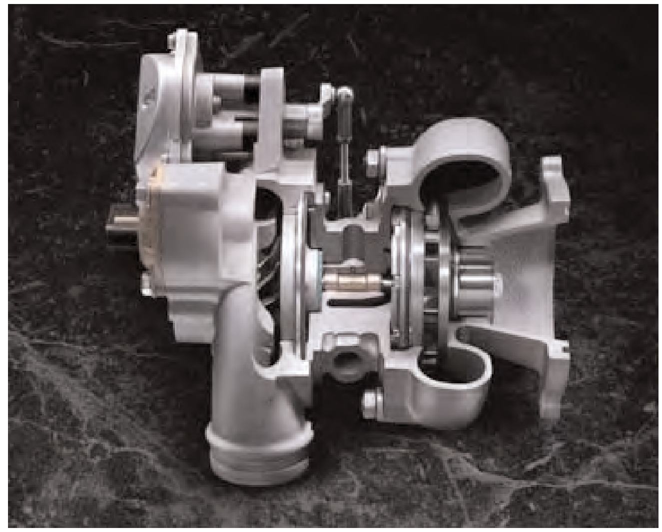
The new 911 Turbo with variable turbine geometry again sets new standards for Otto engines with exhaust turbocharging.

Technical Challenge

The design of variable turbine geometry is based on adjustable vanes which guide the exhaust mass flow from the engine onto the turbine of the turbocharger in a variable and targeted manner. The use of variable turbine geometry for Otto engines is made more difficult by the significantly higher exhaust temperatures. Compared with temperatures of approx. 1472° F (800° C) in the case of diesel engines, the maximum exhaust temperatures at the turbine inlet on Otto engines with exhaust turbocharger are significantly higher at approx. 1832° F (1,000° C). This leads to considerable additional stressing of the material and high demands on design realization. The delicate adjusting elements of the vanes in the hot exhaust stream are particularly critical. In addition to the high-temperature resistance of individual components, it is also necessary to take into account high temperature fluctuations in design.

In view of a possible temperature range from cold starting at -20 F (-30° C) up to a maximum regulated exhaust temperature (at the turbine inlet) of approx. 1832° F (1,000° C), it is necessary to take into account the different material expansion factors and safeguard the functioning of the entire adjustment system, including the many individual components. This is guaranteed, by selection of suitable materials, oil cooling, as well as by additional water cooling of the bearing housing. This can be activated via the Motronic system by an electric coolant pump both at low speed (< 2,000 rpm) combined with high coolant temperature (> 208° F/98° C) as well as after the engine is switched off.

Technical Principle



On the new 911 Turbo, the boost pressure is controlled only by adjusting the vanes (without bypass valve). This is done by way of an adjusting ring, which is actuated by an electric servo motor via a coupling rod (one "boost pressure adjuster" per turbocharger).

Notes:

Small turbochargers have good response characteristics (small "turbo lag") due to the small acceleration mass of the turbine wheel and the high flow momentum of the exhaust gas. This momentum is generated in the turbine housing in the transition to the turbine wheel by way of small flow cross-sections with high flow speeds. However, the small flow cross-sections in both the turbine housing and turbine wheel increase the flow resistance for high air throughputs and therefore high engine speeds, and also produce high exhaust backpressures ("choking"). As a result, the maximum engine power is limited.

Large turbochargers have poor response characteristics (large "turbo lag") due to the high acceleration mass of the turbine wheel and the low flow momentum of the exhaust gas. In contrast to small turbochargers, however, the exhaust backpressures are lower for high air throughputs due to the larger flow cross-sections in the turbine housing and turbine wheel. This results in less exhaust work for the pistons, as well as an improved charge cycle with a lower residual gas amount in the cylinder and better cylinder filling, for example. This results in a higher maximum engine power.

Vane Adjustment System

The principle of variable turbine geometry is essentially based on the following two physical characteristics:

- Variable vane gap
- Variable air impact angle

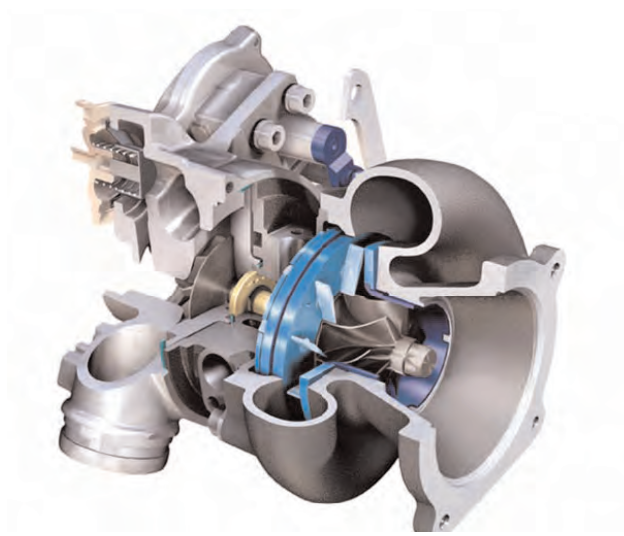
The adjustment system with adjusting ring and movable vanes is the mechanical heart of an exhaust turbocharger with variable turbine geometry. It consists of 11 adjustable vanes which are interconnected by the adjusting ring. The adjusting ring is connected in turn via a coupling rod with the electric servo motor which is responsible for controlling adjustment of the vanes.

With variable turbine geometry, small turbochargers are simulated by closed vanes (small vane gap) and large turbochargers by open vanes (large vane gap). With the respective advantages, variable turbine geometry permits both very good response with high torque values even at low speeds, as well as high output values at high speeds. The high torque is therefore available for a significantly larger rpm range.

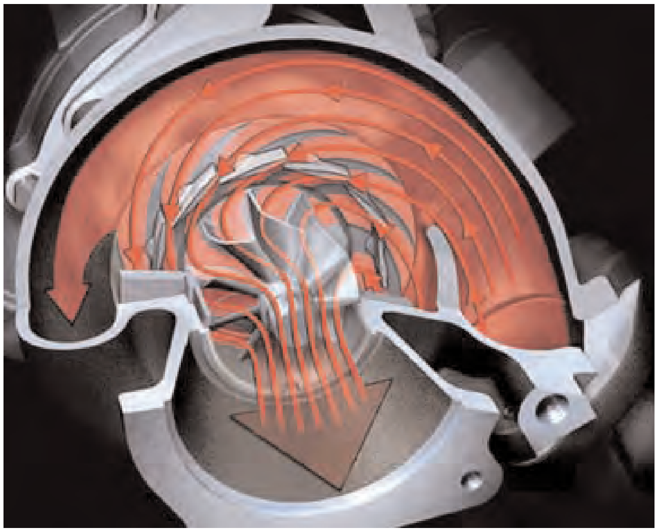
The variable vane gap is achieved by turning the adjusting ring and thus turning the vanes. A small vane gap reduces the flow cross-section. The resultant higher gas speeds mean that the exhaust gas is directed onto the turbine vanes with high momentum. The turbine wheel therefore rotates more quickly and drives the compressor wheel located on the same shaft. This in turn compresses the air which is supplied to the engine for combustion. As a result, the engine receives more air more quickly and accelerates more dynamically.

Vane Adjustment

Adjustment of the vane system and of the vane gap allows the exhaust mass flow to be directed onto the turbine wheel with maximum effectiveness for every operating point throughout the whole rpm range, thereby allowing the boost pressure to be adjusted to the corresponding setpoint value. This control technology combined with selection of a suitable turbine size makes it possible to dispense with the bypass valve (wastegate) usually required for engines with exhaust gas turbocharging. Adjustment of the turbine vanes does not just change the vane gap, it also changes the impact angle of the exhaust gas on the vanes. This variable impact angle assists the dynamic response of turbocharging using variable turbine geometry.

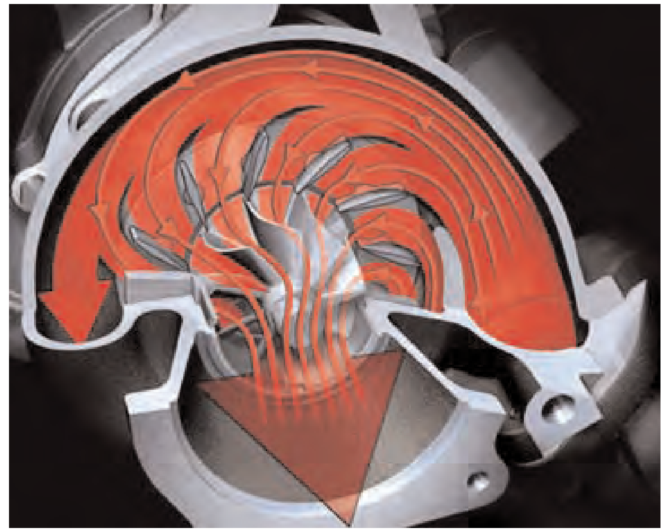


Vanes Closed



Small vane gaps do not just result in higher gas speeds in the vane gap. In this vane position, the impact angle of the exhaust gas on the turbine vanes is more direct and therefore produces higher angular momentum of the turbine wheel. If the vanes are closed at low engine speeds, the exhaust gas is accelerated in the small air gap and impacts on the turbine wheel radially with high energy. As a result, the compressor wheel located on the same shaft is accelerated quickly and increases the boost pressure. This in turn leads to good response characteristics of the turbocharger and thus high dynamic engine and vehicle acceleration.

Vanes Open



If the exhaust mass flow increases (increasing engine speed and load), the vanes are opened by the DME control unit according to a control map when the desired (maximum) boost pressure is reached. The adjustment duration for the vanes from open to closed and vice versa is only approx. 100 milliseconds.

Notes:

Electric Boost Pressure Adjuster

A precondition for optimum functioning of a turbocharger with variable turbine geometry in conjunction with an gasoline fueled engine is adjustment or control by an electric boost pressure adjuster. This is bolted directly onto the turbocharger and actuates the above-described adjusting ring with the integrated, electronically controlled servo motor via a short coupling rod.

The most important advantages compared with the pneumatic adjusting devices used for diesel engines are as follows:

- Fast reaction time (delay max. 100 ms).
- Optimum response characteristics.
- Freely selectable vane position independently of the pressure in the system.
- Optimum control quality of the desired boost pressure.
- Control possible without overshoot.
- Optimum diagnosis and fault detection.

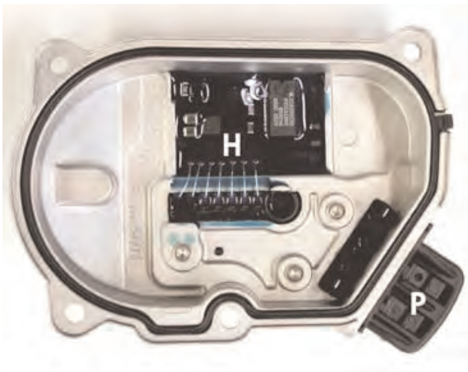
Design Of Electric Boost Pressure Adjuster

M - Electric motor (DC)
S - Sensor magnet
G - Spur gear drive

The boost pressure adjuster consists of an aluminium housing, which accommodates the DC motor with sensor magnet as well as a two-stage spur gear drive with a drive shaft/lever. A two-stage spur gear drive is connected between the DC motor and drive shaft. An aluminium cover with glued-in bonded hybrids and a screwed-in four-pin connector is screwed onto the housing. The hybrid electronic components are designed for an operating temperature from - 40° F (- 40° C) to 266° F (130° C).

Notes:

Position Sensor



A contactless incremental Hall sensor is used to detect the position of the output shaft. The hybrid electronics integrated in the adjuster housing is responsible for position control and control of the DC motor. The sensor magnet wheel is mounted on the DC motor shaft, while the sensor (pick-up) itself is located on the hybrid electronics. The main advantage of the contactless sensor is freedom from wear.

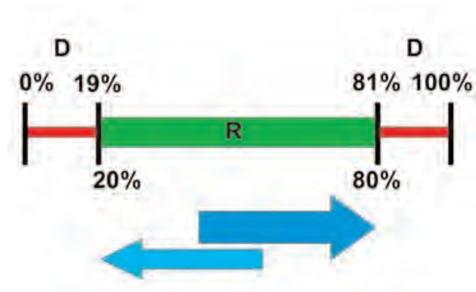
In addition to digital position control and related setpoint/actual value evaluation and driver control, the electronic components also perform actual value output as well as diagnostic and fault detection routines.

Each boost pressure adjuster is connected to the DME control unit by two signal lines. The DME control unit sends a setpoint (PWM signal) or special pulse/duty ratios (e.g. command to travel to and learn end stops) via one of the lines. The electric boost pressure adjuster then sends the actual value (PWM signal) and special pulse/duty ratios (self-diagnosis of electric adjuster for fault memory entry in the DME) to the DME via the other line.

Control By The Motronic Control Unit ME 7.8.1

Optimum adjustment angles are set by way of functions in the engine control unit depending on the engine operating point, so that the target engine torque is reached as quickly as possible. The optimum vane positions for maximum efficiency were determined for the complete engine map as part of extensive application work. The goal was above all to optimize the response behavior particularly for dynamic acceleration. Variable turbine geometry allows a full torque characteristic to be achieved even at low engine speeds and also provides a wide power spectrum in the nominal output range.

Diagnosis Of Electric Boost Pressure Adjuster



The electric boost pressure adjuster features an integrated diagnostic function which transmits a fault to the DME control unit by way of a corresponding pulse/duty ratio.

- The nominal mechanical adjustment range or control range (R) extends from 20 % (vanes open) to 80 % (vanes closed).
- The pulse/duty ratio is approx. 40 % when the ignition is switched on.
- The pulse/duty ratios 0 % to 19 % and 81 % to 100 % are special pulse/ duty ratios for diagnostic routines (D) and for teaching the adjusting device.

Boost Pressure Adjuster Test

When the ignition is switched on, the function "Test boost pressure adjuster" is available on the PIWIS Tester in the DME control unit under the system test function. A corresponding fault is entered after this test in the event of malfunctions.

In order to check functioning of the adjusting device, the electric boost pressure adjuster is supplied with a pulse/duty ratio of 16 % and 84 % after the ignition is switched off. The function test is also audible for the customer.

Teaching The Electric Boost Pressure Adjuster

It is necessary to perform adaptation of the electric boost pressure adjuster if a turbocharger or the electric boost pressure adjuster itself is replaced. When the ignition is switched on, the function "Boost pressure adjuster adaptation" is available on the PIWIS Tester in the DME control unit under the system test function. During this adaptation, the mechanical limit stops (20 % and 80 %) are taught again and stored in the boost pressure adjuster.

Adaptation Of Boost Pressure Control

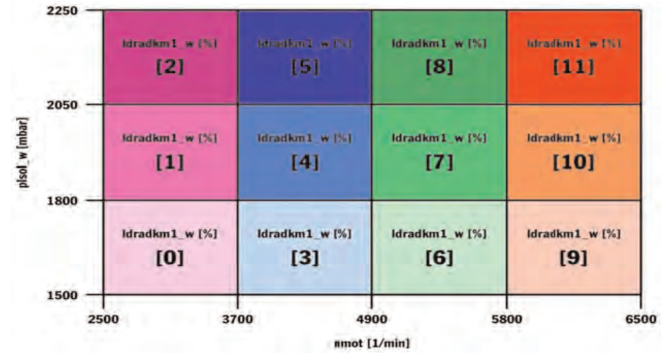
The boost pressure is a variable which is influenced by engine tolerances and ambient conditions. The following ambient conditions influence the boost pressure with respect to the maximum engine torque, protection of the engine and turbocharger as well as fault entries.

- Air pressure (the boost pressure is adapted from an altitude of
  > 5,900 ft (1,800 m) in order to protect the components of the turbocharger).
- Ambient temperature and intake air temperature (charge air temperature) (the boost pressure is reduced at an ambient temperature
  < approx. 32° F (0° C), or a charge air temperature < approx. 50° F.
  (10° C).
- Fuel quality (knock resistance under thermodynamic loading).

The adaption ranges 0 to 11 are available for boost pressure adaptation. These are divided into 3 load ranges (boost pressure) and 4 engine speed ranges. Adaptation of +/- 15 % is possible for each range before a fault is entered.

Notes:

Table Of Boost Pressure And Speed Thresholds



plsol – Boost pressure in mbar
nmot – Engine speed in rpm

Partial Load Adaptation

The adaptation ranges 0 / 3 / 6 / and 9 are available for partial load or reduced full load due to ambient conditions (e.g. poor fuel quality).

Full Load Adaptation

The adaptation ranges 1 / 4 / 7 / and 10 are provided for full load under normal conditions.

Full Load With Overboost

The adaptation ranges 2 and 5 are available for full load with Overboost (Sport Chrono activated). The adaptation ranges 8 and 11 are not normally adapted.

Sport Chrono Package Turbo (Optional)

The Sport Chrono Package Turbo is offered for the first time for the new 911 Turbo. The package contents correspond to those of the Sport Chrono Package Plus from the current 911 Carrera (997) generation, but are supplemented by the functions, Overboost , PTM control and modified starting program for the optional Tiptronic S.

The “Sport Chrono Package Plus” offers the driver distinctively sporty settings for various vehicle functions, therefore providing a completely new sporty driving experience. The accelerator pedal characteristic, engine behavior at the speed limit and in the event of load changes, PSM intervention thresholds as well as the characteristics of PASM and Tiptronic S are all changed at the push of a button. The Sport Chrono program also allows the driver to control these advantages as required to take into account contemporary conditions.

Additional Function – Overboost

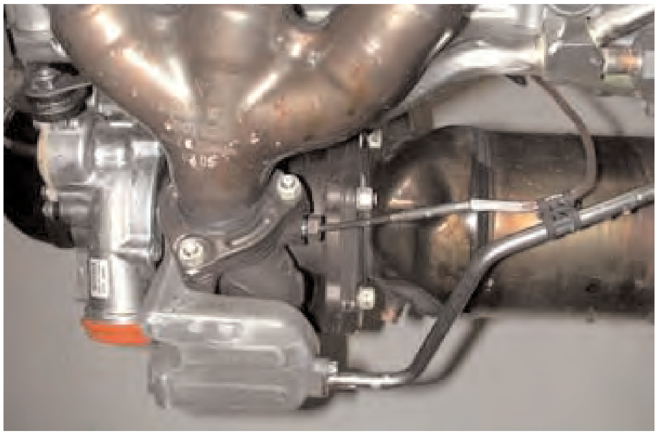
Overboost is a brief excess increase in the boost pressure (max. 10 s) for acceleration under full load (fully depressed accelerator pedal). The function is activated after operation of the Sport button on the center console and fast depression of the accelerator pedal. Overboost is performed with the assistance of the boost pressure control and results in an increase in the maximum boost pressure by approx. 2.9 psi (0.2 bar) (20 %). As a result, the maximum torque is increased from 460 ft lb (620 Nm) to a maximum of 505 ft lb (680 Nm) between 2,100 rpm and 4,000 rpm (the torque is regulated linearly to the “normal” full-load value between 4000 and 5000 rpm) and permits a significant improvement in acceleration performance and elasticity. The higher boost pressure does not just result in an abrupt increase in mechanical loading of the components, but above all also significantly increases thermal stressing. This is due in particular to the continuously rising charge air and combustion chamber temperatures.

The Overboost function is restricted to 10 seconds in order to take these factors and the maximum component loading into account. After this time, the original full-load boost pressure without Overboost is restored. The Overboost function can be reactivated again as soon as the engine load is relieved briefly by the throttle closing (e.g. after a gearshift).

Overboost operation is indicated by an arrow symbol in the boost pressure display of the instrument cluster. The arrow next to the boost pressure display indicates the brief Overboost operation, which is possible only in conjunction with activated Sport function (text “SPORT” shown on display). The boost pressure indication is shown as a digital value and as a graphic representation in the multi-function display. The boost pressure can increase up to approx. 1.2 bar (17.4 psi) when the Sport button is pressed; a pressure of approx. 1.0 bar (14.5 psi) is reached when this function is not activated.

Notes:

Exhaust Temperature Sensors, Banks 1 and 2

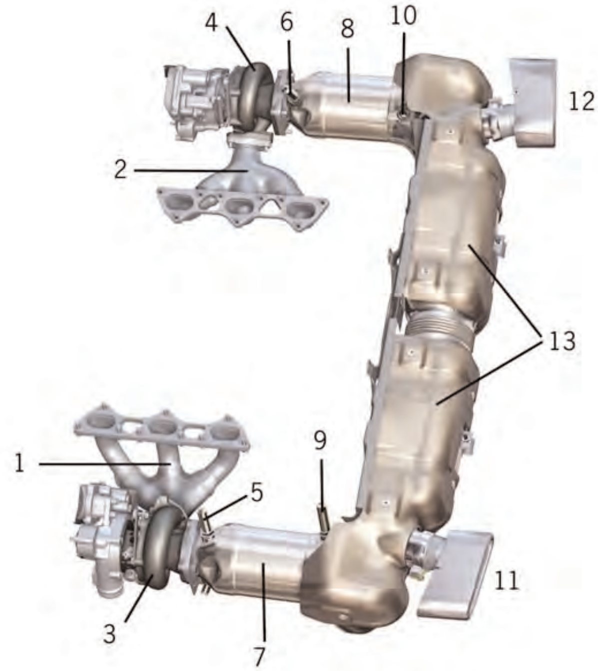


The signal from the exhaust temperature sensors of banks 1 and 2 installed at the turbine inlet is used in the DME control unit for component protection. The exhaust temperature is evaluated for each bank in the DME control unit, and is restricted to a maximum temperature of 1,767° F. (980° C) by enrichment or boost pressure adjustment. The two sensors are combined into one component unit together with their control unit. The measured signals are evaluated in this control unit.

The control unit sends a pulse/duty ratio (PWM) to the DME. The pulse/duty ratio range is from 4 % (corresponds to 25° F/- 4° C) to 96 % (corresponds to 2,030° F/1,110° C). The control unit has a self-diagnosis function. If the control unit detects a cable break/short-circuit to the sensor or in the evaluation circuit, it sends the special pulse/duty ratio of 98 % to the DME and this leads to an entry in the fault memory.

Exhaust System/Emission Control

The exhaust system has been partially newly developed. The new 911 Turbo complies with all worldwide emission regulations with a standard exhaust system. The weight was reduced by using thin-wall technology for the muffler and ceramic main catalytic converters. It was therefore possible to reduce the overall weight of the exhaust system by approx. 8.8 lb/4 kg (16 %) compared with the 911 Turbo (996).



1 – Air-gap insulated exhaust manifold left
2 – Air-gap insulated exhaust manifold right
3 – Turbocharger, left
4 – Turbocharger, right
5 – LSU broadband oxygen sensor, left
6 – LSU broadband oxygen sensor, right
7 – Ceramic main cat. converter, left
8 – Ceramic main cat. converter, right
9 – LSF step oxygen sensor, left
10 – LSF step oxygen sensor, right
11 – Tailpipe cover, left
12 – Tailpipe cover, right
13 – Muffler

Ceramic Main Catalytic Converter

It was possible to further improve the emission values by the use of state-of-the-art catalytic converter technology with one 3-way ceramic main catalytic converter for each cylinder bank and by improved secondary air injection after cold starting (Europe: EU4; USA: LEV II).

Tailpipe Covers

The rear apron of the new 911 Turbo was completed redesigned. In addition to modified side outlet openings for the outgoing air of the charge air coolers, the new 911 Turbo is also equipped with integrated exhaust tailpipes. The tailpipes were relocated to a higher position compared with the 911 Turbo (996), and are integrated in the rear apron of the new 911 Turbo as a distinguishing feature and characteristic design element – analogous to the Carrera GT. In order to protect the rear apron against the high temperatures of the exhaust tailpipes, a shield made of high-temperature-resistant plastic capable of withstanding temperatures up to 536° F (280° C) is installed in the area surrounding the tailpipe.

Secondary Air Injection

The function of the secondary air injection system, with one secondary air valve per cylinder bank, each of which is pressure opened by a pump, is the same as in the current 997 vehicles. The secondary air valves with additional check valve were adopted from Cayenne Turbo.

The following switch-on conditions apply to activation of secondary air injection when the engine is started for the first time:

- Engine temperature (coolant): 14° F (- 10° C) to 108° F (42° C).
- Time: Max. 120 seconds after engine start
- Mass air flow as switch-off condition:
  Secondary air injection is switched off after a time delay as from a mass air flow of > 200 kg/h.

S - Secondary air valve, left
V - Electrically operated switching valve for air recirculation control
P - Auxiliary electrical water pump

Notes:

VarioCam Plus

The new 911 Turbo (997) is provided with the latest development version of the variable valve control VarioCam Plus with continuous adjustment of the intake camshafts and valve lift switching of the intake valves. This system permits optimization of engine output and torque on the one hand and, on the other, also makes it possible to reduce fuel consumption and exhaust emissions while improving running smoothness.

Both individual systems of the VarioCam Plus (camshaft adjustment and valve lift switchover) are controlled by the Motronic control unit ME7.8.1. This control unit has been designed specifically for these requirements with a high processor capacity. This is necessary because the input values for "engine speed", "accelerator pedal position", "engine oil and water temperature" as well as gear speed detection are required to control VarioCam Plus. The demand for torque or power is compared with the stored program maps. A decision on how VarioCam Plus must react is made in milliseconds.

Camshaft Adjustment Of The Intake Camshafts

The 911 Turbo (997) features continuous adjustment of the intake camshafts by vane adjusters. The load and speed dependent adjustment range of the intake camshafts is 0 to 40 ° crankshaft angle.

Valve Lift Switching Of The Intake Camshafts

The small valve lift was increased from 3.0 mm (996) to 3.6 mm in order to make more efficient use of the advantages of VarioCam Plus with continuous camshaft adjustment and a larger adjustment range with respect to consumption, output and exhaust emissions. The valve lift adjustment system consists of switchable flat-base tappets on the intake side of the engine which are operated by means of an electrohydraulic 3/2-way switching valve.

Since there are two different cam forms on the intake camshaft, the corresponding valve lift curves act on the engine when the respective cams are switched. The flat-based tappets consist of two nested tappets which can be locked against each other by way of a pin. The inner tappet is in contact with the small cam and the outer tappet with the large cam. A hydraulic compensating element for the valve clearance is always integrated in the power flow of the tappet.

Cold Start

VarioCam Plus already significantly improves cold starting of the engine, and also allows emissions to be reduced during the warming-up phase.

Idle Speed

The engine is operated with the small intake cam (3.6 mm) at idle speed. Optimum timing is guaranteed thanks to fully variable camshaft adjustment. The small valve lift permits a reduction in fictional loss, a significantly increased charge movement thanks to the extremely short opening times, as well as lower emissions from previous combustions in the combustion chamber. This results in consumption and emission reductions of up to 10 % at the same time as significantly improved idling quality.

Partial Load

Operation with internal exhaust gas recirculation is optimum under partial load conditions for the purpose of dethrottling and in order to reduce the engine consumption. For this purpose, the camshaft phasing for the small valve lift is adjusted in order to achieve a large overlap, therefore allowing a large proportion of time for exhaust recirculation.

Full Load

In full-load operation, a high torque and high maximum output are achieved on the one hand through a low-loss charge cycle and, on the other, by an uncompromising cam contour design with a maximum valve lift of ten millimeters and correspondingly adapted opening and closing times of the valve strokes.

Positive Crankcase Ventilation

The positive crankcase ventilation and turbocharger ventilation are routed into the oil tank. In idling operation, the oil tank ventilation is routed to the intake manifold. Under full-load condition (with boost pressure), the oil tank ventilation is routed to the intake side of the left turbocharger.

Vacuum Pump

Like the current 911 Carrera (997) generation, the new 911 Turbo also has a mechanically driven vacuum pump that uses rotary vane technology. This replaces the conventional vacuum amplifier and provides the vacuum for the brake booster as well as various switching valves for the exhaust turbocharger (pop-off control) and the coolant. The vacuum pump is located on the left cylinder head, and is driven by the corresponding exhaust camshaft.

Electric Auxiliary Water Pump

The new Turbo is equipped with an electric auxiliary water pump which is installed on the left under the intake manifold. This pump can be activated as required by the DME control unit (also when the ignition is switched off) for the purpose of coolant circulation and in order to cool the watercooled turbochargers.

There are three conditions for auxiliary water pump activation:

1. Defined pump operation after engine start. 10 seconds after the engine is started, the pump runs for 10 seconds. This guarantees that the pump starts after every engine start, and therefore allows final stage diagnosis to be performed.
2. Support of cooling in an applied range during engine operation. The pump is switched on when the engine speed is < 2,000 rpm and the water temperature is > 208° F (98° C). It is switched off as soon as the engine speed exceeds 2,500 rpm or if the water temperature falls to below 203° F (95° C). Since both switch-on conditions are linked, it is sufficient if one condition is not satisfied for the pump to be switched off.
3. Cooling during control unit after running after the engine is switched off or stalled. The higher of the two exhaust temperatures is sent through a low pass filter with a filter time constant of 256 seconds. This filtered exhaust temperature value and the water temperature are the input variables which are evaluated in the DME control unit. On the basis of this information, the DME control unit calculates as the output variable the pump after-run time (function of engine temperature and filtered exhaust temperature) in seconds. The pump after-run time may be between 0 to 600 seconds, depending on the engine temperature (185° F/84.8° C to 248° F/120° C) and exhaust temperature (1,260° F/700° C to 1,922° F/1,050° C).

The engine oil temperature is routed through a different low-pass filter with a filter time constant of 64 seconds. This filtered engine oil temperature value and the water temperature represent the input variables for a different map. Output variable: Pump after-run time (function of engine water temperature and filtered engine oil temperature) in seconds.

The pump after-run time may be between 0 to 600 seconds, depending on the engine temperature (194° F/90° C to 248° F/120° C) and engine oil temperature (194° F/90° C to 302° F/150° C).

Example: The after-run time is 300 seconds for an oil temperature of 248° F (120° C) and a water temperature of 194° F (90° C). The engine compartment temperature and ambient temperature do not have any effect on these functions.

Notes:

Electric Fans

The 911 Turbo (997) is provided with a infinite fan control. The electric fans behind the radiators are controlled by the front-end control unit. The front-end control unit receives the information about the desired fan output (in %) via CAN from the DME control unit. The desired fan output is determined in the DME control unit on the basis of a program map as a function of the refrigerant pressure (CAN message from air-conditioning control unit) and engine water temperature. The requested output in % can be read out from the actual values with the PIWIS Tester (e.g. refrigerant pressure = 15 bar, tmot = 194° F (90° C) = > 50 %).

Engine Compartment Fan

The DME control unit switches the 2 relays for the engine compartment fan.

Stage 1 (with low fan speed) is activated from an engine compartment temperature of > 77° F (24.8° C).

Stage 2 (with full fan speed) is activated additionally from an engine compartment temperature of > 158° F (69.8° C) or a coolant temperature of > 221° F (105° C).

When the engine is stopped:

Stage 2 is activated for 180 seconds from an engine temperature of > 163° F (72.8° C). The fan runs again for 180 seconds if the temperature is exceeded again. This continues until the temperature is no longer exceeded again or for a maximum of 40 minutes.

Notes:

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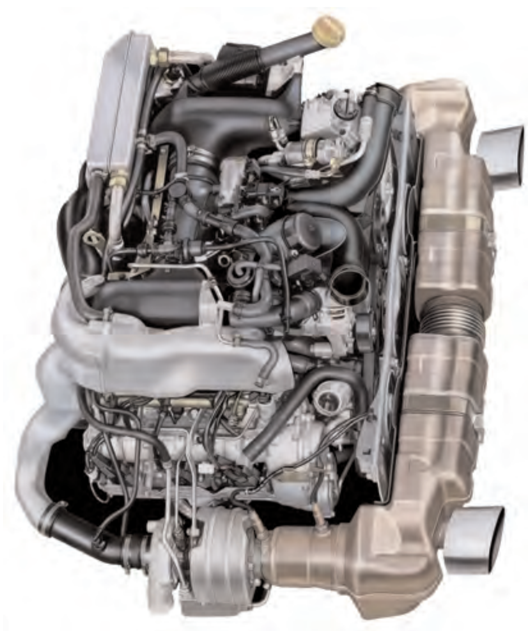
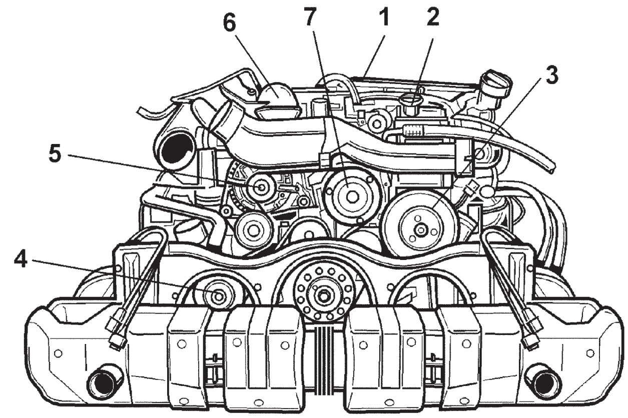
Engine





Component Location

1 - Oil reservoir
2 - Servo reservoir
3 - Steering hydraulics pump
4 - Coolant pump
5 - AC generator
6 - Oil filter housing
7 - Air conditioning compressor

General

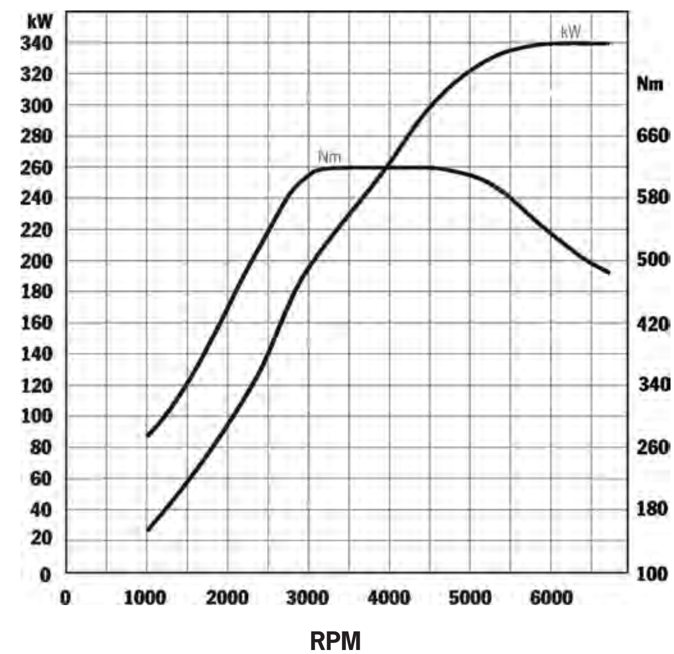
M96.70S (up to M.Y. 2003)

The engine of the M.Y. 2002, 911 GT2 is an evolution of the 6 cylinder Boxer engine from the 911 GT1 and 911 Turbo. Modifications to the supercharging system and exhaust system as well as adjustments to the Motronic have increased the engine's power output by 10% compared to the 911 Turbo. From M96.70 version described in M.Y. 2001 911 Turbo Technical Introduction (PNA 488 120).

The engine has the following features:

- Two piece crankcase
- Crankshaft with 8 bearing points
- Four valve technology
- Valve stroke control on intake side with axial camshaft adjustment (VarioCam Plus)
- Flat-base tappets with hydraulic valve clearance compensation
- Solid state HT distribution with separate ignition coils for each cylinder
- Dry sump lubrication with oil reservoir attached to engine, oil returned via two suction pumps per cylinder head, and one central oil return pump
- On-board diagnostic system worldwide
- Lower fuel consumption

Power/Torque Diagram



Engine Data:

Displacement	3.6 l
Bore	100 mm
Stroke	76.4 mm
Power output	SAE 456 hp (340 kW)
at engine speed	5700 rpm
Max. torque	457 ft lbs (620 Nm)
at engine speed	3500 - 4500 rpm
Compression ratio	9.4 : 1
Governed speed	6750 rpm
Fuel grade	93 Octane (Premium Unleaded)

911 GT2 (996)

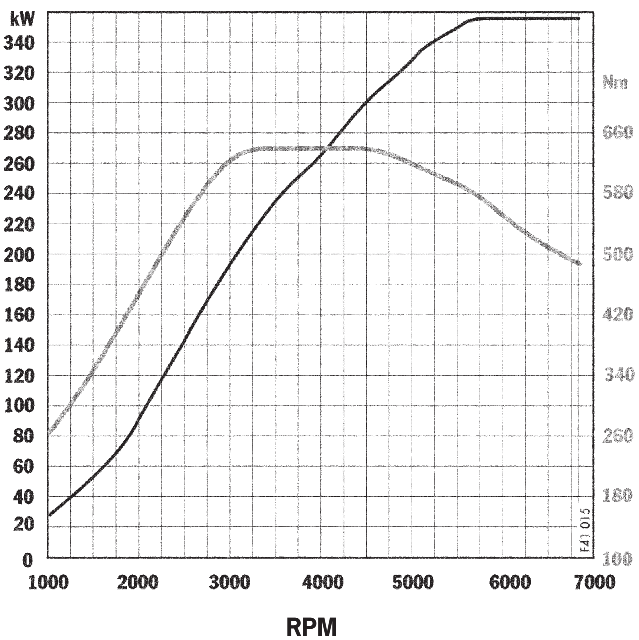
M96.70 SL (M.Y. 2004)

The engine of the 911 GT2 (996) in model year 2004 is based on the previous model and has been further developed with an increase in power. The power output is now SAE 476 HP (355 kW), the maximum torque is 472 ft lb (640 Nm).

Summary of Modifications:

- Modified pistons
- Piston rings
- Cylinder sleeves
- Data record of DME control unit

Full-Load Curve of the M96.70SL Engine



Engine Data:

Engine type	M96.70 SL
Power output	SAE 476 HP (355 kW)
at engine speed	5700 rpm
Max. torque	472 ft lb (640 Nm)
at engine speed	3500 to 4500 rpm
Idling speed	740 ± 40 rpm
Governed speed	6750 rpm (1st to 5th gear), 6800 rpm (6th gear)

Cylinders

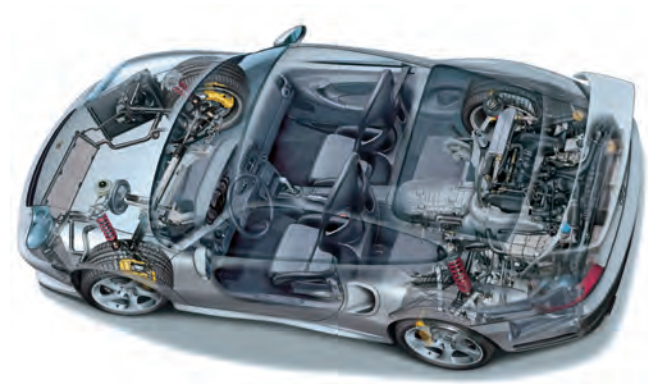
The cylinder sleeves are shot-blasted to increase strength.

Pistons, Piston Rings

The piston crown has been strengthened due to the increased power and the resulting additional loading. Consequently, the valve relief has changed in depth and shape.

The piston rings are manufactured from a different material as that of the previous model.

Fuel and Ignition System



Modifications to 911 GT2 (996), compared to 911 Turbo (996)

The engine of the 911 GT2 (996) is a high performance variant of the 911 Turbo (996) engine and an addition to the engine series based on the 911 GT1 engine.

911 GT2 (996) Objectives At Introduction Were:

- Increase in power output of 911 Turbo (996) engine by approx. 10 % (from SAE 414 HP (309 kW) to SAE 456 HP (340 kWp)
- Increase in maximum torque (from 413 ft lbs (560 Nm) to 457 ft lbs (620 Nm)
- Compliance with all emission regulations, worldwide

The following components/systems used in the 911 GT2 have been modified, compared to the 911 Turbo (996):

- Exhaust gas turbochargers
- Exhaust system
- Charge air intercoolers
- DME control unit ME 7.8 (data record)
- Intake air system
- Overrun air recirculation valves
- Fuel tank

Fuel Tank

For the North American market the fuel tank in the 911 GT2 (996) has a usable tank capacity 16.5 gallons (64 l), in RoW markets the capacity is 23.5 gallons (89 l).

Fuel Cooler

In order to maintain a low fuel temperature, a fuel cooler which is cooled by the refrigerant of the air conditioning system is installed in the engine compartment.

Fuel Grade

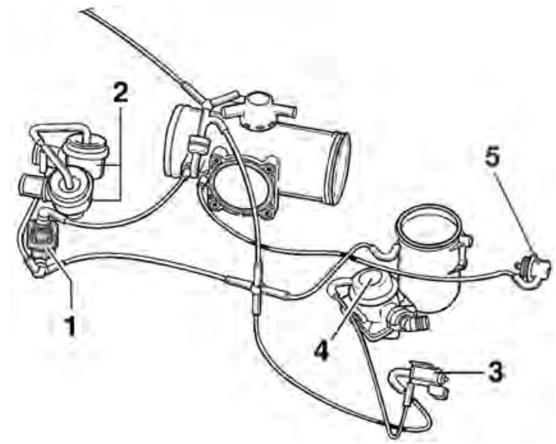
The engine has been designed to provide optimum performance and fuel consumption with 93 Octane premium unleaded fuel. If unleaded fuel with lower octane rating of at least 90 Octane is used, the ignition point and the boost pressure are adapted (reduced).

Notes:

Vent Valve for Active Carbon Canister

The size of the housing has been increased to reduce noise emission and to allow a primary filter to be integrated.

Electric Switching Valve for Deceleration Aiir Recirculation



1 - Electric switching valve for deceleration air recirculation
2 - Deceleration air recirculation valves (pneumatic)
3 - Electric switching valve for secondary-air injection
4 - Valve for secondary-air injection
5 - Fuel-pressure regulator

Deceleration air recirculation valves (2) actuated by a vacuum from the vacuum reservoir, which is switched by an electrically operated valve (3), are used to prevent the exhaust gas turbochargers from pumping in the event of a sudden transition from high load to deceleration.

The ME 7.8 can actuate the electric switching valve (3) irrespective of the intake pipe pressure, where the switching valve then activates the deceleration air recirculation valves (2).

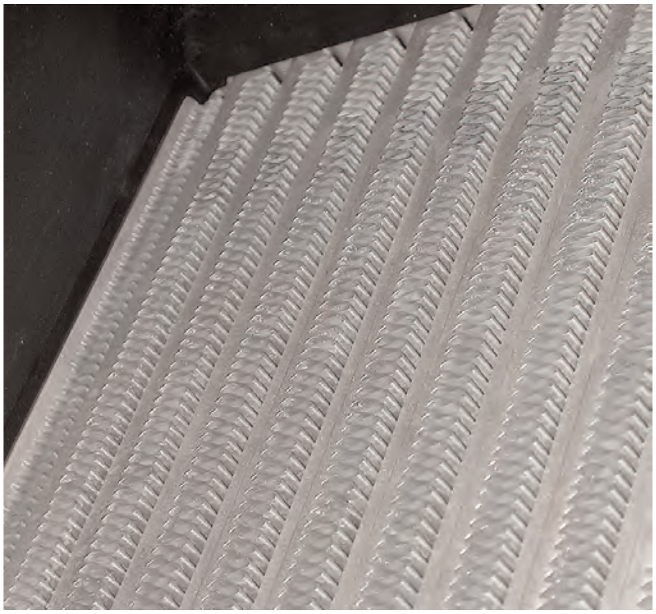
Advantages of electric switching valve for deceleration air recirculation are:

- The controlled opening of the deceleration air recirculation valves reduces noise in the intake tract and has a number of consumption-related benefits.
- The electric switching valve in combination with the vacuum reservoir allows the air recirculation valves to function irrespective of the intake-pipe pressure.
- The system is designed so that the pneumatic deceleration air recirculation valves can continue to be opened by the intake-pipe pressure even if the electric switching valve fails.

Deceleration Air Recirculation Valves (pneumatic)

The control diaphragm of the 2 deceleration air recirculation valves has been reinforced using a brass ring

Charge Air Intercoolers



The charge air temperature upstream of the charge air intercooler increases due to the higher boost pressure of the 911 GT2 (996). For this reason, charge air intercoolers are used which have a 5% higher cooling capacity than those used in the 911 Turbo (996).

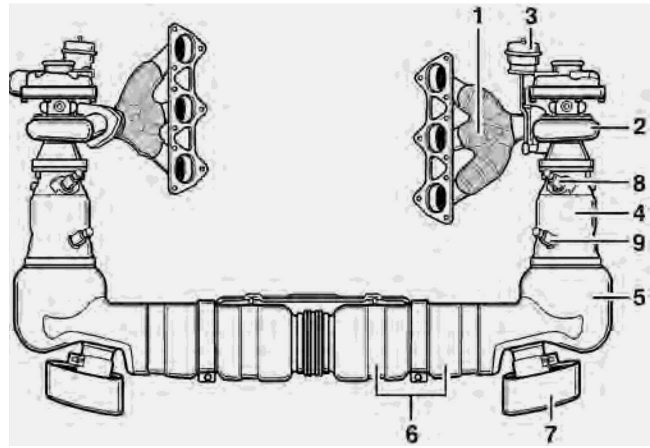
The following design features make this possible without increasing the size of the intercoolers:

- Increased number of fins (between cooling pipes) by reducing gap between fins.
- Longer fins which project by approx. 2.5 mm above surface of cooling pipes on each side of intercooler.

Ducting of Intake Air Through Spoiler in Engine Compartment Lid

The engine intake air passes through air inlets at the ends of the rear spoiler, enters the air box integrated in the engine compartment lid and from there is fed into the air filter. The shape and position of the integrated air inlets are such that a high aerodynamic efficiency is achieved.

Exhaust System



1 - Exhaust manifold (partially air-gap-insulated)
2 - Exhaust gas turbocharger
3 - Boost pressure control valvesensor LSU4
4 - Primary catalytic converter
5 - Main catalytic converter
6 - Rear muffler
7 - Exhaust tailpipe
8 - Wide band oxygen
9 - Offset oxygen sensor LSF4

The exhaust system up to the rear mufflers consists of two exhaust branches which are connected together. In the rear muffler the exhaust gases are merged and in turn mixed.

The exhaust gases are fed to the turbines of the exhaust gas turbochargers via extremely short exhaust manifolds. The short manifolds reduce the amount of energy lost by the exhaust gases before they enter the turbochargers, therefore improve responsiveness.

Sections of the exhaust manifolds are double walled (air gap insulated). This helps the catalytic converters heat up quicker (lowers cold start emissions) and reduces exhaust-noise emission.

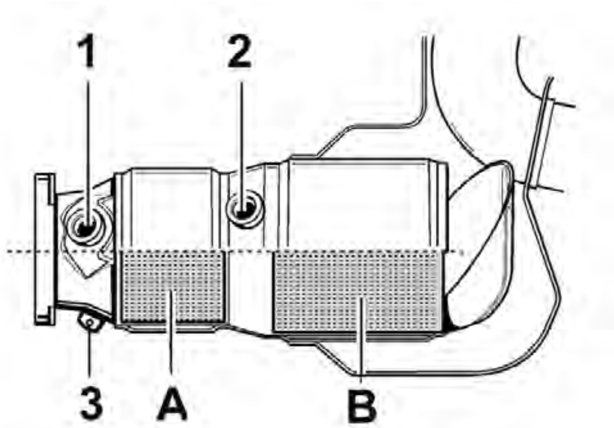
In order to reduce exhaust back pressure, the exhaust system at the rear muffler of the 911 GT2 (996) has been modified compared to that of the 911 Turbo (996).

Catalytic Converters

The catalytic converters are mounted immediately down-stream of the turbochargers. The first catalytic converter (primary catalytic converter) with its small volume reaches its operating temperature very soon after the engine has been started. As a result, it is able to reduce the volume of pollutants during the warm-up phase and not only when the engine has reached operating temperature.

The main catalytic converter which follows is used to reduce the exhaust emission level further to below the specified limit values, even after a long service life.

The catalytic converters used for RoW and USA vehicles differ with regard to their internal construction. In order to satisfy the LEV standard, the USA catalytic converter has a larger number of cells which results in a additional increase in the active surface area of the component and reduction in emissions.



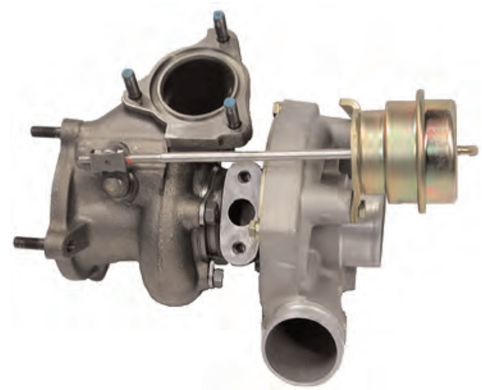
A - Primary catalytic converter
B - Main catalytic converter
1 - Position of wide band oxygen sensor LSU4
2 - Position of offset oxygen sensor LSF4
3 - Exhaust gas sampling point upstream of catalytic converter

Exhaust Gas Classification

The 911 GT2 (996) all regulatory emission standards worldwide.

Notes:

Exhaust Gas Turbochargers



As with other models, the two turbochargers of the 911 GT2 (996) are also installed parallel to each other. The low intake pipe volume and the short exhaust manifolds ensure direct turbocharger response in the lower speed range as well as high torque under full-load conditions.

The exhaust gas turbochargers used in the 911 GT2 (996) engine are a modified version of those used in the 911 Turbo (996). The modified exhaust gas turbochargers which are designed for a higher airflow rate allow the boost pressure to be increased.

The diameter of the compressor wheel is 60.6 mm. The diameter of the turbine wheel is 57 mm. The diameter of the bypass valve (wastegate) has also been increased by 2 mm to 30 mm.

The speed of the turbochargers with the engine running at idling speed is max. 8,000 rpm. The exhaust gas turbochargers are designed for a maximum speed of 157,000 rpm (continuous operation) and max. 167,000 rpm (short time operation lasting up to 30 sec.).

If necessary, the DME control unit reduces the boost pressure at altitudes above 650 ft (2,000 m) in order to ensure that the maximum speed is not exceeded.

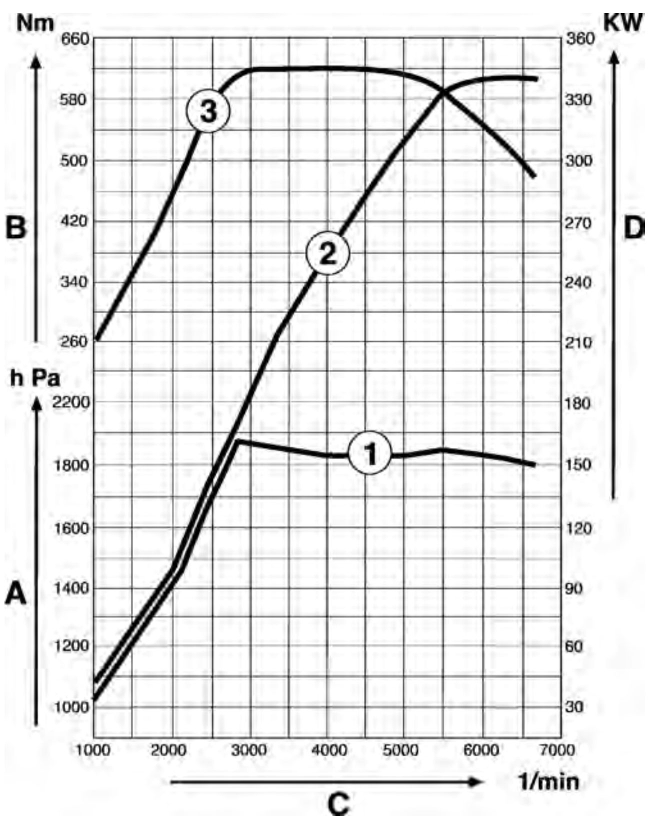
Notes:

Boost Pressure Control

Similar to the 911 Turbo (996), the boost pressure in the 911 GT2 (996) is determined by the pressure sensor and adjusted to the desired boost pressure calculated by the DME control unit.

The electric timing valve which controls the boost pressure is actuated on the basis of a duty factor. This causes pressure to be applied to the boost pressure control valves attached to the turbochargers, and the by-pass valves (wastegate) to be opened. The turbocharger speed is thus reduced and the boost pressure limited. The desired engine torque is calculated in the ME 7.8 control unit according to the accelerator pedal potentiometer (driver requirement), the engine speed and a number of torque related factors.

Boost Pressure Curve With Regulation



A - Absolute pressure (hPa) (2000 hPa corresponds to approx. 1.0 bar positive pressure or 2.0 bar effective pressure)
B - Torque (Nm)
C - Engine speed (rpm)
D - Engine power output (kW)
1 - Characteristic boost pressure curve with regulation
2 - Power curve
3 - Torque curve

The engine induction volume required for a certain torque is determined by calculating the air-mass and is adjusted by controlling the boost pressure. The combination consisting of boost pressure sensor, air-mass sensor and E-Throttle improves torque considerably and permits more accurate boost pressure diagnosis since the effective boost pressure is available to the ME 7.8 control unit as an input signal.

Boost Pressure Adaptation

The 911 GT2 (996) has adaptive boost pressure control. For diagnostic purposes, the adapted value can be read out with the other actual Motronic values as the "boost pressure adaptation".

The adaptation range for boost pressure control is approx. 15 %. Regulation begins at a deviation of greater than approx. 20 %. When regulated, the boost pressure is reduced by approx. 20 %. The adaptive value for boost pressure control can be used to diagnose mechanical and pressure side changes.

For safety reasons, the basic boost pressure is limited to between approx. 4.35 psi (0.3 bar) and 5.8 psi (0.4 bar) (positive pressure) if the timing valve for boost pressure control fails. This results in a perceptible drop in performance.

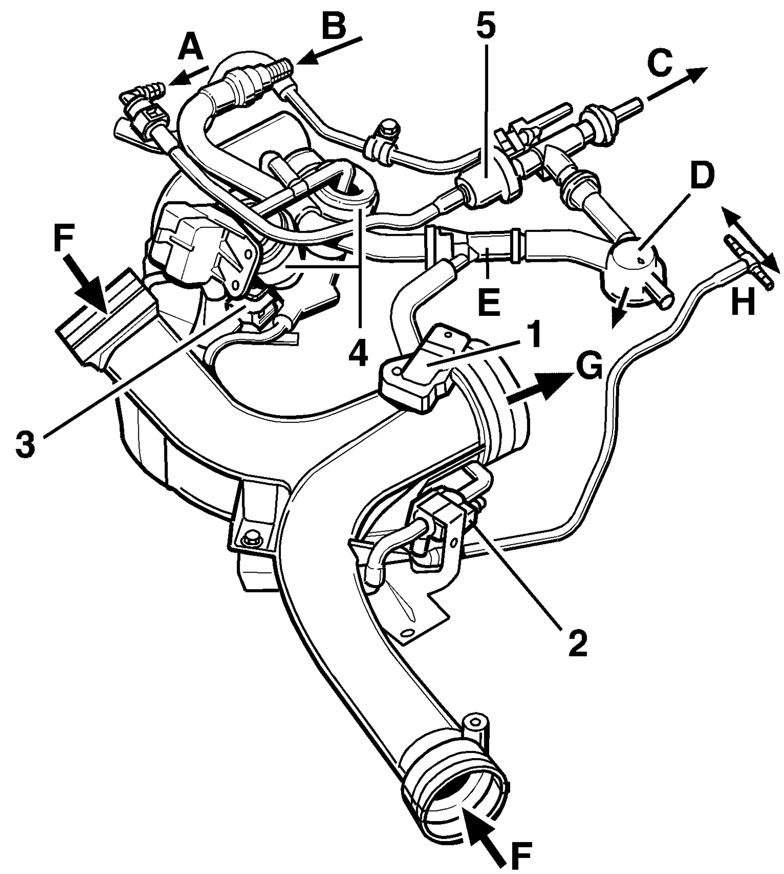
The appropriate boost pressure upstream of the throttle valve is determined according to driving style. In the case of a constant to slightly dynamic driving style, the tuning of the engine is optimized in the part-load range to reduce fuel consumption. This is achieved by permitting only slight pressure upstream of the throttle valve. The throttle valve is opened wide enough so that only a slight drop in pressure is possible via the throttle valve.

With a very dynamic driving style, a higher pressure is generated upstream of the throttle valve. As a result, the turbochargers are already running at a relatively high speed when the throttle valve is opened from the part-load range. The desired full-load boost pressure is thus reached more quickly.

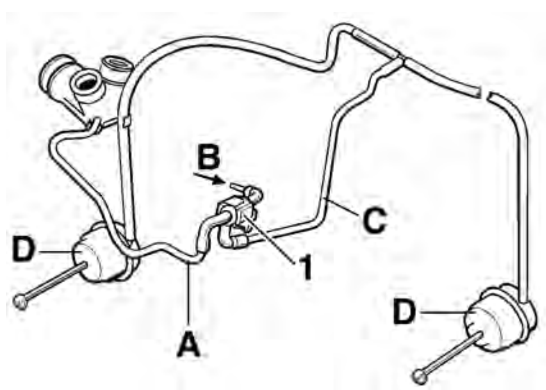
Notes:

Overview of Components

1 - Pressure sensor with temperature sensor (for charge air)
2 - Timing valve for boost pressure control
3 - Electric switching valve for overrun air recirculation
4 - Overrun air recirculation valves (pneumatic)
5 - Electric vent valve for active carbon canister
A - From active carbon canister (tank ventilation)
B - From brake booster (vacuum boost)
C - Tank ventilation at full load (to induction side of left hand turbocharger)
D - Tank ventilation at idling speed/part load (to intake pipe)
E - Vacuum amplifier
F - From charge air intercoolers
G - To throttle valve adjuster (E-Throttle)
H - To boost pressure control valves (barometric cell at exhaust gas turbocharger)



Connection Diagram



1 - Timing valve for boost pressure control
A - Induction side (vacuum)
B - Pressure side upstream of throttle valve adjuster (E-Throttle)
C - Regulated control side (timed)
D - Barometric cell for boost pressure control

The opening cross section of the timing valve for boost pressure control depends on the required boost pressure. Full boost pressure is available from a speed of approx. 3,000 rpm. The boost pressure is regulated at higher speeds.

The timing valve for boost pressure control changes the opening time to atmospheric pressure when actuated (duty factor) by the ME 7.8 control unit. A control pressure, which actuates the barometric cells of the boost pressure control valves accordingly and thereby opens the bypass valves at the turbochargers, is modulated from boost pressure and atmospheric pressure.

When de-energized, the timing valve for boost pressure control is closed. The boost pressure is applied directly to the barometric cells and, as a result, the boost pressure control valves open the bypass valves even at a low boost pressure.

Spark Plugs

Surface gap spark plugs with two ground electrodes and an electrode gap of approx. 1.6 mm are used to ignite the fuel/air mixture. These spark plugs must be changed every 25,000 miles (40,000 km).

Transmission Oil Temperature Sensor

A transmission oil temperature sensor is screwed into the bracket supporting the transmission oil/coolant heat exchanger.

The 911 GT2 (996) is the first vehicle to have a manual transmission where the DME control unit uses the incoming transmission oil and coolant temperature as the basis for actuating the coolant shut-off valve on the heat exchanger to cool the transmission oil.

The switching points are:

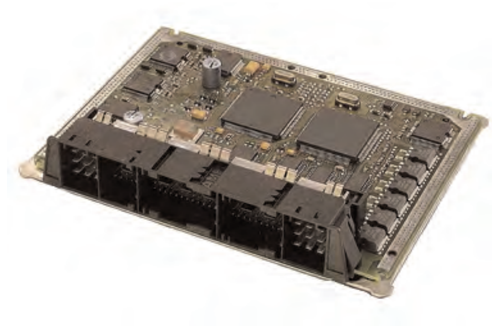
Cooling circuit **OPEN** (de-energized): coolant temperature >212° F. (100° C), or transmission oil temperature >221° F. (105° C).

Cooling circuit **CLOSED** (energized): coolant temperature < 194° F. (90° C) and transmission oil temperature < 203° F. (95° C).

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).

Notes:

DME Control Unit



The data record of the DME control unit varies according to the country version. The data records for the boost pressure, injection and ignition maps have been reconfig-ured. The maximum speed of the engine is limited to 6750 rpm.

The test adapter 9637 (134 pole for ME 7.2 and ME 7.8) can be used for electrical tests on the wiring harness.

DME Data Records (maps)

- RoW vehicles, including Europe (EU 3) and Germany (EU 3/D4).
- Japan/Australia.
- Vehicles with M 150 (countries with leaded fuel).
- Map for USA vehicles (LEV).

ME 7.8 Motronic Control Unit (Model Year 2004)

The modified data record of the Motronic control unit contributes to the significant power and torque increase. In addition, an increase in the maximum speed has been acheived by raising the governed speed in 6th gear by 50 rpm to 6,800 rpm. 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.

From model year 2004, the following data records with modified maps will be available for programming the Motronic control unit of the 911 GT2: LEV, EU3, JAP/AUS, M150.

As with the previous 911 GT2, Model Year 2003, a special programming code must be issued to program the control unit of the 2004 911 GT2

Programming DME Control Unit

A new procedure which at present is only valid for this vehicle is used for programming the DME control unit.

The following procedure must be observed:

- Enter the DME programming code from IPAS at the Porsche System Tester 2.
- The Porsche System Tester uses other data in the DME control unit to generate a special code which is then displayed on the Tester.
- This displayed code is sent to the staff responsible for security related data at Porsche AG.
- At Porsche AG, the actual code needed for programming is generated using a special procedure.
- The programming code is vehicle specific and can only be used once.

When the map is programmed, all ME systems are checked to establish whether the DME control unit already has the latest software version. If this is the case, programming is terminated.

Diagnostic Functions of DME Control Unit ME 7.8

The ME 7.8 has the following new or extended diagnostic functions in conjunction with the Porsche System Tester 2:

Actual Values:

- Approx. 116 actual values can be used. (Recommended: Create special filters and, if necessary, use Datalogger soft keys or Act/Max/Min.)

Actuators:

- Engine compartment scavenging blower, Stage 1 (actuated via fuel pump relay)
- Engine compartment scavenging blower, Stage 2
- Timing valve for boost pressure control
- Engine fan, Stage 1 / 2 / 3 (for coolant)
- Electric switching valve for overrun air recirculation
- Valve stroke control, cylinder bank 1 and 2 Actuators active:
- Valve stroke control, cylinder bank 1 and 2

Vehicle Data:

- Total distance

System Test:

- Valve stroke control, large stroke
- Valve stroke control, small stroke

Short test:
- Continuous oxygen sensing LSU

Notes:

Fault Memory Management

In all vehicle models, the on-board diagnosis system displays a visual warning in the instrument cluster ("Check Engine" light) as soon as an emission related fault or a fault which may damage the catalytic converter occurs; exception:
vehicles in countries with leaded fuel or fuel with an extremely high sulphur content (M 150).

The functions are adapted to the different regulations in the USA (OBD II), Europe (Euro OBD) and the rest of the world.

If a fault occurs, the ME 7.8 control unit activates the "Check Engine" light and the fault is stored in the control unit.

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

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

If the detected fault is not emission related and cannot cause damage to the catalytic converter, it is stored in the fault memory of the ME 7.8 control unit without the "Check Engine" light being activated.

The ambient conditions are stored together with the detected and stored fault. This information can be read out at a later stage using the Porsche System Tester 2. This makes troubleshooting much easier since the operating data for the first and last occurrence of the fault is provided.

Fault Confirmation

If a fault is detected during a diagnosis routine, it is registered as a suspected fault until it is confirmed during a second drive with a fresh diagnosis routine (at least 120 seconds after the engine has been started).

Erasing Counter

A separate erasing counter is assigned to each detected fault. It determines the storage time of a fault. When a fault is first detected, the erasing counter is set to a certain value.

If an unconfirmed fault is recognized as being "cured" (fault no longer exists), the erasing counter is set to a fault specific value (e.g. 10). When a detected fault has been confirmed (i.e. the "Check Engine" light has been activated), the erasing counter is set to 40. This value is retained until the fault no longer exists. If the fault no longer exists, the erasing counter is reduced by 1 after every warm-up cycle (i.e. the engine is started and the coolant temperature has increased from < 86° F. (30° C.) to > 158° F. (70° C.). If the erasing counter reaches 0 (i.e. the same fault no longer occurs), the fault is erased from the memory.

Note:
To ensure that the "Check Engine" light is functioning correctly, it is lit whenever the ignition is switched on.

Cooling Air Flow

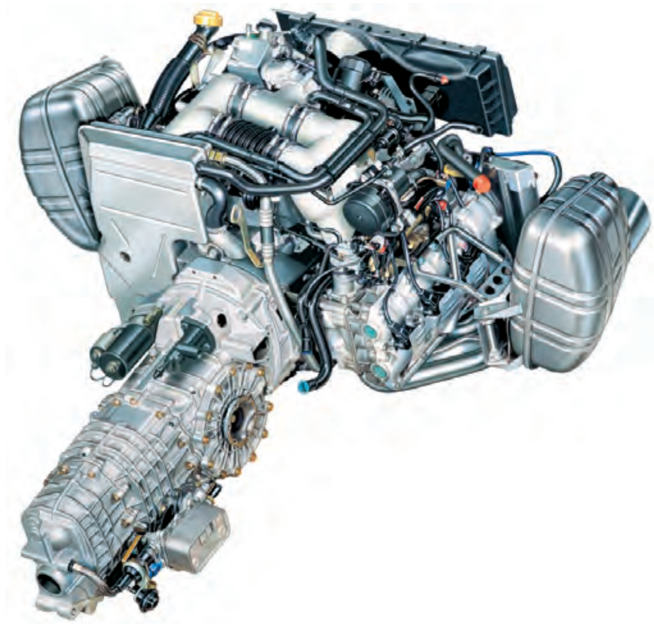
The design of the nose section and the location of the coolant radiators take into consideration the high engine output of the 911 GT2 (996) and the extra cooling capacity needed when the vehicle is driven competitively on racing circuits. The air inlets have been optimized. The efficiency of the middle radiator adopted from the 911 Turbo (996) has been improved by tilting it forwards and by modifying the airflow.

The air heated by the radiator is discharged via an opening in the top of the nose section. The shape of this opening is such that suction is generated behind the tilted radiator. Apart from the increased airflow, this design feature also prevents the air from flowing under the vehicle which would result in lift at the front axle.

The location of the coolant pipes in the front end of the 911 GT2 (996) has been adopted from the 911 GT3 (996). These measures mean that the left-hand radiator fan no longer has to be fitted. This, in turn, has resulted in a reduction in weight and has improved airflow through the radiator.

Notes:

Engine



General

M96.79

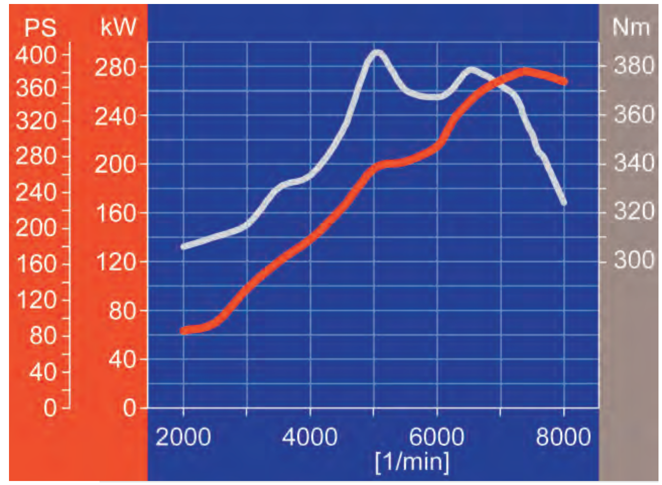
The engine of the new 911 GT3 (996) is a based on the previous model 911 GT3 (M.Y. 01) which was not available in the North American market at that time. The familiar 6-cylinder Boxer engine, which was derived from the power unit used in the 911 GT1.

A key objective was to increase the maximum power output coupled with a well-rounded torque curve over the entire engine speed range and a reduction of the mass of the crankshaft and valve train. The gear-dependent governed speed in 1st to 4th gear has been increased to 8200 rpm. In 5th and 6th gear it is 8000 rpm.

Special features of the engine are:

- Two-piece light-alloy crankcase
- Lightened crankshaft and connecting rods
- 8-bearing, plasma-nitride crankshaft
- Titanium connecting rod
- Cylinder case with Nikasil cylinder sleeves
- Lightened valve train
- High-speed-resistant bucket tappets
- Continuously variable timing of inlet camshaft
- Dry sump lubrication with engine mounted oil tank

Power/Torque Diagram



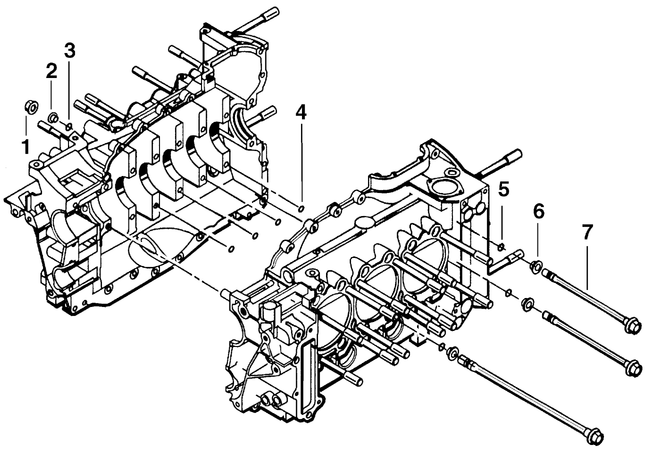
Engine Data:

Displacement	3.6 Liters
Bore	100 mm
Stroke	76.4 mm
Power output	381 hp (280 kW)
At engine speed	7400 rpm
Max. torque	284 ft lb. (385 Nm)
At engine speed	5000 rpm
Compression ratio	11.7 : 1

Notes:

Crankcase

The crankcase is divided into two sections and is made of an aluminium/silicon alloy. The two halves of the crankcase are machined together. It is, therefore, important to ensure that the pairing numbers match when the crankcase is assembled. A ring groove has been cut into the hole for the through bolt of main bearing 7. It is a relief groove and prevents oil from being discharged from the joint between the two crankcase halves. It is important to ensure that this groove is free of sealing compound and dirt particles during engine assembly.



Crankcase Components

The crankcase is bolted together with through bolts (7) which are sealed by the use of round seals (3 and 5) and sealing washers (2 and 6). In addition, o-rings (4) are also attached to the lower part of main bearing seats 2, 3, 4 and 5 in order to reduce vibration along the through bolts.

Crankshaft

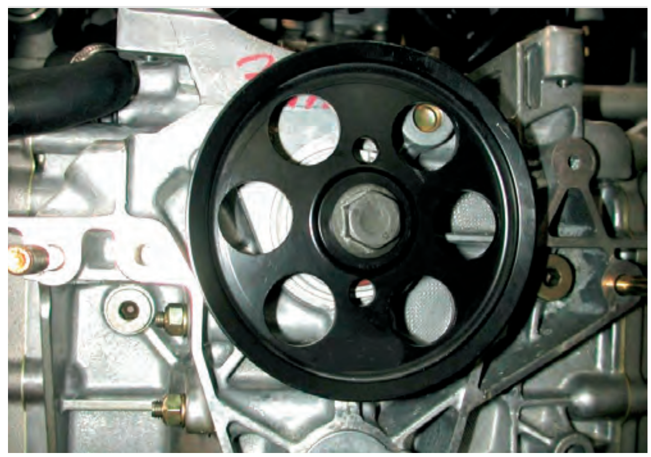
The crankshaft is drop-forged. The shaft has full bearing support, i.e. every connecting rod pin is supported by 2 main bearings, resulting in 8 main bearing points. Main bearing 1 (flywheel end) is configured as a thrust bearing so that it can absorb the axial forces acting on the crankshaft. The structural design specifies an axial clearance of 0.11 ... 0.20 mm.

The main bearings are supplied with lubricating oil directly from the main oil gallery of the crankcase, whereas connecting rod bearings 4, 1, 5 are supplied with oil from main bearing 1 and connecting rod bearings 3, 6, 2 from main bearing 8 via a channel in the crankshaft. This ensures a continuous supply of oil to the connecting rod bearings. After machining, the crankshaft is plasma-nitrided*. This elaborate surface treatment technique gives the main and connecting rod bearing journals excellent surface properties. The crankshaft has a stroke of 76.4 mm.

* Plasma-nitriding is a thermo-chemical heat treatment process and is carried out in temperatures between 660° F (350° C) and 1100° F (600° C). Positively charged ions strike the crankshaft (cathode) at high impact speed from the oven wall (anode). Initially, this ion bombardment achieves a very intensive cleaning of the crankshaft. The nitrogen is fed to the heated crankshaft surface in a vacuum chamber.

The advantages are:

- High wear resistance
- Low distortion
- Creation of corrosion-resistant coatings
- Reducing the coefficients of friction
- Partial hardening
- Heat resistance and starting durability of peripheral layers up to over 930° F (500° C)
- Environmentally friendly


Belt Pulley

Belt Pulley

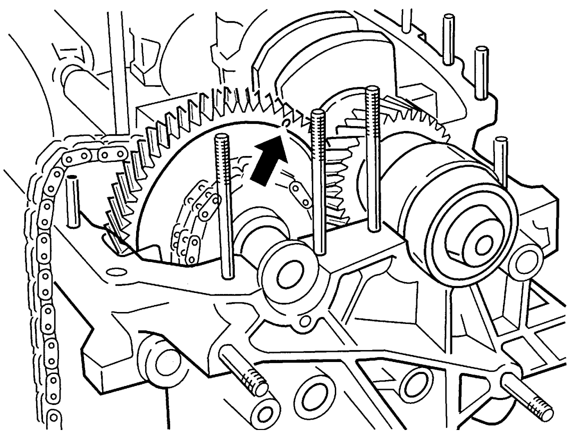
Since the moving masses in the crankgear could be significantly reduced, a torsional vibration damper is no longer necessary. A weight-optimized belt pulley is used.

Notes:

Intermediate Shaft

The intermediate shaft is driven by the crankshaft via spur gears. In order to ensure that the engine runs smoothly and to reduce wear, the gears are made of steel and manufactured in pairs. The chain sprockets on the intermediate shaft which drive the camshafts are made of sintered steel.

The code on the intermediate shaft gear (arrow) and on the left half of the crankcase indicates tolerance group 0 or 1 (eccentricity in the crankcase).



Intermediate Shaft Gear Code

At the end of the intermediate shaft is an intermediate part which is linked to and drives the oil pump. When the intermediate shaft and the oil pump are fitted, it is important to ensure that the intermediate part has axial clearance.

Notes:

Connecting Rods

To keep the crankgear mass as low as possible and for optimum strength even at high speeds, the connecting rods, connecting-rod bolts and connecting-rod nuts in the 911 GT3 (996) engine are made of titanium.

There are three main stages of production:

- Drop-forging of the blanks
- Working of the bearing and wrist pin bore
- Shot blasting to increase strength

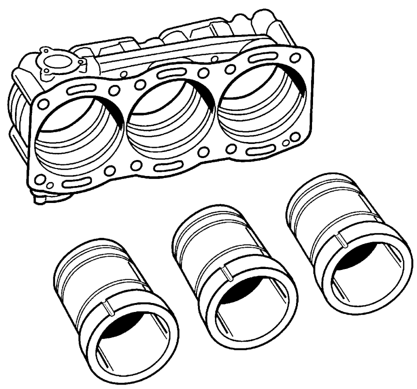
The connecting rods have a length of 130 mm and are therefore 2.4 mm longer than those of the 911 GT3 model year 2001. The advantage is a more efficient force application in the crankshaft.

The connecting rod and connecting rod bearing cap are matched with a pairing number.

Notes:

Cylinders

In order to increase torsional rigidity, the two cylinder banks (each with 3 cylinders) are housed in a single cylinder case. Unlike the 911 Carrera (996) engine, these cylinder cases are not combined with the crankcase, but are a separate component. Cylinder sleeves made of aluminium and coated with Nikasil are used in the light-alloy cylinder cases.



Cylinder Sleeve and Case

The coolant chamber between the cylinder sleeve and cylinder case is sealed by o-rings. The joint between the crankcase and cylinder case is sealed using coated triple-layer sheet-metal gaskets.

Pistons

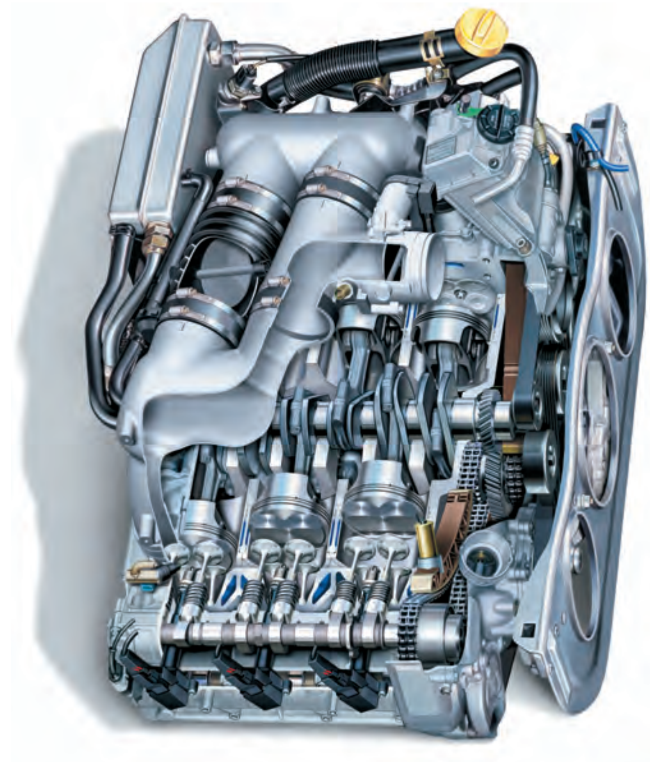
The forged pistons were designed with optimum piston crown form and piston shape along with mass reduction in mind. Therefore, compared to the previous version, the mass of the complete piston was reduced by 50 g (10%). Half of the reduction was achieved on the wrist pin and the other half on the piston. The wrist pin is on a full-floating bearing and lubrication is through oil spray. The wrist pin circlip is twist-locked.

Piston Cooling

Oil spray jets are fitted in the crankcase to reduce the temperature of the pistons.

To ensure that the engine oil pressure is maintained at low engine speeds and high engine oil temperatures, the jets have an opening pressure of 26 psi (1.8 bar).

Cylinder Head and Valve Train



The cylinder heads are manufactured from extreme temperature-resistant light alloy.

The intake and exhaust ports are surface machined to improve the charge cycle and thus power output. The combustion chambers are designed as spherical cups, the two intake and two exhaust valves of each cylinder have a diameter of 41 mm and 35.5 mm respectively around the valve disc.

The are arranged in a "V" at an angle of 27.4°. The exhaust valve stem is hollow and filled with sodium to improve heat dissipation. Due to the power-oriented valve timing and the associated high forces, double valve springs are used to close the intake and exhaust valves.

This ensures the speed stability of the high-speed designed engine. In the valve train area the masses were again reduced in comparison with the previous model.

Notes:

For this reason, the diameter of the flat-base tappets was reduced from 33 mm to 28 mm, thereby reducing the weight of each tappet by 21 g. This equates to a weight reduction of moving masses of approx. 0.5 kg. The contact areas between tappets and cams are cambered. Another 19% (approx. 250 g) of the weight could be saved on the valves, which have a stem diameter of 6 mm.

The chain drive runs with plastic guide rails and hydraulic chain tensioners located at the untensioned end of the chain. A driving flange for the oil suction pump is attached to the input side of each exhaust camshaft.

Cylinder Head Gasket

The multi-layer steel gasket is completely covered with high-temperature resistant plastic in order to enhance the sealing quality of its surface. The advantage of this steel gasket is that heat can be dissipated from the cylinder head very efficiently.

Camshaft Housing

The light-alloy camshaft housing is attached to the cylinder head. The intake and exhaust camshafts are held in the camshaft housing by means of bearing sleeves. The bearing sleeves and camshaft housing are machined together and have pairing numbers.

Camshafts

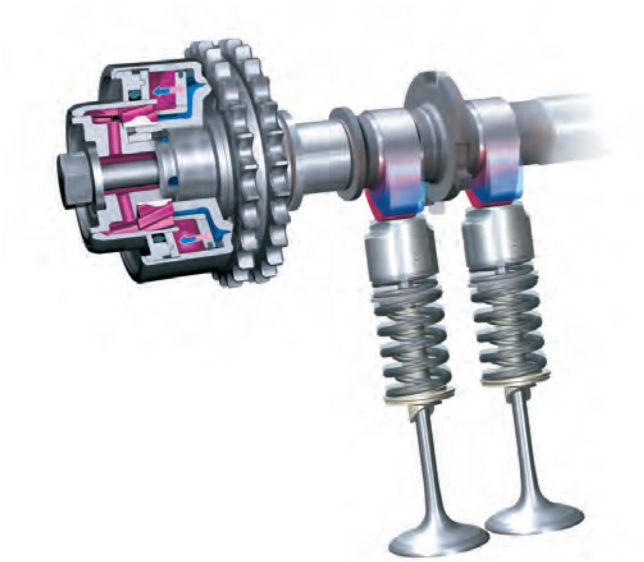
The camshafts are hard-chilled components and hollow-cast to reduce weight. The shaft diameter of all camshafts is 26.6 mm.

The intake valve lift is 12.3 mm
The exhaust valve lift is 11.1 mm

Camshaft

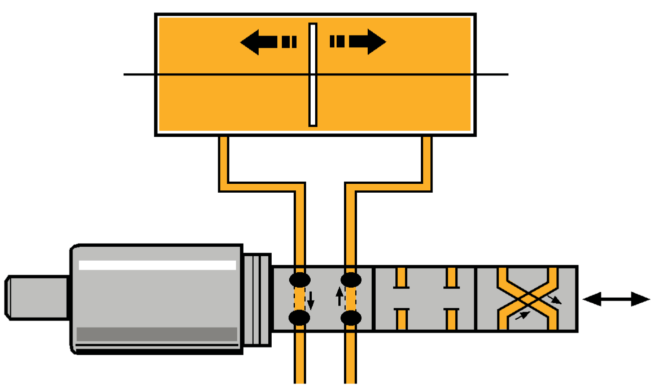
Notes:

Variable Camshaft Timing (VarioCam)



The camshaft adjustment system is based on the principle of a helical sliding gear which has a cylindrical component (3) between the camshaft gear and camshaft stub.

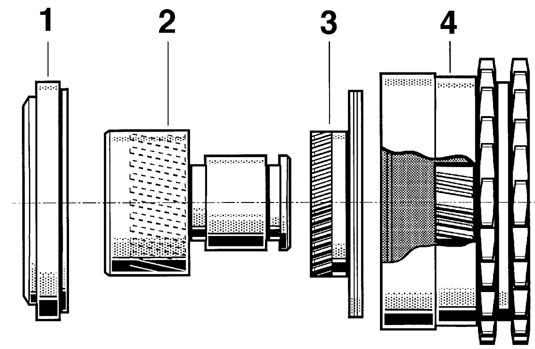
Cylindrical Component



Cylindrical Operation

The cylindrical component has helical gearing both inside and outside. The inner gearing engages with matching gearing on the inside of the camshaft gear (4).

The outer gearing engages with gearing (2) mated to the camshaft stub. At the same time, the cylinder (3) forms a piston on the side facing away from the camshaft. This piston can be moved by oil pressure. A number of teeth have been removed from the gearing to ensure that the oil pressure can act on the piston instantaneously without loss. The component is sealed with a sealing ring (1) and cannot be disasembled.

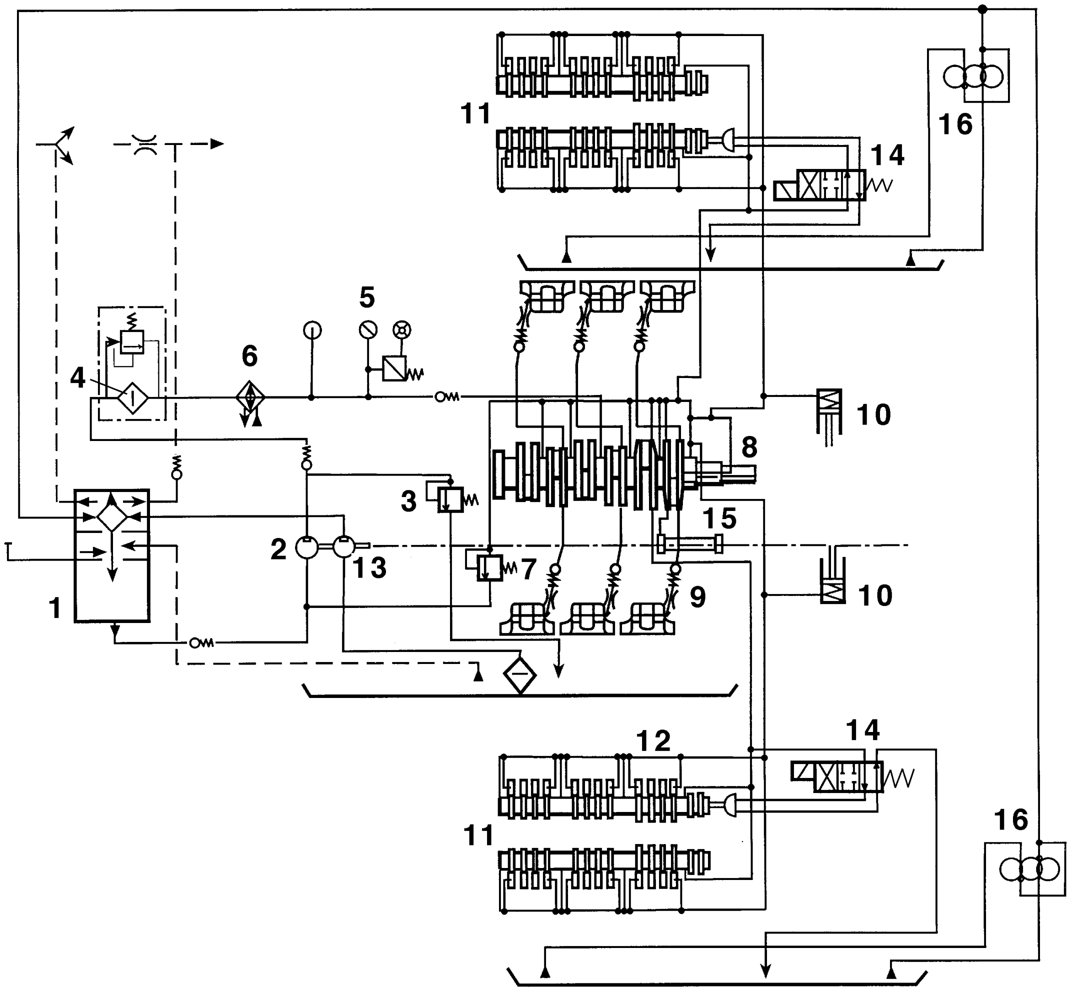


VarioCam Components

The oil pressure is regulated on both side by means of a solenoid valve, which is actuated infinitely variable by the Motronic control unit. The adjustment range designed with a crankshaft angle at 45° allows a very fine adaption to the engine characteristics regarding power, torque and exhaust emission.

Notes:

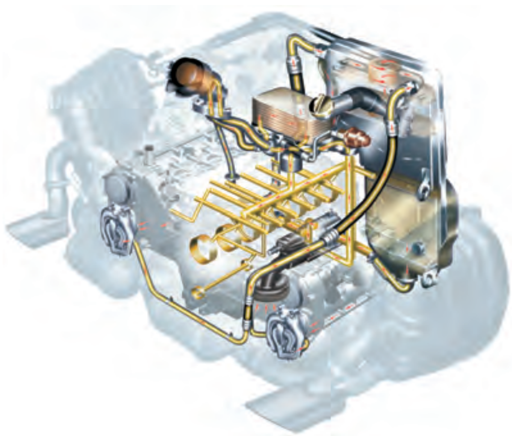
Lubrication System



1 - Oil tank
2 - Pressure pump
3 - Safety valve
4 - Oil filter
5 - Oil pressure sensor
6 - Oil-to-water heat exchanger
7 - Pressure-limiting valve
8 - Crankshaft
9 - Piston oil cooling jet
10 - Chain tensioner
11 - Camshaft
12 - Flat-base tappet
13 - Suction pump
14 - VarioCam
15 - Intermediate shaft
16 - Oil return pump

Notes:

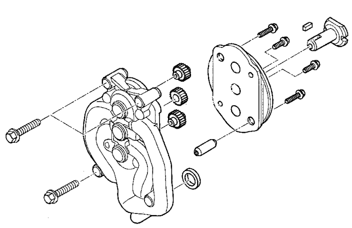
Oil Return Pumps



Due to the design of the engine, a large quantity of oil could collect in the cylinder head during extreme cornering manoeuvres. To prevent this, each cylinder head has its own non-return pump (16) to draw off any excess oil.

The 911 GT3 (996) engine has a dry-sump lubrication system with separate oil tank (1). A double oil pump, which is driven by the intermediate shaft, is fitted in the crankcase. The pressure pump (2) draws the oil from the oil tank (1) and supplies oil to all bearing points, chain tensioners (10), cam surfaces, hydraulic flat-base tappets, the VarioCam (14) and the piston spray jets (9) used to cool the pistons.

The return pump (13) is fitted in the same housing as the pressure pump (2). It draws the foaming oil out of the crankcase via two suction snorkels and feeds it back to the oil tank (1). This pump must be larger to handle the aerated oil.



Oil Pump

The engine oil is filtered before it enters the engine by means of an oil filter (4) fitted on top of the engine in the main oil gallery.

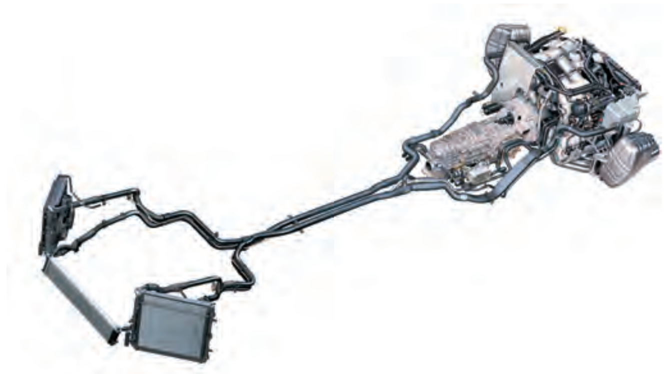
USA and Canada Maintenance Schedule

Change interval for engine oil is: 15,000 miles (24,000 km)
Change interval for the filter is: 30,000 miles (48 000 km)

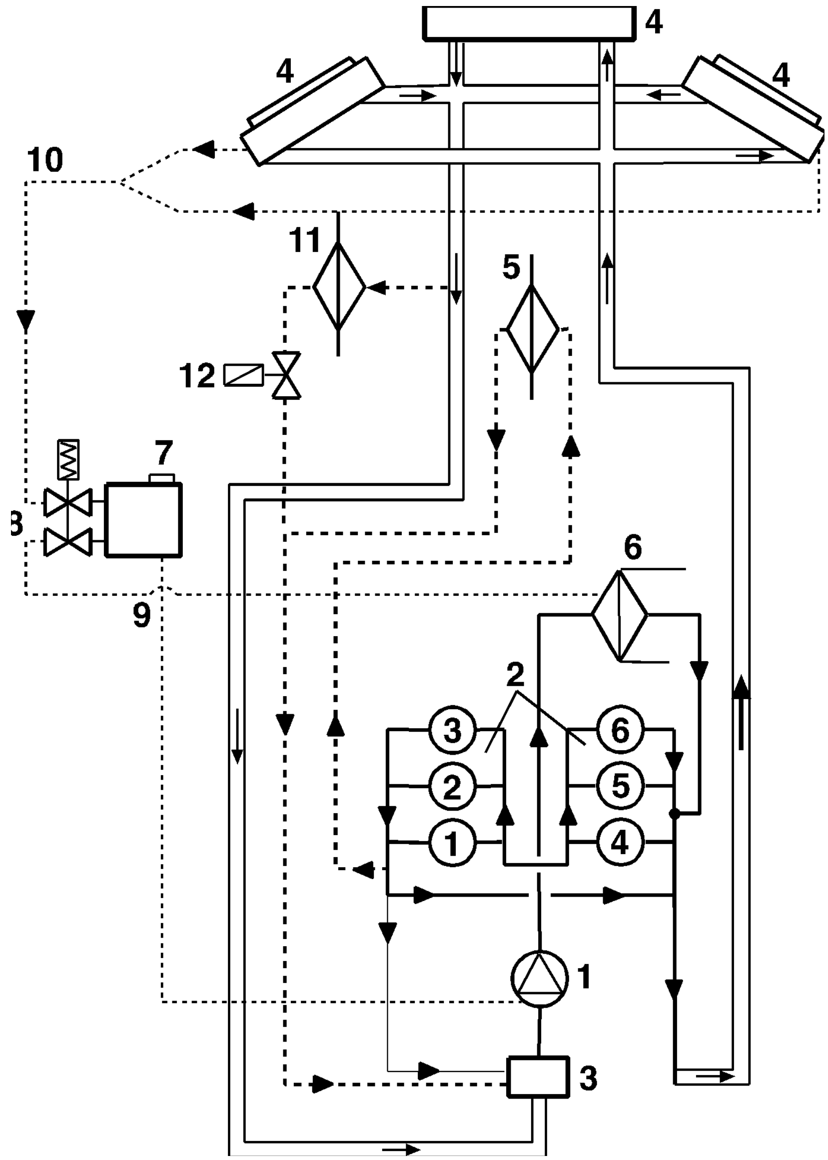
For safety reasons, a pressure-limiting valve (7) and safety valve (3) are fitted in the main oil gallery. The pressure-limiting valve (7) is located in the right-hand half of the crankcase. It opens at 5.3 bar allowing the oil to pass into the intake port until the pressure drops again. The safety valve is fitted in the oil circuit immediately downstream of the pressure pump outlet. It serves as a safety valve if the pressure-limiting valve should fail. The opening pressure is 9 bar in order to prevent damage to the sealing rings, oil-to-water heat exchanger (6) and the oil circuit.

Cooling System

The principle of cross-flow cooling is implemented to ensure uniform distribution of the coolant. This prevents a difference in temperature between the individual cylinders.



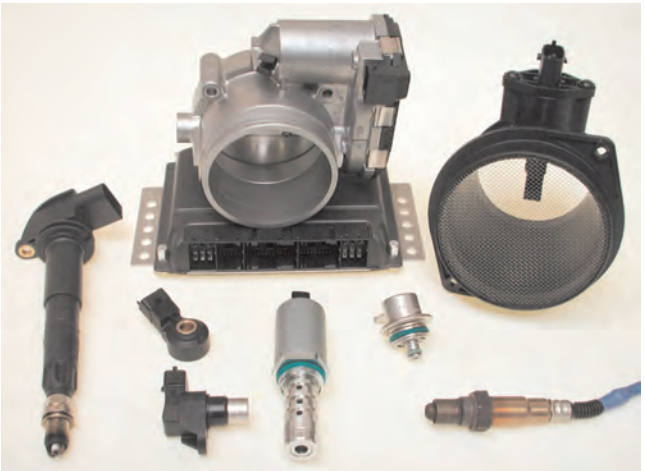
Cooling System



1 - Coolant pump
2 - Crankcase
3 - Thermostat
4 - Radiator
5 - Heat exchanger
6 - Oil-to-water heat exchanger (engine)
7 - Expansion tank
8 - Shut-off valve
9 - Bleeder pipe (engine)
10 - Bleeder pipe (radiator)
11 - Oil-to-water heat exchanger (transmission)
12 - Shut-off valve

Notes:

Fuel and Ignition System



General

The further development of the 3.6 liter 911 GT3 (996) naturally-aspirated engine was specially designed for the highest specific performance and high torque over a wide engine rpm range. It has reduced engine emissions and fuel consunption, and, complies with all exhaust and noise emission requirements worldwide. 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.

Development goals of the 911 GT3 (996)

- Increasing the performance potential of the new 6-cylinder, 3.6 liter Boxer engine
- Well-rounded torque curve over the entire engine rpm range
- Maximum speed concept with lightened valve train
- 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 (996) engine reaches a maximum engine power of 381 HP (280 kW) at 7400 rpm and a max. torque of 284 ft lb. (385 Nm) at 5000 rpm.

ME 7.8 Motronic System

- The Motronic control unit is adapted to the specific requirements of the 911 GT3 (996).
- 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
- Dual oxygen sensor control with oxygen sensors above 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
- Solid-state ignition 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
- Immobilizer with transponder system
- CAN interface to other control units

Additionally, on USA versions:

- ORVR system with tank leak test
- Pressure sensor to measure tank pressure
- Shut-off valve for tank leak test
- 2-chamber carbon canister fuel tank vent filter with a capacity of 2 liters

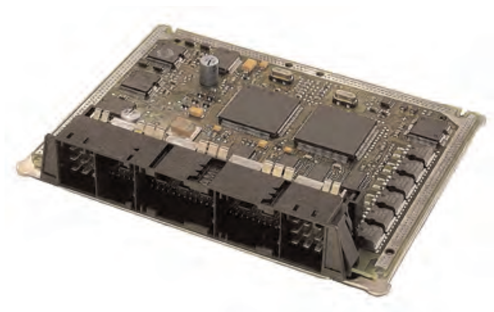
OBD II and EOBD

The driver is informed by a visual warning (check engine light) in the instrument cluster, through the 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 Light

A permanently lit “Check Engine” light indicates an emission-related fault. A flashing “Check Engine” light indicates a combustion fault which may damage the catalytic converter.

Motronic Control Unit



Exhaust Emission Standard

The 911 GT3 (996) 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.

Sound/Acoustics

The 911 GT3 (996) engine has an unmistakable exhaust note 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 underlines the sporty character through accentuation of the engine note.

Notes:

High-speed Concept

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.

Notes:

911 GT3 (996)

Fuel

The engine has been designed to provide optimum performance and fuel consumption with 93 Octane premium unleaded. If unleaded fuel with an octane rating of at least 90 Octane is used, an adjustment is made through the knock control, whereby the ignition point is retarded and the engine power consequently reduced.

Fuel Tank

The fuel tank has been adopted from the 911 GT2 (996). By utilizing the additional space (occupied by the front-axle differential on the 911 Carrera 4). USA models have the 911 Carrera (996) M.Y. 2003 tank with ORVR system (On-board Refueling Vapor Recovery).

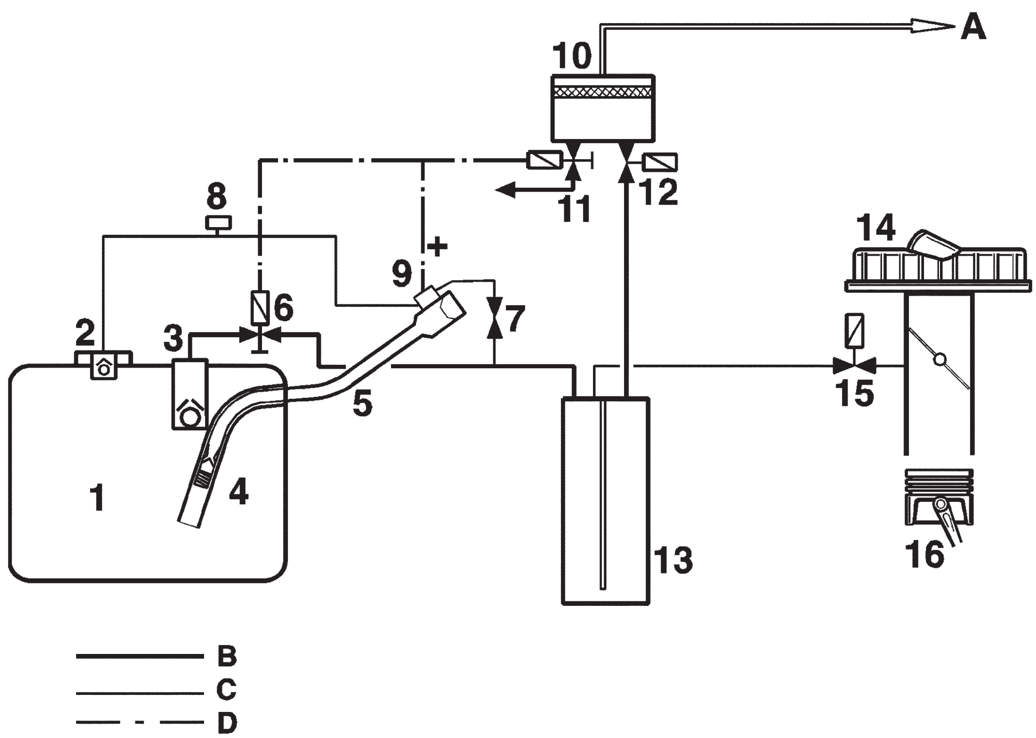
Fuel Supply

The 911 GT3 (996) 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. 55 psi (3.8 bar) at full load. The unused fuel flows through the return line back into the tank.

Injection Valve (EV-6)

A feature of this injection valve is its small overall size, low weight and the very low risk of vapor lock with hot fuel. The atomization 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.

Notes:



ORVR System

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

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 - Carbon canister fuel tank vent filter
14 - Air cleaner
15 - Tank vent valve
16 - Engine

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

Function

When refueling 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 ground, they open. While the tank is filling, the space where the HC vapors collect becomes smaller as the fuel volume in the tank increases. The HC vapors 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 path for venting to atmosphere is over the electric fresh-air valve (11). When the engine is next started, the carbon canister (13) is evacuated and regulated via the tank vent valve (15) by the DME control unit according to certain criteria and elapsed times.

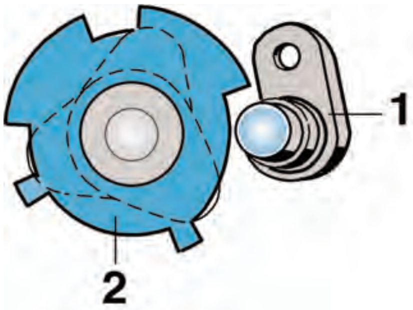
Activated Carbon Canister

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

Tank Leak Test

The tank leak test, which is only carried out on USA models, is described in detail in the 911 Carrera (996) MY '99 Technical Introduction book, in Group 2.

Hall Sensor and Camshaft Rotor



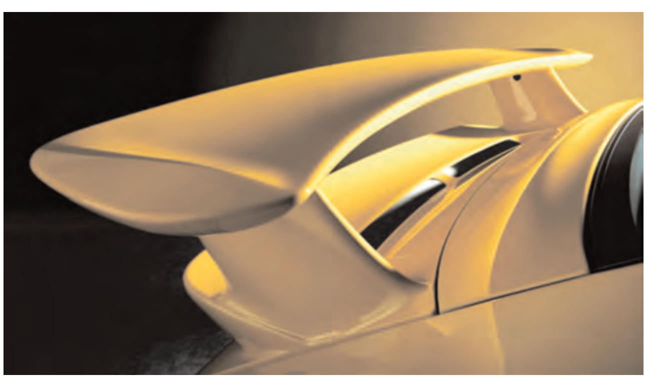
1 - Hall sensor
2 - Camshaft rotor

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.

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 90 Octane rating results in a significant retardation of the ignition timing under load with a consequential reduction in power output.

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.

Notes:

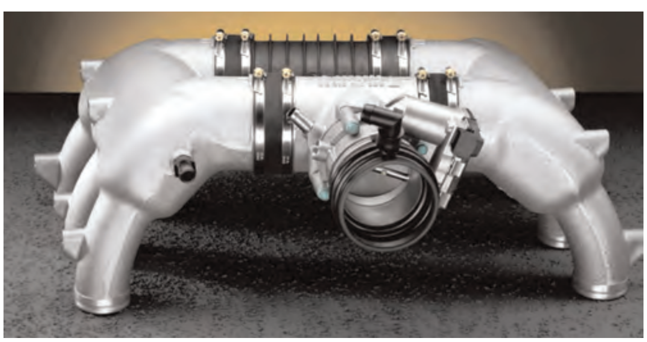
Air Filter

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 plenums. Straight intake runners lead from the plenums 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 (996) is a light-alloy casting. The plenums lying above the two cylinder banks are connected together via two connecting pipes. The inlet ports and plenums are surface machined to optimize the gas flow and the manifolds are matched to the inlet ports.

The resonance tube is mounted between the two plenums in front of the distribution pipe in direction of travel. This component, made of plastic for weight reasons, houses the resonance flap.



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 32° F (0° C), the resonance flap remains open until 2280 rpm. Between 2280 and 5040 rpm, it is closed to optimize torque and it is opened again above this engine speed to optimize performance.

In deceleration, 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 + 140° F (60° C), if intake air is cold, it is reduced (by max. 5% at – 68° F (20° C).

Hot Film Air Mass Flow Sensor (HFM 5)

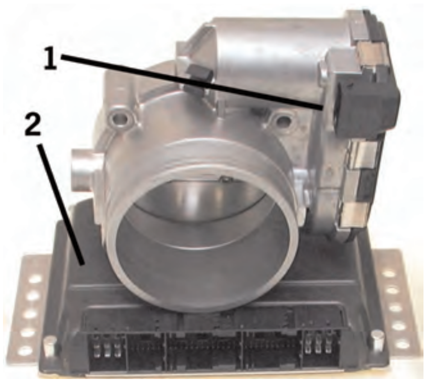
The air mass sensor must not be removed from its measuring tube, as these components are matched to each other on a flow bench. The special air mass flow sensor of the 911 GT3 (996) is designed for a nominal air flow of up to 2137 lbs per hour (970 kg/h).

Notes:

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



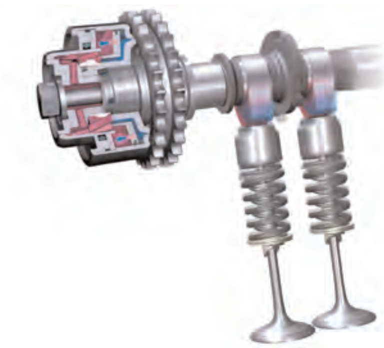
1 - Throttle control unit (E-Throttle)
2 - Motronic control unit

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 prioritizes 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.

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 system to increase oxidation and ensure that the catalytic converter is heated up faster.

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



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 synchronization and consequently puts high demands on the DME control unit. The increased adjustment range allows even finer optimization of the engine characteristics regarding power, torque and exhaust emission.

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 optimized 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.

Partial Load

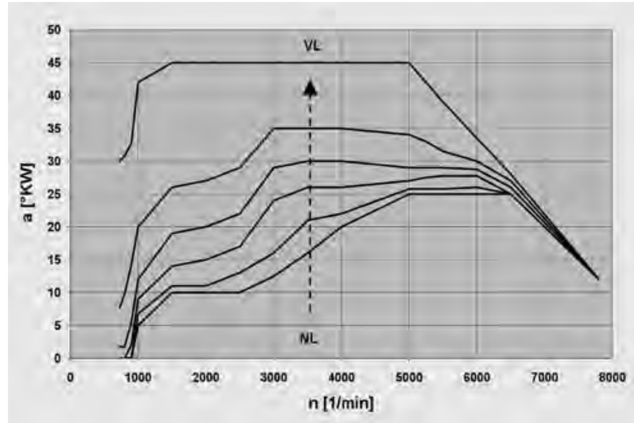
To reduce the charge-exchange losses and to improve the combustion stability when under partial load, operation with high residual-gas levels, i.e. burnt fuel/air mixture, is ideal. This results in both reduced fuel consumption and improved emission values. In part-load range, the engine is run load-dependent,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

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.

Notes:

Continual Adjustment of Inlet Camshafts

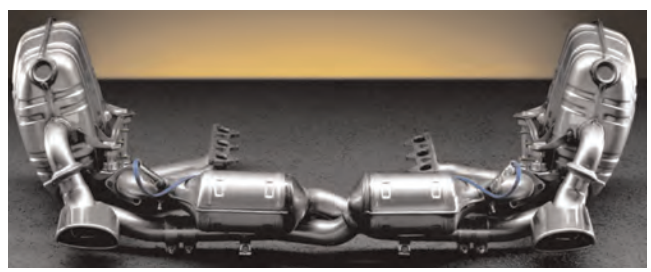


n – Engine speed in rpm
a – VarioCam adjustment angle (advanced) in °crankshaft angle
NL – No load
VL – Full load

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.

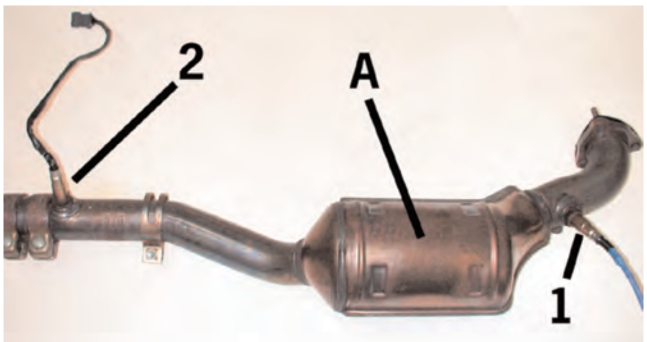
Exhaust System



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 (duplex 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.

Catalytic Converter

The catalytic converter monolith 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 monolith have only 1/3 of the wall thickness of ceramic monoliths.

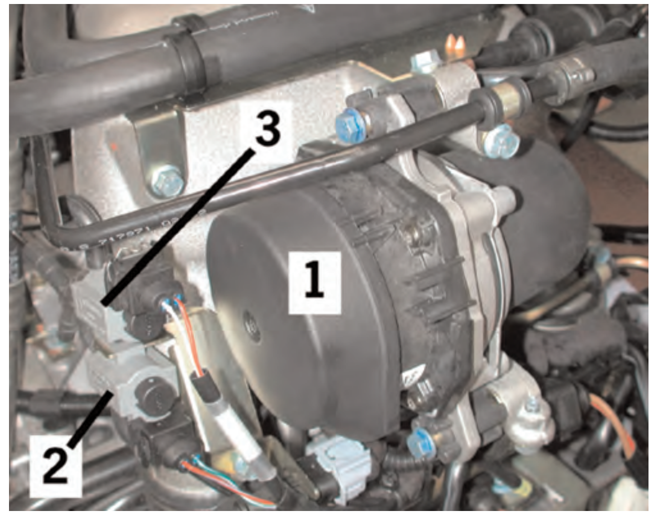


A - Catalytic converter
1 - Oxygen sensor LSF (upstream of catalytic converter)
2 - Oxygen sensor LSF (downstream of catalytic converter)

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. Additionally, a metal catalytic converter is less sensitive to overheating. Higher engine performance is achieved due to the decreased exhaust back-pressure. The metal catalytic converters of the 911 GT3 (996) 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).

Notes:

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 which are higher during the warm-up phase. Therefore, the catalytic converters reach their starting temperature of approx. 660° F. (350° C) faster due to the heat generated by increased oxidation.

During the initial coldstart process, the switch-on condition is reached when the coolant temperature lies between 14° F. (–10° C) and 108° F. (+ 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.

1 - Combination valve

Oxygen Sensing

The 911 GT3 (996) 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.

Oxygen Sensor LSF

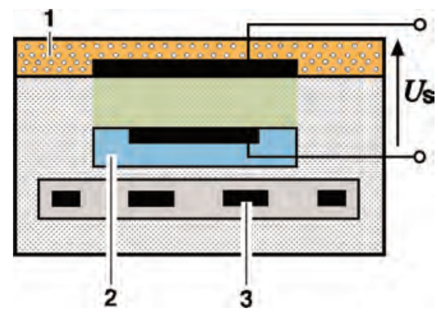
An oxygen sensor LSF (LSF = oxygen sensor, flat design) is fitted up and downstream of the catalytic converters. This planar oxygen sensor is a further development of the heated oxygen sensor. Functionally it equates to the heated oxygen sensor LSH with a step map of 0 to 0.9 volts at Lambda 1. Unlike 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.

Notes:

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.



1 - Exhaust gas
2 - Reference air channel
3 - Heating element
US - Oxygen sensor voltage

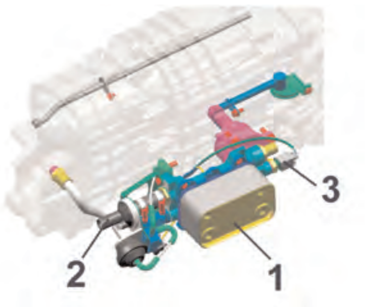
Notes:

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-energized):
  coolant temperature >212° F (100° C), or transmission oil temperature >220° F (105° C).
- Cooling circuit closed (energized):
  coolant temperature < 194° F (90° C) and transmission oil temperature < 203° F (95° C).



1 - Oil-to-water heat exchanger
2 - Coolant shut-off valve
3 - Temperature sensor

Notes:

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Notes:

Engine

General

The engine of the new 911 GT3, with its 3.6 liter displacement, is a further development based on the 911 GT3 (996).

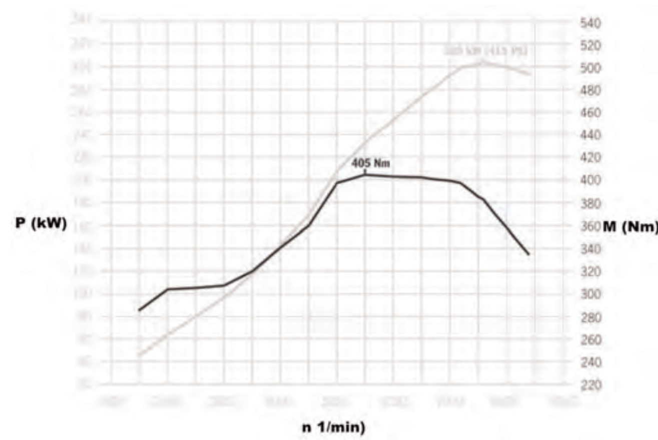
The most demanding task during development was to improve the already outstanding specific output of the 911 GT3 (996) engine while retaining the same displacement. This was achieved by using the very latest technologies, the fine-tuning of all components that have an influence on power output, and the use of materials from racing.

Special attention was paid to the further increase in maximum power, with a higher torque curve throughout the entire rpm range.

Summary of modifications:

- Higher power and torque values
- Higher engine speeds
- Forged pistons
- Reduced weight
- Advanced VarioCam

Power/Torque Diagram



Engine Data:

Displacement	3,600 cm^3
Bore	100 mm
Stroke	76.4 mm
Power output	415 bhp (305 kW)
At engine speed	7,600 rpm
Max. torque	299 ft lbs (405 Nm)
At engine speed	5,500 rpm
Compression ratio	12,0 :1
Governed speed	8,400 rpm
Idling speed	740 rpm

Crankshaft

A reduction in weight was achieved through a deeper central bore in the crankshaft on the pulley side.

Connecting Rods

The titanium rods already used in the 911 GT3 (996) were lengthened by one millimeter to 131 mm, in order to increase the maximum engine speed in the new 911 GT3. This enables a better transfer of forces from the rod to the crankshaft and reduces load on the components.

Pistons/Wrist Pins

To improve combustion, the shape of the piston crown was modified, as was the overall shape of the piston in order to reduce weight. The diameter of the wrist pins was reduced from 22 mm to 21 mm, the resulting weight reduction is approx. 30 g per piston.

Valve Drive

The new 911 GT3 (997) uses a rotary-vane vane actuator, like the 911 Carrera (997), allowing continuous adjustment of the intake camshaft. The adjustment range is 52° crankshaft angle.

Camshaft

The camshafts were taken from the 911 GT3 (996). Due to the increased demand for power, the intake cams were revised and their lift increased from 12.3 mm to 12.7 mm.

Vacuum Pump

Similar to the current 911 (997) generation, the new 911 GT3 also has a mechanically driven vacuum pump that uses rotary vane technology. This replaces the conventional vacuum amplifier to provide the vacuum for the brake booster and for activating various switching valves. It is located on the cylinder head of cylinder bank 1-3 and is driven by the exhaust camshaft.

Fuel, Ignition System & Engine Electrics

General

Outstanding performance through intensive development; besides the high power and torque values of the extremely compact engine, the new 911 GT3 (997) is particularly impressive for its higher revving response and excellent acceleration across the whole rpm range. These characteristics guarantee a very sporty driving experience in all conditions.

The six-cylinder unit reaches its rated output at 7,600 rpm, with the redline at 8,400 rpm. In addition to the higher rpm, further enhancement in the air flow made a decisive contribution to the increased power. This was possible with a new variable intake system with an 82-mm throttle valve (E-gas), optimized cylinder heads and optimization of the flow through the sports exhaust system with reduced backpressure. Compared to the previous model, the air flow has been increased and the gas cycle improved.

Motronic Engine Management System ME 7.8_40_LSU

The Motronic ME 7.8_40 engine management system with broadband oxygen sensors upstream of the catalytic converters is used in all vehicles worldwide.

The Motronic engine management system, with its processing speed of 40 MHz and 1 MB memory, has been adapted to the engine-specific requirements of the following components and systems:

- The familiar On-Board Diagnostics system (OBD – USA) and (EOBD – Europe/RoW) informs the driver via a warning in the instrument cluster as soon as emission and engine related faults arise.
- Sport Chrono function.
- Traction Control.
- Tuning flaps of the intake system.
- Exhaust flaps on the sports exhaust system.
- Variable control system for the radiator fan in the front apron.
- Transmission oil cooling via transmission oil/water heat exchanger.

Data Records

Various country-specific data records are available on the PIWIS Testers for programming the DME control unit.

Adaptation Of The Motronic Engine Management System

The Motronic engine management system has been adapted to the engine-specific requirements of the following components and systems:

- ME 7.8_40_LSU: Worldwide stereo lambda control with LSU broadband oxygen sensors upstream of the catalytic converter and LSF step oxygen sensors downstream of the catalytic converter.
- VarioCam (continuous camshaft adjustment).
- Sequential fuel injection with new EV-14 injection valves.
- Electronic throttle (E-gas).
- Intake system with two tuning flaps.
- One three-way catalytic converter per cylinder bank as the main catalytic converter.
- Secondary air control.
- DM-TL fuel tank leakage check using excess pressure (USA).
- Sport Chrono Package Plus.
- Continuous activation of the electrical radiator fan.
- Engine compartment scavenging blower.

New Input Signals Of The Motronic Engine Management System

- Electronic accelerator pedal unit with pedal sensor 1 and 2.
- LSU broadband oxygen sensors upstream of the catalytic converter, bank 1 and bank 2.
- LSF step oxygen sensors downstream of the catalytic converter, bank 1 and bank 2.
- Tank leakage diagnostics module DM-TL (USA only).
- CAN information.
- Sport Chrono button.

New Drive Links Of The Motronic Engine Management System

- Injection valves for cylinders 1 to 6.
- Valve for intake camshaft adjuster, bank 1 and bank 2.
- Switching valves for tuning flaps.
- Tank ventilation valve.
- Tank leakage diagnostics module DM-TL (USA only).
- Secondary air pump.
- Cooling water fans (via additional control unit).
- Engine compartment scavenging blower.
- "Check Engine" light.

Sport Chrono Package

The basic functions are the same as the current 911 generation, allowing increased sportiness and even more direct responsiveness to be achieved for the purpose of enhancing vehicle agility.

However, pressing the “SPORT” button not only selects a sportier performance, but also activates an engine map with enhanced torque and power output.

When the “SPORT” button on the center console is pressed, this increases the engine torque by up to 18 ft lbs (25 Nm) in the mid-rpm range and selects a sporty tuning for Traction Control (TC).

In the sports setting, the exhaust backpressure in the variable exhaust system is reduced, the gas cycle improved and the torque noticeably increased in the rpm range between approx. 3,000 and 4,200 rpm. This leads to an increase in the torque values of between 15 and 18 ft lbs (20 and 25 Nm) and an increase in the power output of 13 bhp.

Notes:

Anti-Slip Regulation (ASR)

Intervention in the engine management system decreases the engine's power by lowering the engine torque. This is achieved by closing the throttle and reducing the ignition angle. Additional information on this is available in group 4 (Chassis).

Engine Drag Torque Control (EDTC)

Engine Drag Torque Control (EDTC) is activated if lateral stability is lost at the rear axle after a downshift on a slippery surface. EDTC can quickly open the throttle, thereby restoring driving stability.

If the driver wishes to increase the driving dynamics manually, a sporty setup can be selected using the "SPORT" button on the center console, or the system can be switched off completely using the "TC OFF". "TC OFF" appears on the instrument cluster to notify the driver when the system is switched off.

High-revving Engine Concept

The engine in the new GT3 has an advanced high-revving engine concept. A shift indicator, which illuminates shortly before the relevant engine speed is reached, gives the driver an additional signal for the ideal shift points.

DME Power Supply

The power supply of the DME control unit is the same as in the current 911 (997) model. The assignment of the fuse carrier, as well as relay carriers 1 and 2, can be found in the circuit diagram on the PIWIS Tester.

Fuel Supply

Fuel Tank

The fuel tank has a capacity of approx. 17.3 gals. (66 liters). The fuel tank has a reserve of 2.6 gals. (12 liters).

Fuel Pumps

The fuel tank of the GT3 has 2 fuel pumps which are integrated into the common pump chamber. The two fuel pump relays are activated as required by a map in the DME control unit. The quantity of fuel delivered by both fuel pumps can be checked as described in the Technical Manual.

Fuel Filter

The fuel filter is located in the left-hand side of the engine compartment and must be changed every 48,000 miles (80,000 km) or after 6 years.

Fuel Pressure Regulator

The fuel pressure regulator is located on the fuel distributor rail in the engine compartment. A return line runs from the fuel pressure regulator to the fuel tank. The Technical Manual describes how to check the fuel pressure. The holding pressure should be > 29 psi (2 bar) after 1 hour.

Notes:

New EV-14 Injection Valve

The advanced EV 14 Extended Tip injection valve from the EV series is used, and has a very slim shape. This extended 12-hole injection valve has another injection point located in the intake pipe, which results in an even better mixture preparation and a reduction in emissions.

Tank Ventilation System

The tank ventilation system is the same as the one used in the 911 Carrera (997). USA vehicles with the tank leakage diagnostic module (DM-TL), it is located in the front luggage compartment.

Ignition System

The individual ignition coils and spark plug connectors are the same as for the previous model.

Spark Plugs

The spark plugs have two ground electrodes and an M12x1.25 thread. The change interval is every 24,000 miles (40,000 km) or after 4 years.

Intake System

The new intake system of the GT3 engine is an important component of the increase in power. The “ram air box” on the rear lid allows for greater air flow in the intake area. Depending on the speed, this box forces the intake air with increasing pressure directly into the air cleaner housing, and contributes to aerodynamic performance.

The air cleaner housing is a further development from the previous model, and channels the air through an enlarged outlet to the throttle valve. The diameter of this has also been enlarged from 76 to 82 mm, which increases the rate of air flow and improves the charge cycle.

Notes:

Multi-stage Intake System With Two Tuning Flaps

Having passed through the air cleaner, past the hot film air mass air flow sensor and through the throttle valve, the air then flows into a new variable intake system that now has two switchable tuning flaps. The system is now made from aluminum.

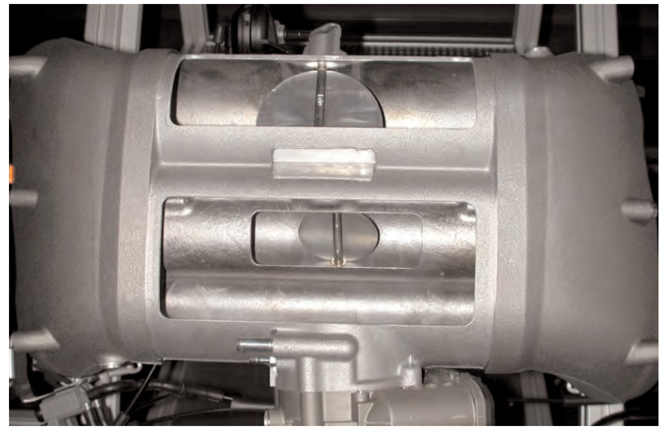
The enhanced flow intake system uses smooth surfaces and large cross-sections to guarantee a good cylinder charge and high power values. Accordingly, the insides of the air collectors and intake pipes of the new 911 GT3 (997) are carefully reworked and generously dimensioned. In addition to the air flow, a good cylinder charge also requires intensive use of the air resonances pulsing through the intake system. This is done using the switchable connecting pipes with tuning flaps, which are controlled by the Motronic engine management system.

Air Oscillations Help To Achieve Optimal Cylinder Charging

The air in the intake system is made to oscillate by the opening and closing of the valves and by the movements of the pistons. The strength of the oscillations depends on the engine speed and on the resonance generated by the intake system. In a limited rpm range, this oscillating system starts to resonate and enables strong air oscillations. These oscillations are used for optimal charging of the cylinders with air and thereby for achieving high torque and power values. The excitation of oscillations changes as the engine rpm changes.

To start the system resonating again, requires a change to the resonance of the intake system. This is done by opening or closing the connecting pipes in the intake system. In order for the resonance effect to be used across the widest range of engine rpms, a multi-stage intake system with several tuning flaps is required.

Switching Points Of The Tuning Flaps



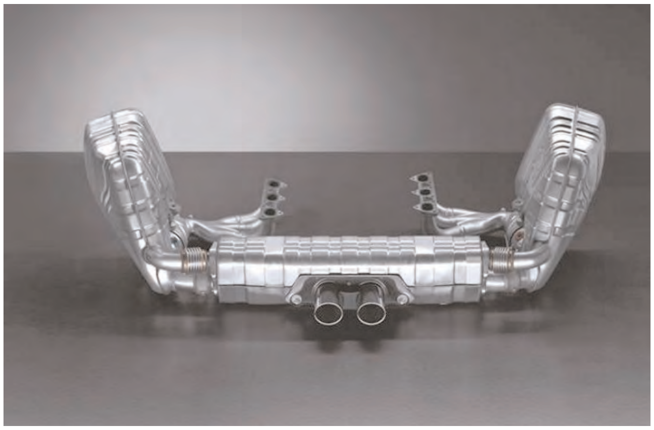
To achieve a smooth and high development of torque, the following switching strategy for the tuning flaps (connecting pipes between the intake distributors) was chosen in the new 911 GT3 (997):

- Up to 5,400 rpm, both tuning flaps are closed.
- From 5,400 to 6,350 rpm, the small tuning flap is opened, while the large one remains closed.
- From 6,350 rpm, the small tuning flap is closed and the large one is opened.
- From 7,500 rpm, both tuning flaps are opened.

These measures enable a high torque curve across a large rpm range on the one hand, and high maximum power on the other.

Notes:

Exhaust System

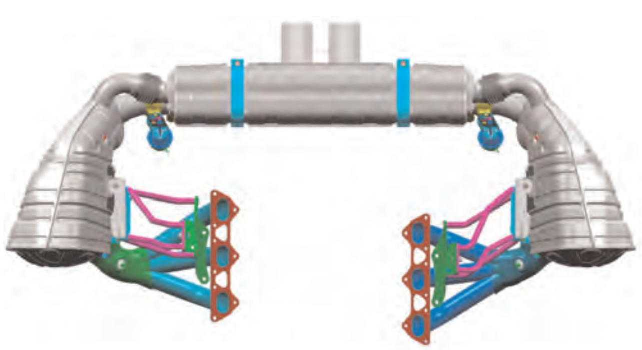


To optimize the gas cycle, the exhaust system was also re-designed. The gases first flow through two high-performance manifolds. Compared to standard manifolds, they offer reduced flow resistance as well as better mixing. This achieves a more effective pre-treatment of the raw emissions, before they are converted in the downstream catalytic converter.

In the new 911 GT3 (997), the catalytic converters are no longer located transversely under the rear end, but at the side, directly behind the manifolds. Positioning them near to the engine allows the catalytic converters to heat and respond more quickly, and reduces exhaust emissions, especially after a cold start.

As a result, the 911 GT3 fulfils the legally prescribed limits of the LEV II stage for the USA, as well as the current Euro 4 emissions standard.

Switchable Front Mufflers



The two catalytic converters are followed by two new front mufflers, which are switched and controlled by maps. This is done using two flaps behind the catalytic converters, which are controlled by vacuum and which direct the gases either into the front mufflers or directly into the rear muffler located under the rear end. Opening the exhaust flaps creates a direct channel to the rear muffler, while the exhaust backpressure falls by around eight percent compared to the previous 911 GT3 (996). The exhaust flaps are controlled by the Motronic engine management system, depending on load and engine speed. The flaps, which are closed when the engine is started, open as more power is required. In both cases, the new 911 GT3 fulfils all noise regulations worldwide.

The design of the entire exhaust system emphasizes the development capabilities of Porsche engineers. The volume of the system not only grew by .42 cu. ft. (12 l), which results in lower exhaust backpressure and therefore, more power, but its weight has also been reduced by 18.7 lbs (8.5 kg) compared to the previous model.

The reason for this is the weight optimized, single-skin construction with reduced wall thicknesses, whose structural integrity was achieved using corrigated construction. Another advantage is the higher degree of system integration: exhaust manifolds and catalytic converter housings are no longer two separate modules, but a single integrated component.

At the same time, another, decisive point was considered. The new design provides a highly characteristic six-cylinder sound, as the single-flow layout allows the exhaust gases of all 6 cylinders to be brought together via a common muffler.

The 911 GT3 has an independent rear end with a centrally positioned tailpipe. It has additional air outlet openings and an internal heat shield. The dual tailpipes are clearly different from those of the Carrera models. Their central position in the middle of the rear end and their larger diameter give the new 911 GT3 (997) a powerful, muscular rear view.

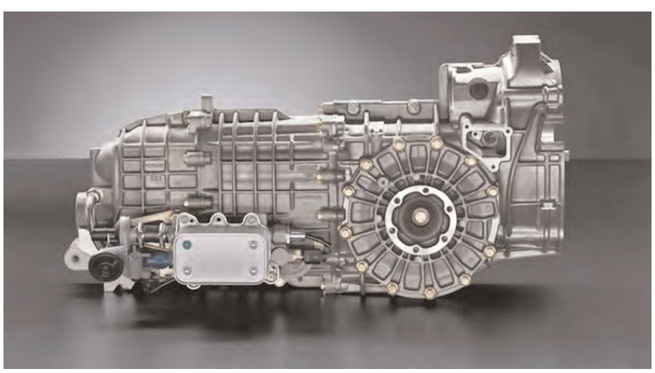
VarioCam

The VarioCam has an extended adjustment range. The intake camshafts are continuously operated by the VarioCam system, and the timing of the intake valves is adjusted. This is now done by a rotary-vane actuator, as also used in the current 911 Carrera models (997).

The advantage of the new system:

The infinite adjustment range of the intake camshaft has grown from 45 to 52 degrees, which allows improvements to engine characteristics such as power output, torque and exhaust behaviour.

Transmission Oil Cooling Control



The DME control unit controls the transmission oil cooling to ensure durability even under extreme load. Depending on the current temperature of the transmission oil and coolant, the coolant shutoff valve on the heat exchanger is activated to cool the transmission oil.

- Coolant circuit open (de-energized)
  Coolant temperature > 212° F (100° C), or transmission oil temperature > 221° F (105° C)
- Coolant circuit closed (energized):
  Coolant temperature < 194° F (90° C), or transmission oil temperature < 203° F (95° C)

Electric Fan

The 911 GT3 (997) has infinite fan control. The final stage of the electric fan is activated by the front control unit based on a controlled input from the DME.

Engine Compartment Scavenging Blower

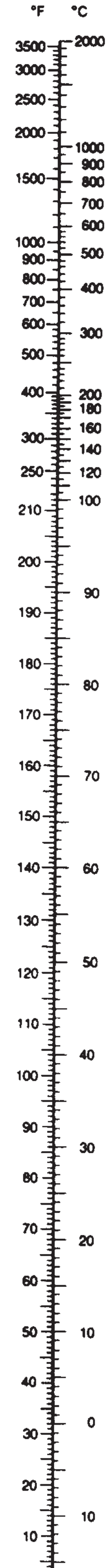
The engine compartment scavenging blower is activated in two stages as in the current 911 (997) vehicles.

Secondary Air Injection

The components and function of the secondary air injection system, with one secondary air valve per cylinder bank, each of which is pressure-opened by a pump, are the same as in the current 911 (997) vehicles.

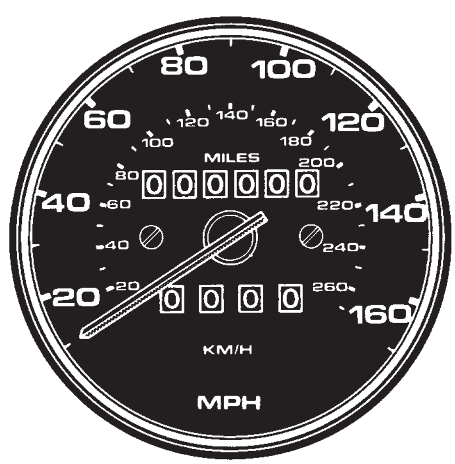
Notes:

Temperature Conversion



Metric Conversion Formulas

INCH	X	25.4	=	MM
MM	X	.0394	=	INCH
MILE	X	1.609	=	KILOMETER(KM)
KM(KILOMETER)	X	.621	=	MILE
OUNCE	X	28.35	=	GRAM
GRAM	X	.0352	=	OUNCE
POUND(lb)	X	.454	=	KILOGRAM(kg)
kg(KILOGRAM)	X	2.2046	=	lb(POUND)
CUBIC INCH	X	16.387	=	CUBIC CENTIMETER(cc)
cc(CUBIC CENTIMETER)	X	.061	=	CUBIC INCH
FOOTPOUND(ft lb)	X	1.3558	=	NEWTON METER(Nm)
Nm(NEWTON METER)	X	.7376	=	ft lb(FOOT POUND)
HORSEPOWER(SAE)	X	.746	=	KILOWATT(Kw)
HORSEPOWER(DIN)	X	.9861	=	HORSEPOWER(SAE)
Kw(KILOWATT)	X	1.34	=	HORSEPOWER(SAE)
HORSEPOWER(SAE)	X	1.014	=	HORSEPOWER(DIN)
MPG(MILES PER GALLON)	X	.4251	=	Km/l(KILOMETER PER LITER)
BAR	X	14.5	=	POUND/SQ. INCH(PSI)
PSI(POUND SQUARE INCH)	X	.0689	=	BAR
GALLON	X	3.7854	=	LITER
LITER	X	.2642	=	GALLON
FAHRENHEIT	-	32÷1.8	=	CELSIUS
CELSIUS	X	1.8+32	=	FAHRENHEIT



Notes:

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