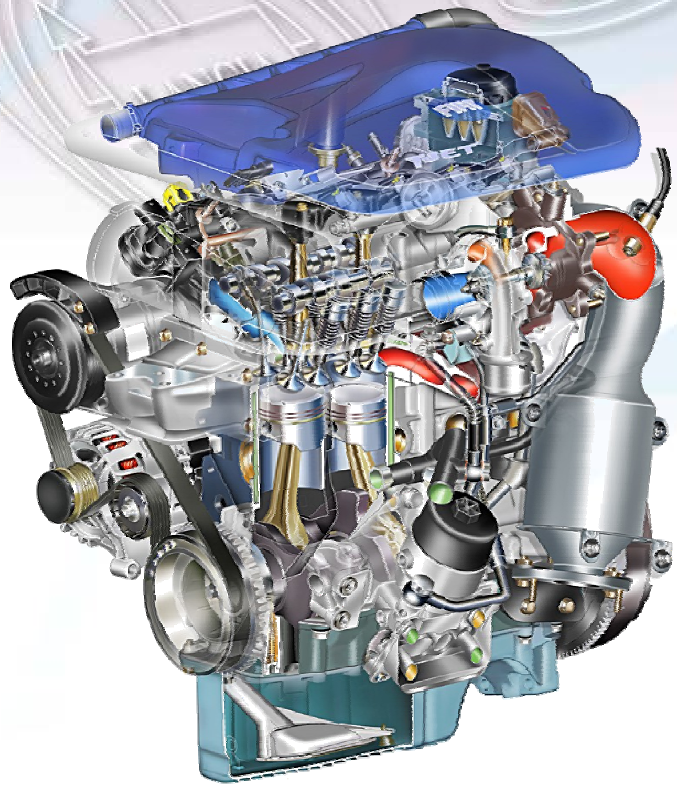

FIAT RITMO (BRAVO)
Engine 1.4 Tjet

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CONTENTS

TECHNICAL DATA

Introduction
This chapter illustrates the technical data for the new Fiat Bravo with 1.4 16V TJET engine

Technical data for Fiat Bravo 150 HP.

Type of vehicle

AUTOVEHICLE	198AXF1B 05 - 05B(1368 Turbo Bz - EURO 4) CM6 - 4 DOORS

Engine

ENGINE (Type)	198A1000
DISPLACEMENT (Bore and stroke)	1368 (72 x 84)
COMPRESSION RATIO	9,8 ± 0,2
MAX POWER (kW - rpm)	110 - 5500
MAX TORQUE (Nm - rpm)	206 – 2250 / 230 - 3000 (con overboost)
ENGINE IDLE SPEED (rpm)	750 ± 50
CO MIN AFTER CATALYSER	< 0,3%
INTAKE TIMING (Open/Close)	-2° p. P.M.S. / 34° d. P.M.I.
EXHAUST VALVES (Open/Close)	27° p. P.M.I. / -2° d. P.M.S.
LUBRICATION	
Engine oil SELENIA K P.E.	SAE 5W-40 Fiat qualification 9.55535-s2

Engine Control

INJECTION	
ECU (Brand - Type)	BOSCH 7910A1
LAMBDA PROBE (Brand - Type)	BOSCH LSF4. 2 (upstream)
	BOSCH LSF4. 2 (downstream)
TURBOCOMPRESSOR (Brand - Type)	IHI VL33
IGNITION	
ECU (Brand - Type)	BOSCH M7. 9.10.A1
COIL (Brand - Type)	BOSCH 0.221.504.024
SPARK PLUGS (Brand)	NGK IKR9F8
INIT. ADVANCE (giri/min)	9° ± 4° at 750 ± 50

Transmission

GEARBOX TYPE	MANUAL M32
GEAR RATIOS	
1	1:3,818
2	1:2,158
3	1:1,475
4	1:1,067
5	1:0,875

6	1:0,744
R.G	1:3,545
FINAL TORQUE RATIO (AXLE)	1:4,176
MAX DECLARED SPEED (GEAR)	212 (VI)

Silencers

SILENCER SYSTEMS (Brand and type (°) emblem	ASP.	AIR FILTER	(°)51793178
		RESONATOR	--
	SCA.	1st ELEMENT	(°)55206760 (CATALYSER)
		2nd ELEMENT	(°)46821879
		3rd ELEMENT	(°)51789970
		4th ELEMENT	--
		5th ELEMENT	--

Wheels

TYRES	195/65R15 91V	205/55R16 91V	225/45R17 91V	225/40R18 92V REINFORCED
(ROLLING CIRCUMFERENCE)	(1937)	(1928)	(1934)	(1943)
RIM	6½JX15-31,5	7JX16-31	7JX17-31	7½JX18-35

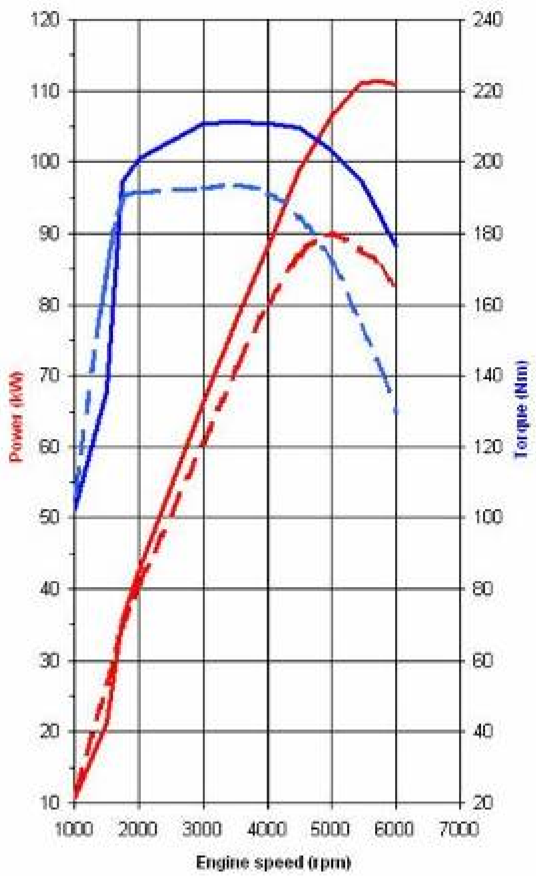
Weights

WEIGHT (STANDARD A) (kg)	FRONT	785
	REAR	490
	TOTAL	1275
MAXIMUM ALLOWABLE MASS ON AXLE (kg)	FRONT	1000
	REAR	860
	TOTAL	1785
TOWABLE MASS (kg)		1300
CAPACITY (kg)		510
TOW HOOK VERTIC. LOAD (kg)		60
FUEL TANK CAPACITY (litres)		58

Emissions

CO2 (g/km)	URBAN	219
	EXTRAURBAN	137
	COMBINED	167
CONSUMPTION (l/100 km)	URBAN	9,3
	EXTRAURBAN	5,8
	COMBINED	7,1

FIRE 1.4 TJET 150 HP AND 120HP ENGINES



General features

The portfolio of FIRE engines includes 8V and 16V versions with displacement from 1.1 to 1.4 litres.
All these engines have atmospheric intake.
With the start of production of the EVO version of the 8V and 16V engines halfway through 2005, the FIRE engines have confirmed a competitive position on the market for petrol engines in terms of performance, costs and fuel consumption.
To maintain competitiveness on a market increasingly oriented toward Diesel engines to the detriment of petrol engines, it is necessary:
Emphasise the reduction in fuel consumption to minimise the gap to reach CO2 targets
create the right “fun to drive” level to assure the right level of customer interest.
In this scenario, a FIRE 16V Turbo represents the first fundamental step with regard to the above points and the FIAT POWERTRAIN TECHNOLOGY petrol engines program.
The FIRE TURBO is directly derived from the FIRE 1.4 MPI.
This engine is developed with two max. power levels:
an 88.2 kW (120 HP) version
a 110 kW (150 HP) version
both versions are coupled with the M32 6 gear transmission.
Turbo charge is provided by a fixed pitch turbocompressor managed by an engine control unit through a turbo pressure electrovalve that regulates the waste gate and a shut off electrovalve (Dump valve).
The FIAT BRAVO represents the first application of the new FIRE Turbo engine.

Specifications sheet

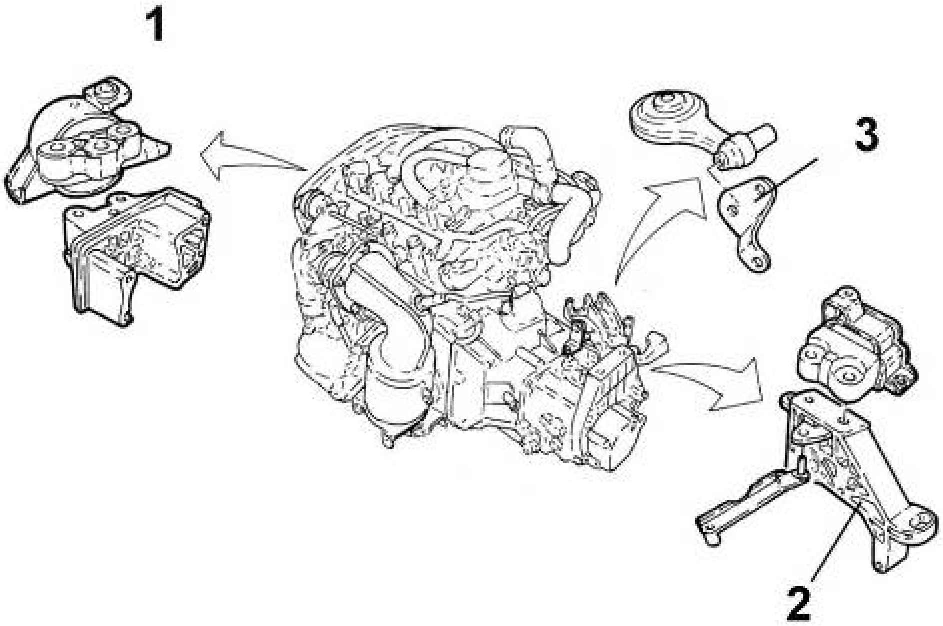
120 HP engine specifications			
Power	88,2 kW	120 HP	a 5000 rpm
Torque	190 Nm	(19kgm)	a 1750 rpm
150 HP engine specifications			
Power	110 kW	150 HP	a 5500 rpm
Torque	206 Nm	20 kgm	a 2250 rpm
Torque with overboost	230 Nm	23 kgm	a 3000rpm
Power			
Cylinder layout	4 in line		
Bore	72 mm		
Stroke	84 mm		
Total displacement	1368 CC		
Compression ratio	9,8		
Cylinder head	Realised in two parts in aluminium alloy		
Engine block	Cast iron		
Crankshaft	Steel with 8 balancing weights and 5 main bearings		
Valve train	Twin overhead camshafts driven by gears with play take-up from intake to exhaust axis, hydraulic tappets and 4 valves per cylinder		
Engine control	Integrated electronic injection-ignition Bosch ME 7.9.10 A1		
Fuel supply	System with fuel recirculation		
Ignition	Individual coils (pencil coils)		
Firing order	1 - 3 - 4 - 2		
Air intake	With turbo compressor adjusted by waste gate control valve, dump valve and intercooler		
Anti-emissions system	With trivalent catalytic converter and lambda probe		
Lubrication	Forced with gear pump and green filter system		
Cooling	Liquid cooled with forced circulation by centrifugal pump and closed circuit. Radiator and auxiliary expansion chamber		
Production site	Termoli Factory (Italy)		

Mechanics

Introduction

This chapter describes the major variants to the 1.4 16V TJET engine with respect to the normal intake version.

Engine group mountings



Key
1. Valve train side mounting
2. Transmission side support
3. Torque arm

Type

This is a barycentric type engine mounting system, consisting of:
- A hydraulic type mounting on the valve gearing side
- A rubber-metal mounting on the transmission side
- A torque rod in the lower part

The mountings are aligned on an axis that passes through the engine centre of gravity such as to obtain reaction force with arm null.

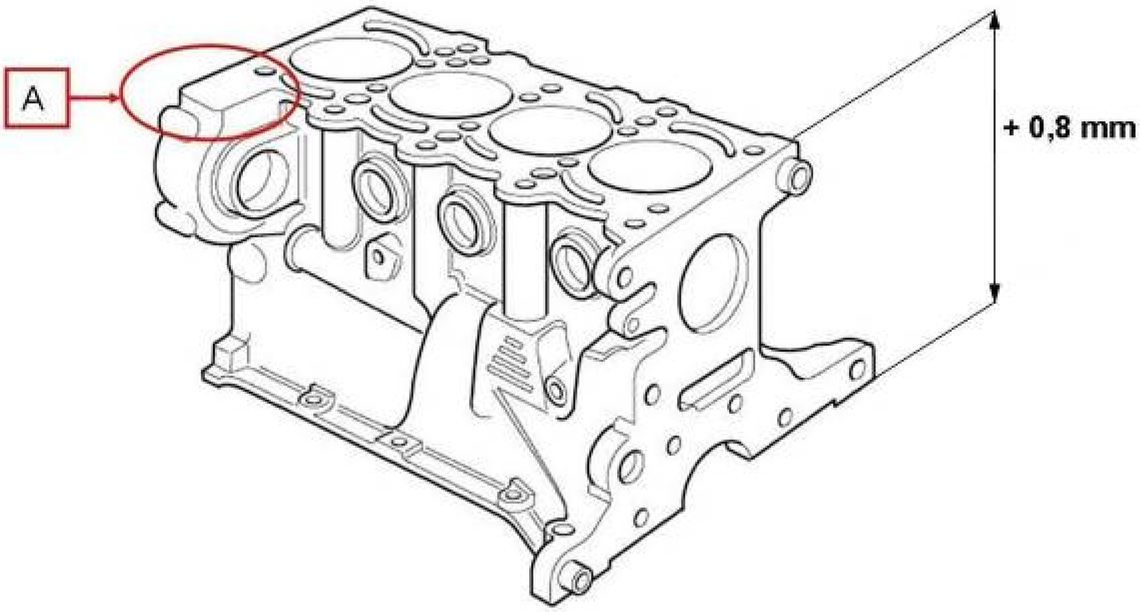
For the Fiat Bravo this system is specific to the 1.4 TJET and so not interchangeable with the normal intake version.

Function

The engine group mountings serve to:
- structurally connect the engine to the body shell;
- dampen the vibration generated by the engine, greatly reducing vibration and noise transferred to the body

The mountings are sized to support the weight of the engine and the loads deriving from the torque transmitted by the engine, and are optimised to adapt to the vehicle lay-out.

Engine block



Type
The block is in cast iron with high mechanical strength.
The crankshaft is supported by five main journals.
The cylinders are cut directly into the engine block and come in three size classes plus one oversize.
Specific channels in the walls of the engine block permit passage of coolant and lubricating oil.
The engine bock is specific to the TJET version, and varies from the non-turbo versions for the internal coolant circulation and height, which has been increased by 0.8 mm

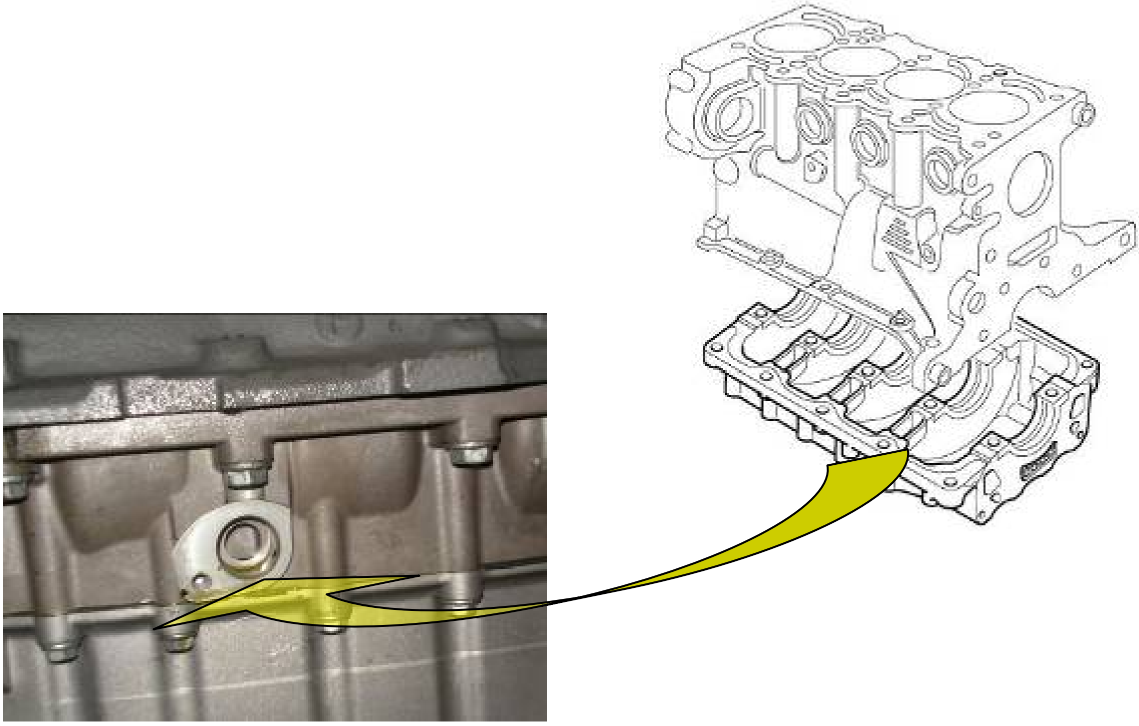
Note: Area A reserved for engine markings

Note: the values below are identical to the non-turbo versions

Cylinder barrel classes

Standard values			Values with oversize of 0.1		
Class			Class		
A	72.000	72.010	A	72.100	72.110
B	72.010	72.020	B	72.110	72.120
C	72.020	72.030	C	72.120	72.130

Lower engine block



Type

The lower block is realised in pressure die cast aluminium oil, with main journal caps in cast iron, cast in.
The main journal supports and caps are machined in union with the upper block.
The coupling between upper and lower block is realised by bolts and centring lugs to assure precise alignment.
A bead of sealant is applied between the two blocks to prevent oil leaks.

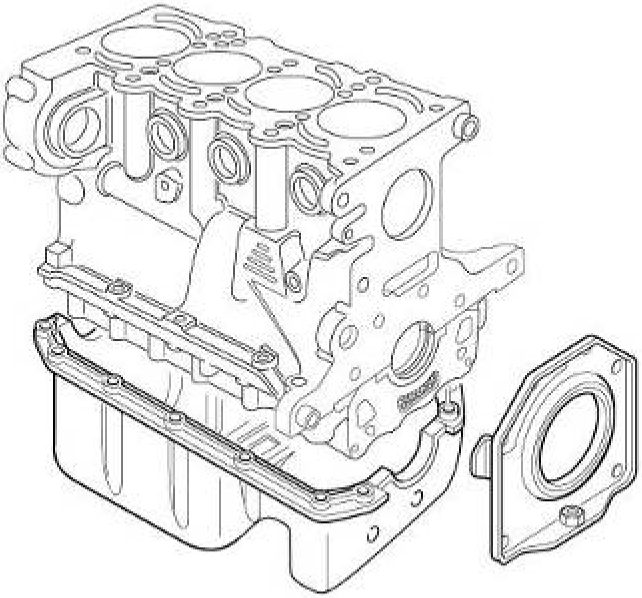
For the turbo version the lower block is specific in that it has a attachment for the oil drain pipe and the fastening of the right half shaft support.

Function

The lower engine block serves to:

- Constitute the load-bearing structure with the upper block.
- Support the reactions and loadings of the crank.
- Constitute the rigid element with the gearbox, through a torque arm.
- Permit oil return to sump.
- Support the sump and engine oil.
- Fasten the axle shaft.

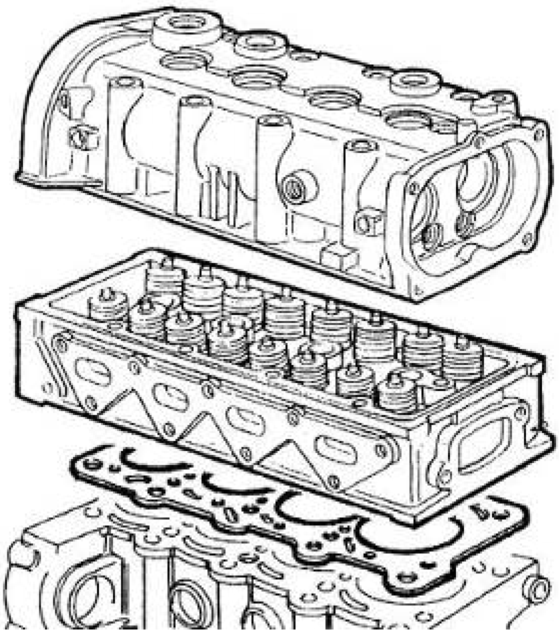
Sump and lower block covers



Function
The sump serves to contain the engine oil. It is entirely realised in aluminium and has a threaded hole for the engine oil drain plug.
The seal with the engine block is formed by a bead of silicon sealant.
The covers to the valve train and flywheel sides seal the crankshaft and are fastened to the engine block with bolts.

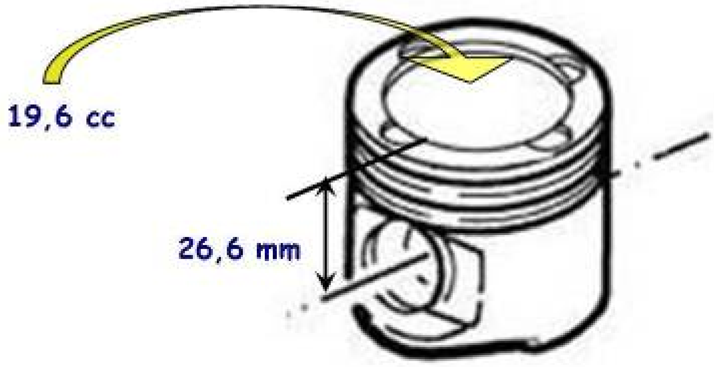
Note: the oil drain plug is fitted with a copper gasket, which must be replaced whenever the plug is removed.

Cylinder head/heads



Type
The cylinder head is a monolithic type in aluminium alloy.
The four valves per cylinder are mounted in the respective guides and operated by two camshafts via hydraulic tappets.
The valve guides are fitted into the corresponding seats in the head with interference.
Precision machining of the internal diameter is carried out after fitting with a specific reaming tool.
The camshafts are inserted into an upper head without tappet covers.
The upper head has two threaded holes through which engine timing tools can be inserted.
Note: the head and upper head are specific to the Turbo version, even though their basic dimensions are the same as for the 1.4 16V version.
A “metallic multi-layer” type gasket is inserted between cylinder head and engine block. The gasket is 0.72 mm thick and specific to the turbo version.
No cylinder head bolt retightening is required for the entire life of the engine.
The cylinder head has also been optimised for coolant circulation, and the head take-off has been eliminated.

Pistons



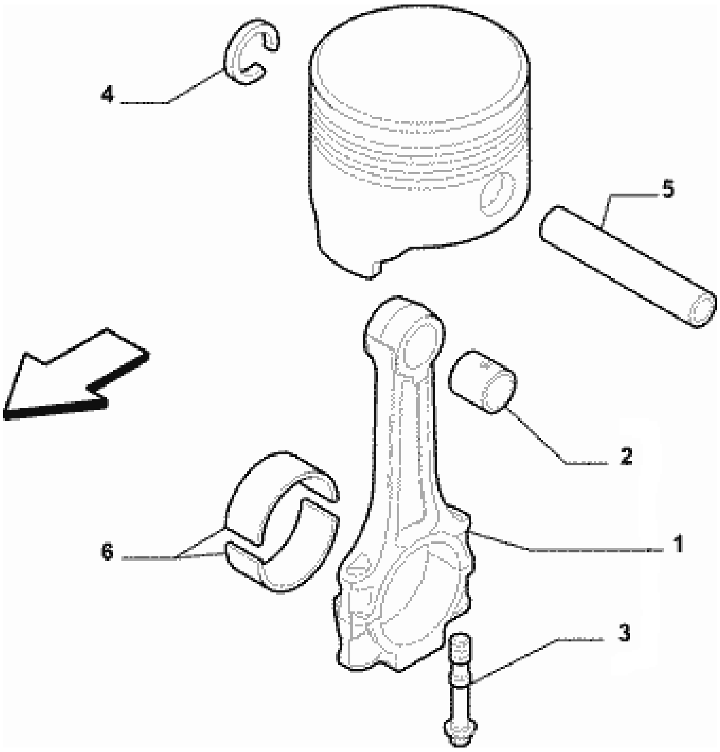
Type
The piston skirts are in silicon aluminium with graphite lining, and the piston heads are marked with a letter indicating class and an arrow, which when mounting the individual pistons must point in the direction of engine rotation (valve train side).
Misalignment between the pin axis and piston axis is 1 +/- 0.15 mm.
The pistons are specific to the turbo version, and differ from the non-turbo version pistons for the dimension between the axis of the gudgeon pin and the head of the piston (26.6 for the turbo version and 26 mm for the non-turbo version) and the capacity of the combustion chamber on the head (19.6 cc for the turbo version and 16.6 cc for the non-turbo version)

Note: The dimensions listed below are identical to the non-turbo version

Piston classes

Standard values			Values with oversize 0.1 mm		
Class	**Barrel diameter**	**Piston diameter**	**Class**	**Barrel diameter**	**Piston diameter**
A	72,000-72.010	71,965-71,970	A	72.100-72.110	72,065-72,070
B	72.010-72.020	71,970-71,980	B	72.110-72.120	72,070-72,080
C	72.020-72.030	71,980-71,990	C	72.120-72.130	72,080-72,090

Piston rods



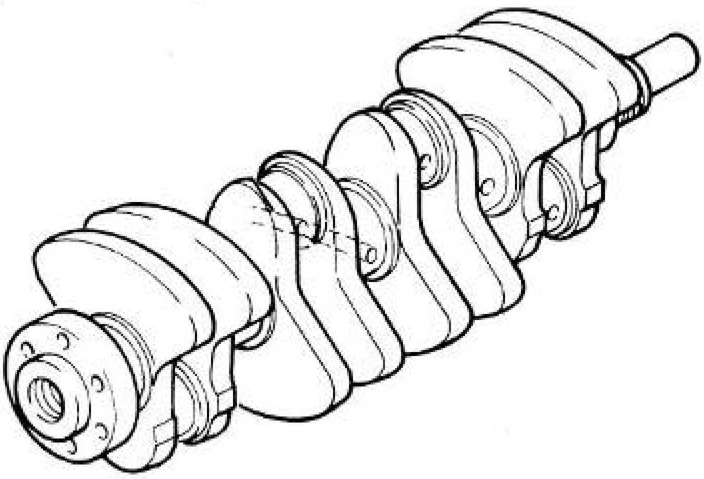
Key

1. Piston rod
2. Small end bush (not supplied as spare part)
3. Screw
4. Gudgeon pin seeger ring
5. Floating type gudgeon pin
6. Big end bearing

Type
The piston rods are realised in carbon steel
The gudgeon pins are floating type (fixed for the non-turbo version)
The small end has an anti-friction bush (not present on non-turbo versions)
The big ends are separated by fracture

Note: No machining is allowed for uniforming weight.
Note. Straightening to recover alignment error with piston is not allowed.

Crankshaft



Type

Realised in forged steel (in cast iron for the non-turbo version) and is hardened using the induction procedure.
It rests on five main journals with half-shells subdivided into size classes.
Crankshaft axial play is adjusted by two shims housed at the central main journal.
Eight counterweights arranged at 180° give the crankshaft a precisely balanced rotational mass.
An oil channel runs through the entire length of the shaft to lubricate the main bearings and big ends.
The flywheel bolts have an M9 thread (M8 for the non turbo version)

Note: the dimensions given below are identical to the non-turbo version

Main journal size classes

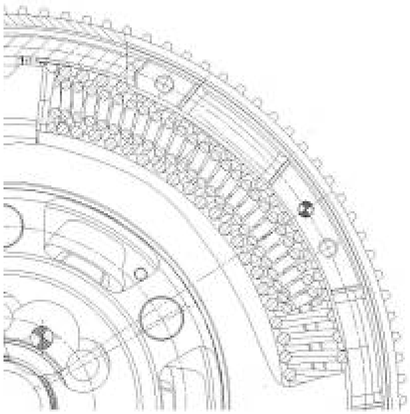
Standard			With undersize 0.127 mm		
Class			Class		
A	47,994	48,000	A	47,867	47,873
B	47,988	47,994	B	47,861	47,867
C	47,982	47,988	C	47,855	47,861

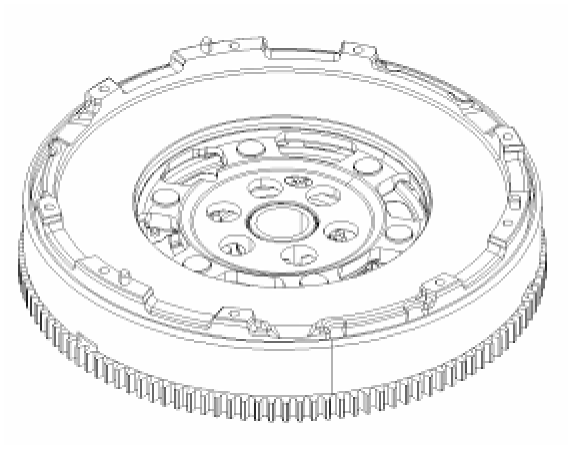
Big end bearings

Standard big end bearing	Big end bearing with undersize 0.127
41,99-42,008	41,881 - 41,863

Note: main journal and big end play are the same as for the non-turbo version

Flywheel





Type
The flywheel is a dual torsional mass type (Dual Mass Flywheel or DVA).
This type of flywheel is used in order to better uniform the motion of the crankshaft, and to prevent transmission of excessive vibration to the gearbox primary shaft, thereby reducing the noise generated by the motion of the gearbox cogs.
The flywheel consists of:

- A primary flywheel in steel
- Primary flywheel cover in steel,
- Secondary flywheel in cast iron in the area of the clutch disk resting plane
- Differential load spring inside flywheel lined with specific grease

The primary flywheel has a toothed crown that engages with the starter motor pinion.
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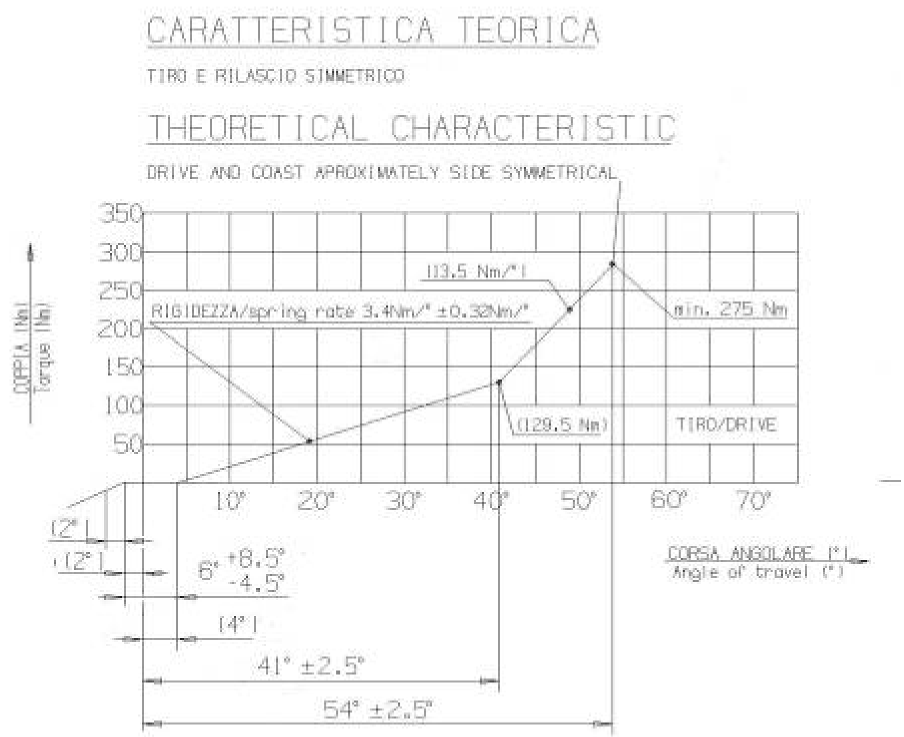
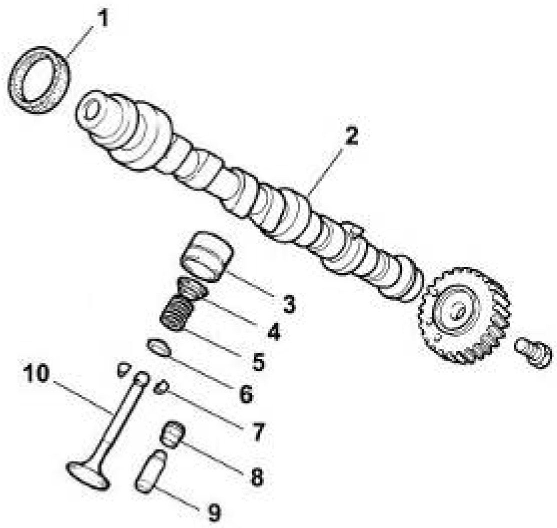


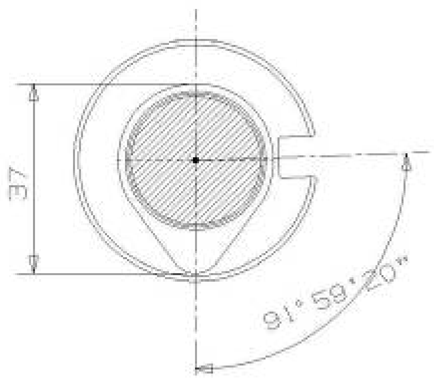
Valve train



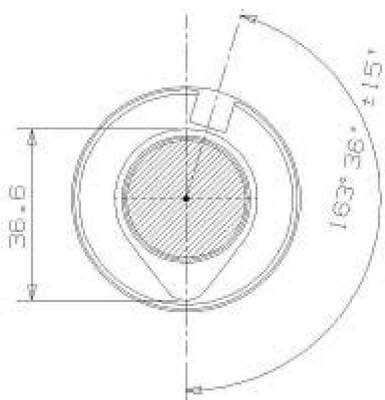
1. Camshaft oil seal
2. Camshaft
3. Tappet
4. Upper cap
5. Spring
6. Lower cap
7. Cotters
8. Oil seal
9. Valve guide
10. Valve

Type
Two overhead cams, in nodular cast iron, housed in an upper head unit, driven by belt and gear.
The shaft has suitably oriented and profiled cams, as many as there are valves to be operated.
The cam rise and timing angles are different for the two versions, 120 HP and 150 HP
To the front, the exhaust shaft is fitted with a toothed pulley via which it is driven by a suitably tensioned toothed belt connected to the crankshaft.
A pair of gears mounted to the front of the shafts, transfers drive from the exhaust shaft to the intake shaft.
Note: the exhaust valves for the 150 HP version are different from the aspirated version (the material is different), while the intake valves are identical.

120 HP intake/exhaust camshaft



Intake cam

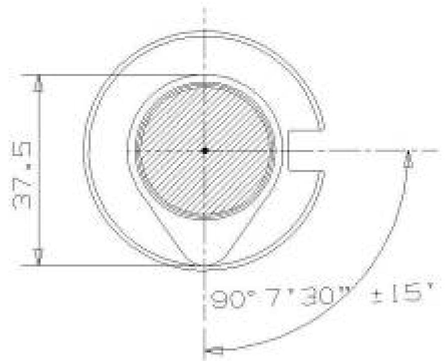


Exhaust cam

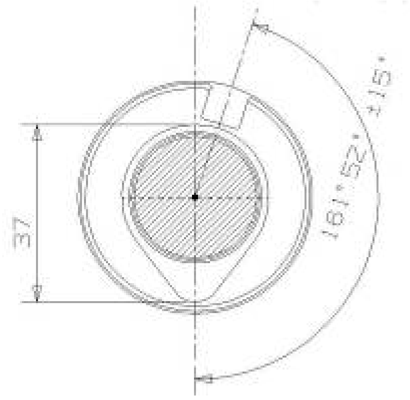
Valve train diagram
The valve train diagram for the 120 HP version envisages:
Intake shaft
Intake valve opening 2° after TDC (Top Dead Centre) and closing 27° after BDC (bottom dead centre) with a control rise of 0.45 mm

Exhaust shaft
Exhaust valve opening 17° before BDC and closing 2° before TDC with a control rise of 0.45 mm

150 HP intake/exhaust camshaft



Intake cam



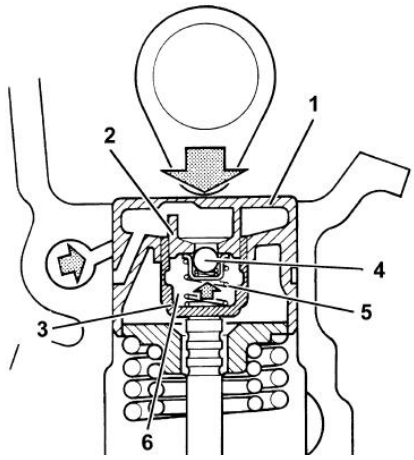
Exhaust cam

Valve train diagram
The valve train diagram for the 150 HP version envisages:
Intake shaft
Intake valve opening 2° after TDC and closing 34° after BDC with a control rise of 0.45 mm
Exhaust shaft
Exhaust valve opening 27° before BDC and closing 2° before TDC with a control rise of 0.45 mm

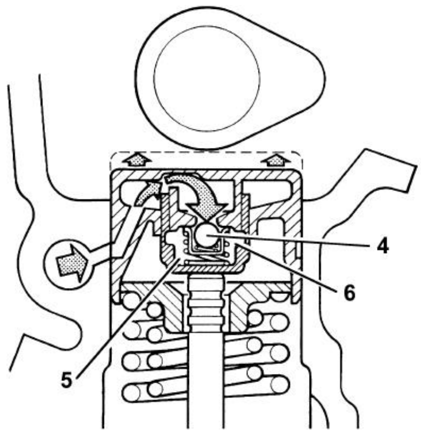
Note: the angular values between timing marks and the apex of the cam are values that allow for precise determination of correct timing, from a constructional point of view. In this publication they only serve to show the difference in timing between the 120 HP version and the 150 HP version

Hydraulic tappets
The hydraulic tappets used on this engine automatically compensate any valve play while the engine is running, with the advantage of reducing:
- Maintenance intervals
- Engine noise.

Opening phase
When the camshaft presses on the cup (1) and as a result on the piston (2), the oil trapped in the chamber (6), by closure of the ball valve (4), transmits the motion of the piston (2) directly to the sleeve (3) and as a result to the valve. In this phase, given the high pressure to which it is subjected, a part of the oil in the chamber (6) seeps through the minimal clearance between the piston (2) and the sleeve (3).

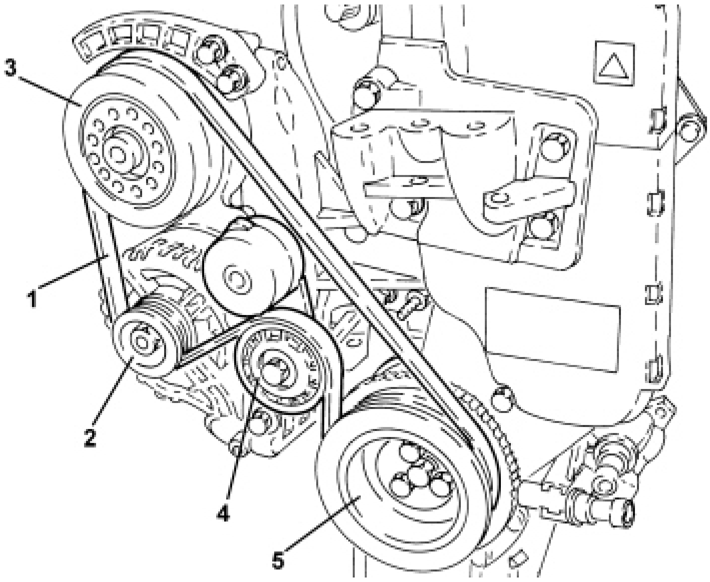


Closing phase
As the valve closes, for the tappet (pushed by the force of the spring (5) follows the profile of the cam and a vacuum is created inside the chamber (6) that causes the ball valve (4) to open, allow oil to enter. The oil entering the chamber (6) replaces the oil pushed out during the valve opening phase.



Auxiliaries drive belt

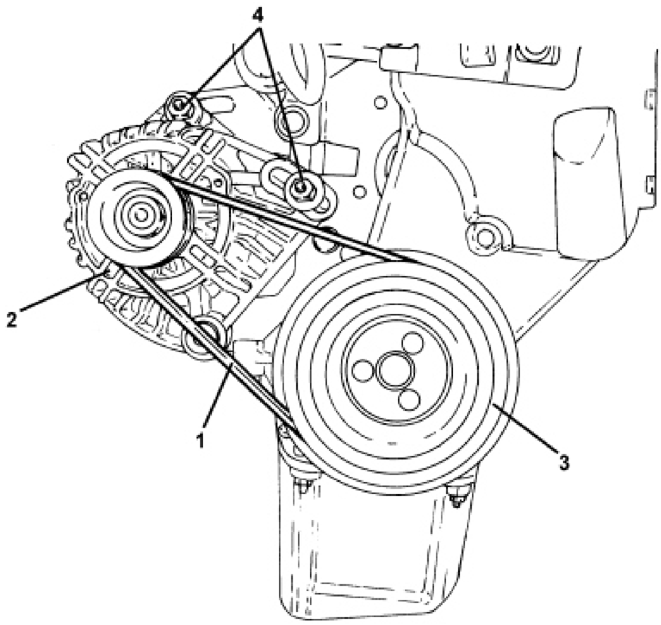
Version with air-conditioner
The alternator and air-conditioner compressor are driven by a Poly-V type drive belt.
The belt is tightened by an automatic tightener, which is maintenance free.



1. Drive belt on engine
2. Alternator
3. Air-conditioner compressor
4. Automatic tightener
5. Crankshaft pulley

Note: the Turbo version has an axially smaller compressor pulley, and tightener loading has been increased

Versions without air-conditioner
Poly-V driving alternator, tightening by alternator upper fasteners with adjuster slits



1. Alternator drive belt
2. Alternator
3. Crankshaft pulley
4. Alternator upper fasteners – belt tightener.

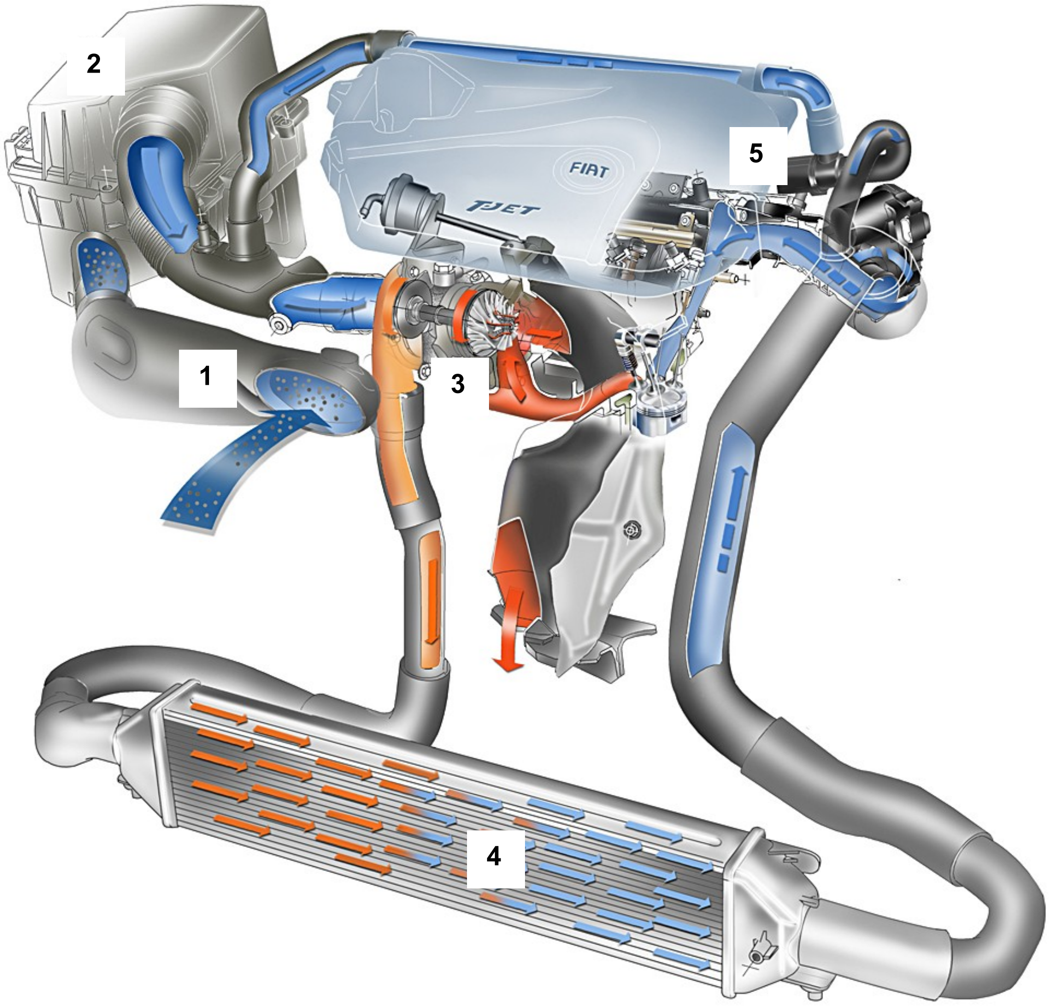
Circuits/systems

Introduction

This chapter describes the features of the following systems:

- *Intake,*
- *Exhaust,*
- *Fuel supply*
- *Crankcase gas/vapour recirculation,*
- *Evaporation control,*
- *Engine oil lubricating circuit,*
- *Engine cooling circuit*

Air intake circuit (turbocompressor)



The air intake circuit consists of:

1. Dynamic air intake
2. Air filter
3. Turbocompressor
4. Intercooler
5. Intake manifold

A pipe to the air filter leads from the dynamic intake in the upper zone of the front crossbar.

After filtering, the air is drawn into the turbocompressor through a pipe, on which converge other pipes from:

- The dump valve system
- The gas recirculation system from crankcase
- The anti-evaporation system

The air compressed and heated by the turbocompressor passes to the intercooler where it exchanges heat with the outside air and cools. Then the compressed and cooled air is delivered to the throttle through a rigid pipe and then on to the intake manifold.
The connector pipe between intercooler and manifold has a bellows type joint that offers a degree of installation flexibility, as well as vibration absorption with turbo running.
A turbo pressure sensor is installed on the intercooler-throttle connector pipe, which also has a connection for the dump valve.
The intake manifold also carries

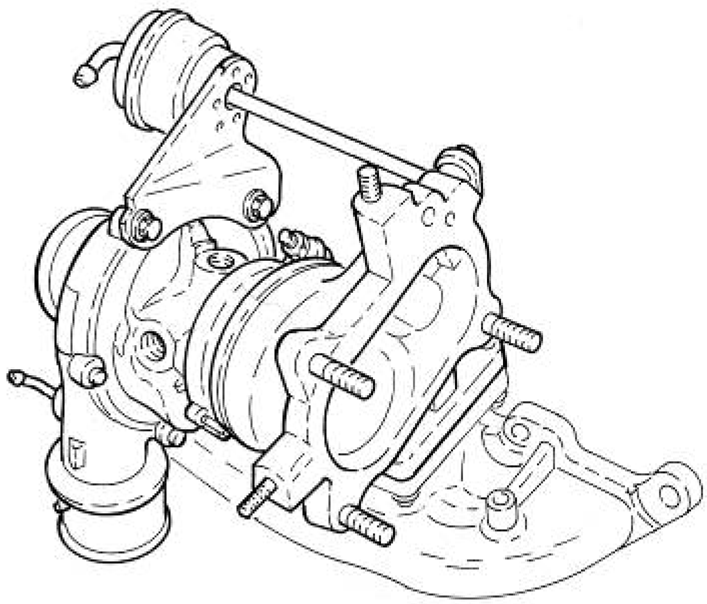
- The motorised throttle,
- The intake air pressure/temperature sensor,
- The injector rail and injectors

The pipes from:

- The crankshaft gas recirculation system
- The antievaporation system.

The fuel supply system differential pressure regulator is also connected to the intake manifold by a rubber tube

Turbocompressor



Type
IHI RFH3 turbocompressor with waste gate entirely managed by the Engine Control Hub via turbo pressure solenoid valve.

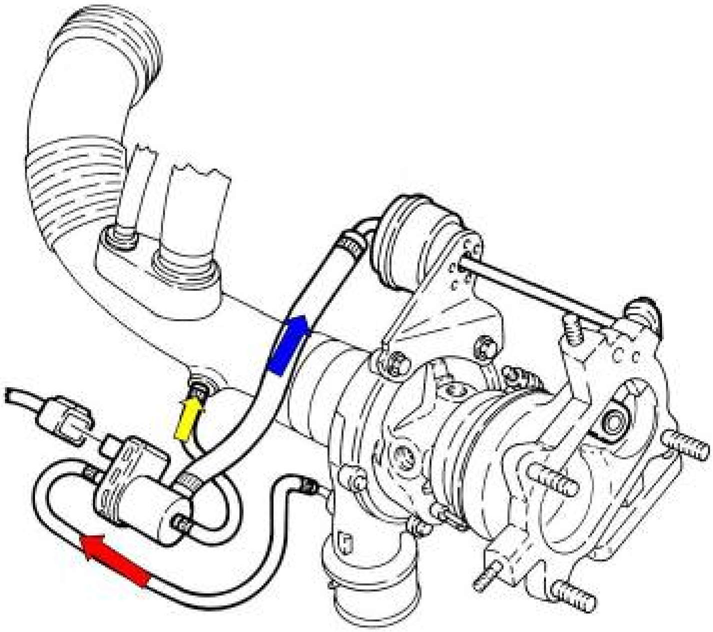
Specifications
The turbocompressor is specific to the 120HP and 150HP versions.
The substantial difference between the two groups are the different characteristics of the internal impeller, which determines the turbocharge logic.
The impeller of the 150HP version gives maximum peak pressure at high torque values, emphasising engine “torque and power” performance.
For Turbocompressor sport mode, a further pressure increase is foreseen, to create a significant “overboost” effect.

On the contrary, the 120HP impeller offers improved performance at low engine speeds, to render driveability more pleasant, without excessive increase in fuel consumption.
The turbocompressor is directly connected to the oil filter (green filter) from which it receives lubrication for the impeller shaft in addition to cooling.
The oil is drained through a pipe attached to the oil filter, that connects the turbocompressor to the lower crankshaft and so to the oil sump.

The turbocompressor is connected to the engine cooling circuit by a feed pipe from the radiator return and a drain pipe connected to the recirculation pipe from the thermostat to the reservoir/expansion chamber.
Coolant is circulated naturally, not forced.
The connection to the cooling circuit serves to prevent the abrupt temperature shifts produced when the engine is switched off, and that may cause burnt oil deposits on the turbine shaft, and consequent damage.
This temperature shift could result in oxidization of the lubricating oil on the turbine shaft with consequent carbon deposits that could damage the turbine mechanics.

Note: the seal between the turbocompressor and exhaust manifold must be replaced if the turbocompressor is dismantled, and the securing studs checked.

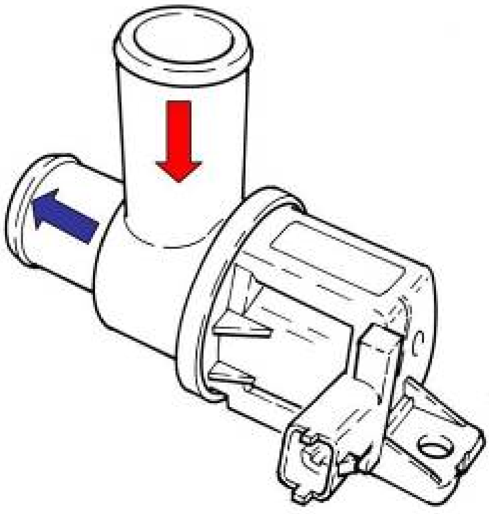
Turbo pressure regulator valve



The turbo regulator electrovalve is controlled by the Engine Control Hub, and is connected as follows.

- A high pressure socket downstream of the turbo impeller,
- A connection to the waste gate actuator
- A connection to the intake pipe upstream of the turbo impeller.

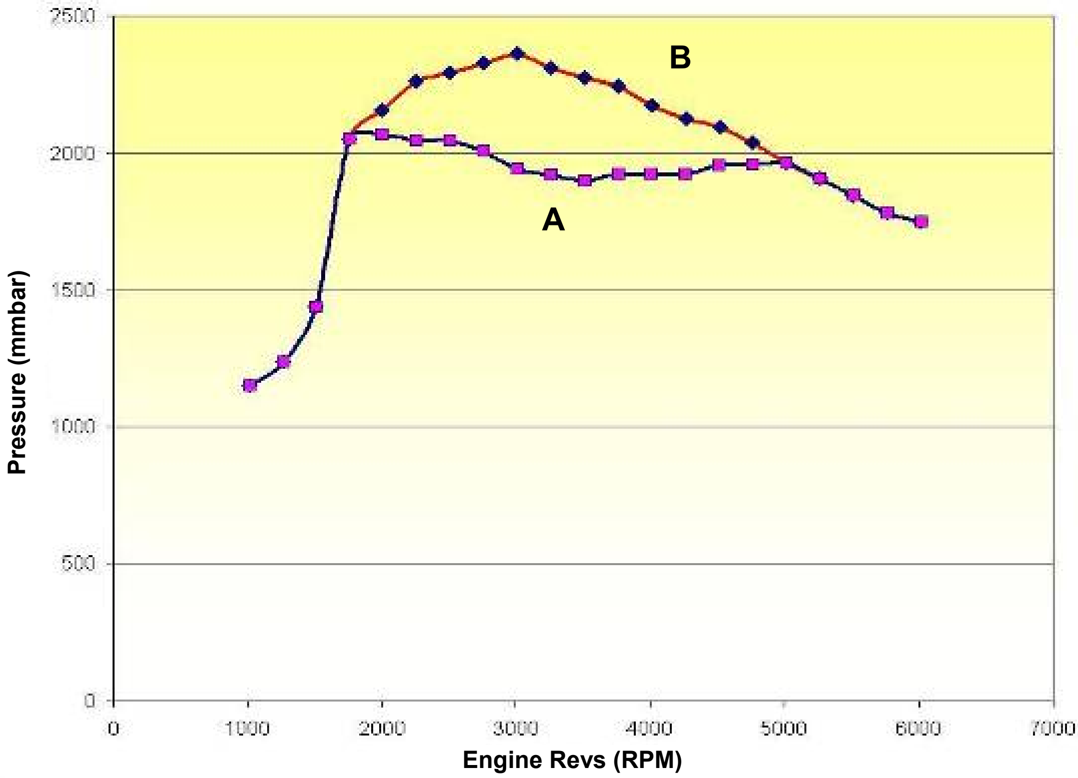
Shut-off or DUMP valve



The dump valve is electrically controlled by the Engine Control Hub.
It is connected to the intake pipe near to the throttle body, and, through a pipe incorporated in the soundproofed engine cover upstream of the turbocompressor, the dump valve discharges excess pressure on throttle release, to prevent excessive pressure increases (ramming) that could damage the intake pipes and interfere with turbine function.

150 HP version turbocompressor specifications

The graph gives the turbo pressure curves without overboost (curve A) and with overboost (curve B).



-

Test 1064 BA – Turbo pressure check
Fit the turbo pressure sensor to tool **N° 1871003500** and fasten it with the corresponding screw.
Connect the electrical connection to the turbo pressure sensor.
Connect tool **EX09** from box **N° 1806338000** to tool **N° 1871003500** and connect connector **N° 2000017500** (as shown in fig. 1)

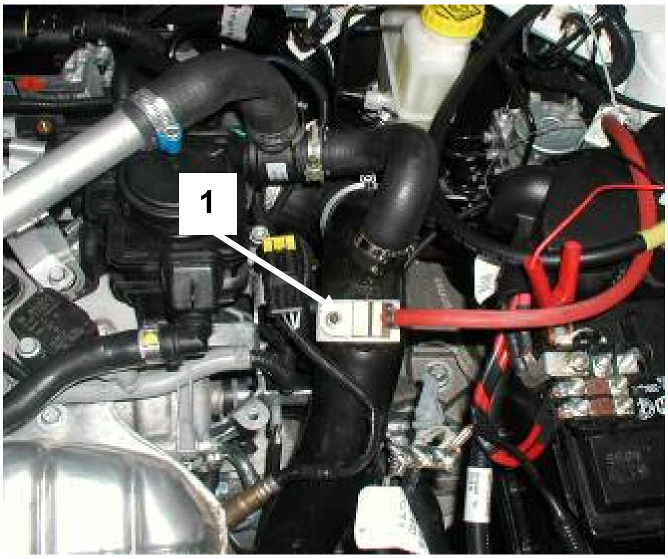
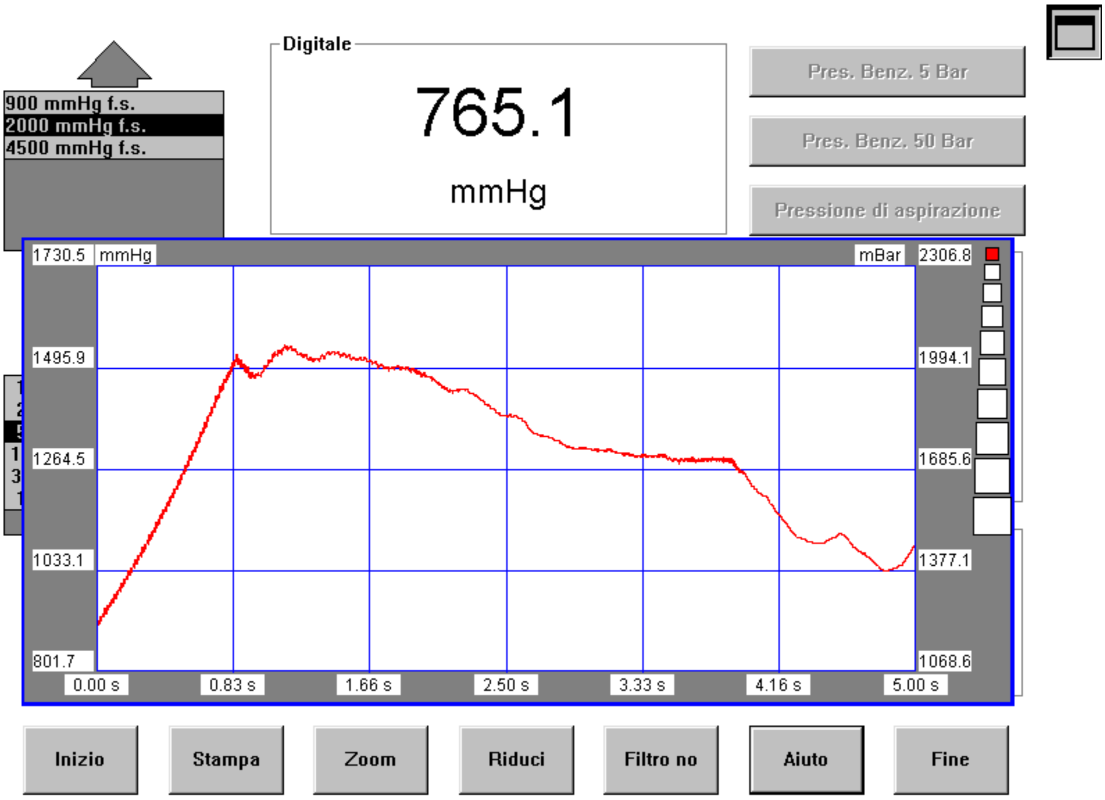


Fig. 1
Connect 5 bar pressure transducer **EX06** to the tool and connect it to the Examiner Sam card with cable **EX01.**
Place the Examiner in the passenger compartment and make the connections.
Select “pressure gauge” on the examiner and set for “intake pressure” data acquisition with end scale 2000 mmHg and time selection 10 seconds.
Take the vehicle out onto the road (observing speed limits set by the highway code) and carry out the following test.
On a country road with 3rd gear engaged.
Begin graph acquisition pressing “start” on the diagnosis instrument and after 5 seconds press full down on the accelerator until reaching 4500 rpm.
On reaching this speed, fully release the accelerator pedal.
Display the resulting graph, read off the maximum peak value between 1900 and 2000 mbar (1444 and 1520 mmHg) corresponding to a turbo pressure of between 900 and 1000 mbar.
Disconnect Examiner and pressure transducer.
Disconnect the turbo sensor connection.
Unscrew and remove the pressure sensor from the tool.
Remove the turbo pressure check tool.
Refit the turbo pressure sensor.

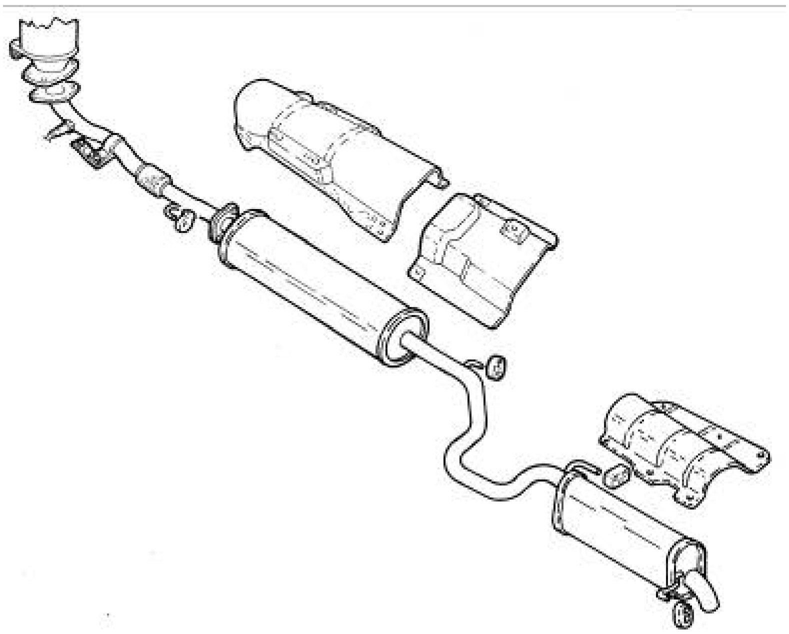


Graph of turbo maximum peak pressure

Test 1064BG Waste Gate valve actuator correct stroke check for 150 HP version

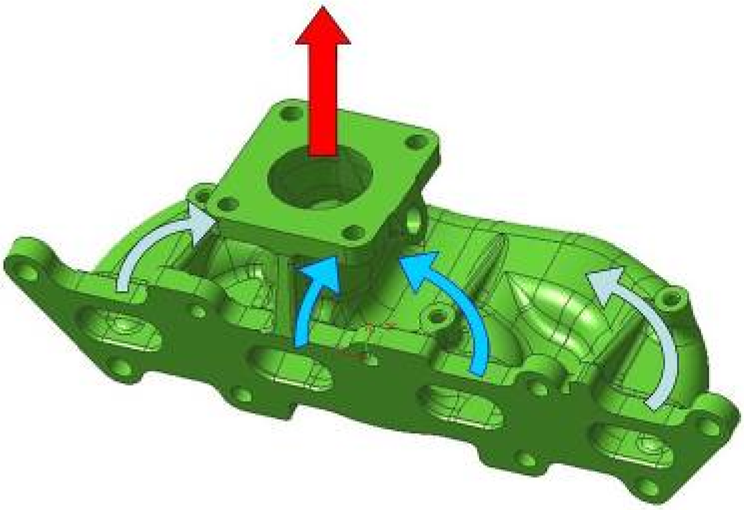
STEP	CHECK	SOLUTION IF CHECK NOT OK
1	With engine cold, check the calibration of overpressure valve under the following operating conditions: -Remove the soundproofing cover on the engine. -Remove the heat guard cover on the turbine. -Disconnect tube (1) connecting valve with turbo overpressure regulation solenoid. -Install tool N° 2000024800 (3) on waste gate rod -Apply a dial gauge so it touches the end of the tool. -Zero the dial gauge -Connect the vacuum pump n.° 2000015500 (2) to the overpressure valve -Introduce a pressure of 0.74±0.03 bar with the pump and check on the dial gauge that the rod moves 2.00±0.5 mm.	Replace turbocompressor

Exhaust pipes



Engine exhaust gases are conveyed to the manifold-three-way catalytic converter assembly, via exhaust manifold 4,2,1, with the turbocompressor inserted between the exhaust manifold and the catalytic converter.
The front part of the exhaust pipe consists of a vibration reducing flexible element and a silencer.
The rear section of the exhaust has a terminal muffler.
The upper part of the exhaust is suitably heat-shielded to prevent heat transfer to the body shell.
The various components are mounted on brackets and flexible rings fastened to the body shell.

Exhaust manifold



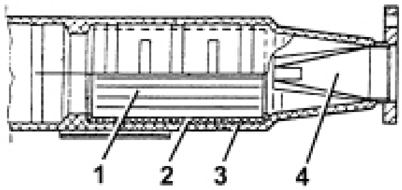
The exhaust manifold is branched into ducts forming a 4-2-1 configuration.
As can be seen in the figure, the ducts of the first and fourth cylinder combine with those of the second and third on the turbocompressor connector flange, so they are separated.
This solution prevents the various gas flows from interfering with each other, improving performance and fuel consumption and reducing pollutant emissions.

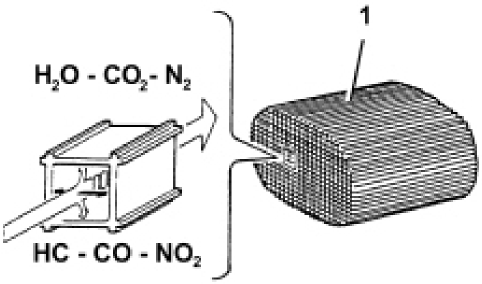
Note: the second and third cylinder ducts come together inside the exhaust manifold.

Catalytic converter
The three-way catalytic converter simultaneously scrubs the three gases present in exhaust emissions:
- Unburned hydrocarbons (HC);
- Carbon monoxide (CO);
- Nitrogen oxide (NOx).

Two types of chemical reaction take place in the catalytic converter:
- Oxidation of the CO and HC, converted into carbon dioxide (CO_2) and water (H_2O);
- Reduction of the Nox, converted into Nitrogen (N_2).

The converter consists of a block, a metal mesh support for dampening impact and vibration and an outer shell in high temperature resistance, corrosion-proof stainless steel.
The block consists of a honeycomb structure made up of a ceramic material lined with a film of active catalytic substances, platinum and rhodium, which accelerate the chemical decomposition of the toxic substances contained in exhaust gases which, through the cells in the core at temperatures in excess of 300 ° - 350 °C, activate the catalysers and thus the oxidation reduction reactions.
To optimise the efficiency and lifespan of the catalytic converter, a perforated sheet metal cone is fitted to improve gas diffusion in the cells of the ceramic core.

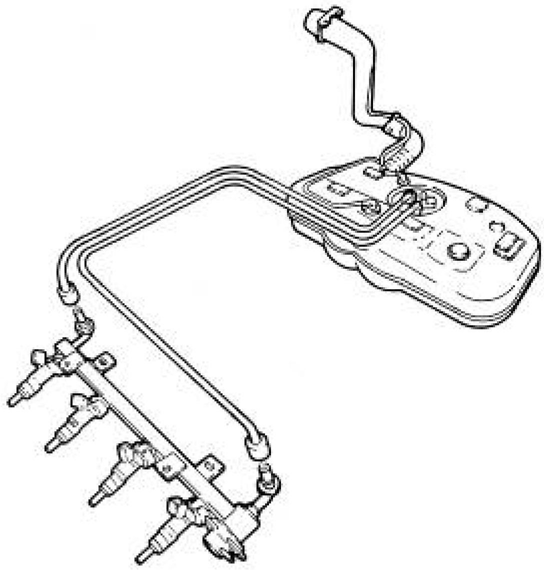




1. Ceramic honeycomb block
2. Metallic support
3. Outer shell
4. Perforated sheet metal cone

Note: Due to the high temperatures present, the precious metals contained in the catalytic converter are highly susceptible to chemical attack by any lead present in exhaust gases. Using fuel containing lead will result in rapid and irreversible damage to the converter. For this reason, fuel containing lead must never be used, even if in case of emergency or for an extremely short time.

Fuel supply system



The fuel supply system serves to supply fuel at the correct working pressure to the injector group.
The system consists of:

- A fuel level indicator/pump group immersed in the fuel tank;
- A delivery pipe;
- An injector rail with built-in differential pressure regulator;
- A recirculation pipe.

The pump group consists of:

- An electric fuel pump;
- Fuel filter;
- Maximum pressure regulator;
- Fuel level sensor.

The fuel pump is controlled by the Engine Control Hub via a specific power relay. An inertia switch is installed between the negative terminal of the fuel pump and the chassis ground, which open in case of collision, to prevent possible fire hazard due to leaking fuel.
The fuel filter is inserted in the pump group and is maintenance-free.
The pump group includes a maximum pressure regulator on the pump delivery pipe, which assures safe recirculation of the fuel if the maximum pressure of 6.9 – 9.8 Bar is exceeded.
The pump group also includes the fuel level sensor, connected directly to the Body Computer Hub

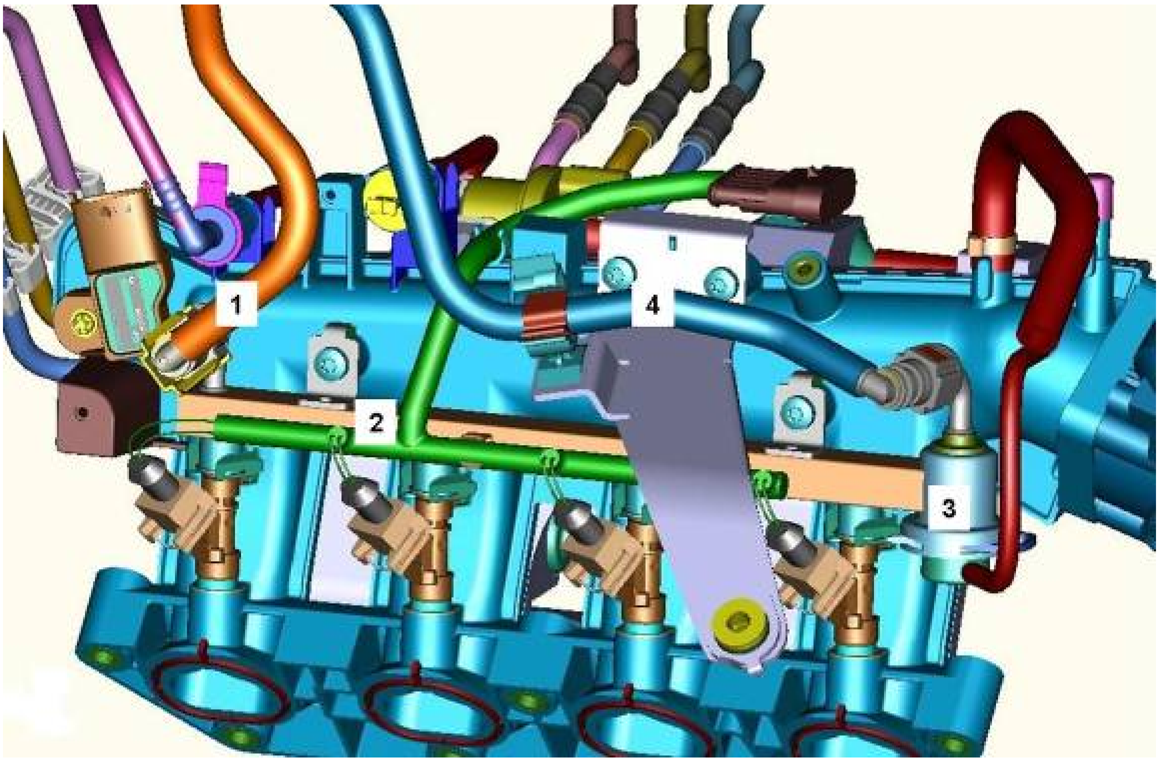
Note: Fuel level information is transmitted from the Engine Control Hub to the Body Computer Hub via C-CAN network.

The fuel return pipe connects the tank to the injector rail. The pipe is connected by quick-fit connectors.
The injector rail supplies fuel to the injectors, is realised in metal and has:

- An inlet, connected to the delivery pipe,
- An outlet connected to the recirculation pipe.

The Rail incorporates a differential pressure regulator mounted in a specific housing located at the connection with the recirculation pipe.
The regulator is in turn connected by rubber pipes to the intake manifold.

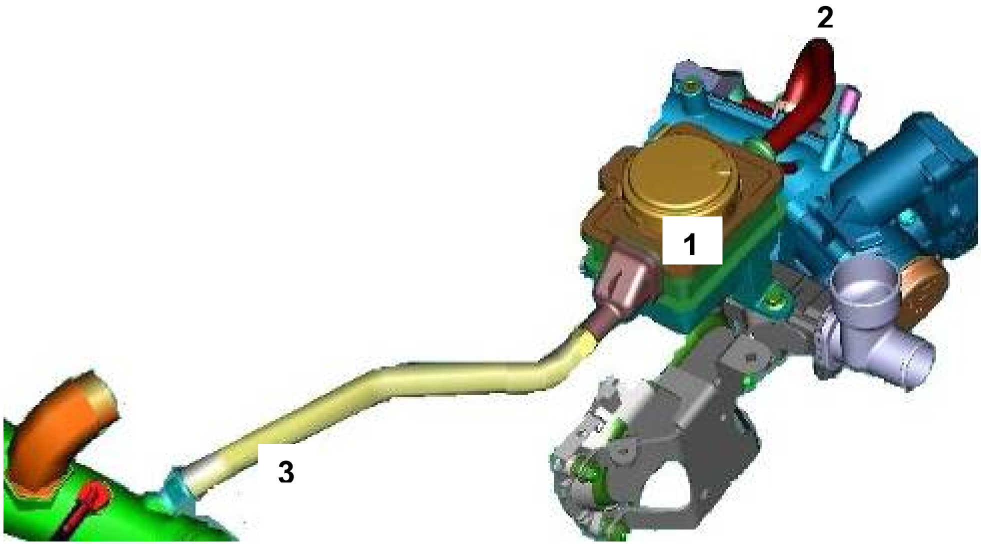
The pressure regulator assures the correct fuel supply pressure in relation to the pressure present in the intake manifold.



Key
1. Delivery pipe
2. Injector rail
3. Pressure regulator
4. Recirculation pipe

Fuel pressure value.
- With key to run 3.0 bar
- With engine idling 3.5 bar

Crankcase vapour/gas recirculation system



The system decants and burns breather gases from the crankcase. These gases consist of mixtures of air, fuel vapours and burnt bases seeping through the piston rings, as well as lubricating oil vapour.
The vented gas from the crankcase rises up to the cylinder head and is conveyed into a separator (1) with a membrane that permits:

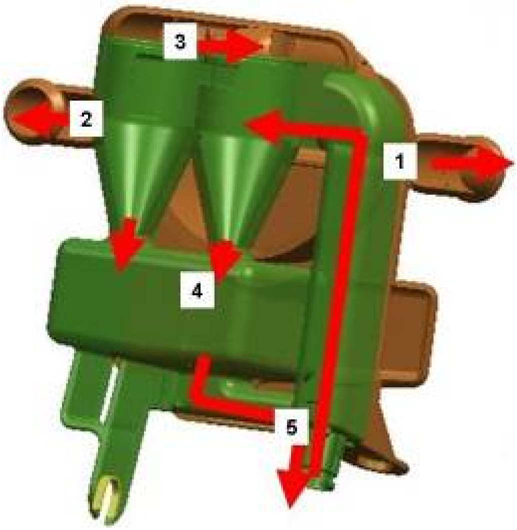
- vapour condensation and recovery
- vapour absorption into the intake circuit for combustion.

Specifically, the system has two vapour intake pipes, one connected to the intake manifold (2) and the other connected upstream of the turbocompressor (3), which permit:

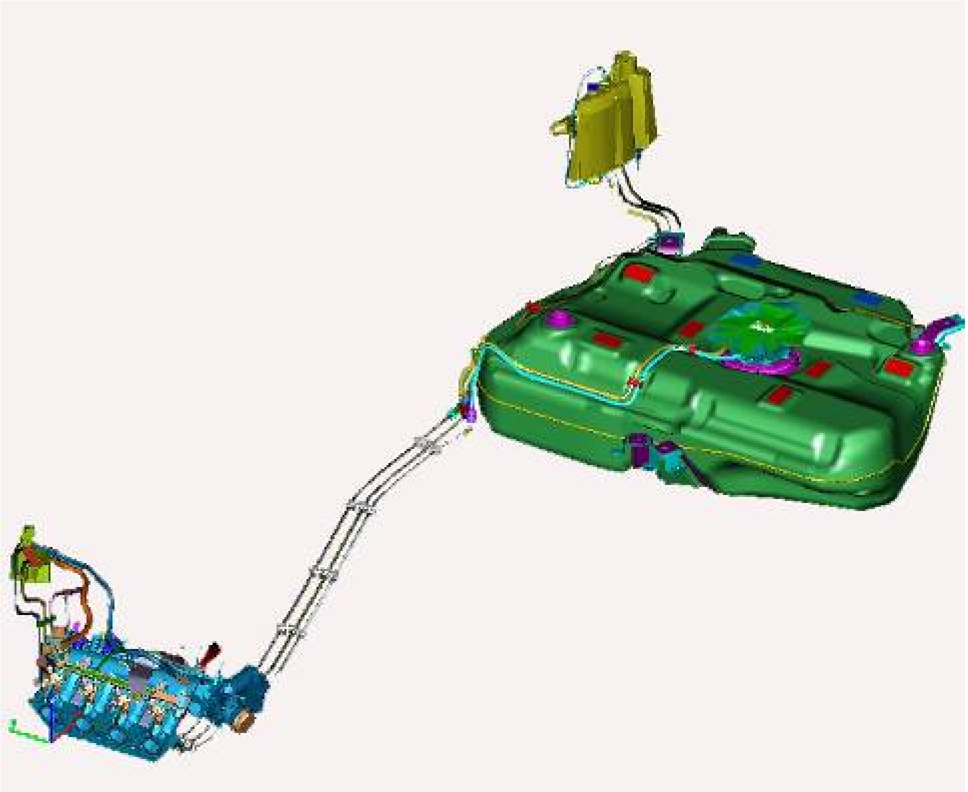
- With turbo operating, gas delivery through a duct connected immediately upstream of the compressor.
- When idling or on release through a duct connected downstream of the throttle.

System cross-section

1. Connection to intake manifold
2. Connection to intake pipe upstream of turbo compressor
3. Passage switching membrane
4. Oil vapour condensation cones
5. Oil vapour recovery on head



Anti-evaporation system



The anti-evaporation system serves to prevent fuel vapour, made up of the lighter fractions of hydrocarbons that mainly form in the fuel tank, from escaping into the atmosphere.
The system consists of:

- Fuel tank,
- Vapour separator,
- Float valve,
- Two-way fuel filler cap vent valve,
- CANISTER active carbon filter
- Active carbon filter cleaning valve,
- Safety check-valve.

The system works most with high external temperatures, meaning when the temperature of fuel in the tank increases, with consequent tendency toward increased evaporation.
This situation causes an increase in pressure inside the tank.
The two float valves on the tank and directly connected to the canister.
The fuel vapour reach the carbon filter through a calibrated hole in a valve located inside the vapour separator/filter group.
The same calibrated hole permits entry of air into the tank through the carbon filter, as necessary as the fuel level drops.
The CANISTER active carbon filter is connected by a pipe to the purification e-valve, which when activated by the Engine Control Hub in certain conditions, permits intake of vapour from the engine consequently cleaning the filter.
If due to malfunction, fuel tank internal pressure should reach dangerously high levels, the safety valve on the filler caps allows this pressure to discharge. If necessary, this valve may open in the other direction to prevent formation of vacuum inside the fuel tank.

Active carbon filter

The active carbon filter is located under the rear right wheelarch and has two intakes, from the vent valves, and a pipe to delivery vapour to the filter cleaning e-valve.

Filter cleaning e-valve

The valve (A) is located on the intake manifolds to the lower side, and is therefore not visible.
The valve is connected to a pipe that forks to one side to the intake manifold downstream of the throttle, and to the other side to a connector upstream of the turbocompressor on the intake pipe. This connection configuration allows fuel vapour to be drawn off whether idling or with engine under turbo power.
The recirculation pipes have safety check-valves (B and C).

Float valve

These valves are used for the following functions:

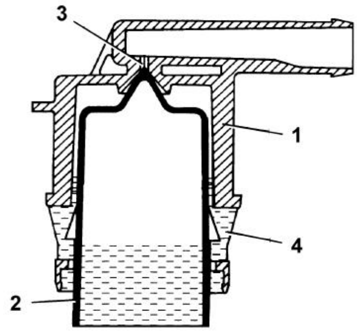
- To prevent liquid fuel escaping in the event of an accident with vehicle overturned;
- To allow fuel vapour to vent from the tank to the separator and active carbon filter;
- To permit tank ventilation in case of internal vacuum formation.

This valve consists of a body (1) and float/valve (2).

The function of the valve can be summarised in the following cases, in relation to the amount of fuel in the tank.

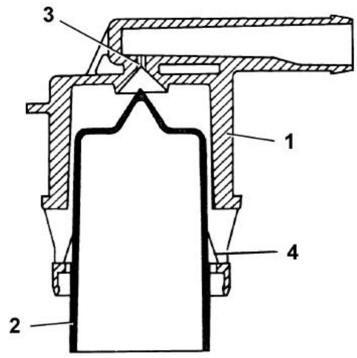
Tank full/vehicle inclined

If the tank is full the float (2) blocks the hole (3) preventing liquid fuel from reaching the separator.



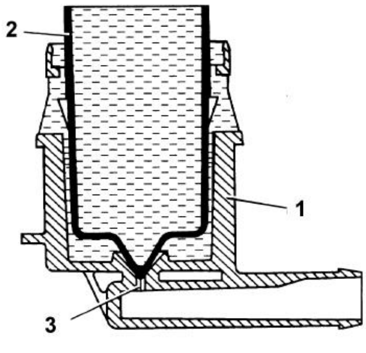
Intermediate fuel level

If the fuel level in the tank is low, the float (2) drops, opening the passage (3). This allows fuel vapour to exit the tank and reach the separator and active carbon filter, or through the same circuit, ventilate the tank if tank internal pressure is lower than external pressure.

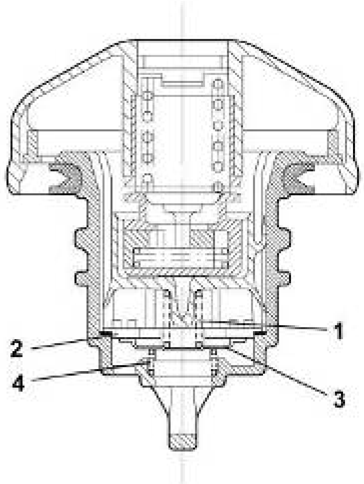


Seal in case of roll-over

If the vehicle rolls over, however full the tank is, the float (2) closes the hole (3) with its own weight plus that of the fuel, preventing a hazardous flow of fuel to the vapour separator and consequent fire risk.



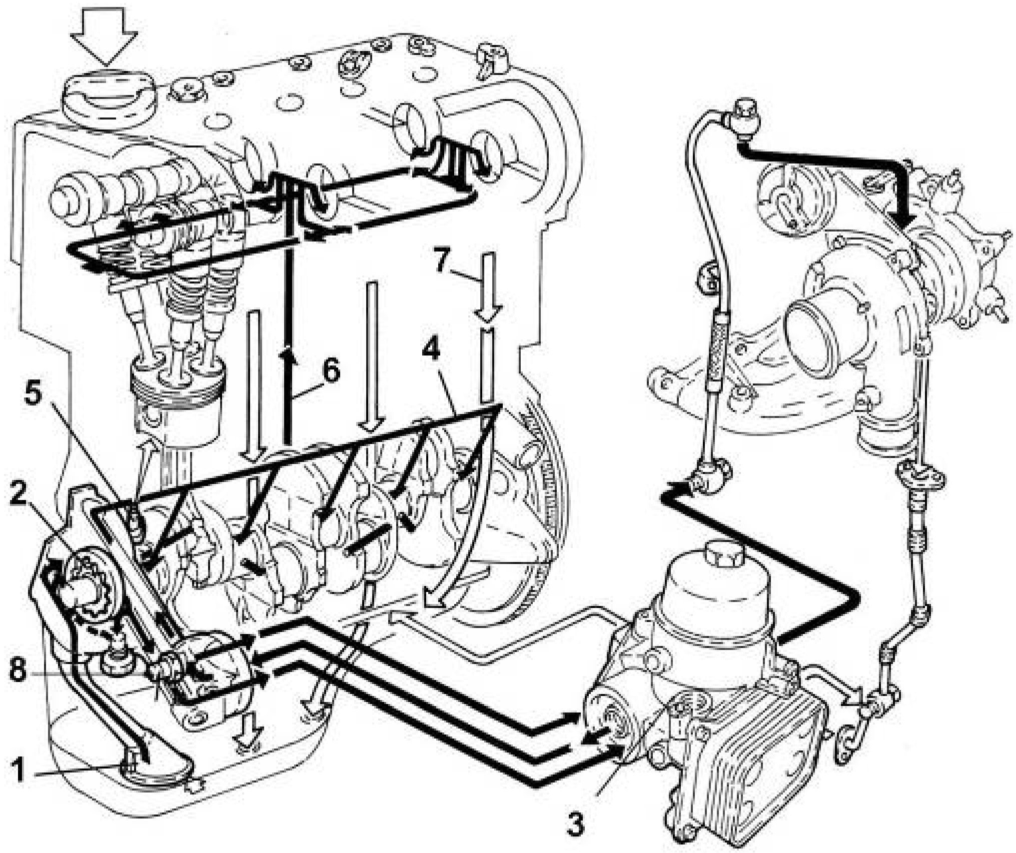
Safety and ventilation valve



This valve is built-in to the fuel filler cap and performs the following functions according to the pressure present in the tank:

- discharge of excess pressure in the tank (safety function). The pressure acts on the plate (2) and, overcoming the pressure of the spring (1), permits excess vapour discharge to the outside.
- permits flow of air into tank when pressure in tank is lower than external pressure due to fuel consumption. In this case, when the vacuum overcomes the pressure of the spring (4), it shifts the valve (3) allowing air to enter the tank.

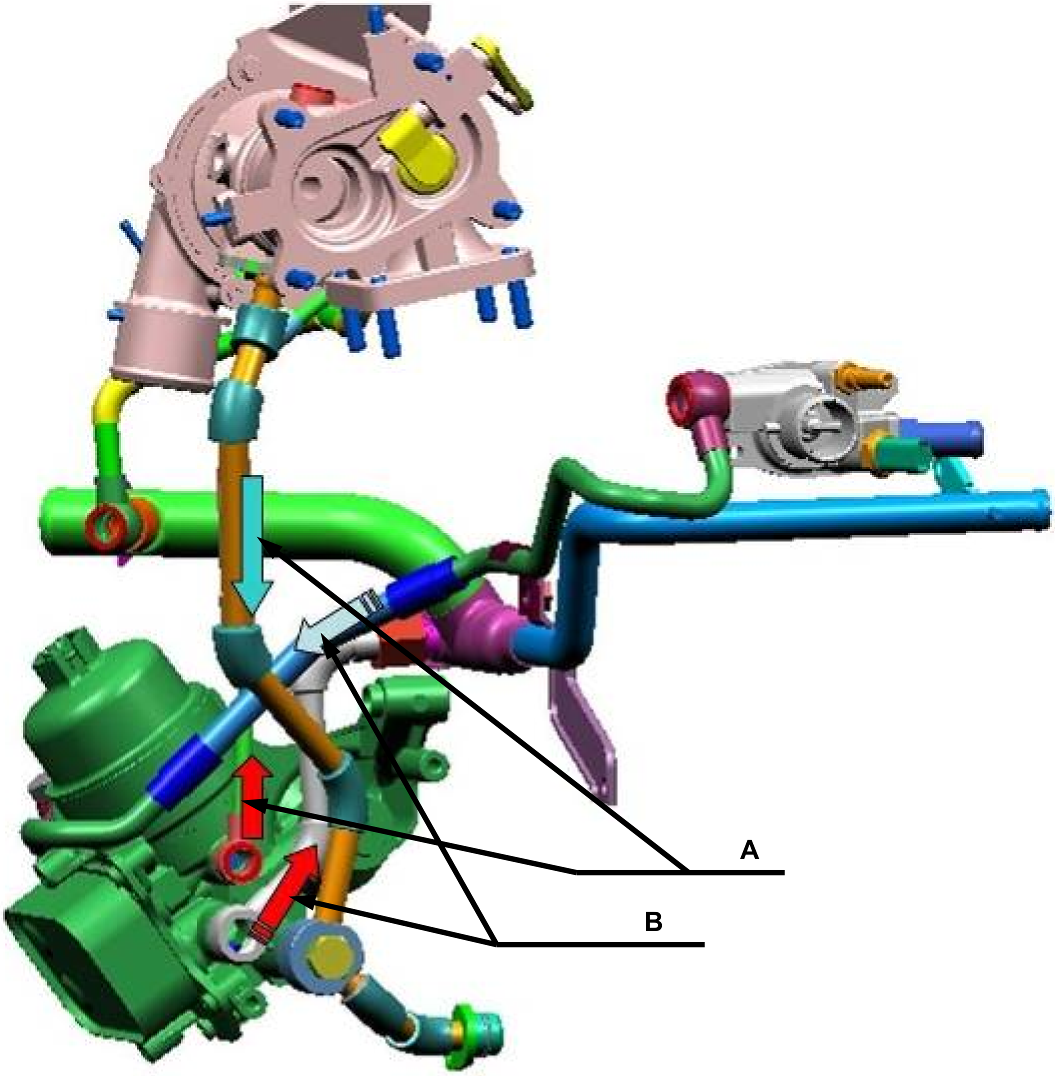
Engine lubricating oil circuit



1. Scavenge pipe with mesh filter
2. Oil pump
3. Integrated engine oil filter system
4. Main longitudinal channel
5. Sprayers (piston skirt cooling)
6. Vertical channels (camshaft bearing lubrication)
7. Oil return to sump
8. Engine oil pressure warning light switch

Note: the oil pressure value is identical to the normal intake version. Moreover, with the integrated filter system, the part of the pump body supporting the oil filter system has been strengthened, a modification that has been made to all FIRE engines.

Integrated engine oil filter system



Key:
A. turbocompressor lubrication circuit
B. modine heat exchanger cooling circuit

The lubrication system has an integrated filter system called Green Filter. The device is mounted on the engine oil filter cartridge.
The system consists of:

- A cup containing the high filtration capacity engine oil filter cartridge, closed by a plastic plug.
- A modine type heat exchanger.

The oil flows from the pump to the oil filter system, to remove any impurities that could be extremely damaging above all to the turbocompressor, and is delivered to the engine.

Note: The oil pressure switch is mounted on the pump oil filter support, as in the non-turbo versions.

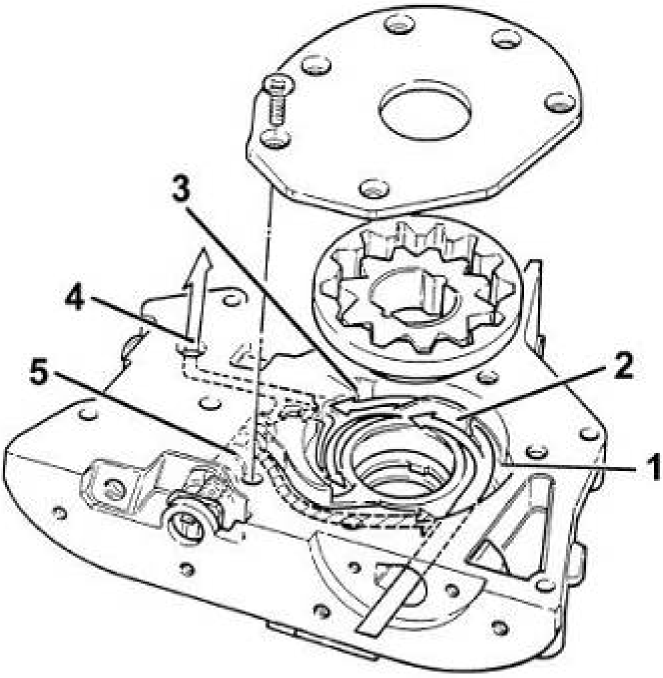
The oil filter system has the connector for the oil delivery pipe to the turbocompressor.
From the turbocompressor the oil flows through specific pipes that connect to the crankcase and then to the sump.

Note: since the turbocompressor is positioned very high on the engine, the oil drain pipe is fastened in an intermediate position on the oil filter system, in order to assure its mechanical integrity.

For oil cooling, a pipe connects directly to the thermostat, and from there the coolant reaches the Modine type heat exchanger built-in to the oil filter system, and after passing through, returns to the main recirculation pipes through a specific tube.

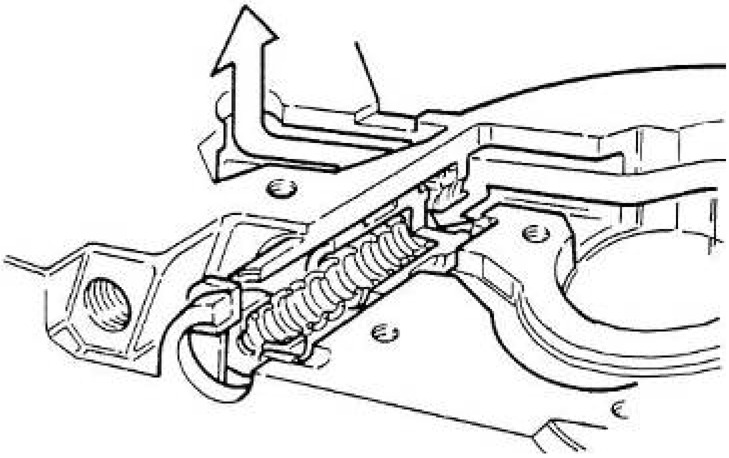
Note: the pipe unions of the integrated engine oil filter system are fitted with copper gaskets that must be replaced whenever the pipes are removed.

Engine oil pump
The engine oil is drawn from the sump by the vacuum created by the rotation of the gears fitted to the crankshaft.
The vacuum is present from the separation bulkhead (2) of the gears up to the oil sump scavenge pipe.
Pressure instead develops from the separation bulkhead (2) into all engine oil delivery pipes (4).
When the pressure exceeds the value of 6 bar +/- 0.3 the pressure exerted by the limiter valve (5) overcomes the reaction of the spring underneath and moves the valve until opening the connection between the pressure chamber (3) and the low pressure chamber (1), limiting the maximum pressure level in the circuit.

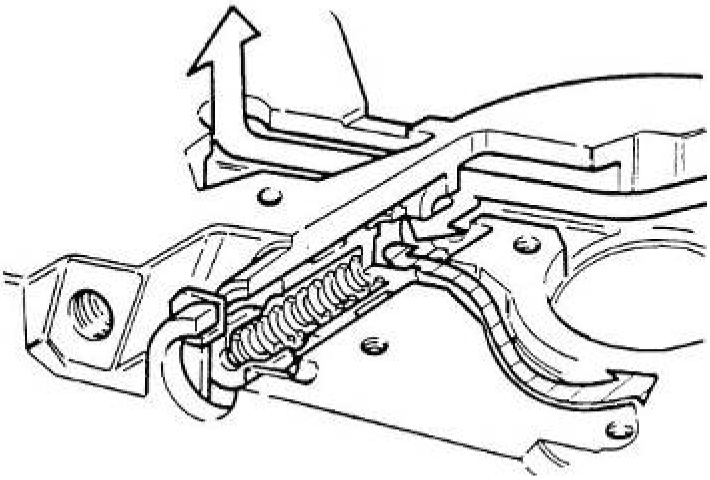


1. Low pressure chamber
2. Separation bulkhead
3. Pressure chamber
4. Oil delivery duct
5. Pressure limiter valve

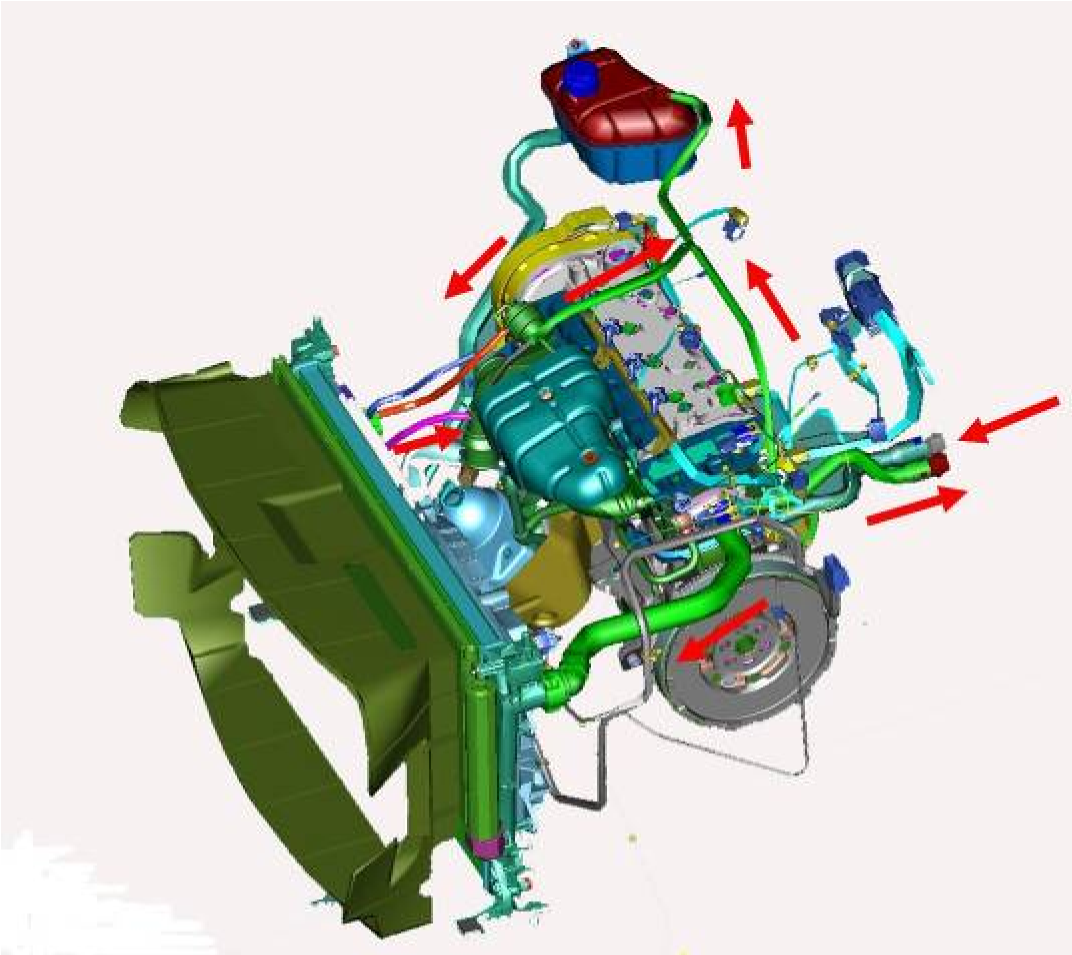
Engine oil pressure limiter valve closed position



Engine oil pressure limiter valve short-circuit position



Engine cooling circuit



The engine cooling circuit consists of:

- Coolant pump
- Fluid passages in engine (optimised for turbo version)
- Thermostat,
- Piping to connect with radiator for vehicle interior heating
- Piping to connect with engine cooling radiator
- Piping to connect with heat exchanger on oil filter system
- Piping to connect with turbocompressor
- Recirculation piping to pump.
- Reservoir/expansion chamber

Reservoir/expansion chamber

The reservoir/expansion chamber feeds the circuit and absorbs the variations in coolant fluid volume, as engine temperature varies.

A calibrated valve, in the pressurised cap, permits:

- Exit of air from circuit collected in pipe from thermostat
- Entry of air when circuit is under low pressure (due to engine cooling).

Radiator

The radiator is a radiant mass with two lateral chambers for coolant intake and output.
The pipes and fins of the radiator are aluminium, the tanks plastic.

Water pump
Blade type centrifugal fastened to the crankcase and driven directly by the valve train drive belt.

Note the pump impeller is larger than the normal intake version.

Thermostat

Mounted on the rear side of the cylinder head, serves to maintain engine at optimal temperature:

- with temperature < 80 ± 2°C the thermostat (closed) switches coolant toward the pump
- with temperature > 80 ± 2°C the thermostat (open) conveys coolant to the radiator.

The thermostat has a coolant temperature sensor (5) connected to the Engine Control Hub, in addition to the various connections to the cooling system pipes:

1. to engine cooling radiator
2. to vehicle interior heater
3. to Modine heat exchanger on oil filter group
4. to reservoir/expansion chamber

Electric fan

The two-speed cooling fan increases the heat dissipation capacity of the radiator and/or conditioning system condenser.
It is directly controlled by the Engine Control Hub according to specific functional logic.

Note: as opposed to the normal intake version, the turbo version fan is two-speed, both for the air-condtioned and for the heated version.

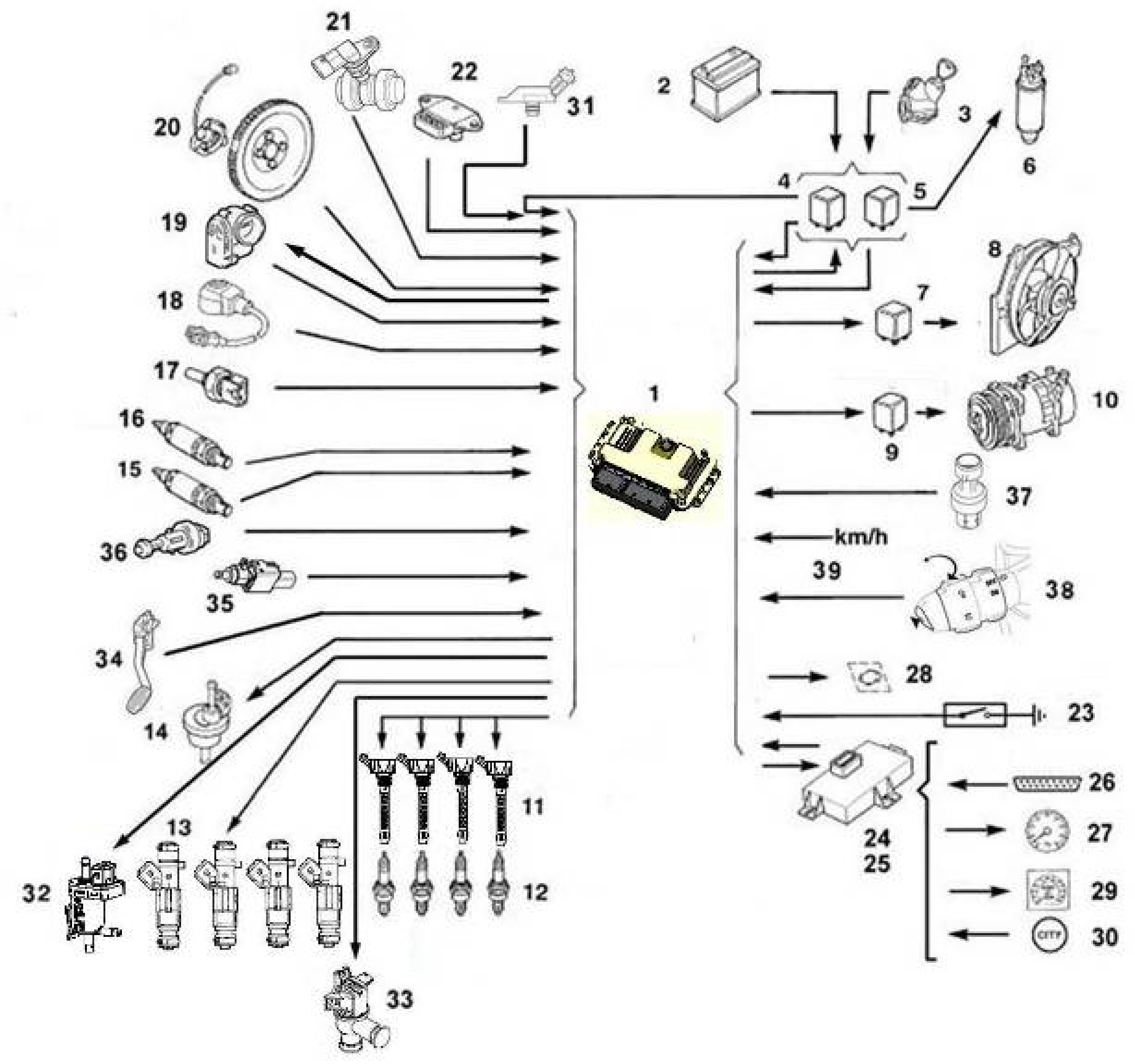
Electrical components

Introduction

This chapter illustrates the features of the electrical components (sensors /actuators) of the engine control system.

Engine Control Hub input/output information diagram

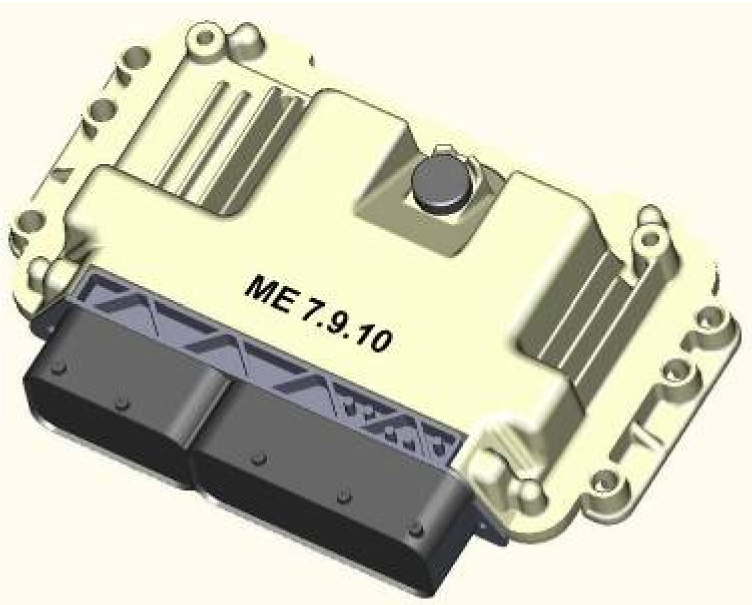
The following diagram shows the information input to and output from the engine control unit.



1. Engine control unit
2. Battery
3. Ignition switch
4. Engine control system relay
5. Fuel pump relay
6. Fuel pump
7. Radiator fan relay/s
8. Radiator fan

9. Compressor enable relay
10. Compressor
11. Ignition coil
12. Spark plugs
13. Electroinjectors
14. Carbon filter cleaning solenoid
15. Lambda probe (pre-catalyser)
16. Lambda probe (post-catalyser)
17. Coolant temperature sensor
18. Pinging sensor
19. Throttle control actuator and throttle position sensor
20. Engine speed and TDC sensor
21. Injection phase sensor
22. Air temperature/absolute pressure sensor
23. Oil pressure switch
24. Body computer (connection to C-CAN network)25. CODE control unit (via CAN network)
26. Diagnosis tool connection (via CAN network)
27. Rev counter (via CAN network)
28. System fault warning light (direct line)
29. Tachometer (via CAN network) and ABS control unit
30. City/sport button for power steering (via CAN network)
31. Turbo pressure sensor
32. Turbo waste gate pressure valve
33. Shut-off valve (DUMP)
34. Accelerator pedal sensor
35. Brake pedal stop light switch
36. Clutch pedal switch
37. Line pressure sensor
38. Cruise control lever
39. Vehicle speed signal (via CAN network)

Engine Control Hub



Type
Bosch Motronic **ME 7.9.10 A1** motorised throttle, based on control of engine torque demanded by driver. This belongs to the category of sequential timed integrated electronic injection/ignition systems.
The control unit has a flash EPROM memory, reprogrammable from the outside without intervening on the hardware.
If the injection control unit or throttle body are replaced, the throttle position self-teaching procedure must be repeated.

Function
The system serves to control the engine and connected systems

Location
The control unit is mounted in engine bay and is capable of withstanding high temperatures.

Specifications and function

Through its sensors, the Engine Control Hub (or ECH) regulates the quantity of air/fuel and the ignition advance, in order to permit correct engine function as engine load and environmental conditions vary.
The fuel injection system is indirect type, so the injectors spray the fuel behind the intake valves.
The ignition system is static type with coil for the spark plugs, and power modules contained in the ECH
The ECH controls and regulates turbo pressure through:

- A turbo pressure sensor located on the intake duct
- An electrovalve acting on the waste-gate actuator.

Through the lambda probe upstream of the converter the ECH verifies that combustion is within optimal values.
The ECH is self-adapting, and so is able to recognise the changes taking place in the engine and compensate for them according to “self-adapting” functions, both at idle speed and under high engine loading.
The system complies with EOBD standards and so is able to detect the presence of misfires, the functional integrity of the catalytic converter and to indicate any malfunctions in the exhaust emissions system through Mil warning lights.
The fuel supply system has a return circuit and mechanical differential pressure regulator. The fuel pump is controlled by the ECH.
Through relays, the ECH controls activation of the engine cooling fan and air-conditioning compressor activation.
The ECH is connected to the C-CAN communications network, of which it is a terminal.
For activation of the MIL engine control warning lights, the connection is direct.

Messages received and transmitted over C-CAN network

The ECH transmits and receives a series of messages over the C-CAN network. These messages are used mainly to carry out functions in synergy with other hubs (for example, transmission/reception of data for ESP function, or transmission of information on engine temperature to the Instrument Panel Hub).
The following table gives the most significant messages defined as states, since in addition to basic information, generally these also contain any error state indications.

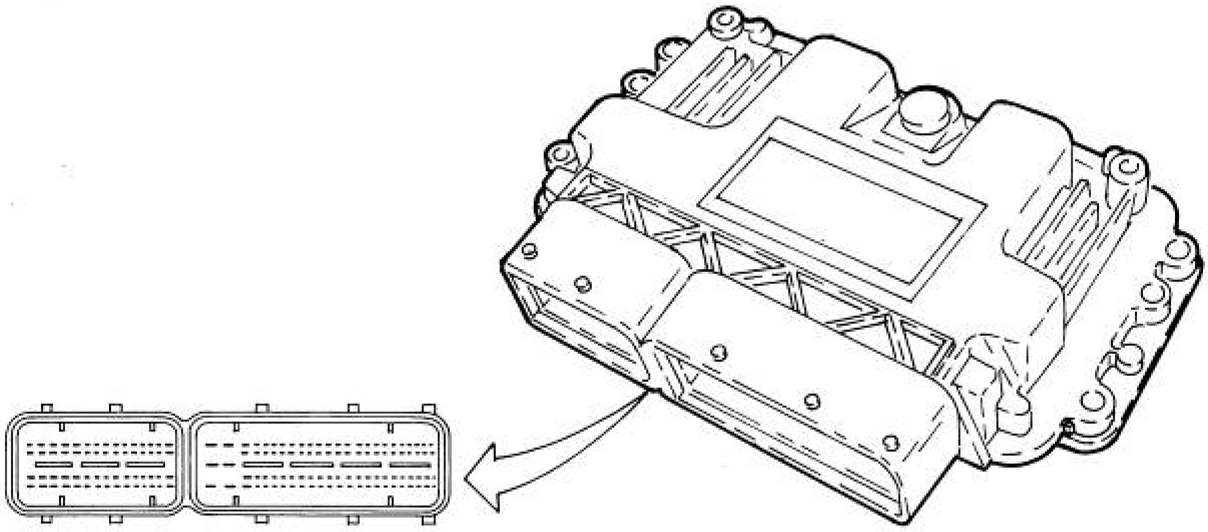
Messages transmitted over C-CAN network

- Requests for ECH unlock code (IMMO code) for the CODE function.
- Engine revs state
- Engine oil minimum pressure state
- Engine temperature state
- Engine over temperature state
- Brake pedal state
- Clutch pedal state
- Cruise control state for display on instrument panel
- Turbocompressor pressure state
- Fuel consumption state
- Condition compressor on state
- ESP/ASR control parameter state
- Engine parameter states for robotic transmission control.

Messages received from C-CAN network

- ECH unlock code for CODE function
- Key to ON state on network
- Vehicle speed state
- Brake Hub parameter state for ESP/ASR control
- Robotic transmission hub parameter states
- Sport button pressed state from Power Steering Hub
- Alternator state
- Fuel level state

Electrical connections



Engine Control Hub Pin out

Note: all pins are listed, including any not effectively used, or not used for Fiat Bravo applications.

60-pin engine side connector

Pin 1 Control (-) Lambda probe heater downstream of catalyser
Pin 2 Control (-) cylinder 3 injector
Pin 3 Control (-) canister electrovalve
Pin 4 Control (-) cylinder 2 injector
Pin 5 Control (-) dump valve
Pin 6 CNG injector **not used**
Pin 7 CNG injector **not used**
Pin 8 CNG injector **not used**
Pin 9 Turbo pressure and air temperature/pressure sensor 5V power supply
Pin 10 Motorised throttle potentiometer 5V power supply
Pin 11 Timing sensor 5V power supply
Pin 12 Timing sensor signal
Pin 13 Motorised throttle potentiometer ground reference
Pin 14 Engine oil temperature reference ground **not used**
Pin 15 Alternator terminal (D+) **not used**
Pin 16 Control (-) Lambda probe heater downstream of catalyser
Pin 17 Control (-) cylinder 1 injector
Pin 18 Control (-) waste gate **not used**
Pin 19 Control (-) cylinder 4 injector
Pin 20 CNG injector **not used**
Pin 21 Turbo pressure sensor signal
Pin 22 Motorised throttle potentiometer TPS2 signal
Pin 23 N.C.
Pin 24 Intake air temperature
Pin 25 Intake air pressure signal
Pin 26 N.C.
Pin 27 oil level switch **not used**
Pin 28 Timing sensor ground reference
Pin 29 Engine temperature sensor ground reference
Pin 30 Exhaust gas temperature sensor ground **not used**
Pin 31 Cylinder 1 ignition coil command
Pin 32 CNG rail temperature sensor signal **not used**
Pin 33 Exhaust gas temperature signal **not used**
Pin 34 Engine oil temperature signal **not used**
Pin 35 Engine oil pressure switch
Pin 36 Pinging sensor ground
Pin 37 Revs sensor (-)
Pin 38 Revs sensor (+)
Pin 39 N.C.
Pin 40 N.C.
Pin 41 N.C.
Pin 42 Motorised throttle potentiometer “TPS1” signal

Pin 43 Engine temperature signal
Pin 44 Turbo pressure and air temperature and pressure sensor reference ground
Pin 45 N.C.
Pin 46 Cylinder 3 ignition coil command
Pin 47 Cylinder 4 ignition coil command
Pin 48 Cylinder 2 ignition coil command
Pin 49 Throttle servo motor power supply (+)
Pin 50 Throttle servo motor power supply (-)
Pin 51 Pinging sensor signal
Pin 52 Reference ground Lambda probe upstream of catalyser
Pin 53 Reference ground Lambda probe downstream of catalyser
Pin 54 Reference ground Lambda probe downstream of catalyser
Pin 55 Signal from Lambda probe upstream of catalyser
Pin 56 N.C.
Pin 57 Alternator terminal F **not used**
Pin 58 CNG rail pressure sensor **not used**
Pin 59 Oil condition sensor **not used**
Pin 60 N.C.

94-pin vehicle side connector

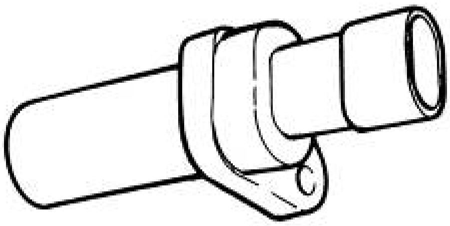
Pin 1 Engine system ground on battery negative
Pin 2 Engine system ground on battery negative
Pin 3. Power supply positive 12V from F17 10A
Pin 4. Engine system ground on battery negative
Pin 5 Power supply positive 12v from F17 10A
Pin 6 Power supply positive 12V from F16 7,5A
Pin 7 Linear pressure sensor reference ground
Pin 8 Starter control relay LSD **not used**
Pin 9 N.C.
Pin 10 N.C.
Pin 11 Conditioner compressor relay command
Pin 12 Engine cool. fan relay command (speed 2)
Pin 13 Engine cool. fan relay command (speed 1 or single speed)
Pin 14 Engine cool. fan relay command (speed 3 or PWM)
Pin 19 Control (-) turbo pressure waste-gate electrovalve
Pin 27 Accelerator pedal potentiometer “POT 2” 5V power supply
Pin 28 Linear pressure sensor 5V power supply
Pin 29 Accelerator pedal potentiometer “POT 2” reference ground
Pin 30 Accelerator pedal potentiometer “POT 1” reference ground
Pin 31 Starter control relay HSD **not used**
Pin 32 N.C.
Pin 33 Alternator L terminal D + **not used**
Pin 34 N.C.
Pin 35 N.C.
Pin 36 N.C.
Pin 37 N.C.
Pin 38 N.C.
Pin 39 N.C.
Pin 40 N.C.
Pin 41 N.C.
Pin 42 N.C.
Pin 43 N.C.
Pin 44 N.C.
Pin 45 N.C.
Pin 46 N.C.
Pin 47 N.C.
Pin 48 N.C.
Pin 49 Accelerator pedal potentiometer “POT 1” 5V power supply
Pin 50 N.C.
Pin 51 N.C.
Pin 52 N.C.
Pin 53 CAN protection ground **not used**
Pin 54 CNG petrol selector switch **not used**
Pin 55 Accelerator pedal potentiometer “POT 2” potentiometer signal
Pin 56 N.C.
Pin 57 Linear pressure sensor signal
Pin 58 N.C.
Pin 59 G force sensor **not used**
Pin 60 Vehicle speed sensor **not used**
Pin 61 “Resume” signal from cruise control stick
Pin 62 N.C.
Pin 63 Clutch pedal switch signal
Pin 64 Conditioner enable command
Pin 65 N.C.
Pin 66 CAN-L network (transit) **not used**
Pin 67 CAN-H network (transit) **not used**
Pin 68 Fuel pump relay command
Pin 70 Power supply positive F18 10A
Pin 71 MIL warning light command
Pin 72 Engine control system main relay command
Pin 73 CNG pressure valve (shut-off) **not used**
Pin 74 N.C.
Pin 75 CNG tank valve **not used**
Pin 76 Accessories key switch **not used**
Pin 77 CNG tank pressure sensor **not used**
Pin 78 N.C.
Pin 79 Accelerator pedal potentiometer “POT 1” potentiometer signal
Pin 80 Clutch potentiometer **not used**
Pin 81 N.C.
Pin 82 Stop light switch signal
Pin 83 N.C.

Pin 84 “+“ signal from cruise control stick
Pin 85 “ON/OFF“ signal from cruise control stick
Pin 86 “-“ signal from cruise control stick
Pin 87 Stop light switch signal
Pin 88 CAN network terminal C-CAN-L
Pin 89 CAN C-CAN-H network

Pin 90 Fiat Code W line **not used**
Pin 91 K line
Pin 92 N.C.
Pin 93 N.C.
Pin 94 Engine revs signal **not used**

Sensors

Revs sensor



Type

The revs sensor is an inductive type sensor, meaning that it functions by means of variations in the magnetic field generated by the passage of the teeth on a phonic wheel (60-2 teeth).

Function

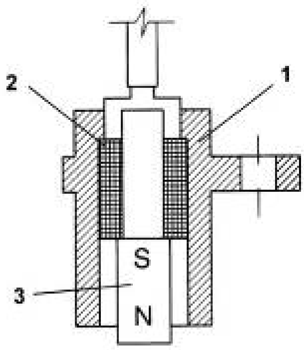
The revs sensor is used by the Engine Control Hub for:

- Determining crankshaft rotation speed
- Determining crankshaft angular position.

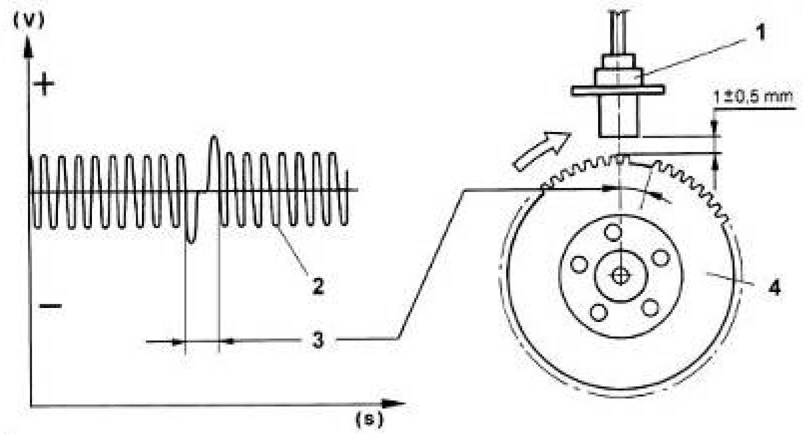
Location

The revs sensor is mounted on a bracket fastened to the engine block “facing” the phonic wheel positioned on the crankshaft pulley.

Specifications and function



The sensor consists of a tubular sheath (1) containing a permanent magnet (3) and an electric winding (2).
The magnetic flux created by the magnet (3) oscillates due to the passage of the phonic wheel teeth.
This oscillation induces an electromotive force in the winding (2), producing a voltage at the winding terminals that is alternately positive (tooth facing sensor) and negative (concave space facing sensor).



1. Sensor
2. Output signal
3. Signal corresponding to two missing teeth
4. Crankshaft pulley with phonic wheel

The peak voltage values output from the sensor depend, all other factors being equal, on the distance between the sensor and the tooth.

The phonic wheel has sixty teeth, two of which are removed to form a zero reference. The gauge of the wheel thus corresponds to an angle of 6° (360° divided by 60 teeth).

The timing point corresponds to the end of first tooth after the space of the two missing teeth: when this passes under the sensor, the engine is with pistons 1-4 at 114° before TDC.

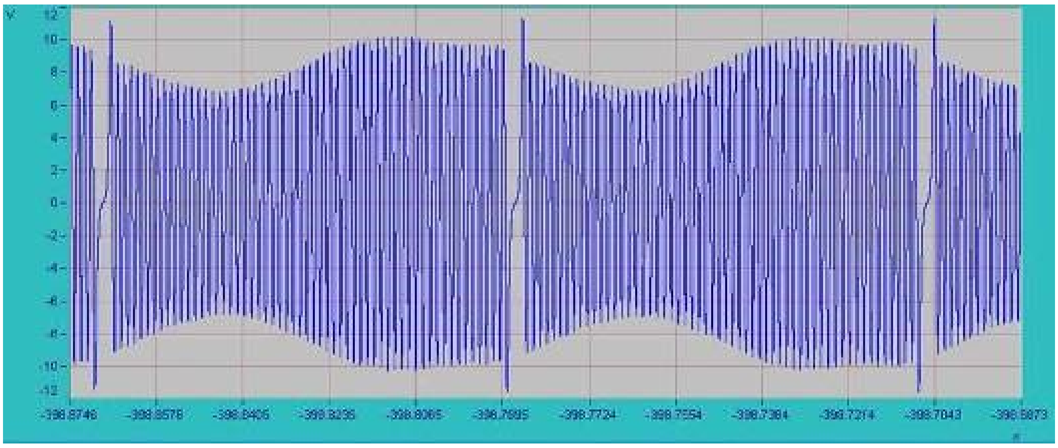
Electrical specifications

Resistance at sensor terminals; 860 Ω +/- 20% at 20°C.

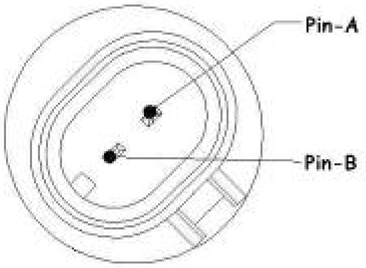
Mechanical specifications

The required distance between phonic wheel and sensor (air gap) to obtain correct signals, must be between 0.5 - 1.5 mm.

Example of revs signal read on an oscilloscope

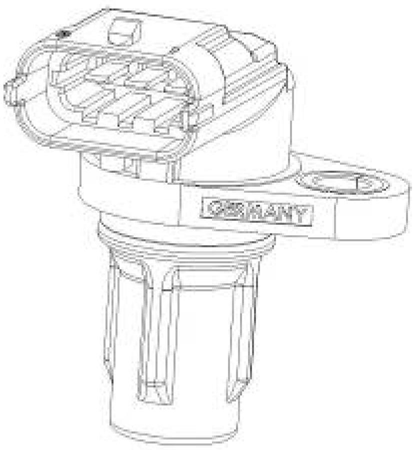


Electrical connections



Pin A	Signal +
Pin B	Signal -

Timing sensor

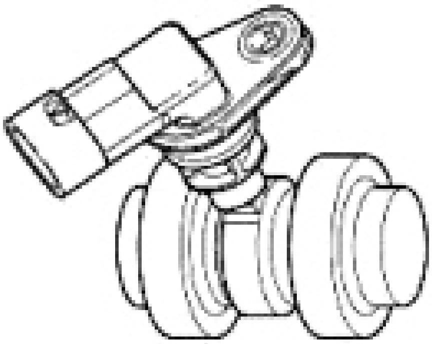


Type
The timing sensor is a Hall effect type sensor. A semiconductor wafer with current flowing through it immersed in a normal magnetic field generates a potential difference at the terminals, known as “Hall” voltage.

Function
The timing sensor is used by the Engine Control Hub to recognise top dead centre of the cylinders in order to synchronise ignition timing and fuel injection

Location
The timing sensor is located on the upper head in a specific housing, and faces onto the intake side camshaft.

Specifications and function

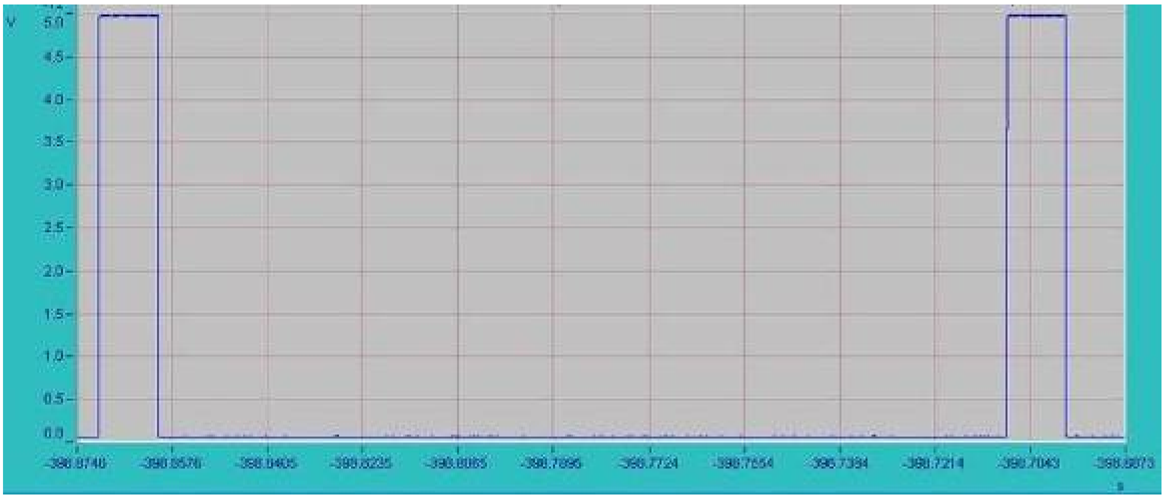


A semiconductor wafer with current flowing through it immersed in a normal magnetic field (force lines perpendicular to direction of current) generates a potential difference at the terminals, known as “Hall” voltage.
If the current intensity remains constant, the voltage generated only depends on the intensity of the magnetic field. It is thus sufficient that the magnetic field intensity varies periodically to obtain a modulated electrical signal, the frequency of which is proportional to the rate of change of the magnetic field.
To obtain this variation, the distance between the sensor and the phonic wheel on the camshaft axis is varied, making use of the valve timing mark.
As the pulley rotates the distance varies and high tension signal is generated at the reference mark.

Electrical specifications
Supply voltage 5V +/- 10%
Maximum voltage 16V

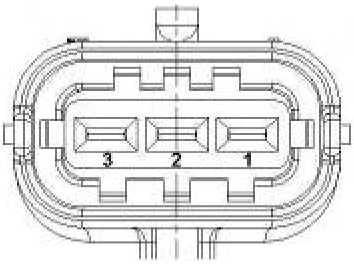
Mechanical specifications
Air gap 1 +/- 0,5 mm
Fastening screw tightening 8 +/- 1,6 Nm

Example of timing signal read on an oscilloscope



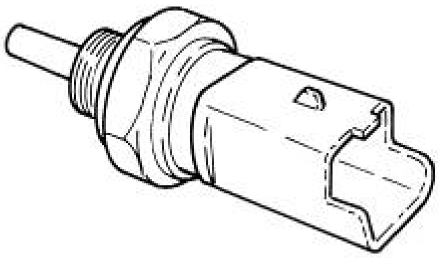
Note: the sensor is powered directly by the Engine Control Hub

Electrical connections



Pin 1	ground
Pin 2	signal
Pin 3	5 V power supply

Engine coolant temperature sensor

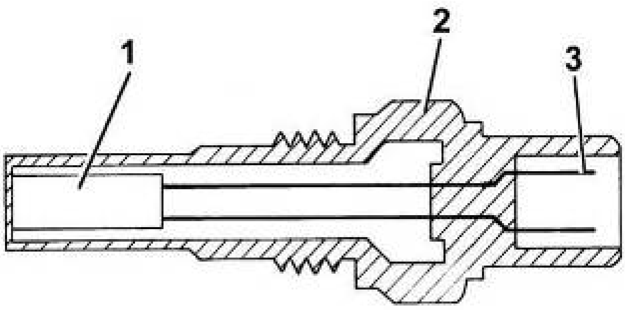


Type
This is an NTC type sensor (Negative Temperature Coefficient).

Function
The engine coolant temperature sensor is used by the Engine Control Hub to calculate engine temperature. This information is obtained by exploiting the capacity of the sensor element to vary its resistance according to temperature.

Location
The engine temperature sensor is mounted on the thermostat group.

Specifications and function



Key

1. NTC resistor
2. Sensor body
3. Electrical connector

The reference voltage for the NTC unit is 5 Volts. Since the Engine Control Hub input circuit is designed as a voltage splitter, this voltage is divided between a resistor present in the Engine Control Hub and the NTC resistor of the sensor.
It follows that the Engine Control Hub is capable of evaluating the variations in sensor resistance through the changes in voltage, and thereby obtain temperature information.

Electrical specifications
Power supply 5 V
Maximum current 2,5 mA
Maximum power at 25 °C 15 mW

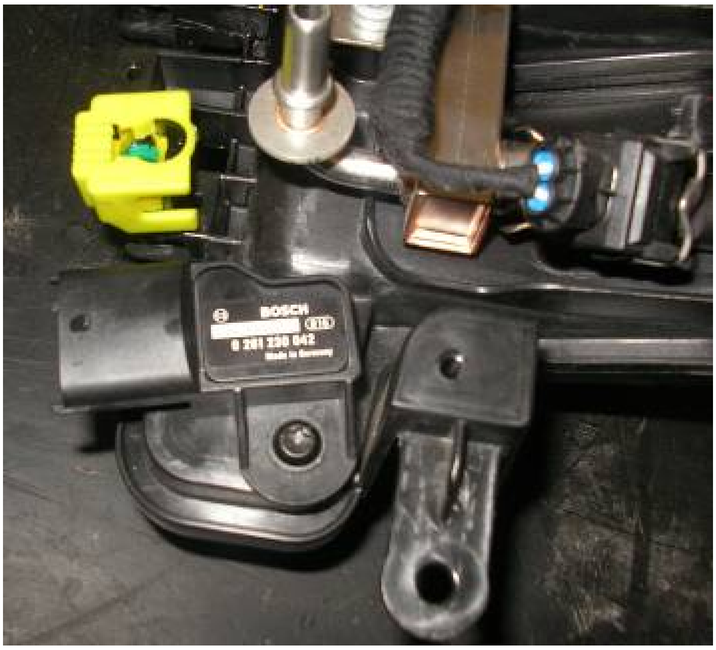
Comparison table °C / Ω Internal resistance given is nominal			
°C	**Ω**		
-40	48805	50	806.9
-30	27414	60	575.8
-20	15971	70	418.1
-10	9620	80	308.6
0	5975	90	231.2
10	3816	100	175.7
20	2502	110	135.2
25	2044	120	105.4
30	1679	130	83.1
40	1152	140	66.2

Mechanical specifications
Tightening torque 22 Nm

Electrical connections

Pin 1	signal
Pin 2	ground

Intake air temperature and pressure sensor



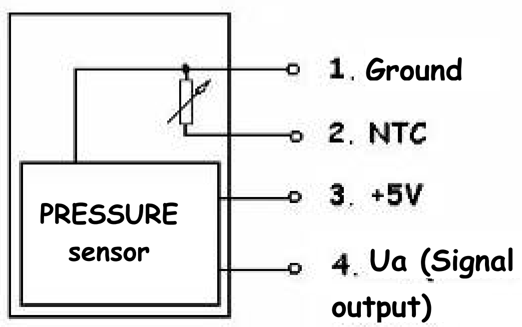
Type
The sensor incorporates:
- An NTC sensor (Negative Temperature Coefficient) to measure intake air temperature;
- A pressure sensor consisting of a Wheatstone bridge printed onto a ceramic membrane.

Function
The intake air temperature and pressure sensor is used by the Engine Control Hub for:
- Calculating the pressure in the intake manifold downstream of the throttle valve
- Calculating the air temperature in the intake manifold downstream of the throttle valve.

Both measurements are used by the Engine Control Hub to define the quantity of air drawn in by the engine, and the information is then used to calculate injection time and ignition point.

Location
The air temperature and pressure sensor is mounted on the intake manifold.

Specifications and function

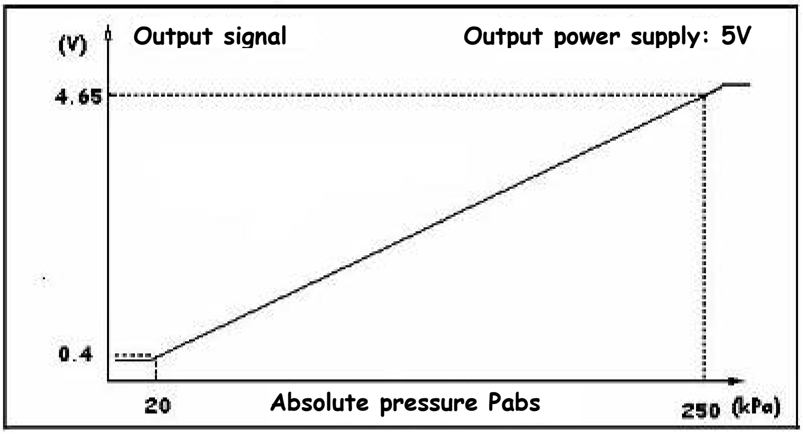


Temperature sensor

Temperature sensor specifications					
T(°C)	Rn(Ω)	T(°C)	Rn(Ω)	T(°C)	Rn(Ω)
-40	48153	20	2510.6	80	329.48
-35	35763	25	2062.9	85	284.06
-30	26376	30	1715.4	90	246.15
-25	20376	35	1431.8	95	213.68
-20	15614	40	1199.6	100	186.00
-15	12078	45	1008.6	105	162.35
-10	9426.0	50	851.10	110	142.08
-5	7419.0	55	720.65	115	124.66
0	5886.7	60	612.27	120	109.65
5	4706.9	65	521.91	125	96.68
10	3791.1	70	446.33	130	85.45
15	3074.9	75	382.89		

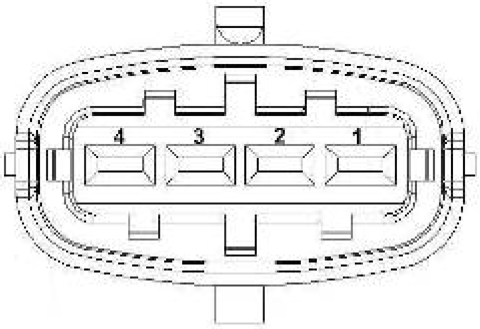
The air temperature sensor consists of an NTC (Negative Temperature Coefficient) thermistor. The resistance presented by the sensor decreases as temperature increases.
The control unit input circuit distributes the 5 volt reference voltage between the sensor resistors and a fixed reference value, obtaining a voltage proportional to resistance and therefore temperature.

Absolute pressure sensor



The sensitive element of the pressure sensor consists of a Wheatstone bridge printed onto a ceramic membrane.
One face of the membrane has the absolute vacuum reference while the other face reacts against the vacuum present in the intake manifold.
Before being transmitted to the engine control unit, the signal (piezoresistance) derived from the deformation the membrane undergoes is amplified by an electronic circuit containing the same support that houses the ceramic membrane.
With engine off, the diaphragm deflects according to atmospheric pressure. This gives precise altitude data with the key inserted.
While the engine is running the effect of the vacuum acts mechanically on the sensor membrane, which deflects varying the resistance value.
Since the power supply is kept rigorously constant (5V) by the control unit, varying the resistance value varies the output voltage value.

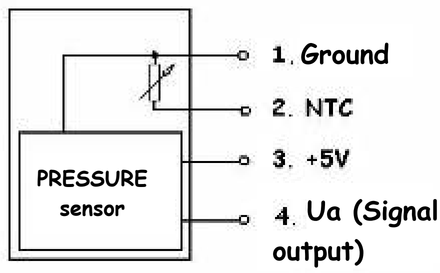
Electrical connections



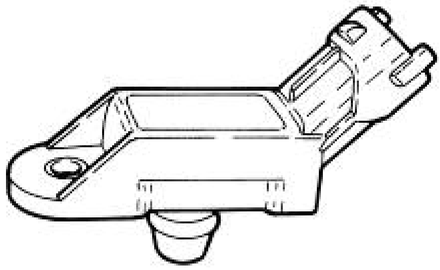
Pin 1	ground
Pin 2	air temperature sensor signal
Pin 3	5 V power supply
Pin 4	intake manifold air pressure signal

Test 1056BU – Intake air temperature and/or pressure sensor function check

STEP	CHECK	SOLUTION IF CHECK NOT OK
1	Sensor power supply check Connect the Examiner in voltmeter mode to pins 1 and 3 of the pressure sensor connector Turn the key to RUN Check for voltage of approx. 5 Volts	Restore continuity of wiring between the engine control unit and the pressure sensor. If power is interrupted at control unit output replace the ECH control unit **[PR_1056B82]**
2	Pressure signal check Connect the Examiner in voltmeter mode: black pin to pin 1 of the sensor and red pin to pin 4 Start the engine Check for voltage signal of approx. 1 volt and that the value increases as per the graph on acceleration	Replace the intake air temperature/pressure sensor **[PR_1056B54]**
3	Temperature signal check Disconnect the sensor connector Connect the Examiner in Ohmmeter mode to sensor pins 1 and 2. Check for resistance as per the characteristic curve.	Replace the intake air temperature/pressure sensor **[PR_1056B54]**



Turbo pressure sensor



Type
The turbo pressure sensor is a sensor consisting of a Wheatstone bridge printed onto a ceramic membrane.

Function
The turbo pressure sensor is used by the Engine Control Hub to calculate turbocharge pressure downstream of the intercooler.

Location
The sensor is mounted on the intake pipes in a specific housing before the motorized throttle valve.

Specifications and function
The sensor has the same features as the intake air pressure sensor.
The Engine Control Hub uses this signal to manage the turbocharge pressure, and to estimate the mass of air trapped in the cylinder, used to meter the fuel.

Main functional parameters

- Pressure range: 20 ÷ 250 kPa +/- 3,4 kPa

Main electrical interface parameters

- Power supply: 5 V from ECU
- Current at 5 V: 9 mA
- Absorption: max 0.1 mA
- Pressure signal: analogue (%of power supply voltage)
- Resistor load: Rpull-up = 680 kΩ

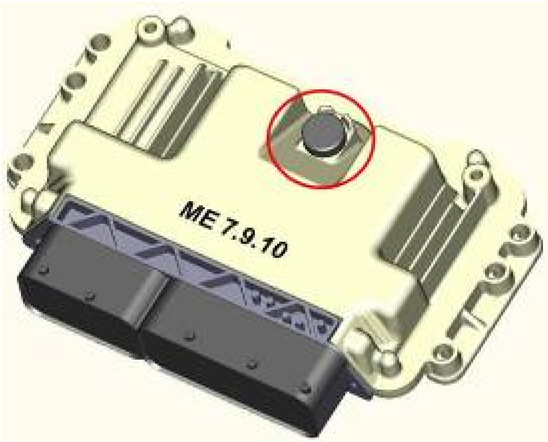
Electrical connections

Pin 1	5 V power supply
Pin 2	ground signal
Pin 3	turbo pressure signal

Test 1064 BI – Turbo sensor function check

STEP	CHECK	SOLUTION IF CHECK NOT OK
1	**Sensor power supply check** Connect with the Examiner in Voltmeter mode to pins 1 and 2 of the pressure sensor connector Turn the ignition key to RUN Check presence of approx. 5 Volt voltage	Restore continuity of the wire between engine control hub and pressure sensor. If power is interrupted at the engine control hub out, replace the control hub **[PR_1056B82]**
2	**Pressure signal check** Connect with the Examiner in Voltmeter mode. black pin to pin 2 of the sensor and red pin to pin 3 Start the engine Check for presence of 1.5 Volt signal and that this increases up to approx 4.5 Volts on acceleration	Replace the turbo sensor **[PR_1064B26]**

Atmospheric pressure sensor

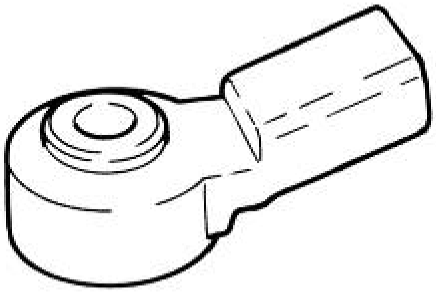


Type
The atmospheric pressure sensor serves to measure atmospheric pressure.

Location
The sensor is built-in to the Engine Control Hub

Specifications and function
The information is used by the ECH to correct the quantity of air drawn in by the engine according to altitude. This information is used to calculate injection time and ignition point, as well as to control the turbocompressor.

Pinging sensor

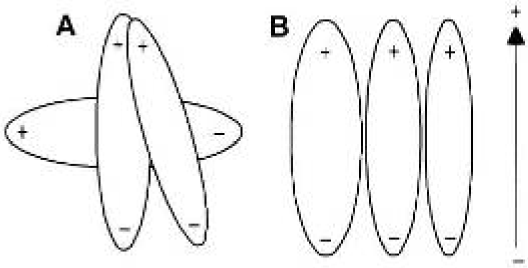


Type
The pinging sensor is piezoelectric type.

Function
The pinging sensor is used by the Engine Control Hub to recognise pinging in the combustion chamber.

Location
The sensor is mounted on the crankcase to the rear, and detects the intensity of the vibration caused by premature ignition in the combustion chamber.

Specifications and function



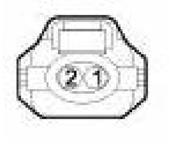
The molecules of a quartz crystal are characterised by electrical polarisation.
In rest conditions (A) the molecules do not have any particular alignment.
When the crystal is subject to pressure or is struck (B), the molecules align the more the higher the pressure the crystal is subjected to.
This alignment produces a voltage at the crystal terminals, which is interpreted and adapted over time (shifts due to engine ageing) by the Engine Control Hub, permitting recognition of engine knock in order to reduce ignition advance until the phenomenon ceases.
Following this, advance is gradually restored to low values.

A. Rest position
B. Position under pressure

Electrical specifications
Resistance at sensor terminals is about 4,87 Mohm +/- 20%

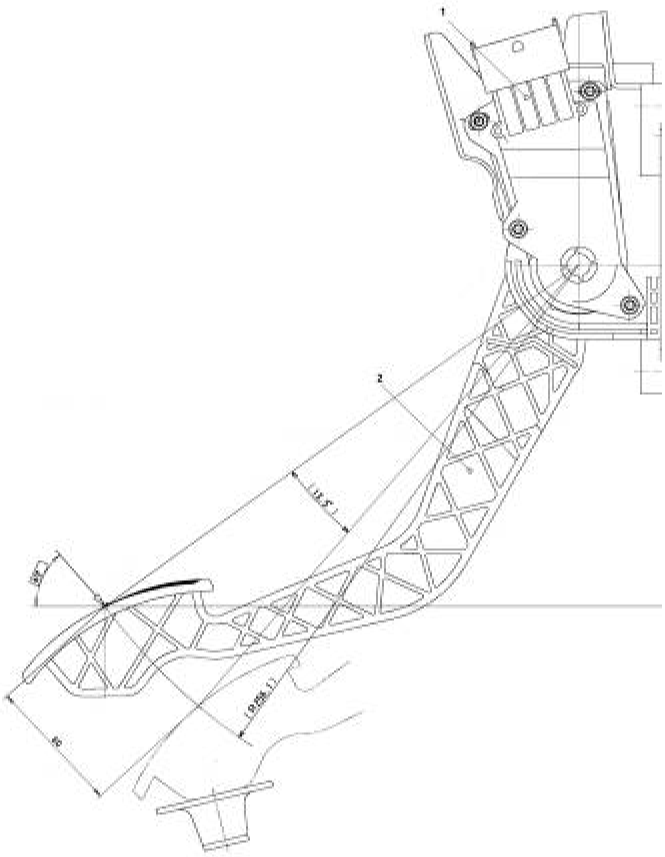
Mechanical specifications
Tightening torque of pinging sensor must be 20 Nm +/- 20%

Electrical connections



Pin 1	signal
Pin 2	ground

Accelerator pedal sensor



Type
The accelerator pedal sensor consists of a main potentiometer and a second safety potentiometer built-in to a single casing.

Function
The sensor is used by the Engine Control Hub to recognise the position of the accelerator pedal in order to manage the torque required by the vehicle user.

Location
The sensor is fitted to the accelerator pedal.

Specifications and function

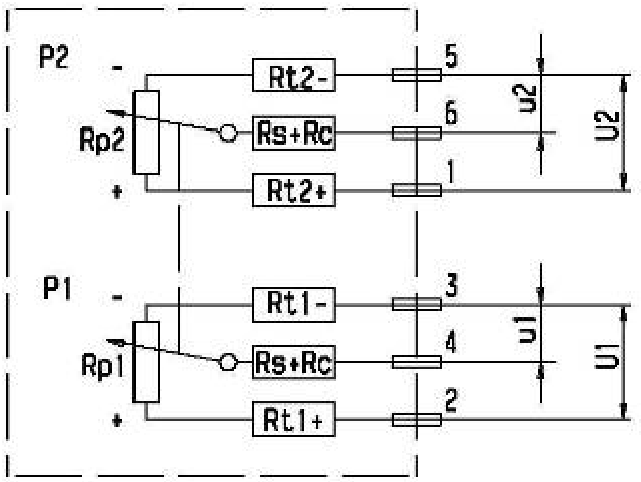
The sensor consists of a casing, fastened to the accelerator pedal support, which contains a shaft mounted in an axial position and connected to the dual track potentiometer.

A spring exerts the correct resistance to pressure on the shaft, while another spring assures pedal return on release.

The injection control unit actuates the following "recovery'" strategies in the following conditions:

- in case of failure of one of the two potentiometers, the control unit uses the remaining track, without limiting torque, and controls plausibility with the brake switch.
- in case of total failure of both potentiometers, it disables throttle aperture.

Diagram of inside accelerator pedal sensor



$$Rn1 = (Rt1-) + Rp1 + (Rt1+)$$
$$Rn2 = (Rt2-) + Rp2 + (Rt2+)$$

Electrical specifications

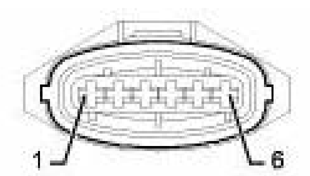
Power supply 5V +/-03V

Series resistance and contact resistance RS+RC 1Kohm +/- 04ohm

Potentiometer resistance RN1 1.2 Kohm +/- 05 Kohm

Potentiometer resistance Rn2 1.7 kohm +/- 08 Kohm

Electrical connections



Pin 1	potentiometer 2 5V power supply
Pin 2	potentiometer 1 5V power supply
Pin 3	potentiometer 1 ground
Pin 4	potentiometer 1 signal

Pin 5	potentiometer 2 ground
Pin 6	potentiometer 2 signal

Lambda probe

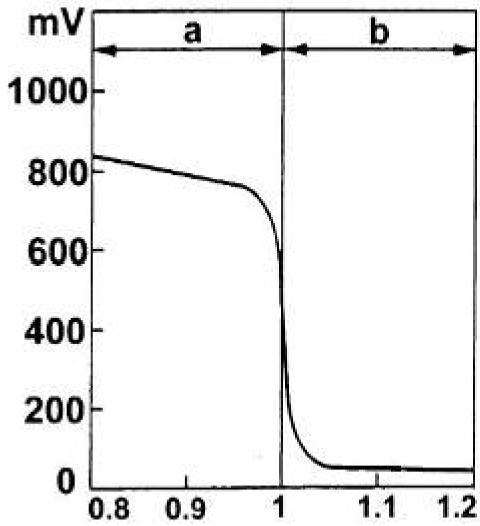
Pre Cat probe

Post Cat probe

Tipologia
The Lambda probes **Bosch LSF4.2** are both (pre-catalyser and post-catalyser) planar type

Funzione
The Lambda probes are used by the Engine Control Hub for:
- Checking combustion performance (stoichiometric ratio) (Pre Cat)
- Making the self-adaptation corrections (Pre Cat)
- Checking the functional status of the catalytic converter (post Cat)

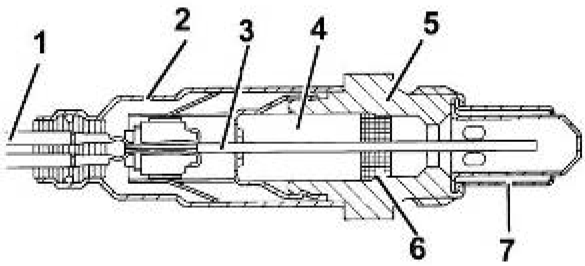
Note: to obtain an optimal fuel/air mixture, the quantity of air drawn in by the engine has to be equal to the theoretical quantity that serves to burn all the fuel injected.
In this case the Lambda factor (l), which is the ratio between the quantity of air taken in and the theoretical quantity of air (to burn all the fuel injected) is equal to 1.
Therefore:
Lambda = 1 ideal mixture
Lambda > 1 lean mixture
Lambda < 1 rich mixture



Rich mixture (lack of air)
Lean mixture (excess air)

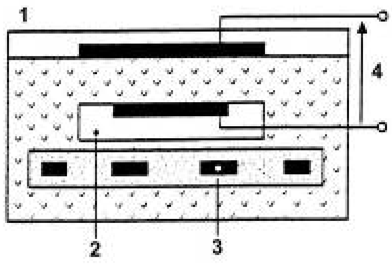
Location
The first probe is fitted downstream of the catalytic converter and the second in the section downstream of the converter.

Specifications and function
When it comes into contact with exhaust gases, the Lambda probe generates an electrical signal, the voltage value of which depends on the concentration of oxygen present in the gases themselves.
This voltage is characterised by an abrupt variation when the composition of the mixture shifts from the value Lambda = 1.
The Lambda probe is heated by the injection control unit proportionally to the temperature of the exhaust gases.
This prevents heat shock to the ceramic body due to contact with condensation, present in the exhaust gas when the engine is cold.
The measuring cell and the heater are built-in to the "planar" (stratified) ceramic element, with the advantage of obtaining rapid heating of the cell, such as to permit "closed loop" (Lambda = 1) control within 10 seconds of starting the engine.



1. Connecting element
2. Protective sleeve
3. Planar sensor element
4. Ceramic support pipe
5. Probe seat
6. Ceramic gasket
7. Protective pipe

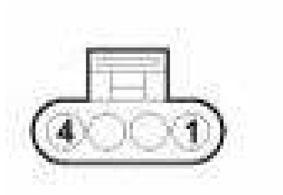
Lambda probe function is based on the principle of an oxygen concentration cell with solid electrolyte. The surfaces of the measuring cell are lined with microporous layers of inert material.



1. Side exposed to exhaust gas
2. Side exposed to atmosphere
3. Heating element
4. Probe terminals where potential difference is generated

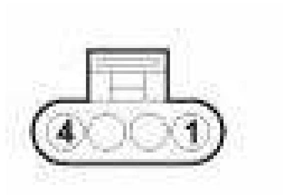
Heater electrical specifications
Nominal voltage 12V
Maximum voltage 14V
Nominal power 7W
9 ohm resistance at 20°C
Maximum current 2.1 A at 13 V ***Tightening torque***
45 +/-4,5 Nm

Electrical connections
Pre Cat probe



Pin 1	signal
Pin 2	ground signal
Pin 3	heater command
Pin 4	12 V power supply

Post Cat probe

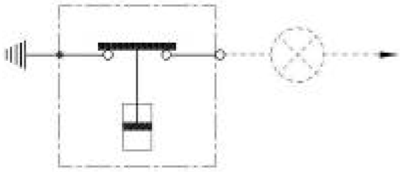


Pin 1	signal
Pin 2	ground signal
Pin 3	heater command
Pin 4	12 V power supply

Engine oil pressure sensor

Type
The sensor is a contact type sensor.

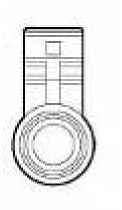
Function



The pressure sensor is used by the control unit to recognise the preset engine oil pressure value. The signal is sent via C-CAN network to the Body Computer Hub to manage the logic for lighting the warning light on the instrument panel.

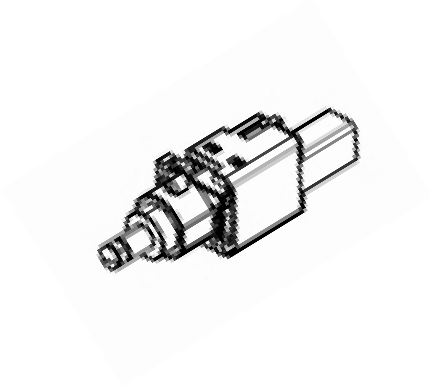
Location
The sensor is positioned on the engine oil filter support

Electrical connections



Pin 1	connection with the Engine Control Hub

Stop pedal switch

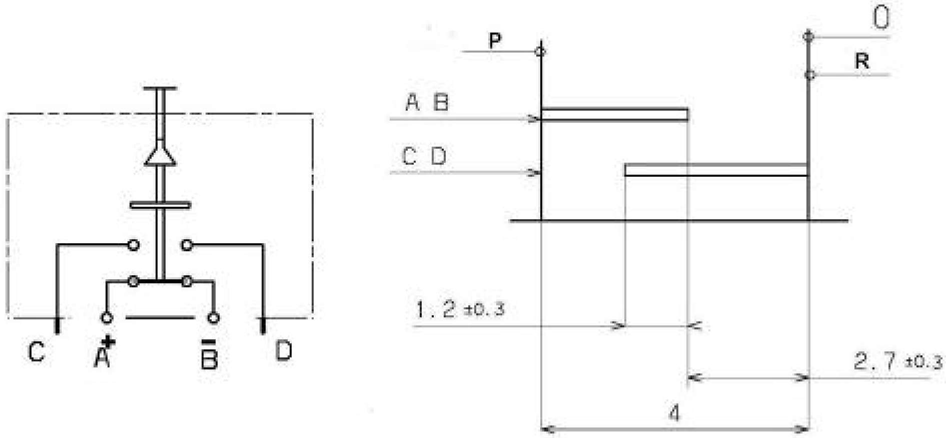


Type
Two stage switch

Function
The stop pedal switch is used by the Engine Control Hub to manage strategies associated with driveability

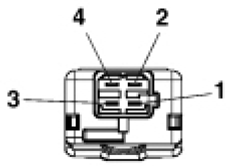
Location
The switch is located on the brake pedal

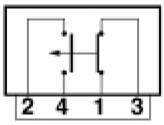
Specifications and function
The switch consists of a container that contains two switches, one normally open (N.O) and one normally closed (N.C).
When operating, the N.O switch closes while the N.C switch opens, so the N.C. switch serves to recognise brake pedal at rest and the N.O switch serves to recognise brake pedal pressed.
The diagram below shows the electrical circuit in brake pedal pressed condition, and its functional principle



Key:
A . power supply positive
B. power to electrical user
C/D redundant control switch.
P brake pedal pressed state
R brake pedal released
Note: at approx. half of the pedal excursion both switches are closed. This situation is used to test the coherence of the signals from the two switches.

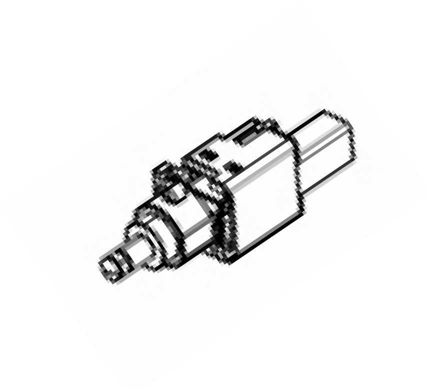
Electrical connections





Pin 1	normally closed switch signal
Pin 2	normally open switch signal
Pin 3	normally closed switch power under key
Pin 4	normally open switch power under key

Clutch pedal switch

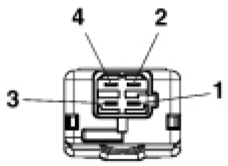


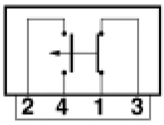
Tipologia
Electric switch
Funzione
The clutch pedal switch is used by the Engine Control Hub to manage strategies associated with driveability

Ubicazione
The switch is fitted to the clutch pedal.
Note: the switch is not present on versions with MTA gearbox.

Specifications and function
The switch consists of a container with a normally open switch (N.O) that closes when the clutch pedal is pressed.

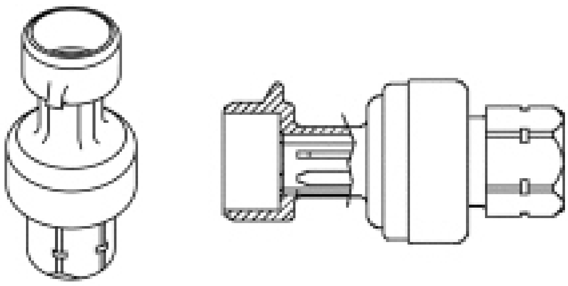
Electrical connections





Pin 1	N.C.
Pin 2	connection to chassis ground
Pin 3	N.C.
Pin 4	switch signal

Linear pressure switch (air-conditioner)



Type
Linear pressure switch

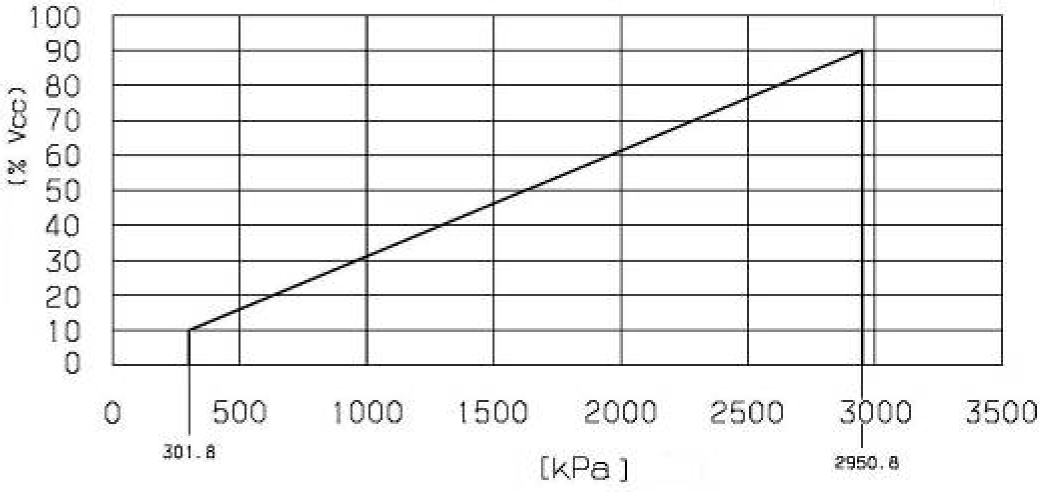
Function
The linear pressure switch controls the correct function of the system substituting the function of the quadrinary pressure switch. It is used by the Engine Control Hub to:

- Control activation of the conditioner compressor safety function
- Control activation of the engine cooling fan.

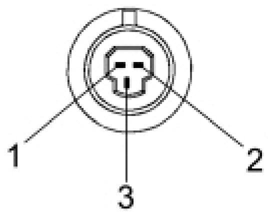
Location
The switch is fitted on the air-conditioner system high pressure circuit.

Specifications and function
Each change in pressure corresponds to a voltage signal.
The operating range of the linear sensor varies from 3.018 bar up to 29.508 bar as per the characteristic pressure curve (Bar) over the output voltage percentage (%Vdc).
Compressor operation is enabled and fan speed adjusted according to the variation in pressure that takes place in this range. Below these values the compressor is disabled as a safety condition to prevent damage to the system itself.

Electrical specifications
Power supply voltage 5V+/-10%
Temperature range -5°C ÷ 80°C
Power supply current 7mA Max
Mechanical specifications
Tightening torque is 8.5 +/-3 Nm



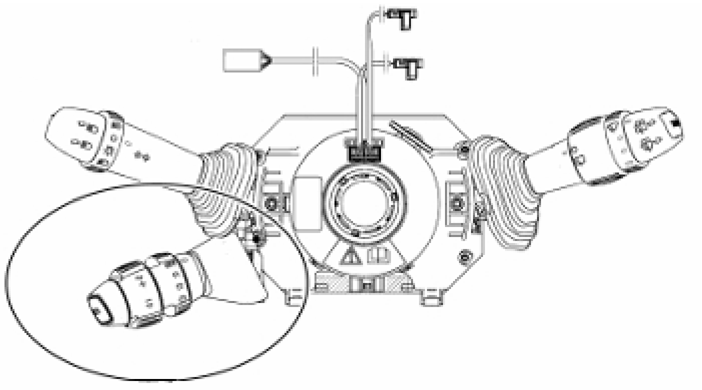
Note. Pressures are expressed in KPa
Electrical connections



Pin 1	Ground
Pin 2	Power supply voltage
Pin 3	Output signal

Note: the power supply voltage may vary by +/- 10% and sensor operating temperature is between 5°C and 80°C.

Cruise control stick

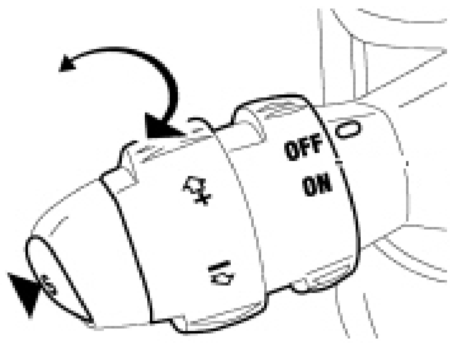


Type
Cruise Control function command switches incorporated in a specific control stick

Function
The switches are used by the Engine Control Hub to:
- Activate the cruise control function;
- Set/adjust vehicle speed;
- Resume previously set function

Location
The switches are on a specific control stick fastened to the combiswitch

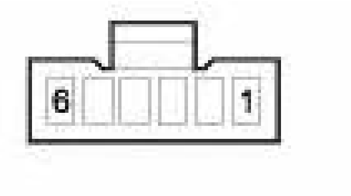
Specifications and function



The petrol engine control system with motorised throttle valve and electronic injection time control have cruise control among their available functions, or the possibility of automatically maintaining the vehicle at a cruising speed set by the driver.
The combiswitch group includes a lever with all the cruise control buttons, and specifically:
- The system enable/disable ring switch;
- The lever with vehicle speed increase(SET +) / decrease (SET-) controls;
- The Resume button to resume a previously memorised speed.

The electronic system is controlled by the Engine Control Hub.
It automatically maintains the cruising speed set by the driver by directly controlling the engine.

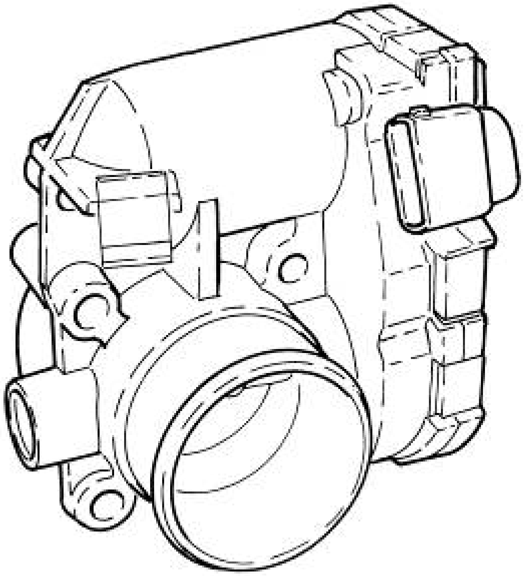
Electrical connections



Pin 1	RESUME button signal
Pin 2	+ 12V power supply
Pin 3	N.C.
Pin 4	ON/OFF switch signal
Pin 5	SET + signal
Pin 6	SET - signal

Actuators

Motorised throttle valve



Type
Throttle valve with motorised throttle control and position sensor

Function
The motorised throttle valve is used by the Engine Control Hub to regulate the quantity of air taken in by the engine.

Location
The motorised throttle valve is mounted on the intake manifold

Specifications and function
The ME 7.9.10 system pilots the motorised throttle valve on the basis of the demand of driving torque from the accelerator pedal signal. This signal is processed by the Engine Control Hub, which produces more or less accentuated throttle apertures.
The aperture of the throttle is controlled by means of a direct current servo motor built-in to the throttle valve body with PWM signals.
Valve excursion is from 0° to 80° and thus includes regulation of engine idle speed.
The throttle body is fitted with two integrated potentiometers installed such that one controls the other and vice-versa.
In case of failure of one of the two potentiometers, or in case of lack of fuel, according to the position of the accelerator, the control unit reduces engine torque:

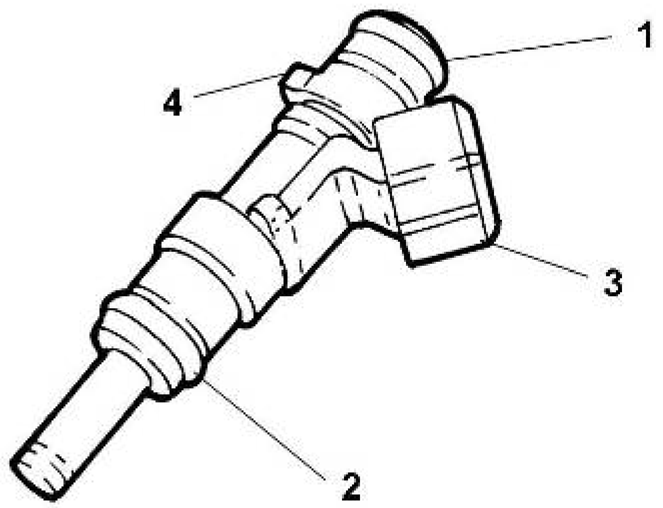
- Pressed fully down, it cuts fuel to one or more pistons up until reaching a maximum speed of 2500 rpm.
- In the intermediate positions, it cuts fuel to one or more pistons until reaching a speed lower than 1200 rpm.

Note: If the throttle body or engine control hub, or air intake manifold are replaced, it is necessary to repeat the self-teaching procedure.

Electrical connections

Pin 1	Throttle aperture servo ground
Pin 2	TPS1 and TPS2 potentiometer ground
Pin 3	TPS1 and TPS2 potentiometers 5V pos.
Pin 4	Throttle aperture servo positive
Pin 5	TPS2 potentiometer signal
Pin 6	TPS1 potentiometer signal

Injectors



Key

1. Seal on rail
2. Seal on intake manifold
3. Connector
4. Reference mark for correct assembly

Type
Bosch EV14 ET Top Feed electroinjectors (fuel intake from top part of injector, where electromagnet is housed.

Function
Used by Engine Control Hub to inject fuel into the intake ducts behind the intake valves.

Location
Fastened in specific housings in the intake manifold and facing onto the two intake valve ducts. United by a shared feed line fitted with differential pressure regulator.

Specifications and function
The injector consists of:
- a central body, housing the command solenoid, connected to its supply,
- the shutter/sprayer assembly,
- the washers, one between injector and Rail connection, the other between injector and intake manifold
- a reference notch for correct orientation

The electroinjectors are double jet type (with spray inclined with respect to the injector axis), and are specific for engines with 4 valves per cylinder. They effectively manage to orient the jets toward the two intake valves.

Note: there are a total of 10 holes on the spray nozzle, divided into 2 banks of 5, which have ten small diffusion cones making up the two diffusion cones that point at the two intake valves.
The injectors are controlled via a grounding command by the Engine Control Hub in a timed sequential manner, meaning that the four injectors are commanded according to the intake sequence of the engine cylinders, whereas the delivery to each cylinder may already start in the expansion phase up to the phase where intake has already started.
When then Engine Control Hub grounds the circuit, a current passes through the winding creating a magnetic field that attracts the shutter and allows pressurised fuel to pass through the nozzle.
The quantity of fuel injected depends on the shutter opening time, which in turn depends on the delivery time of the electromagnet. This time, known as injection time, is calculated by the Engine Control Hub for the various operating condition the engine encounters.
Electrical specifications
Power supply voltage 12 V
Resistance 14,5 ± 5% ohm.

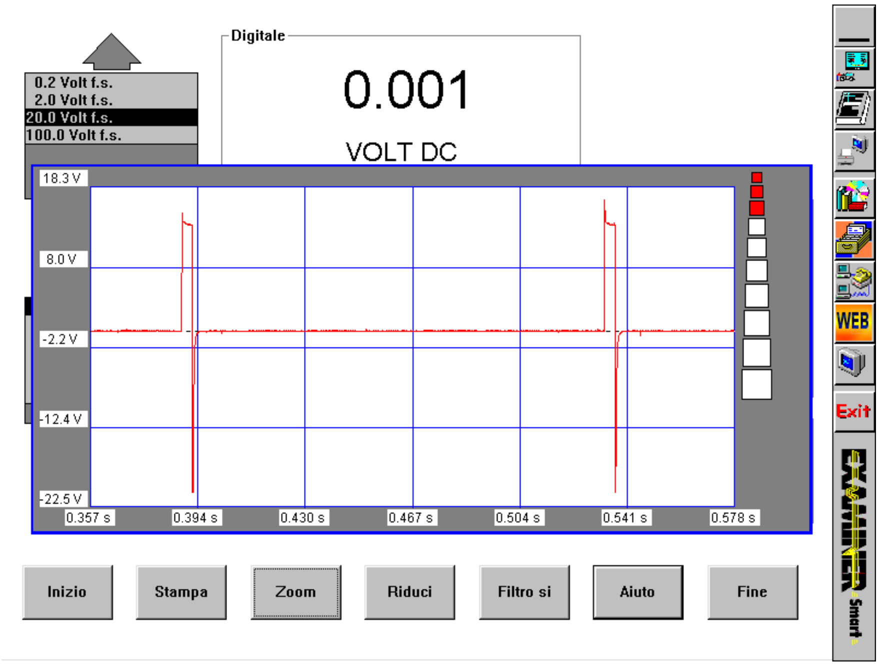
Electrical connections

Pin 1	+ 12 v power supply
Pin 2	Ground command from Engine Control Hub

TEST_1056BA Injector function test

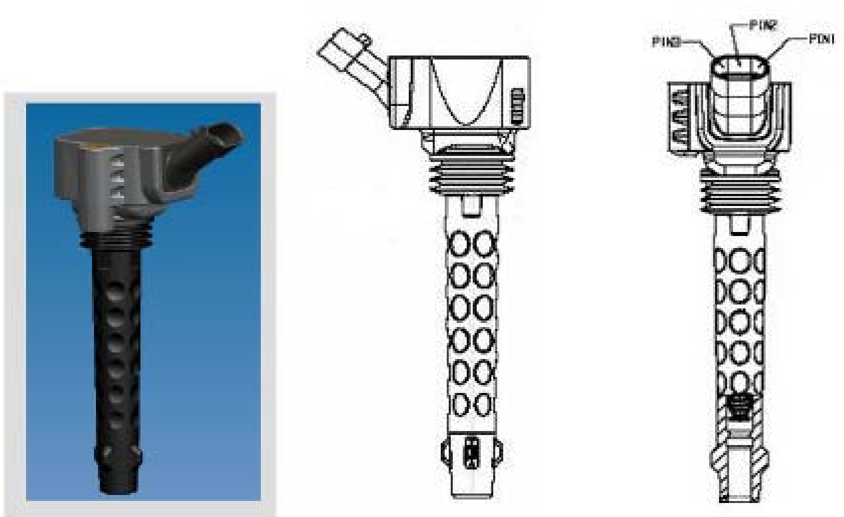
STEP	CHECK	SOLUTION IF CHECK NOT OK
1	**Injection signal check** Set the diagnosis tool to read the voltage curve. From the “TOOLS” menu select the “VOLTMETER” function with time base set to 1 second. Connect the voltmeter between the pins of the faulty injector **(using sectioner AD 233 N° 1806387000).** Press the “START” button on the diagnosis tool to start curve acquisition. Turn the engine over and check that the signal is as per the graph provided	Restore wiring between engine control unit and injector. If the signal is interrupted at the control unit output replace the engine control unit **[PR_1056B82]**
2	**Injector power supply check** Check that the injectors are correctly powered **[EL_5030]** **Proceed to step 4**	Replace 15A fuse F22 in the engine bay after identifying the cause. Restore correct power supply to the injectors
3	**Injector resistance check** Disconnect the injector Connect the Examiner tool in Ohmmeter mode between the terminals and then check resistance: the value must be 14 Ohm ± 10% at 20°C	Replace the injector **[PR_1056B70]**

Breaker AD 233 connection



Injection signal

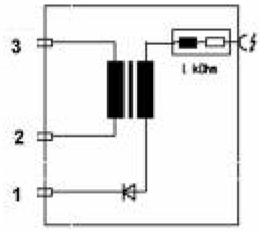
Ignition coils



Type
The coils are directly connected to the spark plugs and are “plug top” type.
Function
The ignition coils are used by the Engine Control Hub to provide the high tension required by the spark plugs

Location
The coils are mounted in specific housings directly on the upper cylinder head and are connected by a heavily insulated connection to the spark plugs.

Specifications and function

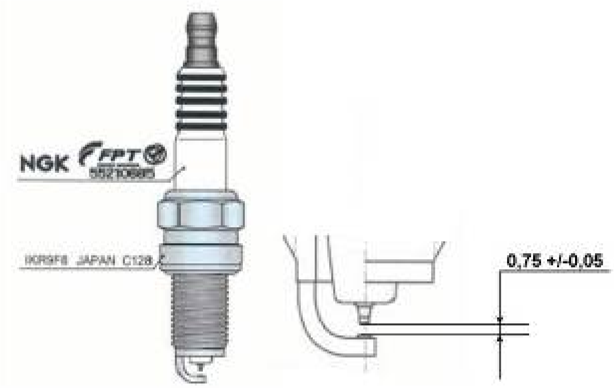


The coils consist of a lamellar packed magnetic internal core (double E) in silicon steel, along the coil head, and the primary and secondary windings are arranged around the core.
The windings are inserted in a moulded plastic container, which carries the low voltage connector and the engine head mounting, and is totally insulated in epoxy resin which has optimal dielectric, mechanical and thermal properties, since the coils are exposed to high temperatures. The coil head is connected to the spark plug with a silicone rubber cap containing a spring that transfers the high voltage from the secondary winding to the spark plug terminal.
The coils are directly controlled by the Engine Control Hub according to a sequential timed logic.
The power drivers are integrated into the Engine Control Hub
The Engine Control Hub grounds the primary winding power circuit creating a strong magnetic field on the primary. When the primary circuit is opened, a high voltage is generated on the secondary winding by induction.
This high voltage is discharged to the engine ground through the electrodes of the spark plug, generating the spark that ignites the air/fuel mixture.
Note: the type of spark depends on the dielectric between the two electrodes
The Engine Control Hub grounds the primary circuit considering the calculated injection advance and coil charging time.

Electrical specifications
Primary circuit resistance 0,53 ohm +/- 5% a 23°C
Secondary circuit resistance 8,1 kohm +/- 5% a 23°C
Nominal current on primary 7,3 A
Voltage on secondary 27 kV

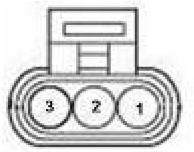
Mechanical specifications
Tightening torque on screw fastening upper head 8 +/-1 Nm

Spark plug specifications



Note: The only certified spark plugs are the NGK IKR9F8 with air gap of 0.75+/-0.05.
Note: The secondary cannot be checked only with ohmmeter as the circuit is fitted with a protective diode.

Electrical connections



Pin 1	Secondary circuit engine ground connection
Pin 2	Primary circuit + 12 V power supply
Pin 3	Primary circuit ground command from Engine Control Hub

Test 5510CE – Ignition control signal check

Connect ammeter clamp **N° 1806505000** using cable **EX01** to the diagnosis tool.

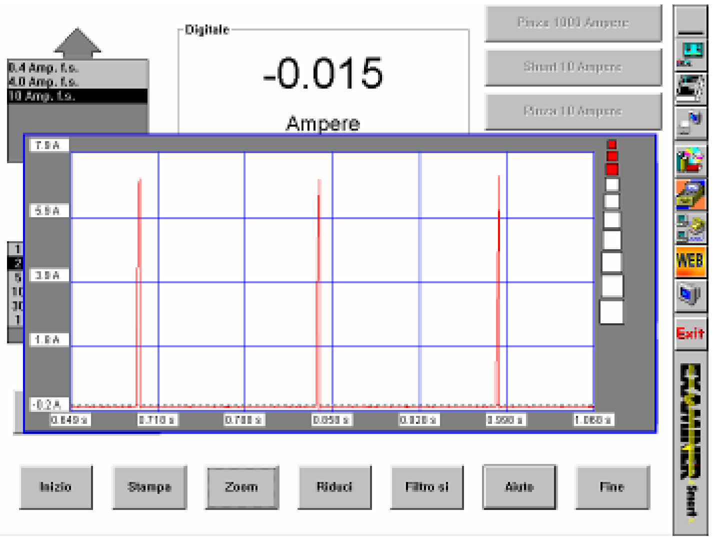
Note: *the grip of the clamp has two red LED's that come on when the ammeter clamp is open, telling the operator not to take the current measurement because it would be wrong*

Position the ammeter with the clamps closed and LED's off near to the measurement point.
Zero the clamp using the "CALIBRATION" key.

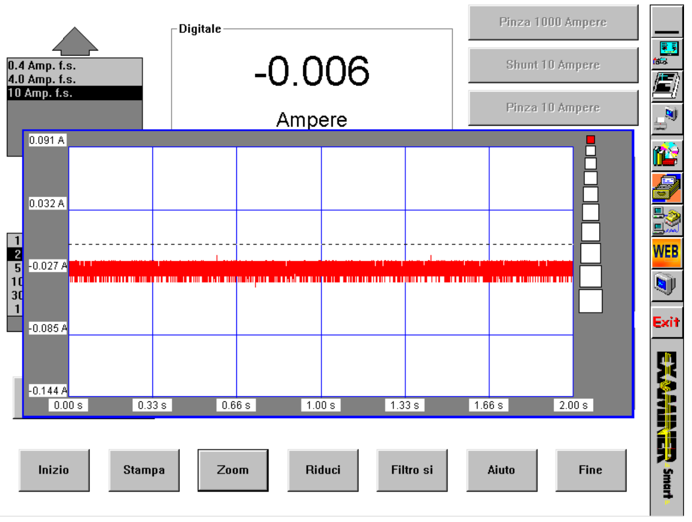
Note: *due to the high degree of instrument sensitivity, it is normal that if the clamp is rotated the reading will vary by a number of mA*

Position the wire connected to pin **3** of the ignition coil (primary control cable) such that it passes inside the ammeter clamp, and check that the red LED's on the clamp itself are off before taking any measurement.

Select "TOOLS" on the diagnosis tool and then the "AMMETER" function.
Select "**10 A** CLAMP".
Select base time **1 sec**.
Press the "start" button and turn the ignition switch to start
The following graph shows normal absorption by the coil primary winding with engine warmed up and idling.
Repeat the same test positioning on the wire connected to pin **3** of the other ignition coil and check for presence of a signal equal to the one below.



Regular ignition signal



Interrupted or grounded ignition signal.

If the ignition control signals to the coil are not present, check continuity and insulation to ground of the following cables:

- between ignition coil and engine control hub

Test 5510CI – Ignition coil function check

Note: the check for spark or no spark between the contacts of the gap SP-02 is carried out after making all connections, by starting the engine, or, in CONTROL UNIT TEST, by active diagnosis. In the case of starting manoeuvre, the fuel pump must be disabled to prevent damage to the lambda probe or catalytic converter

STEP	CHECK	SOLUTION IS CHECK NOT OK
1	**IGNITION SIGNAL CHECK** Check that the ignition key is turned to **STOP** Disconnect the battery negative lead Remove pump 15A fuse F21 in the Engine Control Hub in the engine bay Remove the HT coil from its housing Fit the spark gap SP-02 n° 1806369000 between the HT output of the single coil and the ground on the engine block as shown in fig. 1, using adapter cable N° 3 Reconnect the battery Turn the key to start and check for a spark between the contacts of gap SP-02. Repeat the same test on the other coils. Using the Examiner, check for errors and delete them	Restore the coil primary control circuit Replace the coil if the primary control signal is present If the control signal is interrupted: restore continuity of the wiring between the engine control hub and the coil. If the control signal is interrupted at the control hub output, replace the engine control hub **[PR_1056B82]**

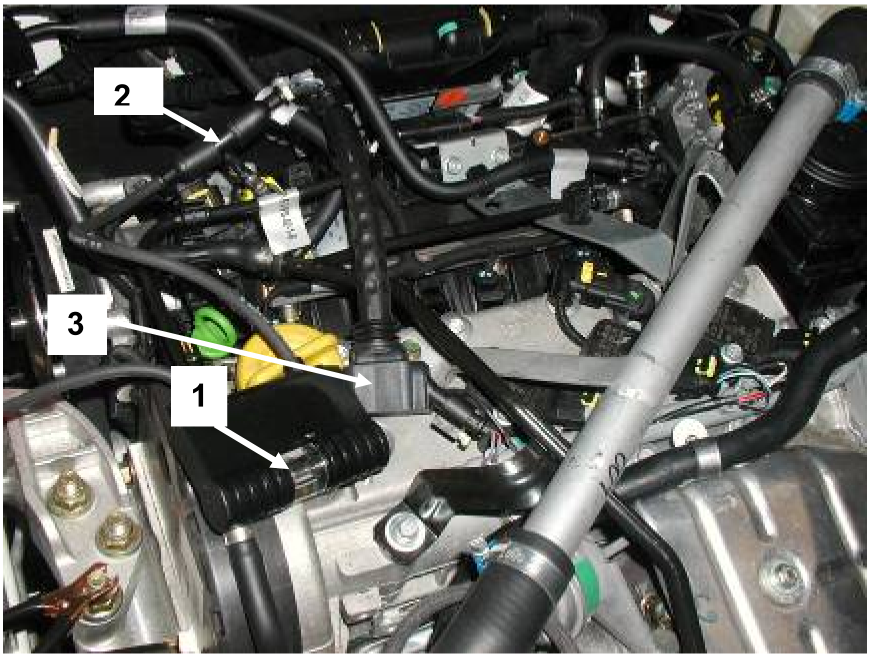


Fig. 1

1 – Spark gap SP-02
2 – Adapter cable n° 3
3 - Single coil

Test 5510OB – Ignition coil resistance check

Connect to the terminals of the **primary circuit** between pins 2 and 3 and check that the resistance values are within the following values:

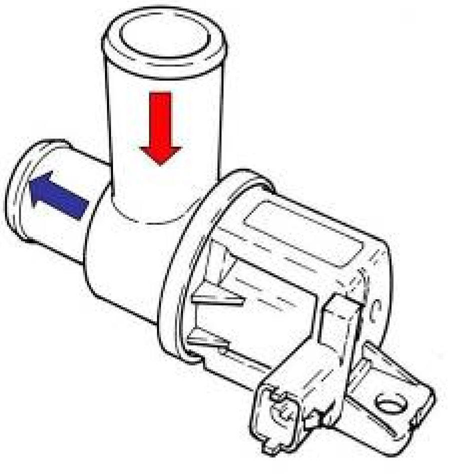
Minimum value: 0.65 Ohm

Maximum value: 0.90 Ohm

Ignition coil connector

To check the secondary circuit, carry out Test **5510CI**

DUMP valve

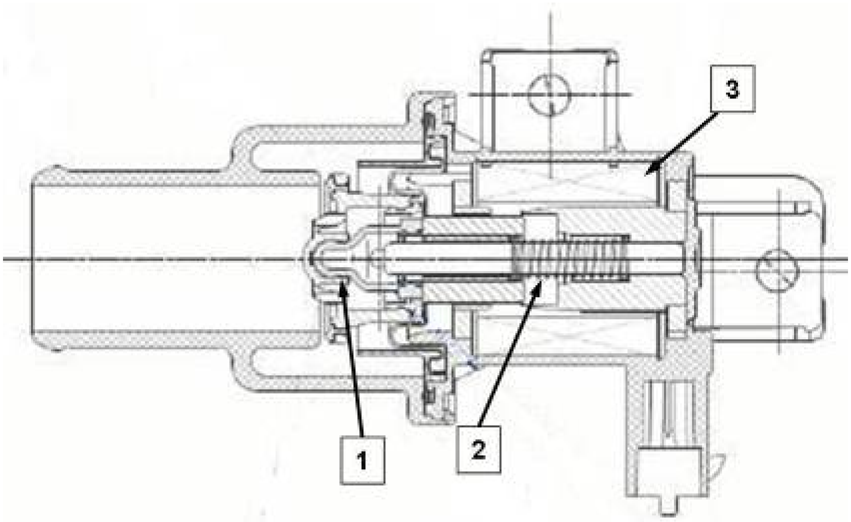


Type
By-pass valve on intake ducts electrically controlled by the Engine Control Hub

Function
The dump valve is controlled by the Engine Control Hub to limit the overpressure in the duct downstream of the compressor, when the throttle is suddenly closed after a release manoeuvre. These pressure peaks could slow the turbocompressor impeller, causing strong vibration and noise.

Location
The dump valve is mounted in a specific housing on the intake duct upstream of the throttle

Specifications and function



The electrovalve consists of an outer body housing a mechanical membrane valve (1) with a return spring (2), and an electromagnet (3) powered by the Engine Control Hub through the connector provided.
On release the Engine Control Hub excites the electromagnet (3) that pulls the mechanical valve (1) that opens a by-pass and discharges excess pressure from the intake ducts upstream of the turbocompressor. Having completed this task, the Engine Control Hub opens the electromagnet circuit allowing the return spring to extend and close the mechanical valve.

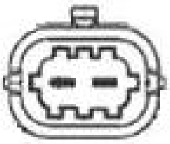
Pneumatic valve main function parameters

- Pressure ratio (p2/p1): 2.5 bar
- Seepage: max 330 l/h at 80 kPa

Electrical specifications

- power supply voltage: 12 V
- working voltage: 8 ÷16 V
- absorption: 1.4 A (at 13V and 25°C)
- electromagnet internal resistance 14 Ω±10% at 20 °C

Electrical connections

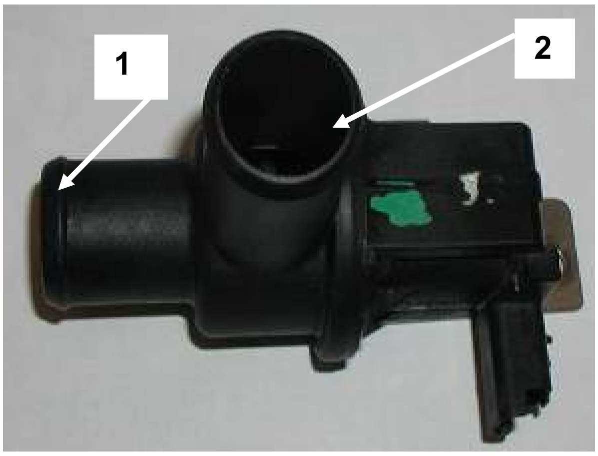


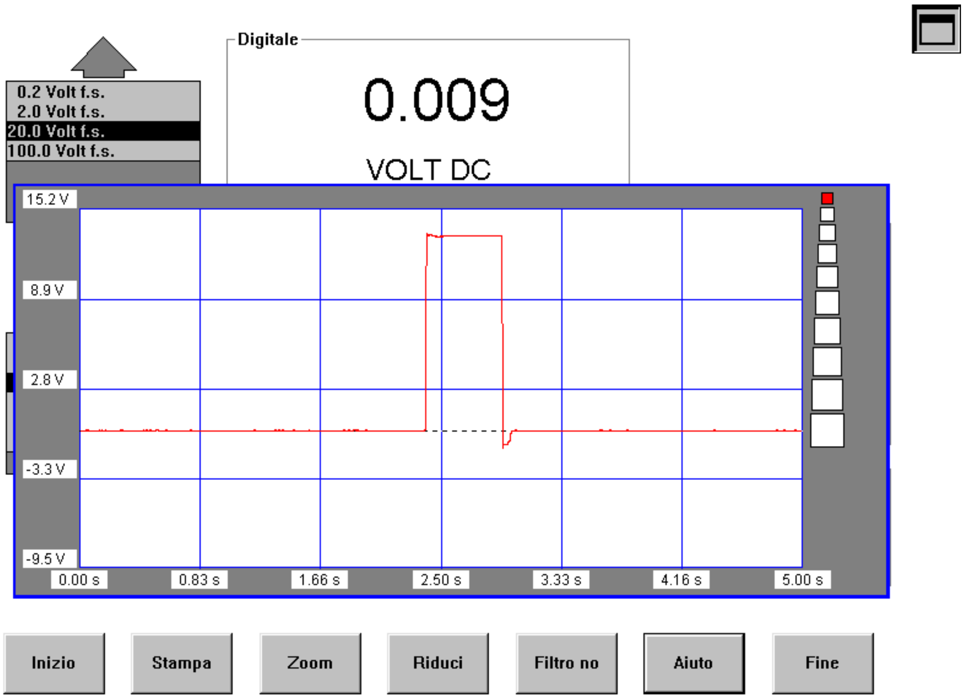
Pin 1	+ 12 V power supply
Pin 2	Ground command from Engine Control Hub

Test 1064BH – Turbo air by-pass electrovalve function check (shut-off)
Note : this is a normally closed electrovalve, and is opened with a voltage signal from the engine control hub when the accelerator is released to discharge the backpressure generated between throttle closed (on releasing the accelerator) and the pressure of the turbine in motion, to prevent turbine stall. It is closed when acceleration is demanded again or with the engine idling.

STEP	CHECK	SOLUTION IF CHECK NOT OK
1	**Electrovalve resistance check** Disconnect the wiring from the electrovalve Check that the resistance between the two terminals of the electrovalve is 14 Ω±10% at 20 °C (**FIG.3**)	Replace the by-pass electrovalve **[PR_1048B58]**
2	**Electrovalve function check** Connect the electrovalve terminals to the battery 12 V supply Check that the electrovalve open and that there is no impediment to the passage of air between ducts 1 and 2 (internal passage open)	Replace the by-pass electrovalve **[PR_1048B58]**
3	**Electrovalve control signal check** Connect the Examiner in Voltmeter mode; red pin to pin 1 of the electrovalve and black pin to pin 2 Set the Examiner base time to 5 seconds and 20 V f.s. Start the engine Take the vehicle out onto the road (observing all speed limits) and carry out the following test. On a country road with 3rd gear engaged. Start graphic acquisition by pressing “start” on the diagnosis tool and press the accelerator pedal full down until reaching 4500 rpm. On reaching this speed fully release the accelerator pedal. Display the resulting graph (acquired during the accelerator release phase) corresponding to the throttle closed phase.	Restore continuity of the wires Restore correct power supply replacing 15A fuse F11 after ascertaining the cause of the fault. Replace the engine control unit if the signal is interrupted at the control unit output **[PR_1056B82]**

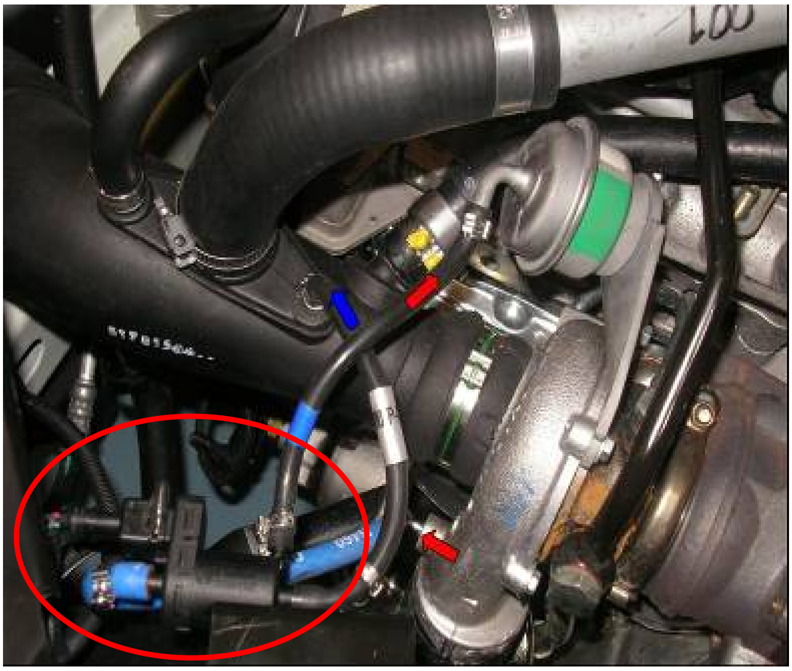
Shut-off valve





Shut-off electrovalve command signal

Turbo waste gate pressure electrovalve



Type
By-pass solenoid valve for controlling turbo pressure

Function
The turbo pressure electrovalve is used by the Engine Control Hub to control turbo pressure by direct action, via compressed air connections on the waste gate valve

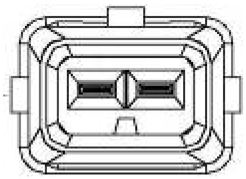
Location
The electrovalve is located in the vicinity of the turbocompressor

Specifications and function
The electrovalve consists of a plastic body that contains a shutter and an electromagnet.
The valve is connected by pipes to:
- turbo compressor outlet (high pressure socket)
- waste gate valve (regulation)
- intake pipes upstream of the turbine (excess high pressure air discharge).

Through the turbo pressure sensor, the Engine Control Hub measures the turbo pressure throughout the entire range of engine function. If this pressure exceeds the value set in the Engine Control Hub activates the valve by powering the electromagnet, that pulls the shutter in, freeing the passage of high pressure air toward the waste gate actuator, allowing it to open.
The command is given in PWM by the Engine Control Hub
On completing the regulation, the electromagnet is deactivated and the high pressure discharges upstream of the turbocompressor.

Electrical specifications
Electromagnet winding resistance **30 Ω±10% a 20**

Electrical connections



Pin 1	Ground command from Engine Control Hub
Pin 2	+ 12 V power supply

Test 1064BB – Turbo pressure control electrovalve function check

STEP	CHECK	SOLUTION IF CHECK NOT OK
1	**Electrovalve resistance check** Disconnect the wiring from the electrovalve Check that the resistance between the two terminals of the electrovalve is 30 Ω±10% a 20 °C (**fig.** 3)	Replace the turbo pressure control electrovalve **[PR_1064B34]**
2	**Electrovalve function check** Connect vacuum pump (**fig.3**) n.° **2000015500** to connector 1 of the turbo pressure electrovalve Operate the pump at pressure of approx. 0.**50** bar Check that there is no impediment to air passage between connector 1 and 2 Connect the terminals of the electrovalve to the 12V supply from the battery (using sectioner AD 233 N° 1806387000) Operate the pump at pressure lower than 0.50 bar (to prevent damage to the electrovalve) Check that air passage between connector 1 and 2 is closed (internal passage closed)	Replace the turbo pressure control electrovalve **[PR_1064B34]**
3	**Pressure control electrovalve command signal check** Connect the Examiner in Voltmeter mode: (using sectioner AD 233 N° 1806387000) connect the red pin to pin 2 of the valve and the black pin to pin 1 Set the Examiner base time to 2 seconds and 20 V f.s. Start the engine Check for square wave signal present as per the graph	Restore continuity of wiring between engine control hub and electrovalve. If the signal is interrupted at control unit output, replace the engine control hub **[PR_1056B82]**

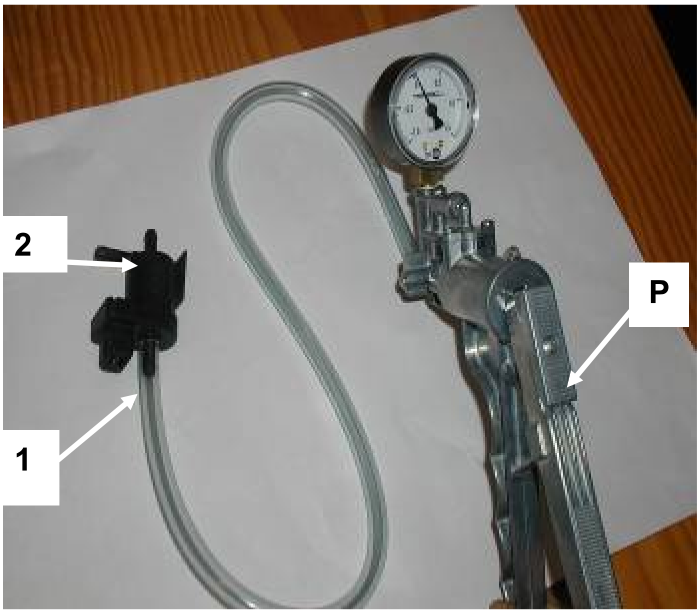
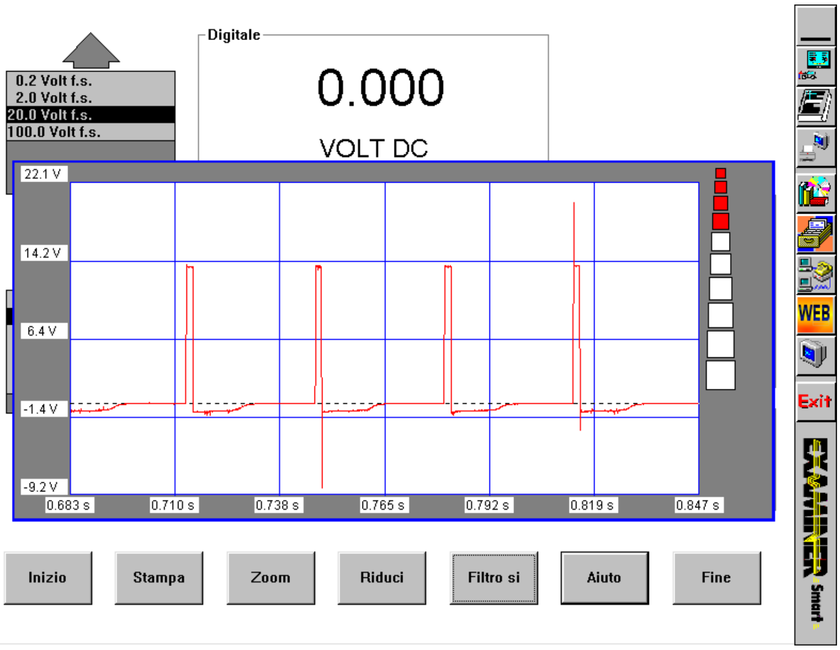


Fig. 3



Turbo pressure control electrovalve piloting signal

Test 1064BF – Waste-gate control pressure check

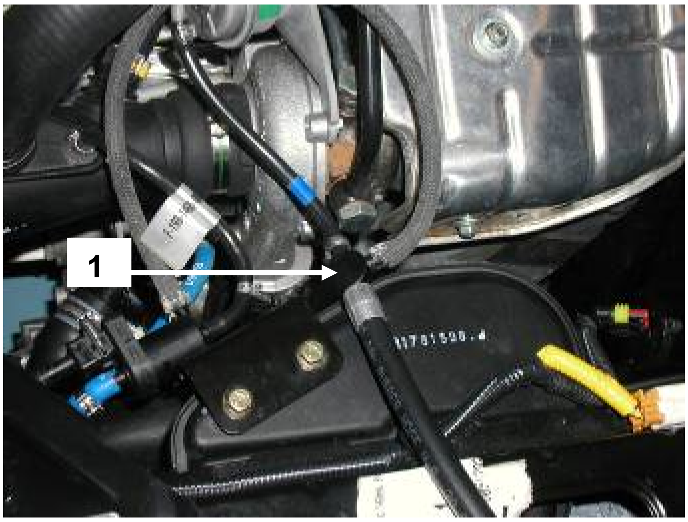


Fig. 1

With the engine stopped, over the section between actuator and electrovalve, connect connector **EX09** (1) contained in case **N° 1806338000**) of the diagnosis tool with the corresponding 5 bar pressure transducer **EX06**

In the **Tools** section, select "**intake pressure measurement pressure gauge**".

Start the engine and leave it idling, wait for pressure to stabilise.

The measured value must not exceed 590 to 720 mbar (450-550 mmHg).

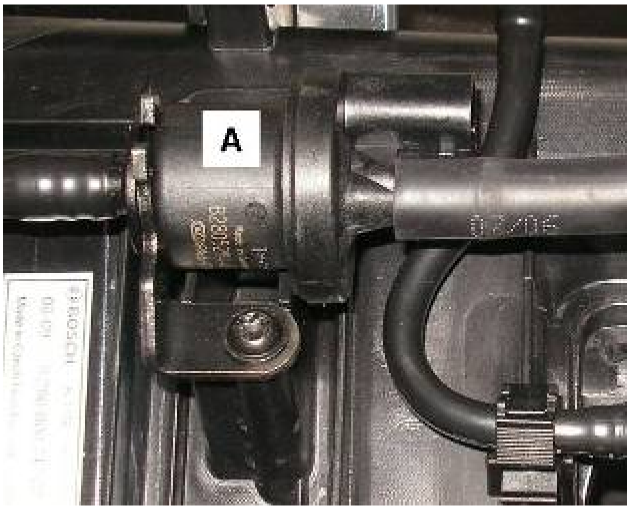
On the Examiner, select the "pressure gauge" tool and set for data acquisition in "intake pressure" more with end scale 2000 mmHg and select time 10 seconds.

Take the vehicle out on the road (observing all speed limits) and carry out the following test.

On a country road, begin graphic acquisition by pressing "start" on the diagnosis tool and after approx. 5 seconds in 2nd gear bring engine speed to 4000 rpm and engage 3rd gear.

Display the resulting graph and read a value of approx. 980 mbar (745 mmHg) at the maximum peak, corresponding to a pressure value of 20 mbar.

CANISTER electrovalve

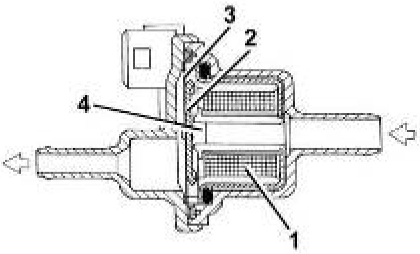


Type
Normally closed electrovalve for fuel vapour recirculation.

Function
Used by the Engine Control Hub to clean the active carbon filters in the antievaporation system

Location
Mounted on the lower part of the intake manifold, in position not visible

Specifications and function

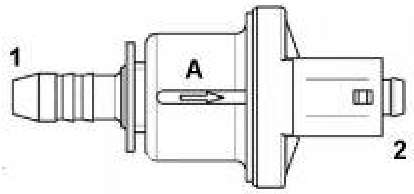


The electrovalve consists of an outer body in plastic that houses and electromagnet and a shutter. Externally there are two sockets for connecting the antievaporation system pipes
The electrovalve is controlled in PWM by the Engine Control Hub according to the mapped strategies.
When the electromagnet (1) is excited, it pulls the shutter (2) that overcomes the pressure of the leaf spring (3) opening the hole (4), allowing passage of fuel vapour.
Without power the valve is closed, preventing fuel vapour from excessively enriching the mixture.

Electrical specifications
Power supply voltage: 13.5 V
Resistance at 20°C: 26 ohm
Piloting frequency: fino a 30 Hz
Current absorbed at 13.5 V: 0.5 A

Mechanical specifications

When assembling the valve, position as indicated by arrow A in the figure.

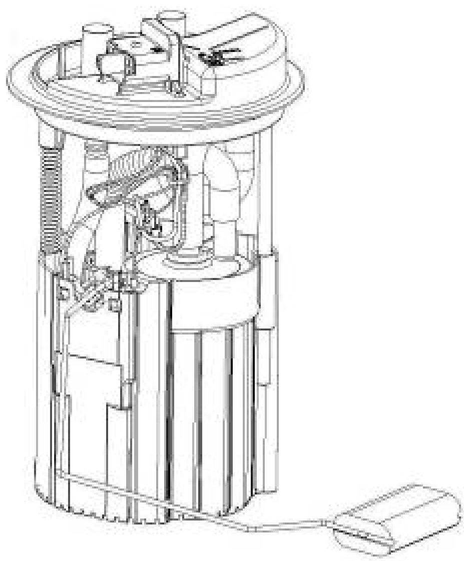


Key
1 CANISTER side socket
A arrow indicating direction of flow
2..intake side socket

Electrical connections

Pin 1	+ 12 V power supply
Pin 2	Ground control from Engine Control Hub

Fuel pump



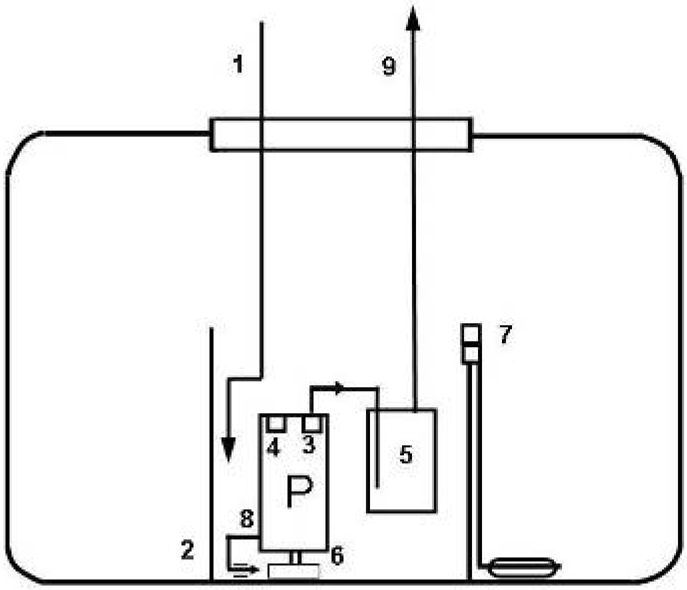
Type
Fully immersed pump commanded by level indicator.

Function
The fuel pump serves to deliver fuel under pressure to the injector rail. The system integrates the fuel level indicator, connected in this case with the Body Computer Hub.

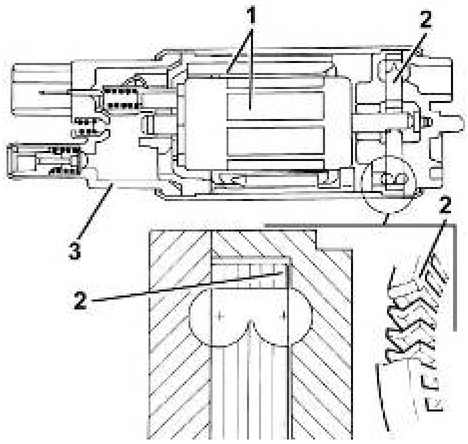
Location
The pump is located in the fuel tank, in its container basket.

Specifications and function
The system essentially consists of an electric fuel pump
- a return pipe attachment
- a delivery pipe attachment
- a membrane pressure regulator
- a mesh pre-filter
- a fuel filter
- a float type level indicator

The pump (P) controlled by the Engine Control Hub, draws fuel through the intake point (8), through a mesh pre-filter (6) and delivers it through a check valve (3) to the delivery pipe (9) through the fuel filter (5).
Note: the filter is maintenance-free.
On the pump (P) there is a safety valve (4) that activates if pressure exceeds 6 bar, short-circuiting the fuel in the pump support (2).
The excess fuel, after passing through the differential pressure regulator, returns to the tank through the return pipe (1).
On the pump support (2) there is a fuel level sensor (7) that sends its voltage signal to the Body Computer Hub.



Fuel pump
The fuel pump has a permanent magnet electric motor (1), which drives the pump impeller (2), and a terminal support cover (3), that contains the electrical and hydraulic connections.
The pump is a single stage pump with peripheral flow, with high performance at low voltage and temperature.
The advantages over pumps that operate on the volumetric principle are:
- reduced weight
- reduced size.



Electrical Specifications:
Power supply voltage 12 V
Typical current at 13 V 7.5 A

Mechanical Specifications:
Flow-rate = 110 l/h
Pressure 4.5-4.9 bar
Maximum pressure calibration, 6.50/9.50 bar

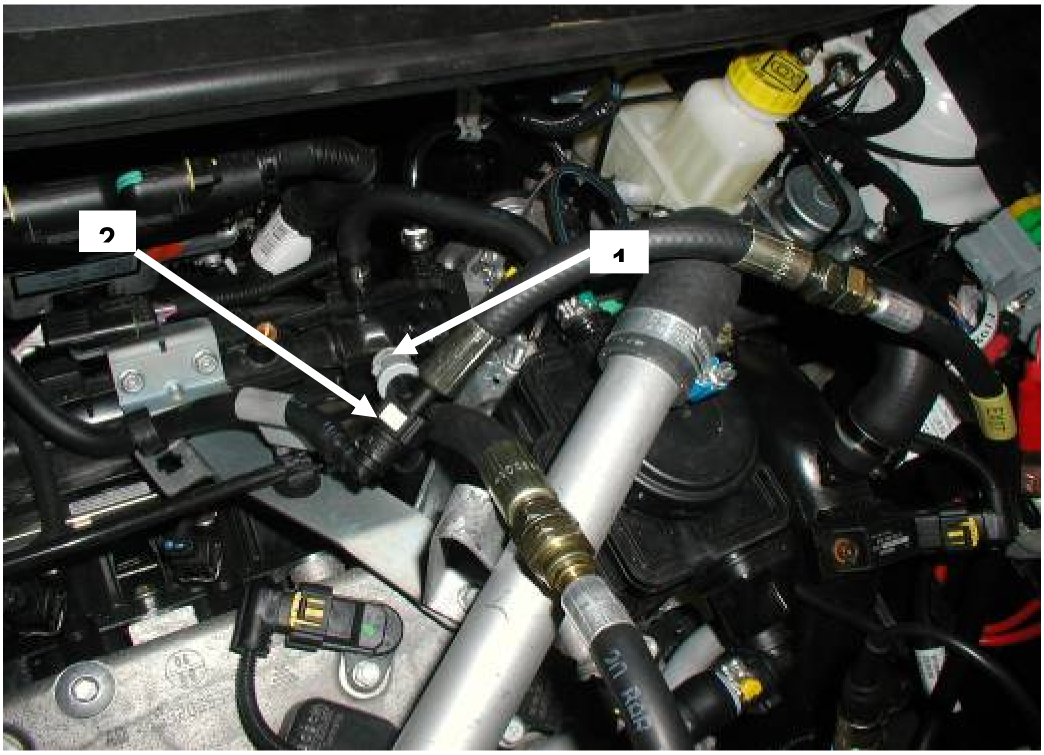
Test 1040AA – Fuel pump power supply voltage and current absorption test
Check that the pump power supply voltage at the pump connectors is equal to **12 V**
Measure pump current absorption by placing the ammeter clamp of the diagnosis tool on the pump power supply cable, on the fuse box or directly on the pump power terminal **[EL_5050]**
Current absorption must be between **6** and **10 A**.

Test 1056BY – Fuel supply system delivery pressure check
Disconnect the negative lead from the battery.
Connect the diagnosis tool pressure transducer between the delivery pipe (1) and the fuel filter intake connector (2) using pipe N° **1870885001 (1)** (Connector pipes) and pipe **N° 2000024501** contained in case **N° 2000024500** using **Kit EX 07** contained in case N° **1806338000**.
Connect the battery negative lead.
Turn the ignition key to **RUN.**
Within **10 seconds** check that the pressure reading on the pressure gauge is approx. **3 bar**
Start the engine and warm up. Check that pressure is greater than **3.5 bar**

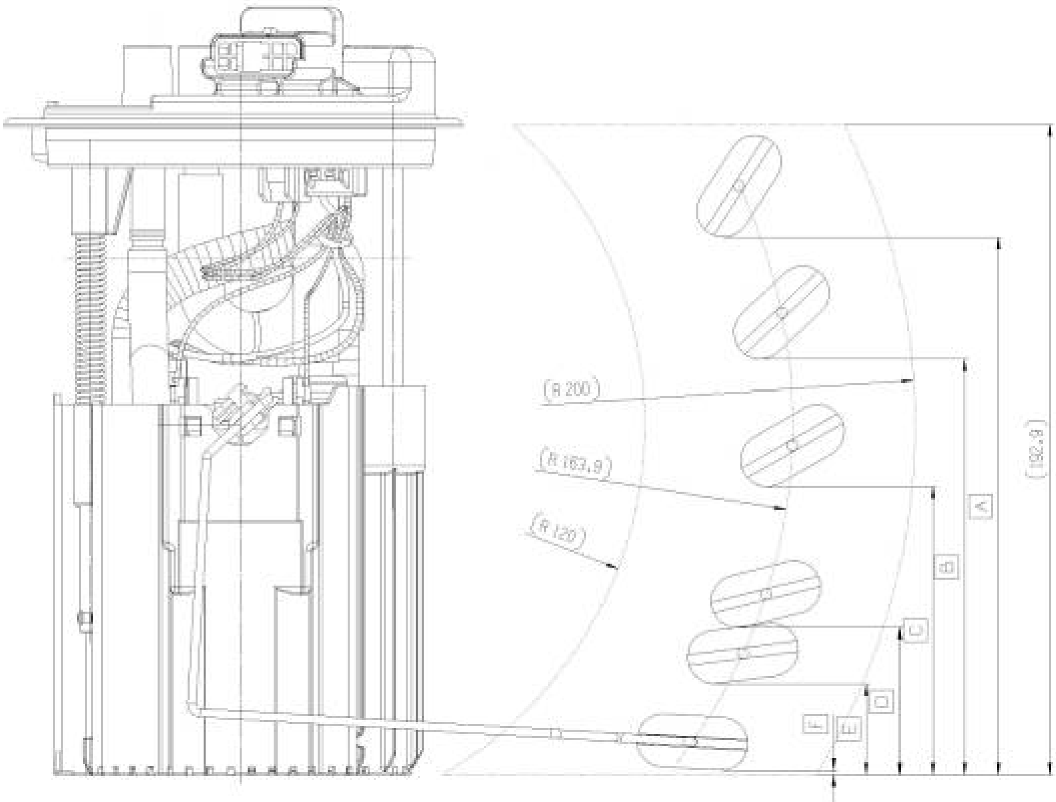
Note: The fuel pump in the tank switches off after a few seconds.

Test 1056BI – Fuel supply return system return pressure check

Disconnect the negative lead from the battery.
Connect the diagnosis tool pressure transducer between the return pipe (2) and the pipe connector (1) using Kit N° 1870885001 (connector pipes with the EX 07 kit in case N° 1806338000
Reconnect the battery negative lead.
Start the engine and check that the pressure reading on the pressure gauge is between 0.6 and 0.8 bar



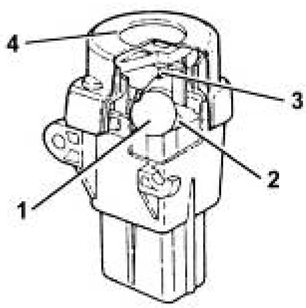
Fuel level indicator
Resistance of level sensor according to quantity of fuel in tank.



Calibrated level

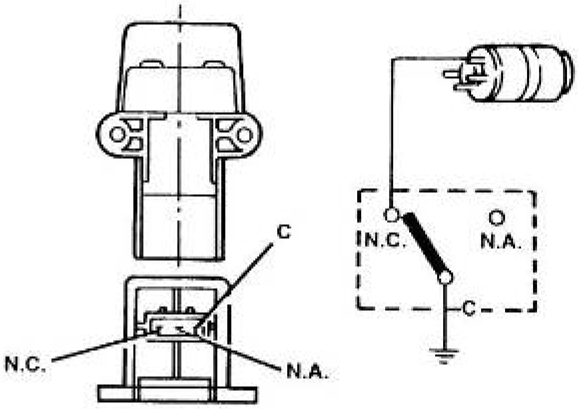
	A	B	C	D	E	F
Float height measurement in (mm)	157.7 +/- 0.8	121.9 +/- 0.6	84.7 +/- 0.4	42.7 +/- 0.9	26.0 +/- 0.8	1.0 + 3/-1
Resistance in ohms	45.4 +/- 1.7	103.9 +/- 2	164.7 +/- 2.3	233.1 +/- 2.5	260.5 +/- 3	300 +/- 3
Fuel level in (mm)	177.5	139	99	54	36	10

Inertia switch
The inertia switch mounted on the right side under the dashboard, passenger side, interrupts the ground connection of the fuel pump and as a result, shuts-off fuel delivery to the injection system.

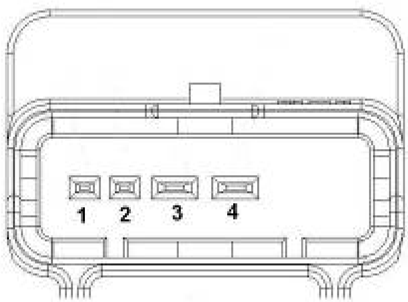


A steel ball (1) mounted in a conical housing (2) is normally held blocked by the attraction of an adjacent magnet.
Under specific deceleration loads, the ball frees itself from the magnet and leaves the conical support moving upwards at the angle of the cone.
Above the ball there is a rapid release mechanism (3) that opens the normally closed electrical circuit (N.C.).
When the mechanism is hit by the ball, it changes position, from NC circuit to NO circuit, breaking the ground connection of the fuel pump.
The switch may be reset by pressing the button protected by a flexible cover (4).

Note: after even light impact, if fuel is smelled or any leaks from the fuel supply system are noted, do not reset the switch but first check for the cause of the problem and repair it. to reduce fire hazard.
Otherwise, if there are no leaks and the vehicle is able to depart after the minor accident, press the button to enable the pump..



Electrical connections

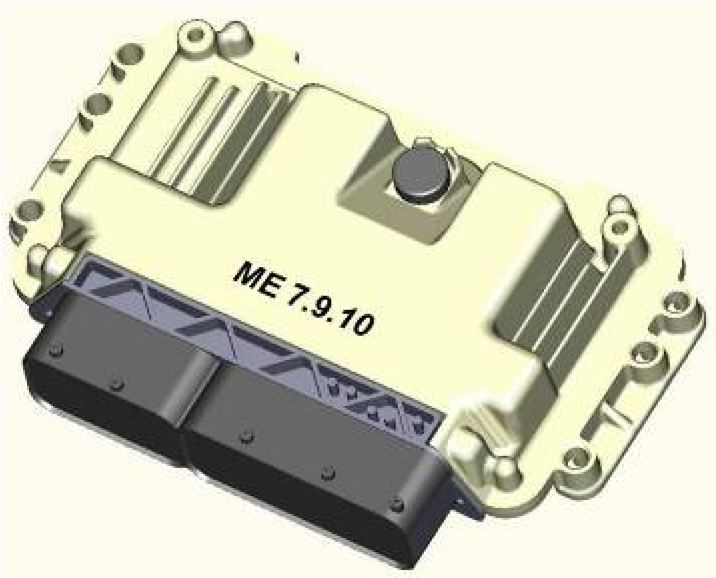


Pin 1	Fuel level sensor signal (+) (C.I.L.C.)
Pin 2	Fuel level sensor signal (-) (C.I.L.C.)
Pin 3	Fuel pump ground (to inertia switch)
Pin 4	Power supply positive +12V from relay T10 (20 A)
Pin 5	N.C.
Pin 6	N.C.

Engine control

Introduction

This chapter illustrates the features of the operating strategies adopted by the Engine Control Hub.



Injection system

The essential conditions that must always be met in the preparation of the air-fuel mixture for optimal engine function are principally:

- The “dose” (air/fuel ratio) has to be maintained as constantly as possible close to the stoichiometric value.
- The “uniformity” of the mixture, consisting of fuel vapour, diffused in the air as finely and as uniformly as possible.

In order to assure:

- ✓ The necessary rapidity of combustion and prevent fuel wastage and excessive exhaust emissions.
- ✓ Prolonged integrity and efficiency of catalyzer.

The Engine Control Hub uses a measurement system of the indirect type "SPEED DENSITY-LAMBDA", or angular rotation speed, density of the intake air and titre of the mixture (retroactive control) to calculate the air/fuel ratio.
In practical terms the system uses ENGINE SPEED data (number of rpm) and AIR DENSITY data (pressure and temperature) to measure the quantity of air taken in by the engine.
In addition to the density of the air drawn in, the quantity of air taken in by each cylinder also depends on the cylinder displacement, volumetric efficiency and turbo charging.

- Air density is understood as that of the air taken in by the engine and calculated according to absolute temperature and pressure, both detected in the intake manifold.
  Note: atmospheric pressure and turbo pressure values are used for this calculation.

- Volumetric efficiency is understood as the parameter related to the cylinder filling coefficient measured according to experimental tests carried out on the engine in all operating conditions and subsequently memorised by the Engine Control Hub.

Having established the quantity of air drawn in, the Engine Control Hub has to provide the quantity of fuel in relation to the titre of the required mixture.
The injection end pulse or injection timing is given by a map memorised in the Engine Control Hub, and is

variable according to engine revs and pressure in the intake manifold.
In practice this deals with the processing that the electronic control unit carries out to control sequential timed aperture of the four injector, one per cylinder, for the time strictly necessary for forming an air-fuel mixture as close as possible to the stoichiometric ratio.
The fuel is injected directly into the manifold in the vicinity of the intake valves at a pressure of circa 3.5 bar.

Since the engine management system is a system based on the management of the driving torque, the amount of fuel is calculated bearing in mind the factors that increase or decrease the torque, as well as the air/fuel ratio calculation concept explained previously.
The other sensors present in the system (accelerator pedal, engine coolant, throttle position, battery voltage, etc.) allow the Engine Control Hub to correct the base injection strategy for all possible engine operating conditions.

Ignition system
The ignition system is an inductive discharge static type, meaning without high tension distributor, with power modules located inside the electronic injection-ignition engine control hub.
The primary of each coil is connected to a power relay (thus powered by battery voltage) and the pins of the electronic control for the ground connection.
After completing the starting phase, the engine control hub manages the basic timing advance obtained from specific maps according to:

- Engine speed
- Absolute pressure value (mmHg) detected by the intake manifold.
- Engine temperature

As for the fuel injection, the spark advance is corrected by the torque management strategy.
The spark plugs in the cylinders are connected directly to the secondary terminals of the coils (one for each spark plug).

Self-teaching

The engine control hub actuates self-teaching logic in conditions of:

- Removal/replacement or substitution of the engine control hub
- Removal/replacement or substitution of the throttle body

The values memorised by the control unit are maintained even with battery disconnected.

Differences between 120 and 150 HP versions

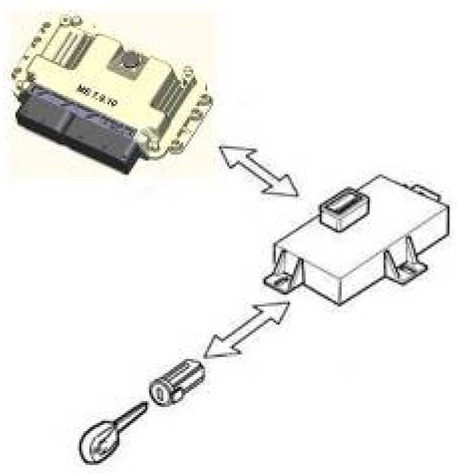
For the two versions, the following Engine Control Hub strategies are different

- Load determination
- Torque control model
- Injection advance map
- Turbocharge control
- Vehicle driveability strategies

Functional strategies
The main functional strategies of the system are as follows:

- Fiat CODE recognition
- Fuel pump control
- Cylinder position recognition
- Engine starting strategy
- Cold starting control;
- Engine torque control
- Idle speed control
- Injection time regulation;
- Enrichment on acceleration control;
- Fuel cut-off on release (Cut-Off);
- Ignition advance regulation;
- Pinging control
- Turbocharge control
- Maximum engine speed control;
- Combustion control with lambda probe;
- Engine cooling fan control;
- Air-conditioner control;
- Cruise control
- Emission control systems
- Self-diagnosis and recovery;
- Self-adaptation

FIAT CODE recognition



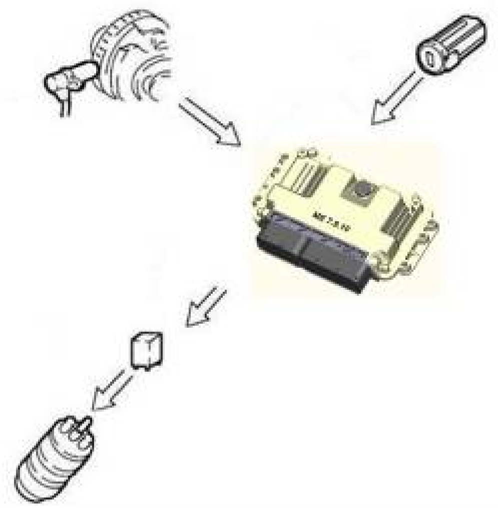
When it receives the key to "RUN" signal, the Engine Control Hub transmits the unlock request to the Body Computer Hub (IMMO code request), if the ignition key is recognised, the Body Computer Hub responds (IMMO code) allowing the Engine Control Hub to start the engine.

Note: the starter motor is directly controlled by the Engine Control Hub.

Communication between the two hubs is exclusively by C-CAN line.

Note: as in the latest versions, the W recovery line is no longer used

Fuel supply – fuel pump control



The pump is powered by the engine control hub:

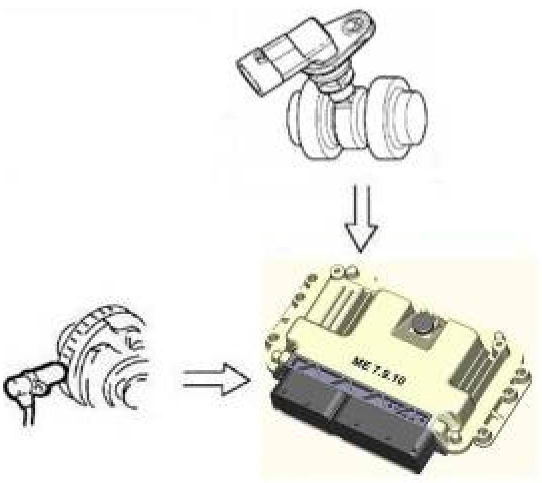
- with key to RUN for 0.8 sec.
- with key to START and engine revs > 20 rpm.

The engine control hub cuts-off power to the pump:

- with key to STOP
- with engine revs < 40 rpm.

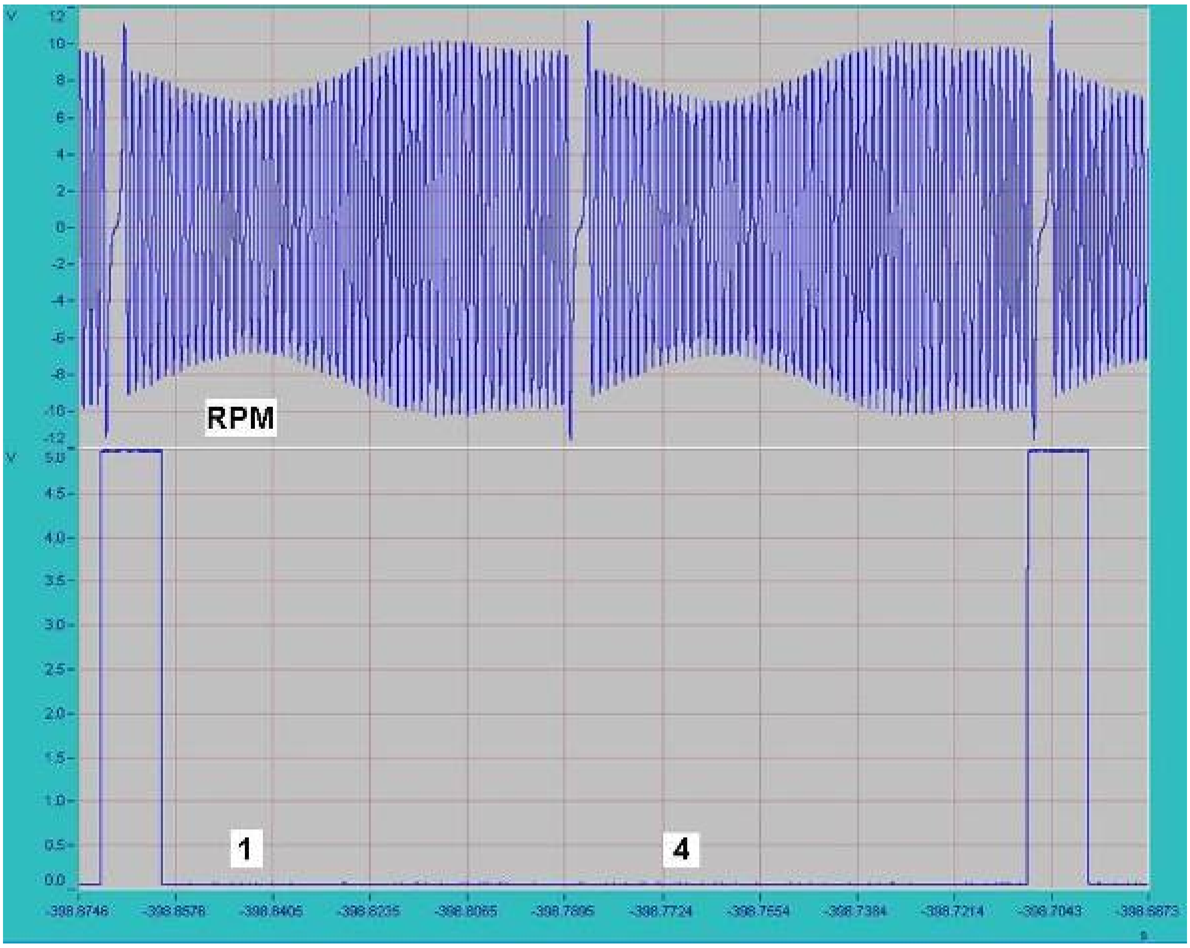
The "no return" fuel supply system envisages constant fuel pressure of 3.5 bar.

Cylinder position recognition



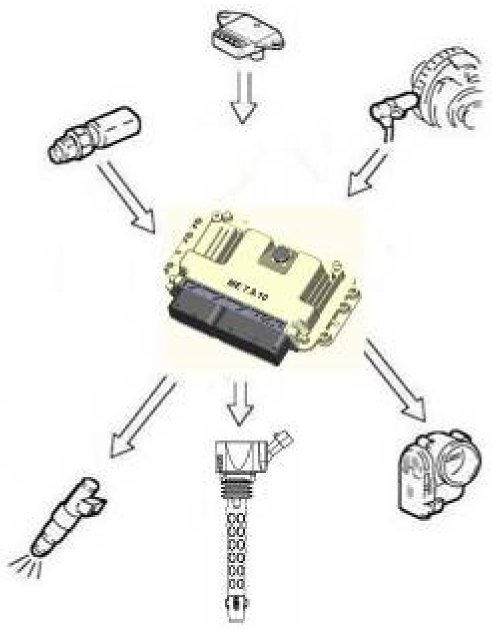
The engine timing signal, along with the engine revs and top dead centre (TDC) signals, allow the engine control hub to recognise the successive cylinder positions in order to implement timed injection.
This signal is generated by a Hall effect sensor positioned on the cylinder head at the phonic wheel on the intake camshaft.

As you can see in the diagram, the next cylinder in the compression phase is cylinder no. 1 if the timing notch (high voltage signal) corresponds to the two missing teeth on the phonic wheel, otherwise, if there is no timing notch (low voltage signal) corresponding to the two missing teeth on the phonic wheel, the next cylinder in the compression phase will be cylinder no. 4.



Key
RPM signal
1-4 pair of cylinders 1-4

Engine starting strategy

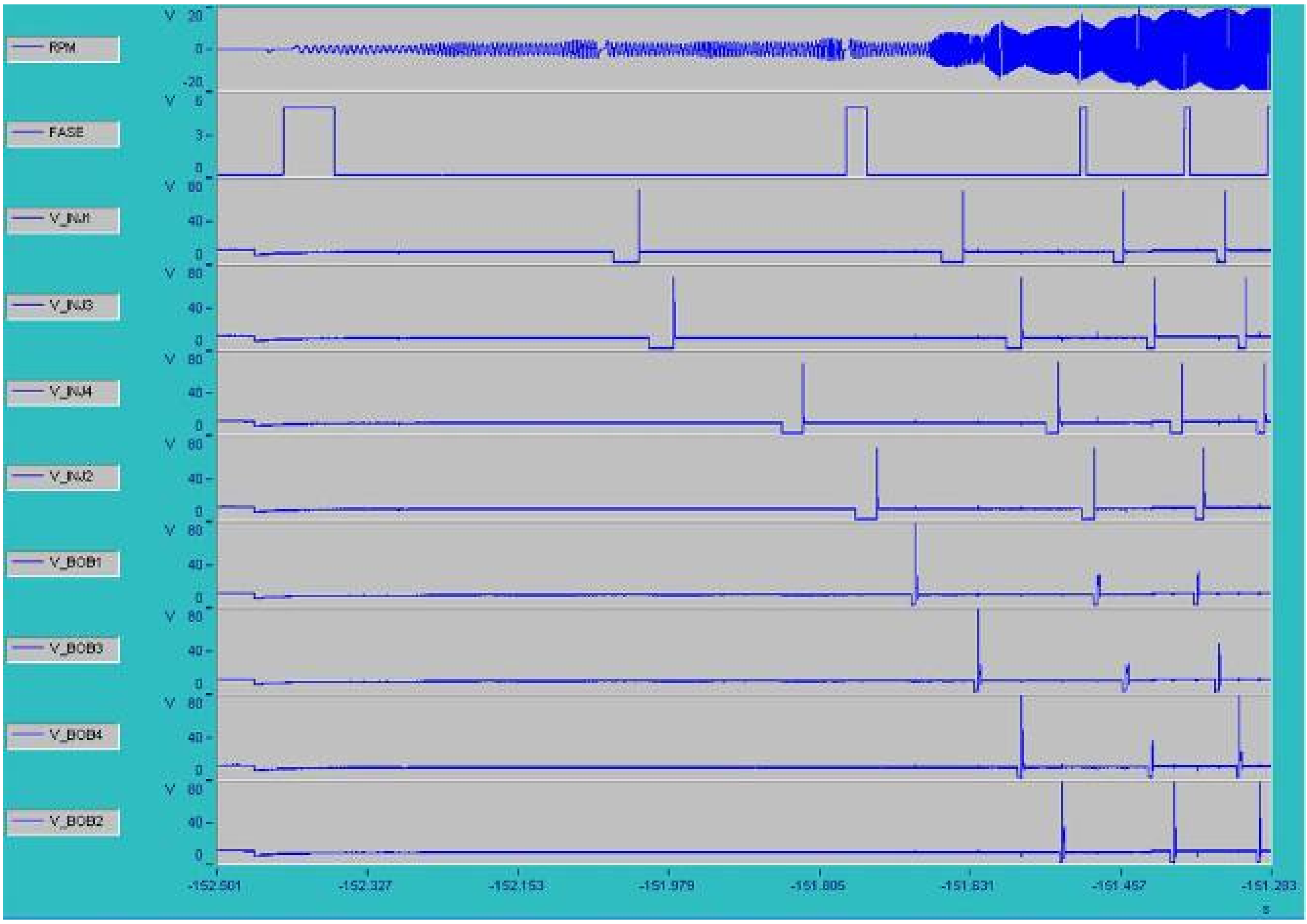


On starting, the Engine Control Hub measures the engine temperature and establishes the appropriate injection time.
On exceeding 20 rpm, the Engine Control Hub commands the injectors and coils in sequential timed mode.
The phase sequential mode during startup is used to reduce the unburnt hydrocarbon emission in the exhaust.
If there are startup failures the Engine Control Hub reduces the amount of fuel with an m multiplication factor to reduce the possibility of flooding.

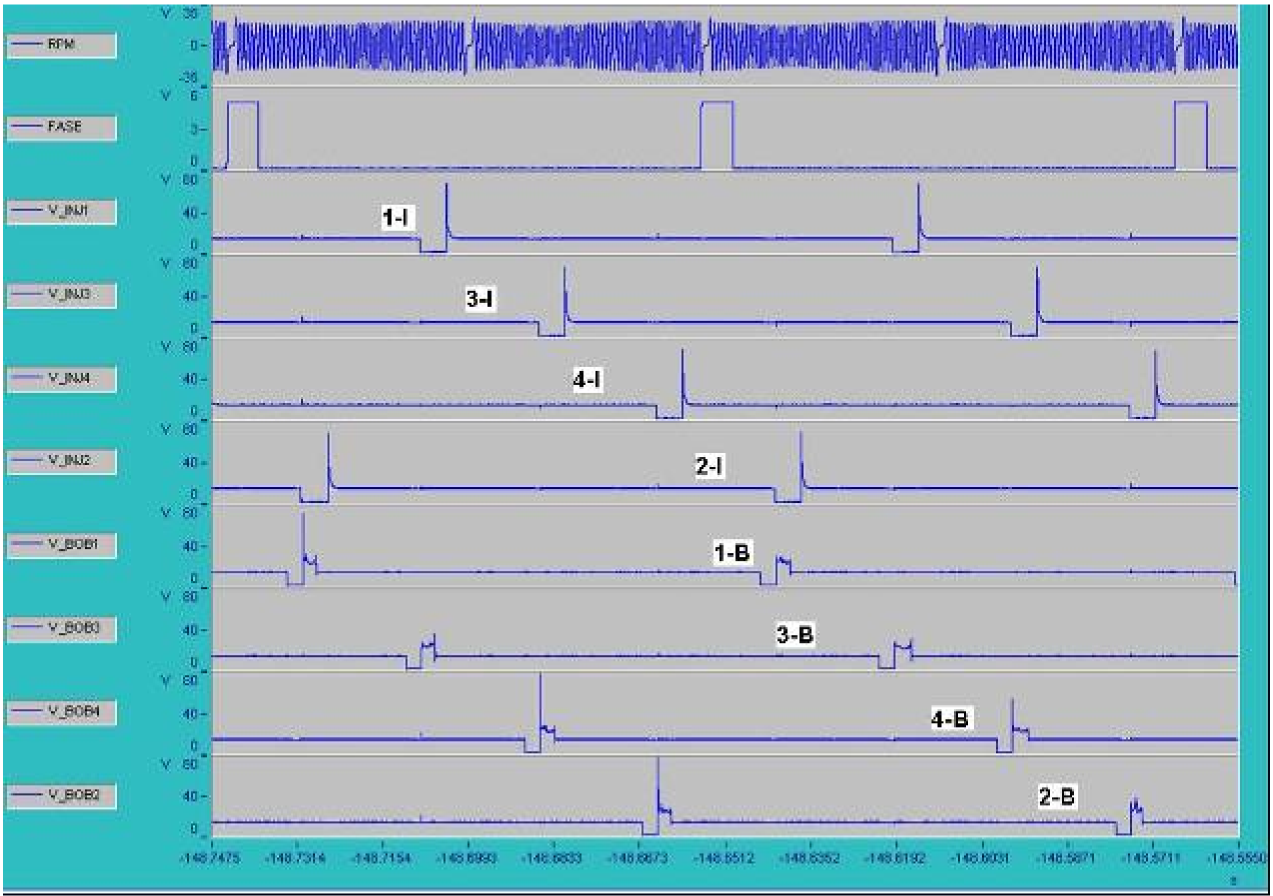
Note: the following signal diagrams are shown merely for didactic purposes, to show that during the startup phase the command is not FULL GROUP, but takes place in the phase sequential mode to display the signals diagram with the engine running.

Signals diagram with engine running

Note: the ignition order of the injectors and the coils is 1,3,4,2

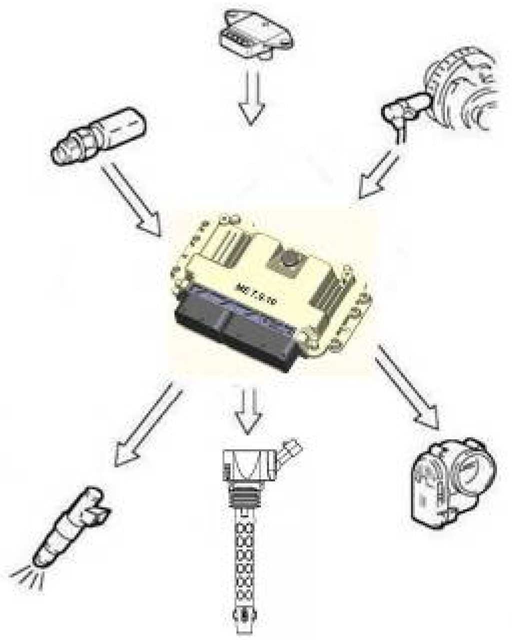

RPM
FASE
V_INJ1
V_INJ3
V_INJ4
V_INJ2
V_BOB1
V_BOB3
V_BOB4
V_BOB2
-152.501
-152.327
-152.153
-151.979
-151.805
-151.631
-151.457
-151.283

Signals diagram with engine started



Key
RPM rev signal
Timing signal phase
V_INJ1 injector one command
V_INJ3 injector three command
V_INJ4 injector four command
V_INJ2 injector two command
V_BOB1 coil one command
V_BOB3 coil three command
V_BOB4 coil four command
V_BOB2 coil two command

Cold starting control

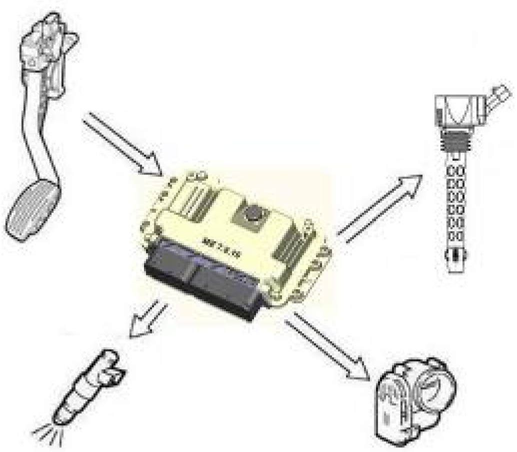


In cold starting conditions there is:
- A natural impoverishment of the mixture (due to poor turbulence of the fuel particles at low temperatures)
- Reduced fuel evaporation
- Condensation of the fuel on the internal walls of the intake manifold
- Greater viscosity of the engine oil.

The engine control hub recognises this condition and corrects injection time based on:
- Engine coolant temperature
- Intake air temperature
- Battery voltage
- Engine speed.

Ignition advance is exclusively a function of engine revs and engine coolant temperature.
The "multi-spark" mode is enabled below a threshold that can be calibrated (from about 15 °C to about -25 °C).
This strategy works by commanding the coils to give a number of sparks in close succession and it makes the combustion of the mixture easier.
Engine speed is decreased proportionally to the increase in engine temperature until reaching the nominal value with engine fully warmed up.

Torque control



To manage the various strategies the Engine Control Hub is mainly based on the principle of torque control.
There are two torque generation laws, which can be defined as follows:
- mechanical torque generation at high loads, i.e. when the throttle read is greater than the full load throttle (95% of the load) calculated on the basis of the engine revs.
- Controlled torque generation (when the mixture strength control is active).

The controlled type occurs when:
the Engine Control Hub picks up the torque request from the user through the accelerator pedal. The ECH then makes various calculations and then acts on the spark advances at throttle opening and the injection times.
There are three main tables for calculating engine torque, these being:
- Low load calculation table
- High load calculation table
- Reverse gear calculation table.

For the versions with SPORT function, another three tables are taken into consideration, and these are:
- Low load calculation table with SPORT function enabled
- High load calculation table with SPORT function enabled
- Reverse gear calculation table with SPORT function enabled

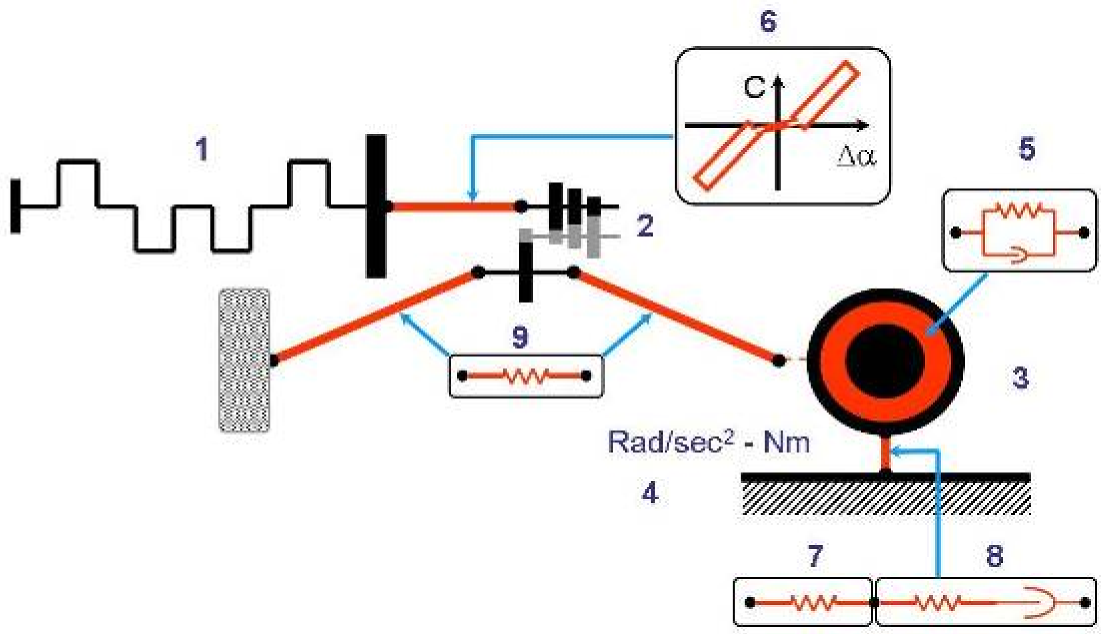
Driving torque evaluation

The torque requested is generated by the engine and transmitted to the wheel through the transmission kinematic chain (clutch, gearbox, half-shafts, etc.)

The engine/transmission assembly is consequently taken to be a system that inputs torque that is generated from the combustion of the air-petrol mixture, and outputs a series of kinematic values such as:

- The angular speed of the crankshaft and flywheel.
- The wheel angular speed and acceleration related proportionally to the longitudinal speed and acceleration.

Example of kinematic chain



Key

1. Engine
2. Gearbox
3. Hub
4. Vehicle inertia/asphalt
5. Tyre wall
6. Flexible coupling
7. Wheel blocks
8. Slips
9. Half shafts

Torque generation by the engine can be divided into two different modes:

- Rapid torque generation, only the spark advance changes.
- Slow torque generation, the throttle opening angle is changed.

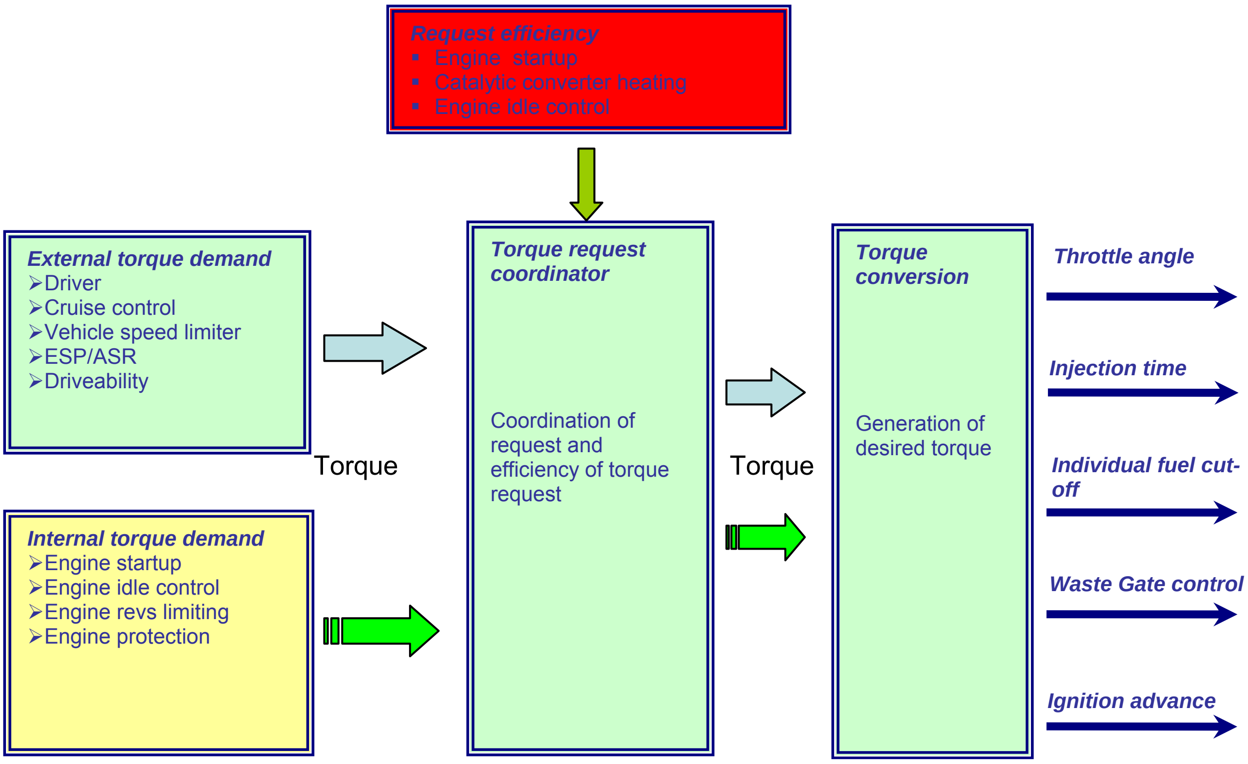
Note: the rapid torque control is generally activated first.

Torque generation immediately results in an increase in vehicle acceleration, which reaches the new steady operating value only after a series of oscillations that cause the user some discomfort (lengthwise shaking of the vehicle).

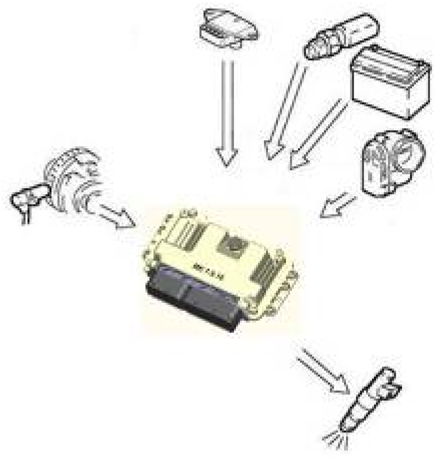
The aim of the “DRIVEABILITY” strategies is to reduce this lengthwise shaking, without however introducing excessive delay between the request for torque and its actual generation.

The system can be illustrated with a block diagram as in the figure given below, where a request for acceleration/deceleration from the user or from the functions inside the Engine Control Hub is first translated into a request for torque, and then into a rapid or slow torque request.
Once the rapid torque has been converted it will be translated into a spark advance value, whereas the slow torque will be used to define the throttle angle.
The estimated amount of air taken in permits the Engine Control Hub to calculate the amount of petrol, and consequently the injector opening time.

A model for engine torque management.



Injection time regulation



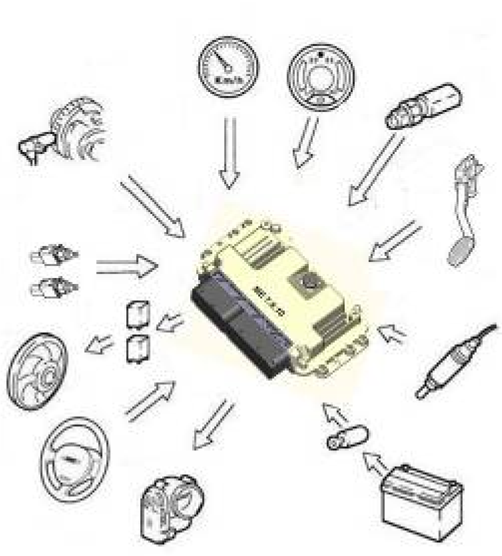
The Engine Control Hub calculates the opening time for the electro-injectors and commands them with great speed and accuracy according to the engine parameters – number of revs and air rate of flow – determined by the torque request. Since injection is sequential and timed for each cylinder, the “injection start” occurs at the optimal injection point, while the “end of injection” remains fixed.
The air rate of flow is calculated bearing in mind the following parameters.

- the pressure measured in the intake manifolds
- the air temperature in the intake manifolds

Plus the following information that is used to correct the air rate of flow calculation:

- Pressure measured by the turbo pressure sensor
- Environmental pressure measured by the sensor in the Engine Control Hub.

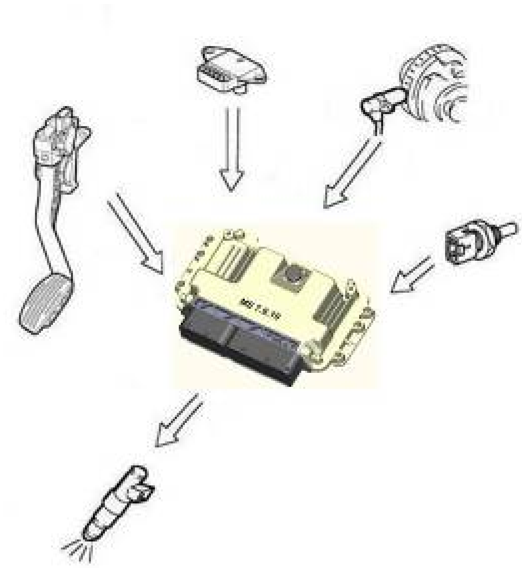
Engine idle speed control



The engine control hub recognises the engine idling condition through the “released” position of the accelerator pedal.
To control idle speed, the engine control hub, according to the utilities being used and the brake – clutch pedal signals, pilots the position of the motorised throttle valve.
The foreseen idle speed with engine warm is 750 ± 50 rpm.

Electrical balance
The Engine Control Hub actuates electrical balance strategies, considering battery load.
When the battery voltage is reduced with a derivative greater than a calibrated threshold, the target idle is increased (ramp).

Enrichment control in acceleration



In this phase the engine control hub adequately increases the quantity of fuel supplied to the engine (to obtain maximum torque) according to the signals arriving from the following components:

- Accelerator pedal potentiometer
- Revs and TDC sensor

The base injection time is multiplied by a coefficient according to:

- Engine coolant temperature, throttle aperture
- Pressure increase in the intake manifold

If the abrupt change in injection time is calculated when the injector is already closed, the engine control hub re-opens the injector (extra pulse) in order to compensate the titre with maximum rapidity. Successive injections will instead be increased on the basis of the aforementioned coefficients.

Note: in controlling ASR and ESP the Engine Control Hub has to reduce injection times and act on the throttle and ignition advance times.

Fuel cut-off on release (CUT-OFF)

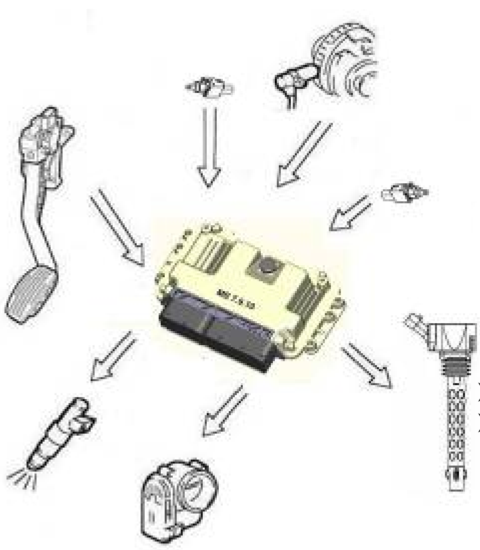
When the accelerator is released and beyond a certain predetermined engine speed threshold, the engine control hub:

- Cuts-off fuel to the injectors
- Reactivates fuel supply to the injectors at 1200 in 1st gear, and at 1000 rpm in the other gears both for 120 and 150 HP versions.

Without fuel, engine speed drops more or less rapidly according to vehicle travelling conditions.
Before reaching idle speed, engine deceleration is verified. If greater than a certain value, fuel supply is partially restored to provide a “gentle deceleration” down to idle speed.
The thresholds for reopening fuel supply and for fuel cut-off vary according to:

- Engine coolant temperature
- Vehicle speed
- Engine revs.

Vehicle driveability strategy



The driveability strategies include all the actions that the Engine Control Hub carries out in order to make the lengthwise shaking of the vehicle, caused during transients, more gentle and progressive, so that driving the vehicle becomes as pleasant as possible.

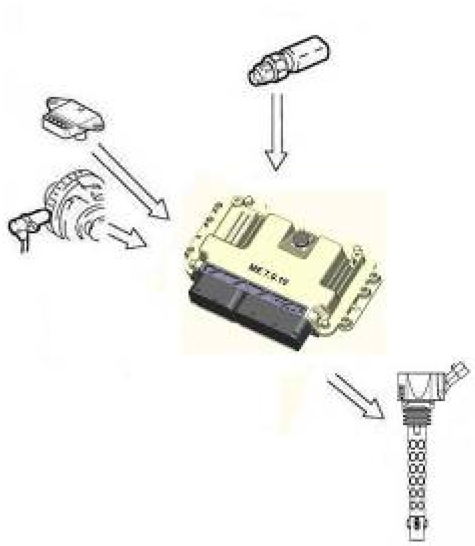
Note: in this case the term transients is intended to mean the accelerations and decelerations that may be more or less sharp due to the pressing of the acceleration pedal and the changes in gear.

The Engine Control Hub recognises the acceleration and deceleration transients through the following:

- The accelerator pedal sensor
- The clutch and brake pedal switches

It then intervenes on the management of the torque, and adapts it with the calculation modules called TIP-UP and TIP-DOWN.
Depending on the situation, the Engine Control Hub then sets a rapid torque control, which acts on the spark advances, and if this is not sufficient, a slow torque control that acts on the throttle opening and consequently on the injection times.

Ignition advance regulation

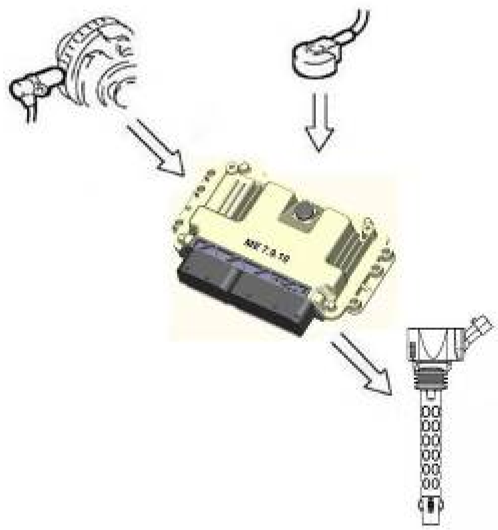


Through the map memorised in its internal memory, the engine control hub is able to calculate ignition advance according to:

- Engine load (idle, partial, full, according to revs and air flow-rate)
- Intake air temperature
- Engine coolant temperature.

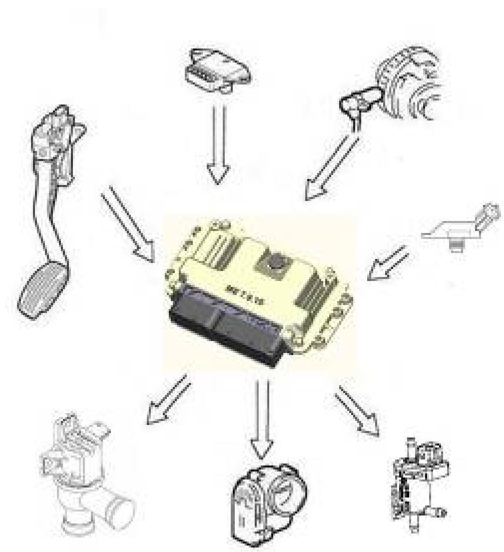
It is possible to selectively retard ignition at the cylinder requiring it, which is recognised by the combination of the value recorded by the rpm sensor and the "timing" data.

Pinging control



The engine control hub detects the presence of pinging (head knock) by processing the signal from the corresponding sensor.
The engine control hub continually compares the signals from the sensor with a threshold value, which is in turn continually updated to take account of background noise and engine ageing.
The engine control hub is thus able to detect the presence of pinging (or incipient pinging) in each individual cylinder, and reduces ignition advance for the cylinder concerned (in 3° steps up to a maximum of 6°) until this phenomenon ceases. Afterwards, ignition advance is gradually restored up to the base value (in 0.8° steps)
In acceleration, a higher threshold is applied, to take account of the increased noise of the engine in these conditions.
The pinging control logic is also provided with a self-adapting function, which memorises the reductions to the advance that should be continually repeated, such as to adapt the map to the various conditions the motor finds itself in.

Turbocharge control



Turbo pressure control
The control unit directly control engine torque, considering turbocharging as well, directly piloting the waste-gate actuator on the turbocompressor group so as to reach an mapped target pressure in the intake ducts, based on:

- engine point
- atmospheric pressure
- turbo pressure

In particular, when the desired boost pressure exceeds a calculated threshold, the ECH begins to modulate the flow of exhaust gas on the turbine through the waste gate. In this way a negative feedback action is introduced that assures system stability (intrinsically unstable). Based on the required boost pressure, the power necessary for the compressor to achieve it is calculated. This power has to be delivered by the turbine. The exhaust gas flow is modulated to assure that power is reached.

Dump valve control
In systems with turbocompressor, when the throttle is suddenly closed, overpressure is generated in the ducts upstream of the throttle, that tend to slow the compressor impeller and cause strong vibration and noise.
The dump valve recirculates the air from downstream to upstream of the compressor, reducing pressure in the duct. The engine control hub directly controls duct pressure, commanding the dump valve actuator according to:

- Engine point
- Atmospheric pressure
- Turbo pressure

Normal / Sport (overboost) control (150 HP version only)

Pressing the Normal/Sport button, in addition to changing the power steering settings, softer at low speed and harder at high speed, the Overboost function is also enabled.
The Normal/Sport button is connected by a discrete line to the Power Steering Hub, so the Sport and normal state information is rendered available to the ECH via C-CAN network.
To control the Overboost function, the ECH mainly considers the position of the accelerator pedal and acts consequentially on the waste gate electrovalve, regulating turbocompressor pressure and acting on the aperture logic of the motorised throttle valve.
The following are the salient features of the Normal and Sport functions

Normal mode enabled

- Maximum torque 206 Nm
- Maximum power 150 HP
- Driveability strategy “Soft”
- Limited fuel consumption for high engine loads

Sport mode enabled

- Maximum torque 230 Nm
- Maximum power 150 HP
- Sports driving strategy
- Higher consumption at high engine loads

Overboost specifications

The overboost is set for a maximum torque increase up to 230 Nm.
The overboost conditions (sport button) are defined by the position of the accelerator pedal, (torque request from user), equal to the maximum value for a maximum time of 80s,

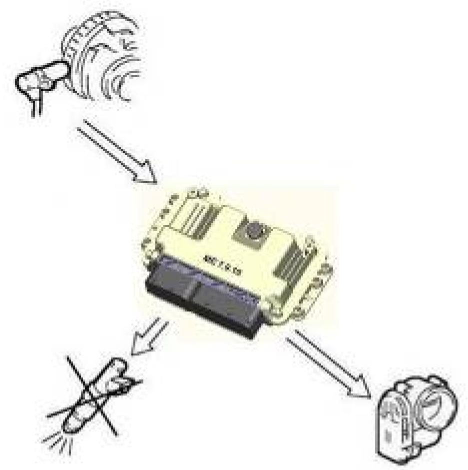
Note: overboost should not be taken to mean a pressure that damages the turbine, but as the possibility to have a pressure greater than the maximum at that moment.

Turbo pressure recovery

If the difference between the target pressure and the pressure measured is greater than 200 mbar during the increase in turbo pressure in the acceleration transients, then the throttle is closed.
If there is an error on the accelerator pedal or on the throttle actuator, the turbo pressure is limited.

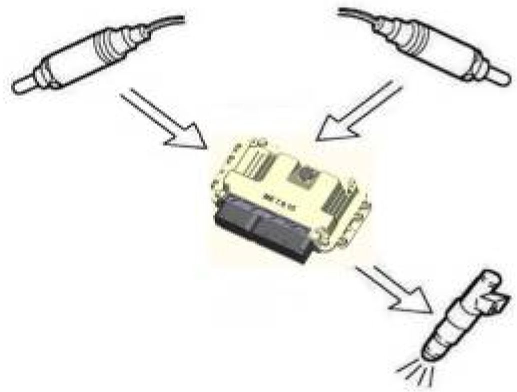
To protect the turbine, the Engine Control Hub checks the temperature of the exhaust gases against a mapped calculation model, since an excessive increase in the temperature could damage it.

Engine speed limiter



The control unit controls the maximum engine speed, limiting engine torque
First the Engine Control Hub cuts fuel by changing injection times.
If this is not sufficient, the Engine Control Hub closes the throttle valve.
The maximum engine speed for the 120 HP version is 6350 rpm, whereas for the 150 HP version it is 6500 rpm.

Combustion control – Lambda probe

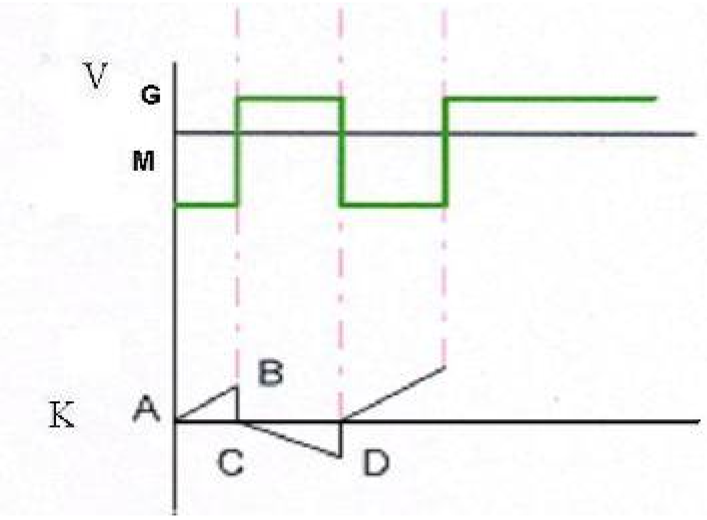


In EOBD systems the lambda probes, which are all of the same type, are installed upstream and downstream of the catalytic converter.
The pre-converter probe determines control of the titre denominated 1st loop (closed loop of upstream probe).
The post-converter probe is used to diagnose the converter itself and to fine tune the control parameters of the 1st loop.
In this context the adaptiveness of the second loop serves to recover both production dispersion and the hysteresis derived from the response of the pre-converter probe due to ageing and pollutant build-up.
This control is referred to as 2nd loop control (closed loop of post catalytic converter probe).

The check on the first loop is enabled when the upstream lambda probe is able to provide a reliable signal, which occurs some time after the engine has been started.
Probe activation time depends on the initial engine temperature.
The second loop check is enabled after much longer than the first loop, for example:
if the first loop check occurs 80 seconds after engine startup, the second loop check will take place after 450 seconds.

Note: the probe voltage downstream is about 630mV and is constant (if it begins to oscillate it means that the catalytic converter has deteriorated).

Fuel injection time correction strategy.

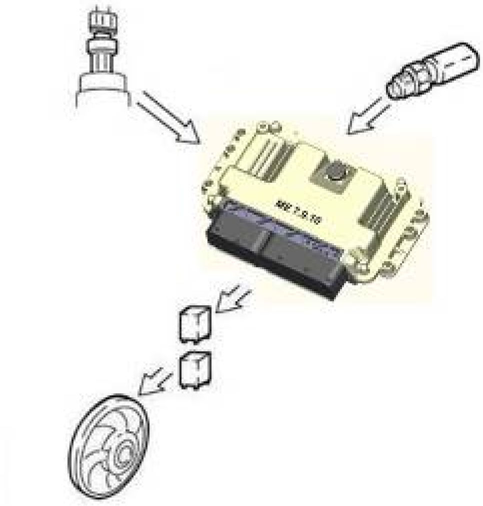


Calculation of the K correction parameter of the fuel injection time.

Key
V lambda probe voltage
G rich range
M lean range
K correction parameter
A;B;C;D variation points
In order to reduce pollutant emissions, the Air/Fuel ratio of the mixture feeding the engine is controlled by a parameter called K, which alters the fuel injection time.
This parameter is calculated using a suitable algorithm by a control unit that only takes into consideration the rich/lean and lean/rich changes in the probe voltage.
This control strategy then produces an alternative probe voltage pattern.
The calculation strategy of the K parameter is a compromise between the need to keep the strength variation less than 3% and the need to obtain a high oscillation frequency in the probe voltage. Frequencies of about 2 Hz in fact are obtained due to the fact that the strength is varied by more than 3% in the attempt to obtain better results.

Note: positioning the probe as close as possible to the combustion chamber results in a better oscillation frequency for the probe voltage.
Note: the Engine Control Hub runs the diagnosis on the lambda probe on the basis of the lambda voltage, lean rich peak value, and rise time and fall time switching.

Radiator cooling fan control

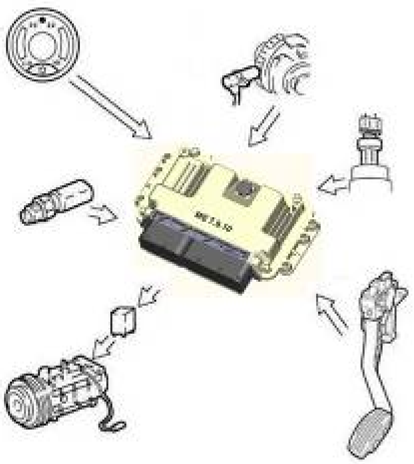


The Engine Control Hub commands activation of the radiator fan according to coolant temperature:

- Fan speed 1 activation at 97°C with hysterisis of about 5°C
- Fan speed 2 activation at 102°C with hysterisis of about 5°C

There is then a further control (linear pressure sensor signal) that activates the fan at speed 1 or speed 2, according to the coolant gas pressure with the conditioning system on.
In the absence of the coolant fluid temperature signal, the control unit actuates recovery by activating fan speed 2 until the error is eliminated.

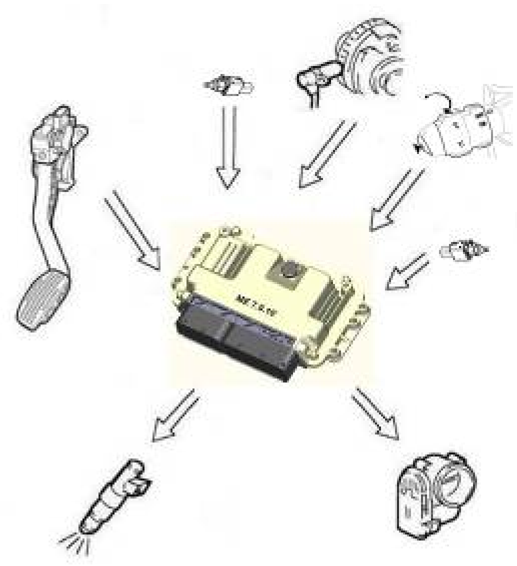
Connection with the air-conditioning system



The air conditioner is always managed together with the torque control. The user-requested torque is added to the conditionr-requested torque and if the result is less than a threshold set in relation to the engine revs, conditioner operation is enabled. If however the result is greater than a threshold set in relation to the engine revs and the speed is less than a minimum of 10 kph, then conditioner operation is disabled.
The engine control hub momentarily interrupts power to the compressor:

- During starting
- Deactivating it with engine temperature > 115°C and is reactivating with a hysterisis of 5.3°C
- During pick-up with accelerator pressed fully down.

Cruise Control



The cruise control system is entirely managed by the Engine Control Hub in the following modes.
Note: vehicle speed information is obtained from the C-CAN network.

Memorising a chosen speed
To enable Cruise Control, proceed as follows:
Turn the two-position ring switch to ON;
Bring the vehicle to the required speed; note that Cruise Control can only be enabled for speeds over 40 kph. It is advisable to enable it in 4th gear or upwards and in road conditions that allow the speed to be safely maintained.
Push the control stick upward to increase speed (stick with automatic return spring, not stable)
Release the accelerator pedal and allow the system to run the vehicle;
On the instrument panel, the warning light lights steady according to the signal from the Engine Control Hub, through the CAN network, indicating Cruise Control state. The warning light goes out when the system disables cruise control.

Changing a speed setting
Proceed as follows to change speed settings:

Speed increase:
Push the stick upwards. This generates an acceleration ramp with constant programmable gradient;
On releasing the lever (automatic return), the system maintains and memorises the new speed reached by the vehicle.
Sped reduction:
Push the lever downwards. Having reach the required speed, release the stick and the system will maintain the vehicle at the new speed.
The Cruise Control can function throughout the entire range of possible engine speeds.

Resume button
By pressing the corresponding button, this function returns the vehicle to the last memorised speed, if for particular conditions (example, pressing brake or clutch pedals) the cruise control has been disabled.

Disattivazione del cruise control
Disabling cruise control
Cruise Control can be disabled by the driver by:
- turning the ring switch to OFF
- switching off engine;
- pressing the brake or clutch pedal (in these cases the last speed reached is saved, and can be resumed by pressing the resume button)
- vehicle speed lower than allowed (approx 40 kph) or greater than permitted maximum;

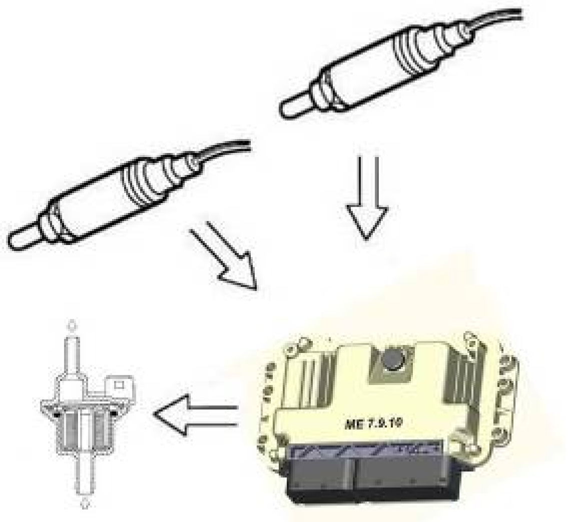
If the stick is used without the clutch pedal, coherence is lost between engine revs and vehicle speed. In all these cases pressing the resume button will enable the system again.
Pressing the accelerator with Cruise Control enabled: pressing the accelerator (example, overtaking) the Cruise Control permits a temporary increase in speed since it disables itself temporarily, but as soon as the accelerator pedal is released the system resumes the set speed.
Recognition of the gear engaged is achieved through comparison of vehicle speed and engine speed with clutch engaged.
Cruise Control is automatically disabled if:

- acceleration is greater than calibrated maximum (example, rapid descent);
- deceleration greater than set maximum (using gear lever without clutch pedal).

The system in any case disables cruise control automatically if any signals used by cruise control logic are incorrect due to component faults:

- vehicle speed sensor;
- accelerator pedal potentiometer;
- brake switch plausibility;
- clutch switch plausibility;
- Cruise switch and Resume button plausibility;
- Cruise switch plausibility and position of speed increase or decrease stick.

Emissions control system



The emissions control system includes devices designed to reduce toxic emissions into the atmosphere.
The major pollutant emissions caused by the vehicle are:

- Exhaust emissions
- Vapour/gas emissions from the engine block
- Fuel vapour emissions from the fuel supply circuit

Exhaust emissions are limited by means of a trivalent catalytic converter, managed by two Lambda probes, the upstream one for obtaining the optimal stoichiometric ratios to improve catalyser performance, and the downstream one to control efficiency, (see EOBD strategies).

To ensure that the catalytic converter functions correctly for a long time, the Engine Control Hub checks the temperature of the exhaust gases using a mapped calculation model.

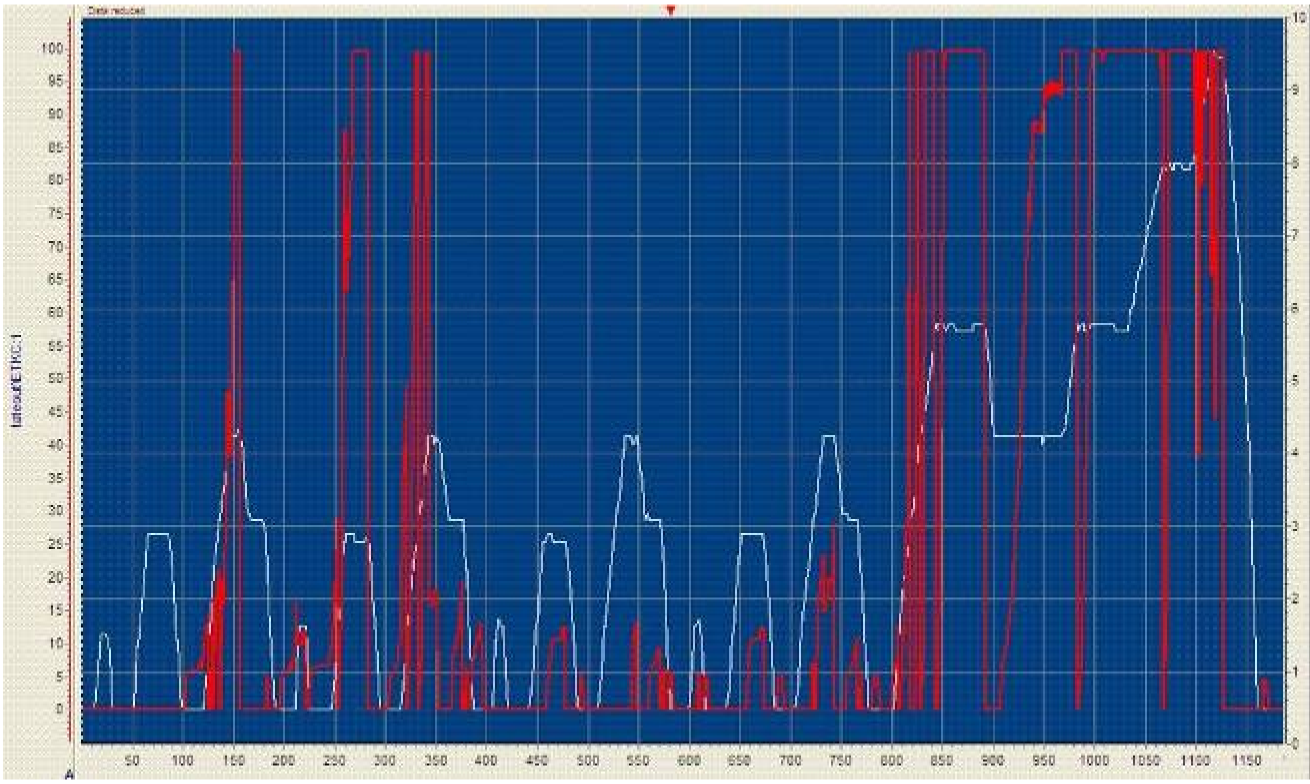
The crankcase vapour/gas emissions are controlled by the vapour recovery system
Note: system not controlled by the Engine Control Hub.
Fuel vapour emissions from the supply circuit are managed by the antievaporation system, a system fitted with an electrovalve controlled by the Engine Control Hub.
The canister valve is used to wash the active carbon filter to prevent it becoming saturated and sending the hydrocarbons (fuel vapours) that form in the tank, into the atmosphere, especially when the outside temperature is high or during shaking of the vehicle.
When the valve opens, it uses the vacuum in the intake manifold to draw in fresh air from the outside through the filter, collect the petrol vapours and take them to the intake manifold where they are aspirated by the engine.
This operation results in a variation of the mixture strength that is compensated for by the control unit (mixture strength control).
The adaptive parameters are deactivated during canister washing.
CANISTER washing takes place under the following conditions:

- At idle: washing takes place periodically.
- Under certain engine conditions, with throttle partially open

The NEDC areas have been used as an example of operation with throttle partially open.

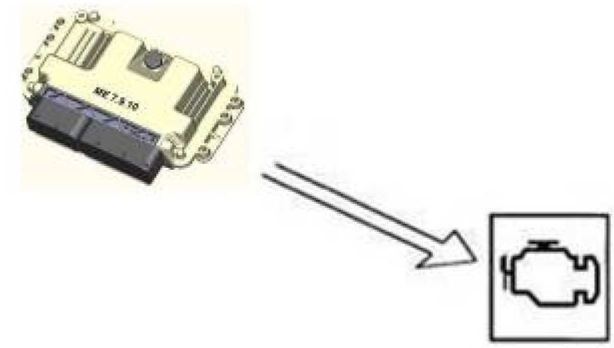
- On the third ramp of the 1st urban sub-cycle
- On the second and third ramp of the 2nd urban sub-cycle
- Pratically for the whole EUDC cycle

Washing is inhibited during gearchanges and cut-off for the whole cycle.



The figure shows acquisition of the “canister valve target opening “ variable (in red) on a NEDC cycle. The “vehicle speed” (white variable) is also shown to identify the cycle areas.
More consistent washing obviously occurs with valve opening at 100%.

Self-diagnosis and recovery



The engine control hub self diagnosis system controls the correct function of the system and indicates any faults by means of a warning light (mil) on the control panel, with European standard colour and ideogram. This warning light indicates both engine control faults and problems detected by the EOBD diagnosis strategies.
The functional logic of the warning light (mil) is as follows.
With key to RUN the light comes on and remains on until the engine effectively starts. The engine control hub self-diagnosis system checks the signals from the sensors comparing them with the permitted limit values.

Engine starting fault indications:

- if the warning light does not go out after starting the engine, this indicates presence of a fault memorised in the engine control hub
- Fault indications during operation:
- flashing light indicates possible damage to the catalytic converter due to misfiring.
- light on steady indicates presence of engine management faults or EOBD diagnosed faults.
- the engine control hub defines the type of recovery for each fault, according to which component is faulty.

The recovery parameters are managed by the components still functioning correctly.
The recovery strategies that can be actuated by the Engine Control Hub are:

- Limp home after throttle body error
- Limp home after accelerator pedal error
- Turbocharge:
  - ✓During turbo pressure increase in acceleration transients if the difference (target)-(read)>200mbar the throttle closes.
  - ✓If there is an accelerator pedal or throttle actuator error turbo pressure is limited.

EOBD Controls

Since 1970, in Europe there has been a standard for autovehicle emissions (EC Directive 70/220) which over the course of the years has undergone repeated updating, the most recent being in October 1998 (EC directive 98/69).
Directive EC 98/69 has established the initial requirements for approving EOBD systems, defining EOBD as a system as an electronic on board diagnosis system for emissions control, capable of identifying the zone in which a fault has probably occurred, by means of codes entered into the memory of a computer. The system includes a warning light on the instrument panel (called *Malfunction Indicator*, MI) which indicates to the driver the presence of faults that could cause the vehicle to produce a greater quantity of pollutant emissions than permitted by law.
According to the standard, this system must undergo a series of approval tests by the authorities, along with tests on those installed on vehicles in current use, sampled by the approval authority.
For approval purposes, the vehicle with a representative age of 80,000 km, undergoes a test to verify average carbon monoxide (CO), unburned hydrocarbon (HC) and nitrogen oxide (Nox) emissions. The test, conducted in the laboratory on dynamometric benches, consists of executing a standard running cycle (NEDC cycle).
European standards require that the EOBD system carries out at least four diagnoses on the engine subsystems with a direct impact on emissions:

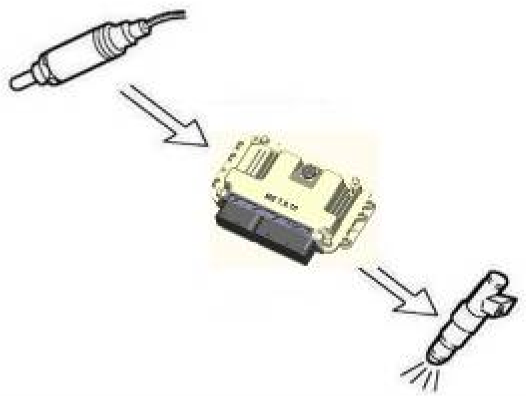
- Fuel supply system (*fuel system diagnosis*)
- Lambda probe diagnosis
- Catalytic converter diagnosis

- Diagnosis of irregular ignition (misfire diagnosis) that prevents correct converter function, in extreme cases leading to irreversible damage.

In detail:

- Fuel system diagnosis serves to detect any malfunctions in the fuel supply line.
- Lambda probe diagnosis to reveal the behaviour of the probes upstream and downstream of the converter, by comparison with certain quantities and corresponding thresholds.
- Converter diagnosis serves to measure the degradation of the converter through indirect measurement of its capacity to store oxygen.
- Misfire analysis serves to detect misfiring with destructive effect on catalytic converter and non-destructive effect, but that lead to high pollutant emissions.

System self-adaptation



The engine control hub is equipped with a self-adapting function that serves to recognise changes that take place in the engine due to settlement over time and ageing both of the components and the engine as a whole.
These changes are memorised in the form of modifications to the base maps, and serve to adapt system function to the progressive alteration of the engine and its components with respect to their characteristics when new.
The self-adapting function also allows the engine to compensate for inevitable differences (due to production tolerance) in any substituted components.
From analysing the exhaust gas, the engine control hub modifies the base map with respect to the characteristics of the engine as new.

In detail, the Engine Control Hub implements the following self-adaptation strategies:

- Multiplicative coefficient of the mixture strength control (FRA). It takes into account the variations in the mixture strength related to the derivatives of the probes, injectors and intake manifold (seepage). It updates itself during vehicle operation (when the strength control is active).
- Additive coefficient of mixture strength control (ORA). Corrects any leaks from the injectors. It updates itself at idle.

The self-adapting parameters are not cancelled if the battery is disconnected.

Electronic diagnosis

Introduction
This chapter contains lists of the parameters and corresponding helps (if available), the list of errors with corresponding DTC codes and MIL warning lights activation modes, and the list of active diagnoses with corresponding helps available in the Examiner diagnosis.

Description	Unit of easurement/ Status value
ODOMETER Indicates the kilometres travelled by the vehicle.	Km
NUMBER OF OUT OF REVS Indicates the number of times the engine has gone out of revs.	-
MAX OPER. CONDIT. TIME COUNTER: Indicates for how long the engine has run at maximum speed	msec
MAXIMUM ENGINE SPEED	Rpm
NUMBER OF PROGRAMMINGS Indicates the number of times the control unit has been programmed	-
ODOMETER LAST PROGRAMMING Indicates the kilometres when the control unit was last programmed.	Km
ENGINE REVS Indicates the engine rotation speed	Rpm
TEMPERATURA ACQUA Indicates the temperature of the engine coolant.	Deg./Cent
AIR TEMPERATURE Indicates the temperature of the air taken into the intake manifold.	Deg./Cent
SPARK ADVANCE Indicates the advance value assigned by the control unit, therefore the mechanical keying value is not taken into consideration	Deg./Ang.
INJECTION TIME Indicates the opening time of the injector or injectors	Msec
ENGINE LOAD Indicates in % the volumetric engine load (independently from engine displacement and number of cylinders)	%
THROTTLE ANGLE Indicates the angular position of the motorised throttle	%
AIR RATE OF FLOW Indicates the amount of air taken in by the engine.	Kg/h
BATTERY VOLTAGE Indicates the value of the control unit power supply voltage	Volt
VEHICLE SPEED (from CAN) Is the vehicle speed coming from the ABS control unit through CAN line	Kph
LAMBDA 1 VOLTAGE UPSTREAM OF CAT. Help not available	mv
LAMBDA 1 VOLTAGE DOWNSTREAM OF CAT. Help not available	mv
TARGET ENGINE IDLE REVS	Rpm

Description	Unit of easurement/ Status value
Indicates the engine revs calculated by the control unit to which the idle control refers.	
ANTI-EVAP. VALVE OPENING Indicates the opening percentage of the anti-evaporation valve.	%
ACCELERATOR POSIT. TRACK 1 Indicates the percentage value of the accelerator potentiometer signal track 1.	Volt
ACCELERATOR POSIT. TRACK 2 Indicates the percentage value of the accelerator potentiometer signal track 2.	Volt
ACCELERATOR PEDAL POSITION Indicates in percentage the position of the pedal measured by the potentiometer.	%
LAMBDA PROBE INTEGRATOR This is the correction made by the control unit on the amount of fuel needed to reach the correct air/petrol ratio.	-
AD/C EXHAUST GAS TEMPERATURE	mv
FACTOR BETWEEN (high loads)	-
FACTOR BETWEEN (low loads)	-
FACTOR BETWEEN 1 and 2 (CURRENT LOAD) Multiplication correction factor of the amount of petrol injected. Recovers the manufacturing tolerances of air flow meter/lambda probe/injectors	-
DTV 1 FACTOR Addition correction factor of the amount of petrol injected. Recovers the manufacturing tolerances of air flow meter/lambda probe/injectors when the engine is idling.	-
TURBO ACTUATOR COMMAND Indicates the % value of the Duty cycle of the Wastegate valve command	%
DTV 2 FACTOR Addition correction factor of the amount of petrol injected. Recovers the manufacturing tolerances of air flow meter/lambda probe/injectors when the engine is idling.	-
THROTTLE LEARN PHASE Indicates the point reached in the learn procedure of the throttle lower limit value. The value ranges between 0 and 7, and the learn procedure is complete when it reaches 7, otherwise it is not complete or has not taken place correctly.	-
INTAKE PRESSURE Indicates the pressure in the intake manifold	MBar
ATMOSPHERIC PRESSURE Indicates the value read by the pressure sensor.	Mbar
TURBO PRESSURE MEASURED Indicates the pressure read in the turbo pressure circuit.	MBar
TARGET TURBO PRESSURE Indicates the pressure value calculated by the control unit.	MBar
AD/C TURBO PRESSURE Is the voltage value read directly on the sensor.	MVolt
ENGINE TORQUE (MEASURED) No help available	%

Description	Unit of easurement/ Status value
ENGINE TORQUE (TARGET): Indicates the toreque requested by the control being examined by the engine control unit.	%
EXHAUST GAS TEMPERATURE	Deg./Cent
CLOSED THROTTLE AIR FLOW RATE The air flow rate through the air flow meter when the throttle is in the position of maximum mechanical closure.	Kg/h
END OF INJECTION ANGLE Help not available	Deg./Ang.
ECU SERIAL NUMBER	-
OVERBOOST COUNTER The amount of time in overpressure on values that are too high. Two thresholds are associated to the turbo, minimum and maximum. Once the minimum threshold has been exceeded, the turbo intervenes and the counter does not increase. Once the maximum threshold is exceeded the counter increases. If it remains for too long in OVERBOOST (over the max. threshold) the diagnosis strategies associated with the turbo intervene.	Minutes
ENGINE STARTUP Indicates whether the injection control unit permits engine startup	Allowed Not allowed
INJECTION CONTROL UNIT Indicates whether the injection control unit is programmed.	Programmed Not programmed
UNIVERSAL CODE	Received Not received Not enabled
DEDICATED LINE	Present Not present
SET CRUISE DEC.(-)	Requested Not requested
SET CRUISE ACC (+)	Requested Not requested
CRUISE SWITCH Can be 'On' or 'Off' and, when 'On', permits the cruising speed set by the driver to be maintained automatically.	ON Off
CRUISE RESTORE BUTTON (RCL)	Pressed Released
CRUISE CONTROL	Present Absent
REQUEST FROM CRUISE LEVER Indicates the request assumed by the cruise lever (No request, Cruise restore button (RCL), Set Cruise deceler (-),Set Cruise deceler (+)	No request Cruise restore button (RCL) Set Cruise deceler (-) Set Cruise deceler

Description	Unit of easurement/ Status value
	(+)
OIL PRESSURE SWITCH If 'ON' indicates that the oil pressure needed for engine operation has been reached	ON Off
TURBO VACUUM VALVE The vacuum valve located in the intake duct upstream of the throttle body. May be Active (open) or Not Active (closed).	Active Not active
SPEED GEAR USED Indicates the speed currently used by the gearbox. The states of 'Reverse' and 'Neutral' relate to vehicles with automatic gearbox	Neutral/None First/reverse Second Third Fourth Fifth Sixth Reverse
COOLING FAN 1 Indicates the fan is activated at low speed	Active Not active
COOLING FAN 2 Indicates the fan is activated at high speed.	Active Not active
PINGING CONTROL	Activated Deactivated
KEY POSITION Indicates the status of the key position.	Run Stop During startup
CLUTCH PEDAL Indicates the clutch pedal position.	Pressed Released
BRAKE PEDAL Indicates whether the brake pedal is 'Pressed' or ‘Released’	Pressed Pressed
CONDIT. ACTIVAT. REQUEST Indicates the request to activate the air conditioner compressor	Activated Deactivated
CONDITIONER COMPRESS. Indicates the status of the compressor command sent from the control unit.	Activated Deactivated
ENGINE STATUS Indicates the engine operating conditions.	Idle Out of idle
CUT-OFF STATUS Indicates the release condition in which the control unit triggers a fuel cut-off.	Activated Deactivated
ENGINE HEATING	Performed ==
STATUS LAMBDA 1 UPSTREAM CAT. Help not available	Closed Loop Open Loop

Description	Unit of easurement/ Status value
STATUS LAMBDA 2 UPSTREAM CAT. Help not available	Closed Loop Open Loop
CATALYTIC CONVERT. 1 HEATING The 'Active' status indicates that the functions to bring the catalytic converter quickly to operating temperature have been activated.	Active Not active
STATUS LAMBDA 1 DOWNSTREAM CAT. Help not available	Closed Loop Open Loop
STATUS LAMBDA 2 DOWNSTREAM CAT. Help not available	Closed Loop Open Loop
ANTI-EVAPORATION VALVE May be 'Active' or 'Not active' and when 'Active' it can recover the hydrocarbon vapours emitted from the tank.	Active Not active
CONTROL UNIT POWER SUPPLY.	Present Absent
ANTI-SKID (ASR)	Present Absent
CATALYTIC CONVERTER 1	Present Absent
THROTTLE LEARN RESULTS Indicates whether the self-learn procedure of the lower limit of the motorised throttle has been terminated correctly	Correct Not correct
THROTTLE LEARN May be 'Not allowed' when the conditions are not, '...in progress' and 'Terminated' (if it has been completed successfully).	Not allowed ..in progress Terminated
FUEL PUMP RELAY Indicates the activation status of the fuel pump relay	Active Not active
BRAKE HUB (NFR) The presence of ABS/VDC/ASR (only if connected by CAN) is 'LEARNT' by the reception of at least one message on CAN	Learnt Not learnt
TYPE OF CRUISE PRESENT Indicates the type of cruise used on the vehicle. The status 'None' may only occur when the vehicle is not fitted with cruise control.	None Cruise control Adaptive (ACC)
AIR CONDITIONER CLIMATE CONTROL Is automatically 'LEARNT' by the control unit at the activation of the climate control	Learnt Not learnt
TYPE OF GEARBOX PRESENT Indicates the type of gearbox used on the vehicle. The 'Not plausible' status may only occur after the ECU is exchanged on vehicles with different types of gearbox, manual and selespeed	Automatic Manual Selespeed Not learnt

DTC	Description	Description	W.lamp
P0016	Camshaft Assembly	Above the upper limit	ON1
		Below the lower limit	
P0033	Turbo vacuum valve	S.C. to +VBatt.	ON?
		S.C. to Ground	
		Circuit open	
P0039	Turbo vacuum valve	Signal not valid	ON1
P0105	Intake pressure sensor	O.C. or S.C. to +VBatt.	ON1
		S.C. to Ground	
P0106	Plausibility with pressure sensor	Above the upper limit	ON1
		Below the lower limit	
		Circuit open	
		Signal not valid	
P0110	Air temperature sensor	S.C. to Ground	ON3
		O.C. or S.C. to +5 Volt	
P0115	Water temperature sensor	S.C. to Ground	ON1
		S.C. to +VBatt./5V	
		Signal not valid	
P0120	Accelerator pedal potentiometer 1	O.C. sensor ground/S.C. to +Vbatt or 5V	ON1
		O.C., S.C. to Ground or S.C. to +VBatt	ON1
		S.C. bet. signals of two potent.	
P0121	Throttle potentiometer track 1	O.C., S.C. to Ground or S.C. to +VBatt	ON1
		S.C. to Ground / O.C.	
		Signal not valid	
P0130	Lambda 1 signal upstream	S.C. to +VBatt.	ON3
		Below the lower limit	
		Circuit open	
		S.C. to +VBatt.or S.C. bet. poles	
P0133	Lambda 1 signal upstream (slow)	Above the upper limit	ON3
		Below the lower limit	
P0135	Preheating resistance 1 upstream	S.C. to +VBatt.	ON3
		S.C. to Ground	
		Circuit open	
P0136	Lambda 1 signal downstream	S.C. to +VBatt.	ON3
		Below the lower limit	
		Circuit open	
		S.C. to Ground	
P0139	Lambda 1 signal downstream (slow)	S.C. to Ground	ON3
		S.C. to +VBatt.	
		S.C. to +VBatt.	
P0141	Preheating resistance 1 downstream	S.C. to +VBatt.	ON3
		S.C. to Ground	

DTC	Description	Description	W.lamp
		Circuit open	
P0201	Injector cylinder 1	S.C. to +VBatt.	0N1
		S.C. to Ground	
		Circuit open	
P0202	Injector cylinder 2	S.C. to +VBatt.	ON1
		S.C. to Ground	
		Circuit open	
P0203	Injector cylinder 3	S.C. to +VBatt.	ON1
		S.C. to Ground	
		Circuit open	
P0204	Injector cylinder 4	S.C. to +VBatt.	ON1
		S.C. to Ground	
		Circuit open	
P0220	Potentiometer 2 accelerator pedal	O.C. sensor ground/S.C. to +Vbatt or 5V	ON1
		O.C., S.C. to Ground or S.C. to +VBatt	
P0221	Throttle potentiometer track 2	O.C./S.C. to +Vbatt/5V	ON1
		S.C. to Ground / O.C.	
P0230	Fuel pump relay	O.C. or S.C. to +VBatt.	ON1
		S.C. to Ground or final stages overheated	
P0235	Turbo pressure sensor	O.C. or S.C. to +VBatt.	ON3
		S.C. to Ground	
P0236	Turbo pressure difference	Above the upper limit	ON3
		Below the lower limit	
		No signal	
		Signal not valid	
P0240	Turbo pressure	Above the upper limit	ON1
		Below the lower limit	
P0243	Overboost solenoid	Above the upper limit	ON1
		Below the lower limit	
		Signal not valid	
P0300	Misfiring (generic)	Danger of catal. overheating	ON3
		Influence on emission values	
P0301	Misfiring cyl.1	Danger of catal. overheating	ON3 Blink
		Influence on emission values	
P0302	Misfiring cyl.2	Danger of catal. overheating	ON3 Blink
		Influence on emission values	
P0303	Misfiring cyl.3	Danger of catal. overheating	ON3 Blink
		Influence on emission values	
P0304	Misfiring cyl.4	Danger of catal. overheating	ON3 Blink
		Influence on emission values	
P0325	Knock control 1	Above the upper limit	OFF
		O.C. or S.C.	

DTC	Description	Description	W.lamp
P0335	Revs sensor	O.C., S.C. to Ground or S.C. to +VBatt	ON1
P0336	Revs sensor (phonic wheel)	Signal not valid	ON1
P0340	Timing sensor	O.C. or S.C. to +VBatt.	ON1
		S.C. to Ground	
		No signal	
		Signal not valid	
P0420	Catalytic converter 1	Above the upper limit	ON3
P0443	Anti-evaporation valve piloting.	S.C. to +VBatt.	ON3
		S.C. to Ground	
		Circuit open	
P0460	Fuel level sensor	Signal not valid	ON3
P0480	Fan 1 relay	S.C. to +VBatt.	OFF
		S.C. to Ground	
		Circuit open	
P0481	Fan 2 relay	S.C. to +VBatt.	OFF
		S.C. to Ground	
		Circuit open	
P0500	Vehicle speed sensor	No signal	ON3
P0505	Idle control	Above the upper limit	ON3
		Below the lower limit	
P0520	Oil pressure switch	O.C. or S.C. to +VBatt.	OFF
P0530	Conditioner pressure sensor	S.C. to +VBatt.	OFF
		S.C. to Ground / O.C.	
P0560	Battery Voltage	Above the upper limit	ON3
		Below the lower limit	
		Signal not valid	
P0564	Cruise control lever	Above the upper limit	OFF
		Below the lower limit	
		No signal	
		Signal not valid	
P0571	Brake switch	O.C., S.C. to Ground or S.C. to +VBatt	OFF
P0576	Cruise control	Signal not valid	OFF
P0579	Cruise activat. commands	Above the upper limit	OFF
		Signal not valid	
P0601	Control Unit Failure (EEPROM memory)	Signal not valid	ON1
P0604	Control Unit Failure (RAM memory)	Signal not valid	ON1
P0605	Control Unit Failure (ROM memory)	Signal not valid	ON1
P0606	Control Unit Failure (microprocessor)	Signal not valid	ON1
P0638	Motorised throttle (circuit)	Signal not valid	ON1
P0645	Conditioner compres. Relay	S.C. to +VBatt.	OFF
		S.C. to Ground	

DTC	Description	Description	W.lamp
		Circuit open	
P0685	Main relay	Circuit open	ON1
		Signal not valid	
P0704	Clutch switch	O.C., S.C. to Ground or S.C. to +VBatt	OFF
P1135	Preheating resistance 1 upstream	O.C. or S.C.	ON3
P1141	Preheating resistance 1 downstream	O.C. or S.C.	ON3
P1171	Mixture strength 1 (additive)	Above the upper limit	ON3
		Below the lower limit	
P1172	Mixture strength 1 (multiplication)	Above the upper limit	ON3
		Below the lower limit	
P1226	Accelerator pedal movement	Signal not valid	ON1
P1302	Type of gearbox recognition	To be performed	ON / OFF
		Signal not plausible	
P1336	Torque control (request)	Above the upper limit	ON1
P1337	Torque control (comparison)	Signal not valid	ON1
P1680	Motorised throttle (spring)	Above the upper limit	ON1
		Circuit open	
P1682	Motorised throttle	Signal not valid	ON1
P1683	Motorised throttle (recovery)	Signal not valid	ON1
P1684	Motorised throttle (plausibility)	Above the upper limit	ON1
		Below the lower limit	
P1685	Motorised throttle (no learn)	Signal not valid	ON1
P1686	Motorised throttle (1st learn idle)	Signal not valid	ON1
P1687	Motorised throttle (stop learn)	Above the upper limit	ON1
		Below the lower limit	
P1688	Motorised throttle (2nd learn idle)	Signal not valid	ON1
P1689	Throttle piloting (self-compensat.)	Signal not valid	ON1
P1690	Safety cut-off	Signal not valid	ON1
P1692	Safety cut-off (for pedal potent.)	Signal not valid	ON1
P1693	Safety cut-off (for revs sensor)	Signal not valid	ON1
P1694	Safety cut-off (for engine load)	Signal not valid	ON1
P1696	Safety cut-off	Above the upper limit	ON1
		Below the lower limit	
		No signal	
P1697	Safety cut-off	Signal not valid	ON1
P1703	Engine switch-off from robotised gearbox	No signal	OFF
P2226	Atmospheric pressure signal	Above the upper limit	ON3
		Circuit open	
P2227	Atmospheric pressure sensor	Above the upper limit	ON3

DTC	Description	Description	W.lamp
		Below the lower limit	
		Signal not valid	
U0426	Electronic key	Key code incorrect	OFF
		Unknown code	
		Cde not received	
		Not programmed	
U1601	CAN Network	Mute	ON3
		Bus off	
U1700	CAN Network (NCM – NBC)	No signal (hub absent)	OFF
		Signal not valid	
U1706	CAN Network (NCM – NFR)	No signal (hub absent)	ON3
		Signal not valid	
D1711	CAN Network (NCM - NCR)	No signal (hub absent)	OFF
		Signal not valid	

List of active diagnoses

CODE CARD STARTUP

Can be used, with the vehicle Code Code, to start the engine if the Key or the Electronic Key Control Unit/Body Computer is faulty (if present).

Remember that if the key is turned to STOP the procedure must be repeated using the Code Card.

FAN 1 RELAY

The cooling fan is driven at low speed for a few seconds.

FAN 2 RELAY

The cooling fan is driven at high speed for a few seconds.

CONDIT. RELAY COMMAND

You should hear the CONDITIONER COMPRES. RELAY tick for 10 seconds.

FUEL PUMP RELAY COMMAND

You should hear the fuel pump relay tick for about 10 seconds.

FAILURE LAMP COMMAND

You should see the failure lamp flash for about 10 seconds

WARNING: this component is connected to the engine control unit via the CAN line and therefore is considered remote. Correct activation does not necessarily mean that the active diagnosis will be carried out as activation is actually carried out by the remote control unit.

MOTORISED THROTTLE

You should hear the motorised throttle tick for about 10 seconds.

INJECTOR 1

You should hear the injector tick for about 10 seconds.

INJECTOR 2

You should hear the injector tick for about 10 seconds.

INJECTOR 3

You should hear the injector tick for about 10 seconds.

INJECTOR 4

You should hear the injector tick for about 10 seconds.

WASTEGATE SOLENOID The wastegate solenoid is driven
TURBO VACUUM VALVE You should hear the valve tick.
LAMBDA 1 HEATER UPSTREAM The heating element positioned inside the lambda probe is driven
LAMBDA 1 HEATER DOWNSTREAM The heating element positioned inside the lambda probe is driven
ANTI-EVAPORATION VALVE You should hear the anti-evaporation valve tick for about 10 sections.

List of resettings

RESETTING OF SELF-LEARNT FUNCTIONS This command resets the parameters relating to the self-learnt functions (climate control and cruise control) in the control unit. WARNING: This command must only be used to restore the control units exchanged between vehicles with different functions. Following the resetting of the self-learnt functions, the state of the parameters (available in the selection list) will be updated as follows:\n- the presence of the conditioner and the cruise control is learnt automatically when they are activated.\n- the presence of ABS/VDC/ASR (only if connected by CAN) and Selespeed is learnt when at least one message is received on CAN.\n- the presence of the ‘Manual’ type of gearbox is learnt when the clutch pedal changes from 'Released' to 'Pressed'\r\n
AZZERAMENTO CONTATORE OVERBOOST This command is used to reset the Overboost counter. It should only be used if the turbo compressor is replaced.
AZZERAMENTO PARAMETRI AUTOADATTATIVI When the self-adaptive parameters are reset, the factory-set values are restored in the control unit maps. WARNING: after resetting the self-adaptive parameters, carrying out operations in the workshop with the battery disconnected or control unit reprogramming, remember to run the climate control learn procedure (key on run with climate control enabled for 1 minute) to avoid the active diagnoses ‘Fan 2 relay’ and ‘Conditioner compressor relay’ giving ‘Function not available’.

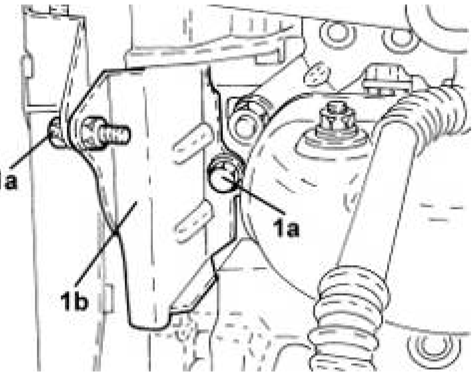
Procedure

Introduction

This chapter presents the repair procedures given in the technical manuals 1004 E10 and 1004E20.

1004E10 **ENGINE, DETACHED – DETACHMENT OF HEAD/AND CYLINDERS AND OIL SUMP FOR INSPECTION – INCLUDES PLACING ON STAND AND REMOVAL**

1. Unscrew the screws (1a) and remove the protection inside the valve train drive belt (1b).

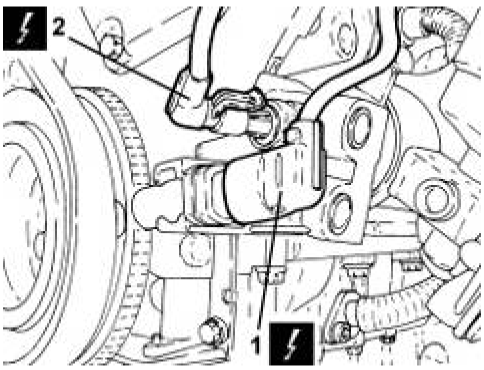


1. Electrically disconnect the engine revs sensor.

	Name	Connector
1	Revs sensor	See K046 REVS SENSOR

2. Electrically disconnect the engine oil minimum pressure switch.

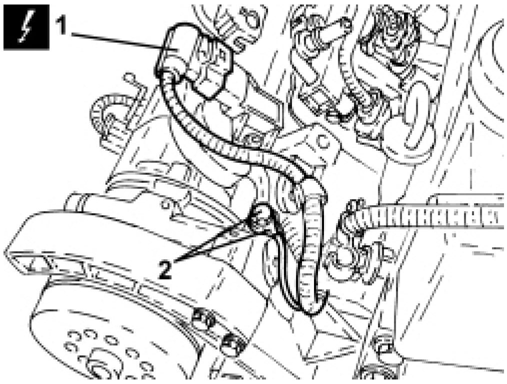
	Name	Connector
2	Engine oil pressure sensor (switch)	See K030 ENGINE OIL PRESSURE SENSOR (SWITCH)



1. Electrically disconnect the air temperature and pressure sensor.

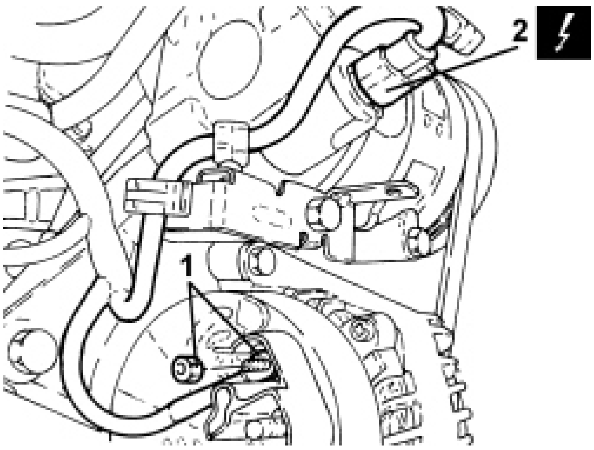
	Name	Connector
1	Air temperature/pressure sensor	See K044 AIR TEMPERATURE/PRESSURE SENSOR

2. Unscrew the screw and remove the ground cable from the auxiliaries support.



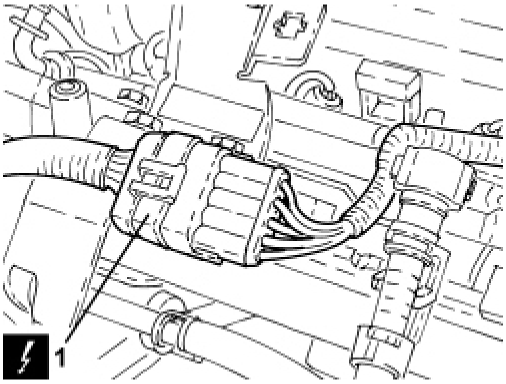
1. Unscrew the nut and remove the alternator ground cable.
2. Electrically disconnect the air conditioning compressor.

	Name	Connector
2	Conditioner compressor enable solenoid	See L021 CONDITIONER COMPRESSOR ENABLE SOLENOID



1. Disconnect the injectors wiring connection.

	Name	Connector
1	Injectors connection	See D081 INJECTORS CONNECTION



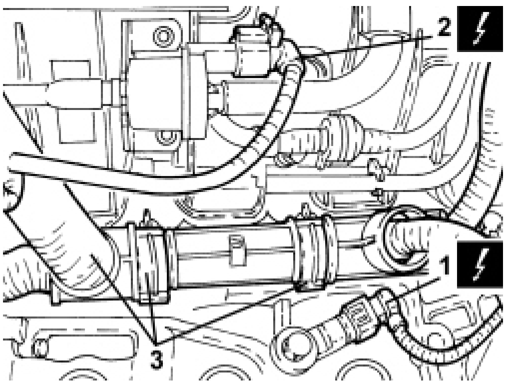
1. Electrically disconnect the pinging sensor.

	Name	Connector
1	Pinging sensor	K050 PINGING SENSOR

2. Electrically disconnect the fuel vapours solenoid.

	Name	Connector
2	Fuel vapours recovery solenoid	L010 FUEL VAPOURS RECOVERY SOLENOID

3. Open the retaining clips and move the wiring to one side.

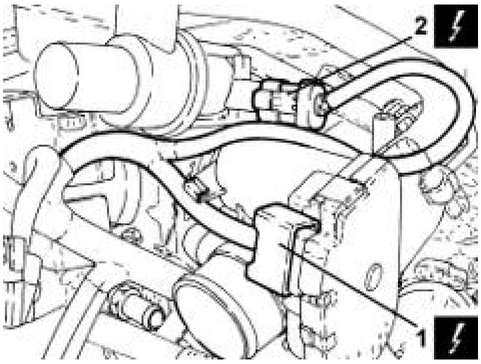


1. Electrically disconnect the throttle body.

	Name	Connector
1	Built-in throttle body actuator	See N075 BUILT-IN THROTTLE BODY ACTUATOR

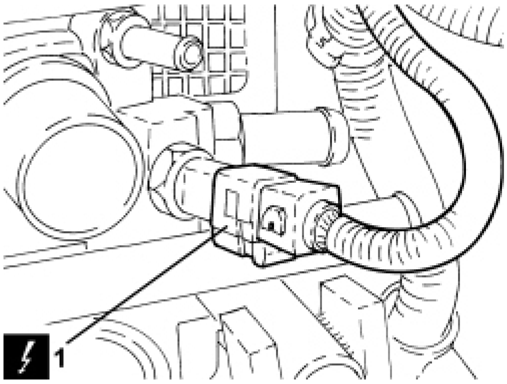
2. Electrically disconnect the solenoid controlling the air by-pass under pressure.

	Name	Connector
2	Turbocompressor by-pass solenoid	L102 TURBOCOMPRESSOR BY-PASS SOLENOID



1. Electrically disconnect the engine coolant temperature sensor.

	Name	Connector
1	Engine coolant temperature sender/sensor	K036 ENGINE COOLANT TEMPERATURE SENDER/SENSOR



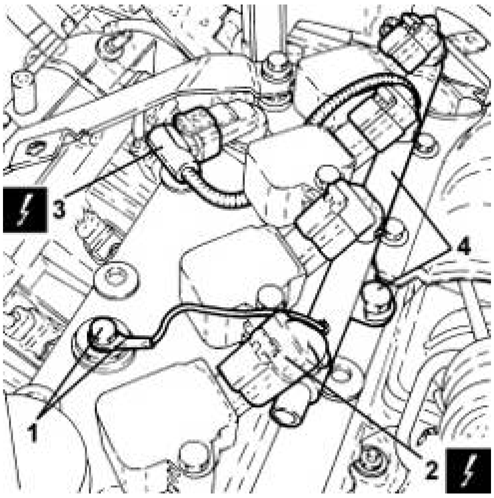
1. Unscrew the screw and remove ground cable.
2. Electrically disconnect the ignition coils.

	Name	Connector
2	Ignition coils	A030 IGNITION COIL

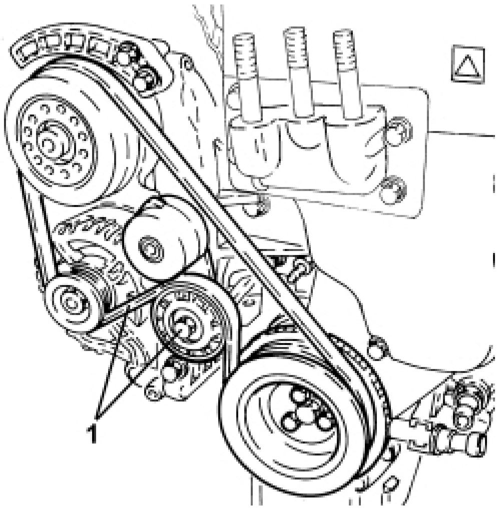
3. Electrically disconnect the timing sensor.

	Name	Connector
3	Timing sensor	K047 TIMING SENSOR

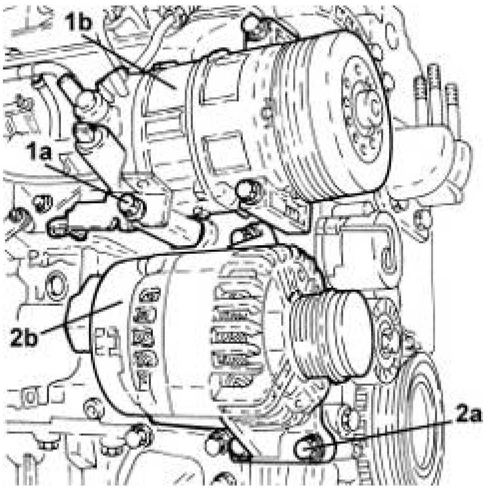
4. Unscrew the screw and remove the engine harness.



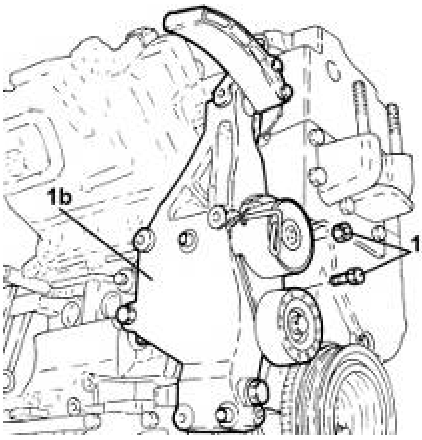
1. Move the mobile tensioner, secure it with a suitable pin and remove the engine components belt.



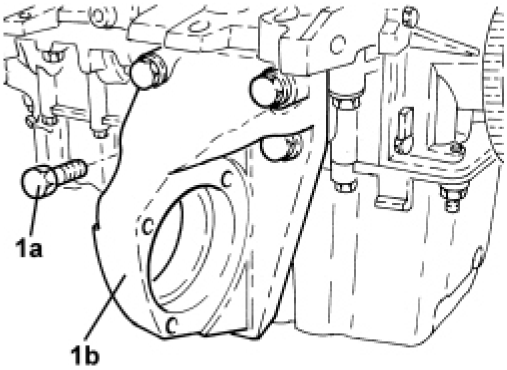
1. Unscrew the screws (1a) and remove the air conditioning compressor (1b).
2. Unscrew the screws (2a) and remove the alternator (2b).



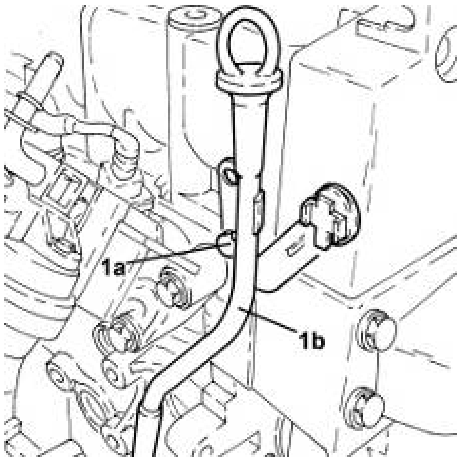
1. Unscrew the fastenings (1a) and remove the alternator support and conditioning compressor (1b) complete with mobile tensioner.



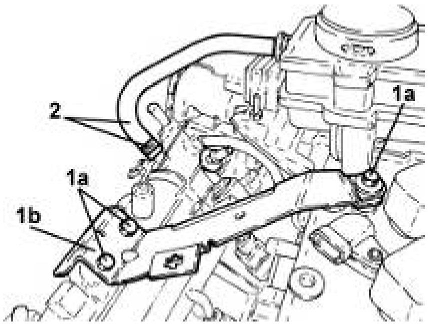
1. Unscrew the screws (1a) and remove intermediate shaft bearing support (1b).



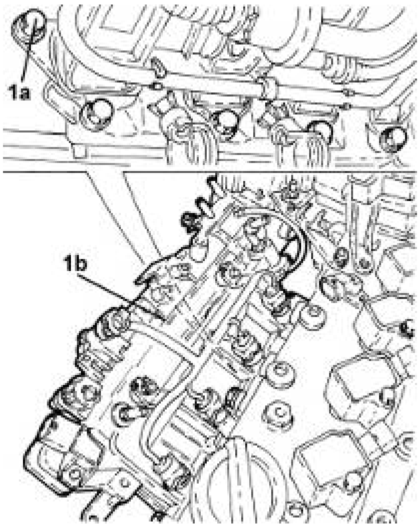
1. Unscrew the screw (1a) and remove the pipe (1b) complete with engine oil dips-stick.



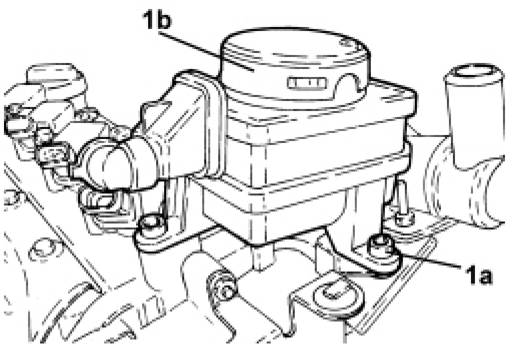
1. Unscrew the screws (1a) and remove the bracket (1b).
2. Loosen the clamp and remove the oil vapours delivery pipe form the air capacity box.



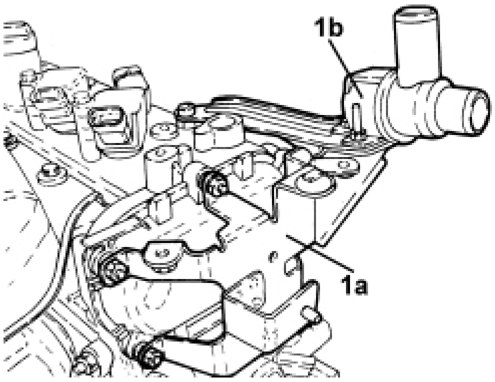
1. Unscrew the screws (1a) and remove the air capacity box (1b).



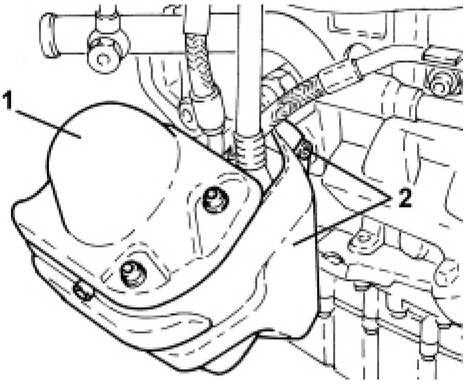
1. Unscrew the screws (1a) and remove the oil vapours separator (1b).



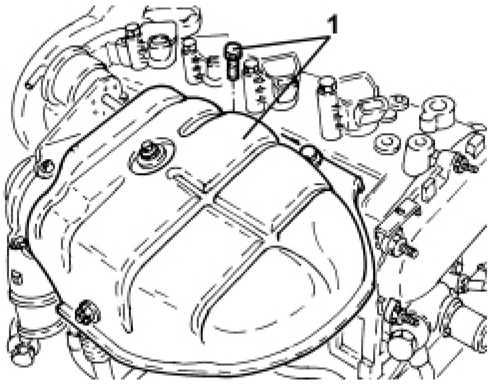
1. Unscrew the fastenings and remove the bracket (1a) complete with pressurised air by-pass solenoid (1b).



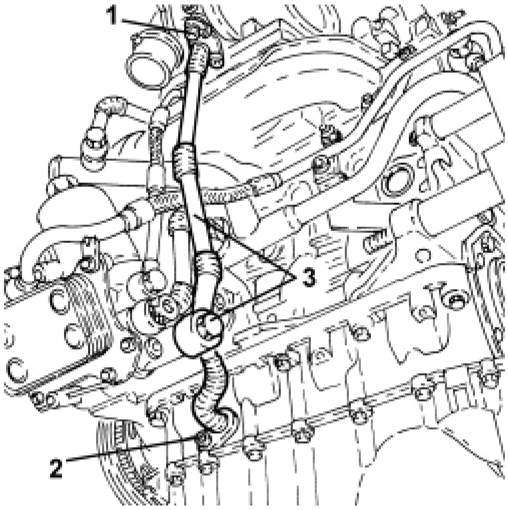
1. Unscrew the screws and remove the engine oil filter heat guard.
2. Unscrew the screws and remove the heat guard for the engine water-oil exchanger.



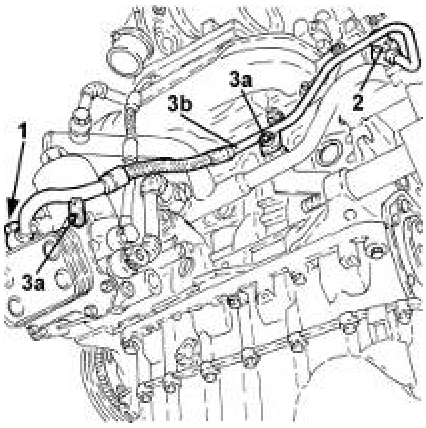
1. Unscrew the fastenings and remove the turbocompressor heat guard.



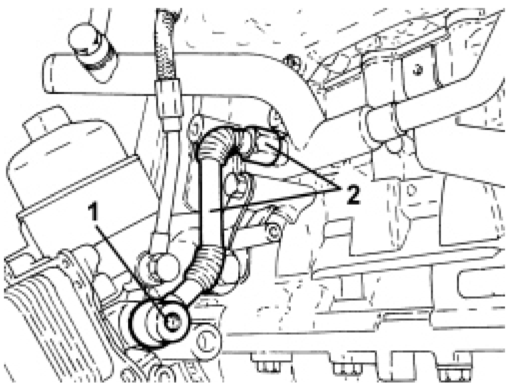
1. Unscrew the screws securing the turbocompressor lubricating oil return pipe to the engine crankcase, on the turbocompressor side.
2. Unscrew the screws securing the turbocompressor lubricating oil return pipe to the engine crankcase, on the engine crankcase side.
3. Unscrew the intermediate union securing the turbocompressor lubricating oil return pipe to the engine crankcase, on the engine oil exchanger side, and remove it.



1. Unscrew the union of the water to engine oil heat exchanger delivery pipe, on the exchanger side.
2. Unscrew the union of the water to engine oil heat exchanger delivery pipe, on the thermostat side.
3. Unscrew the screw (3a) and remove the water to engine oil heat exchanger delivery pipe (3b).

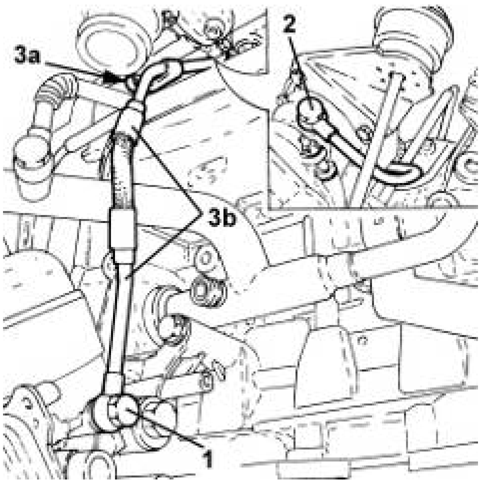


1. Unscrew the union of the water return pipe from the engine oil heat exchanger, on the heat exchanger side.
2. Unscrew the union of the water return pipe from the engine oil heat exchanger, on the return pipe to the water pump side, and remove it.

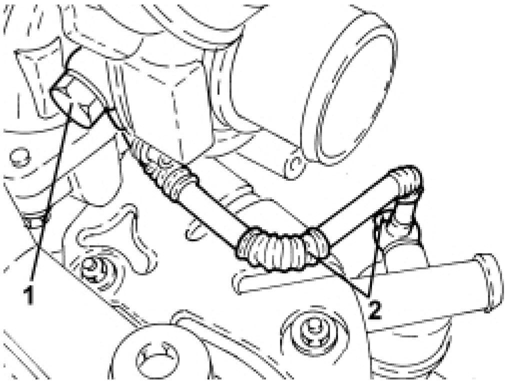


1. Unscrew the union of the turbocompressor lubricating oil delivery pipe, on the heat exchanger side.
2. Unscrew the union of the turbocompressor lubricating oil delivery pipe, on the turbocompressor side.

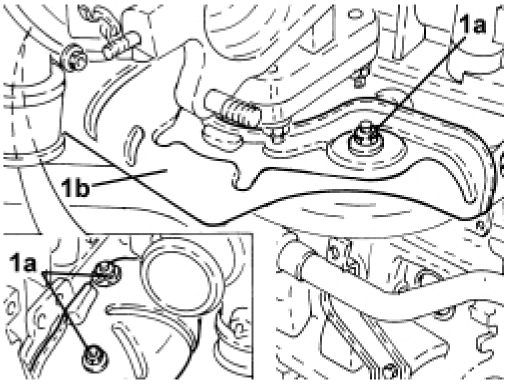
3. Unscrew the screw securing the intermediate bracket of the turbocompressor lubricating pipe, and remove it.



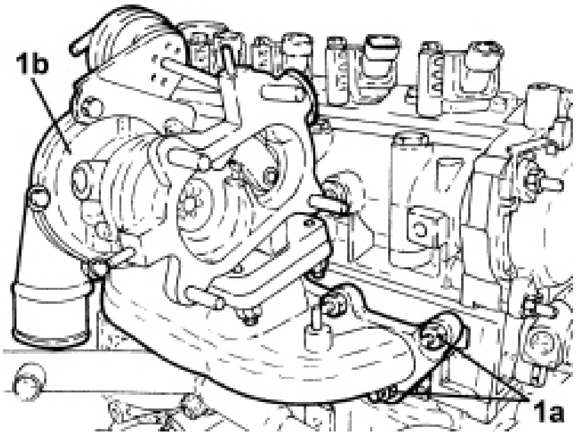
1. Unscrew the union the union, on the turbocompressor side.
2. Unscrew the union the union, on the return pipe to the water pump side, and remove it.



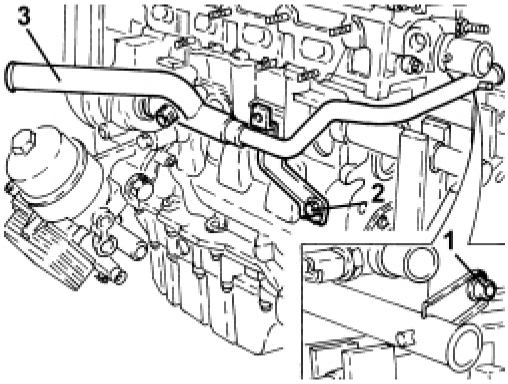
1. Unscrew the nuts (1a) and remove the exhaust manifold heat shield (1b).



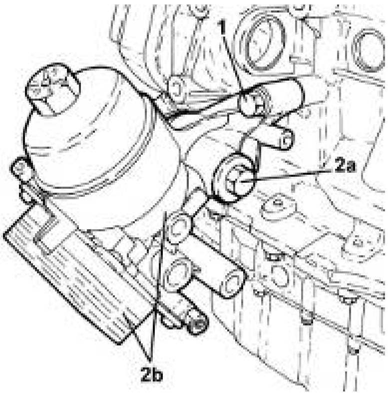
1. Unscrew the nuts (1a) and remove the exhaust manifold-turbocompressor assembly (1b).



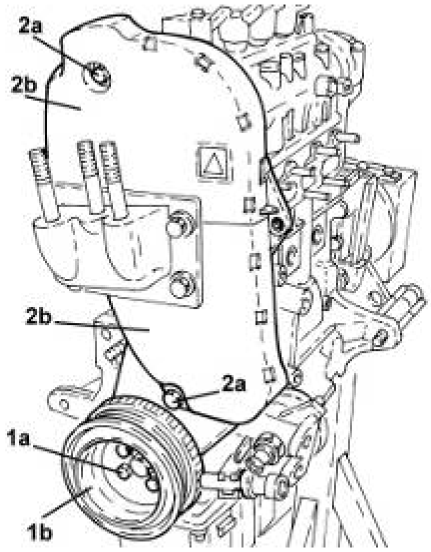
1. Unscrew the screw securing the return pipe to the water pump, cylinder head side.
2. Unscrew the screw securing the return pipe to the water pump, crankcase side.
3. Remove the return pipe to the water pump complete with seal.



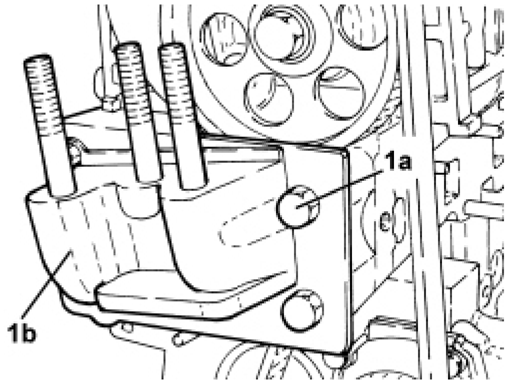
1. Unscrew the screw securing the oil filter support assy and engine oil heat exchanger, on crankcase side.
2. Unscrew the union (2a) securing the oil filter support and engine oil heat exchanger (2b), on crankshaft oil seal front cover side, and remove it.



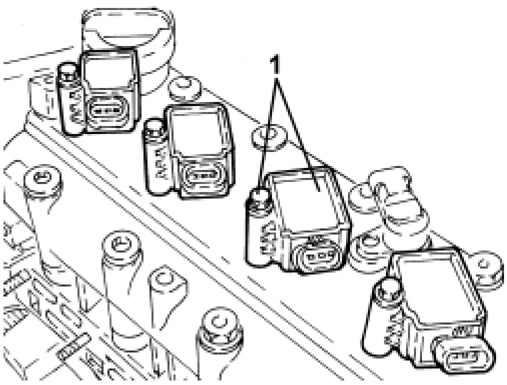
1. Unscrew the screws (1a) and remove crankshaft pulley (1b).
2. Unscrew the screws (2a) and remove valve train belt covers (2b).



1. Unscrew the screws (1a) and remove the engine rigid support (1b).

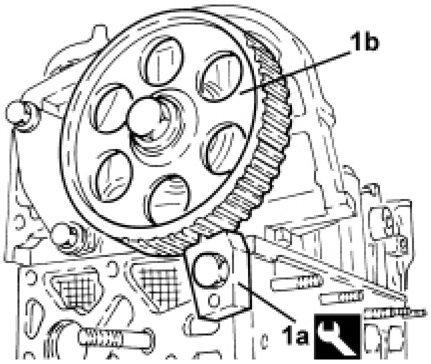


1. Unscrew the screws and remove ignition coils.

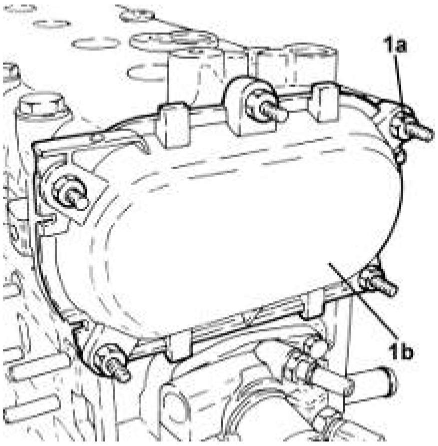


1. Fit the tool (1a) blocking the camshaft conduit pulley (1b).

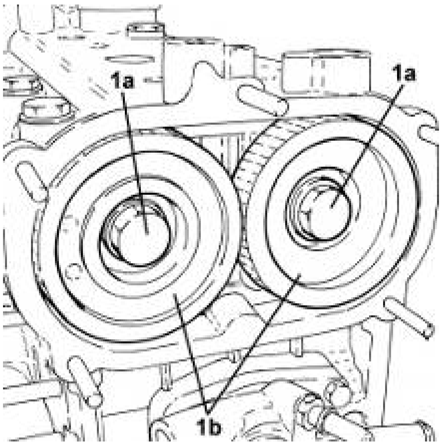
2000015800	Locking tool	Locking camshaft conduit pulley	1.4 16v



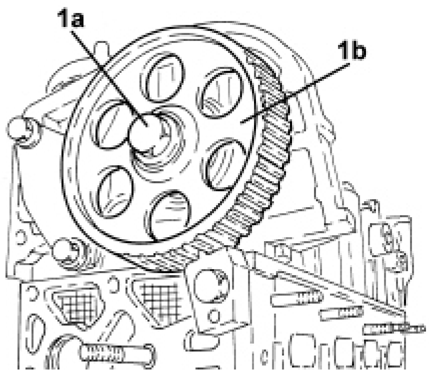
1. Unscrew nuts (1a) and remove the cover (1b).



1. Loosen the screws (1a) securing camshaft rear gears (1b).



1. Unscrew the screw (1a) and remove camshaft conduit pulley (1b).



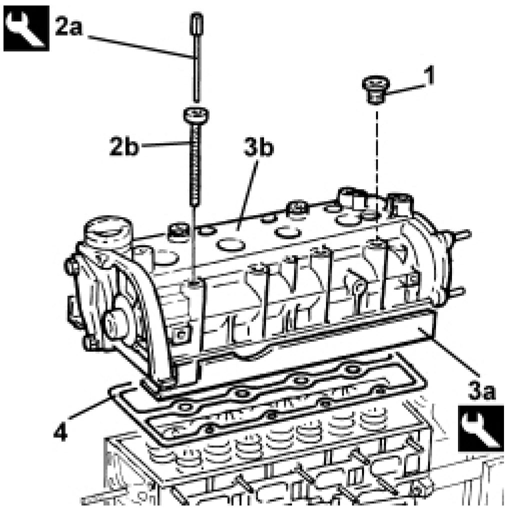
Unscrew the screw and remove the tool locking the camshaft conduit pulley.
1. Unscrew the caps protecting the screws securing the upper part of the cylinder head.
2. Using tool (2a) unscrew the screws (2b) securing upper part of cylinder head.

1860834000	Wrench	Unscrew/tighten screws on upper part of cylinder head	1.4 16v

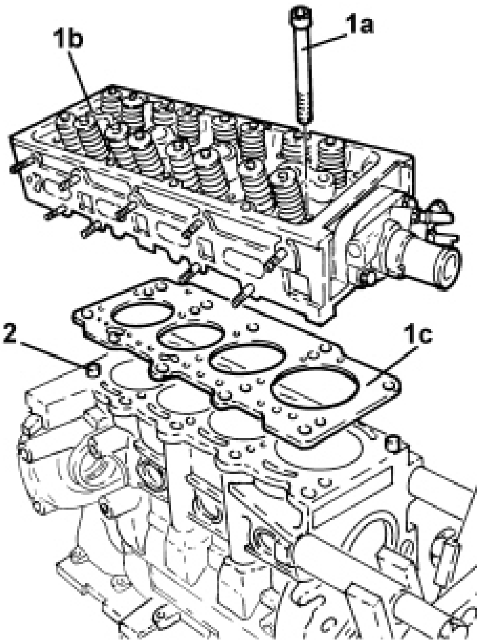
3. Position the tool for retaining the tappets (3a) under the upper part of the head (3b) and remove it.

1860988000	Tappet retainer tool	Tappet retainer	1.4 16v

4. Remove the gasket.



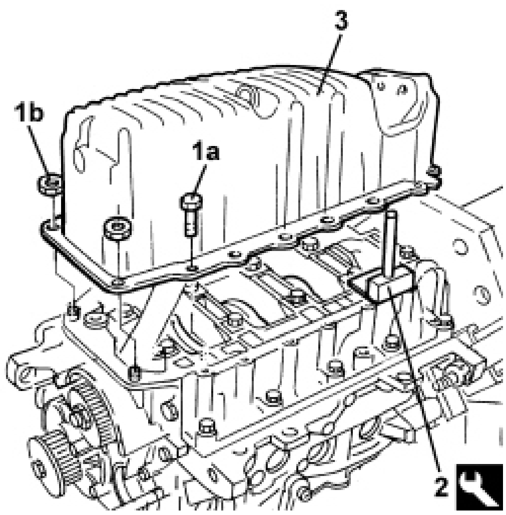
1. Unscrew the screws (1a), remove the cylinder head (1b) and recover the gasket (1c).
2. Remove the dowels.



- Turn the engine 180° on the overhaul stand.
1. Unscrew the screws (1a) and nuts (1b) securing the engine oil sump to the crankcase.
2. Using the tool, cut the silicone sealant all along the perimeter of the engine oil sump

1870718000	Blade	Cut sealant

3. Remove engine oil sump.



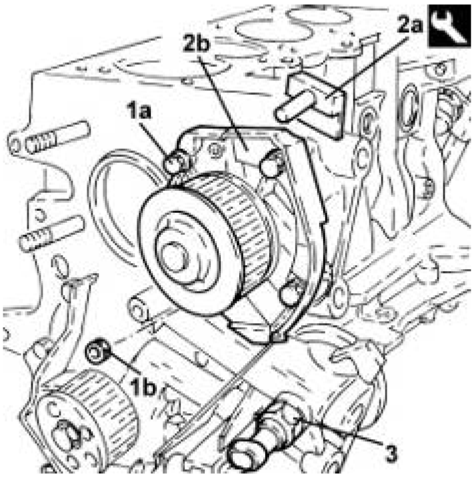
Note- Thoroughly clean the contact surfaces between the crankcase and oil sump.

1*004E20*   ENGINE – DISM. AND REASS. AFTER OP. 1004E10 – CLEANING AND CHECKING REMOVED PARTS – CYLINDER HEAD AND SUMP FITTING – DOES NOT INCLUDE WORKS ON CYLINDER HEAD AND AUXILIARY COMPONENTS

REMOVAL:
1. Remove the screws (1a) and the nut (1b) fastening the water pump to the crankcase.
2. Remove the sealant with the tool (2°) and remove the water pump (2b).

1870718000	Blade	Cut sealant

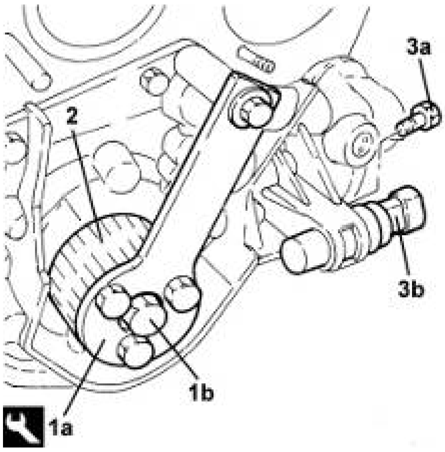
Thoroughly clean the crankcase-water pump coupling surfaces.
3. Remove the engine oil minimum pressure switch.



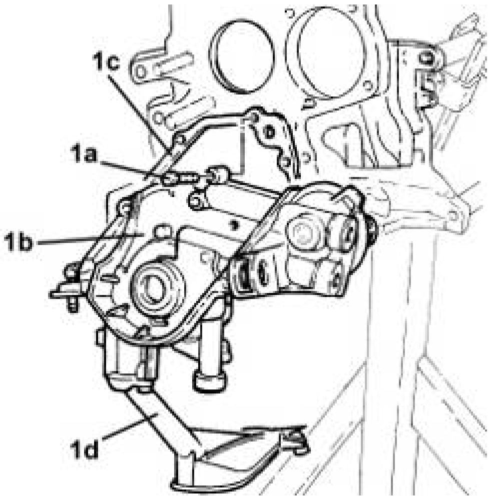
1. Fit the tool (1a) and unscrew the screw (1b) fastening the crankshaft gear

2000004500	Template	Crankshaft timing	1.4 16v

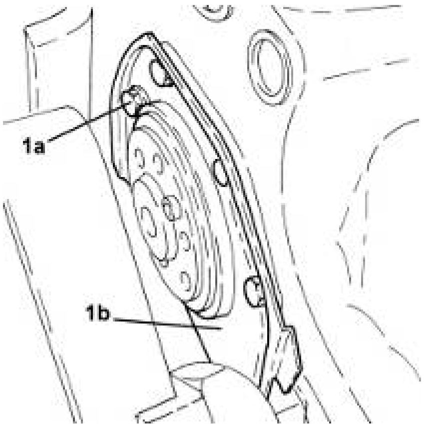
Remove the previously fitted template.
2. Remove the crankshaft gear.
3. Remove the screws (3a) and remove the revs sensor (3b).



1. Unscrew the screws (1a) and remove the front crankcase cover (1b) with oil pump, complete with the gasket (1c) and intake funnel (1d).

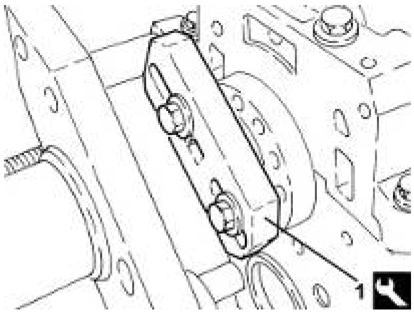


1. Unscrew the screws (1a) and remove the rear crankshaft cover (1b) with oil seal.



Turn the crankcase by 180°.
1. Fit the tool for turning the crankshaft.

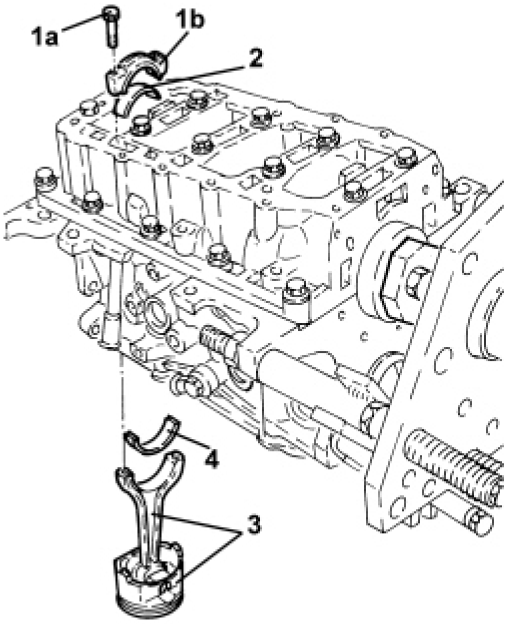
1860815000	Flange	Crankshaft rotation	1.4 16v



1. Unscrew the screws (1a) and remove the big end caps (1b).
2. Remove the lower half-bearings.

3. Remove the con rod-piston assembly.
4. Remove the upper half-bearings.

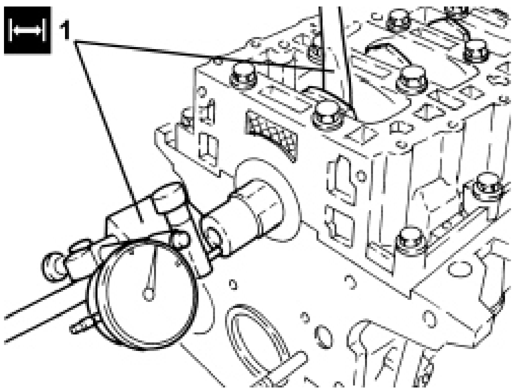
There is an arrow on the top of the piston that indicates fitting position.
The con rod-cap coupling is “BREAK” type and so with mandatory positioning. The piston is also punched with the corresponding cylinder number.



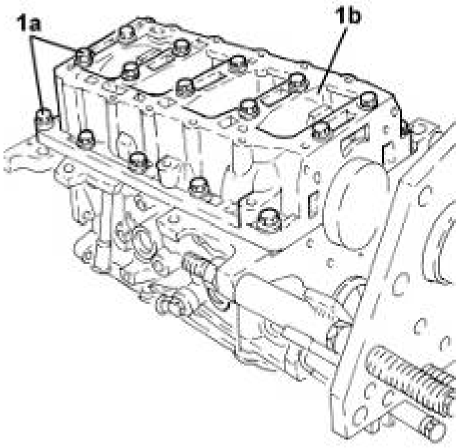
Remove the previously fitted flange for turning the crankshaft.
Using a comparator, check that crankshaft axial play is within the specified values.

Crankshaft axial play (mm)	0.155 ÷ 0.355	1.4 16v

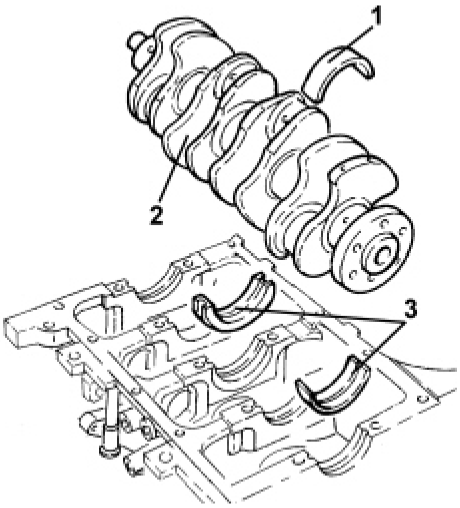
Remove the comparator.
If crankshaft axial play is not within the specified values, the crankcase journals must be machined and the central crankshaft journal fitted with suitably oversize half bearings before refitting the crankshaft.



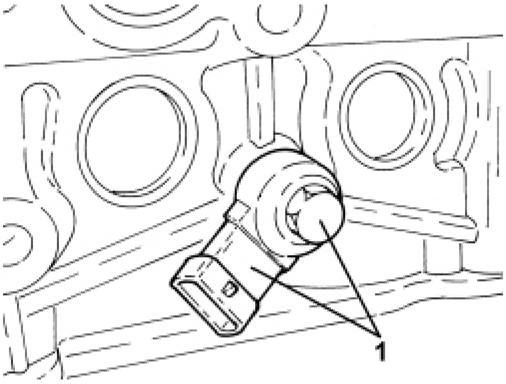
1. Unscrew the screws (1a) and remove the lower crankcase (1b) complete with half-bearings.



1. Remove the lower half-bearings from the crankcase.
2. Remove the crankshaft.
3. Remove the upper half-bearings.

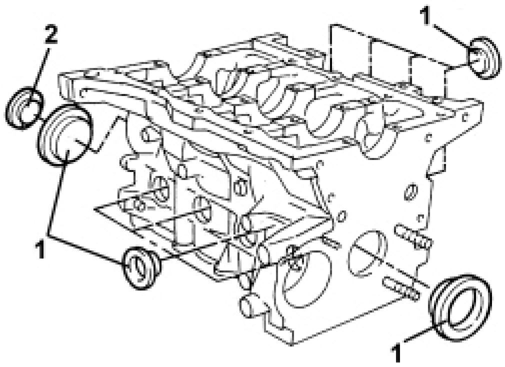


1. Unscrew the screws and remove the pinging sensor.



Remove the lower crankcase-engine block centering bushes.
Suitable harness the crankcase and lift it onto a suitable workbench using a hydraulic hoist.
Op. 1028H60
PISTON, PINS AND RINGS SET – REPL. PISTON WITH CON-RODS ON BENCH – INCLUDES BALANCING
Op. 1084B18

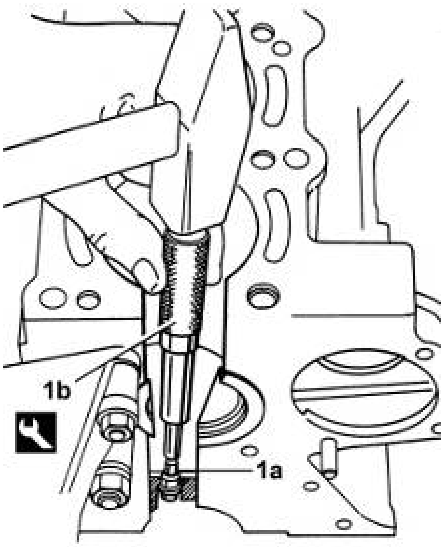
ENGINE OIL PUMP, REMOVED – BENCH CHECK
1. Remove the plugs from the crankcase cooling fluid chambers with a suitable steel driver.
2. Remove lubrication channel plug from the crankcase with a suitable steel driver.



1. Remove the oil sprayers (1a) using the tool (1b).

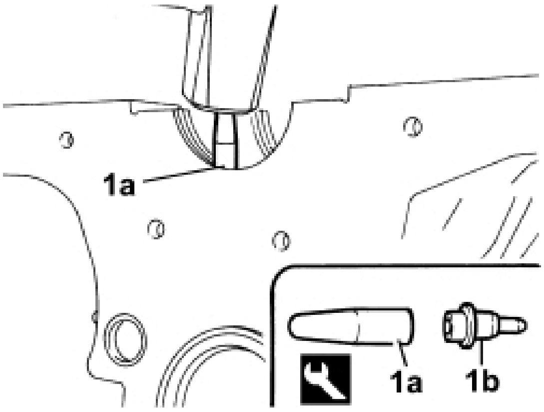
1860395000	Driver	Engine oil sprayers removal	1.4 16v

Insert the guide hole of the driver over the sprayer surface to prevent the driver from slipping and damaging the cylinder barrel.
Use new oil sprayers when reassembling.



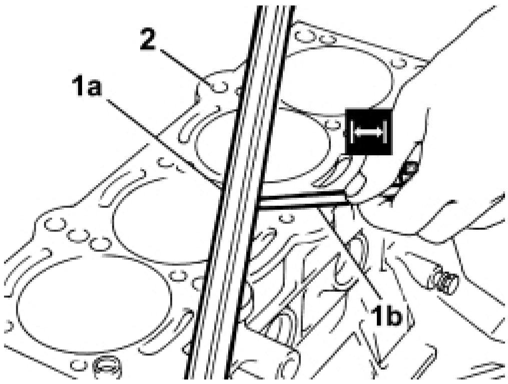
REASSEMBLY:
- Clean and visually inspect the condition of all removed components.
- Position the crankcase on the overhaul stand.
- Fit the water/oil plugs to the crankcase using suitable inserters and sealant.
- Fit the centering bushes to the crankcase.
1. Using tool (1a) and a plastic mallet, fit the new oil sprayers (1b).

1860313000	Inserter	Engine oil sprayer insertion	1.4 16v



1. Using a calibrated metal rule 1a) and a feeler gauge (1b), check the flatness of the cylinder head-crankcase coupling surfaces.
2. If flatness is not within the specified values, machine the cylinder head.

Cylinder head contact surface flatness (mm)	< 0.1	1.4 16v



Measure and check that the diameter of the cylinder barrels is within specified values.

Barrel diameter - Class A (mm)	72.000 ÷ 72.010	1.4 16v
Barrel diameter - Class B (mm)	72.010 ÷ 72.020	1.4 16v
Barrel diameter - Class C (mm)	72.020 ÷ 72.030	1.4 16v

Check that barrel ovalization is within specified values.

Barrel ovalization (mm)	+/- 0.05	1.4 16v

Check that barrel taper is within specified values.

Barrel taper (mm)	+/- 0.005	1.4 16v

If barrel diameter, ovalization or taper is not within specifications, ream the barrels to the required oversize.
If reaming is necessary, all barrels must be brought to the same oversize.

Barrel oversize (mm)	0.1	1.4 16v

Check that main journal diameters are within specified values.

Main journal diameter - Class A (mm)	47.994 ÷ 48.000	1.4 16v
Main journal diameter - Class B (mm)	47.988 ÷ 47.994	1.4 16v
Main journal diameter - Class C (mm)	47.982 ÷ 47.988	1.4 16v

If main journal diameters are not within specified values, machine them to the required undersize.
The crankshaft is nitrided. If machined, it must undergo liquid nitride treatment again, followed by a dimensional check.

Main journal undersize (mm)	0.127	1.4 16v

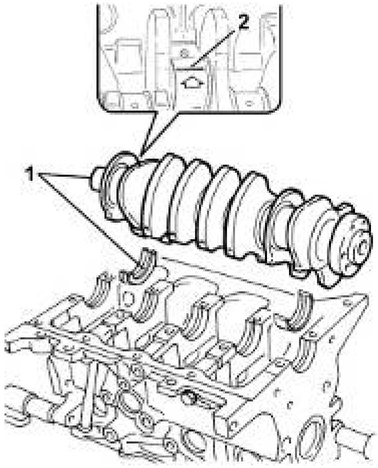
Check that the diameters of the crank pins are within specified values.

Crank pin diameter (mm)	41.990 ÷ 42.008	1.4 16v

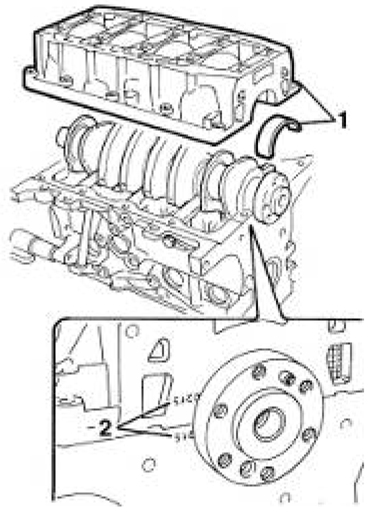
If the crank pins are not within the specified values, machine them down to the required undersize.
The crankshaft is nitrided. If machined, it must undergo liquid nitride treatment again, followed by a dimensional check

Crank pin undersize (mm)	0.127	1.4 16v

Check the crankshaft main bearings. These cannot be machined. If scoring or signs of seizure are found, they must be replaced.
Fit the crankshaft half-shells to the seats in the upper crankcase and align the oil holes. This operation must be carried out in scrupulously clean conditions. The central half-bearings have built-in shoulder half-rings, since it also serves as thrust bearing.
IF the crankshaft has been machined, fit new suitably oversized half-bearings, to restore the original tolerance.
1. Fit the crankshaft into its seat on the crankcase fitted with the corresponding upper half-bearings.
2. Apply the plastigage to measure main journal play.



1. Fit the lower half-bearings onto the lower crankshaft.
2. Fit the lower crankcase to the upper engine block checking that the punch markings on both crankcase components correspond, since the crankcase components are not interchangeable.



The following table gives the main journal half-bearing thickness.

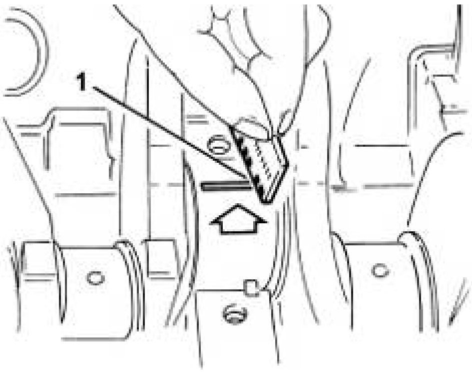
Main journal half-bearing thickness - Class 1 (Red) (mm)	1.836 ÷ 1.840	1.4 16v
Main journal half-bearing thickness - Class 2 (Blue) (mm)	1.843 ÷ 1.847	1.4 16v
Main journal half-bearing thickness - Class 3 (Yellow) (mm)	1.848 ÷ 1.852	1.4 16v
Main journal half-bearing undersize (mm)	0.127	1.4 16v

Tighten the lower and upper crankcase bolts to the specified torque.

Crankcase	Centre bolt	M10	1.9 ÷ 2.1 + 87° ÷ 93°	1.4 16v
Crankcase	Side bolt	M10	2.8 ÷ 3.2	1.4 16v

1. Remove the lower crankcase and check main journal play by measuring the width of the plastigage with a specific measuring tool.
Check one journal at a time without turning the crankshaft.

Main bearings – crankshaft journals play (mm)	0.025 ÷ 0.040	1.4 16v



After checking all journals, apply sealant between the lower and upper crankcases and complete the final coupling of the lower crankcase, tightening the bolts to the previously specified torque.
Apply a continuous bead of sealant to the lower crankcase coupling surface. Thickness 2 mm.
Check that the external diameter of the pistons is within specified values. If not, replace the pistons along with rings and pins.

Piston external diameter - Class A (mm)	71.960 ÷ 71.970	1.4 16v
Piston external diameter - Class B (mm)	71.970 ÷ 71.980	1.4 16v
Piston external diameter - Class C (mm)	71.980 ÷ 71.990	1.4 16v

Measure perpendicular to gudgeon pin axis at 9 mm from lower edge of skirt.
Fit the pistons into the barrels and measure play with a feeler gauge.

Piston - cylinder barrel play (mm)	0.030 ÷ 0.050	1.4 16v

Check that internal diameter of the gudgeon pin seat is within specified values. If not, replace the pistons.

Gudgeon pin seat (mm)	17.978 ÷ 17.982	1.4 16v

Check that the external diameter of the gudgeon pins is within specified values. If not, replace the worn parts.

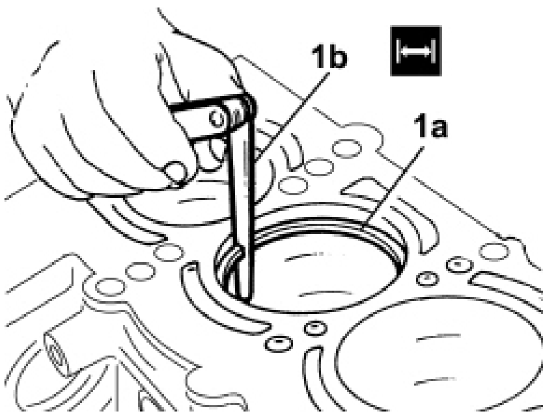
Gudgeon pin external diameter (mm)	17.970 ÷ 17.974	1.4 16v

Using a micrometer, measure the thickness of the piston rings.

1st compression ring thickness (mm)	1,170 ÷1,195	1.4 16v
2nd compression ring thickness (mm)	1.170 ÷ 1.190	1.4 16v
3rd compression ring thickness (mm)	1.970 ÷ 1.990	1.4 16v
Piston ring oversize (mm)	0.1	1.4 16v

1. Fit the piston rings (1a) to the piston and using a micrometer (1b) check that the distance between the ends of the rings is within specified values. If not, replace the rings.

1st compression ring distance (mm)	0.20 ÷ 0.35	1.4 16v
2nd compression ring distance (mm)	0.40 ÷ 0.60	1.4 16v
3rd compression ring distance (mm)	0.20 ÷ 0.40	1.4 16v



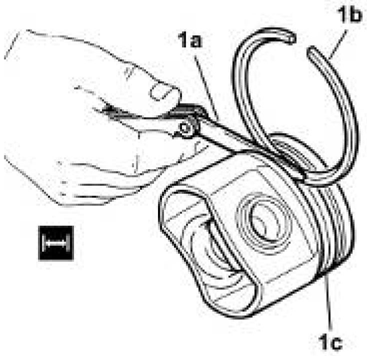
Check that the ring seats on the pistons are within specified values.

Piston ring seat – 1st groove (mm)	1.220 ÷ 1.240	1.4 16v
Piston ring seat – 2nd groove (mm)	1.210 ÷ 1.230	1.4 16v
Piston ring seat – 3rd groove (mm)	2.010 ÷ 2.030	1.4 16v

1. Using a feeler gauge (1a) check play between the rings (1b) and the grooves on the pistons (1c).

1st compression ring axial play (mm)	0.025 ÷ 0.070	1.4 16v
2nd compression ring axial play (mm)	0.020 ÷ 0.060	1.4 16v

3rd compression ring axial play (mm)	0.020 ÷ 0.060	1.4 16v



Check that the diameters of the con rod big ends and small ends are within specified values.

Big end diameter (mm)	45.138 ÷ 45.148	1.4 16v
Small end diameter (mm)	17.993 ÷ 18.000	1.4 16v

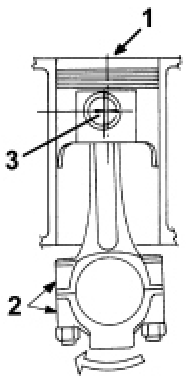
Op.1028H60
PISTON, PINS AND RINGS SET – REPL. PISTON WITH CON-RODS ON BENCH – INCLUDES BALANCING

Op.1084B18
OIL PUMP, REMOVAL – BENCH CHECK

Fit the tool for turning the crankshaft.

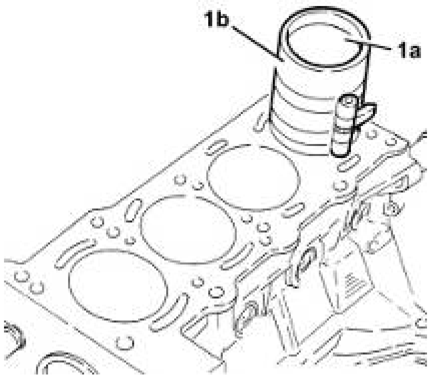
1860815000	Flange	Crankshaft turning	1.4 16v

The con rod-piston assemblies must be fitted and aligned with the following references.
1. Piston class and arrow pointing to valve train side
2. Barrel number to which the con rod assembly corresponds
3. Gudgeon pin offset

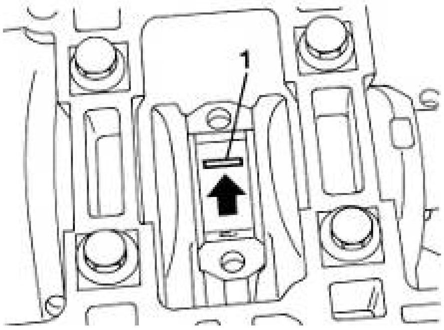


The con rod-cap coupling is "BREAK" type and so with mandatory positioning. The piston is also punched with the corresponding cylinder number.

The barrel class letter is marked on the crankcase.
1. Fit the con rod-piston assembly (1a) complete with half-shells using the tool (1b) for compressing the piston rings and inserting the piston into the barrel.



Turn the engine on the overhaul stand.
1. Apply Plastigage to measure crank pin play.



The following table gives the thickness of the big end half-bearings.

Standard big end bearings (mm)	1.544 ÷ 1.548	1.4 16v
Oversize big end bearings 0.127 mm	1.607 ÷ 1.611	1.4 16v
Oversize big end bearings 0.254 mm	1.669 ÷ 1.675	1.4 16v
Oversize big end bearings 0.508 mm	1.796 ÷ 1.802	1.4 16v

Fit the con rod caps complete with half-shells and fasten with the bolts to the specified torque.
The con rods have fracture type big end caps. If replaced they are supplied pre-fractured. Check that parts are free of burrs, bubbles, scratches or other surface faults. Before fitting the parts must be thoroughly cleaned and dried. The con rod caps must be fitted with the punch marking facing the same way as the one on the big end.
Each con rod must be coupled with its corresponding cap, according to the numbers punched on it. Con rods and con rod caps are not interchangeable.

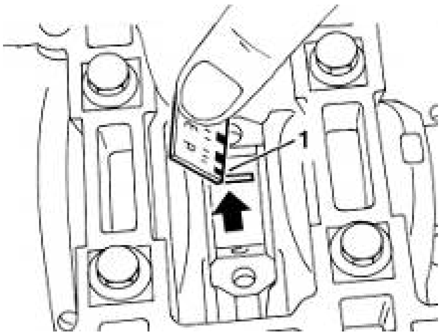
Con rod caps	Screw	M8	1.9 ÷ 2.1 + 40° +/- 2°	1.4 16v

1. Remove the con rod caps and check crank pin play measuring the width of the plastigage with a specific measuring tool.

Check one crank pin at a time without turning the crankshaft.

Big end bearings – crankshaft crank pin play (mm)	0.024 ÷ 0.060	1.4 16v

If the measured values are not within specifications, replace the big end bearings.



Refit the con rod caps with half-shells and fasten the bolts to the previously specified torque.
Turn the engine on the overhaul stand.
Fit a new oil pump gasket.
Replace the crankcase front cover with oil pump in its seat, complete with intake funnel, and fasten the bolts to the specified torque

Engine oil pump	Screw	M6	0.9 ÷ 1.1	1.4 16v

Replace the minimum oil pressure switch in its seat and fasten it to the specified torque.

Engine oil minimum pressure switch	M14	2.9 ÷ 3.5

Fit the oil seal to the crankshaft front cover using the tool.

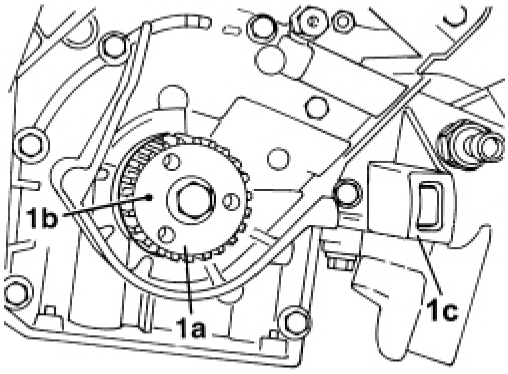
1860990000	Inserter	Crankshaft front cover oil seal insertion Exhaust side camshaft oil seal fitting	1.4 16v

Remove the previously fitted flange used to turn the crankshaft.
Fit a new crankcase rear cover and fasten the bolts to the specified torque.

Crankshaft rear cover on crankcase	Screw	M6	0.8 ÷ 1.0	1.4 16v

Refit the cog onto the crankshaft.

1. Valve train timing must be carried out with the four pistons aligned, meaning at halfway through the stroke. It is essential to align the crankshaft with the camshafts. Approximate positioning can be obtained by turning the crankshaft gear (1a) until the centering pin (1b) is opposite to the revs sensor (1c) and with the first piston descending on the intake stroke.



1. Position of locking tool.

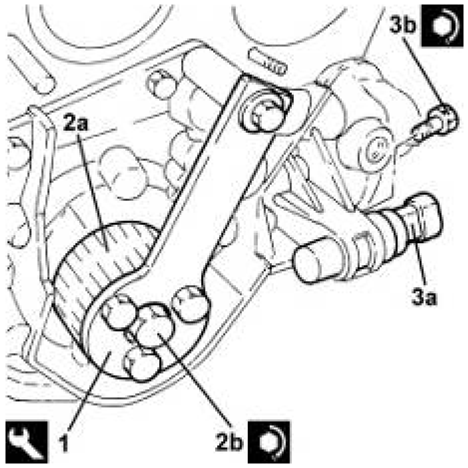
2000004500	Template	Crankshaft timing	1.4 16v

2. Fasten the crankshaft gear (2a) with the screw (2b), tightening it to the specified torque.

Crankshaft gear	Screw	M12	1.9 ÷ 2.1 + 107° ÷ 113°	1.4 16v

3. Fit the revs sensor to its seat (3a) and fasten it with the corresponding bolt (3b) to the specified torque.

Revs sensor	Screw	M6	0.8 ÷ 1.0	1.4 16v



Apply silicon sealant to the groove on the flange fastening the water pump to the crankcase
Position the water pump in its seat and secure it with the corresponding bolts and nut to the specified torque.

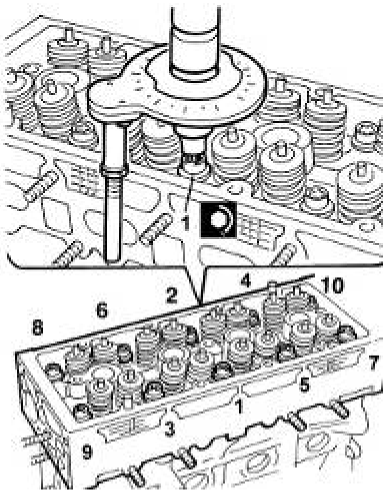
Water pump	Screw	M6	0.9 ÷ 1.1	1.4 16v
Water pump	Nut	M6	0.9 ÷ 1.1	1.4 16v

Turn the engine 180° on the overhaul bench.
Clean the surfaces between the lower crankcase and oil sump, removing any silicon sealant residues.
Apply a continuous bead of sealant to the entire perimeter of the oil sump.
Refit the sump and fasten it with the nuts and bolts, to the specified torque.
When positioning the oil sump, avoid any significant horizontal shift that could remove the sealant.

Engine oil sump	Screw	M6	0.8 ÷ 1.0	1.4 16v
Engine oil sump	Nut	M6	0.8 ÷ 1.0	1.4 16v

Turn the engine by 180° on the overhaul stand.
Fit the centering bushes to the crankcase.
Fit a new cylinder head gasket to the crankcase.
Position the cylinder head on the block, aligning the centering bushes.
1. Tighten the cylinder head bolts to the specified torque.
For each tightening sequence, follow the order given in the diagram.

Cylinder head	Screw	M9	3 + 90° + 90°	1.4 16v



Fit the centering bushes and position the upper cylinder head gasket on the lower cylinder head.
Fit the tools for retaining the tappets below the upper head, then position the upper head on the cylinder head and remove the retainers.
Using the tool, tighten the upper head bolts to the specified torque.

1860834000	Wrench	Loosen/tighten upper head bolts	1.4 16v

Upper cylinder head	Screw	M8	1.3 ÷ 1.6	1.4 16v

Refit the plugs with new o-rings and tighten them to the specified torque.

Upper cylinder head plugs	M16	1.3 ÷ 1.6	1.4 16v

Refit the camshaft drive pulley without tightening the bolts.
Fit the camshaft drive pulley locking tool.

2000015800	Locking tool	Timing adjuster/camshaft drive pulley	1.4 16v

Tighten the camshaft drive pulley bolts to the specified torque.
Camshaft drive pulley Bolt, M12; 10.8 - 13.2 daNm, Val. 1.4 16v TJet
Tighten the camshaft drive gears bolts to the specified torque.

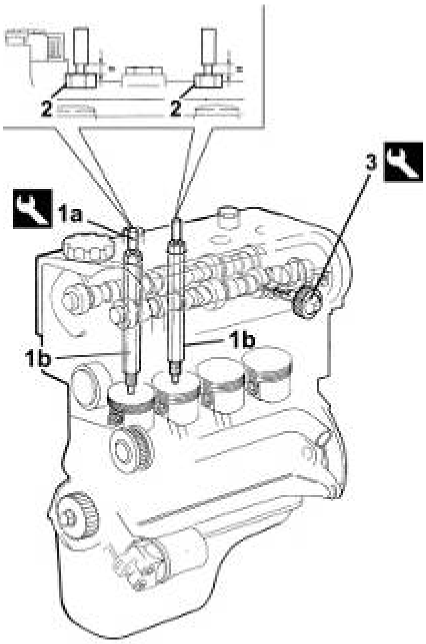
Camshaft gears	Screw	M12	12.0	1.4 16v

Loosen the camshaft drive pulley bolts and remove the locking tool.
Remove the previous tool used as lock for tightening the camshaft drive gear bolts.
1. Fit the tools (1a) into the seats of the 1st and 2nd cylinder spark plugs, tightening the pins (1b) to a torque of 0.5 daNm.

1860992000	Pins	Crankshaft timing	1.4 16v

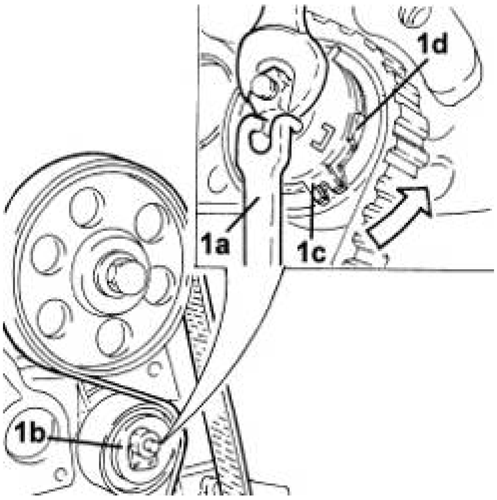
2. Turn the crankshaft in its normal direction until the mobile pins of the previously mounted tool are all aligned.
Turn the crankshaft gradually to prevent the tools from being pushed out by piston compression.
3. The camshafts have been previously timed by applying the tools shown in the diagram.

1860985000	Centering pins	Camshaft timing	1.4 16v



Proceed to fit the valve train drive belt, initially fitting it to the crankshaft gear, then the water pump pulley, the camshaft drive pulley and lastly onto the tensioner.
Check that this operation is carried out with the camshaft pulley loosened.
1. Tighten the valve train belt by turning the tensioner (1b) anticlockwise with the tool (1a), and fasten it when the reference fork (1c) is flush (1d)

1860987000	Wrench	Valve train drive belt tightening	1.4 16v



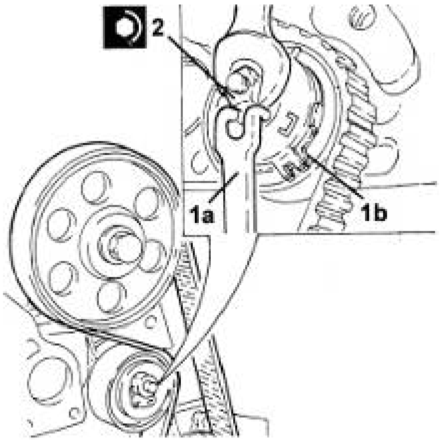
Fit the camshaft pulley locking tool.

2000015800	Locking tool	Timing adjuster/drive pulley locking	1.4 16v

Tighten the camshaft drive pulley screw to the specified torque.

Valve train drive pulley, Screw, M12; 10.8 - 13.2 daNm, Val. 1.4 16v TJet
Remove the previously fitted tools for timing and locking the camshafts, and turn the crankshaft by two turns.
1. Loosen the tensioner fastening nut and work on the front fork with the tool (1a) until it coincides with the rear fork (1b).
2. Tighten the tensioner nut to the specified torque.

Valve train drive belt tensioner	Nut	M8	2.2 ÷ 2.7	1.4 16v



Turn the crankshaft another two turns in its normal direction, then reposition the tools used for engine timing and check that the engine is correctly timed.
Remove the engine timing tools.
Replace the upper head side plugs and tighten them to the specified torque.

Upper cylinder head plugs	M16	1.3 ÷ 1.6	1.4 16v

Replace the flywheel side rear camshaft cover and fasten it with the corresponding nuts.
Replace the rigid water pump intake pipe, complete with new gasket, and fasten it with the bolts to the crankcase and cylinder head, tightening to the specified torque.

Rigid water pump intake pipe	Screw	M6	0.9 ÷ 1.1	1.4 16v

Replace the ignition coils in their respective seats and fasten them to the specified torque.

Ignition coils	Screw	M6	0.8 ÷ 1.0	1.4 16v

Replace the timing sensor in its seat and fasten it with the corresponding screw.
Replace the rigid engine support, valve train side, in its seat and fasten it with the screws to the specified torque.

Rigid engine support, valve train side	Screw	M8	2.2 ÷ 2.7	1.4 16v

Replace the upper and lower valve train drive belt covers and fasten them with the corresponding screws.
Replace the crankshaft pulley and fasten is with the corresponding screws to the specified torque.

Auxiliary pulley on crankshaft	Screw	M8	**2.3 ÷ 2.8**	1.4 16v

Replace the oil filter and engine oil heat exchanger in its seat and fasten the connector, crankshaft oil seal cover side, to the specified torque.
Engine oil filter and heat exchanger support – crankshaft oil seal cover side – **Connector - M20 - 4.1 - 4.9 daNm, Val. 1.4 16v TJet**

Tighten the oil filter and heat exchanger assembly screws, crankcase side, to the specified torque.
Oil filter and heat exchanger support – crankcase side - Screw- M10 - 4.5 - 5.5 daNm, Val. 1.4 16v TJet

Replace the exhaust manifold – turbo compressor assembly in its seat, complete with a new gasket, and tighten the new nuts to the specified torque.
Exhaust manifold – Nut (to be replaced) - M8, 1.4 - 1.6 + 30° +/- 2° daNm - Val. 1.4 16v Tjet

Replace the exhaust manifold heat shield in its seat and tighten the corresponding nuts to the specified torque.
Exhaust manifold heat shield, Nut, M6, 0.8 - 1.0 daNm, Val. 1.4 16v TJet

Replace the turbo compressor coolant return pipe in its seat, complete with new gasket, and tighten the corresponding connectors.
Replace the turbo compressor oil delivery pipe in its seat, complete with new gasket and tighten the connectors to the specified torque.
Turbo compressor oil delivery pipe – heat exchanger side, Connector, M6, 0.8 - 1.0 daNm, Val. 1.4 16v TJet
Turbo compressor oil delivery pipe – turbo compressor side, Connector, M12, 1.8 - 2.2 daNm, Val. 1.4 16v TJet

Tighten the turbo compressor oil delivery pipe intermediate bracket screws.
Replace the water return pipe from the engine oil heat exchanger, complete with new gasket, and tighten it the corresponding connectors.
Replace the water delivery pipe to the engine oil heat exchanger, complete with new gasket, and tighten the corresponding connectors to the specified torque.
Water delivery pipe to engine oil heat exchanger, Connector, M16, 3.0 - 3.6 daNm, Val. 1.4 16v TJet

Tighten the screw of the water delivery pipe to the engine oil heat exchanger.
Replace the turbo compressor oil return pipe, complete with new gaskets, and tighten the corresponding screws to the specified torque.
Turbo compressor oil return pipe to crankcase, Screw, M6, 0.8 - 1.0 daNm, Val. 1.4 16v TJet

Tighten the intermediate connector fastening the turbo compressor oil return pipe to the crankcase, engine oil heat exchanger side.
Turbo compressor lubricating oil return pipe to sump, Connector, M16, 3.0 - 3.6 daNm, Val. 1.4 16v TJet

Replace the heat shield for the water-oil heat exchanger in its seat and tighten the corresponding screws to the specified torque.
Heat shield for engine oil-water heat exchanger, Screw, M6, 0.8 - 1.0 daNm, Val. 1.4 16v TJet

Replace the engine oil filter heat shield in its seat and tighten the corresponding screws to the specified torque.
Engine oil filter heat shield, Screw, M6, 0.8 - 1.0 daNm, Val. 1.4 16v TJet

Replace the bracket complete with pressurized air by-pass solenoid valve in its seat and tighten the corresponding fasteners.
Replace the oil vapor separator in its seat and tighten the corresponding screws.
Replace the air capacity box in its seat and tighten the new screws to the specified torque.
Air capacity box, Screw (to be replaced), M6, 0.8 - 1.0, Val. 1.4 16v TJet

Connect the oil vapour delivery pipe to the air capacity box and tighten the corresponding clamp.
Replace the air capacity box support bracket and tighten the corresponding screws.
Replace the engine oil dipstick tube in its seat and fasten it with the corresponding screw.
Replace the intermediate shaft bearing support in its seat and fasten the screw to the specified torque.
Intermediate shaft bearing support, Screw, M8, 2.3 - 2.8 daNm, Val. 1.4 16v TJet

Replace the alternator and air-conditioner compressor support in its seat and tighten the corresponding screws to the specified torque.

Alternator/air-conditioner compressor support	Screw	M10	4.5 ÷ 5.5	1.4 16v

Replace the alternator in its seat and tighten the corresponding screws.
Replace the air-conditioner compressor in its seat and tighten the corresponding screws.
Fit the engine auxiliaries belt using the tensioner and remove the locking pin.
Replace the engine wiring harness in its seat and tighten the ignition coils cable duct fastening screw.
Connect the ignition coil electrical connections.
Connect the timing sensor.
Connect the ground cable and tighten the corresponding screw.
Connect the engine coolant temperature sensor.
Connect the pressurized air by-pass control solenoid valve.
Connect the throttle body.
With the retainer clips, connect the air capacity box wiring conduit.
Connect the fuel vapor solenoid valve.
Connect the pinging sensor.
Connect the electro injectors wiring connection.
Connect the air-conditioner compressor.
Connect the alternator ground wire and tighten the corresponding nut.
Replace the valve train drive belt inner cover in its seat and tighten it with the corresponding screws.
Connect the ground cable to the auxiliaries support and tighten the corresponding screw.
Connect the air temperature and pressure sensor.
Connect the exhaust gas temperature sensor.
Connect the engine oil minimum pressure switch.
Connect the engine revs sensor.

Tools for procedure 1004E10

2000015800	Locking tool	Camshaft drive pulley lock
1860834000	Wrench	Wrench for upper cylinder head bolts
1860988000	Tappet retainer	Tappet retainer
1870718000	Blade	Sealant cutter

Tools for procedure 1004E20

1870718000	Blade	Sealant cutter
2000004500	Template	Crankshaft timing
1860815000	Flange	Crankshaft rotation
1860395000	Driver	Engine oil sprayer removal
1860313000	Inserter	Engine oil sprayer insertion
1860990000	Inserter	Crankshaft front cover oil seal fitting Camshaft exhaust side oil seal fitting
1860834000	Wrench	Upper cylinder head bolts loosen/tighten
2000015800	Locking tool	Timing adjuster/drive pulley lock
1860992000	Pins	Crankshaft timing
1860985000	Centering pin	Camshaft timing
1860987000	Wrench	Valve train drive belt tension