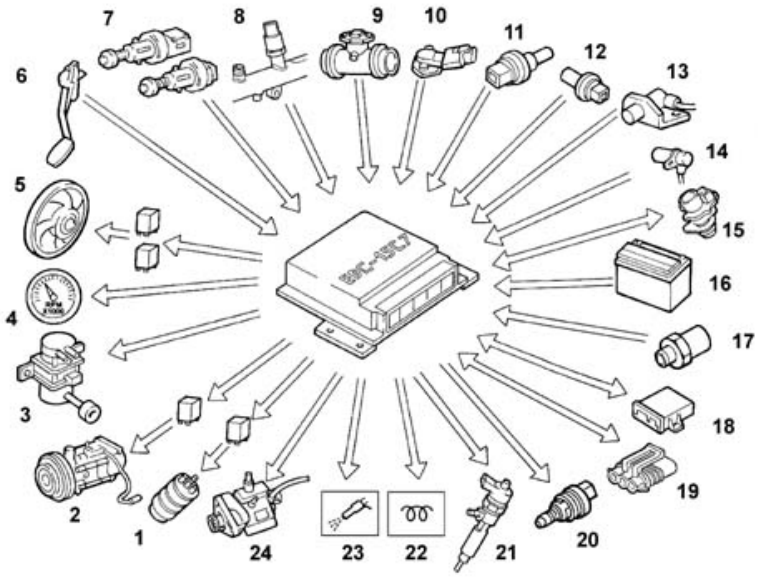
DIAGRAM SHOWNING INPUT/OUTPUT FLOWS BETWEEN ENGINE MANAGEMENT UNIT SENSORS/ACTUATORS.

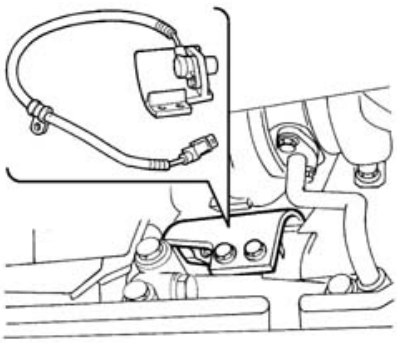
The following figure shows a diagram of input/output signals exchanged between the engine control unit and sensors/actuators



- 1 - Fuel pre-feed pump;
- 2 - Compressor.
- 3 - EGR modulator solenoid.
- 4 - Rev counter.
- 5 - Engine radiator fans.
- 6 - Accelerator pedal potetiometer.
- 7 - Brake and clutch pedal switches.
- 8 - Fuel pressure sensor.
- 9 - Intake air quantity and temperature (debimeter - vesions with EGR).
- 10 - Air pressure/temperature sensor (versions without EGR).
- 11 - Engine coolant temperature sensor.
- 12 - Fuel temperature sensor.
- 13 - Timing sensor.
- 14 - Engine rpm sensor.
- 15 - Pulse generator.
- 16 - Battery.
- 17 - 4 stage pressure switch.
- 18 - Fiat CODE control unit.
- 19 - Tester input.
- 20 - Fuel pressure regulator.
- 21 - Injectors.
- 22 - Preheating warning light on instrument panel.
- 23 - Injection system failure.
- 24 - 3rd pump element cut-out from high pressure pump (Radialjet).
- 25 - VGT solenoid valve (where fitted)

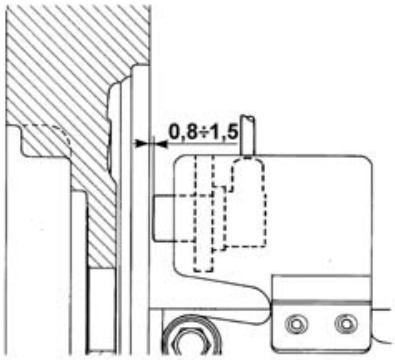
ENGINE RPM SENSOR

This inductive sensor is located on the engine near the flywheel. The sensor generates signals produced by magnetic flow lines that close through holes in the flywheel. The number of holes is 58.
The electronic control unit uses the signal to detect engine rotation speed and angular position and to govern the electronic rev counter.

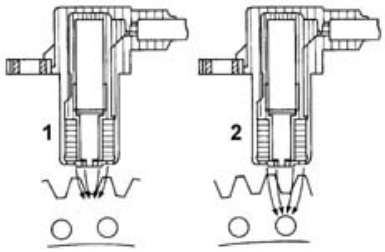


OPERATION

The changeover from full to empty determined by the presence or absence of a gap brings about a magnetic flux change sufficient to generate an induced alternating voltage proportional to the number of holes on the flywheel phonic wheel.
Rpm sensor peak output voltage depends, all else being equal, on the distance between the sensor and the phonic wheel holes.



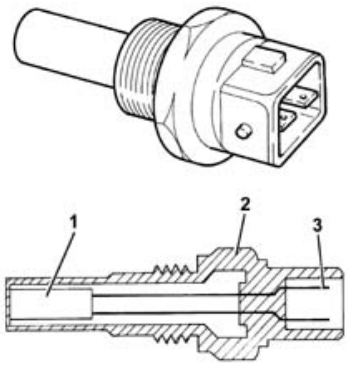
To obtain correct signals, the specified distance between phonic wheel and sensor (gap) must be between 0.8 - 1.5 mm.
This distance is not adjustable. If the gap is found to be outside the tolerance limits, check the condition of the sensor and phonic wheel.



- 1 - Maximum magnetic flux.
- 2 - Minimum magnetic flux.

ENGINE COOLANT TEMPERATURE SENSOR

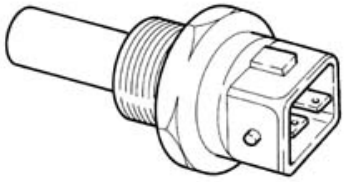
The sensor is installed on the thermostat and detects engine coolant temperature by means of an NTC thermistor with a negative resistance coefficient.
The sensor is designed using semiconductor technology. In other words, the resistance level drops if sensor element temperature increases with increasing coolant temperature.
Because the resistance does not change in linear fashion as temperature increases, it is relatively higher at low temperatures than at high temperatures.



- 1 - N.T.C. resistance
- 2 - Resistor case.
- 3 - Electrical connector.

FUEL TEMPERATURE SENSOR

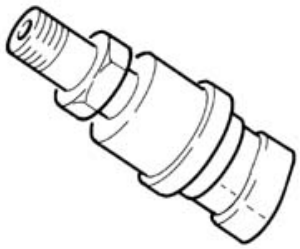
Fuel temperature sensor (1) incorporated in the fuel filter detects fuel temperature and sends it to the electronic control unit. When fuel temperature is excessive (outdoor environmental temperature condition, engine under full load and tank on reserve), effective high pressure pump lubrication can no longer be guaranteed. The control unit determines fuel density and volume on the basis of input values and corrects output to limit engine performance.



FUEL PRESSURE SENSOR

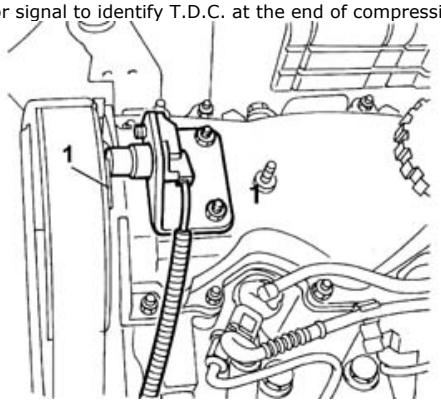
The sensor is installed in the middle of the fuel delivery manifold (rail) and is responsible for sending the engine control unit a return signal (feedback) to:

- modulate injection pressure;
- regulate fuel injection duration.



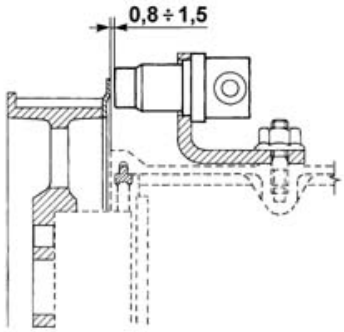
TIMING SENSOR

This Hall-effect sensor is installed on the cylinder head, where it faces the camshaft pulley.
A sector (1) on the pulley allows the timing sensor to detect engine timing position and notify the engine control unit accordingly.
The injection control unit uses the timing sensor signal to identify T.D.C. at the end of compression.



OPERATION

A current-carrying semiconductor layer immersed in a normal magnetic field (force lines at right angles to current direction) generates a potential difference known as a Hall voltage at its terminals.
If current intensity remains constant, the generated voltage depends on magnetic field intensity alone. Periodic changes in magnetic field intensity are sufficient to generate a modulated electrical signal with frequency proportional to the speed of magnetic field change.
This change is achieved by making a magnetic ring (internal part of pulley) with an opening pass the sensor.
As it moves, the metal part of the ring covers the sensor to block the magnetic field and thus generate a low ouput signal. Conversely, the sensor generates a high signal when the opening is over the sensor and a magnetic field is present.
This signal, combined with the rpm and T.D.C. signals, allows the injection control unit to identify piston position and determine the injection point.
To obtain correct signals, the specified distance between camshaft pulley and sensor (gap) must be between 0.8 - 1.5 mm.



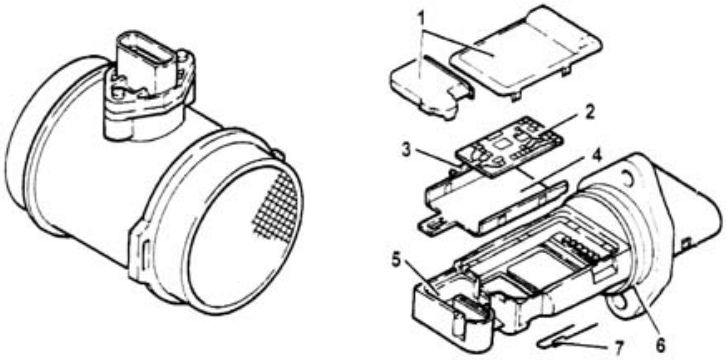
This distance is not adjustable. If the gap is found to be outside the tolerance limits, check the condition of the sensor and camshaft pulley.

AIR FLOW METER

The debimeter is located on the air intake sleeve and is hot film type.
The debimeter contains an integral intake air temperature sensor. The debimeter is used in the version with EGR versions.

OPERATION

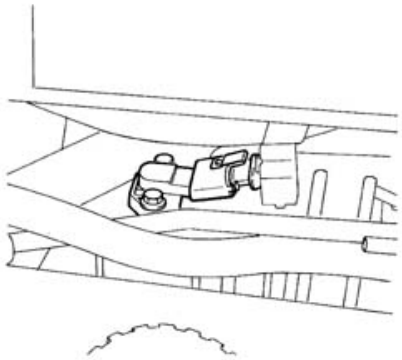
The principle of operation is based on a heated membrane positioned within a measurement channel that carries air into the engine.
The hot film membrane is maintained at constant temperature (about 120°C higher than the incoming air temperature) by the heating coil.
The air mass that flows through the measurement channel tends to remove heat from the membrane. Current must therefore flow through the coil to maintain the membrane at a constant temperature.
Current uptake is proportional to the air mass that flows into the engine. It is measured using a Wheatstone bridge and the resulting signal is sent to the engine control unit.



- 1 - Covers.
- 2 - Electronic card.
- 3 - Sensor.
- 4 - Mounting plate.
- 5 - Mount.
- 6 - Sealing ring.
- 7 - Temperature sensor.

AIR PRESSURE - TEMPERATURE SENSOR

The air pressure/temperature sensor is located on the intake manifold and detects the level of turbocharged air pressure taken into the intake manifold.
This value, combined with the air temperature sensor reading, allows the electronic control unit to determine the precise amount of air taken into the cylinders. The unit can then govern the injectors to modulate fuel delivery, limit harmful emissions and improve fuel consumption and performance.
The sensor contains an electronic circuit that corrects temperature to optimise pressure detection as a function of intake air temperature. The sensor is fitted to the version without EGR.



INJECTORS

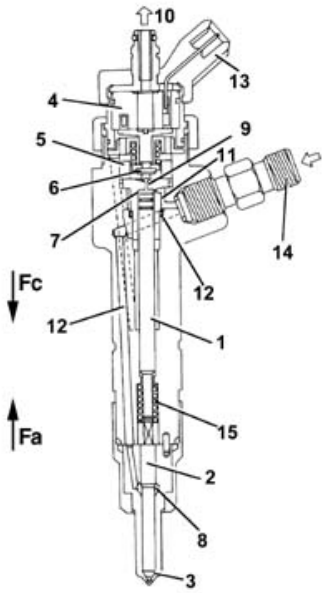
The injectors fitted to the cylinder head are electromagnetic and controlled directly by the engine control unit.
The injectors are equipped with a high pressure supply duct (1350 bars) and an environmental pressure recirculation pipe. The supply duct is connected to the delivery manifold (rail) by means of pipes designed to support the high service pressures.
The injector may be divided into two sections:

- actuator/nebuliser consisting of pressure rod (1), pin (2) and nozzle (3);
- coil (4) and pilot valve (5).

OPERATION

Injector operation is divided into three stages:

- Rest position: coil (4) is deactivated and plunger (6) is in closed position to prevent fuel from being introduced into the cylinder: Fc > Fa, where Fc is the force generated by the pressure acting on control area (7) of push-rod (1) and Fa is the force due to pressure acting in supply volume (8).
- Injection start: coil (4) is excited and causes plunger (6) to rise. Fuel flows from control volume (9) to the return manifold to bring about a pressure drop on control area (7). Simultaneously, line pressure flowing through intake duct (12) exercises a force Fa > Fc in supply volume (8) to cause pin (2) to lift and allow fuel into the cylinders.
- Injection end: Coil (4) is deactivated and causes plunger (6) to return to closed position. This rebalances the forces so that pin (2) returns to closed position and thus ends the injection.



- 1 - Push-rod.
- 2 - Pin.
- 3 - Nozzle.
- 4 - Coil.
- 5 - Pilot valve.
- 6 - Ball plunger.
- 7 - Control area.
- 8 - Supply volume.
- 9 - Control volume.
- 10 - Fuel outlet fitting (low pressure).
- 11 - Control duct.
- 12 - Supply duct.
- 13 - Electrical connection.
- 14 - Fuel intake fitting (high pressure).
- 15 - Spring.

COLD STARTIGN DEVICE - FLAME START (THERMAL STARTER)

This device has the task of guaranteeing engine starting even at low temperatures (<0°C).
It comprises: a thermal starter (1a) located on the intake manifold, a solenoid valve (2) supplying (diesel) fuel to the thermal starter, a pressure regulating valve. The system is controlled by the engine management control unit which also manages the warning light in the instrument panel.
This device is fitted as an alternative to the heat flange (see appropriate paragraph).

THERMAL STARTER DESCRIPTION AND OPERATION

The thermal starter (1) basically comprises a diesel injector and a heater plug.
It is supplied with fuel coming from the high pressure pump recirculation by means of a pressure regulation valve (calibrated at 0.5 bar) and a solenoid valve (2) controlled by the engine management control unit. Whilst it is working (starting and post-heating stages) the solenoid valve is activated, the fuel enters the thermal starter by the inlet connector (3) and, dripping on the heater plug in the burner (5), it burns. The flame produced is injected into the intake manifold; the temperature of the intake air increases considerably and thereby facilitates starting and efficiency at low temperatures.
For the thermal starter to work smoothly the heater plug must be very hot: the pre-heating stage is designed precisely to heat up the heater plug.

OPERATION OF THE SYSTEM

When the panel is switched on the heater warning light always comes on for 0.5 secs to allow a check on the system.
Pre-heating stage
Later on, if the following conditions are satisfied:

- outside temperature < 0°C
- battery voltage > 5 V

the pre-heating stage is begun, with the duration depending on the battery voltage and it can vary between 19 and 30 secs. The Flame Start heater plug is heated during this stage until the temperature is suitable for burning the diesel and the heater warning light remains on.
At the end of the pre-heating stage, the heater warning light goes out but the heater plug remains on for 12.5 secs (distraction time) whilst the driver should start up the engine or else the procedure has to be repeated.


Starting should not begin before the end of the pre-heating stage (indicated by the heater warning light going out) or else the pre-heating is interrupted.

Starting stage
The driver turns the key to begin starting.
During stating the heater plug remains on and the solenoid valve provding the diesel that supplies the Flame Start is activated; in this way the thermal starter heats up the air drawn in by the engine to facilitate starting. The solenoid valve remains open until the engine speed is above 200 pm (the engine is considered to be started). The heater warning light remains off.
Post-heating stage
If starting is successful and the engine reaches about 900 pm, the post-heating stage begins which may last, depending on the outside temperature, between 60 and 110 secs. During this stage, the heater warning light remains off, the heater plug is on and the solenoid valve (reactivated at the beginning of the stage) is open; this allows the heater to heat the intake air to facilitate the engine warming up and reaching operating temperature. At the end of the stage, the heater plug goes out and the solenoid valve is deactivated.
Starting unsuccessful
If the starting is unsuccessful (the key is released) the solenoid valve is deactivated when the engine switches off, whilst the heater plug remains on until the panel switches off.
To make another attempt at starting the panel must be switched off first before starting the procedure once again.


Switching off the panel interrupts the procedure at any point and the switching back on is started once again.

The table below summarizes the status of the components during the various operating stages

Stage	Stage duration	Heater warning light	Heater plug	Solenoid valve
Pre-heating	19"÷30"	ON	ON	OFF
Distraction	12,5"	OFF	ON	OFF
Start-up	> 200 rpm	OFF	ON	ON
Post-heating	60"÷110"	OFF	ON	ON