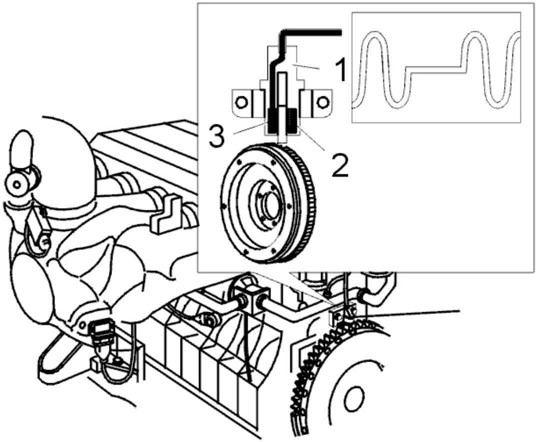
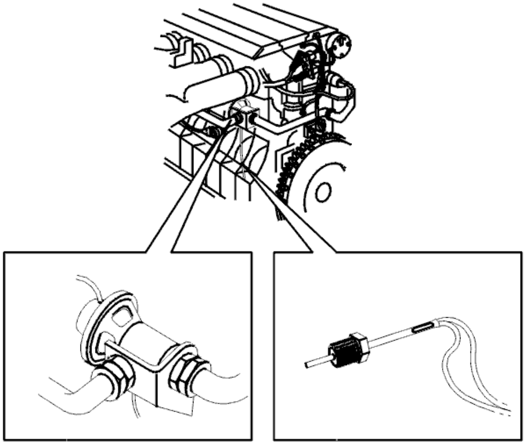
RPM sensor



Around the periphery of the flywheel/carrier plate, there are a number of holes, each of which generates a voltage in the RPM sensor coil as it passes. This generates an AC signal, the frequency of which is a function of the number of holes passing per second. Its voltage can also vary between 0.1 and 55 V AC (10 kΩ load) depending on engine speed and temperature. Voltage and frequency increase with engine speed, so by detecting the voltage pulses, the ECM determines crank angle and speed.
At a point corresponding to 90° before TDC for cylinder 1, the distance between one pair of holes is greater. This interrupts the voltage pulses and allows the ECM to determine the crank angle.
The engine stops if signals from the sensor to the ECM are lost.
The sensor incorporates the following components:

- Housing (1).
- Permanent magnet (2).
- Coil (3).

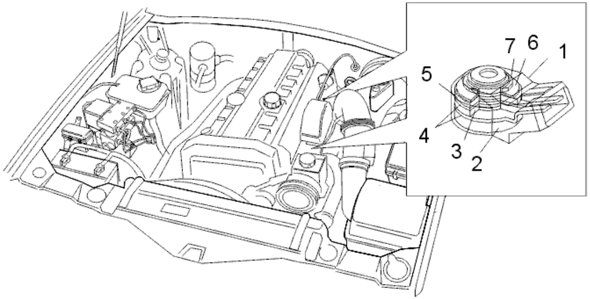
EGR temperature sensor



The EGR temperature sensor measures the temperature of the exhaust gases which are led back to the intake manifold. By comparing EGR and engine temperature, the ECM can determine whether or not the EGR system is operating.
EGR temperature sensors come in three forms:

1. PTC type (Positive Temperature Coefficient) in older designs using a PTC temperature sensor in which voltage increases with temperature. The temperature sensor is located in the upper EGR pipe. This type was in production up to 1991 models.
2. PTC type in service and spare parts equipped with PTC temperature sensor located in the EGR valve. It is used for vehicles as above when it is necessary to service or replace EGR system components.
3. NTC type (Negative Temperature Coefficient) using an NTC temperature sensor, have replaced the PTC type in production. The temperature sensor has a resistance with a negative temperature coefficient. The ECM delivers a nominal (unloaded) voltage of 5V to the terminals of the sensor. The other terminal is grounded. Depending on the temperature of the returning exhaust gas and thus on the resistance of the sensor, this voltage varies between 0 and 5V with its maximum when the sensor is cold and the minimum when it is hot. The EGR temperature sensor is located in the EGR valve.

Knock sensors (KS)



The function of the knock sensors is to provide the ECM with information on the onset of engine knock.

The signals from the KS and CMP sensor allow the ECM to determine which cylinder is knocking.

The engine management system has two KS, which incorporate the following:

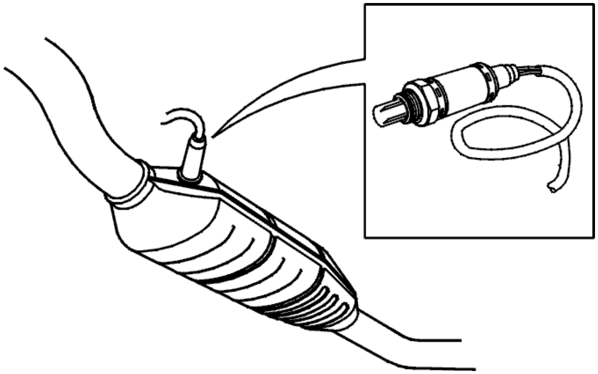
- Housing (1).
- Sleeve (2).
- Piezoelectric crystal (3).
- Contact strips (4).
- Damping weight (5).
- Washer (6).
- Nut (7).

Engine knock generates vibrations which are transmitted through the engine block. The piezoelectric crystal (3) detects these vibrations and sends a signal proportional to frequency and amplitude to the ECM.

The front KS detects knock in cylinders 1, 2 and 3, and the rear KS in cylinders 4, 5 and 6.

The KS are mounted on the engine block.

Heated oxygen sensor (HO2S)



The HO2S is located in the catalysator, and provides the ECM with information on the air/fuel mixture. The sensor, which is electrically heated, produces a voltage which varies according to the exhaust gas oxygen content.

To measure exhaust oxygen content, the HO2S requires a supply of ambient air as a reference. Since this is supplied via the cable, the lead must not be clamped or damaged in any way, nor must oil be used on the sensor contacts since this could also affect the reference air supply.

Function

The HO2S only works above a certain temperature: 285°C (545°F). The normal working temperature lies in a range of 350°C to 850°C (662°F – 1562°F).

The HO2S is electrically heated. When the engine starts, a current flows through a PTC resistance. Since the HO2S is cold, the resistance is low and the current passed through the circuit is therefore high. As the temperature of the PTC resistance rises, the current falls proportionally.

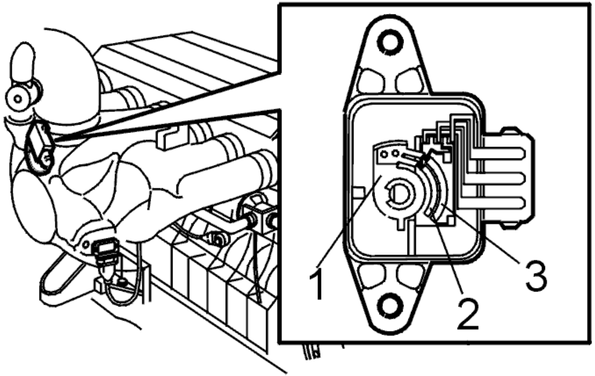
When the engine is running rich ($\lambda<1$), the exhaust gas oxygen content is low and the HO2S gives a signal of approx. 0.9 V.

Under leaner running ($\lambda>1$), excess oxygen occurs in the exhaust and the output signal from the HO2S drops to nearly zero.

The change from high to low signal level occurs at the ideal (stoichiometric) air/fuel ratio of 14.7:1.

The ECM uses the HO2S signal to continually control the amount of fuel injected so as to maintain the ideal mixing conditions of $\lambda=1$.

Throttle position (TP) sensor



The TP sensor sends information on throttle opening to the ECM. This information is used to compute engine loading, for example under acceleration and at idle.
The TP sensor consists of the following:

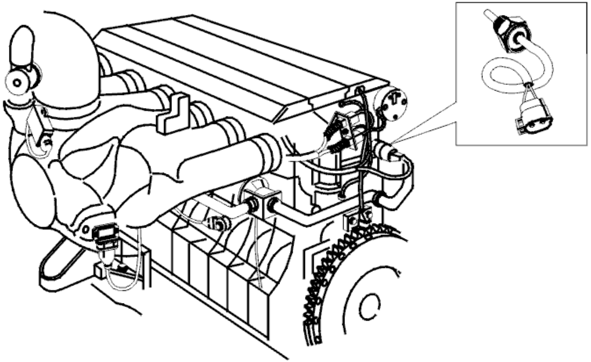
- Hub and wiper contacts (1).
- Contact strip (2).
- Rheostat (3).

The hub and wiper contacts rotate with the throttle spindle varying the sensor output signal. The ECM sends a 5 volt supply to the TP sensor contact strip so that output signal increases with increased throttle angle.

The ECM uses default values if the TP sensor signal is absent or faulty.

The TP sensor is located in the throttle housing.

Engine coolant temperature (ECT) sensor



The MAF sensor supplies the ECM with information on cooling water temperature which is used to control the following:

- Injection period.
- Idle speed.
- Engine coolant fan.
- Ignition advance angle.

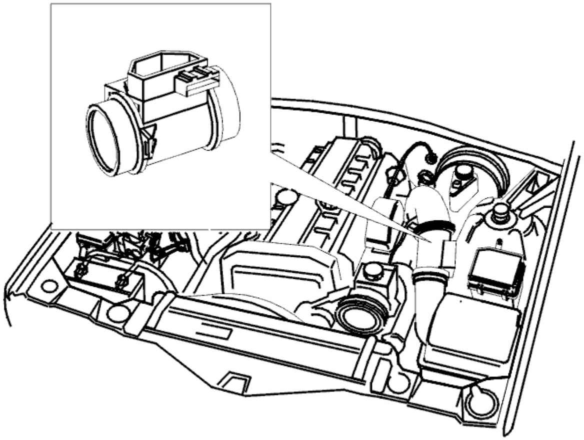
The sensor incorporates a temperature sensitive resistance with a negative temperature coefficient (NTC). The ECM delivers a 5 volt supply to one of the sensor terminals. The second terminal is grounded.

Depending on engine temperature and, therefore, sensor resistance, the voltage across the sensor varies.

The ECM uses default values if the signal from the ECT sensor is absent or faulty.

The ECT sensor is located to the rear of the engine.

Mass air flow (MAF) sensor



The MAF sensor measures engine intake air mass and supplies this information continuously to the ECM, which is used to calculate:

- Injection period
- Point of ignition
- Whether engine coolant fan is required.

In automatics, the TCM also uses the information to determine gear changes.

The MAF sensor is supplied with 12 volts via the main relay, and has separate grounds for power and signal. The signal from the sensor varies from 1.5 volts to 5 volts depending on air mass, increasing with air flow.

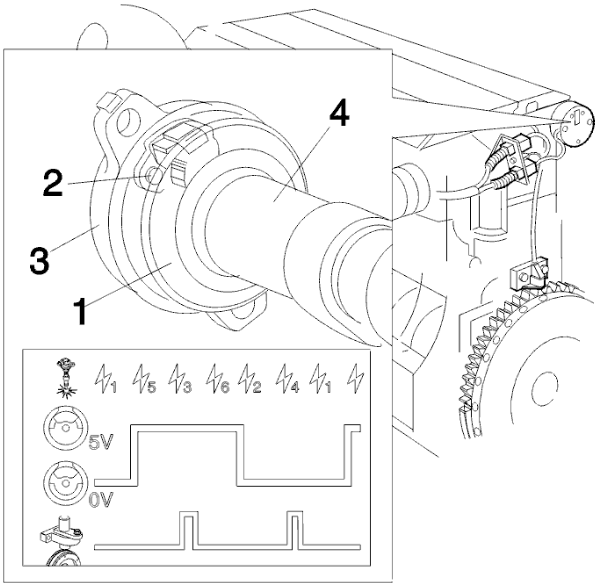
The element of the MAF sensor is a wire heated to a temperature 155°C (311°F) higher than the intake air temperature. As the air passes the sensor, the wire is cooled and more current is required to return it to temperature. This current is therefore a measure of the air flow passing the hot wire.

When the engine is stopped and certain load and speed conditions have been fulfilled, any fouling on the wire is removed by heating it electrically to over 1,000°C (1,832° F) for less than a second. If the fouling is not removed, the ECM receives a faulty signal and gives incorrect fuel/air mixing.

The ECM uses default values if the signal from the MAF sensor is absent or faulty.

The MAF sensor is located between the air filter capsule and the fresh air hose.

Camshaft position (CMP) sensor



The function of the CMP sensor is to tell the ECM whether the camshaft is on the first or second revolution of a working cycle. A further function is to enable the ECM to determine which cylinder is knocking on the basis of other information supplied by the RPM sensor and the two knock sensors.

The CMP sensor consists of the following:

- Trigger rotor (1).
- Hall–effect sensor (2).
- cover (3).

The trigger rotor turns at the same speed as the camshaft (4). The ECM sends a 5 V supply to the Hall–effect sensor, and this is grounded when the slot in the rotor passes the sensor, giving a zero output signal. When the Hall–effect sensor is shielded, the voltage supply is unaffected, and the output signal is 5 V.

As the camshafts rotate at half crank–speed, the output signal is either high or low every second crankshaft revolution, corresponding to the working stroke of the respective cylinder.

The CMP signal allows the ECM to determine which pistons are approaching TDC in the pairs of cylinders (1–6, 5–2 and 3–4). Together with the signal from the RPM sensor, it allows the ECM to determine in which cylinder ignition is required.

The CMP sensor is located to the rear of the engine.