284: Engine control module (ECM), B5244S2

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284: Engine control module (ECM), B5244S2

Accelerator pedal (AP) position sensor

Air conditioning (A/C) compressor

Air conditioning (A/C) relay

Brake light switch

Camshaft position (CMP) sensor

Camshaft reset valve (Continuous variable valve timing (CVVT))

Clutch pedal sensor (manual transmissions only)

Cooling fan for control modules

Electronic throttle unit

Emissions warning lamp

Engine coolant level sensor

Engine coolant temperature (ECT) sensor

Engine cooling fan (FC) control module

Engine speed (RPM) sensor

Evaporative emission system (EVAP) valve

Fuel pressure sensor / fuel temperature sensor (only vehicles with demand controlled fuel pumps)

Fuel pump (only vehicles with demand controlled fuel pumps)

Fuel pump control module (only vehicles with demand controlled

fuel pumps)

Heated oxygen sensors (HO2S)

Ignition coils

Ignition switch

Immobilizer

Injectors

Knock sensor (KS)

Leak diagnostic unit (certain markets only)

Main relay (system relay)

Manifold absolute pressure (MAP) sensor

Mass air flow (MAF) sensor with integrated temperature sensor

Oil level sensor (2005-, certain markets only)

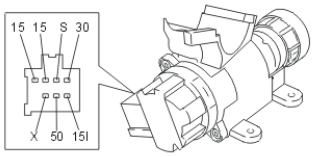
Oil pressure sensor

Outside temperature sensor

Throttle position (TP) sensor

Design

Ignition switch



The Engine Control Module (ECM) uses the signal from the ignition switch to detect when the ignition key has been turned to position II or III. When the key is in the ignition position (position II) or starting position (position III) a high signal (U_{bat}) is

transmitted from the ignition switch to the engine control module (ECM). The engine management system prepares for start-up (for example, temporarily activates the fuel pump (FP) relay). When the flywheel in the engine rotates, the engine speed (RPM) sensor signal is used to keep the fuel pump (FP) relay activated.

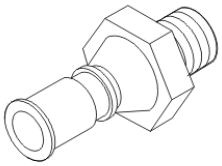
The fuse in the fuse box in the passenger compartment supplies current to the ignition switch.

The central electronic module (CEM) has diagnostics for the ignition switch.

Immobilizer

See Design and Function, Immobilizer.

Oil pressure sensor



The function of the oil pressure sensor is to warn the driver about low oil pressure via the driver information module (DIM).

The oil pressure sensor switch has a pressure sensing switch which is powered (signal) by the engine control module (ECM) and grounded in the cylinder block. The oil pressure sensor is affected by the oil pressure of the engine.

When the oil pressure exceeds a certain value, the switch in the oil pressure sensor will open. A high signal is then sent to the engine control module (ECM).

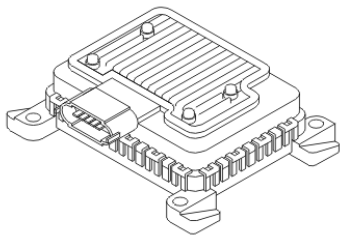
If the oil pressure is below a certain value, the switch in the oil pressure sensor will close and a high signal will be sent to the engine control module (ECM). The engine control module (ECM) then transmits a CAN signal to the driver information module (DIM) to light the indicator lamp for low oil pressure.

The oil pressure sensor is on the cylinder block.

The engine control module (ECM) cannot diagnose the oil pressure sensor.

Fuel pump control module (only vehicles with demand

controlled fuel pumps)



The fuel pump control module powers the fuel pump and regulates the output of the pump. The fuel pressure changes with the output of the pump.

The fuel pump control module is supplied with battery voltage by the fuel pump (FP) relay and is grounded in the car body. The fuel pump (FP) relay is controlled by the central electronic module (CEM) when requested by the engine control module (ECM). The engine cannot be started if the power supply to the fuel pump control module is faulty because the fuel pump will not then be powered.

The fuel pump control module is controlled by the engine control module (ECM) via serial communication. The fuel pump control module then controls the fuel pump by transmitting pulse width modulated (PWM) signals on the ground lead for the fuel pump. This means that the

voltage drop across the fuel pump changes, and with it the output of the fuel pump. See also: Function:Fuel pressure regulation (only vehicles with demand controlled fuel pumps)

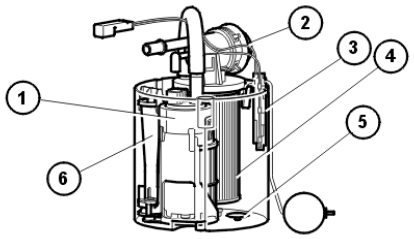
The central electronic module (CEM) controls the fuel pump (FP) on models without on-demand fuel pumps.

There are no diagnostics for the fuel pump control module. The engine control module (ECM) has diagnostics for fuel pressure regulation and the associated components.

The pulse-width modulated (PWM) signal from the engine control module (ECM) to the fuel pump control module can be read using VIDA.

The fuel pump control module is on the outside of the fuel tank.

Fuel pump (only vehicles with demand controlled fuel pumps)



The central electronic module (CEM) controls the fuel pump (FP) on models without on-demand fuel pumps.

The function of the fuel pump is to ensure that the pressure is correct in the delivery lines for the injectors when requested by the fuel pump control module.

The fuel pump consists of:

1. An electrical pump with an integrated safety valve
2. A pressure equalization valve. This valve equalizes rapid pressure peaks which occur, for example, when the injectors close during engine braking. The built-in check valve ensures that the system pressure does not drop when the engine is switched off
3. Fuel level sensor
4. Fuel filter, cannot be replaced separately
5. Relief valve, releases fuel into

the pump housing

6. Ejector pump, continuously fills the pump housing with fuel. The fuel always flows from the fuel pump through the ejector and back to the pump housing.

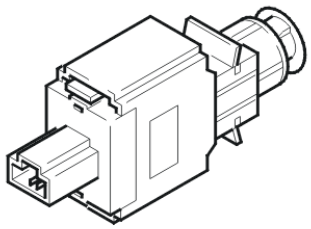
The fuel pump is supplied with battery voltage by the fuel pump control module and is grounded in the car body via the fuel pump control module.

The engine control module (ECM) has diagnostics for the fuel pump function to ensure that the pressure is correct.

The fuel pump can be activated and its status read off using VIDA.

The pressure in the fuel rail can be measured by connecting a manometer to a nipple. This nipple is on the right-hand end of the fuel rail.

Brake light switch



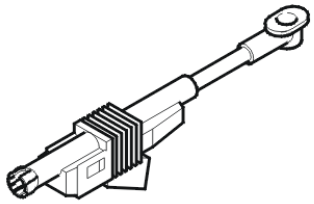
The purpose of the brake light switch is to provide the engine control module (ECM) with information indicating whether the brake pedal is depressed.
A signal is transmitted to the engine control module (ECM) when the brake pedal is pressed. The engine control module (ECM) disengages the cruise control (if activated). The brake pedal sensor also disengages cruise control. For further information, see Design and Function, Brake system, design.

The brake light switch is supplied with power from the ignition switch (terminal 30). When the brake pedal is depressed the switch closes and a high signal (12 V) is transmitted to the engine control module (ECM).

The engine control module (ECM) can diagnose the brake light switch. The status of the switch (pressed or not) can be read using VIDA.

The brake light switch is on the pedal box by the brake pedal.

Clutch pedal sensor (manual transmissions only)



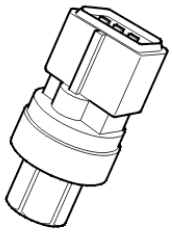
The clutch pedal sensor provides the Engine Control Module (ECM) with information about the position of the clutch pedal.
This information is used by the control module to switch off the cruise control.
The sensor signal is also used by the control module to prevent engine start if the clutch pedal is not pressed (certain markets).

The sensor consists of a sliding potentiometer which is supplied with power by the control module (signal) and which is grounded in the control module.
The resistance in the sensor reduces as pressure increases on the clutch pedal.

The engine control module (ECM) can diagnose the clutch pedal sensor. The status (position) of the sensor can be read using VIDA.

The sensor is on the pedal box by the clutch pedal.

Air conditioning (A/C) compressor

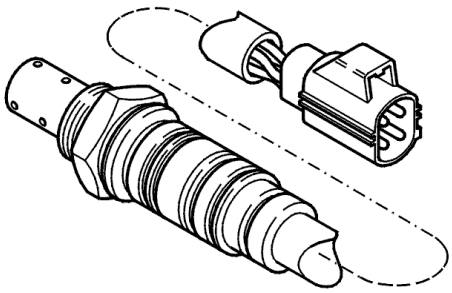


The air conditioning (A/C) pressure sensor detects the pressure in the high-pressure side of the air conditioning (A/C) system.

The sensor is linear. It is grounded in the control module and supplied with a 5 Volt current from the control module. A linear signal (which depends on the pressure in the air conditioning (A/C) system) is transmitted to the engine control module (ECM). Low pressure produces low voltage, high pressure produces high voltage.

The engine control module (ECM) can diagnose the air conditioning (A/C) pressure sensor. The sensor value can be read off using VIDA.

The air conditioning (A/C) pressure sensor is positioned on the high pressure delivery line for the air conditioning (A/C) system.



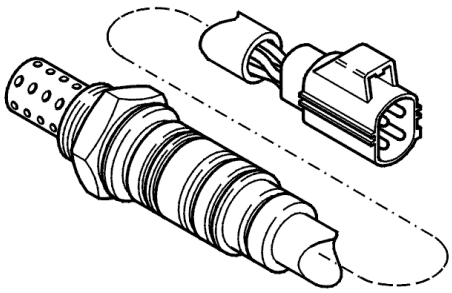
Heated oxygen sensors (HO2S)

Front heated oxygen sensor (HO2S)

The front heated oxygen sensor (HO2S) is used to provide the engine control module (ECM) with information about the remaining oxygen content of the exhaust gases in front of the three-way catalytic converter (TWC). This is so that the Engine Control Module (ECM) can continually check the combustion so that λ=1. λ=1 is the ideal fuel-air ratio, with 14.7 kg air/1 kg fuel. The heated oxygen sensor uses current regulation and its signal characteristic is linear. With a linear signal characteristic, the amplitude of the signal curve is low when changing the oxygen content in the exhaust gases. The probe consists of a preheating element (see "Pre-heating heated oxygen sensors (HO2S)") and the actual lambda sensor. The lambda sensor is an oxygen sensitive ceramic body consisting of zirconium oxide. The control module supplies power to the ceramic body, which reacts to the oxygen content of the exhaust gases. This in turn affects the signal to the engine control module (ECM). In order to determine the oxygen content in the exhaust pipe, the heated oxygen sensor needs reference air from the surrounding air. This reference air reaches the heated oxygen sensor via the air lines.

Caution! The wiring for the heated oxygen sensors (HO2S) must not be trapped or damaged in any way. The connectors for the heated oxygen sensors (HO2S) must not be greased under any circumstances. The oil in the grease would disrupt the reference air and the function of the heated oxygen sensors (HO2S).

The engine control module (ECM) can diagnose the heated oxygen sensor



(HO2S).

VIDA can be used to read off the calculated lambda value from the heated oxygen sensor.

Rear heated oxygen sensor (HO2S)

The rear heated oxygen sensor (HO2S) is used to provide the Engine Control Module (ECM) with information about the remaining oxygen content of the exhaust gases behind the three-way catalytic converter (TWC). This information is used by the Engine Control Module (ECM) to check the function of the three-way catalytic converter (TWC). This check is carried out when the conditions for the catalytic converter diagnostics have been met. The rear heated oxygen sensor (HO2S) has no direct effect on regulation of the fuel/air mixture. However the Engine Control Module (ECM) uses the signal to optimize the signal from the front heated oxygen sensor (HO2S).

The heated oxygen sensor (HO2S) uses voltage control. The signal characteristic is binary. With a binary signal characteristic, the amplitude of the signal curve changes considerably when changing the oxygen content in the exhaust gases. Otherwise its components and function are the same as the front heated oxygen sensor (HO2S).

Caution! The air lines for the heated oxygen sensors (HO2S) must not be trapped or damaged in any way. The connectors for the heated oxygen sensors (HO2S) must not be greased under any circumstances. The oil in the grease would disrupt the reference air and the function of the heated oxygen sensors (HO2S).

The engine control module (ECM) can diagnose the rear heated oxygen sensor. The signal can be read using VIDA.

Preheating of the heated oxygen sensors (HO2S)

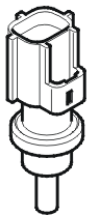
The heated oxygen sensor (HO2S) only functions above a certain temperature, approximately 300 °C. The normal operating temperature is between 300-900 °C. The heated oxygen sensors (HO2S) are electrically pre-heated so that operating temperature is rapidly reached. This also ensures that the heated oxygen sensors (HO2S) maintain a normal operating temperature and to prevent condensation which could damage the heated oxygen sensor (HO2S).

The heater element in the probe consists of a positive temperature coefficient (PTC) resistor. The system relay supplies the heater element with voltage. The element is grounded in the engine control module (ECM). When the control module grounds the connection a current flows through the PTC resistor. When the heated oxygen sensor (HO2S) is cold, the resistance in the PTC resistor is low and a large current will flow through the circuit. The current from the Engine Control Module (ECM) is pulsed at first to prevent condensation damage to the heated oxygen sensor (HO2S). Depending on the temperature, allowances are made for

factors such as the dew point. As the temperature in the PTC resistor rises, the resistance rises, the current falls and switches in stages to a constant current. The pre-heating time for the front heated oxygen sensor (HO2S) is short, approximately 20 seconds.

Probe preheating begins as soon as the engine is started. The heater element heats the heated oxygen sensors (HO2S) to approximately 350 °C. The probes maintain this as a minimum temperature.
The engine control module (ECM) can diagnose the heater element.

Engine coolant temperature (ECT) sensor



The engine coolant temperature (ECT) sensor checks the temperature of the engine coolant. The temperature of the engine coolant is required so that the engine control module (ECM) can regulate:

- the injection period
- the idle speed
- the engine cooling fan (FC)
- the ignition advance
- engagement and disengagement of the A/C compressor
- diagnostic functions.

The sensor is a negative temperature coefficient (NTC) type which is supplied with power from the control module (signal) and is grounded in the control module.

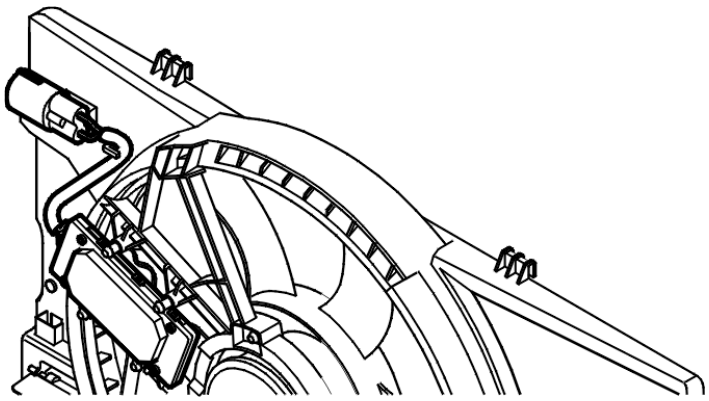
The resistance in the sensor changes depending on the temperature of the coolant. Depending on the resistance in the sensor, voltage (signal) is transmitted to the engine control module (ECM). The lower the temperature the higher the voltage (high resistance). A high temperature results in low voltage (low resistance).

The engine coolant temperature (ECT) sensor is located beside the thermostat.

The engine control module (ECM) can diagnose the engine coolant temperature sensor. The sensor value can be read off

using VIDA.

Engine cooling fan (FC) control module



The engine cooling fan (FC) cools the coolant, engine compartment and the condenser when the air conditioning (A/C) compressor is running.

The engine control module (ECM) transmits a pulse width modulated (PWM) signal to the engine cooling fan (FC) control module. The control module then activates the fan at different speeds. The speed of the engine cooling fan (FC) is determined by the engine control module (ECM), depending on the coolant temperature (based on the signal from the engine coolant temperature (ECT) sensor) and the vehicle speed.
The temperature conditions for engagement of the different engine cooling fan (FC) stages may vary slightly, depending on the engine variant

and the equipment level. The temperature conditions apply when:

- the A/C is off
- no faults are detected by the Engine Control Module (ECM).

There is an internal diagnostic function in the engine cooling fan (FC). This function transmits a signal to the engine control module (ECM) if the fan is partially or fully blocked. To do this, the engine cooling fan (FC) control module grounds the pulse width modulation (PWM) signal based on a predetermined pattern.

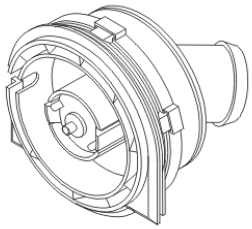
Note! The engine cooling fan may have a post-run of up to approx. 6 minutes after the engine has been turned off. The time for the fan's post-run depends on engine temperature, temperature in the engine compartment and pressure level in the AC-system.

Warning! Be careful since the engine cooling fan may have a post-run after the engine has been turned off.

The engine cooling fan (FC) and its control module are behind the radiator.

The engine control module (ECM) can diagnose the engine cooling fan. The fan can be activated using VIDA.

Cooling fan for control modules



The engine control module (ECM) is in a control module box in the engine compartment. The transmission control module (TCM) is also in this box in vehicles with automatic transmissions.
The function of the cooling fan is to cool the control modules in the control module box in the engine compartment. The control modules may be damaged if they overheat.

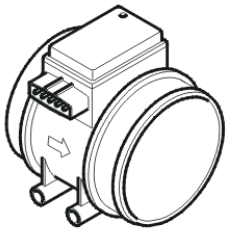
A temperature sensor is integrated in the engine control module (ECM). The engine control module (ECM) activates the fan if the control module registers that the temperature is too high. The fan then runs continuously until the temperature has dropped to a normal level.

The cooling fan is in the hose between the control module box and the firewall.

The engine control module (ECM) can diagnose the cooling fan. The fan can be activated using VIDA.

A diagnostic trouble code (DTC) is stored if the temperature in the engine control module (ECM) gets too high.

Mass air flow (MAF) sensor with integrated temperature sensor



Overview

The mass air flow (MAF) sensor on naturally aspirated engines is a combined sensor and contains two sensors in the same component:

- mass air flow (MAF) sensor
- temperature sensor.

The mass air flow (MAF) sensor is positioned between the air cleaner (ACL) housing and the

intake manifold.

Mass air flow (MAF) sensor

The mass air flow (MAF) sensor gauges the air mass sucked into the engine. It continuously transmits signals to the engine control module (ECM) about the mass of the intake air. This data is used by the engine control module (ECM) to calculate:

- the injection period
- the fuel pressure
- the ignition timing
- the engine load.

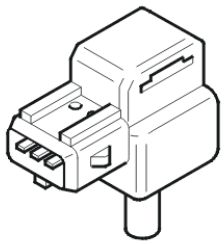
The transmission control module (TCM) also uses this data for its gear shift calculations. This data is transmitted to the transmission control module (TCM) from the engine control module (ECM) via the high speed side of the Controller area network (CAN).
The mass air flow (MAF) sensor is a hot wire type. Unlike other hot wire types, the mass air flow sensor in the Denso system uses a hot wire which has a ceramic casing. This eliminates the need for a clean burn function.
The mass air flow (MAF) sensor is supplied with battery voltage by the system relay and is grounded in the engine control module (ECM).
The signal from the gauge is analog. It

varies depending on air mass. Low air flow (low mass) results in low voltage, high air flow (high mass) gives high voltage.
On turbocharged engines the mass air flow (MAF) sensor has a slightly different design. It is not a combined sensor and only contains sensors for the mass air flow.
The engine control module (ECM) can diagnose the mass air flow (MAF) sensor. The signal can be read using VIDA.

Temperature sensor
The temperature sensor checks the temperature of the intake air in the intake manifold. This data is used by the engine control module (ECM) to calculate injection period. The control module also controls certain diagnostic functions using the signal from the temperature sensor.
The sensor, which is an NTC resistor, is grounded in the engine control module (ECM) and supplied with power (signal) from the control module.
The signal to the engine control module (ECM) is based on the temperature of the intake air. The temperature changes the resistance in the sensor. The lower the temperature the higher the voltage (high resistance). A high temperature results in

low voltage (low resistance).
The engine control module (ECM) can diagnose the temperature sensor.
The sensor signal can be read using VIDA.

Manifold absolute pressure (MAP) sensor

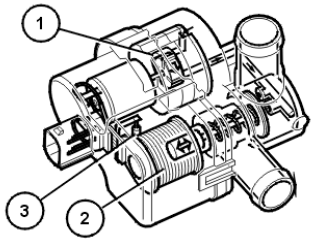


The manifold absolute pressure (MAP) sensor is on top of the radiator and is connected to the intake manifold by a hose.
The manifold absolute pressure (MAP) sensor detects quick pressure changes in the intake manifold after the throttle. The signal from the sensor is used by the engine control module (ECM) to supplement the mass air flow (MAF) sensor when calculating injection period.
The semi-conductor sensor is grounded in the control module and is supplied with power from the control module.
As the pressure in the intake manifold varies, the position of the silicone membrane in the sensor changes. This generates a signal to the engine control

module (ECM). Low pressure produces low voltage, high pressure produces high voltage.

The engine control module (ECM) can diagnose the manifold absolute pressure (MAP) sensor. The sensor signal can be read using VIDA.

Leak diagnostic unit (certain markets only)



The function of the leak diagnostic unit is to pressurize the fuel tank system during leak diagnostics and to open the fuel tank system to the surrounding air during evaporative emissions control.

The leak diagnostic unit consists of a plastic housing with:

1. electrical air pump
2. a valve / solenoid which governs the air flow in the unit
3. a heater element (PTC resistor) which warms up the pump.

The electrical pump,

valve and heater element in the unit are supplied with voltage by the system relay. The pump, valve and heater element are grounded (control) in the engine control module (ECM).

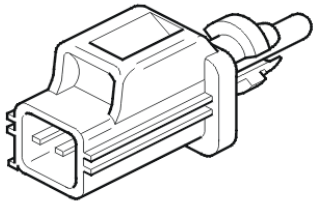
During leak diagnostics the pump in the leak diagnostic unit starts. The valve in the unit is operated by the engine control module (ECM) by grounding the different circuits internally in the engine control module (ECM). The engine control module (ECM) gauges the power consumption of the pump during pressurization. The power consumption corresponds to a certain pressure in the fuel tank system.

The engine control module (ECM) can diagnose the leak diagnostic unit.

The valve in the leak diagnostic unit can be activated and the power consumption of the pump can be read off using VIDA.

The leak diagnostic unit is at the upper front edge of the fuel tank.

Outside temperature sensor



The outside temperature sensor detects the temperature in the surrounding air. The signal is used by the engine control module (ECM) as a substitute value in the event of a fault in certain components or functions and to control certain diagnostic functions.

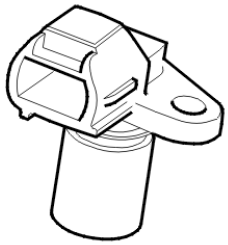
The sensor is a negative temperature coefficient (NTC) type which is supplied with power from the control module (signal). The resistance in the sensor changes with the outside temperature. This alters the signal to the engine control module (ECM). The lower the temperature the higher the voltage (high resistance). A high temperature results in low voltage (low resistance).

The outside temperature sensor is positioned in the left door mirror.

The engine control module (ECM) can diagnose the outside

temperature sensor.
The sensor value can be read off using VIDA.

Engine speed (RPM) sensor



The engine speed (RPM) sensor provides the engine control module (ECM) with information about the speed and position of the crankshaft. The Engine Control Module (ECM) is able to use the signal from the engine speed (RPM) sensor to determine when a piston is approaching top dead center (TDC). However the engine control module (ECM) is unable to use the signal from the engine speed (RPM) sensor to determine whether the piston is in the combustion stroke or whether the exhaust valve is open (exhaust stroke). A signal from the camshaft position (CMP) sensor is also required to determine the operating cycle of the engine.
The signal from the engine speed (RPM) sensor is also used to check the engine for misfires (misfire diagnostics).

The engine speed (RPM) sensor detects the holes in a steel ring (stamped). This steel ring is welded to the edge of the carrier plate. The holes are positioned at 6° intervals. This arrangement creates a hole for each tooth. There are 360° in one revolution. 6° between each hole means that there are 60 holes. However two holes are not stamped (long tooth - reference tooth). These holes provide a reference position for the crankshaft. The first hole after the "long tooth" indicates 84° before top dead center in cylinder 1 on a 5 cylinder engine.

The engine speed (RPM) sensor is at the rear of the engine above the flywheel.
The sensor is inductive with a permanent magnet. An alternating current is induced in the sensor when the carrier plate passes the engine speed (RPM) sensor. The generated voltage and frequency increases with the engine speed (rpm).
The signal voltage varies with engine speed (RPM).

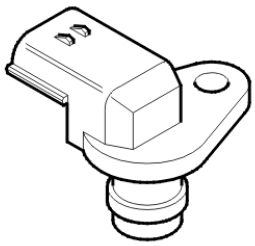
The Engine Control Module (ECM) is able to determine the engine speed (RPM) by counting the number of holes per time unit.

When the reference tooth passes the engine speed (RPM) sensor, the voltage and frequency drop momentarily to zero, even though the engine is still running. This allows the engine control module (ECM) to determine the position of the crankshaft.

If the signal from the engine speed (RPM) sensor is incorrect or missing, the control module will use the signals from the camshaft position (CMP) sensor, on the condition that the position of the camshaft has been adapted and the car can be driven if there is no signal.

The engine control module (ECM) can diagnose the engine speed (RPM) sensor. The sensor value (engine speed (rpm)) can be read off using VIDA.

Camshaft position (CMP) sensor



The Engine Control Module (ECM) uses the signals from the camshaft position (CMP)

sensor and the engine speed (RPM) sensor to establish the operating cycle of the engine. This enables the engine control module (ECM) to:

- start the engine more quickly
- control the correct ignition coil and injector
- function as a substitute for the engine speed (RPM) sensor
- check the camshaft continuous variable valve timing (CVVT).

The pulse wheel on the camshaft has five teeth with different gaps which correspond to a specific cylinder.
For further information, also see: Design:Knock sensor (KS) , Design:Engine speed (RPM) sensor and Function:Camshaft control (CVVT)

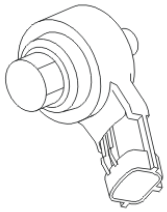
The sensor, which is a magnetic resistor with a permanent magnet, is grounded in the control module and supplied with current from the control module. The signal voltage varies with the shape of the camshaft pulse wheel. When one of the teeth on the camshaft pulse wheel passes the camshaft position (CMP) sensor, a signal is transmitted to the engine control module

(ECM) from the camshaft position (CMP) sensor. A low signal is transmitted to the engine control module (ECM) when the camshaft position (CMP) sensor is between two teeth.

The camshaft position (CMP) sensor is positioned at the rear of the engine on the camshaft with continuous variable valve timing (CVVT). On vehicles with twin camshaft position sensors, the signals are offset in relation to each other. This allows the cylinder to be identified more quickly.

The engine control module (ECM) can diagnose the camshaft position (CMP) sensor.

Knock sensor (KS)



The function of the knock sensor (KS) is to monitor combustion knocking from the engine. Knocking may damage the engine and reduces the efficiency of engine combustion.
If the engine control module (ECM) registers

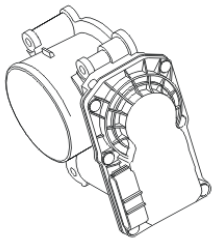
knocking from any of the cylinders, the ignition will be retarded for that cylinder at the next combustion stage. If repeated ignition retardation does not prevent knocking, the injection period will be increased. This has a cooling effect.

The sensor is made up of a Piezo electrical crystal. If there is engine knock, vibrations (sound waves) spread through the cylinder block to the knock sensor (KS). The resultant mechanical stress in the Piezo electrical material in the knock sensors generates a voltage. This signal is transmitted to the engine control module (ECM). The signal corresponds to the frequency and amplitude of the sound waves. This allows the Engine Control Module (ECM) to determine if the engine is knocking. The camshaft position (CMP) sensor and engine speed (RPM) sensor are used to determine the operating cycle of the engine (which cylinder is igniting) and thereby which cylinder is knocking.

The knock sensor (KS) is positioned on the cylinder block below the intake manifold.

The engine control module (ECM) can diagnose the knock sensor (KS).

Electronic throttle unit



The electronic throttle unit, using the PWM control signal from the engine control module (ECM), regulates the amount of air for engine combustion. This is done using an electronically controlled shutter.

The aluminum electronic throttle unit consists of a round throttle disc on a spindle. The spindle is driven by a DC motor (damper motor), gear wheel and two springs; one for opening and one for return.

By changing the polarity of the power supply, the DC motor can be run in both directions. At one of the limit positions the throttle disc is closed so that minimal air can pass the throttle unit. In the other limit position, the throttle disc is parallel to the air flow.

This provides maximum airflow through the electronic throttle unit.

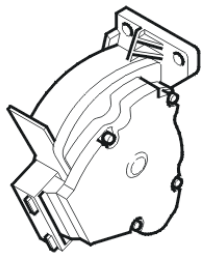
Two permanent magnets in the gear sector on the throttle spindle are used to check the position of the throttle disc. The permanent magnets affect two throttle position (TP) Hall sensors in the cover. The analog signals from the two sensors are transmitted to the engine control module (ECM). The signals are offset. The engine control module (ECM) compares these signals with the stored desired values to check if they are plausible.

The electronic throttle unit is located on the engine intake manifold. In the event of a fault, the throttle unit must be replaced as a single unit.
The engine control module (ECM) can diagnose the electronic throttle unit.

Throttle position (TP) sensor

See Design, Electronic throttle unit.

Accelerator pedal (AP) position sensor



The function of the accelerator pedal (AP) position sensor is to provide the engine control module (ECM) and central electronic module (CEM) with information about the position of the accelerator pedal. This data is used by the engine control module (ECM) to deploy the shutter in the throttle unit to the correct angle.

The accelerator pedal (AP) position sensor consists of a plastic housing with two potentiometers, and an Analog/Digital converter. The potentiometers are connected to a common shaft which is affected by the position of the accelerator pedal (AP).

The accelerator pedal (AP) position sensor transmits an analog and a pulse width modulated (PWM signal to the engine control module (ECM). These signals indicate the position of the accelerator pedal (AP). The digital signal is generated by the sensors Analog/Digital

converter.
The analog and digital signals are used at the same time by the engine control module (ECM) to regulate the throttle shutter angle.

The power supply to the two potentiometers is different. The analog potentiometer is supplied with 5 V via the engine control module (ECM). The digital potentiometer is supplied with 12 V via the system relay and is grounded in the car body.

The digital signal is also used in conjunction with the analog signal for accelerator pedal (AP) position sensor diagnostics.

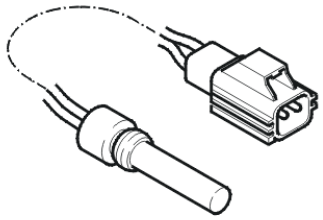
Signals from the accelerator pedal position sensor can be read out using VIDA.

A diagnostic trouble code (DTC) is stored if the engine control module (ECM) detects a difference between the analog and digital signals. The engine control module (ECM) then uses a minimal value to ensure the function (limp home).

The accelerator pedal (AP) position sensor is located on the

accelerator pedal bracket.

Engine coolant level sensor



The function of the engine coolant level sensor is to alert the driver if the engine coolant level in the expansion tank is too low.

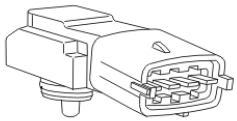
The sensor is a magnetic reed switch, which is enclosed in a pipe on the bottom of the expansion tank. Around the pipe, on the inside of the expansion tank is a float. This float contains a magnet. When the engine coolant level is above minimum, the float is too high in the tank to affect the switch. However if the engine coolant level falls below the minimum level, the magnetic field acts on the switch.
The sensor is supplied with voltage (signal) from the Engine Control Module (ECM) and grounded in chassis. When the engine coolant level in the expansion tank is over a certain level the circuit closes, which produces a low signal. When the

engine coolant level is below a certain level the circuit is opened by the engine coolant level sensor, which produces a high signal. When the engine control module (ECM) detects a high signal the information about low engine coolant level is transmitted via the Controller area network (CAN) to the driver information module (DIM), which warns the driver.

Note! There are no functions controlled by the engine which are directly connected to the low coolant level warning lamp. The Engine Control Module (ECM) only transfers the signal which is used by the Driver Information Module (DIM).

The engine control module (ECM) cannot diagnose the engine coolant level sensor.

Fuel pressure sensor / fuel temperature sensor (only vehicles with demand controlled fuel pumps)



The fuel pressure sensor is combined and consisted of both the fuel pressure sensor and the fuel temperature sensor. The sensor detects the fuel pressure (the absolute pressure) and the temperature of the fuel in the fuel rail.

Fuel pressure sensor

The pressure sensor is a Piezo resistive type resistor, the resistance of which changes with the pressure. The signal voltage varies with the pressure in the fuel rail. Low pressure produces low voltage, high pressure produces high voltage.
The engine control module (ECM) compares the signal with its integrated atmospheric pressure sensor. The engine control module (ECM) uses the fuel pump control module to regulate the pressure in the fuel rail. See also: Function:Fuel pressure regulation (only vehicles with demand controlled fuel pumps)

The engine control module (ECM) can diagnose the fuel pressure sensor. Its signals (pressure and temperature) can be read using VIDA.

Note! The absolute pressure is displayed when using VIDA parameter readout to

read off the fuel pressure. If there is no pressure at the fuel rail, the atmospheric pressure will be displayed.

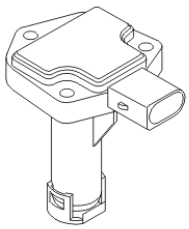
Hint:
The relative pressure (absolute pressure minus atmospheric pressure) is displayed when reading off the fuel pressure via a manometer connected to the fuel rail.

Fuel temperature sensor

The temperature sensor is an NTC sensor. The sensor is supplied with voltage (signal) from and grounded in the engine control module (ECM).
The signal to the engine control module (ECM) varies depending on the fuel temperature. The resistance in the sensor changes with temperature. Low temperature results in high voltage (high resistance). High temperature results in low voltage (low resistance).
The engine control module (ECM) uses the signal to calculate the volume of the fuel.

The fuel pressure sensor is on the left-hand end of the fuel rail.

Oil level sensor (2005-, certain markets only)



The oil level sensor provides the engine control module (ECM) with information about the quality and temperature of the engine oil and the oil level in the oil trough. Which of these functions is used by the sensor varies between different car models.

All three functions are combined in one unit with a sensor section and an electronics section.
There are no moving parts in the sensor.

The sensor consists of:

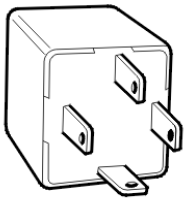
- a terminal with three pins
- integrated electronics
- 2 capacitive gauge elements
- a PTC resistor.

The oil level sensor is supplied with 5 V by the engine control module (ECM). The oil level sensor generates a PWM signal for the engine control module (ECM). See also: Function:Oil monitoring (2005-, certain markets

only)

The engine control module (ECM) has diagnostics for oil level sensor functions.
The pulse-width modulated (PWM) signal from the oil level sensor can be read using parameter readout.

Main relay (system relay)



The function of the main relay (system relay) is to supply certain components with voltage.

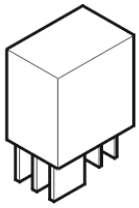
The relay is mechanical and has a closing/opening function. In the rest position the circuit in the relay is open.
The main relay terminals (#30 and #86) are supplied with voltage by the battery.
When the ignition key has been turned and the engine control module (ECM) is powered, the terminal (#85) on the main relay is grounded by the engine control module (ECM).
When the terminal (#85) is grounded, the

relay is activated and a number of components are powered via the relay terminal (#87).

The engine control module (ECM) has diagnostics for the main relay.

The main relay is in the relay/fuse box in the engine compartment.

Air conditioning (A/C) relay



The air conditioning (A/C) relay supplies the A/C compressor with voltage. The relay is controlled by the engine control module (ECM) based on information from different signals:

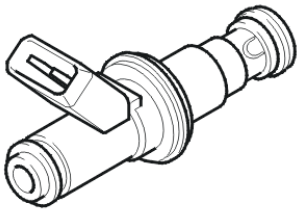
- the climate control module (CCM) (via the control area network (CAN))
- the engine coolant temperature
- the position of the accelerator pedal (AP)
- the pressure in the system.

The engine control module (ECM) can

temporarily disengage the A/C compressor during wide open throttle (WOT) acceleration.

The relay is mechanical. It has a closing / breaking function and is supplied with power from the system relay. In the rest position the circuit in the relay is open.
The system relay supplies the coil and the relay with power. The relay activates when the coil is grounded in the engine control module (ECM), the circuit closes and the A/C compressor is supplied with power via the relay voltage output.
The relay coil is grounded (signal) when the engine control module (ECM) receives a signal via the Controller area network (CAN) from the climate control module (CCM) to activate the relay and start the compressor.

Injectors



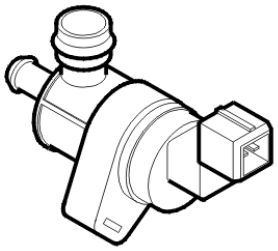
The function of the injectors is to spray fuel into the cylinders in the correct spray patterns. This happens sequentially.

The injectors are in the intake manifold.
It is essential that the injectors are correctly installed with no air leakage around them. Fuel leakage from the top of an injector when it is not activated may lead to starting and driving problems.

The engine control module (ECM) controls the injectors using a pulse width modulation (PWM) signal.

The engine control module (ECM) can diagnose the injectors. The injectors can be activated using VIDA.

Evaporative emission system (EVAP) valve



The evaporative emission system (EVAP) valve is used to open and close the connection between the EVAP canister and the intake manifold. The valve controls the flow of hydro-carbons (fuel vapor) from the EVAP canister to the engine intake manifold using the vacuum in the

intake manifold. This ensures that hydro-carbons stored in the EVAP canister are used in the engine combustion process.

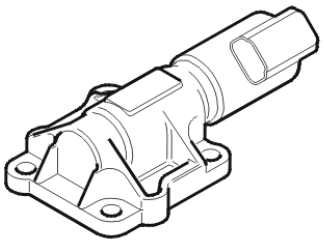
The valve is an electro-magnetic valve which is powered from the system relay. The evaporative emission system (EVAP) valve is closed when in the standby position (open-circuit).

When the engine control module (ECM) requests that the EVAP canister should be emptied (the hydrocarbons stored in the canister should be released into the engine), the engine control module (ECM) deploys the evaporative emission system (EVAP) valve by grounding it using a PWM signal. The engine control module (ECM) is able to govern the extent to which the evaporative emission system (EVAP) valve opens and adapt the emptying of the EVAP canister based on how full it is, engine speed, load etc.

The engine control module (ECM) can diagnose the evaporative emission system (EVAP) valve. The valve can be activated using VIDA.

The evaporative emission system (EVAP) valve is close to the intake manifold.

Camshaft reset valve (Continuous variable valve timing (CVVT))



The camshaft reset valve controls the oil flow to the continuous variable valve timing (CVVT) unit.
The valve consists of an electro-magnetic valve with a spring-loaded piston. There are slits in the piston which channel the engine lubricating oil to different channels in the continuous variable valve timing (CVVT) unit by moving the piston in the reset valve. The continuous variable valve timing (CVVT) unit turns the camshaft (the cam timing changes). The direction in which the camshaft turns depends on the chamber in the CVVT unit which is supplied with oil (pressure).
See also Function:Camshaft control (CVVT)

The system relay supplies the reset valve with voltage. The valve

is grounded (control stage) in the engine control module (ECM). When the valve is grounded using a pulse width modulation (PWM) signal, the oil flow in the valve can be regulated to the different chambers in the continuous variable valve timing (CVVT) unit at variable rates. This allows the cam timing to be changed precisely and steplessly.

The engine control module (ECM) can diagnose the camshaft reset valve. The value of the reset valve can be read using VIDA.

The valve is on the cylinder head above the camshaft with CVVT (certain markets have CVVT on both the intake and exhaust camshafts).

Ignition coils

The ignition coils supply the spark plugs with high voltage to produce sparks. The engine control module (ECM) controls the ignition coils so that sparks are generated at the correct

time.

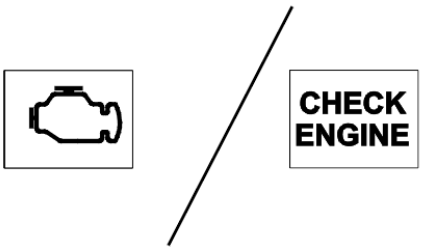
Each ignition coil has its own integrated power stage.

The ignition coils are in the sparkplug wells above each spark plug.

The ignition coils transmit a PWM signal to the engine control module (ECM). The diagnostic signal is transmitted to the engine control module (ECM) if the voltage in the ignition coil exceeds a preset value. The engine control module (ECM) is then able to check that the relevant ignition coil is working.

The engine control module (ECM) can diagnose the ignition coils.

Emissions warning lamp



The emissions warning lamp in the Driver Information Module (DIM) has a warning symbol. This warning symbol varies

depending on the market. The warning symbols are:

- "Engine symbol" (not USA)
- "CHECK ENGINE" (MIL - Malfunction Indicator Lamp, USA only).

The warning symbol lights when the ignition key is turned to position II and goes out when the engine is started if the engine management system does not detect any faults.

The warning lamp is directly connected to the engine control module (ECM).

The warning lamp will light if there is a fault in one of the parameters in the engine management system. The warning lamp will also light in response to a request transmitted via the Control area network (CAN) if there is a fault in one of the following systems which affects emissions:

- transmission control module (TCM)
- brake system control module (BCM)