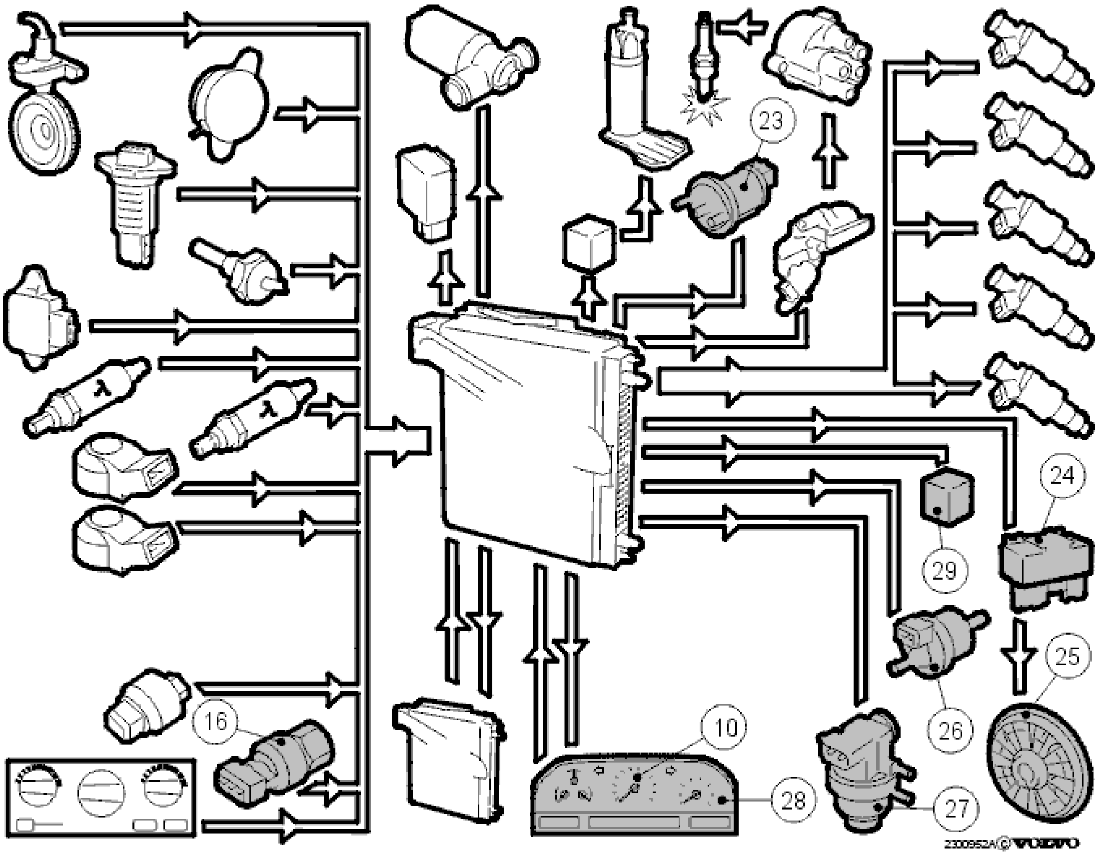
Other functions



Other functions can be controlled by the control modules

On certain systems the engine control module (ECM) is also used to control functions other than fuel, ignition and idle air trim. Because the control module already knows the engine drive relationship it is just a question of connecting components and programming the control module.

The control module is often connected to other control systems in order to send information to them. The following can occur.

Air conditioning (AC)

The air conditioning (A/C) compressor is controlled via a relay (29). The control module can disconnect the compressor at:

- Wide open throttle (WOT) for the maximum acceleration, using the signals from the throttle position (TP) sensor signal.
- Hot engine where there is a risk of overheating, using signals from the engine coolant temperature (ECT) sensor.
- Excessive pressure in the air conditioning (A/C) system, using signals from the high pressure sensor (16) in the AC system.

Engine cooling fan (FC)

Controlled via a relay (24).

The control module can start the engine cooling fan (FC) if

- Engine coolant temperature (ECT) rises above a certain value, based on information from the engine coolant temperature (ECT) sensor.
- AC is selected when the vehicle speed is low, based on information from the speedometer and climate control system.
- Excessive pressure in the air conditioning (A/C) system, based on information from the pressure sensor in the AC system.
- The exhaust temperature is too high. The control module can derive exhaust temperature theoretically based on information about engine speed (RPM), load and throttle position.

If the engine has been under heavy load the engine cooling fan (FC) will occasionally continue running for one or more minutes after the engine has been switched off. This is called engine cooling fan (FC) "run-on". The control module calculates whether the engine cooling fan (FC) should run on by looking at how the engine is loaded and how high the engine coolant temperature (ECT) is.

Evaporative system for fuel vapor

Normally called the EVAP system which stands for "Evaporative Emission System".

The evaporative emission (EVAP) system takes care of fuel vapor in the fuel tank so that it is not released into the atmosphere. The fuel which evaporates is drawn to and stored in a reservoir with a carbon filter which is called a canister. While driving the canister is drained using an electrical canister purge (CP) valve (26).

The control module determines when the canister purge (CP) valve is opened. When the valve is opened the fuel vapor is routed to the intake manifold and is mixed with the air flowing into the engine.

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Exhaust gas recirculation

Normally called the EGR system which stands for "Exhaust Gas Recirculation".

Exhaust gas recirculation is used to minimize the amount of nitrous oxides (NO_x) left in the exhaust gases. nitrous oxides are a compound of the oxygen and the nitrogen in the air which develop at high pressures and temperatures. By routing a part of the exhaust gases to the engine via an Exhaust Gas Recirculation Valve (EGR Valve) the combustion temperature is lowered. This is partially because exhaust gases contain a relatively high amount of water vapor which requires a lot of energy to heat up and partially because the exhaust gases are inert and take up room but do participate in the combustion process.

The control module controls the EGR valve opening via a solenoid valve/ vacuum converter (27).

The solenoid valve opens only when the engine is at operating temperature at partially open throttle.

Boost pressure reduction

On certain turbocharged engines the boost pressure is controlled by a turbocharger (TC) control valve (23). It is connected to the turbocharger (TC) pressure regulator which controls the boost pressure control (BPC) valve and therefore the boost pressure. The turbocharger (TC) control valve can led off part of the boost pressure from the pressure regulator to the turbocharger (TC) inlet. This means that a relatively high boost pressure can be obtained at low engine speeds (RPM).

The control module controls the boost pressure by varying the valve opening based on information about the throttle position, load, engine speed (RPM), engine coolant temperature (ECT), and any knocking.

On certain engines the boost pressure is also affected by factors such as the gear in use, the driving mode selected and the stop (brake) lamp switch.

Pulsed secondary air injection system (PAIR) pump (not illustrated)

Controlled via a relay.

The pulsed secondary air injection system (PAIR) pump is started by the control module and only runs for a short period after a cold start.

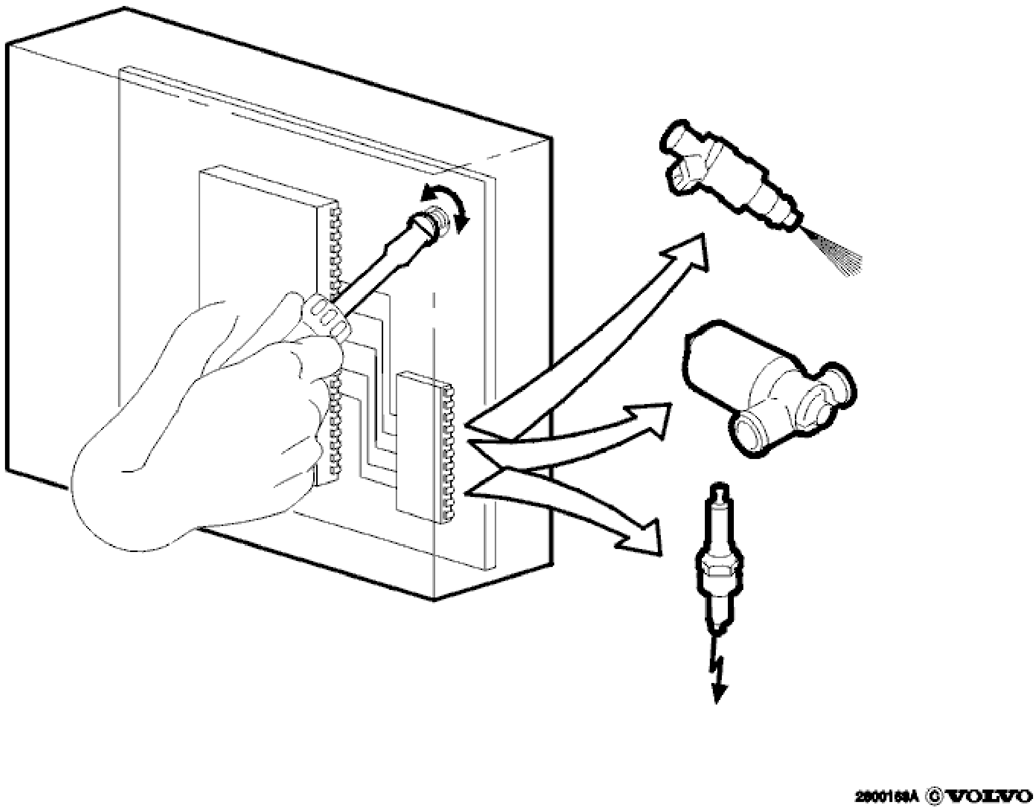
The pump blows air into the exhaust system immediately after the exhaust valves so that exhaust afterburning begins. This makes emissions cleaner, CO (carbon monoxide) and HC (hydro-carbons) values are reduced. This also heats the three-way catalytic converter (TWC) faster.

Gauges

The control module sends signals to the combined instrument panel (28) with engine speed (RPM), engine coolant temperature and injected fuel quantity. The instrument panel in turn uses the information for engine speed, temperature and trip computer displays.

The speedometer (10) transmits signals about the vehicle speed and distance covered to the control module. This signal can be used by the control module to evaluate and diagnose signals from the volume air flow (VAF) sensor and control signals to the idle air control (IAC) valve.

In addition the vehicle speed signal can be used to limit the maximum vehicle speed (injection is shut off) and to calculate which gear the car is being driven in.



Adaptation (≈ self learning)

Most modern engine management system are self learning, or as it is usually referred to adaptive functions for fuel, idling speed and ignition setting.

When the engine is new the control module determines what the normal fuel quantities, idle air control (IAC) valve openings and ignition settings for various driving conditions are.

These normal values are modified later, because as the engine is run in the is less, valve play can vary, there may be carbon build up in the cylinders, dirt may stick to the throttle plate and small air leakages may occur on both the intake and exhaust sides. There are a number of factors which are changed when the engine ages.

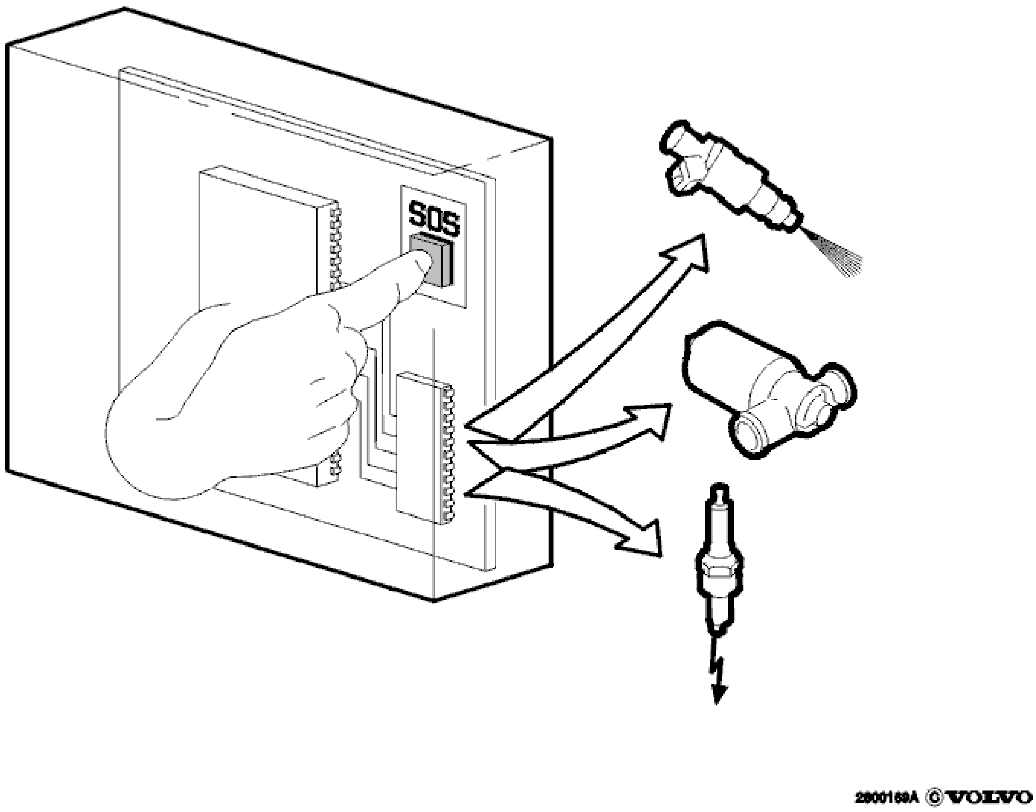
The control module aligns the control successively to the altered conditions. Soon the "new" normal values are used for control, so that the correct opening on the idle air valve can be set even if the engine has a little air leakage which passes the throttle plate.

The system becomes self learning or self adjusting. The control module cannot however manage too great an adjustment with reaching the stop position. This can occur as a result of late execution of a scheduled maintenance, large air leakage, low fuel pressure etc.

Our sense of smell is also adaptive!

If you enter a room with a strong smell you initially experience this smell as something unpleasant. However after a while you become accustomed to the smell and do not notice it so much. We can therefore say that we have an adaptive sense of smell, because we accustom ourselves to a new "normal position".

When you then leave the room the sense of smell will adapt itself to the cleaner air again.



Emergency program

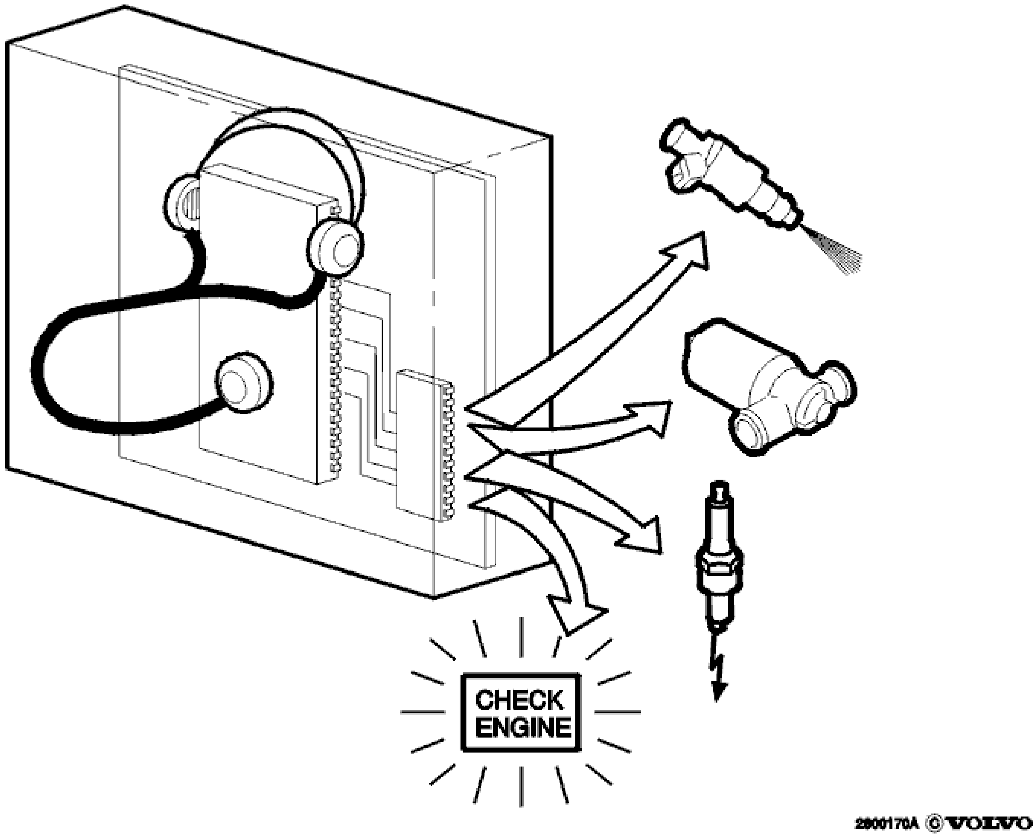
The control module continuously monitors input and output signals.

If any signal is missing or is outside its permitted range the control module connects an emergency program for that signal. The aim is that the car should be driveable even if a fault has occurred.

In the emergency program there are instructions to use another signal to assist certain calculations or to use a fixed value instead of the missing signal.

The number of emergency programs for each system varies as does the number of replacement values which are used in the different cases. However the one signal that no fuel injection or ignition system can do without is the engine speed (RPM) signal. If this is missing the engine stops immediately.

On many systems the function with the emergency program is reversible. This means that if the fault disappears (a loose connection for example) the control module returns to normal function. What is required for this varies between systems. In a number of systems it occurs the next time the ignition is switched on, other systems require the car to be driven a number of times with different loadings for a certain period of time.



Diagnostic functions

All new systems have integrated diagnostic functions, in certain countries this is a legal requirement.

Normally this means that the control module continuously monitors its own function and a number of input and output signals.

If a fault is discovered the control module stores a Diagnostic trouble code (DTC) which also connects, if possible, an emergency program.

For faults which affect the exhaust output the control module lights a warning lamp in the combined instrument panel. This warning lamp has a k-symbol or the text "CHECK ENGINE".

The on-board diagnostic (OBD) system is used to facilitate fault-tracing. There are up to four diagnostic test modes (DTM) in the engine management system on-board diagnostic (OBD) system:

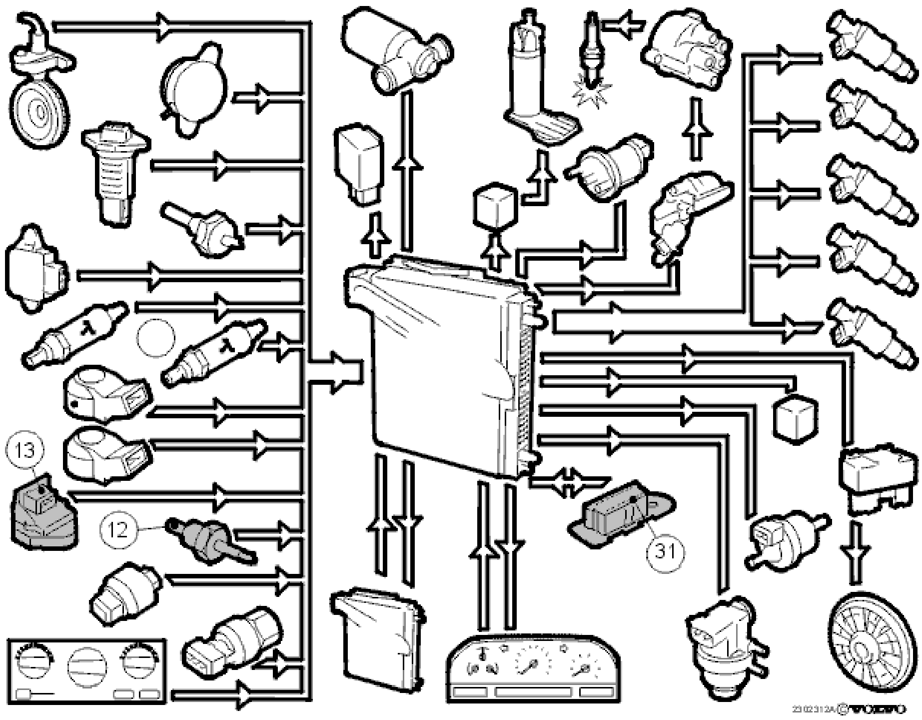
- Function 1: Monitors for any faults that occur while driving. Faults that have occurred can then be displayed using diagnostic trouble codes (DTCs).
- Function 2: Makes it possible to check that

the signals reach the control module from certain sensors. When a sensor is activated the control module replies by giving an acknowledgment code.

- Function 3: Check that certain signals reach the controlled component by the control module activating certain components in a certain order.
- Function 4: One can activate a particular component to see if the component functions and that the control signal from the control module reaches the component.

On newer systems the function with diagnostic trouble codes (DTCs) and warning lamps is reversible. This means that if the fault disappears:

- the warning lamp goes out after a relatively short time.
- the DTC in the control module is erased after a relatively long time.



Special sensors for certain diagnostic functions

In a number of cases (legally required in certain countries) further sensors are required to diagnose certain functions.

I The EGR-system needs a temperature sensor (12) in the exhaust gas recirculation pipe. The control module uses the signal from this temperature sensor to determine if the EGR valve opens or closes.

On a number of cars there is an accelerometer (13) which measures the car vertical movement (up and down). The control module uses the signal to determine whether variation in the engine speed (RPM) is dependent on misfiring or driving on a bumpy road surface.

Data link connector (DLC)

Data Link Connector (DLC) (31) in passenger compartment. Also called On Board Diagnostic II (OBD II) In certain countries this is a legal requirement. The connector is standardized so that a general tool common to all car models can be used. There are also requirements as to which faults the system must be able to diagnose and how the diagnostic trouble codes (DTCs) should be developed.

(On a number of the older ignition system there is an output/connector without an LED.)

How is the diagnostic information read off?

The different diagnostic test modes (DTM) in the on-board diagnostic (OBD) system can be activated in different ways:

- By connecting Volvo Diagnostic Key (text readout unit).
- By connecting Volvo Scan Tool.

Only the Volvo Scan Tool (ST) can give access to all the fault tracing aid that the system can provide for example:

- Reading off the exact values of the input and output signals.
- If the fault is intermittent (temporary) or permanent (constant.
- How many times the fault has occurred etc.
- If the signal is too high or too low (if the fault is caused by a short-circuit to ground or by system voltage).
- Freezing the diagnostic trouble codes (DTCs) and signals during test drives in order to read them off later.