VOLVO
for life

Course Code: 0819

2004 Model Year Product, Featuring the R-Range

TECHNICAL UPDATE 1

Name:_____ S.S.N./S.I.N.:_____ Retailer/Code:_____ Date:_____

IMPORTANT SAFETY NOTICE

WARNING: Before performing service, diagnosis or troubleshooting procedures on a vehicle equipped with safety devices containing pyro-technical igniters, i.e., airbags, seatbelt tensioners, side impact curtains, etc., **you must be aware of certain precautions, and follow special procedures to help ensure your safety**. Refer to applicable SAFETY SYSTEM service information for these procedures and precautions.

NOTE: The information contained in this manual is intended for technical training purposes **ONLY**. Always refer to appropriate Volvo service information & wiring diagram manuals when performing fault tracing or service procedures.

Following proper service and repair procedures is essential for the safe, reliable operation of motor vehicles, as well as for the personal safety of the individual doing the work. This manual provides general directions for accomplishing service and repair work with tested, effective techniques.

Numerous variations in procedures, techniques, tools and parts for servicing vehicles, as well as the skill of individual doing the work cannot possibly be anticipated or provided for. Accordingly, anyone who departs from instructions provided in this manual must first establish that they compromise neither their own personal safety nor the vehicle integrity by their choice of methods, tools or parts.

As you read through the procedures, you will come across NOTES, CAUTIONS, and WARNINGS. Each one is there for a specific purpose. NOTES give you added information that can help you to complete a particular procedure. CAUTIONS are given to help prevent you from making an error that could damage the vehicle. WARNINGS remind you to be especially careful in areas where carelessness can cause personal injury. The following list contains some general WARNINGS that you should follow whenever you work on a vehicle.

- Always wear safety glasses for eye protection.
- Use safety stands whenever a procedure requires you to be under the vehicle.
- Turn the ignition switch OFF unless otherwise required by the procedure.
- Set the parking brake when working on the vehicle. If you have an automatic transmission, set it in PARK unless instructed otherwise for a specific service operation. If you have a manual transmission it should be in NEUTRAL unless instructed otherwise for a specific service operation.
- Operate the engine only in a well-ventilated area to avoid the danger from carbon monoxide.
- Keep yourself and your clothing away from moving parts when the engine is running, especially the cooling fan and belts.
- To prevent serious burns, avoid contact with hot metal parts such as the radiator, exhaust manifold, tail pipe, catalytic converter and muffler.
- Do not smoke while working on the vehicle.
- To avoid injury, always remove rings, watches, loose hanging jewelry, and loose clothing before beginning to work on a vehicle. Tie long hair securely behind your head.
- Keep hands and other objects clear of the radiator fan blades. Electric cooling fans can start to operate at any time even with the ignition turned OFF.

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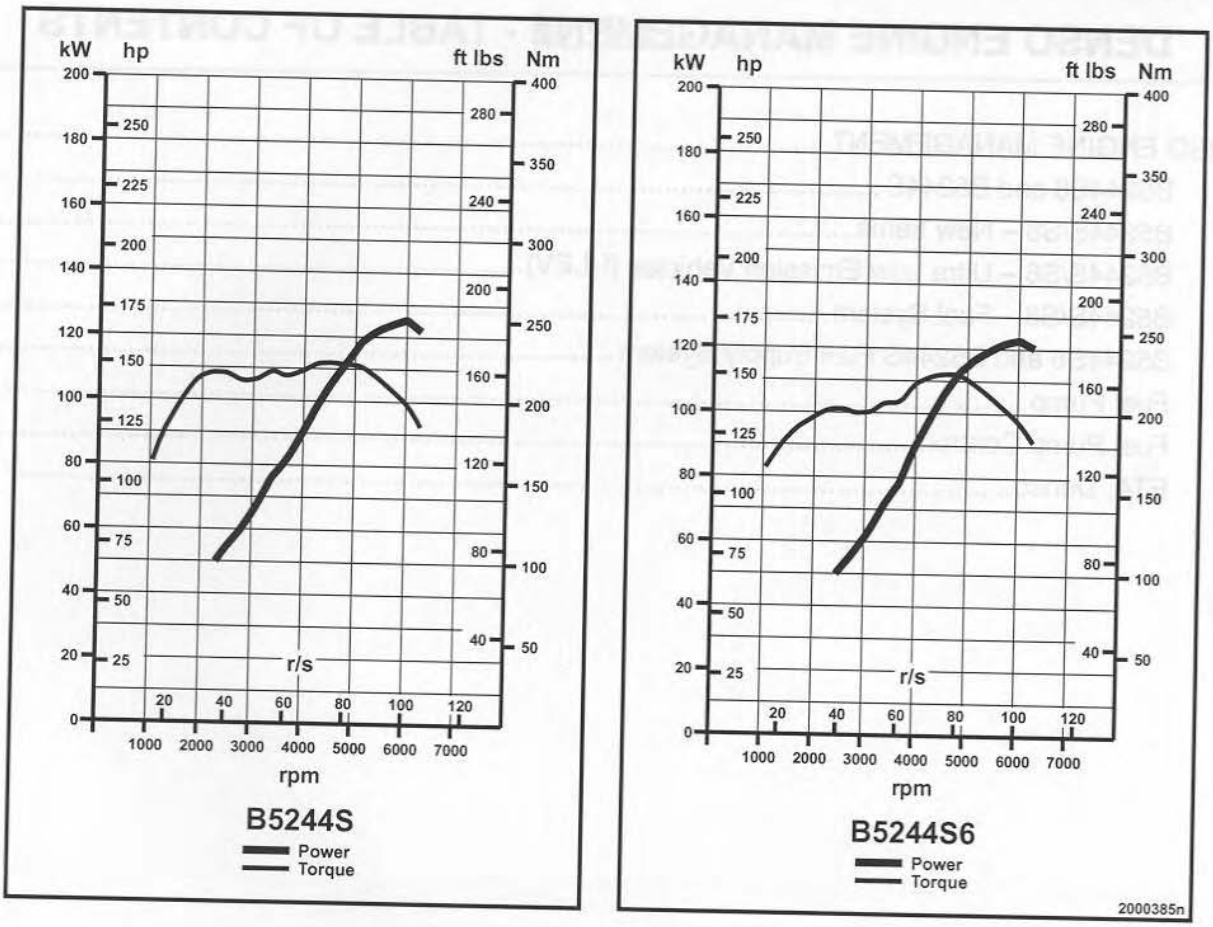
DENSO ENGINE MANAGEMENT - TABLE OF CONTENTS



DENSO ENGINE MANAGEMENT

B5244S6 AND B5244S

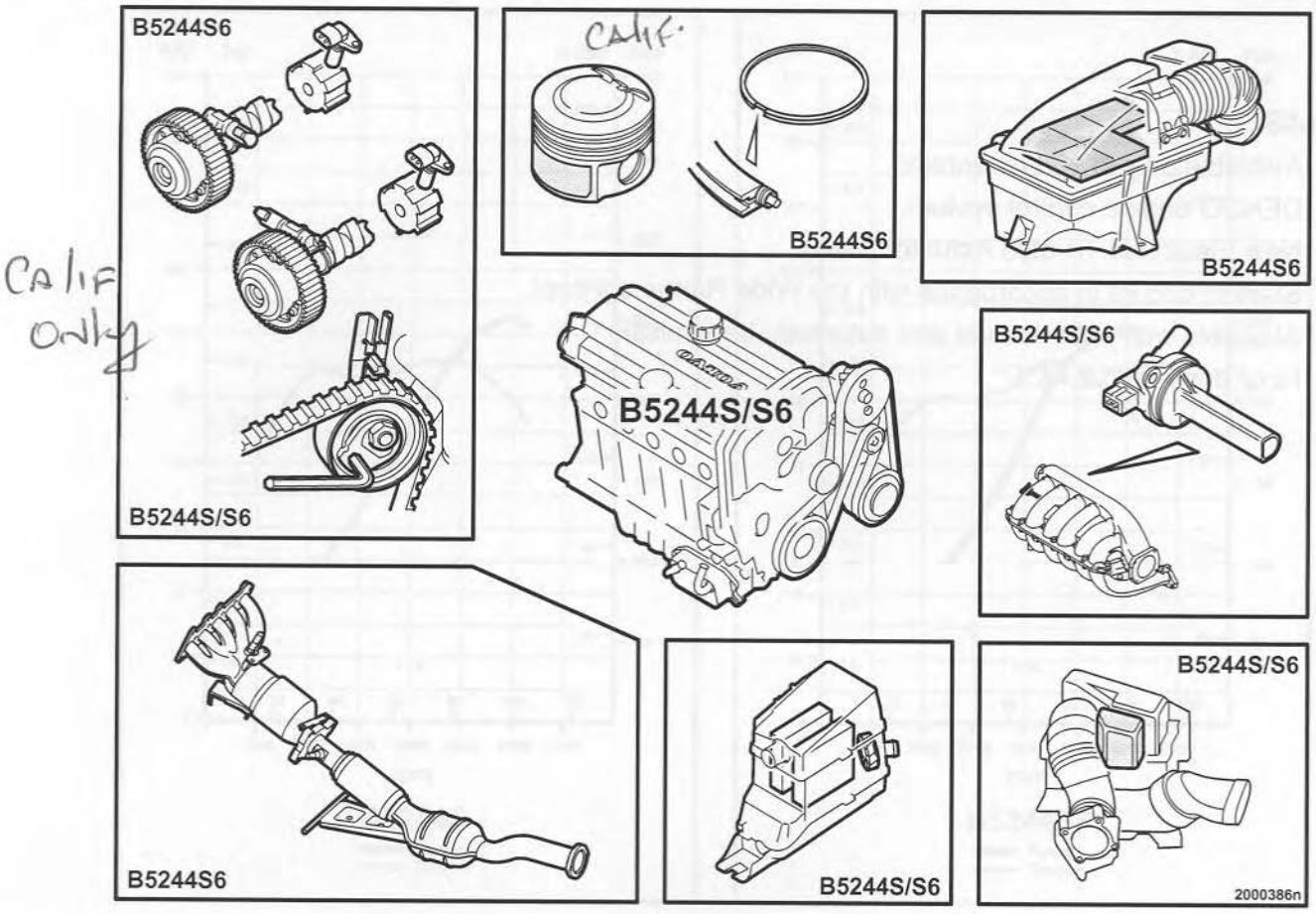
GENERAL

B5244S6 (Super Ultra Low Emission Vehicle + [SULEV+] - California)

- B5244S6 is based on B5244S.
- Corresponds to Partial Zero Emission Vehicle (PZEV) emission requirements. The vehicle will be able to fulfill the warranty, exhaust and EVAP requirements imposed by the authorities.
- Introduced only in the S60 and V70.
- Available only in certain markets.
- Maximum torque is 225 N•m (166 ft•lbs). Maximum power output is 165 hp.
- New Electronic Throttle Actuator (ETA).
- Starting occurs in accordance with the Wide Range concept.
- Available only with automatic transmission AW 55-50SN.
- The final drive ratio is 2.65:1.

B5244S

- Available only in 168 hp version.
- DENSO engine control system.
- New Electronic Throttle Actuator (ETA).
- Starting occurs in accordance with the Wide Range concept.
- Available with both manual and automatic transmission.
- Final drive ratio 2.44:1.



B5244S/S6 - NEW ITEMS

Cylinder head

A cylinder head with Continuous Variable Valve Timing (CVVT) system for both the inlet camshaft and the exhaust camshaft.

- Adjustment angle, CVVT:
  - Inlet = 60 crankshaft degrees.
  - Exhaust = 30 crankshaft degrees.
- Wide Range. For cold start at position P, N (automatic transmission) or neutral (manual transmission) the engine speed can reach approximately 2000 rpm initially, then immediately drops to approximately 1650 rpm for 15 - 20 seconds. The engine then runs with retarded ignition and a lean lambda value. The speed then drops to approximately 750 rpm idling speed, to reduce the emissions during the warm up phase.
- The toothed camshaft belt is reinforced to prolong service life. The belt tensioner has a new gasket to improve sealing.

Pistons

- Graphite-coated.
- The pistons have a two piece oil ring. The stainless steel ring and nitrided steel spring design ensure long service life. The oil ring thickness is 2 mm (0.08 in.).

B5244S

Piston rings

- Oil ring thickness - 2.5 mm (0.10 in.).

Carbon filter, air filter housing

- A carbon filter is integrated into the air filter housing cover.
- There is no service interval for the carbon filter on B5244S6 engine. If the filter must be changed due to damage, the entire cover must be replaced.
- The filter absorbs the hydrocarbons passed backward through the filter when the engine is turned off. When the engine is started, absorbed hydrocarbons follow the flow of air and are combusted.

Wide Range, B5244S6 and B5244S

- Differences compared with Bosch 7.01:
  - If the engine is restarted within a given time interval and the catalytic converter temperature is high enough, the engine drops immediately to the idling speed from its initial post-start speed, which is approximately 1650 rpm.
  - For restarting, the catalytic converter temperature is calculated based on the lapsed time since the engine was turned off, outdoor temperature and coolant temperature.
  - If the vehicle has cooled and the catalytic converter temperature is cold (<approximately + 350°C [+662°F]), starting occurs so the catalytic converter is heated as quickly as possible, at high RPM, retarded ignition and a lean fuel/air mixture.

Crankcase ventilation

- Crankcase ventilation nipple at the inlet pipe has changed to provide more uniform distribution of crankcase vapors to the cylinders. A PTC element prevents freezing.
- Oil trap with intricate passages separates the oil from the crankcase vapors before they are returned to the inlet manifold.

B5244S/S6 - NEW ITEMS (CONTINUED)

Resonator

- A resonator is mounted on the hose between the mass airflow sensor and the ETA to reduce inlet and exhaust noise which can occur at high engine RPM to meet European requirements.
- Pulsation affects the measuring function performed by the mass airflow sensor. The engine control module compensates for this. Since the pulsation level is reduced, the programming also changed compared to earlier engine control modules.
- If the resonator were removed, the signals sent from the mass airflow sensor will be interpreted incorrectly by the ECM.

Electrical cooling fan, control module box

- The fan starts at a temperature of +70°C (+158°F) and stops at +65°C (+149°F). The temperature sensor in the ECM is used as a reference.

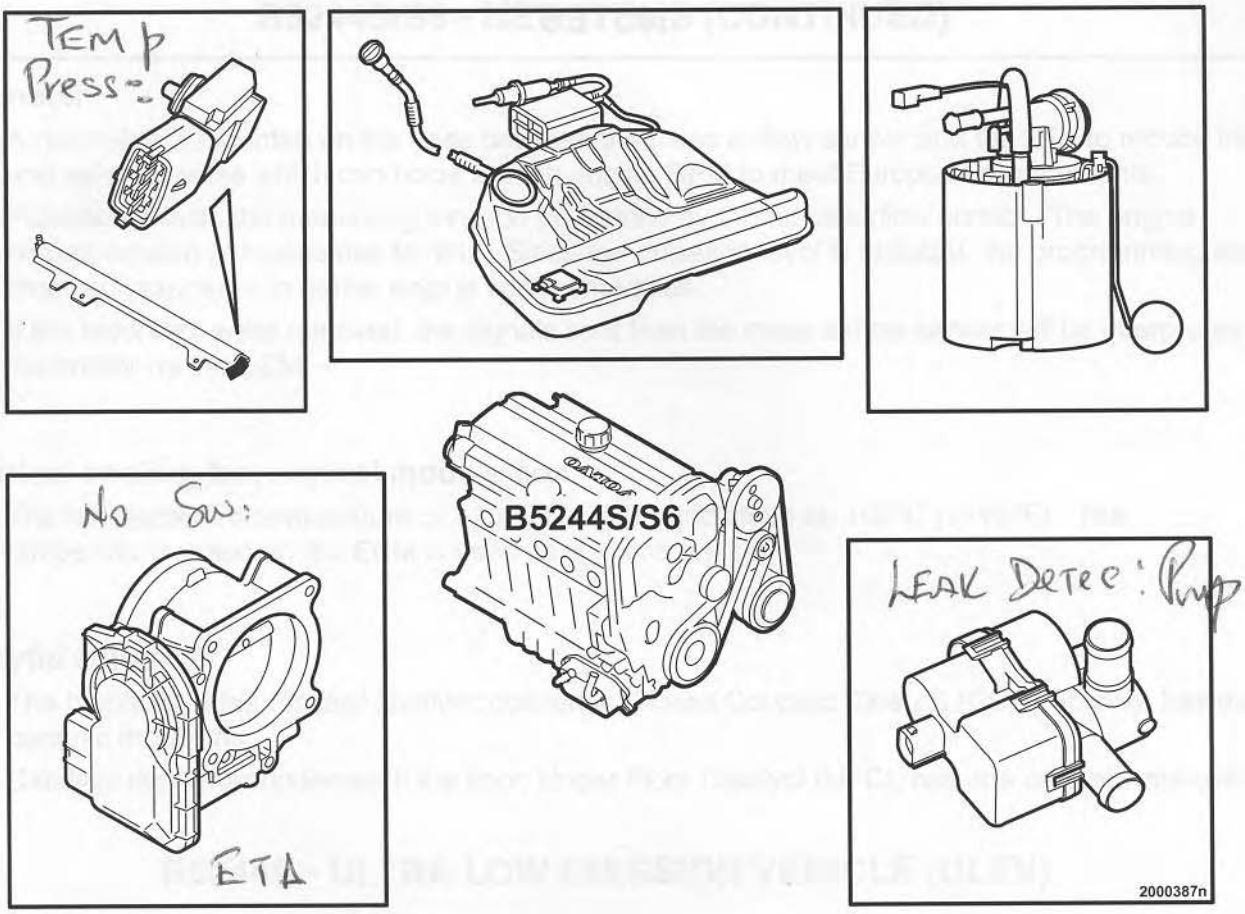
Catalytic converter

- The manifold at the forward catalytic converter, Closed Coupled Catalyst (CCC) S6 only, has dual ceramic monoliths.
- Catalytic converter underneath the floor, Under Floor Catalyst (UFC), has one ceramic monolith.

B5244S - ULTRA LOW EMISSION VEHICLE (ULEV)

Differences, compared with B5244S6:

- Continuous Variable Valve Timing (CVVT) for inlet camshaft only. Adjustment angle, CVVT inlet = 60 crankshaft degrees.
- Emissions requirements apply for 170,000 km (105,600 miles) /10 years.
- Pistons have three-way split oil rings that are 2.5 mm (0.10 in.) thick.
- New manifold provides better torque at low rpm.
- No carbon filter in air filter housing.
- Only UFC with two ceramic monoliths and built-in muffler.



B5244S/S6 - FUEL SYSTEM

COMBINED FUEL PRESSURE / FUEL TEMPERATURE SENSOR

Fuel temperature sensor

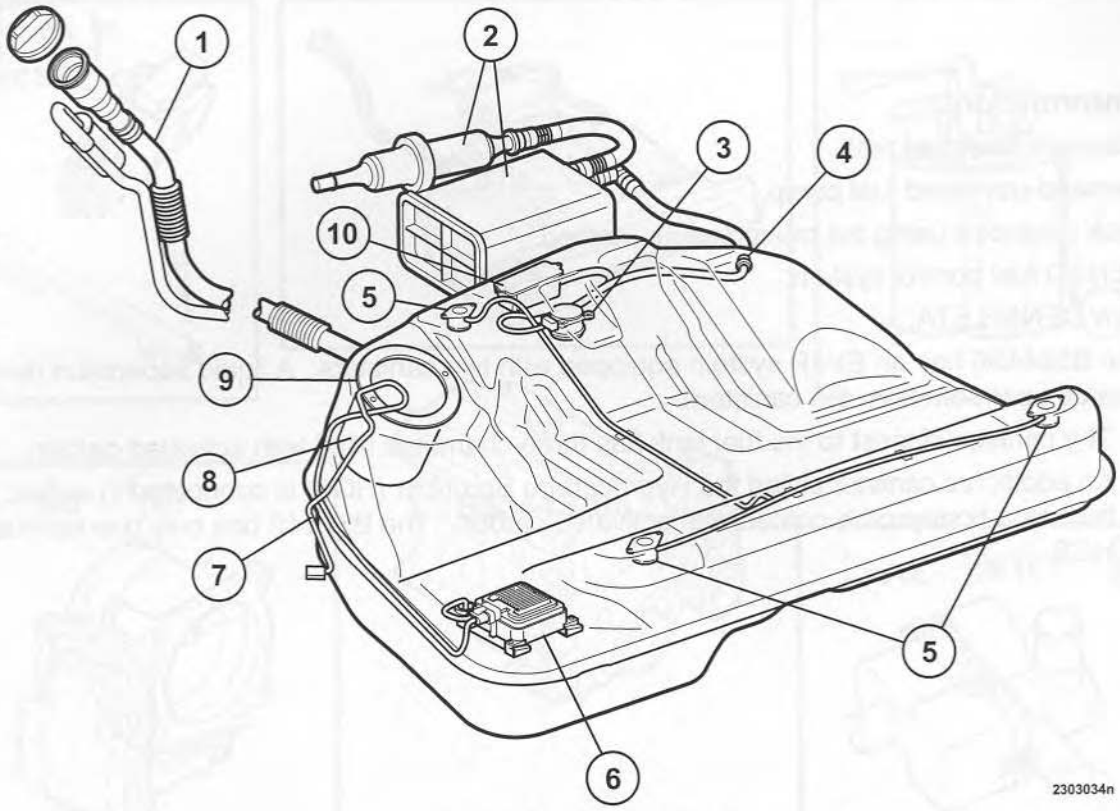
- An NTC sensor sends a voltage signal (that corresponds to a given temperature) to the ECM. This signal is used to compensate fuel temperature changes. Compensation is completed by regulating the length of the injection interval.
- Example: If the engine is restarted after a short period, the temperature of the fuel in the fuel rail will have increased. The signal emitted by the sensor enables the ECM to compensate for the rise in temperature by prolonging the injection time. (Hot fuel contains less energy per unit of volume than cold fuel).

Fuel pressure sensor

- Refer to 'Fuel Pump Control' section for fuel pressure sensor function description.

Other information:

- Stainless steel fuel tank.
- Demand-governed fuel pump.
- Leak diagnosis using the overpressure method.
- DENSO fuel control system.
- New DENSO ETA.
- The B5244S6 has an EVAP system equipped with two canisters. A liquid separation device is located upstream from the canisters.
  - The canister closest to the fuel tank has three chambers filled with activated carbon.
  - An additional canister called the Hydrocarbon Scrubber (HCS) is connected in series; it is built as a honeycomb coated with activated carbon. The B5244S has only one canister and no HCS.



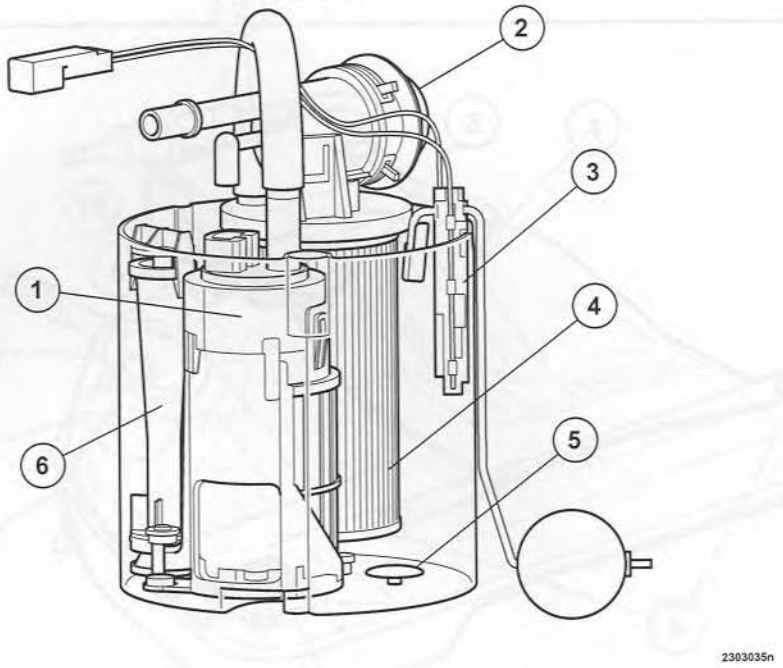
1	Filler Pipe	6	Pump Electronic Module (PEM)
2	Canisters	7	Wire harness
3	Float Limit Vent Valve (FLVV)	8	Fuel pump
4	Outlet to canisters	9	Service cover
5	Roll-over valves	10	Liquid Separation Device (LSD)

B5244S6 AND B5244S FUEL SUPPLY SYSTEM

FUEL TANK

- To comply with California regulation, the fuel tank is made of stainless steel, which is a more dense material than plastic, HC emissions are reduced.
- Capacity is 70 Liters (18.5 gallons).
- The fuel filler pipe is made of stainless steel and is welded to the tank. The small-diameter pipe limits the amount of air into the tank when fuel is added. Added air affects the saturation level of the canisters which affect emissions.
- The filler cap now has more effective pressure valves.
- The fuel tank is provided with three roll-over valves because of its geometric shape.
- The service cover is made of plastics and fixed by a stainless steel nut.
- The B5244S6 has an EVAP system equipped with two canisters. A liquid separation device is located upstream from the canisters.
  - The canister closest to the fuel tank has three chambers filled with activated carbon.
  - An additional canister called the Hydro Carbon Scrubber (HCS) is connected in series; it is built as a honeycomb, coated with activated carbon.

  The B5244S has only one canister and has no HCS.



1	Pump with integral Pressure Relief Valve (PRV)	3	Fuel level sensor	5	Non-return valve
2	Pressure Ventilation Valve (PVV)	4	Fuel filter	6	Ejector pump

FUEL PUMP

The ECM regulates, by means of a PWM signal, the position of the DC motor.

- Fuel pump with demand-governed flow. By using engine fuel demand to control pump current consumption the following is accomplished:
  - Long service life (must cover 240,000 K (150,000 miles) / 15 years).
  - Matched current consumption to demand.
- A DC motor drives a pump that operates on the turbine principle.
- Pump flow at:
  - Full load is 90 l/h at 400 kPa (23.8 gal/h at 58 psi), corresponds to 380 kPa (55 psi) at the fuel rail.
  - Idling speed is 1.2 to 2.0 l/h.
- Current consumption varies from 8 A at full capacity to 2 A while idling.

VALVES

Pressure Ventilation Valve (PVV)

- The valve compensates for pressure surges which occur when fuel injection is stopped, for example during engine braking. Continuous fuel flow through the valve ensures faster pressure compensation. The excess fuel flows out into the pump housing.
- Pressure is limited to 400 kPa (58 psi), corresponds to 380 kPa (55 psi) at the fuel rail.
- When the engine is not running, the valve maintains a residual pressure in the fuel system to prevent vapor lock.

Non-return valve

- Allows fuel to enter the pump housing when a virtually empty fuel tank is filled. The valve closes when the vehicle leans, fuel remains in the pump housing.

Pressure Relief Valve (PRV)

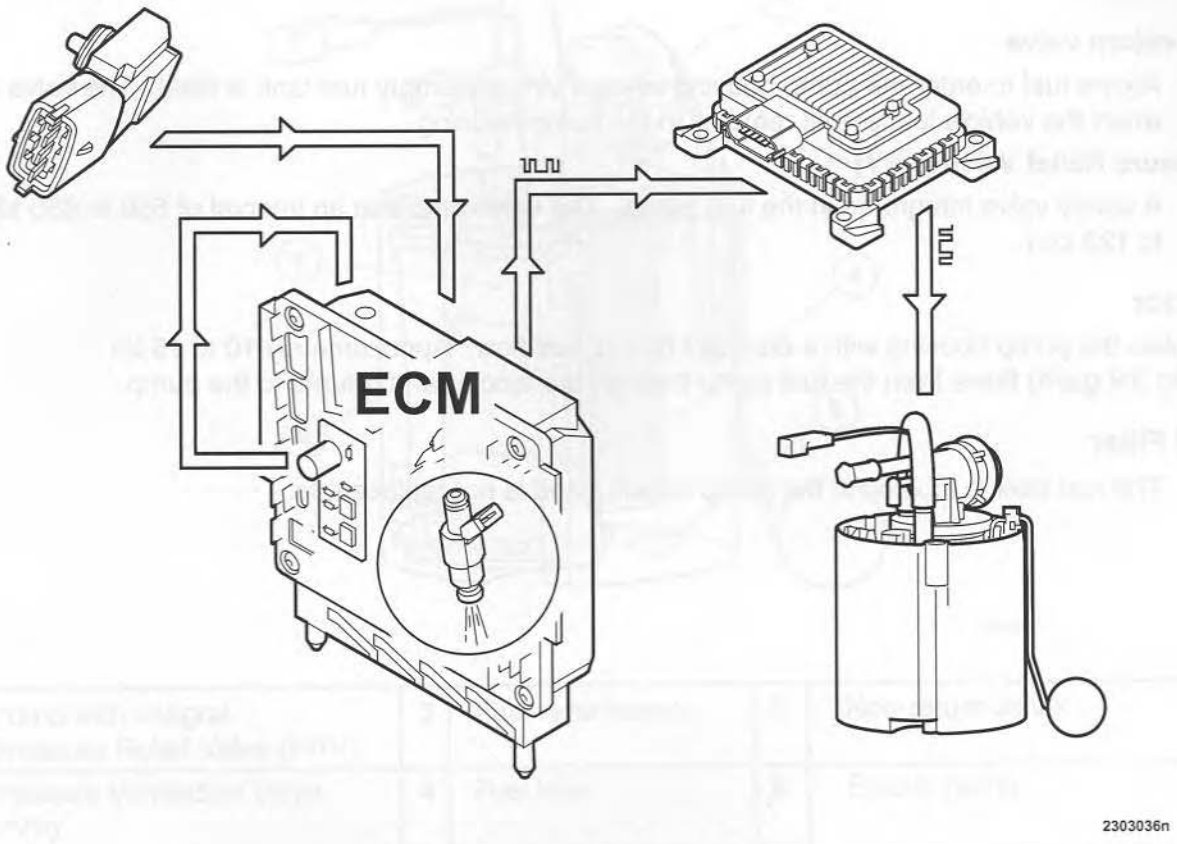
- A safety valve integrated in the fuel pump. The valve opens at an interval of 550 to 850 kPa (80 to 123 psi).

Ejector

Supplies the pump housing with a constant flow of fuel flow. Approximately 10 to 15 l/h (2.6 to 3.9 gal/h) flows from the fuel pump through the ejector and returns to the pump.

Fuel Filter

- The fuel filter is located in the pump housing and is not replaceable.



FUEL PUMP CONTROL

OPERATION

- A piezoelectric fuel pressure sensor sends a voltage signal to the ECM indicating the actual pressure in the fuel rail.
- The ECM compares this signal with a signal emitted by the atmospheric pressure sensor. The fuel pressure is regulated so the pressure in the fuel rail is always 380 kPa (55.1 psi) above atmospheric pressure; i.e. the pressure differential is 380 kPa.
- Depending on factors like speed and load, the ECM sends a calculated Pulse Width Modulated (PWM) signal to the Pump Electronic Module (PEM).

  The PEM forwards the signal at a higher frequency to the fuel pump.
- The PWM signal corresponds to a given pump supply voltage which corresponds to a given pump flow. By regulating this supply voltage, the pump load follows the demand for fuel.
- If the engine runs at high rpm and carries a heavy load, the pump runs at a greater flow than when the load is low and the engine is running at low rpm.
- If the pressure during acceleration rises to 400 kPa (58 psi) for a short period, fuel compensation occurs by shortening the length of the injection interval. For longer injection intervals, compensation is achieved by lowering the fuel pressure via the fuel pump.
- If the pressure sensor detects a pressure fixed at the same level for too long, a Diagnostic Trouble Code (DTC) is set for the pressure sensor. If this same error persists or recurs in the next driving cycle, the emission lamp will turn on.
- If no signal is detected by the pressure sensor, or considered erroneous, a DTC is set for the fuel pressure system and the fuel pump is controlled by a PWM signal. Using the injection intervals and the desired pressure, the signal is calculated on fuel flow.

Background, emission requirements:

- Beginning in model year 2003, 10% of all motor vehicles sold in California must fulfill the emission requirements set forth for a Zero Emission Vehicle (ZEV).
- Vehicle manufacturers who have no vehicles meeting the ZEV level, but have vehicles with extremely low emissions can qualify as Partial Zero Emission Vehicles (PZEVs). The requirements allow the substitution of PZEV for ZEV - if a certain percentage of the vehicles sold fulfill the PZEV requirement.
- For model year 2003, 12.5% of sold vehicles is the percentage level for the PZEV requirement. The requirements will be gradually increased until 2006 when a percentage level of at least 50% of sold vehicles fulfill the PZEV requirement.
- The Volvo designation for PZEV is SULEV+.

B5244S

- CVVT only for inlet camshaft. Wrapping angle for CVVT inlet = 60 crankshaft degrees.
- New manifold improves torque at low rpm.
- Only Under-Floor Catalytic Converter (UFC) with two ceramic monoliths and built-in silencers.
- New ETA.
- Starting in accordance with Wide Range concept.
- Electrical cooling fan for the control module box. Fan starts at a temperature of +70°C (+158°F) and stops at +65°C (+149°F). The temperature sensor in the ECM is used as a reference.
- Crankcase ventilation nipple at inlet manifold has changed to provide a more even distribution of crankcase vapors to the cylinders. A PTC element prevents freezing.

RESONATOR

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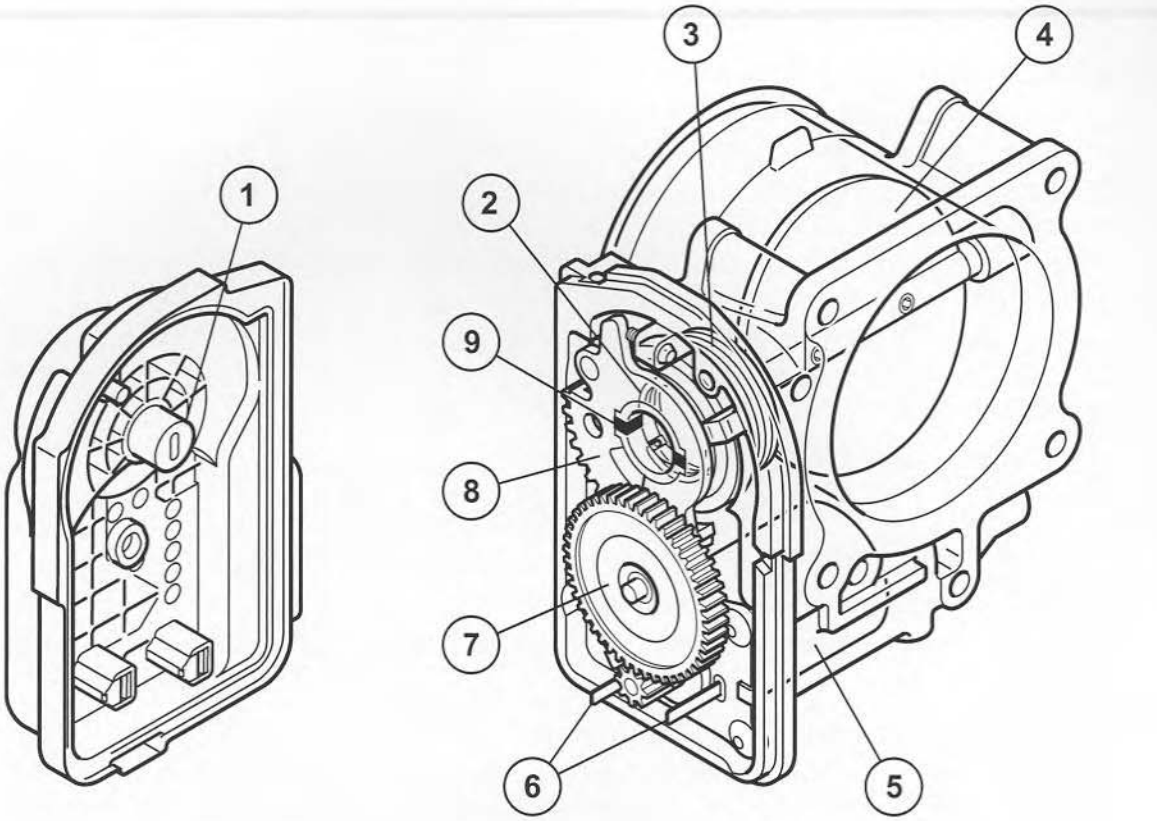
- Pulsation affects the measuring function performed by the mass airflow sensor. The engine control module compensates for this. Since the pulsation level reduced, the programming also changed compared to earlier engine control modules.
- If the resonator were removed, the signals sent from the mass air flow sensor would be interpreted incorrectly by the ECM.



1	Hall sensor	4	Throttle Plate	7	Gear
2	Spring	5	DC motor	8	Gear segment
3	Spring	6	Connector pins	9	Permanent magnets

ETA, DENSO

OPERATION

The ECM regulates, by means of a PWM signal, the position of the DC motor and the position of the throttle.

- The DC motor can be run in both directions by reversing the polarity of the supplied power.
- To check the position of the throttle, two permanent magnets are mounted in the gear segment used for the throttle spindle.
  - The permanent magnets activate two Hall sensors mounted in the cover.
  - When the throttle spindle is turned, the position and strength of the magnetic field changes and affects the Hall sensors.
  - Internal circuits convert the Hall signals to two voltage signals sent to the ECM.

OPERATION (CONTINUED)

- The two signals are displaced relative to each other.
  - The main signal has a voltage of 0.6 V when the throttle is closed, and increases at a rate of 40 mV per degree as the throttle opens. When the throttle is fully open, the voltage is 4 V.
  - The redundancy signal has a voltage of 1.48 V when the throttle is closed, and increases at a rate of 32 mV per degree as the throttle opens. When the throttle is fully open, the voltage is 4.2 V.
- To make certain the ECM will know whether or not the voltage signals are reasonable, the actual values are compared with stored desired values. Deviant values outside certain tolerances cause a DTC to be set. In certain situations, depending on the type of error in question, this can mean the voltage being supplied to the DC motor is interrupted. In this case, the throttle is positioned by the springs so the vehicle can be driven with limited drivability.

DIAGNOSIS FUNCTION

When an error flag is set because, for example, the throttle-opening angle is too wide, the amount of fuel injected is reduced by shutting off the fuel supply entirely for one or more cylinders. This is done to reduce engine torque to what is desired by the driver, or to correspond to the signal received from the Accelerator Pedal Module (APM). In situations where this error 'corrects itself,' a temporarily binding throttle for example, the driver may be unaware the error since the vehicle's characteristics did not deviate from normal. If the cruise control was on when the error occurred, it is turned off.

If the throttle remains at the wrong position when the amount of fuel is increased, the amount of fuel is reduced again by shutting off the fuel for one or more cylinders. This is a relatively coarse regulation and can give rise to surging.

In some situations when an error flag is set, the functionality of certain systems can be limited, such as a refusal to accept cruise control. Errors that entail too high a current being sent to the throttle cause the system to be reconfigured to the mechanical 'limp-home' state. This means that maximum engine torque is sharply limited. Errors that indicate the throttle has become stuck at a position above the limp-home position put a maximum limit on vehicle speed. This prevents the vehicle from being driven at high speed when a sufficient brake vacuum cannot be generated.

- There are two prerequisites for implementing adaptation: The ignition key must be turned from position I to position II and the engine must be shut off. Adaptation is interrupted when the vehicle is cranked, or the ignition key is at position III.
- For adaptation, the throttle moves from the 'limp-home' position to the closed position determined by the mechanical stop lug. The ECM updates the values if they deviate from those stored.
- The ETA has a return spring and a 'limp-home' spring. These springs are always actuated after the engine is turned off.
- First, the DC motor closes the throttle, after the 'limp-home' spring must reset the throttle to the 'limp-home' position. The throttle is then opened a number of degrees after the return spring must close the throttle to the 'limp-home' position. A DTC is set if the throttle does not reach the 'limp-home' position within a certain time interval after opening.
- DTCs related to the ETA are set in the ECM.
- The sounds heard during adaptation and while the springs are being actuated are made by the throttle as it moves to the different positions.
- The pins in the connector are gold-plated. Damage to the surface coating on one of the pins can cause malfunctions.
- The terminating resistor used for the CAN network has been moved to the ECM.

DIAGNOSTIC FUNCTION (CONTINUED)

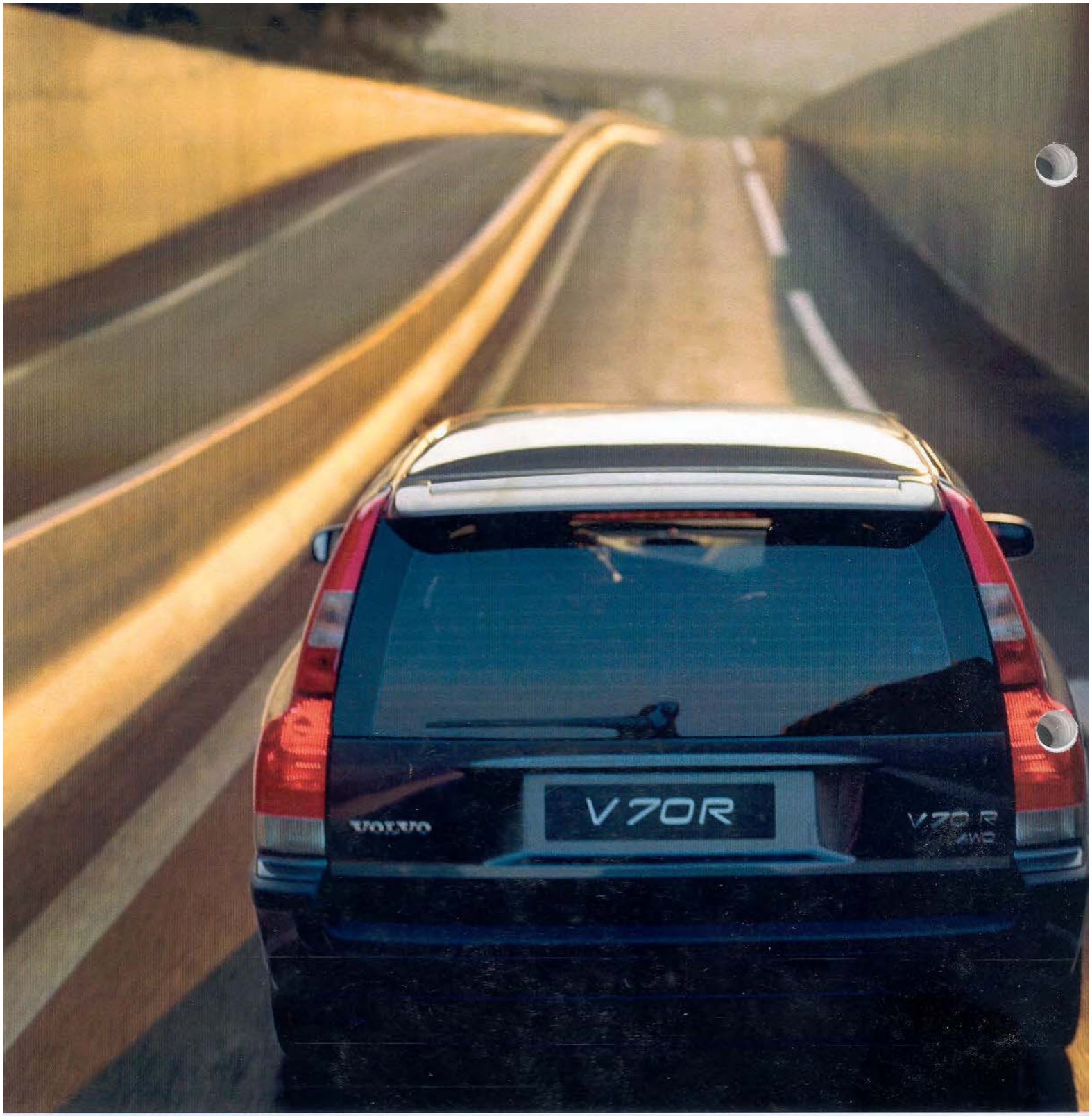
Diagnosis

Diagnosis in the ETA differs from that found in the earlier Magneti-Marelli ETM. The ECM reads the actual engine torque continuously, and if it exceeds what is expected, for example, the throttle opening angle is too wide, an error flag is set and the system is reconfigured. This means the torque is limited by control mechanisms other than those normally used, such as fuel shutoffs. If cruise control is on, it will be turned off.

- The following occur, depending on the type of error:
  - A DTC is set if the error persists for a predetermined time interval.
  - If operation returns to the normal state, the error flag vanishes and the system exits from the reconfiguration mode. If the error flag was set for only a brief period (a few seconds), no DTC is set.
- Compared with what occurred previously in connection with diagnosis, the tolerances used before an error flag is set have been broadened, while the error flag is set within narrower tolerances. The DTC is not set until the error flag has been in the error zone throughout a certain cumulative time interval.
- New troubleshooting functions are provided in VADIS.
- The new troubleshooting functions are based on the presence of a tool which reads the ranking values assigned to the relevant DTCs.
- An error code's ranking value shows how close the system has come to setting a DTC.
- A high ranking value can mean reconfiguration has taken place even though an error code has not been set. A customer can have a detected specific behavior in a vehicle without a DTC being set. In such cases, the cause can be ascertained by reading the ranking values.
- Using the tool, one can read two ranking value attributes: 'Worst' and 'Latest.'
  - 'Worst' is the highest ranking value encountered since the DTCs were cleared.
  - 'Latest' is the ranking value for the DTC encountered just prior to readout.

GLOSSARY

ABS	**A**nti-lock **B**raking **S**ystem
A/C	**A**ir **C**onditioning
ACS	**A**ctive **C**hassis **S**etting
AUX	**AUX**iliary
AWD	**A**ll **W**heel **D**rive
AYC	**A**ctive **Y**aw **C**ontrol
BCM	**B**rake **C**ontrol **M**odule
BGC	**B**rake **G**rip **C**ontrol
BRC	**B**ump and **R**ebound **C**ontrol
CAN	**C**ontroller **A**rea **N**etwork
CCC	**C**lose **C**oupled **C**atalyst
CCM	**C**limate **C**ontrol **M**odule
CEM	**C**entral **E**lectronic **M**odule
CM	**C**ontrol **M**odule
CVVT	**C**ontinuously **V**ariable **V**alve **T**iming
DBC	**D**ynamic **B**ody **C**ontrol
DCC	**D**ynamic **C**ornering **C**ontrol
DDM	**D**river **D**oor **M**odule
DEM	**D**ifferential **E**lectronic **M**odule
DIM	**D**river **I**nformation **M**odule
DLC	**D**ive and **L**ift **C**ontrol
DSTC	**D**ynamic **S**tability and **T**raction **C**ontrol
DTC	**D**iagnostic **T**rouble **C**ode
DVD	**D**igital **V**ersatile/**V**ideo **D**isc
EBA	**E**mergency **B**rake **A**ssistance
ECM	**E**ngine **C**ontrol **M**odule
FOUR-C	**C**ontinuously **C**ontrolled **C**hassis **C**oncept
FWD	Front Wheel Drive
GDL	**G**as **D**ischarge **L**ightning
IR	**I**nfra **R**ed
ISM	**I**nclination **S**ensor **M**odule
KIR	**K**ey **I**ntegrated **R**emote
LDC	**L**oad **D**ependable **C**ontrol
LED	**L**ight **E**mitting **D**iode
LEV	**L**ow **E**mission **V**ehicle
LSM	**L**ight **S**witch **M**odule
MHz	**M**ega**H**ertz
MLS	**M**ulti **L**ayer **S**ealing
MMS	**M**ass **M**ovement **S**ensor
MOST	**M**edia **O**riented **S**ystems **T**ransport
PDM	**P**assenger **D**oor **M**odule
PEM	**P**ump **E**lectronic **M**odule
Prog-mode	Programming mode
PRV	**P**ressure **R**egulation **V**alve
PVV	**P**ressure **V**entilation **V**alve
PWM	**P**ulse **W**idth **M**odulated
RSC	**R**oll **S**tability **C**ontrol
REM	**R**ear **E**lectronic **M**odule
SAS	**S**teering **A**ngle **S**ensor
SBL	**S**econdary **B**oot**L**oader
SC	**S**tability **C**ontrol
SCM	**S**iren **C**ontrol **M**odule
SRS	**S**upplementary **R**estraint **S**ystem
SULEV	**S**uper **U**ltra **L**ow **E**mission **V**ehicle
SUM	**SU**spension **M**odule
TCM	**T**ransmission **C**ontrol **M**odule
TCV	**T**urbo **C**ontrol **V**alve
TRACS	**TRAC**tion Control **S**ystem
UEM	**U**pper **E**lectronic **M**odule
VADIS	**V**olvo **A**ftersales **D**iagnostics & **I**nformation **S**ystem
WHC	**W**heel **H**op **C**ontrol



VOLVO

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Service Training and Development Department

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