

130 Fuel Injection MS45.1 (M54 Engine)

GENERAL	130-1
DME applications	130-2
Warnings and Cautions	130-3

DRIVEABILITY TROUBLESHOOTING	130-5
Basic engine settings	130-5
System voltage	130-5
Main grounds	130-6
On-board diagnostics	130-6

ENGINE MANAGEMENT FUSES AND POWER SUPPLY COMPONENTS	130-7
Power supply fuses	130-7

SIEMENS DME MS45.1 (M54 ENGINE) ...	130-8
DME MS45.1 system description	130-8
Secondary air injection	130-10
Secondary air injection system components .	130-11
Secondary air injection illustrations	130-12

Air filter housing and ducts, removing and installing	130-13
Mass air flow, measurement	130-14
Mass air flow sensor, replacing	130-14
Throttle housing (EDK), replacing	130-15
Idle speed control valve, replacing	130-17
Fuel rail and injectors, removing and installing	130-18
Intake manifold, removing and installing	130-21
Crankcase breather valve components	130-24
Engine coolant temperature (ECT) sensor, replacing	130-24
DME main relay, testing	130-25
ECM pin assignments (Siemens DME MS45.1)	130-27

TABLE

a. 5 Series engine management applications	130-4
b. Siemens DME MS45.1 ECM pin assignments	130-27

GENERAL

This repair group covers service and repair of engine management system for 5 Series models with M54 engine and Siemens DME MS45.1.

See also:

- **020 Maintenance** for air filter, fuel filter and spark plug replacement
- **100 Engine-General** for engine identification
- **120 Ignition System** for ignition coil, camshaft sensor, crankshaft sensor and knock sensor service
- **160 Fuel Tank and Fuel Pump** for fuel pump and fuel pump relay service, fuel pressure tests and fuel pressure regulator replacement
- **180 Exhaust System** for oxygen sensor service
- **ECL Electrical Component Locations**
- **ELE Electrical Wiring Diagrams**
- **OBD On-Board Diagnostics**

130-2 Fuel Injection MS45.1 (M54 Engine)

DME applications

DME applications

BMW 5 Series models are equipped with digital motor electronics (DME), also known as Motronic. In these systems, fuel injection and ignition are controlled by an integrated engine control module (ECM). Application information for DME systems is in **Table a**.

Table a. 5 Series engine management applications

Year, model	Engine code	Engine management	Features
2004-2005			
Sedan: 525i, 530i	M54	Siemens MS 45.1	Double VANOS
Sedan: 545i	N62	Bosch DME ME 9.2 with Valvetronic control module	Valvetronic, VANOS
2006 - 2007			
Sedan, Sports Wagon: 525i, 525xi, 530i, 530xi Sports Wagon	N52	Siemens MSV70	Valvetronic, VANOS
2008 - 2010			
Sedan, Sports Wagon: 528i, 528xi	N52KP	Siemens MSV80	Valvetronic, VANOS
Sedan, Sports Wagon: 535i, 535xi	N54	Siemens MSD80 (to 03 / 2008) MSD81 (from 03 / 2008)	VANOS, turbocharged
2004-2005			
Sedan: 545i	N62	Bosch DME ME 9.2 with valvetronic control unit	Valvetronic, VANOS
2006 - 2010			
Sedan: 550i	N62TU	Bosch DME ME 9.2.2	Valvetronic, VANOS

Warnings and Cautions

WARNING—

- The fuel system is designed to retain pressure even when the ignition is OFF. When working with the fuel system, loosen the fuel lines slowly to allow residual fuel pressure to dissipate. Avoid spraying fuel. Use shop towels to capture leaking fuel.
- Fuel in fuel lines is under pressure (approx. 3 - 5 bar or 45 - 75 psi) and may be expelled forcibly. Do not smoke or work near heaters or other fire hazards. Keep a fire extinguisher handy.
- Unscrew the fuel tank cap to release pressure in the tank before working on fuel lines.
- Plug open fuel lines and fittings.
- Before beginning work on the fuel system, place a fire extinguisher in the vicinity of the work area.
- Work only on the fuel system when engine temperature is below 40°C (104°F).
- When disconnecting a fuel line, clamp off the line and wrap a clean shop towel around the fitting before disconnecting. Residual fuel pressure is present in the line.
- Fuel is highly flammable. When working around fuel, do not disconnect wires that could cause electrical sparks. Do not smoke or work near heaters or other fire hazards.
- Wear eye protection and protective clothing to avoid injuries from contact with fuel.
- When working on an open fuel system, wear suitable hand protection, as prolonged contact with fuel can cause illnesses and skin disorders.
- Unscrew the fuel tank cap to release pressure in the tank before working on fuel lines.
- Do not use a work light with an incandescent bulb near fuel. Fuel may spray on the hot bulb causing a fire.
- Make sure the work area is properly ventilated.
- Due to risk of personal injury, be sure the engine is cold before beginning work on engine components.
- The ignition system produces high voltages that can be fatal. Avoid contact with exposed terminals. Use extreme caution when working on a car with the ignition switched ON or the engine running.

130-4 Fuel Injection MS45.1 (M54 Engine)

Warnings and Cautions

CAUTION—

- Renew fuel system hoses, clamps and O-rings any time they are removed.
- Prior to disconnecting the battery, read the battery disconnection cautions in **001 Warnings and Cautions**.
- Connect and disconnect the DME system wiring and test equipment leads only when the ignition is switched OFF.
- Wait at least 1 minute after switching the ignition OFF before disconnecting engine control module (ECM) connectors. If the connectors are removed before this time, residual power in the system relay may damage the control module.
- Tests or repair procedures in this section may set fault codes (DTCs) in the ECM and illuminate the MIL. After repairs are completed, access and clear DTC memory using a BMW scan tool. See **On-board diagnostics** in this repair group.
- Fuel system cleaners and other chemical additives other than those specifically recommended by BMW may damage catalytic converters, oxygen sensors or other fuel supply components.
- Do not connect any test equipment that delivers a 12-volt power supply to terminal 15 (+) of the ignition coils. The current flow may damage the ECM. Connect test equipment only as specified by BMW or the equipment maker.
- Relay positions can vary. Be sure to confirm relay location and function by identifying the wiring in the socket using the wiring diagrams found in **ELE Electrical Wiring Diagrams**.
- Use a digital multimeter for electrical tests. Use an LED test light for quick tests.

DRIVEABILITY TROUBLESHOOTING

The self-diagnostic DME engine management systems monitor and store diagnostic trouble codes (DTCs). If the malfunction indicator light (MIL) illuminates, it indicates that an emissions-related fault has occurred and that one or more DTCs are stored in the engine control module (ECM).

◀ If faults arise, or if the MIL is illuminated, begin troubleshooting by connecting BMW scan tool to the OBD II plug under the dashboard.

The capabilities of OBD II software has the potential to save hours of diagnostic time and to help avoid incorrect component replacement and possible damage to system components. See **On-board diagnostics** in this repair group.

Basic engine settings

Idle speed, idle mixture (%CO), and ignition timing are not adjustable. The DME system is adaptive and automatically compensates for changes in the engine due to age, minor wear or small problems such as a disconnected vacuum hose. However, the adaptive range is limited. Once the limits are exceeded, driveability problems become noticeable.

Poor initial driveability may be encountered when the battery is disconnected and reconnected. When the battery is disconnected, ECM adaptive memory may be reset. The system readapts after about ten minutes of driving.

System voltage

Digital motor electronics (DME) requires that the system (battery) voltage be maintained within a narrow range of DC voltage. DC voltage levels beyond or below the operating range, or any AC voltage in the electrical system can cause havoc.

- When troubleshooting an illuminated MIL, make sure the battery is fully charged and capable of delivering all its power to the electrical system. An undercharged battery can amplify AC alternator output ripple.
- To make a quick check of battery charge, measure voltage across battery terminals with all cables attached and ignition OFF. A fully charged battery measures 12.6 volts or slightly more, compared to 12.15 volts for a battery with a 25% charge.

The DME system operates at low voltage and current levels, making it sensitive to small increases in resistance. The electrical system is routinely subject to corrosion, vibration and wear, so faults or corrosion in the wiring harness and connectors are not uncommon.

- Check battery terminals for corrosion or loose cable connections. See **121 Battery, Starter, Alternator**.



130-6 Fuel Injection MS45.1 (M54 Engine)

Main grounds

- If a battery cable connection has no visible faults but is still suspect, measure voltage drop across the connection. A large drop indicates excessive resistance, meaning that the connection is corroded, dirty or damaged. Clean or repair and retest. See **600 Electrical System-General** for voltage drop test procedure.
- Visually inspect wiring, connectors, switches and fuses. Loose or damaged connectors can cause intermittent problems, especially small terminals in ECM connectors. Disconnect wiring harness connectors to check for corrosion, and use electrical cleaning spray to remove contaminants.

Main grounds

Good grounds are critical to proper DME operation. If a ground connection has no visible faults but is still suspect, measure the voltage drop across the connection. A large voltage drop means high resistance. Clean or repair the connection and retest.

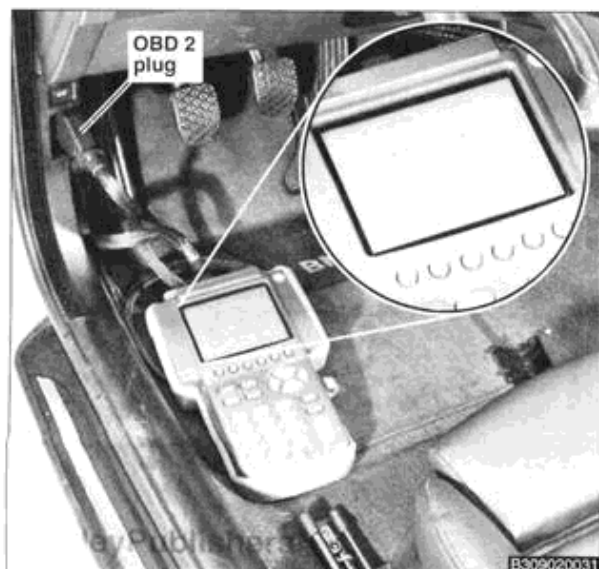
For voltage drop testing, see **600 Electrical System-General**.

For ground locations, see **ECL Electrical Component Locations**.

On-board diagnostics

Second generation on-board diagnostics (OBD II) software and hardware is incorporated in the engine management systems. The OBD II system monitors components that influence exhaust and evaporative emissions. If a problem is detected, the OBD II system stores the associated diagnostic trouble code (DTC) and condition.

If vehicle emissions levels exceed 1.5 times Federally mandated criteria, the OBD II system illuminates a malfunction indicator light (MIL) in the instrument cluster.



- Scan tool connected to OBD II plug on floor post below left dashboard.

Professional diagnostic scan tools available at the time of this printing include the BMW GT1, ISTA and a small number of aftermarket BMW-specific tools.

In addition to professional scan tools, there are inexpensive generic OBD II scan tool software programs and handheld units available. Although these have limited capabilities as compared to the dedicated tools, they are powerful diagnostic tools.

For the DIY owner, a simple aftermarket DTC reader is available through <http://www.peakresearch.com>. This tool is capable of checking for DTCs as well as switching the illuminated MIL OFF and resetting service indicator lights.

NOTE—

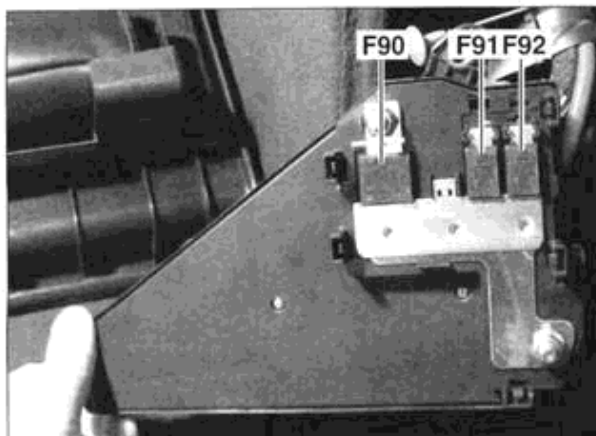
- OBD II DTC memory (including an illuminated MIL) can only be reset using a BMW scan tool or equivalent. Removing the connector from the ECM or disconnecting the battery does not erase DTC memory.

ENGINE MANAGEMENT FUSES AND POWER SUPPLY COMPONENTS

Power supply fuses

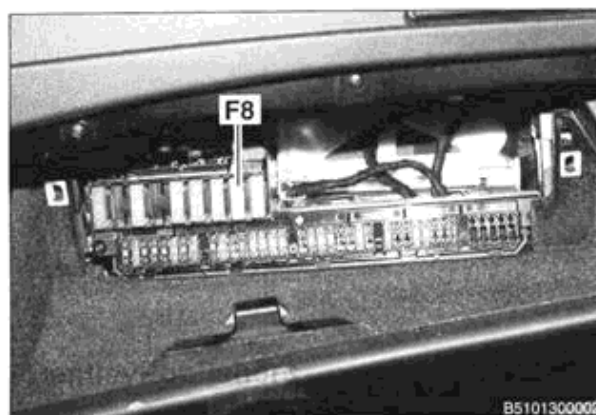
See **ECL Electrical Component Locations** for fuse panel access information.

- ◀ Rear distribution panel (A46) in trunk, installed in right rear fender:
 - **F90** 200A: Power supply to fuse panel A41a.

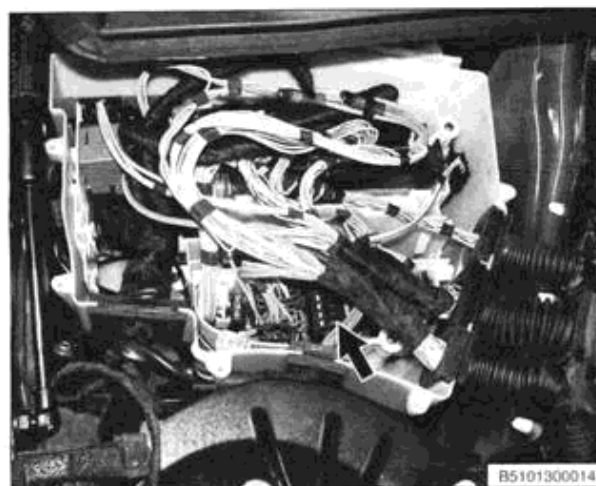


- ◀ **A41a**: fuse and relay panel behind glove compartment:
 - **F8** 60A:
 - Engine control module (ECM) (A6000)
 - ECM main relay (K6300)
 - Engine electronics fuse carrier (A8680)
 - Engine electronics fuse carrier (A8681)

See **ECL Electrical Component Locations** for specific vehicle fuse locations.



- ◀ Engine electronics fuse carrier A8680 (arrow).



130-8 Fuel Injection MS45.1 (M54 Engine)

DME MS45.1 system description

SIEMENS DME MS45.1 (M54 ENGINE)

DME MS45.1 system description

DME MS45.1 manages and monitors the following functions:

Air

- Idle speed valve
- Electronic throttle
- Hot film mass air flow sensor
- Resonance-turbulence intake control

Fuel

- Fuel supply (returnless)
- Fuel injection

Ignition

- Direct ignition
- Knock control
- Primary / secondary ignition monitoring

Emissions

- OBD II compliance
- Secondary air injection and monitoring
- Pre- and post-catalyst oxygen sensors
- Electrically heated DME-mapped thermostat
- Misfire detection
- Evaporative emission control and leak detection
- Ambient pressure sensing
- Malfunction indicator light (MIL)

Performance controls

- Double VANOS control
- Electric radiator cooling fan
- E-box cooling fan
- CAN-bus communication
- CAS (car access system) - EWS 3.3
- Cruise control
- Comfort start
- ECM programming
- Alternator interface (BSD, IBS)
- Dynamic stability control (DSC) interface

Engine control module (ECM)

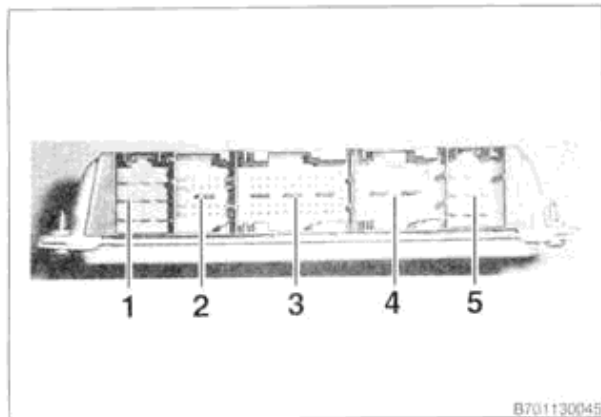
- The engine control module (ECM) (**arrow**) is mounted in the electronics box (E-box) at right rear of engine compartment.



- The MS45.1 ECM is flash-programmable and features 5 electrical harness connectors with a total of 134 pins.

- **Connector 1:** Voltages and grounds
- **Connector 2:** Ancillary signals (oxygen sensors, etc.)
- **Connector 3:** Engine signals
- **Connector 4:** Vehicle signals
- **Connector 5:** Ignition signals

The EEPROM (chip) in the MS45.1 ECM is coded to the vehicle. It can be flashed (reprogrammed) up to 13 times.



Fuel metering

The ECM meters pressurized fuel by changing the opening time (pulse width) of the fuel injectors. The exact amount of fuel injected is determined by the amount of time the injectors are open. To ensure that injector pulse width is the only factor that determines fuel metering, fuel pump pressure is maintained by a pressure regulator. The injectors are mounted to a common fuel rail.

- The fuel-injectors inject fuel at an angle in a dual cone spray pattern.

The ECM monitors engine operating conditions to determine injector opening duration. Each injector can be individually controlled for cylinder selective fuel trim.

Air intake

Air entering the engine passes through a pleated paper element in the air filter housing. Intake air mass is then measured by a mass air flow sensor. A reference current is used to heat a thin film in the sensor when the engine is running. The current needed to hold the temperature of the film constant is the basis of the electronically converted voltage measurement corresponding to the mass of the intake air.



130-10 Fuel Injection MS45.1 (M54 Engine)

Secondary air injection

Idle speed control

Idle speed is electronically controlled via the idle speed control valve by bypassing varying amounts of air around the closed throttle valve. Idle speed is not adjustable. The ECM determines idle speed by controlling a dual-winding rotary idle control valve. The basic functions and parameters of idle speed control are as follows:

- Control of cold air intake volume. For example, at air temperatures below 0°C (32°F), electronic throttle control (EDK) is also opened during idle.
- Smooth idle speeds regardless of load and inputs
- Smooth transition from acceleration to deceleration

Idle speed stabilization is active during the following conditions:

- Engine warm up
- Heating or A/C activation
- Drive gear selected (automatic transmission)
- Varying engine cooling fan speeds

If the ECM detects a fault in the idle control valve, it increases or decreases air flow, depending on the nature of the fault:

- If the fault causes decreased air flow (idle control valve closed), the electronic throttle control compensates to maintain idle.
- If the fault causes increased air flow (idle control valve failed open), VANOS and knock control are deactivated. This reduces engine performance noticeably.

Throttle control

In order to integrate the driver's wish with the requirements of the traction control system (DSC) and cruise control, DME systems feature electronic throttle control (EDK). There is no throttle cable between the accelerator pedal and the throttle housing

Knock (detonation) control

Knock sensors monitor and control ignition knock through the ECM. Knock sensors function like microphones and are able to convert mechanical vibration (knock) into electrical signals. The ECM is programmed to react to frequencies that are characteristic of engine knock and adapt the ignition timing point accordingly.

Knock sensor replacement is covered in **120 Ignition System**.

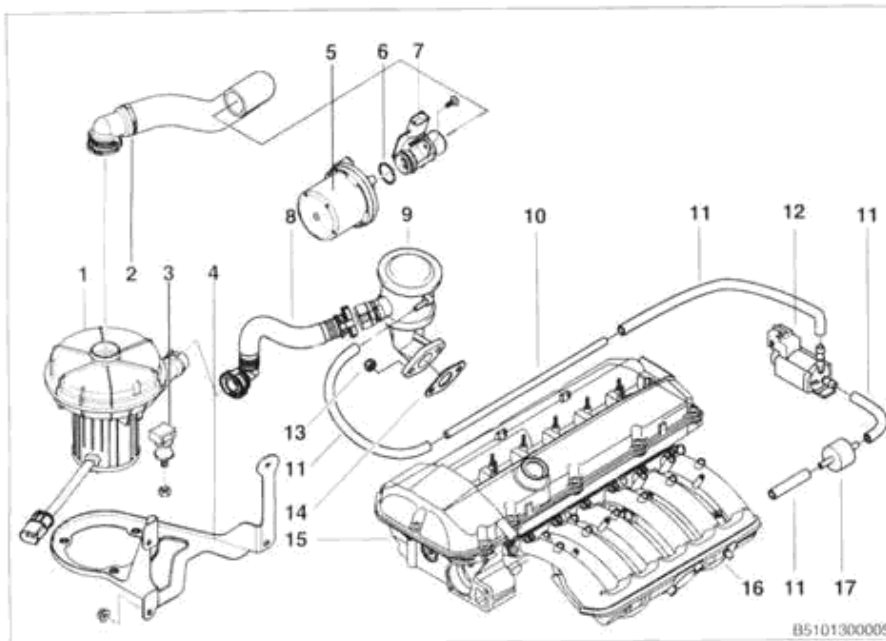
Secondary air injection

The secondary air system pumps ambient air into the exhaust stream after a cold engine start to reduce catalytic converter warm-up time and to reduce HC and CO emissions. The ECM controls and monitors the secondary air injection system.

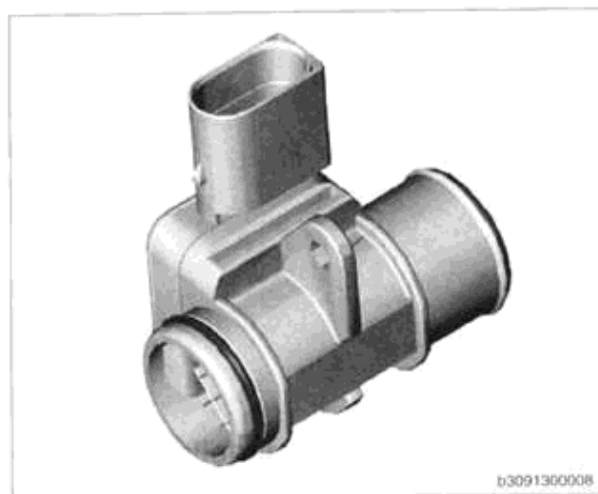
The electric air pump draws in ambient air and supplies it to the secondary air valve. The air injection valve is opened by a solenoid using engine vacuum and is closed by an internal spring.

The secondary air valve is bolted to the right front of the cylinder head. Cast passageways within the cylinder head duct the secondary air directly into the cylinder head exhaust ports.

Secondary air injection system components



1. Air pump
2. Filter air duct
3. Air pump mount
4. Air pump bracket
5. Air pump filter
6. O-ring
7. Air pump mini mass air flow sensor
8. Pressure hose
9. Secondary air valve
10. Vacuum pipe
11. Vacuum hose (3.3 mm)
12. Vacuum solenoid (ECM controlled)
13. Mounting nut M6
14. Gasket
15. Cylinder head
16. Intake manifold
17. Check valve



⚡ A miniature mass air flow sensor in the secondary air system detects the air mass supplied by the secondary air pump. This function monitors the secondary air system for OBD II compliance.

When the mini mass air flow sensor detects no or insufficient air flow, a fault is stored in the ECM and the malfunction indicator light (MIL) is illuminated.

Secondary air injection illustrations

⚡ Secondary air pump is in right front fender behind wheel well liner.

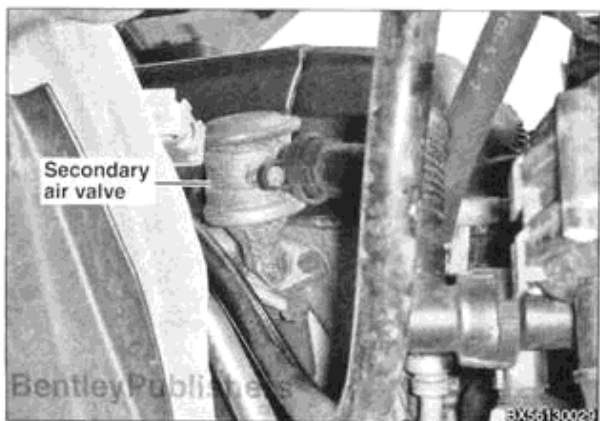


130-12 Fuel Injection MS45.1 (M54 Engine)

Secondary air injection illustrations



◀ B2606 Mini mass air flow sensor.



◀ Secondary air valve is bolted to right front of cylinder head.

Air filter housing and ducts, removing and installing

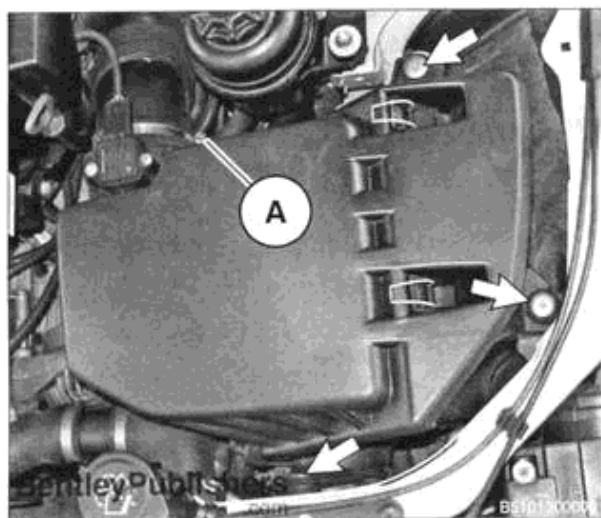
For air filter servicing, see **020 Maintenance**.

- Disconnect mass air flow sensor connector (**arrow**).



- Loosen hose clamp (**A**) and remove air filter housing fasteners (**arrows**).

- Remove air filter housing by lifting up and out in direction of **arrow**.
- Working at throttle body, loosen duct clamp. Remove duct from throttle body.
- Installation is reverse of removal.
- After reinstalling, check and clear fault codes from ECM memory.



130-14 Fuel Injection MS45.1 (M54 Engine)

Mass air flow, measurement



Mass air flow, measurement

- The mass air flow sensor, incorporating an electrically heated film in the air flow stream, sends to the ECM a varying voltage (approx. 0.5 - 4.5 volts) representing the mass of the intake air.

The ECM provides operating voltage and ground to the air flow sensor. As air flows through the sensor, the film is cooled. To maintain the film at a constant temperature, additional current is necessary. It is this additional current that is the basis for the air mass signal.

If there is no output signal from the air flow sensor, the ECM operates the engine using throttle position and engine rpm inputs. A faulty air flow sensor illuminates the MIL.



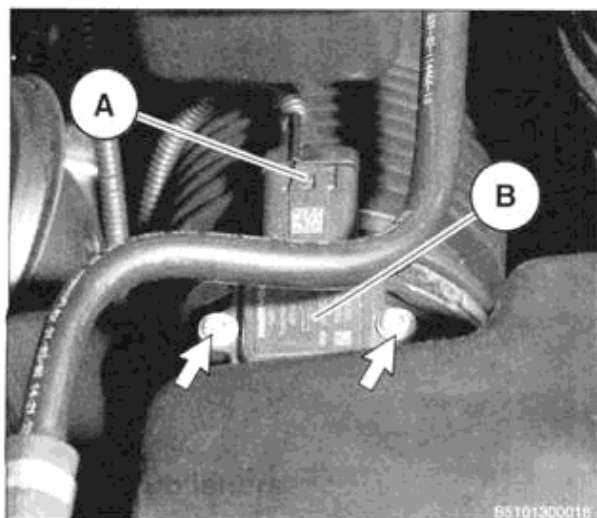
- The intake air temperature sensor (**inset**) is integrated into the mass air flow sensor. The sensor is an NTC thermistor which receives a 5 volt reference current and ground from the ECM.

A faulty air flow sensor can produce the following problems:

- Difficult to restart when engine is hot.
- Engine starts then stalls.
- Engine starts and runs only with accelerator pedal depressed.

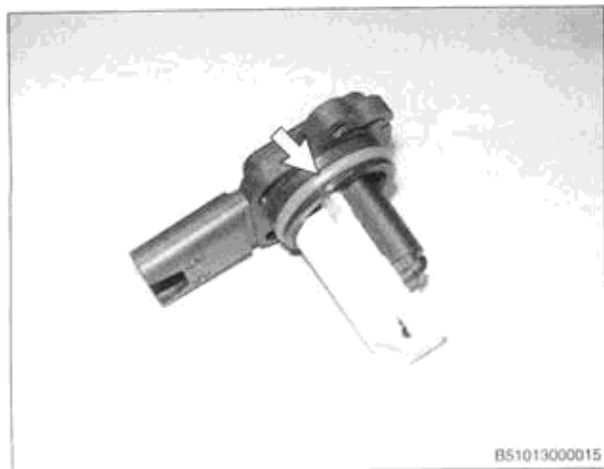
Mass air flow sensor, replacing

- Switch ignition OFF and remove key.
- Working at left front of engine compartment at air filter housing:
 - Detach mass air flow sensor electrical connector (**A**).
 - Remove fasteners (**arrows**).
 - Remove mass air flow sensor (**B**).
- Check intake ducts for cracks and vacuum leaks.



Fuel Injection MS45.1 (M54 Engine) 130-15

Throttle housing (EDK), replacing



Installation is reverse of removal.

- Inspect O-ring (**arrow**) and replace if necessary. Keep O-ring and duct sealing area free from oil.

— After reinstalling, check and clear fault codes from ECM memory.

Tightening torques

Mass air flow sensor to housing	3 Nm (26 in-lb)
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Throttle housing (EDK), replacing

There is no mechanical (cable) link between the accelerator pedal and the throttle plate.

The accelerator pedal module (PWG) at the pedal assembly communicates pedal position directly to the ECM. The module provides two variable voltage signals (via two Hall sensors) to the ECM for pedal position and rate of movement.

The ECM provides an independent voltage and ground supply for each Hall sensor. Each Hall sensor is provided with 5 volts and ground. As the accelerator pedal is moved from rest to full throttle, the sensors produce a variable voltage signal.

The output of the Hall sensors is checked for plausibility. The voltage range of Hall sensor 1 is approximately 0.5 to 4.5 volts. Hall sensor 2 ranges from approximately 0.5 to 2.5 volts.

The throttle housing unit EDK is nonadjustable. If found to be faulty, replace as a complete unit.

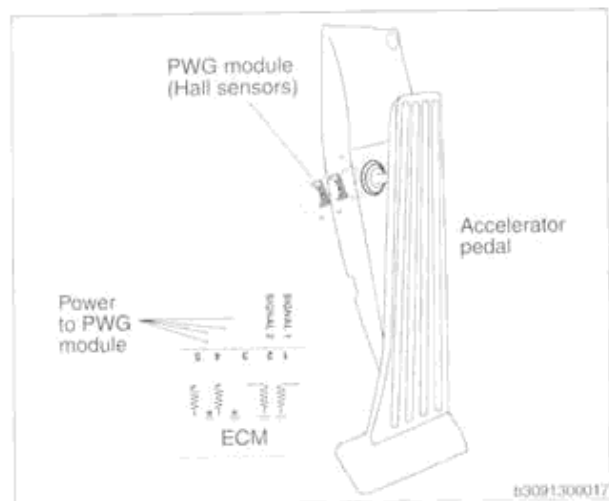
After replacing the throttle housing, use BMW scan tool to reset adaptation values.

CAUTION—

- If the adaptation process is not completed correctly, the engine does not start.

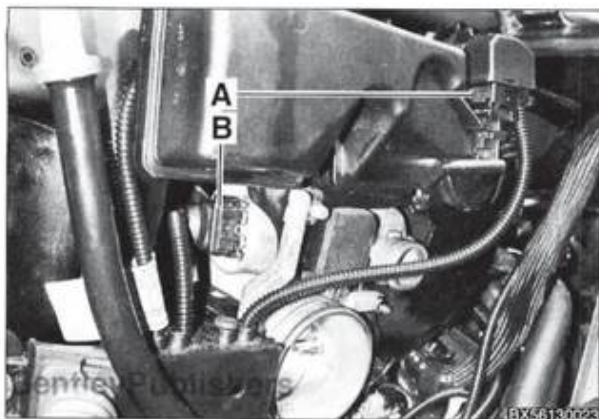
— Switch ignition OFF and remove key.

— Remove air filter housing and air intake ducts. See **Air filter housing and ducts, removing and installing** in this repair group.

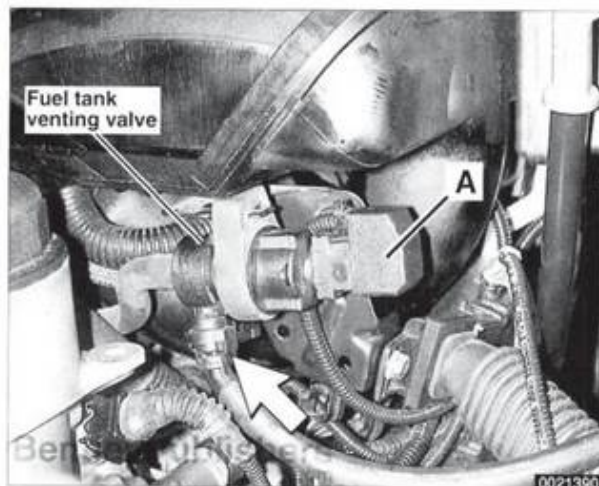


130-16 Fuel Injection MS45.1 (M54 Engine)

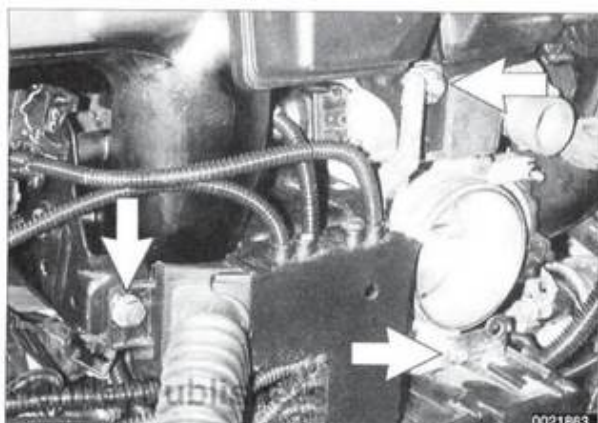
Throttle housing (EDK), replacing



- ◀ Working at side of intake manifold, disconnect electrical connectors:
 - Intake manifold resonance valve (A)
 - Idle speed control valve (B)
- Disconnect electrical connectors at oil pressure sender and oil temperature sender at base of oil filter housing.



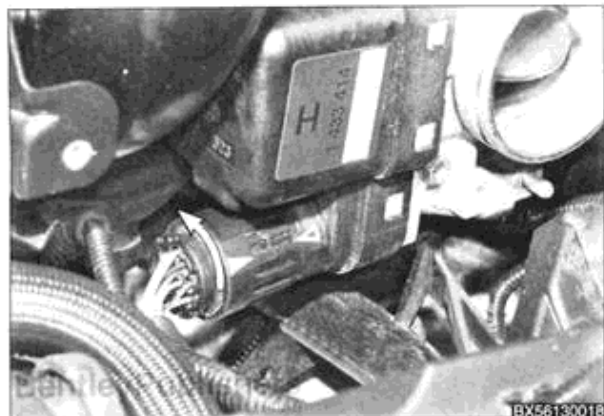
- ◀ Working at left side and underneath intake manifold:
 - Detach electrical connector (A) at fuel tank venting valve.
 - Disconnect hose at quick disconnect fitting (arrow).
 - Remove valve from manifold and set aside.



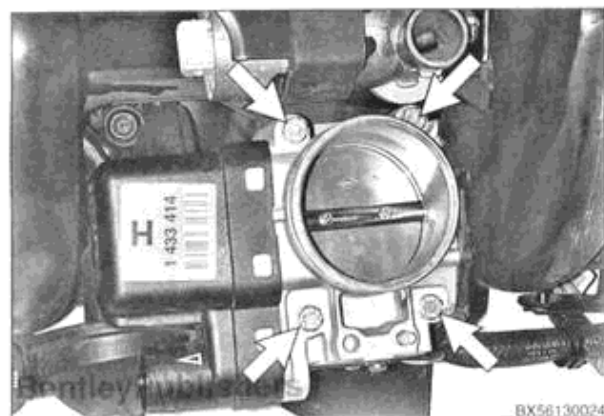
- ◀ Remove wiring harness housing mounting fasteners (arrows) and pull housing away from throttle assembly.
- Remove engine oil dipstick tube.

Fuel Injection MS45.1 (M54 Engine) 130-17

Idle speed control valve, replacing



- ◀ Working at throttle housing, unscrew harness plug counterclockwise (**arrow**) to disconnect.



- ◀ Remove throttle housing mounting fasteners (**arrows**) and pull assembly off manifold.
- Installation is reverse of removal.
 - Replace profile gasket (sealing O-ring) between throttle assembly and intake manifold.
 - Reattach throttle assembly connector with care. Arrow on fully tightened connector must line up with corresponding arrow on throttle assembly housing.
- Using BMW scan tool:
 - Check and clear fault codes from ECM memory.
 - Reset throttle adaptation.

Idle speed control valve, replacing

The idle speed control valve, mounted directly above the throttle housing, regulates idle speed by redirecting air around the throttle valve. The valve, supplied with battery voltage from the DME main relay, incorporates a two-coil rotary actuator. Coil grounds are pulsed simultaneously by the ECM. The duty cycle of each circuit is varied to achieve the required idle speed.

A faulty idle speed control valve sets a DTC. The MIL illuminates if OBD II fault criteria are exceeded.

- Switch ignition OFF and remove key.
- Disconnect battery negative (-) cable in cargo compartment.

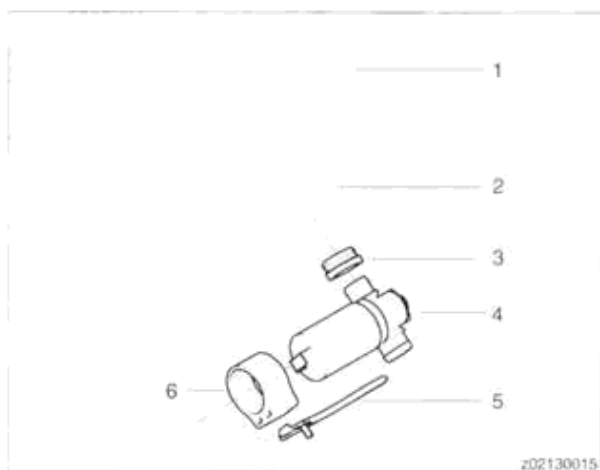
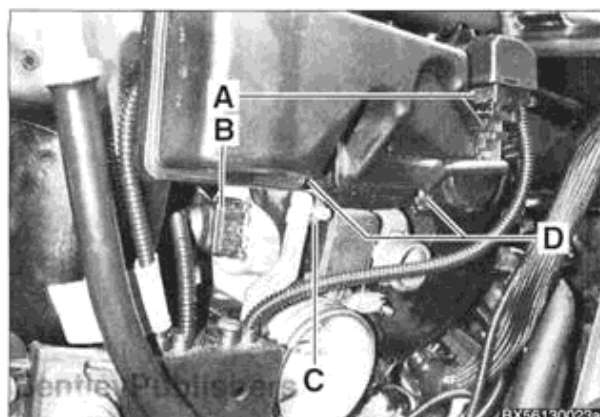
CAUTION—

- Prior to disconnecting the battery, read the battery disconnection cautions in **001 Warnings and Cautions**.

- Remove air filter housing and air intake ducts. See **Air filter housing and ducts, removing and installing** in this repair group.

130-18 Fuel Injection MS45.1 (M54 Engine)

Fuel rail and injectors, removing and installing



Working at side of intake manifold:

- Disconnect electrical connector to intake manifold resonance valve (A).
- Disconnect electrical connector to idle speed control valve (B).
- Remove upper wiring harness housing mounting fastener (C). Pull harness housing back slightly.
- Remove idle speed valve mounting bracket screws (D).
- Pull idle regulator off intake manifold. It is fitted to manifold using a sealing grommet.

When reinstalling, replace rubber grommet. Coat grommet on inside with assembly lubricant, then install in manifold. Press idle valve into place.

1. Intake manifold
2. Intake manifold resonance valve
3. Sealing grommet
4. Idle speed control valve
5. Mounting bracket
6. Rubber mounting

- Reattach wiring harnesses. Reinstall air filter assembly and ducts.
- Check and clear fault codes from ECM memory.

Fuel rail and injectors, removing and installing

Fuel injectors are electrically controlled solenoid valves that provide precisely metered and atomized fuel into the engine intake ports.

Injectors receive voltage from the DME main relay. The engine control module (ECM) controls injector opening by activating the ground circuit for the injector valve solenoids. The ECM varies the duration (in milliseconds) of injector opening to regulate air / fuel ratio.

- To access injectors, remove engine covers. See **020 Maintenance**.
- For a quick check of injectors, run engine and touch each injector with a screwdriver or stethoscope. You should feel a vibration or hear a buzzing. Switch engine OFF.
- Disconnect battery negative (-) cable.

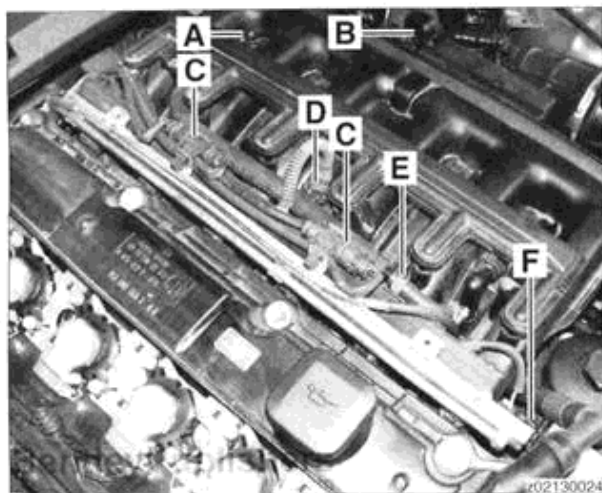
CAUTION—

- Prior to disconnecting the battery, read the battery disconnection cautions in **001 Warnings and Cautions**.

- Remove upper engine covers. See **020 Maintenance**.

Fuel Injection MS45.1 (M54 Engine) 130-19

Fuel rail and injectors, removing and installing

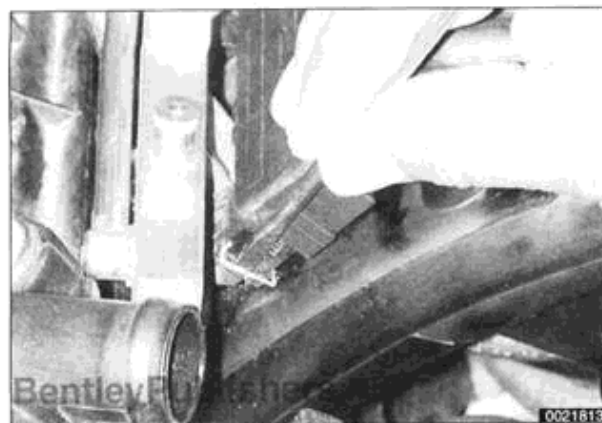


Working above engine, detach the following:

- B Resonance valve electrical connector
- C Oxygen sensor connectors
- D Electrical connector for intake air temperature sensor
- E Manifold vacuum line
- F VANOS solenoid electrical connector

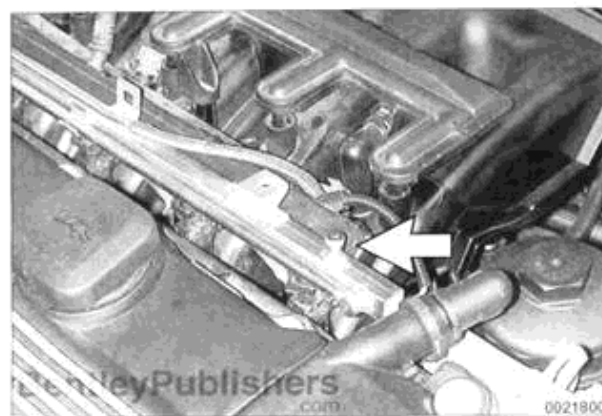
CAUTION—

- Be sure to mark oxygen sensor connectors so that they can be reassembled as before.



Disconnect fuel injector electrical connectors from injectors:

- Use small screwdriver to pry one corner of wire lock clip on fuel injector 1 connector.
- Repeat for all injectors.
- Lift off connector loom and set aside.



Unscrew Schrader valve cap (arrow) from fuel rail.

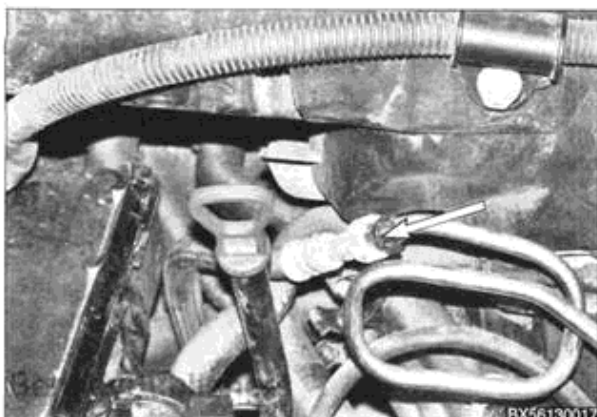
- Unscrew fuel tank cap to release pressure.
- Using a brief burst of compressed air (maximum of 3 bar or 43.5 psi), blow fuel back into fuel tank.

WARNING—

- Wrap a clean shop towel around fitting before connecting. Residual fuel pressure is present in the fuel rail.

130-20 Fuel Injection MS45.1 (M54 Engine)

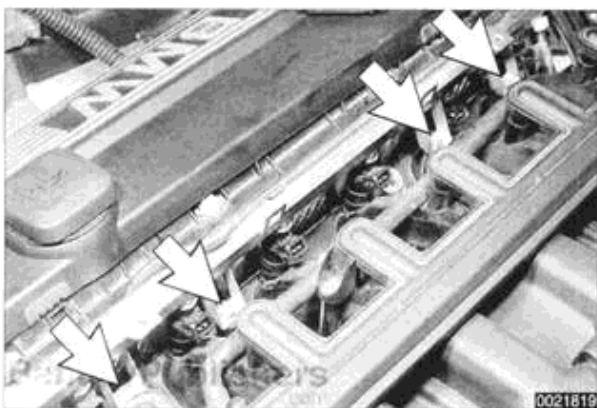
Fuel rail and injectors, removing and installing



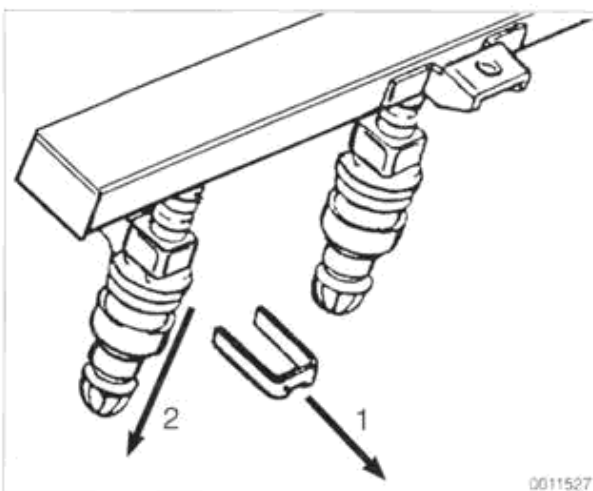
- Working at rear of manifold, use BMW special tool 16 1 050 or equivalent to press locking clip inside end of fuel line fitting (arrow) to disconnect fuel supply line from fuel rail.

WARNING —

- Wrap a clean shop towel around fitting before disconnecting. Residual fuel pressure is present in the fuel line.



- Remove fuel rail mounting bolts (arrows).
- Carefully pry fuel rail and injectors off manifold.
 - Separate fuel line support bracket at rear of intake manifold.
 - Guide fuel line(s) out of rear of engine compartment while lifting fuel rail out.



- Remove individual injectors:
- Pry retaining clip from injector (1).
 - Pull injector from rail (2).
- Installation is reverse of removal. Remember to:
- Fit new sealing O-rings when installing injectors. For ease of installation, lightly lubricate O-rings with assembly lubricant.
 - Check that injector electrical connections are correctly fitted and that injectors are fully seated prior to installing fuel rail mounting bolts.
 - Check fuel line rubber O-rings and replace as necessary. For ease of installation, lightly lubricate O-rings with assembly lubricant.
 - Replace wire ties.

Tightening torque

Fuel rail to cylinder head	10 Nm (7 ft-lb)
----------------------------	-----------------

- Check and clear fault codes from ECM memory.

Intake manifold, removing and installing

- Switch ignition OFF and remove key.
- Disconnect battery negative (-) cable.

CAUTION—

• Prior to disconnecting the battery, read the battery disconnection cautions in 001 Warnings and Cautions.

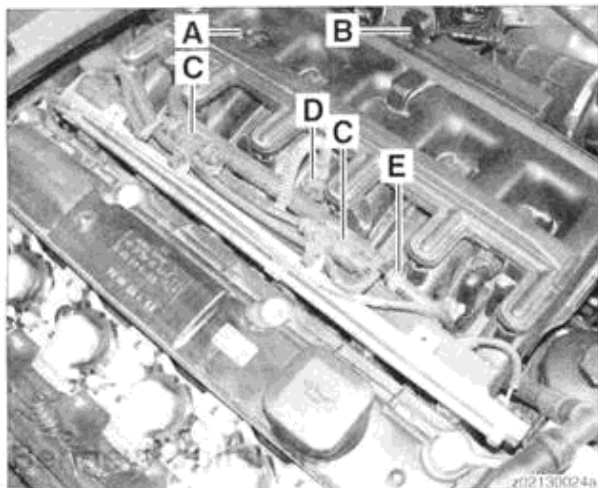
- Remove upper engine covers. See 020 Maintenance.

Working above engine, detach the following:

- A B+ lead bracket
- B Resonance valve electrical connector
- C Oxygen sensor connectors
- D Electrical connector for intake air temperature sensor
- E Manifold vacuum line

CAUTION—

• Be sure to mark oxygen sensor connectors so that they can be reassembled as before.

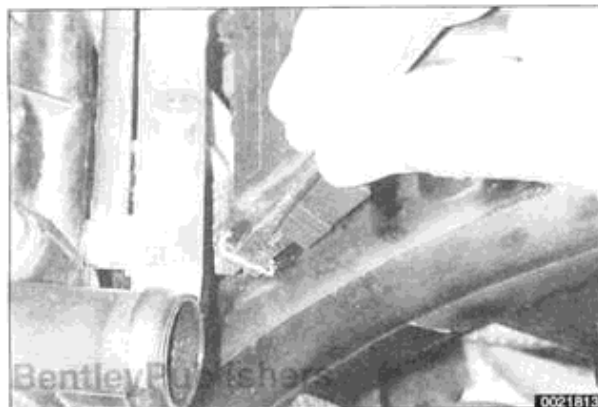


Working at left side of cylinder head:

- Detach engine vent hose from cylinder head cover by pinching spring clips (**arrows**).
- Detach VANOS solenoid electrical connector (**A**).

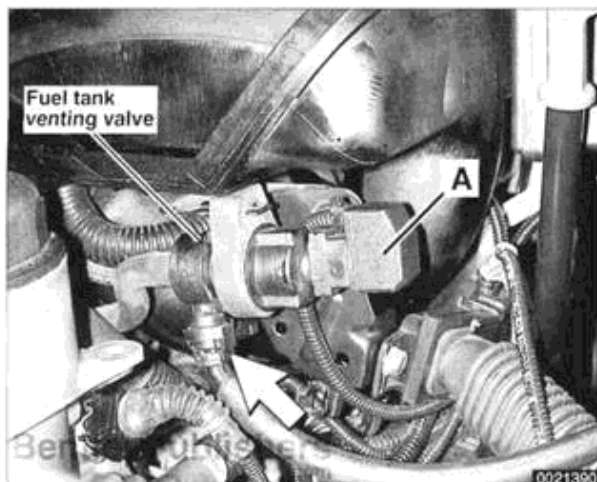
Detach fuel injector electrical connectors from injectors:

- Use small screwdriver to pry one corner of wire lock clip on fuel injector 1 connector.
- Repeat for all injectors.
- Remove two main harness hold-down fasteners. Lift off entire harness and lay aside.

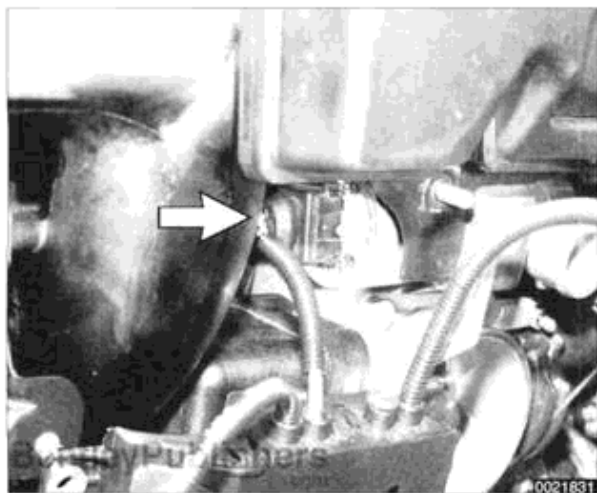


130-22 Fuel Injection MS45.1 (M54 Engine)

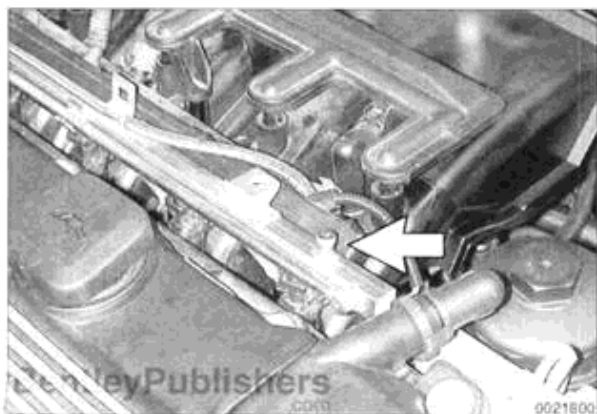
Intake manifold, removing and installing



- Working at left side and underneath intake manifold:
- Detach electrical connector (**A**) at fuel tank venting valve.
 - Disconnect hose at quick disconnect fitting (**arrow**).
 - Remove valve from manifold and set aside.



- Disconnect electrical connector (**arrow**) at idle speed control valve.
- Remove throttle housing. See **Throttle housing (EDK)**, replacing in this repair group.



- Unscrew Schrader valve cap (**arrow**) from fuel rail.
- Unscrew fuel tank cap to release pressure.
 - Using a brief burst of compressed air (maximum of 3 bar or 43.5 psi), blow fuel back into fuel tank.

WARNING —

- *Wrap a clean shop towel around fitting before connecting. Residual fuel pressure is present in the fuel rail.*

Fuel Injection MS45.1 (M54 Engine) 130-23

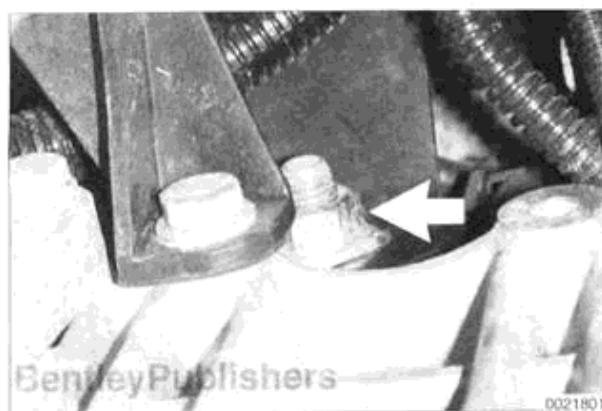
Intake manifold, removing and installing



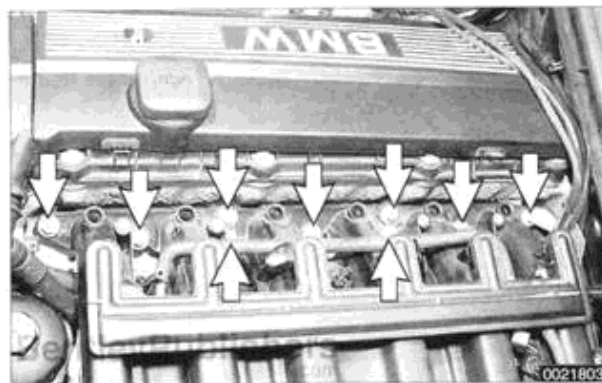
- ◀ Working at rear of manifold, use BMW special tool 16 1 050 or equivalent to press locking clip inside end of fuel line fitting (**arrow**) to disconnect fuel supply line from fuel rail.

WARNING—

- Wrap a clean shop towel around fitting before disconnecting. Residual fuel pressure is present in the fuel line.



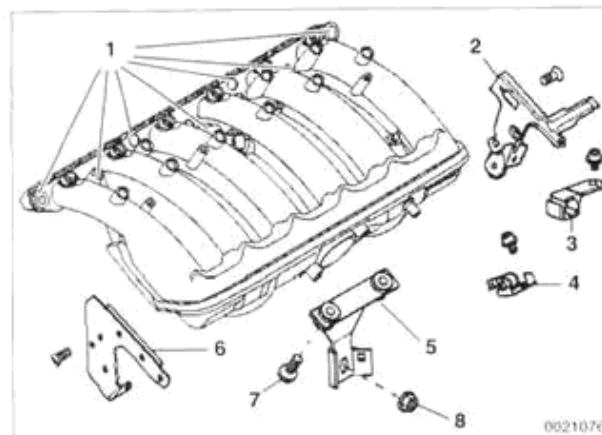
- ◀ Working underneath car, remove lower intake manifold support mounting bolt (**arrow**), located adjacent to left engine mount.
- Detach knock sensor connector from bracket at base of manifold.
- Remove manifold lower support nuts.



- ◀ Remove intake manifold mounting nuts (**arrows**).
- Remove intake manifold from cylinder head while carefully checking for electrical connections or hoses that might become snagged.

CAUTION—

- Plug open intake ports to prevent parts or debris from falling into the engine intake.



- ◀ Note intake manifold brackets and mounts:

1. Manifold mounting nuts
 - tighten to 15 Nm (11 ft-lb)
2. Fuel pipe bracket
3. Fuel pipe bracket
4. Vacuum pump bracket
5. Manifold mounting bracket
6. Tank venting valve bracket
7. Mounting bracket to manifold bolt (M6)
 - tighten to 10 Nm (7 ft-lb)
8. Mounting bracket to engine block nut (M10)
 - tighten to 47 Nm (33 ft-lb)

130-24 Fuel Injection MS45.1 (M54 Engine)

Crankcase breather valve components

- Intake manifold installation is reverse of removal.
- Use new fuel injector seals.
- Carefully check intake manifold gaskets and replace if necessary.
- Check condition of rubber seals at throttle housing and idle speed control valve. Replace as necessary.
- Inspect O-ring seal between mass air flow sensor and air filter housing. To facilitate reassembly, coat seal with assembly fluid.

CAUTION—

- When reattaching throttle assembly harness connector, make sure arrows on connector and plug line up when fully tightened.

Tightening torques

Intake manifold to cylinder head (M7)	15 Nm (11 ft-lb)
Mounting bracket to engine block (M10)	47 Nm (33 ft-lb)
Mounting bracket to intake manifold (M6)	10 Nm (7 ft-lb)

Crankcase breather valve components

- Cylinder head cover
- Connecting hose
- Oil return hose
- Breather valve
- Vacuum hose
- Dipstick guide tube vent hose
- Dipstick guide tube
- Vent pipe
- Screw

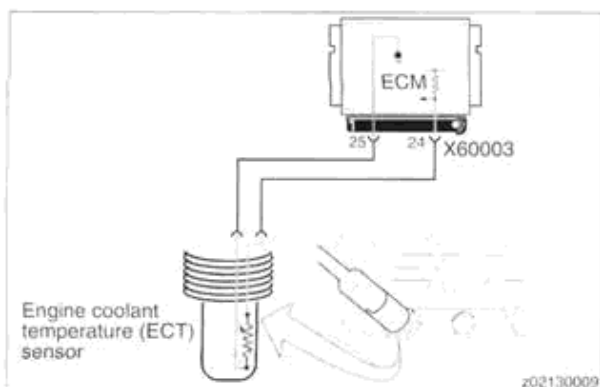
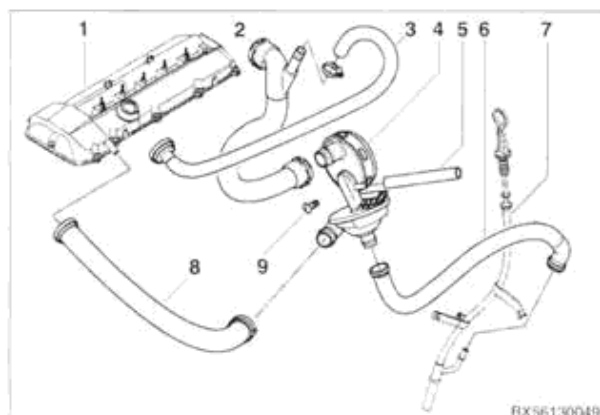
The M54 engine crankcase is ventilated by breather valve under the intake manifold. If the diaphragm valve in the breather housing leaks, full intake vacuum may be applied to the crankcase, resulting in excessive oil consumption, irregular idle, whistling or howling noises or oil smoke in the exhaust.

To gain access to breather valve, remove air filter housing and ducts. See **Throttle housing, removing and installing** in this repair group.

Engine coolant temperature (ECT) sensor, replacing

- ◀ The ECT sensor is an NTC (negative temperature coefficient) sensor. As coolant temperature rises, resistance through the sensor decreases.

The ECM varies ignition timing and air / fuel mixture based on engine coolant temperature. The ECT sensor is supplied a 5 volt reference voltage. The voltage drop across the sensor varies as the coolant temperature (sensor resistance) changes.



If the ECT sensor input is faulty or not plausible, the MIL is illuminated. The ECM assumes a substitute value (80° C / 176°F) to maintain engine operation. The ignition timing is set to a safely conservative basic setting.

The ECT sensor is located below cylinder 6 intake port at the rear of the engine, underneath the intake manifold.

- With engine fully cooled off, remove intake manifold. See **Intake manifold, removing and installing** in this repair group.

➤ Disconnect ECT sensor connector (arrow).

- Unscrew ECT sensor from cylinder head. Be prepared to catch small amount of coolant.

- Installation is reverse of removal:

- Use new copper sealing washer when installing sensor.
- Replace lost coolant.
- Check and clear fault codes from ECM memory.

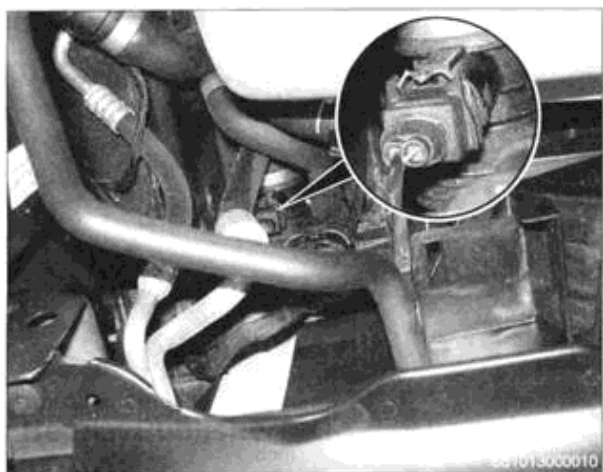
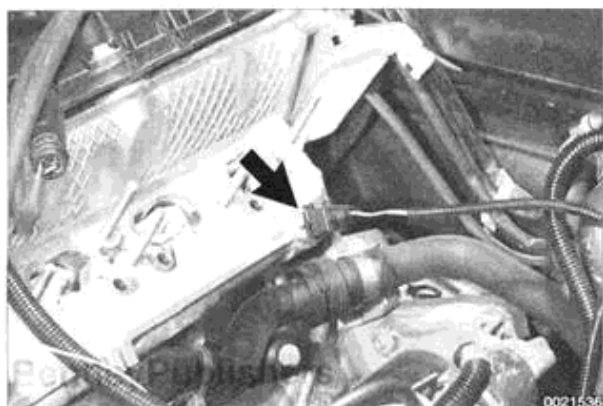
Tightening torque

Temperature sensor to cylinder head	13 Nm (10 ft-lb)
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Radiator outlet coolant temperature sensor

- The radiator outlet temperature sensor (**inset**) is an NTC (negative temperature coefficient) sensor. As coolant temperature rises, resistance through the sensor decreases.

The ECM varies cooling fan speed based on radiator outlet coolant temperature. The radiator outlet coolant temperature sensor is supplied a 5 volt reference voltage. The voltage drop across the sensor varies as the coolant temperature (sensor resistance) changes.



130-26 Fuel Injection MS45.1 (M54 Engine)

DME main relay, testing

DME main relay, testing

The DME main relay is energized via the ECM and supplies battery positive (B+) power to the following:

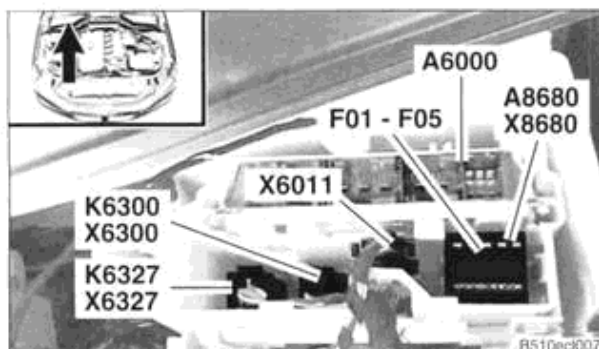
- ECM
- Ignition coils
- Fuel injectors
- Fuel tank leak detection pump
- Idle air control valve
- Camshaft sensors
- Evaporative emissions valve
- Mass air flow sensor
- Fuel pump relay
- Oxygen sensor heaters

If the DME main relay is faulty, the engine does not start.

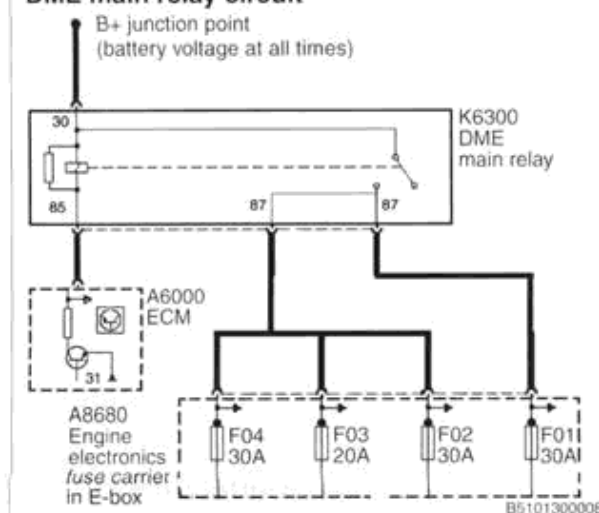
- With ignition off, remove DME main relay (K6300) (arrow) in electronics box (E-box) at right rear of engine compartment.

NOTE—

- Relay locations can vary. Confirm relay identification by matching wiring colors and terminal numbers. See **ELE Electrical Wiring Diagrams**.



DME main relay circuit



- Check for voltage at terminal 6 of relay socket (corresponds to terminal 30 on relay).
- If battery voltage is present, continue testing.
 - If battery voltage is not present, check the following:
 - Large red wire in relay socket
 - A2076 (battery positive junction) in E-box, right rear of engine compartment
 - Fuse F8 in fuse and relay panel above glove compartment. See **Power supply fuses** in this repair group.
 - See **ELE Electrical Wiring Diagrams** for more details
 - Check for ground at relay socket 4 (corresponds to terminal 85 on relay).
 - If ground is present, continue testing.
 - If ground is not present, signal from ECM is missing. Check wire between relay and ECM 24-pin connector X60002. See **ECM pin assignments (Siemens DME MS45.1)** in this repair group.
 - If no faults are found:
 - Check ECM grounding.
 - ECM may be defective.

Fuel Injection MS45.1 (M54 Engine) 130-27

ECM pin assignments (Siemens DME MS45.1)

- With ignition ON and relay installed, check for battery voltage at relay sockets 2 and 5 (correspond to terminals 87 on relay).

NOTE—

- In some models there is only one terminal 87.

- If battery voltage is present, relay has energized and is functioning correctly.
- If battery voltage is not present and all earlier tests are OK, relay is faulty. Replace.
- If no faults are found during relay testing but power is not reaching ECM or other components, check fuses in engine electronics fuse carrier (A8680) in E-box. See fuses in **ECL Electrical Component Locations**.
- When finished testing, check for DTCs and clear and reset ECM memory.

ECM pin assignments (Siemens DME MS45.1)

- The engine control module (ECM) (arrow) is located in the right rear of the engine compartment in the E-box.

- The ECM has 5 electrical connectors with a total of 134 pins:

- Connector 1 (X60001), 9 pins: Power and grounds
- Connector 2 (X60002), 24 pins: Ancillary signals (oxygen sensors, CAN-bus, etc.)
- Connector 3 (X60003), 52 pins: Engine signals
- Connector 4 (X60004), 40 pins: Vehicle signals
- Connector 5 (X60005), 9 pins: Ignition signals

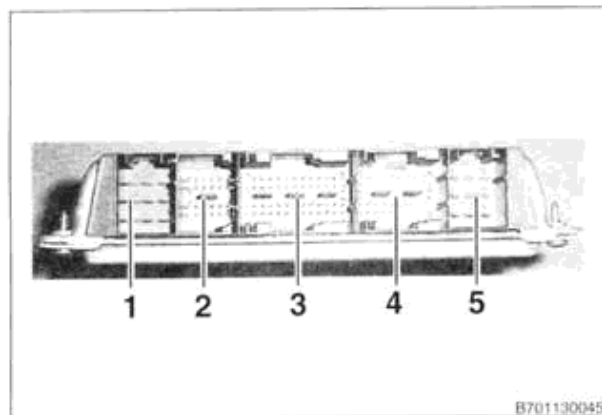
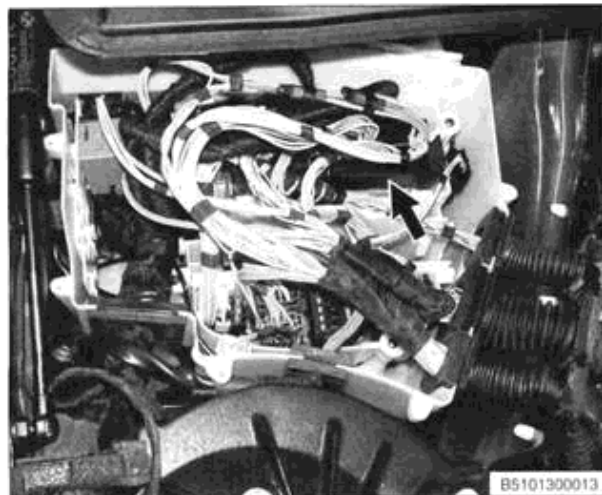
ECM pin assignments for Siemens DME MS45.1 are given in **Table b**. This information can be helpful when diagnosing faults to or from the ECM.

Generally, absence of voltage or continuity means there is a wiring or connector problem. Test results with incorrect values do not necessarily mean that a component is faulty. Check for loose, broken or corroded connections and wiring before replacing components. For engine management system electrical schematics, see **ELE Electrical Wiring Diagrams**.

When making checks at the ECM, use a break-out box to allow tests to be made with the connector attached to the ECM. This prevents damage to the small terminals in the connector. As an alternative, the connector housing can be separated so that electrical checks can be made from the back of the connector.

CAUTION—

- Wait at least one minute after switching the ignition OFF before removing the connector from the ECM. If the connector is removed before this time, residual power in the system relay may damage the ECM.
- Connect or disconnect the control module connector and meter probes with the ignition OFF.



130-28 Fuel Injection MS45.1 (M54 Engine)

ECM pin assignments (Siemens DME MS45.1)

Table b. Siemens DME MS45.1 ECM pin assignments

Connector X60001 9-pin (power, grounds)

Pin	Type	Component or function	Note
1	-	Not used	
2	-	Not used	
3	input / output	TXD signal	Solder connector
4	ground	ECM	
5	ground	ECM	
6	ground	ECM	
7	input	Power supply (terminal 30)	Battery voltage (B+) at all times, fuse F105
8	input	Terminal 87, fuse F2	Voltage supply
	-	Not used	

Connector X60002 24-pin (ancillary signals)

Pin	Type	Component or function	Note
1	output	Oxygen sensor heater (pre-catalyst cyl. 1-3)	Negative activation
2	output	Oxygen sensor heater (pre-catalyst cyl. 4-6)	Negative activation
3	-	Not used	
4	-	Not used	
5	-	Not used	
6	output	Oxygen sensor heater (post-catalyst cyl. 1-3)	Negative activation
7	input	Oxygen sensor (pre-catalyst, cyl. 1-3)	Negative Signal
8	input	Oxygen sensor (post-catalyst, cyl. 4-6)	Negative Signal
9	input	Oxygen sensor (pre-catalyst, cyl. 4-6)	Negative Signal
10	input	Oxygen sensor (post-catalyst, cyl. 1-3)	Negative Signal
11	-	Not used	
12	output	Oxygen sensor heater (post-catalyst cyl. 4-6)	Negative activation
13	input	Oxygen sensor (pre-catalyst, cyl. 1-3)	Signal
14	output	Oxygen sensor (post-catalyst, cyl. 4-6)	Signal
15	output	Oxygen sensor (pre-catalyst, cyl. 4-6)	Signal
16	output	Oxygen sensor (post-catalyst, cyl. -3)	Signal
17	-	Not used	
18	-	Not used	
19	input	Oxygen sensor (pre-catalyst, cyl. 1-3)	Signal
20	input	Oxygen sensor (pre-catalyst, cyl. 1-3)	Signal
21	input	Oxygen sensor (pre-catalyst, cyl. 4-6)	Signal
22	input	Oxygen sensor (post-catalyst, cyl. 4-6)	Signal
23	input	DME system power supply, terminal 87	Battery voltage from DME main relay
	-	Not used	

Fuel Injection MS45.1 (M54 Engine) 130-29

ECM pin assignments (Siemens DME MS45.1)

Connector X60003 52-pin (engine signals)			
Pin	Type	Component or function	Note
1	input	Mass air flow sensor	Signal
2	-	Not used	
3	input	Crankshaft sensor	Signal
4	output	Mass air flow sensor	Voltage supply
5	output	Throttle valve (EDK)	Voltage supply
6	output	Fuel injector 2	Pulsed ground
7	output	Fuel injector 4	Pulsed ground
8	output	Fuel injector 6	Pulsed ground
9	output	VANOS solenoid exhaust	Signal
10	output	VANOS solenoid intake	Signal
11	output	Fuel injector 5	Pulsed ground
12	output	Thermostat heating	Signal
13	output	Fuel injector 1	Pulsed ground
14	ground	Mass air flow sensor	
15	ground	Throttle valve (EDK)	
16	ground	Oil pressure switch	
17	-	Not used	
18	-	Not used	
19	input / output	Alternator BSD	Interface
20	-	Not used	
21	output	Fuel tank vent valve	Signal
22	output	Idle speed control valve	Signal
23	output	Idle speed control valve	Signal
24	-	Not used	
25	-	Not used	
26	output	Fuel injector 3	Pulsed ground
27	input	Intake air temperature sensor	Signal
28	input	Coolant temperature sensor	Signal
29	input	Camshaft position sensor 1	Signal
30	input	Camshaft position sensor 2	Signal
31	input	Throttle position signal	Throttle valve (EDK)
32	input	Throttle position signal	Throttle valve (EDK)
33	input	Knock sensor	Double knock sensor
34	input	Knock sensor, cyl. 4 - 6	Signal
35	ground	Coolant temperature sensor	
36	ground	Camshaft position sensor 1	
37	ground	Crankshaft position sensor	

130-30 Fuel Injection MS45.1 (M54 Engine)

ECM pin assignments (Siemens DME MS45.1)

Connector X60003 52-pin (engine signals) (continued)

Pin	Type	Component or function	Note
38	-	Not used	
39	output	Secondary air injection vacuum solenoid	Signal
40	output	DISA changeover valve	Signal
41	-	Not used	
42	output	Throttle valve (EDK)	Signal
43	output	Throttle valve (EDK)	Signal
44	input	Oil temperature sensor	Signal
45	ground	Oil temperature sensor	Signal
46	input	Knock sensor	Double knock sensor
47	input	Knock sensor	Double knock sensor
48	-	Not used	
49	ground	Camshaft position sensor 2	
50	input	Oil level sensor	Signal
51	-	Not used	
52	-	Not used	

Connector X60004 40-pin (vehicle signals)

Pin	Type	Component or function	Note
1	-	Not used	
2	output	Diagnostic module tank leak (DM-TL) detection	Signal
3	output	Secondary air injection pump relay	Signal
4	input	Electric cooling fan	Signal
5	ground	Mass air flow sensor	
6	-	Not used	
7	ground	Pedal position sensor	
8	input	Pedal position sensor 1	Signal
9	output	Pedal position sensor	Voltage supply
10	output	Fuel pump relay	Signal
11	-	Not used	
12	ground	Pedal position sensor	
13	input	Pedal position sensor 2	Signal
14	output	Pedal position sensor	Voltage supply
15	input	Mass air flow sensor	Signal
16	-	Not used	
17	output	Crankshaft speed signal	OBD II connector or 20-pin DLC
18	-	Not used	
19	output	E-box cooling fan	Signal

Fuel Injection MS45.1 (M54 Engine) 130-31

ECM pin assignments (Siemens DME MS45.1)

Connector X60004 40-pin (vehicle signals) (continued)

Pin	Type	Component or function	Note
20	output	Diagnostic module tank leak (DM-TL) detection	Signal
21	output	Radiator shutter solenoid	Signal
22	input	Wheel speed sensor	Signal
23	input	Clutch pedal position switch	Signal
24	input	Brake light switch	Signal
25	-	Not used	
26	input	Terminal 15, fuse F31 (wake up signal)	Switched power
27	-	Not used	
28	input	Brake light switch	Signal
29	-	Not used	
30	input	Fuel tank leakage diagnosis pump (DM-TL)	Signal
31	-	Not used	
32	-	Not used	
33	input	EWS (electronic immobilizer)	Car access system
34	-	Not used	
35	-	Not used	
36	input/output	CAN-bus high	Signal
37	input/output	CAN-bus low	Signal
38	ground	Radiator coolant outlet temperature sensor	
39	input	Radiator coolant outlet temperature sensor	Signal
40	input	Start signal	Car access system

Connector X60005 9-pin (ignition signals)

Pin	Type	Component or function	Note
1	output	Ignition coil 5	Signal
2	-	Not used	
3	-	Not used	
4	output	Ignition coil 3	Signal
5	ground	ECM ground	
6	ground	Ignition coil 1	
7	output	Ignition coil 2	Signal
8	output	Ignition coil 4	Signal
9	output	Ignition coil 6	Signal



