

132 Fuel Injection MSD80, MSD81 (N54 Engine)

GENERAL	132-1	Charge air duct pressure sensor, replacing	132-17
DME applications	132-2	Intake manifold charge air pressure sensor, replacing	132-18
Warnings and Cautions	132-3	Throttle housing (EDK), replacing	132-19
DRIVEABILITY TROUBLESHOOTING	132-5	Fuel injector service	132-20
Basic engine settings	132-5	Fuel injectors, removing	132-21
System voltage	132-5	Injector bore, cleaning	132-24
Main grounds	132-6	Fuel injector PTFE seal, replacing	132-24
On-board diagnostics	132-6	Fuel injectors, installing	132-27
ENGINE MANAGEMENT FUSES AND POWER SUPPLY COMPONENTS	132-7	Fuel injector adaptation	132-29
Power supply fuses	132-7	Fuel rail, removing	132-30
SIEMENS DME MSD80, MSD81 (N54 ENGINE)	132-8	Fuel rail, installing	132-32
DME engine management system description	132-8	Intake manifold, removing and installing	132-34
Air filter housing and ducts, removing and installing	132-11	Crankcase breather valve	132-37
Charge air ducts, left side, removing and installing	132-12	Engine coolant temperature (ECT) sensor, replacing	132-38
Charge air ducts, right side, removing and installing	132-14	Radiator outlet coolant temperature sensor ..	132-38
Mass air flow, measurement	132-17	DME main relay, testing	132-39
		ECM pin assignments	132-41

TABLE

a. 5 Series engine management applications	132-2
b. Siemens DME MSD80 / 81 ECM pin assignments ..	132-42

GENERAL

This repair group covers service and repair of engine management systems for turbocharged N54 engines with Siemens DME MSD80 or MSD81.

See also:

- **020 Maintenance** for air filter, fuel filter and spark plug replacement
- **100 Engine-General** for engine identification and application
- **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**

132-2 Fuel Injection MSD80, MSD81 (N54 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).
- 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.

132-4 Fuel Injection MSD80, MSD81 (N54 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 system monitors and stores 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 have 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**.



132-6 Fuel Injection MSD80, MSD81 (N54 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 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 below left dashboard.

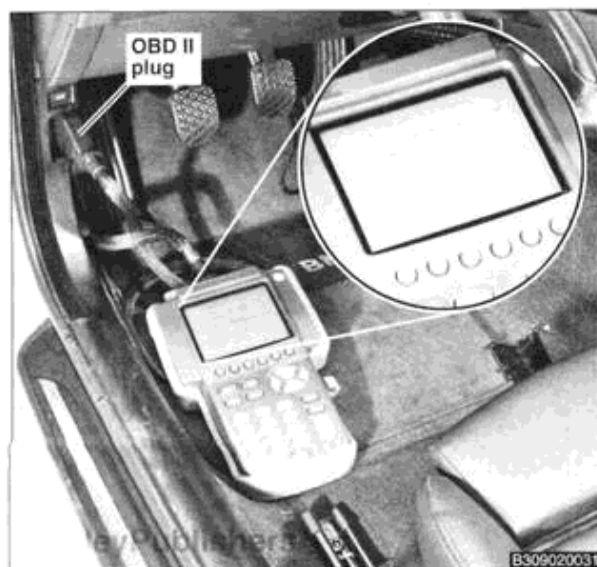
Professional diagnostic scan tools available at the time of this printing include the BMW GT1, ISTA and a small number of aftermarket BMW-specific tools.

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.peakeresearch.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.

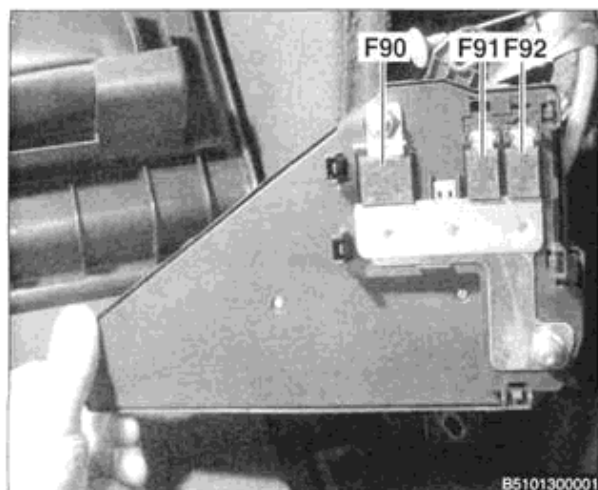


ENGINE MANAGEMENT FUSES AND POWER SUPPLY COMPONENTS

Power supply fuses

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

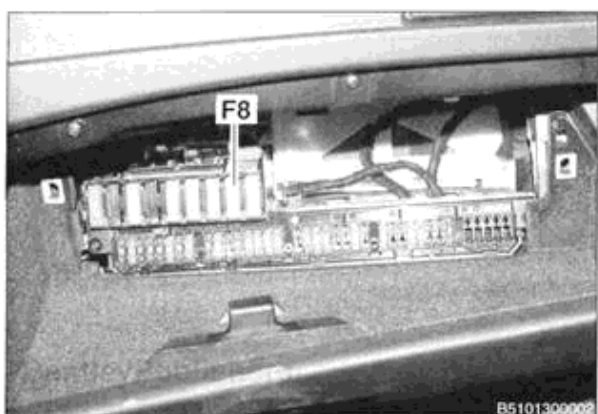
- ◀ Rear distribution panel (A46) in trunk, installed in right rear fender:
 - **F90** 200A: Power supply to fuse panel A41a.



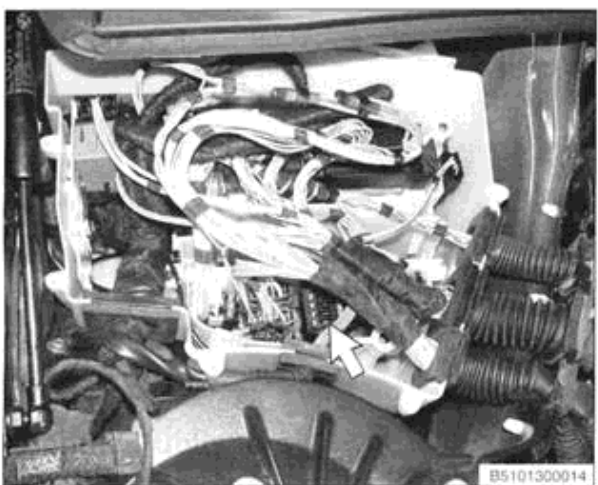
- ◀ **A41a**: fuse and relay panel behind glove compartment:

- **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**).



132-8 Fuel Injection MSD80, MSD81 (N54 Engine)

DME engine management system description

SIEMENS DME MSD80, MSD81 (N54 ENGINE)

DME engine management system description

The DME manages and monitors the following functions:

Air

- Twin-turbo chargers
- Electronic throttle
- Charge air intercoolers

Fuel

- Fuel supply
- Direct fuel injection

Ignition

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

Emissions

- OBD II compliance
- Pre- and post-catalyst oxygen sensors
- Electrically heated DME-mapped thermostat
- Misfire detection
- Evaporative emission control and leak detection
- Malfunction indicator light (MIL)

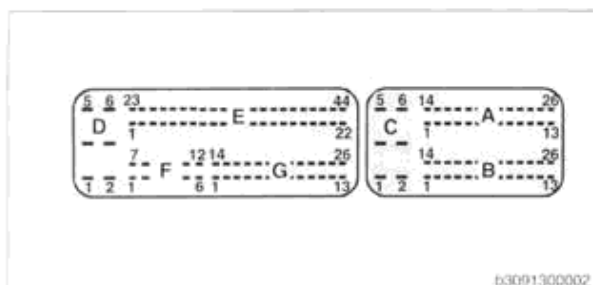
Performance controls

- Double VANOS control
- Output of injection signal (TI) for fuel economy gauge
- Output of engine rpm (TD) for tachometer
- A/C compressor control
- Electric radiator cooling fan
- CAN-bus communication
- Dynamic stability control (DSC) interface
- Car access system (CAS) with EWS 3.3
- Cruise control
- ECM programming



Engine control module (ECM)

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



- The ECM is flash-programmable and features 2 main electrical harness connectors, one with 4 modular connections and the other with 3 for a total of 7 subconnectors and 147 pins.

- A: X60001 (signals)
- B: X60002 (signals)
- C: X60003 (voltage, ground supply)
- D: X60004 (ignition coils)
- E: X60005 (signals)
- F: X60006 (fuel injectors)
- G: X60007 (signals)

The EEPROM (chip) in the ECM is coded to the vehicle.

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.

- 5 Series model with N54 engine utilizes direct fuel injection. Each fuel injector (**arrow**) is mounted into a machined hole in the cylinder head near the spark plug.

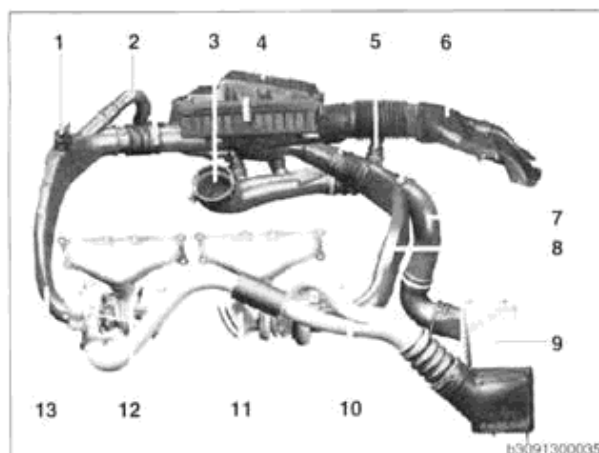


A direct injection turbocharged engine achieves a higher compression ratio when compared to ones utilizing manifold injection. At the same time, the exhaust gas temperature is reduced under full load. Another advantage of this injection process is improved efficiency in part-load operation.

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

132-10 Fuel Injection MSD80, MSD81 (N54 Engine)

DME engine management system description



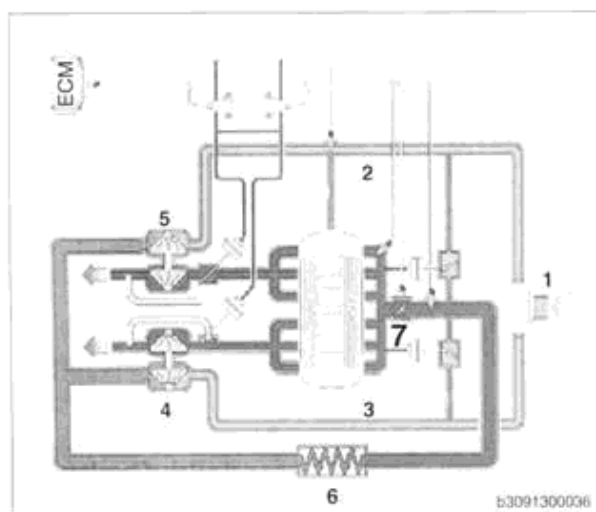
Air intake

➤ Air intake ducting plays a significant role due to the requirements of a turbocharged engine. In principle, the energy of escaping exhaust gases is utilized to precompress the inducted fresh air and thus introduce a greater air mass into the combustion chamber. This is only possible if air intake ducting is leak free and installed properly.

1. Heater for blow by gases (PTC)
2. Recirculated air line, bank 2
3. Connection to throttle valve
4. Air filter housing
5. Recirculated air line, bank 1
6. Air intake snorkel
7. Charge air pressure line
8. Charge air suction line, bank 1
9. Charge air intercooler
10. Charge air manifold
11. Turbocharger, bank 1
12. Turbocharger, bank 2
13. Charge air suction line, bank 2

➤ Fresh air is drawn in via the air cleaner (1) and charge-air suction lines (2, 3) to the turbochargers (4, 5) and compressed. Because the turbochargers can get very hot during operation, they are connected to the engine coolant and engine oil circuits. The charge air is greatly heated when compressed in the turbocharger, making it necessary for the air to be cooled in an intercooler (6).

The compressed and cooled charge air is routed from the intercooler via the throttle valve (7) into the intake manifold. The system is equipped with several sensors and actuators in order to ensure that the volume of air is optimally adapted to engine operating conditions.



Idle speed control

The ECM controls idle speed by varying throttle valve actuation. Idle speed is not adjustable. The basic functions and parameters of idle speed control are as follows:

- Control of cold air intake volume.
- 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 cooling fan speeds

Throttle control

The N54 engine features electronic throttle control (EDK). There is no throttle cable between the accelerator pedal and the throttle housing. EDK integrates driver commands with the requirements of the traction control system (DSC) and cruise control.

Knock (detonation) control

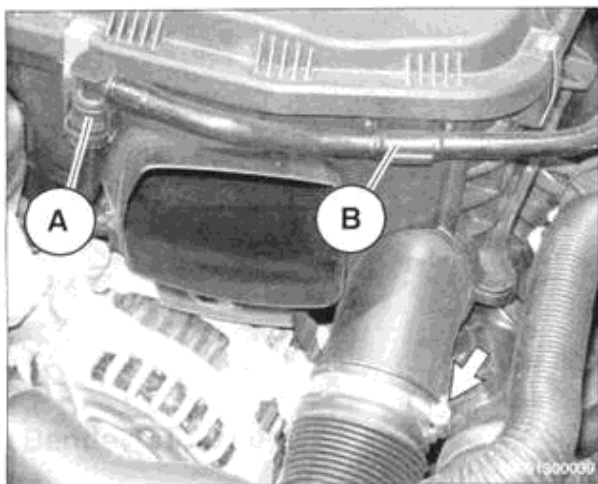
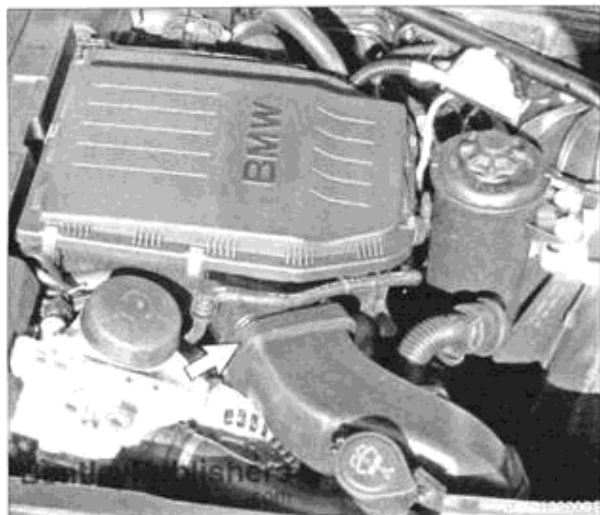
Knock sensors monitor and control ignition knock through the ECM. Knock sensors function like microphones and are able to convert mechanical vibration (knock) into electrical signals. The ECM is programmed to react to frequencies that are characteristic of engine knock and adapt the ignition timing point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

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

Air filter housing and ducts, removing and installing

Working at top of engine, detach air intake duct (arrow) and lift out of radiator support.

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

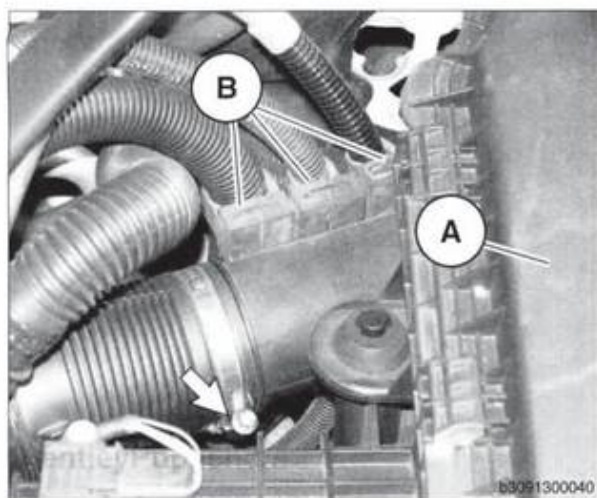


Remove complete air cleaner housing, disconnecting and labeling connectors, ducting and hoses as necessary:

- Air duct hose clamp (arrow).
- Disconnect line (A) and detach from air intake housing (B).

132-12 Fuel Injection MSD80, MSD81 (N54 Engine)

Charge air ducts, left side, removing and installing



- Loosen clamp (**arrow**) and remove air intake hose.
 - Pull up wiring harness rubber mounts (**B**) to detach.
 - Detach intake filter housing (**A**) from rubber mounts, then lift and remove.

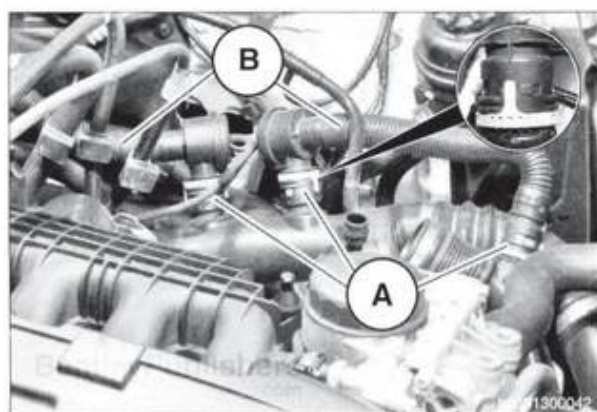
— Installation is reverse of removal.

CAUTION—

- Turbocharger failure may result if charge air ducts are not installed dry and free of grease. Install using antiseize compound only.

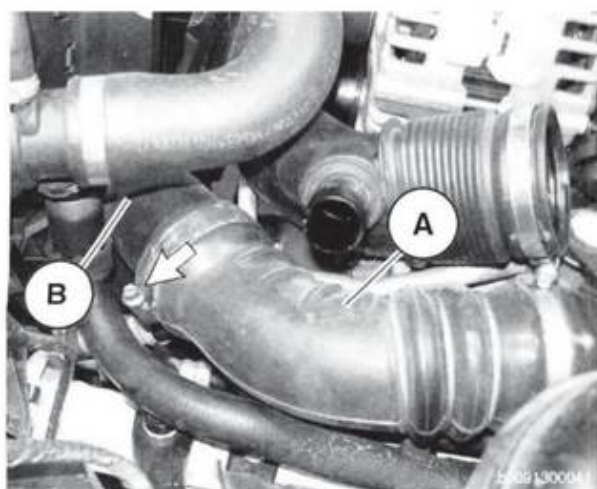
— After reinstalling, check and clear fault codes from ECM memory.

Charge air ducts, left side, removing and installing



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

- Turn quick release coupling locks (**A**) 90° to disconnect. Detach recirculated air hoses (**B**) and lay aside. Note position of arrows on quick connector for reinstallation.

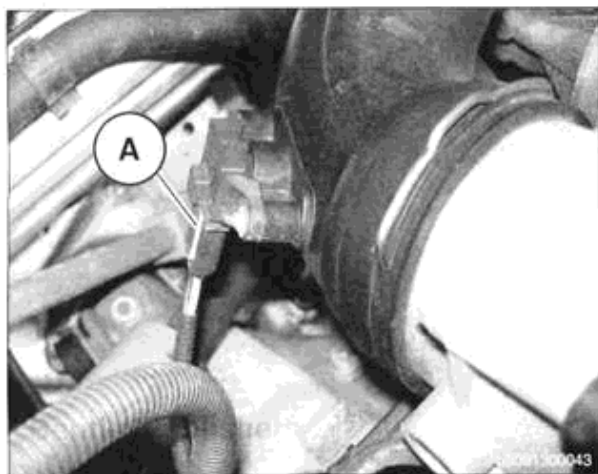


- Working at left charge air duct:

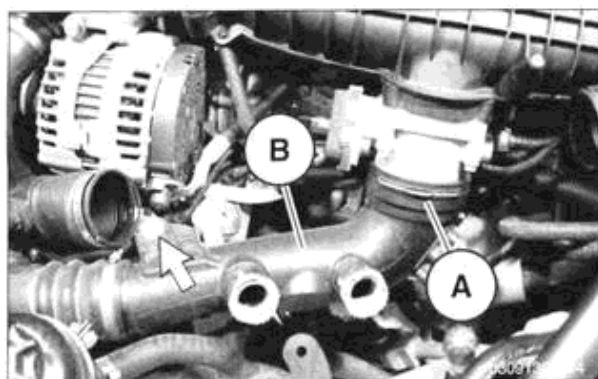
- Loosen clamp (**arrow**) and remove charge air hose (**A**) from duct (**B**).

Fuel Injection MSD80, MSD81 (N54 Engine) 132-13

Charge air ducts, left side, removing and installing



- ◀ Disconnect electrical connector (A) and place harness aside.



- ◀ Remove fastener (arrow).
- Unlock quick connect (A) and remove charge air duct (B) from throttle valve.
- Raise vehicle and support safely.

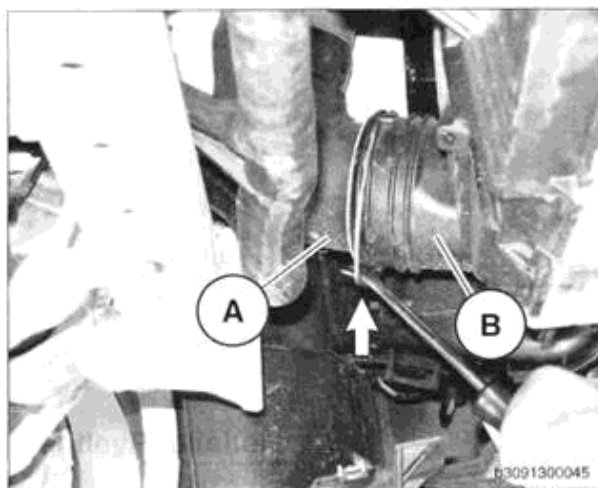
WARNING —

- Make sure the vehicle is stable and well supported at all times. Use a professional automotive lift or jack stands designed for the purpose. A floor jack is not adequate support.

- Remove splash shield underneath engine. See 020 Maintenance.

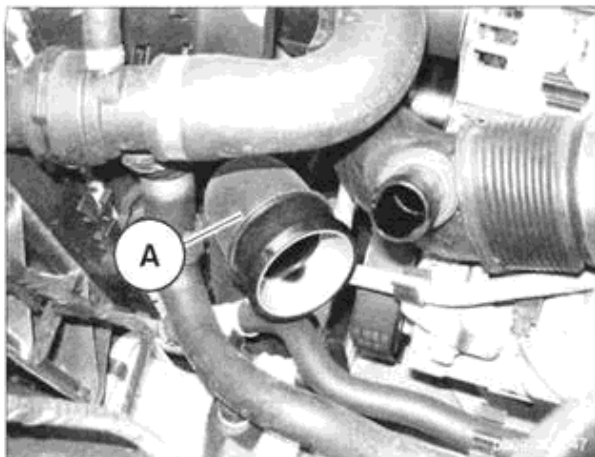
- ◀ Working under vehicle at right front air charge duct:

- Unlock quick connect (arrow) and disconnect charge air duct (A) from intercooler (B).



132-14 Fuel Injection MSD80, MSD81 (N54 Engine)

Charge air ducts, right side, removing and installing



➤ Feed air charge duct (A) through top and remove.

— Installation is reverse of removal.

CAUTION—

• Turbocharger failure may result if charge air ducts are not installed dry and free of grease. Install using antiseize compound only.

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

Charge air ducts, right side, removing and installing

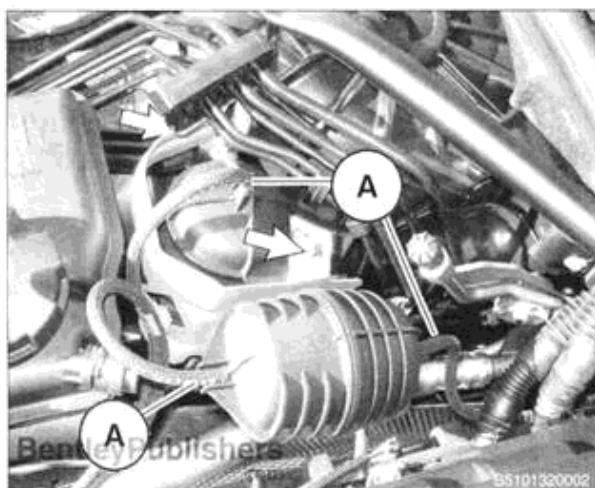
— Drain coolant and remove coolant expansion tank. See 170 Radiator and Cooling System.

— Remove splash shield underneath engine. See 020 Maintenance.

➤ Working in right front engine compartment:

- Label and detach vacuum lines (A) from canisters.
- Remove fasteners (arrows).

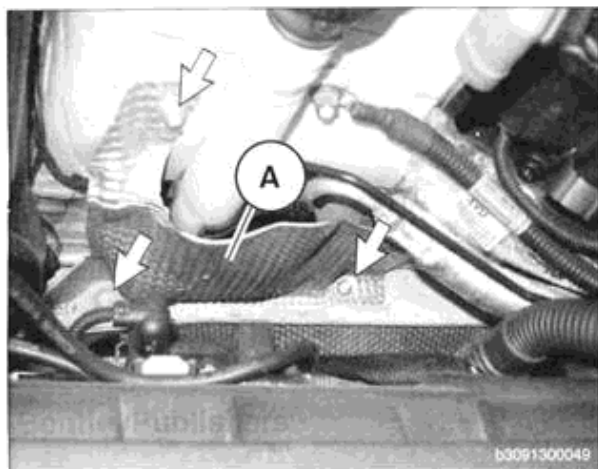
— Raise bracket slightly. Label and detach vacuum hose from bottom of canisters. Remove assembly.



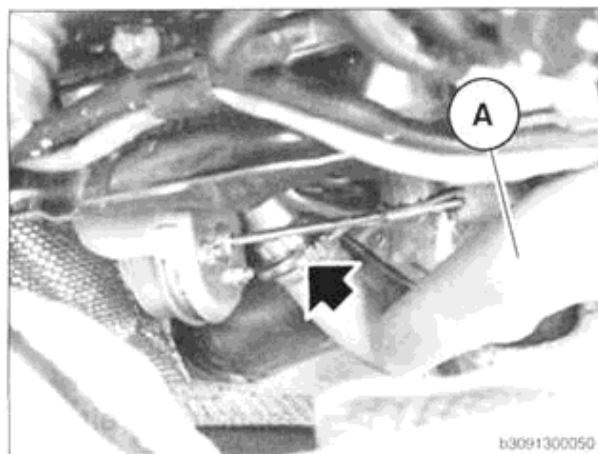
Fuel Injection MSD80, MSD81 (N54 Engine) 132-15

Charge air ducts, right side, removing and installing

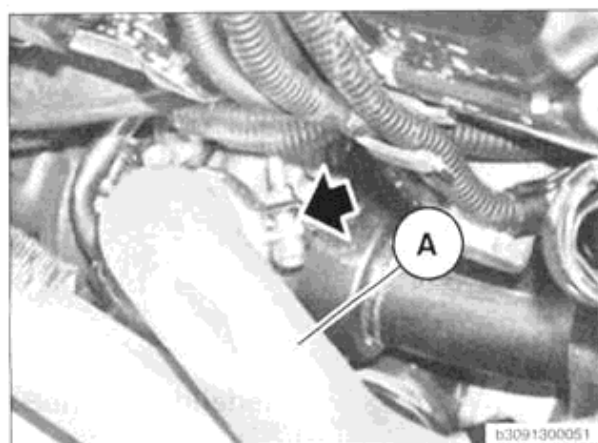
- Working at right strut tower, remove nuts (**arrows**) and remove heat shield (**A**) if equipped.



- Working above turbocharger, loosen clamp (**arrow**) and remove charge air duct (**A**).

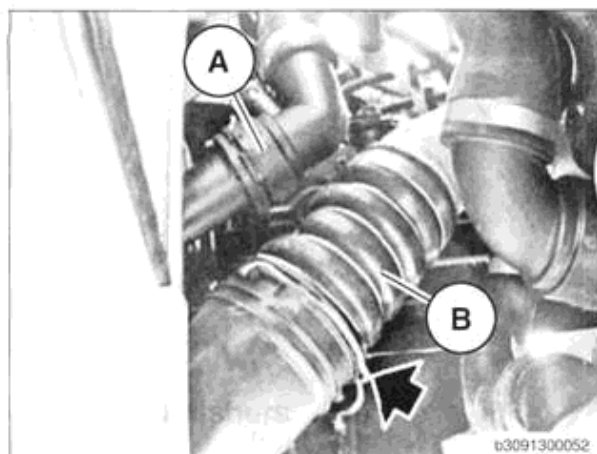


- Working above turbocharger, loosen clamp (**arrow**) and remove charge air duct (**A**).

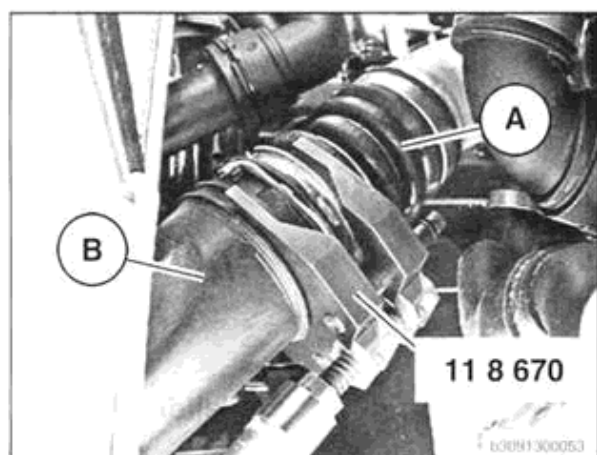


132-16 Fuel Injection MSD80, MSD81 (N54 Engine)

Charge air ducts, right side, removing and installing



- Working beneath right front of vehicle:
- Unlock quick connect and remove radiator hose (A).
 - Unlock quick connect (arrow) and remove charge air duct (B).



- When reinstalling charge air duct to intercooler use BMW special tool 11 8 670.



- Coat charge air duct O-ring (arrow) with antiseize before reinstalling.

— Remainder of installation is reverse of removal.

CAUTION—

- Turbocharger failure may result if charge air ducts are not installed dry and free of grease. Install using antiseize compound only.

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

Mass air flow, measurement

The N54 engine utilizes a calculated air mass system. This calculation makes use of the following signals:

- VANOS setting (load acquisition)
- Throttle setting
- Intake air temperature (air density correction)
- Engine temperature (air density correction)
- Engine speed (cylinder charge)
- Intake manifold pressure (throttle correction)
- Ambient pressure (air density, altitude correction)

➤ The calculated air mass is adjusted with the oxygen sensor signal (mixture ratio) and injector timing and corrected if necessary.

1. Intake air temperature sensor
2. Throttle valve position
3. Intake manifold
4. Residual oxygen measurement in exhaust
5. Intake manifold vacuum
6. Engine speed
7. ECM with charge calculation model
8. Injection timing

In the event of an oxygen sensor failure, a fault code is stored in the ECM (air mass plausibility). The calculated air mass is not adjusted in this case.

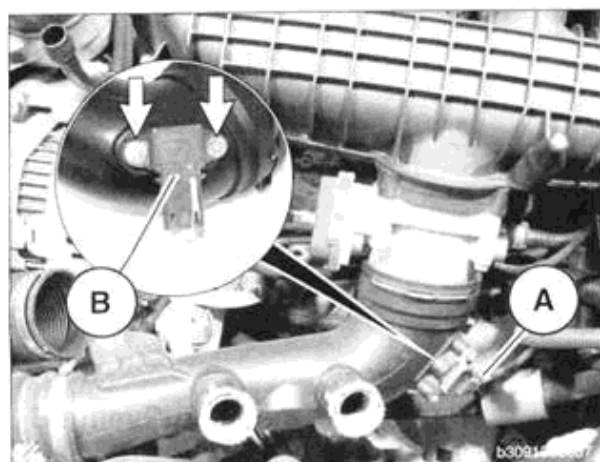
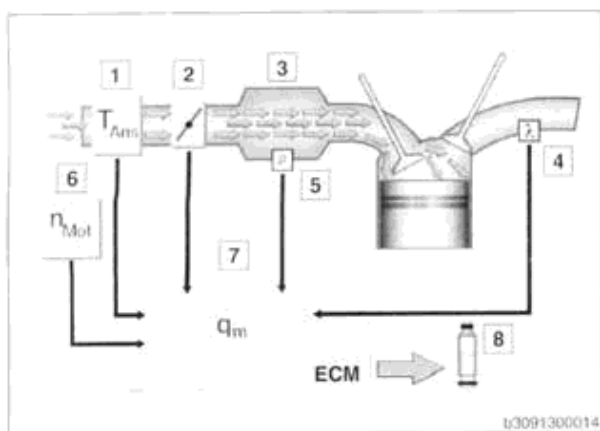
Charge air duct pressure sensor, replacing

- Switch ignition OFF and remove key.

Remove air filter housing and ducts. See **Air filter housing and ducts, removing and installing** in this chapter.

➤ Working at throttle body charge air duct:

- Detach sensor electrical connector (A).
- Remove fasteners (arrows).
- Remove sensor (B).



132-18 Fuel Injection MSD80, MSD81 (N54 Engine)

Intake manifold charge air pressure sensor, replacing



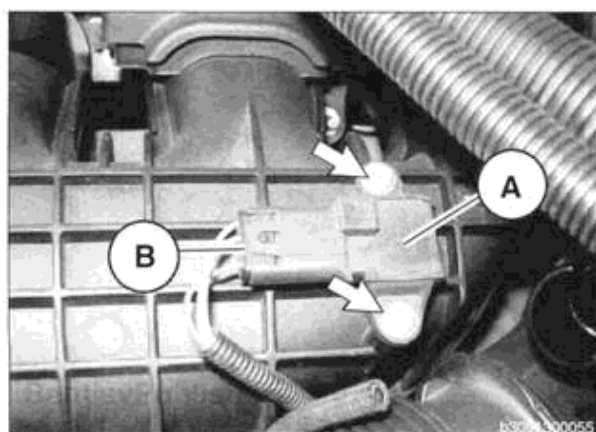
- ◀ Installation is reverse of removal.
 - Inspect sealing O-ring (**arrow**) and replace in necessary.
- After reinstalling, check and clear fault codes from ECM memory.

Tightening torques

Sensor to charge air duct	3.5 Nm (31 in-lb)
---------------------------	-------------------

Intake manifold charge air pressure sensor, replacing

- Switch ignition OFF and remove key.
- Remove upper engine covers. See **020 Maintenance**.



- ◀ Working at rear of intake manifold:
 - Detach sensor electrical connector (**B**).
 - Remove fasteners (**arrows**).
 - Remove sensor (**A**).



- ◀ Installation is reverse of removal.
 - Inspect sealing O-ring (**arrow**) and replace if necessary.
- After reinstalling, check and clear fault codes from ECM memory.

Tightening torques

Sensor to intake manifold	3.5 Nm (31 in-lb)
---------------------------	-------------------

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 5V and ground supply for each Hall sensor. 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.

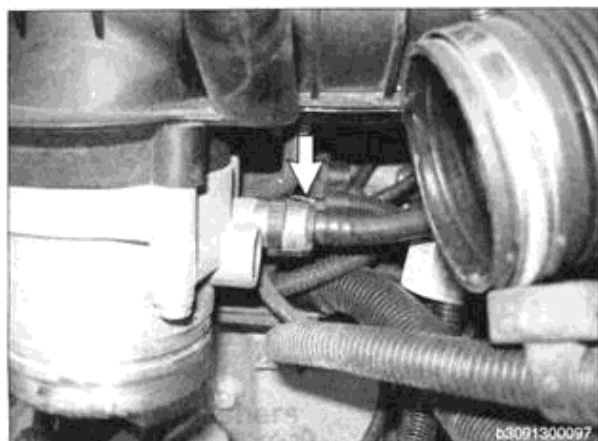
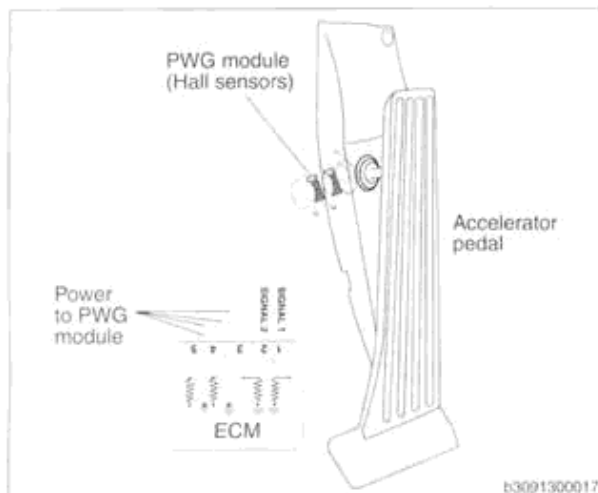
The throttle housing unit is non-adjustable. If found to be faulty, replace as a complete unit.

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

CAUTION—

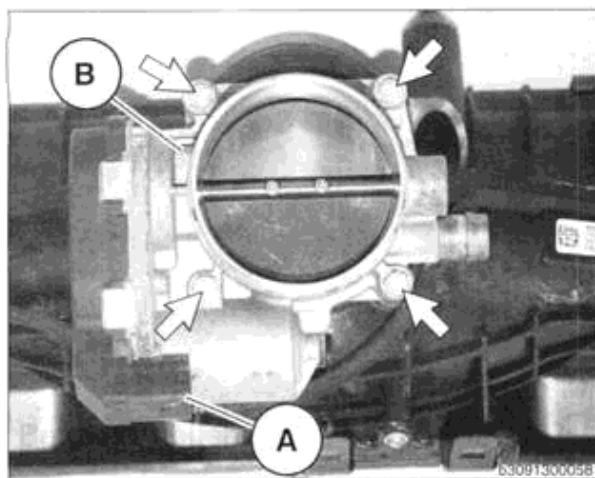
- If the adaptation process is not completed correctly, the engine will not start.

- Switch ignition OFF and remove key.
- Remove air filter housing and ducts. See **Air filter housing and ducts, removing and installing** in this chapter.
- Remove charge air ducts. See **Charge air ducts, left side, removing and installing** in this chapter.
- ◀ Working at side of throttle assembly, disconnect line (arrow).



132-20 Fuel Injection MSD80, MSD81 (N54 Engine)

Fuel injector service



- Working under throttle assembly, disconnect electrical connector (A).

- Remove fasteners (arrows) and remove throttle housing (B).

- Replace profile gasket (sealing O-ring) between throttle assembly and intake manifold.

Tightening torques

Throttle housing to intake manifold	8 Nm (70 in-lb)
-------------------------------------	-----------------

- Installation is reverse of removal.
- Reattach throttle assembly connector with care.

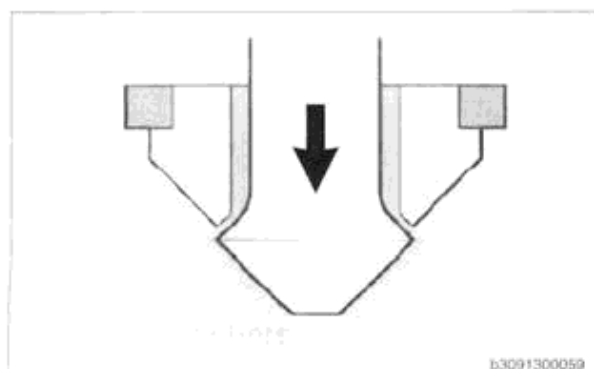
CAUTION—

- It is possible to twist the connector before plugging it in. This can cause damage to the harness and connector.

- After reinstalling, check and clear fault codes from ECM memory. Reset throttle plate adaptation values following BMW scan tool on-screen instructions.

Fuel injector service

- Fuel injectors are electrically controlled solenoid valves that provide precisely metered and atomized fuel into the engine intake ports. The N54 turbocharged engine utilizes a high precision injection (HPI) direct fuel injection system.



- The HPI system uses piezo-electric fuel injectors. These injectors open in an outward direction, which forms a precise tapered spray pattern. With the aid of high system pressure (200 bar), the HPI system is capable of providing a high level of efficiency.

Voltage from the ECM controls injector opening by activating the injector valve piezo element. The ECM varies the duration (in milliseconds) of injector opening to regulate air / fuel ratio.



- During manufacture, the tolerance ranges for injector-quantity adjustment are determined and specified in a six-digit number combination. Make note of tolerance numbers. They are required for fuel injector adaptation. See **Fuel injector adaptation** in this repair group.

Information on the lift performance of the injector is also added for injector voltage adjustment. Injector adjustment is required because of the individual voltage demand of each piezo actuator. This data is programmed in the ECM. During engine operation, these values are used to compensate for deviations in fuel metering.

When replacing an injector, it is essential to carry out an injector adjustment using BMW factory scan tool or equivalent.

If a fault is diagnosed in the system, such as failure of the high pressure sensor, the fuel-supply control valve is de-energized; fuel then bypasses into the rail. In the event of limp-home mode, turbocharging is deactivated by an opening of the wastegate valves.

Additional causes of limp-home mode can be:

- Implausible high-pressure sensor values
- Failure of the fuel-supply control valve
- Leakage in the high-pressure system
- Failure of the high-pressure pump
- Failure of the high-pressure sensor

Fuel injectors, removing

- Disconnect battery negative (-) cable in cargo compartment.

CAUTION—

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

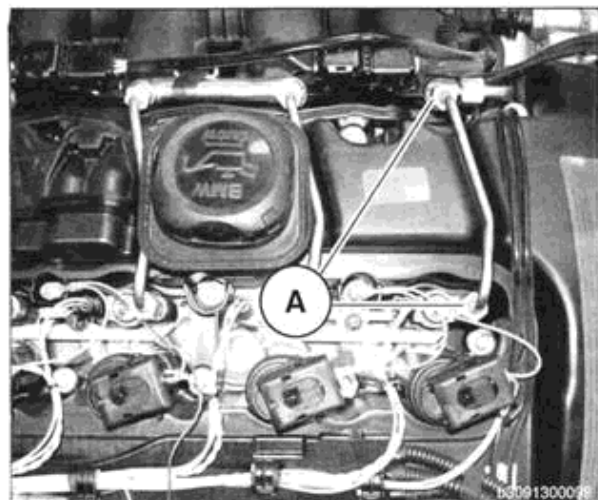
- Remove upper engine covers. See **020 Maintenance**.
- Remove ignition coil at corresponding cylinder of fuel injector service. See **120 Ignition System**.

CAUTION—

- Maintain a high level of cleanliness when servicing ignition coils. Fuel, oil residue can break down the electrical resistance qualities of silicone used in ignition coil production, resulting in coil failure.

132-22 Fuel Injection MSD80, MSD81 (N54 Engine)

Fuel injectors, removing



Remove fuel line to corresponding fuel injector (A).

WARNING—

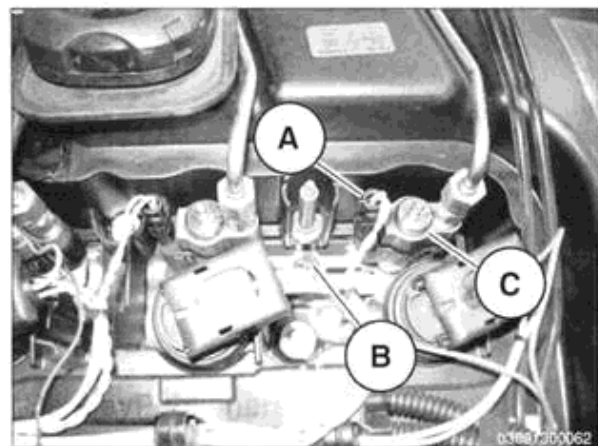
- Fuel in the fuel line is under pressure (approx. 200 bar or 2900 psi) and may be expelled forcibly. Do not smoke or work near heaters or other fire hazards. Keep a fire extinguisher handy.
- Work only on fuel system when engine temperature is below 40°C (104°F).
- Unscrew the fuel tank cap to release pressure in the tank before working on the fuel line.
- Plug open fuel lines and fittings.
- Wrap a clean shop towel around fitting before disconnecting. Residual fuel pressure is present in the fuel line.
- To reduce fuel pressure, place towel over injector and carefully tap with a wrench.

CAUTION—

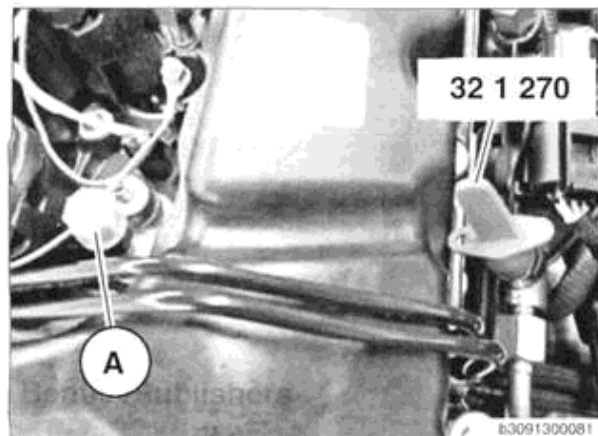
- Maintain a clean work area when servicing high pressure fuel system. Contaminants can cause a system malfunction.
- Seal open fuel system lines with protective caps.
- Replace high pressure fuel lines if tightened 10 times.

NOTE—

- If several injectors are removed, ensure that each injector is reinstalled in its original location (cylinder).



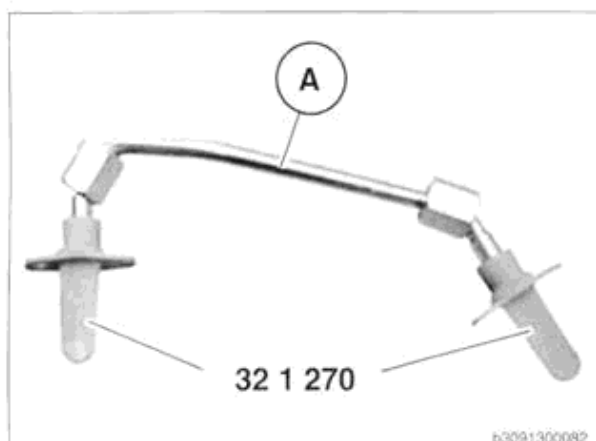
Unlock and remove electrical connector (A). Remove fastener and remove hold-down bracket (B). Remove injector (C).



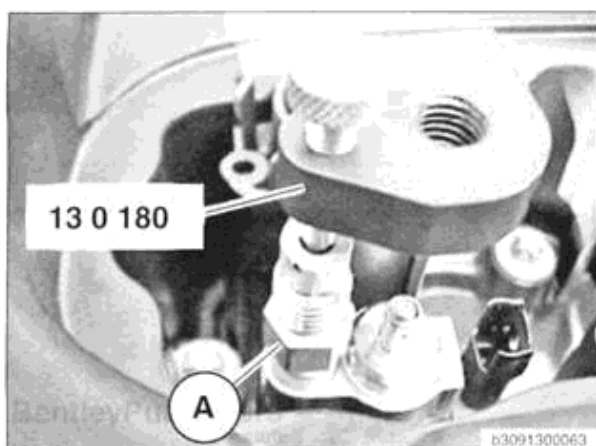
Seal injector (A) with cap and fuel rail connections with plug from special tool kit 32 1 270.

Fuel Injection MSD80, MSD81 (N54 Engine) 132-23

Fuel injectors, removing

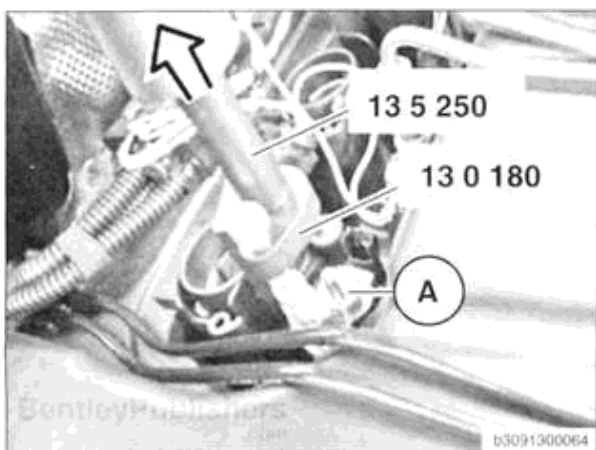


- Seal high pressure fuel lines (A) with caps from special tool kit 32 1 270.



The following procedure can be used if of an injector is stuck in the cylinder head.

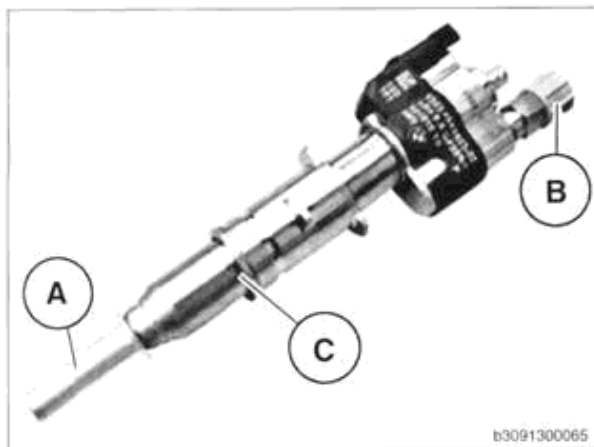
- Install special tool 13 0 180 on injector (A).



- Install special tool 13 5 250 (slide hammer) and carefully knock fuel injector (A) out.

132-24 Fuel Injection MSD80, MSD81 (N54 Engine)

Injector bore, cleaning

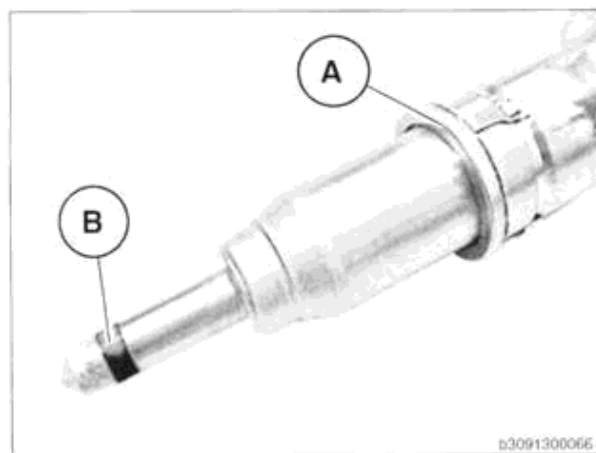


- Once injector (C) is removed, install sealing caps to fuel line connection (B) and injector tip (A). Caps are available from BMW dealer parts department.

Injector bore, cleaning

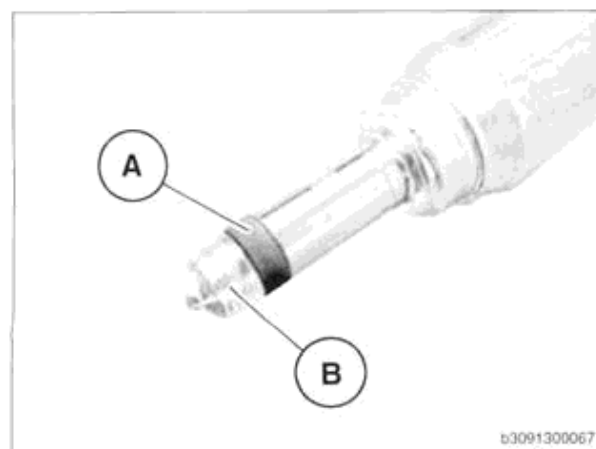
Only use the following procedure if injector bores are dirty.

- To clean injector bore, slide injector, without uncoupling element (A) but with new PTFE sealing ring (B), in and out of injector bores several times. Replace PTFE sealing ring after cleaning.
- Clean contact surfaces of uncoupling element and cylinder head. Replace uncoupling element (A).



Fuel injector PTFE seal, replacing

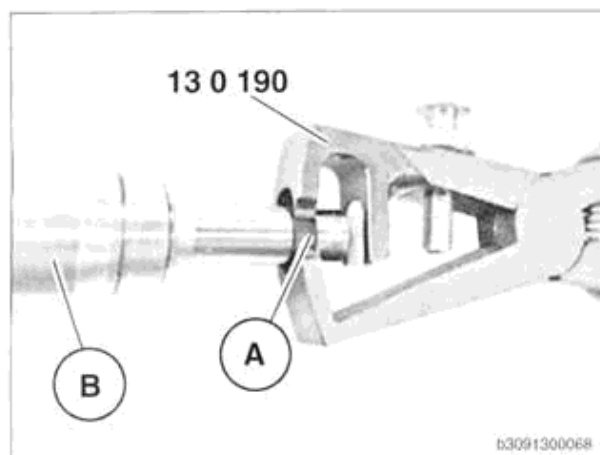
- Before replacing PTFE sealing ring (A) make sure your hands and work surface are clean and free of oil. Avoid mechanical contact with injector tip (B).



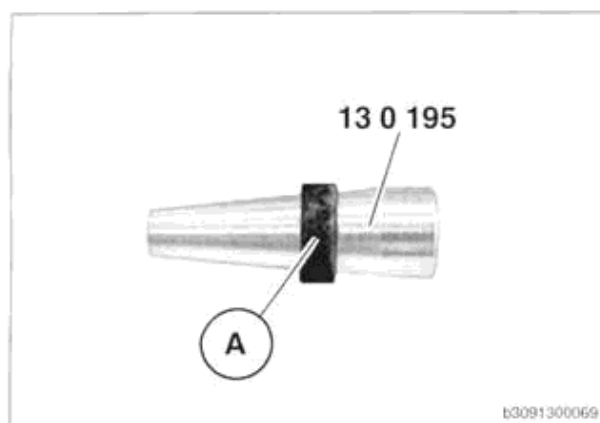
Fuel Injection MSD80, MSD81 (N54 Engine) 132-25

Fuel injector PTFE seal, replacing

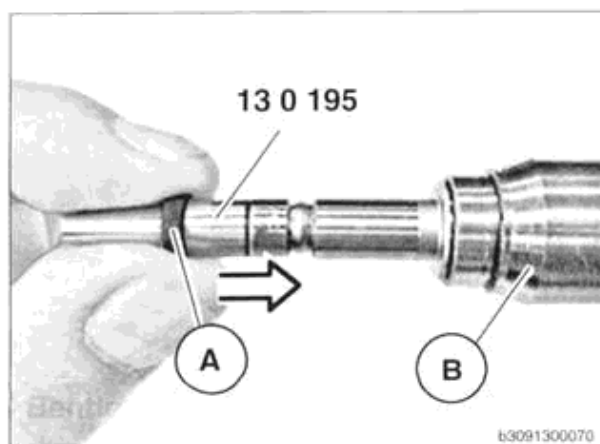
- ◀ Using special tool 13 0 190, remove PTFE sealing ring (A) from injector (B). Use a lint-free cloth to remove combustion residue from cylindrical part of injector tip. Do not clean injector tip.



- ◀ Slide new PTFE sealing ring (A) on mounting taper 13 0 195.

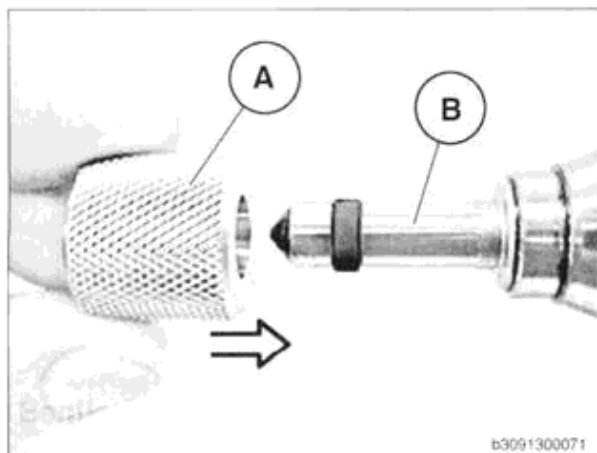


- ◀ Using fingers and mounting taper (13 0 195) install PTFE sealing ring (A) on injector (B).

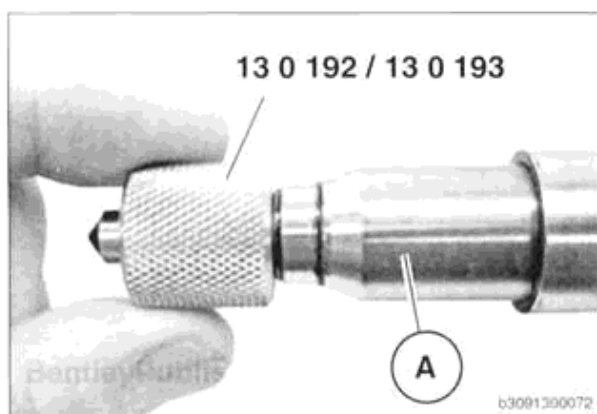


132-26 Fuel Injection MSD80, MSD81 (N54 Engine)

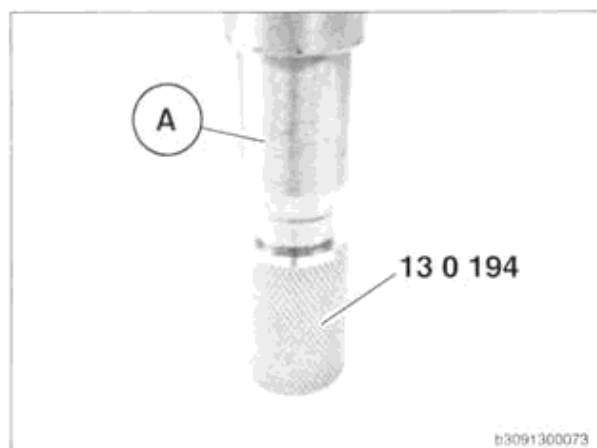
Fuel injector PTFE seal, replacing



- To bring the PTFE sealing ring to its installation dimension, slide three mounting sleeves (A) with decreasing diameters on injector (B).



- First slide 13 0 192 (large diameter sleeve) on injector (A). Then slide mounting sleeve 13 0 193 on injector (A).

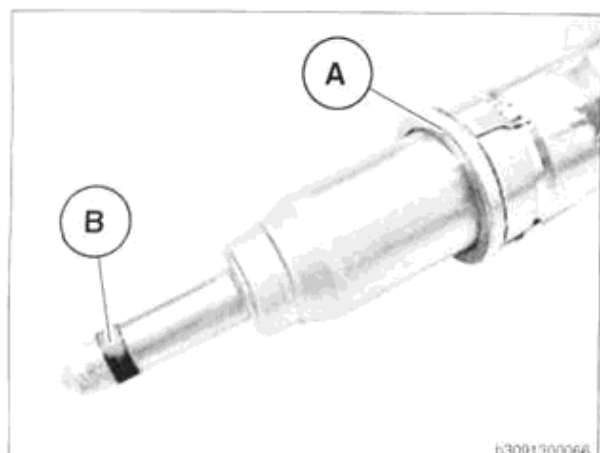


- Next press injector (A) into mounting sleeve 13 0 194 (small diameter). Install injector within 10 minutes of removing mounting sleeve.

Fuel injectors, installing

Remember to:

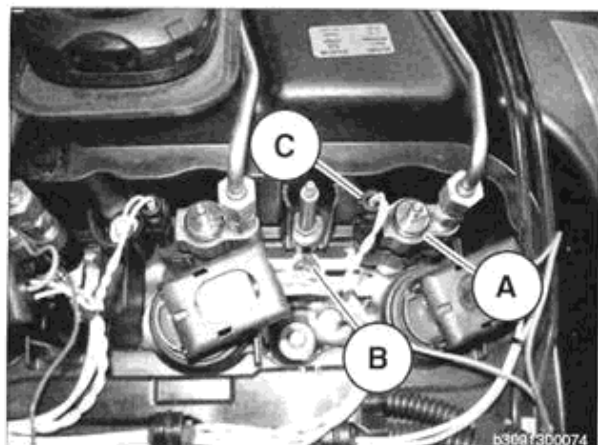
- Replace uncoupling element (A).
- Replace PTFE sealing ring (B).
- Remove PTFE protective cap a maximum of 10 minutes before installing. Sealing ring swells up once cap is removed.
- If injector adaptation is needed, note injector tolerance range numbers for each corresponding cylinder.



b3091300066

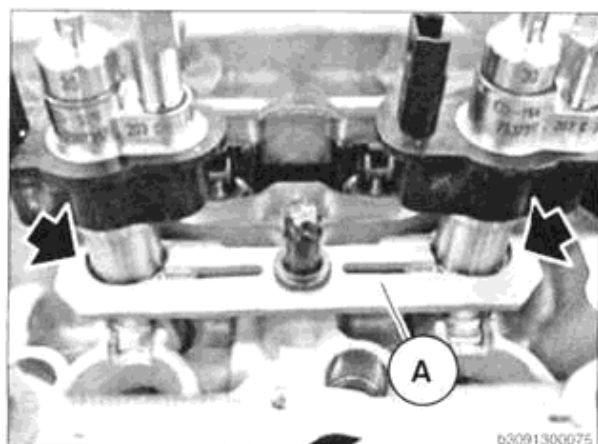
Working at cylinder head:

- Install injector (A) into cylinder head.
- Install hold-down bracket (B). Fastener (arrow) should be finger tight allowing injector (A) to be adjusted.
- Install electrical connector (C).



b3091300074

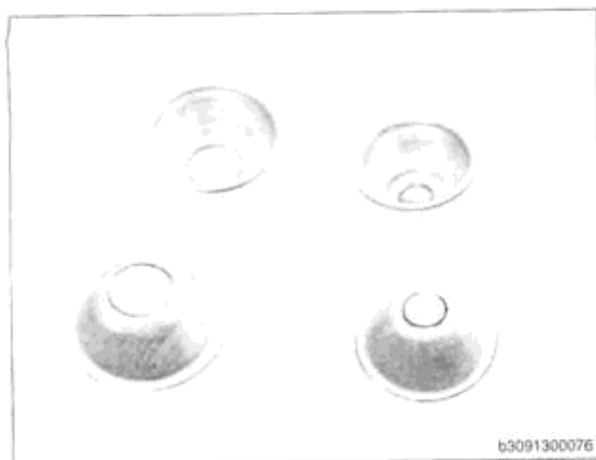
Check that hold-down bracket (A) is correctly installed (arrows).



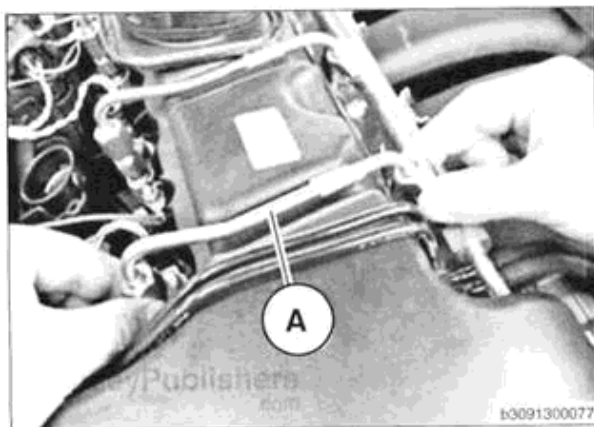
b3091300075

132-28 Fuel Injection MSD80, MSD81 (N54 Engine)

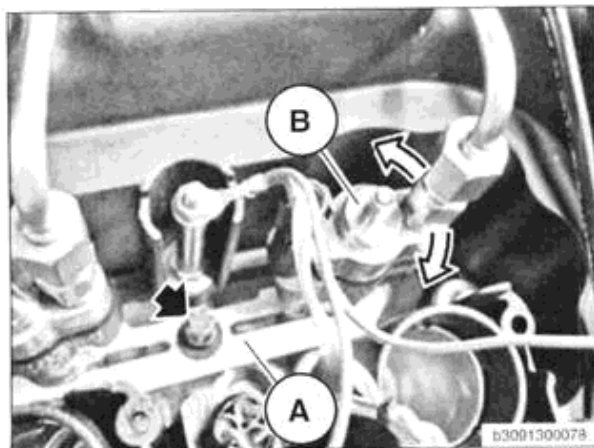
Fuel injectors, installing



- ◀ Copper seals on high pressure lines installed at factory are no longer needed. Remove and discard.



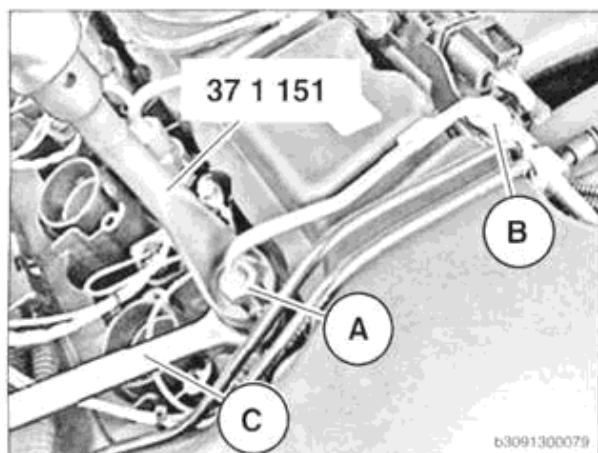
- ◀ Connect high pressure line (A) finger tight.
- If reusing high pressure line, coat nut threads with gear oil.
 - High pressure line may only be retightened 10 times.
 - If both nuts on line cannot be installed easily by hand, adjust position of injector using following step.



- ◀ If fuel line union cannot be easily installed by hand, rotate injector in direction of **arrows** until high pressure line nuts can be easily tightened by hand.

- Tighten fastener for hold-down bracket (**arrow**).

Tightening torque	
Hold-down bracket to cylinder head	13 Nm (9.5 ft-lb)



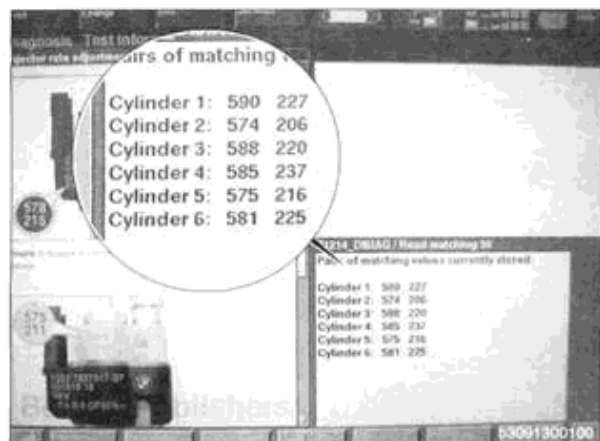
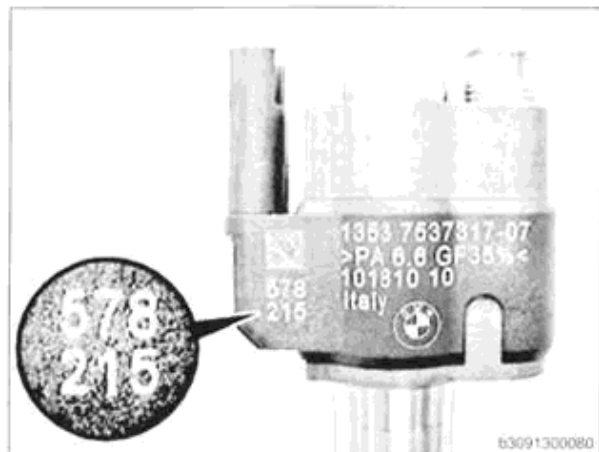
- Use following tightening sequence:
 - Tighten nut (A) using special tool 37 1 151 while holding injector with wrench (C).
 - Tighten nut (B) using special tool 37 1 151.
- Clean all fuel from ignition coil hole.
- Check fuel system for leaks.
- Perform injector adaptation. See **Fuel injector adaptation** in this repair group.
- Check and clear fault codes from ECM memory.

Tightening torque

High pressure line to injector	23 Nm (17 ft-lb)
High pressure line to fuel rail	23 Nm (17 ft-lb)

Fuel injector adaptation

- Connect BMW scan tool and perform following tasks:
 - Identify vehicle.
 - Select **Function selection**.
 - Select **Service functions**.
 - Select **Adjustment programs**.
 - Select **Adjust injectors**.
 - Change **Test schedule**.
- For each replaced injector, enter fuel injector tolerance range (**inset**) to corresponding cylinder.



- Confirm correct tolerance range (**inset**) has been entered for each injector.

132-30 Fuel Injection MSD80, MSD81 (N54 Engine)

Fuel rail, removing

Fuel rail, removing

- Disconnect battery negative (-) cable in trunk or cargo compartment.

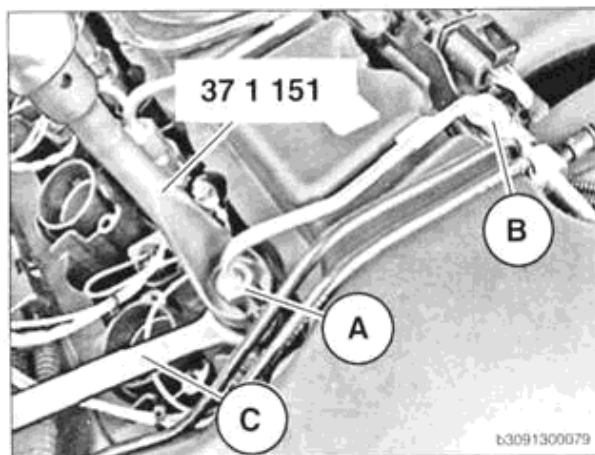
CAUTION—

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

- Remove upper engine covers. See **020 Maintenance**.
- Remove ignition coils. See **120 Ignition System**.

CAUTION—

- Maintain a high level of cleanliness when servicing ignition coils. Fuel or oil residue causes a breakdown of the electrical resistance qualities of silicone used in production. Resulting in failure of the ignition coil.



- ◀ Label position and remove high pressure fuel lines:

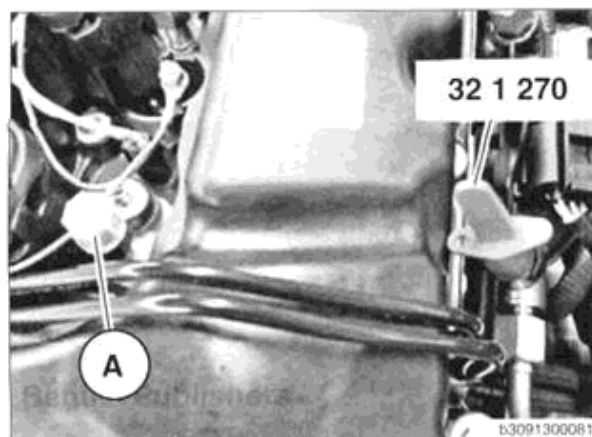
- Using special tool 37 1 151 loosen nut (A) while holding injector with wrench.
- Using special tool 37 1 151, loosen nut (B).

WARNING—

- Fuel in the fuel line is under pressure (approx. 200 bar or 2900 psi) and may be expelled forcibly. Do not smoke or work near heaters or other fire hazards. Keep a fire extinguisher handy.
- Work only on fuel system when engine temperature is below 40°C (104°F).
- Unscrew the fuel tank cap to release pressure in the tank before working on the fuel line.
- Plug open fuel lines and fittings.
- Wrap a clean shop towel around fitting before disconnecting. Residual fuel pressure is present in the fuel line.
- To reduce fuel pressure, place towel over injector and carefully tap with a wrench.
- Protect alternator from dripping fuel and oil.

CAUTION—

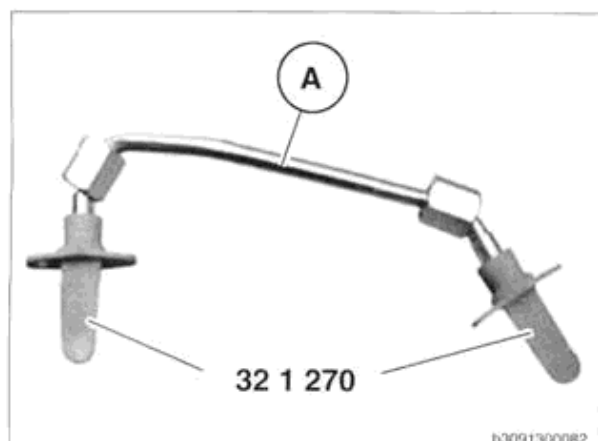
- Maintain a clean work area when servicing high pressure fuel system. Contaminants can cause a system malfunction.
- Seal all fuel system opening with protective caps.
- Replace high pressure fuel lines if tightened 10 times.



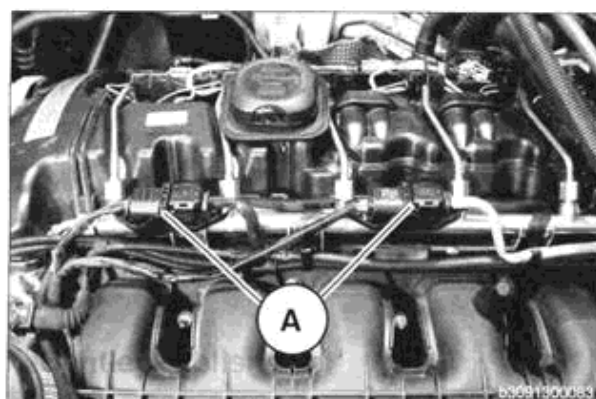
- ◀ Seal injector (A) with cap and fuel rail connections with plug from special tool kit 32 1 270.

Fuel Injection MSD80, MSD81 (N54 Engine) 132-31

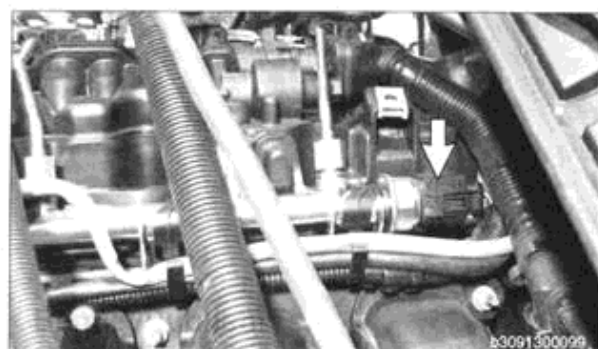
Fuel rail, removing



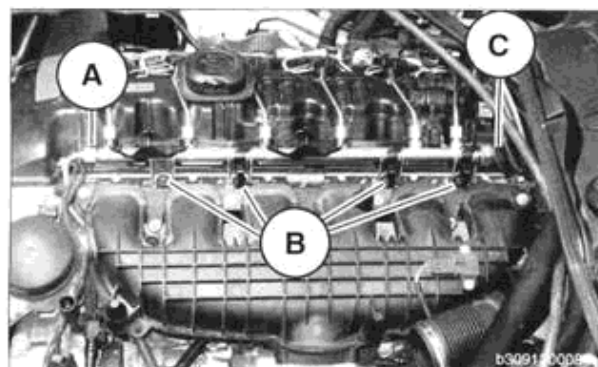
- Seal high pressure fuel lines (A) with caps from special tool kit 32 1 270.



- Unlock and remove electrical connector (A) from fuel rail.
- Remove electrical connector brackets from fuel rail.



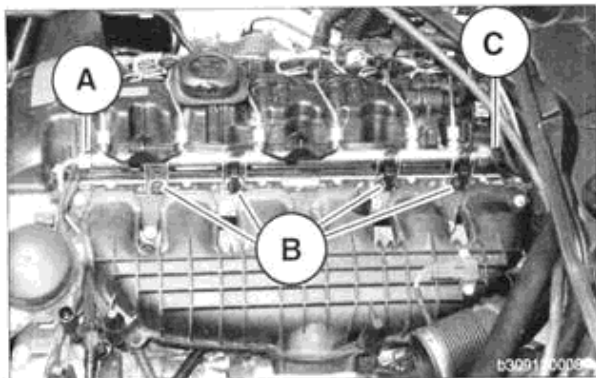
- Detach fuel rail pressure sensor electrical connector (arrow).



- Working at fuel injector rail:
 - Loosen fuel line union nut (A).
 - Plug open fuel lines and fittings.
 - Wrap a clean shop towel around fitting before disconnecting. Residual fuel pressure is present in fuel line.
 - Remove fasteners (B) and remove fuel rail (C).
 - Seal connections at high pressure line (A) and fuel rail (C).

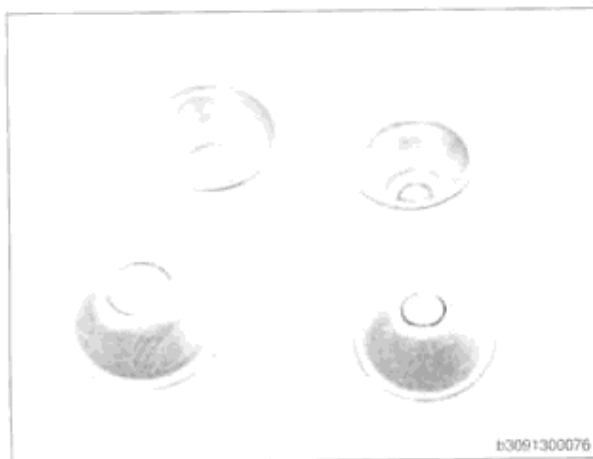
132-32 Fuel Injection MSD80, MSD81 (N54 Engine)

Fuel rail, installing

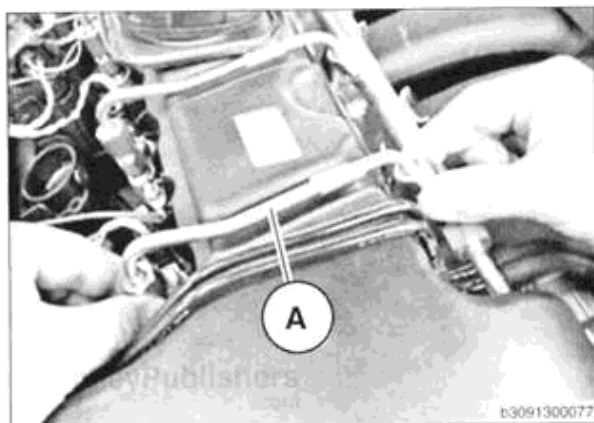


Fuel rail, installing

- Install high pressure rail:
- Connect fuel line union (A) finger tight.
 - Install fasteners (B) finger tight.
 - Install electrical connector (C).



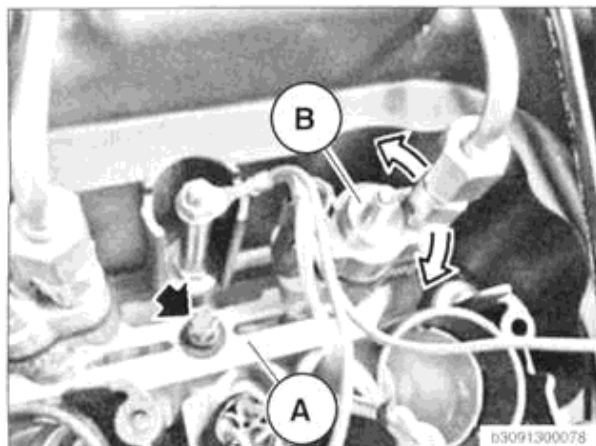
- Copper seals on high pressure lines installed at factory are no longer needed. Remove and discard.



- Connect high pressure line (A) finger tight.
- If reusing high pressure line, coat nut threads with gear oil.
 - High pressure line may only be retightened 10 times.

Fuel Injection MSD80, MSD81 (N54 Engine) 132-33

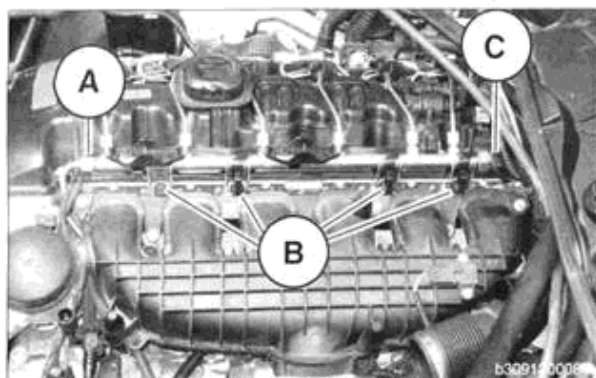
Fuel rail, installing



- ⚠ If fuel lines cannot be easily installed by hand:
- Loosen fastener (**arrow**)
 - Rotate injector in direction of **arrows** until high pressure line nuts can be easily tightened by hand.
- Tighten fastener for hold-down bracket (**arrow**).

Tightening torque

Hold-down bracket to cylinder head	13 Nm (9.5 ft-lb)
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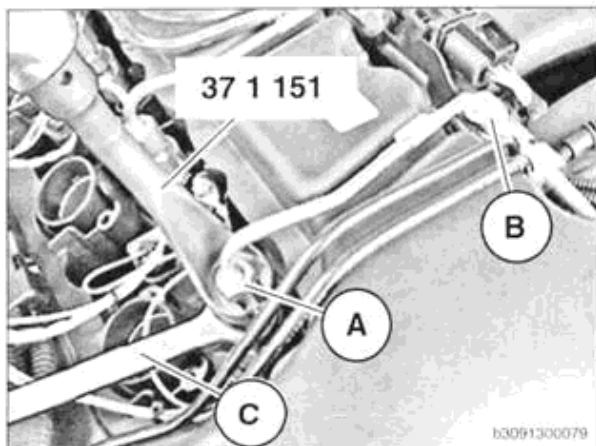


- ⚠ Tighten fuel injector rail (**C**) fasteners (**B**).

- Tighten fuel line nut (**A**).

Tightening torque

Fuel injector rail to cylinder head	13 Nm (9.5 ft-lb)
High pressure line to fuel rail	30 Nm (22 ft-lb)



- ⚠ Use following tightening sequence:
- Tighten nut (**A**) using special tool 37 1 151 while counter holding injector with wrench (**C**).
 - Tighten nut (**B**) using special tool 37 1 151.
- Clean all fuel from ignition coil hole and install ignition coil.
- Check fuel system for leaks.
- Check and clear fault codes from ECM memory.

Tightening torque

High pressure line to injector	23 Nm (17 ft-lb)
High pressure line to fuel rail	23 Nm (17 ft-lb)

132-34 Fuel Injection MSD80, MSD81 (N54 Engine)

Intake manifold, removing and installing

Intake manifold, removing and installing

- Disconnect battery negative (-) cable in trunk or cargo compartment.

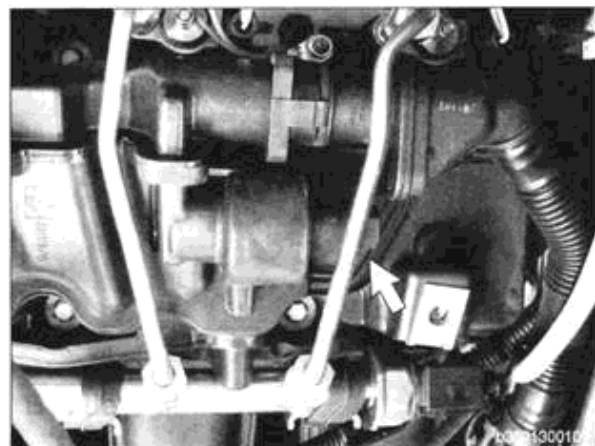
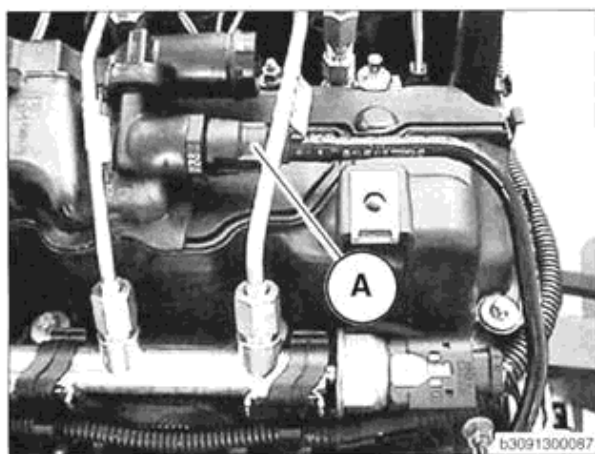
CAUTION—

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

- Remove upper engine covers. See **020 Maintenance**.
- Remove complete air filter housing and air intake ducts. See **Air filter housing and ducts, removing and installing** in this repair group.
- ◀ Disconnect crankcase breather line (A) at cylinder head cover if equipped.

NOTE—

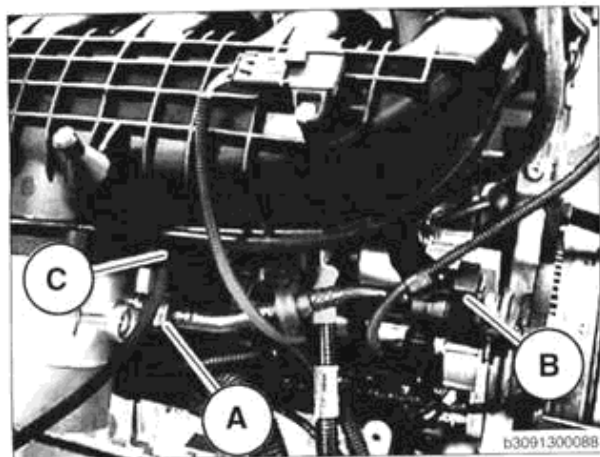
- Not all models have additional line.



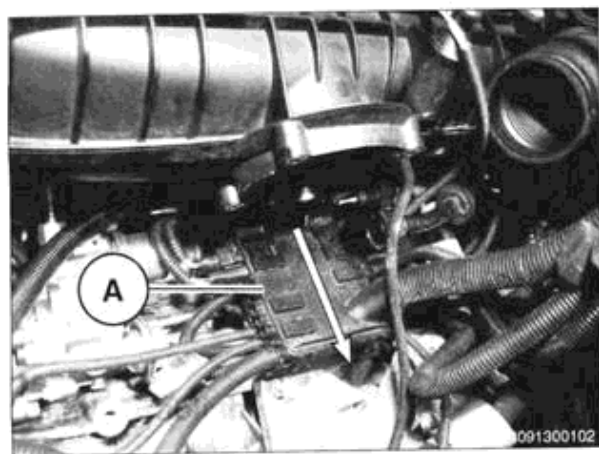
- ◀ Example of N54 engine without additional crankcase breather line. There is a plug (arrow) in its place.
- Remove throttle housing. See **Throttle housing (EDK), replacing** in this repair group.

Fuel Injection MSD80, MSD81 (N54 Engine) 132-35

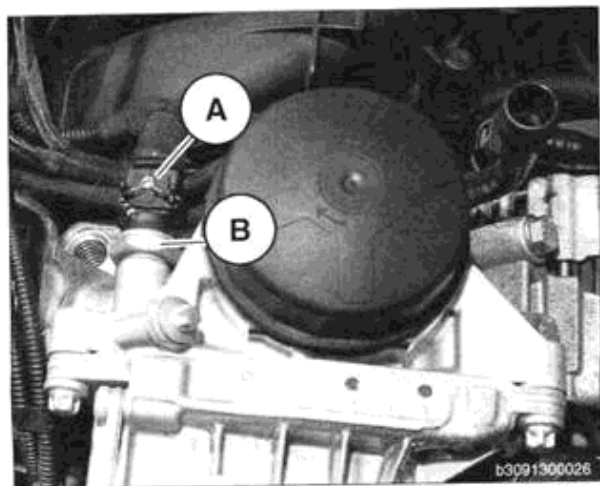
Intake manifold, removing and installing



- ◀ Working at right side underneath intake manifold:
- Disconnect vacuum hose (A), if equipped.
 - Remove fuel tank vent valve (B) from mounting bracket.
 - Remove vacuum hose (C) and lay aside.



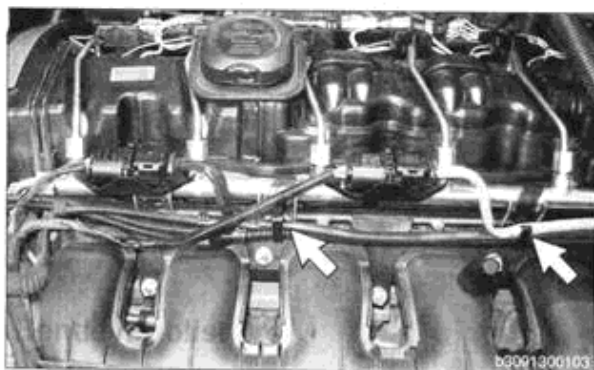
- ◀ Slide wiring harness junction box (A) off bracket under intake manifold.



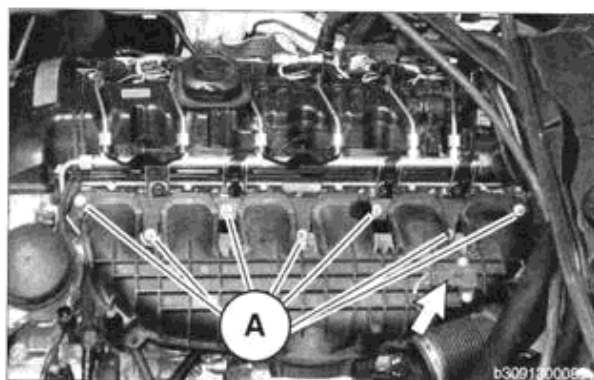
- ◀ Disconnect electrical connector (A) at oil pressure switch (B).

132-36 Fuel Injection MSD80, MSD81 (N54 Engine)

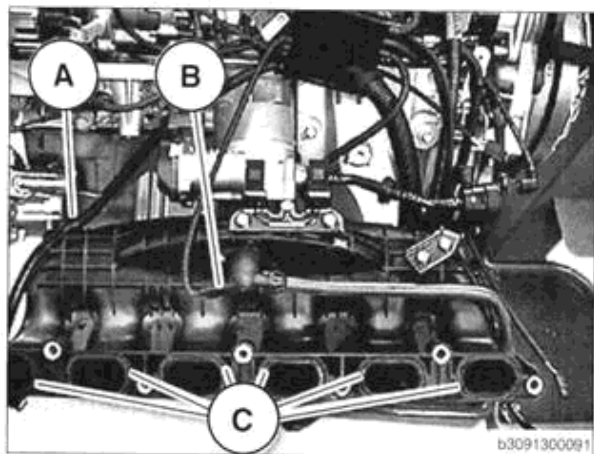
Intake manifold, removing and installing



- Working at top of intake manifold, unhook electrical harness retainers (A) and place harness out of way.



- Remove electrical connector (arrow) and remove fasteners (A).



- Working at backside of intake manifold:
- Cut cable tie (A).
 - Disconnect electrical connector (B), if equipped

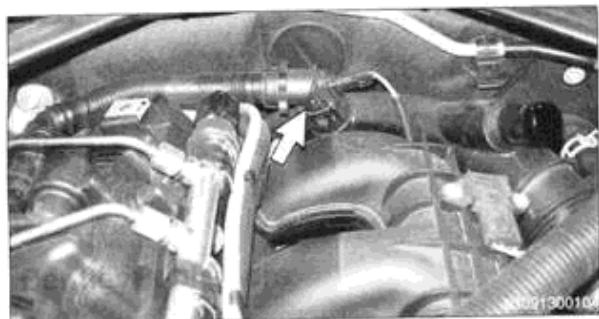
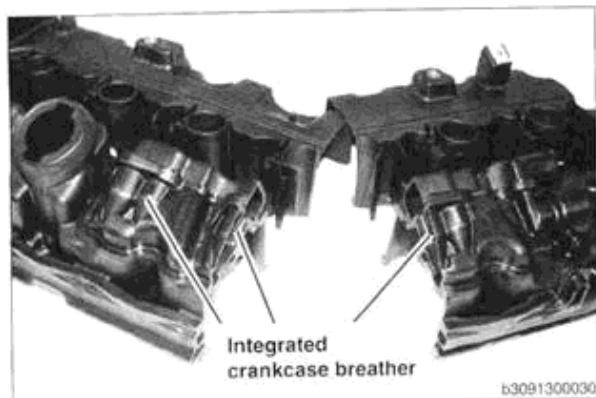
CAUTION—

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

- Installation is reverse of removal. Remember to replace intake manifold seals (C) if necessary.

Tightening torque

Manifold to cylinder head	15 Nm (11 ft-lb)
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Crankcase breather valve

- ⚡ The crankcase breather valve is part of the cylinder head cover and is not serviceable as a separate component.

Oil separation is carried out via a labyrinth system and two cyclone separators incorporated into the cylinder head cover. By having the system components integrated into the cylinder head cover, the crankcase gases are heated by the engine.

- ⚡ However, there is one electric heating element at the manifold inlet (arrow). Once the liquid oil is separated from the crankcase vapors, the oil is allowed to drain back through check valves back into the engine.

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.

Intake vacuum specifications for N54 engines

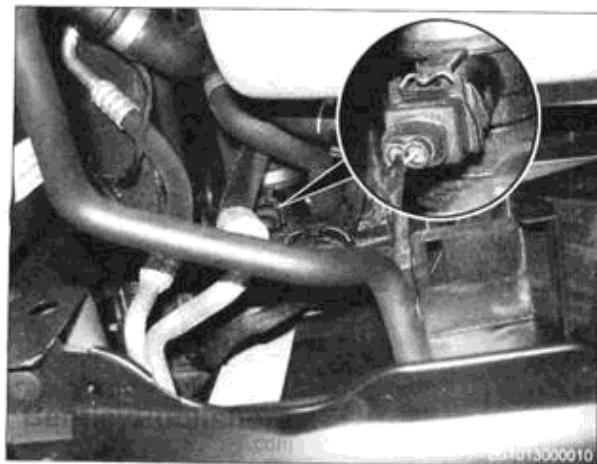
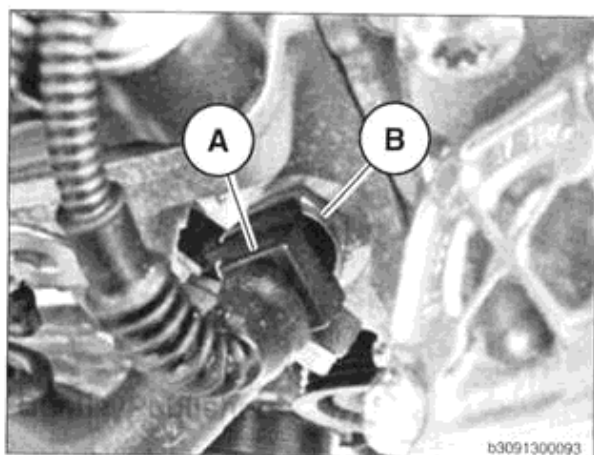
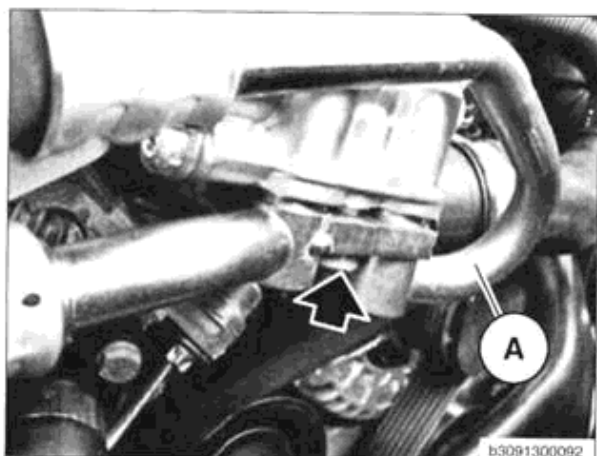
The breather valve sets a pressure range of 7 to 11 mbar.

A faulty crankcase breather valve causes significant deviations from the specified value:

- Crankcase ventilation clogged: Ambient pressure +100 mbar
- Crankcase ventilation internal leak: Ambient pressure -170 mbar

132-38 Fuel Injection MSD80, MSD81 (N54 Engine)

Engine coolant temperature (ECT) sensor, replacing



Engine coolant temperature (ECT) sensor, replacing

The engine coolant temperature (ECT) sensor is a negative temperature coefficient (NTC) 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 when OBD II fault criteria are exceeded. The ECM assumes a substitute value (80°C / 176°F) to maintain engine operation. Ignition timing is set to a safely conservative basic setting.

The ECT sensor is located at front of cylinder head.

- With engine fully cooled off, remove fastener (**arrow**) and line (**A**).

CAUTION—

- Be prepared to catch any dripping coolant

- Remove electrical connector (**A**). Unscrew ECT sensor (**B**) 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 O-rings on coolant line.
- Replace lost coolant.

Tightening torque

Temperature sensor to cylinder head	19 Nm (14 ft-lb)
Coolant pipe to cylinder head	19 Nm (14 ft-lb)

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

Radiator outlet coolant temperature sensor

- The radiator outlet temperature sensor (**inset**) is a negative temperature coefficient (NTC) 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.

DME main relay, testing

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

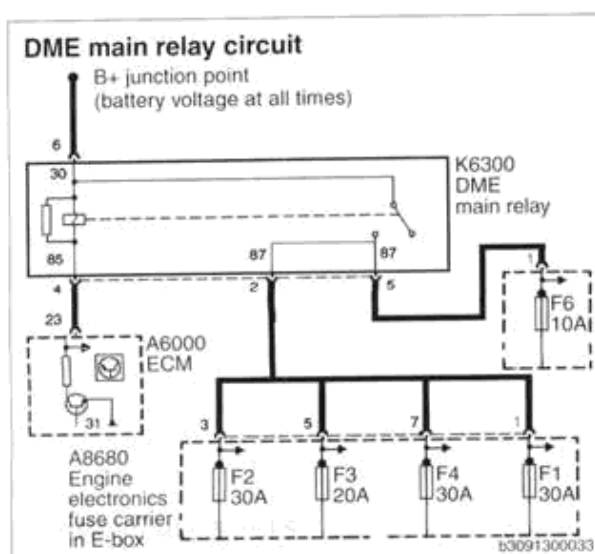
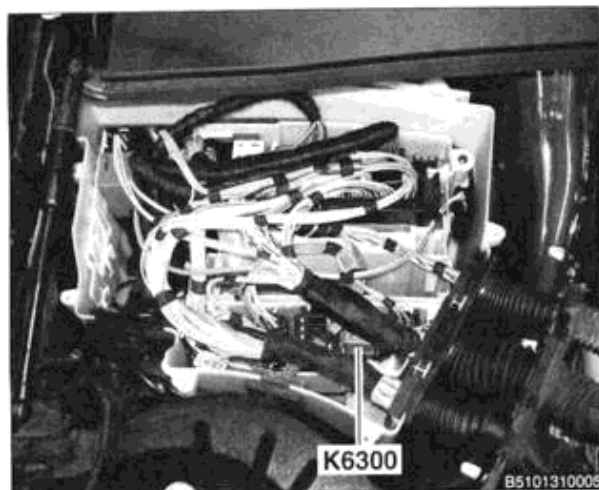
- ECM
- Ignition coils
- Tailpipe flap
- E-box cooling fan
- Fuel tank leak detection pump
- Crankshaft sensor
- Camshaft sensors
- Evaporative emissions valve
- Crankcase breather valve heater
- Oil condition sensor
- Electric coolant pump
- Thermostat
- Oxygen sensor heaters

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

- With ignition off, remove DME main relay (**K6300**) 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**.



- 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 behind glove compartment. See **Power supply fuses** in this repair group.
 - Wiring can vary. 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 44-pin connector X60005. See **ECM pin assignments** in this repair group.

132-40 Fuel Injection MSD80, MSD81 (N54 Engine)

DME main relay, testing

- If no faults are found:
 - Check ECM grounding.
 - ECM may be defective.
- With ignition ON and relay installed, check for battery voltage at relay sockets **2** and **5** (correspond to terminals **87** on relay).

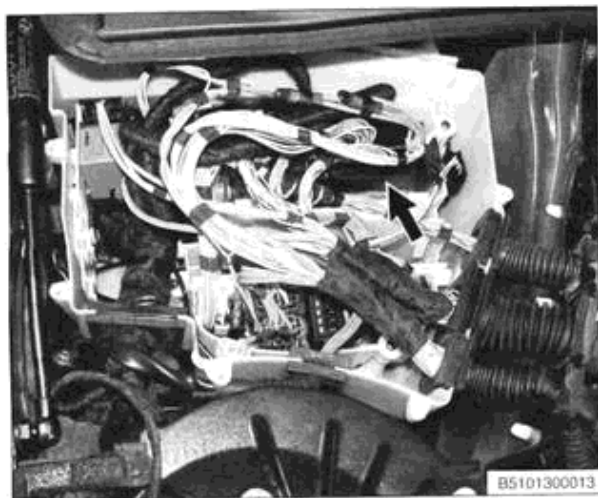
NOTE—

- *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 **Power supply fuses** in this repair group.
- When finished testing, check and clear fault codes from ECM memory.

ECM pin assignments

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



- The ECM has 2 main electrical harness connectors, one with 4 modular connections and the other with 3 for a total of 7 sub connectors and 147 pins.

- A: X60001 (signals)
- B: X60002 (signals)
- C: X60003 (voltage, ground supply)
- D: X60004 (ignition coils)
- E: X60005 (signals)
- F: X60006 (fuel injectors)
- G: X60007 (signals)

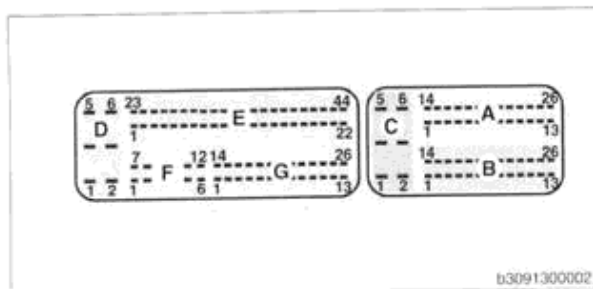
ECM pin assignments for turbo engines are given in **Table b**. This information can be helpful when diagnosing faults to or from the ECM.

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.



132-42 Fuel Injection MSD80, MSD81 (N54 Engine)

ECM pin assignments

Table b. Siemens DME MSD80 / 81 ECM pin assignments

Connector X60001 26-pin (signals)			
Pin	Type	Component or function	Note
1	input/output	Signal PT-CAN low	Powertrain CAN-bus
2	input	Start signal	Car access system
3	input/output	BSD signal	Battery sensor
4	input	Brake light signal	Brake light switch
5	-	Not used	
6	input	Radiator outlet temperature sensor signal	Temperature sensor at radiator outlet
7	input	Accelerator pedal module signal	Accelerator pedal module
8	output	Electric fan signal	Electric engine cooling fan
9	-	Not used	
10	ground	Accelerator pedal module	Accelerator pedal module
11	output	Accelerator pedal module supply voltage	Accelerator pedal module
12	-	Not used	
13	-	Not used	
14	input/output	Signal PT-CAN high	Powertrain CAN-bus
15	input	EWS signal	Car access system
16	input	Brake light test signal	Brake light switch
17	input	Right rear wheel speed sensor signal	Connector X10186 (right rear wheel speed sensor)
18	input	Clutch switch signal	Clutch switch module
19	input	Radiator outlet temperature sensor signal	Temperature sensor at radiator outlet
20	input	Accelerator pedal module signal	Accelerator pedal module
21	input/output	TD signal	TD signal connector
22	-	Not used	
23	ground	Accelerator pedal module	Accelerator pedal module
24	output	Accelerator pedal module supply voltage	Accelerator pedal module
25	-	Not used	
26	-	Not used	

Connector X60002 26-pin (signals)

Pin	Type	Component or function	Note
1	input	Wake up signal, terminal 15	Terminal 15 wake up connector
2	-	Not used	
3	-	Not used	
4	-	Not used	
5	input	Oxygen sensor signal	Bank 2 sensor 1
6	input	Oxygen sensor signal	Bank 1 sensor 1
7	input	Oxygen sensor signal	Bank 2 sensor 1

Connector X60002 26-pin (signals) (continued)

Pin	Type	Component or function	Note
8	input	Oxygen sensor signal	Bank 1 sensor 1
9	input	Oxygen sensor signal	Bank 2 sensor 1
10	ground	Oxygen sensor	Bank 1 sensor 1
11	ground	Oxygen sensor	Bank 2 sensor 1
12	input	Oxygen sensor heating	Bank 1 sensor 1
13	input	Oxygen sensor heating	Bank 2 sensor 1
14	-	Not used	
15	-	Not used	
16	input	DMTL pump signal	Diagnosis module for fuel tank leakage
17	input	DMTL heating signal	Diagnosis module for fuel tank leakage
18	input	Oxygen sensor signal	Bank 1 sensor 1
19	input	Oxygen sensor signal	Bank 2 sensor 2
20	input	Oxygen sensor signal	Bank 1 sensor 2
21	-	Not used	
22	-	Not used	
23	ground	Oxygen sensor	Bank 1 sensor 2
24	input	Oxygen sensor	Bank 2 sensor 2
25	input	Oxygen sensor	Bank 2 sensor 2
26	output	Oxygen sensor	Bank 1 sensor 2

Connector X60003 6-pin (voltage, ground supply)

Pin	Type	Component or function	Note
1	input	Terminal 30	B+ potential distributor
2	input	Terminal 87	Fuse F03
3	ground	Ground	Ground point
4	ground	Ground	Ground point
5	ground	Ground	Ground point
6	ground	Ground	Ground point

Connector X60004 6-pin (ignition coils)

Pin	Type	Component or function	Note
1	output	Ignition coil signal	Ignition coil signal 1
2	output	Ignition coil signal	Ignition coil signal 2
3	output	Ignition coil signal	Ignition coil signal 3
4	output	Ignition coil signal	Ignition coil signal 4
5	output	Ignition coil signal	Ignition coil signal 5
6	output	Ignition coil signal	Ignition coil signal 6

132-44 Fuel Injection MSD80, MSD81 (N54 Engine)

ECM pin assignments

Connector X60005 44-pin (signals)			
Pin	Type	Component or function	Note
1	-	Not used	
2	-	Not used	
3	output	Volume control valve	Control signal
4	-	Not used	
5	-	Not used	
6	-	Not used	
7	output	Low pressure fuel sensor ground	Low pressure fuel sensor
8	output	Low pressure fuel sensor voltage supply	Low pressure fuel sensor
9	input	Boost pressure sensor signal	Boost pressure sensor
10	input	Boost pressure sensor signal	Boost pressure sensor
11	output	Boost pressure sensor voltage supply	Boost pressure sensor
12	-	Not used	
13	output	DME main relay activation	DME main relay
14	output	Throttle valve voltage supply	Throttle valve
15	input	Throttle valve signal	Throttle valve
16	input	Throttle valve signal	Throttle valve
17	input	Intake air temperature signal	Integral to boost pressure sensor
18	-	Not used	
19	input	Knock sensor signal	Knock sensor
20	input	Knock sensor signal	Knock sensor
21	-	Not used	
22	-	Not used	
23	output	Fuel tank vent valve signal	Fuel tank vent valve
24	-	Not used	
25	-	Not used	
26	-	Not used	
27	-	Not used	
28	-	Not used	
29	input	Crankshaft position sensor signal	Crankshaft position sensor
30	ground	Crankshaft position sensor	Crankshaft position sensor
31	output	Intake manifold pressure sensor voltage supply	Intake manifold pressure sensor
32	ground	Intake manifold pressure sensor	Intake manifold pressure sensor
33	input	Intake manifold pressure sensor signal	Intake manifold pressure sensor
34	input	Low pressure fuel sensor signal	Low pressure fuel sensor
35	input/output	BSD signal	BSD signal connector
36	input	Throttle valve signal	Throttle valve
37	input	Throttle valve signal	Throttle valve

Fuel Injection MSD80, MSD81 (N54 Engine) 132-45

ECM pin assignments

Connector X60005 44-pin (signals) (continued)

Pin	Type	Component or function	Note
38	ground	Throttle valve	Throttle valve
39	-	Not used	
40	-	Not used	
41	input	Knock sensor signal	Knock sensor
42	input	Knock sensor signal	Knock sensor
43	-	Not used	
44	-	Not used	

Connector X60006 12-pin (ignition coils)

Pin	Type	Component or function	Note
1	output	Fuel injector voltage supply	Fuel injector 1
2	output	Fuel injector voltage supply	Fuel injector 2
3	output	Fuel injector voltage supply	Fuel injector 3
4	output	Fuel injector voltage supply	Fuel injector 4
5	output	Fuel injector voltage supply	Fuel injector 5
6	output	Fuel injector voltage supply	Fuel injector 6
7	output	Fuel injector trigger	Fuel injector 1
8	output	Fuel injector trigger	Fuel injector 2
9	output	Fuel injector trigger	Fuel injector 3
10	output	Fuel injector trigger	Fuel injector 4
11	output	Fuel injector trigger	Fuel injector 5
12	output	Fuel injector trigger	Fuel injector 6

Connector X60007 26-pin (signals)

Pin	Type	Component or function	Note
1	-	Not used	
2	-	Not used	
3	-	Not used	
4	input	Engine coolant temperature signal	Engine coolant temperature sensor
5	output	Intake VANOS solenoid signal	Intake VANOS solenoid
6	-	Not used	
7	output	Wastegate control valve signal	Wastegate control valve
8	input	Fuel rail pressure sensor signal	Fuel rail pressure sensor
9	output	Fuel rail pressure sensor signal	Fuel rail pressure sensor
10	output	Fuel rail pressure sensor voltage supply	Fuel rail pressure sensor
11	input	Camshaft position sensor 1 signal	Camshaft position sensor 1
12	input	Camshaft position sensor 2 signal	Camshaft position sensor 2
13	input	Oil pressure switch signal	Oil pressure switch

132-46 Fuel Injection MSD80, MSD81 (N54 Engine)

ECM pin assignments

Connector X60007 26-pin (signals) (continued)

Pin	Type	Component or function	Note
14	output	Wastegate control valve signal	Wastegate control valve signal
15	-	Not used	
16	-	Not used	
17	ground	Engine coolant temperature sensor	Engine coolant temperature sensor
18	output	Exhaust VANOS solenoid signal	Exhaust VANOS solenoid
19	input	Thermostat signal	Thermostat
20	-	Not used	
21	-	Not used	
22	-	Not used	
23	-	Not used	
24	ground	Camshaft position sensor 1	Camshaft position sensor 1
25	ground	Camshaft position sensor 2	Camshaft position sensor 2
26	input/output	BSD signal	Electric coolant pump

