

160 Fuel Tank and Fuel Pump

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TABLE

a. Fuel tank capacity for 3 Series models	160-2
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GENERAL

This repair group covers service information for the fuel supply system.

See also:

- **100 Engine-General** for model year, engine code, and DME applications
- **130 Fuel Injection**
- **ECL Electrical Component Locations** for fuel pump fuse and relay access information

160-2 Fuel Tank and Fuel Pump

Fuel tank

Fuel tank

The saddle-shaped plastic fuel tank is mounted underneath the center of the car (underneath the rear seat). Mounted in the fuel tank are the electric fuel pump, fuel level sending units and suction jet pump. Connecting lines for the evaporative emission control system are also attached to the tank.

Fuel tank capacity for 3 Series models is listed in **Table a**.

Table a. Fuel tank capacity for 3 Series models

Tank capacity	60 liters (15.8 gal)
Reserve capacity	6 liters (1.5 gal)

Fuel delivery systems

3 Series models use two main fuel delivery systems:

- Non-turbo engines use a multi-port injection system
- Turbo models use a direct injection system.

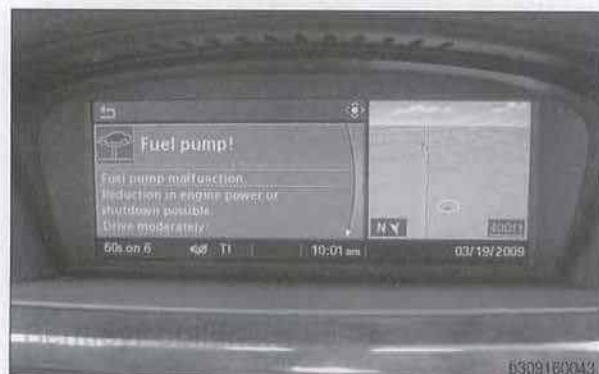
Non-turbo engine fuel injectors are installed in machine-bored holes in the cylinder head. See **130 Fuel Injection**. An in-tank electric fuel pump delivers pressure-regulated fuel to the fuel rail. The fuel pump is a variable speed pump controlled by the EKP (electric fuel pump control) module delivers only the amount of fuel needed for engine operation. This eliminates excess fuel delivery and reduces pump wear. It can operate at up to 5 bar (72.5 psi) and 95 liters (25 gallons) per hour.

Direct fuel injection in the turbo engine allows for precise metering of mixture and higher compression. This is made possible by locating a fuel injector for each cylinder centrally between the valves. See **130 Fuel Injection**. The electric fuel pump delivers fuel to a high pressure fuel pump. The high pressure fuel pump is driven by a chain and can provide fuel pressure from 5 bar (72.5 psi) up to 200 bar (2900 psi).

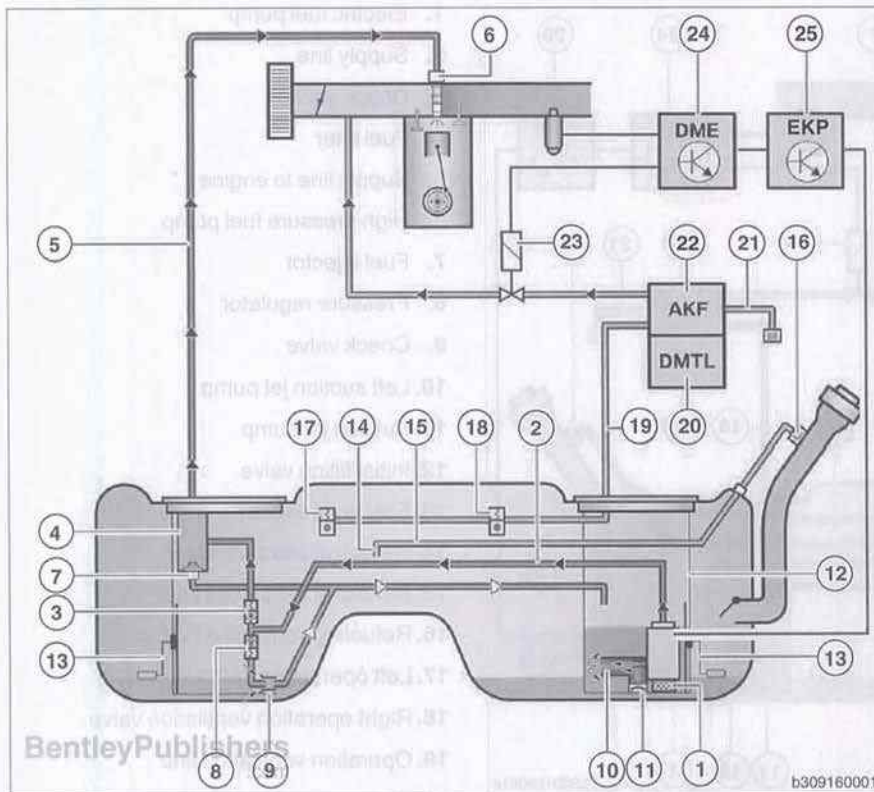
Electric fuel pump

An electric fuel pump is mounted in the fuel tank in tandem with the right side fuel level sender and suction jet pump. A suction jet pump is located in the left side of the tank to transfer fuel to the right side. The combined fuel filter / pressure regulator delivers pressurized fuel to the fuel injection system. The system is a non-return design; there is one fuel line to the fuel injectors and excess fuel flows directly from the fuel filter / pressure regulator back into the tank.

- Fuel pump self-diagnostics are built into the DME. A failure in the fuel pump circuit will set a fault code.



Fuel system schematic (non-turbo)

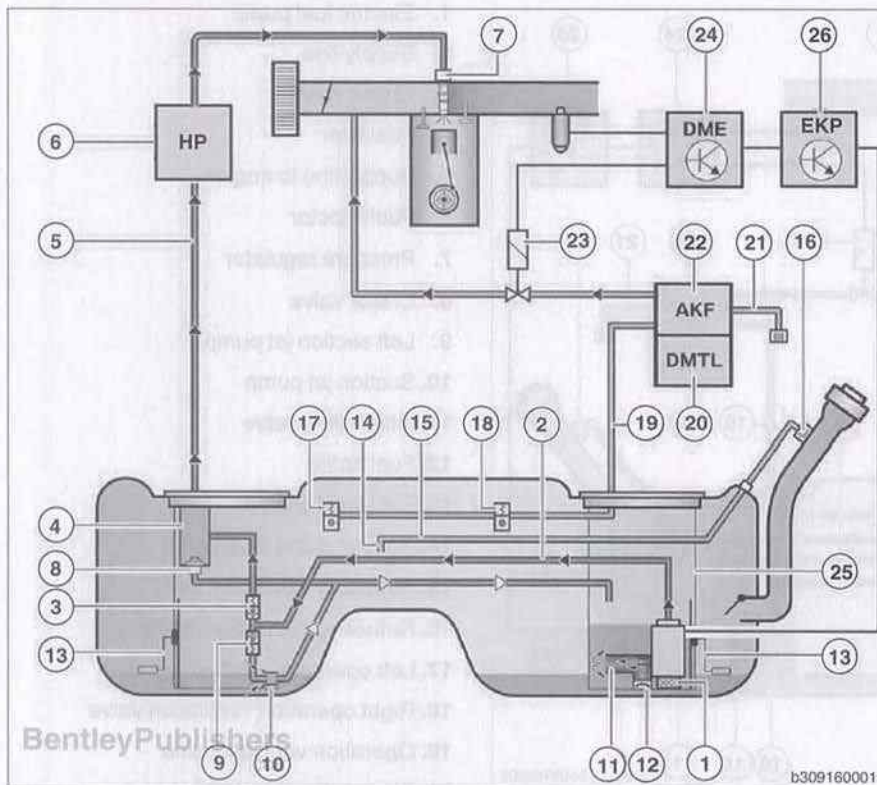


1. Electric fuel pump
2. Supply line
3. Check valve
4. Fuel filter
5. Supply line to engine
6. Fuel injector
7. Pressure regulator
8. Check valve
9. Left suction jet pump
10. Suction jet pump
11. Initial filling valve
12. Fuel baffle
13. Fuel level sender
14. Refueling line connector
15. Refueling ventilation line
16. Refueling ventilation nipple
17. Left operation ventilation valve
18. Right operation ventilation valve
19. Operation ventilation line
20. Diagnosis pump for tank leakage (DMTL)
21. Fresh air vent line
22. Activated carbon canister
23. Fuel tank vent valve
24. Engine control module (ECM)
25. Fuel pump module (EKP)

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Fuel system schematic (turbo)

Fuel system schematic (turbo)



1. Electric fuel pump
2. Supply line
3. Check valve
4. Fuel filter
5. Supply line to engine
6. High pressure fuel pump
7. Fuel injector
8. Pressure regulator
9. Check valve
10. Left suction jet pump
11. Suction jet pump
12. Initial filling valve
13. Fuel level sender
14. Refueling line connector
15. Refueling ventilation line
16. Refueling ventilation nipple
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20. Diagnosis pump for tank leakage (DMTL)
21. Fresh air vent line
22. Activated carbon canister
23. Fuel tank vent valve
24. Engine control module (ECM)
25. Fuel baffle
26. Fuel pump module (EKP)

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.
- 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.
- Electric fuel pump starts each time door is opened.
- 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, face shield 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.

CAUTION—

- Prior to disconnecting the battery, read the battery disconnection cautions given in **001 Warnings and Cautions**.
- Before making any electrical tests with ignition switched ON, disable the ignition system as described in **120 Ignition System**. Be sure the battery is disconnected when replacing components.
- To prevent damage to the ignition system or other DME components, including the engine control module (ECM), connect and disconnect wires and test equipment with ignition OFF.
- Cleanliness is essential when working with the fuel system. Thoroughly clean the fuel line unions before disconnecting any of the lines. Plug open fuel lines and ports.
- Use only clean tools. Keep removed parts clean and sealed or covered with a clean, lint-free cloth, especially if completion of the repair is delayed.
- Do not move the car while the fuel system is open.
- Avoid using high pressure compressed air to blow out lines and components. High pressure can rupture internal seals and gaskets.
- Use new seals, O-rings and hose clamps when replacing fuel system components

FUEL TANK EVAPORATIVE CONTROL SYSTEM

Evaporative control, also referred to as running losses control, is designed to prevent fuel system evaporative losses from venting into the atmosphere. The components of this system allow control and monitoring of evaporative losses by on-board diagnostic (OBD II) software incorporated into the engine control module (ECM).

Listed below are the main components of the evaporative control system and their functions:

- Carbon canister stores fuel vapors.
- Plumbing ducts vapors from fuel tank to canister and from canister to intake manifold.
- Carbon canister purge valve is controlled by engine control module (ECM).
- Pressure regulator shunts excess fuel volume directly back to fuel tank before it circulates through the fuel lines.
- Leak detection unit (DMTL) pressurizes fuel tank and evaporative system to monitor system leaks.

Evaporative system troubleshooting

Start by accessing diagnostic trouble codes (DTCs) using a BMW or compatible aftermarket scan tool.

- For purposes of OBD II emissions compliance, the DME system sets a diagnostic trouble code (DTC) when it detects a leak in the evaporative control system.
- Malfunction indicator light (MIL) is illuminated upon second recurrence of fault. See **OBD On-Board Diagnostics**.

— When leak testing, observe the following conditions to obtain plausible results:

- Fuel tank $\frac{1}{4}$ to $\frac{3}{4}$ full.
- Vehicle parked for at least 2 hours to allow fuel to reach ambient temperature. Ideal fuel temperature is 10° - 20°C (50° - 68°F).
- Do not refuel immediately before leak test.

— If a leak is detected, check the following areas:

- Fuel filler cap leaking or off.
- Fuel tank ventilation lines leaking at fuel tank or activated carbon canister.
- Tank ventilation valve leaking (in engine compartment).
- Fuel level sensor and fuel pump assembly cover leaking.

For evaporative system component replacement, see **Fuel Supply Components** in this repair group.

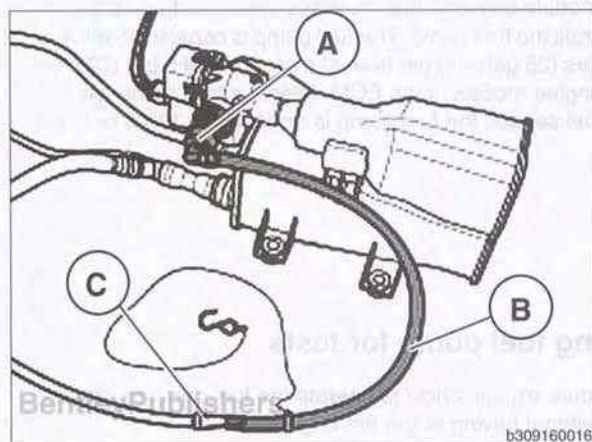


Evaporative system leak test

Use the following leak test when diagnosing evaporative system leak fault codes.

- Working underneath left rear bumper: gain access to activated carbon canister. See **Activated carbon canister, removing and installing** in this repair group.

➤ Remove fresh air line (inset) from DMTL pump.



➤ Install BMW test adapter 83 30 0 433 207 (B) (or suitable substitute) at DMTL fresh air connection (A).

- Connect evaporative system smoke machine (C) to test adapter (B). BMW recommends VACUTEC 625-522B (nitrogen pressure swing absorption technology).
- Remove fuel filler cap.
- Activate smoke machine and fill fuel system with smoke until it escapes from fuel filler neck. Shut off smoke machine.

WARNING —

- Use only smoke machine that utilizes nitrogen to pressurize fuel system.
- The fuel system may release a substantial amount of fuel-rich gasoline vapors during testing. Work in a well ventilated area.

- Reinstall fuel filler cap.
- Reactivate smoke machine and fill fuel system with smoke.

WARNING —

- Do not exceed a maximum fuel system pressure of 0.3 bar (4 psi) when using smoke machine.

- Examine fuel system components for signs of escaping smoke. Repair or replace faulty components.
- After completing tests:
 - Attach DMTL fresh air line.
 - Check for fault codes and reset ECM memory.

Fuel pump fuse and module

➤ Fuel pump circuit is fuse-protected by:

- CAUTION—**

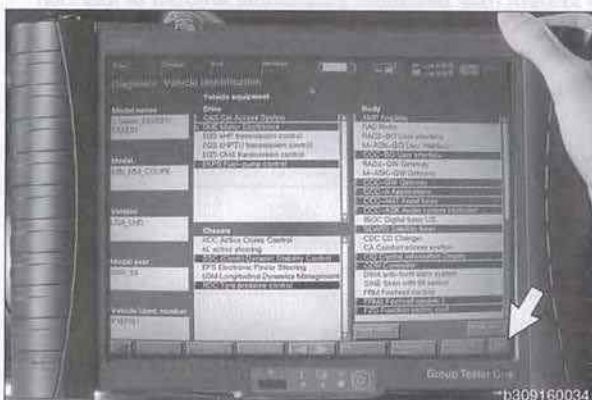
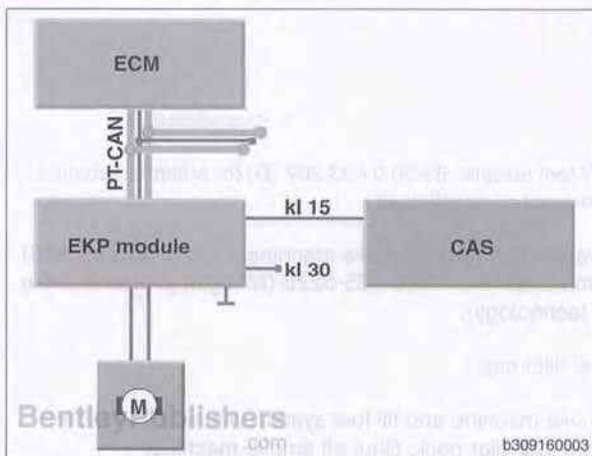
➤ The ECM calculates the amount of fuel required at the given point in time and the electric fuel pump is activated as required. The total volume required is transmitted as a message to the EKP control module via PT-CAN.

Operating fuel pump for tests

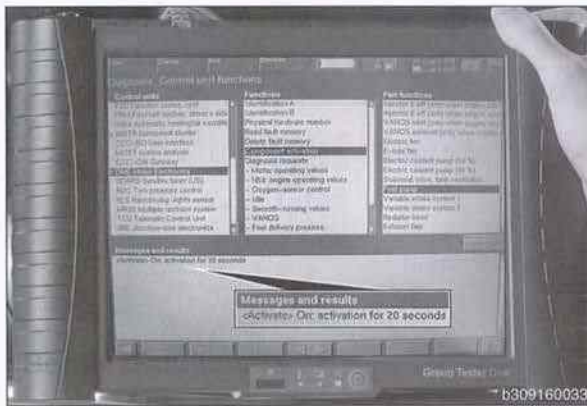
This procedure explains how to operate the fuel pump for testing purposes without having to run the engine.

- Using BMW factory scan tool or equivalent:

- Identify vehicle
- Select **Next (arrow)**
- Select **Control Module Functions**
- Select **Complete Vehicle**
- Select **Drive**
- Select **DME**
- Select **Component Activation**
- Select **Fuel Pump**



- Fuel pump will run at 100% (5 bar) for 20 seconds.



Fuel pump electrical circuit, testing

If fuel pump does not operate or there is no fuel pressure, first test fuel pump electrical circuit.

- Remove rear seat to access fuel pump and fuel level sender. See **Accessing fuel pump and fuel level senders** in this repair group.
- Disconnect harness connector from fuel pump and fuel level sender.



- Connect voltmeter between fuel pump leads (arrows) on connector.
- Activate fuel pump. See **Operating fuel pump for tests** in this repair group.
- Use digital multimeter to test for battery voltage at fuel pump connector leads.
- If voltage and ground are present, fuel pump is probably faulty. If there is no voltage, check wiring between fuel pump and fuel pump module.
- After completing tests, reconnect fuel pump harness connector.

160-10 Fuel Tank and Fuel Pump

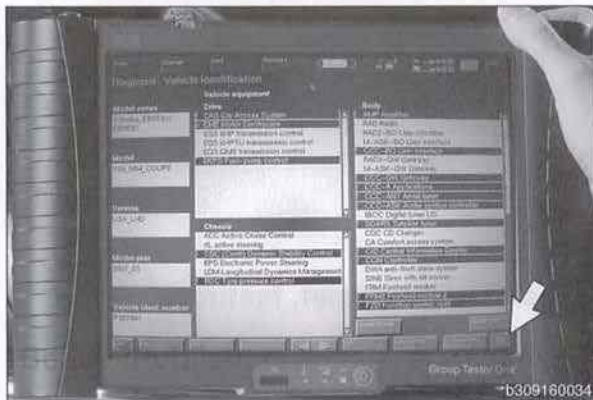
Fuel pump power consumption, testing

Fuel pump power consumption, testing

If fuel delivery is erratic or poor, or if fuel pump makes abnormally loud noises, test pump power consumption.

Using BMW factory scan tool or equivalent:

- Identify vehicle
- Select **Next** (arrow)
- Select **Function Selection**
- Select **DME**
- Select **Fuel Pump**
- Select **Control Current B1612_STR00**
- Select **Next** (arrow)

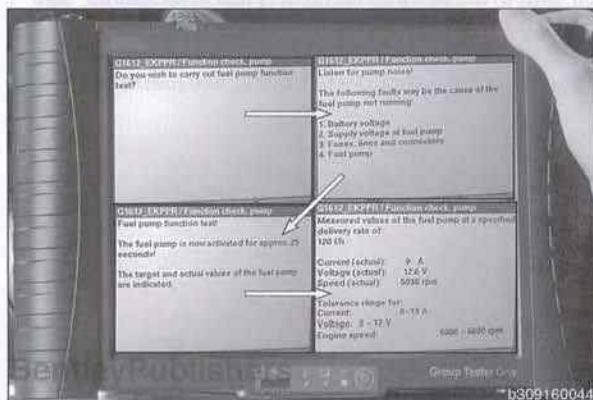


Follow steps on screen to monitor fuel pump current.

Fuel pump current

Current consumption (activated with scan tool)

8 - 13 amps



An alternative method is to install a digital ammeter in fuel pump circuit using the following steps.

- Remove rear seat to access fuel pump and fuel level sender. See **Accessing fuel pump and fuel level senders** in this repair group.

Disconnect harness connector from fuel pump.

- Make sure battery voltage at fuel pump connector is 12.6 volts. Charge battery if necessary.



- Attach digital ammeter between pump lead and harness. Connect jumper wire between pump and harness.

CAUTION—

- Do not allow the test leads to short to ground.



- Activate fuel pump. See **Operating fuel pump for tests** in this repair group.

- Compare ammeter reading with specification listed in table.

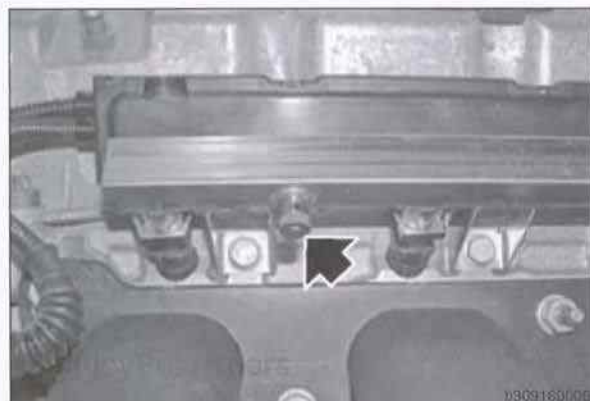
Fuel pump current

Current consumption (activated with scan tool)	8 - 13 amps
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- Higher than normal power consumption by fuel pump may indicate a worn pump, causing intermittent fuel starvation due to pump overheating and seizure. Replace pump.
- Lower than normal power consumption may indicate blockage in a fuel line. Before replacing fuel pump, be sure to check that return line and pump pickup (inside fuel tank) are not obstructed.

Fuel pressure gauge, installing (non-turbo)

- Remove ignition coil cover. See **020 Maintenance**.
- Remove Schrader valve cap (**arrow**) at fuel rail and connect fuel pressure gauge.
- Use a fuel pressure gauge with a minimum range of 0 to 7 bar (0 to 100 psi).



WARNING—

- The fuel system is designed to retain pressure even when the ignition is OFF. When working with the fuel system, loosen fuel lines slowly to allow residual fuel pressure to dissipate. Avoid spraying fuel. Use shop towels to capture leaking fuel.
- Fuel pump starts each time door is opened.
- Make sure the fuel pressure gauge is securely connected to the fuel rail to prevent it from coming loose under pressure.

160-12 Fuel Tank and Fuel Pump

Fuel pressure gauge, installing (turbo)

Fuel pressure gauge, installing (turbo)

Use a fuel pressure gauge with a minimum range of 0 to 7 bar (0 to 100 psi).

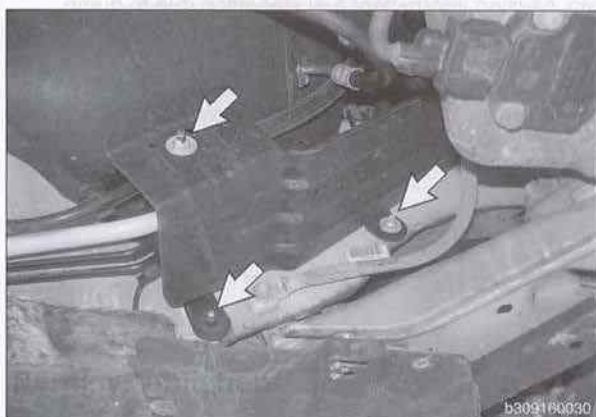
WARNING —

- The fuel system is designed to retain pressure even when the ignition is OFF. When working with the fuel system, loosen fuel lines slowly to allow residual fuel pressure to dissipate. Avoid spraying fuel. Use shop towels to capture leaking fuel.
- Fuel pump starts each time door is opened.
- Make sure the fuel pressure gauge is securely connected to the fuel rail to prevent it from coming loose under pressure.

- Remove splash shield for transmission. See **020 Maintenance**.

- ◀ Working underneath vehicle on drivers side:

- Remove fasteners (**arrows**) for fuel line protective shield and remove protective shield.



- ◀ Disconnect fuel line (**arrow**).



- ◀ Install compatible T-style test adapter and install fuel pressure gauge.



Fuel pressure regulator

Fuel pressure is created by the fuel pump and maintained by the fuel pressure regulator.

Fuel pressure regulator is integrated into the fuel pump assembly. See **Fuel pump, removing and installing** in this repair group.

Fuel delivery, testing

Checking fuel delivery is a fundamental part of troubleshooting and diagnosing the DME system. Fuel pressure directly influences fuel delivery. There are two significant fuel delivery values to be measured:

- **System pressure** is created by fuel pump and maintained by pressure regulator. System pressure is adjustable only by the ECM.
- **Residual pressure** is pressure maintained in closed system after engine and fuel pump are shut off.

System pressure, engine not running

- Attach fuel pressure gauge. See **Fuel pressure gauge, installing (non-turbo) (turbo)** in this repair group.
- Activate fuel pump. See **Operating fuel pump for tests** in this repair group. Compare fuel pressure to specifications in accompanying table.

Fuel pressure specification

System pressure, engine not running	5 ± 0.2 bar (72.5 ± 2.9 psi)
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CAUTION—

- *The fuel pump is capable of developing a higher pressure than that regulated by the pressure regulator. Do not allow pressure to rise above 6.5 bar (94 psi). Damage to the fuel lines or fuel system components could result.*

- After completing tests without running engine, check for fault codes and reset ECM memory.

System pressure, engine running

If fuel pressure tests show normal pressure but engine lacks power under acceleration, test fuel pump pressure control regulation function.

- With fuel pressure gauge attached, start engine and check fuel pressure.

Fuel pressure specification

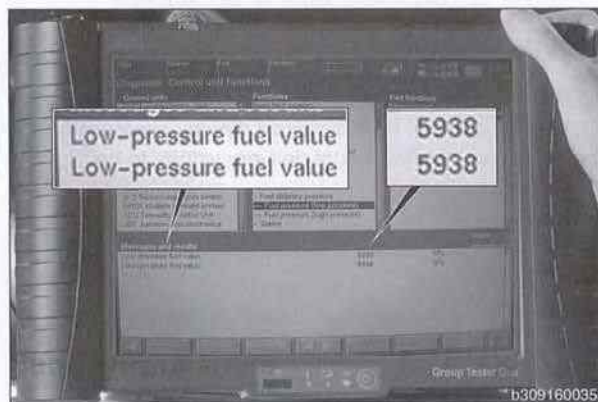
System pressure, engine running	5 ± 0.2 bar (72.5 ± 2.9 psi)
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160-14 Fuel Tank and Fuel Pump

Fuel delivery, testing

CAUTION—

- The fuel pump is capable of developing a higher pressure than that regulated by the pressure regulator. Do not allow pressure to rise above 6.5 bar (94 psi). Damage to the fuel lines or fuel system components could result.



On turbo engine models compare fuel pressure on gauge to data value on BMW factory scan tool or equivalent.

- If pressure does not match, replace fuel pressure regulator. See **Fuel pump, removing and installing** in this repair group.
- After completing tests, note the following:
 - Non turbo: replace Schræder valve cap.
 - Turbo reassemble fuel line.
 - Check for fault codes and reset ECM memory.

Residual pressure

For quick restarts and to avoid vapor lock when the engine is hot, the fuel injection system retains fuel pressure after the engine is shut off. This residual pressure is primarily maintained by the fuel pressure regulator and a check valve at the fuel pump outlet.

- Attach fuel pressure gauge. See **Fuel pressure gauge, installing** in this repair group.
- Start engine and allow it to run for approximately one minute. Note fuel pressure reading. Shut OFF engine.
- Note fuel pressure after approximately 20 minutes. Make sure pressure does not drop more than 0.5 bar from system pressure.

Fuel pressure specification

System pressure, engine not running	5 ± 0.2 bar (72.5 ± 2.9 psi)
-------------------------------------	---------------------------------------

- When finished, disconnect pressure gauge and fitting, and replace Schræder valve cap.
- If fuel system does not maintain pressure:
 - Visually check for leaks in fuel lines and unions.
 - Check for leaking injector(s).
 - Check for faulty fuel pump check valve.

FUEL PUMP AND FUEL LEVEL SENDERS

Accessing fuel pump and fuel level senders

NOTE—

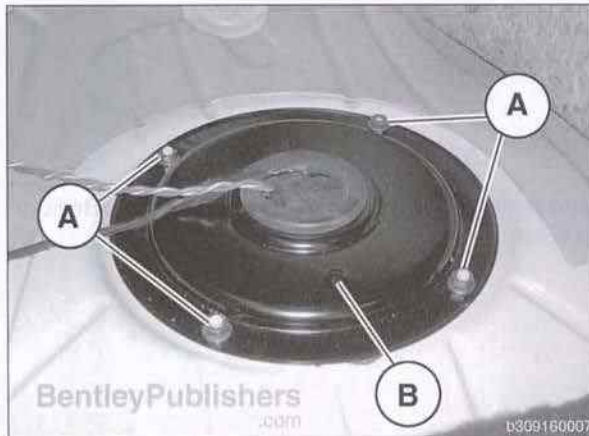
- Right side fuel pump / fuel level sender shown. Accessing left side fuel level sender is similar.

- Remove rear seat cushion. See **520 Seats**.

Working at ride side fuel tank:

- Remove fasteners (A).
- Remove fuel pump access cover (B).

- Installation is reverse of removal.



Fuel pump and fuel level sender (right side), removing

- Drain fuel tank. See **Fuel tank, draining** in this repair group.
- Disconnect negative cable from battery.

CAUTION—

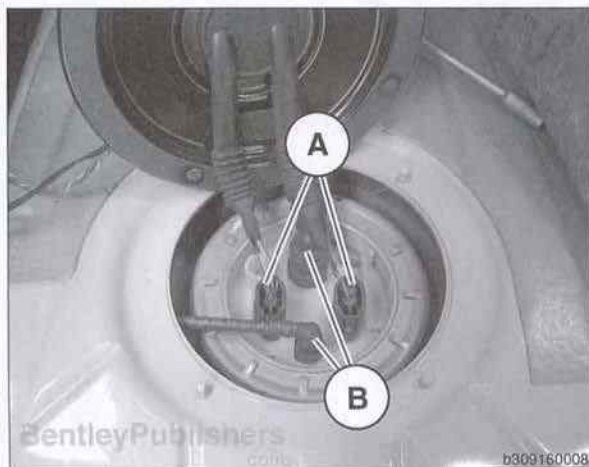
- Prior to disconnecting the battery, read the battery disconnection cautions given in **001 Warnings and Cautions**.

- Remove fuel pump access cover. See **Accessing fuel pump and fuel level senders** in this repair group.

Remove electrical connectors (A) and fuel lines (B).

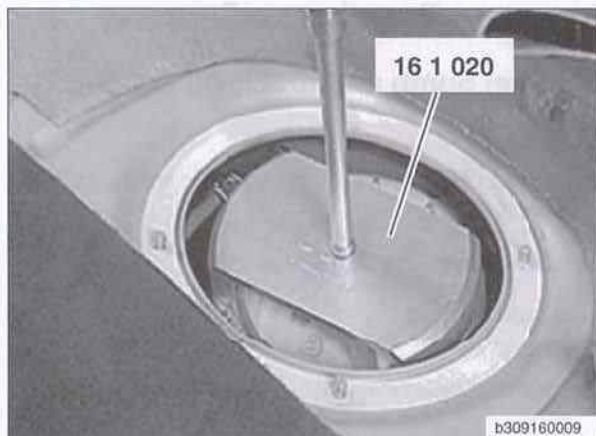
WARNING—

- When disconnecting fuel hose, wrap shop towel around end of hose to prevent spray of fuel under pressure.

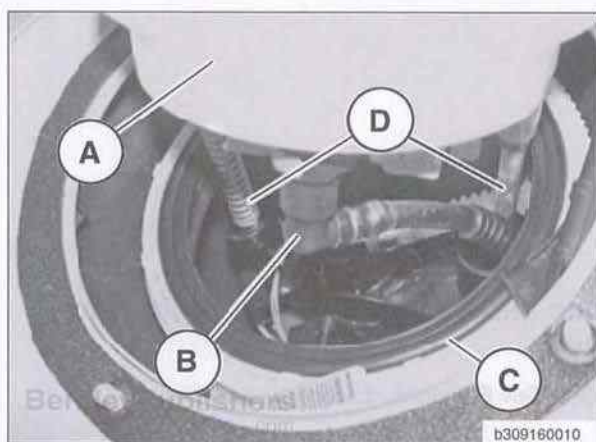


160-16 Fuel Tank and Fuel Pump

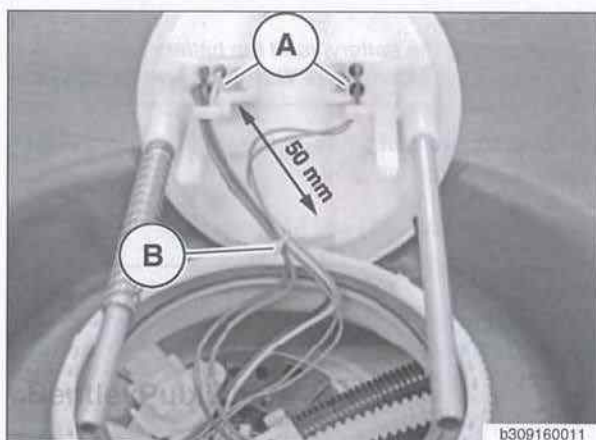
Fuel pump and fuel level sender (right side), removing



Using special tool 16 1 020, remove fuel pump service cap.



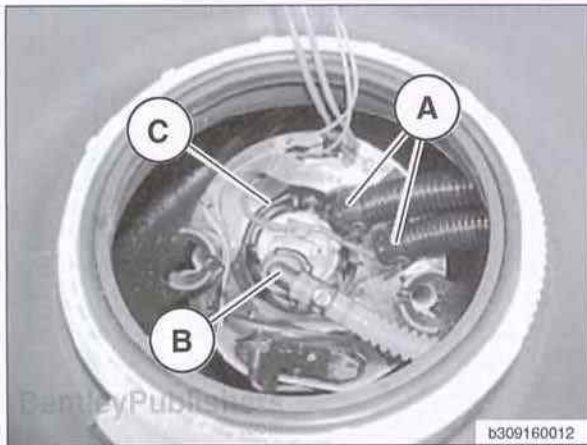
Carefully raise service cap (A) and disconnect fuel line (B). Remove and discard O-ring (C).



Disconnect electrical connectors (A), cut and dispose of wire tie (B).

Fuel Tank and Fuel Pump 160-17

Fuel pump and fuel level sender (right side), installing



Working inside fuel tank:

- Disconnect black fuel return lines (A).
- Unlock and disconnect fuel line (B) using only your fingers.
- Carefully lift fuel pump and fuel level sender (C) out of tank. If necessary rotate 90° counterclockwise and tilt towards fuel level sender.

CAUTION—

- Do not bend fuel sender arm.

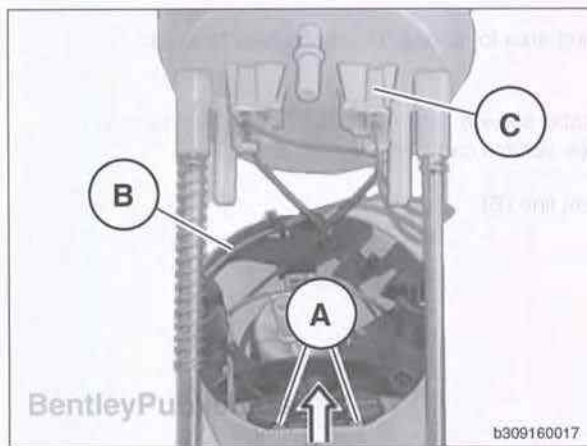
NOTE—

- Be prepared to catch any dripping fuel.

To replace fuel level sender use following step.

- Carefully unlock tabs (A) and pull fuel level sensor off in direction of arrow. Remove wire (B) from holders and disconnect electrical connector (C).

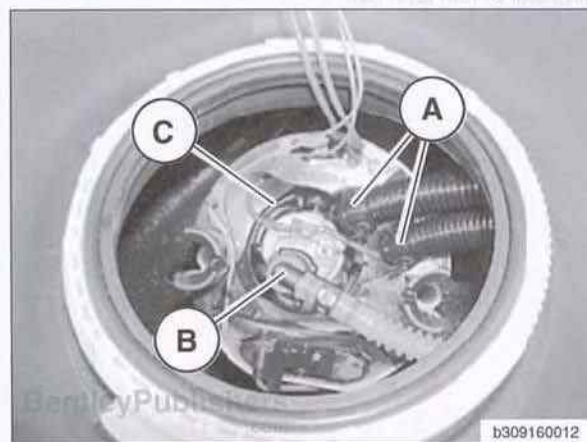
- Installation of fuel level sender is reverse of removal. **See Fuel pump and fuel level sender (right side), installing** in this repair group for fuel pump installing.



Fuel pump and fuel level sender (right side), installing

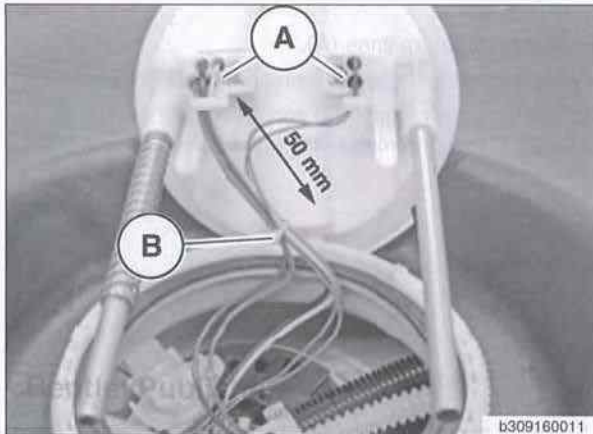
Working inside fuel tank:

- Carefully install fuel pump and fuel level sender (C). If necessary rotate 90° clockwise and tilt toward fuel level sender.
- Connect black fuel return lines (A).
- Connect and lock fuel line (B) using only your fingers.

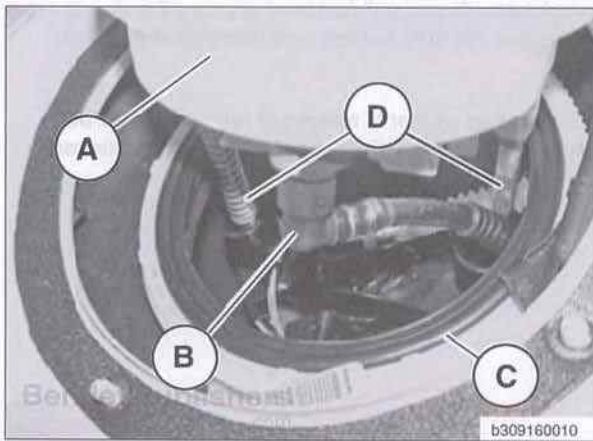


160-18 Fuel Tank and Fuel Pump

Fuel pump and fuel level sender (right side), installing



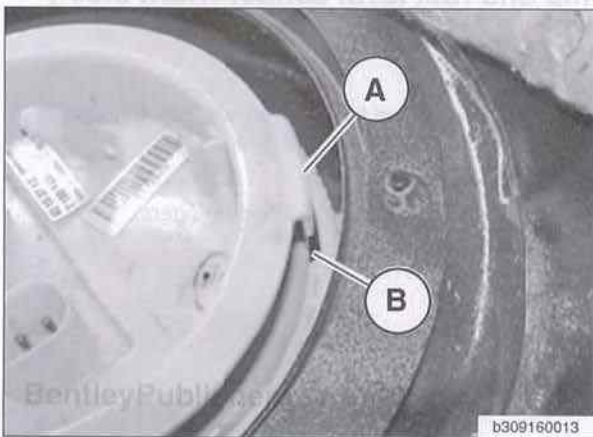
Connect electrical connectors (A), and attach wires with wire tie (B).



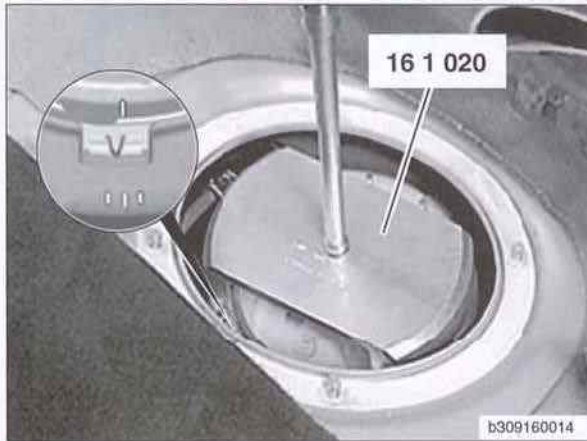
Clean sealing area for O-ring (C). Remember to replace O-ring (C) with new.

- Carefully install service cap (A) while aligning locating rods (D). Check to see service cap freely, do not force.

- Connect vent line (B).

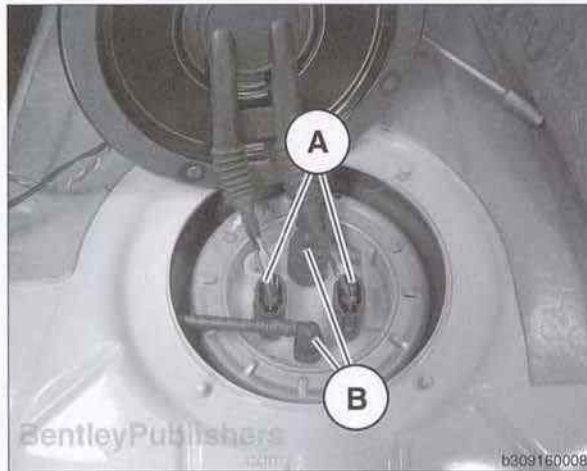


When installing, check to see that service cap lug (A) engages with corresponding slot of fuel tank (B).



➤ Install service cap hand tight.

- Using special tool 16 1 020 tighten service cap until marking on service cap point to notch on fuel tank (inset).



➤ Connect electrical connectors (A) and fuel lines (B).

- Install fuel tank access cover.

CAUTION—

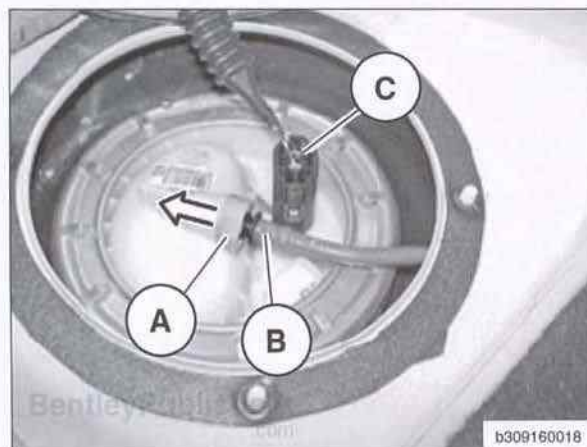
- After finishing repairs but before starting engine, be sure there is at least 5 liters (1.5 gallons) of fuel in the tank. The fuel pump is damaged if run without fuel.

Fuel level sender (left side), removing

- Drain fuel tank. See **Fuel tank, draining** in this repair group.
- Disconnect negative cable from battery.

CAUTION—

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

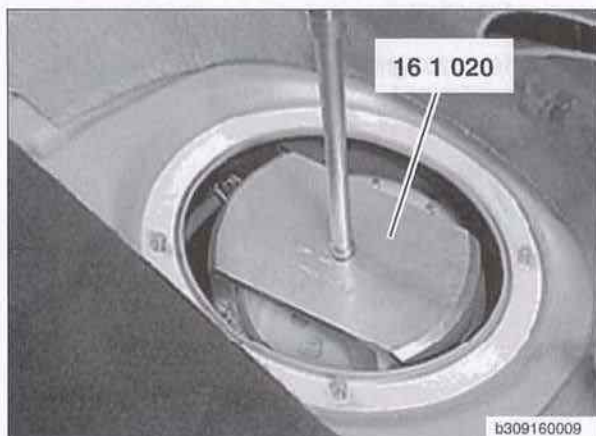


- Remove fuel sender access cover. See **Accessing fuel pump and fuel level senders** in this repair group.
- Remove left side fuel level sender. See **Fuel pump and fuel level sender (right side), removing**, in this repair group

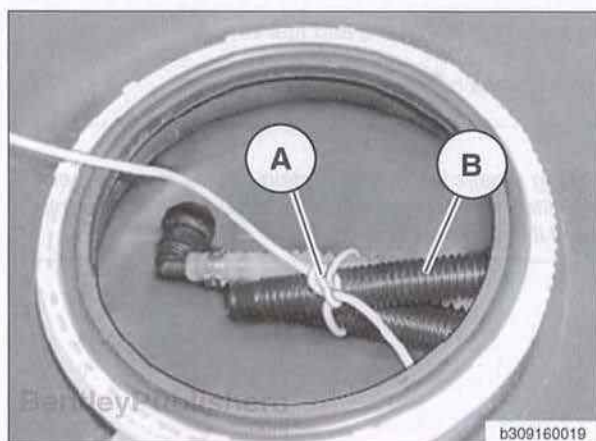
➤ Disconnect electrical connector (C). Using only your fingers press gray ring (A) toward sensor and pull fuel supply (B) line straight out.

160-20 Fuel Tank and Fuel Pump

Fuel level sender (left side), removing



Using special tool 16 1 020, remove fuel pump service cap.



Attach stiff wire (A) to hose pack (B) through right side fuel tank opening. The wire is pulled through to the left side to aid installation.

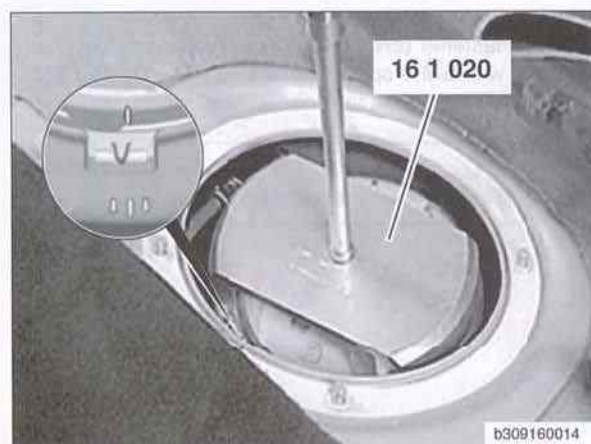
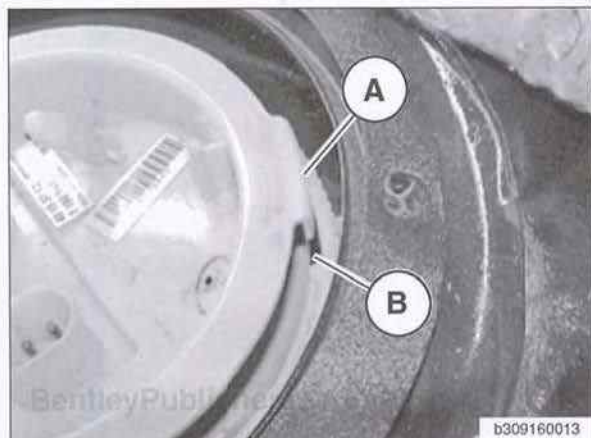


To remove assembly, press tab (B) against spring force and carefully lift sender (A) out of tank with hose pack. Remember to replace fuel tank seals (O-rings).

Fuel level sender (left side), installing

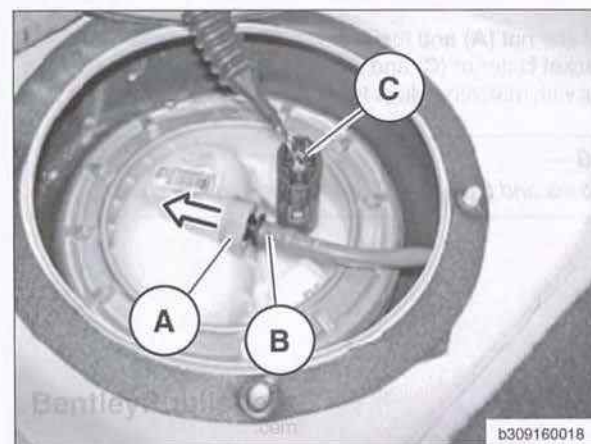
- Carefully feed hose pack through tank with mechanics wire and guide fuel level sender into position.

- ◀ When installing check to see that service cap lug (A) engages with corresponding slot of fuel tank (B).



- ◀ Install service cap hand tight.

- Using BMW special tool 16 1 020 tighten service cap until marking on service cap point to notch on fuel tank.



- ◀ Connect electrical connector (C) and fuel line (B).

- Install fuel tank access cover.

CAUTION—

- After finishing repairs but before starting engine, be sure there is at least 5 liters (1.5 gallons) of fuel in the tank. The fuel pump is damaged if run without fuel.

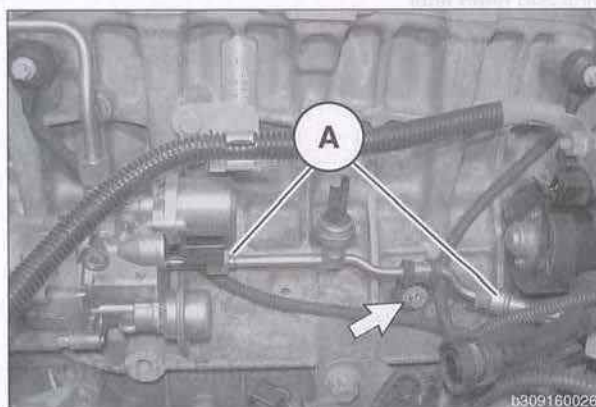
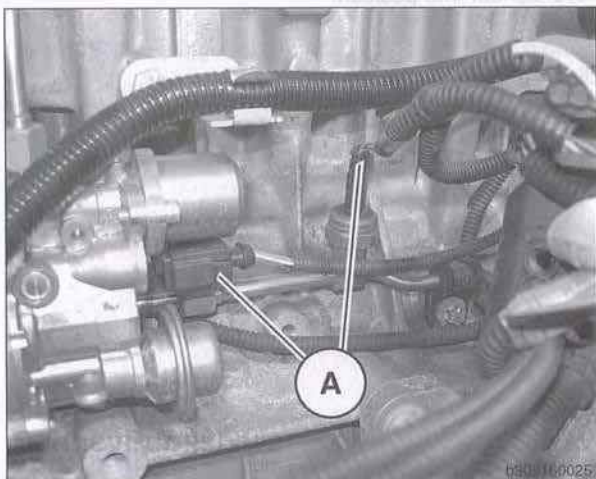
160-22 Fuel Tank and Fuel Pump

High-pressure fuel pump, removing (turbo)

High-pressure fuel pump, removing (turbo)

— Remove intake manifold. See **130 Fuel Injection**.

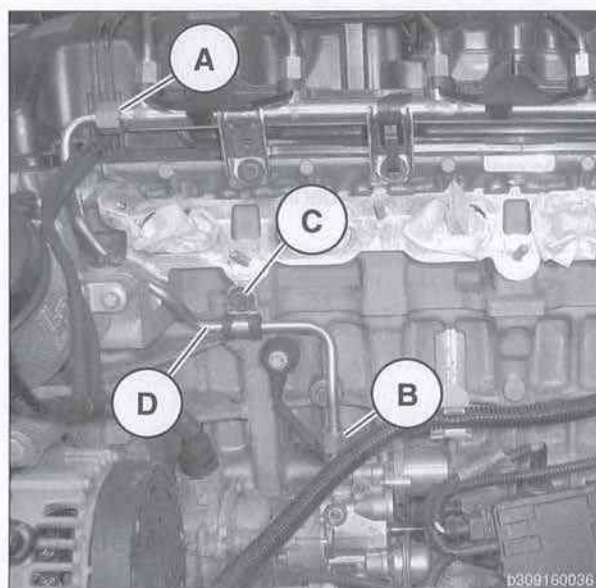
➤ Remove electrical connectors (A) and lay harness aside.



➤ Remove aluminum fastener (arrow) and discard. Detach fuel line (A). Seal fuel lines with BMW special tools 13 5 281 and 13 5 282. Remember to replace aluminum fastener (arrow) with new.

WARNING—

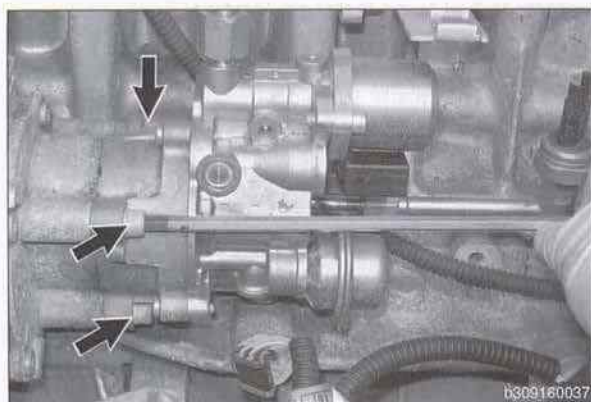
• Wear gloves and face shield when loosening fuel lines.



➤ Loosen fuel line nut (A) and fuel line nut (B) in this order. Remove fuel line bracket fastener (C) and remove fuel line (D). Seal fuel line connections with matching plugs from BMW special tool kit 32 1 270.

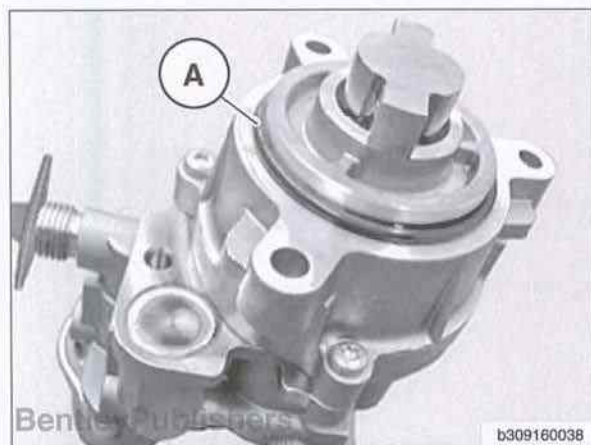
WARNING—

• Wear gloves and face shield when loosening fuel lines.

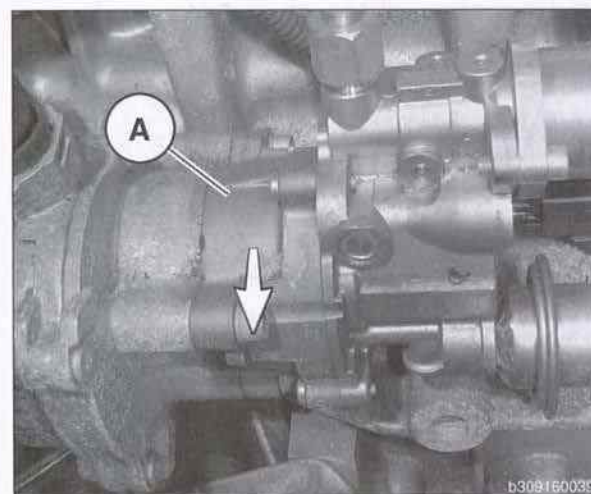


- Remove high-pressure fuel pump mounting fasteners (**arrows**) and remove high-pressure fuel pump. Be prepared to catch any dripping oil with shop cloth.

High-pressure fuel pump, installing (turbo)



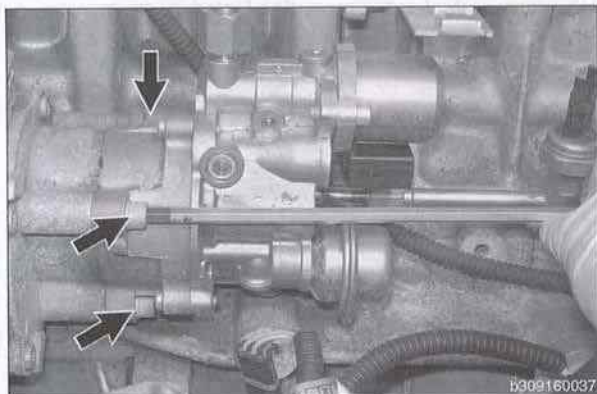
- Replace high-pressure fuel pump O-ring (**A**) and clean mounting surfaces.



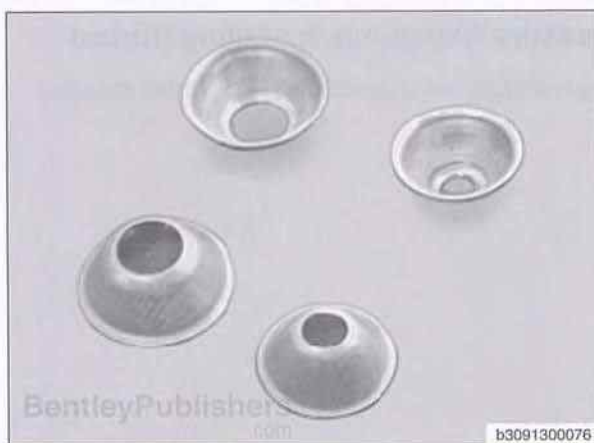
- When installing, rotate pump (**A**) in direction of **arrow** until flush with mounting surface.

160-24 Fuel Tank and Fuel Pump

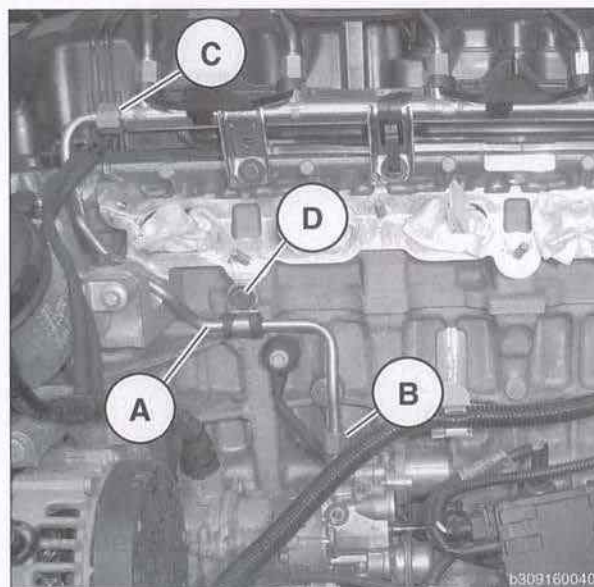
High-pressure fuel pump, installing (turbo)



Install high-pressure fuel pump fasteners (arrows) finger tight.



Prior to installing high-pressure fuel lines, dispose of any copper sealing rings installed at the factory. They are no longer needed.

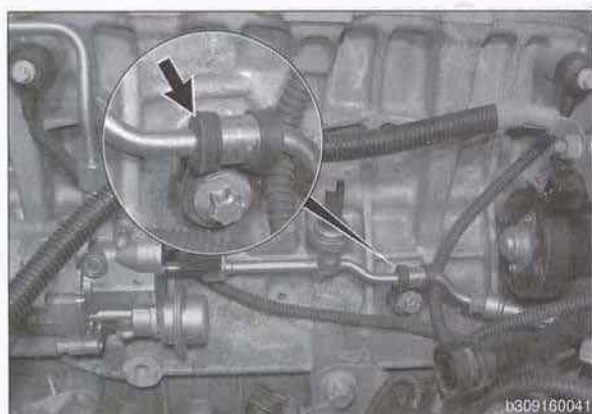


Use the following sequence when installing the fuel line.

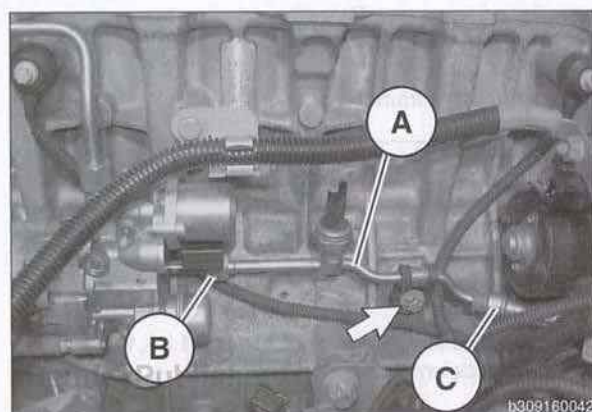
- Coat fuel line connections with transmission fluid.
- Preinstall fuel line (A).
- Tighten nuts (B) (C) finger tight.
- Tighten nut (B) to proper torque.
- Tighten nut (C) to proper torque.
- Tighten fuel line bracket fastener (D).

Tightening torques

Fuel line to high-pressure fuel pump	30 Nm (22 ft-lb)
Fuel line to fuel rail	30 Nm (22 ft-lb)
Fuel line mount to cylinder head	13 Nm (9.5 ft-lb)



- Before installing high-pressure fuel pump supply line, confirm it has the updated elastomer mounting clamp (**arrow**). If it has a soldered hold down clamp replace fuel supply line with updated part.



- Use the following sequence when installing the fuel supply line.
- Coat fuel line connections with transmission fluid.
 - Pre-install fuel line (**A**).
 - Tighten nut (**B**) and mount fastener (**arrow**) finger tight. Remember to replace fuel line bracket aluminum fastener with new.
 - Connect fuel line (**C**) to fuel supply line (**A**). Listen for audible click.
 - Tighten nut (**B**) to proper torque.
 - Tighten fuel line bracket fastener (**arrow**).

Tightening torques

Fuel line to high-pressure fuel pump	30 Nm (22 ft-lb)
Fuel line bracket to engine	10 Nm (7.3 ft-lb)
• Stage 1	Additional 90° ± 15°
• Stage 2	

- Reassemble engine.
- Check fuel system for leaks.
- Check for fault codes and reset ECM memory.

FUEL SUPPLY COMPONENTS

Fuel tank, draining

When draining fuel tank, use a safe storage unit and an approved fuel pumping device.

WARNING—

- Before starting to work on tank removal, make sure hot components, such as the exhaust system, are completely cooled down.
- Fuel may be spilled. Do not smoke or work near heaters or other fire hazards.

- Start engine and allow to run 10 - 15 seconds to fill fuel compensating siphon assembly. This allows both lobes of fuel tank to be drawn off through fuel filler pipe.

- Disconnect negative cable from battery.

CAUTION—

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

- Remove fuel tank filler cap.
- Slide suction hose into filler neck about 130 cm (51 in), twisting as necessary. Withdraw fuel into storage unit.
- Monitor fuel level reduction in both lobes:
 - Remove rear seat cushion and access both fuel tank sender harness connectors. See **Accessing fuel pump and fuel level senders** in this repair group.
 - Use multimeter to measure resistance at both senders. Resistance should drop as fuel level drops.
- If siphoning mechanism is faulty, drain left tank lobe separately by removing sender cover and pumping fuel directly out of left lobe.
- Remove suction hose from tank filler neck carefully to avoid damaging filler neck baffle plate.

CAUTION—

- After finishing repairs but before starting engine, be sure there is at least 5 liters (1.5 gallons) of fuel in tank. The fuel pump is damaged if run without fuel.

Fuel filter

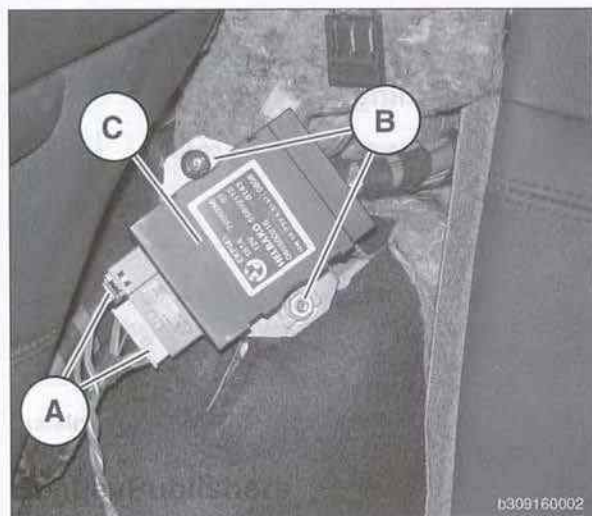
The fuel filter is a lifetime filter. It is integrated into the left side fuel level sender. See **Fuel level sender (left side), removing** in this repair group.

Fuel pressure regulator

The fuel pressure regulator is integrated into the left side fuel level sender. See **Fuel level sender (left side), removing** in this repair group.

Fuel pump module (EKP), removing and installing

- E90: Remove rear seat backrest. See **520 Seats**.
- E91, E92: Remove rear right backrest side bolster. See **520 Seats**.
- Working at EKF module:
 - Remove electrical connectors (A).
 - Remove fasteners (B) and remove EKP module (C).
- Installation is reverse of removal.
 - Remember to perform coding / programming on EKP module if replaced. See **600 Electrical System-General**.
- Check for fault codes and reset ECM memory.



Activated carbon canister, removing and installing

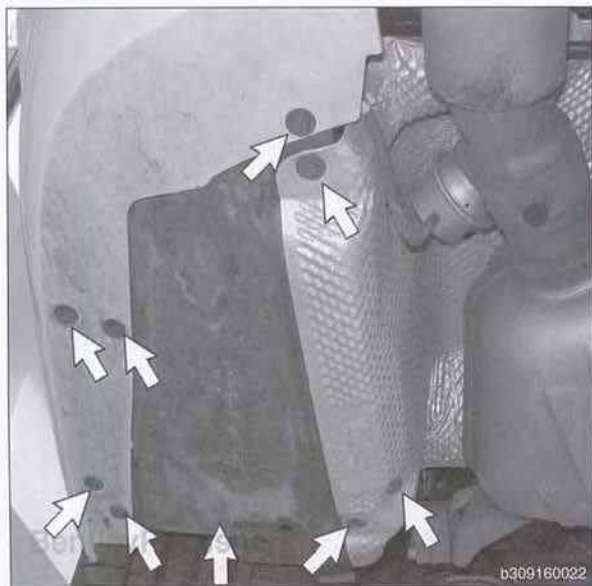
The carbon canister is on the left side underneath the rear bumper.

- Raise rear end of car and support safely.

CAUTION—

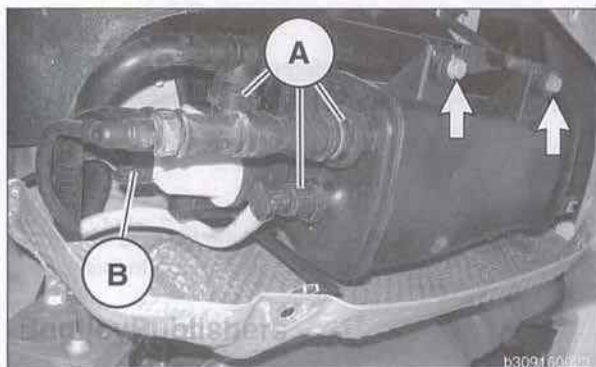
- Make sure the car is stable and well supported at all times. Use a professional automotive lift or jack stands designed for the purpose. A floor jack is not adequate support.

- Remove left side rear bumper splash shield fasteners (arrows).



160-28 Fuel Tank and Fuel Pump

Fuel tank leak detection unit (DMTL), removing and installing



- Remove activated carbon canister:
 - Remove line connections at leak detection pump (A).
 - Disconnect electrical harness connector (B).
 - Remove fasteners (**arrows**) and remove carbon canister from vehicle.
- Installation is reverse of removal.

Fuel tank leak detection unit (DMTL), removing and installing

The DMTL is mounted to the activated carbon canister.

- Raise car and support safely.

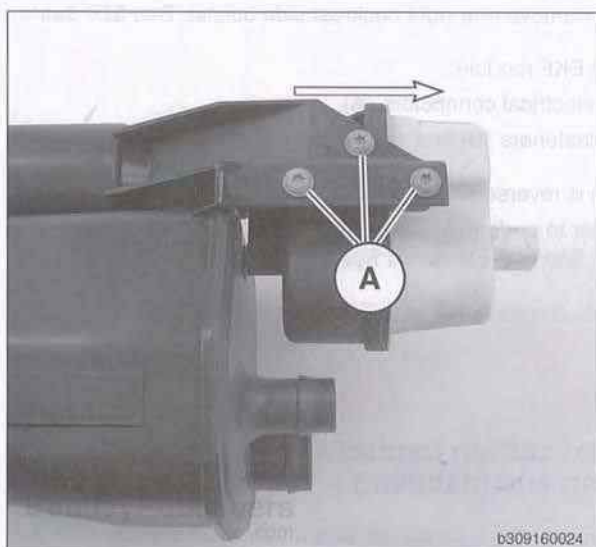
WARNING—

- Make sure the car 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 activated carbon canister. See **Activated carbon canister, removing and installing** in this repair group.

- Remove fasteners (A) and pull DMTL unit out of carbon canister in direction of **arrow**.

- Installation is reverse of removal.



721 Airbag System (SRS)

GENERAL	721-1
Airbag system overview	721-1
MRS components	721-2
MRS control module	721-2
Crash sensors	721-3
Driver airbag and horn contact spring	721-4
Passenger seat occupancy sensor (OC-3 mat)	721-5
Airbag status light	721-5

Pyrotechnic devices	721-6
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MRS control module, replacing	721-13
Driver airbag, removing and installing	721-13
Passenger airbag, removing and installing ..	721-15

GENERAL

This repair group covers the airbag system and component replacement. Airbag system problems can only be diagnosed using BMW scan tool or equivalent.

See also:

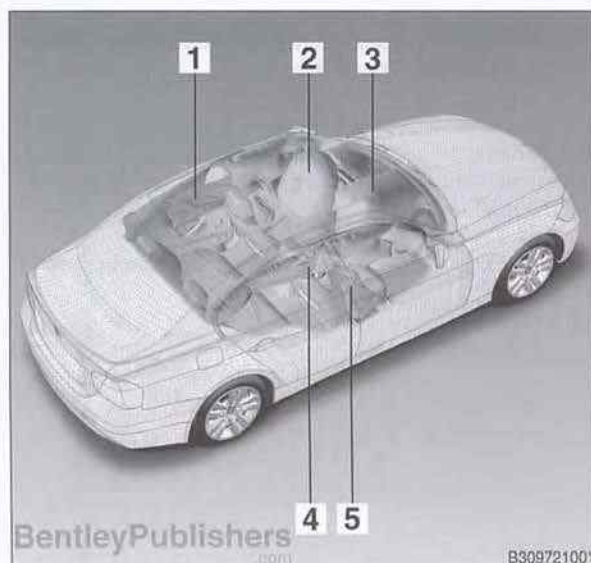
- **121 Battery, Starter, Alternator** for battery safety terminal
- **411 Doors** for door panel removal
- **513 Interior Trim** for center console and glove compartment removal
- **520 Seats** for seat removal
- **612 Switches** for steering column switch cluster
- **720 Seat Belts**
- **ECL Electrical Component Locations**

Airbag system overview

The BMW airbag system, including pyrotechnic seat belt tensioners and battery safety terminal, is called multiple restraint system (MRS). (The industry name is supplemental restraint system or SRS.)

Airbag system application	
Year	Restraint system
From 2006	MRS 5

1. Side rear airbag
2. Driver airbag
3. Passenger airbag
4. Curtain side airbag
5. Side front airbag (seat backrest)



721-2 Airbag System (SRS)

MRS components



MRS components

➤ The MRS system consists of the following components:

- MRS control module (1) under center console
- Crash sensors in B-pillars
- Crash sensors in engine compartment
- Door pressure sensors
- Warning light in instrument cluster
- Driver airbag and horn contact spring
- Passenger seat occupancy sensor (OC-3 mat)
- Driver and passenger airbags (2, 3)
- Driver and passenger thorax (side) airbags (4)
- Right and left curtain airbags (5)
- Front and rear seat belt pyrotechnic tensioners (6)
- Seat belt buckle microswitches
- Battery safety terminal (BST) (7)

MRS control module

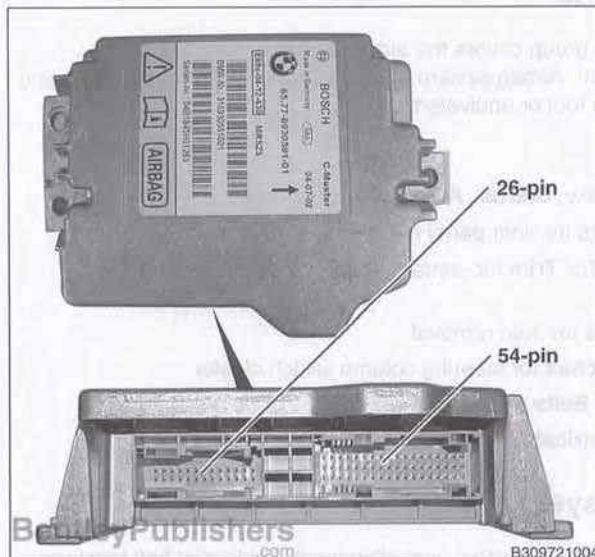
➤ The MRS control module, located under the center console between the parking brake handle and the gear selector lever, connects to other MRS system components and vehicle electronics via two connectors:

- 26-pin connector to instruments
- 54-pin connector to vehicle harness.

The module houses two crash sensors.

Communication with other control modules in the vehicle network takes place via K-CAN. In case of a crash, a K-bus protocol is transmitted via a separate data line to the telematics control module (TCU) and an emergency call is triggered.

For a description of vehicle bus systems, see **600 Electrical System-General**.



➤ The red MRS warning LED in the instrument cluster is illuminated for a short period after switching the ignition ON.

If a fault is stored in the MRS control module, the LED illuminates and remains ON until the ignition is switched OFF. A check control icon also appears in either yellow or red depending on the system fault along with a brief text message.

With the warning LED illuminated, MRS may not operate in case of a collision.



Crash sensors

In addition to two acceleration sensors in the MRS control module, satellite sensors are installed in the B-pillars, frame rails and doors. Together with the acceleration sensors in the control module, the longitudinal and transverse acceleration sensors and door pressure sensors serve the purpose of detecting side crashes.

The longitudinal acceleration sensors detect front end and rear end crashes.

➤ **B-pillar satellite**, a combined longitudinal and transverse acceleration sensor, detects frontal, side and rear end crashes. The left and right sensors are identical and are mechanically coded to side during installation.

➤ Acceleration sensor data is converted to digital signals and transmitted to the MRS control module as data telegrams every 228 microseconds (μs). The main sensors in the control module provide a directional signal so that the control module recognizes the direction of impact.

➤ **Front sensors** on the front frame rails detect frontal impacts and provide the MRS control module with initial information on the progression and severity of the impact. The front sensor consists of an acceleration sensor for detecting deceleration, a signal converter and a microprocessor for data transmission.

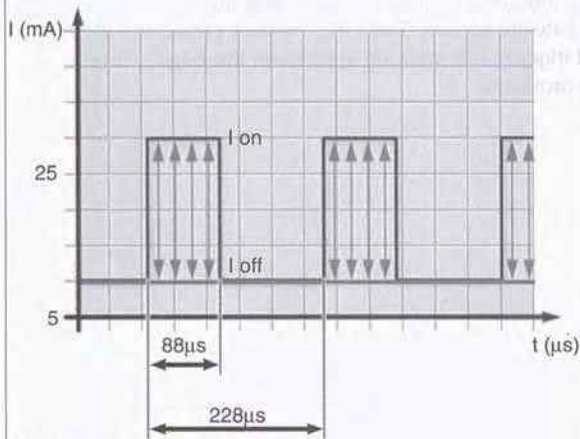
Front sensors transmit a digital data message cyclically every 228 μs . Power supply of 5 - 10 mA is via a current-signal interface.

B-pillar sensor



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B309721006



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B309721007

Front sensor

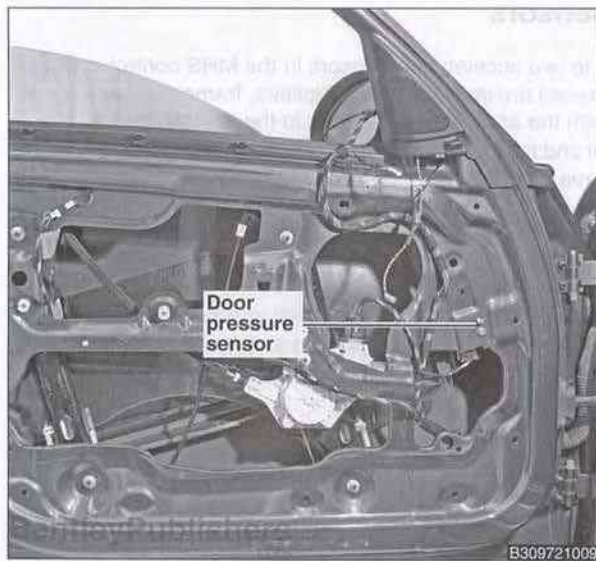


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721-4 Airbag System (SRS)

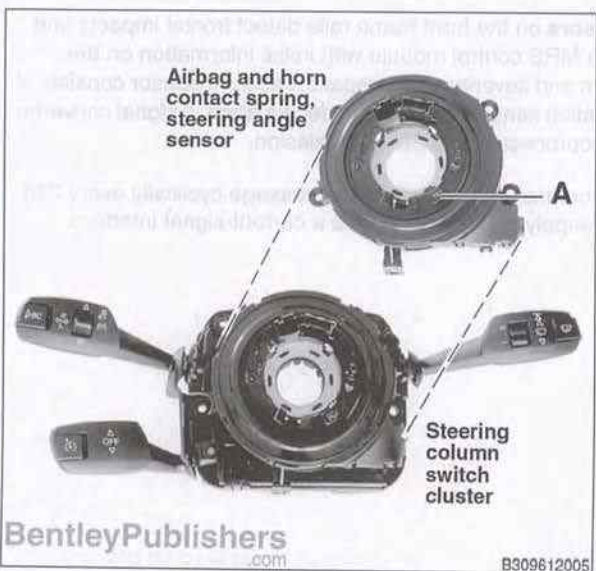
Driver airbag and horn contact spring



- **Door pressure sensor** in the front door cavity measures the pressure inside the door, providing supplementary side impact detection. In case of a side crash, the outer door panel is pushed inward, thus compressing the space inside the door and increasing the pressure, detected by the door pressure sensor.



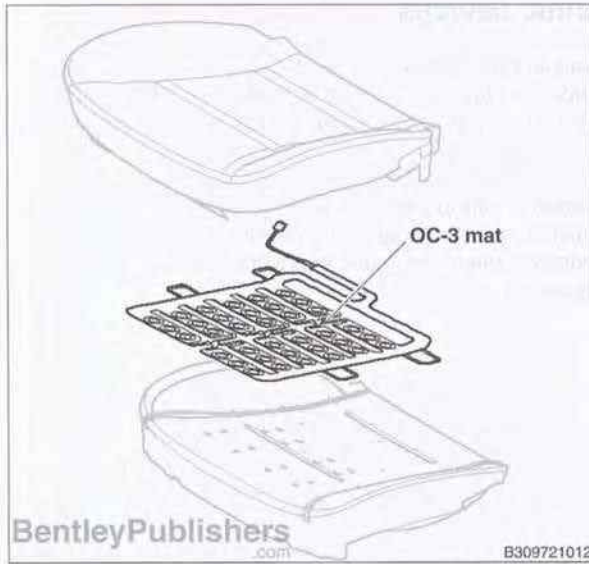
- The door pressure sensor contains a pressure sensor and an electronic module which digitizes and transmits data cyclically to the MRS control module. At the same time, side impact is detected by the B-pillar satellite sensor. The MRS module processes the two signals and triggers the restraint system on the basis of the information provided.



Driver airbag and horn contact spring

- The contact spring on the steering column switch cluster (SZL) behind the steering wheel provides the electrical interface between the fixed wiring harness and the moveable driver airbag. SZL service is covered in **612 Switches**.

The contact spring cassette consists of outer and inner housings with integral connectors and contains a ribbon type flexible cable.

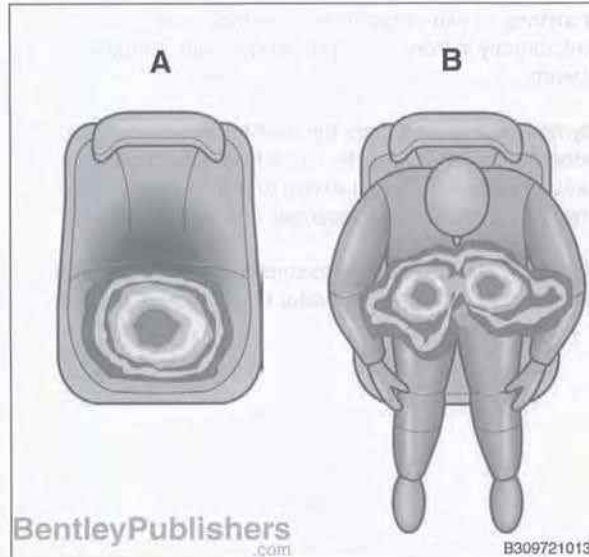


Passenger seat occupancy sensor (OC-3 mat)

- ▶ The passenger seat occupancy sensor (occupant classifier or OC-3 mat) is integrated into the seat area of the passenger seat. The sensor consists of conductors with pressure-dependent resistor (force sensitive resistance or FSR) elements connected to an electronic analyzer.

The FSR elements are wired in such a way that they can be sampled individually. When the mechanical load on a sensor element increases, its electrical resistance decreases and the current changes accordingly. By analyzing the signals from different sections of the mat, the analyzer maps the occupancy of the seat surface and can identify local concentrations of weight.

The purpose of the OC-3 mat is to monitor the presence of a person or object placed on the front passenger seat and determine whether to deactivate passenger side airbags. The mat is capable of detecting a child seat that conforms to the NHTSA FMVSS 208 standard by the weight pattern on the seat. If detected, passenger airbags are deactivated.



- ▶ The OC-3 mat is capable of distinguishing between a one-year-old child in a child's seat (A) and a light person (B). The distances between the areas where pressure is applied and the concentrations of pressure reveal who occupies the seat.

The OC-3 mat analyzer transmits a message to the MRS control module via the K-CAN. If the system detects that the seat is unoccupied or that a child seat for a child up to one year old is fitted, the airbags on the passenger side are deactivated. If a child seat is detected, the passenger airbag status light illuminates, indicating that passenger side airbags are deactivated.

Airbag status light

- ▶ The airbag status light in the roof function center (FZD) glows yellow when the front passenger airbag and the side passenger airbag are deactivated.



721-6 Airbag System (SRS)

Pyrotechnic devices



Pyrotechnic devices

➤ **Driver airbag**, of two-stage design, is attached to the steering wheel by spring clips. Electrical connection to the MRS control module is provided via the driver airbag and horn contact spring in the steering column.

Once the airbag is fully inflated, vents in the airbag prevent further pressure build-up, so that progressive deceleration is provided as the driver contacts the cushion and injury due to sudden impact forces is prevented.



➤ **Passenger airbag**, of two-stage design, is above the glove compartment, directly in front of the passenger seat, mounted to the body crossbeam.

Upon deployment, the airbag tears the dashboard cover through several predetermined shear points. Once free of the housing and fascia, the airbag inflates to its full extent to provide a protective cushion between the front seat passenger and the windshield.

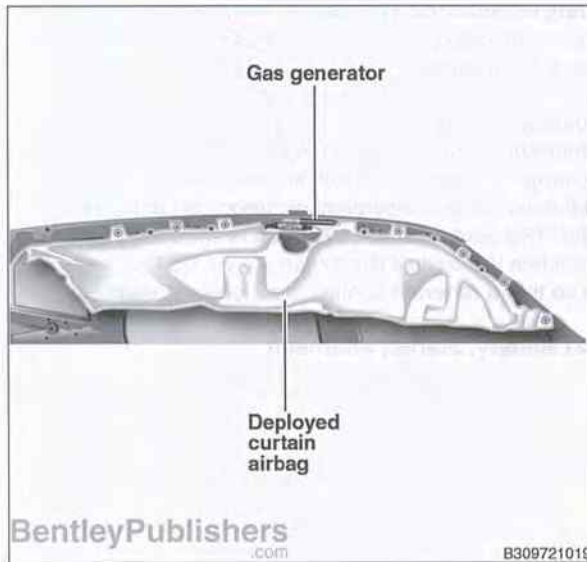
Vents in the airbag prevent excess pressure bursting the bag and, as soon as the material in the gas generator is exhausted, the airbag deflates.



➤ **Thorax (side) airbag**, mounted to the front seat backrest frame, is designed to protect the front seat occupant during a side impact. Side airbags are activated by a signal from the MRS control module in case of a side impact or a front angled impact of sufficient severity to cause both front and side airbag deployment.

The side airbag module consists of a molded plastic case housing a folded nylon fabric bag, gas generating capsules and an igniter squib. Two studs at the rear of the side airbag module are used for mounting the module to the seat frame and are secured in position by two nylon locknuts.

The side airbag module has a 2-pin connector under the seat where it connects to the vehicle main harness.



➤ **Curtain airbag**, extending all the way from the A-pillar to the C-pillar, covering the entire side-window area, inflates between the vehicle occupants and the side windows and pillar trims.

The curtain airbag reduces the risk of occupant's head or other extremities protruding through the windows in a sideways collision. Advantages of the system are:

- Extended covered area for side windows, front and rear.
- Protection against glass splinters and penetrating objects.
- Optimized protective area offering protection for occupants of differing sizes.

The curtain airbag is positioned along the line of the roof side member, folded up. It consists of a gas generator, two gas nozzles and curtain. In the event of a severe enough side collision, the generator is detonated and the gas flows through the two gas nozzles into the curtain. Simultaneous inflation of the curtain at the front and back achieves more even deployment.

Because the curtain generators and curtain are a sealed system, the curtain airbag retains its shape and strength for several seconds.



➤ **Seat belt tensioner**. Each seat belt buckle is equipped with a pyrotechnic (explosive charge) tensioner capable of cinching the belt an additional 55 mm (approx. 2 inches) in case of an accident. The belt buckle is attached via steel cable to a tube containing explosive propellant and a piston. An igniter (squib) in the base of the tube provides an ignition source when triggered by a signal from the MRS control module. A 2-pin connector located on a bracket underneath the seat frame links the igniter to MRS wiring.

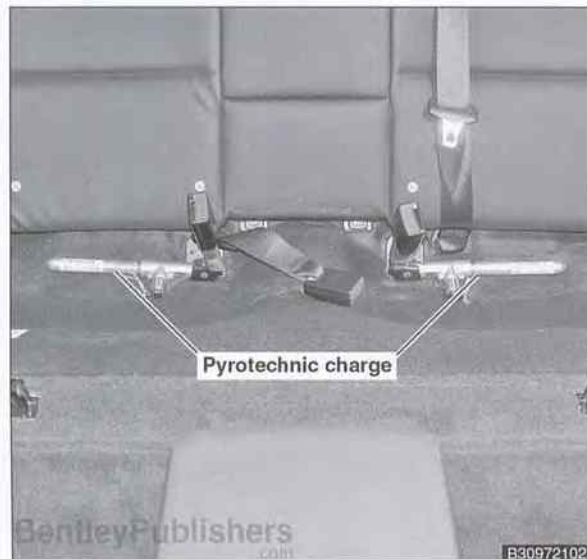
The MRS control module deploys the pyrotechnic seat belt tensioners at a slightly lower impact threshold level than the front airbags.

Belt buckle Hall microswitch in the front seat belt buckle is used to detect whether the seat belt is fastened or not. The detection signal is used by the MRS control module as a criterion for selective triggering of airbags and seat belt tensioners in case of a crash.

The switch is supplied current by the MRS control module via a current-signal interface. The current draw of the switch is the signal for switch position. The belt buckle switch is monitored while the ignition is ON.

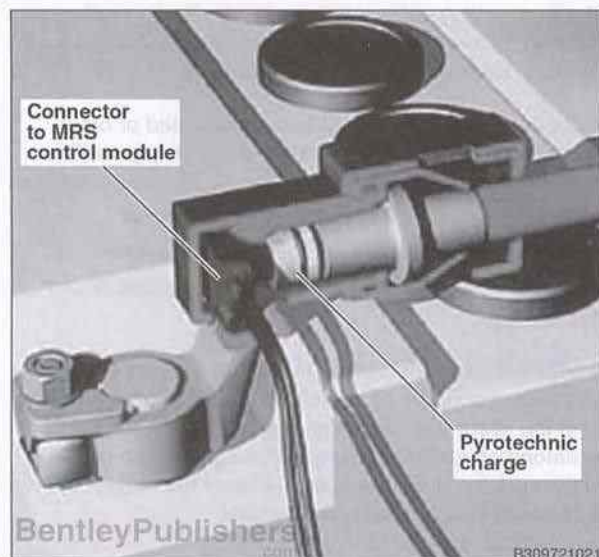
➤ **Rear belt tensioners** are also equipped with pyrotechnic devices.

Seat belt tensioner replacement is covered in **720 Seat Belts**.



721-8 Airbag System (SRS)

Pyrotechnic devices

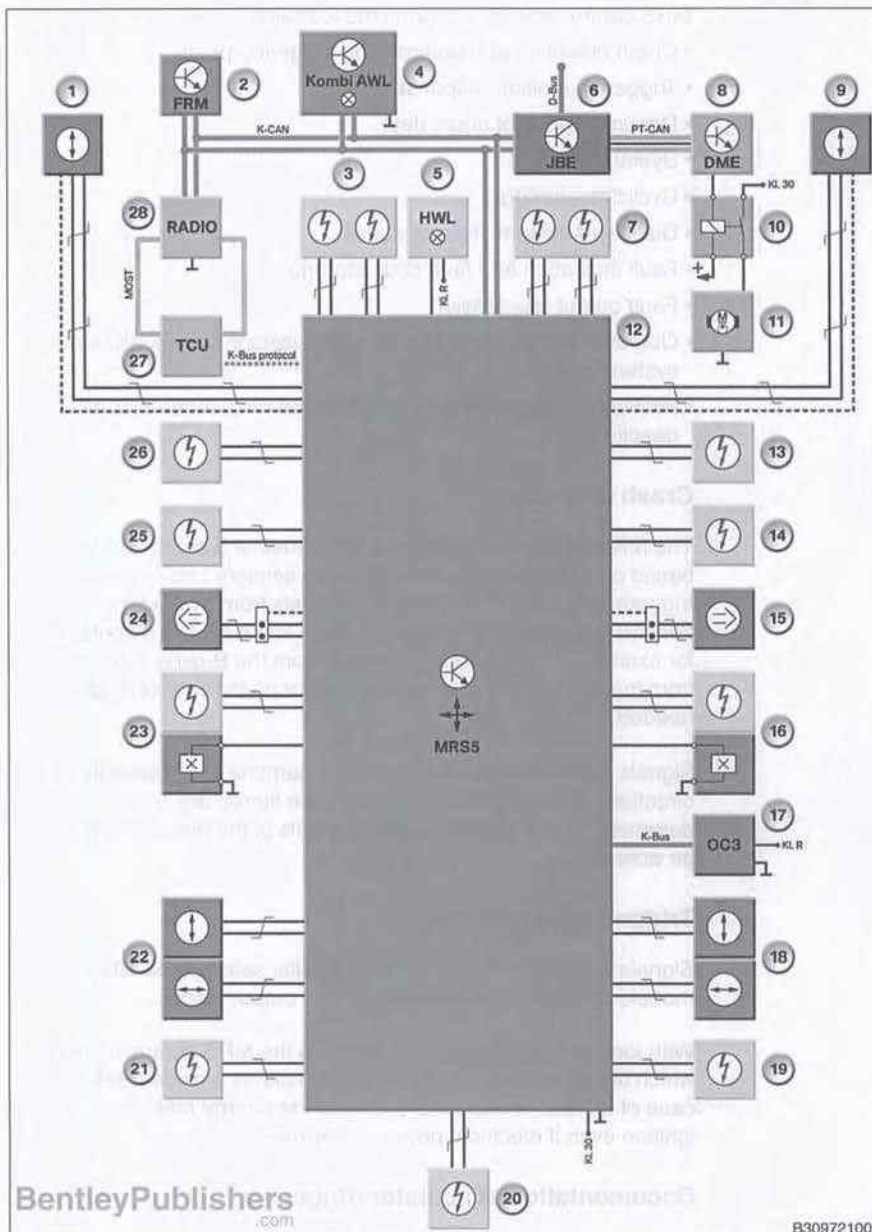


▲ **Battery safety terminal (BST)** is used to minimize the possibility of a short circuit at the heavy gauge B+ wire that runs the length of the vehicle in case of an accident.

The BST consists of a conventional clamp that is screwed to the positive terminal from above and connected with a hollow cylinder. A propellant charge is stored in this hollow cylinder. As with airbags and seat belt tensioners, this pyrotechnic device is controlled and ignited by the MRS control module. The unit is enclosed in a plastic shell that captures the cable if it is forced out via BST deployment and locks it so that a renewed contact is no longer possible.

See also 121 **Battery, Starter, Alternator.**

MRS system inputs, outputs



1. Left front crash sensor
2. Footwell module (FRM)
3. Driver airbag
4. Instrument cluster
5. Airbag warning light
6. Junction box electronic module (JBE)
7. Passenger airbag
8. Engine control module (ECM)
9. Right front crash sensor
10. Fuel pump relay
11. Fuel pump
12. MRS control module
13. Right side curtain airbag
14. Passenger thorax (side) airbag
15. Passenger door pressure sensor
16. Right front belt buckle status and seat belt tensioner
17. Passenger seat occupancy sensor (OC-3)
18. Right B-pillar sensor crash sensor
19. Right rear seat belt tensioner
20. Battery safety terminal (BST)
21. Left rear seat belt tensioner
22. Left B-pillar crash sensor
23. Left front belt buckle status and seat belt tensioner
24. Left front door pressure sensor
25. Driver thorax (side) airbag
26. Left curtain airbag
27. Telematics control module (TCU)
28. Radio (RAD2 or CCC)

Principles of operation

MRS control module performs the following functions:

- Crash detection and determining triggering point.
- Triggering ignition output stages.
- Documentation of crash data.
- System self-test.
- Cyclic monitoring.
- Display of system standby status.
- Fault indication and fault code storage.
- Fault output (diagnosis).
- Output of a crash telegram for other users in communication system network.
- Activation of airbag indicator light when passenger airbag is deactivated.

Crash detection

The MRS control module determines whether a crash has occurred based on the values detected by crash sensors and calculated by a triggering algorithm. Deceleration signals from two independent sensors are needed to indicate a crash. In the case of a frontal crash for example, the acceleration values from the B-pillar satellite and from the longitudinal acceleration sensor (in the control module) are needed.

Signals from different sensors help determine crash severity and direction. Based on this information, the stored algorithm determines the triggering (ignition) points of the restraint systems to be activated.

Triggering output stages

Signals from two different sensors, B-pillar satellite and MRS control module sensor, triggers airbag ignition output stages.

With ignition ON, voltage is supplied to the MRS control module, which becomes operational once it completes a system self-test. In case of a crash, a capacitor provides the energy reserve for airbag ignition even if electrical power is interrupted.

Documentation of actuator triggering

The triggering (ignition) commands are recorded in case of a crash where one or several actuators are triggered. The most important crash event data are stored in the form of a crash telegram in the non-volatile memory of the MRS control module. This data is only available to the manufacturer.

A maximum of 3 crash telegrams can be stored, after which the control module needs to be replaced.

System self-test

The control module performs a system self-test when the ignition is switched ON. The airbag warning light is illuminated for 3 - 5 seconds during system self-test.

If system self-test finds no faults, the airbag warning light switches OFF and the system is ready for operation.

Cyclic monitoring

Once system self-test is successfully concluded and the system is ready for operation, cyclic fault monitoring is performed as long as ignition is ON.

Indication of system operability

System operability is indicated by the airbag warning light switching OFF in the instrument cluster.

Fault code storage

A fault in the system is indicated by the airbag warning light and stored in nonvolatile control module memory. A distinction is made between internal and external faults.

Fault output (diagnosis)

Using BMW scan tool or equivalent, fault codes can be read out via the diagnosis interface. After rectifying faults, the fault codes can be cleared by means of "clear fault code memory" diagnosis command.

Crash telegram output

In case of a crash which triggers restraint system components, the MRS control module sends a crash telegram via bus system. The following control modules then perform the following functions depending on crash severity:

Crash telegram responses	
Fuel pump control module (EKP)	Switches fuel pump OFF
Engine control module (ECM)	Switches alternator OFF
Junction box module (JBE)	Releases central locking
Footwell module (FRM)	Activates hazard warning lights
Footwell module (FRM)	Activates interior lights
Telematic control module (TCU)	Places emergency call

Deactivation of passenger airbags

MRS control module utilizes the OC-3 mat signal to deactivate the front and side passenger airbags when a child seat is mounted on the passenger side. Airbag deactivation is indicated by a yellow airbag indicator light.

Seat belt reminder

The seat belt reminder (SBR) function monitors whether the driver or passenger has fastened his or her seat belt. If the seat belt is not worn or is unbuckled while driving at a speed in excess of approx. 1 kph (0.6 mph), a reminder is illuminated and a chime is sounded.

Left and right front seat belt buckle microswitches are monitored separately.

Warnings and Cautions

WARNING—

- The airbag is inflated by an explosive device. Handled improperly or without adequate safeguards, it can be very dangerous. Observe special precautions prior to any work at or near airbags.
- Serious injury may result if system service is attempted by persons unfamiliar with the BMW airbag system and its approved service procedures. BMW advises that airbag system inspection and service be performed by an authorized BMW dealer.
- Special test equipment is required to retrieve airbag fault codes, diagnose system faults and switch the airbag warning light OFF. The warning light remains ON until problems are corrected and fault memory cleared.
- If the airbag warning light is ON, there is a risk that airbags are not triggered in case of an accident. Be sure to have the system inspected and repaired immediately.
- Disconnect the battery and cover the negative (–) battery terminal with an insulator before starting diagnostic, troubleshooting or service work associated with the airbags, and before doing any welding on the car.
- After disconnecting the battery, wait 1 minute before beginning work on airbag components.
- If an airbag deploys due to an accident, BMW specifies that airbag components be replaced. For more information on post-collision airbag service, see an authorized BMW dealer.
- If the driver airbag deploys in an accident, BMW specifies that the steering column be replaced during repairs.
- Do not fire an airbag unit prior to disposal. It must be fired by a special disposal company or shipped back to BMW in the packaging of the new components.
- Wear gloves and avoid skin contact when removing a deployed airbag unit. In case of skin contact, wash with water.
- Do not allow airbag system components to come in contact with cleaning solutions or grease. Do not subject airbag components to temperatures above 75°C (167°F). When reconnecting the battery, make sure no person is inside the vehicle.
- Place a removed airbag unit with the padded side facing upward. Do not leave an airbag unit unattended.
- If the airbag unit or airbag control module is dropped from a height of ½ meter (1½ feet) or more, do not use it.

CAUTION—

- To avoid damaging plastic interior trim, use a plastic prying tool or a screwdriver with the tip wrapped with masking tape.

MRS COMPONENT REPLACEMENT**MRS control module, replacing**

- Disconnect negative (–) cable from battery and cover negative terminal with insulating material.

CAUTION—

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

- Remove center console between front seats. See 513 Interior Trim.
- Remove MRS control module mounting fasteners (arrows) and lift up module. Disconnect electrical harness connectors (A).
- Installation is reverse of removal. Make sure ground (B) is on threaded stud before reinstalling module.

Tightening torque

MRS control module to center tunnel	8 Nm (6 ft-lb)
-------------------------------------	----------------

- Use BMW scan tool or equivalent to code new module.

Driver airbag, removing and installing

Vehicles covered by this manual are equipped with either a multifunction steering wheel or a sport steering wheel. Follow applicable procedure below to remove airbag.

- Disconnect negative (–) cable from battery and cover negative terminal with insulating material.

WARNING—

- After disconnecting the battery, wait 1 minute before beginning work on airbag components.

CAUTION—

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

**Multifunction steering wheel**

- Insert Torx screwdriver (T20) or equivalent vertically from below into opening on back side of steering wheel up to stop (approx. 5.5 cm or 2 in). Swing screwdriver sideways against spring retainer until one side of airbag unit is unlocked.
- Repeat procedure on other side and tilt back airbag.

721-14 Airbag System (SRS)

Driver airbag, removing and installing



- Press on electrical connector lock (**arrow**) to detach, then remove airbag unit.

WARNING—

- Place a removed airbag unit with the padded side facing upward. Do not leave an airbag unit unattended.
- Do not pinch airbag harness in center of steering wheel when removing or installing airbag.

- Installation is reverse of removal:
- Make sure electrical lead is positioned correctly.
 - Press airbag directly down on steering wheel until it snaps in place.



Sport steering wheel

- Insert Torx screwdriver (T25) at an angle into concealed opening on back side of steering wheel until spring resistance is felt (approx. 1.5 cm or 0.6 in). Increase pressure on spring until airbag unit is unlocked.
- Repeat procedure on other side and tilt back airbag.



- Disconnect electrical connectors (**arrows**) and remove airbag unit.

WARNING—

- Place a removed airbag unit with the padded side facing upward. Do not leave an airbag unit unattended.
- Do not pinch airbag harness in center of steering wheel when removing or installing airbag.

- Installation is reverse of removal:
- Make sure electrical leads are positioned correctly. Connect same color connectors to each other.
 - Press airbag directly down on steering wheel until it snaps in place.

Passenger airbag, removing and installing

If the passenger airbag deploys, it tears a hole through the dashboard surface. Be prepared to replace the dashboard.

- Disconnect negative (–) cable from battery and cover negative terminal with insulating material.

WARNING—

- After disconnecting the battery, wait 1 minute before beginning work on airbag components.

CAUTION—

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

- Remove glove compartment. See 513 Interior Trim.



Working from below right side of dashboard:

- Detach electrical connectors (A).
- While supporting airbag unit, remove mounting fasteners (arrows), then lower airbag.

WARNING—

- Place a removed airbag unit with the padded side facing upward. Do not leave an airbag unit unattended.

NOTE—

- Airbag unit shown is in 2007 vehicle. Models built before 03 / 2006 are equipped with one electrical connector.

- Models from 03 / 2006: Installation is reverse of removal.

Tightening torque

Passenger airbag to body crossbeam	7 Nm (5 ft-lb)
------------------------------------	----------------

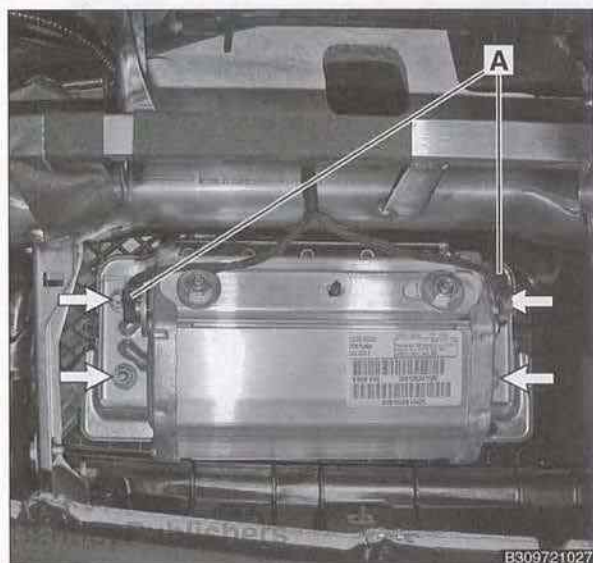


Models to 03 / 2006:

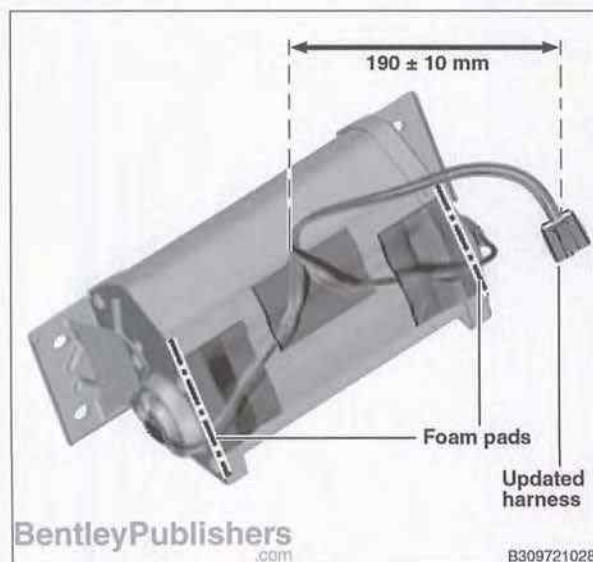
- Attach updated (2-connector) harness to new airbag module. Connect same color connectors to each other.
- Tape harness to airbag, making sure that approx 190 ± 10 mm (7.5 ± 0.5 in) of cable is free.
- Attach foam pads to airbag as indicated.
- Install airbag and plug in single harness connector.

Tightening torque

Passenger airbag to body crossbeam	7 Nm (5 ft-lb)
------------------------------------	----------------



B309721027



B309721028



Passenger side - removing and installing

If the passenger side display is not a new diagnostic dashboard surface. Be prepared to replace the dashboard.

- Disconnect negative (-) cable from battery and cover negative terminal with insulating material.

WARNING

- After disconnecting the battery, wait 1 minute before working on wiring components.

CAUTION

- Prior to disconnecting the battery, read the battery reconnection caution given in the Warnings and Cautions.

- Remove glove compartment. See 615 battery test.

Working from left side of dashboard.

- Detach electrical connectors (A).
- While supporting side rail, remove mounting brackets (arrow) from lower edge.

WARNING

- Place a control wiring unit with the bracket side facing upward. Do not leave an wiring out unsecured.

NOTE

- Wiring unit shown is for 2007 vehicles. Models with battery 03-1500B are equipped with one electrical system.

- Models from 03-1500B installation is identical. However,

Tightening torque

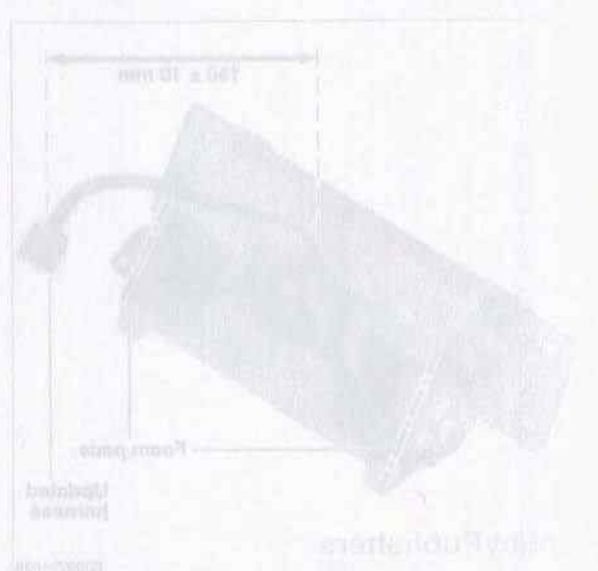
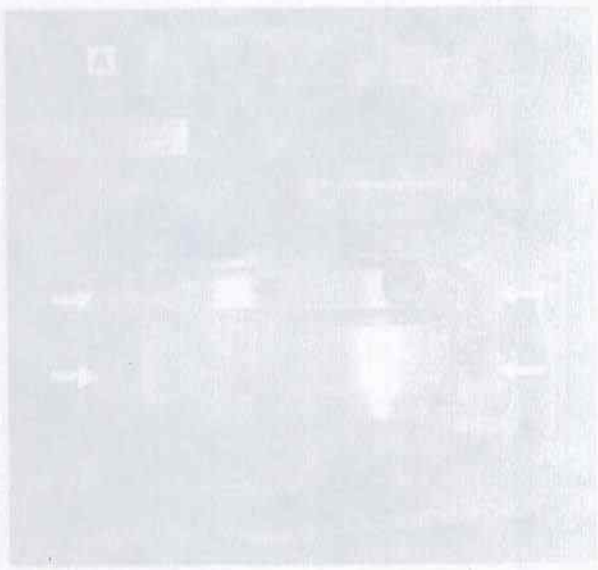
Passenger side to body attachment	7 Nm (52 in-lb)
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Models to 03-1500B

- Attach updated (S) connector harness to new side rail. Connect both color connectors to each other.
- Join harness to side rail. Mounting hole size: 100 x 10 mm (7.8 x 3.9 in) or larger.
- Attach form body to side rail as indicated.
- Install end of side rail in side harness connector.

Tightening torque

Passenger side to body attachment	7 Nm (52 in-lb)
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TABLE

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GENERAL

This repair group covers service information for the fuel supply system.

See also:

- **100 Engine-General** for model year, engine code, and DME applications
- **130 Fuel Injection**
- **ECL Electrical Component Locations** for fuel pump fuse and relay access information

160-2 Fuel Tank and Fuel Pump

Fuel tank

Fuel tank

The saddle-shaped plastic fuel tank is mounted underneath the center of the car (underneath the rear seat). Mounted in the fuel tank are the electric fuel pump, fuel level sending units and suction jet pump. Connecting lines for the evaporative emission control system are also attached to the tank.

Fuel tank capacity for 3 Series models is listed in **Table a**.

Table a. Fuel tank capacity for 3 Series models

Tank capacity	60 liters (15.8 gal)
Reserve capacity	6 liters (1.5 gal)

Fuel delivery systems

3 Series models use two main fuel delivery systems:

- Non-turbo engines use a multi-port injection system
- Turbo models use a direct injection system.

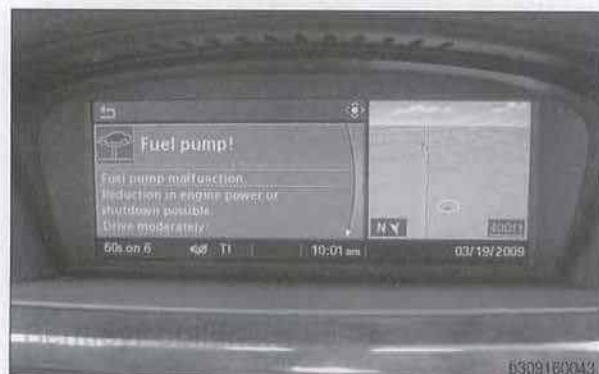
Non-turbo engine fuel injectors are installed in machine-bored holes in the cylinder head. See **130 Fuel Injection**. An in-tank electric fuel pump delivers pressure-regulated fuel to the fuel rail. The fuel pump is a variable speed pump controlled by the EKP (electric fuel pump control) module delivers only the amount of fuel needed for engine operation. This eliminates excess fuel delivery and reduces pump wear. It can operate at up to 5 bar (72.5 psi) and 95 liters (25 gallons) per hour.

Direct fuel injection in the turbo engine allows for precise metering of mixture and higher compression. This is made possible by locating a fuel injector for each cylinder centrally between the valves. See **130 Fuel Injection**. The electric fuel pump delivers fuel to a high pressure fuel pump. The high pressure fuel pump is driven by a chain and can provide fuel pressure from 5 bar (72.5 psi) up to 200 bar (2900 psi).

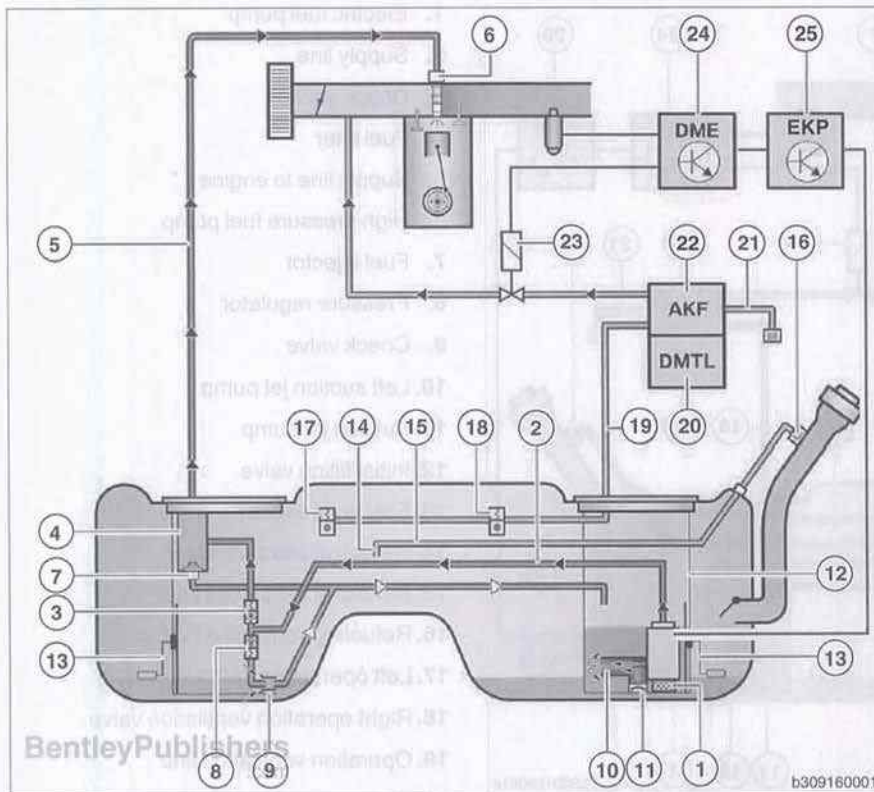
Electric fuel pump

An electric fuel pump is mounted in the fuel tank in tandem with the right side fuel level sender and suction jet pump. A suction jet pump is located in the left side of the tank to transfer fuel to the right side. The combined fuel filter / pressure regulator delivers pressurized fuel to the fuel injection system. The system is a non-return design; there is one fuel line to the fuel injectors and excess fuel flows directly from the fuel filter / pressure regulator back into the tank.

- Fuel pump self-diagnostics are built into the DME. A failure in the fuel pump circuit will set a fault code.



Fuel system schematic (non-turbo)

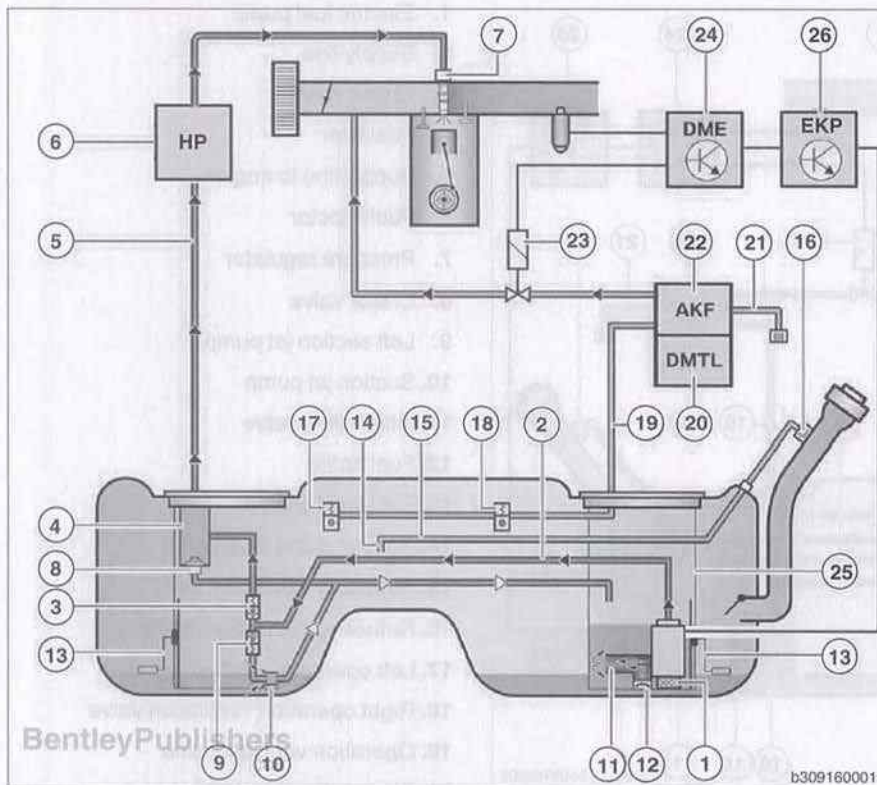


1. Electric fuel pump
2. Supply line
3. Check valve
4. Fuel filter
5. Supply line to engine
6. Fuel injector
7. Pressure regulator
8. Check valve
9. Left suction jet pump
10. Suction jet pump
11. Initial filling valve
12. Fuel baffle
13. Fuel level sender
14. Refueling line connector
15. Refueling ventilation line
16. Refueling ventilation nipple
17. Left operation ventilation valve
18. Right operation ventilation valve
19. Operation ventilation line
20. Diagnosis pump for tank leakage (DMTL)
21. Fresh air vent line
22. Activated carbon canister
23. Fuel tank vent valve
24. Engine control module (ECM)
25. Fuel pump module (EKP)

160-4 Fuel Tank and Fuel Pump

Fuel system schematic (turbo)

Fuel system schematic (turbo)



1. Electric fuel pump
2. Supply line
3. Check valve
4. Fuel filter
5. Supply line to engine
6. High pressure fuel pump
7. Fuel injector
8. Pressure regulator
9. Check valve
10. Left suction jet pump
11. Suction jet pump
12. Initial filling valve
13. Fuel level sender
14. Refueling line connector
15. Refueling ventilation line
16. Refueling ventilation nipple
17. Left operation ventilation valve
18. Right operation ventilation valve
19. Operation ventilation line
20. Diagnosis pump for tank leakage (DMTL)
21. Fresh air vent line
22. Activated carbon canister
23. Fuel tank vent valve
24. Engine control module (ECM)
25. Fuel baffle
26. Fuel pump module (EKP)

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.
- 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.
- Electric fuel pump starts each time door is opened.
- 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, face shield 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.

CAUTION—

- Prior to disconnecting the battery, read the battery disconnection cautions given in **001 Warnings and Cautions**.
- Before making any electrical tests with ignition switched ON, disable the ignition system as described in **120 Ignition System**. Be sure the battery is disconnected when replacing components.
- To prevent damage to the ignition system or other DME components, including the engine control module (ECM), connect and disconnect wires and test equipment with ignition OFF.
- Cleanliness is essential when working with the fuel system. Thoroughly clean the fuel line unions before disconnecting any of the lines. Plug open fuel lines and ports.
- Use only clean tools. Keep removed parts clean and sealed or covered with a clean, lint-free cloth, especially if completion of the repair is delayed.
- Do not move the car while the fuel system is open.
- Avoid using high pressure compressed air to blow out lines and components. High pressure can rupture internal seals and gaskets.
- Use new seals, O-rings and hose clamps when replacing fuel system components

FUEL TANK EVAPORATIVE CONTROL SYSTEM

Evaporative control, also referred to as running losses control, is designed to prevent fuel system evaporative losses from venting into the atmosphere. The components of this system allow control and monitoring of evaporative losses by on-board diagnostic (OBD II) software incorporated into the engine control module (ECM).

Listed below are the main components of the evaporative control system and their functions:

- Carbon canister stores fuel vapors.
- Plumbing ducts vapors from fuel tank to canister and from canister to intake manifold.
- Carbon canister purge valve is controlled by engine control module (ECM).
- Pressure regulator shunts excess fuel volume directly back to fuel tank before it circulates through the fuel lines.
- Leak detection unit (DMTL) pressurizes fuel tank and evaporative system to monitor system leaks.

Evaporative system troubleshooting

Start by accessing diagnostic trouble codes (DTCs) using a BMW or compatible aftermarket scan tool.

- For purposes of OBD II emissions compliance, the DME system sets a diagnostic trouble code (DTC) when it detects a leak in the evaporative control system.
- Malfunction indicator light (MIL) is illuminated upon second recurrence of fault. See **OBD On-Board Diagnostics**.

— When leak testing, observe the following conditions to obtain plausible results:

- Fuel tank $\frac{1}{4}$ to $\frac{3}{4}$ full.
- Vehicle parked for at least 2 hours to allow fuel to reach ambient temperature. Ideal fuel temperature is 10° - 20°C (50° - 68°F).
- Do not refuel immediately before leak test.

— If a leak is detected, check the following areas:

- Fuel filler cap leaking or off.
- Fuel tank ventilation lines leaking at fuel tank or activated carbon canister.
- Tank ventilation valve leaking (in engine compartment).
- Fuel level sensor and fuel pump assembly cover leaking.

For evaporative system component replacement, see **Fuel Supply Components** in this repair group.

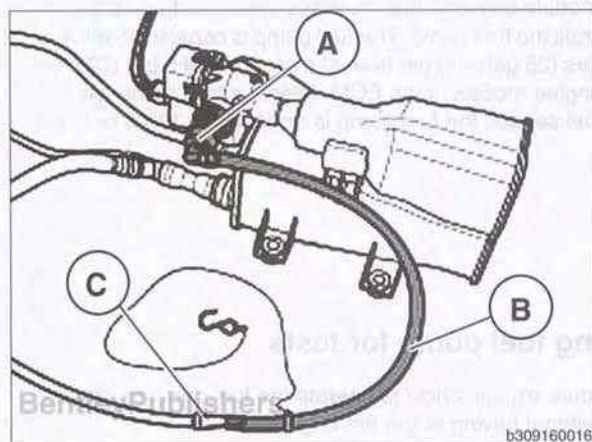


Evaporative system leak test

Use the following leak test when diagnosing evaporative system leak fault codes.

- Working underneath left rear bumper: gain access to activated carbon canister. See **Activated carbon canister, removing and installing** in this repair group.

➤ Remove fresh air line (inset) from DMTL pump.



➤ Install BMW test adapter 83 30 0 433 207 (B) (or suitable substitute) at DMTL fresh air connection (A).

- Connect evaporative system smoke machine (C) to test adapter (B). BMW recommends VACUTEC 625-522B (nitrogen pressure swing absorption technology).
- Remove fuel filler cap.
- Activate smoke machine and fill fuel system with smoke until it escapes from fuel filler neck. Shut off smoke machine.

WARNING —

- Use only smoke machine that utilizes nitrogen to pressurize fuel system.
- The fuel system may release a substantial amount of fuel-rich gasoline vapors during testing. Work in a well ventilated area.

- Reinstall fuel filler cap.
- Reactivate smoke machine and fill fuel system with smoke.

WARNING —

- Do not exceed a maximum fuel system pressure of 0.3 bar (4 psi) when using smoke machine.

- Examine fuel system components for signs of escaping smoke. Repair or replace faulty components.
- After completing tests:
 - Attach DMTL fresh air line.
 - Check for fault codes and reset ECM memory.

160-8 Fuel Tank and Fuel Pump

Fuel pump fuse and module

FUEL SYSTEM TROUBLESHOOTING

Fuel pump fuse and module

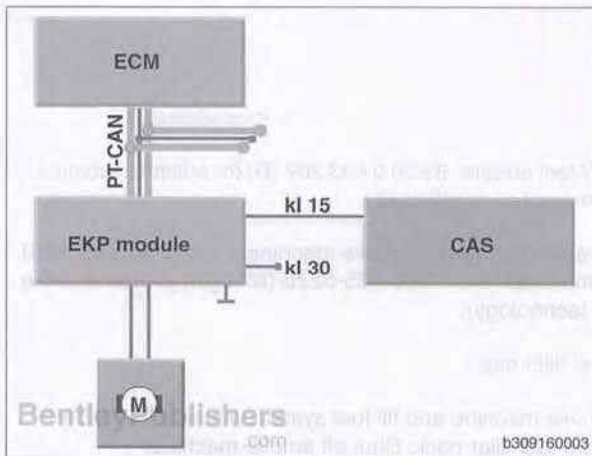
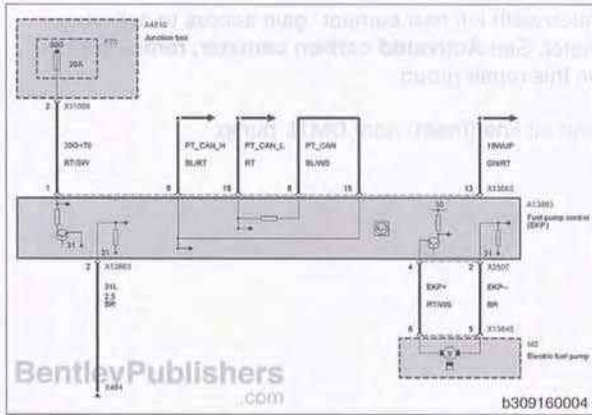
Begin troubleshooting fuel system faults by checking fuel pump fuse. The fuel pump fuse is located in the junction box (JB) behind the glove compartment. See **ECL Electrical Component Locations** for access information.

➤ Fuel pump circuit is fuse-protected by:

- F70 up to 03/2007.
- F88 from 03/2007 to 09/2007.
- F70 0/20079 and up.

CAUTION—

- *Relay and fuse positions and wire colors vary. A good way to verify a relay position or wire colors is to compare the wiring colors at the relay socket to the colors indicated on the wiring diagrams in ELE Electrical Wiring Diagrams.*



➤ The ECM calculates the amount of fuel required at the given point in time and the electric fuel pump is activated as required. The total volume required is transmitted as a message to the EKP control module via PT-CAN.

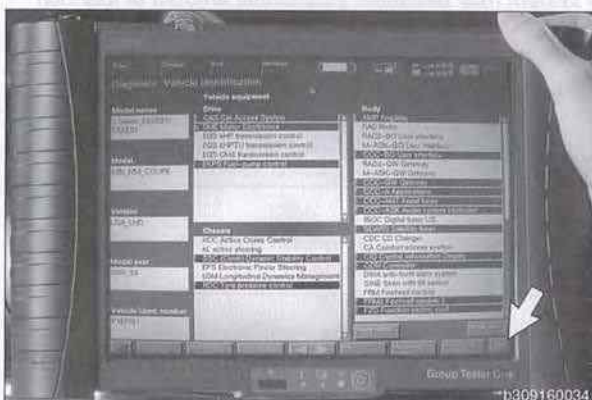
The EKP module converts this message into an output voltage which controls the fuel pump. The fuel pump is capable of delivering up to 95 liters (25 gallons) per hour at a pressure of 5 bar (72.5 psi). On turbo engine models, if the ECM detects a fault in the low pressure fuel sensor, the fuel pump is activated to 100% or 5 bar (72.5 psi).

Operating fuel pump for tests

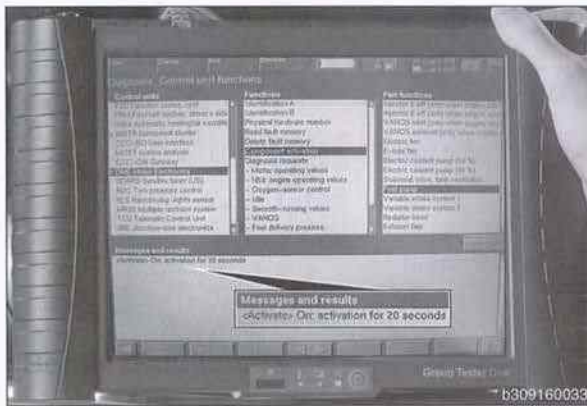
This procedure explains how to operate the fuel pump for testing purposes without having to run the engine.

➤ Using BMW factory scan tool or equivalent:

- Identify vehicle
- Select **Next (arrow)**
- Select **Control Module Functions**
- Select **Complete Vehicle**
- Select **Drive**
- Select **DME**
- Select **Component Activation**
- Select **Fuel Pump**



- Fuel pump will run at 100% (5 bar) for 20 seconds.



Fuel pump electrical circuit, testing

If fuel pump does not operate or there is no fuel pressure, first test fuel pump electrical circuit.

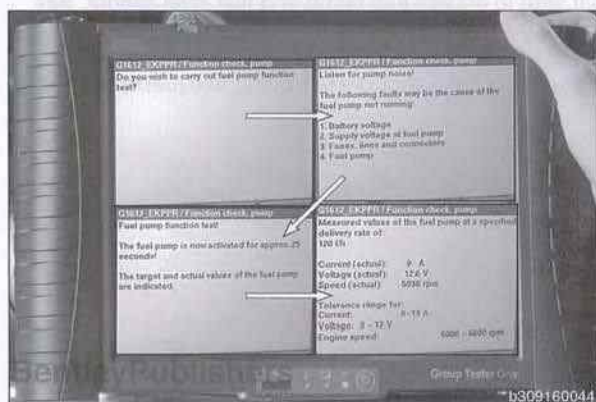
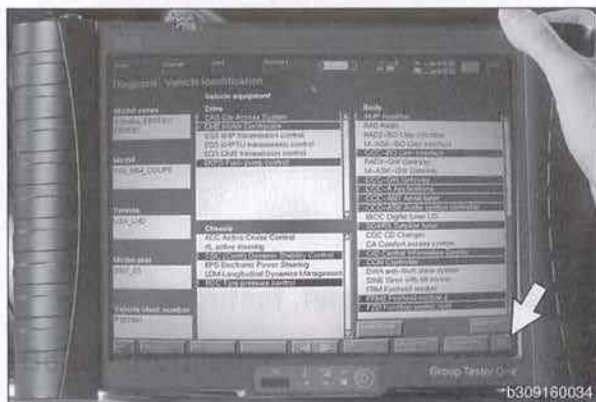
- Remove rear seat to access fuel pump and fuel level sender. See **Accessing fuel pump and fuel level senders** in this repair group.
- Disconnect harness connector from fuel pump and fuel level sender.



- Connect voltmeter between fuel pump leads (arrows) on connector.
- Activate fuel pump. See **Operating fuel pump for tests** in this repair group.
- Use digital multimeter to test for battery voltage at fuel pump connector leads.
- If voltage and ground are present, fuel pump is probably faulty. If there is no voltage, check wiring between fuel pump and fuel pump module.
- After completing tests, reconnect fuel pump harness connector.

160-10 Fuel Tank and Fuel Pump

Fuel pump power consumption, testing



Fuel pump power consumption, testing

If fuel delivery is erratic or poor, or if fuel pump makes abnormally loud noises, test pump power consumption.

Using BMW factory scan tool or equivalent:

- Identify vehicle
- Select **Next** (arrow)
- Select **Function Selection**
- Select **DME**
- Select **Fuel Pump**
- Select **Control Current B1612_STR00**
- Select **Next** (arrow)

Follow steps on screen to monitor fuel pump current.

Fuel pump current

Current consumption (activated with scan tool)

8 - 13 amps

An alternative method is to install a digital ammeter in fuel pump circuit using the following steps.

- Remove rear seat to access fuel pump and fuel level sender. See **Accessing fuel pump and fuel level senders** in this repair group.

Disconnect harness connector from fuel pump.

- Make sure battery voltage at fuel pump connector is 12.6 volts. Charge battery if necessary.



- Attach digital ammeter between pump lead and harness. Connect jumper wire between pump and harness.

CAUTION—

- Do not allow the test leads to short to ground.



- Activate fuel pump. See **Operating fuel pump for tests** in this repair group.

- Compare ammeter reading with specification listed in table.

Fuel pump current

Current consumption (activated with scan tool)	8 - 13 amps
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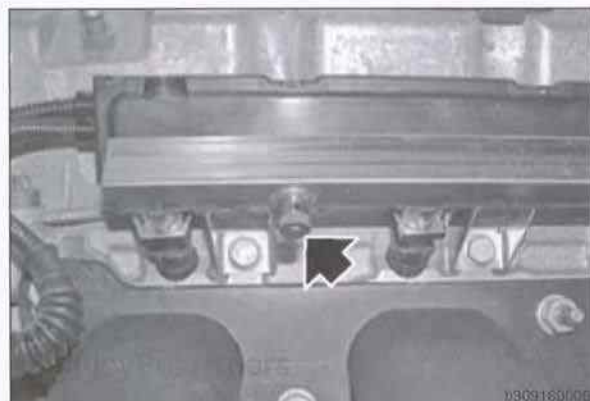
- Higher than normal power consumption by fuel pump may indicate a worn pump, causing intermittent fuel starvation due to pump overheating and seizure. Replace pump.
- Lower than normal power consumption may indicate blockage in a fuel line. Before replacing fuel pump, be sure to check that return line and pump pickup (inside fuel tank) are not obstructed.

Fuel pressure gauge, installing (non-turbo)

- Remove ignition coil cover. See **020 Maintenance**.

- Remove Schrader valve cap (**arrow**) at fuel rail and connect fuel pressure gauge.

- Use a fuel pressure gauge with a minimum range of 0 to 7 bar (0 to 100 psi).



WARNING—

- The fuel system is designed to retain pressure even when the ignition is OFF. When working with the fuel system, loosen fuel lines slowly to allow residual fuel pressure to dissipate. Avoid spraying fuel. Use shop towels to capture leaking fuel.
- Fuel pump starts each time door is opened.
- Make sure the fuel pressure gauge is securely connected to the fuel rail to prevent it from coming loose under pressure.

160-12 Fuel Tank and Fuel Pump

Fuel pressure gauge, installing (turbo)

Fuel pressure gauge, installing (turbo)

Use a fuel pressure gauge with a minimum range of 0 to 7 bar (0 to 100 psi).

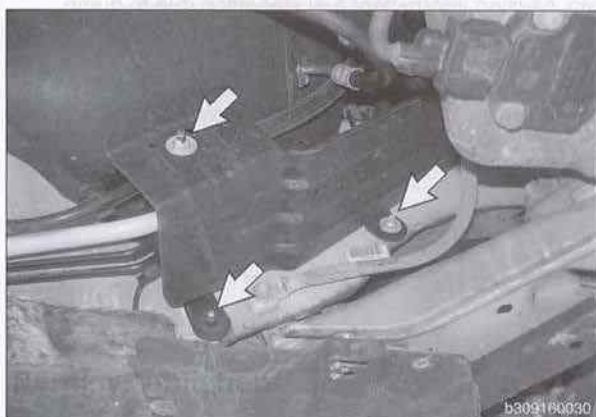
WARNING —

- The fuel system is designed to retain pressure even when the ignition is OFF. When working with the fuel system, loosen fuel lines slowly to allow residual fuel pressure to dissipate. Avoid spraying fuel. Use shop towels to capture leaking fuel.
- Fuel pump starts each time door is opened.
- Make sure the fuel pressure gauge is securely connected to the fuel rail to prevent it from coming loose under pressure.

- Remove splash shield for transmission. See **020 Maintenance**.

- ◀ Working underneath vehicle on drivers side:

- Remove fasteners (**arrows**) for fuel line protective shield and remove protective shield.



- ◀ Disconnect fuel line (**arrow**).



- ◀ Install compatible T-style test adapter and install fuel pressure gauge.



Fuel pressure regulator

Fuel pressure is created by the fuel pump and maintained by the fuel pressure regulator.

Fuel pressure regulator is integrated into the fuel pump assembly. See **Fuel pump, removing and installing** in this repair group.

Fuel delivery, testing

Checking fuel delivery is a fundamental part of troubleshooting and diagnosing the DME system. Fuel pressure directly influences fuel delivery. There are two significant fuel delivery values to be measured:

- **System pressure** is created by fuel pump and maintained by pressure regulator. System pressure is adjustable only by the ECM.
- **Residual pressure** is pressure maintained in closed system after engine and fuel pump are shut off.

System pressure, engine not running

- Attach fuel pressure gauge. See **Fuel pressure gauge, installing (non-turbo) (turbo)** in this repair group.
- Activate fuel pump. See **Operating fuel pump for tests** in this repair group. Compare fuel pressure to specifications in accompanying table.

Fuel pressure specification

System pressure, engine not running	5 ± 0.2 bar (72.5 ± 2.9 psi)
-------------------------------------	------------------------------

CAUTION—

- *The fuel pump is capable of developing a higher pressure than that regulated by the pressure regulator. Do not allow pressure to rise above 6.5 bar (94 psi). Damage to the fuel lines or fuel system components could result.*

- After completing tests without running engine, check for fault codes and reset ECM memory.

System pressure, engine running

If fuel pressure tests show normal pressure but engine lacks power under acceleration, test fuel pump pressure control regulation function.

- With fuel pressure gauge attached, start engine and check fuel pressure.

Fuel pressure specification

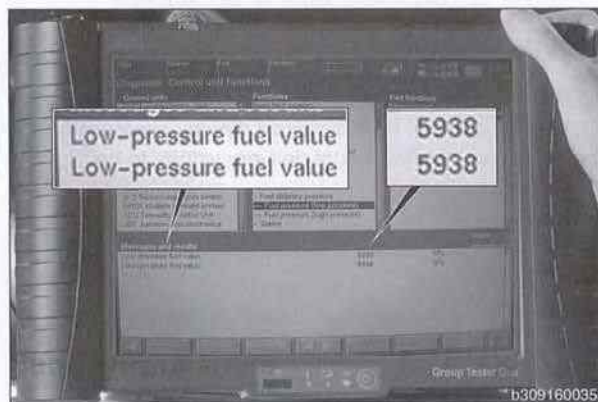
System pressure, engine running	5 ± 0.2 bar (72.5 ± 2.9 psi)
---------------------------------	------------------------------

160-14 Fuel Tank and Fuel Pump

Fuel delivery, testing

CAUTION—

- The fuel pump is capable of developing a higher pressure than that regulated by the pressure regulator. Do not allow pressure to rise above 6.5 bar (94 psi). Damage to the fuel lines or fuel system components could result.



On turbo engine models compare fuel pressure on gauge to data value on BMW factory scan tool or equivalent.

- If pressure does not match, replace fuel pressure regulator. See **Fuel pump, removing and installing** in this repair group.
- After completing tests, note the following:
 - Non turbo: replace Schræder valve cap.
 - Turbo reassemble fuel line.
 - Check for fault codes and reset ECM memory.

Residual pressure

For quick restarts and to avoid vapor lock when the engine is hot, the fuel injection system retains fuel pressure after the engine is shut off. This residual pressure is primarily maintained by the fuel pressure regulator and a check valve at the fuel pump outlet.

- Attach fuel pressure gauge. See **Fuel pressure gauge, installing** in this repair group.
- Start engine and allow it to run for approximately one minute. Note fuel pressure reading. Shut OFF engine.
- Note fuel pressure after approximately 20 minutes. Make sure pressure does not drop more than 0.5 bar from system pressure.

Fuel pressure specification

System pressure, engine not running	5 ± 0.2 bar (72.5 ± 2.9 psi)
-------------------------------------	---------------------------------------

- When finished, disconnect pressure gauge and fitting, and replace Schræder valve cap.
- If fuel system does not maintain pressure:
 - Visually check for leaks in fuel lines and unions.
 - Check for leaking injector(s).
 - Check for faulty fuel pump check valve.

FUEL PUMP AND FUEL LEVEL SENDERS

Accessing fuel pump and fuel level senders

NOTE—

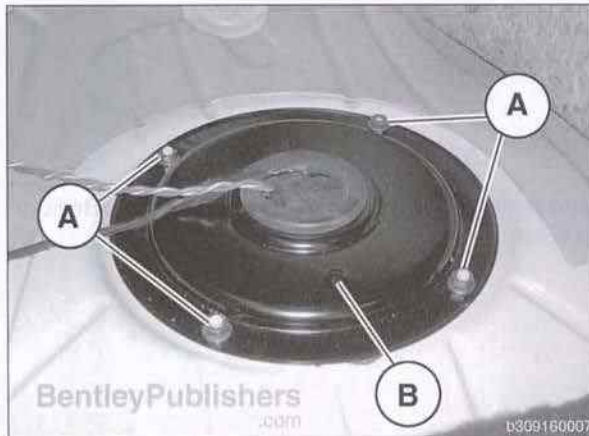
- Right side fuel pump / fuel level sender shown. Accessing left side fuel level sender is similar.

- Remove rear seat cushion. See **520 Seats**.

Working at ride side fuel tank:

- Remove fasteners (A).
- Remove fuel pump access cover (B).

- Installation is reverse of removal.



Fuel pump and fuel level sender (right side), removing

- Drain fuel tank. See **Fuel tank, draining** in this repair group.
- Disconnect negative cable from battery.

CAUTION—

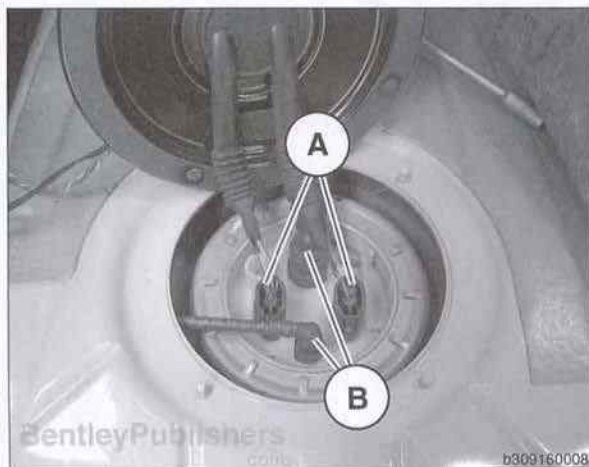
- Prior to disconnecting the battery, read the battery disconnection cautions given in **001 Warnings and Cautions**.

- Remove fuel pump access cover. See **Accessing fuel pump and fuel level senders** in this repair group.

Remove electrical connectors (A) and fuel lines (B).

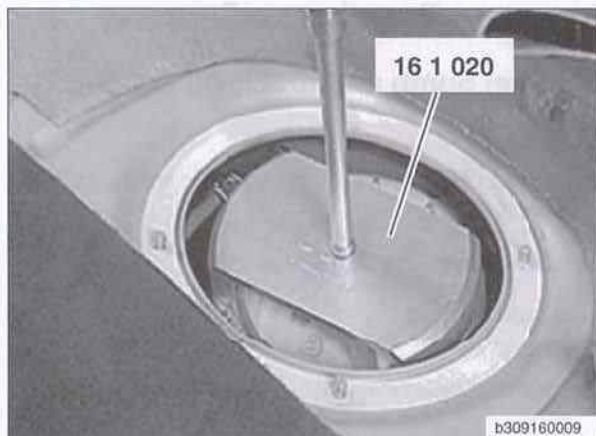
WARNING—

- When disconnecting fuel hose, wrap shop towel around end of hose to prevent spray of fuel under pressure.

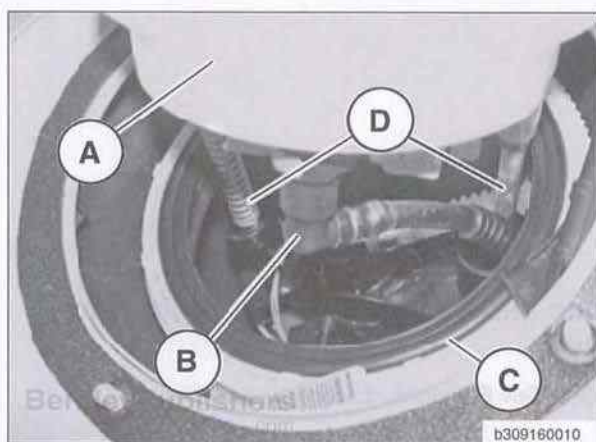


160-16 Fuel Tank and Fuel Pump

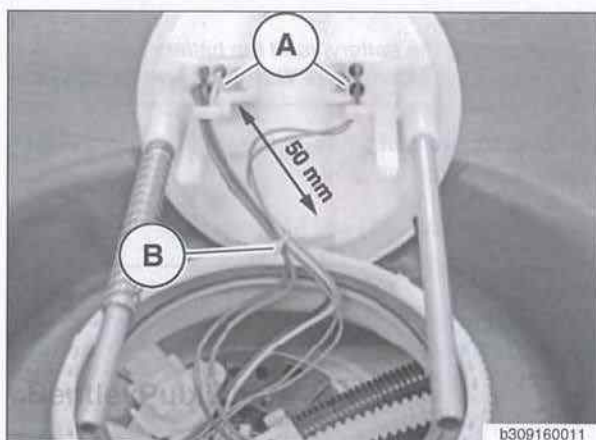
Fuel pump and fuel level sender (right side), removing



Using special tool 16 1 020, remove fuel pump service cap.



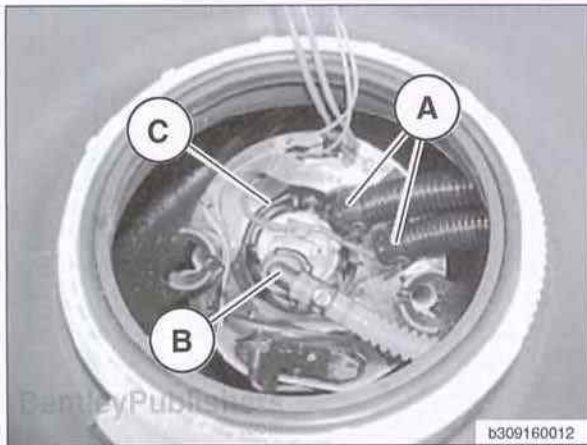
Carefully raise service cap (A) and disconnect fuel line (B). Remove and discard O-ring (C).



Disconnect electrical connectors (A), cut and dispose of wire tire (B).

Fuel Tank and Fuel Pump 160-17

Fuel pump and fuel level sender (right side), installing



Working inside fuel tank:

- Disconnect black fuel return lines (A).
- Unlock and disconnect fuel line (B) using only your fingers.
- Carefully lift fuel pump and fuel level sender (C) out of tank. If necessary rotate 90° counterclockwise and tilt towards fuel level sender.

CAUTION—

- Do not bend fuel sender arm.

NOTE—

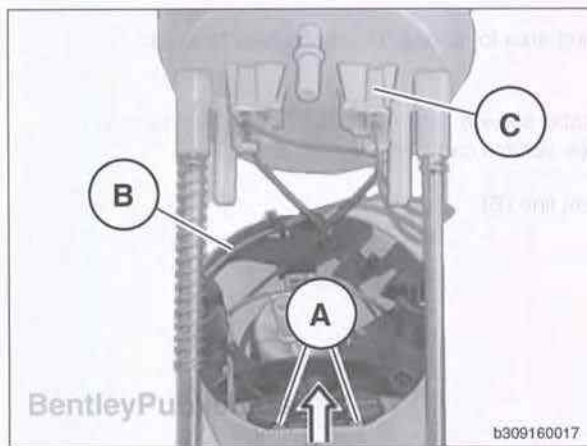
- Be prepared to catch any dripping fuel.

To replace fuel level sender use following step.

Working inside fuel tank:

Carefully unlock tabs (A) and pull fuel level sensor off in direction of arrow. Remove wire (B) from holders and disconnect electrical connector (C).

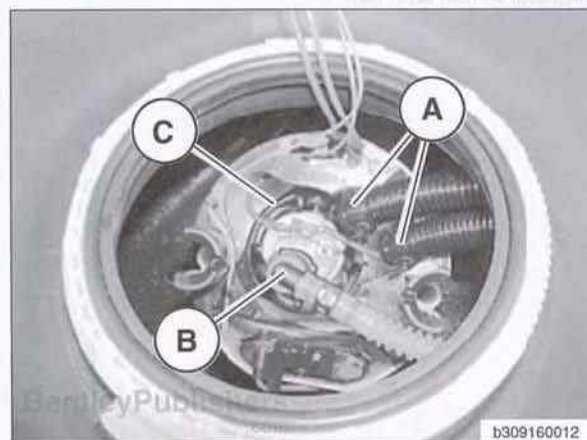
- Installation of fuel level sender is reverse of removal. **See Fuel pump and fuel level sender (right side), installing** in this repair group for fuel pump installing.



Fuel pump and fuel level sender (right side), installing

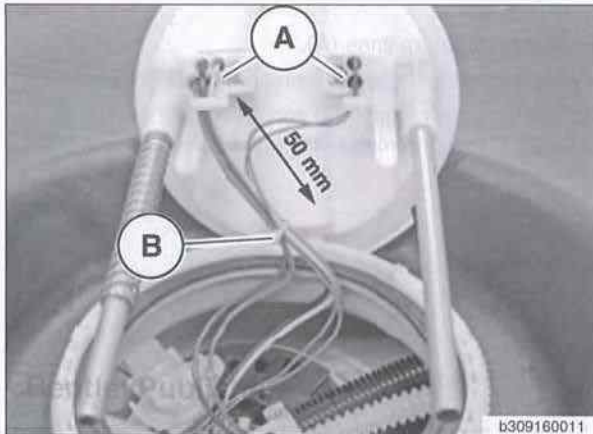
Working inside fuel tank:

- Carefully install fuel pump and fuel level sender (C). If necessary rotate 90° clockwise and tilt toward fuel level sender.
- Connect black fuel return lines (A).
- Connect and lock fuel line (B) using only your fingers.

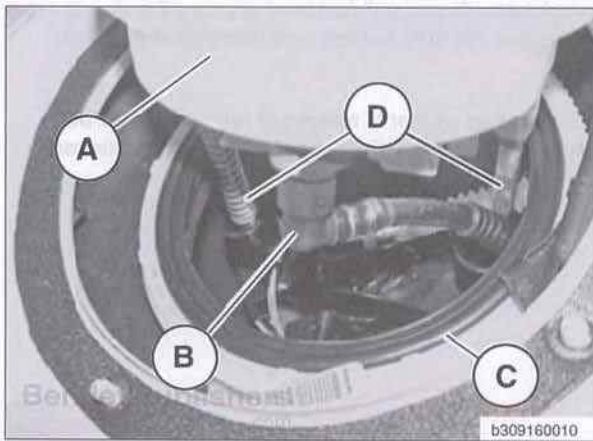


160-18 Fuel Tank and Fuel Pump

Fuel pump and fuel level sender (right side), installing

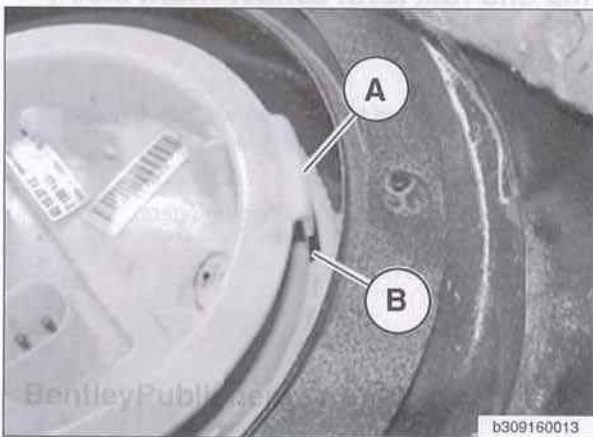


Connect electrical connectors (A), and attach wires with wire tie (B).

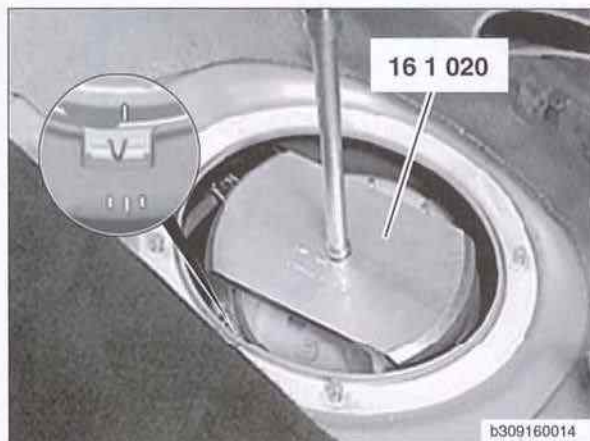


Clean sealing area for O-ring (C). Remember to replace O-ring (C) with new.

- Carefully install service cap (A) while aligning locating rods (D). Check to see service cap freely, do not force.
- Connect vent line (B).

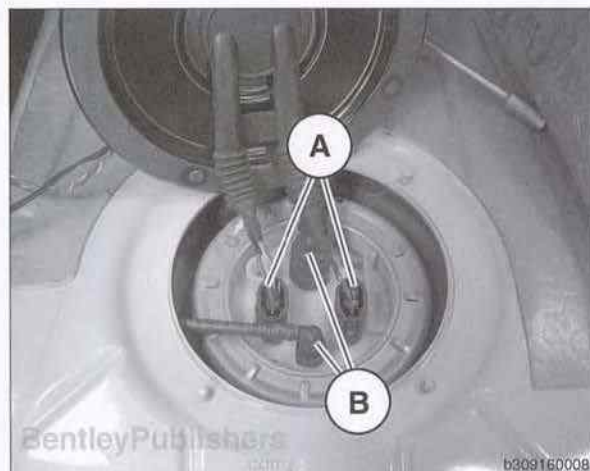


When installing, check to see that service cap lug (A) engages with corresponding slot of fuel tank (B).



➤ Install service cap hand tight.

- Using special tool 16 1 020 tighten service cap until marking on service cap point to notch on fuel tank (inset).



➤ Connect electrical connectors (A) and fuel lines (B).

- Install fuel tank access cover.

CAUTION—

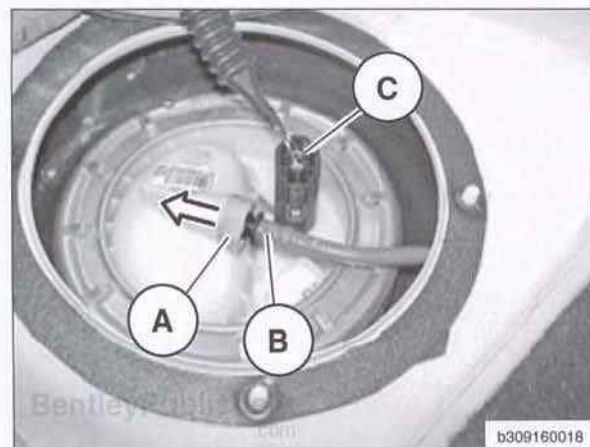
- After finishing repairs but before starting engine, be sure there is at least 5 liters (1.5 gallons) of fuel in the tank. The fuel pump is damaged if run without fuel.

Fuel level sender (left side), removing

- Drain fuel tank. See **Fuel tank, draining** in this repair group.
- Disconnect negative cable from battery.

CAUTION—

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

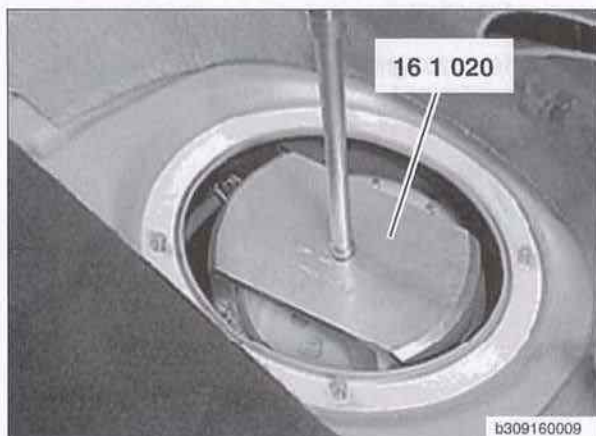


- Remove fuel sender access cover. See **Accessing fuel pump and fuel level senders** in this repair group.
- Remove left side fuel level sender. See **Fuel pump and fuel level sender (right side), removing**, in this repair group

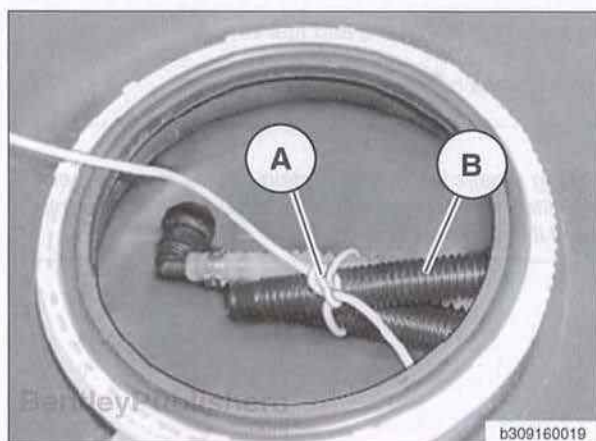
➤ Disconnect electrical connector (C). Using only your fingers press gray ring (A) toward sensor and pull fuel supply (B) line straight out.

160-20 Fuel Tank and Fuel Pump

Fuel level sender (left side), removing



Using special tool 16 1 020, remove fuel pump service cap.



Attach stiff wire (A) to hose pack (B) through right side fuel tank opening. The wire is pulled through to the left side to aid installation.

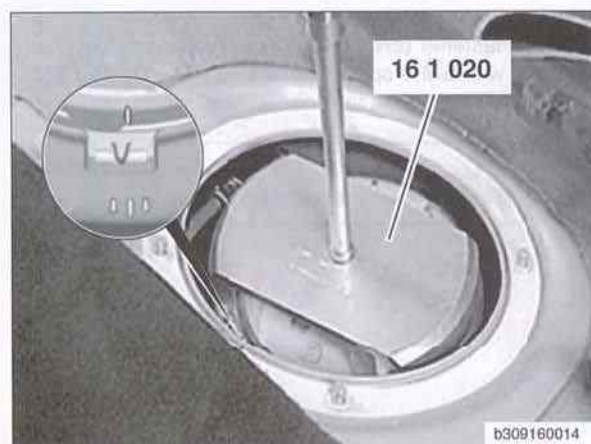
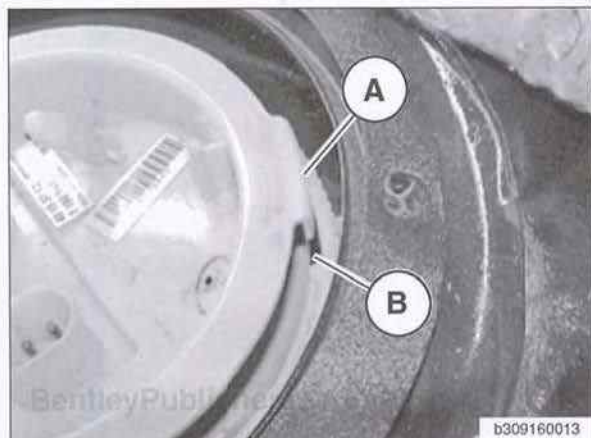


To remove assembly, press tab (B) against spring force and carefully lift sender (A) out of tank with hose pack. Remember to replace fuel tank seals (O-rings).

Fuel level sender (left side), installing

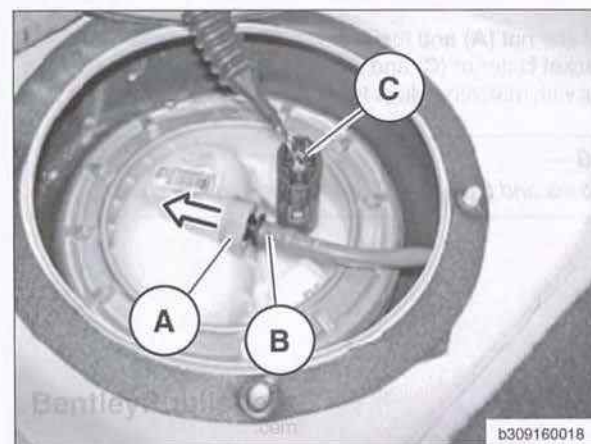
- Carefully feed hose pack through tank with mechanics wire and guide fuel level sender into position.

- ◀ When installing check to see that service cap lug (A) engages with corresponding slot of fuel tank (B).



- ◀ Install service cap hand tight.

- Using BMW special tool 16 1 020 tighten service cap until marking on service cap point to notch on fuel tank.



- ◀ Connect electrical connector (C) and fuel line (B).

- Install fuel tank access cover.

CAUTION—

- After finishing repairs but before starting engine, be sure there is at least 5 liters (1.5 gallons) of fuel in the tank. The fuel pump is damaged if run without fuel.

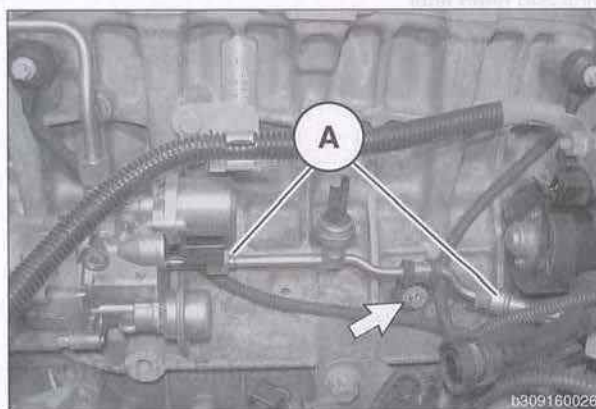
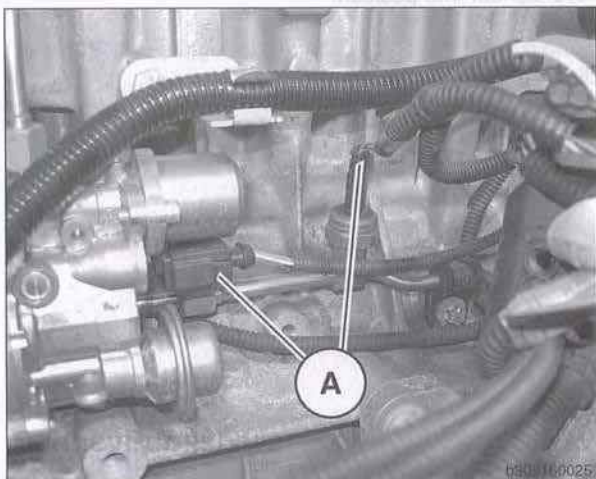
160-22 Fuel Tank and Fuel Pump

High-pressure fuel pump, removing (turbo)

High-pressure fuel pump, removing (turbo)

— Remove intake manifold. See **130 Fuel Injection**.

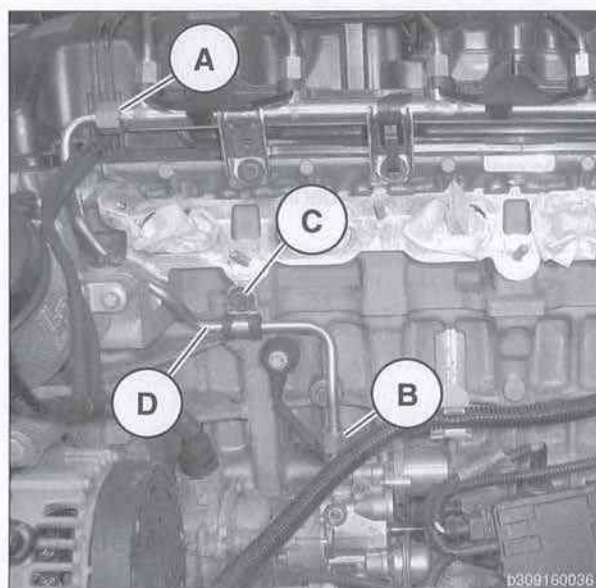
➤ Remove electrical connectors (A) and lay harness aside.



➤ Remove aluminum fastener (arrow) and discard. Detach fuel line (A). Seal fuel lines with BMW special tools 13 5 281 and 13 5 282. Remember to replace aluminum fastener (arrow) with new.

WARNING—

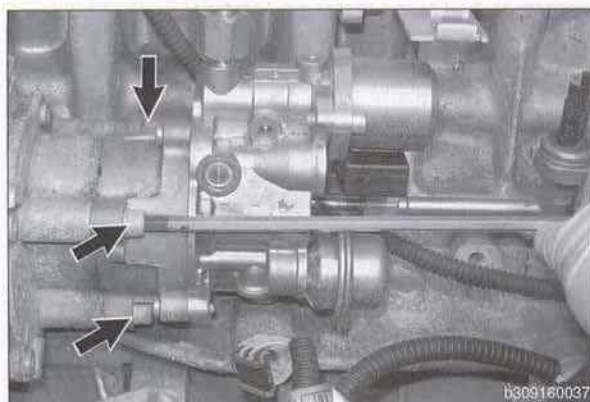
• Wear gloves and face shield when loosening fuel lines.



➤ Loosen fuel line nut (A) and fuel line nut (B) in this order. Remove fuel line bracket fastener (C) and remove fuel line (D). Seal fuel line connections with matching plugs from BMW special tool kit 32 1 270.

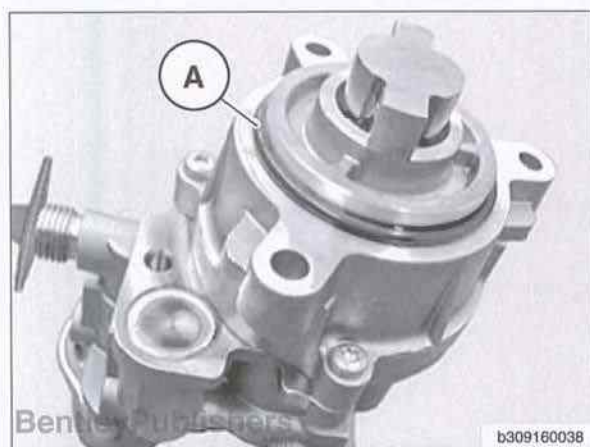
WARNING—

• Wear gloves and face shield when loosening fuel lines.

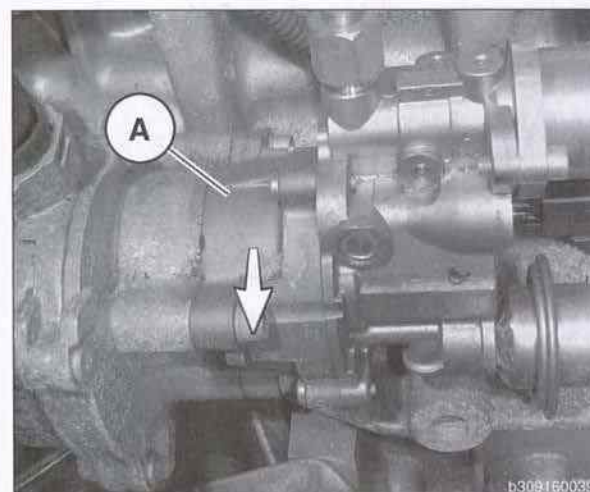


- Remove high-pressure fuel pump mounting fasteners (**arrows**) and remove high-pressure fuel pump. Be prepared to catch any dripping oil with shop cloth.

High-pressure fuel pump, installing (turbo)



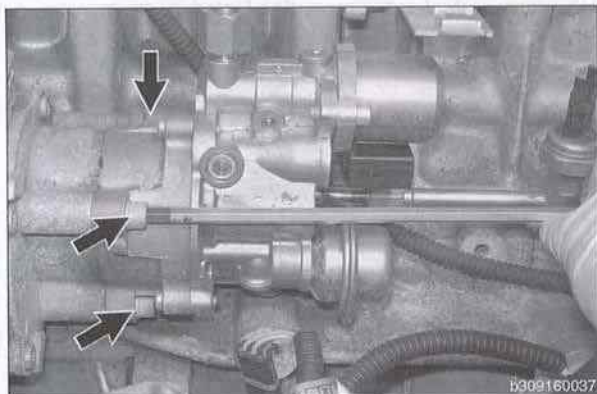
- Replace high-pressure fuel pump O-ring (**A**) and clean mounting surfaces.



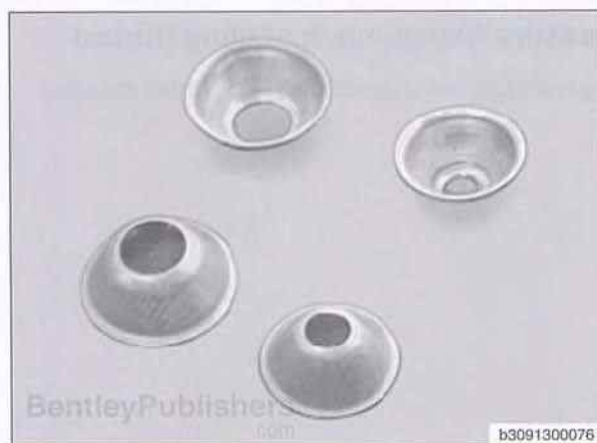
- When installing, rotate pump (**A**) in direction of **arrow** until flush with mounting surface.

160-24 Fuel Tank and Fuel Pump

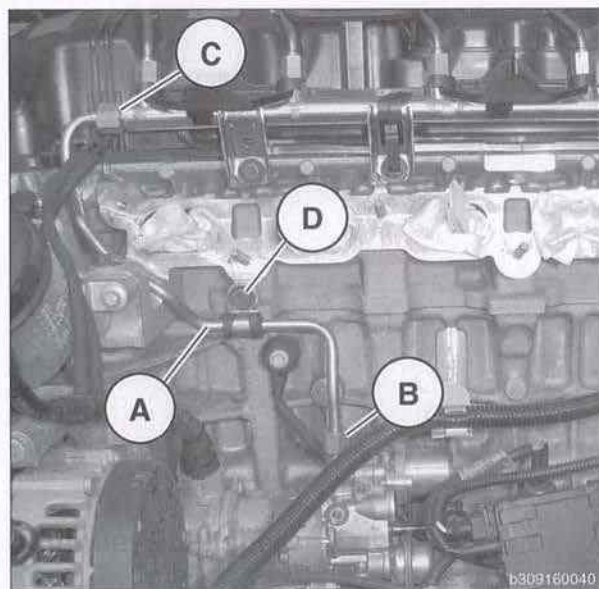
High-pressure fuel pump, installing (turbo)



Install high-pressure fuel pump fasteners (arrows) finger tight.



Prior to installing high-pressure fuel lines, dispose of any copper sealing rings installed at the factory. They are no longer needed.

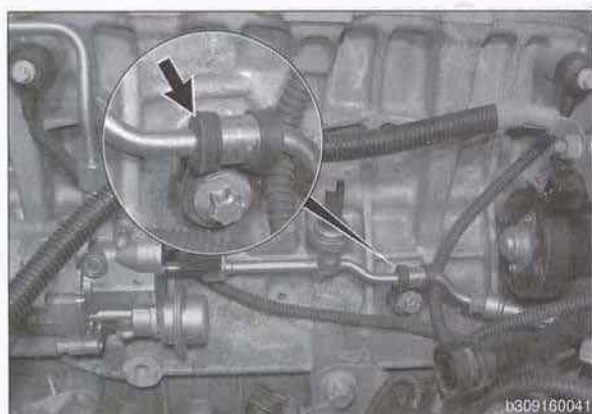


Use the following sequence when installing the fuel line.

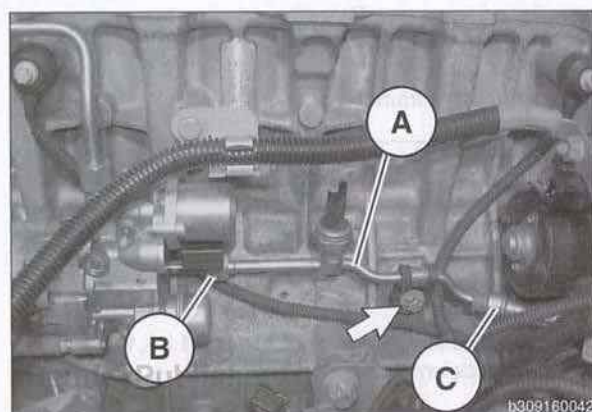
- Coat fuel line connections with transmission fluid.
- Preinstall fuel line (A).
- Tighten nuts (B) (C) finger tight.
- Tighten nut (B) to proper torque.
- Tighten nut (C) to proper torque.
- Tighten fuel line bracket fastener (D).

Tightening torques

Fuel line to high-pressure fuel pump	30 Nm (22 ft-lb)
Fuel line to fuel rail	30 Nm (22 ft-lb)
Fuel line mount to cylinder head	13 Nm (9.5 ft-lb)



- Before installing high-pressure fuel pump supply line, confirm it has the updated elastomer mounting clamp (**arrow**). If it has a soldered hold down clamp replace fuel supply line with updated part.



- Use the following sequence when installing the fuel supply line.
- Coat fuel line connections with transmission fluid.
 - Pre-install fuel line (**A**).
 - Tighten nut (**B**) and mount fastener (**arrow**) finger tight. Remember to replace fuel line bracket aluminum fastener with new.
 - Connect fuel line (**C**) to fuel supply line (**A**). Listen for audible click.
 - Tighten nut (**B**) to proper torque.
 - Tighten fuel line bracket fastener (**arrow**).

Tightening torques

Fuel line to high-pressure fuel pump	30 Nm (22 ft-lb)
Fuel line bracket to engine	10 Nm (7.3 ft-lb)
• Stage 1	Additional 90° ± 15°
• Stage 2	

- Reassemble engine.
- Check fuel system for leaks.
- Check for fault codes and reset ECM memory.

FUEL SUPPLY COMPONENTS

Fuel tank, draining

When draining fuel tank, use a safe storage unit and an approved fuel pumping device.

WARNING—

- Before starting to work on tank removal, make sure hot components, such as the exhaust system, are completely cooled down.
- Fuel may be spilled. Do not smoke or work near heaters or other fire hazards.

- Start engine and allow to run 10 - 15 seconds to fill fuel compensating siphon assembly. This allows both lobes of fuel tank to be drawn off through fuel filler pipe.

- Disconnect negative cable from battery.

CAUTION—

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

- Remove fuel tank filler cap.
- Slide suction hose into filler neck about 130 cm (51 in), twisting as necessary. Withdraw fuel into storage unit.
- Monitor fuel level reduction in both lobes:
 - Remove rear seat cushion and access both fuel tank sender harness connectors. See **Accessing fuel pump and fuel level senders** in this repair group.
 - Use multimeter to measure resistance at both senders. Resistance should drop as fuel level drops.
- If siphoning mechanism is faulty, drain left tank lobe separately by removing sender cover and pumping fuel directly out of left lobe.
- Remove suction hose from tank filler neck carefully to avoid damaging filler neck baffle plate.

CAUTION—

- After finishing repairs but before starting engine, be sure there is at least 5 liters (1.5 gallons) of fuel in tank. The fuel pump is damaged if run without fuel.

Fuel filter

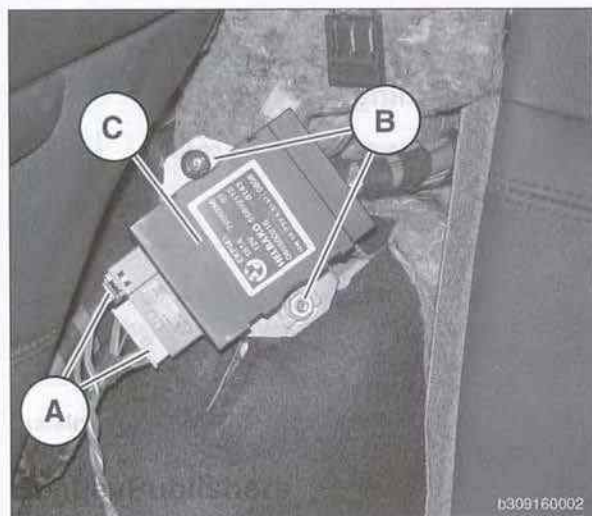
The fuel filter is a lifetime filter. It is integrated into the left side fuel level sender. See **Fuel level sender (left side), removing** in this repair group.

Fuel pressure regulator

The fuel pressure regulator is integrated into the left side fuel level sender. See **Fuel level sender (left side), removing** in this repair group.

Fuel pump module (EKP), removing and installing

- E90: Remove rear seat backrest. See **520 Seats**.
- E91, E92: Remove rear right backrest side bolster. See **520 Seats**.
- Working at EKF module:
 - Remove electrical connectors (A).
 - Remove fasteners (B) and remove EKP module (C).
- Installation is reverse of removal.
 - Remember to perform coding / programming on EKP module if replaced. See **600 Electrical System-General**.
- Check for fault codes and reset ECM memory.



Activated carbon canister, removing and installing

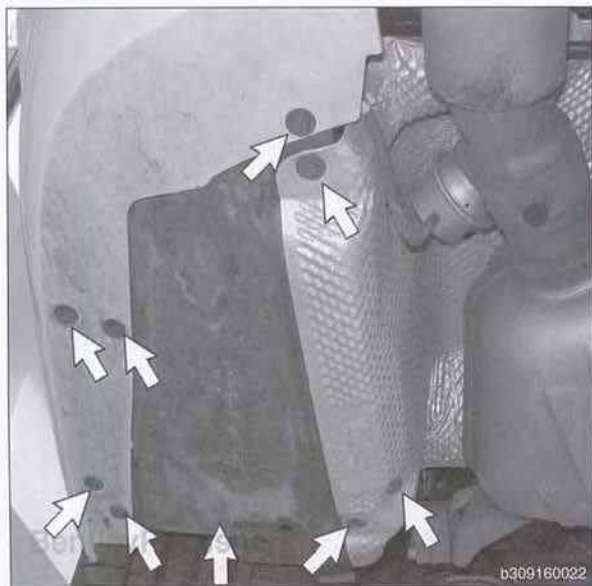
The carbon canister is on the left side underneath the rear bumper.

- Raise rear end of car and support safely.

CAUTION—

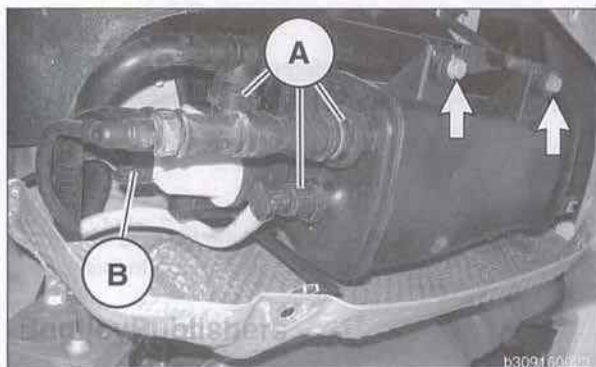
- Make sure the car is stable and well supported at all times. Use a professional automotive lift or jack stands designed for the purpose. A floor jack is not adequate support.

- Remove left side rear bumper splash shield fasteners (arrows).



160-28 Fuel Tank and Fuel Pump

Fuel tank leak detection unit (DMTL), removing and installing



- Remove activated carbon canister:
 - Remove line connections at leak detection pump (A).
 - Disconnect electrical harness connector (B).
 - Remove fasteners (**arrows**) and remove carbon canister from vehicle.
- Installation is reverse of removal.

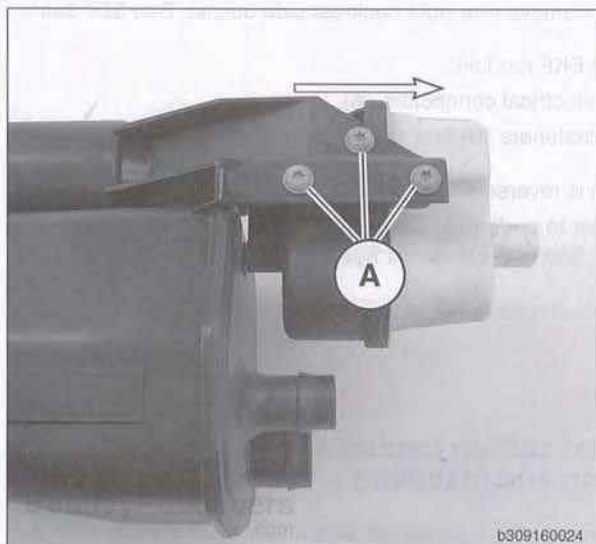
Fuel tank leak detection unit (DMTL), removing and installing

The DMTL is mounted to the activated carbon canister.

- Raise car and support safely.

WARNING—

- Make sure the car 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 activated carbon canister. See **Activated carbon canister, removing and installing** in this repair group.
- Remove fasteners (A) and pull DMTL unit out of carbon canister in direction of **arrow**.
- Installation is reverse of removal.



130 Fuel Injection

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130-2 Fuel Injection

Warnings and Cautions

GENERAL

This repair group covers service and repair of engine management systems. Information in this repair group is organized by engine (non-turbo, turbo).

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**

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.
- Before beginning work on the fuel system, place a fire extinguisher in the vicinity of the work area.
- Work only on 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.

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 removing the engine control module (ECM) connector. If the connector is 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 or equivalent. 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.

DIGITAL MOTOR ELECTRONICS (DME)

BMW 3 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. E90 engine management applications

Year, model	Engine code	Engine management	Features
2006			
Sedan: 325i, 325xi Sport Wagon: 325xi Sedan: 330i, 330xi	N52	Siemens MSV70	Valvetronic, VANOS
2007-2008			
Sedan, Sport Wagon, Coupe, Convertible: 328i, 328xi (automatic transmission)*	N51	Siemens MSV80 SULEV II	Valvetronic, VANOS
Sedan, Sport Wagon: 328i, 328xi	N52KP	Siemens MSV70	Valvetronic, VANOS
Coupe, Convertible: 328i, 328xi	N52KP	Siemens MSV80	Valvetronic, VANOS
Sedan: 335i, 335xi Coupe: 335i Coupe: 335xi (2008 only) Convertible: 335i	N54	Siemens MSD80/MSD81	VANOS
2009-2010			
Sedan, Sport Wagon, Coupe, Convertible: 328i, 328xi (automatic transmission)*	N51	Siemens MSV80 SULEV II	Valvetronic, VANOS
Sedan, Coupe: 328i, 328xi Convertible: 328i Sport Wagon: 328i, 328xi	N52KP	Siemens MSV80 ULEV II	Valvetronic, VANOS
Sedan, Coupe: 335i, 335xi Convertible: 335i	N54	Siemens MSD81 ULEV II	VANOS

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 or equivalent to the data link connector (DLC) in the engine compartment or 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**.



- 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 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.



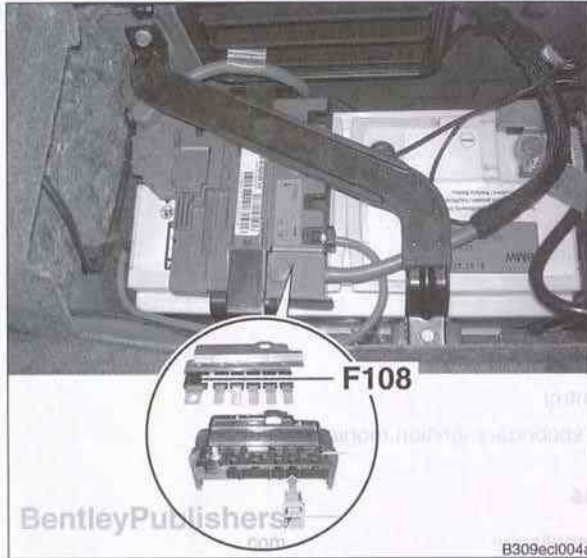
ENGINE MANAGEMENT FUSES AND POWER SUPPLY COMPONENTS

Power supply fuses

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

- Rear distribution panel (A46) in trunk, installed directly on top of battery:

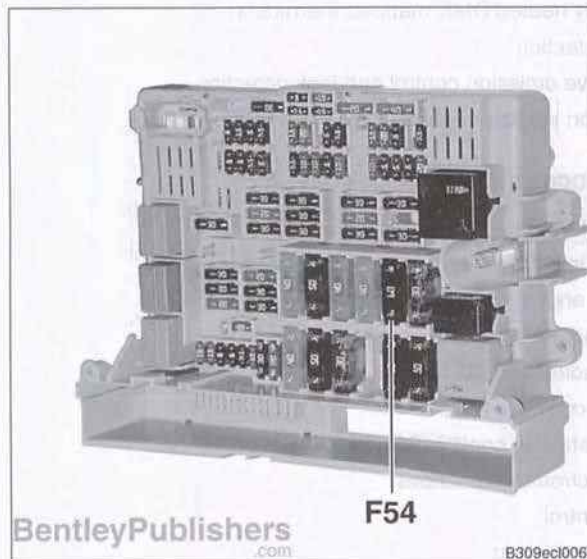
- **F108** 250A: Power supply to fuses (not replaceable separately): F54



- 2006 fuse and relay panel behind glove compartment:

- **F54** 60A:
Engine control module (ECM) (A6000)
ECM main relay (K6300)
Engine electronics fuse carrier (A8680)
Engine electronics fuse carrier (A8681)

From 03/2007 fuse and relay panel may vary. See **ECL Electrical Component Locations** for specific vehicle fuse locations.



SIEMENS DME (NON-TURBO)

DME engine management system description

The DME manages and monitors the following functions:

Air

- Electronic throttle
- Mass air flow
- Resonance-turbulence intake control
- Valvetronic II

Fuel

- Fuel supply
- Fuel injection

Ignition

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

Emissions

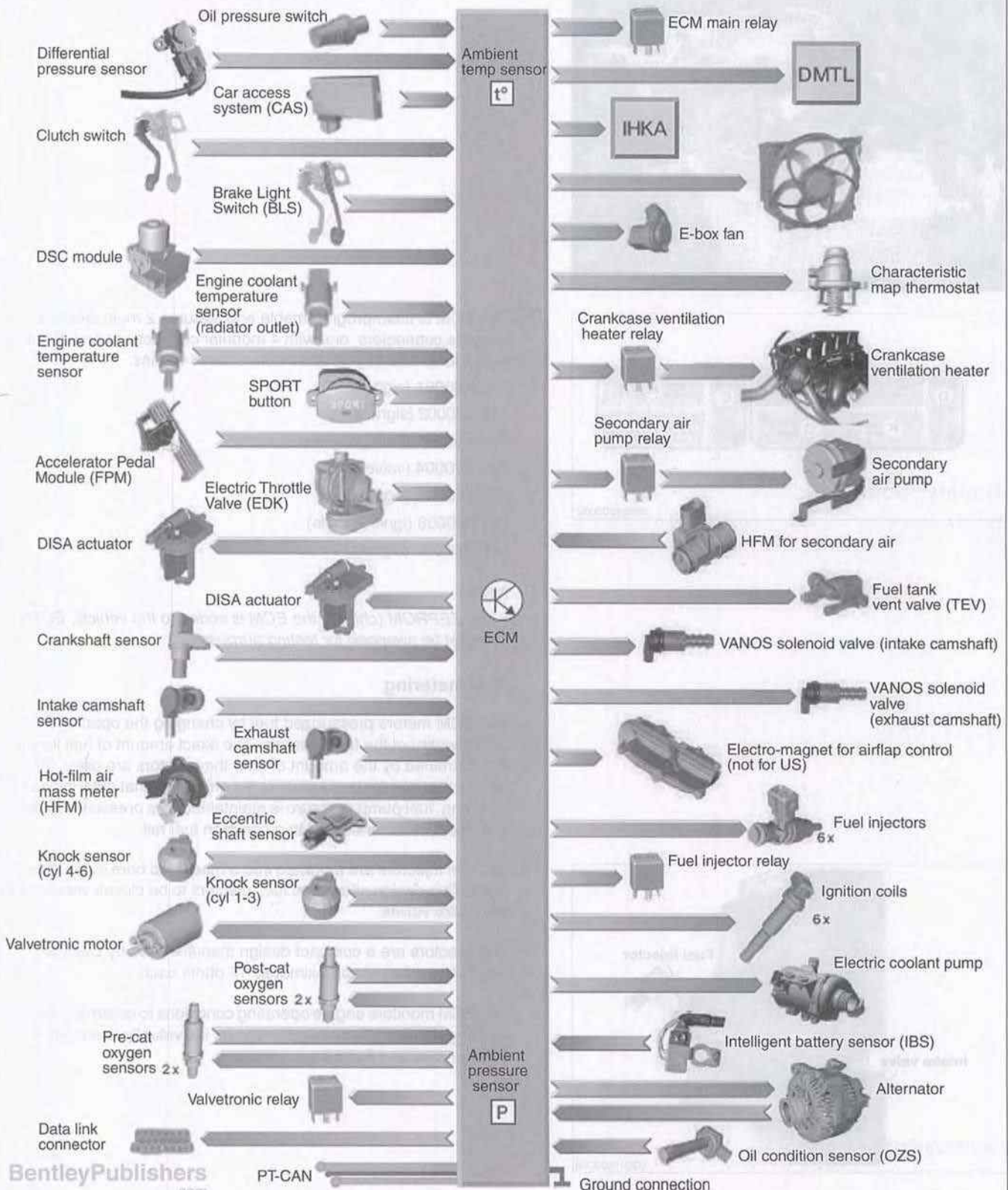
- OBD II compliance
- Pre and post-catalyst oxygen sensors
- Electrically heated DME-mapped thermostat
- Misfire detection
- Evaporative emission control and leak detection
- Malfunction indicator light (MIL)

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
- EWS (electronic immobilizer)
- Cruise control
- ECM programming

The accompanying IPO (input-processing-output) diagram illustrates DME features. In this type of stylized diagram, sensor inputs to the control module are on the left, control module processing is in the center and control module output commands are on the right of the diagram.

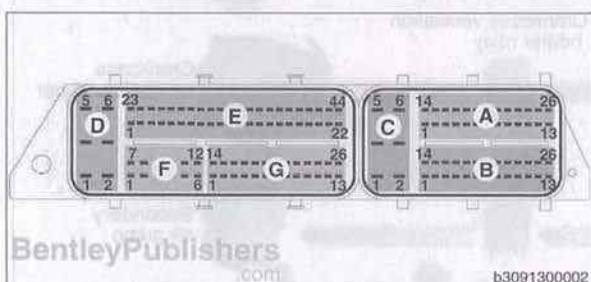
DME IPO diagram (non-turbo)





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 (valvetronic)
- E: X60005 (signals)
- F: X60006 (ignition coils)
- G: X60007 (signals)

NOTE —

- The EEPROM (chip) in the ECM is coded to the vehicle. ECMs cannot be swapped for testing purposes.

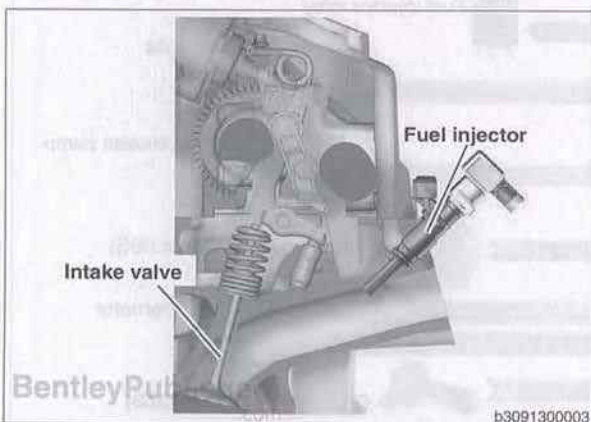
Fuel metering

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 are mounted into a machined bore in the cylinder head. This design allows the fuel injectors to be closely mounted to the intake valves.

The injectors are a compact design manufactured by Deka with a resistance value of approximately 12 ohms each.

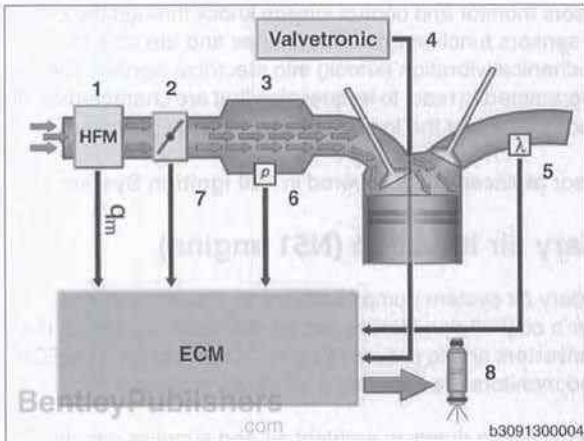
The ECM monitors engine operating conditions to determine injector opening duration. Each injector can be individually controlled for cylinder selective fuel trim.



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 used to calculate the mass of the intake air.

1. Air mass measurement (HFM)
2. Throttle valve
3. Intake manifold
4. Variable intake valve lift (valvetronic)
5. Residual oxygen measurement in exhaust
6. Intake manifold vacuum
7. Engine speed
8. Injection timing



Idle speed control

➤ The ECM controls Idle speed by varying intake valve lift via the valvetronic system.

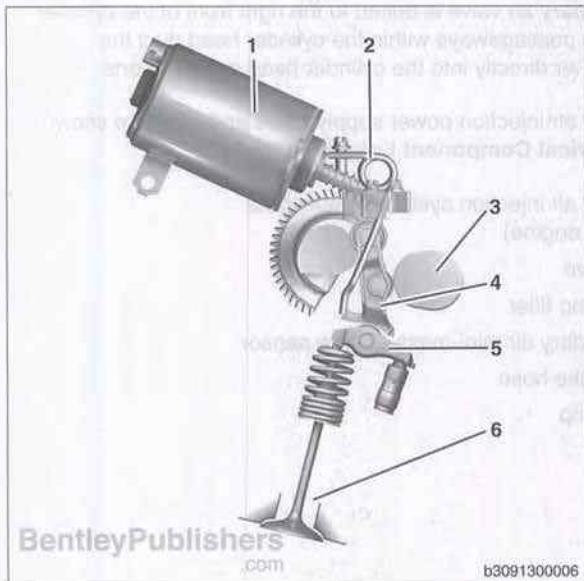
1. Valvetronic motor
2. Return spring
3. Intake camshaft
4. Intermediate lever
5. Intake rocker arm
6. Intake valve

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 throttle module (EDK) is not needed for engine load control. Engine load control is carried out by the valvetronic function of the ECM. However, the throttle may be slightly closed to allow sufficient manifold vacuum for the crankcase ventilation and canister purge systems.



130-12 Fuel Injection

Secondary air injection (N51 engine)

Knock (detonation) control

Knock sensors monitor and control ignition knock through the ECM. The 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**.

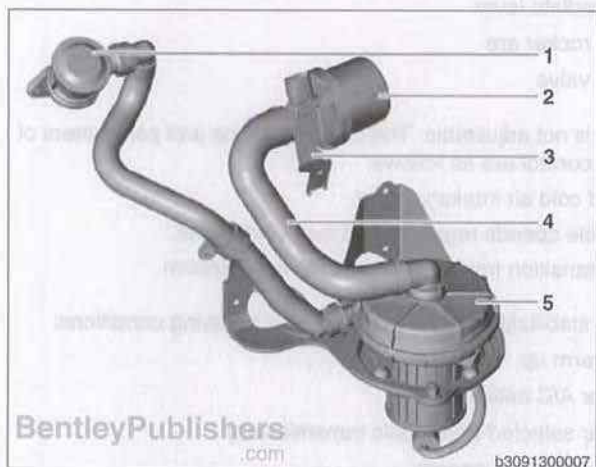
Secondary air injection (N51 engine)

The secondary air system pumps ambient air into the exhaust stream after a cold engine start to reduce the warm-up time of the catalytic converters 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 air pressure (from the pump) 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 power supply fuses and relay are shown in **ECL Electrical Component Locations**.



Secondary air injection system components (6-cylinder engine)

1. Air valve
2. Air pump filter
3. Secondary air mini-mass air flow sensor
4. Air intake hose
5. Air pump

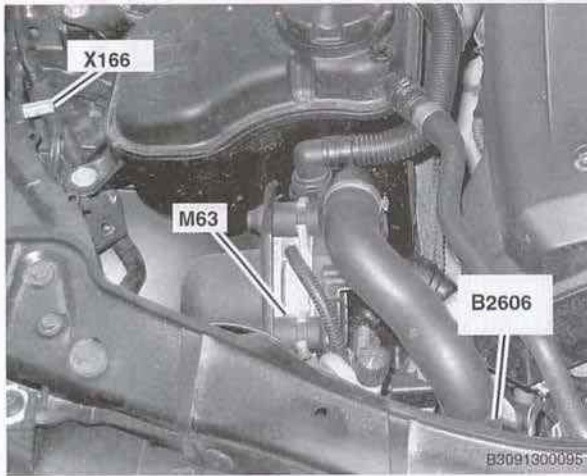


A miniature mass air flow sensor in the secondary air system detects the air mass supplied by the secondary-air pump. This function monitors the secondary air system for OBD compliance.

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

Secondary air injection illustrations (N51 engine)

- Secondary air pump is in front of coolant expansion tank:
 - M63 Secondary air pump.
 - B2606 Mini mass air flow sensor (if equipped).
 - X166 Secondary air pump ground.



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



Air filter housing and ducts, removing and installing (non-turbo)

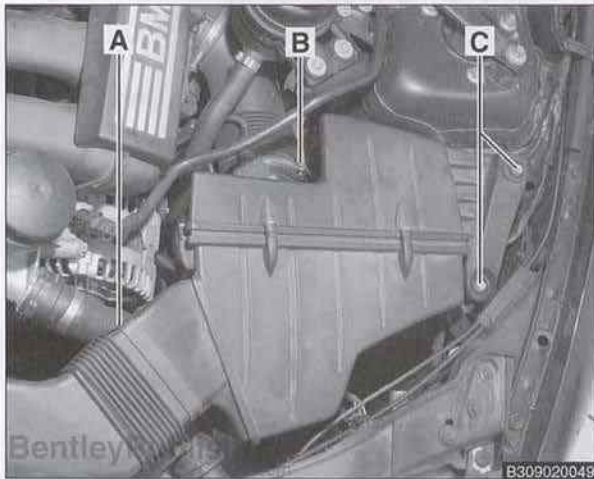
- Working at front of engine compartment above radiator, remove air intake hood screws (A). Detach air intake duct connection (arrow) and lift out of radiator support.

For air filter replacing, see 020 Maintenance.



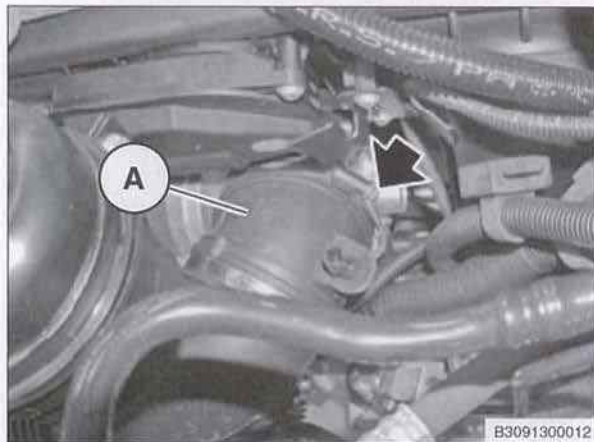
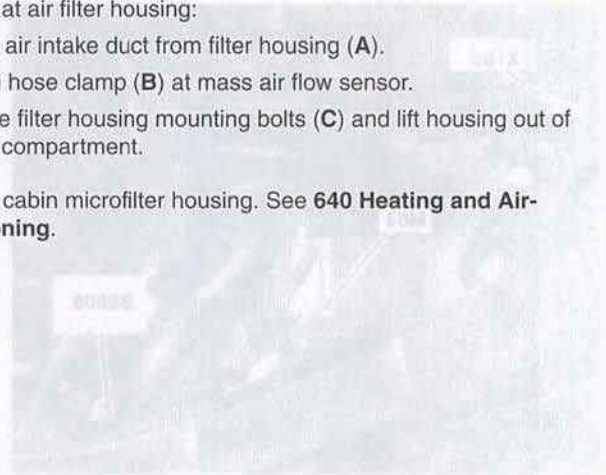
130-14 Fuel Injection

Air filter housing and ducts, removing and installing (non-turbo)



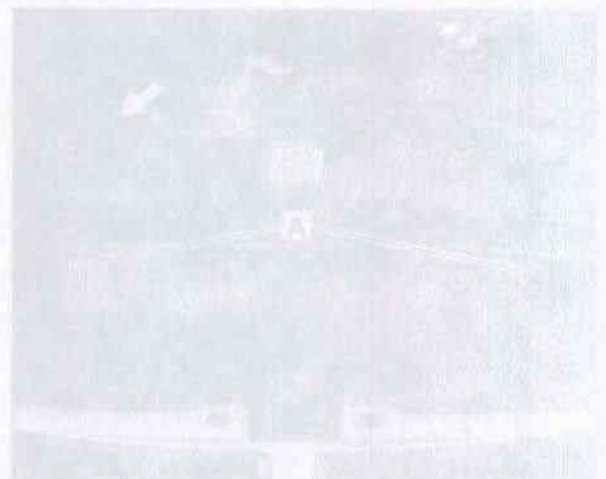
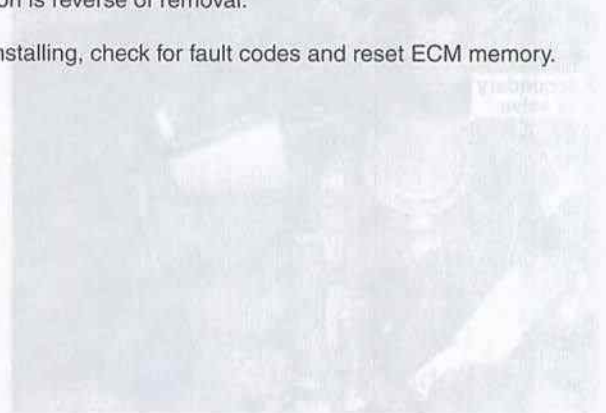
Working at air filter housing:

- Detach air intake duct from filter housing (A).
 - Loosen hose clamp (B) at mass air flow sensor.
 - Remove filter housing mounting bolts (C) and lift housing out of engine compartment.
- Remove cabin microfilter housing. See 640 Heating and Air-conditioning.



Loosen duct clamp (arrow). Remove duct (A) from throttle body.

- Installation is reverse of removal.
- After reinstalling, check for fault codes and reset ECM memory.



Mass air flow, measurement

- 3 Series non-turbo engines utilize two different air mass measurement systems.

Analog mass air flow sensor is used in models produced to 09 / 2006. The 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 input 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.

Digital mass air flow sensor is used in models from 09 / 2006. In this system, a duty cycle signal corresponds to changes in intake air mass. This eliminates the need for signal conversion in the ECM.

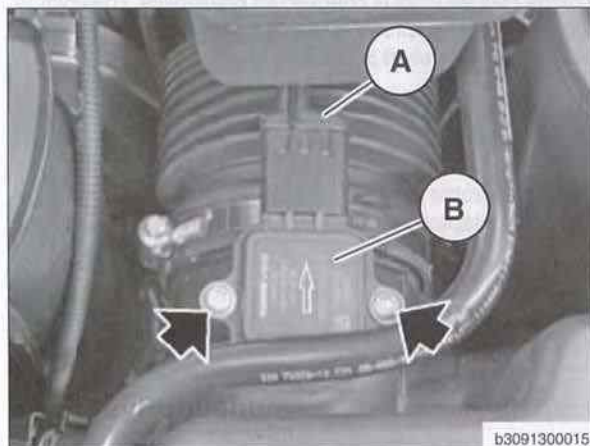
The intake air temperature sensor is integrated into the mass air flow sensor. The sensor is an NTC thermistor which receives a 5 volt reference current and ground from the ECM.

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 (non-turbo)

- 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.





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

Tightening torques

Mass air flow sensor to housing	3 Nm (26 in-lb)
---------------------------------	-----------------

Throttle housing, replacing (non-turbo)

The throttle housing (EDK) is not used for engine load control. Engine load control is carried out by the valvetronic function of the ECM. However, the throttle may be slightly closed to allow sufficient manifold vacuum for the crankcase ventilation and canister purge systems. 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.

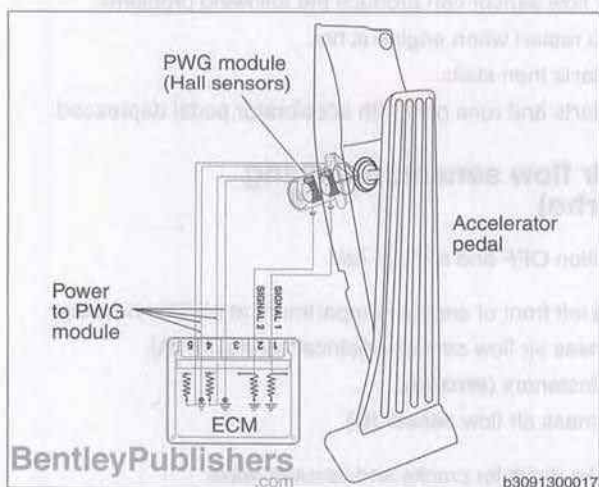
The throttle housing unit is nonadjustable. If found to be faulty, replace as a complete unit.

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

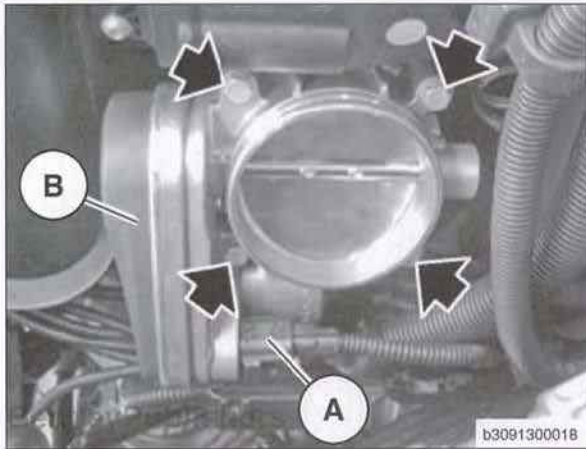
CAUTION—

- If the adaptation process is not completed correctly, the engine 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 (non-turbo)** in this repair group.



Valvetronic motor, removing and installing (non-turbo)



Working at left side of intake manifold:

- Disconnect electrical connector (A).
- Remove fasteners (arrows) and remove throttle housing (B).

— Installation is reverse of removal.

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

Tightening torques

Throttle housing to intake manifold	9 Nm (80 in-lb)
-------------------------------------	-----------------

- Reattach throttle assembly connector with care. It is possible to twist the connector before plugging it in. This can cause damage to the harness and connector.

- After reinstalling, check for fault codes and reset ECM memory. Reset throttle plate adaptation values following on-screen directions.

Valvetronic motor, removing and installing (non-turbo)

- Switch ignition OFF and remove key.
- Remove cabin microfilter housings. See 640 Heating and Air-conditioning.
- Remove ignition coil cover. See 020 Maintenance.
- Disconnect battery negative (-) cable.

CAUTION—

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

- Disconnect ignition coil electrical connectors and remove ignition coil overlay harness (arrows).

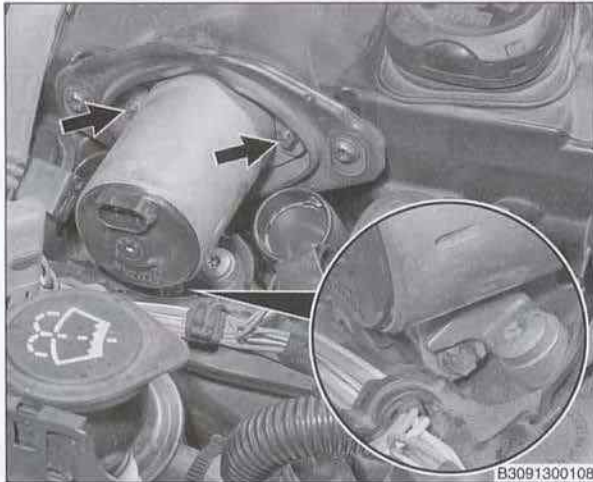


- Gently screw valvetronic motor in clockwise direction (arrow) until you feel resistance of the eccentric shaft stop.

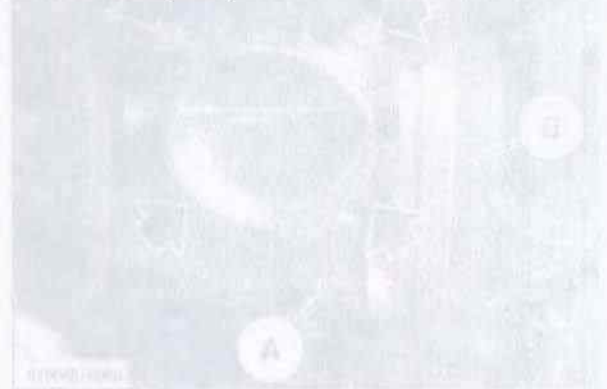


130-18 Fuel Injection

Fuel rail and injectors, removing and installing (non-turbo)



- Remove valvetronic motor fasteners (**arrows**) and valvetronic motor support bracket fastener (**inset**).



- Gently screw valvetronic motor in counterclockwise direction while sliding motor out of cylinder head cover (**arrow**).



- Installation is reverse of removal. Remember to:
 - Replace aluminum fasteners.
 - Route ignition harness correctly

Tightening torque

Valvetronic motor to cylinder head	4 Nm (2.9 ft-lb)
------------------------------------	------------------

- After reinstalling, check for fault codes and reset ECM memory.

Fuel rail and injectors, removing and installing (non-turbo)

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.

- Switch ignition OFF and remove key.
- Remove cabin microfilter housing. See **640 Heating and Air-conditioning**.
- Remove ignition coil cover. 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.

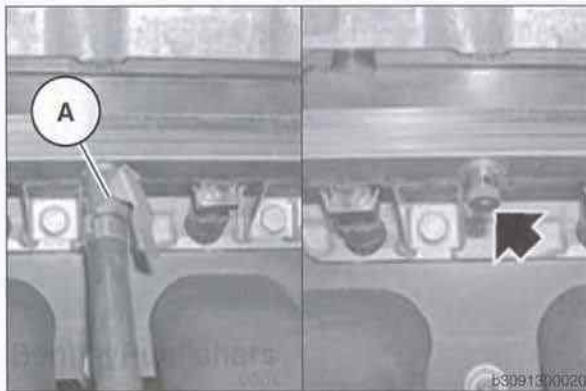
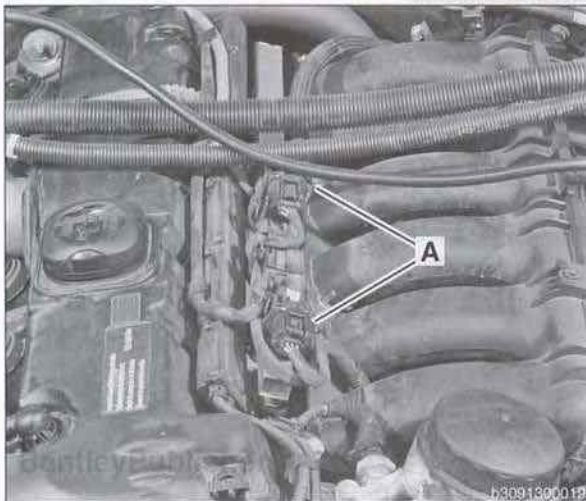
CAUTION—

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

- Working above engine, detach oxygen sensor connectors (A) and unclip wiring harness from holder.

CAUTION—

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



- Unscrew Schrader valve cap (arrow) from fuel rail. Connect air line adapter (A) to fitting.

- 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—

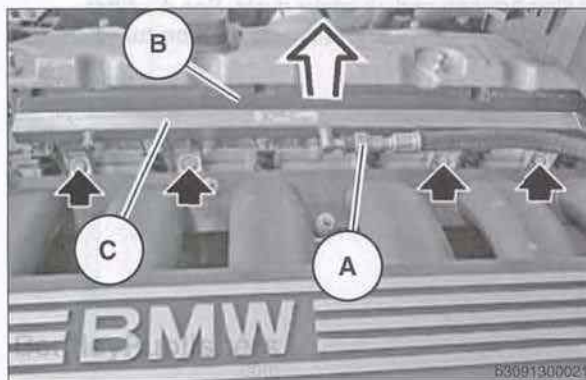
- Fuel in the fuel line is under pressure (approx. 3 - 5 bar or 45 - 75 psi) and may be expelled forcibly. Do not smoke or work near heaters or other fire hazards. Keep a fire extinguisher handy.
- Unscrew the fuel tank cap to release pressure in the tank before working on the fuel line.
- Plug open fuel lines and fittings.

- Working above engine:

- Remove and detach fuel line (A).
- Disconnect connector strip (B) in direction of arrow.
- Remove fasteners (arrows).
- Remove fuel rail (C).

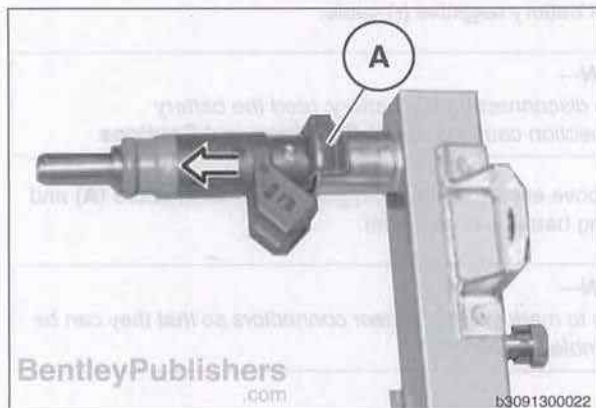
WARNING—

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



130-20 Fuel Injection

Intake manifold, removing and installing (non-turbo)



Remove individual injectors:

- Pry retaining clip from injector (A).
- Pull injector from rail (arrow).

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.
- Replace wire ties.

Tightening torque

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

After reinstalling, check for fault codes and reset ECM memory.

Intake manifold, removing and installing (non-turbo)

Disconnect battery negative (-) cable in cargo compartment.

CAUTION—

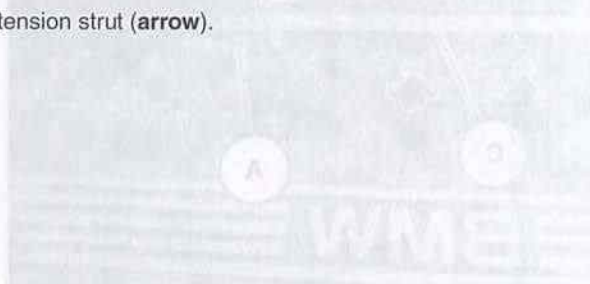
- Prior to disconnecting the battery, read the battery disconnection cautions in 001 Warnings and Cautions.

Remove cabin microfilter housing. See 640 Heating and Air-conditioning.

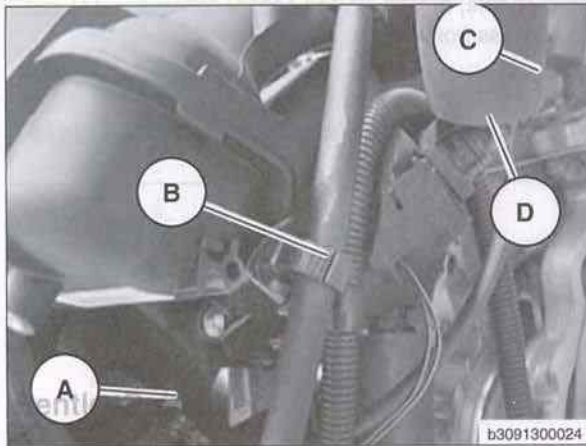
Remove ignition coil cover. See 020 Maintenance.

Remove air filter housing and air intake ducts. See Air filter housing and ducts, removing and installing (non-turbo) in this repair group.

Remove tension strut (arrow).

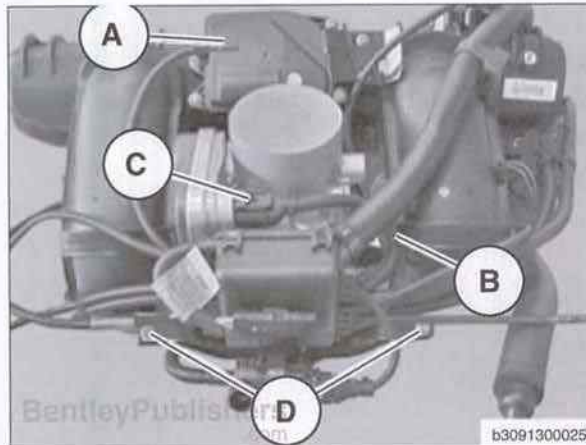


Intake manifold, removing and installing (non-turbo)



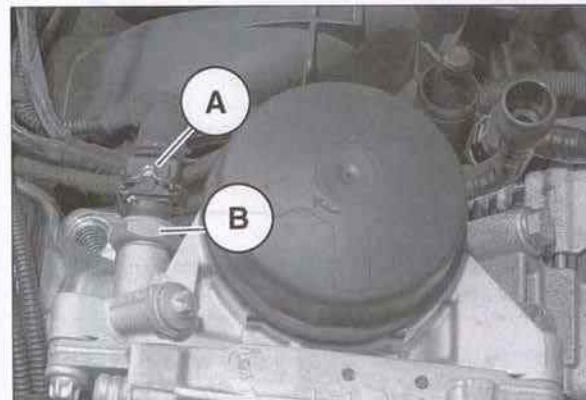
Working at left side and underneath intake manifold:

- Open harness holder (B).
- Disconnect electrical connector (A).
- Release both crankcase breather connections (C,D).



Working at left side and underneath intake manifold:

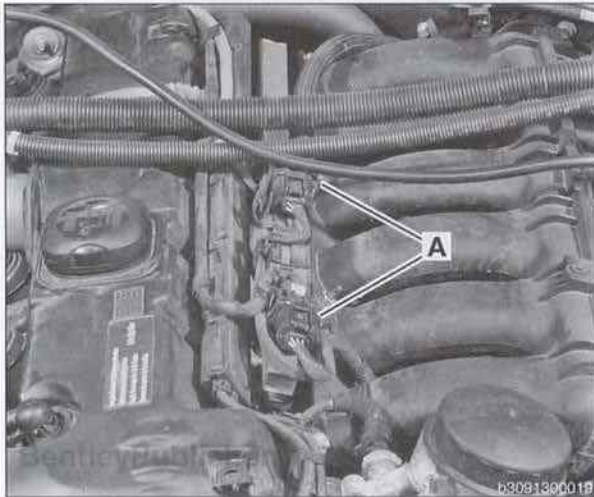
- Disconnect electrical connectors (A,C).
- Remove fasteners (D).
- Detach engine wiring harness (B) from intake manifold and lay aside.



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

130-22 Fuel Injection

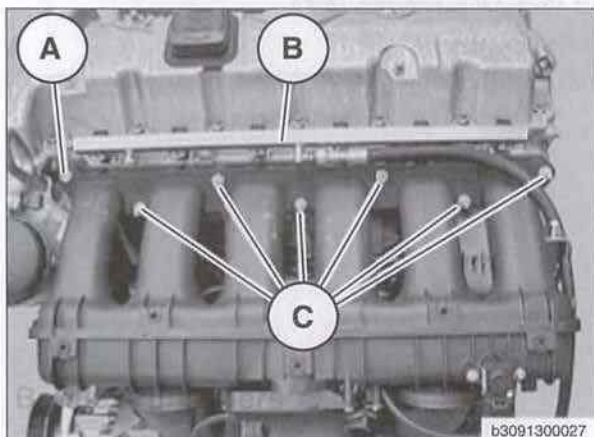
Intake manifold, removing and installing (non-turbo)



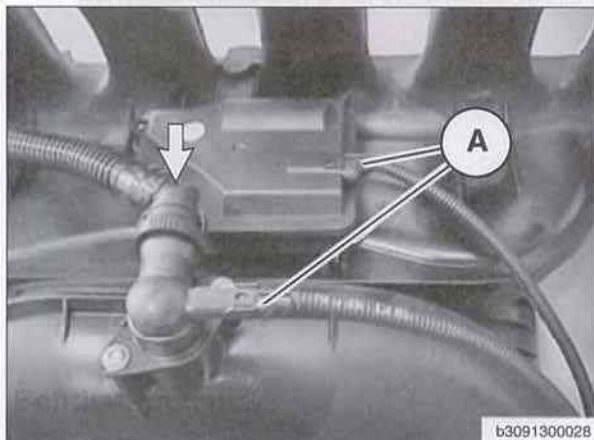
- Working above engine, detach oxygen sensor connectors (A) and unclip wiring harness from holder.

CAUTION—

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



- Working above engine:
- Remove and lay fuel rail (B) aside. Do not disconnect fuel line.
 - Remove fastener (A).
 - Remove nuts (C).



- Raise intake manifold approximately 10 cm (4 in). Working underneath:
- Disconnect electrical connector (A).
 - Release fuel tank vent line (arrow) behind throttle valve assembly.
 - Raise and remove intake manifold.

CAUTION—

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

- Installation is reverse of removal. Remember to replace all seals.

Tightening torque

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

Crankcase breather valve (non-turbo)

Non-turbo engine crankcase is ventilated by either a breather valve under the intake manifold or a breather valve integrated in the cylinder head cover. Engines with a metal cylinder head cover utilize an external breather valve, engines with a plastic valve cover utilize an internal breather valve.

- The crankcase ventilation system has an electrically heated crankcase breather valve. The pressure control valve and cyclonic oil separator are combined into one unit. The assembly is located under the intake manifold (**arrow**).

The pressure control valve varies the vacuum applied to the crankcase breather depending on engine load. The valve is balanced between spring pressure and the amount of manifold vacuum.

At idle when the intake manifold vacuum is high, vacuum reduces the valve opening, allowing a small amount of crankcase vapors to be drawn into the intake manifold.

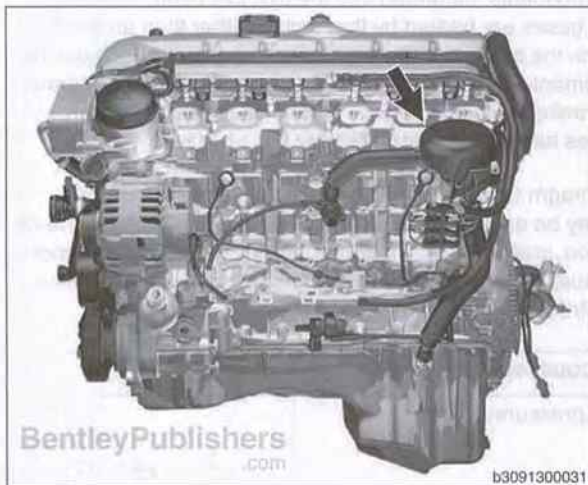
At part to full load conditions when intake manifold vacuum is lower, the spring opens the valve and additional crankcase vapors are drawn into the intake manifold.

Crankcase breather heating (non-turbo)

- Integrated into the design of the crankcase breather valve is an electric heating system (**arrow**) designed to prevent moisture buildup. Moisture buildup can eventually lead to ice at low ambient temperatures leading to malfunctions of the crankcase breather valve. The crankcase breather valve is insulated by a protective foam covering to provide additional shelter from low ambient temperatures.

The heating elements are integrated into the crankcase ventilation valve and hose assemblies. There is a junction point on the intake manifold which provides a connection point for the individual heating elements.

There is also a heating element located on the centrally located port on the intake manifold. This port is also provided with a separate heating circuit controlled by a PTC thermistor. For wiring schematic **ELE Electrical Wiring Diagrams**.





✦ The internal crankcase ventilation system is integrated into the plastic cylinder head cover. 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 rather than an electric heater as on the external system. However, there is still one electric heating element at the manifold inlet. 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. A faulty crankcase breather valve causes significant deviations from the values specified below:

Intake vacuum specifications (non-turbo engines)	
Operating pressure range	
• N52	24 to 28 mbar
• N52KP	28 to 32 mbar
Deviation to ambient pressure:	+20 mbar to -60 mbar
Fault condition:	
• Clogged crankcase ventilation	+100 mbar over ambient pressure
• Internal leak in crankcase ventilation	-170 mbar under ambient pressure

To access to breather valve, remove air filter housing and ducts. See **Air filter housing and ducts, removing and installing (non-turbo)** in this repair group.

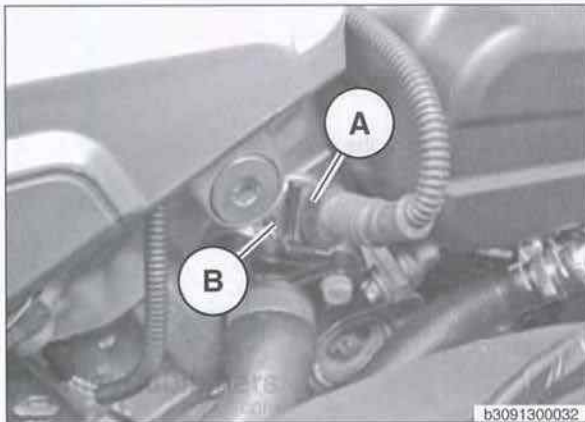
Engine coolant temperature (ECT) sensor, replacing (non-turbo)

The engine coolant temperature (ECT) sensor is an 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. The ignition timing is set to a safely conservative basic setting.

The ECT sensor is located in the left front of the engine near oil filter housing.



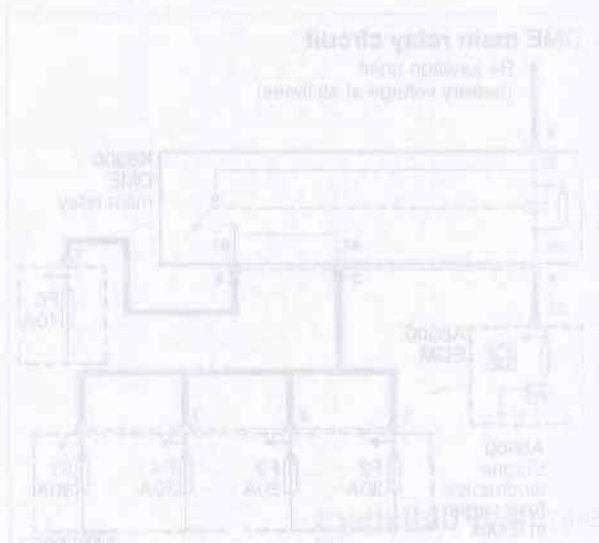
With engine fully cooled off, disconnect ECT sensor connector (A).

- 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 lost coolant.

Tightening torque

Temperature sensor to cylinder head	18 Nm (13 ft-lb)
-------------------------------------	------------------

- After reinstalling, check for fault codes and reset ECM memory.



DME main relay, testing (non-turbo)

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

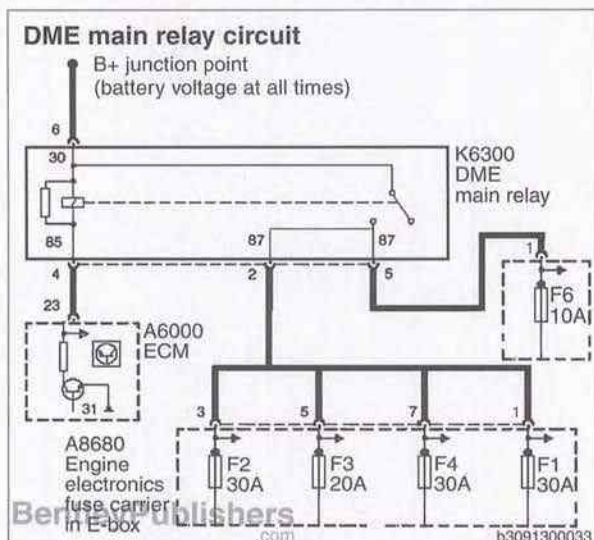
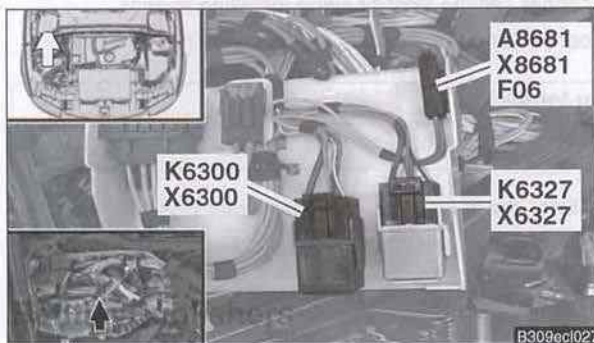
- ECM
- Ignition coils
- Exhaust flap
- Mass air flow sensor
- Mini mass air flow sensor
- Fuel tank leak detection pump
- Crankshaft sensor
- Camshaft sensors
- Evaporative emissions valve
- EAC sensor
- Crankcase breather valve heater
- Oil condition sensor
- variable intake manifold (DISA) controllers
- 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 F54 in fuse and relay panel behind 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 44 pin connector X60005. See **ECM pin assignments (non-turbo)** in this repair group.

- 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.

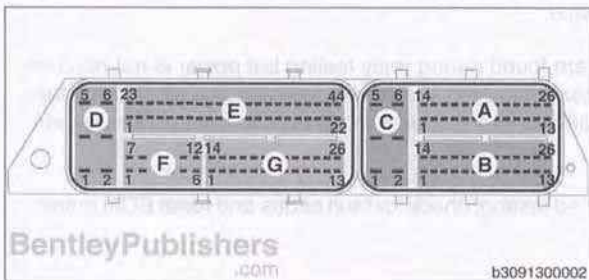
— If no faults are found during relay testing but power is not reaching ECM or other components, check fuses in engine electronics fuse carrier (A8680) in E-box. See **Power supply fuses** in this repair group.

— When finished testing, check for fault codes and reset ECM memory.



ECM pin assignments (non-turbo)

◀ 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 (valvetronic)
- E: X60005 (signals)
- F: X60006 (ignition coils)
- G: X60007 (signals)

ECM pin assignments for non-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.

Table b. Non-turbo 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	output	Exhaust flap signal	Exhaust flap
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	output	Secondary air pump relay signal	Secondary air pump relay
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	input	Mini mass air flow sensor signal	Mass air flow sensor secondary air
26	output	E-box fan signal	E-box fan

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

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ECM pin assignments (non-turbo)

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	input	DMTL valve signal	Diagnosis module for fuel tank leakage
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 (valvetronic)

Pin	Type	Component or function	Note
1	input	Terminal 87	VVT relay
2	input	Terminal 87	VVT relay
3	output	Valvetronic actuator signal	Valvetronic actuator timing actuator
4	output	Valvetronic actuator signal	Valvetronic actuator timing actuator
5	output	Valvetronic actuator signal	Valvetronic actuator timing actuator
6	output	Valvetronic actuator signal	Valvetronic actuator timing actuator

Connector X60005 44-pin (signals)

Pin	Type	Component or function	Note
1	-	Not used	
2	-	Not used	
3	-	Not used	
4	-	Not used	
5	-	Not used	
6	-	Not used	
7	-	Not used	
8	-	Not used	
9	-	Not used	
10	-	Not used	
11	-	Not used	
12	output	Crankcase breather valve heating activation	Crankcase breather valve heating relay
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	-	Not used	
18	output	DISA changeover valve signal	DISA controller 2
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	output	Mass air flow sensor voltage supply	Mass air flow sensor
26	input	Mass air flow sensor signal	Mass air flow sensor
27	ground	Mass air flow sensor	Mass air flow sensor
28	input	Intake air temperature sensor signal	Intake air temperature sensor
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	-	Not used	
35	input/output	BSD signal	BSD signal connector
36	input	Throttle valve signal	Throttle valve
37	input	Throttle valve signal	Throttle valve

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ECM pin assignments (non-turbo)

Connector X60005 44-pin (signals) (continued)

Pin	Type	Component or function	Note
38	ground	Throttle valve	Throttle valve
39	-	Not used	
40	output	DISA changeover valve signal	DISA controller 1
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	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
7	-	Not used	
8	-	Not used	
9	-	Not used	
10	-	Not used	
11	-	Not used	
12	-	Not used	

Connector X60007 26-pin (signals)

Pin	Type	Component or function	Note
1	output	Fuel injector signal	Fuel injector 1
2	output	Fuel injector signal	Fuel injector 2
3	output	Fuel injector signal	Fuel injector 3
4	input	Engine coolant temperature signal	Engine coolant temperature sensor
5	output	Intake VANOS solenoid signal	Intake VANOS solenoid
6	input	Eccentric shaft sensor signal	Eccentric shaft sensor
7	input	Eccentric shaft sensor signal	Eccentric shaft sensor
8	input	Eccentric shaft sensor signal	Eccentric shaft sensor
9	input	Eccentric shaft sensor signal	Eccentric shaft sensor
10	ground	Wire shielding	Eccentric shaft 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

Connector X60007 26-pin (signals) (continued)

Pin	Type	Component or function	Note
14	output	Fuel injector signal	Fuel injector signal 4
15	output	Fuel injector signal	Fuel injector signal 5
16	output	Fuel injector signal	Fuel injector signal 6
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	ground	Eccentric shaft sensor	Eccentric shaft sensor
21	output	Eccentric shaft sensor voltage supply	Eccentric shaft sensor
22	input	Eccentric shaft sensor signal	Eccentric shaft sensor
23	output	Valvetronic actuator relay signal	Valvetronic actuator relay
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

SIEMENS DME (TURBO)

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)

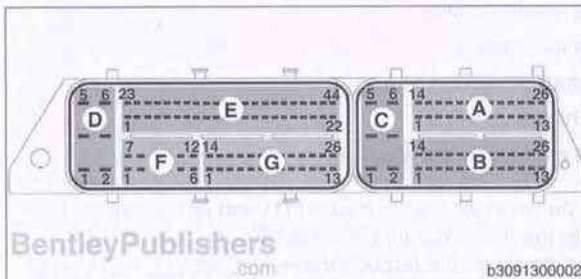
Performance controls

- 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
- EWS (electronic immobilizer)
- 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 sub connectors and 147 pins.

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

NOTE—

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

Fuel metering

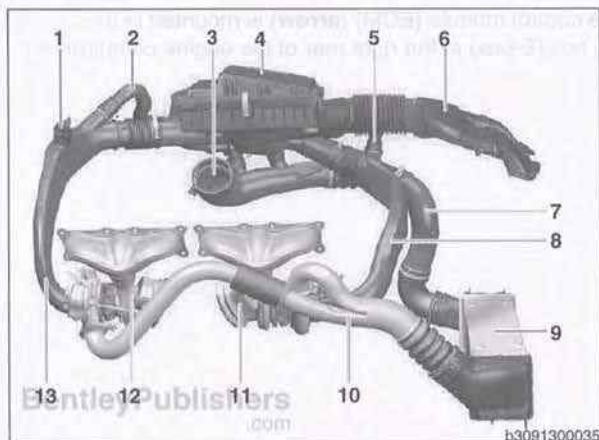
The ECM meters pressurized fuel by changing the opening time (pulse width) of the fuel injectors. The exact amount of fuel injected is determined by the amount of time the injectors are open.

➤ 3 Series model turbo charged engines utilize direct fuel injection. The fuel injector (**arrow**) is mounted into a machined hole in the cylinder head near the spark plug.

A direct injection turbo charged 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 the 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.

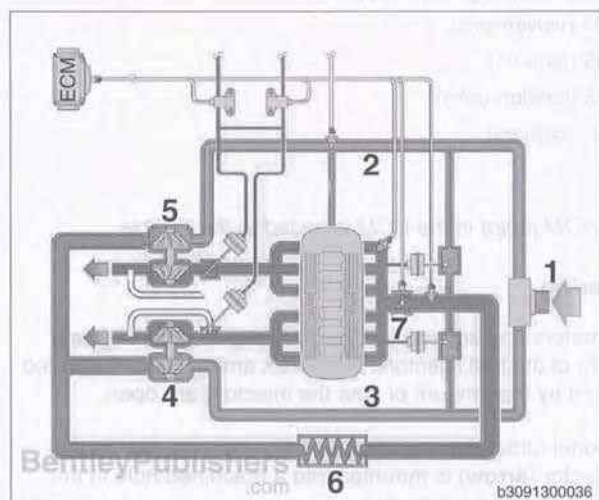




Air intake

➤ 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 the air intake ducting is leak free and installed properly.

1. PTC heater for blow by gases
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 compressors (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

3 Series turbocharged engine features electronic throttle control (EDK). There is no throttle cable between the accelerator pedal and the throttle housing. EDK integrates the driver command 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. The 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.

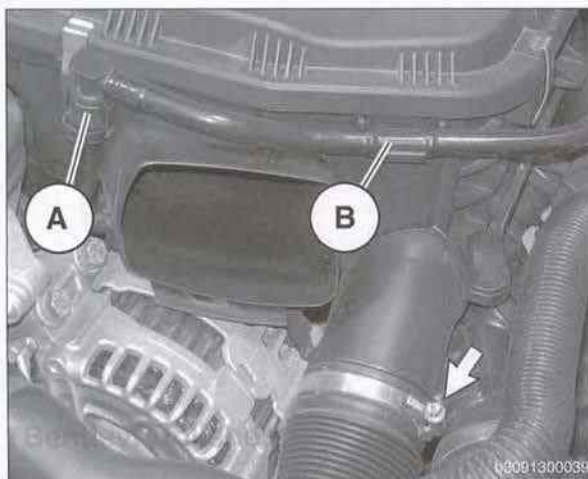
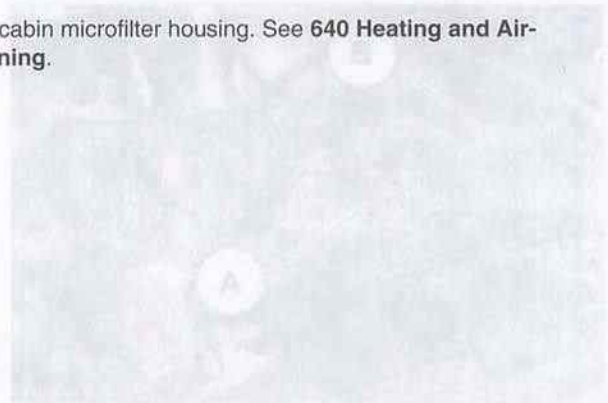
Knock sensor replacement is covered in **120 Ignition System**.

Air filter housing and ducts, removing and installing (turbo)



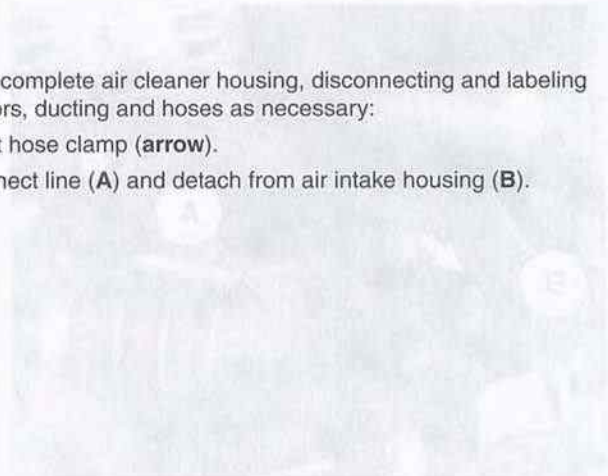
Working at front of engine compartment above radiator, remove air intake hood screws (A). Detach air intake duct (arrow) and lift out of radiator support.

— Remove cabin microfilter housing. See **640 Heating and Air-conditioning**.



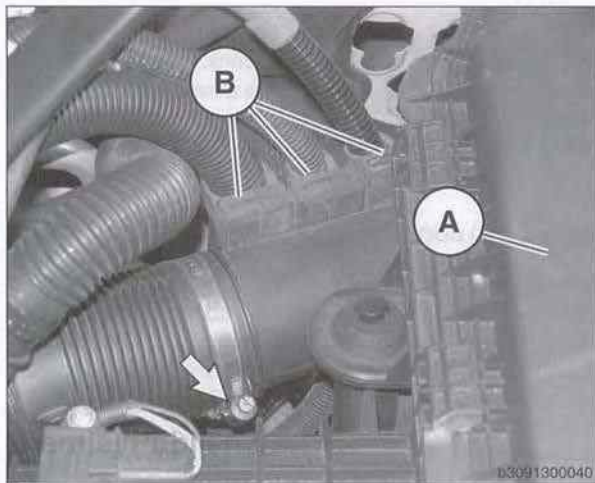
Remove complete air cleaner housing, disconnecting and labeling connectors, ducting and hoses as necessary:

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



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Charge air ducts, left side, removing and installing (turbo)



- ◀ Loosen clamp (**arrow**) and remove air intake hose.
 - Pull off wiring harness holders (**B**) in upward direction.
 - Detach intake filter housing (**A**) from rubber mounts then lift and remove.
- Installation is reverse of removal.

CAUTION—

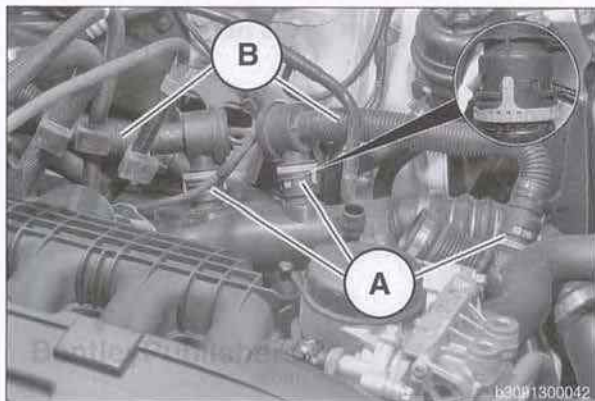
- Turbocharger failure may result if charge air ducts are not installed dry and free of grease. Install using antiseize compound only.

- After reinstalling, check for fault codes and reset ECM memory.

Charge air ducts, left side, removing and installing (turbo)

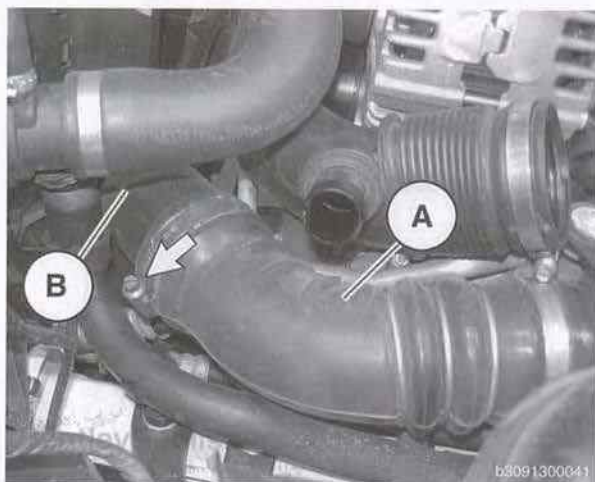
- Remove air filter housing and ducts. See **Air filter housing and ducts, removing and installing (turbo)** in this chapter.

- ◀ 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.

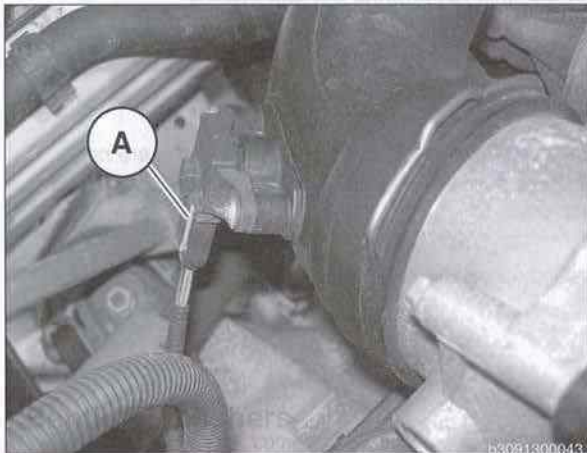


- ◀ Working at left charge air duct:

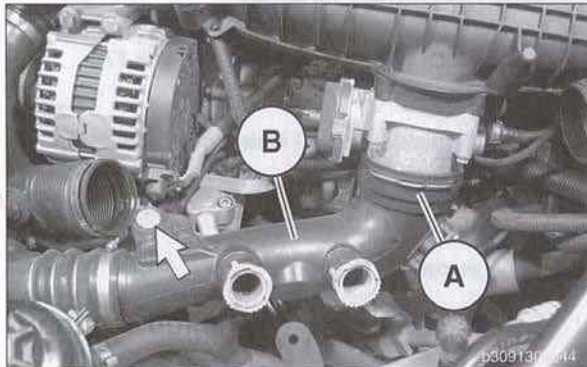
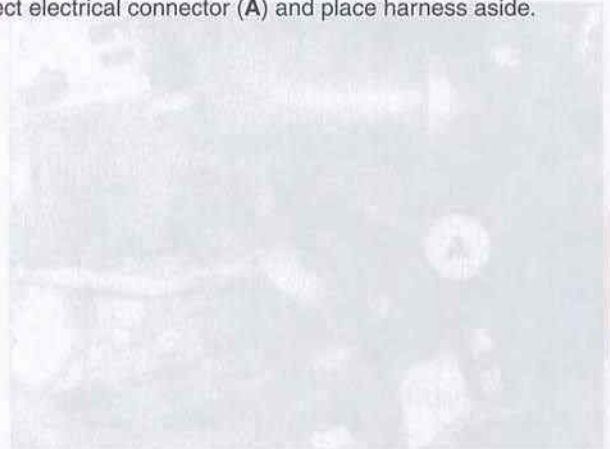
- Loosen clamp (**arrow**) and remove charge air hose (**A**) from duct (**B**).



Charge air ducts, left side, removing and installing (turbo)



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

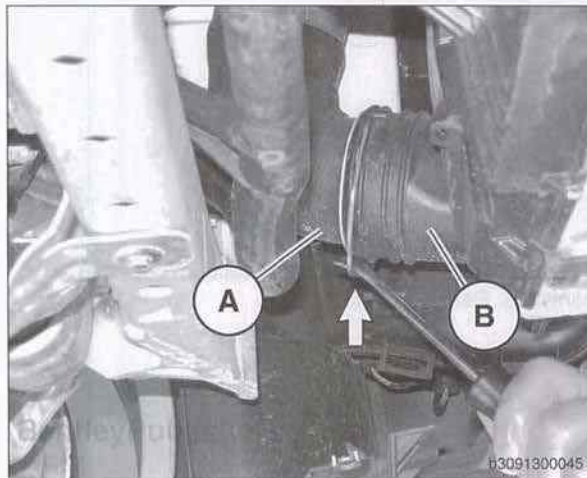


- Remove fastener (arrow).
- Unlock quick connect (A) and remove charge air duct (B) from throttle valve.
- Raise vehicle and support safely.

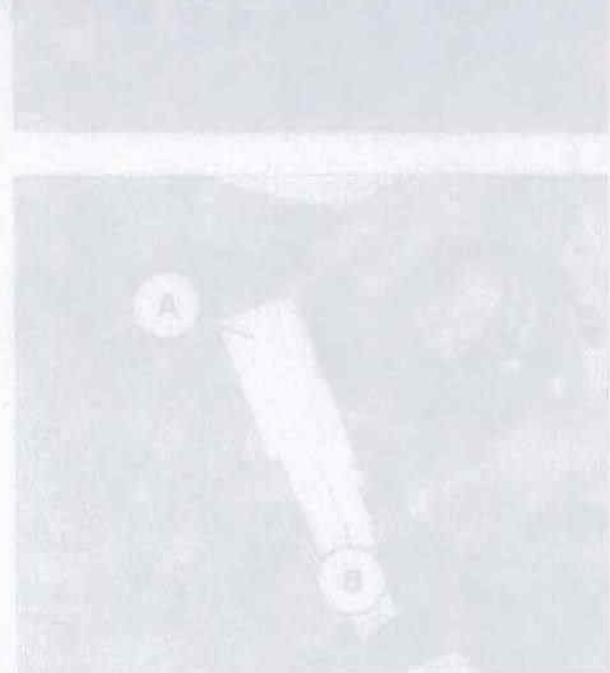
WARNING —

- 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 engine splash shield. See 020 Maintenance.

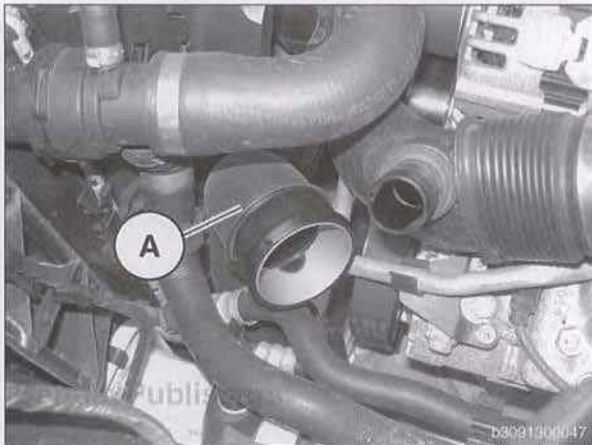


- Working under vehicle at right front air charge duct:
- Unlock quick connect (arrow) and disconnect charge air duct (A) from intercooler (B).



130-40 Fuel Injection

Charge air ducts, right side, removing and installing (turbo)



➤ 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 for fault codes and reset ECM memory.

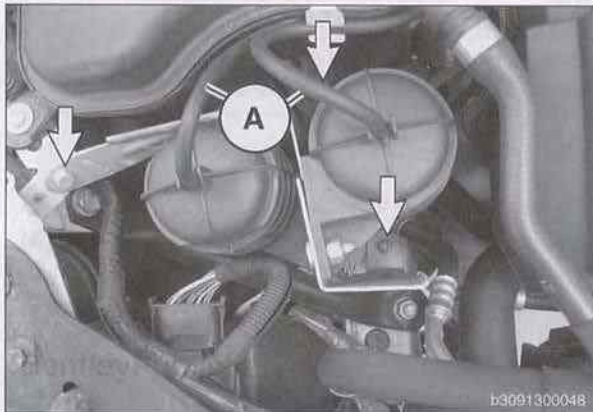
Charge air ducts, right side, removing and installing (turbo)

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

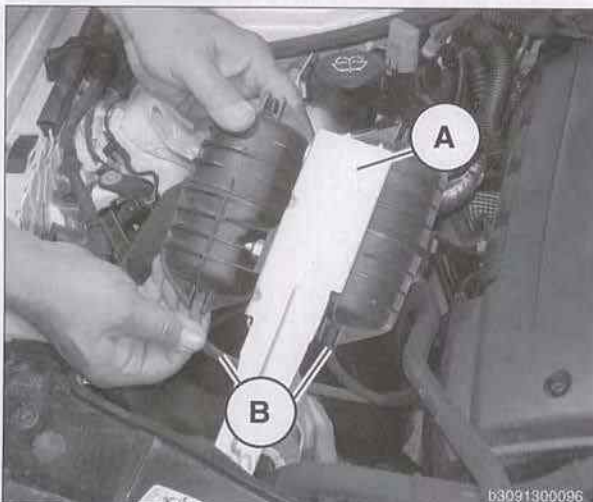
— Remove engine splash shield. See 020 Maintenance.

➤ Working in right front engine compartment:

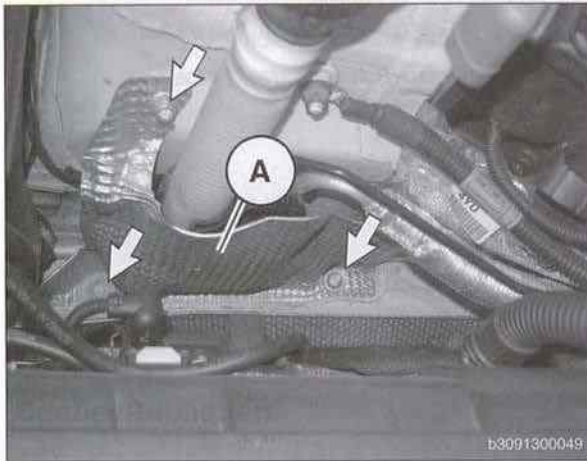
- Label and remove vacuum lines (A).
- Remove fasteners (arrows).



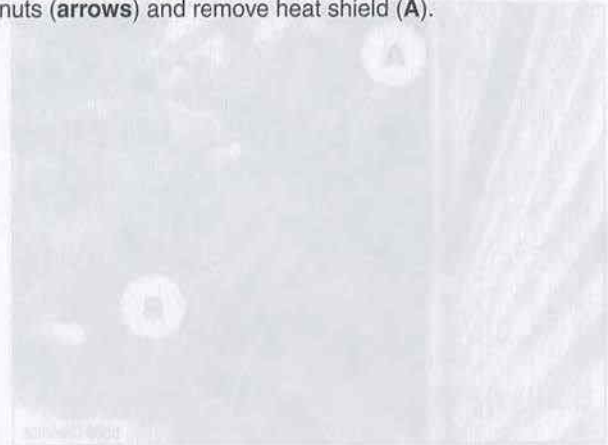
➤ Raise bracket (A) slightly, label and remove vacuum hoses (B) from bottom of canisters. Remove assembly.



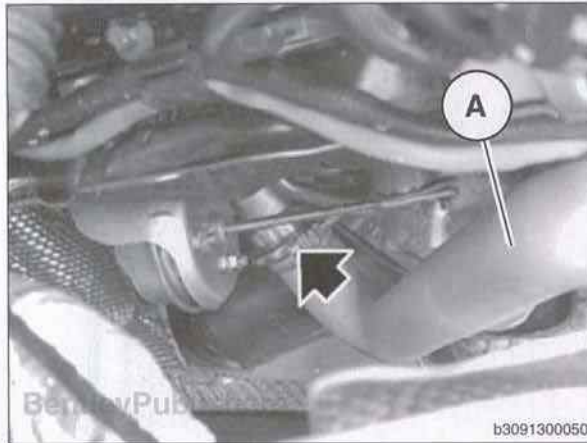
Charge air ducts, right side, removing and installing (turbo)



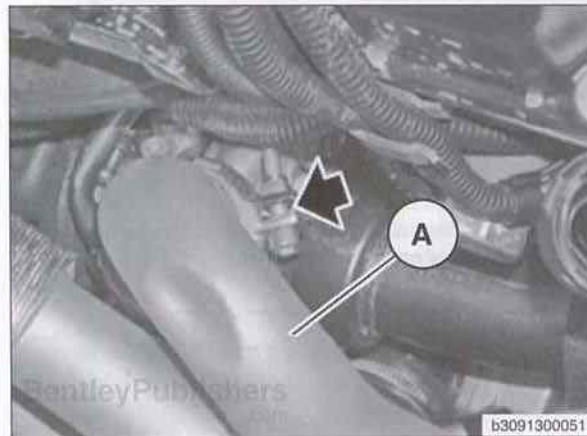
Remove nuts (**arrows**) and remove heat shield (**A**).



130



Loosen clamp (**arrow**) and remove charge air duct (**A**).

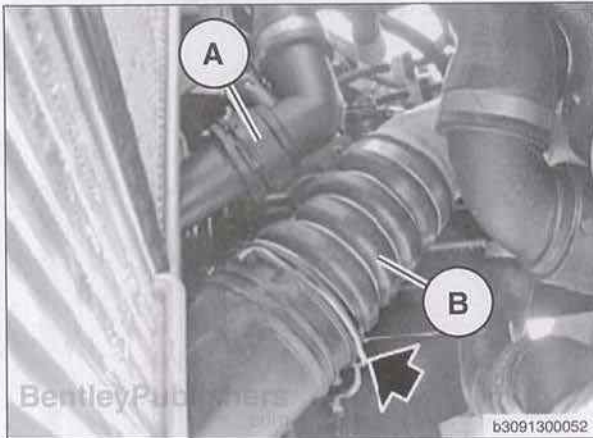


Loosen clamp (**arrow**) and remove charge air duct (**A**).



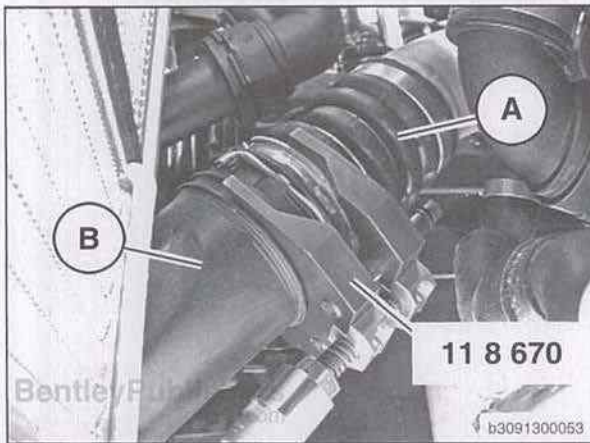
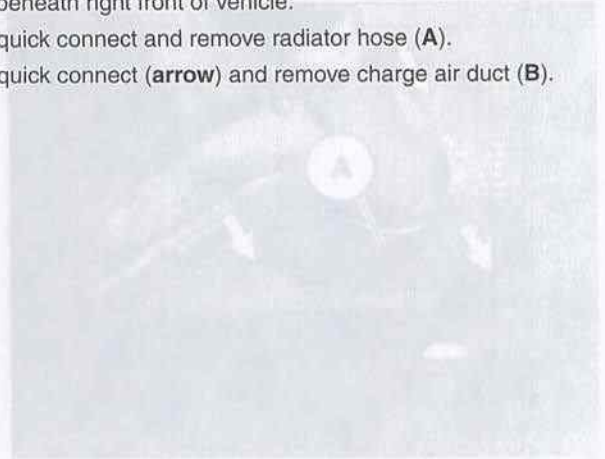
130-42 Fuel Injection

Charge air ducts, right side, removing and installing (turbo)

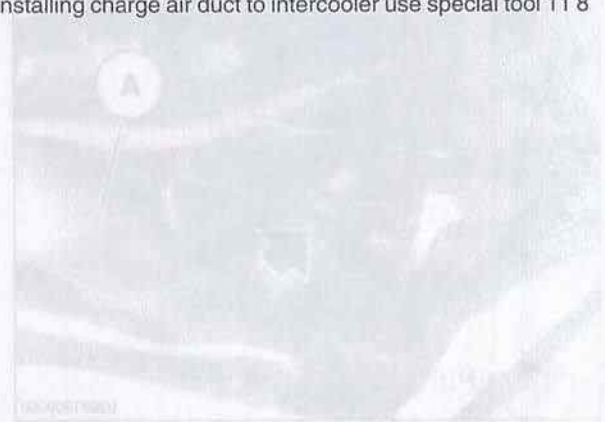


Working beneath right front of vehicle:

- 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 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 for fault codes and reset ECM memory.

Mass air flow, measurement (turbo)

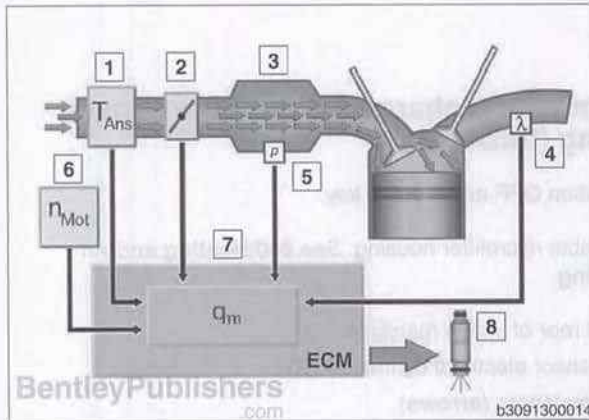
3 Series turbo engine utilizes a calculated air mass system. This calculation makes use of the following signals:

- 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.



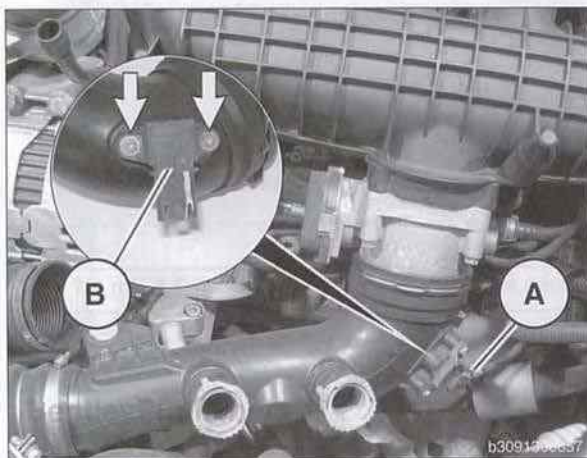
Charge air duct pressure sensor, replacing (turbo)

- Switch ignition OFF and remove key.

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

➤ Working at throttle body charge air duct:

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



130-44 Fuel Injection

Intake manifold charge air pressure sensor, replacing (turbo)



Installation is reverse of removal. Inspect O-ring (**arrow**) and replace in necessary.

- After reinstalling, check for fault codes and reset ECM memory.

Tightening torques

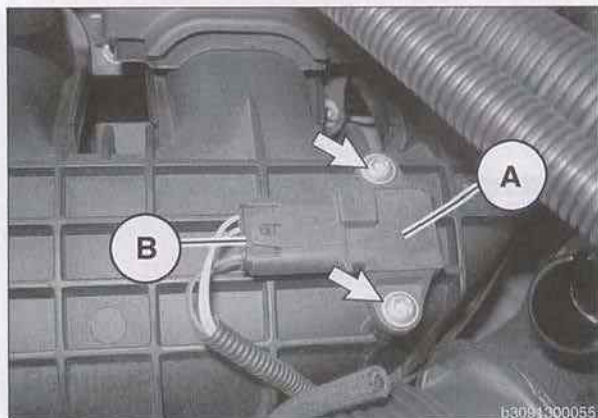
Sensor to charge air duct	3.5 Nm (31 in-lb)
---------------------------	-------------------

Intake manifold charge air pressure sensor, replacing (turbo)

- Switch ignition OFF and remove key.
- Remove cabin microfilter housing. See 640 Heating and Air-conditioning.

Working at rear of intake manifold:

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



Installation is reverse of removal.

- Inspect O-ring (**arrow**) and replace if necessary.

- After reinstalling, check for fault codes and reset ECM memory.

Tightening torques

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



Throttle housing, replacing (turbo)

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.

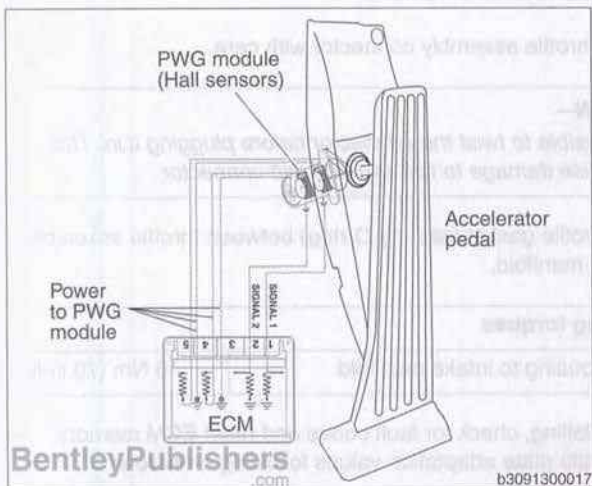
The throttle housing unit is non-adjustable. If found to be faulty, replace as a complete unit.

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

CAUTION—

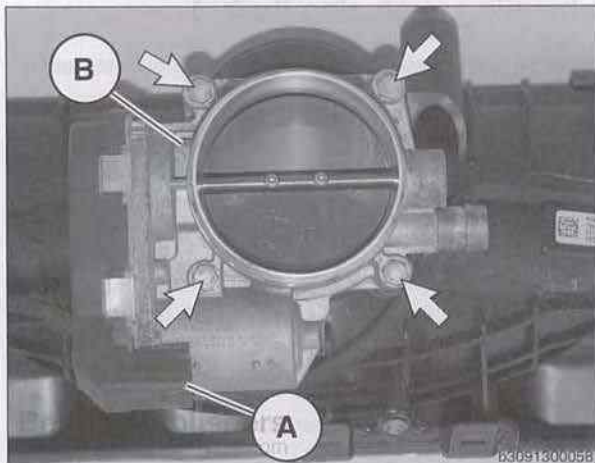
- If the adaptation process is not completed correctly, the engine will not start.

- Switch ignition OFF and remove key.
- Remove air filter housing and ducts. See **Air filter housing and ducts, removing and installing (turbo)** 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).



130-46 Fuel Injection

Fuel injector service (turbo)



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

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

- 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.

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

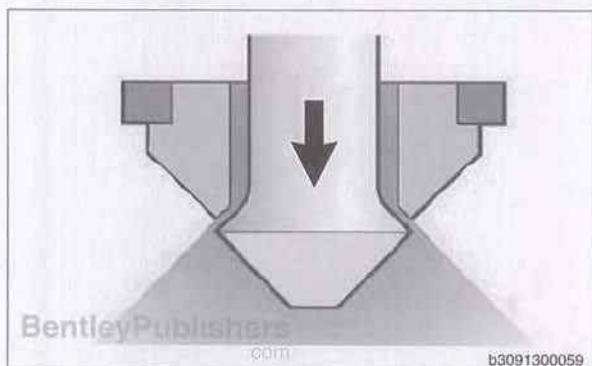
Tightening torques

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

- After reinstalling, check for fault codes and reset ECM memory. Reset throttle plate adaptation values following on-screen directions.

Fuel injector service (turbo)

- Fuel injectors are electrically controlled solenoid valves that provide precisely metered and atomized fuel into the engine intake ports. E90 turbo 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 the metering and switching performance.

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 flows 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 (turbo)

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

CAUTION—

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

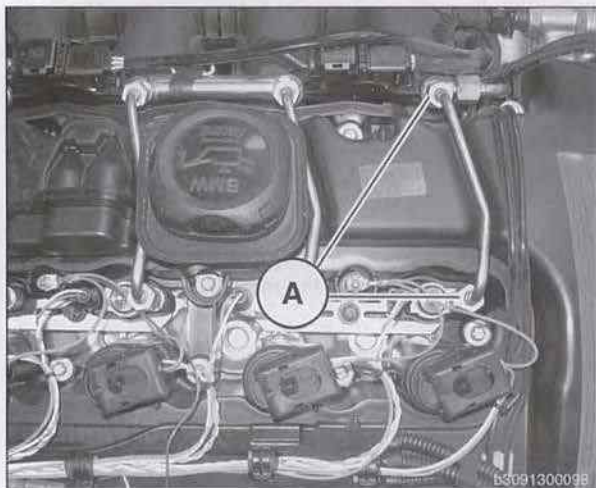
- Remove cabin microfilter housing. See **640 Heating and Air-conditioning**.
- Remove ignition coil cover. See **020 Maintenance**.
- Remove ignition coil at corresponding cylinder of fuel injector service. See **120 Ignition System**.

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.

130-48 Fuel Injection

Fuel injectors, removing (turbo)



- Remove fuel line to corresponding fuel injector (A).

WARNING—

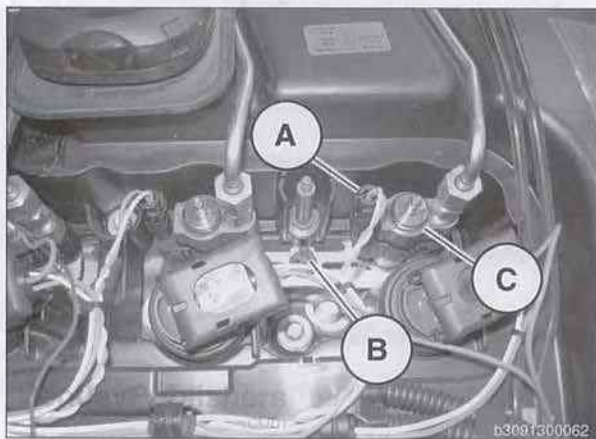
- Fuel in the fuel line is under pressure (approx. 200 bar or 2900 psi) and may be expelled forcibly. Do not smoke or work near heaters or other fire hazards. Keep a fire extinguisher handy.
- Work only on fuel system when engine temperature is below 40°C (104°F).
- Unscrew the fuel tank cap to release 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 all fuel system opening 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).

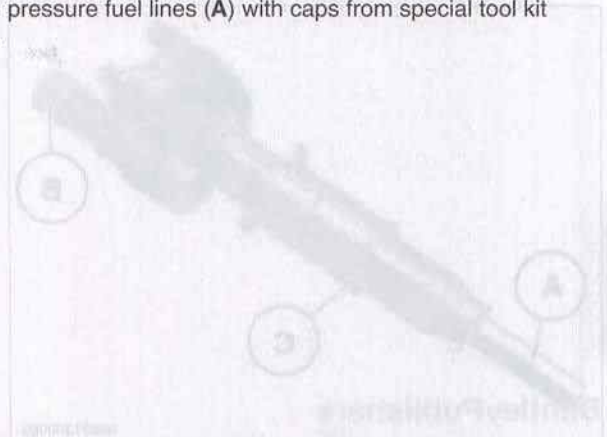
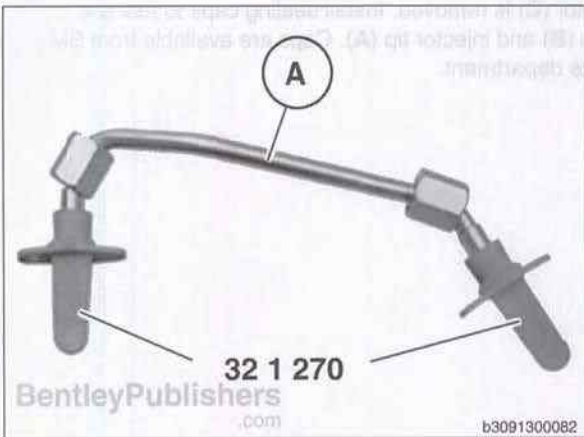


- Unlock and remove electrical connector (A). Remove fastener and remove hold-down bracket (B). Remove injector (C)



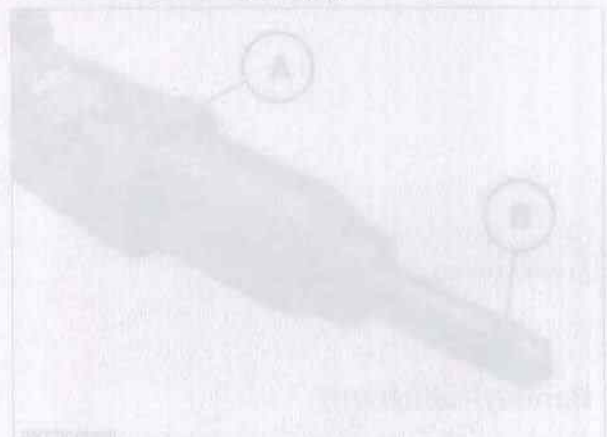
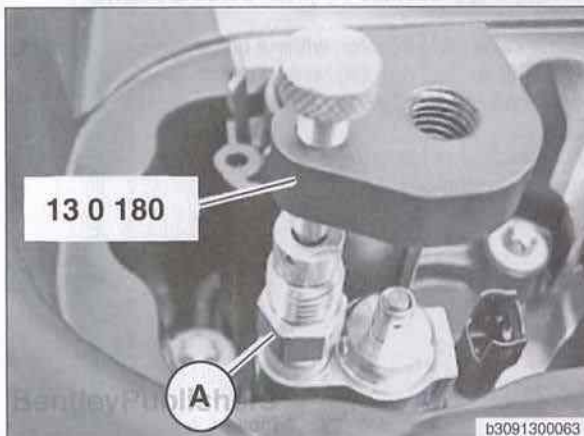
- Seal injector (A) with cap and fuel rail connections with plug from special tool kit 32 1 270.

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

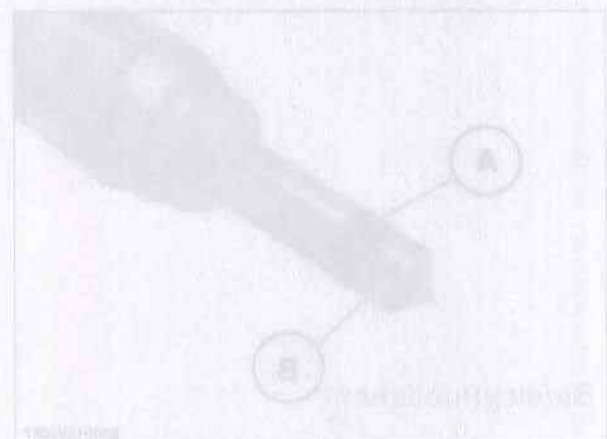
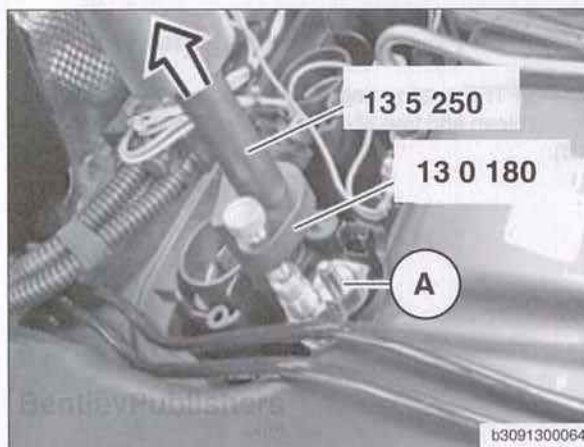


The following procedure can be used if of an injector is stuck in the cylinder head.

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



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

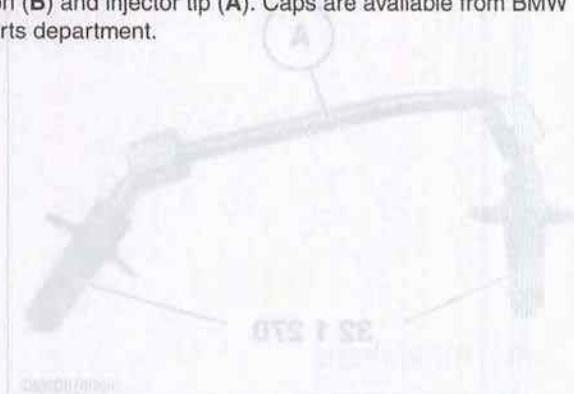


130-50 Fuel Injection

Injector bore, cleaning (turbo)



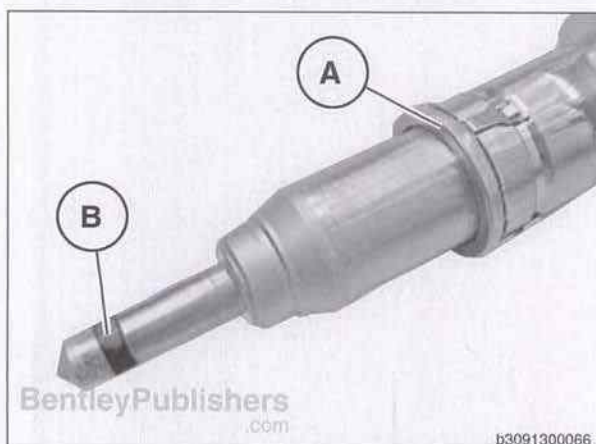
- Once injector (C) is removed. Install sealing caps to fuel line connection (B) and injector tip (A). Caps are available from BMW dealer parts department.



Injector bore, cleaning (turbo)

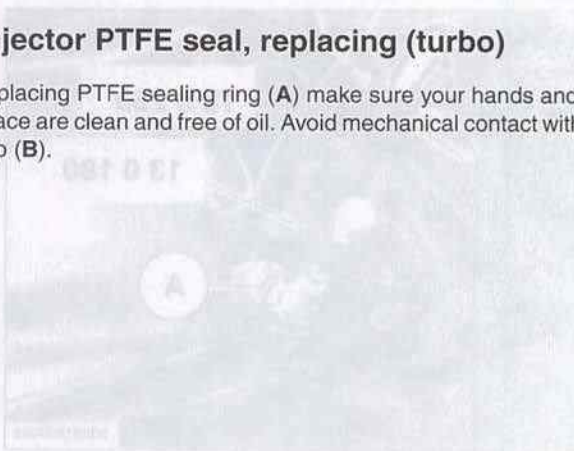
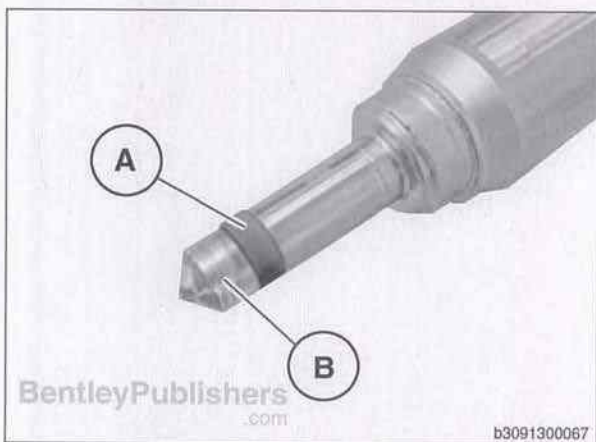
Only use the following procedure if injector bores are dirty.

- 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).

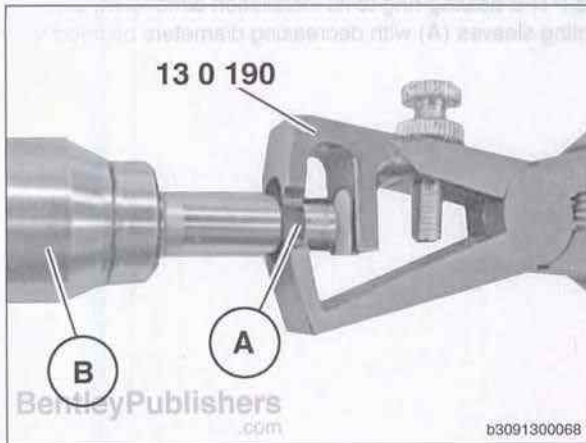


Fuel injector PTFE seal, replacing (turbo)

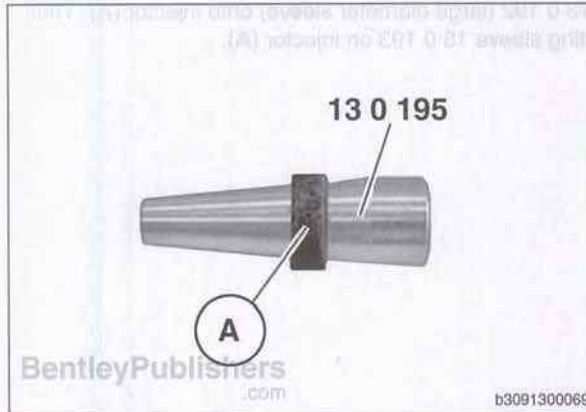
- Before replacing PTFE sealing ring (A) make sure your hands and work surface are clean and free of oil. Avoid mechanical contact with injector tip (B).



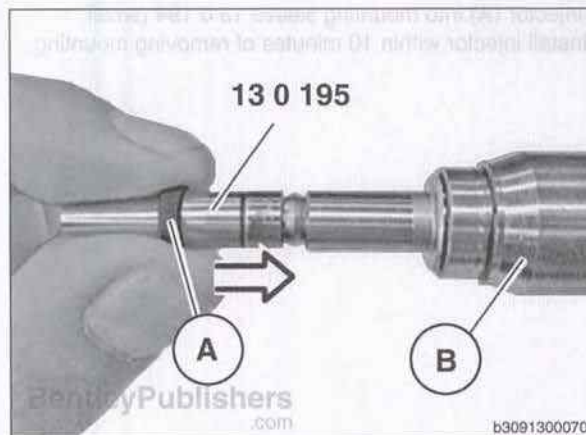
- Using special tool 13 0 190, remove PTFE sealing ring (A) from injector (B). Use a lint-free cloth to remove combustion residue from cylindrical part of injector tip. Do not clean injector tip.



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

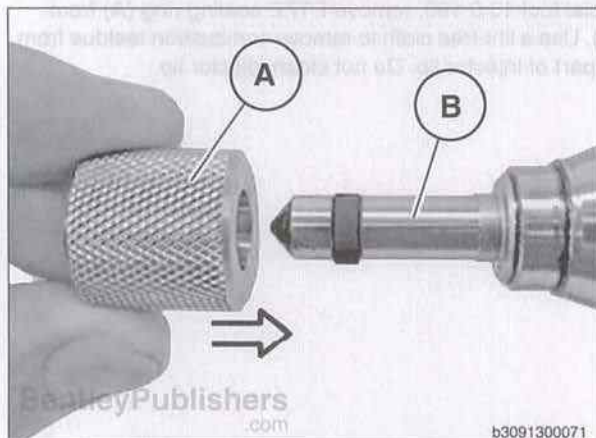


- Using fingers and mounting taper (13 0 195) install PTFE sealing ring (A) onto injector (B).

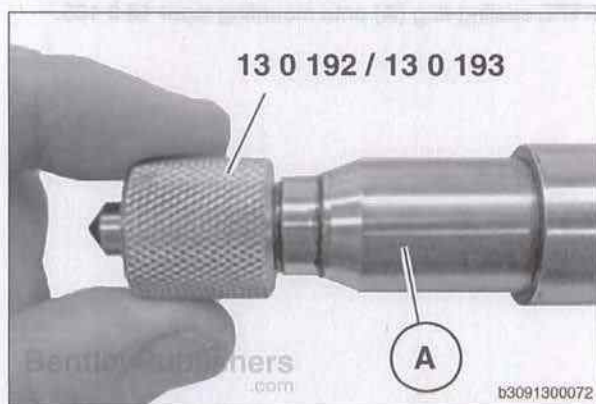


130-52 Fuel Injection

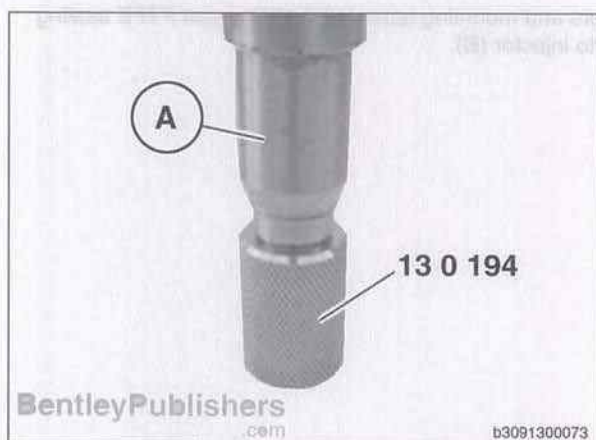
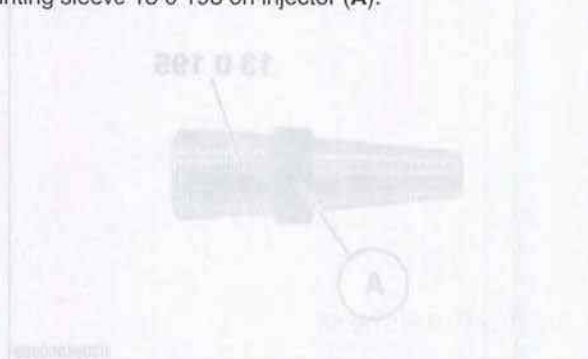
Fuel injector PTFE seal, replacing (turbo)



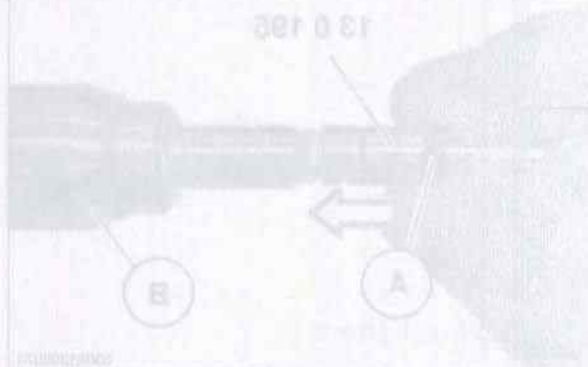
◀ To bring the PTFE sealing ring to its installation dimension, slide three mounting sleeves (A) with decreasing diameters on injector (B).



◀ First slide 13 0 192 (large diameter sleeve) onto 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.

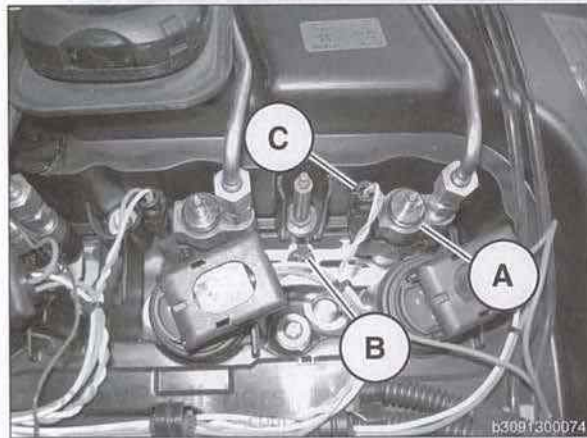
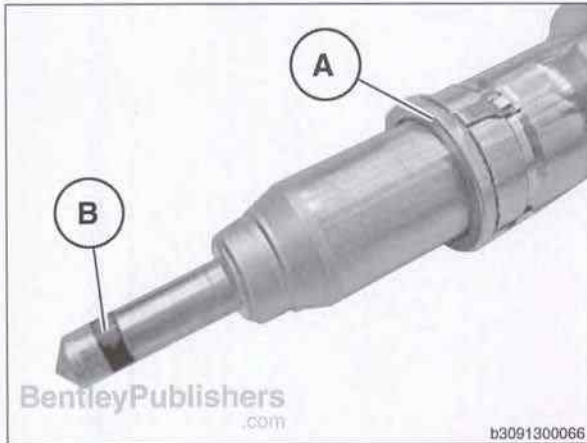


Fuel injectors, installing (turbo)



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.

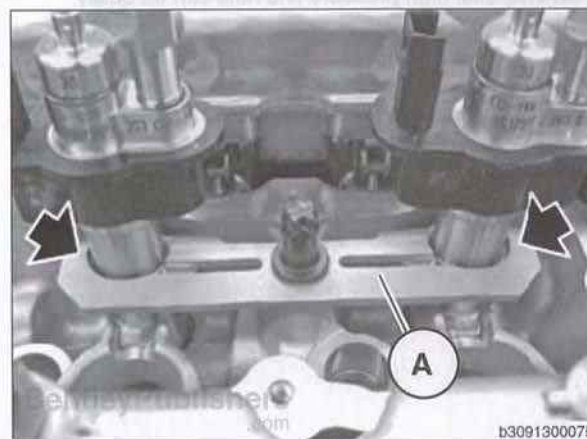


Working at cylinder head:

- 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).

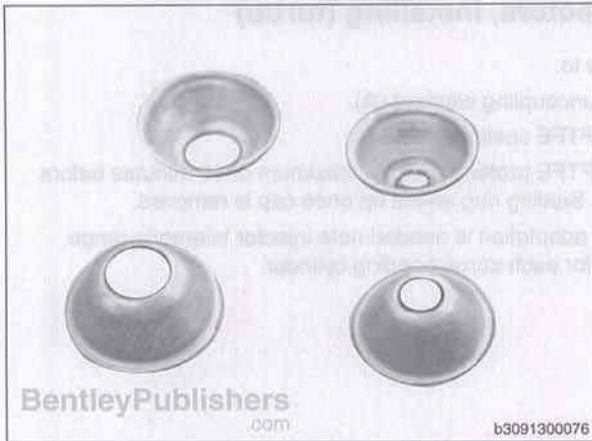


Check that the hold-down bracket (A) is correctly installed (arrows).

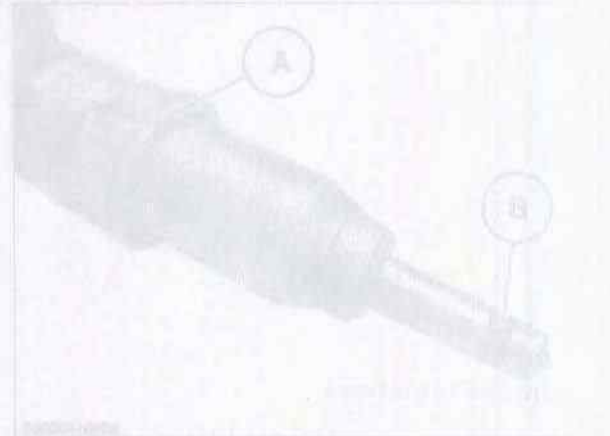


130-54 Fuel Injection

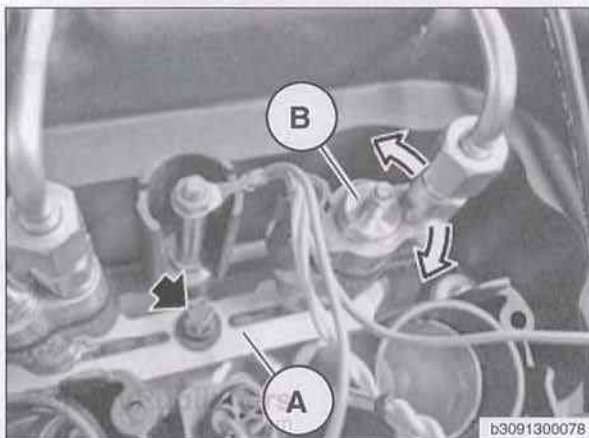
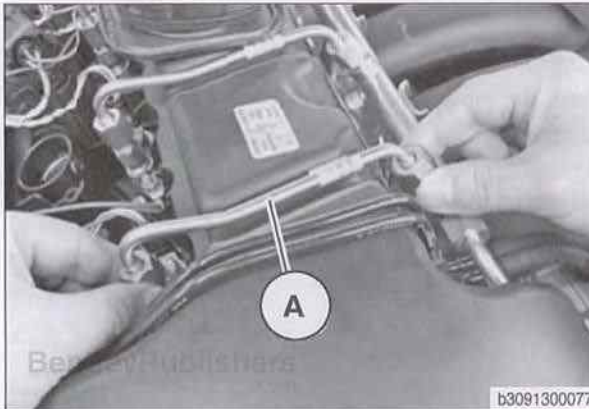
Fuel injectors, installing (turbo)



- ⚠ 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.

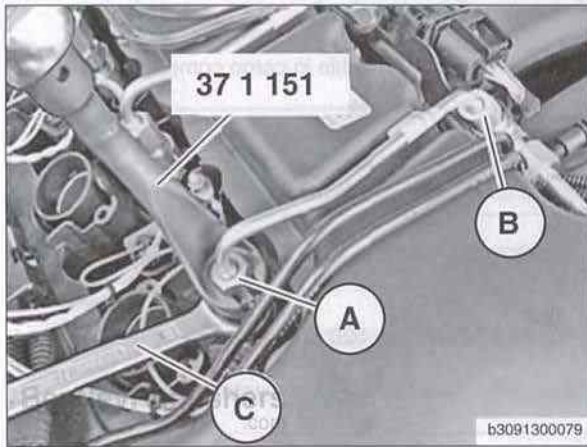


- ⚠ If fuel lines cannot be easily installed by hand, rotate injector in direction of **arrows** until high pressure line nuts can be easily tightened by hand.

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

Tightening torque

Hold-down bracket to cylinder head	13 Nm (9.5 ft-lb)
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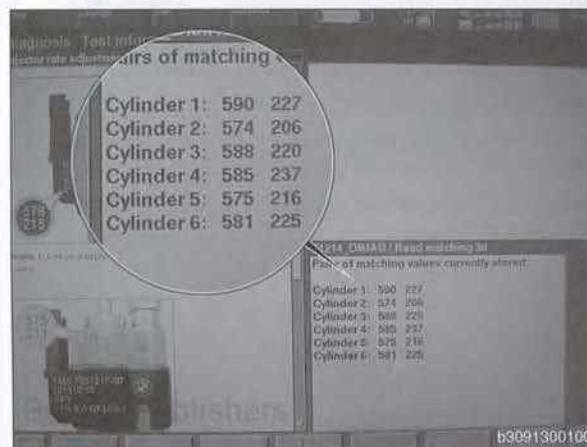
- Use following tightening sequence:
- Tighten nut (A) using special tool 37 1 151 while holding injector with wrench (C).
 - Tighten nut (B) using special tool 37 1 151.
- Clean all fuel from ignition coil hole.
 - Check fuel system for leaks.
 - Perform injector adaptation. See **Fuel injector adaptation** in this repair group.
 - Check for fault codes and reset 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 (turbo)

- Connect BMW scan tool or equivalent 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 the correct tolerance range (**inset**) has been entered for each injector.

Fuel rail, removing (turbo)

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

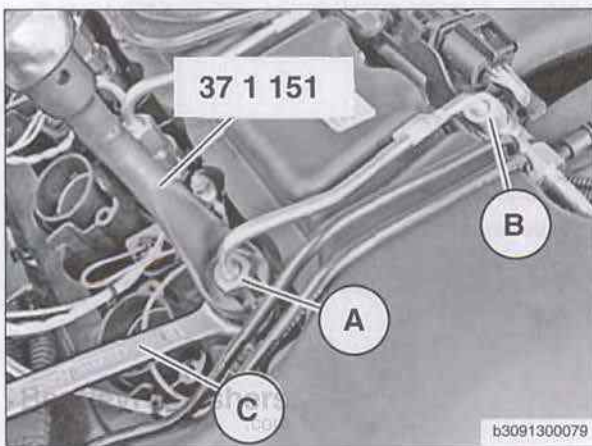
CAUTION—

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

- Remove cabin microfilter housing. See **640 Heating and Air-conditioning**.
- Remove ignition coil cover. See **020 Maintenance**.
- Remove ignition coils. See **120 Ignition System**.

CAUTION—

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

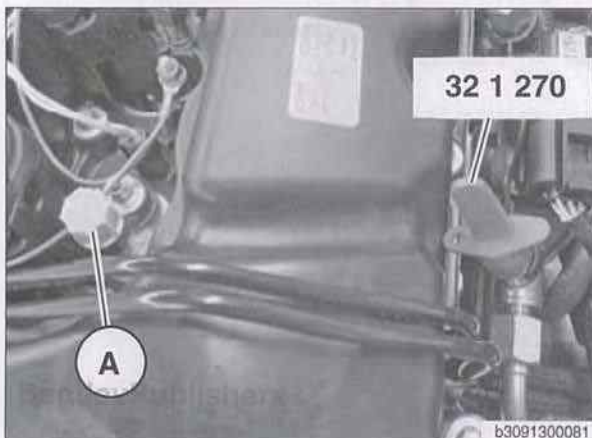


- Label position and remove high pressure fuel lines:

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

WARNING—

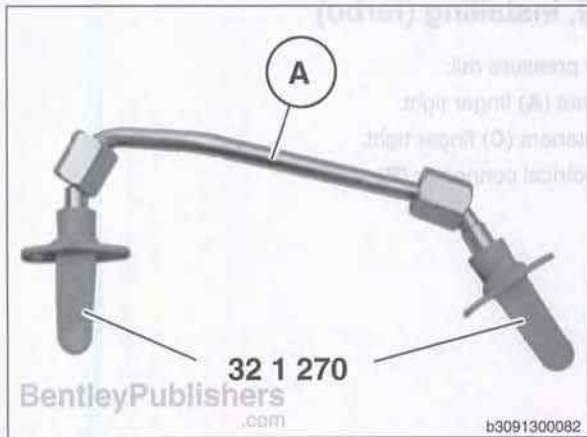
- Fuel in the fuel line is under pressure (approx. 200 bar or 2900 psi) and may be expelled forcibly. Do not smoke or work near heaters or other fire hazards. Keep a fire extinguisher handy.
- Work only on fuel system when engine temperature is below 40°C (104°F).
- Unscrew the fuel tank cap to release 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.



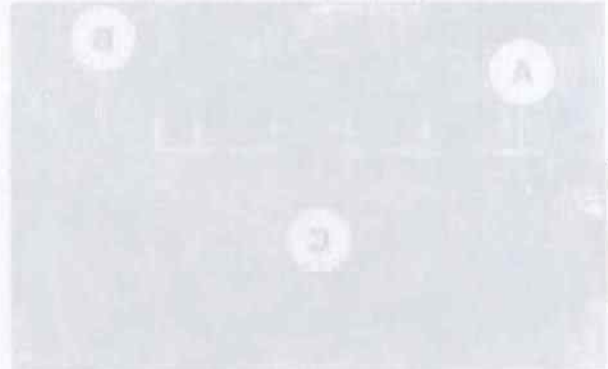
CAUTION—

- 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.

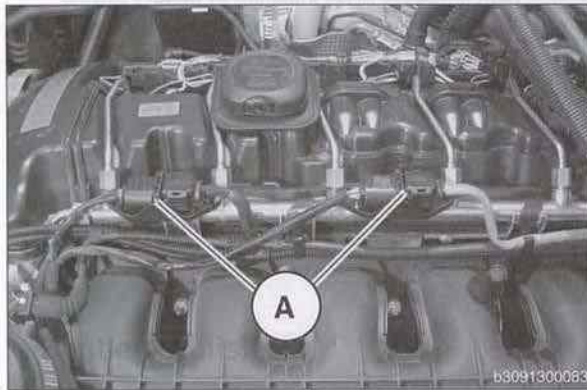
- Seal injector (A) with cap and fuel rail connections with plug from special tool kit 32 1 270.



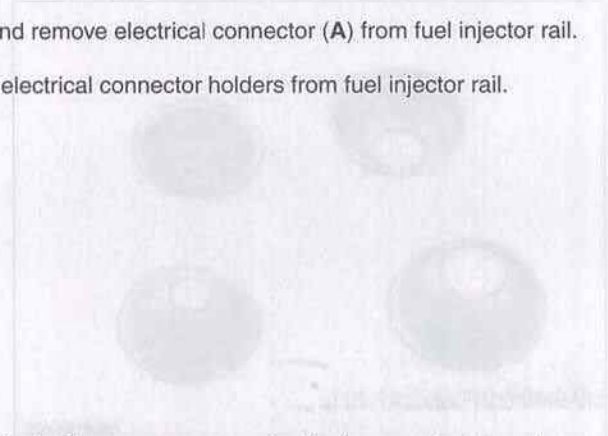
- Seal high pressure fuel lines (A) with caps from special tool kit 32 1 270.



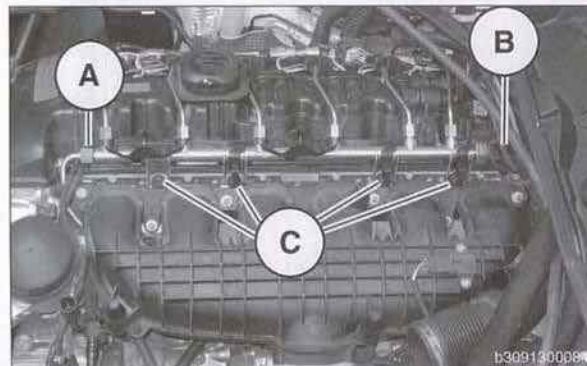
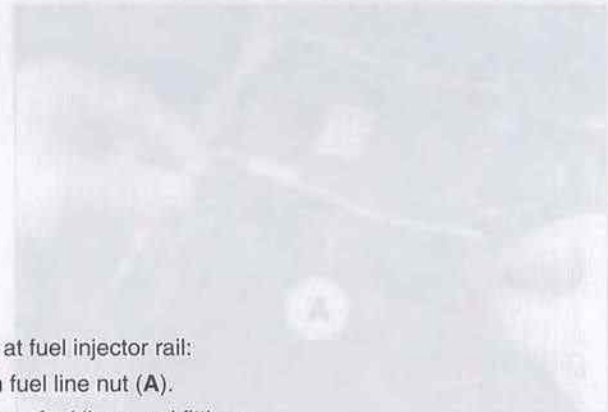
130



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



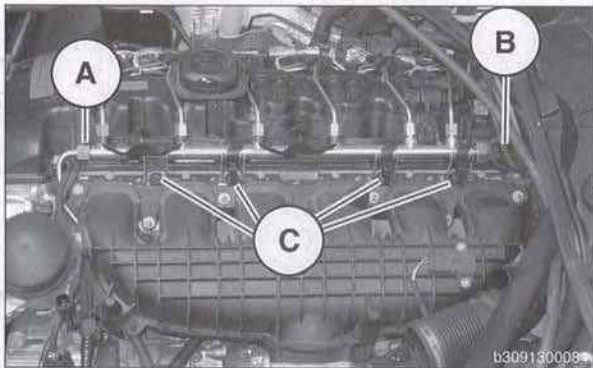
- Remove fuel rail pressure sensor electrical connector (arrow).



- Working at fuel injector rail:
 - Loosen fuel line 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 injector rail (C).
 - Seal connections at high pressure line (A) and fuel rail (C).

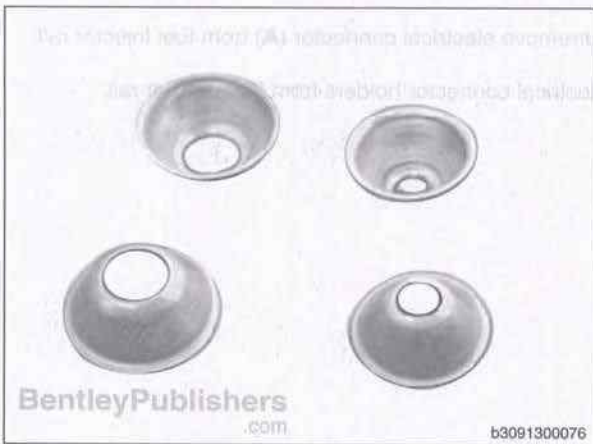
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Fuel rail, installing (turbo)

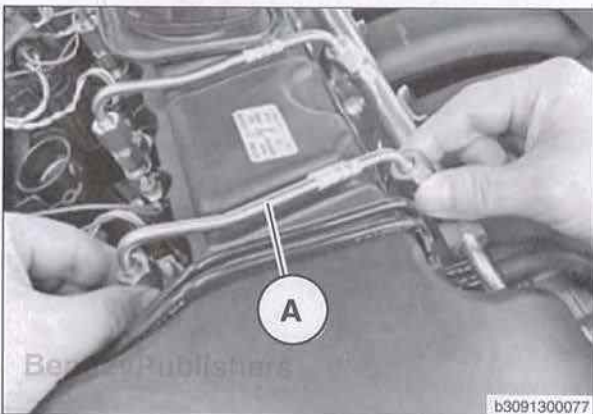


Fuel rail, installing (turbo)

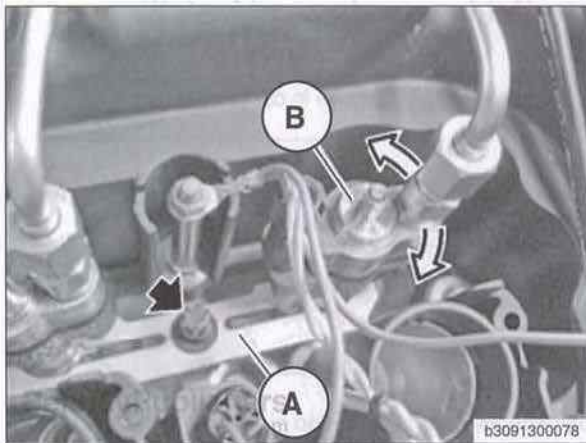
- Install high pressure rail:
- Connect nut (A) finger tight.
 - Install fasteners (C) finger tight.
 - Install electrical connector (B).



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



- Connect high pressure line 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.



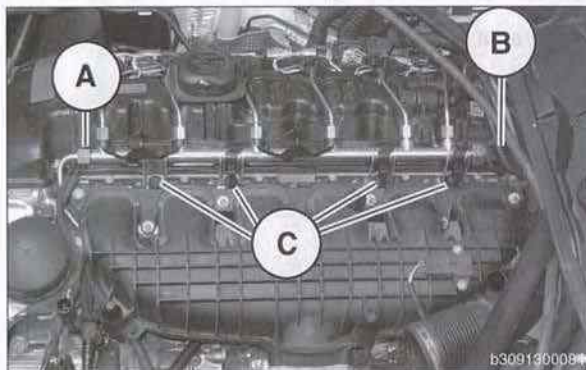
⚡ If fuel lines cannot be easily installed by hand:

- 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)
------------------------------------	-------------------

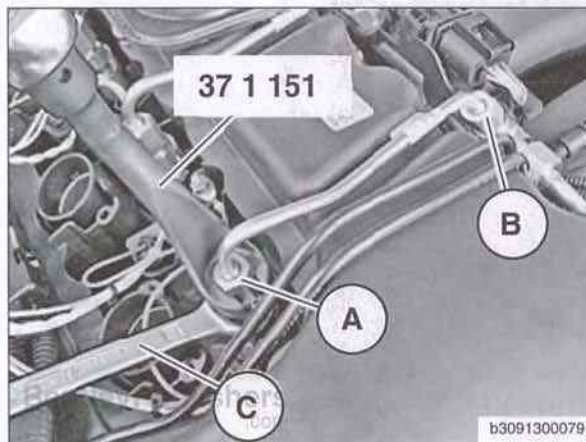


⚡ Tighten fuel injector rail (C) fasteners (B).

— 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 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.

— Check for fault codes and reset 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)

130-60 Fuel Injection

Intake manifold, removing and installing (turbo)

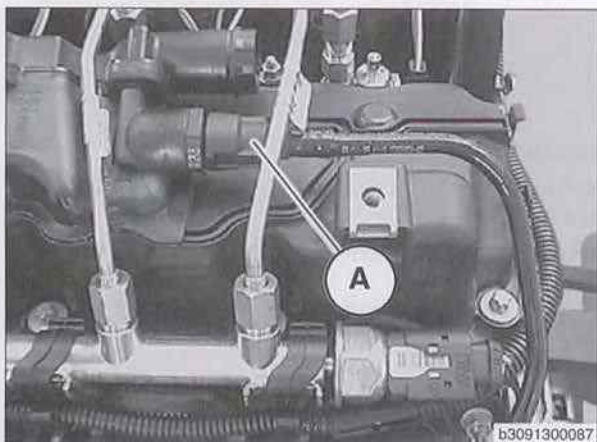
Intake manifold, removing and installing (turbo)

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

CAUTION—

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

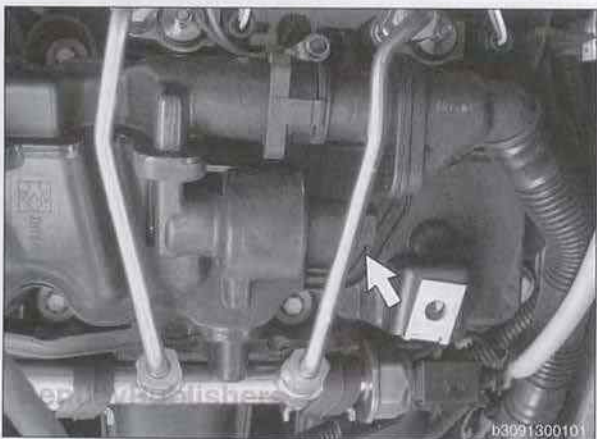
- Remove cabin microfilter housing. See 640 Heating and Air-conditioning.
- Remove ignition coil cover. See 020 Maintenance.
- Remove complete air filter housing and air intake ducts. See **Air filter housing and ducts, removing and installing (turbo)** in this repair group.
- Remove tension strut (arrow) if necessary.



- Disconnect crankcase breather line (A) at cylinder head cover if equipped.

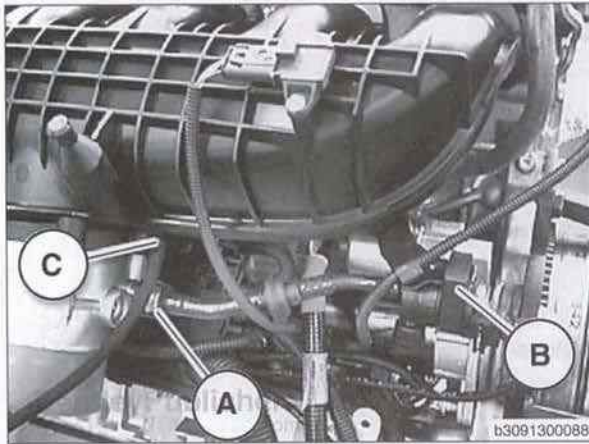
NOTE—

- Not all models have additional line.



- Example of N54 engine without additional crankcase breather line. There will be a plug (arrow) in its place.

Intake manifold, removing and installing (turbo)



Remove throttle housing. See **Throttle housing**, replacing in this repair group.

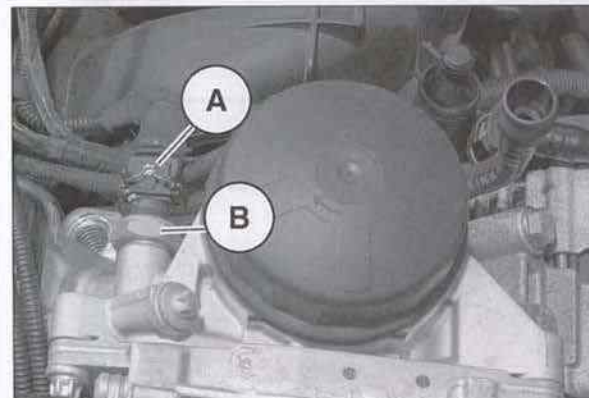


Working at right side underneath intake manifold:

- 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.



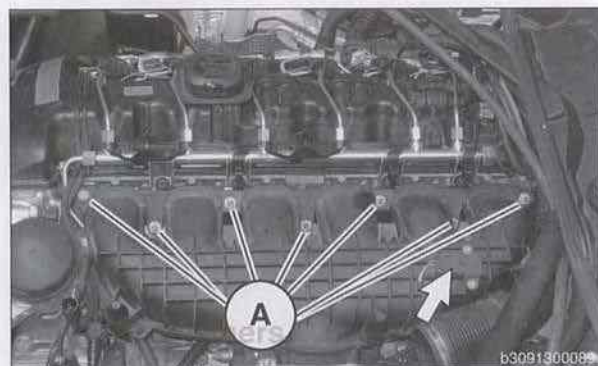
Disconnect electrical connector (A) at oil pressure switch (B).

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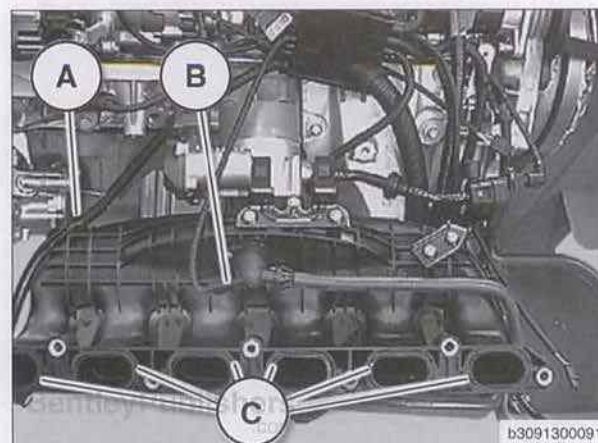
Intake manifold, removing and installing (turbo)



- 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)
---------------------------	------------------

Crankcase breather valve (turbo)

- 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 (turbo engines)

Operating pressure range	7 to 11mbar
Deviation to ambient pressure:	+20 mbar to -60 mbar
Fault condition:	
• Clogged crankcase ventilation	+100 mbar over ambient pressure
• Internal leak in crankcase ventilation	-170 mbar under ambient pressure



Engine coolant temperature (ECT) sensor, replacing (turbo)

The engine coolant temperature (ECT) sensor is an 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.

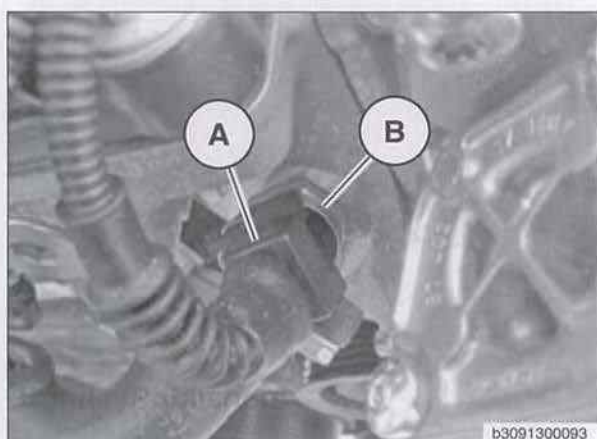
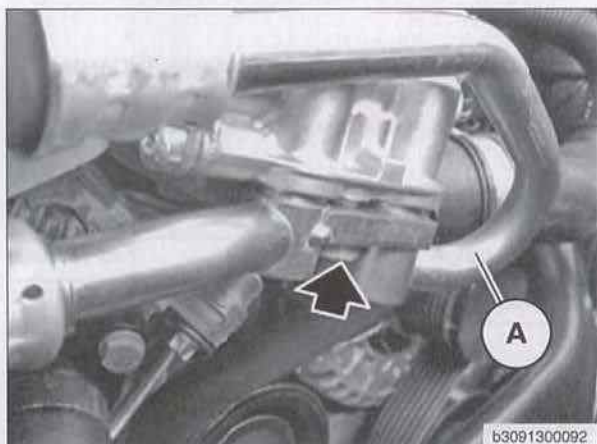
If the ECT sensor input is faulty or not plausible, the MIL is illuminated when OBD II fault criteria are exceeded. The ECM assumes a substitute value (80°C / 176°F) to maintain engine operation. The ignition timing is set to a safely conservative basic setting.

The ECT sensor is located in the 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 for fault codes and reset ECM memory.

DME main relay, testing (turbo)

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

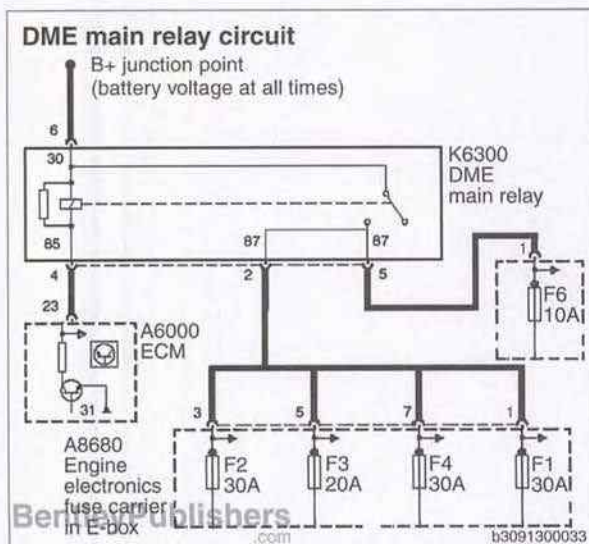
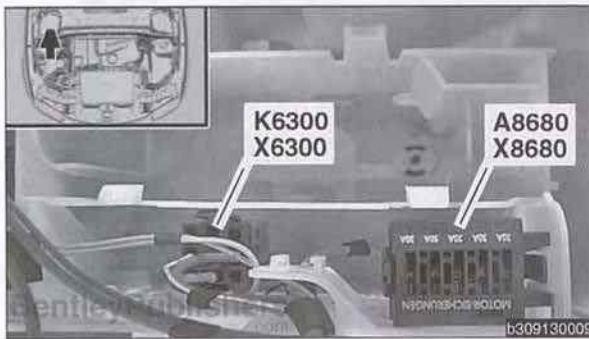
- ECM
- Ignition coils
- Exhaust flap
- E-box cooling fan
- Fuel tank leak detection pump
- Crankshaft sensor
- Camshaft sensors
- Evaporative emissions valve
- Crankcase breather valve heater
- Oil condition sensor
- Electric coolant pump
- Thermostat
- Oxygen sensor heaters

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 F54 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 (turbo)** in this repair group.

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DME main relay, testing (turbo)

— 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 —

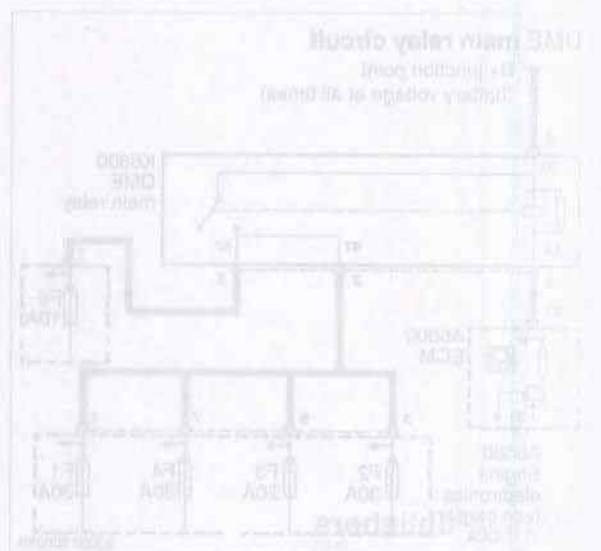
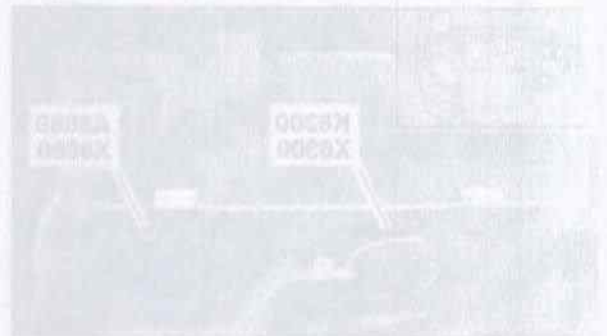
• In some models there is only one terminal 87.

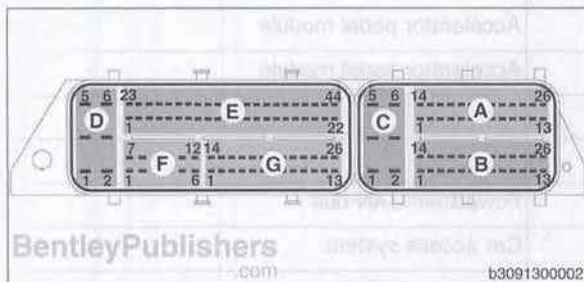
— If battery voltage is present, relay has energized and is functioning correctly.

— 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 for fault codes and reset ECM memory.





ECM pin assignments (turbo)

➤ 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.

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ECM pin assignments (turbo)

Table c. Turbo 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

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ECM pin assignments (turbo)

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

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

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ECM pin assignments (turbo)

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



Connector X60007 26-pin (signals)

Pin	Type	Component or function	Note
1	input	Oil pressure switch	
2	input	Camshaft position sensor 2	
3	input	Camshaft position sensor 1	
4	output	Fuel rail pressure sensor	
5	output	Fuel rail pressure sensor	
6	output	Fuel rail pressure sensor	
7	output	Fuel rail pressure sensor	
8	output	Fuel rail pressure sensor	
9	output	Fuel rail pressure sensor	
10	output	Fuel rail pressure sensor	
11	output	Fuel rail pressure sensor	
12	output	Fuel rail pressure sensor	
13	output	Fuel rail pressure sensor	
14	output	Wastegate control valve signal	
15	output	Exhaust VANOS solenoid signal	
16	input	Engine coolant temperature sensor	
17	Not used		
18	Not used		
19	Not used		
20	Not used		
21	Not used		
22	Not used		
23	Not used		
24	Not used		
25	Not used		
26	Not used		

121 Battery, Starter, Alternator

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GENERAL

This repair group covers the battery, alternator, starter and associated components of the electrical system.

See also:

- **020 Maintenance** for accessory belt replacement and battery routine service.
- **600 Electrical System—General** for bus system information, power reset procedure and general electrical troubleshooting
- **721 Airbag System (SRS)** for battery safety terminal (BST)
- **ECL Electrical Component Locations**
- **ELE Electrical Wiring Diagrams**

Engine electrical system

The alternator and starter are wired directly to the battery. To prevent accidental shorts that might blow a fuse or damage wires and electrical components, disconnect the negative (–) battery cable before working on the electrical system.

121-2 Battery, Starter, Alternator

Troubleshooting

Different versions of alternators, starters and batteries are used in E90 models. Replace components according to the original equipment specifications.

Troubleshooting

Basic battery, starter and charging system troubleshooting information is in **Table a**.

Table a. Battery, starter and charging system troubleshooting

Symptom	Probable cause	Corrective action
Engine does not crank	Fault in car access system (CAS).	Try another ignition key. If problem persists, contact your authorized BMW dealer.
Engine cranks slowly or not at all, solenoid clicks when starter is operated.	Battery cables loose, dirty or corroded.	Clean or replace cables. See 020 Maintenance .
	Battery discharged.	Charge battery and test. Replace if necessary.
	Battery to body ground cable in trunk loose, dirty or corroded	Inspect ground cable. Clean, tighten or replace if necessary.
	Poor connection at starter motor terminal X6512.	Check connections at starter motor.
Battery does not stay charged more than a few days.	Starter motor or solenoid faulty.	Test starter.
	Short circuit draining battery.	Test for excessive current drain with everything electrical off.
	Short driving trips and high electrical drain on charging system does not allow battery to recharge.	Evaluate driving style. Where possible, reduce electrical consumption when making short trips.
	Engine accessory belt loose, worn or damaged.	Inspect or replace accessory belt. See 020 Maintenance .
	Battery faulty.	Test battery and replace if necessary.
	Battery cables loose, dirty or corroded.	Clean or replace cables. See 020 Maintenance .
	Alternator faulty.	Test alternator.

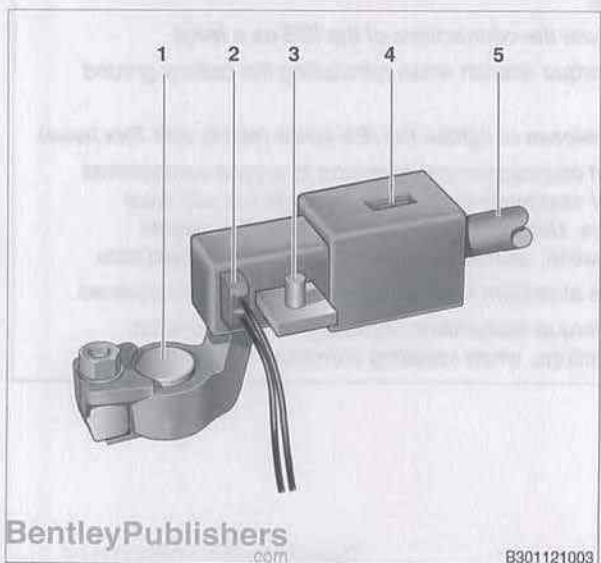
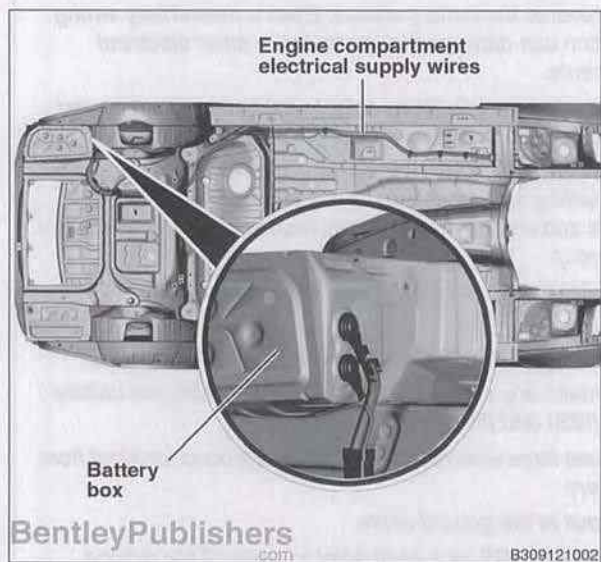
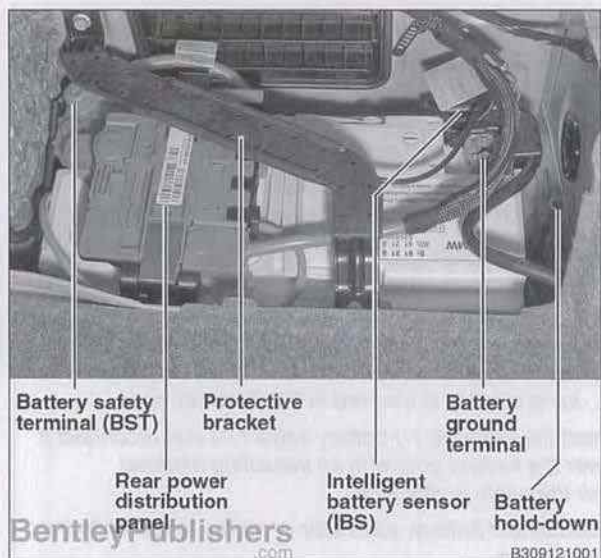
Warnings and Cautions

WARNING—

- Wear goggles, rubber gloves, and a rubber apron when working around the battery or battery acid (electrolyte).
- Battery acid contains sulfuric acid and can cause skin irritation and burning. If acid is spilled on your skin or clothing, flush the area at once with large quantities of water. If electrolyte gets into your eyes, flush them with large quantities of clean water for several minutes and call a physician.
- A battery that is being charged or is fully charged gives off explosive hydrogen gas. Keep sparks and open flames away. Do not smoke.
- Battery lead and battery acid are both hazardous materials. When disposing of an old battery, follow federal, state and local regulations on hazardous waste disposal.

CAUTION—

- Use a digital multimeter when testing automotive electrical components.
- If a repair procedure specifies disconnecting the battery, follow the instruction for safety reasons.
- Prior to disconnecting the battery, read the battery disconnection cautions in **001 Warnings and Cautions**.
- Disconnecting the battery cables may erase fault codes stored in ECM memory.
- Using a conventional battery charger to jump start the vehicle may damage electronic control modules. Use an electronic vehicle power supply or another 12-volt battery for jump-starting. Jump starting is covered in **020 Maintenance**.
- Disconnect the negative (–) battery cable first and reconnect it last. Cover the battery post with an insulating material whenever the cable is removed.
- Do not disconnect battery, alternator or starter wires while the engine is running.
- Do not reverse the battery cables. Even a momentary wrong connection can damage the alternator or other electrical components.
- Do not depend on insulation color to tell battery positive and negative cables apart. Label cables before removing.
- Power windows and sunroof may fail to function properly after disconnecting and reconnecting the battery. Reinitialize windows and sunroof. See **Battery reconnection notes** in this repair group.
- Do not make any additional connections at the negative terminal of the battery.
- Do not modify the battery ground cable.
- Do not make any connections between the intelligent battery sensor (IBS) and the sensor screw.
- Do not use force when disconnecting the ground terminal from the battery.
- Do not pull at the ground cable.
- Do not use the IBS as a pivot point to lever off the ground terminal.
- Do not use the connections of the IBS as a lever.
- Use a torque wrench when reinstalling the battery ground cable.
- Do not release or tighten the IBS screw (screw with Torx head).
- To avoid electrochemical corrosion to engine components made of aluminum-magnesium alloy, do not use steel fasteners. Use aluminum fasteners only. For reliable identification, aluminum fastener heads are painted blue.
- Replace aluminum fasteners each time they are loosened.
- Follow torque instructions, including angle of rotation specifications, when installing aluminum fasteners.



BATTERY

Battery basics

The wet-cell lead-acid battery is rated by ampere / hours (Ah) and cold cranking amps (CCA) listed on the battery.

Battery location and connections

- Underneath the vehicle in the right side of the trunk or cargo compartment, underneath the floor trim.

For rear power distribution panel details, see **ECL Electrical Component Locations**.

- Underneath the vehicle at the battery box are two power transfer points for the two cables that run to the engine compartment.

- One cable goes to the jump start terminal in the engine compartment and then connects to the starter and alternator.
- The second cable is used to supply power to engine electronics (DME and Valvetronic).

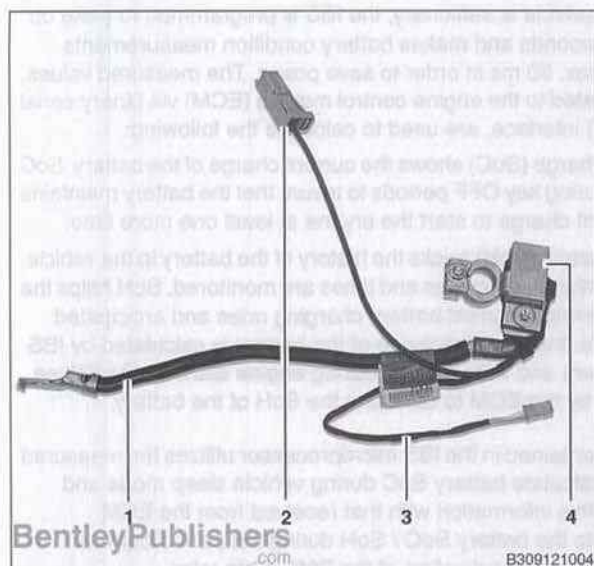
The power cables are routed in a protected area underneath the body of the vehicle.

Battery safety terminal (BST)

- Positive battery terminal (B+)
- BST igniter connector
- B+ to rear power distribution box (A46)
- BST cover retaining clip
- B+ to starter and alternator

The battery safety terminal (BST) is controlled by the multiple restraint system (MRS) control module. The system disconnects electrical power to the engine compartment in case of a significant crash. MRS fires an encapsulated pyrotechnic device in the positive (+) battery terminal that disconnects power to the engine compartment but maintains power to the exterior lights and interior of the vehicle.

See also 721 Airbag System (SRS).



Intelligent battery sensor (IBS)

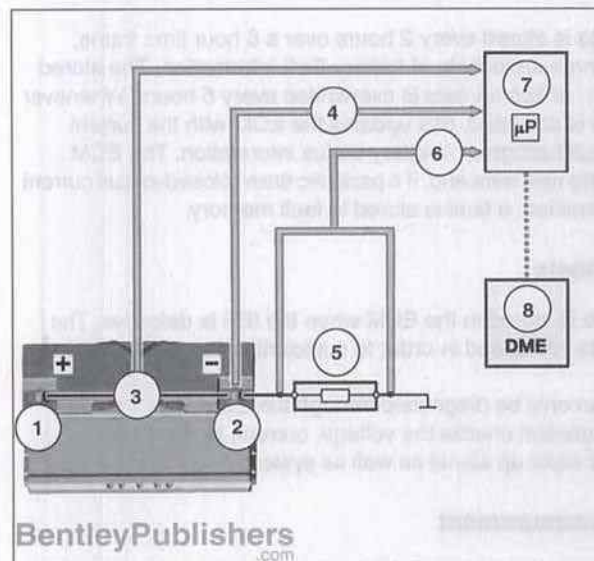
Intelligent battery sensor (IBS) is connected to the negative battery terminal.

1. Battery ground cable
2. B+ connection to IBS
3. Bit-serial data (BSD) interface
4. Intelligent battery sensor (IBS)

The IBS is sensitive to mechanical stress and strain. See **Warnings and Cautions** in this repair group.

Replace IBS as a complete unit with the battery ground cable. The ground cable serves as a heat sink for the IBS.

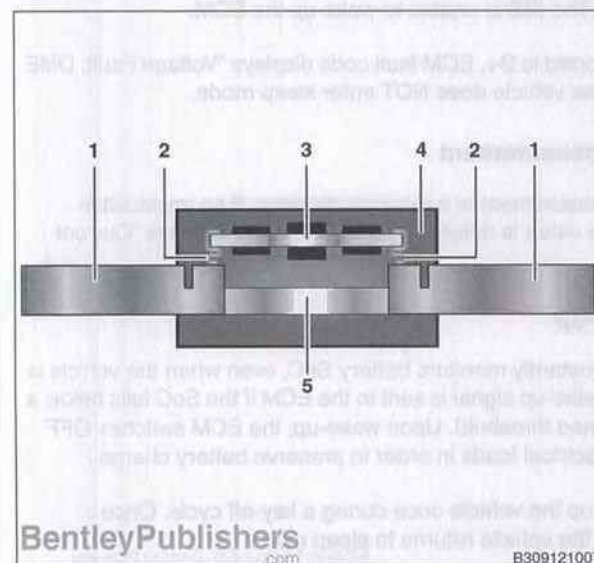
If IBS is replaced, allow vehicle to rest unused at least 3 hours. Only then can the new IBS determine battery status.



The IBS microprocessor monitors and measures battery conditions such as:

- Terminal voltage via measurement from B+ to ground
- Charge / discharge current via integrated shunt resistor
- Temperature of battery acid via integrated temperature sensor

1. B+ battery positive terminal
2. Battery ground terminal
3. Voltage measurement
4. Temperature measurement
5. Integrated shunt resistor
6. Current measurement
7. IBS microprocessor
8. Engine control module (ECM)



IBS components:

1. Copper plate
2. Gull wing tabs
3. PC board with evaluation electronics
4. Housing
5. Manganin copper alloy resistor maintains constant temperature regardless of current flow, used to measure current flow.

IBS evaluation function

IBS electronics continuously measure the following values under all vehicle operating conditions:

- Voltage (6 v to 16.5 v)
- Starting current (0 A to 1000 A)
- Charging current (20 A to 200 A)
- Temperature (-40°C to 105°C or -40°F to 221°F)
- Parasitic draw or closed circuit current (0 A to 10 A)

121-6 Battery, Starter, Alternator

Intelligent battery sensor (IBS)

When the vehicle is stationary, the IBS is programmed to wake up every 40 seconds and makes battery condition measurements within approx. 50 ms in order to save power. The measured values, communicated to the engine control module (ECM) via binary serial data (BSD) interface, are used to calculate the following:

- State of charge (SoC) shows the current charge of the battery. SoC is used during key OFF periods to insure that the battery maintains a sufficient charge to start the engine at least one more time.
- State of health (SoH) tracks the history of the battery in the vehicle. Charge / discharge cycles and times are monitored. SoH helps the ECM determine correct battery charging rates and anticipated battery life. Internal resistance of the battery is calculated by IBS from current and voltage drop during engine start. These values are used by the ECM to calculate the SoH of the battery.

Software contained in the IBS microprocessor utilizes the measured values to calculate battery SoC during vehicle sleep mode and compares this information with that received from the ECM pertaining to the battery SoC / SoH during the period between engine OFF and deactivation of the DME main relay.

Battery data is stored every 2 hours over a 6 hour time frame, providing three snapshots of battery SoC information. The stored information / snapshot data is overwritten every 6 hours. Whenever the ignition is activated, IBS updates the ECM with the current closed circuit histogram / battery status information. The ECM evaluates the new data and, if a parasitic draw (closed-circuit current draw) is identified, a fault is stored in fault memory.

IBS diagnosis

A fault code is stored in the ECM when the IBS is defective. The ECM boosts idle speed in order to sufficiently charge the battery.

The IBS can only be diagnosed through the ECM. The self-diagnosis function checks the voltage, current, temperature, terminal 15 wake up signal as well as system errors in the IBS.

Voltage measurement

If IBS is shorted to ground, ECM fault code displays "Voltage Fault DME ON". The IBS is unable to wake up the ECM.

If IBS is shorted to B+, ECM fault code displays "Voltage Fault, DME not ON". The vehicle does NOT enter sleep mode.

Current measurement

Current measurement is a dynamic process. If an implausible current flow value is detected, ECM fault code displays "Current Fault".

IBS wake-up

The IBS constantly monitors battery SoC, even when the vehicle is asleep. A wake-up signal is sent to the ECM if the SoC falls below a predetermined threshold. Upon wake-up, the ECM switches OFF auxiliary electrical loads in order to preserve battery charge.

IBS wakes up the vehicle once during a key-off cycle. Once awakened, the vehicle returns to sleep mode.

Wake-up signal faults

The IBS detects wake-up line faults under the following conditions:

- ECM switched ON.
- Ignition switched ON (voltage high at IBS).
- Terminal 15 running via alternator output at BSD.

If voltages at IBS terminal 15 and terminal 15 via the BSD are not equal, a fault is indicated either in the BSD line or the IBS.

Battery, testing

BMW batteries are rated as follows:

- **Ah rating** is determined by the average amount of current the battery can deliver over time without dropping below a specified voltage.
- **CCA rating** is determined by the battery's ability to deliver starting current at 0°F (-18°C) without dropping below a specified voltage.

Battery testing determines battery condition and state of charge. Before testing the battery, check that the battery cables are tight and free of corrosion.

Electronic battery testing

- ◀ Electronic battery testers such as Midtronics® MCR 717 are recommended for testing all battery types.



Hydrometer testing

On conventional or low-maintenance batteries, check the specific gravity of the electrolyte using a hydrometer. The more dense the concentration of sulfuric acid in the electrolyte, the higher the state of charge.

Before hydrometer testing, load the battery with 15 amperes for one minute. If the battery is installed in the vehicle, this can be done by switching the headlights ON for about one minute without the engine running. The state of battery charge based on specific gravity values are in **Table b**.

121-8 Battery, Starter, Alternator

Battery open-circuit voltage test

Note that electrolyte temperature affects hydrometer reading. Check the electrolyte temperature with a thermometer. Add 0.004 to the hydrometer reading for every 6°C (10°F) that the electrolyte is above 27°C (80°F). Subtract 0.004 from the reading for every 6°C (10°F) that the electrolyte is below 27°C (80°F).

Table b. Specific gravity of battery electrolyte at 27°C (80°F)

Specific gravity	State of charge
1.265	Fully charged
1.225	75% charged
1.190	50% charged
1.155	25% charged
1.120	Fully discharged

If the specific gravity is at or above 1.225 but the battery lacks power for starting, determine the battery's service condition with a load voltage test. See **Battery load voltage test** in this repair group.

If the average specific gravity of the six cells is below 1.225, charge battery and retest. See **Battery charging notes** in this repair group.

Battery open-circuit voltage test

- Before testing, load battery with 15 amperes for one minute with battery load-tester or switch headlights ON for about one minute without engine running. Connect digital voltmeter across battery terminals. Open-circuit voltage levels are given in **Table c**.

Table c. Open-circuit voltage and battery charge

Open-circuit voltage	State of charge
12.6 or more	Fully charged
12.4	75% charged
12.2	50% charged
12.0	25% charged
11.7 or less	Fully discharged

- If open-circuit voltage is OK but battery still lacks power for starting, perform a load voltage test. See **Battery load voltage test** in this repair group.
- If open-circuit voltage is below 12.4 volts, recharge battery and retest. See **Battery charging notes** in this repair group.

Battery load voltage test

A battery load tester is required for a load voltage test. The test is made by applying a high resistive load to the battery terminals and simultaneously measuring battery voltage. For the most accurate results, make sure the battery is fully charged. Disconnect battery cables before making the test. Replace the battery if the voltage is below that listed in **Table d**.

WARNING —

- Wear protective goggles and clothing when performing a load test.

Table d. Battery load test—minimum voltage

Ambient temperature	Voltage*
27°C (80°F)	9.6
16°C (60°F)	9.5
4°C (40°F)	9.3
-7°C (20°F)	8.9
-18°C (0°F)	8.5
* Measure after applying a 200 amp load for 15 seconds.	

Battery parasitic draw, testing

If the vehicle battery is discharged for an unknown reason, perform the parasitic draw test designed to detect excessive current flow from the battery when everything in the vehicle is shut down. This is also known as a closed circuit current measurement.

- Check that battery voltage is 12 volts or higher. If lower, recharge battery.
- Remove negative cable and install battery isolation switch (OTC tool 7645 or equivalent).
- Close switch. Connect digital multimeter in series across switch. Set meter to milliamp (mA) scale.
- Turn trunk lock to locked position using screwdriver or similar (simulates trunk lid being closed). With exception of trunk, keep all other doors and lids closed.
- To simulate normal parasitic draw conditions: Switch ignition ON and activate all electrical consumers, including any accessories. Switch ignition OFF. Open and close driver's door (simulates somebody getting out). Lock car, arming alarm if installed.
- Open battery isolation switch and monitor current draw.
 - Vehicle without telematics (TCU): Wait 30 minutes.
 - Vehicle with telematics (TCU): Wait 60 - 70 minutes.
- Maximum allowable parasitic draw after waiting: Approx. 40 mA.
- If draw exceeds maximum allowable, find consumer(s) at fault by removing individual fuses and noting change in parasitic draw. Repair or replace component(s) found at fault.

Fuse locations and applications are in **ECL Electrical Component Locations**.



430-watt Deutronic power supply



BentleyPublishers.com

B309121013

70-amp ACCTIVA Professional power supply



BentleyPublishers.com

B309121014



BentleyPub

B3009601022

Battery charging notes

Consistent, clean voltage is essential when charging the battery or maintaining battery charge while coding or programming control modules. A transformer-based battery charger is inadequate for this task. BMW recommends the use of a vehicle power supply instead of a battery charger.

A power supply is a constant voltage, high-amperage power station with electronically controlled functions. It insures clean DC voltage and eliminates AC. It also provides fast, efficient and safe battery charging. Once proper battery voltage is obtained, the power supply floats the charge to maintain that voltage.

Battery charging voltage

BMW recommendation	14.8 v
--------------------	--------

Power supply units from different manufacturers are illustrated on this page.

If using a power supply, recharge battery without removing it. Otherwise, remove the battery from the trunk or cargo compartment during charging. See **Battery, removing and installing** in this repair group.

Prolonged charging with a conventional charger can cause battery electrolyte evaporation to a level that can damage. It is best to use a low-current charger (6 amperes or less) to prevent battery damage caused by overheating.

WARNING—

- Hydrogen gas given off by the battery during charging is explosive. Do not smoke. Keep open flames away from the top of the battery, and prevent electrical sparks by turning off the battery charger before connecting or disconnecting it.

CAUTION—

- Battery electrolyte (sulfuric acid) can damage the car. If electrolyte is spilled, clean the area with a solution of baking soda and water.
- Allow a frozen battery to thaw before attempting to recharge it.
- Do not exceed 16.5 charging voltage at the battery.

Battery, charging

- Connect vehicle power supply charger to engine compartment B+ and ground. Follow manufacturer's instructions for setting charging voltage.

Battery, removing and installing

CAUTION—

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

— Switch ignition OFF.

➤ Working in trunk or cargo compartment, open battery compartment. Twist plastic retainer counterclockwise (arrow) and remove right side trim.



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➤ Working at top of battery, remove protective bracket mounting fasteners (arrows) and lift off bracket.



B301121031

➤ Working at top of battery:

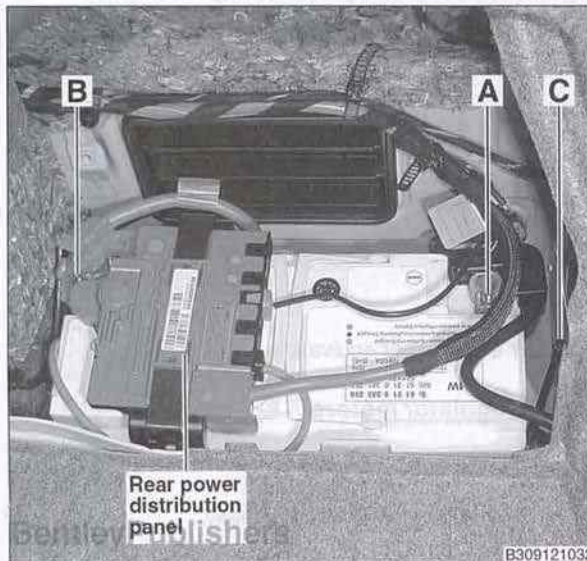
- Loosen fastener (A) and disconnect negative cable first.
- Unlock battery safety terminal plastic cover and loosen positive cable fastener (B).
- Carefully lift rear power distribution panel, positive cable, negative cable and intelligent battery sensor off battery and lay aside.

CAUTION—

- Do not damage intelligent battery sensor (IBS), which is attached to ground cable. See Warnings and Cautions in this repair group.

- Remove battery hold-down bolt (C).
- Disconnect battery vent hose at side of battery, if applicable.

— Lift battery out of trunk or cargo compartment.



Rear power distribution panel

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121-12 Battery, Starter, Alternator

Replacement battery registration

- Clean away corrosion in and around battery tray and on cables ends.
- When reinstalling battery, reconnect negative cable last.

Tightening torques

Battery post pinch bolt

- M6
- M8

5 Nm (44 in-lb)
15 Nm (11 ft-lb)

Once the battery is reinstalled, the following steps are necessary:

- If higher rating battery is installed, recode CAS with correct battery specifications.
- Register battery. See **Replacement battery registration** in this repair group.
- Follow **Battery reconnection notes** in this repair group.

Replacement battery registration

After fitting a new battery, connect BMW scan tool or equivalent and run service function "Register battery replacement" to notify vehicle power management (software in the engine electronics and intelligent battery sensor) that a new battery is fitted in the vehicle.

Without new battery registration, CAS and vehicle power management does not run properly and this can lead to function limitations; for example: reduction or deactivation of individual consumer functions.

During battery registration, the following operations are performed:

- Current mileage is stored.
- Stored values from old battery (charge status, current, voltage, temperature, etc.) are deleted.
- Power management is initialized.

Battery reconnection notes

In addition to **Warnings and Cautions** in this repair group and in **001 Warnings and Cautions**, observe the following whenever the battery is disconnected or accidentally discharged and then reconnected.

Clock

- Reset.

Radio

- Enter presets.

Steering angle sensor

- Adjust using BMW scan tool or equivalent.

Power window regulator motors

Initialize as follows:

- Switch ignition ON and close window completely.

- Release window button, then hold switch in Close direction again for approx. 1 second.
- Open window completely.
- Release window button, then hold switch in Open direction again for approx. 1 second.
- Close window completely again.
- Release window button, then hold switch in Close direction again for approx. 1 second.
- Check to make sure one-touch control, anti-trapping and comfort functions are activated.

See **512 Door Windows** for additional information.

Sunroof

Initialize as follows (if applicable):

- Switch ignition ON and press and hold sunroof switch in Raised direction (**arrow**).
- After sunroof reaches Raised position, keep switch pressed for approx. 15 seconds longer.
- Initialization is complete when sunroof attempts briefly to lift again.

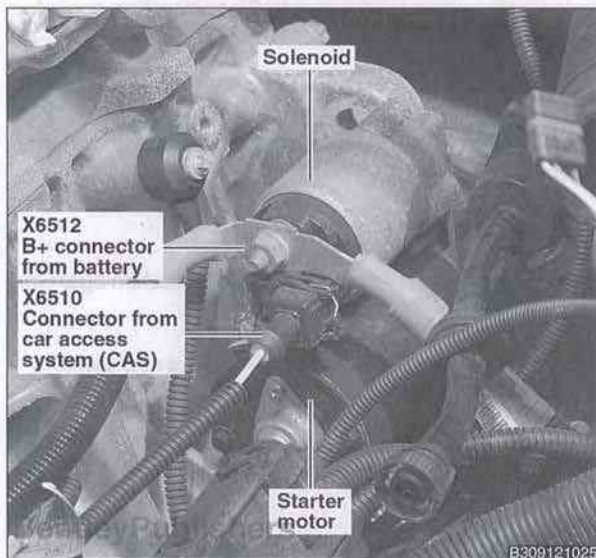


Compass in interior mirror

Calibration (if applicable):

- Switch ignition ON
- Using thin bladed screwdriver or equivalent tool, press push button at base of mirror until C appears in compass display (**oval**).
- Drive vehicle 2 - 3 times in a circle at approx. 10 mph.
- Calibration is complete when direction display appears.





STARTER

Starter troubleshooting

➤ The starter is bolted to the engine bell housing under the intake manifold. Starter wiring connects to the solenoid, above the starter, as follows:

- Large wire (X6512 or B+ connector) is direct battery voltage.
- Smaller wire (X6510) operates starter solenoid via ignition switch and car access system (CAS).

- If starter and solenoid click repeatedly without starting vehicle:
 - Check battery state of charge.
 - Inspect battery and starter cables, terminals, and ground connections for good contact. In particular, make sure ground connections between battery, body and engine are completely clean and tight.
 - If no faults are found, starter may be faulty and should be replaced.
- If starter fails to operate, check the following:
 - Car access system (CAS). Try another ignition key. If no faults can be found, have CAS checked using BMW scan tool equipment. CAS replacement is covered in **CAS module, removing and installing** in this repair group.
 - Clutch switch module (manual transmission). Make sure clutch is pressed all the way to the floor. See **210 Clutch**.

NOTE —

• Automatic transmission neutral safety switch function is built into transmission mechatronics electronics. Failure of this function causes a no-start condition.

- Access to starter is difficult as it is under the intake manifold. If possible, check for battery voltage (12.6 volts) at B+ terminal (X6512).
- Check for battery voltage at terminal X6510 of starter motor with ignition in START position.
 - If voltage is not present, check wiring between CAS and starter terminal.
 - Check CAS and other inputs that disrupt power to solenoid. See **ELE Electrical Wiring Diagrams**.
 - If voltage is present and no other visible wiring faults can be found, problem is most likely in starter motor.

CAS module, removing and installing

CAUTION—

- CAS module is static sensitive. Static discharge may damage it permanently. Handle using static prevention equipment and techniques. See 600 Electrical System—General.

- Remove left side dashboard lower trim (pedal cluster trim). See 513 Interior Trim.
- Working to left of steering column:
 - Detach ribbon harness (A) from CAS module.
 - Detach harness connector (B) from CAS module.
 - Remove module mounting screw (C) and withdraw module to left and down to remove from dashboard.
- Inspect ribbon cable and replace if damaged. (Ribbon cable connects CAS to ignition key slot and Start / Stop button.)
- When installing, make sure CAS module guide fits correctly into mounting slot.
- After reassembly, carry out vehicle coding and programming. See 600 Electrical System—General.

Starter, removing and installing

- Switch ignition OFF. Disconnect negative (–) battery cable and cover battery terminal to keep cable from accidentally contacting terminal.

CAUTION—

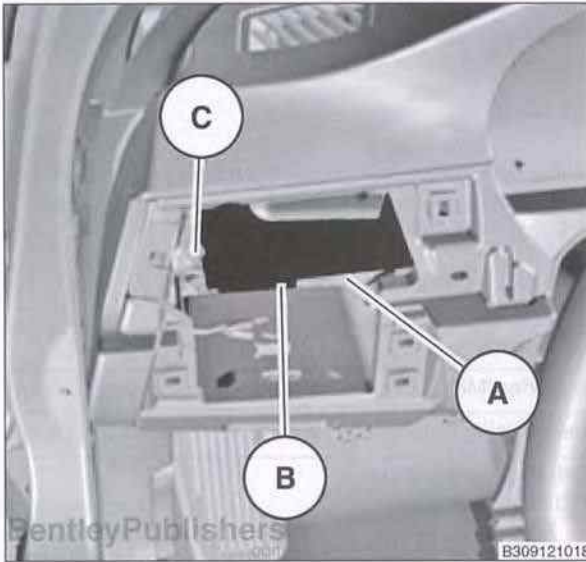
- Prior to disconnecting the battery, read the battery disconnection cautions in 001 Warnings and Cautions.

- Remove upper and lower cabin air microfilter housings. See 640 Heating and Air-conditioning.
- Remove engine air filter housing and ducts. See 130 Fuel Injection.
- Remove left front upper tension strut (crossbrace from rear engine compartment bulkhead to left strut tower).
- Remove ignition coil cover. See 020 Maintenance.
- Remove intake manifold. See 130 Fuel Injection.

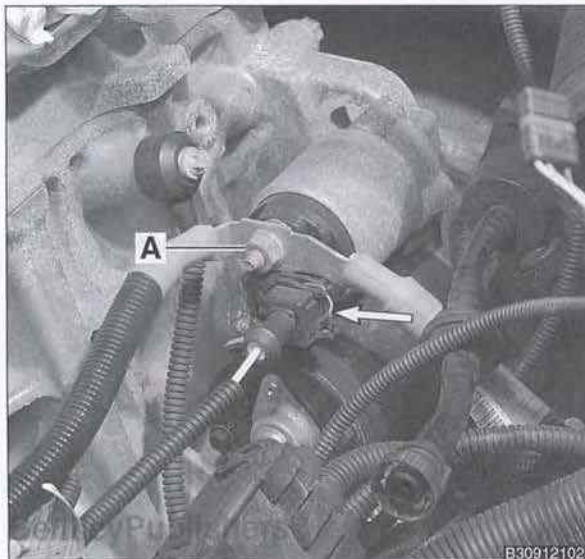
CAUTION—

- Do not detach fuel lines or injectors.

- Working at starter solenoid electrical connections:
 - Remove fastener (A) and detach B+ cable from solenoid.
 - Press in wire clip (arrow) to release solenoid wire connector.



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121-16 Battery, Starter, Alternator

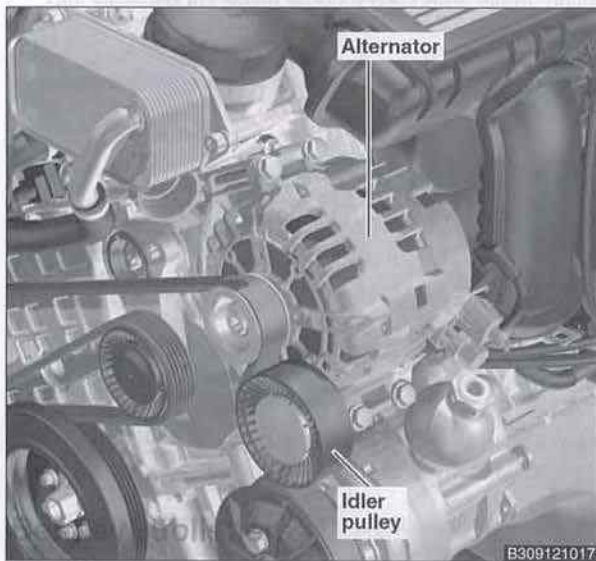
Alternator basics



- Remove starter mounting bolts (**arrows**). Discard aluminum bolts. (Aluminum bolt heads are not always marked with blue paint. Use a magnet to identify them.)
- Lift out starter motor.
- Before installing new starter, rotate engine and inspect flywheel or torque plate gear teeth through starter hole. Replace if damaged. See **210 Clutch** or **240 Automatic Transmission**.
- Reinstall starter and reattach electrical connectors.

Tightening torques

B+ cable to starter (M8)	13 Nm (10 ft-lb)
Starter to bell housing (turbo)	38 Nm (28 ft-lb)
Starter to bell housing (non-turbo) (replace M10 aluminum bolts)	20 Nm (15 ft-lb) additional 180°
• Stage 1	
• Stage 2	



ALTERNATOR AND CHARGING SYSTEM

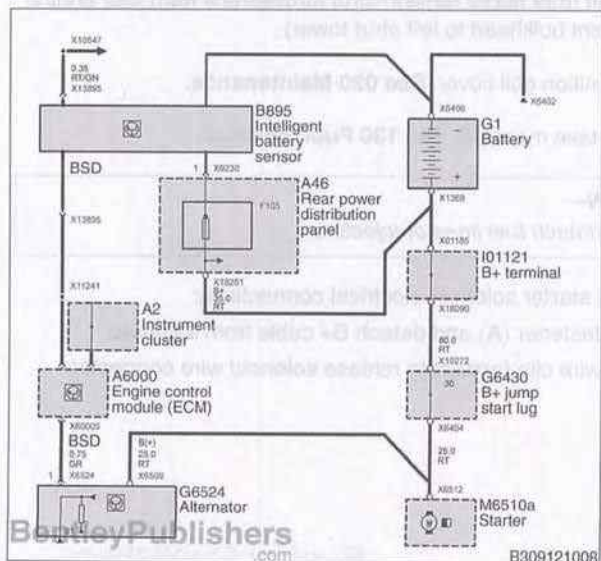
Alternator basics

- The alternator is bolted to the left side of the engine block. It is driven by the engine accessory belt. A belt idler pulley is bolted to the bottom of the alternator housing. Accessory belt replacement is covered in **020 Maintenance**.

Several versions of alternators are used in E90 vehicles. Be sure that the replacement alternator is correct for the application.

Alternator interface

- The alternator communicates with the engine control module (ECM) via bit-serial data (BSD) interface. This single wire connection allows the ECM to adapt its calculations and control data to alternator output. The ECM controls the following functions:
 - Alternator activation and deactivation.
 - Informing the voltage regulator of the nominal voltage value to be set.
 - Alternator load response control.
 - BSD line diagnosis.
 - Alternator fault code storage.
 - Charge indicator light activation in instrument cluster.



Charging system troubleshooting

Some charging system tests require special test equipment. If the test equipment is not available, charging system fault diagnosis can be performed by an authorized BMW dealer or other qualified repair shop. See **Table a** for general electrical component troubleshooting.

Before checking the alternator, make sure the battery is fully charged and capable of holding a charge. Check that the battery terminals are clean and tight and the engine accessory drive belt is properly tensioned and not severely worn.

Charging system quick-check

- Use a digital multimeter to measure voltage across the battery terminals with ignition OFF and then again with engine running. Battery voltage should be about 12.6 volts with key OFF and between 13.5 and 14.5 volts with engine running.
- Run engine at about 2000 rpm and switch ON electrical loads (fans, lights, rear window defroster, and wipers). With all accessories on, battery voltage should be above 12.6 volts.

The regulated voltage (engine running, battery charged, accessories and lights OFF) is usually between 13.2 and 14.5, depending on temperature and operating conditions. If the voltage is higher than 14.8, the voltage regulator is most likely faulty.

Charging system, checking

CAUTION—

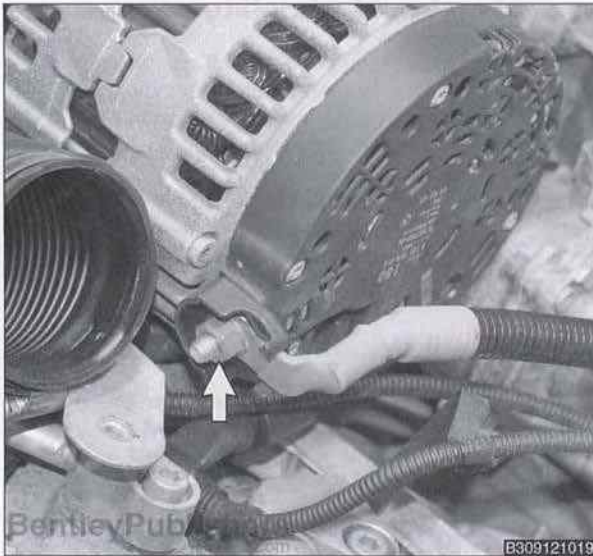
- Do not disconnect the battery while the engine is running. Damage to the alternator or engine electronic systems may result.
- Only use a digital multimeter when testing charging system components.

- Switch ignition ON. Check that battery warning light comes ON. If warning light does not come ON, check for fault codes.

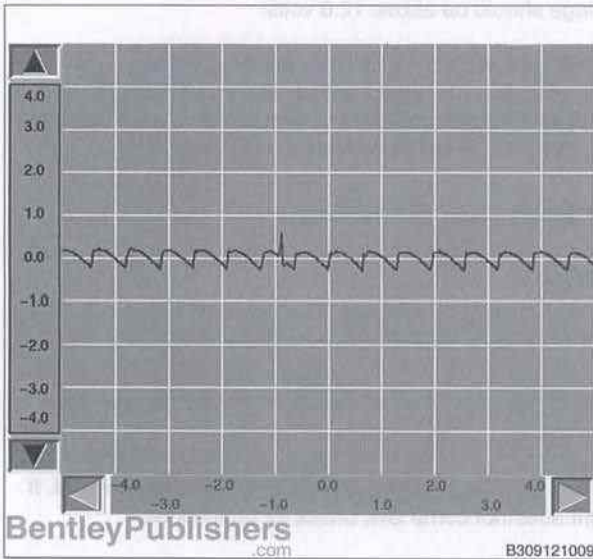


121-18 Battery, Starter, Alternator

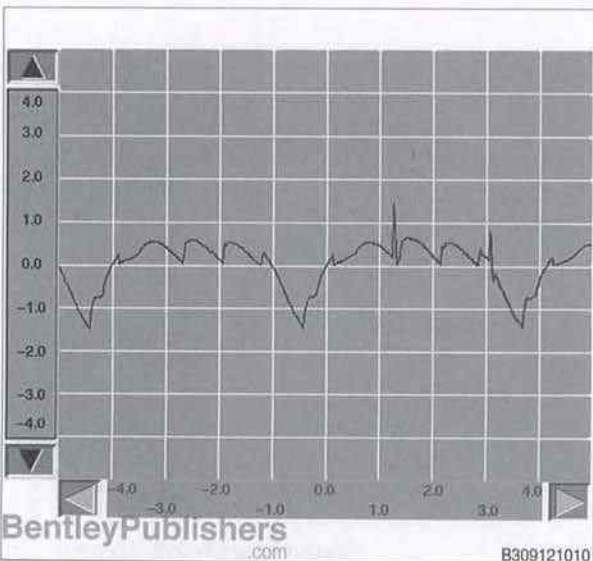
Charging system, checking



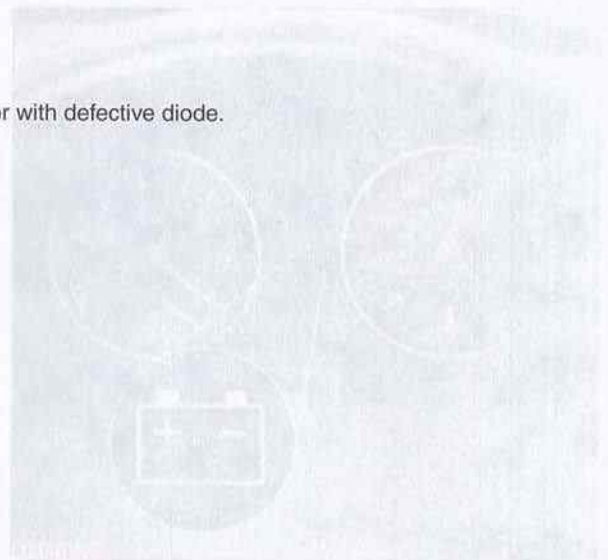
- Check for battery voltage at alternator terminal 30 (B+):
 - Pull off insulating cover at terminal 30 (arrow) at rear of alternator.
 - Connect voltmeter between terminal 30 and ground and check for battery voltage. If voltage is not present, check wiring for faults.
- Connect oscilloscope to check alternator function:
 - Positive test lead of oscilloscope to positive battery terminal.
 - Negative test lead of oscilloscope to negative battery terminal.
 - Set oscilloscope to A/C volts and a time base of 500ms.



Normal alternator pattern.

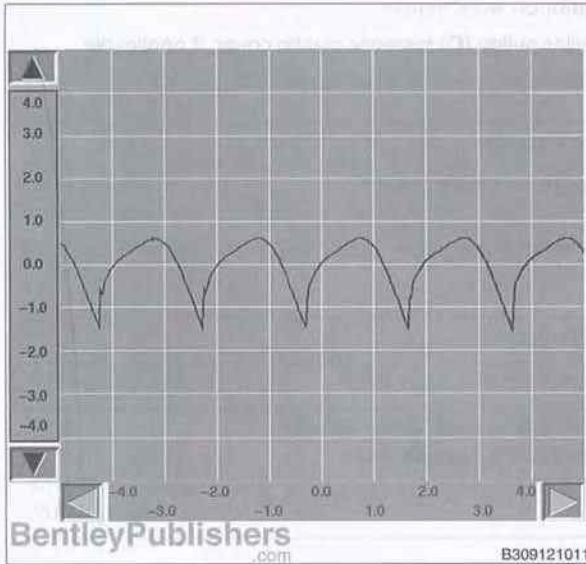


Alternator with defective diode.



➤ Alternator with broken winding.

- If test indicate a defective alternator, replace unit. Repair parts are not available for the alternator.



Alternator, removing and installing (non-turbo)

- Switch ignition OFF. Disconnect negative (–) battery cable and cover battery terminal to keep cable from accidentally contacting terminal.

CAUTION—

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

- Raise vehicle and support safely.

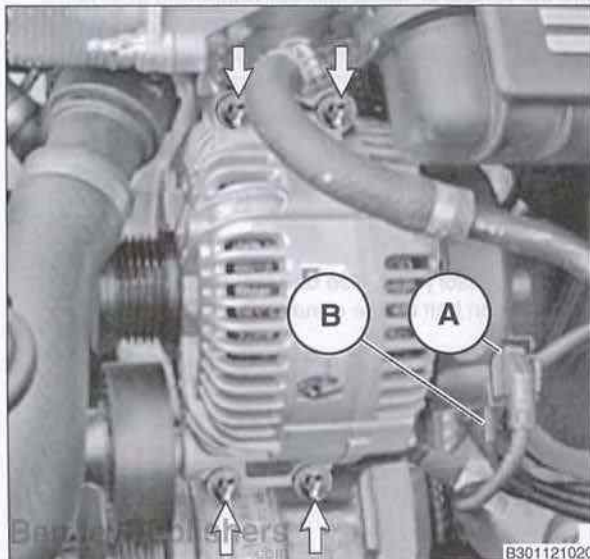
WARNING—

- 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 compartment. See 020 Maintenance.
- Remove electric fan cowl and fan. See 170 Radiator and Cooling System.
- Remove engine accessory belt. See 020 Maintenance. Mark direction of rotation on belt before removing.
- Remove intake air filter housing. See 130 Fuel Injection.

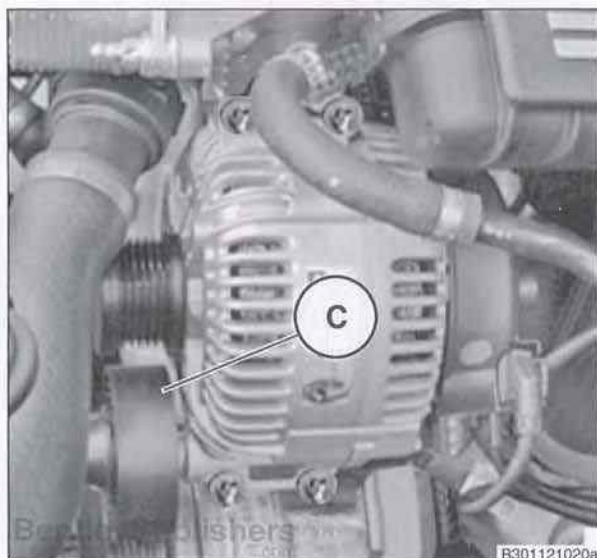
➤ Working at rear of alternator:

- Detach harness connector (A)
- Remove nut (B) and detach alternator cable.
- Remove alternator mounting bolts (arrows) and discard (aluminum bolts).
- Lift out alternator.



121-20 Battery, Starter, Alternator

Alternator, removing and installing (turbo)



With alternator on work bench:

- Remove idler pulley (C) fastener plastic cover, if applicable.
- Remove idler pulley and transfer to new alternator.

Tightening torques

Idler pulley to alternator housing	80 Nm (59 ft-lb)
------------------------------------	------------------

- Reinstall alternator using new aluminium bolts. Reattach electrical harnesses.

Tightening torques

Alternator cable to alternator (M8)	19 Nm (14 ft-lb)
Alternator to engine block (M8 x 82 mm aluminum bolts, replace with new)	
• Stage 1	10 Nm
• Stage 2	additional 180°

- Reassemble front of engine. Remember to:
 - Reinstall accessory belt using previously made direction-of-rotation marks.
 - Make sure accessory belt grooves engage pulleys correctly.
 - After reconnecting battery, see **Battery reconnection notes** in this repair group.

Alternator, removing and installing (turbo)

- Switch ignition OFF. Disconnect negative (–) battery cable and cover battery terminal to keep cable from accidentally contacting terminal.

CAUTION—

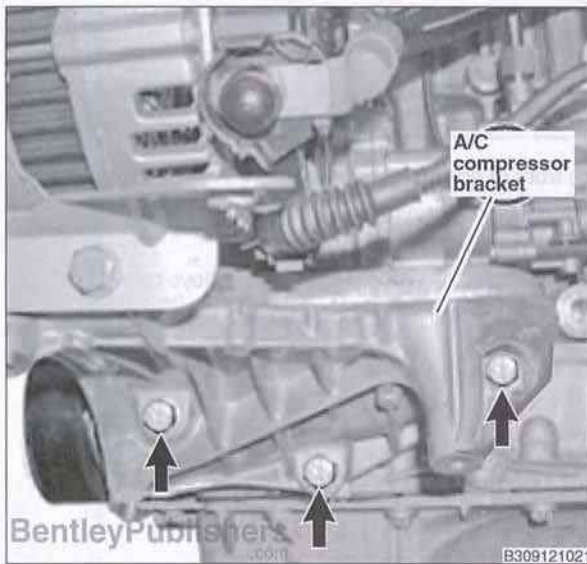
- Prior to disconnecting the battery, read the battery disconnection cautions in 001 Warnings and Cautions.

- 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 compartment. See 020 Maintenance.
- Remove electric fan cowl and fan. See 170 Radiator and Cooling System.
- Remove engine accessory belt. See 020 Maintenance. Mark direction of rotation on belt before removing.
- Remove intake air filter housing. See 130 Fuel Injection.
- Remove left side charge air duct. See 130 Fuel Injection.



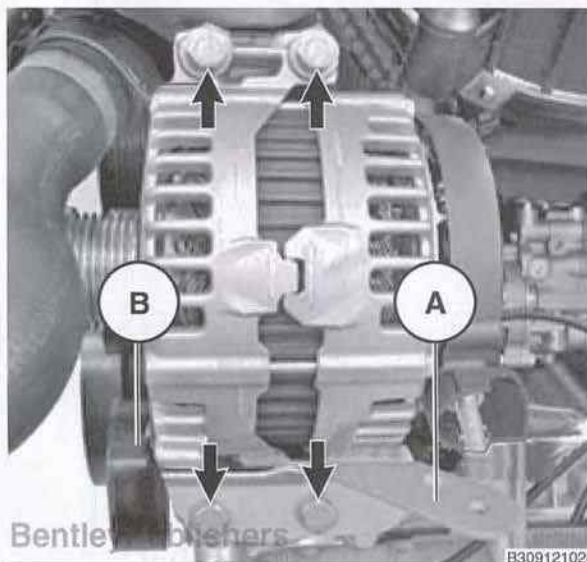
- Remove A/C compressor from mounting bracket and hang aside. See **640 Heating and Air-conditioning**. Do not detach A/C refrigerant lines.

- Loosen A/C compressor bracket bolts (arrows) a few turns. Do not remove bracket.



- Working at rear of alternator:

- Detach harness connector (A)
- Pull off plastic protective cover and remove nut (B) to detach alternator terminal 30 (B+) cable.



- Working at left side of engine:

- Remove alternator mounting bolts (arrows).
- Lift out alternator with bracket (A).

- With alternator on work bench:

- Remove idler pulley (B) fastener plastic cover, if applicable.
- Remove idler pulley and transfer to new alternator.

Tightening torques

Idler pulley to alternator housing	80 Nm (59 ft-lb)
------------------------------------	------------------

- Reinstall alternator and reattach electrical harnesses.

Tightening torques

Alternator cable to alternator (M8)	19 Nm (14 ft-lb)
Alternator to engine block (M8)	19 Nm (14 ft-lb)

121-22 Battery, Starter, Alternator

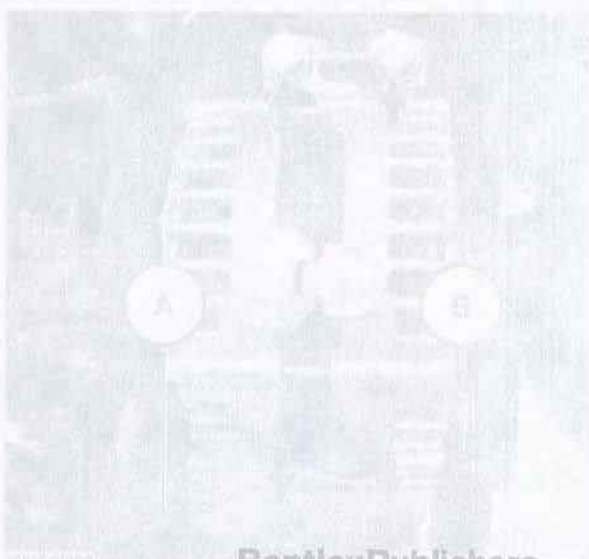
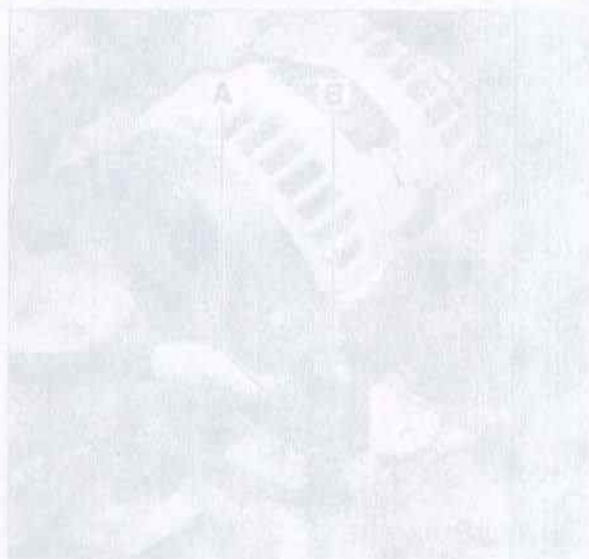
Alternator, removing and installing (turbo)

- Tighten A/C compressor bracket bolts, then reinstall compressor.

Tightening torque

A/C compressor bracket to engine block	19 Nm (14 ft-lb)
--	------------------

- Reassemble front of engine. Remember to:
 - Reinstall accessory belt using previously made direction-of-rotation marks.
 - Make sure accessory belt grooves engage pulleys correctly.
 - After reconnecting battery, see **Battery reconnection notes** in this repair group.



120 Ignition System

GENERAL	120-1
Ignition firing order	120-2
Disabling ignition system	120-2
Warnings and Cautions	120-2

DIGITAL MOTOR ELECTRONICS (DME)

IGNITION SYSTEM	120-4
Ignition coils	120-5
Crankshaft sensor	120-6
Camshaft sensors	120-6
Knock sensors	120-7

TROUBLESHOOTING	120-8
On-board diagnostics	120-8
Misfire detection	120-8
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CRANKSHAFT SENSOR SERVICE	120-12
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CAMSHAFT SENSOR SERVICE	120-13
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KNOCK SENSOR SERVICE	120-14
Knock sensors, replacing (non-turbo)	120-14
Knock sensors, replacing (turbo)	120-15

TABLE

a. Ignition firing order	120-2
b. E90 engine management system applications	120-4
c. Ignition secondary voltage diagnostics	120-8

GENERAL

This repair group covers ignition component troubleshooting and replacement.

See also:

- **020 Maintenance** for spark plug replacement
- **100 Engine-General** for engine applications
- **130 Fuel Injection** for DME system applications, description and power supply fuses
- **ECL Electrical Component Locations**
- **ELE Electrical Wiring Diagrams**
- **OBD On-Board Diagnostics**

120-2 Ignition System

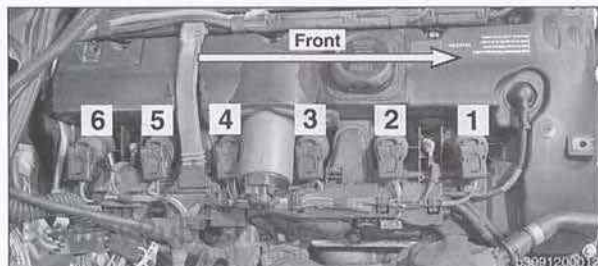
Ignition firing order

Ignition firing order

Table a. Firing order

6-cylinder engine	1-5-3-6-2-4
-------------------	-------------

➤ Cylinder 1 is at the front of the engine.



Disabling ignition system

The ignition system operates in a lethal voltage range. Disable the ignition system any time engine service or repair work is being done that requires the ignition to be switched ON.

One way of disabling the ignition is by removing the DME main relay. The relay is located in the electronics box (E-box) in the right rear of the engine compartment. DME fuse, relay and power supply information is in **130 Fuel Injection**.

CAUTION—

- Relay locations vary. Use care when identifying relays. See **ECL Electrical Component Locations**.

Warnings and Cautions

WARNING—

- Do not touch or disconnect any cables from the ignition coils while the engine is running or being cranked by the starter.
- 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.
- Connect and disconnect the DME system wiring and test equipment leads when the ignition is OFF.
- Before operating the starter without starting the engine (for example when testing compression), disable the ignition. See **Disabling ignition system** in this repair group.

CAUTION—

- Do not attempt to disable the ignition by removing the coils from the spark plugs.
- Do not connect any test equipment that delivers a 12-volt power supply to terminal 15 (+) of the ignition coil. The current flow may damage the engine control module (ECM). Connect test equipment only as specified by BMW or the equipment maker.
- Connect or disconnect ignition system wires, multiple wire connectors and ignition test equipment leads only while the ignition is OFF. Switch multimeter functions or measurement ranges with test probes disconnected.
- Do not disconnect the battery while the engine is running.
- Prior to disconnecting the battery cables, read the battery disconnection cautions in **001 Warnings and Cautions**.
- Wait at least 1 minute after switching the ignition OFF before removing the ECM connector. If the connector is removed before this time, residual power in the system relay may damage the control module.
- Use a digital multimeter for electrical tests. Use an LED test light for quick tests.
- To avoid electrochemical corrosion to engine components made of aluminum-magnesium alloy, do not use steel fasteners in place of aluminum. For reliable identification, the end faces of aluminum fasteners are painted blue.
- Replace aluminum bolts each time they are loosened.
- Follow torque instructions, including angle of rotation specifications, when installing aluminum fasteners.

DIGITAL MOTOR ELECTRONICS (DME) IGNITION SYSTEM

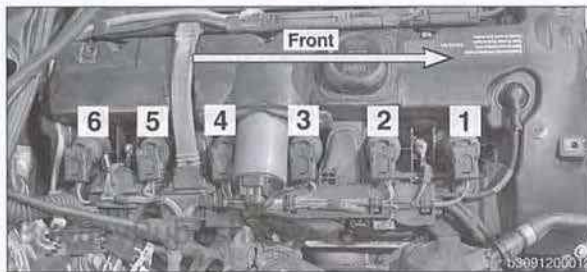
BMW E90 models are equipped with digital motor electronics (DME), also known as Motronic. In these systems, fuel injection and ignition are controlled by an integrated engine control module (ECM). Application information for DME systems is in **Table b**.

Most DME functions are described in **130 Fuel Injection**. In the topics that follow, functions that are traditionally associated with ignition are given fuller treatment.

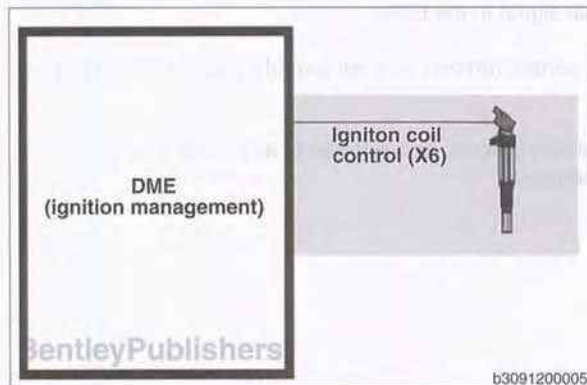
Table b. E90 engine management applications

Year, model	Engine code	Engine management	Features
2006			
Sedan: 325i, 325xi Sport Wagon: 325xi Sedan: 330i, 330xi	N52	Siemens MSV70	Valvetronic, VANOS
2007-2008			
Sedan, Sport Wagon, Coupe, Convertible: 328i, 328xi (automatic transmission)	N51	Siemens MSV80 SULEV II	Valvetronic, VANOS
Sedan, Sport Wagon: 328i, 328xi	N52KP	Siemens MSV70	Valvetronic, VANOS
Coupe, Convertible: 328i, 328xi	N52KP	Siemens MSV80	Valvetronic, VANOS
Sedan: 335i, 335xi Coupe: 335i Coupe: 335xi (2008 only) Convertible: 335i	N54	Siemens MSD80/MSD81	VANOS
2009-2010			
Sedan, Sport Wagon, Coupe, Convertible: 328i, 328xi (automatic transmission)	N51	Siemens MSV80 SULEV II	Valvetronic, VANOS
Sedan, Coupe: 328i, 328xi Convertible: 328i Sport Wagon: 328i, 328xi	N52KP	Siemens MSV80 ULEV II	Valvetronic, VANOS
Sedan, Coupe: 335i, 335xi Convertible: 335i	N54	Siemens MSD81 ULEV II	VANOS

Ignition coils



E90 engines use a distributorless ignition system with individual ignition coils (**numbered**) for each cylinder. There is no distributor cap or ignition rotor. (N52 engine shown in photo.)

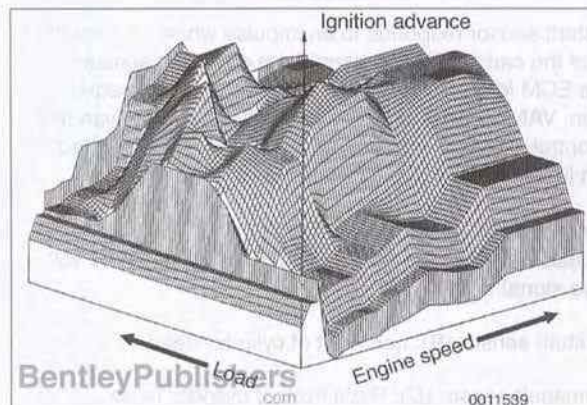


Each coil is separately controlled and monitored by the ECM.

When the ignition is switched ON, the ECM receives wake-up (KL 15w) via the bus network and a hardwire KL15 wake-up signal directly from the car access system (CAS). It will then energize the ECM main relay to supply power to the engine electronics fuse carrier and to the ignition coils.

CAUTION—

- Maintain a high level of cleanliness when servicing ignition coils. Fuel / oil residue can cause a breakdown the electrical resistance qualities of silicone used in production. This in turn can result in a failure of the ignition coil.



Ignition timing is electronically mapped and not adjustable. The ECM uses engine load, engine speed, coolant temperature, knock detection, and intake air temperature as the basic inputs for timing control.

A three-dimensional map similar to the one shown is digitally stored in the ECM. The initial ignition point is determined by the crankshaft sensor during cranking. Once the engine is running, the ECM refers to the stored map to continually adjust ignition timing based on operating conditions.

120-6 Ignition System

Crankshaft sensor

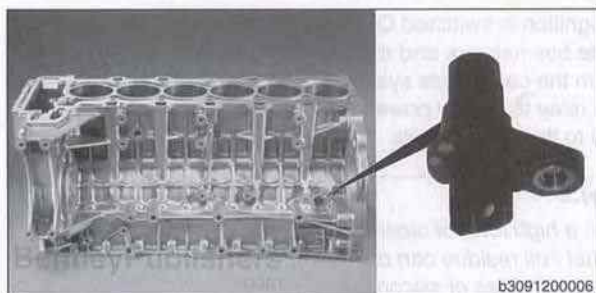
Crankshaft sensor

The crankshaft sensor detects crankshaft position and rotation speed via a toothed pulse wheel mounted on flywheel. If the ECM does not receive an impulse signal from the crankshaft sensor during cranking, the engine does not start. If the OBD II system misfire detection protocol detects a catalyst damaging fault due to a malfunction in crankshaft sensor components, the malfunction indicator light (MIL) is illuminated.

The crankshaft position sensor is supplied 12 volts from the engine electronics fuses and ground from the ECM. It produces a 5 volt square wave signal to the ECM.

◀ Crankshaft sensor (**arrow**) is at left rear of cylinder block below starter.

The crankshaft sensor is also referred to as engine speed / reference sensor.



Camshaft sensors

◀ Each camshaft sensor responds to an impulse wheel (**A**) mounted at the end of the camshaft. The signal from camshaft sensors are used by the ECM for cylinder recognition, spark timing, sequential fuel injection, VANOS (camshaft timing) and Valvetronic (variable valve lift) control. If a fault with the camshaft sensor is detected the malfunction indicator light (MIL) is illuminated

The camshaft position sensor is supplied 12 volts from the engine electronics fuses and ground from the ECM. It produces a 5 volt square wave signal to the ECM.

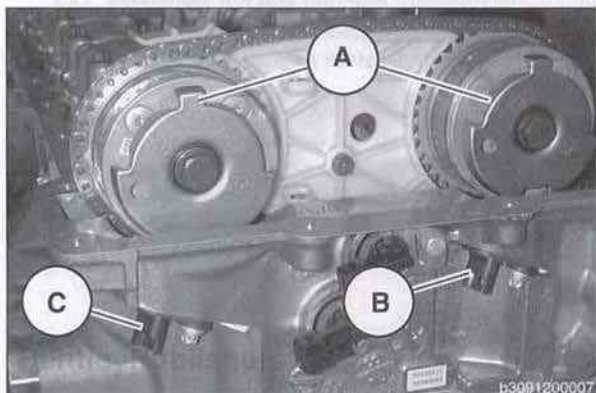
Intake camshaft sensor (**B**): Left front of cylinder head.

Exhaust camshaft sensor (**C**): Right front of cylinder head.

The camshaft sensor is also called the cylinder identification sensor.

NOTE—

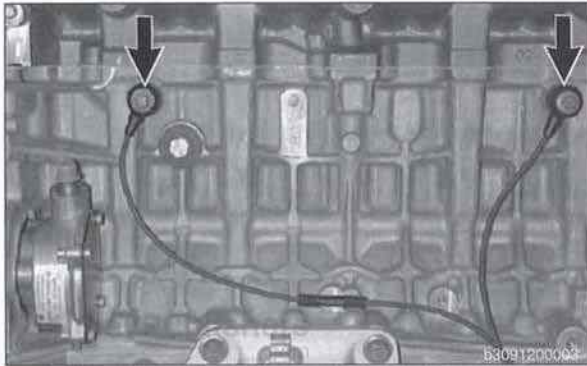
- A malfunctioning or sticking VANOS solenoid may set camshaft position sensor fault codes. If you suspect this, swap VANOS solenoid from bank with fault code to the other bank. If the camshaft position sensor fault code follows the location of the solenoid, the solenoid is at fault.



Knock sensors

Knock sensors monitor the combustion chamber for engine-damaging knock. A knock sensor is a piezoelectric microphone tuned to the frequencies of engine knock or detonation. If engine knock is detected, ignition spark is retarded by the ECM. If a fault with the knock sensor is detected the malfunction indicator light (MIL) is illuminated

Knock sensors are bolted to left side of cylinder block under intake manifold (arrows). They share an electrical connector and have to be replaced as a pair.



Oscilloscope diagnostic diagrams

One way to diagnose faulty engine management components is to use an oscilloscope to analyze spark timing and engine running.

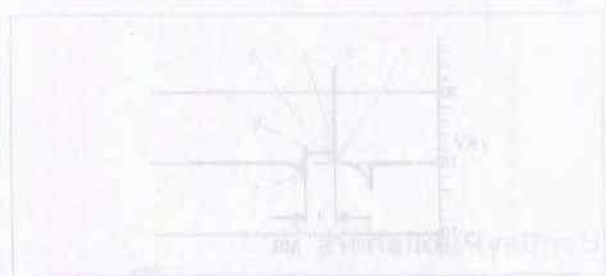
See Table 2 for a list of common ignition coil voltage faulting related causes.

Table 2 Ignition secondary voltage diagnostics

Secondary voltage low	Secondary voltage high
Spark plug electrodes gap too small	Spark plug electrodes gap too big
Spark plug electrodes condition	Spark plug electrodes condition
Spark plug electrodes too high	Spark plug electrodes too low
Engine compression too low	Engine compression too high
Spark plug wires faulty	Spark plug wires faulty
Fuel air mixture too lean	Fuel air mixture too rich

Normal scope trace of spark voltage

1. Start of ignition voltage peak
2. Level of ignition voltage
3. Level of combustion voltage
4. Period of combustion
5. Combustion curve characteristics
6. Start of spark decay
7. Termination oscillation



TROUBLESHOOTING

On-board diagnostics

If faults arise, or if the malfunction indicator light (MIL) is illuminated, begin troubleshooting by connecting BMW scan tool or equivalent to the data link connector (DLC or OBD II plug). For information on how to access diagnostic trouble codes (DTCs), see **020 Maintenance**.

Misfire detection

Engine misfire in one or more cylinders may be caused by malfunctions in various subsystems. The OBD II system incorporated into the engine management systems is designed to detect and warn of misfire faults during engine operation. See **OBD On-Board Diagnostics**.

WARNING —

- Ignition misfires can cause high hydrocarbon exhaust emissions and catalytic converter damage. For this reason, if a severe misfire is detected, the fuel injector to the specific cylinder is switched OFF and the MIL is illuminated. A misfire may also overheat the catalytic converter(s), a fire hazard.

Oscilloscope diagnostic diagrams

One way to diagnose faulty engine management components or functions is to use an oscilloscope to analyze spark quality with the engine running.

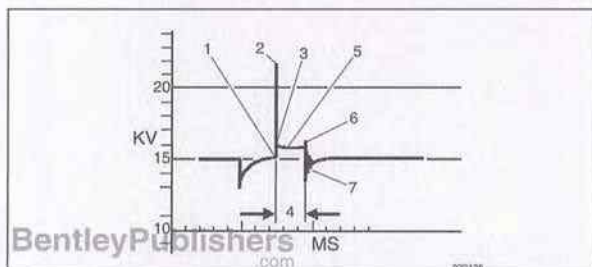
See **Table c** for a list of common ignition coil voltage faults and related causes.

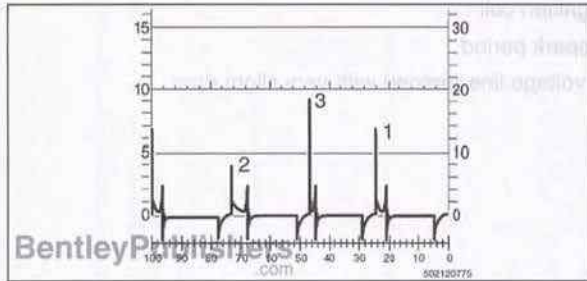
Table c. Ignition secondary voltage diagnostics

	Secondary voltage low	Secondary voltage high
Spark plug electrode gap	Too small	Too big
Spark plug electrode condition		Worn/burnt
Spark plug electrode temperature	Too high	Too low
Engine compression	Too low	Too high
Spark plug wires		Faulty
Fuel air mixture		Too lean

Normal scope trace of spark at idle

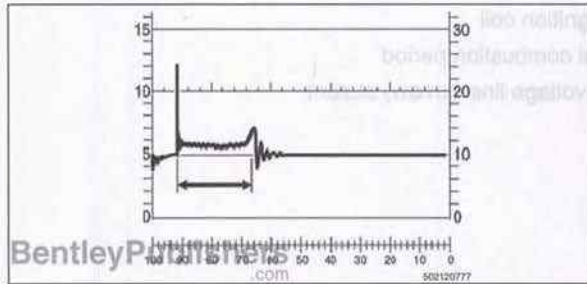
- Start of ignition voltage peak
- Level of ignition voltage
- Level of combustion voltage
- Period of combustion
- Combustion curve characteristics
- Start of spark decay
- Termination oscillations



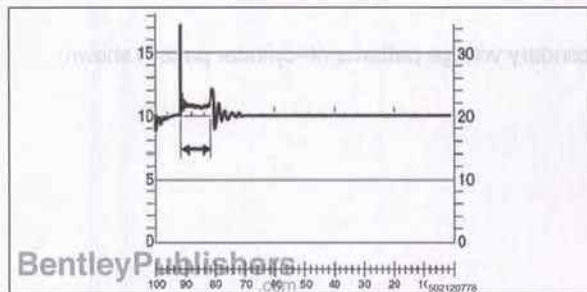


➤ Ignition spark at idle speed

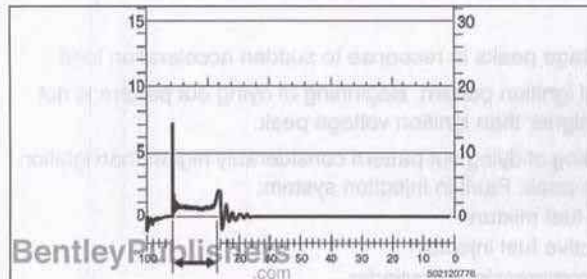
1. Normal ignition voltage peak: Good spark plug
2. Low voltage peak: Closed plug gap
3. High voltage peak: Open plug gap



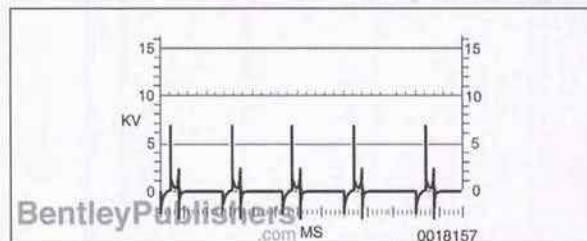
➤ Long combustion period: Small spark plug gap



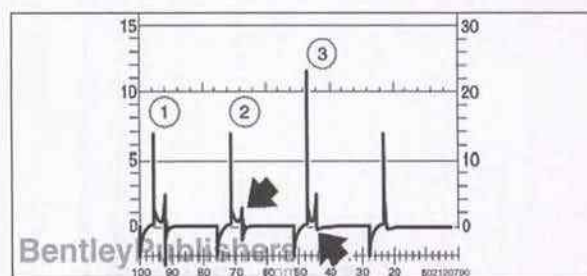
➤ Short combustion period: Large spark plug gap



➤ Normal combustion period at idle



➤ Normal oscilloscope pattern for ignition system at idle

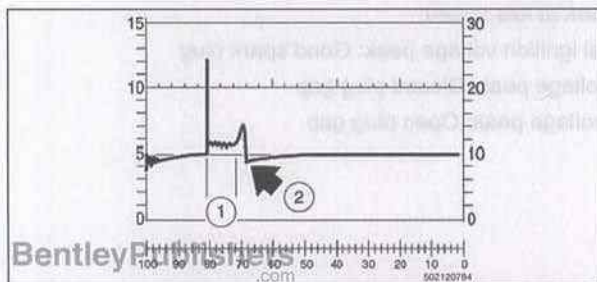


➤ Ignition voltage peaks at idle

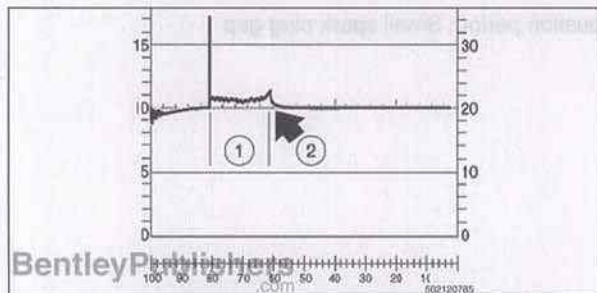
1. Normal ignition peaks
2. Downward peak (arrow) shortened: Ignition coil defective
3. Downward peak (arrow) missing completely: Ignition coil defective

120-10 Ignition System

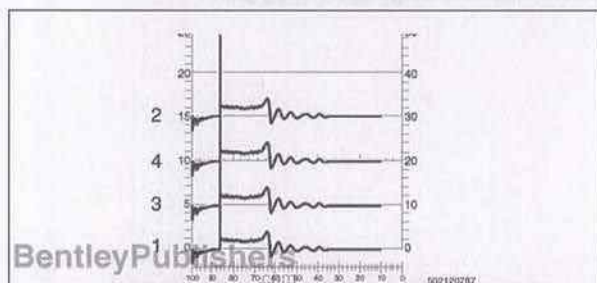
Oscilloscope diagnostic diagrams



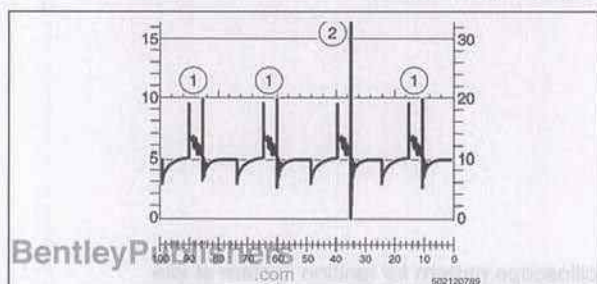
- Defective ignition coil
- 1. Short spark period
- 2. Spark voltage line (arrow) with very slight drop



- Defective ignition coil
- 1. Normal combustion period
- 2. Spark voltage line (arrow) absent



- Normal secondary voltage patterns (4-cylinder pattern shown)



- Ignition voltage peaks in response to sudden acceleration load:
- 1. Normal ignition pattern. Beginning of dying out pattern is not much higher than ignition voltage peak.
- 2. Beginning of dying out pattern considerably higher than ignition voltage peak. Fault in injection system:
 - Lean fuel mixture
 - Defective fuel injector
 - Low compression in cylinder

IGNITION COIL SERVICE

There is a separate ignition coil above each spark plug. Spark plug replacement is covered in **020 Maintenance**.

Ignition coil, replacing

- Make sure ignition is switched OFF.
- Remove ignition coil cover. See **020 Maintenance**.
- Unlock (**curved arrow**) ignition coil connector. Pull (**straight arrow**) connector off coil.



- Slide rod-shaped ignition coil straight out of spark plug hole.

CAUTION—

- Maintain a high level of cleanliness when servicing ignition coils. Fuel / oil residue can cause a breakdown in the electrical resistance qualities of silicone used in production. This in turn can result in a failure of the ignition coil.

- Installation is reverse of removal.
- Check for fault codes and reset ECM memory.

CRANKSHAFT SENSOR SERVICE

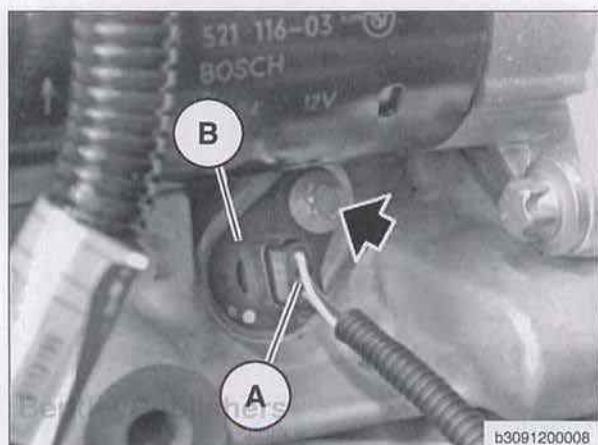
Crankshaft sensor, replacing

Crankshaft sensor is on left rear of engine block, underneath intake manifold and starter motor.

- Make sure ignition is OFF.
- Raise car and support in a safe manner.

WARNING—

- Make sure the car 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.



Working underneath starter:

- Disconnect crankshaft sensor harness connector (A) from sensor (B).
- Remove sensor mounting fastener (arrow) and remove sensor from cylinder block. Be prepared to catch dripping oil.
- Installation is reverse of removal. Remember to:
 - Use new sealing O-ring when installing sensor.
 - Replace mounting bolt.
 - Be sure wiring is routed as before.
 - Check and clear fault codes from ECM memory.

Tightening torque

Crankshaft sensor to engine block (M6, replace bolt)	8 Nm (6 ft-lb)
--	----------------

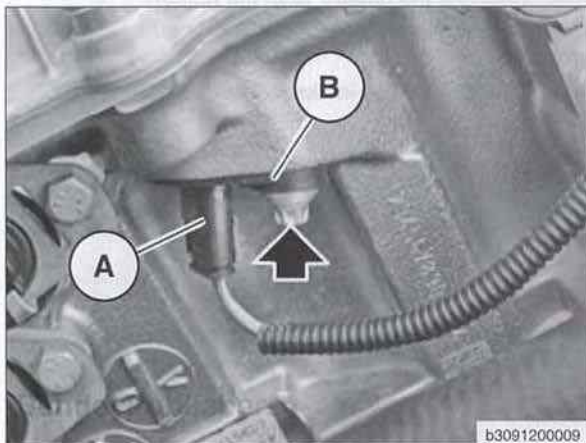
CAMSHAFT SENSOR SERVICE

Intake camshaft sensor, replacing

Intake camshaft sensor is mounted to left front of cylinder head.

- Make sure ignition is OFF.
- Remove upper engine covers. See **020 Maintenance**.
- Remove air filter housing and ducts. See **130 Fuel Injection**.
- Detach camshaft sensor electrical connector (A).

- Remove camshaft sensor mounting bolt (arrow). Remove sensor (B) from cylinder head. be prepared to catch dripping oil.
- Installation is reverse of removal. Remember to:
 - Replace camshaft sensor mounting bolt.
 - Use new sealing O-rings when installing sensor.
 - Be sure sensor harness is routed as before.
 - Check and clear fault codes from ECM memory.



Tightening torques

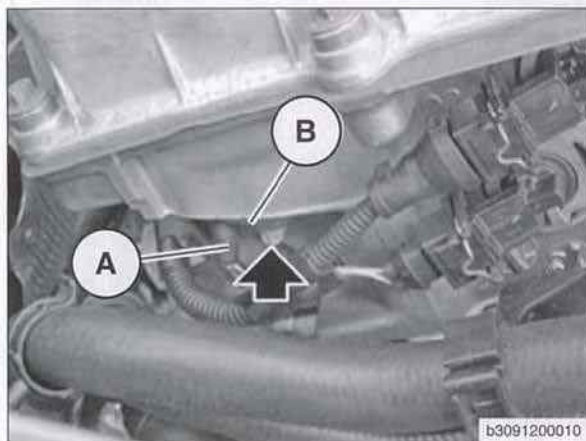
Intake camshaft sensor to cylinder head (M6, replace bolt)	9 Nm (6.5 ft-lb)
--	------------------

Exhaust camshaft sensor, replacing

Exhaust camshaft sensor is mounted to right front of cylinder head.

- Make sure ignition is OFF.
- Remove upper engine covers. See **020 Maintenance**.
- Remove air filter housing and ducts. See **130 Fuel Injection**.
- Detach camshaft sensor electrical connector (A).

- Remove camshaft sensor mounting bolt (arrow). Remove sensor (B) from cylinder head. Be prepared to catch dripping oil.
- Installation is reverse of removal. Remember to:
 - Replace camshaft sensor mounting bolt.
 - Use new sealing O-rings when installing sensor.
 - Be sure sensor harness is routed as before.
 - Check and clear fault codes from ECM memory.



Tightening torques

Intake camshaft sensor to cylinder head (M6, replace bolt)	9 Nm (6.5 ft-lb)
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KNOCK SENSOR SERVICE

Knock sensors, replacing (non-turbo)

Non-turbo engine knock sensors are under the intake manifold on the left side of the cylinder head.

- Disconnect negative (-) battery cable and cover battery terminal to keep cable from accidentally contacting terminal.

CAUTION—

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

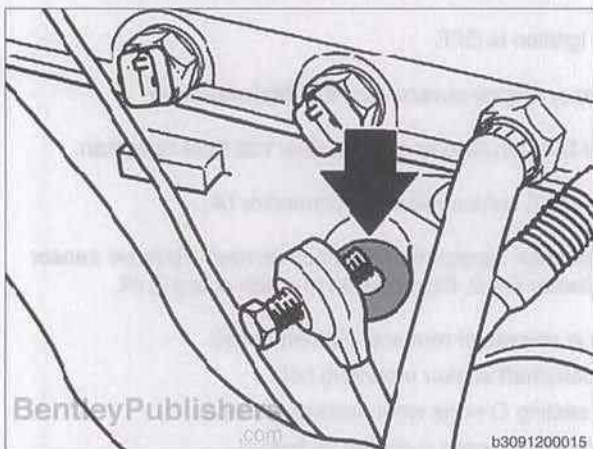
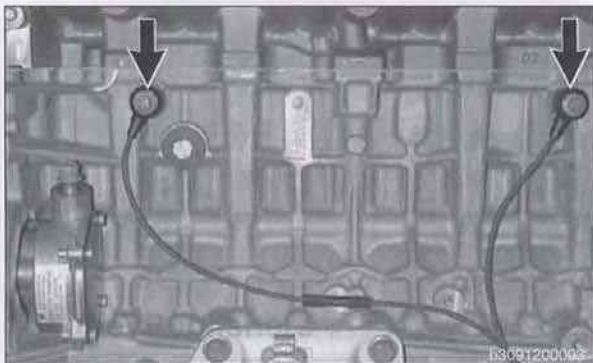
- With engine fully cooled, remove intake manifold. See **130 Fuel Injection**.

- Disconnect knock sensor electrical harness connector.

- Remove knock sensor mounting bolts (arrows) on side of cylinder block. Remove sensors.

CAUTION—

- Note the installed angle of the knock sensor on the block before removing it. Reinstall the sensor in the same position. Be sure to use a torque wrench when tightening the sensor mounting bolt.



- Clean knock sensor contact surface on engine block and sensor (arrow) before installing knock sensor.

CAUTION—

- Do not overtighten knock sensors.

Tightening torques

Knock sensor to engine block (use new aluminum M8 fasteners)

- Stage 1
- Stage 2

7 Nm (63 in-lb)
additional 90°

- Installation is reverse of removal. Remember to:
 - Replace knock sensor mounting bolt.
 - Be sure sensor harness is routed as before.
- Check and clear fault codes from ECM memory.

Knock sensors, replacing (turbo)

Turbo engine knock sensors are under the intake manifold on the left side of the cylinder head.

- Disconnect negative (-) battery cable and cover battery terminal to keep cable from accidentally contacting terminal.

CAUTION—

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

- With engine fully cooled, remove intake manifold. See 130 Fuel Injection.



- Disconnect electrical connectors (A), remove and seal fuel line connections (B). Be prepared to catch dripping fuel.

WARNING—

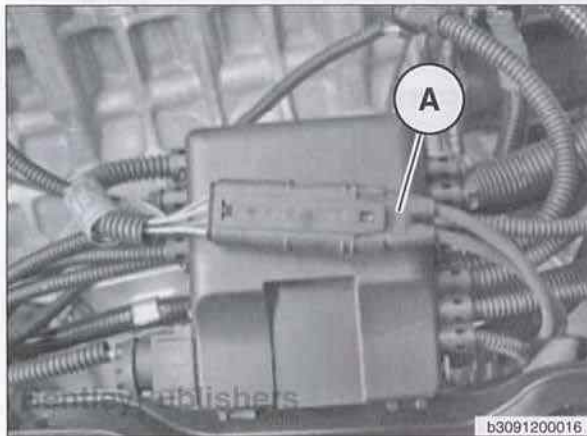
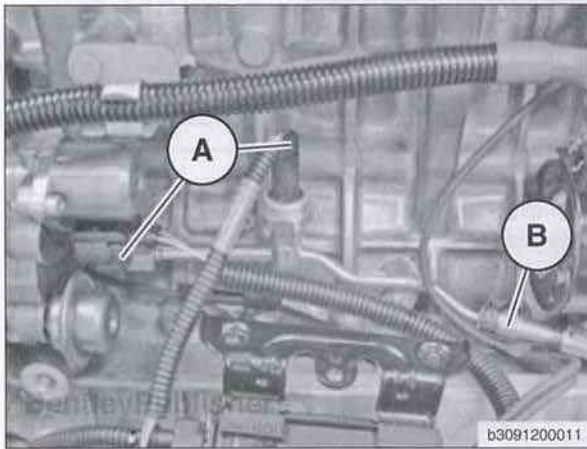
- The fuel system is designed to retain pressure even when the ignition is OFF. When working with the fuel system, remove fuel lines slowly to allow residual fuel pressure to dissipate. Avoid spraying fuel. Use shop rags to capture leaking fuel.
- Electric fuel pump starts automatically when door is opened.
- Carry out installation work on fuel system with coolant temperature below 40°C (104°F).

CAUTION—

- When working with high pressure fuel lines observe clean working habits. Any dirt or debris introduced into system will cause malfunctions.

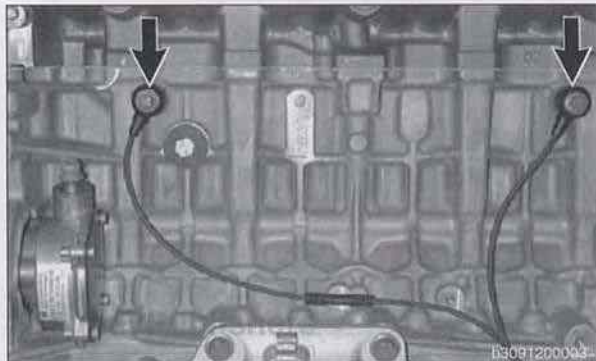


- Disconnect knock sensor electrical connector (A) on left side of engine block.



120-16 Ignition System

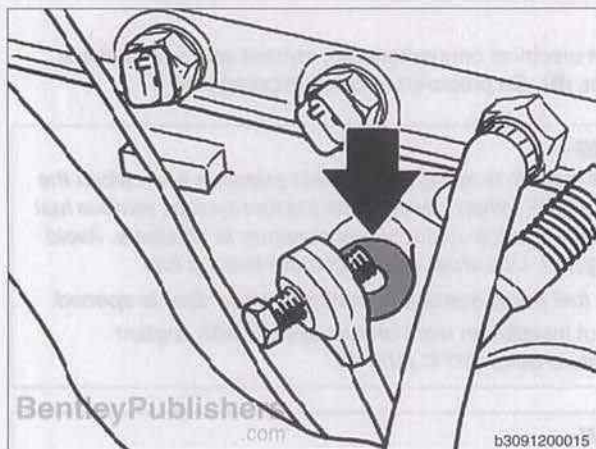
Knock sensors, replacing (turbo)



- Remove knock sensor mounting bolts (**arrows**) on side of cylinder block. Remove sensors.

CAUTION—

- Note the installed angle of the knock sensor on the block before removing it. Reinstall the sensor in the same position. Be sure to use a torque wrench when tightening the sensor mounting bolt.



- Clean knock sensor contact surface on engine block and sensor (**arrow**) before installing knock sensor.

CAUTION—

- Do not overtighten knock sensors.

Tightening torques

Knock sensor to engine block (use new aluminum M8 fasteners)	
• Stage 1	7 Nm (63 in-lb)
• Stage 2	additional 90°
Fuel line nut to high pressure pump (coat thread with transmission fluid)	30 Nm (22 ft-lb)
Fuel line mounting bracket to engine block	8 Nm (87.5 in-lb)

- Installation is reverse of removal. Remember to:
- Replace knock sensor mounting bolt.
 - Be sure sensor harness is rerouted as before.
 - Check for fuel system leaks.
 - Check and clear fault codes from ECM memory.



110 Engine Removal and Installation

GENERAL	110-1
Warnings and Cautions	110-1

ENGINE REMOVAL AND INSTALLATION	110-2
Engine, removing and installing	110-2

GENERAL

This repair group includes an overview of non-turbo and turbo engine removal and installation. The procedures have been combined and steps applying to an individual engine have been highlighted.

Transmission removal is required before the engine can be removed.

See also:

- **020 Maintenance** for engine covers removal
- **100 Engine-General** for engine codes and applications
- **121 Battery, Starter, Alternator**
- **170 Radiator and Cooling System**
- **180 Exhaust System**
- **230 Manual Transmission**
- **240 Automatic Transmission**
- **260 Driveshafts**
- **310 Front Suspension**
- **410 Fenders, Engine Hood**

110-2 Engine Removal and Installation

Warnings and Cautions

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 fuel lines slowly to allow residual fuel pressure to dissipate. Avoid spraying fuel.
- Before beginning any work on the fuel system, place a fire extinguisher in the vicinity of the work area.
- Fuel is highly flammable. When working around fuel, do not disconnect any wires that could cause electrical sparks. Do not smoke or work near heaters or other fire hazards.
- Loosen the fuel tank cap to release pressure in the tank before working on the tank or lines.
- When disconnecting a fuel hose, wrap a shop towel around the end of the hose to prevent fuel spray.
- Do not use a work light with an incandescent bulb near any fuel. Fuel may spray on the hot bulb causing a fire.
- Make sure the work area is properly ventilated.
- Steel fasteners may not be used in place of aluminum fasteners due to the threat of corrosion.
- Magnesium crankcase requires aluminum fasteners.
- Replace aluminum fasteners each time they are removed.
- Aluminum fasteners are identified with blue paint marking.

CAUTION—

- If the MIL (malfunction indicator light, also called Check Engine or Service Engine Soon light) is illuminated, **see** **OBD On-Board Diagnostics** for DME fault code information.
- If other system faults are indicated by an illuminated ABS, SRS or DSC warning light, see the appropriate repair group in this manual or an authorized BMW dealer for more information on fault codes.

ENGINE REMOVAL AND INSTALLATION

Be sure to cover painted surfaces before beginning the removal procedure. As an aid to installation, label components, wires and hoses before removing them. Do not reuse gaskets, O-rings or seals during reassembly.

WARNING—

- Due to risk of personal injury, be sure the engine is cold before beginning the removal procedure.

Engine, removing and installing

- Place hood in service position.
- Remove exhaust system. See **180 Exhaust System**.
- Remove transmission. See **230 Manual Transmission** or **240 Automatic Transmission**.
- Drain engine oil.

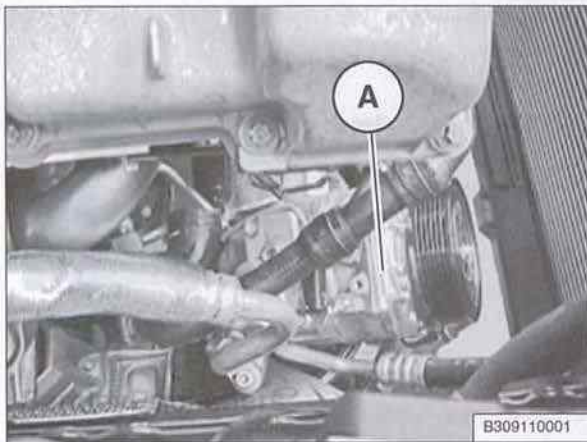
- Drain engine coolant.
- Disconnect negative (–) cable from battery.

CAUTION—

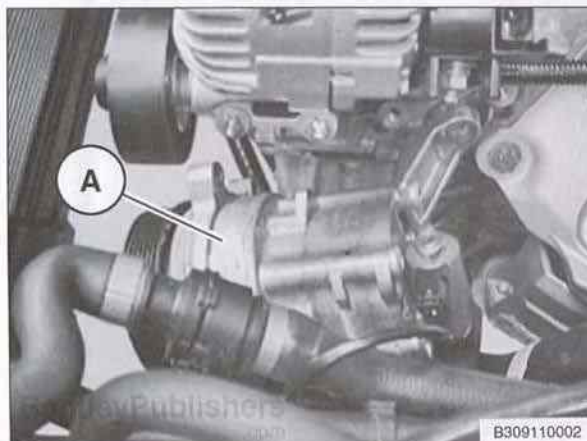
- Prior to disconnecting the battery, read the battery disconnection cautions in 001 Warnings and Cautions.

- Remove air cleaner housing and fresh air ducts. See 130 Fuel Injection.
- Remove fan cowl with electric cooling fan. See 170 Radiator and Cooling System.
- Remove radiator. See 170 Radiator and Cooling System.
- Remove thermostat. See 170 Radiator and Cooling System.
- Remove all cooling system hoses from vehicle.
- Remove intake manifold. See 130 Fuel Injection.
- Remove vacuum line from brake booster.
- Disconnect electrical connectors and harness from ignition coils and lay harness aside.
- Disconnect engine electrical harness and lay aside.
- Turbo engine: Remove fuel supply line to high pressure fuel pump. See 160 Fuel Tank and Fuel Pump for high pressure fuel pump removal and installation.

- Remove A/C compressor (A) from engine and set on front axle carrier. Do not disconnect A/C lines or discharge system.

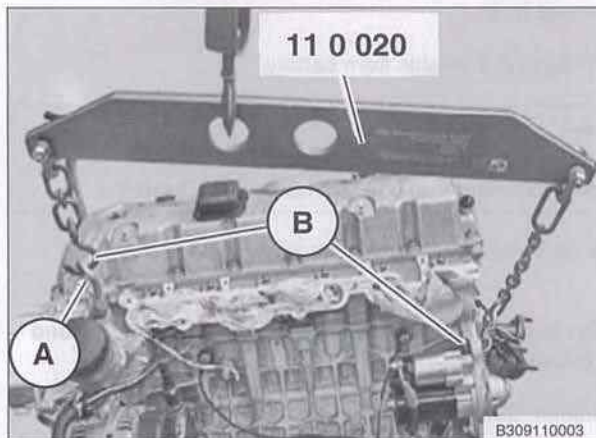


- Remove power steering pump (A) and set on front axle carrier. Do not disconnect hydraulic lines.

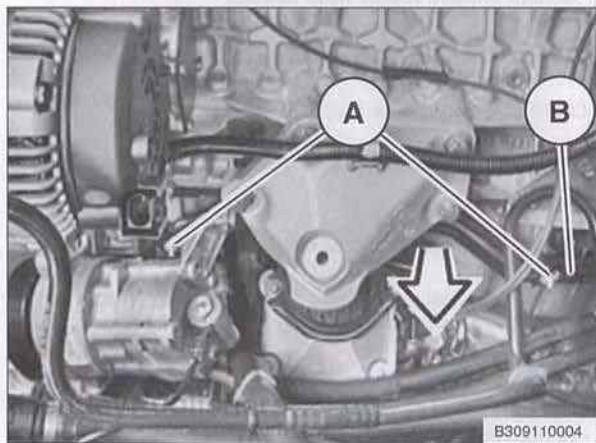


110-4 Engine Removal and Installation

Engine, removing and installing



- Install engine tow hook (from tool kit in trunk) to front of engine (A). Attach BMW special tool 11 0 020 to engine using only specified mounting places (B).



- If equipped with automatic transmission: Raise engine 10 cm (4 in) and remove fasteners (A) for ATF cooler lines (B).
- Remove engine from vehicle using engine hoist attached to BMW special hook 11 0 020.
 - Raise engine slowly while watching carefully to make sure no lines, wires or hoses become snagged.
 - Installation is reverse of removal. Remember to:
 - Replace aluminum fasteners.
 - Check for fuel leaks.
 - Check for coolant leaks.
 - Check and clear any fault codes using BMW factory scan tool or equivalent.

