

100 Engine—General

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GENERAL

There are various engine configurations used in the 1992-1998 E36 cars. See **Table a**.

Table a. Engine Specifications

Model	Engine code	No. of cylinders	Displacement liters (cu. in.)	Compression ratio	Horsepower SAE net @ rpm
318i/is/iC 1992-1995	M42	4	1.8 (109.6)	10.0:1	100 @ 6000
1996-1998	M44	4	1.9 (115.6)	10.0:1	103 @ 6000
323is/iC 1998	M52	6	2.5 (152.2)	10.5:1	168 @ 5,500
325i/is/iC 1992-1995	M50	6	2.5 (152.2)	10.0:1	110 @ 5,900
328i/is/iC 1996-1998	M52	6	2.8 (170.4)	10.2:1	190 @ 5,300
M3 1995	S50US	6	3.0 (182.5)	10.5:1	240 @ 6,000
1996-1998	S52US	6	3.2 (192.3)	10.5:1	240 @ 6,000

Cylinder Block and Crankshaft

On both four- and 6-cylinder engines, the cylinder block is cast iron with integral cylinders. The cylinders are exposed on all sides to circulating coolant.

The fully counterweighted crankshaft rotates in replaceable split-shell main bearings. Oilways drilled into the crankshaft provide bearing lubrication. Oil seals pressed into alloy seal housings are installed at both ends of the crankshaft.

Connecting Rods and Pistons

The forged connecting rods use replaceable split-shell bearings at the crankshaft end and solid bushings at the piston pin end. The pistons are of the three-ring type with two upper compression rings and a lower one-piece oil scraper ring. Full-floating piston pins are retained with circlips.

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Cylinder Head and Valvetrain

The aluminum cylinder head uses chain-driven double overhead camshafts and four valves per cylinder. See Fig. 1. The cylinder head employs a crossflow design for greater power and efficiency. Intake air enters the combustion chamber from one side while exhaust gasses exit from the other. Oilways in the head provide lubrication for the camshaft(s) and valvetrain.

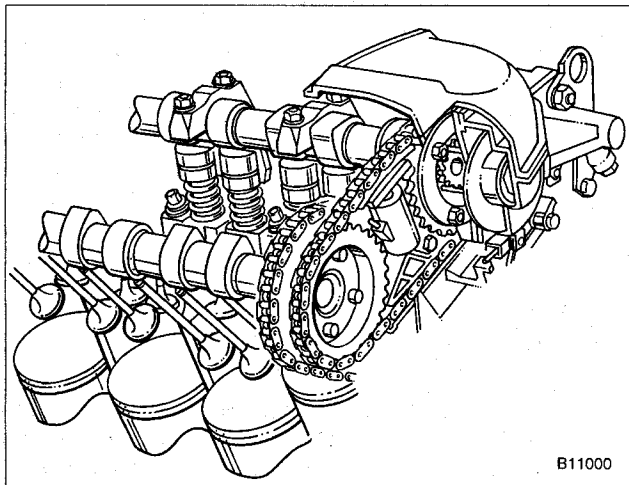


Fig. 1. M52 twin-cam, 4-valve-per-cylinder engine with hydraulic lifters.

On all engines except the M44 engine, valve clearance is by self-adjusting hydraulic lifters. On M44 engines, instead of hydraulic lifters, hydraulic pedestals are used in combination with roller rocker arms to actuate the valves. Hydraulic pedestals have the same function as hydraulic lifters, which is to maintain zero valve clearance, reduce valve noise, and eliminate routine adjustment. See Fig. 2.

VANOS (Variable Valve Timing)

1993 and later 6-cylinder engines are equipped with a variable intake valve timing system, known as VANOS (from the German words Variable Nockenwellen Steuerung). The VANOS system electro-hydraulically adjusts intake valve timing for enhanced mid-range performance. The VANOS system is controlled by the engine control module (ECM), using engine speed, engine load and engine temperature as the primary inputs.

At low speeds, the intake valves open late to ensure smooth engine operation. At mid-range speeds, the valves open early (valve timing advanced, VANOS actuated) for increased torque, improved driveability, and reduced emissions. And at high speeds, the valves again open late for optimum power and performance.

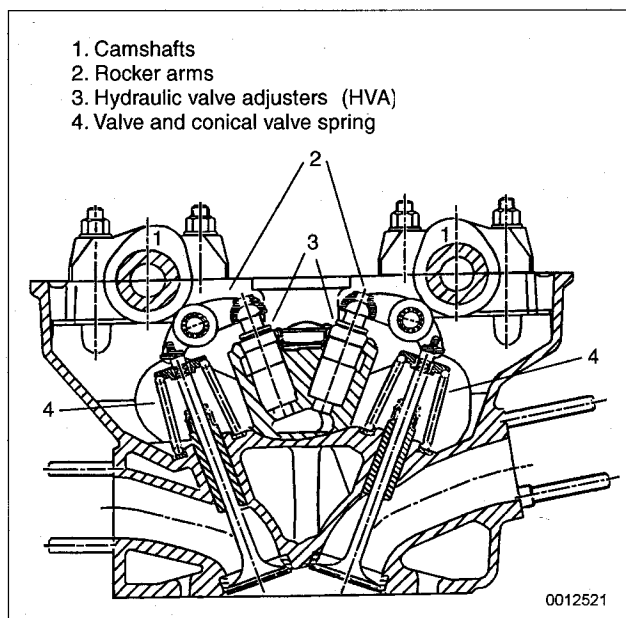


Fig. 2. Cross section of M44 twin-cam, 4-valve-per-cylinder head. Note function of hydraulic pedestal in combination with rocker arm (with roller bearing for reduced friction).

The main components of the VANOS system are the piston housing with integral spool valve and solenoid, and the modified intake camshaft and sprocket assembly. See Fig. 3.

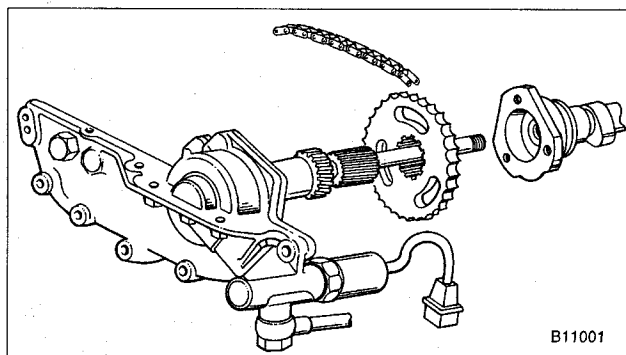


Fig. 3. VANOS (variable intake valve timing) system used on M52 engine. When solenoid is actuated, oil pressure is directed to front side of gear cup piston. This forces gear cup into camshaft to advance intake valve timing.

When the engine is running, the piston housing is supplied with pressurized engine oil via the solenoid-actuated spool valve. Depending on the position of the spool valve, oil is directed to either the front or back side of the gear cup piston.

When the solenoid is in the off position, engine oil is directed to the back side of the piston. This holds the gear cup forward and valve timing is maintained at the normal "late" position. When the solenoid is energized, the spool valve is moved forward and oil pressure is directed to the front side of the piston. This in turn moves the gear cup further into the

camshaft secondary drive, causing the camshaft to "advance" 12.5°. The helical gears are cut so that forward motion of the gear cup is translated into rotational motion of the camshaft. See **117 Camshaft Timing Chain** for testing and repair information on the VANOS system.

DISA (Dual Resonance Intake System)

DISA, used on 4-cylinder engines, is a dual intake runner system that effectively provides the advantages of both short and long intake runners within the same engine. For best performance, long intake runners are most beneficial at low- and mid-engine speeds (below 4,200 rpm), and short intake runners enhance torque at high engine speeds (above 4,200 rpm).

NOTE—

The term DISA comes from the German words *Differenzierte Sauganlage*, and can roughly be translated as a differing intake manifold configuration.

The DISA solenoid valve is controlled by the DME control module, using engine speed as the primary input. The main components of the system are the modified twin-section intake manifold with change-over valve, the twin-barrel throttle body, and the electrical/pneumatic actuating components. See Fig. 4.

The DISA system electro-pneumatically changes the intake runner length through the twin-section intake manifold and a change-over butterfly valve. The change-over valve is located at a point in the intake manifold where four pipes come into two. When the change-over valve is closed, the 4-way primary intake manifold and the 2-way ram air manifold are connected to make the "long" configuration. When the change-over valve opens, intake air flow is redirected through only the short 4-way primary intake manifold.

The change-over valve is held in the normally open position by a spring. This allows for an open valve in the event of system failure. During low and mid engine speeds, the DME control module supplies power to the solenoid valve, which in turn allows vacuum to be applied to the vacuum diaphragm. This causes the valve to close (long-pipe configuration). When engine speed reaches approximately 4,800 rpm, the DME control module electrically signals the solenoid valve and the valve opens, creating the short pipe configuration.

Further details on DISA can be found in **130 Fuel Injection**.

Engine Management System

All engines covered by this manual use an advanced engine management system called Digital Motor Electronics (DME). In the DME system, advanced On-Board Diagnostics (OBD), fuel injection, ignition, and other functions, are combined under the control of the Engine Control Module (ECM). See Fig. 5.

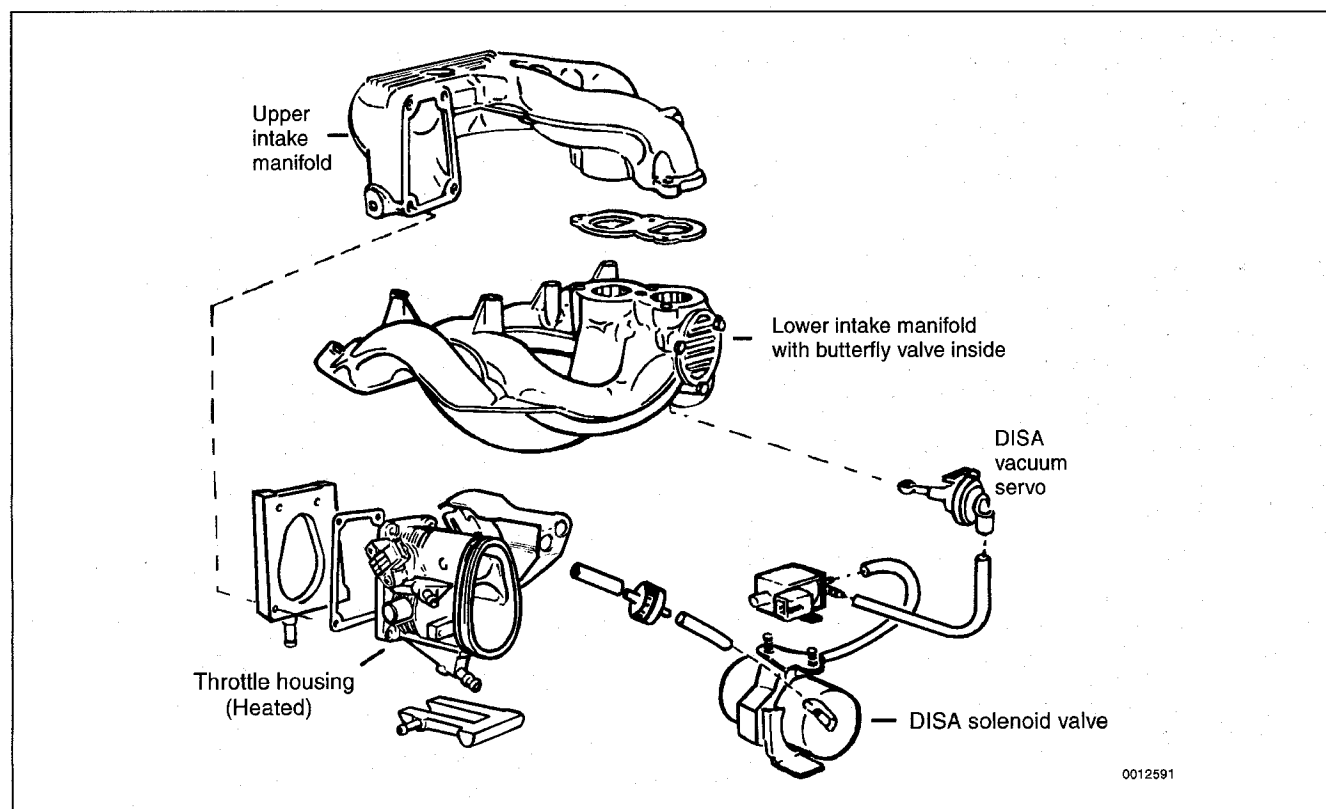


Fig. 4. DISA system components. DISA changes the intake runner length based on engine speed.

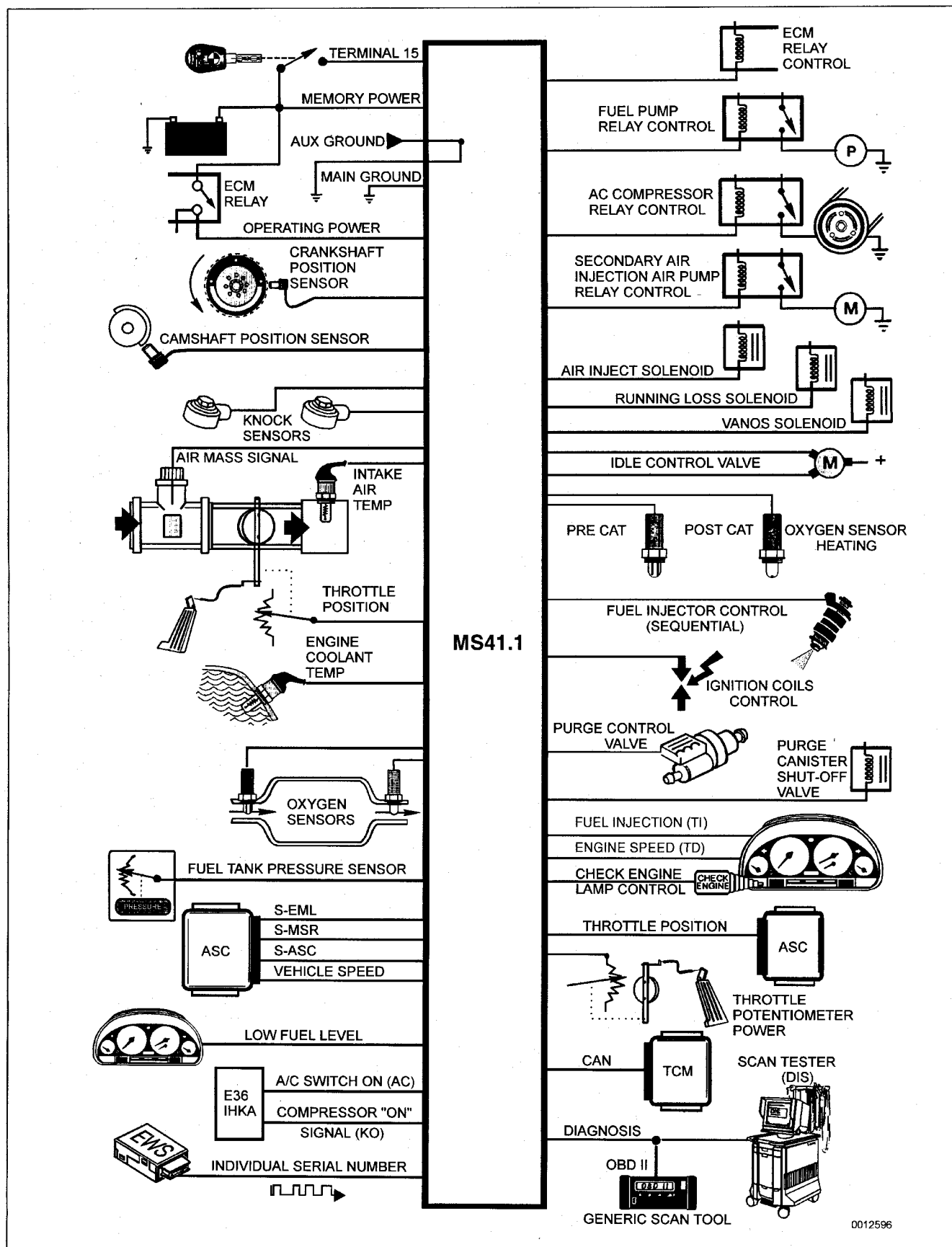


Fig. 5. Siemens MS 41.1 OBD II engine management system used on 1996 and later M52 engines.

GENERAL

Various versions of DME systems are used on the cars covered by this manual. See **Table b.** Each system is highly adaptive to compensate for things such as engine wear and vacuum leaks.

Table b. Engine Management Systems

Engine	System
4-cylinder engines M42 (1992-1995) M44 (1996-1998)	Bosch DME M1.7 Bosch DME M5.2 (OBD II)
6-cylinder engines M50 (1992) M50 VANOS (1993-1995) M52 (1996-1998) S50US (1995) S52US (1996-1998)	Bosch DME M3.1 Bosch DME M3.3.1 Siemens MS41.1 (OBD II) Bosch DME M3.3.1 Siemens MS41.1 (OBD II)

Ignition

Both the 4-cylinder and 6-cylinder engines use a distributor-less ignition system with individual ignition coils for each cylinder.

Fuel Delivery

Pressurized fuel from the in-tank fuel pump is injected via solenoid-type fuel injectors. The ECM controls the opening and closing of the injectors by switching the ground side of each injector circuit. The exact amount of fuel injected is determined by the amount of time the injectors are open.

Cooling System

Whenever the engine is running, a coolant pump circulates coolant through the engine and, if either heater control valves are open, through the heater core in the passenger compartment. The coolant absorbs excess heat and carries it to the radiator where it is transferred into the passing airstream. A thermostat controls the flow of coolant through the radiator based on engine temperature.

Lubrication System

The lubrication system is pressurized whenever the engine is running. The oil pump draws oil through a pickup in the bottom of the oil pan, then forces it through a replaceable oil filter and into the engine oil passages.

On 4-cylinder engines, the oil pump is mounted to the front engine cover. On 6-cylinder engines, the chain-driven oil pump is bolted to the bottom of the cylinder block.

A pressure relief valve limits the maximum system pressure. A bypass valve prevents the oil filter from bursting and insures engine lubrication should the filter become plugged. See **119 Lubrication System** for additional information.

MECHANICAL TROUBLESHOOTING

When troubleshooting an engine that fails to start or runs poorly, first check its mechanical condition—particularly if the engine has high mileage.

Warnings and Cautions

For personal safety, as well as the protection of sensitive electronic components, the following warnings and cautions must be adhered to during all troubleshooting, maintenance, and repair work.

WARNING —

- The ignition system produces high voltages that can be fatal. Avoid contact with exposed terminals and use extreme caution when working on a car with the ignition switched on or the engine running.
- Do not touch or disconnect any high voltage cables from the coil, distributor, or spark plugs while the engine is running or being cranked by the starter
- Connect and disconnect the engine management system wiring and test equipment leads only when the ignition is switched off.
- Gasoline is highly flammable and its vapors are explosive. Do not smoke or work on a car near heaters or other fire hazards when diagnosing and repairing fuel system problems. Have a fire extinguisher available in case of an emergency.
- Disconnecting the battery may erase fault code(s) stored in control module memory. Using special BMW diagnostic equipment, check for fault codes prior to disconnecting the battery cables. If the Check Engine light is illuminated, see **On-Board Diagnostics (OBD)** for fault code information. If any other system faults have been detected (indicated by an illuminated warning light), see an authorized BMW dealer.

CAUTION —

- Prior to disconnecting the battery, read the battery disconnection cautions given at the front of this manual on page viii.
- 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 ECM. In general, connect test equipment only as specified by BMW, this manual, or the equipment maker.
- Do not disconnect the battery with the engine running. Do not run the engine with any of the spark plug wires disconnected.

Cylinder compression, checking

A compression tester is needed to make a compression test. To obtain accurate test results, the battery and starter must be capable of cranking the engine at 250–300 rpm, and the engine should be at normal operating temperature. Use compressed air to clean around the spark plugs before removal.

1. Disable the ignition system by removing the engine management system main relay and the fuel pump relay. See Fig. 6.

WARNING —

The ignition system produces high voltages that can be fatal. Avoid contact with exposed terminals and use extreme caution when working on a car with the ignition switched on or the engine running.

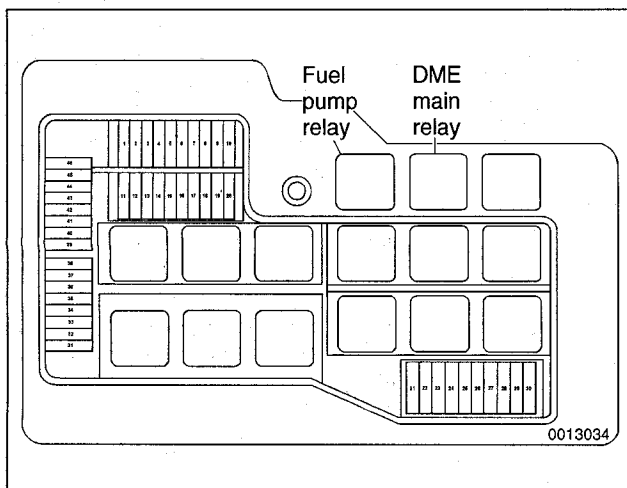


Fig. 6. Engine management relays in power distribution box in left rear of engine compartment.

CAUTION —

- On OBD II cars, making a compression test may cause a fault to set in the ECM and may also illuminate the Check Engine light. The light can only be turned out using special scan tool equipment, using either the BMW special service tool or using a "generic" OBD II scan tool. Disconnecting the battery will not erase the fault memory nor turn out the light.
- Failure to remove the main relay or attempting to disable the ignition system by other methods may result in damage to the engine control module.

2. On 4-cylinder engine: Remove plastic engine cover from top of cylinder head. Disconnect spark plug wires and remove spark plugs. See Fig. 7.
3. On 6-cylinder engine: Remove top engine cover by prying off nut covers and removing mounting nuts. See Fig. 8.

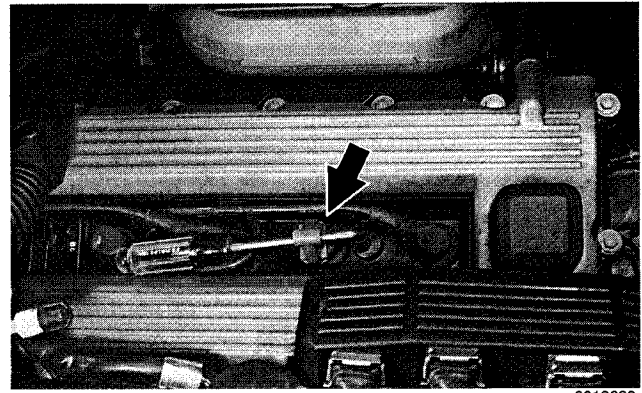


Fig. 7. Remove spark plug wires from spark plugs on 4-cylinder engine using special tool. Tool is stored under cover at rear of cylinder head (arrow).

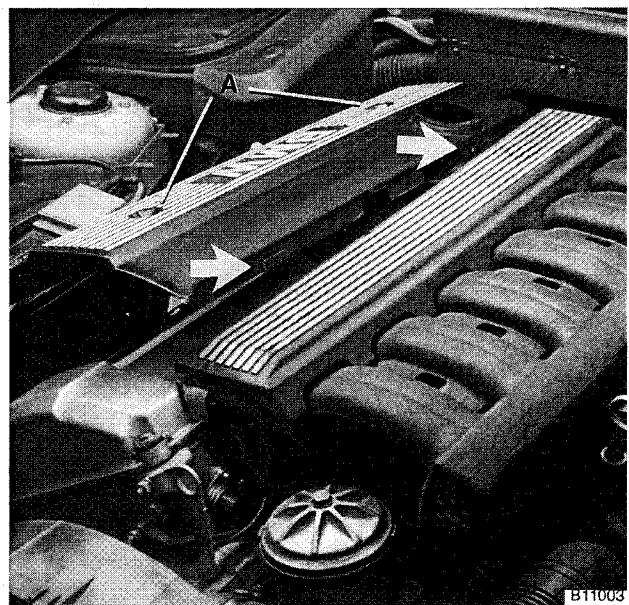


Fig. 8. Remove engine cover on 6-cylinder engine by prying off nut covers and removing nuts (A). Be careful not to let rubber insulators fall off as cover is removed (arrows).

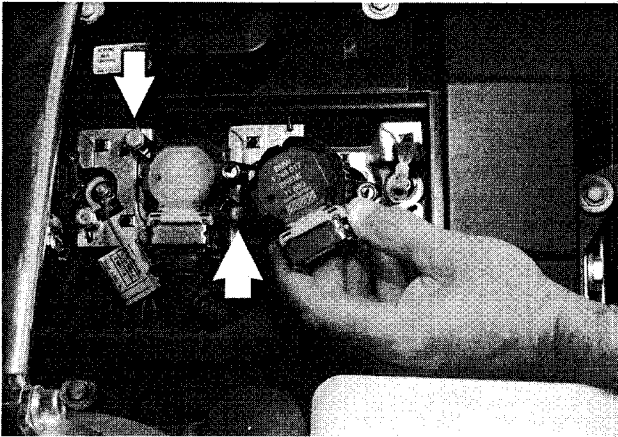
4. On 6-cylinder engines, disconnect the harness connectors from the ignition coils by lifting the retaining clip. Remove the coil mounting nuts and remove the six coils. See Fig. 9. Remove the spark plugs.

NOTE —

Used spark plugs should be reinstalled in the same cylinder from which they were removed.

5. Install the compression gauge in the first cylinder's spark plug hole, tight enough to form a good seal.

MECHANICAL TROUBLESHOOTING



B11004

Fig. 9. Remove ignition coils on 6-cylinder engine by disconnecting harness connector and removing mounting bolts (**arrows**).

6. With the parking brake set, the transmission in Park or Neutral, and the accelerator pedal pressed to the floor, crank the engine with the starter. Record the highest value indicated by the gauge.

NOTE —

- The compression gauge reading should increase with each compression stroke and reach near its maximum reading in about 4-6 strokes.
- All cylinders should reach maximum compression in the same number of strokes. If a cylinder needs significantly more strokes to reach maximum compression, there is a problem.

7. Release the pressure at the compression gauge valve, then remove the gauge from the spark plug hole. Repeat the test for each of the other cylinders and compare the results with the values given below.

Compression Pressure

- Minimum 10-11 bar (142-156 psi)
- Maximum difference between cylinders 0.5 bar (7 psi)

Reinstall the spark plugs and spark plug wires or ignition coils. The remainder of installation is the reverse of removal. Be sure to reinstall all wires disconnected during the test, especially ground wires at the coils and cylinder head cover (where applicable).

Tightening Torque

- Spark plug to cylinder head 25 Nm (18 ft-lb)

Low compression indicates a poorly sealed combustion chamber. Relatively even pressures that are below specification normally indicate worn piston rings and/or cylinder walls. Erratic values tend to indicate valve leakage. Dramatic differences between cylinders are often the sign of a failed head gasket, burned valve, or broken piston ring.

Engine Mechanical Troubleshooting Table

Table c lists the symptoms of common engine mechanical problems, their probable causes and the suggested corrective actions. The bold type indicates the repair groups where applicable test and repair procedures can be found.

Table c. Engine Mechanical Troubleshooting

Symptom	Probable cause and corrective action
1. Engine will not start or run. Starter cranks engine at normal speed.	a. No fuel reaching engine. Check for fuel in tank. Fuel pump not operating. Repair Group 160 b. No spark. Check ignition system. Repair Group 120 c. Incorrect valve timing. Check timing chain. Repair Group 117
2. Check Engine warning light illuminated.	a. DME engine management system self-diagnostic fault detected. See an authorized BMW dealer or other qualified shop for OBD II fault code diagnosis. See also On-board Diagnostics (OBD) , given later in this repair group.
3. White exhaust smoke (steam).	a. Failed cylinder head gasket (probably accompanied by low compression readings). Replace gasket and resurface cylinder head if necessary. Repair Group 113 b. Warped or cracked cylinder head. Resurface or replace cylinder head. Repair Group 113 c. Cracked cylinder block. Replace engine or short block.
4. Blue-gray exhaust smoke and oily spark plugs. Indicates oil burning in combustion.	a. Contaminated or gasoline-diluted engine oil. Change engine oil and replace oil filter. Repair Group 020 b. Faulty valve guide seals or valve guides. Replace valve guide oil seals or overhaul cylinder head. Repair Group 116 c. Worn piston rings. Overhaul or replace engine. d. Failed cylinder head gasket. Replace gasket. Repair Group 113
5. Pinging or rattling when under load, traveling uphill, or accelerating, especially from low speeds. Indicates pre-ignition or detonation.	a. Ignition timing too advanced. Ignition knock sensors faulty (Check Engine light illuminated). Repair Group 120 b. Fuel octane level too low. c. Engine running too hot or overheating. Check cooling system. Repair Group 170 d. Air/fuel mixture too lean (Check Engine light illuminated). Repair Group 130
6. Light metallic tapping that varies directly with engine speed. Oil pressure warning light not illuminated.	a. Valve clearances excessive. Check hydraulic valve adjusters. Repair Group 116 b. Low oil pressure or possibly defective warning light circuit. Check oil pressure and warning light circuit. Repair Group 119 c. Dirty oil. Change oil. Repair Group 020 .
7. Light metallic knock that varies directly with engine speed. Oil pressure warning light blinking or fully illuminated; may be most noticeable during hard stops or cornering.	a. Low oil level. Check and correct oil level. b. Low oil pressure/worn or faulty oil pump. Oil pump pickup restricted/clogged. Check oil pressure. Repair Group 119
8. Screeching or squealing under load that goes away when coasting.	a. Loose, worn, or damaged drive belt. Inspect belt(s). Repair Group 020
9. Growling or rumbling that varies with engine rpm. Indicates a bad bearing or bushing in an engine-driven accessory.	a. Remove drive belt(s) to identify faulty component. Check for play, bearing roughness, and loose mountings. Refer to appropriate repair group for repair procedures.

DRIVEABILITY TROUBLESHOOTING

On-Board Diagnostics is incorporated into all engine management systems used on the cars covered by this manual. Therefore, checking for fault codes should be the first step in troubleshooting a driveability problem. For additional information on engine management and repair see **130 Fuel Injection**.

On-Board Diagnostics (OBD)

Two generations of OBD are used on the cars covered by this manual:

On-Board Diagnostics

- 1992-1995 models OBD I
- 1996-1998 models OBD II

The OBD system detects emissions-related engine management malfunctions and turns on the Check Engine light in the instrument cluster. The Check Engine light will stay on until the code(s) are called up and the memory is erased. When faults are detected, the OBD system stores a Diagnostic Trouble Code (DTC) in the system ECM. In addition, the Check Engine warning light will come on if an emissions-related fault is detected.

NOTE —

- On cars with OBD II, specialized OBD II scan tool equipment must be used to access the DTCs, either using the BMW special tool or a "generic" OBD II scan tool. See **130 Fuel Injection**.
- The OBD II fault memory (including an illuminated Check Engine light) can only be reset using the special scan tool. Removing the connector from the ECM or disconnecting the battery will not erase the fault memory.

On cars with OBD I, fault codes can be read by turning the ignition key on and fully depressing the accelerator pedal to the floor five times within five seconds. The Check Engine light will then remain on for five seconds, blink off, come on for

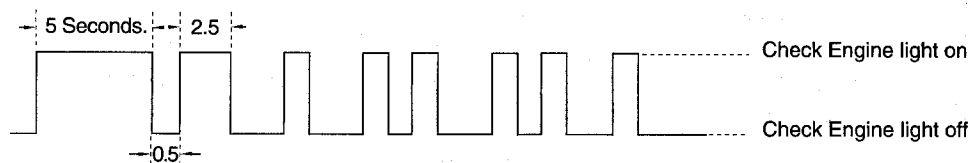
2.5 seconds, then go off for 2.5 seconds. At this point, the fault codes will begin to flash. See **Table d**.

If more than one fault has been detected, each code will be separated by a 2.5 second pause. When all fault codes have been displayed, there will be 0.5 second flash and then the light will remain off. To read the codes again, turn the key off and then on again. Depress the accelerator pedal to the floor five times quickly (within 5 seconds). The codes will begin to repeat.

To erase the fault code memory, first make sure the fault code 1000 (short blink and then light goes out for long period) is present, then depress the throttle fully for at least 10 seconds. Read the fault codes as described earlier and check for the 1444 code (no faults stored).

**Table d. OBD I Fault (Blink) Codes
(1992-1995 models only)**

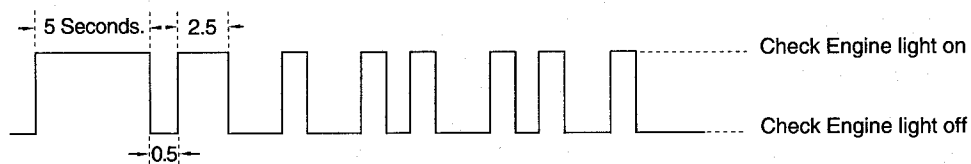
Graphic representation of flashing Check Engine light fault code: 1221



Fault code and meaning	Corrective action
Code 1211: DME Control Module	DME control module may be faulty. This code appears if the control module fails the self test. Check inputs to control module. Repair Group 130
Code 1215: Mass air flow sensor	Check air flow or mass air flow sensor and wiring to sensor. Repair Group 130
Code 1216: Throttle potentiometer	Test throttle potentiometer resistance and wiring. Repair Group 130
Code 1218: Output stage, group #1 (DME 3.3.1 only)	Test DME control module input/outputs. Repair Group 130
Code 1219: Output stage, group #2 (DME 3.3.1 only)	Test DME control module input/outputs. Repair Group 130
Code 1221: Oxygen sensor #1	Check sensor output signal to DME control module. Repair Group 130
Code 1222: Oxygen sensor lean/rich control stop	Check for intake air leaks or reasons for rich mixture. See Driveability Troubleshooting given earlier in this repair group
Code 1223: Coolant temperature sensor (NTC)	Test coolant temperature sensor. Repair Group 130
Code 1224: Air temperature sensor (NTC)	Test intake air temperature sensor. Repair Group 130
Code 1225: Knock sensor #1 (DME 3.3.1 only)	Check knock sensor and sensor wiring. Repair Group 120
Code 1226: Knock sensor #2 (DME 3.3.1 only)	Check knock sensor and sensor wiring. Repair Group 120
Code 1231: Battery voltage monitor	Test battery voltage and battery, check charging system and starter. Repair Group 121
Code 1234: Speedometer "A" signal (DME 3.3.1 only)	Check wiring between instrument cluster and DME control module. Electrical Wiring Diagrams
Code 1237: A/C compressor cutoff (DME 3.3.1 only)	Test DME control module inputs/outputs from A/C system. Repair Group 130
Code 1242: A/C compressor signal (DME 3.3.1 only)	Test DME control module inputs/outputs from A/C system. Repair Group 130

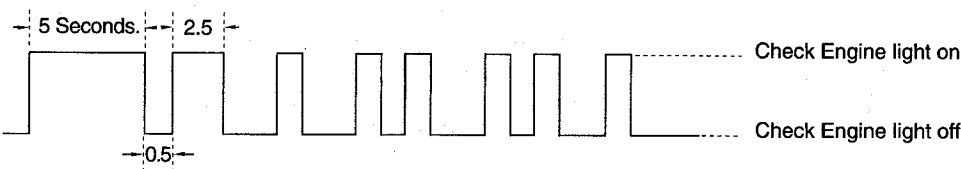
Table d. OBD I Fault (Blink) Codes (continued)
(1992-1995 models only)

Graphic representation of flashing Check Engine light fault code: 1221



Fault code and meaning	Corrective action
Code 1243: Crankshaft position sensor (DME 3.3.1 only)	Test crankshaft position/rpm sensor and wiring from sensor to DME control module. Repair Group 120
Code 1244: Camshaft position sensor (DME 3.3.1 only)	Test camshaft position sensor and wiring from sensor to DME control module. Repair Group 130
Code 1245: Electronic transmission control intervention (DME 3.3.1 only)	Check wiring between DME control module and auto. transmission control module
Code 1247: Ignition secondary monitor (DME 3.3.1 only)	Check secondary voltage to ignition coils. Check wiring at ignition coils. Repair Group 120
Code 1251: Fuel injector #1 (DME 3.1/3.3.1 only)	Test injector operation/signal to injector. Repair group 130
Code 1252: Fuel injector #2 (DME 3.1/3.3.1 only)	Test injector operation/signal to injector. Repair group 130
Code 1253: Fuel injector #3 (DME 3.1/3.3.1 only)	Test injector operation/signal to injector. Repair group 130
Code 1254: Fuel injector #4 (DME 3.1/3.3.1 only)	Test injector operation/signal to injector. Repair group 130
Code 1255: Fuel injector #5 (DME 3.1/3.3.1 only)	Test injector operation/signal to injector. Repair group 130
Code 1256: Fuel injector #6 (DME 3.1/3.3.1 only)	Test injector operation/signal to injector. Repair group 130
Code 1261: Fuel pump control	Test fuel pump relay and fuel pump circuit. Repair group 160
Code 1262: Idle speed control	Test idle air control valve and signal to valve. Repair Group 130
Code 1263: Fuel tank evaporative (EVAP) system	Test EVAP purge valve. Repair Group 160
Code 1264: Oxygen sensor heater	Test oxygen sensor heater and heater relay. Repair group 130
Code 1265: Check engine lamp (DME 3.3.1 only)	Test for faulty bulb or wiring. Electrical Wiring Diagrams
Code 1266: VANOS (DME 3.3.1 only)	Test VANOS solenoid. Check for signal to VANOS solenoid.
Code 1267: Air pump relay control (DME 3.3.1 only)	Test air pump relay and wiring (where applicable) Electrical Wiring Diagrams
Code 1271: Ignition coil #1 (DME 3.3.1 only)	Test ignition coil and wiring to ignition coil. Repair Group 120
Code 1272: Ignition coil #2 (DME 3.3.1 only)	Test ignition coil and wiring to ignition coil. Repair Group 120
Code 1273: Ignition coil #3 (DME 3.3.1 only)	Test ignition coil and wiring to ignition coil. Repair Group 120
Code 1274: Ignition coil #4 (DME 3.3.1 only)	Test ignition coil and wiring to ignition coil. Repair Group 120
Code 1275: Ignition coil #5 (DME 3.3.1 only)	Test ignition coil and wiring to ignition coil. Repair Group 120
Code 1276: Ignition coil #6 (DME 3.3.1 only)	Test ignition coil and wiring to ignition coil. Repair Group 120
Code 1281: DME control module memory supply (DME 3.3.1 only)	Check voltage supply from battery to DME control module. Electrical Wiring Diagrams
Code 1282: Fault code memory (DME 3.3.1 only)	Check DME control module inputs/outputs. Control module may be faulty. Repair Group 130
Code 1283: Fuel injector output stage (DME 3.3.1 only)	Check DME control module inputs/outputs. Control module may be faulty. Repair Group 130

Table d. OBD I Fault (Blink) Codes (continued)
(1992-1995 models only)

Graphic representation of flashing Check Engine light fault code: 1221	
	
Fault code and meaning	Corrective action
Code 1286: Knock control test pulse (DME 3.3.1 only)	Check DME control module inputs/outputs. Control module may be faulty. Repair Group 130
Code 1000 (light remains off):	End of fault code output—all fault codes have been displayed. No corrective action necessary. Repeat test if necessary
Code 1444:	No more faults. No corrective action necessary. This code must be present to erase fault memory

Basic Requirements

The following list contains basic checks that should be made when experiencing driveability problems.

1. Check intake (induction) system for leaks. Check for cracked, loose, or disconnected hoses and duct work. Check that all hose clamps are tight.

NOTE —

An air leak allows unmeasured air to enter the engine, often resulting in an overly lean fuel mixture and causing driveability problems which will cause the Check Engine light to come on.

2. Check that the battery is in good condition. Check that the cables are tight and free of corrosion at both ends. Check that all related ground points are firmly connected and in good condition. Check all harness connectors for damage and corrosion.
3. Check for power and ground at the Engine Control Module (ECM). Check the main grounds for the ECM. See **130 Fuel Injection**.
4. Check the fuses. Check for sufficient fuel in the tank. If the engine ran out of fuel, it will take a little time to restore fuel pressure. See **160 Fuel Tank and Fuel Pump**.
5. Check for spark at the spark plugs. If the tachometer needle bounces while the engine is cranked by the starter then the ignition system is probably working correctly. See **120 Ignition System**.
6. Check for any faults through the On-Board Diagnostics system. See **On-Board Diagnostics (OBD)**.

Preventive Maintenance

The condition of the fuel, ignition and emission control system components has a direct effect on engine performance and driveability. BMW specifies maintenance of certain parts at regular intervals to keep the engine in proper tune. Extending maintenance intervals beyond the time or mileage recommended by the manufacturer can adversely affect the way the engine runs. When troubleshooting driveability problems, a good starting point is to perform a major engine service, particularly if one is overdue. For maintenance schedules, major engine service and other driveability-related maintenance procedures, see **020 Maintenance Program**.

Basic Engine Settings

Idle speed, idle mixture (%CO), and ignition timing are not adjustable. The adaptive engine management system is designed to automatically compensate for changes in engine operating conditions, although the adaptive range is limited. Once these limits are exceeded, driveability problems usually become noticeable.

NOTE —

*If the DME adaptive limits are exceeded, the Check Engine light will come on, indicating an emission related fault. See **130 Fuel Injection**.*

Oxygen Sensors

A high oxygen level in the engine exhaust indicates a lean air-fuel mixture and a low oxygen level indicates a rich mixture. The oxygen sensor, shown in Fig. 10, measures the oxygen content in the exhaust gas and generates a variable voltage signal. Using that feedback signal as an input, the DME control module fine tunes the air-fuel mixture.

NOTE —

The oxygen sensor signal is ignored until the engine reaches a specified minimum temperature. Therefore, when troubleshooting cold engine driveability problems, the oxygen sensor can be ruled out as a possible cause.

As the oxygen sensor ages, its ability to react quickly to changing conditions deteriorates, and it may eventually cease to produce any signal at all. To check the operation of the oxygen sensor, see **130 Fuel Injection**.

NOTE —

On 1996 and later cars, OBD II enhanced emission standards require the engine control module (ECM) to monitor the oxygen content in the exhaust both before and after the catalytic converter. This allows for tighter control of the tail pipe emissions and also allows the ECM to diagnose converter problems. If the DME detects that catalytic converter or oxygen sensor efficiency has degraded past a certain pre-programmed limit, it will turn on the Check Engine light, and store a diagnostic trouble code (DTC) in the ECM.

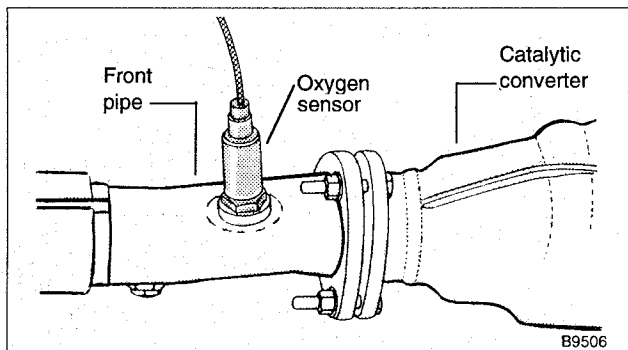


Fig. 10. Regulating oxygen sensor measures oxygen content of exhaust gas as indicator of air-fuel ratio and combustion efficiency. Monitoring oxygen sensor (not shown) monitors catalytic converter operation.

Replacement of oxygen sensors at the specified intervals ensures that the engine and emission control system will continue to operate as designed. As the oxygen sensor ages, its ability to react quickly to changing conditions deteriorates, and it may eventually cease to produce any signal at all.

As the oxygen sensor ages, its ability to react quickly to changing conditions deteriorates, and it may eventually cease to produce any signal at all. To check the operation of the oxygen sensor, see **130 Fuel Injection**.

Air Flow Measurement and Vacuum Leaks

The primary input used by the fuel injection system to determine how much fuel should be delivered is the signal from the mass air flow sensor in the intake air ductwork.

Because proper fuel metering depends on accurate measurement of the incoming air, any unmeasured air that enters the engine downstream of the mass air flow sensor will cause a lean air-fuel mixture and possibly affect driveability.

NOTE —

If a large air leak is causing driveability problems, the Check Engine light will usually be illuminated and a fault will be stored in the fault code memory. See **On Board Diagnostics (OBD)**.

There are many places for unmeasured air to enter the engine. First, inspect all hoses, fittings, ducts, seals, and gaskets in the intake air tract for cracks or looseness. It may be necessary to remove parts that cannot be fully checked in their installed positions. Also make sure all of the intake manifold and throttle body mounting nuts are tight.

In addition to air leaks, air restrictions can also cause driveability problems. Remove the air filter and hold it up to a strong light source. If the filter does not pass light, it is restricted and should be replaced. Also, remove the intake air ductwork and check for oily deposits at the throttle plate. Buildup in this area can cause an erratic idle. Clean away any deposits using a cloth wetted with carburetor cleaner and reinstall the ductwork.

CAUTION —

Do not spray carburetor cleaner directly in the throttle area. Spraying cleaner may force it into the throttle position switch or sensor and cause damage.

Battery Voltage

All of the electrical components in the fuel injection and ignition systems require a minimum voltage to operate properly. When troubleshooting engine driveability problems, one of the first checks should be to make sure the battery is fully charged and capable of delivering all its power to the electrical system.

To make a quick check of battery charge, measure the voltage across the battery terminals with all cables attached and the ignition off. A fully charged battery will measure 12.6 volts or slightly more, compared to 12.15 volts for a battery with a 25% charge.

Even a fully charged battery cannot deliver power unless it is properly connected to the electrical system. Check the battery terminals for corrosion and loose cable connections. If the battery does not maintain the proper voltage, the charging system may be at fault. See **121 Battery, Starter, Alternator**.

If a battery cable connection has no visible faults, but is still suspect, measure the voltage drop across the connection. A large drop indicates excessive resistance, meaning the connection is corroded, dirty, or damaged. Clean or repair the connection and retest.

NOTE —

For instructions on conducting a voltage drop test, and other general electrical troubleshooting information, see 600 Electrical System—General.

Wiring and Harness Connections

The electronic fuel injection and ignition systems operate at low voltage and current values, making them sensitive to small increases in resistance. The electrical system is routinely subjected to corrosion, vibration and wear, so faults or corrosion in the wiring harness and connectors are common causes of driveability problems.

Visually inspect all wiring, connectors, switches and fuses in the system. Loose or damaged connectors can cause intermittent problems, especially the small terminals in the ECM connectors. Disconnect the wiring harness connectors to check for corrosion, and use electrical cleaning spray to remove contaminants. Often, simply disconnecting and reconnecting a dirty connector several times will clean the terminals and help to reestablish good electrical contact.

If a wiring harness connector has no visible faults, but is still suspect, measure the voltage drop across the connector. A large drop indicates excessive resistance, meaning the connector is corroded, dirty or damaged. Clean or repair the connector and retest.

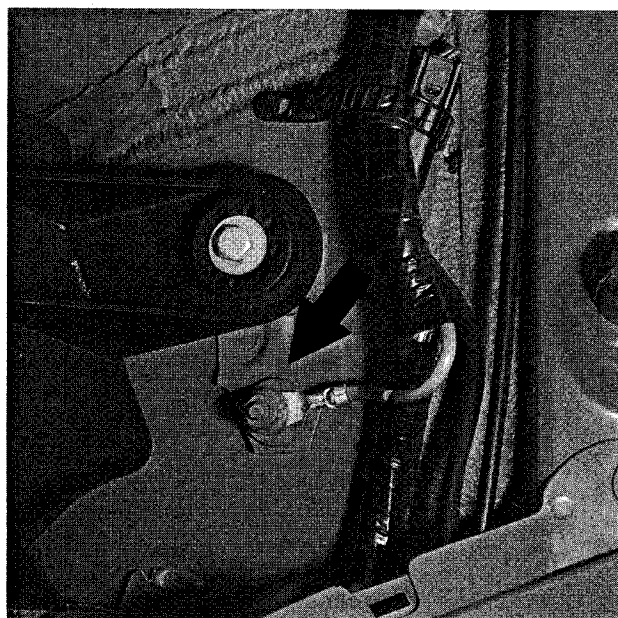
Ground Connections

For any electrical circuit to work, it must make a complete path, beginning at the positive (+) battery terminal and ending at the negative (–) terminal. The negative (–) battery cable is attached to the car's chassis. Therefore, any wire or metal part attached to the chassis provides a good ground path back to the negative (–) battery terminal.

Poor ground connections are a major source of driveability problems. If any of the main ground connections for the ignition system or the fuel injection system are faulty, the increased resistance in that circuit will cause problems.

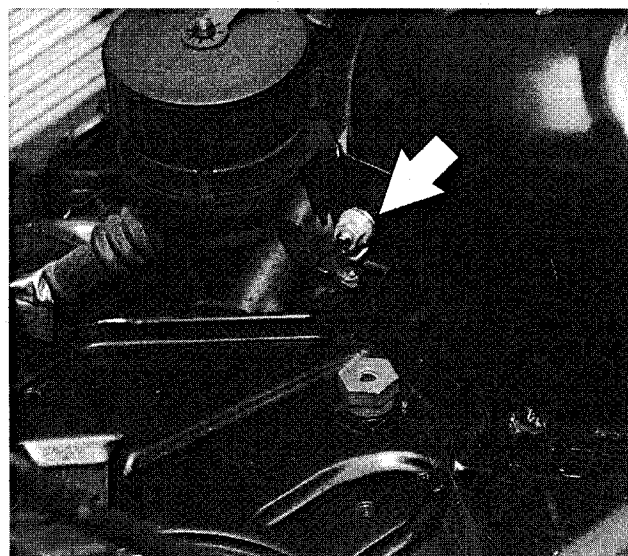
Visually inspect all ground wires and connections for breaks, looseness or corrosion. Be careful because wires sometimes break internally or in areas not easily visible. The main grounds for the DME system are shown in Fig. 11, Fig. 12, and Fig. 13. Also check the main fuel pump ground in the center console, below the emergency brake handle.

If a ground connection has no visible faults, but is still suspect, measure the voltage drop across the connection. A large drop indicates high resistance, meaning the connection is corroded, dirty or damaged. Clean or repair the connection and retest.



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Fig. 11. Main ground (arrow) for engine management system. Grounds are in right rear of engine compartment.



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Fig. 12. Main ground for ignition coils on MS 41.1 engine management system (arrow).

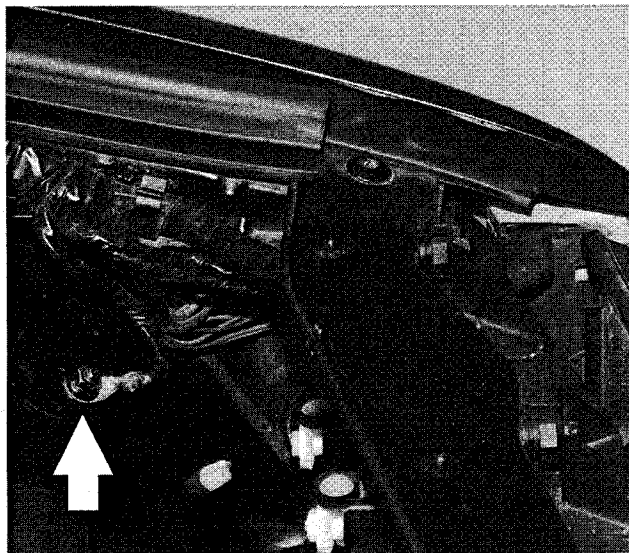


Fig. 13. Main chassis ground (arrow) in left front of engine compartment.

Fuel Supply

For the engine to start and run properly, the injection system must deliver fuel in precise proportion to the amount of air entering the engine. To do this, the injection system requires an unrestricted supply of fuel from the fuel pump.

If the fuel pump is not working, the engine will not run. If the fuel filter or a fuel line is restricted, the engine may run poorly. If the restriction is severe enough the engine will not start. If fuel delivery problems are suspected, perform the tests described in **160 Fuel Tank and Fuel Pump**.

The fuel pressure created by the fuel pump is controlled by a pressure regulator that returns excess fuel to the tank. Any change in fuel pressure will cause a change in the base air-fuel mixture delivered to the engine. If the fuel pressure is too low, the base air-fuel mixture will be lean. If the fuel pressure is too high, the base mixture will be rich. Fuel pressure tests are described in **160 Fuel Tank and Fuel Pump** and **130 Fuel Injection**.

NOTE —

Fuel pressure tests require a pressure gauge. If this tool is not available, the tests can be performed by an authorized BMW dealer or other qualified shop.

Properly operating fuel injectors play a major role in fuel delivery. The DME ECM switches the injectors on and off at the negative (–) or ground side of the connectors. Positive (+) battery voltage is always present at the connectors when the engine is running. An injector that fails or loses power will not open, creating a lean air-fuel mixture and causing the engine to run poorly when cold or stumble on acceleration. An injector that shorts to ground will remain open constantly when the engine is running, creating a rich air-fuel mixture that can dilute engine oil, foul the spark plugs, cause a rough idle, and damage the catalytic converter.

Table e lists additional symptoms of common engine driveability problems, their probable causes, and the suggested corrective actions. The entries in bold type in the corrective action column indicate the repair groups where applicable test and repair procedures can be found.

NOTE —

*Most of the symptoms listed in **Table e** will also cause the Check Engine light to come on. If the light is on, check for any stored faults as the first step in troubleshooting driveability complaints.*

Table e. Engine Driveability Troubleshooting

SYMPTOMS											
a. Engine fails to start											
b. Engine starts but stops immediately											
c. Erratic engine idle											
d. Poor engine response on acceleration											
e. Erratic engine operation in all speed ranges											
f. Excessive fuel consumption											
g. Poor engine power, fails to rev up											
h. CO content too low											
i. CO content too high											
										CAUSES	CORRECTIVE ACTION
a										Fuel pump faulty	Test fuel pump. Repair Group 160
a				e						Ignition system faulty	Test ignition system. Repair Group 120
a										Main relay or fuel pump relay faulty	Test main relay. Repair Group 130
a										Crankshaft/rpm position sensor faulty	Test crankshaft/rpm sensor. 120
	b	c						h	i	Idle speed control valve faulty	Test idle speed control valve.
		c	d	e						Throttle position sensor faulty or idle signal to DME control module missing.	Test throttle position sensor.
		c	d					h	i	Mass air flow sensor faulty	Test mass air flow sensor Repair Group 130
a	b	c	d	e				h		Large air intake system leak	Check for major intake air leaks downstream of mass air flow sensor.
a		c	d	e			g	h		Fuel pressure too low	Test fuel pressure. Repair Group 130
		c				f			i	Fuel pressure too high	Test fuel pressure. Repair Group 130
			d	e			g	h		Fuel pump delivery volume too low	Test fuel pump delivery volume. Repair Group 160
a		c		e	f			h	i	Coolant temperature sensor faulty	Test coolant temperature sensor.
		c			f					Oxygen sensor faulty	Test oxygen sensor.
		c		e	f				i	Fuel injectors leaking	Check fuel injectors and replace leaking injectors. Repair Group 130
		c								Throttle plate binding or incorrectly adjusted	Check throttle plate and adjust if necessary.
a		c								Electrical connections loose, broken, or corroded	Visually inspect connectors and correct any faults. Repair Group 600
a		c	d							Ground connections loose, broken, or corroded	Visually inspect ground connections and correct any faults. Repair Group 600
		c		e	f					CO content too high	Test air flow or mass air flow sensor. Repair Group 130
a	b	c	d	e			g			CO content too low	Test mass air flow sensor.
	b	c	d	e	f	g	h	i		Input signals to ECM missing, ECM in limp home mode	Make electrical tests at DME ECM relay. Repair Group 130
a	b	c	d	e	f	g	h	i		ECM faulty	Test DME ECM inputs. If all inputs are correct, replace ECM.



