

100 Engine—General

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GENERAL

There are three different engine configurations used in the 7 Series cars covered by this manual: the 3.5 liter M30 (straight-six) engine, the 4.0 liter (V-8) M60 engine and the 5.0 liter (V-12) M70 engine. See **Table a**.

Cylinder Block and Crankshaft

The cylinder block contains oil drillings for the lubrication system. All three engine block castings are unique and are not interchangeable.

Table a. Engine Specifications

Year & Model	Engine code	Cylinders	Valves/cylinder	Displacement liters (in ³ .)	Compression ratio	Horsepower lb-ft @ rpm (Kw @ rpm)	Torque lb-ft @ rpm (Nm @ rpm)
1988 - 1992 735i/iL	M30	6	2	3.5 (209.3)	9.0:1	182 @ 5,700 155 @ 5,700	225 @ 4,000 305 @ 4,000
1993 - 1994 740i/iL	M60	8	4	4.0 (243)	10:1	282 @ 5,800 210 @ 5,800	295 @ 4,500 400 @ 4,500
1988 - 1994 750iL	M70	12	2	5.0 (304)	8.8:1	296 @ 5,200 220 @ 5,200	332 @ 4,100 450 @ 4,100

GENERAL

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

On V-8 engines, the cylinder block is cast aluminum alloy. Instead of steel cylinder liners, the cylinders have a "Galnikal" lining. This lining or coating is created by depositing a "dispersion layer" of nickel on the aluminum cylinder walls.

The V-12 engine cylinder block is also cast aluminum alloy, with silicon-coated cylinder walls.

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

Connecting Rods and Pistons

The 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.

The V-12 engine uses a drop-forged steel crankshaft and connecting rods. The connecting rod big ends are machined asymmetrically.

Cylinder Head and Valvetrain

On 6-cylinder engines, the cylinder head is an aluminum alloy casting that bolts to the cylinder block. V-8 engines use two 4-cylinder aluminum alloy cylinder heads. The V-12 cylinder heads are identical aluminum alloy castings.

The cylinder head casting(s) 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.

M30 engines use a single chain-driven camshaft operating two valves per cylinder. The valve-lifters are mechanical. Valve clearance needs to be adjusted at the rockers periodically. See **116 Cylinder Head and Valvetrain**.

On M60 engines, chain-driven twin camshafts (intake and exhaust) operate four valves per cylinder through hydraulic lifters.

On M70 engines, each bank of cylinders has a single camshaft. Both camshafts are driven by a single chain. The two valves per cylinder are operated through rockers. Valves have dual springs. Each rocker arm is anchored by a hydraulic valve adjuster (HVA).

M60 and M70 engines do not require valve adjustment.

Lubrication System

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

BMW engines are equipped with a dynamic oil pressure warning system and an oil level warning system. See **119 Lubrication System** for additional information.

Fuel Supply System

The fuel supply system stores fuel and provides the injection system with pressurized fuel. The fuel tank is installed under the rear of the car. The fuel gauge sending unit and the electric fuel pump(s) are mounted in the tank. One or more in-line fuel filters clean the fuel before it reaches the engine. See **160 Fuel Tank and Fuel Pump** for additional information.

Engine Management System

All engines covered by this manual use an advanced engine management system called Digital Motor Electronics (DME) or Motronic. In the DME system, fuel injection, ignition, and other functions are combined under the control of one engine control module (ECM).

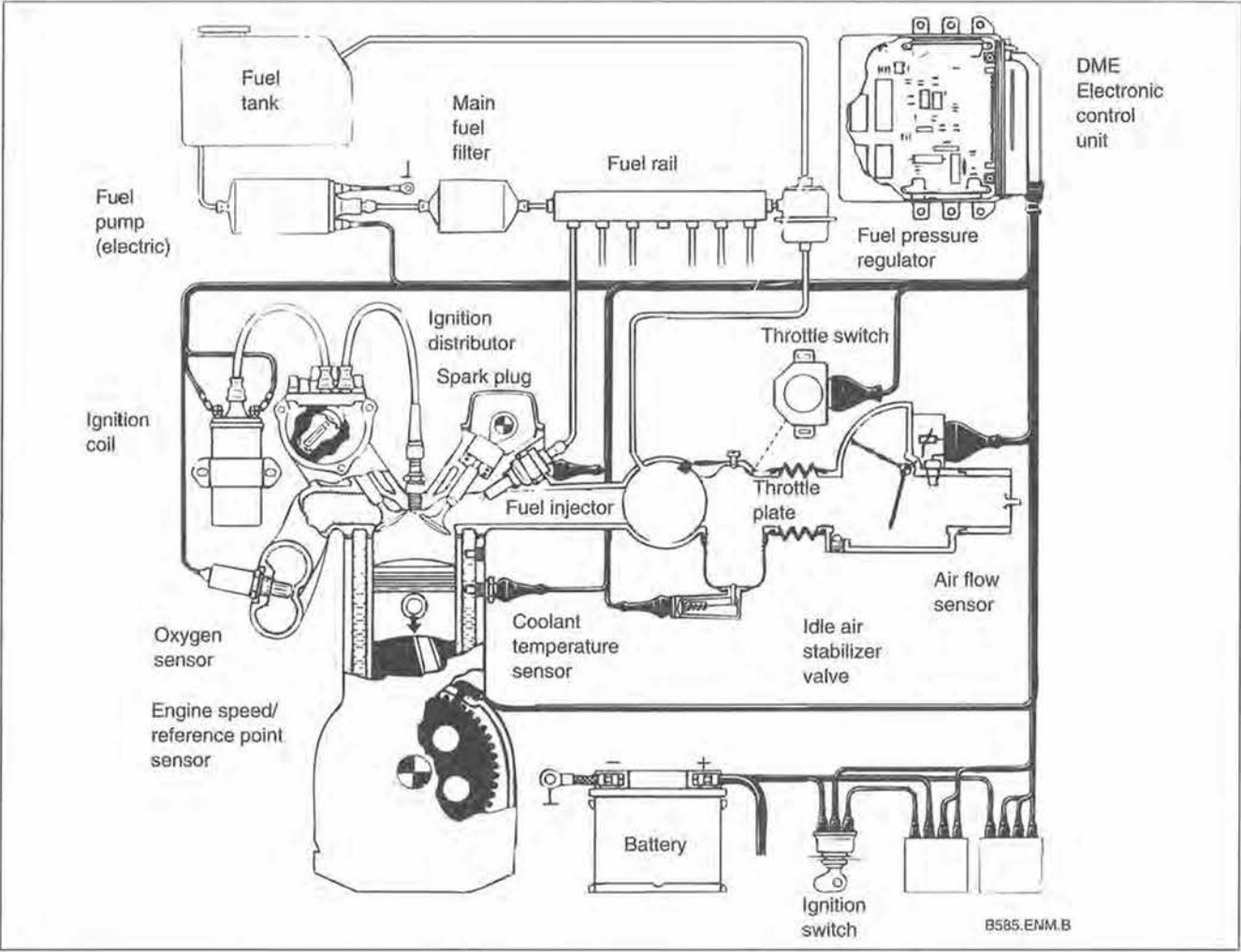
The DME engine management system uses the electrical signals from the volume air flow sensor with the M30 engine and the mass air flow (MAF) sensor with the M60 and M70 engines. Signals from the air and coolant temperature sensors, the speed/reference point sensor and oxygen sensor(s) are also used as its primary inputs to electronically calculate fuel delivery and ignition timing.

On M30 and M70 engines, the distributor is part of the upper timing chain cover at the front of the cylinder head, with the ignition rotor being driven directly off the camshaft. On M60 engines, individual ignition coils are located directly at the spark plugs, eliminating the distributor.

Fuel under pressure is injected via electronically controlled solenoid-type fuel injectors. The ECM electrically 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.

Four versions of DME systems are used on the cars covered by this manual, as listed below. The differences between the systems are mainly in the electronic circuitry, although some major differences do exist and most parts are not interchangeable between systems. All systems have adaptive abilities that adjust and reprogram the system to compen-

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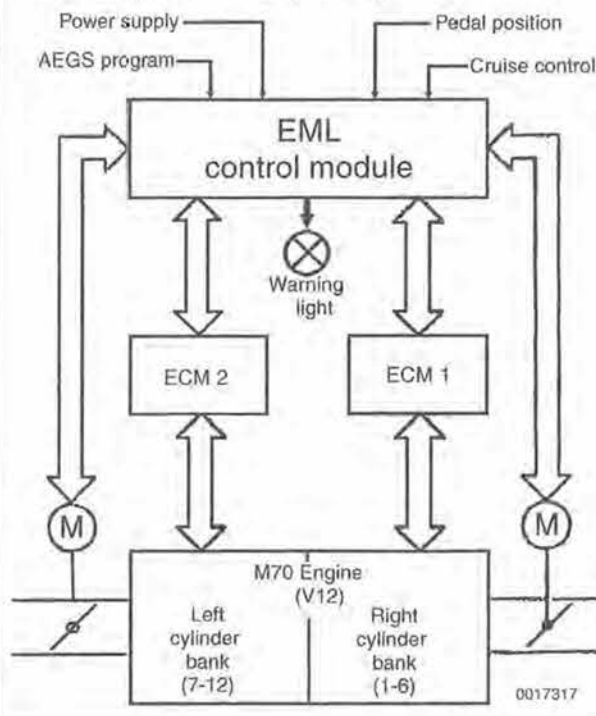
sate for things such as engine wear and vacuum leaks. For more information on DME engine management systems, see **130 Fuel Injection**.

The illustration on this page shows the DME 1.3 Motronic system with volume air flow sensor. Most components in the various systems are similar.

DME (Motronic) Engine Management Systems		
Model	Year	System
735i/iL	1988 - 1992	DME 1.3
740i/iL	1993 - 1994	DME 3.3
750iL	1988 - 1990	DME 1.2
	1991 - 1994	DME 1.7

NOTE—
The information in this manual labeled “Motronic” or “DME” applies to all versions, unless a particular version is specifically mentioned.

Electronic motor load regulation (EML)



Electronic Throttle Control (EML or ADS)

Electronic motor load regulation (EML) operates the throttle valve(s) electrically via a throttle position actuator instead of a mechanical throttle cable. Idle speed is controlled by EML, eliminating the need for a idle speed control valve.

735i/iL models with the ASC option are equipped with EML. The presence of EML in these cars can be determined by checking for the presence of a throttle cable at the throttle housing end of the intake manifold.

In 750iL models the two banks of cylinders are configured to operate as two separate 6-cylinder engines with a shared cylinder block and crankshaft. The two DME control modules are synchronized by the EML control module.

See **130 Fuel Injection** for additional details.

NOTE—

740i/iL models with the ASC+T option have a conventional throttle cable and an additional throttle housing operated by a second throttle cable controlled by the automatic throttle valve system (ADS). EML is not used on 740i/iL models.

Cooling System

Whenever the engine is running, a coolant pump circulates coolant through the engine and, if either heater control valve(s) is open, through the heater core(s) in the passenger compartment. The coolant absorbs excess engine 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.

MECHANICAL TROUBLESHOOTING

The troubleshooting information under this heading deals only with problems that affect the basic engine assembly: The cylinder block, the cylinder head and their internal parts. For problems relating to how the engine runs, see **Driveability Troubleshooting** later in this repair group.

Only a few basic mechanical functions are required of the engine. The cylinder block, the cylinder head and their internal moving parts must fit together properly, operate smoothly and seal well enough to create and maintain compression while keeping the pistons, valvetrain and ignition properly timed in relation to one another.

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(s), distributor(s), or spark plugs while the engine is running or being cranked by the starter.
- Connect and disconnect the DME system wiring and test equipment leads only when the ignition is switched off.
- Disconnecting the battery will erase any fault code(s) stored in memory. To ensure driver safety, check for fault codes prior to disconnecting the battery cables. If the Check Engine light is illuminated, see **On-Board Diagnostics (OBD)** below for DME Motronic fault code information. If any other system faults have been detected (indicated by an illuminated warning light), see an authorized BMW dealer. Additional systems with self-diagnostic capabilities include; ABS (anti-lock brakes), SRS (air-bags), EML/ASC (traction control).
- 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.

CAUTION—

- 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 DME ECM. In general, connect test equipment only as specified by BMW, this manual, or the equipment maker.
- Do not attempt to disable the ignition system by removing the center coil wire or by removing the distributor cap (where applicable). High voltage may arc to other electrical components causing extensive damage.
- Do not disconnect the battery with the engine running.
- Do not run the engine with any of the spark plug wires disconnected. Catalytic converter damage may result.

Noise

Most internal engine noises are the result of excessive clearance caused by wear, component failure or a lack of lubrication.

A high-pitched metallic tapping noise occurring under load often signals pre-ignition or detonation of the air-fuel mixture in the combustion chamber. Most such problems can be resolved by repairs or adjustments to the fuel, ignition or emission control systems. In high-mileage engines, however, carbon buildup in the combustion chambers may cause pre-ignition or detonation that can only be eliminated by removing the cylinder head and cleaning away the deposits.

High-pitched metallic tapping noises may also be caused by excessive clearance between small, lightweight parts such as those in the valvetrain. Often a simple valve adjustment (where applicable) will cure the problem. However, valvetrain noise accompanied by blue-gray exhaust smoke, particularly when the engine is started, often indicates worn valve guides.

Low-pitched metallic knocking sounds are usually caused by excessive clearance between heavy components. Piston slap, caused by too much clearance between the piston skirt and cylinder wall, is worst when the engine is cold, and may decrease or go away entirely as the engine warms.

Crankshaft bearing problems produce a deep, hollow knock that usually gets worse as the engine warms. An intermittent knock that lessens or disappears when the clutch pedal is depressed may indicate excessive crankshaft end play, the result of worn crankshaft thrust bearings.

A rumbling or groaning from the engine compartment may not indicate an engine problem, but rather a worn bearing or bushing in an engine-driven accessory. Possible noise sources include the coolant pump, alternator, power steering pump and air conditioning compressor. To check each accessory, run the engine briefly with the drive belt disconnected and see if the noise stops. With the belt removed and the engine off, turn the pulley and shaft by hand to check for a bad bearing or bushing. With the exception of the air conditioning compressor, a properly functioning engine accessory should turn smoothly.

NOTE—

- *The air conditioning compressor is equipped with an electromagnetic clutch-type pulley. A bad compressor makes noise when the A/C is engaged. The noise should change or disappear when A/C is turned off.*
- *A bad A/C compressor clutch bearing will make a louder noise when the A/C is disengaged. The noise should change or disappear when A/C is engaged.*

Fluid Leaks

Fluid leaking from the engine compartment may be gasoline, oil, coolant, brake fluid, or automatic transmission fluid. For all types of leaks, look for wet areas to help pinpoint the source. It is helpful to start by cleaning the suspected area.

Smoking

Blue-gray smoke in the exhaust is caused by burning oil that has entered the combustion chamber by getting past the piston rings, valve guides, cylinder head gasket or some combination of the three. See **Compression Test** below to help pinpoint the source.

Oil smoke or white smoke (steam) that appears in the exhaust, combined with low compression in one or more cylinders, is most likely the result of a failed cylinder head gasket. Look for bubbles in the coolant or coolant loss, oil in the radiator, or water in the oil that turns the oil an opaque, creamy brown.

Black smoke in the exhaust results from the engine receiving too much fuel. See **Driveability Troubleshooting** below for additional diagnostic information.

Excessive Oil Consumption

Some oil consumption is normal and indicates the proper distribution of lubricant to the piston rings. This is why the oil level must be checked, and occasionally corrected, between oil changes. Aside from leaks, high oil consumption is usually accompanied by smoking, however slight. The causes of excessive oil consumption are generally the same as those for oil smoke in the exhaust. As with smoking symptoms, gradual increases are usually caused by engine wear.

High Fuel Consumption and Low Power

High fuel consumption and low power usually indicate problems with the fuel or ignition systems, particularly on a low-mileage engine. On an engine with high mileage, low compression from accumulated wear may be the cause. Normal wear of the valves, valve seats, piston rings and cylinder walls decreases their ability to seal. As a result, the engine becomes less efficient and has to work harder, using more fuel, to produce the same amount of power. See **Compression Test** below to help evaluate engine condition.

Engine Not Running

If the battery, fuel and ignition systems are OK, an engine problem that affects valve or ignition timing may prevent the engine from starting and running. The timing chain and sprockets are responsible for synchronizing the movements of the camshaft and valves with those of the crankshaft and pistons.

Compression Test

The compression pressures in the individual cylinders can tell a lot about the condition of an engine without the need to take it apart.

NOTE—

If a compression gauge is not available, a compression test can be performed by an authorized BMW dealer or other qualified shop at a reasonable cost.

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.

CAUTION—

Clean around the spark plugs before removal to prevent debris from entering the engine.

Compression, testing

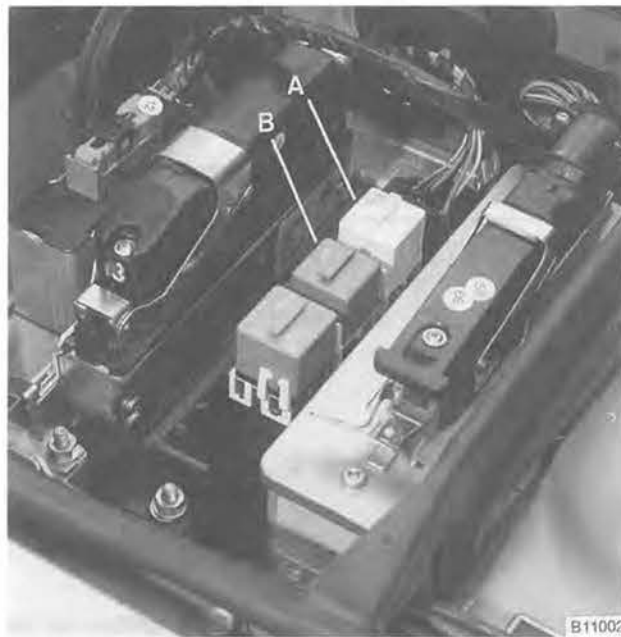
- On all engines except those with EML: Remove main DME and fuel pump relays.

Relay locations for M30 or M60 engine in electronics box (E-box).

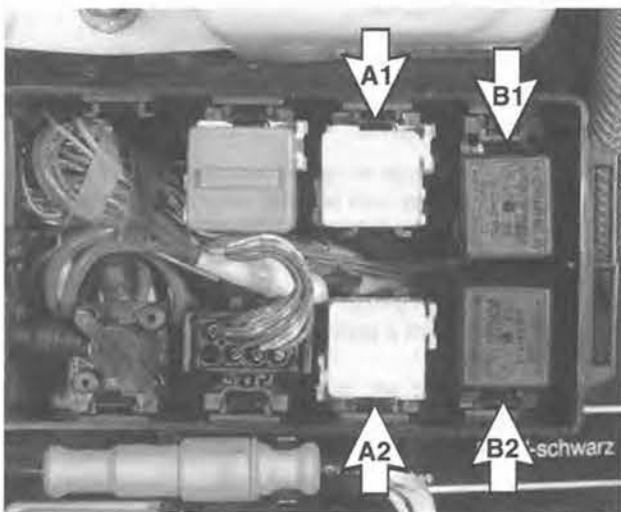
- Main DME relay (A).
- Fuel pump relay (B).

NOTE—

Relay positions may vary. The main DME relay is normally white in color. To confirm that the main DME relay has been correctly identified, check for a large (6 mm²) red wire at terminal 30 of the relay socket.



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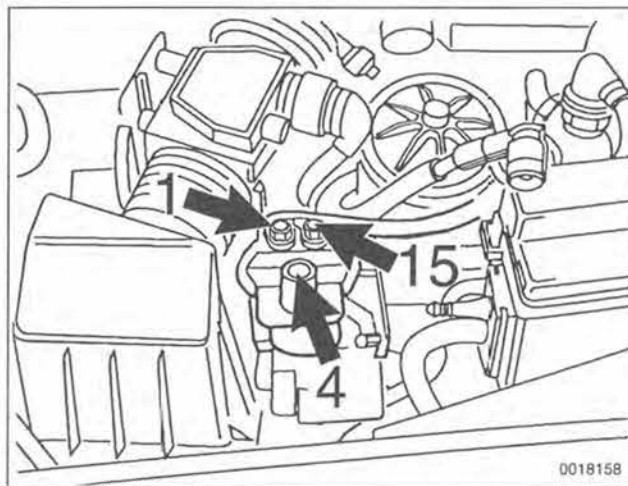


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Relay locations for M70 engine in auxiliary relay panel II.

- Main DME 1 relay (A1).
- Main DME 2 relay (B1).
- Fuel pump 1 relay (B1).
- Fuel pump 2 relay (B2).

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- On engines with EML: Remove fuel pump relay(s).
- On M30 engine: Disable ignition by disconnecting wire at terminal 1 of ignition coil.

NOTE—

On 735i/iL models, the ignition coil is mounted at the front right (passenger) side shock tower. Be sure to insulate the disconnected wire end using electrical tape.

- Remove air cleaner assembly.
- Disconnect spark plug wires and then remove spark plugs.

➤ On M60 engine: Remove engine cover from top of engine by prying off nut covers and removing mounting nuts.

- On M60 engine: disconnect harness connectors from ignition coils by lifting up on retaining clip (A). Remove coil mounting nuts (B) and remove coils.
- Remove spark plugs.

CAUTION—

Note location of coil ground straps before removing coils. Always reinstall in same location.

➤ On M70 engine: Detach wiring from each ignition coil (arrows).

- Remove all spark plugs.

NOTE—

- Use a 5/8 in. spark plug socket to remove the spark plugs on M60 and M70 engines.

- Check the spark plugs for oil deposits that may indicate poor cylinder sealing, then set them aside in order. Used spark plugs should be reinstalled in the same cylinder from which they were removed.

- Install compression gauge in cylinder no. 1 spark plug hole tight enough to form a good seal.

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

NOTE—

- The compression gauge reading should increase with each compression stroke, and reach its maximum reading in 4 to 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.
- On engines with EML, check that the throttle plate opens when the starter is actuated.

- Release pressure with compression gauge valve, then remove gauge from spark plug hole. Repeat test for all cylinders and compare results with values given below.

Compression Pressure

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

- Reinstall spark plugs and spark plug wires or ignition coils to their original locations. Remainder of installation is reverse of removal. Be sure to reinstall all wires disconnected during test.

Spark Plug Tightening Torques

- M30 engine 30 Nm (22 ft-lb)
- M60 or M70 engine 23 Nm (18 ft-lb)

Low compression, or gauge readings that increase gradually over many engine strokes, indicates a poorly sealed combustion chamber. Relatively even pressures that are below specification indicate worn piston rings and/or cylinder walls. Readings that change erratically during successive compression tests of the same cylinder tend to indicate valve leakage. Consistent large differences, such as good values in some cylinders and low values in one or two other cylinders are often the sign of a localized failure like a blown head gasket, burned valve, or broken piston ring.

Table b 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.

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Table b. 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, fuel tank empty. Check for fuel in tank. b. No voltage to spark plugs. Check ignition system. 120 Ignition system c. Incorrect valve timing. Check timing chain. 117 Camshaft Timing Chain d. Fuel pump not operating. 160 Fuel Tank and Fuel Pump
2. Check Engine warning light illuminated.	a. Engine management system self-diagnostic fault detected. Check fault codes described below under On-Board Diagnostics (OBD).
3. 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. b. Faulty valve guide seals or valve guides. Replace valve guide oil seals or overhaul cylinder head. 116 Cylinder Head and Valvetrain c. Worn piston rings. Overhaul or replace engine. d. Failed cylinder head gasket. Replace gasket. 113 Cylinder Head Removal and Installation
4. White exhaust smoke (steam).	a. Failed cylinder head gasket (probably accompanied by low compression readings). Replace gasket and resurface cylinder head if necessary. 113 Cylinder Head Removal and Installation b. Warped or cracked cylinder head. Resurface or replace cylinder head. 113 Cylinder Head Removal and Installation c. Cracked cylinder block. Replace engine or short block.
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. Knock sensors faulty (M60 engines only) 120 Ignition system b. Fuel octane level too low. Use higher octane fuel. c. Engine running too hot or overheating. Check cooling system. 170 Radiator and Cooling System d. Wrong spark plug (incorrect heat range). Replace spark plugs. 120 Ignition system e. Air/fuel mixture too lean. 130 Fuel injection f. Excessive carbon deposits in combustion chambers. Remove cylinder head and decarbonize combustion chamber. 116 Cylinder Head and Valvetrain
6. Light metallic tapping that varies directly with engine speed. Oil pressure warning light not illuminated.	g. Valve clearances out of adjustment or hydraulic lifter(s) faulty. Adjust valve clearances (M30 engine) or replace hydraulic lifters (M60 engine) or hydraulic valve adjusters (HVA) (M70 engine). 116 Cylinder Head and Valvetrain h. Low oil pressure or defective warning light. Check oil pressure and warning light circuit. 119 Lubrication System
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. Contaminated or gasoline-diluted engine oil. Change engine oil and replace oil filter. c. Low oil pressure/worn or faulty oil pump. Oil pump pickup restricted/clogged. Check oil pressure. 119 Lubrication System
8. Screeching or squealing under load that goes away when coasting.	a. Slipping drive belt due to looseness, wear or damage. Inspect, replace, or tighten V-belt (M30 engine) or poly-ribbed belt (M60/M70 engines). 020 Maintenance
9. Growling or rumbling that varies with engine rpm.	a. Bad bearing or bushing in an engine-driven accessory. Remove drive belt(s) to identify faulty component. Check for play, bearing roughness or loose mountings. Refer to appropriate repair group in this section for repair procedures.

DRIVEABILITY TROUBLESHOOTING

DME engine management systems have self-diagnostic capabilities. When a problem is detected, a fault code is stored in the engine control module (ECM). When a fault code is set, the Check Engine warning light may also come on, indicating an emissions-related fault. Always check for fault codes as the first step in troubleshooting a driveability problem. Check Engine light fault codes and the most common reasons for the malfunctions are given below.

On-Board Diagnostics (OBD)

An On-Board Diagnostic (OBD) system is incorporated into the DME Motronic control module. This system detects certain 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.

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 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 c** or **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. Reactivate the fault code memory as described earlier and check for the 1444 code (no faults stored).

**Table c. DME 1.3 or 3.3 Check Engine Light Fault Codes
M30 or M60 Engine**

Graphic representation of flashing Check Engine light fault code: 1221	
Fault code and meaning	Corrective action
Code 1211: DME engine control module (ECM)	This code appears if ECM fails self test. Check inputs to ECM. 130 Fuel Injection
Code 1215: Mass air flow (MAF) sensor	Check MAF sensor and wiring to sensor. 130 Fuel Injection
Code 1216: Throttle potentiometer	Test throttle potentiometer resistance and wiring. 130 Fuel Injection
Code 1218: Output stage, group #1 (DME 3.3 only)	Test DME control module input/outputs. 130 Fuel Injection
Code 1219: Output stage, group #2 (DME 3.3/DME 3.3 only)	Test DME control module input/outputs. 130 Fuel Injection
Code 1221: Oxygen sensor #1	Check sensor output signal to DME control module. 130 Fuel Injection
Code 1212: Oxygen sensor #2 (DME 3.3 only)	Check sensor output signal to DME control module. 130 Fuel Injection
Code 1222: Oxygen sensor #1 lean/rich control stop	Check for intake air leaks or reasons for rich mixture. See Driveability Troubleshooting given earlier in this repair group
Code 1213: Oxygen sensor #2 lean/rich control stop (DME 3.3 only)	Check for intake air leaks or reasons for rich mixture. See Driveability Troubleshooting given earlier in this repair group
Code 1223: Engine coolant temperature (ECT) sensor	Test ECT sensor. 130 Fuel Injection

**Table c. DME 1.3 or 3.3 Check Engine Light Fault Codes
M30 or M60 Engine (continued)**

Graphic representation of flashing Check Engine light fault code: 1221	
Fault code and meaning	Corrective action
Code 1224: Intake air temperature (IAT) sensor	Test IAT sensor. 130 Fuel Injection
Code 1225: Knock sensor #1 (DME 3.3 only)	Check knock sensor and sensor wiring. 120 Ignition System
Code 1226: Knock sensor #2 (DME 3.3 only)	Check knock sensor and sensor wiring. 120 Ignition System
Code 1227: Knock sensor #3 (DME 3.3 only)	Check knock sensor and sensor wiring. 120 Ignition System
Code 1228: Knock sensor #4 (DME 3.3 only)	Check knock sensor and sensor wiring. 120 Ignition System
Code 1231: Battery voltage monitor	Test battery voltage and battery, check charging system and starter. 121 Battery, Starter, Alternator
Code 1232: Idle position signal (DME 1.3 only)	Test closed throttle (idle) signal to DME control module. 130 Fuel Injection
Code 1233: Full throttle position signal (DME 1.3 only)	Check full throttle signal to DME control module. 130 Fuel Injection
Code 1234: Speedometer "A" signal (DME 3.3 only)	Check wiring between instrument cluster and DME control module. Electrical Wiring Diagrams
Code 1237: A/C compressor cutoff (DME 3.3 only)	Test DME control module inputs/outputs from A/C system. 130 Fuel Injection
Code 1242: A/C compressor signal (DME 3.3 only)	Test DME control module inputs/outputs from A/C system. 130 Fuel Injection
Code 1243: Crankshaft position sensor (DME 3.3 only)	Test crankshaft position/rpm sensor and wiring from sensor to DME control module. 120 Ignition System
Code 1244: Camshaft position sensor (DME 3.3 only)	Test camshaft position sensor and wiring from sensor to DME control module. 130 Fuel Injection
Code 1245: Electronic transmission control intervention (DME 3.3 only)	Check wiring between DME control module and automatic transmission control module
Code 1247: Ignition secondary monitor (DME 3.3 only)	Check secondary voltage to ignition coils. Check wiring at ignition coils. 120 Ignition System
Code 1251: Fuel injectors (DME 1.3 only- cylinders 1, 3, 5)	Test injector operation/signal to injectors. 130 Fuel Injection
Code 1252: Fuel injectors (DME 1.3 only - cylinders 2, 4, 6)	Test injector operation/signal to injectors. 130 Fuel Injection
Code 1251: Fuel injector #1 (DME 3.3 only)	Test injector operation/signal to injector. 130 Fuel Injection
Code 1252: Fuel injector #2 (DME 3.3 only)	Test injector operation/signal to injector. 130 Fuel Injection
Code 1253: Fuel injector #3 (DME 3.3 only)	Test injector operation/signal to injector. 130 Fuel Injection
Code 1254: Fuel injector #4 (DME 3.3 only)	Test injector operation/signal to injector. 130 Fuel Injection
Code 1255: Fuel injector #5 (DME 3.3 only)	Test injector operation/signal to injector. 130 Fuel Injection
Code 1256: Fuel injector #6 (DME 3.3 only)	Test injector operation/signal to injector. 130 Fuel Injection
Code 1257: Fuel injector #7 (DME 3.3 only)	Test injector operation/signal to injector. 130 Fuel Injection
Code 1258: Fuel injector #8 (DME 3.3 only)	Test injector operation/signal to injector. 130 Fuel Injection
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. 130 Fuel Injection
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. 130 Fuel Injection
Code 1265: Check Engine lamp (DME 3.3 only)	Test for faulty bulb or wiring. Electrical Wiring Diagrams
Code 1267: Air pump relay control (DME 3.3 only)	Test air pump relay and wiring (where applicable) Electrical Wiring Diagrams
Code 1271: Ignition coil #1 (DME 3.3 only)	Test ignition coil and wiring to ignition coil. 120 Ignition system
Code 1272: Ignition coil #2 (DME 3.3 only)	Test ignition coil and wiring to ignition coil. 120 Ignition system
Code 1273: Ignition coil #3 (DME 3.3 only)	Test ignition coil and wiring to ignition coil. 120 Ignition system

**Table c. DME 1.3 or 3.3 Check Engine Light Fault Codes
M30 or M60 Engine (continued)**

Graphic representation of flashing Check Engine light fault code: 1221	
Fault code and meaning	Corrective action
Code 1274: Ignition coil #4 (DME 3.3 only)	Test ignition coil and wiring to ignition coil. 120 Ignition system
Code 1275: Ignition coil #5 (DME 3.3 only)	Test ignition coil and wiring to ignition coil. 120 Ignition system
Code 1276: Ignition coil #6 (DME 3.3 only)	Test ignition coil and wiring to ignition coil. 120 Ignition system
Code 1277: Ignition coil #7 (DME 3.3 only)	Test ignition coil and wiring to ignition coil. 120 Ignition system
Code 1278: Ignition coil #8 (DME 3.3 only)	Test ignition coil and wiring to ignition coil. 120 Ignition system
Code 1281: DME control module memory supply (DME 3.3 only)	Check voltage supply from battery to DME control module. Electrical Wiring Diagrams
Code 1282: Fault code memory (DME 3.3 only)	Check DME control module inputs/outputs. Control module may be faulty. 130 Fuel injection
Code 1283: Fuel injector output stage (DME 3.3. only)	Check DME control module inputs/outputs. Control module may be faulty. 130 Fuel injection
Code 1286: Knock control test pulse (DME 3.3 only)	Check DME control module inputs/outputs. Control module may be faulty. 130 Fuel injection
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

**Table d. DME 1.7 Check Engine Light Fault Codes
M70 Engine**

Graphic representation of flashing Check Engine light fault code: 1221			
DME I fault code	DME II fault code	Meaning	Corrective action
1111	2111	Ignition problem	Diagnose ignition system. 120 Ignition System
1211	2211	DME engine control module	This code appears if ECM fails self test. Check inputs to ECM. 130 Fuel Injection
1215	2215	Mass air flow sensor	Check mass air flow sensor and wiring to sensor. 130 Fuel Injection
1216	2216	Throttle potentiometer	Test throttle potentiometer resistance and wiring. 130 Fuel Injection
1221	2221	Oxygen sensor	Check sensor output signal to DME control module. 130 Fuel Injection
1222	2222	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

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**Table d. DME 1.7 Check Engine Light Fault Codes
M70 Engine**

Graphic representation of flashing Check Engine light fault code: 1221			
DME I fault code	DME II fault code	Meaning	Corrective action
1223	2223	Engine coolant temperature (ECT) sensor	Test ECT sensor. 130 Fuel Injection
1224	2224	Intake air temperature (IAT) sensor	Test IAT sensor. 130 Fuel Injection
1231	2231	Battery voltage monitor	Test battery voltage and battery, check charging system and starter. 121 Battery, Starter, Alternator
1232	2232	Idle position signal	Test closed throttle (idle) signal to DME control module. 130 Fuel Injection
1233	2233	Full throttle position signal	Check full throttle signal to DME control module. 130 Fuel Injection
1251	2251	Fuel injectors	Test injector operation/signal to injectors. 130 Fuel Injection
1252	2252	Fuel injectors	Test injector operation/signal to injectors. 130 Fuel Injection
1261	2261	Fuel pump control	Test fuel pump relay and fuel pump circuit. 160 Fuel Tank and Fuel Pump
1262	2262	Idle speed control	Test idle air control valve and signal to valve. 130 Fuel injection
1263	2263	Fuel tank evaporative (EVAP) system	Test EVAP purge valve. 160 Fuel Tank and Fuel Pump
1264	2264	Oxygen sensor heater	Test oxygen sensor heater and heater relay. 130 Fuel injection
1268	2268	Idle speed, CO potentiometer	Check ECM inputs/outputs. 130 Fuel Injection
1278	2278	Ignition timing correction	Test ignition system. 120 Ignition System
1444	2444	No faults stored	No more faults. No corrective action necessary. This code must be present to erase fault memory

Mechanical Condition

When troubleshooting an engine that fails to start or runs poorly, first check its mechanical condition — particularly if the engine has high mileage. See **Compression Test** earlier in this repair group to help determine whether the engine has mechanical problems.

On M30 engines, check that the valves are correctly adjusted. If the clearances are too small, the valves may not close all the way, resulting in low compression and a loss in power. If the clearances are too large, the valves may not fully open, causing a reduction in engine efficiency. Procedures for checking and adjusting valve clearances are described in **116 Cylinder Head and Valvetrain**.

NOTE—

M60 engines are equipped with hydraulic lifters. M70 engines are equipped with hydraulic valve adjusters (HVA). Neither require periodic adjustment.



Carbon Deposits

Carbon deposits on injectors and intake valves can cause driveability problems such as rough idle, stalling or hesitation. Problems are likely to occur after a cold start and during engine warm-up. Severe fouling can be identified by a visual inspection, but special equipment is required to check for minor carbon build-up on the injectors. Intake valve inspection is more difficult, as the intake manifold must first be removed. Carbon deposits on intake valves and injectors should be removed prior to troubleshooting a driveability problem.

NOTE—

Always consult an authorized BMW dealer for approved fuel injector and intake valve cleaning methods and/or chemicals.

Preventive Maintenance

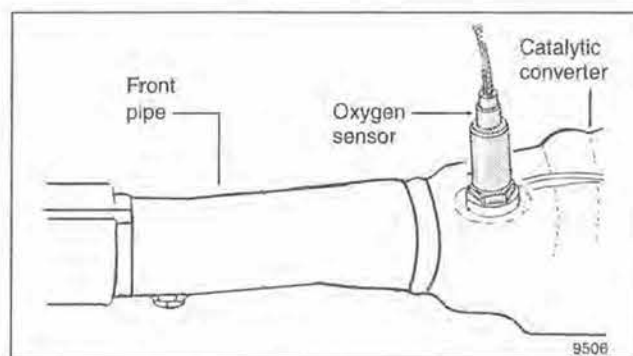
The condition of the fuel, ignition and emission control system components has a direct effect on engine performance and driveability. BMW specifies maintenance of certain parts at regular intervals to keep the engine in proper tune. Extending maintenance intervals beyond the time or mileage recommended 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**.

Basic Engine Settings

Idle speed, idle mixture (%CO), and ignition timing are not adjustable on the DME systems covered by this manual. The adaptive DME 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. For Check Engine light diagnostics and On-Board Diagnostic fault codes, see **On-Board Diagnostics** given above.



Oxygen Sensor

⚠ 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 measures the oxygen content in the exhaust gas and generates a variable voltage signal. Using that feedback signal as an input, the engine control module (ECM) 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**.

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 volume air flow sensor (M30 engine) or mass air flow sensor (M60/M70 engines) 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.

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(s) and hold 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(s). 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 into 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 cables for corrosion and loose 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.

NOTE—

A faulty engine control module (ECM) is seldom the cause of a driveability problem. These control modules are very reliable and failures are rare. Most driveability problems are caused by incorrect or missing signals to the ECM, or by other defective components.

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.



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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 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 DME system (**arrows**) (where applicable) 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. Also check the main fuel pump ground under the right side of the rear seat cushion.

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.

NOTE—

Instructions for making voltage drop test and other general electrical troubleshooting information can be found in **600 Electrical System-General**.

Fuel Supply

For the engine to start and run properly under various operating conditions, 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**.

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 engine control module (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 eventually destroy the catalytic converter. See **130 Fuel Injection** for fuel injection system troubleshooting and repair.

The fuel injectors must deliver the fuel in a fine, even, cone-shaped mist for optimum combustion. Restricted fuel injectors typically have poor spray patterns that result in overall driveability problems. Carbon deposits and fuel contaminants are the common causes of fuel injector restrictions. Severe injector fouling can be identified by deposit buildups on the injector tips; less extreme restrictions can be identified by checking the injector spray pattern.

Basic Requirements

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

- Check the 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 and an illuminated Check Engine light.

- Check that the battery is in good condition.
- Check that the battery cables are tight and free of corrosion.
- Check that all related ground points are firmly connected and in good condition. Don't forget to check the main ground at the battery.
- Check all of the harness connectors for damage and corrosion.
- Check for power and ground at the DME ECM.
- 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**.
- 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 **130 Ignition System**.
- Check for any faults through the on-board diagnostics system. See **On-Board Diagnostics (OBD)**.

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 9. Engine Drivability Troubleshooting

SYMPTOMS									CAUSES	CORRECTIVE ACTION
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									
a									Fuel pump faulty	Test fuel pump. 160 Fuel Tank and Fuel Pump
a			e						DME ignition system faulty	Test ignition system. 120 Ignition system
a									DME main relay or fuel pump relay faulty	Test DME main relay. 130 Fuel injection
a									DME speed/reference sensor faulty	Test speed/reference sensor. 120 Ignition system
	b	c					h	i	Idle stabilizer valve faulty	Test idle stabilizer valve. 130 Fuel injection
		c	d	e					Throttle position switch or sensor faulty or idle signal to DME control module missing.	Test throttle position switch/sensor and adjust if necessary. 130 Fuel injection
a		c	d		f		h	i	Air flow or mass air flow sensor faulty	Test air flow or mass air flow sensor. 130 Fuel injection
a	b	c	d	e			h		Large air intake system leak	Check for major intake air leaks downstream of air flow or mass meter.
a		c	d	e		g	h		Fuel pressure too low	Test fuel pressure. 130 Fuel injection
		c			f			i	Fuel pressure too high	Test fuel pressure. 130 Fuel injection
	b		d	e		g	h		Fuel pump delivery volume too low	Test fuel pump delivery volume. 130 Fuel injection
a		c		e	f		h	i	Coolant temperature sensor faulty	Test coolant temperature sensor. 130 Fuel injection
		c			f				Oxygen sensor faulty	Test oxygen sensor(s). 130 Fuel injection
		c		e	f			i	Fuel injectors leaking	Check fuel injectors and replace leaking injectors. 130 Fuel injection
		c							Throttle plate binding or incorrectly adjusted	Check throttle plate and adjust if necessary. 130 Fuel injection
a		c							Electrical connections loose, broken, or corroded	Visually inspect connectors and correct any faults. 600 Electrical System-General
a		c	d	e					Ground connections loose, broken, or corroded	Visually inspect ground connections and correct any faults. 600 Electrical System-General
		c		e	f				CO content too high	Test air flow or mass air flow sensor. 130 Fuel injection
	b	c	d	e		g			CO content too low	Test air flow or mass air flow sensor. 130 Fuel injection
	b	c	d	e	f	g	h	i	Input signals to ECM missing, ECM in limp home mode	Make electrical tests at DME ECM connector. 130 Fuel injection
a	b	c	d	e	f	g	h	i	ECM faulty	Test DME ECM inputs. If all inputs are correct, replace ECM. 130 Fuel injection

