

130 Fuel Injection

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130-2 FUEL INJECTION

GENERAL

This repair group covers fuel injection component testing and repair. Special equipment may be necessary for some of the procedures given in this repair group. If you do not have the equipment required to do the job, it is recommended that these repairs be left to an authorized BMW dealer. The BMW dealer is equipped with sophisticated diagnostic test equipment that is capable of quickly pinpointing hard-to-find DME fuel injection problems.

NOTE—

- Wiring diagrams for the DME engine management system, including the electronic throttle control (EML/ADS) circuits, can be found at the rear of the manual in **Electrical Wiring Diagrams**.
- For DME ignition repair information, including testing the crankshaft position/rpm sensor and the knock sensors, see **120 Ignition System**.
- For fuel supply component testing and repair, including fuel pump relay and electrical circuit, see **160 Fuel Tank and Fuel Pump**.

Principles Of Operation

BMW E32 cars are equipped with one of four versions of digital motor electronics (DME). The differences among the systems are mainly in refinements of certain operations and additional functions.

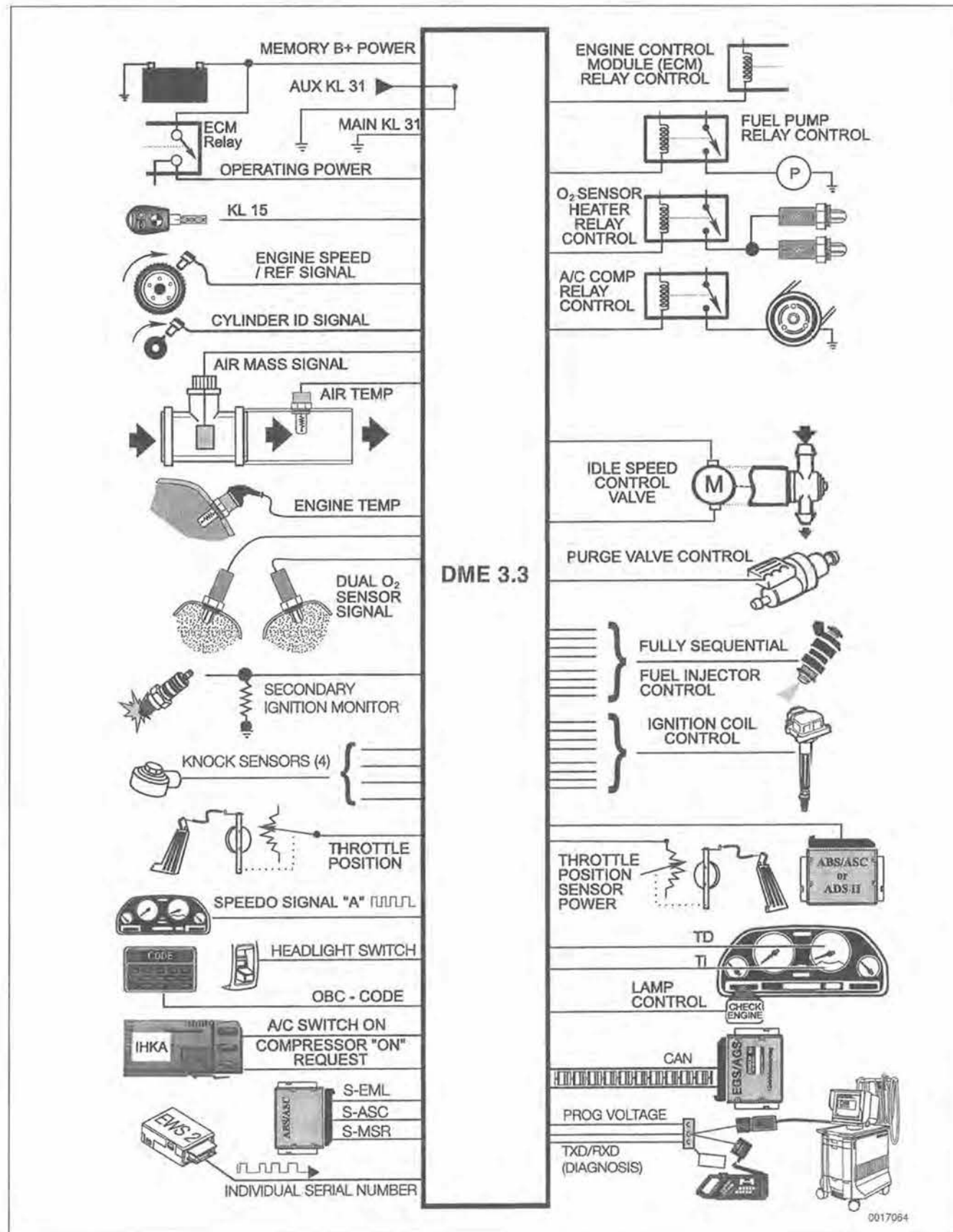
DME System Variants

Model/Year	Variant (engine code)
735i/iL 1988-1992	DME 1.3 (M30)
740i/iL 1993-1994	DME 3.3 (M60)
750iL 1988-1990 1991-1994	DME 1.2 (M70) DME 1.7 (M70)

The DME system is completely electronic in operation. Air flow is measured electronically and additional sensors supply information about engine operating conditions. The engine control module (ECM), also referred to as the DME control module, calculates the amount of fuel needed for the correct air-fuel ratio and actuates the fuel injectors accordingly. The amount of fuel metered to the engine is determined by how long the injectors are open.

NOTE—

The M70 (V12) engine uses two separate engine management systems. This includes two DME modules, two mass air flow sensors, two oxygen sensors, two crankshaft position sensors, etc. In essence, the V12 engine is managed as if it were two 6-cylinder engines.



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Air Intake. Air entering the engine passes through a pleated paper air filter in the air cleaner. Air flow into the engine is regulated by the throttle valve and measured by the air flow sensor. Various types of air flow sensors are used depending on the DME version:

Air Flow Sensor Applications

- DME 1.3 Volume air flow (vane type)
 - DME 1.2 and DME 1.7 Mass air flow (hot wire)
 - DME 3.3 Mass air flow (hot film)
-

NOTE—

- *On cars with Automatic Stability Control+Traction (ASC+T), throttle valve intervention is controlled by an electronic throttle actuator (called EML or ADS). Special electrical testing equipment is required to service these systems. See Electrical Wiring Diagrams for traction control electrical circuits.*
- *735i/iL models with ASC+T and all 750iL models are fitted with EML. In this "drive-by-wire" system there is no accelerator cable.*
- *740i/iL models with traction control use ADS, with accelerator cable and secondary throttle housing.*

Fuel Metering. The engine control module (ECM), also referred to as the DME control module, meters fuel by changing the opening time (pulse width) of the fuel injectors. To ensure that pulse width is the only factor that determines fuel metering, fuel pressure is maintained by a fuel pressure regulator. The injectors are mounted to a common fuel supply called the fuel rail.

The ECM monitors engine speed to determine the rate of injector openings. Other signals to the ECM help determine injector pulse time for different operating conditions. A temperature sensor signals engine temperature for mixture adaption. A throttle position sensor signals throttle position. An exhaust oxygen sensor signals information about combustion efficiency for control of the air-fuel mixture.

Idle Speed Control. On cars without EML (Electronic Motor Load Regulation), idle speed is electronically controlled via the idle speed control valve. The idle speed control valve maintains idle speed by bypassing varying amounts of air around the closed throttle valve. Idle speed is not adjustable.

On cars with EML, idle speed is electronically controlled via the throttle position actuator(s) which maintain idle speed by constantly adjusting the position of the primary throttle plate. Idle speed is not adjustable.

Knock Control (M60 engine only). The M60 engine is equipped with four knock sensors, two per cylinder bank. Knock sensors monitor and control ignition knock through the ECM. The knock sensors function like microphones and are able to convert mechanical vibration (knock) into electrical signals. The ECM is programmed to react to frequencies that are characteristic of engine knock and vary the ignition timing point accordingly.

Basic Engine Settings

Idle speed, idle mixture (%CO), and ignition timing are not adjustable. 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 most likely come on, indicating an emissions-related fault. For Check Engine light diagnostics, see 100 Engine-General.

The DME system compensates automatically for changes in the engine due to age, minor wear or small problems, such as a vacuum leak. As a result, idle speed and mixture do not need to be adjusted as part of routine maintenance.

NOTE—

Poor initial driveability may be encountered when the battery is disconnected and reconnected. When the battery is disconnected, the DME adaptive memory is erased. The DME system will readapt after about ten minutes of driving.

Fault Diagnosis

The management of engine functions is controlled through a number of systems—ignition, fuel injection, and emission control. Because these functions are interrelated, it is difficult to isolate general driveability problems by examining individual components. For this reason, engine management and driveability troubleshooting information can be found in **100 Engine-General**. This information is organized to help isolate problems and suggest more specific troubleshooting steps by taking all of the interrelated systems into consideration.

NOTE—

DME systems have an On-Board Diagnostic (OBD) feature that detects engine management malfunctions. When a problem is identified, a fault code (DTC) is stored in the engine control module (ECM) and the Check Engine lamp in the instrument cluster may also illuminate. Always check for fault codes as the first step in troubleshooting a driveability problem. See 100 Engine-General.

Warnings and Cautions

For personal safety, as well as the protection of sensitive electronic components, the following warnings and cautions should be adhered to when working on the DME system.

WARNING—

- *The ignition system produces high voltages that can be fatal. Avoid contact with exposed terminals. Use extreme caution when working on a car with the ignition switched on or the engine running.*
- *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.*
- *Disconnecting the battery will erase fault code(s) stored in memory. Check for fault codes prior to disconnecting the battery cables.*
- *Connect and disconnect the DME system wiring and test equipment leads only when the ignition is switched off.*
- *When working on an open fuel system, wear suitable hand protection, as prolonged contact with fuel can cause illnesses and skin disorders.*
- *Before making any electrical tests that require the engine to be cranked using the starter, disable the ignition system as described in 120 Ignition System.*
- *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—

- *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 run the engine with any of the spark plug wires disconnected. Catalytic converter damage may result.*
- *Always wait at least 40 seconds after turning off the ignition before removing control module connectors. Residual power in the system may damage sensitive electronic components.*
- *Cleanliness is essential when working on an open fuel system. Thoroughly clean fuel line connections and surrounding areas before loosening. Avoid the use of compressed air, and avoid moving the car. Only install clean parts.*
- *Fuel system cleaners and other chemical additives other than those specifically recommended by BMW may damage the catalytic converter, the oxygen sensor or other fuel supply components.*

ELECTRICAL CHECKS AND COMPONENT TESTING

The tests given under this heading must be made using a digital multimeter. Always check for On-Board Diagnostic fault codes (DTCs) as the first step in troubleshooting DME problems. See **100 Engine-General**.

CAUTION—

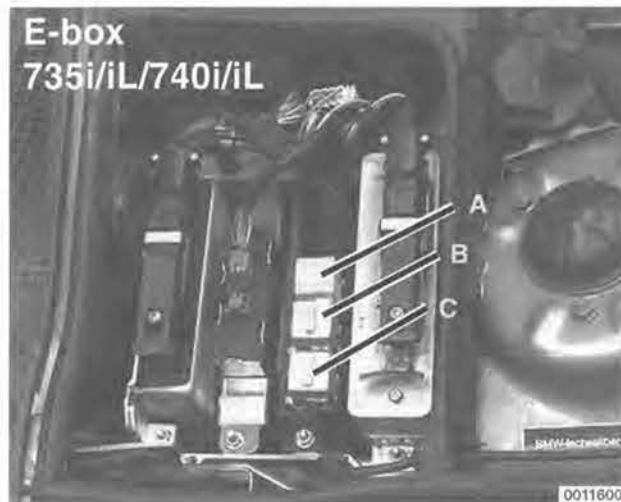
- Avoid damaging harness connectors or relay panel sockets. Jumper wires should be fabricated with flat-blade end connectors that are the same size as the connector or relay terminals being tested.
- Always switch the test meter to the appropriate function and range before making test connections. Connect and disconnect test equipment only with the ignition switched off.

Main DME relay, testing

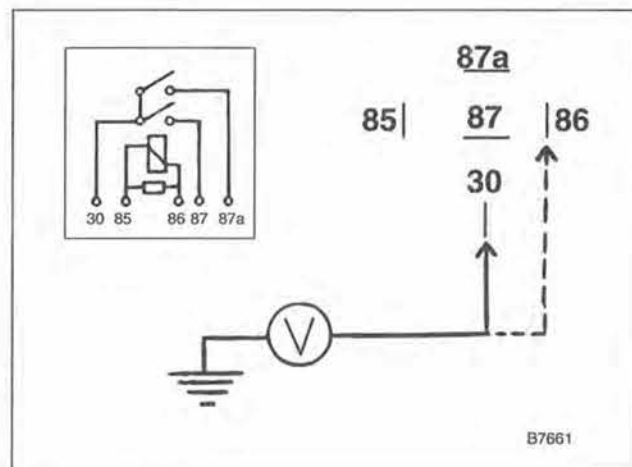
The main DME relay is energized via the DME engine control module and supplies plus (+) power to the many of the DME components and subsystems, including the fuel pump relay. If this relay is faulty, the engine will not start.

- ◀ Main DME relay (A) is in the electronics box (E-box) on M30 and M60 engines.

- A: Main relay
- B: Fuel pump relay
- C: Oxygen sensor heater relay (where applicable)



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Main DME relays (2 and 5) are in the auxiliary relay panel II in right front of M70 engine compartment.

- With the ignition off, remove main DME relay.

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.

Turn ignition on and check for voltage at terminals 30 and 86 of relay socket.

- If battery voltage is present continue testing
- If battery voltage is not present at either point, check large red wire in relay socket. See **Electrical Wiring Diagrams**.

NOTE—

The wiring to terminals 85 and 86 in the main DME relay may be reversed. Electrically, the relay functions the same. If voltage is not present at terminal 86, check for voltage at terminal 85.

Reinstall relay and turn ignition on. Gain access to underside of relay socket and check for ground at terminal 85 (brown or brown with color trace wire).

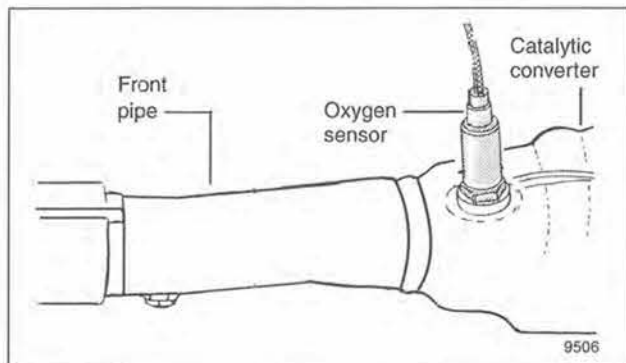
- If ground is present continue testing.
- If ground is not present, the signal from the ECM is missing. Check wire between ECM and relay. If no faults can be found, the ECM may be faulty.

With the ignition on and the relay installed, check for battery voltage at terminals 87 and 87a.

- If battery voltage is present, the relay has energized and is functioning correctly.
- If battery voltage is not present and all earlier tests are OK, the relay is faulty and should be replaced.

NOTE—

The relay may be marked with terminal 87 at two of the terminals instead of 87 and 87a.



Oxygen sensor, testing

- The oxygen sensor provides an input voltage signal (0-1 VDC) to the ECM based on the oxygen content in the exhaust gas. To generate voltage, the sensor temperature must exceed 600°F. Therefore it is electrically heated. M30 engines use one oxygen sensor.

M60 and M70 engines are equipped with two oxygen sensors, one for each catalytic converter.

NOTE—

The test given below is not a conclusive test of oxygen sensor efficiency and does not test how quickly the oxygen sensor reacts to changing conditions. For the most accurate test, an exhaust gas analyzer should be used.

- Connect a digital voltmeter to pins 1 and 2 (black wire, yellow wire) in oxygen sensor connector. Leave connector attached.

NOTE—

Oxygen sensor terminal identification can vary. Consult **Electrical Wiring Diagrams** for detailed terminal identification.

Oxygen Sensor Connector Location (4-pin, Black)

- M30 engine rear of engine compartment, lower left-hand side
- M60 engine beneath car, under transmission
- M70 engine beneath car, under transmission

- Start car and let it idle. The oxygen sensor should start to produce a fluctuating voltage within a short period. If the voltage is incorrect, turn the engine off and check the pre-heater circuit as described below.

WARNING—

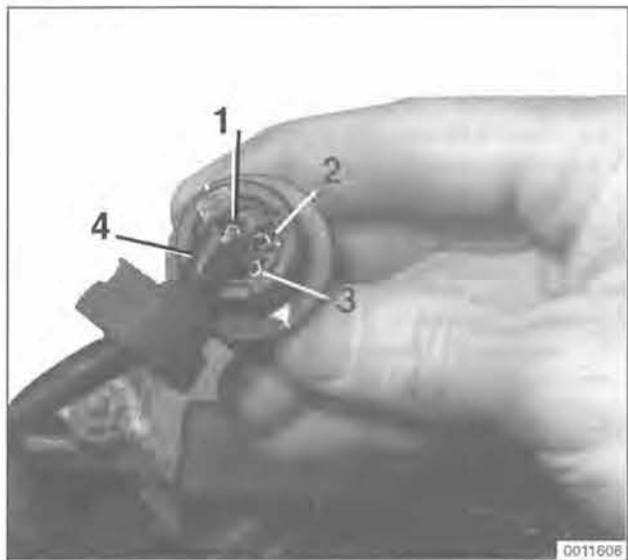
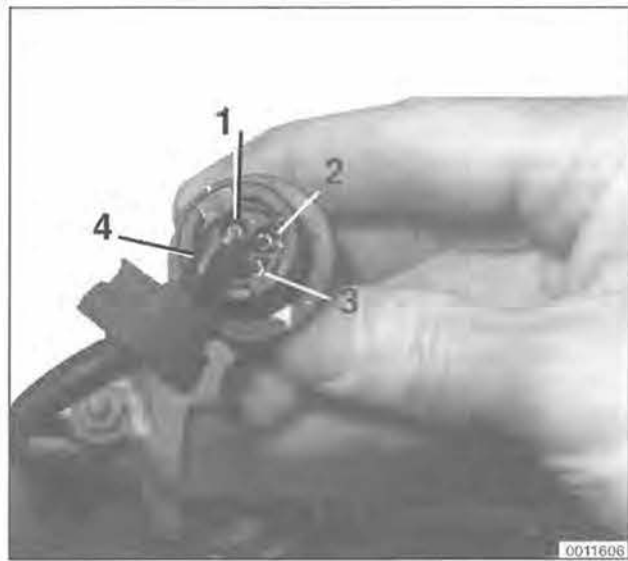
Exhaust manifolds and pipes can be hot enough to cause serious burns. Wear suitable heavy gloves and other appropriate protection.

Oxygen sensor

- Voltage at idle 0.2 to 0.8 VDC, fluctuating

- To check sensor response to lean and rich mixtures, create an air leak, or pull vacuum hose off fuel pressure regulator to increase fuel pressure.

- Separate sensor harness connector from sensor. Check for battery voltage between terminals 3 and 4 in harness side of connector with engine running. If voltage is not present, check that oxygen sensor heater relay is functioning correctly. See **610 Electrical Component Locations**.



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NOTE—

- The oxygen sensor heater relay is energized with positive (+) battery voltage from the main DME relay and a switched ground from the ECM. See **Electrical Wiring Diagrams**.
 - On some DME systems, the oxygen sensor heater circuit is not controlled by a relay. See **610 Electrical Component Locations** for more specific relay location information.
- Check heater element resistance between terminals 3 and 4 in sensor side of connector. If element is electrically open (no continuity), replace sensor.
- If oxygen sensor isn't producing a fluctuating voltage and preheater circuit is OK, replace sensor.

Tightening Torque

- Oxygen sensor to exhaust pipe 55 Nm (41 ft-lb)

NOTE—

If not already applied, coat oxygen sensor threads with anti-seize compound before installation. Do not get compound on sensor tip.

FUEL PRESSURE TESTS

Checking fuel pressure is a fundamental part of troubleshooting and diagnosing the DME system. Fuel pressure directly influences fuel delivery. An accurate fuel pressure gauge will be needed to make the tests.

There are two significant fuel pressure values:

- **System pressure**—created by the fuel pump and maintained by the pressure regulator
- **Residual pressure**—the pressure maintained in the closed system after the engine (and fuel pump) is shut off.

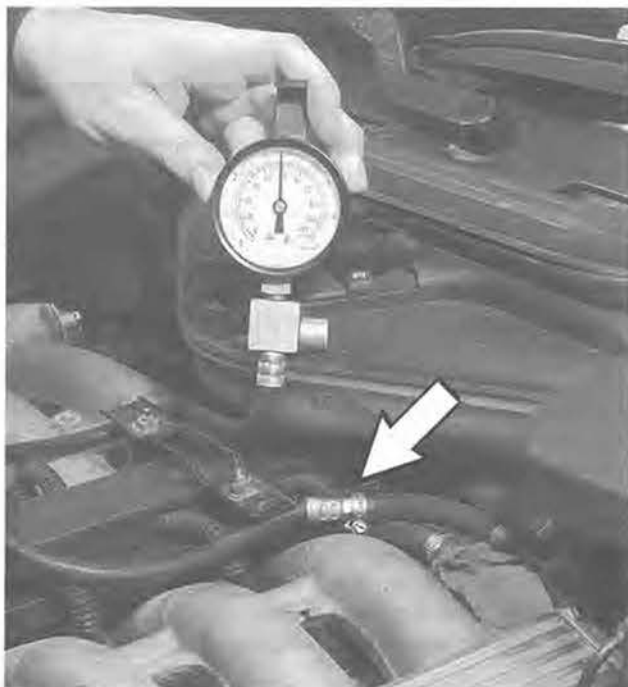
Relieving fuel pressure and connecting fuel pressure gauge

- To prevent fuel from spraying on a hot engine, relieve system pressure by wrapping a shop towel around fuel supply line and then disconnecting it from fuel rail.

NOTE—

The supply line connects to the fuel rail at the opposite end from where the fuel pressure regulator is connected.

- Connect a length of fuel line and a T-fitting to the fuel rail and reconnect the supply line to the T-fitting. Connect the fuel gauge to the T-fitting.



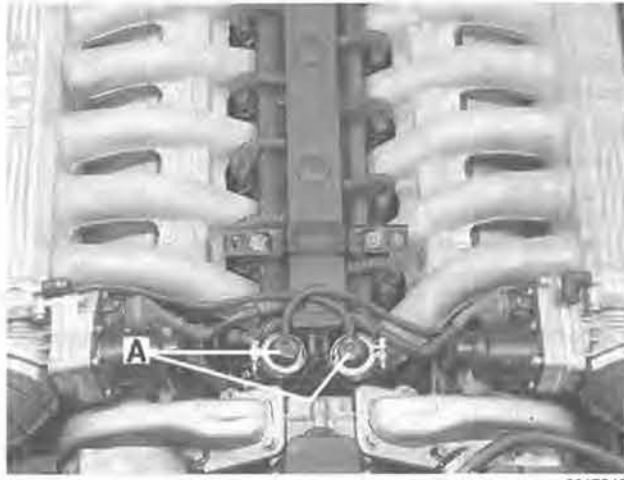
FUEL PRESSURE TESTS

NOTE —

Use BMW pressure gauge (special tool no. 13 3 060) or an equivalent. The fuel pressure gauge should have a range of 0 to 5 bar (0 to 75 psi) and must be securely connected with hose clamps to prevent it from coming loose under pressure.

System pressure, testing

Fuel system pressure is created by the fuel pump and regulated by the pressure regulator. System pressure is not adjustable.



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- ◀ Fuel pressure deflects diaphragm in fuel pressure regulator(s) (A) to return fuel to tank when pressure reaches desired limit (M70 engine shown).
- Relieve fuel pressure and connect a pressure gauge as described earlier.
- Operate fuel pump by bypassing fuel pump relay as described in **160 Fuel Tank and Fuel Pump**.

CAUTION —

The fuel pump is capable of developing a higher pressure than that regulated by the pressure regulator. If the fuel pump check valve malfunctions (stuck closed), make sure the fuel pressure does not rise above 6.0 bar (87 psi). Damage to the fuel lines or fuel system components could result.

- Compare fuel pressure to specifications.

System Fuel Pressure Specifications

Engine	Fuel pressure
M30	3.0±0.06 bar (43.5 ± 0.9 psi)
M60	3.5±0.06 bar (51 ± 0.9 psi)
M70	3.0±0.06 bar (43.5 ± 0.9 psi)

- When finished testing, disconnect pressure gauge and reconnect fuel line. Tighten hose clamp.

If system pressure is too high, check the return line from the pressure regulator to the fuel tank. Check for kinks in the return hose. Blow compressed air through the line to check for blockages. If no faults can be found, the pressure regulator is faulty and should be replaced.

CAUTION —

Do not use compressed air above 40 psi to blow out lines or components. Internal damage to components may result.

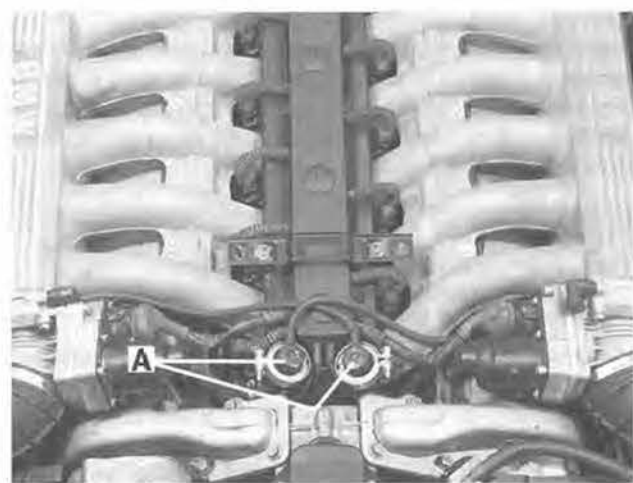
If the system pressure is too low, repeat the pressure test while gradually clamping off the fuel return line. The fuel pressure should quickly rise. If the pressure does not respond and no leaks can be found, the fuel pump may be faulty. Test the fuel pump delivery rate as described in **160 Fuel Tank and Fuel Pump**.

FUEL PRESSURE TESTS

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FUEL PRESSURE TESTS

Residual pressure, testing

For quick restarts and to avoid vapor lock, the fuel system is designed to retain fuel pressure after the engine has been turned off. This residual pressure is primarily maintained by a check valve at the fuel pump outlet and the fuel pressure regulator.

NOTE—

On some models, the fuel pump check valve may be available as an individual replacement part.

- Fuel pressure gauge attached to fuel supply line (arrow).
- Relieve fuel pressure and connect a pressure gauge as described earlier.

WARNING—

Fuel will be discharged. Wrap a shop towel around the fuel line fitting when disconnecting the fuel line. Do not smoke or work near heaters or other fire hazards. Keep an approved fire extinguisher handy.

- Operate fuel pump for approximately one minute by bypassing fuel pump relay as described in **160 Fuel Tank and Fuel Pump**.
- Observe fuel pressure gauge after 20 minutes. Pressure should not drop off more than 0.5 bar from system pressure listed earlier.
- When finished testing, disconnect pressure gauge and reconnect fuel line. Tighten hose clamp.
- If fuel system does not maintain pressure, check visually for leaks in fuel lines or at unions. Leaks can also be due to a leaking injector or a faulty fuel pump check valve.
- Check pump check valve by repeating test, but before turning fuel pump off pinch off return line at fuel rail. If pressure is now maintained, the fault is most likely at the fuel pump check valve.

Fuel pressure regulator response to engine load, testing

- With fuel pressure gauge connected, reinstall fuel pump relay. Start engine and allow it to idle.

NOTE—

The fuel pressure should be slightly lower than the specifications listed earlier. Engine vacuum acting on the fuel pressure regulator diaphragm reduces the fuel pressure.

- With engine idling, remove vacuum hose (A) from regulator. Pressure should increase. (M70 engine shown)
- Reconnect hose and check that pressure drops.

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- When finished testing, disconnect pressure gauge and reconnect fuel line. Tighten hose clamp.

If any faults are found, either the fuel pressure regulator or the vacuum hose at the pressure regulator is faulty.

NOTE—

A cracked or leaking pressure regulator vacuum hose may cause an erratic idle.

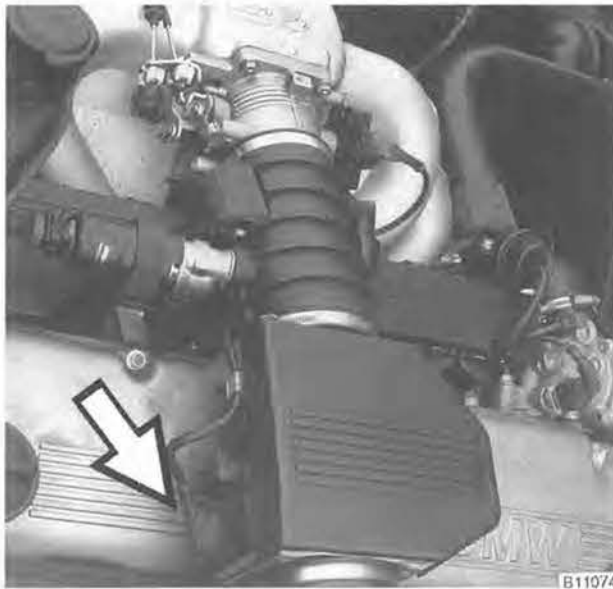
DME 1.3 (M30 ENGINE)

The 6-cylinder M30 engine uses DME 1.3. This system is equipped with On-Board Diagnostics (OBD). Be sure to check for diagnostic fault codes (DTCs) as the first step in diagnosing DME faults. To activate DTC output, see **100 Engine-General**.

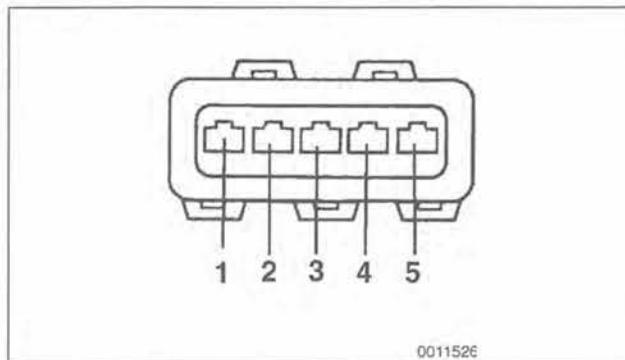
Volume air flow sensor, testing and replacing (M30 engine)

DME 1.3 uses a vane-type air flow sensor.

- Disconnect harness connector (**arrow**) from air flow sensor.



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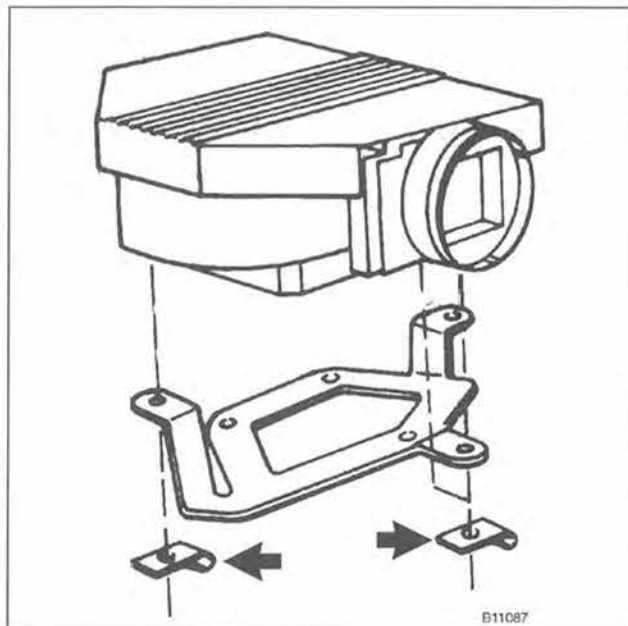
- Using a digital voltmeter, test for voltage at terminal 3 in connector. With ignition on there should be approximately 5 volts.
- Turn ignition off and remove intake air boot. Connect a digital ohmmeter across sensor terminals 2 and 3. Swing air flow sensor vane through its range of travel. Resistance should change steadily without interruption.

DME 1.3 (M30 ENGINE)

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➤ To replace sensor, disconnect intake air boots (A) and harness connector (B) from sensor.



➤ Working underneath sensor, remove sensor retaining clips (arrows) and lift sensor off mount.

— Reinstallation is reverse of removal.

Engine coolant temperature (ECT) sensor, testing and replacing (M30 engine)

The engine coolant temperature (ECT) sensor sends continuous engine coolant temperature information to the ECM. The ECT sensor is of the NTC (negative temperature coefficient) type; as temperature increases sensor resistance decreases.

- Disconnect harness connector from ECT sensor (B).

ECT Sensor Location

- M30 engine front of engine in coolant flange (blue plug)

- Turn ignition on. Using a digital voltmeter check for 5 volts (VDC) between supply voltage wire in connector and ground. If voltage is not present, test ECM inputs/outputs as described later.
- With harness connector detached use a digital ohmmeter to test resistance across sensor terminals.

Engine Coolant Temperature Sensor (M30 engine)

Test temperature	Resistance (k Ohms)
14 ± 2°F (−10 ± 1° C)	7–11.6
68 ± 2°F (20 ± 1° C)	2.1–2.9
176 ± 2°F (80 ± 1° C)	0.27–0.40

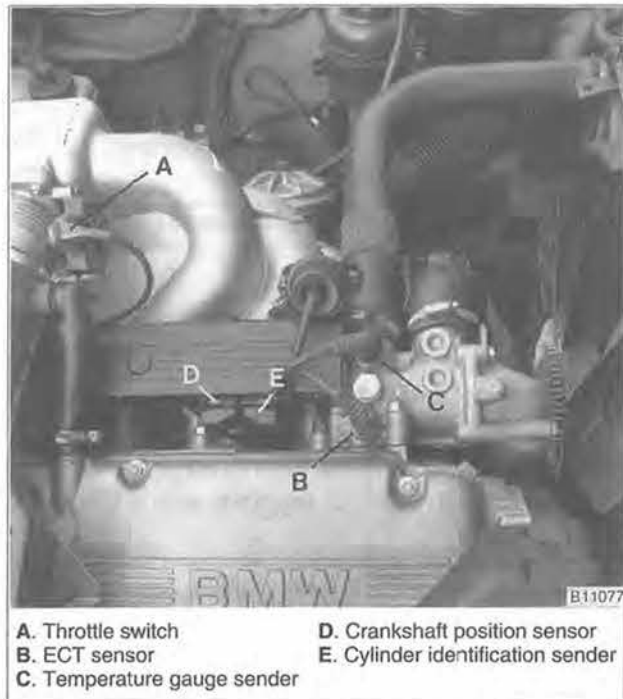
- If any faults are found replace sensor.
 - Use a new copper sealing washer when installing a new sensor.
 - Replace any lost coolant.

WARNING—

Allow engine to cool to room temperature before removing sensor.

Tightening Torque (M30 Engine)

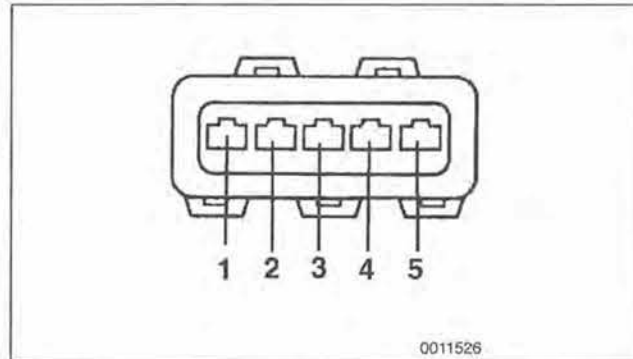
- ECT sensor to coolant flange 18 Nm (13 ft-lb)



A. Throttle switch
B. ECT sensor
C. Temperature gauge sender
D. Crankshaft position sensor
E. Cylinder identification sender

Intake air temperature (IAT) sensor, testing and replacing (M30 engine)

The intake air temperature (IAT) sensor is used by the ECM to modify/correct the intake air signal from the air flow sensor based on the temperature of the intake air. The IAT sensor is integrated into the air flow sensor housing and is not separately available as a replacement part.



- Using a digital voltmeter, test for voltage across terminals 1 and 4 in volume air flow sensor connector.
- Compare resistance value to values listed below.

Intake Air Temperature Sensor (M30 Engine)

Test temperature	Resistance (k Ohms)
14 ± 2°F (-10 ± 1° C)	7-11.6
68 ± 2°F (20 ± 1° C)	2.1-2.9
176 ± 2°F (80 ± 1° C)	0.27-0.40

- If any faults are found, replace air flow sensor.

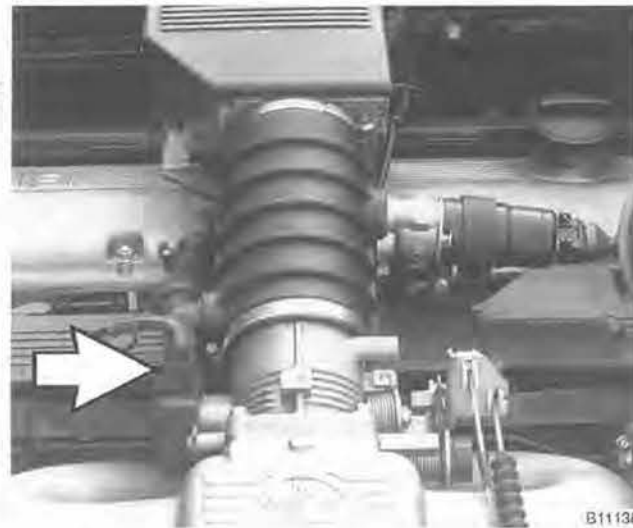
Throttle position switch (TPS), testing and adjusting (M30 engine w/o EML)

On the M30 engine without EML (electronic throttle control), a throttle position switch (TPS) provides an idle and full throttle position signal to the ECM. The idle position signal is used mainly for activation of the idle speed control valve. The full throttle position signal is used for A/C compressor cutout and fuel enrichment.

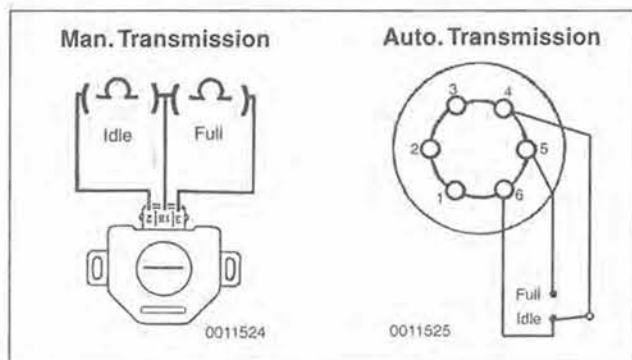
The TPS is mounted to the side of the throttle housing. The switch can be checked with the throttle housing installed.

NOTE—

On 735i/iL models (M30 engine) with traction control (ASC), the EML control module provides the throttle position signal to the ECM.



- Disconnect harness connector (**arrow**) from throttle switch.
- With ignition on, check for supply voltage (VDC) to switch. If voltage is not present, check wiring from ECM.



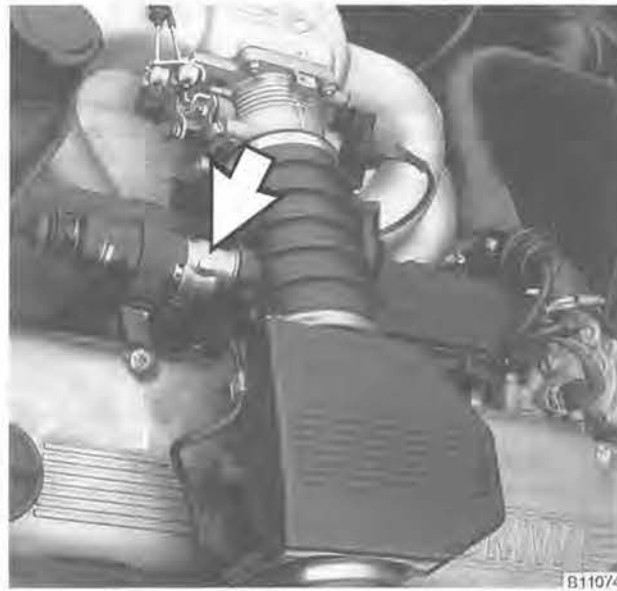
TPS test terminals (M30 engine)

- Manual transmission
 - Idle position. 2 and 18
 - Full throttle position. 3 and 18
- Automatic transmission
 - Idle position 4 and 6
 - Full throttle position. 4 and 5

FUEL INJECTION 130-17

- Check for continuity at switch terminals with throttle at idle and at full open positions. Adjust or replace switch if any faults are found.
- To adjust throttle switch, loosen switch screws and connect an ohmmeter across switch terminals. With throttle at idle, rotate switch just until there is continuity. Tighten mounting screws. Seal mounting screws using paint or lacquer.

Idle speed control valve, testing and replacing (M30 engine w/o EML)



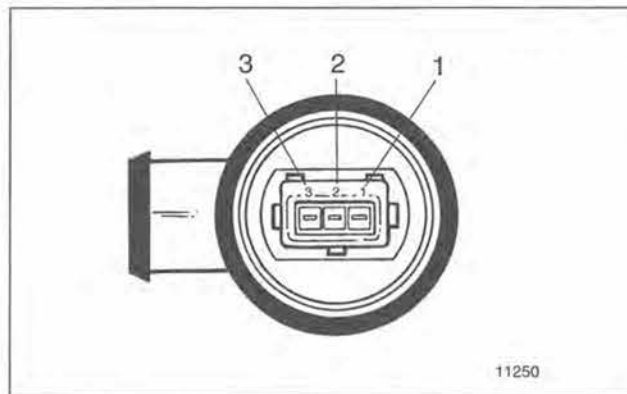
- On the M30 engine without EML (electronic throttle control), idle speed is maintained through the idle speed control valve (arrow). The idle control function compensates for engine load and engine operating conditions. Idle speed is adaptive through the ECM and no idle speed adjustments can be made.

NOTE—

- Before checking the valve, confirm that the throttle position switch is working correctly.
- The test given below is an electrical check only. It does not check the mechanical operation of the valve. If the valve is sticking, hanging up or is sluggish in operation, substituting a known good valve is the best way to check it.
- On 735i/L models with traction control (ASC), an idle speed control valve is not used. Instead, idle speed is controlled via the EML electronic throttle position actuator. See EML (M30 or M70 engine) later in this repair group.

- With engine running, check that idle speed control valve is buzzing.
- Turn on A/C or shift car into Drive. Idle should remain steady or increase slightly.
- If valve is not buzzing or if idle decreases, stop engine and disconnect harness connector from valve.

- Check resistance of valve across its terminals. Test values are listed below.



Idle Speed Control Valve Coil Resistance Values (M30 engine)

- Terminals 1 and 2 20 ± 2 ohms
- Terminals 2 and 3 20 ± 2 ohms
- Terminals 1 and 3 40 ± 4 ohms

NOTE—

If you suspect an intermittent fault, lightly tap the valve while testing resistance.

130-18 FUEL INJECTION

- With valve harness connector disconnected, check for battery voltage at red/white wire in connector with ignition on.
 - If there is no voltage, check wiring between connector and main DME relay. See **Electrical Wiring Diagrams**.

NOTE—

The idle speed control valve receives positive (+) battery voltage from the main DME relay.

- If voltage is present as described above, check wiring between ECM and valve. If no wiring faults are found, check ECM output signal to valve.

NOTE—

*There are some additional inputs to the control module that affect idle speed, such as throttle position, A/C-on signal or automatic transmission Drive position. Check these signals if idle problems persist. See **ECM Pin Assignments**.*



- To replace idle speed control valve turn off ignition and disconnect harness connector (A).

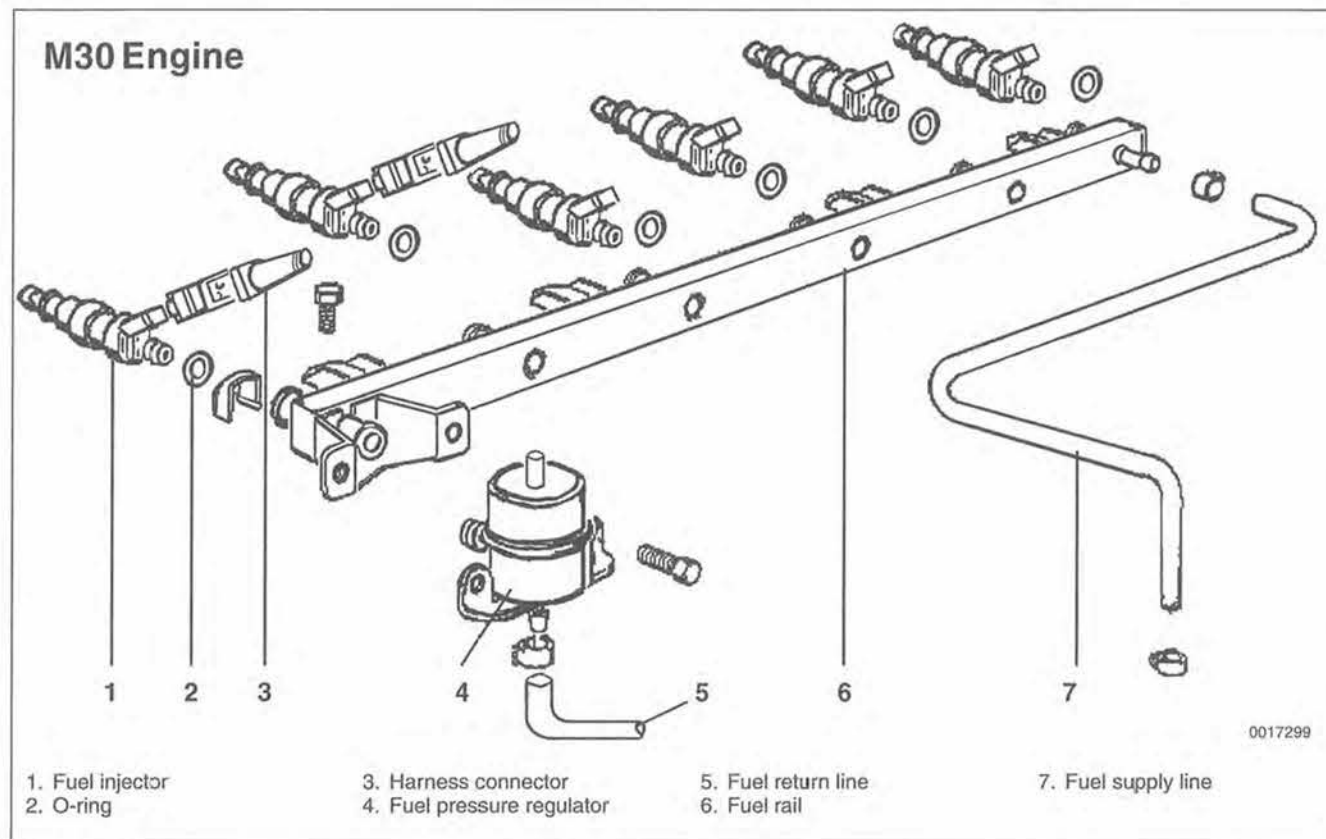
- Detach rubber retaining strap (B) from support bracket.
- Loosen hose clamps (C) and remove valve from hoses.
- Installation is reverse of removal.

NOTE—

Poor driveability and inconsistent idle may be noticed immediately after replacing idle speed control valve. Drive car for 10 minutes under varying conditions to allow the DME to adapt.

Fuel injectors, testing and replacing (M30 engine)

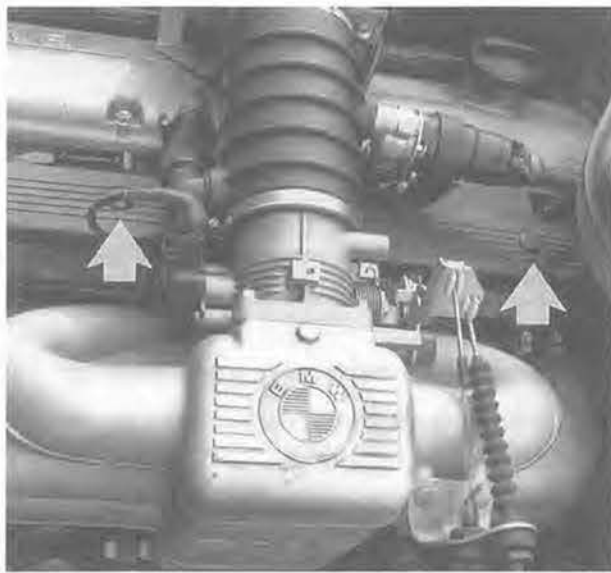
The fuel injectors are switched on and off (opened and closed) by the ECM. The injectors are connected to a common fuel supply called the fuel rail.



NOTE—

The information given here is an electrical test only. The test does not check spray patterns or fuel supply to the injectors.

- Disconnect and remove intake air boot between throttle housing and air filter housing.
- Remove plastic trim covers (arrows). Remove injector harness cover mounting screws, and then remove cover.



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130-20 FUEL INJECTION



➤ Connect digital voltmeter to wiring in injector housing.

- Operate starter or run engine.
- Check for pulsed voltage (approx. 0.3–1.0 VDC).

CAUTION—

Use a digital multimeter only. Analog meters or test lights may damage the ECM.

NOTE—

To quick-check a single injector, place a screwdriver or stethoscope on the injector with the engine running. If the injector is operating, there should be an audible buzz.

- If there is no voltage, check for power (+) at red/white wire of each injector connector with ignition key on. If voltage is not present, check main DME relay and wiring to injector using wiring diagrams listed in **Electrical Wiring Diagrams**.

NOTE—

If there is positive (+) battery voltage at injector harness connector, but no response at voltmeter during cranking, check the wire(s) from ECM to injectors. If no wiring faults can be found, the pulsed ground signal from the control module may be missing. Check outputs from ECM.

- If power is present as described in above step, unplug injector connectors and check injector electrical resistance. Replace injector if resistance is incorrect.

Fuel Injector Coil Resistance

- M30 engine 16 ohms at 20°C

NOTE—

Injector resistance will vary depending on temperature. In general, the range should be between 10 and 20 ohms.

- If no faults are found up to this point, check pulse-time regulation function of ECM with engine cold.

➤ Connect digital voltmeter to wiring in injector housing as shown.

CAUTION—

Use a digital multimeter only. Analog meters or test lights may damage the ECM.

- Start engine.
- Check that voltage decreases as engine warms up.

- If any faults are found, check ECM inputs and outputs as described later.

- To replace injectors, disconnect negative (–) battery cable as described in **020 Maintenance**.

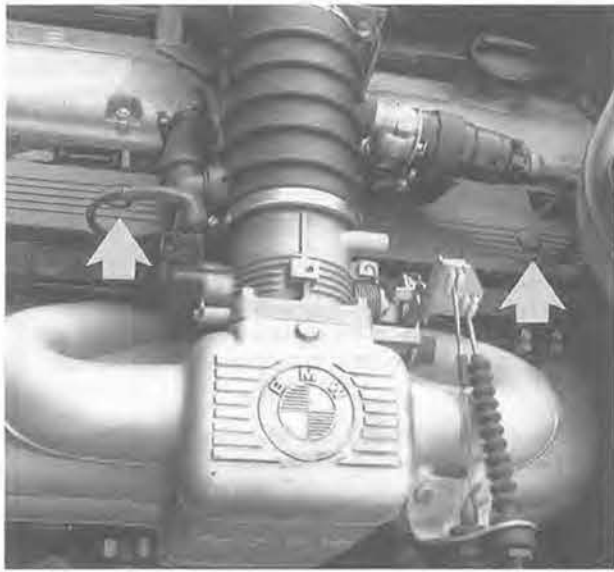


DME 1.3 (M30 ENGINE)

FUEL INJECTION 130-21

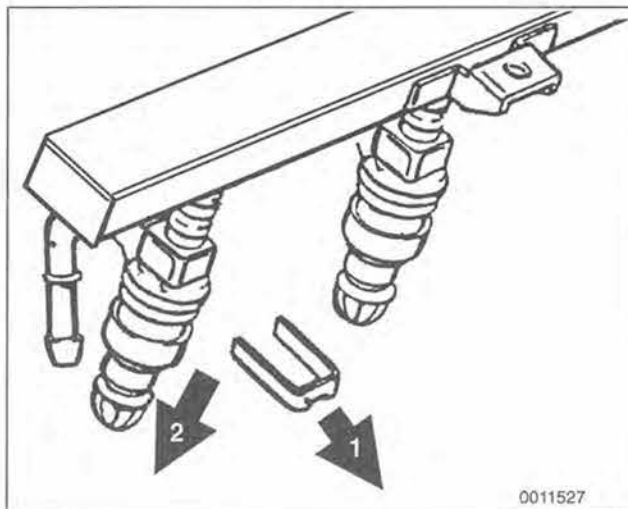
CAUTION—

Prior to disconnecting the battery, read the battery disconnection cautions given at the front of this manual on page viii.



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- Disconnect and remove intake air boot between throttle housing and air filter housing.
- Remove plastic trim covers (arrows). Remove injector harness cover mounting screws, and then remove cover.
- Remove fuel rail mounting bolts.
- Pry up on fuel rail and remove fuel rail and fuel injectors as an assembly.



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- Remove injector retaining clip (1) and pull injector from rail (2).

WARNING—

Fuel will be discharged. Do not disconnect any wires that could cause electrical sparks. Do not smoke or work near heaters or other fire hazards. Keep an approved fire extinguisher handy.

- Installation is reverse of removal.
 - Fit new O-rings when installing injectors.
 - Lightly lubricate O-rings with SAE 90w gear lube.

NOTE—

Be sure injector electrical connectors are correctly fitted and injectors are fully seated prior to installing fuel rail mounting bolts.

Tightening Torque (M30 Engine)

- Fuel rail to cylinder head 10 Nm (89 in-lb)

DME 1.3 (M30 ENGINE)

**Engine control module (ECM),
testing and replacing (M30 engine)**

DME 1.3 ECM pin assignments are given later in **Table c**. This pinout information can be helpful when diagnosing faults to or from the ECM. If all inputs and wiring are OK but operational problems still exist, the ECM itself may be faulty.

Test results with incorrect values do not necessarily mean that a component is faulty. Check for loose, broken or corroded connections and wiring before replacing components. If the results are still incorrect, test the component itself. For electrical schematics of the DME system, see **Electrical Wiring Diagrams**.

CAUTION—

- Always wait at least 40 seconds after turning off the ignition before removing the connector from the engine control module (ECM). If the connector is removed before this time, residual power in the system relay may damage the ECM.
- Always connect or disconnect the control module connector and meter probes with the ignition off.

When making checks at the ECM itself, a breakout box should be used to allow tests to be made with the connector attached to the ECM. This also prevents damage to the small terminals in the connector. As an alternative, the harness connector housing can be separated so that electrical checks can be made by back-probing the connector.

➤ The engine control module (ECM) is mounted in the right rear of the engine compartment, inside the electronics box (E-box) (arrow). Terminal numbers are identified on the harness connector and/or on the ECM.

**CAUTION—**

- Use only a digital multimeter when making electrical checks at ECM or other solid state DME components.
- Control modules and relay locations may vary within the E-box. Consult **610 Electrical Component Locations** or **Electrical Wiring Diagrams** for supplemental information.

NOTE—

Electrical parts are not returnable. Before replacing an ECM, run all tests and check harness and connections for possible malfunctions.

- Disconnect negative (–) battery cable. See **020 Maintenance**.

CAUTION—

Prior to disconnecting the battery, read the battery disconnection cautions given at the front of this manual on page viii.

- Remove cover from electronics box (E-box). The cover is retained with four captive screws. Peel back weather stripping from body for improved access.
- Unplug ECM harness connector by releasing fastener and pivoting connector up and off ECM.
- Remove ECM retaining nuts or clips and lift out ECM.
- Installation is reverse of removal.

CAUTION—

Poor driveability may be noticed immediately after replacing the ECM. Drive for at least 10 minutes under varying conditions to allow ECM to adapt.

DME 3.3 (M60 ENGINE)

DME 3.3 systems are equipped with advanced On-Board Diagnostics (OBD). Be sure to check for diagnostic fault codes (DTCs) as the first step in diagnosing DME faults. To activate fault code output, see **100 Engine-General** for fault codes.

Mass air flow sensor, testing and replacing (M60 engine)



- ◀ The DME 3.3 system uses a hot film mass air flow sensor. When the engine is running, a current is used to heat a thin film in the center of the meter. The current used to heat the film is electronically converted into a voltage measurement corresponding to the mass of intake air.

NOTE—

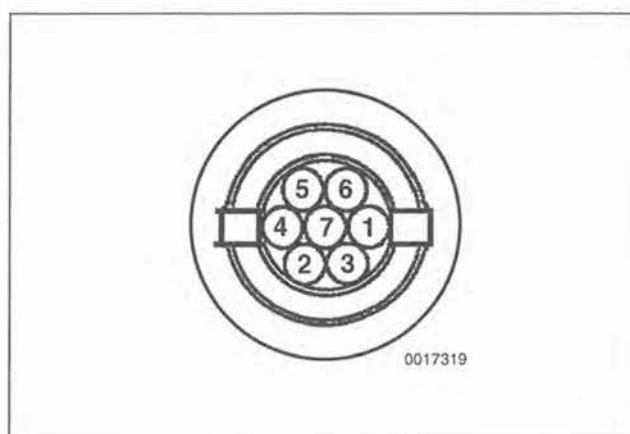
A burn-off cycle is not used on hot film sensors.

If the hot film breaks or if there is no output from the air flow sensor, the ECM automatically switches to a "limp-home" mode and turns on the Check Engine light. The engine can usually be started and driven.

The mass air flow sensor has no internal moving parts and cannot be serviced or adjusted.

- Disconnect harness connector from mass air flow sensor.

130-24 FUEL INJECTION



➤ Turn ignition on and check for voltage and ground at connector. There should be ground at pin **1** and positive (+) battery voltage at pin **3**.

— If any faults are found, check for wiring breaks between air flow sensor and ECM and between mass air flow sensor and main DME relay.

• Also check operation of main DME relay.

— To remove mass air flow sensor, detach electrical harness connector and loosen air duct clamps.

— Installation is reverse of removal.

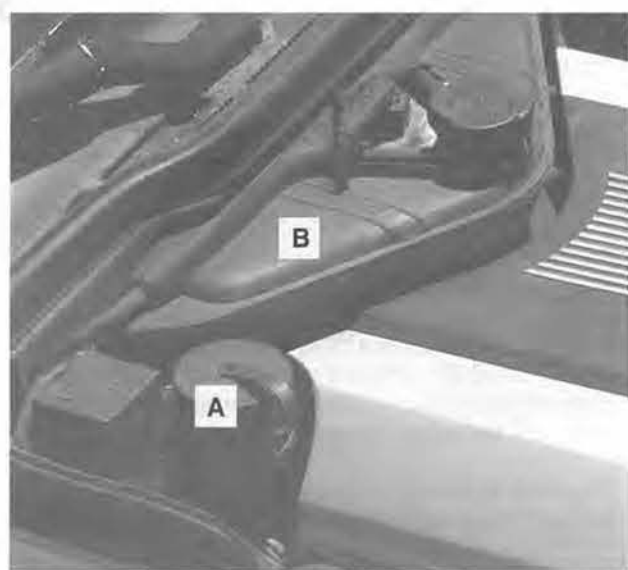
NOTE —

Use only acid free grease or silicone lubricant on gasket and air boot.

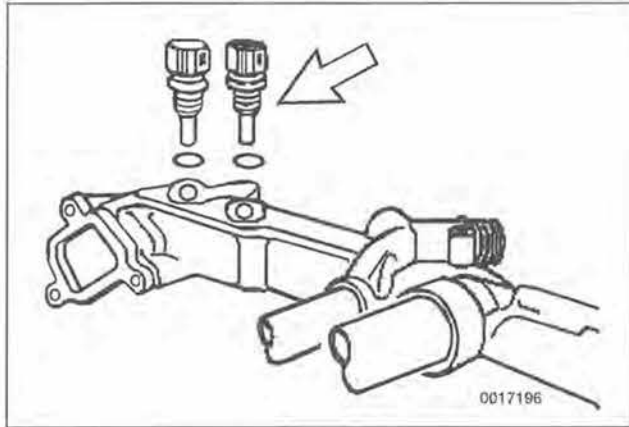
Engine coolant temperature (ECT) sensor, testing and replacing (M60 engine)

The engine coolant temperature (ECT) sensor sends coolant temperature information to the ECM. The ECT sensor is of the NTC (negative temperature coefficient) type; as temperature increases sensor resistance decreases.

➤ Detach data link (diagnostic) plug (**A**) from holder and unbolt coolant expansion reservoir (**B**) and set aside.



FUEL INJECTION 130-25



Working at right rear of engine, disconnect harness connector from the ECT sensor (white plug) (arrow).

- Turn ignition on. Using a digital voltmeter check for 5 volts (VDC) between supply voltage wire in connector and ground. If voltage is not present, test ECM inputs/outputs as described later.

CAUTION—

Use only a digital multimeter when testing any part of the DME system. Use of an analog meter or test light may damage control modules and sensors.

- When replacing ECT sensor, use a new copper sealing washer. Replace any lost coolant.

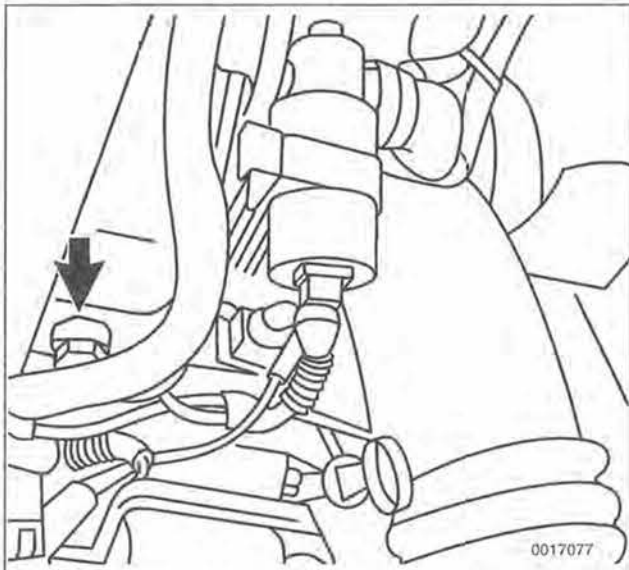
Tightening Torque (M60 Engine)

- ECT sensor to crosspipe 18 Nm (13 ft-lb)

Intake air temperature (IAT) sensor, testing and replacing (M60 engine)

- Remove top engine cover.

Disconnect harness connector from intake air temperature (IAT) sensor (arrow).



IAT Sensor Location

- M60 engine in intake manifold, right front

- Turn ignition on. Using a digital voltmeter check for 5 volts (VDC) between supply voltage wire in connector and ground. If voltage is not present, test ECM inputs/outputs as described later.

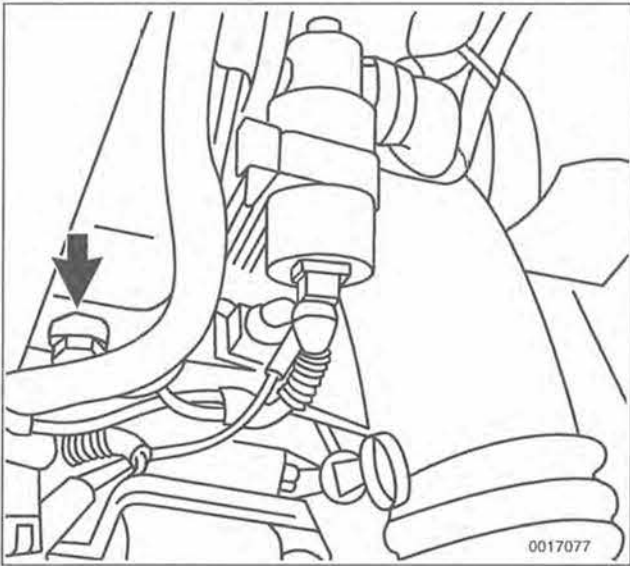
IAT Sensor Voltage Supply

- M60 engine yellow/red wire

- With harness connector disconnected, test resistance across sensor terminals. If any faults are found, replace IAT sensor.

Intake Air Temperature Sensor (M60 Engine)

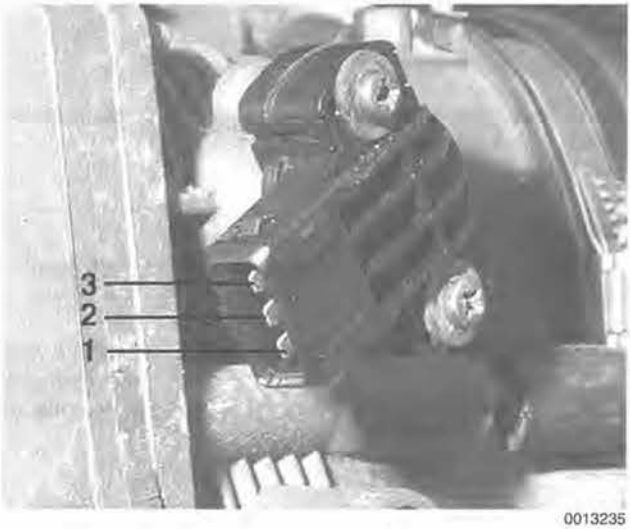
Test temperature	Resistance (k Ohms)
14 ± 2°F (−10 ± 1° C)	7-11.6
68 ± 2°F (20 ± 1° C)	2.1-2.9
176 ± 2°F (80 ± 1° C)	0.27-0.40



Throttle position sensor (TPS), testing (M60 engine)

➤ The throttle position sensor (**arrow**) is mounted on the side of the primary throttle housing and is directly connected to the throttle valve shaft. The ECM sends a voltage signal to the potentiometer-type sensor and monitors the voltage that comes back. Resistance decreases (voltage increases) as the throttle opens.

NOTE —
Do not confuse the TPS on the primary throttle housing with the throttle switch on the ADS secondary throttle housing.



➤ Check throttle position sensor function by disconnecting harness connector and checking across terminals.

Throttle position sensor (M60 engine)

test conditions	terminals	test value
Harness connector disconnected, ignition on	1 in harness connector and ground	5 VDC (approx.)
Harness connector disconnected, ignition off	1 and 3 at sensor terminals	4.0 k ohms (approx.)
Throttle plate rotated from idle to full throttle position	1 and 2 at sensor terminals	Continuously variable from 1.0–4.0 k ohms (approx.) without interruption

NOTE —
The throttle position sensor is not adjustable. If test results are incorrect, the sensor should be replaced.

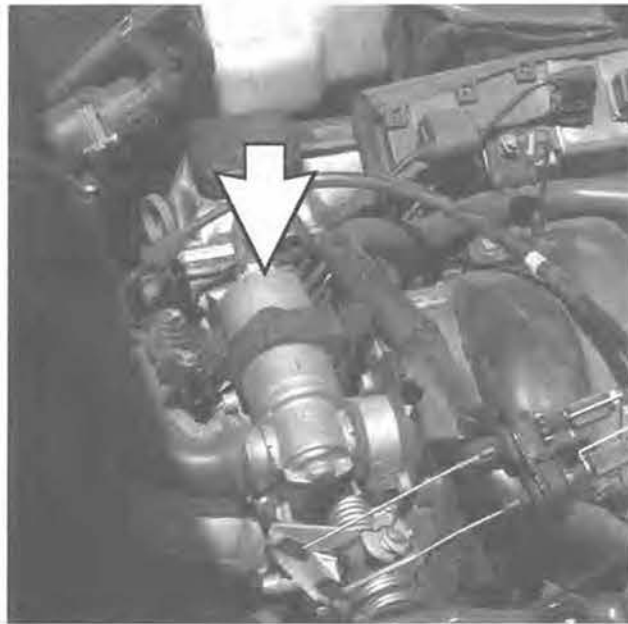
Idle speed control valve, testing and replacing (M60 engine)

Idle speed is maintained by the ECM through the idle speed control valve. The idle control function compensates for engine load and engine operating conditions. Idle speed is adaptive through the ECM and no adjustments can be made.

Before checking valve, confirm that throttle position sensor is working correctly.

NOTE—

The test given below is an electrical check only. It does not check the mechanical operation of the valve. If the valve is sticking, hanging up or is sluggish in operation, substituting a known good valve is the best way to check it.

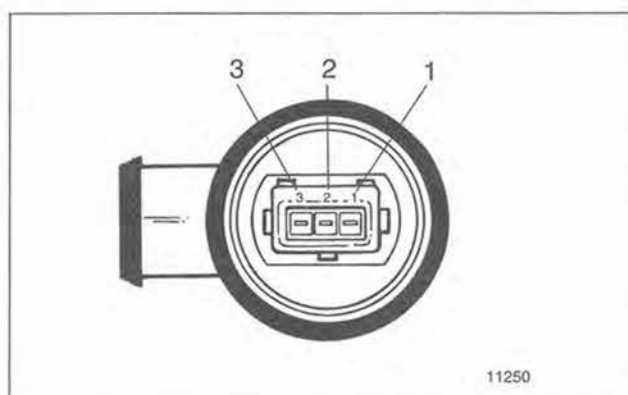


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◀ With engine running, check that idle speed control valve (arrow) is buzzing.

— Turn on A/C or shift car into drive. Idle should remain steady or increase slightly.

— If valve is not buzzing, or if idle decreases in step above, stop engine and disconnect harness connector from valve.



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◀ Check resistance of valve across its terminals. Test values are listed below.

Idle Speed Control Valve Coil Resistance Values (M60 Engine)

- Terminals 1 and 2 20 ± 2 ohms
- Terminals 2 and 3 20 ± 2 ohms
- Terminals 1 and 3 40 ± 4 ohms

NOTE—

If you suspect an intermittent fault, lightly tap the valve while testing resistance.

130-28 FUEL INJECTION

- With valve harness connector disconnected, check for battery voltage at red/white wire in connector with ignition turned on.
- If there is no voltage, check wiring between connector and main DME relay. See **Electrical Wiring Diagrams**.

NOTE—

The idle speed control valve receives positive (+) battery voltage from the main DME relay.

- If voltage is present as described above, check wiring between ECM and valve. If no wiring faults are found, check ECM signal to valve.

NOTE—

• The idle speed control valve signal can be checked using a duty cycle meter (or dwell meter). Connect the meter to the valve following the manufacturer's instructions. Turn on the A/C or create a large air leak and check that the valve's duty cycle reacts while the idle speed remains steady.

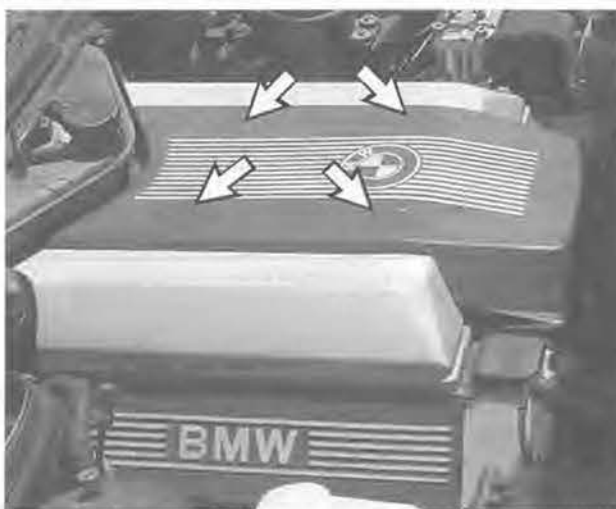
• There are some additional inputs to the control module that affect idle speed such as throttle position, A/C-on signal or automatic transmission Drive position. Check these signals if idle problems persist. See **ECM Pin Assignments**.

- When replacing idle speed control valve, clean and inspect all sealing areas.
- Inspect sealing ring in throttle body and replace if necessary.

Camshaft position (CMP) sensor, replacing (M60 engine)

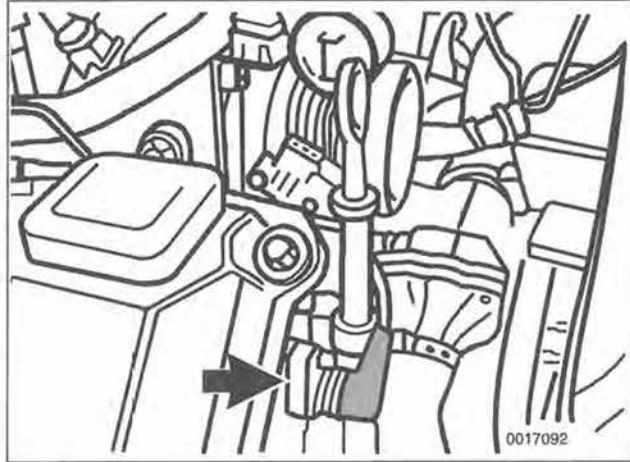
The camshaft position (CMP) sensor is located in the front of the right cylinder head, next to the oil dipstick guide tube.

- Remove plastic cover from top center of engine.
 - Pry out plugs (**arrows**) from covers.
 - Remove nuts and bolts from beneath plugs
 - Lift off cover.
- Detach CMP sensor electrical harness connector and pull harness away from brackets.
- If necessary, remove air intake duct to gain access to front of right cylinder head.



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FUEL INJECTION 130-29



- Remove CMP sensor (**arrow**) from front of right cylinder head by unscrewing mounting bolt.
- Installation is reverse of removal.
 - Reattach CMP sensor harness with wire ties.
 - Check and clear fault memory.

Fuel injectors, testing (M60 engine)

The fuel injectors are switched on and off (opened and closed) by the ECM. The injectors are connected to a common fuel supply, called the fuel rail.

NOTE—

The test below is an electrical check only. The test does not check spray patterns or fuel supply to injectors.

- Remove plastic engine covers from top of engine and pry off cover from injector wiring duct.
- Connect digital voltmeter to wiring in injector housing as shown.

CAUTION—

Use a digital multimeter only. Analog meters or test lights may damage the ECM.

- Operate starter or run engine.
- Check for pulsed voltage (approx. 0.3–1.0 VDC).

NOTE—

To quick-check a single injector, place a screwdriver or stethoscope on the injector with the engine running. If the injector is operating, there should be an audible buzz.

- If there is no voltage, check for power to injector. There should be battery voltage (+) at red/white wire of each injector connector with ignition key on. If not, check main DME relay and wiring to injectors. See **Electrical Wiring Diagrams**.



130-30 FUEL INJECTION

NOTE—

If there is positive (+) battery voltage at connector, but there was no response during cranking, check the wire(s) from the ECM to the injectors. If no wiring faults can be found, the pulsed ground signal from the control module may be missing. Check the outputs from the ECM.

- If no faults are found up to this point, check pulse-time regulation function of ECM with engine cold. Connect a voltmeter to wires in connector. Start engine. Check that voltage decreases as engine warms up.

If any faults are found, check the ECM inputs and outputs as described later.

Fuel rail and injectors, removing and installing (M60 engine)

The fuel injectors are removed by first removing the complete injector/fuel rail assembly and then unclipping the injectors from the fuel rail.

Cleanliness is essential when working with fuel circuit components. Thoroughly clean the unions before disconnecting any fuel lines. Use clean tools.

WARNING—

Fuel will be expelled when fuel lines are disconnected. Do not smoke or work near heaters or other fire hazards. Keep a fire extinguisher handy.

- Disconnect negative (–) battery cable. See 020 Maintenance.

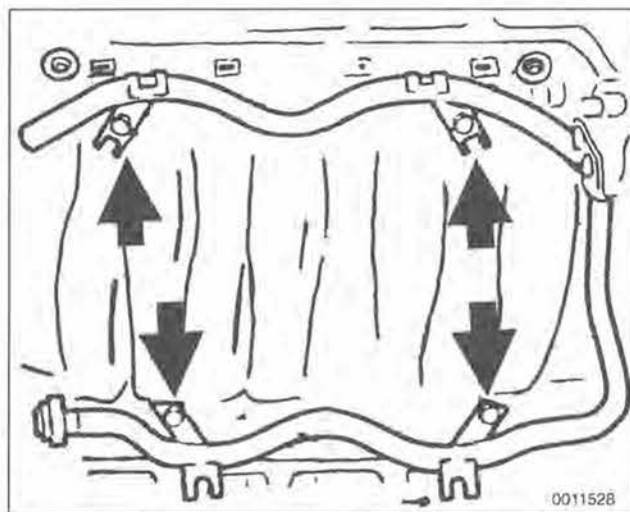
CAUTION—

Prior to disconnecting the battery, read the battery disconnection cautions given at the front of this manual on page viii.

- Remove plastic engine covers from top of engine and pry off cover from injector wiring duct.
- Unplug ignition coils and fuel injectors.
- Disconnect throttle cable(s) and lay aside.
- Detach wiring ducts and lay aside.
- Disconnect fuel lines from fuel rail and fuel pressure regulator.

WARNING—

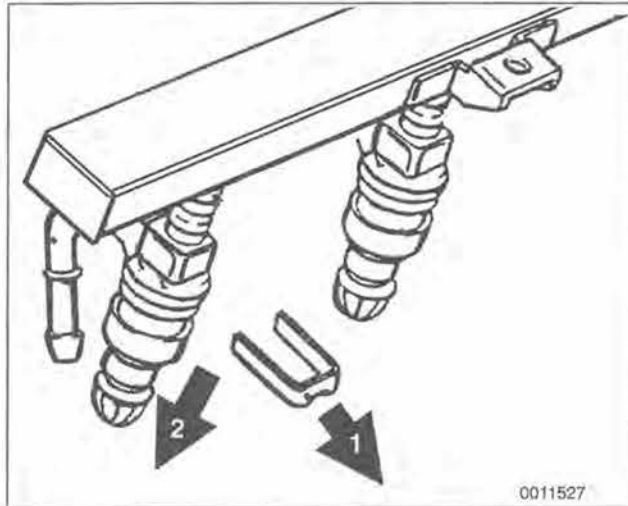
Fuel will be discharged. Do not disconnect any wires that could cause electrical sparks. Do not smoke or work near heaters or other fire hazards. Keep an approved fire extinguisher handy.



DME 3.3 (M60 ENGINE)

- Remove fuel rail mounting bolts (arrows).
- Pry up fuel rail and remove with injectors.

FUEL INJECTION 130-31



- Remove injector retaining clip (1) and pull injector from rail (2).

— Installation is reverse of removal.

- Fit new O-rings when installing injector. For ease of installation, lightly lubricate O-rings with SAE 90w gear lube.
- Check that injector electrical connections are correctly fitted and that injectors are fully seated prior to installing fuel rail mounting bolts.
- Replace any missing wire ties.
- Install new hose clamps.

Tightening Torque (M60 Engine)

- Fuel rail to cylinder head. 10 Nm (89 in-lb)

Fuel pressure regulator, replacing (M60 engine)

- Disconnect negative (–) battery cable. See 020 Maintenance.

CAUTION—

Prior to disconnecting the battery, read the battery disconnection cautions given at the front of this manual on page viii.

- Detach coolant expansion tank and data link (diagnostic) connector and lay aside.

- Remove top engine cover.

- Disconnect fuel pressure regulator vacuum line (arrow).

- Note installed position of regulator then remove fuel pressure regulator retaining circlip.

- Wrap a shop rag around regulator. Pull regulator from fuel rail.

WARNING—

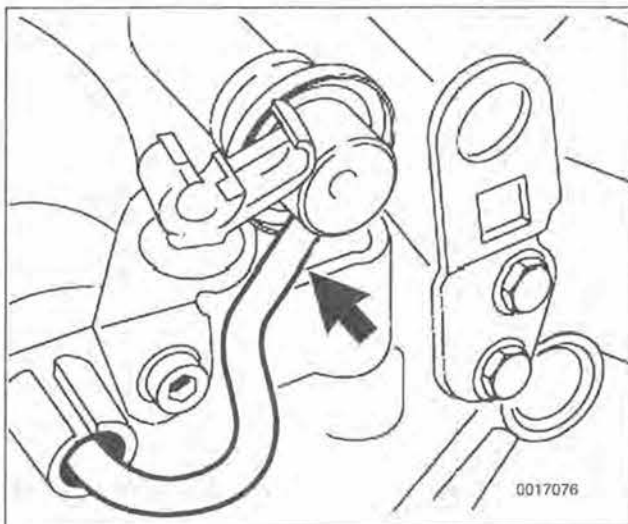
Fuel will be discharged. Do not disconnect any wires that could cause electrical sparks. Do not smoke or work near heaters or other fire hazards. Keep an approved fire extinguisher handy.

- Installation is reverse of removal.

- Tabs on circlip must engage slots in fuel rail.
- Always replace O-rings.

NOTE—

Be sure the part number on the new pressure regulator matches that of the old regulator.



130-32 FUEL INJECTION

Engine control module (ECM), testing and replacing (M60 engine)

DME 3.3 ECM pin assignments are given later in **Table d**. This pinout information can be helpful when diagnosing faults to or from the ECM. If all inputs and wiring are OK but operational problems still exist, the ECM itself may be faulty.

Test results with incorrect values do not necessarily mean that a component is faulty. Check for loose, broken or corroded connections and wiring before replacing components. If the results are still incorrect, test the component itself. For electrical schematics of the DME system, see **Electrical Wiring Diagrams**.

CAUTION —

- Always wait at least 40 seconds after turning off the ignition before removing the connector from the engine control module (ECM). If the connector is removed before this time, residual power in the system relay may damage the ECM.
- Always connect or disconnect the control module connector and meter probes with the ignition off.

When making checks at the ECM itself, a breakout box should be used to allow tests to be made with the connector attached to the ECM. This also prevents damage to the small terminals in the connector. As an alternative, the harness connector housing can be separated so that electrical checks can be made by back-probing the connector.



➤ The engine control module (ECM) is mounted in the right rear of the engine compartment, inside the electronics box (E-box) (arrow). Terminal numbers are identified on the harness connector and/or on the ECM.

CAUTION —

Use only a digital multimeter when making electrical checks at ECM or other solid state DME components.

NOTE —

Electrical parts are not returnable. Before replacing the ECM, run all tests and check harness and connections for possible malfunctions.

- Disconnect negative (–) battery cable. See **020 Maintenance**.

CAUTION —

Prior to disconnecting the battery, read the battery disconnection cautions given at the front of this manual on page viii.

- Remove cover from electronics box (E-box). The cover is retained with four captive screws. Peel back weather stripping from body for improved access.
- Unplug ECM harness connector by releasing fastener and pivoting connector up and off ECM.

DME 3.3 (M60 ENGINE)

- Remove ECM retaining nuts or clips and lift out ECM.
- Installation is reverse of removal.

CAUTION—

Poor driveability may be noticed immediately after replacing the ECM. Drive for at least 10 minutes under varying conditions to allow ECM to adapt.

DME 1.2 AND DME 1.7 (M70 ENGINE)

DME systems are equipped with On-Board Diagnostics (OBD). Be sure to check for diagnostic fault codes (DTCs) as the first step in diagnosing DME faults. See **100 Engine-General** for fault codes.

NOTE—

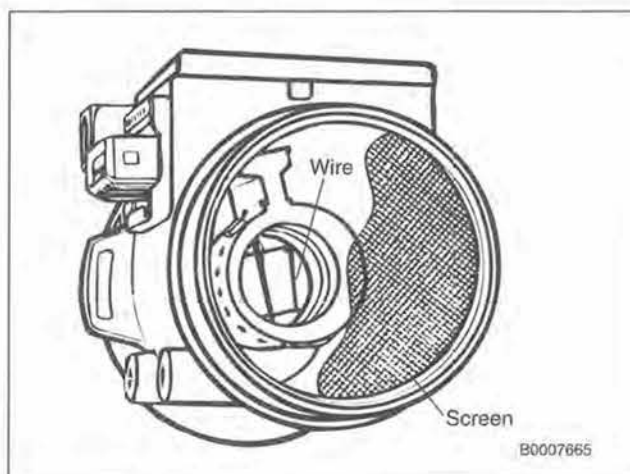
- M70 V12 engines are managed by two separate 6 cylinder DME systems. Cylinders 1-6 (right bank) use DME control module 1, IAT sensor 1, etc. Cylinders 7-12 (left bank) use DME control module 2, IAT sensor 2, etc.
- Each DME control module will store its own fault codes.

Mass air flow sensor, testing and replacing (M70 engine)

NOTE—

The left mass air flow sensor supplies air to the right bank of cylinders (cyl. 1-6) and the right mass air flow sensor supplies air to the left bank (cyl 7-12).

The mass air flow sensor is not adjustable. Diagnosis of the sensor should be done using specialized diagnosis equipment. The mass air flow sensor operation is monitored by the DME On-Board Diagnostics.



- ◀ When the engine is running, a current is used to heat a thin wire. The current in the wire is regulated to maintain a temperature of 155°C more than air passing over it. The current is electronically converted into a voltage measurement corresponding to the mass of intake air.

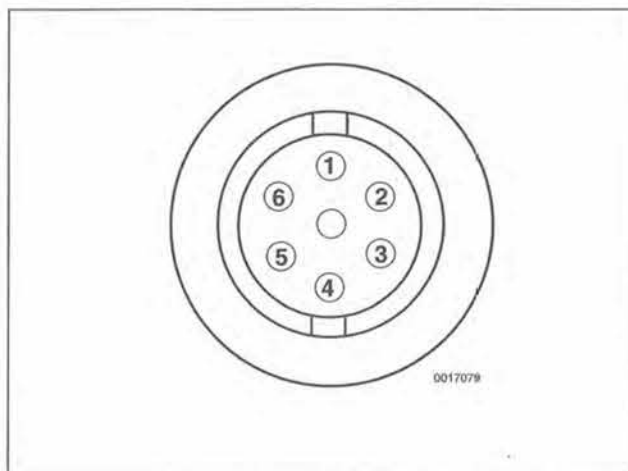
The mass air flow sensor is self-cleaning via the DME control module. Upon engine shut down, the wire is quickly heated to about 1000°C (1830°F) for one second. This "burn-off" cycle takes place automatically.

If the hot wire breaks or if there is no output from the air flow sensor, the ECM automatically switches to a "limp-home" mode and turns on the Check Engine light. The engine can usually be started and driven. The air flow sensor has no internal moving parts and cannot be serviced.

130-34 FUEL INJECTION



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- Disconnect air flow sensor from air filter duct only (A).
 - Leave sensor connected to intake manifold duct (B).
 - Leave wiring harness connected (C).
- Start engine and run to normal operating temperature.
- Rev engine to at least 2,500 rpm, then shut it off. Look through front of meter. After approximately 2 to 4 seconds hot wire should glow brightly for one second.

NOTE —

If the wire glows as specified, then the air flow sensor and ECM are probably operating correctly.

- If glow was not observed, remove air flow sensor and check carefully for a broken wire. If wire is not intact, sensor should be replaced.

- Detach harness connector and test electrical terminals with ignition key in ON position.

Mass Air Flow Sensor Electrical Checks (M70 Engine)

- Left sensor (cyl. 1-6)
 - Terminal 2 (red/blue) and ground battery voltage
 - Terminal 3 (grey/white/yellow) and ground 5 VDC
 - Terminal 4 (brown) and ground continuity
- Right sensor (cyl. 7-12)
 - Terminal 2 (red-blue) and ground battery voltage
 - Terminal 3 (grey/white) and ground 5 VDC
 - Terminal 4 (brown) and ground continuity

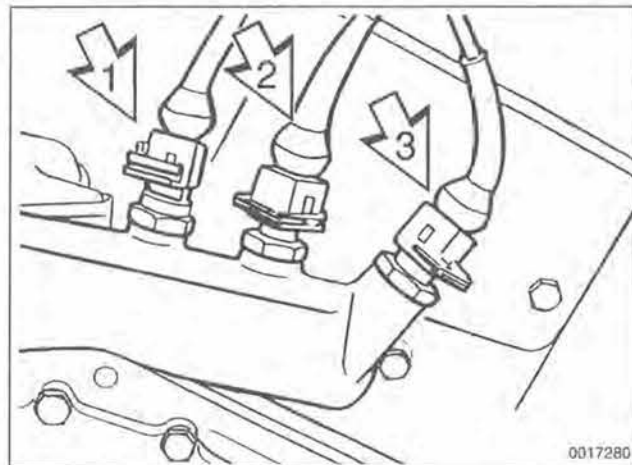
- If any faults are found, check wiring to sensor harness connector from ECM and main DME relay. See **Electrical Wiring Diagrams**.

- To replace mass air flow sensor, loosen air duct clamps (A and B) and detach electrical harness connector (C), then lift out sensor, removing mounting fasteners as necessary.

DME 1.2 AND DME 1.7 (M70 ENGINE)

Engine coolant temperature (ECT) sensor, testing and replacing (M70 engine)

The engine coolant temperature (ECT) sensor sends coolant temperature information to the engine control module (ECM). The ECT sensor is of the NTC (negative temperature coefficient) type; as temperature increases sensor resistance decreases. The ECT sensor housing contains two sensors, one for each DME system.



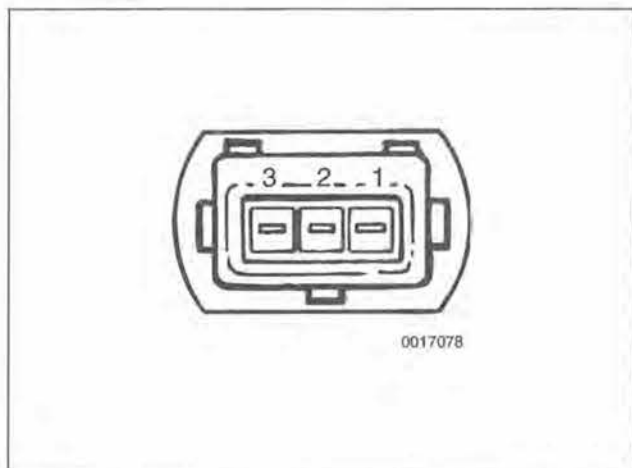
- Detach harness connector from ECT sensor (1) at right rear of engine on coolant cross pipe.

NOTE—

The coolant reservoir tank may need to be removed to access the ECT sensor.

ECT Sensor Location

- M70 engine right rear of engine in coolant cross pipe (3-pin)



- Turn ignition on and check for 5 volts (VDC) between supply voltage wire in connector and ground. If voltage is not present, test ECM inputs/outputs as described later.

ECT Sensor Voltage Supply (M70 Engine)

- DME 1 brown/red wire and ground
- DME 2 brown/red/yellow wire and ground

ECT Sensor Terminal Identification (M70 Engine)

- ECT sensor 1 pin 1
- ECT sensor 2 pin 3
- Ground pin 2

- With harness connector detached, check resistance across sensor terminals.
 - Compare readings to specifications listed.
 - If any faults are found, replace sensor.

Engine Coolant Temperature Sensor (M70 Engine)

Test temperature	Resistance (k Ohms)
14 ± 2°F (-10 ± 1° C)	7-11.6
68 ± 2°F (20 ± 1° C)	2.1-2.9
176 ± 2°F (80 ± 1° C)	0.27-0.40

DME 1.2 AND DME 1.7 (M70 ENGINE)

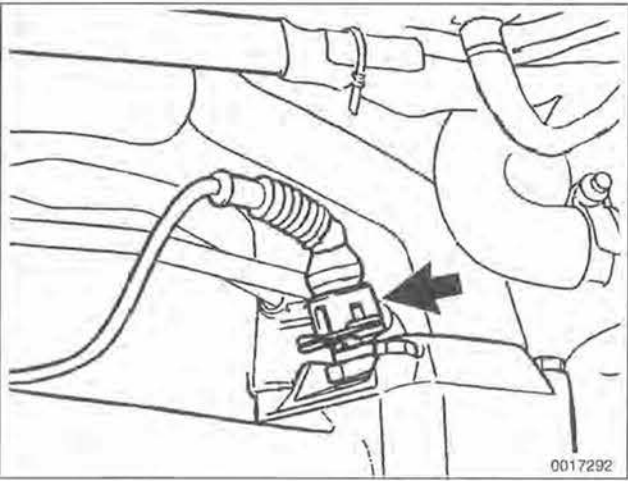
NOTE—
The test values listed represent only three test points from a continuous resistance NTC sensor. For a more accurate test, the sensor can be removed and tested in a bath of hot water using a thermometer.

Use a new copper sealing washer when replacing sensor.
Replace any lost coolant.

- Tightening Torques (M70 Engine)**
- ECT sensor to crosspipe 18 Nm (13 ft-lb)

Intake air temperature (IAT) sensor, testing and replacing (M70 engine)

The intake air temperature (IAT) sensor sends intake air temperature information to the ECM. The IAT sensor is of the NTC (negative temperature coefficient) type; as temperature increases sensor resistance decreases.



- Detach harness connector from IAT sensor (arrow).

- IAT Sensor Location**
- M70 engine rear of left/right intake manifold.

- Turn ignition on and check for 5 volts between supply voltage wire in connector and ground. If voltage is not present, test ECM inputs/outputs as described later.
- With harness connector detached, check resistance across sensor terminals. Compare resistance readings to specifications listed. If any faults are found, replace sensor.

Intake Air Temperature Sensor (M70 Engine)	
Test temperature	Resistance (k Ohms)
14 ± 2°F (–10 ± 1° C)	7–11.6
68 ± 2°F (20 ± 1° C)	2.1–2.9
176 ± 2°F (80 ± 1° C)	0.27–0.40

NOTE—
The test values listed represent only three test points from a continuous resistance NTC sensor. For a more accurate test, the sensor can be removed and tested in a bath of hot water using a thermometer.

- When replacing IAT sensor, install using a new seal.

- Tightening Torque (M70 Engine)**
- IAT sensor to intake manifold 13 Nm (9.5 ft-lb)

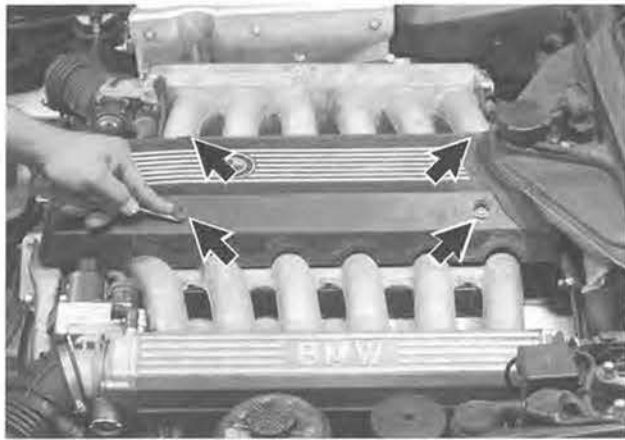
FUEL INJECTION 130-37

Fuel injectors, testing (M70 engine)

The fuel injectors are switched on and off (opened and closed) by the ECM. The injectors are connected to a common fuel supply called the fuel rail.

NOTE—

The test below is an electrical check only. The test does not check spray patterns or fuel supply to the injectors.



0017215

- Remove plastic engine cover from top of engine.
 - Remove plastic trim covers.
 - Remove four retaining screws (arrows).



0017075

- Pry off connector boot (arrow) to access fuel injector electrical connector terminals (connector attached to injector). Connect digital voltmeter to wiring in injector housing as shown.
- Operate starter or run engine and check for pulsed voltage (approx. 0.3–1.0 VDC).

CAUTION—

Use a digital multimeter only. Analog meters or test lights may damage the ECM.

NOTE—

To quick-check a single injector, place a screwdriver or stethoscope on the injector with the engine running. If the injector is operating, there should be an audible buzz.

- If there is no voltage, check for power (+) at red/white wire of each injector connector with ignition key on. If voltage is not present, check wiring from main DME relay or fuel pump relay and wiring to injectors using wiring diagrams See **Electrical Wiring Diagrams**.

DME 1.2 AND DME 1.7 (M70 ENGINE)

130-38 FUEL INJECTION



0017075

NOTE—

- On most M70 motors with DME 1.2 (late production 1988-1991), the fuel injectors get positive (+) battery power from the fuel pump relay. On all other models, the fuel injectors get positive (+) battery power from the DME main relay. See **Electrical Wiring Diagrams**.

- If there is positive (+) battery voltage at injector harness connector, but no response at voltmeter during cranking, the pulsed ground signal from the ECM may be missing. Check outputs from ECM.

- If power is present as described in above step, unplug injector connectors and check injector electrical resistance. Replace injector if resistance is incorrect.

Fuel Injector Coil Resistance

- M70 engine 16 ohms at 68°F (20°C)

NOTE—

Injector resistance will vary depending on temperature. In general, the range should be between 10 and 20 ohms.

- If no faults are found up to this point, check ECM pulse-time regulation function of ECM with engine cold. Peel back rubber boot from injector connector (**arrow**) and connect voltmeter to wires in connector. Start engine. Check that voltage decreases as engine warms up.
- If any faults are found, check ECM inputs and outputs as described later.

Fuel rail and injectors, removing and installing (M70 engine)

The fuel injectors are removed by first removing the complete injector/fuel rail assembly and then unclipping the injectors from the fuel rail.

Cleanliness is essential when working with fuel circuit components. Thoroughly clean the unions before disconnecting any fuel lines. Use clean tools.

- Disconnect negative (–) battery cable. See **020 Maintenance**.

CAUTION—

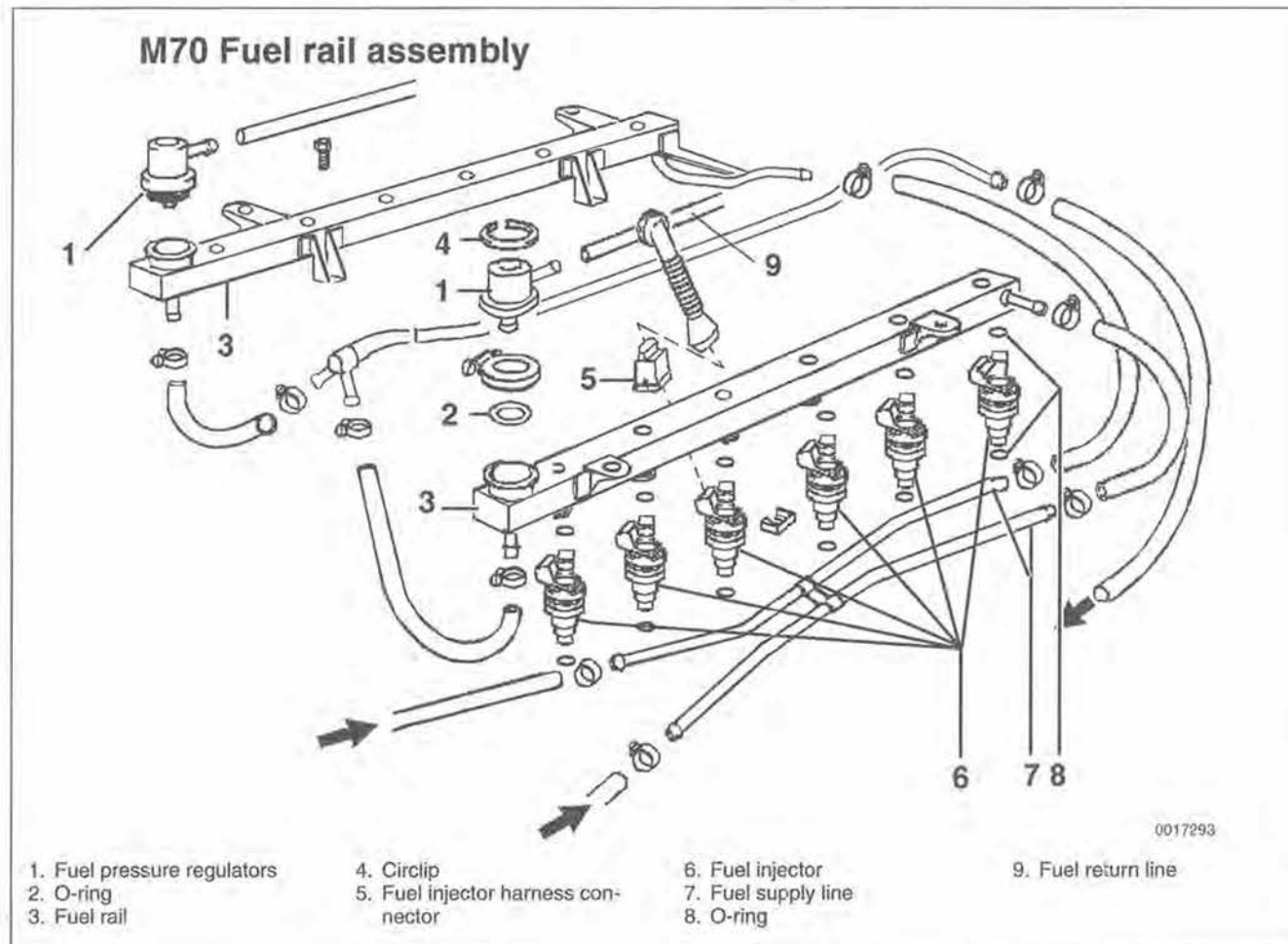
Prior to disconnecting the battery, read the battery disconnection cautions given at the front of this manual on page viii.

- Remove coolant reservoir tank and top engine cover.

DME 1.2 AND DME 1.7 (M70 ENGINE)

FUEL INJECTION 130-39

- Unplug fuel injectors and throttle position actuators.
 - Label and disconnect other wiring as necessary.
 - Remove wiring duct from above fuel injectors.



- Disconnect fuel lines from left and right fuel rails.

WARNING—

Fuel will be discharged. Do not disconnect any wires that could cause electrical sparks. Do not smoke or work near heaters or other fire hazards. Keep an approved fire extinguisher handy.

- Remove fuel rail mounting bolts and pry up fuel rail.
- Remove individual injectors by removing injector retaining clip and pulling injector from rail.
- Installation is reverse of removal.
 - Fit new O-rings when installing injectors.
 - For ease of installation, lightly lubricate O-rings with SAE 90w gear lube.
 - Check that injector electrical connections are correctly fitted and that injectors are fully seated prior to installing fuel rail mounting bolts.

DME 1.2 AND DME 1.7 (M70 ENGINE)

Tightening Torque

- Fuel rail to cylinder head. 10 Nm (89 in-lb)

Engine control module (ECM), testing and replacing (M70 engine)

NOTE—

The M70 engine has two identical engine control modules (ECMs). Before beginning work, identify the module to be replaced. When experiencing ECM problems, try switching the ECMs as an aid to diagnosis.

ECM pin assignments are given in **Table e**, **Table f**, and **Table g**. The pinout information can be helpful when diagnosing faults to or from the ECM. If all inputs and wiring are OK but operational problems still exist, the ECM(s) may be faulty.

Test results with incorrect values do not necessarily mean that a component is faulty. Check for loose, broken or corroded connections and wiring before replacing components. If the results are still incorrect, test the component itself. For electrical schematics of the DME system, see **Electrical Wiring Diagrams**.

CAUTION—

- Always wait at least 40 seconds after turning off the ignition before removing the connector from the engine control module (ECM). If the connector is removed before this time, residual power in the system relay may damage the ECM.
- Always connect or disconnect the control module connector and meter probes with the ignition off.

When testing the ECM itself, a breakout box should be used to allow tests to be made with the connector attached to the ECM. This prevents damage to the small terminals in the connector. As an alternative, the harness connector housing can be separated so that electrical tests can be made by back-probing the connector.

➤ The ECMs are mounted in the right rear of the engine compartment, inside the electronics box (E-box). Terminal numbers are identified on the harness connector and/or on the ECM.

CAUTION—

- Use only a high-quality digital multimeter (DVOM) when making electrical checks at ECM or other solid state DME components.
- Prior to disconnecting the battery, read the battery disconnection cautions given at the front of this manual on page viii.

— Disconnect negative (–) battery cable. See **020 Maintenance**.



DME 1.2 AND DME 1.7 (M70 ENGINE)

0017257

- Remove cover from electronics box (E-box). Cover is retained with four captive screws. Peel back E-box weather stripping for improved access.
- To remove ECM, unplug control module harness connector by releasing fastener and pivoting connector up and off ECM.
 - On 1988-1990 models: Remove ECM retaining nuts and lift ECM from its holder.
 - On 1991 and later models: Pry out ECM retaining clips and lift ECM out.
- Installation is reverse of removal.

ELECTRONIC THROTTLE CONTROL SYSTEMS

Most E32 models are equipped with one of two versions of electronic throttle control.

- **EML**— Electronic motor load regulation (M30, M70 engines)
- **ADS**— Automatic throttle valve system (M60 engines)

This section provides basic descriptions of the two systems and some component replacement procedures. System fault diagnosis should be carried out using special BMW dealer test equipment.

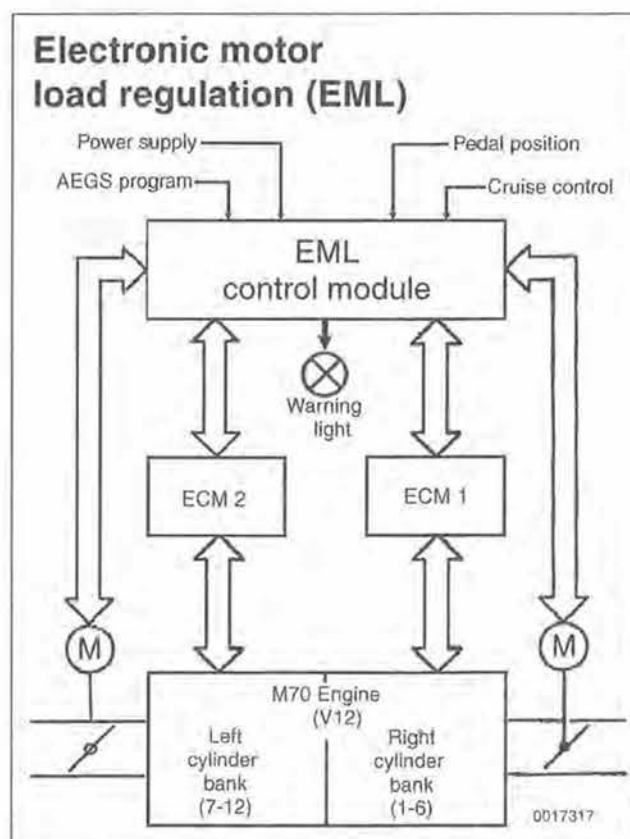
EML (M30 or M70 engine)

M30 engines with ASC and all M70 engines are equipped with EML (electronic motor load regulation). The EML control module, AEGS (transmission) control module and DME control module(s) are part of an engine management system allowing communication between control modules. The EML system eliminates the need for idle stabilizer valves, cruise control servos and throttle cables.

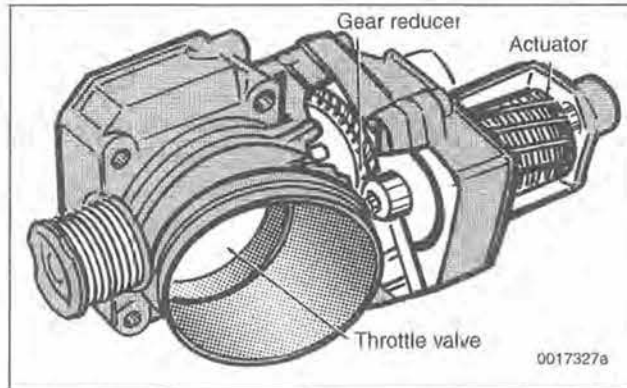
EML is a "drive-by-wire" system. There are no throttle cables. The EML electronic control module controls idle speed, throttle position and throttle synchronization. Adjustments are not possible.

WARNING—

BMW strictly warns that the external safety path must be checked any time repairs or component replacement are carried out on the EML system. The procedure is described below.



130-42 FUEL INJECTION



◀ An EML actuator-driven throttle housing assembly is mounted to each manifold (750iL models are equipped with two EML throttle housings). The throttle housing assembly is comprised of two parts, a conventional throttle body and a throttle position actuator or motor.

CAUTION—

Do not disassemble EML throttle housings. Individual throttle housing parts are not available. Throttle housings must be replaced as a complete assembly. Tamper-proof screws are used to assemble throttle housings.

NOTE—

On 750iL models, each intake manifold supplies the opposite bank of cylinders. Cylinders 1-6 (passenger side) use the left intake manifold, left air filter, left mass air flow sensor and left EML throttle housing. Cylinders 7-12 (driver side) use the right intake manifold, etc.

EML warning light

Illumination of the EML warning light signals that the system has detected a fault and one or more fault codes have been stored in the EML control module. Fault code information can be read using BMW diagnostic equipment or an appropriate aftermarket scan tool.

The EML warning light also signals that the EML control module has switched to fail-safe operation. In this condition functions including throttle opening will be limited.

NOTE—

The EML system is highly sensitive to voltage fluctuations. Low battery voltage will set a fault code and turn on the EML warning light.

- If the warning light is on, check to see if the battery or electrical charging system are causing the problem.

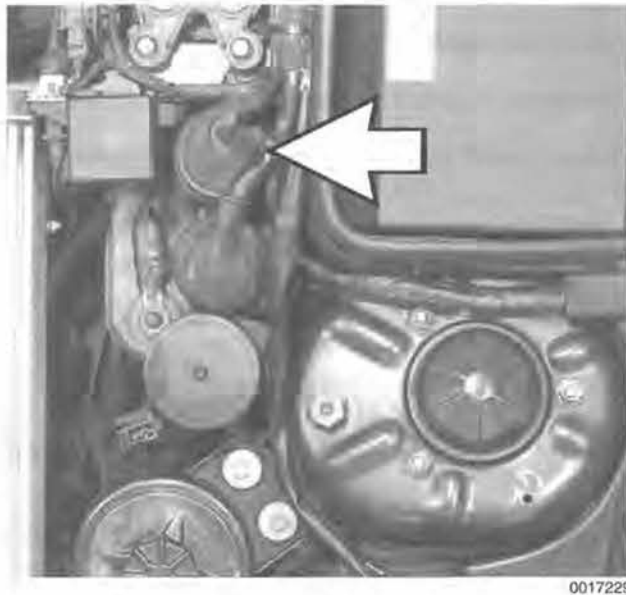
- Check battery connections and battery condition (voltage and specific gravity).
- Check charging system.

NOTE—

If battery is not properly charging due to driving patterns, consult an authorized BMW parts department for an modified alternator pulley. This will help to keep the battery charge at low engine speeds.)

- Check 50A fusible link near battery (encased in heat shrink tubing).
- Check positive (+) junction under pedal assembly.
- Check grounds (–) and multi-pin connectors for damage or corrosion.
- Check engine oil for proper viscosity for climate. Make sure starter current is not excessive.

External safety path, checking (M30 or M70 engine)



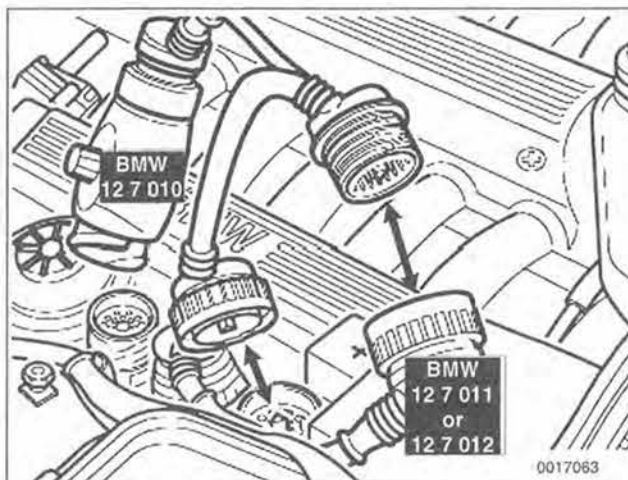
0017229

The external safety path is a safety function built into the EML control module. In the event of an EML malfunction, applying the brake pedal will return the engine speed to idle. BMW recommends that this test be carried out any time an EML component is replaced.

NOTE —

- A special EML safety path test adapter kit is required to make this test:
 - BMW special tool 12 7 010: harness with control dial used to manually control engine speed.
 - BMW special tool 12 7 011: adapter for the 20-pin EML harness connector.
 - BMW special tool 12 7 012: adapter for the 25-pin EML harness connector.
- The BMW special tool numbers are not the part numbers. The above tools can be ordered by adding 88 88 6... to the tool number.

➤ Switch ignition off and disconnect EML harness connector (arrow).



0017063

➤ Install EML safety path test adapter tools.

- On cars with 20 pin plug use BMW special tools no. 12 7 010 and 12 7 011.
- On cars with 25 pin plug use BMW special tools no. 12 7 010 and 12 7 012.

- Turn knob on test harness fully to (–) position.
- Start engine and turn knob to (+) until engine runs at 2,500 rpm.
- Step on brake pedal. Engine speed should immediately drop.
- Remove adapter. Erase fault codes.

EML throttle synchronization, (M70 engine)

- Disconnect battery for at least 1 hour. See 020 Maintenance.

CAUTION —

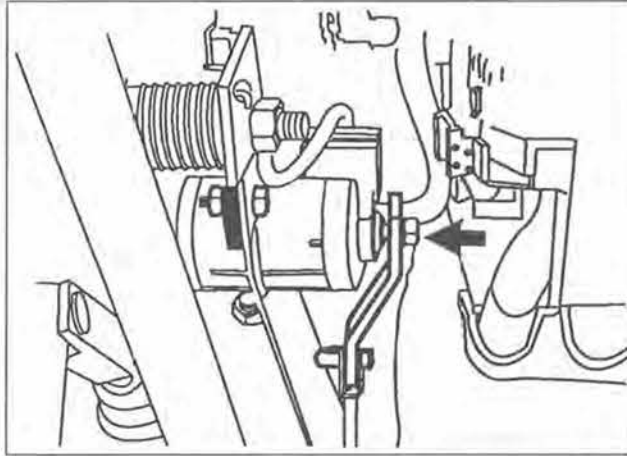
Prior to disconnecting the battery, read the battery disconnection cautions given at the front of this manual on page viii.

- Reconnect battery and start engine. Let engine reach operating temperature without touching accelerator pedal.

CAUTION —

Obey traffic laws. Perform remaining steps in an isolated area.

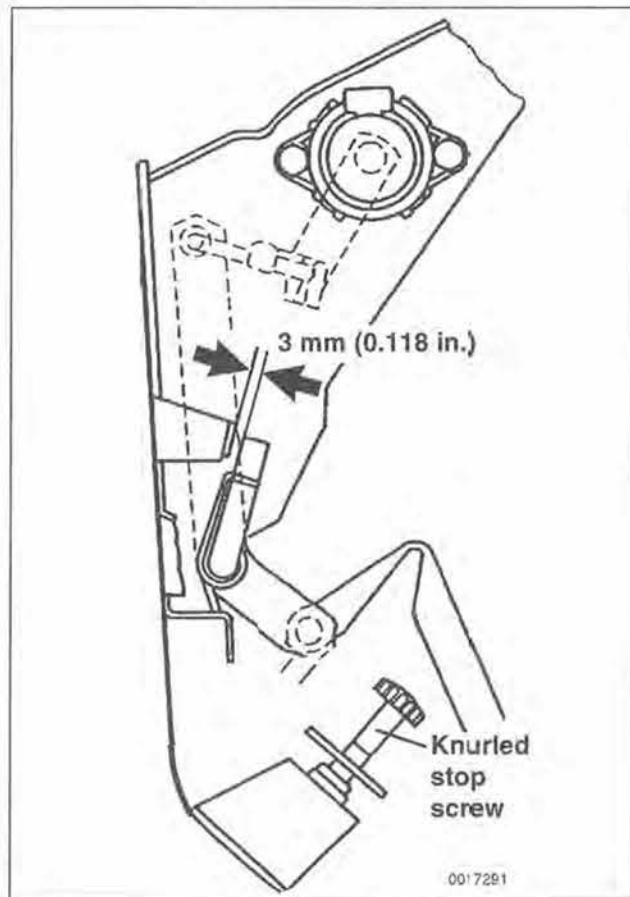
130-44 FUEL INJECTION



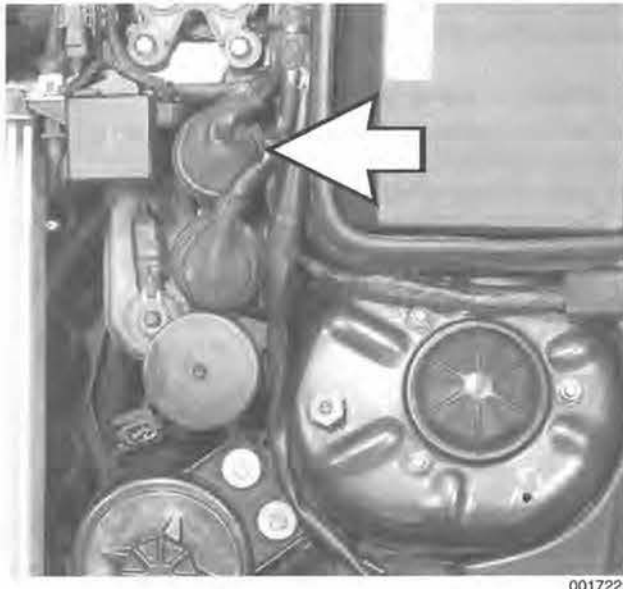
- With transmission in first gear accelerate until engine speed is over 5,000 rpm. Release accelerator pedal and coast until engine is at idle.
- Repeat above operation two consecutive times.
- Allow engine to idle in neutral or park for at least 5 minutes.
- Turn engine off. EML throttles should now be synchronized.

Pedal position sensor, checking and adjusting (M30 or M70 engine)

- Loosen pedal position sensor arm retaining nut (arrow).
- Set gap of 3 mm (0.118 in.) between accelerator pedal bracket and idle stop.
- Support arm and tighten nut. Idle position is now set.
- Adjust pedal travel stop: Press accelerator pedal down by hand just until kickdown pressure point is felt.
 - Manual transmission: Adjust knurled stop screw so that pedal travel is stopped (limit stop) at this point. Tighten locknut.
 - Automatic transmission: Adjust knurled stop screw so that there is a 6 mm gap between pedal and top of stop screw. Tighten locknut.



FUEL INJECTION 130-45



0017229

- To check adjustment, peel back rubber boot from EML harness connector (**arrow**) and connect digital voltmeter between specified pin in connector and ground.

EML Connector Pedal Position Test Pin

- M30 (DME 1.3)(blue/brown) pin 20
- M70 (DME 1.2)(brown/violet) pin 1
- M70 (DME 1.7)(blue/brown) pin 20

NOTE—

Terminal numbers are molded in the EML connector face. These numbers are very small and may be difficult to read

- Turn ignition on.
- Check signal from pedal position sensor while moving accelerator pedal.

EML Pedal Position Sensor Test

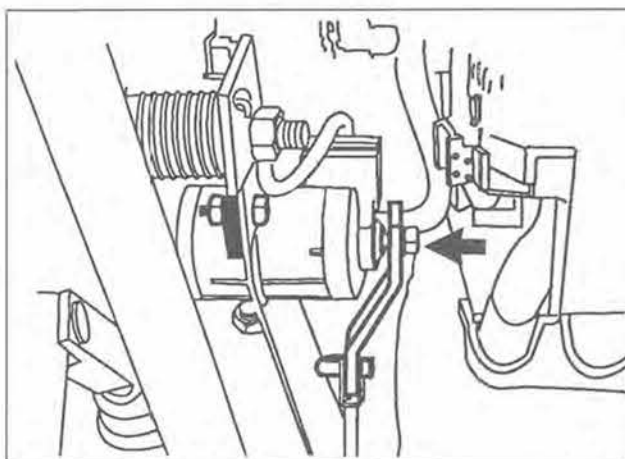
- Pedal at idle position
 - Manual transmission 0.34-0.43 VDC
 - Automatic transmission 0.35-0.45 VDC
- Pedal at full throttle
 - Manual transmission 3.1-3.3 VDC
 - Automatic transmission 3.7-3.8 VDC

Pedal position sensor, replacing (M30 or M70 engine)

The pedal position sensor is mounted above the accelerator pedal and provides pedal position to the EML control module. An accelerator cable is not used.

CAUTION—

The throttle position sensor must be adjusted after installation.

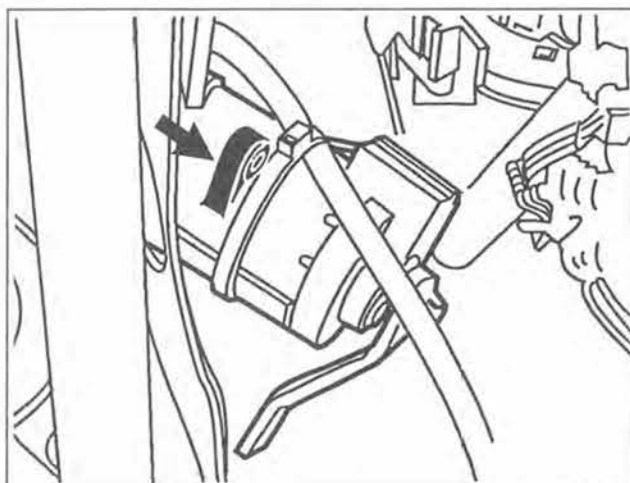


0017294

- Switch off ignition.
- Remove driver's side knee bolster as described in **513 Interior Trim**.
- Disconnect pedal position sensor lever from accelerator pedal.
- Remove sensor lever clamping nut (**arrow**) and carefully pry lever from pedal position sensor.
- Unplug harness connector from sensor.
- Remove sensor mounting screws, noting location of spacers.

ELECTRONIC THROTTLE CONTROL SYSTEMS

130-46 FUEL INJECTION



0017295

➤ Rotate sensor while removing from pedal console. Note eyelet (**arrow**) fits in oval opening of pedal console.

- Installation is reverse of removal.
 - Once installation is complete, adjust pedal position sensor as described earlier.
 - Check external safety path as described earlier.
 - Synchronize throttles if necessary.

EML throttle housing, testing and replacing (M30 or M70 engine)

An actuator-driven throttle plate is used for each bank of cylinders. The actuator is controlled via the EML control module. Individual parts for throttle housing assemblies are not available..

CAUTION—

- *DO NOT* disassemble the throttle housing assembly. Individual parts are not available from BMW and BMW warns that the EML throttle actuator housing must never be disassembled from the throttle body.
- The throttle plates in the actuator-driven EML throttle housings may move without warning. Never put fingers or tools in throttle housing.

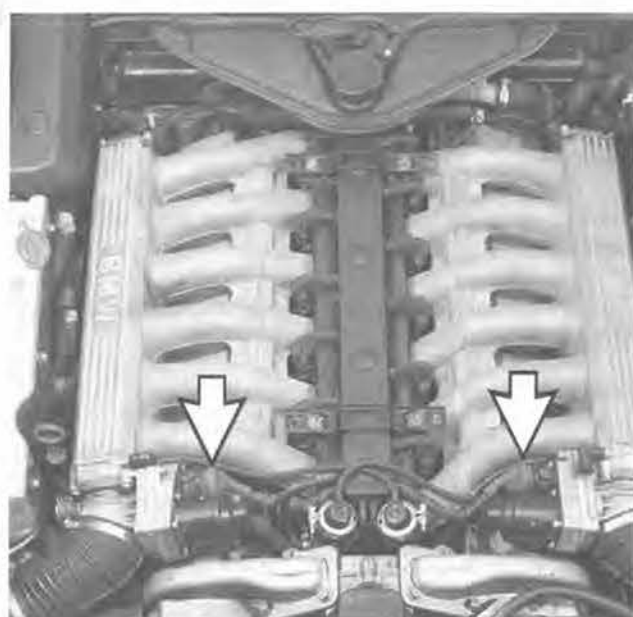
- Remove mass air flow sensor and intake boot on EML throttle housing so that throttle plate is visible.
- Turn on ignition. EML throttle position actuator should hum and throttle plate should flutter.
- Turn ignition off.

➤ Peel back boot at EML throttle actuator harness connector (**arrow**).

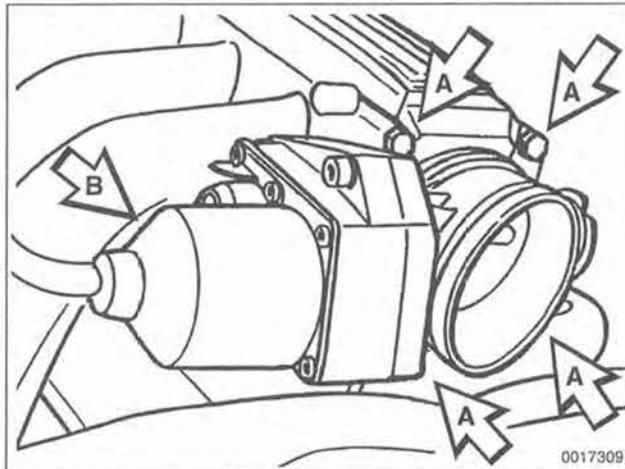
- Connect digital frequency meter between pins 3 and 5 at back of connector.
- Turn ignition on. Meter should read frequency.
- Using a digital multimeter, test for ground and reference voltage at throttle actuator harness connector:

Throttle Position Actuator Check

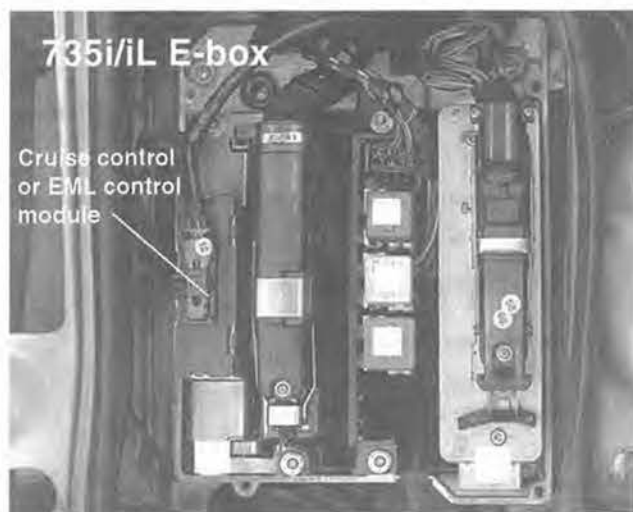
- Pin 8 and ground 0 ohms (approx.)
- Pin 7 and 8 5.0 VDC (approx.)
- Pin 2 and 8 (M30 engine only) 5.0 VDC (approx.)



0017240



- If test fails check wiring and connectors. See **Electrical Wiring Diagrams**.
- Turn ignition off. Disconnect air intake boot from EML throttle housing.
- Disconnect harness connector from EML actuator (B) and remove 4 bolts (A) and remove EML throttle housing assembly.
- Installation is reverse of removal.
 - Always replace gaskets.
 - Synchronize EML throttles and check external safety path as described earlier.



EML control module, replacing (M30 or M70 engine)

EML control module pin assignments are listed in **Table a** or **Table b**. This information can be helpful when diagnosing faults to or from the EML system. If all inputs and wiring are OK but operational problems still exist, the EML control module may be faulty.

CAUTION—

The EML control module and ECMs must be matched. Under no circumstances may early and late versions of EML and DME be mixed. See an authorized BMW parts department for the latest information.

- When replacing EML control module (3), switch ignition off.

NOTE—

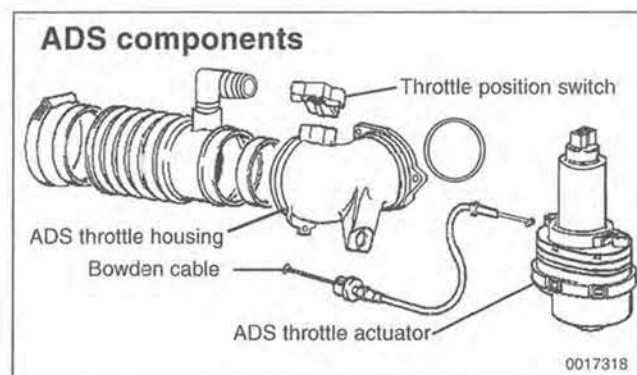
In some models the cruise control module is in the 3 position.

WARNING—

Wait at least 1 minute before disconnecting harness connector. Residual voltage may damage the control module.



- Remove cover from E-box in right rear of engine compartment.
- Release clip and pivot connector up and off EML control module. Remove retaining nuts or clips and remove EML control module.
- Installation is reverse of removal.
 - Check external safety path as described earlier.



Auxiliary Throttle Valve (ADS) (M60 engine only)

740i/iL models with ASC+T (traction control) are fitted with a motor-driven auxiliary throttle valve and housing ahead of the standard throttle housing. The ADS throttle valve controls engine throttle intervention based on signals from the DME control module if road conditions (slipping driven wheel) warrant reduced engine power.

ADS throttle housing, replacing

NOTE—

Before replacing the ADS throttle housing read fault codes.

- Switch off ignition and disconnect electrical connector on ADS throttle body.
- Remove hose from idle control valve.
- Loosen hose clamps and remove throttle housing air intake boot.
- Disconnect bowden cable and remove from ADS throttle body.
- Unscrew 3 bolts and remove ADS throttle body.
- Installation is reverse of removal.
 - Replace gasket.
 - Adjust cable to zero backlash.

ADS throttle switch, replacing

NOTE—

Before replacing ADS throttle housing read fault codes.

- Switch off ignition and remove harness connector from ADS throttle switch (A).
- Remove mounting screws and remove switch.
- Installation is reverse of removal.
 - Clear fault codes and test drive.
 - Recheck fault codes.



EML PIN ASSIGNMENTS

EML control module pin assignments are listed in **Table a** or **Table b**. The control module is located in the E-box. See **EML control module, replacing (M30 or M70 engine)** earlier in this section.

Table a. EML Pin Assignments—DME 1.3 (M30 engine)

Pin	Signal	Component	Signal/function
1	output	Throttle position sensor	Square wave
2	vacant	—	—
3	input	Instrument cluster	Vehicle speed sensor
4	output	DME control module	Idle signal
5	input	Engine coolant temp sensor	0-5 VDC
6	input/out-put	Diagnostic connector (Txd)	Diagnosis
7	input	Pedal position sensor	0.4 VDC-4.5 VDC (Approx.)
8	input	A/C relay/DME	12 VDC
9	output	Diagnostic connector (Rxd)	Diagnosis
10	input	Throttle housing assembly	Square wave
11	output	Electronic ground	Component ground
12	output	Instrument cluster	EML warning lamp
13	output	ASC/EGS	Square wave
14	ground	Ground	Ground point
15	input	Pedal position sensor	0.4-4.0 VDC
16	input	Throttle body	Throttle position sensor
17	output	Throttle body	5.0 VDC (approx.)
18	input	DME control module	P/N identifier
19	Input/out-put	FGR switch	0-5.0 VDC
20	input	Brake light switch	12 VDC (on)
21	input	Throttle housing assembly, 9 switch	5 VDC (on)
22	input	Throttle housing assembly, 17 switch	5 VDC (on)
23	ground	Component ground	Ground
24	input	DME control module	Square wave
25	input	Main relay	12 VDC (approx.)
26	input	Clutch pedal switch	0 VDC (approx.)
27	output	EGS control module	Kick down signal
28	output	DME control module	Full load signal, approx. 0 VDC
29	input	DME control module	Square wave

130-50 FUEL INJECTION

Table a. EML Pin Assignments—DME 1.3 (M30 engine)

Pin	Signal	Component	Signal/function
30	vacant	—	—
31	input	EGS control module	approx 0 VDC
32	output	PWG potentiometer	approx. 5 VDC (not short circuit proof)
33	input	A/C compressor clutch	approx. 12 VDC (on)
34	input	ABS/ASC control module	Square wave
35	input	ABS/ASC control module	Square wave
36-55	vacant	—	—

Table b. EML Pin Assignments—DME 1.2 and DME 1.7 (M70 engine)

Pin	Signal	Component	Signal/function
1	output	Throttle position sensor	Ignition coil primary control
2	ground	Ground	Ground
3	vacant	—	—
4	input	Slip control module	Square wave
5	output	Full load signal	DME control unit 1
6	output	Idle signal	DME control unit 1
7	input	Throttle position sensor	0.4 VDC-4.5 VDC (Approx.)
8	input	Instrument cluster	Road speed signal
9	output	Throttle position sensor	5 VDC
10	input	Cylinder 7-12 throttle body	Electronic ground
11	output	Cylinder 7-12 throttle body	5 VDC
12	output	Cylinder 1-6 throttle body	5 VDC
13	output	Diagnostic connector (RxD)	Diagnostic RxD (receive) signal
14	ground	Ground	Ground point
15	output input	EML warning lamp, ignition on ignition off	EML lamp control Voltage supply for defect code memory
16	output	Cylinder 7-12 throttle body	Drive throttle (DK) actuator
17	output	Cylinder 1-6 throttle body	Drive throttle (DK) actuator
18	input	Engine control module relay cylinder 1-6	Power supply (terminal 15)
19	ground	Ground	Ground point
20	input	Transmission control module	Kick down signal
21	vacant	—	—
22	input	Slip control module	DK angle increase (DKE)
23	output	ASC/EGS	Throttle position signal (DKV)

EML PIN ASSIGNMENTS

Table b. EML Pin Assignments—DME 1.2 and DME 1.7 (M70 engine)

Pin	Signal	Component	Signal/function
24	vacant	—	—
25	vacant	—	—
26	input	Throttle body, cylinder 1-5	Electronic ground
27	input	Throttle body, cylinder 1-5	throttle position
28	input	Throttle body, cylinder 7-12	Throttle position
29	vacant	—	—
30	ground	Ground	Ground point
31	input	Cruise control switch	Electronic ground
32	output	DME control module, cylinder 7-12	Idle signal
33	output	DME control module, cylinder 7-12	Full load signal
34	output	Throttle body, cylinder 7-12	Drive throttle (DK) actuator
35	output	Throttle body, cylinder 1-6	Drive throttle (DK) actuator
36	input	Engine control module relay, cylinder 7-12	12 VDC (terminal 15)
37	input	Engine control module relay, cylinder 1-6	12 VDC (terminal 15)
38	input	Throttle body, cylinder 1-6	Throttle (17° switch)
39	vacant	—	—
40	input	Throttle body, cylinder 7-12	Throttle (17° switch)
41	input	A/C relay	A/C switch
42	input	Automatic transmission (A/T) range switch	A/T park or neutral position signal
43	input/output	Cruise control switch	Cruise control switch
44	input	EML control module	A/C compressor on
45	input	Engine temperature sensor	Engine coolant temperature (0-5 V, temperature dependent)
46	input	Cruise control switch	Cruise control
47	input	DME control module, cylinder 1-6	Engine speed signal
48	vacant	—	—
49	input	DME control module, cylinder 1-6	Injection signal
50	input	DME control module, cylinder 7-12	Injection signal
51	vacant	—	—
52	input	Transmission control module	S-program identifier
53	input	Brake light switch	Brake light switch)
54	vacant	—	—
55	input/output	Diagnostic connector (TxD)	Diagnostic TxD (transmit) and RxD (receive) signal

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ECM PIN ASSIGNMENTS

ECM control module pin assignments are listed in **Table c** through **Table g**. This information can be helpful when diagnosing faults to or from the ECM. If all inputs and wiring are OK but operational problems still exist, the ECM control module may be faulty.

Table c. ECM Pin Assignments—DME 1.3 (M30 Engine without EML)

Pin	Signal	Component	Signal/function
1	output	Ignition coil	Ignition coil primary control
2	ground	Ground	Chassis ground
3	output	Fuel pump relay (terminal 85)	Fuel pump relay control (crankshaft position signal must be present for relay to switch)
4	output	Idle speed control valve	Pulsed ground (duty cycle) close signal (see also terminal 22)
5	output	Evaporative purge valve	Pulsed ground (mapped) with engine running at normal temperature and varying engine load
6	output	Instrument cluster	RPM signal to instrument cluster
7	input	Volume air flow sensor	Voltage signal from volume air flow sensor (0-5 VDC, varies with engine load)
8	input	Cylinder identification sensor	Voltage pulse (VAC) between pin 8 and pin 31 when cylinder no. 6 fires (for ignition control)
9	vacant	—	—
10	ground	Oxygen sensor	Ground for oxygen sensor signal
11	vacant	—	—
12	output	Volume air flow sensor	Voltage supply (5 VDC) to volume air flow sensor
13	input	Diagnostic connector (RxD)	Diagnostic RxD (receive) signal to pin 15 in data link connector
14	ground	ground distribution	Ground for fuel injectors output stage
15	output	Check Engine lamp	Check engine lamp control
16	output	Fuel injectors, cyl. 1,3,5	Pulsed ground (injection pulse width in ms)
17	output	Fuel injectors, cyl. 2, 4, 6	Pulsed ground (injection pulse width in ms)
18	input	Power supply (terminal 30)	Battery voltage (B+) at all times (terminal 30)
19	ground	Shielding ground	Ground for ECM and sensor shielding
20	vacant	—	—
21	vacant	—	—
22	output	Idle speed control valve	Pulsed ground (duty cycle) open signal (see also terminal 4)
23	vacant	—	—
24	ground	Ground	Ground for output stages other than injectors and ignition
25	vacant	—	—
26	ground	Volume air flow sensor	Ground for volume air flow sensor
27	input	Power supply (terminal 15)	Battery voltage (B+) with key in on or start position

ECM PIN ASSIGNMENTS

Table c. ECM Pin Assignments—DME 1.3 (M30 Engine without EML) (continued)

Pin	Signal	Component	Signal/function
28	input	Oxygen sensor	Oxygen sensor signal wire (0-1 VDC fluctuating with engine running)
29	input	Instrument cluster	Vehicle speed signal from instrument cluster
30	vacant	—	—
31	input	Cylinder identification sensor	Voltage pulse (VAC) between pin 8 and pin 31 when cyl. no. 6 fires (for ignition control)
32	output	Instrument cluster	Fuel consumption output (KVA signal) to instrument cluster
33	vacant	—	—
34	vacant	—	—
35	vacant	—	—
36	output	Main relay (terminal 85)	Main relay activation
37	input	Main relay (terminal 87a)	Voltage supply from main relay to DME control unit
38	input	On-board computer	Drive-away protection enable
39	input	Data link connector	Programming voltage
40	input	A/C compressor on)	A/C refrigerant pressure switch and compressor clutch
41	input	A/C on	Auxiliary fan on signal
42	input	Automatic transmission (A/T) range switch	A/T park or neutral position signal
43	vacant	—	—
44	input	Intake air temperature	Intake air temperature via volume air flow sensor (0-5 V, temperature dependant)
45	input	Engine temperature	Engine coolant temperature (0-5 V, temperature dependent)
46	vacant	—	—
47	input	Engine speed and crankshaft position sensor	Crankshaft position/rpm (voltage (VAC) between pins 47 and 48)
48	input	Engine speed and crankshaft position sensor	Crankshaft position/rpm (voltage (VAC) between pins 47 and 48)
49	vacant	—	—
50	vacant	—	—
51	input	Ignition timing intervention	from Automatic transmission control module
52	input	Throttle position switch	Ground with throttle in idle position via throttle position switch
53	input	Throttle position switch	Ground with throttle in full open position via throttle position switch)
54	input	Electronic transmission control unit	Torque converter clutch WK
55	input/out-put	Diagnostic connector (Tx/D)	Diagnostic Tx/D (transmit) and Rx/D (receive) signal to/from pin 20 in Data link connector

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Table d. ECM Pin Assignments—DME 3.3 (M60 Engine)

Pin	Signal	Component	Signal/function
1	output	Fuel pump relay (terminal 85)	Fuel pump relay switches with engine running or cranking (crankshaft position signal must be present for relay switchover)
2	output	Idle speed control valve	Pulsed ground—close signal (see also pin 29)
3	output	Fuel injector, cyl. 1	Pulsed ground (injection pulse width in ms) cyl. 1
4	output	Fuel injector, cyl. 4	Pulsed ground (injection pulse width in ms) cyl. 4
5	output	Fuel injector, cyl. 6	Pulsed ground (injection pulse width in ms) cyl. 6
6	ground	Ground	Ground point X6452
7	output	Fuel injector, cyl. 7	Pulsed ground (injection pulse width in ms) cyl. 7
8	output	Check Engine lamp	Instrument cluster, Check Engine lamp
9	vacant	—	—
10	vacant	—	—
11	output	Electronic throttle control module	Throttle angle signal to traction control module
12	input	Oxygen sensor #2, (cyl. 5-8)	Oxygen sensor #2 signal (0-1 VDC fluctuating with engine running)
13	input	Oxygen sensor #1, (cyl. 1-4)	Oxygen sensor #1 signal (0-1 VDC fluctuating with engine running)
14	ground	Mass air flow sensor	Ground for mass air flow sensor
15	input	Ignition circuit	Ground for ignition circuit monitoring
16	input	Crankshaft position/rpm sensor	Voltage pulse (VAC) between pin 16 and 43)
17	input	Camshaft position sensor	Voltage pulse (VAC) between pin 17 and 44)
18	vacant	—	—
19	vacant	—	—
20	vacant	—	—
21	vacant	—	—
22	output	Ignition coil, cyl. 7	Primary signal, ignition coil 7
23	output	Ignition coil, cyl. 6	Primary signal, ignition coil 6
24	output	Ignition coil, cyl. 4	Primary signal, ignition coil 4
25	output	Ignition coil, cyl. 1	Primary signal, ignition coil 1
26	input	Power supply (terminal 30)	Battery voltage (B+) at all times
27	output	Main relay (terminal 85)	Main relay activation
28	ground	Ground	Ground for ECM and sensor shielding
29	output	Idle speed control valve	Pulsed ground—open signal (see also pin 2)
30	vacant	—	—
31	output	Fuel injector, cyl. 5	Pulsed ground (injection pulse width in ms) cyl. 5
32	output	Fuel injector, cyl. 8	Pulsed ground (injection pulse width in ms) cyl. 8
33	output	Fuel injector, cyl. 3	Pulsed ground (injection pulse width in ms) cyl. 3
34	ground	Ground	Ground for remaining output stages

ECM PIN ASSIGNMENTS

Table d. ECM Pin Assignments—DME 3.3 (M60 Engine) (continued)

Pin	Signal	Component	Signal/function
35	output	Fuel injector, cyl. 2	Pulsed ground (injection pulse width in ms) cyl. 2
36	output	Evaporative purge valve control	Pulsed ground with engine at normal temperature and varying engine load
37	output	Oxygen sensor relay (terminal 85)	Oxygen sensor relay control
38	vacant	—	—
39	ground	Oxygen sensor #2 (cyl. 5-8)	Oxygen sensor #2 signal ground
40	ground	Oxygen sensor #1 (cyl. 1-4)	Oxygen sensor #1 signal ground
41	input	Mass air flow sensor	Mass air flow voltage signal (0-5 VDC, varies with engine load)
42	input	Instrument cluster	Road speed signal from instrument cluster
43	input	Crankshaft position/rpm sensor	Voltage pulse (VAC) between pin 16 and 43)
44	input	Camshaft position sensor	Voltage pulse (VAC) between pin 17 and 44)
45	ground	Ignition signal shield	Ground for ignition circuit monitoring
46	output	Instrument cluster	Fuel consumption output to instrument cluster
47	output	Instrument cluster	Engine speed (TD) signal to instrument cluster
48	output	A/C compressor control relay	A/C compressor disable via A/C compressor relay
49	output	Ignition coil, cyl. 2	Primary signal, ignition coil 2
50	output	Ignition coil, cyl. 3	Primary signal, ignition coil 3
51	output	Ignition coil, cyl. 8	Primary signal, ignition coil 8
52	output	Ignition coil, cyl. 5	Primary signal, ignition coil 5
53	vacant	—	—
54	input	Main relay (terminal 87)	Battery voltage from main relay
55	ground	Ground	Ground point (X6452)
56	input	Power supply (terminal 15)	Battery voltage with key in on or start position
57	vacant	—	—
58	vacant	—	—
59	output	Throttle position sensor (TPS)	Voltage supply to TPS (5 VDC)
60	input	Data link connector	Programming voltage via data link connector
61	vacant	—	—
62	input	Traction control module	Throttle control signal
63	vacant	—	—
64	input	A/C relay (terminal 87a)	A/C ready signal
65	input	A/C pressure switch	from integrated climate control module via A/C pressure switch
66	input	On-board computer	Drive-away protection enable
67	input	Knock sensor #4 (cyl. 7-8)	Knock sensor #4 signal
68	input	Knock sensor #3 (cyl. 5-6)	Knock sensor #3 signal

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Table d. ECM Pin Assignments—DME 3.3 (M60 Engine) (continued)

Pin	Signal	Component	Signal/function
69	input	Knock sensor #2 (cyl. 3-4)	Knock sensor #2 signal
70	input	Knock sensor #1 (cyl. 1-2)	Knock sensor #1 signal
71	ground	Ground	Ground for analog signals and knock sensors
72	vacant	—	—
73	input	Throttle position sensor (TPS)	Throttle position signal
74	vacant	—	—
75	vacant	—	—
76	vacant	—	—
77	input	Intake air temperature sensor	Intake air temperature signal (0-5 VDC, temperature dependent)
78	input	Engine coolant temperature sensor	Engine coolant temperature signal (0-5 VDC, temperature dependent)
79	vacant	—	—
80	vacant	—	—
81	input	Light switch	Headlights on signal
82	input	Traction control module	Engine coasting signal
83	input	Traction control module	Traction control regulation signal
84	output	Ground, EGS shield	CAN shield to A/T transmission control module
85	input/out-put	Automatic transmission control module	A/T transmission control module connection, data signal
86	input/out-put	Automatic transmission control module, electronic throttle control module	Data link connector
87	input	Diagnostic connector (RxD)	Diagnostic RxD (receive) signal to Data link connector
88	input/out-put	Diagnostic connector (TxD)	Diagnostic TxD (transmit) signal to Data link connector

Table e. ECM Pin Assignments—DME 1.2 early (M70 Engine)

Pin	Signal	Component	Signal/function
1	output	Ignition coil	Ignition coil primary control, Diagnostic connector
2	ground	Ground	Chassis ground
3	output	Fuel pump relay control	Fuel pump relay switches with engine running or cranking (crankshaft position signal must be present for relay to switch)
4	vacant	—	—
5	output	Evaporative purge valve control	Pulsed ground (mapped) with engine running at normal temperature and varying engine load
6	output	Engine speed	RPM signal to EML control module and instrument cluster
7	input	Mass air flow sensor	Voltage signal from Mass air flow sensor (0-5 VDC, varies with engine load)
8	input	Cylinder identification	Voltage pulse (VAC) between pin 8 and pin 31 for cylinder identification
9	vacant	—	—
10	ground	Oxygen sensor	Ground for oxygen sensor signal
11	vacant	—	—
12	vacant	—	—
13	input	Diagnostic connector (RxD)	Diagnostic RxD (receive) signal to pin 15 in data link connector
14	ground	Fuel injectors	Ground for fuel injectors output stage
15	vacant	—	—
16	output	Fuel injectors, cyl. 1,3,5 (control unit 1) Fuel injectors, cyl. 7,9,11 (control unit 2)	Pulsed ground (injection pulse width in ms)
17	output	Fuel injectors, cyl. 2, 4, 6 (control unit 1) Fuel injectors, cyl. 8, 10, 12 (control unit 2)	Pulsed ground (injection pulse width in ms)
18	input	Power supply (terminal 30)	Battery voltage (B+) at all times (terminal 30)
19	ground	Shielding ground	Ground for ECM and sensor shielding
20	vacant	—	—
21	vacant	—	—
22	vacant	—	—
23	output	Oxygen sensor relay control	Oxygen sensor heater
24	ground	Output stage ground	Ground for output stages other than injectors and ignition
25	input	Mass air flow sensor	—
26	ground	Mass air flow sensor	Ground for Mass air flow sensor
27	input	Power supply (terminal 15)	Battery voltage (B+) with key on or engine running (terminal 15)
28	input	Oxygen sensor	Oxygen sensor signal wire (0-1 VDC fluctuating with engine running)
29	vacant	—	—
30	vacant	—	—
31	input	Cylinder identification sensor on no. 6 and no.12 plug wires	Voltage pulse (VAC) between pin 8 and pin 31 when cyl. no. 6 fires (for ignition control)

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Table e. ECM Pin Assignments—DME 1.2 early (M70 Engine)

Pin	Signal	Component	Signal/function
32	output	Fuel consumption	Fuel consumption output to instrument cluster
33	vacant	—	—
34	vacant	—	—
35	vacant	—	—
36	output	Main relay	Main relay activation (relay terminal 85)
37	input	Main relay	Voltage supply from main relay to ECM (relay terminal 87)
38	input	On-board computer, anti-theft system	Drive-away protection enable
39	input	Data link connector	Programming voltage
40	vacant	—	—
41	vacant	—	—
42	input	Automatic transmission (A/T) range switch	A/T park or neutral position signal
43	input	Mass air flow sensor	0-5 VDC
44	input	Intake air temperature	Intake air temperature via Mass air flow sensor (0-5 V, temperature dependent)
45	input	Engine coolant temperature	Engine coolant temperature (0-5 V, temperature dependent)
46	vacant	—	—
47	input	Engine speed and crankshaft position sensor	Crankshaft position/rpm (voltage (VAC) between pins 47 and 48)
48	input	Engine speed and crankshaft position sensor	Crankshaft position/rpm (voltage (VAC) between pins 47 and 48)
49	vacant	—	—
50	not used	control units 1 and 2 connected	not used
51	input	Ignition timing intervention	from Electronic transmission control module
52	input	Throttle position	Ground with throttle in idle position from EML control module
53	input	Throttle position	Ground with throttle in full open position from EML control module
54	input	Torque converter clutch WK	Electronic transmission control module
55	input/output	Diagnostic connector (Tx/D)	Diagnostic Tx/D (transmit) and Rx/D (receive) signal to/from pin 20 in Data link connector

Table f. ECM Pin Assignments—DME 1.2 late (M70 Engine)

Pin	Signal	Component	Signal/function
1	output	Ignition coil	Ignition coil primary control, Diagnostic connector
2	ground	Ground	Chassis ground
3	input	Switched voltage from main relay	Battery voltage through 1K resistor, approx. 10 VDC
4	vacant	—	—
5	output	Evaporative purge valve control	Pulsed ground (mapped) with engine running at normal temperature and varying engine load
6	output	Engine speed	RPM signal to EML control module and instrument cluster
7	input	Mass air flow sensor	Voltage signal from Mass air flow sensor (0-5 VDC, varies with engine load)
8	input	Cylinder identification	Voltage pulse (VAC) between pin 8 and pin 31 for cylinder identification
9	vacant	—	—
10	ground	Oxygen sensor	Ground for oxygen sensor signal
11	vacant	—	—
12	vacant	—	—
13	input	Diagnostic connector (RxD)	Diagnostic RxD (receive) signal to pin 15 in data link connector
14	ground	Fuel injectors	Ground for fuel injectors output stage
15	vacant	—	—
16	output	Fuel injectors, cyl. 1,3,5 (control unit 1) Fuel injectors, cyl. 7,9,11 (control unit 2)	Pulsed ground (injection pulse width in ms)
17	output	Fuel injectors, cyl. 2, 4, 6 (control unit 1) Fuel injectors, cyl. 8, 10, 12 (control unit 2)	Pulsed ground (injection pulse width in ms)
18	input	Power supply (terminal 30)	Battery voltage (B+) at all times (terminal 30)
19	ground	Shielding ground	Ground for ECM and sensor shielding
20	vacant	—	—
21	vacant	—	—
22	vacant	—	—
23	output	Oxygen sensor relay control	Oxygen sensor heater
24	ground	Output stage ground	Ground for output stages other than injectors and ignition
25	output	Mass air flow sensor	Burn off after engine stops
26	ground	Mass air flow sensor	Ground for Mass air flow sensor
27	input	Power supply (terminal 15)	Battery voltage (B+) with key on or start position (terminal 15)
28	input	Oxygen sensor	Oxygen sensor signal wire (0-1 VDC fluctuating with engine running)
29	vacant	—	—
30	vacant	—	—
31	input	Cylinder identification sensor on no. 6 and no.12 plug wires	Voltage pulse (VAC) between pin 8 and pin 31 when cyl. no. 6 fires (for ignition control)

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Table f. ECM Pin Assignments—DME 1.2 late (M70 Engine)

Pin	Signal	Component	Signal/function
32	output	Fuel consumption	Fuel consumption output to instrument cluster
33	vacant	—	—
34	vacant	—	—
35	vacant	—	—
36	output	Main relay	Main relay activation (relay terminal 85)
37	input	Main relay	Voltage supply from main relay to ECM (relay terminal 87 or 87a)
38	input	On-board computer, anti-theft system	Drive-away protection enable
39	input	Data link connector	Programming voltage
40	ground	—	—
41	vacant	—	—
42	input	Automatic transmission (A/T) range switch	A/T park or neutral position signal
43	input	Mass air flow sensor	0-5 VDC
44	input	Intake air temperature	Intake air temperature via Mass air flow sensor (0-5 V, temperature dependent)
45	input	Engine coolant temperature	Engine coolant temperature (0-5 V, temperature dependent)
46	vacant	—	—
47	input	Engine speed and crankshaft position sensor	Crankshaft position/rpm (voltage (VAC) between pins 47 and 48)
48	input	Engine speed and crankshaft position sensor	Crankshaft position/rpm (voltage (VAC) between pins 47 and 48)
49	vacant	—	—
50	not used	control units 1 and 2 connected	not used
51	input	Ignition timing intervention	from Electronic transmission control module
52	input	Throttle position	Ground with throttle in idle position from EML control module
53	input	Throttle position	Ground with throttle in full open position from EML control module
54	input	Torque converter clutch WK	Electronic transmission control module
55	input/output	Diagnostic connector (TxD)	Diagnostic TxD (transmit) and RxD (receive) signal to/from pin 20 in Data link connector

Table g. ECM Pin Assignments—DME 1.7 (M70 Engine)

Pin	Signal	Component	Signal/function
1	Output	Fuel pump relay, terminal 85	Fuel pump relay control
2	Not used	—	—
3	Output	Fuel injectors 2, 4, 6 DME control unit 1 or Fuel injectors 8, 10, 12 DME control unit 2	Pulsed ground for fuel injection control
4	Not used	—	—
5	Not used	—	—
6	Ground	Ground, fuel injection valve output stages	Ground point
7	Not used	—	—
8	Output	Instrument cluster	"Check engine" indicator control
9	Not used	—	—
10	Not used	—	—
11	Output	Transmission control module (EGS)	DKV potentiometer signal
12	Input	EML control module	Throttle position signal (full throttle)
13	Input	Mass air flow sensor	—
14	Input	Mass air flow sensor	Mass air flow sensor (signal ground)
15	Not used	—	—
16	Input	Cylinder 6 spark plug wire	Spark plug wire sensor (cylinder identification)
17	Output	Instrument cluster	Measurement signal (fuel consumption)
18	Not used	—	—
19	Not used	—	—
20	Not used	—	—
21	Not used	—	—
22	Not used	—	—
23	Not used	—	—
24	Not used	—	Cyl. 3 ignition coil
25	Output	Ignition coil terminal 1	Ignition coil control
26	Input	B + junction point	Battery voltage
27	Output	Main relay, terminal 85	Main relay control
28	Ground	Ground for electronics and shielding of sensors	Ground point
29	Not used	—	—
30	Not used	—	—
31	Not used	—	—
32	Output	Fuel injectors 1, 3, 5 (DME control unit 1) or Fuel injectors 7, 9, 11 (DME control unit 2)	Pulsed ground
33	Not used	—	—

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Table g. ECM Pin Assignments—DME 1.7 (M70 Engine)

Pin	Signal	Component	Signal/function
34	Ground	Ground, output stages (except for ignition and fuel injection valves)	Ground point
35	Not used	—	—
36	Output	Evaporative emission valve	Evaporative emission valve control
37	Not used	—	—
38	Not used	—	—
39	Not used	—	—
40	Not used	—	—
41	Input	Mass Air Flow sensor	Mass air flow sensor (voltage varies with engine load)
42	Not used	—	—
43	Ground	Ground for sensors	Engine coolant temperature sensor, intake air temperature sensor
44	Input	Spark plug wire sensor	Spark plug wire sensor (cylinder identification)
45	Not used	—	—
46	Not used	—	—
47	Not used	—	—
48	Not used	—	—
49	Not used	—	—
50	Not used	—	—
51	Not used	—	—
52	Not used	—	—
53	Not used	—	—
54	Input	Main relay terminal 87 or 87a	Battery voltage from main relay
55	Ground	Ground point	Ground, ignition
56	Input	Ignition switch, terminal 15	12V with ignition switch in start or run position
57	Not used	—	—
58	Not used	—	—
59	Not used	—	—
60	Input	Data link connector	Programming voltage
61	Not used	—	—
62	Input	Throttle position sensor	Closed throttle
63	Input	Electronic transmission control unit	Electronic transmission control
64	Input	Electronic transmission control unit	—
65	Input	Automatic transmission range switch	12V in park or neutral
66	Not used	—	—
67	Input	Crankshaft position/RPM sensor	Crankshaft position/RPM

ECM PIN ASSIGNMENTS

Table g. ECM Pin Assignments—DME 1.7 (M70 Engine)

Pin	Signal	Component	Signal/function
68	Ground	Crankshaft position/RPM sensor	Crankshaft position RPM sensor ground
69	Not used	—	—
70	Input	Oxygen sensor signal	0-1v
71	Ground	Heated oxygen sensor	Oxygen sensor signal ground
72	Not used	—	—
73	Input	Instrument cluster	Vehicle speed sensor
74	Output	Instrument cluster, EML control unit	Engine speed signal
75	Not used	—	—
76	Input	Mass air flow sensor	0-5v
77	Input	Intake air temperature sensor (IAT)	Intake air temperature sensor (IAT)
78	Input	Engine coolant temperature sensor	Engine coolant temperature
79	Not used	—	—
80	Not used	—	—
81	Input	On-board computer, anti-theft module	Drive-away protection signal (code)
82	Input	Automatic stability control (ASC or ASC+T)	Automatic stability control (ASC or ASC+T)
83	Input	Automatic stability control (ASC or ASC+T)	Automatic stability control (ASC or ASC+T)
84	Not used	—	—
85	Ground	Ground point	Ground
86	Not used	—	—
87	Output	RxD diagnosis data line	Data link connector
88	Output-Input	TxD diagnosis data line	Data link connector

