# 130 Fuel Injection

## GENERAL

This repair group covers fuel injection system component testing and repair. Special equipment is 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 fuel injection problems.

***NOTE —***

- *Wiring diagrams for the engine management system, can be found at the rear of the manual under* **Electrical Wiring Diagrams**.
- *For ignition system repair information, see* **120 Ignition System**.
- *For fuel supply system testing and repair, see* **160 Fuel Tank and Fuel Pump**.

### Principles Of Operation

There are five versions of engine management systems used on the E36 cars. Each has the same basic components and operating principles. The most notable difference is that 1996 and later cars use a sophisticated OBD II-compliant system. See **Table a**.

**Table a. Engine Management System Variants**

| Engine code/year | System |
|---|---|
| 4-cylinder | |
| M42 (1.8 l) 1992-1995 | Bosch DME M1.7 |
| M44 (1.9 l) 1996-1998 | Bosch DME M5.2 (OBD II) |
| 6-cylinder | |
| M50 | |
| 1992 (2.5 l) | Bosch DME M3.1 |
| 1993-1995 (2.5 l) | Bosch DME M3.3.1 (VANOS) |
| M52 | |
| 1996-1998 (328i - 2.8 l) | Siemens MS 41.1 (OBD II) |
| 1998 (323i - 2.5 l) | Siemens MS 41.1 (OBD II) |
| M-Power | |
| S50US (M3 - 3.0 l) 1995 | Bosch DME M3.3.1 |
| S52US (M3 - 3.2 l) 1997-1998 | Siemens MS 41.1 (OBD II) |

***NOTE —***

- *Descriptions and procedures in the first part of this repair group refer to all the various engine management systems.*
- *Particulars of each fuel injection system are treated in separate sections in the second part of this repair group.*
- *The 16-pin OBD II diagnostic connector is located on the lower left dash panel. See Fig. 1.*

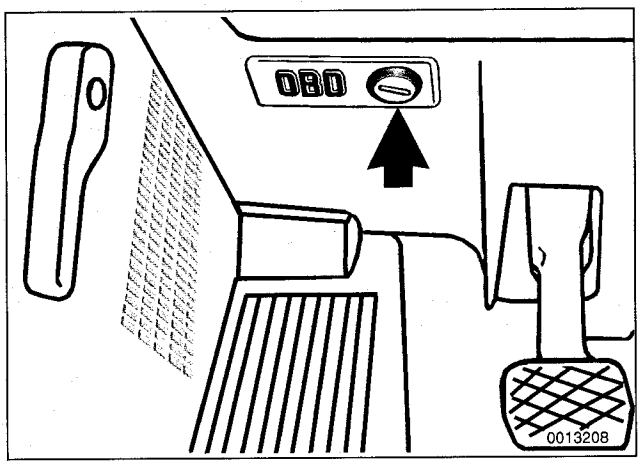



**Fig. 1.** OBD II diagnostic connector location.

The engine control module (ECM) uses electrical signals from the mass air flow sensor, the air and coolant temperature sensors, the crankshaft position/rpm sensor, the knock sensors and the oxygen sensors as the primary inputs to electronically control fuel delivery and ignition timing.

The fuel injection system is completely electronic in operation. Air flow is measured electronically via a mass air flow sensor and additional sensors supply information about engine operating conditions. The ECM 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.

**Air intake.** Air entering the engine passes through a pleated paper air filter in the air cleaner. Intake air volume or mass is then measured by a mass air flow (MAF) sensor. In all except the vane type sensor (DME M1.7), a reference current is used to heat a thin wire or film in the sensor when the engine is running. The current used to heat the wire/film is electronically converted into a voltage measurement corresponding to the mass of the intake air.

**Table b. Mass Air Flow Sensor Variants**

| System | Air flow sensor type |
|---|---|
| Bosch DME M1.7 | Vane (volume sensor) |
| Bosch DME M3.1 | Hot wire (mass sensor) |
| Bosch DME M3.3.1 | Hot film (mass sensor) |
| Bosch DME M5.2 | Hot film (mass sensor) |
| Siemens MS 41.1 | Hot film (mass sensor) |

***NOTE —***

*On cars equipped with traction control, an additional throttle valve is controlled by an electronic throttle actuator (motor). This valve is used for engine speed intervention. Repair information for this system is not covered here due to the special electrical testing equipment required to service it.*

**Fuel metering.** The ECM meters fuel by changing the opening time (pulse width) of the fuel injectors. To ensure that injector 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 duration 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. The exhaust oxygen sensor(s) signal information about combustion efficiency for control of the air-fuel mixture. 1992 to 1995 engines are equipped with a single sensor. 1996 and later (OBD II) engines are equipped with an oxygen sensor before and one after each catalytic converter. For example, the M52 engine is equipped with four oxygen sensors.

**Idle speed control.** Idle speed is electronically controlled via the idle speed control valve, which maintains idle speed by bypassing varying amounts of air around the closed throttle valve. Idle speed is not adjustable.

**Knock (detonation) control.** Knock sensors monitor and control ignition knock through the ECM. The knock sensors function like microphones and are able to convert mechanical vibration (knock) into electrical signals. The ECM is programmed to react to frequencies that are characteristic of engine knock and adapt the ignition timing point accordingly. See **120 Ignition System** for further details.

***NOTE —***
*The 1992 M50 engine is not equipped with knock sensors. All other engines are equipped with two knock sensors.*

## Basic Engine Settings

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

***NOTE —***
*If the system 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 engine management system compensates automatically for changes in the engine due to age, minor wear or small problems, such as a disconnected vacuum hose. As a result, idle speed and mixture do not need to be adjusted as part of routine maintenance.

***NOTE —***
*Poor driveability may be encountered when the battery is disconnected and reconnected. When the battery is disconnected, the adaptive memory is lost. The system will readapt after about ten minutes of driving.*

## DISA (Dual Resonance Intake System)

The E36 4-cylinder engine is equipped with a dual intake runner system, termed DISA. DISA offers the advantages of both short and long intake pipes. Long intake runners are most useful at low to medium engine rpm for producing good torque characteristics. Short intake runners produce higher horsepower at higher engine speeds.

***NOTE —***
*The term DISA comes from the German words Differenzierte Sauganlage, and can roughly be translated as "differing intake manifold configuration." See* **100 Engine-General** *for additional information on DISA operation.*

**Manifold construction.** The intake manifold is a two-piece metal construction, with a pair of runners in the top section and four runners in the lower section. A butterfly valve is installed in the lower section, enabling the DISA solenoid to isolate one pair of runners from the other pair. See Fig. 2.

**Operation.** With the DISA butterfly valve closed, the pipes in the top half of the manifold act together with the ram air pipes in the lower half to produce a single, long air intake pipe for each cylinder. See Fig. 3. The column of air oscillating in this combined pipe significantly increases engine torque in the medium rpm range.

Above approximately 4,800 rpm, the butterfly valve between the intake air pipes for the two cylinder groups is opened. The shorter pipes in the lower manifold section now become the main suppliers of ram air to the cylinders, yielding greater power at the upper end of the engine rpm range. See Fig. 4.

**Control components.** The DISA butterfly valve is actuated electro-pneumatically via the engine control module (ECM). The valve begins to open as engine speed rises above 4,840 rpm and closes below 4,760 rpm. The action of the valve is deliberately delayed to prevent it from opening and closing repeatedly within a short time.

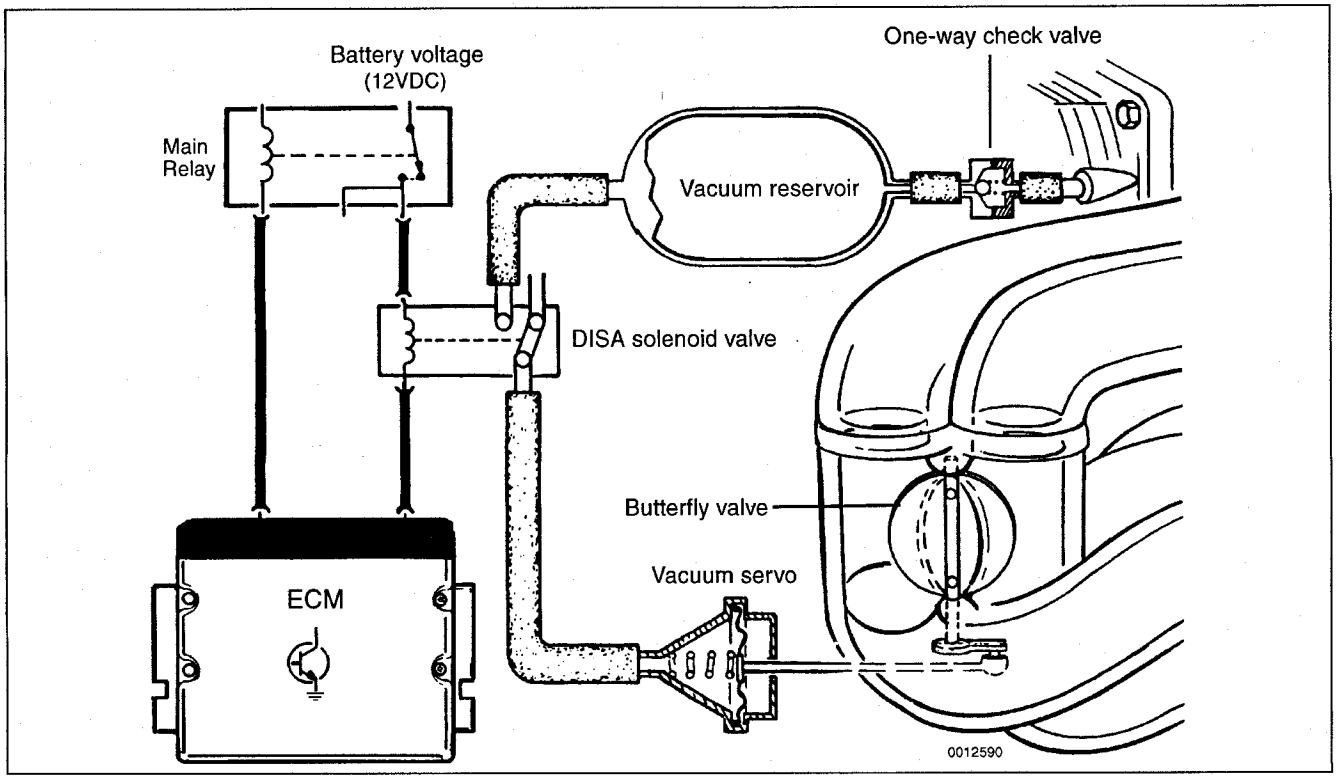



**Fig. 2.** DISA system components. DISA is controlled via the engine control module (ECM).

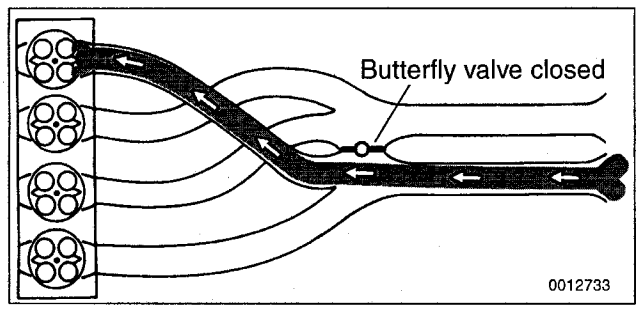



**Fig. 3.** DISA manifold runners with butterfly valve closed for low rpm-high torque operation.

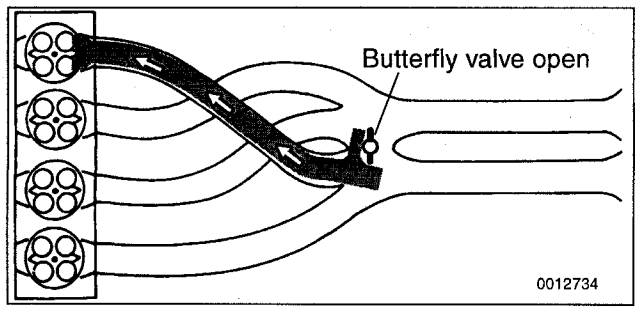



**Fig. 4.** DISA manifold runners with butterfly valve open for high rpm-high power operation.

## On-Board Diagnostics (OBD) and Fault Diagnosis

Poor driveability may have a variety of causes. The fault may lie with the ignition system, the fuel system, parts of the emission control system, or a combination of the three. Because of these interrelated functions and their effects on each other, it is often difficult to know where to begin looking for problems.

For this reason, effective troubleshooting should always begin with an interrogation of the On-Board Diagnostic (OBD) system.

The OBD system detects certain emissions-related engine management malfunctions. When faults are detected, the OBD system stores a Diagnostic Trouble Code (DTC) in the system ECM. In addition, the Check Engine warning light will come on if an emissions-related fault is detected.

Two generations of OBD are used on the cars covered by this manual. See **100 Engine–General** for OBD I information and fault codes.

**On-Board Diagnostics**

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

The fuel injection systems used on the 1996 and later cars covered by this manual are OBD II compliant. This system is incorporated into both the Bosch M5.2 (M44 engine) and the Siemens MS 41.1 (M52/S52US engine) engine management systems. OBD II systems use sophisticated diagnostic software capable of recognizing and electronically storing hundreds of DTCs in the system ECM. DTCs can only be accessed using special scan tool test equipment. The BMW dealer is equipped with the specialized OBD II scan tool to quickly and efficiently locate engine management problems. Alternately, a "generic" scan tool can be used to access OBD II fault information.

***NOTE —***

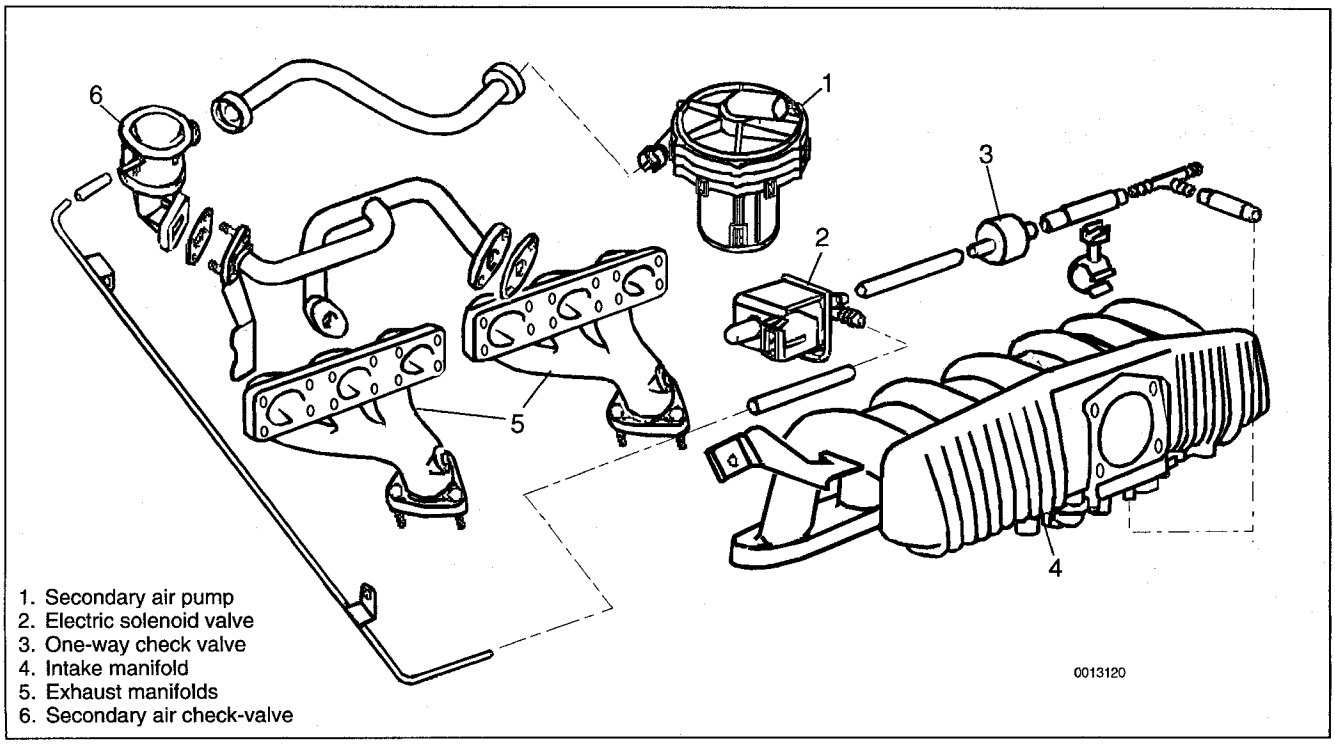
- *At the time this manual went to press, generic scan tools were not widely available for BMW vehicles. The generic scan tool is a specialized tool that plugs into a standardized OBD II connector on 1996 and later passenger vehicles built for sale in the US.*
- *The OBD II fault memory (including an illuminated Check Engine light) can only be reset using the special scan tool. Removing the connector from the ECM or disconnecting the battery will not erase the fault memory.*
- *The 16-pin OBD II diagnostic connector is located on the lower left dash panel. Refer to Fig. 1.*

## Secondary Air Injection

All OBD II 6-cylinder engines are equipped with a secondary air injection system. In addition, beginning in January 1997, the M44 engine was classified as a TLEV (Transitional Low Emission Vehicle) engine and is also equipped with secondary air injection.

Typical components of the secondary air injection system are depicted in Fig. 5.

Secondary air injection uses an electric pump to pump fresh air into the exhaust system upstream of the catalytic converter during engine warm-up. By providing extra oxygen to the unburned fuel in the exhaust, hydrocarbons oxidize and carbon monoxide combines with oxygen to form carbon dioxide and water. The air injection pump stops within a specified timed interval.




1. Secondary air pump
2. Electric solenoid valve
3. One-way check valve
4. Intake manifold
5. Exhaust manifolds
6. Secondary air check-valve

**Fig. 5.** Components of 6-cylinder secondary air injection system. 4-cylinder system is similar.

## 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 engine management 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 coils or spark plugs while the engine is running or being cranked by the starter.*
- *Connect and disconnect the DME system wiring and test equipment leads only when the ignition is switched off.*
- *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.*
- *When working on an open fuel system, wear suitable hand protection, as prolonged contact with fuel can cause illnesses and skin disorders.*
- *Renew fuel system hoses, clamps and O-rings any time they are removed.*
- *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**.

***CAUTION —***

- *Prior to disconnecting the battery, read the battery disconnection cautions given at the front of this manual on page viii.*
- *Do not connect any test equipment that delivers a 12-volt power supply to terminal 15 (+) of the ignition coil. The current flow may damage the ECM. In general, connect test equipment only as specified by BMW, this manual, or the equipment maker.*
- *Only use a digital multimeter for electrical test.*
- *Only use an LED test light for quick tests.*
- *Disconnecting the battery may erase fault code(s) stored in memory. Check for fault codes prior to disconnecting the battery cables. If the Check Engine light is illuminated, see* **100 Engine–General** *for DME fault code information. If any other system faults have been detected (indicated by an illuminated warning light), see an authorized BMW dealer. Additional systems with self-diagnostic capabilities include; ABS (Anti-lock brakes), SRS (Airbags), EML and ASC+T and AST (Traction Control).*
- *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 the engine control module (ECM) connector. If the connector is removed before this time, residual power in the system relay may damage the control module.*
- *Cleanliness is essential when working on an open fuel system. Thoroughly clean fuel line connections and surrounding areas before loosening. 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

## Main relay, testing

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

1. With ignition off, remove main relay. See Fig. 6.

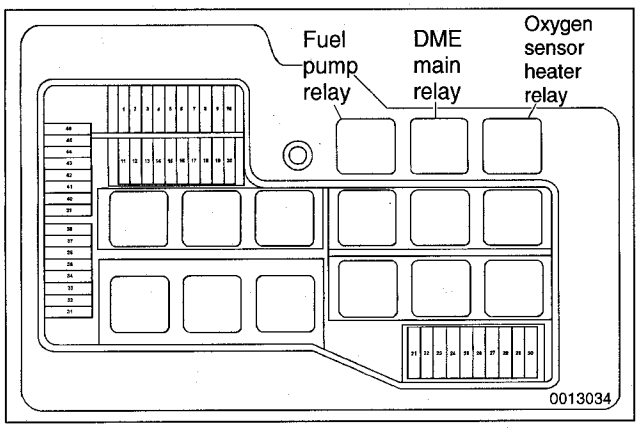



**Fig. 6.** Engine management relays in the power distribution box, left rear of engine compartment.

> ***CAUTION —***
> *Relay positions can vary. Be sure to confirm relay position by identifying the wiring in the socket using the wiring diagrams found at the rear of this manual.*

2. Check for voltage at terminal 30 and terminal 86 of relay socket. See Fig. 7.
   - 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 relay may be reversed. Electrically, the relay functions either way. If voltage is not present at terminal 86, check for voltage at terminal 85.*

3. Reinstall relay and turn ignition on. Gain access to underside of relay socket and check for ground at terminal 85 (brown wire).
   - If ground is present continue testing.
   - If ground is not present, signal from ECM is missing. Check wire between ECM and relay. If no faults can be found, ECM may be faulty.

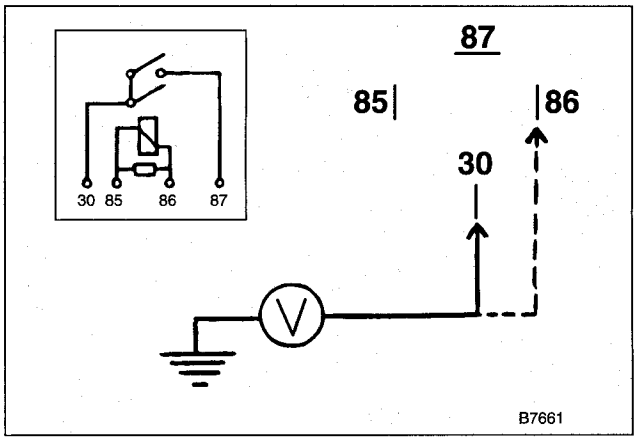



**Fig. 7.** Check for battery voltage at main relay terminals 30 and 86. Voltage should be present at all times.

4. With ignition on and relay installed, check for battery voltage at terminals 87.
   - If battery voltage is present, relay has energized and is functioning correctly.
   - If battery voltage is not present and all earlier tests are OK, relay is faulty and should be replaced.

## Fuel pump relay, testing

The fuel pump relay is located in the power distribution box. Refer to Fig. 6.

The ECM supplies power to the coil side of the fuel pump relay. During starting, the fuel pump runs as long as the ignition switch is in the start position and continues to run once the engine starts. If the relay is faulty the fuel pump will not run.

1. Remove fuel pump relay from its socket.
2. With key off, check for battery voltage at socket terminal 30. See Fig. 8.
3. With ignition key in start position check for battery voltage at terminal 86.
4. With ignition key, use digital multimeter to check for ground at terminal 85.

> ***NOTE —***
> *The ground at terminal 85 is switched by the ECM. The ECM harness must be connected to check the switched ground connection.*

5. If no faults are found up to this point, test fuel pump operation as described in **160 Fuel Tank and Fuel Pump**.

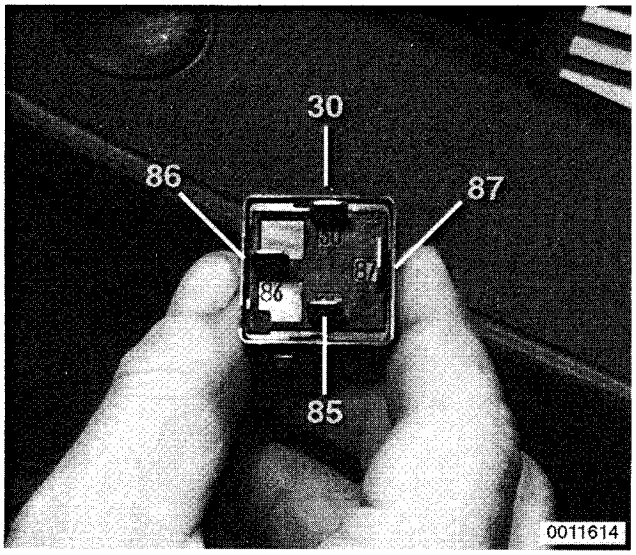



**Fig. 8.** Fuel pump relay terminal identification.

## Oxygen sensor, testing (Bosch systems only)

***CAUTION —***

- *The information in this section applies to Bosch engine management systems only.*
- *The Siemens MS 41.1 system uses resistive-type oxygen sensors. This sensor uses a 5-volt reference signal input and the output to the ECM varies from 1-5 volts, in stepped increments based on oxygen content in the exhaust.*

***NOTE —***

- *On pre-OBD II (1992-1995) cars, there is one oxygen sensor mounted upstream of the catalytic converter(s) in the exhaust pipe. See Fig. 9.*
- *On OBD II cars (1996-1998) cars, there is one oxygen sensor before and one after each catalytic converter.*
- *On M52 and S52US engines, the front pair of oxygen sensors are installed in the exhaust manifolds.*

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 575°F (300°C). Therefore it is electrically heated.

***NOTE —***

- *The test given below is not a conclusive test of oxygen sensor efficiency and does not test how quickly the oxygen sensor can react to changing conditions.*
- *Pin numbers and wire colors can vary. Always check the wiring diagrams to confirm wire color and pin assignment.*

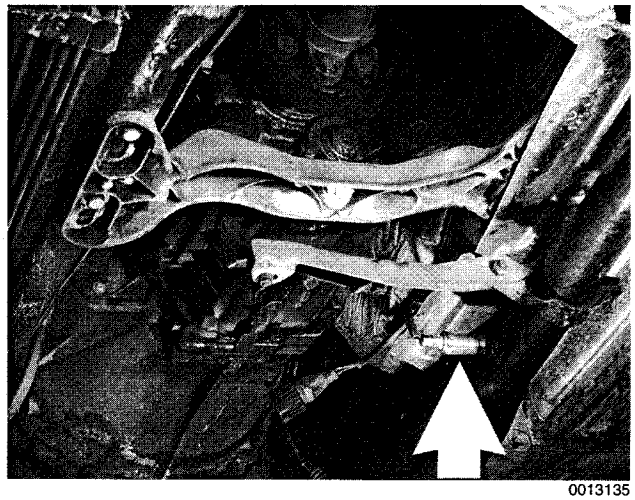
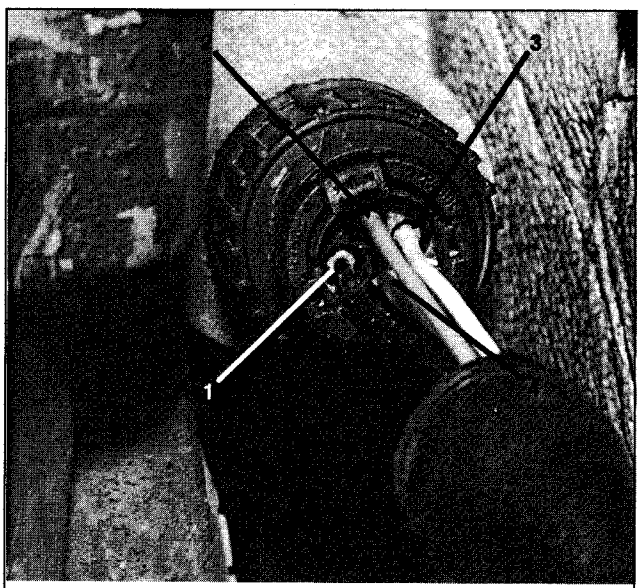



**Fig. 9.** Oxygen sensor location (**arrow**) ahead of catalytic converter. 318i model with M42 engine shown.

1. Peel back rubber boot on oxygen sensor electrical harness connector (car wiring side). With connector attached to sensor, connect digital voltmeter to pins 1 and 2 in rear of connector. See Fig. 10.




1. Black (ground)
2. Grey (signal)
3. White (heater circuit)
4. White (heater circuit)

**Fig. 10.** Oxygen sensor connector terminal identification (sensor side). Terminals numbers are molded into connector.

2. Start engine. Oxygen sensor should start to output a fluctuating voltage within a short period. If voltage is incorrect, turn engine off and check preheater 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

***NOTE —***

*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.*

3. Separate sensor harness connector from sensor. Check for battery voltage between terminals 3 and 4 (green wire and brown wire) in main wiring harness side of connector with engine running. If voltage is not present, check oxygen sensor heater relay. See **610 Electrical Component Locations**.

4. Check heater element resistance between terminals 3 and 4 in sensor side of connector. If element is electrically open (no continuity), replace sensor.

***NOTE —***

*The oxygen sensor heater relay is mounted in the main power distribution box in the left rear of the engine compartment. Refer to Fig. 6. The heater relay is energized with positive (+) battery voltage from the main relay and a switched ground from the ECM. See* **Electrical Wiring Diagrams**.

5. If oxygen sensor doesn't produce a fluctuating voltage and preheater circuit is OK, replace sensor.

***NOTE —***

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

**Tightening Torque**

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

# FUEL DELIVERY TESTS

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

There are three significant fuel delivery values to be measured:

- **System pressure**—created by the fuel pump and maintained by the pressure regulator.
- **Fuel delivery volume**—created by the fuel pump and affected by restrictions, such as clogged fuel filter.
- **Residual pressure**—the pressure maintained in the closed system after the engine and fuel pump are shut off.

Procedures for measuring the first two quantities are described in **160 Fuel Tank and Fuel Pump**. Residual fuel pressure is checked using the procedure detailed later in this group.

## Operating fuel pump for tests

To operate the fuel pump for testing purposes without having to run the engine, the fuel pump relay can be bypassed to power the pump directly. Fuel pump relay location is shown in Fig. 6.

To run the fuel pump, remove the fuel pump relay and connect the socket for relay terminal 30 to the socket for relay terminal 87 with a fused jumper wire. After completing the tests, remove the jumper wire.

***CAUTION —***

- *Relay locations may vary. Use care when identifying relays and making electrical checks at the fuse/relay panel. See* **610 Electrical Component Locations** *for additional relay information.*
- *The fuel pump relay has a 1.5 mm² red wire at terminal 30 in the relay socket. Terminal 87 has a 1.5 mm² green/violet wire. See* **Electrical Wiring Diagrams** *for additional wiring information.*

***NOTE —***

*The jumper wire should be 1.5 mm² (14 ga.) and include an in-line fuse holder with a 15 amp fuse. To avoid fuse/relay panel damage from repeated connecting and disconnecting, also include a toggle switch. A heavy-duty jumper, BMW tool no. 61 3 050, is also available from an authorized BMW dealer.*

## Relieving fuel pressure and connecting fuel pressure gauge

> ***WARNING —***
> - *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.*
> - *When working on an open fuel system, wear suitable hand protection. Prolonged contact with fuel can cause illnesses and skin disorders.*

To prevent fuel from spraying on a hot engine, system fuel pressure should be relieved before disconnecting fuel lines. One method is to tightly wrap a shop towel around a fuel line fitting and loosen or disconnect the fitting.

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

***NOTE —***
- *On M44 engines, a Schræder valve is integrated in the fuel rail. Compressed air pressure can be applied at the valve to force the fuel in the system back into the tank. See Fig. 11.*

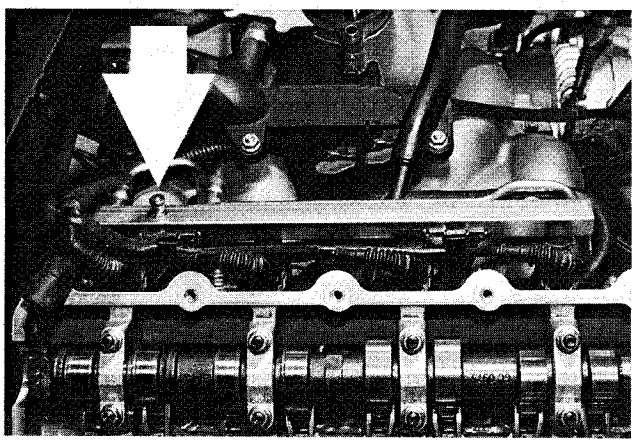


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**Fig. 11.** Fuel rail showing location of Schræder valve fitting on M44 engine (**arrow**).

***NOTE —***
*BMW specifies a special gauge and special connecting adapters to measure fuel pressure. If the special tools are not available, a length of fuel line and a T-fitting can be installed to the inlet fuel line and connected to a fuel gauge. On some vehicles, this is not possible without cutting into a fuel line. In these instances, it is recommended that fuel pressure be checked at the output side of the fuel pump. See* **160 Fuel Tank and Fuel Pump**.

On OBD II 6-cylinder engines, the fuel lines use a special locking fitting. Use BMW special tool 16 1 050 to release the fittings and connect the fuel gauge. See Fig. 12.

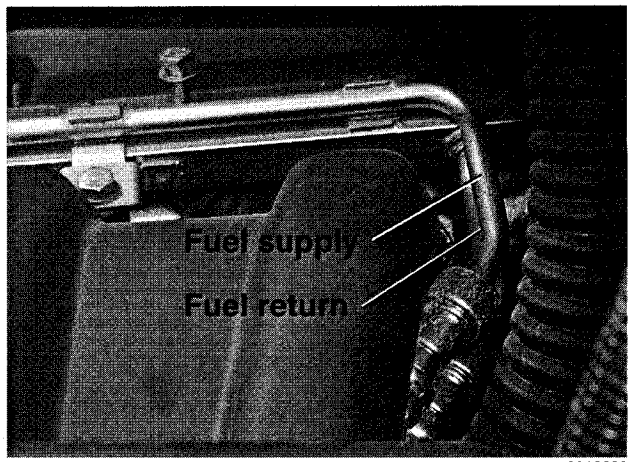


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**Fig. 12.** Fuel lines at rear of intake manifold on M52 engine. Use BMW special tool 16 1 050 to release fittings.

> ***WARNING —***
> - *Gasoline is highly flammable and its vapors are explosive.*
> - *The fuel pressure gauge must be securely connected to prevent it from coming loose under pressure.*

***NOTE —***
- *The fuel pressure gauge should have a range of 0 to 5 bar (0 to 75 psi).*
- *On 6-cylinder engine, the top left-side engine cover will have to be removed to access the fuel rail.*

## Residual fuel pressure, testing

For quick restarts and to avoid vapor lock when the engine is hot, the fuel injection 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. The fuel pump check valve is not serviceable as an individual part.

1. 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.*

2. Operate fuel pump for approximately one minute by bypassing fuel pump relay as described earlier. Observe fuel pressure.

3. Observe fuel pressure gauge after 20 minutes. The pressure should not drop off more than 0.5 bar from system pressure listed in **Table c.**

4. When finished testing, disconnect pressure gauge and reconnect fuel line.

If the 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 the pump check valve by repeating the test, but before turning the fuel pump off, pinch off the return line at the fuel rail. If the pressure is now maintained, the fault is most likely the fuel pump check valve.

**Table c. Fuel Pressure Specifications**

| Engine | Fuel pressure |
|---|---|
| 4-cylinder | 3.0 ± 0.2 bar (43.5 ± 2.9 psi) |
| 6-cylinder<br>M50/S50US engine<br>M52/S52US engine | <br>3.0 ± 0.2 bar (43.5 ± 2.9 psi)<br>3.5 ± 0.2 bar (51 ± 2.9 psi) |

## Fuel pressure regulator response to engine load, testing

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

***NOTE —***
*The fuel pressure should be lower by 0.4-0.7 bar from the specifications listed in* **Table c**. *Engine vacuum acting on the fuel pressure regulator diaphragm reduces the fuel pressure.*

2. With engine idling, remove vacuum hose from regulator. Pressure should increase.

3. Reconnect hose and check that pressure decreases.

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

If fuel pressure does not drop with the vacuum hose connected and no faults are found with fuel the pressure regulator vacuum hose, the fuel pressure regulator is faulty.

***NOTE —***
*A cracked or leaking pressure-regulator vacuum hose may cause an erratic idle.*

## Fuel rail and injectors, checking

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.

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

***CAUTION —***
*Use only a digital multimeter or an LED injector tester when testing injectors or wiring. Use of an analog VOM or incandescent test light may damage the engine control module.*

***NOTE —***
- *On 4-cylinder cars pry up the injector wiring duct and then pry off the cover. See Fig. 13.*
- *On 6-cylinder cars it is necessary to remove the top engine cover(s) to access the fuel rail and injectors.*

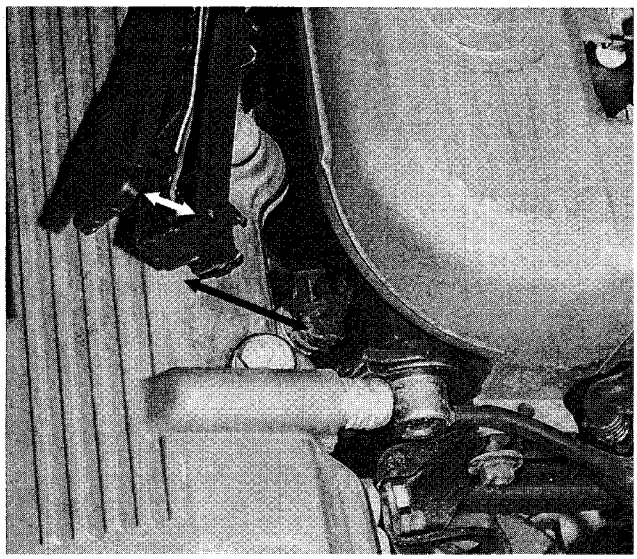

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**Fig. 13.** For electrical tests, 4-cylinder fuel injector harness duct can be accessed between intake manifold and cylinder head cover.

1. Check that ECM signal is present at injector connector.
   - Back probe injector harness connector using digital voltmeter. See Fig. 14.
   - Operate starter or run engine and check for pulsed voltage signal.
   - Repeat for each injector.

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


**Fig. 14.** Voltmeter connected across fuel injector connector with engine running. M50 engine shown.

2. If no signal is present, check for b+ power to injectors. There should be battery voltage (+) at red/white wire of each injector connector with the ignition key on. If voltage is not present, check main relay output. Injector b+ power comes from main relay (terminal 87).

***NOTE —***
*If there is positive (+) battery voltage at injectors but there was no pulsed response at voltmeter, 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.*

## Fuel rail and injectors, replacing

1. Disconnect negative (–) battery cable.

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

2. M42 and M50/S50US engines: Working at end of fuel rail, disconnect small vacuum hose from fuel pressure regulator.

3. M50/S50US engines: Remove two nuts from injector duct. Carefully pry injector wiring duct off injectors. See Fig. 15.

4. On 4-cylinder cars, remove upper intake manifold to access the fuel-rail and injectors. See **113 Cylinder Head Removal and Installation**.

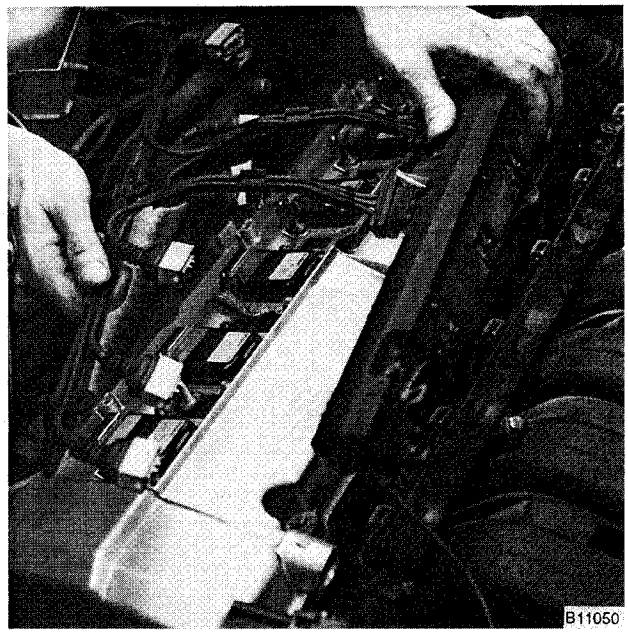


**Fig. 15.** Injector wiring harness duct being removed from M50 engine.

***NOTE —***
*Late-model M42 and all M44 fuel injectors are air-shrouded. See Fig. 16. When removing the fuel rail it is necessary to remove the air shroud feeder hose from the intake manifold ducting.*

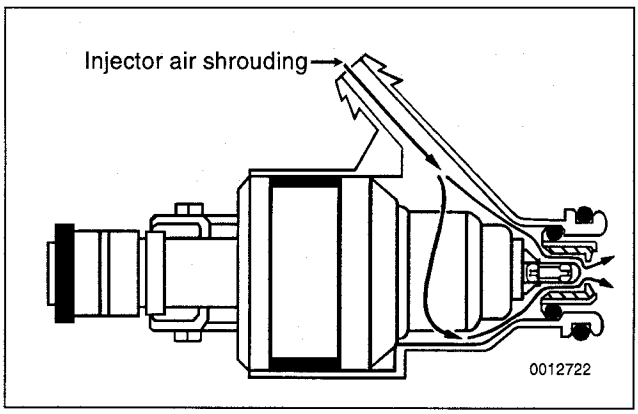


**Fig. 16.** Cutaway view of fuel injector used on M42 or M44 engine.

5. Disconnect fuel supply line and fuel return line from fuel rail ends.

***WARNING —***
- *Clamp off the fuel lines and then wrap a clean shop towel around the lines before removing them. Residual fuel pressure is present in the lines.*
- *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.*

6. Remove fuel rail mounting bolts. See Fig. 17.

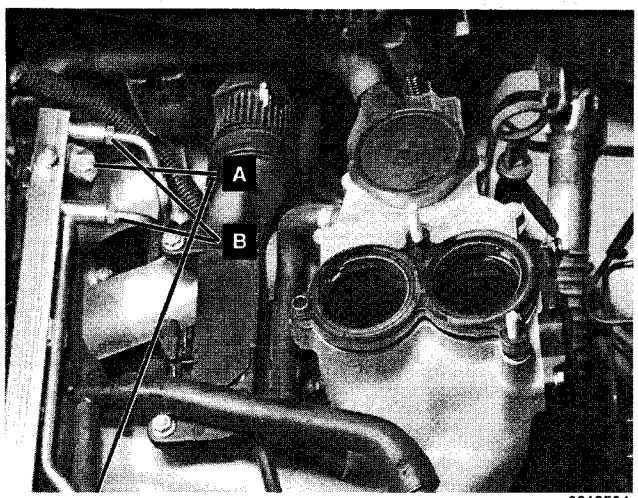


**Fig. 17.** Location of fuel rail mounting bolts (**A**) and fuel inlet and return lines (**B**) on M44 engine. Upper manifold has been removed.

7. Pull up on fuel rail and remove injector rail with injectors. Remove individual injectors by removing injector retaining clip and pulling injector from rail. See Fig. 18.

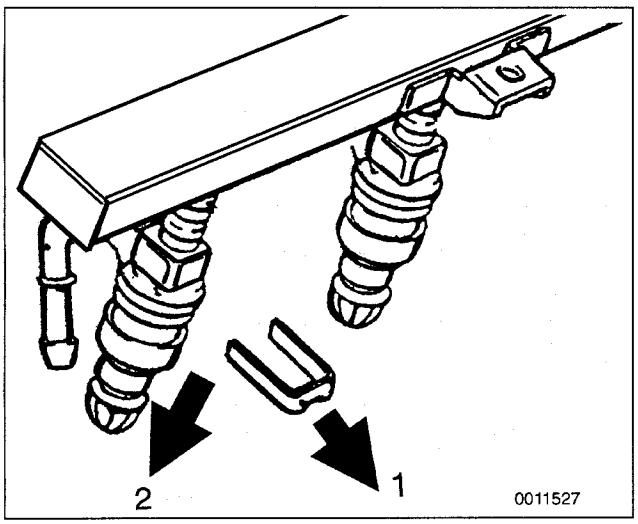


**Fig. 18.** Pry retaining clip from injector (**1**), then pull injector from rail (**2**).

8. Installation is reverse of removal.
   - Fit new O-rings when installing injectors. For ease of installation, lightly lubricate O-rings with SAE 90 or equivalent lubricant.
   - Check that injector electrical connections are correctly fitted and that injectors are fully seated prior to installing fuel rail mounting bolts.
   - Replace wire ties.

**Tightening Torque**

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

## Fuel Pressure Regulator

The fuel pressure regulator location on E36 models is mounted in one of two locations:

**Fuel Pressure Regulator Location**

- 4-cylinder engines
  - 1992- January 1997 . . . . . on fuel rail
  - January 1997- on . . . . . under car
- 6-cylinder engines
  - 1992-1995 . . . . . on fuel rail
  - 1996- on . . . . . under car

## Fuel pressure regulator, replacing (fuel rail mount)

***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.*

9. On 6-cylinder engines, remove top engine covers. Remove fuel rail mounting bolts and lift up fuel rail.

1. Disconnect vacuum hose from fuel pressure regulator. See Fig. 19.

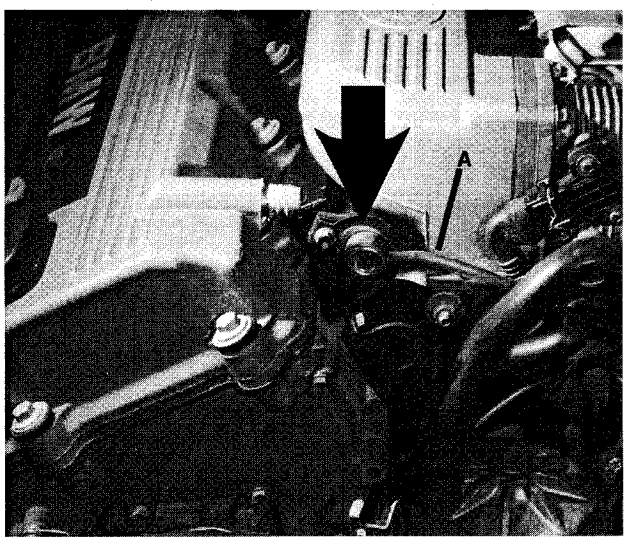


**Fig. 19.** Fuel pressure regulator (**arrow**) on M42 engine. Vacuum hose shown at **A**.

2. Remove bolt from regulator clamp. Remove clamp. Note installed direction of regulator to fuel rail.

3. Wrap a shop rag around regulator, then remove regulator from fuel rail by pulling straight out.

***NOTE —***
*Be sure to retrieve thrust washer behind fuel pressure regulator on 6-cylinder engine.*

4. Installation is reverse of removal. Replace O-rings.

## Fuel pressure regulator, replacing (under car mount)

***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.*

On late 4- and 6-cylinder cars, the fuel pressure regulator is mounted beneath the left side of the car, under a protective cover. See Fig. 20.

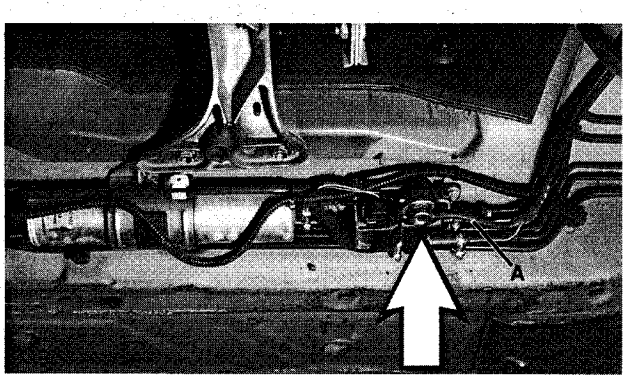


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**Fig. 20.** Fuel pressure regulator location underneath car (**arrow**). Vacuum hose to regulator is shown at **A**. (Protective cover has been removed.)

1. Working under car below driver's seat, remove protective cover from below fuel pressure regulator.
2. Remove vacuum hose from fuel pressure regulator.
3. Remove locking clip retaining fuel pressure regulator.
4. Wrap a shop rag around regulator, then remove regulator from 2/3 way valve by pulling straight out.
5. Installation is reverse of removal. Replace O-rings.

# BOSCH DME M1.7 COMPONENT TESTS AND REPAIRS

***CAUTION —***
*Use only a digital multimeter when testing components and wiring. Use of an analog VOM may damage the engine control module.*

4-cylinder cars with M42 engines (1992 to 1995) use the Bosch DME M1.7 fuel injection system.

Electrical tests of the main and fuel pump relays and the DME engine control module (ECM) are covered earlier in this section. Fuel pump tests are covered in **160 Fuel Tank and Fuel Pump**.

## Air flow sensor, testing and replacing

DME M1.7 fuel injection uses a volume air flow type sensor with integrated intake air temperature (IAT) sensor. The sensor provides a varying voltage signal to the ECM based on the position of the air vane. As the vane door swings open the potentiometer increases the voltage signal to the ECM. The IAT sensor adapts the output signal to the ECM based on intake air temperature.

1. Check ECM reference voltage to sensor:
   - Peel back rubber boot from air flow sensor harness connector.
   - Turn ignition key on.
   - Check for 5 volts between terminal 1 of harness connector and ground. See Fig. 21.
   - Turn ignition key off.
   - If voltage is not present or incorrect, check wring from ECM and check air flow sensor reference voltage output at ECM. See **Table h**.
2. Check air flow sensor potentiometer:
   - Remove intake air boot from sensor.
   - Connect a digital multimeter (ohms) across terminals 1 and 2. Swing air flow sensor vane through its travel range. Resistance should change steadily without interruption.
   - If any faults are found, the air flow sensor is faulty and should be replaced.
3. Check IAT sensor resistance:
   - With harness connector disconnected at air flow sensor, check resistance across sensor terminals 4 and 5 of air flow sensor. Compare tests results to values in **Table d** given later. If any faults are found, the air flow sensor should be replaced.

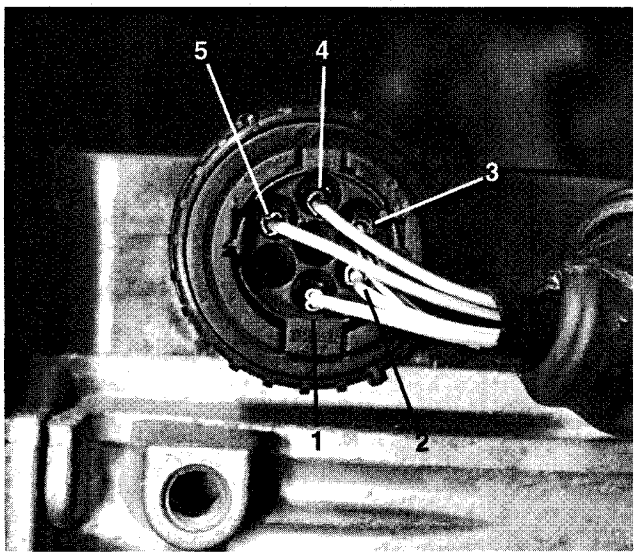


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**Fig. 21.** Air flow sensor harness connector terminal identification.

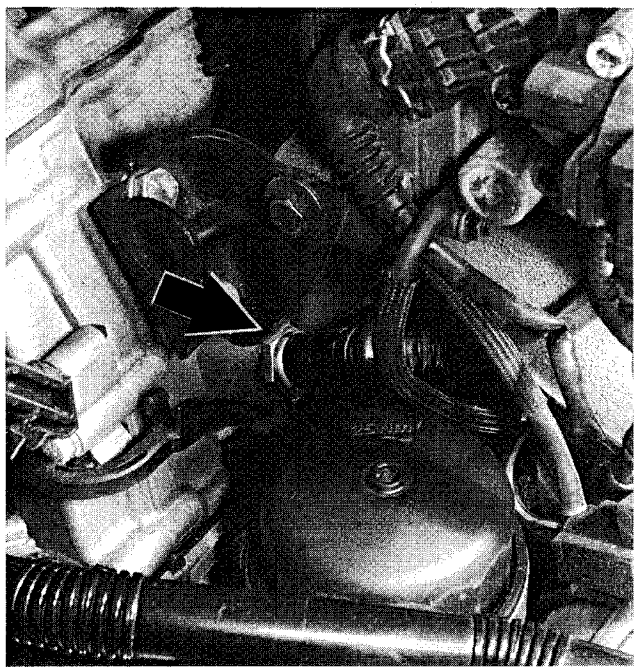
4. Replacing air flow sensor:
   - Remove large band clamp attaching air boot to sensor.
   - Remove air filter top cover, then remove air flow sensor mounting nuts inside cover.
   - Reconnect air boot and harness connector.

## Engine coolant temperature (ECT) sensor, testing and replacing

The engine coolant temperature (ECT) sensor sends continuous engine coolant temperature information to the ECM. As temperature increases, sensor resistance decreases.

The ECT sensor is located under number one intake runner. See Fig. 22.

1. Check ECM reference voltage to sensor:
   - Disconnect harness connector from ECT sensor.
   - Turn ignition key on.
   - Check for 5 volts between supply voltage (brown/red) wire of harness connector and ground.
   - Turn ignition key off.
   - If voltage is not present or incorrect, check wring from ECM and check ECT sensor reference voltage output at ECM. See **Table h.**
2. Check ECT sensor resistance:
   - With harness connector disconnected, check resistance across sensor terminals.
   - Compare tests results to values in **Table d.**



0011984

**Fig. 22.** M42 engine coolant temperature (ECT) sensor (**arrow**).

**Table d. Engine Coolant Temperature Sensor or Intake Air Temperature Sensor Test Values (DME 1.7)**

| Test temperatures | 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. Check the full linear response to increasing temperature as the engine warms up.*

3. If ECT sensor fails these tests, it is faulty and should be replaced. If no faults are found, reconnect electrical harness.

***NOTE —***
*Use a new copper sealing washer when installing sensor. Replace any lost coolant.*

***WARNING —***
*Do not replace the ECT sensor unless the engine is cold. Hot coolant can scald.*

**Tightening Torque**
- ECT sensor to cylinder head . . . . . 13 Nm (10 ft-lb)

## Throttle position sensor (TPS), testing and replacing

The throttle position sensor (TPS) is mounted on the side of the 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.

Check TPS function by disconnecting the harness connector and checking reference voltage and sensor resistance. See **Table e** and Fig. 23. If voltage is not present, check the output voltage signal from the ECM and check the wiring between the sensor and the ECM. If the sensor resistance is incorrect, replace the throttle position sensor.

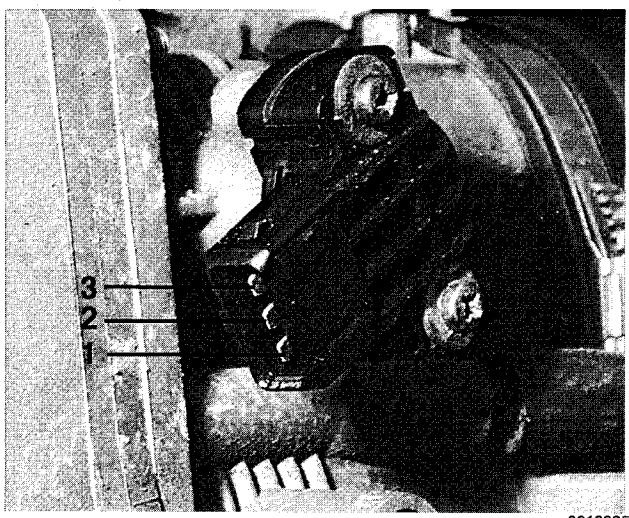



**Fig. 23.** Throttle position sensor terminal identification on M42 engine.

***NOTE —***

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

**Table e. Throttle Position Sensor Tests (DME 1.7)**

| Test conditions | Terminals | Test value |
|---|---|---|
| Harness connector disconnected, ignition on | 1 and ground in harness connector | 5 VDC (approx.) |
| Harness connector disconnected, ignition off | 1 and 3 at sensor terminals | 4 k ohms (approx.) |
| Connector disconnected, ignition off. Throttle rotated from idle to full position | 1 and 2 at sensor terminals | Continuously variable from 1– 4 k ohms (approx.) without interruption |

## Idle speed control valve, testing and replacing

Idle speed is maintained by the ECM via the idle speed control valve. See Fig. 24. Idle speed is adaptive through the ECM and no idle speed adjustments can be made. Before testing the valve, confirm that the throttle position sensor (TPS) is working correctly.

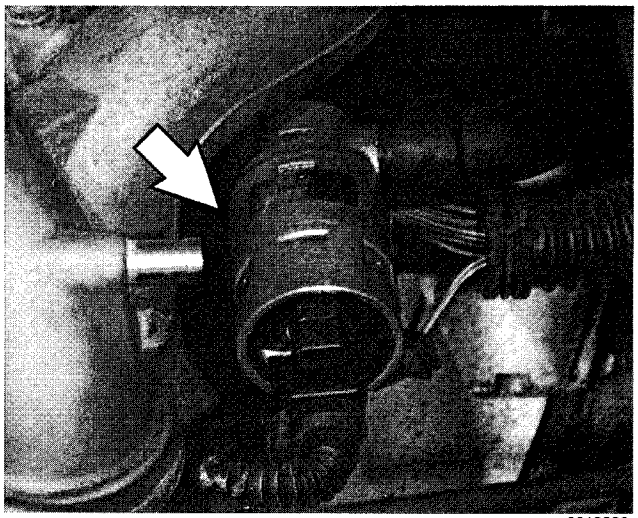



**Fig. 24.** Idle speed control valve (**arrow**) on M42 engine.

***NOTE —***

*• The tests given below are electrical checks only. They do not check the mechanical operation of the valve or if the valve is sticking or worn. If the valve is suspect, substituting a known good valve is the best way to check for a mechanical fault.*

1. Check battery (+) voltage to valve:
   - Disconnect harness connector from valve.
   - Check for battery voltage at terminal 2 (red/white wire).
   - If voltage is not present check wiring between valve and main relay (terminal 87).
2. Check that ECM signal is reaching valve:
   - With engine running, check that idle speed control valve is audibly buzzing.
   - If valve is not working, disconnect wiring harness connector.
   - Connect 12V probe light across connector terminals.
   - Turn ignition key on; probe should light. If probe does not light, check the wiring from the ECM (pin 29) to the valve. See **Table h**. If probe does light but idle quality is poor, the valve is most likely sticking and or worn and should be replaced.

# BOSCH DME M3.1 AND M3.3.1 COMPONENT TESTS AND REPAIRS

Consult **Table a** for engine application information for the Bosch DME 3.1 and 3.3.1 systems.

The DME 3.1 and DME 3.3.1 systems are similar in operation, with knock control and VANOS operation being the key differences. DME 3.1 engines are not equipped with VANOS or knock detectors, while the DME 3.3.1 system is.

> ***CAUTION —***
> *Use only a digital multimeter when testing wiring. Use of an analog VOM may damage the engine control module.*

Electrical tests of the main and fuel pump relays and the DME engine control module (ECM) are covered earlier in this section. Fuel pump tests are covered in **160 Fuel Tank and Fuel Pump**.

## Mass Air Flow Sensor

There are two types of mass air flow sensors used on the cars covered by this section. Testing procedures vary depending on type installed. The air flow sensor is not adjustable and must only be tested with a digital multimeter.

**Mass Air Flow Sensor Variants**

- 1992 M50 engine
  DME M3.1 . . . . . mass air flow sensor—hot wire
- 1993-1995 M50 and S50US
  DME M3.3.1) . . . . . mass air flow sensor—hot film

## Mass air flow sensor (hot wire), testing and replacing

When the engine is running, a current is used to heat a thin wire in the center of the sensor. See Fig. 25. The current in the wire is regulated to maintain a temperature of 100°C more than the air passing over it. The current used to heat the wire is electronically converted into a voltage measurement corresponding to the mass of intake air.

To keep the wire clean, it is heated to a temperature of about 1,000°C (1,830°F) for one second. This "burn-off" cycle takes place automatically, four seconds after the engine is turned off.

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.

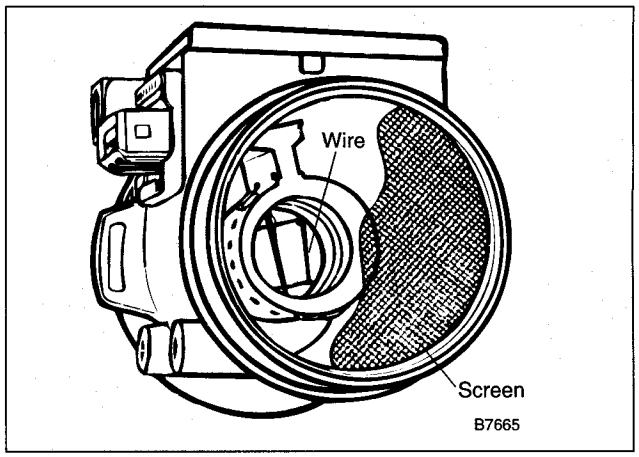



**Fig. 25.** Mass air flow sensor. Hot wire sensor used on cars with DME 3.1 (1992 6-cylinder models).

> ***CAUTION —***
> *Use only a digital multimeter when checking the mass air flow sensor. An analog meter can damage the air flow sensor.*

1. Disconnect air flow sensor from air cleaner only. Leave it connected to duct leading to intake manifold and leave wiring harness connected.
2. Start engine and run it to normal operating temperature.
3. Rev engine to at least 2,500 rpm, then shut it off. Look through meter at hot wire. After approximately four seconds wire should glow brightly for about one second.

> ***NOTE —***
> *If the wire glows as specified, then the air flow meter and ECM are probably operating correctly. If the wire does not glow, continue testing.*

4. If the wire does not glow, remove air flow sensor and look through it to see if wire is broken. If wire is broken, meter will have to be replaced.
5. Reinstall air flow sensor and harness connector. Peel back rubber boot from harness connector. Working from rear of connector, connect digital voltmeter across terminals 1 and 4. See Fig. 26.
6. Start and rev engine to at least 2,500 rpm, then shut it off. After about 4 seconds, voltage should rise to about 4 volts for about one second. If voltage is present, but wire does not glow, air flow sensor is faulty and should be replaced.
7. If voltage is not present in step 6, turn ignition key on and check for voltage and ground at sensor. There should be ground at pin 4. There should be positive (+) battery voltage at pin 2.

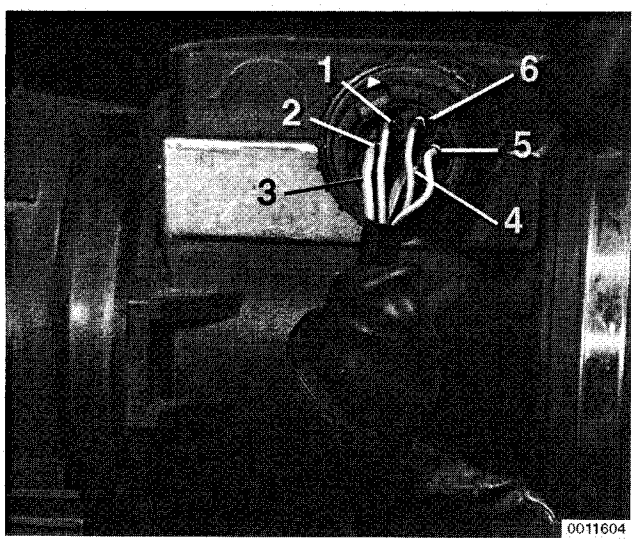



**Fig. 26.** Mass air flow sensor terminal identification on cars with DME M3.1 fuel injection.

8. With ignition off, disconnect harness connector from air flow sensor. Using a digital multimeter, check resistance at terminals listed.

**Air Flow Sensor Test Values (DME M3.1)**

- Terminals 5 and 6. . . . . 3-4 ohms

If any faults are found, check wiring to and from the ECM. Make ECM pinout test as listed in See **Table i**. Main power to air flow sensor comes from DME main relay.

## Mass air flow sensor (hot film), testing and replacing

On cars with DME M3.3.1 a hot film mass air flow sensor is used. When the engine is running, a current is used to heat a thin film in the center of the sensor. This current 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 air flow sensor has no internal moving parts and cannot be serviced or adjusted.

***CAUTION —***
*Use only a digital multimeter when checking the mass air flow sensor. An analog meter can damage the air flow sensor.*

1. Disconnect harness connector from air flow sensor.

2. Turn ignition on and check for voltage and ground at connector. There should be ground at pin 1. There should be positive (+) battery voltage at pin 3. If any faults are found, check wiring to and from ECM. Make ECM pinout test. See **Table j**.

***NOTE —***
*Positive (+) battery voltage to air flow sensor comes from DME main relay when the ignition is switch on or engine running.*

## Engine coolant temperature (ECT) sensor, testing and replacing

The engine coolant temperature (ECT) sensor sends continuous engine coolant temperature information to the ECM. As temperature increases sensor resistance decreases.

**ECT Sensor Location**

- M50/S50US engine . . . . . left side of cylinder head under intake manifold

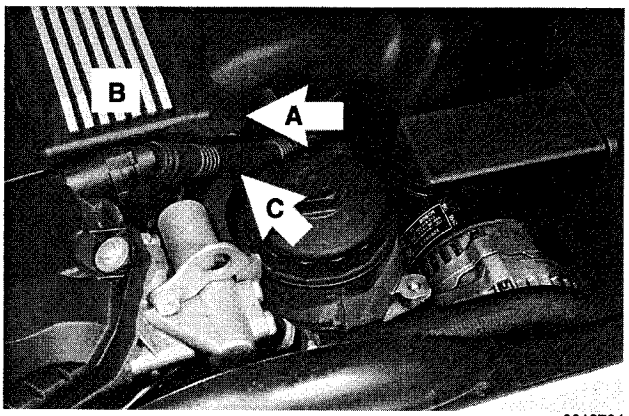



**Fig. 27.** Engine coolant temperature (ECT) sensor (**A**) is located beneath top engine cover (**B**) and crankcase vent hose (**C**). M52 engine shown. M50 is similar.

1. Check ECM reference voltage to sensor:
   - Disconnect harness connector from ECT sensor.
   - Turn ignition key on.
   - Check for 5 volts between supply voltage wire (brown/red) wire of harness connector and ground.
   - Turn ignition key off.
   - If voltage is not present or incorrect, check wiring from ECM and check reference voltage output at ECM (pin 78). See **Table i** (DME 3.1) or **Table j** (DME 3.3.1)

2. Check ECT sensor resistance:
   - With harness connector disconnected, check resistance across sensor terminals.
   - Compare tests results to values in **Table f**.

**Table f. Engine Coolant Temperature Sensor or Intake Air Temperature Sensor Test Values (DME 3.1/3.3.1)**

| Test temperatures | 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. Check the full linear response to increasing temperatures as the engine warms up.*

3. If ECT sensor fails these tests, it is faulty and should be replaced. If no faults are found, reconnect electrical harness.

***WARNING —***
*Do not replace the ECT sensor unless the engine is cold. Hot coolant can scald.*

***NOTE —***
- *Use a new copper sealing washer when installing sensor. Replace any lost coolant.*

**Tightening Torque**
- Engine coolant temperature sensor to cylinder head . . . . . 13 Nm (10 ft-lb)

## Intake air temperature (IAT) sensor, testing and replacing

The intake air temperature (IAT) sensor signal is used as a correction factor for fuel injection and ignition timing. This sensor is mounted in the intake manifold behind the throttle position switch. See Fig. 28.

1. Check that ECM reference voltage is reaching IAT sensor:
   - Disconnect IAT sensor harness connector.
   - Turn ignition key on.
   - Check for 5 volts between supply voltage wire of harness connector and ground.
   - Turn ignition key off.

**IAT Sensor Supply Voltage**
- M50/S50US engines . . . . . grey wire and ground

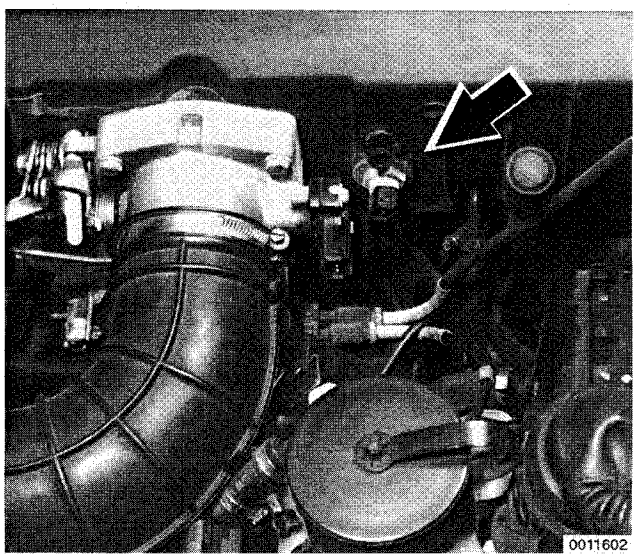



**Fig. 28.** Intake air temperature sensor location on M50/S50US engine (**arrow**).

If voltage is not present or incorrect, check wiring from ECM and check reference voltage signal at ECM (pin 77). See **Table i** or **Table j**.

2. Check IAT sensor resistance:
   - With harness connector disconnected, check resistance across sensor terminals. Compare tests results to values in **Table f** given earlier.
   - If IAT sensor fails this test it is faulty and should be replaced.
3. If no faults are found, reconnect electrical harness.

## Throttle position sensor (TPS), testing and replacing

The throttle position sensor (TPS) is mounted on the side of the 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.

Check TPS function by disconnecting the harness connector and testing continuity across the terminals while changing the throttle position. Resistance test values are listed below. If the results are incorrect, replace the throttle position sensor. See Fig. 29.

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

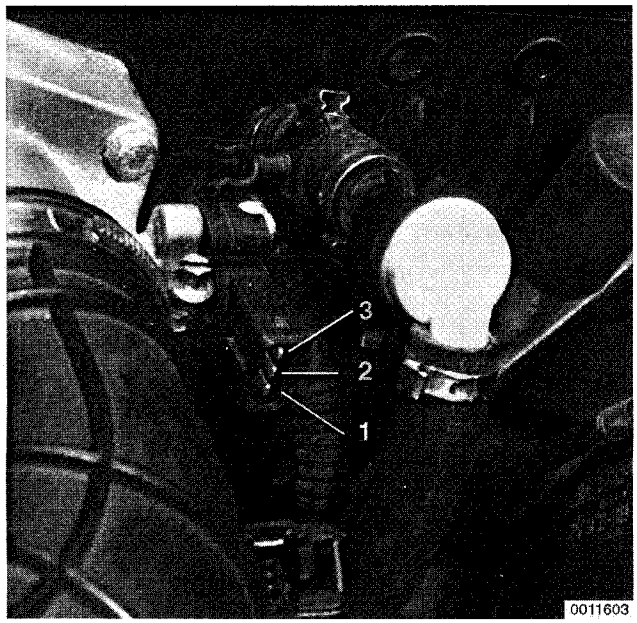



**Fig. 29.** Throttle position sensor terminal identification on M50 engine.

**Table g. Throttle Position Sensor Tests (DME 3.1/3.3.1)**

| Test conditions | Terminals | Test value |
|---|---|---|
| Harness connector disconnected, ignition on | 3 and ground in harness connector | 5 VDC (approx.) |
| Harness connector disconnected, ignition off | 1 and 3 at sensor terminals | 4 k ohms (approx.) |
| Throttle plate rotated from idle to full throttle position | 1 and 2 at sensor terminals | Variable from 1 – 4 k ohms (approx.) without interruption |

***NOTE —***
*On cars with traction control, do not confuse the throttle position sensor on the main throttle body with the throttle position switch on the secondary throttle body, where applicable.*

## Idle speed control valve, testing

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 idle speed adjustments can be made.

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

***NOTE —***
*• The tests given below are electrical checks only. They do not check the mechanical operation of the valve. If the valve is suspected of causing poor idle, substituting a known good valve is the best way to check for a mechanical fault.*

1. With engine running, check that idle speed control valve is buzzing.
2. Turn on A/C or shift car into drive. Idle should remain steady or increase slightly.
3. If valve is not buzzing, or if idle decreases in step 2, stop engine and disconnect harness connector from valve. Check resistance of valve across its terminals. See Fig. 30. Test values are listed below.

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

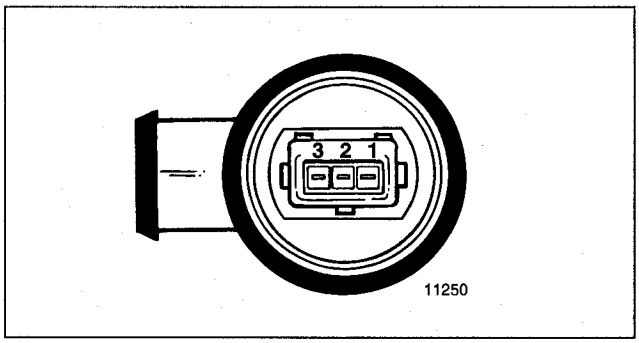



**Fig. 30.** Idle speed control valve terminal identification.

**Idle Speed Control Valve Coil Resistance Values**

• M50/S50US engine
Terminals 1 and 2 . . . . . 20 ± 5 ohms
Terminals 2 and 3 . . . . . 20 ± 5 ohms
Terminals 1 and 3 . . . . . 40 ± 5 ohms

4. 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 relay terminal 87. See **Electrical Wiring Diagrams**.

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

5. 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 meter reading reacts while the idle speed remains steady.*
- *There are some additional inputs to the control module that affect idle speed (i.e. throttle position, A/C-on signals, and A/T Drive position). Check these signals if idle problems persist. See* **Table i** *or* **Table j**.

## Idle speed control valve, replacing

The idle speed control valve is mounted beneath the intake manifold. Accessing the valve is best accomplished by first removing the intake manifold.

***NOTE —***

*It is recommended that the intake manifold gaskets be replaced whenever the intake manifold is removed.*

1. Remove top engine covers from engine. See Fig. 31.

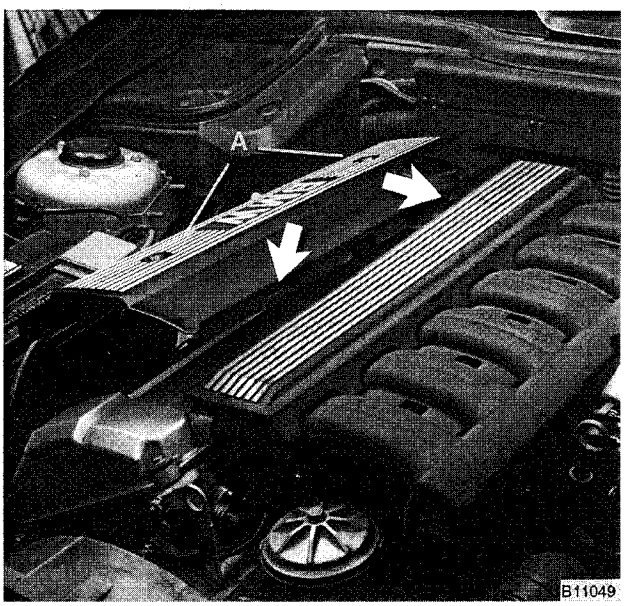



**Fig. 31.** Remove top engine covers by prying out caps and removing nuts (**A**). Note rubber gaskets at cover edge (**arrows**).

2. Remove two hold down nuts from fuel injector wiring duct. Pry back injector connector retainers and lift off wiring duct.
3. Disconnect intake air boot from throttle housing. Where applicable disconnect accelerator cable and cruise control cable from their brackets.
4. Unbolt intake manifold and move it out of way enough to access idle speed control valve.

***NOTE —***

*The intake manifold is held in place with 7 nuts from above and 2 support bracket bolts from underneath. On DME 3.1 cars, carefully disconnect the idle air hose from the intake manifold when lifting the manifold off. For more information, see* **113 Cylinder Head Removal and Installation**.

5. Disconnect all necessary hoses and remove idle speed control valve.
6. Installation is reverse of removal. Use new gaskets when installing intake manifold.

***NOTE —***

*Poor driveability may be noticed after installing a replacement idle speed control valve. After about 10 minutes of driving, the system will adapt the base setting of the valve and the idle speed should return to normal.*

**Tightening Torque**

- Intake manifold to cylinder head (M7) . . . . . 15±2 Nm (11±1 ft-lb)

# BOSCH DME M5.2 COMPONENT REPLACEMENT

On-Board Diagnostics II (OBD II) is incorporated into the Bosch DME M5.2 engine management systems used on the M44 engine. OBD II is capable of detecting a full range of faults. When faults are detected, a Diagnostic Trouble Code (DTC) is stored in the system ECM. The Check Engine warning light will also come on if an emissions-related fault is detected.

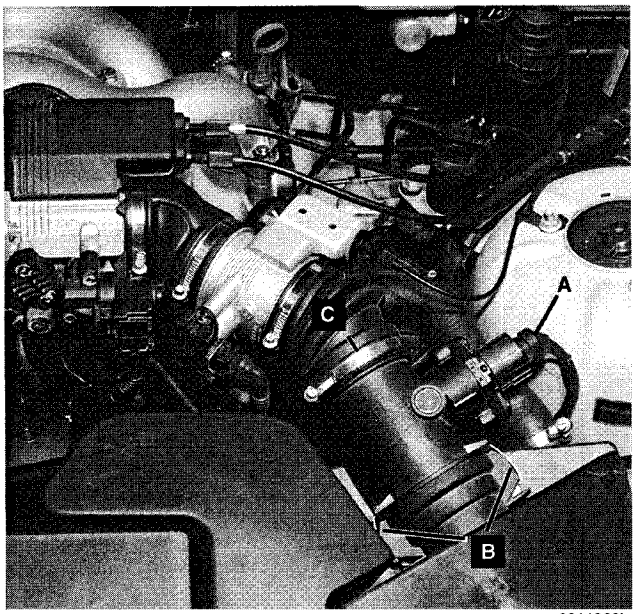
The most efficient way to diagnose the Bosch OBD II system is by using a specialized scan tool. The OBD II system is capable of storing hundreds of faults, making diagnostics with a scan tool the only viable method. Therefore, system diagnostics is not covered here.

***NOTE —***

- *The OBD II fault memory (including an illuminated Check Engine light) can only be reset using the special scan tool. Removing the connector from the ECM or disconnecting the battery will not erase the fault memory.*
- *The 16-pin OBD II diagnostic connector is located on the lower left dash panel. Refer to Fig. 1.*
- *BMW special scan tool or a "generic" OBD II scan tool must be used to access DTCs.*
- ***Table k** lists engine control module (ECM) pinouts for the DME M5.2 system*

## Mass air flow sensor, replacing

1. Disconnect harness connector and intake air boot from air flow sensor. See Fig. 32.




0011969b

**Fig. 32.** To detach air flow sensor, disconnect harness connector (**A**); unclip retaining clips to air filter housing (**B**); and remove large hose clamp at air intake bellows (**C**). M44 engine with traction control shown.

2. Detach two large clips at air filter housing and work air flow sensor out of rubber seal in filter housing.

3. Installation is reverse of removal.
   - For ease of installation, lubricate large rubber seal in air filter housing with silicone lubricant or equivalent.
   - No adjustment to air flow sensor is possible.
   - Carefully check that all hoses and seals are seated properly.

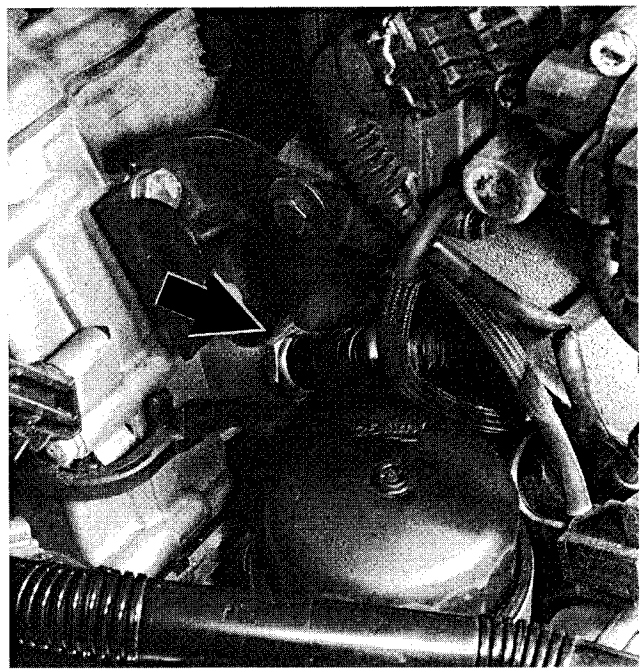
## Engine coolant temperature (ECT) sensor, replacing

The engine coolant temperature (ECT) sensor is a dual temperature sensor. One circuit provides coolant temperature information to the ECM while the other circuit provides coolant temperature information to the instrument cluster.

> ***WARNING —***
> *Do not replace the ECT sensor unless the engine is cold. Hot coolant can scald.*

1. Disconnect harness connector from ECT sensor. See Fig. 33.

2. Unscrew temperature sensor from cylinder head and remove



0011984a

**Fig. 33.** M44 engine coolant temperature (ECT) sensor located above oil filter (**arrow**).

3. Installation is reverse of removal.
   - Use a new copper sealing washer when installing sensor.
   - Replace any lost coolant.

**Tightening Torque**
- Engine coolant temperature to cylinder head . . . . . 13 Nm (10 ft-lb)

## Intake air temperature (IAT) sensor, replacing

The intake air temperature (IAT) sensor on cars with M44 engine is mounted in the top section of the intake air filter housing. See Fig. 34.

1. Remove electrical harness connector from IAT sensor.

2. Unclip temperature sensor and remove from air filter housing.

3. Installation is reverse of removal.

## Throttle position sensor (TPS), replacing

The throttle position sensor is located on the side of the throttle housing. See Fig. 35.

1. Unplug harness connector from sensor.

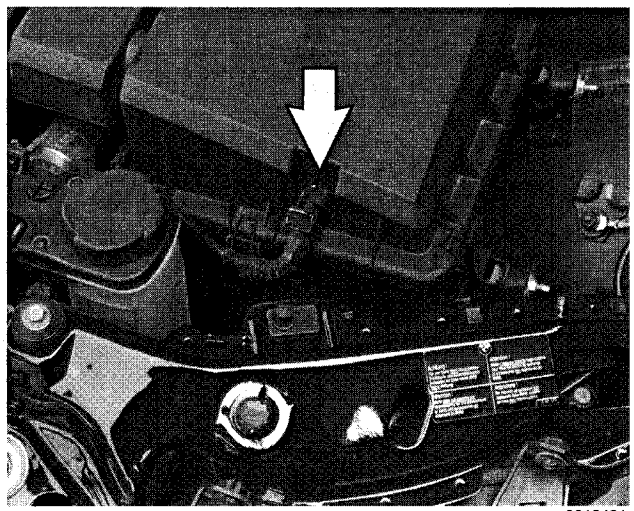



**Fig. 34.** Intake air temperature (IAT) sensor in top section of air filter housing.

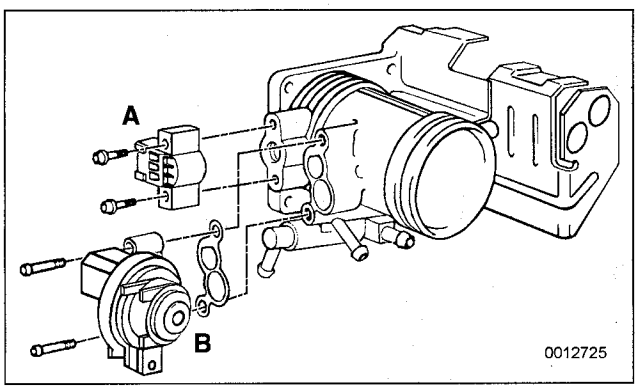



**Fig. 35.** M44 engine: Throttle housing showing (**A**) throttle position sensor (TPS) and (**B**) idle speed control valve.

2. Remove two mounting screws holding sensor to throttle housing.

3. Installation is reverse of removal. No adjustment is necessary.

## Idle speed control valve, replacing

The idle speed valve on the M44 engine is located on the side of the throttle body. See Fig. 35.

1. Disconnect harness connector from idle valve.

2. Disconnect vacuum hose and retaining screws.

3. Pull idle speed control valve from its fittings.

4. Installation is reverse of removal. Always replace O-rings and seals.

***NOTE —***
*Poor driveability may be noticed after installing a replacement idle control valve. After about 10 minutes of driving, the idle speed should return to normal.*

# SIEMENS MS 41.1 COMPONENT REPLACEMENT

On-Board Diagnostics II (OBD II) is incorporated into the Siemens MS 41.1 engine management systems used in the M52 and S52US engine. Refer to Fig. 36.

OBD II is capable of detecting a full range of faults. When faults are detected, a Diagnostic Trouble Code (DTC) is stored in the system ECM. The Check Engine warning light will also come on if an emissions-related fault is detected. The most efficient way to diagnose the Siemens OBD II system is by using a specialized scan tool. The OBD II system is capable of storing hundreds of faults, making diagnostics with a scan tool the only viable method. Therefore, system diagnostics is not covered here.

***NOTE —***
- *The OBD II fault memory (including an illuminated Check Engine light) can only be reset using the special scan tool. Removing the connector from the ECM or disconnecting the battery will not erase the fault memory.*
- *The 16-pin OBD II diagnostic connector is located on the lower left dash panel. Refer to Fig. 1.*
- *BMW special scan tool or a "generic" OBD II scan tool must be used to access DTCs.*
- ***Table I** lists engine control module (ECM) pinouts for the MS 41.1 systems.*

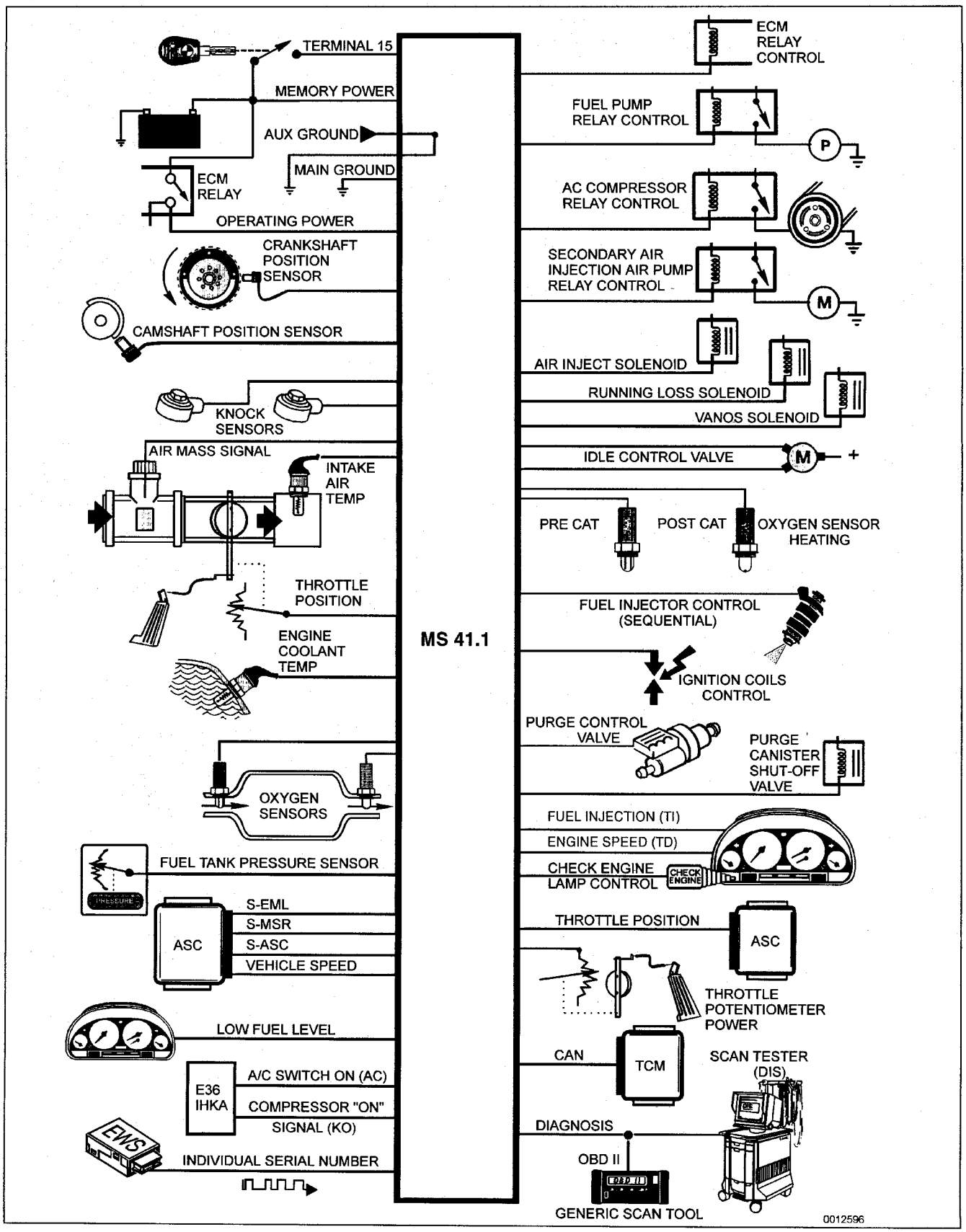
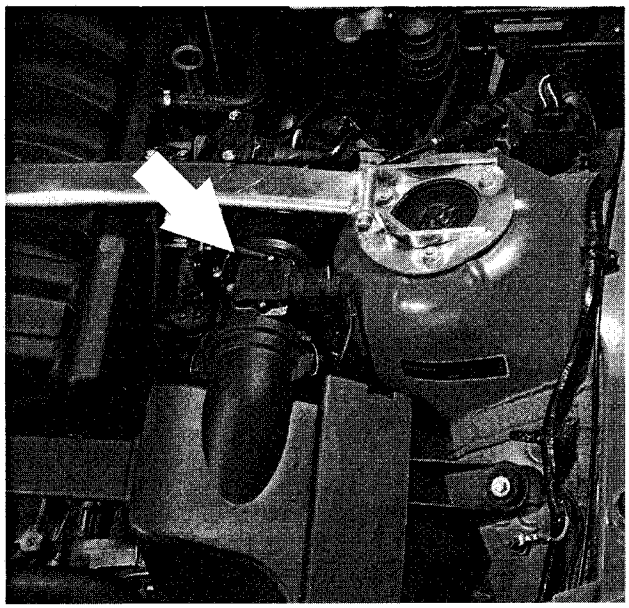



**Fig. 36.** Siemens MS 41.1 OBD II engine management system used on M52 engine. Bosch M5.2 system used on M44 engine is similar.

*SIEMENS MS 41.1 COMPONENT REPLACEMENT*

## Mass air flow sensor, replacing

1. Disconnect harness connector and intake air boots from air flow sensor. See Fig. 37.



0012703

**Fig. 37.** Mass air flow sensor (**arrow**) on M52 engine.

2. Installation is reverse of removal.
   - No adjustment to air flow sensor is possible.
   - Check intake hoses for cracks and vacuum leaks.

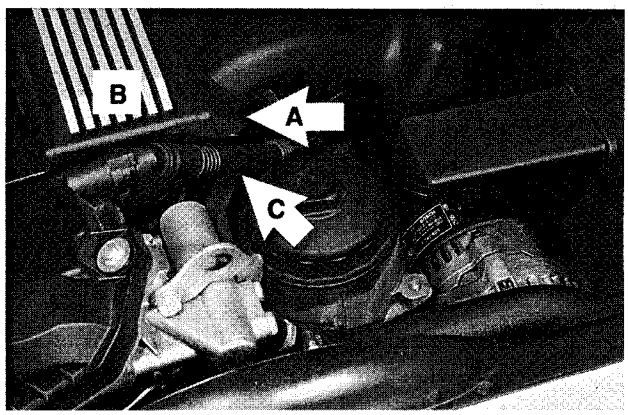
## Engine coolant temperature (ECT) sensor, replacing

The ECT sensor is a dual temperature sensor. One circuit provides coolant temperature information to the ECM while the other circuit provides coolant temperature information to the instrument cluster.

1. Remove left-side top engine cover.
2. Unclip crankcase venting hose from cylinder head cover. See Fig. 38.
3. Under intake manifold, disconnect harness connector from sensor.
4. Remove sensor.
5. Installation is reverse of removal.
   - Use a new copper sealing washer when installing new sensor.
   - Replace any lost coolant.

**Tightening Torque**

- Engine coolant temperature to cylinder head . . . . . 13 Nm (10 ft-lb)

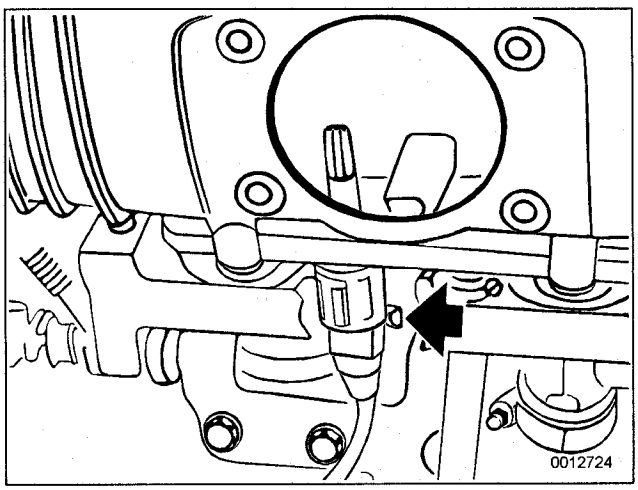



0012704b

**Fig. 38.** M52 engine: Engine coolant temperature (ECT) sensor (**A**) is located beneath top engine cover (**B**) and crankcase vent hose (**C**).

## Intake air temperature (IAT) sensor, replacing

The intake air temperature (IAT) sensor for the M52/S52US engine is mounted on the bottom of the intake manifold. See Fig. 39.



0012724

**Fig. 39.** M52/S52US engine: Intake air temperature sensor location in bottom of intake manifold (**arrow**). Throttle housing shown removed.

1. Disconnect intake air boot from throttle housing. Unbolt throttle housing and lay aside. (It is not necessary to disconnect throttle cable or electrical harness connectors from throttle housing.)
2. Remove electrical harness connector from IAT sensor.
3. Unclip temperature sensor and remove from intake manifold.
4. Installation is reverse of removal. Use a new gasket at the throttle housing.

## Throttle position sensor (TPS), replacing

The throttle position sensor is located on the side of the throttle housing. See Fig. 40.

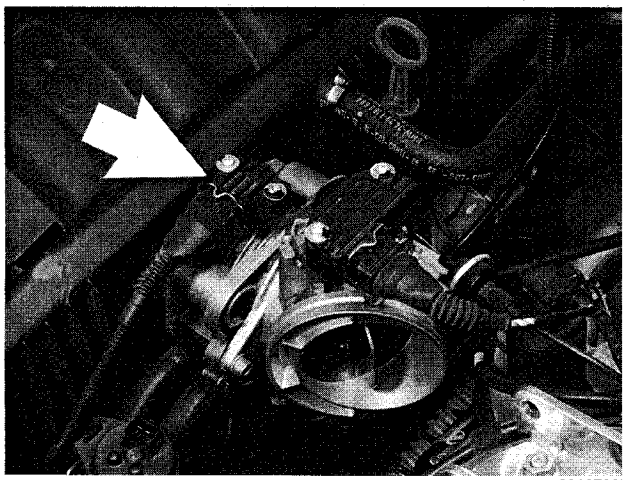



**Fig. 40.** M52 engine: Throttle position sensor (**arrow**).

1. Unplug harness connector from sensor.

***NOTE —***
*On cars with traction control, do not confuse the throttle position sensor on the main throttle body with the throttle position switch on the secondary throttle body, where applicable.*

2. Remove two mounting screws holding sensor to throttle housing.

3. Installation is reverse of removal.

## Idle speed control valve, replacing

The idle speed control valve is mounted on the underside of the intake manifold adjacent to the dipstick tube bracket. Accessing the valve is best accomplished by first removing the throttle housing.

1. Disconnect intake air boot from throttle housing. Unbolt throttle body and lay aside. (Do not disconnect throttle cable or electrical harness connectors to throttle body.)

2. Unbolt dipstick tube bracket from intake manifold.

3. Working under intake manifold, disconnect electrical harness connector from idle speed control valve.

4. Remove two bolts retaining idle speed control valve to underside of intake manifold. Remove valve from intake manifold. Remove hose clamp and disconnect hose.

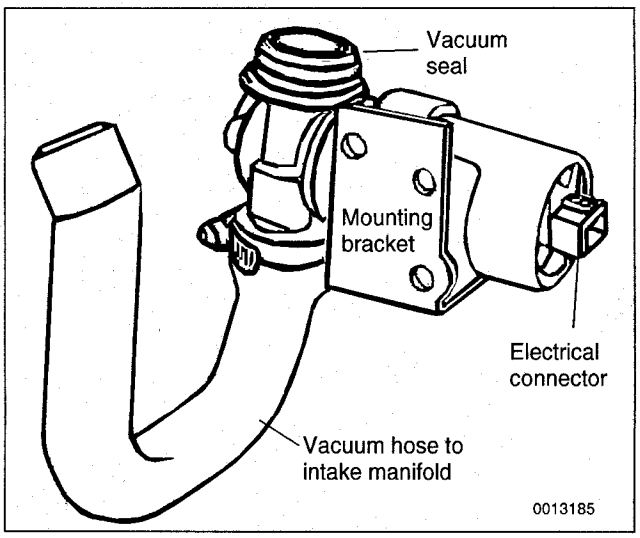



**Fig. 41.** M52 engine: Idle speed control valve (located under intake manifold).

5. Installation is reverse of removal. Use new gaskets when installing.

***NOTE —***
*Poor driveability may be noticed after installing a replacement idle speed control valve. After about 10 minutes of driving the idle speed should return to normal.*

# ECM PIN ASSIGNMENTS

## Engine control module (ECM), accessing

1. Disconnect negative (–) battery cable. Wait approximately one minute.

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

2. Remove engine control module (ECM) compartment cover from right side of engine compartment rear bulkhead. Cover is retained with four captive screws. See Fig. 42.

3. Disconnect control module harness connector by releasing fastener and pivoting connector up and off ECM.

4. Remove ECM from retaining brackets and pull ECM from its holder.

5. Installation is reverse of removal.

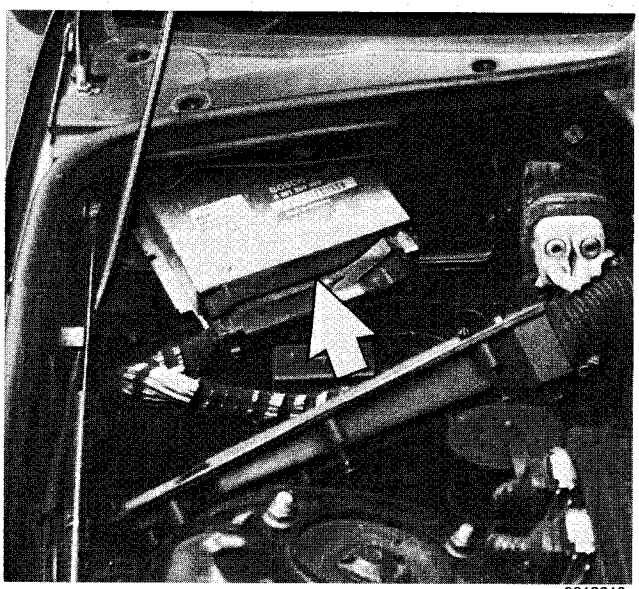



**Fig. 42.** Engine control module (ECM) located in compartment in right-rear of engine compartment (**arrow**).

***NOTE —***

*Replacement ECMs must be coded with application information (i.e. engine code, transmission type, etc.) prior to installation. Consult an authorized BMW dealer before replacing the ECM.*

ECM pin assignments are given in **Tables h** through **Table I**. 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 itself may be faulty.

Generally, absence of voltage or continuity means there is a wiring or connector problem. Test results with incorrect values do not necessarily mean that a component is faulty. Check for loose, broken or corroded connections and wiring before replacing components. If the results are still incorrect, test the component itself. For engine management system electrical schematics, 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 from the back of the connector. ECM pin numbering is shown in Fig. 43.

***NOTE —***

*On cars with traction control, do not confuse the throttle position sensor on the main throttle body with the throttle position switch on the secondary throttle body.*

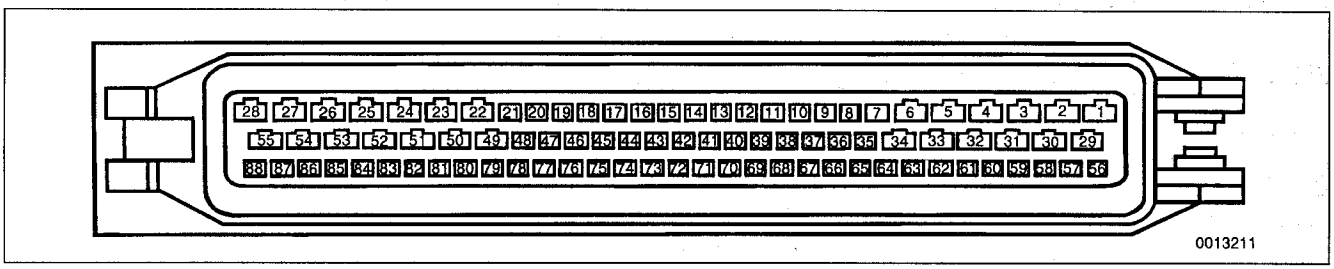



**Fig. 43.** ECM pin numbers as seen from back of ECM connector.

**Table h. ECM Pin Assignment—Bosch DME M1.7**

| Pin | Signal | Component/function | Signal |
|---|---|---|---|
| 1 | Output | Fuel pump relay control | Fuel pump relay, terminal 85 |
| 2 | Not used | | |
| 3 | Output | Cyl. 2 and cyl. 4 fuel injection valve control | Cyl. 2 and cyl. 4 fuel injection valves |
| 4 | Not used | | |
| 5 | Not used | | |
| 6 | Ground | Ground, fuel injection valve output stages | Ground point |
| 7 | Not used | | |
| 8 | Output | "Check engine" indicator control | Instrument cluster |
| 9 | Not used | | |
| 10 | Not used | | |
| 11 | Output | DKV potentiometer signal | Transmission control module (EGS) |
| 12 | Input | Throttle position sensor | Throttle position signal |
| 13 | Not used | | |
| 14 | Input | Volume air flow sensor | Volume air flow sensor (signal ground) |
| 15 | Input | Cyl. 1-2 knock sensor | Cyl. 1-2 knock sensor |
| 16 | Input | Camshaft position sensor (cylinder identification) | Camshaft position sensor (cylinder identification) |
| 17 | Output | ti measurement signal (fuel consumption) | Instrument cluster |
| 18 | Output | Intake air resonance changeover valve (DISA) | Intake air resonance changeover valve |
| 19 | Not used | | |
| 20 | Not used | | |
| 21 | Not used | | |
| 22 | Not used | | |
| 23 | Not used | | |
| 24 | Output | Cyl. 3 ignition coil control | Cyl. 3 ignition coil |
| 25 | Output | Cyl. 1 ignition coil control | Cyl. 1 ignition coil |
| 26 | Input | Battery voltage | B + junction point |
| 27 | Output | Engine control module relay control | Engine control module relay, terminal 85 |
| 28 | Ground | Ground for electronics and shielding of sensors | Ground point |
| 29 | Output | Idle speed control valve control | Idle speed control valve |
| 30 | Not used | | |
| 31 | Not used | | |
| 32 | Output | Cyl. 1 and cyl. 3 fuel injection valve control | Cyl. 1 and cyl. 3 fuel injection valves |
| 33 | Not used | | |
| 34 | Ground | Ground, output stages (except for ignition and fuel injection valves) | Ground point |
| 35 | Not used | | |
| 36 | Output | Evaporative emission valve control | Evaporative emission valve |
| 37 | Output | Oxygen sensor heater control | Oxygen sensor relay, terminal 85 |
| 38 | Not used | | |
| 39 | Not used | | |
| 40 | Not used | | |
| 41 | Input | Volume Air Flow sensor | Volume air flow sensor (voltage varies with engine load) |
| 42 | Input | Cyl. 3-4 knock sensor | Cyl. 3-4 knock sensor |
| 43 | Ground | Ground for sensors | Engine coolant temperature sensor, cyl. 1-2 knock sensor, cyl. 3-4 knock sensor, and throttle position sensor |
| 44 | Input | Camshaft position sensor (cylinder identification) | Camshaft position sensor (cylinder identification) |

*ECM PIN ASSIGNMENTS*

**Table h. ECM Pin Assignment—Bosch DME M1.7**

| Pin | Signal | Component/function | Signal |
|---|---|---|---|
| 45 | Not used | | |
| 46 | Not used | | |
| 47 | Not used | | |
| 48 | Output | A/C compressor cut-out | Compressor control relay, terminal 85 |
| 49 | Not used | | |
| 50 | Not used | | |
| 51 | Output | Cyl. 4 ignition coil control | Cyl. 4 ignition coil |
| 52 | Output | Cyl. 2 ignition coil control | Cyl. 2 ignition coil |
| 53 | Not used | | |
| 54 | Input | Battery voltage from engine control module | Engine control module relay, terminal 87a |
| 55 | Ground | Ground, ignition | Ground point |
| 56 | Input | Ignition switch, terminal 15 | Ignition switch, terminal 15 |
| 57 | Not used | | |
| 58 | Not used | | |
| 59 | Output | Throttle position sensor and volume air flow sensor | Reference voltage (5 VDC) |
| 60 | Input | Programming voltage | Data link connector |
| 61 | Not used | | |
| 62 | Not used | | |
| 63 | Not used | | |
| 64 | Input | Ignition timing intervention | Transmission control module (EGS) |
| 65 | Input | Drive range P/N | Automatic transmission range switch |
| 66 | Not used | | |
| 67 | Input | Crankshaft position RPM sensor | Crankshaft position RPM sensor |
| 68 | Input | Crankshaft position RPM sensor | Crankshaft position RPM sensor |
| 69 | Not used | | |
| 70 | Input | Oxygen sensor signal | Heated oxygen sensor |
| 71 | Ground | Oxygen sensor signal ground | Heated oxygen sensor |
| 72 | Not used | | |
| 73 | Input | Vehicle speed signal | Instrument cluster |
| 74 | Output | Engine speed signal | Instrument cluster |
| 75 | Not used | | |
| 76 | Input | Volume air flow sensor | Volume air flow sensor |
| 77 | Input | Intake air temperature sensor (IAT) | Intake air temperature sensor (IAT) |
| 78 | Input | Engine coolant temperature | Engine coolant temperature sensor |
| 79 | Not used | | |
| 80 | Not used | | |
| 81 | Input | Drive-away protection signal (code) | On-board computer |
| 82 | Not used | | |
| 83 | Not used | | |
| 84 | Not used | | |
| 85 | Input | A/C pressure | Pressure switch |
| 86 | Input | A/C switch | Integrated climate regulation control module |
| 87 | Output | RxD diagnosis data line | Data link connector |
| 88 | Output-Input | TxD diagnosis data line | Data link connector |

**Table i. ECM Pin Assignment—Bosch DME M3.1**

| Pin | Signal | Component/function | Signal |
|---|---|---|---|
| 1 | output | Fuel pump relay control | 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 control, cyl. 1 | Pulsed ground (injection pulse width in ms) with engine running |
| 4 | output | Fuel injector control, cyl. 3 | Pulsed ground (injection pulse width in ms) with engine running |
| 5 | output | Fuel injector control, cyl. 2 | Pulsed ground (injection pulse width in ms) with engine running |
| 6 | ground | Ground | Ground for fuel injector output stages |
| 7 | vacant | — | — |
| 8 | output | Check Engine | Check engine lamp control ground |
| 9 | vacant | — | — |
| 10 | vacant | — | — |
| 11 | output | Throttle valve position | Load signal to transmission control module |
| 12 | input | Throttle position sensor | Voltage varies with throttle position |
| 13 | output | Mass air flow sensor | Air flow sensor hot wire burn off (voltage for 0.5 seconds after shutdown) |
| 14 | ground | Mass air flow sensor | Ground for air flow sensor |
| 15 | vacant | — | — |
| 16 | input | Cylinder identification sensor | A/C voltage pulse per camshaft revolution (between pin 16 and 44) |
| 17 | output | Fuel consumption (ti) | Fuel consumption output (KVA signal) to instrument cluster |
| 18 | vacant | — | — |
| 19 | vacant | — | — |
| 20 | vacant | — | — |
| 21 | vacant | — | — |
| 22 | vacant | — | — |
| 23 | output | Ignition control (terminal 1), cyl. no. 2 | Primary signal, ignition coil cyl. no. 2 |
| 24 | output | Ignition control (terminal 1), cyl. no. 3 | Primary signal, ignition coil cyl. no. 3 |
| 25 | output | Ignition control (terminal 1), cyl. no. 1 | Primary signal, ignition coil cyl. no. 1 |
| 26 | input | Power supply (terminal 30) | Battery voltage (B+) at all times (terminal 30) |
| 27 | output | Main relay control | Main relay activation (to relay terminal 85) |
| 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. no. 5 | Pulsed ground (injection pulse width in ms), cyl. no. 5 |
| 32 | output | Fuel injector, cyl. no. 6 | Pulsed ground (injection pulse width in ms), cyl. no. 6 |
| 33 | output | Fuel injector, cyl. no. 4 | Pulsed ground (injection pulse width in ms), cyl. no. 4 |
| 34 | ground | Ground | Ground for output stages |
| 35 | vacant | | |
| 36 | output | Evaporative purge valve control | Pulsed ground with engine at normal temperature and varying engine load |
| 37 | output | Oxygen sensor heater relay control | Oxygen sensor heater relay activation (ground at terminal 85) |
| 38 | vacant | — | — |
| 39 | vacant | — | — |
| 40 | vacant | — | — |
| 41 | input | Mass air flow sensor | Voltage (+) |
| 42 | vacant | — | — |
| 43 | ground | Ground | Ground for temperature sensors (ECT sensor, IAT sensor, TP sensor) |
| 44 | input | Cylinder identification sensor | A/C voltage pulse per camshaft revolution (between pin 16 and 44) |

**Table i. ECM Pin Assignment—Bosch DME M3.1**

| Pin | Signal | Component/function | Signal |
|---|---|---|---|
| 45 | vacant | — | — |
| 46 | vacant | — | — |
| 47 | vacant | — | — |
| 48 | output | A/C compressor control | A/C compressor disabled via compressor control relay |
| 49 | vacant | — | — |
| 50 | output | Ignition control (terminal 1), cyl. no. 4 | Primary signal, ignition coil cyl. no. 4 |
| 51 | output | Ignition control (terminal 1), cyl. no. 6 | Primary signal, ignition coil cyl. no. 6 |
| 52 | output | Ignition control (terminal 1), cyl. no. 5 | Primary signal, ignition coil cyl. no. 5 |
| 53 | vacant | — | — |
| 54 | input | Power supply | Battery voltage (+) from main relay terminal 87 |
| 55 | ground | Ground | Ground for ignition control |
| 56 | input | Power supply (terminal 15) | Battery voltage (+) with key on or engine running |
| 57 | vacant | — | — |
| 58 | vacant | — | — |
| 59 | output | Throttle position sensor | Throttle position sensor supply voltage (5 VDC) |
| 60 | input | Data link connector | Programming voltage |
| 61 | vacant | — | — |
| 62 | vacant | — | — |
| 63 | vacant | — | — |
| 64 | input | Ignition timing intervention | from A/T control module (only active during gearshift) |
| 65 | input | Automatic transmission (A/T) range switch | Transmission park or neutral signal |
| 66 | vacant | — | — |
| 67 | input | Engine speed/crankshaft position sensor | Crankshaft position/rpm (voltage (VAC) between pins 67 and 68) |
| 68 | input | Engine speed/crankshaft position sensor | Crankshaft position/rpm (voltage (VAC) between pins 67 and 68) |
| 69 | vacant | — | — |
| 70 | input | Oxygen sensor | Oxygen sensor signal (0–1 VDC fluctuating with engine running) |
| 71 | ground | Oxygen sensor | Oxygen sensor signal ground |
| 72 | vacant | — | — |
| 73 | input | Road speed | Road speed signal from instrument cluster |
| 74 | output | Engine speed (TD) | Engine speed (TD) signal to instrument cluster |
| 75 | vacant | — | — |
| 76 | vacant | — | — |
| 77 | input | Intake air temperature (IAT) sensor | Intake air temperature (0-5 V, temperature dependent) |
| 78 | input | Engine coolant temperature (ECT) sensor | Engine coolant temperature (0-5 V, temperature dependent) |
| 79 | vacant | — | — |
| 80 | vacant | — | — |
| 81 | input | On-board computer | Drive-away protection enable |
| 82 | vacant | — | — |
| 83 | vacant | — | — |
| 84 | vacant | — | — |
| 85 | input | A/C pressure switch | From Integrated climate control module via A/C pressure switch |
| 86 | input | A/C compressor on | From Integrated climate control module |
| 87 | input | Diagnostic connector (RxD) | Diagnostic RxD (receive) signal to pin 15 in Data link connector |
| 88 | input/output | Diagnostic connector (TxD) | Diagnostic TxD (transmit) signal to pin 20 in Data link connector |

**Table j. ECM Pin Assignment—Bosch DME M3.3.1**

| Pin | Signal | Component/function | Signal |
|---|---|---|---|
| 1 | output | Fuel pump relay control | 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 control, cyl. 5 | Pulsed ground (injection pulse width in ms) cyl. 5 |
| 4 | output | Fuel injector control, cyl. 6 | Pulsed ground (injection pulse width in ms) cyl. 6 |
| 5 | output | Fuel injector control, cyl. 4 | Pulsed ground (injection pulse width in ms) cyl. 4 |
| 6 | ground | Ground | Ground for fuel injector output stage |
| 7 | output | Camshaft actuator (VANOS solenoid) control | Camshaft actuator (VANOS solenoid) |
| 8 | output | Check Engine | Instrument cluster, Check Engine lamp |
| 9 | vacant | — | — |
| 10 | vacant | — | — |
| 11 | output | Throttle position | Throttle angle signal to A/T control module |
| 12 | vacant | — | — |
| 13 | input | Oxygen sensor | Oxygen sensor signal (0-1 VDC fluctuating with engine running) |
| 14 | input | Mass air flow sensor | Mass air flow sensor |
| 15 | ground | Ground | Ground |
| 16 | input | Crankshaft position/rpm sensor | Voltage pulse (VAC) between pin 16 and 43 (crank position/rpm sensor) |
| 17 | input | Camshaft position sensor | Hall effect camshaft sensor |
| 18 | vacant | — | — |
| 19 | vacant | — | — |
| 20 | vacant | — | — |
| 21 | vacant | — | — |
| 22 | vacant | — | — |
| 23 | output | Ignition coil control, cyl. 4 | Ignition coil 4 |
| 24 | output | Ignition coil control, cyl. 6 | Ignition coil 6 |
| 25 | output | Ignition coil control, cyl. 5 | Ignition coil 5 |
| 26 | input | Power supply (terminal 30) | Battery voltage (B+) at all times |
| 27 | input | Main relay control | Main relay activation (terminal 85) |
| 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 control, cyl. 3 | Injection pulse width in ms—cyl. 3 |
| 32 | output | Fuel injector control, cyl. 2 | Injection pulse width in ms—cyl. 2 |
| 33 | output | Fuel injector control, cyl. 1 | Injection pulse width in ms—cyl. 1 |
| 34 | ground | Ground | Ground for remaining output stages |
| 35 | vacant | — | — |
| 36 | output | Evaporative purge valve control | |
| 37 | vacant | — | — |
| 38 | output | Oxygen sensor heater relay control | Oxygen sensor heater relay switchover (terminal 85) |
| 39 | vacant | — | — |
| 40 | ground | Oxygen sensor | Oxygen sensor signal ground |
| 41 | input | Mass air flow sensor | Mass air flow voltage signal |
| 42 | input | Vehicle speed | Vehicle speed signal from instrument cluster |
| 43 | input | Crankshaft position/rpm sensor | Voltage pulse (VAC) between pin16 and 43 |
| 44 | ground | Ground | Ground for intake air temp. sensor, engine coolant temp. sensor, throttle position sensor |

**Table j. ECM Pin Assignment—Bosch DME M3.3.1**

| Pin | Signal | Component/function | Signal |
|---|---|---|---|
| 45 | ground | Ignition circuit shield | Ground shield for ignition circuit monitoring |
| 46 | output | Fuel consumption (KVA signal) | To instrument cluster |
| 47 | output | Crankshaft rpm | Engine speed (TD) signal to instrument cluster |
| 48 | output | A/C compressor control | A/C compressor relay terminal 85 |
| 49 | vacant | — | — |
| 50 | output | Ignition coil control, cyl. 1 | Primary signal, ignition coil 1 |
| 51 | output | Ignition coil control, cyl. 2 | Primary signal, ignition coil 2 |
| 52 | output | Ignition coil control, cyl. 3 | Primary signal, ignition coil 3 |
| 53 | vacant | — | — |
| 54 | input | Power supply | Battery voltage from main relay (terminal 87a) |
| 55 | ground | Ground | Ground for ignition control |
| 56 | input | Power supply (terminal 15) | Battery voltage with key on or engine running |
| 57 | input | Ignition timing intervention | From A/T control module |
| 58 | vacant | — | — |
| 59 | output | Throttle position sensor (TPS) | Voltage supply to TPS (5 VDC) |
| 60 | input | Programming voltage | Data link connector |
| 61 | vacant | — | — |
| 62 | vacant | — | — |
| 63 | vacant | — | — |
| 64 | input | A/C on signal | From integrated climate control module |
| 65 | input | A/C pressure signal | From integrated climate control module via A/C pressure switch |
| 66 | input | On-board computer | Drive-away protection enable (starter immobilization relay) |
| 67 | vacant | — | — |
| 68 | vacant | — | — |
| 69 | input | Knock sensor #2 (cyl. 4, 5, 6) | Knock sensor #2 signal |
| 70 | input | Knock sensor #1 (cyl. 1, 2, 3) | Knock sensor #1 signal |
| 71 | ground | Ground | Ground for knock sensors and shields |
| 72 | vacant | — | — |
| 73 | input | Throttle position sensor (TPS) | Throttle position signal |
| 74 | vacant | — | — |
| 75 | vacant | — | — |
| 76 | vacant | — | — |
| 77 | input | Intake air temperature | Intake air temperature sensor (0-5 VDC) |
| 78 | input | Engine coolant temperature | Engine coolant temperature sensor (0-5 VDC) |
| 79 | vacant | — | — |
| 80 | vacant | — | — |
| 81 | input | Automatic transmission gear position/neutral safety switch | A/T park or neutral position signal |
| 82 | vacant | — | — |
| 83 | vacant | — | — |
| 84 | vacant | — | — |
| 85 | vacant | — | — |
| 86 | vacant | — | — |
| 87 | input | Diagnostic connector (RxD) | Diagnostic RxD (receive) signal to pin 15 in Data link connector |
| 88 | input/output | Diagnostic connector (TxD) | Diagnostic TxD (transmit) signal to pin 20 in Data link connector |

**Table k. ECM Pin Assignment—Bosch DME M5.2**

| Pin | Signal | Component/function | Signal |
|---|---|---|---|
| 1 | output | Oxygen sensor (monitoring sensor) heater | Oxygen sensor heater control (switched ground) |
| 2 | output | Idle speed control valve | Pulsed ground—close signal (see also pin 29) |
| 3 | output | Fuel injector control, cyl. 1 | Pulsed ground (injection pulse width in ms) cyl. 1 |
| 4 | output | Fuel injector control, cyl. 4 | Pulsed ground (injection pulse width in ms) cyl. 4 |
| 5 | not used | — | — |
| 6 | ground | Ground | Ground for fuel injector output stage |
| 7 | not used | — | — |
| 8 | output | Check Engine | Instrument cluster, Check Engine lamp |
| 9 | not used | — | — |
| 10 | input | Electronic immobilizer control (EWS II) | Electronic immobilizer control (EWS II) module |
| 11 | output | Automatic climate control | Automatic climate control, to evaporator controller |
| 12 | not used | — | — |
| 13 | not used | — | — |
| 14 | not used | — | — |
| 15 | not used | — | — |
| 16 | input | Intake air temperature | Intake air temperature signal |
| 17 | input | Mass air flow meter | Intake air signal |
| 18 | not used | — | — |
| 19 | input | Oxygen sensor (monitoring sensor) | Oxygen sensor control |
| 20 | output | Crankshaft/rpm sensor | Crankshaft/rpm sensor control |
| 21 | input | Camshaft position sensor | Camshaft position signal |
| 22 | output | Ignition coil control, cyl. 3 | Primary signal, ignition coil 3 |
| 23 | output | Ignition coil control, cyl. 4 | Primary signal, ignition coil 4 |
| 24 | not used | — | — |
| 25 | not used | — | — |
| 26 | input | Power supply (terminal 30) | Battery voltage (B+) at all times |
| 27 | input | Main relay control | Main relay activation (terminal 85) |
| 28 | ground | Ground | Ground for ECM and sensor shielding |
| 29 | output | Idle speed control valve | Pulsed ground—open signal (see also pin 2) |
| 30 | output | Oxygen sensor (monitoring sensor) heater | Oxygen sensor heater control (switched ground) |
| 31 | output | Fuel injector control, cyl. 3 | Pulsed ground (injection pulse width in ms) cyl. 3 |
| 32 | output | Fuel injector control, cyl. 2 | Pulsed ground (injection pulse width in ms) cyl. 2 |
| 33 | not used | — | — |
| 34 | ground | Ground | Ground for ECM/ output stages |
| 35 | not used | — | — |
| 36 | input | A/C compressor relay | A/C compressor relay control |
| 37 | not used | — | — |
| 38 | not used | — | — |
| 39 | not used | — | — |
| 40 | input | Knock sensor #2 (cyl. 3,4) | Knock sensor #2 signal |
| 41 | not used | — | — |
| 42 | input | Vehicle speed | Vehicle speed signal from instrument cluster |
| 43 | not used | — | — |
| 44 | output | Throttle position sensor (TPS) | Throttle position reference signal |

**Table k. ECM Pin Assignment—Bosch DME M5.2 (continued)**

| Pin | Signal | Component/function | Signal |
|---|---|---|---|
| 45 | output | Mass air flow meter | Intake air signal |
| 46 | output | Oxygen sensor (monitoring sensor) | Oxygen sensor control |
| 47 | not used | — | — |
| 48 | not used | — | — |
| 49 | output | Ignition coil control, cyl. 1 | Primary signal, ignition coil 1 |
| 50 | output | Ignition coil control, cyl. 2 | Primary signal, ignition coil 2 |
| 51 | not used | — | — |
| 52 | not used | — | — |
| 53 | input | Throttle position sensor | Throttle position signal |
| 54 | input | Power supply | Battery voltage from main relay (terminal 87) |
| 55 | ground | Ground | Ground for ECM |
| 56 | input | Power supply (terminal 15) | Battery voltage with key on or engine running |
| 57 | output | Activate cooling fan (man. trans.) control | Normal speed relay |
| 58 | not used | — | — |
| 59 | not used | — | — |
| 60 | input | Programming voltage | Programming voltage via data link connector, pin 18 |
| 61 | output | Evaporative emission valve | Evaporative emission valve control |
| 62 | vacant | — | — |
| 63 | output | Fuel pump relay | Fuel pump relay control |
| 64 | not used | — | — |
| 65 | not used | — | — |
| 66 | not used | — | — |
| 67 | not used | — | — |
| 68 | input | Signal above 80°C (man. tran.) | Double temperature switch |
| 69 | input | Automatic climate control | Automatic climate control |
| 70 | input | Knock sensor #1 (cyl. 1,2) | Knock sensor #1 signal |
| 71 | ground | Ground | Ground for analog signals and knock sensors |
| 72 | not used | — | — |
| 73 | not used | — | — |
| 74 | input | Engine coolant temperature sensor | Engine coolant temperature signal |
| 75 | not used | — | — |
| 76 | not used | — | — |
| 77 | output | Oxygen sensor (regulating sensor) | Oxygen sensor control |
| 78 | input | Crankshaft/rpm sensor | Crankshaft position/rpm signal |
| 79 | input | ABS or traction control | ABS or AST control |
| 80 | input | Engine speed | Engine speed signal |
| 81 | not used | — | — |
| 82 | not used | — | — |
| 83 | input | On-board computer | From On-board computer (terminal 4) |
| 84 | not used | — | — |
| 85 | not used | — | — |
| 86 | not used | — | — |
| 87 | input | Diagnostic connector (RxD) | Diagnostic RxD (receive) signal to pin 15 in Data link connector |
| 88 | output | Diagnostic connector (TxD) | Diagnostic TxD (transmit) signal to pin 17in Data link connector |

**Table I. ECM Pin Assignment—Siemens DME MS 41.1**

| Pin | Signal | Component/function | Signal |
|---|---|---|---|
| 1 | output | Ignition coil control, cyl. 2 | Primary signal, ignition coil 2 |
| 2 | output | Ignition coil control, cyl. 4 | Primary signal, ignition coil 4 |
| 3 | output | Ignition coil control, cyl. 6 | Primary signal, ignition coil 6 |
| 4 | ground | Ground | Ground |
| 5 | output | Fuel injector control, cyl. 2 | Pulsed ground (injection pulse width in ms) cyl. 2 |
| 6 | output | Fuel injector control, cyl. 1 | Pulsed ground (injection pulse width in ms) cyl. 1 |
| 7 | output | Mass air flow meter | Mass air meter signal |
| 8 | input | Mass air flow meter | Mass air meter signal |
| 9 | output | Instrument cluster | Fuel consumption signal |
| 10 | output | Engine coolant temperature (ECT) sensor | ECT signal |
| 11 | output | Fuel tank pressure sensor | Fuel tank pressure sensor control |
| 12 | input | Throttle position sensor (TPS) | Throttle position signal |
| 13 | — | | |
| 14 | input | Intake air temperature (IAT) sensor | Intake air temperature signal |
| 15 | | Traction control | AST module |
| 16 | input | Automatic climate control | Automatic climate control |
| 17 | — | | |
| 18 | input | Electronic immobilizer control (EWS II) | Electronic immobilizer control (EWS II) module |
| 19 | | Automatic climate control | Automatic climate control |
| 20 | — | Instrument cluster | Instrument cluster |
| 21 | output | Camshaft actuator (VANOS solenoid) control | Camshaft actuator (VANOS solenoid), switched ground |
| 22 | output | Fuel injector control, cyl. 3 | Pulsed ground (injection pulse width in ms) cyl. 3 |
| 23 | | Fuel injector control, cyl. 6 | Pulsed ground (injection pulse width in ms) cyl. 6 |
| 24 | | Fuel injector control, cyl. 4 | Pulsed ground (injection pulse width in ms) cyl. 4 |
| 25 | output | Oxygen sensor heater control | Oxygen sensor heater ground |
| 26 | input | Power supply (terminal 30) | Battery voltage (B+) at all times |
| 27 | output | Idle speed control valve | Pulsed ground—open signal (see also pin 53) |
| 28 | ground | Ground | Ground |
| 29 | output | Ignition coil control, cyl. 1 | Primary signal, ignition coil 1 |
| 30 | output | Ignition coil control, cyl. 3 | Primary signal, ignition coil 3 |
| 31 | output | Ignition coil control, cyl. 5 | Primary signal, ignition coil 5 |
| 32 | ground | Ground | Ground |
| 33 | output | Fuel injector control, cyl. 5 | Pulsed ground (injection pulse width in ms) cyl. 5 |
| 34 | ground | Ground | Ground |
| 35 | output | Secondary air injection | Secondary air injection pump relay control |
| 36 | output | Engine speed output | Engine speed signal |
| 37 | — | | |
| 38 | ground | Knock sensor | Shielding for knock sensors |
| 39 | output | Intake air temperature sensor (IAT Sensor)<br>Engine coolant temperature (ECT) sensor | Voltage supply to IAT sensor and ECT sensor |
| 40 | output | Crankshaft position sensor (Hall effect) | Crankshaft position sensor control |
| 41 | ground | Camshaft position (CMP) sensor | Shielding for CMP sensor |
| 42 | output | Throttle position sensor (TPS) | TPS ground |
| 43 | input | Camshaft position/rpm sensor | Camshaft position/rpm sensor control |
| 44 | output | Throttle position sensor (TPS) | Voltage supply to TPS (5 VDC) |
| 45 | | Traction control | AST module |
| 46 | — | Instrument cluster | Instrument cluster |

*ECM PIN ASSIGNMENTS*

**Table I. ECM Pin Assignment—Siemens DME MS 41.1 (continued)**

| Pin | Signal | Component/function | Signal |
|---|---|---|---|
| 47 | — | | |
| 48 | input | Crankshaft position sensor (Hall effect) | Crankshaft position sensor control |
| 49 | input | Power supply (terminal 15) | Battery voltage with key on or engine running |
| 50 | output | Solenoid valve (running losses) | Running losses |
| 51 | output | Carbon canister valve | Carbon canister valve control |
| 52 | vacant | — | — |
| 53 | output | Idle speed control valve | Pulsed ground—close signal (see also pin 29) |
| 54 | input | Power supply | Battery voltage from main relay (terminal 87) |
| 55 | vacant | — | — |
| 56 | — | | |
| 57 | input | Knock sensor (cyl. 1-3) | Knock sensor input signal |
| 58 | output | Knock sensor (cyl. 1-3) | Knock sensor control |
| 59 | input | Knock sensor (cyl. 4-6) | Knock sensor input signal |
| 60 | input/output | Diagnostic connector (TxD) | Diagnostic TxD (transmit) signal to pin 18 in Data link connector |
| 61 | output | Oxygen sensor heater (monitoring sensor) | Oxygen sensor heater ground |
| 62 | output | Secondary air injection | Secondary air injection control valve |
| 63 | output | Knock sensor (cyl. 4-6) | Knock sensor control |
| 64 | input | Camshaft position/rpm sensor | Camshaft position/rpm sensor control |
| 65 | input | Camshaft position/rpm sensor | Camshaft position/rpm sensor control |
| 66 | — | | |
| 67 | output | Oxygen sensor | Oxygen sensor reference voltage |
| 68 | output | Evaporative purge valve control | Pulsed ground with engine at normal temperature and varying engine load |
| 69 | output | Fuel pump relay control | Fuel pump relay switches with engine running or cranking (crankshaft position signal must be present for relay switchover) |
| 70 | vacant | — | — |
| 71 | output | Oxygen sensor heater (regulating sensor) | Oxygen sensor heater ground |
| 72 | output | Oxygen sensor (monitoring sensor) | Oxygen sensor reference voltage |
| 73 | input | Main relay control | Main relay activation (terminal 85) |
| 74 | output | A/C compressor control | A/C compressor relay control |
| 75 | input | Oxygen sensor | Oxygen sensor signal |
| 76 | not used | — | — |
| 77 | input | Oxygen sensor (regulating sensor) | Oxygen sensor signal |
| 78 | input | Oxygen sensor (monitoring sensor) | Oxygen sensor signal |
| 79 | output | Oxygen sensor (regulating sensor) | Oxygen sensor reference voltage |
| 80 | | Traction control | AST module |
| 81 | | Traction control | AST module |
| 82 | | Traction control | AST module |
| 83 | output | Crankshaft position sensor (Hall effect) | Crankshaft position sensor control |
| 84 | vacant | — | — |
| 85 | output | Automatic transmission | Automatic transmission control module |
| 86 | input | Automatic transmission | Automatic transmission control module |
| 87 | input | Power supply | Battery voltage from main relay (terminal 87) |
| 88 | input/output | Diagnostic connector (TxD) | Diagnostic TxD (transmit) signal to pin 17 in Data link connector |