

Chapter 7

Fuel and Engine Management

Part 1. General Servicing and Repair

Contents

Description	90
Routine Maintenance	92
Trouble Shooting	93
Service Precautions and Procedures	94
Fuel System	95
Air Intake System	103
Electrical System	106

Specifications

Type	Electronic sequential multipoint fuel injection with ignition control
¹ Idle speed	700 ± 50 rpm
Ignition timing (non adjustable)	8 - 12° BTDC
Spark plugs:	
Type —	
NGK	BKR5EKB - 11
Nippondenso	K16TR11
Gap	1.1 mm
Spark plug lead resistance (maximum)	25 k/ohms
Ignition coil resistance:	
Primary	0.67 - 1.05 ohms
Secondary	9.3 - 16.0 k/ohms
Fuel pressure at idle	Approximately 265 kPa
Fuel pressure within 5 minutes of turning engine Off	147 kPa
Injectors:	
Resistance at 21°C	13.4 - 14.2 ohms
Flow rate —	
Early models	55 - 70 cc per 15 seconds
Late models	60 - 73 cc per 15 seconds
Maximum flow rate variation between injectors —	
Early models	6 cc
Late models	13 cc
Leakage	Less than 1 drop per minute
Fuel pump resistance at 20°C	0.2 - 3.0 ohms

TORQUE WRENCH SETTINGS

Air cleaner housing bolts	20 Nm
Cam angle sensor bolt	8 Nm
Crank angle sensor	8 Nm
Coolant temperature sensor	20 Nm
Fuel rail:	
Pressure pipe banjo bolts	34 Nm
Pressure regulator bolts	8 Nm
Retaining bolts	13 Nm

Fuel tanks:

Drain plugs	7 Nm
Strap bolts	40 Nm
Stoneguard retaining bolts —	
Main fuel tank	20 Nm
Sub fuel tank	3 Nm
Ignition coil assembly bolts	8 Nm
Inlet manifold to cylinder head	18 Nm
Knock sensors	39 Nm
Oxygen sensor	20 Nm
Plenum chamber:	
To inlet manifold nuts/bolts	18 Nm
Upper to lower plenum chamber nuts/bolts	18 Nm
Support bracket —	
To cylinder head bolt	40 Nm
To upper plenum chamber bolt	18 Nm
Throttle body to plenum chamber nuts/bolts	18 Nm

¹ Measured with the vehicle in Park or Neutral and all accessories Off.

Description



To prevent severe electrical shock, extreme care must be taken when working on or near the electronic ignition systems as dangerous voltages are produced.

The fuel and engine management system employs sensitive electronic components. Refer to the Service Precautions and Procedures heading in this chapter before attempting any service procedures.

The engine management system on the range of vehicles covered by this manual, control the operation of the fuel injection and ignition systems.

The central component of the engine management system is the electronic control unit (ECU), which is a microcomputer used to control the ignition system and the amount of fuel injected according to signals received from various sensors. As changes are detected in engine load and speed, coolant temperature, air temperature and throttle position, the ECU alters the ignition timing and the fuel injection duration to achieve optimum engine efficiency and fuel economy under those conditions. The ECU also controls the air conditioning compressor and the operation of the automatic transmission.

The ECU is located behind the glove compartment on the passenger side of the vehicle.

In the multipoint fuel injection system, a metered amount of fuel is injected into the air stream at the entrance to each inlet port of the cylinder head. The air/fuel mixture then enters the combustion chamber via the inlet valve. The fuel is supplied by a high pressure electric fuel pump mounted inside each fuel tank. The fuel is maintained at a constant pressure, by the fuel pressure regulator and excess fuel is returned to the fuel tanks via the fuel return line.

The air flow assisted fuel injectors receive filtered air through openings in the inlet manifold, to assist the atomisation process of the fuel droplets.

The fuel pressure and the duration that the injectors are open regulate the injection quantity. The basic time that the injectors remain open is controlled by the ECU which uses information from the crank angle sensor, air flow meter/sensor, throttle position sensor and air temperature sensor. The basic injection time is then modified by the ECU which uses information from the coolant temperature sensor, throttle position sensor and the vehicle speed sensor to give optimum engine efficiency and exhaust emissions for the relevant conditions.

Early model vehicles employ a mechanical type air flow meter, using a moving inner core acting on a potentiometer. The inlet air temperature sensor is incorporated within the air flow meter.

On late model vehicles, a hot wire air flow sensor is mounted to the air cleaner top cover to measure the mass of the air drawn into the inlet manifold. The sensing component is a platinum wire that is suspended across the inside of the sensor cylinder. The platinum wire is maintained at a constant temperature by the ECU which controls a current flow through the wire. As air passes over the platinum wire causing its temperature to change, the ECU detects the variation in temperature and adjusts the current flow through the wire.

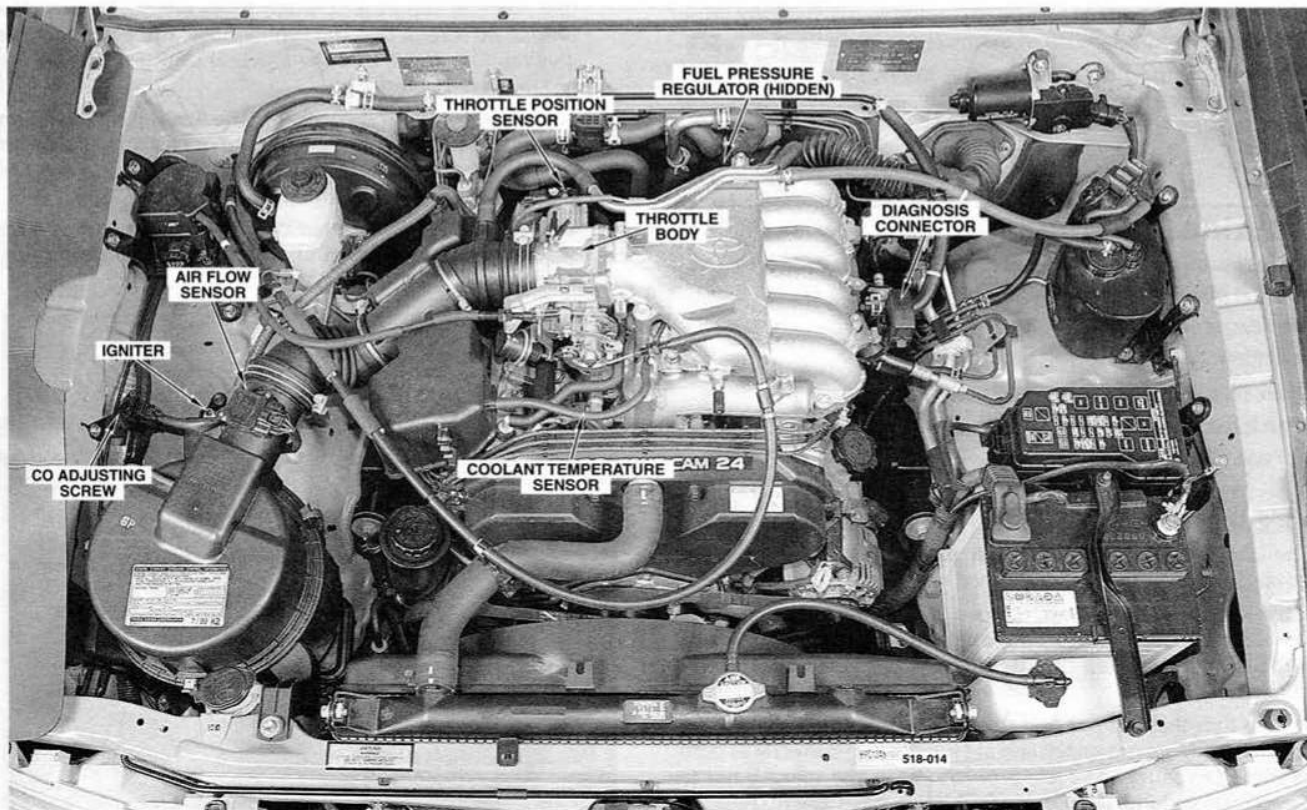
The ignition system consists of an igniter module and three ignition coils. Each coil directly fires two spark plugs simultaneously, eliminating the need for a distributor. The firing sequence ensures that one spark plug fires on the compression stroke and the other on the exhaust stroke. The operation of the ignition coils is controlled by the igniter module which receives signals from the ECU. Due to the high secondary voltages produced by the coils, in excess of 40 kilovolts at any engine speed, use extreme care when working near the ignition system when the engine is running.

To achieve optimum engine efficiency, the ECU continually advances the ignition timing until detonation occurs. When detonation occurs, the ECU receives a low voltage signal which is generated by one or both knock sensors and the ignition timing is instantly retarded.

The idle speed control (ISC) valve controls the idle speed during engine warm up and maintains the basic idle speed at a set value by allowing a controlled amount of air to bypass the throttle valve. This compensates for loads such as air conditioning, power steering or the selection of Drive on automatic transmission models.

The throttle body, which is mounted to the side of the upper plenum chamber, controls the amount of air entering the engine by the action of the throttle pedal. A throttle position sensor is attached to the throttle body to indicate the driver demand to the ECU.

Some vehicles are fitted with an oxygen sensor. When the engine is running above idle speed and at normal operating temperature, the exhaust gases are monitored using the oxygen sensor. Under these conditions, the injection duration is constantly altered in response to the oxygen sensor signal. These models are also equipped with a three way catalytic converter.



Engine compartment showing various engine management system components.

92 | Fuel and Engine Management

Part 1

On models without oxygen sensor, manual CO adjustment is provided and no catalytic converter is installed.

Efficient operation of the engine management system depends on controlled inlet air flow, correct fuel supply and accurate signals being received by the ECU. Therefore, it is essential that all air, fuel and electrical connections are clean and secure.

When the engine is running, the ECU monitors the signals it is receiving from the various sensors. If the ECU detects that an abnormal signal has continued for an extended period, a fault code will be recorded and the ECU will substitute an alternate signal for the abnormal one, enabling near normal driveability except in the most severe failure situations. When the self diagnosis mode is activated, the ECU will generate coded signals to indicate the circuit that the fault has been detected.

The diagnosis connector is attached to the plenum chamber on the engine. Late models vehicle have an additional diagnosis connector inside the vehicle, located beneath the driver side lower dash panel.

If the fault rectifies itself, the warning lamp will extinguish after 10 seconds and the area in which the fault has occurred will be stored in the ECU as a fault code to assist diagnosis. The code will remain stored until power to the ECU has been interrupted for at least 30 seconds.

For people with the confidence and knowledge to identify and undertake fault code retrieval and repair procedures, refer to Part 2 of this chapter.

Part 1 of this chapter covers common servicing and repair procedures, which are considered within the scope of the average home mechanic.

Part 2 provides more detailed specifications and test procedures. These procedures should only be attempted by mechanics or those with a good understanding of electrical components and circuits.

Reference should be made to the Service Precautions and Procedures heading before performing any repair procedures in this chapter.

Routine Maintenance

The following routine maintenance items are covered under the Routine Maintenance heading in Engine (chapter 4).

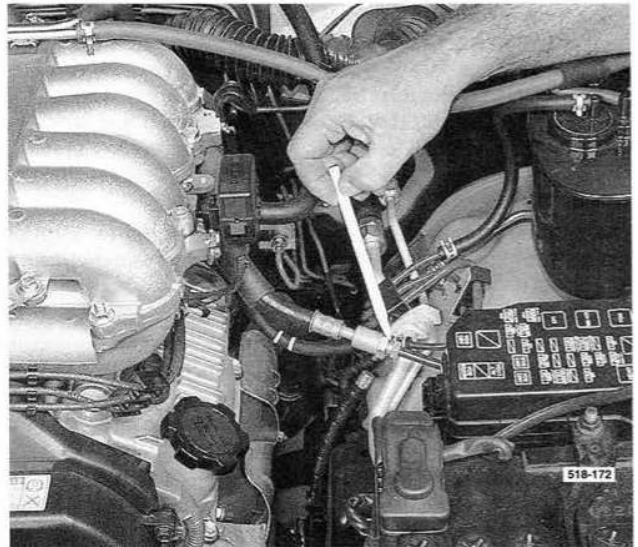
- Air cleaner element.
- Fuel filter.
- Spark plugs.
- High tension leads.
- Ignition timing inspection.

IDLE SPEED

The idle speed is not adjustable. A vacuum leak will cause a fast erratic idle or surging depending on how large the leak is.

If the idle speed is too slow, remove the air inlet hose and check the throttle body for heavy deposits of carbon etc. If necessary, remove and clean the throttle body as described later in this chapter.

Ensure that the dashpot and the throttle opening valve on the throttle body are not seized and are functioning correctly as both of these can cause a fast idle problem. If the idle speed is not to Specifications and all other possibilities have been checked, check the ISC valve and all vacuum hoses.



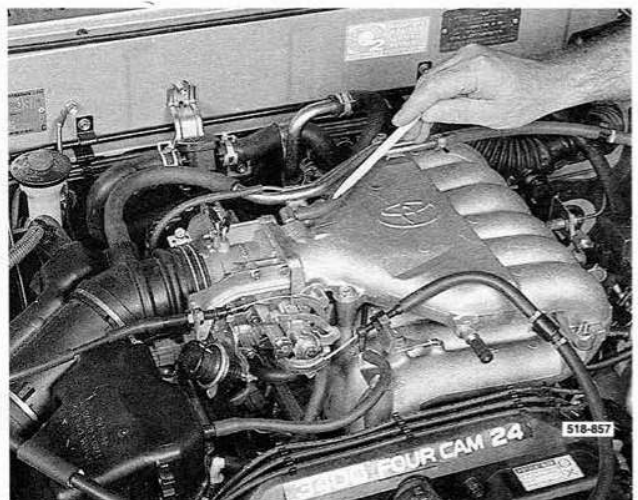
Check for fuel leakage at the fuel line connections.

CO CONCENTRATION

Checking and adjusting the CO concentration is described in Engine (chapter 4).

HOSES, PIPES AND CONNECTIONS

- 1 Raise the vehicle and check the fuel tanks and connections for leaks. Also check the fuel tanks for damage.
- 2 Check that the fuel supply and return lines are not leaking between the fuel tanks and the engine compartment. Check that the fuel supply and return pipes are not damaged or unsecured. Check that the rubber hoses are not cracked or chafing. Also check that the charcoal canister and lines are not damaged or leaking.
- 3 Lower the vehicle and check that the fuel supply and return lines in the engine compartment are not leaking. Check that there are no leaks at the fuel rail connections to the fuel hoses, the pressure regulator and the injectors.
- 4 Check that all vacuum hoses in the engine compartment are secure at each connection. Check that the hoses are not split, cracked or perished.



Check the vacuum hoses for splitting and deterioration.

AIR INLET HOSE

- 1 Check that the air inlet hoses and connections between the air cleaner, air flow sensor and the throttle body are secure. Check that the hoses are not split or cracked. Also check the silencer for damage and deterioration.
- 2 Check that the air cleaner inlet is not obstructed.

THROTTLE LEVER

- 1 Operate the throttle body lever by hand and check that the movement is smooth and free. If necessary, lubricate the throttle lever and shaft. When the throttle is slowly released, check that it closes fully.
- 2 If the throttle does not close fully, check for an incorrectly adjusted throttle cable, cruise control cable if applicable, or malfunctioning dashpot or throttle opening valve, as described later in this chapter.
- 3 Check that the inner throttle or cruise cable is not frayed at the ends of the cable.

Trouble Shooting

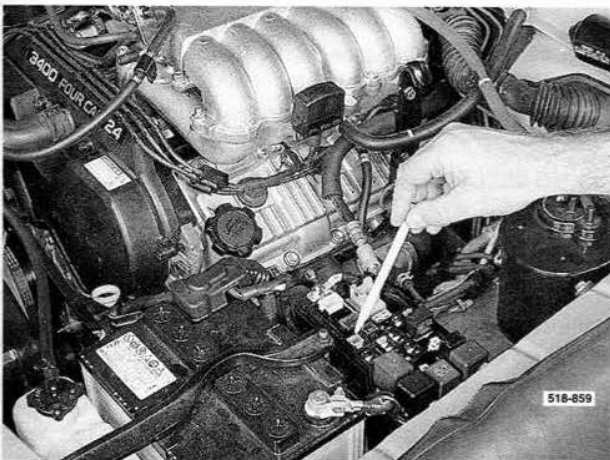
i The following trouble shooting procedures are basic checks only and assume that the checks in Roadside Trouble Shooting (chapter 3) have been performed to confirm that the problem is in the fuel and engine management system. Prior to performing any of the following checks, refer to the Service Precautions and Procedures heading.

Blown or corroded fusible links or fuses are commonly the cause of the following symptoms. Using the wiring diagrams as a guide, the circuits supplying power to the ECU can be easily traced. This can also apply for ECU earth circuits. Refer to the wiring diagrams in Part 2 of this chapter.

If the following checks fail to locate the fault, refer to Part 2 of this chapter for more thorough testing, or refer the vehicle to an authorised dealer or fuel injection specialist.

ENGINE HARD TO START OR WILL NOT START

- 1 Faulty ALT or AM2 fusible links: Check the fusible links and renew as necessary.



Check the condition of the AM2 fusible link.

- 2 Fault in the engine immobiliser system: Check the immobiliser system.
- 3 Faulty circuit opening relay or ECU relay: Test the relays and renew if necessary.
- 4 Fault in the fuel supply: Test the fuel pump and the fuel pressure.
- 5 Faulty engine management component wiring connections: Check that all wiring connections are clean and secure, especially the ignition coil connections.
- 6 Faulty ignition coils: Check the ignition coil resistances. Check the ignition system.
- 7 Faulty injectors: Test the injector circuit.
- 8 Engine flooded: Depress the throttle pedal fully while cranking the engine until it starts.



Use the wiring diagrams at the end of Body Electrical (chapter 16). To trace the wiring and power supplies to various components.

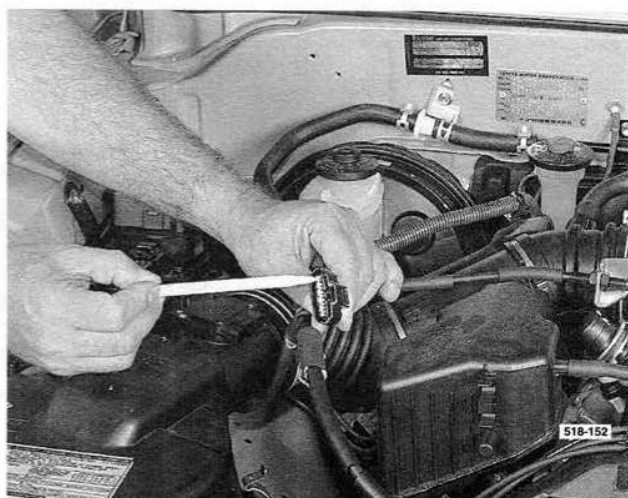
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ENGINE STARTS THEN STALLS

- 1 Incorrect idle speed: Check for air leaks around the inlet manifold and all vacuum hoses.
- 2 Faulty engine management component wiring connections: Check that all wiring connections are clean and secure.
- 3 Faulty idle speed control (ISC) solenoid: Check the ISC solenoid operation.
- 4 Fault in the fuel supply: Check the fuel pressure.

ENGINE MISFIRES

- 1 Faulty, dirty or incorrectly adjusted spark plugs: Renew or clean and adjust the spark plugs.
- 2 Faulty high tension leads: Check the resistance of the leads and renew as necessary.
- 3 Faulty wiring connections: Check that the wiring connections at the crank angle sensor and at the igniter module are clean and secure.
- 4 Water in the fuel: Drain the fuel from the system and renew the fuel filter.
- 5 Faulty ignition coils: Check the coil resistances and renew if necessary.



Check that all the electrical connections are clean and secure.

94 | Fuel and Engine Management

Part 1

- 6 Faulty fuel injectors: Check the electrical connections and test the injectors.



To check if a fuel injector is functioning, hold the blade of a long screwdriver against the body of the fuel injector while the engine is idling. Listen to the opposite end of the screwdriver for a clicking sound, indicating that the fuel injector is functioning.

ENGINE LACKS POWER

- 1 Blocked air cleaner element: Check the element and renew as necessary.
- 2 Incorrectly adjusted throttle cable: Adjust the throttle cable.
- 3 Low fuel pressure: Check the fuel pressure. If low, renew the fuel filter and check the lines for blockage. Check the fuel pressure regulator.
- 4 Water in the fuel: Drain the fuel from the system and renew the fuel filter.
- 5 Excessive high tension lead resistance: Test each lead and renew as necessary.
- 6 Exhaust system blockage: Check the exhaust system for damage and remove any restrictions.
- 7 Faulty air flow meter/sensor: Check the air flow meter/sensor circuit as described in Part 2 of this chapter under the relevant fault code.
- 8 Timing belt has jumped a tooth: Check that the valve timing is correctly set as described under the Timing Belt heading in Engine (chapter 4).

EXCESSIVE FUEL CONSUMPTION

- 1 External leakage in the fuel supply system: Check the connections and components for leakage.
- 2 Blocked air cleaner element: Check the element and renew as necessary.
- 3 Incorrect base ignition timing: Check the ignition timing as described in Engine (chapter 4).
- 4 Engine running below correct operating temperature due to a faulty thermostat: Check and renew the thermostat as described in Cooling System (chapter 5).



A blocked or restricted air cleaner element can reduce the engine power and increase fuel consumption.

- 5 High fuel pressure: Test the fuel pressure. If high, check for a faulty fuel pressure regulator or a blocked fuel return line.
- 6 Exhaust system blockage: Check the exhaust system for damage and remove any restrictions.



Excessive fuel consumption can also be caused by driver compensation for loss of engine power. Check the cylinder compressions as described under the Routine Maintenance heading in Engine (chapter 4).

Service Precautions and Procedures

To avoid injury or damage to system components, note the following precautions and procedures before commencing any work on the engine management system.

Electronic ignition systems can produce dangerously high voltages. For this reason, extreme care must be taken when working on or near the ignition system.

Do not start the engine if the battery terminals are not clean and tight.

Do not disconnect the battery terminals while the engine is running.

Do not use the fast charge or boost settings on a battery charger to start the engine.

Disconnect the battery terminals before charging the battery. Do not subject the ECU to temperatures above 80° C.

Ensure that all wiring connectors are clean and tight.

Ensure that the ignition is Off or the battery terminals are disconnected before disconnecting any engine management component.

Reduce the fuel system pressure before disconnecting any fuel supply components. The fuel supply circuit maintains a high residual pressure at all times.

Check the fuel system for external leakage whenever a connection in the fuel supply system has been disturbed.

Disconnect the battery terminals and the ECU wiring connector and remove the ECU from the vehicle before attempting any welding operations.

Do not direct a steam cleaning or pressure washing nozzle at engine management components when cleaning the engine. Refer to the illustration in Part 2 of this chapter for information on how to read insets.

Handle all engine management components with care.

Do not attempt to dismantle any of the electrical components. If faulty, these components must be renewed as complete assemblies.

Do not directly apply battery voltage to the injectors.

USING ELECTRICAL TEST EQUIPMENT

Multimeter

It is essential that in all tests where voltage or resistance is to be measured, a digital or analogue display multimeter with a minimum 10 mega ohm impedance be used.

All meter readings are to be performed with the component wiring connectors installed unless otherwise instructed. This can be done by inserting the meter test probes from the wiring harness side of the connector or backprobing. If the test probes are not thin, they should be modified by attaching a thin piece of wire to the end of the probe, giving a fine point that will not

damage the connector. Ensure that the wire is making good contact with the probe.

If sealing plugs or boots are removed from the wiring connectors to facilitate backprobing, ensure that they are correctly installed at the conclusion of the test procedure.

Test Lamp

When a test lamp is specified, it is essential that the test lamp does not draw a current of more than 0.3 amps to avoid damage to the electronic components.

To check the current draw of the test lamp, connect an accurate ammeter, such as the multimeter described previously, in series with the test lamp. Test the assembly across the vehicle battery. If the ammeter reads less than 0.3 A or 300 mA, the test lamp is suitable.

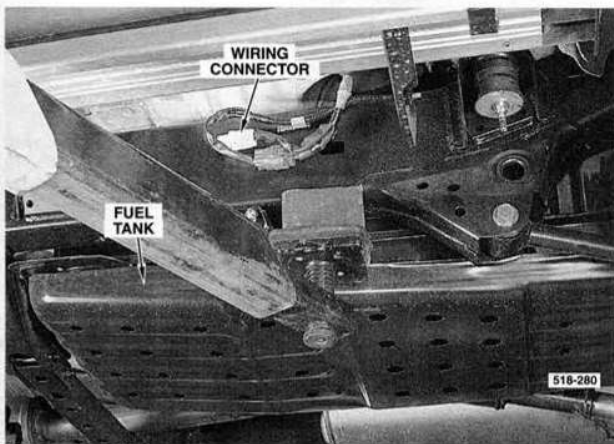
LED (Light Emitting Diode) test lamps draw less than 0.3 amps making them the safest types of test lamps to be used. They have become more widely used and are available from most automotive accessory or electronic outlets. The cost of the LED test lamp far outweighs the problems that can be caused by using an alternative type test lamp. Alternately, fabricate an LED test lamp as described in General Information (chapter 1).

Some LED test lamps will only allow current flow in one direction. Therefore, the lamp will only operate with the lead connected to negative (earth) and the probe to a positive terminal.

PRELIMINARY CHECKS

Prior to investigating a fault or referring the vehicle to an authorised dealer or fuel injection specialist, the following checks should be made.

- 1 Check for adequate fuel in the fuel tanks.
- 2 Check the wiring connectors and earth points of all engine management components for clean and secure connections.
- 3 Check the condition of the battery. Refer to the Routine Maintenance heading in Engine Electrical (chapter 6) for checking procedures. Rectify any faults as necessary.
- 4 Check the air cleaner element for restrictions.
- 5 Check the fuel pressure as described later in this chapter.
- 6 Ensure that the engine is in satisfactory mechanical condition and is in tune. Refer to the Routine Maintenance heading in Engine (chapter 4).
- 7 Check that all engine vacuum and emission control hoses are serviceable and securely connected.



Location of the sub fuel tank pump wiring connector.

- 8 Check that there are no air leaks at the inlet manifold, throttle body and plenum chambers. Also check that the vacuum hose between the engine and the charcoal canister is not cracked or damaged.
- 9 Check the operation of the positive crankcase ventilation (PCV) valve as described in Emission Control (chapter 8).
- 10 Check the coolant level and ensure that the engine is reaching normal operating temperature.

Fuel System



To Check Fuel Pressure — 600 kPa pressure gauge and adapters

REDUCING FUEL SYSTEM PRESSURE

The pressure in the fuel system should be reduced before disconnecting any fuel lines or removing any components of the fuel supply system.

- 1 Ensure that the fuel tank changeover switch is in the sub tank position.

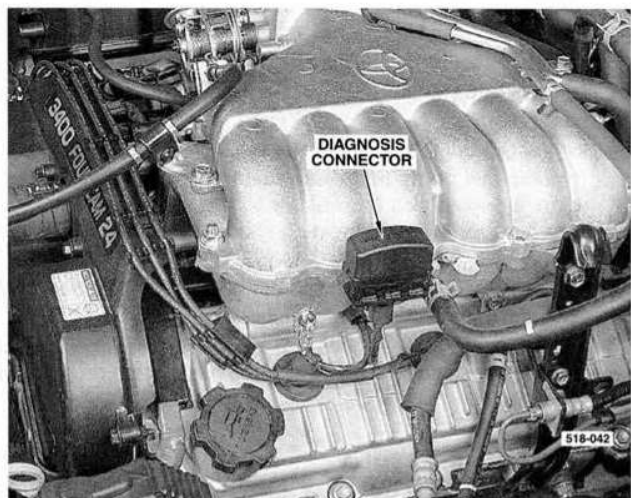


In this position the lamp in the sub fuel tank gauge should be illuminated with the ignition On.

- 2 Working under the left hand side of the vehicle, forward of the rear wheel, disconnect the white, sub fuel tank pump wiring connector.
- 3 When the engine stalls, operate the starter for 5 seconds.
- 4 Turn the ignition Off and connect the wiring connector securely.

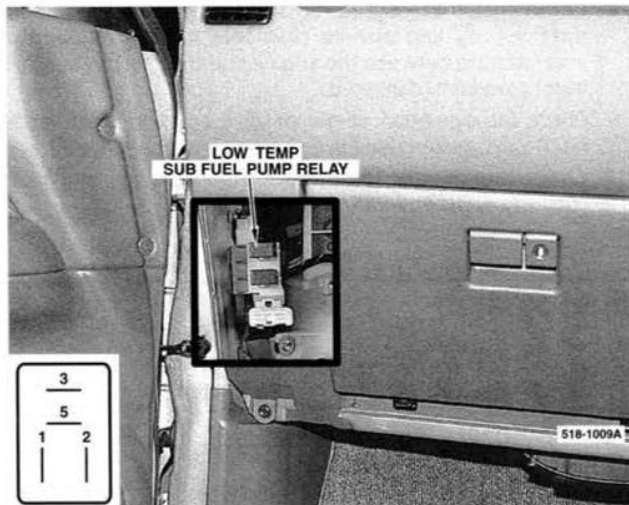
TO CHECK FOR EXTERNAL FUEL LEAKAGE

- 1 To test the main fuel tank components, proceed as follows:
 - a Ensure that the fuel tank changeover switch is in the main tank position.



Location of the engine compartment diagnosis connector. The terminal identification is inside the cover. On late model vehicles another diagnosis connector is located beneath the driver side lower dash panel.

96 | Fuel and Engine Management Part 1



The low temperature sub fuel pump relay is located behind the dashboard on the passenger side. Inset shows the terminal identification.

TIP In this position the lamp in the sub fuel tank gauge should be extinguished with the ignition On.

- b Switch the ignition On, but do not start the engine.
 - c Bridge terminals +B and FP of the engine compartment diagnosis connector and check that the fuel pump can be heard operating. It should also be possible to feel a slight vibration at the fuel supply line, indicating that the fuel pump is operating.
- 2 To test the sub fuel tank components, proceed as follows:
- a Remove the glove compartment, referring to Body (chapter 17), if necessary.
 - b Ensure that the fuel tank changeover switch is in the sub tank position.

TIP In this position the lamp in the sub fuel tank gauge should be illuminated with the ignition On.

- b Switch the ignition On, but do not start the engine.
 - c Disconnect the low temp sub fuel pump relay wiring connector.
 - d Bridge terminals 3 and 5 of the relay connector and check, that the fuel pump in the sub fuel tank can be heard operating. It should also be possible to feel a slight vibration at the fuel supply line, indicating that the fuel pump is operating.
- 3 Check all fuel line connections between the appropriate fuel tank and injectors for leakage.
- 4 If repair of any leak requires loosening a fuel line or clamp, or removal of a component, reduce the fuel system pressure as previously described.

TO TEST FUEL PRESSURE

Check the fuel pressure using both fuel tanks. This is helpful especially when trying to diagnose a problem by eliminating each fuel pump and fuel supply line going to the changeover valve.

- 1 Reduce the fuel system pressure and install a pressure gauge at the fuel supply union using suitable fittings.

i If suitable fittings are not available, the pressure gauge can be installed by cutting the fuel supply hose and installing a T piece, using clamps. On completion of the test procedure, remove the T piece and join the fuel hose using a double ended barbed fitting and clamps. Ensure that all connections are capable of withstanding pressures of up to 600 kPa.

- 2 Test the fuel pressure of the main fuel tank pump as follows:
 - a Ensure that the fuel tank changeover switch is in the main tank position.

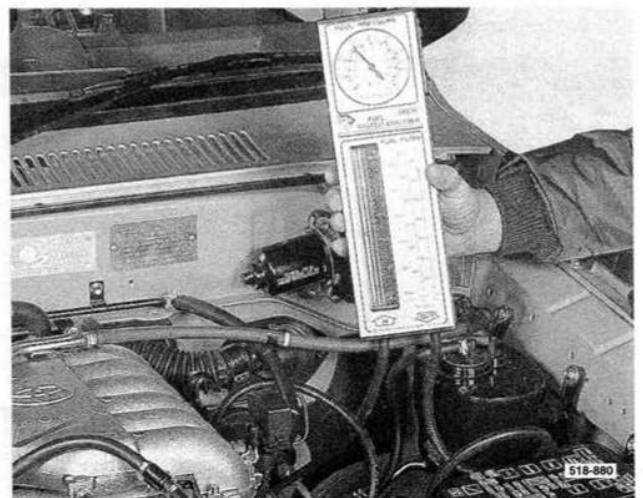
TIP In this position, the lamp in the sub fuel tank gauge will be extinguished with the ignition On.

- b Bridge terminals +B and FP of the diagnosis connector and switch the ignition On.
 - c Check that there are no leaks at the pressure gauge connections and start the engine and check the fuel pressure at idle. Note the fuel pressure reading.
- 3 Test the fuel pressure of the sub fuel tank pump as follows:
 - a Ensure that the fuel tank changeover switch is in the sub tank position.

TIP In this position, the lamp in the sub fuel tank gauge should be illuminated with the ignition On.

- b Start the engine and check the fuel pressure at idle.
- 4 If the fuel pressure exceeds Specifications when running on each fuel tank, check the fuel return line between the engine and the changeover valve for a restriction. If no fault can be found, renew the fuel pressure regulator.
- If the pressure exceeds Specifications on one tank, but is within Specifications on the other tank, check for a restriction in the return line between the changeover valve and the tank with the high fuel pressure.

i Also check that the changeover valve is not restricted and is switching fully between tanks. If the valves are not opening fully to create a clear passage for the return lines back to each fuel tank, it can cause a restriction, resulting in an increase in fuel pressure.



Checking the fuel pressure.

- 5 If the pressure is low, proceed as follows:
 - a Run the engine, noting the fuel pressure.
 - b Stop the engine and check that the fuel pressure remains above 147 kPa for five minutes. If the fuel pressure decreases, pinch the return line closed. If the pressure now remains steady, renew the pressure regulator.
 - c If the pressure continues to drop, while testing the main fuel pump, repeat operation 5 with the engine operating on the sub fuel tank.
If the pressure now remains steady, renew the main fuel pump.
If the pressure continues to drop, a leaking injector is indicated.

i If the pressure continues to drop when running on the sub tank fuel pump but remains steady when running on the main fuel tank pump, a faulty sub fuel tank pump is indicated. Renew the sub fuel tank pump.

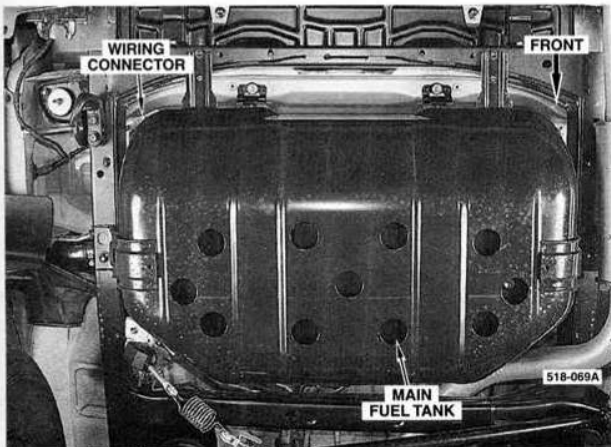
FUEL PUMPS

To Test — Main Tank Fuel Pump

- 1 Switch the ignition On but do not start the engine.
- 2 Ensure that the fuel tank changeover switch is in the main tank position.

TIP In this position the lamp in the sub fuel tank gauge should be extinguished with the ignition On.

- 2 Bridge terminals +B and FP on the diagnosis connector and operate the fuel pump. It should be possible to feel a slight vibration at the fuel supply line, indicating that the fuel pump is operating. In quiet conditions it may also be possible to hear the fuel pump operating inside the fuel tank.
- 3 If the pump is not operating, check for power between the red/black and white/black wires at the pump wiring connector. If there is no power, check the wiring for continuity and shorts, using the wiring diagrams in Part 2 of this chapter as a guide.



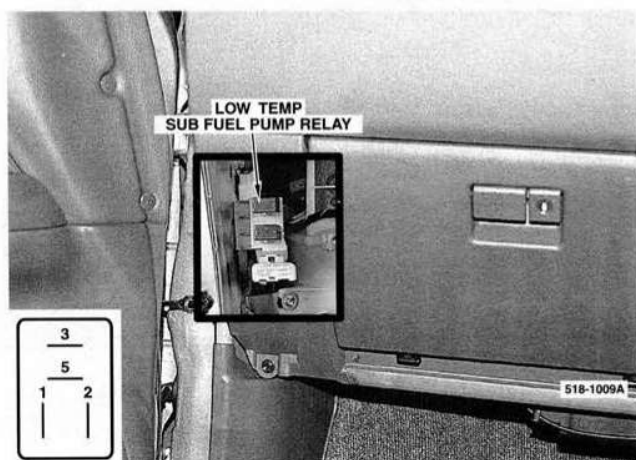
Main fuel tank pump wiring connector location.

- 4 Measure the resistance between the red/black and the white/black wires of the main fuel tank pump wiring connector terminals. Renew the pump if the resistance is more than 3 ohms, or an open circuit is indicated.
- 5 Start the engine and disconnect the bridge wire from the diagnosis connector. If the engine stalls shortly after disconnecting the bridge wire, check the circuit opening relay, the fuel pump select relay and the wiring between the circuit opening relay terminal FC and the ECU terminal FPM1. Check the power supply circuit of the ECU, using the wiring diagrams in Part 2 of this chapter. If no fault can be found, a fault is indicated within the ECU.

To Test — Sub Tank Fuel Pump

- 1 Remove the glove compartment, referring to Body (chapter 17), if necessary.
- 2 Remove the low temp sub fuel pump relay.
- 3 Bridge terminals 3 and 5 of the wiring connector and switch the ignition On to operate the sub tank fuel pump. It should be possible to feel a slight vibration at the fuel supply line, indicating that the fuel pump is operating. In quiet conditions it may also be possible to hear the fuel pump operating inside the fuel tank.
- 4 If the pump is not operating, disconnect the white fuel pump wiring connector, attached to the left hand side chassis rail, forward of the rear wheel. Check for power between the red/green and white/black wires at the pump wiring connector. If there is no power, check the wiring for continuity and shorts, using the wiring diagrams in Part 2 of this chapter as a guide.
- 5 Measure the resistance between the red/green and the white/black wires. Renew the pump if the resistance is more than 3 ohms, or an open circuit is indicated.
- 6 If the fuel pump is serviceable, reconnect the white fuel pump wiring connector.
- 7 Probe terminal FP of the engine compartment diagnosis connector with an LED test lamp.
- 8 Switch the fuel tank changeover switch to the main tank position.

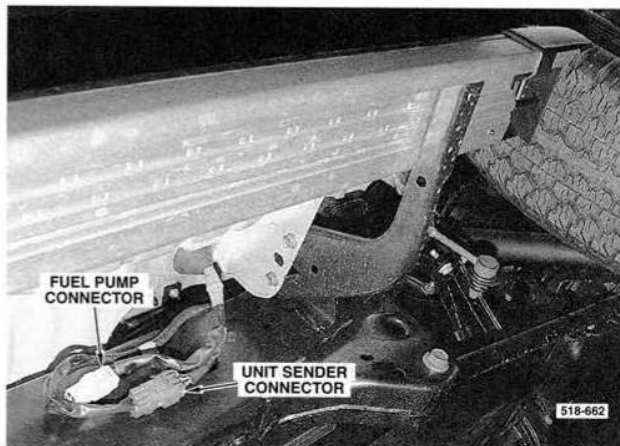
TIP In this position, the lamp in the sub fuel tank gauge should be extinguished.



Location of the low temperature sub fuel pump relay. Inset shows the terminal identification.

98 | Fuel and Engine Management

Part 1

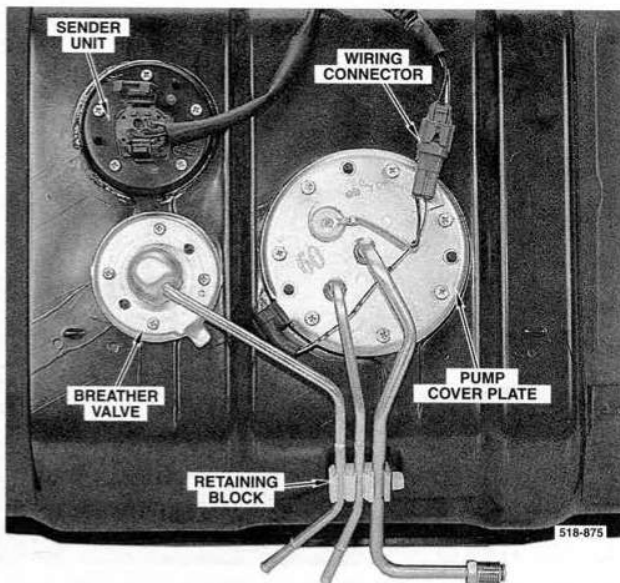


Location of the sub fuel tank wiring connectors.

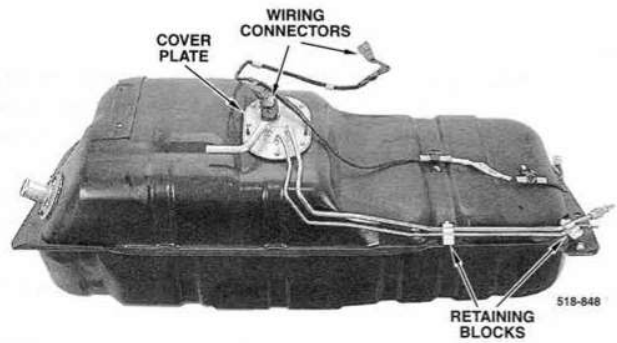
- 9 Observe the test lamp while cranking the engine. Battery voltage should be available at terminal FP while cranking the engine.
If the battery voltage is not available, a fault exists between the EFI relay and the fuel pump select relay.
If battery voltage is available, a fault exists in the fuel pump select relay, the relay circuits, or the wiring between the relay and the sub fuel tank white wiring connector.
Use the wiring diagrams in Part 2 of this chapter to check the circuits. Also check the relays as described later in this chapter.

To Remove and Install

- 1 Remove the respective fuel tank as described later in this chapter.
- 2 Release the pipes from the retaining block(s).
- 3 If removing the main fuel pump mark the relationship between the pump cover plate and fuel tank to ensure that the cover plate is returned to the same position. Disconnect the wiring connector.



Location of the main fuel pump cover plate.



Sub fuel tank removed, showing components.

i The sub tank fuel pump cover has fixed pipes and can only be installed in one position.

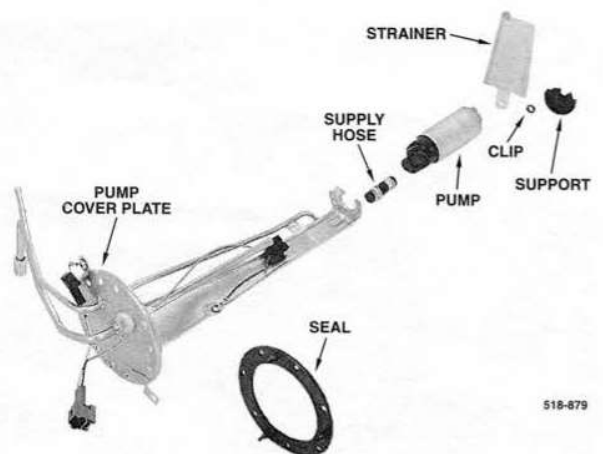
- 4 Remove the retaining bolts and then remove the fuel pump/gauge sender unit from the fuel tank. Release the seal retaining tab and discard the seal.

Installation is a reversal of the removal procedure with attention to the following points:

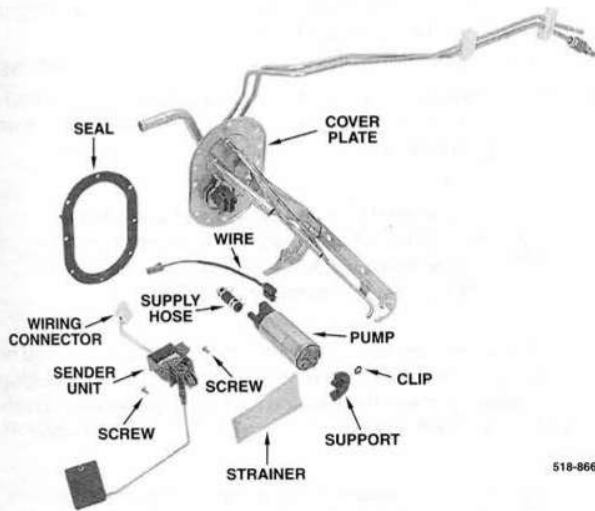
- 1 Install the cover plate to the position noted during removal, using a new seal. Ensure that the seal tabs correctly engage the holes in the cover plate. Tighten the retaining screws evenly and securely.
- 2 Install the fuel tank, referring to the procedure described later in this chapter.

To Dismantle and Assemble

- 1 Slide the bottom of the fuel pump and the strainer assembly from the sender unit bracket and remove the rubber support from the base of the pump.
- 2 Slide the supply hose clamp away from the fuel pump and separate the hose from the pump.
- 3 Disconnect the wiring connector from the top of the fuel pump.
- 4 Remove the clip retaining the strainer to the bottom of the pump and remove the strainer from the pump.
- 5 If necessary, remove the sub fuel tank sender from the fuel pump bracket as follows:



Main fuel tank pump components.

**Sub fuel tank pump components.**

- a Disconnect the sender wiring connector from the cover plate.
- b Remove the bolts retaining the sender to the bracket and withdraw the sender.
- 6 Check all components for deterioration and renew as necessary. It is advisable to renew the strainer as the material ages over time.

Assembly is a reversal of the dismantling procedure, with attention to the following points:

- 1 Position the strainer onto the pump and install the retaining clip securely.
- 2 Connect the pump to the supply hose and install the clamp and the wiring connector.
- 3 Install the rubber support to the base of the pump and slide the base of the pump into the sender unit bracket.
- 4 If removed, install the sender to the sub fuel tank bracket and connect the wiring connector securely.

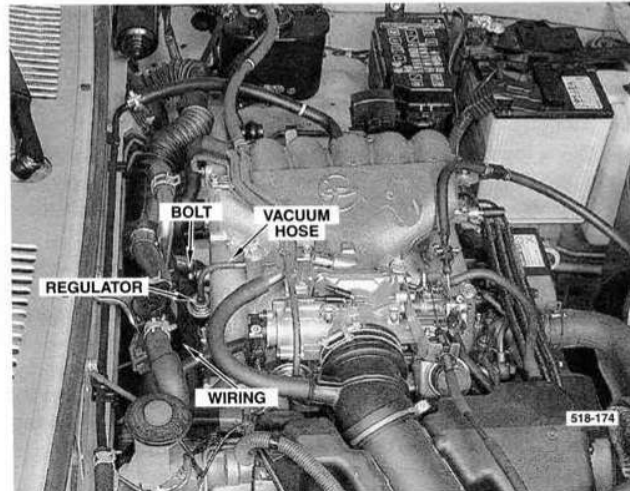
FUEL PRESSURE REGULATOR**To Remove and Install**

- 1 Reduce the fuel system pressure as previously described.
- 2 Disconnect the negative battery terminal.
- 3 Disconnect the vacuum hose from the pressure regulator.
- 4 Remove the bolt retaining the wiring harness to the rear of the lower plenum chamber and release the clip retaining the wiring to the bracket at the rear of the right hand side cylinder head. Place the harness clear of the work area.
- 5 Release the clip retaining the fuel return hose to the regulator and disconnect the hose.



Loosen the fuel filler cap several turns to prevent pressure build up in the fuel tank from causing a fuel leak.

- 6 Remove the bolts retaining the fuel pressure regulator to the fuel rail. Using a twisting motion, remove the regulator from the fuel rail. Discard the O ring.
- 7 Seal the opening in the fuel rail to prevent the entry of dirt.



Fuel pressure regulator installed.

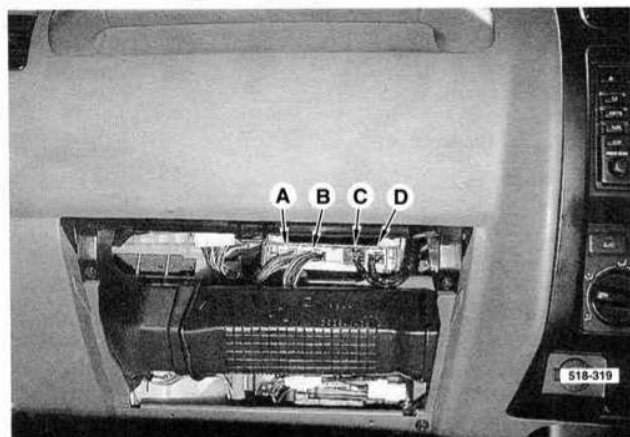
Installation is a reversal of the removal procedure with attention to the following points:

- 1 Install the regulator to the fuel rail ensuring that a new O ring is installed and lubricated with engine oil.
- 2 Securely connect the return and the vacuum hoses.
- 3 Run the engine and check the system for external fuel leakage.

FUEL RAIL AND INJECTORS**To Test Injector Circuit**

Due to the position of some of the fuel injectors, access to the injector wiring is difficult. Therefore, it is recommended that the injectors be tested at the ECU.

- 1 Ensure that power is available at one of the black/red wires of the fuel injectors with the ignition On. If power is not available, check the condition of the AM2 fusible link and the ignition switch.
- 2 Ensure that the ignition is switched Off and working in the passengers compartment, remove the screws retaining the glove compartment. Withdraw the compartment from the dashboard.



Location of the ECU wiring connectors. Refer to the wiring diagrams in this chapter for the terminal identification.

100 Fuel and Engine Management

Part 1

- 3 Remove the screws retaining the glove compartment roof panel and withdraw it from the dashboard.
- 4 Referring to the wiring diagrams in Part 2 of this chapter disconnect connector A (early models) or connector B (late models) from the ECU.
- 5 Using the back probing method, connect a suitable length of 3 or 4 mm wire to the black/red wire on one of the accessible injectors. The connection must be good to avoid misleading results.
- 6 Measure the resistance between the black/red wire and each injector terminal at the relevant connector of the ECU. The terminals are labelled #10 for No 1 injector, up to #60 for No 6 injector. If any of the injector resistances are not to Specification, it will be necessary to disconnect the wiring from that injector and measure the resistance between the injector terminals, to eliminate problems with the wiring. Renew any injectors that are not to Specifications.

i It will be necessary to remove the plenum chambers from the inlet manifold, as described in Engine (chapter 4) to access the injectors for cylinder No 2, 4 and 6.

- 7 Connect the ECU wiring connector and remove the length of wire from the injector.
- 8 Backprobe one of the injector trigger wires at the same ECU connector used in the last test with a test lamp connected to battery power. Check that the test lamp flashes when the starter motor is operated. Repeat this on each injector trigger wire terminal.

If the test lamp does not flash at one or more of the terminals, check that the ECU terminals are clean and secure. If no fault can be found, a fault is indicated in the ECU. Using the wiring diagram as a guide, check the ECU power supply and earth circuits. Also refer to Part 2 of this chapter and check for any stored fault codes or refer the vehicle to an authorised dealer or fuel injection specialist.

If the test lamp flashes when connected to each injector trigger wire terminal, the circuit can be considered serviceable.

- 9 To check that each injector is functioning, proceed as follows:
 - a While the engine is idling, disconnect the wiring from each injector in turn for no more than five seconds. The engine should misfire each time the injector is disconnected.

i This can only be done on No 1, 3 and 5 cylinders, as access to No 2, 4 and 6 cylinders is restricted by the plenum chambers. Do not attempt to start the engine with the plenum chamber removed.

- b If the engine does not misfire, the injector may be blocked or sticking. However, before removing the injectors for testing and cleaning, check the ignition high tension circuit as previously described in Roadside Trouble Shooting (chapter 3).

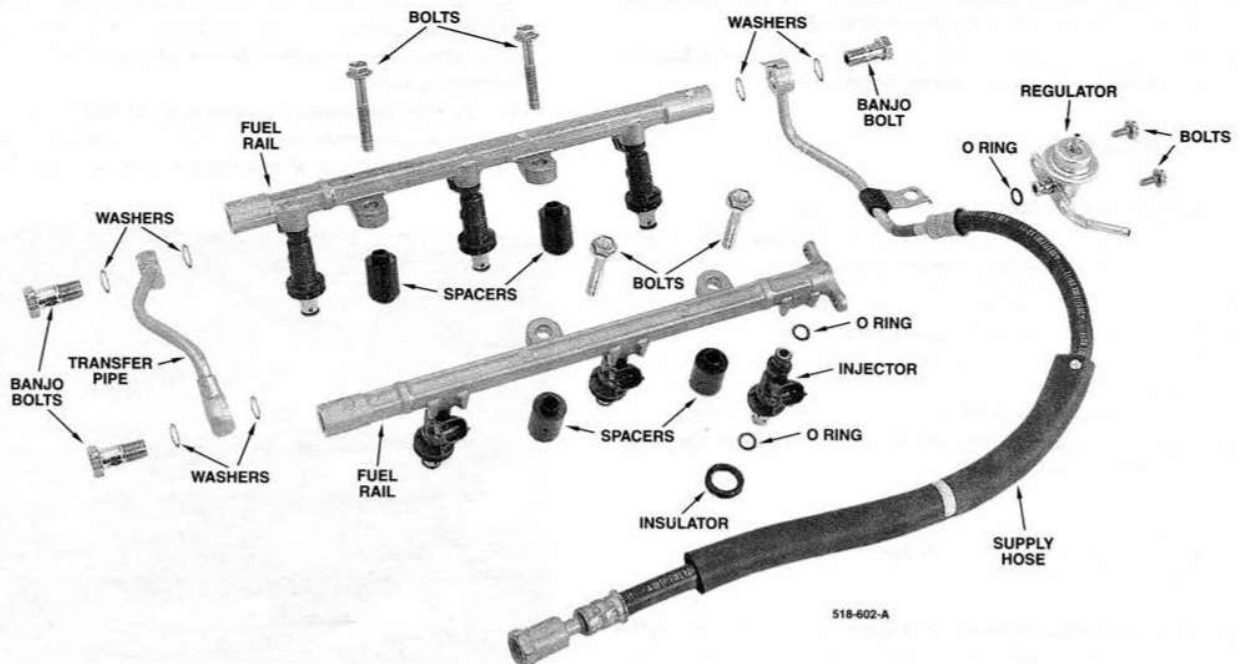
i Special equipment is required to clean and test the injectors. Refer to an authorised dealer or a fuel injection specialist.

To Remove and Install

- 1 Reduce the fuel system pressure as previously described in this chapter.

TIP Loosen the fuel filler cap several turns to prevent pressure build up in the fuel tank from causing a fuel leak.

- 2 Remove the upper and lower plenum chambers. Refer to Engine (chapter 4).
- 3 Remove the supply hose banjo bolt and discard the sealing washers. Release the retaining clamp and disconnect the



Fuel rail and associated components.

return hose from the pressure regulator. Seal the hoses to prevent the entry of dirt.

- 4 Remove the bolts retaining the fuel rail to the inlet manifold, and noting their installed position of the spacers, withdraw the fuel rail, ensuring that the injectors do not fall from the fuel rail.
- 5 Noting their installed position, pull the injectors from the fuel rail, using a twisting motion. Discard the O rings from the top of the injectors.
- 6 Remove and discard the insulators and the O rings from the lower end of the injectors.



The insulators may be stuck in the inlet manifold.

- 7 If necessary, remove the fuel pressure regulator from the fuel rail and discard the O ring.
- 8 If the fuel rails must be separated, remove the banjo bolts and noting its installed position, withdraw the transfer pipe. Discard the sealing washers.

Installation is a reversal of the removal procedure with attention to the following points:

- 1 If separated, install the transfer pipe in the position noted during removal, using new sealing washers. Do not fully tighten the banjo bolts at this stage.
- 2 Renew the insulators and the O rings sealing the injectors in the fuel rail and the inlet manifold.
- 3 Lubricate the O rings sparingly with engine oil and install the injectors squarely into the fuel rail. Ensure that the injectors can be rotated smoothly in the fuel rail.
- 4 Ensure that the spacers are correctly installed to the fuel rail and that the injectors are correctly positioned.
- 5 Tighten the fuel rail retaining bolts to the specified torque and verify that the injectors can be rotated smoothly. Tighten the transfer pipe banjo bolts to the specified torque.
- 6 If removed, install the pressure regulator using a new O ring, and tighten the retaining bolts to the specified torque.
- 7 Install the plenum chambers, referring to Engine (chapter 4), if necessary. Ensure that the wiring is securely connected to the injectors.
- 8 Test the fuel system for external leakage as previously described. Tighten the fuel filler cap securely.

FUEL GAUGE SENDER UNIT

The sub tank fuel gauge sender unit is combined with the fuel pump. Refer to the Fuel Pump heading for the removal procedure of the sender.

To remove the main fuel tank sender unit, proceed as follows:

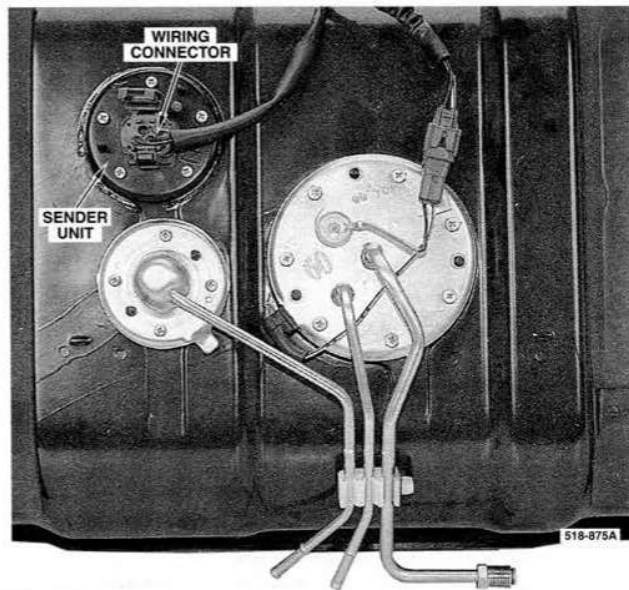
- 1 Remove the main fuel tank as described later in this chapter.
- 2 Disconnect the sender unit wiring connector on the top of the fuel tank.
- 3 Mark the installed position of the sender unit in relation to the main fuel tank and remove the retaining screws. Manoeuvre the sender unit from the fuel tank.

Installation is a reversal of the removal procedure with attention to the following points:

- 1 Ensure that the gasket is in serviceable condition.



The gasket is part of the sender unit, and is not available as a separate component.



Sender unit installed on the main fuel tank.

- 2 Tighten the retaining screws securely.

FUEL TANKS

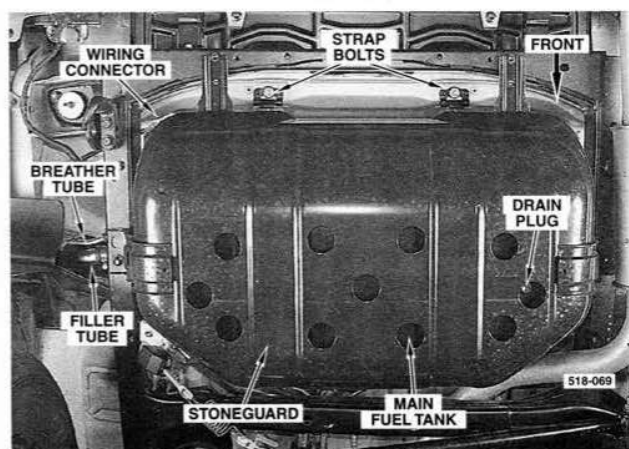
To Remove and Install — Main Tank

- 1 Raise the front and rear of the vehicle and support on chassis stands. Refer to General Information (chapter 1) for the positions of the jacking points.
- 2 Release the clip retaining the fuel pump/sender unit wiring connector to the chassis, and disconnect the wiring connector, located at the left hand rear of the fuel tank.
- 3 Ensure that the fuel tank changeover switch is in the main tank position.



In this position the lamp in the sub fuel tank gauge should be extinguished with the ignition On.

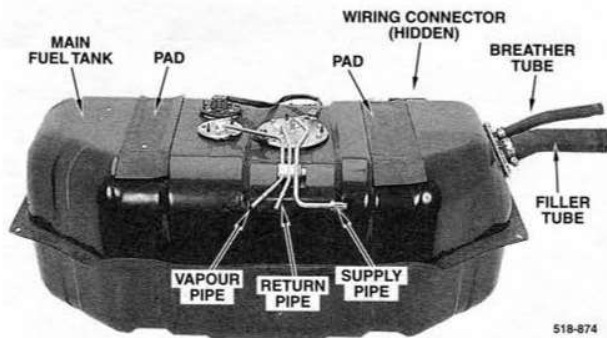
- 4 Start and run the engine, until it stops, to reduce the fuel system pressure. Turn the ignition Off and disconnect the



Main fuel tank installed, showing components.

102 | Fuel and Engine Management

Part 1



Main fuel tank removed showing components.

fuel supply and return pipes and the canister vapour hose, located at the front of the main fuel tank. Seal the hoses and pipes to prevent the entry of dirt.

- 5 Remove the bolts retaining the stoneguard and remove the stoneguard from beneath the vehicle.
- 6 Remove the drain plug from the fuel tank and drain the fuel into a clean container. Once the fuel is drained, install a new sealing washer and tighten the drain plug to the specified torque.
- 7 Release the clamps and disconnect the filler and breather tubes from the left hand side of the fuel tank.
- 8 Support the main fuel tank on a floor jack. Remove the bolts retaining the rear of the straps to the vehicle body and lower the straps. Carefully lower the jack and manoeuvre the fuel tank from the vehicle.

Installation is a reversal of the removal procedure with attention to the following points:

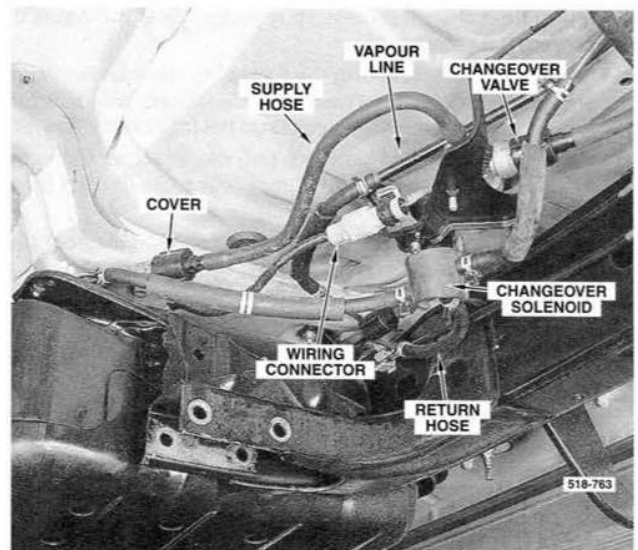
- 1 Carefully inspect all fuel hoses and renew any that are not serviceable.
- 2 Ensure that the insulator pads are correctly positioned on the fuel tank prior to installation.
- 3 Manoeuvre the fuel tank into position and install the retaining strap bolts. Ensure that the hoses and the wiring connector is not trapped between the fuel tank and the body. Tighten the retaining bolts to the specified torque.
- 4 Install the filler and breather hoses to the fuel tank and tighten the hose clamps securely.
- 5 Install the fuel tank stoneguard and tighten the retaining bolts to the specified torque.
- 6 Install the fuel supply hose union using two spanners and connect the return hose and the canister vapour line to the front of the fuel tank.
- 7 Connect the fuel pump/sender unit wiring connector securely. Check for external fuel leakage before lowering the vehicle.

To Remove and Install — Sub Tank

- 1 Raise the front and rear of the vehicle and support on chassis stands. Refer to General Information (chapter 1) for the positions of the jacking points.
- 2 Ensure that the fuel tank changeover switch is in the sub tank position.



In this position the lamp in the sub fuel tank gauge should be illuminated with the ignition On.

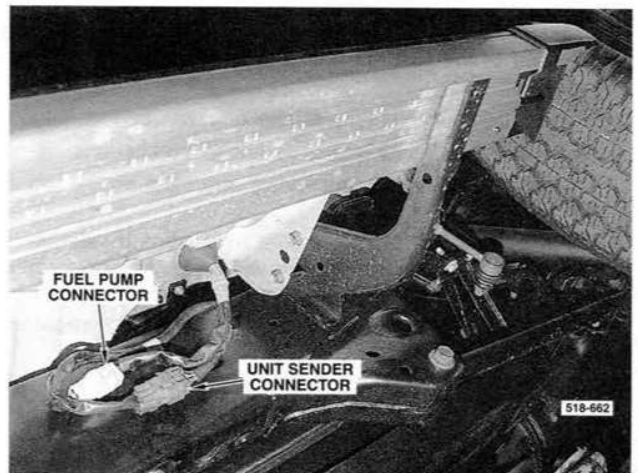


Location of the changeover valve and associated components.

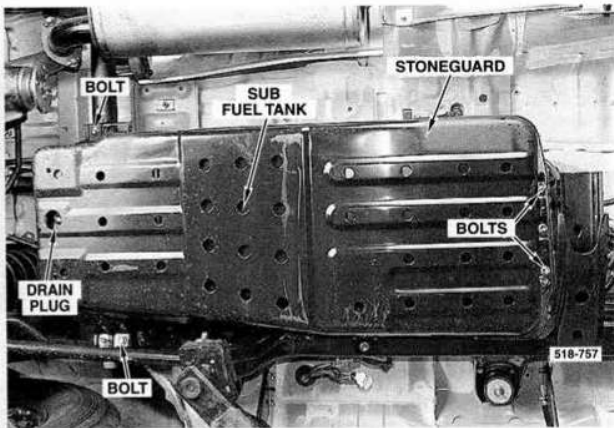
- 3 Working under the left hand side of the vehicle, forward of the rear wheel, disconnect the white sub fuel tank pump wiring connector and the sub fuel tank gauge sender unit wiring connector.
- 4 Release the clips retaining both wiring connectors to the chassis rail and place the wiring connectors over the chassis rail, onto the top of the sub fuel tank.
- 5 Start and run the engine, until it stops, to reduce the fuel system pressure.
- 6 Remove the drain plug from the fuel tank and drain the fuel into a clean container. Once the fuel is drained, install a new sealing washer and tighten the drain plug to the specified torque.
- 7 Using a flat bladed screwdriver, release the supply hose cover at the front of the sub fuel tank.
- 8 Squeeze the locking tabs of the supply hose together and pull the hose away from the steel pipe.



The locking tab will remain on the steel pipe.



Location of the sub fuel tank wiring connectors.



Sub fuel tank installed showing the stoneguard retaining bolts.

- 9 Release the clip and withdraw the return hose from the steel pipe.
- 10 Disconnect the vapour line from the pipe.
- 11 Disconnect the changeover valve wiring connector, located front of the sub fuel tank.
- 12 Release the clamps and disconnect the filler and breather tubes, located directly above the rear of the sub fuel tank. Seal the hoses and tubes to prevent the entry of dirt.
- 13 Remove the stoneguard retaining bolts and lower the guard away from the fuel tank.

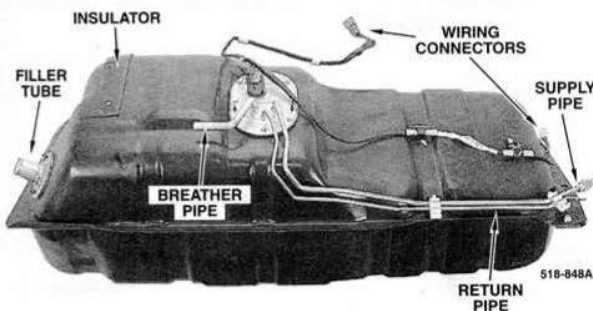


Do not remove the tank retaining bolt, located at the front of the sub fuel tank, as the tank may drop.

- 14 Support the sub fuel tank on a trolley jack. Remove the bolt and strap retaining the fuel tank to the vehicle body. Carefully lower the jack and manoeuvre the fuel tank from beneath the vehicle.

Installation is a reversal of the removal procedure with attention to the following points:

- 1 Carefully inspect all fuel hoses and renew any that are not serviceable.
- 2 Manoeuvre the fuel tank into position and install the strap and retaining bolt. Ensure that the hoses and the wiring connector is not trapped between the fuel tank and the body/chassis rail. Tighten the retaining bolts to the specified torque.
- 3 Install the filler and breather hoses to the fuel tank and install the hose clamps securely.



Sub fuel tank removed, showing components.

- 4 Install the supply and return hoses, ensuring that the locking tab is returned to the locked position. Install the supply hose cover and snap it shut.
- 5 Connect the fuel pump, the sender unit and the changeover valve wiring connectors. Check for external fuel leakage before lowering the vehicle.

Air Intake System

THROTTLE BODY

The throttle stop screw on the throttle body is set at the factory and must not be moved. If the screw is altered, the throttle position sensor adjustment, dashpot adjustment and throttle opening valve adjustment will all be affected. If the throttle stop screw is moved, the throttle body will have to be renewed.

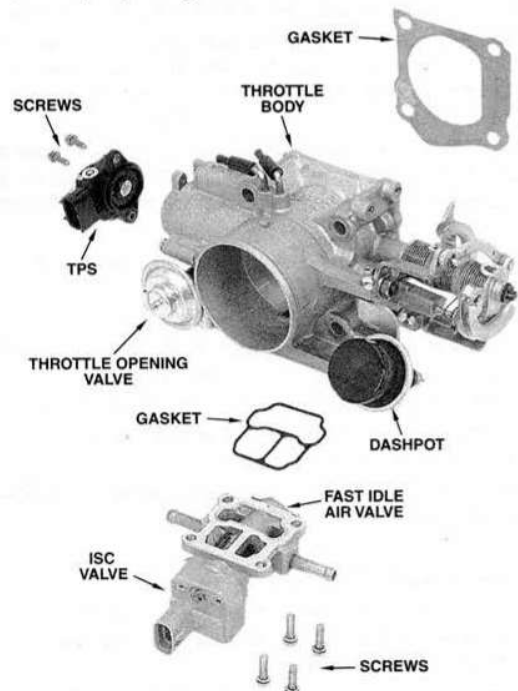
To Remove and Install

- 1 Remove the air inlet hose and the air cleaner top cover, as described under the next heading.
- 2 Open the throttle valve and disconnect the throttle cable and if fitted, the cruise control cable from the throttle lever.
- 3 Remove the bolts retaining the throttle cable and if fitted, the cruise control cable brackets and place the cable(s) with the bracket(s) clear of the work area.
- 4 Release the clamps retaining the coolant hoses to the throttle body, and using a twisting motion, remove the hoses from the fittings. Using 8 mm diameter bolts, seal the end of the hoses.



Remove and seal one coolant hose at a time, to prevent the loss of coolant.

- 5 Disconnect the idle speed control (ISC) and throttle position sensor (TPS) wiring connectors.



Throttle body components.

104 | Fuel and Engine Management

Part 1

- 6 Remove the retaining bolts and nuts and withdraw the throttle body from the upper plenum chamber. Discard the gasket.

Installation is a reversal of the removal procedure with attention to the following points:

- 1 Ensure that the plenum chamber and the throttle body mating faces are free of old gasket material.
- 2 Using a new gasket, install the throttle body to the plenum chamber. Install the retaining bolts and nuts and tighten to the specified torque.
- 3 Open the throttle lever by hand and connect the throttle cable and, if applicable, the cruise control cable to the throttle lever. Install the bracket(s) and tighten the retaining screws securely.
- 4 Check that the coolant and vacuum hoses are not soft, cracked or deteriorated and renew if necessary before connecting them to the throttle body.
- 5 Connect the throttle position sensor and idle speed control valve wiring connectors securely.
- 6 Check the throttle cable adjustment as described later in this chapter.
- 7 Check and if necessary top up the coolant level.

To Dismantle

- 1 Remove the throttle body as previously described.
- 2 Remove the bolts retaining the fast idle air valve assembly to the bottom of the throttle body. Separate the components and discard the gasket.



The ISC valve is part of the fast idle air valve and cannot be separated.

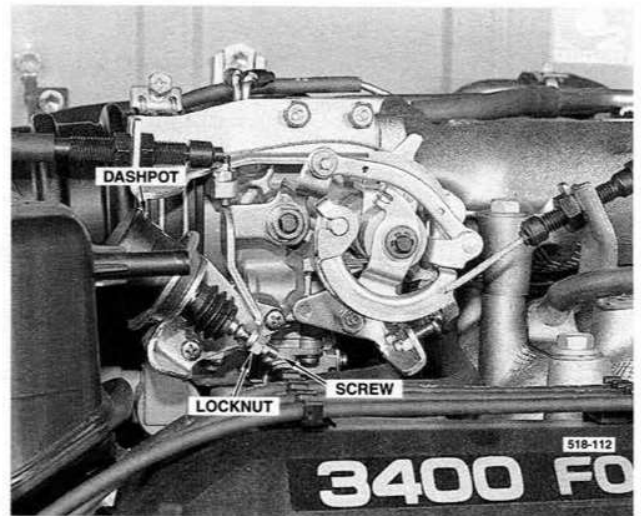
- 3 Remove the screws retaining the TPS and noting its installed position, withdraw the sensor from the shaft.
- 4 Remove the retaining screws and withdraw the dashpot.
- 5 Thoroughly clean the throttle body using suitable solvent (carburettor cleaner or similar) with particular attention to the throttle valve and idle passages. Do not use this type of cleaner to clean the TPS or the ISC motor.
- 6 Operate the throttle lever and check for smooth operation. Ensure that the throttle closes fully when slowly released. Lubricate the throttle shaft with a small amount of machine oil.

Installation is a reversal of the removal procedure with attention to the following points:

- 1 Ensure that the throttle body and the fast idle air valve mating faces are free of corrosion and old gasket material.
- 2 Install a new gasket and then install the fast idle air valve onto the throttle body. Tighten the retaining bolts securely.
- 3 Install the TPS in the position noted during removal, and tighten the retaining bolts securely.
- 4 Install the throttle body to the upper plenum chamber, as previously described.

To Inspect Throttle Opening Valve

- 1 Start the engine and allow it to reach normal operating temperature. Ensure that all accessories are turned off and the idle speed is 700 ± 50 rpm.
- 2 Disconnect the vacuum hose from the throttle opening valve and plug the end of the vacuum hose. The idle speed



Dashpot installed, showing the locknut and adjusting screw.

should increase to 900 – 1950 rpm, indicating the correctly functioning throttle opening valve. Switch the engine Off.

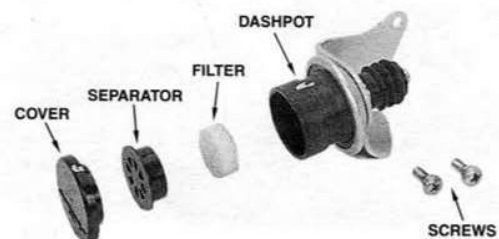
- 3 Connect the vacuum hose, start the engine and check that the idle speed returns to 700 ± 50 rpm.



At the time of publication, the throttle opening valve was only available with the throttle body. Therefore a faulty valve means that the throttle body must be renewed.

To Inspect and Adjust Dashpot

- 1 Start the engine and allow it to reach normal operating temperature. Ensure that all accessories are turned off and the idle speed is 700 ± 50 rpm.
- 2 Prise the cover from the end of the dashpot and, noting their installed position, remove the separator and the filter from the dashpot chamber.
- 3 Open the throttle to raise the idle speed to approximately 2 500 rpm or higher and maintain that speed.
- 4 Using a finger, block the valve opening in the dashpot chamber and release the throttle. The engine speed should drop to about 1 800 – 2 200 rpm, indicating the correct operation of the dashpot. If necessary, loosen the locknut and adjust the screw at the end of the dashpot pushrod.
- 5 Remove the finger from the valve opening. The engine should return to idle speed in approximately 1 second.
- 6 If the dashpot is operating correctly, install the filter and the separator in the position noted during removal and clip the cover on the chamber.



Dashpot components.



518-720

The valve opening location in the dashpot chamber, viewed with the cover, separator and the filter removed.



When installing the filter, ensure that the coarse side of the filter is towards the cover.

- 7 If the dashpot is faulty, remove the retaining screws and renew the dashpot. Adjust the new dashpot as previously described.

AIR CLEANER

To Service

The procedure to service the air cleaner element is described under the Routine Maintenance heading in Engine (chapter 4).

To Remove and Install

- 1 Disconnect the vacuum hoses from the air cleaner top cover, the resonator and from the inlet hose.
- 2 Release the clips retaining the wiring to the resonator and to the air inlet hose. Disconnect the air flow meter/sensor wiring connector.

- 3 Release the clamp retaining the air inlet hose to the throttle body.
- 4 Release the retaining clips and lift the top cover away from the air cleaner body. Withdraw the air cleaner element.
- 5 Disconnect the vacuum switch wiring connector from the side of the air cleaner body.
- 6 Remove the retaining bolts and withdraw the air cleaner body from the engine compartment. Ensure that the spacer in the front bush is not misplaced.
- 7 If necessary, release the clamps and noting their installed position, separate the inlet hoses from the top cover and from the silencer.

Installation is a reversal of the removal procedure with attention to the following points:

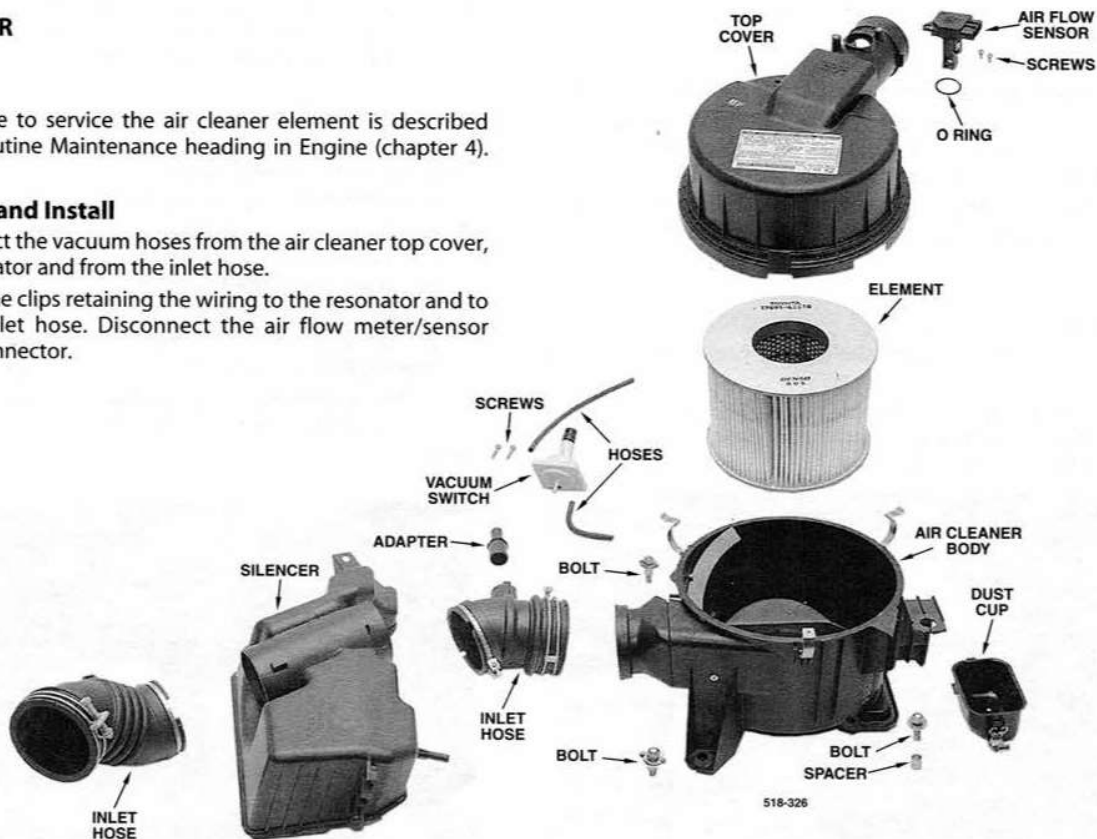
- 1 If separated, install the inlet hoses to the silencer and to the air cleaner top cover, in the position noted during removal.
- 2 Ensure that the bushes on the air cleaner body are in serviceable condition, and tighten the retaining bolts securely.
- 3 Connect the wiring connectors securely.

7

THROTTLE CABLE

To Remove and Install

- 1 Working in the engine compartment, loosen the adjusting nuts and disconnect the outer throttle cable from the mounting bracket.

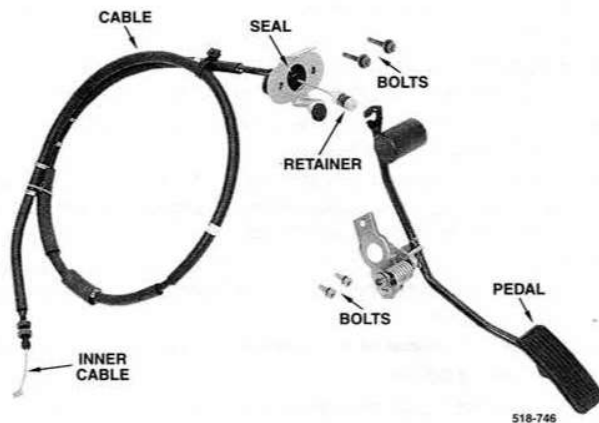


518-326

Air cleaner components. Late model shown, early similar.

106 | Fuel and Engine Management

Part 1



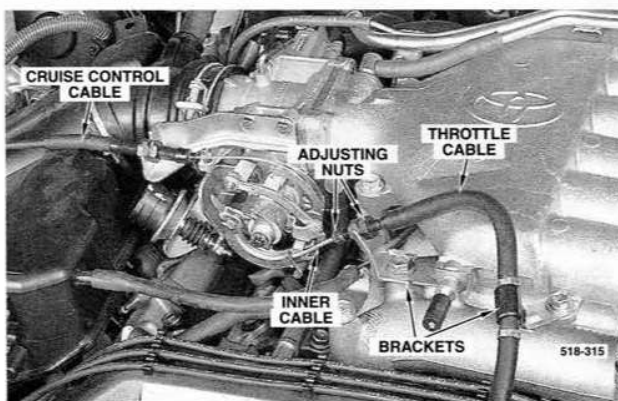
Throttle pedal and cable removed from vehicle.

- 2 Open the throttle lever by hand and disconnect the inner throttle cable. Release the throttle cable from the retaining brackets.
- 3 Remove the lower dash panel as follows:
 - a Remove the screws retaining the bonnet and fuel filler door remote handles. Pull the handles toward the rear of the vehicle, to release the hooks, and manoeuvre the handles from the lower dash panel.
 - b Remove the bolt and screw retaining the lower dash panel.
 - c Release the retaining clips and partially remove the panel, disconnect the wiring connectors and withdraw the panel from the dashboard.
- 4 Detach the inner cable retainer from the top of the throttle pedal and disengage the inner throttle cable from the pedal.
- 5 Remove the retaining bolts, release the seal assembly from the firewall and pull the throttle cable through the firewall, and into the drivers compartment.

Installation is a reversal of the removal procedure, ensuring that the throttle cable is adjusted as described under the following heading.

To Adjust

- 1 Have an assistant depress the throttle pedal fully and check that the throttle valve opens fully.
- 2 If necessary, adjust the throttle cable adjusting nuts until the throttle valve is in the fully open position. Tighten the adjusting nuts securely.



Throttle cable adjusting point.



If the throttle cable does not open the throttle fully, the engine will have a noticeable decrease in power. If the throttle pedal opens the throttle lever before the pedal is against the floor, wear and possible breakage of the throttle cable is possible. Ensure the throttle cable is adjusted so as to open the throttle fully only when the pedal touches the floor of the vehicle.

- 3 Release the throttle pedal and ensure that the throttle valve is fully closed, with the throttle lever touching the throttle stop screw. A small amount of freeplay must exist on the inner cable.
- 4 Tighten the adjusting nuts against the brackets and check the throttle cable adjustment. If the adjustment has altered, repeat the procedure.

Electrical System



To Test Igniter — Frequency meter

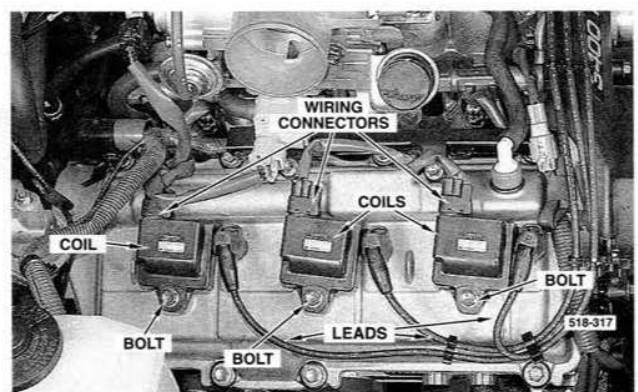
Some of the components under this heading cannot be accurately tested, even with the manufacturers dedicated test equipment. Where it is suggested in the text to substitute the component with a known good one, a substitute component can be obtained through several engine management component remanufacturers. Often, these companies have loan units to enable the technician to substitute a known good component with theirs to see if the fault is then rectified. It is recommended that this avenue be explored before purchasing new components.

IGNITION SYSTEM

To Remove and Install Coils

- 1 Remove the air cleaner top cover as previously described.
- 2 Release the locking tab retaining the high tension lead to the coil and withdraw the lead from each coil. Disconnect the wiring connector from each coil.
- 3 Ensure that the area around each coil is clean and remove the bolts retaining the coils to the rocker cover. While twisting the coil, withdraw it from each spark plug.

Installation is a reversal of the removal procedure, ensuring that the wiring connectors and high tension leads are securely connected.



Location of the ignition coils.



518-723

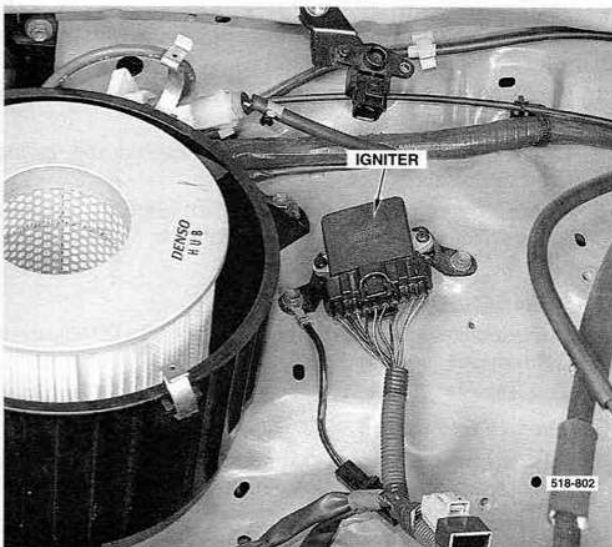
Checking the coil secondary resistance.

To Test

The procedure to check the ignition circuit is described in Roadside Trouble Shooting (chapter 3) under the heading Ignition and Electrical System Checks.

If spark is not available at each of the high tension leads, or the spark is weak, check the high tension lead resistance as described in Engine (chapter 4). If no fault can be found with the high tension leads, proceed with the following preliminary checks.

- 1 Disconnect the wiring connector from one of the coils. Check that battery voltage is available at the black/red wire of the connector with the ignition On. If battery voltage is not present, check the wiring between the harness connector and the ignition switch for an open circuit or a short to earth.
- 2 Remove the coils as previously described. Measure the coil primary resistance between the coil wiring connector



Location of the igniter. The terminal identification is printed on the connector.

terminals and the secondary resistance between the spark plug connector and the high tension lead connector of the coil. Renew the coil if the resistances are not to Specifications.

- 3 Disconnect the wiring connector from the igniter and check the wiring between the igniter wiring connector and the ECU for continuity or shorts to earth.



Use the wiring diagrams in Part 2 of this chapter as a guide to trace the igniter circuits.

- 4 Check for continuity to earth at terminal 3 of the igniter wiring connector.
 - 5 Check for battery voltage at terminal 9 of the igniter wiring connector with the ignition On. If battery voltage is not present, check the wiring between the ignition switch and the igniter.
 - 6 Using a frequency meter, backprobe terminal 4 (black/red wire) of the igniter wiring connector and check that there is approximately 40 Hz available with the engine idling at operating temperature. If the Hz reading is not as specified, check the wiring between the ECU and the igniter for continuity and shorts to earth. If no fault can be found, renew the igniter.
 - 7 Backprobe terminal 5 (black/white wire) of the igniter wiring connector and check that there is approximately 8 – 12 Hz available with the engine idling at operating temperature. Repeat this check at terminal 6 (green/black wire) and terminal 7 (black wire). The Hz readings taken at the three ignition control terminals should all be the same. If the reading is lower on one of these terminals, check the wiring between the ignition control terminal with the low reading and the ECU. If no fault can be found, a problem is indicated in either the ECU or the igniter. Substitute the igniter with a known good unit and repeat step 6. Renew faulty components as necessary.
 - 8 Disconnect the white sub fuel tank pump wiring connector from the left hand chassis rail. With the engine running on the main fuel tank, switch to the sub fuel tank and allow the engine to stall, depressurising the fuel system.
 - 9 Disconnect the primary wires from each ignition coil.
 - 10 Backprobe terminal 1 (blue/yellow wire) of the igniter wiring connector and check that there is approximately 9 – 12 Hz while cranking the engine. Repeat this check at terminal 2 (blue/red wire) and terminal 10 (blue/white wire). The Hz readings taken at the three coil trigger terminals should all be the same.
- If the igniter Hz readings are not as specified, check the wiring between the ECU and the igniter for continuity and shorts to earth. If no fault can be found, a fault with the ECU is indicated. Check the ECU power supply and earth circuits.
- If the Hz reading is lower on one or more cylinders, but tested okay in step 7, renew the igniter.
- 11 Connect the wiring to each ignition coil and the sub fuel tank pump white wiring connector.

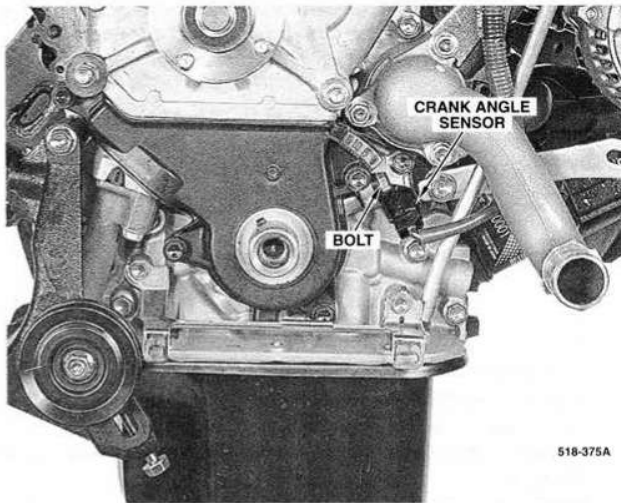
CRANK ANGLE SENSOR

To Test

Testing the crank angle sensor is covered in Part 2 of this chapter.

108 | Fuel and Engine Management

Part 1



Crank angle sensor location, viewed with the crankshaft pulley removed.

To Remove and Install

- 1 Raise the front of the vehicle and support on chassis stands. Refer to General Information (chapter 1) for the positions of the jacking points.
- 2 Working at the front of the engine, adjacent to the alternator, disconnect the crank angle sensor wiring connector.
- 3 Remove the retaining bolt and manoeuvre the sensor from the oil pump housing.

Installation is a reversal of the removal procedure, ensuring that the mating surface of the oil pump housing is clean prior to installing the crank angle sensor.

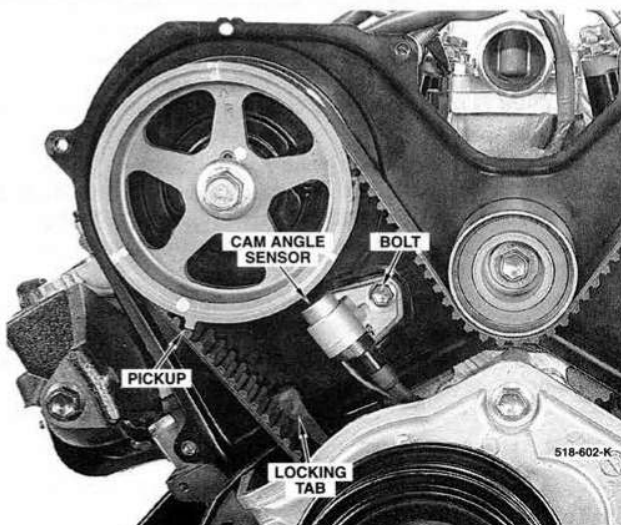
CAM ANGLE SENSOR

To Test

Testing the cam angle sensor is covered in Part 2 of this chapter.

To Remove and Install

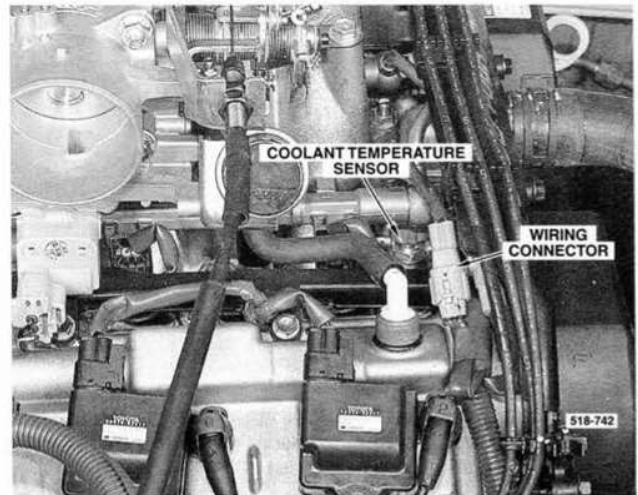
- 1 Disconnect the camshaft position sensor wiring connector.



Location of the cam angle sensor.

- 2 Remove the upper timing belt cover, referring to the Engine (chapter 4), if necessary.
- 3 Remove the retaining bolt and release the wiring from the locking tab. Manoeuvre the cam angle sensor wiring from behind the timing belt and remove the sensor from the engine compartment.

Installation is a reversal of the removal procedure, ensuring that the wiring is securely held by the locking tab and is not in contact with the timing belt.



Coolant temperature sensor location.

COOLANT TEMPERATURE SENSOR

To Test

Testing the coolant temperature sensor is a straightforward operation and is covered in Part 2 of this chapter.

To Remove and Install

- 1 Disconnect the wiring from the coolant temperature sensor.
- 2 Ensure that the engine is cold. Remove the sensor from the inlet manifold. Discard the sealing washer.

Installation is a reversal of the removal procedure with attention to the following points:

- 1 Install the coolant temperature sensor using a new sealing washer and tighten to the specified torque.
- 2 Ensure that the wiring is securely connected and making good electrical contact.
- 3 If necessary, top up the cooling system using the specified coolant. Refer to Cooling System (chapter 5), if necessary.

OXYGEN SENSOR

Not all models are fitted with an oxygen sensor. If a CO adjuster is fitted, no oxygen sensor is used.

To Remove and Install

- 1 Raise the front of the vehicle and support on chassis stands. Refer to General Information (chapter 1) for the positions of the jacking points.
- 2 Disconnect the oxygen sensor wiring connector.
- 3 Lubricate with penetrating oil and remove the retaining nuts. Withdraw the sensor and discard the gasket.

Installation is a reversal of the removal procedure, ensuring that a new gasket is used during installation and the retaining nuts are tightened to the specified torque.

IDLE SPEED CONTROL (ISC) VALVE

To Remove and Install

The idle speed control valve is part of the fast idle air valve and should not be separated from it. The removal and installation of the fast idle air valve is previously described under the Throttle Body heading.

To Test

Testing the ISC valve is a straightforward operation and is covered in Part 2 of this chapter.

EFI RELAY

To Test

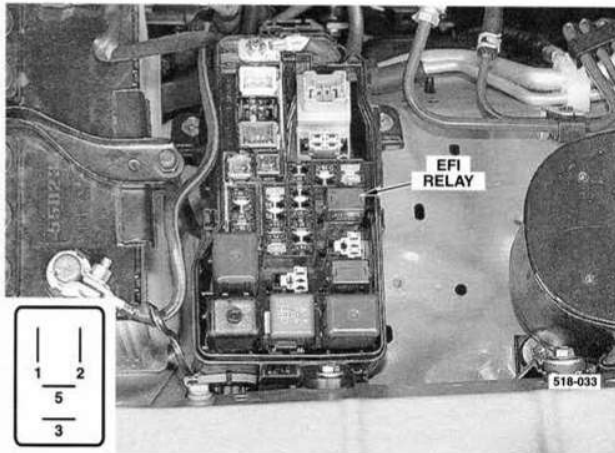
- 1 Remove the relay from the engine compartment relay box.
- 2 Check that continuity exists between terminals 1 and 2.
- 3 Check that continuity does not exist between terminals 3 and 5.
- 4 Apply 12 volts between terminals 1 and 2 and check that continuity exists between terminals 3 and 5. Renew the relay if necessary.

CIRCUIT OPENING RELAY, FUEL PUMP SELECT RELAY AND LOW TEMPERATURE SUB FUEL PUMP RELAY

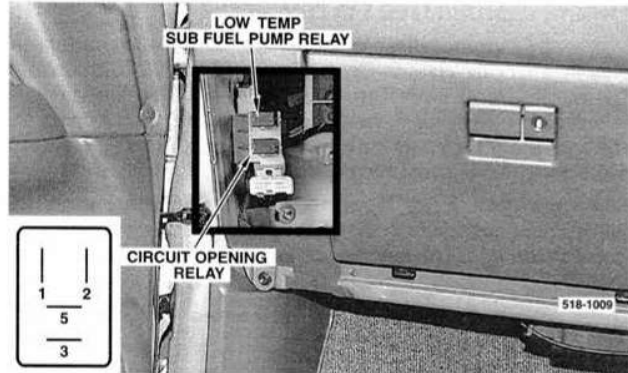
To Remove and Install — Circuit Opening Relay and Low Temperature Sub Fuel Pump Relay

- 1 Remove the screws retaining the glove compartment and withdraw the compartment from the dashboard.
- 2 Remove the retaining screw and withdraw the ventilation ducts from the glove compartment aperture.
- 3 Remove the bolt retaining the relay panel to the vehicle body, release the clip and partially withdraw the panel. Pull the relays from the relay panel.

Installation is a reversal of the removal procedure, ensuring that the relays are securely connected.



Location of the EFI relay. Inset shows the terminal identification.



Location of the low temperature sub fuel pump and the circuit opening relays. The inset shows the terminal identification.

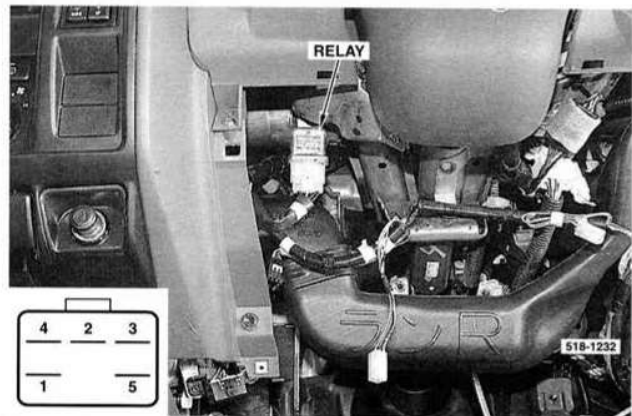
To Remove and Install — Fuel Pump Select Relay

- 1 Working under the steering column, remove the lower dash panel as follows:
 - a Remove the screws retaining the bonnet and fuel filler door remote handles. Push the handles toward the front of the vehicle, to release the hooks, and manoeuvre the handles from the lower dash panel.
 - b Remove the bolt and screw retaining the lower dash panel.
 - c Partially remove the panel, disconnect the wiring connectors and withdraw the panel from the dashboard.
- 2 Disconnect the wiring from the bottom of the relay.
- 3 Remove the retaining screw and remove the relay from beneath the dashboard.

Installation is a reversal of the removal procedure, ensuring that the relay is securely connected.

To Test

- 1 Remove the relay as previously described.
 - 2 Check that continuity exists between terminals 1 and 2.
 - 3 Check that continuity does not exist between terminals 3 and 5. On the fuel pump select relay, check that continuity also exists between terminals 3 and 4.
 - 4 Apply 12 volts to terminals 1 and 2 and check that continuity exists between terminals 3 and 5. On the fuel pump select relay, check that continuity does not exist between terminals 3 and 4.
- Renew the relay if necessary.



Lower dash panel removed showing the fuel pump select relay. Inset shows the terminal identification.

110 | Fuel and Engine Management

Part 1

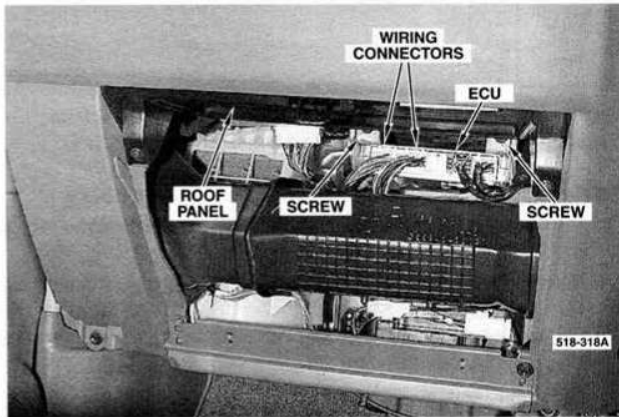
ENGINE IMMOBILISER SYSTEM

The engine immobiliser disables the engine management system when the ignition key is removed from the ignition lock. The warning lamp in the instrument cluster will flash once every two seconds, indicating the system is armed. When armed, the starter relay, fuel injectors and engine ECU are isolated, preventing the vehicle being started.

When the correct key is inserted in the ignition switch, the transponder microchip in the key will transmit an electronic code to the security ECU on early models, or to the engine ECU on late

models via the key reader surrounding the ignition lock assembly. If the correct signal is received, the security warning lamp on the dashboard will stop flashing, indicating that the engine immobiliser is disarmed and the vehicle will start. This is useful when diagnosing a no start problem with the vehicle. If the security warning lamp is flashing with the ignition On, a fault is indicated within the engine immobiliser system.

Detailed procedures to trouble shoot the engine immobiliser system is described in Body Electrical (chapter 16), under the Security System heading.



Glove compartment removed showing the ECU.

ENGINE CONTROL UNIT (ECU)

To Remove and Install

- 1 Ensure that the ignition is switched Off and disconnect the negative battery terminal.
- 2 Working in the passengers compartment, remove the screw and bolt retaining the glove compartment and withdraw the compartment from the dashboard.
- 3 Remove the screws retaining the glove compartment roof panel and withdraw it from the dashboard.
- 4 Disconnect the ECU wiring connectors.
- 5 Remove the retaining screws and withdraw the ECU from the dashboard.

Installation is a reversal of the removal procedure, ensuring that the wiring connectors are securely connected.