ELECTRONIC FUEL INJECTION

Description

Fuel Injection System

Fuel is drawn from the fuel tank by a high pressure electric pump located in the fuel tank. The fuel pump operates only when the pump relay and/or the starter motor circuits are energised. Fuel passes to the pressure regulator via an in-line filter. The pressure regulator varies pressure in direct proportion to manifold depression and thus varies injection pressure between 1.8 to 2.5 kgf/cm², 26 to 36 lbf/in². Excess fuel is returned to the fuel tank.

A fuel rail links the pressure regulator with the fuel injectors, one injector being fitted to each inlet manifold spur. The injectors are solenoid operated being pulse energised by the electronic control unit, ECU, completing a circuit to 'earth'. When 'open' the injectors spray fuel into the inlet manifold to be drawn into the engine cylinders at the next induction stroke of each piston.

Therefore there needs to be no fixed relationship between the injector timing and the engine ignition or valve timing.

The injectors are programmed to 'open' alternately in two banks of four, twice per engine operating cycle. The time that the injectors are 'open' governs the amount of fuel supplied to the engine and this 'open' time is computed by the ECU from the inputs it receives from the various sensors.

To assist cold starting, a separate cold start injector sprays a fine jet of fuel against the air stream entering the plenum chamber. The cold start injector is energised from the engine starter motor circuit and is in series with a thermo-time switch which is dual activated by the engine coolant temperature (heat) and a heater coil around a bi-metal strip (time) the coil being energised from the starter motor circuit. The thermotime switch ensures that the cold start injector will not be energised when the engine is at normal operating temperature or during prolonged operation of the starter motor when the engine is below normal operating temperature. The switch will isolate the cold start injector after approximately 8 to 12 seconds at −20°C, −4°F, this time is decreased as the engine approaches its normal operating temperature.

Fuel Pump

The fuel pump is energised initially via a relay during operation of the starter motor solenoid and then by a switch operated by the air flow meter and is independent of the ECU.

Electronic Control Unit — ECU.

The ECU is a sealed unit and receives input signals from various sensors and computes from these an output signal to the fuel injector solenoid circuits. When activated the solenoids 'open' the injectors to spray fuel into the engine inlet manifold spurs, the injectors remaining open for between 1.5 and 10 milli-seconds depending on engine running requirements.

The ECU is protected by various devices: the diode pack protects against reversed battery connection. The main relay is controlled by the ignition switch and connects battery voltage directly to the ECU.

Engine Speed

Low tension circuit pulses from the ignition coil negative terminal, are passed to the ECU to be computed into an engine speed input.

Air Flow Meter

The air flow meter measures induction air flow mass. The plenum chamber absorbs any rapid fluctuations in air flow that might upset the air flow meter signals.

The movement of the measuring flap is dampened by a compensating flap which prevents flutter. The position of the flap is controlled by the air drawn into the engine and the action of a return spring. The mass of air drawn into the engine at any time is indicative of the engine load and a signal from a potentiometer, variable resistance, proportional to the flap position, is passed to the ECU. However, the air mass and air density is dependent upon air temperature. Therefore, an air temperature sensor is incorporated into the air flow meter and this sends a separate signal to the ECU.

Due to the action of the return spring, the measuring flap is almost closed when the engine is idling and an idle air by-pass channel is provided to assist the engine to breath at low speed. Air passing through the by-pass channel is not registered by the air flow meter measuring flap. The idle air mixture screw is fitted into the by-pass channel to regulate the air flow to adjust the air to fuel ratio CO content at idle speed.

Coolant Temperature Sensor

The sensor provides coolant temperature information to the ECU.

The sensor causes the ECU to lengthen slightly, the time that the main injectors are 'open' reducing this time as the engine warms up and cutting it off when normal engine operating temperature is reached.

Continued

Extra Air Valve

This valve is mounted above a water passage in the inlet manifold and registers engine coolant temperature. The valve provides the additional air required to maintain satisfactory cold start mixture until the engine reaches normal operating temperature. This air is taken after it has passed through the air flow meter, so that the air is registered by the ECU, and returned to the plenum chamber after the throttle butterfly.

The valve allows extra air to pass under cold start conditions, the extra air source is reduced and finally terminated as normal engine operating temperature is reached.

The valve is controlled by a bi-metal strip which is heated from two sources; the coolant and a heater coil around the strip. The heater coil is energised from the fuel pump circuit and comes into operation when the engine is under crank or running.

Throttle Potentiometer

The electrical signal from the potentiometer to the ECU depends upon the position of the throttle butterfly spindle and hence the accelerator pedal. By using the variable voltage output in conjunction with the information from the other sensors, the ECU adjusts fuel input to accommodate requirements for acceleration, deceleration and constant engine speed. When sudden acceleration is signalled to the ECU by the throttle potentiometer, all injectors are instantly pulsed to operate once simultaneously to ensure adequate engine response.

Over-run Fuel Cut-off — Vacuum Switch

The manifold depression switch senses manifold depression above 24 in Hg ± 1 in Hg. The switch operates the over-run relay which interrupts the ignition signal to the ECU.

Air Temperature Sensor

The air temperature sensor is an integral part of the air flow meter and cannot be replaced as a separate item.

The sensor sends a separate signal to the ECU, the ECU then alters the length of time the injectors remain open, correcting the air/fuel mixture.

FUEL INJECTION SYSTEM

CAUTION: The fuel system incorporates fine metering components that would be affected by any dirt in the system; therefore it is essential that working conditions are scrupulously clean.

If it is necessary to disconnect any part of the fuel injection system i.e. pipes, hoses, etc., these must be blocked off to prevent ingress of dirt.

ENGINE SETTING PROCEDURE — FUEL INJECTION

If a major overhaul has been undertaken on the fuel injection/engine system, the following check and adjustments must be carried out before attempting to start the engine.

A. **Throttle potentiometer setting** — see 'Throttle switch —potentiometer' setting procedure.

B. **Spark plug gaps**—see 'Data section'.

C. **Throttle levers**—see 'Throttle lever setting procedure'.

D. **Ignition timing—static**—see 'Engine tuning data'.

E. **By-pass idle screw**—see 'Engine tuning procedure'.

NOTE: If the previous checks and adjustments are satisfactory but the engine will not start the fuel injection electrical circuitory must be checked using the appropriate recommended equipment.

Recommended Equipment:

Lucas 'Electronic Ignition Analyser'
Lucas Part Number—TWB 119.

Lucas 'E.F.I. Throttle Potentiometer Adjustment Gauge'
Lucas Part Number—YWB 121.

Lucas 'Epitest' diagnostic system
Lucas Part Number—YWB 105.

Use in conjunction with the Lucas Operating Instruction Manuals.

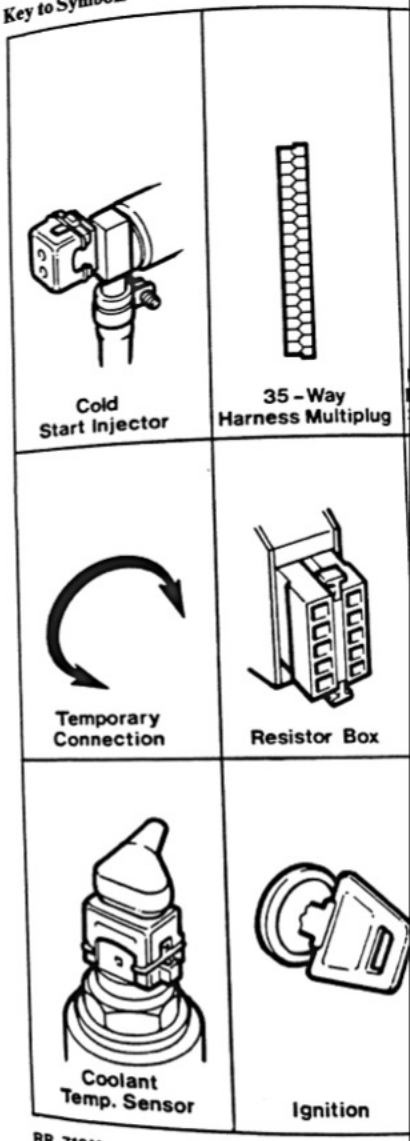
If the above equipment is unavailable the tests can be carried out using an AVO meter, following the instructions given in the charts.

CAUTION: Ensure the AVO is correctly set to volts or ohms, dependent upon which test is being undertaken.

CONTINUITY TESTS—Using an AVO meter

The following continuity tests are intended as a g
should be made to the fuel injection circuit diagra

Key to Symbols



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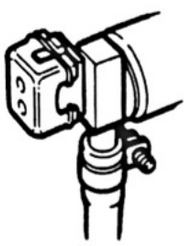
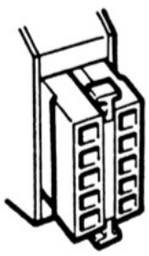
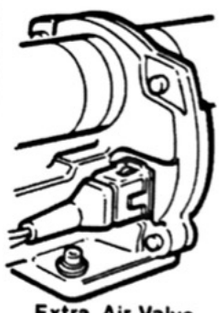
CONTINUITY TEST—Using an AVO met

**NOTE: All tests are carried out from the ele
procedure.**

CONTINUITY TESTS—Using an AVO meter

The following continuity tests are intended as a guide to identifying where a fault may occur within a circuit; reference should be made to the fuel injection circuit diagram for full circuit information.

Key to Symbols

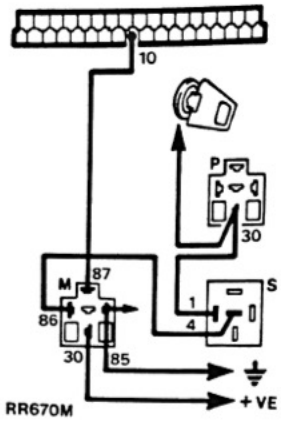
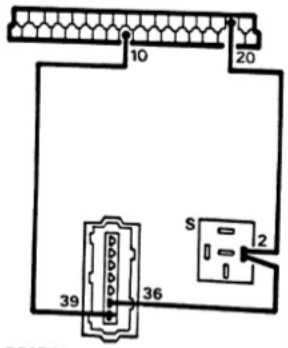
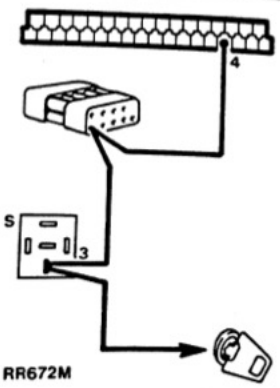
 Cold Start Injector	 35-Way Harness Multiplug	 P-Pump Relay M-Main Relay S-Steering Module	 Airflow Meter Harness Plug	 Throttle Switch (potentiometer type)
 Temporary Connection	 Resistor Box	 Injector	 Thermotime Switch	 Extra Air Valve
 Coolant Temp. Sensor	 Ignition	 Pressure Gauge	 Electrical Multiplug	 Constant Energy Unit

RR 716M

CONTINUITY TEST—Using an AVO meter

NOTE: All tests are carried out from the electronic control unit (ECU) harness multi-plug unless stated otherwise in the test procedure.

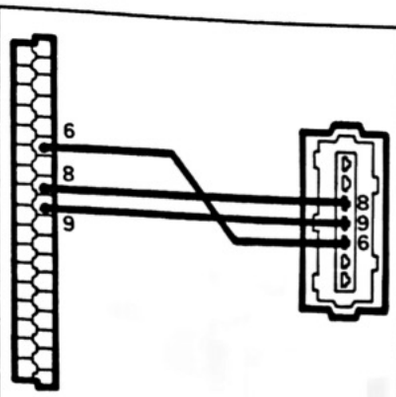
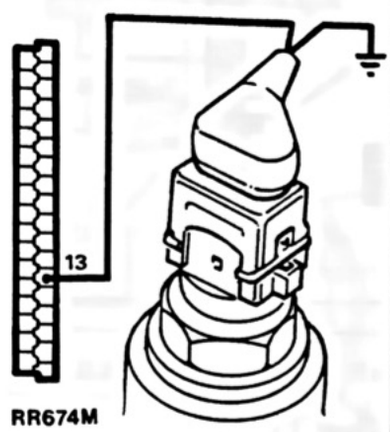
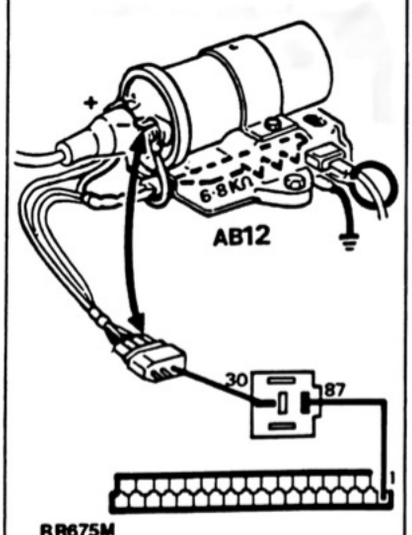
Continued

TEST	CIRCUIT TESTING	EXPECTED RESULTS	POSSIBLE FAULTS AND REMEDIES
1. ECU SUPPLY Disconnect the mutli-plug from the ECU. Switch on the ignition. Connect a voltmeter between pin 10 and earth.	 RR670M	11–12.5 volts	No reading; check all wiring to main relay, check main relay by substitution. Below 11 volts; check battery. Check circuit for high resistance connection.
2. FUEL PUMP CONTACTS Switch on the ignition and connect a voltmeter between pin 20 and earth. Airflow meter flap closed. – – – – – – – – – – – – – – Operate the flap in the airflow meter.	 RR671M	0 volts – – – – – – – – – – – – – – 11–12.5 volts	If reading registered, check airflow meter switch action. – – – – – – – – – – – – – – No reading, check wiring from main relay to airflow meter. Check wiring from airflow meter to fuel pump relay. Check pump relay by substitution. Check fuel pump operation by connecting a direct supply to the pump terminals.
3. CRANKING SIGNAL Connect a voltmeter between pin 4 and earth. Crank the engine.	 RR672M	8–12 volts	No reading but starter motor operates; check wiring from starter relay to steering module and from steering module to ECU. No reading starter motor does not operate; check starter relay and starter motor. Below 8 volts check battery, check starter motor.

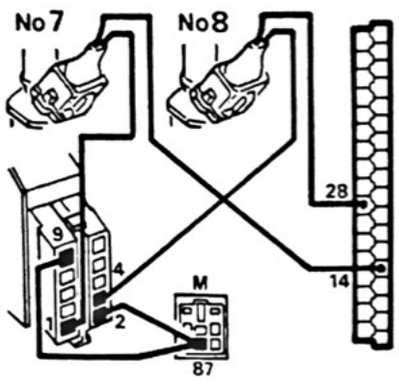
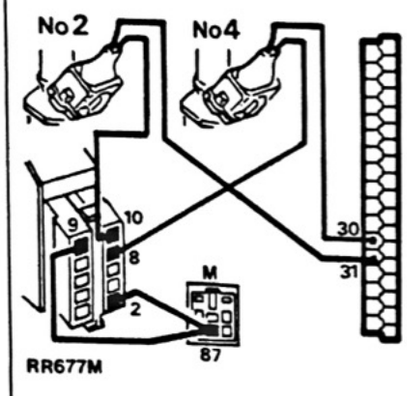
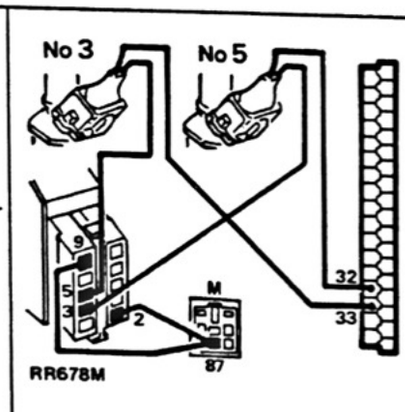
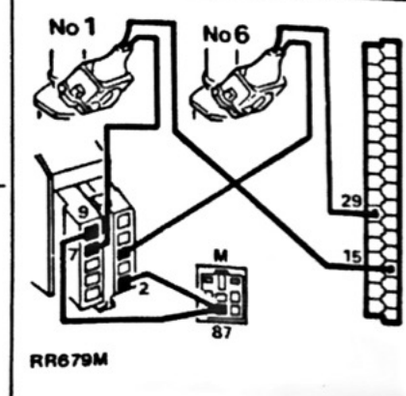
4. AIRFLOW METER
Connect ohmmeter betwee
pin 6 and 8.
– – – – – – – – – – – –
Connect ohmmeter betwee
pins 6 and 9.
– – – – – – – – – – – –
Connect ohmmeter betwee
pins 8 and 9.

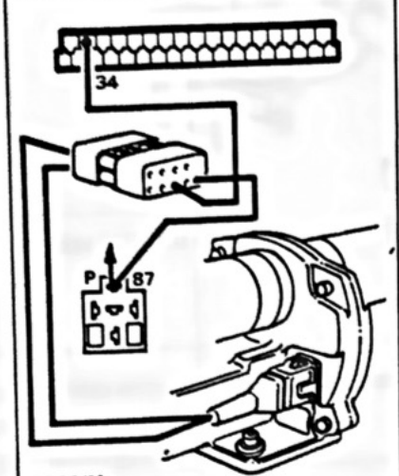
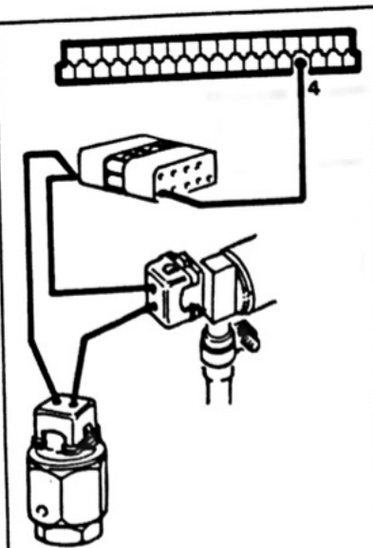
5. WATER TEMPERATURE SENSO
Connect ohmmeter betwee
pin 13 and earth.

6. SPEED SIGNAL
(Constant energy ignition)
Fit a jump lead between the
negative terminal on the
ignition coil and pin 1.
Connect voltmeter between
pin 1 and earth. Crank engi

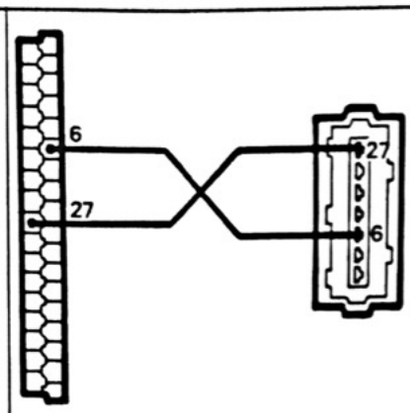
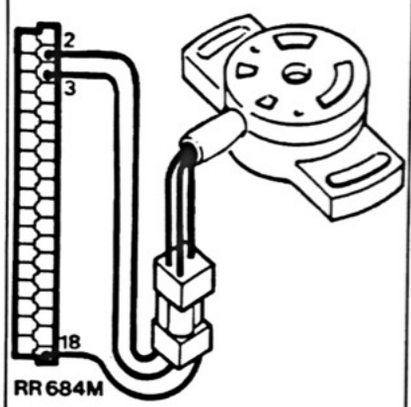
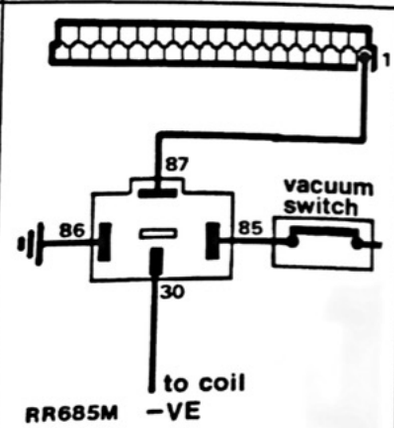
4. AIRFLOW METER Connect ohmmeter between pin 6 and 8. — — — — — — — — — Connect ohmmeter between pins 6 and 9. — — — — — — — — — Connect ohmmeter between pins 8 and 9.	 RR673M	360 ± 10 Ω — — — — — 560 ± 10 Ω — — — — — 200 ± 10 Ω	Should readings be different from expected results; check harness continuity between ECU plug and airflow meter plug, i.e. pins 6–6, 8–8, 9–9. Check variable resistor circuit in airflow meter with ohmmeter, check that meter flap is closed before substituting airflow meter.
5. WATER TEMPERATURE SENSOR Connect ohmmeter between pin 13 and earth.	 RR674M	Temp °C — K Ω −10 ± 1 °C — 7.0 to 11.6 +20 ± 1 °C — 2.1 to 2.9 +80 ± 1 °C — 0.27 to 0.39	Incorrect reading; check wiring and electrical plug, renew sensor if readings do not comply with results. **NOTE: Connect the AVO measuring leads to the sensor for short periods only, to minimise the effect of self heating due to the measuring current.**
6. SPEED SIGNAL **(Constant energy ignition)** Fit a jump lead between the negative terminal on the ignition coil and pin 1. Connect voltmeter between pin 1 and earth. Crank engine.	 RR675M	6–9 volts fluctuating	No reading; check harness connections between coil and ECU.

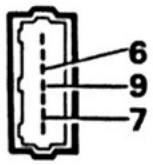
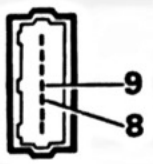
Continued

TEST	CIRCUIT TESTING	EXPECTED RESULTS	POSSIBLE FAULTS AND REMEDIES
7. INJECTOR CHECK **Numbers 7 and 8** **Injector 7** Connect ohmmeter between pin 14 and 87 on main relay. **Injector 8** Connect ohmmeter between pin 28 and 87 on main relay.	 RR676M	7–10 KΩ 7–10 KΩ	If reading is below expected results, disconnect each injector in turn to find injector with '00' or low reading; renew injector. If winding resistance of injector is satisfactory, check wiring circuits and resistor pack for open circuit condition.
7A. INJECTOR CHECK **Numbers 2 and 4** **Injector 2** Connect ohmmeter between pin 31 and 87 on main relay. **Injector 4** Connect ohmmeter between pin 30 and 87 on main relay.	 RR677M	7–10 KΩ 7–10 KΩ	See injectors 7 and 8.
7B. INJECTOR CHECK **Numbers 3 and 5** **Injector 3** Connect ohmmeter between pin 15 and 87 on main relay. **Injector 5** Connect ohmmeter between pin 29 and 87 on main relay.	 RR678M	7–10 KΩ 7–10 KΩ	See injectors 7 and 8.
7C. INJECTOR CHECK **Numbers 1 and 6** **Injector 1** Connect ohmmeter between pin 33 and 87 on main relay. **Injector 6** Connect ohmmeter between pin 32 and 87 on main relay.	 RR679M	7–10 KΩ 7–10 KΩ	See injectors 7 and 8.

8. PRESSURISED FUEL RAIL Fit pressure gauge to cold start injector fuel hose. Switch the ignition on and operate the airflow meter spring return switch to energise the fuel pump.	 RR680M	2.4–2.6 kgf/cm² 34–37 lbf in²	No pressure build up; check fuel pump circuit with voltmeter. If a reading of 12 volts obtained, check fuel pump earth circuit, satisfactory. If earth circuit check pump. Check operation of fuel pump relay and main relay by substitution if pressure reading is zero. Fuel pressure above or below limits; check pipe work and regulator for blockages and falling pressure reading, check pipe work for leaks, check for leaking injectors, pressure regulator and fuel pump non-return valve.
9. EXTRA AIR VALVE Connect ohmmeter between pin 34 and 87 on fuel pump relay.	 RR681M	30–40 Ω	No reading; check wiring and connections between the pump relay, extra air valve and ECU. Check air valve for continuity with an ohmmeter.
10. COLD START INJECTOR Disconnect the thermotime switch. With each of the leads being connected to earth in turn. Connect ohmmeter between pin 4 and earth.	 RR682M	0–5.0 Ω	No reading; check wiring and connections between the ECU cold start injector and thermotime switch. Open circuit; check wiring and connections and cold start injector windings.

Continued

11. AIR TEMPERATURE SENSOR (Airflow meter) Connect ohmmeter between pin 6 and 27. **NOTE: Connect the AVO measuring leads to the sensor for short periods only, to minimise the effect of self heating due to the measuring current.**	 RR683M	Temp °C K Ω −10 ±0.5 °C 8.26 to 10.56 +20 ±0.5 °C 2.28 to 2.72 +50 ±0.5 0.76 to 0.91	If reading is infinity; disconnect airflow meter, bridge terminals 6 and 27. If ohmmeter reads zero air temperature, sensor is faulty. If after replacement ohmmeter shows infinity, check wiring and connections to the ECU.
12. THROTTLE POTENTIOMETER **CAUTION: Ensure the AVO is set to volts.** Reconnect the ECU switch ignition on. Measure voltage between green −VE lead and yellow +VE lead by inserting the meter probes into the rear of the multi plug. With ECU connected insert meter −VE lead to green wire and meter +VE lead to red wire measure voltage. ECU connected and with leads connected as above; open throttle voltage should steadily increase.	 RR684M	4.3 ± 0.2 volts 0.3–0.36 volts Smooth swing within 0.3 to 4.5 volt range	No reading or low reading; check wiring and connections If meter reading drops and suddenly picks up through the voltage range—indicates faulty track—renew potentiometer.
13. OVER-RUN RELAY Disconnect the negative lead from coil to relay. Ignition off, connect ohmmeter between pin 1 and 30 on relay. Ignition on, connect ohmmeter between pin 1 and 30 on relay. Disconnect the vacuum switch and repeat the above test.	 RR685M	Infinity Ω 0 Ω Infinity Ω	Reading other than infinity; check wiring and connections for security. Substitute relay. Readings other than zero; check wiring and connections, renew vacuum switch if necessary. Readings other than infinity; renew relay.

14. AIRFLOW METER (Potentiometer) Reconnect the ECU switch ignition on. Peel back rubber boot on plug. Insert +VE meter probe to pin 6 and −VE lead to pin 9 Connect −VE meter probe to pin 9 and +VE probe to pin 7 measure voltage With leads connected as above gradually open air flap. Voltage should decrease.	 RR714M	1.55 ± 0.1 volts 3.7 ± 0.1 volts 1.6 ± 0.1 volts	No reading or low reading; check wiring and connections Renew airflow meter if results are not within expected results.
15. AIRFLOW METER (Potentiometer) Disconnect the ECU. Switch ignition on. Peel back electrical plug rubber boot. Insert −VE meter probe to pin 9 and +VE probe to pin 8.	 RR715M	4.3 ± 0.2 volts	If actual results do not meet expected results, renew the airflow meter.

After completing the tests with either the 'Epitest' equipment or AVO meter, retest the vehicle to ensure the faults have been rectified.
If faults still persist, check the ECU by substitution.

FAULT DIAGNOSIS—FUEL INJECTION—HOT START

SYMPTOM	POSSIBLE CAUSE	CURE
A. Engine will not start.	1. Battery discharged.	1. Remove battery from vehicle and recharge.
	WARNING: BEFORE CARRYING OUT THE NEXT TWO OPERATIONS, ENSURE THAT THE RECOMMENDED INSULATED EQUIPMENT IS USED WHEN HANDLING THE HIGH TENSION LEAD.	
	2. Ignition—coil.	2. Remove HT lead from distributor, turn ignition on and check for spark at HT to earth—no spark—renew coil and amplifier.
	3. Ignition—distributor.	3. Remove HT lead from spark plug, turn ignition on and crank engine—no spark—rectify or renew distributor.
	4. Injectors failing to operate.	4. Turn ignition on and operate the throttle briskly; injectors should be heard to click. If no clicking audible, check throttle potentiometer connections.
	5. Fuel tank ventilation.	5. Check ventilation pipe work and that a non-vented petrol cap is fitted, rectify or renew.
	6. Cold start system operating.	6. Cold start system should be inoperative at coolant temperatures above 35°C. If the cold start injector is operating it will cause over-richness of fuel and the vehicle will not start. Disconnect cold start injector, if vehicle starts renew thermotime switch and or cold start injector if injector is leaking.
	7. Loss of fuel pressure.	7. Disconnect the high tension lead from the coil. Insert a pressure gauge between fuel pump and fuel rail (between fuel rail and cold start injector), crank engine to pressurise fuel system, pressure under cranking should be 2.5 kgf/cm² (36 lbf/in²). Pressure should not drop by more than 0.7 kgf/cm² (10 lbf/in²) in first hour, if greater check for fuel leaks in system. Clamp fuel pipe between gauge and fuel rail, if pressure drops renew fuel pump.
	8. Loss of pressure due to faulty fuel pressure regulator.	8. Insert a pressure gauge between fuel pump and fuel rail. (Between fuel rail and cold start injector). Crank engine to pressurise fuel system, and clamp fuel pipe between pressure regulator and fuel rail; if pressure still drops rectify or renew pressure regulator. If regulator leaking it may be due to ingress of dirt or grit lodged on the valve seat. It is possible to clear this by clamping fuel return pipe after the regulator, run engine for no more than two seconds; release the clamp quickly. The resultant fuel flow may be sufficient to move the dirt or grit off the valve seat. If valve still loses pressure after re-testing—renew the pressure regulator.
	9. Loss of fuel pressure due to leaking injectors.	9. Insert a pressure gauge between fuel pump and fuel rail; crank engine to pressurise fuel system. Clamp fuel pipe between pressure regulator and fuel rail; if pressure drops locate and renew a faulty injector or cold start injector.

FAULT DIAGNOSIS CHART—GENERAL—FUEL INJECTION

SYMPTOM	POSSIBLE CAUSE	CURE
1. Fuel/air mixture weak.	Air leaks (unmetered air entering engine).	Check engine for air leaks, renew 'O' rings and gaskets as necessary.
	Low fuel pressure.	See fault diagnosis 'Hot start' tests 7, 8, 9.
	Blocked fuel injectors.	Remove injectors from manifold; do not disconnect from fuel rail. Using Lucas 'Epitest' diagnostic equipment locate faulty injector and renew.
2. Fuel/air mixture rich.	Fuel pressure high.	See fault diagnosis 'Hot start' test 8. Check for faulty pressure regulator; check fuel return pipes for blockages.
	Cold start system operating continuously.	Disconnect cold start injector; if mixture returns to correct levels, renew the thermotime switch or cold start injector.
	Exhaust leaks.	Check all exhaust joints, pipes, silencers for security and leaks; retighten or renew as necessary.
	Leaking injector.	Locate and renew faulty injector.
3. Engine erratic (hesitating/ intermittent).	Engine compressions.	If pressure is considerably low, this indicates faulty valves or piston rings. Low pressure in other cylinders indicates faulty cylinder head gasket.
	Fuel injection electrical earth.	Check earth connection on rear of block, clean and check for security.
	Ignition system.	See fault diagnosis 'Hot start' test 2 and 3 for H.T. checks. Check low tension side of ignition using 'Lucas Electronic Ignition Analyser' Part number YWB 119.
	Electrical connections.	Check all connections for security.
	Air filter blocked.	Check filter—renew if necessary.
	Inadequate fuel pressure.	Insert pressure gauge into fuel system; check for correct operating pressure. If pressure low, investigate for blockages on fuel feed line.

ENGINE TUNING PROCEDURE

Before carrying out 'Engine Tuning' on fuel injection vehicles, it is important that all other engine related setting procedures are undertaken first; air meter and air cleaner correctly fitted, ignition and throttle potentiometer correctly set; all hoses correctly fitted and secured.

When the engine is running at its normal operating temperature; thermostat open, the following additional checks and adjustments can be made.

CHECK AND ADJUST IGNITION TIMING

1. Timing to be checked at not more than 600 rev/min from number 1 cylinder using a stroboscopic lamp.
2. If adjustment is necessary, slacken the distributor clamp bolt and rotate clockwise to retard or anti-clockwise to advance. When the required setting has been attained, tighten the clamp bolt and re-check the setting.

   NOTE: Timing must be checked with vacuum pipe disconnected.

CHECK AND ADJUST IDLE SPEED

1. Remove tamperproof plug from the plenum chamber.
2. Rotate the idle adjustment screw to set the engine idle speed at 700 to 800 rev/min.
   (Clockwise decreases speed — anti-clockwise increases speed.)

CHECK AND ADJUST IDLE CO LEVEL

The following measurements must be taken with the air cleaner connected, exhaust system correctly fitted and checked for leaks.

1. Remove the tamperproof blanking plug from the top of the air flow meter.
2. Adjust the screw until the CO level reading is to specification; 1% maximum.

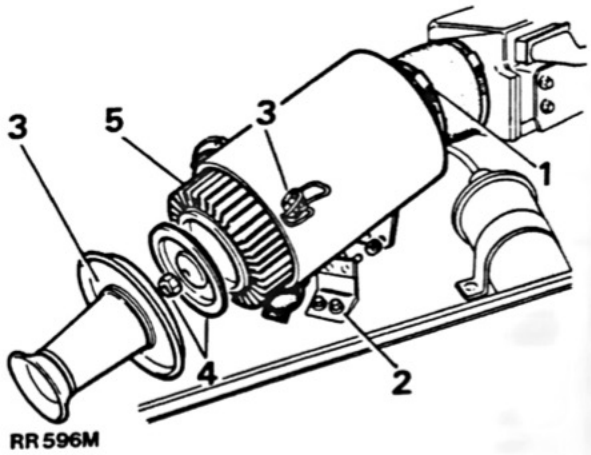
   NOTE: Do not allow the engine to idle for longer than 3 minutes when setting.

3. Give engine a 'clear out' burst of 30 seconds at 2000 rev/min light load or longer if necessary to maintain normal running temperature.
4. Re-check CO level and idle speed; adjust if necessary.
5. Fit new tamperproof plugs to air flow meter and idle adjustment screws.

AIR CLEANER

Remove

1. Release the hose clip securing the hose to the rear of the air cleaner canister.
2. Remove the two nuts and bolts securing the air cleaner to the left-hand valance. Pull the canister from the hose and remove the air filter canister from the engine compartment.
3. Unclip the three catches securing the inlet tube to the air cleaner canister and remove the inlet tube.
4. Remove the nut and end plate securing the air cleaner element in position.
5. Withdraw the air cleaner element and discard.



RR596M

Refit

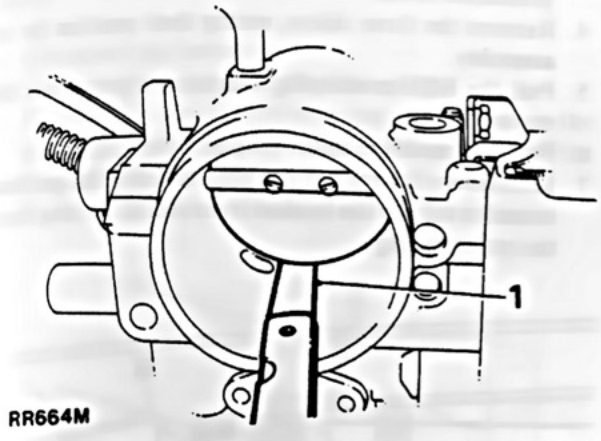
6. Fit new element and secure in position.
7. Refit the inlet tube to the air cleaner canister.
8. Refit the air cleaner to the mounting bracket and tighten the two nuts.
9. Fit the hose to the air cleaner outlet aperture and tighten the hose clip.

RESETTING THROTTLE LEVERS—fuel injection

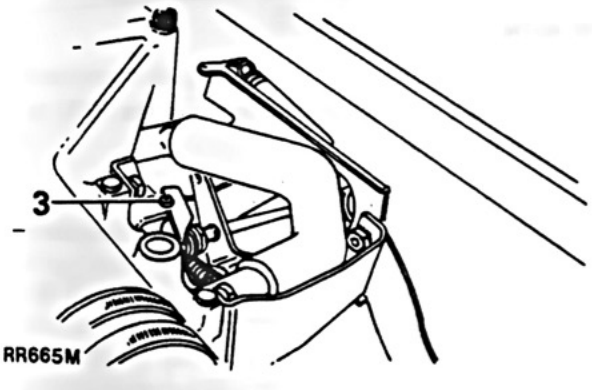
Manual/Automatic Transmission

NOTE: The setting procedure outlined is applicable at minimum throttle condition only.

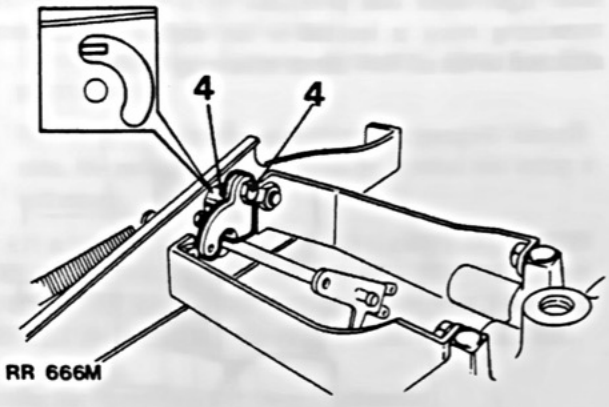
1. Set the throttle butterfly to a maximum of 0.05 mm (0.002 in) clearance, measured at the vertical centre line within ± 10°.



2. Ensuring that the butterfly is retained at its setting, remove the stop adjustment screw tamperproof cap (if fitted).
3. Rotate the screw until contact is made with the stop lever, refit the tamperproof cap (if fitted).



4. Release the throttle operating lever securing screw and adjust the lever until contact is made with the top end of the slot in the throttle lever mounting bracket; retaining the lever in this position re-tighten the screw.



NOTE: Re-check the throttle potentiometer setting after adjusting the throttle levers.

RENEW THE THROTTLE CABLE

Removing

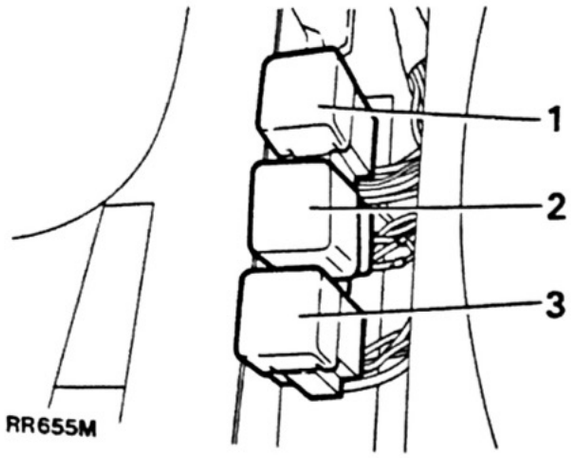
1. Remove the split pin, washer and clevis pin securing the throttle linkage end of the cable.
2. Carefully prise the throttle cable adjustment nut out of the linkage mounting bracket.
3. Withdraw the cable from the mounting bracket.
4. Release the outer cable from the retaining clips within the engine compartment.
5. Remove the lower fascia panel from beneath the steering column.
6. Disconnect the cable from the throttle pedal.
7. Feed the cable through the bulkhead grommet and into the engine compartment.

FIT NEW THROTTLE CABLE

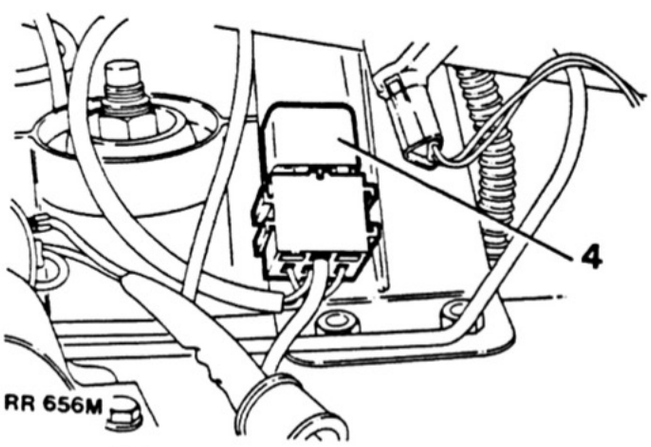
8. Feed the new cable from the engine compartment through the bulkhead grommet.
9. Connect the cable to the throttle pedal.
10. Connect the cable to the throttle linkage, fit a new split pin and secure in position.
11. Clip the outer cable adjustment nut into the mounting bracket.
12. Adjust the outer cable to give 1.57 mm (0.062 in) free play in the throttle cable and check the throttle operation.

ELECTRONIC FUEL INJECTION RELAYS

Incorporated into the fuel injection electrical circuits are three relays and a current steering diode pack. Two of the relays and the steering diode pack are located beneath the front right-hand seat protected by a black cover. The remaining relay is located in the engine compartment attached to the air flow meter mounting bracket.



Relays viewed from within the vehicle.



Relay viewed from engine compartment

1. Fuel pump relay (Item 11 on fuel injection circuit diagram).
2. Steering module (red case) (Item 9 on fuel injection circuit diagram).
3. Main relay (Item 10 on fuel injection circuit diagram).
4. Over-run fuel shut-off relay (Item 4 on fuel injection circuit diagram).

Removing

1. Disconnect the battery.
2. Remove the black protective cover (applicable only to the relays located under the right-hand seat).
3. Pull the relay(s) from the multi-plug(s).

Refitting

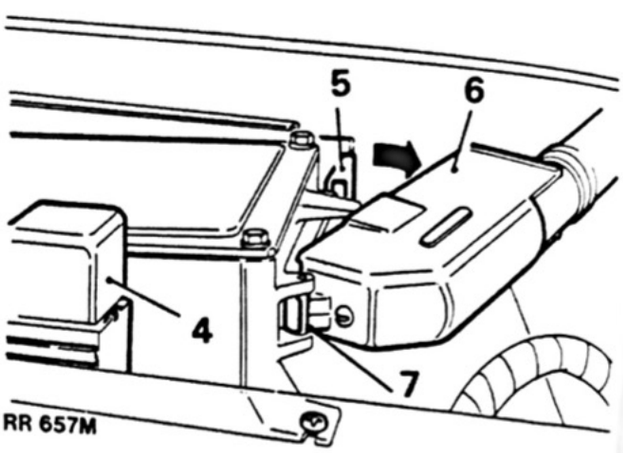
4. Reverse the removal procedure.

ELECTRONIC CONTROL UNIT—ECU

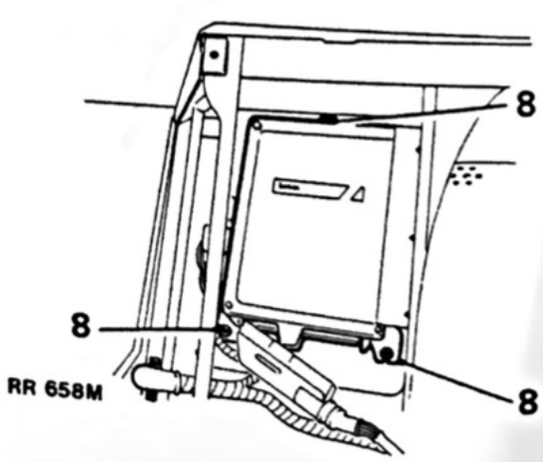
Remove and refit

Removing

1. Disconnect the battery.
2. The ECU is located under the front right-hand sea and is accessible through the front aperture of the sea plinth.
3. Release the quarter turn screw and lift off the black protection cover.
4. Remove the three relays, noting their position for re-assembly.
5. Pull the ECU multi-plug retaining clip towards the rear of the seat.
6. Pull the rear of the multi-plug out of the ECU.
7. Manoeuvre the rear of the plug towards the gearbox tunnel to release the hooked front end of the plug from the retaining peg.



8. Release the three screws securing the ECU to the mounting bracket.



9. Withdraw the ECU from beneath the seat.

NOTE: The ECU is not itself a serviceable item, in the event of a unit failure, the ECU must be renewed.

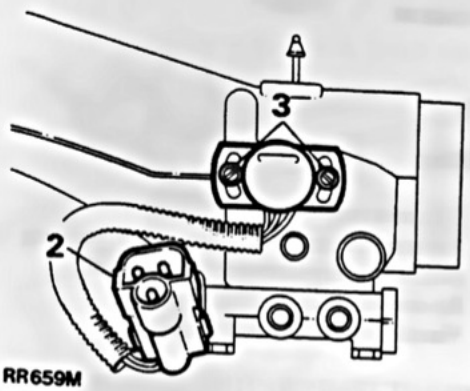
Refitting

10. Secure the ECU in position.
11. Push the multi-plug into the ECU until an audible click is heard denoting that the plug is fitted securely.
12. Refit the relays.
13. Refit the ECU protective cover.
14. Re-connect the battery.

THROTTLE POTENTIOMETER

Remove

1. Disconnect the battery.
2. Disconnect the electrical three pin plug.
3. Remove the two screws securing the switch to the plenum chamber and carefully pull the switch off the throttle butterfly spindle.



4. Remove the old gasket.

Refit

5. Fit a new gasket between the throttle switch and plenum chamber.
6. Align the switch and spindle flats; slide the switch onto the throttle spindle and secure the switch to the plenum chamber.
7. The throttle potentiometer must be reset using a potentiometer adjustment gauge.

Setting the potentiometer

Equipment required:—

Lucas electronic fuel injection throttle potentiometer adjustment gauge — **Lucas Part Number YWB 121.**

8. Slacken the potentiometer securing screws.
9. Disconnect the three-pin plug from the potentiometer electrical lead. Connect the adjustment gauge plug to the potentiometer.
10. Connect the two crocodile clips from the throttle potentiometer gauge to the appropriate battery terminals.
11. Rotate the potentiometer clockwise or anti-clockwise until the middle lamp of the three indication lamps remains illuminated.
12. Tighten the potentiometer securing screws.
13. Re-check the potentiometer setting.
14. Disconnect the adjustment gauge from the potentiometer and battery terminals.
15. Re-connect the harness three-pin plug to the potentiometer.

NOTE: If a potentiometer adjustment gauge is unavailable, the setting procedure can be carried out using a voltmeter.

IF AN AVO METER IS USED TO CARRY OUT THIS CHECK — ENSURE THE AVO IS SET TO VOLTS. AN AVO METER SETTING OTHER THAN VOLTS WILL RESULT IN DAMAGE TO THE POTENTIOMETER.

Setting the Potentiometer using a voltmeter

16. Slacken the potentiometer securing screws.
17. Switch on the ignition.
18. Connect a voltmeter between the red and green leads at the potentiometer electrical plug.
19. Rotate the potentiometer clockwise or anti-clockwise, until the volt meter reads 290 ± 20 Mv.
20. Tighten the potentiometer securing screws.
21. Re-check the voltmeter reading.

THERMOTIME SWITCH

Test

WARNING: When the cooling system is hot take care to avoid scalding.

1. Remove the pressure relief cap from the coolant expansion tank and remove the filler plug from the radiator. Use a thermometer and note the coolant temperature.
2. Disconnect the battery and pull the electrical connector from the thermotime switch.

   Note the rated value stamped on body of the switch.
3. Connect ohmmeter between switch terminal 'W' and earth:
   (a) Coolant temperature higher than the switch rated value; a very high resistance reading, (approximately 300 ohms at temperature greater than 40°C) open circuit, should be obtained. Renew the switch if a low resistance, short circuit, is shown.
   (b) Coolant temperature lower than the switch rated value; a very low resistance reading, closed circuit, (approximately zero ohms at temperature less than 40°C) should be obtained. Renew the switch if a high reading, open circuit, is shown.
4. Connect a 12v supply via an isolating switch to terminal 'G' of the thermotime switch.

   Use a stopwatch, check the time delay between making the isolating switch, and the ohmmeter showing the change from low to high resistance. The delay period must closely approximate to time, according to temperature:

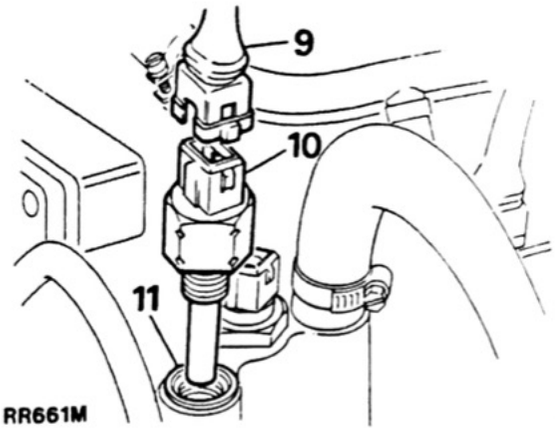
Coolant Temperature °C	Delay in Seconds
−10	8
0	4.5
10	3.5
35	0

   Renew the thermotime switch if necessary.
5. Re-connect the plug to the switch and connect the battery.

Removing

WARNING: When the cooling system is hot take care to avoid scalding

6. Remove the pressure relief cap from the coolant expansion tank.
7. Remove the radiator bottom hose and partially drain the cooling system.
8. Disconnect the battery.
9. Remove the electrical plug from the switch.
10. Unscrew the switch and remove it from the inlet manifold.
11. Remove the copper seating washer.



Refitting

12. Fit a new copper washer.
13. Reverse the removal instructions ensuring that the switch is firmly screwed into position.
14. Re-connect the electrical plugs.
15. Visually inspect for water leaks.

COOLANT TEMPERATURE SENSOR

Test

NOTE: When using an AVO connect the measuring leads to the sensor for short periods of time only to minimise the effects of self heating due to the measuring current.

1. Disconnect the battery and remove the electrical plug from the temperature sensor.
2. Connect an ohmmeter between the sensor terminals and note the resistance reading, disconnect the ohmmeter.

   The reading should closely approximate the following according to temperature:

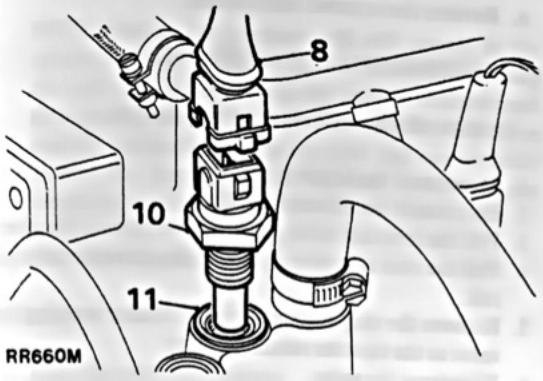
Coolant Temperature °C	Resistance Kilohms
−10	9.2
0	5.9
20	2.5
40	1.18
60	0.60
80	0.33

3. Check the resistance between each terminal in turn against the body of the sensor. A very high resistance reading, open circuit, must be obtained.
4. Re-connect the sensor and the battery.

Removing

WARNING: When the cooling system is hot take care to avoid scalding.

5. Remove the pressure relief cap from the coolant expansion tank.
6. Remove the radiator bottom hose and partially drain the cooling system.
7. Disconnect the battery.
8. Remove the electrical plugs from the coolant sensor and thermotime switch.
9. Unscrew the thermotime switch to give access to the coolant sensor.
10. Unscrew the coolant sensor and remove it from the inlet manifold.
11. Remove the copper washer from the manifold.



Refitting

12. Reverse the removal procedure ensuring that the switches are securely fitted. Fit new copper washers.
13. Re-connect the electrical plugs.
14. Visually inspect for water leaks.

AIR TEMPERATURE SENSOR

Test

NOTE: To prevent self heating of the sensor during the test procedure connect the measuring leads to the sensor for short periods of time only.

1. Disconnect the battery and the electrical multiplug from air flow meter.
2. Connect the ohmmeter between terminals 6 and 27 of the air flow meter and note the resistance reading. The reading should closely approximate the following, according to temperature:

Ambient air temperature (°C)	Resistance kilohms
−10	9.2
0	5.9
20	2.5
40	1.18
60	0.60

3. Disconnect the ohmmeter. Re-connect the multi-plug and the battery.

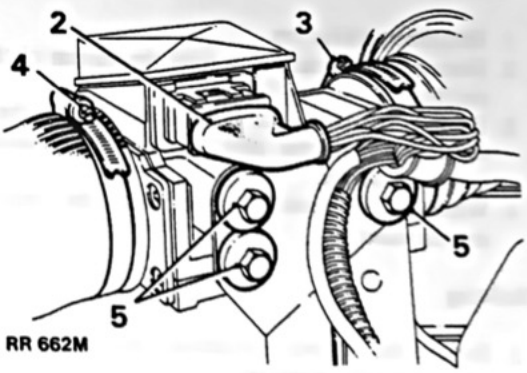
The air temperature sensor is not a serviceable item. If it does not meet the test requirements, the complete air flow meter must be renewed.

AIR FLOW METER

Remove and Refit

Removing

1. Disconnect the battery.
2. Disconnect the electrical multi-plug from the side of the air flow meter.
3. Release the hose clip and remove the plenum chamber hose from the rear of the meter.
4. Release the hose clip at the air intake side of the air flow meter.
5. Remove the three securing screws and plain washers retaining the meter to the mounting bracket.
6. Detach the air flow meter from the hose and withdraw it from the engine compartment.

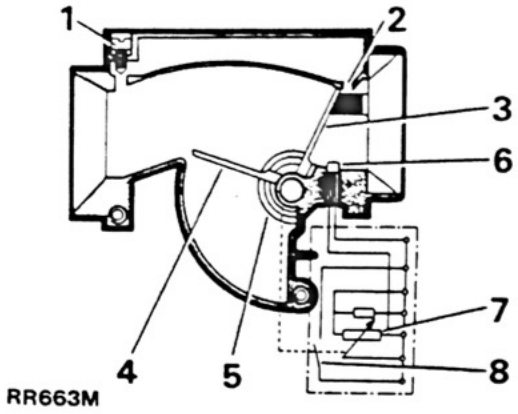


Refitting

7. Reverse the removal operations ensuring the multi-plug is firmly re-connected on re-assembly.

NOTE: The air flow meter is not a serviceable item. In the event of failure or damage the complete unit is to be renewed.

Continued



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1. Idle mixture adjustment screw
2. Air by-pass channel
3. Measuring flap
4. Compensating flap
5. Coil spring—flap return
6. Air temperature sensor
7. Potentiometer
8. Fuel pump switch

POWER RESISTOR RACK

The power resistor pack is located under the air flow meter attached to the meter mounting bracket.

The resistor pack is not a serviceable item, in the event of failure or damage the unit must be renewed.

Removing

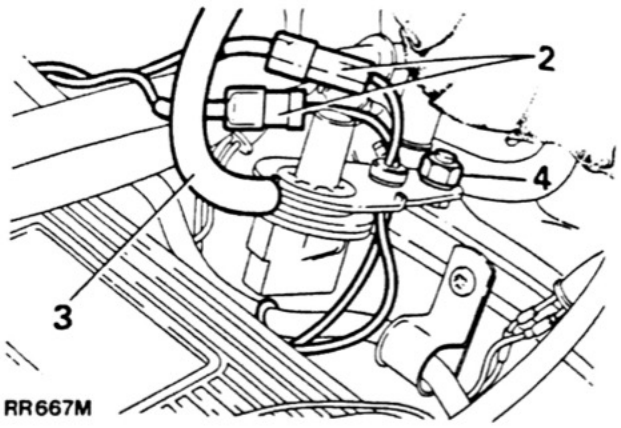
1. Disconnect the battery.
2. Disconnect the multi-plug from the bottom of the resistor pack.
3. Remove the two nuts, bolts and spring washers securing the resistor pack to the air flow meter mounting bracket.
4. Withdraw the resistor pack from the engine compartment.

Refitting

5. Reverse the removal instructions ensuring that the multi-plug is fitted securely.

OVER-RUN FUEL SHUT-OFF VALVE—VACUUM SWITCH

1. Disconnect the battery.
2. Disconnect the two electrical leads.
3. Remove the vacuum hose from the valve.
4. Remove the single nut and spring washer securing the valve to the injector retaining plate.
5. Withdraw the valve.



RR667M

NOTE: In the event of failure or damage the valve is not serviceable.

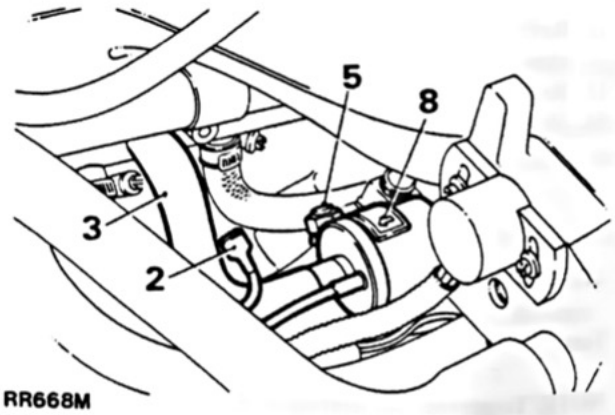
Refitting

6. Reverse the removal instructions.

SOLENOID OPERATED AIR VALVE

—fitted to vehicles with air conditioning only.

1. Disconnect the battery.
2. Disconnect the electrical lead.
3. Pull the front air valve pipe from the plenum chamber.
4. Pull the rear air valve pipe from the extra air valve air rail.
5. Remove the single nut and spring washer securing the valve to the injector retaining plate.
6. Withdraw the valve.
7. Remove the hoses from the valve.



RR668M

Refitting

8. Reverse the removal procedure, observing the direction of flow arrow on the air valve body. The direction of flow is from air rail to plenum chamber.

DEPRESSURISING THE FUEL SYSTEM

WARNING: Under normal operating conditions the fuel injection system is pressurised by a high pressure fuel pump, operating at 1.8 to 2.5 kgf/cm² (26 to 36 lbf/in²). When the engine is stationary this pressure is maintained within the system.
To prevent pressurised fuel escaping and to avoid personal injury it is necessary to depressurise the fuel injection system before any service operations are carried out.

1. Remove the ECU protective cover located under the front right hand seat.
2. Pull the fuel pump relay off its multi-plug (see Electronic fuel injection relays).
3. Start and run the engine.
4. When sufficient fuel has been used up causing the fuel line pressure to drop, the injectors will become inoperative, resulting in engine stall. Switch ignition off.

   NOTE: Fuel at low pressure will still remain in the system. This low pressure can be removed by releasing the cold start injector from the plenum chamber and them placing the injector with hose still attached into a suitable container. Release the hose clip and carefully remove the hose from the injector to release any remaining pressurised fuel.

5. Disconnect the battery.

Refitting

6. Refit the cold start injector.
7. Refit the fuel pump relay, re-connect the battery.
8. Crank the engine (engine will fire within approximately 6 to 8 seconds).

FUEL PRESSURE REGULATOR

Test

1. Depressurise the fuel system.
2. Release the clip and pull the cold start injector supply hose from the fuel rail. Connect a pressure gauge to the fuel rail.
3. Switch the ignition on and operate the flap in the air flow meter to energise the fuel pump.
4. Check that the pressure gauge reading is between 2.5 to 2.6 kgf/cm² (35 to 37 lbf/in²).
5. Switch off the ignition. The fuel pressure should be maintained between 2.1 to 2.6 kgf/in² (30 to 37 lbf/in²).

   NOTE: The pressure reading may slowly drop through either the regulator valve or the fuel pump non-return valve. A slow steady drop is permissable; a rapid fall must be investigated.

6. If the pressure reading is unsatisfactory renew the pressure regulator.

7. After fitting a new regulator re-test the system, if the pressure continues to drop off, the fuel injectors, fuel pump, non-return valve and fuel system pipework should be checked for leaks.
8. Depressurise the fuel system. Remove the gauge and connect the cold start injector supply hose.
9. Check for fuel leaks around the hose connection.

Remove and Refit

Removing

10. Depressurise the fuel system.
11. Disconnect the battery.
12. Pull the flexible rubber vacuum hose from the bottom of the regulator.
13. Release the spill return hose from the side of the regulator.
14. Release the clip and remove the spill return hose from the top of the regulator.
15. Release the single large nut securing the regulator to the regulator mounting bracket.
16. Withdraw the regulator.

Refitting

17. Reverse the removal instructions ensuring that all hose connections are secure.
18. Energise the fuel pump and visually inspect all hose connections for fuel leaks.