ENGINE MANAGEMENT & FUEL INJECTION

SECTION EMO - ELISE 2001 M.Y. Onwards

COMPONENT LOCATION DIAGRAM

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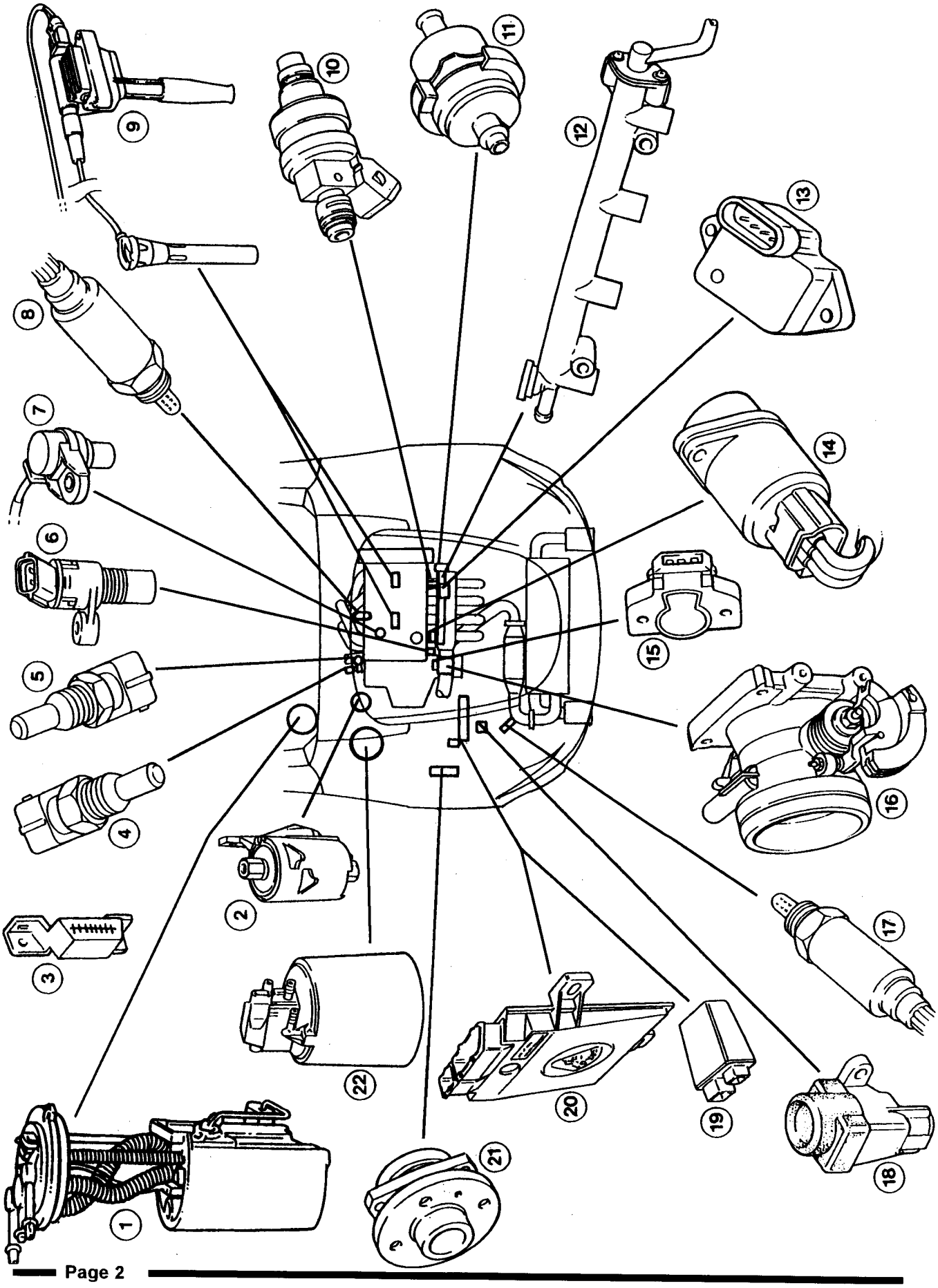


EMO.1 - INTRODUCTION

Key to Component Location Diagram

1. Fuel pump/gauge sender unit
2. Fuel filter
3. Data Link Connector (DLC) - passenger footwell
4. Engine Coolant Temperature (ECT) sensor (horiz.)
5. Water temperature gauge sender (vertical)
6. Crankshaft Position (CKP) sensor
7. Camshaft Position (CMP) sensor
8. Pre-cat. Oxygen (O_2) sensor
9. High tension ignition coil
10. Fuel injector
11. Fuel pressure regulator valve
12. Fuel rail
13. Inlet Air Temperature & Manifold Absolute Pressure (TMAP) sensor
14. Idle Air Control (IAC) valve
15. Throttle Position (TP) sensor
16. Throttle body
17. Post-cat. Oxygen (O_2) sensor
18. Inertia switch
19. Relay module
20. Engine Control Unit (ECU)
21. Hub unit with Vehicle Speed Sensor (VSS)

The 1.8 K Series engine fitted to the Elise from 2001 model year is equipped with the Lotus K4 engine management system. A single Engine Control Unit (ECU) is used to control both the fuel injection and ignition systems, with the control strategy based on engine speed/air density measurement. Engine speed data is derived from a flywheel sensor, with air density calculated from inlet air temperature and manifold air pressure (TMAP) signals. The engine is fully compliant with European Community Directive 3 (ECD3), including full European On Board Diagnostics (EOBD), in order closely to control and monitor exhaust emission levels and illuminate a Malfunction Indicator Lamp (MIL) in the event of a system fault.

The engine features a throttle body housing a single, position sensed, throttle butterfly valve, feeding air into a lightweight moulded plastic intake plenum chamber with four individual intake tracts, each of which is fitted with a fuel injector positioned to spray fuel onto the back of the intake valves. Fuel delivery quantity is controlled by the length of time (pulse width) for which the solenoid operated injectors are energised, with the ECU using a fully sequential strategy for individual control of each injector.

The air/fuel ratio is calculated by the ECU using a three dimensional map to provide a basic fuelling specification under various operating conditions. In order to refine the fuel delivery and cater for special conditions, various types of compensation are provided:

- *Cranking enrichment;* During cranking, when engine speed is below about 400 rpm, the injection pulse width is increased, dependent on coolant temperature, to aid starting.
- *Warm up enrichment;* Immediately after starting, the pulse width is increased, but decays at a rate dependent on coolant temperature.
- *Acceleration enrichment;* Signals received from the throttle position and MAP sensors which indicate acceleration is demanded, will prompt additional fuel for smooth and ready response.
- *Overrun fuel cut-off;* At normal running temperature, when the throttle is closed and engine speed is above about 2,000 rpm, indicating engine overrun, the fuel supply is shut off to enhance economy and reduce emissions.
- *Overspeed fuel cut-off;* At 6950 rpm, the injectors are cut off in order to help protect the engine from overspeed damage.
- *Oxygen sensor feedback;* By measuring the oxygen content of the exhaust gas, any adjustment necessary to maintain the air/fuel ratio to that required by the catalytic converter for optimum conversion efficiency may be computed by the ECU. An electrically heated oxygen sensor is used to ensure its speedy attainment of working temperature after a cold start.
- *Battery voltage correction;* The ECU senses battery voltage, and applies a correction factor to take account of any variation in fuel delivery due to battery voltage fluctuation.

An idle air control valve mounted on the throttle body, is used to regulate the amount of air by-passing the throttle plate, and hence control engine idle speed when the throttle is fully closed.

The ignition system uses a distributorless ignition system (DIS) which employs a pair of double ended ignition coils and a 'waste spark' system whereby each coil fires two spark plugs simultaneously (1 paired with 4, and 2 with 3), the spark in the cylinder on the exhaust stroke being 'wasted'. The two H.T. coils are mounted on the cam cover, each connecting directly with one spark plug, and via a short H.T. lead with a second plug.

The ECU is calibrated to recognise sensor readings which are outside of the acceptable range, and if such a signal is received from the coolant, throttle position or TMAP sensor, it will substitute a default value to enable the engine to continue to run, in a 'back up', or 'get you home' mode.

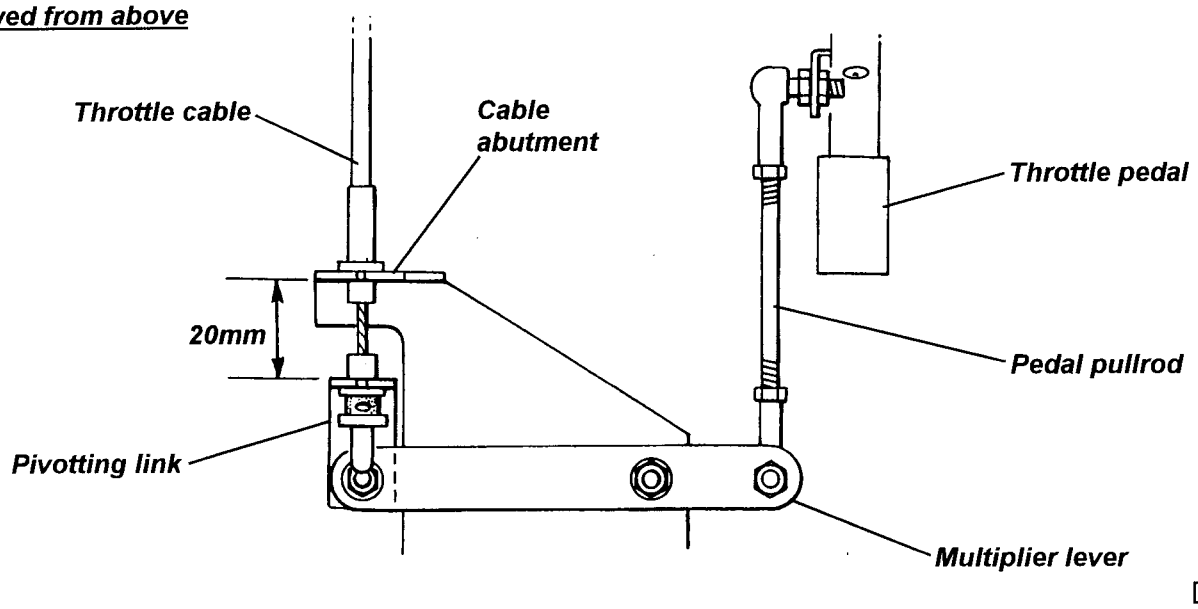
EMO.2 - THROTTLE CABLE ADJUSTMENT

Before adjusting the cable, first check that the pedal end of the cable is correctly located, and that the cable is correctly routed with no sharp bends or entrapment. Do not attempt to adjust the throttle cable or idle speed by means of the stop screw on the throttle body, which should not be disturbed.

The throttle cable and associated components must be adjusted in a specific sequence to ensure full and correct throttle operation without cable strain.

- Adjust the pedal upstop for a pedal height 30mm below brake and clutch pedals.
- Adjust the ball jointed pull rod connecting to the pedal to achieve a gap of 20mm between outer cable abutment and multiplier lever pivotting link as shown.
- Adjust the outer cable abutment at the engine end to allow a small amount of free play to accommodate temperature change effects.
- Adjust the pedal downstop so that full travel of the throttle butterfly can just be achieved without allowing the cable to be strained.

Viewed from above



EMO.3 - ENGINE CONTROL UNIT (ECU)

The engine ECU is an electronic processor mounted on a steel panel, providing electromagnetic shielding, at the LH rear of the engine compartment. The ECU is an adaptive unit which 'learns' the optimum setting of the idle air control valve, and the fuelling offset required to achieve the correct exhaust oxygen content for a particular engine relative to its wear and performance characteristics. This feature speeds the response of the system, and minimises the time spent adjusting to changed operating conditions.

A summary of the sensors supplying inputs to the ECU, and the components to which the ECU supplies output control, follows:

Inputs
Crankshaft position
Manifold absolute pressure
Engine coolant temperature
Intake air temperature
Pre and post cat. exhaust oxygen content
Throttle position
Camshaft position
Wheel speed
Diagnostic input
Battery supply
Starter signal
Earth supply

ECU

Outputs
Ignition coils
Fuel injectors
Idle air control valve
Fuel pump relay
Diagnostic connector
Oxygen sensor heaters
Main relay
Radiator cooling fans
Speedometer)
Tachometer) Instrument pack
Temp. gauge)

To replace the ECU:
- Disconnect the battery earth cable;
- Remove the ECU protective water shield by releasing the two screws securing the top of the ECU mounting bracket to the body;
. The two harness connector blocks are retained by sliding retainers incorporated into the connectors. To release, pull each retainer outwards and ease the connector block from the ECU.
- Release the two screws securing the ECU to the mounting bracket, and withdraw the unit from the lower tongue.
- When refitting, position the two connector blocks before pressing in the retaining sliders to secure.
- Ensure that the connector water shield is refitted.

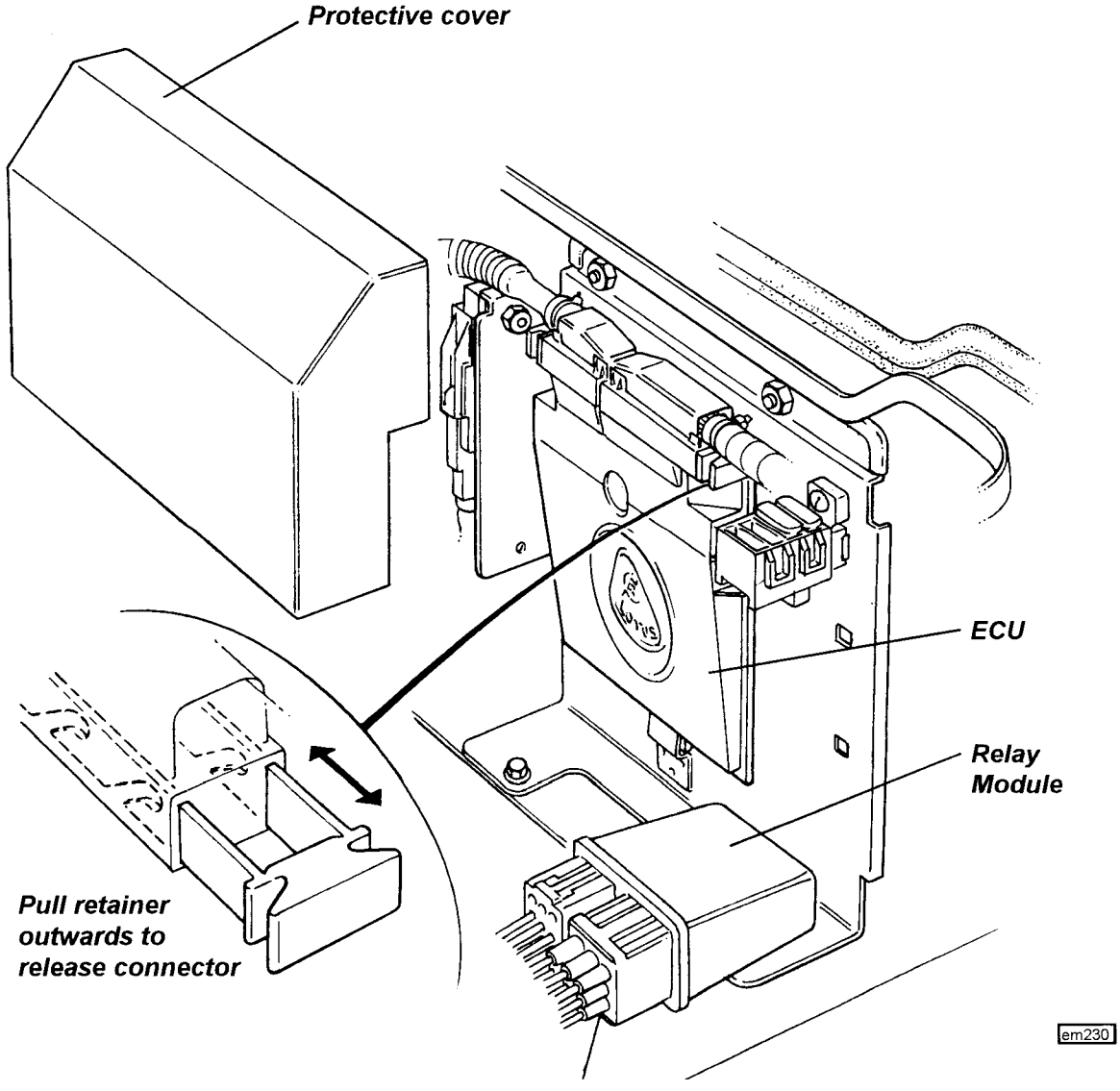
Illustration overleaf .....

EMO.4 - RELAY MODULE

The relay module is mounted at the left hand rear corner of the engine bay, on a locating tongue incorporated on the bottom of the ECU mounting bracket. The unit incorporates the following relays, but is serviced only as one sealed component:

- **Engine Control Relay;** Supplies current to the fuel pump relay and oxygen sensor heaters when the ignition is switched on.
- **Fuel Pump Relay;** Closed by the ECU for a 2 second period each time the ignition is switched on. Continuously closed during engine cranking and while the engine is running as signalled by the crankshaft sensor.
- **Starter Relay;** Energised by the cranking output from the ignition switch. Supplies current to the starter motor solenoid.

If any of the above functions are faulty, the inputs to the module should be checked, and if the outputs indicate a fault with an internal relay, the relay module should be replaced: Pull the module off its mounting tongue, and release the two harness connector blocks (press the retaining clips). On re-assembly, ensure the connector blocks are fully engaged by the retaining clips.
Important Note: The relay module is identical in appearance to the fan control module used on a.c. cars, but the function of the two modules is entirely different and must not be transposed. The relay module A111E6024F has a white label marked YWB100970; The a.c. fan module A117M0038F has a brown label marked YWB100800.



EMO.5 - INLET AIR TEMPERATURE & MANIFOLD ABSOLUTE PRESSURE (TMAP) SENSOR

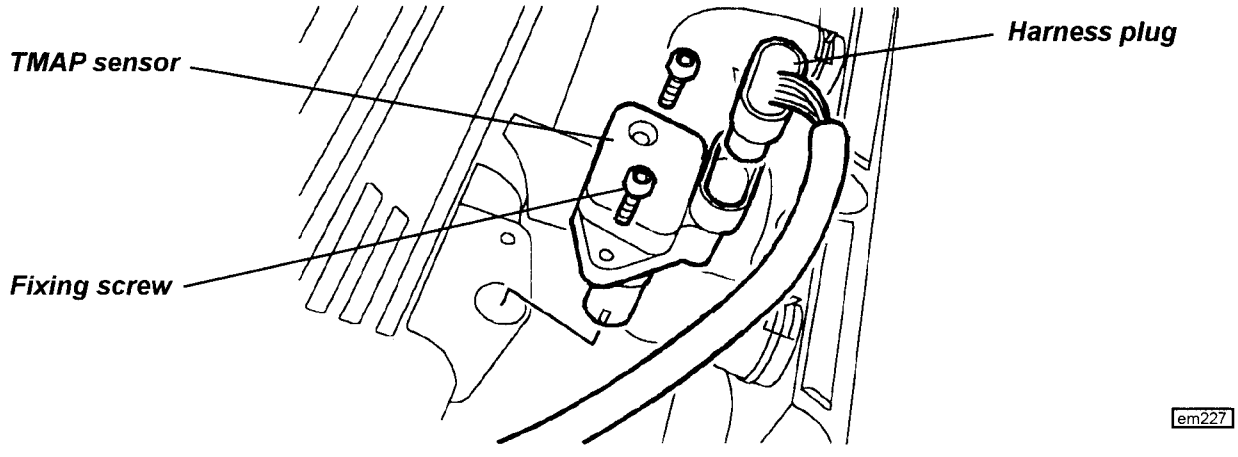
The TMAP sensor, which incorporates separate elements to monitor both temperature and pressure, is mounted directly on the intake plenum for optimum response to temperature and pressure changes, and has a plastic cap to protect the electrical connector from water ingress. The pressure signal provides an indication of engine load, and is fundamental to the calculation of air consumption and fuel calibration. The air temperature sensor is a transducer with a negative temperature coefficient, such that its electrical resistance reduces with increasing temperature. Using this signal in conjunction with that from the pressure sensor, the ECU is able to determine the air consumption of the engine, and adjust the injector pulse width accordingly for correct fuelling. Low air temperature results in denser air requiring more fuel. High air temperatures are also used by the ECU to retard the ignition timing and avoid knock.

The ECU provides a 5 volt supply and earth path to each sensor element, each of which returns a voltage representing the measured value.

MAP: When using the 'Lotus Check II' scanner tool, an atmospheric pressure of approximately 100 KPa should be displayed with the engine stopped, and a lower value between 25 - 40 KPa during idle. Very high values may indicate a faulty sensor, or an electrical connection problem. Moderately raised values indicate a possible engine fault. If the MAP signal is absent, the ECU will substitute a default value based on engine speed and throttle angle, and the engine will continue to operate with reduced performance with the MIL illuminated. A fault code will be stored in the ECU for retrieval by the scanner tool.

IAT: The scanner tool should display ambient temperature when the engine is completely cold, and higher figures with a warm engine. If the ECU receives no signal from the IAT sensor, a default value will be substituted to allow the engine to continue to run, the MIL will be illuminated and a fault code will be stored in the ECU memory.

To remove the sensor, remove the plastic cap, unplug the electrical connector and release the two 'Torx' screws securing the unit to the intake plenum. When refitting, ensure that the two 'O' rings are fitted on the sensor spigot, and that the protective cover is used over the harness plug.



EMO.6 - CRANKSHAFT POSITION (CKP) SENSOR

The signals provided by the crankshaft position sensor enable the ECU to determine:

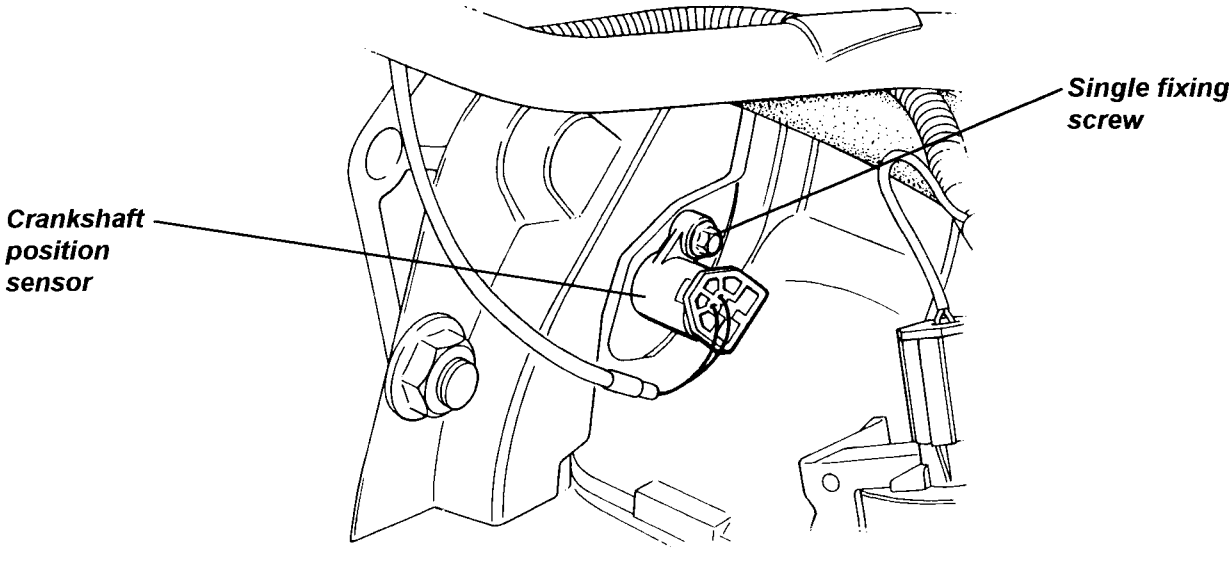
- engine speed;
- crankshaft position.

Note that in order to time the fully sequential injection strategy, the crankshaft position signal must be supplemented by a camshaft position signal.

The variable reluctance type crankshaft sensor is mounted by a single fixing into a flange at the right hand rear of the cylinder block, where it protrudes towards a reluctor ring machined into the engine side of the flywheel. The CKP sensor is positioned at 55° before the cylinder axis as viewed from the front of the clockwise rotating engine. Holes in the reluctor ring are positioned at 10° intervals, with four 'missing' holes to provide timing signals. With number one cylinder at TDC, the missing holes are positioned before the CKP sensor, at 80°, 110°, 260° and 300°.

To prevent damage from engine overspeed on acceleration, the ECU will implement fuel cut-off at engine speeds above approximately 7,000 rpm by inhibiting the earth path for the injectors. Fuel is reinstated as engine speed falls.

If the sensor signal is missing, the engine will not run. Faults in the crankshaft sensor or circuit may be indicated on the scanner tool by a '0' display during cranking. Sensor resistance is 1.3 kohms. Fixing screw torque = 6 Nm.

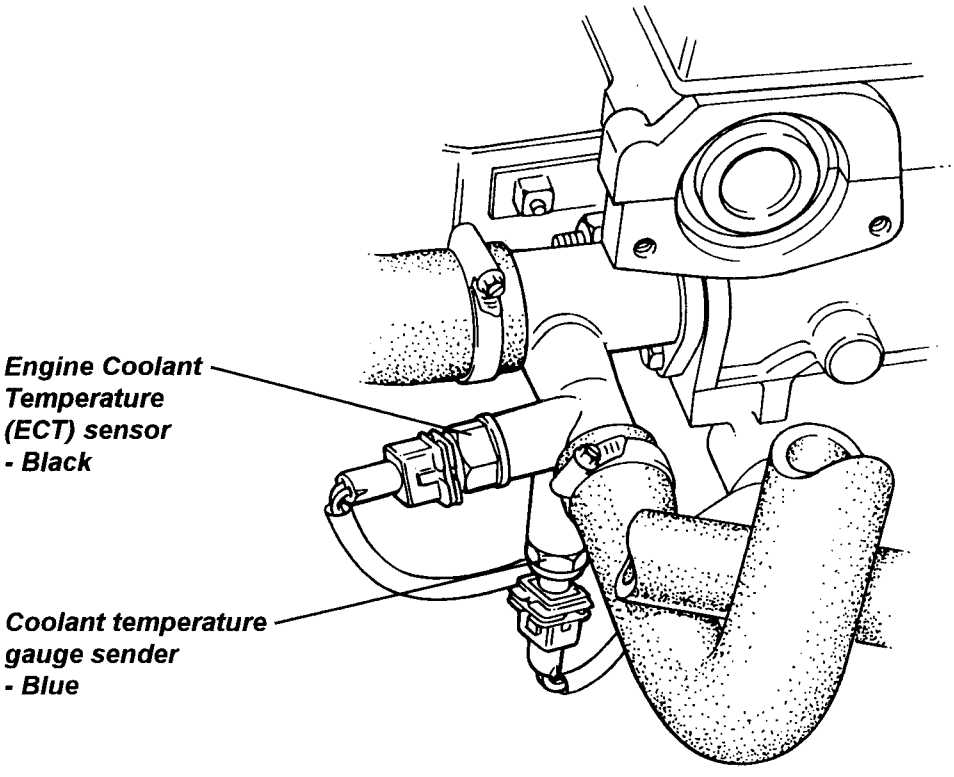


EMO.7 - ENGINE COOLANT TEMPERATURE (ECT) SENSOR

The ECU requires a coolant temperature input signal in order to increase fuel delivery and maintain driveability during the cold running and warm-up phase. The signal from this sensor is used for many different parameters within the engine management system to control and switch various components dependent on engine temperature.

The sensor is a thermistor (a resistor which changes value with temperature) mounted in the outlet junction pipe at the flywheel end front side of the engine. Note that the ECT sensor has a brown body and harness connector and is mounted horizontally. This should not be confused with the water temperature gauge sender which is fitted in the same pipe, but has a blue body and harness connector and is mounted vertically from below. Low coolant temperature produces a high resistance, whereas high temperature causes low resistance. At normal running temperature, the resistance will be approximately 300 - 400 ohms.

This data is also used to control the radiator fan, which is switched on by the ECU at a rising coolant temperature of 102°C, and switched off on falling temperature at 98°C.



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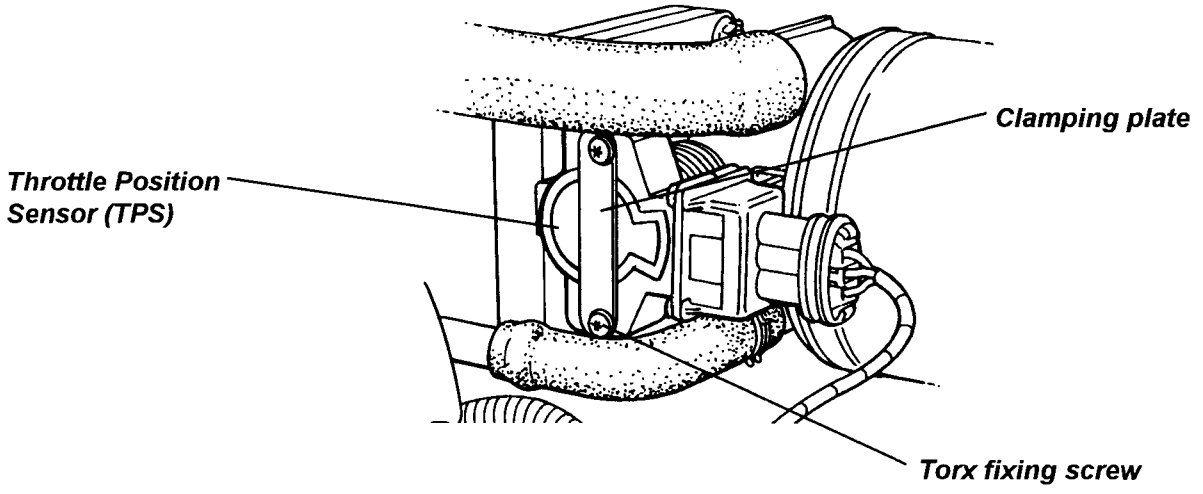
If the ECU receives a signal voltage outside of the acceptable range, a default setting equating to 70°C will be substituted, the cooling fan energised and the MIL illuminated. The Lotus Check II tool will display 70°C in Live Data. Sensor faults may cause several symptoms including poor starting, fast idle speed, poor fuel consumption and cooling fans running continuously.

To replace the sensor, disconnect the harness plug, and position a container to catch the escaping coolant when the sensor is removed. Unscrew the sensor from the junction pipe. Clean the threads of the pipe and sensor before applying Teflon tape to the sensor thread and screwing into the pipe. Tighten to 6 Nm. Refit the harness plug, and top up with coolant (see Cooling Section KF).

EMO.8 - THROTTLE POSITION SENSOR (TPS)

The throttle position sensor (TPS) is a potentiometer fitted directly to the end of the throttle spindle, and provides the ECU with information on both throttle opening, and rate of change of throttle opening. For example, when a fully closed throttle and appropriate engine speed is signalled, the ECU activates the idle air control valve to regulate idle speed; a rapid or sudden opening of the throttle will initiate fuel enrichment for acceleration; and a closed throttle overrun condition will prompt fuel cut-off.



The ECU provides the 4 kohm sensor with a 5 volt supply, and monitors the returning signal from the earth line bridge, which is proportional to throttle opening. The switch position is not adjustable, as the ECU will learn the lower voltage limit corresponding to a closed throttle.

Acceleration enrichment: When the throttle pedal is depressed, the ECU receives a rising voltage from the TPS and detects a rise in manifold pressure from the MAP sensor. The ECU provides additional fuel by increasing the normal injector pulse width and also provides a small number of extra pulses on rapid throttle openings.

Over-run fuel cut-off: The ECU implements over-run fuel cut-off when the engine speed is above 2000 rpm with engine at normal operating temperature and the throttle position sensor in the closed position, i.e. the vehicle is coasting with the throttle released. The ECU indexes the idle air control valve open slightly to increase the air flow through the engine to maintain a constant manifold depression and keep emissions low. Fuel is progressively reinstated as the throttle position sensor is opened.

To remove the sensor, disconnect the IAC by-pass hose for access, unplug the harness connector and remove and discard the two Torx screws securing the sensor. Remove the clamping plate and withdraw the sensor from the throttle spindle.

To fit the sensor:

- Clean the mating faces of sensor and throttle body, and align the flat of the sensor with the machined flat on the throttle spindle.
  CAUTION: The TPS can be easily damaged if carelessly fitted. When pressing the sensor onto the spindle, use only finger pressure on the centre of the sensor. Do not use the securing screws to pull the sensor into position.
- Press the sensor into position and rotate counterclockwise to align the fixing holes.
  CAUTION: Do not rotate the sensor in a clockwise direction, and ensure it is not rotated beyond its internal stops.
- Fit the clamping plate and tighten two new Torx screws to 1.5 Nm. Mate the harness connector plug. Refit the IAC hose.
- Operate the throttle and check that full travel of the throttle spindle, from fully closed to fully open, is achieved.
- Use Lotus Check II to carry out a throttle initialisation procedure.

EMO.9 - IDLE AIR CONTROL (IAC) VALVE

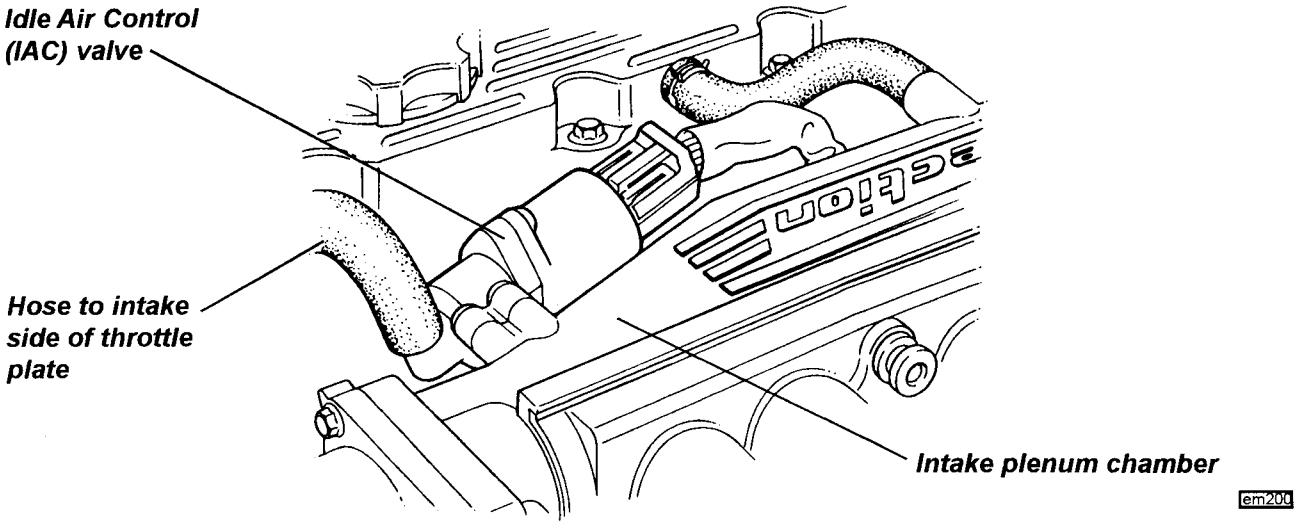
The idle air control (IAC) valve is mounted on the intake plenum, and controls an air passage which by-passes the throttle valve. When the pintle of the valve is fully extended, the passage is closed off for a minimum idle speed, but as the ECU commands the IAC stepper motor to withdraw the pintle, a progressively greater amount of air is allowed to by-pass the throttle. In this way, the ECU is able to control engine idle speed independently of the throttle butterfly.

NOTE: The closed setting of the throttle butterfly valve is preset during manufacture, and should NOT be adjusted.

During cold starts, the IAC is opened to provide a raised idle speed, dependent on coolant temperature, with a gradual decay as the engine warms to normal operating temperature. The ECU also uses the fast response of ignition timing variation to maintain idle stabilisation, such that at idle, the ignition timing will be constantly changing. When loads are placed onto or removed from the engine, the ECU senses the change in engine speed and uses both ignition timing and IAC position to control idle speed.

The position of the idle air control valve should be within the range of 10 - 20% (as displayed by a 'Lotus Check II' scanner) when the engine is idling at normal engine temperature. This ensures that the idle air control valve is able to supply varying amounts of by-pass air to compensate for all loads and temperature conditions. If outside of this range, there is likely to be a mechanical fault, such as an intake manifold air leak.

When the ignition is switched off, the ECU will keep the main relay energised for a short period whilst the IAC valve is driven to its power down position, ready for the next engine start.



To remove the valve, unplug the harness connector and remove the two Torx screws securing the valve body to the plenum adaptor. Withdraw the valve and discard the 'O' ring.

To fit the valve:

- Ensure the mating faces of the plenum adaptor and valve are clean.
- Lubricate a new 'O' ring with silicone grease, and fit to the valve.
- Fit the valve into the adaptor, and tighten the two Torx screws to 1.5 Nm.
- Mate the electrical connector plug.

EMO.10 - OXYGEN (O_2) SENSORS

The Lotus K4 system operates a 'closed loop' fuel control system whereby the output signal from an oxygen sensor in the exhaust system downpipe is monitored by the ECU, which constantly adjusts the air/fuel ratio to that providing the most efficient conversion of gases by the catalyst. A lean air/fuel ratio results in the combustion process being unable to utilise all of the available oxygen, leaving a high oxygen content in the exhaust gas. This oxygen sensor output to the ECU is reduced, which signals the ECU to adjust the air/fuel ratio richer, resulting in reduced exhaust oxygen and a higher sensor output voltage. In this way the mixture strength constantly sways either side of the ideal setting.

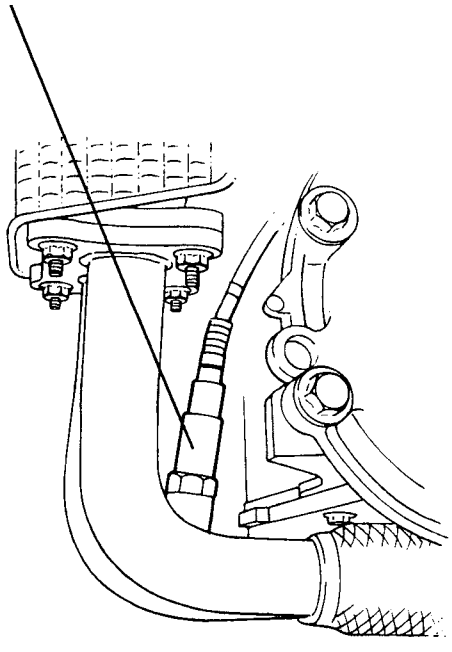
A second oxygen sensor is fitted in the outlet pipe from the catalytic converter, and supplies the ECU with a signal used to monitor the efficiency of the converter. If the upstream sensor should fail, the ECU adopts an 'open loop' strategy, using a fixed oxygen content value, with an adverse effect on emissions. If the down-stream sensor fails, the ECU is unable to monitor catalytic converter efficiency. In either case, the MIL would be illuminated.

Because the ceramic element of the sensors becomes active only above 300°C, each sensor is equipped with an integral heating element controlled by the ECU, to ensure that it reaches operating temperature soon after a cold start. The resistance of the sensor heating element should be 6 ohms at 20°C.

Using the 'Lotus Check II' scanner tool, 'O2 VOLTAGE' shows the voltage across the sensor as read by the ECU. Once the engine is fully warm, and during most idle and driving conditions, this voltage will switch rapidly between 0.7 V - 1.0 V.

To remove either sensor, unplug and free the electrical connector, and use a 22 mm crows foot spanner to unscrew the sensor from the exhaust. Fit a new sealing washer to the sensor, and apply anti-sieze compound (A910E6966) to the threads WITHOUT contaminating the sensor tip, before tightening to 55 Nm and mating the electrical connector plug. Do **NOT** use copper based lubricants when refitting.

Pre-cat O2 sensor



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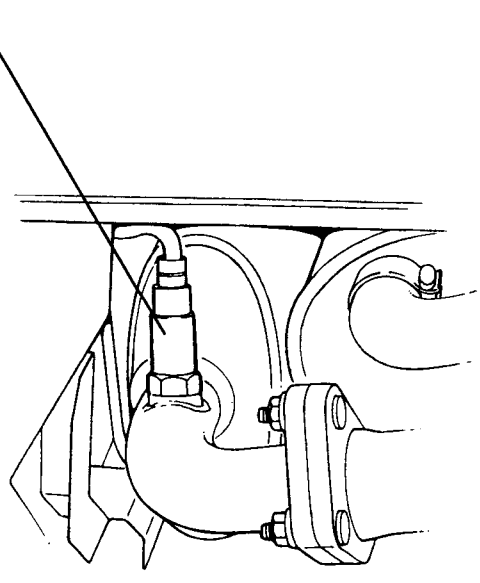
Post-cat O2 sensor



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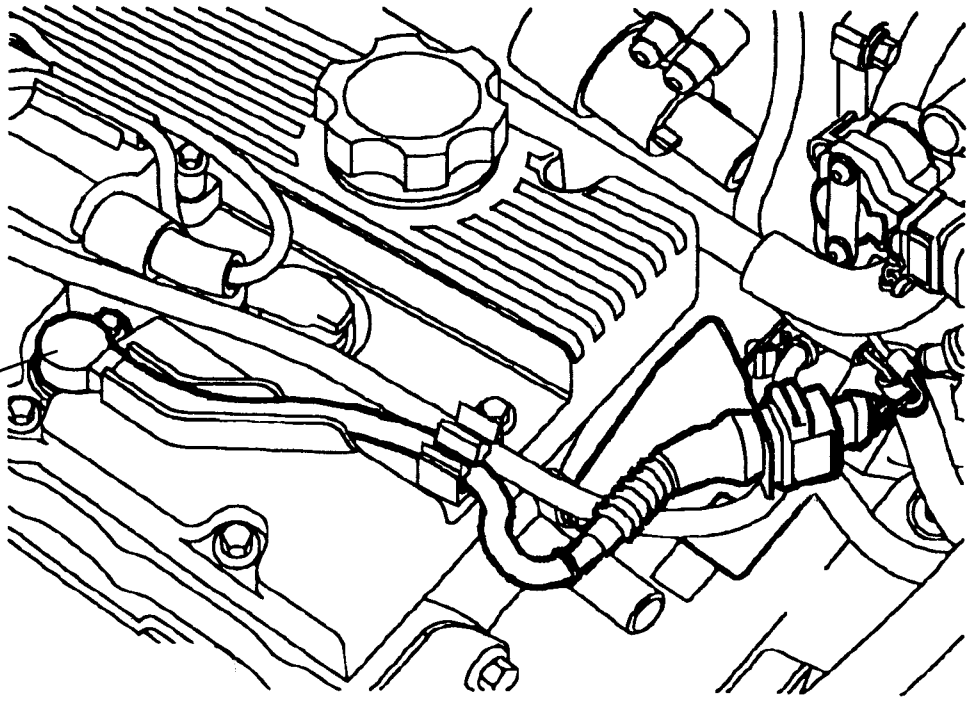
EMO.11 - CAMSHAFT POSITION (CMP) SENSOR

The CMP sensor is used to provide an engine position reference for the sequential injection. The Hall effect sensor is mounted on the left hand rear of the cylinder head, beneath the spark plug cover, and projects into the cam housing to be in close proximity to a half moon reluctor on the exhaust camshaft. By interpreting the signal received, the ECU is able to distinguish firing TDC from exhaust TDC, and initiate the injection sequence on engine start. If the CMP signal is missing, the engine will still start and run, but the fuel injection timing may be out of phase, resulting in reduced performance and driveability and increased emissions. If sensor failure occurs whilst the engine is running, the engine will continue to run with correct sequential fuelling until ignition switch off. Note that a cam sensor fault will only be recorded by the ECU if the fault is detected at start-up, which will then illuminate the MIL.

To replace a CMP sensor, remove the spark plug cover, unplug and unclip the sensor harness, and release the single screw securing the sensor. When refitting, tighten the sensor screw to 6 Nm.



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EMO.12 - FUEL SYSTEM

The fuel system is a high pressure recirculating type, using an 'in tank' submerged 3-stage impeller pump, an in line canister filter, a common fuel rail supplying all four injectors, and a fuel pressure regulating valve controlling the return line to the tank.

WARNING: The fuel line between pump and injector rail, and the injector rail itself, contain pressurised fuel both when the engine is running, and after switching off. This feature aids engine starting by reducing the time needed to build up operating fuel pressure, and inhibiting the formation of vapour pockets in the supply line of a stopped hot engine.

i) To minimise the risk of fire and personal injury, relieve the fuel system pressure before servicing the fuel rail or any related component. See 'Fuel Pressure Relief Procedure' below.
ii) To reduce the possibility of sparks occurring when a fuel line is disconnected, or when fuel vapour is present, the negative battery cable should be disconnected before work is commenced.
iii) When fuel lines are disconnected, absorb any escaping fuel in an absorbent cloth and dispose of safely.

Fuel Pressure Relief Procedure

This procedure should be used prior to disconnecting any part of the fuel line except the unpressurised return line.

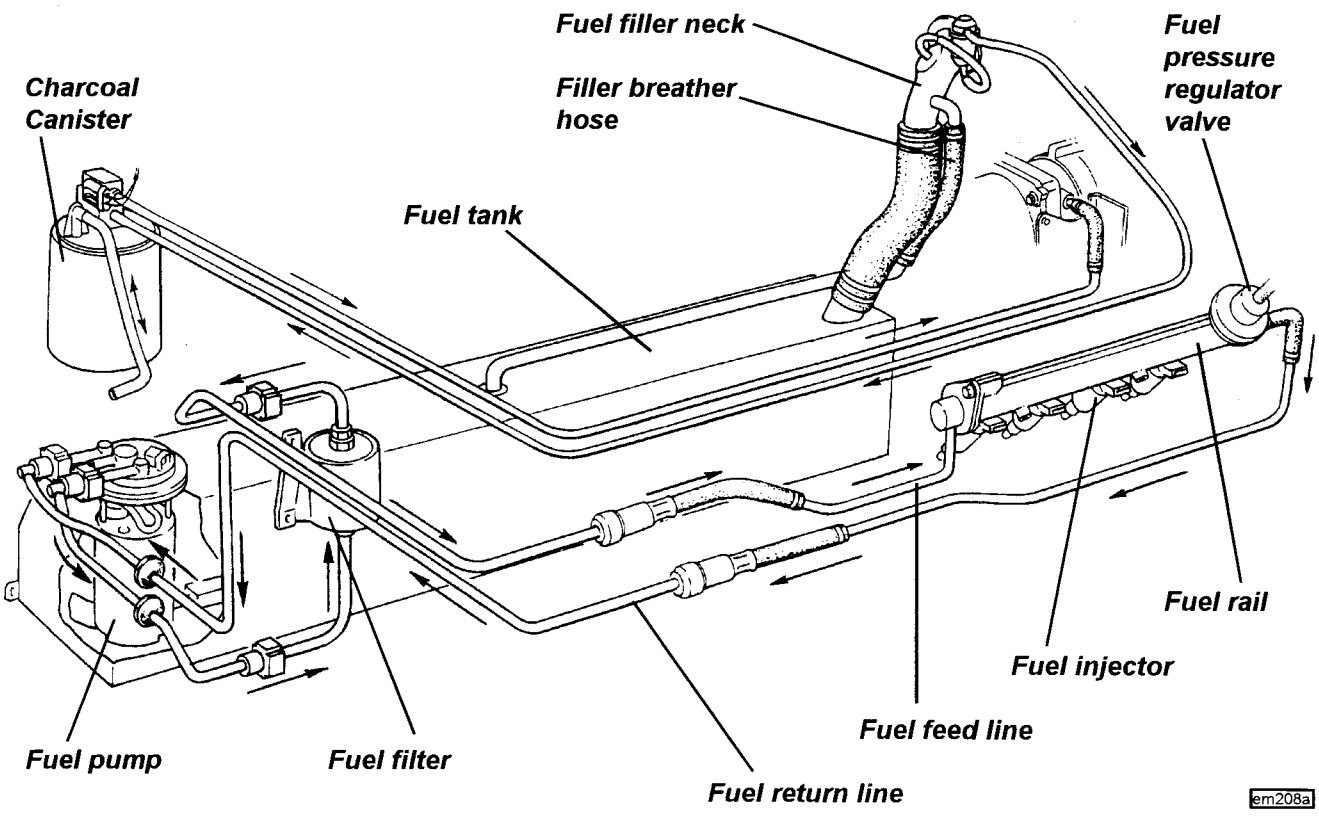
- Pull out the 20A fuel pump fuse (rearmost of fuses to left of engine management ECU), start the engine, and run until it stops from starvation. Crank the engine for a further few seconds.
- If the engine is a non-runner, pull out the fuel pump fuse, and crank the engine for 20 seconds to minimise residual fuel pressure.
- Disconnect the battery.
- Surround the pipe joint with a shop towel to absorb fuel contained in the pipework before releasing the joint.

  WARNING: Be aware of the possibility of full pressure retention in the fuel line caused by an injector circuit fault.

The modular fuel pump/sender assembly uses an electric motor to power a three stage impeller type pump system submerged within the tank. In order to avoid fuel starvation from surge effects caused by vehicle acceleration and cornering forces, the pump is housed within a reservoir canister kept filled with fuel irrespective of the tank fuel level. The pump connects with a port on the bottom of the canister fitted with a strainer sock in order to screen dirt particles from the fuel line and help separate any water content from the fuel. The first stage impeller pump draws fuel from the tank via this sock, and outputs it into the canister, which fills up to its overflow port in the top surface. The second stage impeller pump draws fuel from within the canister via another strainer sock, and supplies the high pressure third stage tubine pump which outputs fuel from the top end of the pump into the flexible pipe connected to the supply connection on the pump assembly top plate. From here, fuel is piped to the fuel rail on the engine, from which it returns to the inlet connection on the top plate and spills into the canister to supplement the primary pump output and keep the canister fully filled.

An umbrella valve in the bottom of the canister allows fuel to flow into the canister whenever the tank level is higher than the canister level. This feature also permits a continued fuel supply to the secondary pump stage in the event of a blocked primary stainer.

For further details of the fuel pump, filter and tank, refer to section LI.

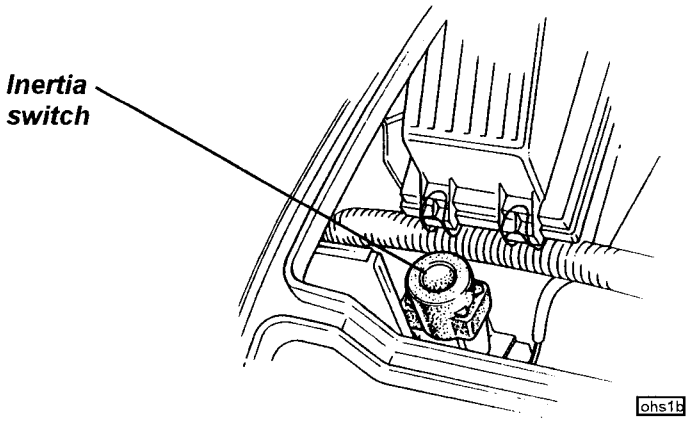


Fuel Pump Switching

The fuel pump is controlled by the ECU via the fuel pump relay located in the relay module, and is energised under the following conditions:

. When the ignition is first switched on, the ECU grounds the pump relay coil for a few seconds in order to pressurise the fuel rail, and then switches off.
- When cranking, the ECU receives an engine speed signal from the crankshaft position sensor and operates the pump continuously.
- When the engine is running, the ECU receives an engine speed signal and operates the pump continuously.
- If the engine stalls, the ECU will switch off the pump immediately.

- A safety inertia switch is mounted at the left hand rear of the engine bay, and controls the supply to the fuel pump relay. Vehicle impact will trip the switch and isolate the fuel pump. Reset by pressing the button on top of the switch.



Fuel Rail and Pressure Regulator Valve - Testing

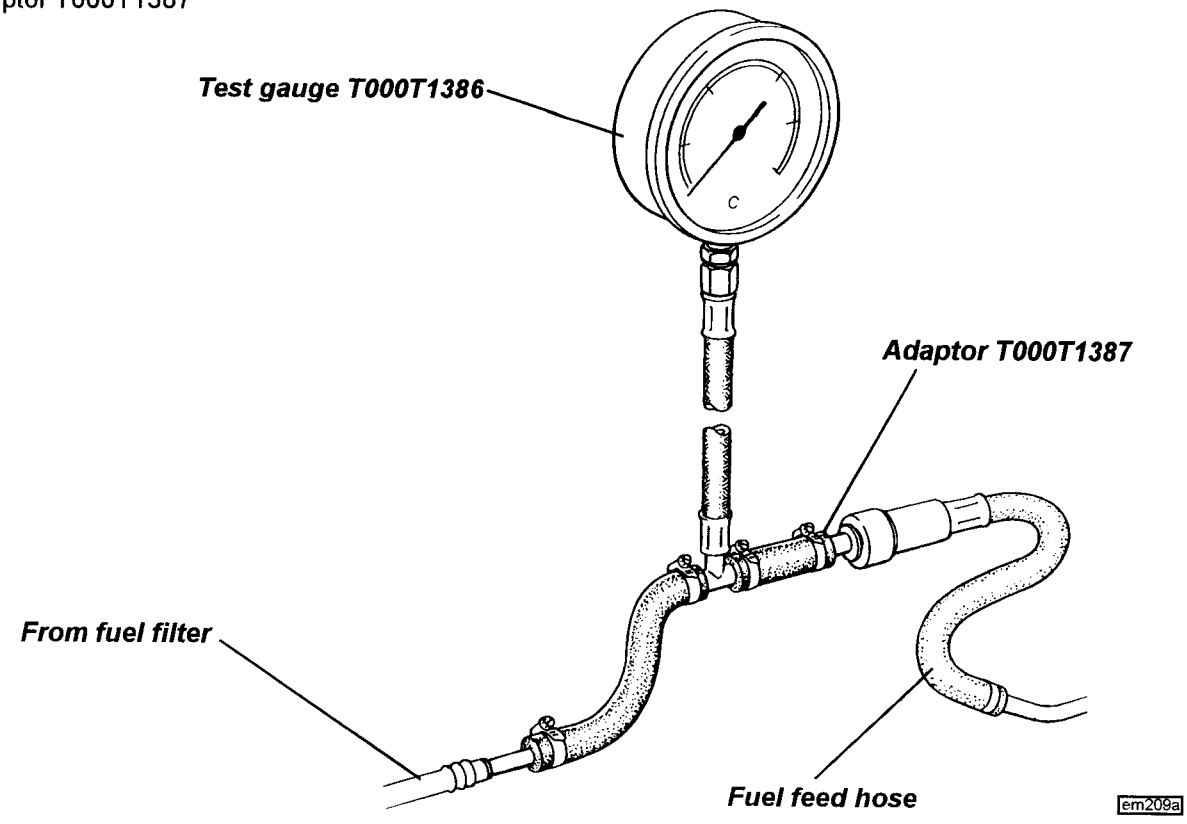
The single fuel rail is used to link the four port injectors to provide a balanced fuel supply at common pressure, and also to retain the port injectors in the inlet manifold. The left hand end of the fuel rail receives fuel from the in line filter, and the right hand end houses the pressure regulator valve, from which fuel returns to the tank. The fuel pressure regulator is a diaphragm operated relief valve with fuel pump pressure acting on one side of the diaphragm, and regulator spring pressure and intake plenum pressure on the other. The

function of the regulator is to maintain a constant pressure differential across the injectors at all times. i.e. a constant difference between fuel pressure supplied to the injector, and inlet manifold pressure at the port injector nozzle. By using an intake plenum pressure (vacuum) signal to modify regulator spring pressure in the valve, the valve is able to regulate fuel supply pressure in accordance with engine load - pressure will decrease at idle and light engine loads, and increase at wide throttle openings . The non-adjustable pressure regulator is factory set to approximately 3.0 bar, and is serviced as a complete assembly.

To check the fuel pressure:

i) Relieve fuel pressure as detailed above.

ii) Connect fuel pressure test gauge T000T1386 into the supply line between the fuel filter and fuel rail using adaptor T000T1387



iii) Disconnect the vacuum hose between the pressure regulator and the intake plenum.

iv) With the engine idling, the pressure gauge should read 2.9 - 3.1 bar.
If below specification, progressively restrict the fuel return line between regulator valve and tank.
- If the specification can then be achieved, the regulator valve is faulty;
- If this makes little or no difference, the fuel pump may be restricted or faulty.

If above specification, the regulator valve may be faulty.

v) With the engine still idling, re-connect the vacuum hose to the regulator valve. The pressure should drop to approximately 2.2 bar.
- If the pressure does not drop, check the hose for kinking or blockage, or replace the regulator valve.

vi) Switch off the ignition and observe the pressure drop after one minute. Pressure should not drop by more than 0.7 bar.
- Too great a pressure drop may be caused by (a) faulty regulator valve; (b) faulty non-return valve in the fuel pump; (c) leaking injector
- If clamping off the return hose reduces the pressure drop, a faulty regulator valve is indicated.
- If clamping off the supply hose reduces the pressure drop, a faulty fuel pump is indicated.
- If clamping off both hoses does not reduce the pressure drop, a leaking injector is indicated.

vii) To check that the pump has sufficient reserves of delivery for full demand conditions, progressively clamp off the return hose with the pump running. The pressure should increase by approximately 2 bar.

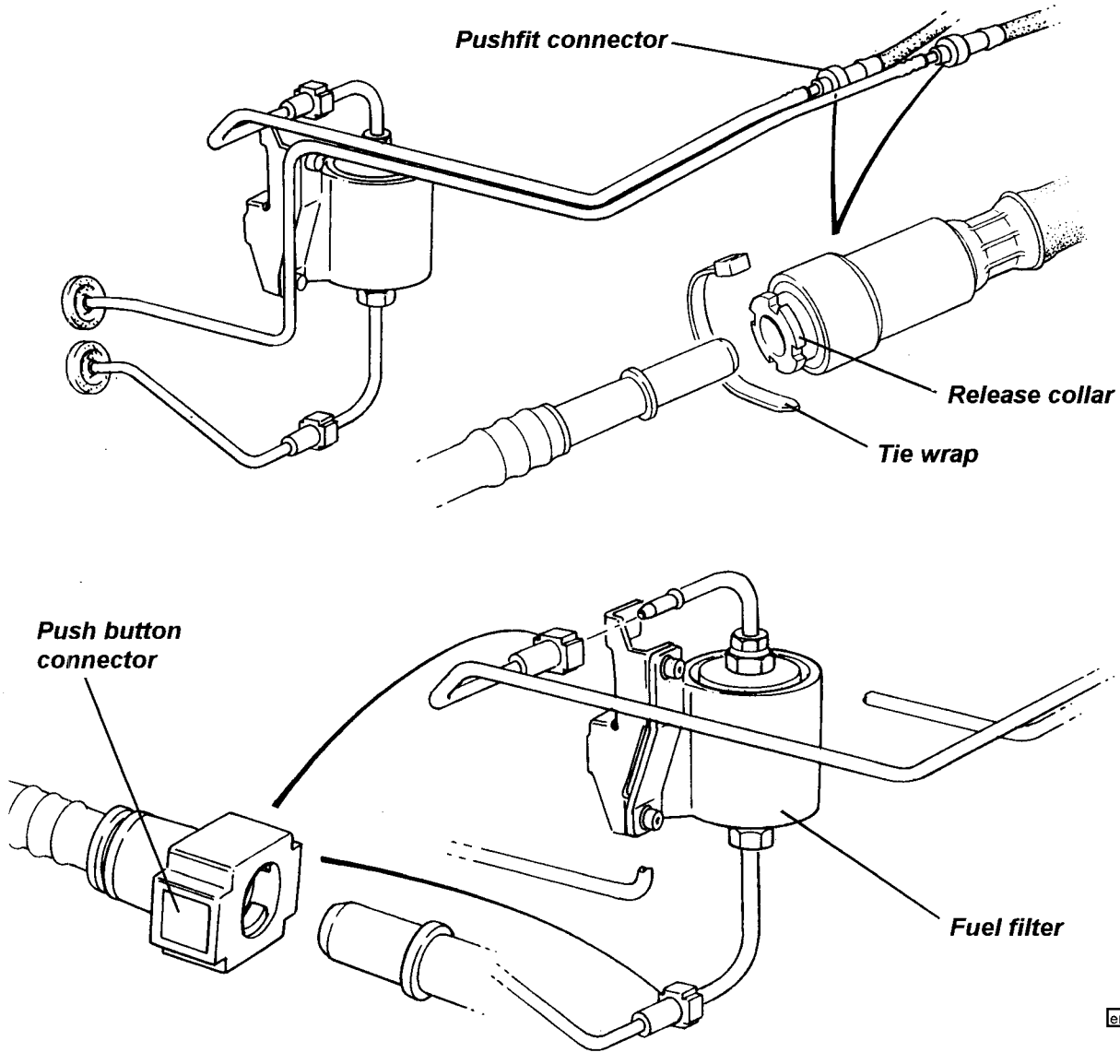
CAUTION: Only clamp the return hose momentarily and observe the gauge to ensure pressure does not exceed gauge capacity.

Push Fit Connectors

The fuel rail feed and return hoses are equipped with push fit connectors to allow easy powertrain removal. The feed line connector is colour coded orange, and the return line connector green. Note that the feed line should not be opened without first carrying out the fuel pressure relief procedure detailed above. With the system depressurised, cut the safety tie wrap from the connector collar, and use an absorbent cloth to collect fuel draining from the pipe before pressing the collar into the connector, and separating the joint.

Clean the pipe spigot and lubricate with a light spray of WD40 or similar before remaking the joint, pressing firmly together until full engagement is indicated be an audible 'click'. Check security by pulling and twisting the joint. To guard against any possibility of accidental release, fit a small tie wrap (A075W6038Z) around the release collar as shown.

The fuel filter uses 'press button' quick release connections, the spigot pipes for which should similarly be lightly sprayed with WD40 before insertion.



Fuel Injectors

The four fuel injectors are fitted between the pressurised fuel rail and the inlet manifold. Each injector comprises a solenoid operated needle valve and a specially designed nozzle to ensure good fuel atomisation. The ECU energises the injectors under engine run conditions, and provides an earth signal for the period the injectors are required to be open (referred to as 'pulse width'), spraying fuel onto the back of the inlet valves. The Elise 2001 M.Y. uses fully sequential injection, with each injector activated individually.

During cranking, when the engine speed is below approx. 400 rpm, the ECU increases the pulse width (dependent on coolant temperature) to aid starting, and operates the injectors in group mode.

Fuel Rail and Pressure Regulator Valve - Replacement

Do not attempt to remove the pressure regulator valve from the fuel rail; The valve is supplied only as an assembly with the rail. The fuel rail is removed from the engine complete with the four fuel injectors.

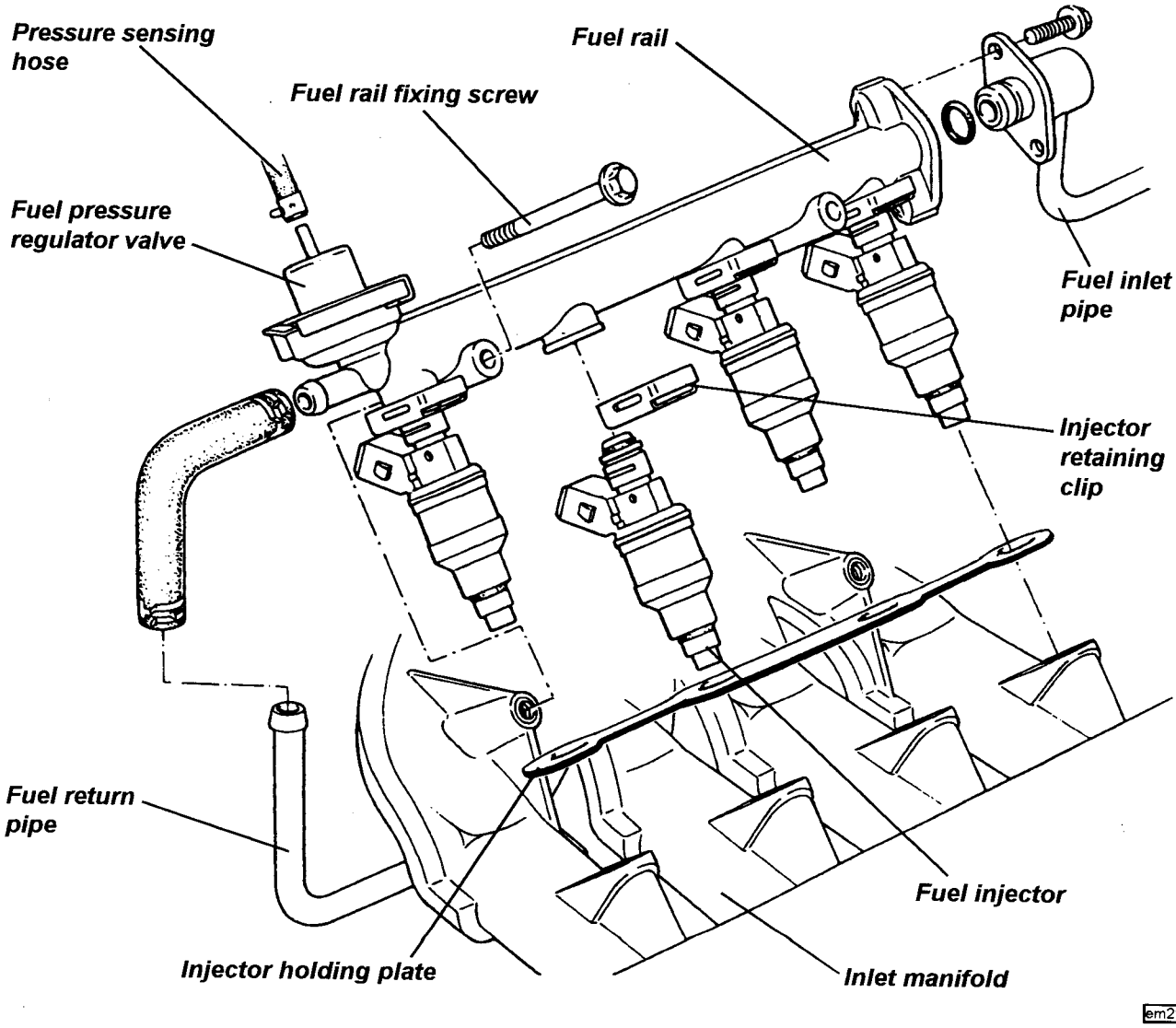
1. De-pressurise the fuel system, and disconnect the battery.

2. Disconnect the vacuum hose between regulator valve and plenum, and unplug the MAP/IAT sensor harness. Unplug the injector harness from each of the injectors.

3. Release the fuel return hose from the right hand end of the fuel rail and plug the connections.

4. Remove the two screws securing the fuel inlet pipe to the left hand end of the rail and withdraw. Discard the 'O' ring, and plug the connections.

5. Remove the two bolts securing the fuel rail to the inlet manifold, and carefully withdraw the rail complete with the four injectors and pressure regulator valve. Take great care not to damage the injector tips during the removal process. Cap the injectors and plug the manifold ports to prevent dirt ingress.



em210

6. To remove an injector from the rail, remove the injector holding plate, remove the clip, and withdraw the injector from the rail. Discard the two 'O' rings.

7. Before re-fitting the injectors and rail, clean the injector recesses in the rail and inlet manifold, and fit each injector with 2 new 'O' rings lubricated with silicone grease. Fit the injectors into the rail, and retain with the spring clip. Fit the injector holding plate to aid alignment of the injectors.

8. Carefully insert each of the injectors into its inlet manifold bore, and retain the rail with the two fixing bolts, tightened to 10 Nm.

9. Continue re-assembly in the reverse order to disassembly, tightening the inlet pipe to rail screws to 8 Nm.

EMO.13 - IGNITION SYSTEM

The ignition system uses a distributorless ignition system (DIS) which employs a pair of double ended ignition coils and a 'waste spark' system whereby each coil fires two spark plugs simultaneously (1 paired with 4, and 2 with 3), the spark in the cylinder on the exhaust stroke being 'wasted'. The two H.T. coils are mounted on the cam cover, each connecting directly with one spark plug, and via a short H.T. lead with a second plug.

WARNING: The H.T. voltage of the ignition system is in excess of 50 kV and the low tension voltage is in excess of 400 volts. Voltages this high can cause serious injury and may even be fatal. Never touch any ignition components while the engine is running or being cranked.

Each ignition coil consists of a pair of windings wrapped around a laminated iron core. The primary winding has a resistance of 0.7 ohms, and the secondary winding 10 kohms.

Each double ended coil contains a primary winding, connected in series with the supply and the ECU, and an isolated secondary winding, connected in series with two spark plugs. It is important to note that there is no connection between the primary and secondary windings. The coils are triggered by the ECU which switches off the primary voltage and induces a high tension current to produce a spark in the spark plug connected to each end of the secondary winding. The direction in which the secondary winding is wound determines that plugs 1 & 2 receive positive sparks, and plugs 3 & 4 negative sparks.

It is important to note that if it is necessary to run or crank an engine with one or more plug leads disconnected, either the coil low tension must be disconnected, or provision for the spark energy to be dissipated must be made (e.g. fitting a loose, grounded spark plug to the lead); otherwise the electrical stress produced will cause deterioration of the H.T. coil and/or ECU.

Each coil has a primary winding resistance of approx. 0.7 ohms at 20°C and a secondary winding resistance of approx. 10 kilohms.

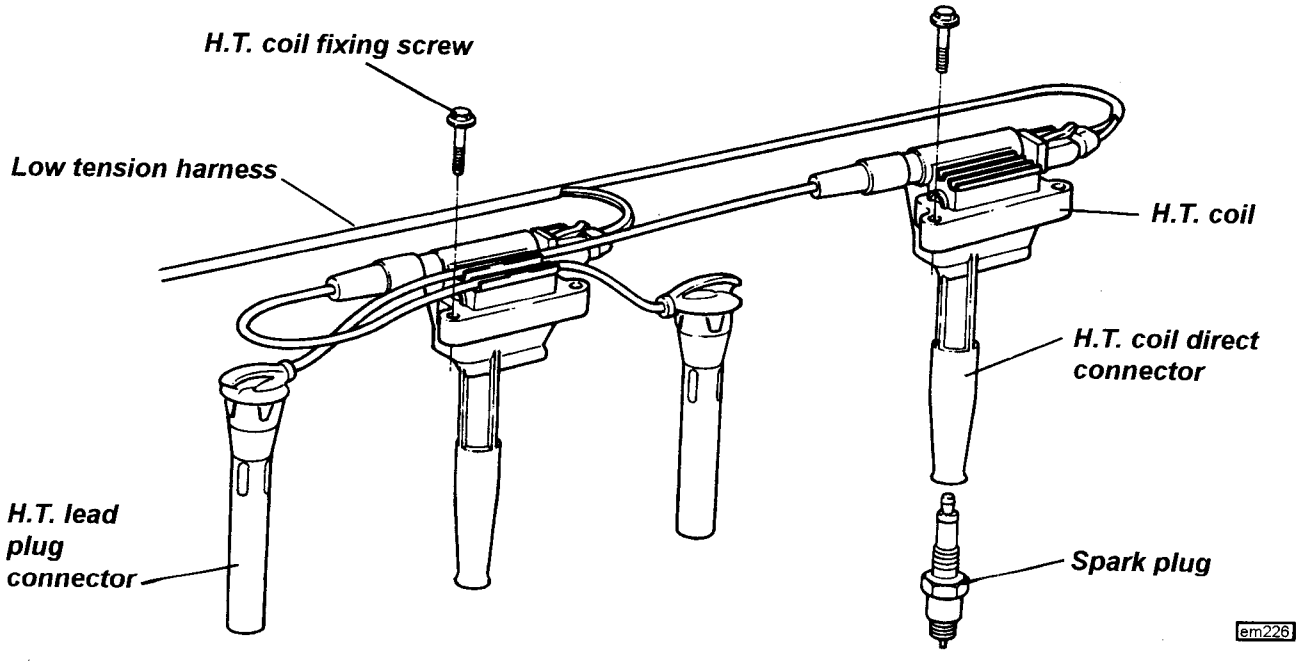
To Replace Ignition Coil

1. Release the three fixings securing the spark plug cover, unscrew the oil filler cap and remove the cover.

2. Pull off the H.T. lead from the spark plug, and release the lead from its routing clips.

3. Release the two screws securing the H.T. coil, pull the coil off the spark plug, and disconnect the low tension connector plug.

4. When refitting, tighten the coil fixings to 8 Nm. Ensure the 'O' ring is fitted around the oil filler neck before refitting the spark plug cover and tightening to 8 Nm.

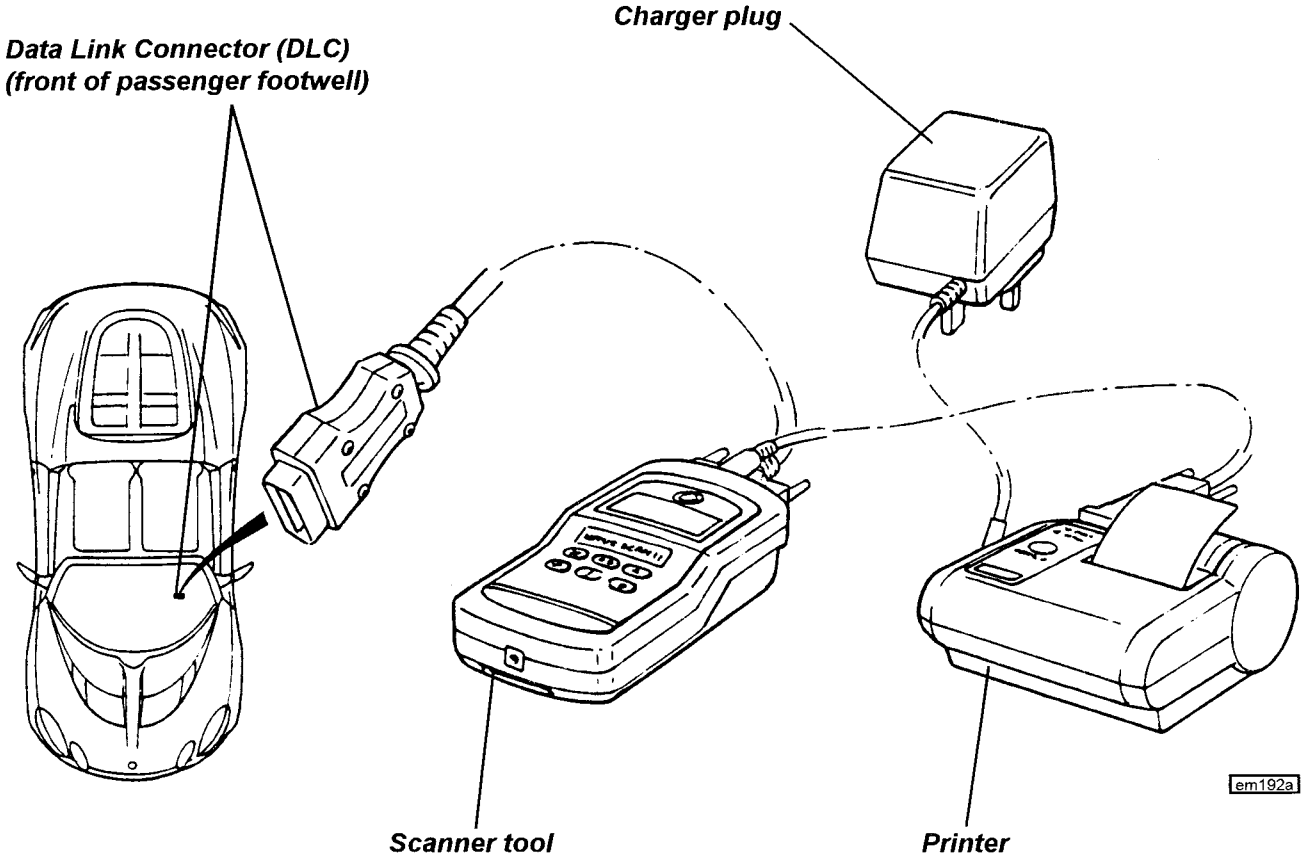


EMO.14 - 'LOTUS CHECK II' SCANNER TOOL

In order to provide for communication with the engine management system electronic control module, a hand held electronic scanner 'Lotus Check II' (part number T000T1418F), may be plugged into a special 16 terminal harness connector socket, known as a Data Link Connector (DLC), located at the front of the passenger footwell. Note that this tool may also be used on previous Elise models (excluding Exige, 340R and 160 models).

Amongst the operations available using the 'Lotus Check II' tool are:
- Reading of Trouble Codes
- Clearing of Trouble Codes
- Reading live data
- Test operation of individual solenoids
- Running engine history report
- Reprogramming ECU

Operating instructions are provided with the tool.



EMO.15 - TROUBLE CODE DIAGNOSIS

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P0107)	- Circuit Low Input	)
P0108)	- Circuit High Input	)
P0111 } Intake Air Temperature	- Circuit Range/Performance Problem	} 25
P0112 }	- Circuit Low Input	}
P0113 }	- Circuit High Input	}
P0117] Engine Coolant Temperature	- Circuit Low Input	] 26
P0118]	- Circuit High Input	]
P0121) Throttle Position	- Circuit Range/Performance Problem	) 27
P0122)	- Circuit Low Input	)
P0123)	- Circuit High Input	)
P0131 } Oxygen Sensor	- Circuit Low Voltage - pre catalyst sensor	} 28
P0132 }	- Circuit High Voltage - pre catalyst sensor	}
P0133 }	- Circuit Slow Response - pre catalyst sensor	}
P0134 }	- Circuit No Activity Detected - pre catalyst sensor	] 29
P0135 }	- Heater Circuit Malfunction- pre catalyst sensor	]
P0137 }	- Circuit Low Voltage - post catalyst sensor	) 28
P0138 }	- Circuit High Voltage - post catalyst sensor	)
P0140 }	- Circuit No Activity Detected – post catalyst sensor	} 29
P0141 }	- Heater Circuit Malfunction-post catalyst sensor	}
P0171] Fuel Control System	- Too Lean	] 30
P0172]	- Too Rich	]
P0201) Injector Circuit Malfunction	- Cylinder 1	) 31
P0202)	- Cylinder 2	)
P0203)	- Cylinder 3	)
P0204)	- Cylinder 4	)
P0300 } Misfire Detected	- Random	} 32
P0301 }	- Cylinder 1	}
P0302 }	- Cylinder 2	}
P0303 }	- Cylinder 3	}
P0304 }	- Cylinder 4	}
P0335] Engine Speed/Position Sensors	- Crankshaft Position Sensor Circuit Malfunction	] 33
P0340]	- Camshaft Position Sensor Circuit Malfunction	]
P0420 Catalyst System Efficiency	- Below Threshold	34
P0444) Evap. Emission Control System	- Purge Control Valve Circuit Open	) 35
P0445)	- Purge Control Valve Circuit Shorted	)
P0500 Vehicle Speed Sensor Malfunction		36
P0506 } Idle Speed Control	- RPM Lower Than Expected	} 37
P0507 }	- RPM Higher Than Expected	}
P0562] Battery Voltage	- Voltage Too Low	] 38
P0563]	- Voltage Too High	]
P0601) ECU Integrity	- Watchdog	) 39
P0606)	- Checksum	)
P1100 } Fuel Pump	- #1 Relay or Circuit Open	} 40
P1101 }	- #1 Relay or Circuit Shorted	}
P1301] Misfire	- Misfire Level Causing Emissions Increase	] 41
P1302]	- Misfire Level Causing Catalyst System Damage	]
P1336 Misfire learns not complete		42
P1400) Coolant Fan Relay	- #1 Short Circuit	) 43
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P1460 } Air Conditioning Control Relay	- Open Circuit	} 44
P1461 }	- Short Circuit	}

Circuit Diagram) Sheet 5	- Fuel Pump, Injectors & Coil Packs
Circuit Diagram) Sheet 5A	- Sensors
Circuit Diagram) Sheet 5B	- Sensors (cont.)
Circuit Diagram) Sheet 5C	- Controls
Circuit Diagram) Sheet 5D	- Controls (revised recirc. solenoid control)
Circuit Diagram) Sheet 5E	- Sensors (revised O2 heater control)

Trouble Code Diagnosis

The reading of trouble codes using the Lotus Check II tool (T000T1418F), or any other OBD II scanner tool, is fully described in sub-section EMO.2. Sub-section EMO.15 contains information on each trouble code, compiled in approximate numerical order, to explain under what conditions the code will be set, and the possible causes. Each table includes data under the following headings:

Description:	Describes the rationale of the code.
Malfunction Criteria:	The limits or conditions which must occur for the code to be set.
Secondary enable conditions:	The conditions which must prevail before the test is run. In some cases, the malfunction test will be run only when certain other conditions apply.
Disabled by faults:	Some trouble codes will be disabled if another code is already set.
Time required:	The continuous time period for which the malfunction criteria must apply.
Potential failure modes:	Suggests possible causes of the problem.
Limp home:	Certain detected problems will cause the ECU to substitute a fixed value for a signal which is percieved as faulty, in order to enable the engine to continue to run, albeit at a reduced level of performance.

Notes

i) There are various market and vehicle specifications which may differ in the number of codes which are enabled. Section EMO.15 contains all the potential codes, some of which may not apply to certain markets.

ii) Some codes may be set and stored in memory to be accessed with the Lotus Check II tool, but will not activate the Malfunction Indicator Lamp (MIL).

iii) These tables should be used only to diagnose set trouble codes. The absence of a set trouble code does not preclude a fault from being present.

iv) A trouble code will remain stored in the ECU memory after the fault has been rectified (or does not recur) until; a) 40 engine warm up cycles have been completed, or b) the code is cleared using the programme provided in the Lotus Check II tool.

Diagnostic Trouble Code Report - LSL350

Lotus' policy of continuous product improvement requires that all sources of data are explored and analysed to the potential benefit of Lotus customers past, present and future. Lotus dealers are requested to make full use of the Diagnostic Trouble Code Report Form (LSL350), a copy of which is included at the end of this section, in order to help with diagnosis and their own record keeping, as well as telefaxing the information to Lotus via Technical Service on +44 (0)1953 608253.

Note that any engine management related warranty claim must be accompanied by a completed Diagnostic Trouble Code Report form LSL350.

Manifold Absolute Pressure P0106/7/8

P0106 *Circuit Range/Performance Problem*

Description:	Rationality check, manifold pressure not too low at high throttle position
Malfunction Criteria: **Secondary enable conditions:**	Manifold pressure < 320 mBar Throttle position > 80% + engine speed > 960 RPM **or** Manifold pressure > 960 mBar Throttle position < 14.8% + engine speed > 960 RPM
Disabled by faults:	None
Time required:	1 sec
Potential failure modes:	- Connector - Intermittent wire failure - Blocked sensor port - Partial short to voltage or ground - Sensor damaged; check datalist for pressure with engine not running
Limp home:	Alpha-N. (TPS based MAP measurement).
Note:	This fault will be indicated by the MIL

P0107 *Circuit Low Input*

Description:	Out of limit voltage check
Malfunction Criteria:	MAP sensor voltage < 0.05V
Secondary enable conditions:	None
Disabled by faults:	None
Time required:	1 sec
Potential failure modes:	- Signal wire shorted to ground - Signal wire open circuit - Sensor disconnected - Reference voltage missing - Reference voltage wire shorted to ground - Reference voltage wire open circuit - Sensor failed - ECU input circuit failed
Limp home:	Alpha-N. (TPS based MAP measurement).
Note:	This fault will be indicated by the MIL

P0108 *Circuit High Input*

Description:	Out of limit voltage check
Malfunction Criteria:	MAP sensor voltage > 4.907V
Secondary enable conditions:	Throttle position < 80%
Disabled by faults:	None
Time required:	1 sec
Potential failure modes:	- Signal wire shorted to 12V or reference 5V - Ground wire open circuit - Sensor failed - ECU input circuit failed
Limp home:	Alpha-N. (TPS based MAP measurement).
Note:	This fault will be indicated by the MIL

Intake Air Temperature P0111/2/3

P0112 *Circuit Low Input*

Description:	Out of limit voltage check
Malfunction Criteria:	IAT sensor voltage < 0.05V
Secondary enable conditions:	Engine running
Disabled by faults:	None
Time required:	1 sec
Potential failure modes:	- Signal wire short circuit - Sensor failed - ECU input circuit failed
Limp home:	If a fault is indicated a substitute value for air inlet temperature is used. The value is the lower of either the coolant temperature or 40°C.
Note:	This fault will be indicated by the MIL.

P0113 *Circuit High Input*

Description:	Out of limit voltage check
Malfunction Criteria:	IAT sensor voltage > 4.93 V
Secondary enable conditions:	Engine running
Disabled by faults:	None
Time required:	1 sec
Potential failure modes:	- Signal wire open circuit - Sensor failed - ECU input circuit failed
Limp home:	If a fault is indicated a substitute value for air inlet temperature is used. The value is the lower of either the coolant temperature or 40°C.
Note:	This fault will be indicated by the MIL.

Engine Coolant Temperature P0117/8

P0117 *Circuit Low Input*

Description:	Out of limit voltage check
Malfunction Criteria:	CLT sensor voltage < 0.02 V
Secondary enable conditions:	Engine running
Disabled by faults:	None
Time required:	1 sec
Potential failure modes:	- Signal wire short circuit - Sensor failed - ECU input circuit failed
Limp home:	If a fault is indicated a substitute value for coolant temperature is used (70°C)
Note:	This fault will be indicated by the MIL.

P0118 *Circuit High Input*

Description:	Out of limit voltage check
Malfunction Criteria:	CLT sensor voltage > 4.93 V
Secondary enable conditions:	Engine running
Disabled by faults:	None
Time required:	1 sec
Potential failure modes:	- Signal wire open circuit - Sensor failed - ECU input circuit failed
Limp home:	If a fault is indicated a substitute value for coolant temperature is used (70°C)
Note:	This fault will be indicated by the MIL.

Throttle Position P0121/2/3

P0121 *Circuit Range/Performance Problem*

Description:	Rationality check, Throttle not too high at low manifold pressure or too low at high manifold pressures
Malfunction Criteria: **Secondary enable conditions:**	Throttle position > 88% Manifold pressure < 600 mBar + vehicle speed > 30 KMH **or** Throttle position < 25% Manifold pressure >800 mBar + engine speed > 960 RPM
Disabled by faults:	None
Time required:	1 sec
Potential failure modes:	- Intermittent wire failure - Partial short to voltage or ground
Limp home:	If a fault is indicated a substitute value for throttle position is used. If the engine is not running the substitute value is taken from a table referenced by manifold pressure.
Note:	This fault will be indicated by the MIL

P0122 *Circuit Low Input*

Description:	Out of limit voltage check
Malfunction Criteria:	TP sensor voltage < 0.0488 V
Secondary enable conditions:	None
Disabled by faults:	None
Time required:	1 sec
Potential failure modes:	- Signal wire shorted to ground - Signal wire open circuit - Reference voltage missing - Reference voltage wire shorted to ground - Reference voltage wire open circuit - Sensor failed - ECU input circuit failed
Limp home:	If a fault is indicated a substitute value for throttle position is used.
Note:	This fault will be indicated by the MIL.

P0123 *Circuit High Input*

Description:	Out of limit voltage check
Malfunction Criteria:	TP sensor voltage > 4.93 V
Secondary enable conditions:	None
Disabled by faults:	None
Time required:	1 sec
Potential failure modes:	- Signal wire shorted to 12V or reference 5V - Ground wire open circuit - Sensor failed - ECU input circuit failed
Limp home:	If a fault is indicated a substitute value for throttle position is used.
Note:	This fault will be indicated by the MIL.

02 Sensor P0131/2/3 P0137/8

P0131) Circuit Low Voltage - pre catalyst sensor
P0137) - post catalyst sensor

Description: Out of limit voltage check
Malfunction Criteria: O2 sensor voltage < 0.005 V
Secondary enable conditions: Duration below voltage > 1 sec
Disabled by faults: None
Time required: 1 sec
Potential failure modes: - Signal wire shorted to voltage
- Sensor failed
- ECU input circuit failed
Limp home: Closed loop fuel control is disabled
Note: These faults will be indicated by the MIL.

P0132) Circuit High Voltage - pre catalyst sensor
P0138) - post catalyst sensor

Description: Out of limit voltage check
Malfunction Criteria: O2 sensor voltage > 2.0 V
Secondary enable conditions: Duration above voltage > 1 sec
Disabled by faults: None
Time required: 1 sec
Potential failure modes: - Signal wire shorted to voltage
- Sensor failed
- ECU input circuit failed
Limp home: Closed loop fuel control is disabled
Note: These faults will be indicated by the MIL.

P0133 Circuit Slow Response - pre catalyst sensor

Description: Rationality check, slow switching
Malfunction Criteria: - Average switch time lean to rich > 1000 mSec
or - Average switch time rich to lean > 1000 mSec
or - Ratio of average switch times >1.8
or - Ratio of average switch times < 0.2
Secondary enable conditions: Throttle position between 4% and 15%
Manifold pressure < 450 mBar
Engine speed < 2100 RPM
Engine run time > 800 seconds.
Coolant temperature > 80 degrees C
Sensor ready, in closed loop control
Disabled by faults: None
Time required: 5 sec; Two trips with the fault
Potential failure modes: - Sensor contamination; poor / wrong quality fuel
- Sensor gas slots blocked; exhaust deposits
- Grounding circuit problem
Limp home: Closed loop fuel control is disabled
Note: These faults will be indicated by the MIL.

02Sensor P0134/5 P0140/1

P0134) No Activity Detected - pre catalyst sensor
P0140) - post catalyst sensor

Description:	Rationality check, to see if the sensor is active (a non active sensor shows 0.5V nominal)
Malfunction Criteria:	O2 sensor not ready
Secondary enable conditions:	Engine run time > 30 seconds Monitored for 60 seconds.
Disabled by faults:	None
Time required:	N/A
Potential failure modes:	- Sensor contamination; poor quality fuel - Sensor gas slots blocked; exhaust deposits - Heater circuit failure - Sensor failure - ECU input circuit failure
Limp home:	Closed loop fuel control is disabled
Note:	P0134, P0140 will activate the MIL

P0135)Heater Circuit Malfunction - pre catalyst sensor
P0141) - post catalyst sensor

Description:	Check for open and closed circuit faults.
Malfunction Criteria:	Logic level low / high
Secondary enable conditions:	N/A
Disabled by faults:	None
Time required:	N/A (two trips required for post catalyst sensors)
Potential failure modes:	- If P0134 is not set then Sensor heater circuit failure is most likely, as the sensor is OK when hot. - Sensor circuit failure - Sensor failure - ECU input circuit failure.
Limp home:	None
Note:	This fault will be indicated by the MIL.

Fuel Control System Too Lean Or Rich P0171/2

P0171 Too Lean

Description:	Long term fuel trim too high
Malfunction Criteria:	Any of the long term trims > +20%
Secondary enable conditions:	Closed loop fuel control active
Disabled by faults:	P0131- P0135 disables P0171
Time required:	N/A (Two trips required for post catalyst sensors)
Potential failure modes:	- Fuel pressure problem - Air leakage into plenum / injector housing - Faulty injectors - O2 sensors poisoned - Air leakage into exhaust before O2 sensors
Limp home:	None
Note:	This fault will be indicated by the MIL.

P0172 Too Rich

Description:	Long term fuel trim too low
Malfunction Criteria:	Any of the long term trims < -20%
Secondary enable conditions:	Closed loop fuel control active
Disabled by faults:	P0131- P0135 disables P0171
Time required:	N/A (Two trips required for post catalyst sensors)
Potential failure modes:	- Fuel pressure problem - Air leakage - Faulty injector/s - O2 sensors poisoned
Limp home:	None
Note:	This fault will be indicated by the MIL.

Injector Circuit Malfunction

P0201 - 0204

P0201 Cylinder 1
P0202 Cylinder 2
P0203 Cylinder 3
P0204 Cylinder 4

Description:	This is a circuit check, to see if an injector is in circuit.
Malfunction Criteria:	Logic level low
Secondary enable conditions:	Engine running
Disabled by faults:	None
Time required:	1 sec
Potential failure modes:	- Connectors - Wire open or short circuit - Relay faulty; injector control - Inertia switch disturbed (during maintenance or service) - Injector fault - ECU injector circuit failed
Limp home:	None
Note:	These faults will be indicated by the MIL.

Misfire

P0300 - 0304

P0300	)	*- Random*
P0301	)	*- Cylinder 1*
P0302	) *Misfire Detected*	*- Cylinder 2*
P0303	)	*- Cylinder 3*
P0304	)	*- Cylinder 4*

Description: The detection system attempts to specify a single misfiring cylinder. If the engine misfire is severe, the system will indicate more than one cylinder. The DTC code storage will rank the cylinders into the most likely problem cylinder.

Malfunction Criteria: These codes will be displayed only if P1301 is indicated.

Secondary enable conditions:
P0300-P0304 active
Battery voltage between 11 & 16 V
Engine speed between 750 & 7000 (approx.) RPM
MAP between 350 & 1100 mBar
Coolant temperature between -6°C & +120°C

Disabled by faults: P0122, P0123, P0107, P0108, P0117, P0108, P0340.

Time required: 1000 revs continuously

Potential failure modes:
- Spark plug fault
- Plug lead loose or faulty
- Ignition coil circuit problems
- Ignition coil problem
- Low compression in cylinder

Limp home: None

Note:

Engine Speed / Position Sensors

P0335
P0340

P0335 *Crankshaft Position Sensor Circuit Malfunction*

Description:	Rationality checks - looks for intermittent loss of crank pulses
Malfunction Criteria:	Crankshaft pulses < 20
Secondary enable conditions:	Camshaft sensor pulses >3
Disabled by faults:	None
Time required:	Immediate
Potential failure modes:	- Connector - Incorrect sensor gap - Wiring circuit
Limp home:	None. If a crank sensor circuit fault is present the engine will not fire or start. No fuel will be scheduled

P0340 *Camshaft Position Sensor Circuit Range/Performance*

Description:	Rationality checks - looks for intermittent loss of crank pulses
Malfunction Criteria:	Camshaft pulses < 3
Secondary enable conditions:	Crankshaft pulses > 20
Disabled by faults:	P0335
Time required:	Immediate
Potential failure modes:	- Connector - Sensor gap - Wiring circuit
Limp home:	None. If a Cam sensor circuit fault is present the engine will fire & start but may be wrong injector phasing. However if the failure occurs during driving the engine will continue to run. This usually occurs when the engine is stalled or turned off.

Catalyst System Efficiency P0420

P0420 Below Threshold

Description:	This is a check on the oxygen storage efficiency of the catalyst. The O2 sensors at rear of the catalyst check if the oxygen is being used efficiently. The diagnostics analyse the amount of switching activity on the post O2 sensor.
Malfunction Criteria:	N/A
Secondary enable conditions:	Engine run time > 880sec Coolant temperature > 80 degrees C MAP between 250 MAP and 450 MAP Vehicle Speed between 40Kmh and 60Kmh Engine speed <2100rpm Throttle position > 3.9%
Disabled by faults:	P0117, P0118, P0131, P0135, P0171, P0172, P0300-P0304
Time required:	25 sec; 2 trips required
Potential failure modes:	Catalyst damaged resulting in poor emissions
Limp home:	None
Note:	This fault will be indicated by the MIL.

Evaporative Emission Control System P0444/5

P0444 *Purge Control Valve Circuit Open*

Description:	Circuit check
Malfunction Criteria:	Logic level High
Secondary enable conditions:	Purge valve state off
Disabled by faults:	None
Time required:	1 sec
Potential failure modes:	- Connectors - Wire open circuit - ECU output circuit failed
Limp home:	None
Note:	This fault will be indicated by the MIL.

P0445 *Purge Control Valve Circuit Shorted*

Description:	Circuit check
Malfunction Criteria:	Logic level Low
Secondary enable conditions:	Purge valve state on
Disabled by faults:	None
Time required:	1 sec
Potential failure modes:	- Connectors - Wire short circuit - ECU output circuit failed
Limp home:	None
Note:	This fault will be indicated by the MIL.

Vehicle Speed Sensor P0500

P0500 *Vehicle Speed Sensor Malfunction*

Description:	Rationality checks - looks at the road speed signals when the engine is in overrun, (engine braking). The vehicle speed signal is the vehicle speed sensors. The engine management system uses only one channel - Rear right hand wheel speed.
Malfunction Criteria:	Vehicle speed < 5 Kmh
Secondary enable conditions:	Throttle closed; MAP < 140 mbar (14 kPa); engine speed < 3000 rpm
Disabled by faults:	None
Time required:	2 seconds; 2 trips required
Potential failure modes:	- Connectors - Wiring short or open circuit - Sensor fault.
Limp home:	Vehicle speed = 0 is assumed

Idle Speed Control P0506/7

P0506 RPM Lower Than Expected

Description:	Engine speed monitoring
Malfunction Criteria:	Deviation from target idle speed < -200 RPM
Secondary enable conditions:	(Battery voltage between 11 and 15V)
	(Engine idling)
	(Idle control integrator >20 % {lost control})
Disabled by faults:	N/A
Time required:	Once fault condition is met = 1 sec; 1 trips required
Potential failure modes:	- Connectors
	- IAC stuck / closed / blocked
Limp home:	None

P0507 RPM Higher Than Expected

Description:	Engine speed monitoring
Malfunction Criteria:	Deviation from target idle speed > +400 RPM
Secondary enable conditions:	(Battery voltage between 11 and 15 V)
	(Engine idling)
	(Idle control integrator < -20 % {lost control})
Disabled by faults:	N/A
Time required:	Once fault condition is met = 1 sec
Potential failure modes:	- Connectors
	- Air leak into plenum
	- Stuck valve
Limp home:	None

Battery Voltage P0562/3

P0562 *Too Low*

Description:	This is a circuit check, to see if the voltage is too low
Malfunction Criteria:	Battery voltage < 6.0 V
Secondary enable conditions:	Engine running
Disabled by faults:	None
Time required:	10 sec; 2 trips required
Potential failure modes:	Alternator or battery fault
Limp home:	None

P0563 *Too High*

Description:	This is a circuit check, to see if the voltage is too high
Malfunction Criteria:	Battery voltage > 16 V
Secondary enable conditions:	Engine running
Disabled by faults:	None
Time required:	26 sec; 2 trips required
Potential failure modes:	Alternator or battery fault
Limp home:	None

ECU Integrity

P0601/6

P0601 *Watchdog*

Description:	This is a rationality check. The ECU will monitor it self for correct software execution.
Malfunction Criteria:	Watchdog reset detected.
Secondary enable conditions:	N/A
Disabled by faults:	None
Time required:	N/A
Potential failure modes:	ECU fault
Limp home:	ECU resets.

P0606 *Checksum*

Description:	This is a rationality check. The ECU will perform a checksum on all diagnostic and learn data, and compare this against a previously stored value.
Malfunction Criteria:	Incorrect checksum result
Secondary enable conditions:	N/A
Disabled by faults:	None
Time required:	N/A
Potential failure modes:	ECU fault
Limp home:	Default diagnostic and learn values loaded.

Fuel Pump P1100/1

P1100 Relay Or Circuit Open

Description:	Open circuit check
Malfunction Criteria:	Feedback logic low
Secondary enable conditions:	Fuel pump off
Disabled by faults:	None
Time required:	1 sec
Potential failure modes:	- Connectors - Wire open circuit - Relay missing - Relay faulty - ECU input circuit failed
Limp home:	
Note:	This fault will be indicated by the MIL.

P1101 Relay Or Circuit Shorted

Description:	Short circuit checks
Malfunction Criteria:	Feedback logic high
Secondary enable conditions:	Fuel pump state on
Disabled by faults:	None
Time required:	1 sec
Potential failure modes:	- Connectors - Wire short circuit - Relay faulty - ECU input circuit failed
Limp home:	
Note:	This fault will be indicated by the MIL.

Misfire P1301/2

P1301 *Misfire Level Causing Emissions Increase*

Description:	Misfire detected which could cause emissions increase by 1.5 X standard, or an I/M emissions failure. Fluctuations in crankshaft speed are used to determine misfire.
Malfunction Criteria:	Misfires on all cylinders evaluated over a 1000 engine revolution period > 3%
Secondary enable conditions:	P0300-P0304 active
Disabled by faults:	P0122, P0123, P0107, P0108, P0117, P0108,
Time required:	1 sec; 2 trips required
Potential failure modes:	- Spark plug fault - Plug lead loose or faulty - Ignition coil circuit problems - Ignition coil problem - Low compression in cylinder
Limp home:	None
Note:	This fault will be indicated by the MIL.

P1302 *Misfire Level Causing Catalyst System Damage*

Description:	Misfire detected which could cause possible damage to the catalytic converter. Fluctuations in crankshaft speed are used to determine misfire.
Malfunction Criteria:	Misfires on all cylinders evaluated over 200 revs > 10%
Secondary enable conditions:	P0300-P0304 active
Disabled by faults:	P0122, P0123, P0107, P0108, P0117, and P0108
Time required:	200 revs continuously
Potential failure modes:	- Spark plug fault - Plug lead loose or faulty - Ignition coil circuit problems - Ignition coil problem - Low compression in cylinder
Limp home:	None
Note:	This fault will be indicated with a flashing 'check engine' light during the misfiring condition.

Misfire Learns Not Complete P1336

P1336

Description:	Memory Blank (new or reprogrammed ECU)
Malfunction Criteria:	N/A
Secondary enable conditions:	N/A
Disabled by faults:	None
Time required:	None
Potential failure modes:	None
Limp home:	None
Note:	This fault will be indicated by the MIL.

Coolant Fan Relay P1400/1

P1400 #1 Short Circuit

Description:	Open circuit check
Malfunction Criteria:	Feedback logic low
Secondary enable conditions:	fan off
Disabled by faults:	None
Time required:	1 sec
Potential failure modes:	- Connectors - Wire open circuit - Relay missing - Relay faulty - ECU input circuit failed
Limp home:	
Note:	N/A

P1401 #1 Open Circuit

Description:	Short circuit checks
Malfunction Criteria:	Feedback logic high
Secondary enable conditions:	Fuel pump state on
Disabled by faults:	None
Time required:	1 sec
Potential failure modes:	- Connectors - Wire short circuit - Relay faulty - ECU input circuit failed
Limp home:	
Note:	N/A

Air Conditioning Control Relay

P1460/1

P1460 *Open Circuit*

Description:	Circuit check
Malfunction Criteria:	Logic level low
Secondary enable conditions:	Relay state off
Disabled by faults:	None
Time required:	1 sec; 1 trips required
Potential failure modes:	- Connectors - Wire open circuit - Relay missing - Relay faulty - ECU input circuit failed
Limp home:	None

P1461 *Short Circuit*

Description:	Circuit check
Malfunction Criteria:	Logic level high
Secondary enable conditions:	Relay state on
Disabled by faults:	None
Time required:	1 sec; 1 trips required
Potential failure modes:	- Connectors - Wire short circuit - Relay faulty - ECU input circuit failed
Limp home:	None