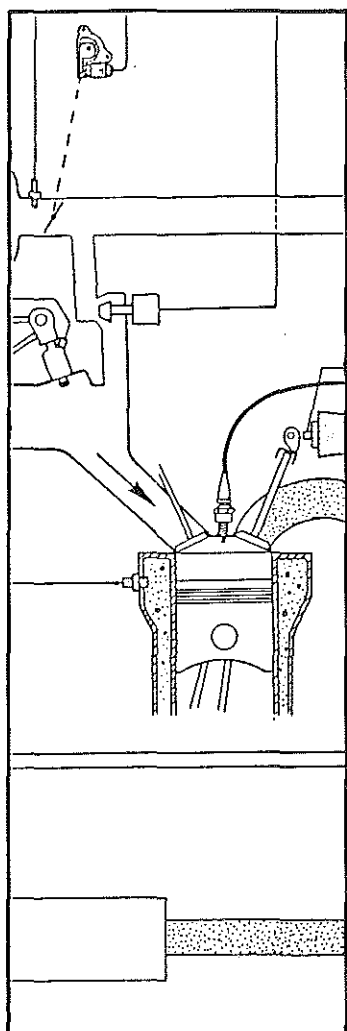


SERVICE NOTES

Section EML

To be read in conjunction with Service Notes manual
A100T0327J-Elan 1990 model year onwards



Electronic Multi Point Fuel Injection

Elan (Naturally Asp)

LOTUS CARS LTD

Norwich, Norfolk, England NR14 8EZ Telephone (0953) 608000
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ENGINE MANAGEMENT & FUEL INJECTIONSECTION EML - LOTUS ELAN (Naturally Aspirated)

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SECTION EML.1 - INTRODUCTION

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EML.1 - A EML SECTIONS EXPLAINEDIntroduction - EML.1

This section starts with a general description of the fuel injection and engine management system to provide an overview of the system and its components.

The operation of the 'Check Engine' light is explained, and how to read trouble codes without a scanner tool. The 'Tech 1' scanner tool is introduced and its operation and advantages explained. Further tools required for full diagnostic/ repair procedures are also listed.

Basic Function - Systems and Components - EML.2

This section explains the function of each individual component and where it is fitted in order that a thorough understanding of the operation of the system may be gained.

Individual Component Diagnosis and Replacement - EML.3

This section contains the circuit diagrams, fault finding charts and test procedures necessary to diagnose faults in each component. Replacement procedures and torque figures are also included.

Trouble Code Diagnosis Using 'Tech 1' Tool - EML.4

'Trouble Codes' are numbers which relate to certain types of fault as detected by the on-vehicle self diagnostic system. The 'Tech 1' tool is an electronic scanner which plugs into the on-vehicle diagnostics and displays trouble codes stored by the electronic control module.

If a 'Tech 1' tool is available, this section should be used to diagnose any problem by following three basic steps.

- i) Are the on-vehicle diagnostics working? This is established by performing the "Diagnostic Circuit Check" contained at the front of the section.

ALWAYS START HERE.

If the on-vehicle diagnostics are not working, this procedure will refer to another chart in section EML.4 to correct the problem. If the on-vehicle diagnostics are O.K. the next step is:

- ii) Is there a trouble code stored? If a trouble code is stored, refer directly to the trouble code chart of that number in section EML.4. This will determine if the fault is still present. If no trouble code is stored, the third step is:
- iii) 'Scan' serial data. This involves using the 'Tech 1' tool to read the information available from the serial data stream. Information on the 'Tech 1' tool and the meaning of the displays is contained in section EML.1 - G.

This procedure, which takes only a short time will result in problem diagnosis being made in the most cost effective and reliable manner.

'Trouble Code' Diagnosis Without 'Tech 1' Tool - EML.5

This section enables fault diagnosis to be made without the use of a scanner tool ('Tech 1').

Fault Diagnosis With Intermittent or No Trouble Codes - EML.6

If a problem is diagnosed as being 'intermittent' the trouble code charts in section EML.4 should be used only as a guide, or good components may be needlessly replaced. Section EML.6 helps to diagnose intermittent problems and driveability problems which do not cause a trouble code to be set.

EML.1 - B GENERAL DESCRIPTION

The electronic multi-point fuel injection system used on the Lotus Elan is a General Motors fully electronic, processor controlled system, using a separate fuel injector in the intake tract of each cylinder.

The injectors are supplied with fuel at constant pressure (relative to intake manifold pressure) from a common fuel rail, with the quantity of fuel delivered to the engine being controlled by the length of time for which the solenoid operated injectors are opened. All four injectors are 'pulsed' simultaneously once every engine revolution, with half of the fuel requirement for each cylinder's combustion being supplied by each pulse. The injectors are controlled by a processor called an Electronic Control Module (E.C.M.) which calculates the amount of fuel required by the engine under the operating conditions at any particular time. This information is fed into the E.C.M. by a series of sensors measuring air and coolant temperature, inlet manifold pressure, throttle position, and engine and vehicle speed. On the basis of these signals and others, the E.C.M. also controls the ignition timing, engine idle speed, and air conditioning compressor clutch.

The 'High Energy Ignition' system uses a variable reluctance trigger within a distributor driven off the end of the exhaust camshaft, an ignition coil, and control circuitry within the E.C.M. At cranking speed, the ignition timing is controlled by the distributor module, but at higher speeds the E.C.M. takes over control of electronic spark timing (EST).

In addition to these functions, the E.C.M. monitors the signals received from the various sensors and compares them with pre-programmed tolerance bands to enable it to recognise 'faults' in the system and light a 'check engine' tell tale lamp on the fascia. This informs the driver that a fault has been detected and furthermore stores in its memory a 'trouble code' for the particular type of fault detected in order that a technician may access the code and be guided to the problem area.

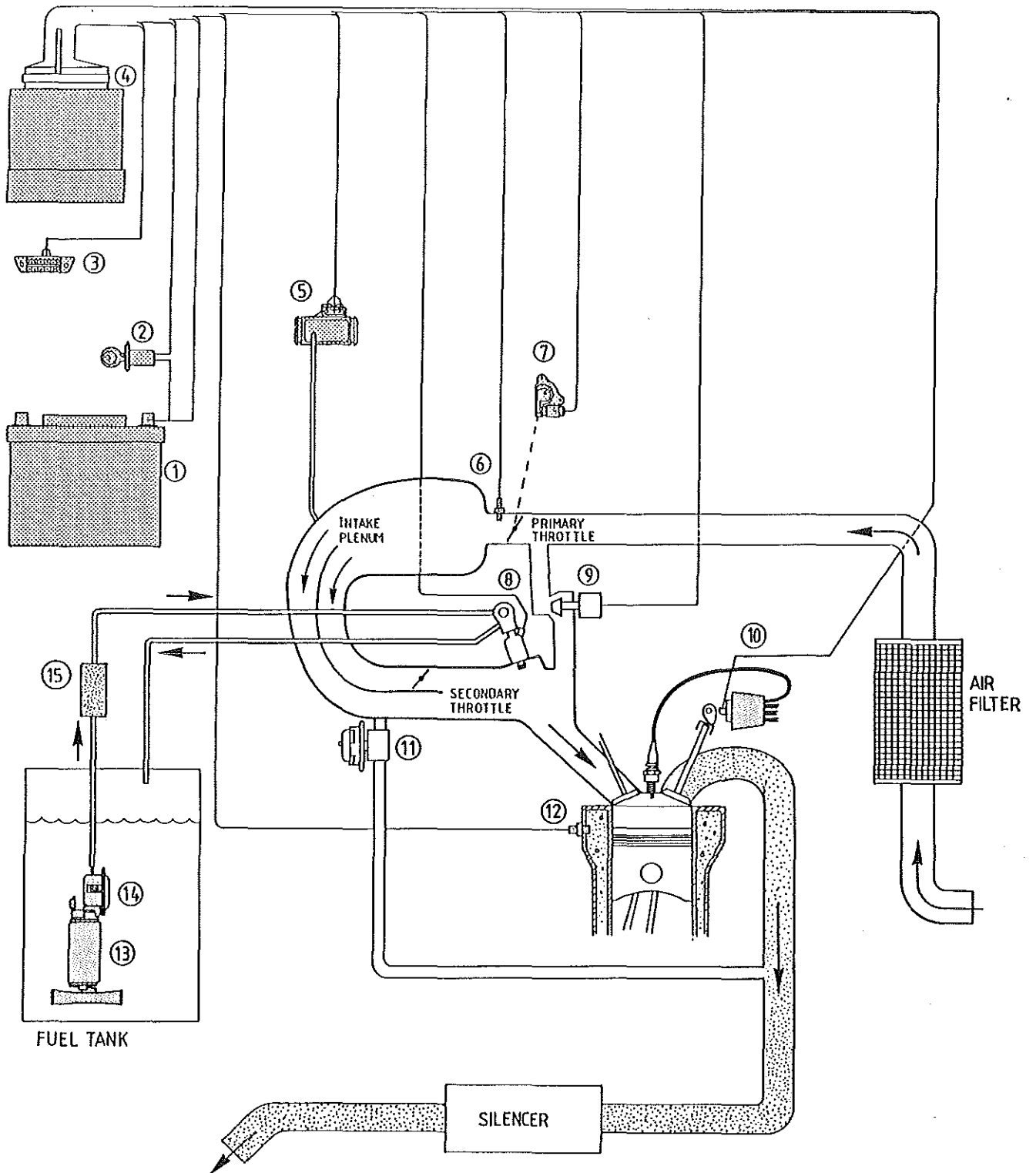
A facility is also provided for the data monitored by the E.C.M. to be tapped via a hand held electronic scanner (known as the 'Tech 1' tool) with an LCD display panel. This tool aids rapid fault diagnosis by displaying all sensor readings and trouble codes.

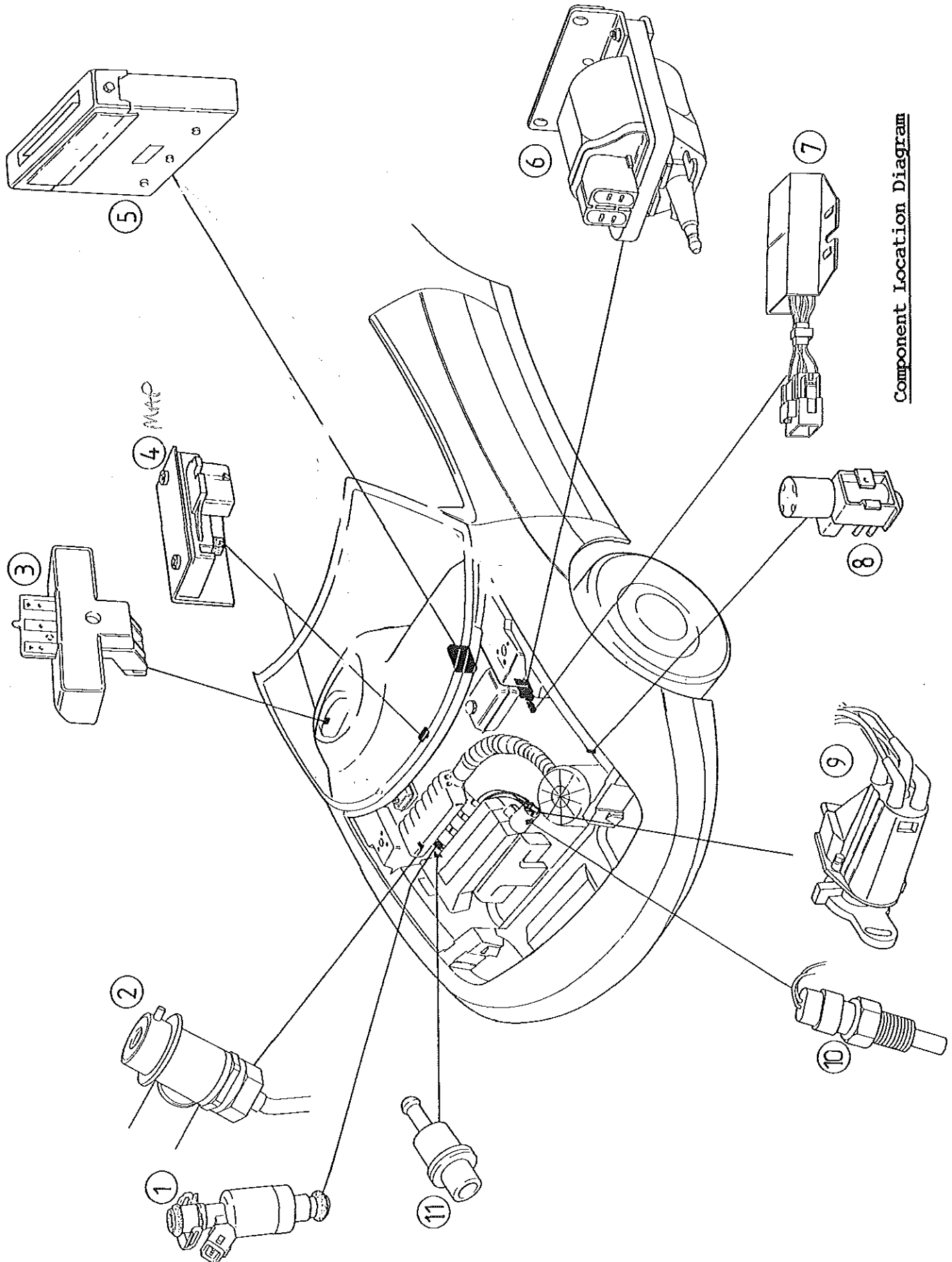
Key to Schematic Diagram

- | | |
|---|---|
| 1. Battery | 9. Idle Air Control (IAC) valve |
| 2. Ignition switch | 10. High Energy Ignition (HEI) module and distributor |
| 3. Assembly Line Diagnostic Link (ALDL) | 11. Exhaust Gas Recirculation (EGR) valve |
| 4. Electronic Control Module (ECM) | 12. Coolant Temperature Sensor (CTS) |
| 5. Manifold Air Pressure (MAP) sensor | 13. Fuel pump |
| 6. Mass Air Temperature (MAT) sensor | 14. Pulsator |
| 7. Throttle Position Sensor (TPS) | 15. Fuel filter |
| 8. Fuel injector (4 off) | |

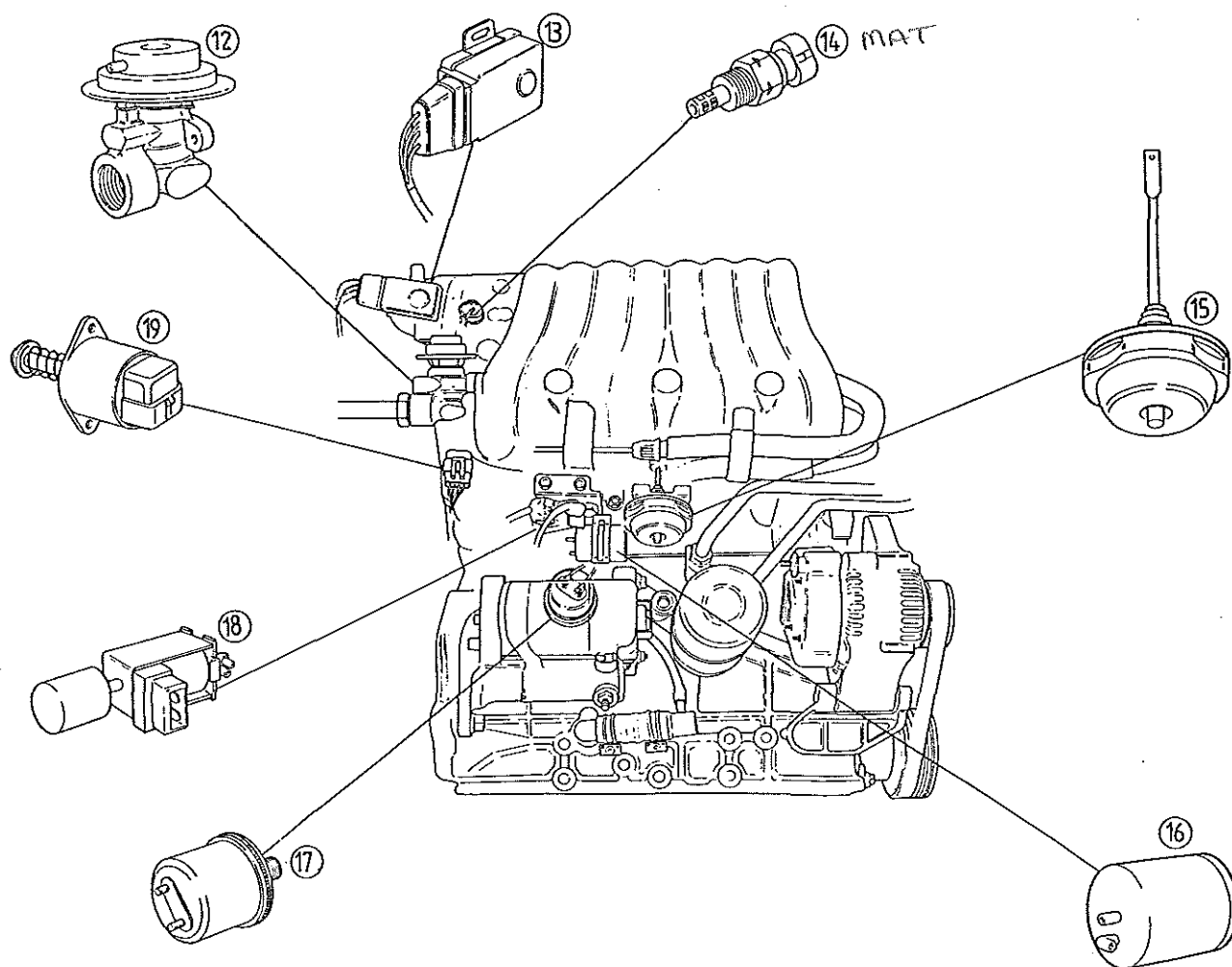


Schematic Diagram





Component Location Diagram



Component Location - Rear Side of Engine

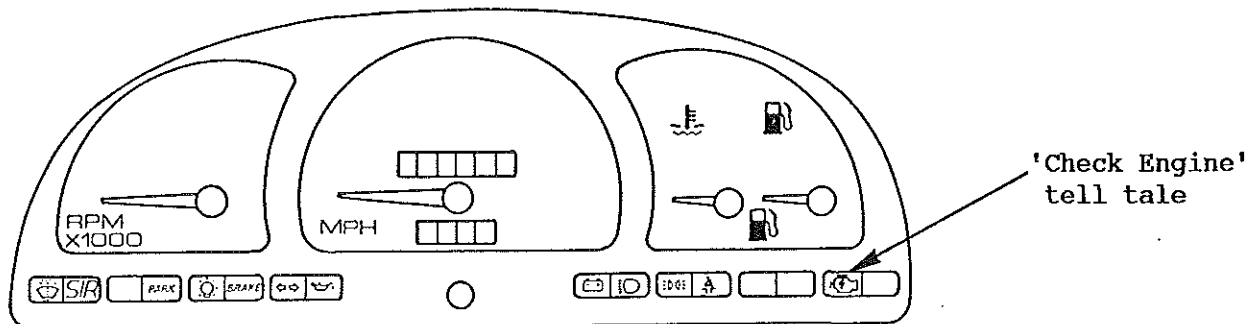
Key to Component Location Diagram

- | | |
|--|--|
| 1. Fuel injector | 12. Exhaust Gas Recirculation (EGR) valve |
| 2. Fuel pressure regulator valve | 13. Throttle Position Switch (TPS) |
| 3. Vehicle Speed Sensor (VSS) | 14. Manifold Air Temperature (MAT) sensor |
| 4. Manifold Air Pressure (MAP) sensor | 15. Secondary throttle vacuum actuator |
| 5. Electronic Control Module (ECM) | 16. Secondary throttle vacuum reservoir |
| 6. Ignition coil | 17. Oil pressure transducer |
| 7. Injector dropping resistor | 18. Secondary throttle vacuum solenoid valve |
| 8. Exhaust Gas Recirculation (EGR) vacuum solenoid valve | 19. Idle Air Control (IAC) valve |
| 9. Ignition module & distributor | |
| 10. Coolant temperature sensor (CTS) | |
| 11. Positive Crankcase Ventilation (PCV) valve | |

EML.1 - C 'CHECK ENGINE' LIGHT

A 'check engine' tell tale lamp in the instrument binnacle is provided to:

- i) To tell the driver that a problem has occurred and that the vehicle should be taken for check/repair as soon as is practicable;
- ii) To enable the technician to read out any 'trouble codes' and help diagnose system problems.



As a bulb and system check, the lamp will light with the ignition on, and should go out when the engine is started. If, however, the lamp remains on, or comes on whilst driving, this indicates that the self diagnostic system has detected a problem and a trouble code has been stored in the memory. If the fault cures itself, or is no longer detected, the lamp will go out in most cases after about 10 seconds but the trouble code will remain stored in the memory for the next 50 starts to indicate to the technician that an intermittent fault has been detected. If no recurrence is recorded during this period, the stored trouble code will be erased from the memory.

Trouble Codes

Trouble codes may be categorised as either 'intermittent' or 'hard' where an 'intermittent' code is one which was set by a detected fault no longer present, and a 'hard' code is one where the fault still exists. The trouble code charts in sections EML.4 and EML.5 are designed to use this discrimination to aid diagnosis.

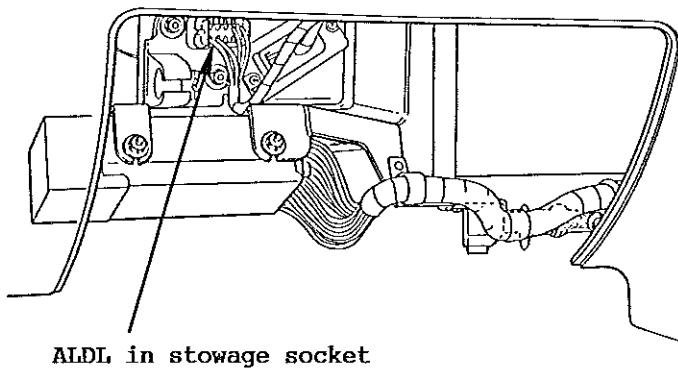
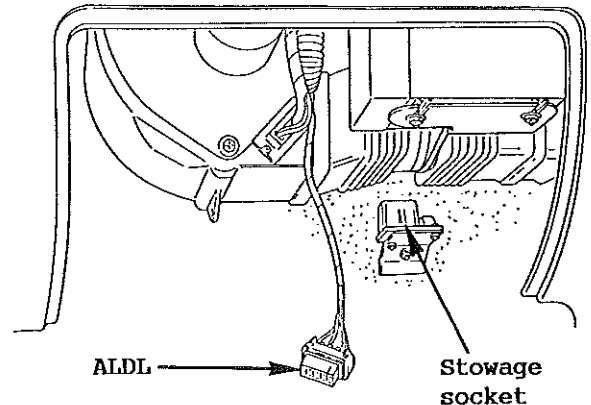
On the facing page of each trouble code chart are the readings the E.C.M. expects to receive from the relevant sensors. If these readings are outside of the specification, the check engine tell tale will be lit and a trouble code stored in the memory. The trouble code indicates in which CIRCUIT a problem was detected. Such a circuit would include the sensor, the wiring and connectors to it, and the E.C.M.

In order to read any trouble codes stored in the memory, it is necessary to use the Assembly Line Diagnostic Link (ALDL) connector.

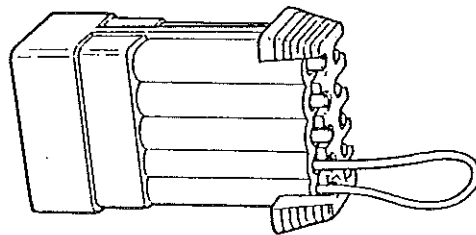
EML.1 - D ASSEMBLY LINE DIAGNOSTIC LINK (ALDL) CONNECTOR

The ALDL connector is plugged into a stowage socket fixed: on a/c cars on the rear face of the blower housing (drop glovebox for access), and on heater cars to the bulkhead at the front of the passenger footwell. The connector is used:

- i) at the end of the factory production line to check out the engine management system;
- ii) to connect the hand held diagnostic scanner tool ('Tech 1'). Data is read via terminal G;
- iii) to read stored trouble codes without a scanner tool.

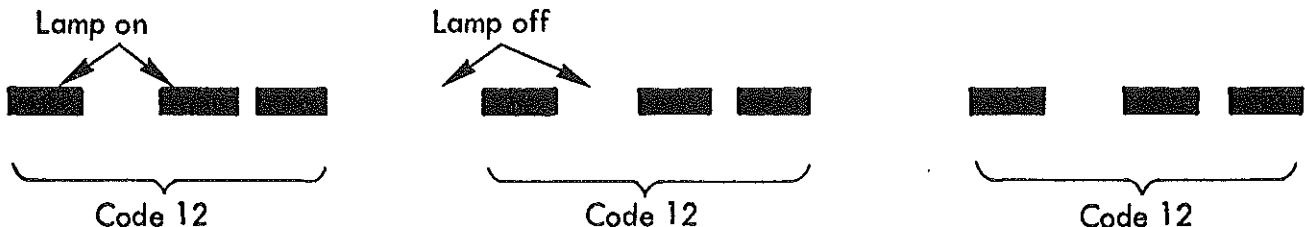
a/c carsHeater carsEML.1 - E DIAGNOSTIC MODE (no scanner tool)

If the diagnostic terminal (B) of the ALDL connector is grounded (terminal A) using bridging connector T000T0909 with the ignition on and the engine stopped, the system will enter the diagnostic mode, and:



Bridging plug
T000T0909

- i) Display a code 12 by flashing the 'Check Engine' tell tale, and relay box repeater lamp to indicate that the diagnostic mode is operating. Codes are displayed by the lamp quickly flashing the first digit of the (two digit) number with a short pause before the second digit is similarly flashed.
For example, code 12 would consist of one flash, followed by a short pause then two flashes in quick succession.
If no trouble codes are stored, code 12 will continue to be flashed repeatedly until the diagnostic terminal is ungrounded.



- ii) If one or more trouble codes are stored, code 12 will flash 3 times, followed by a short pause before the first trouble code is flashed 3 times in succession, then the next trouble code (if any), until code 12 is again flashed to complete the cycle.
The trouble codes charts in section EML.5 are used to diagnose the



problem and determine if the fault is 'hard' or 'intermittent'.

- iii) Energise all ECM controlled relays and solenoids except the fuel pump relay.
- iv) Fully extend the idle air control (IAC) valve.

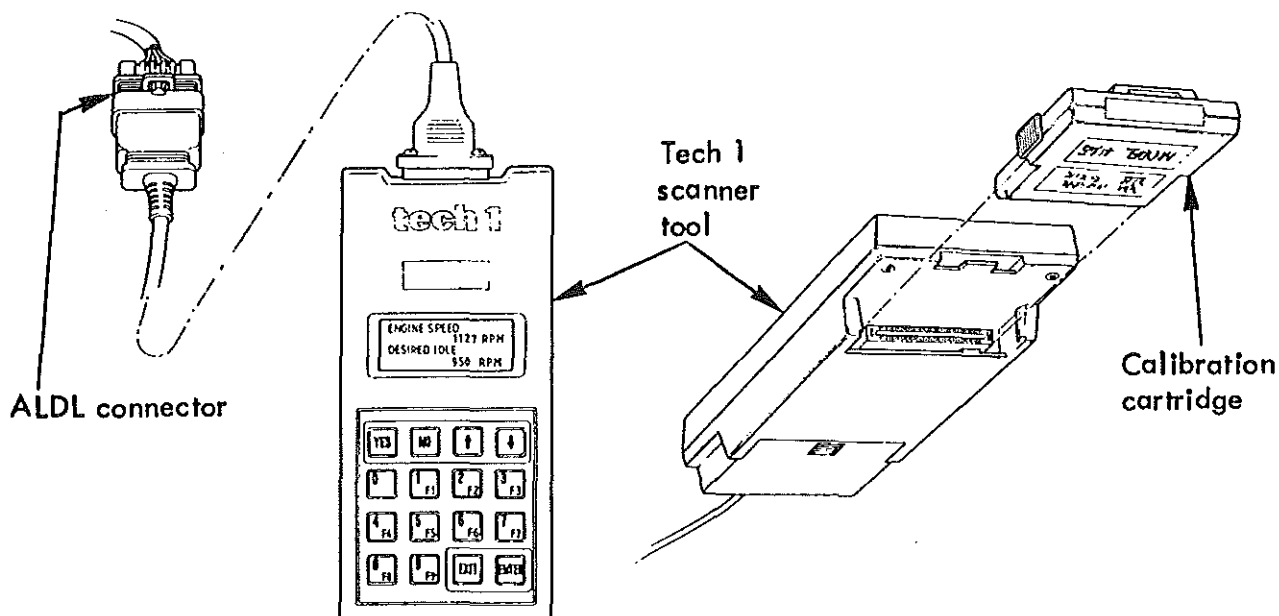
Note that trouble codes can only be displayed with the engine stopped. Grounding the diagnostic terminal with the engine running provides the 'CO adjustment mode' described below.

EML.1 - F CO ADJUSTMENT MODE

If the diagnostic terminal (B) of the ALDL connector is grounded (use tool T000T0909) with the engine running, the system will enter the CO adjustment mode, and the 'Check Engine' tell tale will light. See section EML.3 - E for the CO adjustment procedure.

EML.1 - G 'TECH 1' SCANNER TOOL

The 'Tech 1' is a hand held electronic scanner tool with an LCD display panel which, by plugging into the ALDL connector, is able to display (numerically) any stored trouble codes and allow a quick check of sensors and switches which are inputs to the ECM. Any pair of sensor inputs may be displayed simultaneously either in the workshop, or if necessary whilst driving on the road.





The 'Tech 1' scanner tool does not make the use of diagnostic charts unnecessary. It is used in conjunction with the charts to identify in which circuit a problem is located, and in some cases the tool can provide information that is extremely difficult, or indeed impossible to obtain using other equipment.

'Snapshot' Mode

This facility is extremely useful for diagnosing driveability or intermittent problems which may not set a trouble code.

The tool is plugged in and observed whilst the car is driven, and a continually updated block of data covering the latest time period, from all the sensors is stored in the memory. When the driveability problem is encountered, or the intermittent fault occurs, the 'snapshot' may be triggered manually or automatically, and a further block of sensor data is recorded for a similar time period after the trigger point. Back in the workshop, the readings from each of the sensors may be recalled and assessed before, during and after the trigger point. A variation in sensor reading at the trigger point may indicate a problem area, if necessary comparing readings with a known good vehicle.

Data Displays Available on the Tech 1 Tool

ENGINE SPEED: Displays engine rpm. Often useful if extra reference pulses are suspected. A sudden high rpm indication while at a steady throttle would indicate electrical interference in the reference circuit. This interference is usually caused by ECM wires too close to ignition secondary wires.

DESIRED IDLE: Indicates the rpm to which the ECM is trying to control idle speed

COOLANT TEMP: Displays engine temperature in degrees Centigrade and Fahrenheit.

After engine is started the temperature should rise steadily to about 85 - 95°C then stabilise when the thermostat opens.

MASS AIR TEMP: (MAT) Displays temperature of air entering the intake plenum.

Should read close to ambient air temperature when the engine is cold, and rise as underhood and engine temperature increases.

MAP: (Manifold Air Pressure) The MAP sensor produces a low signal voltage when inlet manifold pressure is low (high vacuum) and a high voltage when the pressure is high (low vacuum). With the ignition on and the engine stopped, the manifold pressure is equal to atmospheric pressure and the signal voltage will be approximately 2.4 volts.

BARO: (Barometric pressure) Sensed via MAP sensor at instant of ignition switch on. Should read the same, or very close to MAP before engine is started.

IDLE AIR CONTROL: (IAC) This system is used to control engine idle speed to the desired rpm, for different operating conditions. In this mode, the numbers will indicate what position the ECM thinks the valve is in. The ECM moves the IAC in counts and it is the count number which is displayed on the Tech 1 tool.

ENGINE SPEED: Repeated for convenience of use.

THROT POSITION: Displays TPS output in volts.

THROTTLE ANGLE: Displays throttle opening as a percentage.

OXYGEN SENSOR: Not used in this application.

INJ PULSE WIDTH: In this position, the reading is given in milliseconds which is the on time that the ECM is commanding to the injectors.

SPARK ADVANCE: Displays ignition advance in degrees.

MPH KPH: Displays vehicle road speed.

FUEL INTEGRATOR: Not used in this application.

BLOCK LEARN: Not used in this application.

OPEN/CLOSED LOOP: Open loop system used on this model.

BLOCK LEARN CELL: Not used in this application.



KNOCK RETARD: Not used in this application.

KNOCK SIGNAL: Not used in this application.

BATTERY VOLTAGE: Displays the battery voltage detected at the ECM ignition input.

PURGE DUTY CYCLE: Not used in this application.

A/C REQUEST: Displays the state of the A/C signal line to the ECM. Should read "NO" if car is not fitted with air conditioning.

A/C CONTROL: Displays ECM commanded to the A/C clutch. Should read "OFF" on cars without A/C.

SYNC PULSES: Not used in this application.

PARK/NEUTRAL: Should display "-R-DL". Function not used on manual transmission cars.

POWER STEERING: On cars fitted with power steering, display will change from "NORMAL" to "HIGH" when high steering loads are applied.

2ND THROTTLE SOL: Should display "ACTIVE" at low engine speeds, and "INACTIVE" at high speed. Note that with ignition on and engine stopped, solenoid is inactive, but Tech 1 will display "ACTIVE".

AIR CONTROL SOL: Not used in this application.

EGR SOLENOID: Indicates state of EGR solenoid valve.

CO ADJ VOLTS: Displays voltage sensed by ECM on CO potentiometer circuit.

WASTEGATE D.C.: Not used in this application.

PROM ID: This number identifies whether the correct ECM assembly is fitted.

TIME FROM START: Displays time in minutes and seconds since ignition switch on.

EML.1 - H CLEARING TROUBLE CODES

A trouble code will remain stored in the ECM memory after the fault has been rectified (or does not recur) until the engine is started 50 times, or the code is cleared using the programme provided in the 'Tech 1' tool, or if the battery voltage is disconnected from the ECM for 30 seconds.

CAUTION: To prevent ECM damage, the ignition key must be 'OFF' when disconnecting or reconnecting power to the ECM (e.g. battery cable, ECM pigtail, ECM fuse, jumper cables, etc.).

Trouble codes should be cleared after repairs have been completed. Some diagnostic charts will require codes to be cleared before using the chart in order that the ECM be allowed to set the code during the test and identify the problem more quickly.

Note that when clearing trouble codes with the 'Tech 1' tool, the ignition should first be switched off for 10 seconds.



EML.1 - I ECM LEARNING ABILITY

The ECM has a 'learning' ability which enables it to make corrections for engine condition in order to maintain the correct idle speed at all times.

If, after ten seconds have elapsed since switching off the engine, the battery is disconnected, or the power supply to the ECM interrupted, these 'learned' settings will be erased in addition to any stored trouble codes. On reconnection, the ECM will re-learn the idle air control (IAC) valve position after engine start up, and there is unlikely to be any noticeable change. However, if the battery is disconnected, or the ECM power supply interrupted before ten seconds have elapsed since stopping the engine, (or whilst the engine is running), the ECM will not have time to 'park' the IAC valve at a known position, and will lose track of where it is. When first starting the engine after reconnecting the battery or ECM power supply, it may be necessary to partially depress the accelerator pedal, and to release the accelerator very slowly when first returning to idle, to prevent stalling whilst the ECM re-learns the IAC valve position. Alternatively, if after reconnection of the power, the ignition is switched on, and then switched off to 'power down' the ECM, the IAC valve will be parked at a known position, and after ten seconds the engine may be started normally.

When clearing trouble codes the 'Tech 1' tool should always be used so that the trouble code(s) only is cleared, and not any other ECM memories.

EML.1 - J BASIC PRECAUTIONS

THE LOTUS ELAN IS CERTIFIED BY THE EMISSIONS AUTHORITIES AS CONFORMING TO THE REQUIREMENTS OF THE REGULATIONS FOR THE CONTROL OF AIR POLLUTION FROM NEW MOTOR VEHICLES. THIS CERTIFICATION IS CONTINGENT ON CERTAIN ADJUSTMENTS BEING SET TO FACTORY STANDARDS. IN MOST CASES, THESE ADJUSTMENT POINTS HAVE BEEN EITHER PERMANENTLY SEALED AND/OR MADE INACCESSIBLE TO PREVENT INDISCRIMINATE OR ROUTINE ADJUSTMENT IN THE FIELD. FOR THIS REASON, THE FACTORY PROCEDURE FOR TEMPORARILY REMOVING PLUGS, CAPS, ETC., FOR THE PURPOSES OF SERVICING THE PRODUCT, MUST BE STRICTLY FOLLOWED AND, WHEREVER PRACTICABLE, RETURNED TO THE ORIGINAL INTENT OF THE DESIGN.

Chocking Drive Wheels

The vehicle drive wheels should always be securely chocked whenever performing system diagnoses with the engine running.

Visual/Physical Inspection

Before embarking on any other diagnostic procedures, it is most important to carry out a thorough and comprehensive visual and physical check of all vacuum pipes/hoses and wires for correct routing, and any signs of pinches, cuts, chafes, poor connections, etc. Do not overlook the more inaccessible areas.

Fuel System

All parts of the fuel feed line between the tank and fuel pressure regulator valve remain under pressure even after switching off the ignition. It is most important that before releasing any fuel connection or component, the fuel pressure relief procedure and safety precautions detailed in EML.3 - I are followed.

Ignition System

Be aware that the ignition coil output to the spark plugs is in the region of 50 kV, which if received as a 'shock', could in rare circumstances cause medical



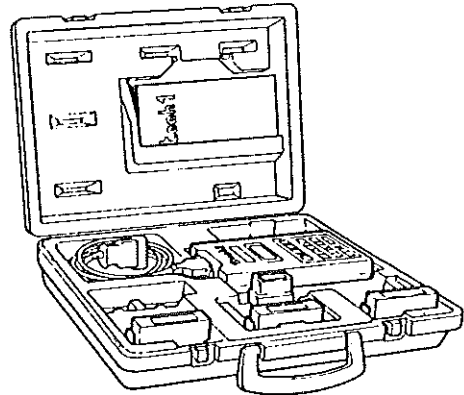
distress to persons with a weak heart.

EML.1 - K SPECIAL TOOLS

'Tech 1' Diagnostic Scanner Kit T000T0896

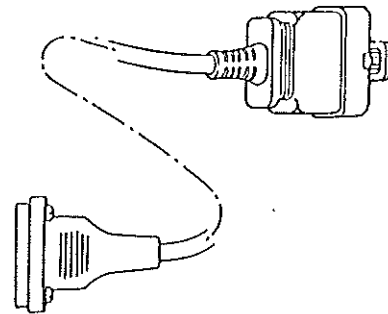
Plugs into ALDL connector and displays stored trouble codes and sensor readings.

Kit includes scanner, ~~cartridge~~, lead, self-test adaptor, operator's manual and carrying case.



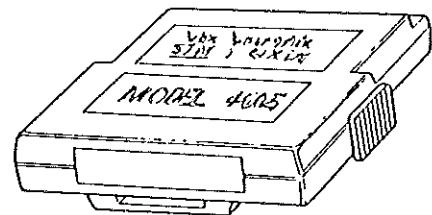
Connector Lead, 'Tech 1' Scanner T000T0897/2

Included in 'Tech 1' kit T000T0896
Connects Tech 1 to ALDL socket.
Use only /2 version (may have TA00053 or gold spot on ALDL end connector).
Resistance between terminals F & G:
/1 version = 0.56 ohm (approx)
/2 version = infinite



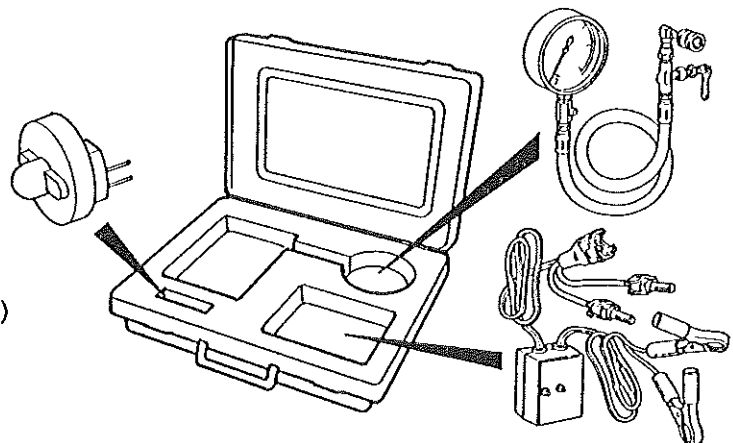
Calibration Cartridge, 'Tech 1' Scanner T000T0898/3

~~Included in 'Tech 1' kit T000T0896.~~
Plugs into Tech 1 scanner.
Contains data for Elan and Esprit models.
Identified by "LOTUS 89-90 ECM 'PLUS'".



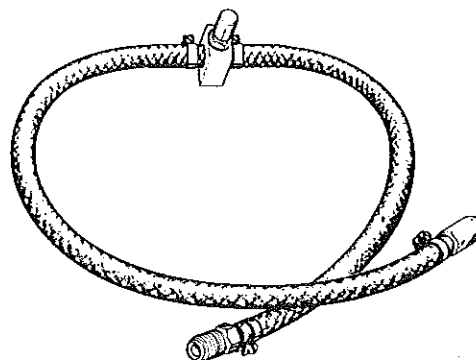
Fuel Pressure and Injector Diagnostic Kit T000T0899

Used to diagnose fuel system problems.
Kit includes; fuel pressure gauge, to check pump delivery pressure and compare individual injector pressure drop; injector test light, to check electrical circuit to an injector; injector tester, to energise an individual injector for a precise time period.
(Replacement seal for gauge A082L6202F)

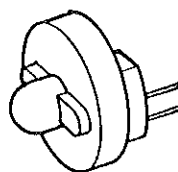


Fuel Pressure Test Hose T000T1083

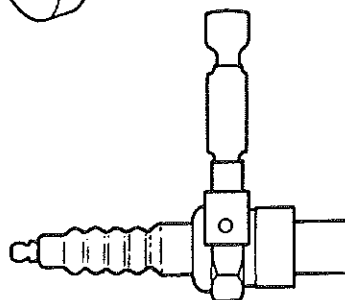
Fitted between fuel feed line and fuel rail inlet pipe to provide a take-off point for the fuel pressure test gauge, and a means of restricting fuel flow to test fuel pump performance.

Injector Test Light T000T0900

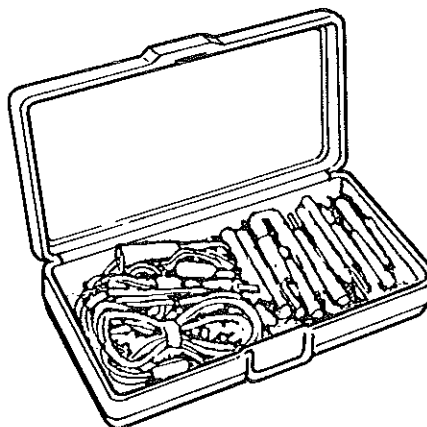
Included in kit T000T0899.
Used to check electrical circuit to an injector.

Spark Tester T000T0901

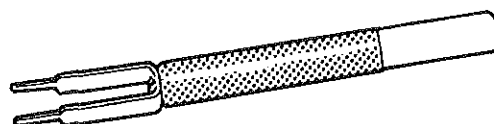
Used to check available secondary ignition voltage.

Connector Test Adaptor Kit T000T0902

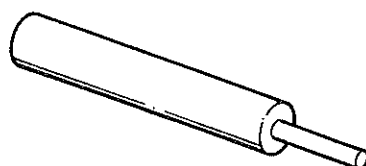
Used to make electrical test connections in Weather Pack, Metri-Pack and Micro-Pack connector blocks.

Metri-Pack Terminal Remover T000T0903

Used to remove terminals from connector blocks.

Weather-Pack Terminal Remover T000T0904

Used to remove terminals from connector blocks





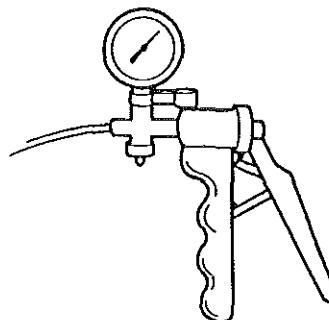
ECM Connector Terminal Remover T000T0905

Used to remove terminals from ECM connector.



Vacuum Pump T000T0907

Used to operate and diagnose faults in vacuum operated components.



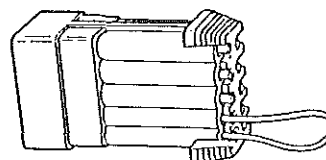
'Speedfit' Connector Release Tool T000T0989

Used to release fuel feed and return pipes from their tank spigots.



ALDL Bridging Connector T000T0909

Used to bridge ALDL connector terminals B and A to enter diagnostic mode without 'Tech 1'.





EML.1 - L HARNESS CONNECTOR BLOCKS

Because of the very low voltage and current levels used in the electronic engine management system, most connectors in the engine compartment are protected against moisture and dirt which could create oxidation and deposits on the terminal.

Take care when probing connector blocks or replacing terminals, to avoid shorting between adjacent terminals, since this can result, in some circumstances, in damage being caused to the electronic components. Always use jumper wires between connectors for circuit checking. Never probe through the Weather-Pack seals.

When diagnosing, open circuits are often difficult to locate by sight because oxidation or terminal misalignment are hidden by the connectors. Merely wiggling a connector on a sensor or in the wiring harness may correct the open circuit condition. This should always be considered when an open circuit or failed sensor is indicated. Intermittent problems may also be caused by oxidised or loose connections.

Before making a connector repair, be certain of the type of connector. Weather-Pack and Compact Three connectors look similar but are serviced differently.

Weather-Pack Connector

The diagram shows a Weather-Pack type connector and the tool T000T0904 required for removing the pin and sleeve terminals. If removal of a terminal is attempted using any other tool, it is likely that the terminal will be bent or deformed. These terminals cannot be straightened once bent.

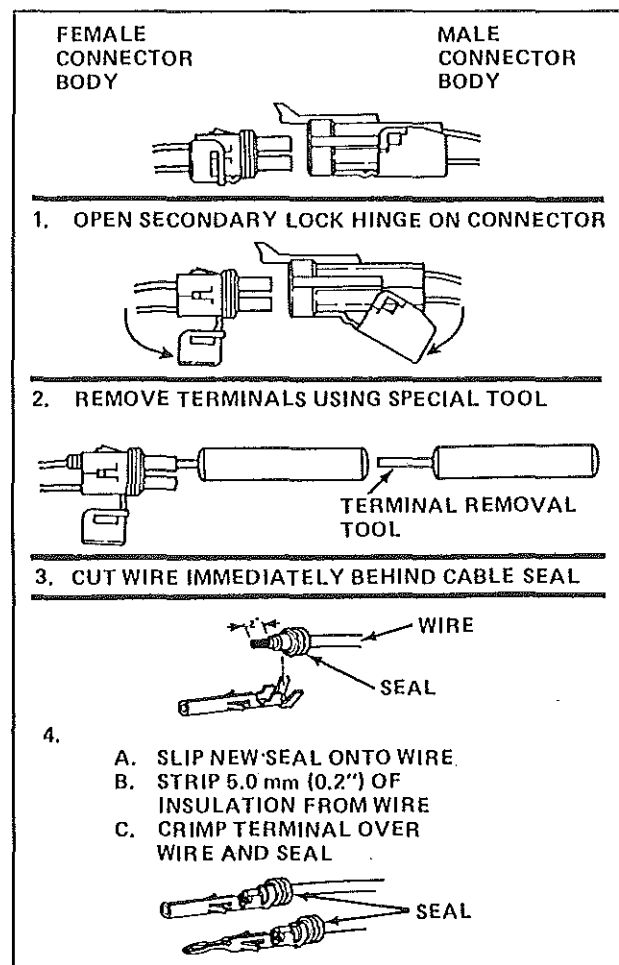
Ensure that the connectors are properly seated and all of the sealing rings in place when connecting leads. The hinge type flap provides a backup, or secondary locking feature for the connector. They are used to improve the connector reliability by retaining the terminals if the small terminal lock tangs are not positioned properly.

Weather-Pack connections cannot be replaced with standard connections. Instructions are provided with Weather-Pack connector and terminal packages.

Compact Three Connectors

The Compact Three connector which looks similar to a Weather-Pack connector is not sealed and is used where resistance to the environment is not required.

Use standard methods when repairing a terminal. Do not use the Weather-Pack terminal tool T000T0904.



Metri-Pack Series 150 Connectors

Some connectors used to connect various sensors to the ECM harness use terminals called "Metri-Pack".

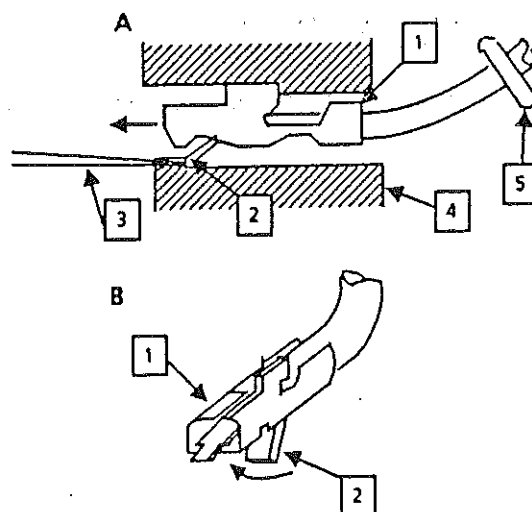
They are also called "Pull-to-seat" terminals because, to install a terminal on a wire the wire is first inserted through the seal (5) and connector (4). The terminal is then crimped on the wire and the terminal pulled back into the connector to seat it in place.

To remove a terminal:

1. Slide the seal back on the wire,

2. Insert tool (3) T000T0903 or equivalent, as shown in insert "A" and "B" to release the terminal locking tab (2).

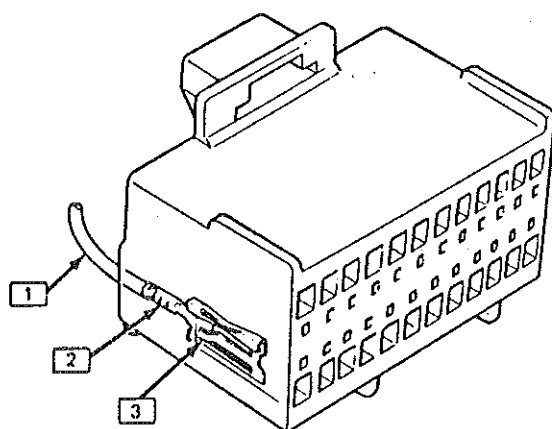
3. Push the wire and terminal out through the connector. If re-using the terminal, reshape the locking tang (2).



- | | |
|--|-------------------|
| 1. Metri-Pack series 150 female terminal | 3. Tool T000T0903 |
| 2. Locking tang | 4. Connector body |
| | 5. Seal |

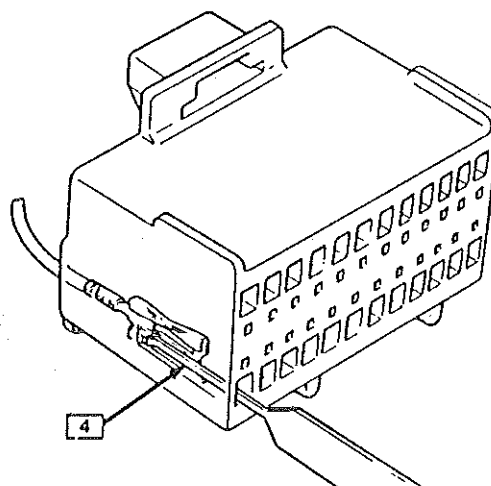
Micro-Pack Connectors

The diagram shows a Micro-Pack connector used on the harness to ECM connection. Terminal replacement requires the use of tool T000T0905 in the manner shown.



- | | |
|-------------|-------------------|
| 1. CABLE | 3. LOCKING TANG |
| 2. TERMINAL | 4. TOOL T000T0905 |

1. GRASP CABLE AND PUSH TERMINAL TO THE MOST FORWARD POSITION.
2. INSERT TOOL T000T0905 STRAIGHT INTO THE FRONT OF THE CONNECTOR CAVITY. DO NOT USE CONVENTIONAL PICK TO REMOVE TERMINAL.



3. WITH TOOL IN PLACE, GENTLY PULL ON THE CABLE TO REMOVE TERMINAL.
4. VISUALLY CHECK TERMINAL AND REPLACE IF TERMINAL CAVITY OR TANG IS DAMAGED.
5. INSTALL TERMINAL INTO CONNECTOR CAVITY UNTIL LOCKING TANG HAS SNAPPED INTO POSITION.

EML.1 - M ABBREVIATIONS AND GLOSSARY OF TERMS

A/F	Air/Fuel ratio.
ALDL	Assembly Line Diagnostic Link. Connector block located in engine bay relay box. Used for verification of management system at the factory and for connection of 'Tech 1' diagnostic scanner tool.
Batt +ve	Battery positive terminal (12 volts).
Cal-Pak	Calibration Package incorporated into Mem-Cal. Allows fuel delivery in the event of a PROM or ECM malfunction.
CEL	Check Engine Light. Tell tale lamp on fascia. Warns driver fault has been detected and can flash fault codes when diagnostic terminal of ALDL connector is grounded.
CKT	Circuit.
CO	Carbon Monoxide.
CTS	Coolant Temperature Sensor.
Diagnostic Terminal	Lead of ALDL connector which is grounded to display stored trouble codes.
DI	Direct Ignition. Uses no distributor.
DVM (10meg)	Digital Voltmeter with 10 million ohm resistance.
ECM	Electronic Control Module. Computer controlling injection and engine management.
EGR	Exhaust Gas Recirculation
ESC	Electronic Spark Control. Retards ignition timing when detonation is detected.
EST	Electronic Spark Timing. ECM control of ignition timing.
HC	Hydrocarbons. Exhaust pollutant.
High Impedance Voltmeter	Used on circuits with very low current flow, as meter does not affect current in circuit under test.
Hg	Mercury. A calibration material used to measure vacuum.
IAC	Idle Air Control valve. Controls airflow past throttle plates to control idle speed.
MAP	Manifold Absolute Pressure.
MAT	Mass Air Temperature. Sensor in intake plenum.



Mem-Cal	Memory Calibrator. Cartridge fitted into ECM. Contains calibrations specific to a particular model variant.
MFI	Multiport Fuel Injection. System using individual injectors for each cylinder.
Mode	A particular state of operation.
NC	Normally Closed. State of relay contacts of solenoid plunger when no voltage is applied.
NO	Normally Open. State of relay contacts or solenoid plunger when no voltage is applied
NOx	Nitrogen Oxides. Exhaust gas pollutant.
Open Loop	ECM fuel control without use of oxygen sensor.
PCV	Positive Crankcase Ventilation. System prevents crankcase fumes passing directly into atmosphere.
PROM	Programmable Read Only Memory. Contained within Mem-Cal.
PSPS	Power Steering Pressure Switch.
TPS	Throttle Position Sensor.
VSS	Vehicle Speed Sensor.
WOT	Wide Open Throttle.

Circuit Diagram Cable Colour Code

B	Black	O	Orange	U	Blue
G	Green	P	Purple	W	White
K	Pink	R	Red	Y	Yellow
LG	Light Green	S	Slate		
N	Brown	T	Tan		

SECTION EML.2BASIC FUNCTION - SYSTEMS & COMPONENTS

	<u>Sub-Section</u>	<u>Page</u>
Electronic Control Module (ECM)	EML.2 - A	2
- Engine Coolant Temperature Sensor	EML.2 - B	3
- Mass Air Temperature (MAT) Sensor	EML.2 - C	4
- Manifold Absolute Pressure (MAP) Sensor	EML.2 - D	5
- Throttle Position Sensor (TPS)	EML.2 - E	5
- Air Conditioning Control	EML.2 - F	6
- Vehicle Speed Sensor (VSS)	EML.2 - G	6
- CO Potentiometer	EML.2 - H	6
Fuel Control System	EML.2 - I	7
- Fuel Pump	EML.2 - J	8
- Fuel Rail & Pressure Regulator	EML.2 - K	9
- Fuel Injectors	EML.2 - L	9
- Intake System	EML.2 - M	11
- Idle Air Control (IAC) Valve	EML.2 - N	12
High Energy Ignition (HEI)	EML.2 - O	13
Positive Crankcase Ventilation	EML.2 - P	14
Exhaust Gas Recirculation	EML.2 - Q	15

EML.2 - A ELECTRONIC CONTROL MODULE (ECM)

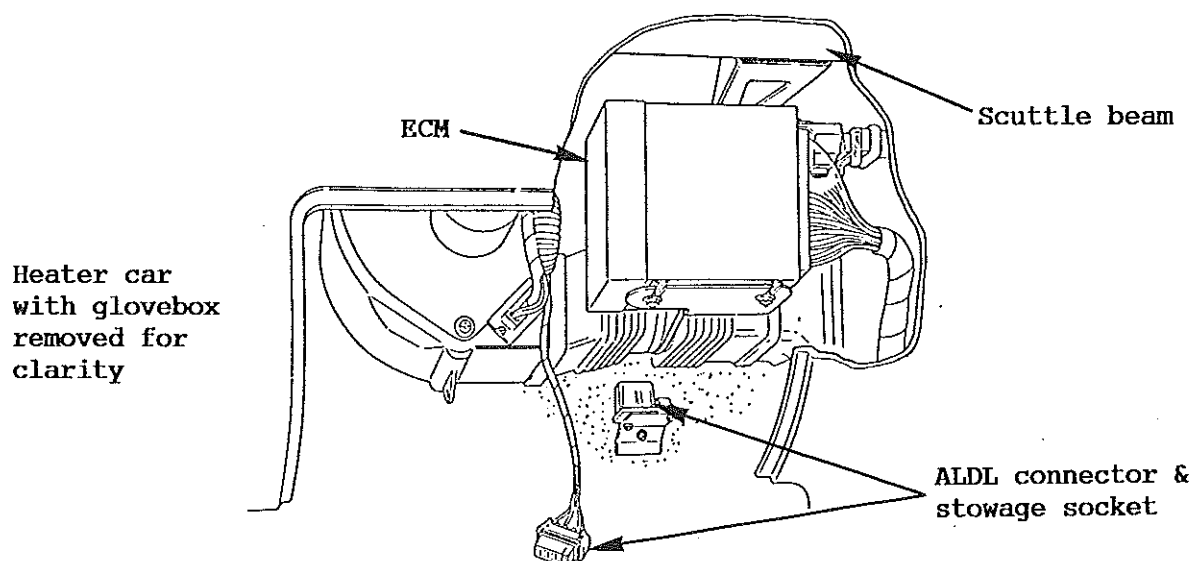
The Electronic Control Module (ECM), mounted, on a/c cars below the blower fan housing, and on heater cars hanging from a scuttle beam bracket behind the glovebox, is the controlling computer for the fuel injection and engine management system. It constantly monitors data received from various sensors and controls engine operation to provide optimum performance and driveability consistent with the minimum of harmful emissions.

The different parameters sensed and the systems controlled are as follows:-

PARAMETERS SENSED	SYSTEMS CONTROLLED						
	Fuel Delivery		Idle Speed				
			Spark Timing				
				EGR Control			
					Secondary Throttles		Air Conditioning*
						Check Engine	
Engine Speed	X	X	X	X	X		X
Vehicle Speed	X	X	X	X		X	X
Coolant Temp.	X	X	X	X	X	X	X
Mass Air Temp.			X				X
Manifold Pressure	X	X	X	X	X		X
Barometric Pressure	X	X					
Throttle Position	X	X	X	X		X	X
Battery Voltage	X	X					
Time	X	X	X	X		X	
A/C Request		X				X	
CO Potentiometer	X						X
Power Steer Switch*		X				X	
Camshaft Position	X		X				

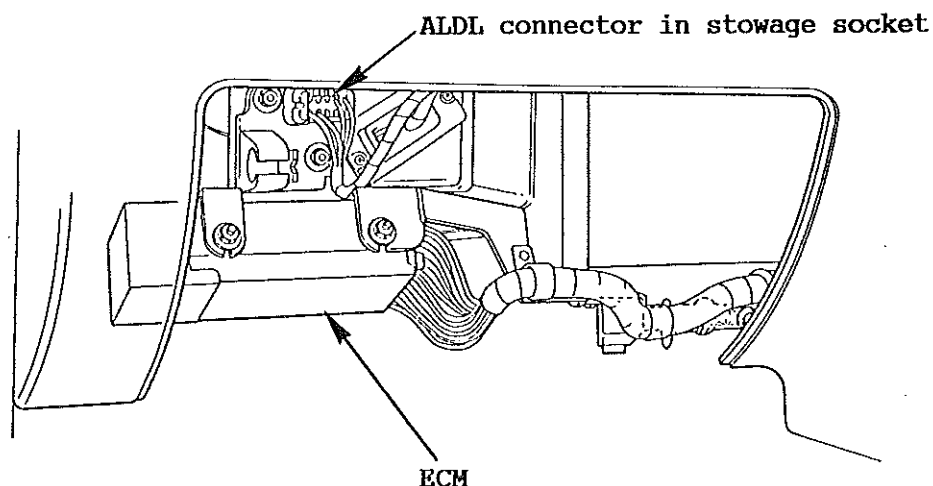
* not functionable on 1990 M.Y. cars.

The ECM controls most output circuits by switching the ground circuit through Quad Driver Modules (QDMs). A QDM is a group of electronic switches which can independently control up to four outputs.





A/c car with
glovebox removed
for clarity



ALDL Connector Plug

The ECM can also recognise operational problems and alert the driver via a 'Check Engine' tell tale lamp on the fascia, whilst storing a 'trouble code' to help the technician make rapid fault diagnosis. An 'Assembly Line Diagnostic Link' (ALDL) connector plug adjacent to the ECM is provided for use both at the end of the assembly line to check for correct system operation, and in service, for diagnostic purposes. A special hand held electronic scanner tool ('Tech 1') plugs into this connector and enables all the sensor readings to be displayed, together with any stored trouble codes.

See Section EML.1 for a full explanation of using the diagnostic facility.

Mem-Cal

The ECM consists of two principal parts:-

- Controller. This is the main body of the ECM and includes the basic control circuits.
- Mem-Cal. This is a "Memory and Calibration" cartridge which plugs into the controller. It contains data specific to particular vehicles, together with the functions of the PROM - programmable read only memory, and Cal-Pak - calibration package designed to allow fuel delivery in the event of malfunction in the controller or PROM, as a 'get you home' facility.

On the Elan, the ECM is a non-servicable sealed unit, which must not be opened.

Use of a Voltmeter in Diagnostic Procedures

The ECM powers various sensors and switches with either 5 or 12 volts derived via resistances in the ECM which are so high in value that a test light will not function when connected to the circuit. In some cases even conventional voltmeters will not give an accurate reading because the meter resistance is too low, and the current used by the meter itself is significant enough to affect the characteristics of the circuit being measured. It is therefore essential to use a 10 megohm input impedance digital voltmeter to ensure accurate voltage readings are obtained.

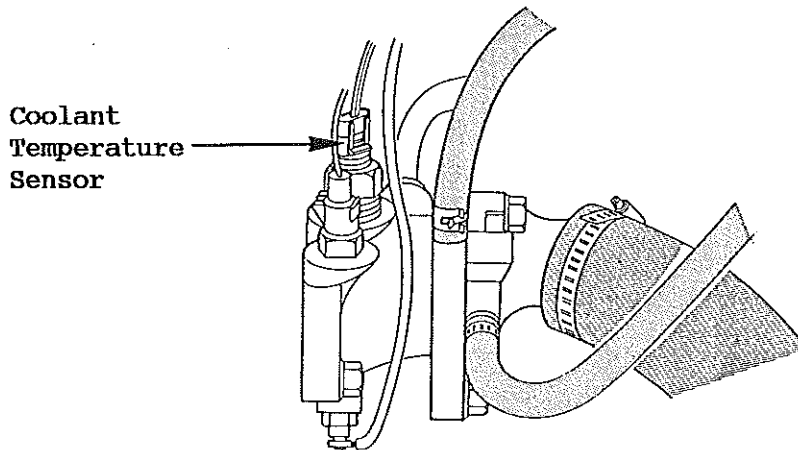
EML.2 - B ENGINE COOLANT TEMPERATURE SENSOR

The ECM 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.

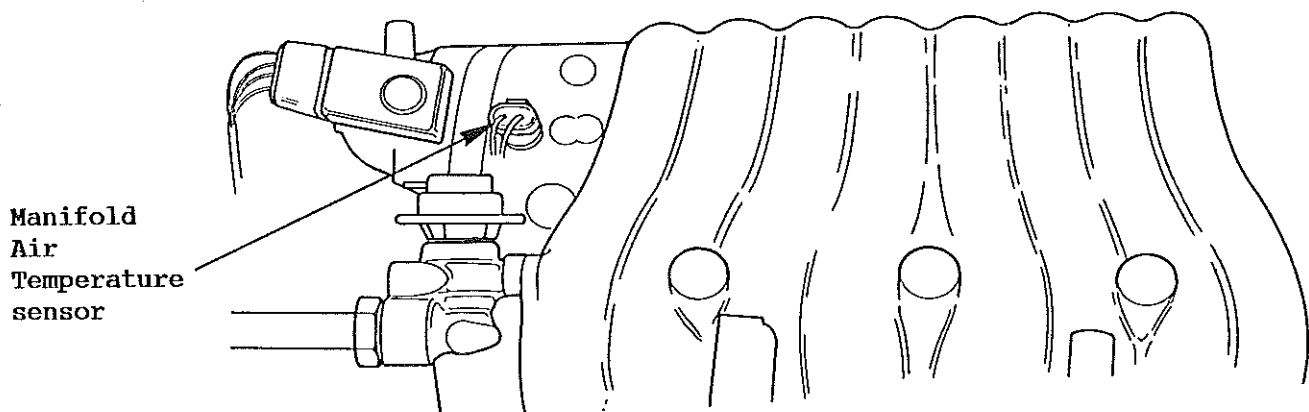
The sensor is a thermistor (a resistor which changes value with temperature) mounted in the thermostat housing (LH end face of cylinder head). Low coolant temperature produces a high resistance (100,000 ohms at minus 40°C) while high temperature causes low resistance (70 ohms at 130°C).



The ECM supplies a 5 volt signal to the coolant temperature sensor through a resistor in the ECM and monitors the terminal voltage. Since this forms a series circuit to ground through the coolant sensor, high sensor resistance (low temperature) will result in high ECM terminal voltage. When the coolant sensor's resistance is low (high temperature), the terminal voltage will be drawn lower. This terminal voltage indicates engine coolant temperature to the ECM.

EML.2 - C MASS AIR TEMPERATURE (MAT) SENSOR

The Mass Air Temperature (MAT) sensor is fitted into the inlet of the intake plenum chamber. The ECM uses the signal from this sensor in conjunction with others to calculate air density and the appropriate fuel delivery for both starting and running.



The mass air temperature sensor is a thermistor (a resistor which changes value with temperature) similar to the coolant temperature sensor. Low temperature produces a high resistance (100,000 ohms at minus 40°C) while high temperature causes low resistance (185 ohms at 100°C). The ECM supplies a 5 volt reference signal to the MAT sensor, and by measuring the sensor output voltage is able to calculate the sensor resistance, and thereby the plenum air temperature.

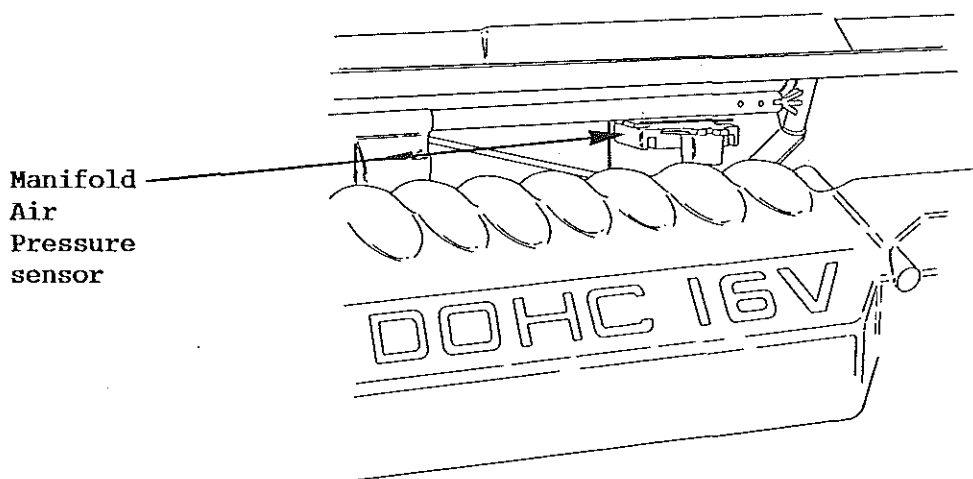
Low air temperature produces a high sensor resistance for a higher fuel requirement.

EML.2 - D MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR

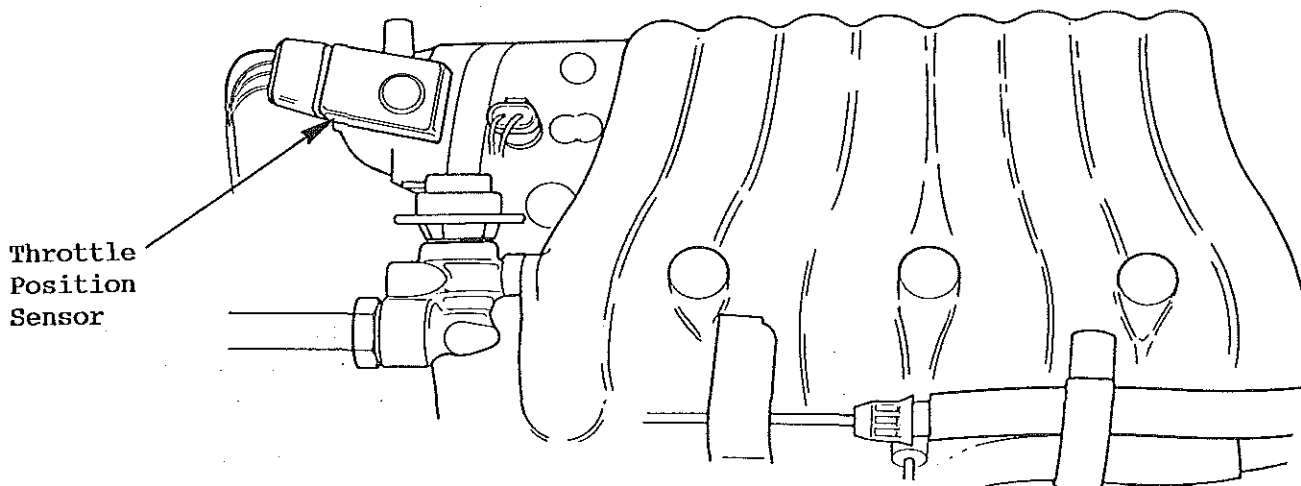
The MAP sensor is mounted at the centre top of the front bulkhead and is connected by hose to the right hand end of the intake plenum chamber. The ECM uses an inlet manifold pressure signal to help interpret engine operating conditions and fuel requirements. The MAP sensor is also used to provide a barometric pressure signal to the ECM at the instant of ignition switch on and off. This allows the ECM to automatically adjust fuel delivery to compensate for the variation in pressure that occurs at different altitudes.

Note that manifold absolute pressure is the OPPOSITE of manifold vacuum. For example, a closed throttle on engine overrun would produce a low manifold absolute pressure (high vacuum) signal. The ECM sends a 5 volt reference signal to the MAP sensor, and by measuring the sensor output voltage is able to calculate manifold pressure.

High manifold pressure produces a high sensor resistance for a higher fuel requirement. If the MAP sensor fails, the ECM will substitute a value and use the throttle position sensor and other sensors to control fuel delivery.

EML.2 - E THROTTLE POSITION SENSOR (TPS)

The throttle position sensor is a potentiometer fitted to the end of the primary throttle spindle on the intake plenum chamber. The ECM supplies 5 volts to the sensor and by monitoring the voltage on a returning signal line, the ECM is able to determine throttle position and calculate the fuel requirement.





With the throttle closed, the TPS output is low (typically 0.5 volt), but increases as the throttle is opened until at wide open throttle, output voltage is typically 4.0 volts. This signal is used by the ECM for fuel control and for many of the ECM controlled outputs. If a fault is detected and a trouble code set, the ECM will substitute an artificial default value for the TPS signal to enable the vehicle to 'limp home'. This mode may result in a high idle speed.

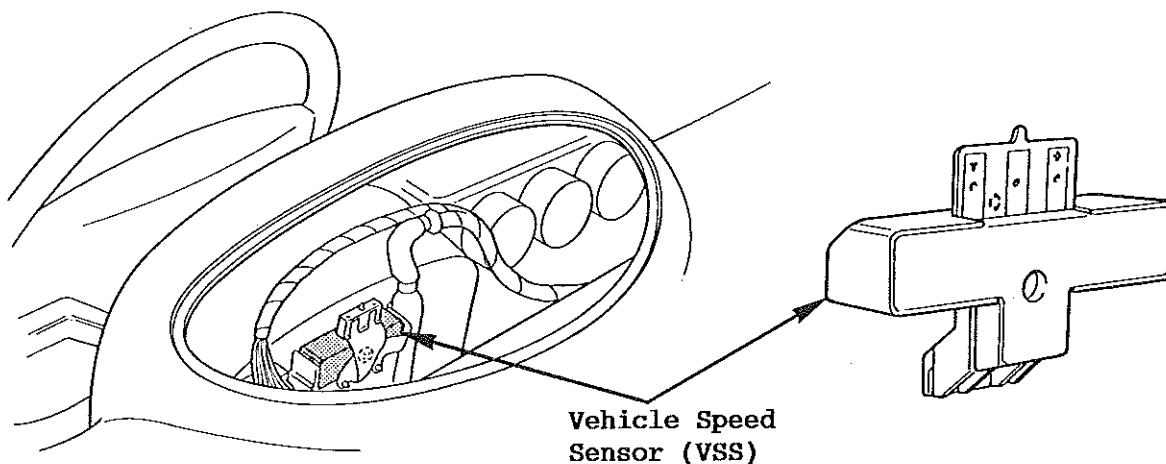
EML.2 - F AIR CONDITIONING CONTROL (not fitted 1990 M.Y.)

When the air conditioning is switched on, the ECM receives the signal from the thermistor control unit requesting operation of the compressor. Before energising the a/c compressor, the ECM first amends the idle speed setting via the idle air control valve to compensate for the extra loading on the engine. The radiator fans (2 off) are energised to cool the condenser whenever the compressor is operating.

Some engine operating conditions will override the a/c request signal and switch off the air conditioning. These include: wide open throttle to make available full engine power; high vehicle speed to increase engine cooling system margins; abnormally high engine coolant temperature to help prevent overheating.

EML.2 - G VEHICLE SPEED SENSOR (VSS)

Vehicle speed information is supplied to the ECM by the vehicle speed sensor which is an optical pulse generator incorporated into the back of the speedometer head. The generator produces a square wave DC output whenever the vehicle speed is over about 2 km/h (1 mph) and which increases in frequency with increasing vehicle speed.

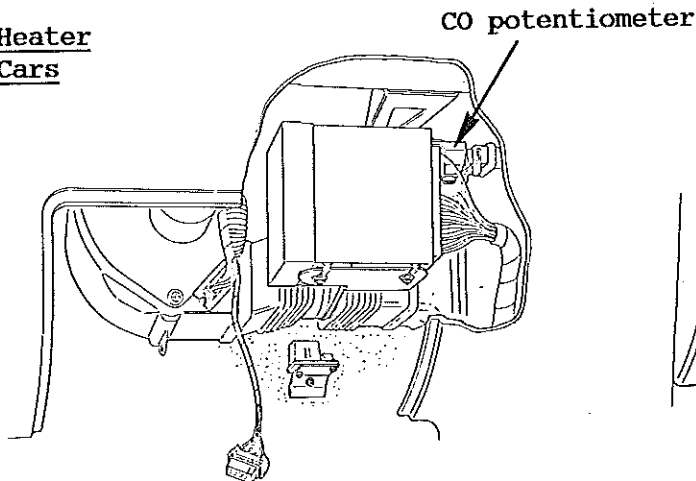
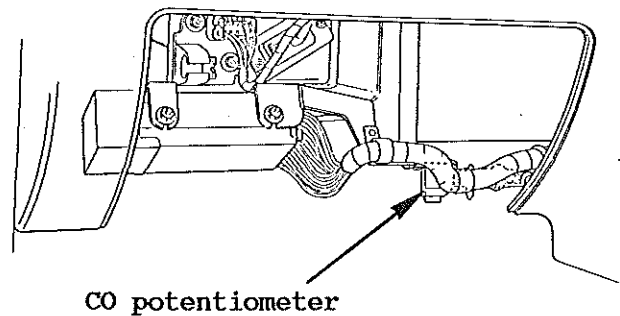


This information is used by the ECM in its control of the air conditioning, idle air control valve and exhaust gas recirculation.

EML.2 - H CO POTENTIOMETER

The CO potentiometer is a variable resistor, the adjustment of which controls the base setting of the air/fuel ratio. This setting is made when the engine is idling at normal running temperature, to achieve a specified tailpipe CO level.

The potentiometer is located on the ECM mounting bracket (heater cars, accessed with a long screwdriver), or on the underside of the evaporator housing

Heater
CarsA/C Cars

(a/c cars). The potentiometer is adjusted as detailed in section EML.3 - E.

EML.2 - I FUEL CONTROL SYSTEM

Fuel is stored in a single fuel tank ahead of the left hand rear wheel arch. A submerged electric pump within the tank pumps fuel through an in line filter located adjacent to the tank, to a fuel rail with pressure regulator. The amount of fuel supplied to the fuel rail is over and above that required by the injectors at maximum demand, with the pressure regulator returning the extra fuel back into the tank.

The fuel rail connects with the four solenoid injectors fitted in the lower inlet manifold. The ECM pulses all four injectors simultaneously, once every engine revolution, with half of the fuel necessary for each cylinder's combustion being delivered by each injector pulse. The single injector driver circuit uses a 'peak and hold' method to open the injectors rapidly with a high voltage, which is then dropped to a lower value by a resistor module to hold the injectors open for the remainder of the pulse width. The dropping resistor is mounted on the ignition coil baseplate (heatsink) at the left hand side of the engine bay.

Modes of Operation

The ECM uses voltage inputs from several sensors to determine how much fuel to deliver to the engine. The fuel may be delivered in any one of several different 'modes' with the ECM controlling which mode is appropriate according to the readings it receives from the sensors at that particular time.

Starting Mode

When the ignition is first turned on, the ECM turns on the fuel pump relay for two seconds to pressurise the system ready for starting. The ECM also checks the coolant temperature sensor and throttle position sensor readings and determines the appropriate air/fuel ratio for starting. This ranges from approximately 0.8:1 at minus 40°C to 16.8:1 at 104°C engine coolant temperature.

The ECM controls the quantity of fuel delivered by changing the injector 'pulse width' i.e. length of time the injector is energised and opened.

Clear Flood Mode

Provision is made for clearing a flooded engine as follows:

If the throttle is held fully open and the engine cranked, the ECM will set a lean air/fuel ratio for as long as engine speed is below approximately 600 rpm. If throttle opening becomes less than 70% the ECM returns to the starting mode.



Run Mode

Above 600 rpm, the ECM switches to 'run mode', with the amount of fuel supplied dependent on signals received by various sensors.

Acceleration Mode

The ECM responds to rapid changes in throttle position and manifold absolute pressure and provides extra fuel.

Deceleration Mode

The ECM responds to changes in throttle position and manifold pressure and reduces the amount of fuel. When deceleration is very rapid, the ECM can cut off fuel completely for short periods.

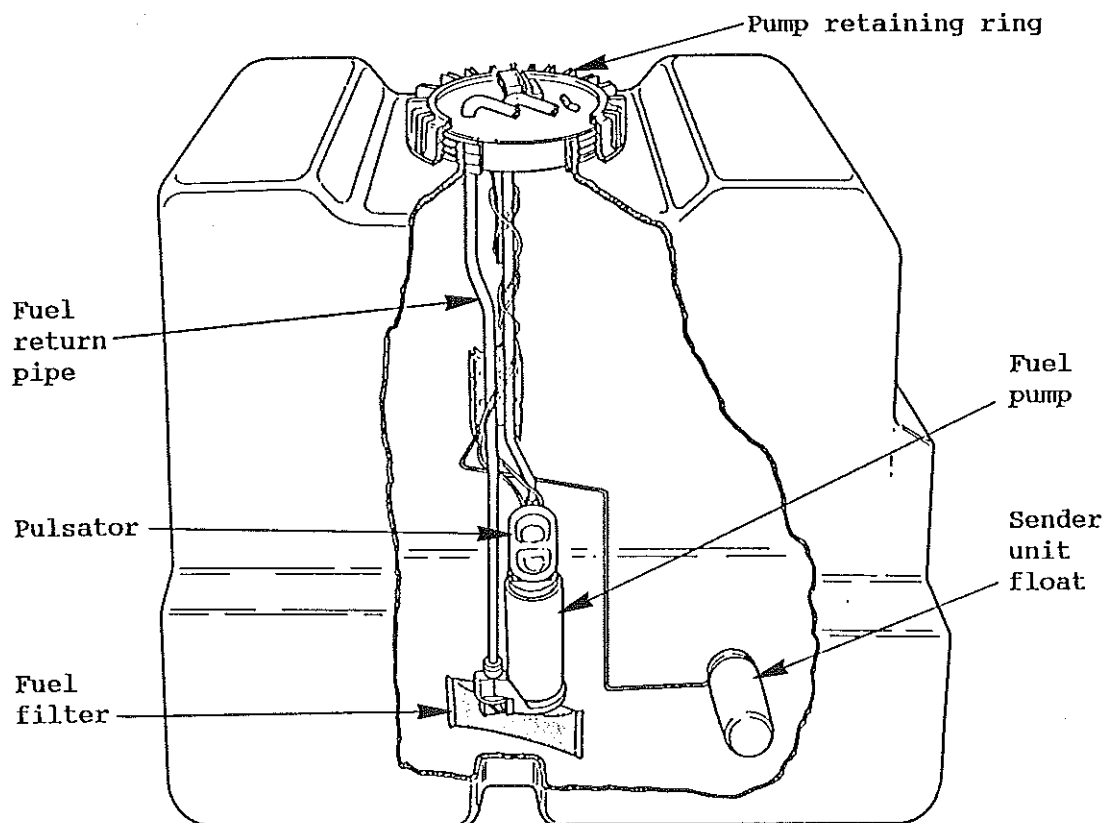
Battery Voltage Correction Mode

If the ECM senses a battery voltage low enough to affect the correct operation of ignition and fuel systems, compensating amendments are made to various functions to permit near normal operation, until normal voltage is again sensed.

Fuel Cut-Off Mode

In order to prevent dieseling when the engine is switched off, the ECM turns off the injectors together with the ignition. Also, no fuel is delivered unless the ECM receives a reference pulse from the distributor, which means that the engine is either cranking or running. This prevents flooding of a stalled engine. To protect the engine from over-revving, the ECM shuts off the injectors if an engine speed of 7,700 rpm is exceeded.

EML.2 - J FUEL PUMP





The fuel pump is a roller vane type, high pressure electric pump mounted submerged within the fuel tank. The pump supplies fuel at a pressure of 211 - 379 kPa (30.5 - 55 psi) dependent on operating conditions, through an in line filter located adjacent to the tank (accessible via a removeable panel in the hood stowage compartment) to the fuel rail assembly. A fuel strainer is attached to the fuel pump inlet line and prevents dirt particles from entering the fuel line and tends to separate water from the fuel. A pulsator is fitted above the fuel pump and is connected to its outlet line to reduce pressure pulsations in the supply line. The whole assembly of pump, strainer and pulsator is fixed by the supply and return pipes, to a mounting plate secured by cam ring to the top face of the tank.

The pump is able to deliver 4 - 5 times the engine's maximum requirement, so that fuel is constantly circulated through the in-line fuel filter, fuel rail, and via the fuel pressure regulator, back to the tank. This fuel circulation helps avoid excessive fuel temperature with the consequent risk of vapour locks.

When the ignition is switched on, the ECM energises the fuel pump which will continue to run for as long as the ECM receives ignition pulses from the ignition module (engine cranking or running). If no ignition pulses are received, the ECM switches off the pump either 2 seconds (approx) after the ignition was switched on, or about 10 seconds after a stall.

EML.2 - K FUEL RAIL & PRESSURE REGULATOR

The extruded aluminium fuel rail receives fuel at its left hand end (from the in-line filter) and supplies all four injectors with fuel, the pressure of which is controlled by the fuel pressure regulator fitted to the right hand end of the rail.

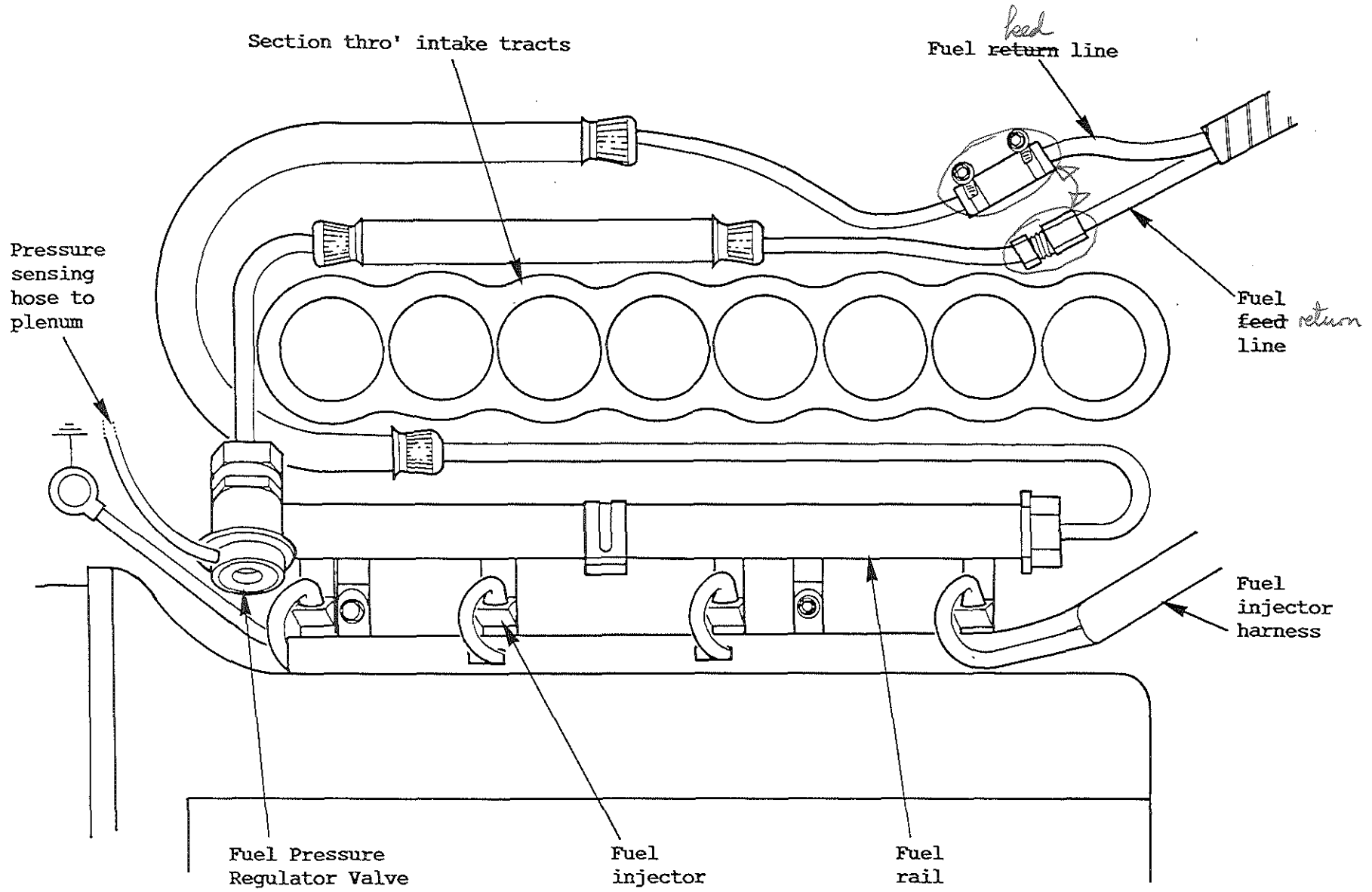
The pressure regulator assembly is a diaphragm operated relief valve with fuel pump pressure acting on one side of the diaphragm, and regulator spring pressure and intake manifold pressure on the other. The function of the regulator is to maintain a constant pressure differential across the injectors at all times. i.e. a constant difference between fuel pressure supplied to the injector, and inlet manifold pressure at the injector nozzle. By using an inlet manifold pressure signal to supplement regulator spring pressure in the valve, the valve is able to regulate fuel supply pressure in accordance with engine load.

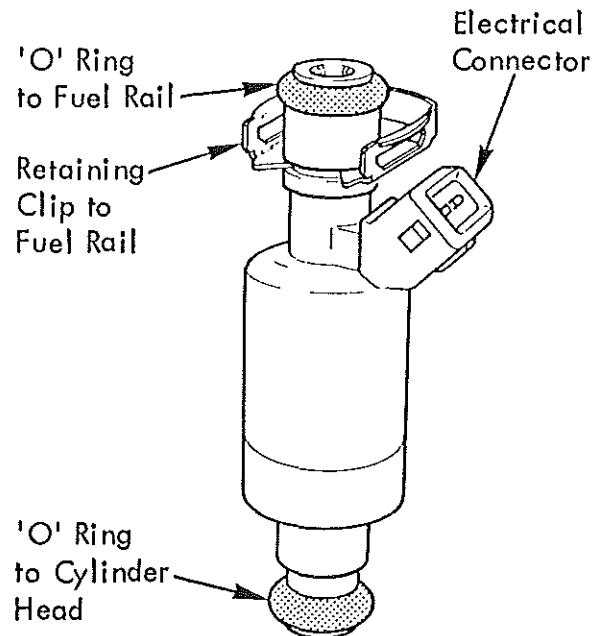
The pressure regulator is not adjustable and is serviced as a complete assembly.

EML.2 - L FUEL INJECTORS

The port fuel injector assembly is a solenoid-operated device, controlled by the electronic control module (ECM), that meters pressurized fuel to a single engine cylinder. The ECM energizes the low impedance (2.0 ohms) solenoid to open a normally closed ball valve. This allows fuel to flow into the top of the injector, past the ball valve, and through a recessed flow director plate at the injector outlet. The director plate has six machined holes that control the fuel flow, generating a conical spray pattern of finely atomized fuel at the injector tip. Fuel from the tip is directed at the intake valve, causing it to become further atomised and vapourised before entering the combustion chamber.

The ECM uses a single injector driver circuit, controlling all four injectors. The injectors are pulsed simultaneously once every crankshaft revolution, with half of the fuel necessary for each cylinders combustion delivered by each injector pulse.

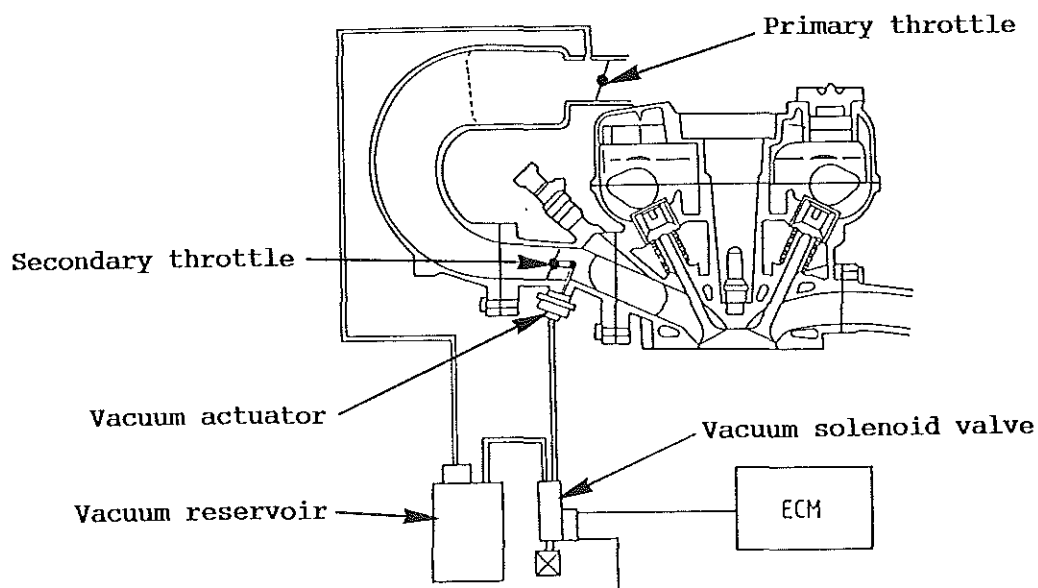




The ECM receives an engine speed and crankshaft position signal twice per engine revolution from the ignition module, and uses these to trigger the injector timing sequence.

EML.2 - M INTAKE SYSTEM

The intake system incorporates a water heated throttle body containing a primary throttle valve; a plenum chamber integral with eight individual intake tracts; and a lower intake manifold feeding the four bifurcated cylinder head ports. The lower intake manifold contains a fuel injector for each of the four ports and a secondary throttle valve controlling one of the two tracts for each cylinder. These secondary throttle valves are operated by a single vacuum actuator whose vacuum supply is controlled by a vacuum switching solenoid. At engine speeds below 5,200 rpm, the ECM energises the solenoid valve and supplies

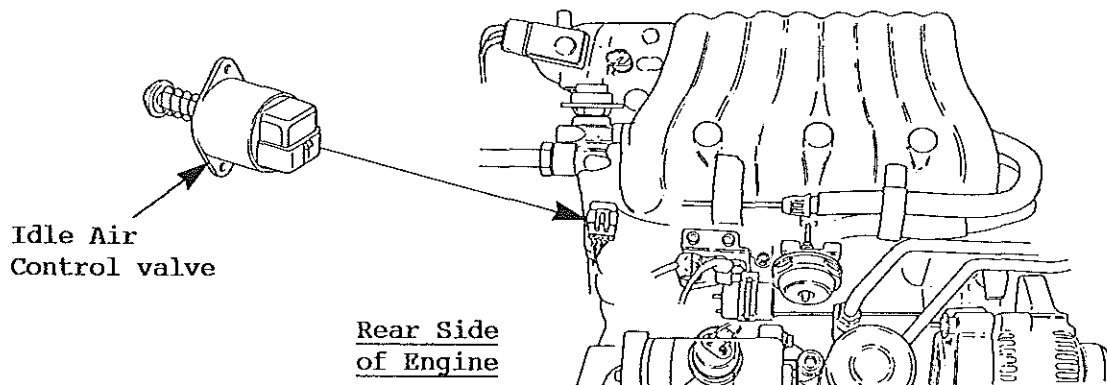




vacuum to the actuator, which closes the secondary throttles against spring pressure. At higher engine speeds, the solenoid is de-energised and vents the actuator capsule to atmosphere, allowing the throttles to spring open. By this means, the intake air column inertia effects are tuned both for low speed driveability and idle quality, and also for efficiency at high engine speed. To reduce drain on the battery, the solenoid valve is de-energised with ignition on and engine stopped.

EML.2 - N IDLE AIR CONTROL (IAC) VALVE

The purpose of the idle air control valve (IAC) valve assembly, is to control engine idle speed, and prevent stalls due to changes in engine load. The IAC valve is mounted on the left hand end of the lower intake manifold, and controls an airway between the upstream side of the primary throttle body (to which it is connected by hose), and an air rail on the secondary intake manifold. This air rail runs beneath the manifold and connects with each of the four intake ports. By moving a conical valve (called a pintle) towards the orifice (to decrease air flow) or away from the orifice (to increase air flow), a controlled amount of air is allowed to by-pass the throttle plate. If rpm is too low, more air is bypassed around the throttle valve to increase rpm. If rpm is too high, less air is bypassed to decrease rpm. In order to aid starting, the valve is opened during engine cranking to an extent governed by the coolant temperature sensor. The colder the coolant, the greater the valve opening.



The electronic control module (ECM) moves the IAC valve in small steps called "Counts". These can be measured by the 'Tech 1' scanner tool.

During idle, the proper position of the IAC valve is calculated by the ECM, based on battery voltage, coolant temperature, engine load, and engine rpm. If the rpm drops below specification, and the throttle valve is closed, the ECM senses a near stall condition and calculates a new valve position to prevent stalls. In this way, the ECM "learns" the proper positioning of the IAC valve and retains this information in memory. If the battery, or the power supply to the ECM is disconnected, this part of the ECM memory will be cleared, and idle quality may be degraded slightly until the correct setting is relearned.

Each time the ignition is switched off, the ECM fully extends the IAC pintle to the fully seated position, which it then uses to reset the position count at '0', before retracting to the 80 count 'park' position. Always allow 10 seconds for this process to occur before disconnecting the battery.

If the IAC valve or battery is disconnected before this sequence is completed (or whilst the engine is running), the ECM will assume, on reconnection, that the IAC valve is at 80 counts, and will take time to learn the correct position. To overcome this, after the battery or IAC is reconnected, the ignition should be



switched on and then off again for ten seconds. This will allow the IAC to be reset, as described above, before switching on again and starting the engine.

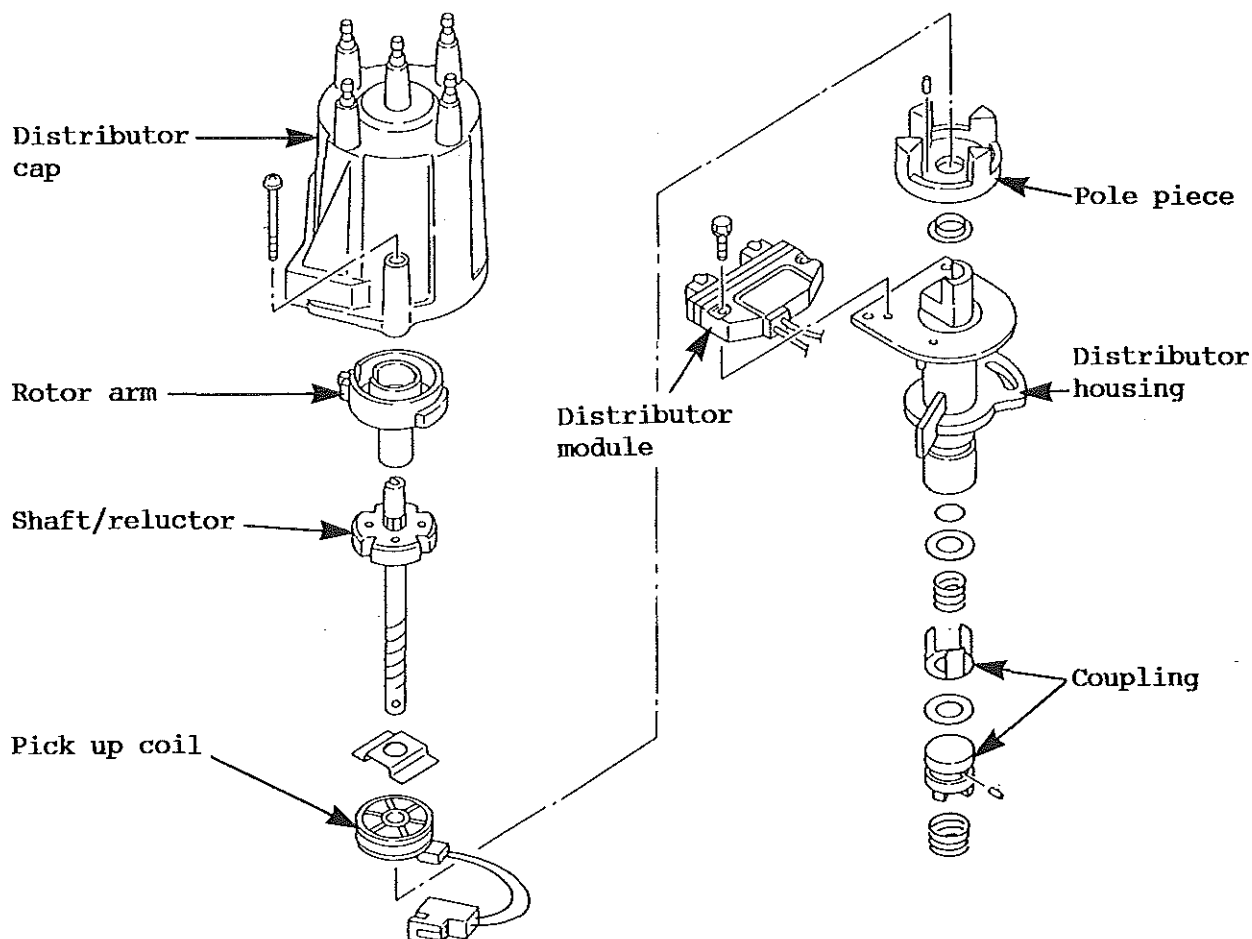
As an additional aid to IAC control, when the engine is first started after a power supply interruption, (which clears the memory), the ECM will carry out an IAC reset when the car is driven above 30 mph on a light throttle, by extending the pintle to the fully seated position for a moment to establish the zero count position. This process, which occurs only once after each power supply re-connection, will not be noticed by the driver, and is designed to regain proper IAC control if the recommended reset procedure is not carried out before starting the engine.

EML.2 - 0 HIGH ENERGY IGNITION (HEI)

The High Energy Ignition system fitted on naturally aspirated engines, uses a distributor unit driven off the left hand end of the exhaust camshaft, an ignition coil mounted at the left hand side of the engine bay, and control circuitry within the E.C.M..

Distributor

A four position reluctor, pick up coil and module in the distributor, provide the E.C.M. with rpm and crankshaft position information which it uses to control ignition and fuel injector pulse timing. At engine speeds below 800 rpm, (i.e. cranking) the distributor module triggers the ignition coil and controls ignition timing based on rpm data alone. This is called 'module mode'. At engine speeds above 800 rpm, the E.C.M. takes over control of electronic spark timing ('EST mode') and commands when the module is to trigger the ignition coil. The distributor body may be rotated to adjust the basic timing position. If this is





set incorrectly, the whole ignition advance curve will be incorrect, in both module and EST modes.

Secondary current is received from the ignition coil by the distributor, which uses a rotor and distributor cap to supply the appropriate spark plug.

Electronic Spark Timing (EST)

The electronic spark timing function is incorporated into the ECM 'Mem-Cal' cartridge. The ignition module sends a square wave signal, generated from the camshaft sensor pulses, to the ECM which interprets engine speed and crankshaft position. When engine speed exceeds 800 rpm, the ECM applies a 5 volt signal to the module which then switches spark timing from the module to the ECM. In this mode the ECM uses various sensor inputs to determine the optimum ignition timing, and sends a square wave signal to the ignition module which then triggers the ignition coil.

Parameters used for EST are:

- crankshaft position
- engine speed
- engine load (MAP)
- atmospheric pressure
- coolant temperature

As a back up 'get you home' feature, if some faults in the EST circuit should develop causing a stall, the engine can be restarted, and will continue to operate in module mode timing, with reduced performance and fuel economy.

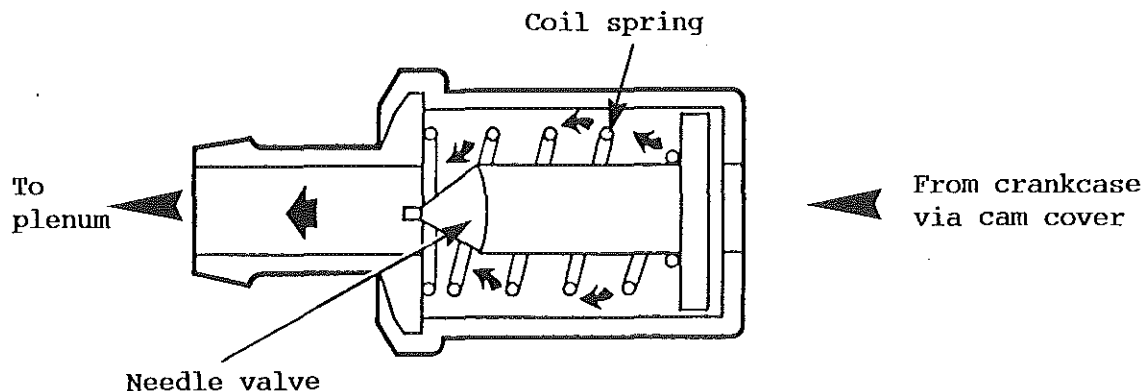
EML.2 - P POSITIVE CRANKCASE VENTILATION

A positive crankcase ventilation (PCV) system is used to provide complete scavenging of the crankcase vapours. Fresh air from the air cleaner is supplied to the crankcase, where it mixes with blow-by gases, before being drawn into the intake plenum chamber to be consumed by normal combustion.

The system comprises of a PCV valve fitted into the right hand end of the camshaft cover, and connected to the intake plenum chamber, and a hose connecting the left hand end of the cam cover to the air intake trunking.

PCV Valve

The PCV valve is a spring loaded needle-type valve pressed into the right hand end of the camshaft cover. A hose connects the valve with the right hand end of the intake plenum chamber. When the engine is stopped, the spring acts to keep the valve closed and prevent any oil/air mixture entering the plenum and causing difficulty in starting. With the engine running, the negative pressure

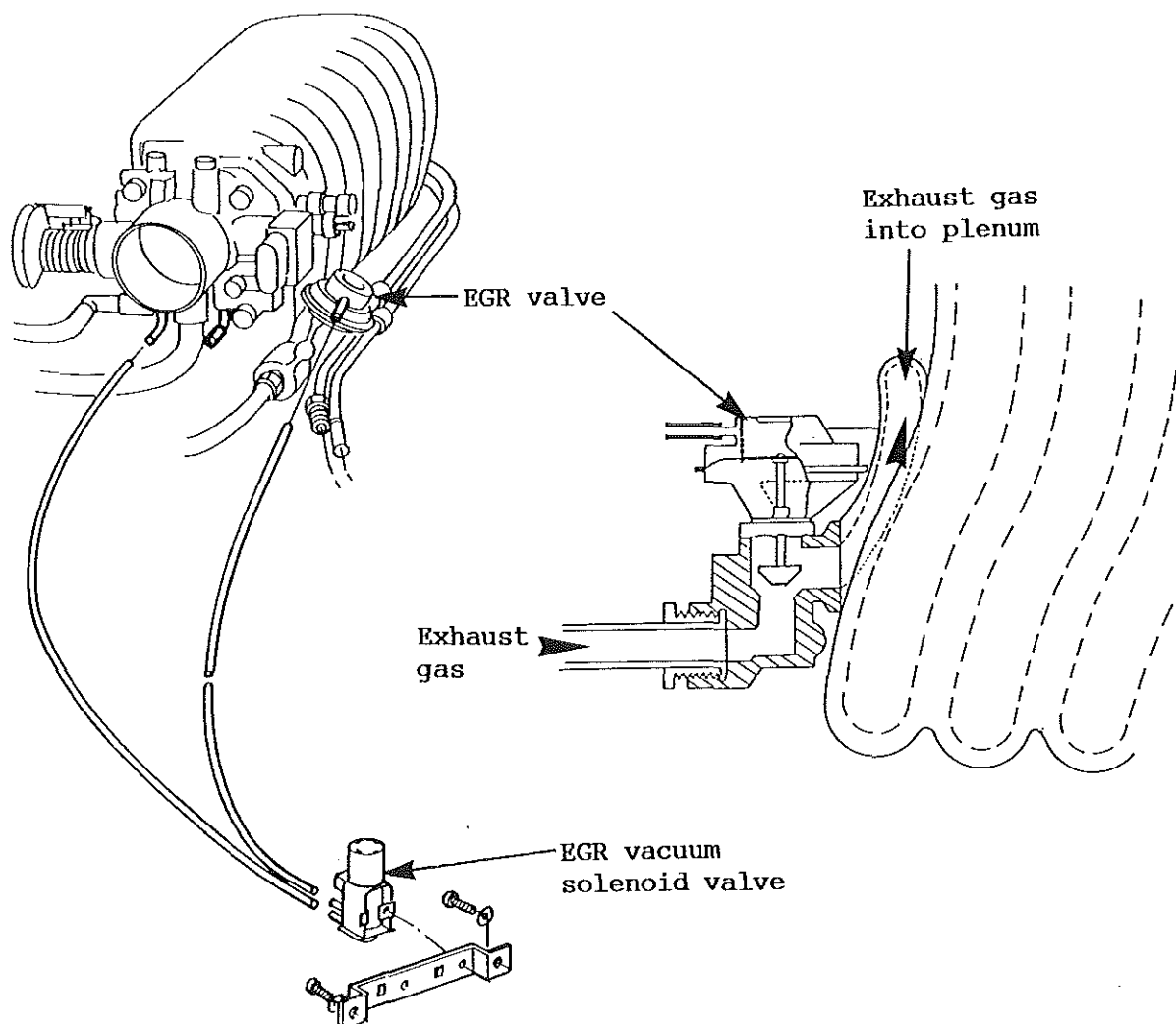




in the intake plenum opens the valve and draws blow-by gases into the engine. At idle, when intake vacuum is high, the needle valve restricts the flow of gases to maintain idle quality. As the throttle opening is increased, and intake plenum vacuum decreases, the needle valve allows a greater degree of purging to take place, with fresh air being drawn into the engine via the hose linking the left hand end of the cam housing, with the intake trunking downstream of the air filter.

EML.2 - Q EXHAUST GAS RECIRCULATION

The exhaust gas recirculation (EGR) system is used to lower NOx (nitrous oxide) levels caused by high combustion temperatures. A vacuum operated diaphragm valve is used to feed small amounts of exhaust gas back into the intake plenum chamber in order to reduce combustion temperature. Too much recirculation would result in poor combustion.



The EGR valve is mounted on the left hand end of the intake plenum chamber, and controls the flow of exhaust gas in a pipe connecting the exhaust manifold with the plenum. The diaphragm valve is normally held closed by spring pressure, and is opened by the application of vacuum to the top of the diaphragm. The vacuum line is controlled by a solenoid valve (mounted on the left hand



wheelarch), itself switched by the E.C.M.. The E.C.M. energises (opens) the solenoid valve, to permit the throttle edge ported vacuum signal to be applied to the E.G.R. valve and allow exhaust gas to recirculate, under the following conditions:

- above a specified coolant temperature
- throttle opening above idle
- engine speed above idle
- MAP indicating engine under load
- above a certain vehicle speed
- above a certain manifold air temperature (MAT)

SECTION EML.3COMPONENT DIAGNOSIS & REPLACEMENT PROCEDURE

	<u>Sub-Section</u>	<u>Page</u>
Electronic Control Module (ECM)	EML.3 - A	2
Engine Coolant Temperature Sensor (CTS)	EML.3 - B	3
Mass Air Temperature (MAT) Sensor	EML.3 - C	3
Manifold Absolute Pressure (MAP) Sensor	EML.3 - D	4
CO Potentiometer	EML.3 - E	6
Throttle Position Sensor (TPS)	EML.3 - F	7
Vehicle Speed Sensor (VSS)	EML.3 - G	7
Fuel Control System	EML.3 - H	8
Fuel Pump	EML.3 - I	9
Fuel Rail, Pressure Regulator and Injectors	EML.3 - J	11
Secondary Throttle Valve Control	EML.3 - K	14
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Positive Crankcase Ventilation (PCV)	EML.3 - N	22
Exhaust Gas Recirculation (EGR)	EML.3 - O	22
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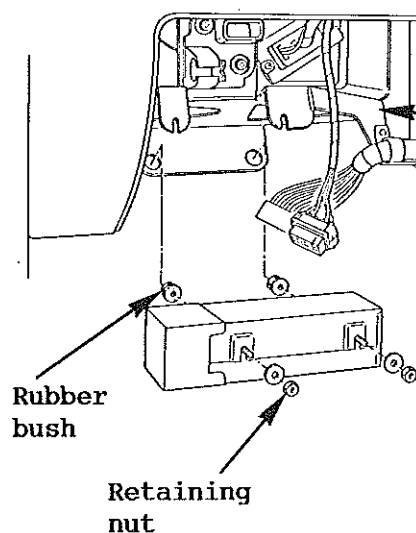
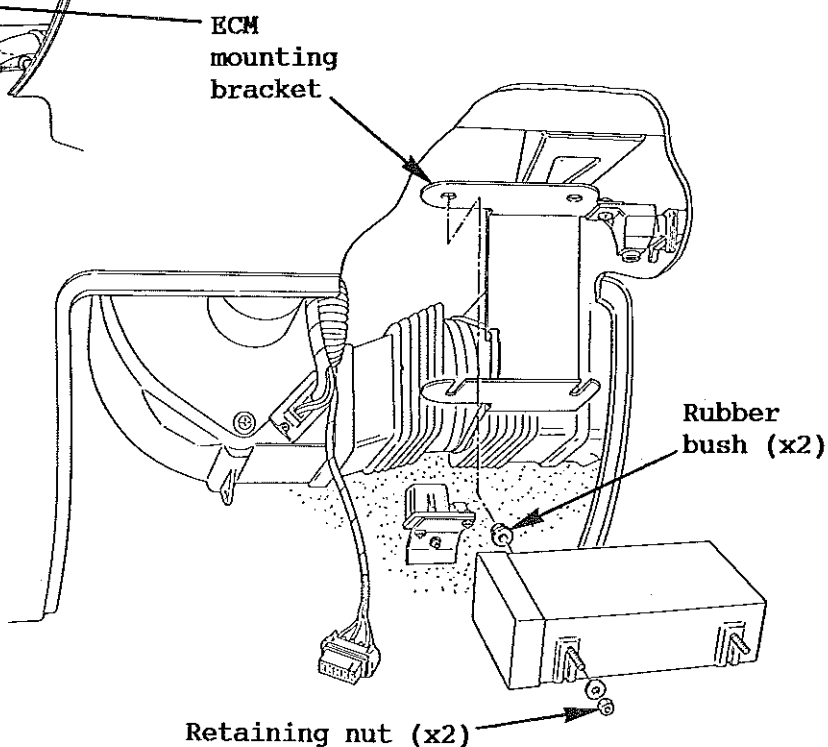
EML.3 - A ELECTRONIC CONTROL MODULE

If the diagnostic procedures call for the Electronic Control Module (ECM) to be replaced, first check that the correct ECM/Mem-Cal assembly is fitted by using the 'Tech 1' tool to check the PROM ID. On the Lotus Elan, the ECM is serviced only as a complete assembly, including the Mem-Cal cartridge. The Mem-Cal is not serviced as a separate item, but only as part of the sealed ECM assembly. The Mem-Cal access cover on the ECM is sealed at the factory, and if the seal is broken, the engine warranty is invalidated.

Caution: To prevent internal ECM damage, the ignition must be "OFF" when disconnecting or reconnecting power to ECM (for example, battery cable, ECM pigtail, ECM fuse, jumper cables, etc.). The ignition should be "OFF" for at least 10 seconds before disconnecting power to the ECM so the IAC valve has time to move to engine "OFF" position.

Replacement of ECM/'Mem-Cal' Assembly

1. Ensure ignition is switched off for at least 10 seconds before disconnecting negative battery lead.
2. Remove the glovebox pivot pins and the glovebox for improved access.
3. Unplug the connector block from the ECM, release the two retaining nuts, lower the rear edge, and withdraw the unit from the mounting bracket.
4. Locate the studs on the new ECM into the rubber bushes, and secure in the

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mounting bracket with the two nuts. Fit the harness connector block, and reconnect the battery.

Functional Check

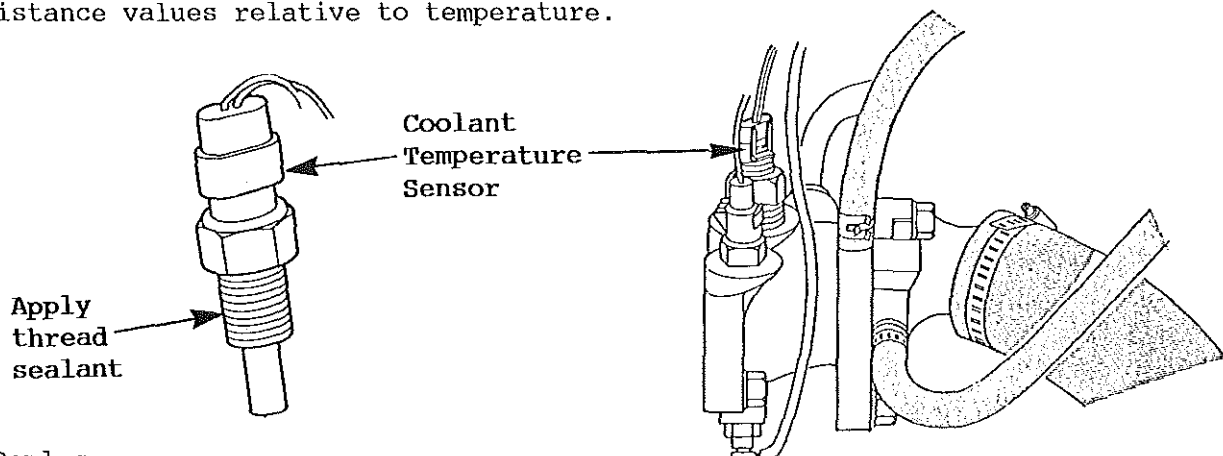
Turn on ignition and enter diagnostics. Code 12 should flash at least 3 times (if no other codes are present). This indicates that the ECM/Mem-Cal assembly is installed and functioning correctly.

If trouble code 51 is displayed, or if the 'check engine' light comes on constantly with no codes, the ECM should be considered defective and replaced.

EML.3 - B ENGINE COOLANT TEMPERATURE SENSOR

The coolant temperature sensor is fitted in the thermostat housing on the left hand end face of the cylinder head.

A 'Tech 1' scanner tool displays the engine temperature in degrees Celsius. After the engine is started, the temperature should rise steadily to about 82°C then stabilise when the thermostat opens. If the engine has not been run for several hours (overnight) the coolant temperature and MAT temperatures should be close to each other. A fault in the coolant sensor circuit should set a Code 14 or 15. The code charts in section EML.4 also contain a chart to check for sensor resistance values relative to temperature.



To Replace

Drain sufficient coolant to empty the thermostat housing, release the electrical connector and unscrew from the housing.

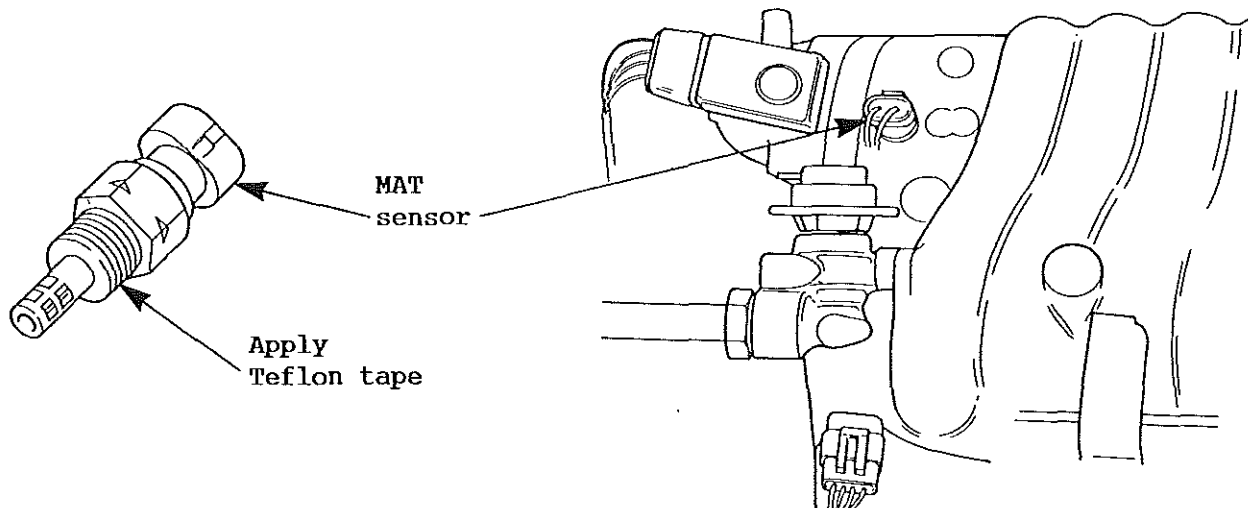
Note: Take care when handling the sensor as any damage may seriously affect the operation of the engine management system.

Before refitting a sensor, apply thread sealant to the thread, (pre-applied on a new sensor) carefully fit into the thermostat housing, and torque tighten to 20 Nm (15 lbf.ft). Refit electrical connector and refill with the approved coolant mixture.

EML.3 - C MASS AIR TEMPERATURE (MAT) SENSOR

The MAT sensor is fitted into the inlet of the intake plenum chamber.

A 'Tech 1' scanner tool displays the temperature of the air entering the engine, which should be close to ambient air temperature when engine is cold, and rise as engine bay temperature increases. If the engine has not been run for several hours (overnight), the readout of MAT sensor temperature and coolant temperature should be close to each other. A failure in the MAT sensor circuit should set a Code 23 or 25. The code charts in section EML.4 also contain a chart to check for sensor resistance values relative to temperature.



To Replace

Unplug the electrical connection and unscrew the sensor from the plenum chamber.

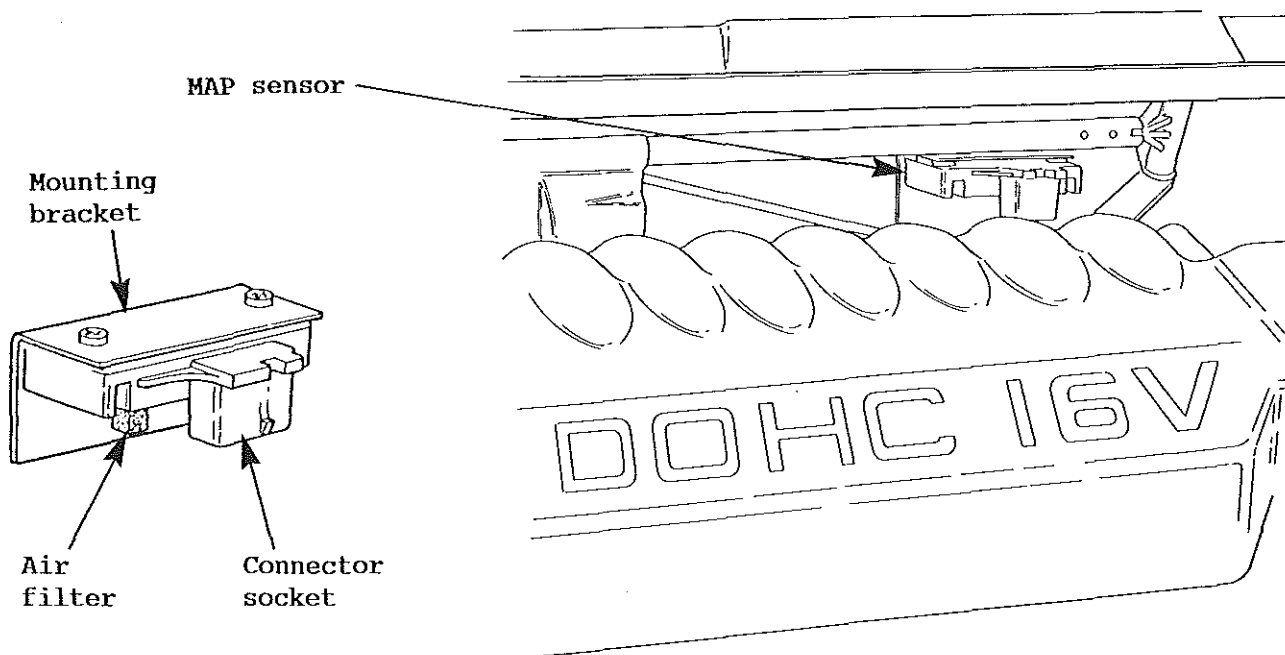
On re-fitting, apply $1\frac{1}{2}$ turns of teflon tape *or a liquid thread sealant* to the threads of the sensor, and torque tighten to 20 Nm (15 lbf.ft).

EML.3 - D MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR

The MAP sensor is fitted in the engine bay at the centre top of the cabin front bulkhead, beneath the windscreen landing.

A 'Tech 1' scanner tool displays manifold pressure in kPa and MAP sensor signal voltage. Low pressure (high vacuum) displays a low voltage while a high pressure (low vacuum) displays a high voltage. A failure in the MAP sensor circuit should set a Code 33 or 34 and using the applicable trouble code chart (section EML.4) will lead to the cause of the problem. A Code 33 may be set if a rough or unstable idle exists.

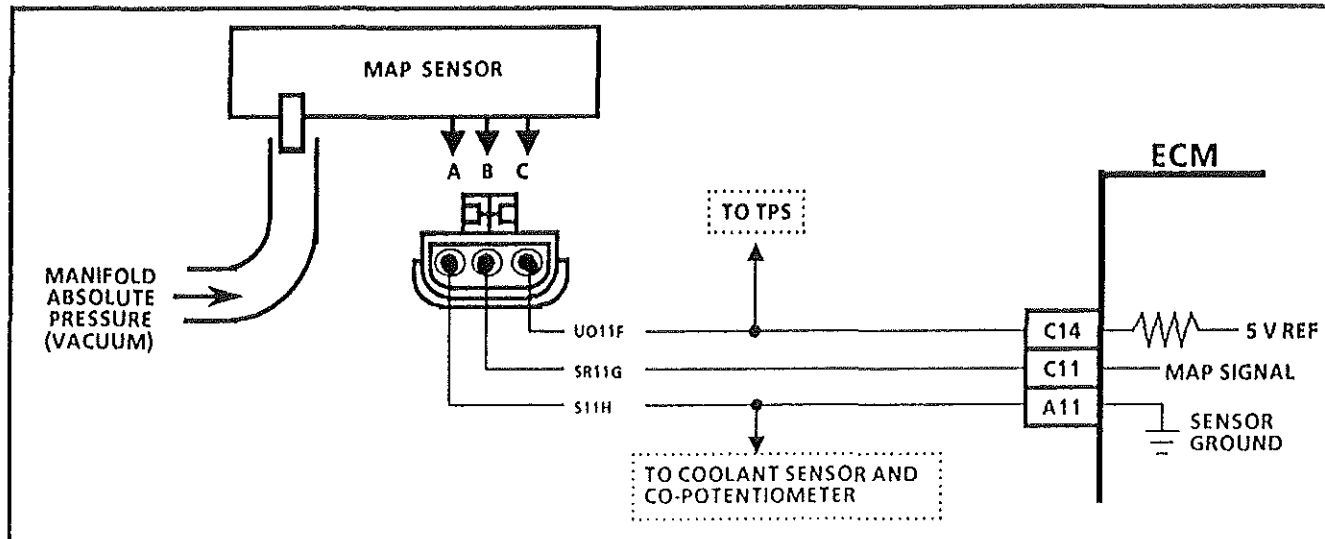
For access to the MAP sensor, release the two screws securing the mounting plate to the front bulkhead, and withdraw. Disconnect the electrical and pressure hose connections.



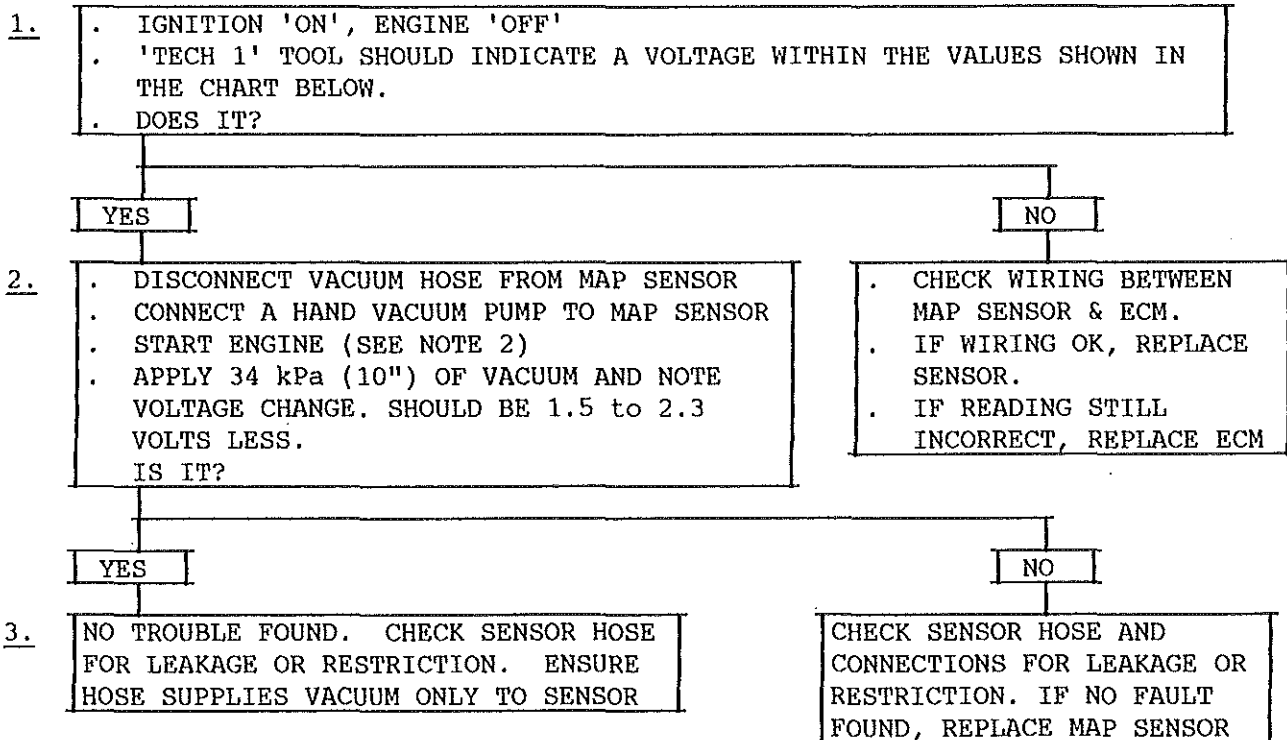


Circuit Description

The MAP sensor is a solid state sensor which is provided with a 5 volt reference source and an earth, and produces an output signal voltage to indicate intake manifold pressure.



Diagnostic Chart - MAP



Vacuum (kPa)

0
20
40
60

Output Voltage

2.3 to 2.5
1.6 to 1.8
1.2 to 1.4
0.7 to 0.9

Clear codes, confirm closed loop operation and no check engine light.



Test Description

Numbers below refer to underlined numbers on the diagnostic chart.

1. Checks MAP sensor output voltage to the ECM. This voltage, without engine running, represents barometer reading to the ECM. Comparison of this BARO reading with a known good vehicle with the same sensor may identify a faulty MAP sensor. Readings should be within ± 0.4 volts.
2. Applying 34 kPa (10" Hg) vacuum to the sensor should cause MAP output to be 1.2 volts less than in Step 1. Upon applying vacuum to the sensor, the change in voltage should be instantaneous. A slow voltage change indicates a faulty sensor.

NOTE: The engine must be running in this step or the 'Tech 1' will not indicate a change in voltage. It is normal for the Check Engine light to come on and for the system to set a Code 33 during this step. Make sure the code is cleared when this test is completed.

3. Check vacuum hose to sensor for leaking or restriction. Ensure no other vacuum devices are connected to the MAP sensor.

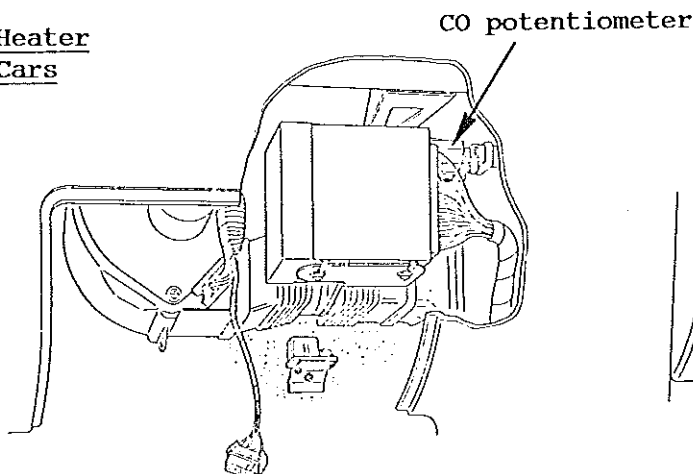
EML.3 - E CO POTENTIOMETER

The CO potentiometer is secured to the ECM harness behind the glovebox, with the adjuster screw protected by a plastic cap. Remove the glovebox pivot pins and glovebox for improved access.

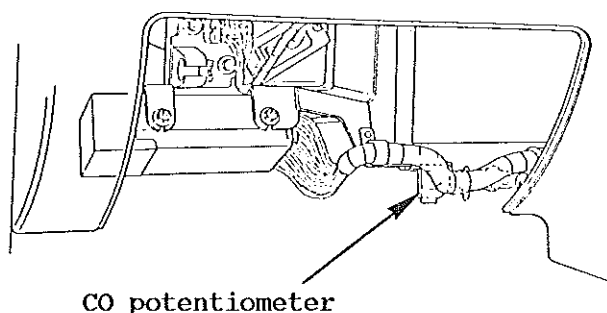
To Adjust

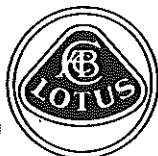
1. With the air conditioning and all electrical ancillaries switched off, run the engine up to normal operating temperature as indicated by the switching on of the engine cooling fans.
2. Connect an exhaust gas analyser to measure CO level at the tailpipe, and record the reading at idle when the cooling fans have cycled off.
Specification = $1.0\% \pm 0.5\%$
3. If necessary, prise off the anti-tamper cap protecting the CO potentiometer adjustment screw, and adjust to achieve specification.
4. Wait until the fans have cycled on and off again before rechecking CO reading, and adjusting further if necessary.
5. Fit a new anti-tamper cap (A100E6152) over the adjustment screw, and refit the glovebox.

Heater
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SERVICE BULLETIN

Date 04.02.91

Model Elan S.E.
non-catalyst

Number
1991/04

CLASS 3

Service Manager	Service Reception	Supervisor	Parts Manager

TITLE: Correct specification of CO potentiometer.

REASON: Some non-catalyst Turbo models may have been fitted with potentiometers having an inadequate range of adjustment. The CO potentiometer, fitted only on non-catalyst cars, is a variable resistor, the adjustment of which controls the idle setting of the air/fuel ratio in order to achieve the specified tailpipe CO level. The potentiometer is located close to the engine management ECM, and is fully described in the separate manual 'Section EMK' (C100T0327J). As the engine is run-in, the idle tailpipe CO level will tend to rise, necessitating a CO pot adjustment to bring down the voltage (as read by a Tech 1 tool) and CO emissions. Normal CO potentiometer resistor values allow the voltage to be reduced to 0.6V. Faulty parts fitted to some vehicles allow a reduction only to 1.1V.

ACTION: If in the course of a vehicle service, or at any other time when the idle CO level is being set, it is found that the correct tailpipe CO specification of $1.0\% \pm 0.5\%$ cannot be achieved due to the adjustment limit imposed by the potentiometer, check the minimum voltage reading on the Tech 1. If this is found to be around 1.1 volts rather than 0.6 volts, the potentiometer is faulty and should be replaced (A100E6151F).

EML.3 - F THROTTLE POSITION SENSOR (TPS)

The throttle position sensor is fitted to the rear end of the throttle spindle on the primary throttle body.

A 'Tech 1' scanner tool displays throttle position in volts. The 'Tech 1' tool should display 0.4 volts with the throttle closed (as at idle) and ignition "ON". Voltage should increase at a steady rate as the throttle opens. Voltage should be near 4.0 volts at wide open throttle (WOT).

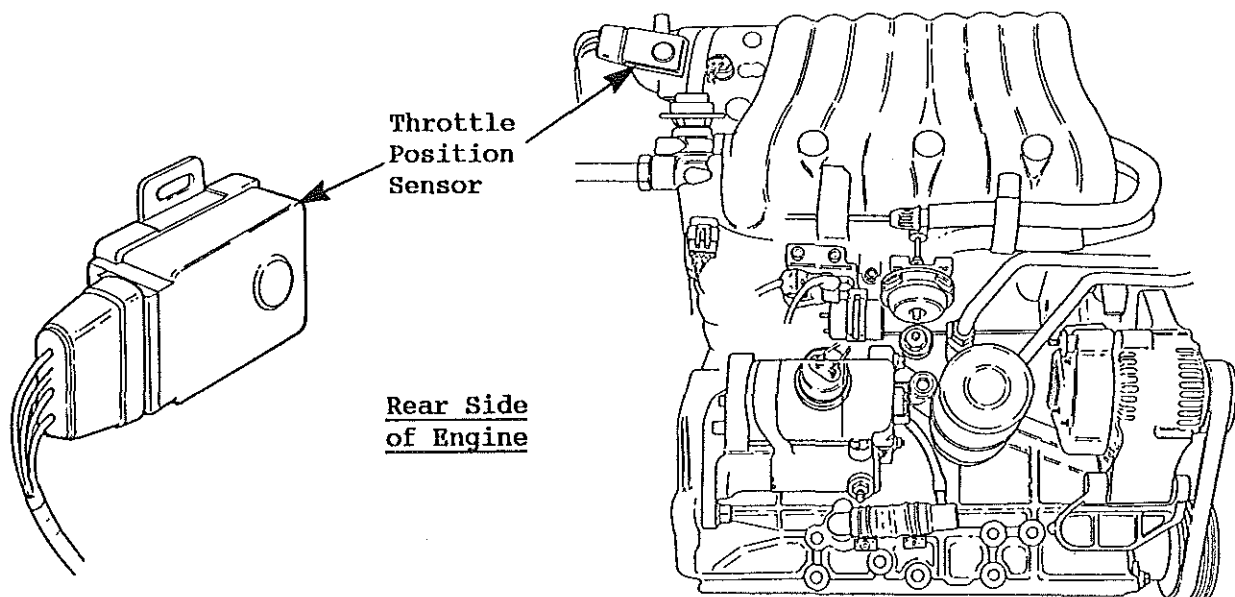
The electronic control module (ECM) has the ability to auto-zero the throttle position sensor (TPS) voltage if it is below 0.66 volts. This means that any voltage less than 0.66 V will be determined by the ECM to be 0% throttle. 'Tech 1' tools also have the ability to display the throttle angle and should display 0% when the throttle is closed, and increase smoothly to near 100% at WOT. A failure in the TPS or circuit should set a Code 21 or 22.

To Remove

Unplug electrical connector, release the two fixing screws and withdraw the sensor from the end of the throttle spindle.

To Replace

Fit the sensor on to the end of the throttle spindle, and retain with the two fixing screws. Select 'TPS' on the 'Tech 1' tool and adjust the position of the switch to obtain a 0.4 V reading before tightening the screws to 2.0 Nm (18 lbf.in)

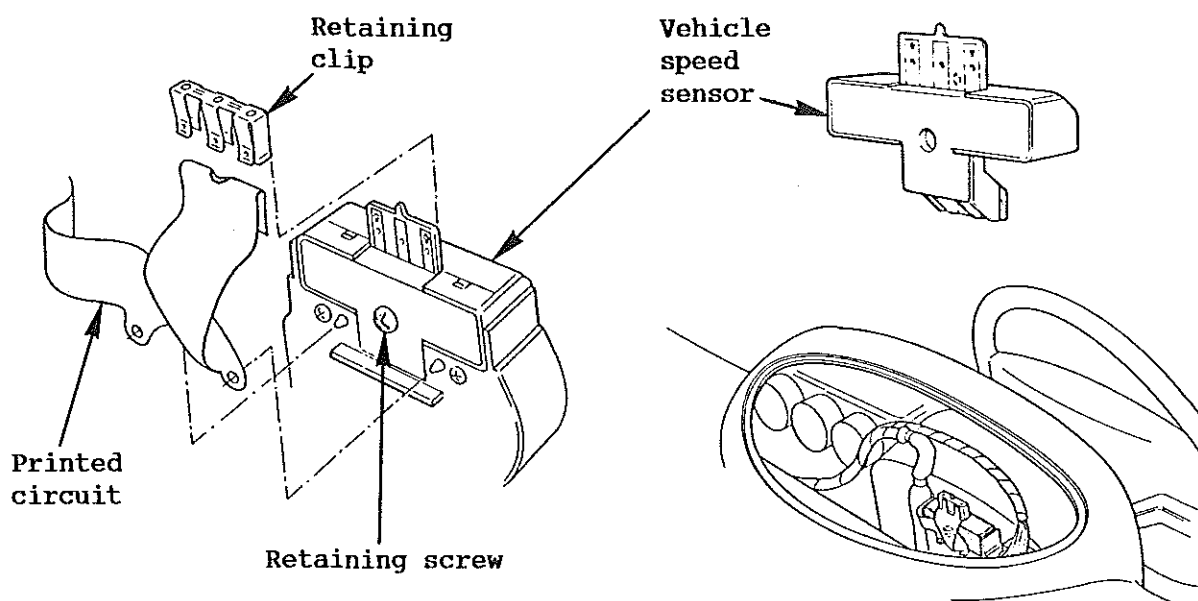
EML.3 - G VEHICLE SPEED SENSOR (VSS)

The vehicle speed sensor is incorporated into speedometer head.

A 'Tech 1' scanner tool MPH display should closely match the speedometer reading with the drive wheels turning. A failure in the vehicle speed sensor (VSS) circuit should set a code 24.

To Replace

Remove the access panel from the top of the instrument binnacle. The VSS is a small black rectangular module fixed to the top rear of the speedo head. Pull off



the printed circuit connector from the top of the VSS, and use a small cranked cross head screwdriver to release the single central recessed fixing screw.

EML.3 - H FUEL CONTROL SYSTEM

Some failures in the fuel system will result in a condition where the "Engine Cranks But Won't Run". If this condition exists, see chart EML.4 - 3. This chart will determine if the problem is caused by the ignition system, ECM or fuel pump circuit. If it is determined to be a fuel problem, Chart EML.4 - 5 or EML.4 - 7 should be used. This includes the injectors, pressure regulator, fuel pump and fuel pump relay. The fuel system wiring schematic diagram is covered on the facing page of Chart EML.4 - 5.

WARNING: - Safety Precautions

- 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.
- iii) When fuel lines are disconnected, absorb escaping fuel under residual pressure 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.

- Trip the inertia switch (RHD: in battery compartment; LHD: behind left hand speaker trim panel) to disconnect the fuel pump feed, and start the engine.
- After the engine stops from fuel starvation (crank for at least 60 secs if non starter), crank the engine for at least 5 secs to reduce remaining fuel pressure. Disconnect the negative battery cable.



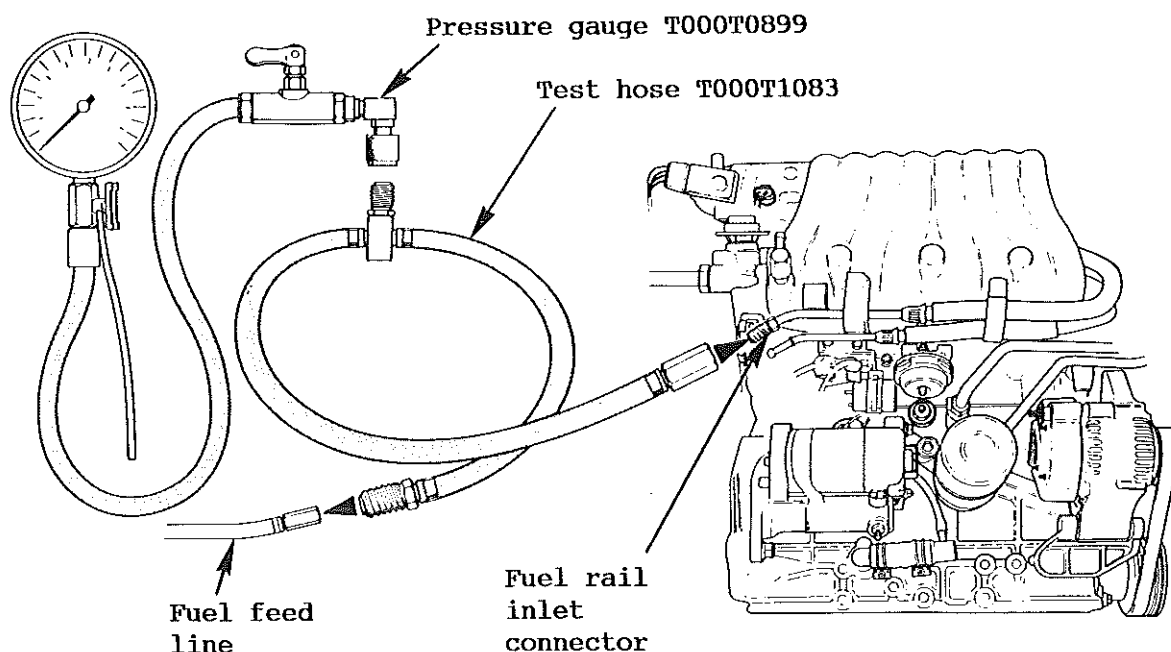
- Fuel connections may now be opened using a shop towel for protection from any residual fuel pressure, and to absorb the small amount of fuel escaping from the fuel lines.

EMK.3 - I FUEL PUMP

To establish if fuel pump performance is satisfactory, proceed as follows:

Tools Required: - Fuel pressure test gauge T000T0899
- Fuel pressure test hose T000T1083

1. **WARNING:** Relieve system fuel pressure as detailed in section EML.3 - H.
2. Use a shop towel for protection from any residual fuel pressure, and to absorb the small amount of fuel escaping as the fuel feed line connection to the fuel rail inlet pipe is released at the back of the engine using two spanners.
Fit test hose T000T1083 between the feed line and fuel rail inlet pipe.
3. Connect fuel pressure gauge T000T0899 to the adaptor in the test hose. Bleed the gauge during the two second period for which the pump runs after switching on the ignition. Repeat as necessary, noting that the ignition must be switched off for five seconds before the pump will again run for two seconds after switch on.



4. After bleeding the gauge, switch on the ignition and observe the build up of pressure during the two second period for which the pump runs. A pressure of between 280 - 325 kPa (40 - 47 lb/in²) should be recorded. If outside of this range, refer to chart EML.4 - 7.
5. Progressively clamp off the test hose between gauge and engine whilst repeating step (4). The pressure should build up to at least maximum gauge pressure of 400 kPa. **Do not exceed max. gauge pressure.** A pressure relief valve in the pump is designed to open at 450 - 650 kPa. If 400 kPa cannot be



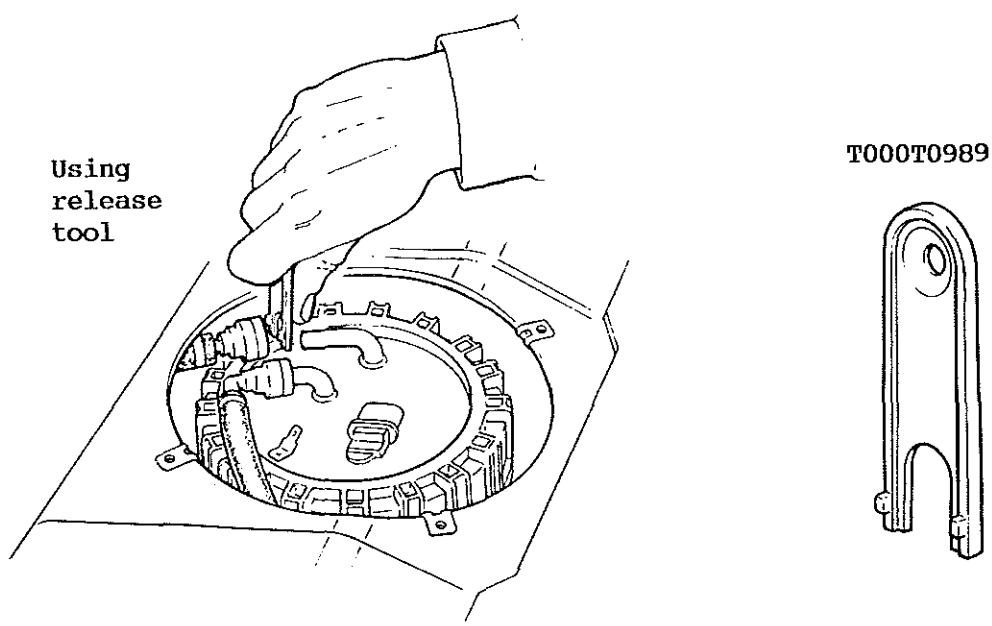
achieved, check the in-line fuel filter and fuel feed pipe for blockage or restriction, and replace if necessary. If specification can still not be achieved, check the fuel pump intake filter for contamination, and if O.K., replace the fuel pump assembly.

6. Relieve system fuel pressure using the gauge bleed valve and remove the gauge and test hose. Reconnect the fuel feed line.

To Remove Fuel Pump

The fuel pump is located, submerged within the fuel tank.

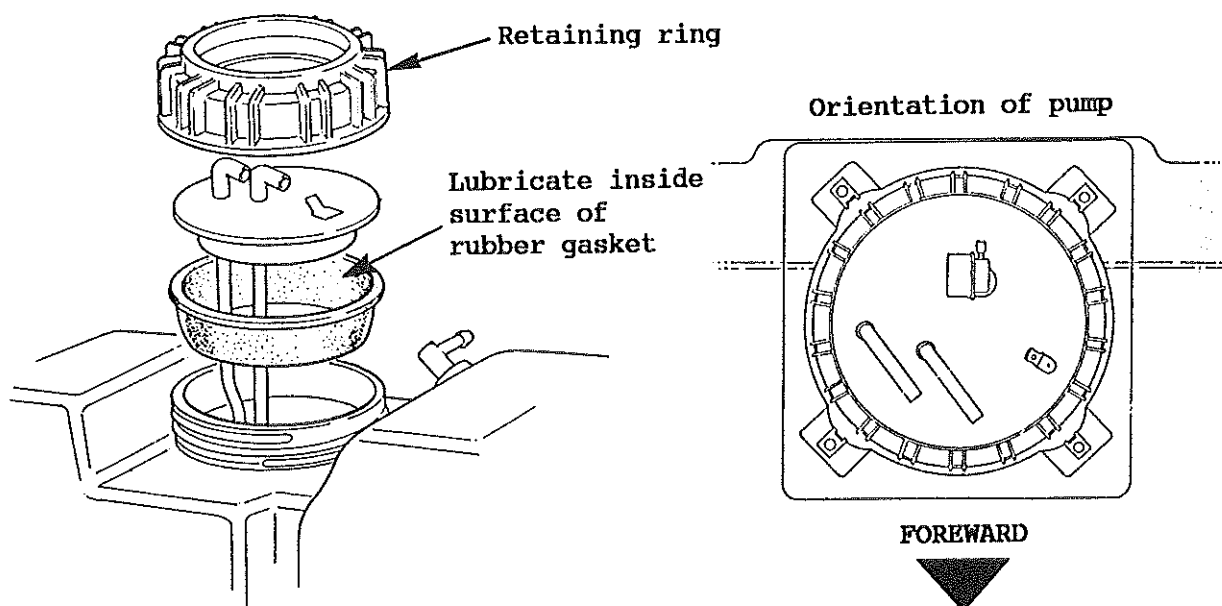
1. **WARNING:** Relieve system fuel pressure as detailed in section EML.3 - H.
2. Remove the roof stowage compartment floor and fuel pump access panel.



3. Disconnect fuel feed and return lines from fuel pump assembly. The special fuel pipe connectors are released by using a two prong tool (T000T0989) inserted into the holes in the connector end; press in to release the grip collar and pull each connector off the feed and return spigot. Unplug the electrical connector and earth lead.
4. Unscrew the fuel pump retaining ring to release the fuel pump assembly retaining ring and withdraw complete fuel pump/gauge sender unit assembly using an absorbent cloth to catch dripping fuel. Temporarily cap fuel tank aperture to reduce fire risk.

To Replace

1. Check condition and cleanliness of pump intake filter, and condition of sealing collar around tank aperture. Replace if necessary. Fit the seal into the tank aperture and smear the inside surface with engine oil before fitting the pump assembly and retaining with the threaded ring. Ensure the pump is orientated as shown before tightening the ring as fully as possible by hand. Mark the position of the ring, and use a hardwood or plastic drift and a mallet to further tighten the ring a $\frac{1}{4}$ turn. Recheck orientation after tightening.



2. Push on the fuel feed and return pipes, mate the electrical connector plug, and connect the earth lead.
3. Refit the fuel pump access panel and roof stowage compartment floor.

EML.3 - J FUEL RAIL, PRESSURE REGULATOR & INJECTORS

The system operates, with the engine running, in an acceptable pressure range of 211 - 379 kPa (30.5 - 55 lb/sq.in) depending on engine conditions. If the pressure is too low, poor performance could result. If the pressure is too high, poor idle quality could result. Check CO emissions and potentiometer adjustment. Chart EML.4 - 5 and EML.4 - 7 should be used to diagnose fuel pressure irregularities.

Important: When servicing any part of the fuel rail assembly, take care to prevent dirt and other contaminants from entering the fuel passages. Fittings should be capped, and holes plugged during servicing.

Fuel Rail & Injectors

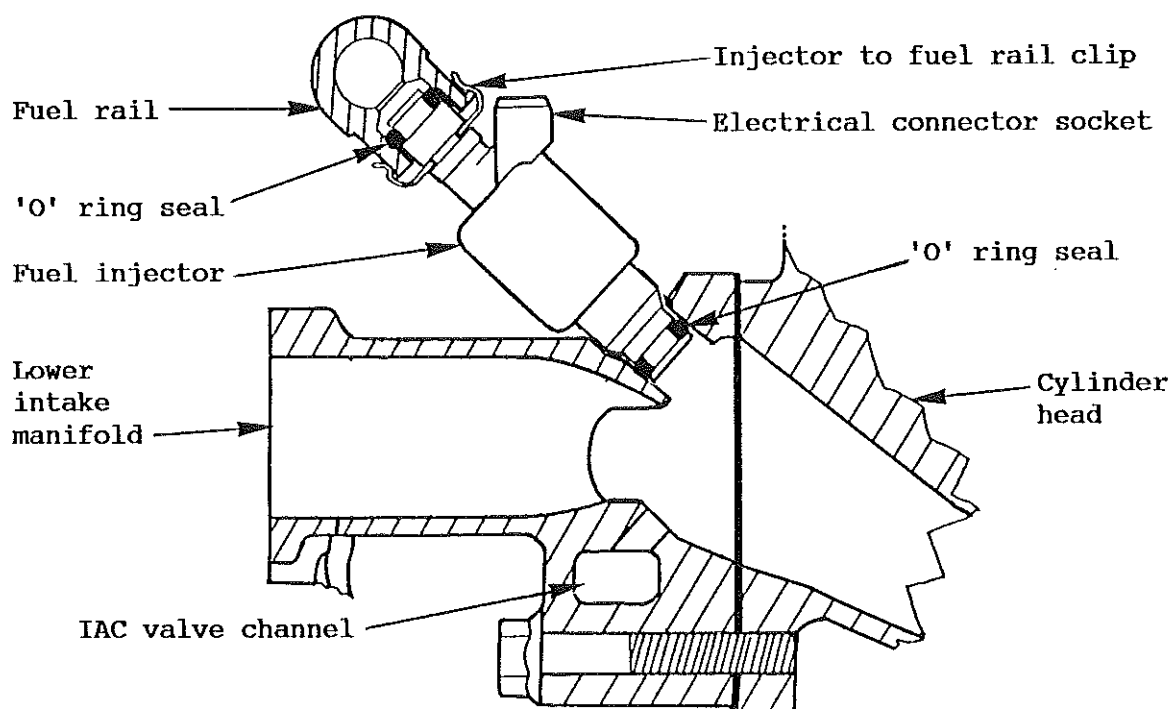
Before removing the fuel rail assembly, it is recommended to use a spray type engine cleaner such as AC Delco X-30A following package instructions to help prevent dirt ingress into the open ports of the assembly.

1. **WARNING:** Relieve system fuel pressure as detailed in section EML.3 - H.
2. Use an airline to blow any dirt from around the injectors, and disconnect the electrical plug from each injector. If necessary, use an open ended 14 mm spanner as a lever to release the injector connector plugs.
3. Release the pressure sensing hose from the top of the regulator valve. Using a back up wrench to prevent the fuel rail outlet from turning, release the fuel return pipe from the right hand end of the rail. Use a shop towel to absorb any escaping fuel.
4. Pull off the clips securing each injector to the fuel rail, and remove the two bolts securing the rail to the manifold. Carefully push the rail off the



injectors, whilst holding the injectors in the manifold. Remove the injectors from the manifold.

Caution: Take care to prevent damage to the injector electrical connector sockets and injector spray tips. Each fuel injector is serviced only as a complete assembly, and since it is an electrical component, must not be immersed in any cleanser.



5. To remove the fuel rail, use a back up wrench to prevent the fuel rail inlet connector from turning, and release the fuel inlet pipe from the rail. Use an absorbent cloth to soak up any escaping fuel. If necessary, remove the cam cover for improved access. Withdraw the rail and pressure regulator valve assembly.

Note: Do not attempt to remove the fuel inlet adaptor from the front end of the rail, since it is retained by staking of the rail end.

6. Before re-assembly, fit new 'O' rings to the top and bottom of each injector and lubricate with red silicone rubber grease. Fit new injector retaining clips to each injector. Renew the fuel rail inlet connection 'O' ring and lubricate with rubber grease.
7. Feed the fuel rail into position, and connect the fuel inlet pipe using a back up wrench to prevent the inlet connection turning whilst torque tightening to 30 Nm (22 lbf.ft).
8. Carefully fit the four injectors into the fuel rail, and check that each retaining clip is fully engaged in its machined slot. Position the electrical connectors uppermost. Carefully fit the four injectors into their inlet manifold bores, and press in until the rail fixing holes are aligned with those in the manifold. Fit and tighten the two bolts.
9. Connect the fuel return and pressure sensor lines to the pressure regulator.



10. Plug in each fuel injector electrical connector. Energise the fuel pump and check for leaks.

Pressure Regulator

Check using chart EML.4 - 7. The valve may be removed with the fuel rail 'in situ', but first carry out the 'Fuel Pressure Relief Procedure' in EML.3 - H.

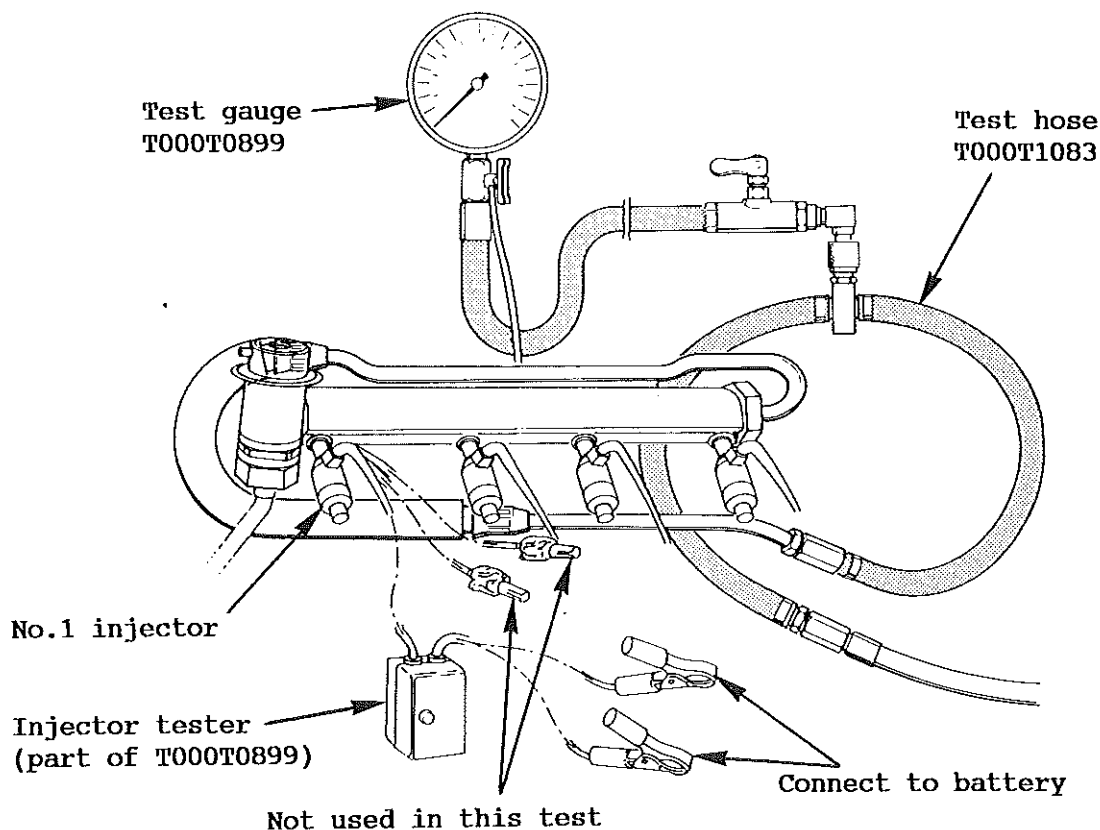
Disconnect the fuel return pipe and pressure sensing hose. Remove the single Torx screw retaining the valve and carefully withdraw the valve from the rail.

Before replacing the valve assembly, renew the sealing ring on the valve spigot, and lubricate with silicone rubber grease. Carefully push the valve spigot into the fuel rail, and retain with the fixing screw.

Injector Balance Test

The injector balance tester is a tool contained within the fuel injection diagnostic kit T000T0899 which is used to turn an injector on for a precise period of time, thus spraying a measured amount of fuel into the manifold. This causes a drop in fuel rail pressure which can be recorded and compared between each injector. Any injector with a pressure drop that is 10kPa (or more) greater or less than the average drop of the other injectors should be considered faulty and replaced.

1. Allow an engine cool down period of 10 minutes to avoid irregular readings due to 'hot soak' fuel boiling.
2. **WARNING:** Relieve system fuel pressure as detailed in section EML.3 - H.
3. Use a shop towel for protection from any residual fuel pressure, and to absorb the small amount of fuel escaping as the fuel feed line connection to the fuel rail inlet pipe is released at the back of the engine using two spanners.
Fit test hose T000T1083 between the feed line and fuel rail inlet pipe.





4. Connect fuel pressure gauge T000T0899 to the adaptor in the test hose. Bleed the gauge during the two second period for which the pump runs after switching on the ignition. Repeat as necessary, noting that the ignition must be switched off for five seconds before the pump will again run for two seconds after switch on.
5. Switch ignition off for at least 10 seconds to complete ECM shutdown cycle. Connect injector tester (part of kit T000T0899) to no.1 injector.
6. Turn on ignition, and record steady fuel pressure reading. (If reading is not steady, refer to chart EML.4 - 7.)
7. Energise the tester once, and note pressure drop at lowest point (disregard any slight pressure increase after drop hits low point). By subtracting this second pressure reading from the initial pressure, the individual pressure drop may be calculated.
8. Transfer the tester to the other injectors in turn and repeat step 7 recording the readings. Good injectors will record virtually the same pressure drop. Retest any injector that has a pressure difference of 10 kPa from the average of the other 3 injectors. Replace any injector that fails the retest.

CAUTION: The entire test should not be repeated more than once without running the engine to prevent flooding. (This includes any retest on faulty injectors.)

EML.3 - K SECONDARY THROTTLE VALVE CONTROL

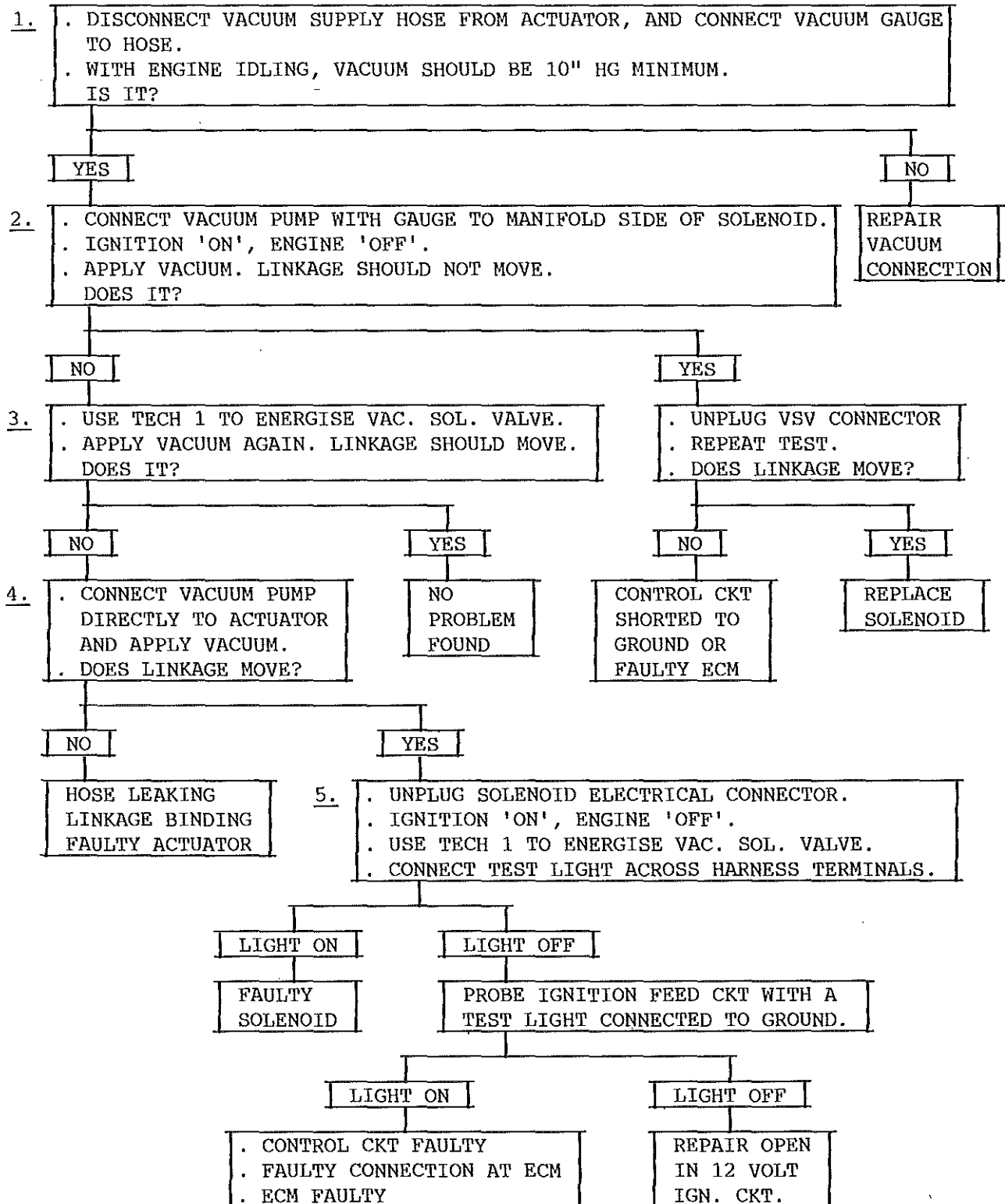
The system consists of the four throttle valves mounted in the lower intake manifold, a vacuum operated actuator with reservoir, a vacuum solenoid valve, and a control circuit within the ECM.

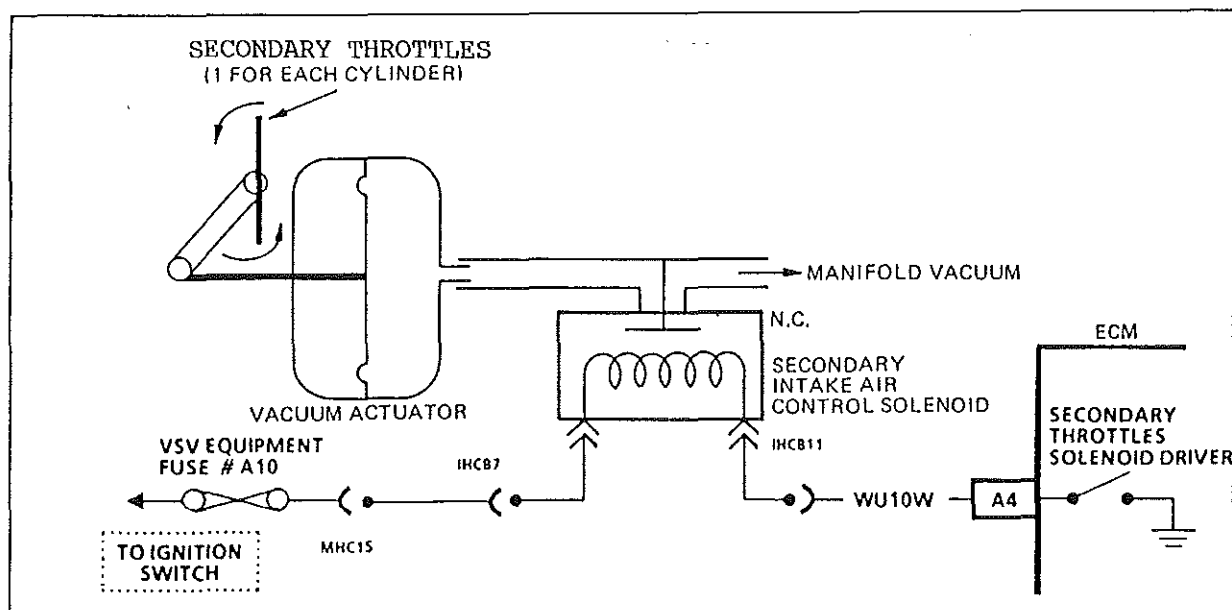
Test Description: Numbers below refer to underlined numbers on the diagnostic chart.

1. If sufficient vacuum is not available at the solenoid valve, the system will not function correctly.
2. With the ignition 'on' and the engine not running, the solenoid should be de-energised and closed. Vacuum should not be able to pass to the actuator.
3. With the diagnostic terminal grounded, the ECM should ground the control circuit to energise the solenoid and allow vacuum to pass to the actuator.
4. This step checks the ability of the actuator to move the linkage.
5. This step, and the following steps, checks for circuit continuity.



Diagnostic Chart - Secondary Throttle



Secondary Throttle Schematic DiagramEML.3 - L IDLE AIR CONTROL (IAC) VALVE

A 'Tech 1' scanner tool will display idle air control (IAC) valve position in 'Counts' or steps. '3' steps indicates that the electronic control module (ECM) is commanding the IAC valve to be fully extended to a fully seated position. This condition is usually caused by a vacuum leak. The higher the number of counts, the more air is being allowed to pass the IAC valve. If the IAC valve is unable to control the idle speed within calibrated limits, chart EML.4 - 9 (in section EML.4) should be used to diagnose the IAC system. Refer to 'Rough, Unstable, or Incorrect Idle, Stalling' in the Symptoms Section EML.6 for other possibilities of the cause of idle problems.

The throttle by-pass screw on the throttle body is pre-set at the factory and should require no adjustment. If necessary however, the screw may be reset as follows:

1. Run engine to normal operating temperature and check that all electrical loads including the cooling fans and a/c are off. Enter field service mode using 'Tech 1' (or ALDL bridging plug). Briefly rev the engine to over 2,000 rpm using more than 10% throttle opening, to reset the IAC valve.
2. Check ignition timing is 16° BTDC (see section EML.3 - M).
3. Remove the rubber plug from the top of the primary throttle body, and slowly turn the throttle by-pass screw to achieve a 20 count IAC position, allowing time for the IAC to re-adjust and maintain an idle speed of 900 rpm.
4. Check tailpipe CO reading is $1.25 \pm 0.5\%$. Adjust if necessary (see section EML.3 - E), and recheck idle speed.
5. Stop engine and power down ECM (ignition off for 5 seconds) to reset IAC valve. Exit field service mode. Restart engine and recheck tailpipe CO.

For schematic wiring diagram and diagnostic chart, refer to EML.4 - 9 in section EML.4.

To Remove

1. Release the electrical connector, remove the two retaining screws and withdraw the valve from the manifold.
2. Remove the mating spigot 'O' ring and discard.

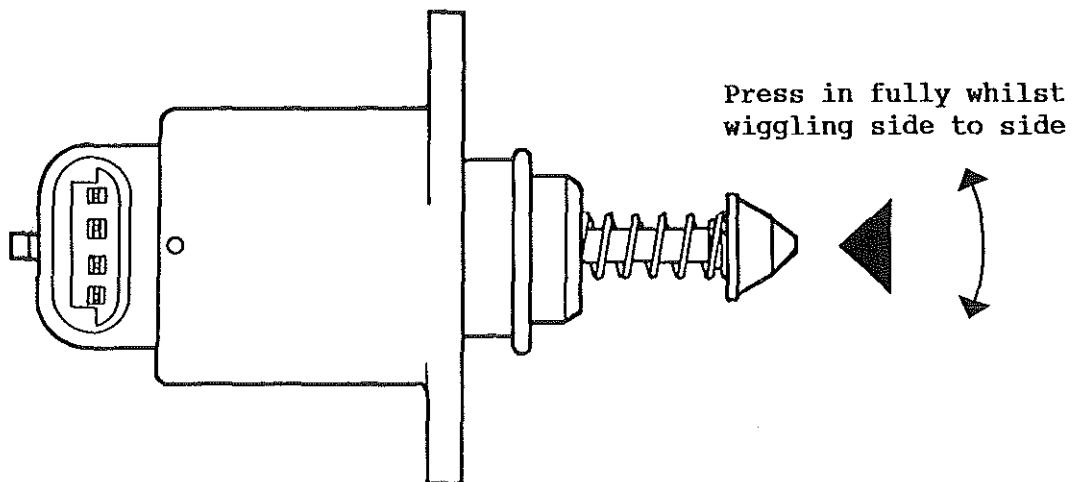
Note: As the IAC valve is an electrical component, it must not be soaked in any liquid cleaner or solvent, or damage may result.

To Replace

The IAC valve used on the Elan has a dual taper pintle. Check that any replacement valve has the correct part number and pintle shape.

Before fitting a replacement IAC valve, the plunger should be fully retracted to ensure that no damage is caused to the valve during installation:

1. Carefully press the plunger inwards whilst 'wiggling' from side to side until fully retracted. If too much force is applied to the pintle, the worm drive mechanism may be damaged.



2. Fit a new IAC valve 'O' ring and lubricate with engine oil.
3. Clean the IAC valve sealing surfaces on the manifold and fit the valve in position. Fit and tighten the two retaining screws to 3.4 Nm (30 lbf.in).
4. Refit electrical connector, switch on the ignition and then switch off again. This will cause the ECM to carry out an IAC valve reset, and park at 80 counts. If this is not done, the idle speed will be incorrect on initial start up, until the IAC position is relearned.

EML.3 - M HIGH ENERGY IGNITION (HEI) SYSTEM

The HEI system generates a spark to ignite the fuel/air mixture, and for optimum performance, fuel economy and control of emissions, uses Electronic Spark Timing (EST) controlled by the ECM. The EST system consists of the distributor module, ECM and connecting wires.



EST System Circuits

- Distributor Reference Input:

This provides the ECM with rpm and crankshaft position information. The ECM compares the pulses on this circuit to any that are on the distributor reference ground circuit. The ECM also uses the pulses on this circuit to 'time' the fuel injection pulses. If the ECM receives no pulses on this input circuit, no fuel injection pulses will occur, and the engine will not run.

- Distributor Reference Ground:

This wire is grounded through the distributor module. The ECM compares the voltage pulses on this line to those on the distributor reference input line. If the ground circuit is open, it may cause poor engine performance and possibly a 'Check Engine' light with no stored code.

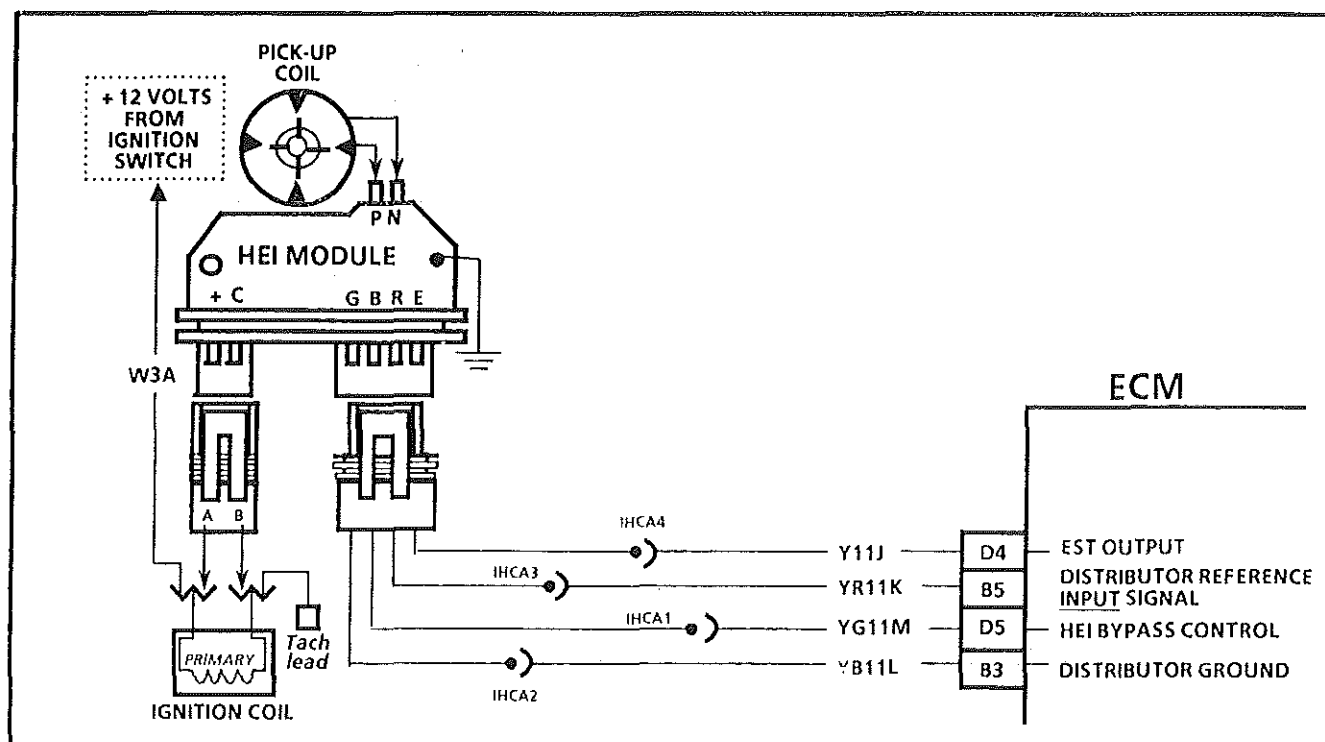
- HEI Bypass Control:

Above 800 rpm, the ECM applies 5 volts to this circuit to command the HEI module to allow the ECM to control spark timing and dwell. When this occurs, the ignition system is operating in 'EST' mode. When the HEI module does not receive this 5 volt command, the HEI module itself controls ignition dwell and timing, in 'module mode'. An open or grounded bypass control line would result in the engine will running on HEI module base timing, plus a small amount of advance built into the HEI module.

- EST Output:

This ECM output triggers the HEI module during the EST mode. The ECM receives a basic timing signal from the distributor reference input line, and controls ignition timing relative to this point, so that if the base timing is set incorrectly, the entire spark advance curve will be incorrect. An open or grounded EST output circuit will cause a running engine to stall.

HEI System Circuit





When the engine is running in module mode, both performance and fuel economy will be reduced.

The ECM uses information from the MAP and coolant sensors in addition to rpm to calculate spark advance as follows:

- . Low MAP Output Voltage (low engine load) = More spark advance
- . Cold engine = More spark advance
- . High MAP Output Voltage (high engine load) = Less spark advance
- . Hot engine = Less spark advance

Therefore, detonation could be caused by low MAP output or high resistance in the coolant sensor circuit.

Poor performance could be caused by high MAP output or low resistance in the coolant sensor circuit.

If the engine cranks but will not run or immediately stalls, CHART EML.4 - 3 must be used to determine if the failure is in the DI system or the fuel system.

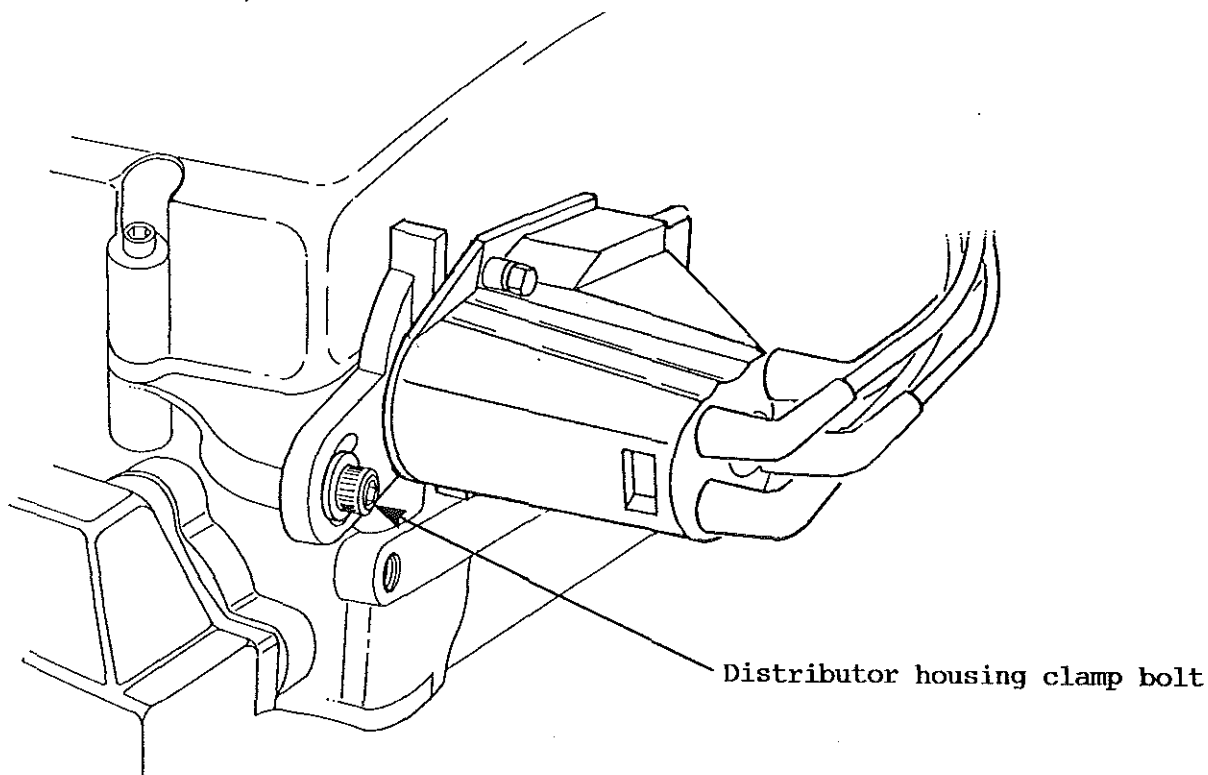
If the symptom is engine miss and the HEI system is suspected, the following diagnostic chart should be used.

Code 41: Code 41 is set if the engine speed signal is not received by the ECM. Refer to the trouble code chart in section EML.4.

Setting Timing

The base ignition timing is set at idle in field service mode, (when the ignition timing is fixed rather than varied by the ECM to control idle speed), by rotating the distributor body.

1. Run the engine to normal operating temperature, and check that all electrical loads including the cooling fans and a/c are off. Briefly rev the engine to over 2,000 rpm using more than 10% throttle to reset the IAC valve.
2. Enter field service mode either by fitting bridging plug T000T0909 into the ALDL connector, or use the 'Tech 1' tool.





3. Connect a stroboscopic timing light to no.1 spark plug lead, and using the timing marks on the front pulley, note the base ignition timing.
Specification = 16° BTDC
If necessary, slacken the distributor housing clamp bolt, and rotate the distributor as required to achieve specification. Tighten the clamp bolt to 24 Nm (17 lbf.ft).

Test Description

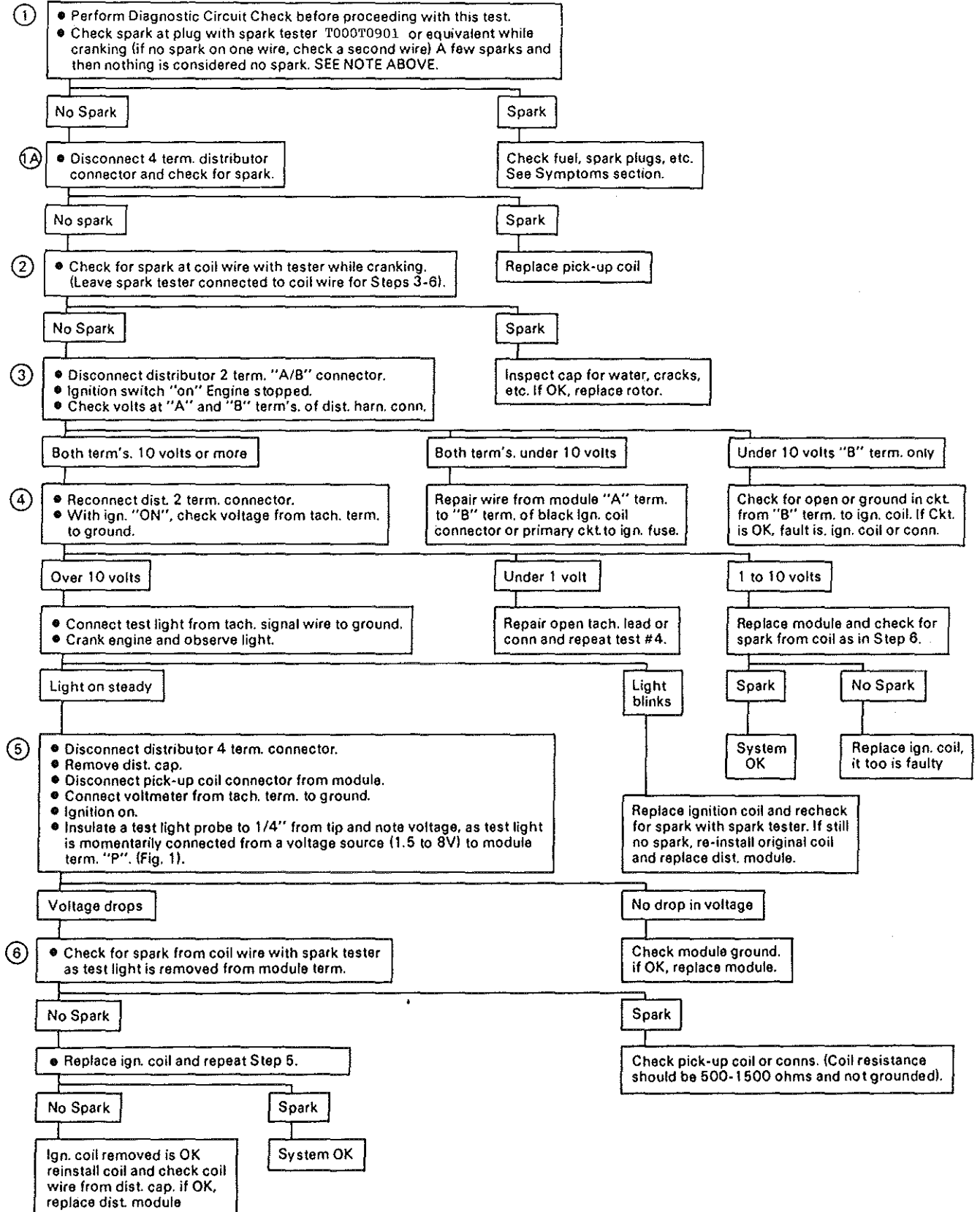
Numbers below refer to circled numbers on the diagnostic chart.

1. Two wires are checked, to ensure that an open is not present in a spark plug wire.
- 1A. If a spark occurs with 4 terminal distributor connector disconnected, pick-up coil output is too low for EST operation.
2. A spark indicates the problem must be the distributor cap or rotor.
3. Normally, there should be battery voltage at the 'C' and '+' terminals. Low voltage would indicate an open or a high resistance circuit from the distributor to the coil or ignition switch. If 'C' term. voltage was low, but '+' term. voltage is 10 volts or more, circuit from 'C' term. to ign. coil or ignition coil primary is open.
4. Checks for a shorted module or earthed circuit from the ignition coil to the module. The dist. module should be turned 'OFF', so normal voltage should be about 12 volts.
If the module is turned 'ON', the voltage would be low but above 1 volt. This could cause the ign. coil to fail from excessive heat.
With an open ignition coil primary winding, a small amount of voltage will leak through the module from the 'BAT' to the tach terminal.
5. Applying a voltage (1.5 to 8) to module terminal 'P' should turn the module 'ON' and the tach. term. voltage should drop to about 7-9 volts. This test will determine whether the module or coil is faulty or if the pick-up coil is not generating the proper signal to turn the module 'ON'. This test can be performed by using a DC battery with a rating of 1.5 to 8 volts. The use of the test light is mainly to allow the 'P' terminal to be probed more easily. Some digital multi-meters can also be used to trigger the module by selecting ohms, usually the diode position. In this position the meter may have a voltage across its terminals which can be used to trigger the module. The voltage in the ohm's position can be checked by using a second meter or by checking the manufacturer's specification of the tool being used.
6. This should turn "OFF" the module and cause a spark. If no spark occurs, the fault is most likely in the ignition coil because most module problems would have been found before this point in the procedure.



Diagnostic Chart - HEI

NOTE: Do not use a sparkplug in open air grounded to the engine as an indication of sufficient "spark". Only a few kilovolts are required to jump the gap of a sparkplug outside of the engine, and that would be an inadequate test of the ignition coil output ability.



EML.3 - N POSITIVE CRANKCASE VENTILATION

If the PCV valve is stuck closed, or the hose blocked, the following symptoms could be caused:

- rough idle
- stalling or slow idle speed
- oil leaks
- oil in air cleaner
- sludge in engine

A leaking valve or hose could cause:

- rough idle
- stalling
- high idle speed

Functional check of PCV valve

To check the correct operation of the valve:

1. Remove the valve from the cam cover, but leave attached to the hose.
2. Run the engine at idle.
3. Place a thumb over the end of the valve to check for vacuum. If no vacuum can be detected, check the hose for blockage, and replace the valve if necessary.
4. Stop engine and remove the valve. Shake the valve and listen for the rattle of the check needle. Blow down the plenum end of the valve to check that it seals.

With this system, any blow-by in excess of system capacity (from a badly worn engine, sustained heavy load etc.) is exhausted into the intake trunking. Check that there is no restriction in this hose.

Proper operation of the PCV system is dependent upon a sealed engine. If oil sludging or dilution is noted, and the PCV system is functioning correctly, check the engine for possible causes.

EMG.3 - O EXHAUST GAS RECIRCULATION (EGR)

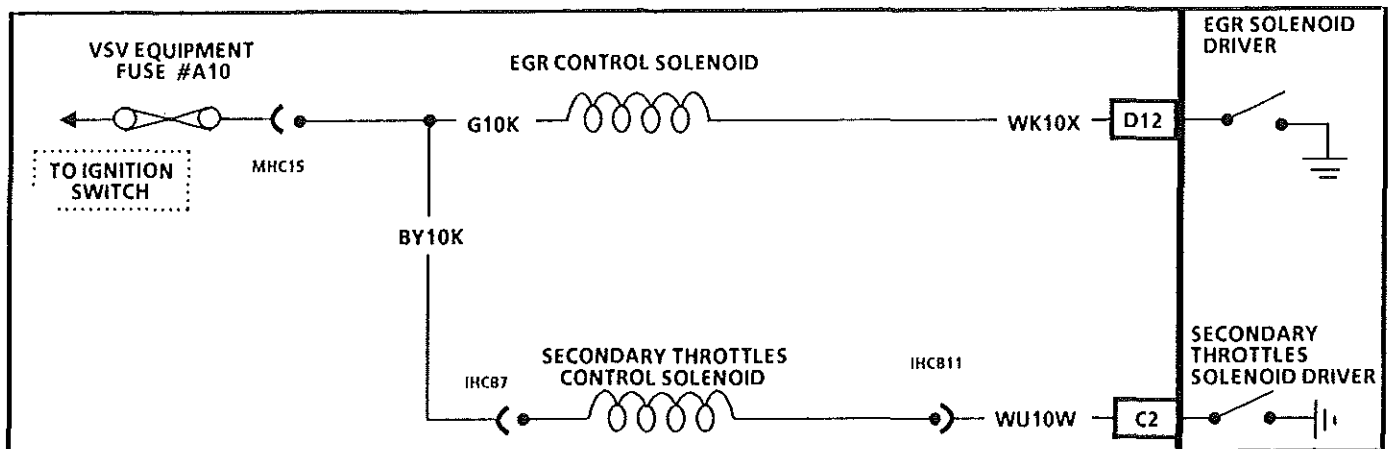
The EGR system consists of an EGR diaphragm valve, a controlling vacuum solenoid valve, the connecting pipework and the control circuitry within the ECM. The ECM energises (opens) the solenoid valve to turn on EGR, when coolant temperature is above 30°C, TPS above idle, rpm above 1,000, and MAP indicating the engine is under load.

Too much EGR flow tends to weaken combustion, causing the engine to run roughly or stop. With too much EGR flow at idle, cruise, or cold operation, any of the following conditions may occur:

- engine stops after cold start.
- engine stalls after deceleration.
- car surges during cruise.
- rough idle. If the EGR valve is stuck open, the engine may not idle.

Too little, or no EGR flow allows combustion temperatures to get too high during acceleration and high load conditions, which could cause:

- high emissions of NOx.

Circuit DiagramTest Description

Numbers below refer to underlined numbers on the diagnostic chart.

1. With ignition on and engine stopped, the vacuum solenoid valve should not be energised and vacuum should not pass to the EGR valve.
2. Grounding the ALDL diagnostic terminal will energise the solenoid and allow vacuum to pass to the valve.
3. When the VSV is de-energised, the vacuum in the EGR valve should bleed off through the vent.
4. Checks for blocked EGR passages. If the passages are blocked, the engine may have severe detonation on acceleration.

To Replace EGR Valve

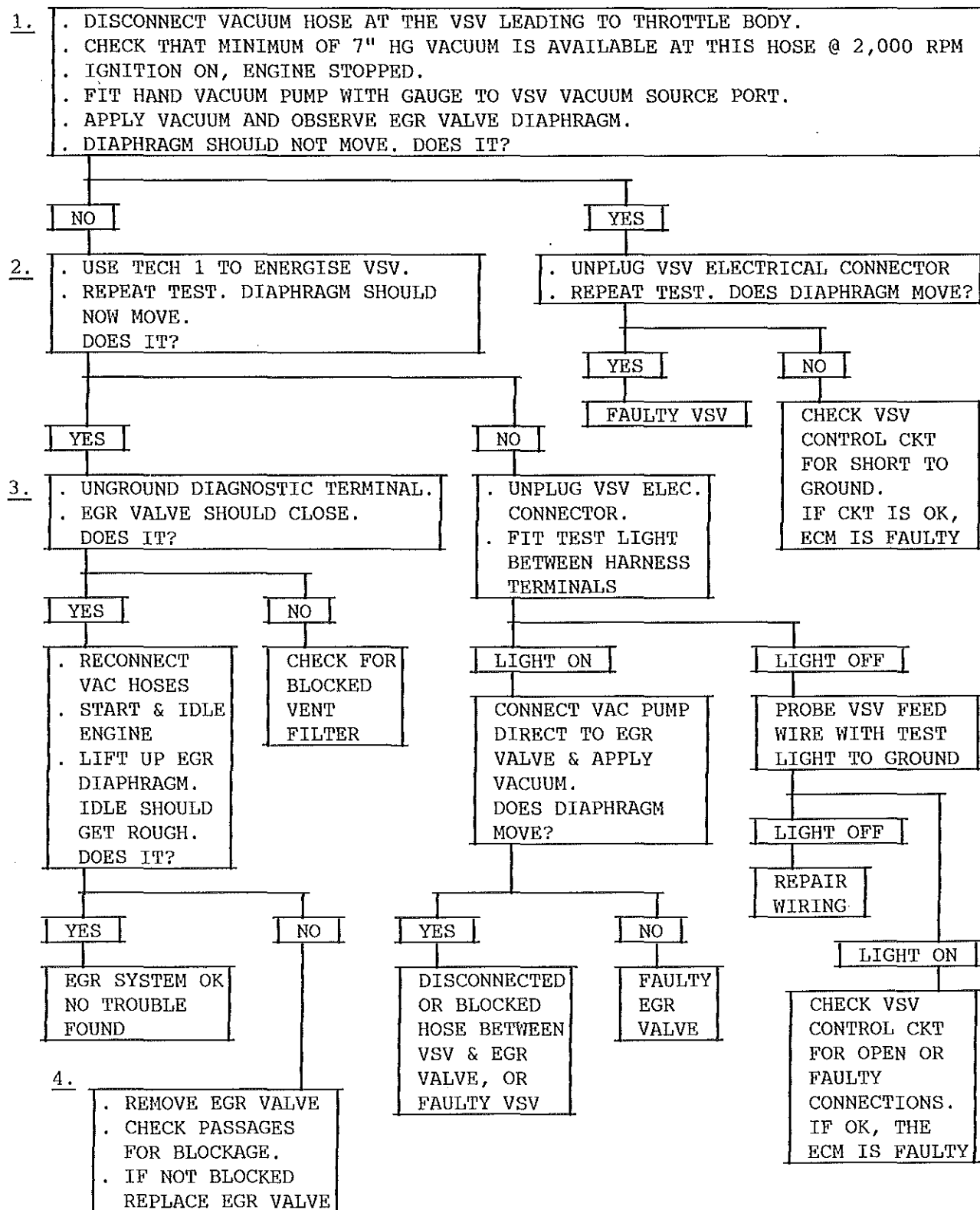
- Disconnect the EGR pipe from the valve.
- Disconnect the vacuum pipe from the EGR capsule.
- Release the two valve fixing screws, and remove the valve from the plenum tract.

Refit the valve in the reverse order to removal, and torque tighten the EGR pipe to 45 Nm (33 lbf.ft).

Diagnostic chart overleaf -

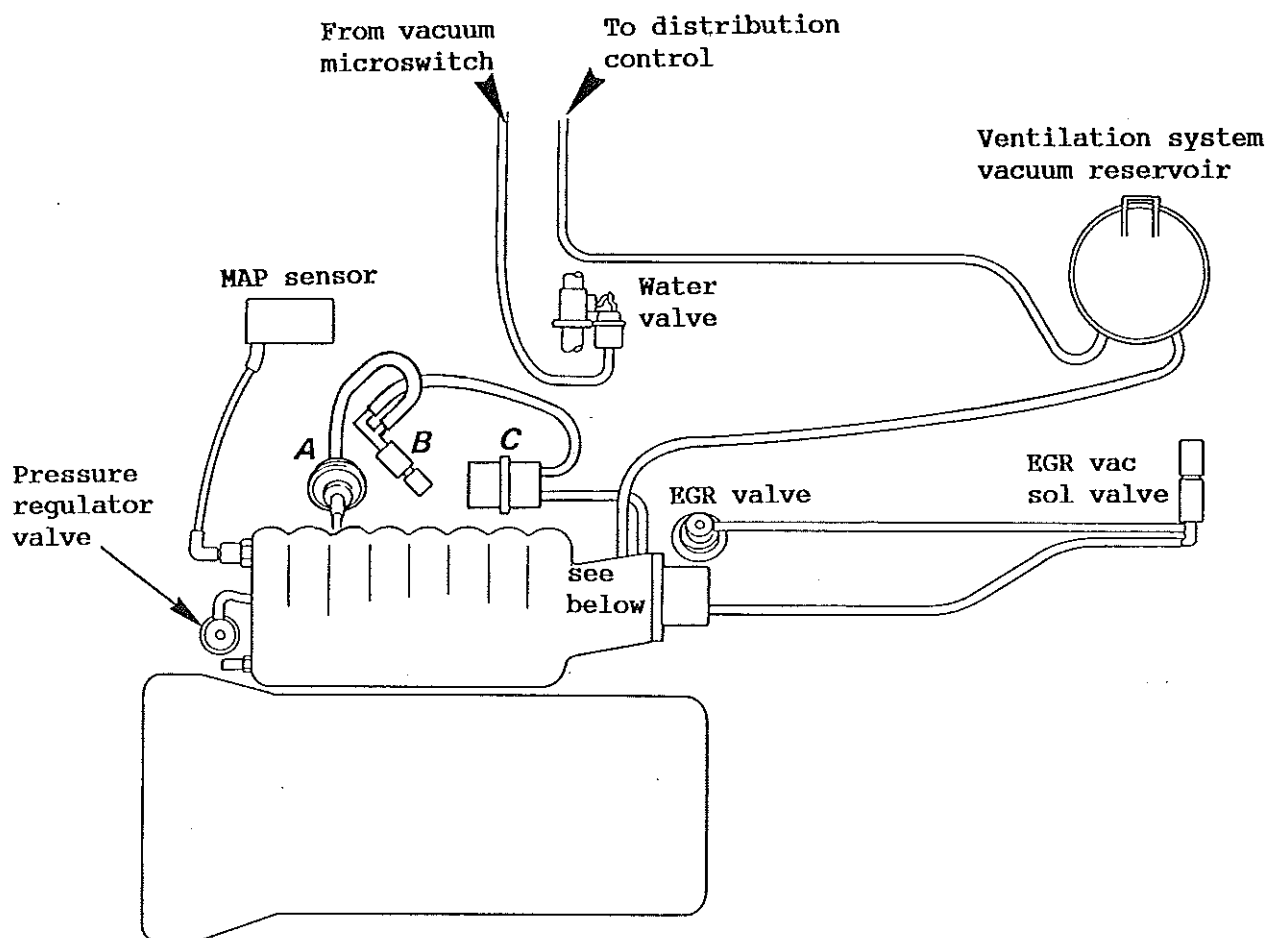


Diagnostic Chart - EGR

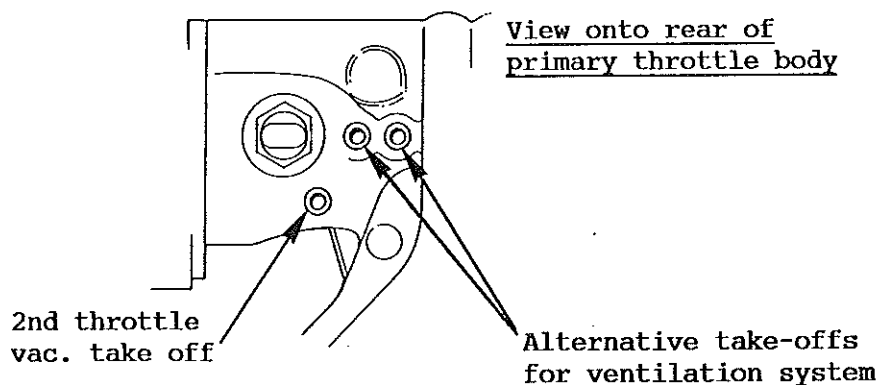




EML.3 - P VACUUM CONNECTION DIAGRAM



- A - 2nd throttle actuator
- B - 2nd throttle vac. sol. valve
- C - 2nd throttle vac. reservoir



**SECTION EML.4****1.6L LOTUS ELAN****ENGINE COMPONENTS / WIRING DIAGRAMS / DIAGNOSTIC CHARTS**

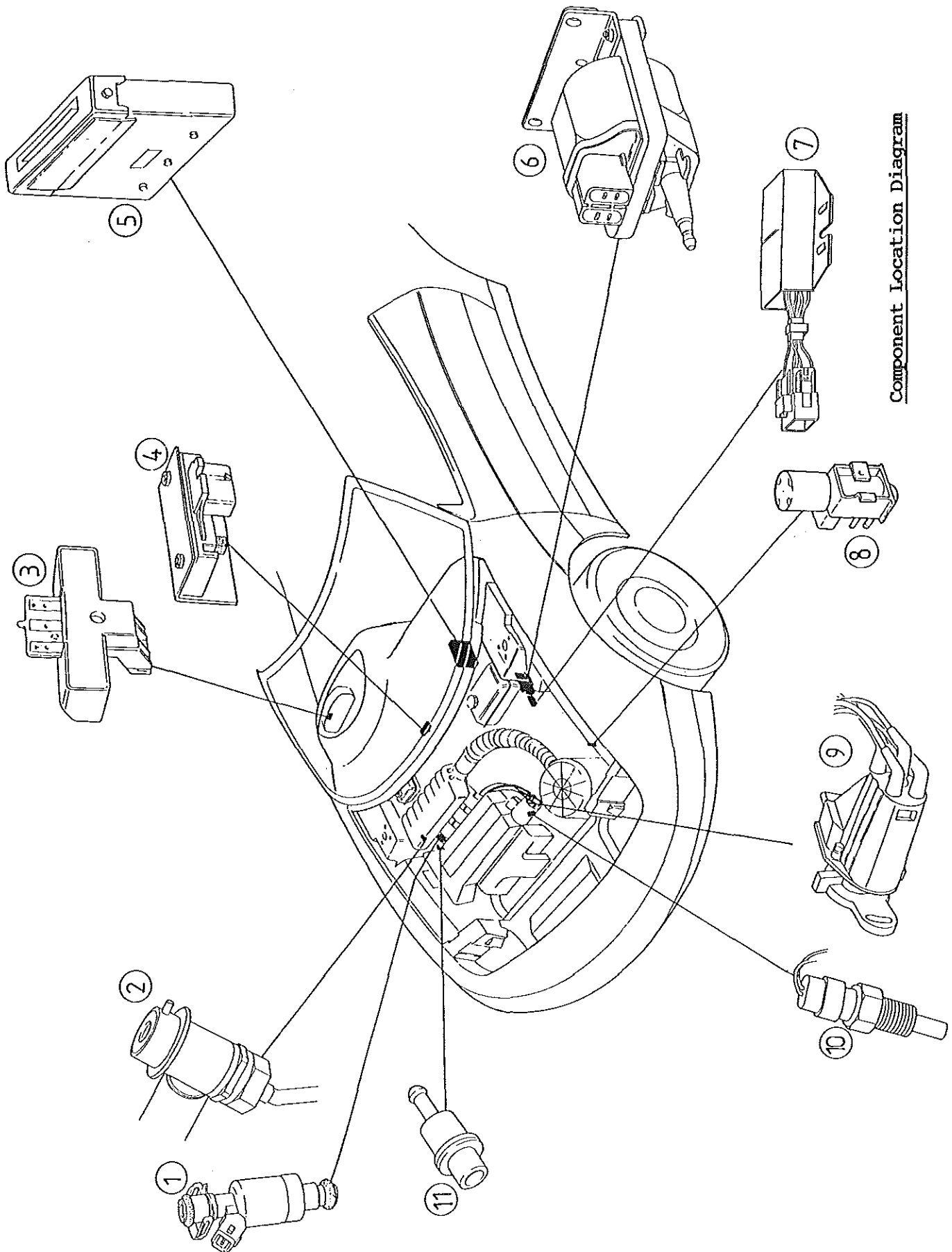
Component Locations - Figure EML. 4-1	Page EML. 4- 2
Fuse & Relay Locations - Figure EML.4-2	Page EML. 4- 4
ECM Terminal End View - Figure EML. 4-3	Page EML. 4- 6
Wiring Harness Connector Face Views - Figure EML. 4-4	Page EML. 4- 7
Wiring Diagrams	Page EML. 4- 8
Diagnostic Circuit Check - Tech 1 Data	Page EML. 4- 11
No "Check Engine" Light - Chart EML. 4-1	Page EML. 4- 14
No ALDL or Won't Flash Code 12 ("Check Engine" Light on Steady) - Chart EML. 4-2 ..	Page EML. 4- 16
Engine Cranks But Won't Run - Chart EML. 4-3	Page EML. 4- 18
Fuel Pump Relay Circuit - Chart EML. 4-5	Page EML. 4- 24
Fuel Delivery System - Chart EML. 4-7	Page EML. 4- 26
Idle Speed Error - Chart EML. 4-9	Page EML.4- 30
Electronic Spark Timing (EST) Circuit - Chart EML. 4-10	Page EML. 4- 32
"SCAN" CODE CHARTS	
Code 14- Coolant Temperature Sensor Circuit	Page EML. 4- 34
Signal Voltage Low - High Temperature Indicated)	
Code 15- Coolant Temperature Sensor Circuit	Page EML. 4- 36
(Signal Voltage High - Low Temperature Indicated)	
Code 21- Throttle Position Sensor (TPS) Circuit (Signal Voltage High)	Page EML. 4- 38
Code 22- Throttle Position Sensor (TPS) Circuit (Signal Voltage Low)	Page EML. 4- 40
Code 23- Manifold Air Temperature (MAT) Sensor Circuit	Page EML. 4- 42
(Low Temperature Indicated)	
Code 24- Vehicle Speed Sensor (VSS) Circuit	Page EML. 4- 44
Code 25- Manifold Air Temperature (MAT) Sensor Circuit	
(High Temperature Indicated)	Page EML. 4- 46
Code 31/33 - MAP Sensor Circuit (Signal Voltage High - Low Vacuum)	Page EML. 4- 48
Code 34- MAP Sensor Circuit (Signal Voltage Low - High Vacuum)	Page EML. 4- 50
Code 51- PROM Error (Faulty or Incorrect Mem-Cal)	Page EML. 4- 52
Code 54- CO-Potentiometer Circuit (Signal Voltage High or Low)	Page EML. 4- 52

DIAGNOSTIC CIRCUIT CHECK

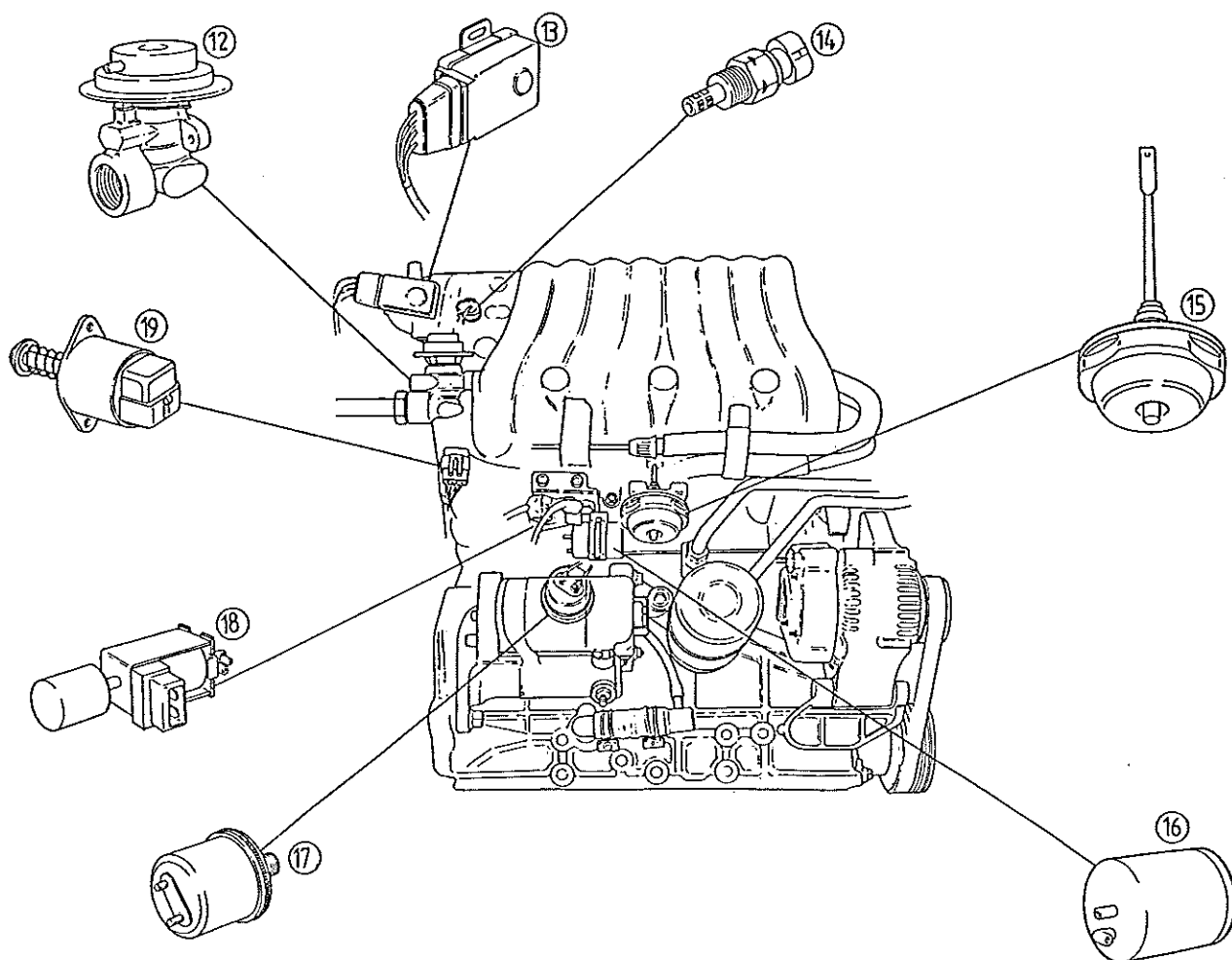
The "Diagnostic Circuit Check" verifies the system is functioning correctly. Some special considerations to keep in mind while making the "Diagnostic Circuit Check" are:

Blocking Drive Wheels

The vehicle drive wheels should always be blocked while checking the system.



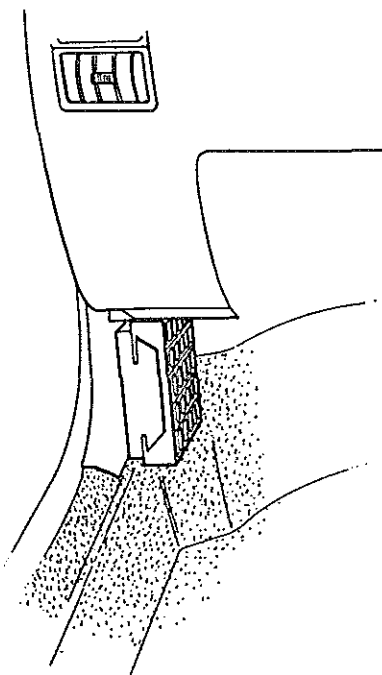
Component Location Diagram



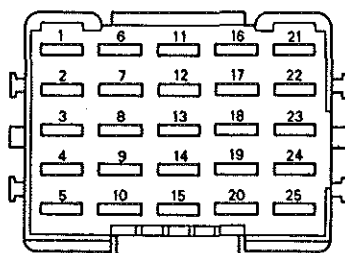
Component Location - Rear Side of Engine

Key to Component Location Diagram

- | | |
|--|--|
| 1. Fuel injector | 12. Exhaust Gas Recirculation (EGR) valve |
| 2. Fuel pressure regulator valve | 13. Throttle Position Switch (TPS) |
| 3. Vehicle Speed Sensor (VSS) | 14. Manifold Air Temperature (MAT) sensor |
| 4. Manifold Air Pressure (MAP) sensor | 15. Secondary throttle vacuum actuator |
| 5. Electronic Control Module (ECM) | 16. Secondary throttle vacuum reservoir |
| 6. Ignition coil | 17. Oil pressure transducer |
| 7. Injector dropping resistor | 18. Secondary throttle vacuum solenoid valve |
| 8. Exhaust Gas Recirculation (EGR) vacuum solenoid valve | 19. Idle Air Control (IAC) valve |
| 9. Ignition module & distributor | |
| 10. Coolant temperature sensor (CTS) | |
| 11. Positive Crankcase Ventilation (PCV) valve | |

FUSES & RELAYSMain Fusebox (A) - ahead of passenger door hinge postRight Hand
Drive Shown

Fuse	Rating	Circuit	Fuse	Rating	Circuit
1	15A	Horns	9	-	
2	7.5A	Air Cond.	10	3A	VSV
3	7.5A	Fuel Pump	11	10A	Hazard
4	10A	RHD Lighting	12	3A	Batt Services
	7.5A	LHD CDL	13	5A	Stoplamps
5	10A	ECM	14	5A	Int. Lamps
6	5A	RH Sidelamps	15	15A	Rear Fog
7	5A	LH Sidelamps	16	10A	DI & Reverse
8	3A	Radio Relay	17	15A	Wash/wipe
		Logic (USA)	18	3A	Ignition 1
			19	3A	Mirror Timer
			20	3A	Ign. Relay
			21	5A	Mirrors
			22	3A	Window Switch
			23	20A	Heater Blower
			24	15A	Cigar Lighter
			25	-	

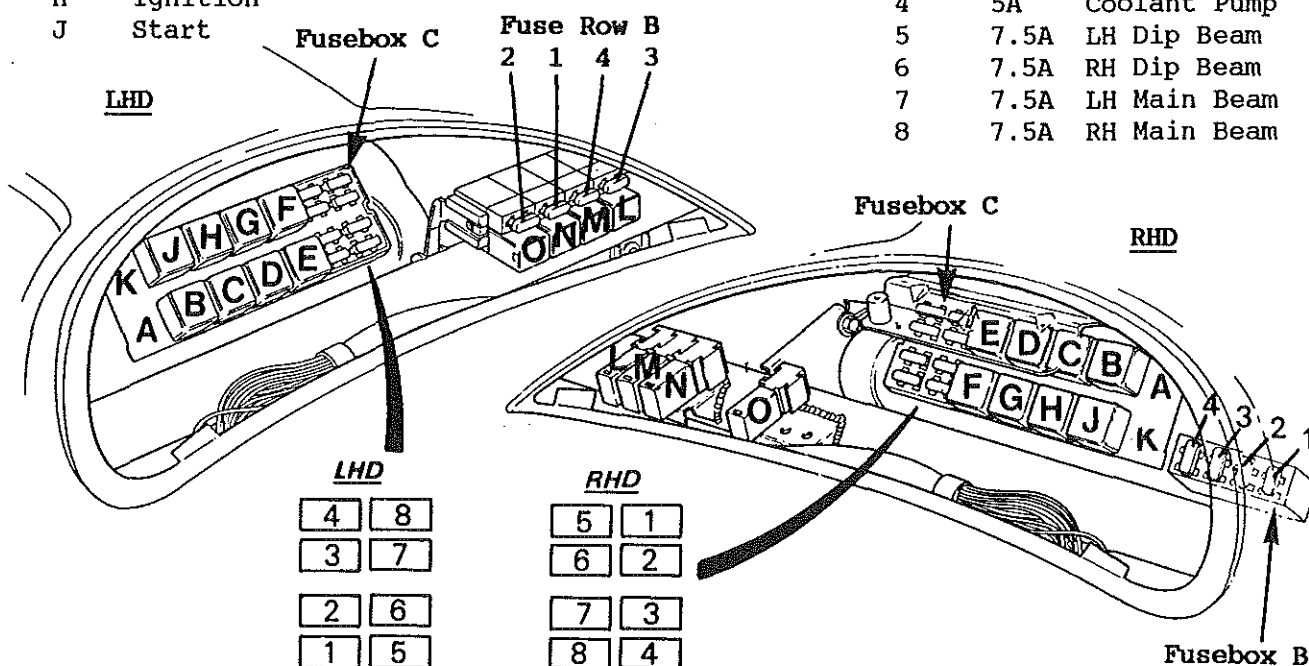
Fuses Above Instrument ClusterRelays Above Instrument Cluster

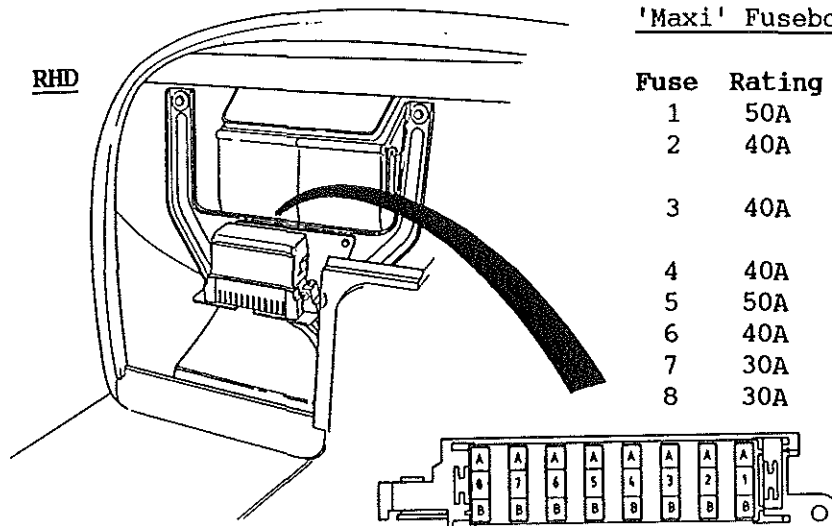
Relay	Circuit	Relay	Circuit
A	-	K	-
B	Air Conditioning	L	Rear Fog Lamps
C	Cooling Fans	M	ECM
D	Blower Fan Fast	N	Blower Fan Slow
E	Main Beam		(a/c cars only)
F	Dip Beam	O	Horns
G	Elec Coolant Pump		
H	Ignition		
J	Start		

Fuse	Rating	Circuit
1	20A	RH Window Lift
2	20A	LH Window Lift
3	15A	RH Cooling Fan
4	15A	LH Cooling Fan

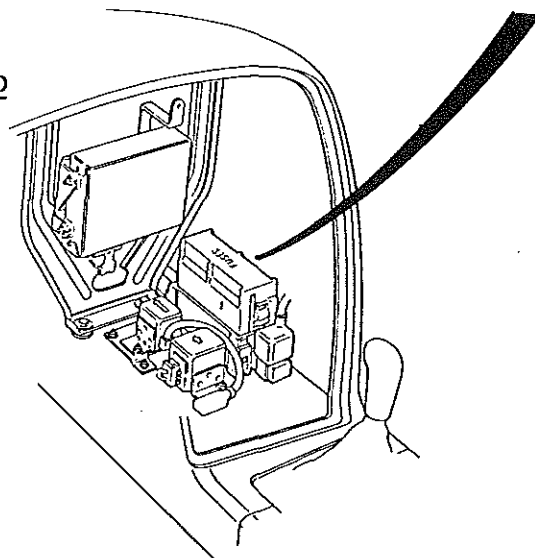
Fusebox/Row B	Rating	Circuit
1	20A	RH Window Lift
2	20A	LH Window Lift
3	15A	RH Cooling Fan
4	15A	LH Cooling Fan

Fusebox C	Rating	Circuit
1	15A	LH H/L Motor
2	15A	RH H/L Motor
3	7.5A	RHD CDL
	10A	LHD Lighting
4	5A	Coolant Pump
5	7.5A	LH Dip Beam
6	7.5A	RH Dip Beam
7	7.5A	LH Main Beam
8	7.5A	RH Main Beam



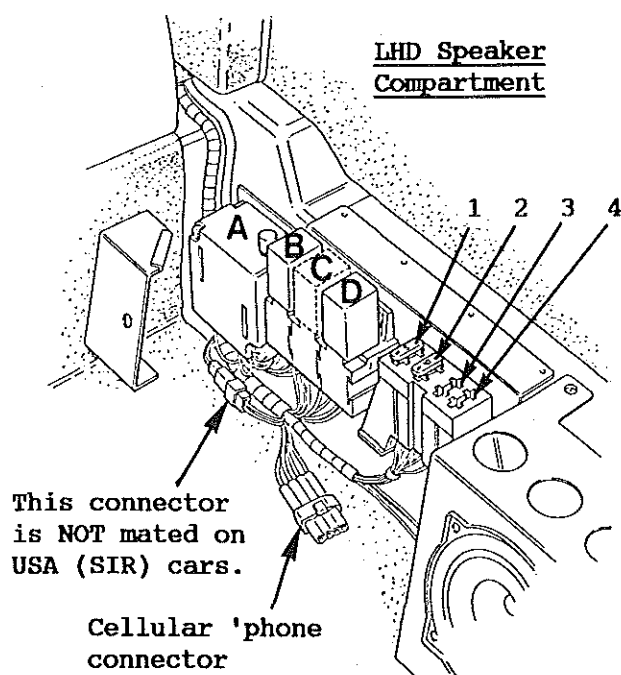
RHD'Maxi' Fusebox (D) on Tunnel Top

Fuse	Rating	Circuit
1	50A	Window Lift Motors
2	40A	Horn, A/C, Fuel Pump, Lights RHD Lights, LHD CDL
3	40A	Haz, Batt Serv, Stop Lamps, Int Lamps, Rear Fog
4	40A	Ignition Switch
5	50A	Start Relay
6	40A	H/Lamps & Mtrs, LHD Lights
7	30A	Cooling Fans Relay
8	30A	ECM

LHDFuses & Relays in Battery Compartment
& Speaker Compartment

Fuse	Rating	Circuit
1	5A	Radio
2	7.5A	Radio Antenna
3	-	'phone +12V Battery
4	-	'phone +12V Ignition

Relay	Circuit
A	Inertia Switch
B	Fuel Pump
C	Cellular 'Phone
D	Radio Feed (USA only)

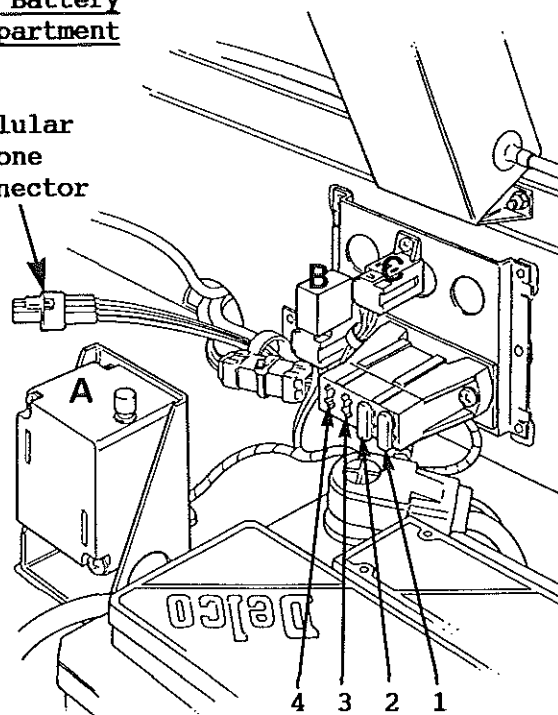
LHD Speaker
Compartment

This connector
is NOT mated on
USA (SIR) cars.

Cellular 'phone
connector

RHD Battery
Compartment

Cellular
'phone
connector



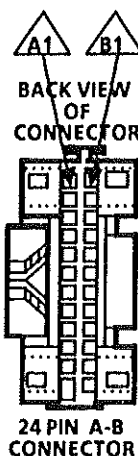
**ECM CONNECTOR IDENTIFICATION**

This ECM voltage chart is for use with a digital voltmeter to further aid in diagnosis. The voltages you get may vary due to low battery charge or other reasons, but they should be very close.

THE FOLLOWING CONDITIONS MUST BE MET BEFORE TESTING:

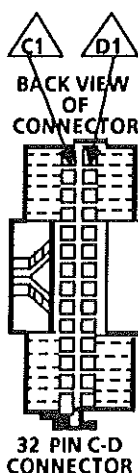
- Engine at operating temperature • Engine idling • A/C "OFF"
- ALDL Test terminal not grounded • ALDL tool not installed
- All voltages showing "B + " indicates battery or charging system voltage
- All voltages showing "0" are ground circuits, and should read less than 0.10 volts

VOLTAGE DC KEY "ON"	ENG. RUN	CIRCUIT	PIN	WIRE COLOUR
*	B +	FUEL PUMP RELAY	A1	WLG
0	0	A/C CLUTCH CONTROL	A2	KG
			A3	
			A4	
.1	B +	CHECK ENGINE LIGHT	A5	PLG
B +	B +	12 VOLT IGNITION	A6	RG
			A7	
5.0	5.0	SERIAL DATA OUTPUT	A8	OY
5.0	5.0	DIAGNOSTIC REQUEST	A9	WB
**	**	VSS SIGNAL INPUT	A10	BY
0	0	MAT-, CTS-, CO- SENSOR GROUND	A11	S
0	0	ENGINE GROUND	A12	B

J1

WIRE COLOUR	PIN	CIRCUIT	VOLTAGE DC KEY "ON"	ENG. RUN
NP	B1	12V BATTERY	B +	B +
	B2			
YB	B3	DISTRIBUTOR REFERENCE GROUND	0	0
	B4			
YR	B5	DISTRIBUTOR REFERENCE INPUT SIGNAL	0	1.0
	B6			
	B7			
KU	B8	AIR CONDITIONING REQUEST INPUT	.1	.1
	B9			
	B10			
	B11			
	B12			

			C1	
B +	0.2	SECONDARY INTAKE AIR INDUCTION	C2	WU
NOT VALID		IAC (COIL B LOW)	C3	NY
NOT VALID		IAC (COIL B HIGH)	C4	NR
NOT VALID		IAC (COIL A HIGH)	C5	NB
NOT VALID		IAC (COIL A LOW)	C6	NW
B +	B +	POWER STEERING SWITCH INPUT	C7	BU
			C8	
			C9	
***	2.4 TO 1.0	COOLANT TEMP SENSOR SIGNAL INPUT	C10	SB
2.5	0.7 TO 1.0	MAP SENSOR SIGNAL INPUT	C11	SR
***	3.0 TO 1.5	MAT SENSOR SIGNAL INPUT	C12	UB
0.4 ± 0.02	0.4 ± 0.02	TPS SIGNAL INPUT	C13	UR
5.0	5.0	+5V REFERENCE VOLTAGE OUTPUT	C14	UO
			C15	
B +	B +	12V BATTERY	C16	NP

J2

B	D1	ENGINE GROUND	0	0
BW	D2	TPS-, MAT- SENSOR GROUND	0	0
B	D3	ENGINE GROUND	0	0
Y	D4	EST OUTPUT	.1	1.2
YG	D5	HEI MODULE BYPASS CIRCUIT	0	4.5
	D6			
	D7			
SU	D8	CO-POTENTIOMETER INPUT	0.6 TO 4.2	0.6 TO 4.2
	D9			
B	D10	ENGINE GROUND	0	0
	D11			
WK	D12	EGR CONTROL	B +	B +
	D13			
	D14			
YW	D15	INJECTOR 3 & 4 DRIVE	B +	B +
OU	D16	INJECTOR 1 & 2 DRIVE	B +	B +

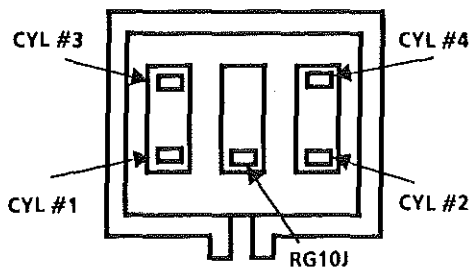
* + 12 VOLTS FOR TWO SECONDS AFTER KEY "ON", THEN 0 VOLT ...

** WHILE TURNING THE DRIVE WHEEL THE VOLTAGE ALTERNATES BETWEEN 0 AND 12 VOLTS ... *** DEPENDING ON AMBIENT TEMPERATURE

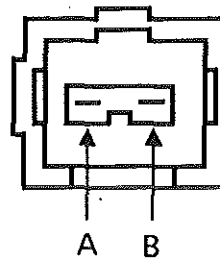
Figure EML. 4-3 - ECM Terminal End View - 1.6L LOTUS ELAN



LOTUS ELAN WIRING CONNECTOR FACE VIEWS

INJECTOR DROPPING
RESISTOR MODULE CONNECTORLOCATED AT THE LEFT HAND
SIDE OF ENGINE BAY

INJECTOR CONNECTOR



CO-POTENTIOMETER CONNECTOR

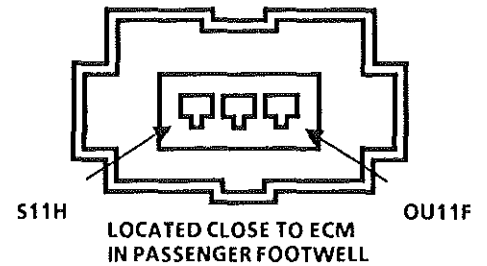
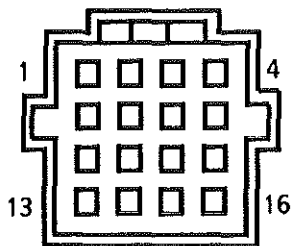
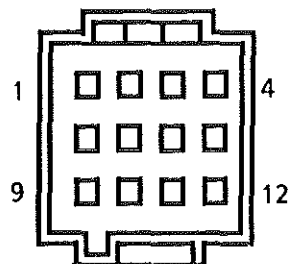
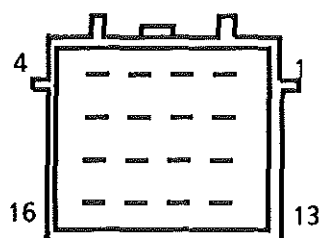
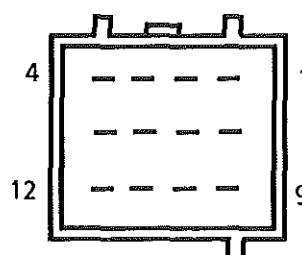
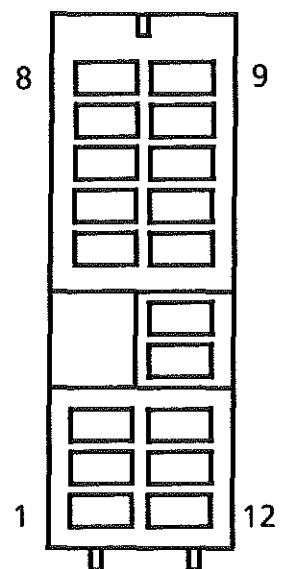
INJECTOR HARNESS CONNECTOR A
IHCA (ECM SIDE VIEW)LOCATED AT THE LEFT HAND
SIDE OF ENGINE BAYINJECTOR HARNESS CONNECTOR B
IHCB (ECM SIDE VIEW)LOCATED AT THE LEFT HAND
SIDE OF ENGINE BAYINJECTOR HARNESS CONNECTOR A
IHCA (INJECTOR SIDE VIEW)LOCATED AT THE LEFT HAND
SIDE OF ENGINE BAYINJECTOR HARNESS CONNECTOR B
IHCB (INJECTOR SIDE VIEW)LOCATED AT THE LEFT HAND
SIDE OF ENGINE BAYMAIN HARNESS CONNECTOR
MHCLOCATED UNDER INSTRUMENT
PANEL (BEHIND RADIO)

Figure EML. 4-4- Wiring Harness Connector Face Views - 1.6L LOTUS ELAN

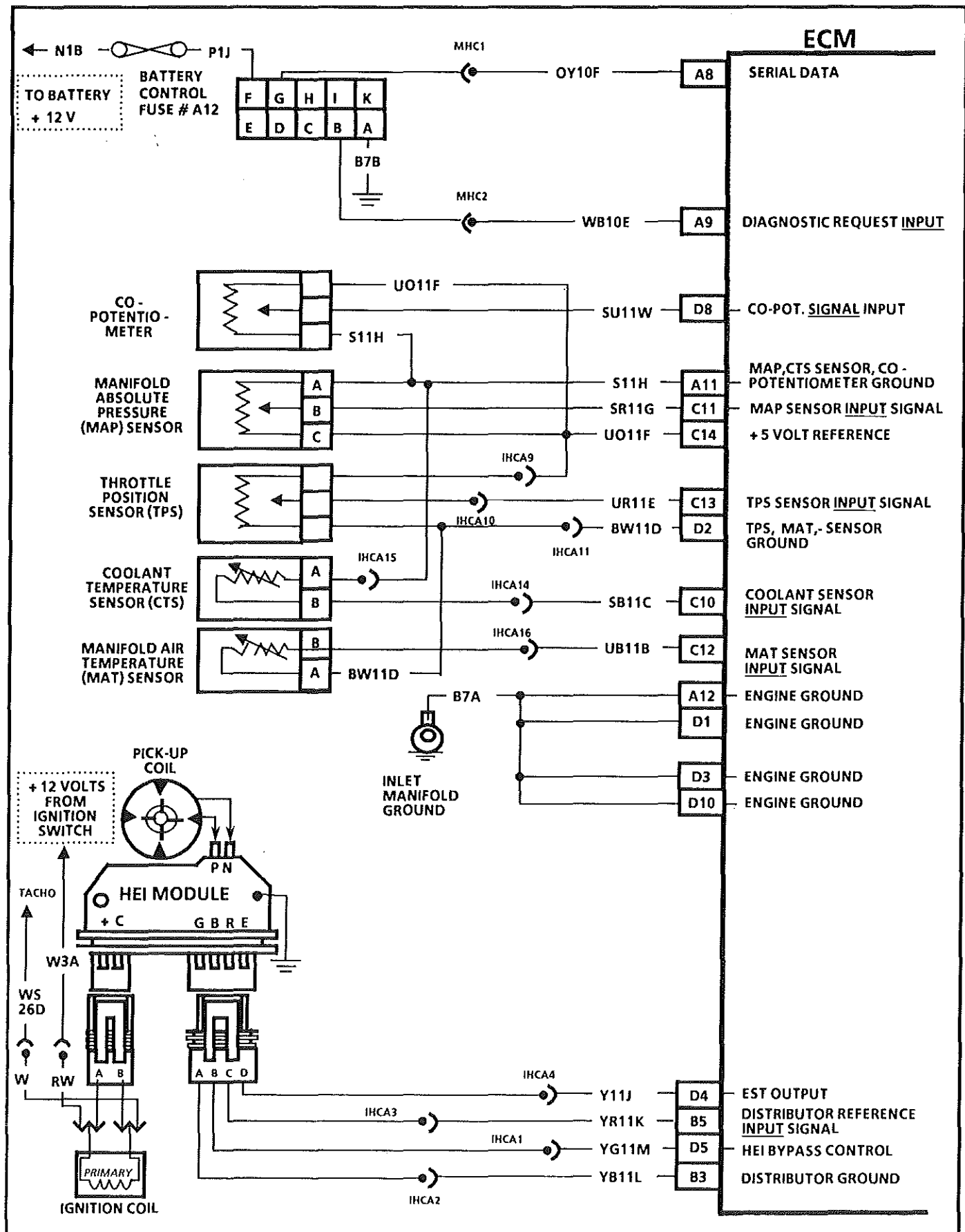


Figure EML.4 - 5 - ECM Wiring Diagram - 1.6L LOTUS ELAN (1 of 3)

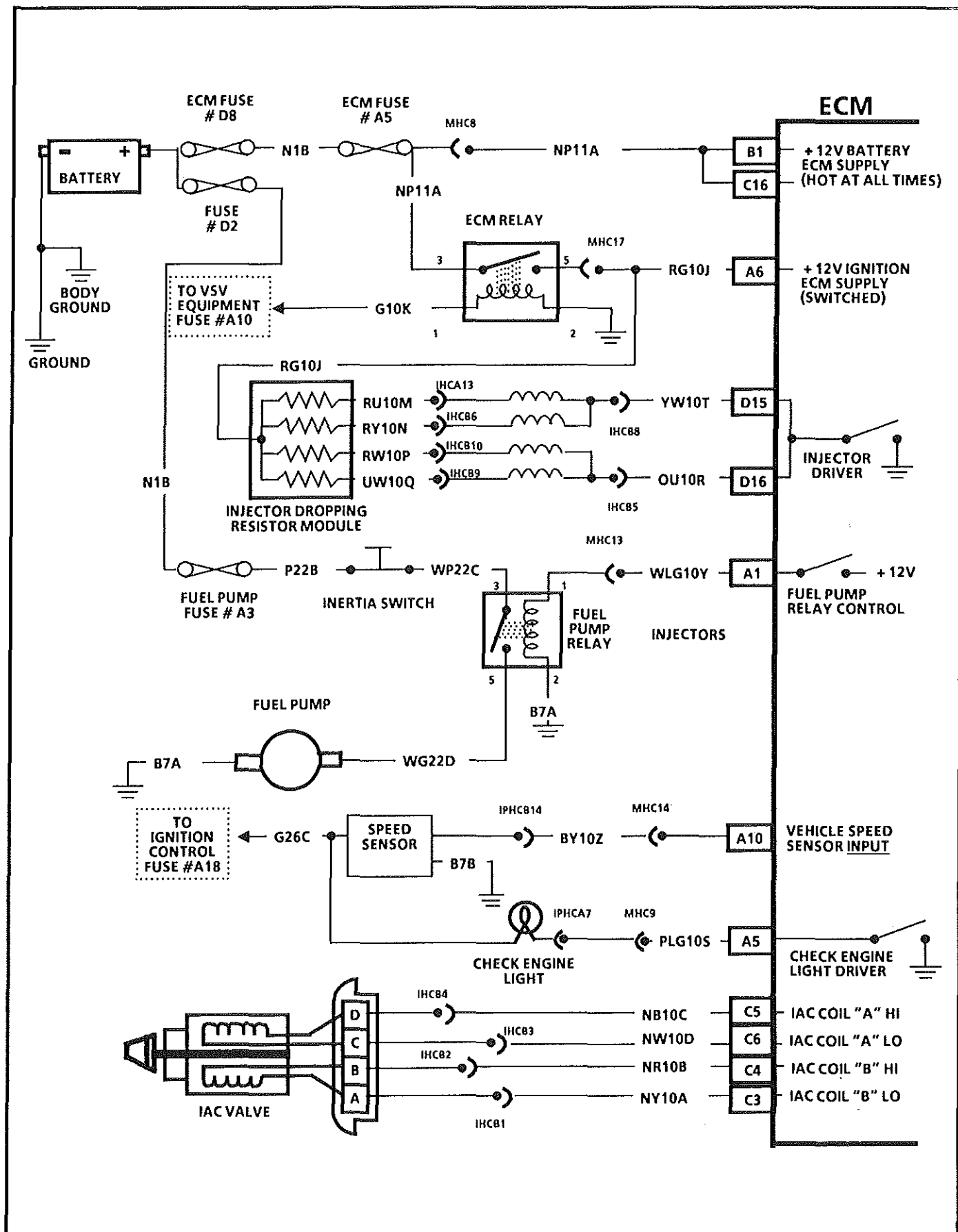


Figure EML.4 - 6 - ECM Wiring Diagram - 1.6L LOTUS ELAN (2 of 3)

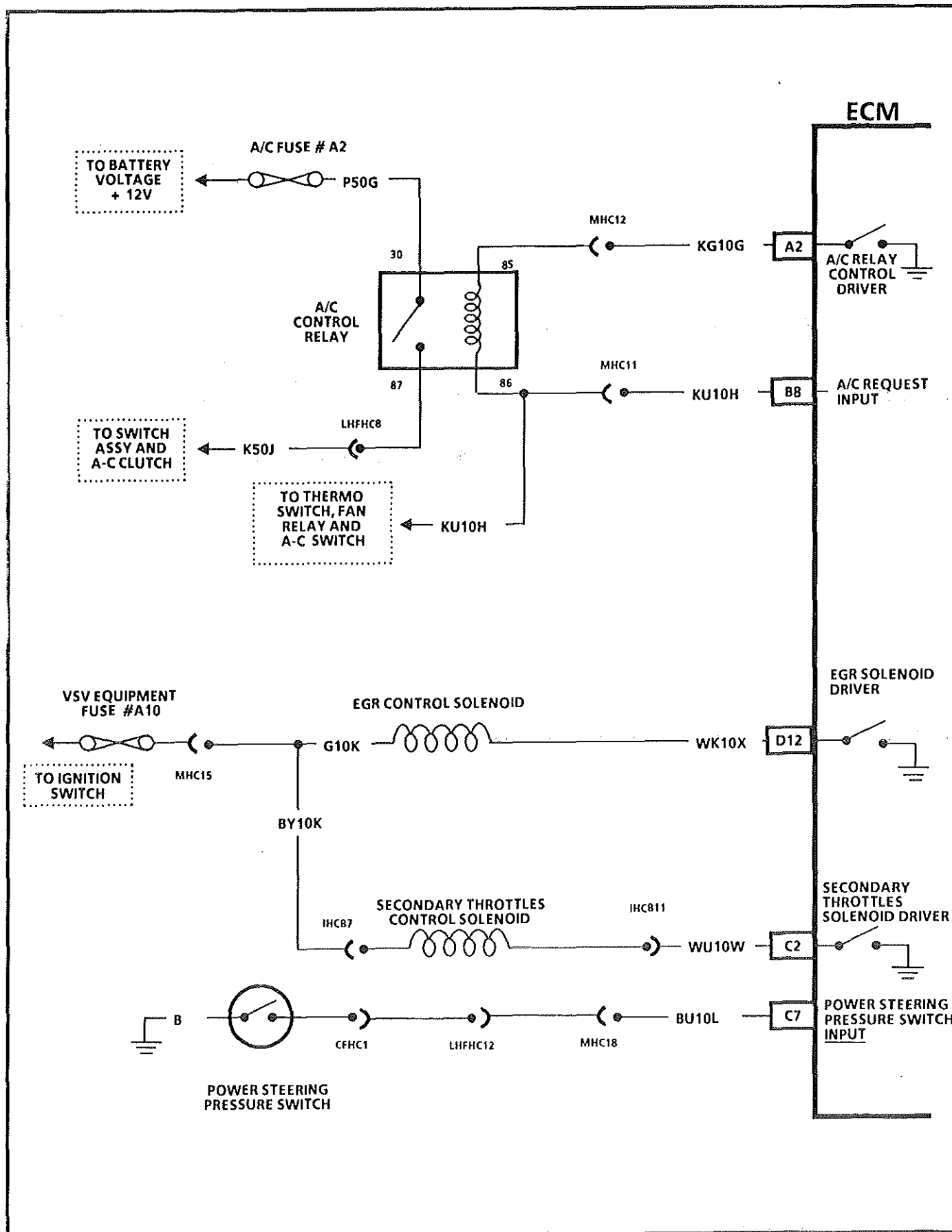


Figure EML.4 - 7 - ECM Wiring Diagram - 1.6L LOTUS ELAN (3 of 3)



DIAGNOSTIC CIRCUIT CHECK

1.6L LOTUS ELAN

The Diagnostic Circuit Check is an organized approach to identifying a problem created by an Electronic Engine Control System malfunction. It must be the starting point for any driveability complaint diagnosis, because it directs the Service Technician to the next logical step in diagnosing the complaint.

The TECH1 Data listed in figures EML.4-8 and EML.4-9 may be used for comparison, after completing the Diagnostic Circuit Check and finding the on-board diagnostics functioning properly and no trouble codes displayed. The "Typical Values" are an average of display values recorded from normally operating vehicles and are intended to represent what a normally functioning system would typically display.

Only the parameters listed in figures EML.4-8 and EML.4-9 are used in this manual for diagnosing. If TECH 1 reads other parameters, check if the correct Lotus cartridge is inserted. Check engine according to figure EML.4-8 first and correct problems referring to the charts specified. If all values are within the range illustrated, start engine, run it up to normal operating temperature and proceed checking according to figure EML.4-9

*NOTE: At "Ign. ON, Eng. OFF" the state of the "2nd Throttle Solenoid" should be "inactive" but is displayed as "active".

Eng. "OFF" / Ign. "ON" / Eng. Cold (parked overnight)

TECH 1 Position	Units Displayed	Typical Data Value (Range)	If Data Out Of Range, Refer To ...
Engine Speed	RPM	0	-
Desired Idle	RPM	depends on coolant	-
Coolant Temp.	C/F	close to ambient	Code 14 / 15 Charts
Mass Air Temp.	C/F	ambient	Code 23 / 25 Charts
MAP	kPa, V	close to baro	Code 33 / 34 Charts
BARO	kPa, V	dep. on altitude and baro	Code 33 / 34 Charts
Idle Air Control	0-255 Counts	80	-
Engine Speed	RPM	0	-
Throt. Position	V	0.40 ± 0.02 (closed)	Code 21 / 22 Chart
Throttle Angle	0 to 100%	0 closed, >95 at WOT	Code 21 / 22 Chart
Oxygen Sensor	mV	Not used	-
Inj. Pulse Width	ms	depends on coolant	-
Spark Advance	Degrees	0	-
MPH KPH	Units per hour	0 0	-
Fuel Integrator	Counts	Not used	-
Block Learn	Counts	Not used	-
Open/Closed Loop	Open/Closed Loop	Open Loop	-
Block Learn Cell	No.	Not used	-
Knock Retard	Degrees	Not used	-
Knock Signal	Yes/No	Not used	-
Battery Voltage	V	11.0 - 12.5	Check Battery Voltage
Purge Duty Cycle	Active / Inactive	Not used	-
A/C Request	Yes/No	No	-
A/C Control	On/Off	Off	-
Sync Pulses	0-255	Not used	-
Park / Neutral	P- N / - R DL	- R - DL	-
Power Steering	High Press./Normal	Normal	-
2nd Throttle Sol *	Active / Inactive	Active	-
Air Control Sol	Active/Inactive	Not used	-
EGR Solenoid	Active/Inactive	Inactive	-
CO Adj. Volts	V	0.6 - 4.2	Code 54 Chart
Wastegate D.C.	%	Not used	-
PROM ID	#	7059	PROM Specification
Time from Start	min:sec	0:00	-

Figure EML.4-8 - LOTUS TECH 1 DATA



TECH 1 DATA

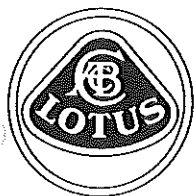
The TECH1 Data listed in figure EML.4-9 may be used for comparison, conducting the Diagnostic Circuit Check and finding the on-board diagnostics functioning properly and no trouble codes displayed. The "Typical Values" are an average of display values recorded from normally operating vehicles and are intended to represent what a normally functioning system would typically display.

IF THE TECH 1 DISPLAYS FAULTY DATA IT SHOULD NOT BE USED, AND THE PROBLEM SHOULD BE REPORTED TO THE MANUFACTURER. THE USE OF A FAULTY "TECH 1" CAN RESULT IN MISDIAGNOSIS AND UNNECESSARY PARTS REPLACEMENT.

Idle / Upper Radiator Hose Hot / Closed Throttle / A/C "OFF"

TECH 1 Position	Units Displayed	Typical Data Value (Range)	If Data Out Of Range, Refer To ...
Engine Speed	RPM	900	EML. 4-9
Desired Idle	RPM	900	-
Coolant Temp.	C/F	80 to 100	Code 14 / 15 Charts
Mass Air Temp.	C/F	20 to 60	Code 23 / 25 Charts
MAP	kPa, V	30 to 40	Code 33 / 34 Charts
BARO	kPa, V	dep. on altitude and baro	Code 33 / 34 Charts
Idle Air Control	0-255 Counts	15 - 25	EML. 4-9
Engine Speed	RPM	900	-
Throt. Position	V	0.40 ± 0.02	Code 21 / 22 Charts
Throttle Angle	0 to 100%	0	-
Oxygen Sensor	mV	Not used	-
Inj. Pulse Width	msec	1.0 - 1.5	-
Spark Advance	Degrees	8 ... 20	-
MPH KPH	Units per hour	0 0	Code 24 Chart
Fuel Integrator	Counts	Not used	-
Block Learn	Counts	Not used	-
Open/Closed Loop	Open/Closed Loop	Open Loop	-
Block Learn Cell	No.	Not used	-
Knock Retard	Degrees	Not used	-
Knock Signal	Yes/No	Not used	-
Battery Voltage	V	13.0 - 15.0	Check Battery
Purge Duty Cycle	Active / Inactive	Not used	-
A/C Request	Yes/No	No	-
A/C Control	On/Off	Off	-
Sync Pulses	0-255	Not used	-
Park /Neutral	P- N / - R DL	R - DL	-
Power Steering	High Press./Normal	Normal	-
2nd Throttle Sol	Active / Inactive	Active	EML.3-K
Air Control Sol	Active/Inactive	Not used	-
EGR Solenoid	Active/Inactive	Inactive	EMK.3-O
CO Adj. Volts	V	0.6 - 4.2	Code 54 Chart
Wastegate D.C.	%	Not used	-
PROM ID	#	7059	PROM Specification
Time from Start	min:sec	depends on time	-

Figure EML.4 - 9 - LOTUS TECH 1 DATA



ENGINE MANAGEMENT: 'TECH 1' DIAGNOSTIC CHART

ELAN - Naturally Aspirated

Date: V.I.N.: Mileage:

Reg. No.: Owner's Name:

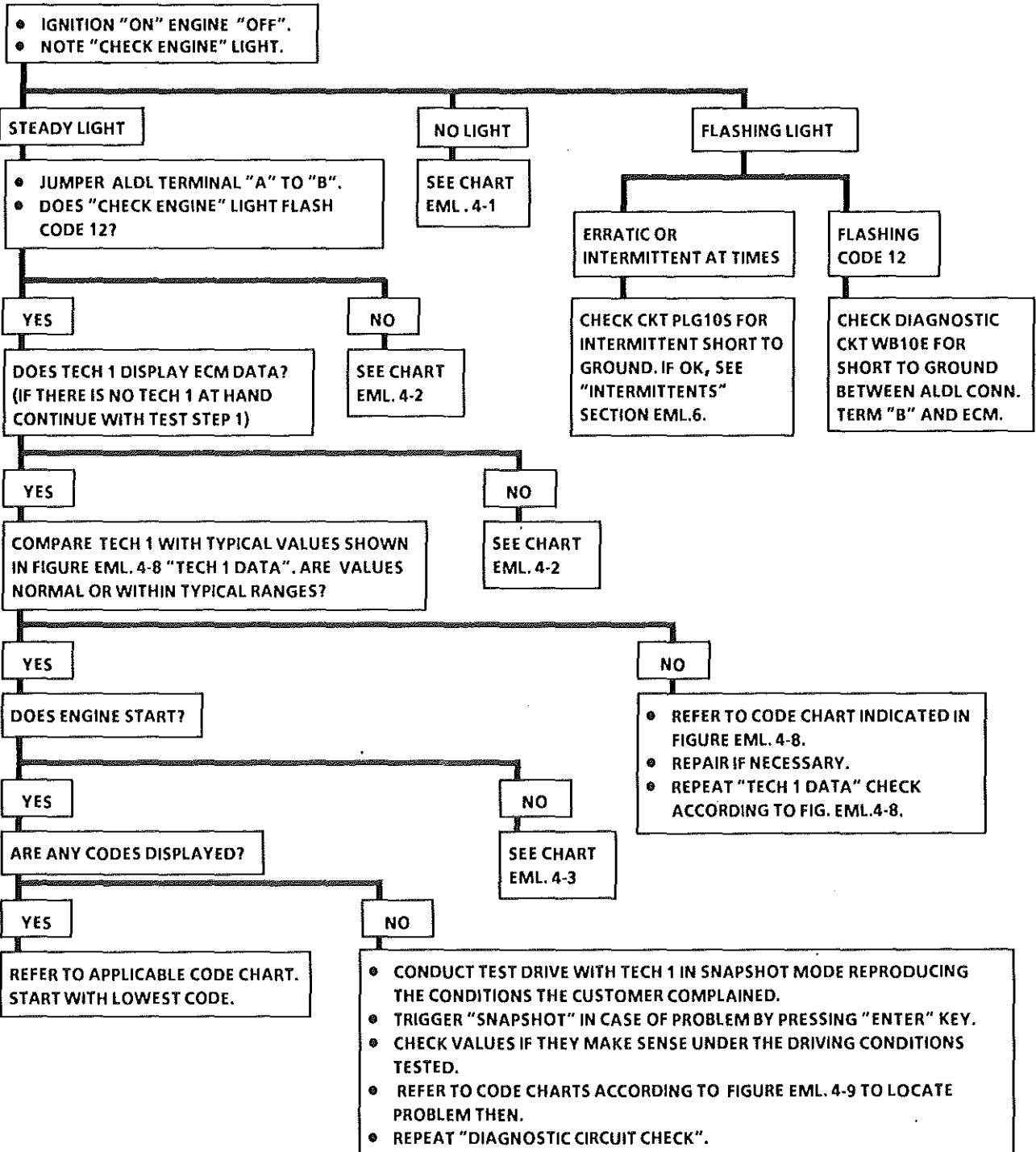
Engine 'OFF', ignition 'ON'. Engine COLD (parked overnight)			Idle. Normal running temperature Air conditioning OFF.	
Tech 1 Display	Typical Data Value (Range)	Result	Typical Data Value (Range)	Result
Engine Speed	0	.....	900	.....
Desired Idle	Depends on coolant	.....	900	.....
Coolant Temp	Close to ambient	.....	80-110°C/176-230°F	.....
Mass Air Temp	Ambient	.....	20-60°C/68-140°F	.....
MAP	Close to baro	.....	30-40 kPa/0.56-0.82 V	.....
BARO	Dep on altitude & baro	.....	Dep on altitude & baro	.....
Idle Air Control	80	.....	10 - 30	.....
Engine Speed	0	.....	900	.....
Throt Position	0.40 - 0.70 (closed)	.....	0.40 - 0.70	.....
Throttle Angle	0 closed >95 @ WOT	.....	0	.....
Oxygen Sensor	Not used	.....	Not used	.....
Inj Pulse Width	Depends on coolant	.....	1.0 - 1.5	.....
Spark Advance	0	.....	8 - 20	.....
MPH KPH	0 0	.....	0 0	.....
Fuel Integrator	Not used	.....	Not used	.....
Block Learn	Not used	.....	Not used	.....
Open/Closed Loop	OPEN LOOP	.....	OPEN LOOP	.....
Block Learn Cell	Not used	.....	Not used	.....
Knock Retard	Not used	.....	Not used	.....
Knock Signal	Not used	.....	Not used	.....
Battery Voltage	11.0 - 12.5	.....	13.0 - 15.0	.....
Purge Duty Cycle	Not used	.....	Not used	.....
A/C Request	NO	.....	NO	.....
A/C Control	OFF	.....	OFF	.....
Sync Pulses	Not used	.....	Not used	.....
Park/Neutral	-R-DL	.....	-R-DL	.....
Power Steering	NORMAL	.....	NORMAL/HIGH PRESS	.....
2nd Throttle Sol	ACTIVE*	.....	ACTIVE	.....
Air Control Sol	Not used	.....	Not used	.....
EGR Solenoid	INACTIVE	.....	INACTIVE	.....
CO Adj Volts	0.6 - 4.2	.....	0.6 - 4.2	.....
Wastegate D.C.	Not used	.....	Not used	.....
Prom ID	7059	.....	7059	.....
Time from start	0:00	.....	Depends on time	.....
Exhaust Sample Probe				
CO	-		0.5 - 1.5%	.....
HC	-		700 ppm max.	.....

* Note that with ignition 'ON' and engine 'OFF' the secondary throttle solenoid should be 'INACTIVE' (de-energised), but is displayed as 'ACTIVE'.



DIAGNOSTIC CIRCUIT CHECK

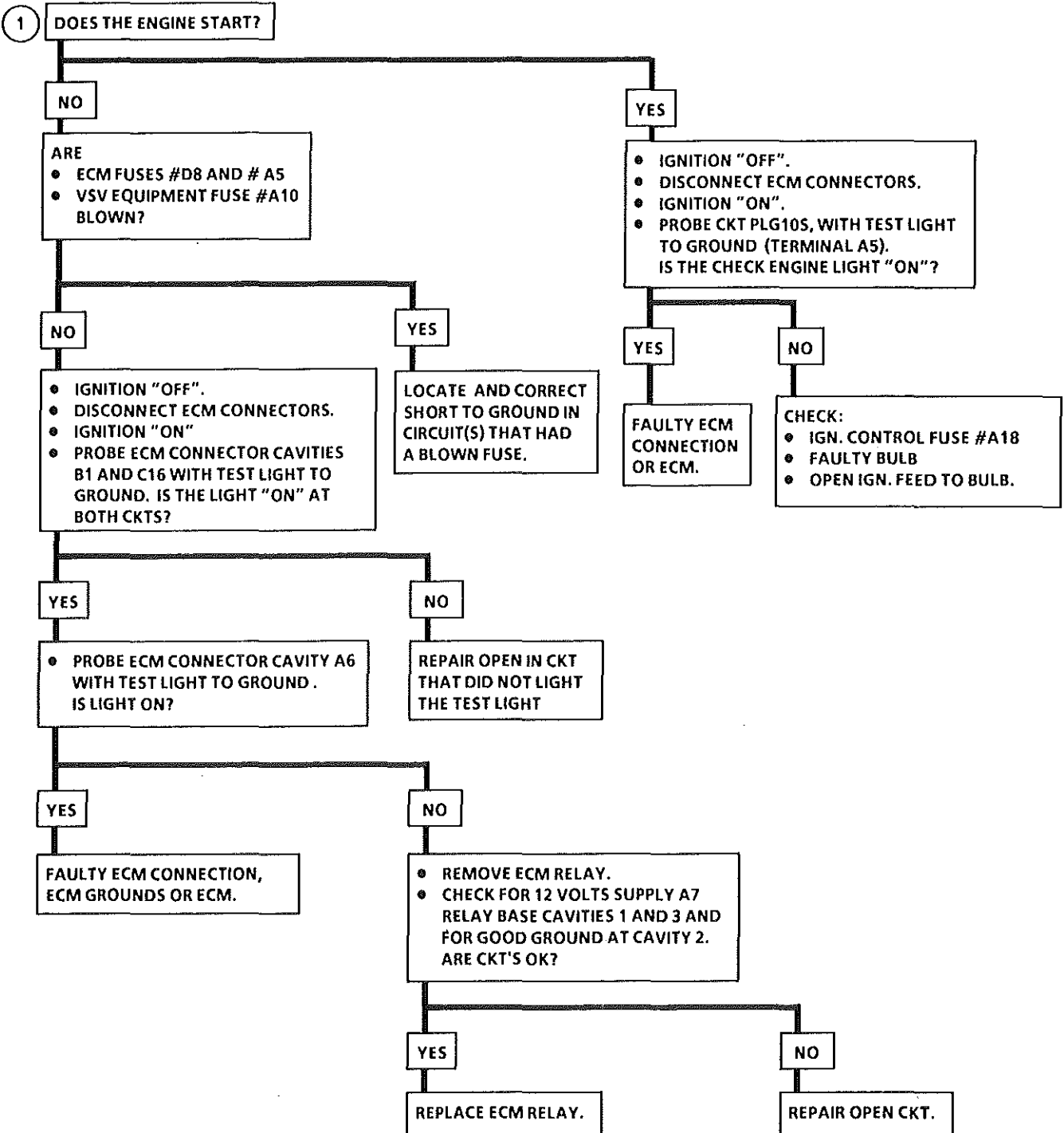
1.6L LOTUS ELAN



CLEAR CODES AND CONFIRM NO "CHECK ENGINE" LIGHT.



CHART EML.4-1 NO "CHECK ENGINE" LIGHT 1.6L LOTUS ELAN



CLEAR CODES AND CONFIRM NO "CHECK ENGINE" LIGHT.

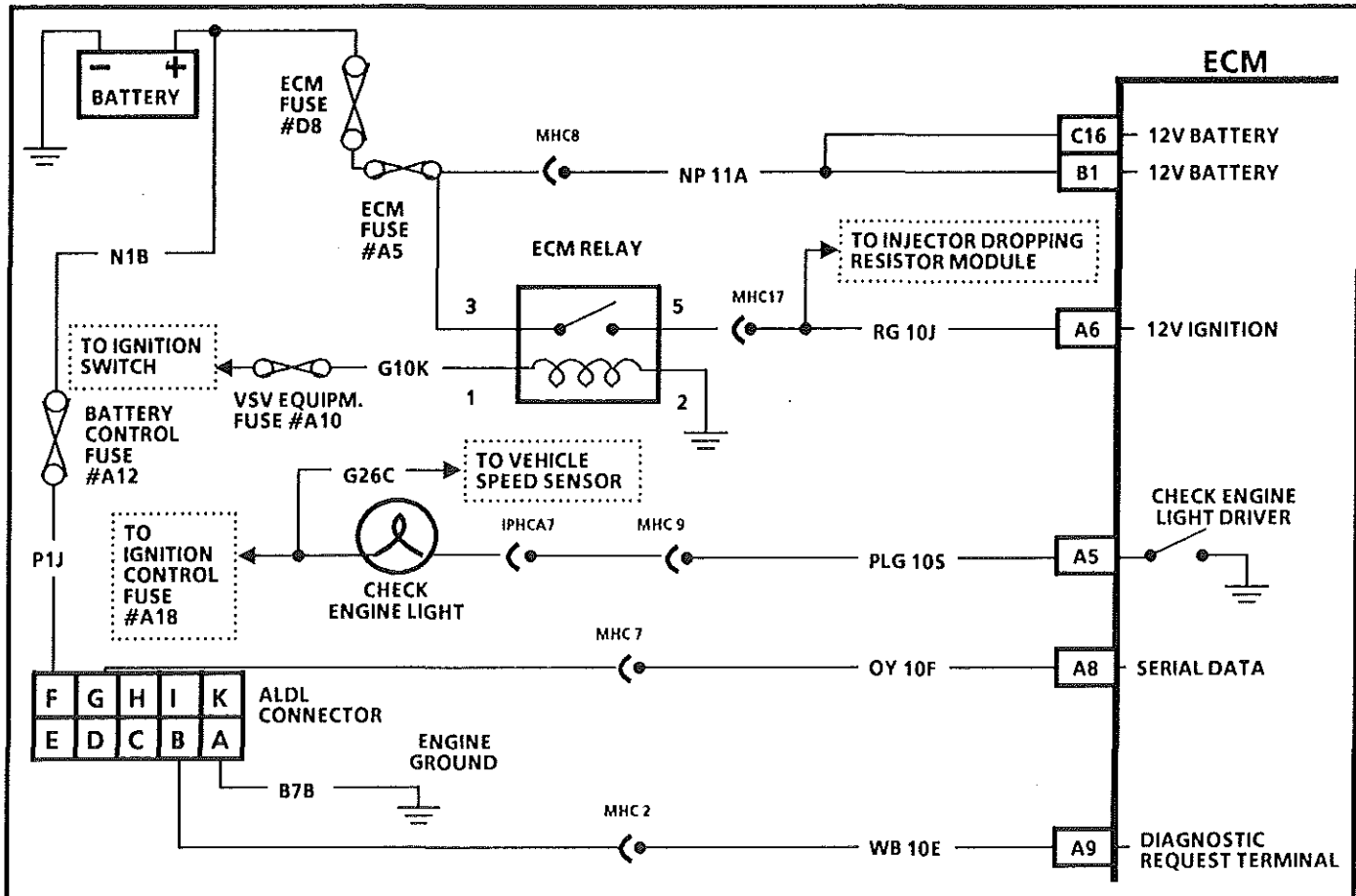


CHART EML 4-2

NO ALDL DATA OR WON'T FLASH CODE 12
("CHECK ENGINE" LIGHT ON STEADY)
1.6L LOTUS ELAN

Circuit Description:

There should always be a steady "Check Engine" light when the ignition is "ON" and engine stopped. Battery ignition voltage is supplied directly to the light bulb. The Electronic Control Module (ECM) will turn the light on by grounding CKT PLG10S to the ECM.

With the diagnostic terminal grounded, the light should flash a Code 12, followed by any trouble code(s) stored in memory.

A steady light suggests a short to ground in the light control CKT PLG10S, or an open in diagnostic CKT WB10E. The CHART EML 4-2 will confirm and suggest the cause.

Test Description: Numbers below refer to circled numbers on the diagnostic chart.

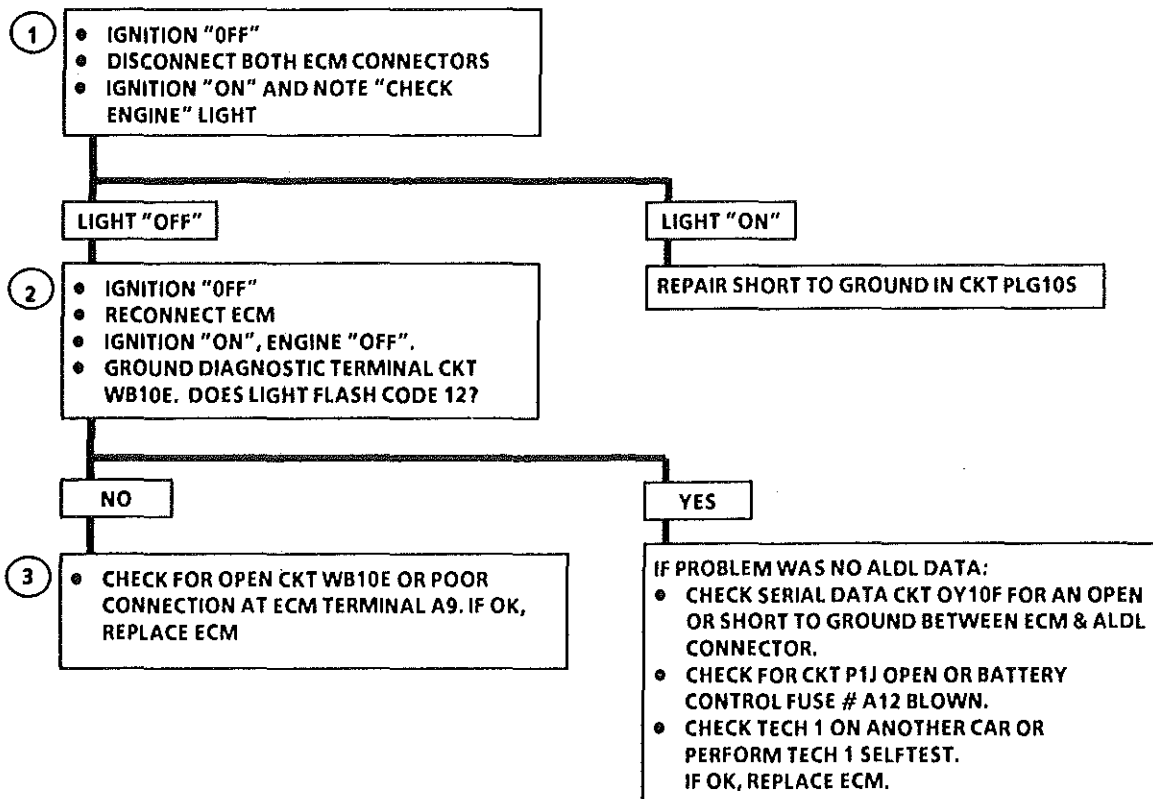
1. If the light goes off when the ECM connector is disconnected, then CKT PLG10S is not shorted to ground. Take this opportunity to physically check the connector terminals for proper contact.
2. If there is a problem with the ECM that causes the Tech 1 tool to not read serial data, then the ECM should not flash a Code 12. If Code 12 does flash,

be sure that the Tech 1 is working properly on another vehicle and/or conduct Tech 1 selftest. If the Tech 1 is functioning properly and CKT's OY10F and P1J are OK, the ECM may be at fault for the NO ALDL symptom.

3. This step will check for an open diagnostic CKT WB10E.



CHART EML. 4-2
NO ALDL DATA OR WON'T FLASH CODE 12
("CHECK ENGINE" LIGHT ON STEADY)
1.6L LOTUS ELAN



CLEAR CODES AND CONFIRM NO "CHECK ENGINE" LIGHT.

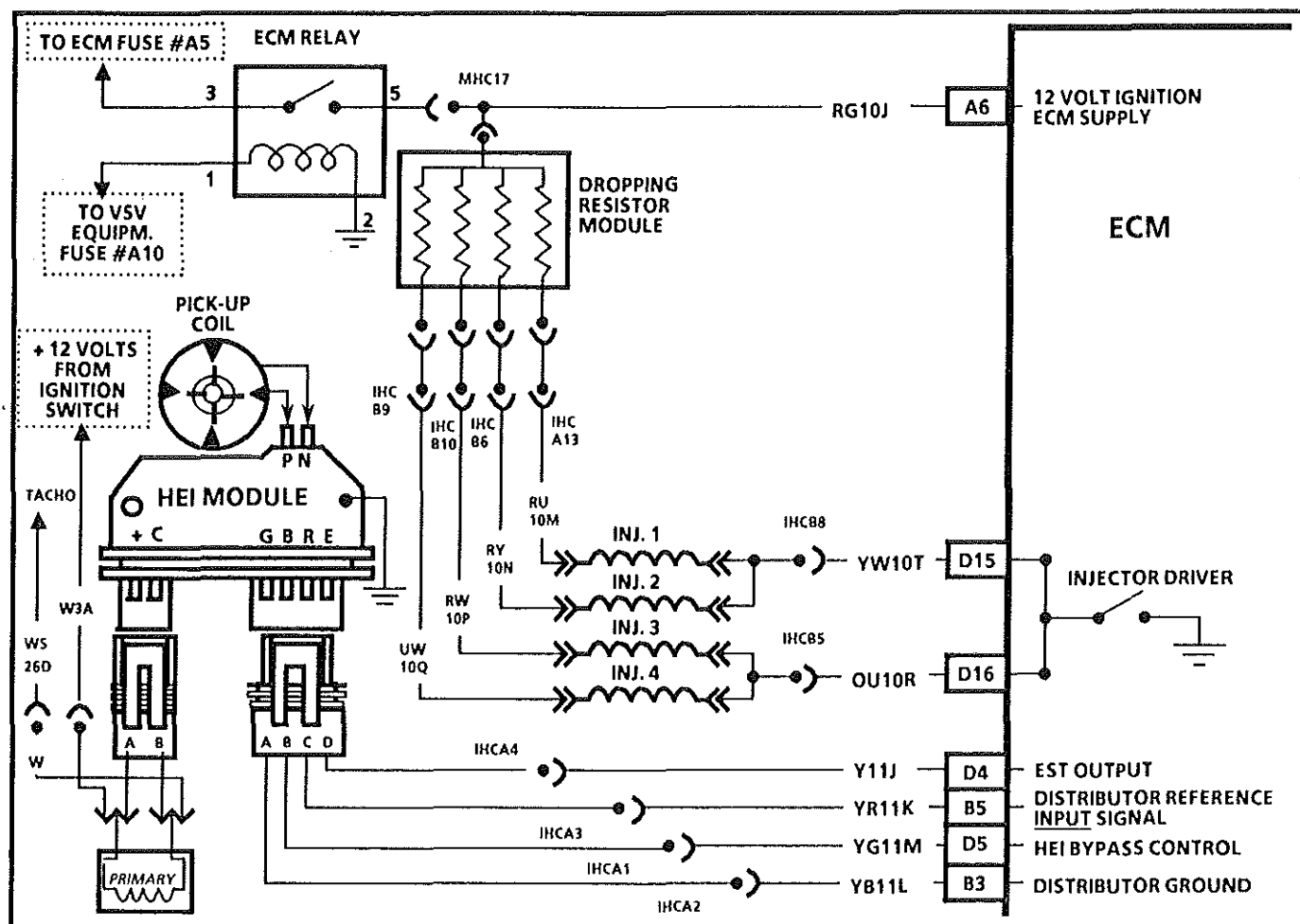


CHART EML. 4-3

(Page 1 of 3)

ENGINE CRANKS BUT WON'T RUN 1.6L LOTUS ELAN

Circuit Description:

This chart assumes that battery condition and engine cranking speed are OK, and there is adequate fuel in the tank.

Test Description:

Numbers below refer to circled numbers on the diagnostic chart.

1. A "Check Engine" light "ON" is a basic test to determine if there is a 12 volt supply and ignition 12 volts to ECM. No ALDL may be due to an ECM problem and CHART EML.4-2 will diagnose the ECM. If TPS is over 2.5 volts the engine may be in the clear flood mode which will cause starting problems.
2. The engine will not start without reference pulses and therefore the Tech 1 should read RPM during crank or a voltage greater than 0 should be indicated on terminal B5 using a voltmeter.
3. No spark may be caused by one of several components related to the Ignition System. Section EML.2-0 will address all problems related to the causes of a no spark condition.

4. The test light should blink, indicating the ECM is controlling the injectors OK. How bright the light blinks is not important. The engine may not start if only 2 injectors are functioning and therefore each injector should be tested.
5. Use fuel pressure gauge T000T0899 and test hose T000T1083 as detailed in Section EML.3 - I.

Diagnostic Aids:

- An EGR valve sticking open can cause a too lean mixture during cranking.
- An injector stuck open could flood the engine and result in a no start. In "Clear Flood" mode the engine might start. Check for fouled spark plugs.
- EST line open or grounded. See chart EML.4-10. If above are all OK, refer to Symptoms in Section EML.6, "Hard Start".

**CHART EML. 4-3**

(Page 1 of 3)
**ENGINE CRANKS BUT WON'T RUN
1.6L LOTUS ELAN**

1

- FUEL QUANTITY OK.
- IGNITION "ON". IF "CHECK ENGINE" LIGHT IS "OFF", SEE CHART EML. 4-1.
- INSTALL TECH 1 TOOL. IF "NO ALDL", SEE CHART EML. 4-2
- CHECK TECH 1 DATA ACCORDING TO FIGURE EML.4-8. ARE DATA WITHIN RANGE SPECIFIED?

YES

- DISCONNECT INJECTOR DROPPING RESISTOR MODULE
- IGNITION "OFF" FOR 10 SECONDS
- IGNITION "ON". LISTEN FOR IN-TANK FUEL PUMP.
- PUMP SHOULD RUN FOR 2 SECONDS AFTER IGNITION "ON". DOES IT?

YES

2

- CHECK "ENGINE SPEED" ON TECH 1 WHILE CRANKING. SPEED INDICATED? (IF NO TECH 1 AVAILABLE:
- IGNITION ON
- VOLTMETER ON AC SCALE
- BACKPROBE ECM CONNECTOR TERMINAL B5 WITH VOLTMETER TO GROUND. SHOULD BE .7 VOLTS AC OR MORE WHILE CRANKING.

YES

3

- INSTALL SPARK TESTER T000T0901 AT DISTRIBUTOR CENTER WIRE.
- CHECK FOR SPARK WHILE CRANKING.

SPARK PRESENT

4

- RECONNECT INJECTOR DROPPING RESISTOR MODULE.
- INSTALL INJECTOR TESTER T000T0900 AT EACH INJECTOR CONNECTOR.
- CRANK ENGINE AND OBSERVE TEST LIGHT. SHOULD BLINK ON ALL TESTS.

BLINKING LIGHT ON ALL

- WITH DVM ON 200 OHM SCALE MEASURE RESISTANCE OF INJECTORS. SHOULD BE BETWEEN 1.6 AND 2.2 OHMS*. IS IT?

YES

5

- IGNITION "OFF".
- INSTALL FUEL PRESSURE GAUGE AND NOTE PRESSURE WHILE CRANKING ENGINE. SHOULD BE 280-325 kPa (40-47 psi) AND SHOULD HOLD WHEN ENGINE STOPS.

OK

- SEE DIAGNOSTIC AIDS ON FACING PAGE FOR ADDITIONAL ITEMS TO CHECK. IF ALL OK, FUEL INJECTION SYSTEM OK. REFER TO "HARD START" IN SECTION EML.6

NOT OK

SEE CHART EML. 4-7

NO

REFER TO SYSTEM CHECKS AS INDICATED IN FIGURE EML.4-8

NO

SEE CHART EML. 4-5

NO

SEE CHART EML. 4-3 (3 OF 3)

NO SPARK

CHECK FOR BATT. VOLTAGE TO IGNITION SYSTEM. IF OK, THERE IS A BASIC IGNITION SYSTEM PROBLEM. SEE EML.3-M.

BLINKING LIGHT NOT ON ALL

SEE CHART EML.4-3 (2 OF 2)

NO

REPLACE INJECTOR

* NOTE: INJECTOR RESISTANCE SPECIFICATION IS AT 60°C (140°F) AND MAY BE SLIGHTLY HIGHER IF THE INJECTOR IS HOTTER

CLEAR CODES AND CONFIRM NO "CHECK ENGINE" LIGHT.

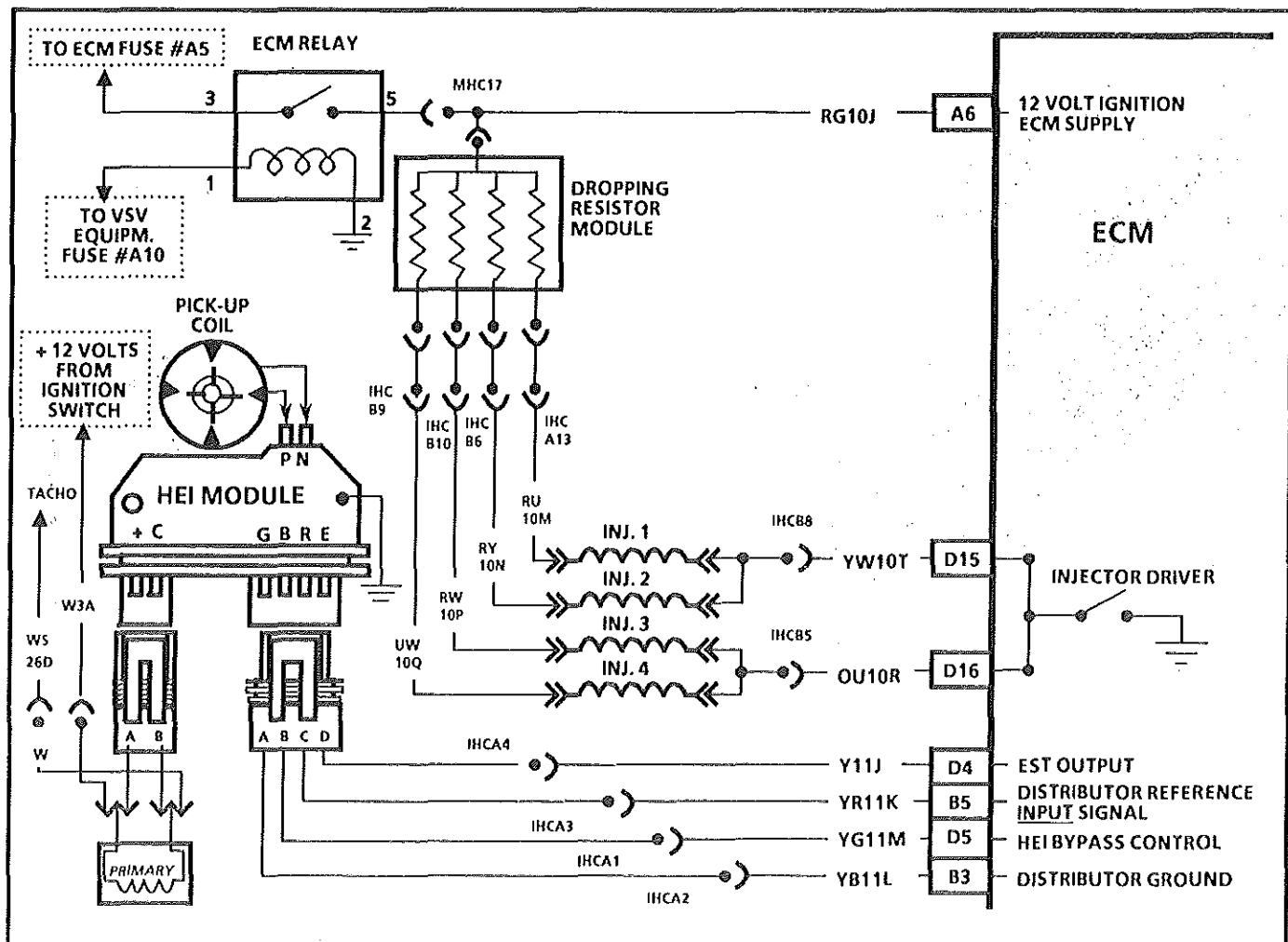


CHART EML.4-3

(Page 2 of 3)
ENGINE CRANKS BUT WON'T RUN
1.6L LOTUS ELAN

Circuit Description:

This chart assumes that battery condition and engine cranking speed are OK, and there is adequate fuel in the tank.

Test Description:

- This test determines if the problem is caused either by a faulty Dropping Resistor Module or open circuits or the ECM.

Diagnostic Aids:

- An EGR valve sticking open can cause a too lean mixture during cranking.
- An injector stuck open could flood the engine and result in a no start. In "Clear Flood" mode the engine might start. Check for fouled spark plugs.

If above are all OK, refer to Symptoms in Section EML.6, "Hard Start".

**CHART EML. 4-3**

(Page 2 of 3)
ENGINE CRANKS BUT WON'T RUN
1.6L LOTUS ELAN

FROM
 CHART
 EML. 4-3
 (1 OF 3)

NO BLINKING LIGHT AT ONE OR
 MORE INJECTORS TESTED

NO LIGHT

STEADY LIGHT

6

- IGNITION "ON"
- PROBE INJECTOR CONNECTOR TERMINAL A OF EACH INJECTOR WITH A TEST LIGHT TO GROUND
- LIGHT SHOULD BE "ON" AT ALL TERMINALS.

- CHECK INJECTOR DRIVER CKT WITH STEADY LIGHT FOR SHORT TO GROUND.

OK

FAULTY ECM

NOT OK

REPAIR SHORT TO GROUND.

LIGHT "OFF" ALL

- DISCONNECT DROPPING RESISTOR MODULE CONNECTOR
- IGNITION "ON"
- CHECK CKT RG10J FOR 12 VOLT SIGNAL FROM ECM RELAY BY USING A TEST LIGHT CONNECTED TO GROUND.

OK

REPLACE RESISTOR MODULE

NOT OK

REPAIR OPEN CKT RG10J

LIGHT "ON" ALL

- RECONNECT INJECTOR(S)
- IGNITION "OFF"
- DISCONNECT ECM
- IGNITION "ON"
- PROBE TERMINALS D15 AND D16 WITH A TEST LIGHT TO GROUND

LIGHT "ON"

POOR CONNECTION OR
 FAULTY ECM

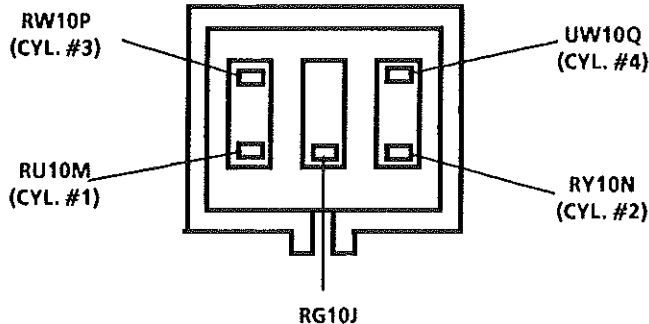
LIGHT "ON" LESS THAN ALL

- CHECK FOR OPEN CKT RU10M OR RY10N OR RW10P OR UW10Q. IF OK, FAULTY INJECTOR DROPPING MODULE.

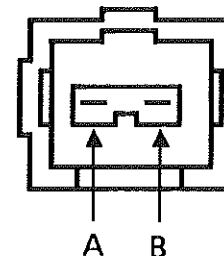
LIGHT "OFF"

OPEN CKT YW10T OR OU10R

DROPPING RESISTOR MODULE CONNECTOR



INJECTOR CONNECTOR



CLEAR CODES AND CONFIRM NO "CHECK ENGINE" LIGHT.

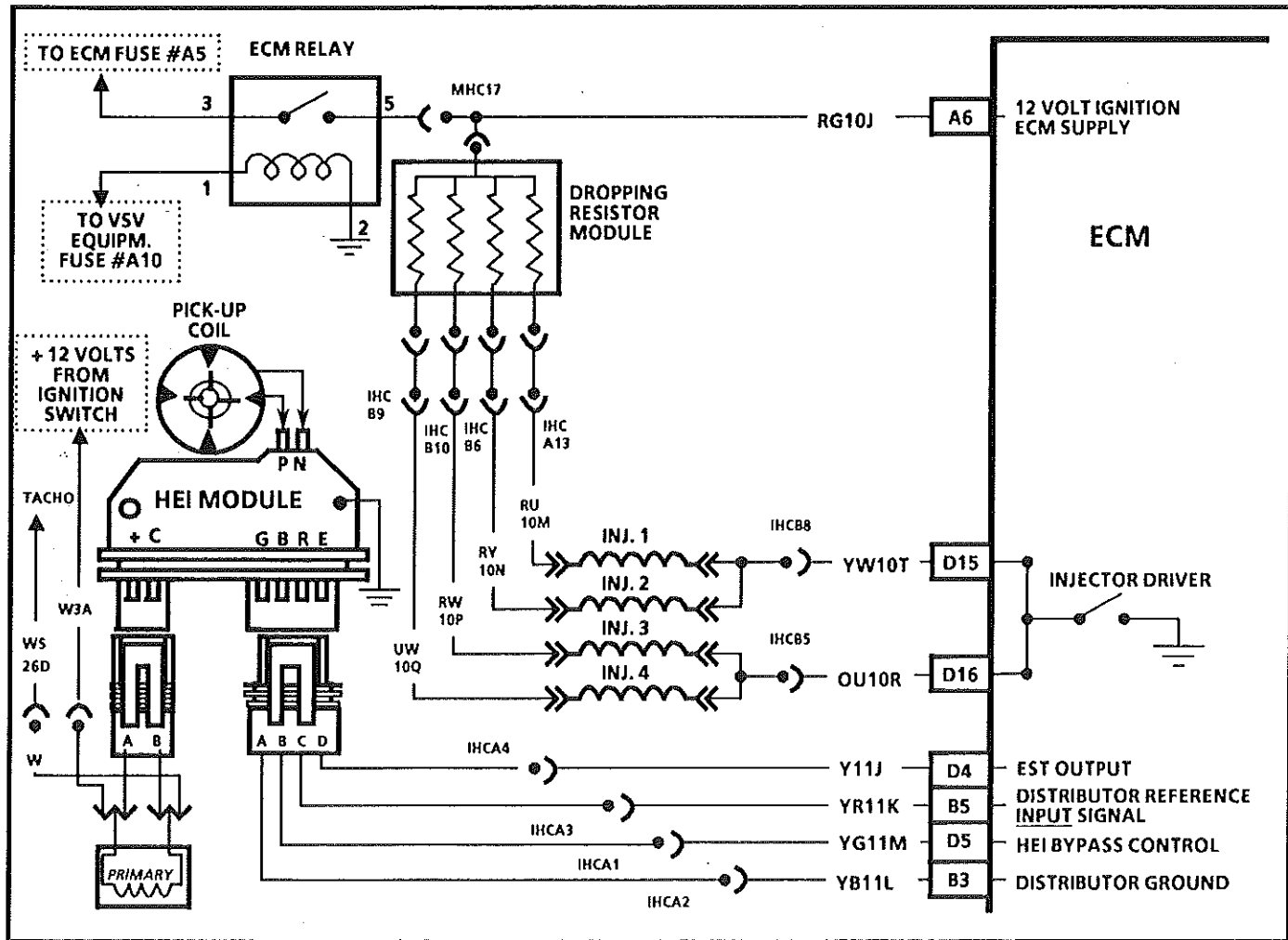


CHART EML.4 - 3

(Page 3 of 3) ENGINE CRANKS BUT WON'T RUN 1.6L LOTUS ELAN

Circuit Description:

This chart assumes that battery condition and engine cranking speed are OK, and there is adequate fuel in the tank.

Test Description:

- Use reverse lamp switch connector for 12 volts supply. The connector is located below the air filter. Make sure to reconnect reverse lamp connector again after testing.

(GREEN) REVERSE LAMP
SWITCH CONNECTOR



**CHART EML. 4-3**

(Page 3 of 3)
**ENGINE CRANKS BUT WON'T RUN
1.6L LOTUS ELAN**

FROM
CHART
EML. 4-3
(1 OF 3)

7

- IGNITION "OFF".
- DISCONNECT DISTRIBUTOR 4-WAY CONNECTOR.
- IGNITION "ON".
- MOMENTARILY TOUCH HARNESS CONNECTOR TERMINAL "C", CKT YR11K WITH A TEST LIGHT CONNECTED TO 12 VOLTS.
- TECH 1 SHOULD INDICATE RPM WHEN TEST IS PERFORMED. DOES IT?
- IF NO TECH 1 IS AVAILABLE:
INSTALL INJECTOR TESTER T000T0901 AT INJECTOR HARNESS CONNECTOR CYL. 1. LIGHT SHOULD BLINK. DOES IT?

YES

- RE-CONNECT 4-WAY PLUG.
 - REMOVE DISTRIBUTOR CAP
 - DISCONNECT YELLOW CONNECTOR AT IGNITION MODULE.
 - TOUCH LOWER MODULE PIN WITH TEST LIGHT CONNECTED TO 12 VOLTS.
 - TECH 1 SHOULD INDICATE RPM WHEN TEST IS PERFORMED. DOES IT?
- IF NO TECH 1 AVAILABLE:
- INJECTOR TESTER STILL CONNECTED TO INJECTOR HARNESS SHOULD BLINK WHEN TEST LIGHT TOUCHES MODULE PIN. DOES IT?

YES

FAULTY PICK-UP COIL

NO

CHECK CKT YR11K FOR
OPEN OR SHORTED TO
GROUND.
IF OK, FAULTY ECM.

NO

FAULTY IGNITION
MODULE

CLEAR CODES AND CONFIRM NO "CHECK ENGINE" LIGHT.

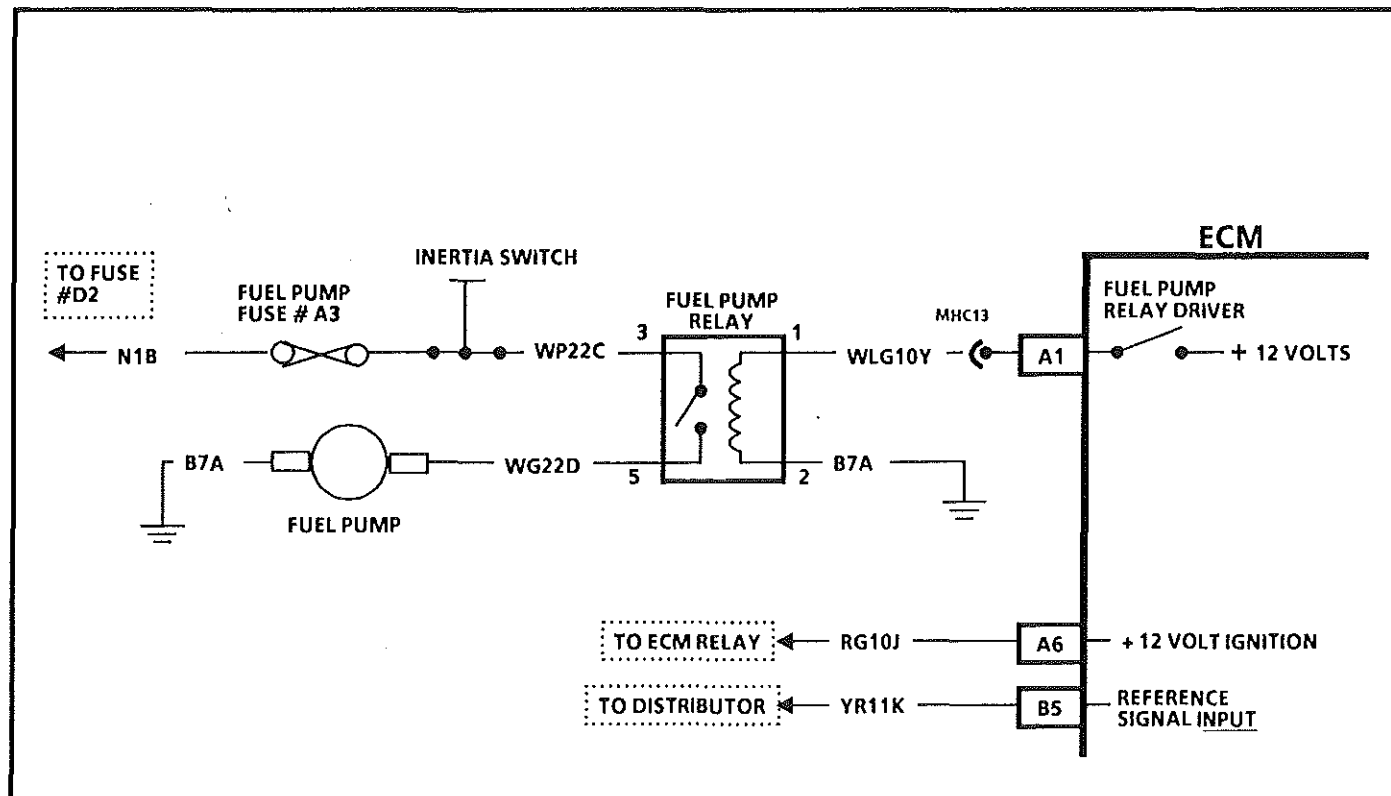


CHART EML. 4-5

FUEL PUMP RELAY CIRCUIT 1.6L LOTUS ELAN

Circuit Description:

When the ignition switch is turned "ON", the Electronic Control Module (ECM) energizes its fuel pump relay control output. It will provide +12 volts to the fuel pump relay, as long as the engine is cranking or running, and the ECM is receiving distributor reference input signal pulses.

If there are no distributor reference pulses, (key "ON", engine stopped) the ECM will shut "OFF" the fuel pump relay within 2 seconds.

Test Description:

Numbers below refer to circled numbers on the diagnostic chart.

1. If one of the fuses is blown, this test will check for short to ground on CKT WP22D. To prevent mis-diagnosis, be sure fuel pump is disconnected and ignition is "OFF" before performing this test.
2. Checks if fuel pump supplies fuel to the fuel rail.

Diagnostic Aids:

See figures EML. 4-1 and EML. 4-2 for location of fuses and relays.



CHART EML. 4-5

FUEL PUMP RELAY CIRCUIT

1.6L LOTUS ELAN

- IGNITION "OFF" FOR 10 SECONDS. INERTIA SWITCH CLOSED
- IGNITION "ON" LISTEN FOR IN-TANK FUEL PUMP
- PUMP SHOULD RUN FOR 2 SEC. AFTER IGNITION "ON". DOES IT?

NO

IS FUEL PUMP FUSE #A3 OR #D2 BLOWN?

NO

2

- DISCONNECT FUEL PUMP RELAY
- INSTALL PRESSURE GAUGE AS DETAILED IN SECTION EML.3 - I.
- JUMPER RELAY BASE CAVITIES 3 & 5 PRESSURE SHOULD BE 280 - 325 KPA. IS IT?

YES

- PROBE RELAY BASE TERMINAL 3 WITH A TEST LIGHT TO GROUND.

LIGHT "ON"

CONNECT A TEST LIGHT BETWEEN RELAY BASE TERMINALS 3 AND 2 (CKT WP22C & B7A)

LIGHT "ON"

- CONNECT TEST LIGHT BETWEEN TERMINAL 1 (CKT WLG10Y) AND GROUND.
- IGN. "OFF" FOR 10 SECONDS.
- NOTE TEST LIGHT DURING 2 SECONDS AFTER IGN. "ON".

LIGHT "ON"

FAULTY RELAY

YES

NO TROUBLE FOUND.

YES

1

- DISCONNECT FUEL PUMP ELECTRICAL CONNECTOR AND FUEL PUMP RELAY.
- PROBE FUEL PUMP RELAY CKT WG22D WITH A TEST LIGHT CONNECTED TO 12 VOLTS.

LIGHT "OFF"

- REPLACE FUEL PUMP FUSE AND RECONNECT FUEL PUMP RELAY.
- IGNITION "ON" AND RECHECK FUSE

FUSE "OK"

- IGNITION "OFF"
- RECONNECT FUEL PUMP
- IGNITION "ON"
- RECHECK FUSE

FUSE "OK"

PROBLEM WAS AN INTERMITTENT SHORT TO GROUND IN FUEL PUMP CIRCUIT.

LIGHT "ON"

REPAIR SHORT TO GROUND IN CKT WG22D

FUSE "NOT OK"

REPLACE FUEL PUMP RELAY

FUSE "NOT OK"

SHORTED FUEL PUMP

SEE CHART EML. 4-7

LIGHT "OFF"

CHECK FOR OPEN CKT WP22C. IF OK FAULTY INERTIA SWITCH.

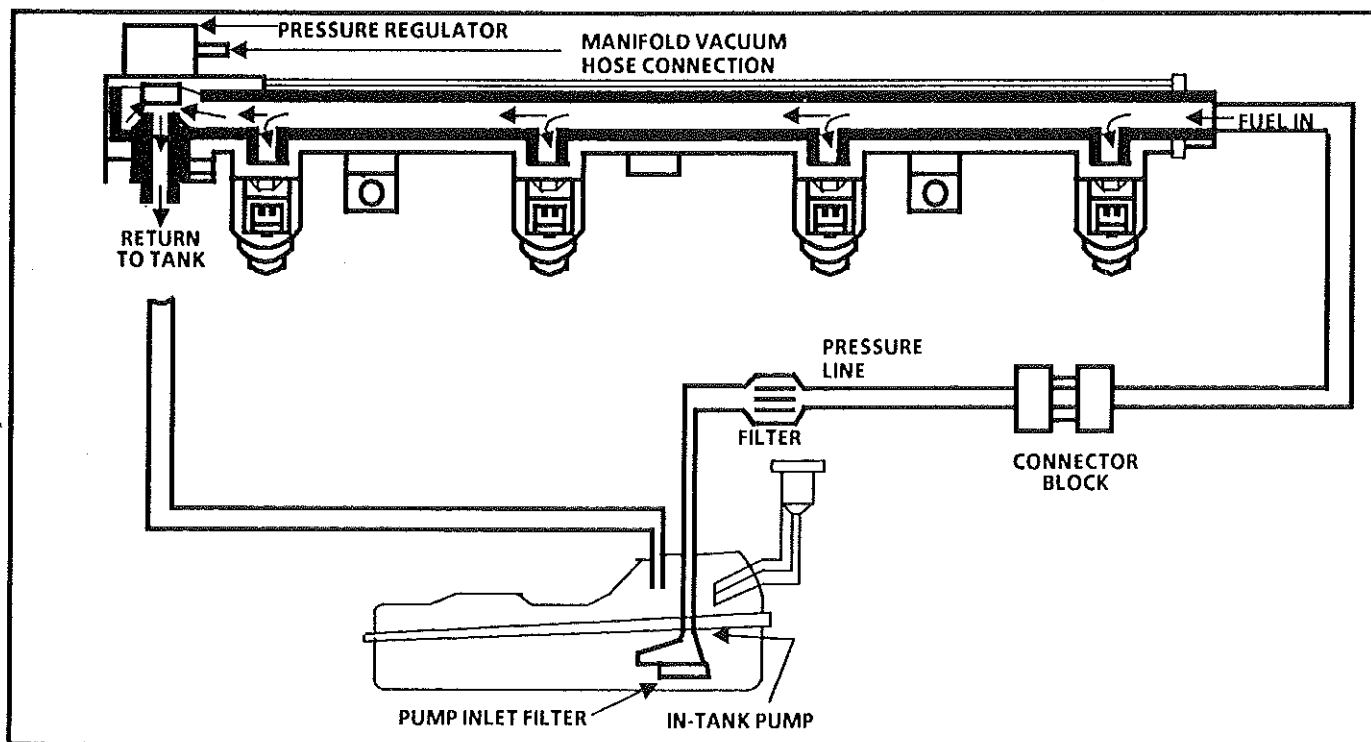
LIGHT "OFF"

REPAIR OPEN GROUND CIRCUIT

LIGHT "OFF"

CHECK FOR OPEN OR SHORT TO GROUND IN CKT WLG10Y. IF OK, IT'S A FAULTY ECM.

CLEAR CODES AND CONFIRM NO "CHECK ENGINE" LIGHT.

**CHART EML. 4-7**

(Page 1 of 2)

**FUEL DELIVERY SYSTEM
1.6L LOTUS ELAN****Circuit Description:**

Fuel is drawn from the tank by the electric fuel pump and is fed under pressure through a fuel filter and continues on into the fuel rail and then is injected into the ports through the fuel injectors.

Fuel pressure in the system is governed by the pressure regulator, in such a manner that a certain pressure difference between fuel pressure and inlet manifold pressure is maintained. Excess fuel above the regulated pressure is returned to the fuel tank by the pressure regulator and the fuel return lines.

- Continued on Chart EML. 4-7 (Page 2 of 2) -

Test Description: Numbers below refer to circled numbers on the diagnostic chart.

1. If the engine does not start, be sure to start with CHART EML. 4-3 to prevent misdiagnosis.
2. Ⓢ is to purge any air from the lines after installing the gauge. It also serves to cool the fuel rail for more accurate pressure testing if the engine is hot. Ⓢ is to allow the ECM to "power down", so the next time the ignition is turned "ON", the ECM will energize its fuel pump relay control for 2 seconds. Ⓢ & Ⓢ indicate what the pressure should do when the ignition is turned "ON". There are two things to note: (A) - pressure reading, and (B) - that the pressure does not continue to drop after the pump stops running.
3. At this point, the regulated pressure should be within specification, and the pressure does not drop when the pump stops running. This check

is to see if the pressure regulator will modulate the regulated fuel pressure when the vacuum signal to it changes. During normal engine operation, the regulated pressure can change, based on intake manifold pressure. When the manifold pressure is at its lowest (engine idling), fuel pressure will be at its lowest regulated pressure. When intake manifold pressure is at its highest (wide open throttle), regulated fuel pressure will be at its highest regulated pressure.

4. If the pressure continues to drop after the pump stops running, there is a leak somewhere. Either the check valve in the pump is leaking pressure back into the tank, the regulator has an internal leak allowing fuel to leak from the pressure side to the return side, or an injector is leaking (dripping).



THIS CHART ASSUMES THERE IS
SUFFICIENT FUEL IN THE TANK.

CHART EML. 4-7

(Page 1 of 2)
FUEL DELIVERY SYSTEM
1.6L LOTUS ELAN

1 IF ENGINE CRANKS BUT WON'T RUN, START WITH CHART EML. 4-3 (1 OF 3).

- 2
- ① - IGNITION "OFF", REMOVE FUEL PUMP RELAY.
 - ② - INSTALL PRESSURE GAUGE AS DETAILED IN SECTION EML.3 - I.
 - ③ - JUMPER CKT'S WP22C AND WG22D IGNITION "ON". ALLOW PUMP TO RUN 1 MINUTE. THIS IS TO PURGE THE LINES OF ANY AIR BEFORE PRESSURE TESTING.
 - ④ - IGNITION "OFF" FOR 10 SECONDS. REMOVE JUMPER AND RECONNECT RELAY.
 - ⑤ - OBSERVE FUEL PRESSURE WHEN IGNITION IS TURNED "ON".
 - ⑥ - PRESSURE SHOULD BE 280 - 325 kPa (40 - 47 psi), & NOT CONTINUE TO DROP AFTER PUMP STOPS RUNNING. (Pump should run about 2 seconds, then shut off.) SEE *NOTE.

***NOTE:** It is normal for the pressure to drop slightly after the pump stops running, but should then hold steady and drop no further.

If the engine is hot when this pressure test is performed, it is OK if the pressure very slowly begins to rise after the pump stops.

OK

NOT OK

- 3
- DISCONNECT FUEL PUMP RELAY
 - JUMPER CKT'S WP22C AND WG22D AND NOTE FUEL PRESSURE.
 - CONNECT A HAND VACUUM PUMP TO THE REGULATOR VACUUM FITTING, AND APPLY 50 kPa OF VACUUM TO THE REGULATOR.
 - NOTE FUEL PRESSURE WITH VACUUM APPLIED TO REGULATOR. IT SHOULD BE AT LEAST 15 kPa LESS THAN WHEN NO VACUUM WAS APPLIED.
 - IS IT?

YES

NO

NO
TROUBLE
FOUND

REPLACE
PRESSURE
REGULATOR

4 PRESSURE, BUT
CONTINUES TO DROP
AFTER PUMP STOPS

- IGNITION "OFF" FOR 10 SECONDS.
- IGNITION "ON".
- WHEN THE PUMP STOPS RUNNING (after 2 seconds), AND WHILE THE PRESSURE IS DROPPING, PINCH SHUT THE TEST HOSE.
- PRESSURE NOW HOLDS

YES

NO

CHECK FOR LEAKS
IN THE
"PRESSURE-SIDE"
OF THE FUEL
SYSTEM. IF OK,
REPLACE FUEL
PUMP.

CHECK FOR
LEAKING
INJECTORS (WET
SPARK PLUGS!)
IF OK, REPLACE
REGULATOR

HOLDS
PRESSURE
BUT

LESS THAN 280 kPa (40 psi)
-OR-
MORE THAN 325 kPa (47 psi)

SEE CHART EML. 4-7
(PAGE 2 OF 2)

NO
PRESSURE

CHECK FOR:

- FUEL PRESSURE LINE RESTRICTED BETWEEN PUMP AND TEST POINT.
- FUEL SUPPLY LINE BETWEEN TANK AND PUMP EITHER RESTRICTED -OR- LEAKING (sucking air).
- RESTRICTED FUEL FILTER.
- RESTRICTED IN-TANK FUEL STRAINER.
- DEFECTIVE FUEL PUMP.

CLEAR CODES AND CONFIRM NO "CHECK ENGINE" LIGHT

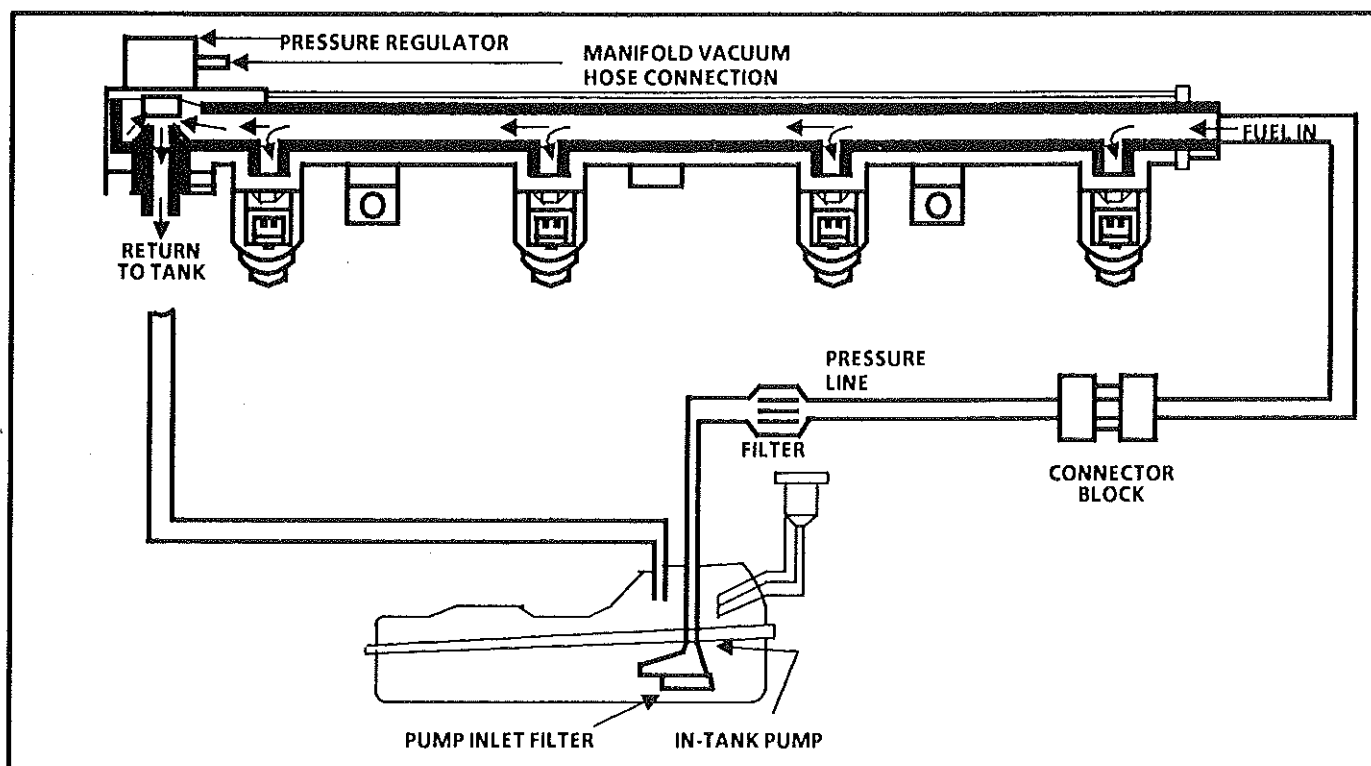


CHART EML. 4-7

(Page 2 of 2) FUEL DELIVERY SYSTEM 1.6L LOTUS ELAN

Circuit Description:

- Continued from Chart EML. 4-7 (Page 1 of 2) -

The fuel pump has a check valve in it to maintain pressure at the fuel rail after the pump stops running. The check valve plays an important part in the fuel delivery system: to keep the fuel rail "charged" with fuel after the pump shuts off. When the engine begins cranking to start, there is *no delay* before fuel injection begins, and quick starting is insured. The check valve is part of the fuel pump, and is not serviced separately.

Test Description:

Numbers below refer to circled numbers on the diagnostic chart.

5. If any fuel lines, fittings, filter, or components are restricted, full pressure cannot be attained.
6. At this point, the pressure checks are OK, but a complete test has not been performed. Return to CHART EML. 4-7 (page 1 of 2) step 3 to complete the testing.
7. When the fuel pressure test hose is pinched shut, there is no pressure regulator control to limit the pressure. The pressure reading will be whatever the fuelpump is capable of producing. This is the same as attaching a pressure gauge directly to the output of the fuel pump. The pressure reading would be a "maximum pressure - no flow" reading, and should be well over 325 kPa



CHART EML. 4-7

(Page 2 of 2)
FUEL DELIVERY SYSTEM
1.6L LOTUS ELAN

FROM CHART EMK. 4-7
(PAGE 1 OF 2)

HOLDS PRESSURE BUT
LESS THAN 280 kPa (40 psi)
-OR-
MORE THAN 325 kPa (47 psi)

FUEL PRESSURE LESS THAN 280 kPa (40 psi)

NO PRESSURE

FUEL PRESSURE MORE THAN 325 kPa (47 psi)

5

- MAKE CLOSE INSPECTION OF ALL FUEL LINES BETWEEN FUEL TANK AND FUEL RAIL FOR RESTRICTIONS. THIS INCLUDES THESE LINES:
 - TANK-TO-PUMP
 - PUMP-TO-DAMPER
 - DAMPER-TO-FILTER
 - FILTER-TO-FUEL RAIL

RETURN TO
CHART EMK. 4-7
(PAGE 1 OF 2)

CHECK FOR RESTRICTION / KINKS IN FUEL RETURN LINE. IF OK, REPLACE PRESSURE VACUUM REGULATOR.

ALL OK

NOT OK

REPLACE FUEL FILTER, THEN RECHECK PRESSURE.

REPAIR, THEN RECHECK PRESSURE.

PRESSURE STILL LESS
THAN 280 kPa (40 psi)

PRESSURE NOW 280 - 325 kPa (40 - 47 psi),
AND DOES NOT CONTINUE DROPPING
WHEN PUMP STOPS.

6

RETURN TO
CHART EMK. 4-7
(PAGE 1 OF 2)
STEP 3

7

- IGNITION "OFF".
- JUMPER CKT 'S WP22C AND WG22D AT FUEL PUMP RELAY AND NOTE FUEL PRESSURE.
- PINCH SHUT THE FUEL PRESSURE TEST HOSE. **

PRESSURE NOW
MORE THAN 325 kPa

PRESSURE STILL
LESS THAN 325 kPa

REPLACE PRESSURE REGULATOR
AND RECHECK PRESSURE.

REPLACE FUEL PUMP, AND
RETURN TO CHART EMK. 4-7
(PAGE 1 OF 2) STEP 2

** NOTE: BE SURE NOT TO
EXCEED MAX.
ALLOWED GAUGE
PRESSURE OR 400 KPA.

CLEAR CODES AND CONFIRM NO "CHECK ENGINE" LIGHT.

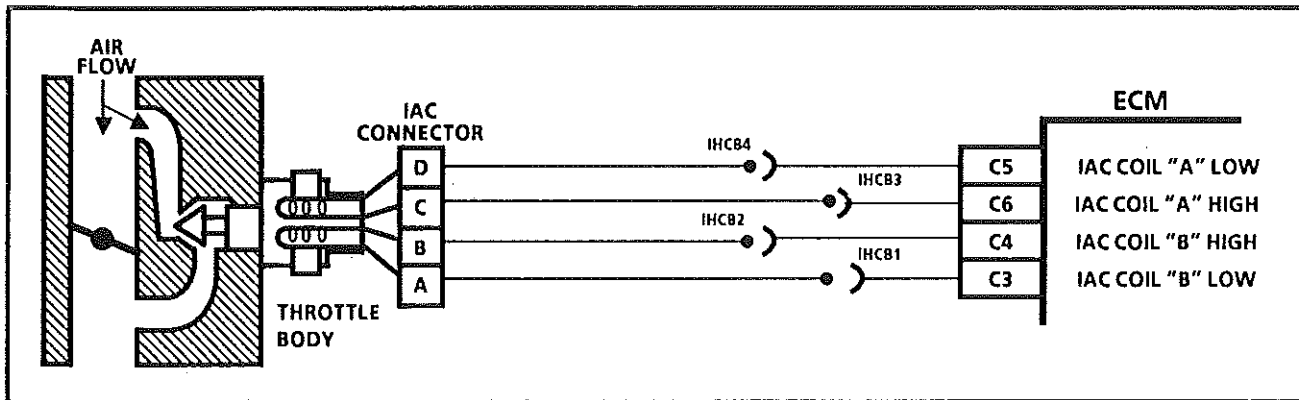


CHART EML. 4-9

IDLE SPEED ERROR 1.6L LOTUS ELAN

Circuit Description:

This chart should be used, when the closed throttle engine speed is 50 rpm above or below the desired idle speed for 20 seconds with engine fully warmed up and idle speed stabilized for at least 20 seconds. The ECM controls idle rpm with the IAC valve. To increase idle rpm, the ECM moves the IAC valve in, allowing more air to bypass the throttle plate. To decrease rpm, it moves the IAC valve out, reducing air flow by-passing the throttle plate. The Tech 1 will read the ECM commands to the IAC valve in counts. The higher the counts, the more air allowed (higher idle). The lower the counts, the less air allowed (lower idle).

Test Description:

Numbers below refer to circled numbers on the diagnostic chart.

1. Run test, even if engine will not idle. If idle is too low, the Tech 1 will display 80 or more counts, or steps. If idle is high, it will display "5" counts or less. Occasionally an erratic or unstable idle may occur. Engine speed may vary 200 rpm or more up and down. Disconnect IAC. If the condition is unchanged, the IAC is not at fault.
2. When the engine was stopped, the IAC Valve retracted (more air) to a fixed "Park" position for increased air flow and idle speed during the next engine start. The Tech 1 will display 80 counts on engine stopped, ignition "ON".
3. The IAC valve should extend as the ECM commands idle speed to decrease to desired rpm.
4. The test light will confirm the ECM signals by a steady or flashing light on all circuits.
5. There is a remote possibility that one of the circuits is shorted to voltage, which would have been indicated by a steady light. Disconnect the ECM and turn the ignition "ON" and probe terminals to check for this condition.

Diagnostic Aids:

A slow unstable idle may be caused by a system problem that cannot be overcome by the IAC.

Tech 1 counts will be above 60 counts if idle is too low, and "3" counts if idle is too high. If idle speed is excessively high, check for and correct any trouble code problem or vacuum leak.

● System too lean

Idle speed may be too high or too low. Engine speed may vary up and down, disconnecting IAC does not help. Check CO emissions.

● System too rich

Idle speed too low. Tech 1 counts usually above 60. System obviously rich and may exhibit black smoke exhaust.

Check

- CO emissions
- High fuel pressure
- Injector leaking or sticking

● Intake Manifold - Remove IAC and inspect bore for foreign material or evidence of IAC valve seat or pintle damage.

● Refer to "Rough, Unstable, Incorrect Idle or Stalling" in "Symptoms" in Section EML. 6.

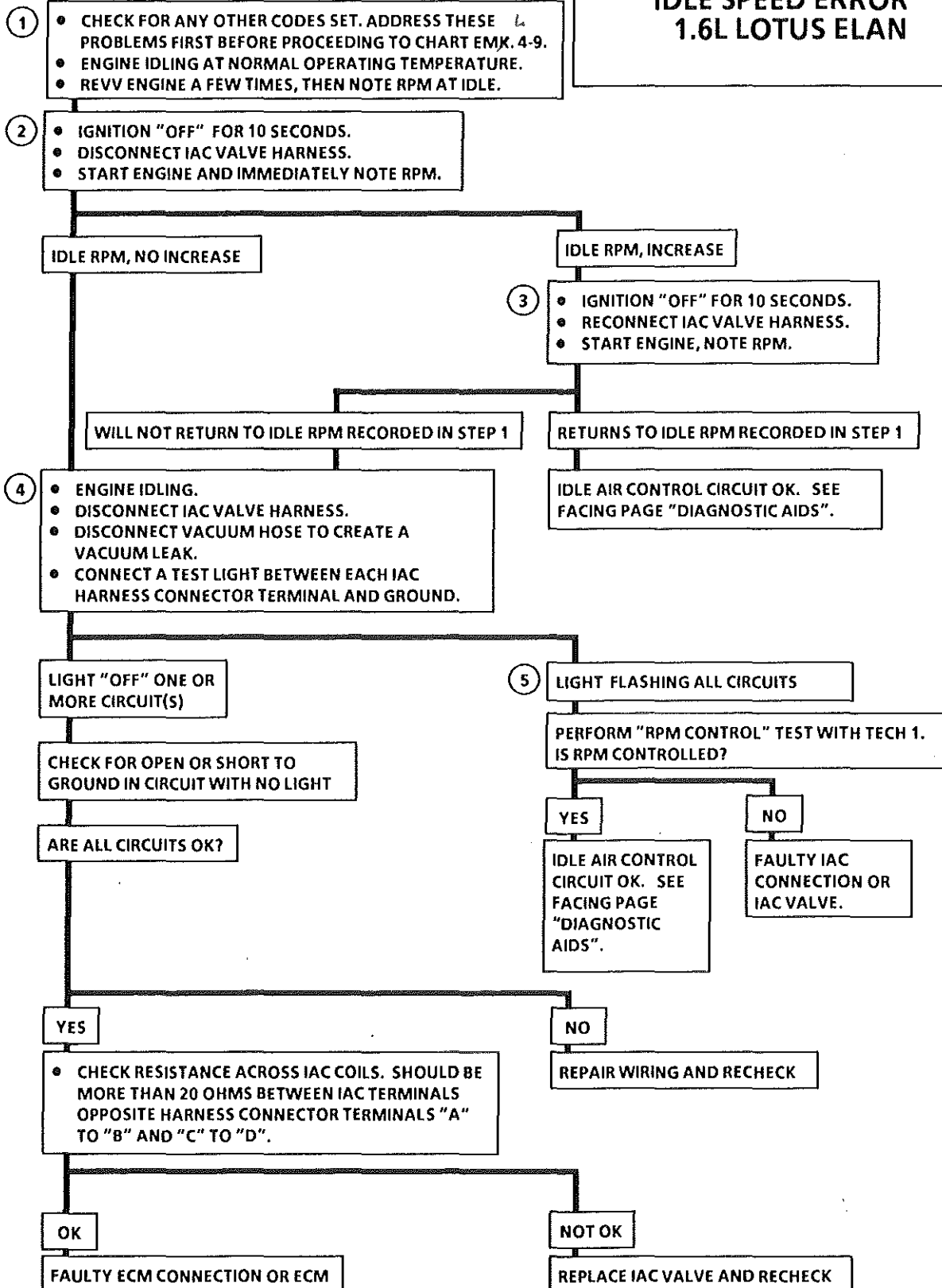
● Check (wiggle) IAC pins at ECM and valve while watching "IDLE AIR CONTROL" on TECH 1 display. Should be fairly stable.

● A faulty TPS or TPS circuit causes unstable or elevated idle speed.

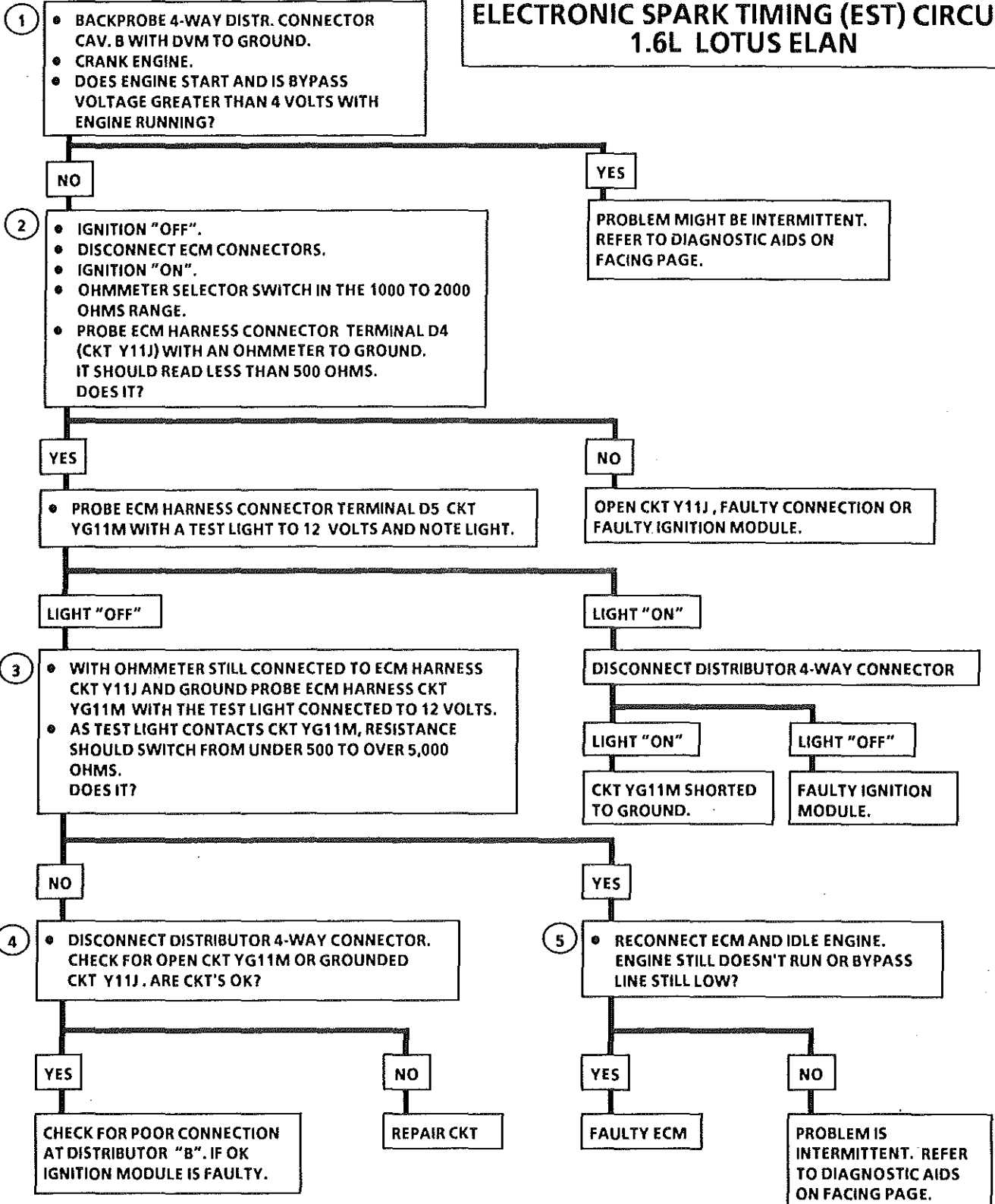


CHART EML. 4-9

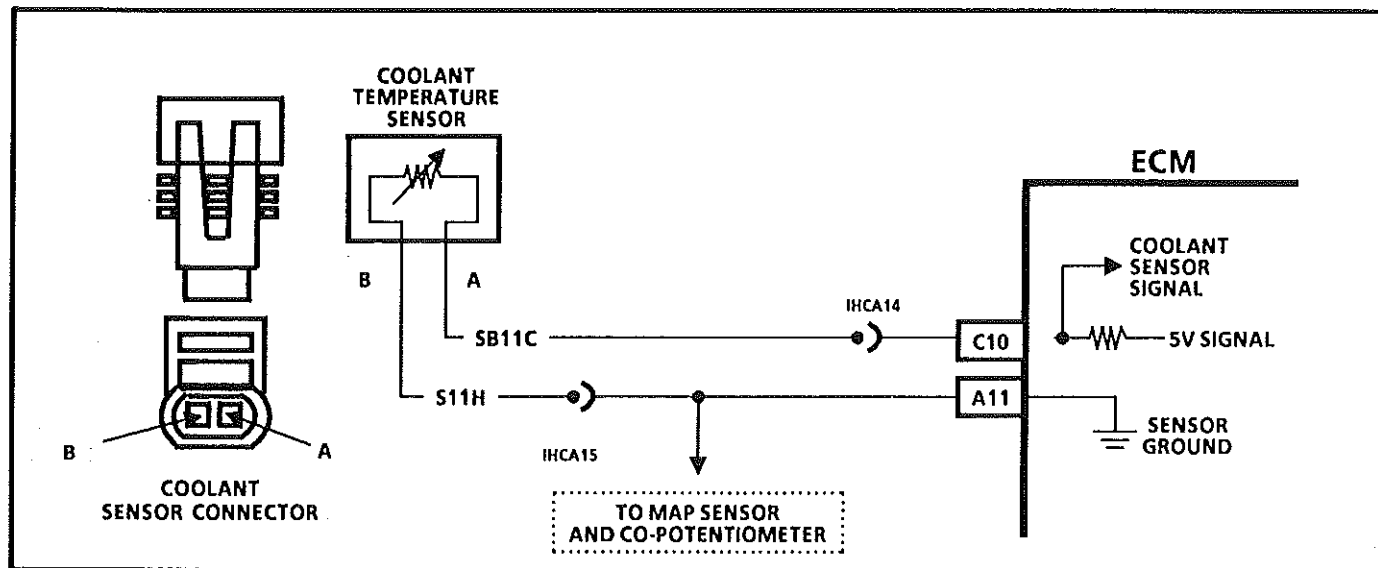
IDLE SPEED ERROR 1.6L LOTUS ELAN



CLEAR CODES AND CONFIRM NO "CHECK ENGINE LIGHT".

**EML. 4-10****ELECTRONIC SPARK TIMING (EST) CIRCUIT
1.6L LOTUS ELAN**

CLEAR CODES AND CONFIRM NO "CHECK ENGINE" LIGHT.



CODE 14

COOLANT TEMPERATURE SENSOR CIRCUIT (SIGNAL VOLTAGE LOW - HIGH TEMPERATURE INDICATED) 1.6L LOTUS ELAN

Circuit Description:

The Coolant Temperature Sensor uses a thermistor to control the signal voltage at the ECM. The ECM applies a voltage on CKT SB11C to the sensor. When the engine is cold, the sensor (thermistor) resistance is high, therefore, the ECM will see high signal voltage.

As the engine warms, the sensor resistance becomes less, and the voltage drops. At normal engine operating temperature, the voltage will measure about 1.0 to 2.4 volts at the ECM terminal "C10".

Coolant temperature is one of the inputs used to control:

- Fuel delivery
- Engine Spark Timing (EST)
- Idle (IAC)
- Exhaust Gas Recirculation (EGR)
- Secondary Throttles
- Boost Control
- Air Conditioning

Test Description:

Numbers below refer to circled numbers on the diagnostic chart.

1. Checks to see if code was set as result of hard failure or intermittent condition.

Code 14 will set if:

- Signal Voltage indicates a coolant temperature above 145°C (275°F) for 2 minutes.
2. This test simulates conditions for a Code 15. If the ECM recognizes the open circuit (high voltage), and displays a low temperature, the ECM and wiring are OK.

Diagnostic Aids:

Check harness routing for a potential short to ground in SB11C.

The Tech 1 displays engine temperature in degrees celcius. After engine is started, the temperature should rise steadily to about 82°C, and then stabilize when thermostat opens.

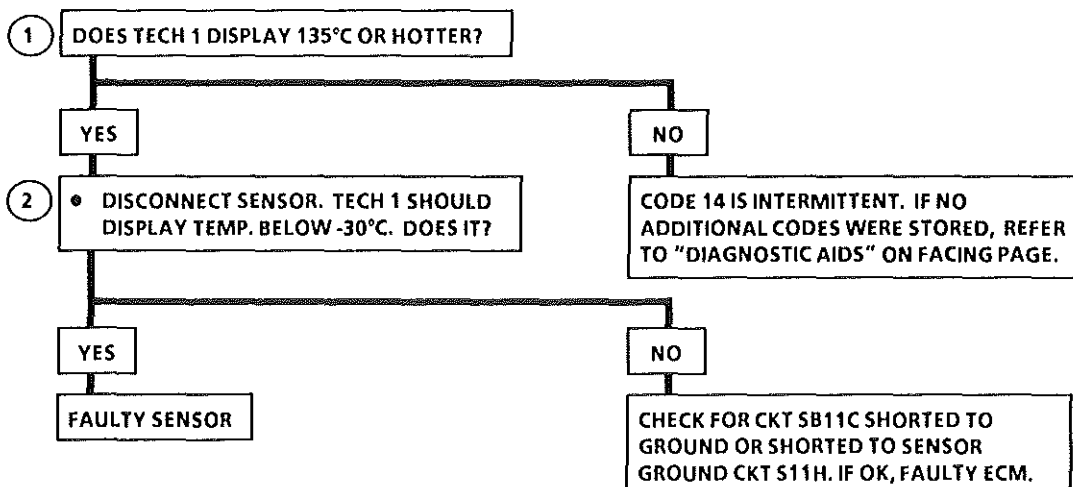
Verify that engine is not overheating and has not been subjected to conditons which could create an overheating condition (i.e. overload, trailer towing, hilly terrain, heavy stop and go traffic, etc.). The "Temperature To Resistance Value" scale at the right may be used to test the coolant sensor at various temperature levels to evaluate the possibility of a "shifted" (mis-scaled) sensor. A "shifted" sensor could result in poor driveability complaints.

If Code 14 is intermittent:

- Check (wiggle) ECM connector pins C10 and A11, sensor wires and connector while watching "COOLANT TEMP" on TECH1 display. Temperature should be stable.
- Clear Code and conduct a test drive with TECH 1 in "Snapshot" mode. Set trigger on Code 14.
- Refer to "Intermittents" in Section EML.6.

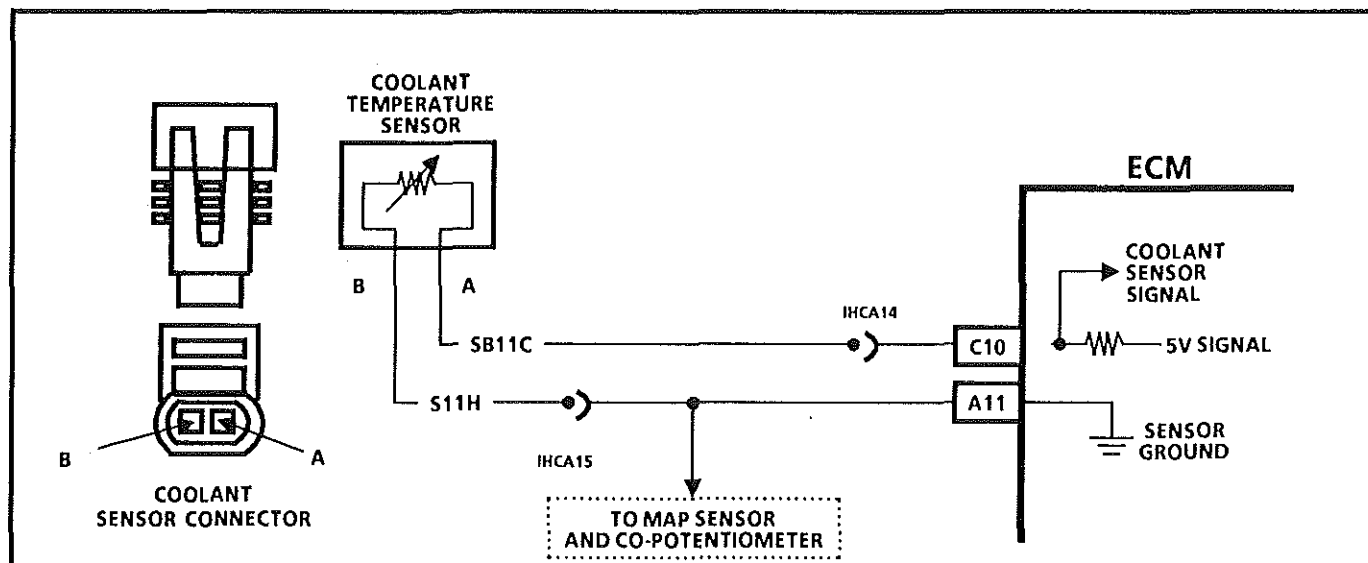
**CODE 14**

**COOLANT TEMPERATURE SENSOR CIRCUIT
(SIGNAL VOLTAGE LOW - HIGH TEMPERATURE INDICATED)
1.6L LOTUS ELAN**

**DIAGNOSTIC AID**

COOLANT SENSOR		
TEMPERATURE TO RESISTANCE VALUES (APPROXIMATE)		
°F	°C	OHMS
210	100	185
160	70	450
100	38	1,800
70	20	3,400
40	4	7,500
20	-7	13,500
0	-18	25,000
-40	-40	100,700

CLEAR CODES AND CONFIRM NO "CHECK ENGINE" LIGHT.



CODE 15

COOLANT TEMPERATURE SENSOR CIRCUIT (SIGNAL VOLTAGE HIGH - LOW TEMPERATURE INDICATED) 1.6L LOTUS ELAN

Circuit Description:

The Coolant Temperature Sensor uses a thermistor to control the signal voltage at the ECM. The ECM applies a voltage on CKT SB11C to the sensor. When the engine is cold, the sensor (thermistor) resistance is high, therefore, the ECM will see high signal voltage.

As the engine warms, the sensor resistance becomes less, and the voltage drops. At normal engine operating temperature, the voltage will measure about 1.0 to 2.4 volts at the ECM terminal "C10".

Coolant temperature is one of the inputs used to control:

- Fuel delivery
- Engine Spark Timing (EST)
- Idle (IAC)
- Exhaust Gas Recirculation (EGR)
- Secondary Throttles
- Boost Control
- Air Conditioning

Test Description:

Numbers below refer to circled numbers on the diagnostic chart.

1. Checks to see if code was set as result of hard failure or intermittent condition.

Code 15 will set if:

- The engine has been running for 1 minute.
- Signal Voltage indicates a coolant temperature below -37°C.

2. This test simulates conditions for a Code 14. If the ECM recognizes the grounded circuit (low voltage), and displays a high temperature, the ECM and wiring are OK.

3. This test will determine if there is a wiring problem or a faulty ECM. If CKT S11H is open, there may also be a Code 33 stored. Be sure to carefully check terminals at the engine harness connectors.

Diagnostic Aids:

The Tech 1 displays engine temperature in degrees celsius. After engine is started the temperature should rise steadily to about 82°C, and

then stabilize when thermostat opens. A faulty connection or an open in CKT SB11C or CKT S11H can result in a Code 15.

Codes 15 and 33 stored at the same time could be the result of an open CKT IHCA15.

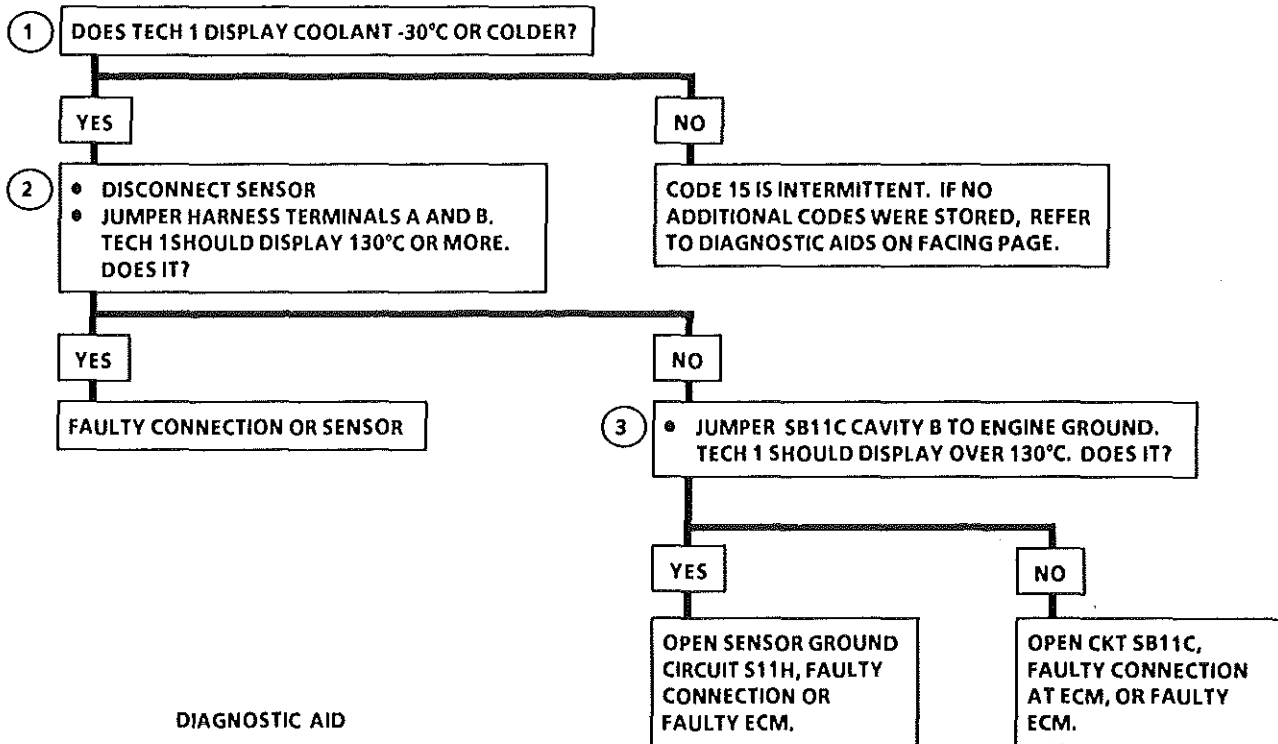
The "Temperature to Resistance Value" scale at the right may be used to test the coolant sensor at various temperature levels to evaluate the possibility of a "shifted" (mis-scaled) sensor. A "shifted" sensor could result in poor driveability complaints.

If Code 15 is intermittent:

- Check (wiggle) ECM connector pins C10 and A11, sensor wires and connector while watching "COOLANT TEMP" on Tech 1 display. Temperature should be stable.
- Clear Code and conduct a test drive with Tech 1 in "Snapshot" mode. Set trigger on Code 15.
- Refer to "Intermittents" in Section EML.6.

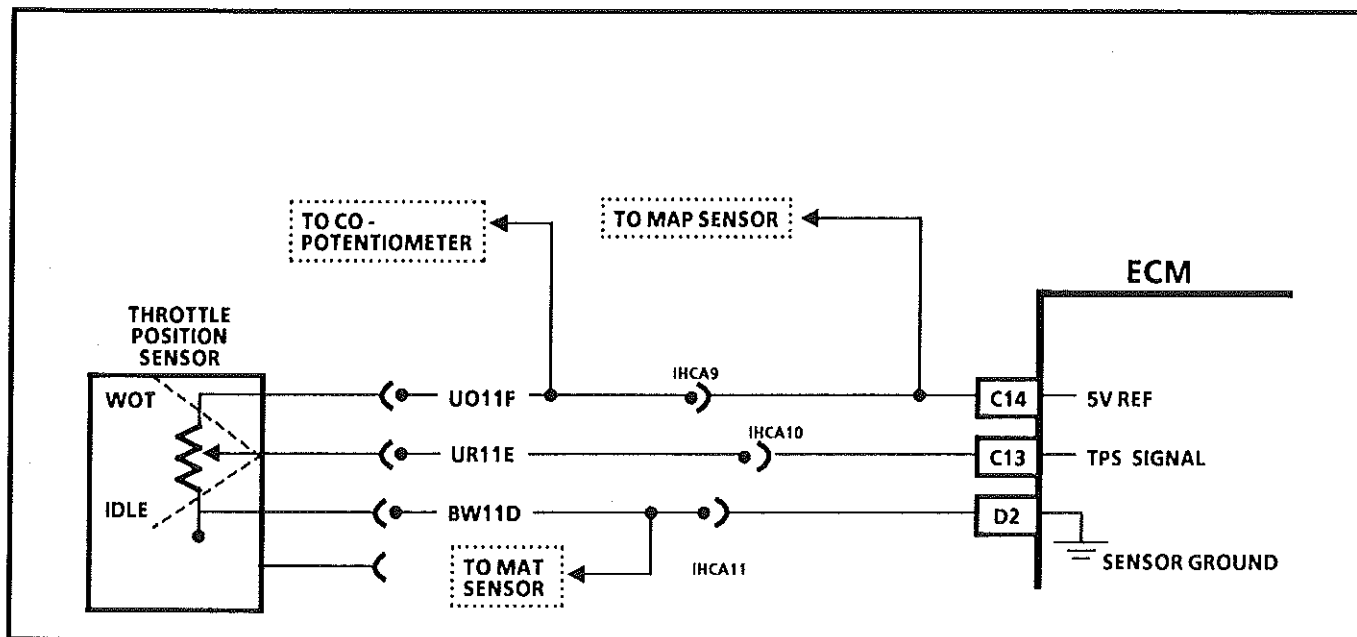
**CODE 15**

**COOLANT TEMPERATURE SENSOR CIRCUIT
(SIGNAL VOLTAGE HIGH - LOW TEMPERATURE INDICATED)
1.6L LOTUS ELAN**

**DIAGNOSTIC AID**

COOLANT SENSOR		
TEMPERATURE TO RESISTANCE VALUES (APPROXIMATE)		
°F	°C	OHMS
210	100	185
160	70	450
100	38	1,800
70	20	3,400
40	4	7,500
20	-7	13,500
0	-18	25,000
-40	-40	100,700

CLEAR CODES AND CONFIRM NO "CHECK ENGINE" LIGHT.



CODE 21

THROTTLE POSITION SENSOR (TPS) CIRCUIT (SIGNAL VOLTAGE HIGH) 1.6L LOTUS ELAN

Circuit Description:

The Throttle Position Sensor (TPS) provides a voltage signal that changes relative to the throttle valve position. Signal voltage will vary from about 0.4 volts at idle to about 4.0 volts at wide open throttle (WOT).

The TPS signal is one of the most important inputs used by the ECM for fuel control and for many of the ECM controlled outputs.

Test Description: Numbers below refer to circled numbers on the diagnostic chart.

1. This step checks to see if Code 21 is the result of a hard failure or an intermittent condition. A Code 21 will set if:
 - TPS reading above 4.7 volts.
 - Engine speed less than 1200 rpm.
 - MAP reading below 50 kPa.
 - All of the above conditions present for 5 seconds.
2. This step simulates conditions for a Code 22. If the ECM recognizes the change of state, the ECM and CKTs UO11F and UR11E are OK.
3. This step isolates an open CKT BW11D.

Diagnostic Aids:

The Tech 1 displays throttle position in volts. It should display 0.40 ± 0.02 volt with throttle closed and ignition "ON" or at idle. Voltage should increase at a steady rate as throttle is moved towards wide open throttle (WOT).

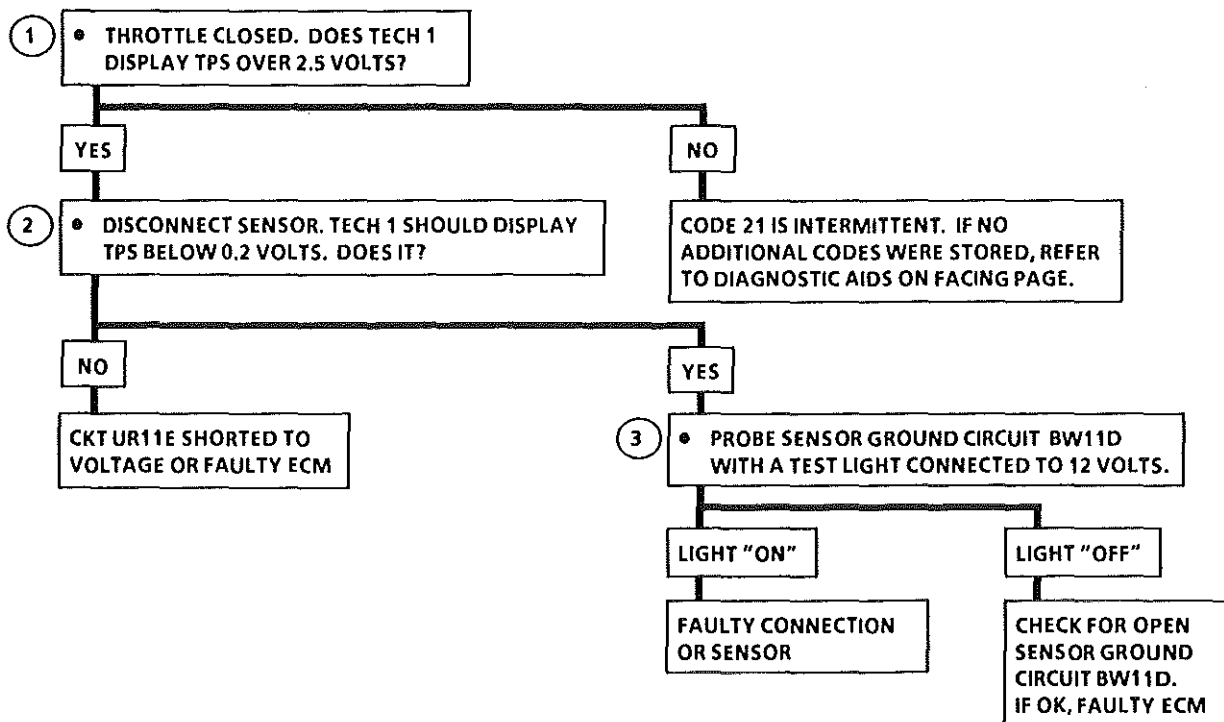
The Tech 1 will also display throttle angle %, 0% = closed throttle, >95% = WOT.

An open in CKT BW11D will result in a Code 21. Codes 23 and 21 stored at the same time could be the result of an open CKT BW11D. Tech 1 TPS while depressing accelerator pedal with engine stopped and ignition "ON". Display should vary from 0.40 ± 0.02 volt when throttle is closed, to over 4.0 volts when throttle is held wide open.

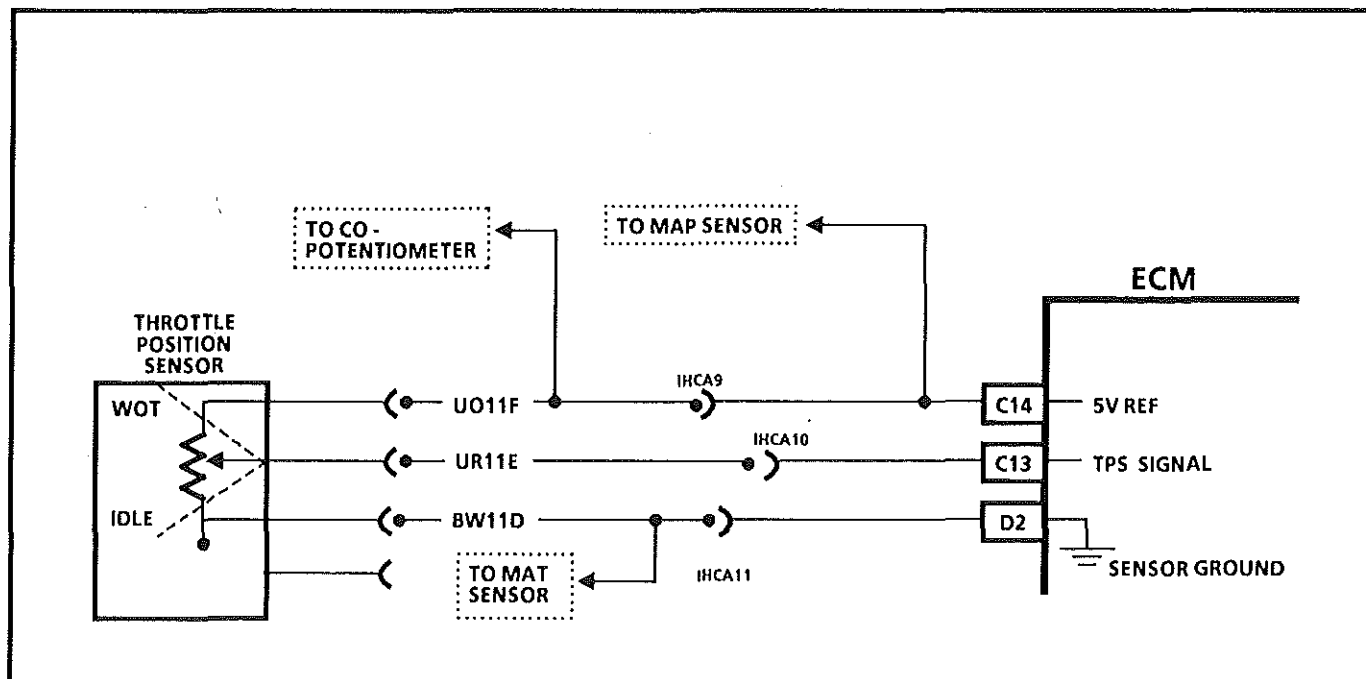
Check condition of connector and sensor terminals for corrosion, and clean or replace as necessary. If corrosion found, check condition of connector seal, repair and/or replace if necessary.

If Code 21 is intermittent:

- Check (wiggle) ECM connector pins C14, C13, D2, sensor wires and sensor connector while watching "THROT POSITION" on Tech1 display. Voltage should be constant.
- Clear Code and conduct test drive with Tech 1 in "Snapshot" mode. Set trigger on Code 21.
- Refer to "Intermittents" in Section EML.6.

**CODE 21****THROTTLE POSITION SENSOR (TPS) CIRCUIT
(SIGNAL VOLTAGE HIGH)
1.6L LOTUS ELAN**

CLEAR CODES AND CONFIRM NO "CHECK ENGINE" LIGHT.



CODE 22

THROTTLE POSITION SENSOR (TPS) CIRCUIT (SIGNAL VOLTAGE LOW) 1.6L LOTUS ELAN

Circuit Description:

The Throttle Position Sensor (TPS) provides a voltage signal that changes, relative to the throttle valve position. Signal voltage will vary from about 0.4 volts at idle to about 4.0 volts at wide open throttle (WOT).

The TPS signal is one of the most important inputs used by the ECM for fuel control and for many of the ECM controlled outputs.

Test Description:

Numbers below refer to circled numbers on the diagnostic chart.

1. This step checks to see if Code 22 is the result of a hard failure or an intermittent condition. A Code 22 will set if:
 - The engine is running.
 - TPS voltage is below .20 volts (200 mv).
2. This step simulates conditions for a Code 21. If a Code 21 is set, or the Tech 1 tool displays over 4 volts, the ECM and wiring are OK.
3. The Tech 1 does not display 12 volts. The important thing is that the ECM recognizes the voltage as over 4 volts, indicating that CKT UR11E and the ECM are OK.
4. If CKT UO11F is open or shorted to ground, there may also be a stored Code 34.
5. An internally shorted MAP sensor can pull down 5V REF voltage.

Diagnostic Aids:

Scan TPS while depressing accelerator pedal with engine stopped and ignition "ON". Display should vary from 0.40 ± 0.02 volt when throttle is closed, to about 4.0 volt when throttle is held wide open.

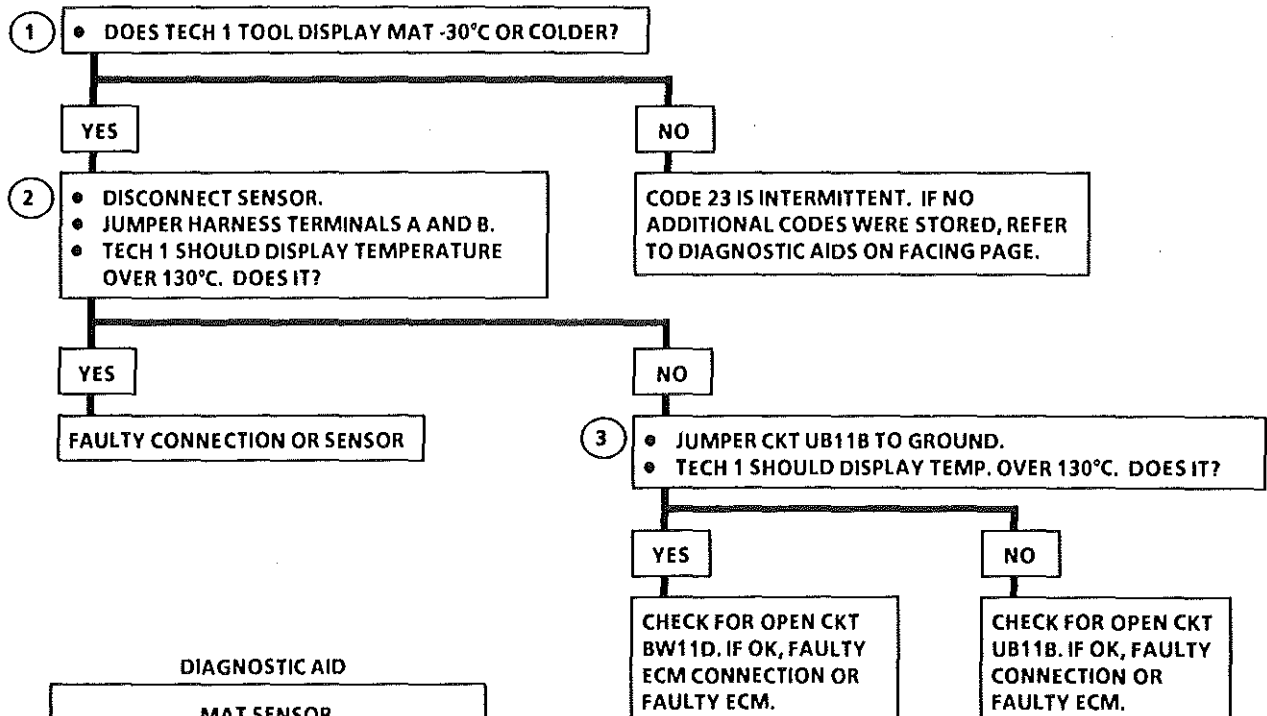
Also, Tech 1 will display throttle angle %:

0% = closed throttle; >95% = WOT

Should check condition of connector and sensor terminals for corrosion, and clean and/or replace as necessary. If corrosion is found, check condition of connector seal and repair or replace if necessary.

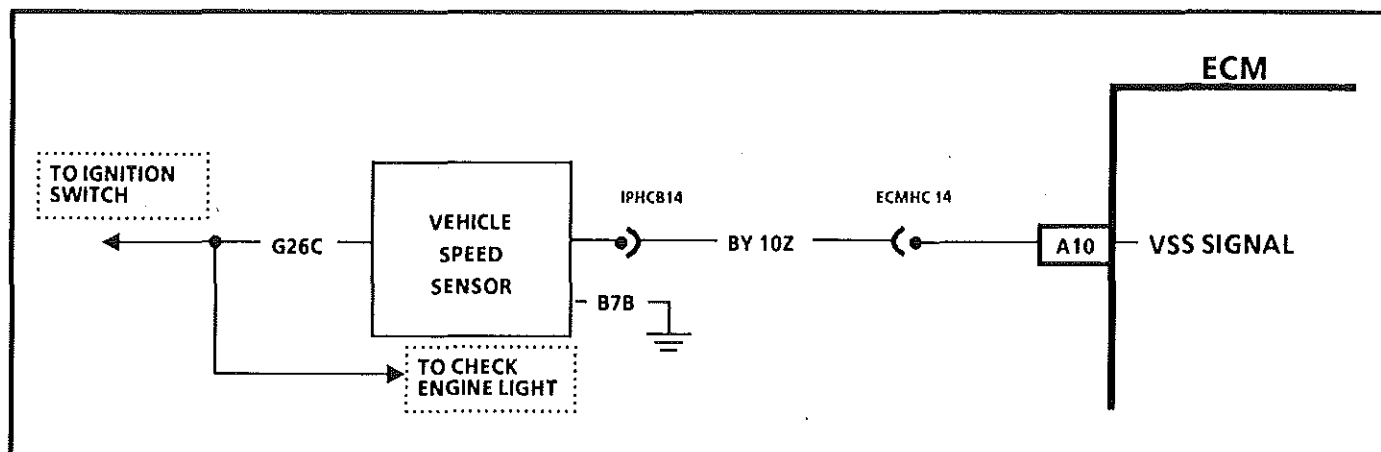
If Code 22 is intermittent:

- Check (wiggle) ECM connector pins C14, C13, D2, IHCA11, sensor wires and connector while watching "THROT POSITION" on Tech1 display. Voltage should be constant.
- Clear Code and conduct test drive with Tech 1 in "Snapshot" mode. Set trigger on Code 22.
- Refer to "Intermittents" in Section EML.6.

**CODE 23****MANIFOLD AIR TEMPERATURE (MAT) SENSOR CIRCUIT
(LOW TEMPERATURE INDICATED)
1.6L LOTUS ELAN****DIAGNOSTIC AID**

MAT SENSOR		
TEMPERATURE TO RESISTANCE VALUES (APPROXIMATE)		
°F	°C	OHMS
210	100	185
160	70	450
100	38	1,800
70	20	3,400
40	4	7,500
20	-7	13,500
0	-18	25,000
-40	-40	100,700

CLEAR CODES AND CONFIRM NO "CHECK ENGINE" LIGHT.



CODE 24

VEHICLE SPEED SENSOR (VSS) CIRCUIT 1.6L LOTUS ELAN

Circuit Description:

Vehicle speed information is provided to the ECM by the vehicle speed sensor which is an optical device mounted in the back of the speedometer head. The VSS driven by the tacho cable produces electrical pulses which the ECM uses to calculate mph or kph.

Test Description:

Numbers below refer to circled numbers on the diagnostic chart.

1. Code 24 will set if vehicle speed is less than 5 mph when:

- Engine speed is between 2400 and 4400 rpm.
- MAP signal is lower than 20 kPa.
- All conditions met for 10 seconds.
- No Code 21, 22, 33 or 34.

These conditions are met during a road load operation. Disregard Code 24 that sets when drive wheels are not turning.

Diagnostic Aids:

Tech 1 should indicate a vehicle speed whenever drive wheels are turning greater than 1 mph, (2 kph).

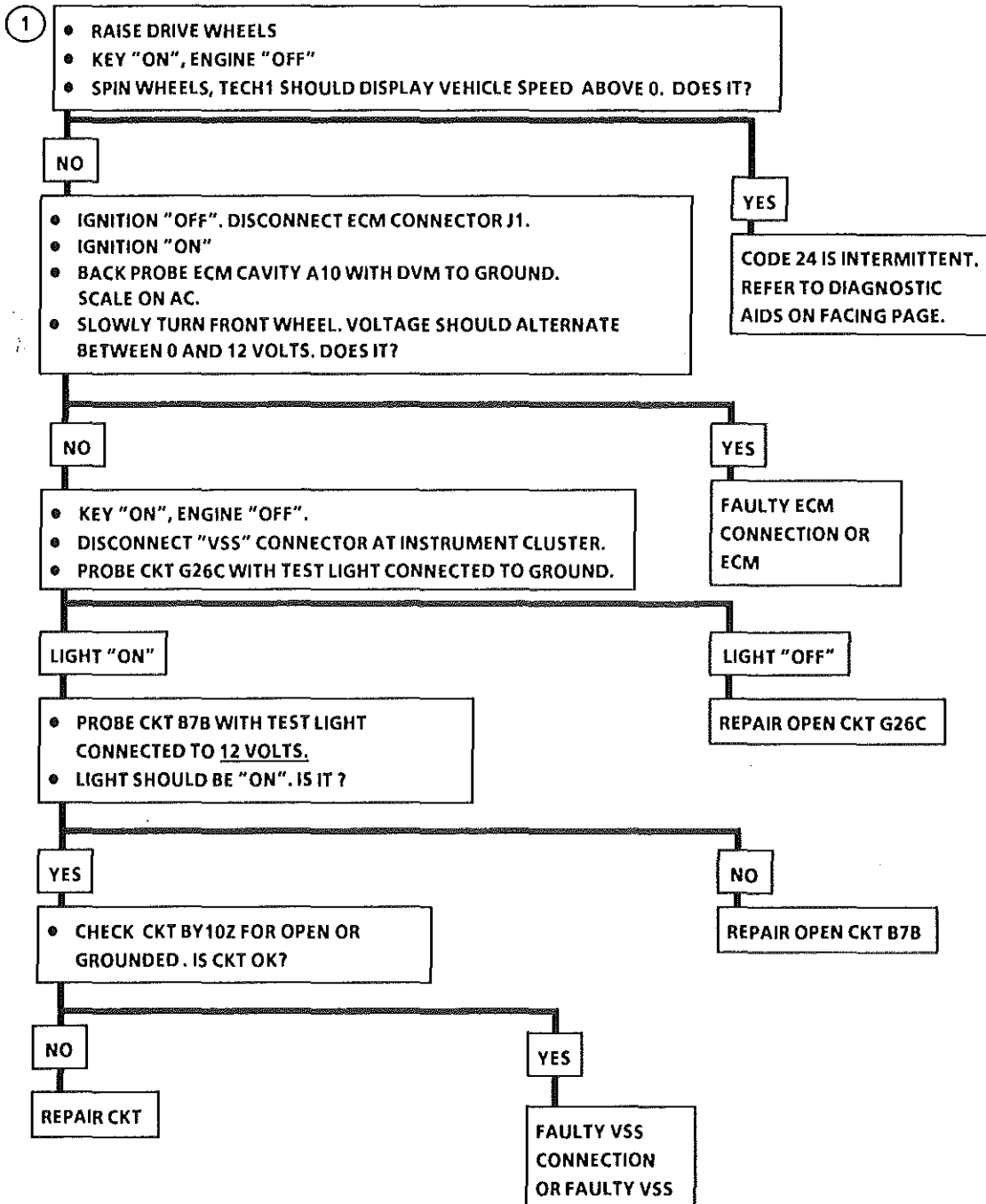
Check CKT's BY10Z, G26C and B7B for proper connections. Be sure they are clean and tight and the harness is routed correctly.

If Code 24 is intermittent:

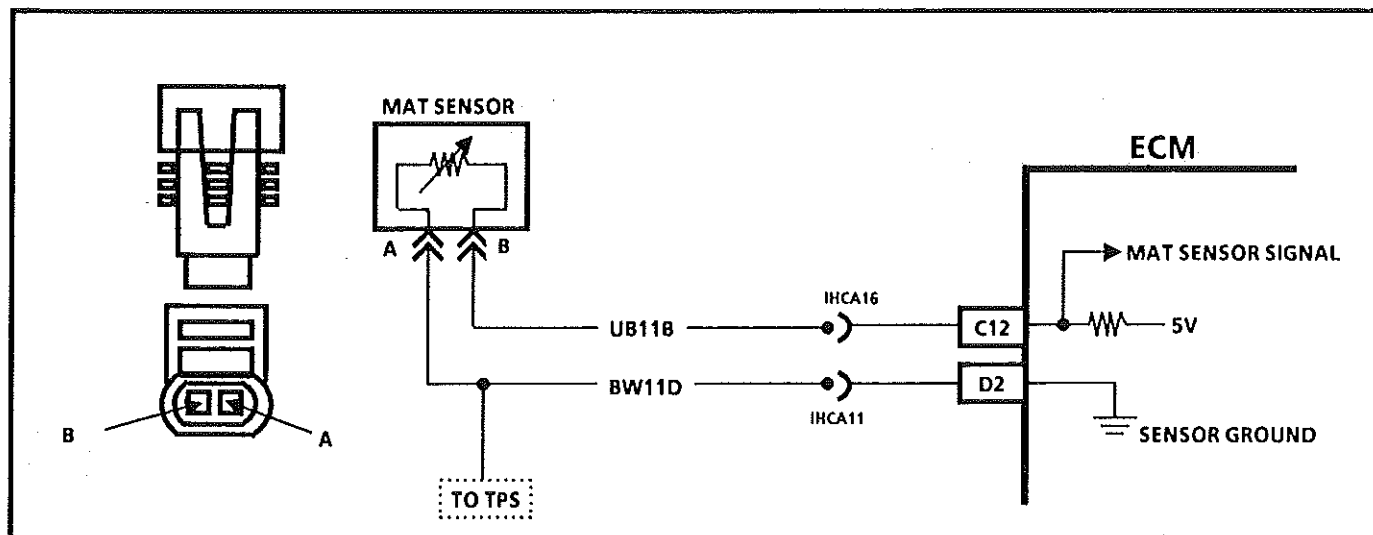
- Clear Code and conduct test drive with TECH 1 in "Snapshot" mode watching "MPH KPH" display. Vehicle speed displayed on TECH 1 should always be approx. speedometer reading.
- Refer to "Intermittents" in Section EML.6.

**CODE 24****VEHICLE SPEED SENSOR (VSS) CIRCUIT
1.6L LOTUS ELAN**

DISREGARD CODE 24, IF SET WHILE DRIVE WHEELS ARE NOT TURNING.



CLEAR CODES AND CONFIRM NO "CHECK ENGINE" LIGHT.



CODE 25

MANIFOLD AIR TEMPERATURE (MAT) SENSOR CIRCUIT (HIGH TEMPERATURE INDICATED) 1.6L LOTUS ELAN

Circuit Description:

The Manifold Air Temperature Sensor uses a thermistor to control the signal voltage to the ECM. The ECM applies a voltage (4-6 volts) on CKT UB11B to the sensor. When manifold air is cold, the sensor (thermistor) resistance is high, therefore, the ECM will see a high signal voltage. As the air warms, the sensor resistance becomes less and the voltage drops.

Test Description:

Numbers below refer to circled numbers on the diagnostic chart.

1. This check determines if the Code 25 is the result of a hard failure or an intermittent condition.

A Code 25 will set if:

- A MAT temperature greater than 145°C is detected for a time longer than 2 minutes.

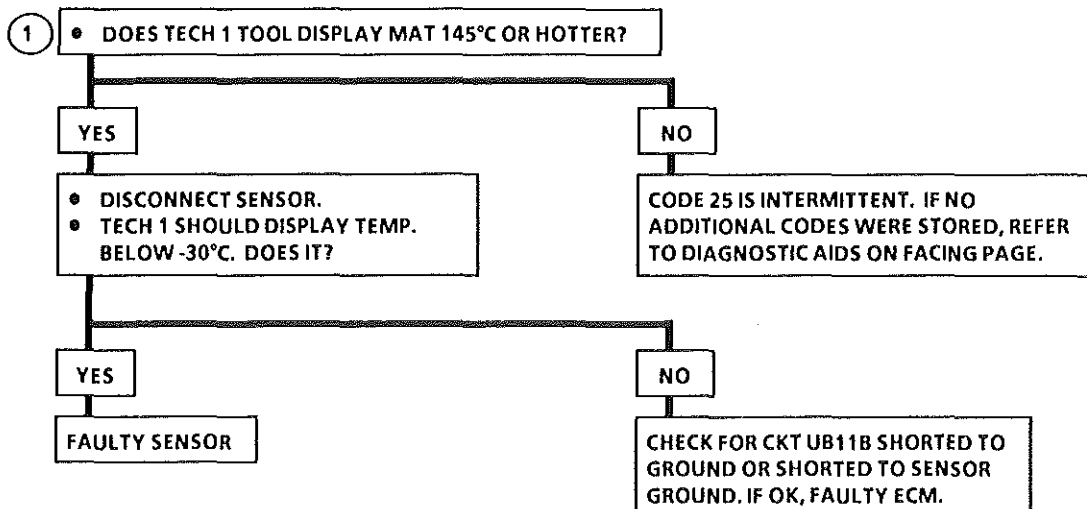
Diagnostic Aids:

If the engine has been allowed to cool to an ambient temperature (overnight), coolant and MAT temperatures may be checked with a Tech 1 and should read close to each other.

The "Temperature To Resistance Value" scale at the right may be used to test the MAT sensor at various temperature levels to evaluate the possibility of a "slewed" (mis-scaled) sensor. A "slewed" sensor could result in poor driveability complaints.

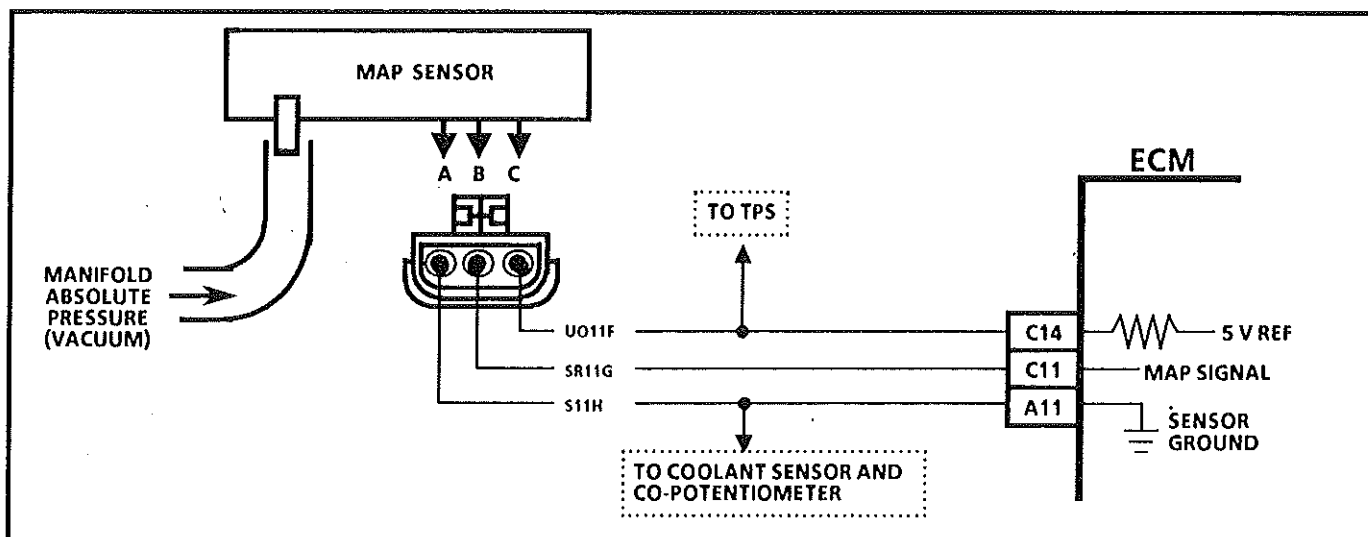
If Code 25 is intermittent:

- Check (wiggle) ECM pins C12 and D2, sensor wires and connector while watching "MASS AIR TEMP" on Tech 1 display. Temperature should be stable.
- Clear Code and conduct test drive with Tech 1 in "Snapshot" mode. In case of a drastic change of MAT reading trigger manually by pressing Tech 1 "ENTER" key.
- Refer to "Intermittents" in Section EML.6.

**CODE 25****MANIFOLD AIR TEMPERATURE (MAT) SENSOR CIRCUIT
(HIGH TEMPERATURE INDICATED)
1.6L LOTUS ELAN****DIAGNOSTIC AID**

MAT SENSOR		
TEMPERATURE TO RESISTANCE VALUES (APPROXIMATE)		
°F	°C	OHMS
210	100	185
160	70	450
100	38	1,800
70	20	3,400
40	4	7,500
20	-7	13,500
0	-18	25,000
-40	-40	100,700

CLEAR CODES AND CONFIRM NO "CHECK ENGINE" LIGHT.



CODE 31/33

MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR CIRCUIT (SIGNAL VOLTAGE HIGH - LOW VACUUM) 1.6L LOTUS ELAN

Circuit Description:

The Manifold Absolute Pressure (MAP) Sensor responds to changes in manifold pressure (vacuum). The ECM receives this information as a signal voltage that will vary from about 0.7 to 1.0 volts, at closed throttle idle, to 2.2-2.4 volts at wide open throttle (low vacuum).

If the MAP sensor fails, the ECM will substitute a fixed MAP value and use the Throttle Position Sensor (TPS) to control fuel delivery.

Test Description:

Numbers below refer to circled numbers on the diagnostic chart.

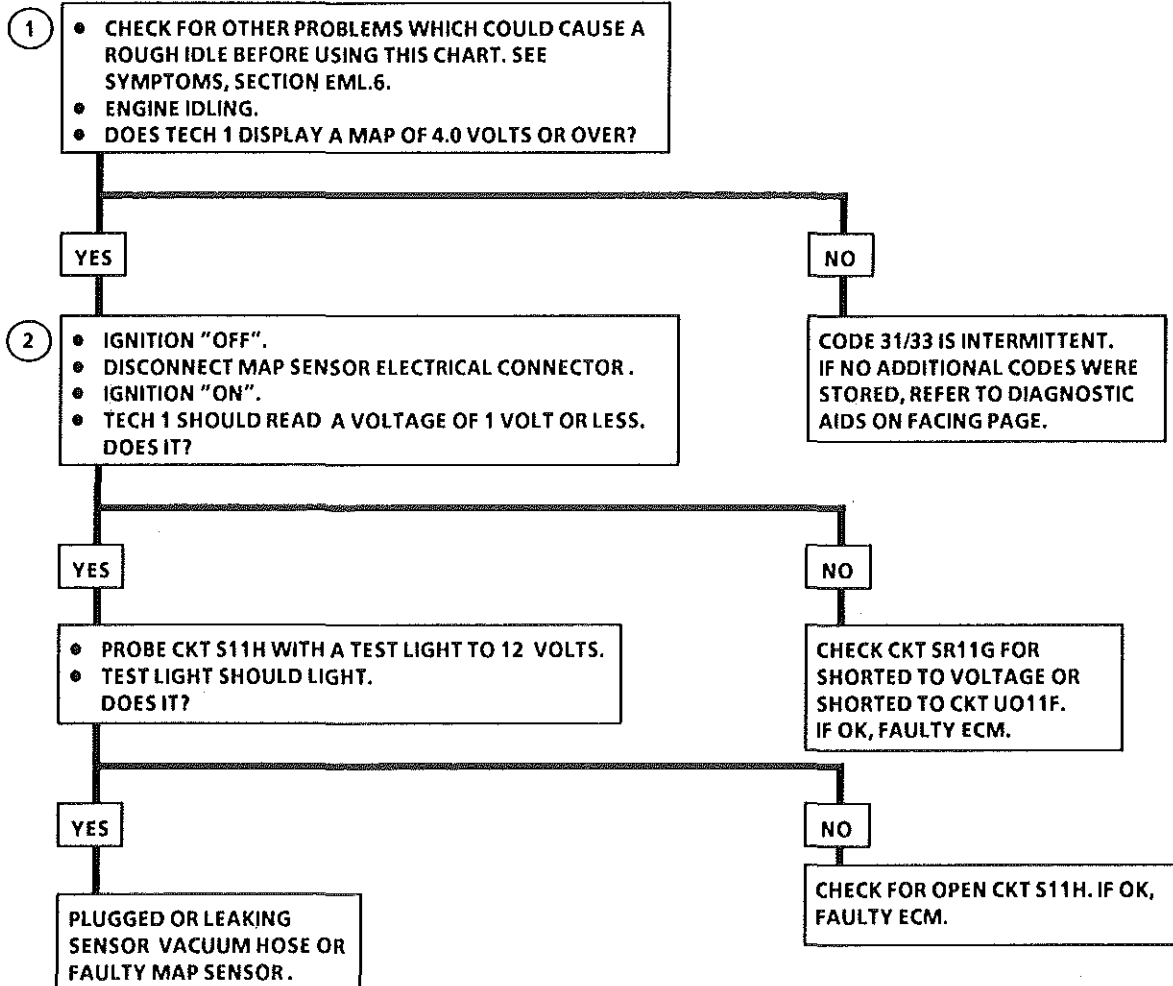
1. This step will determine if Code 33 is the result of a hard failure or an intermittent condition.
A Code 33 will set if:
 - MAP signal indicates greater than 95 kPa (over 2.4V) (low vacuum).
 - TPS less than 1.2%.
 - These conditions are present for a time longer than 0.2 seconds.
2. This step simulates conditions for a Code 34. If the ECM recognizes the change, the ECM, and CKT's U011F and SR11G, are OK. If CKT S11H is open, there may also be a Code 15 stored.

Diagnostic Aids:

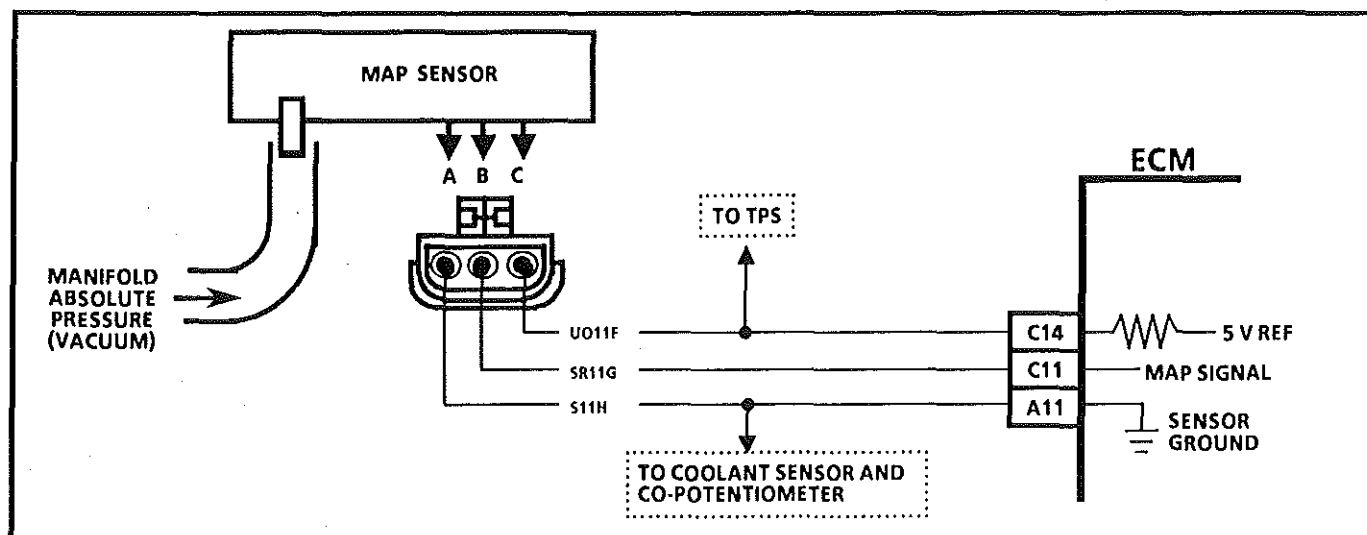
With the ignition "ON" and the engine stopped, the manifold pressure is equal to atmospheric pressure and the signal voltage will be high. This information is used by the ECM as an indication of vehicle altitude and is referred to as BARO. Comparison of this BARO reading with a known good vehicle with the same sensor is a good way to check accuracy of a "suspect" sensor. Readings should be the same $\pm .4$ volt.

An intermittent open in CKT S11H can cause a Code 33.

- Check (wiggle) ECM connector pin A11, wiring and sensor connector while watching "MAP" on Tech1 display, engine idling. Voltage should not increase above 2.5 volts.
- Clear Code and conduct test drive with Tech 1 in "Snapshot" mode. Set trigger on Code 33.
- Refer to "Intermittents" in Section EML.6.

**CODE 31/33****MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR CIRCUIT
(SIGNAL VOLTAGE HIGH - LOW VACUUM)
1.6L LOTUS ELAN**

CLEAR CODES AND CONFIRM NO "CHECK ENGINE" LIGHT.



CODE 34

MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR CIRCUIT (SIGNAL VOLTAGE LOW - HIGH VACUUM) 1.6L LOTUS ELAN

Circuit Description:

The Manifold Absolute Pressure (MAP) Sensor responds to changes in manifold pressure (vacuum). The ECM receives this information as a signal voltage that will vary from about 0.7 to 1.0 volts at closed throttle idle, to 2.2-2.4 volts at wide open throttle.

If the MAP sensor fails, the ECM will substitute a fixed MAP value and use the Throttle Position Sensor (TPS) to control fuel delivery.

Test Description:

Numbers below refer to circled numbers on the diagnostic chart.

1. This step determines if Code 34 is the result of a hard failure or an intermittent condition.

A Code 34 will set when:

- Engine rpm is less than 1200 rpm.
- MAP signal voltage is too low (14 kPa).

OR

- MAP reading less than 14 kPa.
- Engine rpm greater than 1200 rpm.
- TPS is less than 3.5%.

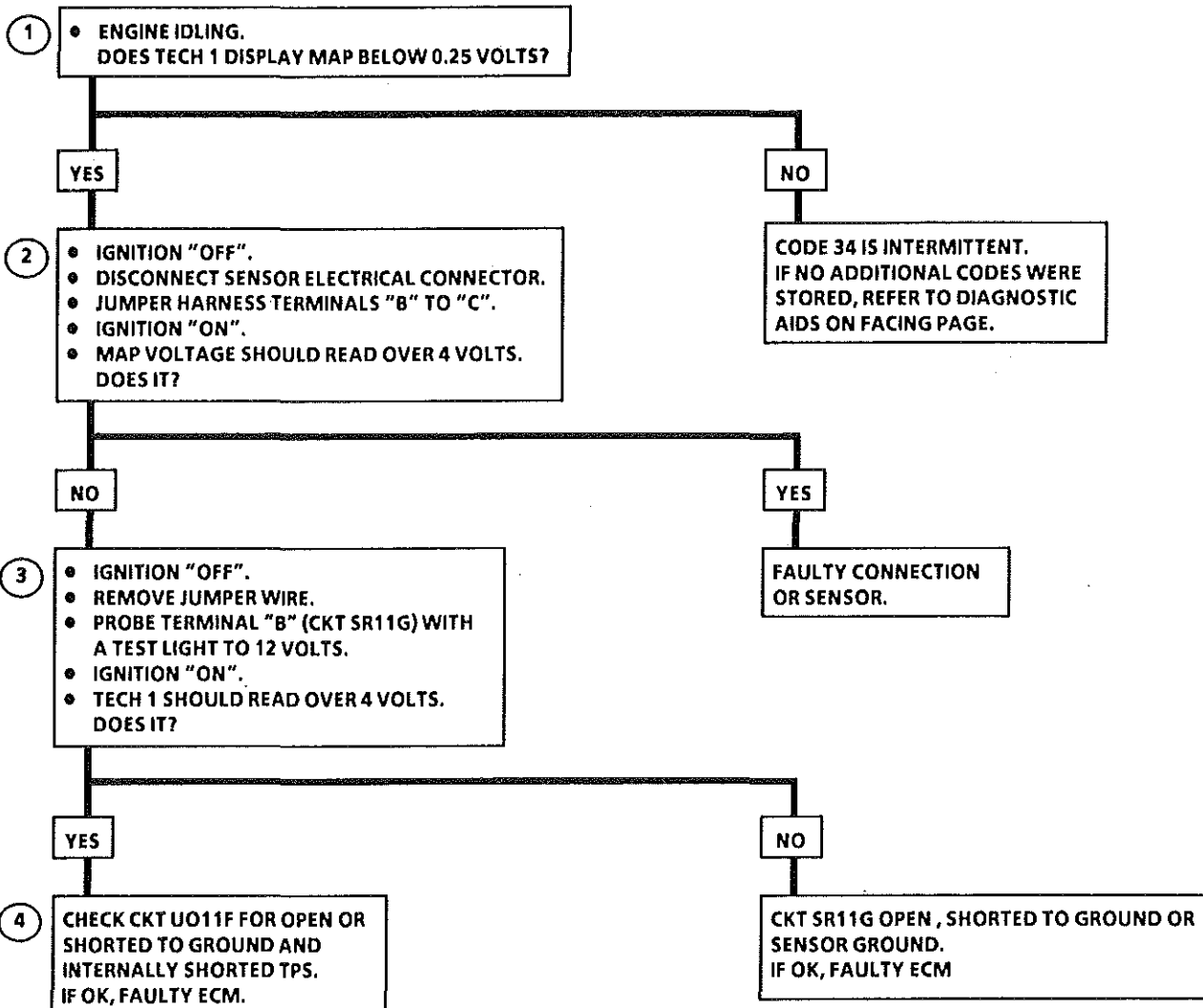
2. Jumpering harness terminals "B" to "C", 5 volt to signal, will determine if the sensor is at fault, or if there is a problem with the ECM or wiring.
3. The Tech 1 tool does not display 12 volts. The important thing is that the ECM recognizes the voltage as more than 4 volts, indicating that the ECM and CKT SR11G are OK.
4. Disconnect TPS in order to check for internally shorted sensor.

Diagnostic Aids:

With the ignition "ON" and the engine stopped, the manifold pressure is equal to atmospheric pressure and the signal voltage will be high. This information is used by the ECM as an indication of vehicle altitude and is referred to as BARO. Comparison of this BARO reading with a known good vehicle with the same sensor is a good way to check accuracy of a "suspect" sensor. Readings should be the same $\pm .4$ volt.

If Code 34 is intermittent:

- Check (wiggle) pins C11 and C14, sensor wiring and connector while watching "MAP" on Tech1 display. Voltage should not drop.
- Clear Code and conduct test drive with Tech 1 in "Snapshot" mode. Set trigger on Code 34.
- Refer to "Intermittents" in Section EML.6.

**CODE 34****MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR CIRCUIT
(SIGNAL VOLTAGE LOW - HIGH VACUUM)
1.6L LOTUS ELAN**

CLEAR CODES AND CONFIRM NO "CHECK ENGINE" LIGHT.

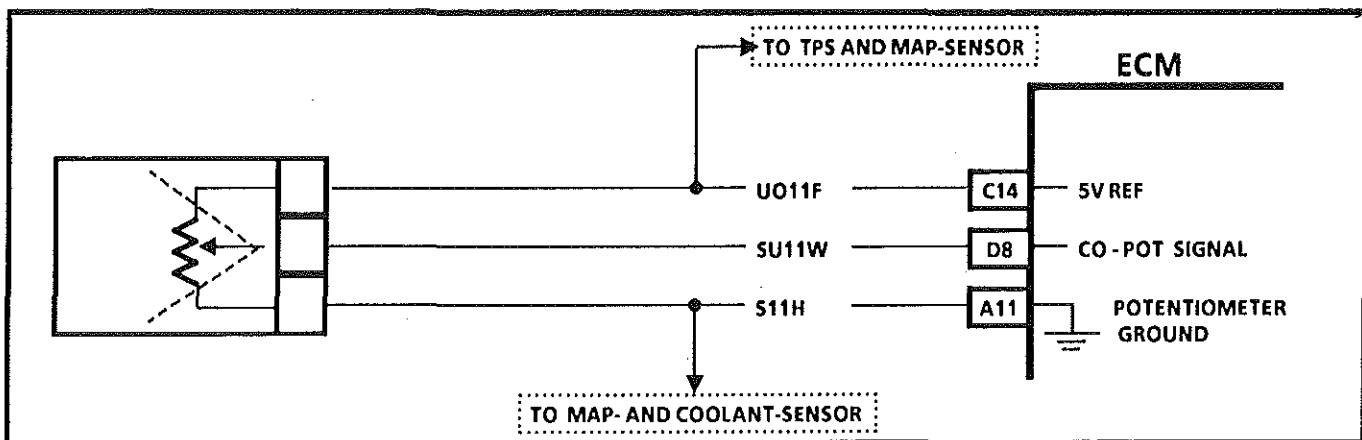


CODE 51

PROM ERROR (FAULTY ECM) 1.6L LOTUS ELAN

THE ECM ON THE 1.6L LOTUS ELAN IS A SEALED UNIT, AND NO ACCESS TO THE MEM-CAL IS POSSIBLE. IF CODE 51 IS DISPLAYED, THE COMPLETE ECM SHOULD BE REPLACED.

CLEAR CODES AND CONFIRM NO "CHECK ENGINE" LIGHT.



CODE 54

(PAGE 1 OF 2)

CO - POTENTIOMETER CIRCUIT (SIGNAL VOLTAGE HIGH OR LOW) 1.6L LOTUS ELAN

Circuit Description:

The CO - Potentiometer provides a voltage signal vary from about 0.6 volts to about 4.2 volts. Depending on the signal voltage the ECM will decrease or increase injection pulse width in order to obtain the CO emission percentage required. See. EML.3-E for CO checking and reset.

Test Description:

Numbers below refer to circled numbers on the diagnostic chart.

1. This step checks to see if Code 54 is the result of a hard failure or an intermittent condition.
A Code 54 will set if:
 - CO - Potentiometer output voltage is either lower than 0.2 volt or above 4.7 volts
2. This test determines if the potentiometer is faulty or other CKT components.
3. Internally shorted TPS or MAP-sensor could pull down 5V-Reference voltage. Code 34 and/or 22 could be stored.

Diagnostic Aids:

A Code 54 will be set, if one or more circuits to the CO potentiometer are open or CKT's UO11F or SU11W are grounded or shorted.

The Tech 1 displays "CO Adj. Volts".

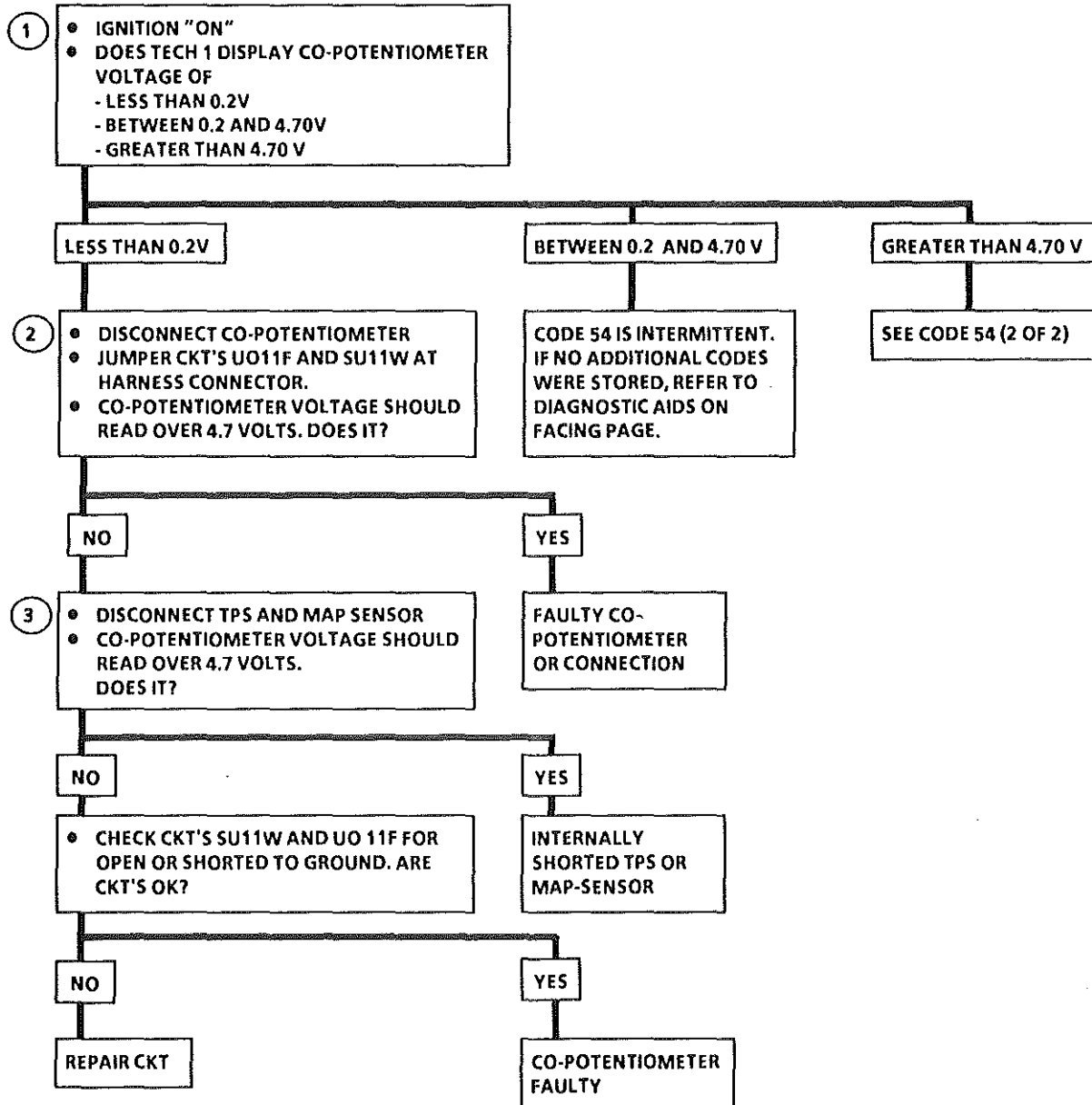
If Code 54 is intermittent:

- Check (wiggle) ECM connector pins D8, A11, C14, CO potentiometer connector and wiring which watching "CO Adj. Volts" on Tech 1 display. Voltage should be constant.
- Check/reset CO-emissions after repair (see EML.3-E).

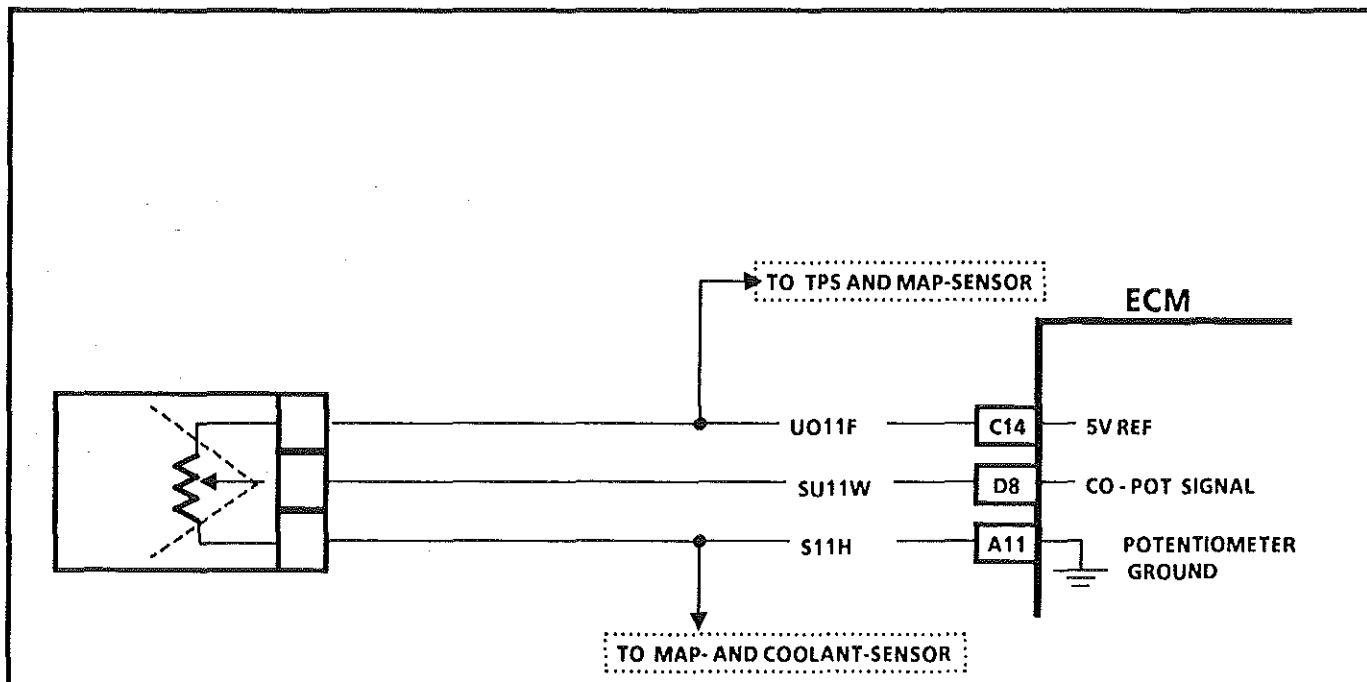
NOTE: IF CODE 54 IS SET TOGETHER WITH 41 AND/OR 42, THE SETTING OF CODE 54 IS LIKELY TO BE FALSE. DO NOT CHANGE CO POTENTIOMETER BEFORE INVESTIGATING CODES 41 AND/OR 42.

**CODE 54**

(PAGE 1 OF 2)

**CO - POTENTIOMETER CIRCUIT
(SIGNAL VOLTAGE HIGH OR LOW)
1.6L LOTUS ELAN**

CLEAR CODES AND CONFIRM NO "CHECK ENGINE" LIGHT.

**CODE 54**

(PAGE 2 OF 2)

**CO - POTENTIOMETER CIRCUIT
(SIGNAL VOLTAGE HIGH OR LOW)
1.6L LOTUS ELAN****Circuit Description:**

The CO - Potentiometer provides a voltage signal vary from about 0.6 volts to about 4.2 volts. Depending on the signal voltage the ECM will decrease or increase injection pulse width in order to obtain the CO emission percentage required. See EML.3-E for CO checking and reset.

Test Description:

Numbers below refer to circled numbers on the diagnostic chart.

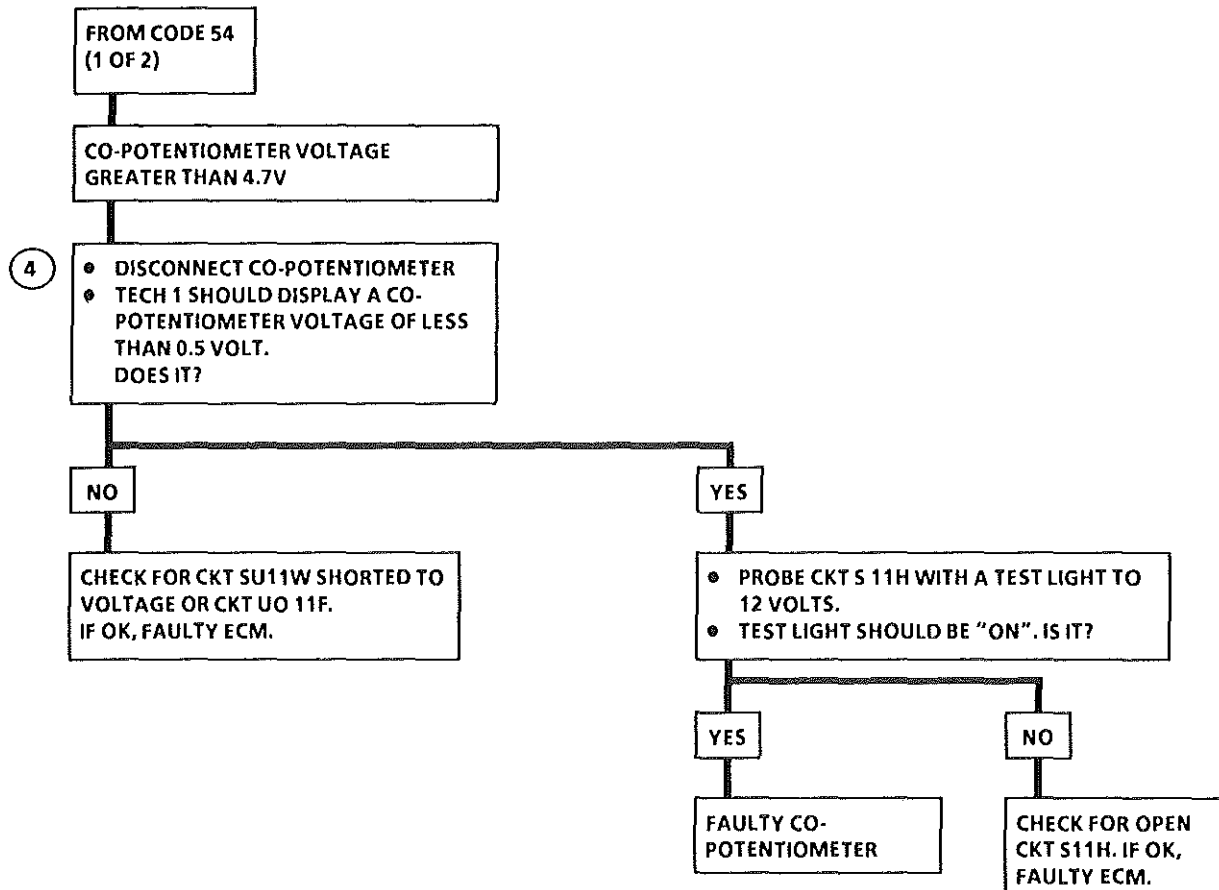
4. This simulates a Code 54 to be set for low signal voltage.

Diagnostic Aids:

The TECH 1 displays CO-Potentiometer volts. A Code 54 will result if CKT's or OU11F are open or shorted to ground or voltage or if CKT S11H is open.

If Code 54 is intermittent:

- Check (wiggle) ECM connector pins D8, A11, C14 while watching "CO-POT" on Tech 1 display. Voltage should be constant.
- Re-set CO-emission (see EMK.3-E).
- Check for injector leaking and incorrect fuel pressure.

**CODE 54****(PAGE 2 OF 2)****CO - POTENTIOMETER CIRCUIT
(SIGNAL VOLTAGE HIGH OR LOW)
1.6L LOTUS ELAN**

CLEAR CODES AND CONFIRM NO "CHECK ENGINE" LIGHT.



SECTION EML.5

1.6L LOTUS ELAN

DIAGNOSTIC CHARTS

"Non-Scan" Diagnostic Circuit Check	Page EML. 5- 2
Code 14 - Coolant Temperature Sensor Circuit (Signal Voltage Low - High Temperature Indicated)	Page EML. 5- 4
Code 15 - Coolant Temperature Sensor Circuit (Signal Voltage High - Low Temperature Indicated)	Page EML. 5- 6
Code 21 - Throttle Position Sensor (TPS) Circuit (Signal Voltage High)	Page EML. 5- 8
Code 22 - Throttle Position Sensor (TPS) Circuit (Signal Voltage Low)	Page EML. 5-10
Code 23 - Manifold Air Temperature (MAT) Sensor Circuit (Signal Voltage High)	Page EML. 5-12
Code 24 - Vehicle Speed Sensor (VSS) Circuit	Page EML. 5-14
Code 25 - Manifold Air Temperature (MAT) Sensor Circuit (Signal Voltage Low) .	Page EML. 5-16
Code 31/33 - MAP Sensor Circuit (Signal Voltage High - Low Vacuum)	Page EML. 5-18
Code 34 - MAP Sensor Circuit (Signal Voltage Low - High Vacuum)	Page EML. 5-20
Code 51 - PROM Error (Faulty ECM)	Page EML. 5-22
Code 54 - CO-Potentiometer Circuit (Signal Voltage High or Low)	Page EML. 5-22

DIAGNOSTIC CIRCUIT CHECK

The "Diagnostic Circuit Check" verifies the system is functioning correctly. Some special considerations to keep in mind while making the "Diagnostic Circuit Check" are:

Blocking Drive Wheels

The vehicle drive wheels should always be blocked while checking the system.



"NON-SCAN" DIAGNOSTIC CIRCUIT CHECK

1.6L LOTUS ELAN

Circuit Description:

The Diagnostic Circuit Check is an organized approach for identifying a problem caused by the Fuel Injection System.

Driver comments normally fall into one of the following areas:

- Steady "Check Engine" light
- Driveability Problem
- Engine "Cranks But Will Not Run"

Understanding the chart and using it correctly will reduce diagnosis time and prevent the unnecessary replacement of parts.

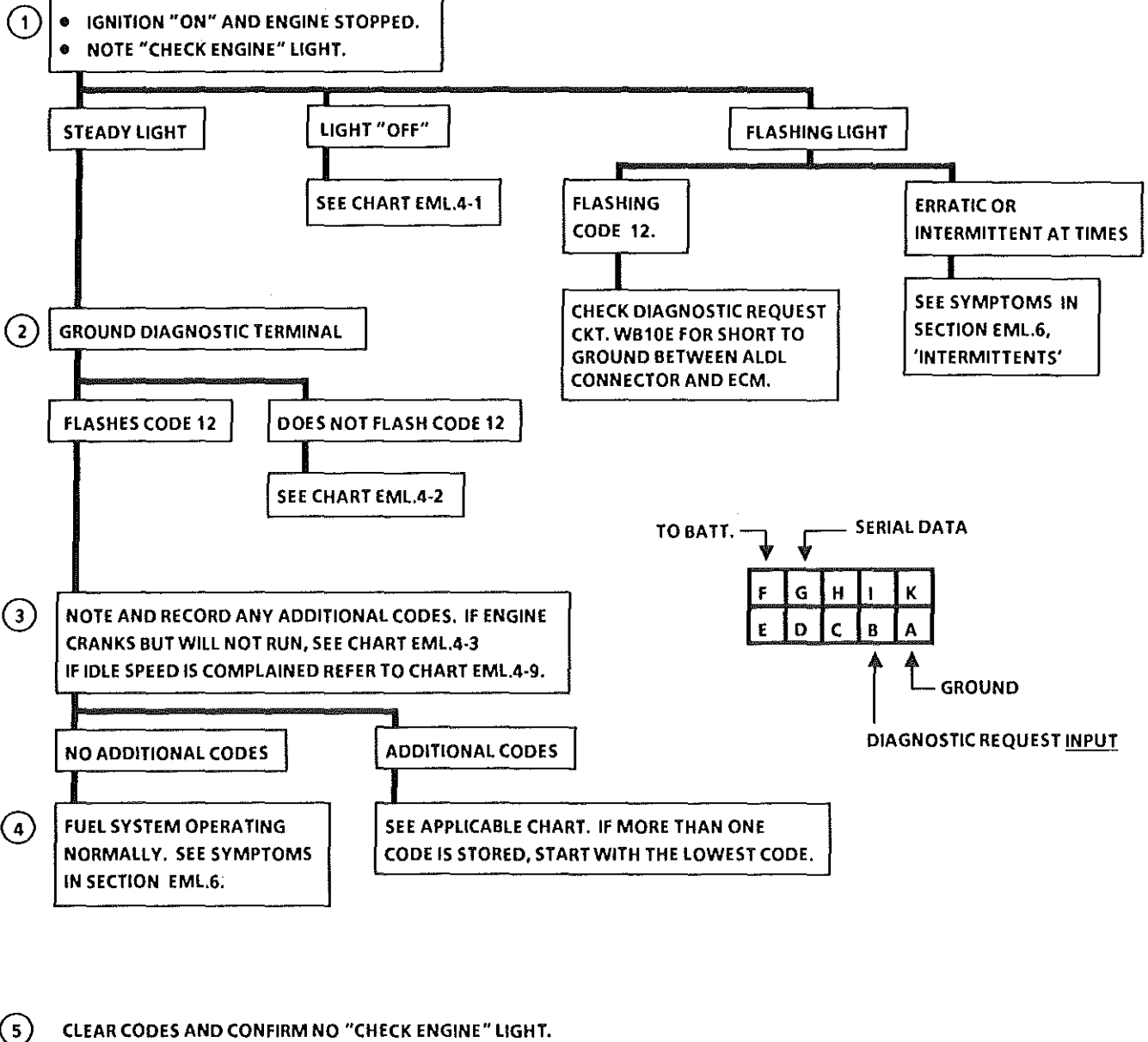
Test Description:

Numbers below refer to circled numbers on the diagnostic chart.

1. A steady "Check Engine" light with the ignition "ON" and engine stopped confirms battery and ignition voltage to the Electronic Control Module (ECM).
2. Ground diagnosis terminal by jumpering terminal "A" to "B" in the ALDL connector located beside the ECM in the driver compartment.
The ECM will cause the "Check Engine" light to flash Code 12, indicating that the ECM diagnostics are working. Code 12 will flash three (3) times, followed by any other trouble codes stored in the memory. Each additional code will flash three (3) times, starting with the lowest code, and then start over again with Code 12. If there are no other codes, Code 12 will flash until the diagnostic "test" terminal jumper is disconnected or the engine is started.
3. Record all stored codes except for Code 12. If the problem is "Engine Cranks But Will Not Run", go to chart EML. 4-3. In case of idle speed problems, refer to chart EML.4-9.
4. If no additional codes were recorded, see section EML.6 for driveability symptoms and recommended service procedures.
5. Clearing codes. Ignition "OFF". Disconnect battery for ten seconds.

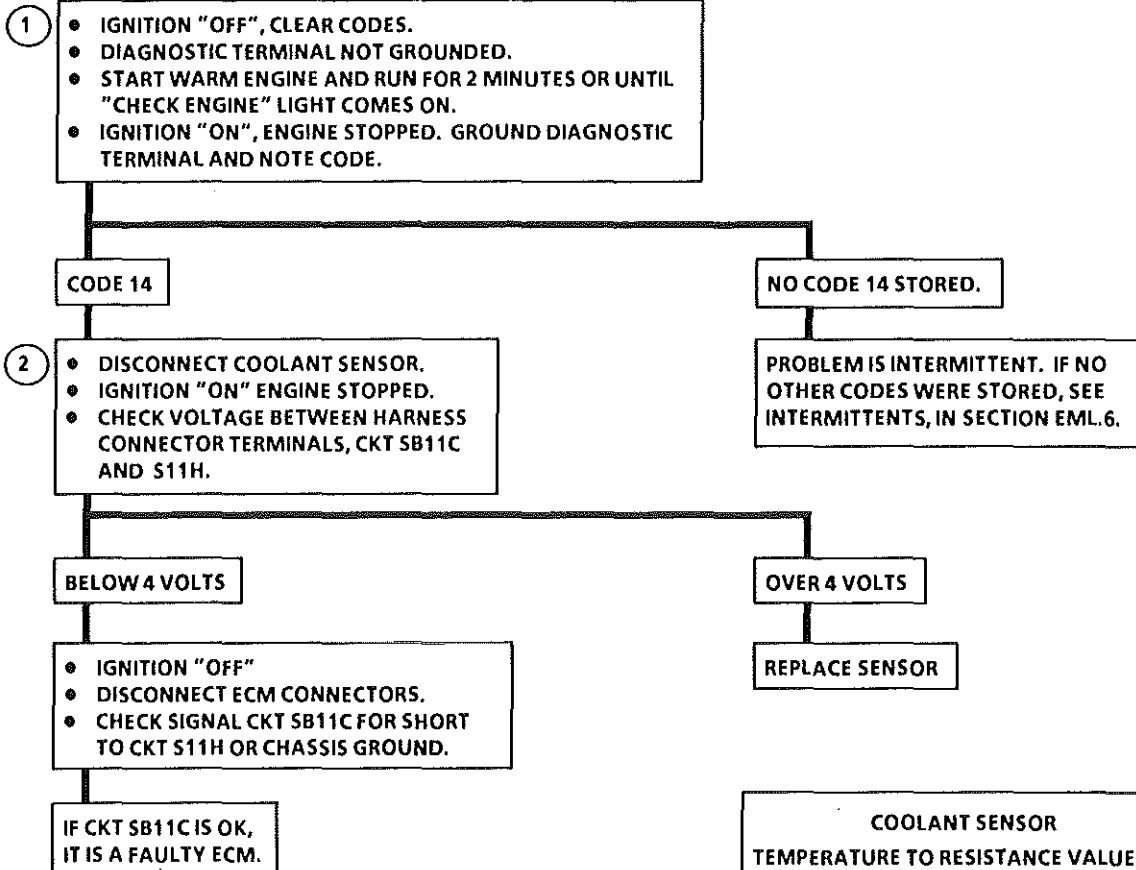


"NON-SCAN" DIAGNOSTIC CIRCUIT CHECK 1.6L LOTUS ELAN



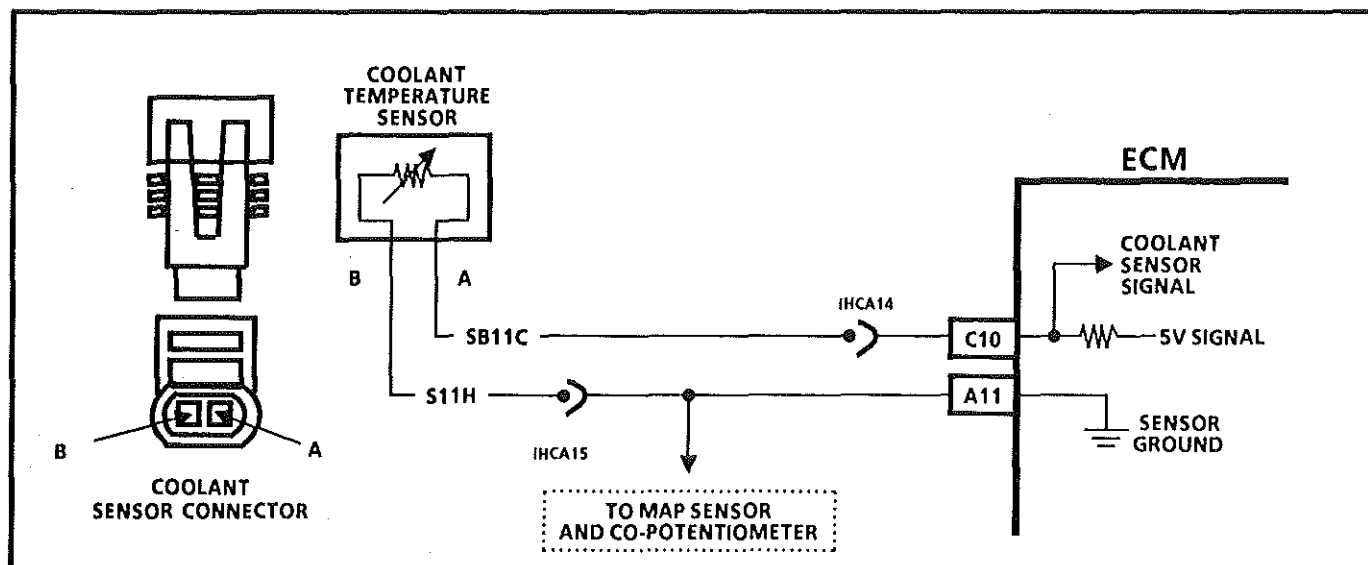
**"NON-SCAN" DIAGNOSTICS****CODE 14**

**COOLANT TEMPERATURE SENSOR CIRCUIT
(SIGNAL VOLTAGE LOW -
HIGH TEMPERATURE INDICATED)
1.6L LOTUS ELAN**



COOLANT SENSOR TEMPERATURE TO RESISTANCE VALUES (APPROXIMATE)		
°F	°C	OHMS
210	100	185
160	70	450
100	38	1,800
70	20	3,400
40	4	7,500
20	-7	13,500
0	-18	25,000
-40	-40	100,700

CLEAR CODES AND CONFIRM NO "CHECK ENGINE" LIGHT.



CODE 15

COOLANT TEMPERATURE SENSOR CIRCUIT (SIGNAL VOLTAGE HIGH - LOW TEMPERATURE INDICATED) 1.6L LOTUS ELAN

Circuit Description:

The Coolant Temperature Sensor uses a thermistor to control the signal voltage at the ECM. The ECM applies a voltage on CKT SB11C to the sensor. When the engine is cold, the sensor (thermistor) resistance is high, therefore, the ECM will see high signal voltage.

As the engine warms, the sensor resistance becomes less, and the voltage drops. At normal engine operating temperature (open thermostat), the voltage will measure about 1.0 to 2.4 volts at the ECM terminal "C10".

Coolant temperature is one of the inputs used to control:

- Fuel delivery
- Engine Spark Timing (EST)
- Idle (IAC)
- Exhaust Gas Recirculation
- Secondary Throttles
- Boost Control
- Air Conditioning

Test Description:

Numbers below refer to circled numbers on the diagnostic chart.

1. Checks to see if code was set as result of hard failure or intermittent condition.

Code 15 will set if:

- The engine has been running for 2 minutes.
- Signal Voltage indicates a coolant temperature below -40°C .

2. This test simulates conditions for a Code 14. If the ECM recognizes the grounded circuit (low voltage), and displays a high temperature, the ECM and wiring are OK.

3. This test will determine if there is a wiring problem or a faulty ECM. If CKT S11H is open, there may also be a Code 33 stored. Be sure to carefully check terminals at the engine harness connectors.

Diagnostic Aids:

When a Code 15 is set, the ECM will turn on the Engine Cooling Fan.

A Code 15 will result if CKT's SB11C or S11H are open.

If Code 15 is intermittent, refer to Section EML.6.

**"NON-SCAN" DIAGNOSTICS****CODE 15****COOLANT TEMPERATURE SENSOR CIRCUIT
(SIGNAL VOLTAGE HIGH -
LOW TEMPERATURE INDICATED)
1.6L LOTUS ELAN**

- 1
- IGNITION "OFF", CLEAR CODES.
 - DIAGNOSTIC TERMINAL NOT GROUNDED.
 - START WARM ENGINE IN W.O.T. (CLEAR FLOOD)
 - RUN FOR 2 MINUTES OR UNTIL "CHECK ENGINE" LIGHT COMES ON.
 - IGNITION "ON", ENGINE STOPPED.
 - GROUND DIAGNOSTIC TERMINAL AND NOTE CODE.

CODE 15**NO CODE 15.**

- 2
- DISCONNECT COOLANT SENSOR CONNECTOR
 - IGNITION "ON" ENGINE STOPPED.
 - CHECK VOLTAGE BETWEEN HARNESS CONNECTOR TERMINALS, CKT SB11C AND S11H.

PROBLEM IS INTERMITTENT. IF NO OTHER CODES WERE STORED, SEE INTERMITTENTS, SECTION EML. 6.

4 VOLTS OR OVER

**FAULTY COOLANT SENSOR
CONNECTION OR FAULTY SENSOR**

BELOW 4 VOLTS

- PROBE COOLANT SENSOR CKT SB11C (CAVITY B) WITH A VOLTMETER TO GROUND.
- SHOULD BE 4-6 VOLTS.

VOLTAGE OK**VOLTAGE NOT OK**

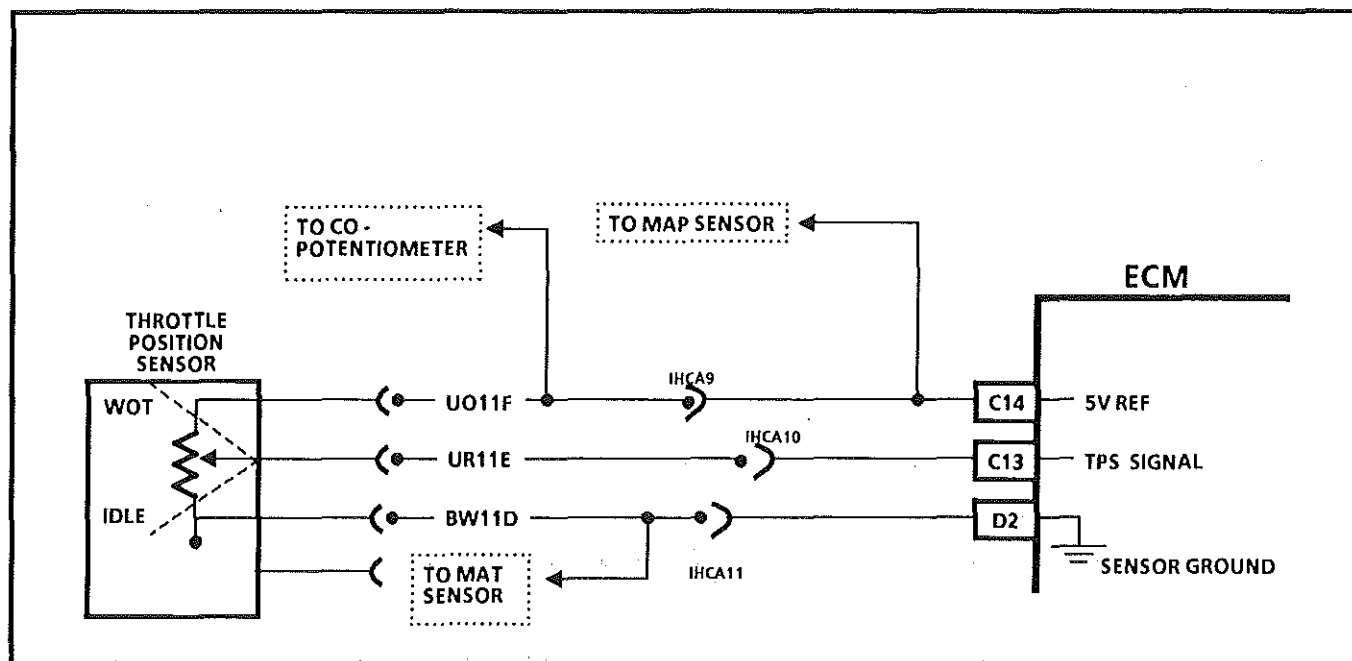
3

- CHECK FOR OPEN CKT S11H. IF NOT OPEN, IT IS FAULTY ECM CONNECTION OR ECM.

- CHECK FOR OPEN CKT SB11C. IF NOT OPEN, IT IS FAULTY ECM CONNECTION OR ECM.

COOLANT SENSOR TEMPERATURE TO RESISTANCE VALUES (APPROXIMATE)		
°F	°C	OHMS
275	135	68
210	100	185
160	70	450
100	38	1,800
70	20	3,400
40	4	7,500
20	-7	13,500
0	-18	25,000
-22	-30	53,000
-40	-40	100,700

CLEAR CODES AND CONFIRM NO "CHECK ENGINE" LIGHT.



CODE 21

THROTTLE POSITION SENSOR (TPS) CIRCUIT (SIGNAL VOLTAGE HIGH) 1.6L LOTUS ELAN

Circuit Description:

The Throttle Position Sensor (TPS) provides a voltage signal that changes relative to the throttle valve position. Signal voltage will vary from about 0.4 volts at idle to about 4.0 volts at wide open throttle (WOT).

The TPS signal is one of the most important inputs used by the ECM for fuel control and for many of the ECM controlled outputs.

Test Description:

Numbers below refer to circled numbers on the diagnostic chart.

1. This step checks to see if Code 21 is the result of a hard failure or an intermittent condition.

A Code 21 will set if:

- TPS reading above 4.7 volts.
- Engine speed less than 1800 rpm.
- MAP reading below 45 kPa.
- All of the above conditions present for 5 seconds.

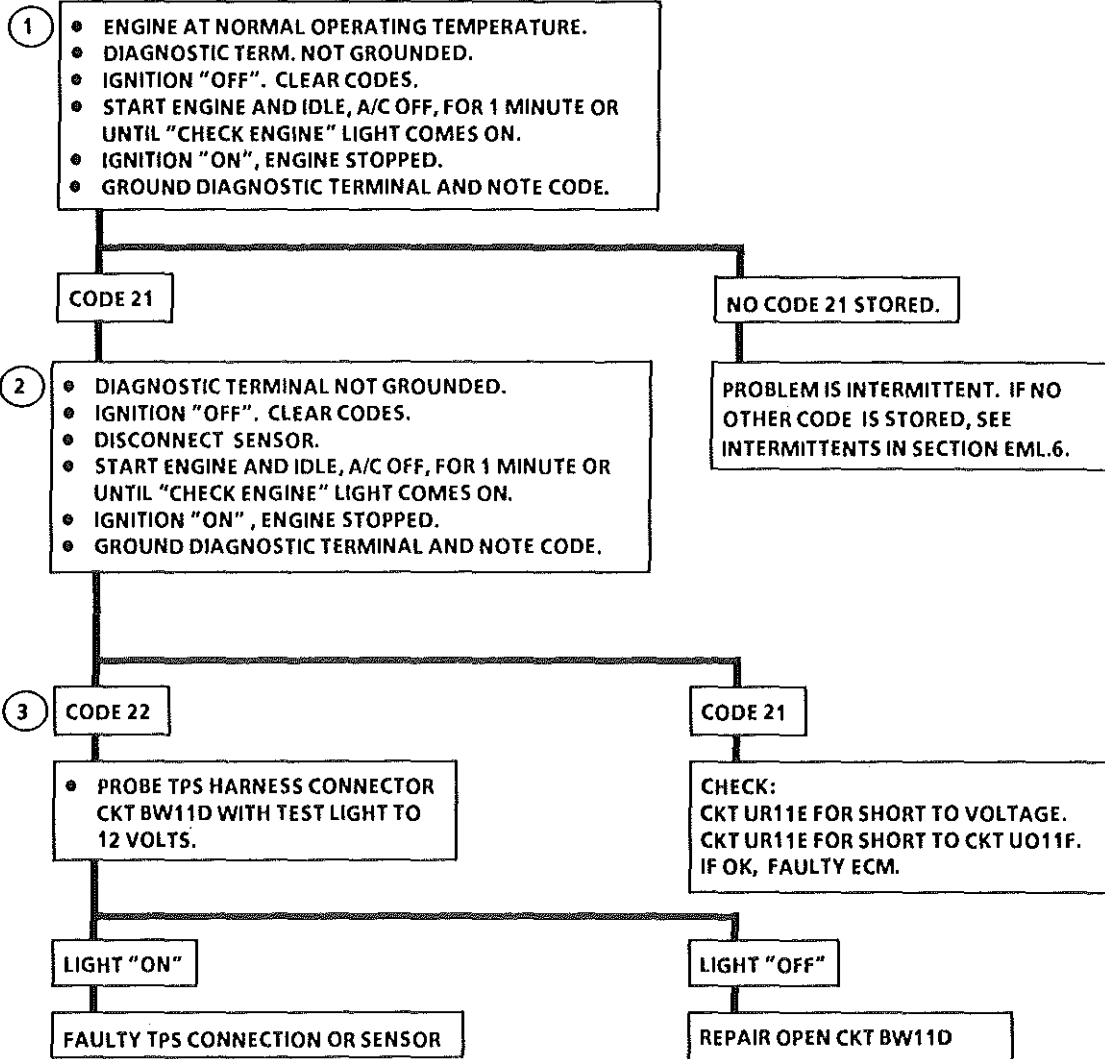
2. This step simulates conditions for a Code 22. If the ECM recognizes the change of state, the ECM and CKTs UO11F and UR11E are OK.

3. This step isolates a faulty sensor, ECM, or an open CKT BW11D. If it is determined CKT BW11D is the fault be sure to check the terminals at the injector harness connector.

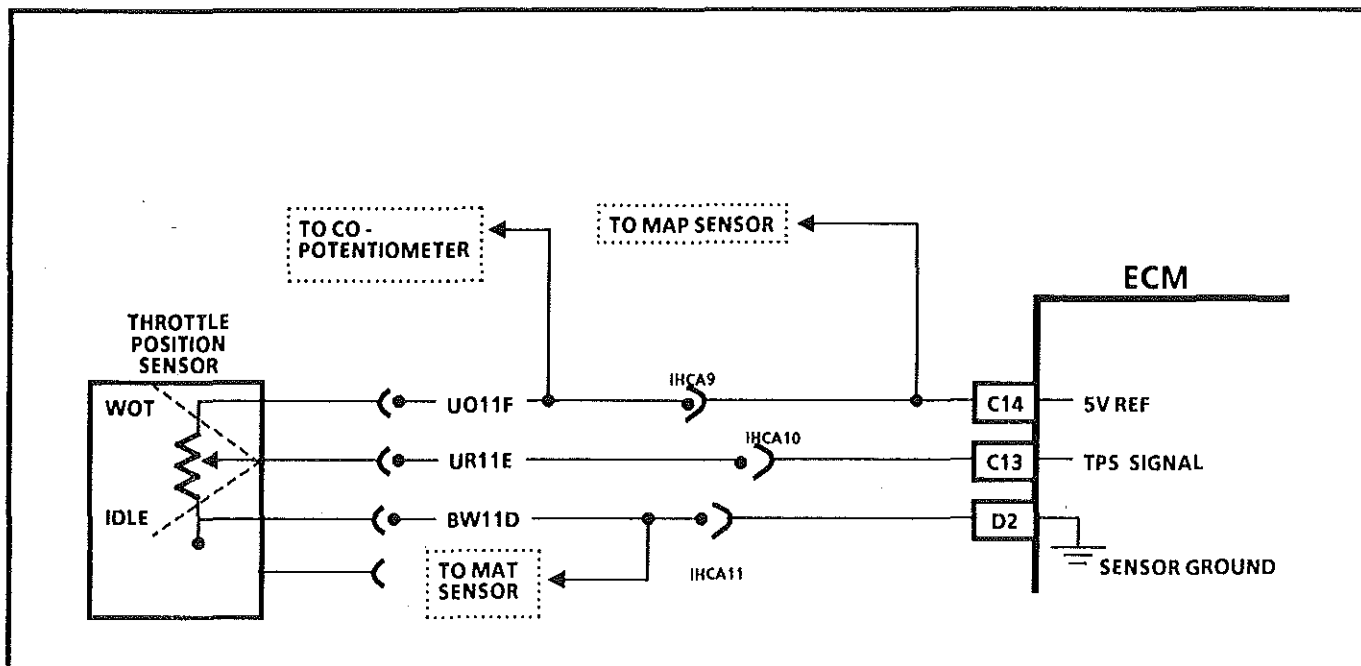
Diagnostic Aids:

Closed throttle voltage should be 0.4 ± 0.02 volts, TPS voltage should increase at a steady rate as throttle is moved to WOT.

A Code 21 will result if CKT BW11D is open or CKT UR11E is shorted to voltage. If Code 21 is intermittent, refer to Section EML. 6.

**"NON-SCAN" DIAGNOSTICS****CODE 21****THROTTLE POSITION SENSOR (TPS) CIRCUIT
(SIGNAL VOLTAGE HIGH)
1.6L LOTUS ELAN**

CLEAR CODES AND CONFIRM NO "CHECK ENGINE" LIGHT.



CODE 22

THROTTLE POSITION SENSOR (TPS) CIRCUIT (SIGNAL VOLTAGE LOW) 1.6L LOTUS ELAN

Circuit Description:

The Throttle Position Sensor (TPS) provides a voltage signal that changes, relative to the throttle valve position. Signal voltage will vary from about 0.4 volts at idle to about 4.0 volts at wide open throttle (WOT).

The TPS signal is one of the most important inputs used by the ECM for fuel control and for many of the ECM controlled outputs.

Test Description:

Numbers below refer to circled numbers on the diagnostic chart.

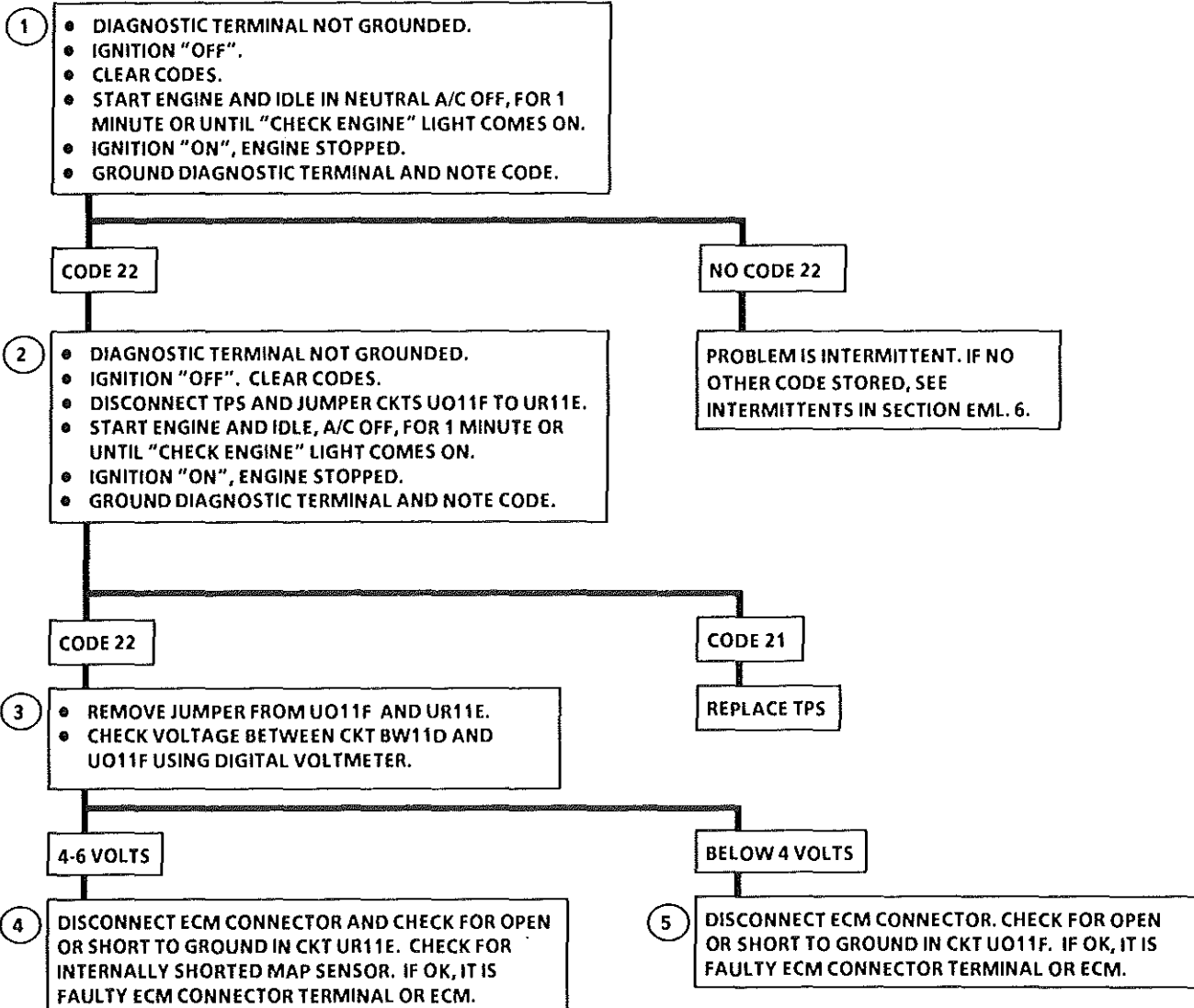
1. This step checks to see if Code 22 is the result of a hard failure or an intermittent condition.
A Code 22 will set if:
 - The engine is running.
 - TPS voltage is below .20 volts.
2. This step simulates conditions for a Code 21. If a Code 21 is set, or the ECM wiring are OK, indicating a faulty TPS sensor.
3. This step checks for the reference signal to CKT UO11F.
4. If voltage is present then, CKT UR11E may be open or have a short to ground (check engine harness connector). To check if MAP sensor is faulty, disconnect it. Voltage on CKT UO11F should return to 5 volts. If OK, ECM connector terminal or ECM itself may be faulty.
5. If CKT UO11F is open or shorted to ground, there may also be a stored Code 34.

Diagnostic Aids:

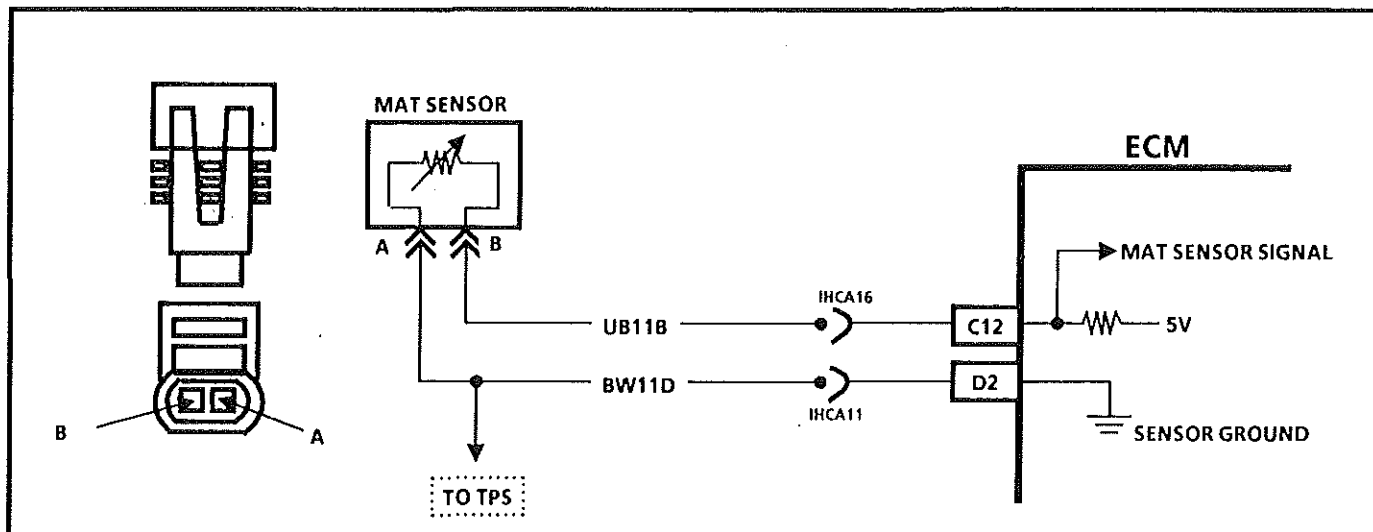
Closed throttle voltage should be 0.4 ± 0.02 volts. TPS voltage should increase at a steady rate as throttle is moved to WOT.

An open or grounded UO11F or UR11E will result in a Code 22.

If Code 22 is intermittent, refer to Section EML. 6.

**"NON-SCAN" DIAGNOSTICS****CODE 22****THROTTLE POSITION SENSOR (TPS) CIRCUIT
(SIGNAL VOLTAGE LOW)
1.6L LOTUS ELAN**

CLEAR CODES AND CONFIRM NO "CHECK ENGINE" LIGHT.



CODE 23

MANIFOLD AIR TEMPERATURE (MAT) SENSOR CIRCUIT (LOW TEMPERATURE INDICATED) 1.6L LOTUS ELAN

Circuit Description:

The Manifold Air Temperature Sensor uses a thermistor to control the signal voltage to the ECM. The ECM applies a voltage of about 5 volts on CKT UB11B to the sensor. When manifold air is cold, the sensor (thermistor) resistance is high, therefore, the ECM will see a high signal voltage. As the air warms, the sensor resistance becomes less and the voltage drops.

Test Description:

Numbers below refer to circled numbers on the diagnostic chart.

1. A Code 23 will set due to an open sensor, wire or connection 3 minutes after problem has been detected by the ECM. This test will determine if the wiring and ECM are OK.

2. If the resistance is greater than 25,000 ohms, replace the sensor.

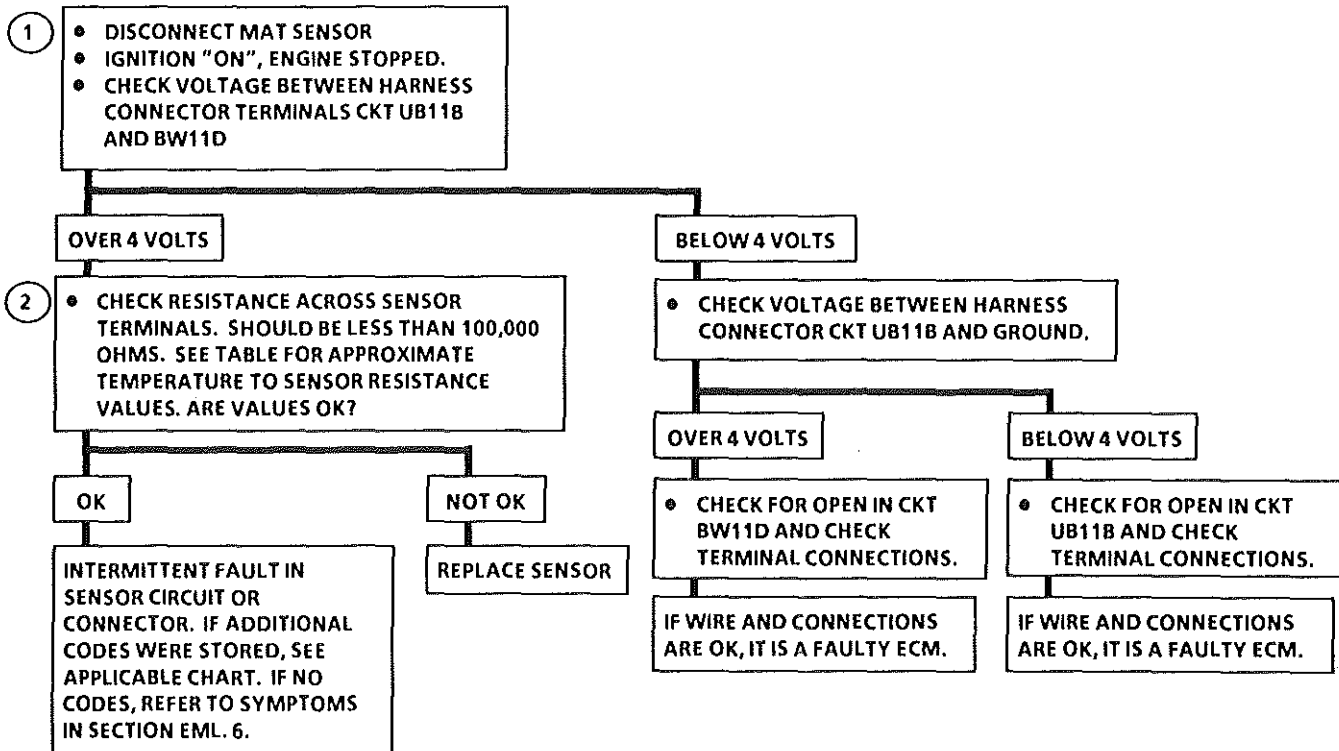
If CKT BW11D is open there may also be a Code 21 stored.

If Code 23 is intermittent, refer to Section EML. 6.



"NON-SCAN" DIAGNOSTICS

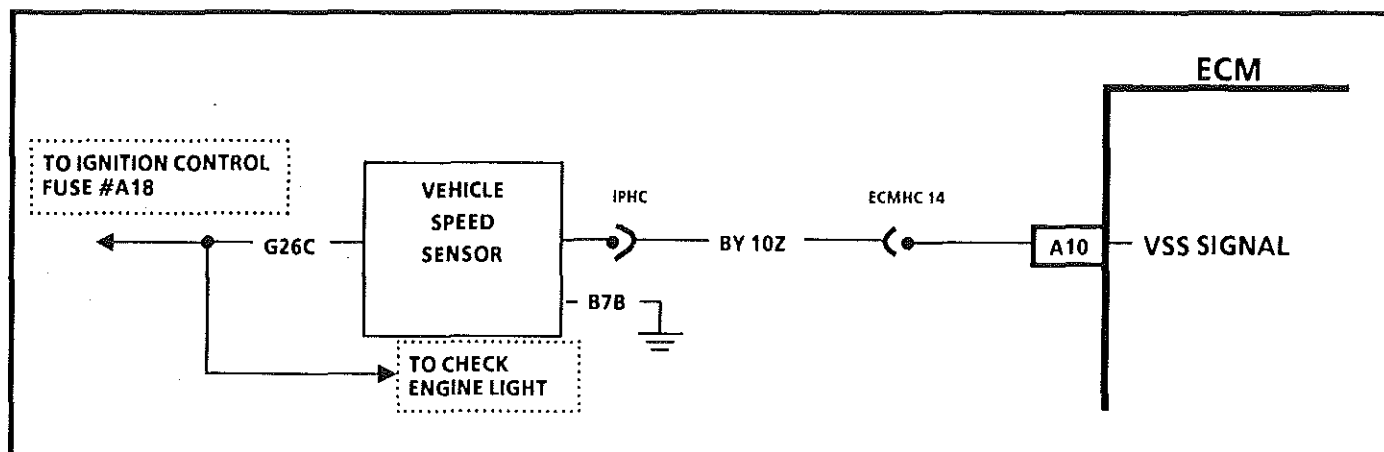
CODE 23

MANIFOLD AIR TEMPERATURE
(MAT) SENSOR CIRCUIT
(SIGNAL VOLTAGE HIGH)
1.6L LOTUS ELAN

DIAGNOSTIC AID

MAT SENSOR		
TEMPERATURE TO RESISTANCE VALUES (APPROXIMATE)		
°F	°C	OHMS
210	100	185
160	70	450
100	38	1,800
70	20	3,400
40	4	7,500
20	-7	13,500
0	-18	25,000
-40	-40	100,700

CLEAR CODES AND CONFIRM NO "CHECK ENGINE" LIGHT.



CODE 24

VEHICLE SPEED SENSOR (VSS) CIRCUIT 1.6L LOTUS ELAN

Circuit Description:

Vehicle speed information is provided to the ECM by the vehicle speed sensor which is an optical device mounted in the instrument cluster. The VSS driven by the tachometer cable produces electrical pulses which the ECM uses to calculate mph or kph.

Test Description:

Numbers below refer to circled numbers on the diagnostic chart.

1. Code 24 will set if vehicle speed is less than 2 mph when:

- Engine speed is between 1600 and 4800 rpm.
- TPS is greater than 5%.
- MAP signal between 65 and 207 kPa.
- All conditions met for 5 seconds.
- No Code 21, 22, 33 or 34.

These conditions are met during a road load operation. Disregard Code 24 that sets when drive wheels are not turning.

Diagnostic Aids:

The voltmeter should indicate a voltage change whenever the wheels are turning.

Check CKT's BY10Z, G26C and B7B for proper connections. Be sure they are clean and tight and the harness is routed correctly.

If Code 24 is intermittent, refer to Section EML. 6.

**"NON-SCAN" DIAGNOSTICS****CODE 24****VEHICLE SPEED SENSOR (VSS) CIRCUIT
1.6L LOTUS ELAN****1**

- SPEEDOMETER WORKING OK. IF NOT, REPAIR THAT PROBLEM BEFORE USING THIS CHART.
- LIFT DRIVE WHEELS AND SUPPORT FRONT OF VEHICLE, ALLOWING FRONT WHEELS TO ROTATE.
- IGNITION "ON".
- BACK PROBE ECM CONNECTOR, VSS SIGNAL CKT BY10Z CAVITY A10 WITH A VOLTMETER TO GROUND, DVM ON DC SCALE.
- ROTATE RIGHT DRIVE WHEEL SLOWLY BY HAND. VOLTAGE SHOULD ALTERNATE BETWEEN 0 AND 12 VOLTS. DOES IT?

NO

- CHECK CKT BY10Z FOR OPEN, GROUNDED OR SHORTED TO VOLTAGE IS CKT OK?

YES

REPAIR CKT

- IGNITION ON
- CHECK VEHICLE SENSOR IGNITION FEED CKT G26C AND GROUND CKT B7B. ARE CKT'S OK?

YES

REPLACE VEHICLE SPEED SENSOR

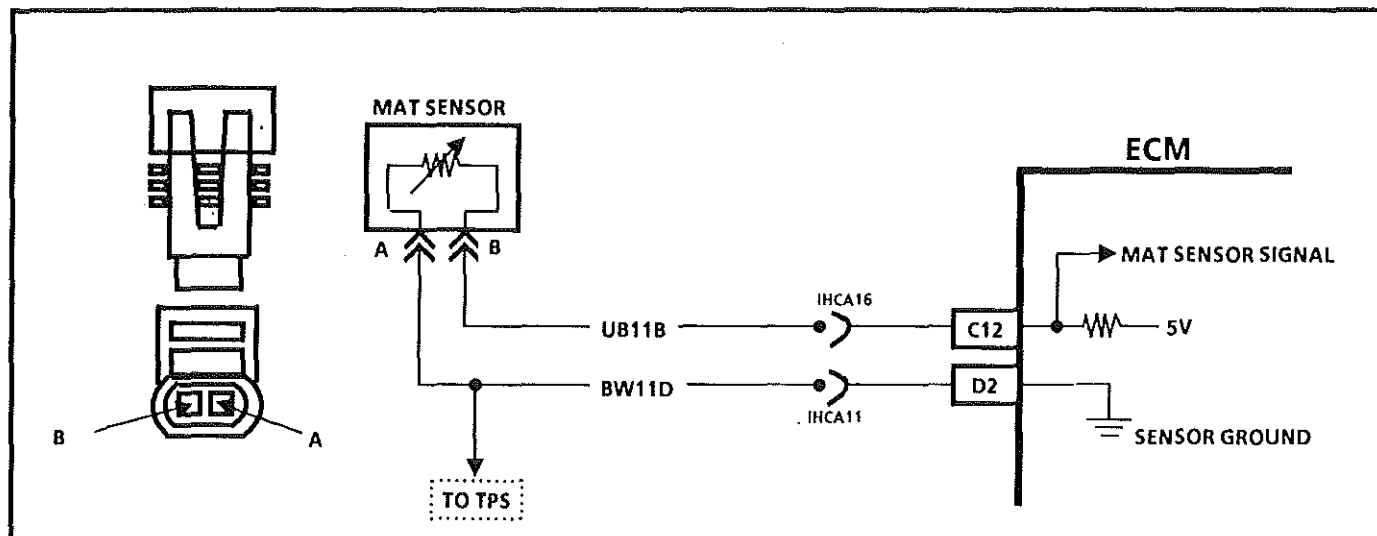
NO

REPAIR CKT

YES

CLEAR CODE, CHECK ALL CONNECTIONS AND DRIVE THE CAR. BE SURE THE CONDITIONS TO SET THE CODE ARE MET (SEE FACING PAGE). IF CODE SETS AGAIN, REPLACE ECM.

CLEAR CODES AND CONFIRM NO "CHECK ENGINE" LIGHT.



CODE 25

MANIFOLD AIR TEMPERATURE (MAT) SENSOR CIRCUIT (HIGH TEMPERATURE INDICATED) 1.6L LOTUS ELAN

Circuit Description:

The Manifold Air Temperature Sensor uses a thermistor to control the signal voltage to the ECM. The ECM applies a voltage of about 5 volts on CKT UB11B to the sensor. When manifold air is cold, the sensor (thermistor) resistance is high, therefore, the ECM will see a high signal voltage. As the air warms, the sensor resistance becomes less and the voltage drops.

A code 25 will be set 2 minutes after ECM detected a problem in the MAT sensor circuitry.

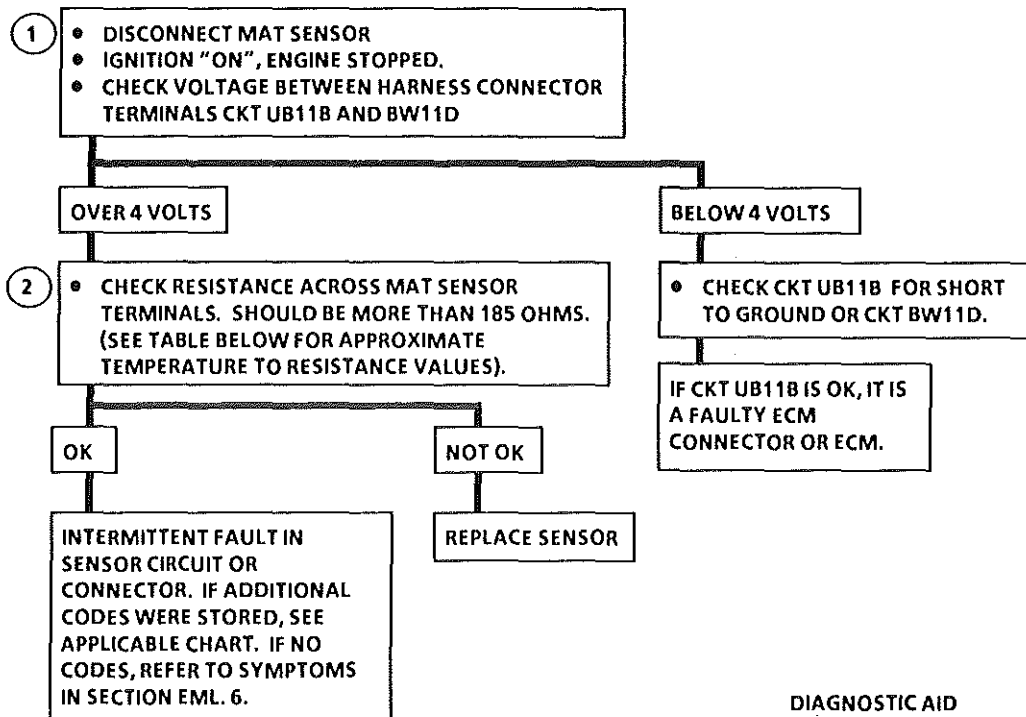
Test Description:

Numbers below refer to circled numbers on the diagnostic chart.

1. If voltage is above 4 volts, the ECM and wiring are OK.
2. If resistance is less than 185 ohms, replace the sensor.

**"NON-SCAN" DIAGNOSTICS****CODE 25**

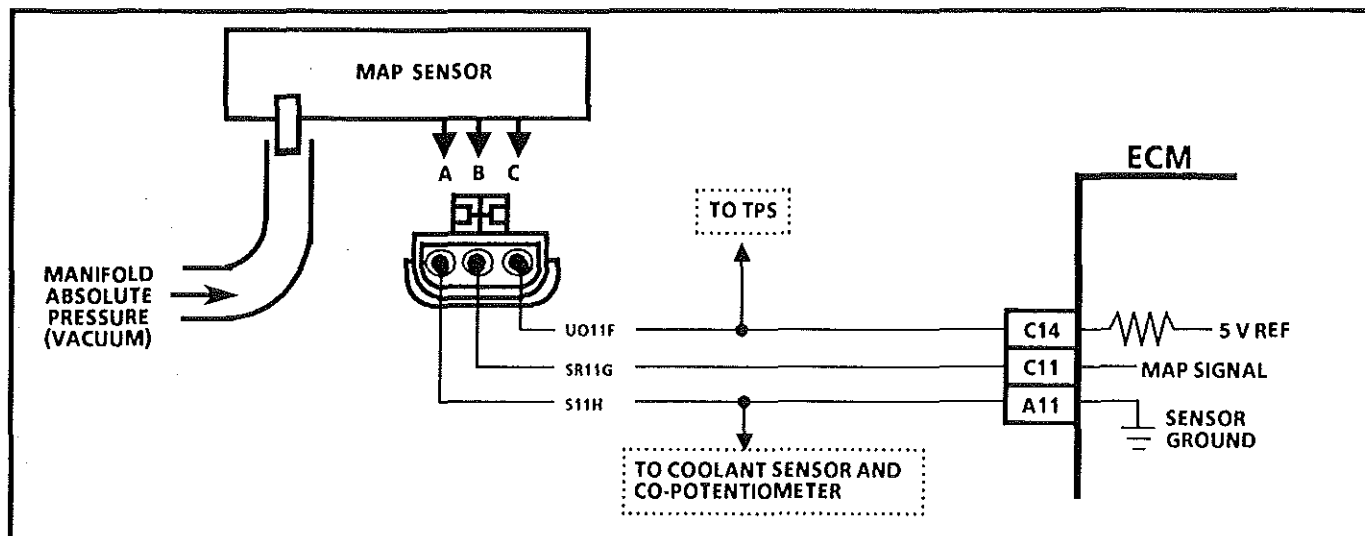
**MANIFOLD AIR TEMPERATURE
(MAT) SENSOR CIRCUIT
(SIGNAL VOLTAGE LOW)
1.6L LOTUS ELAN**



DIAGNOSTIC AID

MAT SENSOR		
TEMPERATURE TO RESISTANCE VALUES (APPROXIMATE)		
°F	°C	OHMS
210	100	185
160	70	450
100	38	1,800
70	20	3,400
40	4	7,500
20	-7	13,500
0	-18	25,000
-40	-40	100,700

CLEAR CODES AND CONFIRM NO "CHECK ENGINE" LIGHT.

**CODE 31/33****MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR CIRCUIT
(SIGNAL VOLTAGE HIGH - LOW VACUUM)
1.6L LOTUS ELAN****Circuit Description:**

The Manifold Absolute Pressure (MAP) Sensor responds to changes in manifold pressure (vacuum). The ECM receives this information as a signal voltage that will vary from about 0.7 to 1.0 volts, at closed throttle idle, to 2.2 to 2.4 volts at wide open throttle (low vacuum).

If the MAP sensor fails, the ECM will substitute a fixed MAP value and use the Throttle Position Sensor (TPS) to control fuel delivery.

Test Description:

Numbers below refer to circled numbers on the diagnostic chart.

1. This step will determine if Code 33 is the result of a hard failure or an intermittent condition. A Code 33 will set if:
 - MAP signal indicates more than 2.6 V (110 kPa).
 - TPS less than 5%.
 - These conditions are present for a time longer than 0.2 seconds.
2. This step simulates conditions for a Code 34. If the ECM recognizes the change, the ECM, and CKT's UO11F and SR11G, are OK. If CKT S11H is open, there may also be a Code 15 stored.

Diagnostic Aids:

With the ignition "ON" and the engine stopped, the manifold pressure is equal to atmospheric pressure and the signal voltage will be high. This information is used by the ECM as an indication of vehicle altitude and is referred to as BARO. Comparison of this BARO reading with a known good vehicle with the same sensor is a good way to check accuracy of a "suspect" sensor. Readings should be the same $\pm .4$ volt.

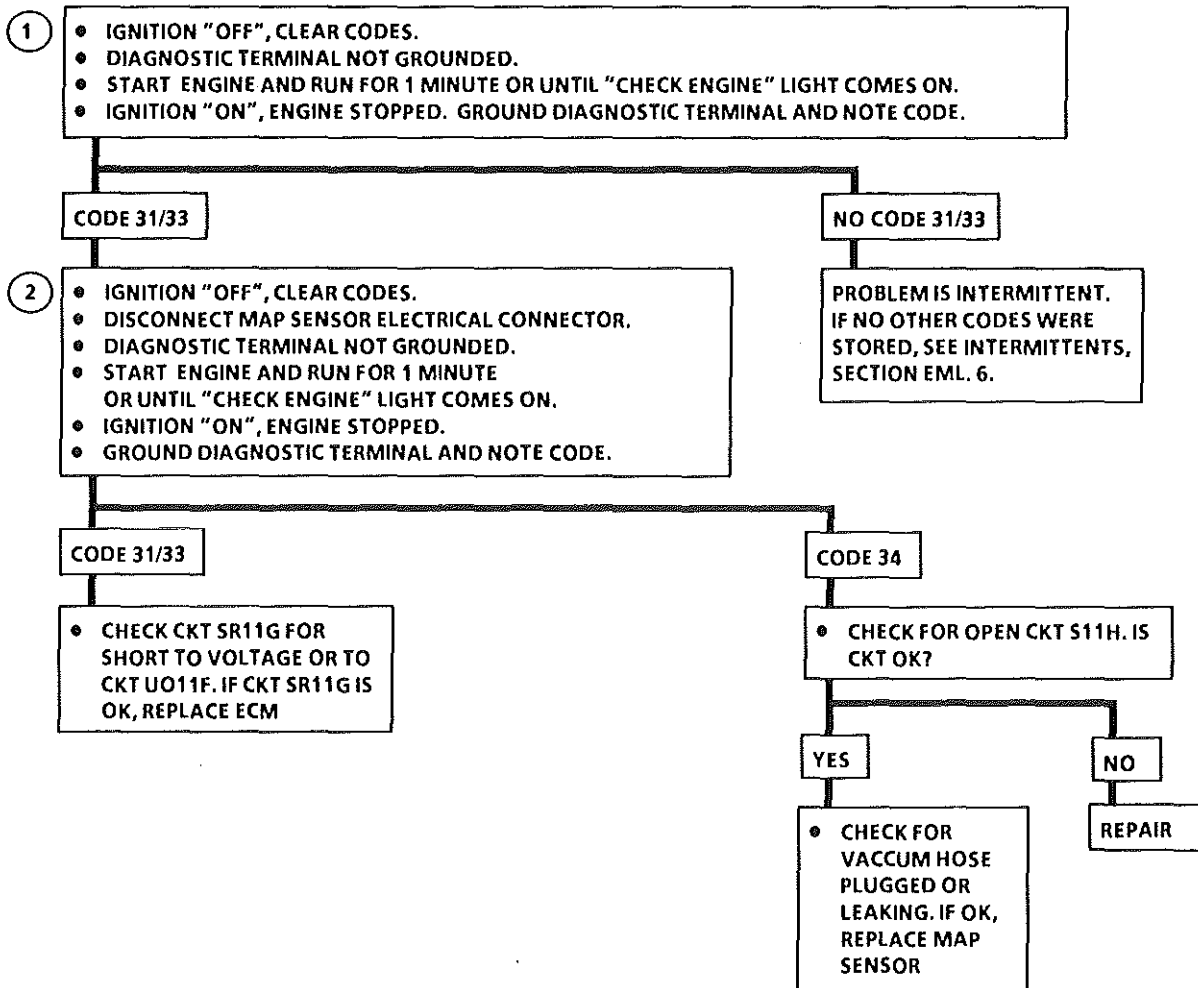
A Code 33 will result if CKT S11H is open, or if CKT SR11G is shorted to voltage or to CKT UO11F.

If Code 33 is intermittent, refer to Section EML. 6.

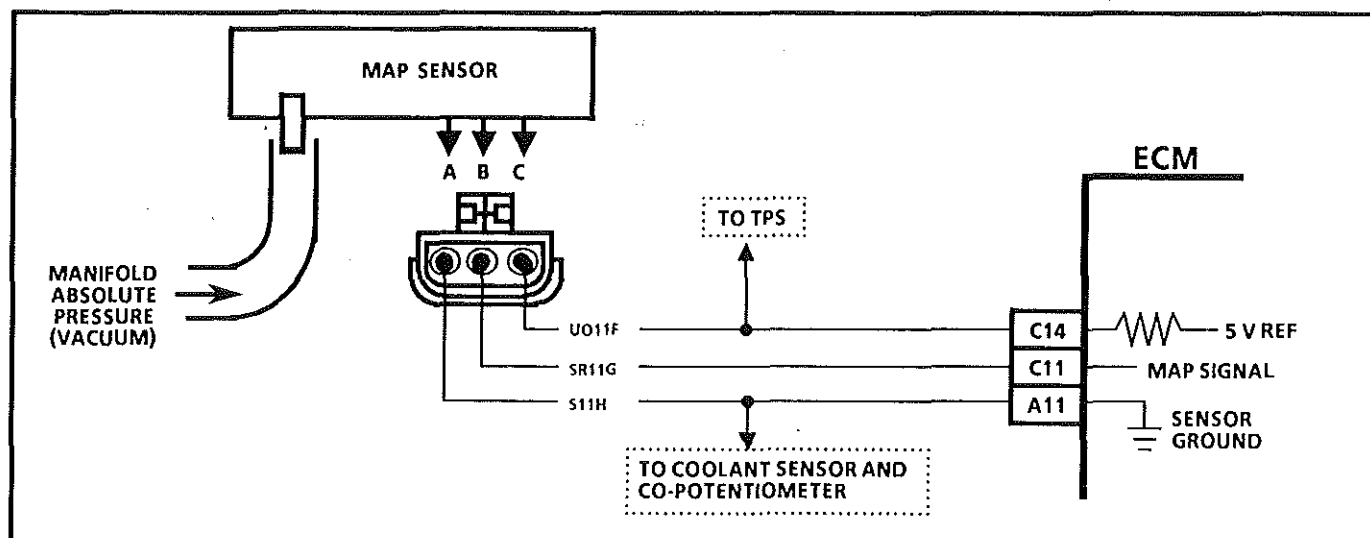
**"NON-SCAN" DIAGNOSTICS****CODE 31/33**

**MANIFOLD ABSOLUTE PRESSURE
(MAP) SENSOR CIRCUIT
(SIGNAL VOLTAGE HIGH - LOW VACUUM)
1.6L LOTUS ELAN**

CHECK FOR PROBLEMS WHICH COULD CAUSE A ROUGH, UNSTABLE IDLE BEFORE USING THIS CHART.
SEE SYMPTOMS SECTION EML 6.



CLEAR CODES AND CONFIRM NO "CHECK ENGINE" LIGHT.



CODE 34

MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR CIRCUIT (SIGNAL VOLTAGE LOW - HIGH VACUUM) 1.6L LOTUS ELAN

Circuit Description:

The Manifold Absolute Pressure (MAP) Sensor responds to changes in manifold pressure (vacuum). The ECM receives this information as a signal voltage that will vary from about 0.7 to 1.0 volts at closed throttle idle, to 2.2 to 2.4 volts at wide open throttle.

If the MAP sensor fails, the ECM will substitute a fixed MAP value and use the Throttle Position Sensor (TPS) to control fuel delivery.

Test Description:

Numbers below refer to circled numbers on the diagnostic chart.

1. This step determines if Code 34 is the result of a hard failure or an intermittent condition.

A Code 34 will set when:

- Engine rpm is less than 1200 rpm.
- MAP signal voltage is too low (14 kPa).

OR

- MAP reading less than 14 kPa.
- Engine rpm greater than 1200 rpm.
- TPS is less than 15%.

2. Jumpering harness terminals "B" to "C", 5 volt to signal, will determine if the sensor is at fault, or if there is a problem with the ECM or wiring.

Diagnostic Aids:

With the ignition "ON" and the engine stopped, the manifold pressure is equal to atmospheric pressure and the signal voltage will be high. This information is used by the ECM as an indication of vehicle altitude and is referred to as BARO. Comparison of this BARO reading with a known good vehicle with the same sensor is a good way to check accuracy of a "suspect" sensor. Readings should be the same $\pm .4$ volt.

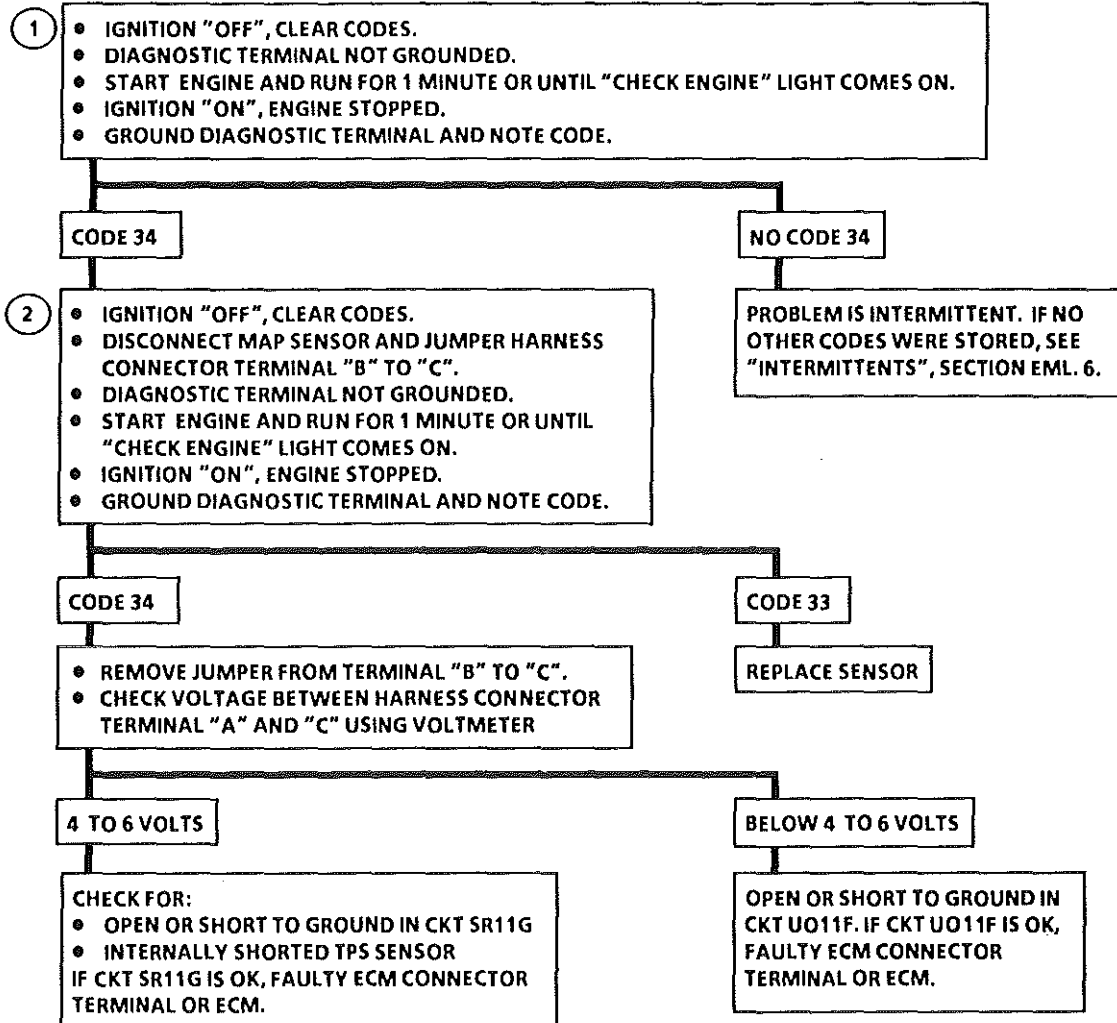
A Code 34 will result if CKTs are open or shorted to ground

If Code 34 is intermittent, refer to Section EML. 6.

An internally shorted TPS sensor will cause a Code 34.

**"NON-SCAN" DIAGNOSTICS****CODE 34**

**MANIFOLD ABSOLUTE PRESSURE
(MAP) SENSOR CIRCUIT
(SIGNAL VOLTAGE LOW - HIGH VACUUM)
1.6L LOTUS ELAN**



CLEAR CODES AND CONFIRM NO "CHECK ENGINE" LIGHT.

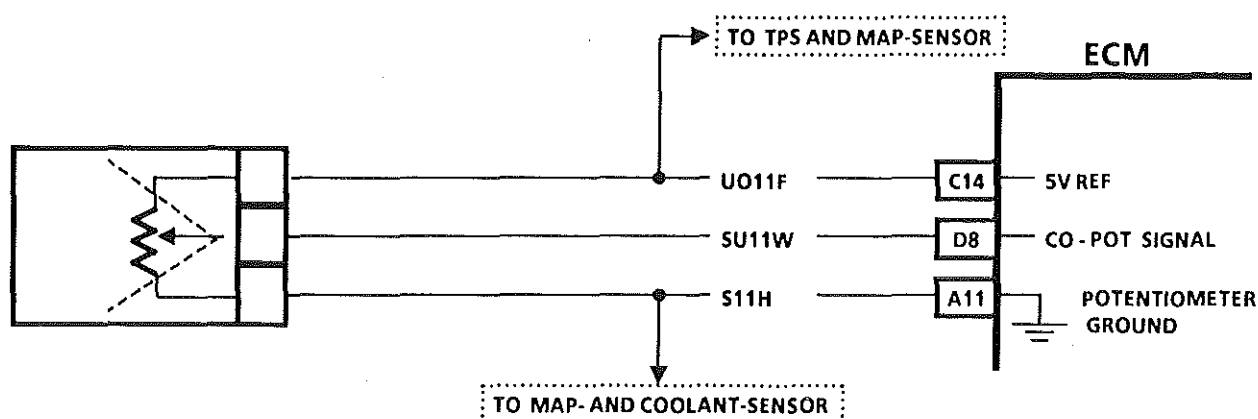


CODE 51

PROM ERROR (FAULTY ECM) 1.6L LOTUS ELAN

THE ECM ON THE 1.6L LOTUS ELAN IS A SEALED UNIT, AND NO ACCESS TO THE MEM-CAL IS POSSIBLE. IF CODE 51 IS DISPLAYED, THE COMPLETE ECM SHOULD BE REPLACED.

CLEAR CODES AND CONFIRM NO "CHECK ENGINE" LIGHT.



CODE 54

(PAGE 1 OF 2)

CO - POTENTIOMETER CIRCUIT (SIGNAL VOLTAGE HIGH OR LOW) 1.6L LOTUS ELAN

Circuit Description:

The CO - Potentiometer provides a voltage signal vary from about 0.6 volts to about 4.2 volts. Depending on the signal voltage the ECM will decrease or increase injection pulse width in order to obtain the CO emission percentage required. See EML.3-E for CO checking and reset.

Test Description:

Numbers below refer to circled numbers on the diagnostic chart.

1. This step checks to see if Code 54 is the result of a hard failure or an intermittent condition.
A Code 54 will set if:
 - CO - Potentiometer output voltage is below 0.2 or above 4.7 volts .
2. This test determines if the potentiometer is faulty or other CKT components.
3. Internally shorted TPS or MAP-sensor could pull down 5V-Reference voltage. Code 34 and /or 22 could be stored.

Diagnostic Aids:

The TECH 1 displays CO - Potentiometer volts.

A Code 54 will result if CKT `s or OU11F are open or shorted to ground or voltage or if CKT S11H is open.

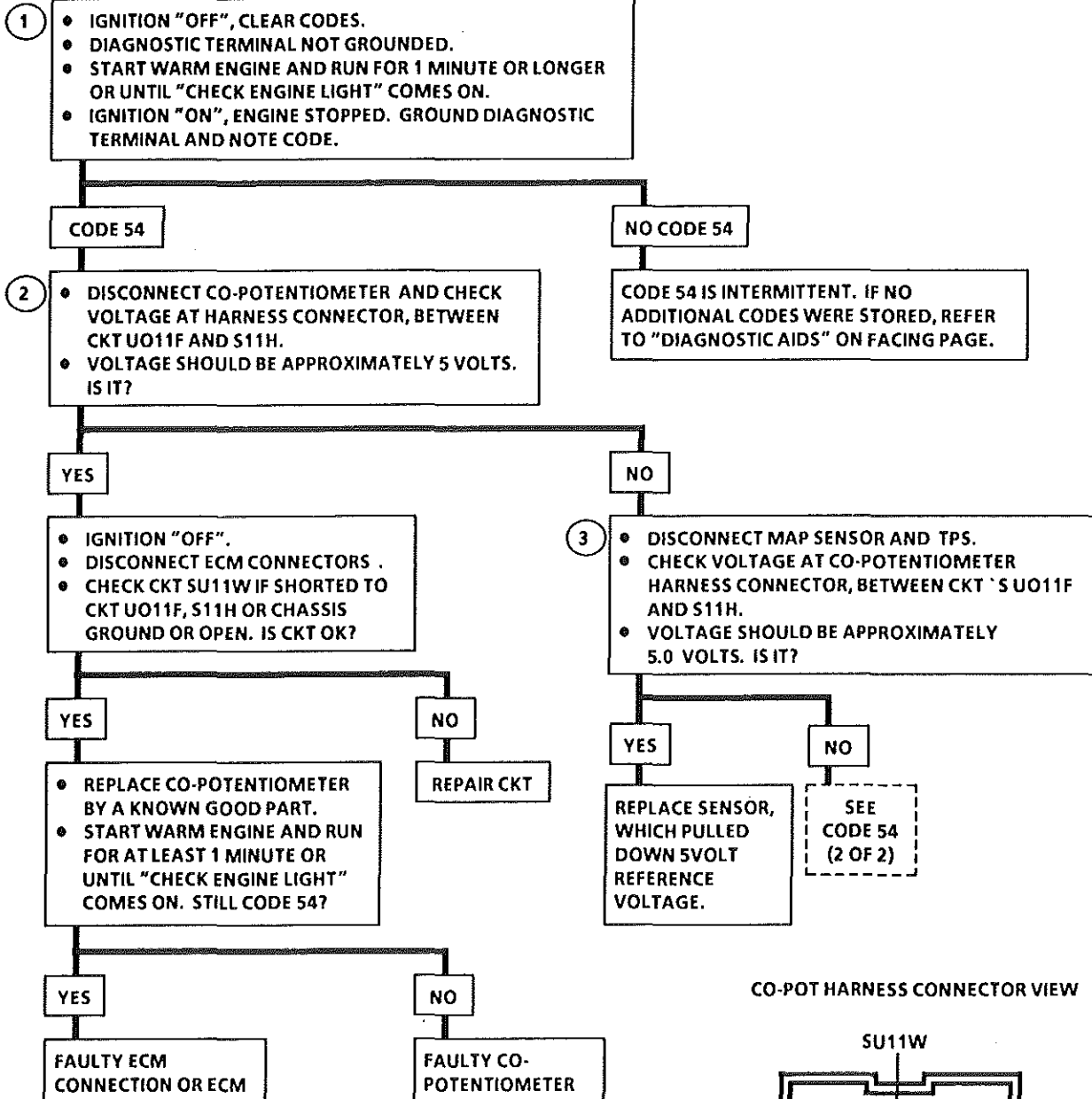
If Code 54 is intermittent:

- Check (wiggle) ECM connector pins D8, A11, C14 to see if Code resets.

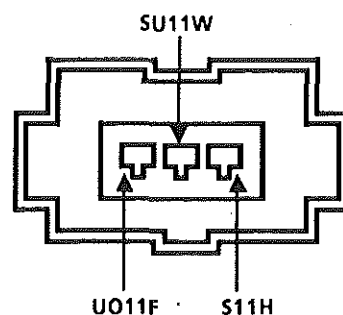
Check CO-emission, correct if necessary (see section EML.3-E).

**"NON-SCAN" DIAGNOSTICS****CODE 54**

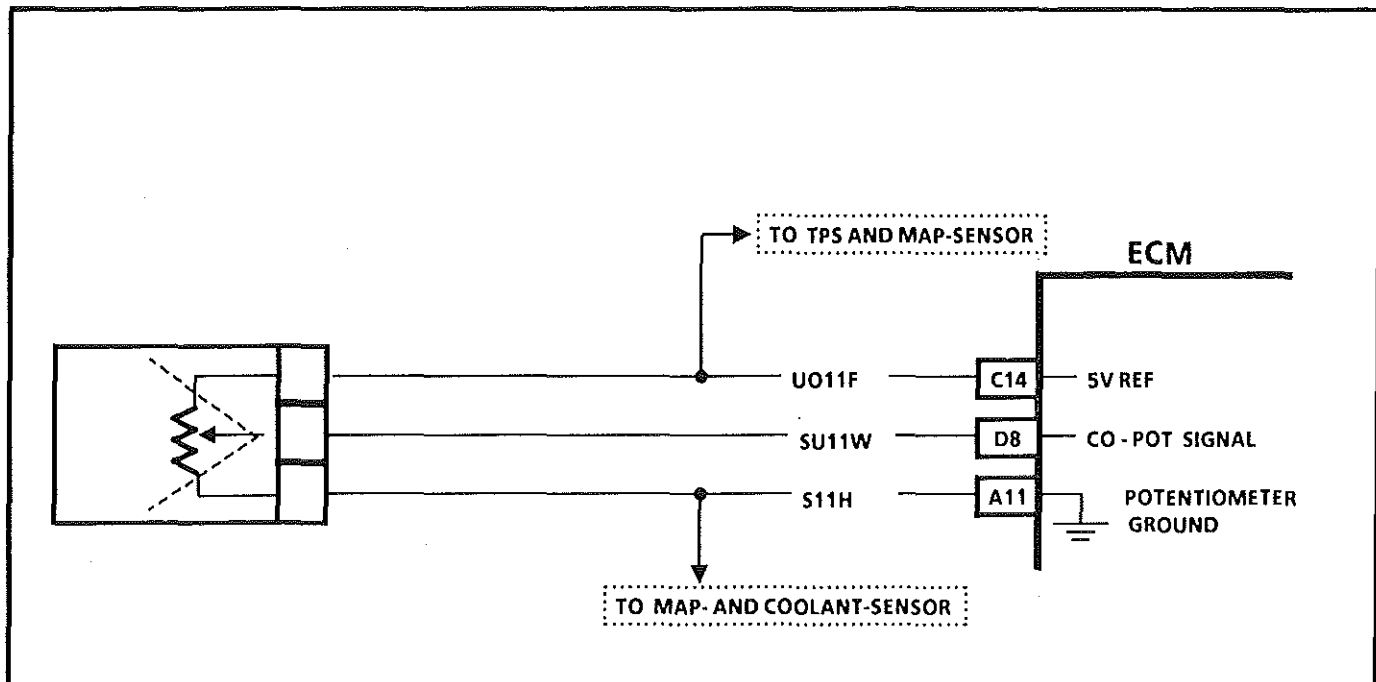
(Page 1 of 2)

**CO-POTENTIOMETER CIRCUIT
(SIGNAL VOLTAGE LOW OR HIGH)
1.6L LOTUS ELAN**

CO-POT HARNESS CONNECTOR VIEW



CLEAR CODES AND CONFIRM NO "CHECK ENGINE LIGHT".



CODE 54

(PAGE 2 OF 2)

CO - POTENTIOMETER CIRCUIT (SIGNAL VOLTAGE HIGH OR LOW) 1.6L LOTUS ELAN

Circuit Description:

The CO - Potentiometer provides a voltage signal vary from about 0.6 volts to about 4.2 volts. Depending on the signal voltage the ECM will decrease or increase injection pulse width in order to obtain the CO emission percentage required. See EML.3-E for CO checking and reset.

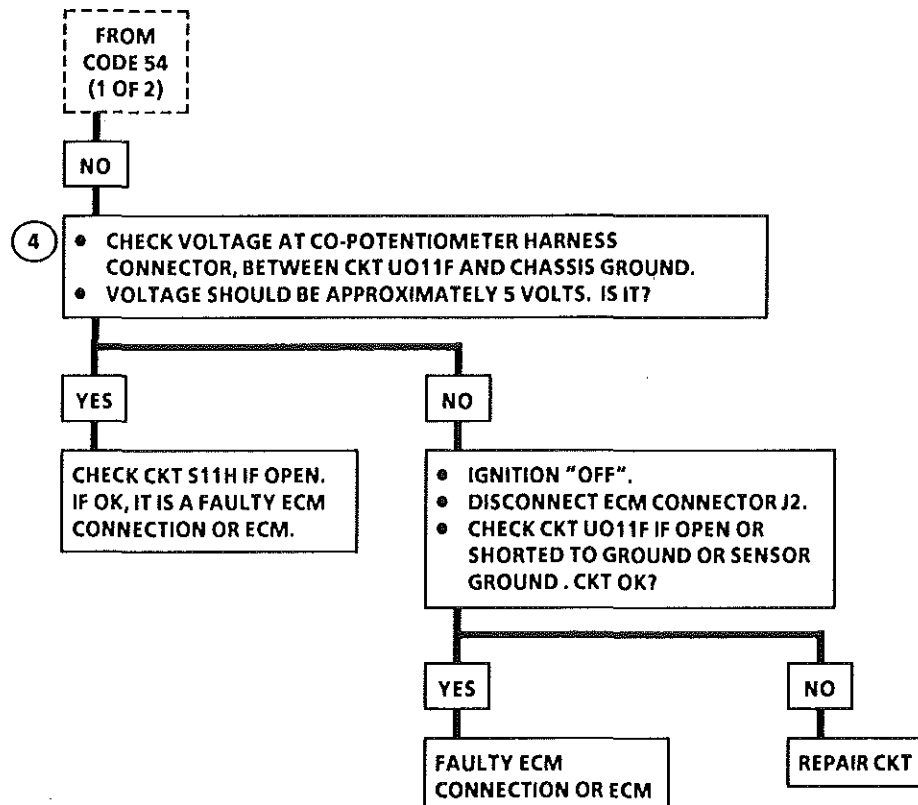
Test Description:

Numbers below refer to circled numbers on the diagnostic chart.

4. This test determines if the problem is a faulty CKT UO11F.

**"NON-SCAN" DIAGNOSTICS****CODE 54**

(Page 2 of 2)

**CO-POTENTIOMETER CIRCUIT
(SIGNAL VOLTAGE LOW OR HIGH)
1.6L LOTUS ELAN**

CLEAR CODES AND CONFIRM NO "CHECK ENGINE LIGHT".



SECTION EML.6

FAULT DIAGNOSIS WITH INTERMITTENT OR NO TROUBLE CODES

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PERFORMING SYMPTOM DIAGNOSIS

The DIAGNOSTIC CIRCUIT CHECK should be performed before using this section. The purpose of this section is to locate the source of a driveability or emissions problem when other diagnostic procedures cannot be used. This may be because of difficulties in locating a suspected sub-system or component.

Many driveability related problems can be eliminated by following the procedures found in Service Bulletins. These bulletins supersede this manual. Be sure to check all bulletins related to the complaint or suspected system.

The sequence of the checks listed in this section is not intended to be followed as on a step-by-step procedure. The checks are listed such that the less difficult and time consuming operations are performed before more difficult ones.

Most of the symptom procedures call for a careful visual and physical check. ***The importance of this step cannot be stressed too strongly. It can lead to correcting a problem without further checks, and can save valuable time.*** This procedure includes checking the following.

- Vacuum hoses for splits, kinks, and proper connections.
- Throttle body and intake manifold for leaks
- Ignition wires for cracking, hardness, proper routing, and carbon tracking
- Wiring for proper connections, pinches, and cuts

If engine cranks but will not run, see Chart EML. 4-3



INTERMITTENTS

Definition: Problem may or may not activate the "Check Engine Light" or store a trouble code.

DO NOT use the trouble code charts in Section EML.4 for intermittent problems other than a guide to the circuitry probably causing the problem. The fault must be present to locate the problem. If a fault is not present, the use of trouble code charts may result in the replacement of good parts.

- Most intermittent problems are caused by faulty electrical connections or wiring. Perform careful checks of suspected circuits for

- Poor mating of the connector halves and terminals not fully seated in the connector body (backed out)
- Improperly formed or damaged terminals. All connector terminals in problem circuit should be carefully reformed to increase contact tension.
- Poor terminal to wire connection. This requires removing the terminal from the connector body to check as outlined in the introduction to Section EML.1 - L.
- Check (wiggle) suspected circuit wiring and connectors while watching TECH 1 data on display. See figure EML.4-9 TECH 1 DATA for typical data values at idle speed.

- If a visual and physical check does not locate the cause of the problem, the car can be driven with a voltmeter connected to a suspected circuit or a Tech 1 tool may be used performing a test called "Snapshot".

See EML.1-G and Tech 1 manual for further explanation. An abnormal voltage reading while the problem occurs indicates that the problem may be in that circuit.

- Check for loss of trouble code memory. To check, disconnect the TPS and allow the engine to idle until the "Check Engine Light" (CEL) turns "ON." Code 22 should be stored and kept in memory when the ignition is turned "OFF" for at least 10 seconds. If not, the ECM is faulty.
- An intermittent CEL and no trouble codes may be caused by
 - Electrical system interference caused by a defective relay, ECM driven solenoid, or switch. They can cause a sharp electrical surge. Normally, the problem will occur when the faulty component is operated.
 - Improper installation of electrical options, such as lights, 2-way radios, etc.
 - EST and Distributor Reference Input wires which should be routed away from spark plug wires, ignition system components, and generator. Ground wire from ECM to ignition system which may be faulty.
 - Ignition secondary wire shorted to ground.
 - "Check Engine Light" and diagnostic test terminal circuits intermittently shorted to ground.
 - Faulty ECM.

HARD START

Definition: Engine cranks well but does not start for a long time. Engine does eventually start, but may or may not continue to run.

Perform careful visual and physical check as described at the beginning of Section EML.6.

Perform "Diagnostic Circuit Check".

• CHECK

- For possibility of misfiring, crossfiring, or cutting under load or at idle. Locate misfiring cylinder(s) by performing the following test.
run up to normal op. temp.
 1. Start engine. Disconnect idle air control valve. Remove one spark plug wire from a spark plug and ground it against the engine.
 2. Note drop in engine speed.
 3. Repeat for all four cylinders.

4. Stop engine and reconnect idle air control valve.

If the engine speed dropped equally (within 50 rpm) on all cylinders, refer to "Rough, Unstable, or Incorrect Idle, Stalling" symptom.

If there was no drop or excessive variation in engine speed on one or more cylinders, check for spark on the respective cylinder(s) with spark tester T000T0901. If spark is present, remove the spark plugs from the cylinder(s) and check for the following.

- Cracks
- Wear
- Heavy deposits
- Improper gap
- Burned electrode



- Fuel for poor quality, "stale" fuel, and water contamination.
- Ignition wires for shorts or faulty insulation.
- Ignition coil connections.
- Fuel pump relay. Connect test light between fuel pump relay base terminal WLG10Y and battery voltage. Light should be "ON" for 2 seconds following ignition "ON."
- Secondary ignition voltage output with spark tester T000T0901.
- Spark plugs. Look for wetness, cracks, improper gap, burned electrodes, and heavy deposits. Visually inspect ignition system for moisture, dust, cracks, burns, etc.
- For faulty ECM and ignition grounds.
- Spray plug wires with fine water mist to check for shorts.
- Idle Air Control system. Use EML.4-9 chart.
- Fuel system for restricted filter or improper pressure. Use EML.4-7 chart.
- Injectors for leakage.
- Coolant sensor for a shift in calibration. Use Code 14 or Code 15 chart.
- TPS for sticking or binding. TPS voltage should read 0.40 ± 0.02 volt on the Tech 1 or measured with a digital voltmeter.
- Injector balance by performing injector balance test (see EML.3-J).
- In-tank fuel pump check valve. A faulty valve would allow the fuel in the lines to drain back to the tank after the engine is stopped.
- Engine valve timing and compression.
- EST problem. See chart EML.4-10.

ROUGH, UNSTABLE, OR INCORRECT IDLE, STALLING

Definition: The engine runs unevenly at idle. If severe, the car may shake. Also, the idle speed may vary (called "hunting"). Either condition may be severe enough to cause stalling. Engine idles at incorrect speed.

Perform careful visual and physical check as described at the beginning of Section EML.6.

Perform "Diagnostic Circuit Check".

● CHECK

- For possibility of misfiring, crossfiring, or cutting under load or at idle. Locate misfiring cylinder(s) by performing the following test.
 1. Start engine. Disconnect idle air control valve. Remove one spark plug wire from a spark plug and ground it against the engine.
 2. Note drop in engine speed.
 3. Repeat for all four cylinders.
 4. Stop engine and reconnect idle air control valve.

If the engine speed dropped equally (within 50 rpm) on all cylinders, proceed through the causes listed. If there was no drop or excessive variation in engine speed on one or more cylinders, check for spark on the respective cylinder(s) with spark tester T000T0901. If spark is present, remove the spark plugs from the cylinder(s) and check for the following.

- Cracks
- Wear
- Improper gap
- Burned electrode
- Heavy deposits

- Throttle for sticking shaft or binding linkage. This will cause a high TPS voltage (open throttle indication) and the ECM will not control idle. TPS voltage should be 0.40 ± 0.02 volt with throttle closed.
- TPS reading at closed throttle should be stable; any variation of signal output causes idle speed instability.
- EGR valve stuck open. Push diaphragm up with engine running. (Use gloves, valve is very hot!) Pintle should return onto seat immediately.
- Ignition wires for shorts or faulty insulation.
- Ignition system for moisture, dust, cracks, burns, etc. Spray plug wires with fine water mist to check for shorts.
- Secondary ignition voltage output with T000T0901 spark tester.
- ECM and ignition system for faulty grounds.
- Proper operation of EST.
- Spark plugs. Look for wetness, cracks, improper gap, burned electrodes, and heavy deposits.
- Fuel system for restricted filter or improper pressure. Use EML.4-7 chart.
- Injectors for leakage.



- For vacuum leaks at intake manifold gasket
- Idle Air Control system faulty. Use EML.4-9 chart.
- Electrical system voltage. IAC valve will not move if voltage is below 9 volts or greater than 17.8 volts. Also check battery cables and ground straps for poor contact. Erratic voltage will cause the IAC valve to change its position, resulting in poor idle quality.
- MAP sensor output. Check sensor by comparing it to the output on a similar vehicle if possible.
- MAP sensor vacuum hose clogged.
- Incorrect CO-setting. Check and reset according to EML. 3-E
- Coolant sensor for a shift in calibration. Use Code 14 or Code 15 chart.
- A/C refrigerant pressure for high pressure. Check for overcharging.
- Generator output voltage. Repair if less than 9 volts or more than 17.1 volts.
- Engine valve timing and compression.
- For worn or incorrect basic engine parts such as cam, heads, pistons, etc. Also check for broken or weak valve springs.
- Injector balance by performing injector balance test (see EML.3-J).
- For overheating and possible causes. Look for the following:
 - * Restricted air flow to radiator, or restricted water flow through radiator.
 - * Faulty or incorrect thermostat
 - * Inoperative electric radiator fan circuit

POOR GAS MILEAGE

Definition: Gas mileage, as measured by an actual road test, is noticeably lower than expected. Gas mileage is noticeably lower than it was during a previous actual road test.

Perform careful visual and physical check as described at the beginning of Section EML.6.

Perform "Diagnostic Circuit Check".

● CHECK

- For possibility of misfiring, crossfiring, or cutting under load or at idle. Locate misfiring cylinder(s) by performing the following test.

1. Start engine. Disconnect idle air control valve. Remove one spark plug wire from a spark plug and ground it against the engine.
2. Note drop in engine speed.
3. Repeat for all four cylinders.
4. Stop engine and reconnect idle air control valve.

If the engine speed dropped equally (within 50 rpm) on all cylinders, refer to "Rough, Unstable, or Incorrect Idle, Stalling" symptom. If there was no drop or excessive variation in engine speed on one or more cylinders, check for spark on the respective cylinder(s) with spark tester T000T0901. If spark is present, remove the spark plugs from the cylinder(s) and check for the following:

- Cracks
- Burned electrode
- Wear
- Heavy deposits
- Improper gap

- Proper operation of EST.
- Spark plugs. Look for wetness, cracks, improper gap, burned electrodes, and heavy deposits.
- Spark plugs for correct heat range.
- Fuel for poor quality, "stale" fuel, and water contamination.
- Fuel system for restricted filter or improper pressure. Use EML.4-7 chart.
- Injectors for leakage.
- For vacuum leaks at intake manifold gasket
- Air cleaner element (filter) for dirt or plugging.
- Throttle shaft or TPS for sticking or binding. TPS voltage should read about 0.40 ± 0.02 volt on a Tech 1 with the throttle closed.
- MAP sensor output. Check sensor by comparing it to the output on a similar vehicle if possible.
- MAP sensor vacuum hose clogged.
- Incorrect CO-setting. Check and reset according to CHART EML. 3-E.
- Coolant sensor for a shift in calibration. Use Code 14 or Code 15 chart.
- Radiator fan operation.
- Thermostat for incorrect heat range or being inoperative.
- Engine valve timing and compression.



Done, this check should be included in EMK.6

'ROUGH, UNSTABLE, OR INCORRECT IDLE, STALLING' AND 'POOR

'LACK OF POWER' OR 'SPOGGY'

Definition:

Gas mileage, as measured by an actual road test, is noticeably lower than expected. Gas mileage is noticeably lower than it was during a previous actual road test.

POOR GAS MILEAGE GAS MILEAGE

Perform careful visual and physical check as described at the beginning of Section EMJ.6.

Perform "Diagnostic Circuit Check".

• CHECK

- For possibility of misfiring, crossfiring, or cutting under load or at idle. Locate misfiring cylinder(s) by performing the following test.
 1. Start engine. Disconnect idle air control valve. Remove one spark plug wire from a spark plug and connect it to spark tester T000T0901.
 2. Note drop in engine speed.
 3. Repeat for all four cylinders.
 4. Stop engine and reconnect idle air control valve.

If the engine speed dropped equally (within 50 rpm) on all cylinders, refer to "Rough, Unstable, or Incorrect Idle, Stalling" symptom. If there was no drop or excessive variation in engine speed on one or more cylinders, check for spark on the respective cylinder(s) with spark tester T000T0901. If spark is present, remove the spark plugs from the cylinder(s) and check for the following.

- Cracks
- Burned electrode
- Wear
- Heavy deposits
- Improper gap
- Proper operation of EST.
- Spark plugs. Look for wetness, cracks, improper gap, burned electrodes, and heavy deposits.
- Spark plugs for correct heat range.
- Fuel for poor quality, "stale" fuel, and water contamination.
- Fuel system for restricted filter or improper pressure.
- Injectors for leakage.
- For vacuum leaks at intake manifold gasket.
- Air cleaner element (filter) for dirt or plugging.
- Idle Air Control system. Use EMJ.4-9 Chart.
- Canister purge system for proper operation.
- Throttle shaft or TPS for sticking or binding. TPS voltage should read 0.40 ± 0.02 volt on a Tech 1 with the throttle closed.
- MAP sensor output. Check sensor by comparing it to the output on a similar vehicle if possible.
- Oxygen sensor for silicone contamination from contaminated fuel or use of improper RTV sealant. The sensor will have a white, powdery coating and will cause a high but false signal voltage (rich exhaust indication). The ECM will reduce the amount of fuel

delivered to the engine, causing a severe driveability problem.

- Coolant sensor for a shift in calibration. Use Code 14 or Code 15 chart.
- Vehicle speed sensor (VSS) input with Tech 1 to make sure reading of VSS matches that of vehicle speedometer.
- A/C relay operation. A/C should cut out at wide open throttle.
- A/C refrigerant pressure for high pressure. Check for overcharging.
- Injector balance by performing injector balance test.
- Generator output voltage. Repair if less than 9 volts or more than 17.1 volts.
- Radiator fan operation.
- Thermostat for incorrect heat range or being inoperative.
- Engine valve timing and compression.
- For worn or incorrect basic engine parts such as cam, heads, pistons, etc.

For the possibility of an exhaust restriction or improper valve timing by performing the following test.

1. With engine at normal operating temperature, connect a vacuum gauge to any convenient vacuum port on intake manifold.
2. Run engine at 1000 rpm and record vacuum reading.
3. Increase engine speed slowly to 2500 rpm. Note vacuum reading at steady 2500 rpm.
4. If vacuum at 2500 rpm decreases more than 3" Hg from reading at 1000 rpm, the exhaust system should be inspected for restrictions. Use CHART EMJ.6 - 1.
5. Disconnect exhaust pipe from engine and repeat Steps 3 & 4. If vacuum still drops more than 3" Hg with exhaust disconnected, check valve timing.

- Check driver's driving habits and vehicle conditions which affect gas mileage.
- Is A/C "ON" full time (Deliquidifier mode "ON")?
- Are tyres at correct pressure?
- Are excessively heavy loads being carried?
- Is acceleration often heavy?
- Are the wheels aligned correctly?
- Is the speedometer calibrated correctly?
- Are the vehicle brakes dragging?
- Is the brake switch applying excessive force on the brake pedal?
- If the system is running RICH, (block learn less than 90), refer to "Diagnostic Aids" on facing page of Code 45.



- Vehicle speed sensor (VSS) input with Tech 1 to make sure reading of VSS matches that of vehicle speedometer.
 - A/C relay operation. A/C should cut out at wide open throttle.
 - A/C refrigerant pressure for high pressure. Check for overcharging.
 - Injector balance by performing injector balance test.
 - Generator output voltage. Repair if less than 9 volts or more than 17.1 volts.
 - For worn or incorrect basic engine parts such as cam, heads, pistons, etc.
- Check driver's driving habits and vehicle conditions which affect gas mileage.
 - Is A/C "ON" full time?
 - Are tyres at correct pressure?
 - Are excessively heavy loads being carried?
 - Is acceleration often heavy?
 - Are the wheels aligned correctly?
 - Is the speedometer calibrated correctly?
 - Are the vehicle brakes dragging?
 - Is the brake switch applying excessive force on the brake pedal?

DETONATION/SPARK KNOCK

Definition: A mild to severe ping, usually worse under acceleration. The engine makes sharp metallic knocks that change with throttle opening.

Perform careful visual and physical check as described at the beginning of Section EML.6.

Perform "Diagnostic Circuit Check".

• CHECK

- For possibility of misfiring, crossfiring, or cutting under load or at idle. Locate misfiring cylinder(s) by performing the following test.
 1. Start engine. Disconnect idle air control valve. Remove one spark plug wire from a spark plug and ground it against the engine.
 2. Note drop in engine speed.
 3. Repeat for all four cylinders.
 4. Stop engine and reconnect idle air control valve.

If the engine speed dropped equally (within 50 rpm) on all cylinders, refer to "Rough, Unstable, or Incorrect Idle, Stalling" symptom. If there was no drop or excessive variation in engine speed on one or more cylinders, check for spark on the respective cylinder(s) with spark tester T000T0901. If spark is present, remove the spark plugs from the cylinder(s) and check for the following.

- Cracks
- Wear
- Improper gap
- Burned electrode
- Heavy deposits
- Ignition wires for shorts or faulty insulation
- Spark plugs for correct heat range

- Fuel for poor quality, "stale" fuel, and water contamination
- Fuel system for restricted filter or improper pressure.
- For excessive oil entering combustion chamber. Oil will reduce the effective octane of fuel.
- For vacuum leaks at intake manifold gasket
- MAP sensor output. Check sensor by comparing it to the output on a similar vehicle, if possible.
- Coolant sensor for a shift in calibration.
- Vehicle speed sensor (VSS) input with Tech 1 to make sure reading of VSS matches that of vehicle speedometer.
- Vehicle brakes for dragging.
- For overheating and possible causes. Look for the following.
 - * Low or incorrect coolant solution.
 - * Loose water pump belt.
 - * Restricted air flow to radiator or restricted water flow through radiator.
 - * Faulty or incorrect thermostat.
 - * Inoperative electric cooling fan circuit.
 - * Engine valve timing and compression.
 - * For worn or incorrect basic engine parts such as cam, heads, pistons, etc.
- Remove internal engine carbon with top engine cleaner.
- Incorrect CO-setting. Check and reset according to EML.3-E.
- Incorrect ignition base timing. Check and reset according to EML.3-M.



LACK OF POWER, SLUGGISH, OR SPONGY

Definition: Engine delivers less than expected power. There is little or no increase in speed when the accelerator pedal is depressed partially.

Perform careful visual and physical check as described at the beginning of Section EML.6.

Perform "Diagnostic Circuit Check".

● CHECK

- For possibility of misfiring, crossfiring, or cutting under load or at idle. Locate misfiring cylinder(s) by performing the following test.

1. Start engine. Disconnect idle air control valve. Remove one spark plug wire from a spark plug and ground it against the engine.
2. Note drop in engine speed.
3. Repeat for all four cylinders.
4. Stop engine and reconnect idle air control valve.

If the engine speed dropped equally (within 50 rpm) on all cylinders, refer to "Rough, Unstable, or Incorrect Idle, Stalling" symptom. If there was no drop or excessive variation in engine speed on one or more cylinders, check for spark on the respective cylinder(s) with spark tester T000T0901. If spark is present, remove the spark plugs from the cylinder(s) and check for the following:

- Cracks
 - Burned electrode
 - Wear
 - Heavy deposits
 - Improper gap
- Ignition wires for shorts or faulty insulation.
 - Ignition system for moisture, dust, cracks, burns, etc. Spray plug wires with fine water mist to check for shorts.
 - Secondary ignition voltage output with T000T0901 tester.
 - Ignition coil connections.
 - ECM and ignition system for faulty grounds.
 - Proper operation of EST (use EML.4-10 to check if ECM switches to EST mode).
 - Spark plugs. Look for wetness, cracks, improper gap, burned electrodes, and heavy deposits.
 - Spark plugs for correct heat range.

- Fuel for poor quality, "stale" fuel, and water contamination
- Fuel system for restricted filter or improper pressure. Use chart EML.4 - 7.
- For vacuum leaks at intake manifold gasket.
- Air cleaner element (filter) for dirt or plugging.
- Throttle shaft or TPS for sticking or binding. TPS voltage should read 0.40 ± 0.02 volts on Tech 1 with the throttle closed, about 4.0 volts and more than 95% throttle travel at WOT.
- MAP sensor output. Check sensor by comparing it to the output on a similar vehicle if possible.
- Coolant sensor for a shift in calibration. Use Code 14 or Code 15 chart.
- Vehicle speed sensor (VSS) input with Tech 1 to make sure reading of VSS matches that of vehicle speedometer.
- Engine for improper or worn camshaft.
- A/C relay operation. A/C should cut out at wide open throttle.
- A/C refrigerant pressure for high pressure. Check for overcharging.
- Generator output voltage. Repair if less than 9 volts or more than 17.1 volts.
- Radiator fan operation.
- Vehicle brakes for dragging
- Engine valve timing and compression.
- For worn or incorrect basic engine parts such as cam, heads, pistons, etc.
- Inoperative Secondary Throttle Valve Control. Perform test according to EML.3-K.
- For overheating and possible causes. Look for the following:
 - Low or incorrect coolant solution.
 - Loose water pump belt.
 - Restricted air flow to radiator, or restricted water flow through radiator.
 - Faulty or incorrect thermostat.
 - Inoperative electric cooling fan circuit.
- Incorrect CO-setting. Check and reset according to chart EML. 3-E.



SURGES AND/OR CHUGGLE

Definition: Engine power variation under steady throttle or cruise. Feels like the car speeds up and slows down with no change in the accelerator pedal.

Perform careful visual and physical check as described at the beginning of Section EML.6.

Perform "Diagnostic Circuit Check".

● CHECK

- For possibility of misfiring, crossfiring, or cutting under load or at idle. Locate misfiring cylinder(s) by performing the following test.

1. Start engine. Disconnect idle air control valve. Remove one spark plug wire from a spark plug and ground it against the engine.
2. Note drop in engine speed.
3. Repeat for all four cylinders.
4. Stop engine and reconnect idle air control valve.

If the engine speed dropped equally (within 50 rpm) on all cylinders, refer to "Rough, Unstable, or Incorrect Idle, Stalling" symptom. If there was no drop or excessive variation in engine speed on one or more cylinders, check for spark on the respective cylinder(s) with spark tester T000T0901. If there is no spark, see chart EML.4-3. If spark is present, remove the spark plugs from the cylinder(s) and check for the following:

- Cracks
- Burned electrode
- Wear
- Heavy deposits
- Improper gap
- Ignition wires for shorts or faulty insulation.
- Ignition system for moisture, dust, cracks, burns, etc. Spray plug wires with fine water mist to check for shorts.
- Secondary ignition voltage output with T000T0901 tester.
- ECM and ignition system for faulty grounds.
- Proper operation of EST.
- Spark plugs. Look for wetness, cracks, improper gap, burned electrodes, and heavy deposits.
- Spark plugs for correct heat range.
- Fuel for poor quality, "stale" fuel, and water contamination.

- Fuel system for restricted filter or improper pressure. Use EML.4-7 chart.
- Injectors for leakage (see chart EML.4-7 and EML.3-J).
- Injector balance by performing injector balance test (see EML.3-J).
- For vacuum leaks at intake manifold gasket.
- Idle Air Control system. Use EML.4-9 chart.
- Electrical system voltage. IAC valve will not move if voltage is below 9 volts or greater than 17.8 volts. Also check battery cables and ground straps for poor contact. Erratic voltage will cause the IAC valve to change its position, resulting in poor idle quality.
- Throttle shaft or TPS for sticking or binding. TPS voltage should read 0.40 ± 0.02 volt on Tech 1 with the throttle closed.
- MAP sensor output. Check sensor by comparing it to the output on a similar vehicle, if possible.
- MAP sensor vacuum hose clogged.
- Coolant sensor for a shift in calibration. Use Code 14 or Code 15 chart.
- Vehicle speed sensor (VSS) input with Tech 1 to make sure reading of VSS matches that of vehicle speedometer.
- A/C relay operation. A/C should cut out at wide open throttle.
- Incorrect CO-setting. Check and reset according to chart EML. 3-E.



CUTS OUT, MISSES

Definition: Steady pulsation or jerking that follows engine speed, usually more pronounced as engine load increases. The exhaust has a steady spitting sound at idle or low speed.

Perform careful visual and physical check as described at the beginning of Section EML.6.
Perform "Diagnostic Circuit Check".

● CHECK

- Ignition wires for shorts or faulty insulation.
- Ignition system for moisture, dust, cracks, burns, etc. Spray plug wires with fine water mist to check for shorts.
- Secondary ignition voltage output with tester T000T0901.
- Ignition coil connections.
- ECM and ignition system for faulty grounds.
- Proper operation of EST.
- Spark plugs. Look for wetness, cracks, improper gap, burned electrodes, and heavy deposits.
- Spark plugs for correct heat range.
- Fuel for poor quality, "stale" fuel, and water contamination.
- Fuel system for restricted filter or improper pressure. Use EML.4-7 chart.
- Throttle shaft or TPS for sticking or binding. TPS voltage should read 0.40 ± 0.02 volt on Tech 1 or DVM with the throttle closed.

- Injector balance by performing injector balance test (see EML.3-J).
- For possibility of misfiring, crossfiring, or cutting under load or at idle. Locate misfiring cylinder(s) by performing the following test.

1. Start engine. Disconnect idle air control valve. Remove one spark plug wire from a spark plug and ground it against the engine.
2. Note drop in engine speed.
3. Repeat for all four cylinders.
4. Stop engine and reconnect idle air control valve.

If the engine speed dropped equally (within 50 rpm) on all cylinders, refer to "Rough, Unstable, or Incorrect Idle, Stalling" symptom. If there was no drop or excessive variation in engine speed on one or more cylinders, check for spark on the respective cylinder(s) with spark tester T000T0901. If spark is present, remove the spark plugs from the cylinder(s) and check for the following:

- Cracks
- Burned electrode
- Wear
- Heavy deposits
- Improper gap

HESITATION, SAG, STUMBLE

Definition: Momentary lack of response as the accelerator is pushed down. Can occur at all vehicle speeds. Usually most severe when first trying to make the car move, as from a stop sign. May cause the engine to stall if severe enough.

Perform careful visual and physical check as described at the beginning of Section EML.6.
Perform "Diagnostic Circuit Check".

● CHECK

- For possibility of misfiring, crossfiring, or cutting under load or at idle. Locate misfiring cylinder(s) by performing the following test.
- 1. Start engine. Disconnect idle air control valve. Remove one spark plug wire from a spark plug and ground it against the engine.
- 2. Note drop in engine speed.
- 3. Repeat for all four cylinders.
- 4. Stop engine and reconnect idle air control valve.

If the engine speed dropped equally (within 50 rpm) on all cylinders, refer to "Rough, Unstable, or Incorrect Idle, Stalling" symptom. If there was no drop or excessive variation in engine speed on one or more cylinders, check for spark on the respective cylinder(s) with spark tester T000T0901. If spark is present, remove the spark plugs from the cylinder(s) and check for the following:

- Cracks
- Burned electrode
- Wear
- Heavy deposits
- Improper gap
- Ignition wires for shorts or faulty insulation.
- Ignition system for moisture, dust, cracks, burns, etc. Spray plug wires with fine water mist to check for shorts.



- Secondary ignition voltage output with T000T0901 tester.
- ECM and ignition system for faulty grounds
- Proper operation of EST.
- Spark plugs. Look for wetness, cracks, improper gap, burned electrodes, and heavy deposits.
- Spark plugs for correct heat range
- Fuel for poor quality, "stale" fuel, and water contamination.
- Fuel system for restricted filter or improper pressure.
- For vacuum leaks at intake manifold gasket.
- Air cleaner element (filter) for dirt or plugging.
- Incorrect CO-setting. Check and adjust according to chart EML. 3-E.
- Idle Air Control system. Use EML.4-9 chart.
- Check electrical system voltage. IAC valve will not move if voltage is below 9 volts or greater than 17.8 volts. Also check battery cables and ground straps for poor contact. Erratic voltage will cause the IAC valve to change its position, resulting in poor idle quality.
- Throttle shaft or TPS for sticking or binding. TPS voltage should read 0.40 ± 0.02 volt on Tech 1 with the throttle closed.
- MAP sensor output. Check sensor by comparing it to the output on a similar vehicle, if possible.
- Coolant sensor for a shift in calibration. Use Code 14 or Code 15 chart.
- A/C relay operation. A/C should cut out at wide open throttle.
- Injector balance by performing injector balance test (see EML.3-J).
- A/C refrigerant pressure for high pressure. Check for overcharging.
- Generator output voltage. Repair if less than 9 volts or more than 17.1 volts.
- Vehicle brakes for dragging.
- Engine valve timing and compression.
- For worn or incorrect basic engine parts such as cam, heads, pistons, ect.
- For overheating and possible causes. Look for the following:
 - * Low or incorrect coolant solution.
 - * Restricted air flow to radiator, or restricted water flow through radiator.
 - * Faulty or incorrect thermostat.
 - * Inoperative electric radiator fan circuit.

EXCESSIVE EXHAUST EMISSIONS

Definition: Vehicle fails an emission test.

Perform careful visual and physical check as described at the beginning of Section EML.6.
Perform "Diagnostic Circuit Check".

- **CHECK**

- Vacuum leaks.
- Faulty coolant system and/or coolant fan operation.
- Remove carbon with top engine cleaner. Follow instructions on can.

- Check, if necessary adjust, CO-setting.
See EMJ.3-E.

If emission test indicates excessive HC and CO or exhaust has excessive odors, check for items which cause car to run RICH.

- Incorrect fuel pressure.
Use CHART EML.4-7.
- Crankcase breather valve plugging, sticking, or blocked breather hose. Check for fuel in crankcase.
- Improper fuel cap installation.
- Faulty spark plugs, plug wires, or ignition components.



DIESELING, RUN-ON

Definition: Engine continues to run after key is turned "OFF", but runs very roughly. (If engine runs smoothly, check ignition switch).

Perform careful visual and physical check as described at the beginning of Section EML.6.

Perform "Diagnostic Circuit Check".

- **CHECK**

- Injectors for leakage.

BACKFIRE

Definition: Fuel ignites in intake manifold or in exhaust system, making a loud popping sound.

Perform careful visual and physical check as described at the beginning of Section EML.6.

Perform "Diagnostic Circuit Check".

- **CHECK**

- For possibility of misfiring, crossfiring, or cutting under load or at idle. Locate misfiring cylinder(s) by performing the following test.

1. Start engine. Disconnect idle air control valve. Remove one spark plug wire from a spark plug and ground it against the engine.
2. Note drop in engine speed.
3. Repeat for all four cylinders.
4. Stop engine and reconnect idle air control valve.

If the engine speed dropped equally (within 50 rpm) on all cylinders, refer to "Rough, Unstable, or Incorrect Idle, Stalling" symptom. If there was no drop or excessive variation in engine speed on one or more cylinders, check for spark on the respective cylinder(s) with spark tester T000T0901. If spark is present, remove the spark plugs from the cylinder(s) and check for the following:

- Cracks
- Wear
- Improper gap
- Burned electrode
- Heavy deposits
- Intake manifold gasket for leaks.
- Spark plugs. Look for wetness, cracks, improper gap, burned electrodes, and heavy deposits.
- Ignition system for moisture, dust, cracks, burns, etc. Spray plug wires with fine water mist to check for shorts.
- ECM and ignition system for faulty grounds
- Secondary ignition voltage output with T000T0901 tester
- For vacuum leaks at intake manifold gasket
- Engine valve timing and compression.
- For worn or incorrect basic engine parts such as cam, heads, pistons, etc.