Description

General

The Modular Engine Management System Version 3 (MEMS 3) is a sequential, multiport fuel injection system controlled by the Engine Control Module (ECM).

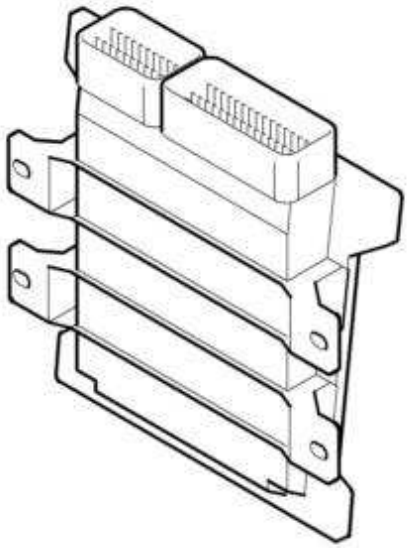
The ECM controls the operation of the fuel system, ignition system, evaporative emission control, cooling system and the air conditioning system.

The ECM uses the speed/density method of air flow measurement to calculate fuel delivery. This method calculates the density of the intake air by measuring its pressure and temperature.

The density signal, combined with the engine speed signal, allows the ECM to make a calculation of the air volume being inducted and determine the quantity of fuel to be injected to give the correct air/fuel ratio.

MEMS 3 is designed to meet new exhaust emission standard; ECD 3 (European Commission Directive Stage 3), also known as OBD (On-Board Diagnostics).

Engine Control Module



M18 0603

The ECM is located in the Environmental box (E-box) on the left hand side of the engine compartment. The ECM is accessible by loosening five cap screws to release the lid on the box.

The E-box is a lidded container that provides a protected environment for the ECM and the EAT ECU. An open hub, centrifugal fan powered by an electric motor ventilates the E-box with air from the passenger compartment. Exhaust air from the E-box is directed back into the passenger compartment. The ventilating and exhaust air is routed between the passenger compartment and the E-box through plastic ducting and corrugated rubber hoses.

Operation of the cooling fan is controlled by a thermostatic switch in the E-box. The thermostatic switch receives a power feed while the ignition switch is in position II. If the temperature in the E-box reaches 35 °C (95 °F) the thermostatic switch closes and connects the power feed to the fan, which runs to cool the E-box with air from the passenger compartment. When the temperature in the E-box decreases to 27 °C (80 °F), the thermostatic switch opens and stops the fan. To prevent the fan seizing up in colder climates,

where it may not operate for long periods of time, the fan also receives a power feed from the starter circuit so that it runs each time while the engine is cranked.

The ECM electronic components are housed in an aluminium case for heat dissipation and protection from electro-magnetic interference.

Two harness connectors, C0913 and C0914 are used to connect the ECM to the main harness. The ECM is connected to earth using three wires. Pins 59, 66 and 73 of ECM connector C0913 are connected to a body earth at connector C1964, C1947 and C1413 respectively. With the ignition off, the ECM is supplied with permanent battery voltage to power the memory. The voltage is supplied from the battery positive terminal via the engine compartment fusebox fusible link 1 and fuse 5 to pin 80 of ECM connector C0913.

When the ignition switch is in position II (ignition on), the ECM receives battery voltage, via the engine compartment fusebox fusible link 3 and the passenger compartment fusebox fuse 6, to pin 61 of ECM connector C0913. The ECM energises the main relay by completing the earth path for the relay coil which is connected to the ECM at pin 54 of connector C0913. The main relay provides battery voltage to various peripheral components and also to the ECM at pin 19 of connector C0914.

When the ignition switch is turned to position II, the ECM primes the fuel system by running the fuel pump for approximately two seconds. This is achieved by completing the earth path for the fuel pump relay coil. The fuel pump relay coil is connected to battery voltage from the main relay, the earth being supplied by the ECM at pin 68 of connector C0913. The ECM references the sensors and the IACV stepper motor prior to start-up.

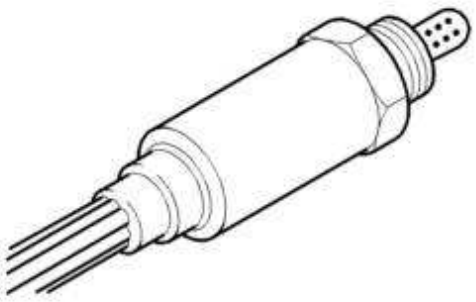
Security code information is exchanged between the ECM and the immobilisation ECU via a wire connected from pin 72 of connector C0913 on the ECM.

When the ignition switch is turned to position III (crank), the ECM communicates with the immobilisation ECU. If it receives authority to start, the ECM begins ignition and fuelling when CKP and CMP sensor signals are detected. The ECM will run the fuel pump continuously when CKP sensor signals are received (crank turning).

When the ignition switch is turned to position 0 (off), the ECM switches off ignition and fuelling to stop the engine. The ECM continues to hold the main relay in the on position until it has completed the power down functions. Power down functions include engine cooling and referencing the IACV stepper motor and includes memorising data required for the next start up. When the power down process is completed, the ECM switches off the main relay and enters a low power mode. During low power mode the ECM will consume less than 1mA.

If the ECM suffers an internal failure, such as a break down of the processor or driver circuits, there are no back up systems or limp home capability. If a sensor circuit fails to supply an input, this will result in a substitute or default value being adopted where possible. This enables the vehicle to function, but with reduced performance.

Heated Oxygen Sensors (HO2S)



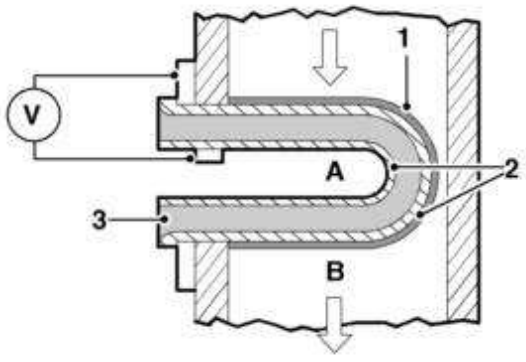
M18 0604

Two HO2S are used on the MEMS 3 system to comply with the requirements of ECD 3. A pre-catalyst HO2S is located in the exhaust manifold, upstream of the starter catalyst and a post catalyst HO2S is located in the exhaust system, downstream of the main catalyst. The sensors provide feedback signals to the ECM which enable it to control the Air/Fuel Ratio (AFR). The principal purpose of the sensors is to enable tight control of AFR around the 14.7:1 AFR (by weight) which produces the best composition of exhaust gas for peak catalytic converter efficiency.

The upstream (pre-catalyst) sensor is the main sensor used for closed loop fuelling. The downstream (post-catalyst) sensor is used to monitor the performance of the main catalyst and to trim the fuelling provided by the pre-catalyst sensor.

If an HO2S fails, the ECM adopts an open loop fuelling strategy to minimise emissions, stores fault codes which can be retrieved using T4 and, on vehicles manufactured after the EDC3 compliance date, illuminates the Malfunction Indicator Lamp (MIL) in the instrument pack.

The HO2S consists of a sensing element, the outer surface of which is exposed to exhaust gases, whilst the inner surface is exposed to ambient air. The sensor has a ceramic coating to protect the sensing element from contamination and heat damage.



M18 0605

A = Ambient Air; B = Exhaust Gases

1. Protective ceramic coating
2. Electrodes
3. Zirconium oxide

CAUTION: HO2 sensors are easily damaged by dropping, excessive heat or contamination. Care must be taken not to damage the sensor housing or tip.

- The HO2S becomes very hot, take care when working near it.
- Do not measure the resistance of the sensing element.
- Observe the correct torque tightening value when installing the HO2S.
- Do not subject the HO2S to mechanical shocks.

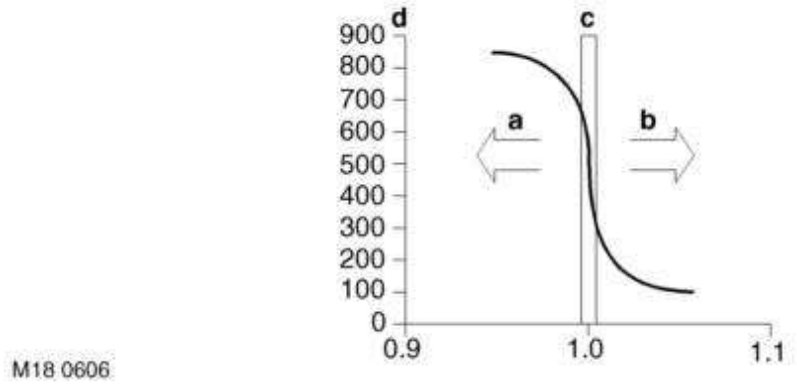
- The HO2S may be contaminated if fuel with added lead is used.

The amount of oxygen in ambient air is constant at approximately 20%. The oxygen content of the exhaust gases varies with the AFR with a typical value for exhaust gas of around 2%.

The difference in oxygen content of the two gases produces an electrical potential difference across the sensing element. Rich mixtures, which burn almost all of the available oxygen, produce high sensor voltages. During lean running, there is an excess of oxygen in the mixture and some of this oxygen leaves the combustion chamber unburnt.

In these conditions, there is less difference between the oxygen content of the exhaust gas and the ambient air, and a low potential difference (voltage) is output by the HO2S. The ECM uses the voltage produced in the HO2S sensing element to calculate the AFR and thereby control fuelling to a high degree of accuracy.

The material used in the sensing element only becomes active at a temperature of 300°C (572°F), therefore it is necessary to provide additional heating via an electrical resistive element. The element uses a 12V supply from the main relay when the ECM energises the relay coil and allows a short warm up time and minimises emissions from start-up. The resistance of the heating element can be measured using a multimeter and should be 6W at 20°C (68°F).



1. Rich AFR
2. Lean AFR
3. Lambda window (0.97 to 1.03 mV)
4. HO2S Output in mV.

Crankshaft Position (CKP) Sensor

The variable reluctance CKP sensor is mounted at the rear of the engine with the sensor tip facing the engine side of the flywheel and is secured in the casting with a single screw. The sensor tip of the CKP sensor is adjacent to a profiled target ring formed on the inner face of the flywheel.

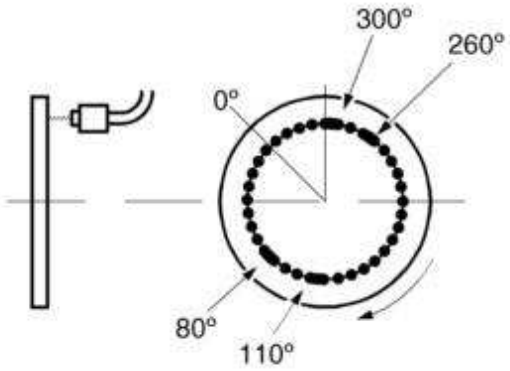
M18 0676

The signal produced by the CKP sensor allows the ECM to calculate the rotational speed and angular position of the crankshaft. This information is required by the ECM to calculate ignition timing, fuel injection timing and fuel quantity during all conditions when the engine is cranking or running. If the CKP sensor signal is missing, the vehicle will not run as there is no substitute signal or default value.

The CKP sensor is a variable reluctance sensor and provides an analogue voltage output to pins 4 and 30 of ECM connector C0914, relative to the speed and position of the target on the flywheel. A permanent magnet inside the sensor applies a magnetic flux to a sensing coil winding. This creates an output voltage which is read by the ECM.

As the gaps between the poles of the target pass the sensor tip, the magnetic flux is interrupted and this causes a change to the output voltage (e.m.f.).

It is important to note that the ECM is unable to determine the exact position of the engine with its four stroke cycle from the CKP sensor alone, the CMP sensor must also be referenced to provide sufficient data for ignition control and sequential injection.



M18 0607

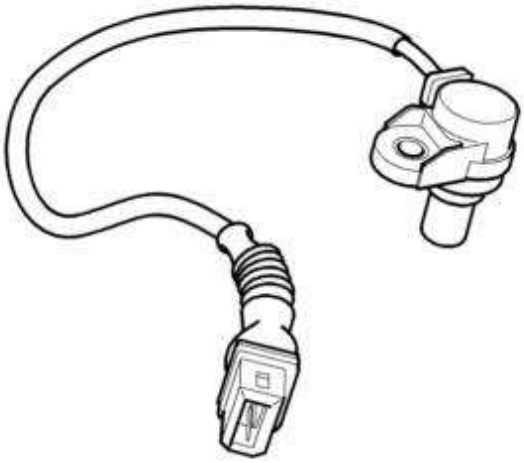
Camshaft (CMP) Sensor

The CMP sensor provides a signal which enables the ECM to determine the position of the camshaft relative to the crankshaft. This allows the ECM to synchronise fuel injection for start and run conditions. The CMP sensor provides an output to pin 16 of the ECM connector C0914. The ECM provides an earth for the sensor on pin 42 of ECM connector C0914.

The CMP sensor is located on the camshaft cover (under the plastic cover) at the opposite end to the camshaft drive and reads off a reluctor on the exhaust camshaft.

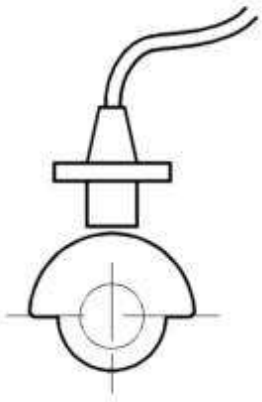
The sensor is a hall effect sensor which detects the reluctor mounted on the exhaust camshaft. The sensor receives a battery supply from the main relay. The sensor operates on the principle of a voltage generated

when the sensor is exposed to a magnetic flux. This causes a potential difference in voltage as the reluctor passes the sensor which is detected as an digital signal by the ECM.



M18 0608

The reluctor consists of a single 'tooth' design which extends over 180 of the camshaft's rotation, for this reason it is known as a half moon cam wheel.



M18 0609

The half moon cam wheel reluctor enables the ECM to provide sequential fuel injection at start up, but it cannot provide a back-up signal in cases of CKP sensor failure.

If the CMP sensor signal is missing, the engine will still start and run, but the fuel injection may be out of phase. This will be noticeable by a reduction in performance and drivability, together with an increase in fuel consumption and emissions.

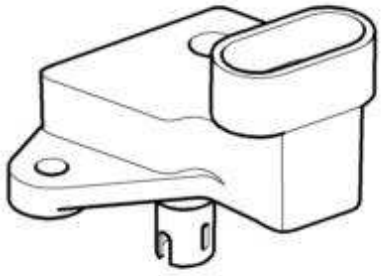
As the camshaft rotates the signal will switch between the high and low voltages. The position of the half moon cam wheel relative to the camshaft is not adjustable. The air gap between the CMP sensor tip and the half moon cam wheel is not adjustable.

Manifold Absolute Pressure (MAP) Sensor

The MAP sensor is located on the forward face of the inlet manifold and is secured with two Torx screws.

The output signal from the MAP sensor, together with the CKP and IAT sensors, is used by the ECM to calculate the amount of air induced into the cylinders. This enables the ECM to determine ignition timing and fuel injection duration values.

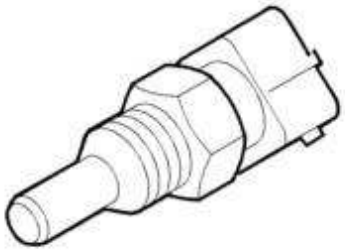
The MAP sensor receives a 5V ±4% supply voltage from pin 8 of ECM connector C0914 and provides an analogue signal to pin 45 of ECM connector C0914, which relates to the absolute manifold pressure and allows the ECM to calculate engine load. The ECM provides an earth for the sensor via pin 31 of ECM connector C0914. Pin 10 of connector C0914, although connected is not used by the ECM and is provided for future development.



M18 0610

If the MAP signal is missing, the ECM will substitute a default manifold pressure reading based on crankshaft speed and throttle angle. The engine will continue to run with reduced drivability and increased emissions, although this may not be immediately apparent to the driver. The ECM will store fault codes which can be retrieved using T4.

Engine Coolant Temperature (ECT) Sensor



M18 0611

The ECT sensor is located in the cooling system outlet elbow from the cylinder head and provides a signal to pin 33 of ECM connector C0914 which allows the engine temperature to be determined. The ECM provides an earth for the sensor via pin 7 of ECM connector C0914.

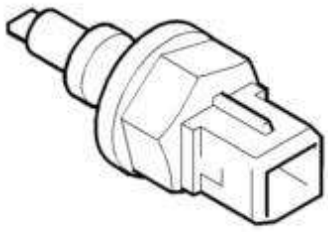
On vehicles with air conditioning, the A/C compressor clutch will be disengaged if the engine coolant temperature reaches a predetermined level, and will not re-engage until it falls to a predetermined level.
***** Operation *****

The ECT sensor consists of an encapsulated Negative Temperature Coefficient (NTC) thermistor which is in contact with the engine coolant. The ECM uses engine coolant temperature to calculate fuelling and ignition timing parameters during start up. It is also used to provide a temperature correction for fuelling and ignition timing when the engine is warming up, running normally or overheating. The ECT signal is also used by the ECM to control the engine cooling fans.

If the ECT sensor fails or becomes disconnected, the ECM will use a default value which is based on values from the engine oil temperature sensor. The driver may not notice that a fault is present although a fault code will be stored in the ECM which can be retrieved using T4. The default value will also include operation of the cooling fans in fast mode when the engine is running.

***** Description *****

Intake Air Temperature (IAT) Sensor



M18 0612

The IAT sensor is located in the intake manifold near cylinder number four fuel injector. The sensor consists of an NTC thermistor mounted in an open housing to allow air flow over the sensing element.

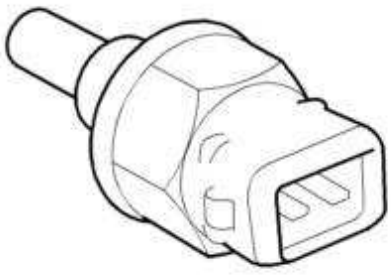
The IAT sensor provides a signal to pin 44 of ECM connector C0914, which enables the ECM to adjust ignition timing and fuelling quantity according to the intake air temperature, thus ensuring optimum performance, drivability and low emissions. The ECM provides an earth for the sensor via pin 18 of ECM connector C0914.

The IAT sensor is part of a voltage divider circuit which consists of a regulated 5 volt supply, and a fixed resistor (both are inside the ECM) and a temperature dependent variable resistor (the IAT sensor).

If the IAT sensor fails, or is disconnected, the vehicle will continue to run. The ECM will substitute a default value using the information from the speed/load map to run the engine, but adaptive fuelling will be disabled.

This condition would not be immediately apparent to the driver, but the ECM will store fault codes which can be retrieved using T4.

Engine Oil Temperature Sensor



M18 0613

The engine oil temperature sensor is located in the oil filter housing. The oil temperature measured by the ECM is used to adjust fuelling values according to engine oil temperature.

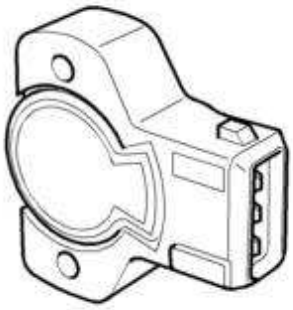
The use of an engine oil temperature sensor allows the ECM to provide optimum engine performance and minimum emissions during the engine warm up phase. The sensor provides a signal to pin 32 of ECM connector C0914. The ECM provides an earth for the sensor on pin 6 of ECM connector C0914.

The sensor consists of an encapsulated Negative Temperature Coefficient (NTC) thermistor which is in contact with the engine oil.

If the sensor fails, the ECM will substitute a default value which is ramped up 90°C (194°F). This condition will not be apparent to the driver.

The vehicle will run but may suffer from reduced engine performance and increased emissions as adaptive fuelling is disabled. The ECM will store fault codes which can be retrieved using T4.

Throttle Position (TP) Sensor



M18 0614

The TP sensor is mounted on the throttle body and is driven from the end of the throttle spindle. The TP sensor consists of a potentiometer which provides an analogue voltage that the ECM converts to throttle position information.

The TP sensor signal is required for the following vehicle functions:

- Idle speed control.
- Throttle damping.
- Deceleration fuel cut off.
- Engine load calculations.
- Acceleration enrichment.
- Full load enrichment.
- Automatic gearbox shift points.

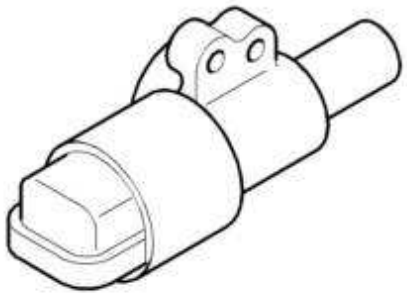
The TP sensor is a potentiometer which acts as a voltage divider in an external ECM circuit. The potentiometer consists of a 4kW ±20% resistive track and a wiper arm, driven by the throttle spindle, which sweeps over the track.

The track receives a regulated 5 V ±4% supply from pin 46 of ECM connector C0914, together with an earth path from pin 34 of ECM connector C0914. As the wiper arm moves over the track it will connect to areas of different voltage ranging from 0 to 5 volts. The 'output' from the wiper arm is connected to pin 20 of ECM connector C0914, to provide an analogue voltage signal.

The TP sensor requires no adjustment as the ECM will learn the lower voltage limit which corresponds to closed throttle.

If the TP sensor signal is missing the vehicle will continue to run but may suffer from poor idle control and throttle response. The ECM will store fault codes which can be retrieved using T4.

Idle Air Control Valve (IACV)



M18 0615

The IACV is located on the inlet manifold. It allows the ECM to control the engine idling speed by regulating the amount of air which by-passes the throttle valve. It also allows the ECM to provide a damping function when the throttle is closed under deceleration which reduces hydrocarbon (HC) emissions.

The IACV is controlled by the ECM using a stepper motor. This consists of a core which is rotated by magnetic fields produced by two electro-magnet bobbins set at 90° to each other.

The stepper motor controls the volume of air passing through a duct which leads from the inlet manifold to a pipe connected to the throttle body. The bobbins are connected to the ECM driver circuits.

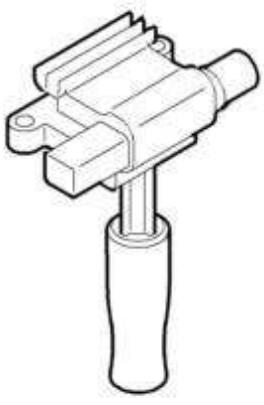
Each of the four connections can be connected to 12 volts or earth, enabling four 'phases' to be obtained. The ECM drives the four phases, known as 'A', 'B', 'C' and 'D', from pins 39, 13, 50 and 24 respectively of ECM connector C0914, to obtain the desired idle speed.

When the ignition is switched off the ECM enters a power down routine which includes 'referencing' the stepper motor. This means that the ECM will rotate the motor so that it can memorise the position when it next needs to start the engine.

The stepper motor referencing procedure can take from three to five seconds. If the ECM cannot reference the stepper motor during power down, it will do so at ignition on. If the stepper motor fails, there are no back up idle control systems. The idle speed may be too high or too low and if a load is placed on the engine it may stall. The ECM will store fault codes which can be retrieved by T4.

Ignition Coils

Two ignition coils are mounted on the camshaft cover above the spark plugs for cylinders 1 and 3 and secured with screws.



M18 0616

Each coil operates a pair of spark plugs using the wasted spark principle. The coil has a plug connection on its lower face and an HT lead which connects to the second plug.

Coil No. 1 is connected to earth via pin 52 of ECM connector C0914 and coil No. 2 is connected to earth via pin 26 of ECM connector C0914. Each coil receives a battery supply from the main relay, via fuse 2 in the engine compartment fusebox.

Coil No. 1 is fitted above cylinder 1 and is attached to the spark plug for cylinder 1 and the HT lead connects to the spark plug for cylinder 4.

Coil No. 2 is fitted above cylinder 3 and is attached to the spark plug for cylinder 3 and the HT lead connects to the spark plug for cylinder 2.

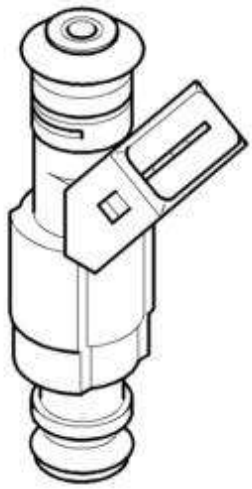
WARNING: The HT voltage of the ignition system is in excess of 50 kV and the LT voltage is in excess of 400 volts. Voltages this high can cause serious injury and may even be fatal. Never touch any ignition components while the engine is running or being cranked.

CAUTION: Never crank or run the engine with the HT leads disconnected from the ignition coils; failure of the ECM and/or the coil will result. Always disable the ignition system by disconnecting the LT connectors from the coil.

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

Fuel Injectors

The fuel injectors are located directly under the fuel rail and connect to the intake manifold runners. Each injector delivers fuel to the engine in a targeted, atomised spray (onto the intake valve heads) which takes place once per cycle. Each injector opens during the intake stroke of the cylinder it supplies.



M19 3315

An injector consists of a pintle type needle and seat, and a solenoid winding which lifts the needle against a return spring. The injector nozzle delivers the fuel spray to precise areas of the intake ports to maximise the benefits of the swirl and turbulence in the manifold and head ports.

The solenoid winding has a resistance of 13 - 16W at 20°C (68°F). The fuel injectors operate at a regulated pressure of 3.5 bar (50 lbf/in^2). The regulator is located on the end of the fuel rail and excess fuel is returned to the swirl pot via a return line to the tank.

The injectors receive fuel under pressure from the fuel rail and a 12 volts supply from the main relay. To

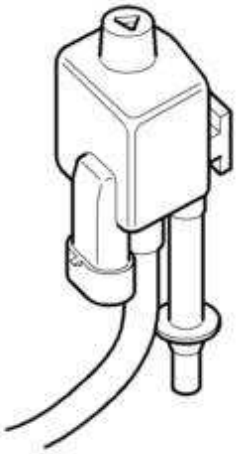
deliver fuel to the engine, the ECM has to lift the needle off the injector seat by energising the solenoid.

To energise the solenoid the ECM supplies an earth path from connector C0914 to the winding of each injector on the following pins:

- Injector No. 1 - pin 25.
- Injector No. 2 - pin 51.
- Injector No. 3 - pin 14.
- Injector No. 4 - pin 40.

If an injector fails, the engine may lose power and drivability. The ECM will store fault codes which can be retrieved using T4.

Evaporative Emissions (EVAP) Purge Valve



M18 0618

The EVAP purge valve is located in the engine compartment, on the LH inner wing, below the E-box. The purge valve is connected via a flexible pipe to the inlet manifold. The EVAP canister is located in the RH rear wheel arch, behind the liner.

The purge valve consists of a solenoid operated valve which is controlled by the ECM which provides a PWM earth signal on pin 48 of connector C0914. The purge valve receives a battery feed from the main relay via fuse 1 in the engine compartment fusebox.

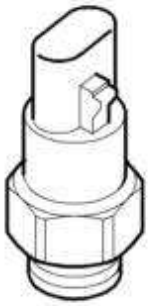
The EVAP purge valve controls the flow of fuel vapours from the EVAP canister to the intake manifold of the engine. When the vehicle is being driven the ECM will purge the EVAP canister by opening the purge valve, this allows the vacuum present in the intake manifold to draw fuel vapour from the canister into the cylinders for combustion.

When fuel vapour is being removed from the canister, fresh air is allowed to enter via an automatic one-way valve, this makes the canister ready for the next 'absorption' phase. The amount of fuel vapour which enters the cylinders can affect the overall AFR, therefore the ECM must only open the purge valve when it is able to compensate by reducing fuel injector duration.

The purge valve will only operate under the following conditions:

- Engine at normal operating temperature.
- Adaptive fuelling enabled.
- Closed loop fuelling enabled.

Air Conditioning (A C) Refrigerant Pressure Sensor



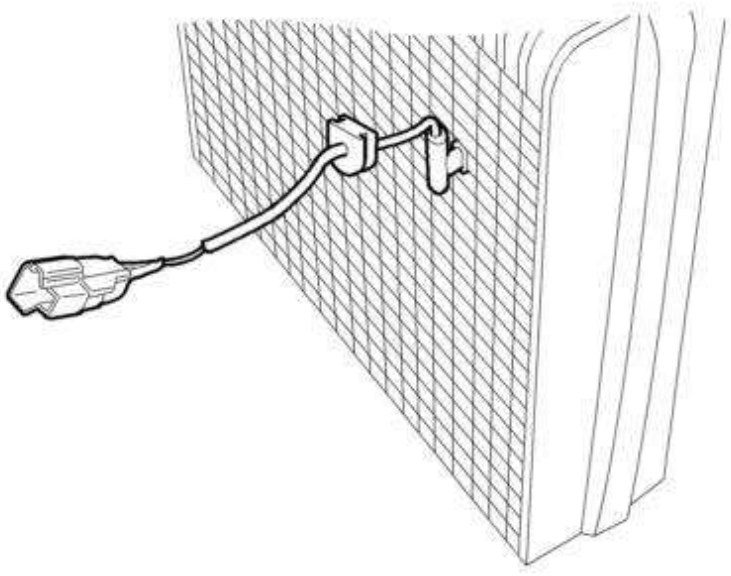
M18 0619

The pressure sensor is located in an A/C pipe from the condensor on the front RH side of the engine compartment. For further information on the air conditioning system and pressure sensor switching pressures:
***** Description *****

The sensor is used by the ECM, in conjunction with the evaporator sensor, to calculate the loads applied to the engine by the variable load A/C compressor for engine load calculations and idle speed control. The sensor is connected to ECM pins 57, 70 and 71 of connector C0913. Pin 57 is a 5V sensor supply, pin 70 is the return signal from the sensor and pin 71 is for the sensor earth.

The ECM uses the signals from the sensor to disengage the compressor electro-mechanical clutch should the pressure become too low or too high and to switch the cooling fans to high or low speed at predetermined pressures.
***** Description *****

Air Conditioning (A C) Evaporator Temperature Sensor



M18 0620

The evaporator temperature sensor is a NTC thermistor located in the evaporator. This is used by the ECM, in conjunction with the A/C pressure sensor, to monitor evaporator temperature and calculate the loads applied to the engine by the variable load compressor for engine load calculations and idle speed control.

The evaporator temperature sensor is connected to ECM pins 37 and 47 of connector C0914. Pin 37 supplies the sensor earth and pin 47 supplies the sensor signal to the ECM.

If evaporator temperature falls low enough for ice to form on the evaporator fins, the ECM will disengage the compressor electro-mechanical clutch until evaporator temperature rises sufficiently.

***** Description *****

Alternator

The alternator is located on a bracket which is attached to the cylinder block on the front RH side of the engine. The alternator is driven by a Polyvee belt from the crankshaft pulley. The alternator converts mechanical energy into electrical energy to power the electrical systems and maintain the battery charge.

The alternator outputs a signal to pin 35 of ECM connector C0914 which represents the electrical load on the vehicle systems and the mechanical load exerted on the engine by the alternator. The signal output from the alternator is a variable PWM signal which is proportional to the load applied to the engine.

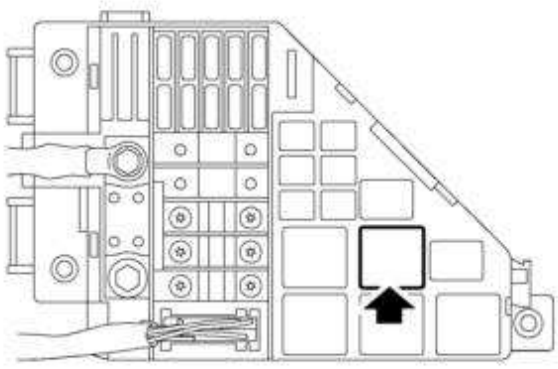
The ECM uses the load signal to provide idle speed compensation and to reduce engine speed fluctuations. If the load signal fails, the ECM uses a default value and stores a fault code which can be retrieved using T4.

Ignition Switch Signal

A hardwired digital input to pin 61 of ECM connector C0913 provides an ignition on signal. When the ECM has been idle for a period of time, it goes into 'sleep' (power saving) mode.

When the ECM receives an ignition on signal from the ignition switch, the ECM 'wakes up' to energise the main relay.

Main Relay



M18 0621

The main relay is located in the engine compartment fusebox which is located on the LH side of the engine compartment.

The main relay is normally open when the ignition is off. When the ignition is switched on to position II, the ECM provides an earth path for the relay coil which energises, closing the contacts.

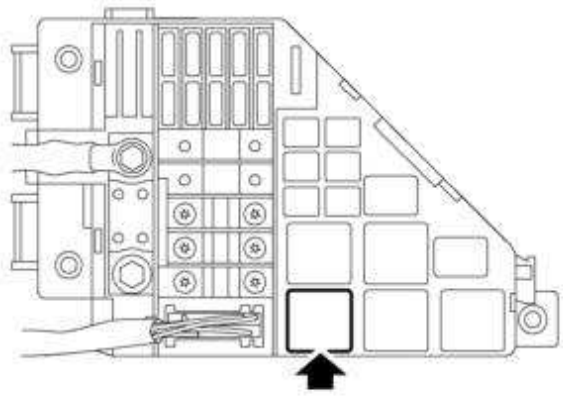
A permanent battery supply is provided direct to the relay contacts. The main relay supplies battery voltage to the following components:

- ECM connector C0914 pin 19
- Pre and post HO2S.
- CMP sensor.
- Purge valve.

- Fuel injectors.
- Ignition coils.
- A/C relay coil.
- Fuel pump relay coil.

If the main relay fails, power will not be supplied to the above components and the engine will not start. The ECM will store fault codes which can be retrieved using T4.

Fuel Pump Relay



M18 0622

The fuel pump relay is located in the engine compartment fusebox which is positioned on the LH side of the engine compartment. The relay is normally open when the ignition is off.

When the ignition switch is in position II (ignition on), the ECM provides an earth path for the relay coil on pin 68 of connector C0913. With the ignition on, the relay receives a feed from the main relay which energises the relay coil, closing the contacts.

A permanent battery supply is provided to the relay contacts from fuse 10 in the engine compartment fusebox, via the fuel shut-off switch. The feed passes through the relay contacts and operates the fuel pump to pressurise the fuel system. The relay will be energised for a short time only to pressurise the fuel system.

When the ignition switch is moved to position III (crank), the ECM will energise the relay when the engine starts cranking and will remain energised until the engine stops.

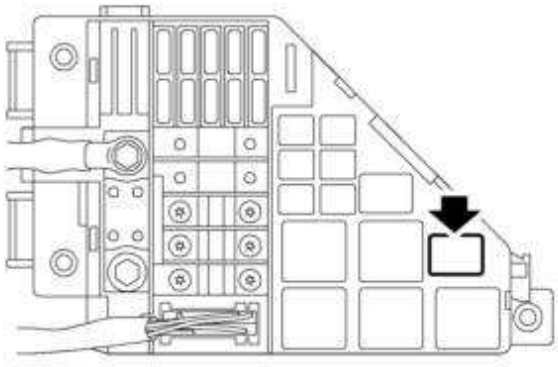
If the engine stalls and the ECM stops receiving a signal from the CKP sensor, the ECM will remove the earth path for the relay, stopping the fuel pump.

The fuel shut-off switch, when tripped, cuts off the power supply to the relay contacts, disabling the fuel pump in the event of a sudden deceleration. If the fuel pump fails to operate, check that the fuel shut-off switch is not tripped. The switch is reset by depressing the rubber cap on the top of the switch.

WARNING: Ensure there are no fuel leaks and confirm the integrity of the fuel system before resetting the fuel shut-off switch.

If the fuel pump relay fails, power will not be supplied to the fuel pump and the engine will not start or will stop if already running due to fuel starvation. The ECM will store fault codes which can be retrieved using T4.

A C Compressor Clutch Relay



M18 0623

On vehicles fitted with air conditioning, an A/C relay is located in the engine compartment fusebox. When the engine is running and the driver requests A/C on, the ECM receives an earth signal from the A/C switch to pin 56 of ECM connector C0913.

If conditions are correct, the ECM grants the A/C request by completing an earth path from pin 53 of ECM connector C0913 to the A/C clutch relay coil. The relay coil receives a battery feed from the main relay and, when the earth path is granted, the coil will energise closing the relay contacts.

A permanent battery supply, via fusible link 1 and fuse 9 in the engine compartment fusebox, passes through the relay contacts and operates the compressor clutch.

The ECM will remove the earth path from the relay coil, disengaging the A/C compressor clutch if:

- Engine coolant temperature exceeds a predetermined level and will re-engage the A/C compressor clutch when the coolant temperature falls to a predetermined level.
- If the A/C refrigerant pressure becomes too low or too high. For details on refrigerant pressures: ***** Description *****

If the A/C clutch relay fails, A/C will be inoperative and the ECM will store fault codes which can be retrieved using T4.

Engine Cooling Fans

On vehicles without A/C, a single speed cooling fan is located behind the radiator. The fan is controlled by the ECM via a relay located in the E-box.

On vehicles with A/C, a cooling fan is located behind the radiator, adjacent to a second similar cooling fan used by the air conditioning system for condensor cooling. For engine cooling and A/C, both fans operate in parallel controlled by the ECM via a cooling fan ECU.

Cooling Fan Operation - Vehicles Without A C

The ECM will energise the cooling fan relay in the E-box at a coolant temperature of 102°C (215°F) and will go off when the coolant temperature decreases to less than 96°C (204°F).

When the engine is switched off, the ECM maintains the cooling fan in an active condition for up to eight minutes. If the temperature does not reach a predetermined value within four minutes, the ECM will terminate the active period. If the fan is active and the temperature falls below a predetermined value, the ECM will terminate further fan operation.

Cooling Fan Operation - Vehicles With A C

The engine cooling fan and the condensor fan are operated in parallel by the ECM via a cooling fan ECU. The cooling fan ECU, which is located behind the radiator below the bonnet closing panel, receives a Pulse Width Modulated (PWM) signal from the ECM. The frequency of the PWM signal, which is varied by the ECM, is used by the cooling fan ECU to determine the output voltage supplied to the fan motors.

Fan operation is also dependent on vehicle road speed. The ECM will adjust the required fan speed in relation to the road speed using CAN signals received from the ABS ECU.

The ECM varies the duty cycle of the PWM signal between 10% and 90%. At duty cycles of between 10% and 49% the cooling fan ECU will not supply any power to the fan motors. At a duty cycle of 50%, the ECU supplies 6 volts to the fan motors to operate them at a minimum speed of approximately 1300 rev/min. As the duty cycle increases above 50%, the ECU increases the voltage, non-linearly, to the fan motors up to 90%. At this point the fan motors are supplied with 12 volts and operate at a maximum speed of approximately 3000 rev/min.

When the main relay is energised, the cooling fan ECU requires a PWM signal from the ECM of between 10% and 90% duty cycle. If this condition is not detected, the ECU will assume a fault condition (open or short circuit) exists and operate the fans continuously at full speed when the main relay is energised to ensure that engine and A/C system do not overheat.

The ECM will operate the fans in response to inputs from the ECT sensor and the A/C switch and A/C pressure sensor. Refer to A/C system for details
***** Description *****

When the engine is switched off, the ECM maintains the cooling fans in an active condition for up to 8 minutes. If the temperature does not reach a predetermined value within 4 minutes, the ECM will terminate the active period. If the fans are active and the temperature falls below a predetermined value, the ECM will terminate further fan operation.

Fuel Tank Level Sensor

The ECM receives a fuel tank level signal on the CAN bus from the fuel tank level sensor via the instrument pack and the ABS ECU. This signal is stored in a misfire freeze frame by the ECM for OBD misfire detection when the fuel tank level falls to below 15% of maximum capacity.

Malfunction Indicator Lamp (MIL)

The MIL is located in the instrument pack to inform the driver that there is fault with an emission critical part of the engine management system. When the ignition is switched to position II, the MIL is illuminated until the engine starts to check bulb function.

If a fault occurs on an emission related component, the ECM provides a CAN message to the instrument pack, via the ABS ECU, to operate the MIL LED.

Tachometer Drive

The tachometer drive is a CAN message output from the ECM to the instrument pack, via the ABS modulator.

Vehicle Immobilisation

The vehicle immobilisation system operates by the EWS3D immobilisation ECU transmitting a unique code to the ECM when the ignition is switched on. If the code is recognised by the ECM it will energise the injectors and allow the engine to start.

If no code is received or the code is incorrect, the ECM will disable the vehicle by not energising the fuel injectors.

The immobilisation ECU also controls the starter relay and will passively disarm the starter relay when the key is removed from the ignition switch. Rearming is performed by switching the ignition on, which activates a coil around the ignition key barrel.

The coil transmits a waveform signal which excites the remote handset to transmit a re-mobilisation signal. When the signal is received by the anti-theft alarm ECU, the starter relay will be enabled.

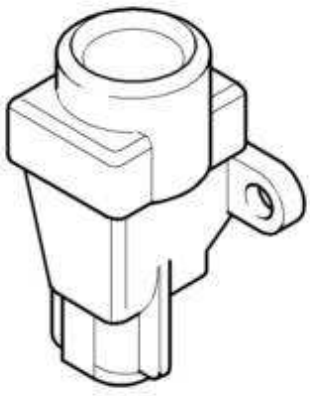
Replacement ECM's are supplied blank and must learn the immobilisation ECU security code for the vehicle to which it is fitted. When the ECM is connected to the vehicle, T4 is required to enable the ECM to learn the immobilisation ECU code. If a new immobilisation ECU is fitted, the ECM will need to learn the new security code using T4. A procedure must be followed when replacing the ECM or immobilisation ECU. This procedure is detailed in the Security Description and Operation section.
***** Description *****

Rough Road Detection

MEMS 3 has a misfire detection facility which is part of the On-Board Diagnostics (OBD) system. Misfire detection is disabled when the ECM senses that the vehicle is on a 'rough road'. The system software receives rough road signal outputs from the ABS ECU and can disable misfire detection to prevent incorrect faults being logged by the ECM.

The 'rough road' signal is passed from the ABS ECU to ECM pins 65 and 79 on the CAN bus. The CAN message is a measure of the maximum wheel acceleration from any one of the four wheel sensors, which is updated by the ABS ECU every 20 ms.

Fuel Shut-off Switch



M18 0624

The fuel shut-off switch is located in the engine compartment to the rear of the LH suspension turret. In the event of a sudden deceleration the switch removes the power supply to the fuel pump relay, stopping the fuel pump.

The fuel shut-off switch, when tripped can be reset by depressing the rubber top of the switch. The switch receives a power supply from fuse 10 in the engine compartment fusebox. The supply is passed through the

switch to the contacts of the fuel pump relay in the engine compartment fusebox. the supply from the switch is also passed to the Central Control Unit (CCU) to unlock the doors in the event of a collision causing the fuel shut-off switch to be tripped.

WARNING: Ensure there are no fuel leaks and confirm the integrity of the fuel system before resetting the fuel shut-off switch.

Throttle Pedal Switch

The throttle pedal switch is located at the top of the pedal box and secured in a cut-out hole in the fabrication. The switch is a proximity type Hall effect switch which senses a target located on the throttle pedal. The switch is connected on a single wire to pin 77 of ECM connector C0913.

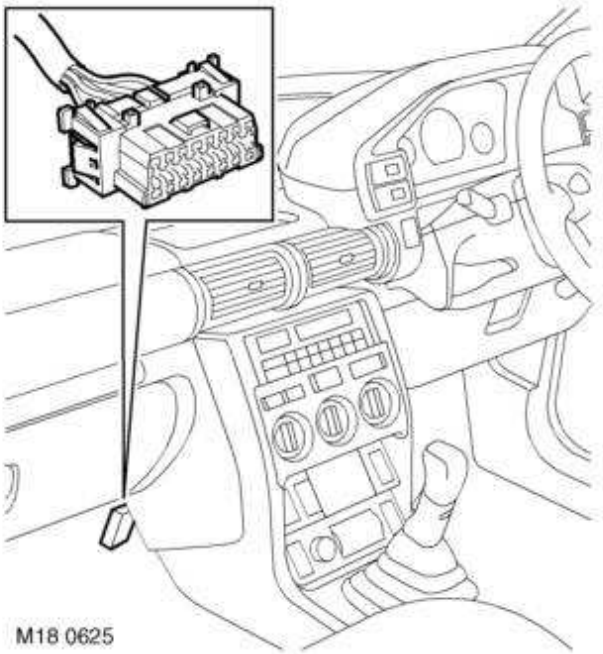
The switch is normally open when the throttle pedal is at rest. When the throttle pedal is depressed, the target on the pedal moves away from the switch causing the switch to close and complete an earth path from the ECM. This is sensed by the ECM which uses the signal as a throttle status to detect for stuck throttle when using Hill Descent Control (HDC). The pedal status is compared with the inputs from the TP sensor to confirm that the throttle is being depressed.

Diagnostics

A diagnostic socket allows the exchange of information between the ECM and T4 or a diagnostic tool using Keyword 2000 protocol.

The diagnostic socket is located in the driver's footwell behind the centre console.

A dedicated diagnostic (ISO 9141 K Line) bus is connected between the ECM and the diagnostic socket and allows the retrieval of diagnostic information and the programming of certain functions using T4.



The ECM uses a 'P' code diagnostic strategy and can record faults relating to the engine management system. P codes are accessed via the ECM when T4 is connected.

On-Board Diagnostics (OBD)

The MEMS 3 ECM software is programmed to meet current emission standard ECD 3. This regulation is being introduced throughout Europe from the year 2000 and is similar to the OBD (phase II) regulations in place in North America.

OBD is concerned with the monitoring of certain functions, the failure of which would result in an increase of exhaust emissions above legislated thresholds. The OBD is concentrated on the engine management system.

If a fault occurs the ECM will store an applicable 'P' code in its memory and the MIL will be illuminated. The failure codes can be accessed with T4 and the faults stored by the ECM are normally qualified by one of the following failure types:

- Min - the minimum expected value has been exceeded
- Max - the maximum expected value has been exceeded.
- Signal - the signal is not present.
- Plaus - an implausible condition has been detected.

The OBD operates in the background, monitoring the operations controlled by the ECM. The systems are monitored as the driver operates the vehicle, although the driver will be unaware that any monitoring is being performed. Individual system tests take place as the applicable circumstances occur.

Diagnostic Trouble Codes (DTC)

The following table lists P codes, affected components and fault description.

P Code	Component	Description
P0106	Manifold pressure input	Circuit fault
P0107	Manifold pressure input	Circuit fault
P0108	Manifold pressure input	Circuit fault
P0111	Inlet Air Temperature (IAT) input	Circuit fault
P0112	Inlet Air Temperature (IAT) input	Circuit fault
P0113	Inlet Air Temperature (IAT) input	Circuit fault
P0116	Coolant temperature input	Circuit fault
P0117	Coolant temperature input	Circuit fault
P0118	Coolant temperature input	Circuit fault
P0121	Throttle Potentiometer (TP) input	Circuit fault
P0123	Throttle Potentiometer (TP) input	Circuit fault
P0130	Upstream (pre-catalyst) oxygen sensor input	Switching frequency too low

P0131	Upstream (pre-catalyst) oxygen sensor input	Electrical fault
P0132	Upstream (pre-catalyst) oxygen sensor input	Electrical fault
P0133	Upstream (pre-catalyst) oxygen sensor input	Signal out of range
P0135	Upstream (pre-catalyst) oxygen sensor input	Electrical fault
P0136	Downstream (post-catalyst) oxygen sensor input	Signal implausable
P0137	Downstream (post-catalyst) oxygen sensor input	Electrical fault
P0138	Downstream (post-catalyst) oxygen sensor input	Electrical fault
P0140	Downstream (post-catalyst) oxygen sensor input	Signal missing
P0141	Downstream (post-catalyst) oxygen sensor input	Electrical fault
P0170	Fuel system	Adaptions out of range
P0197	Oil temperature input	Circuit fault
P0198	Oil temperature input	Circuit fault
P0261	Injector 1 drive	Circuit fault
P0262	Injector 1 drive	Circuit fault
P0264	Injector 2 drive	Circuit fault
P0265	Injector 3 drive	Circuit fault
P0267	Injector 3 drive	Circuit fault
P0268	Injector 3 drive	Circuit fault
P0270	Injector 4 drive	Circuit fault
P0271	Injector 4 drive	Circuit fault
P0301	Cylinder 1	Misfire
P0302	Cylinder 2	Misfire
P0303	Cylinder 3	Misfire

P0304	Cylinder 4	Misfire
P0335	Crankshaft Position (CKP) sensor	No signal
P0340	Camshaft Position (CMP) sensor	No signal
P0351	Ignition coil 1	Signal missing
P0352	Ignition coil 2	Signal missing
P0420	Main catalytic converter	Catalyst general failure
P0444	Purge valve drive	Circuit fault
P0445	Purge valve drive	Circuit fault
P0462	Fuel tank level input	Circuit fault
P0463	Fuel tank level input	Circuit fault
P0480	Radiator fan drive	Circuit fault
P0481	Condensor fan drive	Circuit fault
P0500	Vehicle speed sensor	Signal fault
P0501	Vehicle road speed input	Signal implausable
P0505	Idle speed stepper motor (IACV)	Short circuit to battery or earth or open circuit
P0532	Air conditioning pressure sensor	Circuit fault
P0533	Air conditioning pressure sensor	Circuit fault
P0562	Battery voltage input	Circuit fault
P0563	Battery voltage input	Circuit fault
P0650	Malfunction Indicator Lamp (MIL)	Circuit fault
P1185	Upstream (pre-catalyst) oxygen heater sensor	Electrical fault
P1186	Upstream (pre-catalyst) oxygen sensor heater	Electrical fault
P1191	Downstream (post catalyst) oxygen sensor heater	Electrical fault
P1192	Downstream (post catalyst) oxygen heater sensor	Electrical fault

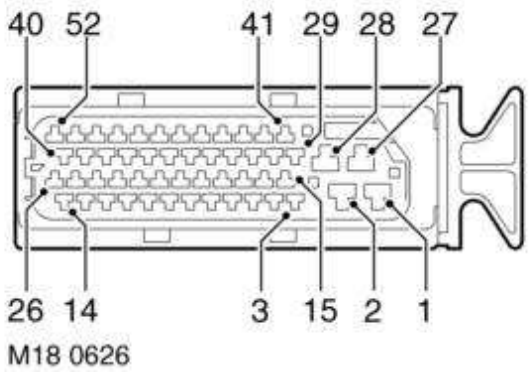
P1231	Fuel pump relay	Circuit fault
P1232	Fuel pump relay	Circuit fault
P1300	Main catalytic converter	Misfire causing catalyst damage
P1316	Cylinder block	Misfire causing increased emissions
P1506	Idle Air Control Valve (IACV) stepper motor drive	Circuit fault
P1507	Idle Air Control Valve (IACV) stepper motor drive	Circuit fault
P1508	Idle Air Control Valve (IACV) stepper motor drive	Circuit fault
P1537	Air conditioning drive	Circuit fault
P1538	Air conditioning drive	Circuit fault
P1590	Rough road sensor	Signal fault
P1610	Main relay drive	Circuit fault
P1611	Main relay drive	Circuit fault
P1640	CAN Bus	CAN message failure

ECM Harness Connector Details

The following tables give input/output information for the two harness connectors used on the ECM.

Connector C0914 (black) - 52 pin

Connector C0914 is used to provide inputs and outputs from and to the ECM for engine sensor operation.



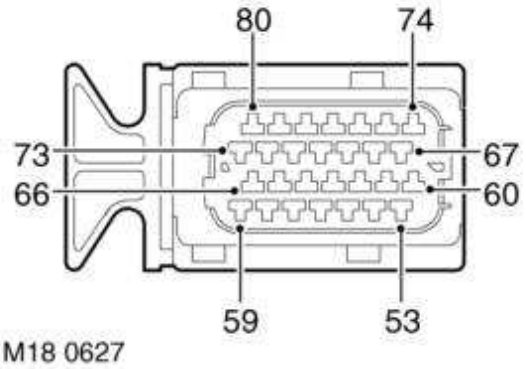
Pin No.	Description	Input Output
1	HO2S (pre-catalyst) heater drive	Output
2	Not used	-
3	HO2S (post catalyst) positive	Output
4	CKP sensor positive	Output
5	Not used	-
6	Engine oil temperature sensor earth	Input
7	ECT sensor earth	Input
8	MAP sensor supply +5V	Output
9	Not used	-
10	MAP sensor intake air temperature signal	Not used
11	Not used	-
12	Not used	-
13	IACV stepper motor phase B	Input/Output
14	Injector 3 earth	Input
15	HO2S (pre catalyst) positive	Output
16	CMP sensor signal	Input
17	CKP sensor screened earth	Input
18	IAT sensor earth	Earth
19	Main relay 12V supply	Input
20	TP sensor signal	Input
21	Not used	-
22	Not used	-
23	Not used	-
24	IACV stepper motor phase D	Input/Output

25	Injector 1 earth	Input
26	Ignition coil 2 earth	Input
27	HO2S (post catalyst) heater drive	Output
28	HO2S (post catalyst) screened earth	Input
29	HO2S (post catalyst) negative	Input
30	CKP sensor negative	Input
31	MAP sensor earth	Input
32	Engine oil temperature sensor signal	Input
33	ECT sensor signal	Input
34	TP sensor earth	Input
35	Alternator load signal	Input
36	Not used	-
37	A/C evaporator temperature sensor earth	Input
38	EVAP Purge valve drive	Output
39	IACV stepper motor phase A	Input/Output
40	Injector 4 earth	Input
41	HO2S (pre-catalyst) negative	Input
42	CMP sensor earth	Input
43	Not used	-
44	IAT sensor signal	Input
45	MAP sensor signal	Input
46	TP sensor supply +5V	Output
47	A/C evaporator temperature sensor signal	Input
48	Not used	-
49	Not used	-

50	IACV stepper motor phase C	Input/Output
51	Injector 2 earth	Input
52	Ignition coil 1 earth	Input

Connector C0913 (black) - 28 pin

Connector C0913 is used to provide inputs and outputs from and to the ECM for A/C, immobilisation, ABS ECU and diagnostic information.



M18 0627

Pin No.	Description	Input Output
53	A/C clutch relay coil earth	Input
54	Main relay coil earth	Input
55	Not used	
56	Not used	-
57	A/C pressure sensor supply +5V	Output
58	Diagnostic ISO 9141 K Line	Input/Output
59	Main earth 1	Input
60	Cooling fan relay coil earth (non A/C)	Input
61	Ignition switch signal	Input
62	Not used	-
63	Not used	-
64	Not used	-
65	CAN Positive	Input/Output

66	Main earth 3	Input
67	PWM fan drive (A/C only)	Input
68	Fuel pump relay coil earth	Input
69	Not used	-
70	A/C pressure sensor signal	Input
71	A/C pressure sensor earth	Input
72	EWS3D Immobilisation coded signal	Input
73	Main earth 2	Input
74	Not used	-
75	Not used	-
76	Not used	-
77	Throttle pedal switch	Input
78	Not used	-
79	CAN Negative	Input/Output
80	Battery permanent supply - Engine compartment fusebox Fuse 2	Input