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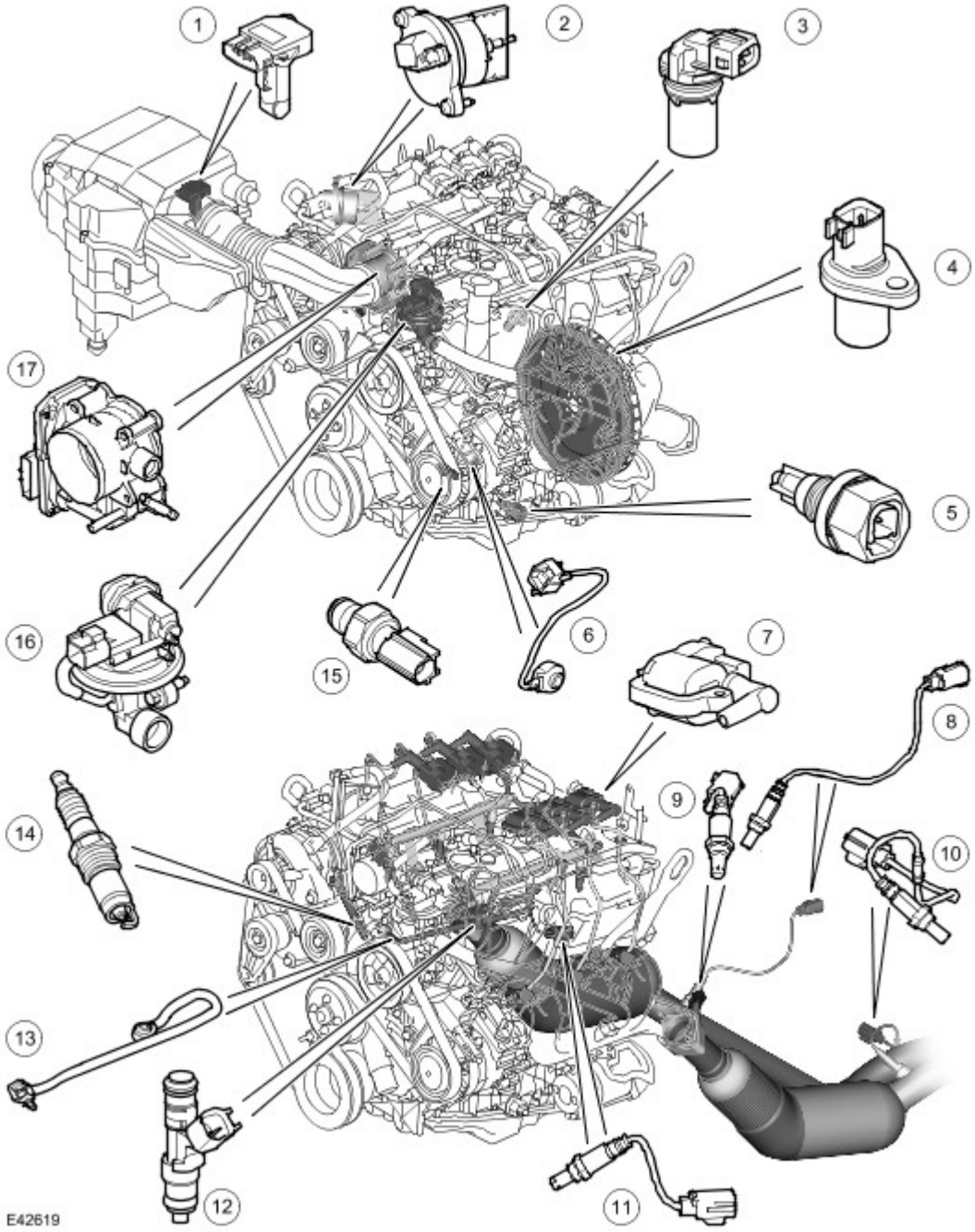
Electronic Engine Controls

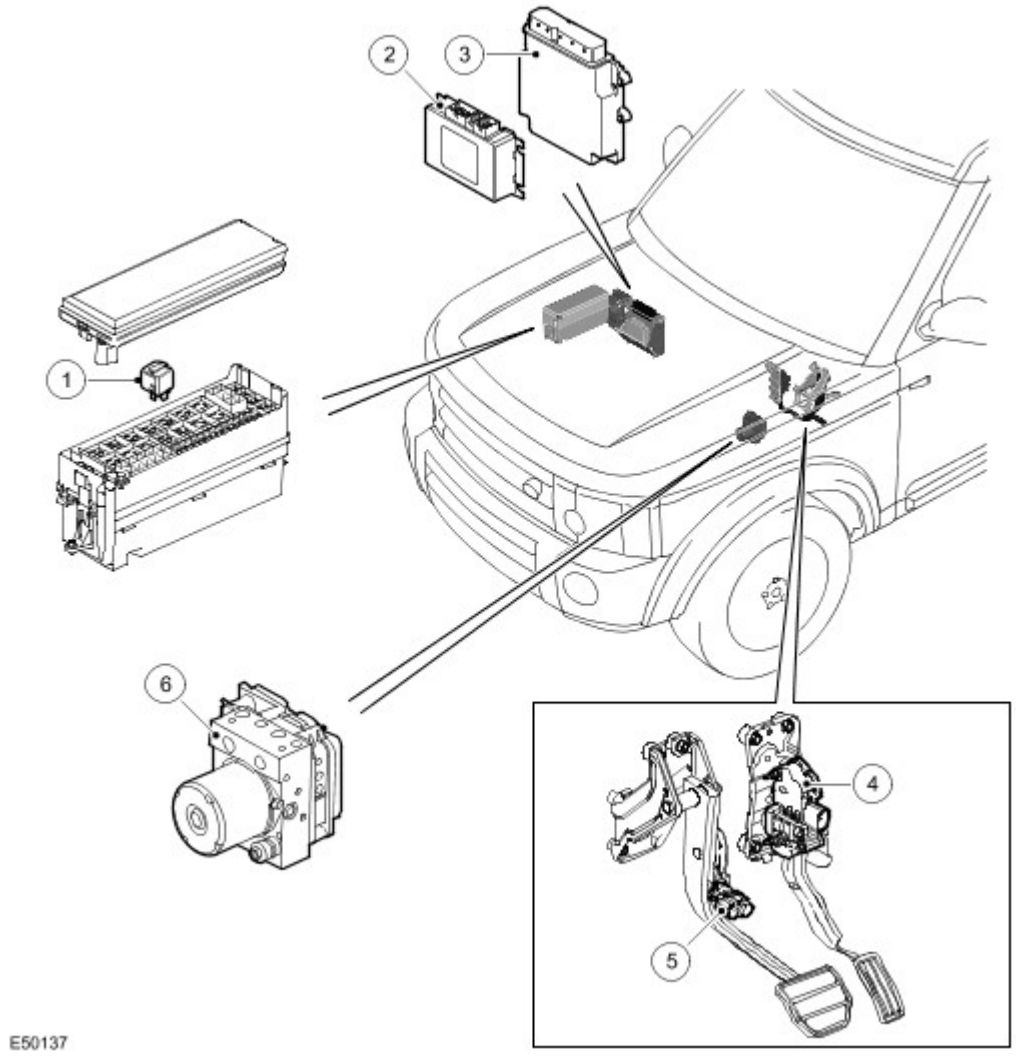
4.0 Liter Electronic Engine Controls Component Location Sheet 1 of 2



Item	Part Number	Description
1	-	Mass air flow/ inlet air temperature sensor (MAF/IAT)
2	-	Inlet manifold tuning valve (IMTV)
3	-	Camshaft position sensor (CMP)
4	-	Crankshaft position sensor (CKP)

5	-	Engine oil temperature sensor
6	-	Knock sensor
7	-	Ignition coils
8	-	Heated Exhaust Gas Oxygen sensor (HEGO)
9	-	Universal Heated Exhaust Gas Oxygen sensor (UHEGO)
10	-	Heated Exhaust Gas Oxygen sensor (HEGO)
11	-	Universal Heated Exhaust Gas Oxygen sensor (UHEGO)
12	-	Injectors
13	-	Knock sensor
14	-	Spark plugs
15	-	Engine oil pressure sensor
16	-	Exhaust Gas Reticulation (EGR) valve and pressure differential sensor
17	-	Electric throttle

4.0 Liter Electronic Engine Controls Component Location Sheet 2 of 2



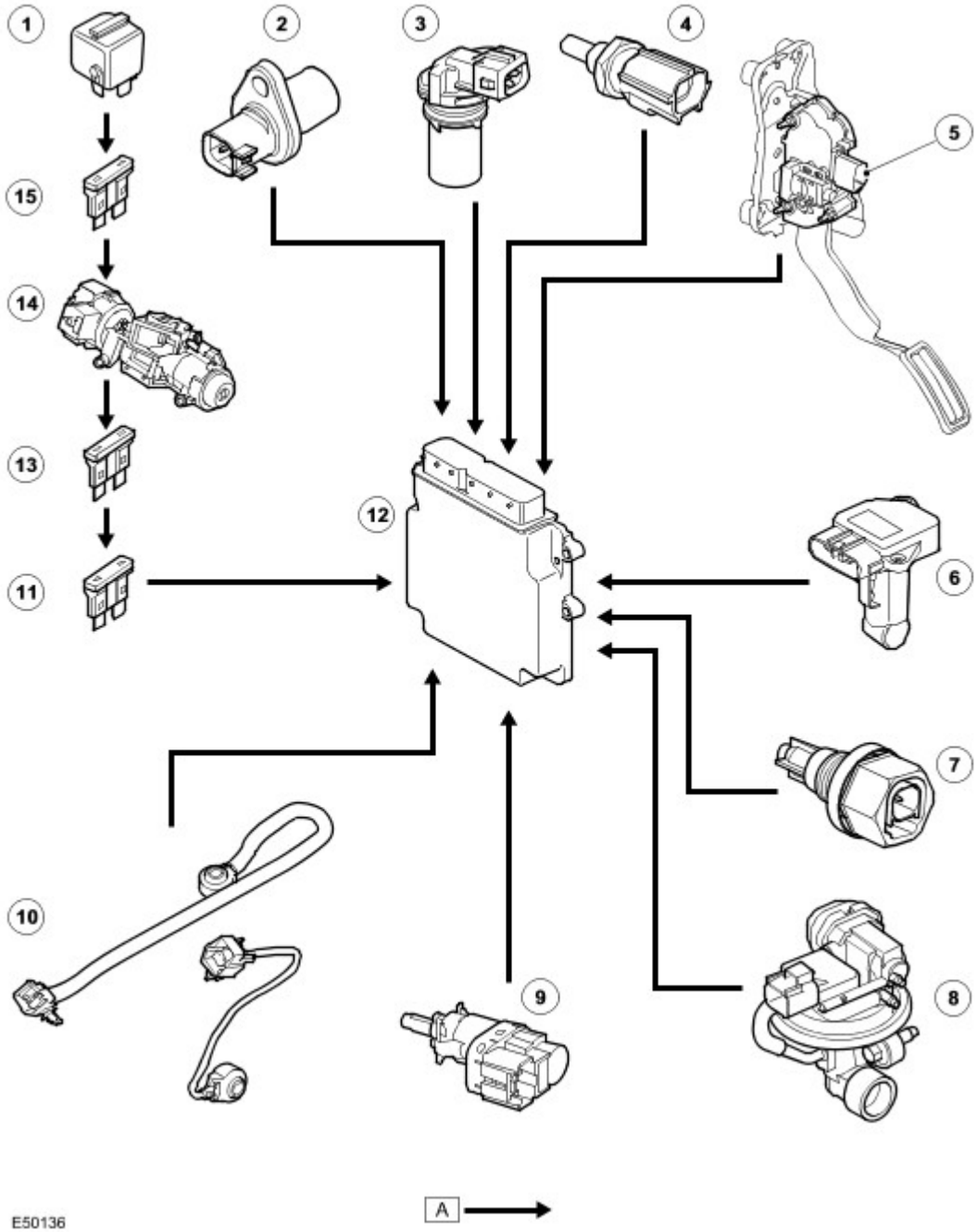
Item	Part Number	Description
1	-	Main relay

3	-	Transfer box control module
2	-	ECM
4	-	Brake lamp switch
5	-	clutch switch
6	-	ABS control module

4.0L EMS Control Diagram Sheet 1 of 2

NOTE :

A= Hardwired

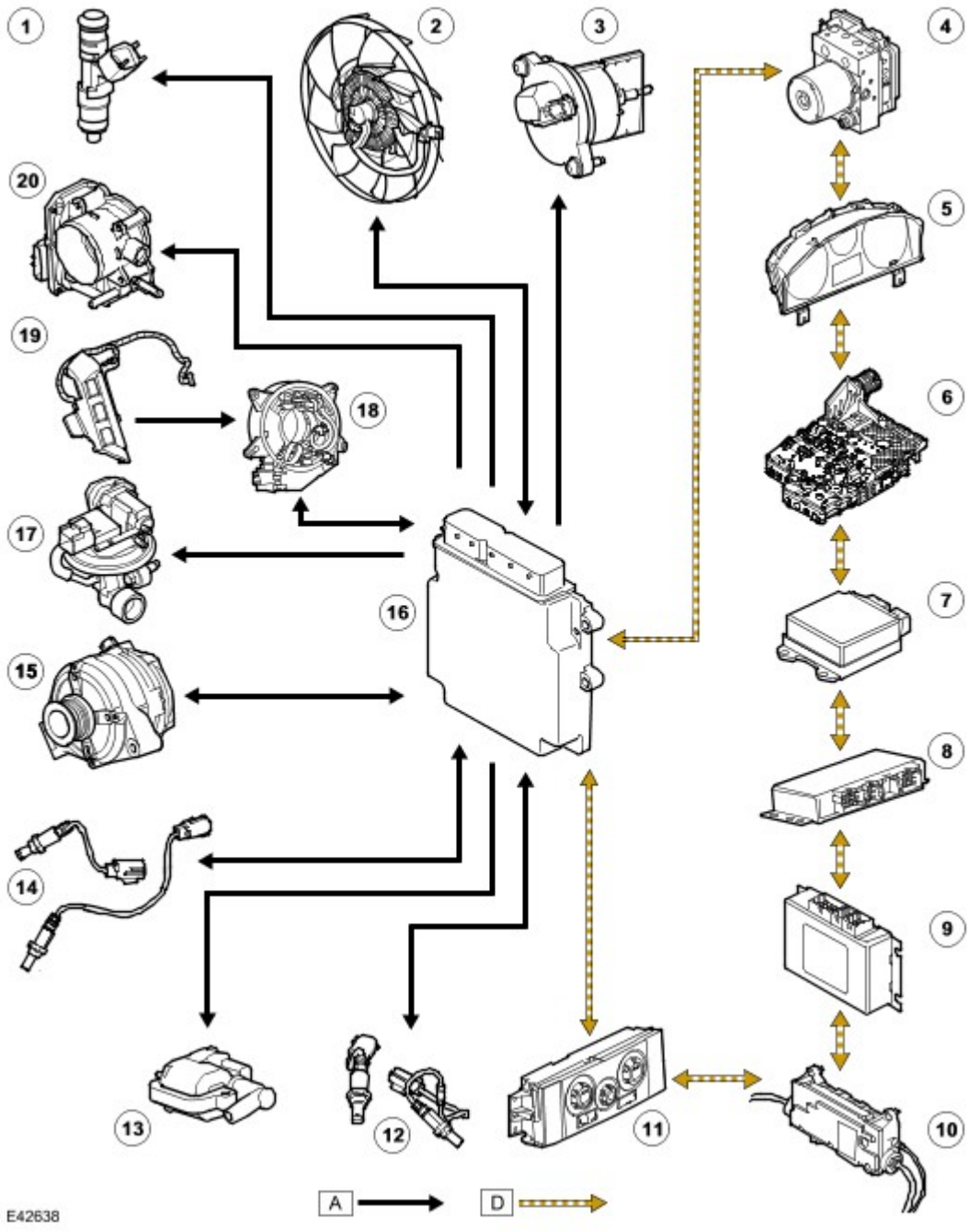


Item	Part Number	Description
1	-	Main relay
2	-	Crankshaft position sensor (CKP sensor)
3	-	Camshaft position sensor (CMP sensor)
4	-	Engine coolant temperature sensor (ECT)
5	-	Accelerator pedal
6	-	Mass air flow meter (MAF)
7	-	Engine oil temperature sensor
8	-	Manifold absolute pressure sensor (MAP)
9	-	Brake light switch
10	-	Knock sensor
11	-	Fuse No 25P
12	-	ECM
13	-	Fuse 60P
14	-	Ignition switch
15		Fuseable link 11E

4.0L EMS Control Diagram Sheet 1 of 2

NOTE :

A= Hardwired D= CAN Bus



Item	Part Number	Description
1	-	Injectors
2	-	Engine cooling fan
3	-	Inlet manifold tuning valve (IMTV)
4	-	ABS control module
5	-	Instrument cluster
6	-	Transmission Control Module (TCM)
7	-	Restraints control module
8	-	Differential control module
9	-	Transfer box control module

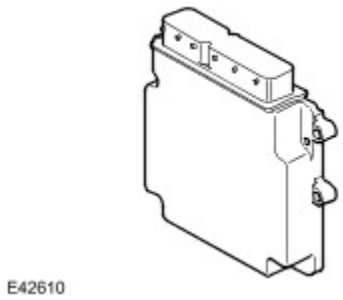
10	-	Electric park brake control module
11	-	Automatic temperature control module (ATCM)
12	-	Universal Heated Exhaust Gas Oxygen sensor (UHEGO) and Heated Exhaust Gas Oxygen sensor (HEGO)
13	-	Ignition coils
14	-	Universal Heated Exhaust Gas Oxygen sensor (UHEGO) and Heated Exhaust Gas Oxygen sensor (HEGO)
15	-	Generator
16	-	ECM
17	-	EGR valve/ differential pressure sensor
18	-	Clock spring
19	-	Cruise control switches
20	-	Electric throttle body

GENERAL

The V6 4.0 Liter engine is controlled by a Engine Control Module (ECM) manufactured by DENSO. The Engine Management System (EMS) controls the following:

- Engine fuelling
- Ignition timing
- Closed loop fuelling
- Knock control
- Idle speed control
- Emission control
- On Board Diagnostic
- Interface with the immobilisation system
- Cruise control

ENGINE CONTROL MODULE (ECM)


E42610

The ECM is located in the E-Box in the plenum area on the passenger side of the engine compartment attached to the bulkhead.

Inputs

The ECM has the following inputs:

- Central Junction Box
- Engine Coolant Temperature
- Brake Switch
- Manifold Absolute Pressure
- Accelerator Pedal Position 1
- Accelerator Pedal Position 2
- Throttle Position 1
- Throttle Position 2

- Engine cooling fan Speed
- Engine speed and position sensor (crankshaft sensor)
- Camshaft position sensor
- Engine Oil Temperature
- Inlet Air Temperature sensor (integrated into MAF)
- Mass Air Flow sensor (MAF)
- Knock sensors (2)
- Cruise Control Switches (resistive ladders)
- Oxygen sensors (4)
- Vehicle Speed (via CAN)
- EGR Differential Pressure
- EGR MAP
- Generator Monitor

Outputs

The ECM outputs to the following:

- Throttle Actuator
- Ignition coils (6)
- Oxygen sensor heaters (4)
- Fuel injectors (6)
- EGR Valve
- Inlet Manifold Tuning Valve (IMTV)
- Purge Valve
- Fuel pump relay
- Starter Relay
- Air conditioning condenser fan module (CAN)
- EMS Main Relay
- Viscous Fan Control
- Generator Control

The ECM controls the engine fuelling by providing sequential fuel injection to all cylinders. Ignition is controlled by a direct ignition system, provided by six plug top coils. The ECM is able to detect and correct for ignition knock on each cylinder and adjust the ignition timing for each cylinder to achieve optimum performance.

The ECM uses a torque-based strategy to generate the torque required by the driver and other vehicle ECU's. The EMS uses various sensors to determine the torque required from the engine. These include:

- Mass Air Flow meter
- Accelerator Pedal Position sensor
- Engine temperatures
- Oxygen sensors

The EMS processes these signals and decides how much torque to generate. Torque is then generated by using various actuators to supply air, fuel and spark to the engine (electronic throttle, injectors, coils, etc.)The EMS also interfaces with other vehicle ECU's, via CAN, to obtain additional information, these include

- ABS control module
- TCM
- Transfer box control module

Pin No	Description	Input/Output
1	CAN	Input/Output
2	CAN	Input/Output
3	Generator monitor	Input
4	UHEGO Bank A ground	-
5	UHEGO Bank B ground	-
6	Crank sensor -	Input
7	Cam sensor ground	-

8	NC	-
9	NC	-
10	Sensor ground 3	-
11	Sensor ground 4	-
12	Sensor ground 5	-
13	NC	-
14	Spare ground	-
15	Sensor ground 6	-
16	NC	-
17	NC	-
18	MAF ground	-
19	Knock sensor bank A ground	-
20	Knock sensor bank B ground	-
21	NC	-
22	NC	-
23	Oil temperature sensor	Input
24	Sensor power 6	Output
25	LIN A	Output
26	UHEGO B +	Input
27	UHEGO B -	-
28	UHEGO A +	+
29	UHEGO A -	-
30	Crank sensor +	Input
31	NC	-
32	NC	-
33	NC	-
34	CMP signal bank A	Input
35	NC	-
36	NC	-
37	NC	-
38	Differential pressure sensor	Input
39	NC	-
40	Fuel pressure sensor	Input
41	NC	-
42	Knock sensor A +	Input
43	Knock sensor B +	Input
44	NC	-
45	NC	-
46	Fuel temperature sensor	Input
47	Sensor power 5	Output
48	Sensor power 4	Output
49	NC	-
50	NC	-
51	NC	-
52	NC	-
53	NC	-

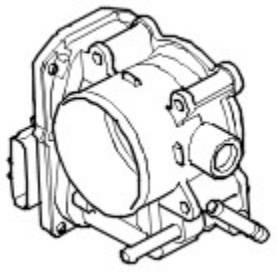
54	NC	-
55	NC	-
56	Ignition coil cylinder 3 B	Output
57	Ignition coil cylinder 3 A	Output
58	Ignition coil cylinder 2 B	Output
59	Ignition coil cylinder 2 A	Output
60	Ignition coil cylinder 1 B	Output
61	Ignition coil cylinder 1 A	Output
62	Ignition coil ground bank A	-
63	Viscous fan monitor	Input
64	Ignition coil ground bank B	-
65	Throttle position sensor 1	-I
66	Air temperature sensor	Input
67	Throttle position sensor 2	Input
68	Coolant temperature sensor	Input
69	MAP	Input
70	MAF	Input
71	NC	-
72	Sensor power 3	Output
73	NC	-
74	Throttle valve open direction -	Output
75	Throttle valve open direction +	Output
76	UHEGO Heater bank A	Output
77	UHEGO Heater bank B	Output
78	Injector cylinder 1 B	Output
79	Injector cylinder 1 B	Output
80	Injector cylinder 2 A	Output
81	Injector cylinder 2 B	Output
82	Injector cylinder 3 A	Output
83	Injector cylinder 3 B	Output
84	Inlet manifold tuning valve 1	Output
85	NC	-
86	NC	Output
87	NC	Output
88	NC	Output
89	NC	-
90	EGR	Input
91	NC	-
92	Purge valve	Output
93	Viscous fan request	Output
95	Fuel pump relay	Output
96	Alternator control	Output

ECM Connector C0635 Pin Out Table

Pin No	Description	Input/Output

1	Signal ground 1	-
2	Power ground 1	-
3	Power ground 2	-
4	ECM power	Input
5	Power ground 3	-
6	APP sensor ground 1	-
7	APP sensor ground 2	-
8	NC	-
9	NC	-
10	NC	-
11	NC	-
12	Park/ Neutral signal	Input
13	NC	-
14	NC	-
15	NC	-
16	EMS relay	Output
17	Crank request	Output
18	CAN +	Output
19	APP sensor 2 power	Output
20	Fuel pump control	Output
21	NC	-
22	NC	-
23	NC	-
24	APP sensor 1 signal	Output
25		
26	Brake light switch	Input
27	NC	-
28	NC	-
29	NC	-
30	Ignition switch	Input
31	CAN +	Input
32	APP sensor 1 power	Output
33	DMTL	Output
34	NC	-
35	Cruise switch -	Output

ELECTRONIC THROTTLE



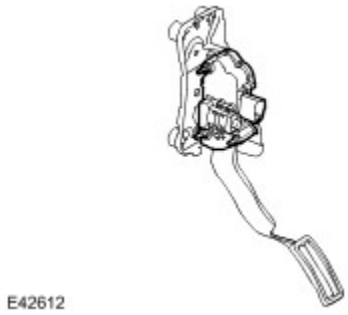
E42611

The V6 engine torque is regulated via an electronic throttle body which is located on the intake manifold in the engine compartment. An Accelerator Pedal Position sensor (APP) determines the driver demand to control throttle opening. This value is input into the EMS and the throttle is opened to the correct angle by means of an electric motor integrated into the throttle body. Sensors in the throttle body are used to determine the position of the throttle plate and the rate of change in its angle. A software strategy within the ECM enables the throttle position to be calibrated each ignition cycle. When the ignition is turned 'ON', the ECM opens and closes the throttle fully, thus performing a self-diagnostic and calibration. The throttle body is connected to the ECM via a pair of twisted wires to avoid electrical interference. For additional information, refer to Acceleration Control (310-02A Acceleration Control - 4.0L)

C0175 Electronic Throttle Pin Out Table

Pin No	Description	Input/Output
1	Signal 1	Output
2	5 volt supply	Input
3	Signal 2	Output
4	Ground	-
5	Actuator +	Input
6	Actuator -	-

ACCELERATOR PEDAL POSITION SENSOR (APP)



The Accelerator Pedal Position Sensor (APP) is used in conjunction with the Electronic Throttle Body to provide a drive-by-wire system. The sensor is a resistive type. Sensors in the accelerator pedal are used to determine the driver's request for vehicle speed, acceleration and deceleration. This value is input into the EMS and the throttle is opened to the correct angle by means of an electric motor integrated into the throttle body.

The APP sensor signals are checked for range, and for plausibility. Two separate reference voltages are supplied to the pedal. If one sensor fails, the other can be used as a 'limp – home' input.

The wires that connect the ground and signal from both potentiometers to the EMS are twisted together into two pairs, avoiding having to use a screen wire.

If signal failure occurs, the ECM enters limp home mode. The APP Sensor is located at the accelerator pedal .

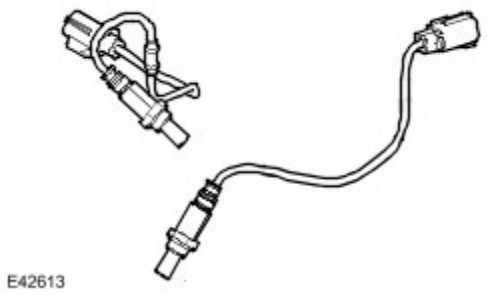
C0787 APP Sensor Connector Pin Out Table

Pin No	Description	Input/Output
1	Sensor 2 ground	-
2	Sensor 1 demand	Output
3	Sensor 1 ground	-
4	NC	-
5	Sensor 2 demand	Output

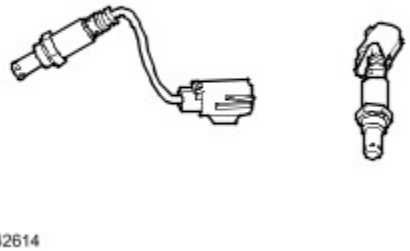
6	Supply 2 5 volt	Input
7	Supply 1 5 volt	Input
8	NC	-

OXYGEN SENSORS

Oxygen Sensor-Upstream



Oxygen Sensor-Downstream



There are four oxygen sensors located in the exhaust system. Two upstream (UHEGO) before the catalytic converter and two down stream (HEGO) after the catalytic converter. The sensors monitor the level of oxygen in the exhaust gases and is used to control the fuel/air mixture. Positioning a sensor in the stream of exhaust gasses from each bank enables the ECM to control the fuelling on each bank independently of the other, allowing much closer control of the air / fuel ratio and catalyst conversion efficiency.

The Oxygen Sensor needs to operate at high temperatures in order to function correctly. To achieve the high temperatures required, the sensors are fitted with heater elements that are controlled by a PWM signal from the ECM. The heater elements are operated immediately following engine start and also during low load conditions when the temperature of the exhaust gases is insufficient to maintain the required sensor temperatures. A non-functioning heater delays the sensor’s readiness for closed loop control and influences emissions. The PWM duty cycle is carefully controlled to prevent thermal shock to cold sensors.

UHEGO (Universal Heated Exhaust Gas Oxygen) sensors also known as Linear or "Wide Band" sensors produces a constant voltage, with a variable current that is proportional to the oxygen content. This allows closed loop fuelling control to a target lambda, i.e. during engine warm up (after the sensor has reached operating temperature and is ready for operation). This improves emission control.

The HEGO sensor uses Zirconium technology that produces an output voltage dependant upon the ratio of exhaust gas oxygen to the ambient oxygen. The device contains a Galvanic cell surrounded by a gas permeable ceramic, the voltage of which depends upon the level of O2 defusing through. Nominal output voltage of the device for l =1 is 300 to 500m volts. As the fuel mixture becomes richer (l<1) the voltage tends towards 900m volts and as it becomes leaner (l>1) the voltage tends towards 0 volts. Maximum tip temperature is 1,000 Degrees Celsius for a maximum of 100 hours.

Sensors age with mileage, increasing their response time to switch from rich to lean and lean to rich. This increase in response time influences the ECM closed loop control and leads to progressively increased emissions. Measuring the

period of rich to lean and lean to rich switching monitors the response rate of the upstream sensors.

Diagnosis of electrical faults is continually monitored in both the upstream and downstream sensors. This is achieved by checking the signal against maximum and minimum threshold, for open and short circuit conditions.

Oxygen sensors must be treated with the utmost care before and during the fitting process. The sensors have ceramic material within them that can easily crack if dropped / banged or over-torqued. The sensors must be torqued to the required figure, (40-50Nm), with a calibrated torque wrench. Care should be taken not to contaminate the sensor tip when anti-seize compound is used on the thread.

Failure Modes

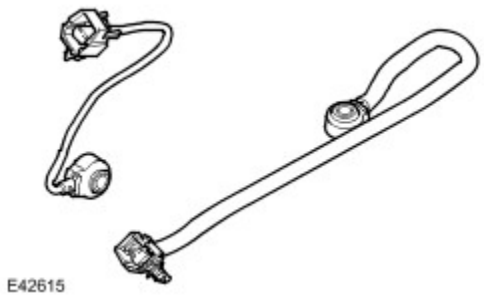
- Mechanical fitting & integrity of the sensor.
- Sensor open circuit / disconnected.
- Short circuit to vehicle supply or ground.
- Lambda ratio outside operating band.
- Crossed sensors Bank A & B.
- Contamination from leaded fuel or other sources.
- Change in sensor characteristic.
- Harness damage.
- Air leak into exhaust system.

Failure Symptoms

- Default to Open Loop fuelling for the particular cylinder bank
- High CO reading.
- Strong smell of H2S (rotten eggs) till default condition.
- Excess Emissions.

It is possible to fit front and rear sensors in their opposite location. However the harness connections are of different gender and colour to ensure that the senors cannot be incorrectly connected. In addition to this the upstream sensors have two holes in the sensor tip, whereas the down stream sensors have four holes in the sensor tip for the gas to pass through.

KNOCK SENSORS



The ECM uses active knock control, which serves to prevent engine damaging pre-ignition or detonation under all operating conditions enabling the engine to operate without additional safety margins. For the ECM to be able to determine the point at which a cylinder is pre-detonating, 2 piezo-ceramic sensors are mounted on the engine block. Each sensor monitors engine knock by converting the engine block noise into a suitable electrical signal, which is then transmitted back to the ECM via a twisted pair cable. The signal is then processed within the ECM to identify the data that characterises knocking.

This information is compared to known signal profiles to determine whether knock is present. If so, the closed loop control system then retards the ignition on that cylinder, for a number of cycles, after which it gradually moves back towards its original setting.

Failure Symptoms

The following describes the failure symptoms of the knock sensors:

- Knock control disabled and a default “safe ignition map” are used.
- Possible rough running and reduced engine performance.

One sensor is located in the centre of the engine valley and the other is located on the front RH side of the cylinder block.

CRANKSHAFT SPEED AND POSITION SENSOR

E42616

The Crankshaft Position Sensor (CKP) is located on the top of the transmission bell housing just to the left of the centre line with the sensor tip adjacent to the flywheel rim. The sensor is a variable reluctance type with a resistance of 1100 Ohms +- 150 Ohms.

The sensor produces the signal which enables the ECM to determine the angle of the crankshaft, and the engine RPM. From this, the point of ignition, fuel injection, etc. is calculated. If the signal wires are reversed a 3° advance in timing will occur, as the ECM uses the falling edge of the signal waveform as its reference / timing point for each tooth.

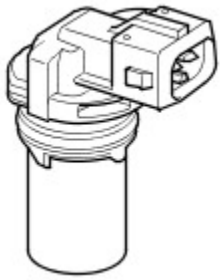
The sensor picks up its signal from a reluctor ring machined into the diameter of the drive plate. The reluctor ring has 36 teeth at 10° intervals and 3° wide. One of the teeth is removed to provide a reference mark which is 60 degrees BTDC No.1 cylinder.

The sensor operates by generating an output voltage caused by the change in magnetic field that occurs as the teeth pass in front of the sensor. The output voltage varies with the speed of the teeth passing the sensor. The higher the engine speed, the higher the output voltage.

The ECM transmits the engine speed over the CAN bus.

If the CKP sensor fails while the engine is running the engine will stall, misfire or run poorly and a relevant fault code will be stored. If the engine is not running when a fault occurs then the engine will not start.

CAMSHAFT POSITION SENSOR (CMP)

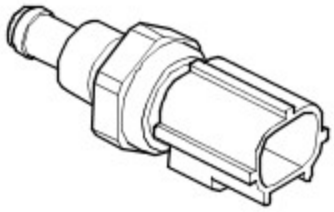


E42617

The Camshaft Position Sensor (CMP) is a variable reluctance type sensor located at the front of the engine in the valve cover above number 4 cylinder.

The CMP sensor produces one pulse for every two engine revolutions. The sensor picks up on a reluctor on the LH camshaft.

ENGINE COOLANT TEMPERATURE SENSOR



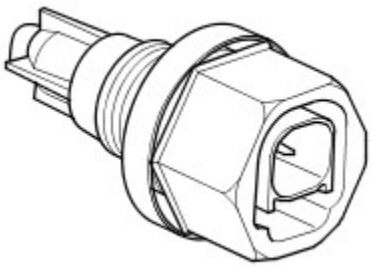
E42618

The Engine Coolant Temperature sensor (ECT) is a Negative Temperature Coefficient (NTC) type sensor. As coolant temperature rises the resistance of the sensor falls.

The sensor is located at the front of the engine behind and below the throttle body.

Should the sensor fail the ECM use the oil temperature sensor signal as a backup coolant temperature signal.

ENGINE OIL TEMPERATURE SENSOR

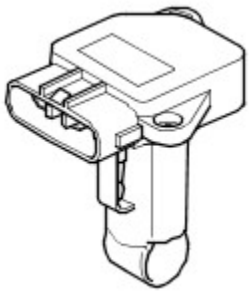


E42632

Oil temperature is monitored through a level sensor mounted in the engine sump.

The sensor operates in the range -40 TO 150 degrees Celsius.

MASS AIR FLOW /INLET AIR TEMPERATURE SENSOR (MAF/IAT)



E42634

The MAF and IAT sensor is located in the air duct between the air filter and throttle body.

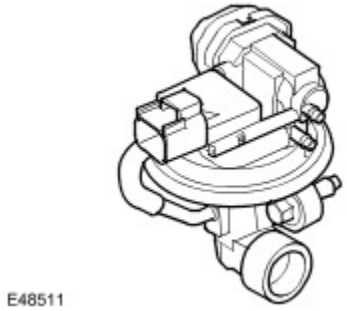
The air mass flow is determined by the cooling effect of inlet air passing over a “hot film” element contained within the device. The higher the air flow the greater the cooling effect and the lower the electrical resistance of the element. The signal from the device is then calculated by the ECM to determine the Air Mass Flow into the engine.

The measured air mass flow is used in determining the fuel quantity to be injected in order to maintain the stichometric air/fuel mixture required for correct operation of the engine and exhaust catalysts. Should the device fail there is a software backup strategy that will be evoked once a fault has been diagnosed.

The Inlet Air Temperature (IAT) sensor is integrated into the Mass Air Flow meter. It is a temperature dependent resistor (thermistor), i.e. the resistance of the sensor varies with temperature. This thermistor is a negative temperature coefficient (NTC) type element meaning that the sensor resistance decreases as the sensor temperature increases. The sensor forms part of a voltage divider chain with an additional resistor in the ECM. The voltage from this network changes as the sensor resistance changes, thus relating the air temperature to the voltage measured by the ECM.

The fixed default value for air temperature is 35°C

MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR


E48511

The MAP sensor provides a voltage proportional to the absolute pressure in the intake manifold.

This signal allows the load on the engine to be calculated and used within the internal calculations of the ECM.

The sensor is located in the EGR valve at the front LH side of the engine.

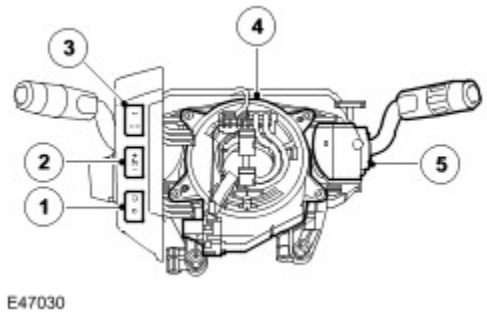
DIFFERENTIAL PRESSURE FEEDBACK-ELECTRONIC/MANIFOLD ABSOLUTE PRESSURE SENSOR (DPFE/MAP)

This pressure transducer monitors the pressure differential on either side of an orifice in the EGR system flow path and transmits that information to the ECM. The pressure drop measured across this orifice is used to estimate the flow rate of recirculated exhaust gas. An Electronic Vacuum Regulator (EVR) is used to control the vacuum signal to the EGR valve based on the electrical signal from the ECM. The ECM monitors the EGR level based on the feedback from the DPFE/MAP transducer, which creates a closed loop system.

EXHAUST GAS RETICULATION VALVE (EGR)

The EGR (exhaust gas recirculation) Valve is a PWM controlled valve that allows burned exhaust gas to be recirculated back into the engine. Since exhaust gas has much less oxygen than air, it is basically inert. It takes the place of air in the cylinder and reduces combustion temperature. As the combustion temperature is reduced, so are the oxides of nitrogen (NOx) emissions.

CRUISE CONTROL SWITCHES



E47030

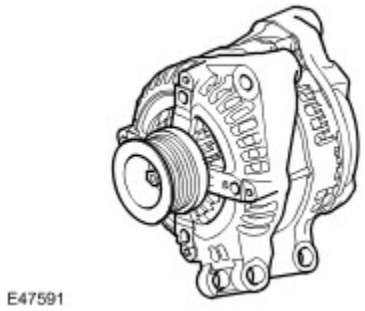
Item	Part Number	Description

1		On/Suspend/Off Switch
2		Resume/Accelerate/Decelerate (+/–) Switches
3		Active cruise control time gap switches (for future release)
4		Clock spring
5		Wiper control column switch

The V6 ECM incorporates a cruise control function. Active Cruise Control (ACC) is also an option. The EMS uses a set of resistive ladders to interface with the driver cruise control requirements. The cruise control is operated from the steering wheel mounted switches. There are three illuminated rocker switches on a resistive ladder. For additional information, refer to Speed Control (310-03A Speed Control)

The cruise control does not have a master switch, it is enabled by pressing the set switch.

GENERATOR


E47591

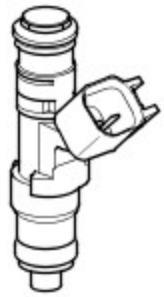
The Generator has a multi function voltage regulator for use in a 14V charging system with 6÷12 zener diode bridge rectifiers.

The ECM monitors the load on the electrical system via PWM signal and adjusts the generator output to match the required load. The ECM also monitors the battery temperature to determine the generator regulator set point. This characteristic is necessary to protect the battery; at low temperatures battery charge acceptance is very poor so the voltage needs to be high to maximise any recharge ability, but at high temperatures the charge voltage must be restricted to prevent excessive gassing of the battery with consequent water loss. For additional information, refer to Generator (414-02A Generator and Regulator - 4.0L)

The Generator has a smart charge capability that will reduce the electrical load on the Generator reducing torque requirements, this is implemented to utilise the engine torque for other purposes. This is achieved by monitoring three signals to the ECM:

- Generator sense (A sense), measures the battery voltage at the CJB.
- Generator communication (Alt Com) communicates desired Generator voltage set point from ECM to Generator.
- Generator monitor (Alt Mon) communicates the extent of Generator current draw to ECM. This signal also transmits faults to the ECM which will then sends a message to the instrument pack on the CAN bus to illuminate the charge warning lamp.

FUEL INJECTORS



E42640

The ECM controls six fuel injectors located on the cylinder head. The injectors are fed from a common fuel rail as part of a ‘return less’ fuel system.

Fuel rail pressure is constant at 4.5 bar (59 psi) and is regulated by a regulator that is integral to the fuel pump module. The ECM monitors the output power stages of the injector drivers for electrical faults. The injector has a default resistance of 14.5 Ohms at 20 Degrees Celsius. For additional information, refer to Fuel Charging and Controls (303-04A Fuel Charging and Controls - 4.0L)

SPARK PLUGS

It is essential that only factory-approved spark plugs be used in service. DO NOT attempt to use ‘equivalent’ spark plugs. Use of unapproved spark plugs may cause the misfire detection system to malfunction, and the ECM to store misfire faults.

IGNITION COILS

E42644

The Land Rover V6 engine is fitted with ignition coils that are driven directly by the ECM. The coils are mounted on top of the inlet manifold and are connected to the spark plugs by High Tension (HT) leads. The positive supply to the coil is fed from fuse 19 in the Battery Junction Box (BJB). Each coil contains a power stage to trigger the primary current. The ECM sends a signal to each of the coils power stage to trigger the power stage switching. Each bank has a feedback signal that is connected to each power stage. If the coil power stage fails the feedback signal is not sent, causing the ECM to store a fault code.

FUEL PUMP RELAY

The V6 engine has a return less fuel system. The system pressure is maintained at a constant 4.5 bar , with no reference to intake manifold pressure. The fuel is supplied to the injectors from a fuel pump located within the fuel tank. The electrical supply to this fuel pump is controlled by the ECM via the fuel pump relay, in the event of a vehicle impact the ECM will receive a crash signal from the restraints control module and will cut the power supply to the fuel pump relay. The fuel system is pressurised as soon as the ECM is powered up, the pump is then switched off until engine start has been achieved.

The fuel pump relay is located in the Central Junction Box (CJB). The Fuel pump is contained within the fuel tank. For additional information, refer to Fuel Tank and Lines (310-01A Fuel Tank and Lines - 4.0L)

VISCOUS FAN CONTROL

The ECM controls an electronically controlled viscous coupled fan to provide engine cooling. The ECM supplies the fan with a PWM signal that controls the amount of slippage of the fan, thus providing the correct amount of cooling fan speed and airflow. The EMS uses a Hall Effect sensor to determine the fan speed.

STARTER RELAY

The starter relay is supplied with power from fuseable link 19 in the Battery Junction Box.

The ECM controls the starter relay by supplying a 12 volt signal to the relay coil when the ignition is in crank position. This relies on the transmission gear position being either P or N.

CONDENSER FAN CONTROL

The ECM receives CAN messages from the ATC control module for idle speed adjustment and for cooling fan.

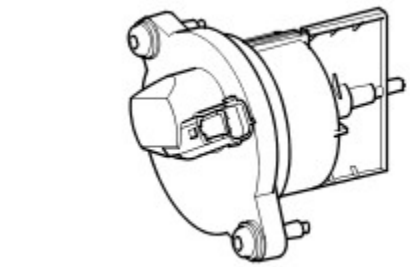
AirConCoolingRequest

This signal defines the level of cooling (from engine cooling fan(s)) required by the ATC system. Calibration within the EMS determines the fan speed required, and which fans will be used, at each requested level.

AirConIdleSpeedRequest

This signal defines whether or not an increase in the engine idle speed is required by the ATC system. The amount of idle speed increase is defined in the EMS calibration.

INTAKE MANIFOLD TUNING VALVE (IMTV)


E42646

The Intake Manifold Tuning Valve (IMTV) moves a plate within the inlet manifold to allow or block sonic pulses between the split manifold halves. This, in effect, extends the inlet tracts for better low rpm torque. The IMTV is a two position valve and is either fully open or fully closed. For additional information, refer to Intake Air Distribution and Filtering (303-12A Intake Air Distribution and Filtering - 4.0L)

ECM ADAPTIONS

The ECM has the ability to adapt the values it uses to control certain outputs. This capability ensures the EMS can meet emissions legislation and improve the refinement of the engine throughout its operating range.

The components which have adaptions associated with them are:

- The APP sensor
- The HO2S
- The MAF/IAT sensor
- The CKP sensor
- Electric throttle body.

UHEGO/HEGO and MAF/IAT Sensor

There are several adaptive maps associated with the fuelling strategy. Within the fuelling strategy the ECM calculates short-term adaptions and long term adaptions. The ECM will monitor the deterioration of the HO2S over a period of time. It will also monitor the current correction associated with the sensors.

The ECM will store a fault code in circumstances where an adaption is forced to exceed its operating parameters. At the same time, the ECM will record the engine speed, engine load and intake air temperature.

CKP Sensor

The characteristics of the signal supplied by the CKP sensor are learned by the ECM. This enables the ECM to set an adaption and support the engine misfire detection function. Due to the small variation between different flywheels and different CKP sensors, the adaption must be reset if either component is renewed, or removed and refitted. It is also necessary to reset the flywheel adaption if the ECM is renewed or replaced. The ECM supports four flywheel adaptions for the CKP sensor. Each adaption relates to a specific engine speed range. The engine speed ranges are detailed in the table below:

Adaptions	Engine Speed, rev/min
1	1800 - 3000
2	3001 - 3800
3	3801 - 4600
4	4601 - 5400

Misfire Detection

Legislation requires that the ECM must be able to detect the presence of an engine misfire. It must be able to detect misfires at two separate levels. The first level is a misfire that could lead to the vehicle emissions exceeding 1.5 times the Federal Test Procedure (FTP) requirements for the engine. The second level is a misfire that may cause catalyst damage.

The ECM monitors the number of misfire occurrences within two engine speed ranges. If the ECM detects more than a predetermined number of misfire occurrences within either of these two ranges, over two consecutive journeys, the ECM will record a fault code and details of the engine speed, engine load and engine coolant temperature. In addition, the ECM monitors the number of misfire occurrences that happen in a 'window' of 200 engine revolutions. The misfire occurrences are assigned a weighting according to their likely impact on the catalysts. If the number of misfires exceeds a certain value, the ECM stores catalyst-damaging fault codes, along with the engine speed, engine load and engine coolant temperature.

The signal from the crankshaft position sensor indicates how fast the poles on the flywheel are passing the sensor tip. A sine wave is generated each time a pole passes the sensor tip. The ECM can detect variations in flywheel speed by monitoring the sine wave signal supplied by the crankshaft position sensor.

By assessing this signal, the ECM can detect the presence of an engine misfire. At this time, the ECM will assess the amount of variation in the signal received from the crankshaft position sensor and assigns a roughness value to it. This roughness value can be viewed within the real time monitoring feature, using T4. The ECM will evaluate the signal against a number of factors and will decide whether to count the occurrence or ignore it. The ECM can assign a roughness and misfire signal for each cylinder, (i.e. identify which cylinder is misfiring).

T4 Diagnostics

The ECM stores faults as Diagnostic Trouble Codes (DTC), referred to as 'P' codes. The 'P' codes are defined by OBD legislation and, together with their associated environmental and freeze frame data, can be read using a third party scan tool or T4. T4 can also read real time data from each sensor, the adaptive values currently being employed and the current fuelling, ignition and idle settings.

P Code No	Component/ Signal	Fault Description
P0011	CMP/CKP/VVT	Bank A CMP/CKP Position error high , VVT retard position

		high
P0012	CMP/CKP/VVT	Bank A CMP/CKP Position error low, VVT retard position low
P0021	CMP/CKP/VVT	Bank B CMP/CKP Position error, VVT retard position high
P0022	CMP/CKP/VVT	Bank B CMP/CKP Position error low , VVT retard position low
P0026	VVT	Bank A circuit malfunction range high/ low
P0028	VVT	Bank B circuit malfunction range high/ low
P0031	UHEGO	Bank A heater control circuit low
P0032	UHEGO	Bank A heater control circuit high
P0051	UHEGO	Bank B heater control circuit low
P0052	UHEGO	Bank B heater control circuit high
P0069	HAC	Sensor circuit/range performance
P0071	Ambient air temperature sensor	Range performance
P0072	Ambient air temperature sensor	Circuit low input
P0073	Ambient air temperature sensor	Circuit high input
P0075	VVT	Bank A open circuit
P0076	VVT	Bank A short to ground
P0077	VVT	Bank A short to battery
P0081	VVT	Bank B open circuit
P0082	VVT	Bank B short to ground
P0083	VVT	Bank B short to battery
P0087	Fuel pressure system	Low fault
P0088	Fuel pressure system	High fault
P0089	Fuel pressure system	Noise fault
P0093	Fuel pressure system	Large leak
P0096	IAT	Sensor range performance
P0101	AFM	Circuit range performance
P102	AFM	Circuit low input
P103	AFM	Circuit high input
P0106	MAP	Sensor range performance
P0107	MAP	Circuit low input
P0108	MAP	Circuit high input
P0111	IAT	Stuck high/ low at engine start, stuck high
P0112	IAT	Sensor 1 circuit low input
P0113	IAT	Sensor 1 circuit high input
P0116	ECT	Implausible signal
P0117	ECT	Circuit low input
P0118	ECT	Circuit high input
P0121	Throttle circuit 1 and 2	Range/ performance
P0122	Throttle circuit 1	Low input
P0123	Throttle circuit 1	High input
P0125	ECT	Insufficient coolant temperature for closed loop control
P0128	Thermostat monitor	Low coolant temperature – thermostat stuck open
P0131	UHEGO	Bank A short circuit to ground
P0132	UHEGO	Bank A Short circuit to battery
P0133	UHEGO	Bank A slow response
P0136	HEGO	Bank A adaptions

P0137	HEGO	Bank A short circuit to ground
P0138	HEGO	Bank A short circuit to battery
P0139	HEGO	Bank A slow response
P0140	HEGO	Bank A no activity
P0141	HEGO	Bank A heater control circuit malfunction
P0151	UHEGO	Bank B short circuit to ground
P0152	UHEGO	Bank B short circuit to battery
P0153	UHEGO	Bank B slow response
P0156	HEGO	Bank B adaptions
P0157	HEGO	Bank B short circuit to ground
P0158	HEGO	Bank B short circuit to battery
P0159	HEGO	Bank B slow response
P0160	HEGO	Bank B no activity
P0161	HEGO	Bank B heater control circuit malfunction
P00171	lambda control	Bank A too lean
P0172	lambda control	Bank A too rich
P0174	lambda control	Bank B too lean
P0175	lambda control	Bank B too rich
P0181	Fuel rail temperature sensor	Temperature signal implausible
P0182	Fuel rail temperature sensor	Circuit low input
P0183	Fuel rail temperature sensor	Circuit high input
P0191	Fuel rail pressure sensor	Range /performance
P0192	Fuel Rail Pressure Sensor	Low Input
P0193	Fuel Rail Pressure Sensor	High Input
P0196	Oil temperature sensor	Range/performance
P0197	Oil temperature sensor	Low input
P0198	Oil temperature sensor	High input
P0201	Injector Circuit	Malfunction - Cylinder 1
P0202	Injector Circuit	Malfunction - Cylinder 2
P0203	Injector Circuit	Malfunction - Cylinder 3
P0204	Injector Circuit	Malfunction - Cylinder 4
P0205	Injector Circuit	Malfunction - Cylinder 5
P0206	Injector Circuit	Malfunction - Cylinder 6
P0207	Injector Circuit	Malfunction - Cylinder 7
P0208	Injector Circuit	Malfunction - Cylinder 8
P0222	APP sensor 2	Low input
P0223	APP sensor 2	High input
P0227	APP sensor 1	Low input
P0228	APP sensor 1	High input
P0229	APP sensor	Intermittent fault
P0297	Active speed control	Vehicle over speed condition
P0300	Misfire	Random/ multiple cylinder misfire
P0301	Misfire	Cylinder 1
P0302	Misfire	Cylinder 2
P0303	Misfire	Cylinder 3
P0304	Misfire	Cylinder 4

P0305	Misfire	Cylinder 5
P0306	Misfire	Cylinder 6
P0307	Misfire	Cylinder 7
P0308	Misfire	Cylinder 8
P0313	Misfire	Misfire under low fuel condition
P0316	Misfire	Misfire detected in first 1000 revs
P0326	Knock sensor	Sensor 1 high/low performance error
P0327	Knock sensor	Bank A sensor low input fault
P0328	Knock sensor	Bank A high input fault
P0331	Knock sensor	Sensor 2 high/low performance error
P0332	Knock sensor	Bank B sensor low input fault
P0333	Knock sensor	Bank A high input fault
P0335	Crank sensor	Sensor circuit malfunction during crank/ running
P0336	Crank sensor	Range/performance fault
P0340	Intake CMP sensor bank A	Fault during cranking/running
P0341	Intake CMP sensor bank A	Range/performance fault
P0345	Intake CMP sensor bank B	Fault during cranking/running
P0346	Intake CMP sensor bank B	Range/performance fault
P0351	Ignition coil	Circuit malfunction cylinder 1
P0352	Ignition coil	Circuit malfunction cylinder 2
P0353	Ignition coil	Circuit malfunction cylinder 3
P0354	Ignition coil	Circuit malfunction cylinder 4
P0355	Ignition coil	Circuit malfunction cylinder 5
P0356	Ignition coil	Circuit malfunction cylinder 6
P0357	Ignition coil	Circuit malfunction cylinder 7
P0358	Ignition coil	Circuit malfunction cylinder 8
P0365	Exhaust CMP sensor bank A	Fault during cranking/running
P0366	Exhaust CMP sensor bank A	Range/performance fault
P0390	Exhaust CMP sensor bank B	Fault during cranking/running
P0391	Exhaust CMP sensor bank B	Range/performance fault
P0401	EGR system	Insufficient flow detected
P0403	EGR system	Valve circuit high/low input
P0405	Differential pressure sensor	Short to ground
P0406	Differential pressure sensor	Short to battery
P0409	Differential pressure sensor	Range performance
P0420	Catalyst system bank A	Efficiency below threshold
P0430	Catalyst system bank	Efficiency below threshold
P0441	Purge valve	Range performance
P0442	DMTL	Medium leak detected
P0447	DMTL	Short to ground
P0448	DMTL	Short to battery
P0455	DMTL	Large leak detected
P0456	DMTL	Small leak detected
P0458	Purge valve	Short to ground
P0459	Purge valve	Short to battery
P0461	Fuel level sensor	Range/performance fault

P0480	Radiator fan module	Control circuit malfunction
P0493	Viscous fan	Speed Out of range
P0501	Vehicle speed	Range/performance malfunction
P0504	Brake switch	Circuit malfunction
P0506	Idle Control System	RPM Lower Than Expected
P0507	Idle Control System	RPM higher Than Expected
P0512	Crank request circuit	High/low input
P0513	Security key	Key invalid
P0532	Air conditioning refrigerant pressure sensor	Low input
P0533	Air conditioning refrigerant pressure sensor	High input
P0560	Battery back up	Malfunction
P0562	Sensor power supply	Low input
P0563	Sensor power supply	High input
P0566	Cruise control cancel switch	ON fault
P0567	Cruise control resume switch	ON fault
P0568	Cruise control	Low/high input
P0569	Decelerate/set/inch switch	ON fault
P0570	Accelerate/set/inch switch	On fault
P0574	Cruise control	Speed monitoring
P0576	Cruise control	Low input
P0577	Cruise control	High input
P0604	ECM self test	RAM error
P0605	ECM self test	ROM error
P0606	ECM self test	Processor error
P0616	Starter relay	Low input
P0617	Starter relay	High input
P0627	Primary fuel pump	no commands received
P0628	Fuel pump	Electrical low
P0629	Fuel pump	Electrical high
P0633	Security	No ID in ECM
P0634	ECM temperature	Internal temperature too high
P0646	Air conditioning clutch relay	Low input
P0647	Air conditioning clutch relay	High input
P0661	Manifold valve output drive 1	Open circuit or short circuit to ground
P0662	Manifold valve output drive 1	Short circuit to battery
P0664	Manifold valve output drive 2	Open circuit or short circuit to ground
P0665	Manifold valve output drive 2	Short circuit to battery
P0668	ECM temperature sensor	Short to ground
P0669	ECM temperature sensor	Short to battery
P0687	EMS control relay	Relay malfunction
P0831	Clutch switch circuit A	Low input
P0832	Clutch switch circuit A	High input
P0834	Clutch switch circuit B	Low input
P0835	Clutch switch circuit B	High input
P0851	Park / Neutral Switch	Input Circuit Low

P0852	Park / Neutral Switch	Input Circuit High
P1136	E Box fan	Fan malfunction
P1146	Generator command line	Low input/ communication error
P1155	HEGO Heater bank A	
P1160	UHEGO Bank A	Slow activation
P1197	UHEGO Bank A	Slow activation/open shorted
P1198	UHEGO Bank B	Slow activation/open shorted
P1233	Secondary fuel pump	Output circuit open
P1234	Primary fuel pump	No commands received
P1236	Primary fuel pump	Pump not working when requested
P1244	Alternator command line	High input
P1260	Security limited start	Theft attempt
P1339	Secondary fuel pump	Driver circuit output low/high
P1367	Ignition coil bank A	
P1368	Ignition coil bank A	
P1452	DMTL	Reference current too low
P1453	DMTL	Reference current too high
P1482	DMTL heater control circuit	Low
P1483	DMTL heater control circuit	High
P1582	Flight recorder	Data stored
P1624	Security ID	ID transfer process failed
P1629	Generator	FR line failure
P1632	Generator	Charge system failure
P1646	UHEGO sensor bank A	Slow activation/ control module open shorted
P1647	UHEGO sensor bank B	Slow activation/ control module open shorted
P1670	E Box fan	Malfunction low
P1671	E Box fan	Malfunction high
P1697	Cruise control	Shorter/Longer switch ON fault
P1700	Low gear ratio	plausibility check
P2066	Secondary fuel pump	Range check
P2070	Manifold valve output drive 1	Performance check stuck open/closed
P2071	Manifold valve output drive 2	Performance check stuck open/closed
P2101	Electric throttle	Range performance
P2103	Electric throttle	Throttle duty at 100% continuously
P2105	Electric throttle	MIL request duel fuel cut off
P2106	Intended reduced availability	Re-configuration failure
P2118	Electric throttle system	Over current detection by hardware
P2119	Electric throttle	Throttle stuck open
P2122	APP sensor	Circuit 2 low input
P2123	App sensor	Circuit 2 high input
P2228	HAC sensor	Circuit low
P2229	HAC sensor	Circuit high
P2299	Accelerator pedal	Brake override
P2401	DMTL Pump	Ground short
P2402	DMTL Pump	Battery short
P2404	DMTL Pump	Noise/reference leak fault

P2450	DMTL	COV stuck open
P2451	DMTL	COV stuck closed
P2503	Charging system	Voltage low
P2504	Charging system	Voltage high
P2601	Water pump	Performance fault
P2610	Engine off timer	Timer malfunction
P2632	Secondary fuel pump driver circuit	Output circuit open
P2633	Secondary fuel pump driver circuit	Output low
P2634	Secondary fuel pump driver circuit	High input
P6365	Primary fuel pump	Pump not working when requested
P2636	Secondary fuel pump	Low flow/ performance

CENTRAL JUNCTION BOX

The Central Junction box is used to initiate the power up and power down routines within the ECM. When the ignition is turned on, 12V is applied to the Ignition Sense input to pin 30 of connector C0635. The ECM then starts its power up routines and turns on the ECM main relay.

When the ignition is turned OFF the ECM will maintain its powered up state for several seconds (this may be up to 20 minutes in extreme cases when cooling fans are required) while it initiates its power down routine and on completion will turn off the ECM main relay.

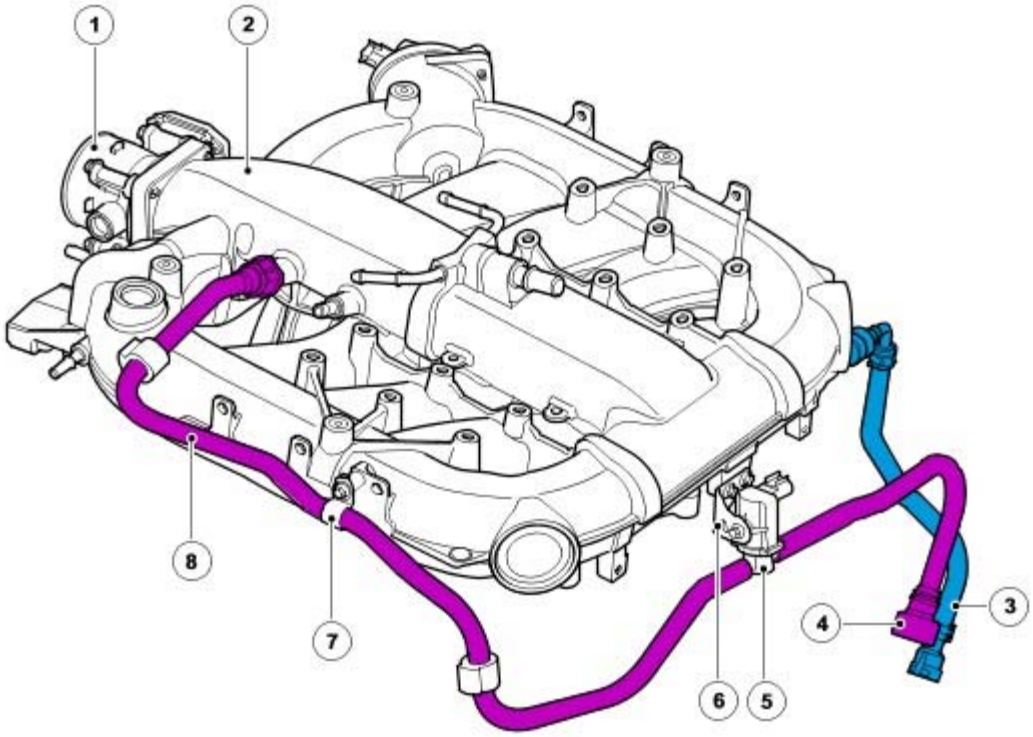
POWER SUPPLIES

The ECM requires a permanent battery level voltage supply and a switched battery level voltage supply. The switched voltage supply is controlled by the ECM via a relay based on the condition of the Central Junction Box input (key position 2).

At key "OFF", the ECM will maintain the switched supply active until internal self checks have been completed. The Main Supply fuse is located in the engine compartment fuse box.

PURGE VALVE

Purge Valve and Hoses



E44559

Item	Part Number	Description
1	-	Electric throttle
2	-	Air intake manifold
3	-	Fuel feed jump hose
4	-	Purge hose connector
5	-	Purge valve
6	-	Purge valve bracket
7	-	Hose clamp
8	-	Manifold to purge valve hose

To meet increasing legislation in fuel evaporative loss the Evaporative Emissions Loss Control System has been introduced to minimise the evaporative loss of fuel vapour from the fuel system to the atmosphere. This is achieved by venting the fuel system through a vapour trap (charcoal cannister). The charcoal acts like a sponge and stores the vapour until the canister is purged under the control of the ECM.

The charcoal canister is connected with the inlet manifold, after the throttle body, via a purge valve. This valve is opened and closed according to a PWM signal from the ECM. The canister is purged by drawing clean air through the charcoal, which carries the hydrocarbons into the engine where they are burnt. To maintain drivability and emission control purging must be closely controlled as a 1% concentration of fuel vapour from the canister in the air intake may shift the air/fuel ratio by as much as 20%. Purging must be carried out at regular intervals, to regenerate the charcoal, as its storage capacity is limited, and is cycled with the Fuelling Adaption, as both cannot be active at the same time.

The ECM alters the PWM signal to the purge valve to control the rate of purging of the canister. The purging of the canister is done in a controlled manner in order to maintain the correct stichometric air/fuel mixture for the engine. It also ensures the canister itself is purged frequently enough to prevent fuel saturation of the charcoal leading to an excessive build up of fuel vapour (and hence vapour pressure) in the system which could increase the likelihood of vapour leaks. For additional information, refer to Evaporative Emissions (303-13A Evaporative Emissions - 4.0L)