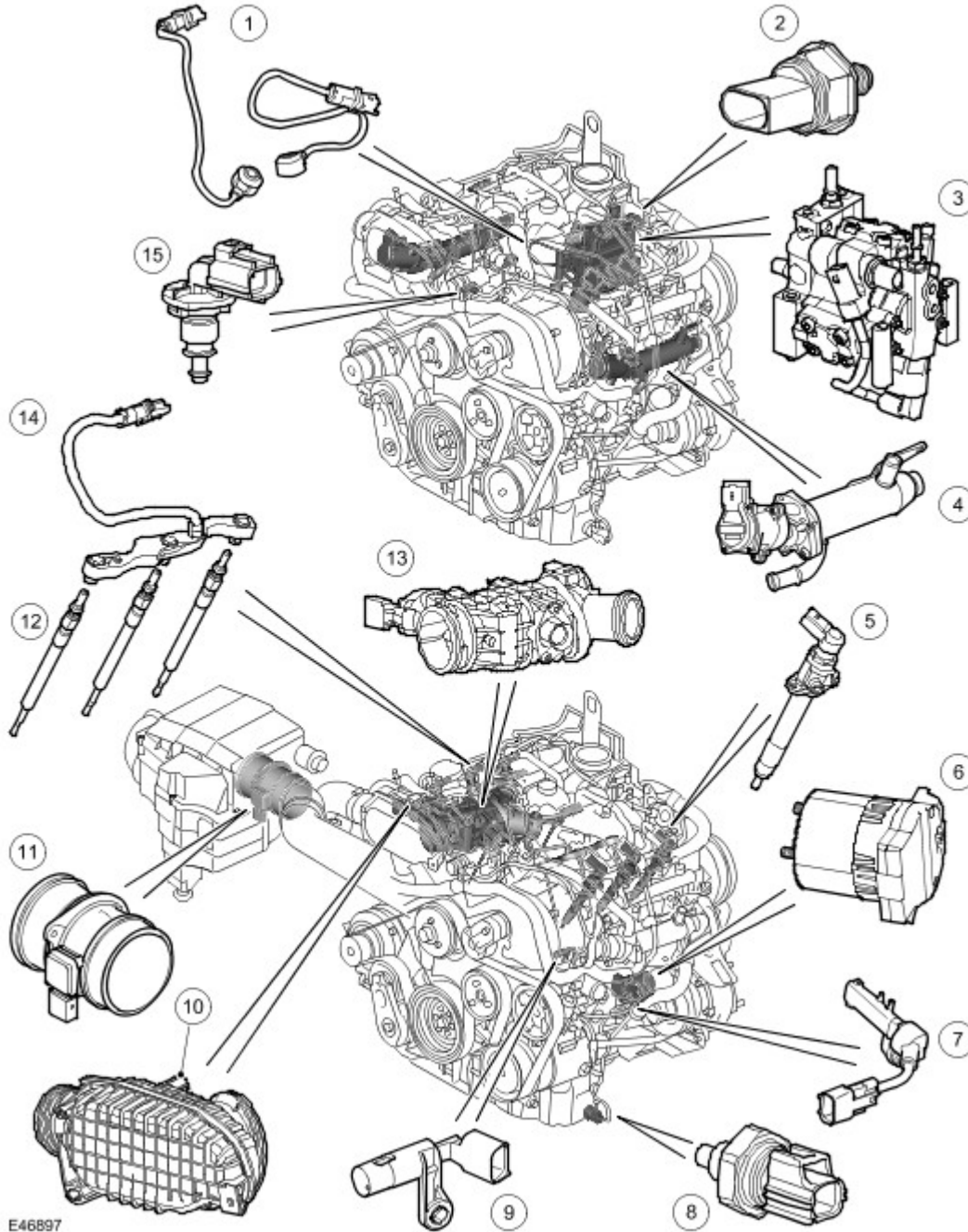


Electronic Engine Controls

TDV6 Engine Management Component Location Sheet 1 of 2

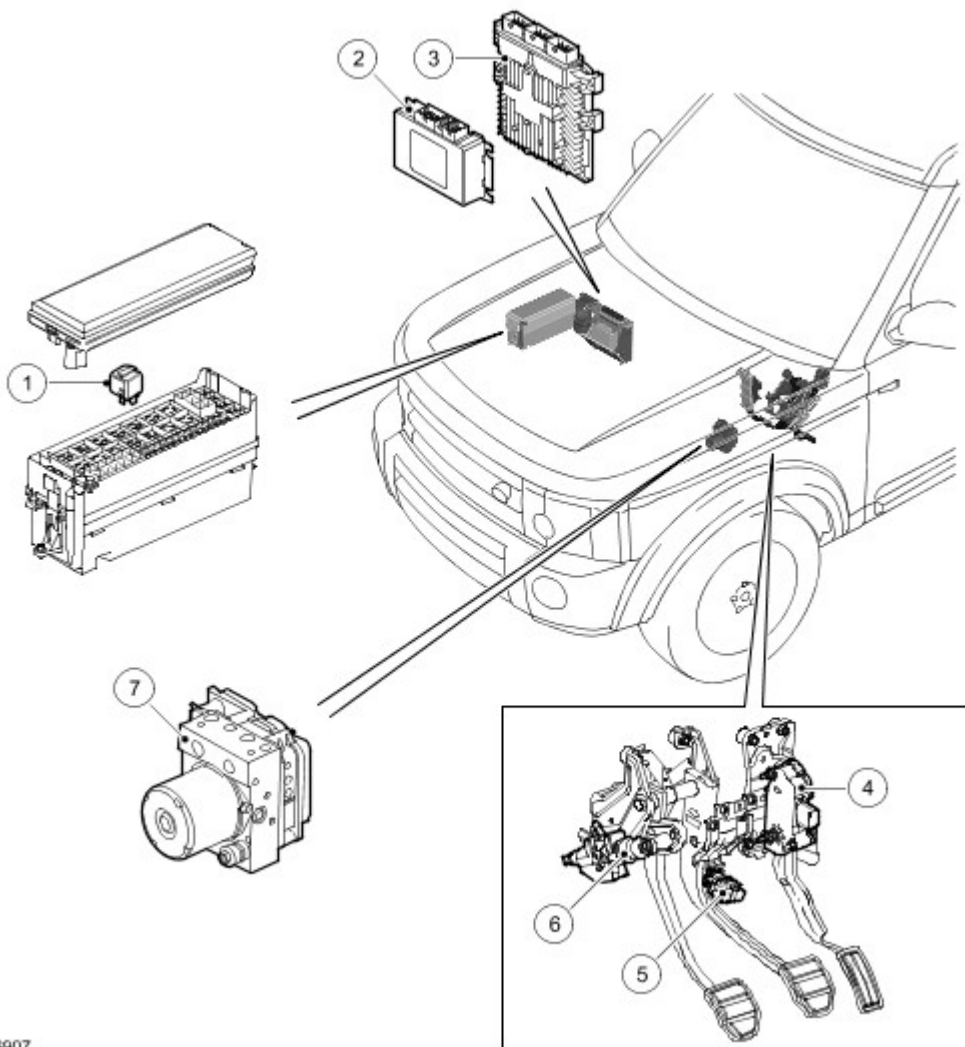


E46897

Item	Part Number	Description
1	-	Knock sensors
2		Fuel rail pressure sensor
3		High pressure fuel pump
4		EGR Valve/ cooler

5		Injector
6		Turbo boost pressure control
7		Crankshaft sensor
8		Oil temperature sensor
9		Camshaft position sensor
10		MAF/IAT
11		Air charge temperature sensor
12		Glow plugs
13		Electronic throttle incorporating MAP sensor
14		Glow plug wiring harness
15		Engine coolant temperature sensor

TDV6 Engine Management Component Location Sheet 2 of 2



E46907

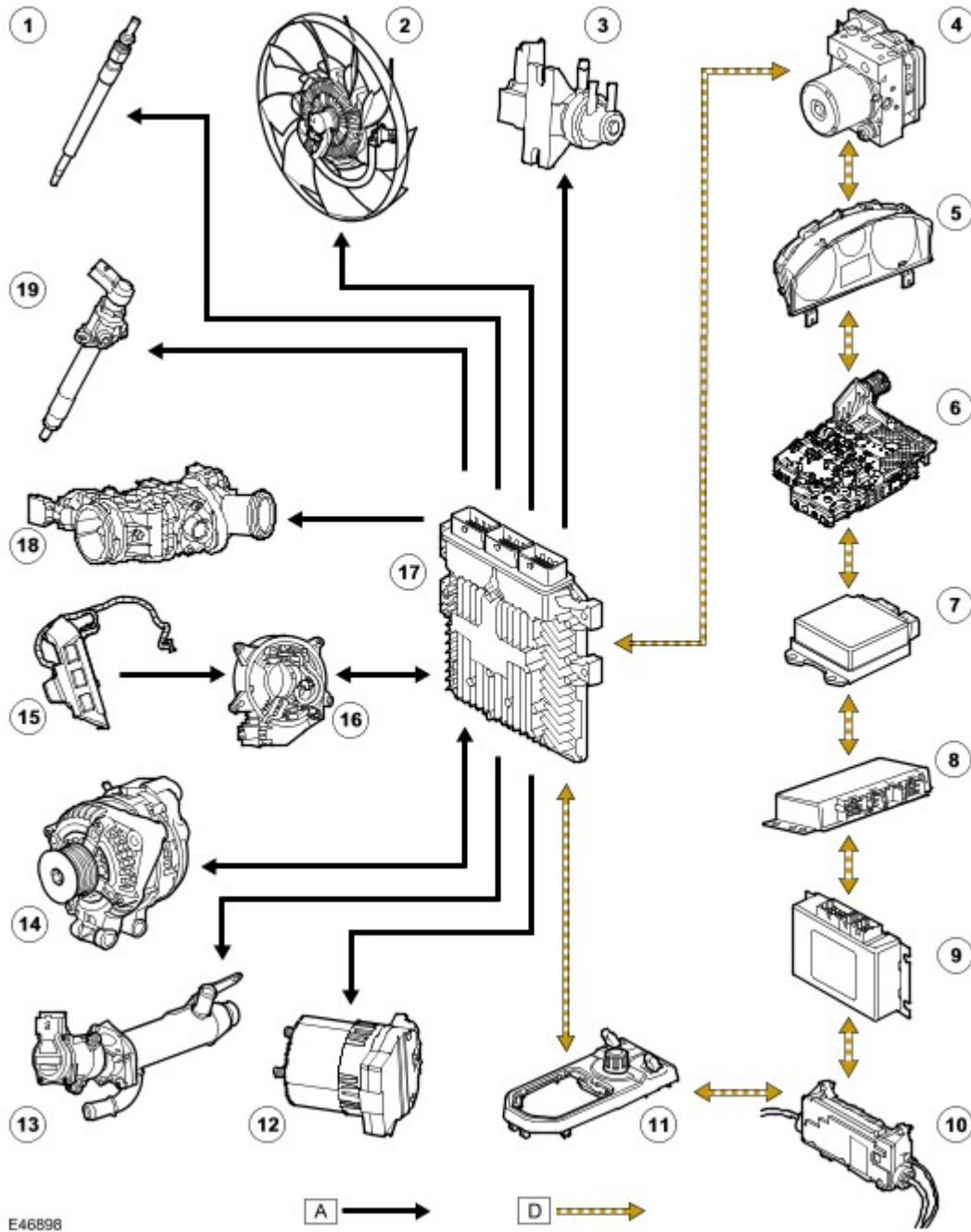
Item	Part Number	Description
1		Main relay
2		Transfer box control module
3		ECM

4		Accelerator pedal position sensor (APP)
5		Stop light switch
6		Clutch switch
7		ABS Control module

TDV6 Engine Management Control Diagram Sheet 1 of 2

NOTE :

A= Hardwired D= CAN



E46898

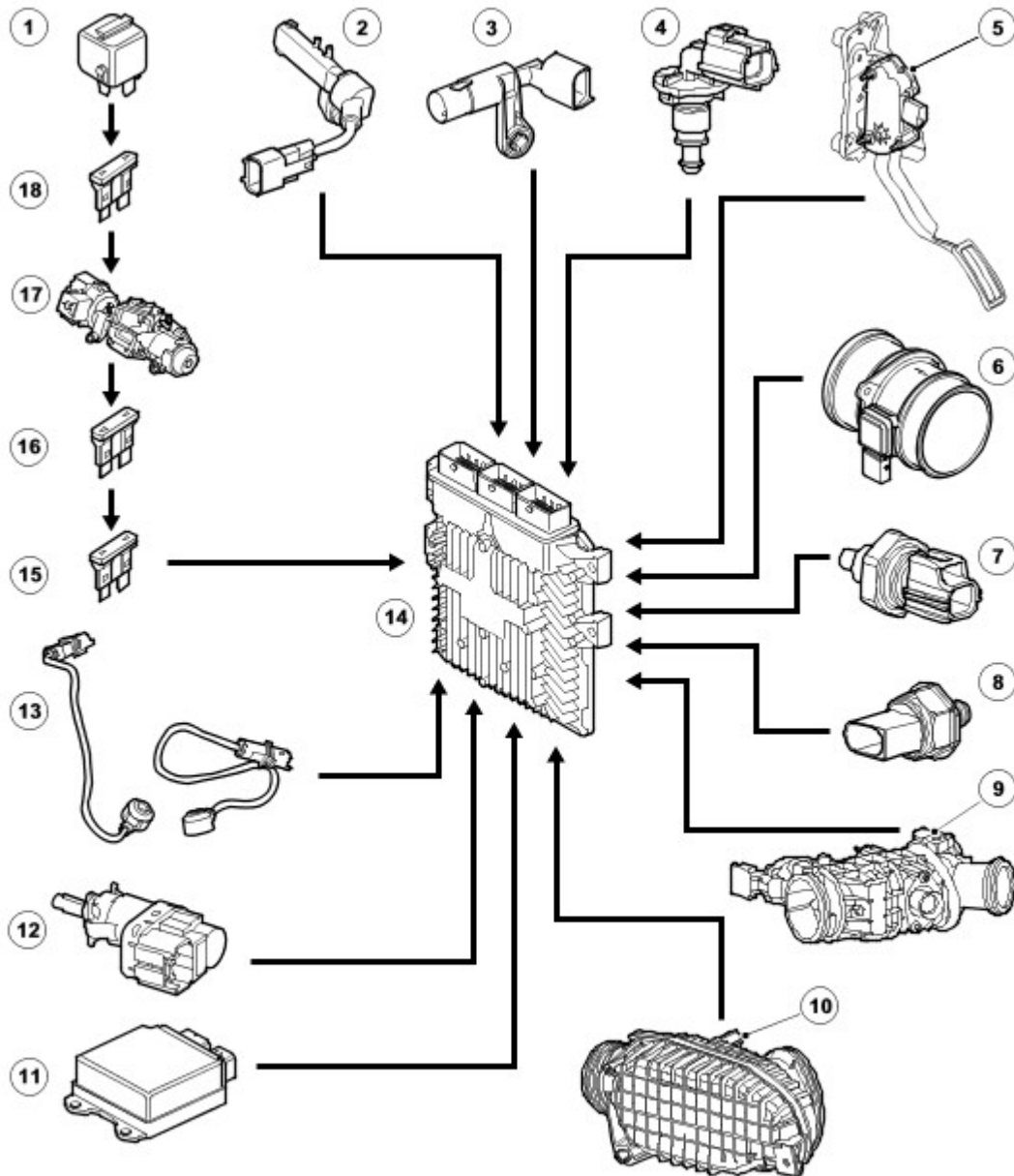
Item	Part Number	Description

1		Glow plugs
2		E-box cooling fan
3		Port de-activation vacuum actuator
4		ABS control module
5		Instrument cluster
6		EAT control module
7		Restraints control module
8		Transfer box control module
9		Differential control module
10		Electric park brake control module
11		Terrain Response™ control module
12		Turbo boost pressure controller
13		EGR valve/ cooler
14		Generator
15		Steering wheel mounted speed control switches
16		Clock spring
17		ECM
18		Electric throttle valve
19		Injectors

TDV6 Engine Management Control Diagram Sheet 2 of 2

NOTE :

A= Hardwired



E46908

A →

Item	Part Number	Description
1		Main relay
2		Crankshaft position sensor
3		Camshaft position sensor
4		Engine coolant temperature sensor
5		Accelerator pedal position sensor
6		MAF/IAT sensor
7		Engine oil temperature sensor
8		Fuel rail temperature sensor
9		Boost pressure sensor
10		Boost air temperature sensor

11		Restraints control module
12		Stop light switch
13		Knock sensors
14		ECM
15		Fuse 60P
16		Fuse 25P
17		Ignition switch
18		Fuse 11E

GENERAL

The TDV6 engine has an Electronic Diesel Control (EDC) engine management system supplied by Siemens. The system is controlled by an Engine Control Module (ECM) and is able to monitor, adapt and precisely control the fuel injection. The ECM uses multiple sensor inputs and precision control of actuators to achieve optimum performance during all driving conditions.

The ECM controls fuel delivery to all six cylinders via a Common Rail (CR) injection system. The CR system uses a fuel rail to accumulate highly pressurised fuel and feed the six, electronically controlled injectors. The fuel rail is located in close proximity to the injectors, which assists in maintaining full system pressure at each injector at all times.

The ECM uses the drive by wire principle for acceleration control. There are no control cables or physical connections between the accelerator pedal and the engine. Accelerator pedal demand is communicated to the ECM by two potentiometers located in a throttle position sensor. The ECM uses the two signals to determine the position, rate of movement and direction of movement of the pedal. The ECM then uses this data, along with other engine information from other sensors, to achieve the optimum engine response.

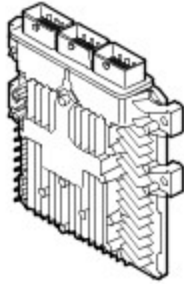
The ECM processes information from the following input sources:

- Crankshaft sensor (CKP)
- Camshaft sensor (CMP)
- Manifold air temperature and pressure
- Coolant temperature
- Oil temperature
- Inlet air flow and temperature
- Fuel rail temperature
- Knock sensors (one per cylinder bank)

The ECM outputs controlling signals to the following sensors and actuator:

- Fuel injectors
- Cooling fan solenoid
- Electronic Throttle
- Electronic vane controlled turbo
- Port deactivation
- Fuel pressure control valve
- Fuel volume control valve
- E-box fan
- Engine mounts
- Electronic EGR
- Glow plugs

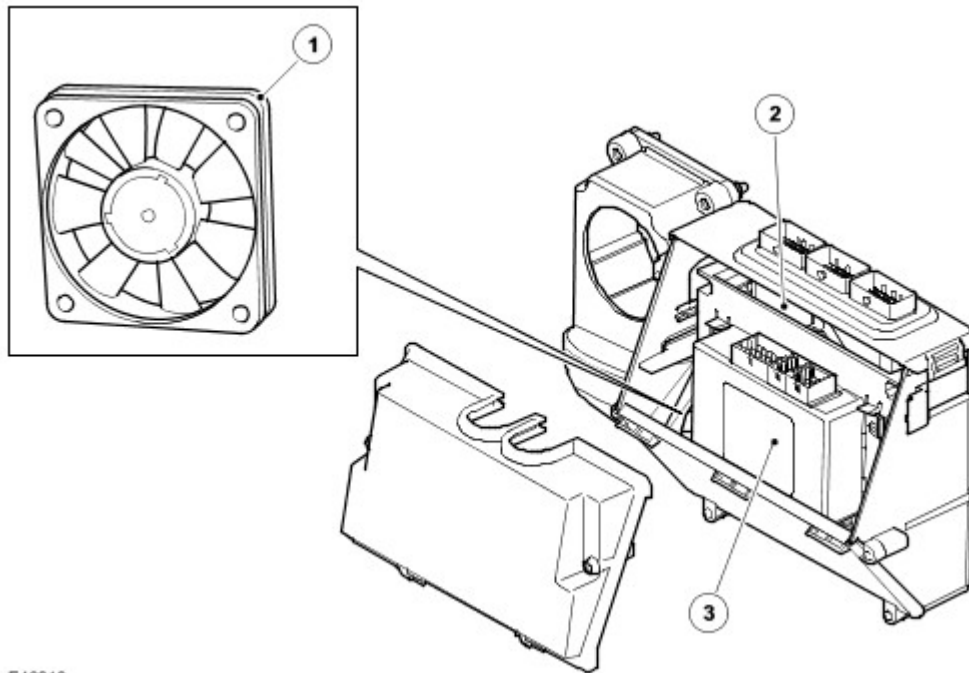
ECM



E46899

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

E Box



E46913

Item	Part Number	Description
1		E box fan
2		ECM
3		Transfer box control module

Inputs

The ECM has the following inputs:

- Engine Coolant Temperature
- Clutch Switch (via electric park brake control module)
- Stop lamp switch (via ABS control module on CAN)
- Manifold Absolute Pressure
- Throttle Pedal Position 1
- Throttle Pedal Position 2
- Electronic throttle Position
- Viscous Fan Speed
- Engine speed and position sensor (crankshaft sensor)
- Camshaft position sensor

- Engine Oil Temperature
- Speed Control Switches (resistive ladders)
- Vehicle Speed (via CAN bus)
- Generator Monitor
- Restraints Control Module
- Manifold Absolute Pressure and Inlet Air Temperature

Outputs

The ECM outputs to the following:

- Throttle Actuator
- Fuel injectors (6)
- EGR Valves
- Engine Cooling Fan
- Fuel pump relay
- Starter Relay
- Air conditioning condenser fan module
- EMS Main Relay
- Viscous Fan Control
- Generator Control

The ECM connected to the vehicle harnesses via three connectors. The ECM contains data processors and memory microchips. The output signals to the actuators are in the form of ground paths provided by driver circuits within the ECM. The ECM driver circuits produce heat during normal operation and dissipate this heat via the casing. The fan in the E-box assists with the cooling process by maintaining a constant temperature with the E-box. The fan is controlled by a thermostatic switch located in the E-box. The E-box has pipe connections to the vehicle interior and receives additional cooled air via the A/C system. Some sensors receive a regulated voltage supplied by the ECM. This avoids incorrect signals caused by voltage drop during cranking.

The ECM performs self diagnostic routines and stores fault codes in its memory. These fault codes and diagnostics can be accessed using T4. If the ECM is to be replaced, the new ECM is supplied 'blank' and must be configured to the vehicle using T4. A 'flash' Electronic Erasable Programmable Read Only Memory (EEPROM) allows the ECM to be externally configured, using T4, with market specific or new tune information up to 14 times. If a fifteenth update is required the ECM must be replaced. The current engine tune data can be accessed and read using T4.

When a new ECM is fitted, it must also be synchronised to the immobilisation control module using T4. ECM's cannot be 'swapped' between vehicles.

The ECM is connected to the engine sensors which allow it to monitor the engine operating conditions. The ECM processes these signals and decides the actions necessary to maintain optimum engine performance in terms of driveability, fuel efficiency and exhaust emissions. The memory of the ECM is programmed with instructions for how to control the engine, this known as the strategy. The memory also contains data in the form of maps which the ECM uses as a basis for fuelling and emission control. By comparing the information from the sensors to the data in the maps, the ECM is able to calculate the various output requirements. The ECM contains an adaptive strategy which updates the system when components vary due to production tolerances or ageing.

The ECM receives a vehicle speed signal on a CAN bus connection from the ABS Control Module. Vehicle speed is an important input to the ECM strategies. The ABS control module derives the speed signal from the ABS wheel speed sensors. The frequency of this signal changes according to road speed. The ECM uses this signal to determine the following:

- How much to reduce engine torque during gear changes.
- When to permit speed control operation.
- To control the operation of the speed control system.
- Implementation of the idle strategy when the vehicle is stationary.

ECM Harness Connector C0872 Pin details

Pin No	Description	Input/Output
A1	Serial to immobilisation control module	Output
A2	Serial from immobilisation control module	Input
A3	CAN Low	Input/Output

A4	CAN High	Input/Output
B1	Starter motor enable	Output
B2	APP sensor ground	-
B3	Radiator outlet temperature sensor ground	-
B4	Speed control	Input
C1	APP 1 Sensor ground	-
C2	APP sensor 2 reference voltage	Output
C3	ECT sensor 2	Output
C4	Speed control	Input
D1	APP 1 signal	Input
D2	APP 2 Sensor ground	-
D3	Voltage 2	Input
D4	Not used	-
E1	APP sensor 1 reference voltage	Output
E2	Water in fuel sensor	Input
E3	Stop switch 1	Input
E4	Inertia switch	Input
F1	Intake air temperature sensor	Input
F2	Not used	-
F3	Engine cranking signal	Input
F4	Mass air flow sensor	Input
G1	Fuel pump power monitor	Input
G2	Stop light switch	Input
G3	Not used	-
G4	Not used	-
H1	Not used	-
H2	Not used	-
H3	Not used	-
H4	Not used	-
J1	Not used	-
J2	E box fan	Output
J3	Main relay	Output
J4	Fuel pump relay	Output
K1	Not used	-
K2	Electric cooling fan control	Output
K3	Ignition switch sense	Input
K4	Keep alive power supply	Input
L1	Battery voltage	Input
L2	Battery voltage	Input
L3	Battery voltage	Input
L4	Ground	-
M1	Ground	-
M2	Ground	-
M3	Ground	-
M4	Ground	-

ECM Harness Connector C0411 Pin details

Pin No	Description	Input/Output
A1	Engine oil temperature sensor	Input
A2	Not used	-
A3	Not used	-
A4	Not used	-
B1	Spare analogue input	Input
B2	Spare analogue input	Output
B3	CAN loop Low	Input/Output
B4	CAN loop High	Input/Output
C1	Not used	Input
C2	Sensor ground	
C3	Not used	
C4	Knock sensor B -	Input
D1	Fuel rail pressure sensor signal	Input
D2	Fuel rail pressure sensor	Output
D3	Knock sensor B +	Output
D4	Knock sensor A-	Input
E1	Throttle valve position sensor	Input
E2	Fuel rail pressure sensor ground	-
E3	Glow plug power monitor bank A	Input
E4	Knock sensor bank A+	Input
F1	Electric throttle voltage	Output
F2	Electric throttle ground	-
F3	Glow plug monitor bank B	Input
F4	Spare PWM output	Output
G1	Active engine mount control 1	Output
G2	Active engine mount control 2	Output
G3	Glow plug relay control	Output
G4	Not used	-
H1	Alternator command	Output
H2	Not used	-
H3	Not used	-
H4	Not used	-
J1	Not used	-
J2	E box fan	
J3	Main relay	Output
J4	Fuel volume control valve	Output
K1	Oil temperature sensor ground	-
K2	Viscous cooling fan control	Output
K3	Fuel pressure control valve	Input
K4	Inlet port deactivation actuator	Output
L1	Injector 1 command	Output
L2	Injector 1 common	-
L3	Injector 3 common	-

L4		Output
M1	Injector 3 command	Output
M2	Injector 5 command	Output
M3	Injector 5 common	-
M4	Ground 7	-

ECM Harness Connector C2518 Pin details

Pin No	Description	Input/Output
A1	Spare analogue input	-
A2	EGR valve position sensor bank B	Input
A3	EGR valve position sensor bank A	Input/Output
A4	Not used	Input/Output
B1	Air charge temperature sensor	Input
B2	Fuel temperature sensor	Input
B3	Not used	-
B4	Not used	-
C1	Manifold absolute pressure sensor	Input
C2	Engine coolant temperature sensor	-
C3	Analogue voltage 1	Input
C4	VGT bank A	Input
D1	Manifold absolute pressure sensor supply	Output
D2	Sensor ground M	Output
D3	Not used	
D4	Not used	
E1	Engine cooling fan monitor	Input
E2	Not used	-
E3	Not used	-
E4	Not used	-
F1	Crankshaft position sensor	Input
F2	Generator load monitor signal	Input
F3	Not used	-
F4	Not used	-
G1	Crankshaft position sensor supply	Output
G2	Crankshaft position sensor ground	-
G3	Variable geometry turbine actuator ground	-
G4	Camshaft sensor signal	Input
H1	EGR bank A +	Output
H2	EGR bank A -	-
H3	Camshaft position sensor ground	-
H4	Camshaft position sensor supply	Output
J1	EGR bank B+	Output
J2	VGT Bank A+	Output
J3	Not used	Output
J4	Throttle valve actuator +	Output
K1	EGR Bank B-	-

K2	VGT -	-
K3	Not used	Input
K4	Throttle valve actuator -	-
L1	Not used	-
L2	Injector 2 common	-
L3	Injector 0 common	-
L4	Injector 4 common	-
M1	Power ground	-
M2	Injector 2 command	Output
M3	Injector 0 command	Output
M4	Injector 4 command	Output

IMMOBILISATION

The immobilisation control module receives information from related systems on the vehicle and passes a coded signal to the ECM to allow starting if all starting parameters have been met. The information is decoded by the ECM which will allow the engine to run if the information is correct.

The information is on a rolling code system and both the immobilisation control module and the ECM will require synchronisation if either component is renewed.

The ECM also protects the starter motor from inadvertent operation. The immobilisation control module receives an engine speed signal from the ECM via the instrument cluster. When the engine speed exceeds a predetermined value, the immobilisation control module prevents operation of the starter motor via an integral starter disable relay. For additional information, refer to [Anti-Theft - Passive](#) (419-01B Anti-Theft - Passive)

CAMSHAFT POSITION SENSOR (CMP)



E46902

The CMP is located on the front face of the left hand cylinder head. The sensor tip protrudes through the face to pick up on the reluctor behind the camshaft pulley. The CMP is a Hall effect type sensor

The ECM uses the CMP sensor signal to determine if the piston in No. 1 cylinder is at injection TDC or exhaust TDC. Once this has been established, the ECM can then operate the correct injector to inject fuel into the cylinder when the piston is at injection TDC.

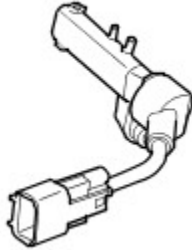
The CMP sensor is a Hall effect sensor which used by the ECM at engine start-up to synchronise the ECM with the CKP sensor signal. The ECM does this by using the CMP sensor signal to identify number one cylinder to ensure the correct injector timing. Once the ECM has established the injector timing, the CMP sensor signal is no longer used.

The CMP sensor receives a 5V supply from the ECM. Two further connections to the ECM provide ground and signal output.

If a fault occurs, an error is registered in the ECM. Two types of failure can occur; camshaft signal frequency too high or total failure of the camshaft signal. The error recorded by the ECM can also relate to a total failure of the crankshaft signal or crankshaft signal dynamically implausible. Both components should be checked to determine the cause of the fault.

If a fault occurs with the CMP sensor when the engine is running, the engine will continue to run but the ECM will deactivate boost pressure control. Once the engine is switched off, the engine will crank but will not restart while the fault is present.

CRANKSHAFT POSITION SENSOR (CKP)



E46903

The CKP sensor is located at the rear of the engine block on the left hand side. The sensor tip is aligned with a magnetic trigger which is attached to the crankshaft. The reluctor is a press fit on the end of the crankshaft. The trigger wheel must be carefully aligned to the crankshaft to ensure correct timing. The sensor produces a square wave signal, the frequency of which is proportional to engine speed.

The ECM monitors the CKP sensor signal and can detect engine over-speed. The ECM counteracts engine over-speed by gradually fading out speed synchronised functions. The CKP is a Hall effect sensor. The sensor measures the magnetic field variation induced by the magnetised trigger wheel.

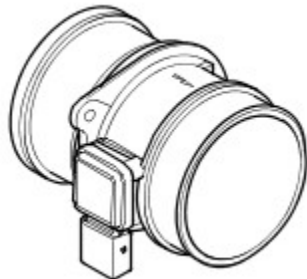
The trigger wheel has two missing teeth representing 6° of crankshaft rotation. The two missing teeth provide a reference point for the angular position of the crankshaft.

When the space with the two missing teeth pass the sensor tip, a gap in the signal is produced which the ECM uses to determine the crankshaft position. The air gap between the sensor tip and the ring is important to ensure correct signals are output to the ECM. The recommended air gap between the CKP and the trigger wheel is 0.4 mm- 1.5 mm.

The ECM uses the signal from the CKP sensor for the following functions:

- Synchronisation.
- Determine fuel injection timing.
- Enable the fuel pump relay circuit (after the priming period).
- Produce an engine speed signal which is broadcast on the CAN bus for use by other systems.

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



E46904

The MAF/IAT sensor is located on the inlet air duct directly after the air filter box. The sensor combines the two functions of a MAF sensor and an IAT sensor in one unit. The sensor is housed in a plastic moulding which is connected between the intake manifold and the air intake pipe.

The MAF sensor works on the hot film principle. Two sensing elements are contained within a film. One element is maintained at ambient (air intake) temperature, e.g. 25°Celsius (77°F). The other element is heated to 200°Celsius (392°F) above the ambient temperature, e.g. 225°Celsius (437°F). Intake air entering the engine passes through the MAF

sensor and has a cooling effect on the film. The ECM monitors the current required to maintain the 200°Celsius (392°F) differential between the two elements and uses the differential to provide a precise, non-linear, signal which equates to the volume of air being drawn into the engine.

The MAF sensor output is a digital signal proportional to the mass of the incoming air. The ECM uses this data, in conjunction with signals from other sensors and information from stored fuelling maps, to determine the precise fuel quantity to be injected into the cylinders. The signal is also used as a feedback signal for the EGR system.

The IAT sensor incorporates a Negative Temperature Coefficient (NTC) thermistor in a voltage divider circuit. The NTC thermistor works on the principle of decreasing resistance in the sensor as the temperature of the intake air increases. As the thermistor allows more current to pass to ground, the voltage sensed by the ECM decreases. The change in voltage is proportional to the temperature change of the intake air. Using the voltage output from the IAT sensor, the ECM can correct the fuelling map for intake air temperature. The correction is an important requirement because hot air contains less oxygen than cold air for any given volume.

The MAF sensor receives a 12V supply from the Battery Junction Box (BJB) and a ground connection via the ECM. Two further connections to the ECM provide a MAF signal and IAT signal.

The IAT sensor receives a 5V reference voltage from the ECM and shares a ground with the MAF sensor. The signal output from the IAT sensor is calculated by the ECM by monitoring changes in the supplied reference voltage to the IAT sensor voltage divider circuit.

The ECM checks the calculated air mass against the engine speed. If the calculated air mass is not plausible, the ECM uses a default air mass figure which is derived from the average engine speed compared to a stored characteristic map. The air mass value will be corrected using values for boost pressure, atmospheric pressure and air temperature.

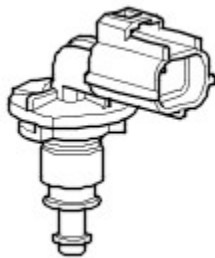
If the MAF sensor fails the ECM implements the default strategy based on engine speed. In the event of a MAF sensor signal failure, any of the following symptoms may be observed:

- Difficult starting
- Engine stalls after starting
- Delayed engine response
- Emission control inoperative
- Idle speed control inoperative
- Reduced engine performance.

If the IAT sensor fails the ECM uses a default intake air temperature of -5°Celsius (23°F). In the event of an IAT sensor failure, any of the following symptoms may be observed:

- Over fuelling, resulting black smoke emitting from the exhaust.
- Idle speed control inoperative.

ENGINE COOLANT TEMPERATURE SENSOR



E46905

The engine coolant temperature sensor is located in the top hose at the coolant manifold junction. The ECT sensor provides the ECM and the instrument cluster with engine coolant temperature status.

The ECM uses the temperature information for the following functions:

- Fuelling calculations
- Limit engine operation if engine coolant temperature becomes too high

- Cooling fan operation
- Glow plug activation time.

The instrument cluster uses the temperature information for temperature gauge operation. The engine coolant temperature signal is also transmitted on the CAN bus by the instrument cluster for use by other systems.

The ECM ECT sensor circuit consists of an internal voltage divider circuit which incorporates an NTC thermistor. As the coolant temperature rises the resistance through the sensor decreases and vice versa. The output from the sensor is the change in voltage as the thermistor allows more current to pass to earth relative to the temperature of the coolant.

The ECM compares the signal voltage to stored values and adjusts fuel delivery to ensure optimum driveability at all times. The engine will require more fuel when it is cold to overcome fuel condensing on the cold metal surfaces inside the combustion chamber. To achieve a richer air/fuel ratio, the ECM extends the injector opening time. As the engine warms up the air/fuel ratio is leaned off.

The input to the sensor is a 5V reference voltage supplied from the voltage divider circuit within the ECM. The ground from the sensor is also connected to the ECM which measures the returned current and calculates a resistance figure for the sensor which relates to the coolant temperature.

The following table shows engine coolant temperature values and the corresponding sensor resistance and voltage values.

Coolant Temperature Sensor Response

Temperature (Degrees Celsius)	Resistance (Kohms)	Voltage (Volts)
-40	925	4.54
-30	496	4.46
-20	277	4.34
-10	160	4.15
0	96	3.88
10	59	3.52
20	37	3.09
30	24	2.62
40	16	2.15
50	11	1.72
60	7.5	1.34
70	5.6	1.04
80	3.8	0.79
90	2.9	0.64
100	2.08	0.49
110	1.56	0.38
120	1.19	0.29
130	0.918	0.22
140	0.673	0.17
150	0.563	0.14

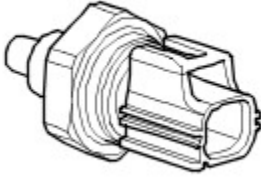
If the ECT sensor fails, the following symptoms may be observed:

- Difficult cold start.
- Difficult hot start.
- Engine performance compromised.
- Temperature gauge inoperative or inaccurate reading.

In the event of ECT sensor signal failure, the ECM applies a default value of 80°Celsius (176°F) coolant temperature for fuelling purposes. The ECM will also permanently operate the cooling fan at all times when the ignition is switched on, to

protect the engine from overheating.

ENGINE OIL TEMPERATURE SENSOR



E46906

The oil temperature sensor is located in the engine sump. The temperature sensor is a NTC type which operates in the -30 Degrees Celsius to +150 Degrees Celsius temperature range.

Oil Temperature Sensor Response

Temperature Degrees Celsius	Resistance Ohms
60	620
90	255
120	117
150	60

FUEL RAIL TEMPERATURE SENSOR

The fuel rail temperature sensor is located on the LP return line.

The sensor is an NTC sensor which is connected to the ECM by two wires. The ECM fuel temperature sensor circuit consists of an internal voltage divider circuit which incorporates an NTC thermistor. As the fuel temperature rises the resistance through the sensor decreases. The output from the sensor is the change in voltage as the thermistor allows more current to pass to earth relative to the temperature of the fuel.

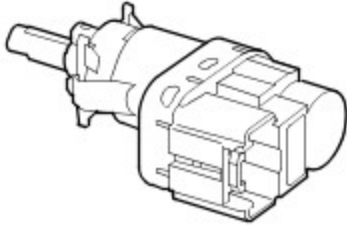
The ECM monitors the fuel temperature constantly. If the fuel temperature exceeds 85°Celsius (185°F), the ECM invokes an engine 'derate' strategy. This reduces the amount of fuel delivered to the injectors in order to allow the fuel to cool. When this occurs, the driver may notice a loss of performance.

Further fuel cooling is available by a bi-metallic valve diverting fuel through the fuel cooler when the fuel reaches a predetermined temperature. In hot climate markets, an electrically operated cooling fan is positioned in the air intake ducting to the fuel cooler. This is controlled by a thermostatic switch, which switches the fan on and off when the fuel reaches a predetermined temperature.

The wires to the fuel sensor are monitored by the ECM for short and open circuit. The ECM also monitors the 5V supply. If a failure occurs a fault is recorded in the ECM memory and the ECM uses a default fuel pressure value.

If the ECM registers an 'out of range' deviation between the pressure signal from the sensor and the pre-programmed 'set point' a fault is stored in the ECM memory. Depending on the extent of the deviation, the ECM will reduce the injection quantity, stop the engine immediately or prevent further engine starting.

BRAKE LIGHT SWITCH



E46910

The brake switch is located on the brake pedal and is operated by the brake pedal. The switch has a normally open circuit which closes the circuit when the driver has applied the brakes. The switch is connected directly to the ECM and the ECM also receives a brake light signal on the CAN bus from the ABS module.

The ECM uses the brake signal for the following:

To limit fuelling during braking

To inhibit/cancel Speed control if the brakes are applied.

In the event of a brake switch failure, the following symptoms may be observed:

Speed control inactive

Increased fuel consumption.

GLOW PLUGS



E46912

Three glow plugs are located in each of the cylinder heads, on the inlet side. The glow plugs and the glow plug relay are a vital part of the engine starting strategy. The glow plugs heat the air inside the cylinder during cold starts to assist combustion. The use of glow plugs helps reduce the amount of additional fuel required on start-up, and consequently reduces the emission of black smoke. The use of glow plugs also reduces the amount of injection advance required, which reduces engine noise, particularly when idling with a cold engine.

There are three phases of glow plug activity:

- Pre-heat
- During crank
- Post heat

The main part of the glow plug is a tubular heating element which protrudes into the combustion chamber of the engine. The heating element contains a spiral filament encased in magnesium oxide powder. At the tip of the tubular heating element is the heater coil. Behind the heater coil, and connected in series, is a control coil. The control coil regulates the heater coil to ensure that it does not overheat.

Pre-heat is the length of time the glow plugs operate prior to engine cranking. The ECM controls the pre-heat time based on ECT sensor output and battery voltage. If the ECT sensor fails, the ECM will use the IAT sensor value as a default value. The pre-heat duration is extended if the coolant temperature is low and the battery is not fully charged.

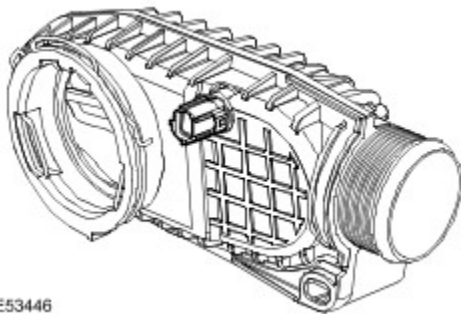
Post heat is the length of time the glow plugs operate after the engine starts. The ECM controls the post heating time based on ECT sensor output. The post heat phase reduces engine noise, improves idle quality and reduces hydrocarbon emissions.

When the ignition is switched on to position II, the glow plug warning lamp illuminates and the instrument cluster displays 'PREHEATING' in the message centre. The glow-lamp is activated separately from the glow-plugs, so is not illuminated during or after start. The plugs can still be ON when the lamp is off in these two phases.

In the event of glow plug failure, the engine may be difficult to start and excessive smoke emissions may be observed after starting.

The glow plug warning lamp also serves a second function within the EDC system. If a major EDC system fault occurs, the glow plug warning lamp will be illuminated permanently and a message generated in the instrument cluster. The driver must seek attention to the engine management system at a Land Rover dealer as soon as possible. For additional information, refer to [Glow Plug System](#) (303-07C Glow Plug System)

INTAKE AIR TEMPERATURE (BOOST AIR TEMPERATURE) SENSOR



The IAT (intake air temperature) is located in the rear of the intake chamber immediately preceding the electric throttle. The sensor is used to measure the intake air temperature from the turbo in order to calculate the required amount of fuelling.

BOOST PRESSURE CONTROL

The Boost Pressure (BP) sensor is located post turbo after the electric throttle valve. The sensor provides a voltage signal to the ECM relative to the intake manifold pressure. The BP sensor has a three pin connector which is connected to the ECM and provides a 5V reference supply from the ECM, a signal input to the ECM and a ground for the sensor.

The BP sensor uses diaphragm transducer to measure pressure. The ECM uses the BP sensor signal for the following functions:

- Maintain manifold boost pressure.
- Reduce exhaust smoke emissions when driving at high altitude.
- Control of the EGR system.
- Control of the vacuum control module.

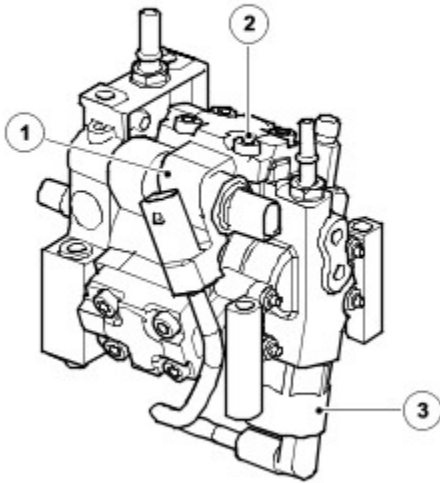
If the BP sensor fails, the ECM uses a default pressure of 1013 mbar (14 lbf/in²). In the event of a BP sensor failure, the following symptoms may be observed:

- Altitude compensation inoperative (black smoke emitted from the exhaust).
- Active boost control inoperative.

Boost control is achieved by the use of a direct drive electric actuator. The actuator is attached to the side of the turbo unit and is connected with the control mechanism via a linkage. The electric actuator works on the torque motor principle and has integrated control module.

The electric actuator moves the control vanes through an 60 degree stroke and has the capability to learn its own maximum stroke positions. The electric actuator is controlled via PWM signals from the ECM. For additional information, refer to [Turbocharger](#) (303-04D Fuel Charging and Controls - Turbocharger - 2.7L Diesel)

FUEL RAIL PRESSURE CONTROL VALVE



E46984

Item	Part Number	Description
1	-	Fuel volume control valve
2	-	High pressure fuel pump
3	-	Fuel rail pressure control valve

The fuel rail pressure control valve is incorporated into the high pressure fuel pump. The control valve regulates the fuel pressure within the fuel rail and is controlled by the ECM. The control valve is a PWM controlled solenoid valve.

When the solenoid is de-energised, an internal spring holds an internal valve closed. At fuel pressure of 100 bar (1450 lbf/in²) or higher, the force of the spring is overcome, opening the valve and allowing fuel pressure to decay into the fuel return pipe. When the pressure in the fuel rail decays to approximately 100 bar (1450 lbf/in²) or less, the spring force overcomes the fuel pressure and closes the valve. When the ECM energises the solenoid, the valve is closed allowing the fuel pressure to build. The pressure in the fuel rail in this condition can reach approximately 1300 bar (18854 lbf/in²).

The ECM controls the fuel rail pressure by operating the control valve solenoid using a PWM signal. By varying the duty cycle of the PWM signal, the ECM can accurately control the fuel rail pressure and hence the pressure delivered to the injectors according to engine load. This is achieved by the control valve allowing a greater or lesser volume of fuel to pass from the high pressure side of the pump to the un-pressurised fuel return line, regulating the pressure on the high pressure side.

The fuel rail pressure control valve receives a PWM signal from the ECM of between 0 and 12V. The ECM controls the operation of the control valve using the following information to determine the required fuel pressure:

- Fuel rail pressure
- Engine load
- Accelerator pedal position
- Engine temperature
- Engine speed.

In the event of a total failure of the fuel rail pressure control valve, the engine will not start.

In the event of a partial failure of the fuel rail pressure control valve, the ECM will activate the solenoid with the minimum

duty cycle which results in the injection quantity being limited.

FUEL VOLUME CONTROL VALVE

The fuel rail volume control valve is incorporated into the high pressure fuel pump. The VCV spills unwanted fuel back to the tank (or LP system) or forwards it to the PCV. This avoids unused fuel being pressurised by the HP stage of the pump, only to be spilt back to LP by the PCV wasting energy and heating the fuel.

INJECTORS

There are six electronic fuel injectors (one for each cylinder) located in a central position between the four valves of each cylinder. The ECM divides the injectors into two banks of three with cylinders 1 to 3 being designated bank A and cylinders 4 to 6 designated bank B, with injector numbers 1 and 4 at the front of the engine. Although the injectors are numbered 1-6 the firing order determined by the ECM software is numbered 0-5.

Injector/Cylinder Numbering

Injector	Cylinder No
0	1
1	4
2	2
3	5
4	3
5	6

Each injector is supplied with pressurised fuel from the fuel rail and delivers finely atomised fuel directly into the combustion chambers. Each injector is individually controlled by the ECM which operates each injector in the firing order and controls the injector opening period via PWM signals. Each injector receives a 12V supply from the ECM and, using programmed injection/timing maps and sensor signals, determines the precise pilot and main injector timing for each cylinder. If battery voltage falls to between 6 and 9V, fuel injector operation is restricted, affecting emissions, engine speed range and idle speed. In the event of a failure of a fuel injector, the following symptoms may be observed:

- Engine misfire
- Idle irregular
- Reduced engine performance
- Reduced fuel economy
- Difficult starting
- Increased smoke emissions.

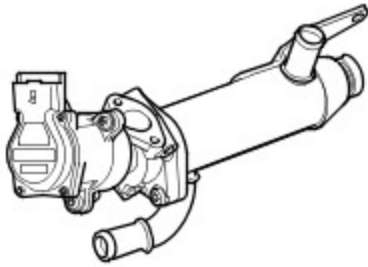
The ECM monitors the wires for each injector for short circuit and open circuit, each injector and the transient current within the ECM. If a defect is found, an error is registered in the ECM for the injector in question. For additional information, refer to [Fuel Charging and Controls](#) (303-04C Fuel Charging and Controls - 2.7L Diesel)

EGR SYSTEM

The EGR system comprises:

- EGR modulator x 2
- EGR cooler x 2
- Associated connecting pipes

EGR



E46914

The EGR modulator and cooler are a combined unit.

The combined EGR modulator and cooler is located under each cylinder bank, between the exhaust manifold and the cylinder head. The cooler side of the EGR is connected to the vehicle cooling system, via hoses. The inlet exhaust side is connected directly into the exhaust manifolds on each side. The exhaust gas passes through the cooler and is expelled via the actuator and a metal pipe into the throttle housing. The EGR modulator is a solenoid operated valve which is controlled by the ECM. The ECM uses the EGR modulator to control the amount of exhaust gas being re-circulated in order to reduce exhaust emissions and combustion noise. The EGR is enabled when the engine is at normal operating temperature and under cruising conditions.

The EGR modulator receives a 12V supply from the ECM and is controlled using a PWM signal. The PWM duty signal of the solenoid ground is varied to determine the precise amount of exhaust gas delivered to the cylinders.

The modulators are operated through their full range at each engine shut down, to clear any carbon deposits that may have built up whilst the engine was running

In the event of a failure of the EGR modulator, the EGR function will become inoperative. The ECM can monitor the EGR modulator solenoid for short circuits and store fault codes in the event of failure. The modulator can also be activated for testing using T4. For additional information, refer to [Engine Emission Control](#) (303-08C Engine Emission Control - 2.7L Diesel)

ACCELERATOR PEDAL POSITION SENSOR (APP)



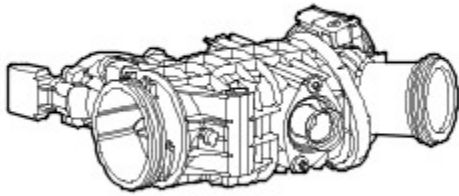
E46901

The Accelerator Pedal Position Sensor (APP) is incorporated into the pedal assembly. The sensor is a twin track rotary potentiometer type.

The APP sensor is located in plastic housing which is integral with the throttle pedal. The housing is injection moulded and provides location for the APP sensor. The sensor is mounted externally on the housing and is secured with two Torx screws. The external body of the sensor has a six pin connector which accepts a connector on the vehicle wiring harness.

The sensor has a spigot which protrudes into the housing and provides the pivot point for the pedal mechanism. The spigot has a slot which allows for a pin, which is attached to the sensor potentiometers, to rotate through approximately 90°, which relates to pedal movement. The pedal is connected via a link to a drum, which engages with the sensor pin, changing the linear movement of the pedal into rotary movement of the drum. The drum has two steel cables attached to it. The cables are secured to two tension springs which are secured in the opposite end of the housing. The springs provide 'feel' on the pedal movement and require an effort from the driver similar to that of a cable controlled throttle. A detente mechanism is located at the forward end of the housing and is operated by a ball located on the drum. At near maximum throttle pedal movement, the ball contacts the detente mechanism. A spring in the mechanism is compressed and gives the driver the feeling of depressing a 'kickdown' switch when full pedal travel is achieved.

ELECTRONIC THROTTLE



E46900

The electric throttle body is located in the inlet tract prior to where the inlet splits to divert air flow into the two separate air intake manifolds. The electric throttle controls the volume of air allowed into the inlet manifold by means of a DC motor which controls a flap in the body of the throttle. This is done in response to inputs from the engine management system.

Just after the throttle flap the tubes from the EGR valves/coolers are joined into the assembly.

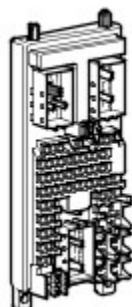
TERRAIN RESPONSE™

Terrain Response™ system allows the driver to select a program which will provide the optimum settings for traction and performance for prevailing terrain conditions.

As part of Terrain Response™ there will be different throttle pedal progression maps associated with different Terrain Response™ modes. The two extremes are likely to be a sand map (quick build up of torque with pedal travel) and grass/gravel/snow (very cautious build up of torque).

The TdV6 implementation of throttle progression is based on a fixed blend time. The torque will blend from that on one map to that on the new map (for the same pedal position) over a fixed time. This means blending will always take the same amount of time but when the torque change is small the torque increase over time will be small, whilst if the torque change is greater then the torque increase over time will be steeper. The resulting acceleration of the vehicle will depend on the torque difference between the two maps as well as on the gear and range selected. The worst case blending that could ever occur has been calibrated to match the blend rate for petrol derivatives as closely as possible, so as to give a transparent behaviour to customers. For additional information, refer to [Ride and Handling Optimization](#) (204-06 Ride and Handling Optimization)

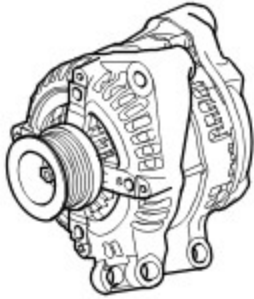
CENTRAL JUNCTION BOX



E47607

The CJB initiates the power up and power down routines within the ECM. When the ignition is turned on 12V is applied to the Ignition Sense input. The ECM then starts its power up routines and turns on the ECM main relay; the main power to the ECM and it's associated system components. When the ignition is turned OFF the ECM will maintain its powered up state for up to 20 seconds while it initiates its power down routine and on completion will turn off the ECM main relay.

GENERATOR



E47591

The generator has a multifunction 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 rechargeability, 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](#) (414-02C Generator and Regulator - 2.7L Diesel)

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 cluster on the CAN bus to illuminate the charge warning lamp.