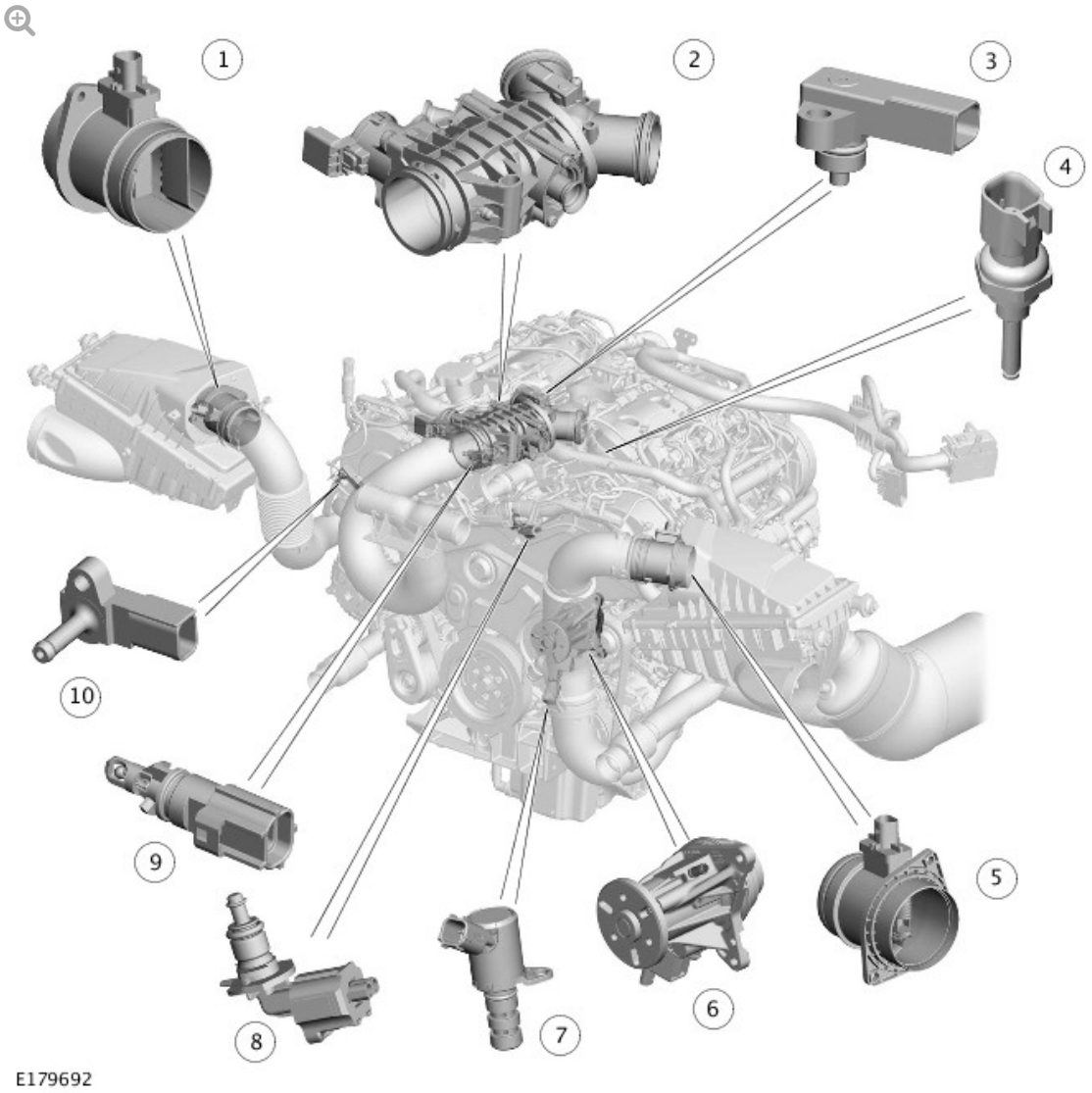
2016.0 RANGE ROVER (LG), 303-14

ELECTRONIC ENGINE CONTROLS – TDV6 3.0L DIESEL

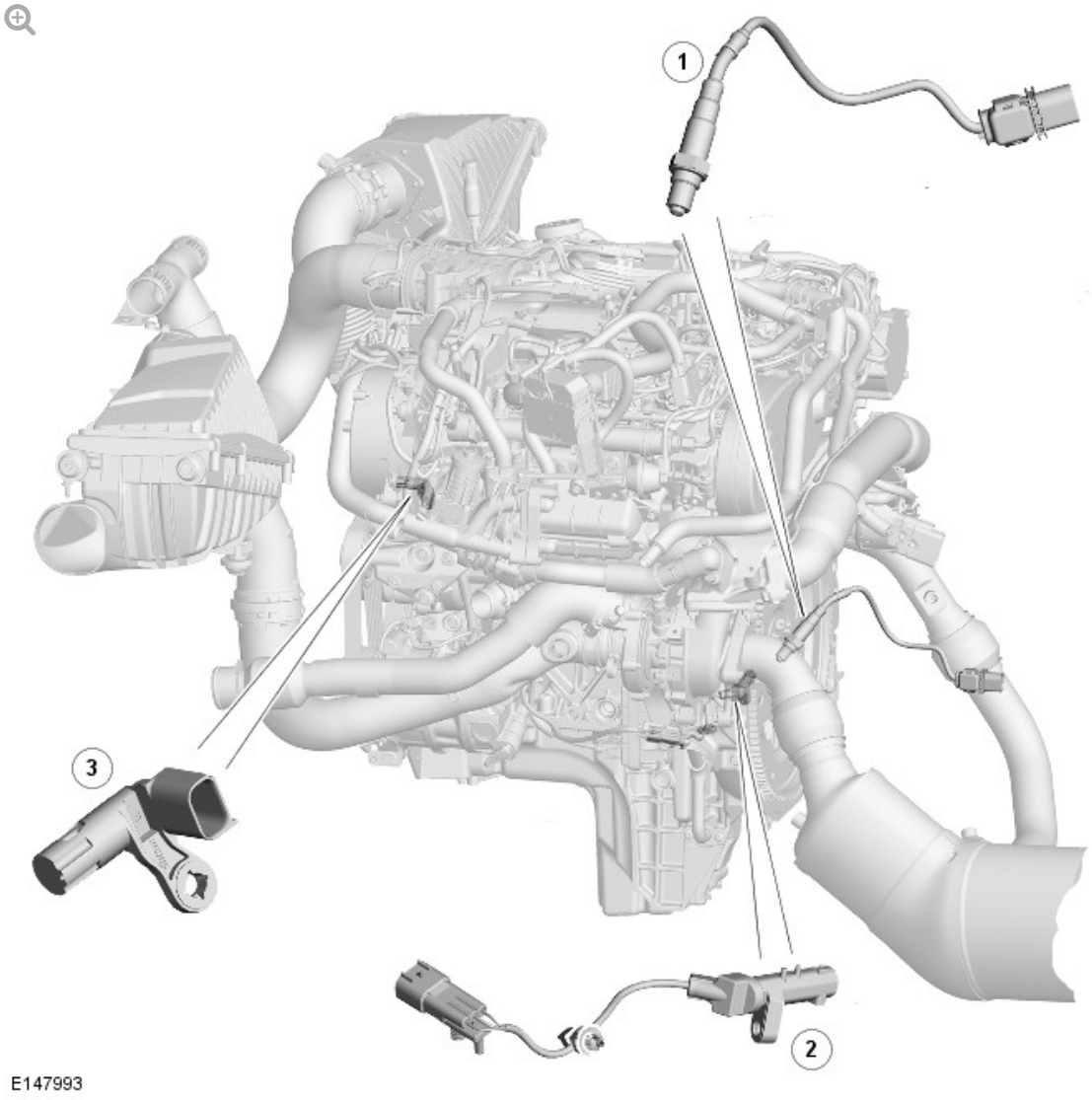
DESCRIPTION AND OPERATION

COMPONENT LOCATION – SHEET 1 OF 3



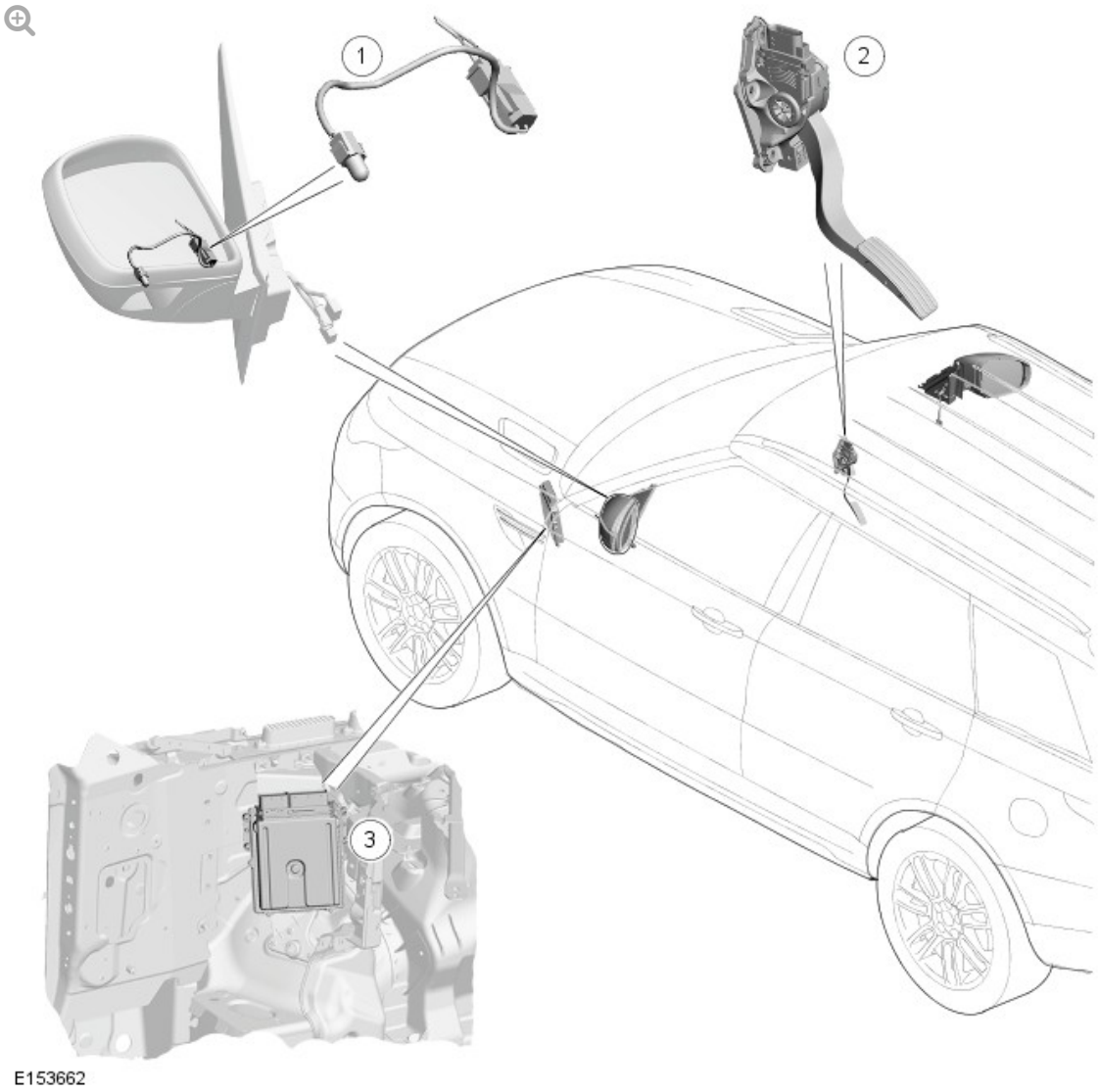
ITEM	DESCRIPTION
1	Mass Air Flow (MAF) sensor - if equipped
2	Electric throttle
3	Manifold Absolute Pressure (MAP) sensor
4	Cylinder head temperature sensor
5	Mass Air Flow and Temperature (MAFT) sensor
6	Variable coolant pump
7	Oil pump control solenoid
8	Engine Coolant Temperature (ECT) sensor
9	Charge air temperature sensor
10	Charge air pressure sensor

COMPONENT LOCATION – SHEET 2 OF 3



ITEM	DESCRIPTION
1	Heated Oxygen Sensor (HO2S)
2	Crankshaft Position (CKP) sensor
3	Camshaft Position (CMP) sensor

COMPONENT LOCATION – SHEET 3 OF 3



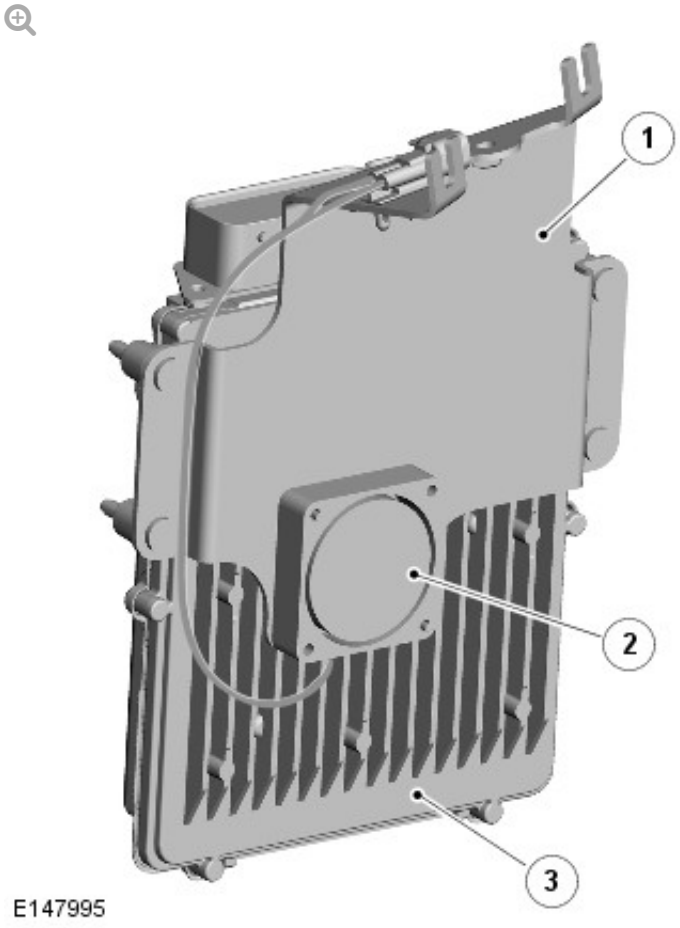
ITEM	DESCRIPTION
1	Ambient Air Temperature (AAT) sensor
2	Accelerator Pedal Position (APP) sensor
3	Engine Control Module (ECM)

OVERVIEW

The TDV6 3.0L diesel engine has an Engine Control Module (ECM) controlled engine management system. The ECM uses multiple sensor inputs and precision control of actuators to achieve optimum performance during all driving conditions.

DESCRIPTION

ENGINE CONTROL MODULE (ECM)



ITEM	DESCRIPTION
1	Upper bracket
2	Cooling fan
3	Engine Control Module (ECM)

The ECM is installed in the rear left corner of the engine compartment, behind the secondary bulkhead panel. The ECM is attached to brackets on the wheel housing and the fender outer support panel.

In some markets, an electric cooling fan is attached to the upper bracket to prevent the ECM from overheating. The ECM controls the operation of the cooling fan using an internal temperature sensor. While the ignition is on,

the cooling fan receives a power supply from the ECM relay located in the Engine Junction Box (EJB). When cooling is required, the ECM connects the cooling fan to ground.

The ECM connected to the vehicle harnesses via 2 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. 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 Land Rover approved diagnostic equipment. If the ECM is to be replaced, the new ECM is supplied 'blank' and must be configured to the vehicle using Land Rover approved diagnostic equipment. A 'flash' Electrically Erasable Programmable Read Only Memory (EEPROM) allows the ECM to be externally configured, using Land Rover approved diagnostic equipment, with market specific or new tune information. The current engine tune data can be accessed and read using Land Rover approved diagnostic equipment.

When a new ECM is fitted, it must also be synchronized to other system control modules using Land Rover approved diagnostic equipment. ECM's cannot be 'swapped' between vehicles as they must be 'matched' with security information to other system modules.

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. The memory also contains data in the form of maps which the ECM uses as a basis for fueling 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 is connected to other system control modules and receives data from these modules on the High Speed (HS) Controller Area Network (CAN) powertrain systems bus to enable precise engine control under all vehicle operating conditions.

The ECM receives and processes information from the following input sources:

- Crankshaft Position (CKP) sensor
- Camshaft Position (CMP) sensor
- Mass Air Flow and Temperature (MAFT) sensor
- Mass Air Flow (MAF) sensor - if equipped
- Manifold Absolute Pressure (MAP) sensor
- Electric throttle
- Engine Coolant Temperature (ECT) sensor
- Cylinder head temperature sensor
- Accelerator Pedal Position (APP) sensor
- Charge air temperature sensor
- Charge air pressure sensor
- Ambient Air Temperature (AAT) sensor
- Heated Oxygen Sensor (HO2S)
- The following brake system components:
  - Anti-lock brake system (ABS)control module
  - Brake pedal switch.
  - For additional information, refer to: Braking Control System (206-11 Brake Controls, Diagnosis and Testing).
  - Brake vacuum sensor (stop/start system vehicles only).
    For additional information, refer to: Brake Booster (206-07 Power Brake Actuation, Description and Operation).

- Oil level and temperature sensor.
  For additional information, refer to: Engine (303-01A Engine - TDV6 3.0L Diesel - Gen 2/TDV6 3.0L Diesel, Description and Operation).
- The following fuel system components:
  - Fuel Rail Pressure (FRP) sensor.
  - Fuel temperature sensor.
  - For additional information, refer to: Fuel Charging and Controls (303-04A Fuel Charging and Controls - TDV6 3.0L Diesel, Description and Operation).
- The following turbocharger system components:
  - Variable Geometry Turbocharger (VGT) vane position sensor.
  - Turbine intake valve position sensor.
  - Turbine temperature sensor.
  - For additional information, refer to: Turbocharger (303-04B Fuel Charging and Controls - Turbocharger - TDV6 3.0L Diesel, Description and Operation).
- The following Exhaust Gas Recirculation (EGR) system components:
  - Exhaust Gas Recirculation (EGR) valve position sensors.
  - Low Pressure (LP) EGR outlet temperature sensor - if equipped
  - LP EGR differential pressure sensor - if equipped.
  - For additional information, refer to: Engine Emission Control (303-08A Engine Emission Control - TDV6 3.0L Diesel - Gen 2/TDV6 3.0L Diesel, Description and Operation).
- Active grille air shutter actuator - if equipped
  For additional information, refer to: Engine Cooling (303-03A Engine Cooling - TDV6 3.0L Diesel - Gen 2/TDV6 3.0L Diesel, Description and Operation).
- Transmission Control Switch (TCS).
  For additional information, refer to: External Controls (307-05C Automatic Transmission/Transaxle External Controls - Vehicles With: 8HP70 8-Speed -

Hybrid Electric Vehicle - Automatic Transmission – AWD, Description and Operation).

- Terrain Response® switchpack.
  For additional information, refer to: Ride and Handling Optimization (204-06 Ride and Handling Optimization, Description and Operation).
- The following catalytic converter and Diesel Particulate Filter (DPF) system components -if equipped:
  - Turbine outlet temperature sensor.
  - Pre and post catalytic converter exhaust gas temperature sensors.
  - Post DPF exhaust gas temperature sensor
  - DPF differential pressure sensor.
  - For additional information, refer to: Exhaust System (309-00A Exhaust System - TDV6 3.0L Diesel, Description and Operation).
- Water in fuel sensor.
  For additional information, refer to: Fuel Tank and Lines (310-01A Fuel Tank and Lines - TDV6 3.0L Diesel, Description and Operation).
- Automatic Temperature Control Module (ATCM).
  For additional information, refer to: Control Components (412-01A Climate Control, Description and Operation).
- Restraints Control Module (RCM).
  For additional information, refer to: Airbag and Safety Belt Pretensioner Supplemental Restraint System (501-20B Supplemental Restraint System, Description and Operation).

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

- Electric throttle motor.
- Oil pump control solenoid
- ECM cooling fan - if equipped
- ABS control module.
  For additional information, refer to: Braking Control System (206-11 Brake

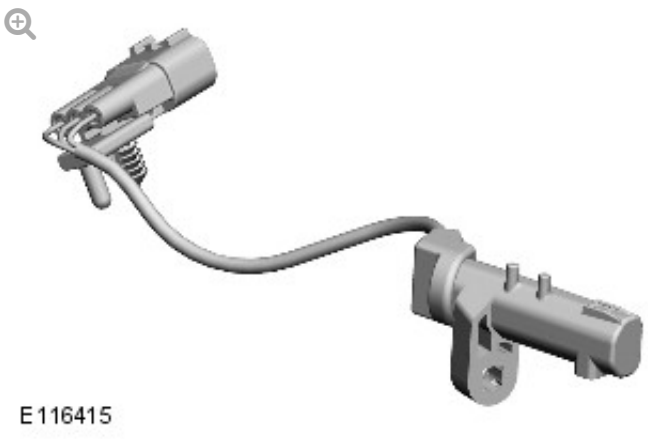
Controls, Description and Operation).

- Active engine mount solenoid.
  For additional information, refer to: Engine (303-01A Engine - TDV6 3.0L Diesel - Gen 2/TDV6 3.0L Diesel, Description and Operation).
- The following cooling system components:
  - Variable coolant pump
  - Engine cooling fans.
  - Active grille air shutter actuator -if equipped
  - Electric coolant pump - if equipped
  - For additional information, refer to: Engine Cooling (303-03A Engine Cooling - TDV6 3.0L Diesel - Gen 2/TDV6 3.0L Diesel, Description and Operation).
- The following fuel system actuators:
  - Fuel injectors.
  - Fuel pressure control valve.
  - Fuel metering valve.
  - For additional information, refer to: Fuel Charging and Controls (303-04A Fuel Charging and Controls - TDV6 3.0L Diesel, Description and Operation).
- The following turbocharger system components:
  - VGT vane actuator
  - Charge air recirculation solenoid - if equipped
  - Charge air solenoid - if equipped
  - Turbine intake shut-off valve solenoid - if equipped
  - For additional information, refer to: Turbocharger (303-04B Fuel Charging and Controls - Turbocharger - TDV6 3.0L Diesel, Description and Operation).
- Starter motor.
  For additional information, refer to: Starting System (303-06A Starting

System - TDV6 3.0L Diesel, Description and Operation).

- Glow plug control module.
  For additional information, refer to: Glow Plug System (303-07C Glow Plug System - TDV6 3.0L Diesel, Description and Operation).
- The following EGR system components:
  - EGR cooler bypass valve solenoid.
  - EGR valve motors.
  - For additional information, refer to: Engine Emission Control (303-08A Engine Emission Control - TDV6 3.0L Diesel - Gen 2/TDV6 3.0L Diesel, Description and Operation).
- Transmission Control Module (TCM).
  For additional information, refer to: Transmission Description (307-01B Automatic Transmission/Transaxle - Vehicles With: 8HP70 8-Speed Automatic Transmission AWD, Description and Operation).
- Automatic Temperature Control Module (ATCM).
- Instrument Cluster (IC).
  For additional information, refer to: Instrument Cluster (413-01 Instrument Cluster, Description and Operation).

CRANKSHAFT POSITION (CKP) SENSOR



The CKP sensor is located on the left side of the crankshaft rear oil seal. The sensor lead passes through a cover in the side of the cylinder block. The sensor tip is aligned with a reluctor ring on the rear flange of the crankshaft.

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 synchronized functions. The CKP is a Hall effect sensor. The sensor measures the magnetic field variation induced by the reluctor ring.

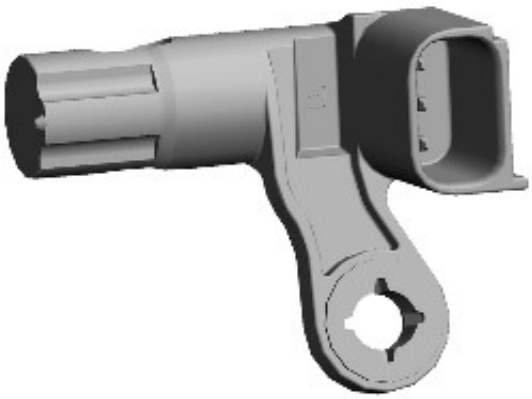
The reluctor ring has a 60 minus 2 pole pattern. The missing poles provide a reference point for the angular position of the crankshaft. When the space with the two missing poles passes the sensor tip, a gap in the signal is produced which the ECM uses to determine the crankshaft position.

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

- Synchronization
- Determine fuel injection timing
- Produce an engine speed signal which is broadcast on the HS CAN powertrain systems bus for use by other systems.

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

CAMSHAFT POSITION (CMP) SENSOR



E138807

The CMP sensor is located on the front face of the Bank 2 cylinder head. The sensor tip protrudes through an aperture in the front face of the cylinder head to pick up on a reluctor ring behind the camshaft pulley.

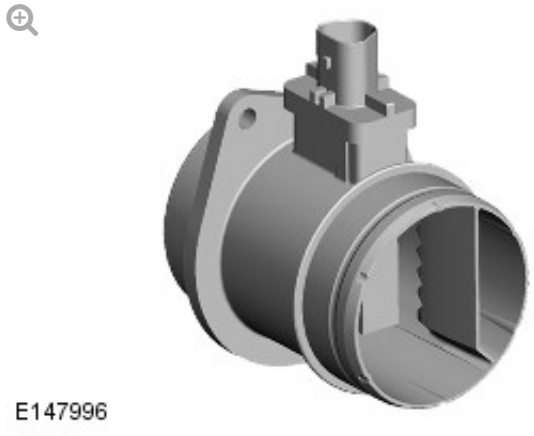
The CMP sensor is a Hall effect sensor which is used by the ECM at engine start-up to synchronize the ECM with the CKP sensor signal. The ECM does this by using the CMP sensor signal to identify the stroke of the piston in No. 1 cylinder to ensure the correct injector timing. Once the ECM has established 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; no CMP sensor signal or a synchronization error of the CMP and CKP sensors. 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 charge air pressure control. Once the engine is switched off, the engine will crank but will not restart while the fault is present.

MASS AIR FLOW (MAF) / MASS AIR FLOW AND TEMPERATURE (MAFT) SENSOR



Identical Mass Air Flow and Temperature (MAFT) sensors are attached to the air cleaner outlets, but only the MAFT sensor attached to the right air cleaner provides both mass air flow and temperature signals for the ECM. The engine harness connection with MAF sensor of the left air cleaner is wired so that only the mass air flow signal is connected to the ECM. On single turbocharger variant vehicles, the left MAFT sensor temperature signal is connected to the ECM.

The MAF and MAFT sensors work on the hot film principle. The output of sensors 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 fueling maps, to determine the precise fuel quantity to be injected into the cylinders. The signals are also used as a feedback for the EGR system.

The temperature sensor in the right MAFT sensor is a Negative Temperature Coefficient (NTC) thermistor in a voltage divider circuit. Using the voltage output from the temperature sensor, the ECM can correct the fueling map for intake air temperature.

The MAFT sensors receive a 12V supply from the ECM relay in the EJB and a ground connection via the ECM. Separate connections to the ECM are provided for the two mass air flow signals and the temperature signal.

The ECM checks the calculated air mass against the engine speed. If the

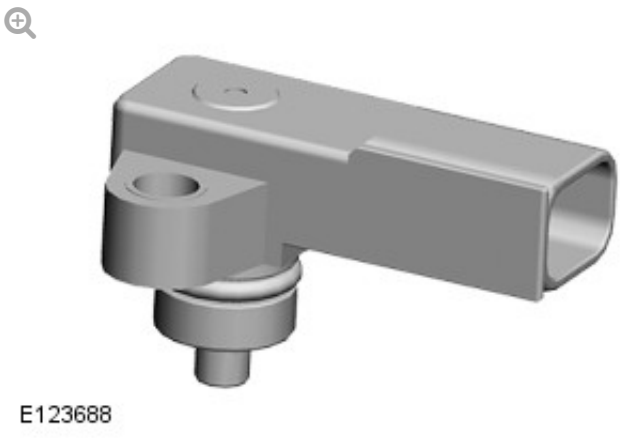
calculated air mass is not plausible, the ECM uses a default air mass figure which is derived from the average engine speed compared to a stored characteristic map. The air mass value will be corrected using values for charge air pressure, ambient air pressure and ambient air temperature.

If one of the mass air flow sensors fails the ECM implements the default strategy based on engine speed. In the event of a mass air flow sensor signal failure, the following symptoms may be observed:

- EGR system off.
- Delayed engine response.
- Reduced engine performance.

If the temperature sensor fails the ECM uses a default intake air temperature of 40°Celsius (104°F). In the event of a temperature sensor failure, under fueling, resulting in reduced engine performance, may be observed.

MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR



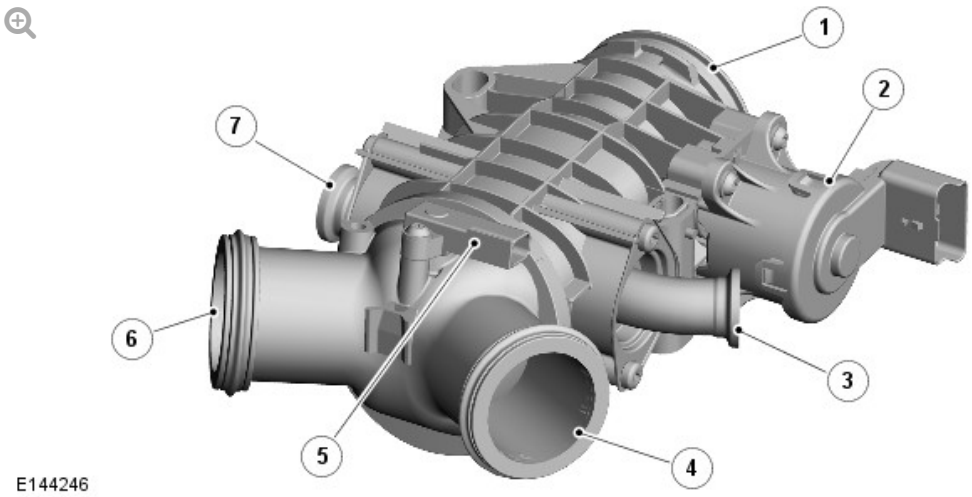
The Manifold Absolute Pressure (MAP) sensor is installed in the outlet of the electric throttle, to measure the pressure of the air entering the intake manifolds. The sensor is a semi-conductor type sensor which responds to pressure acting on a membrane within the sensor, altering the output voltage.

The sensor receives a 5V reference voltage and a ground from the ECM and

returns a signal of between 0.5 - 4.5V to the ECM. A low pressure returns a low voltage signal to the ECM and a high pressure returns a high voltage. The signal is used in conjunction with the mass air flow sensor signals to calculate the injection period.

The ECM monitors the engine MAP sensor for faults and can store fault related codes. These can be retrieved using Land Rover approved diagnostic equipment. If the sensor fails, the ECM uses the MAF and MAFT sensor signals as a substitute.

ELECTRIC THROTTLE



ITEM	DESCRIPTION
1	Air intake
2	Electric motor
3	Right Exhaust Gas Recirculation (EGR) pipe connection
4	Right intake manifold connection
5	Manifold Absolute Pressure (MAP) sensor
6	Left intake manifold connection
7	Left Exhaust Gas Recirculation (EGR) pipe connection - if equipped

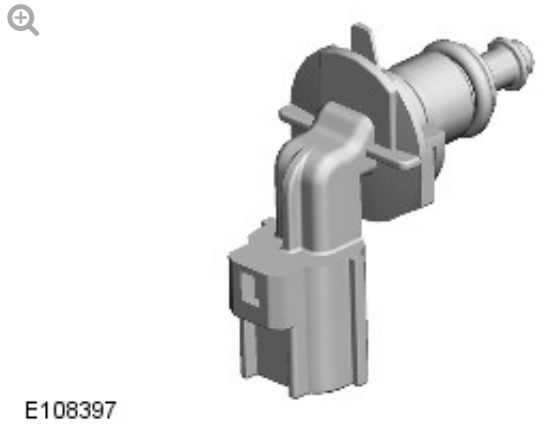
The electric throttle is installed at the front of the engine, between the cylinder heads. The throttle plate is operated by a DC (Direct Current)

electric motor attached to the throttle body. The motor is controlled by the ECM, which operates the motor in response to driver inputs from the Acceleration Pedal Position (APP) sensor and other engine related sensors to provide the correct air flow to the intake manifolds.

The ECM has five connections with the electric throttle motor:

- A ground and two 12V feeds to operate the motor in each direction to open or close the throttle plate
- A 5V reference connection and a signal connection with the Throttle Position Sensor (TPS) in the motor, for closed loop control.

ENGINE COOLANT TEMPERATURE (ECT) SENSOR



The ECT sensor is located in the EGR cooler intake hose, at the front of the engine. The ECM uses the temperature information for the following functions:

- Fueling calculations
- Limit engine operation if engine coolant temperature becomes too high
- Electric cooling fan operation
- Glow plug activation time.

The Instrument Cluster (IC) uses the temperature information for generation of engine temperature messages. The engine coolant temperature signal is also transmitted on the Medium Speed (MS) Controller Area Network (CAN)

comfort and High Speed (HS) CAN powertrain systems buses by the IC for use by other systems.

The ECT sensor circuit consists of an internal voltage divider circuit which incorporates an NTC thermistor. The ECM compares the signal voltage to stored values and adjusts fuel delivery to ensure optimum driveability at all times.

The input to the sensor is a 3.3V 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.

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°C (176°F) coolant temperature for fueling 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.

VARIABLE COOLANT PUMP

E168927

The variable coolant pump has a shroud mechanism which can be used to create zero flow in the engine coolant circuit to enable accelerated engine warm-up. The only control from the ECM is a signal when the engine is cold telling the pump to move the shroud to a 'no coolant flow' position. Once the engine is approaching running temperature, the EMS removes this signal, the shroud retracts and full coolant flow is resumed.
For additional information, refer to: Engine Cooling (303-03A Engine Cooling - TDV6 3.0L Diesel - Gen 2/TDV6 3.0L Diesel, Description and Operation).

NOTE:

There is still a thermostat for conventional thermal transient operation.

CYLINDER HEAD TEMPERATURE SENSOR

E180126

The cylinder head temperature sensor is located in the Bank 2 cylinder head, next to the No. 4 cylinder glow plug. The sensor is connected to the ECM via a hardwired connection and measures the cylinder head metal temperature to provide better temperature control in conjunction with the variable coolant pump.
For additional information, refer to: Engine Cooling (303-03A Engine Cooling - TDV6 3.0L Diesel - Gen 2/TDV6 3.0L Diesel, Description and Operation).

OIL PUMP CONTROL SOLENOID

E180127

The oil pump control solenoid is located at the front of the oil pump, and connected to the ECM via hardwired connection. The oil pump control solenoid receives a 12V power supply from the EJB, and the ECM controls the operation of the solenoid valve by controlling the ground path for the solenoid. When the ECM energizes the control solenoid at low engine speed and low engine loads, the oil pump switches to the low pressure mode to reduce pumping losses within the oil pump, and optimize fuel economy.

For additional information, refer to: Engine (303-01A Engine - TDV6 3.0L Diesel - Gen 2/TDV6 3.0L Diesel, Description and Operation).

ACCELERATOR PEDAL POSITION (APP) SENSOR

NOTE:

LHD pedal shown.

E141165

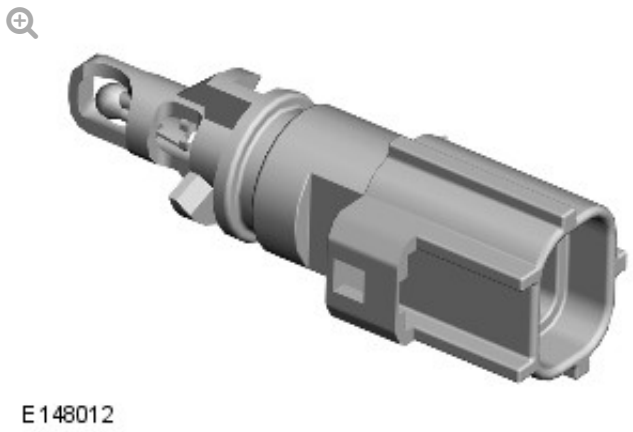
The Accelerator Pedal Position (APP) sensor allows the ECM to determine the driver requests for vehicle speed, acceleration and deceleration. The ECM uses this information to determine the torque demand from the engine via injection control.

The APP sensor consists of a twin track rotary potentiometer integrated into the mounting bracket of the accelerator pedal. The APP sensor receives two separate electrical supplies and generates two different outputs. Both tracks are analogue output signals connected to the ECM. Both signals contain the same positional information, but the secondary track has half the voltage output of the primary track.

If there is a fault with the primary track, the secondary track is used and the vehicle/engine response to pedal demand will be sluggish. If both analogue signals have a fault, the engine adopts a constant HS of 1300 RPM to allow the vehicle to move. Torque application and reduction of engine speed back to normal idle speed can be subsequently controlled via brake pedal switch operation.

The ECM constantly checks the range and plausibility of the two signals and stores a fault code if it detects a fault.

CHARGE AIR TEMPERATURE SENSOR



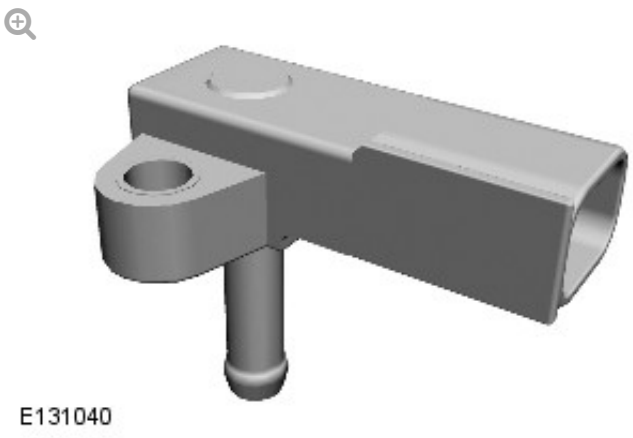
The charge air temperature sensor is located in the charge air duct connection with the electric throttle. The sensor is used to measure the intake air temperature from the turbochargers in order to calculate the required amount of fueling.

The charge air temperature sensor incorporates a NTC thermistor in a voltage divider circuit. The sensor receives a 3.3V reference voltage from the ECM. Using the voltage output from the charge air temperature sensor, the ECM can correct the fueling map for charge air temperature.

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

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

CHARGE AIR PRESSURE SENSOR



The charge air pressure sensor is located on a bracket attached to the right side of the primary drive cover. The sensor is connected via a hose to the charge air outlet pipe from the fixed vane turbocharger compressor.

The charge air pressure sensor provides a voltage signal to the ECM relative to the output charge air pressure from the fixed vane turbocharger. The sensor has a 3 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 charge air pressure sensor uses a diaphragm transducer to measure pressure. The ECM uses the sensor signal for the following functions:

- Maintain manifold charge air pressure.

- Reduce exhaust smoke emissions when driving at high altitude.
- Control of the EGR system.
- To help smooth the transition between mono turbocharger and bi-turbocharger operation.
- To aid the air path diagnostics.

AMBIENT AIR TEMPERATURE (AAT) SENSOR

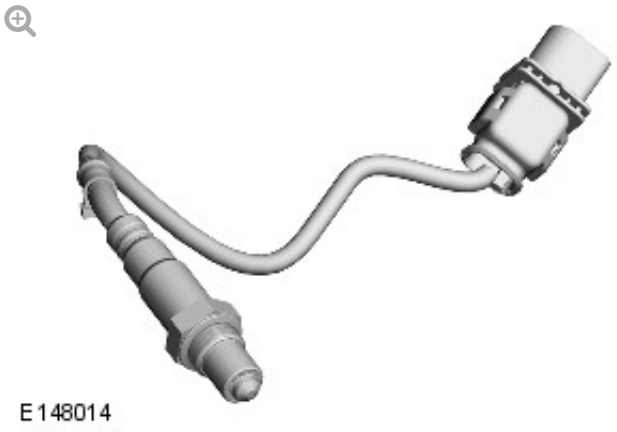
The Ambient Air Temperature (AAT) sensor is a NTC thermistor that allows the ECM to monitor the temperature of the air around the vehicle. The ECM uses the AAT input for a number of functions, including engine cooling fan control. The ECM also transmits the ambient temperature on the HS CAN Powertrain bus for use by other control modules.

The AAT sensor is installed in the left exterior mirror, with the bulb of the sensor positioned over a hole in the bottom of the mirror casing.

The ECM supplies the sensor with a 5 V reference voltage and a ground, and translates the return signal voltage into a temperature.

If there is a fault with the AAT sensor, the ECM calculates the AAT from the temperature inputs of the MAFT sensor. If the AAT sensor and the temperature input of the MAFT sensor are both faulty, the ECM adopts a default ambient temperature of 20 °C (68 °F).

HEATED OXYGEN SENSOR (HO2S)



The Heated Oxygen Sensor (HO2S) is a wide band type oxygen sensor that allows the ECM to provide closed loop control of the air fuel mixture. The sensor is installed in the left downpipe of the exhaust system, immediately after the connection with the primary turbocharger outlet.

Power for the heater element of the HO2S is provided by a battery voltage supply from the ECM relay in the EJB. The circuit through the heater element is completed by a connection with the ECM. The ECM regulates the current flow through the heater element to control the heating of the sensor. The heater element is operated immediately after each engine start and during low load conditions when the temperature of the exhaust gases is insufficient to maintain the required sensor temperature.

The HO2S has four further connections with the ECM, two for the Nernst (oxygen measuring) cell and two for the pump cell. The ECM adjusts the current of the pump cell circuit as necessary to maintain a constant signal from the oxygen measuring cell. The ECM then relates the current of the pump cell circuit to the lambda ratio of the exhaust gases.

If the HO2S fails the ECM defaults to open loop fueling and the emissions content of the exhaust gases increases. With a failed HO2S, the engine will suffer from unstable operation and reduced performance.

EXHAUST GAS TEMPERATURE SENSORS

E153664

Four temperature sensors are used in the DPF system in the following location:

- Pre-DPF Temperature Sensor
- Pre-Catalyst Temperature Sensor (adjacent to the HO2S)
- Post-Catalyst Temperature Sensor
- Post-DPF Temperature Sensor

The pre-sensors measure the temperature of exhaust gas exiting the turbocharger and before it passes through the catalyst converter and DPF, provides the information needed to calculate the DPF temperature. The post-catalyst and post-DPF temperature sensors provide the ECM with temperature signal, which is used as feedback for the ECM, from the actual exhaust gas temperature after the catalyst converter, and DPF. The

information is used, in conjunction with other data, to estimate the amount of accumulated particulates and to control the DPF temperature.
For additional information, refer to: Diesel Particulate Filter (309-00A Exhaust System - TDV6 3.0L Diesel, Description and Operation) / Diesel Particulate Filter (309-00A Exhaust System - TDV6 3.0L Diesel, Description and Operation).

OPERATION

The TDV6 3.0L diesel engine management system is controlled by the ECM and is able to monitor, adapt and precisely control the fuel injection and electric throttle. The ECM uses multiple sensor inputs and precision control of actuators to achieve optimum performance during all driving conditions.

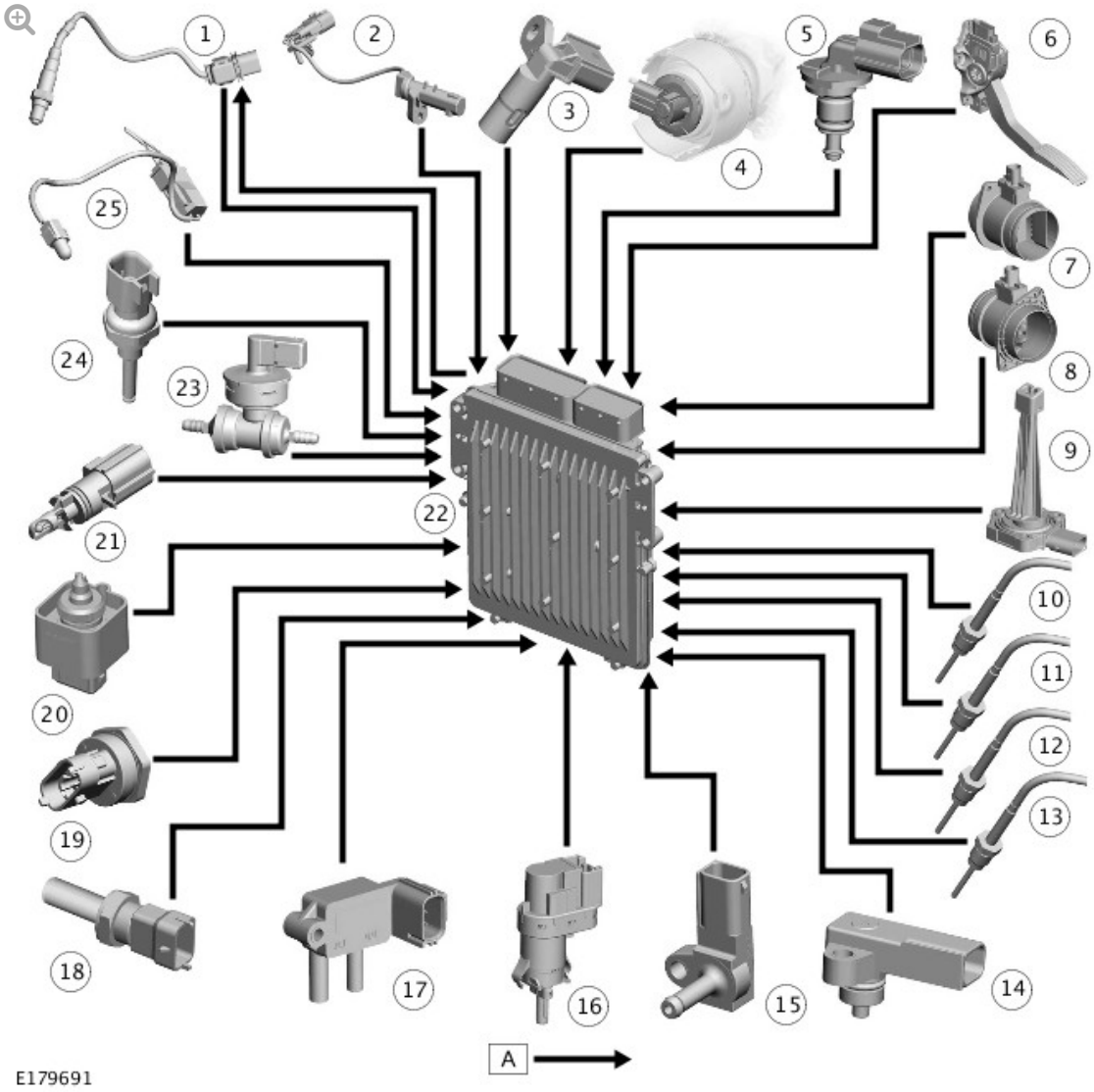
The ECM controls fuel delivery to all six cylinders via a common rail injection system. The common rail system uses a fuel rail to accumulate highly pressurized fuel and feed the six, electronically controlled injectors. The fuel rail is located in close proximity to the injectors, which assists in maintaining 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 the APP 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.

CONTROL DIAGRAM – SHEET 1 OF 2 – INPUT SIGNALS

NOTE:

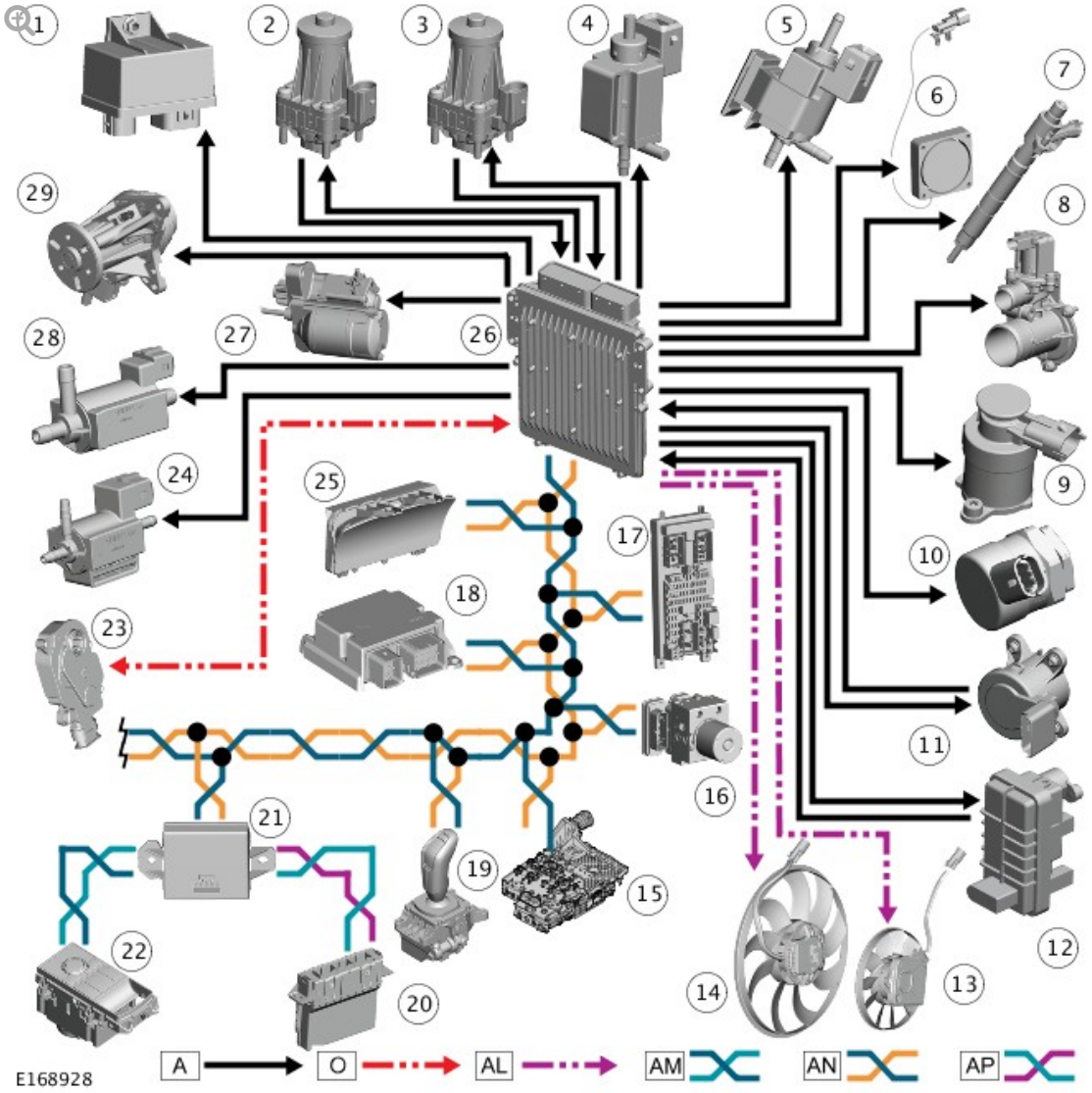
A = Hardwired, **O** = Local Interconnect Network (LIN) bus, **AL** = Pulse Width Modulation (PWM); **AM** = High Speed (HS) Controller Area Network (CAN) chassis systems bus, **AN** = HS CAN powertrain systems bus, **AP** = Medium Speed (MS) CAN comfort systems bus.



ITEM	DESCRIPTION
1	Heated Oxygen (HO2S) sensor
2	Crankshaft Position (CKP) sensor
3	Camshaft Position (CMP) sensor

4	Turbine intake valve position sensor
5	Engine Coolant Temperature (ECT) sensor
6	Accelerator Pedal Position (APP) sensor
7	Mass Air Flow and Temperature (MAFT) sensor
8	Mass Air Flow (MAF) sensor - if equipped
9	Oil level and temperature sensor
10	Pre catalyst exhaust gas temperature sensor (if equipped)
11	Post catalyst exhaust gas temperature sensor (if equipped)
12	Pre DPF exhaust gas temperature sensor (if equipped)
13	Post DPF exhaust gas temperature sensor (if equipped)
14	Manifold Absolute Pressure (MAP) sensor
15	Charge air pressure sensor
16	Brake pedal switch
17	Differential pressure sensor
18	Fuel temperature sensor
19	Fuel Rail Pressure (FRP) sensor
20	Water in fuel sensor
21	Charge air temperature sensor
22	Engine Control Module (ECM)
23	Brake vacuum sensor
24	Cylinder head temperature sensor
25	Ambient Air Temperature (AAT) sensor

CONTROL DIAGRAM – SHEET 2 OF 2 – OUTPUT SIGNALS



ITEM	DESCRIPTION
1	Glow plug control module
2	Left Exhaust Gas Recirculation (EGR) valve
3	Right EGR valve
4	EGR cooler bypass valve solenoid
5	Engine mount solenoid
6	Engine Control Module (ECM) cooling fan (if equipped)
7	Fuel injector (6 off)
8	Charge air recirculation solenoid
9	Fuel metering valve
10	Fuel pressure control valve

11	Electric throttle motor
12	Variable Geometry Turbocharger (VGT) vane actuator
13	Engine cooling fan 2 (if equipped)
14	Engine cooling fan 1
15	Transmission Control Module (TCM)
16	Anti-lock Brake System (ABS) control module
17	Central Junction Box (CJB)
18	Restraints Control Module (RCM)
19	Transmission Control Switch (TCS)
20	Automatic Temperature Control Module (ATCM)
21	Gateway Module (GWM)
22	Terrain Response® switchpack
23	Active grille air shutter actuator (if equipped)
24	Turbine intake shut-off valve solenoid
25	Instrument Cluster (IC)
26	Engine Control Module (ECM)
27	Charge air solenoid
28	Starter motor
29	Variable coolant pump