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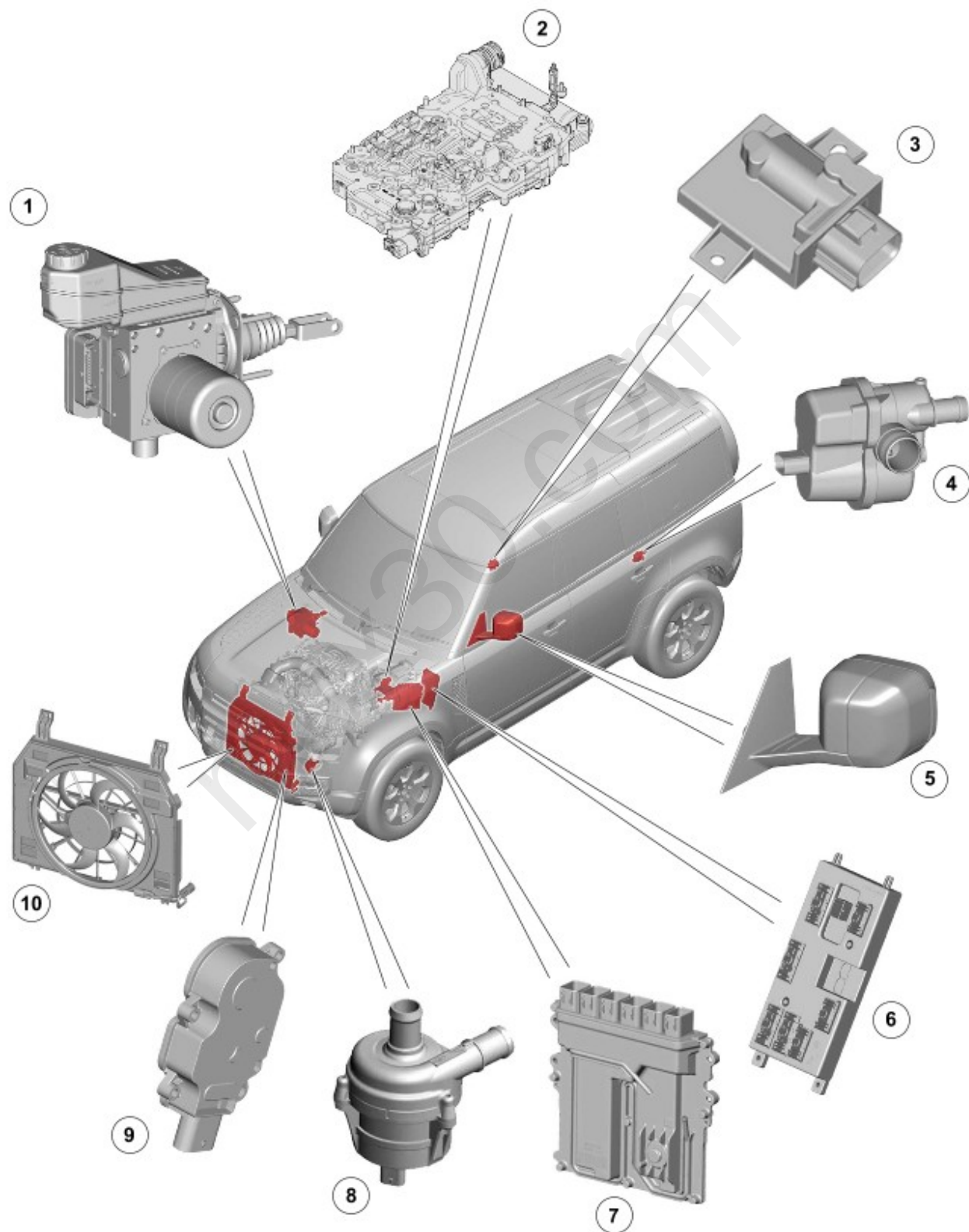
ELECTRONIC ENGINE CONTROLS – INGENIUM I6 3.0 L PETROL (G2341962)

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COMPONENT LOCATION

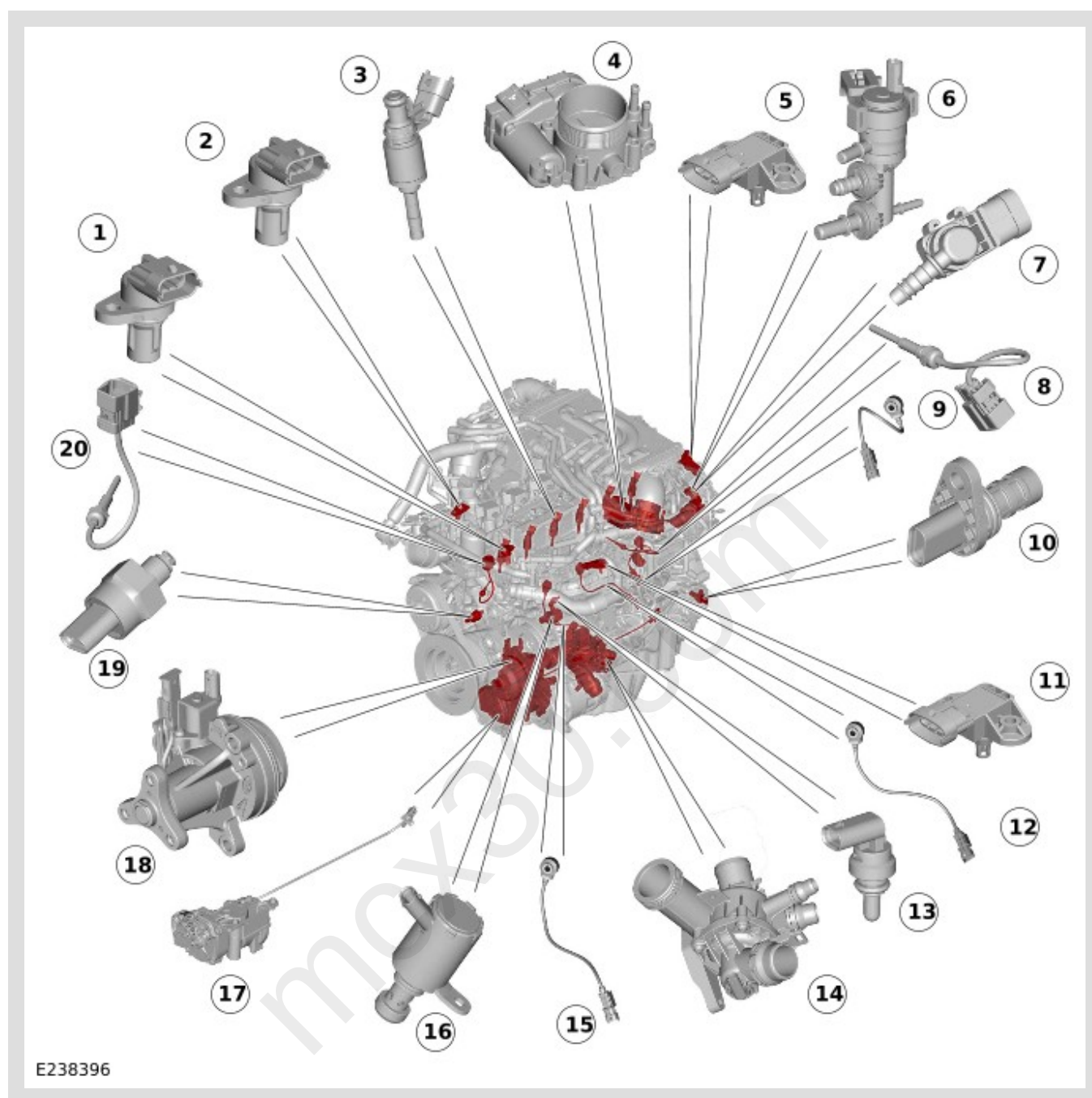
COMPONENT LOCATION - 1 OF 5



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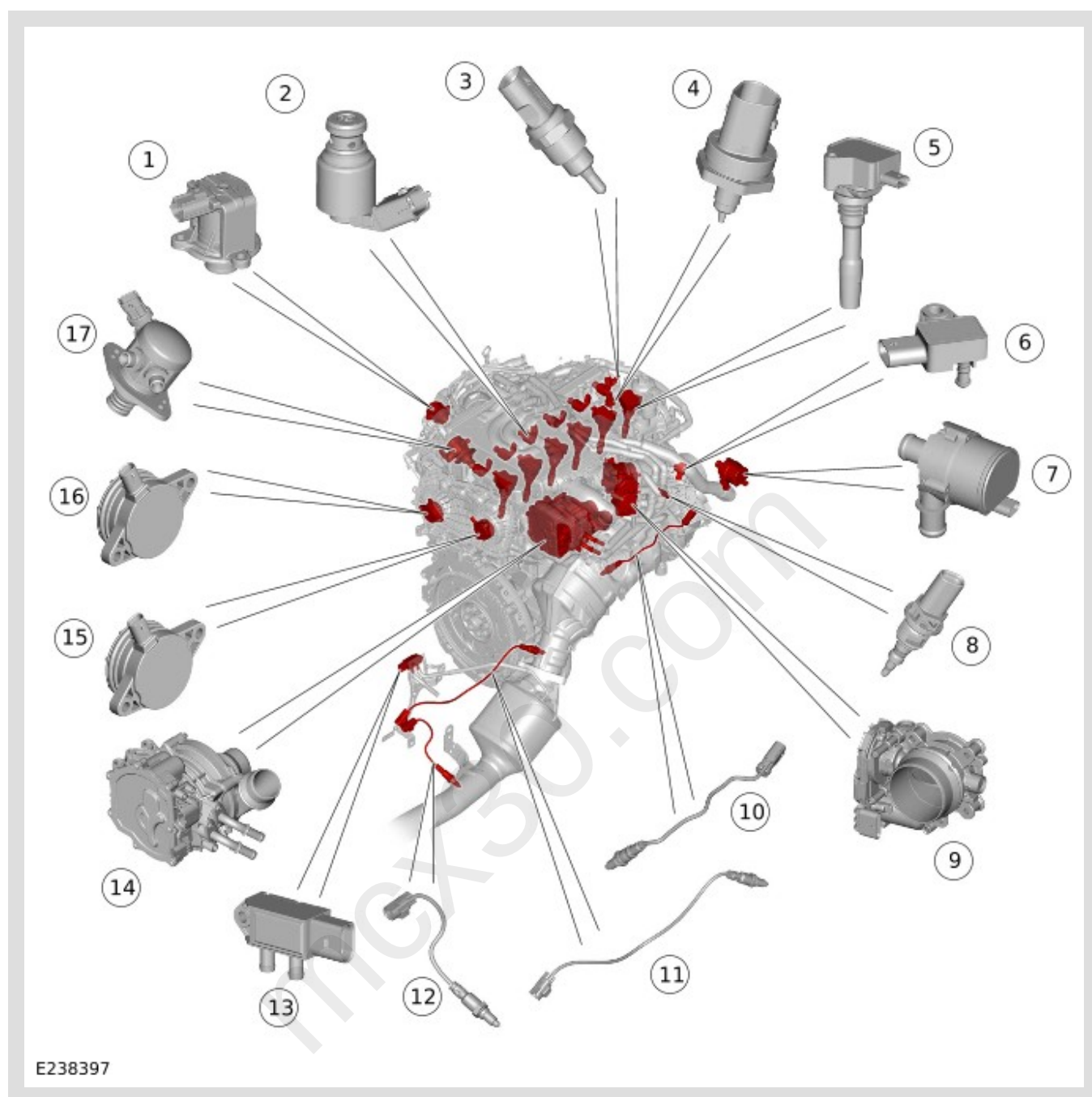
ITEM	DESCRIPTION
1	Integrated Power Brake control module
2	Transmission Control Module (TCM)
3	Fuel Pump Driver Module (FPDM)
4	Diagnostic Module Tank Leakage (DMTL) pump (North American Specification (NAS) market vehicles only)
5	Ambient Air Temperature (AAT) sensor
6	Body Control Module (BCM)/ Gateway Module A (GWM)
7	Powertrain Control Module (PCM)
8	Charge air coolant pump
9	Active grille air shutter motor (if equipped)
10	Electric cooling fan

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ITEM	DESCRIPTION
1	Camshaft Position Sensor (CMP) - Intake
2	CMP - Exhaust
3	Fuel injector (quantity 6)
4	Electric throttle
5	Charge air pressure and temperature sensor
6	Purge valve
7	Purge valve pressure sensor

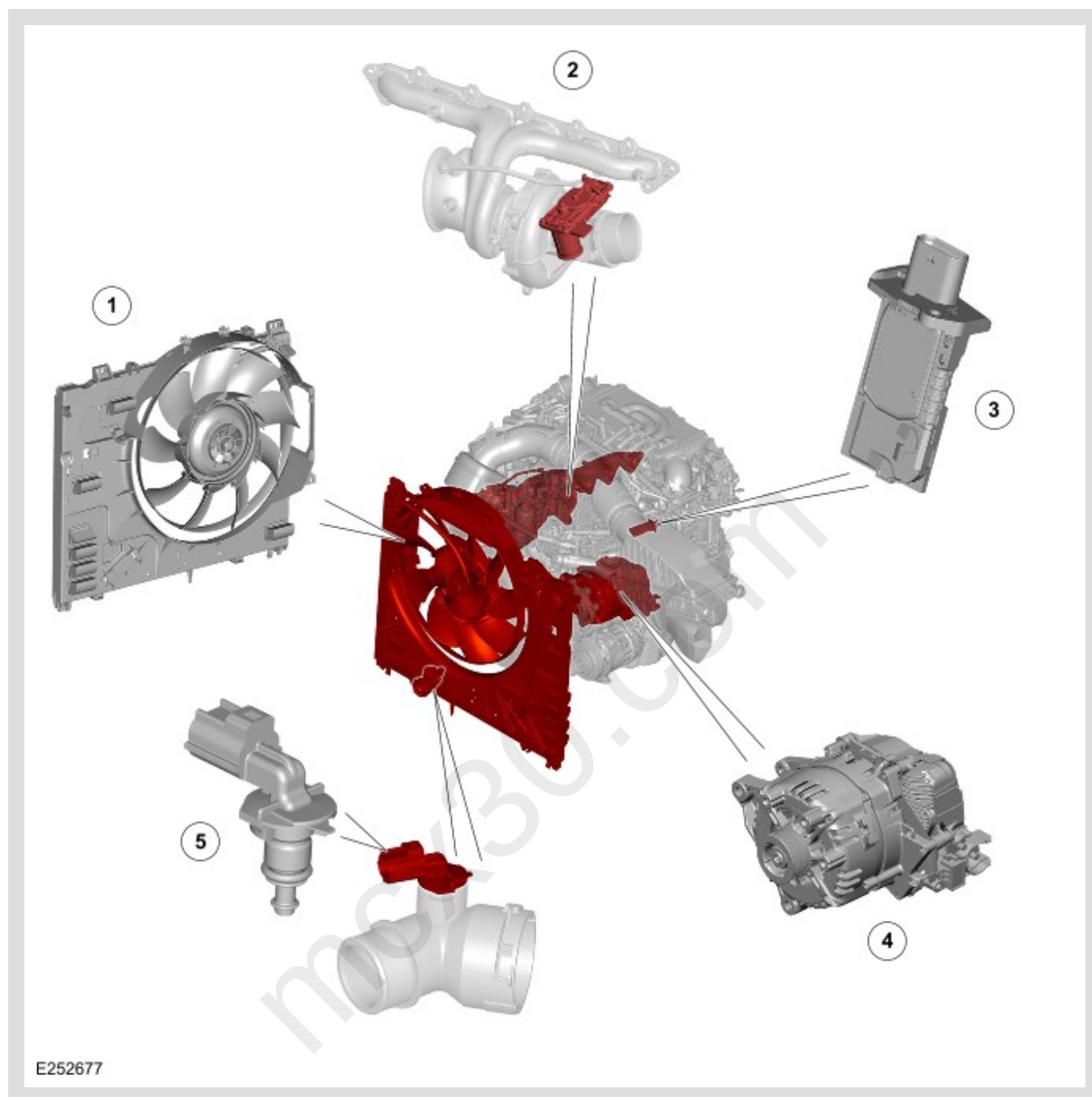
ITEM	DESCRIPTION
8	Cylinder block temperature sensor
9	Knock sensor - Rear
10	Crankshaft Position Sensor (CKP)
11	Manifold Absolute Pressure and Temperature sensor (MAPT)
12	Knock sensor - Center
13	Engine Coolant Temperature (ECT) sensor - Cylinder block outlet
14	Electric thermostat - Heater element
15	Knock sensor - Front
16	Piston cooling oil jet solenoid
17	Oil pump control solenoid
18	Variable coolant pump
19	Oil pressure and temperature sensor
20	Cylinder head temperature sensor



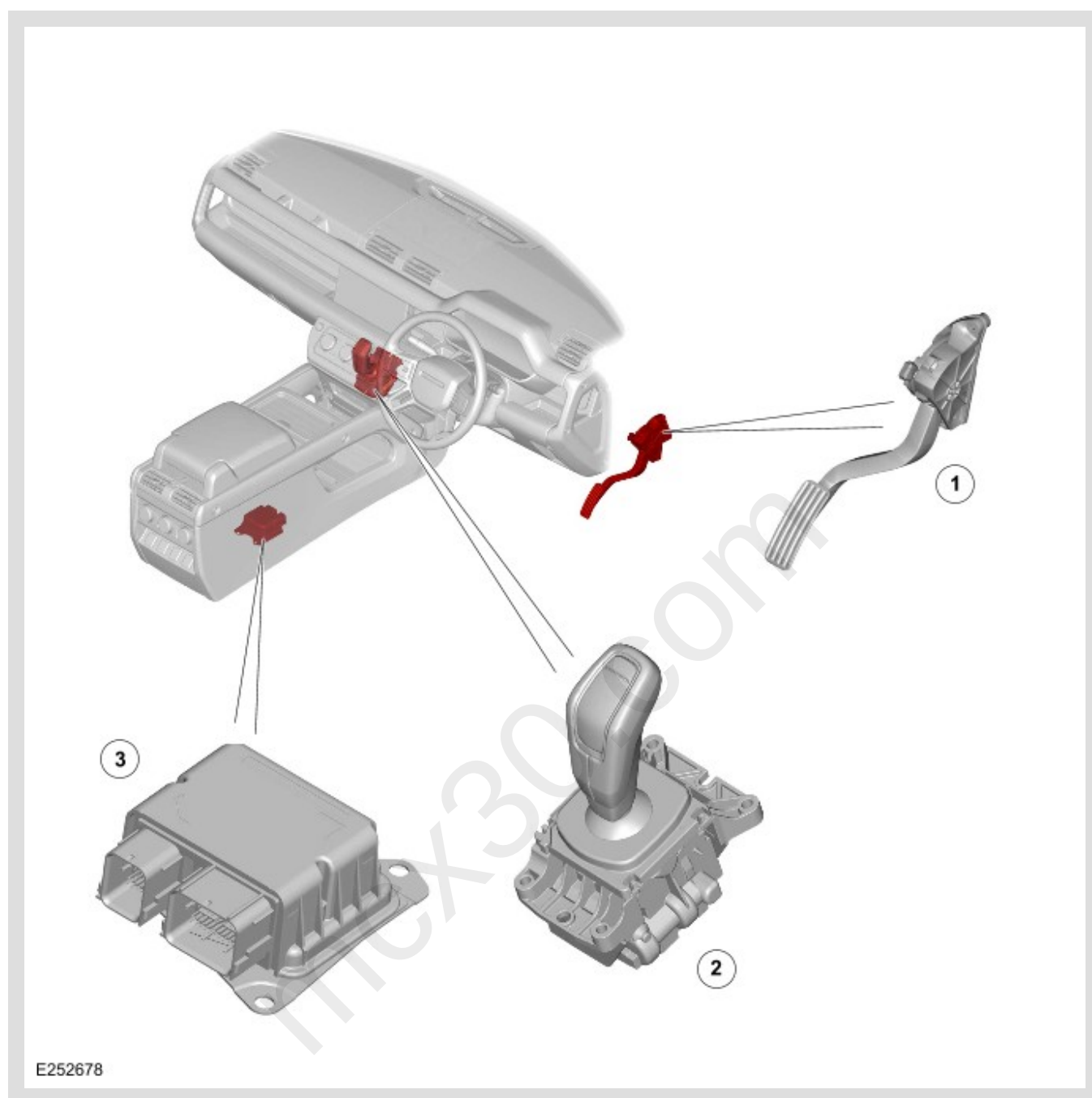
ITEM	DESCRIPTION
1	Compressor Recirculation Valve (CRV)
2	Continuous Variable Valve Lift (CVVL) solenoid (quantity 6)
3	CVVL assembly oil temperature sensor
4	Fuel Rail Pressure and Temperature (FRPT) sensor
5	Ignition coil (quantity 6)
6	Charge air pressure sensor
7	Auxiliary coolant pump

ITEM	DESCRIPTION
8	Charge air temperature sensor
9	Electric supercharger bypass valve
10	Heated Oxygen Sensor (HO2S) - Pre catalyst
11	HO2S - Mid catalyst
12	HO2S - Post catalyst
13	Exhaust back pressure sensor (if equipped)
14	Electric supercharger
15	Variable Camshaft Timing (VCT) solenoid - Exhaust
16	VCT solenoid - Intake
17	High Pressure (HP) fuel pump

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ITEM	DESCRIPTION
1	Viscous cooling fan
2	Turbocharger wastegate actuator
3	Mass Air Flow and Temperature (MAFT) sensor
4	Belt Integrated Starter Generator (BISG)
5	Engine Coolant Temperature (ECT) sensor - Radiator outlet



ITEM	DESCRIPTION
1	Accelerator Pedal Position (APP) sensor
2	Transmission Control Switch (TCS)
3	Restraints Control Module (RCM)

OVERVIEW

The Ingenium I6 engine is an in-line, double overhead camshaft, 6 cylinder engine, which is longitudinally mounted in the engine compartment. The Engine Management System (EMS) is controlled by a PCM located in the engine

compartment. The PCM uses inputs from various sensors to control actuators to achieve optimum conditions of all aspects of engine running, emissions and performance.

DESCRIPTION

POWERTRAIN CONTROL MODULE



The PCM is located in the rear left corner of the engine compartment.

The PCM receives inputs from various sensors and output reference voltages and signal information to other sensors for engine control.

The PCM receives inputs from the following:

- The Integrated Power Brake control module
- CKP
- CMP (quantity 2)
- Brake pedal switch
- TCM
- TCS
- Ambient Air Temperature (AAT) sensor
- Engine Coolant Temperature (ECT) sensor - Radiator outlet
- ECT sensor - Cylinder block outlet
- Electric cooling fan control module
- HO2S (quantity 3)
- Exhaust back pressure sensor (if equipped)
- Mass Air Flow (MAF) sensor
- MAFT sensor
- Charge air temperature sensor
- Charge air pressure sensor
- Charge air pressure and temperature sensor
- Electric throttle - Throttle Position Sensor (TPS)
- Cylinder head temperature sensor
- Cylinder block temperature sensor
- Knock sensor (quantity 3)
- Oil pressure and temperature sensor
- Variable coolant pump - Shroud position sensor
- MAPT
- Continuous Variable Valve Lift (CVVL) assembly temperature sensor
- FRPT sensor
- APP sensor.

The PCM provides outputs to the following:

- Electric throttle
- Fuel injector (quantity 6)
- Ignition coil (quantity 6)

- VCT solenoid (quantity 2)
- Purge valve
- Purge valve pressure sensor
- Electric cooling fan control module
- Viscous cooling fan control module
- Charge air coolant pump
- HP fuel pump
- FPDM
- Compressor Recirculation Valve (CRV)
- Turbocharger wastegate actuator
- Electric supercharger
- Electric supercharger bypass valve
- Oil pump control solenoid
- Heater element - Electric thermostat housing
- Auxiliary coolant pump
- DMTL (North American Specification (NAS) market vehicles only)
- Variable coolant pump
- Piston cooling oil jet solenoid
- CVVL solenoid (quantity 6)
- Active grille air shutter motor (if equipped).

The PCM is connected to the vehicle harnesses through 6 connectors. The PCM contains data processors and memory microchips. The output signals to the actuators and sensors are in the form of ground paths provided by driver circuits within the PCM. The PCM driver circuits produce heat during normal operation. Cooling for the PCM is provided by a ribbed casing and a cooling fan assembly.

The PCM performs self-diagnostic routines and stores Diagnostic Trouble Code(s) (DTC) in its memory. These DTC and diagnostics can be accessed using a Jaguar Land Rover (JLR) approved diagnostic equipment. If the PCM is to be replaced, the new PCM is supplied 'blank' and must be configured to the vehicle using a JLR approved diagnostic equipment. A 'flash' electrically erasable programmable read only memory allows the PCM to be externally configured, with market specific or new tune information. The current engine tune data can be accessed and read using a JLR approved diagnostic equipment.

When a new PCM is installed, it must be synchronized to the BCM/ GWM using a JLR approved diagnostic equipment. The PCMs cannot be 'swapped' between vehicles.

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

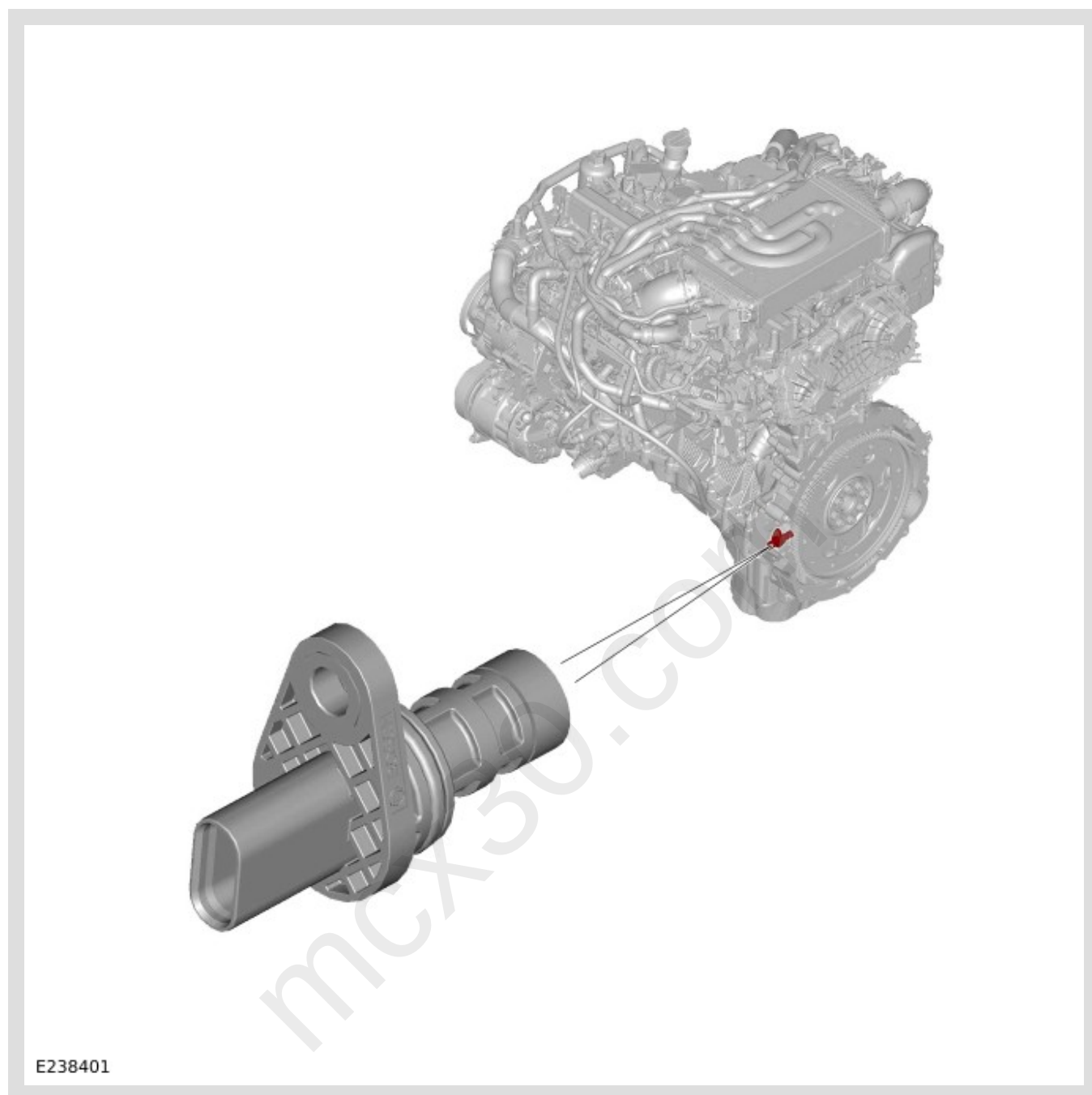
Some sensors receive a regulated voltage supplied by the PCM. This avoids incorrect signals caused by voltage drop during cranking.

The BCM/ GWM receives a vehicle speed signal on the FlexRay systems bus from the Integrated Power Brake control module. The BCM/ GWM provides the vehicle speed signal to the PCM on the FlexRay systems bus. Vehicle speed is an important input to the PCM strategies. The Integrated Power Brake control module derives the speed signal from the wheel speed sensors. The frequency of this signal changes according to road speed.

The PCM uses this signal to determine the following:

- 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.

CRANKSHAFT POSITION SENSOR



The CKP is located at the rear left side of the engine. The CKP is located in a hole and is secured with a screw.

The CKP has a 3-pin connector.

The 3-pin connector provides the following connections:

- A 5V reference voltage from the PCM.
- A CKP signal to the PCM.
- A ground connection.

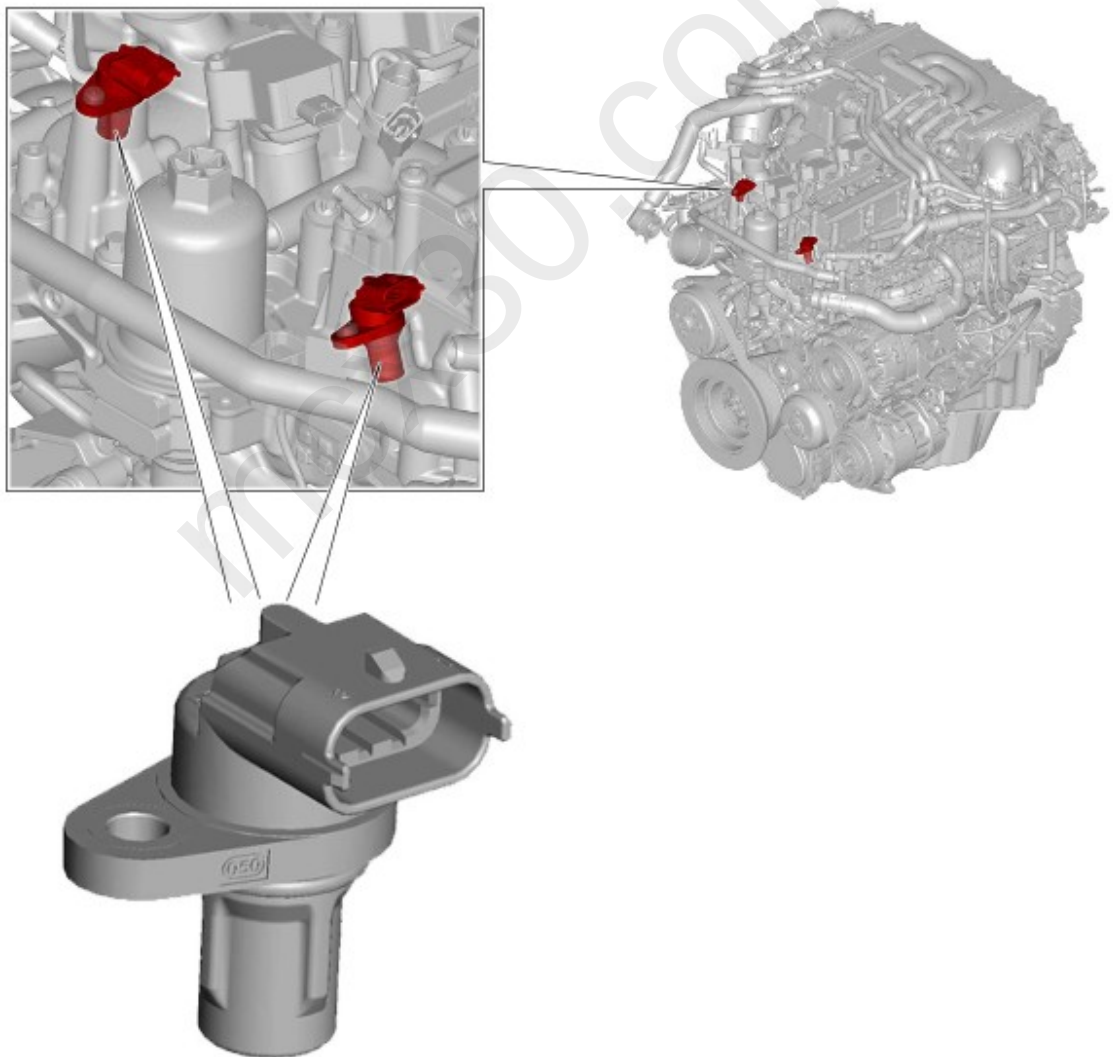
The CKP is positioned adjacent to the reluctor ring, which is an integral part of the drive plate. The reluctor ring has 58 teeth and a section where 2 teeth are missing. The CKP is a Hall effect sensor which uses the missing teeth on the reluctor ring to determine the crankshaft position and rotational speed.

If a fault occurs with the CKP, a DTC is registered in the PCM. The engine continues to operate using data from the CMP until the fault has been corrected.

The PCM uses the signal from the CKP for the following functions:

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

CAMSHAFT POSITION SENSOR



The CMPs are located in the camshaft carriers and are secured with a screw. Both CMPs extend into the camshaft carriers and are sealed with o-ring seals. When the reluctor ring is repeatedly moved over the CMPs, a voltage gets created by the CMPs. The CMPs measure the magnetic field variation induced by the reluctor ring. The CMPs are Hall effect sensors which produce a square wave signal, the frequency of which is proportional to engine speed.

The CMP has a 3-pin connector.

The 3-pin connector provides the following connections:

- A 5V reference voltage from the PCM.
- A CMP signal to the PCM.
- A ground connection.

The PCM uses the signal from the CMPs and the CKP to determine current intake and exhaust camshaft position and camshaft adjustment.

If a fault occurs with any of the CMPs, a DTC is registered in the PCM.

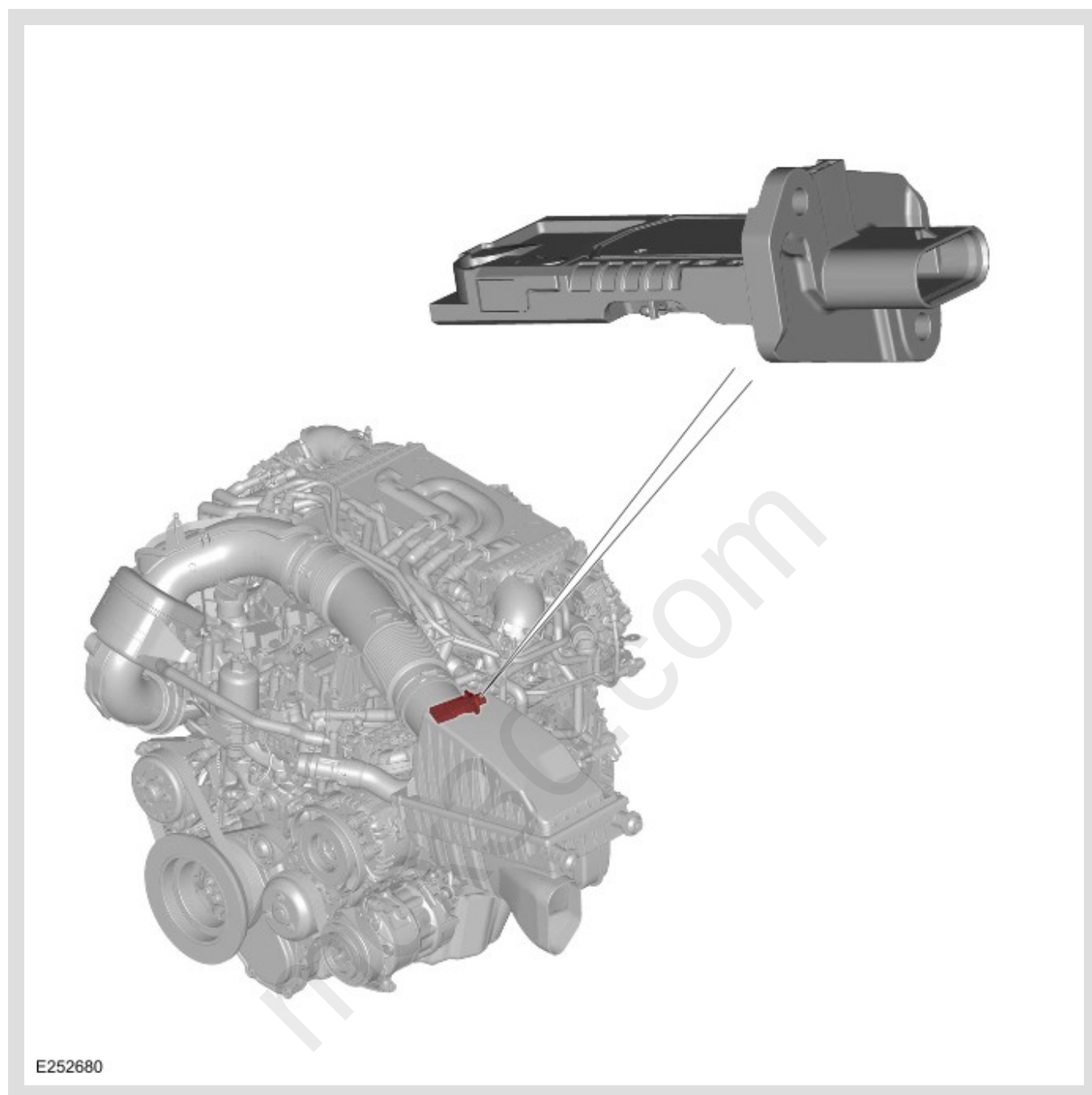
There are 2 types of failure that can occur:

- Camshaft signal frequency too high.
- Total failure of the camshaft signal.

The DTC recorded by the PCM 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 any of the CMPs when the engine is running, the engine continues to run. When the engine is switched off, the engine cranks and restarts while the fault is present, but VCT control is disabled.

MASS AIR FLOW SENSOR AND TEMPERATURE SENSOR



The air filter housing is located in the front left corner of the engine compartment. The air outlet connection of the air filter housing incorporates a MAFT sensor. The MAFT sensor is secured with 2 screws and measures the air entering the clean air duct to the turbocharger.

The MAFT sensor has a 4-pin connector. The 4-pin connector provides the following connections:

- A 5V power supply from the PCM.
- An air mass signal to the PCM.
- An air temperature signal to the PCM.
- A ground connection.

The MAFT sensor works on the hot film principle. Output is a frequency based signal which equates to the mass of air being drawn into the engine.

The PCM checks the calculated air mass against the engine speed. If the calculated air mass is not plausible, the PCM uses a default air mass value. This default air mass value is derived from the average engine speed compared to a stored characteristic map. The air mass value gets corrected using values for charge air pressure, atmospheric pressure and air temperature.

The temperature of the air flow is measured with a Negative Temperature Coefficient (NTC) sensor in the MAFT sensor. The NTC sensor works on the principle of decreasing resistance in the sensor as the temperature of the intake air increases. The change in voltage is proportional to the temperature change of the intake air. Using the voltage output from the MAFT sensor, the PCM can correct the fueling 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 PCM uses the MAFT sensor output, signals from the other sensors and the information stored in fueling maps to determine the precise fuel required by the engine.

If the MAFT sensor fails the PCM implements the default strategy based on engine speed.

In the event of a MAFT sensor signal failure, any of the following symptoms may be observed:

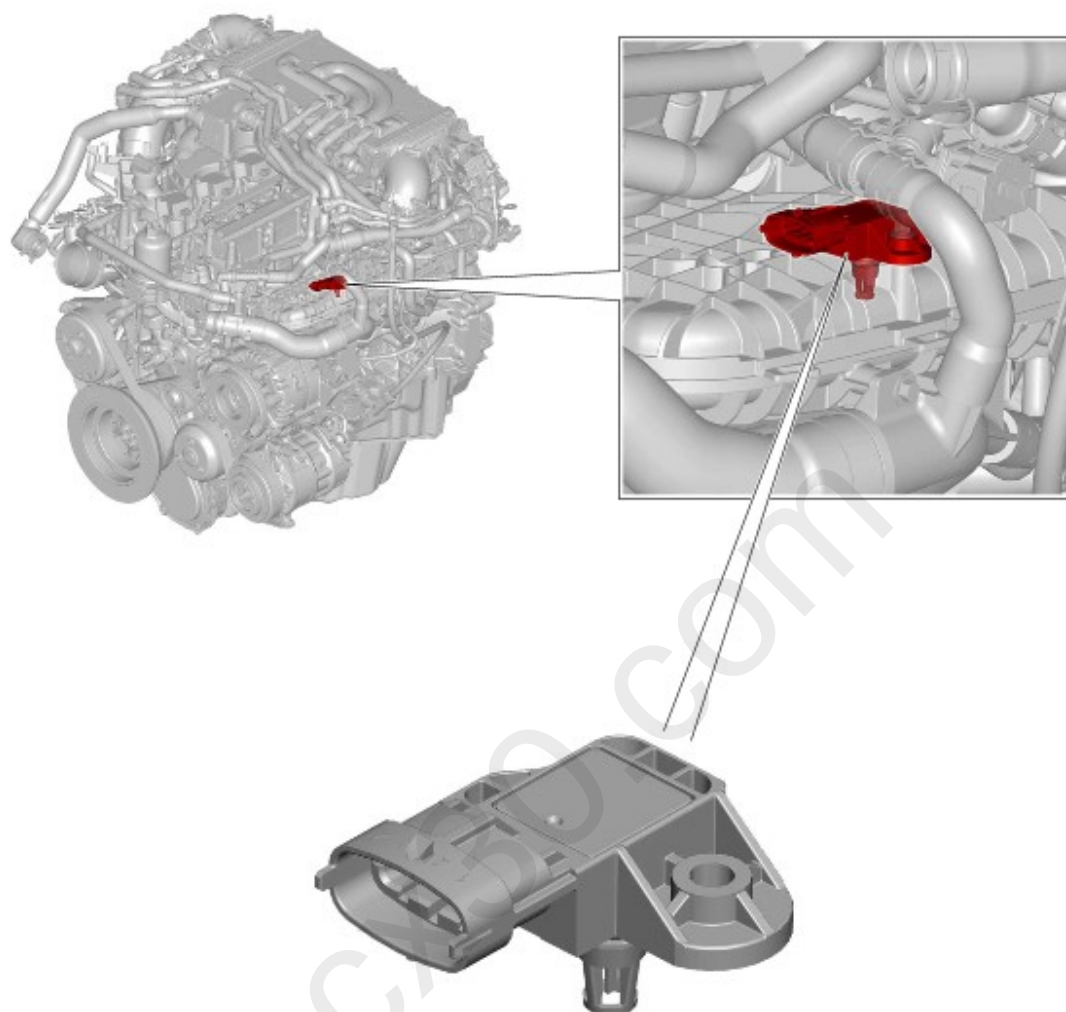
- Difficult starting.
- Engine stalls after starting.
- Delayed engine response.
- Emission control inoperative.
- Idle speed control inoperative.
- Reduced engine performance.

If the temperature sensor of the MAFT sensor fails the PCM uses a default intake air temperature of -5°C (23°F).

In the event of a temperature sensor failure any of the following symptoms may be observed:

- Over fueling
- Idle speed control inoperative.

MANIFOLD ABSOLUTE PRESSURE AND TEMPERATURE SENSOR



E238404

The MAPT is located in the intake manifold. The sensor is secured with a single screw and sealed with an o-ring seal. The sensor provides a voltage signal to the PCM relative to the intake manifold pressure and temperature.

The MAPT has a 4-pin connector.

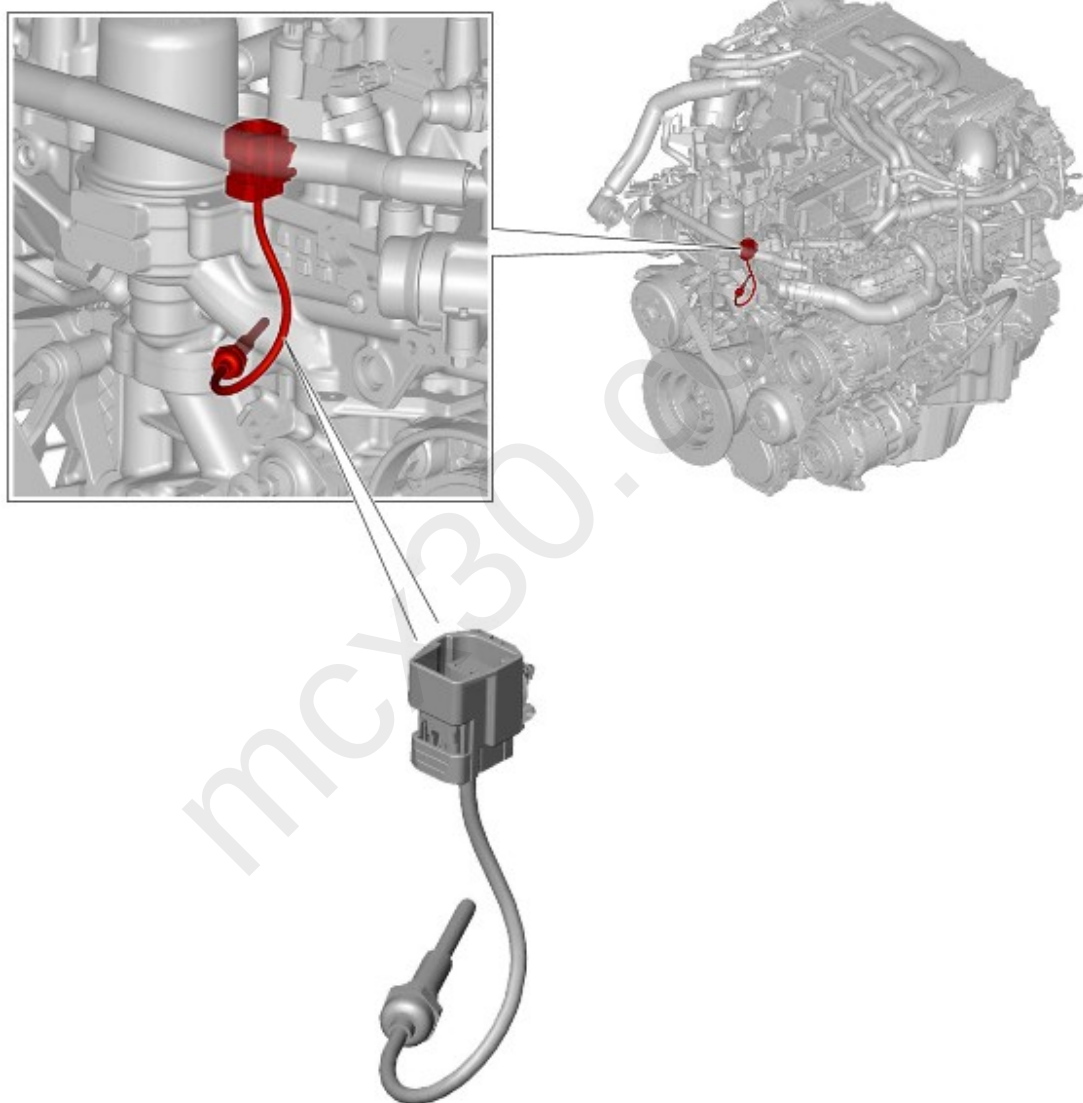
The 4-pin electrical connector provides the following connections:

- A 5V reference voltage from the PCM.
- A pressure signal to the PCM.
- A temperature signal to the PCM.
- A ground connection.

The MAPT allows the PCM to calculate the charge air density immediately before it enters the combustion chamber. This is used to adjust the ignition timing relative to the charge air pressure and to monitor the performance of the charge air cooler.

The MAPT uses a diaphragm transducer to measure the air pressure and a NTC resistor type sensor to measure the temperature.

CYLINDER HEAD TEMPERATURE SENSOR



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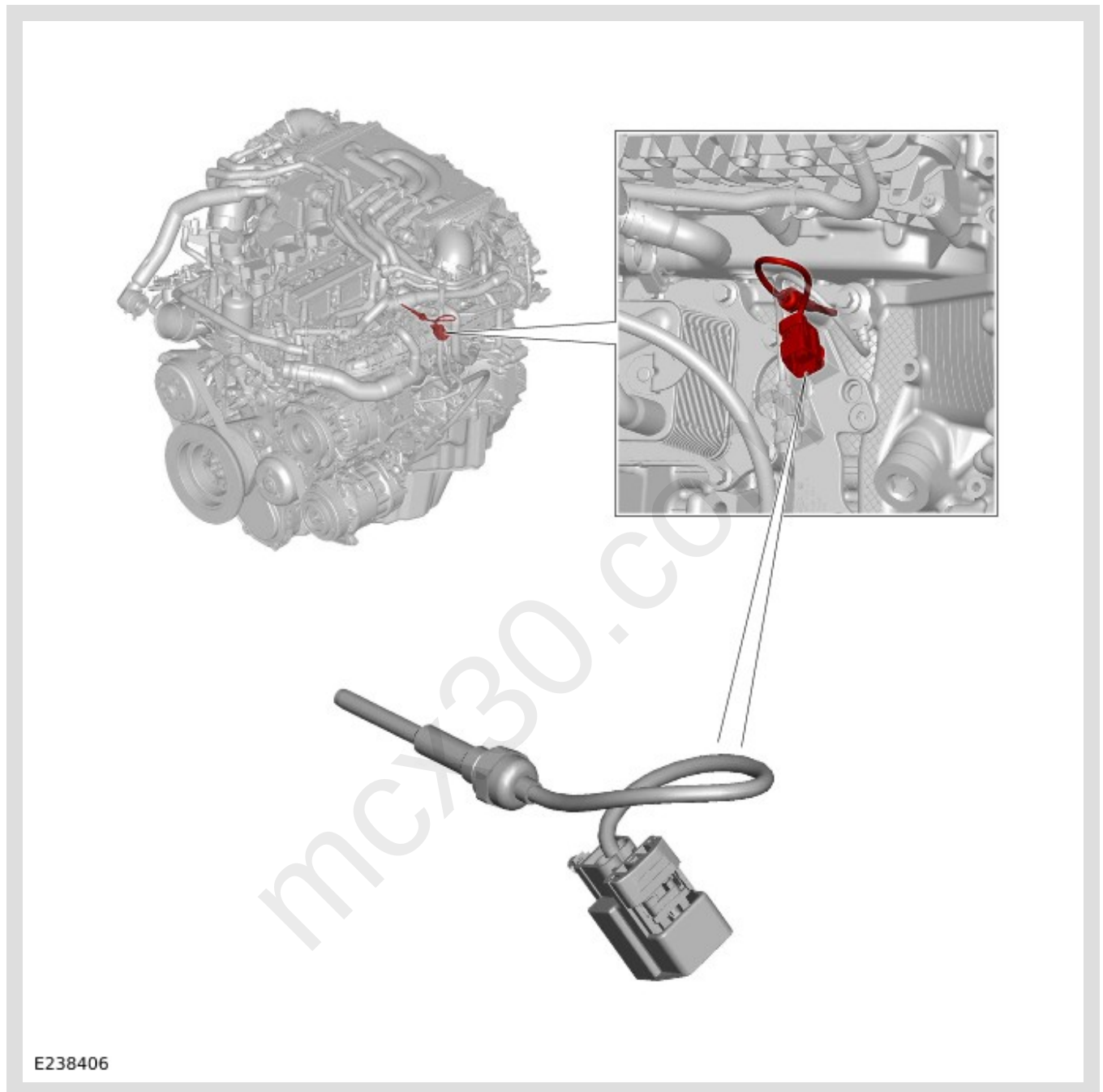
The cylinder head temperature sensor is located in a threaded hole in the front of the cylinder head. The threaded hole is located adjacent to the oil filter housing and the cylinder head engine coolant outlet pipe.

The sensor is a NTC resistor type sensor with a 2-pin connection.

The 2-pin connector provides the following connections:

- A 5V reference voltage from the PCM.
- A cylinder head temperature signal to the PCM.

CYLINDER BLOCK TEMPERATURE SENSOR



The cylinder block temperature sensor is located in a threaded hole on the left side of the cylinder block.

The sensor is a NTC resistor with a 2-pin connection.

The 2-pin connector provides the following connections:

- A 5V reference voltage from the PCM.
- A cylinder block temperature signal to the PCM.

KNOCK SENSORS



E238407

ITEM	DESCRIPTION
1	Knock sensor - Front
2	Knock sensor - Center
3	Knock sensor - Rear

The knock sensors are piezo-ceramic sensors that allow the PCM to employ active knock control and prevent engine damage from pre-ignition or detonation.

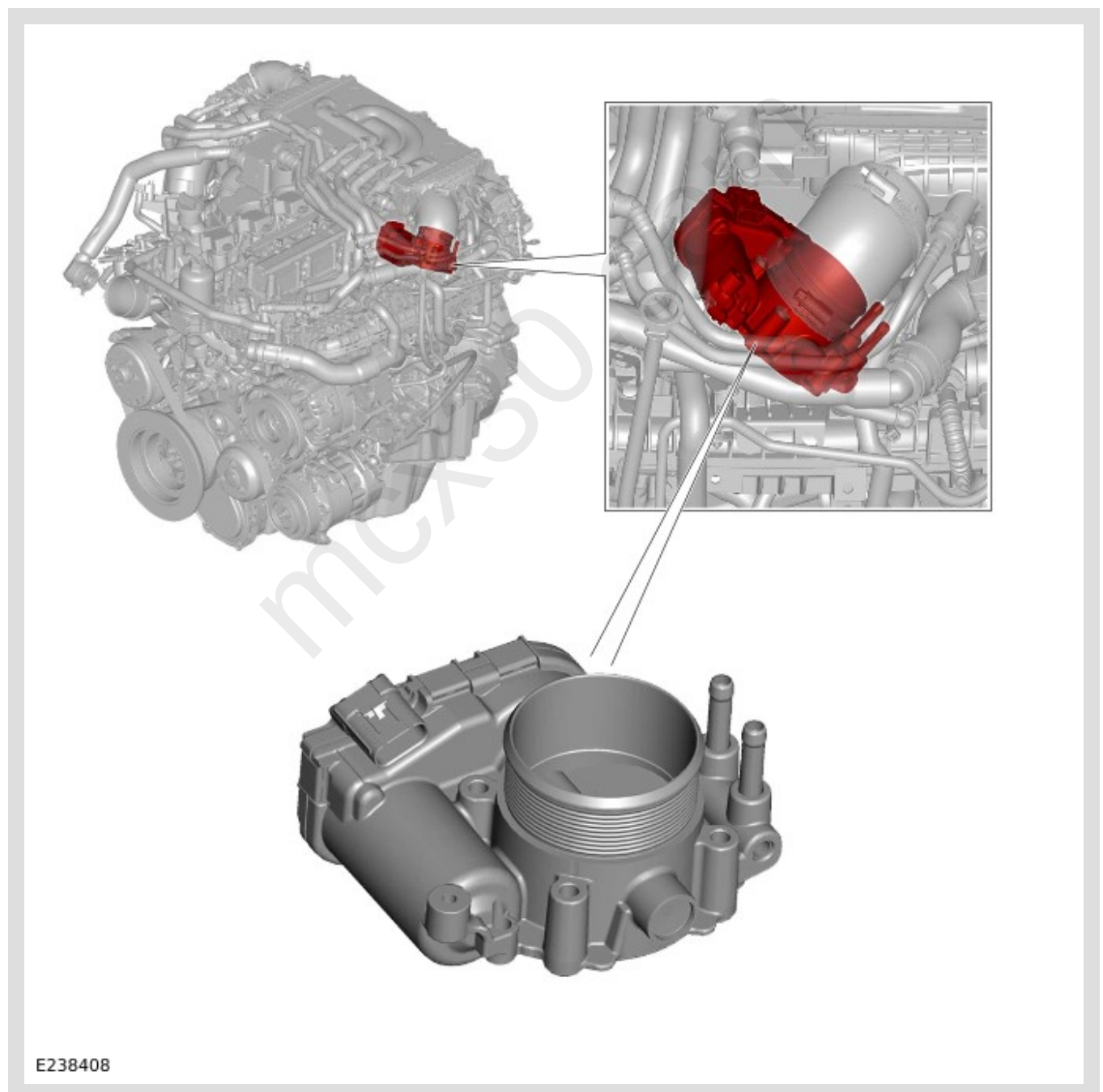
Each knock sensor is secured with a single screw. On each knock sensor, a 2-pin connector provides the interface with the engine harness.

The PCM compares the signals from the knock sensors with preset tables in its memory to determine when detonation occurs. When detonation is detected, the PCM retards the ignition timing on that cylinder and then gradually returns it to the original setting.

The PCM cancels closed loop control of the ignition system if the signal received from a knock sensor becomes implausible. In these circumstances the PCM defaults to base mapping for the ignition timing. This avoids engine damage if low quality fuel is used. The Malfunction Indicator Lamp (MIL) gets illuminated, although the driver may notice that the engine 'knocks' in some driving conditions. The 'knocks' result in a decrease in engine performance and smoothness.

The PCM uses a default stored value if a sensor fails.

ELECTRIC THROTTLE



The PCM uses the electric throttle to help regulate engine torque.

The electric throttle is located between the charge air cooler connecting pipe and the intake manifold. The electric throttle is secured to the manifold with 4 bolts.

The electric throttle comprises the throttle body and a round throttle butterfly valve. The throttle butterfly valve is actuated by a Direct Current (DC) motor. The electric throttle is controlled by the PCM which receives positional signals from the Throttle Position Sensor (TPS).

If a failure of the motor occurs, the throttle butterfly valve is returned to an emergency position by springs. The throttle butterfly valve remains partially open with limited engine speed available to the driver.

The electric throttle has a 6-pin connector which connect to the PCM.

The 6-pin connector provides the following connections:

- A 12V supply for the DC motor.
- A ground for the DC motor.
- A 5V reference voltage from the PCM.
- TPS negative signal to the PCM.
- TPS positive signal to the PCM.
- A ground connection.

As the throttle angle increases, the output of the negative sensor decreases and the output of the positive sensor increases.

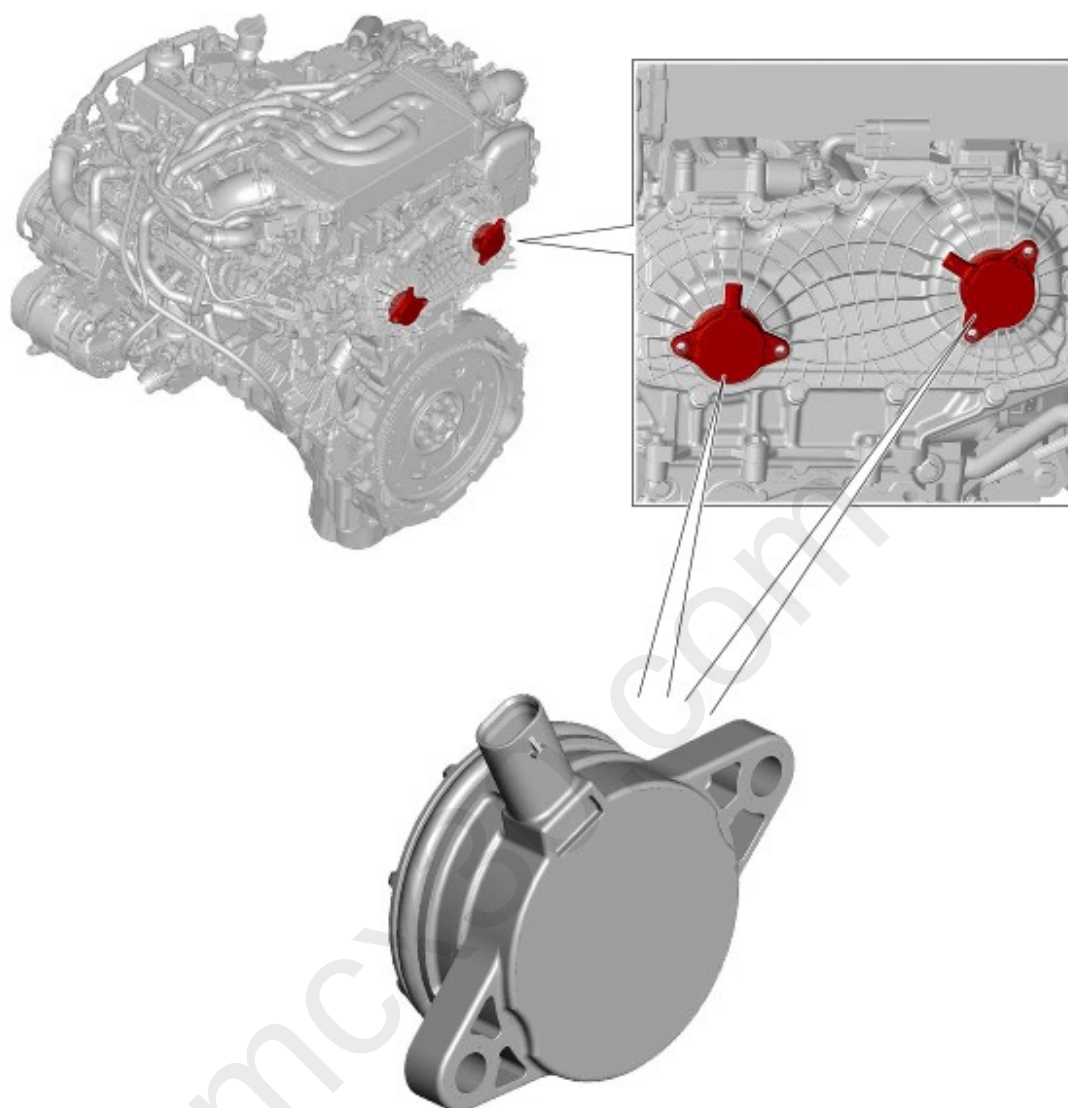
The motor is a DC motor which drives a gear wheel. The motor rotates the spindle to which the throttle butterfly valve is attached. The PCM uses Pulse Width Modulated (PWM) signal to adjust the position of the throttle butterfly valve. The amount of air entering the inlet manifold is regulated by the position of the throttle butterfly valve.

The throttle butterfly valve and the DC motor has 2 maximum positions. The throttle butterfly valve closed which allows minimal air flow through the electric throttle into the intake manifold. The throttle butterfly valve open which allows maximum air flow into the intake manifold.

The PCM calculates the throttle butterfly valve position by comparing the feedback signal from the TPS. The PCM performs a self-test and a calibration routine on the throttle butterfly valve position at each ignition cycle. This is achieved by the PCM powering the DC motor to fully close the throttle butterfly valve and if required, fully open the throttle butterfly valve.

The PCM monitors the DC motor and the TPS for faults and can store fault related DTC. The DTC can be retrieved using a JLR approved diagnostic equipment. In the event of a fault the engine MIL in the Instrument Panel Cluster Control Module (IPC) is also illuminated.

VARIABLE CAMSHAFT TIMING SOLENOID



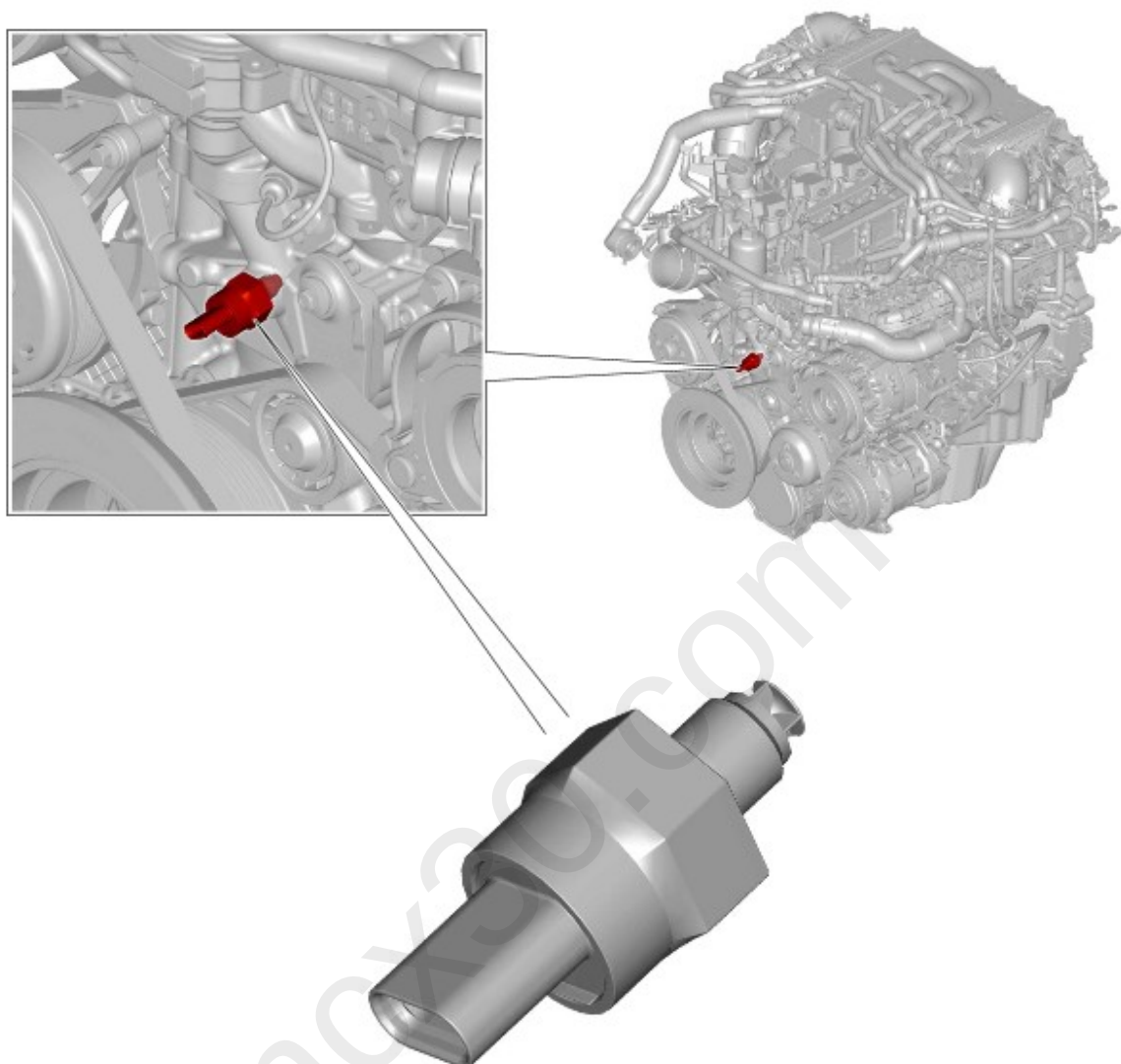
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Each VCT solenoid is located on the timing chain cover and is secured with 2 screws. The VCT allows for the standard camshaft lobe profile to be advanced or retarded for optimum combustion.

The VCT solenoids are controlled by a PWM output from the PCM. The PCM uses signals from the CMPs and determines the position of the VCT actuators. The VCT actuators have a direct interface with the intake and the exhaust camshaft.

Each VCT solenoid incorporates a spindle that acts on the spool valve in the VCT actuator to advance and retard the exhaust camshaft timing.

OIL PRESSURE AND TEMPERATURE SENSOR



E238410

The oil pressure and temperature sensor is located at the front of the cylinder block, under the oil filter and housing assembly. The sensor is located in a threaded hole in the cylinder block.

The oil pressure and temperature sensor has a 3-pin connector.

The 3-pin connector provides the following connections:

- A 5V reference voltage from the PCM.
- An oil pressure and temperature signal output to the PCM.
- A ground connection.

The sensor provides a PWM signal that contains information about the self-diagnosis of the sensor, pressure and temperature. The pressure is measured using a piezo-resistive pressure cell and the temperature is measured using an integrated diode.

The sensor measures pressure between 0.5 bar (7.3 psi) to 10.5 bar (152.3 psi) and temperature between -40°C (-40°F) to +150°C (302°F).

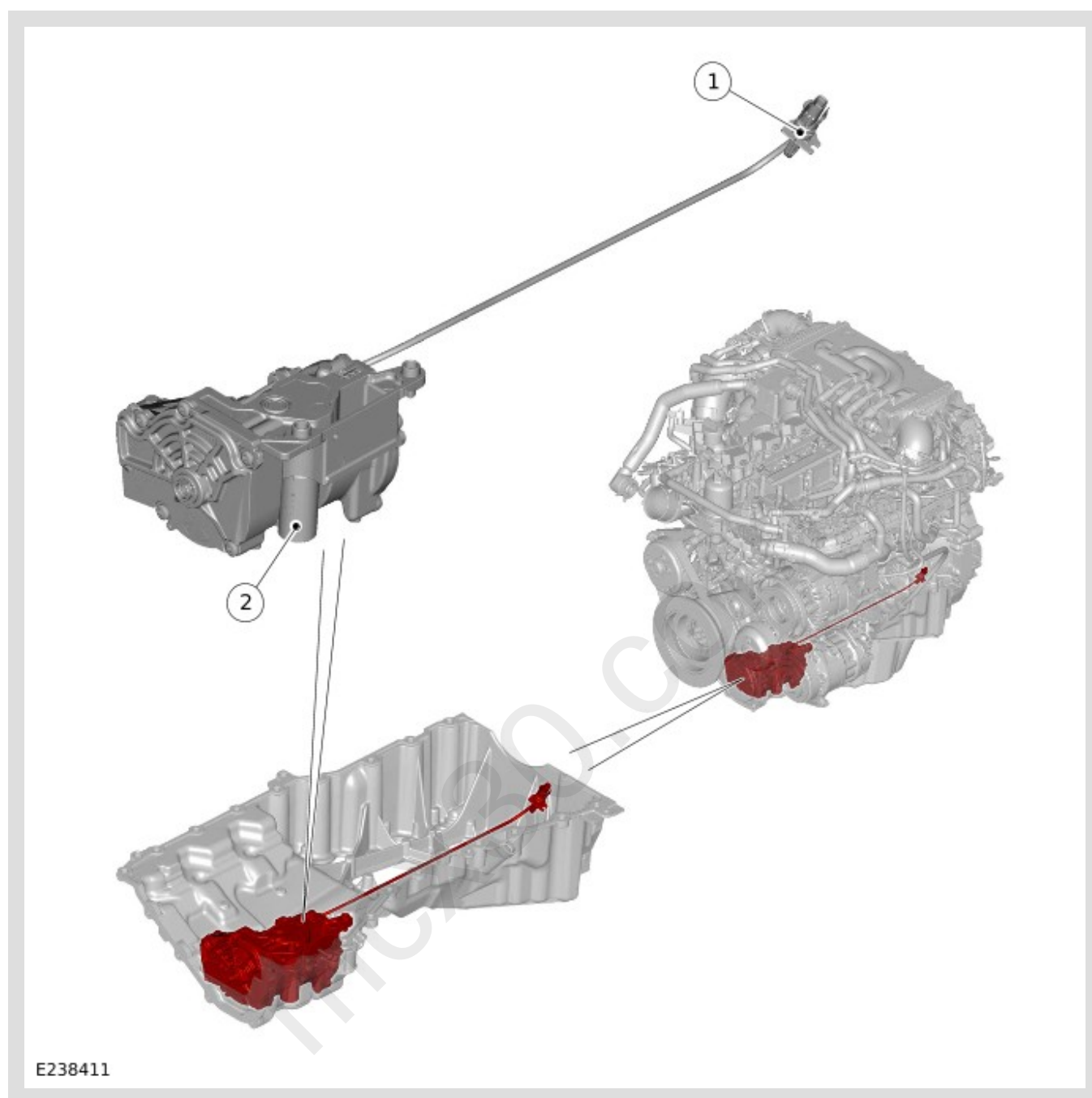
The PCM outputs the engine oil pressure state on the FlexRay systems bus for use by the BCM/ GWM. The BCM/ GWM provides the oil pressure value for the IPC on the High Speed (HS) Controller Area Network (CAN) Human Machine Interface (HMI) systems bus. The signal is used by the IPC to provide oil pressure information to the driver.

In the event of the oil pressure falling below the operating threshold of the sensor:

- The PCM sends a message to display a low oil pressure warning in the IPC message center.
- Illuminates an oil pressure warning indicator in the IPC.

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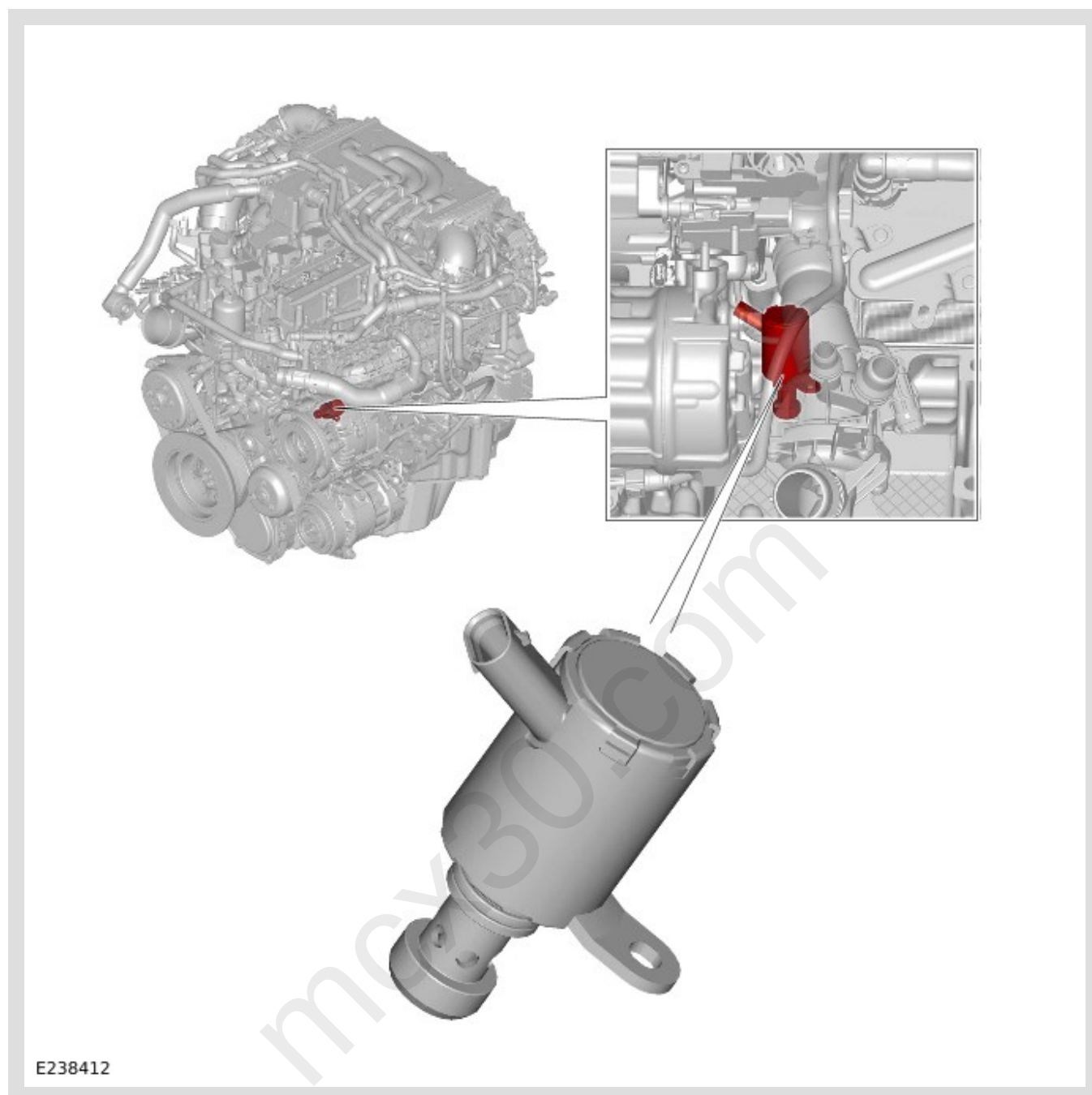
OIL PUMP CONTROL SOLENOID



ITEM	DESCRIPTION
1	Electrical connector
2	Oil pump control solenoid

The oil pump control solenoid is located at the front of the oil pump and connected to the PCM through hardwired connection. The oil pump control solenoid receives a 12V power supply from the Engine Junction Box (EJB). The PCM controls the operation of the oil pump control solenoid valve by controlling the ground path for the solenoid. When the PCM energizes the oil pump control solenoid at low engine speed and loads, the oil pump switches to the low pressure mode. The low pressure mode reduces pumping losses within the oil pump and optimizes the fuel economy.

PISTON COOLING OIL JET SOLENOID

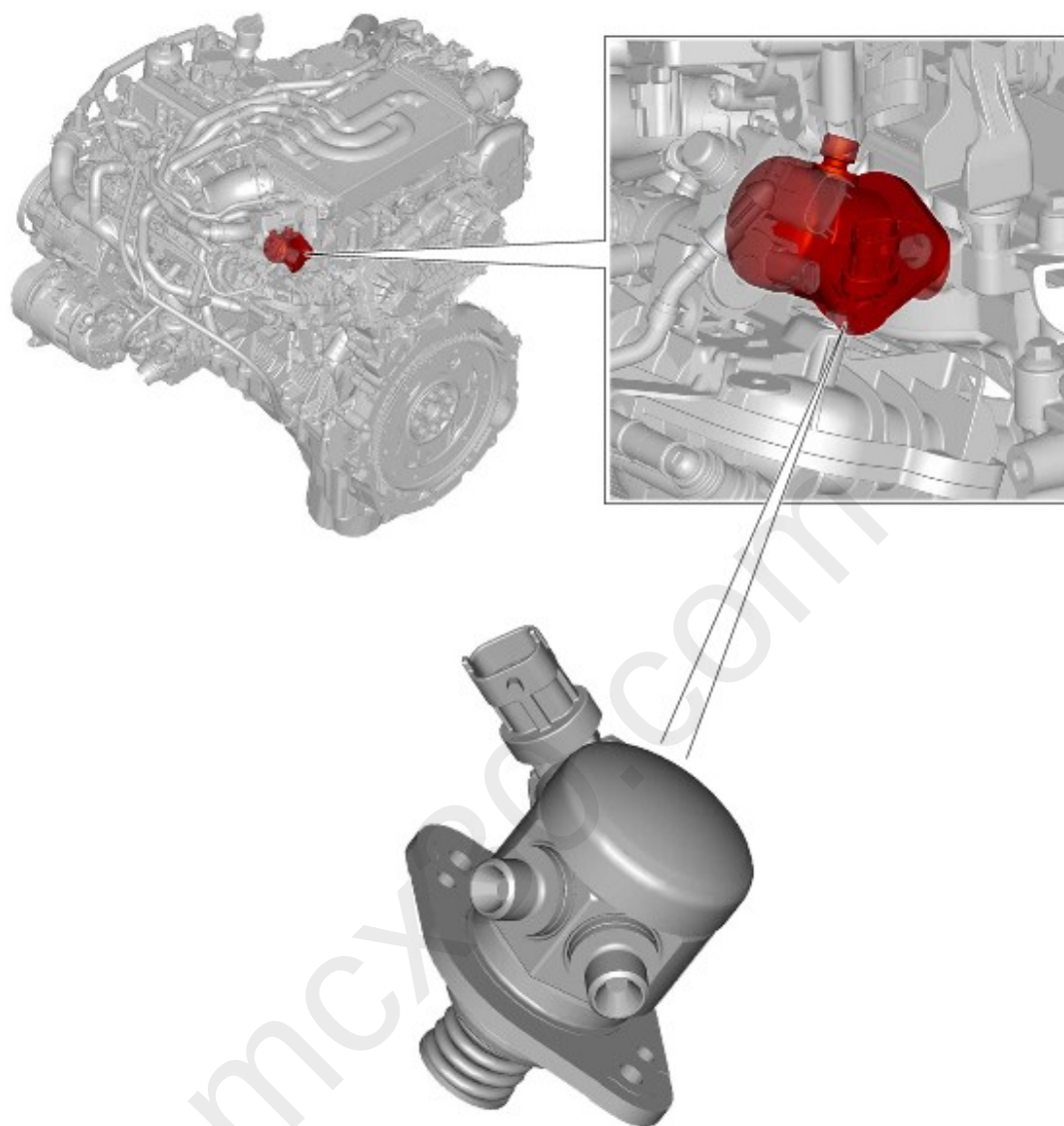


The piston cooling oil jet solenoid is located on the left side of the cylinder block, below the electric throttle. The piston cooling oil jet solenoid is located in a port in the cylinder block and sealed with an o-ring seal. A screw secures the piston cooling oil jet solenoid in the cylinder block.

The piston cooling oil jet solenoid controls the oil supply through a drilling in the cylinder block to the piston cooling oil jets. The piston cooling oil jet solenoid is a 2 stage device and controlled by the PCM. The piston cooling oil jet solenoid can open and close the oil supply to the piston cooling oil jets depending on engine speed and load.

The piston cooling oil jet solenoid is normally open and powered closed by the PCM. Any electrical failures in the solenoid circuitry mean that oil gets supplied to the piston cooling oil jets.

HIGH PRESSURE FUEL PUMP



E238413

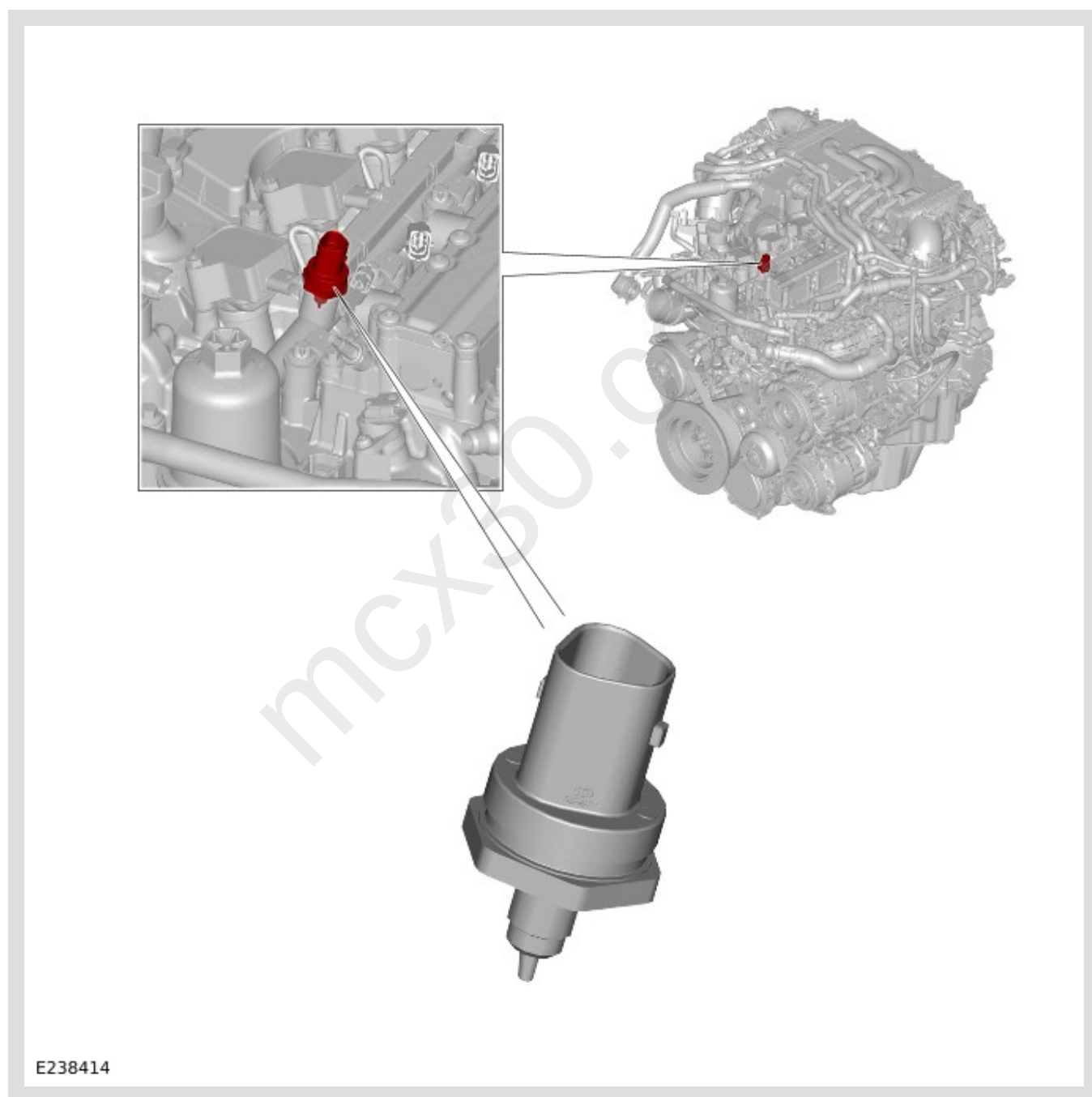
The HP fuel pump is located on the top of the engine. The HP fuel pump is attached to the camshaft carrier with 2 bolts and sealed with an o-ring seal. A protective shield covers the HP fuel pump which is secured to the camshaft carrier with 4 bolts to protect the HP fuel pump from any damage.

The HP fuel pump is mechanically driven by the exhaust camshaft through a plunger. A tappet on the end of the plunger is operated by a 4 lobe cam on the exhaust camshaft. A spring installed on the outside of the plunger holds tight the plunger and the tappet remains in contact with the camshaft. During the downward stroke of the HP fuel pump piston, fuel is delivered to the cylinder at a pressure supplied by the Low Pressure (LP) fuel pump. On the upward stroke of the HP fuel pump piston, the fuel in the cylinder is compressed. If the pressure from the HP fuel pump exceeds the pressure in the fuel rail the fuel is delivered into the fuel rail through a single HP fuel line.

The delivery rate of the HP fuel pump is adjustable by means of a fuel metering valve. The fuel metering valve is controlled by the PCM with a PWM signal.

If the fuel pressure in the fuel rail is sufficient, the PCM opens the fuel metering valve during the compression stroke of the piston. The fuel is then directed from the cylinder back into the low pressure supply to decrease the pressure in the fuel rail. A check valve is located between the fuel rail and the HP fuel pump. This prevents the pressure dropping in the fuel rail due to fuel metering valve operation. The delivered fuel quantity depends on the engine speed and the actuation of the fuel metering valve.

FUEL RAIL PRESSURE AND TEMPERATURE SENSOR



The FRPT sensor is located at the top of the fuel rail. The FRPT sensor is screwed into a threaded hole and sealed with a mating taper in the fuel rail.

The FRPT sensor has a 4-pin connector which is connected to the PCM through the engine harness.

The 4-pin connector provides the following connections:

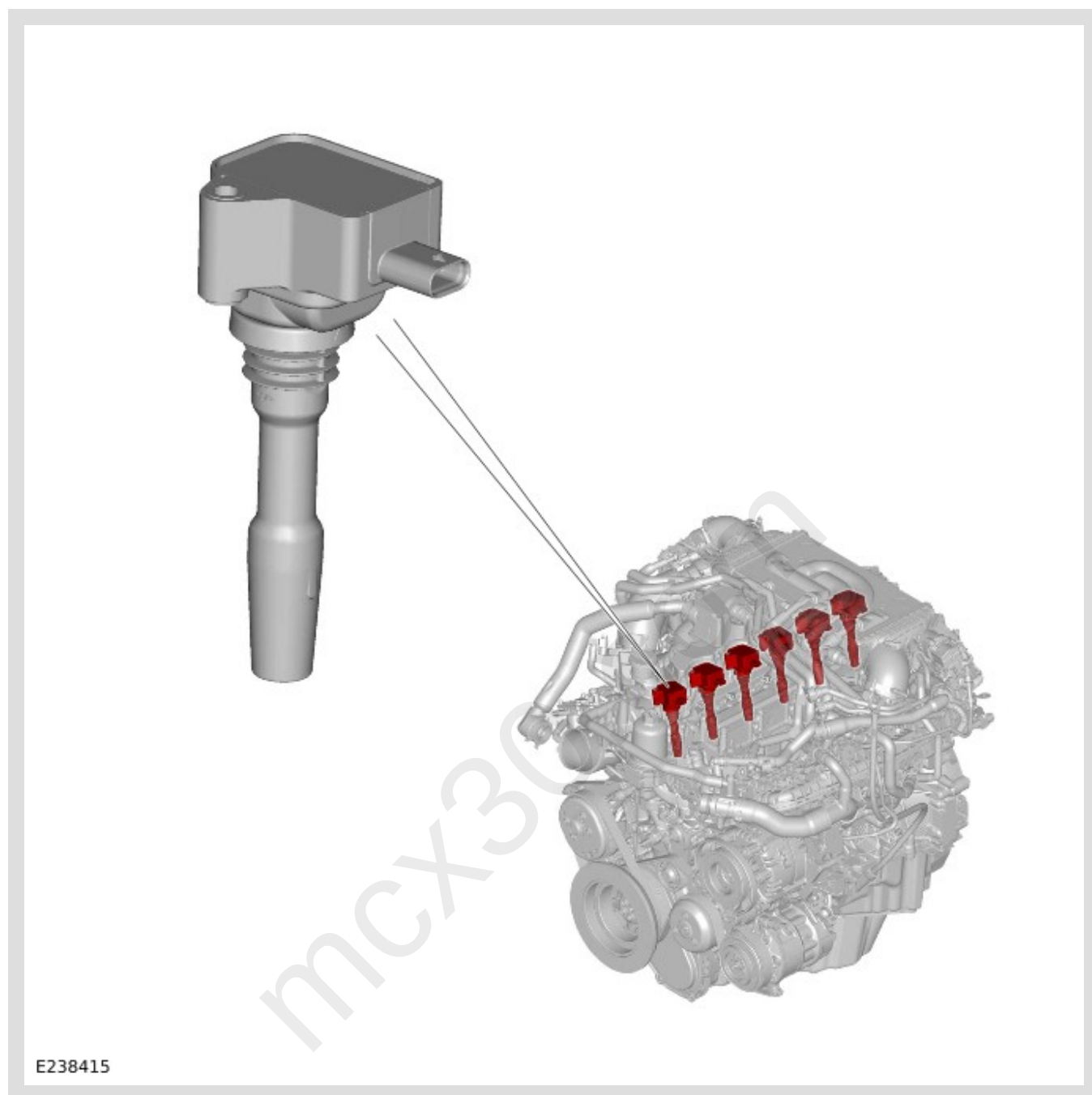
- A 5V reference voltage from the PCM.
- A pressure signal input to the PCM.
- A temperature signal input to the PCM.
- A ground connection.

The FRPT sensor comprises a piezo-resistive type sensor containing an actuating diaphragm. Deflection of the diaphragm provides a proportional signal output voltage to the PCM, dependent on the fuel pressure within the fuel rail.

The temperature sensor is a NTC resistor sensor, which allows the PCM to determine the fuel temperature.

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IGNITION COILS



There are 6 ignition coils installed directly to the spark plugs and they are located in the center of the camshaft carrier. The ignition coils are secured to the camshaft carrier with screws.

The ignition coils each have a 3-pin connector.

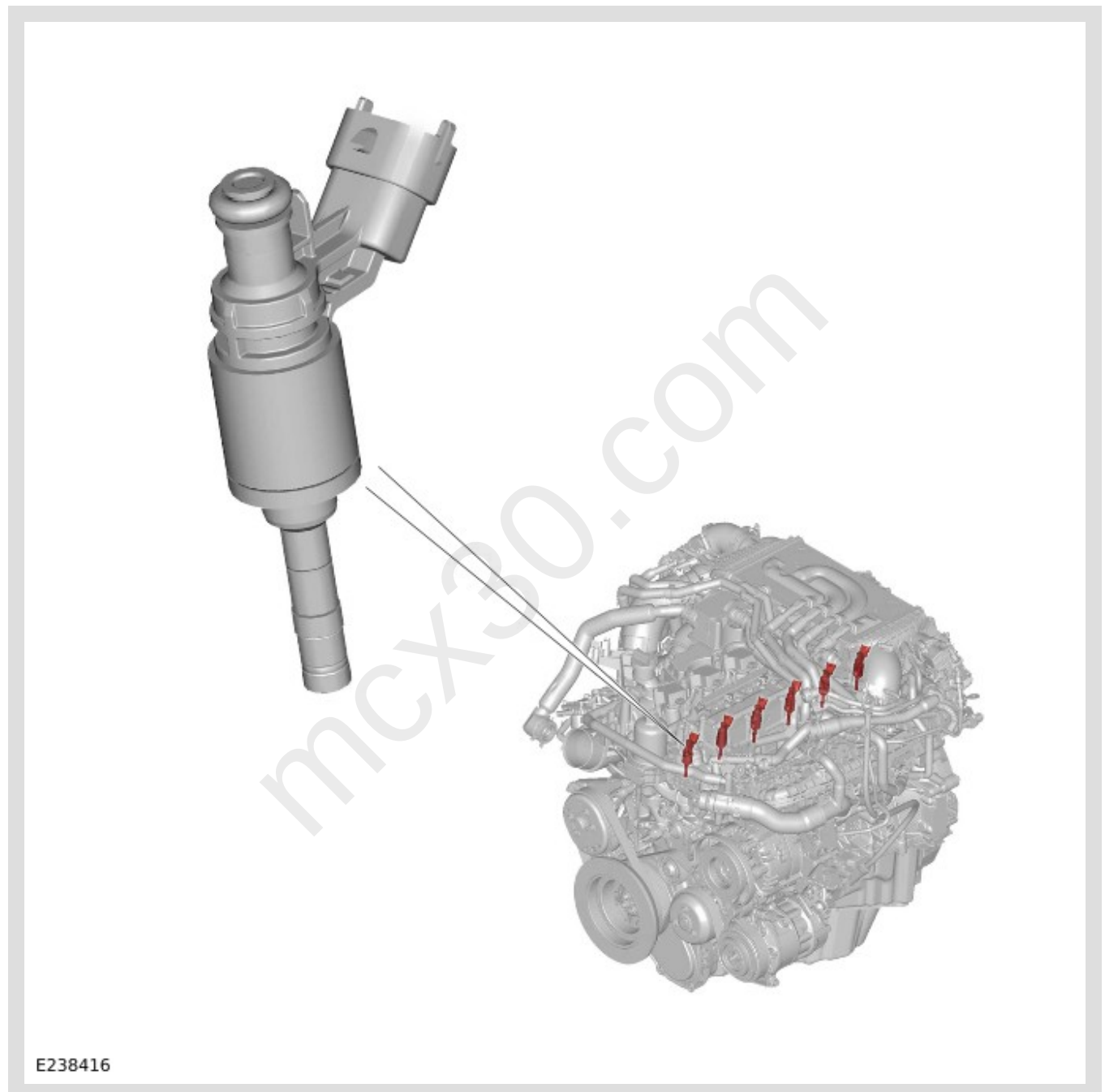
The 3-pin connector provides the following connections:

- A signal wire for the PCM to operate the coil.
- A fused 12V power supply from the PCM relay. The PCM relay is located in the EJB.
- To a splice in the harness with a ground connection.

Each ignition coil contains a power stage which controls the primary current. The PCM controls the spark timing and production by switching the power stage of each ignition coil to ground. This method allows to the coil to charge up and then produce a spark at the spark plug at the appropriate time.

The PCM monitors the ignition coil control wires for faults and can store fault related DTC. These DTC can be retrieved using a JLR approved diagnostic equipment.

FUEL INJECTOR



There are 6 fuel injectors located between the cylinder head and the fuel rail. The fuel injectors are sealed in the cylinder head with o-ring seals and held in position by the fuel rail.

The PCM supplies the power supply and the ground connection for each fuel injector. Each fuel injector contains a solenoid operated needle valve, which opens when the solenoid winding is energized. While the needle valve is open, fuel is sprayed into the combustion chamber. The amount of fuel injected and the timing of the injection period is controlled by the PCM using data from other sensors.

The fuel injectors each have a 2-pin connector which is connected to the PCM.

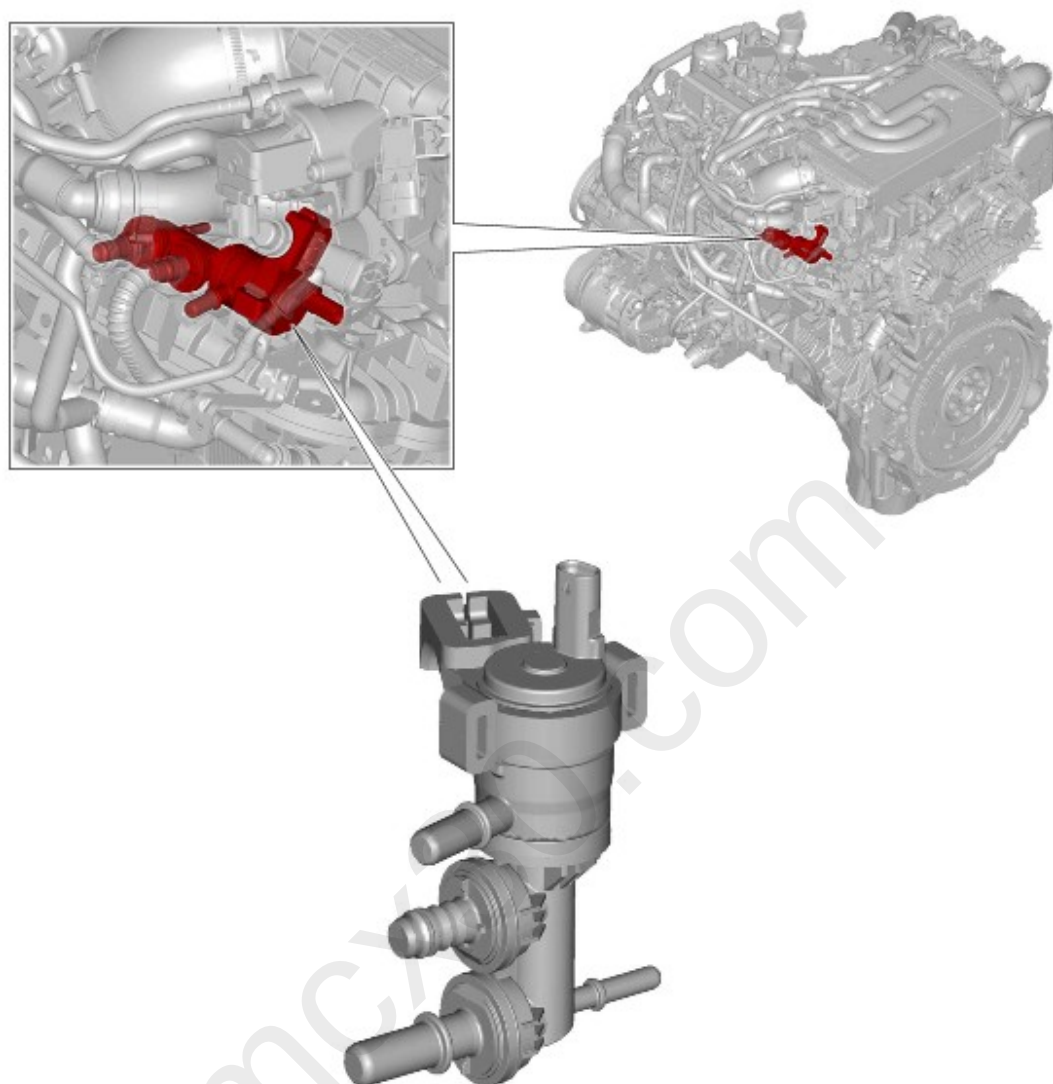
The 2-pin connector provides the following connections:

- An electrical 12V supply from the PCM.
- A ground connection controlled by the PCM.

If a fuel injector fails, the engine suffers from unstable idle speed, poor Noise, Vibration and Harshness (NVH) and poor emissions performance. The MIL in the IPC also becomes illuminated.

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PURGE VALVE



E238417

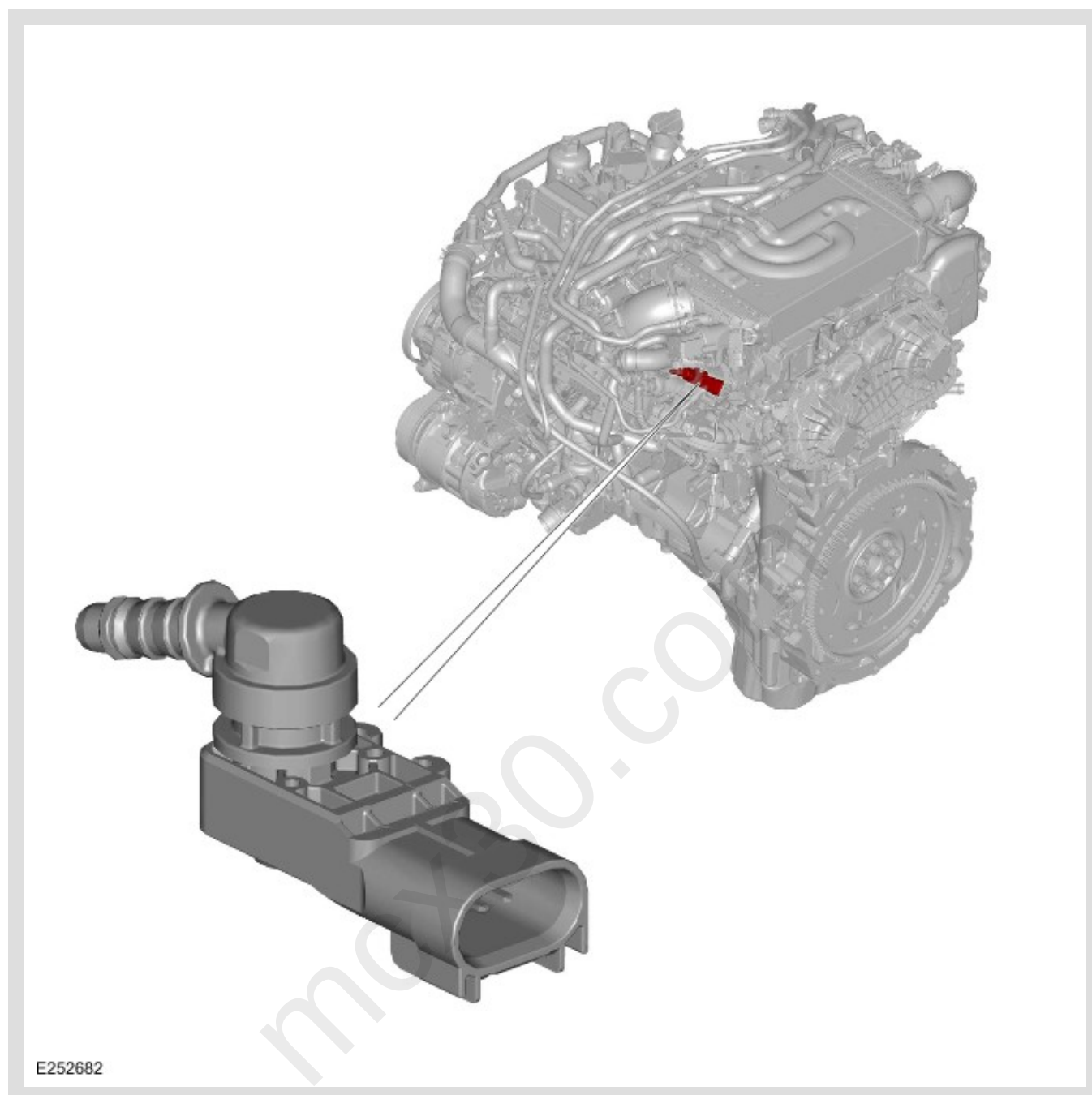
The purge valve is located on the rear left side of the engine. The purge valve is a solenoid operated valve which is closed when de-energized.

The purge valve is controlled by the PCM. The purge valve is operated when the engine operating conditions are correct to allow purging of the evaporative emission canister.

The purge valve is operated at 10 Hz by a PWM control ground from the PCM. The purge valve receives a fused power supply from the EJB. The valve operates at a duty cycle of between 7% and 100%.

Atmospheric pressure in the evaporative emission canister is higher than the pressure at the turbocharger inlet under all throttle settings and engine running conditions. This pressure differential allows vapor to be drawn from the evaporative emission canister, through the open purge valve and into the turbocharger air intake.

PURGE VALVE PRESSURE SENSOR



The purge valve pressure sensor is located on the side of the engine, adjacent to the purge valve. The purge valve pressure sensor is secured to the purge valve mounting bracket.

The purge valve pressure sensor monitors the pressure within the purge valve continuously, to detect hydrocarbon leakage during the engine operation. The pressure signals from the purge valve pressure sensor are compared with the predicted values within the PCM. Then the PCM can determine, if there is a leakage in the fuel vapor system.

The purge valve pressure sensor have a 3-pin connector which is connected to the PCM.

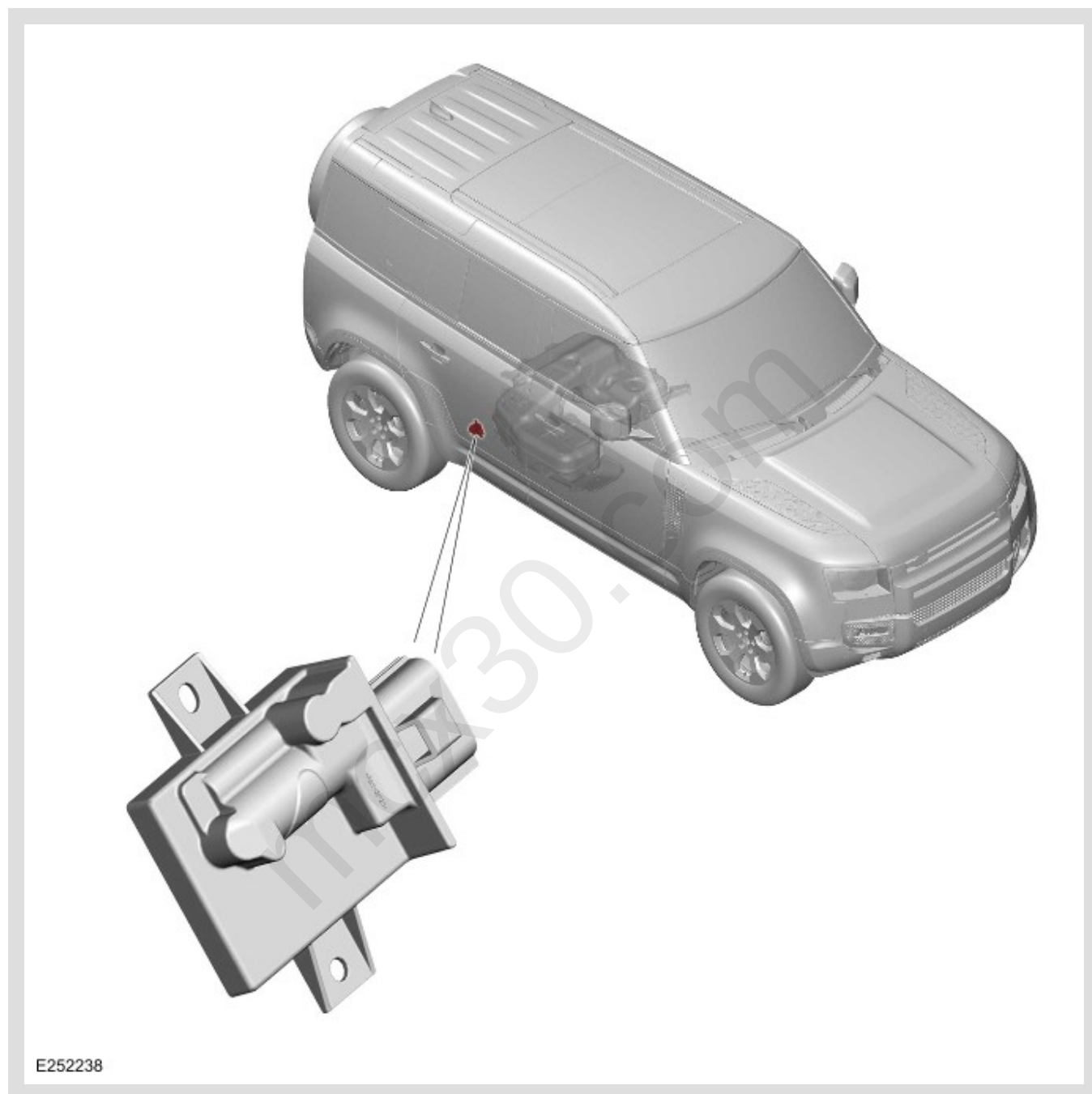
The 3-pin connector provides the following connections:

- An electrical 5V supply from the PCM.
- A pressure signal input to the PCM.

- A ground connection controlled by the PCM.

For additional information, refer to: [Evaporative Emissions](#) (303-13B Evaporative Emissions - INGENIUM I6 3.0L Petrol, Description and Operation).

FUEL PUMP DRIVER MODULE



E252238

The FPDM is located under the floor near the fuel tank.

Operation of the LP fuel pump in the fuel tank mounted fuel pump module is regulated by the FPDM which is controlled by the PCM. The PCM sends a Pulse Width Modulation signal to the FPDM to control the operation of the LP fuel pump, in the fuel tank mounted fuel pump module.

The PWM signal from the PCM tells the FPDM the required speed for the LP fuel pump.

The FPDM only energizes the LP fuel pump if it receives a valid PWM signal, with a duty cycle of between 3.5% and 55%. To switch the LP fuel pump off, the PCM transmits a PWM signal with a duty cycle of 75%.

The FPDM has a switched power supply from the fuel pump relay, located in the Rear Junction Box (RJB).

The following conditions energize the fuel pump relay:

- Opening the driver door.
- Operating the ignition switch.
- Operating the ignition switch with applied brakes - Engine crank.

The FPDM supplies power to the LP fuel pump, in the fuel tank mounted fuel pump module through hardwired connections. The FPDM adjusts the power to control the speed of the fuel pump, thus the fuel pressure and flow in the fuel delivery pipe.

If there is a fault the PCM receives a diagnostic notification signal from the FPDM. Any DTC, produced by the FPDM are stored by the PCM. DTCs can be retrieved from the PCM using the JLR approved diagnostic equipment. The FPDM itself cannot be interrogated by the JLR approved diagnostic equipment.

For additional information, refer to: [Fuel Tank and Lines](#) (310-01B Fuel Tank and Lines - INGENIUM I6 3.0L Petrol, Description and Operation).



E252239

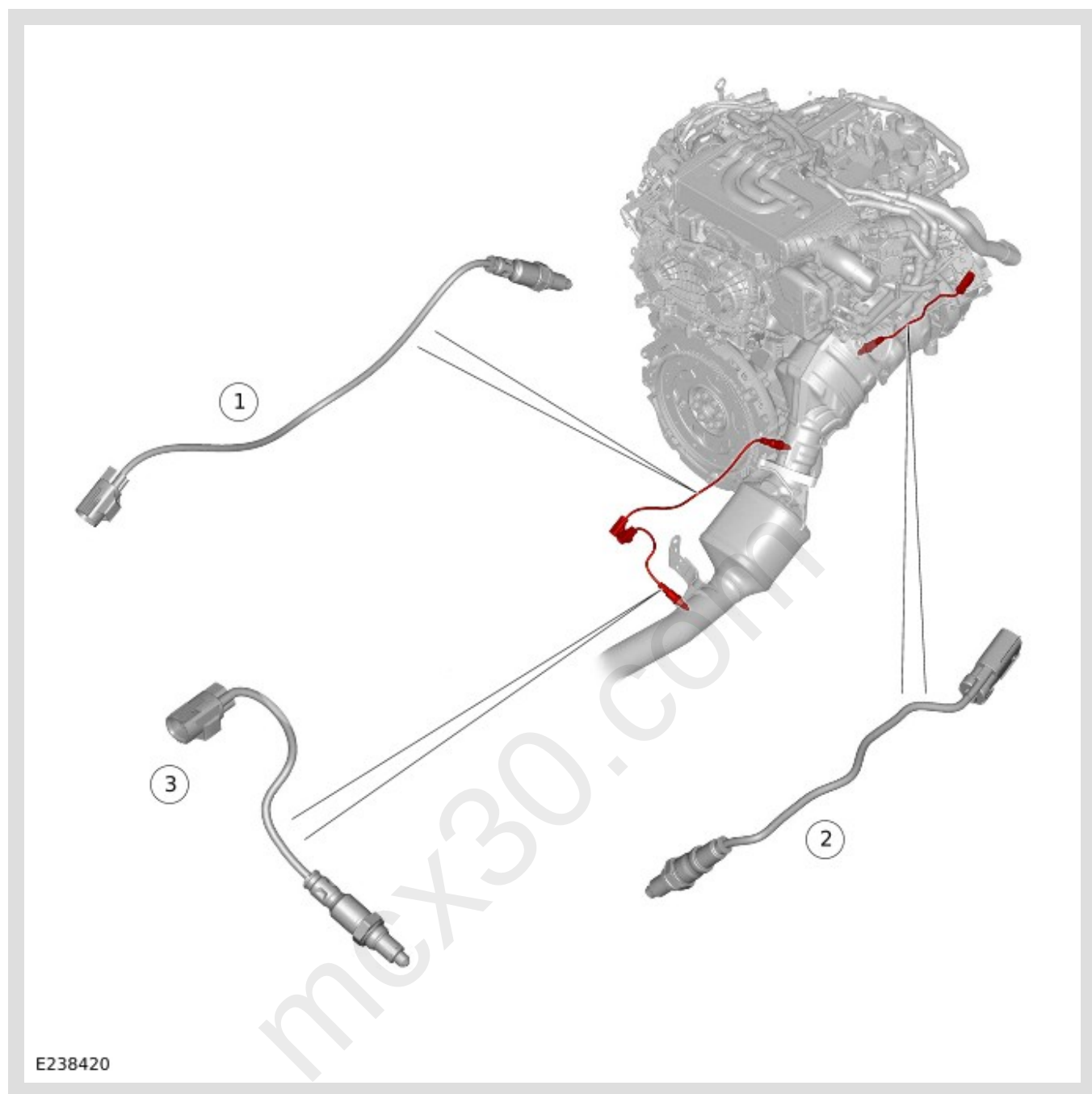
The DMTL pump periodically checks the evaporative emission system and the fuel tank for leaks when the ignition is switched OFF.

The DMTL pump incorporates an electric air pump, a positive temperature coefficient heater element, a normally open changeover valve and a reference orifice. The DMTL pump is only operated when the ignition is switched off and is controlled by the PCM. The PCM also monitors operation of the air pump and the changeover valve for faults.

A connection with the PCM relay in the EJB provides power supply to the DMTL pump. The PCM applies separate ground connections to operate the heater element, the air pump and the changeover valve individually, as required.

For additional information, refer to: [Fuel Tank and Lines](#) (310-01B Fuel Tank and Lines - INGENIUM I6 3.0L Petrol, Description and Operation).

HEATED OXYGEN SENSORS



ITEM	DESCRIPTION
1	HO2S - Mid catalyst
2	HO2S - Pre catalyst
3	HO2S - Post catalyst

The HO2S allows the PCM:

- To measure the oxygen content of the exhaust gases.
- To control the fuel/air mixture.

- For long and short fuel trim calculation.
- For catalytic converter monitoring.

The pre catalyst HO2S is installed in the outlet of the exhaust manifold, which enables independent control of the fuel /air mixture for each combustion chamber. The mid catalyst HO2S is installed in a central position on the side of the catalytic converter. The post catalyst HO2S is installed in the catalytic converter outlet pipe in the exhaust system. These enable the performance of the catalytic converter to be optimized and monitored.

The HO2S needs to operate at high temperatures in order to function correctly. To achieve the required high temperatures, the sensors are installed with heater elements that are controlled by a PWM signal from the PCM. The heater elements are operated after each engine start, when it has been calculated that there is no moisture in the exhaust. The calculation causes a delay between 0 and 10 minutes.

The time period for operation of the heater elements is determined by the temperature of the post catalyst HO2S. The PWM duty cycle is carefully controlled to prevent thermal shock to cold HO2Ss. A non-functioning heater delays the sensors readiness for closed loop control and increases emissions.

The pre catalyst HO2S produce a constant voltage, with a variable current that is proportional to the lambda ratio. The mid and post catalyst HO2S produce an output voltage dependent on the ratio of the exhaust gas oxygen to the ambient oxygen.

The HO2S age with mileage, increasing their response time to switch from rich to lean and lean to rich. This increase in response time influences the PCM 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 pre catalyst sensors.

Diagnosis of electrical faults is continually monitored in pre, mid and post catalyst HO2Ss. This is achieved by checking the signal against maximum and minimum threshold, for open and short circuit conditions.

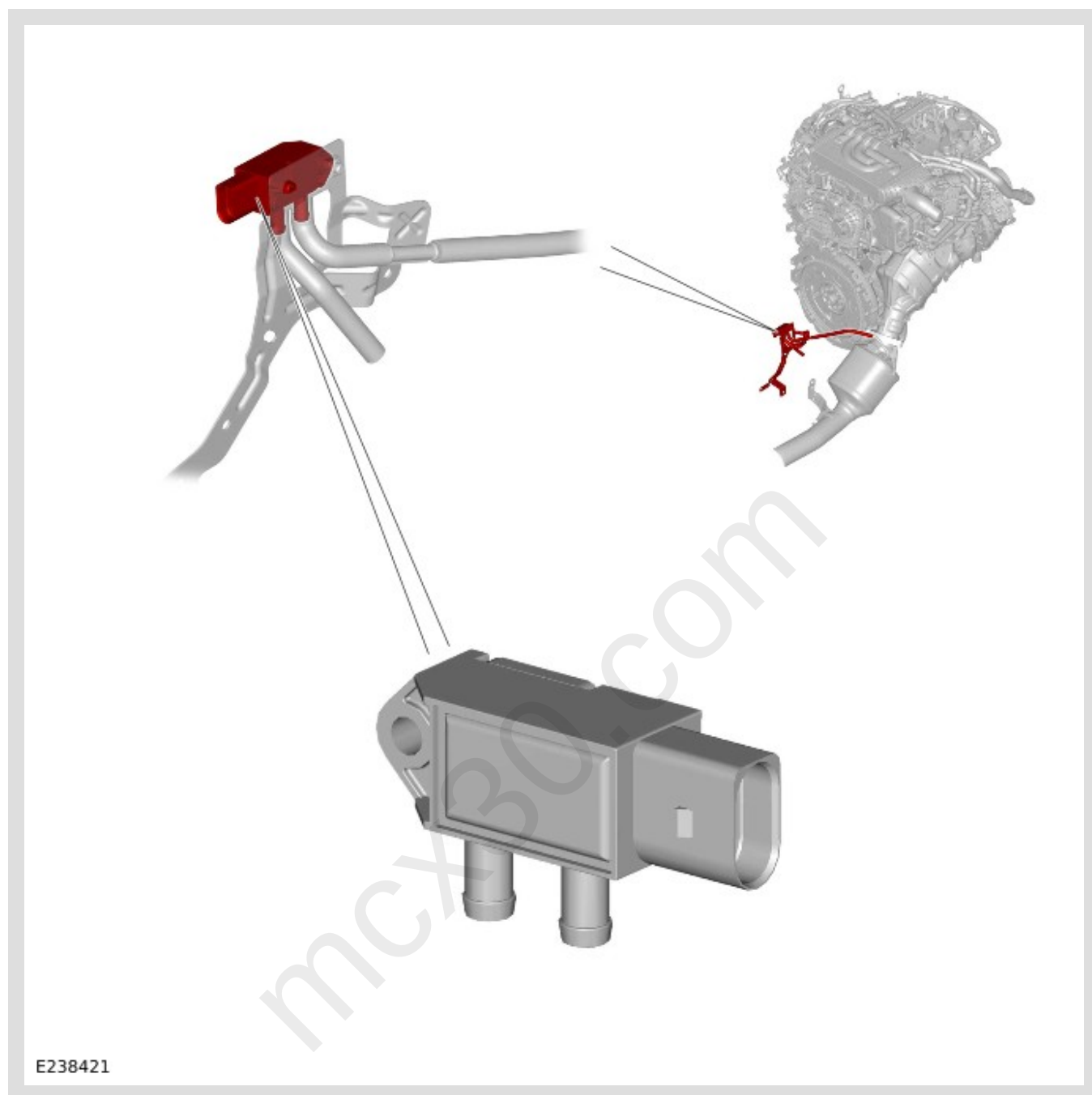
In the event of failure a DTC is recorded within the PCM and the MIL is illuminated.

If a HO2S fails:

- The PCM defaults to open loop fueling.
- The Carbon Monoxide (CO) and emissions content of the exhaust gases may increase.
- Reduced engine refinement and performance.

For additional information, refer to: [Exhaust System](#) (309-00C Exhaust System - INGENIUM I6 3.0L Petrol, Description and Operation).

EXHAUST BACK PRESSURE SENSOR – IF EQUIPPED



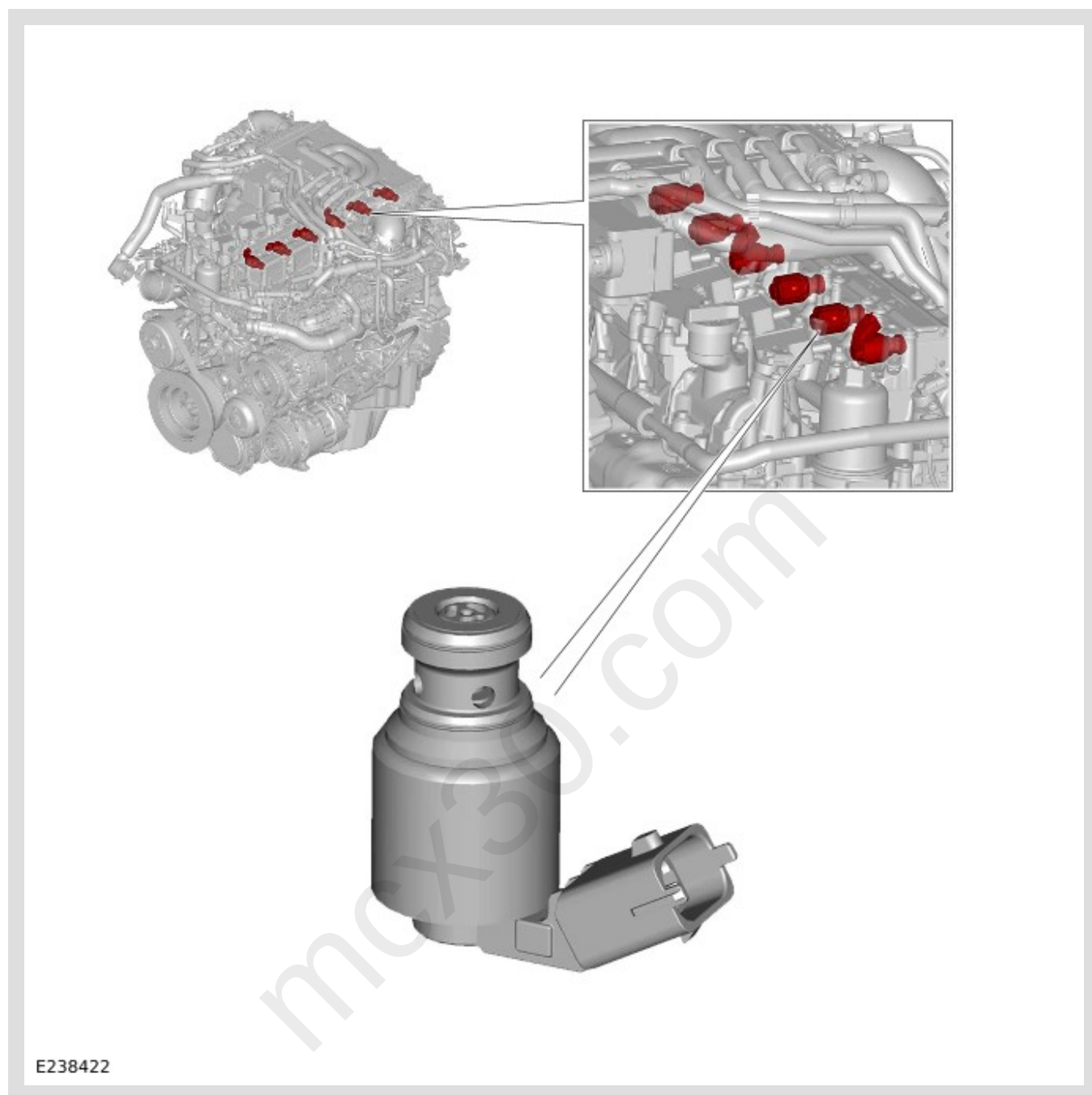
The exhaust back pressure sensor is mounted on a bracket at the rear of the engine.

The exhaust back pressure sensor is to monitor the back pressure in the exhaust system and sends a pressure signal to the PCM.

The output of the exhaust back pressure sensor may be used to start the active regeneration of the Gasoline Particulate Filter (GPF).

For additional information, refer to: [Gasoline Particulate Filter](#) (309-00C Exhaust System - INGENIUM I6 3.0L Petrol, Description and Operation).

CONTINUOUS VARIABLE VALVE LIFT SOLENOID



The 2, non-serviceable Continuous Variable Valve Lift (CVVL) assembly comprises 6 CVVL solenoids which are responsible for the control of the intake valve lift.

The CVVL system converts the camshaft motion into the valve lift through the use of a hydraulic circuit. The variable valve lift system can adjust the valve lift through the use of the oil flow.

The intermediate hydraulic chambers open the valves by means of oil pressure. The oil is allowed to flow to the chambers that actuate the valves dependent on if a solenoid is actuated or not.

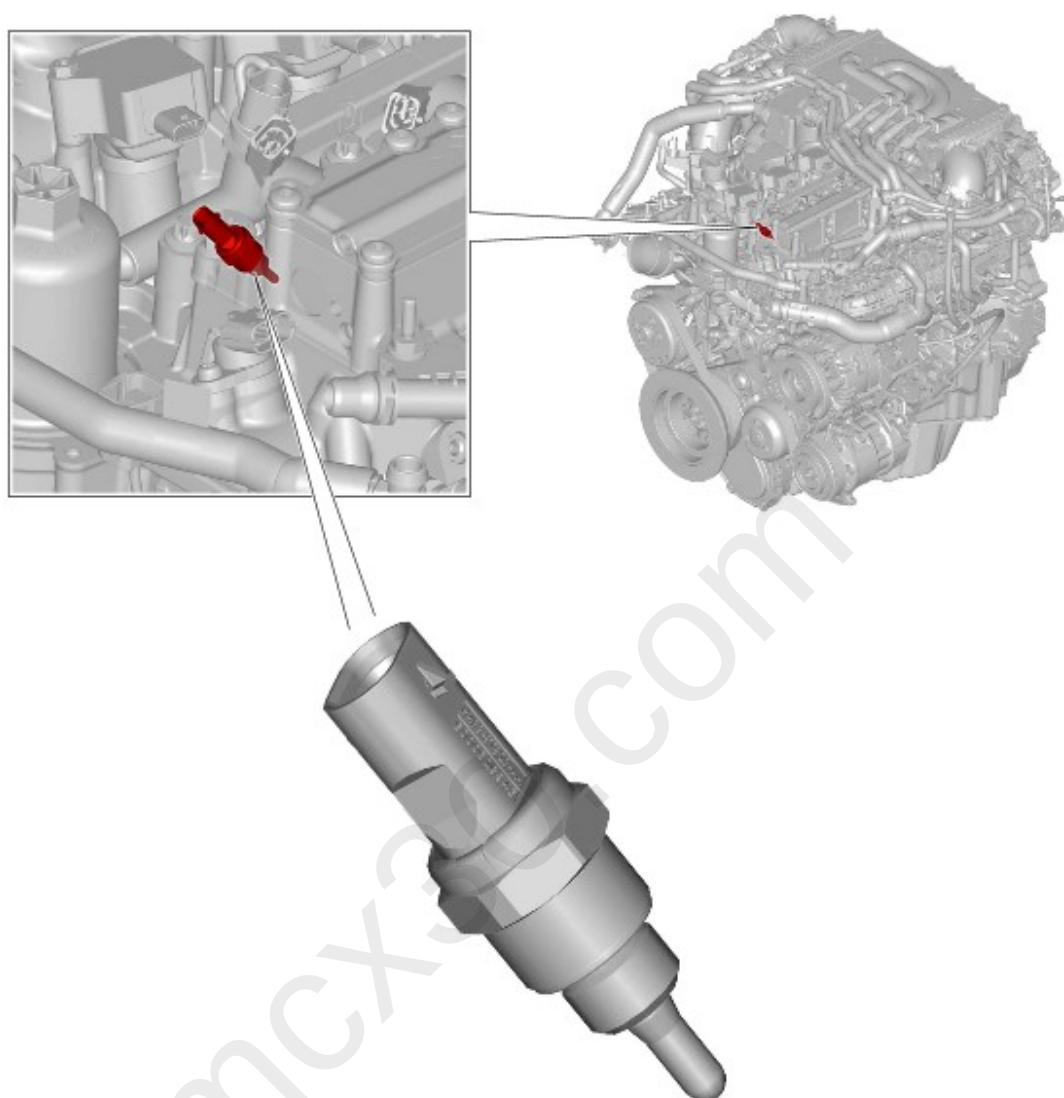
Opening and closing of the solenoid allows the operation of the variable valve lift system in the following 4 different lift modes:

- Full lift mode - The valves are fully opened and closed as normal. The valves are controlled by the camshaft profile. This mode is used at high engine speeds to obtain maximum engine power.
- The late intake valve opening mode - The opening of the intake valves are delayed when starting the engine and during idling. The valves open for a shorter period and at a lower lift providing precise control of the exact amount of air entering the cylinder. As a result fuel economy is improved during idling periods. During a cold start, only a small amount of cold air enters the cylinder, meaning the engine starts more easily.
- The early intake valve closing mode - The intake valves are closed hydraulically before the camshaft profile would normally allow. This reduces pumping losses, increases the engine output per liter and prevents an undesirable backflow of the fuel mixture into the intake ports.
- Composite mode - A combination of the late intake valve opening mode and the early intake valve closing mode.

The CVVL solenoid is controlled by the PCM with PWM signal.

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CONTINUOUS VARIABLE VALVE LIFT ASSEMBLY OIL TEMPERATURE SENSOR



E238423

The Continuous Variable Valve Lift (CVVL) assembly oil temperature sensor is mounted in a threaded hole in the front CVVL assembly. The CVVL assembly oil temperature sensor is a NTC type sensor. The NTC sensor allows the PCM to determine the oil temperature.

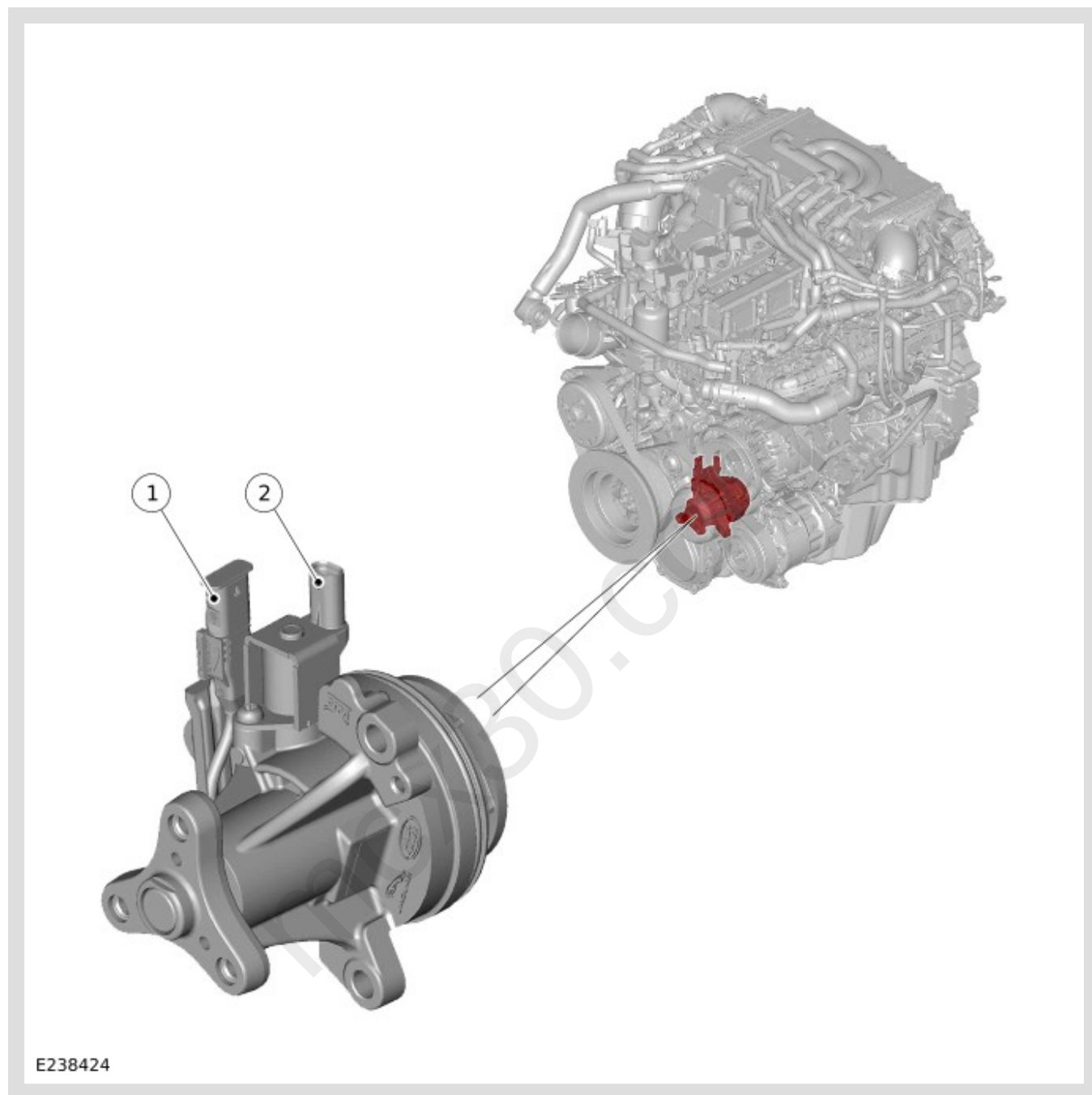
The oil temperature sensor has a 2-pin connector.

The 2-pin connector provides the following connections:

- A temperature signal input to the PCM.
- A ground connection.

The oil temperature sensor data is used by the PCM to determine oil viscosity and allows accurate CVVL solenoid switching time compensation.

VARIABLE COOLANT PUMP



ITEM	DESCRIPTION
1	Variable coolant pump shroud position sensor
2	Variable coolant pump shroud solenoid

The variable coolant pump is installed at the front left of the cylinder block. A pulley attaches to the pump flange. The accessory drive belt drives the pulley at engine speed.

The PCM determines the required level of cooling upon the following inputs:

- Cylinder head temperature
- Cylinder block temperature
- Ambient temperatures
- Engine coolant temperature
- Minimum flow map.

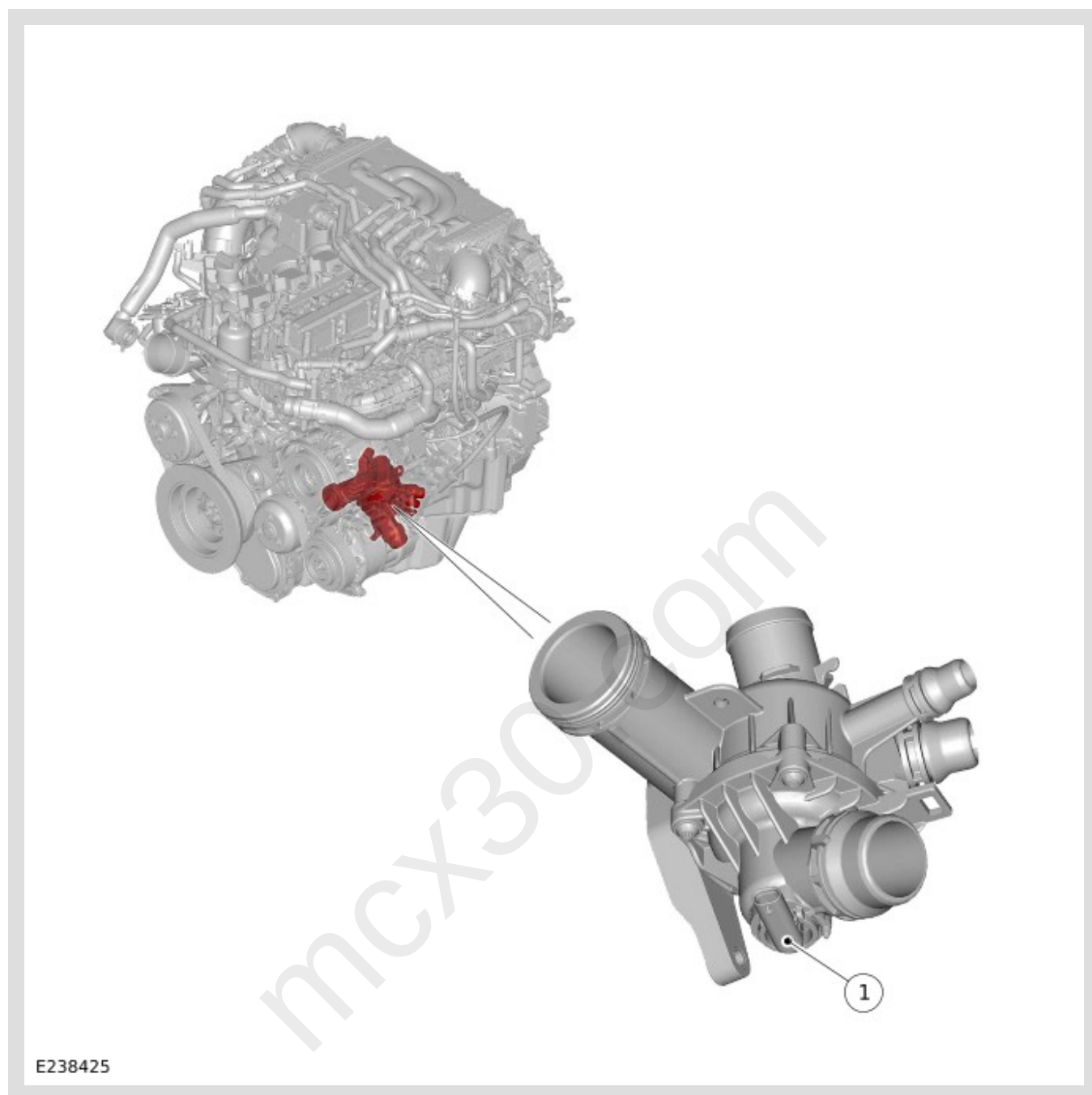
The calibration is able to control the variable coolant pump flow in 5 steps and is controlled by an open-loop map.

The control of the shroud solenoid is by a PWM signal from the PCM. The internal pressure within the pump acts against a return spring in the housing. Without a signal from the PCM the solenoid is de-energized. Therefore the shroud returns to its base position under spring force, resulting in full flow from the coolant pump.

For additional information, refer to: [Engine Cooling](#) (303-03C Engine Cooling - INGENIUM I6 3.0L Petrol, Description and Operation).

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ELECTRIC THERMOSTAT



ITEM	DESCRIPTION
1	Heater element

The electric thermostat is located on the left side of the cylinder block, below the intake manifold.

The electric thermostat independently controls the engine coolant flow in the cylinder block, improving engine warm-up times. The thermostat housing contains a wax expansion element. Inside the wax element is a heater element. When energized the heating element heats the wax element, partially controlling the thermostat function along with engine coolant temperature control. Operation is therefore performed not only by the engine coolant temperature, but as specified by the PCM. This method provides a finer control of the opening and closing of the electric thermostat.

Operation of the electric thermostat is controlled by the PCM upon the following inputs:

- Engine load
- Vehicle speed
- Engine coolant temperature
- Intake air temperature.

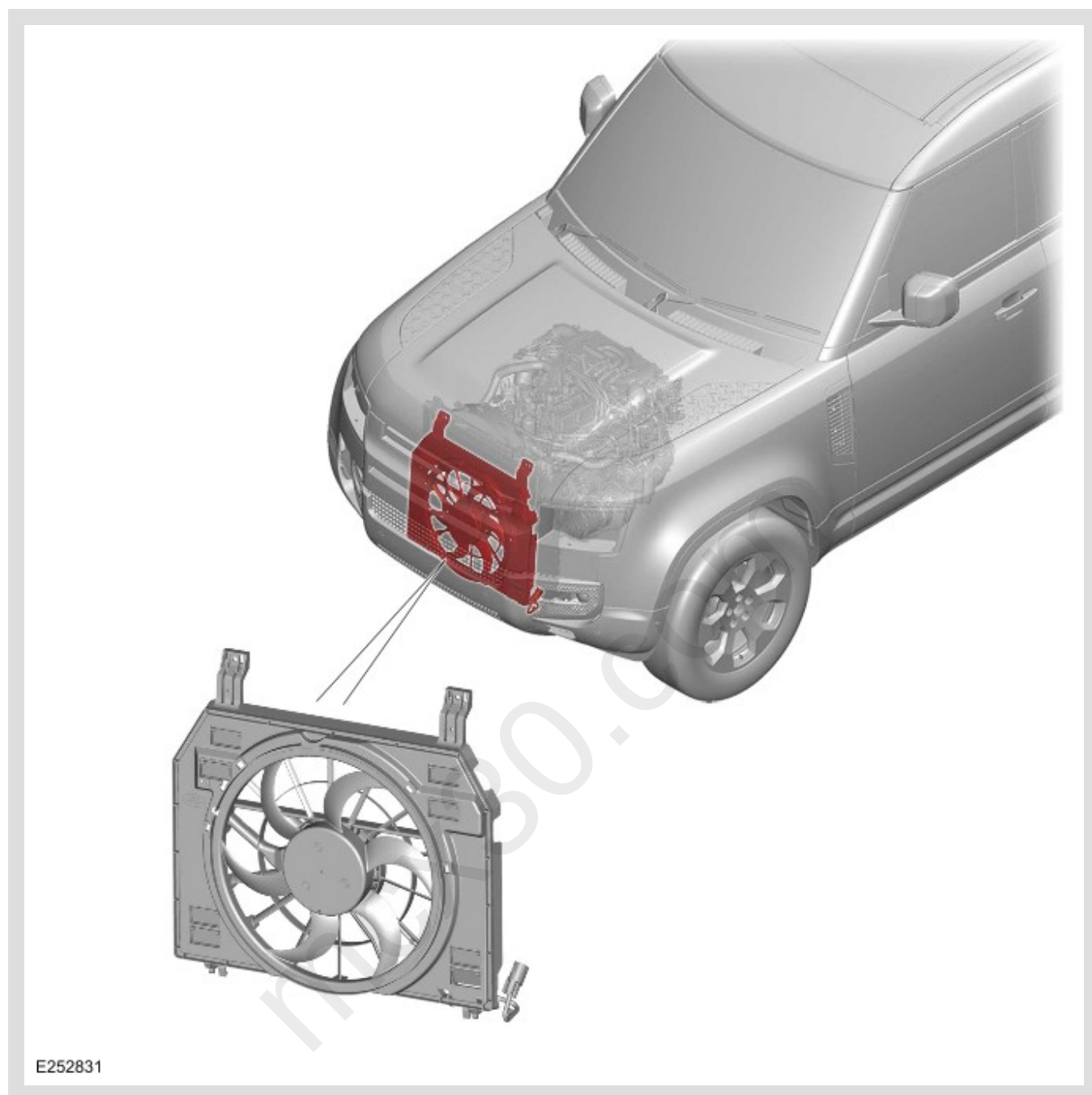
The electric thermostat has:

- A switched power supply from the PCM relay, located in the EJB.
- A ground connection.

When the PCM starts to regulate the system, the PCM supplies a ground path for the heater element in the electric thermostat. This causes the element to expand and increase the opening dimension of the electric thermostat.

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ELECTRIC COOLING FAN CONTROL MODULE



The electric cooling fan is installed in the front of the Air Conditioning (A/C) condenser. The electric cooling fan is operated by the electric cooling fan control module which is integrated into the electric cooling fan motor. The PCM controls the electric cooling fan control module through a PWM signal.

The electric cooling fan control module is provided with:

- Power supply from the EJB
- Ignition signal from the PCM relay in the EJB
- PWM signal from the PCM
- PCM Ground.

To control the electric cooling fan, the PCM varies the duty cycle of the PWM signal. The cooling fan control module translates the duty cycle into a fan target speed and sets the output current to the cooling fan motor accordingly.

The PCM varies the duty cycle of the PWM signal between 0% and 100% to operate the electric cooling fan motor in 1 of 4 modes:

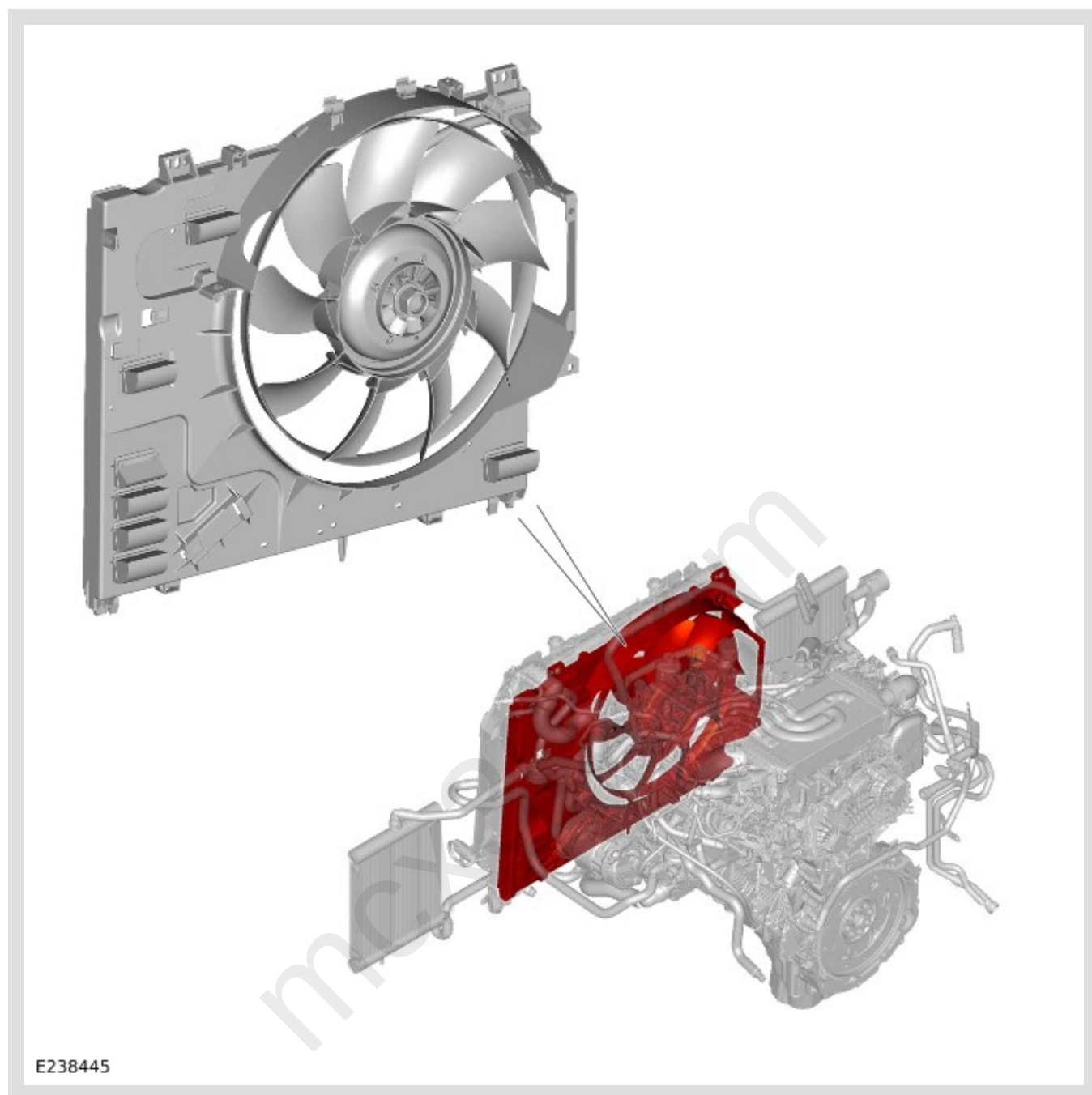
- Off.
- Minimum speed (750 Revolutions Per Minute (RPM)).
- Linear variable speed between minimum and maximum speeds.
- Maximum speed (2,820 RPM).

The engine cooling fan control module incorporates a temperature sensor to prevent damage caused by excessive heat at high ambient temperatures. Operation of the engine cooling fan control module is discontinued if the temperature reaches 135°C (275°F). Operation resumes when the temperature decreases to 120°C (248°F).

For additional information, refer to: [Engine Cooling](#) (303-03C Engine Cooling - INGENIUM I6 3.0L Petrol, Description and Operation).

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VISCOUS COOLING FAN



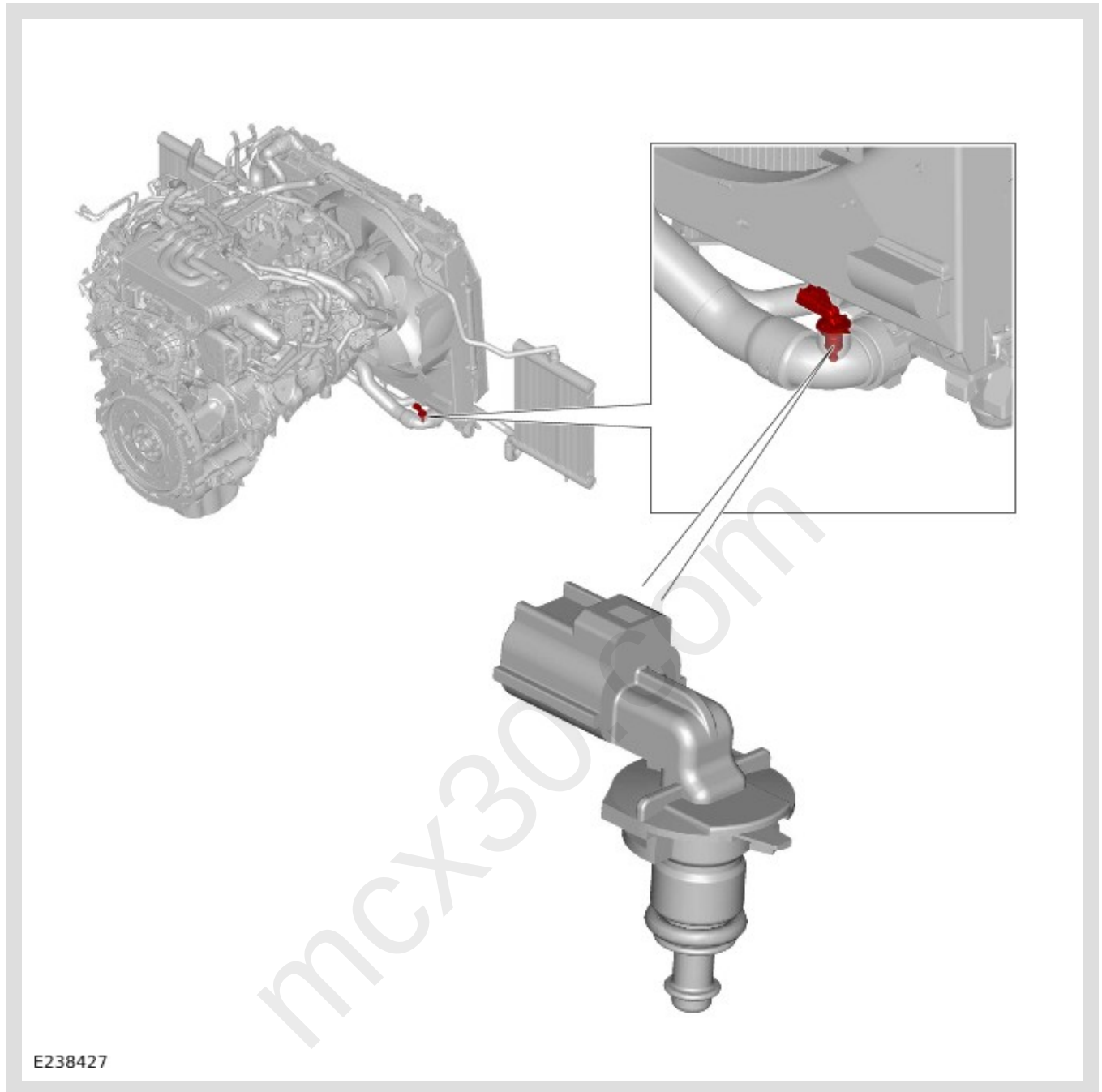
The viscous cooling fan is installed behind the radiator. The viscous cooling fan functions as a normal viscous fan, but with electronic control over the level of engagement of the viscous clutch. The PCM controls the level of engagement to optimize fan speed for all operating conditions.

The viscous cooling fan is provided with:

- Power supply from the EJB
- PWM signal from the PCM
- Ground.

For additional information, refer to: [Engine Cooling](#) (303-03C Engine Cooling - INGENIUM I6 3.0L Petrol, Description and Operation).

ENGINE COOLANT TEMPERATURE SENSOR – RADIATOR OUTLET



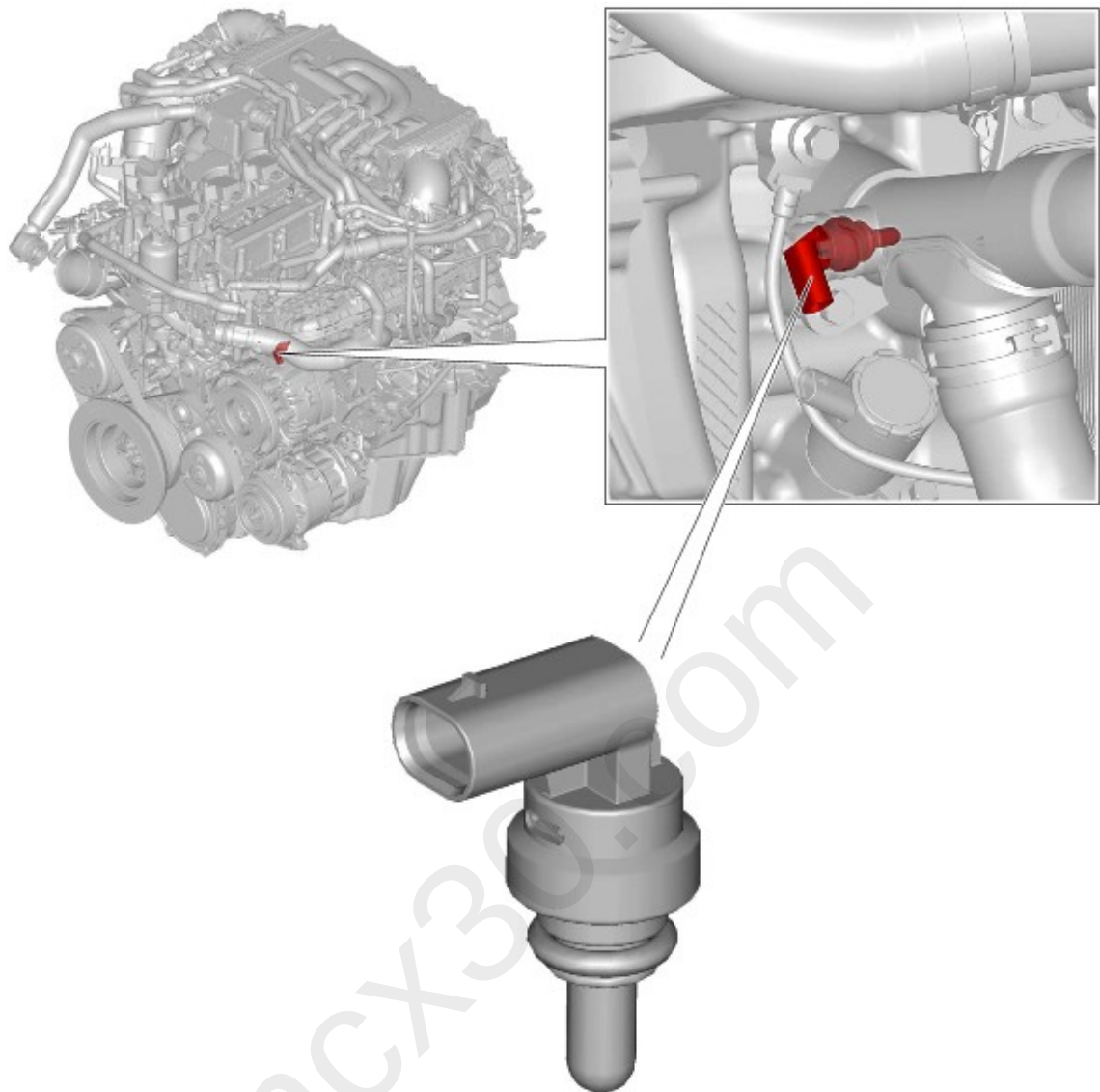
E238427

The Engine Coolant Temperature (ECT) sensor, radiator outlet, is located in the radiator lower hose and is sealed with an o-ring seal. The ECT sensor is a push fit in the radiator lower hose and rotated clockwise to lock in position.

The ECT sensor, radiator outlet, circuit consists of a voltage divider which incorporates a temperature sensor. The temperature sensor is a NTC resistor type sensor. The input to the sensor is a 5V reference voltage supplied through a resistor within the PCM. The ground from the sensor is also connected to the PCM which measures the voltage across the sensor. As the engine coolant temperature rises the resistance of the sensor decreases and vice versa. The PCM calculates the coolant temperature from a map of sensor voltage against temperature.

In the event of the radiator outlet ECT sensor signal failure, the PCM applies a default value of 60°C (140°F) engine coolant temperature. On the second consecutive trip with a sensor fault, the PCM illuminates the MIL.

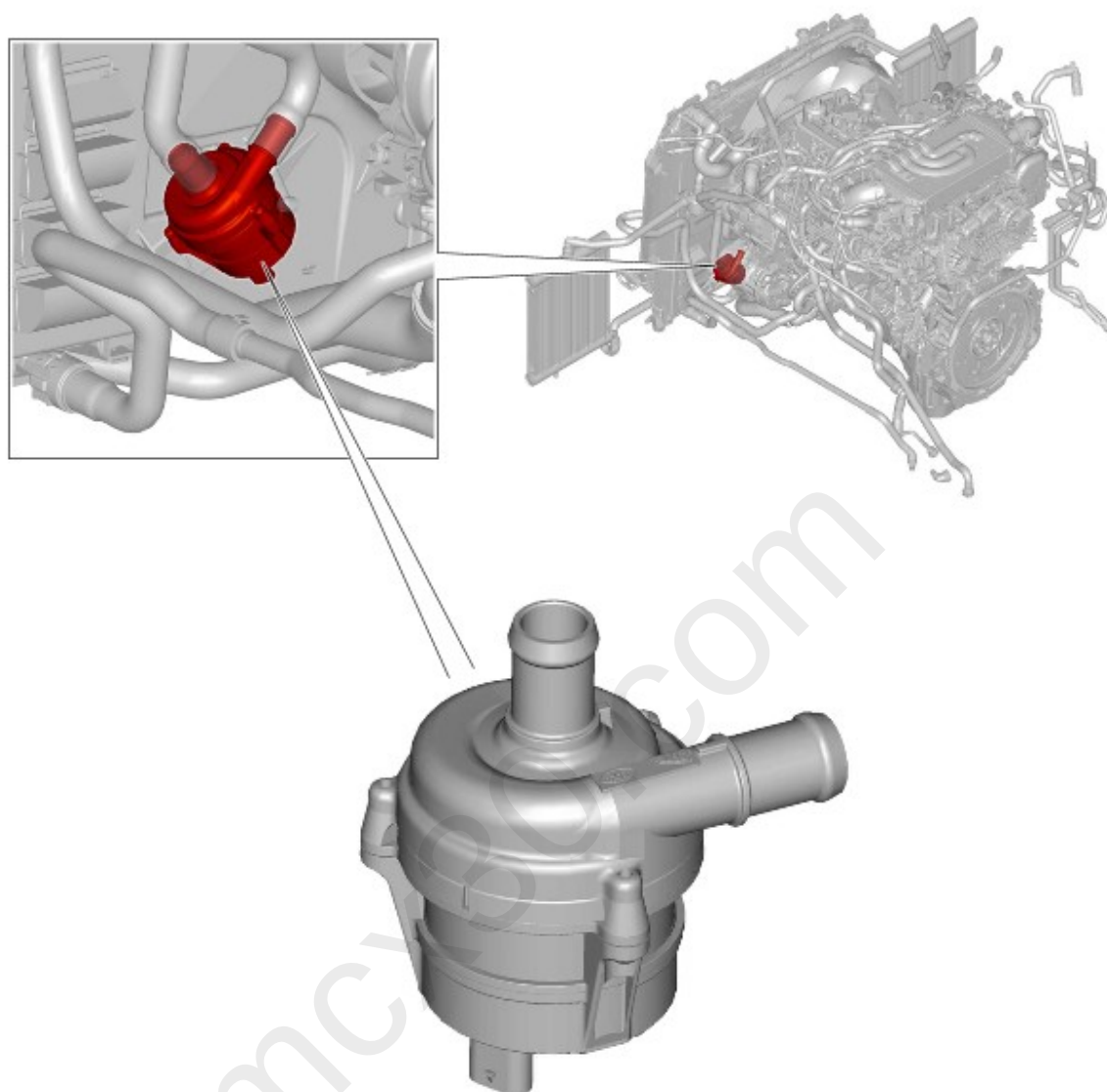
ENGINE COOLANT TEMPERATURE SENSOR – CYLINDER BLOCK OUTLET



E238683

The Engine Coolant Temperature (ECT) sensor is installed in the engine coolant bypass valve which is installed on the left side of the cylinder block. The ECT sensor measures the temperature of the engine coolant from the cylinder block. The signal from the ECT sensor is sent to the PCM through hardwired connection.

CHARGE AIR COOLANT PUMP



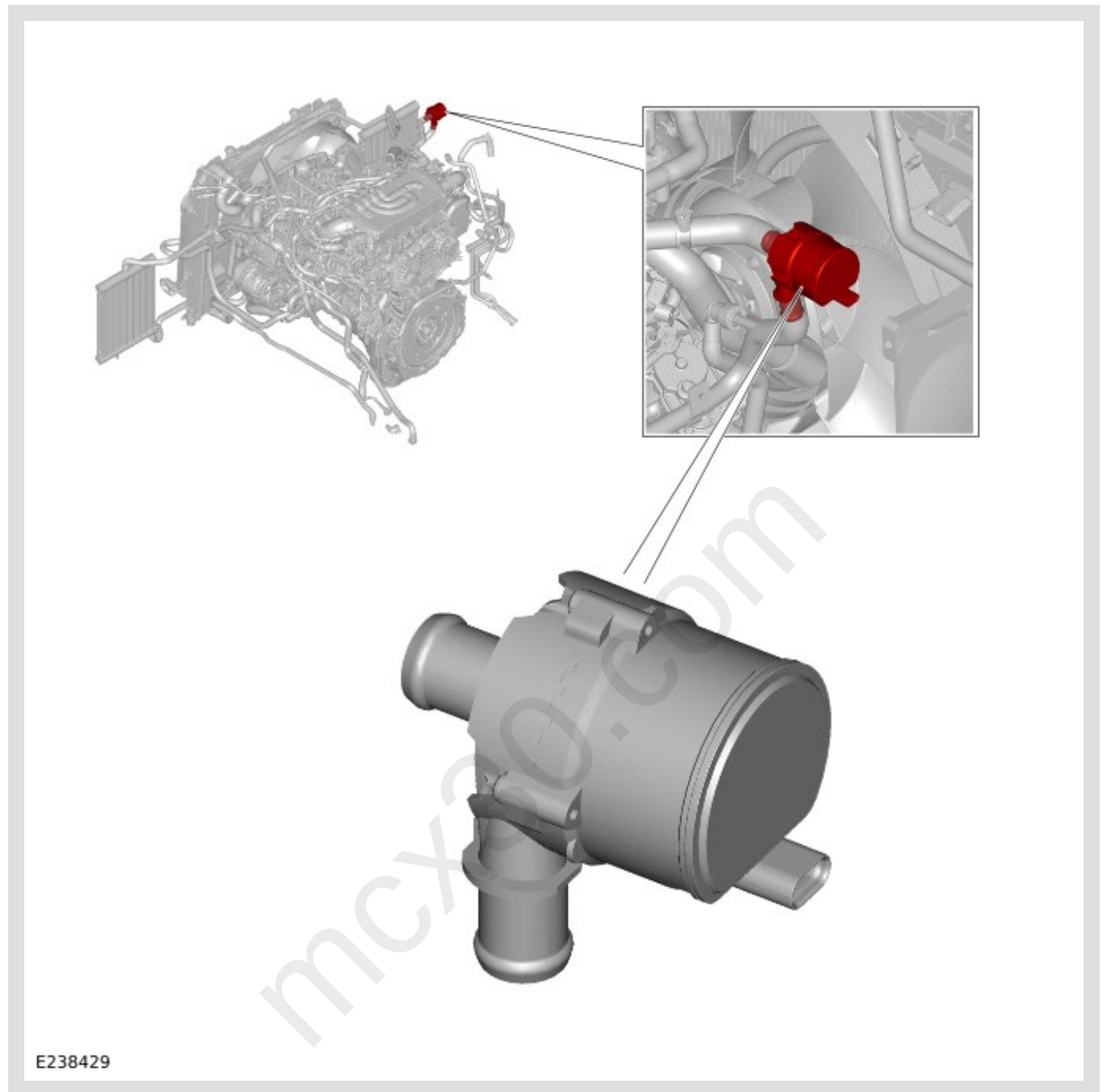
E238428

The charge air coolant pump is installed on the viscous cooling fan shroud.

An electrical connector provides the interface between the motor of the charge air coolant pump and the vehicle wiring.

Electrical power for the charge air coolant pump is supplied from the PCM relay, located in the EJB. When the PCM relay is energized, the PCM connects power supply to the charge air coolant pump. Operation of the charge air coolant pump is controlled by the PCM with a PWM signal.

AUXILIARY COOLANT PUMP



The auxiliary coolant pump is an electric pump attached on a bracket, in the right of the engine compartment.

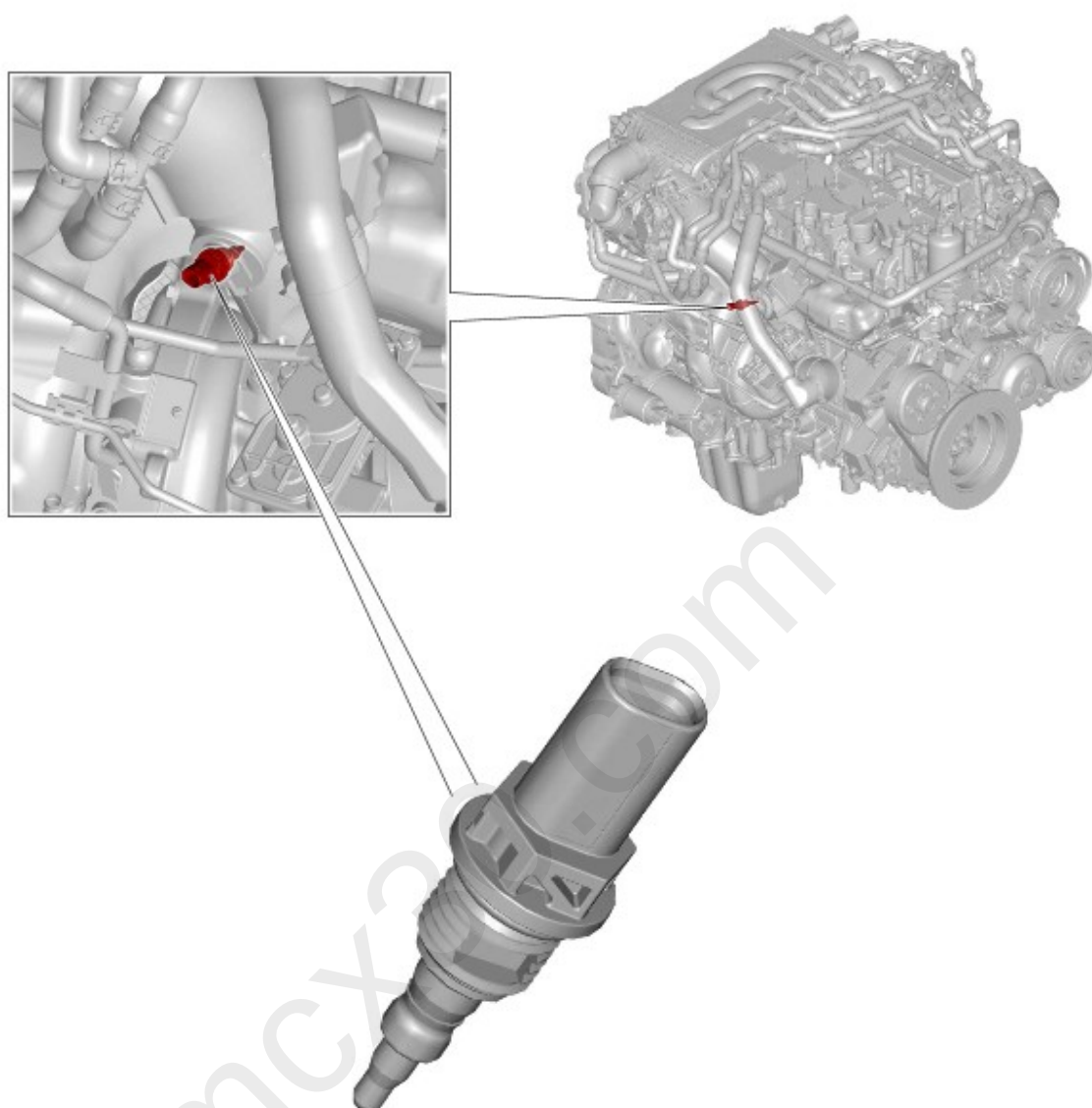
When the engine is turned off the auxiliary coolant pump provides engine coolant flow to prevent coolant boiling in the turbocharger.

The auxiliary coolant pump has a 3-pin connector.

The 3-pin connector provides the following connections:

- A permanent startup battery voltage, supplied from a fused output from the EJB.
- A hardwired connection to the PCM.
- A ground connection.

CHARGE AIR TEMPERATURE SENSOR

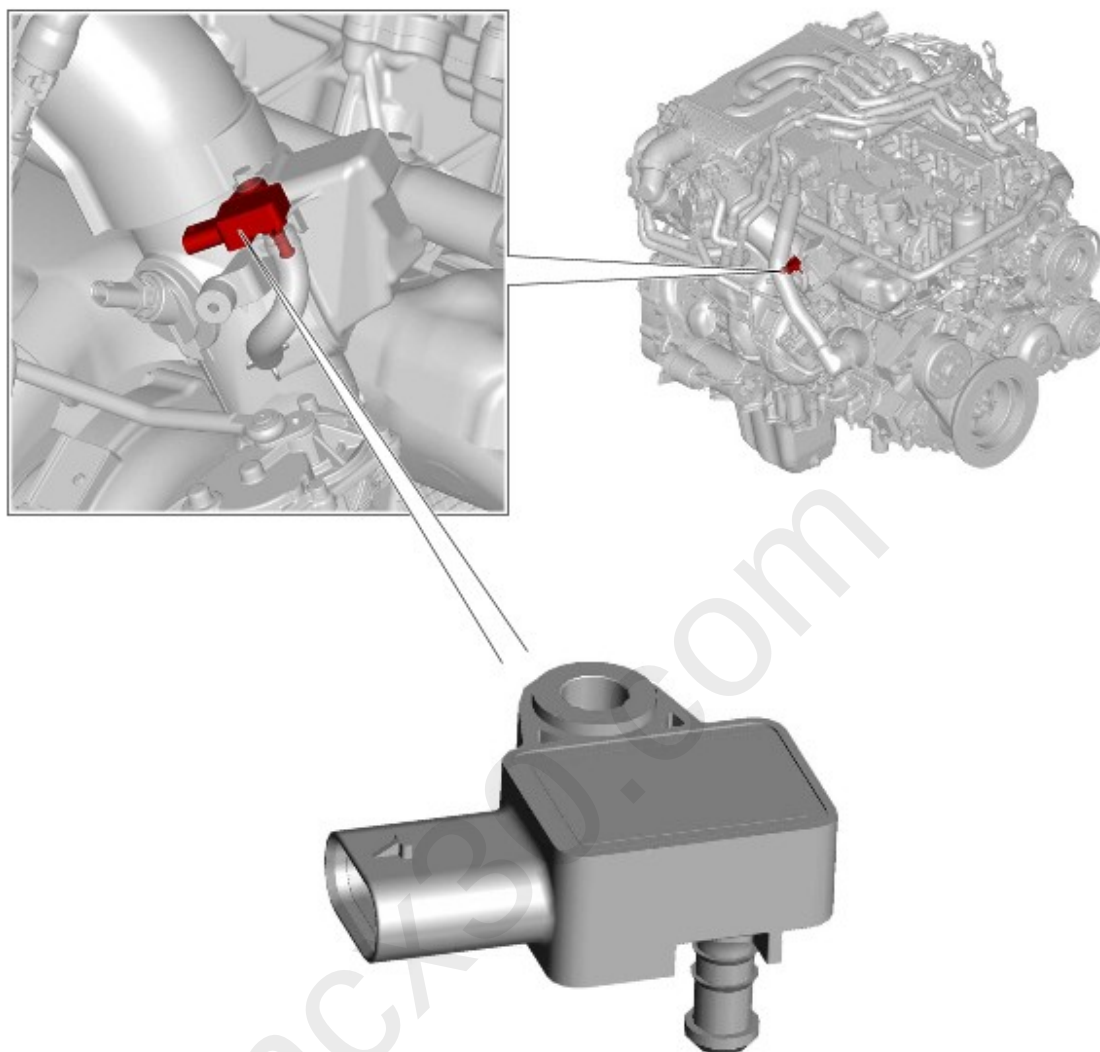


E238438

The charge air temperature sensor is located in the charge air cooler inlet pipe.

The charge air temperature sensor receives a 5V reference voltage from the PCM. The charge air temperature sensor returns a signal relative to the temperature of the charge air output from the turbocharger.

CHARGE AIR PRESSURE SENSOR



E238439

The charge air pressure sensor is located in the charge air cooler inlet pipe. The sensor is connected through a hose to the charge air outlet pipe from the turbocharger.

The charge air pressure sensor has a 3-pin connector.

The 3-pin electrical connector provides the following connections:

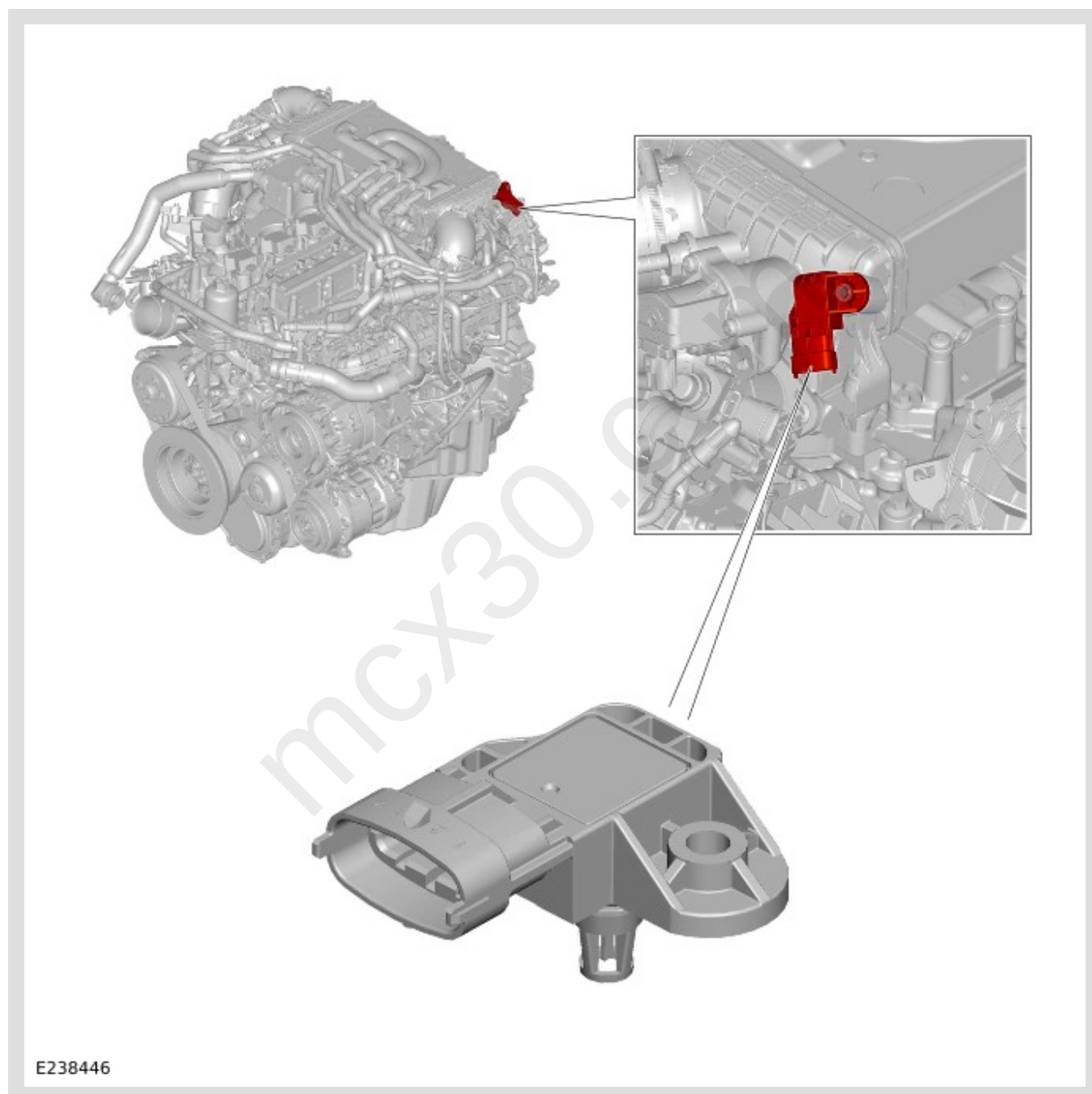
- A 5V reference voltage from the PCM.
- A pressure signal to the PCM.
- A ground connection.

The charge air pressure sensor uses a diaphragm transducer to measure pressure.

The PCM uses the sensor signal for the following functions:

- Maintain charge air cooler charge air pressure.
- Reduce exhaust emissions when driving at high altitude.
- To aid the air path diagnostics.

PRESSURE AND TEMPERATURE SENSOR – CHARGE AIR COOLER



The charge air pressure and temperature sensor is installed on the charge air cooler. The charge air pressure and temperature sensor measures the temperature and pressure of the intake air in the charge air cooler. The signals from the charge air pressure and temperature sensor are sent to the PCM.

The charge air pressure and temperature sensor has a 4-pin connector.

The 4-pin electrical connector provides the following connections:

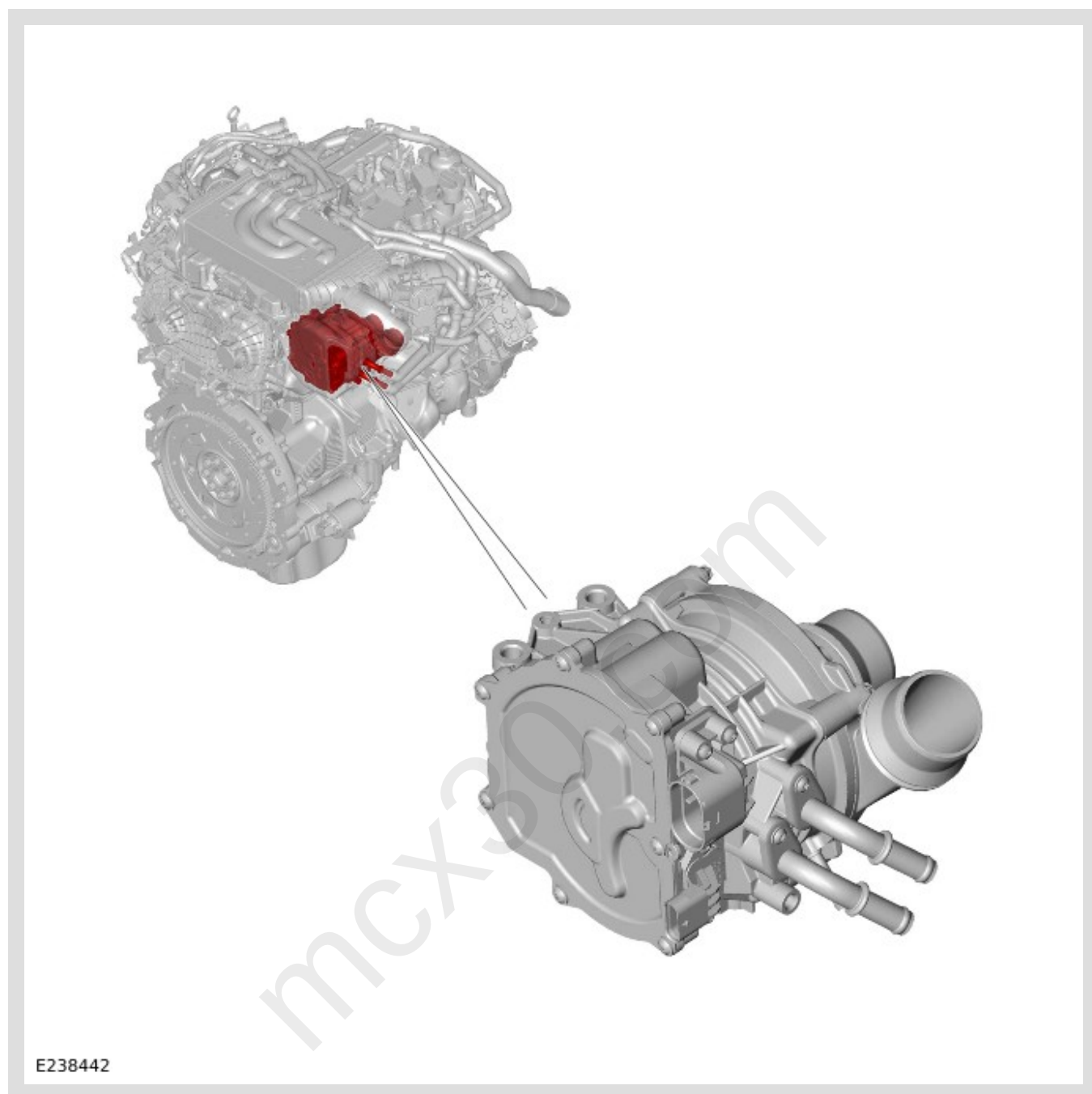
- A 5V reference voltage from the PCM.
- A pressure signal to the PCM.
- A temperature signal to the PCM.
- A ground connection.

The charge air pressure and temperature sensor allows the PCM to calculate the charge air density immediately before it enters the combustion chamber. This is used to adjust the ignition timing relative to the charge air pressure and to monitor the performance of the charge air cooler.

The charge air pressure and temperature sensor uses a diaphragm transducer to measure the air pressure and a NTC resistor type sensor to measure the temperature.

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ELECTRIC SUPERCHARGER

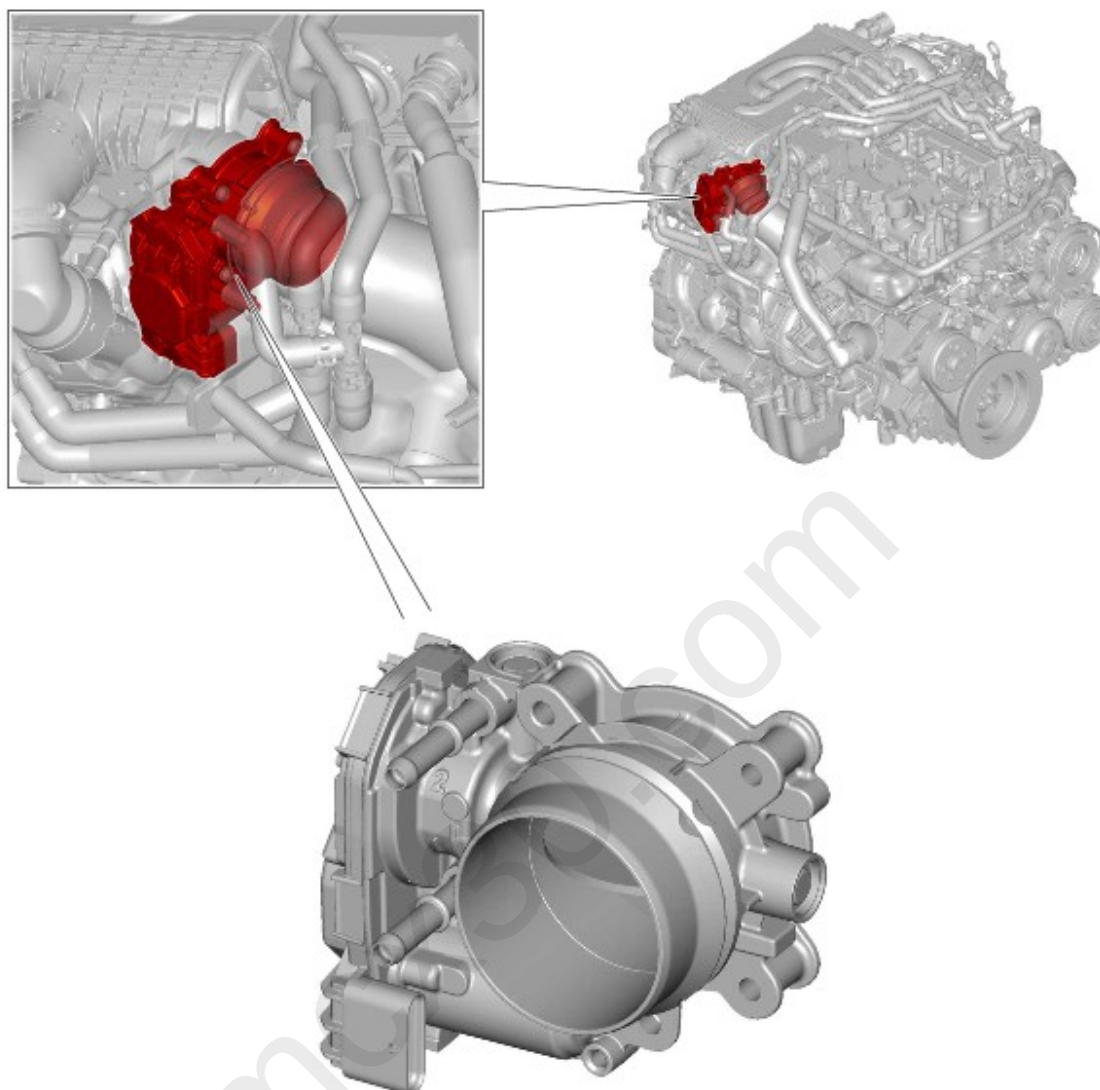


The turbocharger increases the temperature and pressure of the intake air. The electric supercharger also increases the pressure of the intake air from the turbocharger, which increases the power output of the engine.

The Mild Hybrid Electric Vehicle (MHEV) battery junction box supplies the 48V power to the electric supercharger. The PCM controls the operation of the electric supercharger through HS CAN power mode zero systems bus.

For additional information, refer to: [Intake Air Distribution and Filtering](#) (303-12C Intake Air Distribution and Filtering - INGENIUM I6 3.0L Petrol, Description and Operation).

ELECTRIC SUPERCHARGER BYPASS VALVE



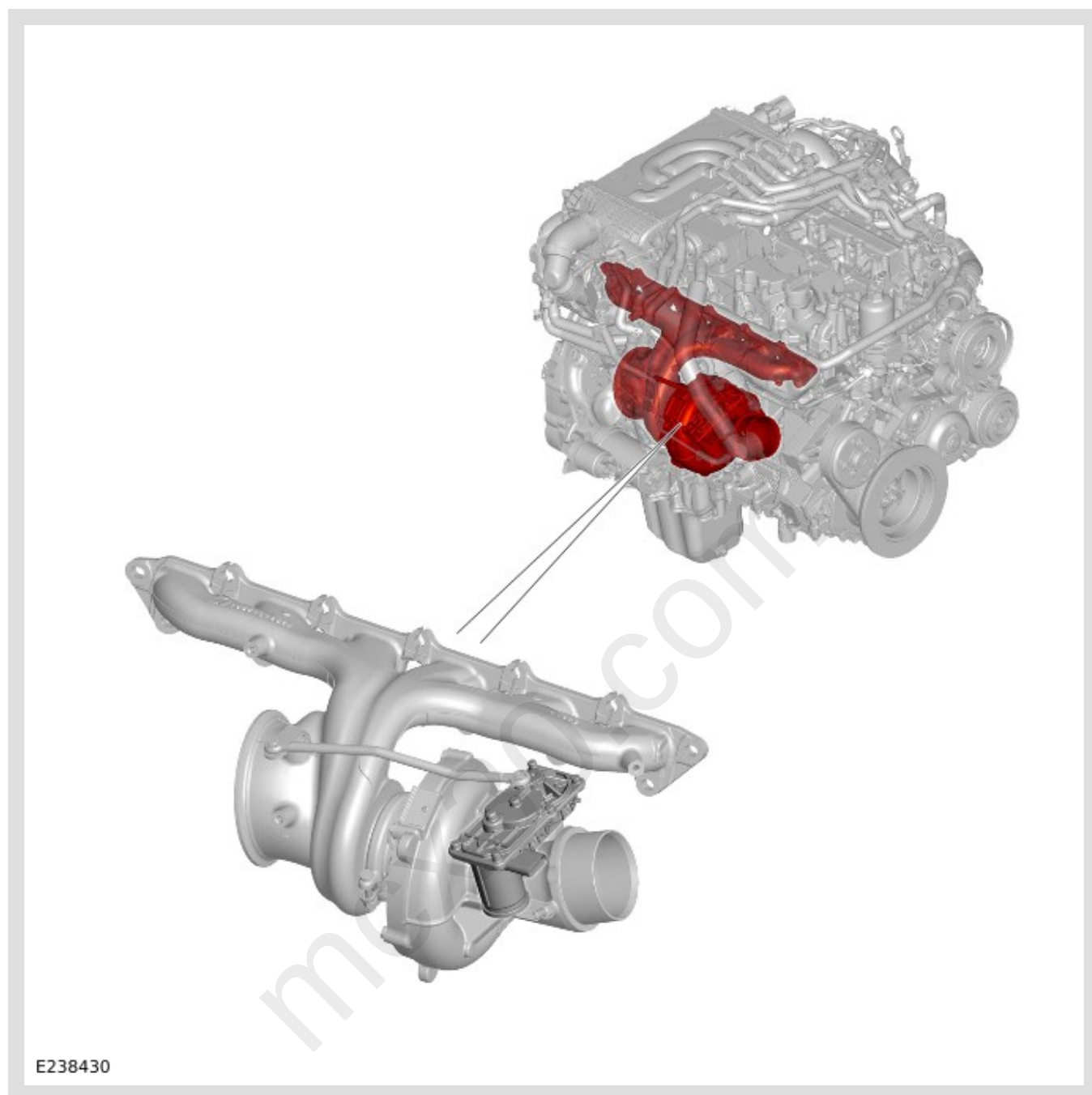
E238437

The electric supercharger bypass valve is installed on the charge air cooler. The electric supercharger bypass valve bypasses the intake air from the turbocharger to the charge air cooler.

The PCM controls the electric supercharger bypass valve through PWM signal.

For additional information, refer to: [Intake Air Distribution and Filtering](#) (303-12C Intake Air Distribution and Filtering - INGENIUM I6 3.0L Petrol, Description and Operation).

TURBOCHARGER WASTEGATE ACTUATOR



E238430

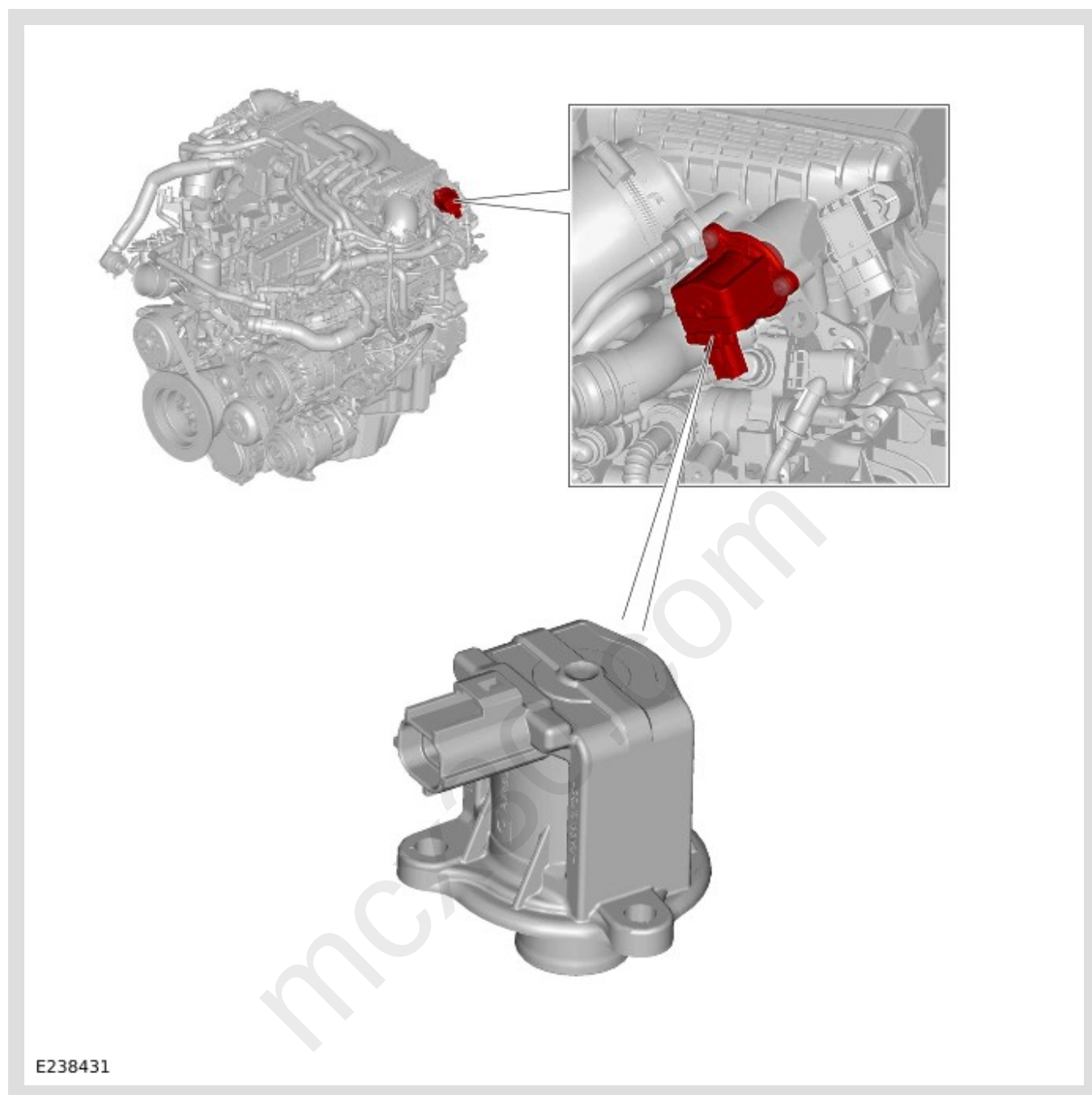
The turbocharger wastegate actuator is attached to the turbocharger compressor housing.

The turbocharger wastegate actuator operates the wastegate flap and allows the exhaust gas to bypass the turbine wheel. The wastegate actuator contains a position sensor. The position sensor and the actuator motor are connected to the PCM. The turbocharger wastegate actuator is controlled by PWM signal from the PCM.

If a fault occurs with the turbocharger wastegate actuator, a DTC is registered in the PCM.

For additional information, refer to: [Turbocharger](#) (303-04F Fuel Charging and Controls - Turbocharger - INGENIUM I6 3.0L Petrol, Description and Operation).

COMPRESSOR RECIRCULATION VALVE

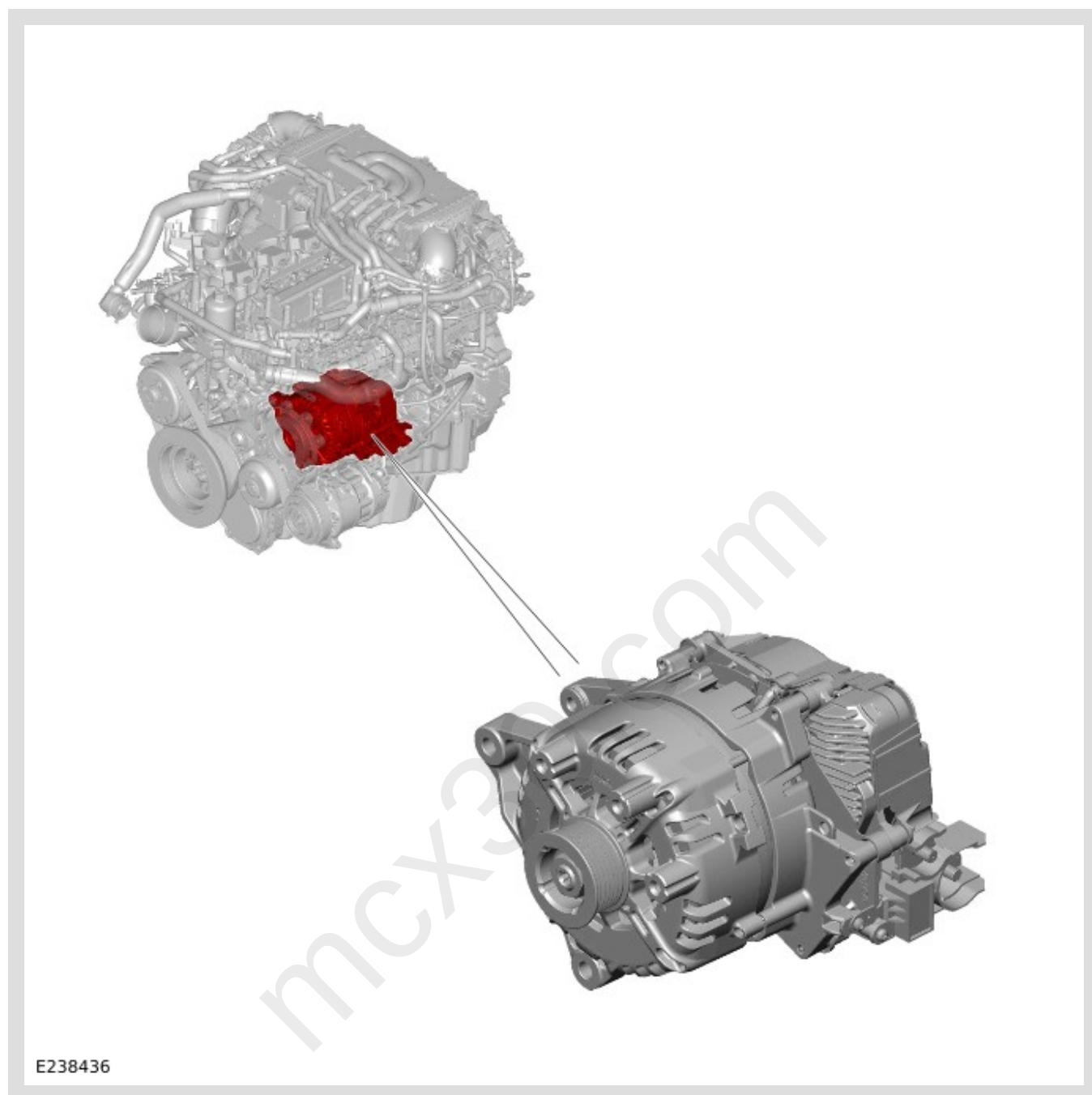


The Compressor Recirculation Valve (CRV) is installed on the left side of the charge air cooler with 3 screws.

During a quick throttle closing event, the engine needs less charge air. The CRV allows the charge air to flow to the intake air pipe incase of creating HP inside the charge air cooler. The PCM controls the CRV through PWM signal.

For additional information, refer to: [Turbocharger](#) (303-04F Fuel Charging and Controls - Turbocharger - INGENIUM I6 3.0L Petrol, Description and Operation).

BELT INTEGRATED STARTER GENERATOR



The BISG is located on the left of the engine towards the front.

The BISG has 2 principle of operations:

- A generator to charge the MHEV battery.
 - Use engine power.
 - To recover energy from the when the engine overruns.
- A motor for the following:
 - To start the engine in Auto stop/start operation when the Ambient Air Temperature (AAT) is more than -5°C (20°F).
 - To provide engine assist and reduce fuel consumption.

The BISG is controlled by the PCM through the HS CAN power mode zero systems bus.

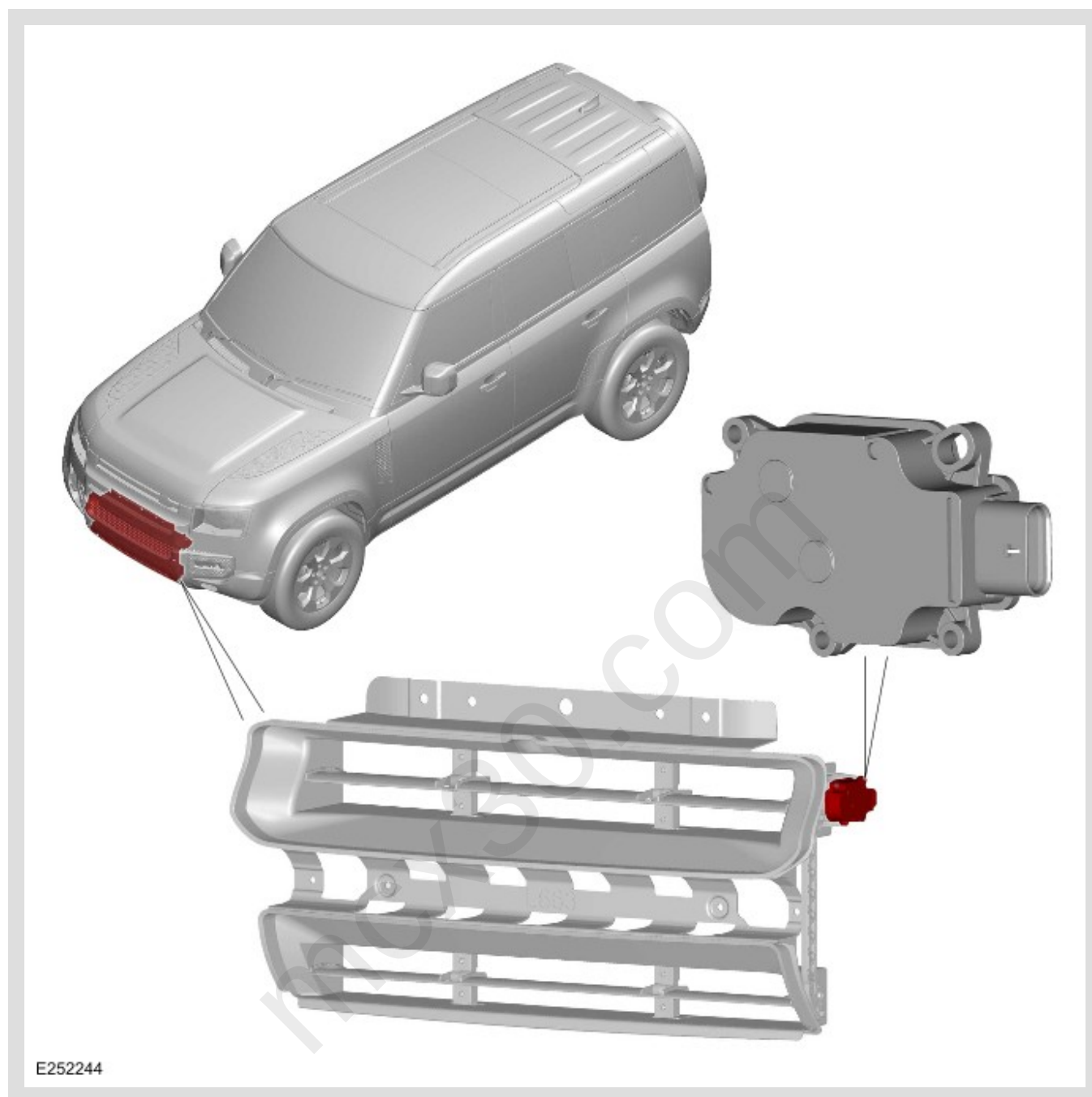
The BISG has 3 electrical connections for the following:

- MHEV battery cable terminal (positive)
- MHEV battery cable terminal (negative)
- Wiring harness connector for the following connections:
 - HS CAN power mode zero system bus
 - A power supply from the EJB
 - A ground connection.

For additional information, refer to: [Belt Integrated Starter Generator](#) (414-03 Battery Charging - INGENIUM I6 3.0L Petrol, [+] MHEV, Description and Operation).

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ACTIVE GRILLE AIR SHUTTER – IF EQUIPPED



The active grille air shutter is installed behind the radiator grille and attached to the hood latch panel. The active grille air shutter incorporates moveable vanes that control the air flow into the top half of the upstream main duct.

The vanes can be set to 1 of 14 positions between fully closed and fully open, and have a range of movement of 80°. During normal operation, for the vanes to move from fully closed to fully open takes approximately 30 seconds. To move the vanes from fully open to fully closed takes approximately 90 seconds.

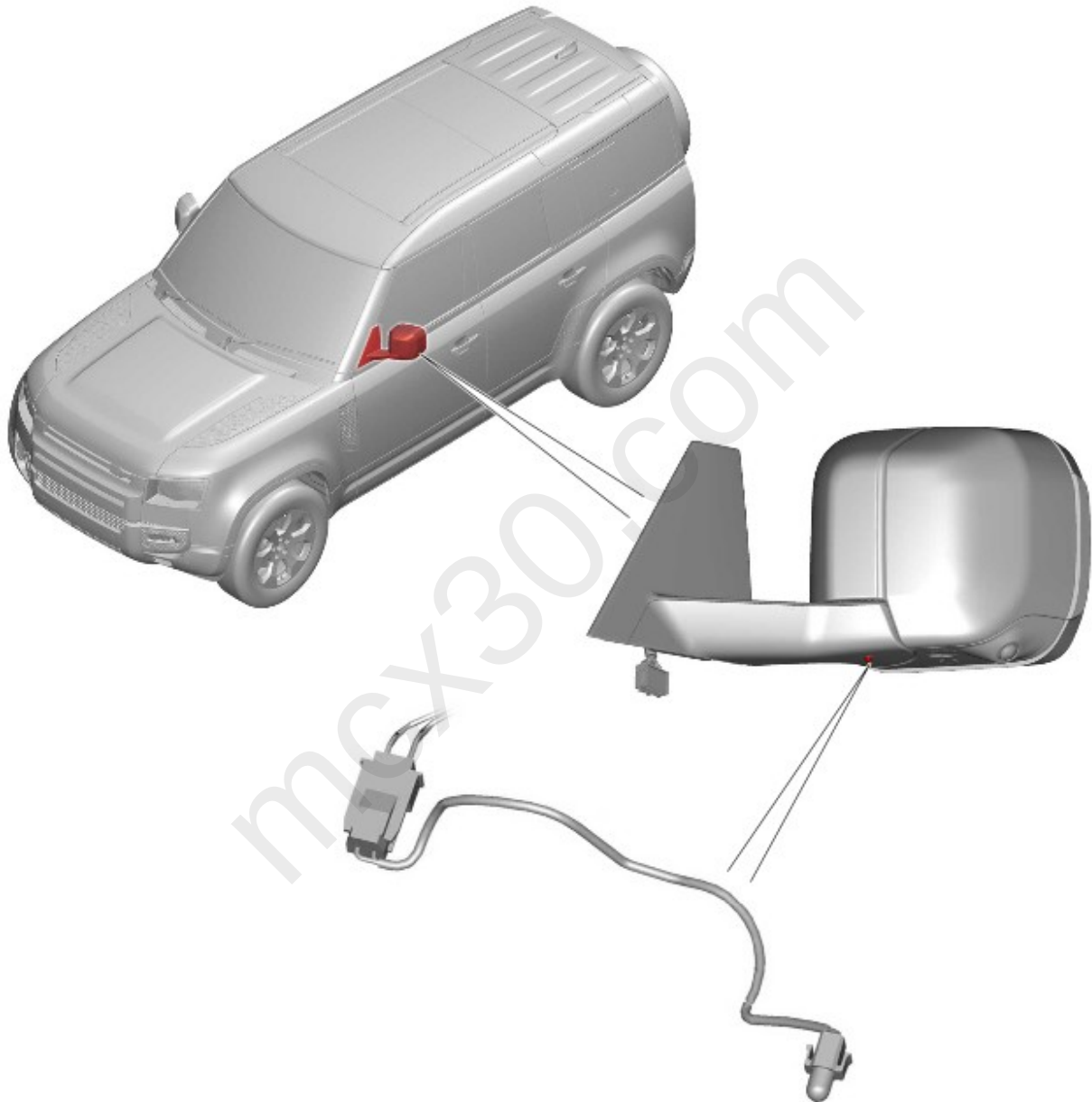
Operation of the active grille air shutter motor is controlled by the PCM. The PCM communicates with the active grille air shutter motor on a local Interconnect Network (LIN) bus connection. Power for the active grille air shutter motor is provided by the PCM relay in the EJB.

For additional information, refer to: [Engine Cooling](#) (303-03C Engine Cooling - INGENIUM I6 3.0L Petrol, Description and Operation).

AMBIENT AIR TEMPERATURE SENSOR

NOTE:

Some variation in the illustration may occur, but the essential information is always correct.



E252233

The Ambient Air Temperature (AAT) sensor is a NTC type sensor. The AAT sensor allows the PCM to monitor the temperature of the air around the vehicle.

The PCM uses the AAT sensor input along with other in-vehicle temperature sensors to control:

- Vehicles interior temperature.

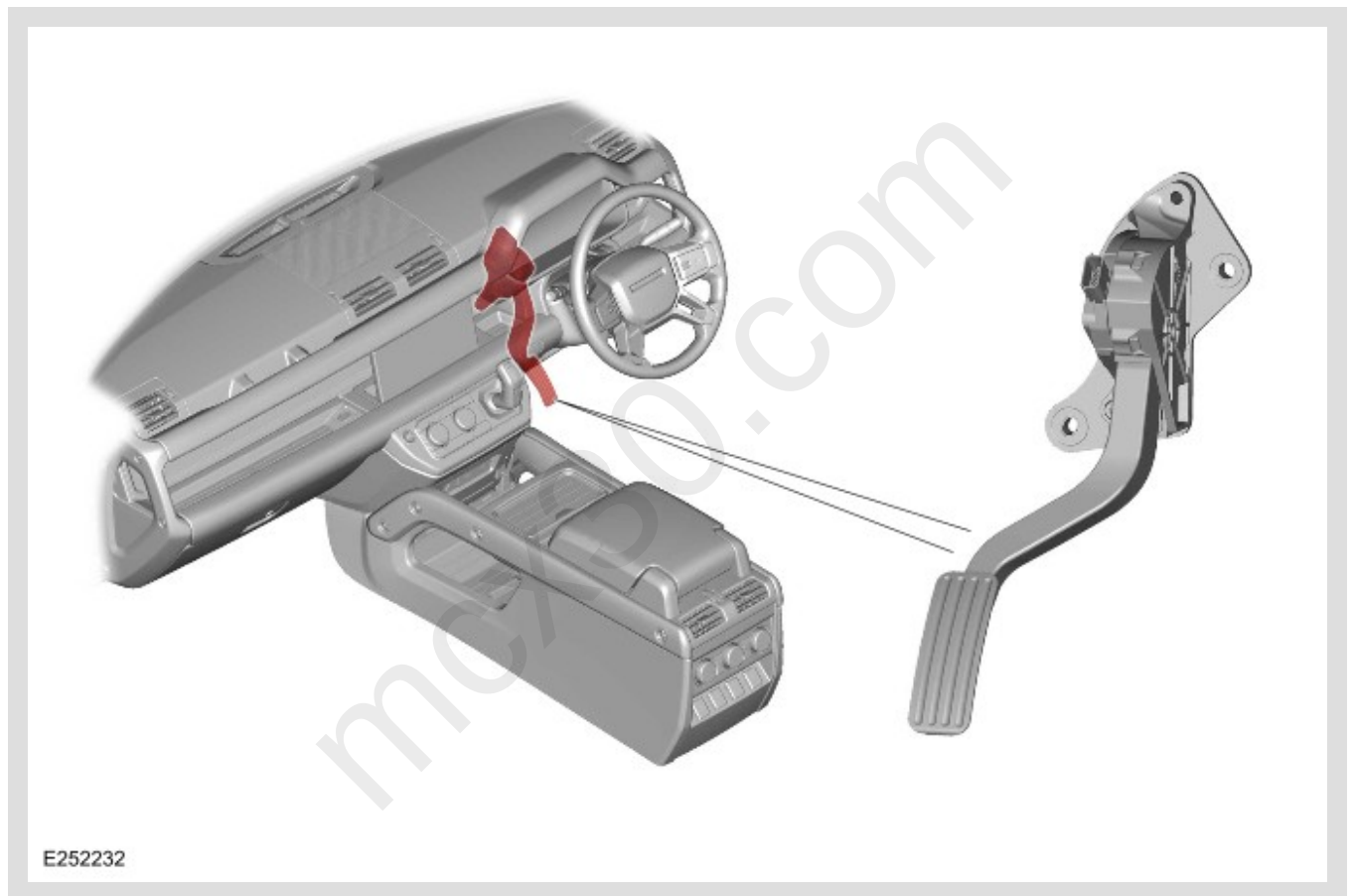
- Engine coolant temperature using the electric cooling fan.

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

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

If there is a fault with the AAT sensor, the PCM calculates the ambient air temperature. The PCM uses the temperature input of the MAFT sensor to calculate the AAT. If the AAT sensor and the temperature inputs of the MAFT sensor are all faulty, the PCM adopts a default AAT of 25°C (77°F).

ACCELERATOR PEDAL POSITION SENSOR



The APP sensors are located on the accelerator pedal.

Accelerator pedal demand is communicated to the PCM by 2 potentiometers located in the APP sensor. The PCM uses the 2 signals to determine the position, rate of movement and direction of movement of the pedal.

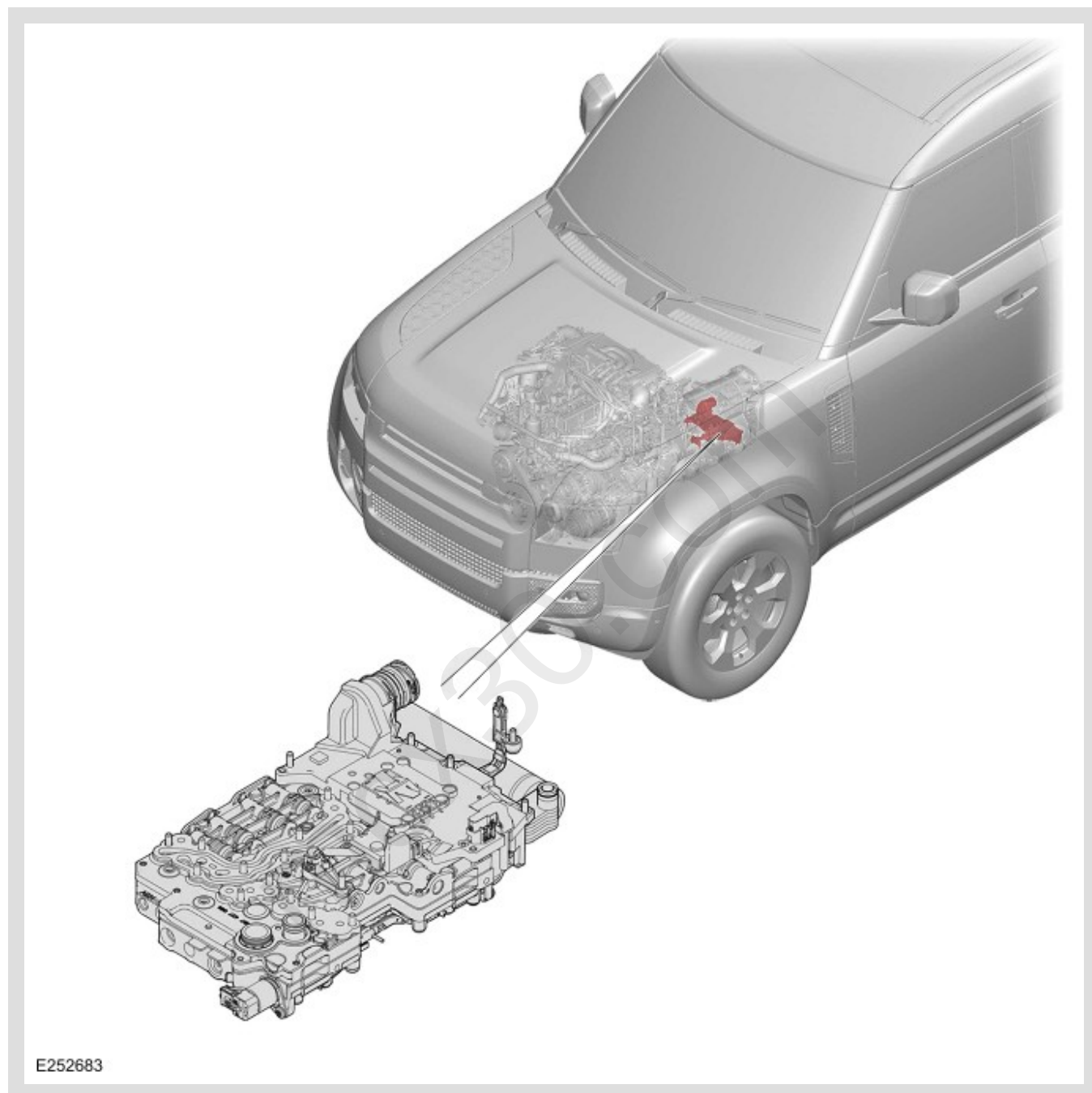
The PCM supplies a 5V reference voltage and a ground for each potentiometer.

BRAKE PEDAL SWITCH SIGNAL

The Integrated Power Brake system does not require the brake pedal switch in the pedal box. This function is created by the Integrated Power Brake control module. The Integrated Power Brake control module outputs 2 12V signals

when the pedal is pressed to replicate the outputs of the pedal switch. These outputs are sent to the PCM and the BCM/ GWM. Additionally, it sends a request to the BCM/ GWM over the FlexRay systems bus. The PCM and BCM/ GWM then forward the brake signal toward to all related control modules through the FlexRay systems bus.

TRANSMISSION CONTROL MODULE

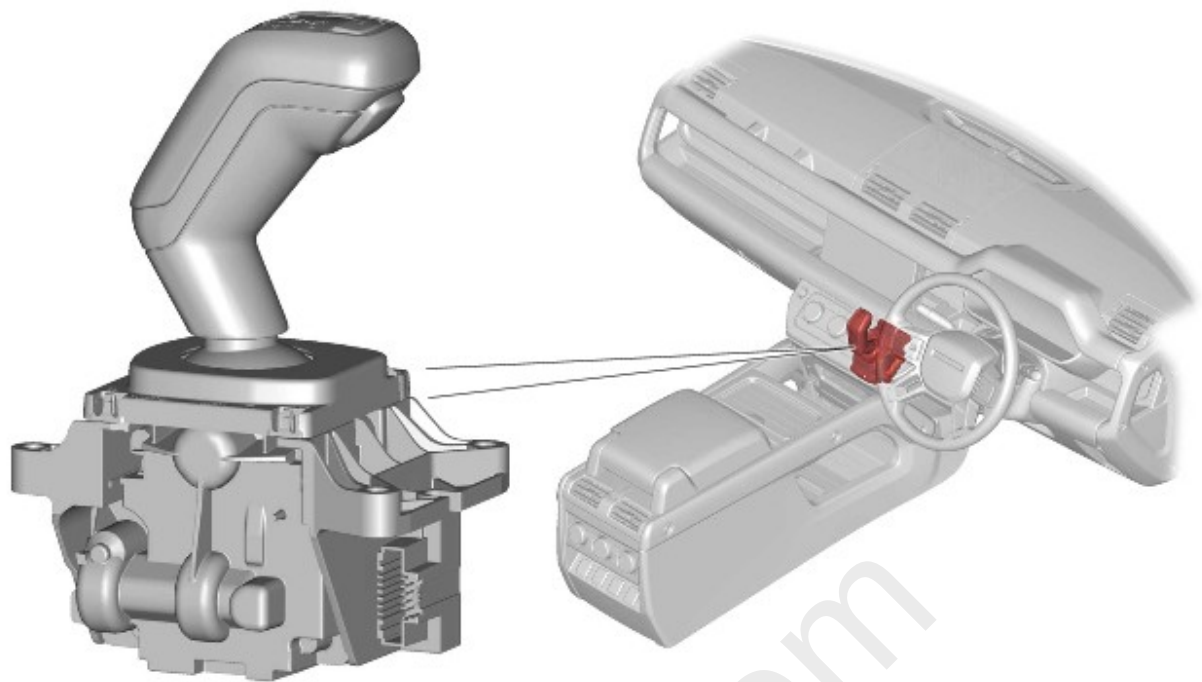


The TCM is an integral part of the mechatronic valve block. The TCM is located at the bottom of the automatic transmission, within the fluid pan. The TCM is the main controlling component of the automatic transmission.

The TCM processes signals from the automatic transmission speed and temperature sensors, PCM and other vehicle systems. From the received signal inputs and pre-programmed data, the TCM calculates the correct gear, torque converter clutch setting and optimum pressure settings for gear shift.

The PCM supplies the Engine Management System (EMS) data over the FlexRay systems bus.

TRANSMISSION CONTROL SWITCH

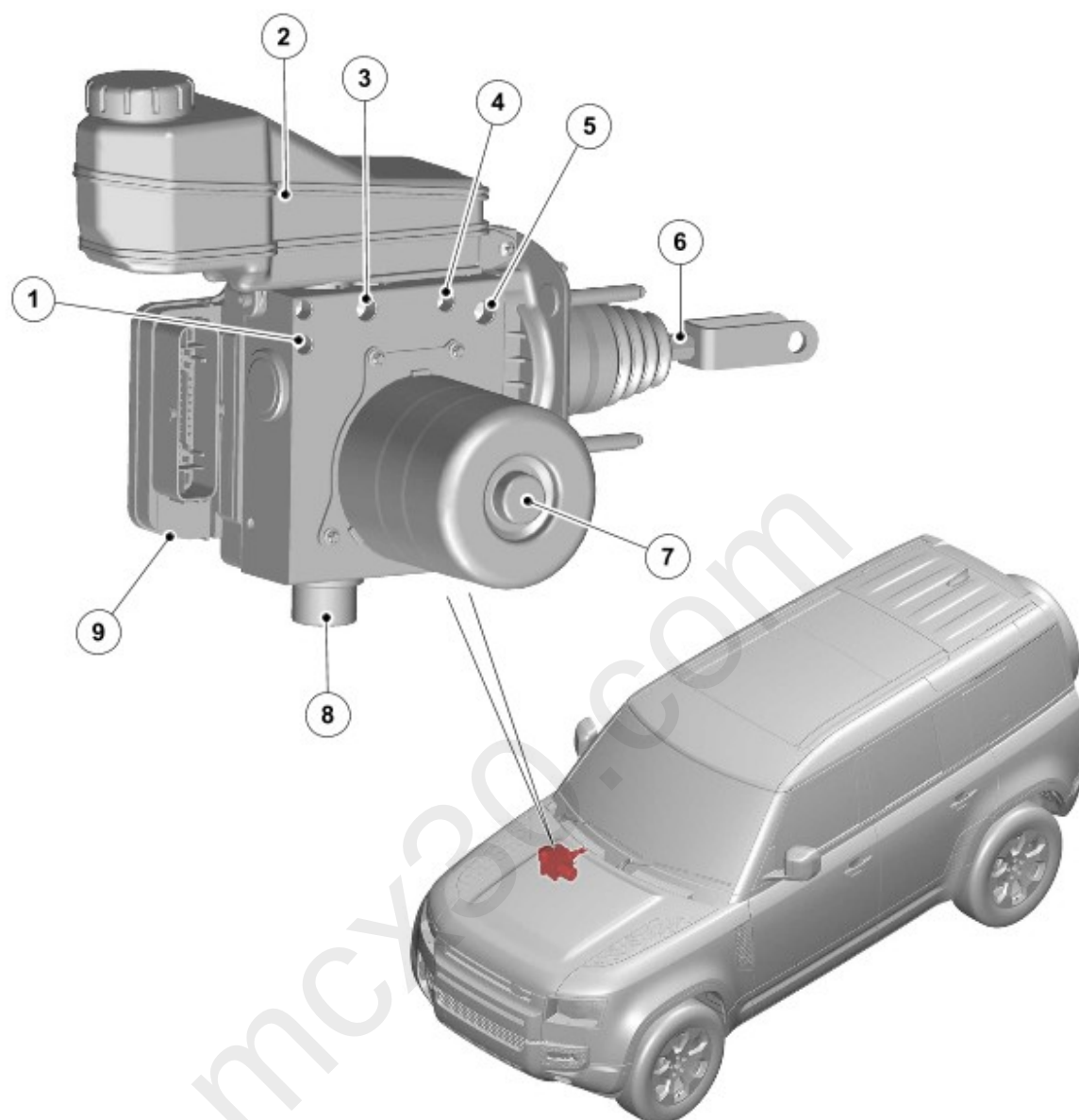


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The TCS is installed in the top of the floor console. The TCS is secured with 4 screws and has 1 electrical connector for all electrical inputs and outputs.

Move of the TCS to any of the 5 positions outputs a signal to the BCM/ GWM. The BCM/ GWM senses the signals through the HS CAN Underbody (UN) systems bus. The BCM/ GWM uses the Flexray systems bus to send the signal to the TCM through the Transfer Case Control Module (TCCM) and reacts according to the selected TCS position. The TCS uses Hall effect sensors to determine the position of the switch.

INTEGRATED POWER BRAKE CONTROL MODULE



E252679

ITEM	DESCRIPTION
1	Rear right brake outlet port
2	Reservoir
3	Front left brake outlet port
4	Front right brake outlet port
5	Rear left brake outlet port
6	Input rod
7	Hydraulic Control Unit (HCU)

ITEM	DESCRIPTION
8	Pedal feel simulator
9	Integrated Power Brake control module

The Integrated Power Brake control module uses the Hydraulic Control Unit (HCU) to modulate hydraulic pressure to the individual wheel brakes to control the brake functions.

The Integrated Power Brake controls the speed of all road wheels to make sure optimum wheel slip when braking at the adhesion limit. This prevents the wheels from locking in order to retain effective steering control of the vehicle.

The brake pressure is modulated separately for each wheel in order to maintain vehicle stability.

When required, the Integrated Power Brake actively intervenes and operates the HCU during braking or vehicle maneuvers to correct the vehicle attitude, stability, traction or speed. During incidents of vehicle correction, the Integrated Power Brake control module may also request the PCM to control engine power in order to further stabilize and correct the vehicle.

For additional information, refer to: [Anti-Lock Control](#) (206-08 Brake Controls and Actuation, Description and Operation).

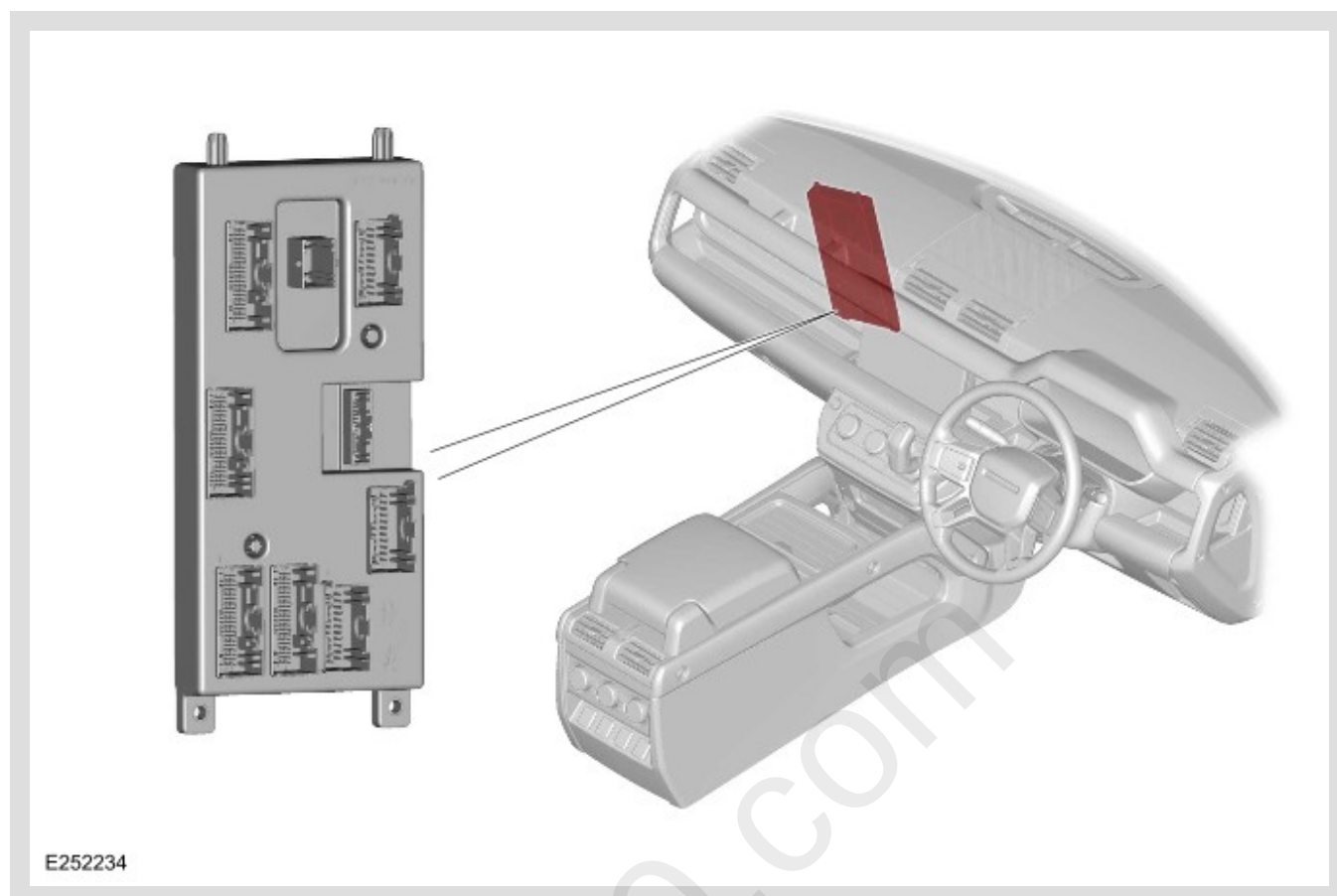
RESTRAINTS CONTROL MODULE



The RCM is installed on the top of the transmission tunnel, below the floor console.

For additional information, refer to: [Seatbelt System](#) (501-20A Seatbelt System, Description and Operation) / [Airbag and Safety Belt Pretensioner Supplemental Restraint System - \[+\] Front Row Seats Only](#) (501-20B Supplementary Restraint System, Description and Operation) / [Airbag and Safety Belt Pretensioner Supplemental Restraint System - \[+\] Vehicles with 2nd / 3rd Row Seats](#) (501-20B Supplementary Restraint System, Description and Operation).

BODY CONTROL MODULE/GATEWAY MODULE



The BCM/ GWM is mounted on a bracket, which is attached to the front passenger side of the vehicle.

The BCM/ GWM contains software to control the following functions:

- Controls and determines the condition of the startup battery using load management software.
- Controls the output from the BISG.
- Controls the charge warning indicator on the IPC.
- Controls the quiescent current relay to enable or disable electrical loads if necessary.
- Controls the auto stop/start system using power management to inhibit unnecessary electrical loads.

OPERATION

POWERTRAIN CONTROL MODULE ADAPTIONS

The PCM has the ability to adapt the input values it uses to control certain outputs. This capability maintains engine refinement and provides the engine emissions remain within the legislated limits.

If the PCM is replaced, the new PCM relearns the adaptions as the vehicle is driven. Some components require a reset of adaptions when replaced and this can be achieved using a JLR approved diagnostic equipment.

DIAGNOSTICS

The PCM stores each fault as a DTC. The DTC and associated environmental and freeze frame data can be read using a JLR approved diagnostic equipment.

The freeze frame data can vary depending on the fault.

Core freeze frame data for every DTC includes:

- Power mode
- Time
- Distance
- Startup battery voltage.

The JLR approved diagnostic equipment can also read the following:

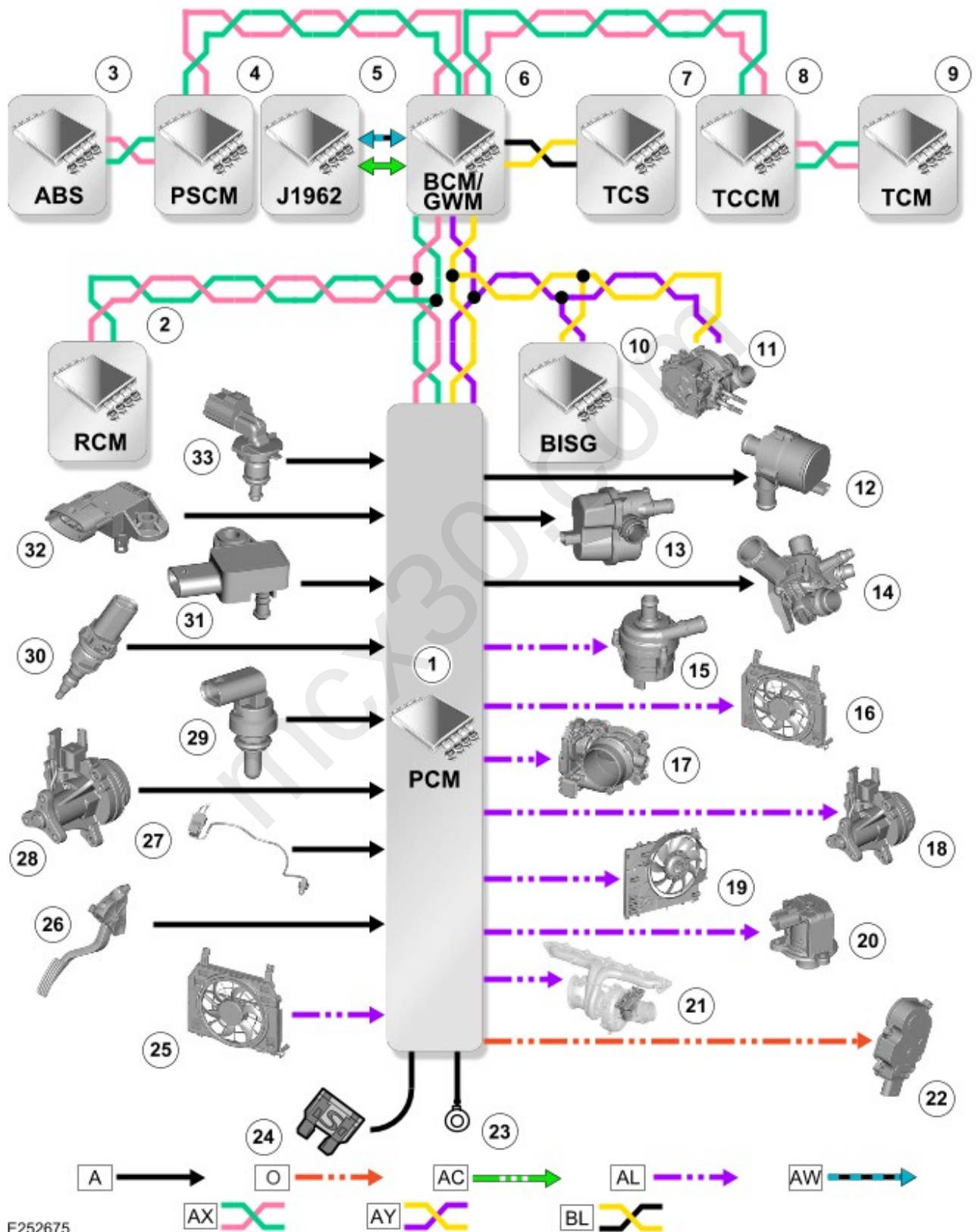
- Real time data from each sensor.
- The adaption values currently being employed.
- The current fueling settings.
- The current ignition settings.
- The current idle speed settings.

Specific sets of data are linked to each DTC. The selected data set gives the most useful supporting data to diagnose the fault.

For additional information, refer to: [Electronic Engine Controls](#) (303-14B Electronic Engine Controls - INGENIUM I6 3.0 L Petrol, Description and Operation).

CONTROL DIAGRAM

CONTROL DIAGRAM - 1 OF 2



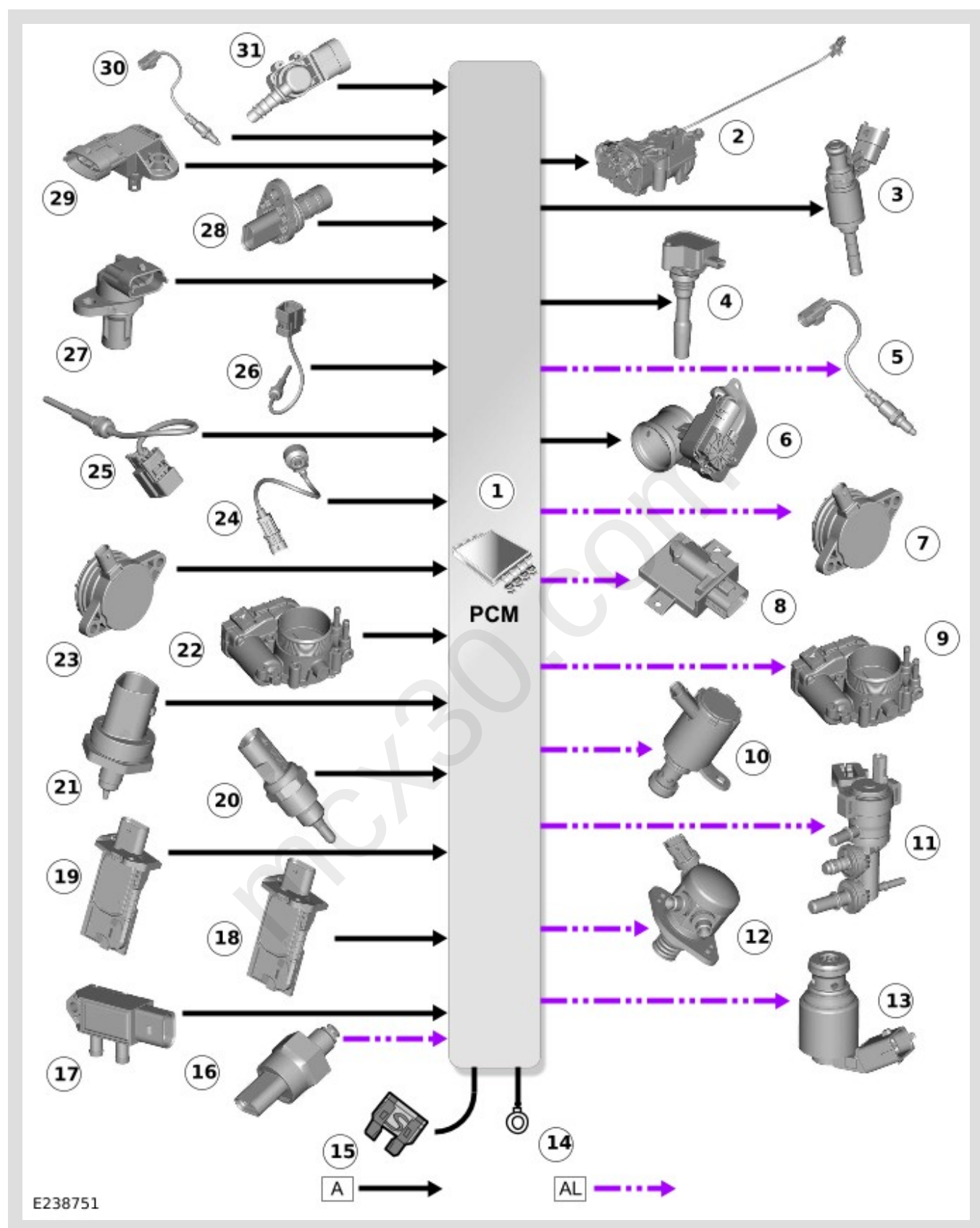
E252675

A = HARDWIRED: O = LIN BUS: AC = DIAGNOSTIC: AL = PWM: AW = BROADR-REACH® ETHERNET: AX = FLEXRAY, AY = HS CAN POWER MODE ZERO (PMZ) SYSTEM BUS: BL = HS CAN UNDERBODY (UN) SYSTEMS BUS.

ITEM	DESCRIPTION
1	PCM
2	RCM
3	Integrated Power Brake control module
4	Power Steering Control Module (PSCM)
5	Diagnostic Connector (J1962)
6	BCM/ GWM
7	TCS
8	TCCM
9	TCM
10	BISG
11	Electric supercharger
12	Auxiliary coolant pump
13	DMTL pump (North American Specification (NAS) market vehicles only)
14	Electric thermostat - Heater element
15	Charge air coolant pump
16	Electric cooling fan
17	Electric supercharger bypass valve
18	Variable coolant pump
19	Viscous cooling fan
20	Compressor Recirculation Valve (CRV)
21	Turbocharger wastegate actuator
22	Active grille air shutter motor (if equipped)
23	Ground
24	Power supply
25	Electric cooling fan
26	APP sensor
27	Ambient Air Temperature (AAT) sensor
28	Variable coolant pump - Shroud position sensor

ITEM	DESCRIPTION
29	Engine Coolant Temperature (ECT) sensor - Cylinder block outlet
30	Charge air temperature sensor
31	Charge air pressure sensor
32	Charge air pressure and temperature sensor
33	Engine Coolant Temperature (ECT) sensor - Radiator outlet

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A = HARDWIRED: AL = PWM.

ITEM	DESCRIPTION
1	PCM
2	Oil pump control solenoid
3	Fuel injector (quantity 6)
4	Ignition coil (quantity 6)
5	HO2S (quantity 3)
6	Active exhaust actuator
7	VCT solenoid (quantity 2)
8	FPDM
9	Electric throttle
10	Piston cooling oil jet solenoid
11	Purge valve
12	HP fuel pump
13	Continuous Variable Valve Lift (CVVL) solenoid (quantity 6)
14	Ground
15	Power supply
16	Oil pressure and temperature sensor
17	Exhaust back pressure sensor (if equipped)
18	MAFT sensor
19	MAF sensor
20	CVVL assembly oil temperature sensor
21	FRPT sensor
22	Electric throttle - Throttle Position Sensor (TPS) signal
23	VCT solenoid position sensor (quantity 2)
24	Knock sensor (quantity 3)
25	Cylinder block temperature sensor
26	Cylinder head temperature sensor
27	CMP (quantity 2)
28	CKP

