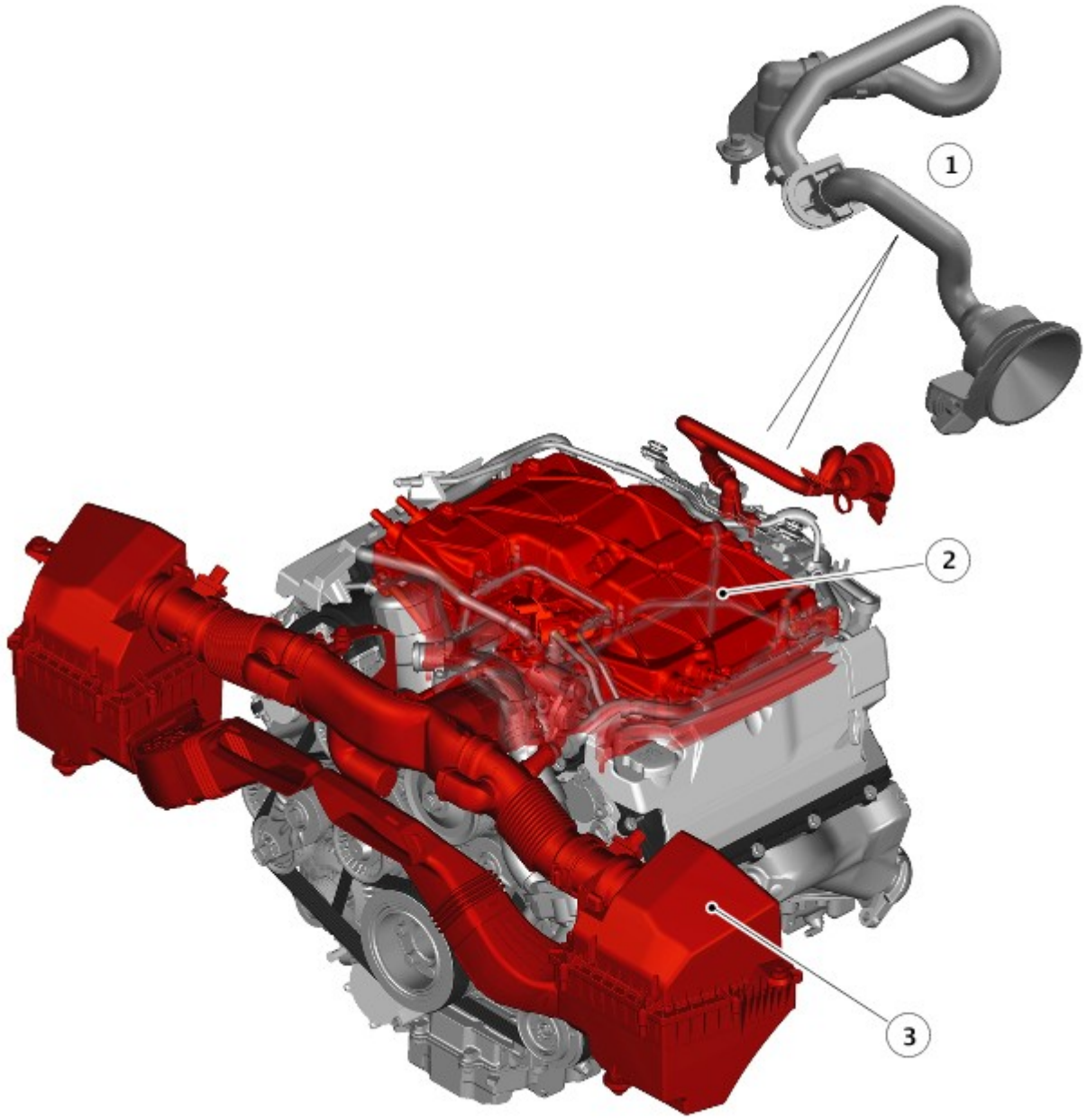
Published: 15-Sep-2015

Intake Air Distribution and Filtering - V6 S/C 3.0L Petrol - Intake Air Distribution and Filtering

Description and Operation

COMPONENT LOCATION



E176764

Item	Description
1	Noise feedback system
2	Supercharger and intake manifolds
3	Air intakes, air cleaners and air ducts

OVERVIEW

The Intake Air Distribution System is designed to allow ambient air to flow through the air intake system to the supercharger. The supercharger then compresses the air, which is then directed through the charge air coolers in the intake manifolds and into the cylinders.

The intake air distribution system comprises off:

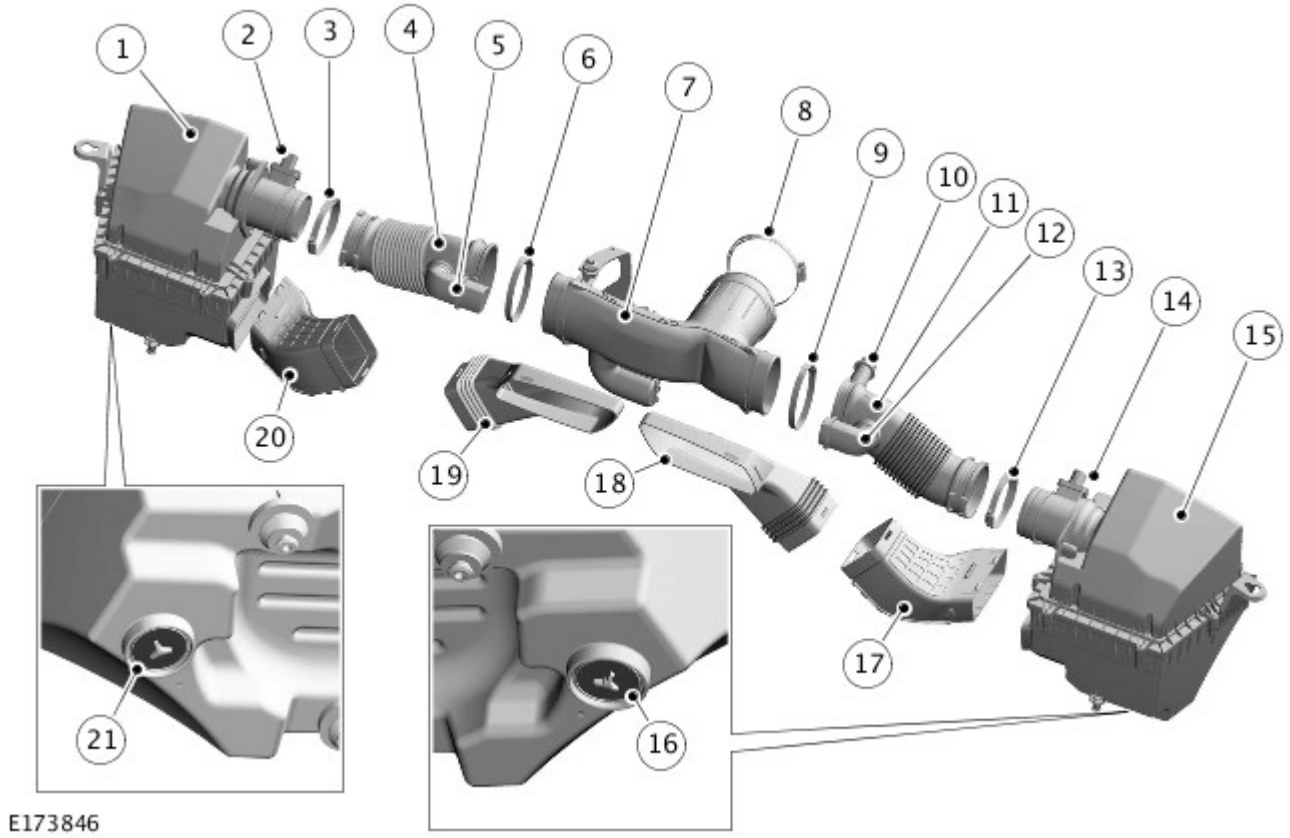
- air intake ducts

- air cleaners
- engine air ducts
- an electric throttle
- a supercharger and intake manifolds
- a noise feedback system.

The noise feedback system generates a sporty, powerful engine sound in the passenger compartment, at high engine load and speed settings, to enhance the driving experience. This is controlled by the Engine Control Module (ECM).

COMPONENT DESCRIPTION

Air Intakes, Air Cleaners and Air Ducts



Item	Description
1	Right air cleaner assembly
2	Right Mass Air Flow and Temperature (MAFT) sensor
3	Hose clamp
4	Right engine intake duct
5	Quarter wave resonator
6	Hose clamp
7	Throttle T-Piece duct
8	Hose clamp
9	Hose clamp
10	Full load breather connection stub
11	Left engine intake duct
12	Quarter wave resonator
13	Hose clamp
14	Left Mass Air Flow and Temperature (MAFT) sensor
15	Left air cleaner assembly
16	Left air cleaner drain valve
17	Left lower air intake duct
18	Left upper air intake duct

19	Right upper air intake duct
20	Right lower air intake duct
21	Right air cleaner drain valve

Air Intakes

The air intake ducts are installed on the top surface of the radiator.

Each air intake duct locates into an air cleaner.

Air Cleaners

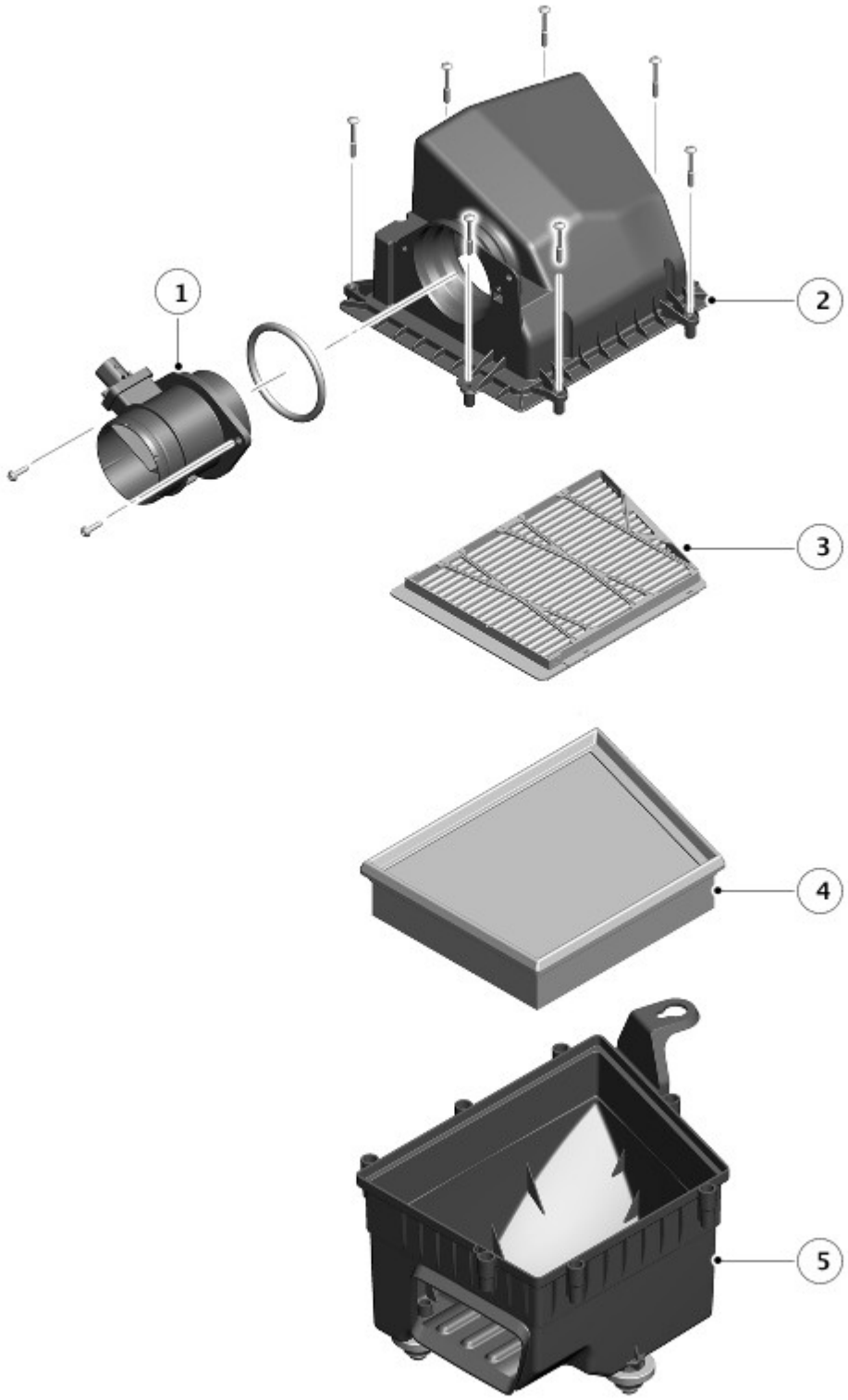
An air cleaner is located in each front corner of the engine compartment.

Each air cleaner consists of a filter element to trap all particulates, to allow for clean air into the engine. The air cleaner element is a replaceable filter.

Each air cleaner incorporates a drain valve to prevent the accumulation of water within the air cleaner housing.

The air outlet connection of each air cleaner incorporates a Mass Air Flow and Temperature (MAFT) sensor. The sensors are connected to the Engine Control Module (ECM).
For additional information, refer to: Electronic Engine Controls (303-14C Electronic Engine Controls - V6 S/C 3.0L Petrol, Description and Operation).

Hydrocarbon Absorber



E182254

Item	Description
1	Mass Air Flow and Temperature (MAFT) sensor
2	Air cleaner lid assembly
3	Hydrocarbon Absorber
4	Air filter
5	Air cleaner tray

On North American Specification (NAS) vehicles there is a Hydrocarbon Absorber fitted in the lid of each air cleaner assembly. The purpose is to absorb hydrocarbons to meet evaporative emissions regulations in the NAS market. The absorber is permanently fitted in the lid of the air cleaner assembly and is a non-serviceable item.

Air Ducts

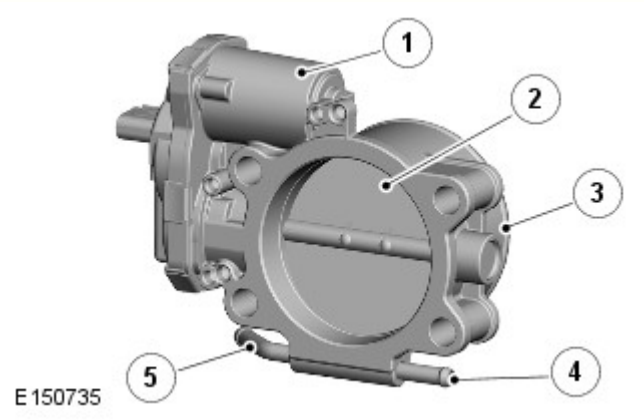
The air ducts transfer clean air from the air cleaner outlets to the electric throttle.

The air ducts incorporate the following:

- Resonators, to reduce air induction noise
- A connector stub for the engine full load breather pipe.

The air duct is supported by a bracket attached to the right cylinder head.

Electric Throttle



Item	Description
1	Electric motor
2	Air outlet
3	Air inlet
4	Coolant feed
5	Coolant return

The electric throttle regulates the ambient air flow into the supercharger.

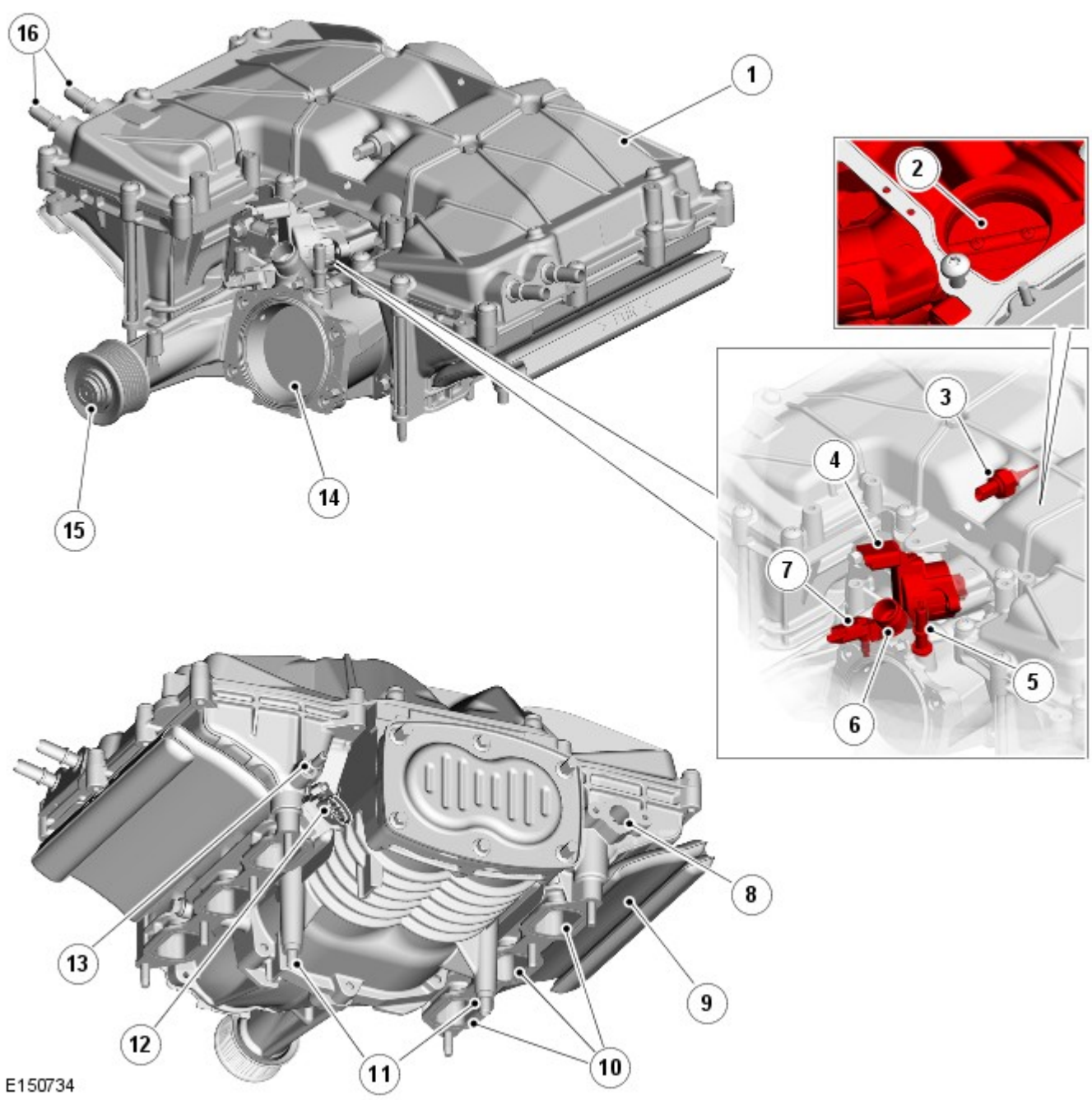
The electric throttle is installed at the front of the engine, between the cylinder heads.

The throttle plate is operated by a Direct Current (DC) electric motor attached to the throttle body. The motor is controlled by the ECM and is constantly adjusted in response to driver inputs with the throttle pedal to precisely control the amount of air allowed into the intake manifolds.

For additional information, refer to: Electronic Engine Controls (303-14C Electronic Engine Controls - V6 S/C 3.0L Petrol, Description and Operation).

To prevent icing, coolant is circulated across the throttle body through coolant feed and return connections.

Supercharger and Intake Manifolds



Item	Description
1	Charge air cooler tank top
2	Supercharger bypass valve
3	Charge air temperature sensor
4	Supercharger bypass valve actuator
5	Evaporative Emission (EVAP) connector stub
6	Part load breather connector stub
7	Manifold Absolute Pressure (MAP) sensor
8	Symposer intake pipe connection
9	Noise, Vibration and Harshness (NVH) pad (2 off)
10	Intake manifold outlet ports (6 off)
11	Dowel (2 off)
12	Manifold Absolute Pressure and Temperature (MAPT) sensor
13	Vacuum pipe connector stub
14	Supercharger intake port
15	Pulley
16	Coolant intake and outlet connections for charge air cooler

The supercharger is a Roots blower with high angle helix rotors driven at 2.5 times engine speed by the secondary belt of the accessory drive.

The supercharger increases the pressure of the air supplied to the engine, to increase the engine's power output.

The supercharger assembly incorporates:

- Air intake duct for the electric throttle
- A connector stub for the part load breather
- A Manifold Absolute Pressure (MAP) Sensor
- A connector stub for a hose from the Evaporative Emissions (EVAP) canister purge valve.

Two separate intake manifolds direct air from the supercharger to the cylinder intake ports. The intake manifolds are attached to their related cylinder heads and the sides of the supercharger.

A charge air cooler tank top is installed on top of the supercharger and intake manifolds to form the air duct from the supercharger outlet to the intake manifolds. A charge air cooler is installed in each intake manifold.

At the rear of the right intake manifold incorporates a connection port for the symposer intake pipe.

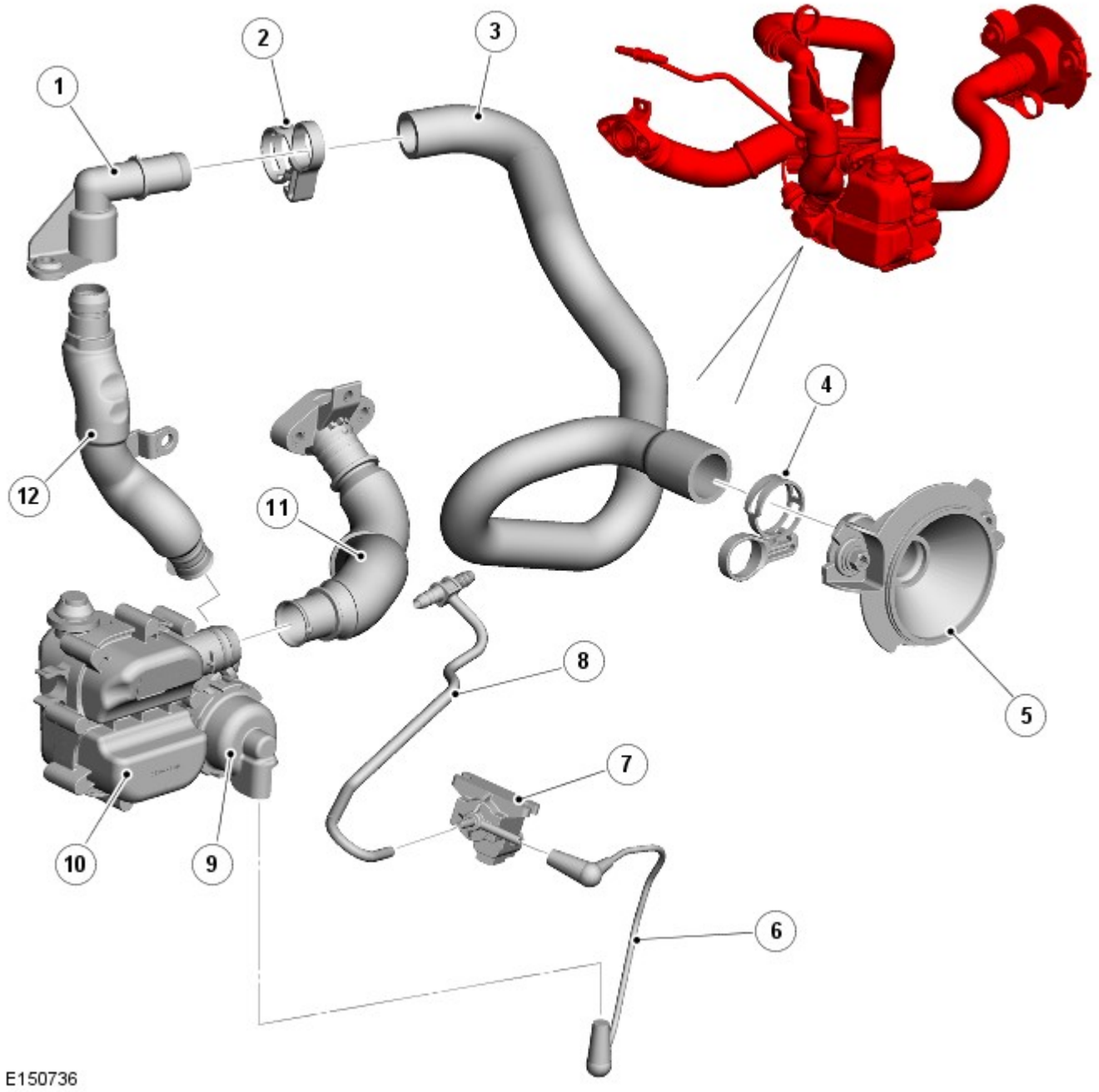
The rear of the left intake manifold incorporates:

- a connector stub for the brake vacuum system
- a MAPT sensor.

Supercharger Bypass Valve Actuator

A DC electric actuator on the front of the supercharger is attached to a bypass valve in the supercharger housing. The bypass valve allows air to bypass the rotors; to control the outlet pressure of the supercharger. Operation of the actuator is controlled by a Pulse Width Modulation (PWM) signal from the ECM. A Hall effect position sensor in the actuator returns a 0.5 to 4.5 V signal to the ECM. This allows the ECM to identify the position of the bypass valve for closed-loop control.

Noise Feedback System



Item	Description
1	Outlet adapter
2	Clamp
3	Feedback tube
4	Clamp
5	Output cone
6	Vacuum hose – Intake manifold tuning valve to pneumatic actuator
7	Intake manifold tuning valve
8	Vacuum hose – Intake manifold tuning valve to brake vacuum system
9	Pneumatic valve
10	Symposer
11	Inlet pipe
12	Outlet pipe

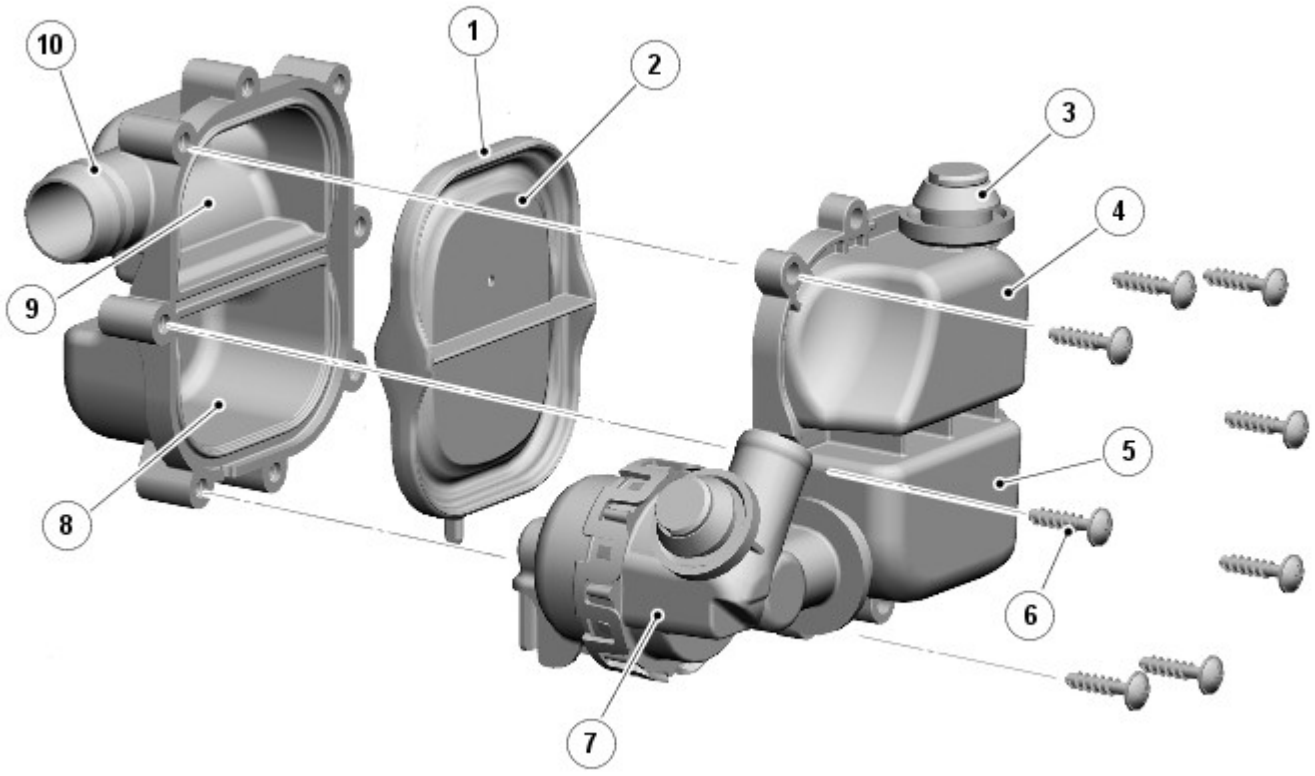
The noise feedback system modifies induction sound waves of a specific frequency range, at given engine settings, to produce the required engine sound. The system consists of:

- an inlet pipe and flange
- a symposer and pneumatic valve assembly

- an intake manifold tuning valve and associated vacuum tubes
- an outlet pipe
- an outlet adapter.

The inlet pipe and flange transfer induction noise from the right intake manifold to the symposer.

The symposer contains two pairs of chambers, one pair on the inlet side and one pair on the outlet side. The inlet pipe connects to one of the chambers on the inlet side of the symposer, and the pneumatic valve connects to one of the chambers on the outlet side of the symposer. A calibrated orifice in the inlet pipe connection on the symposer limits the range of sound waves that pass through it. A 'paddle' installed in a diaphragm forms the separating wall in each pair of chambers. The paddle is able to pivot about its lateral axis where it passes through the wall that separates the two pairs of chambers.



E150737

Item	Description
1	Diaphragm
2	Paddle
3	Isolator
4	Inlet chamber (sealed)
5	Outlet chamber (Open to pneumatic valve)
6	Screw (8 off)
7	Pneumatic valve
8	Outlet chamber
9	Inlet chamber (Open to inlet pipe)
10	Inlet pipe connection

The pneumatic valve controls the flow of sound from the symposer outlet. The valve, that is normally-closed, is connected directly to the outlet of the symposer and operated by vacuum pressure. Two isolators, one on the pneumatic valve and one on the symposer, locate the assembly on a bracket attached to the supercharger rear cover.

The intake manifold tuning valve controls the application of vacuum pressure to the pneumatic valve. The intake manifold tuning valve is a normally-closed solenoid-operated valve installed in the vacuum line between a T-connection in the brake vacuum system and the pneumatic valve. A vent cap on the tuning valve allows atmospheric pressure into the vacuum line to the pneumatic valve when the tuning valve is closed.

The outlet pipe carries sound from the pneumatic valve to the feedback tube via the outlet adapter. The outlet pipe is a push fit on the pneumatic valve and in the outlet adapter

The feedback tube transfers the sound from the symposer system to the output cone.

The resonator directs the sound from the feedback tube into the passenger compartment. The resonator is installed in the passenger compartment side of the engine bulkhead, on two mounting grommets each consisting of an isolator and a compression limiter.

SYSTEM OPERATION

Supercharger

The supercharger is a belt driven unit that pressurizes the intake air to above atmospheric pressure. Intake air is trapped between the lobes and passed to the outlet. The rapid air movement produces a positive pressure in the outlet, therefore increasing the volume of intake air into the engine.

Supercharger Bypass Valve Actuator

At closed or partially open throttle positions, the supercharger bypass valve actuator is fully open, allowing a flow of air from the supercharger outlet, back to the inlet side. This results in little or no pressure increase across the supercharger. Progressive opening of the throttle reduces the depression downstream of the electric throttle. This is sensed by the MAP sensor in the electric throttle housing and the Manifold Absolute Pressure and Temperature (MAPT) sensor in the rear left side of the supercharger left charge air cooler. Signals from these sensors are received by the ECM, which operates the supercharger bypass valve actuator to close the valve. As the supercharger bypass valve closes there is a corresponding increase in the outlet pressure from the supercharger, which increases engine power output.

Noise Feedback System

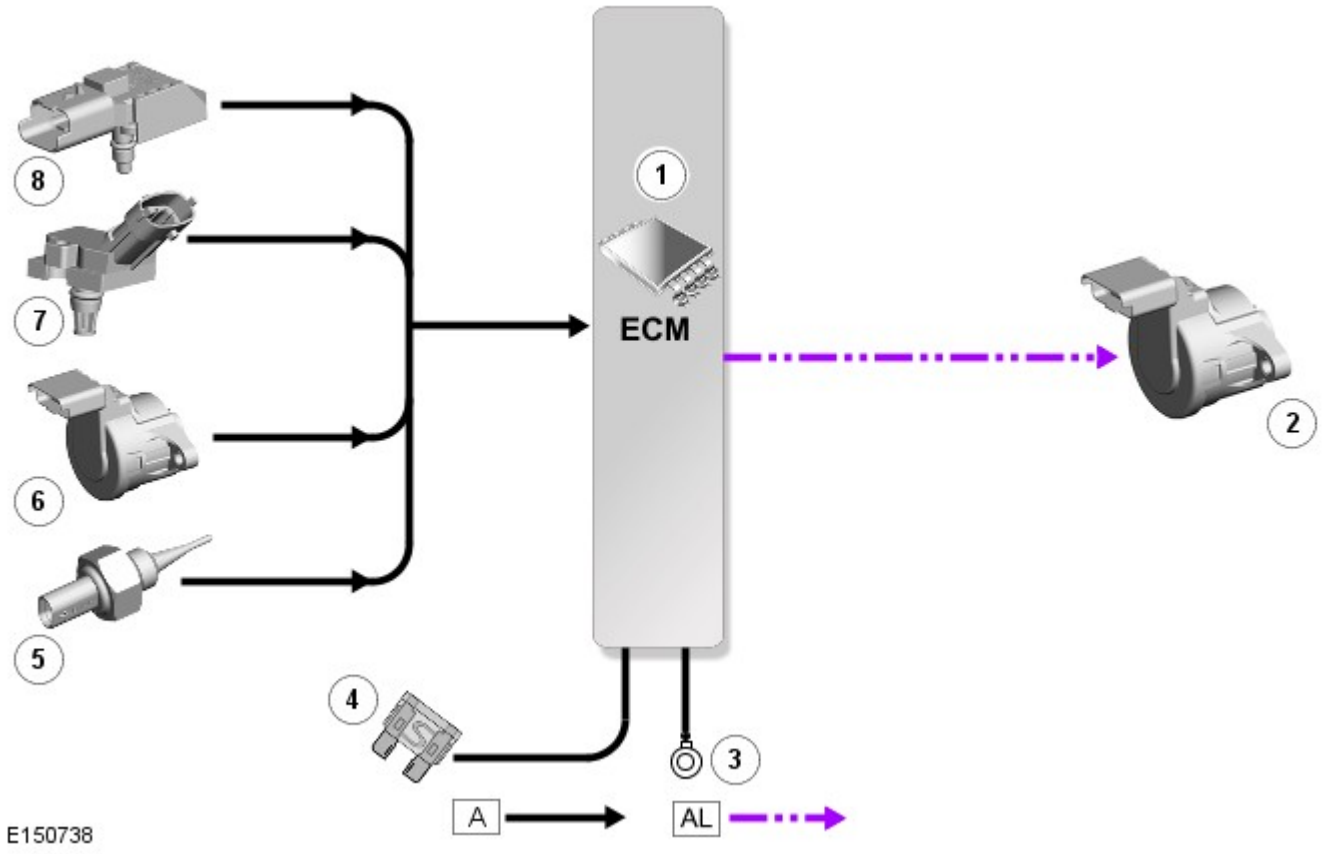
Sound waves from the right intake manifold are filtered by the calibrated orifice in the inlet pipe connection on the symposer. The sound waves make the paddle oscillate and generate pulsations in the outlet chambers. When the pneumatic valve is open, the pulsations are transmitted through the outlet pipe and feedback tube to the output cone in the passenger compartment.

The tuning valve of the noise feedback system receives a power supply from the engine junction and is connected to ground through the ECM. At lower engine loads and speeds the ECM keeps the ground open circuit and the tuning valve is de-energized closed. Atmospheric pressure is sensed at the pneumatic valve through the vent cap on the tuning valve, which keeps the pneumatic valve closed and prevents sound from the symposer entering the feedback system.

At higher engine loads and speeds the ECM connects the tuning valve to ground. The tuning valve energizes, blanks off the atmospheric vent and opens the vacuum line between the brake vacuum system and the pneumatic valve. The depression in the brake vacuum system is sensed at the pneumatic valve, which opens and allows sound from the symposer into the feedback system.

INPUT/OUTPUT DIAGRAM

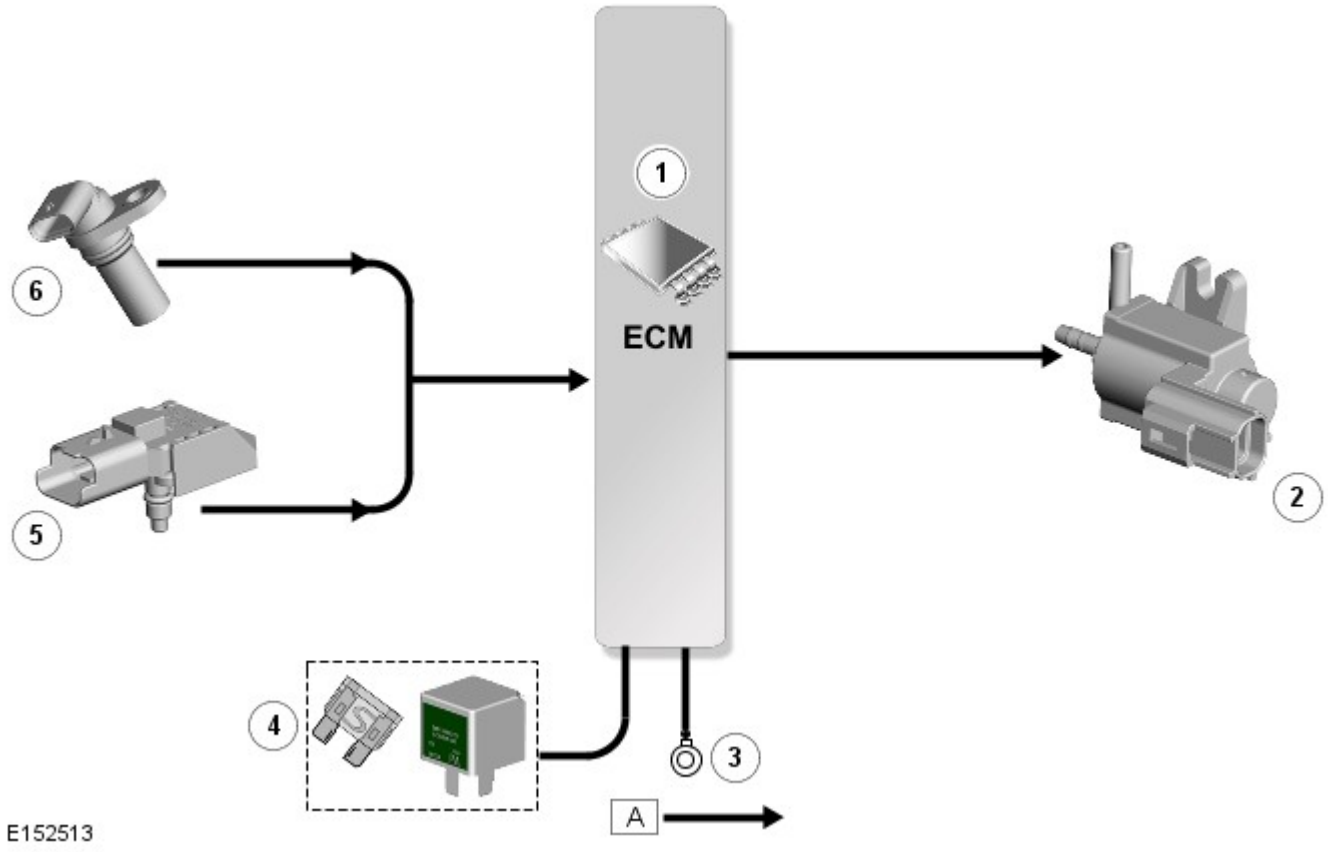
Bypass Valve Operation



A = Hardwired; AL = Pulse Width Modulation (PWM)

Item	Description
1	Engine Control Module (ECM)
2	Supercharger bypass valve actuator
3	Ground
4	Power supply
5	Charge air temperature sensor
6	Supercharger bypass valve actuator
7	Manifold Absolute Pressure and Temperature (MAPT) sensor
8	Manifold Absolute Pressure (MAP) sensor

Intake Manifold Tuning Valve Operation



A = Hardwired

Item	Description
1	Engine Control Module (ECM)
2	Intake manifold tuning valve
3	Ground
4	Power supply
5	Manifold Absolute Pressure (MAP) sensor
6	Crankshaft Position (CKP) sensor

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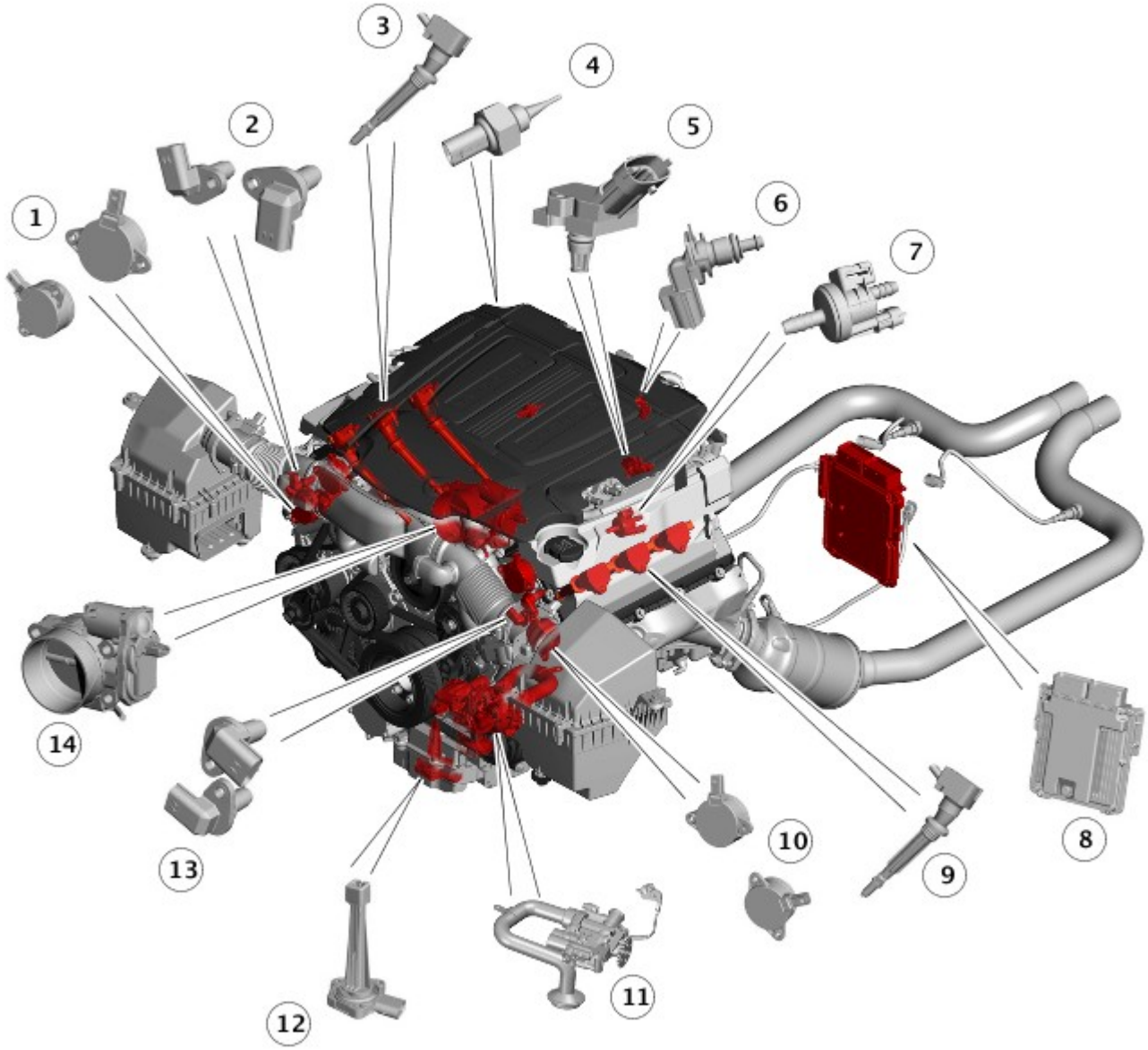
Electronic Engine Controls - V6 S/C 3.0L Petrol - Electronic Engine Controls

Description and Operation

COMPONENT LOCATION

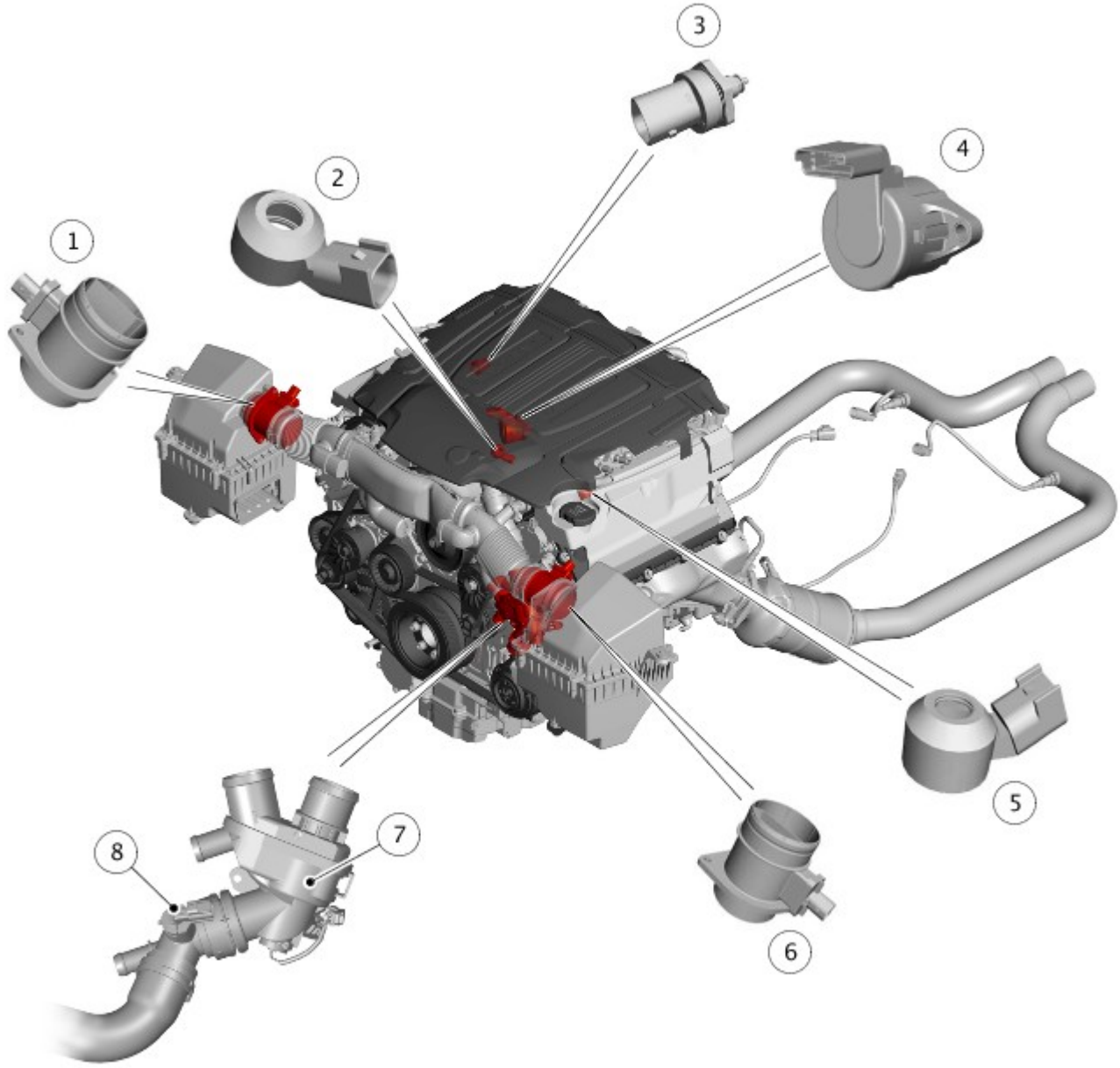
Electronic Engine Controls - Sheet 1 Of 4



E180627

Item	Description
1	Variable Camshaft Timing actuator (VCT) - Bank 2 (2 off)
2	Camshaft Position sensor (CMP) - Bank 2 (2 off)
3	Ignition coil - Bank 2 (3 off)
4	Charge air cooler temperature sensor
5	Manifold Absolute Pressure and Temperature (MAPT) sensor
6	Engine Coolant Temperature (ECT) sensor 1
7	Purge valve
8	Powertrain Control Module (PCM)
9	Ignition coil - Bank 1 (3 off)
10	Variable Camshaft Timing (VCT) actuator - Bank 1 (2 off)
11	Electric oil pump
12	Oil level and temperature sensor
13	Camshaft Position (CMP) sensor - Bank 1 (2 off)
14	Electric throttle

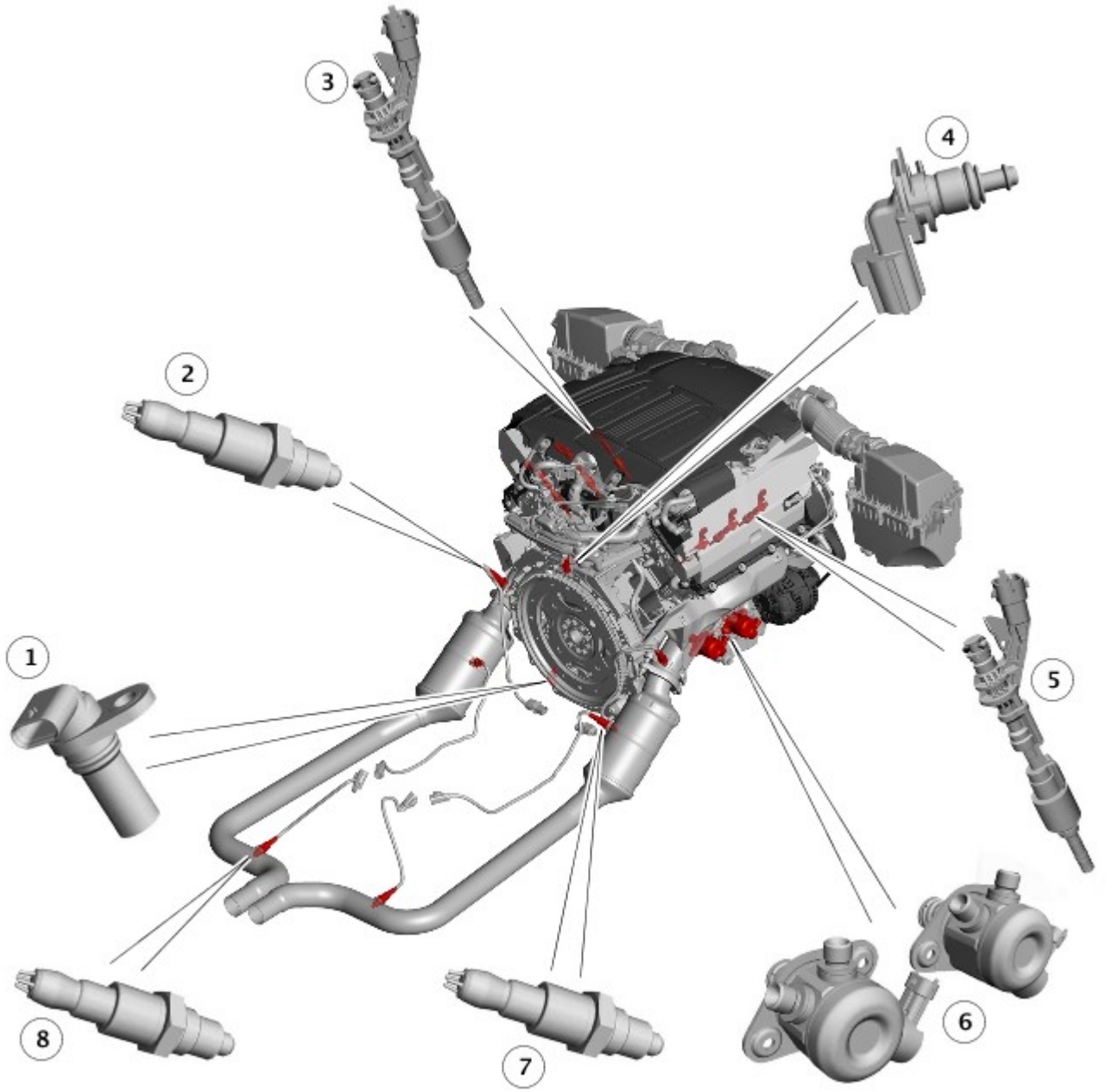
Electronic Engine Controls - Sheet 2 Of 4



E185097

Item	Description
1	Right Mass Air Flow and Temperature (MAFT) sensor
2	Knock sensor - Bank 2
3	Fuel Rail Pressure and Temperature (FRPT) sensor
4	Bypass valve actuator
5	Knock sensor - Bank 1
6	Left Mass Air Flow and Temperature (MAFT) sensor
7	Electric thermostat
8	Engine Coolant Temperature (ECT) sensor 2

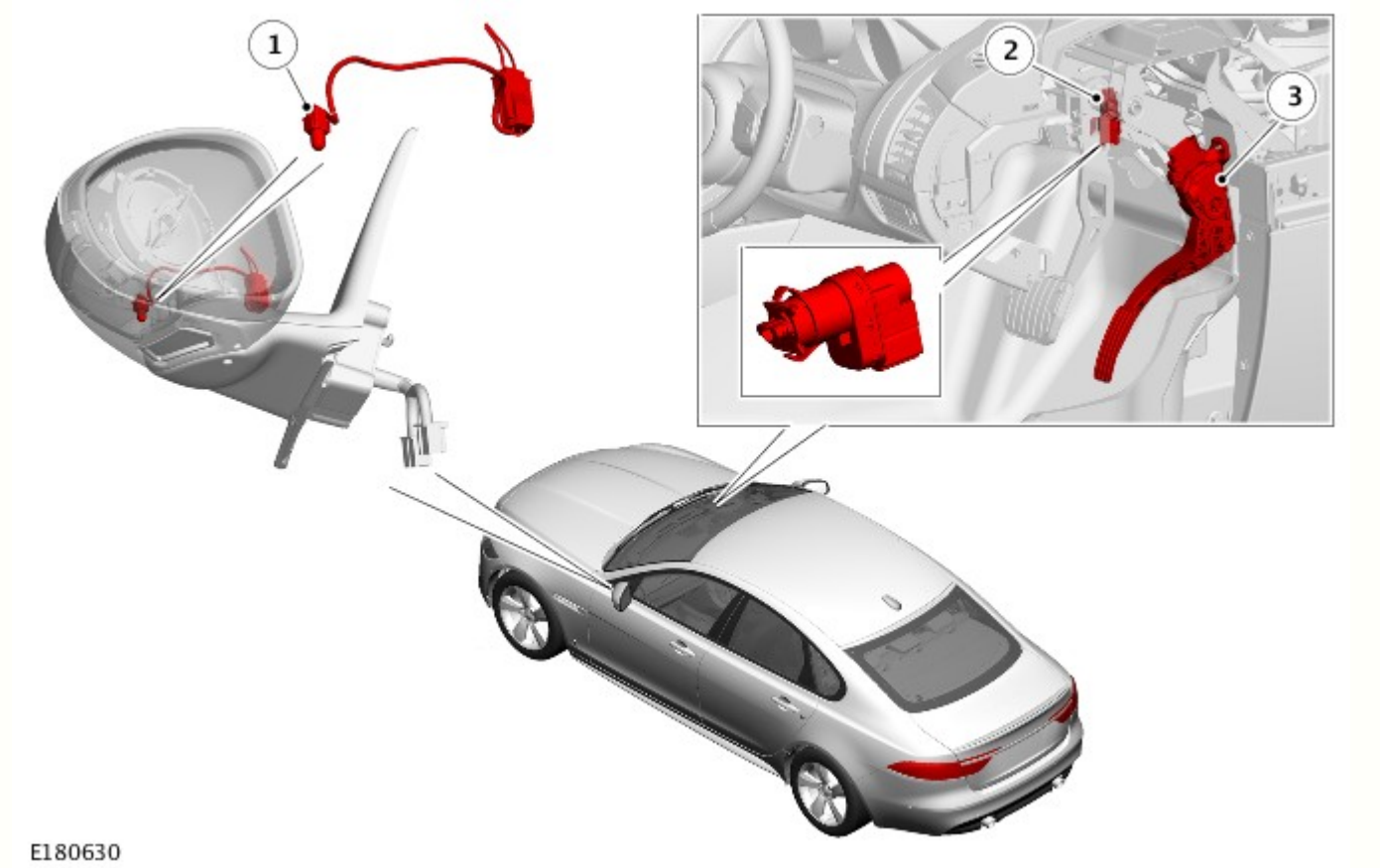
Electronic Engine Controls - Sheet 3 Of 4



E180629

Item	Description
1	Crankshaft Position (CKP) sensor
2	Pre-Catalyst Heated Oxygen Sensor (HO2S) - (2 off)
3	Fuel injector - Bank 2 (3 off)
4	Engine Coolant Temperature (ECT) sensor 1
5	Fuel injector - Bank 1 (3 off)
6	High Pressure (HP) fuel pump (2 off)
7	Mid-Catalyst Heated Oxygen Sensor (HO2S) - (2 off)
8	Post-Catalyst Heated Oxygen Sensor (HO2S) - (2 off)

Electronic Engine Controls - Sheet 4 Of 4



Item	Description
1	Ambient Air Temperature sensor (AAT)
2	Brake pedal switch
3	Accelerator Pedal Position sensor (APP)

OVERVIEW

The electronic engine control system operates the engine to generate the output demanded by the Accelerator Pedal Position (APP) sensor and loads imposed by other systems.

The electronic engine control system has a Powertrain Control Module (PCM) that uses a torque-based strategy to evaluate inputs from sensors and other systems, and then produces outputs to engine actuators to produce the required torque.

The electronic engine control system controls the following:

- Charge Air
- Fueling
- Ignition timing
- Valve timing
- Cylinder knock
- Idle speed
- Engine cooling fan
- Evaporative emissions
- On-Board Diagnostic (OBD)
- Immobilization system interface
- Speed control.

DESCRIPTION

Powertrain Control Module (PCM)

E148512

The Powertrain Control Module (PCM) is located at the rear of the engine compartment, between the bulkhead panel and the secondary bulkhead panel on the opposite side to the hand of drive. The PCM is secured to a mounting bracket with four screws. The bracket is attached to the bulkhead panel.

The PCM has the capability of adapting its fuel and ignition control outputs in response to several sensor inputs.

The PCM receives inputs from the following:

- Crankshaft Position (CKP) sensor
- Camshaft Position (CMP) sensor (4 off)
- Engine Coolant Temperature (ECT) sensor (2 off)
- Knock sensor (2 off)
- Manifold Absolute Pressure (MAP) sensor
- Mass Air Flow and Temperature (MAFT) sensor (2 off)
- Manifold Absolute Pressure and Temperature (MAPT) sensor
- Accelerator Pedal Position (APP) sensor
- Heated Oxygen Sensor (HO2S) (4 off)
- Ambient Air Temperature (AAT) sensor
- Fuel Rail Pressure and Temperature (FRPT) sensor
  For additional information, refer to: Fuel Charging and Controls (303-04C Fuel Charging and Controls - V6 S/C 3.0L Petrol, Description and Operation).
- Brake pedal switch
  For additional information, refer to: Anti-Lock Control - Stability Assist (206-09 Anti-Lock Control - Stability Assist, Description and Operation).
- Speed control switch
  For additional information, refer to: Speed Control (310-03 Speed Control, Description and Operation).
- Oil level and temperature sensor
  For additional information, refer to: Engine (303-01C Engine - V6 S/C 3.0L Petrol, Description and Operation).
- Fuel Pump Driver Module (FPDM)
  For additional information, refer to: Fuel Tank and Lines (310-01C Fuel Tank and Lines - V6 S/C 3.0L Petrol , Petrol, Description and Operation).
- Restraints Control Module (RCM)
  For additional information, refer to: Air Bag Supplemental Restraint System (SRS) (501-20B Supplemental Restraint System, Description and Operation).
- Transmission Control Switch (TCS)
  For additional information, refer to: External Controls (307-05 Automatic Transmission/Transaxle External Controls, Description and Operation).
- Supercharger bypass valve position sensor
  For additional information, refer to: Intake Air Distribution and Filtering (303-12C Intake Air Distribution and Filtering - V6 S/C 3.0L Petrol, Description and Operation).
- Charge air cooler temperature sensor
  For additional information, refer to: Intake Air Distribution and Filtering (303-12C Intake Air Distribution and Filtering - V6 S/C 3.0L Petrol, Description and Operation).
- Brake vacuum sensor (if equipped)
  For additional information, refer to: Starting System (303-06C Starting System - V6 S/C 3.0L Petrol, Description and Operation).

The Powertrain Control Module (PCM) provides outputs to the following:

- Electric Throttle
- PCM Relay
- Pre-catalyst Heated Oxygen Sensor (HO2S) heater elements (2 off)
- Fuel injectors (6 off)
  For additional information, refer to: Fuel Charging and Controls (303-04C Fuel Charging and Controls - V6 S/C 3.0L Petrol, Description and Operation).
- Ignition coils (6 off)
  For additional information, refer to: Engine Ignition (303-07C Engine Ignition - V6 S/C 3.0L Petrol, Description and Operation).
- Variable Camshaft Timing (VCT) actuators (4 off)
  For additional information, refer to: Engine (303-01C Engine - V6 S/C 3.0L Petrol, Description and Operation).

- Evaporative emissions purge valve
  For additional information, refer to: Evaporative Emissions (303-13B Evaporative Emissions - V6 S/C 3.0L Petrol, Description and Operation).
- Starter motor relay
  For additional information, refer to: Starting System (303-06C Starting System - V6 S/C 3.0L Petrol, Description and Operation).
- Engine cooling fan
  For additional information, refer to: Engine Cooling (303-03C Engine Cooling - V6 S/C 3.0L Petrol, Description and Operation).
- Charge air coolant pump
  For additional information, refer to: Supercharger Cooling (303-03D Supercharger Cooling - V6 S/C 3.0L Petrol, Description and Operation).
- High Pressure (HP) fuel pump (2 off)
  For additional information, refer to: Fuel Charging and Controls (303-04C Fuel Charging and Controls - V6 S/C 3.0L Petrol, Description and Operation).
- Fuel Pump Driver Module (FPDM)
  For additional information, refer to: Fuel Tank and Lines (310-01C Fuel Tank and Lines - V6 S/C 3.0L Petrol , Petrol, Description and Operation).
- Diagnostic Module Tank Leakage (DMTL) pump - NAS market vehicles only
  For additional information, refer to: Fuel Tank and Lines (310-01C Fuel Tank and Lines - V6 S/C 3.0L Petrol , Petrol, Description and Operation).
- Supercharger bypass valve actuator
  For additional information, refer to: Intake Air Distribution and Filtering (303-12C Intake Air Distribution and Filtering - V6 S/C 3.0L Petrol, Description and Operation).
- Inlet Manifold Tuning Valve
  For additional information, refer to: Intake Air Distribution and Filtering (303-12C Intake Air Distribution and Filtering - V6 S/C 3.0L Petrol, Description and Operation).

Crankshaft Position (CKP) Sensor

The Crankshaft Position (CKP) sensor is an inductive sensor that allows the Powertrain Control Module (PCM) to determine the angular position of the crankshaft and the engine speed.

The CKP sensor is installed in the rear left side of the oil pan, in line with the engine drive plate. The sensor is secured with a single screw and sealed with an O-ring. A three pin electrical connector provides the interface with the engine harness.

The head of the CKP sensor faces a reluctor ring pressed into the outer circumference of the engine drive plate. The reluctor ring has 60 teeth, with 2 teeth missing. There are 58 teeth at 6° intervals, with two teeth removed to provide a reference point with a centerline that is 21° BTDC (Before Top Dead Center) on cylinder 1 of bank 2.

If the CKP sensor fails, the PCM:

- Uses signals from the CKP sensors to determine the angular position of the crankshaft and the engine speed.
- Adopts a limp home mode where engine speed is limited to a maximum of 3000 RPM.

With a failed CKP sensor, engine starts will require a long crank time while the PCM determines the angular position of the crankshaft using the CMP sensors.

Camshaft Position (CMP) Sensors

E116087

The Camshaft Position (CMP) sensors are magneto-resistive element sensors that allow the Powertrain Control Module (PCM) to determine the angular position of the camshafts. Magneto-resistive element sensors produce a digital output which allows the PCM to detect speeds down to zero.

Four CMP sensors are installed in the front upper timing covers, one for each camshaft.

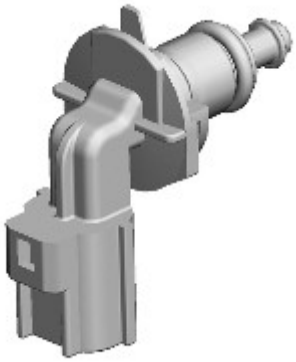
Each CMP sensor is secured with a single screw and sealed with an O-ring. On each CMP sensor, a three pin electrical connector provides the interface with the engine harness.

The head of each CMP sensor faces a sensor wheel attached to the front of the related VCT unit.

If an exhaust CMP sensor fails, the PCM disables the VCT of both exhaust camshafts.

If an intake CMP sensor fails, the PCM disables the VCT of both intake camshafts. This can result in the engine being slow, or failing, to start.

Engine Coolant Temperature (ECT) Sensors



E108397

The Engine Coolant Temperature (ECT) sensors are Negative Temperature Coefficient (NTC) thermistors that allows the Powertrain Control Module (PCM) to monitor the engine coolant temperature.

There are two identical ECT sensors installed, which are identified as ECT 1 and ECT 2. Each sensor is secured with a twist-lock and latch mechanism, and is sealed with an O-ring. A two pin electrical connector provides the interface between the sensor and the engine harness.

Engine Coolant Temperature (ECT) sensor 1

The ECT 1 is installed in the heater manifold, at the rear of the Bank 1 cylinder head. The input from this sensor is used in calibration tables and by other systems.

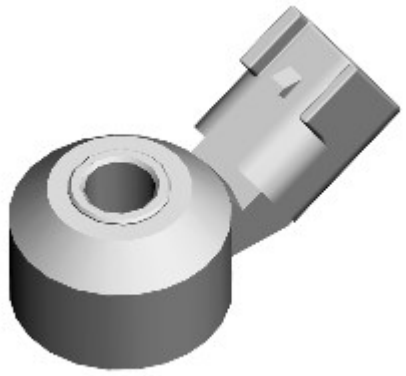
If there is an ECT 1 fault, the PCM adopts an estimated coolant temperature. On the second consecutive trip with an ECT 1 fault, the PCM illuminates the Malfunction Indicator Lamp (MIL).

Engine Coolant Temperature (ECT) sensor 2

The ECT 2 is installed in the lower hose connector which attaches to the bottom of the electric thermostat. The input from this sensor is used for On-Board Diagnostic (OBD) diagnostics and, in conjunction with the input from ECT 1, to confirm that the electric thermostat is functional.

If there is an ECT 2 fault, the ECM illuminates the MIL on the second consecutive trip.

Knock Sensors



E108400

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

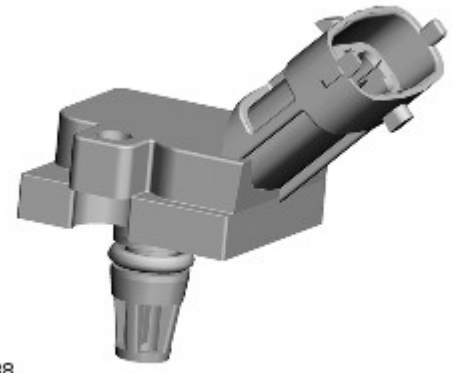
One knock sensor is installed on the inboard side of each cylinder head, adjacent to the air intake for cylinders 3 and 4. Each knock sensor is secured with a single screw. On each knock sensor, a two pin electrical connector provides the interface with the engine harness.

The PCM compares the signals from the knock sensors with mapped values stored in memory to determine when detonation occurs on individual cylinders. When detonation is detected, the PCM retards the ignition timing on that cylinder for a number of engine cycles, 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 ensures the engine will not become damaged if low quality fuel is used. The MIL will not illuminate, although the driver may notice that the engine 'knocks' in some driving conditions and displays a drop in performance and smoothness.

The PCM calculates the default value if a sensor fails on either bank of cylinders.

Manifold Absolute Pressure and Temperature (MAPT) Sensor



E116088

The Manifold Absolute Pressure and Temperature (MAPT) sensor allows the PCM to calculate the charge air density immediately before it enters the cylinders. This is used to adjust the ignition timing relative to the boost pressure, and to monitor the performance of the charge air coolers.

The MAPT sensor is installed in the left charge air cooler outlet. The sensor is secured with a single screw and sealed with an O-ring. A four pin electrical connector provides the interface with the engine harness.

Mass Air Flow and Temperature (MAFT) Sensor

E148513

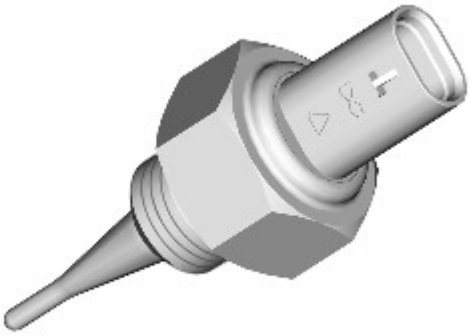
The Mass Air Flow and Temperature (MAFT) sensors allow the Powertrain Control Module (PCM) to measure the mass flow and the temperature of the air flow into the engine. The mass air flow is measured with a hot film element in the sensor. The temperature of the air flow is measured with a NTC thermistor in the sensor. The mass air flow is used to determine the fuel quantity to be injected in order to maintain the target air/fuel mixture required for correct operation of the engine and the catalytic converters.

There are two MAFT sensors installed, one in each air cleaner outlet duct. Each MAFT sensor is integral with the intake duct. On each MAFT sensor, a five pin electrical connector provides the interface with the engine harness.

If the hot film element signal fails, the PCM invokes a software backup strategy to calculate the mass air flow from other inputs. Closed loop fuel control, closed loop idle speed control and evaporative emissions control are suspended. The engine will suffer from poor starting, poor throttle response and, if the failure occurs while driving, the engine speed may dip and surging may occur before recovering.

If the NTC thermistor signal fails the PCM adopts a default value of 25 °C (77 °F) for the intake air temperature.

Charge Air Temperature Sensor



E149162

The charge air temperature sensor is installed in the supercharger top cover. A two pin electrical connector provides the interface between the sensor and the engine harness. The sensor contains an NTC thermistor with supply and return connections to the Powertrain Control Module (PCM).

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

The PCM uses the input:

- To monitor operation of the charge air coolant pump.
- For air mass calculations used in control of the supercharger bypass valve, as part of the charge air strategy that co-ordinates operation of the electric throttle and the bypass valve, and predicts the air mass delivered to the cylinders.

If the charge air temperature sensor fails, the PCM substitutes the input with a modelled temperature. Failure of the sensor is unlikely to be noticeable to the driver.

Heated Oxygen (HO2S) Sensors

E148505

The Heated Oxygen (HO2S) sensor allow the Powertrain Control Module (PCM) to measure the oxygen content of the exhaust gases, for closed loop control of the fuel and air mixture and for catalytic converter monitoring.

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

HO2S need to operate at high temperatures in order to function correctly. To achieve the high temperatures required, the sensors are fitted with heater elements that are controlled by a Pulse Width Modulation (PWM) signal from the PCM. The heater elements are operated after each engine start, once it has been calculated that there is no moisture in the exhaust (between 0 and 10 minutes delay) and also during low load conditions when the temperature of the exhaust gases is insufficient to maintain the required sensor temperature. 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 sensors. 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 sensors. This is achieved by checking the signal against maximum and minimum threshold, for open and short circuit conditions.

If a HO2S fails:

- The PCM defaults to open loop fueling for the related cylinder bank.
- The Carbon Monoxide (CO) and emissions content of the exhaust gases may increase.
- The exhaust may smell of rotten eggs (hydrogen sulphide H2S).

With a failed HO2S, the engine will suffer from reduced refinement and performance.

Accelerator Pedal Position (APP) Sensor

E174902

The Accelerator Pedal Position (APP) sensor allows the Powertrain Control Module (PCM) to determine the driver requests for vehicle speed, acceleration and deceleration. The PCM uses this information, together with information from the Anti-Lock Brake System (ABS) control module and the Transmission Control Module (TCM), to determine the setting of the electric throttle.

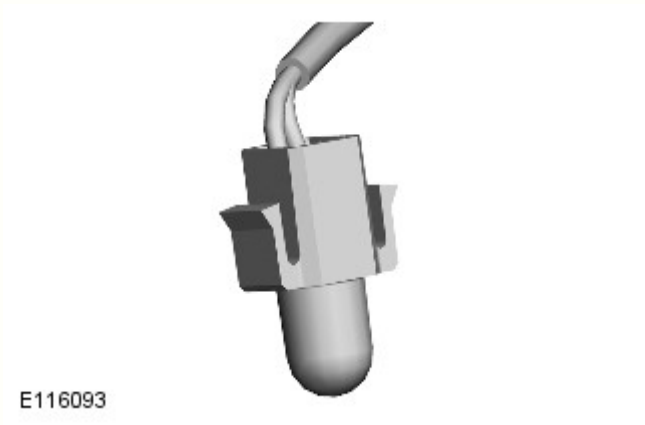
Three screws attach the APP sensor and integrated accelerator pedal to a bracket on the lower instrument panel. A six pin electrical connector provides the interface with the vehicle harness.

The APP sensor is a twin track potentiometer. Each track receives an independent power supply from the PCM and returns an independent analog signal to the PCM. Both signals contain the same positional information, but the signal from track 2 is half the voltage of the signal from track 1 at all positions.

If both signals have a fault, the PCM adopts a limp home mode, which limits the engine speed to 2000 RPM maximum.

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

Ambient Air Temperature (AAT) Sensor



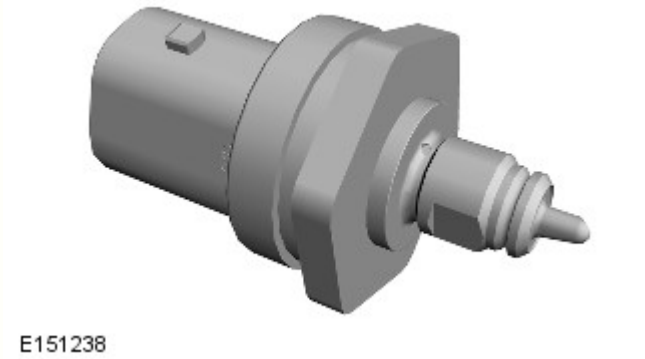
The Ambient Air Temperature (AAT) sensor is a NTC thermistor that allows the Powertrain Control Module (PCM) to monitor the temperature of the air around the vehicle. The PCM uses the AAT sensor input for a number of functions, including engine cooling fan control. The PCM also transmits the ambient air temperature on the HS (High Speed) CAN (Controller Area Network) powertrain systems 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 PCM 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 PCM calculates the AAT from the temperature inputs of the MAFT sensors. If the AAT sensor and the temperature inputs of the MAFT sensors are all faulty, the PCM adopts a default ambient temperature of 25 °C (77 °F).

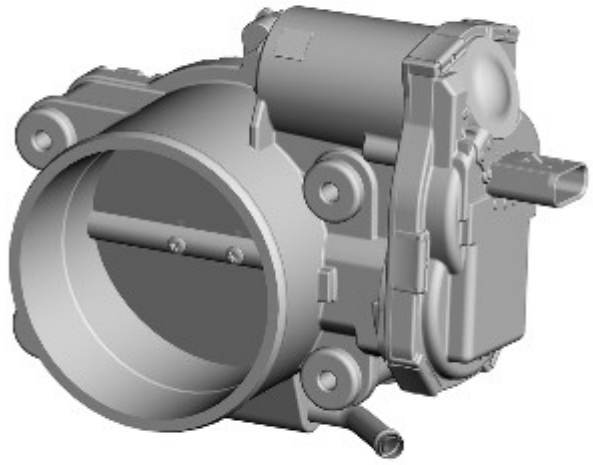
Fuel Rail Pressure and Temperature (FRPT) Sensor



The Fuel Rail Pressure and Temperature (FRPT) sensor provides the Powertrain Control Module (PCM) with a continuous signal of fuel rail pressure via hardwired connection. The FRPT sensor is installed in the rear of the Bank 1 fuel rail. The FRPT sensor is screwed into a threaded boss in the fuel rail.

The FRPT sensor contains a steel diaphragm fitted with strain gages, which are incorporated into a Wheatstone bridge. The output from the Wheatstone bridge is processed by the PCM to determine a pressure value. The FRPT sensor contains a Negative Temperature Coefficient (NTC) sensor which allows the PCM to determine the fuel temperature.

Electric Throttle



E148517

The Powertrain Control Module (PCM) uses the electric throttle to help regulate engine torque.

The electric throttle is installed between the t-piece duct of the intake air distribution and filtering system, and the inlet of the supercharger.
For additional information, refer to: Intake Air Distribution and Filtering (303-12C Intake Air Distribution and Filtering - V6 S/C 3.0L Petrol, Description and Operation).

The throttle plate is operated by an electric Direct Current (DC) motor integrated into the throttle body. The PCM uses a PWM signal to control the DC motor. The PCM compares the APP sensor inputs against an electronic request or value to determine the required position of the throttle plate.

The PCM and electric throttle are also required to:

- Monitor requests for speed control operation.
- Automatically operate the electric throttle for accurate speed control.
- Perform all Dynamic Stability Control (DSC) engine interventions.
- Monitor and carry out maximum engine speed and road speed cut outs.
- Provide different engine maps for the ride and handling optimization system.

A software strategy within the PCM calibrates the position of the throttle plate at the beginning of each ignition cycle. When the ignition is turned on, the PCM performs a self-test and calibration routine by fully closing the throttle plate and then opening it again. This tests the default position springs and allows the PCM to learn the fully closed position.

OPERATION

Powertrain Control Module (PCM) Relay

The Powertrain Control Module (PCM) relay is installed in the Engine Junction Box (EJB) 2.

The PCM relay is used to initiate the power up and power down routines within the PCM.

When the ignition is turned on, battery voltage is applied to the ignition sense input from the Body Control Module/Gateway Module (BCM/GWM) assembly . The PCM then starts its power up routines and energizes the PCM relay.

When the ignition is turned off, the PCM maintains its powered up state while it conducts the power down routines.

This can be for:

- Up to 20 minutes in extreme cases, when the Diagnostic Module Tank Leakage (DMTL) filter system is running (NAS markets)
- Up to 5 minutes when cooling fans are required.

On completion of the power down routines the PCM de-energizes the PCM relay.

Powertrain Control Module (PCM) Adaptions

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

The components which have adaptions associated with them are the following:

- Accelerator Pedal Position (APP) sensor
- Heated Oxygen Sensor (HO2S)
- Mass Air Flow and Temperature (MAFT) sensor
- Crankshaft Position (CKP) sensor
- Electric throttle
- Knock sensors
- Fuel Pump Driver Module (FPDM).

Heated Oxygen Sensor (HO2S) and Mass Air Flow and Temperature (MAFT) Sensor

There are several adaptive maps associated with the fueling strategy. Within the fueling strategy the Powertrain Control Module (PCM) calculates short-term adaptions and long-term adaptions. The PCM will monitor the deterioration of the Heated Oxygen Sensor (HO2S) over a period of time. It will also monitor the current correction associated with the sensors.

The PCM will store a Diagnostic Trouble Code (DTC) in circumstances where an adaption is forced to exceed its operating parameters. Simultaneously, the PCM will record the engine speed, engine load and intake air temperature.

Crankshaft Position (CKP) Sensor

The characteristics of the signal supplied by the Crankshaft Position (CKP) sensor are learned by the PCM. This enables the PCM to set an adaption and support the engine misfire.

Due to a small variation between different drive plates and different CKP sensors, the adaption must be reset if either component is renewed, or removed and refitted. It is also necessary to reset the drive plate adaption if the PCM is renewed or replaced. The PCM supports four drive plate adaptions for the CKP sensor. Each adaption relates to a specific engine speed range. The engine speed ranges are detailed in the table below:

Adaption	Engine Speed (RPM)
1	1800 - 3000
2	3001 - 3800
3	3801 – 4600
4	4601 - 5400

Misfire Detection

Legislation requires that the Powertrain Control Module (PCM) must be able to detect the presence of an engine misfire. It must be able to detect misfires at two separate levels. The first level is an amount of misfire that could lead to the legislated emissions limit being exceeded by a given amount. The second level is a misfire rate that causes degradation in catalytic converter efficiency.

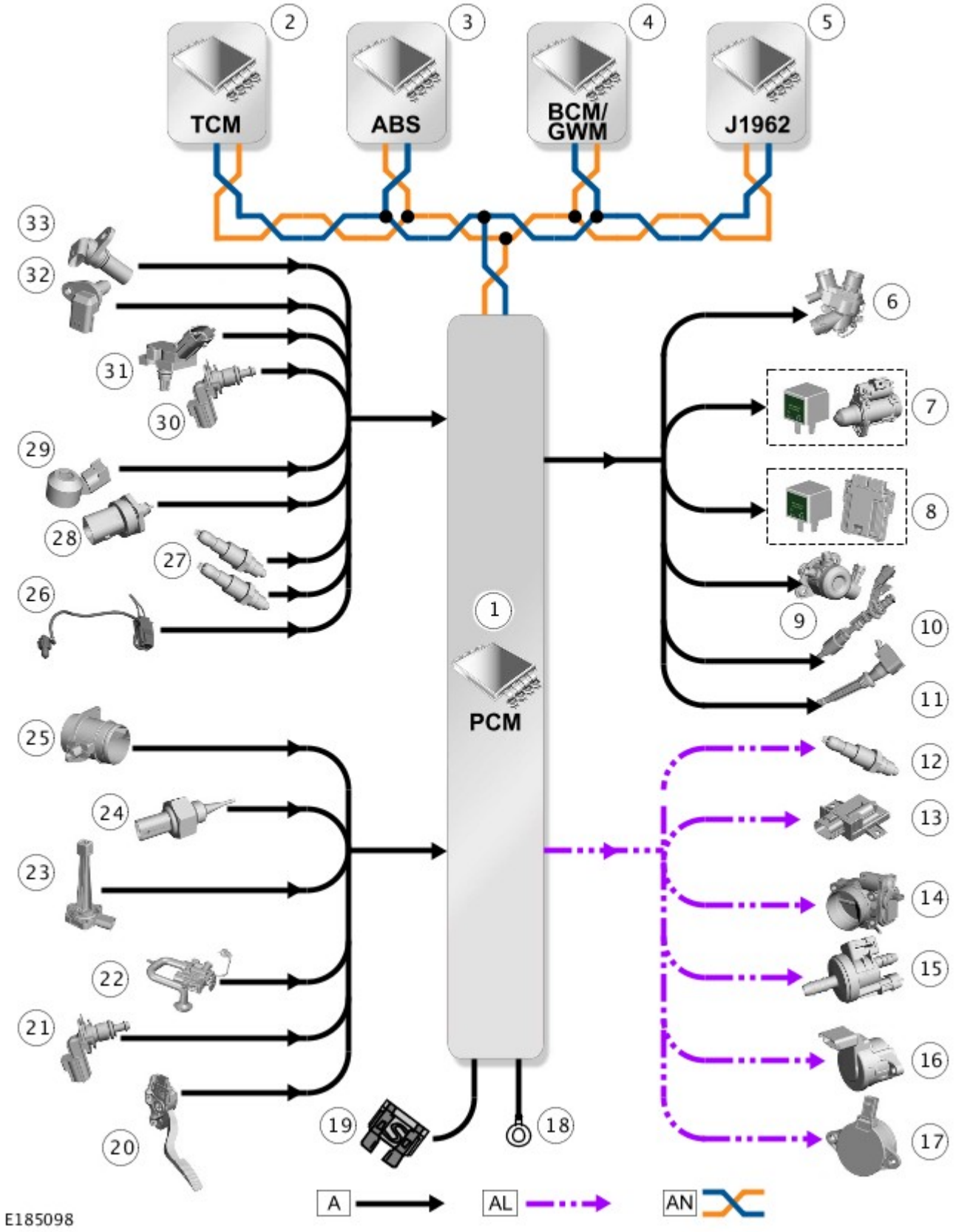
The PCM monitors the number of misfire occurrences within two engine revolution ranges. If the PCM determines a misfire failure within either of these two ranges, over two consecutive journeys, it will record a fault code and details of the engine speed, engine load and engine coolant temperature. In addition, if the second level of misfire occurs on any trip, the PCM flashes the MIL while the fault is occurring.

The signal from the Crankshaft Position (CKP) sensor indicates how fast the poles on the drive plate are passing the sensor tip. A sine wave is generated each time a pole passes the sensor tip. The PCM can detect variations in drive plate speed by monitoring the sine wave signal supplied by the crankshaft position sensor. By assessing this signal, the PCM can detect the presence of an engine misfire. The PCM will evaluate the signal against a number of factors and will decide whether to record the occurrence or ignore it. The PCM can assign a misfire judgement to an individual cylinder, which can be viewed on Jaguar approved diagnostic equipment

Diagnostics

The PCM stores each fault as a Diagnostic Trouble Code (DTC). The DTC and associated environmental and freeze frame data can be read using Jaguar approved diagnostic equipment, which can also read real time data from each sensor, the adaption values currently being employed and the current fueling, ignition and idle speed settings.

CONTROL DIAGRAM



A = Hardwired; AL = Pulse Width Modulation (PWM); AN = High Speed (HS) Controller Area Network (CAN) powertrain system bus.

Item	Description
1	Powertrain Control Module (PCM)
2	Transmission Control Module (TCM)
3	Anti-lock Brake System (ABS) control module
4	Body Control Module/Gateway Module (BCM/GWM) assembly
5	Diagnostic Connector (J1962)

6	Electric thermostat
7	Starter motor relay
8	Powertrain Control Module (PCM) relay
9	High Pressure (HP) fuel pump (2 of)
10	Fuel injector (6 of)
11	Ignition coil (6 of)
12	Pre-Catalyst Heated Oxygen Sensor (HO2S) heater element (2 of)
13	Fuel Pump Driver Module (FPDM)
14	Electric throttle
15	Purge valve
16	Bypass valve actuator
17	Variable Camshaft Timing (VCT) actuator (4 of)
18	Ground
19	Power supply
20	Accelerator Pedal Position (APP) sensor
21	Engine Coolant Temperature (ECT) sensor 1
22	Electric oil pump
23	Oil level and temperature sensor
24	Charge air temperature sensor
25	Mass Air Flow and Temperature (MAFT) sensor (2 of)
26	Ambient Air Temperature (AAT) sensor
27	Mid-catalyst Heated Oxygen Sensor (HO2S) (2 of) and post-catalyst Heated Oxygen Sensor (HO2S) (2 of)
28	Fuel Rail Pressure and Temperature (FRPT) sensor
29	Knock sensor (2 of)
30	Engine Coolant Temperature (ECT) sensor 2
31	Manifold Absolute Pressure and Temperature (MAPT) sensor
32	Camshaft Position (CMP) sensor (4 of)
33	Crankshaft Position (CKP) sensor