SECTION : 303-14 Powertrain Control Management

VEHICLE APPLICATION : 2008.0 Falcon

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DESCRIPTION AND OPERATION

General Information

This section describes the operation and components of the Powertrain Control Module (PCM). The system is designed to provide optimal performance and emission control. Modifying the system or substituting non-Ford components may have an adverse effect on drivability and emissions. Diagnosis of the system requires special tools and training. Maintenance of the PCM system should be performed by Ford trained technicians.

Precautions

The fuel supply lines retain pressure that must be relieved before servicing the fuel system. Leaking fuel poses a potential fire hazard.

The spark ignition system produces high voltages. Use care to avoid personal injury.

When the ignition is ON, the electric engine cooling fans can start at any time. Keep clear of the fans to avoid entanglement and personal injury.

When the ignition is switched off, the electric engine cooling fans can remain on for up to four minutes. Keep clear of the fans to avoid entanglement and personal injury.

With the engine running, there are rotating components within the engine compartment. Use extreme care to avoid entanglement and personal injury.

Some components in the engine compartment are HOT.

The cooling system contains hot liquid under pressure. Allow the engine to cool to ambient temperature before removing the cooling system cap.

Do not reconnect a PCM to the vehicles wiring harness with the ignition turned ON.

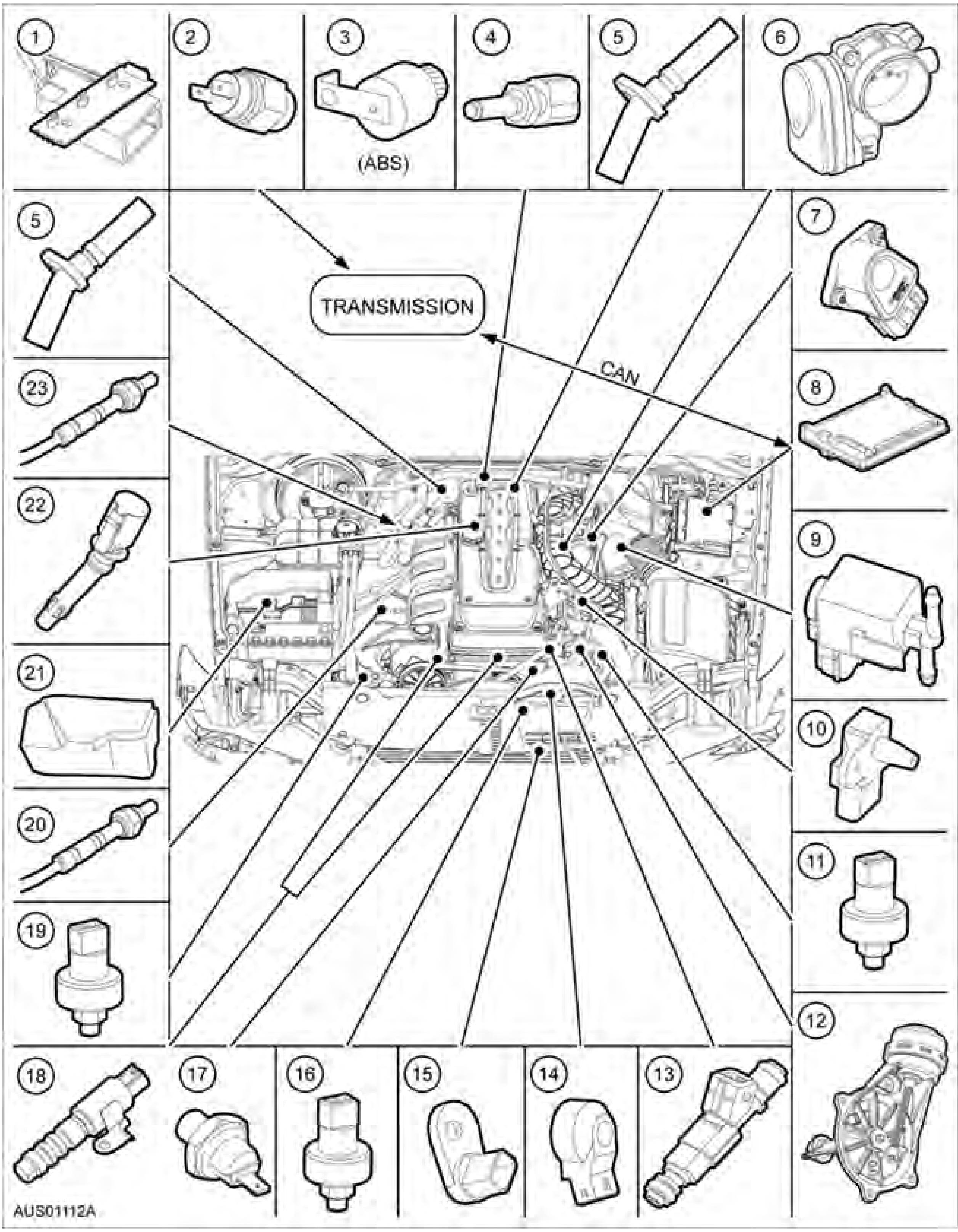
For vehicles fitted with five and six speed automatic transmissions, the vehicle is started by moving the key to the start position momentarily and released. The key will automatically return to the ON position.

Special Notes

- With this issue of the Falcon Workshop Manual, some terminologies in this section for PCM components now reflect Ford’s Global Naming Conventions. The full title of the component is spelt out in full the first time it is mentioned in a section. The acronym for the component is shown in brackets and, where applicable, the previous acronym is shown in Chevrons. Elsewhere in the section, only the acronym is used.
- Information in this section regarding the Traction Control System (TCS) and Dynamic Stability Control (DSC) is only applicable where fitted.
- Information in this section regarding LPG applies only to Ford Factory fitted LPG systems. Installation of after-market LPG systems may operate differently from that described here.
- Information in this section regarding Air Conditioning and Automatic Climate Control Air Conditioning is only applicable where fitted.

DESCRIPTION AND OPERATION (Continued)

PCM Control Components, I6 Petrol Engine



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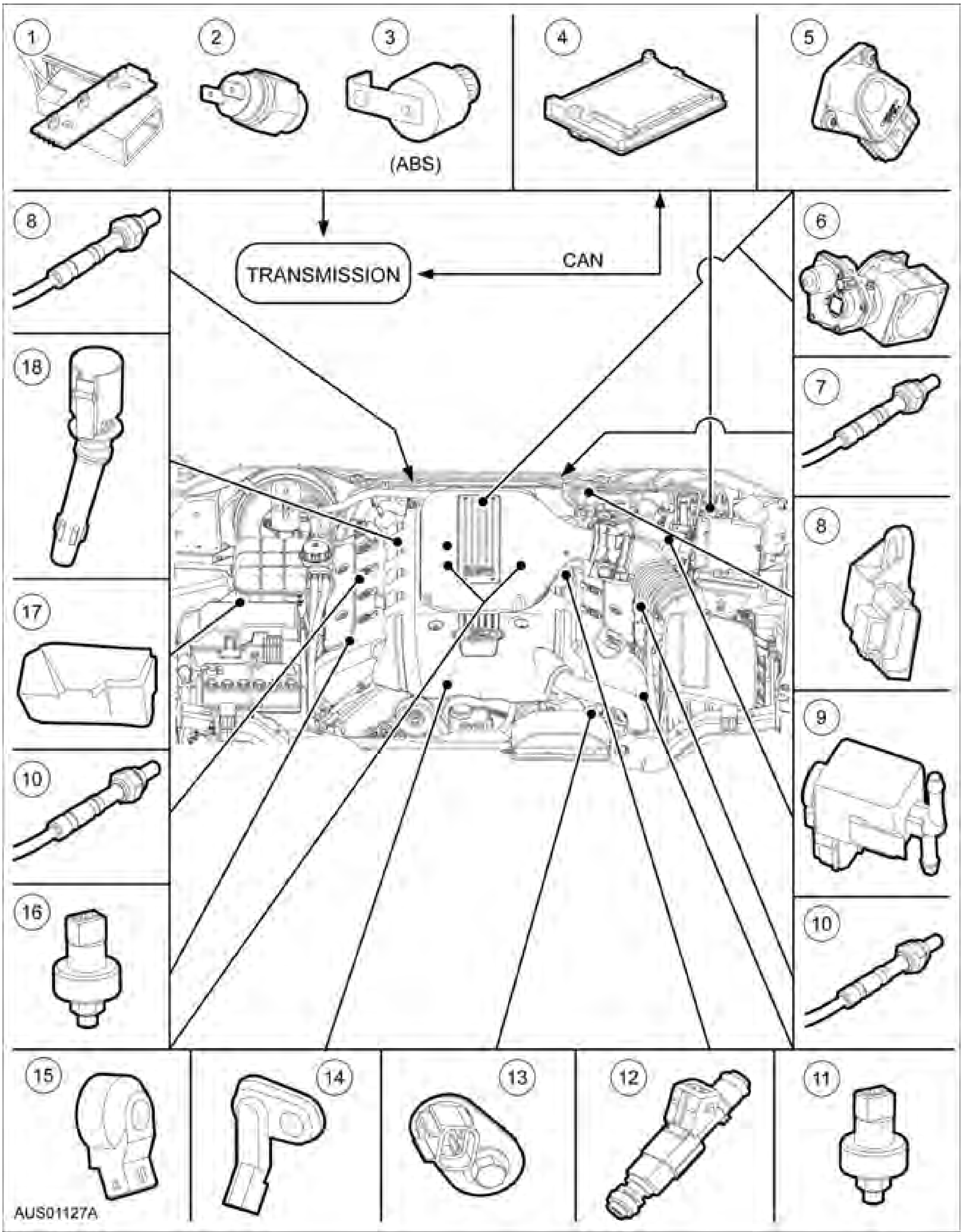
DESCRIPTION AND OPERATION (Continued)

Item	Description
1	Transmission Range Sensor (TR)
2	Reverse Gear Switch (RGS)
3	Vehicle Speed Sensor (VSS) (where fitted)
4	Cylinder Head Temperature (CHT)
5	Camshaft Position Sensors (CMP)
6	Throttle Body
7	Throttle Position Sensor (TP)
8	Powertrain Control Module (PCM)
9	Evaporator Canister Purge Solenoid (EVAP)
10	Temperature and Manifold Absolute Pressure (T-MAP) Sensor
11	Air Conditioner Refrigerant Pressure
12	Intake Manifold Runner Control (IMCC)
13	Fuel Injector (INJ1-6)
14	Knock Sensor (KS)
15	Crankshaft Position Sensor (CKP)
16	Oil Pressure Switch
17	Engine Oil Temperature (Turbo Only)
18	Variable Cam Timing (VCT) Solenoid
19	Power Steering Pressure Switch (PSP)
20	Upstream Heated Exhaust Gas Oxygen Sensor (HEGO11)
21	Power Distribution Box, PCM Relay, Start Enable Relay, Fuel Pump Relay
22	Coil On Plug (1-6)
23	Downstream Heated Exhaust Gas Oxygen Sensor (HEGO12) (Not applicable for South African market)

DESCRIPTION AND OPERATION (Continued)

PCM Control Components, V8 Engine



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DESCRIPTION AND OPERATION (Continued)

Item	Description
1	Transmission Range Sensor (TR) <PRNDL>
2	Reverse Gear Switch (RGS)
3	Vehicle Speed Sensor (VSS) (where fitted)
4	Powertrain Control Module PCM
5	Throttle Body Sensor (TP)
6	Throttle Body
7	Downstream HEGO sensors (HEGO12 and HEGO22) (Not applicable for South African market)
8	Temperature and Manifold Absolute Pressure T-MAP
9	Evaporator Canister Purge Solenoid (EVAP)
10	Upstream HEGO Sensors (HEGO11 and HEGO21)
11	Oil Pressure Switch
12	Fuel Injector (INJ1-8)
13	Camshaft Position Sensor (CMP) (Bank 2)
14	Crankshaft Position Sensor (CKP)
15	Knock Sensors (KS)
16	Air Conditioner Refrigerant Pressure
17	Power Distribution Box, PCM Relay, Start Enable Relay, Fuel Pump Relay
18	Coil On Plug (1-8)

DESCRIPTION AND OPERATION (Continued)

PCM Systems

System Overview

The Powertrain Control Module (PCM) manages the powertrain, providing optimal performance, maximum fuel economy and minimal exhaust emissions.

The PCM system manages the following:

- Fuel Injection
- Ignition
- Throttle
- Variable Camshaft Timing
- Automatic Transmission Gear Shift (Not ZF-HP26, 6 speed)
- Fuel Pump
- Air-Conditioning (PCM and HVAC HIM share control of the A/C system)
- Evaporative Emissions
- Vehicle Immobilisation
- Engine Cooling
- Powertrain Electric’s Diagnostics
- EOBD (Not applicable for South African market)
- Turbocharger (where fitted)
- LPG (where fitted)

At each engine revolution the PCM monitors driving conditions through signals and switches situated on the powertrain. Optimal air, fuel, ignition and camshaft settings for the current driving conditions are then calculated by the PCM using algorithms and look up tables stored in the memory.

A sophisticated diagnostics system monitors the PCM and the interfacing components, compensating for faults and wear during operation. The diagnostics are accessed using the IDS/PDS tester.

DESCRIPTION AND OPERATION (Continued)

Control Systems

Fuel System

The fuel system supplies the fuel injectors with filtered fuel at a controlled pressure. The Powertrain Control Module (PCM) controls the fuel pump and the on/off duration (pulse width) and timing of the fuel injectors.

Fuel Injection

The PCM electronic fuel injection system supplies the correct amount of fuel to the engine as required for the operating conditions. Each cylinder has an individual fuel injector controlled sequentially to inject the fuel at the optimum point in the engine cycle. The Powertrain Control Module (PCM) adjusts the fuel injection pulse width, delivering a precise quantity of fuel into the intake ports. Fuel is injected into the cylinders in the same sequence as the ignition firing order. As the fuel is injected into a closed port, the period that each charge remains in the port is even for all cylinders, ensuring optimum mixture throughout the engine.

Fuel System Components

The fuel system consists of the following components.

- Fuel Tank
- Fuel Pump
- Fuel Supply and Return Lines
- Fuel Filter
- Fuel Rail
- Fuel Injector
- Fuel Pressure Regulator

Fuel tank

The fuel tank is located at the rear of the vehicle and contains a store of fuel to operate the engine. The fuel tank is described in more detail in Section 310-00, Fuel System - General Information.

Fuel pump

The fuel pump assembly is mounted inside the fuel tank within a reservoir. The reservoir maintains a pool of fuel at the pick-up point and prevents fuel starvation during hard acceleration, braking and cornering. To enhance engine start-up, the fuel pump has a discharge check valve that maintains pressure in the fuel lines after the ignition has been turned OFF.

When the ignition switch is in the ON position, the PCM power relay is energised. The PCM ignition power relay provides power to the PCM and the fuel pump relay. The fuel pump relay is then energised by the PCM under certain conditions.

The PCM monitors the Crankshaft Position Sensor (CKP) signal to determine engine speed. Once the engine is running the PCM will keep the fuel pump relay energized until the engine stops. If the engine does not start after two seconds, the PCM disengages the fuel pump relay.

Fuel Supply and Return Lines

Fuel is routed to the fuel rail from the fuel tank along the supply pipe. Excess fuel from the fuel pressure regulator is returned to the fuel tank through the return line. The fuel lines are described in more detail in Section 310-00, Fuel System - General Information.

Fuel Filters

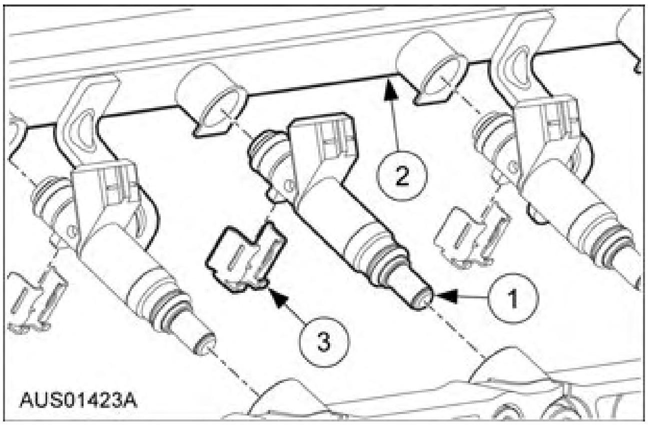
To prevent the fuel injectors becoming clogged or contaminated with foreign material, the fuel system contains four levels of filtering:

- Fuel Pump: A filter screen is mounted on the intake side of the fuel pump. The filter is part of the assembly and cannot be replaced separately.
- Fuel Filter Assembly: The fuel filter assembly is located in the fuel supply line between the fuel pump and the fuel rail. The fuel filter assembly must be periodically replaced according to the maintenance schedule.
- Fuel Pressure Regulator: A filter is located on the inlet side of the fuel pressure regulator. The filter is part of the assembly and cannot be replaced separately.
- Fuel Injectors: A mesh screen on the inlet side of the fuel injector prevents foreign debris and materials from entering the fuel injector mechanism. The filter is part of the assembly and cannot be replaced separately.

DESCRIPTION AND OPERATION (Continued)

Fuel Rail

Fuel from the supply line is conveyed to the fuel injectors through the fuel rail and excess fuel is returned to the fuel tank via the fuel pressure regulator and return line. Each fuel injector seats within a special fitting on the fuel rail pipe. An o-ring on the fuel injector prevents leakage around the joint. On I6 engines the injectors are secured and oriented with a clip.



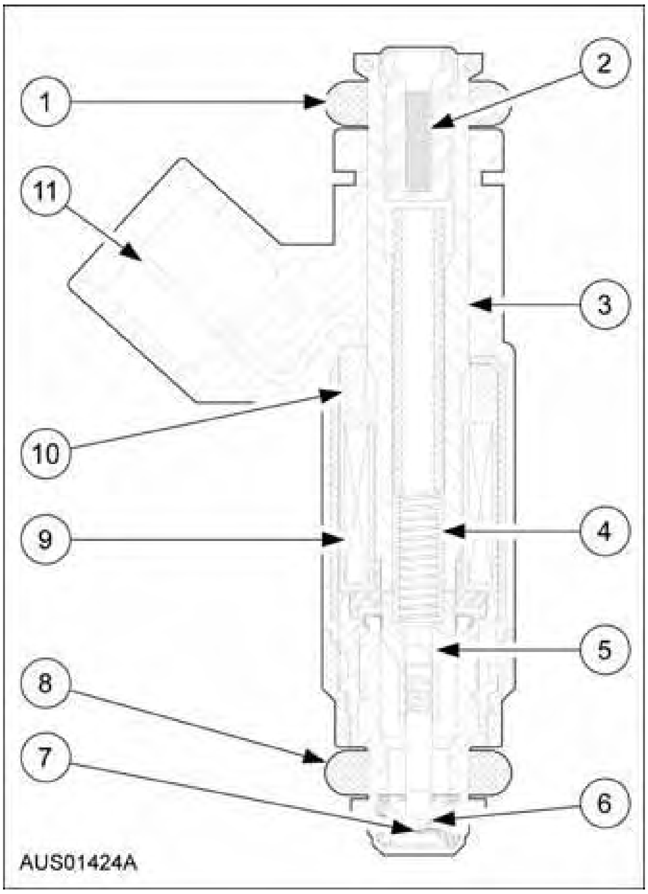
Item	Description
1	Fuel Injector
2	Injector Seat
3	Clip

Fuel Injector

CAUTION: The fuel injectors pulse open momentarily using a signal from the PCM. Applying battery voltage directly to the fuel injector's electrical connector terminals will damage the internal solenoid.

The fuel injector is a solenoid-operated valve that meters fuel flow to the engine. The injector is opened and closed a constant number of times per crankshaft revolution by the Powertrain Control Module (PCM). The length of time the injector is held open and the fuel rail pressure controls the amount of fuel admitted to the engine. The fuel injectors are described in more detail under Components in this section.

Fuel Injector



Fuel Pressure Regulator

The fuel pressure regulator is attached to the outlet side of the fuel rail and controls the pressure within the fuel rail. Fuel is delivered to each injector at the same pressure to ensure the volume of fuel injected is equal for each cylinder.

The regulator is a diaphragm-operated relief valve. One side of the diaphragm senses fuel pressure, and the other side is connected to the intake manifold vacuum. Fuel pressure is established by a spring pre-loading applied to the diaphragm. Balancing one side of the diaphragm with manifold vacuum maintains a constant pressure across the fuel injectors. Excess fuel is bypassed through the regulator and returned to the fuel tank. Fuel pressure is high when engine vacuum is low.

Intake Air System

The intake air system provides clean air to the engine, optimises airflow and is designed to minimise induction noise. The intake air system consists of:

- Air Cleaner Assembly
- Inlet Ducting
- Electronic Throttle Body
- Inlet Manifold

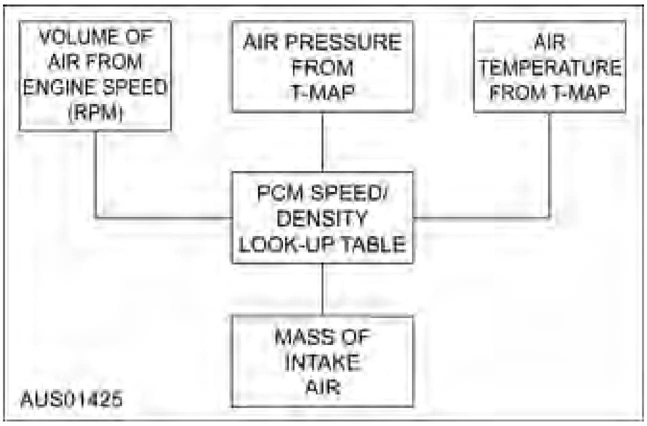
DESCRIPTION AND OPERATION (Continued)

Air Cleaner Assembly

The air cleaner assembly is an essential component of the intake air system. The air cleaner assembly houses a disposable air filter element that removes dust from the intake air. The air cleaner element must be periodically replaced according to the maintenance schedule.

Air Mass Measurement System

The I6 and V8 engines use the "speed density" fuel injection system. In this system, the PCM has stored in its memory the theoretical mass of intake air that will be drawn into the engine at any given speed of operation. Using the engine speed sensor (Crankshaft Position CKP) signal, the Intake Air Temperature and Manifold Absolute Pressure sensor (T-MAP), the PCM can compute the intake air mass, and from it the fuel required to be injected into the engine for combustion. This amount of fuel injected is further corrected by feedback information obtained from the up-stream Heated Oxygen Sensor(s) (HEGO sensor), providing closed loop control of fuel injection. A further feature of this system is the ability to 're-calibrate' itself for changes in fuel requirements as the engine wears and the sensors age. This is known as an adaptive strategy or learning and is an additional function derived from the HEGO sensor information.



Intake Air Ducting

The intake air ducting connects the air filter assembly to the throttle body. The ducts prevent entry of foreign material to the air intake system after the air filter. The design minimises restriction and is tuned to reduce intake noise.

Electronic Throttle Control

The Electronic Throttle Body (ETB) controls the amount of air admitted to the engine by restricting the air intake with a throttle plate.

The accelerator pedal position (APP) sensor, detects the driver's acceleration request to the PCM. The PCM processes this information into an output signal for the ETB. The electric motor in the ETB moves the throttle plate through a gear set. The throttle plate is adjusted and monitored by the PCM in a closed control loop via a Throttle Position (TP) sensor. The TP sensor provides the PCM with feedback on the actual position of the throttle plate.

The electronic throttle body and the Positive Crankcase Ventilation (PCV) provides airflow during idle. The PCM trims the throttle continuously to maintain the proper idle speed under all conditions from cold start to normal operating temperatures. It also compensates for additional loads such as air-conditioning and power steering. The idle speed is not manually adjustable.

Inlet Manifold

The inlet manifold is a plastic moulding for I6 petrol engines and an aluminium casting for DLPG and V8 engines, which directs the intake air to the inlet ports on the cylinder head.

Variable Camshaft Timing

I6 Engine

The I6 Engine is fitted with variable inlet and exhaust camshaft timing. Both camshafts are variable over a 60-degree crank angle. This is achieved by two separate hydraulic mechanisms called 'Phasers', which are integral with the intake and exhaust camshaft drive sprockets.

The camshaft timing is controlled by directing oil under pressure (from the engine oil pump) into one of two ports in the Phaser, one port will retard the cam timing ('Retard port') and the other will advance the timing ('Advance port'). An Oil Control Valve (OCV), one for each camshaft, is used to control the flow of oil into the retard and advance ports of both cams. The OCV is controlled by the PCM.

The PCM uses a pulse width modulated (PWM) voltage or 'Duty Cycle' (DC) to control each OCV to attain the desired camshaft angle. VCT1 output controls the inlet camshaft OCV. VCT2 controls the exhaust camshaft OCV.

A 3 + 1 tooth wheel on the front of each camshaft with an associated sensor mounted on the intake and exhaust sides of the cylinder head are used to calculate the 'Actual cam angle' for both camshafts. The two sensors are called, intake cam position or 'CID1' and exhaust cam position or 'CID2'. Intake and exhaust cam positions are calculated separately.

The PCM uses engine rpm, throttle position and engine load to determine the optimum camshaft timing setting or 'Desired Cam Angle' for both camshafts.

Once the PCM has determined the Desired Cam Angle, it will control the Duty Cycle output VCT1 and VCT2, to the intake and exhaust OCV's based on the difference between the Desired Cam Angle and the Actual Cam Angle. This difference is called the Cam Angle Error. The Cam Angle Error for each cam is calculated individually and used to control both

DESCRIPTION AND OPERATION (Continued)

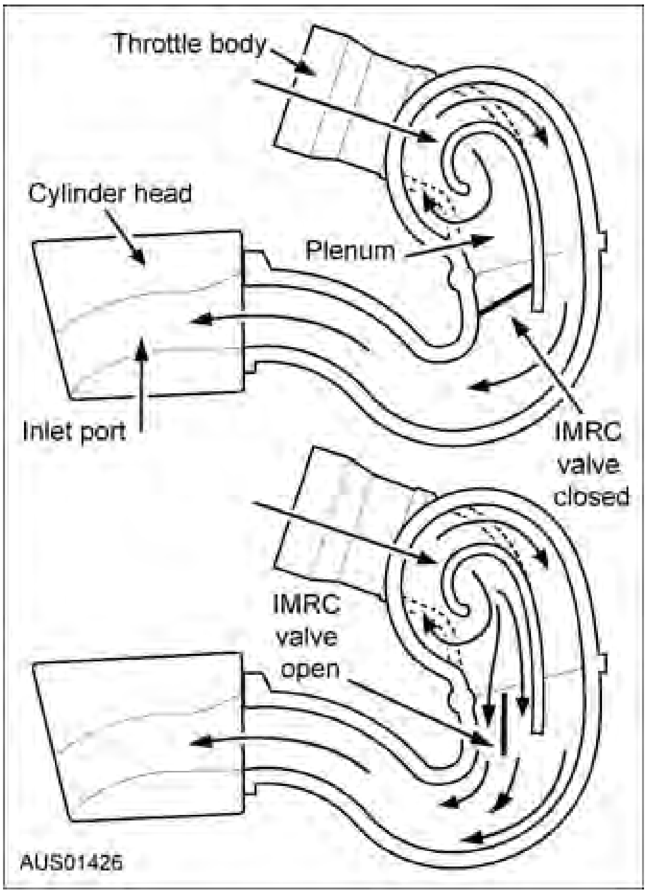
camshafts independently to a single Desired Cam Angle.

An engine oil temperature sensor, which measures oil temperature in the oil gallery, is used to compensate for Phaser response with changing oil viscosity at different temperatures.

Intake Manifold Charge Control (IMCC) (I6 Non-Turbo only)

To improve engine torque over the entire engine operating range, the I6 engine has an Intake Manifold Charge Control (IMCC) system. A butterfly valve situated in the intake runner for each cylinder controls the effective length of the intake path. The Powertrain Control Module (PCM) controls operation of the IMCC system.

At low engine speeds a long intake path improves volumetric efficiency, while at higher engine speeds a short intake path provides better efficiency. Changing the effective length of the intake air path improves drivability and engine power throughout the engines operating range. The lengths of the runners are designed to suit the Ram Air Effect of the I6 engine.



On DLPG engines, in normal operation, below approximately 3,800 RPM, the butterfly valves are closed, causing the intake air to follow the longer path into the engine. At higher engine speeds, above approximately 3,800 RPM, the butterfly valves open allowing the intake air to follow a shorter path into the engine. A vacuum actuator operates the butterfly valves. The Powertrain Control Module (PCM) controls vacuum to the actuator via a solenoid valve.

On I6 non-turbo petrol engines, in normal operation at speeds below approximately 3700 RPM the IMTV is in a closed position, in effect splitting the plenum in half, this causes the intake to follow the longer runner path into the engine. At higher speeds, above 3700 RPM, the IMTV opens, allowing the intake air to flow into the complete plenum volume, hence shortening the path the intake air must follow into the engine. At engine speeds around 5700 RPM the IMTV switches back to the closed position. A vacuum actuator operates the IMTV; the Powertrain Control Module (PCM) controls the vacuum to the actuator via a Solenoid Valve.

Ignition System

The ignition Coil-On-Plug (COP) assembly consists of a coil mounted on top of a spark plug. For each of the engine’s cylinders, there is a corresponding COP assembly.

Individual low side coil drives in the PCM control the COP’s that ignites the air-fuel mixture within the cylinders. The COP’s provide a controlled high voltage spark to each spark plug at the correct time under all engine operating conditions.

The ignition system comprises:

- Individual coil drives: one per cylinder
- Spark Plugs
- Crankshaft Position Sensor (CKP) input
- Camshaft Position Sensors (CMP) and Cylinder Identification (CID1 & 2)
- Knock Sensor(s) (KS)

Spark Advance Map

The Powertrain Control Module (PCM) memory contains a complex spark advance map to ensure optimum ignition timing under all conditions. The ideal advance is applied ensuring the best possible performance, economy and minimal emissions.

Spark Plugs

Spark plugs are described in Section 303-07.

Engine Cooling System

The engine cooling system is described in Section 303-03A. The Powertrain Control Module (PCM) controls operation of the Electro Drive Fans 1-2 (EDF1-2). The PCM operates both fans at low or high speeds through relays depending on engine temperature load and A/C System pressure. The PCM uses the Cylinder Head Temperature Sensor (CHT) and Air Conditioner Refrigerant Pressure Transducer (ACPT), Vehicle Speed and Air Conditioner Control Relay, B2 (ACR) signals to calculate the cooling requirements, and then switches the fan relays accordingly.

DESCRIPTION AND OPERATION (Continued)

CAUTION: The PCM can, under some circumstances, maintain the engine cooling fan's operation at high speed after the driver has turned the key to the off position. The engine cooling fans will operate for up to 4 minutes depending on the Cylinder Head Temperature (CHT).

The PCM transmits CHT information to the instrument cluster temperature gauge and the Climate Control air conditioning on the Controller Area Network (CAN) line.

Engine Cooling Strategy (excludes LPG)

The I6 and V8 engine cooling strategy ensures the continued operation of the engine in the event of coolant loss or extremely high temperatures. If the engine temperature exceeds approximately 120 degrees, to maintain a safe engine operating temperature, the fuel injectors are sequentially shut off to allow each cylinder to be cooled by the intake air. The engine may run rough when operating in overheat management strategy mode. The cluster will display messages to the driver when the PCM senses that the engine has exceeded a safe operating temperature. The messages displayed in the cluster will become more frequent when fail-safe cooling strategy no longer can keep the engine running. Shortly afterwards, the engine will shutdown.

Evaporative Emission System

The Evaporative Emission System prevents fuel vapours from the fuel tank being vented to the atmosphere. Fuel vapours from the fuel tank are collected in a carbon canister while the engine is not running. The vapours remain trapped within the canister until it is purged to the inlet manifold, where the vapours are burnt as part of the normal combustion process.

The Powertrain Control Module (PCM) monitors several system inputs to determine when purging the vapours will have minimum impact on engine operation.

The Powertrain Control Module (PCM) controls the Evaporative (EVAP) Canister Purge solenoid. The solenoid controls the flow of vapours from the carbon canister to the intake manifold for combustion during various engine operating modes. The EVAP canister purge solenoid is a normally closed valve.

Canister purge occurs at all engine operating conditions including idle and after engine warm-up. The solenoid valve purges continuously until the EGO sensor detects no more fuel vapours. The solenoid valve then shuts down for a two minute period before starting the purge cycle again.

Positive Crankcase Ventilation

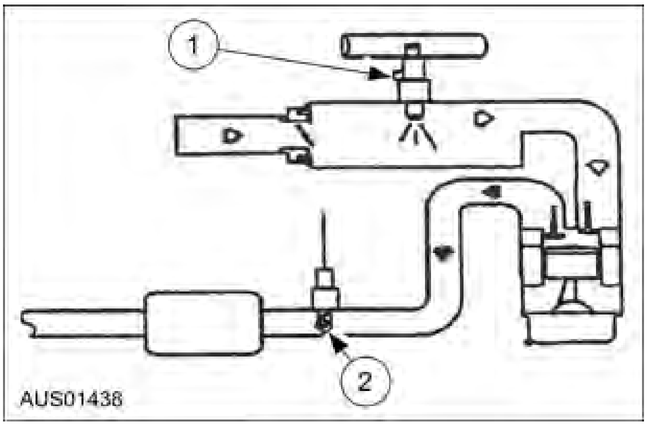
The Positive Crankcase Ventilation (PCV) system cycles crankcase gases back through the engine where they are burned during the combustion process. The PCV valve regulates the amount of ventilating air entering the intake air system and prevents any backfire from reaching the crankcase.

Catalyst and Exhaust System

The exhaust system carries engine emissions from the engine through the exhaust manifold, engine pipe, and catalytic converter to the atmosphere. The exhaust system is described in Section 309-00. A Heated Exhaust Gas Oxygen Sensor (HEGO) is mounted before the catalytic converter. The catalytic converter reduces the concentration of carbon monoxide, unburned hydrocarbons and oxides of nitrogen in the exhaust emissions to a minimum level.

Heated Oxygen Sensors

The Heated Exhaust Gas Oxygen Sensor (HEGO11 and HEGO21 (V8)) provides the PCM with a voltage level that relates to the oxygen content of the exhaust gas.



Item	Description
1	Fuel Injector
2	HEGO Sensor

To comply with the catalytic converter monitoring system for EOBD, a second "down-stream" HEGO12 and HEGO22 (V8) is now fitted. (Not applicable for South African market)

These operate on the same principle as the up-stream HEGO and by monitoring the oxygen content of the exhaust gases post-catalytic converter the PCM can calculate catalytic converter efficiency.

Catalytic Converter

A catalyst is a material that initiates and increases a chemical reaction without itself being consumed. The catalytic converter minimises the concentration of toxic gases released to the atmosphere from the exhaust system. It contains a catalyst in the form of a specially treated honeycomb structure saturated with catalytically active precious metals. As the exhaust gases come in contact with the catalyst, they are changed into mostly harmless products. The catalyst initiates and speeds up heat producing chemical

DESCRIPTION AND OPERATION (Continued)

reactions of the exhaust gas components so they are used up as much as possible. The catalytic reaction only occurs when the air/fuel ratio is near the stoichiometric point.

Air Conditioning System

The PCM controls voltage to the air conditioning compressor clutch relay, switching on and off in response to the AC Clutch request sent on the CAN by the Climate Control HIM Module. The Climate Control HIM Module determines the operational state of the AC compressor needed to maintain a desired evaporator air temperature based on the comfort temperature setting selected by the driver and passenger.

The PCM also controls voltage to the A/C compressor clutch relay in response to engine operating conditions, engine cooling requirements and A/C system pressure. Using these inputs, the PCM may switch the A/C compressor off to protect the engine under extreme operating conditions, to assist in engine cooling or to protect the compressor if there is an A/C system fault. The A/C compressor may be disabled temporarily if the condition is short term (eg. at wide open throttle) or may be disabled until the fault is rectified (eg. major loss of A/C refrigerant). Refer to A/C Disable Strategy Chart in the Air Conditioning section 412-03

When the compressor is commanded to turn on, the PCM utilizes and Air Conditioner Refrigerant Pressure Transducer (ACPT) input (B15), and the Air conditioning Evaporator Air Temperature (AEAT) data on the CAN to monitor the Air Conditioner system performance.

A malfunction of the air conditioning system is detected by the failure of an individual sensor or by a combination of factors calculated from the combined outputs of ACPT and AEAT being out of range over a period of time. The failure mode can be accessed through the diagnostic connector using the IDS tester (Refer to the PID and DTC charts in the Air Conditioning section 412-03).

Traction Control (TCS)

On vehicles fitted with the Traction Control System, the Traction Control operates with additional software and valves for the Anti-locking Brake System (ABS) and additional software for the PCM to minimise wheel slippage. The TCS monitors the speed of each wheel using wheel sensors on each wheel. Wheel spin is detected when one of the rear wheels is spinning or accelerating faster than the front or opposite side wheel. When spin occurs, the TCS/ABS module works to stop wheel spin by, if necessary, momentarily applying the brake of the spinning wheel and signalling the PCM to reduce engine torque to a specific level.

When the PCM receives a torque reduction message from the TCS/ABS module on the CAN line, it reduces engine torque by retarding ignition timing, inhibiting injector operation, closing the throttle plate and leaning off the air-fuel ratio.

The system continues to monitor for wheel slip. When traction is restored, engine torque can be returned to normal levels.

The system is speed sensitive and may activate traction control with engine intervention only

Dynamic Stability Control (DSC)

With the addition of various sensors to the vehicle such as the Steering Angle Sensor and a YAW rate sensor the DSC system can calculate the direction of the vehicle desired by the driver and the true direction the vehicle. The DSC will then "pulse" various brakes independently, via the ABS module, to assist the driver maintain the desired direction of the vehicle. In addition to brake intervention, if required, there may be a torque reduction from the engine managed by the PCM.

Automatic Transmission Control (4-Speed DPLG Only)

The Powertrain Control Module (PCM) for Dedicated LPG applications controls the automatic transmission gear shift. The PCM calculates the shift points and controls the transmission according to driving conditions, engine load and throttle demand. The PCM controls or monitors the following automatic transmission functions:

- Transmission Range Sensor (TR) <PRNDL>
- Transmission Fluid Temperature Sensor (TFT) <TOT>
- Shift Solenoid 1 (SS1) <GSS1>
- Shift Solenoid 2 (SS2) <GSS2>
- Shift Solenoid 3 (SS3) <MCS1>
- Shift Solenoid 4 (SS4) <MCS2>
- Variable Pressure Solenoid 5 (VPS)
- Power Control Solenoid 6 (PCS)
- Lock Up Solenoid 7 (LUS)

Operation, maintenance and the control strategy for the transmission are described in Section 307-01, Automatic Transmission.

Electronic Sport Shift (4-Speed)

The electronic sports shift feature allows driver control of the automatic transmission.

The Transmission Range Sensor, TRS-A1, on the side of the transmission housing senses the sport-shift selection of "P", "R", "N" and "D" position. The resistance of the sensor changes for each position and is measured by the PCM as a voltage on the TRS-A1 input.

The sport shift manual, tip-up and tip-down position is sensed by the TRS-A2 sensor, a printed circuit board with 3 Hall-effect switches in the shifter console. The

DESCRIPTION AND OPERATION (Continued)

sport shift lever contains a magnet in its base that activates the appropriate Hall-effect switch in different shift position. The switches are resistively multiplexed together and are read as a voltage by the PCM on the TRS-A2 input.

Column Shift Auto

Vehicles fitted with column shift automatics (4- and 5-speed) use the same TRS-A1 sensor on the side of the transmission as the electronic sport shift. The column shift mechanism moves the sensor through an arc to allow selection of "P", "R", "N" and "D" as well as the "4", "3", "2" and "1" gear positions for the 4-speed transmission and "5", "4", "3", "2" and "1" gear positions for the 5-speed transmission.

Automatic Transmission Control (6-Speed Only)

Vehicles fitted with the 6 speed automatic ZF-6HP26 transmission, information about the engine is sent to the integrated Transmission Control Module (TCM)/valve body via the Controller Area Network (CAN) system. The gear selection and diagnostics for the transmission are then controlled by the TCM.

Electronic Sport Shift (6-Speed)

With the 6 speed automatic ZF-6HP26 transmission all the driver required information is controlled by sequential sports shifter. This sends information to the TCM and instrument cluster via the CAN.

DESCRIPTION AND OPERATION (Continued)

Control Software

Powertrain Control Module Memory

The Powertrain Control Module (PCM) uses flash Electrically Erasable and Programmable Read Only Memory (EEPROM) to store the software code required to control the powertrain. EEPROM can be electrically erased and reprogrammed without removing the PCM from the vehicle.

European On-Board Diagnostics (EOBD)

It is a legal requirement that vehicle manufacturers utilise some form of diagnostic system to monitor engine emissions and record any deviations from the nationally agreed emission standards.

The Australian Emission standards were first introduced in 1995/96 to meet both the European and US emission regulations. Since that time more stringent standards have, and continue to be, progressively introduced for implementation between 2003 and 2007 meeting the European level II (EURO II) standards during this period, with full implementation of EURO III by 2007.

EOBD is a software system that uses the engine sensors to monitor engine emissions. In addition to the existing sensors the system also uses a downstream HEGO sensor to monitor catalytic converter efficiency, (2 down-stream HEGO's in Vee engine applications).

The requirements of EOBD are:

- Monitors emission control components and exhaust systems with the aid of five monitors
- Monitors emission control components (comprehensive component monitor (CCM))
- Monitors combustion misfires
- Monitors upstream and downstream heated oxygen sensors (HO2S monitor)
- Monitors the fuel system (fuel monitor)
- Monitors catalytic converter efficiency
- Monitors exhaust gas recirculation (EGR monitor) (when hardware is fitted)
- Monitors secondary air injection (AIR monitor) (when hardware is fitted)
- Actuates emission control malfunction indicator lamp (MIL) and fault memory
- Indicates operating conditions in which fault occurred (freeze frame data)
- Indicates test readiness (readiness code P1000)
- Establishes when and how emission control faults must be indicated
- Standardized output of operating data such as engine speed, temperature, etc.
- Standardized names/abbreviations for components and systems (SAE J1930)
- Standardized fault or diagnostic trouble codes (DTC) for all manufacturers ("P0 and P1 codes") (SAE J 2012)
- Standardized communication with diagnostic equipment (SAE J1850)
- Standardized 16-pin data link connector (DLC) in area of instrument panel (SAE J 1962)
- Fault display must be possible using generic scan tool (SAE J1978)
- Standardized protocol contents (SAE J1979)

These sensors and actuators and special software continuously check systems and components which affect emissions while the vehicle is travelling and derive the exhaust emissions accordingly.

The check on systems and components which affect emissions is carried out with so called **monitoring systems** (monitors).

The EOBD for Australian Ford petrol engines comprises 5 monitors from the 2005 model year onwards:

- comprehensive component monitor (CCM) for emission control components
- combustion misfire monitor
- heated oxygen sensor (HO2S) monitor
- fuel system (fuel) monitor
- catalytic converter efficiency monitor

If a monitoring system detects a fault and this is confirmed, the emission control malfunction indicator lamp (MIL) is switched on.

The fault protocols contain information about the nature of the fault and the distance travelled since the illumination of the malfunction indicator lamp (MIL).

The emission control malfunction indicator lamp (MIL) ensures that a fault is recognized promptly so that repairs can be carried out quickly and high exhaust emissions avoided.

In future, when a fault occurs which affects emissions and which is indicated by illumination of the emission control malfunction indicator lamp (MIL), the driver of the vehicle will be obliged by law to go to an approved workshop with the vehicle as quickly as possible to have the fault rectified.

The customer is recommended to take the vehicle to a Ford workshop as this alone has the necessary special tools and test equipment for systematic fault finding and rectification and also guarantees optimum service.

Another part of the EOBD is the data link connector (DLC) which has been standardized for all makes of vehicle and through which the monitoring authorities can read faults which affect emissions which are recorded in the control module.

With the advent of a standardised EOBD DLC connection and the ability to use a generic code reader to retrieve DTCs, this may indicate repairs carried out by non approved repairers may be

DESCRIPTION AND OPERATION (Continued)

acceptable. However, Ford Motor Company has to provide an extended warranty for EOBD compliance.

NOTE: EOBD repairs carried out by a non-approved repairer may fail to meet Ford Motor Company’s repair standards and adversely affect subsequent warranty claims

The DLC is located in the instrument panel fuse box.

The diagnostic characteristics of the EOBD system depend on the manufacturer and engine variant.

Type approval and testing

The operation of the EOBD system must be guaranteed over the entire life of the vehicle. To obtain type approval for the Australian market, vehicle manufacturers must guarantee compliance with the specified exhaust emission limits up to at least 80,000 km (50,000 miles) or 5 years:

Limit values	CO (g/km)	HC (g/km)	NOx (g/km)
Euro Standard Stage 3	2.3	0.2	0.15
EOBD	3.2	0.4	0.6

The **EOBD limit values** are always slightly higher than the exhaust emission limit values of Euro Standard Stage 3, which means that minimal overshooting of the Euro Standard Stage 3 limit values still does not mean that the emission control malfunction indicator lamp (MIL) is inevitably actuated.

Compliance with the specified exhaust emission limits will be monitored in future by the authorities. To this end, vehicles will undergo random testing at various mileages.

If these checks reveal that the specified limits are exceeded systematically, the vehicle manufacturer will be held responsible. This may lead to costly service operations or restrictions to the type approval.

Apart from this, Ford vehicles will comply with the same exhaust emission limits over the entire life of the vehicle, even after 80,000 km (50,000 miles) or 5 years, i.e. the EOBD threshold values in the PCM will always be the same.

Comprehensive Component Monitor (CCM) for emission control components.

The **CCM** checks continuously to establish whether the emission control sensors and actuators are working within the specified tolerances while the engine is running.

If a sensor or actuator should be outside its tolerance band, this is recognized by the monitoring system and a fault or diagnostic trouble code is stored in the keep alive memory (KAM).

If an emission control component is faulty and this fault is confirmed during the second trip, the emission control malfunction indicator lamp (MIL) is switched on.

Only those emission control sensors and actuators in the control loop which are not monitored by another EOBD monitoring system are checked.

The input and output signals are generally checked for short circuits, continuity, plausibility and exceeding threshold values.

The CCM covers a number of components such as for example:

- electronic ignition (EI) system test
- fuel pump (FP) monitor
- intake manifold runner control (IMRC)
- Manifold Air Pressure (MAP) sensor
- maximum engine speed restriction fault code
- temperature sensors (IAT, CHT, TFT)
- throttle position (TP) sensor
- knock sensor (KS)
- active carbon canister (CANP/SPV/VMV)
- variable camshaft timing (VCT)
- keep alive memory (KAM)
- fuel injection circuit
- temperature manifold absolute pressure (TMAP) sensor
- fuel level (in tank) input (FLI)

Some CCM tests may also be activated individually with a diagnostic tool.

Combustion Misfire Monitor

Combustion misfires are identified by the crankshaft position (CKP) sensor to detect exhaust emissions which lie above the EOBD threshold values.

The combustion misfire monitoring system was developed to identify misfires in the engine and the respective cylinder.

These misfires are identified

- when the vehicle is stationary from idle speed (gear lever in neutral position or selector lever in position "P") to 3000 rpm;
- when the vehicle is moving from idle speed to 4500 rpm.

Each individual combustion operation must produce a characteristic acceleration at the flywheel. With combustion misfires the flywheel turns more slowly to the next ignition point.

This monitoring system uses the crankshaft position (CKP) sensor to check the rotation and acceleration in each working cycle.

Through the CKP sensor the monitoring system compares the rotation and acceleration of the crankshaft, enabling it to locate misfires in the cylinders.

Through the CKP sensor the PCM registers any change in crankshaft rotation which indicates a combustion misfire.

DESCRIPTION AND OPERATION (Continued)

The misfiring cylinder can be determined by additionally using the CMP sensor signal.

The **monitoring of combustion misfires is carried out continuously** and is independent of other monitoring systems.

Combustion misfires are caused by:

- the ignition system
- the fuel injection system
- the fuel
- the engine mechanical components

To make combustion misfire monitoring more reliable, there is a "learning mode" for the rotation of the engine. This is necessary since for example an irregular signal caused by an incorrectly mounted flywheel could lead to an incorrect error message.

The learning mode logically becomes active while the fuel supply is shut off during overrun since no combustion misfires can occur in this mode.

Therefore (after the KAM has been cleared) the combustion misfire monitor can only operate correctly when the vehicle has been travelling in overrun long enough (refer to the dealer test cycle).

The data from the learning mode is stored in the KAM.

Type A combustion misfires

Combustion misfires of Type A cause damage to the catalytic converter due to high temperatures.

If a certain number of misfires are detected during these 200 revolutions, these are described as Type A misfires which damage the catalytic converter.

If a Type A combustion misfire is detected, the emission control malfunction indicator lamp (MIL) flashes at once.

In the case of vehicles with FMEM (not with 4-cylinder engines) which therefore cut out the fuel injection to avoid over-enrichment, the emission control malfunction indicator lamp (MIL) does not flash but comes on continuously.

Type B combustion misfires

Combustion misfires of Type B lead to an increase in exhaust emissions above the EOBD threshold values.

If a certain number of misfires are detected during these 1000 revolutions, these are described as Type B misfires which can lead to increased exhaust emissions.

The emission control malfunction indicator lamp (MIL) only comes on when a Type B combustion misfire occurs during a second trip.

If no more misfires occur - in identical conditions - during the following three trips, the emission control malfunction indicator lamp (MIL) goes out again.

Additional Misfire Monitor Information

Profile Correction

Profile Correction is a method of applying correction factors to the raw crankshaft position signals to compensate for periodic noise factors such as EDIS wheel irregularities or engine dynamics. Profile Correction factors are learned during closed throttle 100 – 60 kph decelerations in decel fuel shut off. There are min and max rpm, vehicle speed, load and delta rpm boundaries for enablement. Profile correction is learned once after a KAM reset (such as when the battery is disconnected) or OBD reset (through the diagnostic tool). A couple of closed throttle decelerations from 100 kph without pressing the brake should be enough to learn profile correction and enable misfire detection.

Test Types

There are two main tests performed as part of the misfire detection diagnostic. The Type A test detects high levels of misfire over a short period that could damage the catalytic converter. The Type B test detects lower levels of misfire over a longer period that would cause the exhaust emissions to exceed the EOBD tailpipe pollution standard.

Type A Test – If the misfire rate at the end of a 200 revolution interval exceeds the rate determined to produce catalyst damaging temperatures and the catalyst temperature model indicates a catalyst over temperature condition, a pending fault is indicated and the Malfunction Indicator Light (MIL) will blink at a 1Hz rate. The MIL will continue to blink until a 200 revolution test passes without catalyst damaging levels of misfire. This may take a period of time to complete – refer to note below. If the catalysts damaging levels of misfire are detected on subsequent trip (without the pending fault having been erased), a fault code will be stored, the MIL will flash until the misfire condition clears and then be illuminated continuously. For a V8 with two catalysts, the misfire rate is determined as the number of misfires per cylinder bank.

Type B Test –If the misfire rate calculated during any four consecutive 1000 rev intervals during a trip exceed a calibrated threshold, a type B pending code will be set. If the same criteria are met on a subsequent trip (without the pending fault having been erased), a fault code will be stored and the MIL will be illuminated continuously.

Note that there are many situations which can disable misfire detection. These include low loads, injector fuel cut during deceleration, A/C transitions, vehicle or engine speed limiters, traction control events or torsional noise through the driveline (due to driving over very rough roads). The 200 and 1000 rev test intervals do not include the periods where misfire detection is disabled and hence each test may take many more engine revolutions to complete.

DESCRIPTION AND OPERATION (Continued)

Fault Code / MIL Clearing

A pending code can be cleared before MIL illumination if a Type A or Type B test is completed at similar conditions and the misfire rate is below 0.1%. This must occur on the trip after the one setting the pending code. If similar conditions are not seen after 80 trips, the pending code will be cleared. Similar conditions are defined as follows:

- Engine rpm within +/- 375 RPM of fault condition
- Engine load within +/- 20% of fault condition
- Engine warm up status same as fault condition (warm / cold start)

The MIL may be extinguished on the fourth trip if no test fails for three trips. Diagnostic Test Codes (DTCs) and freeze frame data will remain for 40 trips after the fault.

Snap Shot and Freeze Frame Data

Misfire Snap Shot: This data is taken at the time of the first misfire in a 200 rev Type A test. It is stored until the occurrence of another misfire in a subsequent 200 rev test.

Misfire Freeze Frame: If a 200 or 1000 rev test fails, the Misfire Snap Shot data is transferred and stored to the Misfire Freeze Frame. This data is in addition to the Normal Mode $02 Freeze Frame (below) and more accurately captures the misfire conditions. Misfire Freeze Frame data cannot be overwritten like other OBD faults.

Normal Mode $02 Freeze Frame: If a 200 or 100 rev test fails, Mode $02 Freeze Frame values are both acquired and stored at the end of the failed test. (Misfire may or may not be still occurring at this point in time.) A misfires fault will cause Mode $02 Freeze Frame data from other faults to be overwritten.

The Snap Shot and the Freeze Frame will bracket the occurrence of misfire and assist diagnosis.

If no misfire fault codes are present, Misfire Freeze Frame data is updated whenever a 200 rev test rate exceeds the previous high value saved in the freeze frame.

Misfire Freeze Frame data is stored and held by the first misfire fault code.

Misfire Fault Codes

P0300 – Unknown or irregular cylinder misfire (random misfire). Overall misfire level is above a threshold, but not one individual cylinder misfire rate too high.

P0301 – Misfire on cylinder 1

P0302 – Misfire on cylinder 2

P0303 – Misfire on cylinder 3

P0304 – Misfire on cylinder 4

P0305 – Misfire on cylinder 5

P0306 – Misfire on cylinder 6

P0307 – Misfire on cylinder 7

P0308 – Misfire on cylinder 8

P0316 –Misfire Type B failed in the first 1000 rev interval. This will be concurrent with other misfire codes and only indicates a failure immediately after engine start. Freeze Frame parameters will indicate hot or cold restart status. This fault will set a code but not turn on the MIL.

The following codes exist, but require calibration changes or defective hardware to induce faults..

P0315 – Profile correction unable to be learned, although 255 attempts have been made.

P1336 – Misfire error due to noisy crankshaft or camshaft position sensor. This fault will set a code but not turn on the MIL.

P0606 – PCM error – an error detected in the internal working of the PCM

Fuel Monitor

The operation of the fuel system is monitored to detect faults which lead to high exhaust emissions and lie above the EOBD threshold values.

A strategy was developed to monitor the**trim adjustments** made in the fuel system.

The upstream HO2S measures the oxygen level in the exhaust gas (indicating a rich or lean mixture) and feeds a message back to the PCM.

If the signal is **on average** at the "**rich limit**", too much fuel is being injected.

The PCM then makes a **trim adjustment to the opening times** of the fuel injectors (short term fuel trim = SHRTFT) to lean the mixture.

If the same deviation is registered **a number of times** at a particular engine speed and load, the result is a **permanent correction factor** (long term fuel trim = LONGFT). This is then stored in the **keep alive memory (KAM)**.

The **keep alive memory (KAM)** contains an **adaptive fuel table** (self-learning table) for all engine speed/load combinations.

The information which was collected at different engine speeds/loads is used for calculating the mixture and stored in the cells of the adaptive fuel table.

The value of the adjustment multiplier for the fuel calculation is 0.5 plus the corresponding value taken from the adaptive fuel table.

The PCM calculates the LONGFT from SHRTFT information so as to ensure that switching takes place around the stoichiometric mixture of 14.7:1 while operating in closed loop.

A fault is only registered when a correction factor has become so large that it exceeds a certain threshold value.

This threshold value must be fixed so that a fault or diagnostic trouble code is produced before the

DESCRIPTION AND OPERATION (Continued)

exhaust emissions exceed one and a half times the permitted exhaust emission limits.

The LONGFT range is also expressed as a percentage (%).

These threshold values can be adapted to changes in altitude or to high levels of fuel from the EVAP system without setting a fault.

If a fault is located in the LONGFT or the SHRTFT, a fault code is set. If the fault is still present during the second trip, the emission control malfunction indicator lamp (MIL) is switched on.

When the fuel system monitor has located a fault, it can switch off other monitors (for example the

HO2S and air injection monitors) since this can affect their reliability.

"LONGFT1" and "LONGFT2" (second upstream HO2S) are the parameters for the permanent fuel adjustment in the IDS.

The fuel monitor operates continuously while the engine is running.

Catalytic converter efficiency monitor

The operation of the catalytic converter is monitored to detect any deviation in the efficiency of the catalytic converter. Deviations above the EOBD threshold values lead to increased exhaust emissions.

The exhaust gases from the engine which flow into the catalytic converter contain among other things hydrocarbons (HC), carbon monoxide (CO) and oxides of nitrogen (NOx).

The catalyst has a ceramic honeycomb which is coated with catalytically active material. As the exhaust gases flow through the ceramic honeycomb, the catalytic material ensures that the HC and CO are oxidised and the NOx are broken down. During this process the named gases are converted into water (H2O), carbon dioxide (CO2) and nitrogen (N2).

For this the catalytic converter requires a stoichiometric or chemically balanced mixture of HC and oxygen (O2) for efficient conversion.

This is achieved through the fuel mixture which fluctuates within tight limits around the stoichiometric mixture of 14.7 parts air to 1 part of fuel by mass (14.7:1).

Surplus fuel or a rich mixture reduces the conversion of HC and CO since this causes a shortage of oxygen (O2) in the catalytic converter. In contrast, surplus oxygen reduces the conversion of NOx.

The fuel mixture is monitored continuously by the upstream HO2S and therefore continuously switched between "rich" and "lean".

In addition, the catalytic converter helps to maintain the stoichiometric mixture. For this, when the mixture is "lean", oxygen (O2) is stored which is released again when the mixture is "rich".

The active surface of an efficient catalytic converter stores oxygen (O2) and releases it again to offset deviations in the mixture.

Contamination or premature ageing of this active surface reduces the ability to store oxygen (O2). The result is lower catalytic converter efficiency.

This means that **the catalytic converter efficiency is determined by the storage capacity of the catalytic converter**.

However, this conversion capacity is limited even with an efficient catalytic converter. At high flow rates the exhaust gases do not remain in the catalytic converter long enough to be converted completely, which reduces the catalytic converter efficiency.

The induced mass of air is used as a parameter in the catalytic converter monitoring system as this is directly related to the flow rate of the exhaust gas.

The upstream HO2S measures the quantity of oxygen upstream of the catalytic converter, the downstream HO2S the quantity after it. These two signals are compared with one another to determine the oxygen storage capacity of the catalytic converter.

The signals from the downstream HO2S are different to those of the upstream HO2S.

- When a catalytic converter is working correctly, the signal from the downstream HO2S has a low peak to peak amplitude and a low switching frequency. The mean voltage is more than 0.45 V but less than 1 V.
- When a catalytic converter is working badly, the signal from the downstream HO2S has a higher peak to peak amplitude and a higher switching frequency.

The number of switching operations is counted while the vehicle is travelling and when the monitoring system is activated.

The number of switching operations of the upstream HO2S (from "rich" to "lean" and vice versa) is counted during the different constant driving conditions.

The number of switching operations of the downstream HO2S is counted at the same time as the switching operations of the upstream HO2S.

The test is terminated when the correct number of switching operations of the upstream HO2S is counted during the different driving conditions.

The efficiency of the catalytic converter is estimated by calculation of the ratio of the switching operations of the downstream HO2S to the switching operations of the upstream HO2S.

If the catalytic converter is working correctly, the switching ratio is low (near to 0). If the catalytic converter is not working so efficiently, the switching ratio is high (near to 1).

This means that when the catalytic converter is working badly, the signal of the upstream HO2S and the signal of the downstream HO2S are almost identical. From this it can be concluded that the

DESCRIPTION AND OPERATION (Continued)

exhaust gases flowing into the catalytic converter are flowing out again without any significant conversion process taking place.

Operating Strategies

Adaptive Idle Air Control Strategy

The adaptive idle air control strategy is designed to adjust the idle calibration to correct for wear and ageing of components. When engine conditions meet the adaptive strategy-learning requirement, the strategy monitors the engine and determines the values required for ideal idle calibration. The adaptive strategy stores these values within a table in memory for later reference. This table is used by the PCM for correction factors when controlling idle speed. The adaptive idle table is stored in Keep Alive Memory (KAM) and retains the learned values even after the engine is turned OFF. A Diagnostic Trouble Code (DTC) is output when the adaptive strategy has reached its limits.

Whenever an idle air control system component is renewed or cleaned, or a repair affecting idle is performed, the KAM should be reset to ensure the idle strategy does not use the previous adaptive values. Re-training the PCM is described in the 'Resetting the Powertrain Control Module' section.

Adaptive Fuel Control Strategy

The fuel control system uses the adaptive fuel table to compensate for normal variability of the fuel system components caused by wear or ageing. During closed-loop operation, if the fuel system is biased lean or rich, the adaptive fuel table will shift the fuel delivery calculations to remove the bias. The fuel system monitor has two means of adapting; Short Term Fuel Trim (SHRTFT) and Long Term Fuel Trim (LONGFT). In both cases the range is displayed as a percentage on the IDS tester.

NOTE: With Vee engine configurations the PCM identifies each bank as a separate engine. When monitoring both the long and short term fuel trim the PID descriptors may appear as SHRTFT1 and LONGFT1, indicating bank one and SHRTFT2 and LONGFT2, indicating bank two. This is a useful aid to diagnostics as, if one bank has gone outside the fuel trim limits and the other is still operating correctly, it will give a general indication to the area of concern.

Short Term Fuel Trim (SHRTFT) is a parameter that indicates short-term fuel adjustments. The Powertrain Control Module (PCM) calculates the SHRTFT from Heated Exhaust Gas Oxygen Sensor (HEGO) inputs to maintain a 14.7:1 air-fuel ratio during closed-loop operation. A negative percentage means that the HEGO is indicating a rich mixture and the PCM is attempting to lean the mixture. Ideally, SHRTFT should remain near 0% but has the ability to adjust from between -25%to +35%.

Long Term Fuel Trim (LONGFT) indicates long-term fuel adjustments. LONGFT is also referred to as adaptive fuel control. LONGFT is calculated by the PCM using information from the SHRTFT to maintain a 14.7:1 air-fuel ratio during closed-loop operation. The range of LONGFT is from -35%to +35%. The ideal value is near 0% but variations of +20% are acceptable. Information gathered at different engine speeds and loads is stored in the adaptive fuel tables for later use in fuel calculations.

SHRTFT and LONGFT work together. If the HEGO indicates the engine is running rich the PCM will correct the rich condition by moving SHRTFT in the negative range (less fuel to correct for a rich combustion). If after a certain amount of time SHRTFT is still compensating for a rich condition, the PCM adapts, moving LONGFT into the negative range to compensate and allows SHRTFT to return to a value near 0%.

As the fuel control and air metering components age and vary from nominal values, the adaptive fuel strategy learns corrections while in closed-loop fuel control. The corrections are stored in a table that is a function of engine speed and load. The tables reside in Keep Alive Memory (KAM) and are used to correct fuel delivery during open and closed-loop operation. As changing conditions continue the individual cells are allowed to update for that speed load point. If, during the adaptive process, both SHRTFT and LONGFT reach their high or low limit and can no longer compensate, a Diagnostic Trouble Code (DTC) is reported.

Whenever an injector or the fuel pressure regulator is renewed, the Keep Alive Memory (KAM) should be reset to delete the existing adaptive values. The system will generate new values for the replaced component. Refer to the 'Resetting the Powertrain Control Module' section.

Failure Mode Effects Management

Failure Mode Effects Management (FMEM) is a Powertrain Control Module (PCM) strategy that maintains vehicle operation if one or more of the major input sensors fail.

When an input sensor is out of limits, an alternative strategy is initiated by the PCM. A fixed value is substituted for the faulty one. The PCM then continues to monitor the incorrect sensor input. If the sensor later operates within limits, the PCM returns to the normal engine operation.

This mode allows the PCM to compensate for any of the four major sensor or sensor circuit failures by either inferring sensor values from remaining operational sensors or by using calibrated default values.

- T-MAP sensor failure
- TP sensor failure
- ECT sensor failure
- IAT sensor failure

DESCRIPTION AND OPERATION (Continued)

Speed Limiting Strategy

NOTE: In some cases, excessive engine or road speed may be caused by loss of traction due to wheel slippage on loose surfaces such as; sand, gravel, wet roads, mud, snow or ice.

Over-revving of the engine in park, neutral or while driving may also cause the PCM to initiate its speed limiting strategy.

To prevent damage to the powertrain components, the Powertrain Control Module (PCM) reduces the throttle and disables the fuel injectors whenever the engine or road speed reaches specific limits. Once the speed is reduced to below the set limit, normal operation will resume. Diagnostic Trouble Code (DTC) P1270 is reported if the engine or road speed exceeds the limit. No repair is required. However, the DTC should be cleared and the driver informed of the engine and road speed limits applicable to the vehicle.

The road speed limit varies according to model. The engine speed is limited to approximately 6,000 RPM for both the I6 and V8 4 valve. On automatic transmission vehicles, placing the selector in the NEUTRAL, "N" position limits the engine speed to approximately 3,000 RPM. Engine and vehicle speed limiting is nominally controlled by reducing throttle opening to an appropriate level. Speed overshoots beyond these limits are controlled by momentarily disabling the fuel injectors.

One Touch Start

Operation

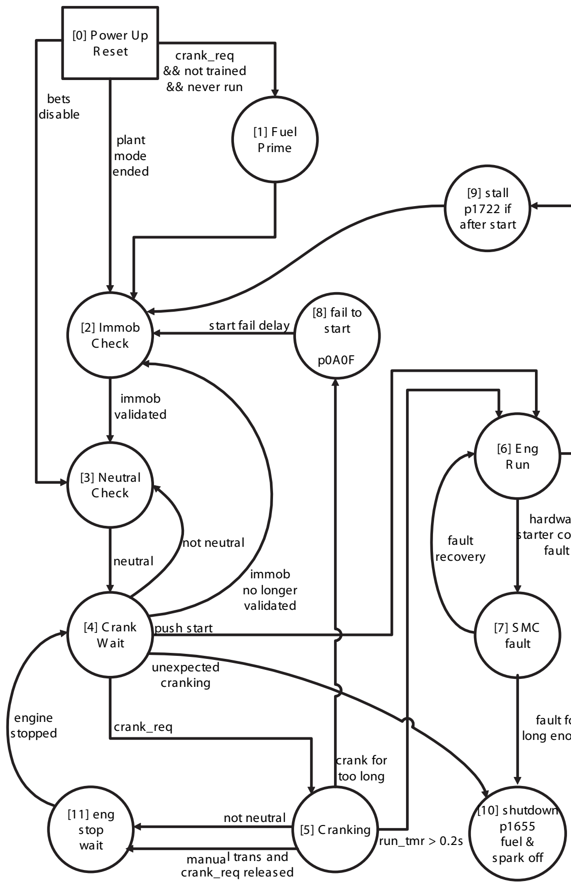
The One Touch Start System (OTS) is designed to start the vehicle automatically. The OTS system is available on all automatic transmission vehicles excluding DLPG.

The driver moves the key to the start position and releases. The engine will crank and start. In the case of no start, the engine will crank for a maximum of 5 seconds then give up. The engine can be forced to crank for a longer period by holding the key in the start position.

Manual vehicles have similar wiring to that of the vehicles with automatic transmissions. The major difference is that there is no P-N input to the PCM on manual vehicles. With no such input, the PCM's strategy will not allow the vehicle to start automatically. The driver must hold the key in the start position.

Implementation

The PCM receives a start input from the ignition switch (PCM PIN B38). The PCM controls the starter by a low side drive output to the starter relay (PCM PIN B5). The high side of the starter relay is driven from the fuel pump circuit. If there is a malfunction in the low side control of the starter relay, e.g. a short to ground, the PCM strategy will terminate the crank by turning off the fuel pump.



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Cranking is only permitted if the vehicle is in park/neutral. The PCM receives a park/neutral input (PCM Pin A2) from the transmission park/neutral switch.

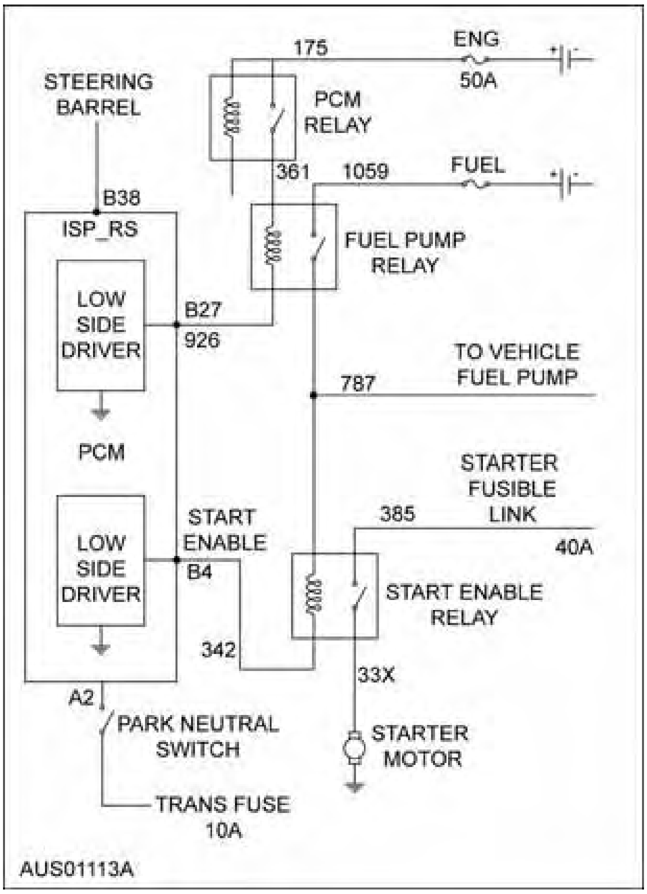
On manuals, the park neutral status cannot be determined accurately and the vehicle assumes it is always in neutral unless it is in reverse and the clutch pedal is up. The PCM receives an input from the clutch switch (PCM Pin 4) and the reverse gear switch (PCM Pin B30). The vehicle will crank unless it is in reverse with the clutch up. Since it is possible to crank in any of the forward gears with the clutch up, auto start has been disabled. Thus cranking will stop if the driver releases the key.

NOTE: On manual vehicles, if the rear lights (reverse lights only) are removed from the vehicle, the PCM infers that the vehicle is in reverse and the driver will need to place their foot on the clutch in order to start the vehicle.

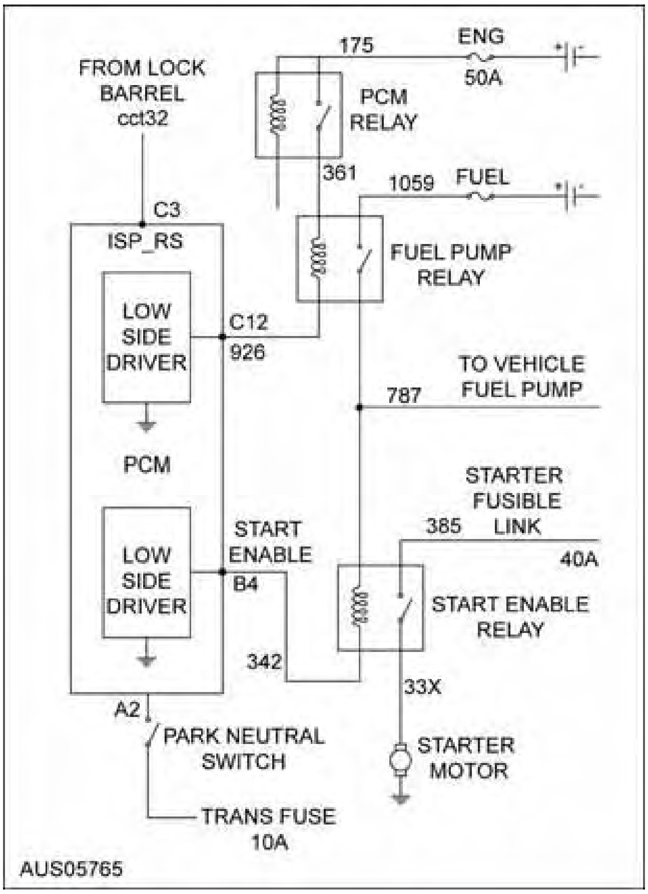
Manual, Auto and DLPG vehicles all use the similar PCM circuitry but the pinouts on DLPG PCMs are different from the pinouts for petrol PCMs.

DESCRIPTION AND OPERATION (Continued)

Petrol PCM pinouts



DLPG PCM pinouts



Starting strategy

At key ON, the OTS system waits for permission to crank from the immobilizer, then waits for the transmission to be in park/neutral and finally it waits for the crank request from the driver. The immobilizer and park neutral checks occur quickly and should be invisible to the driver provided the conditions for cranking are correct.

When the PCM receives the crank request, it pulls the low side drive to the starter relay low and the vehicle begins to crank. Cranking is terminated when the engine enters run mode.

Cranking will also be terminated if the immobilizer system determines that the conditions for starting have not been meet or the vehicle exits park neutral.

Failure Mode Effects Management FMEM

Manual vehicle can still be push started. The correct procedure is:

1. Key ON
2. Clutch pedal down
3. Gear selector in 2nd or 3rd gear
4. Assistant pushes the vehicle up to speed
5. The clutch pedal is raised and the vehicle starts.

The vehicle will not start if the key is not switched on at the start of the procedure.

DESCRIPTION AND OPERATION (Continued)

If the park neutral switch input to the PCM and the PRNDL input disagree as to the park-neutral status, the instrument cluster will flash P-N-P-N.

Starting is still possible but since the park neutral status cannot be accurately determined the handbrake must be on and the brake pedal pressed. This is to prevent the vehicle moving if it is in a drive range. For the same reason, the accelerator pedal must not be pressed for an FMEM start.

Unintended Crank Detection

The PCM has AN un-intended crank detection. The PCM will terminate the crank and shut down the engine if un-intended crank is determined. Un-intended crank is determined at key ON if the engine is turning at crank type speeds without a crank request. Unintended crank is also determined if the PCM low side drive output to the starter relay remains low after the PCM is finished cranking. This would be the case with a short to ground/open circuit on this output.

Unintended crank detection is disabled if the key has been ON for some time or the vehicle is moving.

The engine is shut down by turning off fuel and spark. The starter is shut down by turning off the fuel pump.

Diagnosis

The PCM has a PID which informs the internal state of the OTS system.

The states are:

#define OTS_RESET	0	Briefly in this state at power up (key ON). Too quick to be seen on the service tool.
#define OTS_FUEL_PRIME	1	Fuel prime in progress. Only used in vehicle plant during manufacture to prime a dry fuel system
#define OTS_IMMOB_CHECK	2	Waiting for immobilizer. Will stay in this state until immobilizer permission is granted
#define OTS_NEUTRAL_CHECK	3	Waiting for park/neutral. Will stay in this state until the vehicle in is placed in park/neutral
#define OTS_CRANK_WAIT	4	Waiting for the crank request from the driver.
#define OTS_CRANKING	5	Engine attempting to start by cranking
#define OTS_ENG_RUN	6	Engine is running
#define OTS_SMC_FAULT	7	PCM low side drive to starter relay is detected low after the crank
#define OTS_FAIL_TO_START	8	The engine has cranked but failed to start in the required time.
#define OTS_STALL	9	The engine has stalled
#define OTS_SHUTDOWN	10	The engine has been shut down by the OTS system due to unintended crank
#define OTS_ENG_STOP_WAIT	11	The OTS system is waiting for the engine to stop before allowing a re-crank
#define OTS_FUEL_PRIME_DEBOUNCE	12	Fuel prime de-bounce in progress. Only used in vehicle plant to prevent unintended prime.

Diagnosis is by observing the PID. The best way is to data log the PID and see what values it passes through whilst starting is attempted. The flow chart included shows the above states and what conditions must be present to move to another state. If the PID does not move to a desired state, then the conditions to move to that state must be checked. For example, to go from 4 to 5 the OTS must see a crank (start) request. See below.

Interpretations:

- If the PID gets stuck at 2, there is an immobilizer problem
- If the PID gets stuck at 3, the vehicle is not in park/neutral or there is a problem with park/neutral status determination. If so check, park/neutral switch and PRNDL on auto, reverse gear switch and clutch switch on manuals
- If the PID gets stuck at 4, and the operator is holding the key in the start position, the crank request is not being received by the PCM. Check wiring between starter switch and PCM input (PCM PIN B38).
- If the PID gets to 5, and the vehicle is does not crank this means that the OTS system is trying to crank but some electrical problem with the starter is preventing it. This might happen if the starter or starter solenoid is disconnected or the there is a problem with the starter relay or wiring, the fuel pump relay etc. If the PID gets to 5 this means that there is definitely no problem with immobilizer or OTS inputs such as park/neutral etc

There is also PID (118C ots_crank_time) which holds the duration of the last crank as measured by the PCM. This PIDs suggested use is as a base metric if a car has a hard to start issue.

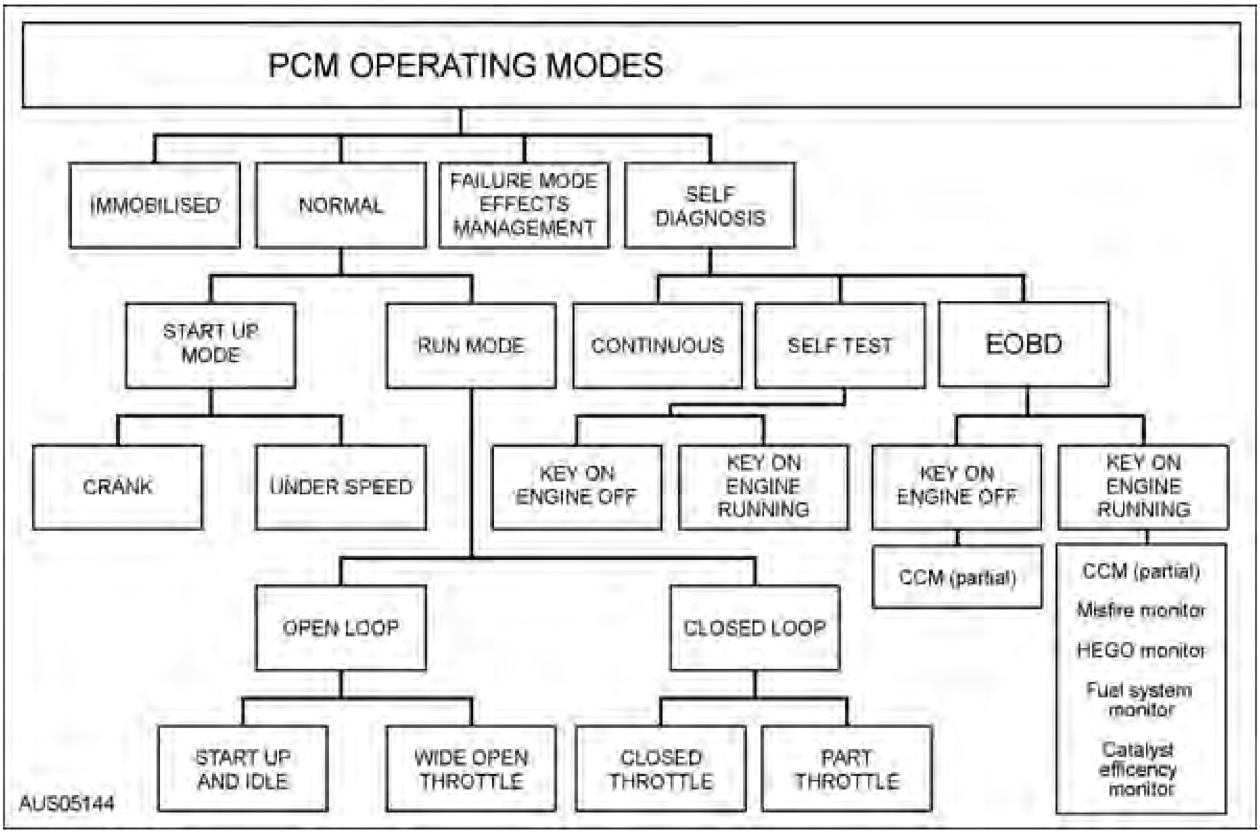
DESCRIPTION AND OPERATION (Continued)

There are DTCs for:

	PID	
Shutdown	P1655	- The OTS system has terminated crank shut down the engine. - The starting problem is definitely no fuel or spark etc. - The problem is not immobilizer or park/neutral status. - The OTS system is faulty. - The OTS system must be repaired.
Start Run Stall	P1722	- The engine has cranked and stalled shortly after start - The problem is not OTS. - The problem is not immobilizer or park/neutral status. - The problem could be fuel system, ignition system etc - The vehicle may be out of fuel.
Failed to start in the required time	P0A0F	- The engine has attempted to crank but failed to start in the required time - The problem is not OTS. - The problem is not immobilizer or park/neutral status. - The problem could be fuel system, ignition system etc - The vehicle may be out of fuel. Therefore there might not be anything wrong with the vehicle at all. Does**not** mean there is definitely something wrong with the vehicle. Is only a guide to where the problem might be.
Crank request stuck ON	P2535	The engine cranks at key ON because the crank request is shorted high. Correct short to high on the PCM start input.

Operating Modes

The mode used by the Powertrain Control Module (PCM) to control the fuel injection and ignition systems depends on the operating conditions. Operating modes are shown in the diagram below, and are described in the following section.



Login Tracking Code

DESCRIPTION AND OPERATION (Continued)

Normal Mode

In normal operating mode the PCM controls the powertrain in all operating conditions. Normal mode commences when the engine is started, either cold or hot, then continues throughout the entire range of engine operation. Normal mode is made-up of two parts: Start-Up Mode and Run Mode. Each mode has further sub-modes that control the powertrain under specific conditions. If engine or vehicle speed exceeds the specified limit, the PCM will initiate the Engine Speed Limiting Strategy to prevent damage to the powertrain.

Start-Up Mode

In Start-Up Mode the PCM starts the engine and manages the engine until it reaches Run Mode. The Start-Up strategy manages the transition between cranking, start-up, cold running and normal engine operation. The PCM uses several phases to reach Run mode.

Crank Mode

Crank Mode provides the engine with the correct parameters for rapid, “one touch” start-up. Crank mode occurs when the ignition switch is moved to the START position and the engine speed is below 200 RPM. In Crank Mode the ignition timing is set to 10° BTDC, and the injector pulse width is determined by the signal from the Cylinder Head Temperature Sensor (CHT).

Whilst cranking, all the injectors fire simultaneously on the rising edge of every internal Profile Ignition Pickup (PIP) signal. With each opening, each injector supplies 1/6th (I6) or 1/8th (V8) of the fuel required for one cycle.

Once engine speed reaches approximately 240 RPM, the PCM will enter under-speed mode.

To assist in clearing a flooded condition, the PCM disables the fuel injectors if the throttle is held wide open during Crank mode. It is possible this may introduce a DTC, **P1124.** If this is the case clear the DTC and proceed with a KOEO and a KOER test.

Under-Speed Mode

Under-speed Mode assists the transition from Crank mode to Run mode and prevents stall. Under-speed mode occurs once the engine fires, indicated by an engine speed of more than 200 RPM. Once the engine fires, the PCM switches to sequential fuel injection, using Crankshaft Position Sensor (CKP) and the Camshaft Position Sensors (Cylinder Identification) (CMP) <CID> to synchronise the fuel injection and ignition timing. The injector pulse width is switched to use the values stored in the adaptive fuel strategy tables and trimmed by input from various sensors. Ignition timing is held at 10…BTDC and the Electronic Throttle Control (ETC) controlling the air intake to maintain idle speed.

When operating in sequential injection mode, the PCM delivers the correct amount of fuel to the port above each intake valve, once every 720… of engine revolution. The PCM will maintain Under-speed mode until the engine speed reaches or exceeds 400 RPM, and until the engine reaches normal operating temperature, at which time the PCM will switch to Run mode.

Run Mode

The Powertrain Control Module (PCM) switches from Under-speed to Run mode when engine speed is greater than 400 RPM. Once the engine and Heated Exhaust Gas Oxygen Sensors (HEGOs) have reached normal operating temperature, the PCM operates in Run Mode and selects either Open or Closed Loop operation according to the throttle position and driving conditions.

In addition to the control sequences for Under-speed mode, in Run mode the ignition timing is varied by the PCM to suit engine load and demand. The engine will operate in Open or Closed Loop mode according to the signal from the Accelerator Pedal Position (APP) Sensor.

During rapid throttle opening, the PCM will provide acceleration enrichment by applying additional pulses to the injectors (increasing injection frequency).

Open Loop

There are two basic modes of fuel injection control: Open Loop and Closed Loop. The PCM will operate in Open Loop depending on the driver’s throttle demand, measured by the APP Sensor or when the Heated Exhaust Gas Oxygen Sensor (HEGO) sensor has not reached operating temperature.

The PCM will operate the engine in Open Loop mode during warm engine start-up, engine warm-up, part throttle mode and wide open throttle conditions.

In Open Loop Mode, the PCM updates the adaptive fuel strategy tables stored in memory. The adaptive fuel strategy is described in the ‘Adaptive Fuel Strategy’ section.

Start-Up and Idle

During Crank Mode and under-speed mode the engine operates in Open Loop mode. The PCM varies the air-fuel ratio (fuel mixture) to maintain the engine speed or assist in warm-up. During cold start and warm-up the fuel mixture is enriched to promote easy starting and smooth idle.

As the engine warms to normal operating temperature, the fuel injector pulse width is gradually reduced, bringing the mixture with the normal operating range. Once the engine is running at normal operating temperature the PCM will switch to Closed Loop Mode once the engine has been idling for approximately 60 seconds. The engine normally operates in Closed Loop Mode when the throttle is closed.

DESCRIPTION AND OPERATION (Continued)

Wide Open Throttle

Wide Open Throttle (WOT) mode is used to enrich the mixture according to the driver’s throttle demand. Wide Open Throttle is indicated when the Accelerator APP sensor signal exceeds approximately 4 volts. Under these conditions, the Powertrain Control Module (PCM) enters Wide Open Throttle mode, enriching the mixture to obtain maximum performance. The Air-Conditioning (Air-con), the charging system (smart charge) and EVAP Canister Purge Solenoid (EVAP) is turned OFF during WOT mode.

Closed Loop

There are two basic modes of fuel injection control: Open Loop and Closed Loop.

The PCM will operate in Closed Loop depending on the driver’s throttle demand, measured by the APP Sensor and when the engine and the Heated Exhaust Gas Oxygen Sensor (HEGO) sensor has reached operating temperature.

Closed Loop Mode controls exhaust emissions of hydrocarbon (HC), carbon monoxide (CO) and nitrogen oxide (NOx) gasses, while providing excellent fuel economy, optimal power and performance. The system regulates emissions and fuel economy by controlling the air-fuel ratio at the optimum level during different driving conditions.

Within the closed loop system, deviations from the optimal air-fuel ratio are measured. The PCM monitors the signal from the HEGO sensor, and then adjusts fuel-air mixture to maintain the correct ratio.

The principle is based on measuring the residual oxygen content in the exhaust with a HEGO sensor. The oxygen content of the exhaust is a measure of the air-fuel ratio being provided to the engine. Where the air-fuel ratio deviates from the stoichiometric point of 14.7:1, the sensor voltage output changes sharply. The PCM evaluates the change and adjusts the injector pulse width to maintain the air fuel ratio within the stoichiometric point. In Closed Loop Mode, the air-fuel ratio is kept at the optimum for all driving conditions.

This precise control of the fuel-air ratio allows a catalytic converter to be used in the exhaust system to burn-up the harmful particles and maintain the lowest exhaust emissions.

After the HEGO has reached operating temperature, the PCM selects Closed Loop Mode during closed throttle or part throttle operation.

Closed Throttle Mode

Closed Throttle Mode occurs whenever there is no demand on the throttle. This occurs during idle, coasting and deceleration. The PCM is able to detect a closed throttle condition by monitoring the signal from the APP sensor.

The PCM controls idle speed, injector pulse width and ignition timing in Closed Throttle Mode to maintain the correct air-fuel ratio.

Under periods of prolonged idle, the PCM will exit closed loop mode and hold the mixture slightly richer than the stoichiometric point to enhance idle quality.

During deceleration at engine speeds above approximately 2,000 RPM, the injectors are shut off. At engine speeds below 2,000 RPM, the fuel injectors are re-enabled.

Whenever an injector or the fuel pressure regulator is renewed, the Keep Alive Memory (KAM) should be reset to delete the existing adaptive values. The system will generate new values for the replaced component. Refer to the "Resetting the Powertrain Control Module" section.

NOTE: If the driver has driven the vehicle enthusiastically, resetting the adaptive fuel tables will result in the fuel defaulting to there original factory settings. The driver may report a perceived reduction in performance, however the performance will return as the PCM "re-learns" the drivers driving style.

DESCRIPTION AND OPERATION (Continued)

Powertrain Control Hardware

Powertrain Control Module

The centre of the PCM system is a microprocessor controlled Powertrain Control Module (PCM). Depending on model, the PCM has 92 or 122 electrical connector pins through which it receives input from sensors and other electronic components. Based on information received and programmed into its memory, the PCM generates output signals to control the engine and transmission through various relays, solenoids and actuators.

Module Programming

Special Tool(s)	
	Integrated Diagnostic System/Portable Diagnostic System (IDS/PDS)

Principles of Operation

PCM modules must be programmed as part of the repair procedure. If this procedure is not followed the module will not function correctly and may set a number of DTCs, including **P1639**, which indicate that some necessary data has not been programmed into the module.

PCMs should not be exchanged between vehicles. In most cases the parameter values or settings are unique to that vehicle, and if not set correctly will cause malfunctions or faults.

IDS will automatically attempt to retrieve the module configuration information from all modules and from a backup location in the PCM when the vehicle ID is carried out. If the module and the PCM do not contain correct information the diagnostic tool will display a list of items that you will need to manually configure. The diagnostic tool will program the module based on the data you enter.

There are three different methods that are used for module programming:

- programmable module installation (PMI)
- module reprogramming
- programmable parameters

Some modules do not support all three methods.

Programmable Module Installation (PMI)

The programmable module installation (PMI) method is used when a new PCM module is installed on the vehicle. The diagnostic tool automatically obtains any available module option content information for the old PCM during the vehicle ID routine that runs when the diagnostic tool is initially connected to the vehicle. It is important that you connect IDS to the vehicle and allow it to identify the vehicle and obtain configuration data prior to removing the old PCM.

PCM Programming

A PCM may need to be reprogrammed or replaced as part of a repair. Additional vehicle concerns may be caused if proper programming procedures are not followed.

Action:

Use the following procedure to reprogram the PCM. Verify repair after reprogramming.

Service Procedure

Preliminary Steps - Existing PCM Reprogramming or PCM Replacement

1. Connect a low amperage battery charger to vehicle.
2. Use IDS.
    1. Make sure IDS is attached to vehicle battery supply.
    2. Verify IDS software is at the latest release level.
3. If there is a communication error, attempt to communicate with a different IDS unit or PDS if available.
4. If you can communicate with another diagnostic scan tool, carryout IDS diagnostics particularly cable test procedures
5. communications cannot be established, check VPWR, ignition supply and ground connections to PCM

PCM Replacement - Standard

1. Open IDS vehicle session with original PCM installed in vehicle. If the original PCM is not able to communicate, to open a session, proceed to the Blank Path Programming procedure.
2. Install the new PCM.

    NOTE: If the IDS is required for use on another vehicle while the PCM is being fitted, place the session on "HOLD" for use later.
3. Attempt to start the vehicle.
4. Run KOEO Self Test to check for diagnostic trouble codes (DTCs) in PCM.
5. Check for DTC P0602/P0605/P1639.
    - If DTC P0602/P0605/P1639 is present then Programmable Module Installation (PMI) procedure must be performed. Use the IDS session opened at Step 1.
    - If DTC P0602/P0605/P1639 is not present, then verify Programmable Parameters are properly set such as tyre size, axle ratio, etc.
6. Check for DTC B2900.
    - If DTC B2900 is present, perform PMI on the ABS module. Do Not replace ABS module for this procedure when directed. You may be

DESCRIPTION AND OPERATION (Continued)

prompted to enter the 9 lines of PCM As-Built data during this procedure.

- If DTC B2900 is not present proceed to Step 7.

7. Diagnose all other DTCs following normal diagnostic procedures.

Reprogramming does not complete or fails - Existing PCM Reprogramming or PCM Replacement

1. Verify all cables are properly connected.
2. Verify vehicle battery is at proper charge level.
3. Verify scan tool battery is at proper charge level.
4. Attempt reprogramming procedure again.
5. If reprogramming still does not complete properly, save current session, reboot IDS, open previous session, and attempt reprogramming again.
6. If reprogramming still does not complete or you are now unable to communicate with PCM, proceed to the Blank Path Programming procedure.

Blank path reprogramming - Existing PCM Reprogramming or PCM Replacement

Perform this procedure prior to PCM replacement if a vehicle comes in with a PCM that will not communicate and previous instructions have failed to establish communication

1. Verify powers and grounds to PCM by loading and voltage drop testing circuits.
2. Follow Pin Point Tests to verify network integrity.

   NOTE: The ignition must remain in the "OFF" position until performing step 8. DO NOT turn the key on when IDS is initially connected to the DLC
3. Connect IDS to vehicle.
4. Select "Start new session, All other", press TICK.
5. Screen shows installation of cable, press TICK.
6. Screen shows to turn ignition ON. DO NOT TURN IGNITION ON. Press TICK.
7. Screen shows progress bar, then screen tells you "No communication can be established with the PCM" and asks you if you want to retry? Select "NO". With the ignition key still OFF, press TICK.
8. Screen shows to turn ignition ON. Turn ignition on, press TICK.
9. Screen shows "The PCM installed to this vehicle is blank". You will be prompted to select VIN from a list of previous sessions. Press TICK.
10. When previous sessions are shown select "None of the above".
11. Screen shows "To enable IDS to reprogram the PCM with the correct calibration", enter one of the following: Vehicle Calibration # (7 digits), Tear Tag # (4 digits), or PCM part #, press TICK.
12. Highlight the box next to the selection chosen, and enter ONLY ONE of the selections listed above. Press TICK.
13. Follow and answer correctly all remaining screens.
14. Once PCM is reprogrammed communication should be re-established and PATS system can be reset (if necessary) as per Section 419-01 of the Workshop Manual.

Module Programming

Calibration update is used to install a new calibration and strategy into a module. The updates are usually issued to fix a concern in the module software and would normally be addressed by a technical service bulletin (TSB).

Vehicle Identification (VID) Block

The PCM’s contain a memory area called the vehicle identification (VID) block. The VID block is used to store powertrain configuration information.

The PCM VID block contains the factory settings for the configurable modules unless the PCM is flashed with a new calibration in which case some PCM parameters may be modified.

DESCRIPTION AND OPERATION (Continued)

NOTE: If the VID is incorrectly programmed it will cause multiple concerns with systems which interact with the PCM, notably the automatic transmission, cruse control, ABS, DSC, incorrect speed display etc.

Reprogramming the VID block

NOTE: Ensure that the most up-to-date software version is installed in IDS.

NOTE: In the case of engine running concerns, module-reprogramming of the PCM may be required. For this purpose, a revised software version is transferred to the PCM using IDS

Select the "Module reprogramming" submenu in the "Module programming" menu tool box and then follow the instructions.

NOTE: Following installation of a wheel/tyre combination, for which the tyre-tread circumference does not correspond to that of standard tyres, the tyre size must be changed in the powertrain control module (PCM) using IDS.

Select the "Programmable parameters" submenu in the "Module programming" menu tool box and enter the corresponding tyre size under the "tyre size" menu item

DESCRIPTION AND OPERATION (Continued)

Tyre Size and Axle Ratio

Using the IDS, select Module Configuration and Programming then follow the screen prompts.

Tyre Size, Axle Ratio and Option Index

Feature	Falcon
Tyre Size	215/60 R16
	225/50 ZR17
	215/55 R16
	245/40 ZR18
	225/55 R16
	235/45 R17
	215/66 R16
Axle Ratio	3.23:1
	2.73:1
	3.45:1
	3.45:1 (Heavy duty-6 Cyl)
	2.53:1 (Heavy duty)
	2.73:1 (Heavy duty)
	3.23:1 (Thick wall tubes)
	3.73:1 (Heavy duty)
	3.45:1 (Thick wall tubes)
	3.45:1 (Heavy duty-8 Cyl)
	3.27:1 (DLPG only)
Speed Control	Not Present
	Present
Speed Source	ABS/Traction Control/DSC
	TCM
	VRS Type Sensor OSS
	Hall Effect Device on OSS

Power and Ground Signals

Vehicle Power

TURN-ON

When the ignition switch is turned to the START or RUN positions, positive battery voltage (B+) is applied to the PCM's IGNSNS input (C-301, Pin B9). The PCM's PWRSTN (C-301, Pin B37) output grounds the VPWR (C-301, Pin B46) relay. Since the other end of the VPWR relay coil is wired to B+, this energises the coil and closes the contacts of the PCM power relay. This supplies VPWR to the PCM, turning it on.

TURN-OFF

When the ignition switch is turned to the OFF or ACC, the PCM IGNSNS input reads 0V. The PCM turns off the injectors and commands the electronic throttle to the closed position. Approximately 1 second later, unless run-on fans are operating (non-DLPG only), the PWRSTN output turns off and de-energises the PCM power relay. This turns off VPWR to the PCM.

Keep Alive Memory

The PCM stores some information in Keep Alive Memory (KAM). The KAM remains powered through Keep Alive Power (KAPWR, C-301, Pin B40) when the ignition key is in the OFF position so that this information is not lost. KAPWR is routed through a fuse, situated in the instrument panel.

If the PCM power supply is interrupted then the PCM may lose the "Keep Alive Memory" data. The KAM data retention time for the PCM depends on the module temperature during the period without power (e.g. battery disconnected).

Vehicle Reference Voltage

Vehicle Reference Voltage (VREF) is a positive 5.0 Volt output from the PCM used by the sensors.

There are a number reference voltage supply pins, some are dedicated to a specific sensor i.e. C-300, pin A32 supplies a reference voltage to the Throttle Position Sensor (TPS) only. The reference voltage from C-300, pin A36 supplies the Temperature-Manifold Absolute Pressure Sensor (T-MAP), the Cylinder Head Temperature (CHT) sensor, the Cylinder Identifier (CID1 and CID2) and the Air-conditioning Pressure Transducer (ACPT)

Signal Return

The Signal Return (SIGRTN) is a dedicated ground circuit used by engine sensors.

Power Ground

Power Ground (PWRGND) is an electric ground return for the Powertrain Control Module (PCM).

There are a number of PWRGND connections utilised within the PCM. (C-301, Pin Nos. 1, 11, 12, 23 and C-302, Pin No 1). Within the PCM each of these PWRGND connections will have specific functions grounding specific sensors or actuators. Hence when carrying out diagnostic procedures it is vitally important to ensure all the PWRGND are in serviceable condition

Power Supply

The PCM's power relay voltage supply (VPWR) is controlled by the PCM's power sustain (PWRSTN) output circuit. The PWRSTN output turns on immediately when the ignition is "ON" and maintains power to the PCM power relay for a further 1 second after key-off, unless run-on fans are operating (non-DLPG only). This key-off delay enables the PCM to position the ETC throttle plate close during engine shut down.

DESCRIPTION AND OPERATION (Continued)

Connections

PCM Pin B9……………………………………… IGNSNS

PCM Pin B37…………………………………… PWRSTN

PCM Pin B34, B46…………………………… VPWR

Failure Mode

If the PCM does not appear to turn on, i.e. no engine crank and no PRNDL display when the shifter is moved (4 speed only), will not be displayed. This indicates that the PCM is being correctly powered up. Failure in the IGNSNS (ignition supply voltage) or PWRSTN* circuit or wiring circuit will result in no power to the PCM.

Testing

. (The PWRSTN circuit provides a ground connection to the EEC relay windings via a transistor within the PCM (pin B-37 in connector C-301))

Prior to commencing tests on the PCM ensure the vehicle battery is in serviceable condition and suitably charged.

Carryout a visual inspection of the accessible wiring to the PCM, PCM relay and general condition of the wiring within the engine compartment.

Before carrying out the following tests, attempt to establish communication with the PCM with IDS/PDS and retrieve any fault codes present.

Check the keep Alive Memory (KAM) fuse (Fuse 24, Instrument panel fuse box)

Testing the PCM Power Supply

Refer to wiring diagrams 303-14-00/04.

(Historically the connections to the PCM have been known as pockets A, B, & C. The connector numbers are, for pocket A C-300, pocket B C301 and pocket C C-302. If you are required to obtain a multi-meter measurement in the pocket it will state for example pin 34, pocket B. If you are required to take a reading from a connector it will state pin B34, connector C301)

1. Ensure that the vehicle ignition system and the instrument cluster are working correctly by observing the warning lamps on the instrument cluster at the ignition "RUN" position. (II)
2. Check the condition of fuse 11 in the PDB (engine compartment fuse box) (30A)
3. Turn the ignition off and remove the ECC relay (R12, PDB).
4. Turn the ignition switch to position II.
5. Using a suitable multimeter and probe adapters check the supply voltage to the relay holder. (A digital multi-meter or the multi-meter function is recommended)
6. With the black multimeter probe connected to ground, probe connection 175B, this should indicate near battery voltage.
7. Then probe connection 175E, this again should read near battery voltage, however it can indicate between 0.5 and 1 volt less than the reading at 175B. This is due to there being a diode included in this section of the circuit. A voltage difference of between 0.5 and 1 volt is acceptable. If however there is a difference of greater than 1 volt, turn the ignition off, replace the ECC diode in the PDB and recheck
8. Check the operation of the relay and if it is suspect, replace with a known functional relay.*
9. Attempt to start the vehicle.

If the vehicle fails to start.

1. Turn the ignition off and remove the ignition relay.
2. Disconnect the PCM and carryout a visual inspection connectors.
3. Check for continuity between connection 513 of the EEC relay holder and the connection to pin B37 on connector C-301. There should be less than 5 ohms resistance.
4. Check for continuity between connection 361A of the EEC relay holder and the connection to pin B34 on connector C-301. There should be less than 5 ohms resistance.
5. Refit the relay and using a suitable pin adaptor and wiring ground pin B37 on connector C-301. Switch the ignition on to position II and check the voltage at pin B34. This should read within 1 volt of battery voltage.
6. Turn the ignition off.
7. Reconnect the PCM wiring.
8. Start the vehicle.

If the PCM is still non-functional. Switch off the ignition and disconnect the PCM.

Check the ground connections on C-301, pin numbers B01, B11, B12, B23 and C01 on connector C-302.

Before replacing the PCM ensure you are using the correct key for the vehicle and the immobiliser system has not been activated.

Ensure the signal to the starter relay is present.

NOTE: Relays are generally of 2 types: DIN and ISO. A DIN relay can be identified by the numbers associated with each pin namely, 30, 85, 86, 87 and 87a. ISO relays are numbered 1, 2, 3, 4 and 5.

WARNING: ISO and DIN relays must never be interchanged. This is because the pin locations can be in different positions. If the relays are interchanged there is a high risk of damage to the vehicle circuitry or possibly even causing a FIRE.

NOTE: Many modern relays incorporate circuit boards and are multifunctional. These are not easily tested without dedicated test equipment but they are easily damaged by inappropriate test procedures.

DESCRIPTION AND OPERATION (Continued)

Relays must be replaced on a "like-for-like" basis.

The following is a simple test procedure for checking the operation of simple relays.

1. With the multi-meter set to Ohms (O), measure the resistance between pins 30 and 87 on a DIN relay or pins 3 and 5 on an ISO relay. This should read open circuit. Any reading at this point indicates the relay contacts have become fused together or are contaminated and the relay should be replaced.
2. Then take a reading across pins 1 and 2 of the ISO relay or 85 and 86 of the DIN relay. You should obtain a reading of approximately 85Ω (+/- 20Ω) on the ISO relay and 75Ω (+/- 20Ω) on the DIN relay. This tests the integrity of the windings within the relay.
3. Using a suitable power source (a square 9V battery can be used for this), power up the windings of the relay. At this point you may hear the relay click. Hearing the relay click, does not necessarily indicate it is satisfactory.

   NOTE: A number of modern relays incorporate a diode as a safety device to protect circuitry in the event of a relay being incorrectly fitted. These will be fitted between pins 85 and 86 of the DIN relay or pins 1 and 2 of the ISO relay. If when trying to obtain a reading for the winding resistance or the relay does not appear to click, try reversing the polarity with the battery before condemning the relay.
4. Using the multi-meter with the relay powered measure the resistance between pins 30 and 87 of the DIN relay or pins 3 and 5 of the ISO relay. Both must read less than 1Ω. If it is higher than this, it indicates contamination of the relay contacts.

EOBD Fault detection and storage

First, definitions of a few terms which are important for all the following explanations of the EOBD functions;

A **drive cycle** begins when the engine is started (with the engine cold or warm) and ends when the engine is switched off. Therefore, this can be very short or very long.

A **monitor trip** begins when the engine is started (with the engine cold or warm) and ends when the engine is switched off. During the trip the monitoring system can detect a fault.

Therefore, this trip can relate to a single monitoring system.

A **readiness trip** begins when the engine is started and is completed when all the monitoring systems have completed their tests. This can take place over a number of drive cycles.

A **dealer test cycle** describes the drive cycle for carrying out one readiness trip as quickly as possible.

A **warm-up cycle** begins when the engine is started with the coolant temperature below 35°C, and ends as soon as the coolant temperature exceeds 70°C

When the ignition is switched on, the PCM continuously checks its inputs and outputs for discontinuity, short circuits and faulty sensors/actuators.

The sensors/actuators can also be checked for plausibility, for example illogical combinations of signals.

In addition, with the EOBD the control systems and components which affect emissions are also monitored by means of **monitoring systems**.

The monitoring systems take the form of test routines initiated by the PCM to check systems which affect emissions such as for example heated oxygen sensor control, catalytic converter operation, etc.

When a fault is detected, a fault or diagnostic trouble code (DTC) is stored in the keep alive memory (KAM).

A **NON-MIL DTC** is a fault which does not affect emissions so the MIL is not actuated.

An **MIL DTC** is a fault which affects emissions so the MIL can be illuminated.

The **EOBD** and the following description relate **solely to MIL DTCs**.

The system detects a fault while the engine is running:

- A fault occurring for the first time is stored in the KAM with the freeze frame data as a presumed fault (pending code).
- If the fault is not confirmed during the next check, it is deleted.
- Presumed faults which relate to combustion misfires or the fuel system are only deleted when the fault is not confirmed in similar conditions (defined as: engine speed ±375 rpm, engine load ±20% and the same warm-up status).

However, if such a fault is confirmed during the **second drive cycle**, the presumed fault (pending code) is automatically changed to a **confirmed fault** (continuous code). The freeze frame data is not changed when this occurs, but remains the same as when the fault occurred for the first time.

The emission control malfunction indicator lamp (MIL) only comes on when the fault is stored as a “confirmed fault”.

This means that the emission control malfunction indicator lamp (MIL) only comes on when the fault has been detected during the second trip.

Exceptions to this are misfires which damage the catalytic converter.

In the case of “misfires which damage the catalytic converter” (for example due to ignition or mixture), the emission control malfunction indicator lamp (MIL) **flashes** at once. With all other faults it **is illuminated continuously** during the second drive cycle.

DESCRIPTION AND OPERATION (Continued)

If the fault does not reoccur during three drive cycles, the emission control malfunction indicator lamp (MIL) is extinguished during the fourth drive cycle.

The fault or diagnostic trouble code remains in the keep alive memory (KAM).

Faults which no longer occur are automatically deleted from the KAM after 40 warm-up cycles.

If a faulty signal is detected and the corresponding fault or diagnostic trouble code is stored during a trip, all the tests in which this signal is required as a reference are discontinued. This prevents storage of consequential faults.

Fault or diagnostic trouble codes can be read out or deleted with a Ford diagnostic tool IDS/PDS or with a generic scan tool.

Emission control malfunction indicator lamp (MIL)

The emission control malfunction indicator lamp (MIL) is located in the instrument cluster and takes the form of an engine symbol (international standard).

The MIL alerts the driver when the EOBD system has found a component or system fault which affects emissions.

Whenever the ignition is switched on, the instrument cluster actuates the MIL.

If the system is in order, the instrument cluster receives a corresponding check message after the engine is started and the MIL is switched off (applies to CAN clusters only, on other systems the emission control malfunction indicator lamp (MIL) is controlled directly by the PCM).

If the emission control malfunction indicator lamp (MIL) **does not go out** after the engine is started, this means that:

- the emission control malfunction indicator lamp (MIL) has been actuated by the PCM due to a fault which affects emissions; or
- the instrument cluster has actuated the emission control malfunction indicator lamp (MIL) because the PCM has not sent a check message to the instrument cluster; or
- the PCM is in the limited operating strategy mode; or
- there is a short-circuit in the wiring of the emission control malfunction indicator lamp (MIL), depending on the vehicle variant; or
- there is a break in the wiring of the emission control malfunction indicator lamp (MIL), depending on the vehicle variant.

If the emission control malfunction indicator lamp (MIL) **does not come on** after the ignition is switched on, the MIL is faulty.

The MIL only comes on while the engine is running when the fault has been stored as a “confirmed fault”, which means that the MIL only comes on when the fault has been confirmed during the second drive cycle. An exception to this is misfires which damage the catalytic converter.

In the case of misfires “which damage the catalytic converter” (type A) the MIL **flashes** with a frequency of 1 Hz (also refer to “Combustion misfire monitor” in the lesson entitled “Monitoring Systems”). With all other faults **it is illuminated continuously** from the second drive cycle onwards.

If the MIL flashes with an irregular frequency, there is a break or short circuit in the wiring of the MIL

To reset the fault memory after a fault has been rectified and thus switch off the MIL, a reset signal must be sent by the diagnostic tool.

Diagnostic Trouble Codes (DTCs)

The DTCs given by the PCM are standardized, which means that generic scan tools can read results from all vehicles.

- The DTC is always a 5 digit alphanumerical code, for example ”P0100".
- The first digit of a code (letter) identifies the system which has set the code. Provision has been made for a total of four systems to be identified although only the ’P’ code is required for EOBD.
  - ’B’ for the body
  - ’C’ for the chassis
  - ’P’ for the powertrain
  - ’U’ for the network communications systems
- All of the ”x0xxx" codes are standardized codes. However, any manufacturer can use additional codes over and above the standardized codes. These will be labelled ”x1xxx", "x2xxx" and so on.
- The third digit of a code (numeric) identifies the sub-system which has set the code.

- ’Px1xx’ for metering of fuel and air supply

- ’Px2xx’ for metering of fuel and air supply

- ’Px3xx’ for ignition system – combustion misfires

- ’Px4xx’ for auxiliary emission control equipment

- ’Px5xx’ for vehicle speed, idle setting and other related inputs

- ’Px6xx’ for trip computer and other related outputs

- ’Px7xx’ for transmission.

- ’Px8xx’ for transmission.

- ’Px9xx’ category to be determined

- ’Px0xx’ category to be determined

- When a concern occurs, the actions taken include storage of the relevant information and actuation of the MIL occurs in line with the relevant legislation.

Dealer test cycle and the P1000 code

Reminder: When the fault memory in the PCM has been cleared, the readiness code P1000 is stored in the KAM.

DESCRIPTION AND OPERATION (Continued)

This readiness code indicates that not **all** the monitoring systems have completed their tests since the KAM was cleared.

For this reason, all the monitoring system tests must be carried out during a readiness trip to delete the readiness code P1000.

Therefore, the Ford workshop is **strongly urged** to carry out the **dealer test cycle** described in the following.

This test is constructed so that **all** the monitoring systems can carry out and complete their tests in a logical order. When all the cycle steps are followed precisely, the readiness code P1000 is deleted.

This alone ensures that the vehicle is in order. The tests of each monitoring system are carried out differently for the dealer test cycle described in the following.

The readiness code P1000 is only **deleted after execution** of the complete dealer test cycle in the specified order.

If the test of a **specific** monitoring system has **not been completed successfully**, the corresponding cycle must **be repeated only for this monitoring system without** clearing the KAM again and **without** switching off the ignition.

If the test of a **specific** monitoring system is to be carried out and completed (after rectification of the fault), the **test preparations** and the test steps described in connection with the corresponding monitoring system must be carried out.

It is important to make sure that the test alone is completed successfully, but not that the readiness code P1000 is not deleted.

Test recommendations

Most of the tests of the EOBD monitoring systems can be completed faster if the accelerator pedal is moved smoothly and not rapidly when driving at constant speed or when accelerating.

Operating the accelerator pedal smoothly reduces the time required to complete an EOBD monitoring system test.

The fuel tank should be between 20% and completely full.

NOTE: If the fuel tank is less than 15% full (FLI = fuel level input to PCM), the combustion misfire monitor, HO2S monitor, catalytic converter efficiency monitor and fuel monitor are disabled.

The dealer test cycle can be carried out either on the road or, when available, on a rolling road.

WARNING: If the test is carried out on the road, the driver must comply with the local traffic regulations and due consideration given to other road users.

Drive Cycle

The following is the information is a guide to completing the drive cycle successfully.

General notes

The tests of each monitoring system are carried out differently for the dealer test cycle described in the following.

The readiness code P1000 is only **deleted after execution** of the complete dealer test cycle in the specified order.

If the test of a **specific** monitoring system has **not been completed successfully**, the corresponding cycle must **be repeated only for this monitoring system without** clearing the KAM again and **without** switching off the ignition.

If the test of a **specific** monitoring system is to be carried out and completed (after rectification of the fault), the **test preparations** and the test steps described in connection with the corresponding monitoring system must be carried out.

It is important to make sure that the test alone is completed successfully, but not that the readiness code P1000 is not deleted.

Test preparations

Procedure:

- Connect the IDS PTU or FDS 2000 PDU to the data link connector (DLC).
- Switch on the ignition (do not start the engine).
- Switch off the ignition, then switch it on again.
- Select the correct vehicle and correct engine.
- Clear the keep alive memory (KAM).
- Start the engine.
- Let the engine run at idle speed for 15 seconds.
- Then drive the vehicle at a speed of 65 km/h until an ECT of at least 76.7°C (170°F) is indicated in the display of the diagnostic equipment.

Test procedure

Carry out the dealer test cycle in the following order:

1. HO2S monitoring system

Accelerate the vehicle to a speed of 68 to 88 km/h and keep the vehicle at a constant speed in this range for 90 seconds.

Purpose of this drive cycle:

The upstream and downstream HO2S monitoring system completes its test.

2. Catalytic converter efficiency monitoring system

Drive the vehicle in a “stop and start” fashion.

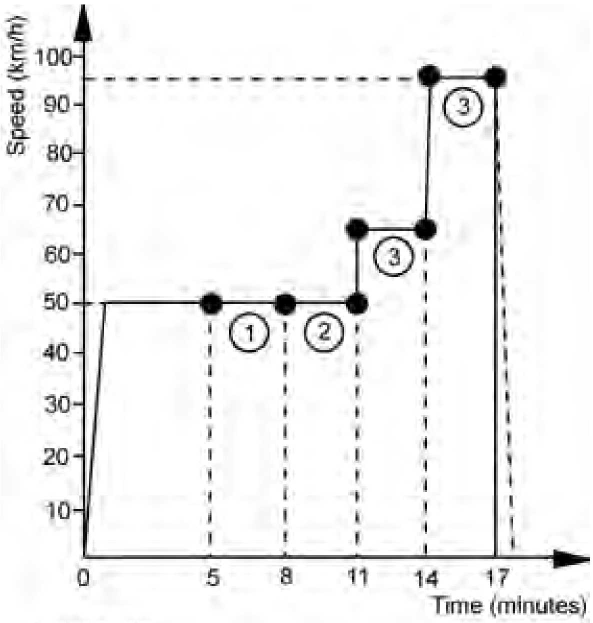
This should include constant motoring at different speeds.

DESCRIPTION AND OPERATION (Continued)

The vehicle must be driven for five minutes before the catalytic converter monitoring system is activated.

Drive at the following speeds for three minutes each time with the accelerator pedal in a constant position:

- 50 km/h in 3rd gear
- 50 km/h in 4th gear
- 50 km/h in 5th gear (70 km/h in 4th gear (4 speed automatic))
- 95 km/h in 5th gear (95 km/h in 4th gear (4 speed automatic))



AUS05325

Purpose of this drive cycle:

- The catalytic converter efficiency monitoring system completes its test.

3. EGR monitoring system ("differential pressure feedback EGR" only if system is present)

Accelerate the vehicle from "0" (standstill) to 75 km/h with the accelerator pedal depressed 75% and maintain this speed for 25 seconds.

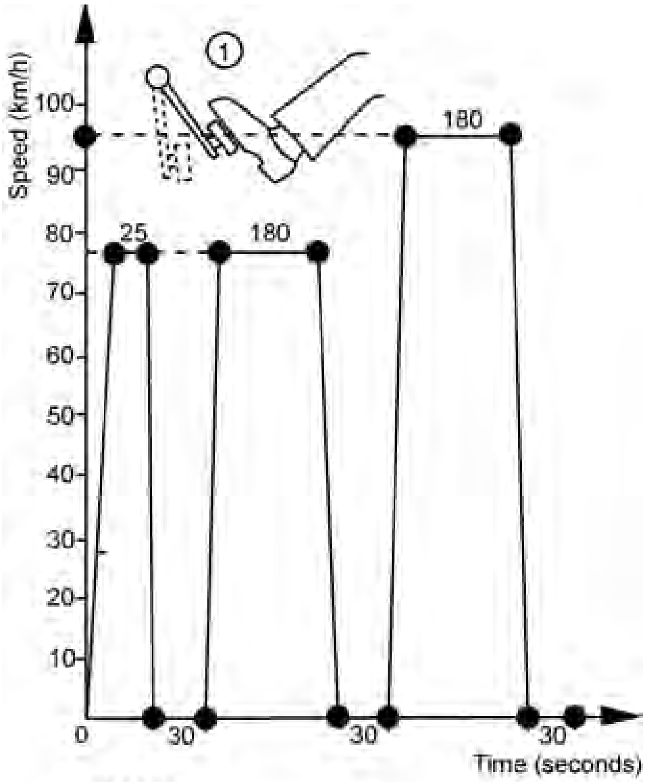
Stop the vehicle and let the engine idle for 30 seconds.

Repeat the procedure described above twice:

- accelerating to 75 km/h and driving for 180 seconds,
- accelerating to 95 km/h and driving for 180 seconds.

Purpose of this drive cycle:

The exhaust gas recirculation system monitor completes its test.



AUS05326

Item	Description
1	Accelerator Pedal Position

Login Tracking Code

DESCRIPTION AND OPERATION (Continued)

4. Monitors for secondary air injection (when the system is present) and emission control components (engine).

Stop the vehicle and let the engine idle for two minutes (manual transmission in neutral position, automatic transmission selector lever in position D).

Purpose of this drive cycle:

The comprehensive component monitor (CCM) completes the engine part of its test.

5. Monitor for emission control components (transmission)

Manual transmission:

Accelerate the vehicle from a standstill to 80 km/h, then continue with item 6.

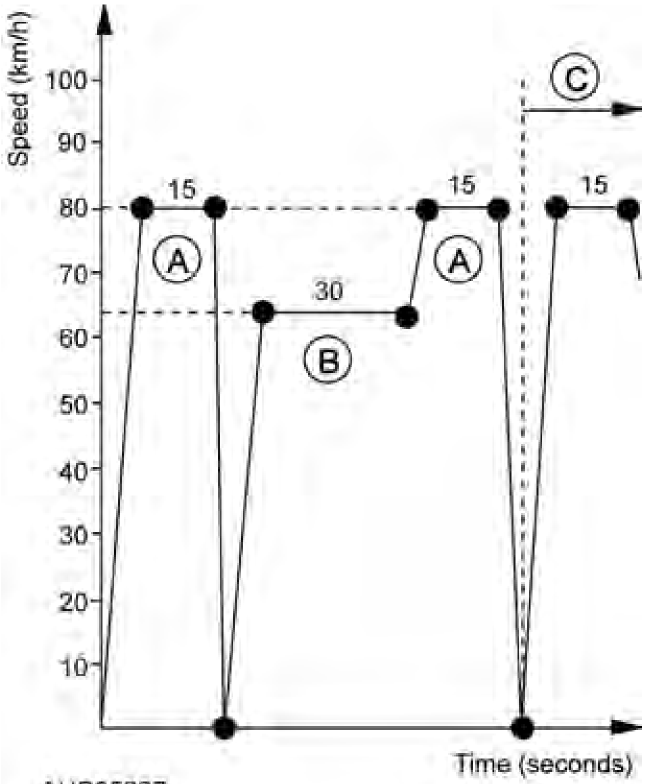
Automatic transmission:

Accelerate the vehicle moderately from a standstill to 80 km/h and maintain this speed for at least 15 seconds.

Stop the vehicle and accelerate moderately to 64 km/h without using “overdrive”, and maintain this speed for at least 30 seconds.

Activate “overdrive” again at a speed of 64 km/h, accelerate to 80 km/h and maintain this speed for at least 15 seconds.

Stop the vehicle for at least 20 seconds and repeat the above five times.



AUS05327

Item	Description
A	With Overdrive
B	Without Overdrive

Item	Description
C	Repeat drive cycle 5 times

Purpose of this drive cycle:

The comprehensive component monitor (CCM) for emission control components completes the transmission part of its test.

6. Combustion misfire monitor and fuel monitor

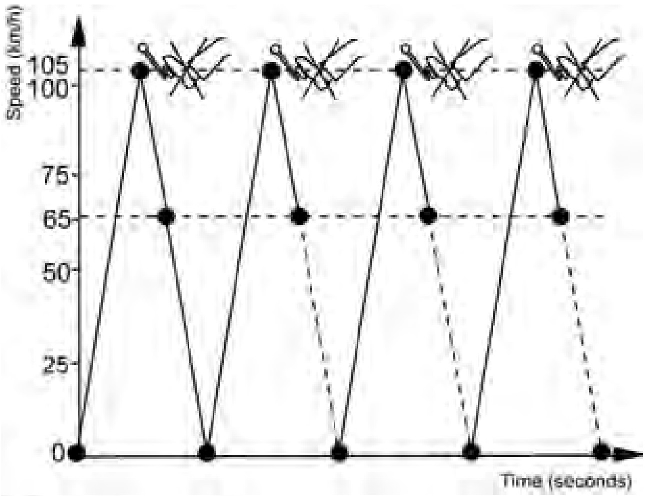
Accelerate the vehicle from a standstill to 105 km/h.

Release the accelerator pedal (close the throttle) and slow down to 65 km/h without applying the brakes (overrun fuel shut off).

Repeat the operation three times.

Purpose of this drive cycle:

The “learning mode” for the combustion misfire monitor is activated.



AUS05328

7. Readiness check

Call up the “On--board system readiness” (EOBD monitor status) function on the diagnostic equipment.

Make sure that all the non--continuous monitors have completed their tests. If not, continue with item 8.

Purpose of this check:

Establishes whether any monitoring system has not completed its test.

8. Check for presumed fault (pending code)

With the diagnostic equipment check for the presence of a presumed fault (pending code).

If a presumed fault is present, carry out the appropriate fault rectification procedures.

If necessary, repeat the uncompleted monitoring system test.

DESCRIPTION AND OPERATION (Continued)

Inputs

Crankshaft Position Sensor (CKP)

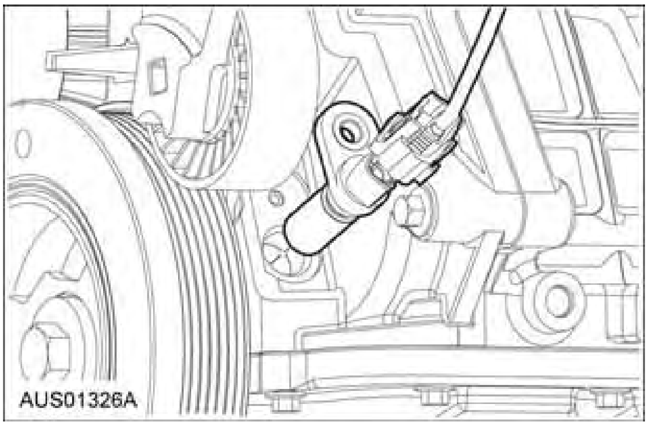
The CKP sensor is a magnetic transducer mounted on the front timing cover. A reluctor (tooth wheel) is mounted on the front of the crankshaft internal to the engine. The CKP is the primary sensor for ignition timing information used by the powertrain control module (PCM).

The reluctor, or trigger wheel, has a total of 35 teeth, spaced 10° apart with one empty space for a missing tooth. By monitoring the trigger wheel, the CKP indicates crankshaft position and speed information to the PCM.

The PCM uses the CKP signal and the Camshaft Position Sensor (Cylinder Identification) (CMP) <CID> signal to determine the position of piston 1 within the cycle. From this, the PCM calculates spark and fuel injection timing.

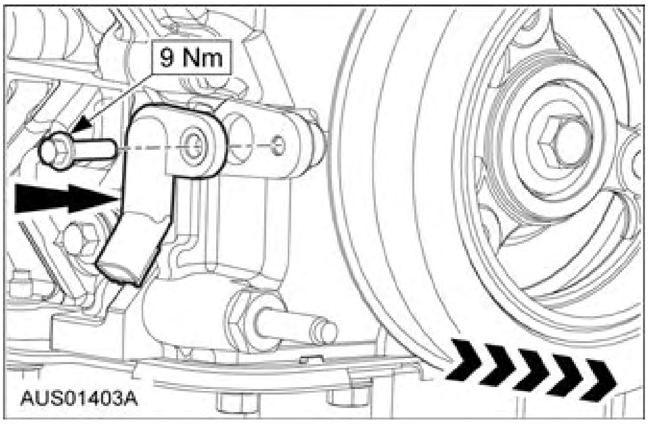
The CKP signal converts the crankshaft position to an electrical signal as shown below. The analogue AC voltage CKP signal is converted to a digital PIP signal; this signal is used internally by the Powertrain Control Module (PCM), every rising edge signals that the crankshaft is 10° before TDC for a particular cylinder's compression stroke.

CKP Sensor, I6 Engine



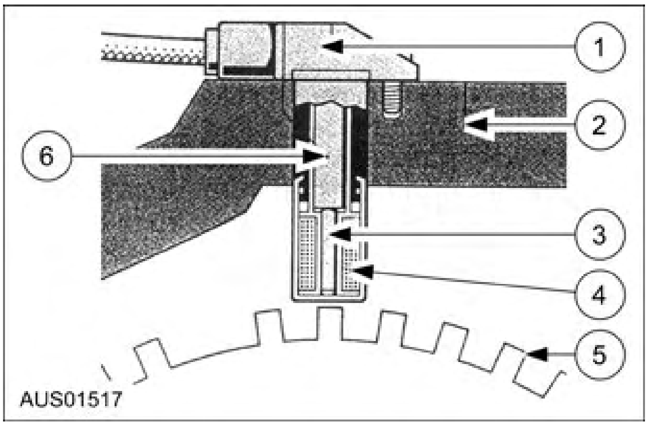
The CKP signal is produced by an Inductive Pulse Generator. Its main components are a reluctor (toothed wheel on the harmonic balancer) and a pick-up coil. When the engine rotates, the toothed wheel passes the coil pick-up. The strength of the magnetic field changes from strong to weak, and vice-versa, as the teeth rotate past the pick-up coil. The amplitude and frequency of the CKP signal is proportional to engine speed. As engine speed increases, so does the voltage amplitude.

CKP Sensor, V8 Engine



The reluctor has a missing tooth positioned before cylinder No. 1 reaches TDC. The PCM keeps count of the teeth as they pass the pick-up, using the missing tooth as a reference point. The PCM can then calculate the exact crankshaft position at any time. As the crankshaft rotates twice between each combustion stroke, the CKP uses a signal from the CMP sensor to determine the position within the cycle. On I6 engines the missing tooth is 60° BTDC, while on V8 engines it is 90° BTDC.

Crankshaft Position Sensor



Item	Description
1	Sensor Housing
2	Timing Cover
3	Soft Iron Core
4	Coil Winding
5	Toothed Wheel
6	Permanent Magnet

The Coil On Plug (COP) Ignition System uses the CKP and CMP signals to generate a digital Profile Ignition Pick-Up (PIP) signal. The PIP signal produces a rising edge when the crankshaft is at 10º BTDC of any cylinder's compression stroke. The PCM uses the PIP signal to calculate spark timing.

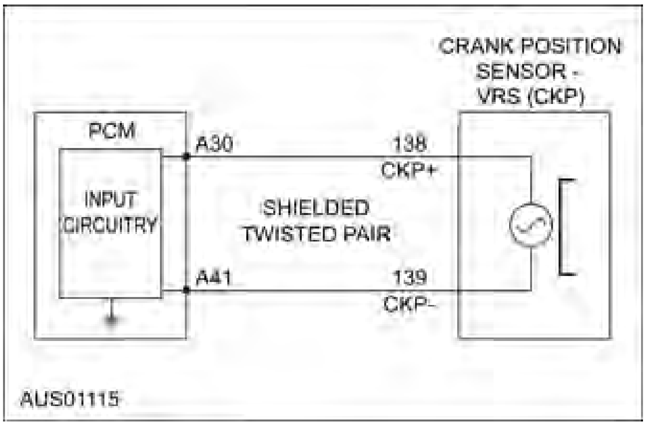
DESCRIPTION AND OPERATION (Continued)

Connections

PCM Pin A30.................................... CKP Positive

PCM Pin A41.................................... CKP Negative

Circuit



Diagnosis

Diagnostic Trouble Codes (DTC) are retrieved through the diagnostic connector using the IDS/PDS tester.

DTCs that may be caused by a CKP concern are predominantly, **P0300, P0315, P0316** and **P0320.**

Please refer to the Quick Reference DTC list.

Failure Mode

The PCM will not be able to determine the current engine speed or crankshaft position without the correct signal from the CKP sensor. If the CKP sensor fails, or an improper signal is received at the PCM, fuel pump operation, spark and fuel injection are suspended.

Testing

Sensor Test

1. Disconnect the harness from the CKP connector.
2. Measure the resistance across the connector terminals using a suitable multimeter. Replace the solenoid if not within specification.
   - **CKP Resistance Specification**
     280 - 380Ω
3. Check the harness for open circuits and short circuits.
4. Using the IDS oscilloscope (OCS) option on IDS and suitable probe adaptors, connect the OCS to the CKP
5. Ensure the cables are routed away from any moving parts.
6. Crank the engine and monitor the signal. It should appear as an AC waveform with a high peak (negative rising positive) to indicate the position of the missing tooth.
7. With a good vehicle battery and reasonable cranking speed, the OCS should indicate a minimum of just under 1 volt AC, higher voltages of up to 5 volts are not a cause for concern. (It should be remembered a slow cranking speed will result in a reduced output from the CKP)
8. If you remove the CKP sensor to replace it, inspect the end of the removed sensor for contamination or evidence of impact damage. A high level of contamination, particularly metal particles, may indicate there is a mechanical concern with the engine. A small amount of metal build up is acceptable, but it can adversely affect the CKP signal.

Temperature and Manifold Absolute Pressure Sensor

The I6 Temperature and Manifold Absolute Pressure (T-MAP) sensor is located on the inlet manifold, below the throttle body. The 5.4L, 4V, V8 T-MAP sensor is located on the inlet manifold, adjacent to the throttle body.

The T-MAP sensor is a combined pressure and temperature sensor that measures both intake air temperature and manifold absolute pressure. The Powertrain Control Module (PCM) provides the T-MAP with a 5 volt reference voltage and monitors the return voltages from both the integral Intake Air Sensor (IAT, the T part of the abbreviation) and the MAP. It uses these signals for air mass calculations.

The T-MAP sensor uses a Piezo resistive sensor and outputs a voltage proportional to the manifold absolute pressure. The voltage increases as manifold vacuum falls.

A temperature-sensing element is incorporated into the T-MAP senor to measure the temperature of the intake air within the manifold. The temperature element employs a Negative Temperature Coefficient (NTC) thermistor that is sensitive to temperature variations. The resistance of the thermistor decreases as the temperature rises.

The sensor also measures barometric pressure when the ignition is moving from the ON to the START positions or whenever the throttle is wide open.

Connections

PCM Pin A38……...............…...............MAP Signal

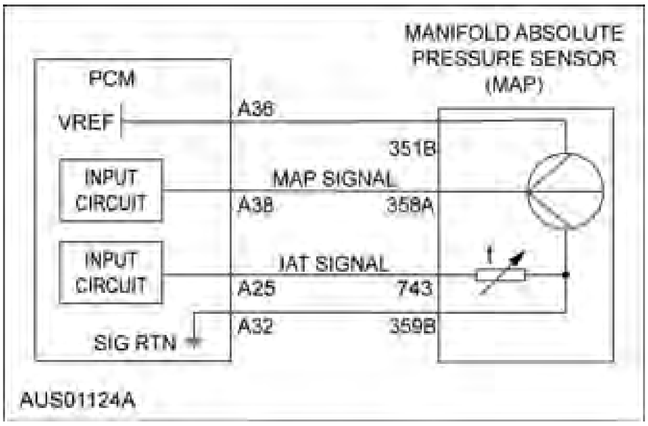
PCM Pin A25……...............…...............IAT Signal

PCM Pin A36.....Vehicle Reference Voltage (VREF)

PCM Pin A32......................Signal Return (SIGRTN)

DESCRIPTION AND OPERATION (Continued)

Circuit



Diagnosis

If the T-MAP sensor is damaged or faulty, but still operating within the operating range, no fault code will be logged in memory and value substitution will not take place. Under these conditions the PCM will increase the injector timing in an attempt to compensate; causing difficult starting, rough running and poor fuel economy.

Incorrect or modified valve timing, worn piston rings or an alteration in manifold vacuum (particularly at idle) can cause a lower than normal vacuum.

Diagnostic Trouble Codes (DTC) are retrieved through the diagnostic connector using the IDS tester.

DTCs applicable to the T-MAP are shown in the following table.

DTC	Test Mode	Condition	MIL
P0107	KOEO, KOER, Cont.	MAP circuit low input	ON
P0108	KOEO, KOER, Cont.	MAP circuit high input	ON
P0109	Cont.	MAP intermittent fault	OFF
P0112	KOEO, KOER	Temperature circuit low input.	ON
P0113	KOEO, KOER, Cont.	Temperature circuit high input.	ON

Failure Mode

The Failure Mode Effects Management (FMEM) strategy will, in most cases, ensure almost normal operation of the vehicle in the event of a T-MAP sensor fault or failure. If the T-MAP signal is not within the operating range, or not present at all, the PCM will substitute a value proportional to the APP sensor signal and adaptive values stored within its memory. The appropriate trouble code will be logged in memory for retrieval during Self-test mode.

Testing

The T-MAP sensor is tested continuously during vehicle operation (cont.) and whenever Key On Engine Off (KOEO) or Key On Engine Running (KOER) tests are performed.

Testing Manifold Absolute Pressure

1. Connect a IDS tester to the diagnostic connector and retrieve all DTCs.
2. Specific MAP DTCs include **P0107, P0108 and P0109.**
3. Evaluate all DTCs and attempt to identify a common theme. For example if P0107 is indicated, MAP low reference voltage, and DTCs associated with the oil temperature sensor (OTS), Cylinder Head Temperature (CHT) sensor, Air-con transducer etc are also indicated this could be something as simple as the connection at A36 being loose or contaminated.
4. Check the Manifold Absolute Pressure Sensor readout on the screen when the engine is at normal operating temperatures. If the value is within specification, then check for other Diagnostic Trouble Codes (DTC) or component faults.

T-MAP Specification (Normally aspirated engines)	
Manifold Pressure	**Signal Voltage**
15 kPa	0.3
30 kPa	1.0
50 kPa	2.0
70 kPa	3.0
90 kPa	4.0
105 kPa	4.8

T-MAP Specification (Turbo)	
Manifold Pressure	**Signal Voltage**
10 kPa	0.3
50 kPa	1.0
100 kPa	1.9
150 kPa	2.8
200 kPa	3.7

5. Check the condition of the wiring loom and connections.

   NOTE: The pressure monitoring option may not be available on IDS other than with the Pressure/Vacuum Transducer (PVT) option. This can be replaced with an accurate conventional vacuum gauge connected into the manifold system.

   NOTE: It may not be possible to achieve a full range of comparative readings as the engine

DESCRIPTION AND OPERATION (Continued)

speed may be limited, particularly with vehicles fitted with an automatic transmission.

Testing Temperature

1. Connect a IDS tester to the diagnostic connector and retrieve all DTCs
2. DTCs associated with the IAT part of the T-MAP are **P0112 and P0113**
3. Evaluate all recorded DTCs and attempt to identify any common theme, i.e. low reference voltage. If multiple DTCs of this nature are evident, check for common wiring connections. Refer to wiring diagrams.

   NOTE: If the vehicle has not been operated for a minimum of 6 hours. Connect IDS and select datalogger. Check the CHT temperature and the T-MAP temperature. They should be within 1°C of each other.

Sensor Test

1. Disconnect the harness from the T-MAP connector.
2. Measure the resistance across the connector terminals using a suitable multimeter. Replace the sensor if not within specification.
3. Check the harness for open circuits and short circuits.

For further tests refer to the **Quick Reference DTC list.**

T-MAP Resistance Specification		
Temperature (±3º C.)	**Resistance, Nominal**	**Voltage Nominal**
0º	5960 Ω	4.3
10º	3820 Ω	4.0
20º	2500 Ω	3.6
25º	2050 Ω	3.4
30º	1690 Ω	3.1
40º	1160 Ω	2.7
60º	580 Ω	1.8

DESCRIPTION AND OPERATION (Continued)

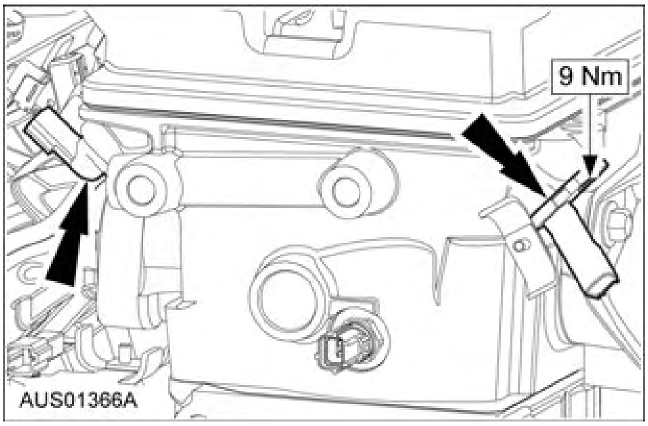
Trimming Sensors

Camshaft Position Sensor

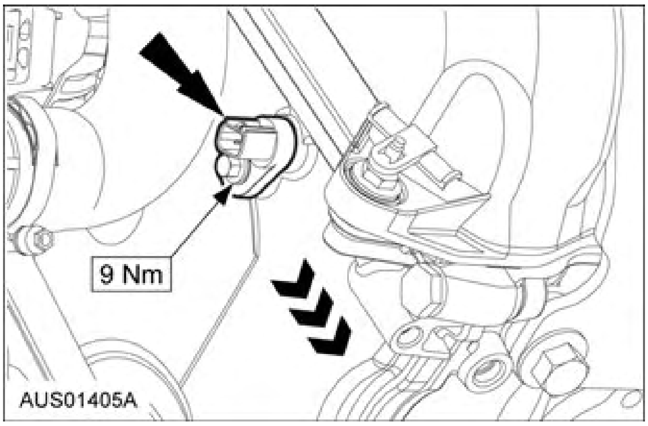
The 2 engine Camshaft Position Sensors (CMP) are Variable Reluctance Sensors. On the I6, the 2 sensors are located on both sides of the cylinder head rear. On the V8, the sensors are located on the engine front cover. The sensor is used in conjunction with the CKP to synchronize the ignition system and the fuel injectors to the firing of each cylinder and to feedback the camshaft position for VCT control (I6 engines only).

The I6 engine uses a 3+1 tooth reluctor wheel on the inlet camshaft and another on the exhaust camshaft. The V8 engine uses a 4+1 tooth reluctor wheel for the camshaft on bank 1.

CMP Sensor Location, I6 Engine



CMP Sensor Location, V8 Engine



Connections

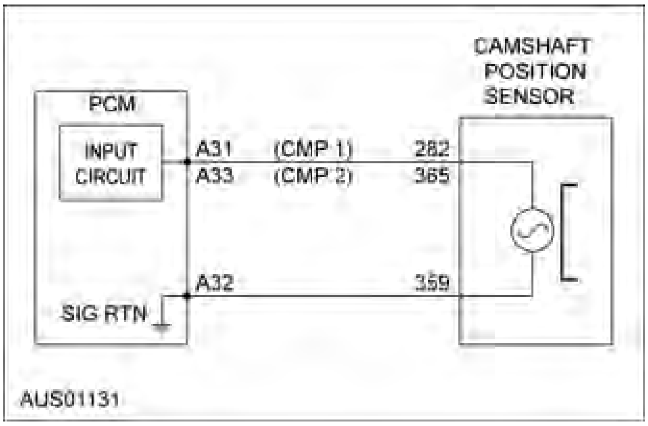
PCM Pin 31.......................... CMP1 Sensor Positive

PCM Pin 32......... CMP1 Sensor Negative/ SIGRTN

PCM Pin 33.......................... CMP2 Sensor Positive

PCM Pin 32.......... CM2 Sensor Negative/ SIGRTN

Circuit



Diagnosis

Diagnostic Trouble Codes (DTC) are retrieved through the diagnostic connector using the IDS tester.

DTCs applicable to the CMP sensor are shown in the following table.

DTC	Test Mode	Condition	MIL ON
P0320	Cont.	Ignition engine speed input circuit Malfunction	YES
P0340	Cont.	CID1 Circuit malfunction	YES
P1340	Cont.	CID2 Circuit malfunction	YES

Failure Mode

Should a CMP signal be missing then the PCM will be unable to identify the camshaft position and VCT operation will be disabled. Should both CMP sensors or signal fail, the PCM will not operate the fuel injectors sequentially, and the engine may run rough.

Testing

The CMP sensor is tested continuously during vehicle operation (cont.).

1. Connect a IDS tester to the diagnostic connector.
2. Check the Parameter Identification (PID) value of the CMP. If the PID value is within specification, then check for other Diagnostic Trouble Codes (DTC) or component faults.

PID Specification

PID	Description
CMPFM	CMP Failure mode flag
SYNC	CMP and CKP signals are synchronised

Sensor Test

1. Disconnect the harness from the CMP Sensor connector.

DESCRIPTION AND OPERATION (Continued)

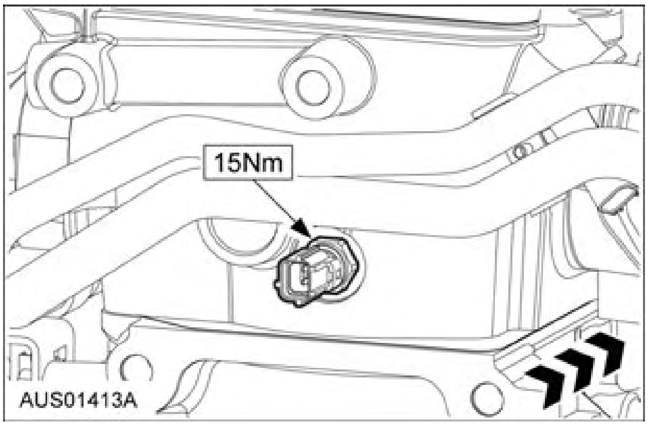
2. Measure the resistance across the connector terminals using a suitable multimeter. Replace the sensor if not within specification.
   - **CMP Resistance Specification**
     280 - 380
3. Check the harness for open circuits and short circuits.
4. Using the IDS oscilloscope (OCS) option on IDS and suitable probe adaptors, connect the OCS to the relevant CMP (It is possible to monitor both CMP sensors by OCS correctly, or monitor the CKP signal against one of the CMP's)
5. Ensure the cables are routed away from any moving parts.
6. Crank the engine and monitor the signal. It should appear as a near flat line with an intermittent AC waveform to indicate the position of the relevant teeth.
7. With a good vehicle battery and reasonable cranking speed, the OCS can indicate from 0.6volt AC upwards, higher voltages of up to 5 volts are not a cause for concern. (It should be remembered a slow cranking speed will result in a reduced output from the CMP)
8. If you remove the CMP sensor to replace it, inspect the end of the removed sensor for contamination or evidence of impact damage. A high level of contamination, particularly metal particles, may indicate there is a mechanical concern with the engine. A small amount of metal build up is acceptable, but it can adversely affect the CMP signal.
9. Where practical, check the air gap between the CMP and reluctor wheel. It should be approximately 1.6mm. Remember variations in this gap will cause variations in the readings. However, even with variations of up to 0.4mm the sensor should still function and not adversely affect engine performance.

For further tests refer to the **Quick Reference DTC list.**

Cylinder Head Temperature Sensor

The Cylinder Head Temperature (CHT) sensor is mounted at the rear of the cylinder head on the I6.

CHT Sensor Location, I6 Engine



The CHT sensor measures the cylinder head temperature for the fail-safe cooling strategy. The PCM also uses this sensor signal in conjunction with the Intake Air Temperature signal to determine fuel requirements and to inhibit activation of some features that only work properly when the engine is at normal operating temperature. These features include closed loop fuel control and canister purge control.

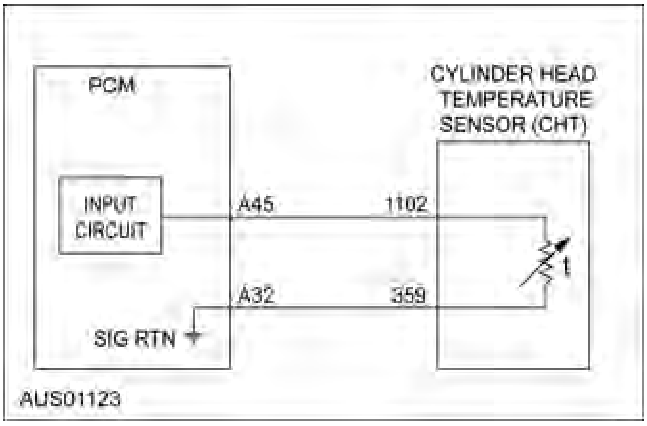
The PCM provides the sensor with a 5 volt reference and employs a Negative Temperature Coefficient (NTC) thermistor that is sensitive to temperature variations. The resistance of the thermistor decreases as the temperature rises.

Connections

PCM Pin A45.................... CHT Temperature Signal

PCM Pin A32.....................Signal Return (SIGRTN)

Circuit



Diagnosis

The CHT sensor element is encased is brass for protection against corrosion. Diagnostic Trouble Codes (DTC) are retrieved through the diagnostic connector using the IDS tester.

DTCs applicable to the CHT sensor are shown in the following table.

DESCRIPTION AND OPERATION (Continued)

DTC	Test Mode	Condition	MIL On
P1285	KOEO, KOER and Cont.	Cylinder head overheat condition	NO
P1288	KOEO, KOER	CHT out of test range	NO
P1289	KOEO, KOER and Cont	CHT sensor / circuit high input	YES
P1290	KOEO, KOER and Cont	CHT sensor / circuit low input	YES
P1299	KOER, Cont	Overheat protection active (FMEM strategy)	YES

(These DTCs have replaced P0116, P0117 and P0118)

Failure Mode (Petrol Engines only)

The PCM has a Failure Mode Effects Management (FMEM) strategy mode that, in most cases, will ensure almost normal operation of the vehicle in the event of a CHT sensor fault or failure. If the CHT sensor fails or produces an invalid signal, the PCM will not be able to sense the engine temperature. Under these conditions, the PCM will substitute the value from the Intake Air Temperature Sensor (IAT). During crank mode, the PCM will substitute the IAT signal for the missing CHT, since both sensors will have “soaked” to approximately the same temperature. When the engine is switched OFF, the whole engine will soak up heat from the cooling system and reach a similar temperature. When the engine starts, the PCM will infer a value for the CHT of approximately 80º C.

Testing

The CHT sensor is tested continuously during vehicle operation (cont.) and whenever Key On Engine Off (KOEO) or Key On Engine Running (KOER) tests are performed.

1. Connect a IDS tester to the diagnostic connector and retrieve all the DTCs.
2. Attempt to identify any common theme such as a range of sensors indicating high, low or intermittent signals. Any of these concerns would normally indicate defective connections, possibly to pocket A (Connector C-300) to the PCM.
3. Select the CHT PID on IDS Datalogger. You will normally have the option of both TEMP and VOLTS. It is recommended you select both.
4. With the engine between ambient air temperature and below 65°C, start the engine and monitor both TEMP and VOLTS.
5. As the temperature increases you should see the voltage decrease proportionally up to 83°C +/- 7°C, at this point you should see the voltage increase up to near 4 volts +/- 0.5 volts again. This indicates the CHT is operating correctly.

   NOTE: This does not apply to coolant temperature sensors, only to cylinder head temperature sensors (CHT’s).
6. If the sensor appears to be operating correctly, with IDS connected and the engine running gently shake the wiring at various positions along its length, particularly near connectors or where the wiring is routed through an acute angle (wiggle test). If this produces variations in the readings on IDS, this indicates defective wiring or poor connections.

For further tests refer to the **Quick Reference DTC list.**

PID	Description
Cylinder Head Temperature	-40° to +180°C

Engine Oil Temperature Sensor (I6 Turbo Only)

The Engine Oil Temperature (EOT) sensor is located on the engine block directly above the engine oil filter (I6) and on the engine sump on the V8 engine.

The EOT sensor measures the temperature of the engine oil for the variable cam timing strategy.

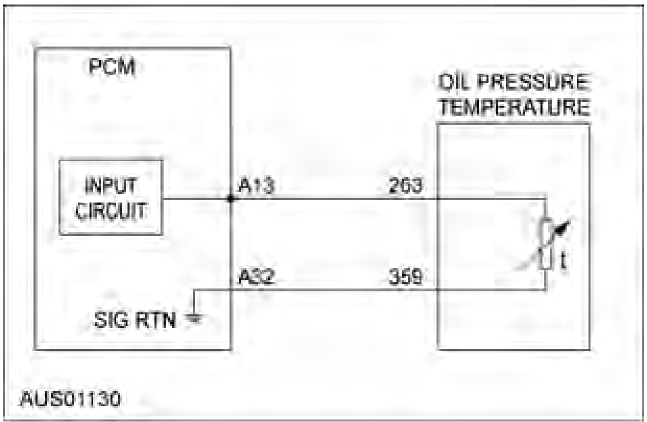
A temperature-sensing element is incorporated into the EOT sensor to measure the temperature of the engine oil within the engine. The sensor operates with a 5 volts supply and the temperature element employs a Negative Temperature Coefficient (NTC) thermistor that is sensitive to temperature variations. The resistance of the thermistor decreases as the temperature rises.

Connections

PCM Pin A13……..……………… …… EOT Signal

PCM Pin A32…..………… Signal Return (SIGRTN)

Circuit



Login Tracking Code

DESCRIPTION AND OPERATION (Continued)

Diagnosis

If the sensor is damaged or faulty, but still operating within the operating range, no fault code will be logged DTCs applicable to this sensor are shown on the following table.

DTC	Test Mode	Condition	MIL ON
P0196	Cont	Engine Oil Temperature Sensor temperature is inconsistent with engine temperature	YES

Failure Mode

The Failure Mode Effects Management (FMEM) strategy will, in most cases, ensure normal operation of the vehicle in the event of an EOT sensor failure. If the EOT signal is not within the normal operating range, or not present at all, the PCM will substitute a temperature value calculated from CHT. The appropriate trouble code will be logged in memory for retrieval during Self-test mode.

Testing

The EOT sensor is tested continuously during vehicle operation.

Testing Engine Oil Temperature Sensor

1. Disconnect the EOT sensor wire connector.
2. Measure the resistance across the connector terminals using a suitable multimeter. Replace the sensor if not within specification.

EOT Resistance Specification		
Temperature (±3º C.)	Resistance, kΩ	Voltage Nominal
0º	96	4.5
20º	37	3.9
25º	30	3.8
30º	24	3.5
40º	16	3.1
60º	7.6	2.2
80º	3.9	1.4
90º	2.8	1.1
100º	2.1	0.9

3. Check the harness for open circuits and short circuits.

For further tests refer to the **Quick Reference DTC list.**

Engine Oil Pressure Sensor

The I6 Engine Oil Pressure (EOP) switch is located on the engine block above and right of the engine oil filter. The V8 engine oil pressure switch is located on the adaptor between the oil filter and the engine block.

The EOP sensor switches to ground at normal oil pressures and opens at low engine oil pressure.

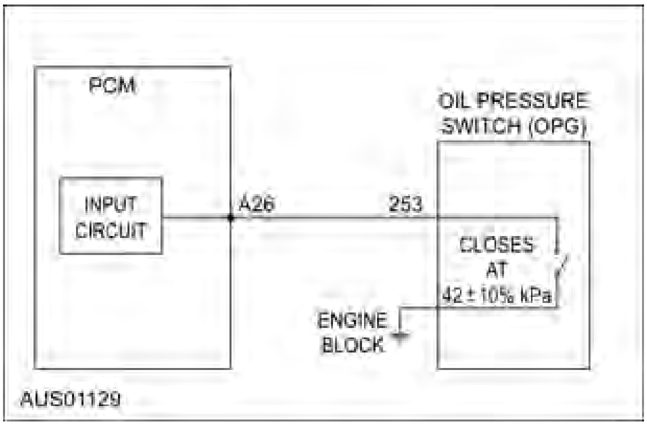
Engine oil pressure is not used for powertrain control but is transmitted on the CAN for display on the instrument cluster to warn the driver the oil pressure is low.

Connections

PCM Pin A26…………………… Pressure Signal

Circuit

EOP Sensor Circuit



Failure Mode

In the event the EOP sensor fail, the instrument cluster warning lamp will not indicate correctly.

NOTE: The instrument cluster warning lamp glows regardless of EOP switch status when the engine is not running.

Testing

1. Connect a IDS tester to the diagnostic connector.
2. Check the Parameter Identification (PID) value of the EOP.

PID Specification

PID	Description
OIL_PRESS	Engine Oil Pressure

EOP sensor specification

Oil Pressure	PID Count	Resistance
Normal	Less than 50	Less than 20 Ω
Low	Greater than 230	Greater than 100kΩ

Boost Pressure Sensor, I6 Turbo Engine

The Boost Pressure Sensor (BPS) is located on the aluminium duct between the intercooler and the throttle body inlet duct.

DESCRIPTION AND OPERATION (Continued)

The BPS measures the absolute pressure of the pre-throttle intake system for speed control and wastegate control strategy.

The pressure-sensing element in the BPS employs a Piezo resistive sensor that outputs a voltage proportional to absolute pressure.

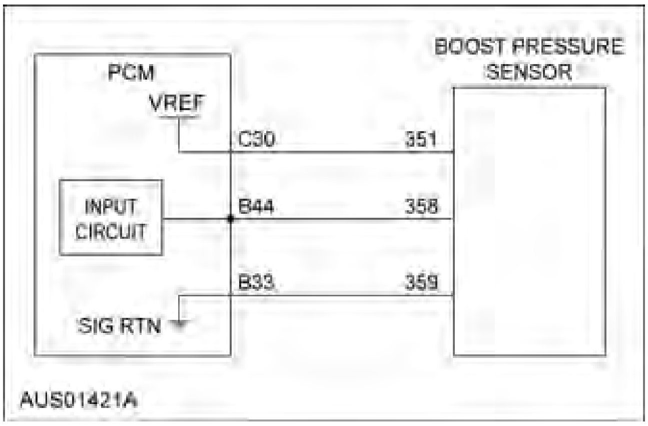
Connections

PCM Pin B44…………………..Boost Pressure Signal

PCM Pin C30… Vehicle Reference Voltage (VREF)

PCM Pin B33..……………. Signal Return (SIGRTN)

Circuit



Diagnosis

DTCs applicable to this sensor are shown on the following table.

DTC	Test Mode	Condition	MIL ON
P0236	Cont	Boost Pressure Sensor Circuit /Range Performance	YES
P0237	KOER KOEO Cont	Boost Pressure Sensor Circuit Low	YES
P0238	KOER KOEO Cont	Boost Pressure Sensor Circuit High	YES
P0243	KOER KOEO Cont	Wastegate solenoid	NO

Failure Mode

The Failure Mode Effects Management (FMEM) strategy will, in most cases, ensure reasonable operation of the vehicle in the event of a BPS failure. If the BPS signal is not within the normal operating range, or not present at all, the PCM will substitute a default value for pre-throttle absolute pressure and use MAP for boost control. The appropriate trouble code will be logged in memory for retrieval during Self-test mode.

Testing

The BPS is tested continuously during vehicle operation (cont.) and whenever Key On Engine Off (KOEO) or Key On Engine Running (KOER) tests are performed.

Testing Boost Pressure Sensor

1. Connect a IDS tester to the diagnostic connector.
2. Check the Parameter Identification (PID) value of the BPS. If the PID value is within specification, (at key-on engine off it should be at atmospheric pressure or 1.8 to 2.2 volts) then check for other Diagnostic Trouble Code (DTC) or component faults

PID Specification

PID	Description
TURBO	Turbo Boost Pressure

BPS Specification	
Absolute Pressure (kPa)	Signal Voltage (V)
10	0.3
50	1.0
100	1.9
150	2.8
200	3.7

DESCRIPTION AND OPERATION (Continued)

Feedback Inputs

Heated Exhaust Gas Oxygen Sensor

On I6 engines, there are 2 Heated Exhaust Gas Oxygen (HEGO) sensors mounted in the exhaust system. The first, HEGO 11, is mounted in the exhaust manifold above the engine pipe connection flange. The second, HEGO 12, is mounted in the exhaust system just after the catalytic converter.

On V8 engines, there are four HEGO sensors, two for each bank. HEGO 11 (right bank) and HEGO 21 (left bank) are mounted in the engine pipe just below the exhaust manifold. HEGO 12 (right bank) and HEGO 22 (left bank) are mounted in the exhaust systems just after the catalytic converters.

The sensors have a built in heating element to bring the sensor to its operating temperature quickly and to prevent them from dropping below its operating temperature during periods of extended engine idle.

NOTE: The HEGOs are identified by bank and position in the exhaust, i.e.

HEGO 11: Bank 1, sensor 1 (upstream) (PID HO2S11)

HEGO 12; Bank 1, sensor 2 (downstream) (PID HO2S12)

HEGO 21: Bank 2, sensor 1 (upstream) (PID HO2S21)

HEGO 22: Bank 2, sensor 2 (downstream) (PID HO2S22)

HEGOs 11 and 21. (Upstream, pre-catalytic converter)

The PCM uses HEGO 11 and HEGO 21 sensor signals to adjust the fuel injector pulse width to maintain the air-fuel ratio at stoichiometry. The PCM compares the amount of fuel that is being used in closed loop operation to the amount of fuel it predicts would be required if there was no HEGO signal. The PCM will also illuminate the Malfunction Indicator Lamp (MIL) if it detects a fault with the HEGO sensors on the second drive cycle.

If there is a difference, the PCM adjusts its 'Open Loop' (i.e. no feedback) predicted values to reflect the actual requirements of the engine as signalled by the HEGO sensor. These corrections are stored in the KAM for use when the system next operates in the open loop mode, i.e. in cold drive conditions, or wide open throttle operation. This adaptive learning enables the PCM to precisely control the air-fuel ratio and compensate for component wear and injector fouling. It does this by having one of its electrodes exposed to the exhaust gas and the other electrode exposed to normal air. The difference in the level of oxygen produces a voltage across the electrodes. The platinum electrodes of the Zirconia element typically only operate effectively above 350ºC so the HEGO sensor has an integral heater element built in.

HEGO's 12 and 22. (Downstream, post-catalytic converter)

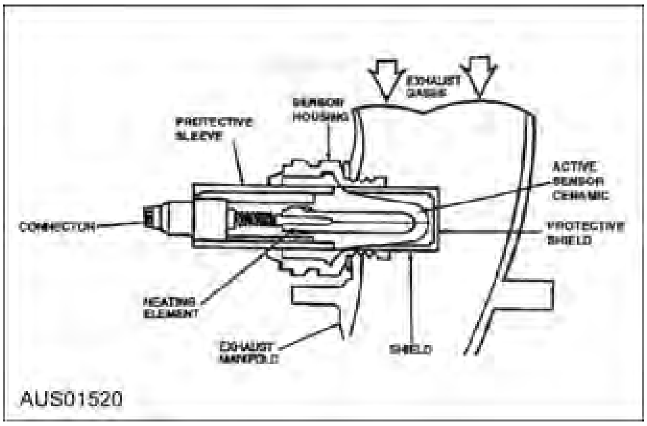
The PCM uses the signals from HEGO12 and HEGO 22 to monitor the oxygen content of the exhaust gases post catalytic converter. The PCM has stored data parameters which compare the switching ratios between the upstream HEGO's (HEGO 11 and HEGO 21) and the downstream HEGO's (HEGO 12 and HEGO 22). Based on this switching ratio the PCM can calculate catalytic converter efficiency. If the switching ratio exceeds the adaptive learning parameters stored in the KAM, it will illuminate the MIL.

The operating principles for both the upstream and downstream HEGO's are identical.

HEGO Heater elements.

As the HEGO relies on a chemical reaction for its operation like most chemical reactions it is heat reliant. All the HEGO's have non-serviceable heater elements built-in to generate a rapid heating of the sensing element and hence achieve the optimum operating temperature of above 350°C as quickly as possible. The heating elements are supplied with 12 volts through a common fuse and grounded via the PCM. Due to this method the PCM can monitor the effectiveness of the HEGO's and adjust the heater operation accordingly. As the up-stream HEGO's (HEGO 11 and HEGO 21) are sensing very hot exhaust gases, the voltage regulation is achieved through Pulse Width Modulation (PWM). This creates very accurate control of the HEGO temperature. The down-stream HEGO's operating in the cooler, post catalyst converter, exhaust gases operate on voltage regulation.

HEGO Sensor, Typical.

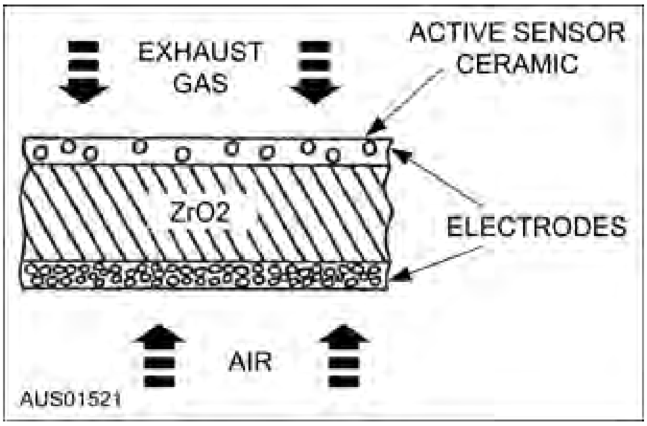


The HEGO detects the amount of unburnt oxygen in the exhaust gasses as a measure of the air-fuel ratio.

The upstream HEGO sensor(s) (HEGO11 and HEGO21) are used for an individual bank of cylinders the signal represents the average air-fuel ratio. In Closed Loop Mode the HEGO sensor provides the PCM with a signal indicating whether the engine is running 'rich' or 'lean'.

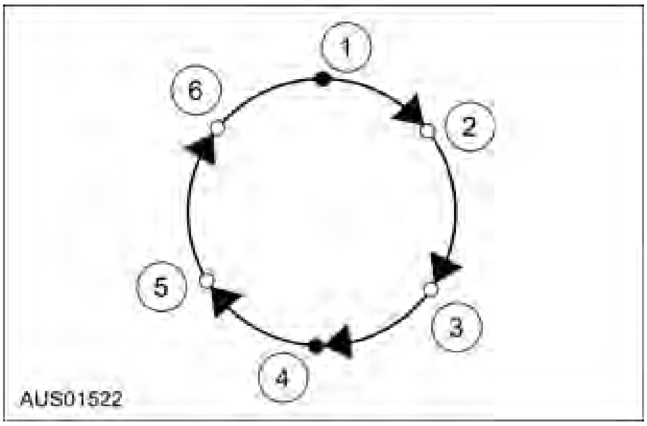
DESCRIPTION AND OPERATION (Continued)

HEGO Sensor Operation



The PCM uses the upstream HEGO signals to maintain the correct air-fuel ratio during closed loop mode by varying the fuel injector pulse width. In open loop mode the HEGO signal is disregarded by the PCM. The PCM also stores values from the sensor in a look-up table as part of its adaptive strategy. See the 'Operating Modes' section.

Closed Loop Process



Item	Description
1	Ideal ratio
2	Oxygen Sensor Signal Lean
3	Increase Pulse Time
4	Ideal Ratio
5	Oxygen Sensor Signal Rich
6	Reduce Pulse Time

DESCRIPTION AND OPERATION (Continued)

Connections

PCM Pin A09…………HHTR12 (I6 and V8)
PCM Pin A17…………EGO11 (I6 and V8)
PCM Pin A18…………EGO21 (V8 only)
PCM Pin A19…………HHTR11 (I6 and V8)
PCM Pin A20………..HHTR21 (V8 only)
PCM Pin A32………..SIGRIN (I6 and V8)
PCM Pin A37………..EGO21 (I6 and V8)
PCM Pin C18………..HHTR22 (V8 only)
PCM Pin C19………..EGO22 (V8 only)

Circuit

Refer to wiring diagram………..303-14-00-8

Diagnosis

Diagnostic Trouble Codes (DTC) are retrieved through the diagnostic connector using the IDS tester.

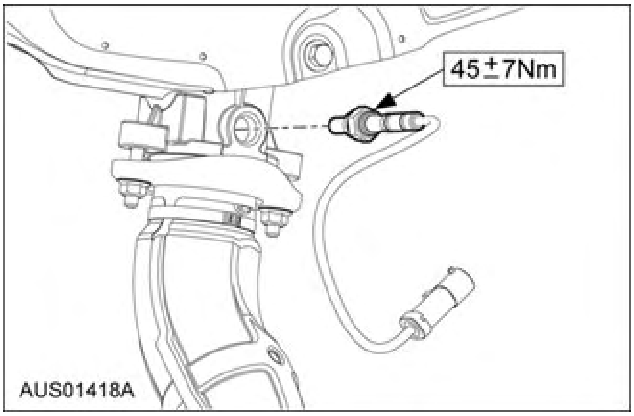
DTCs applicable to the HEGO sensors are shown in the following table.

DTC	Test Mode	Condition	MIL ON
P0131	KOER, Cont	HEGO 11 switching between 0 & -1V	YES
P0132	KOER, Cont	HEGO 11 switching over 1.5V	YES
P0133	KOER, Cont	HEGO 11 slow switching time	YES
P0135	KOEO, KOER, Cont	HEGO 11 heater circuit failure	YES
P0136	KOER, Cont	HEGO 12 switching between 0 & -1V	YES
P0138	KOER, Cont	HEGO 12 switching over 1.5V	YES
P0141	KOEO, KOER, Cont	HEGO 12 heater circuit failure	YES

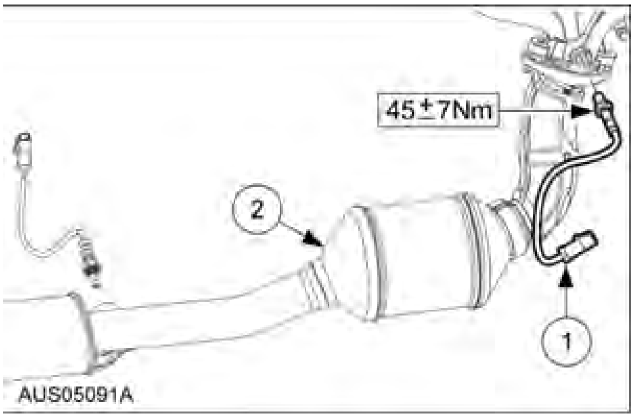
DTC	Test Mode	Condition	MIL ON
P0151	KOER, Cont	HEGO 21 switching between 0 & -1V	YES
P0152	KOER, Cont	HEGO 21 switching over 1.5V	YES
P0153	KOER, Cont	HEGO 21 slow switching time	YES
P0155	KOEO, KOER, Cont	HEGO 21 heater circuit failure	YES
P0156	KOER, Cont	HEGO 22 switching between 0 & -1V	YES
P0158	KOER, Cont	HEGO 22 switching over 1.5V	YES
P0161	KOEO, KOER, Cont	HEGO 22 heater circuit failure	YES
P0171	KOER, Cont	I6 and bank-1 V8 fuel system too lean	YES
P0172	KOER, Cont	I6 and bank-1 V8 fuel system too rich	YES
P0174	KOER, Cont	V8 bank-2 fuel system too lean	YES
P0175	KOER, Cont	V8 bank-2 fuel system too rich	YES
P0420	KOER, Cont	HEGO 12 switching cycle outside projected parameter	YES
P0430	KOER, Cont	HEGO 22 switching cycle outside projected parameter	YES
P1128	Continuous	Connections between bank 1 and bank 2 connections swapped (up stream)	YES

DESCRIPTION AND OPERATION (Continued)

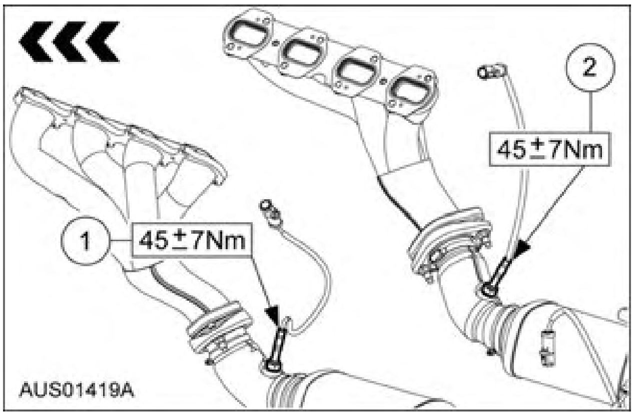
HEGO11 Sensor, I6 Engines



HEGO12 I6



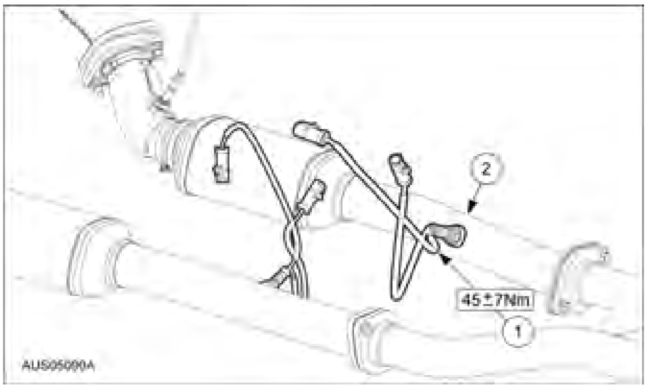
HEGO11 & HEGO21 Sensor, V8 Engines



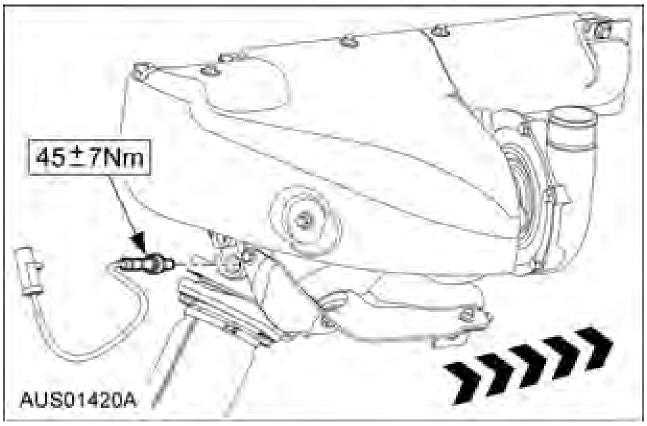
Item	Description
1	HEGO Sensor (LHS only)
2	HEGO Sensor (LHS & RHS)

DESCRIPTION AND OPERATION (Continued)

HEGO12 and HEGO22



HEGO11 Sensor, I6 Turbo



Failure Mode (HEGO 11 or 21)

In the event one of an upstream HEGOs failure, the PCM is not able to operate in Closed Loop Mode. In Open Loop Mode the PCM will use values stored in its look-up tables. These values are stored from the adaptive strategy.

As the strategy constantly updates the table, the PCM should be able to maintain a suitable air-fuel ratio with a faulty HEGO. However the MIL will be illuminated and there may be a slight increase in fuel consumption.

A trouble code for HEGO failure is logged when a Key On Engine Running (KOER) self-test is performed or during continuos tests.

Failure Mode (HEGO 12 or 22)

In the event a downstream HEGO fails the PCM will record a DTC.

NOTE: For P1000 code; HEGOs 12 and 22 are part of the Comprehensive Component Monitoring (CCM) system, specifically for monitoring catalytic converter efficiency. In the event there is a P1000 code displayed "Catalyst Evaluation Incomplete", this DOES NOT indicate a fault with the downstream HEGOs. All this indicates is the vehicle has not completed an adequate drive cycle to carryout the evaluation.

Testing

The HEGO sensors are tested continuously during vehicle operation (cont.) and whenever Key On Engine Off (KOEO) or Key On Engine Running (KOER) tests are performed.

1. Connect a IDS tester to the diagnostic connector, retrieve and record all DTCs.

   NOTE: multiple DTCs can indicate a mechanical fault or an electrical fault and not necessarily a defective HEGO sensor.

2. Check the Parameter Identification (PID) value of the HEGO sensor.
3. It is recommended that during this test the Short Term (SHRTFT) and Long Term Fuel Trim (LONGFT) is also monitored, with Open loop (OPENLOOP) and Closed loop (CLOSELOOP) PIDs if available.

   NOTE: When monitoring with IDS a fixed switching ratio may be displayed, hence the impression is given the HEGO is operating correctly. This can be the fixed default strategy operating within the PCM FMEM.

4. If this is the case, ensure all the DTCs are recorded and then delete them or clear the KAM. Note clearing the KAM will then activate the **P1000** code.
5. This returns all the sensors to factory settings.
6. Monitor the operation of the HEGO sensors to ensure correct switching ratio. This can be checked against the SHRTFT and LONGFT.
7. If the SHRTFT is moving to rich and the LONGFT keeps adapting, this could be caused by sticking injectors, a faulty fuel pressure regulator, incorrect valve clearances or timing etc. and not necessarily by a defective HEGO sensor.
8. It is worth noting old or very high mileage HEGOs can become "lazy" and the chemical reaction slows.

DESCRIPTION AND OPERATION (Continued)

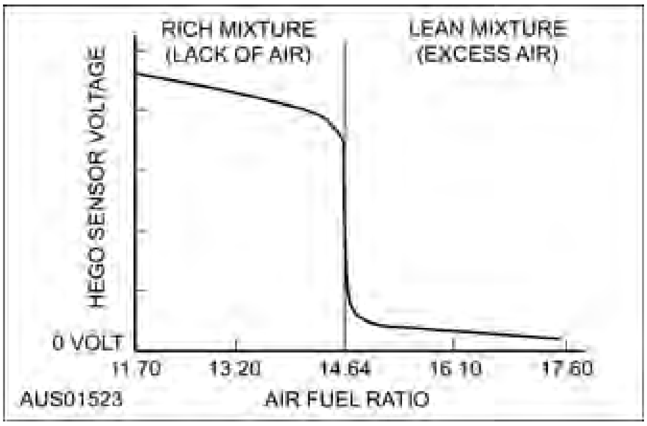
PID Specification

PID	Description	Value
O2S11	Bank 1 HEGO 1 switching voltage	0 - 1 volt
O2S21	Bank 2 HEGO 1 switching voltage (V8)	0 - 1 volt
O2S12	Bank 1 HEGO 2 switching voltage	0 - 1 volt
O2S22	Bank 2 HEGO 2 switching voltage (V8)	0 - 1 volt
O2S11FM	Bank 1 HEGO 1 switching ratio fault	YES - NO
O2S21FM	Bank 2 HEGO 1 switching ratio fault (V8)	YES - NO
O2S12FM	Bank 1 HEGO 2 switching ratio fault	YES - NO
O2S22FM	Bank 2 HEGO 2 switching ratio fault (V8)	YES - NO
O2S11HTR	Bank 1 HEGO 1 heater fault	YES - NO
O2S21HTR	Bank 2 HEGO 1 heater fault (V8)	YES - NO
O2S12HTR	Bank 1 HEGO 2 heater fault	YES - NO
O2S22HTR	Bank 2 HEGO 2 heater fault (V8)	YES - NO

Sensor Test

1. Disconnect the harness from the HEGO sensor connector.
2. Measure the Heater element resistance across the heater wire terminals using a suitable multimeter.
   - **HEGO Sensor Heater Resistance Specification** 4-8 Ω @20º C.
3. Reconnect the HEGO harness and start the engine. With the engine at or near its normal operating temperature and the throttle held open to maintain approximately 2,000 RPM, the HEGO voltage should be switching between High and Low at least once per second, and the rich/lean periods should be reasonably even. If this does not occur and the voltage remains constant, either High or Low, open and close the throttle rapidly and look for a change in voltage. If the voltage changes with throttle movement, it indicates that the sensor is operating correctly but the PCM is not able to control the air-fuel ratio.
4. Check the harness for open circuits and short circuits.

HEGO Sensor Signal Voltage Specification



Monitoring with Datalogger

When monitoring all the HEGO’s with the engine at its normal operating temperature it will be noted the upstream HEGO’s (11 and 21) will be switching rapidly between 0.1 volts and 0.9 volts.

If the engine runs in constant closed loop, theoretically there should be no excess oxygen in the exhaust therefore the downstream HEGO’s (HEGO’s 12 and 22) should be indicating a near constant 0.85 volts (±0.12 volts).

In practice however this does not happen due to the driver requirements of increasing and decreasing of engine load and speed. As the catalytic converter naturally runs "oxygen rich", i.e. with an excess of oxygen, it will need to reduce its oxygen content periodically. This causes a rise in the oxygen content of the exhaust gases post catalytic converter. This rise in oxygen content produces a corresponding fall in downstream HEGO voltage. This can be monitored with IDS datalogger.

The switching speed of the downstream HEGO is very much dependant up on vehicle usage.

It may be found that on a vehicle running for a prolonged period of closed loop operation, i.e. constant cruse on a highway, there may well appear to be long periods of inactivity from the downstream HEGO. However, on the urban cycle the downstream switching period may be considerably shorter due prolonged periods of stop/start driving.

Additionally reaction time to voltage variation on the downstream HEGO is generally much slower than the upstream HEGO. If the switching speed between the upstream and downstream HEGO’s appear very similar, with the engine at its normal operating temperature, this indicates failure of the catalytic converter. This should be detected by the EOBD system and the MIL illuminated.

DESCRIPTION AND OPERATION (Continued)

Knock Sensor

Sensor Description

Vehicles fitted with the I6 petrol engine have two linear Knock Sensors (KS) located on the left hand side of the cylinder block, adjacent to cylinder No. 5, and between cylinders No. 1 and No. 2, to detect pre-ignition detonation (engine knock) within the cylinders. The system detects engine knock by comparing engine noise at crank angles when cylinder pressure of the combustion fuel is highest with engine noise at quieter portions of the engine cycle. If the noise is louder, indicating knock, the Powertrain Control Module (PCM) retards ignition timing until knocking ceases.

The KS is used as a feed-back signal to control ignition timing. The KS is a piezo-electric accelerometer comprised of a piezo crystal mounted in a ceramic case. Whenever the KS detects knock the PCM retards the ignition timing until the knock ceases. The PCM then advances the ignition timing in small increments until knock is again detected. The cycle of retarding and advancing the ignition is continuous in Closed Loop Mode, and maintains the ignition at the optimum spark advance for the fuel quality.

The PCM uses the KS to automatically adjust the engine tune for low octane unleaded fuel or higher performance Premium unleaded fuel.

Connections

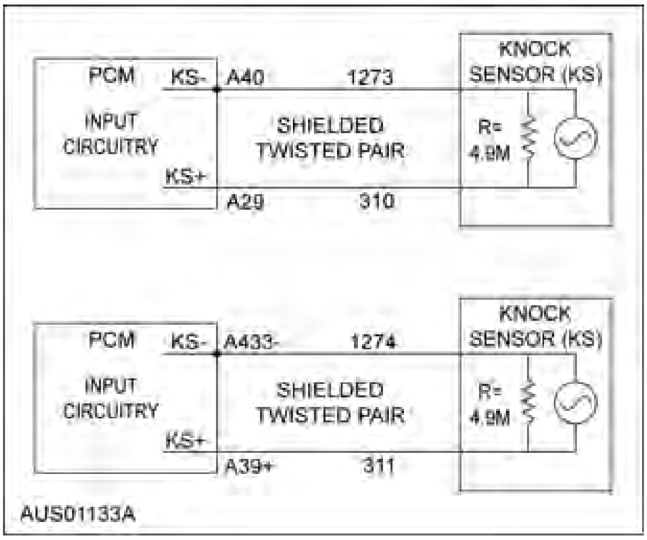
PCM Pin A29…………..Knock Sensor 1 Positive

PCM Pin A42…………..Knock Sensor 2 Positive

PCM Pin A40…………..Knock Sensor 2 Negative

PCM Pin A39…………..Knock Sensor 2 Negative

Circuit



Diagnosis

Diagnostic Trouble Codes (DTC) are retrieved through the diagnostic connector using the IDS tester.

The DTCs applicable to the KS sensor are shown in the following table.

DTC	Test Mode	Condition	MIL ON
P0325	KOER, Cont.	Sensor or circuit malfunction (I6 and Bank 1 V8)	NO
P0330	KOER, Cont,	Sensor or circuit malfunction (Bank 2 (V8only))	NO

Failure Mode

Should the KS fail, or produce the incorrect signal, the PCM will log a fault code, then revert to minimum ignition advance. The vehicle will otherwise operate as normal, possibly with marginally less performance, and some engine knock may occur under certain conditions.

Testing

Testing Knock Sensor

1. Disconnect the knock sensor wire connector.
2. Measure the resistance across the knock sensor connector terminals using a suitable multimeter. Replace the sensor if not within specification.
   - **KS Resistance Specification**
     4 - 6 mΩ
3. Check the harness for open circuits and short circuits.

Feed Forward Inputs

Transmission Range Sensor (TRS-A1, 4-speed DLPG only)

(For 6-Speed Automatic refer to section 307-01B)

The automatic Transmission Range Sensor A1 (TRS-A1), is incorporated in the inhibitor switch mounted on the side of the transmission case. The TRS-A1 sensor reports the current gear lever selector position to the Powertrain Control Module (PCM).

The TRS-A1 signal is used by the PCM for automatic transmission control operations and by the engine management system to predict an impending increase in engine load.

The TRS-A1 is a rheostat that, with the reference voltage, produces a voltage proportional to the gear lever selector position.

The TRS-A1 is a Feed Forward sensor that produces a signal change at the PCM before the actual event takes place. For example, when moving the gear lever

DESCRIPTION AND OPERATION (Continued)

selector from shifting from Park to reverse, the PCM receives the changed signal prior to the engine load actually increasing. This allows the PCM sufficient time to open the Idle Air Control Valve (IAC) valve and increase the fuel injector pulse width to compensate for the additional load.

The Key On Engine Running (KOER) self-test is disabled whenever the gear selector is in any gear. KOER self-test is only operational in either the Park or Neutral positions.

Electrical Description

The TRS-A1 is series of stepped resistors that will drop Vehicle Reference Voltage (VREF) in seven distinct steps from Park down to Manual.

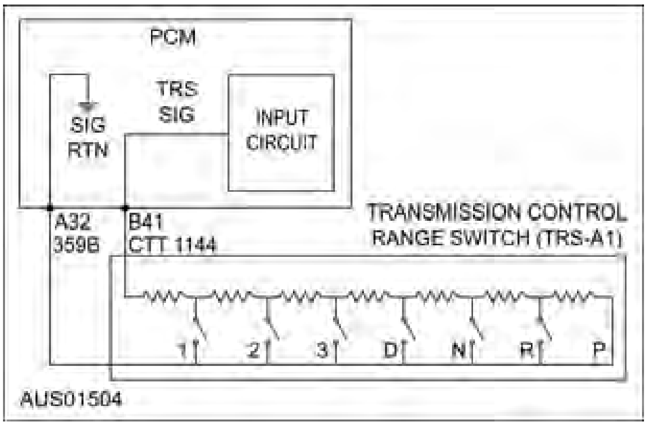
Connections

PCM Pin B41.................................. TRS-A1 Sensor

PCM Pin 45...VREF

PCM Pin B33.....................Signal Return (SIGRTN)

Circuit



DTCs applicable to the TRS-A1 sensor are shown in the following table.

DTC	Test Mode	Condition	MIL ON
P1705	KOEO	Not in Park or Neutral during self-test (Auto)	NO
P0707	KOEO, Cont.	Circuit low input	NO
P0708	KOEO, Cont.	Circuit high input	NO

Failure Mode

In the event the TRS-A1 fails, or the signal is outside the expected range, the PCM will log a fault code, then assume the gear lever selector is in Drive for the purpose of setting the idle speed.

Testing

The TRS-A1 sensor is tested continuously during vehicle operation (cont.) and whenever a Key On Engine Off (KOEO) test is performed.

1. Connect a IDS tester to the diagnostic connector.
2. Check the Parameter Identification (PID) value of the TR sensor. If the PID value is within specification, then check for other Diagnostic Trouble Codes (DTC) or component faults.

PID Specification

PID	Description	Units
TR / PRNDL	Park/Neutral Position (PRNDL) sensor	Position

Sensor Test

1. Disconnect the harness from the TRS-A1 sensor connector.
2. Measure the resistance across the TRS-A1 sensor connector terminals using a suitable multimeter. Replace the TRS-A1 sensor if not within specification.
3. Check the harness for open circuits and short circuits.

TRS-A1 Resistance Specification	
Shift Lever Position	**Resistance Nominal**
Park (P)	17,300 -20,300 Ω
Reverse (R)	10,900 -11,850 Ω
Neutral (N)	6,500 -7,600 Ω
Drive (D)	4,300 - 5,000 Ω
3rd Gear (3)	2,900 -3,400 Ω
2nd Gear (2)	1,850 -2,200 Ω
1st Gear (1)	1,050 -1,270 Ω

Transmission Range Sensor (TRS-A2, 4-speed DLPG only)

(For 6-Speed Automatic refer to section 307-01B)

The electronic sport shift manual, tip-up and tip-down position is sensed by 3 Hall-effect switches mounted on a printed circuit board in the T-bar console. The sport shift lever contains a magnet in its base that activates the appropriate Hall-effect switch in different shift position. The switches are resistively multiplexed together and are read as a voltage by the PCM on the TRS-A2 input.

Connections

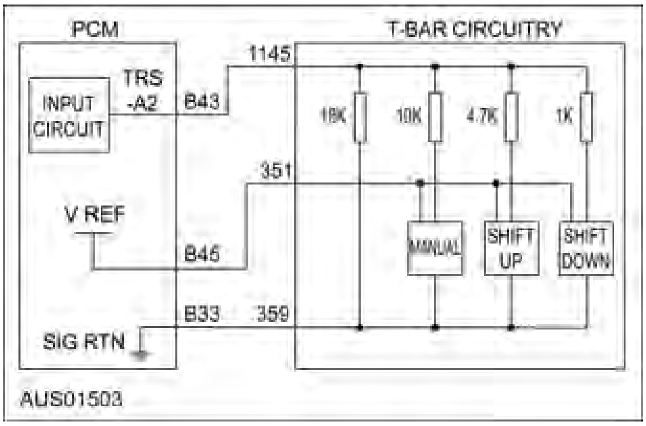
PCM Pin B43................................... TRS-A2 Sensor

PCM Pin B45................... ....VREF

PCM Pin B33......................Signal Return (SIGRTN)

DESCRIPTION AND OPERATION (Continued)

Circuit



Failure Mode

In the event the TRS-A2 fails, or the signal is outside the expected range, the PCM will log a fault code, and then assume the gear lever selector is in the automatic plane.

Testing

The TRS-A2 sensor is tested continuously during vehicle operation and whenever Key On Engine Off (KOEO) or Key On Engine Running (KOER) tests are performed.

Testing TRSA-2 Sensor

1. Connect a IDS tested to the diagnostic connector.
2. Check the Parameter Identification (PID) value of the sensor. If the PID value is within specification, then check for other Diagnostic Trouble Code (DTC) or component faults

PID Specification

PID	Description
GLP_D	ESS Lever in Auto Position
Manual	ESS Lever in “Manual” Position
TP+	ESS Lever in “Tip +” Position
TP-	ESS Lever in “Tip -” Position

Pin-out	Sport Shift	Voltage
1 and 2	All positions	4.8V - 5.2V
2 and 3	ESS Lever in Auto Position	3.7V - 4.2V
2 and 3	ESS Lever in “Manual” Position	2.6V - 3.3V
2 and 3	ESS Lever in “Tip +” Position	1.5V - 2.0V
2 and 3	ESS Lever in “Tip -” Position	0.5V - 1.3V

Pin-out numbers are marked on the back of the white ESS connector

Power Steering Pressure Switch

NOTE: This circuit must not remain by-passed or bridged, since steering load applied when cornering may stall the engine and cause loss of steering control.

The Power Steering Pressure Switch (PSP) which is a pressure sensitive switch that detects when pressure within the power steering system reaches a specified level. To prevent engine stall and maintain idle quality during parking manoeuvres the PCM boosts the engine idle speed by approximately 100 RPM.

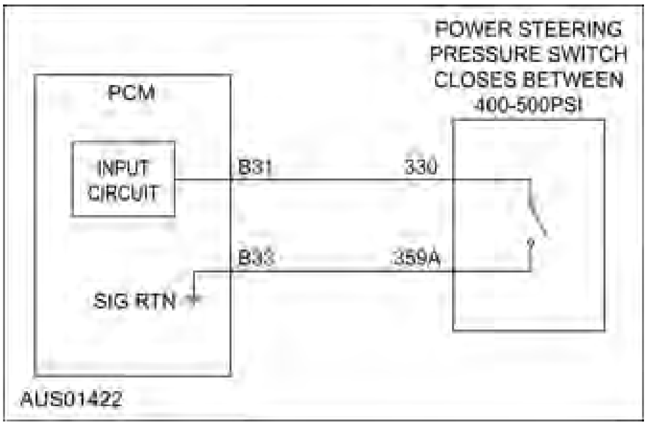
The PSP switch is a normally closed pressure switch. Under no load conditions the switch connects the PSP pin B31 to Signal Return (SIGRTN). When the power steering load is high, the PSP opens causing 5 volts to be detected at PCM Pin.

Connections

PCM Pin B31...PSP Signal

PCM Pin B33......................Signal Return (SIGRTN)

Circuit



Diagnosis

Diagnostic Trouble Codes (DTC) are retrieved through the diagnostic connector using the IDS tester.

DTCs applicable to the PSP switch are shown in the following table.

DTC	Test Mode	Condition	MIL ON
P1650	KOEO, KOER, Cont.	Failure	NO

NOTE:

- These DTCs may be recorded if a KOER test is not completed correctly

Testing

The PSP switch is tested whenever Key On Engine Off (KOEO) or Key On Engine Running (KOER) tests are performed. When a P1650 and a P1651 DTC is reported after a KOEO and KOER test, check the PSP for correct operation.

DESCRIPTION AND OPERATION (Continued)

Switch Test

1. Disconnect the PSP connector harness.
2. Using a multimeter with suitable connectors, measure the resistance if the PSP Switch.
3. Start and run the engine.
4. Actuate the PSP switch by turning the steering wheel and releasing. Ensure that the switch resistance conforms to specifications. If the switch is within specifications, check the wiring for open and short circuits.

Steering	PSP Resistance	PSP voltage
Steering turned	Greater than 10kΩ	4.5 - 5.2V
Steering released	Less than 10Ω	0.0 - 1.0V

Vehicle Speed

The PCM determines the vehicle speed from 3 sources depending on vehicle option. Vehicle speed source, tyre rotations per mile, axle ratio is programmed into the PCM using the IDS tester (see 'Module Configuration' in this section).

Option	VSS input	Signal Type
ABS/TCS/DSC		CAN signal
TCM	Hall Effect Device for OSS	Square wave, 0-5V
VRS	VRS Type Device for OSS	Sine wave frequency signal (0V to 5V)
Hall Effect	Hall Effect Device on OSS (DLPG only)	Square wave frequency signal (0V to 5V)

Output Shaft Speed (OSS) Sensor

The output shaft speed sensor is used in vehicles without the ABS or traction controlled option. It is a gear driven Hall effect sensor mounted in the transmission extension housing. The output signal frequency is proportional the output shaft speed. The PCM calculates vehicle speed using this signal and the programmed axle ratio and tyre rotation per mile.

The PCM uses vehicle speed signal to control:

- Automatic transmission gear shifts
- Speed control operation
- Vehicle speed limiting.
- Engine fan control

NOTE: Where needed, 19-tooth gear is used on the OSS for all axle and tyre size variants. Alternative OSS gears will result in vehicle speed calculation errors and must not be used.

Vehicle speed data is transmitted on the CAN line for the speedometer, odometer, trip computer and air-conditioner functions.

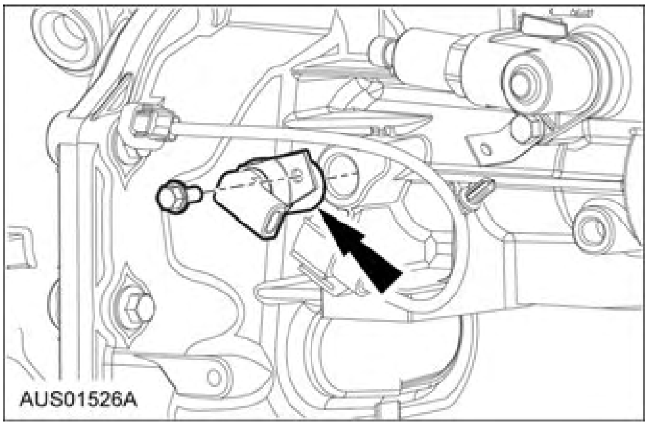
Connections

PCM Pin B7…………….Vehicle Speed Signal VSS

PCM Pin B45…. Vehicle Reference Voltage (VREF)

PCM Pin B33..……………. Signal Return (SIGRTN)

VSS Installation (where fitted)



Diagnosis

If the sensor is damaged or faulty, but still operating within the operating range, no fault code will be logged

DTCs applicable to this sensor are shown on the following table.

DTC	Test Mode	Condition	MIL ON
P0500	KOEO Cont	Missing/erratic speed signal from ABS, ASR or OSS	YES

Failure Mode

Failure of the vehicle speed sensor signal source will result in normal engine running but no speedometer readout, no speed control operation. Automatic transmission will default to 3rd gear when DRIVE is selected.

Testing

1. Check that the instrument cluster is working correctly by observing warning lamps, tachometer, fuel and temperature gauges. Rectify before continuing.
2. Where ABS and traction control is fitted, ensure that the warning lights are not illuminated. Rectify before continuing.
3. Connect a IDS tester to the diagnostic connector.
4. Check the check the Output Shaft Speed and the Vehicle Speed on the IDS screen. If these reads

DESCRIPTION AND OPERATION (Continued)

0, check the electrical connections between the PCM and the vehicle speed source.

5. If vehicle speed is inaccurate, reconfigure the PCM VID block as detailed in the Module Configuration section.

PID Specification

PID	Description
AXLE	Axle Ratio used by the PCM
TYRE SIZE	Tyre size used by the PCM - revs per mile

Vehicle Speed Output (VSOUT)

The PCM transmits a 12V square wave vehicle speed output signal on the VSOUT pin for the satellite navigation system. This pin may be used to drive other devices such as taximeters. The recommended load for this pin is 4.7 to 15 k Ω to ground.

Connections

PCM Pin B7…………………………………. VSOUT

DESCRIPTION AND OPERATION (Continued)

Electronic Throttle Control Inputs

Accelerator Pedal Position (APP) Sensor

A dual output Accelerator Pedal Position (APP) Sensor is used to provide pedal position signal to the PCM. It has an 6-way electrical connector providing 2 independent potentiometer signals.

NOTE: One of the features of the APP/PCM is in the event of the engine becoming choked with fuel (flooded), if the accelerator is held in the WOT position with the engine cranking, the injectors are disabled. This is to "dry" the cylinder quicker. However, prolonged cranking with WOT may trigger a DTC.

Connections

PCM Pin B17………….……………… PPS1 Signal

PCM Pin B18………….……………… PPS2 Signal

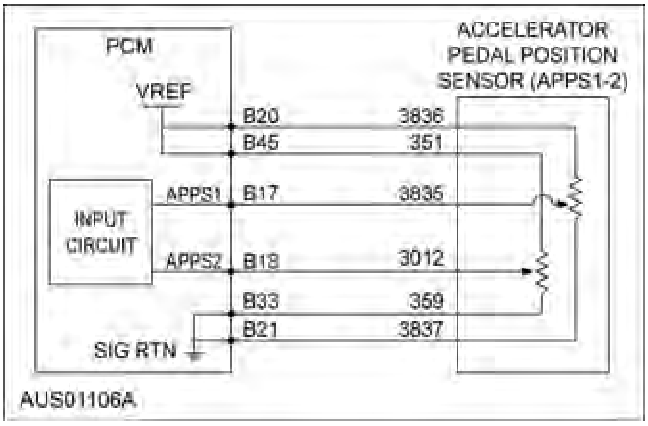
PCM Pin B20………….…………..……APPSVREF1

PCM Pin B28………….………………..…APPSVREF2

PCM Pin B21…………………………….APPSRTN1

PCM Pin B29…………………………….APPSRTN2

Circuit



Diagnosis

DTCs applicable to this sensor are shown on the following table.

DTC	Test Mode	Condition	MIL ON
P2122	KOEO Cont	APP1 fails - Out-of-range low	NO
P2123	KOEO Cont	APP1 fails - Out-of-range high	NO
P2124	KOEO Cont	APP1 fails - intermittent, Out-of-range	NO
P2127	KOEO Cont	APP2 fails - Out-of-range low	NO
P2128	KOEO Cont	APP2 fails - Out-of-range high	NO
P2129	KOEO Cont	APP2 fails - intermittent, Out-of-range	NO
P2138	KOEO Cont	APP1 and APP2 correlation error	NO

Failure Mode

The Failure Mode Effects Management (FMEM) strategy will, in most cases, ensure normal operation of the vehicle if one of the APP potentiometers fails. The ETC warning light will flash. If two or more sensors fail, the ETC will default to limp-home part throttle mode. The appropriate trouble code will be logged in memory for retrieval during Self-test mode.

Testing

The APP sensor is tested continuously during vehicle operation (cont.) and whenever Key On Engine Off (KOEO) or Key On Engine Running (KOER) test are performed.

Testing Pedal Position Sensor

1. Connect a IDS tester to the diagnostic connector and retrieve all recorded DTCs.
2. Attempt to identify any common theme to the recorded DTCs, i.e. low reference voltage to a range of sensors. If a common theme can be identified investigate these first
3. Using IDS datalogger, check the Parameter Identification (PID) value of the APP sensor tracks (APP1 and APP2.)
4. You may have to adjust the display operating scale for IDS. It should be remembered the APP sensor operates on a 5 volt reference so an indicated large operating voltage range may give a poor visual display on the IDS screen.
5. It is recommended, if required, to adjust the visual display to a 0 to 5 volt display and select the bar graph option.
6. With the engine off and the ignition switched on to position II. Slowly press the accelerator pedal and monitor the signal being generated from the TPS. You should see APP1 at approximately 4 volts (+/- 0.7volts) falling to approximately 1 volt and APP2 at approximately 1 volt (+/- 0.7 volts) rising to approximately 4 volts.

The effective differential operating parameters of this sensor are very wide and it is possible you may not achieve the 4 volt operating range and the sensor will still operate correctly. Again this is NOT a reason to reject the sensor.

Over an extended period of use and high mileage the APP sensor can develop specific areas of resistance on the sensing tracks. This can be indicated by the voltage appearing to "jump" when carrying out the test. If this appears to be the case, repeat the test a number of times to confirm the diagnosis. Take at

DESCRIPTION AND OPERATION (Continued)

least 5 to 10 seconds pressing the accelerator pedal from the OFF to the Wide Open Throttle (WOT) position and the same time to return to the OFF position. The slower and steadier the pedal is applied the more accurate the readings will be.

General notes when diagnosing APP concerns.

If **P2110** is displayed this indicates no output from the APP and the engine will be in Guard Mode. Check the APP connector is correctly fitted and the sensor 5 volt reference is being provided.

For **P2124, P2129 and P2134** intermittent faults, it is recommended you carryout a wiggle test whilst monitoring the readouts on IDS. It is recommended you do this with the accelerator pedal held in a range of positions.

PID Specification

PID	Description
APP_F	Accelerator Pedal Position Status, 0= All pedal inputs unreliable, 1= APP1 not reliable, 2= APP2 not reliable, 3= Disagreement between APP1 and APP2, 4= Normal Operation
APP_MODE	Pedal position mode: -1=pedal not depressed, 0=pedal partially depressed, 1=pedal fully depressed
APP1	Voltage of the Pedal Position Sensor number 1 (PPS1) at the PCM connector pin, relative to signal return (SIGRTN)
APP2	Voltage of the Pedal Position Sensor number 2 (PPS2) at the PCM connector pin, relative to signal return (SIGRTN)

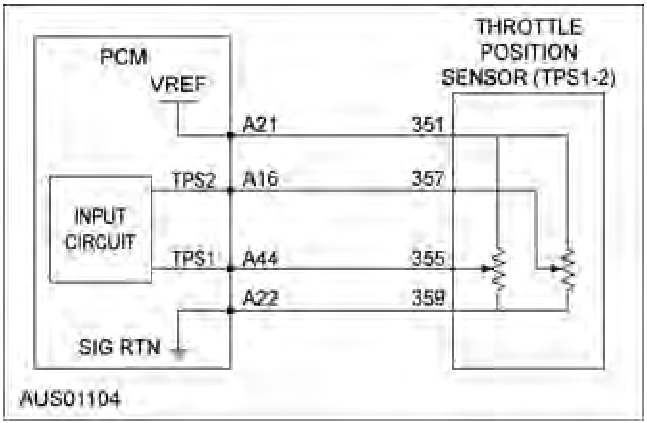
Throttle Position Sensor

A dual (opposing slope) output Throttle Position Sensor (TPS) is used to provide feedback to the Powertrain Control Module (PCM). It has a four way electrical connector providing 5v supply, a return and two output signals. The TPS is replaceable in service and simply bolts onto the ETB in one orientation only by way of a locating pin on the TPS.

Connections

PCM Pin A44................................ TP1 Signal
PCM Pin A16................................ TP2 Signal
PCM Pin A21............................... TPS_VREF
PCM Pin A22................................ TPS_RTN

Circuit



Login Tracking Code

DESCRIPTION AND OPERATION (Continued)

Diagnosis

DTCs applicable to this sensor are shown on the following table

DTC	Test Mode	Condition	MIL ON
P0122	KOEO Cont.	TP1-NS fails - Out-of-range low	NO
P0123	KOEO Cont.	TP1-NS fails - Out-of-range high	NO
P0124	KOEO Cont.	TP1-NS fails - intermittent, Out-of-range	NO
P0221	KOEO Cont.	TP2-PS fails - Out-of-range at commanded settings	NO
P0222	KOEO Cont.	TP2-PS fails - Out-of-range low	NO
P0223	KOEO Cont.	TP2-PS fails - Out-of-range high	NO
P0224	KOEO Cont.	TP2-PS fails - intermittent, Out-of-range	NO
P1124	KOEO, KOER	Throttle Out Of Self-test Range	NO
P1573	KOEO Cont.	Throttle position not available	NO
P2111	Cont.	Throttle Actuator Control System - Higher throttle opening than driver demand	NO
P2112	Cont.	Throttle Actuator Control System - Lower throttle opening than driver demand	NO
P2135	KOEO Cont.	Sensor disagreement, in range	NO
P0124 P0224	KOEO Cont.	Intermittent sensor disagreement, in range	NO
P0124 P0224	KOEO Cont.	Both TPS fail - Out-of-range intermittent	NO

Failure Mode

The Failure Mode Effects Management (FMEM) strategy will, in most cases, ensure normal operation of the vehicle if one of the TPS potentiometers fails. The ETC warning light will flash. If both sensors fail, the ETC will default to limp home part throttle mode. The appropriate trouble code will be logged in memory for retrieval during Self-test mode.

Testing

The TPS sensor is tested continuously during vehicle operation (cont.) and whenever Key On Engine Off (KOEO) or Key On Engine Running (KOER) test are performed.

Testing Throttle Position Sensor

1. Connect a IDS tester to the diagnostic connector and retrieve all recorded DTCs.
2. Attempt to identify any common theme to the recorded DTCs, i.e. low reference voltage to a range of sensors. If a common theme can be identified investigate these first.
3. Using IDS datalogger, check the Parameter Identification (PID) value of the throttle position sensor tracks (TP1 and TP2.)
4. You may have to adjust the display operating scale for IDS. It should be remembered the TP sensor operates on a 5 volt reference so an indicated large operating voltage range may give a poor visual display on the IDS screen.
5. It is recommended, if required, to adjust the visual display to a 0 to 5 volt display and select the bar graph option.
6. With the engine off and the ignition switched on to position II. Slowly press the accelerator pedal and monitor the signal being generated from the TPS. You should see TP1 at approximately 4 volts (+/- 0.7volts) falling to approximately 1 volt, and TP2 at approximately 1 volt (+/- 0.7 volts) rising to approximately 4 volts.

PID Specification

PID	Description
ETC_ACT	The actual throttle angle in degrees as determined from the throttle sensor inputs.
TP1	Voltage of the Electronic Throttle Control (ETC) Throttle Position Sensor number 1 (TPS1) at the PCM connector pin, relative to signal return (TPS_RTN)
TP2	Voltage of the Electronic Throttle Control (ETC) Throttle Position Sensor number 2 (TPS2) at the PCM connector pin, relative to signal return (TPS_RTN)

ETC FMEM Modes

The ETC FMEM strategy will select different FMEM modes based on the APPS and TPS states. When both TPS and APPS are is good condition the strategy will be in normal mode and in all other cases it will be one of the four possible FMEM Modes detailed below.

DESCRIPTION AND OPERATION (Continued)

Valid PPS Valid TP FMEM modes

Valid Pedal Position Sensor	Valid Throttle Position	Failure Management Effects Mode	Customer Symptoms
2 PPS OK	2 TP OK	Normal	Normal
2 PPS OK	1 TP OK	TL	Engine running normal with greatly reduced performance
2 PPS OK	0 TP OK	QDD/RPM GUARD MODE 1	Engine runs rough with greatly reduced performance
1 PPS OK	2 TP OK	QDD	Engine running normal with slow throttle response.
1 PSS OK	1 TP OK	QDD/TL	Engine running normal with slow throttle response and greatly reduced performance.
1 PPS OK	0 TP OK	QDD/RPM GUARD MODE 1	Engine runs rough with greatly reduced performance
0 PPS OK	2 TP OK	RPM GUARD MODE 2	Engine runs rough with greatly reduced performance
0 PPS OK	1 TP OK	RPM GUARD MODE 2	Engine runs rough with greatly reduced performance
0 PPS OK	0 TP OK	RPM GUARD MODE 2	Engine runs rough with greatly reduced performance

Normal Mode

No failures detected. Normal running.

Qualified Driver Demand Mode, QDD

When one accelerator pedal input is failed, or is in disagreement with the other, then Qualified Driver Demand Mode operation is selected, QDD.

Under this mode of operation,

1. When the brake pedal is depressed, the system will result in IMMEDIATE setting of the minimum relative accelerator pedal position to zero, (BOA).
2. When brake pedal is released, the Driver Demand is allowed to return at a limited slew rate. Increasing driver demand is limited to a slew rate (SLOWE). Any reduction in driver demand is immediately applied

Throttle Limit Mode, TL

When one throttle position sensor is failed or two throttle position sensors disagreement, Throttle Limit Mode operation is selected.

Under this mode of operation:

1. ETC clip max TP angle ? 20 deg.
2. Other behaviors are same as Normal.

Qualified Drive Demand with throttle Limit QDD/TL

When one accelerator pedal input is failed, or is in disagreement and one throttle position sensor is failed or in disagreement, then Qualified Driver Demand with Throttle Limit Mode operation is selected (QDD/TL).

Under this mode of operation:

1. When brake pedal is depressed, the system will result in IMMEDIATE setting of the minimum relative accelerator pedal position to zero (BOA).
2. When brake pedal is released, the Driver Demand is allowed to return at a limited slew rate. Increasing driver demand is limited to a slew rate (SLOWE). Any reduction in driver demand is immediately applied. (There is no slew on decrease.)
3. Limit max TP < 40 deg.

Qualified Drive Demand with RPM Guard 1 Mode (QDD/RPM GUARD 1)

When two throttle position sensors are failed or IPC mitigation request but at less one accelerator pedal input is valid, Qualified Driver Demand with Throttle Default and RPM Guard 1 Mode operation is selected.

Under this mode of operation,

1. The PCM disables the ETC motor controller and the throttle plate is in default position.
2. When brake pedal is depressed, the system will

DESCRIPTION AND OPERATION (Continued)

result in IMMEDIATE setting of the minimum relative accelerator pedal position to zero (BOA).

3. When brake is ON, the system guards engine RPM with a predetermined calibration. When fault count within the PCM software is greater than threshold, the control system cuts out all injectors.
4. When brake pedal is released, the moderation of the driver demand is removed and the driver demand is allowed to return at a limited slew rate (SLOWE). Any reduction is immediately applied.
5. When brake pedal is released, the system computes an RPM limit value based on accelerator pedal input and guards engine RPM with the RPM limit value. From this point onwards, a fault persist check is performed until the fault count is greater than the threshold at which point all injectors are cutting out.

Time Based RPM Guard with Default Throttle (RPM GUARD 2)

When two accelerator pedal sensors are failed, RPM Guard Mode 2 is selected.

Under this mode of operation,

1. The PCM disables the ETC motor controller, throttle plate is set to default.
2. In RPM Guard Mode II, brake ON following by brake OFF sequence is required to allow brake OFF action. Otherwise stay brake ON.
3. If the brake ON/OFF sequence has not been applied after the transition into RPB Guard II mode or the brake is currently ON, the system guards engine RPM with a calibration RPM_LIM_BRKON, then performs fault persist check. When fault count is greater than threshold, the system are cutting out all of injectors.
4. If the brake ON/OFF sequence has been applied after the transition into RPM Guard II mode and the brake pedal is release, the system performs time based RPM guard action.

The system is in RPM limiting mode by checking engine speed vs. time. If the engine speed is above the limit, shutdown of the engine by cutting out injectors will occur.

PID 118E

A new PID 118E has been included that will report which FMEM the vehicle has entered.

A vehicle enters one of the FMEM states when a certain system fault occurs. This condition can be caused by a sensor failure or a ’power greater than demand’ condition (i.e. the engine is producing more engine speed than expected or the throttle plate is in an unexpected position). The vehicle can log the following DTCs in the following order:

P2110 - Throttle Control Actuator System: forced limited RPM

The vehicle has entered guard mode (throttle reverts to default angle & RPM controlled by cylinder shutdown)

P1270 - Engine RPM or Vehicle Speed Limit Reached

Whilst in guard mode, the control system controls the RPM by cylinder cut-out, during this time the RPM speed limit code will be set.

P2105 - Throttle Control Actuator System: forced engine shutdown, I6 petrol engines

If the engine RPM cannot be controlled to set limits by shutting down of the cylinders, the engine is shutdown to protect the driver. Conditions that may cause this situation are vehicle momentum or a down hill force that holds the engine RPM high through the driveline.

In this situation if the RPM has exceeded the RPM guard mode limit, and the injectors have been confirmed to be commanded off, the PCM will allow the engine to stay in guard mode.

If guard mode is initiated by a sensor failure, the accompanying logged DTCs will indicate the reason for guard mode initiation. The fault can be diagnosed as specified by reading PID 118E. If the above DTCs are logged without any accompanying DTCs, this may indicate there has been a ’power greater than demand’ incidence. Follow the steps specified below to identify the potential issue.

1. **FOR LOGGED CODES P2110 & P1270 only (no additional codes):**
    1. Inspect the PCV hose connection to the engine. If loose, reconnect.
    2. Inspect TPS wiring at connectors to ensure contact pins are secure and correctly positioned.
    3. Check engine for air leaks using PIDs IACTRIM & IACKAM3 (ensure engine at operating temperature).

       NOTE: Add the PID values together; a negative number may indicate an air leak which can cause the vehicle to enter Guard Mode.
    4. If the combined PID values add to give a positive number, there is no air leak present
2. **FOR LOGGED CODES P2105 and/or P2110 and/or P1270 and P2135:**
    1. Check wiring and connections between the throttle position sensor and PCM. Conduct a continuity check between TPS and PCM and check each wire for any short to ground.
    2. Check C125 connector for good connection / pin contact.
    3. Check condition and operation of ignition coils.

DESCRIPTION AND OPERATION (Continued)

NOTE: Beware, vehicle modifications can cause a vehicle to enter guard mode. Ensure no modifications are present on the vehicle.

3. **FOR LOGGED CODES P2105 and/or P2110 and/or P1270 and any Pedal Position Sensor 'P' codes (P2122, P2123, P2124 P2127, P2128, P2129, and P2138):**
    1. Check the security of the wiring connectors between the Pedal Position Sensor (PPS) and PCM. Conduct a continuity check between PPS and PCM and check each wire for any resistance to ground. If wiring and connections are OK, replace the PPS with new.
4. **FOR LOGGED CODE P2105 only (no other additional codes):**
    1. Obtain "Error To Quizzer" and "Error From Quizzer" bit-mapped PID.
    2. Contact Ford Technical Hotline on 1300 733 600

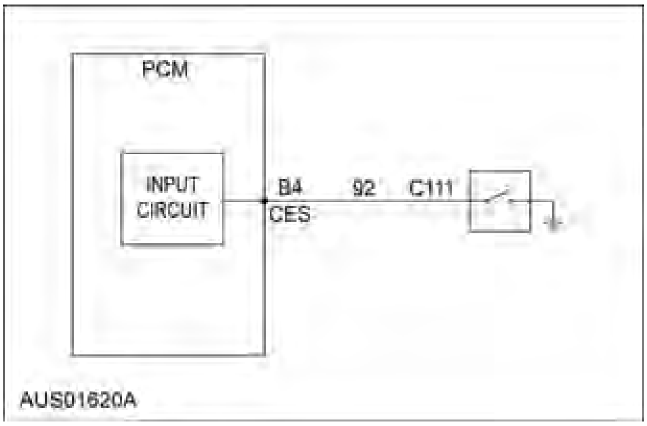
Clutch Engagement Switch (Manual Transmission)

The PCM monitors clutch engagement using the Clutch Engagement Switch (CES). The CES is mounted on the pedal assembly and is actuated by the clutch pedal in the released position. When the clutch is applied, the PCM cancels speed control operation.

Connections

PCM Pin B4……………………………………. CES

Circuit



Failure Mode

Failure of clutch switch in the open circuit position will inhibit speed control operation. A shorted CES will result in engine flaring to a high engine rpm when the clutch pedal is depressed with the speed control engaged.

Testing

Testing Clutch Engagement Switch

1. Connect a IDS tester to the diagnostic connector.
2. Check the Parameter Identification (PID) value of the CES while depressing and releasing the clutch pedal.

PID	Description
CPP	Clutch Pedal Depressed

Brake Switches

The PCM monitors the brake pedal position using two switches - the Brake On-Off (BOO) switch and the Brake Pressure Applied switch (BPA). The BOO and BPA are enclosed in the same housing. Both switches are mounted on the pedal assembly and are directly actuated by the brake pedal. Before cruise can be engaged, the PCM must have registered that BOO has been pressed. If the cruise engagement jewel is flashing, the driver will need to push the brakes in order for them to be able to engage cruise control. Pressing the brake pedal anytime after the key is switched to the ON position will enable cruise control operation. When the brakes are applied, the PCM cancels speed control operation.

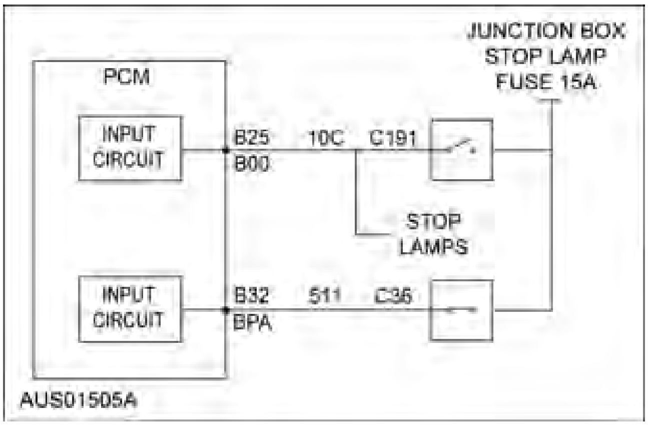
BOO is a normally-open switch that switches 12V to the PCM's BOO input (pin B25) when the brakes are applied and activates the brake lights. BPA is a normally-closed switch that supplies a 12V signal to the PCM (pin B32). The BOO is designed to switch to 12V before BPA breaks the circuit to 12V. If the BPA 12V circuit breaks without the BOO switching to 12V, the speed control cannot be engaged or re-engaged until the next key-on.

Connections

PCM Pin B25……………………………………. BOO

PCM Pin B32……………………………………. BPA

Circuit



Login Tracking Code

DESCRIPTION AND OPERATION (Continued)

Diagnosis

Ensure that the brake lamps operate correctly before continuing.

DTCs applicable to this sensor are shown on the following table.

DTC	Test Mode	Condition	MIL ON
P0504	CONT	Brake pedal switch compare	NO
P0572	CONT	Brake pedal switch stuck high	NO
P0573	CONT	Brake pedal switch stuck low	NO
P1703	CONT	Brake pedal out of self test range	NO

Failure Mode

Failure of either brake switch will inhibit speed control operation.

Testing

The BOO and BPA switches are tested continuously during vehicle operation (cont.) and whenever Key On Engine Off (KOEO) or Key On Engine Running (KOER) test are performed.

Testing Brake Pedal Switches

1. Connect a IDS tester to the diagnostic connector.
2. Select BOO and BPA through the PCM datalogger option.
3. Slowly press the brake pedal and monitor the switching sequence of the BOO and BPA. The correct sequence is as follows;

Switch	Brake off	Light brake pressure	Moderate to heavy braking
BOO	OFF	ON	ON
BPA	OFF	OFF	ON

NOTE: Any variation on this sequence will cause the Speed Control System to become inoperative.

PID Specification

PID	Description
BOO	Brake ON / OFF
BPA	Brake Pressure Applied Switch Status (ON / OFF)

Reverse Gear Switch

The PCM monitors the reverse gear switch (RGS) on manual transmission vehicles to check for reverse gear selection. When 12V is sensed on RGS, engine torque is limited to a suitable value for reverse gear operation. The switch status is transmitted on the CAN for the optional reverse parking sensor.

Connections

PCM Pin B30…………………………………. RGS

Diagnosis

Ensure that the reverse lamps operate correctly. Rectify before continuing.

DTCs applicable to this sensor are shown on the following table.

DTC	Test Mode	Condition	MIL ON
P0812	KOEO Cont	Reverse switch or circuit faulty	NO

Failure Mode

The ETC will implement reverse gear torque limiting under the following conditions:

- RGS switch short circuit fault;
- RGS wire open circuit;
- Both reverse lamps are faulty.

Testing

Testing Reverse Gear Switch

1. Ensure that the reverse lamps operate correctly. Rectify before continuing.
2. Connect a IDS tester to the diagnostic connector.
3. Check the Parameter Identification (PID) value of TRANS_GEAR while selecting reverse gear.

PID Specification

PID	Description
TRANS_GEAR	Transmission Gear state

DESCRIPTION AND OPERATION (Continued)

Speed Control Range Switch Assembly

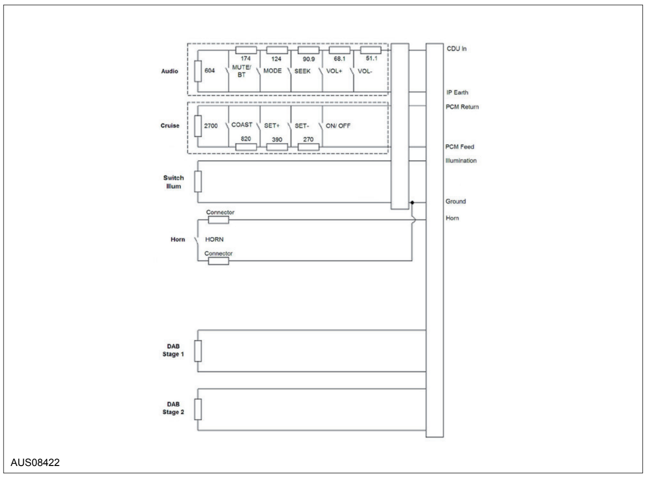
The Speed Control Range Switch Assembly (SCRSA) is located right side of the steering wheel airbag. The switches are resistively multiplexed and connect to the steering wheel clock spring wiring to the PCM. Each switch connects a specific resistor value to ground and produces a distinctive voltage level signal at the SCRSA input. The PCM uses the SCRSA signal to determine driver command of the speed control system.

Connections

PCM Pin B16 ....SCRSA

PCM Pin B33 ....SIGRTN

Circuit



Failure Mode

In the event the SCRSA fails, or the signal is outside the expected range, the PCM will log a fault code. Some or all of the speed control functions will not be available.

Testing

The SCRSA is tested continuously during vehicle operation (CONT) and whenever a Key On Engine Off (KOEO) test is performed.

1. Connect a IDS tester to the diagnostic connector and carryout a full self test of all vehicle systems. Retrieve all DTC's.
2. Attempt to identify any common theme and investigate these before commencing further speed control diagnostics.
3. It should be remembered the Speed Control System is one of the first systems to be deactivated if there is a concern within the engine management system as it is classed as a non-essential system.
4. Monitor the speed control switch status on the IDS screen (Refer to the PID list below). It is also recommended to select the BOO (Brake ON/OFF) and BPA (Brake Pressure Applied) PID's.
5. Select BOO and BPA through PCM datalogger option.
6. Slowly press the brake pedal and monitor the switching sequence of the BOO and BPA. The correct sequence is as follows;

Switch	Brake off	Light brake pressure	Moderate to heavy braking
BOO	OFF	ON	ON
BPA	OFF	OFF	ON

Note: Any variation on this sequence will cause the Speed Control System to become inoperative.

7. Operate the speed control switches in sequence.
8. Check the Parameter Identification (PID) value for each of the status as the button is pressed. If the PID value is within specification, then check for other Diagnostic Trouble Code (DTC) or component faults.

PID Specification

PID	Description	Status and Range
SCCS	Speed Control Switch Status	Voltage display and operation list
SCCS_ NULL	Speed Control Range Switch in "NULL" state	ON / OFF
SCCS_ CANCEL	Speed Control Range Switch "RESUME / CANCEL"	ON / OFF
SC_ON	Speed Control Range Switch "ON / OFF"	ON / OFF
SC_OFF	Speed Control Range Switch "ON / OFF"	ON / OFF
SC_ACCEL	Speed Control Range Switch "SET +"	ON / OFF
SC_COAST	Speed Control Range Switch "SET -"	ON / OFF
SC_OPEN	Speed Control Switch Status	NORMAL / OPEN / SHORT TO GROUND / B+
SC_FAULT	Speed Control Error Warning Indicator	FAULT YES / NO (To IC and IDS)

9. The SC_FAULT PID will display a worded warning if there is an error in the system and it will give an indication of the type of fault.
10. When selecting the SCCS PID you have an option of VOLTS and MODE, it is recommended you select both.

DESCRIPTION AND OPERATION (Continued)

11. Commence the test with a KOEO situation and the Speed Control System switched off.
12. When displayed on the IDS datalogger screen with no switches selected the SCCS voltage should display between 4.5 - 4.8 volts and the MODE will display NONE.
13. Press and hold the cruise select switch and the voltage should now display between 0.0 and 0.5 volts. The SCCS_NULL should display ON. When the button is released it should return to near its original display voltage.
14. CRUISE should now be displayed in the instrument cluster.
15. Press and hold the SET+ button and the SCCS should display between 3.2 and 3.8 volts.
16. Press and hold the SET- button and the SCCS should display between 2.1 and 3.0 volts.
17. Press and hold the RES / COAST button and the SCCS should display between 4.0 and 4.3 volts.
18. If all these parameters are within specification and the speed control continues to function incorrectly, repeat the above test with the engine running while turning the steering wheel. This will indicate if there is a potential concern with the wiring or connections between the Speed Control switch and the PCM.
19. If this does not revel a concern, check the resistance at the switch with due reference to the table below.

Switch Specification

Switch	Voltage Range (V)	Resistance (± 5% Ω)
Default (none)	4.5 - 4.8	4,330
RES COAST	4.0 - 4.3	1470 - 1490
SET +	3.2 - 3.8	650 - 670
SET -	2.1 - 3.0	260 - 280
CRUISE	0 - 0.4	0

A number of concerns with other systems can cause the Speed Control to deactivate, particular attention should be given to VSS signals and ABS concerns. Ensure the correct VID data has been programmed.

20. If the switch is beyond the resistance tolerance, or is short/open circuit, replace the switch. Refer to the section at the end of this chapter.

AIR CONDITIONER INPUTS

For additional information, refer to section 412-03.

Air Conditioner Demand

The Powertrain Control Module (PCM) controls operation of the air conditioning compressor clutch. When an Air Conditioner Demand (ACD) signal is received by the PCM on the CAN, it energises the Air Conditioner Relay (ACR) to engage the air conditioning compressor.

Note: The A/C relay signal may be de-energised to disable the A/C compressor if conditions are unsuitable for A/C operation. (For example, engine overheat, faulty A/C components, etc. Refer to A/C Disable Chart in Air Conditioning section 412-03)

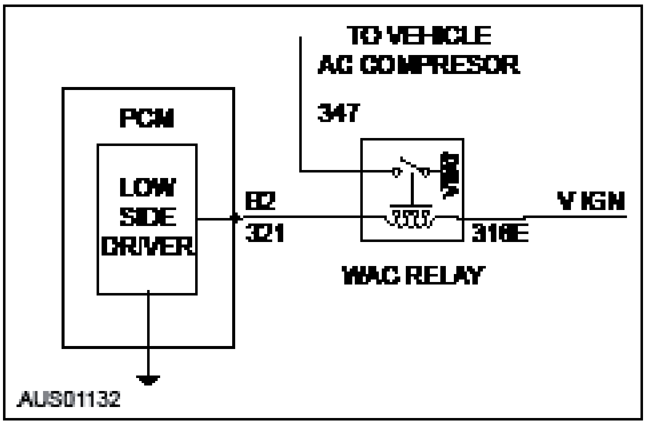
Air Conditioner Relay

The Powertrain Control Module (PCM) energises the Air Conditioning Relay (ACR) whenever air conditioning is required. The air conditioning relay then energises the air conditioning compressor clutch.

Connections

PCM Pin B2 ....ACR Signal

Circuit



Diagnosis

Diagnostic Trouble Codes (DTC) are retrieved through the diagnostic connector using the IDS tester. Fault Finding Tables for DTC's are in 'Diagnosis' in this section, or for specific A/C system diagnosis refer to section 412-03.

DTC's applicable to the ACR relay are shown in the following table.

DTC	Test Mode	Condition	MIL ON
P1465	Cont.	Relay faulty or circuit malfunction	NO

DESCRIPTION AND OPERATION (Continued)

Speed Control Range Switch Assembly

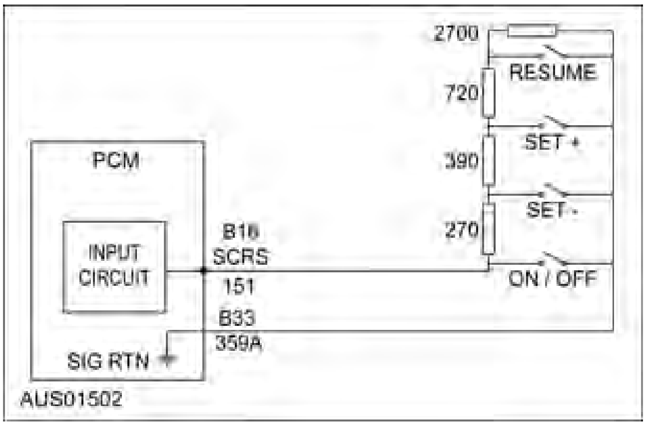
The Speed Control Range Switch Assembly (SCRSA) is located right side of the steering wheel airbag. The switches are resistively multiplexed and connect to the steering wheel clock spring wiring to the PCM. Each switch connects a specific resistor value to ground and produces a distinctive voltage level signal at the SCRSA input. The PCM uses the SCRSA signal to determine driver command of the speed control system.

Connections

PCM Pin B16......................................SCRSA

PCM Pin B33......................................SIGRTN

Circuit



Failure Mode

In the event the SCRSA fails, or the signal is outside the expected range, the PCM will log a fault code. Some or all of the speed control functions will not be available.

Testing

The SCRSA is tested continuously during vehicle operation (CONT) and whenever a Key On Engine Off (KOEO) test is performed.

1. Connect a IDS tester to the diagnostic connector and carryout a full self test of all vehicle systems. Retrieve all DTC's
2. Attempt to identify any common theme and investigate these before commencing further speed control diagnostics.
3. It should be remembered the Speed Control System is one of the first systems to be deactivated if there is a concern within the engine management system as it is classed as a non-essential system.
4. Monitor the speed control switch status on the IDS screen (Refer to the PID list below). It is also recommended to select the BOO (Brake ON/OFF) and BPA (Brake Pressure Applied) PID's
5. Select BOO and BPA through PCM datalogger option.
6. Slowly press the brake pedal and monitor the switching sequence of the BOO and BPA. The correct sequence is as follows;

Switch	Brake off	Light brake pressure	Moderate to heavy braking
BOO	OFF	ON	ON
BPA	OFF	OFF	ON

NOTE: Any variation on this sequence will cause the Speed Control System to become inoperative.

7. Operate the speed control switches in sequence.
8. Check the Parameter Identification (PID) value for each of the status as the button is pressed. If the PID value is within specification, then check for other Diagnostic Trouble Code (DTC) or component faults.

PID Specification

PID	Description	Status and Range
SCCS	Speed Control Switch Status	Voltage display and operation list
SCCS_NULL	Speed Control Range Switch in "NULL" state	ON / OFF
SCCS_CANCEL	Speed Control Range Switch "RESUME / CANCEL"	ON / OFF
SC_ON	Speed Control Range Switch "ON / OFF"	ON / OFF
SC_OFF	Speed Control Range Switch "ON / OFF"	ON / OFF
SC_ACCEL	Speed Control Range Switch "SET +"	ON / OFF
SC_COAST	Speed Control Range Switch "SET -"	ON / OFF
SC_OPEN	Speed Control Switch Status	NORMAL / OPEN / SHORT TO GROUND / B+
SC_FAULT	Speed Control Error Warning Indicator	FAULT YES / NO (To IC and IDS)

DESCRIPTION AND OPERATION (Continued)

Testing

The AC relay is tested continuously during vehicle operation (cont.).

Relay Test

1. Remove the AC relay from its socket in the relay/fuse box adjacent to the battery.
2. Check the condition of the relay
3. Check the harness for open circuits and short circuits.

   NOTE: Relays are generally of 2 types: DIN and ISO. A DIN relay can be identified by the numbers associated with each pin namely, 30, 85, 86, 87 and 87a. ISO relays are numbered 1, 2, 3, 4 and 5.

WARNING: ISO and DIN relays must never be interchanged. This is because the pin locations can be in different positions. If the relays are interchanged there is a high risk of damage to the vehicle circuitry or possibly even causing a FIRE.

NOTE: Many modern relays incorporate circuit boards and are multifunctional. These are not easily tested without dedicated test equipment but they are easily damaged by inappropriate test procedures.

Relays must be replaced on a "like-for-like" basis.

The following is a simple test procedure for checking the operation of simple relays.

1. With the multi-meter set to Ohms (Ω), measure the resistance between pins 30 and 87 on a DIN relay or pins 3 and 5 on an ISO relay. This should read open circuit. Any reading at this point indicates the relay contacts have become fused together or are contaminated and the relay should be replaced.
2. Then take a reading across pins 1 and 2 of the ISO relay or 85 and 86 of the DIN relay. You should obtain a reading of approximately 85Ω (+/- 20Ω) on the ISO relay and 75Ω (+/- 20Ω) on the DIN relay. This tests the integrity of the windings within the relay.
3. Using a suitable power source (a square 9V battery can be used for this), power up the windings of the relay. At this point you may hear the relay click. Hearing the relay click, does not necessarily indicate it is satisfactory.
4. Using the multi-meter with the relay powered, measure the resistance between pins 30 and 87 of the DIN relay or pins 3 and 5 of the ISO relay. Both must read less than 1Ω. If it is higher than this, it indicates contamination of the relay contacts.

   NOTE: A number of modern relays incorporate a diode as a safety device to protect circuitry in the event of a relay being incorrectly fitted. These will be fitted between pins 85 and 86 of the DIN relay or pins 1 and 2 of the ISO relay. If when trying to obtain a reading for the winding resistance or the relay does not appear to click, try reversing the polarity with the battery before condemning the relay.

Air Conditioner Pressure Transducer

The Air Conditioner Pressure Transducer (ACPT) sensor is located on the compressor discharge pipe. The Powertrain Control Module (PCM) uses this signal to monitor the air conditioner discharge pressure and actuate the air conditioning and cooling strategies accordingly.

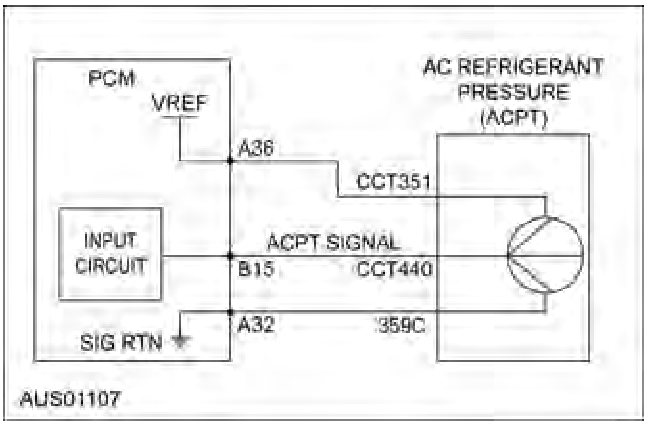
Connections

PCM Pin B15...................................... ACPT Signal

PCM Pin A36.....Vehicle Reference Voltage (VREF)

PCM Pin A32......................Signal Return (SIGRTN)

Circuit



Diagnosis

Diagnostic Trouble Codes (DTC) are retrieved through the diagnostic connector using the IDS tester. Fault Finding Tables for DTCs are in the 'Diagnosis' section.

DTCs applicable to the ACPT sensor are shown in the following table.

DESCRIPTION AND OPERATION (Continued)

DTC	Test Mode	Condition	MIL ON
P0532	KOEO, Cont.	ACPT sensor circuit low input. Most likely causes are no A/C refrigerant charge at all, or faulty pressure transducer (sensor out of calibration, open-circuit)	NO
P0533	KOEO, Cont.	ACPT sensor circuit high input Most likely cause is faulty pressure transducer (sensor out of calibration, short-circuit)	NO

A/C Pressure Transducer tests

The ACPT sensor is tested continuously during vehicle operation (continuous test) and whenever a Key On Engine Running (KOER) or Key on Engine Off (KOEO) test is performed. However, if a KOER test is performed, the PID value can be read and compared against acceptable operating pressures.

1. Conduct a KOER test with A/C check as described later in this section (page 106)
2. Check the Parameter Identification (PID) value of the ACPT. If the PID value is within normal operating pressures, then check for other Diagnostic Trouble Codes (DTC) or component faults (refer to section 412-03).

   NOTE: Normal A/C discharge pressures (as measured by the pressure transducer) **with the A/C compressor operating** are 200 - 3170 kPa.
3. If the A/C system has no refrigerant charge, the pressure transducer could read down to 0 kPa, but the A/C compressor will be disabled below 200kPa (i.e. A/C compressor not operating).
4. If the A/C system has a fault (eg. blockage), the pressure transducer could read higher than 3170 kPa instantaneously, but the compressor will be disabled above this pressure (i.e. A/C compressor not operating) and the pressure relief valve will open from 3170 - 4100kPa to vent refrigerant from the A/C system.
5. Check the A/C pressure transducer harness for open circuits and short circuits.

PID Specification

PID	Description
ACP	A/C pressure

DESCRIPTION AND OPERATION (Continued)

Transmission Inputs (4-speed DLPG only)

The following section is for the 4 speed automatic transmission only.

The 6 speed automatic transmission, (ZF 6HP26), is a self contained unit which is controlled by its own integral module referred to as the Transmission Control Module (TCM), located within the transmission itself.

The following descriptions and test procedures are only applicable to the 4 speed transmission and must never be attempted on the ZF 6HP26, as this will result in damage to the TCM

For ZF 6HP26, refer to section 307-01B and the Quick Reference DTC chart in this section.

Transmission Fluid Temperature Sensor

The Transmission Fluid Temperature (TFT) sensor is located in a harness within the Automatic Transmission oil pan. The TFT measures the temperature of the oil in the automatic transmission sump. The Powertrain Control Module (PCM) uses the TFT signal to vary shift pressures in response to the transmission oil temperature for consistent and smooth shifts. It is also used to indicate transmission overheat conditions.

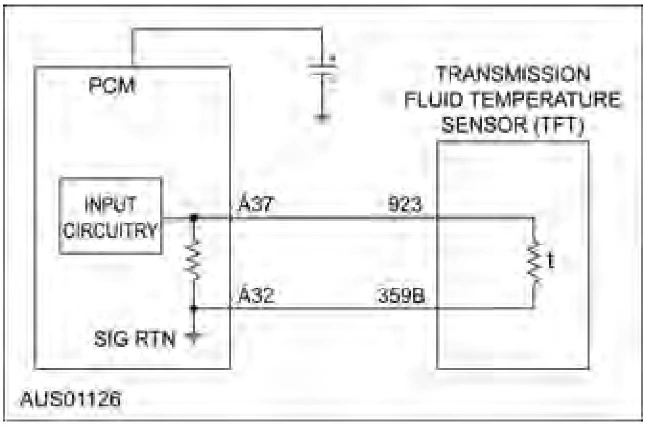
The TFT sensor uses a thermistor that is sensitive to temperature variations. The resistance of the thermistor decreases as the temperature of the transmission oil increases.

Connections

PCM Pin A37... TFT Signal

PCM Pin A32......................Signal Return (SIGRTN)

Circuit



Diagnosis

DTCs applicable to the TFT sensor are shown in the following table.

DTC	Test Mode	Condition	MIL ON
P0712	KOEO, Cont.	TFT circuit low input	NO
P0713	KOEO, Cont.	TFT circuit high input	NO

Testing

The TFT sensor is tested continuously during vehicle operation (cont.) and whenever a Key On Engine Off (KOEO) test is performed.

Testing Engine Oil Temperature Sensor

1. Disconnect the Automatic transmission harness connector.
2. Locate the TFT sensor pins on the harness.
3. Using a suitable measure the resistance of the TFT sensor. Replace the sensor if not within specification.

TFT Specification		
Temperature (±3º C.)	Resistance Nominal	Voltage Nominal
10º	3800 Ω	4.0
20º	2500 Ω	3.5
30º	1700 Ω	3.1
40º	1200 Ω	2.7
60º	600 Ω	1.9
80º	320 Ω	1.2
100º	190 Ω	0.8
120º	110 Ω	0.5

4. Check the harness for open circuits and short circuits.

DESCRIPTION AND OPERATION (Continued)

Output Actuators

Fuel Pump

The Fuel Pump (FP) is powered by the fuel pump relay situated in the power distribution box on the right hand side of the engine compartment. The PCM and the PCM Power Relay control operation of the Fuel Pump.

The fuel pump is a two-stage turbine pump. The first stage is a low-pressure impeller pump. As it rotates, the impeller draws fuel from the tank. Fuel is then forced into the second high pressure stage. The second stage is a gear type pump. As the inner gear rotates, it carries fuel around with the rotor, pressurising it and directing fuel into the outlet. This two stage system eliminates vapour bubbles and ensures the fuel is supplied at the correct pressure. The large number of low volume chambers within the gear pump produces smooth pressure characteristics with minimal pressure pulsation resulting in quiet operation.

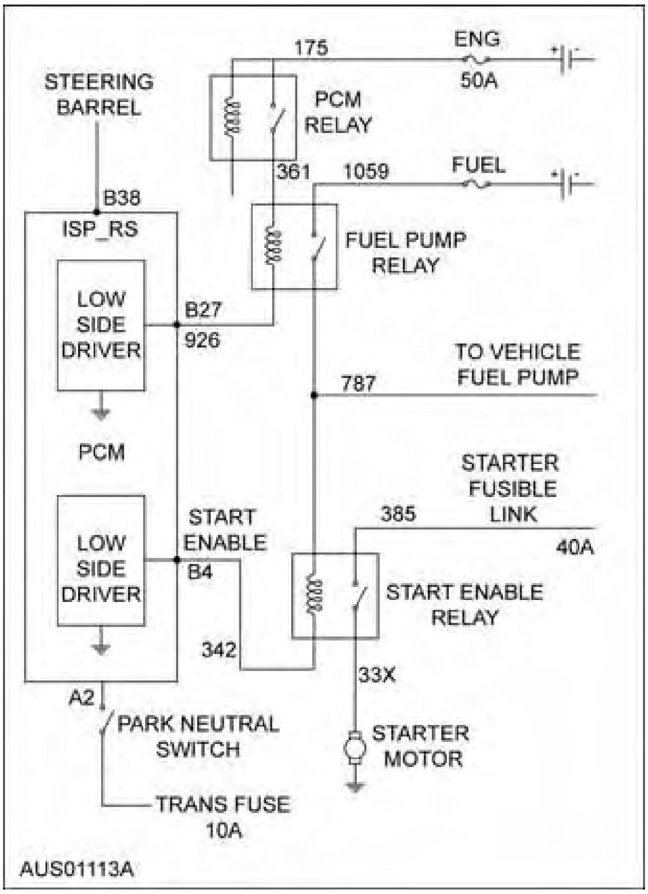
The fuel pump relay winding is supplied with power when the ignition is switched to the ON position. The FP relay switches battery voltage to the Fuel Pump when the coil is energised by the PCM Power Relay and grounded by the PCM. When the ignition is first switched ON, the PCM will operate the fuel pump for one second. If no CKP signal is received at the PCM, the PCM will open the ground circuit, switching OFF the fuel pump relay. This ensures that if the engine stalls, for any reason, fuel pump operation will cease immediately. The fuel pump is also used as a high side driver control for the starter motor relay.

Connections

PCM Pin B27.................... Fuel Pump Relay (FP)

Circuit

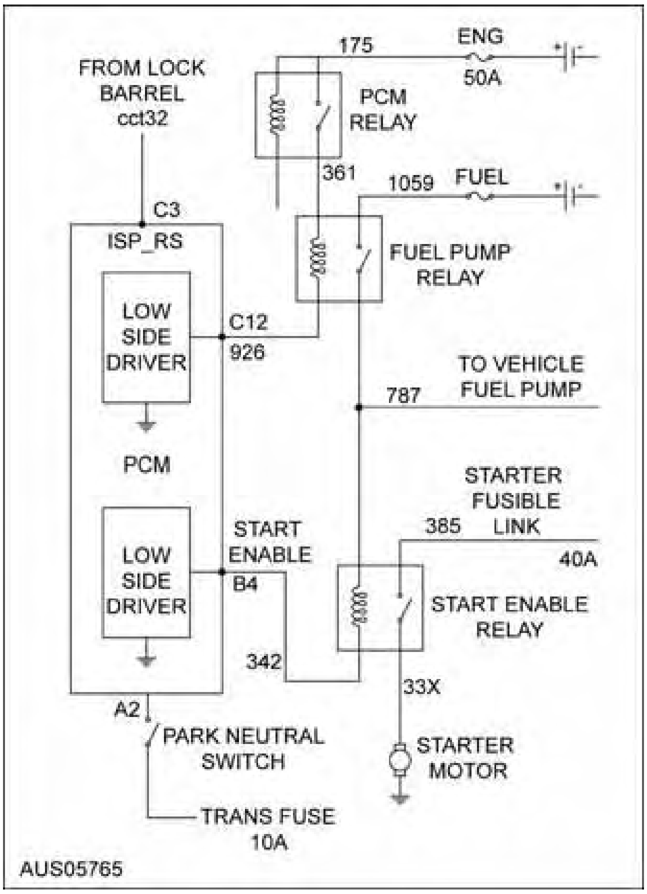
Petrol Engine



Login Tracking Code

DESCRIPTION AND OPERATION (Continued)

DLPG Engine



Diagnosis

Diagnostic Trouble Codes (DTC) are retrieved through the diagnostic connector using the IDS tester. Fault Finding Tables for DTCs are in the Quick Reference DTC list.

DTCs applicable to the fuel pump relay are shown in the following table.

DTC	Test Mode	Condition	MIL ON
P0230	KOEO, Cont.	Relay primary circuit malfunction	NO

Failure Mode

If the Fuel Pump, Fuel Pump Relay or PCM Power Relay fail, the fuel pump will not operate.

Testing

The fuel pump relay is tested continuously during vehicle operation (cont.) and whenever a Key On Engine Off (KOEO) test is performed.

1. Turn the ignition off
2. Check the 20A fuse pump relay fuse (Fuse 20, battery fuse box)
3. Remove the relay from its socket in the relay/fuse box adjacent to the battery.
4. Check the operation and condition of the relay.

   NOTE: Relays are generally of 2 types: DIN and ISO. A DIN relay can be identified by the numbers associated with each pin namely, 30, 85, 86, 87 and 87a. ISO relays are numbered 1, 2, 3, 4 and 5.

WARNING: ISO and DIN relays must never be interchanged. This is because the pin locations can be in different positions. If the relays are interchanged there is a high risk of damage to the vehicle circuitry or possibly even causing a FIRE.

NOTE: Many modern relays incorporate circuit boards and are multifunctional. These are not easily tested without dedicated test equipment but they are easily damaged by inappropriate test procedures.

Relays must be replaced on a "like-for-like" basis.

The following is a simple test procedure for checking the operation of simple relays.

i. With the multi-meter set to Ohms (Ω), measure the resistance between pins 30 and 87 on a DIN relay or pins 3 and 5 on an ISO relay. This should read open circuit. Any reading at this point indicates the relay contacts have become fused together or are contaminated and the relay should be replaced.

ii. Then take a reading across pins 1 and 2 of the ISO relay or 85 and 86 of the DIN relay. You should obtain a reading of approximately 85Ω (+/- 20Ω) on the ISO relay and 75Ω (+/- 20Ω) on the DIN relay. This tests the integrity of the windings within the relay.

iii. Using a suitable power source (a square 9V battery can be used for this), power up the windings of the relay. At this point you may hear the relay click. Hearing the relay click, does not necessarily indicate it is satisfactory.

NOTE: A number of modern relays incorporate a diode as a safety device to protect circuitry in the event of a relay being incorrectly fitted. These will be fitted between pins 85 and 86 of the DIN relay or pins 1 and 2 of the ISO relay. If when trying to obtain a reading for the winding resistance or the relay does not appear to click, try reversing the polarity with the battery before condemning the relay.

iv. Using the multi-meter with the relay powered, measure the resistance between pins 30 and 87 of the DIN relay or pins 3 and 5 of the ISO relay. Both must read less than 1Ω. If it is higher than this, it indicates contamination of the relay contacts.

5. Switch the ignition to position II
6. Check for a 12V supply to the socket for pin 1 of the relay
7. Switch the ignition off
8. Check for continuity between the socket for Pin 2 of the relay and pin B27 of connector B-301 (pocket B of the PCM)

DESCRIPTION AND OPERATION (Continued)

9. Check the condition of connector B-301 and the pins in pocket B of the PCM.
10. Check the harness for open circuits and short circuits.

Fuel Injectors 1-8

The fuel injectors are electronically operated valves, which deliver a metered amount of atomised fuel to the engine. The injectors are conventional solenoid operated injectors with a pintle type nozzle. The injector orifice is a fixed size and the fuel supply pressure to the injector is regulated by the fuel pressure regulator. Fuel flow to the engine, and thus the air-fuel ratio, is controlled by how long the injector solenoid is energised. The Injector Pulse Width is the time the solenoid is energised.

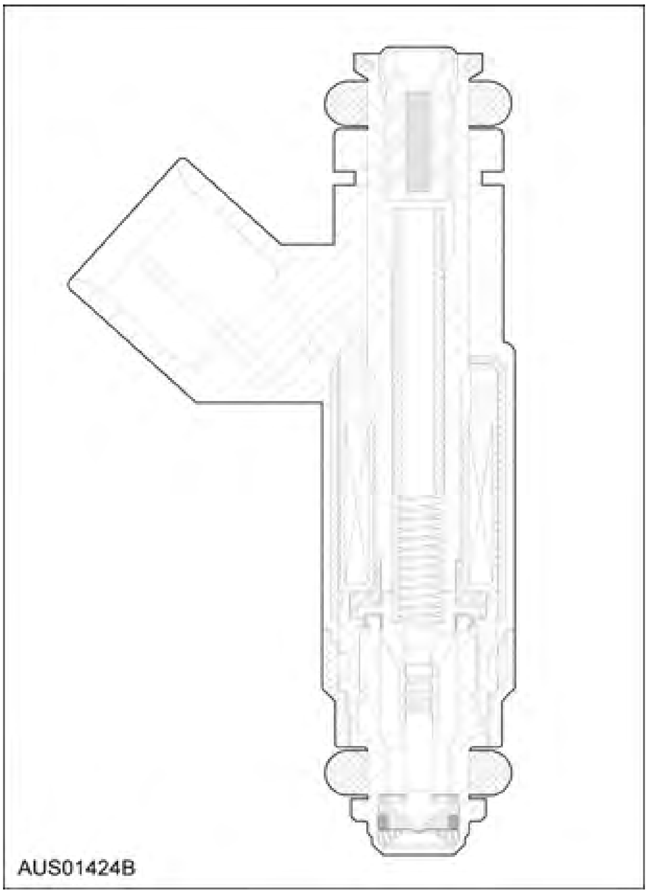
Vehicles fitted with the I6 engine use 6 fuel injectors (INJ1-6),while V8 engines have 8 injectors (INJ1-8),one for each cylinder.

CAUTION: The fuel injectors pulse open momentarily using a signal from the PCM. Applying battery voltage directly to the fuel injector's electrical connector terminals will damage the internal solenoid.

Battery voltage is applied to the positive side of the injector solenoid coil via the PCM Power Relay. The negative side of the injector solenoid is grounded, as required, by the Powertrain Control Module (PCM).

The strategy the PCM uses to control the air-fuel ratio is described in Control Systems.

Fuel Injector Cross Section, Typical



DESCRIPTION AND OPERATION (Continued)

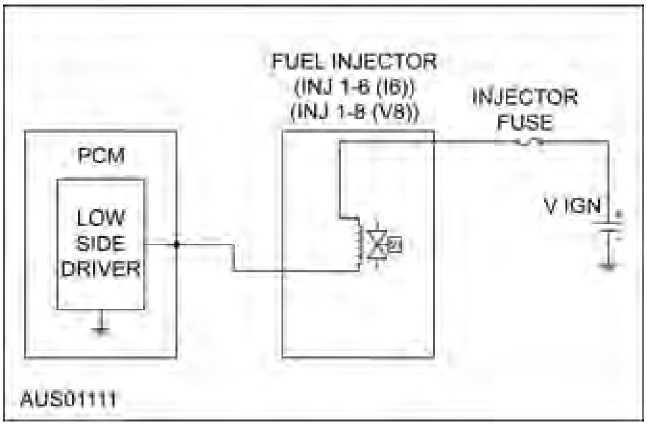
Connections (I6)

PCM Pin A14................................. Injector 1
PCM Pin A7.................................. Injector 2
PCM Pin A15................................. Injector 3
PCM Pin A4.................................. Injector 4
PCM Pin A8.................................. Injector 5
PCM Pin A3.................................. Injector 6

Connections (V8)

PCM Pin A14................................. Injector 1
PCM Pin A3.................................. Injector 2
PCM Pin A8.................................. Injector 3
PCM Pin A10................................. Injector 4
PCM Pin A4.................................. Injector 5
PCM Pin A7.................................. Injector 6
PCM Pin A15................................. Injector 7
PCM Pin A42................................. Injector 8

Circuit



Maintenance

The fuel rail must be removed to replace the fuel injectors. The procedure is described in Fuel Rail in the 'Removal and Installation' section. The fuel injectors have a fixed orifice size and cannot be adjusted

NOTE: If any, or all, of the fuel injectors are replaced, the Keep Alive Memory (KAM) must be reset to ensure the adaptive idle strategy does not use the previous adaptive values. Refer to Resetting The Powertrain Control Module.

Diagnosis

Diagnostic Trouble Codes (DTC) are retrieved through the diagnostic connector using the IDS tester. Fault Finding Tables for DTCs are in the 'Diagnosis' section.

DTCs applicable to the fuel injectors are shown in the following table.

DTC	Test Mode	Condition	MIL ON
P0201	KOEO, Cont.	INJ1 circuit malfunction	YES
P0202	KOEO, Cont.	INJ2 circuit malfunction	YES
P0203	KOEO, Cont.	INJ3 circuit malfunction	YES
P0204	KOEO, Cont.	INJ4 circuit malfunction	YES
P0205	KOEO, Cont.	INJ5 circuit malfunction	YES
P0206	KOEO, Cont.	INJ6 circuit malfunction	YES
P0207	KOEO, Cont.	INJ7 circuit malfunction	YES
P0208	KOEO, Cont.	INJ8 circuit malfunction	YES

Failure Mode

Should a fuel injector fail the engine may run rough, a Diagnostic Trouble Code (DTC) will be logged in memory for the failed injector and subsequent unexpected changes in the air-fuel ratio.

In the unlikely event that all the fuel injectors fail simultaneously, the vehicle will not run. The appropriate DTC will be reported to indicate failure of the individual fuel injectors.

Testing

The fuel injectors are tested continuously during vehicle operation (cont.) and whenever a Key On Engine Off (KOEO) test is performed.

Injector Fouling

Over time, sulphur and other trace elements in petrol can build-up on the injector spray plate and around the nozzle. The quality of the fuel plays an important part in minimising this fouling of the fuel injectors. Fouling affects both the spray pattern and the volume of fuel injected. Incorrect spray pattern will cause poor atomisation and vaporisation of the fuel, which results in poor combustion, rough idle and high hydrocarbon and carbon monoxide emissions.

Fouling of the fuel injectors is a common condition that should be suspected if the engine is running rough or hesitation during cold acceleration.

DESCRIPTION AND OPERATION (Continued)

Injector Test

1. Disconnect the harness from the fuel injector connector.
2. Measure the resistance across the fuel injector connector terminals using a suitable multimeter. Replace the fuel injector if not within specification. Repeat the procedure for each fuel injector.
   - **Fuel Injector Solenoid Resistance Specification**
     13.5 to 16.0 Ω
3. Turn the ignition key to the ON position. Do not start the engine. Positive power should be applied to the fuel injectors from the PCM Power Relay.
4. On the harness, measure the voltage between the positive connector terminal (red wire) and ground using a suitable multimeter. Repeat the procedure for each fuel injector.
   - **Fuel Injector Voltage Specification**
     12 Volts DC
5. Check the harness for open circuits and short circuits.

Fuel Injector Testing

⚠ **CAUTION: Care should be taken to avoid damaging the fuel injector tip.**

1. Remove the fuel injector and place in a clean plastic bag to avoid contamination. Number each bag to identify the cylinder location of the injector spray plate.
2. Visually examine each fuel injector filter basket and protection sleeve for damage and contaminants using a suitable magnifying glass.

   NOTE: The injector spray pattern cannot be tested on the vehicle.
3. Mount the injector in a suitable commercial injector tester and inspect the spray pattern in accordance with the operating instructions.
4. Replace the injector if poor atomisation is found, ie: streaming, uneven spray pattern or dribbling.

Ignition Coils

The ignition system is described in Control Systems section.

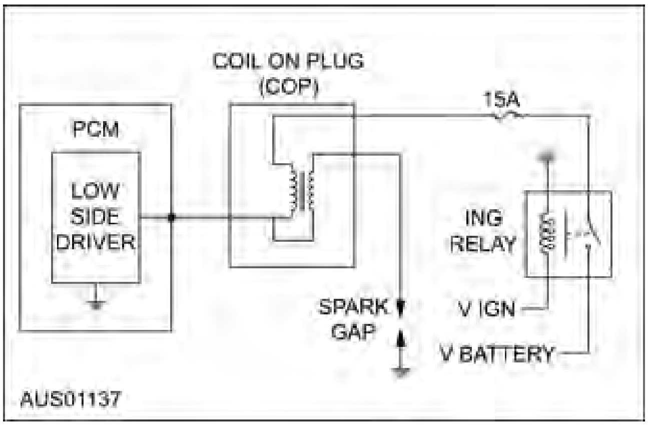
Connections (I6)

PCM Pin A35................................ Ignition Coil 1
PCM Pin A24................................ Ignition Coil 2
PCM Pin A12................................ Ignition Coil 3
PCM Pin A23................................ Ignition Coil 4
PCM Pin A46................................ Ignition Coil 5
PCM Pin A34.................................Ignition Coil 6

Connections (V8)

PCM Pin A35................................ Ignition Coil 1
PCM Pin A24................................ Ignition Coil 2
PCM Pin A12................................ Ignition Coil 3
PCM Pin A1.................................. Ignition Coil 4
PCM Pin A46................................ Ignition Coil 5
PCM Pin A34................................ Ignition Coil 6
PCM Pin A23................................ Ignition Coil 7
PCM Pin A11.................................Ignition Coil 8

Circuit



Diagnosis

Diagnostic Trouble Codes (DTC) are retrieved through the diagnostic connector using the IDS tester. Fault Finding Tables for DTCs are in the 'Diagnosis' section.

DTCs applicable to the ignition coils are shown in the following table.

DESCRIPTION AND OPERATION (Continued)

DTC	Test Mode	Condition (I6)	Condition (V8)	MIL ON
P0351	KOEO, KOER Cont	Ignition Coil 1 Primary / Secondary Circuit Failure	Ignition Coil 1 Primary / Secondary Circuit Failure	YES
P0352	KOEO, KOER Cont	Ignition Coil 5 Primary / Secondary Circuit Failure	Ignition Coil 3 Primary / Secondary Circuit Failure	YES
P0353	KOEO, KOER Cont	Ignition Coil 3 Primary / Secondary Circuit Failure	Ignition Coil 7 Primary / Secondary Circuit Failure	YES
P0354	KOEO, KOER Cont	Ignition Coil 6 Primary / Secondary Circuit Failure	Ignition Coil 2 Primary / Secondary Circuit Failure	YES
P0355	KOEO, KOER Cont	Ignition Coil 2 Primary / Secondary Circuit Failure	Ignition Coil 6 Primary / Secondary Circuit Failure	YES
P0356	KOEO, KOER Cont	Ignition Coil 4 Primary / Secondary Circuit Failure	Ignition Coil 5 Primary / Secondary Circuit Failure	YES
P0357	KOEO, KOER Cont		Ignition Coil 4 Primary / Secondary Circuit Failure	YES
P0358	KOEO, KOER Cont		Ignition Coil 8 Primary / Secondary Circuit Failure	YES

DESCRIPTION AND OPERATION (Continued)

Actuators

Intake Manifold Charge Control

To improve engine torque over the entire engine operating range, the I6 engine has an Intake Manifold Charge Control (IMCC) system. A butterfly valve situated in the intake runner for each cylinder controls the effective length of the intake path. The Powertrain Control Module (PCM) controls operation of the IMCC system.

At low engine speeds a long intake path improves volumetric efficiency, while at higher engine speeds a short intake path provides better efficiency. Changing the effective length of the intake air path improves drivability and engine power throughout the engines operating range. The lengths of the runners are designed to suit the Ram Air Effect of the I6 engine.

On I6 non-turbo petrol engines, in normal operation at speeds below approximately 3700 RPM the IMTV is in a closed position, in effect splitting the plenum in half, this causes the intake to follow the longer runner path into the engine. At higher speeds, above 3700 RPM, the IMTV opens, allowing the intake air to flow into the complete plenum volume, hence shortening the path the intake air must follow into the engine. At engine speeds around 5700 RPM the IMTV switches back to the closed position. A vacuum actuator operates the IMTV; the Powertrain Control Module (PCM) controls the vacuum to the actuator via a Solenoid Valve.

On DLPG I6 engines, the intake manifold has an Intake Manifold Charge Control (IMCC) system. The IMCC housing is an aluminium casting, situated below the plenum chamber. It has two intake air passages for each cylinder. The PCM opens vacuum control solenoid allowing the vacuum to pass to the vacuum actuator drawing the valve plates closed or releasing the vacuum allowing the actuator to push the valve plates open. The direct mounted vacuum actuator system and its return springs are located within the vacuum actuator assembly.

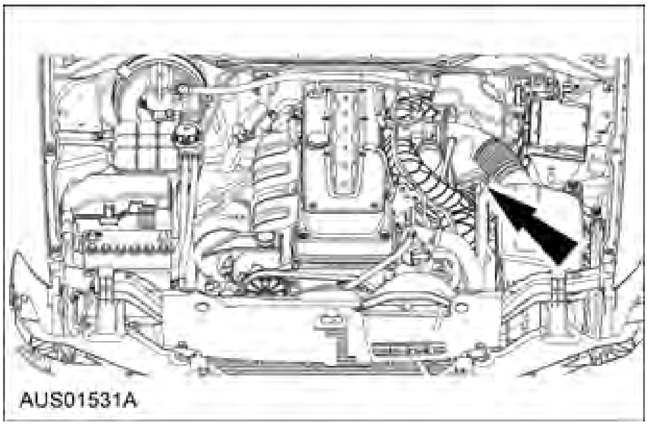
The IMCC system is also described in Control Systems. The IMCC solenoid controls the vacuum signal line to the manifold servo control diaphragm. The solenoid is mounted on the front of the PCM bracket.

IMCC Solenoid Specification (DLPG Engine)			
Engine Speed	Solenoid Condition	PCM Pin B3 Voltage	Butterfly Valves
400 to 3,800 RPM	ON	12 Volts	Closed
above 3,800 RPM	OFF	0 Volts	Open

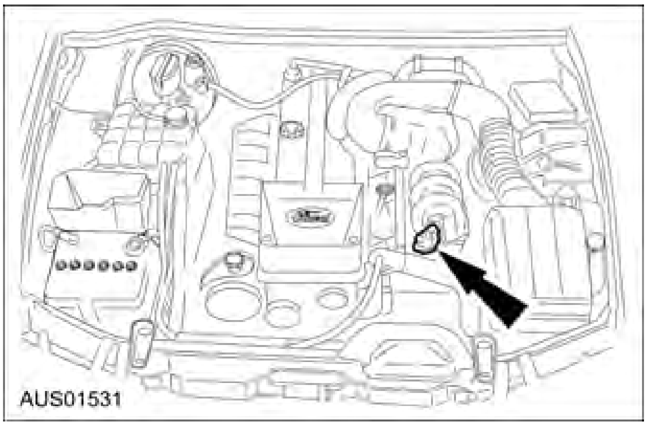
IMCC Solenoid Specification (I6 Non-Turbo Petrol Engine)			
Engine Speed	Solenoid Condition	PCM Pin B3 Voltage	Butterfly Valves
400 to 3,700 RPM	ON	12 Volts	Closed
3,700 to 5,700 RPM	OFF	0 Volts	Open
5,700 RPM	ON	12 Volts	Closed

IMCC Solenoid Location

I6 Petrol Engine



DLPG Engine

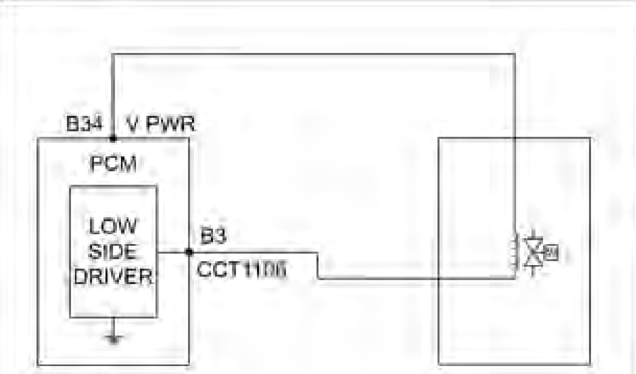


DESCRIPTION AND OPERATION (Continued)

Connections

PCM Pin B3... IMCC Signal
PCM Pin B34........................Vehicle Power (VPWR)

Circuit



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Diagnosis

Diagnostic Trouble Codes (DTC) are retrieved through the diagnostic connector using the IDS tester. Fault Finding Tables for DTCs are in the 'Diagnosis' section.

DTCs applicable to the IMCC solenoid are shown in the following table.

DTC	Test Mode	Condition	MIL ON
P1520	KOEO, Cont.	Circuit malfunction	NO

Failure Mode

During self-test the PCM checks the electrical continuity of the IMCC circuit. If the circuit fails the self-test a DTC will be logged in the PCM memory. Should either the IMCC electrical or vacuum circuit fail, then the IMCC butterflies will remain open throughout the entire engine operating range. This will result in a noticeable lack of power and torque when operating the engine between 400 to 3,800 RPM.

Testing

The IMCC solenoid is tested continuously during vehicle operation (cont.) and whenever a Key On Engine Off (KOEO) test is performed.

Whenever the ignition key is in the ON position, positive power should be applied to the IMCC solenoid from the PCM Power Relay.

1. Connect a IDS tester to the diagnostic connector and retrieve all DTCs
2. Check the Parameter Identification (PID) value of the IMCC. Normally this will indicate an ON / OFF status
3. If IMCC# is available the # indicates the IDS operator can take control of the IMCC. This must be carried out with the engine running to ensure there is adequate manifold pressure to act on the IMCC diaphragm.

Sensor Test

4. Disconnect the engine harness from the IMCC solenoid electrical connector.
5. Connect the multimeter across the IMCC solenoid terminals and measure the resistance of the coil.
   - **IMCC Resistance Spesification**
     50 to 100 Ω
6. Check the harness for open circuits and short circuits.

Electro Drive Fans

CAUTION: The PCM can, under some circumstances, maintain the engine cooling fan's operation at high speed after the driver has turned the key to the off position. The engine cooling fans will operate for up to 4 minutes depending on the Cylinder Head Temperature (CHT).

Electro Drive Fans 1 & 2 provides air flow through the radiator to remove heat from the engine coolant (and through the A/C condenser, where air conditioning fitted). Operation of the fans is controlled by the PCM.

EDF1 and EDF2 PCM outputs control two/three relays to operate the single/dual electric cooling fans on the radiator.

For the single A/C condenser fan (single engine cooling fan), this fan is controlled with two relays (R8 & R10-both white) located in the Engine Compartment Fuse Box. The fan circuit is protected with a 40 amp fuse (F4-green) also located in this fuse box.

For the dual A/C condenser fans (dual engine cooling fans), these fans are controlled with three relays (R8-white, R9-green, R10-white) located in the Engine Compartment Fuse Box. Each fan circuit is protected with a 40 amp fuse (F4, F5-both green) also located in this fuse box.

Under certain conditions, the PCM may continue to operate the cooling fan(s) for up to 4 minutes after the car has been switched off.

The relays are wired to switch the fans in series and parallel combinations to provide low and high speed operation as shown in the following table.

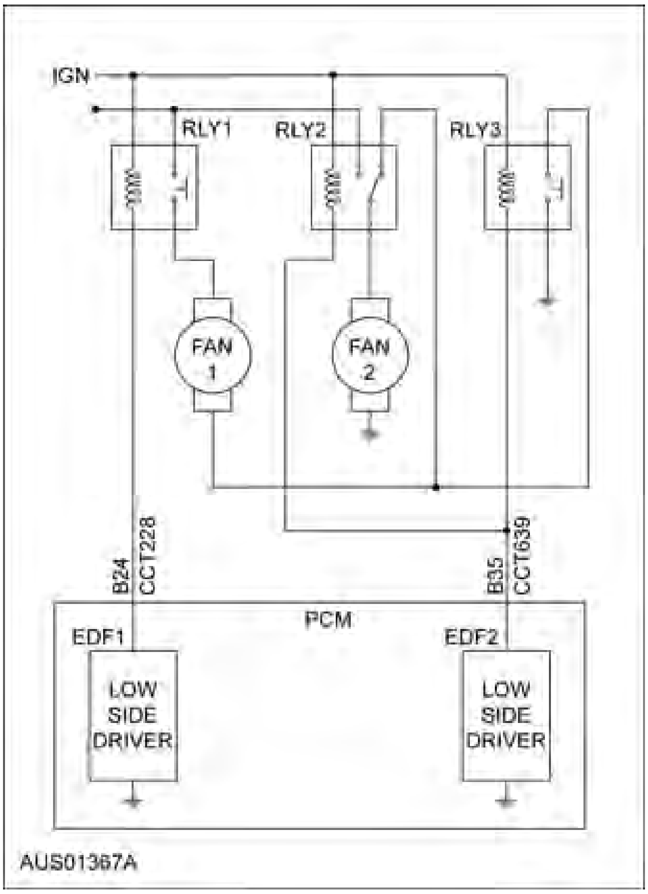
Fan Speed	EDF1	EDF2
Off	OFF	OFF
Low Speed	ON	OFF
High Speed	ON	ON

DESCRIPTION AND OPERATION (Continued)

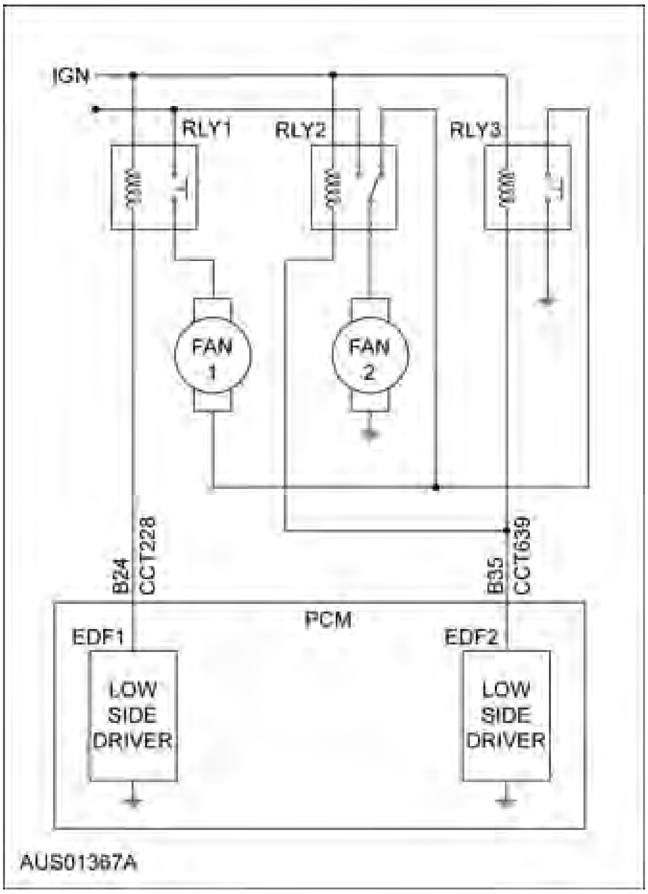
Connections

PCM Pin B24..EDF1-2
PCM Pin B35............................…..................EDF1-2

Circuit (Twin Fan)



Circuit (Single Fan)



Diagnosis

Diagnostic Trouble Codes (DTC) are retrieved through the diagnostic connector using the IDS tester. Fault Finding Tables for DTCs are in the 'Diagnosis' section.

DTC	Test Mode	Condition	MIL ON
P1474	KOEO	EDF1 Fan Control Relay Circuit . Fault in circuit from PCM to cooling fan(s) . Fault in Cooling fan(s)	NO
P1479	KOEO	EDF2 Fan Control Relay Circuit . Fault in PCM signal to engine cooling fan relay(s) . Fault in circuit from PCM to fan relay(s) . Fault in fan relay(s)	NO

Failure Mode

The PCM tests the EDF relay circuits during self test. If any circuit fails the test, then a Diagnostic Trouble Code (DTC) will be logged in the PCM memory.

DESCRIPTION AND OPERATION (Continued)

Testing

1. Initiate an Output Circuit Check as described in Diagnosis.
2. Check the operation of the cooling fan EDF1-2.
3. Check the harness for open circuits and short circuits.
4. Further testing of EDF1-2 is described in Section 303-03, Engine Cooling.

Variable Camshaft Timing

I6 Engine

The I6 Engine is fitted with variable inlet and exhaust camshaft timing. Both camshafts are variable over a 60-degree crank angle. This is achieved by two separate hydraulic mechanisms called ‘Phasers’, which are integral with the intake and exhaust camshaft drive sprockets.

The camshaft timing is controlled by directing oil under pressure (from the engine oil pump) into one of two ports in the Phaser, one port will retard the cam timing (‘Retard port’) and the other will advance the timing (‘Advance port’). An Oil Control Valve (OCV), one for each camshaft is used to control the flow of oil into the retard and advance ports of both cams. The OCV is controlled by the PCM.

The PCM uses a pulse width modulated (PWM) voltage or ‘Duty Cycle’ (DC) to control each OCV to attain the desired camshaft angle. VCT1 output controls the inlet camshaft OCV. VCT2 controls the exhaust camshaft OCV.

A 3 + 1 tooth wheel on the front of each camshaft with an associated sensor mounted on the intake and exhaust sides of the cylinder head are used to calculate the ‘Actual cam angle’ for both camshafts. The two sensors are called, intake cam position or ‘CID1’ and exhaust cam position or ‘CID2’. Intake and exhaust cam positions are calculated separately.

The PCM uses engine rpm, throttle position and engine load to determine the optimum camshaft timing setting or ‘Desired Cam Angle’ for both camshafts.

Once the PCM has determined the Desired Cam Angle, it will control the Duty Cycle output VCT1 and VCT2, to the intake and exhaust OCVs based on the difference between the Desired Cam Angle and the Actual Cam Angle. This difference is called the Cam Angle Error. The Cam Angle Error for each cam is calculated individually and used to control both camshafts independently to a single Desired Cam Angle.

An engine oil temperature sensor, which measures oil temperature in the oil gallery of the engine block, is used to compensate for Phaser response with changing oil viscosity at different temperatures.

Modes of Operation

1. Start-Up Mode

In this mode the VCT phasers will be in the fully advanced position or locked position. The Camshafts are locked mechanically by a hydraulic ‘Locking Pin’ which forms part of the phaser. The VCT1 and VCT2 duty cycle sent to the oil control valves will be 0%. Exit from start-up mode is within 10 seconds of starting.

2. Idle Mode

At idle, the VCT Phasers are in the locked fully advance position as per Start-Up Mode. Exit from Idle Mode occurs when the engine speed is above 1,050 RPM and the throttle is open.

3. Normal Drive Mode

In this mode of operation the camshaft timing angle is controlled to a Desired Cam Angle which is determined by, Engine Speed, Engine Load, Throttle Position. In this condition the PCM VCT1 and VCT2 output duty cycle will be between 20% and 80% (0.2 to 0.8) supplied to the OCVs.

4. Engine Shut down Mode

When the vehicle is keyed off, (normally from idle) the VCT Phasers will remain in the Locked position.

5. Oil Overheat mode

If the oil temperature becomes excessively high engine speed at which the VCT system enters Drive Mode will become higher. See specifications in this section.

6. System Malfunction Mode

If a critical sensor or the VCT system fails the VCT system will be set to the fully advanced locked position. The VCT1 and VCT2 Duty cycle to the OCVs will be set to 0%.

7. Oil Control Valve Cleaning Mode

The VCT system has an automatic Valve Cleaning Mode that is designed to keep the valve free of oil deposits and build up. This mode is activated when the throttle is closed during normal driving.

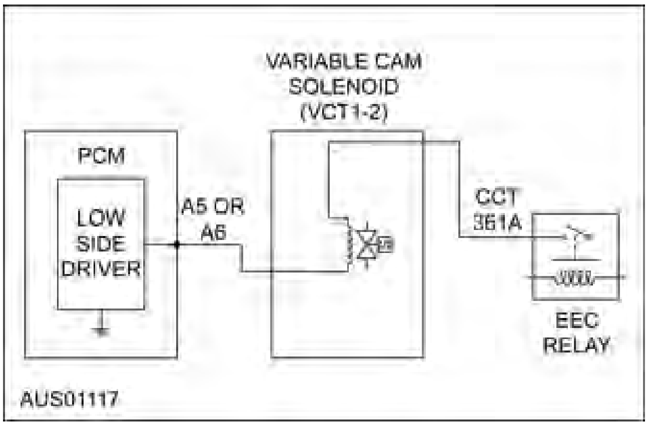
DESCRIPTION AND OPERATION (Continued)

Connections

PCM Pin A5 .... VCT1

PCM Pin A6 .... VCT2

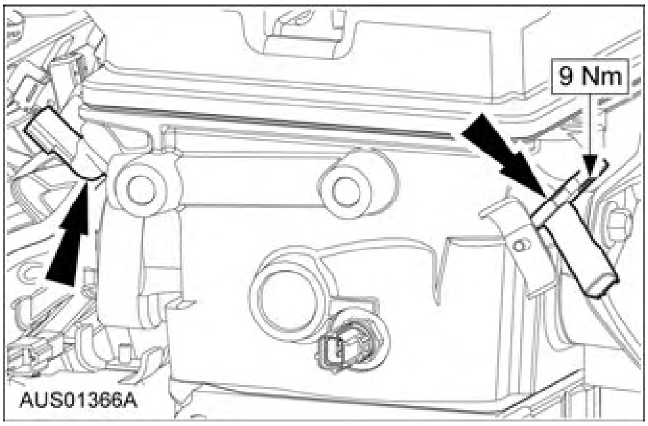
Circuit



Maintenance

Maintenance of the VCT solenoid and mechanisms are described in the Variable Camshaft Timing section.

VCT Sensor Location



Diagnosis

Diagnostic Trouble Codes (DTC) are retrieved through the diagnostic connector using the IDS tester. Fault Finding Tables for DTCs are in the 'Diagnosis' section.

DTCs applicable to the VCT solenoid are shown in the following table.

DTC	Test Type	Description of test	MIL ON
P0340	KOER Cont	Camshaft Position Sensor CID1 (I6 Intake Cam)	YES
P1340	KOER Cont	Camshaft Position Sensor CID2 (I6 Exhaust Cam, V8 Bank 2)	YES
P1380	KOEO Cont	Camshaft Position Actuator, VCT1 Circuit (I6 Intake OCV)	YES
P1385	KOEO Cont	Camshaft Position Actuator, VCT2 Circuit (I6 Exhaust OCV, V8 Bank 2 OCV)	YES
P1381	Cont	Camshaft Position Timing Over Advanced (I6 Intake cam)	YES
P1386	Cont	Camshaft Position Timing Over Advanced (I6 Exhaust Cam, V8 Bank 2)	YES
P1383	Cont	Camshaft Position Timing Over Retarded (I6 Intake cam)	YES
P1388	Cont	Camshaft Position Timing Over Retarded (I6 Exhaust Cam, V8 Bank 2)	YES

Critical Sensors

If the following sensors malfunction the VCT system will be disabled.

Sensor	Description
CHT	Cylinder head temperature sensor
EOT	Engine Oil Temperature Sensor
MAP	Manifold Absolute Pressure Sensor
IAT	Intake Air Temperature Sensor (part of the T-MAP)
TP	Throttle Position Sensor

Check the relevant sections in this chapter to ensure these sensors are operating correctly, Before Performing any other diagnosis on the VCT system.

Specifications / Modes of operation	I6	V8, 3V
Cam Angle at fully advanced Position	-10°	0°
Cam Angle at Fully Retarded Position	50°	60°

VCT Activation RPM

Oil Temperature	I6, 4V	V8, 3V
Normal	1000 RPM	1100 RPM
130°	1250 RPM	1100 RPM
140°	1500 RPM	1100 RPM
150°	VCT off	1100 RPM

DESCRIPTION AND OPERATION (Continued)

Failure Diagnosis

If a fault develops in the VCT control system or a critical sensor, The VCT outputs from the PCM are disabled (the VCT system is turned off) and the appropriate trouble code will be logged in memory for retrieval during Self-test mode.

VCT PID Specification

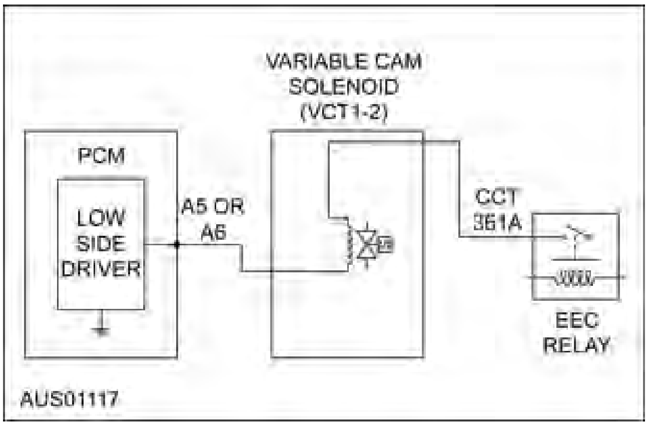
PID	Description
VCT1	cam_dc_0; Duty cycle of the VCT (Variable Camshaft Timing) solenoid output (I6 Intake Cam)
VCT2	cam_dc_1; Duty cycle of the VCT (Variable Camshaft Timing) solenoid output (I6 Exhaust Cam, V8 Bank 2)
VCTADV	cam_angle_0; The actual position in crankshaft degrees of the right or number 1 camshaft for VCT (Variable Camshaft Timing), where zero is the base camshaft timing. A decrease corresponds to an advance of the camshaft timing, while an increase corresponds (I6 Intake Cam)
VCTADV2	cam_angle_1; The actual position in crankshaft degrees of the left or number 2 camshaft for VCT (Variable Camshaft Timing), where zero is the base camshaft timing. A decrease corresponds to an advance of the camshaft timing.(I6 Exhaust Cam, V8 Bank 2)
VCTADVERR	cam_err_0; How far the actual position of the right camshaft is advanced (+) or retarded (-) in crankshaft degrees from the desired position for VCT (Variable Camshaft Timing). (I6 Intake Cam)
VCTADVERR2	cam_err_1; How far the actual position of the left or number 2 camshaft is advanced (+) or retarded (-) in crankshaft degrees from the desired position for VCT (Variable Camshaft Timing). (I6 Exhaust Cam, V8 Bank 2)

Solenoid Test

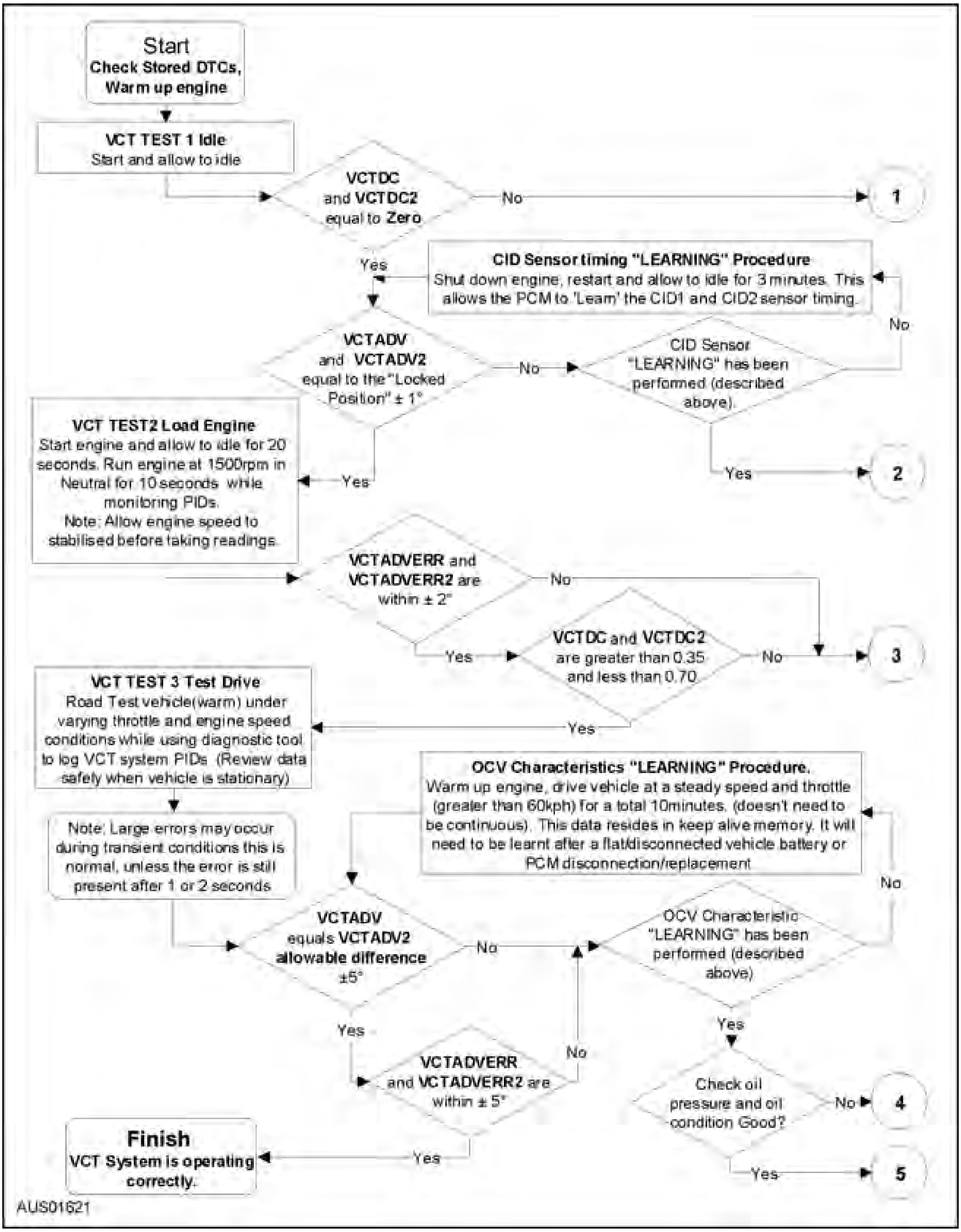
1. Disconnect the wiring harness from the VCT solenoid.
2. Using a suitable multimeter, measure the resistance of the solenoid coil across the terminals.

VCT Solenoid Resistance Specification
I6 7.0 Ω - 9.0 Ω
V8, 3V 8.0 Ω - 10.0 Ω

Circuit



DESCRIPTION AND OPERATION (Continued)



Login Tracking Code

DESCRIPTION AND OPERATION (Continued)

Flow Chart Output Number	Problem	Possible Cause	Possible solution	DTCs that may be set	Additional comments
1	VCT controller not at idle mode.	Throttle pedal is not fully closed.	Check for correct throttle pedal operation.		
		Engine RPM is to high for entry into VCT idle mode.	Check and rectify air leaks, throttle malfunction and other problems that allow engine to idle to be excessively high.		
2	Engine idle rough and/or high RPM idle. One camshaft is retarded when the its OCV duty is equal to zero.	OCV is contaminated, jammed or faulty.	Remove valve, perform cleaning procedure and inspect.	P1383 P1388	Ref: OCV Cleaning Procedure
		PCM VCT output 1 or 2 wiring is shorted to ground. (This problem will power up one of the OCVs).	Check and repair wiring/PCM.	P1383 P1388 P0340 P1340	Check by disconnecting both OCVs and re-running ‘VCT TEST1 IDLE’ in the diagnostic flow chart.
		VCT Phaser is jammed or faulty.	Remove and replace Phaser.	P1383 P1388	Most problems can be attributed to the OCV, ensure that the OCV is checked and cleaned before replacing Phaser Ref: Engine Section 303-01a, b & c.
	Engine performance and/or Idle quality is poor. Camshaft is not at ‘Locked position’ when the OCV duty cycles are = 0	Camshaft or CID timing is incorrect or slipped, moved or damaged.	Check camshaft and engine timing including CID timing.		Ref: Engine Section 303-01a, b & c.

DESCRIPTION AND OPERATION (Continued)

Flow Chart Output Number	Problem	Possible Cause	Possible solution	DTCs that may be set	Additional comments
3	Engine stalls or runs poorly when throttle is opened. Engine operates normally for only 10sec after start. **NOTE:** Engine may recover 5sec after throttle is opened when the PCM Identifies a problem, turns VCT off and sets a DTC.	VCT OCV or CID sensor wiring is connected back the front.	Check for correct OCV wiring orientation.	P1383 P1388 P1381 P1386	This will only be a problem if the engine wiring has been removed and replaced, or the history of the vehicle is not known.
		Open circuit/faulty OCV wiring.	Check VCT1 and VCT2 wiring.	P1381 P1386 P0340 P1340	
		One OCV is jammed in the fully closed position.	Remove and clean the OCV that is jammed or replace faulty valve.	P1381 P1386	Ref: OCV Cleaning Procedure.
		Oil supply or filter blocked on one camshaft.	Check the oil filter in #1 cam cap.	P1381 P1386	Ref: Engine Section 303-01a, b & c.
		VCT Phaser stuck in locked position i.e. locking pin jammed. Phaser is therefore unable to move when a duty cycle is applied to the OCV.	Replace VCT Phaser.	P1381 P1386	This is not a very common fault ensure that the oil supply, OCV, wiring and PCM are operating correctly before replacing Phaser. Ref: Engine Section 303-01a, b & c for Phaser replacement.

DESCRIPTION AND OPERATION (Continued)

Flow Chart Output Number	Problem	Possible Cause	Possible solution	DTCs that may be set	Additional comments
4	Cam_dc_0_ or Cam_dc_1 is high, cam retard is slow or cam error is large.	OCV blocked, jammed, worn or faulty.	Remove OCV, perform cleaning procedure, inspect and re-install.	P1381 P1386	Ref: OCV Cleaning Procedure.
		Blocked VCT oil filter/s in #1 cam cap, or blocked oil supply.	Remove OCVs and cam caps inspect and clean oil filters, oil galleries and OCV. Re-install and re-test.	P1381 P1386	Ref: Engine Section 303-01a, b & c.
	Cam_dc_0_ or Cam_dc_1_ is low But not zero, cam error is large and negative.	OCV worn or faulty.	Check condition of OCVs	P1388 P1383	Ref: Engine Section 303-01a, b & c.
		Phaser return spring is broken or faulty.	Check condition of Phaser return spring.	P1388 P1383	Ref: Engine Section 303-01a, b & c.
		Cam friction is high.	Check cam, journal and valve train condition.	P1388 P1383	Ref: Engine Section 303-01a, b & c.
	When throttle is opened Both Cam_dc_ are = 0, i.e. has been VCT is disabled	A ‘Critical Sensor’ has failed	Run KOEO, KOER and check DTCs	P1388 P1383 P1381 P1386 P0340 P1340 P1380 P1385 MAP EOT ACT CHT TP	Stop engine, check stored DTCs, and clear. Re-run flow chart tests. Check DTCs that indicate that the listed ‘critical sensors’ have failed. **NOTE:** During a test if a fault is found the VCT will be disabled and the stored DTC is set.
		Failed PCM VCT outputs or wiring, i.e. OCVs not connected or wiring damaged.	Check stored DTCs for failed VCT outputs.		
		Failed CID/Cam position sensor or Wiring	Check CID sensors, associated wiring, and stored DTCs		
		VCT control system unable to move camshafts to desired position.	Check OCVs, associated wiring, and stored DTCs		
5	Poor VCT performance. Causing poor drivability. Engine runs well during cruise conditions.	Oil condition is poor and/or engine oil filter is blocked.	Change oil and oil filter.	P1388 P1383 P1381 P1386	Ref: Engine Section 303-01a, b & c.
		Engine oil pressure is low.	Check oil pressure is within specification.	P1388 P1383 P1381 P1386	

DESCRIPTION AND OPERATION (Continued)

Flow Chart Output Number	Problem	Possible Cause	Possible solution	DTCs that may be set	Additional comments
6	Poor VCT performance. Causing poor drivability. Engine runs well during cruise conditions.	VCT oil filters are blocked.	Check and clean filters in cam journal caps.	P1381 P1386	Ref: Engine Section 303-01a, b & c.
		Oil control valve is faulty/Worn out.	Check OCV condition and replace as necessary.	P1381 P1386 P1388 P1383	Ref: Engine Section 303-01a, b & c.
		VCT Phasers are worn/Faulty.	Check Phasers and replace as necessary.	P1381 P1386 P1388 P1383	Ref: Engine Section 303-01a, b & c.
		#1 camshaft journal clearances are too high.	Check journal clearances are within specification.	P1381 P1386 P1388 P1383	Ref: Engine Section 303-01a, b & c.

DESCRIPTION AND OPERATION (Continued)

Electronic Throttle Body

The PCM processes accelerator pedal and speed control demand for the Electronic Throttle Body (ETB). The electric motor in the ETB moves the throttle plate through a gear set. The plate is adjusted and monitored by the PCM in a closed control loop. The TP sensor provides the PCM with feedback on the actual position of the throttle plate.

CAUTION: The Electronic Throttle Body (ETB) must NOT be dismantled. No adjustments can be made to the ETB. The only serviceable item on the ETB is the Throttle Position Sensor (TPS), which can be replaced.

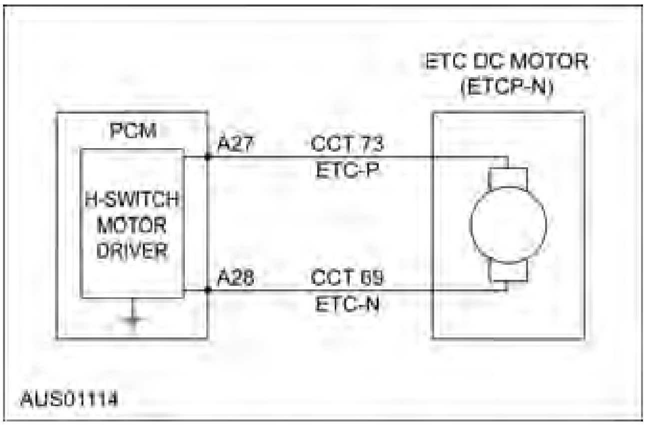
NOTE: The preset stop-screw must not be adjusted as it is factory set and bonded tight. Adjustment will likely cause failure.

Connections

PCM Pin A27…………………………………..ETCP

PCM Pin A28…………………………………..ETCN

Circuit



Diagnosis

DTCs applicable to this output are shown on the following table

DTC	Test Mode	Condition	MIL ON
P2100	KOEO Cont.	Throttle Actuator Control Motor Circuit/Open	NO
P2101	KOEO Cont.	Throttle Actuator Control Motor Circuit Range/Performance	NO
P2102*	KOEO Cont.	ETB motor current is lower than expected	NO
P2103*	KOEO Cont.	ETB motor current is higher than expected	NO
P2105	Cont.	Throttle Actuator Control System - Forced Engine Shutdown	NO
P2107**	Cont.	Throttle Actuator Control System - Forced Engine into guard mode	NO
P2110	Cont	ETC in Guard Mode. (Limp home mode)	NO
P2111	Cont.	Throttle Actuator Control System - Higher throttle opening than driver demand	NO
P2112	Cont.	Throttle Actuator Control System - Lower throttle opening than driver demand	NO

* P2101 and P2102 may not be active DTCs as these are current related. They may become active as later calibrations become available.

**P2107 is a software concern. Ensure the PCM is operating with the current software and the VID data is correctly programmed.

Failure Mode

If a fault develops in the electronic throttle control system, a standby function is carried out. The plate is spring loaded to a slightly open position allowing enough air to pass to provide limited engine operation. This spring-loaded position is preset during manufacture and must not be adjusted in service. When operating in this mode, rpm-limiting by cylinder cutout will occur and the warning light will be set. The appropriate trouble code will be logged in the memory for retrieval during Self-test mode.

Testing

1. Measure the resistance of the electronic throttle motor
   . **ETC Motor Resistance Specification**
   3 to 5 Ω

Evap Canister Purge Solenoid

The Evaporator Canister Purge Solenoid (EVAP) controls purging of vapours from the carbon canister to the air intake system. The canister stores fuel vapours from the fuel tank. The Powertrain Control Module (PCM) monitors several systems to determine when to purge these vapours into the intake manifold with minimum impact on engine operation.

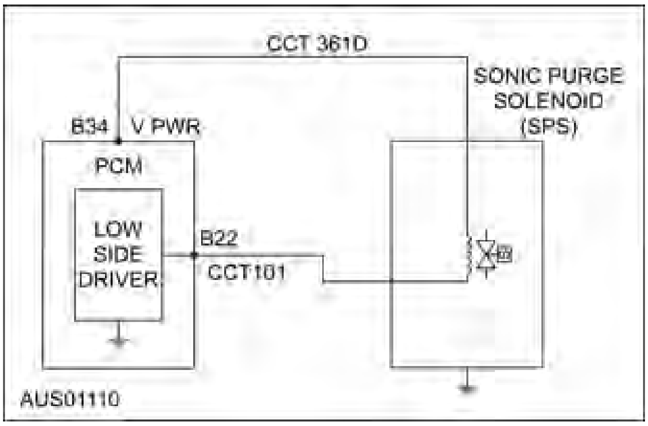
The positive side of the EVAP solenoid is connected to Vehicle Power (VPWR). The PCM completes the electrical circuit by grounding the solenoid coil in a 10 Hz duty cycle. Once purge is initiated, the duty will gradually increase with engine speed to slowly draw the canister vapours in the intake manifold.

DESCRIPTION AND OPERATION (Continued)

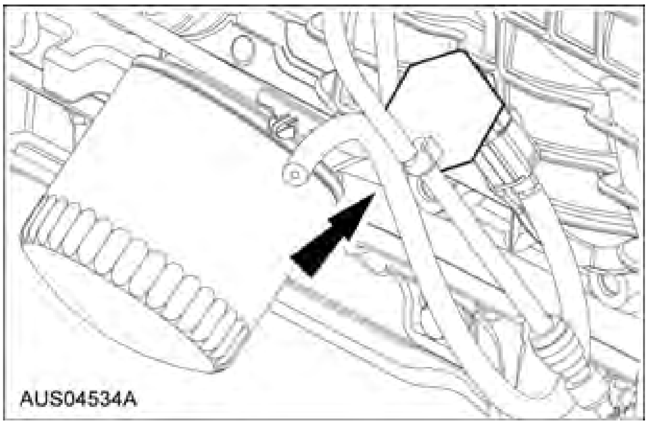
Connections

PCM Pin B22....................................EVAP Solenoid
PCM Pin B34........................Vehicle Power (VPWR)

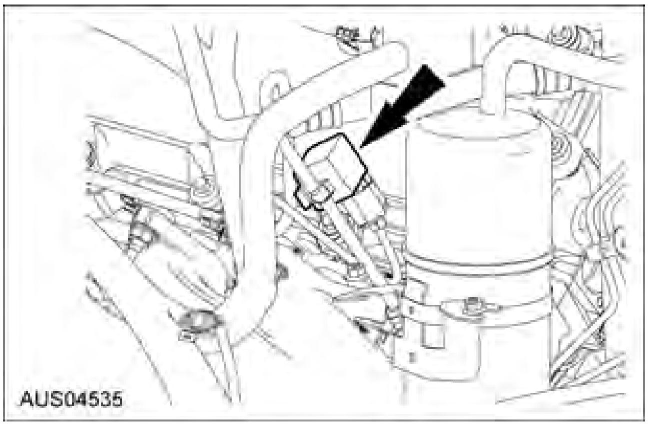
Circuit



EVAP Solenoid Location, I6



EVAP Solenoid Location, V8



Diagnosis

Diagnostic Trouble Codes (DTC) are retrieved through the diagnostic connector using the IDS tester. Fault Finding Tables for DTCs are in the 'Diagnosis' section.

DTCs applicable to the EVAP solenoid are shown in the following table.

DTC	Test Mode	Condition	MIL ON
P0443	KOEO, Cont.	Circuit malfunction	YES

Testing

1. Check the operation of the EVAP solenoid.
2. Measure the resistance of the solenoid.
   - **EVAP Solenoid Resistance Specification**
     50 to 70 Ω
3. Check the harness for open circuits and short circuits.

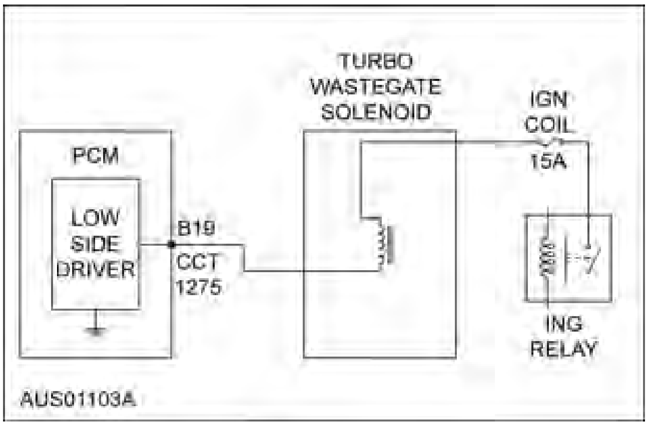
Turbocharger Wastegate Control

The PCM measures the boost pressure of the turbocharger using the boost pressure sensor (BPS). Boost pressure is controlled to a set pressure, which is dependent upon the engine load, temperature and RPM. The control system increases engine intake pressure by diverting excess pressure away from the wastegate actuator, through a wastegate solenoid valve mounted underneath the battery. The solenoid is controlled by the PCM's TURBO output.

Connections

PCM Pin B19………………………………. TURBO

Circuit



DESCRIPTION AND OPERATION (Continued)

Diagnosis

DTCs applicable to this output are shown on the following table.

DTC	Test Mode	Condition	MIL ON
P0243	KOEO, KOER Cont.	Wastegate Solenoid Circuit Malfunction	YES
P1227	Cont	Wastegate Control System Failed closed - Over Pressure	YES
P1228	Cont	Wastegate Control System Failed Open - Under Pressure	YES

The **P1227** and **P1228** codes are total system performance codes, and may relate to a mechanical fault in the control system if **P0243, P0236, P0237** and **P0238** have not been set, possible causes are:

- Blocked or restricted wastegate solenoid ports
- Damaged or missing hose(s) between wastegate solenoid and turbo compressor or wastegate actuator.
- Failed wastegate actuator diaphragm,
- Stuck open/closed wastegate valve (in turbine housing).
- Loose, blocked or damaged hoses from turbo compressor outlet to throttle body
- Damaged intercooler
- Blocked or restricted intake to turbo compressor

Failure Mode

If a fault develops in the turbo wastegate control system, a standby function is carried out. The wastegate solenoid is forced fully open (0% duty cycle) allowing minimum mechanical boost to be delivered. The minimum mechanical boost is controlled by the spring-loaded position of the wastegate actuator. This is preset during manufacture and must not be adjusted in service. If the boost pressure is still higher than desired, torque limiting by cylinder cut-out will occur. The appropriate trouble code will be logged in memory for retrieval during Self-test mode.

Testing

The TURBO solenoid output is tested continuously during vehicle operation (cont.) and whenever Key On Engine Off (KOEO) or Key On Engine Running (KOER) test are performed.

Testing TURBO control solenoid output

1. Connect a IDS tester to the diagnostic connector.
2. Check the Parameter Identification (PID) value of the WGATE. If the PID value is within specification, then check for other Diagnostic Trouble Code (DTC) or component faults

PID Specification

PID	Description
WGATE	Turbocharger Wastegate Control

DESCRIPTION AND OPERATION (Continued)

Transmission Outputs (DLPG Only)

NOTE: The following tests are only applicable to the 4-Speed Automatic Transmission. For the 6-Speed Automatic Transmission refer to section 307-01B.

If several Diagnostic Trouble Code (DTC) applicable to transmission are present, check for a short circuit to Vehicle Power (VPWR) or ground, or moisture in the transmission harness connector.

Shift Solenoid 1

Shift Solenoid 1 (SS1) is used on vehicles fitted with automatic transmission to control shifting of the gear ratios.

The solenoid is wired to 12V within the transmission. The PCM applies 0 Volts to energise the coils of SS1 as required for gearshift operation.

The automatic transmission gear shift strategy is described in Section 307-01, Automatic Transmission.

Connections

PCM Pin A19.....................................SS1 Solenoid

Diagnosis

Diagnostic Trouble Codes (DTC) are retrieved through the diagnostic connector using the IDS tester. Fault Finding Tables for DTCs are in the ‘Diagnosis’ section.

DTCs applicable to the SS1 solenoid are shown in the following table.

DTC	Test Mode	Condition	MIL ON
P0752	KOEO, KOER Cont	Shift Solenoid 1 (SS1) (Auto) stuck on	NO
P0753	KOEO, KOER Cont	Shift Solenoid 1 (SS1) electrical problem	NO

Testing

Solenoid Test

1. Disconnect the harness from the transmission connector.
2. Measure the resistance across the connector terminals using a suitable multimeter. Replace the solenoid if not within specification.
   - **SS1 Solenoid Resistance Specification**
     23 -45 Ω
3. Check the harness for open circuits and short circuits.

Shift Solenoid 2

Shift Solenoid 2 (SS2) is used on vehicles fitted with automatic transmission to control shifting of the gear ratios.

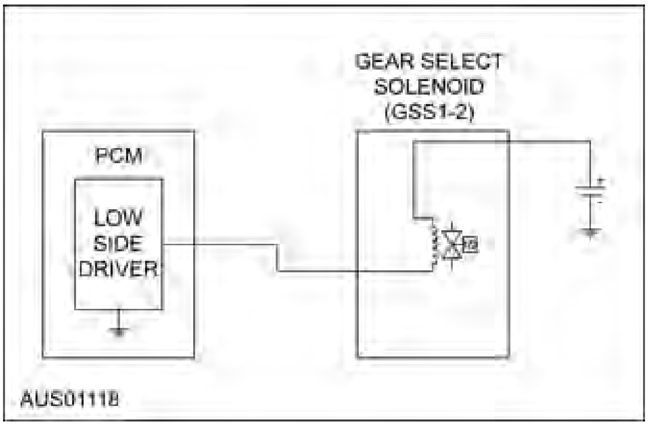
The solenoid is wired to 12V within the transmission. The PCM applies 0 Volts to energise the coils of SS2 as required for gearshift operation.

The automatic transmission gear shift strategy is described in Section 307-01, Automatic Transmission.

Connections

PCM Pin A20......................................SS2 Solenoid

Circuit



DTCs applicable to the SS2 solenoid are shown in the following table.

DTC	Test Mode	Condition	MIL ON
P0757	KOEO, KOER Cont	Shift Solenoid 2 (SS2) (Auto) stuck on.	NO
P0758	KOEO, KOER Cont	Shift Solenoid 2 (SS2) electrical problem	NO

Testing

Solenoid Test

1. Disconnect the harness from the transmission connector.
2. Measure the resistance across the connector terminals using a suitable multimeter. Replace the solenoid if not within specification.
   - **SS2 Solenoid Resistance Specification**
     23 -45 Ω
3. Check the harness for open circuits and short circuits.

Shift Solenoid 3

Shift Solenoid 3 (SS3) is used on vehicles fitted with automatic transmission to control shifting of the gear ratios.

The solenoid is wired to 12V within the transmission. The PCM applies 0 Volts to energise the coils of SS3 as required for gearshift operation.

The automatic transmission gear shift strategy is described in Section 307-01, Automatic Transmission.

DESCRIPTION AND OPERATION (Continued)

Connections

PCM Pin A17......................................SS3 Solenoid

Maintenance

DTCs applicable to the SS3 solenoid are shown in the following table.

DTC	Test Mode	Condition	MIL ON
P0762	KOEO, KOER Cont	Shift Solenoid 3 (SS3) (Auto) stuck on.	NO
P0763	KOEO, KOER Cont	Shift Solenoid 3 (SS3) <MCS1> electrical problem	NO

Testing

Solenoid Test

1. Disconnect the harness from the transmission connector.
2. Measure the resistance across the connector terminals using a suitable multimeter. Replace the solenoid if not within specification.
   - **SS3 Solenoid Resistance Specification** 23 - 45 Ω
3. Check the harness for open circuits and short circuits.

Shift Solenoid 4

Shift Solenoid 4 (SS4) is used on vehicles fitted with automatic transmission to control shifting of the gear ratios.

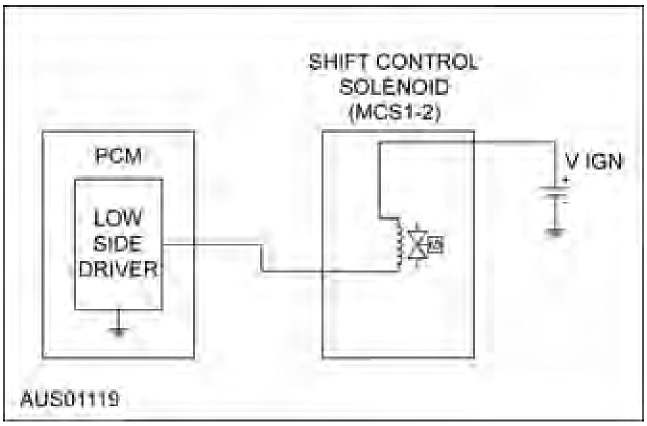
The solenoid is wired to 12V within the transmission. The PCM applies 0 Volts to energise the coils of SS4 as required for gearshift operation.

The automatic transmission gear shift strategy is described in Section 307-01, Automatic Transmission.

Connections

PCM Pin A18......................................SS4 Solenoid

Circuit



DTCs applicable to the SS4 solenoid are shown in the following table.

DTC	Test Mode	Condition	MIL ON
P0768	KOEO, KOER Cont	Shift Solenoid 4 (SS4) <MCS1> electrical problem	NO

Testing

Solenoid Test

1. Disconnect the harness from the transmission connector.
2. Measure the resistance across the connector terminals using a suitable multimeter. Replace the solenoid if not within specification.
   - **SS4 Solenoid Resistance Specification** 23 -45 Ω
3. Check the harness for open circuits and short circuits.

Variable Pressure Solenoid 5

Variable Pressure Solenoid 5 (VPS) is used on vehicles fitted with automatic transmission to control the pressure to the clutches and bands for automatic gear shift.

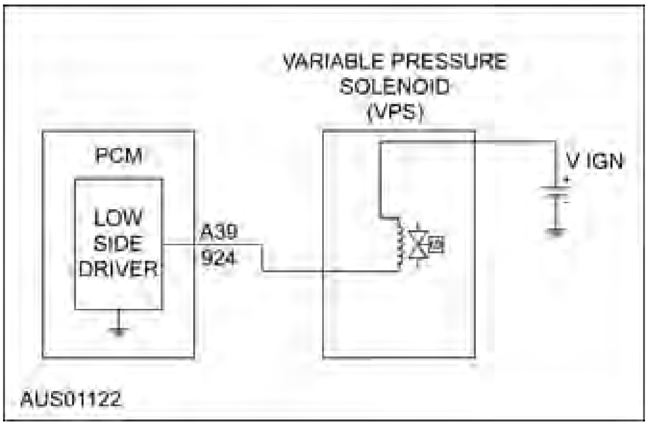
The solenoid is wired to 12V within the transmission. The PCM applies a PWM current to energise the coils of VPS as required for gearshift operation.

The automatic transmission gearshift strategy is described in Section 307-01, Automatic Transmission.

Connections

PCM Pin A39.....................................VPS Solenoid

Circuit



DTCs applicable to the VPS solenoid are shown in the following table.

DESCRIPTION AND OPERATION (Continued)

DTC	Test Mode	Condition	MIL ON
P1746	KOEO, KOER Cont	Solenoid 5 (SS5) <VPS> open circuit fault	NO
P1747	KOEO, KOER Cont	Solenoid 5 (SS5) <VPS> short circuit fault	NO
P1748	KOEO, KOER Cont	Solenoid 5 (SS5) <VPS> circuit fault	NO

Testing

Solenoid Test

1. Disconnect the harness from the transmission connector.
2. Measure the resistance across the connector terminals using a suitable multimeter. Replace the solenoid if not within specification.
   - **SS5 Solenoid Resistance Specification**
     3.8-6.2 Ω
3. Check the harness for open circuits and short circuits.

Power Control Solenoid 6

Power Control Solenoid 6 (PCS) is used on vehicles fitted with automatic transmission to control line pressure in the automatic transmission.

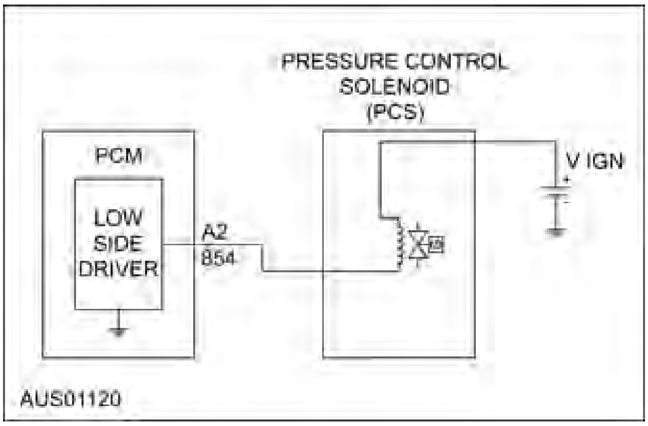
The solenoid is wired to 12V within the transmission. The PCM applies 0 Volts to energise the coils of SS1 as required for gearshift operation.

The automatic transmission gearshift strategy is described in Section 307-01, Automatic Transmission.

Connections

PCM Pin A2..PCS Solenoid

Circuit



Maintenance

Maintenance, removal and installation of PCS is described in Section 307-01, Automatic Transmission.

DTCs applicable to the PCS solenoid are shown in the following table.

DTC	Test Mode	Condition	MIL ON
P0773	KOEO, KOER Cont	Shift Solenoid 6 (SS6) <PCS> electrical problem	NO

Testing

Solenoid Test

1. Disconnect the harness from the transmission connector.
2. Measure the resistance across the connector terminals using a suitable multimeter. Replace the solenoid if not within specification.
   - **PCS Solenoid Resistance Specification**
     23 -45 Ω
3. Check the harness for open circuits and short circuits.

Lock up Solenoid 7

Lock Up Solenoid 7 (LUS) is used on vehicles fitted with automatic transmission to control the automatic transmission torque converter lock-up clutch.

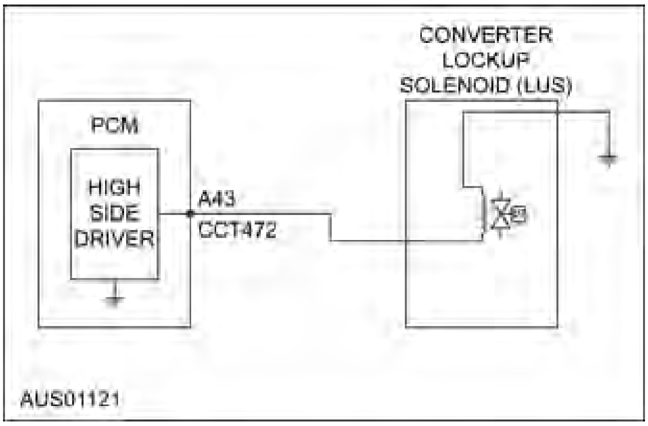
The Powertrain Control Module (PCM) applies 12 Volts to energise the coils of LUS as required.

The automatic transmission gear shift strategy is described in Section 307-01, Automatic Transmission.

Connections

PCM Pin A43.....................................LUS Solenoid

Circuit



Diagnosis

Diagnostic Trouble Codes (DTC) are retrieved through the diagnostic connector using the IDS tester. Fault Finding Tables for DTCs are in the 'Diagnosis' section.

DESCRIPTION AND OPERATION (Continued)

DTC	Test Mode	Condition	MIL ON
P0743	KOEO, KOER Cont	Lock Up Solenoid 7 (LUS) fault	NO

Testing

Solenoid Test

1. Disconnect the harness from the transmission connector.
2. Measure the resistance across the connector terminals using a suitable multimeter. Replace the solenoid if not within specification.
   - **LUS Solenoid Resistance Specification**
     23 -45 Ω
3. Check the harness for open circuits and short circuits.

DESCRIPTION AND OPERATION (Continued)

LPG Fuel System Outputs

The LPG remains unchanged from the BF Falcon. The Powertrain Control Module is still the same Powertrian Control Module used in the BF Falcon. The BF Falcon Powertrain Control has undergone modifications to enable it to work with the Orion CAN and enhancements made to the Electronic Throttle Control.

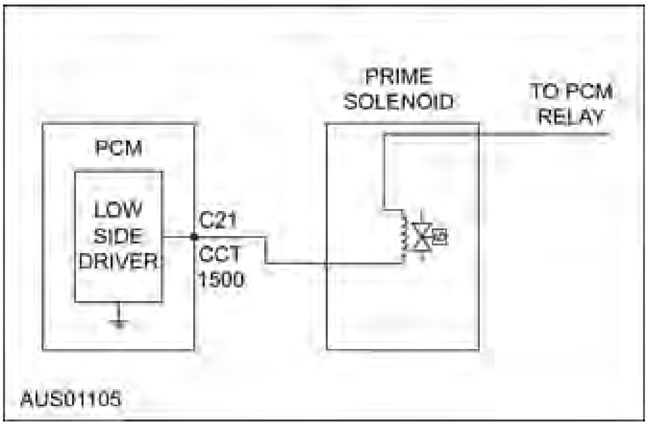
LPG Prime Solenoid PRIME

The LPG prime solenoid primes the LPG hoses and the intake manifold with gas to facilitate engine starting.

Connections

PCM Pin C21.............................…….. PRIME

Circuit



Diagnosis

Diagnostic Trouble Codes (DTC) are retrieved through the diagnostic connector using the IDS tester. Fault Finding Tables for DTCs are in the 'Diagnosis' section.

DTCs applicable to the GCO relay are shown in the following table.

DTC	Test Mode	Condition
P1213	KOEO, Cont.	PRIME circuit malfunction

Testing

Solenoid Test

1. Remove the connector to the PRIME solenoid on the LPG converter.
2. Measure the resistance across the PRIME solenoid using a suitable multimeter.
   - **Prime Solenoid Resistance Specification** 10-14 Ω
3. Check the harness for open circuits and short circuits.

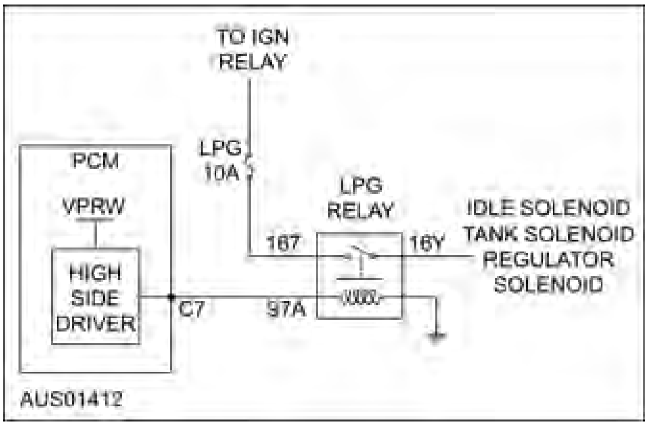
Gas Cut-out Solenoid GCO

In vehicles fitted with Ford factory SF LPG systems, three solenoids control LPG flow from the tank to the converter unit. The three solenoids are controlled by the Gas Cut-Out (GCO) relay. The GCO relay is energised by the PCM, energising the solenoid control relay, which then energises to activate the Tank Lock-off, Engine Bay Lock-off and Idle Circuit solenoids on the LPG fuel line. These solenoids are open when.

Connections

PCM Pin C7..............................Gas Cut-Out (GCO)

Circuit



Diagnosis

Diagnostic Trouble Codes (DTC) are retrieved through the diagnostic connector using the IDS tester. Fault Finding Tables for DTCs are in the 'Diagnosis' section.

DTCs applicable to the GCO relay are shown in the following table.

DTC	Test Mode	Condition
P1182	KOEO, Cont.	Relay circuit malfunction

Failure Mode

Should the GCO relay fail for any reason, LPG mode will not be available.

Testing

Relay Test

1. Remove the GCO Relay.
2. Measure the resistance across the GCO relay coil terminals using a suitable multimeter.
   - **GCO Relay Coil Resistance Specification** 60-120 Ω
3. Check the harness for open circuits and short circuits.

DESCRIPTION AND OPERATION (Continued)

LPG Stepper Motor A-D

LPG Stepper Motor A -D (GSCA-D) signals are used by the Powertrain Control Module (PCM) to control the air-fuel ratio when running in LPG mode. The LPG Stepper Motor moves in discrete steps from 0 (fully open) to 216 (fully closed).

Connections

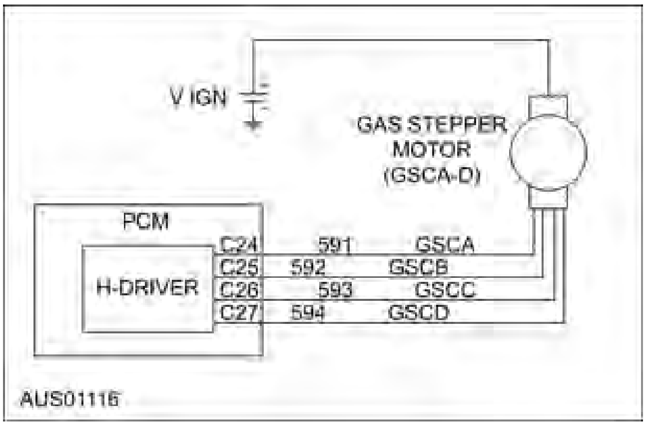
PCM Pin C24.............LPG Stepper Motor A (GSCA)

PCM Pin C25.............LPG Stepper Motor B (GSCB)

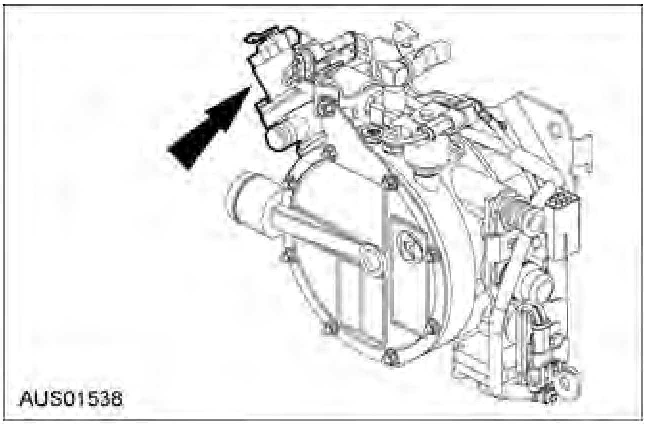
PCM Pin C26…..........LPG Stepper Motor C (GSCC)

PCM Pin C27.............LPG Stepper Motor D (GSCD)

Circuit



LPG Stepper Motor Location



Diagnosis

Diagnostic Trouble Codes (DTC) are retrieved through the diagnostic connector using the IDS tester. Fault Finding Tables for DTCs are in the 'Diagnosis' section.

DTCs applicable to GSMA-D are shown in the following table.

DTC	Test Mode	Condition
P1159	LPG	Fault

Testing

GSMA-D are tested whenever an LPG test is performed.

1. Connect a IDS tester to the diagnostic connector.
2. Check the Parameter Identification (PID) value of the GSM. If the PID value is within specification, then check for other Diagnostic Trouble Codes (DTC) or component faults.

PID Specification

PID	Description	Units
LPG SMP	LPG Stepper Motor Position	100 - 160 Steps

Control Area Network (CAN)

Control Area Network or CAN is a communications bus used in the vehicle for inter-module communications and vehicle diagnostics. Physically the CAN bus is a single balanced twisted pair, the wires in the pair are designated CAN-H and CAN-L. Balanced twisted pair gives greater rejection of EM radiation and better fault tolerance.

Both a high speed, HS, and medium speed, MS, CAN bus structure are present. The gateway between both HS and MS CAN networks is the cluster.

The CAN bus requires termination at either end of the network. The PCM and instrument cluster act as the terminators with the other modules daisy chained or tapping off between them. The PCM and the instrument cluster must be connected for the CAN to function.

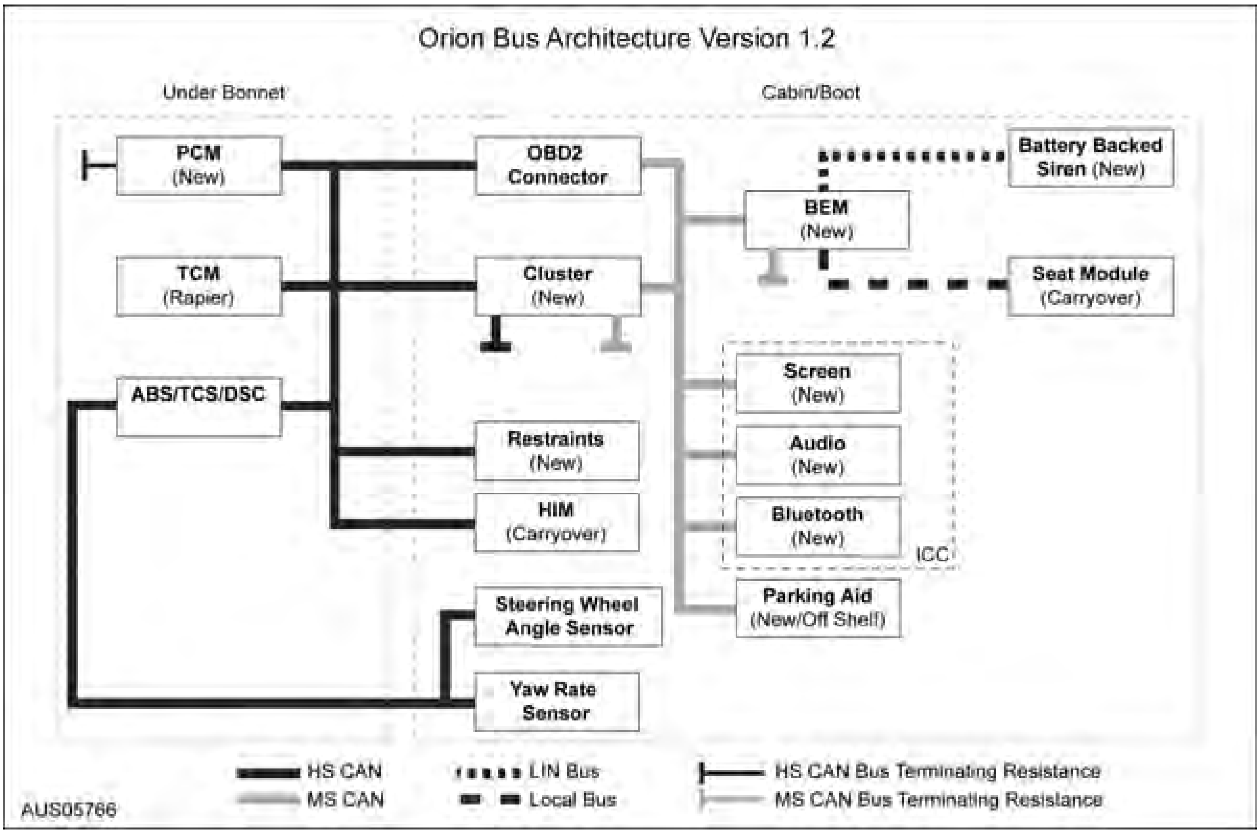
Connection to the CAN bus for diagnostics is via the DLC connector in the fuse panel. The IDS connects to the vehicle using the DLC connector

CAN Wiring Diagram

The layout of the CAN wiring system is dependant up on the vehicle specification and the options fitted.

The following diagrams indicate the CAN and ISO systems utilised across the current model range.

DESCRIPTION AND OPERATION (Continued)



CAN Communications ________________

ISO Communications----------------------------

DESCRIPTION AND OPERATION (Continued)

Communications network (Abbreviations)

ABS	Anti-Locking Brake System
ABS/EVAC	ABS Fluid Evacuation (Service Bleed)
FEM	Front Entertainment Module
ARS	Advanced Restraints System
BEM	Body Electronic Module
BPM	Bluetooth Phone Module
Cluster	Instrument cluster
DLC	Data Link Connector
DSC	Dynamic Stability Control module
FDM	Front Display Module
HIM	HVAC integrated module
ICC	Integrated Central Control Module (Audio / Base heater - blower control)
J/C	Junction Connection
NAV	Navigation System
PAM	Park Assist Module
PCM	Powertrain Control Module
SAS	Steering Angle Sensor
SPM	Sonic Parking Module
TCM	Transmission Control Module
YRS	Yaw Rate Sensor

Commonly received and transmitted signals for the PCM

Signal Name	**Receiving ECU**						
	Traction Control Module	**Body Electronics Module**	**Audio/ Climate Control Module**	**Instrument Cluster**	**Heater Integrated Module**	**TCM**	**IDS Tester**
AC Compressor Clutch status					R		
AC Shed Load					R		
Speed control Telltale				R			
Engine Coolant Temperature				R	R		
Engine RPM	R			R	R		
Engine Temperature Warning				R			
Engine Type	R				R		
Engine Torque	R						
ETC Warning Lamp				R			
Fuel Usage				R			
Log DTC	R	R	R	R			
ODO Count				R			
Oil Pressure Warning				R			
Smartshield Security Codes		R	R	R			
Smartshield Warning Lamp				R			

DESCRIPTION AND OPERATION (Continued)

Signal Name	Receiving ECU						
	Traction Control Module	Body Electronics Module	Audio/ Climate Control Module	Instrument Cluster	Heater Integrated Module	TCM	IDS Tester
Gear Position/ ratio	R		R	R			
Throttle position	R					R	
Transmission Type	R			R			
Vehicle speed		R	R	R	R		
Diagnostics							R

The PCM receives the following data from CAN for its operation:

Signal Name	Transmiting ECU						Function
	Body Electronics Module	Heater Integrated Module	Instrument Cluster	Traction Control	TCM	IDS Tester	
Desired Torque Command				T			Reduce engine torque to the commanded level during traction control events
Evaporator temperature		T					AC compressor protection calculations
Blower voltage		T					Cooling system load calculation to determine appropriate electro-drive fan speed
A/C Clutch request		T					Turns the AC compressor on and off to control the evaporator temperature
Park brake on			T				Cancels speed control
Wheel Speed				T			Vehicle speed calculation
Immobilization Codes	T		T				Smartshield Security
Transmission Fault					T		Indicate fault status of transmission
Transmission Gear					T		Current selected and actual gear
Transmission Mode					T		Indicates the transmission current mode normal/performance
Transmission Oil Temperature					T		Current transmission temperature
Diagnostics						T	Diagnostic Function

DESCRIPTION AND OPERATION (Continued)

Connections

PCM PinB13……………………………… CAN-H

PCM Pin B14……………………………… CAN-L

Diagnosis

Diagnostic Trouble Codes (DTC) are retrieved through the diagnostic connector using the IDS tester. Fault Finding Tables for DTCs are in the ‘Diagnosis’ section.

DTCs applicable to the CAN are shown in the following table.

DTC	Test Mode	Condition
U1900	KOEO, KOER Cont	CAN Communication Bus Fault - Receive Error

Smartshield Security

The PCM forms part of the Smartshield immobilisation system with the BEM, instrument cluster.

Smartshield system diagram

At key-on, the PCM transmit a code on the CAN line to the BEM to determine if the vehicle should be mobilized. The BEM will only respond with a correct code if the key transponder is recognized. The PCM immobilizes the engine if it does not receive the correct response code. The PCM immobilizes the car by deactivating:

- fuel injectors
- ignition system
- fuel pump
- starter motor

The PCM controls the illumination of the Smartshield warning indicator on the instrument cluster using the CAN line. At key-off, the instrument cluster automatically flashes the warning jewel once every 2 seconds. At key-on, the PCM commands the warning jewel to illuminate for 2 seconds for system prove out. The MFD will display ’Vehicle Immobilized’ if the vehicle is in an immobilized state.

Radio Security Code

The PCM transmits a unique PCM ID code on the CAN for the radio’s security system to discourage theft.

Connections

The PCM Smartshield System operates by communicating codes on the CAN line with the BEM, the audio system and the instrument cluster.

Maintenance

Replacement of the PCM, BEM and keys will require a “Parameter Reset ” to be performed.

1. Connect a IDS tester to the Data Link Connector (DLC).
2. Turn the ignition to the RUN/START position
3. Select Tool box icon, "Body Functions", then "Security" and follow the menu directions, then select the appropriate function, e.g. Key Train, Parameter Reset
4. Enter security access for coded parameter reset
5. G-Sevin coded access screen is displayed (copy data)
6. Enter the above data into the G-Sevin network, which will return the incode. Enter the incode and follow the on-screen instructions.
7. When the BEM is trained correctly, the door locks will cycle twice.
8. Remove the IDS tester.
9. Cycle the ignition key OFF then RUN/START.
10. Verify that the Smartshield indicator turns on for 2 seconds and the vehicle will start.

Replacement of the PCM will also require the audio system to be trained to the new PCM ID code. This procedure can be carried out by using the IDS tester.

Diagnosis

DTCs applicable to the PCM Smartshield system are shown on the following table.

DTC	Test Mode	Condition	Action required	
B2139	KOEO Cont	PCM or BEM substituted on vehicle BEM does not recognise ignition key	Re-install original components or perform a Parameter Reset operation to train the immobilization system Check BEM DTCs	
B2141	KOEO Cont	Incomplete PCM/BEM training.	Check KAPWR to PCM, BEM, and CAN lines then perform Parameter Reset Operation again.	
P1260	KOEO Cont	Vehicle Immobilized.	Check other DTCs.	MIL ON **-NO**
U1147	KOEO Cont	Unsuccessful PCM/BEM ID training	Check BEM and CAN operation	

Failure Mode

Failure in any part of the Smartshield Security System will result in no vehicle operation.

DESCRIPTION AND OPERATION (Continued)

Start Relay

The Smartshield and Smart Start function of the PCM strategy control the START relay. The START relay is enabled when the Smartshield immobilisation system is not immobilised. After the vehicle starts, the START relay is de-energise to prevent unintended starter motor operation.

NOTE: If a key erase and program function is used, a parameter reset must be performed to mobilize a vehicle.

Connections

PCM PinB4…………………..… …..…….STRTEN

Testing

1. Observe that the Smartshield warning lamp operates for 2 seconds when the ignition is key is turned from the OFF to the RUN position. If the Smartshield warning lamp flashes, refer to the Smartshield section in this group.
2. Attempt to start the vehicle in the “P” and “N” positions.
3. Check that condition of the start relay located in the fuse/relay box adjacent to the battery.
4. Check the harness for open circuits and short circuits.

DESCRIPTION AND OPERATION (Continued)

Diagnosis

Diagnostic System

A sophisticated on-board diagnostic system is integrated into the PCM software to monitor input and output components.

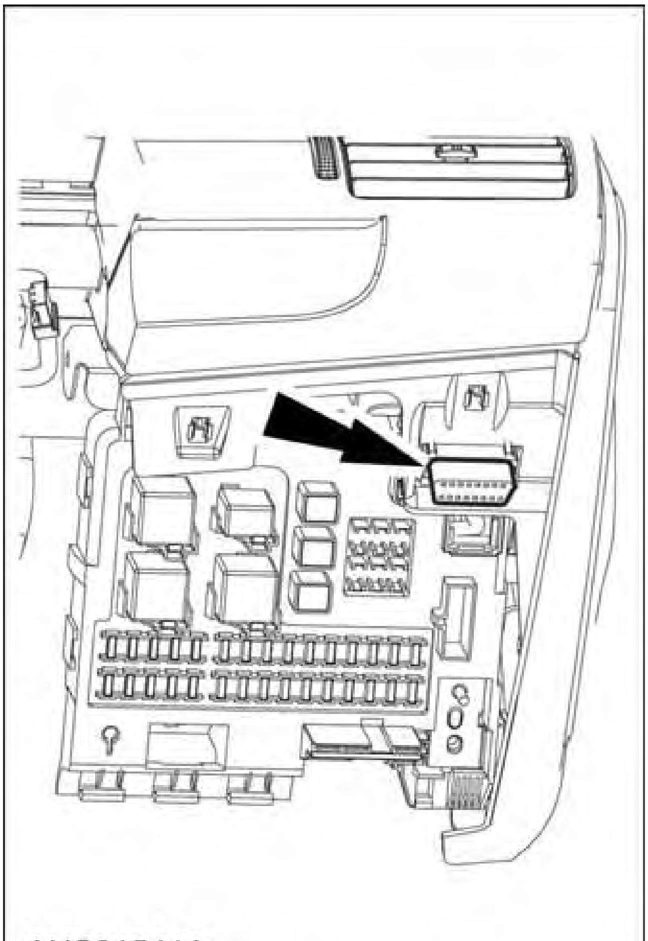
The Powertrain Control Module (PCM) checks that sensors and calculated values are within specified operating parameters. The test varies according to the diagnosis mode and the component. Where a value falls outside of parameters, a Diagnostic Trouble Code (DTC) is reported and logged in the PCM's memory for retrieval. Components and circuits are tested in various ways depending on the hardware, function, and type of signal.

Analogue inputs are typically checked for open or short circuits, and out-of-range values. Outputs are checked for open or short circuits by monitoring the circuit associated with the output driver when the output is energised or de-energised. Some outputs are also monitored for the proper function by measuring the reaction of the control system to a given output command.

Diagnostic Connector

Diagnostics on the PCM are accessed through the diagnostic connected, situated in the fuse compartment below and to the right of the steering column. Connect a Integrated Diagnostic System (IDS) tester to retrieve any Diagnostic Trouble Codes (DTC), initiate self-testing diagnostics, retrieve Parameter Identification (PID) values or reset the Keep Alive Memory (KAM) or adaptive values.

Diagnostic Connector Location



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Diagnostic Modes

The PCM powertrain control management system has two diagnostic modes: Continuous Testing and On-Demand Tests.

Continuous testing occurs during normal vehicle operation. Faults or malfunctions which occur during operation are logged in Keep Alive Memory (KAM) for later retrieval.

On-demand tests are initiated as required to diagnose faults or check vehicle condition. During on-demand tests, the Powertrain Control Module (PCM) checks various sensors and circuits for faults or malfunctions.

Continuous Testing

Continuous testing occurs throughout normal vehicle operation. Testing commences 4 seconds after the ignition key is moved to the ON position. Continuous testing does not occur whenever on-demand tests are being performed.

When the Powertrain Control Module (PCM) detects a fault or malfunction a Diagnostic Trouble Code (DTC) is reported and stored in the PCM's Keep Alive Memory (KAM) memory. KAM has its own power supply that retains the codes even after the ignition is

DESCRIPTION AND OPERATION (Continued)

switched OFF. DTCs can be retrieved by the Integrated Diagnostic System (IDS) testing tool.

Continuous DTCs can be retrieved or cleared at any time using the IDS, independently of on-demand DTCs.

To eliminate the storage of transient conditions, continuous fault codes are filtered. Only DTCs present for a specific duration are stored in memory.

NOTE: Disconnecting the battery will clear the KAM and all DTCs stored in memory.

Once a DTC is stored, it remains in memory until manually cleared or the PCM is disconnected from the battery supply. If a stored continuous DTC does not occur for 80 subsequent key-ons, then the code is erased from memory.

When a DTC is reported from a major input or output sensor or circuit, the PCM will log the DTC. A Failure Mode Effects Management (FMEM) flag is set internally in the PCM, which then, if necessary, will implement a FMEM strategy to allow continued operation of the vehicle.

The PCM performs the following continuous tests:

- Analogue/Digital Limit Check
- Air Conditioning System Tests
- CMP Test
- EDIS Test
- CMP Test
- VSS Test
- Auto Transmission Test
- Traction Control Test
- Output Circuit Check
- Setting Of Failure Mode (FMEM) flags
- Servicing Warm-up Counters
- Fault Filter Calibration

Analogue/Digital Limit Check

The Analogue/Digital Limit Check tests the limits and range of some analogue sensors. The check tests for short or open circuit sensors and performs a range test on each sensor to ensure it is within the expected operating range.

Range checks are only performed where the sensor or circuit passes the limit test.

The following sensor signal limits are checked during the Analogue/Digital Limit Check and associated Diagnostic Trouble Codes (DTC) are reported if items tested are not within specification. Note that the VPWR test is designed to check continuity of the PCMs internal power circuit (IVPWR). VPWR does not test battery voltage.

- Temperature and Manifold Absolute Pressure (T-MAP)
- Throttle Position Sensor (TP) <TPS>
- Air Conditioner Refrigerant Discharge Temperature (ACRT)
- Transmission Fluid Temperature Sensor (TFT) <TOT>
- Transmission Range Sensor (TR) <TRS>
- Knock Sensor (KS)
- Vehicle Power (VPWR)

Air Conditioning System Tests

Key On Engine Running (KOER) test with A/C check

NOTE: The A/C check run during the KOER test is used to determine if the cooling capability of the air conditioning system is below a minimum acceptable limit, known as a Low Charge Protection (LCP) limit, using the IDS diagnostic tool.

Special Tool(s)	
	Integrated Diagnostic System/Portable Diagnostic System (IDS/PDS)

Test Procedure

NOTE: This test is to be conducted in an ambient temperature of 10 C to 40 C.

1. Connect the IDS diagnostic tool to the vehicle via the diagnostic connector.
2. Prior to starting the KOER test, run the vehicle at idle for 2 minutes (minimum) with the A/C switched OFF at the ICC controls, and with FRESH air mode, FACE vents, MAX COLD temperature and MAX FAN speed selected. Ensure all doors and windows are fully closed, and the rear of the vehicle is protected from any tail wind.

NOTE: If the above test conditions are not selected and maintained, the KOER test could result in a false fail and set DTC P0534.

3. Start the KOER test via the IDS.
4. **Within 10 seconds of starting the KOER test,** switch on the A/C button at the ICC controls. (Note that the A/C will be switched off and on automatically by the IDS during the KOER test).

The DTCs applicable to an air conditioning performance issue are shown in the following table.

DESCRIPTION AND OPERATION (Continued)

DTC	Test Mode when DTC set	A/C Pressure when DTC set	Condition	MIL ON
P0534	KOER	All pressures	Poor A/C System performance, most likely cause is low A/C refrigerant charge or compressor clutch electrical connector is not correctly plugged in. Other possible causes are A/C System blockage, faulty evaporator thermistor, faulty HVAC blower, and faulty compressor.	NO
P0532	KOER and continuous	Less than 50kPa	A/C system performance test failed, because A/C disabled with system pressure less than 50kPa. Most likely causes are no A/C refrigerant charge at all, or faulty pressure transducer (sensor out of calibration, open circuit).	NO
P0533	KOER and continuous	All pressures	Most likely cause is faulty pressure transducer (sensor out of calibration, short circuit).	NO
P145A	KOER	Less than 200kPa	A/C system performance test failed, because A/C disabled with system pressure less than 200kPa. Most likely cause is very low A/C refrigerant charge.	NO
P145B	KOER	Greater than 200kPa	A/C System performance test failed, because A/C not switched on at ICC controls when KOER test run	NO

P0534 is the DTC applicable to an A/C Low Charge Protection failure due to poor A/C system performance. This test is only valid if the A/C system is operating with a refrigerant pressure above 200kPa. However, if the A/C is disabled for other reasons, P0534 will be set and other DTCs such as P0532, P145A or P145B will also be set. Once set, DTC P0534 will remain on for 40 engine warm-up cycles only, but will not disable the A/C compressor.

P0532 is the DTC applicable to an A/C zero pressure failure, and occurs if the refrigerant pressure reading is below 50kPa. Once set, this DTC will disable the A/C compressor until the fault is repaired.

P0533 is the DTC applicable to an A/C over-pressure failure, and occurs if the refrigerant pressure reading is out of range. Once set, this DTC will disable the A/C compressor until the fault is repaired.

P145A is the DTC applicable to an A/C low pressure failure in the KOER test only, and occurs if the refrigerant pressure reading is below 200kPa. Once set, this DTC will disable the A/C compressor until the fault is rectified or at the next ignition key-on after an A/C system pressure greater than 200kPa is achieved.

P145B is the DTC applicable to an incorrectly run KOER test, where the A/C was not switched on at ICC controls when the KOER test was run. This DTC will not disable the A/C compressor.

NOTE: Once the fault has been rectified, ALL DTC flags will be cleared and the A/C system re-enabled via the vehicle diagnostic connector, using the IDS diagnostic tool. The ignition must be keyed off for 2 seconds minimum prior to clearing all DTCs with the IDS diagnostic tool

COP Test

The COP Test checks the test checks the continuity of the ignition coil circuits and verifies if a coil has fired since the test was last performed.

CMP Test

The CMP Test checks the Camshaft Position Sensor (Cylinder Identification) (CMP) <CID> signal and circuit.

DTC P0340 is reported if the CMP sensor or its circuit have malfunctioned.

DTC P0320 is reported if duration between CMP signal is greater than a specified value.

VSS Test

The Vehicle Speed Sensor Test checks the Vehicle Speed Sensor (VSS) signal and circuit.

DTC P0500 is reported if the VSS sensor or its circuit has malfunctioned.

DESCRIPTION AND OPERATION (Continued)

Automatic Transmission Tests (4 Speed Automatic Transmissions Only)

The Auto Transmission Tests check the operation and circuit continuity of the Transmission Range Sensor (TRS-A1), (SS1-4, VPS, LUS and PCS).

DTC **P0706** is reported if the TR signal is either out of range or demonstrates a performance problem. DTC P0753 is reported if SS1 or its circuit have failed.

DTC **P0758** is reported if SS2 or its circuit have failed.

DTC **P0763** is reported if SS3 or its circuit have failed.

DTC **P0768** is reported if SS4 or its circuit have failed.

DTC **P0748** is reported if Variable Pressure Solenoid 5 (VPS) or its circuit have failed.

DTC **P0778** is reported if Power Control Solenoid 6 (PCS) or its circuit have malfunction.

DTC **P0743** is reported if the Lock Up Solenoid 7 (LUS) or its circuit have failed.

Solenoids Electrical Fault Logic (4 Speed Automatic Transmissions Only)

When a transmission solenoid electrical fault is detected, the fault is latched: i.e. remains set until next key-on event.

Intermittent faults that do not trigger the latch mechanism are not reported.

Output Circuit Check

The Output Circuit Check tests some outputs for a short or open circuit.

The following sensor signal limits are checked during the Output Circuit Check and associated Diagnostic Trouble Codes (DTC) are reported if items tested are not within specification.

- Electro Drive Fan 1 (EDF1)
- Electro Drive Fan 2 (EDF2)
- Fuel Pump (FP)
- Air Conditioning Request (ACR)
- Evaporative Canister Purge Solenoid (EVAP) <CANP>
- Variable Cam Timing (VCT),
- Intake Manifold Runner Control (IMRC) <BBM>
- Fuel Injectors 1-8 (INJ1-8)

Each time the engine is re-started from cold the warm-up counter is incremented by one. If the fault causing fault the code is not present after 80 warm-up cycles, the code is erased from memory.

Fault Filter Calibration

Each continuous fault code has a fault filter to avoid setting a DTC for transient (seen only for a split second) error conditions. When a particular fault occurs during operation the corresponding fault filter increments a background counter by one. For each key-on event the code is not present, the counter is reduced by one. If the counter reaches a specified limit, then a DTC is logged. Continuous DTCs stay in memory until cleared by Servicing Warm-up Counters or manually using the (IDS) tester, or by resetting the Keep Alive Memory (KAM).

On-Demand Testing

On-demand testing is initiated to diagnose faults or check operating conditions. On-demand Testing can only commence 4 seconds after the ignition key is moved to the ON position. Continuous testing does not occur whenever on-demand tests are being performed.

When the Powertrain Control Module (PCM) detects a fault or malfunction a Diagnostic Trouble Code (DTC) is reported and stored in the PCM’s Keep Alive Memory (KAM) memory. KAM has its own power supply that retains the codes even after the ignition is switched OFF. DTCs can be retrieved by the Integrated Diagnostic System (IDS) testing tool.

On-demand DTCs can be retrieved or cleared at any time using the IDS, independently of continuous DTCs.

If an on-demand test is requested and conditions are not correct for the test to run, a “conditions not correct” message is displayed on the IDS.

On-demand test fault codes are only returned to the IDS tester if the test completes normally. On-demand tests exit the checking procedure under the following conditions:

The test completes normally or runs to completion without interruption unless:

- The test is aborted by the operator; “Cancel” command is issued from the IDS
- The IDS test equipment is unplugged from the vehicle before the test procedure is complete
- Operational or vehicle conditions change so that conditions needed to continue the test are no longer met.
- The time taken to run the test exceeds a pre-set limit for the test.

There are seven on-demand test modes. Each is described in further detail in the following sections.

- Key On Engine Off (KOEO)
- Key On Engine Running (KOER)
- Throttle Test
- Ignition Timing Test
- Cylinder Contribution Test
- Output Test Mode (OTM)
- LPG System Test, I6 engines, where fitted

The KOEO and OTM tests are done with key on, engine off.

All other on-demand tests are done with key on engine running, and the vehicle stationary.

Key On Engine Off (KOEO) and Key On Engine Running (KOER) tests can only be run once during

DESCRIPTION AND OPERATION (Continued)

each key on event. The ignition key must be moved to the OFF position before the tests can be re-initiated.

Key On Engine Off (KOEO) test

NOTE: On manual transmission vehicles, the clutch pedal must be depressed during the whole test.

The Key On Engine Off (KOEO) on-demand self-test is a functional test of the powertrain control system. The test checks various sensors and circuits with the ignition key in the ON position and the engine off:-not running. For a fault to be detected during this test the fault must be present at the time the test is initiated or running. Once a fault is detected a Diagnostic Trouble Code (DTC)will be logged in the Powertrain Control Modules (PCM)memory and output to the Diagnostic Link Connector (DLC) for retrieval by a Integrated Diagnostic System (IDS) tester to the diagnostic tool.

KOEO test is performed only once for each key on event. The ignition must be switched to the ON position for at least 4 seconds; do not move the ignition switch to the START position. When the conditions for KOEO test initiation are met, and the test has not already been performed during the current key on session, the PCM performs the following tests:

- PCM Processor and ROM/RAM Test
- Analogue/Digital Limit and Range Check
- Vehicle State Check
- Electronic Immobilisation Check
- Output Circuit Check
- Engine Cooling Fans Check

PCM Processor and ROM/RAM test

PCM Processor and ROM/RAM Test checks the PCM Central Processing Unit (CPU), Random Access Memory (RAM), Keep Alive [Memory] Power (KAPWR) and Read Only Memory (ROM) checksum. If any item fails the test, a Diagnostic Trouble Code (DTC) is logged in memory and displayed on the Integrated Diagnostic System (IDS) tester.

DTC P0603 is reported if the KAPWR has been reset since the last key on event

DTC P0605 is reported if the ROM checksum test fails

DTC P0606 is reported if either the CPU or RAM check fails

Analogue/Digital Check

The Analogue/Digital Limit Check tests the limits and range of some analogue sensors. The check tests for short or open circuit sensors and performs a range test on each sensor to ensure it is within the expected operating range. Range checks are only performed where the sensor or circuit passes the limit test. The following sensor signal limits are checked during the Analogue/Digital Limit Check and associated Diagnostic Trouble Codes (DTC) are reported if items tested are not within specification.

- Temperature and Manifold Absolute Pressure (T-MAP)
- Throttle Position Sensor (TP) <TPS>
- Air Conditioner Pressure Transducer (ACPT) (ACRT)
- Transmission Fluid Temperature Sensor (TFT) <TOT>
- Transmission Range Sensor (TR) <TRS>
- Vehicle Power (VPWR)

Vehicle State Check

The Vehicle State Check tests that the Power Steering Pressure (PSP)switch is not active, that no Air Conditioner Demand (ACD) is present during KOEO, I6 engines, and for the Transmission Range Sensor (TR) <PRNDL> (automatic transmission only) is in either Park or Neutral.

DTC P1650 is reported the PSP is active

DTC P1705 is reported if the TR is in any position other than Park or Neutral

Output Circuit Check

The Output Circuit Check tests some outputs for a short or open circuit. The outputs are turned off before the check; each output is then switched on in turn for 50 milliseconds during the test.

The following sensor signal limits are checked during the Output Circuit Check and associated Diagnostic Trouble Codes (DTC) are reported if items tested are not within specification.

- Electro Drive Fan 1 (EDF1)
- Electro Drive Fan 2 (EDF2)
- Fuel Pump (FP)
- Air Conditioning Request (ACR)
- Evaporative Canister Purge Solenoid (EVAP) <CANP>
- Variable Cam Timing (VCT)
- Intake Manifold Runner Control (IMRC) <BBM>.

Key On Engine Running (KOER) test

The Key On Engine Running (KOER) on-demand self-test is a functional test performed with the engine operating in normal conditions and temperatures. This test is to be conducted in an ambient temperature of 10°C to 40°C. The test checks various sensors and circuits with the ignition key in the ON position and the engine on:-running. For a fault to be detected during this test the fault must be present at the time the test is initiated or running. This test calls for some operator intervention to test additional sensor information. This includes

1. Turning the steering wheel to open the Power Steering Pressure Switch (PSP) <PSPS>.
2. Depressing the brake pedal.
3. Switching on the Air Conditioning within 10 seconds after starting the KOER test.

DESCRIPTION AND OPERATION (Continued)

Once a fault is detected a Diagnostic Trouble Code (DTC) will be logged in the Powertrain Control Modules (PCM) memory and outputs it to the Diagnostic Link Connector (DLC) for retrieval by a Integrated Diagnostic System (IDS) tester to the diagnostic tool.

KOER test is performed only once for each key on event. The ignition must be switched to the ON position for at least 4 seconds before a new test can be initiated. The test is initiated by the IDS when the vehicle stationary, engine running, transmission in either Park or Neutral, as appropriate; and test has not already been performed during the current key on session:

- Initialisation
- Analogue/Digital Limit Check
- High/Low Idle Speed Test
- Fuel Ramp Lean/Rich Test
- Spark Advance Test
- PSPS Operated Check I6 engines
- Air Conditioning System Test (requires A/C pre-conditioning test procedures, refer to relevant part of this section)

Initialisation

The Initialisation phase prepares the vehicle for KOER test by switching off Evaporative Canister Purge Solenoid (EVAP) <CANP>, switching off any Air Conditioner Demand (ACD)Spark advance feedback is normally enabled during KOER testing, except during the Spark Advance, Ignition Timing and Cylinder Contribution tests. During these tests spark advance feedback is disabled and the timing is fixed.

Analogue/Digital Limit Check

The Analogue/Digital Limit Check tests the limits and range of some analogue sensors that are not covered by Key On Engine Off test. The check tests for short or open circuit sensors and performs a range test on each sensor to ensure it is within the expected range under actual engine operating conditions. Range checks are only performed where the sensor or circuit passes the limit test.

The following sensor signal limits are checked during the Analogue/Digital Limit Check and associated Diagnostic Trouble Codes (DTC) are reported if items tested are not within specification.

- The Cylinder Head temperature Sensor (CHT)
- Temperature and Manifold Absolute Pressure (T-MAP)
- Throttle Position Sensor (TP) <TPS>

High/Low Idle Speed Test

The High/Low Idle Speed Test checks that the Electronic Throttle Control (ETC) can properly control the idle speed. The test increases then decreases the idle speed and measures the change in engine speed.

DTC P0507 is reported if the idle speed is higher than the expected low idle speed

DTC P0506 is reported if the idle speed is lower than the expected high idle speed

Fuel Ramp Lean/Rich Test

The Fuel Ramp Lean/Rich Test varies the Fuel Injector Pulse Width and measures the Heated Exhaust Gas Oxygen Sensors (HEGO) signal to detect if the Powertrain Control Module (PCM) can successfully control the air fuel ratio between lean and rich.

If DTC **P0131** or **P0151**, V8 engine, HEGO sensor short circuit is already set, the Fuel Ramp Lean/Rich Test will not be performed.

I6 Engines

DTC P0172 is reported if the air fuel ratio is too rich during the lean phase of the test

DTC P0171 is reported if the air fuel ratio is too lean during the rich phase of the test

V8 Engines

DTC P0172 is reported if the air fuel ratio is too rich on cylinder bank 1 during the lean phase of the test

DTC P0175 is reported if the air fuel ratio is too rich on cylinder bank 2 during the lean phase of the test

DTC P0171 is reported if the air fuel ratio is too lean on cylinder bank 1 during the rich phase of the test

DTC P0174 is reported if the air fuel ratio is too lean on cylinder bank 2 during the rich phase of the test

Power Steering Pressure Switch Operated Check

A requirement of KOER test is that the test operator moves the steering wheel to either left or right hand extreme lock to operate the Power Steering Pressure Switch (PSP).

The PCM checks that the power steering pressure switch changes state during the KOER test.

DTC P1651 is reported if the PSP does not change state during the test.

DESCRIPTION AND OPERATION (Continued)

Output Test Mode

The Output Test Mode (OTM), No. 84, allows some Powertrain Control Module (PCM) outputs to be switched on and off manually using the Integrated Diagnostic System (IDS) tester. Either an audible sound or visually verification of a device can confirm its operation. The OTM may be performed more than once during a KOEO event. TM can only be entered with the key in the ON position and the engine off:-not running. There are no fault codes reported following this test. The test will time out and abort if the test time in any one state exceeds a specified limit.

Once OTM has been entered, there are 4 states that can be manually selected, as shown in the following table.

Output Test Mode States

State Description

All On The following outputs are switched on (engine cooling fans off): Air Conditioning Clutch Relay (ACR), evaporative Emission Canister Purge (EVAP), Starter Relay (START), Fuel Pump (FP) relay, Intake Manifold Charge Control (IMCC) and Variable Cam Timing (VCT)* All Off The outputs listed above, and engine cooling fans, are switched off.

Fans Low The engine cooling fans (EDF1-2) are switched on at low speed; all other outputs above switched off. Fans High The engine cooling fans (EDF1-2) are switched on at high speed; all other outputs above switched off.

LPG System Test

The LPG System Test checks the operation of the complete LPG fuel control system on vehicles with Ford Factory Fitted LPG systems.

The PCM uses the Heated Exhaust Gas Oxygen Sensor (HEGO) signal to detect that a change in the air fuel ratio occurs when the LPG stepper motor is actuated. The LPG stepper motor is ramped lean and then rich to force a change in the HEGO output. The test will fail if the system fails to switch either lean or rich within a set time or if the RPM drops below its predefined limits. A failure in this test can be caused by faulty stepper motor, wiring, PCM, HEGO sensor or LPG converter.

Code P1159 is reports a fuel stepper motor malfunction if the air fuel ratio cannot be changed by the PCM during the test.

Ignition Test

The Ignition Test sets the ignition spark advance to a fixed value so that ignition timing can be manually checked using a timing light. Fixed timing mode stays in effect for 2 minutes or less if cancelled from the IDS. Fixed timing can be performed more than once during the same Key On Engine Running (KOER) test session.

No fault codes are reported from the ignition test.

Air-Conditioning System Test

Refer to relevant part of this section.

Parameter Identification

A Parameter Identification (PID) represents an internal Powertrain Control Module (PCM) parameter. PIDs accessed using the Integrated Diagnostic System (IDS) tester are displayed as parameter names with operating values of analogue and digital inputs/outputs, calculated values and system status information.

The IDS PID data monitor and record data function can display values and data dynamically during normal running and can also record the data for detailed diagnosis.

Input PID values can immediately confirm the status of a sensor and its associated circuit to the Powertrain Control Module (PCM). Similarly output PID values can monitor the operation of an output device or signal being sent from the PCM.

Use of PIDs minimises the need to perform pin out tests. Circuit continuity and a sensor’s actual operating value can be read directly from the IDS. PIDs can optimize diagnostic time by quickly identifying faulty components or circuits.

DESCRIPTION AND OPERATION (Continued)

Steering Wheel Switches

The steering wheel switches consist of the following:

- Audio Control Switches
- Cruise Control Switches
- Horn-pad switch wiring

DIAGNOSIS AND TESTING

Powertrain Control Management

Diagnostic Trouble Codes

The PCM diagnostic system monitors the condition of various sensors and circuits associated with control of the powertrain. A Diagnostic Trouble Code (DTC) is reported and logged in memory to identify the specific area where a fault has been reported to the Powertrain Control Module (PCM).

Retrieving Diagnostic Trouble Codes

Diagnostic data is accessible with the Integrated Diagnostic System (IDS) tester to assist in diagnosing faults and operating conditions on the vehicle. The system is accessed through the diagnostic connector situated in the fuse box, below and to the right of the steering column.

The functions and operation of the IDS are described in the Integrated Diagnostic System (IDS) Tester Instruction Manual.

Diagnostic Communications

The PCM communicates with the Integrated Diagnostic System (IDS) tester through the diagnostic connector using the Control Area Network (CAN).

Diagnostic communications failure

In the event IDS/PDS is unable to establish communication the following procedures can be adopted.

PCM Programming

A PCM may need to be reprogrammed or replaced as part of a repair. Additional vehicle concerns may be caused if proper programming procedures are not followed.

Action:

Use the following procedure to reprogram the PCM. Verify repair after reprogramming.

Service Procedure

Preliminary Steps - Existing PCM Reprogramming or PCM Replacement

1. Connect a low amperage battery charger to vehicle.
2. Use IDS.
    1. Make sure IDS is attached to vehicle battery supply.
    2. Verify IDS software is at the latest release level.
3. If there is a communication error, attempt to communicate with a different IDS unit or PDS if available.
4. If you can communicate with another diagnostic scan tool, carryout IDS diagnostics particularly cable test procedures
5. If communications cannot be established, check VPWR, ignition supply and ground connections to PCM

PCM Replacement - Standard

1. Open IDS vehicle session with original PCM installed in vehicle. If the original PCM is not able to communicate, to open a session, proceed to the Blank Path Programming procedure.
2. Install the new PCM.

    NOTE: If the IDS is required for use on another vehicle while the PCM is being fitted, place the session on "HOLD" for use later

3. Attempt to start the vehicle.
4. Run KOEO Self Test to check for diagnostic trouble codes (DTCs) in PCM.
5. Check for DTC **P0602/P0605/P1639.**
    * If DTC **P0602/P0605/P1639** is present then Programmable Module Installation (PMI) procedure must be performed. Use the IDS session opened at Step 1.
    * If DTC **P0602/P0605/P1639** is not present, then verify Programmable Parameters are properly set such as tyre size, axle ratio, etc.
6. Check for DTC **B2900.**
    * If DTC **B2900** is present, perform PMI on the ABS module. Do Not replace ABS module for this procedure when directed. You may be prompted to enter the 9 lines of PCM As-Built data during this procedure.
    * If DTC **B2900** is not present proceed to Step 7.
7. Diagnose all other DTCs following normal diagnostic procedures.

REPROGRAMMING DOES NOT COMPLETE OR FAILS - Existing PCM Reprogramming or PCM

Replacement

1. Verify all cables are properly connected.
2. Verify vehicle battery is at proper charge level.
3. Verify scan tool battery is at proper charge level.
4. Attempt reprogramming procedure again.
5. If reprogramming still does not complete properly, save current session, reboot IDS, open previous session, and attempt reprogramming again.
6. If reprogramming still does not complete or you are now unable to communicate with PCM, proceed to the Blank Path Programming procedure.

DIAGNOSIS AND TESTING (Continued)

Resetting The Powertrain Control Module

NOTE: Do not disconnect the battery to clear the Keep Alive Memory (KAM) or Diagnostic Trouble Codes (DTC) unless absolutely necessary. Disconnecting the battery will clear the PCM memory, including the adaptive values.

Clearing Diagnostic Trouble Codes (DTC)

Once a system fault has been rectified, the diagnostic trouble codes must be cleared from the PCM memory using the Integrated Diagnostic System (IDS) tester.

1. Connect the Integrated Diagnostic System (IDS) tester to the diagnostic connector.
2. Initiating Retrieve/Clear Continuous DTCs.
3. After the codes appear on the screen, press "CLEAR", to erase DTCs from memory.
4. Verify the codes have been erased by test-driving the vehicle and then repeat Step 2.

Quick Reference DTC list.

This list has been devised as a basic guide to direct you to the relevant area of concern as quickly as possible.

The Diagnostic Trouble Codes (DTCs) are listed numerically and are not necessarily grouped by fault and or system.

NOTE: Not all the DTCs listed here may be active on the vehicle; it is dependant up on vehicle specification.

Although this section is primarily concerned with PCM related DTCs reference is made to other modules to which PCM performance is either directly or indirectly related.

NOTE: Before commencing any electrical diagnostic procedure, assess the general condition of the associated mechanical components for serviceability. Carry out a preliminary inspection of the condition of the electrical system for damage to wiring and/or connectors. Ensure the vehicle battery is in good condition

If you disconnect a sensor or actuator with the ignition switched ON, you may induce further DTCs. Therefore when carrying out your preliminary inspection ensure the **ignition is in the OFF position**.

This section has been devised as a quick reference guide and consists of general diagnostic procedures. **For specific diagnostics, refer to the relevant sections within this manual.**

You will notice many of the comments in the **"POSSIBLE CAUSE"** sections indicate **"DEFECTIVE PCM".** Modern PCM's are extremely reliable and are rarely the primary cause of the concern.

NOTE: The PCM should only be replaced after all the other diagnostic procedures have been completed

DTCs can be recorded at various times and under differing conditions

CONTINUOUS (Cont.)

These are DTCs that are monitored at all times during vehicle operation.

In the event a customer complains of a potential performance related issue, and there are no current DTCs recorded, it is recommended to run a KOEO test and a KOER test.

KEY-ON ENGINE-OFF (KOEO)

This is carried out with IDS with a view of checking a number of specific components and systems for condition and integrity.

To access the KOEO test. Connect the IDS to the vehicle and ensure it correctly identifies the vehicle. From the toolbox icon select selftest and follow the relevant instructions. Failure to follow the instructions on IDS can lead to additional DTCs being recorded.

Simplified procedure **TOOLBOX > SELFTEST > POWERTRAIN > ENGINE > KOEO**

This self-test is normally completed within 20 seconds.

KEY-ON ENGINE-RUN (KOER)

This is carried out with IDS with a view of checking a number of specific components and systems for condition and integrity.

To access the KOER test. Connect the IDS to the vehicle and ensure it correctly identifies the vehicle. From the toolbox icon select selftest and follow the relevant instructions on IDS. Failure to follow the instructions on IDS can lead to additional DTCs being recorded.

Simplified procedure **TOOLBOX > SELFTEST > POWERTRAIN > ENGINE > KOER**

If the KOER test fails to complete **P1001** will be stored

This self-test is normally completed within 34 seconds

MALFUNCTION INDICATOR LAMP (MIL)

If the PCM detects a DTC which causes the powertrain to operate outside the emissions parameters twice, it will illuminate the MIL. In the following DTC table, MIL related faults are indicated by a **Y** in the **MIL ON** column.

Non MIL related DTCs will be accessible through IDS/PDS.

Faults with either the Throttle Body or Accelerator Pedal Position switch will illuminate the ETB light on the instrument cluster and the engine will be running a Failure Mode Effects Management (**FMEM**) strategy **(Guard Mode)**

Freeze frame data should be available for MIL related DTCs. This is a valuable tool for information indicating the conditions the Powertrain was operating under

DIAGNOSIS AND TESTING (Continued)

when the DTC was recorded.

General note when encountering multiple DTCs

If when retrieving DTCs it is found there are a large number of them, it is suggested to identify and **record the DTCs**. Attempt to identify any common theme i.e. "reference voltage" or "temperature" related defects; this can aid the diagnostic process.

Clear all the DTCs.

Run both a KOEO and a KOER test. Investigate any recorded DTCs during this process before preceding to carryout a road test with IDS/PDS

Monitor the appropriate systems using IDS/PDS under road test conditions. The first DTCs that occur are normally the primary areas of concern and may have triggered further DTCs in associated systems.

Using the World-wide Diagnostic System (IDS)

If you encounter problems establishing communication between IDS and the vehicle, this does not necessarily indicate there is a problem with the vehicle.

Attempt to establish communication using the TEAR TAG, Calibration Code or PCM Part Number.

If you are still having difficulty, carryout the IDS diagnostic procedure for cables and check the serviceability of the 16 pin DLC cable **B-280.**

Also ensure IDS is running the latest software.

Accessing Datalogger

Some of the parameters described in this section may not be available through normal Datalogger. However, with the inclusion of EOBD there is now a second set of Datalogger readings available via the OBD test mode. This Datalogger is exclusively EOBD. If during normal Datalogger monitoring you either cannot find a particular display or you are unable to adjust the parameters to provide an accurate display you may find them via the EOBD Datalogger.

To access EOBD Datalogger:-**VEHICLE SPECIFICATION PAGE > TOOLBOX > POWERTRAIN > OBD TEST MODES > MODE 1 POWERTRAIN DATA.**

PCM Programming

A PCM may need to be reprogrammed or replaced as part of a repair. Additional vehicle concerns may be caused if proper programming procedures are not followed.

ACTION:

Use the following procedure to reprogram the PCM. Verify repair after reprogramming.

SERVICE PROCEDURE

PRELIMINARY STEPS - Existing PCM Reprogramming or PCM Replacement

1. Connect a low amperage battery charger to vehicle.
2. Use IDS.
    1. Make sure IDS is attached to vehicle battery supply.
    2. Verify IDS software is at the latest release level.
3. If there is a communication error, attempt to communicate with a different IDS unit or PDS if available.
4. If you can communicate with another diagnostic scan tool, carryout IDS diagnostics particularly cable test procedures
5. If communications cannot be established, check VPWR, ignition supply and ground connections to PCM

PCM REPLACEMENT - STANDARD

1. Open IDS vehicle session with original PCM installed in vehicle. If the original PCM is not able to communicate, to open a session, proceed to the Blank Path Programming procedure.
2. Install the new PCM.

    NOTE: If the IDS is required for use on another vehicle while the PCM is being fitted, place the session on "HOLD" for use later
3. Attempt to start the vehicle.
4. Run KOEO Self Test to check for diagnostic trouble codes (DTCs) in PCM.
5. Check for DTC **P0602/P0605/P1639.**
    1. If DTC **P0602/P0605/P1639** is present then Programmable Module Installation (PMI) procedure must be performed. Use the IDS session opened at Step 1.
    2. If DTC **P0602/P0605/P1639**is not present, then verify Programmable Parameters are properly set such as tyre size, axle ratio, etc.
6. Check for DTC **B2900**.
    1. If DTC **B2900** is present, perform PMI on the ABS module. Do Not replace ABS module for this procedure when directed. You may be prompted to enter the 9 lines of PCM As-Built data during this procedure.
    2. If DTC **B2900** is not present proceed to Step 7.
7. Diagnose all other DTCs following normal diagnostic procedures.

DIAGNOSIS AND TESTING (Continued)

REPROGRAMMING DOES NOT COMPLETE OR FAILS - Existing PCM Reprogramming Or PCM Replacement

1. Verify all cables are properly connected.
2. Verify vehicle battery is at proper charge level.
3. Verify scan tool battery is at proper charge level.
4. Attempt reprogramming procedure again.
5. If reprogramming still does not complete properly, save current session, reboot IDS, open previous session, and attempt reprogramming again.
6. If reprogramming still does not complete or you are now unable to communicate with PCM, proceed to the Blank Path Programming procedure.

BLANK PATH PROGRAMMING - Existing PCM Reprogramming or PCM Replacement

Perform this procedure prior to PCM replacement if a vehicle comes in with a PCM that will not communicate and previous instructions have failed to establish communication

1. Verify powers and grounds to PCM by loading and voltage drop testing circuits.
2. Follow Pin Point Tests to verify network integrity.

   NOTE: The ignition must remain in the "OFF" position until performing step 8. DO NOT turn the key on when IDS is initially connected to the DLC
3. Connect IDS to vehicle.
4. Select "16 pin", select "All others, except those below", press TICK.
5. Screen shows installation of cable, press TICK.
6. Screen shows to turn ignition ON. DO NOT TURN IGNITION ON. Press TICK.
7. Screen shows progress bar, then screen tells you "No communication can be established with the PCM" and asks you if you want to retry? Select "NO". With the ignition key still OFF, press TICK.
8. Screen shows to turn ignition ON. Turn ignition on, press TICK.
9. Screen shows "The PCM installed to this vehicle is blank". You will be prompted to select VIN from a list of previous sessions. Press TICK.
10. When previous sessions are shown select "None of the above".
11. Screen shows "To enable IDS to reprogram the PCM with the correct calibration", enter one of the following: Vehicle Calibration # (7 digits), Tear Tag # (4 digits on the side of the PCM), or PCM part #, press TICK.
12. Highlight the box next to the selection chosen, and enter ONLY ONE of the selections listed above. Press TICK.
13. Follow and answer correctly all remaining screens.
14. PCM is reprogrammed communication should be re-established and PATS system can be reset (if necessary).

DTC (PID)	Condition Cont KOEO KOER	MIL ON Y/N	Possible Cause	Diagnostic procedures
P000D	Cont. KOER	Y	Exhaust variable cam timing stuck during cranking. (Bank 2 V8)	Check the freeze frame data to check the engine conditions when the fault occurred Refer to section 303-01
P0107- MAP sensor reference voltage low. (MAP)	Cont. KOEO KOER	Y	Supply ref. voltage open circuit or short to ground. Damaged sensor Defective PCM	Check supply voltage to sensor is above 4.0 volts. Use PDS/IDS
P0108 - MAP sensor reference voltage high. (MAP)	Cont. KOEO KOER	Y	Supply ref. voltage short to power MAP return signal short to power Damaged sensor Defective PCM	Check supply voltage to sensor is below 6.0 volts. Monitor return signal with PDS/IDS
P0109- MAP intermittent signal fault (MAP)	Cont.	N	Loose connections. Damaged wiring Defective sensor.	Check condition of wiring and connectors (Wiggle test - PDS/IDS Datalogger)
Notes on MAP (see notes following P0113)				

DIAGNOSIS AND TESTING (Continued)

DTC (PID)	Condition Cont KOEO KOER	MIL ON Y/N	Possible Cause	Diagnostic procedures
P0112 - IAT Failed low voltage self-test <0.2 volts (+121°C) (IAT)	Cont. KOEO KOER	Y	Sensor supply voltage or return short to earth Connectors damaged or loose Damaged sensor Defective PCM	Check the freeze frame data to check the engine conditions when the fault occurred Check condition of wiring and connectors Check resistance of sensor Check supply reference voltage Check resistance of sensor through loom from PCM connection Using **IDS datalogger**, monitor the **IAT** PID for range and performance
P0113 - IAT Failed high voltage self-test >4.6 volts (-50°C) (IAT)	Cont. KOEO KOER	Y	Sensor supply voltage or return short to power Connectors damaged or loose Damaged sensor Defective PCM	Check the freeze frame data to check the engine conditions when the fault occurred Check condition of wiring and connectors Check resistance of sensor Check supply reference voltage Check resistance of sensor through loom from PCM connection

General Notes for T-MAP

The IAT and MAP are combined as a T-MAP sensor.

LOW VOLTAGE:- The nominal reference supply voltage (VREF) is 5 volts. If a number of DTCs are recorded such as **P0112, P0222** etc, all these indicate a number of sensors are recording low voltage inputs. These can be triggered by repeated cranking of an engine with a battery in poor condition.

Preliminary checks would include battery and charging system checks, supply voltage checks to the PCM.

HIGH VOLTAGE:- As the PCM supplies the reference voltage (VREF) it calculates the voltage range that should be returned from the sensor. If the PCM detects a voltage above the one calculated it will store an appropriate DTC. High voltage returns are normally associated with sensor failure or the return signal wiring has been shorted to a vehicle power (VPWR) supply.

Multiple high return signal voltages from a range of sensors would indicate the PCM has developed a fault. It should be noted a number of sensors utilise a common reference supply voltage. It is possible that the increased voltage supply has been caused by a short to vehicle power (VPWR) in a connector. All the wiring between the relevant sensors and the PCM must be checked **before replacing the PCM**

Intermittent faults are generally associated with loose wiring connections or damaged wires. A simple way to check these is by use of a wiggle test.

To carryout a wiggle test use IDS datalogger and select the appropriate system to monitor.

Example: **P0109. -**

- Select MAP (This may be available as a FREQ or VOLT or both) (Additionally select **IAT** this may be available as a voltage or a temperature)
- Start the engine and monitor the signal.
- Gently shake the wiring at various points along the loom, particularly near the connectors and areas where the loom is routed through a sharp angle.
- If the signal changes, this indicates defective wiring or connections. Closely look at where the connector is attached to the sensor. If the connector housing is moving in the sensor, then the sensor is defective.

If the information you are accessing is not available through normal Datalogger you may be able to access additional EOBD information via the OBD test modes:

To access OBD Datalogger:-VEHICLE SPECIFICATION PAGE > TOOLBOX > POWERTRAIN > OBD TEST MODES > MODE 1 POWERTRAIN DATA.

DIAGNOSIS AND TESTING (Continued)

DTC (PID)	Condition Cont KOEO KOER	MIL ON Y/N	Possible Cause	Diagnostic procedures
P0116 - Cylinder head temperature sensor. (CHT) Self-test failure. (CHT)	Cont. KOEO KOER	**Y**	Defective wiring, connector or sensor CHT sensor incorrectly fitted (over or under tightened) Defective cooling system Defective PCM	Check the freeze frame data to check the engine conditions when the fault occurred Check the wiring and connections between the CHT and the PCM. Ensure the cooling system is operating correctly Look for evidence of damage on the CHT sensor, ensure it is not loose in the cylinder head Check the VREF is approximately 5 volts Check the SIGTRN (return signal) has not gone open circuit or shorted to VPWR (See note below)

General notes on Cylinder Head Temperature (CHT) sensor (Also see P1285, P1288, P1289, P1290 and P1299)

If the CHT is incorrectly fitted, either too loose or to tight, it will cause fluctuations in the readings.

NOTE: If the CHT on V8 is removed, it must not be re-used. When replacing a CHT always ensure the area under the sensor is clean, free from swarf and liquid contamination.

DTC P0116 – This will be stored when the CHT has failed a self-test. A simple check is to use IDS datalogger and compare the CHT and IAT when the engine is cold or has not been run for at least 6 hours. The CHT and IAT should be within 1°C of each other. Start the engine and monitor how quickly the CHT starts to record changes. If IDS indicates rapid temperature increase with the CHT, this would indicate sensor failure or a cooling system defect.

LOW VOLTAGE:- The nominal reference supply voltage (VREF) is 5 volts. If a number of DTCs are recorded such as **P0112, P0222,** etc, all these indicate a number of sensors are recording low voltage inputs. These can be triggered by repeated cranking of an engine with a battery in poor condition.

Preliminary checks would include battery and charging system checks, supply voltage checks to the PCM.

Also ensure that all the connections between the PCM and the sensor are in good condition. A connector with even minor evidence of contamination or oxidation can cause a proportionally high resistance.

Intermittent faults are generally associated with loose wiring connections or damaged wires. A simple way to check these is by use of a wiggle test.

To carryout a wiggle test use IDS datalogger and select the appropriate system to monitor.

Example: **P0116.**

- Select CHT (This may be available as TEMP or VOLT or both)
- Start the engine and monitor the signal. **Always exercise great care when working around a running engine**
- Gently shake the wiring at various points along the loom, particularly near the connectors and areas where the loom is routed through a sharp angle.
- If the signal changes, this indicates defective wiring or connections. Closely look at where the connector is attached to the sensor. If the connector housing is moving in the sensor, then the sensor is defective.

NOTE: - If P1299 is displayed, it should be part a multiple DTC list. P1299 is an FMEM over-heat protection strategy.

If the information you are accessing is not available through normal Datalogger you may be able to access additional EOBD information via the OBD test modes:

To access OBD Datalogger:-VEHICLE SPECIFICATION PAGE > TOOLBOX > POWERTRAIN > OBD TEST MODES > MODE 1 POWERTRAIN DATA.

DIAGNOSIS AND TESTING (Continued)

DTC (PID)	Condition Cont KOEO KOER	MIL ON Y/N	Possible Cause	Diagnostic procedures
P0121 - TPS track A out of range (throttle not closed at idle) (TP1)	Cont. KOEO KOER	**N**	Damaged sensor or contaminated track. Wiring/connectors damaged or loose between sensor & PCM. Damaged sensor and or throttle body Defective PCM	Check the operation of the throttle body and flap Check for carbon deposits within the throttle housing Check condition of wiring and connectors Check the freeze frame data **(PID - TP1)** to check the engine conditions when the fault occurred Check supply voltage Check return signal Compare return signal voltages using IDS/PDS Datalogger
P0122 - TPS track A low voltage (TP1)	Cont. KOEO KOER	**N**	Supply voltage to low Return signal to low Damaged sensor (High resistance on track) TP not seated correctly Defective PCM	Check condition of wiring and connectors Check the freeze frame data **(PID - TP1)** to check the engine conditions when the fault occurred Check supply voltage Check return signal voltage Compare return signal voltages using IDS/PDS Datalogger (PID TP1)
P0123 - TPS track A high voltage (TP1)	Cont. KOEO KOER	**N**	Return signal shorted to power Reference voltage short to power Damaged sensor TP not seated correctly Defective PCM	Check condition of wiring and connectors Check supply voltage Check return signal voltage Compare return signal voltages using IDS/PDS Datalogger (PID TP1)
P0124 - TPS track A Intermittent fault (TP1)	Cont. KOEO KOER	**N**	Defective sensor Loose, damaged or contaminated wiring and/or connectors. Defective PCM	Check condition of wiring and connectors Check the freeze frame data **(PID - TP1)** to check the engine conditions when the fault occurred Carryout wiggle test whilst monitoring TPS signals using PDS/IDS (PID TP1)

General Notes for TPS Also see **P0221, P0222, P0223, P0224, P1124, P2111, P2112 and P2135**

If you are checking **P0121** and **P0221**is also stored, this is a good indication of contamination or damage to the throttle body as the PCM cannot detect a fully closed position for the throttle plate.

LOW VOLTAGE:- The nominal reference supply voltage (VREF) is 5 volts. If a number of DTCs are recorded such as **P0112, P0222, P0117** etc, all these indicate a number of sensors are recording low voltage inputs. These can be triggered by repeated cranking of an engine with a battery in poor condition.

Preliminary checks would include battery and charging system checks, supply voltage checks to the PCM.

Also ensure that all the connections between the PCM and the sensor are in good condition. A connector with even minor evidence of contamination or oxidation can cause a proportionally high resistance.

HIGH VOLTAGE:- As the PCM supplies the reference voltage (VREF) it calculates the voltage range that should be returned from the sensor. If the PCM detects a voltage above the one calculated it will store an appropriate DTC. High voltage returns are normally associated with sensor failure or the return signal wiring has been shorted to a vehicle power (VPWR) supply.

Multiple high return signal voltages from a range of sensors may indicate the PCM has developed a fault. It should be noted a number of sensors utilise a common reference supply voltage. It is possible that the increased voltage supply has been caused by a short to vehicle power (VPWR) in a connector. All the wiring between the relevant sensors and the PCM must be checked **before replacing the PCM.**

DIAGNOSIS AND TESTING (Continued)

Intermittent faults are generally associated with loose wiring connections or damaged wires. A simple way to check these is by use of a wiggle test.

To carryout a wiggle test use IDS datalogger and select the appropriate system to monitor.

Example: **P0124.**

- Select **TP1 and TP2** (Additional PIDs that may help are **APP1 and APP2**)
- All these sensors operate within a 5 volt range. Ensure the correct range is selected on IDS and it is suggested convert the display to a bar graph
- Press the accelerator slowly to the wide open throttle (WOT) position and slowly release while monitoring the display. (You should take at least 10 seconds to complete this)
- The TP displays should approximately mirror each other, one falling the other rising.
- If one of the signals appears to "jump", this may indicate a section of resistance or damage on one of the tracks. If this is the case repeat the test a number of times to confirm it. Note the slower and steadier the accelerator is applied, the more accurate the results will be.
- Gently shake the wiring at various points along the loom particularly near the connectors and areas where the loom is routed through a sharp angle. It is recommended to do this with the accelerator in a number of different positions.
- Monitor the system to see if it looses the signal or the signal jumps to its maximum position.
- If this test fails to produce a result repeat the procedure with the engine running
- Start the engine and monitor the signal. **Always exercise great care when working around a running engine**
- Gradually increase the engine speed and monitor the signals. They should approximately mirror each other one voltage rising, the other falling.
- Gently shake the wiring at various points along the loom particularly near the connectors and areas where the loom is routed through a sharp angle, while gradually increasing and decreasing engine speed. (A road test may produce better results as the engine and vehicle will be place under greater load conditions)
- If the signal changes, this indicates defective wiring or connections. Look closely at where the connector is attached to the sensor. If the connector housing is moving in the sensor, then the sensor is defective.

If the information you are accessing is not available through normal Datalogger you may be able to access additional EOBD information via the OBD test modes:

To access OBD Datalogger:-VEHICLE SPECIFICATION PAGE > TOOLBOX > POWERTRAIN > OBD TEST MODES > MODE 1 POWERTRAIN DATA.

DTC (PID)	**Condition Cont KOEO KOER**	**MIL ON Y/N**	**Possible Cause**	**Diagnostic procedures**
P0132 - HEGO11- Above voltage range (O2S11)	KOEO KOER	**Y**	Sensor heater shorting to sensor element Sensor wiring shorted to power Defective PCM	Check the freeze frame data to check the engine conditions when the fault occurred Check condition of wiring and connectors Check resistance of heater circuit Monitor sensor output signal using PDS/IDS
P0133 - HEGO11 - slow switching (O2S11)	KOER	**Y**	Contaminated, damaged or deteriorating sensor Exhaust or induction system leaks Damaged wiring Defective MAP sensor Defective PCM	Check the freeze frame data to check the engine conditions when the fault occurred Check condition of induction and exhaust system, including for after-market modifications Check condition of wiring and connectors Check the condition of the sensor (monitor with PDS/IDS) Check for MAP DTCs

DIAGNOSIS AND TESTING (Continued)

DTC (PID)	Condition Cont KOEO KOER	MIL ON Y/N	Possible Cause	Diagnostic procedures
P0135 - HEGO11 - heater circuit failure (HTR11)	Cont.	**Y**	Contaminated or damaged sensor Wiring open circuit or short circuit Low battery voltage Defective PCM	Check the freeze frame data to check the engine conditions when the fault occurred Check condition of wiring and connectors Check battery condition Check heater circuit resistance
P0136 - HEGO12 - max and min voltages outside parameters (O2S12)	Cont	**Y**	Contaminated sensor. Crossed sensor wires Damaged wiring and/or connectors Exhaust leaking. Defective PCM or software	Check the freeze frame data to check the engine conditions when the fault occurred Check condition of wiring and connectors Check the condition of the sensor (monitor with PDS/IDS, preferably under road test conditions)
P0138 - HEGO12 - Above voltage range (O2S12)	KOER	**Y**	Sensor heater shorting to sensor element Sensor wiring shorted to power Defective PCM	Check the freeze frame data to check the engine conditions when the fault occurred Check condition of wiring and connectors Check resistance of heater circuit Monitor sensor output signal using PDS/IDS
P0141 - HEGO12 - heater circuit failure (HTR12)	KOER	**Y**	Contaminated or damaged sensor Wiring open circuit or short circuit Low battery voltage Defective PCM	Check the freeze frame data to check the engine conditions when the fault occurred Check condition of wiring and connectors Check battery condition Check heater circuit resistance
P0152 - HEGO21 - Above voltage range (O2S21)	KOER	**Y**	Sensor heater shorting to sensor element Sensor wiring shorted to power Defective PCM	Check the freeze frame data to check the engine conditions when the fault occurred Check condition of wiring and connectors Check resistance of heater circuit Monitor sensor output signal using PDS/IDS
P0153 - HEGO21 - slow switching speed (O2S21)	KOER	**Y**	Contaminated, damaged or deteriorating sensor Exhaust or induction system leaks Damaged wiring Defective MAP sensor	Check the freeze frame data to check the engine conditions when the fault occurred Check condition of induction and exhaust system, including for after-market modifications Check condition of wiring and connectors Check the condition of the sensor (monitor with PDS/IDS) Check for MAP DTCs

DIAGNOSIS AND TESTING (Continued)

DTC (PID)	Condition Cont KOEO KOER	MIL ON Y/N	Possible Cause	Diagnostic procedures
P0155 - HEGO21 - Heater circuit failure (HTR21)	KOER	**Y**	Contaminated or damaged sensor Wiring open circuit or short circuit Low battery voltage Defective PCM	Check the freeze frame data to check the engine conditions when the fault occurred Check condition of wiring and connectors Check battery condition Check heater circuit resistance
P0156- HEGO22 - max and min voltages outside parameters (O2S22)	KOER	**Y**	Contaminated sensor. Crossed sensor wires Damaged wiring and/or connectors Exhaust leaking. Defective PCM or software	Check the freeze frame data to check the engine conditions when the fault occurred Check condition of wiring and connectors Check the condition of the sensor (monitor with PDS/IDS, preferably under road test conditions)
P0158 - HEGO22 Above voltage range (O2S22)	KOER	**Y**	Sensor heater shorting to sensor element Sensor wiring shorted to power Defective PCM	Check the freeze frame data to check the engine conditions when the fault occurred Check condition of wiring and connectors Check resistance of heater circuit Monitor sensor output signal using PDS/IDS
P0161 - HEGO22 heater circuit failure (O2S22)	KOER	**Y**	Contaminated or damaged sensor Wiring open circuit or short circuit Low battery voltage Defective PCM	Check the freeze frame data to check the engine conditions when the fault occurred Check condition of wiring and connectors Check battery condition Check heater circuit resistance
P0171 - I6 and bank-1 V8, running lean (LTFT)	KOER	**Y**	Low fuel level Engine mechanical defect Induction and/or exhaust system defects. Defective fuel system Damaged or contaminated wiring to the injectors and/or fuel pump Limit of adaptive fuel strategy	Check the freeze frame data to check the engine conditions when the fault occurred Check the fuel level Ensure the engine mechanical systems are in good condition Check condition of induction and exhaust systems Check the fuel system condition to include: - Fuel pressure regulator, injectors, filters and all associated pipes. Check condition of wiring to all fuel system electrical components Using **IDS datalogger**, check the **SHRTFT** has not exceeded its adaptive values. If it has, check the freeze frame data to see what the engine operating conditions were at the time of the fault. Check PCM for correct calibration.

DIAGNOSIS AND TESTING (Continued)

DTC (PID)	Condition Cont KOEO KOER	MIL ON Y/N	Possible Cause	Diagnostic procedures
P0172 - I6 and bank-1 V8 running rich (LONGFT & SHRTFT)	KOER	**Y**	Low fuel level Engine mechanical defect Induction and/or exhaust system defects. Defective fuel system Damaged or contaminated wiring to the injectors and/or fuel pump Limit of adaptive fuel strategy	Check the freeze frame data to check the engine conditions when the fault occurred Check the fuel level Ensure the engine mechanical systems are in good condition Check condition of induction and exhaust systems Check the fuel system condition to include: - Fuel pressure regulator, injectors, filters and all associated pipes. Check condition of wiring to all fuel system electrical components Check PCM for correct calibration.
P0174 - Bank-2 V8 running lean (LONGFT & SHRTFT)	KOER	**Y**	Low fuel level Engine mechanical defect Induction and/or exhaust system defects. Defective fuel system Damaged or contaminated wiring to the injectors and/or fuel pump Limit of adaptive fuel strategy	Check the freeze frame data to check the engine conditions when the fault occurred Check the fuel level Ensure the engine mechanical systems are in good condition Check condition of induction and exhaust systems Check the fuel system condition to include: - Fuel pressure regulator, injectors, filters and all associated pipes. Check condition of wiring to all fuel system electrical components Using **IDS datalogger**, check the **SHRTFT** has not exceeded its adaptive values. If it has, check the freeze frame data to see what the engine operating conditions were at the time of the fault. Check PCM for correct calibration.
P0175 - Bank-2 V8 running rich (LONGFT & SHRTFT)	KOER	**Y**	Low fuel level Engine mechanical defect Induction and/or exhaust system defects. Defective fuel system Damaged or contaminated wiring to the injectors and/or fuel pump Limit of adaptive fuel strategy	Check the freeze frame data to check the engine conditions when the fault occurred Check the fuel level Ensure the engine mechanical systems are in good condition Check condition of induction and exhaust systems Check the fuel system condition to include: - Fuel pressure regulator, injectors, filters and all associated pipes. Check condition of wiring to all fuel system electrical components Check PCM for correct calibration.

General Notes for Heated Oxygen sensors (HEGO’s).

Understanding the function and operation of a HEGO can be a good diagnostic aid to understanding to overall operation and condition of the engine with regard to the combustion process.

HEGO sensors are generally very reliable and should not be replaced unless it can be clearly shown the sensor has been damaged externally or contaminated internally either with use of incorrect fuel, engine oil or coolant etc.

The HEGO’s are identified by bank and position in the exhaust, i.e.

HEGO 11: Bank 1, sensor 1 (upstream)

HEGO 12: Bank 1, sensor 2 (downstream)

HEGO 21: Bank 2, sensor 1 (upstream)

HEGO 22: Bank 2, sensor 2 (downstream)

DIAGNOSIS AND TESTING (Continued)

Monitoring HEGO sensors with IDS

If monitoring the HEGO sensors with IDS select **O2S11** and **O2S21** for the upstream HEGO's and **O2S12 and O2S22** for the downstream HEGO's

The HEGO generates a switching signal between a nominal 0.1 and 1 volt. (It can, under certain circumstances, switch slightly outside these parameters and still function correctly).

NOTE: If a HEGO related DTC is stored and then the HEGO signal is monitored, it may appear to be responding correctly. If this is the case, check both the Long Term Fuel Trim (LONGTFT) and the Short Term Fuel Trim (SHRTFT) and ensure they are responding. If they are not, or a DTC is recorded that indicates the LONGTFT has exceeded its values, note and clear all the DTCs.

IDS/PDS will be displaying the HEGO substitute values stored in the PCM memory and not the true HEGO signal. Clearing the DTCs will reset the LONGTFT and SHRTFT count and you should see the true HEGO signal.

Monitoring both the LONGTFT and SHRTFT are both good indicators of engine performance.

O2S11 and O2S21 (upstream)

These generate a rapidly switching signal which is used to manage the fuel injection system when it is operating in closed loop.

Closed loop operation can be monitored with **IDS datalogger "CLOSED LOOP"** PID.

If checking the operation of **O2S11 and O2S12** with the relation to **CLOSED LOOP** operation, as a guide,

- the engine should be at its normal operating temperature
- the HEGO's should be switching between at least once and twice a second at 2000 rpm

O2S12 and O2S22 (downstream)

These generate a much slower switching signal than the upstream HEGO's and are used to monitor the catalytic converter efficiency and condition. (Part of the Comprehensive Component Monitoring (CCM) system). The switching rate is determined by vehicle usage, the sensor may switch as quickly as every 30 to 45 seconds or it may take several minutes to produce a switching signal.

IMPORTANT NOTE

If when monitoring the upstream and downstream HEGO's it is noted the switching time is very similar, this provides evidence of **Catalytic Converter failure.**

P0132, P0138, P0152, P0158

These DTCs indicate the signal voltage is considerably above 1 volt. This indicates either the sensor itself has failed and the heater supply has shorted to the sensor circuit or the sensor circuit wiring has shorted to VPWR.

The signals can be monitored using **IDS datalogger O2S11, O2S21** (V8 only) (upstream HEGO's) and **O2S12, O2S22** (V8 only) (downstream HEGO's)

P0133, P0153

These DTCs indicate a slow switching speed signal to the PCM and the PCM is having difficultly maintaining the Short Term Fuel Trim **(SHRTFT).**

A number of concerns could trigger these DTCs including mechanical concerns.

Mechanical concerns:-

- Exhaust leaks particularly around the catalytic converter, exhaust manifold and turbo charger.
- Induction system leaks after the **T-MAP**
- Contaminated fuel or general fuel system concerns particularly fuel rail pressure
- Non Ford approved modifications to the induction and/or exhaust system

Electrical concerns

- It is possible an incorrect **T-MAP** signal can trigger these DTCs as the PCM has a conflict between what it is trying to do and the outcome in the combustion chamber. If additional DTCs such as **P0107, P0108, P0109, P0112 or P0113** are also indicated, rectify these first and then recheck.
- Loose or damaged connections between the HEGO and PCM. The way to check this with **IDS datalogger** and carryout a wiggle test

Wiggle test Example: P0124.

- With the engine at its normal operating temperature, select **O2S11** and **O2S21** (V8 only). Additional signals that may aid diagnosis **RPM, SHRTFT, LONGFT, IAT, MAP, O2S12, O2S22 and CLOSED LOOP.**
- Start the engine and monitor the signal. If conducting this test with a cold engine it may take a few seconds before the switching signal is fully functional. **Always exercise great care when working around a running engine**
- Gradually increase the engine speed to approximately 2000 rpm and monitor the signals. **O2S12** and **O2S22** should be switching between at least once and twice per second. It is important the engine speed is accurately maintained, variations in accelerator pedal position directly affect **CLOSED LOOP** operation. If not switching check the **CLOSED LOOP** PID is still set.
- Gently shake the wiring at various points along the loom particularly near the connectors and areas where the loom is routed through a sharp angle, while maintaining engine speed. (A road test may produce better results as the engine and vehicle will be place under greater load conditions but avoid rapid application of the accelerator)
- If the signal changes, this indicates defective wiring or connections. Closely look at where the connector is attached to the sensor. If the

DIAGNOSIS AND TESTING (Continued)

connector housing is moving in the sensor, then the sensor is defective.

Sensor concerns:-

- If there evidence of contamination in the fuel system such as diesel, lead additive, a non-approved performance enhancer or evidence of engine oil in the exhaust, all of these can coat the surface of the sensor and reduce its effectiveness.
- Additionally with old or very high mileage vehicles the effectiveness of the chemical reaction of the sensor will reduce and the sensor becomes "lazy' any evidence of this requires the sensor replacing

P0135, P0141, P0155, P0161

These DTCs indicate a heater or circuit failure. Any of the other HEGO related DTCs between **P0132 and P0158** could be associated with these.

- Check there is a 12V supply to the heater circuit (All the HEGO's are supplied through a common fuse)
- Check for continuity between the heater return and the PCM
- Carry out a resistance check across the HEGO heater. The heater resistance should be between 4O and 8O.
- **IMPORTANT** It may be possible to monitor the HEGO heater functions with **IDS datalogger. (HTR11, HTR12, HTR21 AND HTR22)**. If monitoring as a voltage, it can show any voltage between 0V and 12V. This is because the upstream HEGO heaters are pulse width modulated (PWM) and the downstream HEGO's are voltage regulated. The voltage is managed by the PCM
- If the HEGO voltage is not available it will display a fault mode, FAULT YES or FAULT NO

P0136 & P0156

These indicate the downstream HEGO's are operating outside their normal parameters (0.1v to 1.0v)

- Monitor the HEGO signals using **IDS datalogger (O2S12 and O2S22)** for the operating range. (It is usefully to monitor the upstream HEGO's at the same time **(O2S11 and O2S21)**, if the switching frequency is similar, this indicates catalytic converter failure)
- If they are outside the voltage range, ensure the exhaust is in good condition and there is no evidence of leaks anywhere in the system
- Check the condition of the wiring and connectors between the HEGO's and PCM. The connections on the downstream HEGO's work in a harsh environment and should be checked closely.

P0171, P0172, P0174, P0175

These indicate combustion condition i.e. operating lean or rich. If these DTCs are displayed the **sensors are functioning correctly**.

There may be multiple DTCs displayed with these and have been triggered though concerns elsewhere with the system. Where multiple DTCs are displayed investigate the other DTCs first.

- Ensure the mechanical systems are in good condition, particularly the induction and exhaust systems.
- Check the fuel system, particularly for leaks, blockages, fuel contamination and fuel pressure.
- If using **IDS datalogger** select **SHRTFT and LONGTFT**. Ensure either has not exceeded its calibrated values, this can be triggered by various defects both mechanical and electrical

If the information you are accessing is not available through normal Datalogger you may be able to access additional EOBD information via the OBD test modes:

To access OBD Datalogger:-VEHICLE SPECIFICATION PAGE > TOOLBOX > POWERTRAIN > OBD TEST MODES > MODE 1 POWERTRAIN DATA.

DIAGNOSIS AND TESTING (Continued)

DTC (PID)	**Condition Cont KOEO KOER**	**MIL ON Y/N**	**Possible Cause**	**Diagnostic procedures**
P0196 - Engine oil temp. out of range (EOT)	Cont	**Y**	Low oil level Damaged or contaminated sensor and/or wiring Engine overheating (Cooling system fault)	Check the freeze frame data to check the engine conditions when the fault occurred Check the oil level and condition Check condition of wiring and connectors Check the condition of the sensor Check the condition of the cooling system
P0201 Fuel injector 1 (INJ-1)	Cont. KOEO KOER	**Y**	Defective wiring between the PCM and injector. Defective power supply to the injector Defective injector Defective PCM (including software)	Check the freeze frame data to check the engine conditions when the fault occurred Check condition of wiring and connectors. Check supply voltage to injector. Check the resistance of the injector windings. Ensure PCM is running current software. Check for continuity between the PCM connector and the injector connector.
P0202 Fuel injector 2 (INJ-1)	Cont. KOEO KOER	**Y**	Defective wiring between the PCM and injector. Defective power supply to the injector Defective injector Defective PCM (including software)	Check the freeze frame data to check the engine conditions when the fault occurred Check condition of wiring and connectors. Check supply voltage to injector. Check the resistance of the injector windings. Ensure PCM is running current software. Check for continuity between the PCM connector and the injector connector.
P0203 Fuel injector 3 (INJ-1)	Cont. KOEO KOER	**Y**	Defective wiring between the PCM and injector. Defective power supply to the injector Defective injector Defective PCM (including software)	Check the freeze frame data to check the engine conditions when the fault occurred Check condition of wiring and connectors. Check supply voltage to injector. Check the resistance of the injector windings. Ensure PCM is running current software. Check for continuity between the PCM connector and the injector connector.

DIAGNOSIS AND TESTING (Continued)

DTC (PID)	Condition Cont KOEO KOER	MIL ON Y/N	Possible Cause	Diagnostic procedures
P0204 Fuel injector 4 (INJ-1)	Cont. KOEO KOER	**Y**	Defective wiring between the PCM and injector. Defective power supply to the injector Defective injector Defective PCM (including software)	Check the freeze frame data to check the engine conditions when the fault occurred Check condition of wiring and connectors. Check supply voltage to injector. Check the resistance of the injector windings. Ensure PCM is running current software. Check for continuity between the PCM connector and the injector connector.
P0205 Fuel injector 5 (INJ-1)	Cont. KOEO KOER	**Y**	Defective wiring between the PCM and injector. Defective power supply to the injector Defective injector Defective PCM (including software)	Check the freeze frame data to check the engine conditions when the fault occurred Check condition of wiring and connectors. Check supply voltage to injector. Check the resistance of the injector windings. Ensure PCM is running current software. Check for continuity between the PCM connector and the injector connector.
P0206 Fuel injector 6 (INJ-1)	Cont. KOEO KOER	**Y**	Defective wiring between the PCM and injector. Defective power supply to the injector Defective injector Defective PCM (including software)	Check the freeze frame data to check the engine conditions when the fault occurred Check condition of wiring and connectors. Check supply voltage to injector. Check the resistance of the injector windings. Ensure PCM is running current software. Check for continuity between the PCM connector and the injector connector.
P0207 Fuel injector 7 (INJ-1)	Cont. KOEO KOER	**Y**	Defective wiring between the PCM and injector. Defective power supply to the injector Defective injector Defective PCM (including software)	Check the freeze frame data to check the engine conditions when the fault occurred Check condition of wiring and connectors. Check supply voltage to injector. Check the resistance of the injector windings. Ensure PCM is running current software. Check for continuity between the PCM connector and the injector connector.

DIAGNOSIS AND TESTING (Continued)

DTC (PID)	Condition Cont KOEO KOER	MIL ON Y/N	Possible Cause	Diagnostic procedures
P0208 Fuel injector 8 (INJ-1)	Cont. KOEO KOER	**Y**	Defective wiring between the PCM and injector. Defective power supply to the injector Defective injector Defective PCM (including software)	Check the freeze frame data to check the engine conditions when the fault occurred Check condition of wiring and connectors. Check supply voltage to injector. Check the resistance of the injector windings. Ensure PCM is running current software. Check for continuity between the PCM connector and the injector connector.

Notes for fuel injector related DTCs (P0201 to P0208)

It should be remembered these DTCs only relate to the fuel injector circuitry contained within the PCM and not to the mechanical condition of the injectors.

- Ensure all the electrical connections to the injectors are in good condition.
- Ensure the supply voltage is within 1 volt of battery supply voltage (The injectors are nominally a 12 volt unit, however they are powered via the battery and low or high standing battery voltage will change the voltage reading at the injector)
- If available, monitor the injector pulse width **IDS datalogger (INJ-1 to INJ-8).** If one of the pulses is considerably longer than the others this could indicate the windings in that injector is deteriorating. If an injector winding is suspected it can be confirmed by a resistance check across the windings. The injector windings should be between **13.5 to 16.0O**

NOTE: If the injector is within specification it may indicate there is a mechanical fault within the cylinder as the PCM will try to correct a fuelling value so that each cylinder produces the same power output.

Other DTCs that may be associated are:-

- Misfire detected **P0300 to P0308** and **P0316**
- HEGO related DTCs **P0132 to P0175** and **P1130 to P1158**

If the information you are accessing is not available through normal Datalogger you may be able to access additional EOBD information via the OBD test modes:

To access OBD Datalogger:-VEHICLE SPECIFICATION PAGE > TOOLBOX > POWERTRAIN > OBD TEST MODES > MODE 1 POWERTRAIN DATA.

DIAGNOSIS AND TESTING (Continued)

DTC (PID)	**Condition Cont KOEO KOER**	**MIL ON Y/N**	**Possible Cause**	**Diagnostic procedures**
P0218 - Transmission overheating (Above 130°C) (TFT)	Cont KOER	**N**	**Possible limp home active.** Incorrect transmission fluid level or fluid contaminated Damaged transmission cooling system Transmission breather blocked Torque converter not locking Defective wiring or connections between the PCM, shifter PCB and connection to the transmission multi-plug. Defective TFT sensor	Check the transmission fluid level and condition **(refer to TRANSMISSION FLUID LEVEL CHECK - 307-01)** Carryout a system check with IDS. Select PID TFT. Road test the vehicle trying to replicate a wide range of operating conditions. If the DTC returns, check the condition of the PCB in the shifter (**P0710** may also be stored) Check the condition of the transmission cooling system. Ensure the breather is not blocked Torque converter not engaging correctly (**P0740, P2763 and P2764** may also be stored). Monitor TCC with IDS. This DTC may be triggered by driver abuse **For further information refer to AUTOMATIC TRANSMISSION - DIAGNOSTICS AND TESTING - 307-01**
P0219 - Engine over speed condition (above 6000prm) (RPM)	Cont KOER	**N**	Defective wiring and or connectors between CKP sensor and the PCM. Defective sensor Incorrect calibration in PCM and/or TCM	Check the condition of the wiring between the PCM and CKP sensor. Monitor the **RPM** signal and carryout a wiggle test at idle. Always **exercise great care when working around a running engine** If **P0300, P0315, P0316 or P0320** are recorded, this is a concern with the CKP circuit or sensor Using **IDS datalogger** monitor engine speed **(RPM)**, transmission speed signals (**OSS, TCCMACT** and **TSS**, if available) and vehicle speed (**VSS**). Road test the vehicle, ensure the RPM approximates the true engine speed. This DTC may be recorded if the vehicle has been driven enthusiastically over uneven road surfaces **For further information refer to AUTOMATIC TRANSMISSION - DIAGNOSTICS AND TESTING - 307-01**
P0221 - TPS track B out of range (TP2)	Cont. KOEO KOER	**N**	Damaged sensor or contaminated track. Wiring/connectors damaged or loose between sensor & PCM. Damaged sensor Defective PCM	Check the operation of the throttle body and flap Check for carbon deposits within the throttle housing Check condition of wiring and connectors Check supply voltage Check return signal Compare return signal voltages using IDS/PDS Datalogger (PID TP2)

DIAGNOSIS AND TESTING (Continued)

DTC (PID)	Condition Cont KOEO KOER	MIL ON Y/N	Possible Cause	Diagnostic procedures
P0222 - TPS track B low voltage (TP2)	Cont. KOEO KOER	**N**	Supply voltage to low Return signal to low Damaged sensor (High resistance on track) TP not seated correctly Defective PCM	Check condition of wiring and connectors Check supply voltage Check return signal voltage Compare return signal voltages using IDS/PDS Datalogger (PID TP2)
P0223 - TPS track B high voltage (TP2)	Cont. KOEO KOER	**N**	Return signal shorted to power Reference voltage short to power Damaged sensor TP not seated correctly Defective PCM	Check condition of wiring and connectors Check supply voltage Check return signal voltage Compare return signal voltages using IDS/PDS Datalogger (PID TP2)
P0224 - TPS track B Intermittent fault (TP2)	Cont. KOEO KOER	**N**	Defective sensor Loose, damaged or contaminated wiring and/or connectors. Defective PCM	Check condition of wiring and connectors Carryout wiggle test whilst monitoring TPS signals using PDS/IDS

General Notes for TPS Also see **P0121, P0122, P0123, P0124, P1124, P2111, P2112 and P2135**

If you are checking **P0221** and **P0121** is also stored, this is a good indication of contamination or damage to the throttle body as the PCM cannot detect a fully closed position for the throttle plate.

LOW VOLTAGE:- The nominal reference supply voltage (VREF) is 5 volts. If a number of DTCs are recorded such as **P0112, P0222, P0117** etc, all these indicate a number of sensors are recording low voltage inputs. These can be triggered by repeated cranking of an engine with a battery in poor condition.

Preliminary checks would include battery and charging system checks, supply voltage checks to the PCM.

Also ensure that all the connections between the PCM and the sensor are in good condition. A connector with even minor evidence of contamination or oxidation can cause a proportionally high resistance.

HIGH VOLTAGE:- As the PCM supplies the reference voltage (VREF) it calculates the voltage range that should be returned from the sensor. If the PCM detects a voltage above the one calculated it will store an appropriate DTC. High voltage returns are normally associated with sensor failure or the return signal wiring has been shorted to a vehicle power (VPWR) supply.

Multiple high return signal voltages from a range of sensors may indicate the PCM has developed a fault. It should be noted a number of sensors utilise a common reference supply voltage. It is possible that the increased voltage supply has been caused by a short to vehicle power (VPWR) in a connector. All the wiring between the relevant sensors and the PCM must be checked **before replacing the PCM.**

Intermittent faults are generally associated with loose wiring connections or damaged wires. A simple way to check these is by use of a wiggle test.

To carryout a wiggle test use IDS datalogger and select the appropriate system to monitor.

Example: **P0224.**

- Select **TP1 and TP2** (Additional PID’s that may help are **APP1 and APP2**)
- All these sensors operate within a 5 volt range. Ensure the correct range is selected on IDS and it is suggested convert the display to a bar graph
- Press the accelerator slowly to the wide open throttle (WOT) position and slowly release while monitoring the display. (You should take at least 10 seconds to complete this)
- The TP displays should approximately mirror each other, one falling the other rising.
- If one of the signals appears to "jump", this may indicate a section of resistance or damage on one of the tracks. If this is the case repeat the test a number of times to confirm it. Note the slower and steadier the accelerator is applied, the more accurate the results will be.
- Gently shake the wiring at various points along the loom particularly near the connectors and areas where the loom is routed through a sharp angle. It is recommended to do this with the accelerator in a number of different positions.
- Monitor the system to see if it looses the signal or the signal jumps to its maximum position.

DIAGNOSIS AND TESTING (Continued)

- If this test fails to produce a result repeat the procedure with the engine running
- Start the engine and monitor the signal. **Always exercise great care when working around a running engine**
- Gradually increase the engine speed and monitor the signals. They should approximately mirror each other one voltage rising, the other falling.
- Gently shake the wiring at various points along the loom particularly near the connectors and areas where the loom is routed through a sharp angle, while gradually increasing and decreasing engine speed. (A road test may produce better results as the engine and vehicle will be place under greater load conditions)
- If the signal changes, this indicates defective wiring or connections. Look closely at where the connector is attached to the sensor. If the connector housing is moving in the sensor, then the sensor is defective.

If the information you are accessing is not available through normal Datalogger you may be able to access additional EOBD information via the OBD test modes:

To access OBD Datalogger:-VEHICLE SPECIFICATION PAGE > TOOLBOX > POWERTRAIN > OBD TEST MODES > MODE 1 POWERTRAIN DATA.

P0230 – Fuel pump primary circuit failure (FP)	Cont. KOEO	N	Fuel pump relay or fuse defective Wiring damaged Fuel pump windings damaged	Check fuel pump relay and fuse Check condition of wiring and connectors Check fuel pump operation. Check the fuel shut off switch has not been activated
NOTE: This DTC will be stored if there is a concern with the fuel pump primary circuit. It will record a defect with the relay windings but not with the relay contacts or the fuel pump circuit. It should be remembered just because a relay "clicks", it does not necessarily indicate it is functioning correctly. Because of this there may be a concern with the fuel pump circuit but a DTC may not be stored.				
P0236 – Turbo boost pressure sensor (BPS) conflict with MAP sensor	Cont. KOEO KOER	Y	Defective wiring or connections to boost pressure sensor Defective boost pressure sensor Defective wiring or connections to T-MAP Defective T-MAP	Check the freeze frame data to check the engine conditions when the fault occurred Ensure there are no air leaks in the induction system. Check the condition of the wiring to both the boost pressure sensor and T-MAP Using IDS/PDS datalogger, compare the output signals from the boost pressure sensor and T-MAP during a KOEO situation. They should be approximately the same
P0237 – Turbo boost pressure sensor (BPS) circuit low voltage	Cont. KOEO	Y	Defective supply voltage (may be part of multiple DTCs) Defective wiring or connection to the boost sensor (short to ground) Defective sensor	Check the freeze frame data to check the engine conditions when the fault occurred Check the condition of the wiring and connections to the boost pressure sensor Ensure sensor is receiving correct supply voltage (5 volts) Ensure sensor is receiving correct supply voltage (5 volts) Check the wiring for continuity between the sensor and the PCM
P0238 - Turbo boost pressure (BPS) sensor circuit high voltage	Cont. KOEO	Y	Defective supply voltage (may be part of multiple DTCs) Defective wiring or connection to the boost sensor (open circuit or short to VPWR) Defective sensor	Check the freeze frame data to check the engine conditions when the fault occurred Check the condition of the wiring and connections to the boost pressure sensor Ensure sensor is receiving correct supply voltage (5 volts) Ensure the wiring on the VREF supply or the SIGRTN has not gone open circuit or shorted to VPWR.

DIAGNOSIS AND TESTING (Continued)

P0243 - Turbo charger wastegate solenoid circuit	Cont. KOEO	N	Defective wiring or connections to the solenoid. Defective solenoid	Ensure solenoid is receiving a 12 volt supply Check for continuity between the solenoid and the PCM Check for continuity across the solenoid.
P0298 - EOT out of range. (FMEM)	Cont. KOEO	N	This DTC indicates the engine is running a FMEM strategy. The PCM is using a substitute value from the cooling system.	Check the oil level and condition Check condition of wiring and connectors Check the condition of the sensor Check the condition of the cooling system (Refer to DTC **P0196**.) Other possible DTCs **P000A** or **P000D**

General Notes for P0298 - This DTC will not be stored on its own

- If it is recorded as part of a large list, the DTCs need to recorded and evaluated for a common theme such as low voltage supply etc.
- If no common theme can be identified. Carry out a preliminary inspection of all the connections and loom, particularly to the PCM
- Record all the stored DTCs and then clear them. Hard faults will be recorded during a KOEO self-test and further faults will be recorded during a KOER test.
- Investigate and rectify any faults which have occurred during the KOEO and KOER tests.
- If there are no apparent DTCs indicated during the KOEO and KOER tests proceed with a road test
- By monitoring the order in which the faults occur will give an indication of the primary source of the concern

P0300 -Random misfire	Cont.	Y	Loose or damaged engine loom Loose or defective CKP Damaged or loose engine mountings Transmission imbalance	Ensure the battery is in good condition Check condition of wiring, connectors and CKP Check the condition of the fuel system including, where practical, fuel quality Check the condition of the engine mountings Check transmission for operation and mountings Check the **freeze frame data** to indicate the engine operating conditions when this fault occurred

General Notes for P0300 – (Part of the misfire monitoring system.) (**P0320, P0315 & P0316** may also be displayed)

The misfire monitoring is achieved by the Crankshaft Position Sensor (CKP) signal back to the PCM. It looks for rapid increases or decreases in engine speed as parts of a single revolution. The **P0300** DTC will be recorded when the PCM cannot identify a single cylinder as the primary cause of a concern.

- Check the condition of the CKP and wiring. A loose CKP or damaged induction wheel can cause this DTC.
- The CKP can be monitored with **IDS datalogger RPM.** A simple check for CKP performance is to compare the RPM signal against the RPM desired **(RPMDSD) P0320** may also be recorded which is a CKP system fault.
- Check the wiring and connections to the injectors, coil packs, throttle body etc. Particular attention should be paid for evidence of oxidation on any of the connectors.

Intermittent faults are generally associated with loose wiring connections or damaged wires. A simple way to check these is by use of a wiggle test.

To carryout a wiggle test use IDS datalogger and select the appropriate system to monitor.

Example: P0300.

- Select **RPM** and **RPMDSD**
- Start the engine and monitor the signal. **Always exercise great care when working around a running engine**
- Increase the engine speed to approximately 2000 – 2500 rpm and monitor the signals.
- Gently shake the wiring at various points along the loom particularly near the connectors and areas where the loom is routed through a sharp angle, while maintaining the engine speed.
- A road test may produce better results as the engine, and vehicle, will be placed under greater load and stress conditions

NOTE: It is possible this DTC may be stored due to the vehicle being used in extreme off-road conditions or due to bad driving practices. Example:- misuse of

DIAGNOSIS AND TESTING (Continued)

gears that cause rapid increases and decreases in engine speed.

If the information you are accessing is not available through normal Datalogger you may be able to access additional EOBD information via the OBD test modes:

To access OBD Datalogger:-VEHICLE SPECIFICATION PAGE > TOOLBOX > POWERTRAIN > OBD TEST MODES > MODE 1 POWERTRAIN DATA.

P0301 – Misfire cylinder 1	Cont.	Y	Loose or damaged engine loom Faulty injector Defective coil pack or spark plug Engine mechanical defect. Induction or exhaust system leaks	Check the freeze frame data to check the engine conditions when the fault occurred. Listen for abnormal engine noise Check the condition of the engine compartment loom. Check the coil and sparkplug Check the operation of the fuel injector. Carry out mechanical condition check for the particular cylinder Check the condition of the exhaust and induction system
P0302 – Misfire cylinder 2	Cont.	Y	Loose or damaged engine loom Faulty injector Defective coil pack or spark plug Engine mechanical defect. Induction or exhaust system leaks	Check the freeze frame data to check the engine conditions when the fault occurred Listen for abnormal engine noise Check the condition of the engine compartment loom. Check the coil and sparkplug Check the operation of the fuel injector. Carry out mechanical condition check for the particular cylinder Check the condition of the exhaust and induction system
P0303 – Misfire cylinder 3	Cont.	Y	Loose or damaged engine loom Faulty injector Defective coil pack or spark plug Engine mechanical defect. Induction or exhaust system leaks	Check the freeze frame data to check the engine conditions when the fault occurred Listen for abnormal engine noise Check the condition of the engine compartment loom. Check the coil and sparkplug Check the operation of the fuel injector. Carry out mechanical condition check for the particular cylinder Check the condition of the exhaust and induction system
P0304 – Misfire cylinder 4	Cont.	Y	Loose or damaged engine loom Faulty injector Defective coil pack or spark plug Engine mechanical defect. Induction or exhaust system leaks	Check the freeze frame data to check the engine conditions when the fault occurred Listen for abnormal engine noise Check the condition of the engine compartment loom. Check the coil and sparkplug Check the operation of the fuel injector. Carry out mechanical condition check for the particular cylinder Check the condition of the exhaust and induction system

DIAGNOSIS AND TESTING (Continued)

P0305 – Misfire cylinder 5	Cont.	Y	Loose or damaged engine loom Faulty injector Defective coil pack or spark plug Engine mechanical defect. Induction or exhaust system leaks	Check the freeze frame data to check the engine conditions when the fault occurred Listen for abnormal engine noise Check the condition of the engine compartment loom. Check the coil and sparkplug Check the operation of the fuel injector. Carry out mechanical condition check for the particular cylinder Check the condition of the exhaust and induction system
P0306 – Misfire cylinder 6	Cont.	Y	Loose or damaged engine loom Faulty injector Defective coil pack or spark plug Engine mechanical defect. Induction or exhaust system leaks	Check the freeze frame data to check the engine conditions when the fault occurred Listen for abnormal engine noise Check the condition of the engine compartment loom. Check the coil and sparkplug Check the operation of the fuel injector. Carry out mechanical condition check for the particular cylinder Check the condition of the exhaust and induction system
P0307 – Misfire cylinder 7	Cont.	Y	Loose or damaged engine loom Faulty injector Defective coil pack or spark plug Engine mechanical defect. Induction or exhaust system leaks	Check the freeze frame data to check the engine conditions when the fault occurred Listen for abnormal engine noise Check the condition of the engine compartment loom. Check the coil and sparkplug Check the operation of the fuel injector. Carry out mechanical condition check for the particular cylinder Check the condition of the exhaust and induction system
P0308 – Misfire cylinder 8	Cont.	Y	Loose or damaged engine loom Faulty injector Defective coil pack or spark plug Engine mechanical defect. Induction or exhaust system leaks	Check the freeze frame data to check the engine conditions when the fault occurred Listen for abnormal engine noise Check the condition of the engine compartment loom. Check the coil and sparkplug Check the operation of the fuel injector. Carry out mechanical condition check for the particular cylinder Check the condition of the exhaust and induction system

General Notes for Cylinder Identifiable Misfire DTCs P0301 to P0308.

The misfire monitoring is achieved by the Crankshaft Position Sensor (CKP) signal back to the PCM. It looks for rapid increases or decreases in engine speed as parts of a single revolution.

The DTC does not indicate what type of misfire is occurring, i.e. ignition related, fuel related or mechanical.

Ignition related misfires may store **P0351** to **P0358** as additional codes

Fuel related misfires may store **P0201** to **P0208** as additional codes

Mechanical defects can be harder to detect through IDS as they can affect the operation of a number of sensors.

Example, the T-MAP signal may be erratic in the event of a poor valve seat

DIAGNOSIS AND TESTING (Continued)

Simple tests can be made to check the integrity of a cylinder such as a compression test or a **RELATIVE COMPRESSION TEST, if available, using IDS.**

If the information you are accessing is not available through normal Datalogger you may be able to access additional EOBD information via the OBD test modes:

To access OBD Datalogger:-VEHICLE SPECIFICATION PAGE > TOOLBOX > POWERTRAIN > OBD TEST MODES > MODE 1 POWERTRAIN DATA.

P0315 - Crankshaft position variation (CKP)	Cont.	Y	Damaged or incorrectly fitted CKP sensor. Damaged or manufacturing defect on CKP sensor wheel Engine misfire (No DTC recorded) Incorrect PCM Calibration	Check the freeze frame data to check the engine conditions when the fault occurred Check the condition of the loom and connections to the CKP Check condition of CKP Where practical, check condition of CKP sensor wheel Ensure PCM is running current software.

General Notes for P0315 – (A slightly uneven idle speed may be evident and **P0300, P0316 & P0320** may also be displayed)

The crankshaft position sensor (CKP) is an inductive type which generates an alternating current. As engine speed increases both the frequency and amplitude (voltage) of the signal increase.

There is a tooth missing off the reluctor wheel which indicates to the PCM the crankshaft speed and position.

Based on the information from the CKP, Camshaft Position Sensor(s) (CMP) and a number of other sensors fitted to the Powertrain, the PCM will activate the fuelling and ignition signals. If the PCM detects variations in the CKP signal, i.e. an increase in amplitude but not in frequency, the fuelling and ignition calculations are adversely affected.

The causes of an increase in amplitude but not in frequency could be;-

- A loose CKP
- Damaged reluctor wheel
- Poor connection on the CKP or PCM

Basic checks

- Check the condition of the CKP and wiring ensuring the sensor is correctly and securely fitted
- The output signal from the CKP can be monitored with **IDS datalogger RPM.** (A simple check for CKP performance is to compare the RPM signal against the RPM desired **(RPMDSD)**)
- Check the resistance of the CKP windings (280O to 380O)
- Where practical check the air gap between the sensor and reluctor wheel (Ideal air gap should be 2mm)
- Where practical check the reluctor wheel for security and damage
- Monitor the CKP signal with **IDS Oscilloscope**.
- **Care should be exercised when doing this as the engine must be cranked to obtain a reading**

If the information you are accessing is not available through normal Datalogger you may be able to access additional EOBD information via the OBD test modes:

To access OBD Datalogger:-VEHICLE SPECIFICATION PAGE > TOOLBOX > POWERTRAIN > OBD TEST MODES > MODE 1 POWERTRAIN DATA.

P0316 - Misfire detected on start-up (first 1000 revolutions)	Cont.	N	Low battery Low fuel pressure Loose or damaged wiring to injectors and/or coil packs Weak injector/s Contaminated spark plugs Loose or damaged wiring to CKP sensor Poor oil quality / air in lash adjusters Poor quality fuel	Ensure the battery is in good condition and fully charged Check the condition of the engine oil and operation of the lash adjusters Check the condition of the wiring and connectors to the coils, injectors and CKP sensor. Check the condition of the spark plugs Check the condition of the fuel system, including starting pressures and injectors

General notes for P0316.

This code can be stored even if the engine appears to be operating normally, the only potential symptom being a slightly longer cranking period before starting

There are a large number of factors that can cause this, however it can be an early indicator of potential developing fault.

- Check the ignition system, including spark plug condition and condition of the wiring
- Check the fuel system, including fuel pressure particularly from cold start.
- Check the condition of the engine and transmission oil

DIAGNOSIS AND TESTING (Continued)

- Ensure the battery and charging system are operating correctly and the engine achieves its correct cranking speed

If the information you are accessing is not available through normal Datalogger you may be able to access additional EOBD information via the OBD test modes:

To access OBD Datalogger:- VEHICLE SPECIFICATION PAGE > TOOLBOX > POWERTRAIN > OBD TEST MODES > MODE 1 POWERTRAIN DATA.

P0320 - CKP erratic signal (CKP)	Cont.	**Y**	Loose or damaged wiring/ connectors to CKP Defective CKP Damaged CKP wheel Crank to cam timing incorrect	Check the freeze frame data to check the engine conditions when the fault occurred Check the condition of the loom and connections to the CKP Check condition of the CKP and CKP wheel Check the engine timing

General Notes for P0320 - (A uneven idle speed may be evident and a poor response to acceleration (P0300, P0316 & P0315 may also be displayed)) The crankshaft position sensor (CKP) is an inductive type which generates an alternating current. As engine speed increases both the frequency and amplitude (voltage) of the signal increase.

There is a tooth missing off the reluctor wheel which indicates to the PCM the crankshaft position. Based on the information from the CKP, Camshaft Position Sensor(s) (CMP) and a number of other sensors fitted to the Powertrain, the PCM will activate the fuelling and ignition signals. If the PCM detects variations in the CKP signal, i.e. an increase in amplitude but not in frequency, the fuelling and ignition calculations are adversely affected.

The causes of an increase in amplitude but not in frequency could be;-

- A loose CKP
- Damaged reluctor wheel
- Poor connection on the CKP or PCM
- Camshaft to crankshaft timing incorrect

Basic checks

- Check the condition of the CKP and wiring ensuring the sensor is correctly and securely fitted
- The output signal from the CKP can be monitored with **IDS datalogger RPM.** (A simple check for CKP performance is to compare the RPM signal against the RPM desired **(RPMDSD)**)
- Check the resistance of the CKP windings (280O to 380O)
- Where practical check the air gap between the sensor and reluctor wheel
- Where practical check the reluctor wheel for security and damage
- Monitor the CKP signal with **IDS Oscilloscope**.
- **Care should be exercised when doing this as the engine must be turned on the key to obtain a reading**
- Check the valve timing

If the information you are accessing is not available through normal Datalogger you may be able to access additional EOBD information via the OBD test modes:

To access OBD Datalogger:- VEHICLE SPECIFICATION PAGE > TOOLBOX > POWERTRAIN > OBD TEST MODES > MODE 1 POWERTRAIN DATA.

P0325 - Knock sensor (bank 1) circuit (KS1)	Cont. KOER	N	Defective wiring or sensor	Check the condition of the wiring and connections. Measure the knock sensor resistance. Ensure knock sensor has not been over tightened
P0330 - Knock sensor (bank 2) circuit (KS2)	Cont. KOER	N	Defective wiring or sensor	Check the condition of the wiring and connections. Measure the knock sensor resistance. Ensure knock sensor has not been over tightened

General Notes for P0325 and P0330

The knock sensor is used to monitor the efficiency of the ignition timing.

It is vitally important the knock sensors are correctly fitted. If over or under tightened it will affect the operating frequency of the sensor, hence affecting the efficiency of the ignition system with the possible results of high fuel consumption and/or a lack of power.

- Inspect the sensor for evidence of damage and correct fit
- Check the condition of the wiring and connectors between the knock sensors and PCM. Ensure there is continuity and no shorts to VPWR or GRND

DIAGNOSIS AND TESTING (Continued)

- Check the sensor resistance 4 - 6 mΩ (Optimum resistance is 4.9 mΩ)

If the information you are accessing is not available through normal Datalogger you may be able to access additional EOBD information via the OBD test modes:

To access OBD Datalogger:- VEHICLE SPECIFICATION PAGE > TOOLBOX > POWERTRAIN > OBD TEST MODES > MODE 1 POWERTRAIN DATA.

P0335 - CKP Sensor failure (CKP)	Cont.	**Y**	Defective wiring or sensor (Wiring short to GRND, VPWR or open circuit) **(Also see P0300, P0316 & P0315)**	Check the freeze frame data to check the engine conditions when the fault occurred Check the condition of the wiring and connections. Measure the CKP sensor resistance. Ensure CKP sensor tip is not damaged or contaminated Using IDS OCR monitor signal from CKP negative rising positive
P0340 - Camshaft Position Sensor failure (CMP)	Cont.	**Y**	P0340 - Camshaft Position Sensor failure (CMP)	Check the freeze frame data to check the engine conditions when the fault occurred Check the condition of the wiring and connections. Ensure sensor is correctly fitted Measure sensor resistance

General Notes for P0340. (Also see **P1340** (V8 only))

The camshaft position sensor/s (CPS) are used to identify cylinder position relative to injector operation and the variable camshaft timing (VCT) system.

In the event of CPS failure, the injectors default to a continuous injection programme and the VCT is disabled. This can result in high fuel consumption, poor throttle response and a lack of power.

- Check the condition of the wiring and connectors between the CPS and PCM, ensure there are no shorts to VPWR, GRND or open circuits
- Check the resistance of the sensor 280 to 380Ω
- The performance of the sensor can be monitored with **IDS datalogger CMPFM**, this indicates the sensor has failed or SYNC, this indicates the camshaft and crankshaft timing is synchronised.

If the information you are accessing is not available through normal Datalogger you may be able to access additional EOBD information via the OBD test modes:

To access OBD Datalogger:- VEHICLE SPECIFICATION PAGE > TOOLBOX > POWERTRAIN > OBD TEST MODES > MODE 1 POWERTRAIN DATA.

P0351 - Ignition coil cylinder 1 Circuit failure (COP-A (or 1))	Cont.	**Y**	Damaged or defective wiring or connectors Defective power supply Defective switching signal from PCM Defective coil pack	Check the freeze frame data to check the engine conditions when the fault occurred Check all wiring and connections Ensure power supply is near battery voltage Monitoring switching signal with IDS.
P0352 - Ignition coil cylinder 2 Circuit failure (COP-B (or 2))	Cont.	**Y**	Damaged or defective wiring or connectors Defective power supply Defective switching signal from PCM Defective coil pack	Check the freeze frame data to check the engine conditions when the fault occurred Check all wiring and connections Ensure power supply is near battery voltage Monitoring switching signal with IDS.
P0353 - Ignition coil cylinder 3 Circuit failure (COP-B (or 3))	Cont.	**Y**	Damaged or defective wiring or connectors Defective power supply Defective switching signal from PCM Defective coil pack	Check the freeze frame data to check the engine conditions when the fault occurred Check all wiring and connections Ensure power supply is near battery voltage Monitoring switching signal with IDS.

DIAGNOSIS AND TESTING (Continued)

P0354 - Ignition coil cylinder 4 Circuit failure (COP-B (or 4))	Cont.	**Y**	Damaged or defective wiring or connectors Defective power supply Defective switching signal from PCM Defective coil pack	Check the freeze frame data to check the engine conditions when the fault occurred Check all wiring and connections Ensure power supply is near battery voltage Monitoring switching signal with IDS.
P0355 - Ignition coil cylinder 5 Circuit failure (COP-B (or 5))	Cont.	**Y**	Damaged or defective wiring or connectors Defective power supply Defective switching signal from PCM Defective coil pack	Check the freeze frame data to check the engine conditions when the fault occurred Check all wiring and connections Ensure power supply is near battery voltage Monitoring switching signal with IDS.
P0356 - Ignition coil cylinder 6 Circuit failure (COP-B (or 6))	Cont.	**Y**	Damaged or defective wiring or connectors Defective power supply Defective switching signal from PCM Defective coil pack	Check the freeze frame data to check the engine conditions when the fault occurred Check all wiring and connections Ensure power supply is near battery voltage Monitoring switching signal with IDS.
P0357 - Ignition coil cylinder 7 Circuit failure (COP-B (or 7))	Cont.	**Y**	Damaged or defective wiring or connectors Defective power supply Defective switching signal from PCM Defective coil pack	Check the freeze frame data to check the engine conditions when the fault occurred Check all wiring and connections Ensure power supply is near battery voltage Monitoring switching signal with IDS.
P0358 - Ignition coil cylinder 8 Circuit failure (COP-B (or 8))	Cont.	**Y**	Damaged or defective wiring or connectors Defective power supply Defective switching signal from PCM Defective coil pack	Check the freeze frame data to check the engine conditions when the fault occurred Check all wiring and connections Ensure power supply is near battery voltage Monitoring switching signal with IDS.

General Notes for P0351 to P0358.

These DTCs are used to indicate coil and/or circuit failure to a particular cylinder.

Preliminary checks would include:-

- Ensure the battery and charging system are in good condition (The coil packs operate on battery voltage, a low battery voltage can result in a weak spark)
- Ensure the wiring and connections between coil packs and PCM are in good condition. Ensure there are no shorts to VPWR, GRND or open circuits
- Check the spark plugs for correct grade, electrode condition and gap.
- Carryout **ignition tests with IDS.**
- Check the condition of the CKP

An ignition system that has deteriorated over a period of time may have triggered a number of DTCs elsewhere.

DTCs that could be associated with ignition component failure are:-

- HEGO related DTCs **P0132 to P0175 and P1130 to P1158**
- Misfire detection **P0300 to P0308 and P0316**
- Catalyst faults **P0420 and P0430**

If the information you are accessing is not available through normal Datalogger you may be able to access additional EOBD information via the OBD test modes:

To access OBD Datalogger:- VEHICLE SPECIFICATION PAGE > TOOLBOX > POWERTRAIN > OBD TEST MODES > MODE 1 POWERTRAIN DATA.

DIAGNOSIS AND TESTING (Continued)

P0420 - Catalyst system failure (I6 and bank 1 V8)	Cont.	**Y**	Catalyst has failed Exhaust or induction system leaks Catalyst has failed Exhaust or induction system leaks	Check the freeze frame data to check the engine conditions when the fault occurred Check the exhaust and induction systems for leaks. Monitor the switching times between the upstream and downstream HEGO sensors with IDS
P0430 - Catalyst system failure (bank 2 V8)	Cont.	**Y**	Catalyst has failed Exhaust or induction system leaks Catalyst has failed Exhaust or induction system leaks	Check the freeze frame data to check the engine conditions when the fault occurred Check the exhaust and induction systems for leaks. Monitor the switching times between the upstream and downstream HEGO sensors with IDS

General notes for P0420 and P0430

These DTCs are part of the Comprehensive Component Monitoring (CCM) system for EOBD, specifically catalyst monitoring.

The CCM compares the switching ratio between upstream and downstream HEGO sensors.

- Ensure both the induction and exhaust systems are in good condition
- Carry out a preliminary inspection of the wiring and connectors between the HEGO sensors and PCM

Preliminary diagnosis with IDS datalogger

- Using **IDS datalogger** select **O2S11** and **O2S12** (plus **O2S21** and **O2S22** for V8). The **CLOSED LOOP** PID is also useful to monitor
- Ensure the engine is at its correct operating temperature and monitor the signals. One method of ensuring the engine is at its correct operating temperature is to select all the HEGOs available and the **CLOSED LOOP** PID, then watch for a switching signal from the downstream HEGOs (**O2S21 and O2S22**). When the downstream HEGOs start switching in **CLOSED LOOP** the engine is at its optimum operating temperature.
- If the downstream HEGOs (**O2S12 and O2S22**) switching speed is similar to the upstream HEGOs (O2S11 and O2S21) then the catalytic converter(s) has failed

NOTE: The switching ratio between the upstream and downstream HEGOs is not clearly defined as the ratio changes with vehicle use. Under certain operating conditions the downstream HEGOs may switch every 30 to 60 seconds. Under different operating conditions it may take several minutes to switch.

Also see DTCs **P0132 to P0175** and **P1128 to P1158**

If the information you are accessing is not available through normal Datalogger you may be able to access additional EOBD information via the OBD test modes:

To access OBD Datalogger:- VEHICLE SPECIFICATION PAGE > TOOLBOX > POWERTRAIN > OBD TEST MODES > MODE 1 POWERTRAIN DATA.

P0443 – EVAP solenoid / circuit failure (EVAP)	Cont. KOEO KOER	Y	Damaged or defective wiring or connections Solenoid failed Defective PCM	Check the freeze frame data to check the engine conditions when the fault occurred Check the freeze frame data to check the engine conditions when the fault occurred Check all wiring and connections Check supply voltage (near battery voltage) Check resistance of solenoid Monitor **EVAP** system with **IDS datalogger**

DIAGNOSIS AND TESTING (Continued)

P0500 – No vehicle speed signal (VSS)	Cont. KOEO KOER	Y	Damaged or defective wiring or connections ABS defective VSS damaged or contaminated Incorrect wheels and tyres fitted Incorrect PCM configuration (rear axle ratio and/or tyre size programmed into **VID**)	Check the freeze frame data to check the engine conditions when the fault occurred Check all wiring and connections Ensure supply to sensor near battery voltage Monitor VSS with IDS Ensure the PCM is correctly programmed with VID information Carryout a NETWORK test using IDS datalogger, particularly looking for "U" codes For further diagnosis REFER to **206-09 Anti lock Control**
P0503 – VSS Erratic signal (VSS)	Cont.	N	Damaged or defective wiring or connections Incorrect wheels and tyres fitted VSS incorrectly fitted. ABS defective Incorrect PCM configuration (rear axle ratio and/or tyre size programmed into **VID**)	Check condition of wiring and connectors between the VSS, the PCM and the ABS modules. Carry out wiggle test on supply voltage and monitor with IDS datalogger Ensure VSS is fitted correctly Carryout a NETWORK test using IDS datalogger, particularly looking for "U" codes For further diagnosis REFER to **206-09 Anti lock Control**
P0504 – Brake Pedal Switch compare	Cont.	N	Occurs when the BOO and BPA values do not correlate. Upon application of the brake switch, the values of BOO and BPA should both change. With the brake pedal fully applied, BOO should be closed and BPA should be opn. If both read the same value, **P0504** will be set.	Use the PIDS to view BOO and RBS
P0505 – IAC not under control (IAC)	KOER	N	Mechanical defects causing erratic idle. To include items as blocked or damaged induction or exhaust system. Damaged or defective wiring or connections Damaged throttle body Incorrectly adjusted throttle body screw.	Ensure the mechanical systems are in serviceable condition. Check the condition of the wiring to the throttle body and PCM Check the throttle body wiring for correct power, signal and ground supplies.

General notes for IAC.

If **P0505** is displayed, this indicates the PCM is not controlling the idle speed. This can be caused by a number of defects.

- Check the condition of the induction system particularly around the **T-MAP** and between the **T-MAP** and the inlet manifold
- Check the condition of the throttle body, particularly for evidence of damage, partial seizure, or contamination around the throttle flap
- Check for integrity of the exhaust system, particularly around the manifold.
- Check the condition of the wiring and connectors to the throttle body
- Check the condition of the wiring and connectors to the **T-MAP**, **CKP**, injectors, ignition coils and upstream HEGO sensors.

A simple check to carryout with **IDS Output State Control (OSC)** function, if available.

- Select Datalogger PCM
- If a PID appears as **"IAC #"** this indicates IDS can take control of the system
- Select this PID and then select the **"#"** button on the right hand side of the screen.
- Below this button 3 more buttons will appear. A finger pressing a button and a + and – sign. Press the finger button and then press the + or – buttons. If the idle speed stabilises this indicates

DIAGNOSIS AND TESTING (Continued)

the PCM can control the IAC but is not receiving the correct information to do so. This would indicate potential concerns with the **T-MAP or HEGO11 or HEGO21**

If the information you are accessing is not available through normal Datalogger you may be able to access additional EOBD information via the OBD test modes:

To access OBD Datalogger:-VEHICLE SPECIFICATION PAGE > TOOLBOX > POWERTRAIN > OBD TEST MODES > MODE 1 POWERTRAIN DATA.

P0520 – Engine oil pressure Sensor/ Circuit defective (OIL_PRESS)	Cont	N	Defective, damaged or contaminated sensor	Ensure the wiring and connections are in good condition. Any evidence of damage or contamination to the sensor replace the sensor and retest.
P0524 – Engine oil pressure too low (OIL_PRESS)	Cont	N	Low oil level in engine Mechanical defect in engine Defective, damaged or contaminated sensor	Check engine oil level Ensure the wiring and connections are in good condition. Any evidence of damage or contamination to the sensor replace the sensor and retest. Monitor sensor with **IDS Datalogger (OIL_PRESS)**
P0532 – A/C pressure sensor circuit, low input. (ACPRESS)	Cont. KOEO	N	Damaged or defective wiring	Check the condition of the wiring and connectors Check sensor reference volt is correct
P0533 - A/C pressure sensor circuit, high input.	Cont. KOEO	N	Damaged or defective wiring Damaged or defective sensor	Check the condition of the wiring and connectors Check sensor reference volt is correct Check A/C for refrigerant charge
P0534 - Insufficient air con refrigerant	KOER	N	Poor A/C system performance Most likely cause is low A/C refrigerant charge. Compressor clutch electrical connector is not correctly plugged in Other possible causes are A/C System blockage, faulty evaporator thermistor, faulty HVAC blower, and faulty compressor.	Conduct A/C system performance test to confirm correct A/C charge
P0552 – PAS switch – low input (I6 only) (PSP)	Cont Cont	N	Defective wiring/connectors Defective wiring/connectors	Check the condition of the wiring between the PCM and switch. Check the condition of the wiring between the PCM and switch. Check the switch is in good condition with no evidence of contamination Check the supply voltage to the switch

DIAGNOSIS AND TESTING (Continued)

P0553 – PAS switch – high input (I6 only) (PSP)	Cont Cont	N	Defective wiring/connectors Defective Switch	Check the condition of the wiring and connectors. Particular attention should be given to ensure the return signal to the PCM has not shorted to VPWR Check the condition of the wiring and connectors. Particular attention should be given to ensure the return signal to the PCM has not shorted to VPWR Check the switch is in good condition. Check condition of charging circuit (multiple DTCs may indicate a charging defects.)
P0562 – Low battery voltage (B+)		N	Defective battery/charging system Defective battery/charging system	Check the connections to the battery and PCM Check the connections to the battery and PCM Battery voltage can be monitored with **IDS datalogger, B+** Carryout **Battery and Charging** system checks section **414-01 and 414-02**
P0563 – High battery voltage (B+)		N	Defective charging system Defective charging system Defective PCM	Carry out charging system checks section 414-02 Carry out charging system checks section 414-02 Battery voltage can be monitored with **IDS datalogger, B+** For further information refer to **AUTOMATIC TRANSMISSION – DIAGNOSTICS AND TESTING – 307-01**
P0572 - Brake pedal switch stuck high	Cont.	N		Check that the switch is correctly mounted on the mounting bracket. Check that the switch assembly is correctly set. Ensure that the wiring between the switch assembly and the PCM pin B25 is not short circuited to 5 volts.
P0573 - Brake pedal switch stuck low	Cont.	N	No power to brake pedal switch	Check for power to the switch assembly - perform KOER test.
P0602 – PCM Error	Cont.	N	PCM programming error PCM programming error	Check PCM has latest calibration. Check PCM has latest calibration. Ensure IDS lead and 16 pin DLC are fully engaged. Check connections on PCM
P0603 – PCM - KAM error (Possible engine operating FMEM and/or transmission limp home)	Cont	N	Blown KAM fuse Blown KAM fuse Loose battery connections Loose connections into PCM/TCM	Check KAM fuse Check KAM fuse Check wiring between battery, PCM and TCM If supply voltage to the PCM is correct and the engine is running an FMEM strategy, suspect internal PCM fault. If the supply voltage to the PCM is correct and the transmission is operating in limp home mode, suspect the TCM Ensure latest software is being used in both the PCM and TCM

DIAGNOSIS AND TESTING (Continued)

P0605 - PCM - ROM error (Possible engine operating FMEM and/or transmission limp home)	Cont	N	PCM/TCM programming error PCM/TCM programming error Incorrect software programmed	Check PCM/TCM has latest calibration. Check PCM/TCM has latest calibration. Ensure IDS lead and 16 pin DLC are fully engaged. Check connections between the DLC, PCM and TCM If DTC has been logged after a new TCM has been fitted and flashed, an error has occurred during the process. Check the file used for flashing process is correct and repeat the flash process. CLEAR ALL DTCs. TEST the system for normal operation. If DTC resets, install a new TCM and Main Control Valve Body.
P0606 – Internal error within PCM (RAM)	Cont	Y	This DTC indicates a fault has developed within the PCM. (Possible overheating of the circuit board)	Check the freeze frame data to check the engine conditions when the fault occurred Check the freeze frame data to check the engine conditions when the fault occurred Check the condition of the wiring and connections to the PCM Using IDS/PDS monitor PCM and ensure latest software is loaded. If unable to communicate with PCM – Check connections to PCM - Check condition of 16 pin connector and 16 pin lead.
P0613 - TCM error	Cont KOEO KOER		Defective wiring between the PCM, TCM and shifter PCB Defective wiring between the PCM, TCM and shifter PCB Defective TCM	Check the condition of the wiring and connections between the PCM, PCB and multi-plug connection on the transmission. Check the condition of the wiring and connections between the PCM, PCB and multi-plug connection on the transmission. Ensure relevant ground (GRND) and supply voltages (VPWR) are correct. Ensure the VID parameters are correct Ensure the PCM and TCM are operating with the latest software calibrations.

Reprogramming the VID block

NOTE: Ensure that the most up-to-date software version is installed in IDS.

NOTE: In the case of engine running concerns, module-reprogramming of the PCM may be required. For this purpose, a revised software version is transferred to the PCM using IDS

Select the "Module reprogramming" submenu in the "Module programming" menu tool box and then follow the instructions.

NOTE: Following installation of a wheel/tyre combination, for which the tyre-tread circumference does not correspond to that of standard tyres, the tyre size must be changed in the powertrain control module (PCM) using IDS.

Select the "Programmable parameters" submenu in the "Module programming" menu tool box and enter the corresponding tyre size under the "tyre size" menu item

DIAGNOSIS AND TESTING (Continued)

P062F - EEPROM Error (Possible engine operating FMEM and/or transmission limp home or Crank non start)	Cont KOEO KOER		Software concern **NOTE** is unlikely this DTC will be displayed as there may be difficulty communicating with the PCM	Ensure IDS 16 pin cable is in serviceable condition and latest calibrations are installed. If unable to establish communication with PCM attempt identify PCM with the **TEAR TAG or PCM PART NO.** If successful, ensure both the PCM and TCM are running the current software. If unable to communicate, replace the PCM.
P0622 – Alternator circuit	Cont KOER	**N**	Fault with the charging system	**Refer to section 414-02 CHARGING SYSTEMS**
P0634 – Internal module overheat detected	Cont KOEO KOER	**N**	Damaged circuitry within a module **NOTE:** (Possible engine operating FMEM and/or transmission limp home or engine crank non start)	An internal overheat has been detected in either the PCM/TCM or PCB. Record all relevant DTCs. Identify any common theme, clear the DTCs and recheck. If DTC returns replace the relevant module and re-flash with latest software. If DTC returns replace the relevant module and re-flash with latest software.
P0641 – Transmission sensors, incorrect voltage	Cont KOEO KOER	**N**	Damaged or defective wiring/connectors between the PCM and transmission multi-plug Defective TCM. **NOTE:** Transmission may be in "LIMP-HOME" mode	Check condition of wiring and connectors between the PCM and TCM Check if any other DTCs are recorded; if so attempt to identify a common theme i.e. incorrect voltage to engine sensors. If incorrect voltage to a range of engine sensors is indicated, suspect PCM fault. If only DTCs indicated relates to transmission faults, suspect TCM CLEAR ALL DTCs. TEST the system for normal operation. If DTC resets, install a new TCM and Main Control Valve Body For further information refer to **AUTOMATIC TRANSMISSION - DIAGNOSTICS AND TESTING - 307-01**
P0657 – Shifter supply voltage open circuit	Cont KOEO KOER	**N**	Damaged or defective wiring to shifter Defective shifter PCB Defective TCM **NOTE:** transmission may be operating in "LIMP-HOME"	Check the condition of the wiring and connections between the PCM, PCB and multi-plug connection on the transmission. Ensure relevant ground (GRND) and supply voltages (VPWR) are correct. Visually inspect the shifter PCB checking for damage or contamination. Any evidence of damage or contamination replace the PCB Ensure the PCM and TCM are operating with the latest software calibrations. Clear all DTCs and re-test. If DTC returns, replace the TCM and Main Control Valve Body. Re-flash with the latest calibration For further information refer to **AUTOMATIC TRANSMISSION - DIAGNOSTICS AND TESTING - 307-01**

DIAGNOSIS AND TESTING (Continued)

P0658 – Shifter supply voltage short to ground	Cont KOEO KOER	**N**	Damaged or defective wiring to shifter Defective shifter PCB Defective TCM **NOTE:** transmission may be operating in "LIMP-HOME"	Check the condition of the wiring and connections between the PCM, PCB and multi-plug connection on the transmission. Check the condition of the wiring and connections between the PCM, PCB and multi-plug connection on the transmission. Ensure relevant ground (GRND) and supply voltages (VPWR) are correct. Visually inspect the shifter PCB checking for damage or contamination. Any evidence of damage or contamination replace the PCB Ensure the PCM and TCM are operating with the latest software calibrations. Clear all DTCs and re-test. If DTC returns, replace the TCM and Main Control Valve Body. Re-flash with the latest calibration For further information refer to **AUTOMATIC TRANSMISSION - DIAGNOSTICS AND TESTING - 307-01**
P0659 – Shifter supply voltage short to power	Cont KOEO KOER	**N**	Damaged or defective wiring to shifter Defective shifter PCB Defective TCM **NOTE:** transmission may be operating in "LIMP-HOME"	Check the condition of the wiring and connections between the PCM, PCB and multi-plug connection on the transmission. Ensure relevant ground (GRND) and supply voltages (VPWR) are correct. Visually inspect the shifter PCB checking for damage or contamination. Any evidence of damage or contamination replace the PCB Ensure the PCM and TCM are operating with the latest software calibrations. Clear all DTCs and re-test. If DTC returns, replace the TCM and Main Control Valve Body. Re-flash with the latest calibration For further information refer to **AUTOMATIC TRANSMISSION - DIAGNOSTICS AND TESTING - 307-01**
P0667 – Internal module overheat detected	Cont KOEO KOER	**N**	Damaged circuitry within a module **NOTE:** (Possible engine operating FMEM and/or transmission limp home or engine crank non start)	An internal overheat has been detected in either the PCM/TCM or PCB. Record all relevant DTCs. Identify any common theme, clear the DTCs and recheck. If DTC returns replace the relevant module and re-flash with latest software.
P0701 – TCM out of range.	KOEO	**N**	Communications error between TCM and PCM or defective TCM	Check the condition of the wiring between the PCM and TCM multi-plug. This could be caused by multiple faults in the transmission. Record all DTCs and clear. Test vehicle and monitor with IDS, noting DTCs as they occur For further information refer to **AUTOMATIC TRANSMISSION - DIAGNOSTICS AND TESTING - 307-01**

DIAGNOSIS AND TESTING (Continued)

P0704 – Clutch position switch (CPP)	KOEO	**N**	Defective wiring on clutch position switch (CPP) or defective switch	Monitor CPP operation with datalogger for function. Check the condition of wiring and connection on CPP
P0705 – Shifter not registering correct position	Cont KOEO KOER	**N**	Defective shifter PCB Defective wiring or connections to shifter PCB Mechanical defect with shifter mechanism	Ensure the connections are in good condition between the shifter and gearbox. Check the PCB for damage or evidence of overheating For further information refer to **AUTOMATIC TRANSMISSION - DIAGNOSTICS AND TESTING - 307-01**
P0706 – Shifter PCB out of range	Cont KOEO KOER	**N**	Indicates a fault with the printed circuit board (PCB) in the shifter. (Transmission may be running a limited operation strategy (LOS))	Ensure the connections are in good condition between the shifter and gearbox. Check the PCB for damage or evidence of overheating For further information refer to **AUTOMATIC TRANSMISSION - DIAGNOSTICS AND TESTING - 307-01**
P0707 – Shifter low voltage input	Cont KOEO	**N**	Low voltage supply to shifter (PCB) **(4 speed only)**	Check supply voltage to PCB in shifter. Check wiring for shorts to ground. For further information refer to **AUTOMATIC TRANSMISSION - DIAGNOSTICS AND TESTING - 307-01**
P0708 – Shifter high voltage	Cont KOEO	**N**	High voltage supply to shifter (PCB) **(4 speed only)**	Check supply voltage to PCB in shifter. Check wiring for shorts to VPWR. For further information refer to **AUTOMATIC TRANSMISSION - DIAGNOSTICS AND TESTING - 307-01**
P0710 – Shifter sensing high gearbox temperature	Cont	**N**	Defective transmission temperature sensor. Wiring between transmission and shifter defective	Monitor transmission temperature sensor with IDS/PDS for range and performance. Check condition of wiring and connectors between transmission and shifter. For further information refer to **AUTOMATIC TRANSMISSION - DIAGNOSTICS AND TESTING - 307-01**
P0711 – Shifter sensing high gearbox temperature	Cont	**N**	Defective transmission temperature sensor. Wiring between transmission and shifter defective	Monitor transmission temperature sensor with IDS/PDS for range and performance. Check condition of wiring and connectors between transmission and shifter. For further information refer to **AUTOMATIC TRANSMISSION - DIAGNOSTICS AND TESTING - 307-01**
P0712 – Transmission temperature sensor outside self-test range (too low) (TFT)	Cont KOEO KOER	**N**	Improper connection; TFT sensor shorted to ground Faulty sensor. Wiring and/or connectors defective	Check condition of wiring and connectors on gearbox Monitor transmission temperature sensor with IDS/PDS for performance For additional checks refer to **SECTIONS 307-01 and 307-05**

DIAGNOSIS AND TESTING (Continued)

P0713 – Transmission temperature sensor outside self-test range (too high) (TFT)	Cont KOEO KOER	**N**	Improper connection; TFT sensor shorted to Vehicle Power (VPWR) or Vehicle Reference Voltage (VREF), Sensor open circuit	Check condition of wiring and connectors on gearbox Monitor transmission temperature sensor with IDS/PDS for performance For additional checks refer to **SECTIONS 307-01 and 307-05**
P0714 - Transmission oil temperature sensor intermittent fault (TFT)	Cont	**N**	Defective wiring and/or connections between PCM, TCM or shifter PCB Defective	Check condition of wiring to multi-plug on the transmission ensuring all power (VPWR) and ground (GRND) connections are serviceable. Using **IDS datalogger** select **TFT** PID and carryout a wiggle test. CLEAR ALL DTCs. TEST the system for normal operation. If DTC resets, install a new TCM and Main Control Valve Body. Re-flash module with current calibrations For further information refer to **AUTOMATIC TRANSMISSION - DIAGNOSTICS AND TESTING - 307-01**
P0715 – Turbine shaft speed sensor circuit (TSS)	Cont	**N**	Defective wiring and/or connections Defective sensor **NOTE:** Possible "LIMP-HOME" active	Check condition of wiring and connectors on gearbox Monitor turbine speed sensor with IDS/PDS for performance For further information refer to **AUTOMATIC TRANSMISSION - DIAGNOSTICS AND TESTING - 307-01**
P0716 – Turbine speed sensor operating outside range (TSS)	Cont	**N**	Defective wiring between PCM and TCM Defective TCM module Defective sensor **NOTE:** Possible "LIMP-HOME" active	Check condition of wiring to multi-plug on the transmission ensuring all power (VPWR) and ground (GRND) connections are serviceable. CLEAR ALL DTCs. TEST the system for normal operation. If DTC resets, install a new TCM and Main Control Valve Body. Re-flash module with current calibrations For further information refer to **AUTOMATIC TRANSMISSION - DIAGNOSTICS AND TESTING - 307-01**
P0718 - Turbine shaft speed sensor circuit intermittent fault (TSS)		**N**	Defective wiring and/or connections Defective sensor	Check condition of wiring and connectors on gearbox Monitor turbine speed sensor with IDS/PDS for performance For further information refer to **AUTOMATIC TRANSMISSION - DIAGNOSTICS AND TESTING - 307-01**
P0720 – Output shaft speed sensor circuit (OSS)	Cont	**N**	Defective wiring between PCM and TCM Defective TCM module Defective sensor **NOTE:** Possible "LIMP-HOME" active	Compare output shaft speed sensor speed to wheel speed sensor speed. REFER to Section 206-09A. Compare output shaft speed sensor speed to wheel speed sensor speed. REFER to Section 206-09A. CLEAR ALL DTCs. TEST the system for normal operation. Carry out a drive cycle test with harsh shifts and rapid deceleration. Monitor **VSS, TSS, OSS and RPM** with **IDS datalogger**

DIAGNOSIS AND TESTING (Continued)

P0721 – Output shaft speed sensor circuit range (OSS)	Cont	**N**	Defective wiring between PCM and TCM Defective TCM module Defective sensor **NOTE:** Possible "LIMP-HOME" active	Check condition of wiring to multi-plug on the transmission ensuring all power (VPWR) and ground (GRND) connections are serviceable Using IDS select **OSS** PID and carryout a wiggle test. CLEAR ALL DTCs. TEST the system for normal operation. If DTC resets, install a new TCM and Main Control Valve Body.
P0722 – Output shaft speed sensor circuit no signal (OSS)	Cont	**N**	Defective wiring between PCM and TCM Defective TCM module Defective sensor **NOTE:** Possible "LIMP-HOME" active	Check condition of wiring to multi-plug on the transmission ensuring all power (VPWR) and ground (GRND) connections are serviceable Check condition of wiring to multi-plug on the transmission ensuring all power (VPWR) and ground (GRND) connections are serviceable Using IDS select **OSS** PID and carryout a wiggle test. CLEAR ALL DTCs. TEST the system for normal operation. If DTC resets, install a new TCM and Main Control Valve Body.
P0723 – Intermittent signal from transmission output shaft (OSS)	Cont	**N**	Defective wiring between PCM and TCM Defective TCM module Defective sensor	Check condition of wiring to multi-plug on the transmission ensuring all power (VPWR) and ground (GRND) connections are serviceable Check condition of wiring to multi-plug on the transmission ensuring all power (VPWR) and ground (GRND) connections are serviceable Using IDS select **OSS** PID and carryout a wiggle test. CLEAR ALL DTCs. TEST the system for normal operation. If DTC resets, install a new TCM and Main Control Valve Body. Re-flash module with current calibrations

DIAGNOSIS AND TESTING (Continued)

P0729 – 6th Gear incorrect ratio	Cont	**N**	Fluid contamination within the transmission Incorrect calibrations PCM/TCM Incorrect torque converter fitted Mechanical defects with clutch packs	Carry out a transmission level and condition check: refer to section **AUTOMATIC TRANSMISSION - FLUID LEVEL CHECK – 307-01** Carry out a transmission level and condition check: refer to section **AUTOMATIC TRANSMISSION - FLUID LEVEL CHECK – 307-01** If during this check a high level of contamination is evident, suspect internal gearbox failure. Ensure the PCM and TCM are operating on current calibrations Ensure the VID details are correct If the transmission has been replaced it is vitally important the torque converter is the correct one for the engine/transmission combination. For further information refer to **AUTOMATIC TRANSMISSION - DIAGNOSTICS AND TESTING - 307-01**
P0731 – 1st Gear incorrect ratio	Cont	**N**	Fluid contamination within the transmission Incorrect calibrations PCM/TCM Incorrect torque converter fitted Mechanical defects with clutch packs	Carry out a transmission level and condition check: refer to section **AUTOMATIC TRANSMISSION - FLUID LEVEL CHECK – 307-01** If during this check a high level of contamination is evident, suspect internal gearbox failure. Ensure the PCM and TCM are operating on current calibrations Ensure the VID details are correct If the transmission has been replaced it is vitally important the torque converter is the correct one for the engine/transmission combination. For further information refer to **AUTOMATIC TRANSMISSION - DIAGNOSTICS AND TESTING - 307-01**
P0732 – 2nd Gear incorrect ratio	Cont	**N**	Fluid contamination within the transmission Incorrect calibrations PCM/TCM Incorrect torque converter fitted Mechanical defects with clutch packs	Carry out a transmission level and condition check: refer to section **AUTOMATIC TRANSMISSION - FLUID LEVEL CHECK – 307-01** If during this check a high level of contamination is evident, suspect internal gearbox failure. Ensure the PCM and TCM are operating on current calibrations Ensure the VID details are correct If the transmission has been replaced it is vitally important the torque converter is the correct one for the engine/transmission combination. For further information refer to **AUTOMATIC TRANSMISSION - DIAGNOSTICS AND TESTING - 307-01**

DIAGNOSIS AND TESTING (Continued)

P0733 – 3rd Gear incorrect ratio	Cont	**N**	Fluid contamination within the transmission Incorrect calibrations PCM/TCM Incorrect torque converter fitted Mechanical defects with clutch packs	Carry out a transmission level and condition check: refer to section **AUTOMATIC TRANSMISSION - FLUID LEVEL CHECK – 307-01** If during this check a high level of contamination is evident, suspect internal gearbox failure. Ensure the PCM and TCM are operating on current calibrations Ensure the VID details are correct If the transmission has been replaced it is vitally important the torque converter is the correct one for the engine/transmission combination. For further information refer to **AUTOMATIC TRANSMISSION - DIAGNOSTICS AND TESTING - 307-01**
P0734 – 4th Gear incorrect ratio	Cont	**N**	Fluid contamination within the transmission Incorrect calibrations PCM/TCM Incorrect torque converter fitted Mechanical defects with clutch packs	Carry out a transmission level and condition check: refer to section **AUTOMATIC TRANSMISSION - FLUID LEVEL CHECK – 307-01** If during this check a high level of contamination is evident, suspect internal gearbox failure. Ensure the PCM and TCM are operating on current calibrations Ensure the VID details are correct If the transmission has been replaced it is vitally important the torque converter is the correct one for the engine/transmission combination. For further information refer to **AUTOMATIC TRANSMISSION - DIAGNOSTICS AND TESTING - 307-01**
P0735 – 5th Gear incorrect ratio	Cont	**N**	Fluid contamination within the transmission Incorrect calibrations PCM/TCM Incorrect torque converter fitted Mechanical defects with clutch packs	Carry out a transmission level and condition check: refer to section **AUTOMATIC TRANSMISSION - FLUID LEVEL CHECK – 307-01** If during this check a high level of contamination is evident, suspect internal gearbox failure. Ensure the PCM and TCM are operating on current calibrations Ensure the VID details are correct If the transmission has been replaced it is vitally important the torque converter is the correct one for the engine/transmission combination. For further information refer to **AUTOMATIC TRANSMISSION - DIAGNOSTICS AND TESTING - 307-01**

DIAGNOSIS AND TESTING (Continued)

P0736 – Reverse Gear incorrect ratio	Cont	**N**	Fluid contamination within the transmission Incorrect calibrations PCM/TCM Incorrect torque converter fitted Mechanical defects with clutch packs	Carry out a transmission level and condition check: refer to section **AUTOMATIC TRANSMISSION - FLUID LEVEL CHECK – 307-01** If during this check a high level of contamination is evident, suspect internal gearbox failure. Ensure the PCM and TCM are operating on current calibrations Ensure the VID details are correct If the transmission has been replaced it is vitally important the torque converter is the correct one for the engine/transmission combination. For further information refer to **AUTOMATIC TRANSMISSION - DIAGNOSTICS AND TESTING - 307-01**
P0740 – Torque converter solenoid open circuit	Cont	**N**	Defective wiring and/or connections to transmission multi-plug. (Would normally be multiple DTCs stored) If only P0740 stored, suspect defective wiring within transmission or defective sensor	Check the operation of the torque converter lock-up clutch under road-test conditions with IDS/PDS Check the wiring and connections on the transmission loom. For further information refer to **AUTOMATIC TRANSMISSION - DIAGNOSTICS AND TESTING - 307-01**
P0741 – Torque converter lock-up clutch (TCC) not working		**N**	Defective torque converter Defective torque converter lock-up clutch solenoid.	Check the operation of the torque converter lock-up clutch under road-test conditions with IDS/PDS Check the wiring and connections on the transmission loom. For further information refer to **AUTOMATIC TRANSMISSION - DIAGNOSTICS AND TESTING - 307-01**
P0743 – Torque converter lock-up clutch solenoid defective	Cont	**N**	Defective or damaged wiring to the TCC solenoid. Defective TCC solenoid	Check the operation of the torque converter lock-up clutch under road-test conditions with IDS/PDS Check the wiring and connections on the transmission loom. For further information refer to **AUTOMATIC TRANSMISSION - DIAGNOSTICS AND TESTING - 307-01**
P0751 – Shift solenoid A stuck off	Cont	**N**	Defective solenoid.	Carry out preliminary transmission condition checks Monitor solenoid operation with IDS/PDS. For further information refer to **AUTOMATIC TRANSMISSION - DIAGNOSTICS AND TESTING - 307-01**
P0752 – Shift solenoid A stuck on	Cont	**N**	Defective solenoid.	Carry out preliminary transmission condition checks Monitor solenoid operation with IDS/PDS. For further information refer to **AUTOMATIC TRANSMISSION - DIAGNOSTICS AND TESTING - 307-01**

DIAGNOSIS AND TESTING (Continued)

P0753 – Shift solenoid A, circuit fault	Cont KOEO	**N**	Defective or damaged wiring to the shift solenoid. Defective solenoid Defective TCM	Check the operation of the torque converter lock-up clutch under road-test conditions with IDS/PDS Check the wiring and connections on the transmission loom. For further information refer to **AUTOMATIC TRANSMISSION - DIAGNOSTICS AND TESTING - 307-01**
P0756 - Shift solenoid B stuck off	Cont	**N**	Defective solenoid.	Carry out preliminary transmission condition checks Monitor solenoid operation with IDS/PDS. For further information refer to **AUTOMATIC TRANSMISSION - DIAGNOSTICS AND TESTING - 307-01**
P0757 - Shift solenoid B stuck on	Cont	**N**	Defective solenoid.	Carry out preliminary transmission condition checks Monitor solenoid operation with IDS/PDS. For further information refer to **AUTOMATIC TRANSMISSION - DIAGNOSTICS AND TESTING - 307-01**
P0758 - Shift solenoid B circuit fault	Cont KOEO	**N**	Defective or damaged wiring to the shift solenoid. Defective solenoid Defective TCM	Check the operation of the torque converter lock-up clutch under road-test conditions with IDS/PDS Check the wiring and connections on the transmission loom. For further information refer to **AUTOMATIC TRANSMISSION - DIAGNOSTICS AND TESTING - 307-01**
P0761 – Shift solenoid C stuck off	Cont	**N**	Defective solenoid.	Carry out preliminary transmission condition checks Monitor solenoid operation with IDS/PDS. For further information refer to **AUTOMATIC TRANSMISSION - DIAGNOSTICS AND TESTING - 307-01**
P0762 – Shift solenoid C stuck on	Cont	**N**	Defective solenoid.	Carry out preliminary transmission condition checks Monitor solenoid operation with IDS/PDS. For further information refer to **AUTOMATIC TRANSMISSION - DIAGNOSTICS AND TESTING - 307-01**
P0763 – Shift solenoid C circuit fault	Cont KOEO	**N**	Defective or damaged wiring to the shift solenoid. Defective solenoid Defective TCM	Check the operation of the torque converter lock-up clutch under road-test conditions with IDS/PDS Check the wiring and connections on the transmission loom. For further information refer to **AUTOMATIC TRANSMISSION - DIAGNOSTICS AND TESTING - 307-01**

DIAGNOSIS AND TESTING (Continued)

P0768 – Shift solenoid D circuit fault	Cont KOEO	**N**	Defective or damaged wiring to the shift solenoid. Defective solenoid Defective TCM	Check the operation of the torque converter lock-up clutch under road-test conditions with IDS/PDS Check the wiring and connections on the transmission loom. For further information refer to **AUTOMATIC TRANSMISSION - DIAGNOSTICS AND TESTING - 307-01**
P0770 – Shift solenoid E circuit fault	Cont KOEO	**N**	Defective or damaged wiring to the shift solenoid. Defective solenoid Defective TCM	Check the operation of the torque converter lock-up clutch under road-test conditions with IDS/PDS Check the wiring and connections on the transmission loom. For further information refer to **AUTOMATIC TRANSMISSION - DIAGNOSTICS AND TESTING - 307-01**
P0773 – Shift solenoid E circuit fault	Cont KOEO	**N**	Defective or damaged wiring to the shift solenoid. Defective solenoid Defective TCM	Check the operation of the torque converter lock-up clutch under road-test conditions with IDS/PDS Check the wiring and connections on the transmission loom. For further information refer to **AUTOMATIC TRANSMISSION - DIAGNOSTICS AND TESTING - 307-01**
P0781 - 1-2 shift	Cont KOEO	**N**	Internal fault with transmission Damaged or defective clutch packs Defective TCM Incorrect TCM/PCM software, including VID parameters Incorrect torque converter fitted	Carry out a transmission level and condition check: refer to section **AUTOMATIC TRANSMISSION - FLUID LEVEL CHECK – 307-01** If during this check a high level of contamination is evident, suspect internal gearbox failure. Check the PCM and TCM are operating on current software, including VID parameters. If a new torque converter has been fitted, ensure it is the correct specification CLEAR ALL DTCs. TEST the system for normal operation. If DTC resets, install a new Transmission. For further information refer to **AUTOMATIC TRANSMISSION - DIAGNOSTICS AND TESTING - 307-01**

DIAGNOSIS AND TESTING (Continued)

P0782 – 2-3 shift	Cont KOEO	**N**	Internal fault with transmission Damaged or defective clutch packs Defective TCM Incorrect TCM/PCM software, including VID parameters Incorrect torque converter fitted	Carry out a transmission level and condition check: refer to section **AUTOMATIC TRANSMISSION - FLUID LEVEL CHECK – 307-01** If during this check a high level of contamination is evident, suspect internal gearbox failure. Check the PCM and TCM are operating on current software, including VID parameters. If a new torque converter has been fitted, ensure it is the correct specification CLEAR ALL DTCs. TEST the system for normal operation. If DTC resets, install a new Transmission. For further information refer to **AUTOMATIC TRANSMISSION - DIAGNOSTICS AND TESTING - 307-01**
P0783 – 3-4 shift	Cont KOEO	**N**	Internal fault with transmission Damaged or defective clutch packs Defective TCM Incorrect TCM/PCM software, including VID parameters Incorrect torque converter fitted	Carry out a transmission level and condition check: refer to section **AUTOMATIC TRANSMISSION - FLUID LEVEL CHECK – 307-01** If during this check a high level of contamination is evident, suspect internal gearbox failure. Check the PCM and TCM are operating on current software, including VID parameters. If a new torque converter has been fitted, ensure it is the correct specification CLEAR ALL DTCs. TEST the system for normal operation. If DTC resets, install a new Transmission. For further information refer to **AUTOMATIC TRANSMISSION - DIAGNOSTICS AND TESTING - 307-01**
P0784 – 4-5 shift	Cont KOEO	**N**	Internal fault with transmission Damaged or defective clutch packs Defective TCM Incorrect TCM/PCM software, including VID parameters Incorrect torque converter fitted	Carry out a transmission level and condition check: refer to section **AUTOMATIC TRANSMISSION - FLUID LEVEL CHECK – 307-01** If during this check a high level of contamination is evident, suspect internal gearbox failure. Check the PCM and TCM are operating on current software, including VID parameters. If a new torque converter has been fitted, ensure it is the correct specification CLEAR ALL DTCs. TEST the system for normal operation. If DTC resets, install a new Transmission. For further information refer to **AUTOMATIC TRANSMISSION - DIAGNOSTICS AND TESTING - 307-01**

DIAGNOSIS AND TESTING (Continued)

P0801 – Reverse inhibit control circuit	Cont KOEO KOER	**N**	Defective or damaged wiring to the shift solenoid. Defective solenoid Defective TCM	Check condition of wiring and connectors to the transmission Monitor solenoid operation with IDS/PDS. For further information refer to **AUTOMATIC TRANSMISSION - DIAGNOSTICS AND TESTING - 307-01**
P0812 – Reverse gear in-put circuit	Cont	**N**	Damaged or defective wiring and/or connections. Defective reversing lamps.	Check the condition of the wiring to the transmission – particular attention to shorts to ground or VPWR. Check the condition of the wiring to the rear lamps
P0826 – Sport shift performance concerns	Cont	**N**	Wiring between shifter printed circuit board (PCB) and TCM defective or damaged. Incorrect software programmed TCM/PCM PCM parameters incorrect i.e. tyre size, axle ratio etc Defective shifter mechanism Defective PCB Defective TCM Defective PCM	Check the correct parameters are programmed into the PCM Check the condition of the wiring between the PCB, TCM and PCM. Check the mechanical operation of the shifter Ensure the latest calibrations are installed in all modules For additional checks refer to **SECTIONS 307-05**
P0827 – Sport shift performance concerns	Cont	**N**	Wiring to the shifter printed circuit board (PCB) shorted to ground. Defective PCB	Check the wiring to the PCB for correct power supply and ground connections. For additional checks refer to **SECTIONS 307-05**
P0829 – 5-6 shift	Cont KOER	**N**	Internal fault with transmission Damaged or defective clutch packs Defective TCM Incorrect TCM/PCM software, including VID parameters Incorrect torque converter fitted	Carry out a transmission level and condition check: refer to section **AUTOMATIC TRANSMISSION - FLUID LEVEL CHECK – 307-01** If during this check a high level of contamination is evident, suspect internal gearbox failure. Check the PCM and TCM are operating on current software, including VID parameters. If a new torque converter has been fitted, ensure it is the correct specification CLEAR ALL DTCs. TEST the system for normal operation. If DTC resets, install a new Transmission. For further information refer to **AUTOMATIC TRANSMISSION - DIAGNOSTICS AND TESTING - 307-01**

DIAGNOSIS AND TESTING (Continued)

P0960 – Pressure Control Solenoid A Control Circuit / Open	Cont KOEO KOER	**N**	Defective wiring or connections to the transmission multi-plug Defective TCM/valve body assembly Defective solenoid	Check condition of wiring to multi-plug on the transmission ensuring all power (VPWR) and ground (GRND) connections are serviceable Using IDS select **PC_A** PID (if available) and monitor signal. CLEAR ALL DTCs. TEST the system for normal operation. If DTC resets, install a new TCM and Main Control Valve Body. Re-flash module with current calibrations For further information refer to **AUTOMATIC TRANSMISSION - DIAGNOSTICS AND TESTING - 307-01**
P0962 - Pressure Control Solenoid A Control Circuit Low	Cont KOEO KOER	**N**	Defective wiring or connections to the transmission multi-plug Defective TCM/valve body assembly Defective solenoid	Check condition of wiring to multi-plug on the transmission ensuring all power (VPWR) and ground (GRND) connections are serviceable Using IDS select **PC_A** PID (if available) and monitor signal. CLEAR ALL DTCs. TEST the system for normal operation. If DTC resets, install a new TCM and Main Control Valve Body. Re-flash module with current calibrations For further information refer to **AUTOMATIC TRANSMISSION - DIAGNOSTICS AND TESTING - 307-01**
P0963 - Pressure Control Solenoid A Control Circuit High	Cont KOEO KOER	**N**	Defective wiring or connections to the transmission multi-plug Defective TCM/valve body assembly Defective solenoid	Check condition of wiring to multi-plug on the transmission ensuring all power (VPWR) and ground (GRND) connections are serviceable Using IDS select **PC_A** PID (if available) and monitor signal. CLEAR ALL DTCs. TEST the system for normal operation. If DTC resets, install a new TCM and Main Control Valve Body. Re-flash module with current calibrations For further information refer to **AUTOMATIC TRANSMISSION - DIAGNOSTICS AND TESTING - 307-01**
P0972 - Shift Solenoid A Control Circuit Range/Performance	Cont KOEO KOER	**N**	Defective wiring or connections to the transmission multi-plug Defective TCM/valve body assembly Defective solenoid	Check condition of wiring to multi-plug on the transmission ensuring all power (VPWR) and ground (GRND) connections are serviceable Using IDS select **SS_A (or SS1)** PID (if available) and monitor signal. CLEAR ALL DTCs. TEST the system for normal operation. If DTC resets, install a new TCM and Main Control Valve Body. Re-flash module with current calibrations For further information refer to **AUTOMATIC TRANSMISSION - DIAGNOSTICS AND TESTING - 307-01**

DIAGNOSIS AND TESTING (Continued)

P0973 – Shift Solenoid A Control Circuit Low	Cont KOEO KOER	**N**	Defective wiring or connections to the transmission multi-plug Defective TCM/valve body assembly Defective solenoid	Check condition of wiring to multi-plug on the transmission ensuring all power (VPWR) and ground (GRND) connections are serviceable Using IDS select **SS_A (or SS1)** PID (if available) and monitor signal. CLEAR ALL DTCs. TEST the system for normal operation. If DTC resets, install a new TCM and Main Control Valve Body. Re-flash module with current calibrations For further information refer to **AUTOMATIC TRANSMISSION - DIAGNOSTICS AND TESTING - 307-01**
P0974 – Shift Solenoid A Control Circuit High	Cont KOEO KOER	**N**	Defective wiring or connections to the transmission multi-plug Defective TCM/valve body assembly Defective solenoid	Check condition of wiring to multi-plug on the transmission ensuring all power (VPWR) and ground (GRND) connections are serviceable Using IDS select **SS_A (or SS1**) PID (if available) and monitor signal. CLEAR ALL DTCs. TEST the system for normal operation. If DTC resets, install a new TCM and Main Control Valve Body. Re-flash module with current calibrations For further information refer to **AUTOMATIC TRANSMISSION - DIAGNOSTICS AND TESTING - 307-01**
P0975 – Shift Solenoid B Control Circuit Range/ Performance	Cont KOEO KOER	**N**	Defective wiring or connections to the transmission multi-plug Defective TCM/valve body assembly Defective solenoid	Check condition of wiring to multi-plug on the transmission ensuring all power (VPWR) and ground (GRND) connections are serviceable Using IDS select **SS_B (or SS2)** PID (if available) and monitor signal. CLEAR ALL DTCs. TEST the system for normal operation. If DTC resets, install a new TCM and Main Control Valve Body. Re-flash module with current calibrations For further information refer to **AUTOMATIC TRANSMISSION - DIAGNOSTICS AND TESTING - 307-01**
P0976 – Shift Solenoid B Control Circuit Low	Cont KOEO KOER	**N**	Defective wiring or connections to the transmission multi-plug Defective TCM/valve body assembly Defective solenoid	Check condition of wiring to multi-plug on the transmission ensuring all power (VPWR) and ground (GRND) connections are serviceable Using IDS select **SS_B (or SS2)** PID (if available) and monitor signal. CLEAR ALL DTCs. TEST the system for normal operation. If DTC resets, install a new TCM and Main Control Valve Body. Re-flash module with current calibrations For further information refer to **AUTOMATIC TRANSMISSION - DIAGNOSTICS AND TESTING - 307-01**

DIAGNOSIS AND TESTING (Continued)

P0977 – Shift Solenoid B Control Circuit High	Cont KOEO KOER	**N**	Defective wiring or connections to the transmission multi-plug Defective TCM/valve body assembly Defective solenoid	Check condition of wiring to multi-plug on the transmission ensuring all power (VPWR) and ground (GRND) connections are serviceable Using IDS select **SS_B (or SS2)** PID (if available) and monitor signal. CLEAR ALL DTCs. TEST the system for normal operation. If DTC resets, install a new TCM and Main Control Valve Body. Re-flash module with current calibrations For further information refer to **AUTOMATIC TRANSMISSION - DIAGNOSTICS AND TESTING - 307-01**
P0978 – Shift Solenoid C Control Circuit Range/ Performance	Cont KOEO KOER	**N**	Defective wiring or connections to the transmission multi-plug Defective TCM/valve body assembly Defective solenoid	Check condition of wiring to multi-plug on the transmission ensuring all power (VPWR) and ground (GRND) connections are serviceable Using IDS select **SS_C (or SS3)** PID (if available) and monitor signal. CLEAR ALL DTCs. TEST the system for normal operation. If DTC resets, install a new TCM and Main Control Valve Body. Re-flash module with current calibrations For further information refer to **AUTOMATIC TRANSMISSION - DIAGNOSTICS AND TESTING - 307-01**
P0979 – Shift Solenoid C Control Circuit Range/ Performance	Cont KOEO KOER	**N**	Defective wiring or connections to the transmission multi-plug Defective TCM/valve body assembly Defective solenoid	Check condition of wiring to multi-plug on the transmission ensuring all power (VPWR) and ground (GRND) connections are serviceable Using IDS select **SS_C (or SS3)** PID (if available) and monitor signal. CLEAR ALL DTCs. TEST the system for normal operation. If DTC resets, install a new TCM and Main Control Valve Body. Re-flash module with current calibrations For further information refer to **AUTOMATIC TRANSMISSION - DIAGNOSTICS AND TESTING - 307-01**
P0980 – Shift Solenoid C Control Circuit High	Cont KOEO KOER	**N**	Defective wiring or connections to the transmission multi-plug Defective TCM/valve body assembly Defective solenoid	Check condition of wiring to multi-plug on the transmission ensuring all power (VPWR) and ground (GRND) connections are serviceable Using IDS select **SS_C (or SS3)** PID (if available) and monitor signal. CLEAR ALL DTCs. TEST the system for normal operation. If DTC resets, install a new TCM and Main Control Valve Body. Re-flash module with current calibrations For further information refer to **AUTOMATIC TRANSMISSION - DIAGNOSTICS AND TESTING - 307-01**

DIAGNOSIS AND TESTING (Continued)

P0981 – Shift Solenoid D Control Circuit Range/Performance	Cont KOEO KOER	**N**	Defective wiring or connections to the transmission multi-plug Defective TCM/valve body assembly Defective solenoid	Check condition of wiring to multi-plug on the transmission ensuring all power (VPWR) and ground (GRND) connections are serviceable Using IDS select **SS_D (or SS4)** PID (if available) and monitor signal. CLEAR ALL DTCs. TEST the system for normal operation. If DTC resets, install a new TCM and Main Control Valve Body. Re-flash module with current calibrations For further information refer to **AUTOMATIC TRANSMISSION - DIAGNOSTICS AND TESTING - 307-01**
P0982 – Shift Solenoid D Control Circuit Low	Cont KOEO KOER	**N**	Defective wiring or connections to the transmission multi-plug Defective TCM/valve body assembly Defective solenoid	Check condition of wiring to multi-plug on the transmission ensuring all power (VPWR) and ground (GRND) connections are serviceable Using IDS select **SS_D (or SS4)** PID (if available) and monitor signal. CLEAR ALL DTCs. TEST the system for normal operation. If DTC resets, install a new TCM and Main Control Valve Body. Re-flash module with current calibrations For further information refer to **AUTOMATIC TRANSMISSION - DIAGNOSTICS AND TESTING - 307-01**
P0983 – Shift Solenoid D Control Circuit High	Cont KOEO KOER	**N**	Defective wiring or connections to the transmission multi-plug Defective TCM/valve body assembly Defective solenoid	Check condition of wiring to multi-plug on the transmission ensuring all power (VPWR) and ground (GRND) connections are serviceable Check condition of wiring to multi-plug on the transmission ensuring all power (VPWR) and ground (GRND) connections are serviceable Using IDS select **SS_D (or SS4)** PID (if available) and monitor signal. CLEAR ALL DTCs. TEST the system for normal operation. If DTC resets, install a new TCM and Main Control Valve Body. Re-flash module with current calibrations For further information refer to **AUTOMATIC TRANSMISSION - DIAGNOSTICS AND TESTING - 307-01**
P0985 – Shift Solenoid E Control Circuit Low	Cont KOEO KOER	**N**	Defective wiring or connections to the transmission multi-plug Defective TCM/valve body assembly Defective solenoid	Check condition of wiring to multi-plug on the transmission ensuring all power (VPWR) and ground (GRND) connections are serviceable Using IDS select **SS_E (or SS5)** PID (if available) and monitor signal. CLEAR ALL DTCs. TEST the system for normal operation. If DTC resets, install a new TCM and Main Control Valve Body. Re-flash module with current calibrations

DIAGNOSIS AND TESTING (Continued)

P0986 – Shift Solenoid E Control Circuit High	Cont KOEO KOER	**N**	Defective wiring or connections to the transmission multi-plug Defective TCM/valve body assembly Defective solenoid	Check condition of wiring to multi-plug on the transmission ensuring all power (VPWR) and ground (GRND) connections are serviceable Using IDS select **SS_E (or SS5)** PID (if available) and monitor signal. CLEAR ALL DTCs. TEST the system for normal operation. If DTC resets, install a new TCM and Main Control Valve Body. Re-flash module with current calibrations. For further information refer to **AUTOMATIC TRANSMISSION - DIAGNOSTICS AND TESTING - 307-01**
P1000 – Shift Solenoid E Control Circuit High	Cont KOEO KOER	**N**	This indicates the EOBD has not completed all its test functions	**Complete EOBD dealer drive cycle as described in the EOBD section 303-14**
P1001 – Shift Solenoid E Control Circuit High	Cont KOER	**N**	Existing faults will not allow a KOER test to be completed.	Check the PCM for existing stored DTCs. Investigate and repair existing DTCs before commencing KOER tests
P1112 – Intake air temperature circuit intermittent fault	Cont	**N**	Defective or damaged wiring and/or connections between TMAP and PCM Defective MAP	Check the condition of the wiring to the TMAP Carry out wiggle test whilst monitoring TMAP functions with IDS/PDS Ensure the TMAP is not blocked by contamination in the induction system

General Note for P1112 (IAT intermittent fault, may also record **P0109)**

Check the condition of the wiring and connections between T-MAP and PCM. This DTC is a strong indicator of a poor connection in the circuit.

If there is nothing obvious, carry out a wiggle test

To carryout a wiggle test use IDS datalogger and select the appropriate system to monitor.

Example: **P1112.**

- Select **RPM, IAT** and **MAP**
- (IAT may be available to be viewed as a temperature (TEMP) or a voltage (VOLT) (MAP may be viewed as a voltage (VOLT) or a frequency (FREQ))
- Start the engine and monitor the signal. **Always exercise great care when working around a running engine**
- Increase the engine speed to approximately 2000 – 2500 rpm and monitor the signals.
- Gently shake the wiring at various points along the loom particularly near the connectors and areas where the loom is routed through a sharp angle, while maintaining the engine speed.
- If the signal starts to fluctuate this indicates the wire is being moved in the area of concern
- A road test may produce better results as the engine, and vehicle, will be placed under greater load and stress conditions

If the information you are accessing is not available through normal Datalogger you may be able to access additional EOBD information via the OBD test modes:

To access OBD Datalogger:-VEHICLE SPECIFICATION PAGE > TOOLBOX > POWERTRAIN > OBD TEST MODES > MODE 1 POWERTRAIN DATA.

DIAGNOSIS AND TESTING (Continued)

P1117 - Engine coolant temperature (ECT) circuit intermittent fault	Cont.	**N**	Defective or damaged wiring and/or connections between ECT and PCM Defective ECT	Check the condition of the wiring to the ECT Carry out wiggle test whilst monitoring ECT functions with IDS/PDS Carry out resistance checks on ECT

General Note for P1117

- Check the condition of the wiring and connections between ECT and PCM. This DTC is a strong indicator of a poor connection in the circuit.
- **Do not remove the sensor unless you have checked the rest of the circuit as the sensor on the I6 and 4V V8 are not reusable**
- It is important the ECT is correctly fitted and the probe is in contact with the cylinder head. (Check the sensor is correctly tightened to the correct torque specification into the cylinder head.)
- If there is nothing obvious, carry out a wiggle test

To carryout a wiggle test use IDS datalogger and select the appropriate system to monitor.

Example: **P1112.**

- Select **ECT**
- ECT may be available to be viewed as a temperature (TEMP) or a voltage (VOLT), dependant on specification
- Start the engine and monitor the signal. **Always exercise great care when working around a running engine**
- Increase the engine speed to approximately 2000 – 2500 rpm and monitor the signals.
- Gently shake the wiring at various points along the loom particularly near the connectors and areas where the loom is routed through a sharp angle, while maintaining the engine speed.
- If the signal starts to fluctuate this indicates the wire is being moved in the area of concern
- A road test may produce better results as the engine, and vehicle, will be placed under greater load and stress conditions

If the information you are accessing is not available through normal Datalogger you may be able to access additional EOBD information via the OBD test modes:

To access OBD Datalogger:-VEHICLE SPECIFICATION PAGE > TOOLBOX > POWERTRAIN > OBD TEST MODES > MODE 1 POWERTRAIN DATA.

DIAGNOSIS AND TESTING (Continued)

P1120 - Throttle position sensor (TP1) out of range	Cont.	**N**	Defective or damaged wiring and/or connectors between the TPS and PCM. Defective or damaged TPS	Check the condition of the wiring to the TPS Carry out wiggle test whilst monitoring TPS functions with IDS/PDS Inspect the TPS for sticking or damage. Ensure the TPS adjustment has not been tampered with or incorrectly adjusted.
P1124 - Throttle position sensor (TP1) out of self-test range.	Cont.	**N**	Accelerator pressed during self-test when not required. (Possible cause, driver pressing throttle at or just after key-on.)	Note and then clear DTC. Re-run self-test if required.

General Notes for TPS Also see**P0121, P0122, P0123, P0124, P0221, P0222, P0223, P0224, P2111, P2112 and P2135**

The nominal reference supply voltage (VREF) is 5 volts. During vehicle operation the effective voltage range is constantly monitored. If it falls outside the recognised parameters it will record the DTC.

- Check the throttle body for damage, contamination and free movement
- Ensure the adjustment screw has not been tampered with
- Ensure the wiring and connections to the TP are in serviceable condition
- Ensure the reference voltage is correct
- Carryout a continuity check between the sensor and the PCM

To check TP operation with IDS

- Select **TP1 and TP2** (Additional PID’s that may help are **APP1, APP2 and APP3**)
- All these sensors operate within a 5 volt range. Ensure the correct range is selected on IDS and it is suggested convert the display to a bar graph
- Press the accelerator slowly to the wide open throttle (WOT) position and slowly release while monitoring the display. (You should take at least 10 seconds to complete this)
- The TP displays should approximately mirror each other, one falling the other rising.
- If one of the signals appears to "jump", this may indicate a section of resistance or damage on one of the tracks. If this is the case repeat the test a number of times to confirm it. Note the slower and steadier the accelerator is applied, the more accurate the results will be.
- Gently shake the wiring at various points along the loom particularly near the connectors and areas where the loom is routed through a sharp angle. It is recommended to do this with the accelerator in a number of different positions.
-
- Monitor the system to see if it looses the signal or the signal jumps to its maximum position.
- If this test fails to produce a result repeat the procedure with the engine running
- Start the engine and monitor the signal. **Always exercise great care when working around a running engine**
- Gradually increase the engine speed and monitor the signals. They should approximately mirror each other one voltage rising, the other falling.
- Gently shake the wiring at various points along the loom particularly near the connectors and areas where the loom is routed through a sharp angle, while gradually increasing and decreasing engine speed. (A road test may produce better results as the engine and vehicle will be place under greater load conditions)
- If the signal changes, this indicates defective wiring or connections. Look closely at where the connector is attached to the sensor. If the connector housing is moving in the sensor, then the sensor is defective.

If the information you are accessing is not available through normal Datalogger you may be able to access additional EOBD information via the OBD test modes:

To access OBD Datalogger:-VEHICLE SPECIFICATION PAGE > TOOLBOX > POWERTRAIN > OBD TEST MODES > MODE 1 POWERTRAIN DATA.

DIAGNOSIS AND TESTING (Continued)

P1127 - Exhaust temperature out of range. HEGO tests not complete	Cont. KOER	**N**	Repeated very short vehicle operation may store this as a pending DTC. Vehicle has not completed the required number of drive cycles. Defective or loose wiring to HEGO Defective HEGO heater	Check wiring to HEGO and check HEGO heater operation. Note and clear the DTC. Road test vehicle and monitor HEGO operation when the vehicle is at its normal operating temperature.
P1128 - Upstream HEGO wiring swapped over. (V8 only)	Cont. KOER	**N**	Upstream HEGO wiring swapped over. Defective PCM	Ensure the wiring on the upstream HEGOs are correctly connected and in good condition. Ensure the PCM is running the correct software with the current calibration. Check the wiring and connectors to the PCM for fit and condition.
P1129 - Downstream HEGO wiring swapped over. (V8 only)	Cont. KOER	**N**	Downstream HEGO wiring swapped over. Defective PCM	Ensure the wiring on the downstream HEGOs are correctly connected and in good condition. Ensure the PCM is running the correct software with the current calibration. Check the wiring and connectors to the PCM for fit and condition.
P1130 - Lack of switching signals from O2S11 (Fuel trim limit reached) (I6 and bank 1 V8)	Cont.	**Y**	Defective wiring or connections to HEGO11 Defective HEGO sensor Fuel trim correction has reached the end of its calibration limits Mechanical faults causing incorrect fuelling I6 and bank 1 V8 (Note:- there may be multiple DTCs displayed that could have triggered this condition)	Check the freeze frame data to check the engine conditions when the fault occurred Check the wiring to HEGO11 for condition. Using IDS check the fuel trim parameters. Using IDS/PDS check the switching operation of O2S11 (It should be noted:- old or very high mileage HEGOs can become "lazy" as their reaction time slows) Check the engine and fuel system for mechanical faults. Ensure the HEGO has not become contaminated by incorrect fuel

DIAGNOSIS AND TESTING (Continued)

P1131 - lack of switching signals from O2S11 (System indicating lean operation) (I6 and bank 1 V8)	Cont.	**Y**	Defective sensor or wiring Air leaks around the sensor Defective induction system Exhaust leaking between the engine and catalyst converter Defective fuel injector/s (Note:- there may be multiple DTCs displayed that could have triggered this condition)	Check the freeze frame data to check the engine conditions when the fault occurred Check the wiring and connections between the HEGO and the PCM Check the integrity of the induction and exhaust system. Ensure the HEGO is correctly fitted, it should be tightened to a torque of 38-52Nm Monitor the switching speed of the O2S11 with IDS Check the fuel system for contamination, sticking injectors and fuel quality. Ensure the HEGO probe has not become contaminated. (It should be noted:- old or very high mileage HEGOs can become "lazy" as their reaction time slows)
P1132 - lack of switching signals from O2S11 (System indicating rich operation) (I6 and bank 1 V8)	Cont	**Y**	Defective sensor or wiring Air leaks around the sensor Defective induction system Exhaust leaking between the engine and catalyst converter Defective fuel injector/s (Note:- there may be multiple DTCs displayed that could have triggered this condition)	Check the freeze frame data to check the engine conditions when the fault occurred Check the wiring and connections between the O2S11 and the PCM Check the integrity of the induction and exhaust system. Monitor the switching speed of the HEGO with IDS Check the fuel system for contamination, sticking injectors and fuel quality. Ensure the HEGO probe has not become contaminated.
P1137 - lack of switching signals from O2S12 Indicating a lean operation (I6 and bank 1 V8)	Cont KOER	**N**	Defective connectors or wiring Contaminated or damaged sensor Air leaks in induction system or exhaust system (particularly post catalytic converter) Catalytic converter failed Mechanical defects to the engine, fuel or ignition system (Multiple DTCs shown)	Check the freeze frame data to check the engine conditions when the fault occurred Inspect the condition of the wiring, connectors and sensor. Check the induction and exhaust system for leaks Ensure the HEGO is correctly fitted, it should be tightened to a torque of 38-52Nm Monitor the switching time between the upstream and downstream HEGOs with IDS/PDS. (note this is a function of the CCM) Check the engine, fuel and ignition systems for correct operation.

DIAGNOSIS AND TESTING (Continued)

P1138 - lack of switching signals from O2S12 Indicating a rich operation (I6 and bank 1 V8)	Cont KOER	**N**	Defective connectors or wiring Contaminated or damaged sensor Induction system or exhaust system partially blocked (particularly post catalytic converter) Catalytic converter failed/blocked Mechanical defects to the engine, fuel or ignition system (Multiple DTCs shown)	Inspect the condition of the wiring, connectors and sensor. Check the freeze frame data to check the engine conditions when the fault occurred Check the induction and exhaust system for evidence of blockage Monitor the switching time between the upstream and downstream HEGOs with IDS/PDS. (note this is a function of the CCM) Check the engine, fuel and ignition systems for correct operation.
P1150 - Lack of switching signals from O2S21 (Fuel trim limit reached) (bank 2 V8 only)	Cont	**Y**	Defective wiring or connections to HEGO21 Defective HEGO sensor Fuel trim correction has reached the end of its calibration limits Mechanical faults causing incorrect fuelling to bank 2 V8 (Note:- there may be multiple DTCs displayed that could have triggered this condition)	Check the freeze frame data to check the engine conditions when the fault occurred Check the wiring to HEGO21 for condition. Using IDS check the fuel trim parameters. Using IDS/PDS check the switching operation of O2S21 (It should be noted:- old or very high mileage HEGOs can become "lazy" as their reaction time slows) Check the engine and fuel system for mechanical faults. Ensure the HEGO has not become contaminated by incorrect fuel
P1151 - lack of switching signals from O2S21 (System indicating lean operation) (bank 2 V8)	Cont	**Y**	Defective sensor or wiring Air leaks around the sensor Defective induction system Exhaust leaking between the engine and catalyst converter Defective fuel injector/s (Note:- there may be multiple DTCs displayed that could have triggered this condition)	Check the freeze frame data to check the engine conditions when the fault occurred Check the wiring and connections between the HEGO and the PCM Check the integrity of the induction and exhaust system. Ensure the HEGO is correctly fitted, it should be tightened to a torque of 38-52Nm Monitor the switching speed of the O2S21 with IDS Check the fuel system for contamination, sticking injectors and fuel quality. Ensure the HEGO probe has not become contaminated. (It should be noted:- old or very high mileage HEGOs can become "lazy" as their reaction time slows)

DIAGNOSIS AND TESTING (Continued)

P1152 - lack of switching signals from O2S21 (System indicating rich operation) (bank 2 V8)	Cont	**Y**	Defective sensor or wiring Air leaks around the sensor Defective induction system Exhaust leaking between the engine and catalyst converter Defective fuel injector/s (Note:- there may be multiple DTCs displayed that could have triggered this condition)	Check the freeze frame data to check the engine conditions when the fault occurred Check the wiring and connections between the HEGO and the PCM Check the integrity of the induction and exhaust system. Monitor the switching speed of the O2S21 with IDS Check the fuel system for contamination, sticking injectors and fuel quality. Ensure the HEGO probe has not become contaminated.
P1157 - lack of switching signals from O2S22 Indicating a lean operation (bank 2 V8)	Cont	**N**	Defective connectors or wiring Contaminated or damaged sensor Air leaks in induction system or exhaust system (particularly post catalytic converter) Catalytic converter failed Mechanical defects to the engine, fuel or ignition system (Multiple DTCs shown)	Inspect the condition of the wiring, connectors and sensor. Check the induction and exhaust system for leaks Ensure the HEGO is correctly fitted, it should be tightened to a torque of 38-52Nm Monitor the switching time between the upstream and downstream HEGOs with IDS/PDS. (note this is a function of the CCM) Check the engine, fuel and ignition systems for correct operation.
P1158 - lack of switching signals from O2S22 Indicating a rich operation (bank 2 V8)	Cont	**N**	Defective connectors or wiring Contaminated or damaged sensor Induction system or exhaust system partially blocked (particularly post catalytic converter) Catalytic converter failed/blocked Mechanical defects to the engine, fuel or ignition system (Multiple DTCs shown)	Inspect the condition of the wiring, connectors and sensor. Check the induction and exhaust system for evidence of blockage Monitor the switching time between the upstream and downstream HEGOs with IDS/PDS. (note this is a function of the CCM) Check the engine, fuel and ignition systems for correct operation.

General Notes for Heated Oxygen sensors (HEGO's).

Understanding the function and operation of a HEGO can be a good diagnostic aid to understanding to overall operation and condition of the engine with regard to the combustion process.

HEGO sensors are generally very reliable and should not be replaced unless it can be clearly shown the sensor has been damaged externally or contaminated internally either with use of incorrect fuel, engine oil or coolant etc.

Note on HEGO numbering: The HEGO's are identified by bank and position in the exhaust, i.e.

HEGO 11: Bank 1, sensor 1 (upstream)

HEGO 12: Bank 1, sensor 2 (downstream)

HEGO 21: Bank 2, sensor 1 (upstream)

HEGO 22: Bank 2, sensor 2 (downstream)

Monitoring HEGO sensors with IDS

If monitoring the HEGO sensors with IDS select **O2S11 and O2S21** for the upstream HEGO's and **O2S12 and O2S22** for the downstream HEGO's

The HEGO generates a switching signal between a nominal 0.1 and 1 volt. (It can, under certain circumstances, switch slightly outside these parameters and still function correctly).

- If a HEGO related DTC is stored and then the HEGO signal is monitored, it may appear to be responding correctly. If this is the case, check both the Long Term Fuel Trim (LONGTFT) and the Short Term Fuel Trim (SHRTFT) and ensure they are responding. If they are not, or a DTC is recorded that indicates the LONGTFT has exceeded its values, note and clear all the DTCs.

IDS/PDS will be displaying the HEGO substitute values stored in the PCM memory and not the true HEGO signal. Clearing the DTCs will reset the

DIAGNOSIS AND TESTING (Continued)

LONGTFT and SHRTFT count and you should see the true HEGO signal.

Monitoring both the LONGTFT and SHRTFT are both good indicators of engine performance

O2S11 and O2S21 (upstream)

These generate a rapidly switching signal which is used to manage the fuel injection system when it is operating in closed loop.

Closed loop operation can be monitored with **IDS datalogger, "CLOSED LOOP"** PID

If checking the operation of **O2S11 and O2S12** with the relation to **CLOSED LOOP** operation, as a guide,

the engine should be at its normal operating temperature

the HEGO's should be switching between once and twice a second at idle

O2S12 and O2S22 (downstream)

These generate a much slower switching signal than the upstream HEGO's and are used to monitor the catalytic converter efficiency and condition. (Part of the Comprehensive Component Monitoring (CCM) system). The switching rate is determined by vehicle usage, the sensor may switch as quickly as every 30 seconds or it may take several minutes to produce a switching signal.

IMPORTANT NOTE

If when monitoring the upstream and downstream HEGO's it is noted the switching time is very similar, this indicates Catalytic Converter failure.

P0132, P0138, P0152, P0158

These DTCs indicate the signal voltage is considerably above 1 volt. This indicates either the sensor itself has failed and the heater supply has shorted to the sensor circuit or the sensor circuit wiring has shorted to VPWR.

The signals can be monitored using **IDS datalogger O2S11, O2S21** (V8 only) (upstream HEGO's) and **O2S12, O2S22** (V8 only) (downstream HEGO's)

P0133, P0153

These DTCs indicate a slow switching speed signal to the PCM and the PCM is having difficultly maintaining the Short Term Fuel Trim (STFT).

A number of concerns could trigger these DTCs including mechanical concerns.

Mechanical concerns:-

- Exhaust leaks particularly around the catalytic converter, exhaust manifold and turbo charger.
- Induction system leaks after the T-MAP
- Contaminated fuel or general fuel system concerns particularly fuel rail pressure
- Non Ford approved modifications to the induction and/or exhaust system

Electrical concerns

- It is possible an incorrect T-MAP signal can trigger these DTCs as the PCM has a conflict between what it is trying to do and the outcome in the combustion chamber. If additional DTCs such as **P0107, P0108, P0109, P0112 or P0113** are also indicated, rectify these first and then recheck.
- Loose or damaged connections between the HEGO and PCM. The way to check this with **IDS datalogger** and carryout a wiggle test

Wiggle test Example: P0124.

- Select **O2S11** and **O2S21** (V8 only). Additional signals that may aid diagnosis **RPM, SHRTFT, LONGFT, IAT, MAP, O2S12, O2S22** and **CLOSED LOOP**.
- Start the engine and monitor the signal. **Always exercise great care when working around a running engine**
- Gradually increase the engine speed to approximately 2000 rpm and monitor the signals. **O2S12** and **O2S22** should be switching between at least once and twice per second. It is important the engine speed is accurately maintained, variations in accelerator pedal position directly affect **CLOSED LOOP** operation. If not switching check the **CLOSED LOOP** PID is still set.
- Gently shake the wiring at various points along the loom particularly near the connectors and areas where the loom is routed through a sharp angle, while maintaining engine speed. (A road test may produce better results as the engine and vehicle will be place under greater load conditions but avoid rapid application of the accelerator)
- If the signal changes, this indicates defective wiring or connections. Closely look at where the connector is attached to the sensor. If the connector housing is moving in the sensor, then the sensor is defective.

Sensor concerns:-

- If there evidence of contamination in the fuel system such as diesel, lead additive, a non-approved performance enhancer or evidence of engine oil in the exhaust, all of these can coat the surface of the sensor and reduce its effectiveness.
- Additionally with old or very high mileage vehicles the effectiveness of the chemical reaction of the sensor will reduce and the sensor becomes "lazy' any evidence of this requires the sensor replacing

P0135, P0141, P0155, P0161

These DTCs indicate a heater or circuit failure. Any of the other HEGO related DTCs between P0132 and P0158 could be associated with these.

- Check there is a 12V supply to the heater circuit (All the HEGO's are supplied through a common fuse)
- Check for continuity between the heater return and the PCM

DIAGNOSIS AND TESTING (Continued)

- Carry out a resistance check across the HEGO heater. The heater resistance should be between 4O and 8O.
- **IMPORTANT** It should be possible to monitor the HEGO heater functions with **IDS datalogger. (HTR11, HTR12, HTR21 and HTR22)**. If monitoring as a voltage, it can show any voltage between 0V and 12V. This is because the upstream HEGO heaters are pulse width modulated (PWM) and the downstream HEGO's are voltage regulated. The voltage is managed by the PCM
- If the HEGO voltage is not available it will display a fault mode, FAULT YES or FAULT NO

P0136 & P0156

These indicate the downstream HEGO's are operating outside their normal parameters (0.1v to 1.0v)

- Monitor the HEGO signals using **IDS datalogger (O2S12 and O2S22)** for the operating range. (It is usefully to monitor the upstream HEGO's at the same time **(O2S11 and O2S21)**, if the switching frequency is similar, this indicates catalytic converter failure)
- If they are outside the voltage range, ensure the exhaust is in good condition and there is no evidence of leaks anywhere in the system
- Check the condition of the wiring and connectors between the HEGO's and PCM. The connections on the downstream HEGO's work in a harsh environment and should be checked closely.

P0171, P0172, P0174, P0175

These indicate combustion condition i.e. operating lean or rich. If these DTCs are displayed the sensors are functioning correctly.

There may be multiple DTCs displayed with these and have been triggered though concerns elsewhere with the system. Where multiple DTCs are displayed investigate the other DTCs first.

- Ensure the mechanical systems are in good condition, particularly the induction and exhaust systems.
- Check the fuel system, particularly for leaks, blockages, fuel contamination and fuel pressure.
- If using **IDS datalogger** select **SHRTFT and LONGFT**. Ensure either has not exceeded its calibrated values, this can be triggered by various defects both mechanical and electrical

If the information you are accessing is not available through normal Datalogger you may be able to access additional EOBD information via the OBD test modes:

To access OBD Datalogger:-VEHICLE SPECIFICATION PAGE > TOOLBOX > POWERTRAIN > OBD TEST MODES > MODE 1 POWERTRAIN DATA.

DIAGNOSIS AND TESTING (Continued)

P1159 - Fuel stepper motor not under control or HEGO not switching		**N**	Defective HEGO signal Defective wiring or connections to stepper motor Damaged stepper motor.	Check for recorded HEGO DTCs and investigate these as a primary cause for concern. Check the condition of wiring and connections between the stepper motor and PCM. Check the resistance of the stepper motor windings. Nominal resistance is 50? (± 15%) NOTE the resistance figure stated is only a guide as the resistance checks primary function is to ensure motor winding continuity **Refer to LPG section 303-04c**
P115E - Throttle body air flow at maximum limit		**N**	**Gas system**	**Refer to LPG section 303-04c**
P116A - Fuel stepper motor control circuit 1 open circuit		**N**	Defective wiring between the PCM and stepper motor Defective stepper motor	Check the condition of wiring and connections between the stepper motor and PCM. Check the resistance of the stepper motor windings. Nominal resistance is 50? (± 15%) NOTE the resistance figure stated is only a guide as the resistance checks primary function is to ensure motor winding continuity **Refer to LPG section 303-04c**
P116B - Fuel stepper motor control circuit 1 short circuit		**N**	Defective wiring between the PCM and stepper motor Defective stepper motor	Check the condition of wiring and connections between the stepper motor and PCM. Check the resistance of the stepper motor windings. Nominal resistance is 50? (± 15%) NOTE the resistance figure stated is only a guide as the resistance checks primary function is to ensure motor winding continuity **Refer to LPG section 303-04c**
P116C - Fuel stepper motor control circuit 2 open		**N**	Defective wiring between the PCM and stepper motor Defective stepper motor	Check the condition of wiring and connections between the stepper motor and PCM. Check the resistance of the stepper motor windings. Nominal resistance is 50? (± 15%) NOTE the resistance figure stated is only a guide as the resistance checks primary function is to ensure motor winding continuity **Refer to LPG section 303-04c**

DIAGNOSIS AND TESTING (Continued)

P116D - Fuel stepper motor control circuit 1 short circuit		**N**	Defective wiring between the PCM and stepper motor Defective stepper motor	Check the condition of wiring and connections between the stepper motor and PCM. Check the resistance of the stepper motor windings. Nominal resistance is 50? (± 15%) NOTE the resistance figure stated is only a guide as the resistance checks primary function is to ensure motor winding continuity **Refer to LPG section 303-04c**
P1182 - Fuel shut off solenoid circuit fault		**N**	Defective wiring between the PCM and fuel shut off solenoid Defective fuel shut off solenoid	Check the condition of wiring and connections between the fuel shut off solenoid and PCM. Check the resistance of the solenoid windings. Nominal resistance is between 12.6? (± 4%) NOTE the resistance figure stated is only a guide as the resistance checks primary function is to ensure solenoid winding continuity **Refer to LPG section 303-04c**
P1183 - Oil temperature circuit defect	Cont KOER	**Y**	Defective wiring to oil temperature sensor Defective sensor	Check the freeze frame data to check the engine conditions when the fault occurred Check the condition and level of the engine oil. Check the condition of the wiring and connectors between the sensor and PCM, particularly for open or short circuits Check the condition of the sensor
P1184 - Oil temperature sensor outside self test range	KOEO KOER	**N**	Defective wiring between sensor and PCM Defective sensor Defective PCM (Multiple DTCs)	Check the condition and level of the engine oil. Check the condition of the wiring and connectors between the sensor and PCM, particularly for open or short circuits Check the condition of the sensor
P1213 - Gas start injector circuit failure		**N**	Defective wiring between the PCM and the gas start injector Defective gas start injector	Check the condition of the wiring and connections between the PCM and the gas start injector Check the resistance of the windings in the gas start injector **Refer to LPG section 303-04c**
P1227 - Turbo wastegate failed closed	Cont	**Y**	Wastegate failed in closed position Damaged induction system Defective TMAP sensor Defective boost pressure sensor (BPS)	Check the freeze frame data to check the engine conditions when the fault occurred Check the operation and condition of the wastegate Check condition of wiring and connector to the BPS and T-MAP Check the condition and operation of the wastegate Check the condition of the induction and exhaust systems

DIAGNOSIS AND TESTING (Continued)

P1228 - Turbo wastegate failed in the open position	Cont	**Y**	Wastegate failed in open position Damaged induction system Defective Boost Pressure Sensor (BPS) Defective TMAP sensor Defective turbocharger	Check the freeze frame data to check the engine conditions when the fault occurred Check the operation and condition of the wastegate Check condition of wiring and connector to the BPS and T-MAP Check the condition and operation of the wastegate Check the condition of the induction and exhaust systems Check the condition of the turbocharger
P1246 - Alternator circuit	Cont KOER	**N**	Fault with the charging system	Refer to section **414-02 CHARGING SYSTEMS**
P1260 - Vehicle immobilised	Cont	**N**	Attempted start with incorrectly programmed key/immobiliser system.	Ensure you have the correct key Carry out PATS checks
P1270 - Engine max RPM reached	Cont	**N**	Maximum road speed has been reached	Clear DTC and recheck.
P1285 - Cylinder head overheating (CHT)	Cont KOEO KOER	**N**	Engine overheating Wiring between sensor and PCM defective Sensor defective Cooling system defects PCM defective	Check to engine operation to check for an overheating condition. Check the condition of the wiring and connectors between the sensor and the PCM Check the sensor condition and resistance. Check the cooling system for correct operation.
P1288 - Cylinder head temperature sensor out of test range (CHT)	KOEO KOER	**N**	Wiring between sensor and PCM defective Sensor defective Cooling system defects PCM defective Attempted restart following an overheat condition.	Check the condition of the wiring and connectors between the sensor and the PCM Check the sensor condition and resistance. Check the cooling system for correct operation. Ensure PCM has current software available
P1289 - Cylinder head temperature sensor reading to high (CHT)	Cont KOEO KOER	**Y**	Wiring to sensor/PCM short to VPWR. Open circuit	Check the freeze frame data to check the engine conditions when the fault occurred Check the condition of the wiring and connectors. Carry out a wiggle test while monitoring CHT with IDS datalogger Check the sensor reference voltage is within required parameters. Check the sensor condition and resistance Check the condition of the wiring between the PCM and sensor

DIAGNOSIS AND TESTING (Continued)

P1290 - Cylinder head temperature sensor circuit to low (CHT)	Cont KOEO KOER	**Y**	Defective wiring and/or connections Sensor reference voltage or return signal short to ground Vehicle battery discharged (Probable multiple DTCs) Defective sensor. Defective PCM	Check the freeze frame data to check the engine conditions when the fault occurred Check the condition of wiring and connectors between the sensor and PCM. Check reference voltage is within prescribed range. Check return signal to PCM Check sensor condition and resistance
P1299 - Running an FMEM strategy to protect the engine from over-heating	Cont KOER	**Y**	The PCM has detected an overheat situation and has defaulted to a FMEM strategy to protect the engine (Possibly multiple DTCs)	Check the freeze frame data to check the engine conditions when the fault occurred Find and repair primary cause of the PCM identifying an overheat situation. This could be an electrical fault from one of the temperature sensors or a defect within the cooling system

General notes on Cylinder Head Temperature (CHT) sensor (Also see P0116, P0117 and P0118)

If the CHT is incorrectly fitted, either too loose or to tight, it will cause fluctuations in the readings. NOTE: If the CHT on V8 is removed, it must not be re-used. When replacing a CHT always ensure the area under the sensor is clean, free from swarf and liquid contamination.

DTC P1288 - This will be stored when the CHT has failed a self-test. A simple check is to use IDS datalogger and compare the CHT and IAT when the engine is cold or has not been run for at least 6 hours. The CHT and IAT should be within 1°C of each other. Start the engine and monitor how quickly the CHT starts to record changes. If IDS indicates rapid temperature increase with the CHT, this would indicate sensor failure or a cooling system defect.

LOW VOLTAGE: - The nominal reference supply voltage (VREF) is 5 volts. If a number of DTCs are recorded such as P0112, P0222, P0117 etc, all these indicate a number of sensors are recording low voltage inputs. These can be triggered by repeated cranking of an engine with a battery in poor condition. Preliminary checks would include battery and charging system checks, supply voltage checks to the PCM.

HIGH VOLTAGE: - As the PCM supplies the reference voltage (VREF) it calculates the voltage range that should be returned from the sensor. If the PCM detects a voltage above the one calculated it will store an appropriate DTC (P1289). High voltage returns are normally associated with sensor failure or the return signal wiring has been shorted to a vehicle power (VPWR) supply.

Multiple high return signal voltages from a range of sensors would indicate the PCM has developed a fault. It should be noted a number of sensors utilise a common reference supply voltage. It is possible that the increased voltage supply has been caused by a short to vehicle power (VPWR) in a connector. All the wiring between the relevant sensors and the PCM must be checked **before replacing the PCM**.

Intermittent faults are generally associated with loose wiring connections or damaged wires. A simple way to check these is by use of a wiggle test. To carryout a wiggle test use IDS datalogger and select the appropriate system to monitor.

Example: **P1288**.

- Select MAP (This may be available as a FREQ or VOLT or both)
- Start the engine and monitor the signal. **Always exercise great care when working around a running engine**
- Gently shake the wiring at various points along the loom, particularly near the connectors and areas where the loom is routed through a sharp angle.
- If the signal changes, this indicates defective wiring or connections. Closely look at where the connector is attached to the sensor. If the connector housing is moving in the sensor, then the sensor is defective.

NOTE: If P1299 is displayed, it should be part a multiple DTC list. P1299 is an FMEM over-heat protection strategy.

If the information you are accessing is not available through normal Datalogger you may be able to access additional EOBD information via the OBD test modes:

To access OBD Datalogger:- VEHICLE SPECIFICATION PAGE > TOOLBOX > POWERTRAIN > OBD TEST MODES > MODE 1 POWERTRAIN DATA.

DIAGNOSIS AND TESTING (Continued)

P1336 - Camshaft to crankshaft timing out of range			Defective wiring between the cam position sensor, crankshaft position sensor and PCM Defective camshaft position sensor (CPS) Defective crankshaft position sensor (CKP) Defective PCM Incorrect crankshaft to camshaft timing	Check the freeze frame data to check the engine conditions when the fault occurred Check the wiring and connections between the CPS, CKP and PCM. If the engine will run, carry out a wiggle test while monitoring CPS and RPM with IDS/PDS. Check the condition of the CPS and CKP for damage or contamination. Check the valve timing
P1340 - Camshaft position sensor circuit defect			Defective wiring between the cam position sensor and the PCM Defective camshaft position sensor Defective PCM	Check the freeze frame data to check the engine conditions when the fault occurred Check the wiring and connectors between the sensor and PCM for condition and security Carry out a wiggle test while monitoring the signal with IDS Check the condition of the sensor for damage, contamination and relative position to the camshaft.

General Notes for P1340 (V8 only) (Also see **P0340**)

The camshaft position sensor/s (CPS) is used to identify cylinder position relative to injector operation and the variable camshaft timing (VCT) system. In the event of CPS failure, the injectors default to a continuous injection programme and the VCT is disabled. This can result in high fuel consumption, poor throttle response and a lack of power.

- Check the condition of the wiring and connectors between the CPS and PCM, ensure there are no shorts to VPWR, GRND or open circuits
- Check the resistance of the sensor **280 to 380Ω**
- The performance of the sensor can be monitored with **IDS datalogger CMPFM**, this indicates the sensor has failed or **SYNC**, this indicates the camshaft and crankshaft timing is synchronised.

If the information you are accessing is not available through normal Datalogger you may be able to access additional EOBD information via the OBD test modes:

To access OBD Datalogger:- VEHICLE SPECIFICATION PAGE > TOOLBOX > POWERTRAIN > OBD TEST MODES > MODE 1 POWERTRAIN DATA.

P1380 - Camshaft position actuator circuit fault. (VCT 1 Intake I6)	Cont KOEO KOER	**Y**	Defective or damaged wiring or connections to VCT actuator Defective PCM	Check the freeze frame data to check the engine conditions when the fault occurred Check the wiring and connectors between the VCT actuator and the PCM. Ensure the wiring has not been shorted to VPWR or ground, or gone open circuit. Ensure the PCM is programmed with the latest calibration.
P1381 - Camshaft timing is over advanced. (VCT 1 Intake I6)	Cont	**Y**	VCT jammed. Crankshaft to camshaft timing incorrect	Check the freeze frame data to check the engine conditions when the fault occurred Check the operation of the VCT unit Check the crankshaft to camshaft timing
P1383 - Camshaft timing is over retarded. (VCT 1 Intake I6)	Cont	**Y**	VCT jammed. Crankshaft to camshaft timing incorrect	Check the freeze frame data to check the engine conditions when the fault occurred Check the operation of the VCT unit Check the crankshaft to camshaft timing

DIAGNOSIS AND TESTING (Continued)

P1385 - Camshaft position actuator circuit fault. (VCT 2 Exhaust I6 Bank 2 V8)	Cont KOEO KOER	**Y**	Defective or damaged wiring or connections to VCT actuator Defective PCM	Check the freeze frame data to check the engine conditions when the fault occurred Check the wiring and connectors between the VCT actuator and the PCM. Ensure the wiring has not been shorted to VPWR or ground, or gone open circuit. Ensure the PCM is programmed with the latest calibration.
P1386 - Camshaft timing is over advanced. (VCT 2 exhaust I6 Bank 2 V8)	Cont	**Y**	VCT jammed. Crankshaft to camshaft timing incorrect	Check the freeze frame data to check the engine conditions when the fault occurred Check the operation of the VCT unit Check the crankshaft to camshaft timing
P1388 - Camshaft timing is over retarded. (VCT 2 Exhaust I6 Bank 2 V8)	Cont	**Y**	VCT jammed. Crankshaft to camshaft timing incorrect	Check the freeze frame data to check the engine conditions when the fault occurred Check the operation of the VCT unit Check the crankshaft to camshaft timing

General notes regarding VCT related DTCs.

For mechanical faults associated with the VCT's, refer to DESCRIPTION AND OPERATION section within 303-14 of this manual

DTCs P1381, P1383, P1386 and P1388 indicates the phasing of the VCT's relative to crankshaft position is incorrect. These indicate mechanical faults, therefore the sensing system is operating correctly and mechanical checks should be carried out.

DTCs P1380 and P1385, indicate a fault with the actuator circuit. To check the circuit:-

- Ensure all the wiring and connections to the VCT actuator are serviceable and in good condition.
- Monitor the performance of the VCT actuators with **IDS datalogger, VCT1 and VCT2**
- Other systems to monitor that may aid VCT diagnosis are **CHT, EOT, MAP, ACT (IAT) and TP**

Under certain operating conditions the VCT operation will shut down and return to a fixed position managed by the PCM. Systems the PCM monitors which it uses to calculate VCT position are:-

- Cylinder head temperature **(CHT)** - Possible DTCs associated with this are, **P0116, P1117, P1120, P1124, P1125, P1285, P1288, P1289, P1290, P1299***
- Engine oil temperature **(EOT)** - Possible DTCs associated with this are, **P0196, P0298, P1183, P1184**
- Manifold absolute pressure **(MAP)** - Possible DTCs associated with this are, **P0107, P0108, P0109**
- Air charge temperature (ACT) or In-take air temperature (IAT) - Possible DTCs associated with this are, **P0112, P0113, P1112,**
- Throttle position sensor **(TP)** - Possible DTCs associated with this are, **P0121, P0122, P0123, P0124, P2100, P2101, P2102, P2103, P2105#, P2110*, P2111 and P2112 to P2140**

NOTE#*

- **P1299* and P2110*** indicate the PCM has activated a FMEM strategy with limited RPM.
- **P2105#** indicate the PCM has activated a forced engine shutdown

If any of the above DTCs are indicated these should be investigated prior to VCT checks

If the information you are accessing is not available through normal Datalogger you may be able to access additional EOBD information via the OBD test modes:

To access OBD Datalogger:- VEHICLE SPECIFICATION PAGE > TOOLBOX > POWERTRAIN > OBD TEST MODES > MODE 1 POWERTRAIN DATA.

P145A - A/C Pressure insufficient	KOER	**N**	Very low A/C refrigerant charge (less than 200kPa), A/C compressor disabled until fault rectified	Refer to SECTION 412-03, Air Conditioning
P145B - A/C demand not activated during self test	KOER	**N**	Operator error. Not following correct self test procedure, A/C not switched on within 10 seconds at ICC controls after KOER test started	Re-run KOER self test and activate A/C when requested. Refer to SECTION 412-03, Air Conditioning

DIAGNOSIS AND TESTING (Continued)

P1463 - A/C Insufficient pressure charge	Cont	**N**	. Insufficient pressure increase when A/C cycles on. Possible causes are: . Slipping compressor clutch or belt . Poor compressor performance/compressor not operating . Low A/C refrigerant charge . Major refrigerant leak such as a burst hose or pierced condenser	Check if compressor clutch electrical connector is correctly plugged in. Confirm P0534 DTC is set by performing Key On Engine Running Test (KOER). Refer to SECTION 412-03, Air Conditioning
P1465 - A/C relay circuit fault	Cont	**N**	. A/C (WAC) Relay fault . Relay wiring circuit fault	Check the condition of the A/C relay wiring and connectors Check A/C relay function Refer to SECTION 412-03, Air Conditioning
P1474 - Fan control primary circuit failure	Cont	**N**	Defective or damaged wiring to fan and/or relay Defective cooling fan	Check condition of fan, relay, wiring and fuse.
P1479 - High speed fan control circuit failure	Cont KOEO KOER	**N**	Defective or damaged wiring to fan and/or relay Defective cooling fan	Check condition of fan, relay, wiring and fuse.
P1500 - No input from vehicle speed sensor (VSS)		**N**	Defective or damaged wiring and/or connectors Defective speed sensor Also see P0500	Check the wiring and connectors for condition. Using IDS/PDS check VSS signal Use IDS pin-point test routine to diagnose VSS sensor For further diagnosis REFER to **206-09 Anti lock Control**
P1501 - Vehicle speed sensor out of self test range (VSS)		**N**	Defective or damaged wiring and/or connectors Defective speed sensor Software concern	Check the wiring and connectors for condition. Ensure all relevant modules are running latest calibrations Using IDS/PDS check VSS signal Use IDS pin-point test routine to diagnose VSS sensor For further diagnosis REFER to **206-09 Anti lock Control**
P1502 - Intermittent fault from vehicle speed sensor. (VSS)		**N**	Defective or damaged wiring and/or connectors Defective speed sensor	Check the wiring and connectors for condition. Using IDS/PDS check VSS signal Use IDS pin-point test routine to diagnose VSS sensor For further diagnosis REFER to **206-09 Anti lock Control**
P1507 - Idle air control under speed Error			Mechanical defects causing erratic idle. To include items as blocked or damaged induction or exhaust system. Damaged or defective wiring or connections Damaged throttle body Incorrectly adjusted throttle body screw.	Ensure the mechanical systems are in serviceable condition. Check the condition of the wiring to the throttle body and PCM Check the throttle body wiring for correct power, signal and ground supplies.

DIAGNOSIS AND TESTING (Continued)

General notes for IAC.

If **P1507** is displayed, this indicates the PCM is not controlling the idle speed. This can be caused by a number of defects.

- Check the condition of the induction system particularly around the T-MAP and between the T-MAP and the inlet manifold
- Check the condition of the throttle body, particularly for evidence of damage, partial seizure, or contamination around the throttle flap
- Check for integrity of the exhaust system, particularly around the manifold.
- Check the condition of the wiring and connectors to the throttle body
- Check the condition of the wiring and connectors to the throttle body

A simple check to carryout with **IDS Output State Control (OSC)** function, if available.

- Select Datalogger PCM
- If a PID appears as **"IAC #"** this indicates IDS can take control of the system
- Select this PID and then select the **"#"** button on the right hand side of the screen.
- Below this button 3 more buttons will appear. A finger pressing a button and a + and - sign. Press the finger button and then press the + or - buttons. If the idle speed stabilises this indicates the PCM can control the IAC but is not receiving the correct information to do so. This would indicate potential concerns with the **T-MAP or HEGO11 or HEGO21**

If the information you are accessing is not available through normal Datalogger you may be able to access additional EOBD information via the OBD test modes:

To access OBD Datalogger:- VEHICLE SPECIFICATION PAGE > TOOLBOX > POWERTRAIN > OBD TEST MODES > MODE 1 POWERTRAIN DATA.

P1534 - SRS circuit	Cont.	**N**	Refer to OCCUPANTS RESTRAINTS SECTION 501-20b	Refer to OCCUPANTS RESTRAINTS SECTION 501-20b
P1549 - Inlet manifold runner control (IMRC) circuit	Cont KOEO	**N**	Damaged or defective wiring and or connectors between PCM and IMRC solenoid (DTC P0660 may be displayed)	Check the condition of the wiring and connectors between PCM and IMRC solenoid. Ensure solenoid connection has correct VPWR and ground connections
P1550 - PAS pressure sensor out of test range (I6 only)	KOEO KOER	**N**	Damaged or defective wiring and/or connections between sensor and PCM. Sensor failed Mechanical concern with PAS system	Check the condition of the wiring and connectors between the PAS sensor and PCM Monitor PAS with IDS/PDS and carryout wiggle test.

DIAGNOSIS AND TESTING (Continued)

P1565 - Speed control command voltage to high.	Cont KOEO KOER	**N**	Damaged or defective wiring and/or connections between speed control switches and PCM. Defective speed control switch Defective PCM	Check the condition of the wiring and connectors between speed control switches and PCM. Check for short circuits to VPWR or reference voltage supplies (particular attention should be given to the wiring around the steering column and connections to the steering wheel switches) Ensure the speed control switches are not damaged. **CAUTION: Do not probe the SRS system.**
P1567 - Speed control circuit defect		**N**	No communication between speed control switches and PCM Damaged or defective wiring and/or connections between speed control switches and PCM. Defective speed control switch Defective PCM	Check the condition of the wiring and connectors between speed control switches and PCM. (particular attention should be given to the wiring around the steering column and connections to the steering wheel switches) Ensure the speed control switches are not damaged. **CAUTION: Do not probe the SRS system.**
P1573 - Throttle position not available (TPS)		**N**	Defective wiring or connections to the throttle body Defective throttle body.	Check the condition of the wiring between the throttle body and PCM Ensure there is continuity between the return signal and PCM Ensure the TPS is supplied with 5 volt reference Ensure the throttle body screw has not been adjusted.
P1610 - PCM failure		**N**	Software failure or hardware defective Damaged or defective wiring at PCM and/or DLC	Attempt to reprogram PCM with correct software and calibrations. Ensure VID information is correct. Ensure connections between the DLC and PCM are in good condition. Ensure 16 pin lead is serviceable **(See IDS self diagnostics)** Replace PCM
P1615 - Flash reprogram failure		**N**	Software failure or hardware defective Damaged or defective wiring at PCM and/or DLC	Attempt to reprogram PCM with correct software and calibrations. Ensure VID information is correct. Ensure connections between the DLC and PCM are in good condition. Ensure 16 pin lead is serviceable **(See IDS self diagnostics)** Replace PCM

DIAGNOSIS AND TESTING (Continued)

P1616 - Flash reprogram failure. (Low voltage)		**N**	IDS battery or vehicle battery discharged Software failure or hardware defective Damaged or defective wiring at PCM and/or DLC	Use the IDS battery leads to power the IDS and ensure the vehicle battery is in good condition Attempt to reprogram PCM with correct software and calibrations. Ensure VID information is correct. Ensure connections between the DLC and PCM are in good condition. Ensure 16 pin lead is serviceable **(See IDS self diagnostics)**Replace PCM
P1617 - Flash reprogram failure		**N**	Software failure or hardware defective Damaged or defective wiring at PCM and/or DLC	Attempt to reprogram PCM with correct software and calibrations. Ensure VID information is correct. Ensure connections between the DLC and PCM are in good condition. Ensure 16 pin lead is serviceable **(See IDS self diagnostics)** Replace PCM
P1618 - Flash reprogram failure. (Low voltage)		**N**	IDS battery or vehicle battery discharged Software failure or hardware defective Damaged or defective wiring at PCM and/or DLC	Use the IDS battery leads to power the IDS and ensure the vehicle battery is in good condition Attempt to reprogram PCM with correct software and calibrations. Ensure VID information is correct. Ensure connections between the DLC and PCM are in good condition. Ensure 16 pin lead is serviceable **(See IDS self diagnostics)** Replace PCM
P1633 - KAM voltage low	Cont KOEO KOER	**Y**	Battery discharged or defective Defective wiring between battery and PCM Fuse holder damaged or improper fuse used Defective PCM	Check the freeze frame data to check the engine conditions when the fault occurred Check the KAM fuse Ensure the vehicle battery is in serviceable condition. Check the wiring between the battery and the PCM, ensure battery voltage is available at PCM
P1635 - Tyre/axle outside acceptable range	Cont	**N**	PCM incorrectly programmed After-market non standard wheels and tyres fitted	Check the PCM has been programmed with the correct VID parameters. Check wheels and tyres for type and size approval

DIAGNOSIS AND TESTING (Continued)

P1639 - VID not programmed		**Y**	Incorrect VID program	Reprogram PCM with correct vehicle identification parameters via IDS If unable to communicate with vehicle, follow no communications routine for IDS If this fails carryout IDS diagnostics and 16 pin cable checks

Reprogramming the VID block

NOTE: Ensure that the most up-to-date software version is installed in IDS.

NOTE: In the case of engine running concerns, module-reprogramming of the PCM may be required. For this purpose, a revised software version is transferred to the PCM using IDS

Select the "Module reprogramming" submenu in the "Module programming" menu tool box and then follow the instructions.

NOTE: Following installation of a wheel/tyre combination, for which the tyre-tread circumference does not correspond to that of standard tyres, the tyre size must be changed in the powertrain control module (PCM) using IDS.

Select the "Programmable parameters" submenu in the "Module programming" menu tool box and enter the corresponding tyre size under the "tyre size" menu item

P1650 - PAS switch (PSP) outside test range (V8 only)	KOEO KOER	**N**	PSPS wiring and/or connectors defective. Defective PSPS	Check wiring and connectors to PSPS. Run self test through IDS menu walker. Check operation of PSPS with multimeter.
P1651 - no signal from PAS switch (PSP) when driving		**N**	PSPS wiring and/or connectors defective. Defective PSPS	Check wiring and connectors to PSPS. Run self test through IDS menu walker. Check operation of PSPS with multimeter.
P1702 - Intermittent fault from transmission range sensor circuit	Cont	**N**	Defective or damaged wiring and/or connections between shifter printed circuit board PCB, TCM and PCM	Check the condition of the wiring and connections between the PCB, TCM and PCM. Using IDS Datalogger, select appropriate signals to monitor and carry out wiggle test. For further information refer to **AUTOMATIC TRANSMISSION - DIAGNOSTICS AND TESTING - 307-01**
P1703 - Brake switch out of test range	KOEO KOER	**N**	BOO not activated during test	Run menu walker and follow instructions as per IDS
P1705 - Transmission range sensor not indicating P or N during self test	Cont KOEO KOER	**N**	Gear selector not in P or N during self test. Selector cables incorrectly adjusted Defective wiring or connections between transmission range (TR) sensor and PCM Defective TR sensor	Check gear selector cables are correctly fitted and adjusted Run menu walker and follow instructions as per IDS Check wiring and connections between TR sensor, TCM and PCM (If there is a fault with the TR sensor, there may be other TR related DTCs stored.) For further information refer to **AUTOMATIC TRANSMISSION - DIAGNOSTICS AND TESTING - 307-01**

DIAGNOSIS AND TESTING (Continued)

P1707 - Transmission range sensor not indicating P or N during self test	Cont KOEO KOER	**N**	Gear selector not in P or N during self test. Selector cables incorrectly adjusted Defective wiring or connections between transmission range (TR) sensor and PCM Defective TR sensor	Check gear selector cables are correctly fitted and adjusted Run menu walker and follow instructions as per IDS Check wiring and connections between TR sensor, TCM and PCM (If there is a fault with the TR sensor, there may be other TR related DTCs stored.) For further information refer to **AUTOMATIC TRANSMISSION - DIAGNOSTICS AND TESTING - 307-01**
P1708 - Clutch position switch (CPS) circuit fault	KOEO	**N**	Clutch not activated during self test Defective wiring and or connectors between the CPS and PCM Defective CPS	Run menu walker and follow instructions as per IDS Check the condition of the switch and wiring on the CPS circuit.
P1709 - Transmission range sensor out of self test range	KOEO	**N**	Gear selector not in P or N during self test. Selector cables incorrectly adjusted Defective wiring or connections between transmission range (TR) sensor and PCM Defective TR sensor	Check gear selector cables are correctly fitted and adjusted Run menu walker and follow instructions as per IDS Check wiring and connections between TR sensor, TCM and PCM (If there is a fault with the TR sensor, there may be other TR related DTCs stored.) For further information refer to **AUTOMATIC TRANSMISSION - DIAGNOSTICS AND TESTING - 307-01**
P1711 - Transmission fluid temperature outside test range	Cont KOER	**N**	Defective wiring, sensor or connections on transmission Transmission over-heated at commencement of test	Check the condition of wiring and connectors on transmissions Check condition of sensor Allow the engine and transmission to operate at normal running temperature during self-test. For further information refer to **AUTOMATIC TRANSMISSION - DIAGNOSTICS AND TESTING - 307-01**
P1719 - Engine torque signal	Cont	**N**		
P1746 - Pressure control solenoid open circuit	Cont	**N**	Transmission pressure control solenoid has gone open circuit or short to ground. Defective wiring and/or connectors Defective solenoid Defective TCM	Check wiring connections to transmission For further information refer to **AUTOMATIC TRANSMISSION - DIAGNOSTICS AND TESTING - 307-01**
P1747 - Pressure control solenoid short circuit	Cont	**N**	Transmission pressure control solenoid short to VPWR. Defective wiring and/or connectors Defective solenoid Defective TCM	Check wiring connections to transmission For further information refer to **AUTOMATIC TRANSMISSION - DIAGNOSTICS AND TESTING - 307-01**

DIAGNOSIS AND TESTING (Continued)

P1748 - Pressure control solenoid circuit	Cont	**N**	Transmission pressure control solenoid has gone open circuit or short to ground or short to VPWR. Defective wiring and/or connectors Defective solenoid Defective TCM	Check wiring connections to transmission For further information refer to **AUTOMATIC TRANSMISSION - DIAGNOSTICS AND TESTING - 307-01**
P1783 - transmission over-heat Condition Transmission running a limited strategy	Cont	**N**	Transmission (4- or 6-speed automatic) has over-heated and defaulted to a FMEM strategy Defective transmission cooling system Defective transmission temperature sensor	Check the transmission oil for condition. Check the transmission cooling system for leaks, blockages etc. Monitor transmission temperature with IDS/PDS. Clear all DTCs and carryout transmission self test For further information refer to **AUTOMATIC TRANSMISSION - DIAGNOSTICS AND TESTING - 307-01**
P1936 - Clutch position switch (CPS)	Cont	**N**	PCM not detecting signal Defective wiring between CPS and PCM Defective CPS	Check the wiring and connectors between the CPS and PCM Monitor the CPS with IDS datalogger. Ensure the CPS is correctly adjusted
P2100 - Electronic throttle body (ETB) motor open circuit	Cont KOEO KOER	**N**	Defective wiring to the ETB Defective ETB (Note DTC **P2110** may also be active, this would be indicated by limited engine speed)	Check the wiring and connections to the ETB. Ensure there is a correct voltage supply. Monitor ETB with IDS datalogger Check the ETB for damage and condition.
P2101 - Electronic throttle body (ETB) motor defective	Cont KOEO KOER	**N**	Defective ETB motor Damaged throttle body	Check the ETB for damage and condition. Ensure the throttle flap is not seized or damaged
P2105 - Electronic throttle body shut down	Cont KOEO KOER	**N**	This DTC indicates the engine is now operating in a FMEM strategy	Check for other DTCs that would have caused this shutdown
P2107 - Throttle actuator internal fault	Cont KOEO KOER	**N**	This DTC indicates the engine is now operating in a FMEM strategy	Check for other DTCs that would have caused this DTC to be active. This DTC can also be triggered by the PCM going into guard mode and storing DTC P2110
P2110 - Forced limited RPM (guard mode)	Cont KOEO KOER	**N**	This DTC indicates the engine is now operating in a FMEM (Guard mode) strategy	Check for other DTCs that would have caused this shutdown
P2111 - Throttle stuck open (Higher RPM than driver demand)	Cont KOEO KOER	**N** **N**	Damaged Throttle body	Check the operation of the throttle plate to ensure full and free movement Check the operation of the APP and TP

DIAGNOSIS AND TESTING (Continued)

P2112 - Throttle sticking. (Not opening in response to driver demand)	Cont KOEO KOER	**N**	Damaged Throttle body. Throttle plate partially seized	Check the operation of the throttle plate to ensure full and free movement

General notes for Electronic Throttle Body (ETB).

All the DTCs from **P2100 to P2112** relate to the PCM monitoring of the Electronic Throttle Body (ETB). The motor part of the ETB assembly is referred to as the Electronic Throttle Control **(ETC)**

If one of these DTCs is indicated it is a strong indicator of a mechanical fault with the ETB or the PCM has taken over the ETB with an FMEM (guard mode) strategy.

Basic checks would include:-

- a visual inspection of the ETB to check for damage to the flap,
- contamination within the throttle body,
- evidence the flap has been fouling the throttle body
- the adjustment screw has not been tampered with.

Electrical checks:-

- ensure the ETB motor has a 12 volt supply (Within 1 volt of battery voltage)
- ensure all the connections and wiring to the ETB is in good condition.
- check the resistance of the ETB motor (it should be between a nominal 3 to 5?, NOTE: these figures are only a guide. The resistance can be slightly outside these parameters and the motor still functioning correctly)

The effectiveness of the TP and be monitored with **IDS datalogger TP1 and TP2** as this is the feed back signal to the PCM.

In addition the relationship between the actual throttle position **(ETC_ACT)** and the desired throttle position **(ETC-DSD)** can be monitored with **IDS datalogger** by gradual application and release of the accelerator pedal.

If the information you are accessing is not available through normal Datalogger you may be able to access additional EOBD information via the OBD test modes:

To access OBD Datalogger:- VEHICLE SPECIFICATION PAGE > TOOLBOX > POWERTRAIN > OBD TEST MODES > MODE 1 POWERTRAIN DATA.

P2122 - Accelerator pedal position (APP) Circuit D (APP1) low input	Cont KOEO KOER	**N**	Damaged wiring and or connectors to APP Damaged APP Defective PCM	Check wiring and connectors between APP and PCM for condition. Check for reference voltage or return signal shorts to ground. Check APP for condition and operation. Monitor APP1 operation with IDS datalogger
P2123 - Accelerator pedal position (APP) Circuit D (APP1) high input	Cont KOEO KOER	**N**	Damaged wiring and or connectors to APP Damaged APP Defective PCM	Check wiring and connectors between APP and PCM for condition. Check for reference voltage or return signal shorts to VPWR. Check APP for condition and operation. Monitor APP1 operation with IDS datalogger
P2124 - Accelerator pedal position (APP) Circuit D (APP1) intermittent fault	Cont KOEO KOER	**N**	Damaged wiring and or connectors to APP Damaged APP Defective PCM	Check wiring and connectors between APP and PCM for condition. Check APP for condition and operation. Carry out wiggle test and monitor APP1 operation with IDS datalogger

DIAGNOSIS AND TESTING (Continued)

P2127 - Accelerator pedal position (APP) Circuit E (APP2) low input	Cont KOEO KOER	**N**	Damaged wiring and or connectors to APP Damaged APP Defective PCM	Check wiring and connectors between APP and PCM for condition. Check for reference voltage or return signal shorts to ground. Check APP for condition and operation. Monitor APP2 operation with IDS datalogger
P2128 - Accelerator pedal position (APP) Circuit E (APP2) high input	Cont KOEO KOER	**N**	Damaged wiring and or connectors to APP Damaged APP Defective PCM	Check wiring and connectors between APP and PCM for condition. Check for reference voltage or return signal shorts to VPWR. Check APP for condition and operation. Monitor APP2 operation with IDS datalogger
P2129 - Accelerator pedal position (APP) Circuit E (APP2) intermittent fault	Cont KOEO KOER	**N**	Damaged wiring and or connectors to APP Damaged APP Defective PCM	Check wiring and connectors between APP and PCM for condition. Check APP for condition and operation. Carry out wiggle test and monitor APP2 operation with IDS datalogger
P2135 - Throttle position (TP) sensors disagree	Cont KOEO KOER	**N**	Damaged or defective wiring between the throttle body and PCM Damaged throttle body sensor	Check the wiring and connections to the throttle body for security and condition. Carryout wiggle test on throttle body monitoring with IDS datalogger
P2138 - Accelerator pedal position APP1 and APP2 disagree	Cont KOEO KOER	**N**	Damaged or defective wiring between the accelerator pedal sensor and PCM Damaged accelerator pedal position sensor	Check the wiring and connections to the accelerator pedal position sensor for security and condition. Carryout wiggle test on the accelerator pedal position sensor (APP1, APP2 and APP3) monitoring with IDS datalogger

General notes for Accelerator Pedal Position (APP) sensor. NOTE there are a number of acronyms in common use for the **APP**.

Other terms used can be:-

- Accelerator Position Sensor **(APS) (IDS datalogger** would be **APS1, APS2 and APS3)**

Initially check the condition of the connector and wiring to the APP on the pedal. These can be damaged by the driver’s foot. Ensure the 5 volt reference voltage is provided.

A quick check that can be carried out with **IDS datalogger**. (you will need to identify the appropriate acronyms used i.e. **APP, PPS, APS or TPS**)

- Select **APP1 and APP2**
- Adjust IDS datalogger to a bar graph and set the parameters to 0 - 5volts
- With a KOEO state, slowly press the accelerator pedal and two of the signals will rise, one of the two offset from the other.
- This indicates the sensor is operating correctly
- If one of the signals fails to respond check the connections for the return signal. If there is no output from the sensor, the sensor is defective and should be replaced

If the information you are accessing is not available through normal Datalogger you may be able to access additional EOBD information via the OBD test modes:

To access OBD Datalogger:- VEHICLE SPECIFICATION PAGE > TOOLBOX > POWERTRAIN > OBD TEST MODES > MODE 1 POWERTRAIN DATA.

DIAGNOSIS AND TESTING (Continued)

P2763 - Torque Converter Clutch Pressure Control Solenoid Control Circuit High	Cont KOEO KOER	**N**	Defective torque converter Defective wiring/connectors between PCM and TCM (normally indicated with multiple DTCs) Defective TCM Defective solenoid	Check the operation of the torque converter lock-up clutch under road-test conditions with IDS/PDS Check the wiring and connections on the transmission loom. For further information refer to **AUTOMATIC TRANSMISSION - DIAGNOSTICS AND TESTING - 307-01**
P2764 - Torque Converter Clutch Pressure Control Solenoid Control Circuit low	Cont KOEO KOER	**N**	Defective torque converter Defective wiring/connectors between PCM and TCM (normally indicated with multiple DTCs) Defective TCM Defective solenoid	Check the operation of the torque converter lock-up clutch under road-test conditions with IDS/PDS Check the wiring and connections on the transmission loom. For further information refer to **AUTOMATIC TRANSMISSION - DIAGNOSTICS AND TESTING - 307-01**

"U" codes.

"U" codes are module communications errors.

Most "U" codes are associated with incorrect software programming or, more commonly, signals being corrupted between modules due to wiring or connection problems.

"U" codes can also occur during module reprogramming. IDS should clear these codes when reprogramming is complete. If IDS fails to do this, it indicates there is a "hard" fault with the system

For further information see additional notes at the end of this section.

U0073 - Torque Converter Clutch Pressure Control Solenoid Control Circuit low	Cont	**N**	Defective wiring between the PCM and TCM (normally indicated with multiple DTCs) Defective TCM Defective solenoid	Check the wiring and connections between the PCM and transmission connection. If stored with multiple DTCs, attempt to identify a common theme and which module they are associated with. CLEAR ALL DTCs. TEST the system for normal operation. If DTC resets, replace the relevant module and re-flash all modules with latest calibrations

DIAGNOSIS AND TESTING (Continued)

U0100 - Torque Converter Clutch Pressure Control Solenoid Control Circuit low	Cont	**N**	Defective wiring between the PCM and TCM (normally indicated with multiple DTCs) Defective TCM Defective solenoid	Check the wiring and connections between the PCM and transmission connection. If stored with multiple DTCs, attempt to identify a common theme and which module they are associated with. CLEAR ALL DTCs. TEST the system for normal operation. If DTC resets, replace the relevant module and re-flash all modules with latest calibrations
U0121 - Lost Communication With Anti-Lock Brake System (ABS) Control Module			Defective wiring or connections between ABS, PCM, IC, BEM and TCM	Carryout network test with IDS Check condition of wiring and connectors between ABS, PCM, IC, BEM and TCM modules. CLEAR ALL DTCs. TEST the system for normal operation. If DTC resets, replace the relevant module and re-flash all modules with latest calibrations.
U301 - TCM incorrect communication with other modules	Cont KOEO KOER		Incorrect software programmed in to TCM Incorrect TCM fitted	Ensure the PCM, TCM, BEM, ABS and IC are correctly programmed with the latest calibrations. For further information refer to **AUTOMATIC TRANSMISSION - DIAGNOSTICS AND TESTING - 307-01**
U0302 - TCM incorrect communication with other modules	Cont KOEO KOER	**N**	Incorrect software programmed in to TCM Incorrect TCM fitted	Ensure the PCM, TCM, BEM, ABS and IC are correctly programmed with the latest calibrations. For further information refer to **AUTOMATIC TRANSMISSION - DIAGNOSTICS AND TESTING - 307-01**
U0323 - Software no communication with instrument cluster (IC)		**N**	Incorrect calibration for IC Wiring between 16 pin DLC, IC and PCM damaged or defective CAN circuit failure 16 pin IDS lead damaged or defective	Ensure latest software and calibrations are in use. Check the wiring between the 16 pin DLC, IC and PCM Carry out multiplex system checks
U1039 - Invalid VSS data via the CAN	Cont	**N**	Damaged wiring or connections between the VSS and PCM. Error on the CAN system between the VSS, PCM, IC and DLC Incorrect VID programmed in to PCM. PCM, IC, ABS not running current software and calibrations	Check the wiring and connections between VSS, PCM and IC. Carryout a wiggle test monitoring VSS with IDS datalogger. Ensure latest software is programmed in PCM, IC, TCM and ABS.

DIAGNOSIS AND TESTING (Continued)

U1146 - Invalid or missing data for vehicle security	Cont	**N**	Attempt to start vehicle with incorrect key. PATS programming incorrect Damaged ignition key/barrel transponder	Ensure you have correct key Reprogram PATS Check the condition of the transponder and receivers.
U1147 - Invalid or missing data for vehicle security	BEM	**N**	Attempt to start vehicle with incorrect key. PATS programming incorrect Damaged ignition key/barrel transponder	Ensure you have correct key Reprogram PATS Check the condition of the transponder and receivers.
U1900 - CAN bus fault	Cont	**N**	Refer to electrical section CAN diagnostics	Refer to electrical section CAN diagnostics
U2197 - Invalid vehicle speed data	Cont	**N**	Damaged wiring or connections between the VSS and PCM. Error on the CAN system between the VSS, PCM, IC and DLC Incorrect VID programmed in to PCM. PCM, IC, ABS not running current software and calibrations	Check the wiring and connections between VSS, PCM and IC. Carryout a wiggle test monitoring VSS with IDS datalogger. Ensure latest software is programmed in PCM, IC, TCM and ABS.
U2473 - Unexpected vehicle speed	Cont	**N**	Damaged wiring or connections between the VSS and PCM. Error on the CAN system between the VSS, PCM, IC and DLC Incorrect VID programmed in to PCM. PCM, IC, ABS not running current software and calibrations	Check the wiring and connections between VSS, PCM and IC. Carryout a wiggle test monitoring VSS with IDS datalogger. Ensure latest software is programmed in PCM, IC, TCM and ABS.
U2050 - Incorrect strategy (TCM)	Cont KOEO		TCM programmed strategy does not fit vehicle specification.	Ensure latest software is programmed in all modules Ensure the VID data is correctly programmed For further information refer to **AUTOMATIC TRANSMISSION - DIAGNOSTICS AND TESTING - 307-01**

DIAGNOSIS AND TESTING (Continued)

U2051 - Incorrect calibration (TCM)	Cont KOEO	**N**	TCM calibration outside parameters or unable to communicate correct data	Ensure latest software is programmed in all modules CLEAR ALL DTCs. TEST the system for normal operation. If DTC resets, replace the relevant module and re-flash all modules with latest calibrations. For further information refer to **AUTOMATIC TRANSMISSION - DIAGNOSTICS AND TESTING - 307-01**
U2514 - Message for VSS missing	Cont	**N**	Damaged wiring or connections between the VSS and PCM. Error on the CAN system between the VSS, PCM, IC and DLC Incorrect VID programmed in to PCM. PCM, IC, ABS not running current software and calibrations	Check the wiring and connections between VSS, PCM and IC. Carryout a wiggle test monitoring VSS with IDS datalogger. Ensure latest software is programmed in PCM, IC, TCM and ABS.

General Notes with reference to DTCs with a "U" pre-fix

DTCs with a "U" pre-fix indicate a communications error.

When using IDS you may run a complete self-test which records a number of "U" codes. Example **U0302 PCM communication with TCM**. Most of the diagnostic procedures within the PCM are generic; therefore the PCM will "look" for the TCM during a **KOEO test**, even though the vehicle is fitted with a manual transmission, hence the stored DTC. DTCs of this nature do affect the normal operation of the vehicle.

Most **"U"** codes are associated with incorrect software programming or, more commonly, signals being corrupted between modules due to wiring or connection problems.

"U" codes can also occur during module reprogramming. IDS should clear these codes when reprogramming is complete. IDS fails to do this, it indicates there is a "hard" fault with the system

However if a module is suspected one of the easiest ways to identify the area of the concern is to use the **out-put state control (OSC)** function on **IDS datalogger**. The **OSC** is identified with a **#** symbol.

Example: A customer complaining of an erratic tacho (RPM) gauge

- Select **IDS datalogger**
- Select **IC** (instrument cluster)
- Select **TACHO#**
- Select the # key on the right-hand side of **IDS** screen
- Below this button another 3 buttons will appear, one a finger pressing a button, the next a + sign and the third a - sign
- Press the finger button, then press the + sign. The RPM gauge will then start to sweep across the gauge.
- Further presses of this button will cause the gauge to travel further
- If as the gauge moves it can be seen to fluctuate, this would indicate a fault with the gauge itself. If it produces a smooth movement, it would indicate a communication error between the PCM and the IC.

DIAGNOSIS AND TESTING (Continued)

Glossary

ABS	Acronym for Anti-lock Brake System. Prevents wheel lockup during an emergency stop by modulating brake pressure. Allows the driver to maintain steering control and stop the vehicle in the shortest possible distance under most conditions
APPS	Acronym for Accelerator Pedal Position Sensor. The pedal position sensor has 3 independent outputs, APPS1, APPS2 and APPS3
APPSVREF	Acronym for Accelerator Pedal Position Sensor VREF. A 5V supply. Two are used for the pedal sensor
APPSRTN	Acronym for Accelerator Pedal Position Sensor Return. A 0V supply. Two are used for the pedal sensor
ASR	Acronym for Acceleration Slip Control system. Also known as the traction control system
Absolute Pressure	The pressure referenced to a perfect vacuum
ACC	Acronym for Air Conditioning Clutch in this section
ACD	Acronym for Air Conditioner Demand.
ACP	Acronym for Air Conditioning Pressure
ACPT	Acronym for Air Conditioner Pressure Transducer
ACR	Acronym for Air Conditioning Clutch Relay
Actuator	A mechanism for moving or controlling something indirectly instead of by hand
AEAT	Acronym for Air Conditioner Evaporator Temperature
Air Conditioning	A vehicular system that modifies the passenger compartment environment by cooling and drying the air
Analogue Signals	are signals that vary within a certain range (ie.0 - 5 volts). An analogue signal is infinitely variable within the rage. The Throttle Position Sensor (TP) produces an analogue signal
ATDC	Acronym for After Top Dead Centre
Base Timing	Spark advance in degrees before top dead centre of the base engine without any control from the PCM
Battery	An electrical storage device designed to produce a DC voltage by means of an electrochemical reaction
BBM	Acronym for Broad Band Manifold, see IMCC
BEM	Acronym for Body Electronic Module
BFS	Acronym for Blower Fan Speed
Blower	A device designed to supply a current of air at a moderate pressure. A blower usually consists of an impeller assembly,a motor and a suitable case. The blower case is designed as part of the ventilation system
BOO	Acronym for the Brake On Off Switch.
BPS	Acronym for Boost Pressure Sensor. Measures the boost pressure of the turbocharger.
BTDC	Acronym for Before Top Dead Centre - relating to the position of the piston within the cylinder
Camshaft	A shaft on which phased cams are mounted. The camshaft is used to regulate the opening and closing of the intake and exhaust valves
CAN	Acronym for Control Area Network. An intermodule communications network comprising a twisted pair wire, CAN-H and
CAN-L	which have complementary output.
Canister	A device designed to hold dry material. An evaporative emission canister contains activated charcoal that absorbs fuel vapours and holds them until the vapours can be purged at an appropriate time
Canister Purge	Controls purging of the EVAP canister
CASEGN	Acronym for PCM Case Ground

DIAGNOSIS AND TESTING (Continued)

Catalytic Converter	An in-line exhaust system device used to reduce the level of engine exhaust emissions
CD1..8	Acronym for Coil Driver. The PCM’s Coil On Plug output drivers.
CHT	Acronym for Cylinder Head Temperature sensor.
Circuit	A complete electrical path or channel, usually includes the source of electrical energy. Circuit may also describe the electrical path between two or more components. May also be used with fluids, air or liquids
CKP	Acronym for Crankshaft Position Sensor
Closed Loop	A control system that uses a signal from an oxygen sensor mounted in the exhaust system to control the ratio of air and fuel provided to the engine. Also known as the Lambda loop
Clutch	A mechanical device that uses mechanical, magnetic or friction type connections to facilitate engaging or disengaging of two shafts or rotating members
CMP	Acronym for Camshaft Position. Indicates camshaft position. Provides camshaft position information for fuel injection synchronisation
CO	Carbon Monoxide. A colourless, odourless, gas toxic gas formed by combustion within the cylinder
CO2	Carbon Dioxide. A colourless, odourless, incombustible gas formed during combustion
Coil	A device consisting of windings of conductors around an iron core, designed to increase the voltage and for use in a spark ignition system
Continuous Memory	The portion of KAM used to store DTCs generated during Continuous Memory Self-Test
Continuous Memory Self-Test	A continuous test of the EEC system conducted by the PCM whenever the vehicle is operating
Control	A means or a device to direct and regulate a process or guide the operation of a machine, apparatus system
Coolant	A fluid used for heat transfer. Coolants usually contain additives such as rust inhibitors and antifreeze
Crankshaft	The part of an engine that converts the reciprocating motion of the pistons to rotary motion
Data	General term for information, usually represented by numbers, letters, or symbols
Digital	Digital signals have only one of two values, either on or off. Some systems measure the duration between the on and off signals to determine a value. The vehicle speed sensor (VSS)is produces a digital signal
DLC	Acronym for Data Link Connector. Connector providing access and/or control of the vehicle information, operating conditions, and diagnostic information
DTC	Acronym for Diagnostic Trouble
Code	An alpha/numeric identifier for a fault condition identified by the On-Board Diagnostic System
EDF1	Acronym for Electro Drive Fan 1. Controls the engine cooling fans at low Speed
EDF2	Acronym for Electro Drive Fan 2. Controls the engine cooling fans at high Speed
EMC	Acronym for Electro-Magnetic Compatibility
Engine	A machine designed to convert thermal energy into mechanical energy to produce force or motion
EOT	Acronym for Engine Oil Temperature
ETB	Acronym for Electronic Throttle Body
ETC	Acronym for Electronic Throttle Control.
ETCN	Acronym for Electronic Throttle Control Negative. The negative of the ETC motor.
ETCP	Acronym for Electronic Throttle Control Positive. The positive of the ETC motor.
EVAP	Acronym for Evaporative Emission Evaporative Emission (EVAP) - A system to prevent fuel vapour from escaping into the atmosphere. Typically includes a charcoal canister to store fuel vapours

DIAGNOSIS AND TESTING (Continued)

Fan	A device designed to supply a current of air. A fan may also have a frame, motor, wiring harness and the like
FEPS	Acronym for Flash EEPROM Power Supply
FMEM	Acronym for Failure Mode Effects Management. An alternative vehicle operation strategy that protects vehicle function from the adverse effect of a system failure
FP	Acronym for Fuel Pump. A pump used to deliver fuel to the engine
Freeze Frame	A block of memory containing the vehicle operating conditions for a specific time
Fuel	Any combustible substance burned to provide heat or power. Typical fuels include gasoline and diesel fuel. Other types of fuel include ethanol, methanol, natural gas, propane or in combination
Fuel Rich/Lean	A qualitative evaluation of air-fuel ratio based on an A/F ratio known as stoichiometry or 14.64:1. In the EEC system, rich/lean is determined by a voltage signal from the H02S. An excess of oxygen (lean) is indicated by an H02S voltage of less than 0.4 volts; a rich condition is indicated by an H02S voltage of greater than 0.6 volts
GCO	Acronym for Gas Cut-out
GLVL	Acronym for Gas Tank Level Sensor
GLVL-RTN	Acronym for Gas Tank Level Sensor Return
GRND	Ground. The ground, or common side of a DC electrical circuit
GSCA-D	Acronym for LPG Stepper Motor A to D
Hall Effect	A process where current is passed through a small slice of semi-conductor material at the same time as a magnetic field to produce a small voltage in the semi-conductor
HC	Hydrocarbon. A compounds that contains only carbon and hydrogen
HO2S	Acronym for Heated Oxygen Sensor. An Oxygen Sensor (02S) that is electrically heated
Hz	Hertz. The measure of a frequency - equal to one cycle per second. Defined by Heinrich Rudolf Hertz
IAC	Acronym for Idle Air Control. Electrical control of throttle bypass air
IAT	Acronym for Intake Air Temperature. The temperature of the intake air
IDM	Acronym for Ignition Diagnostic Monitor
Ignition	System used to provide high voltage spark for internal combustion engines
IGNSNS	Acronym for Ignition Sense input.
IMCC	Acronym for intake Manifold Charge Control
INJ1-8	Acronym for Fuel Injectors 1 to 8
Injector	A device for delivering metered pressurised fuel to the intake system or the cylinders
Intake Air	Air drawn through a cleaner and distributed to each cylinder for use in combustion
Intermittent	A fault that may not be present or identifiable at the present time
KAM	Acronym for Keep Alive Memory. A portion of the memory within the PCM that must maintain power even when the vehicle is not operating
KAPWR	Acronym for Keep Alive memory Power. Dedicated, unswitched power circuit that maintains KAM
Knock	The sharp metallic sound produced when two pressure fronts collide in the combustion chamber of an engine
KOEO	Acronym for Key On Engine Off Self-Test. A test of the EEC system conducted by the PCM with power applied and the engine at rest
KOER	Acronym for Key On Engine Running Self-Test. A test of the EEC system conducted by the PCM with the engine running and the vehicle at rest
KS	Acronym for Knock Sensor. Detects engine knock
L	Litres
Lean	excess air (or too little fuel) in the air- fuel ratio being supplied to the combustion process
LONGFT	Acronym for Long Term Fuel Trim

DIAGNOSIS AND TESTING (Continued)

LPG	Acronym of Liquefied Propane Gas. Used as an alternative to petroleum fuel in combustion engines
LUS	Acronym for Lock up Solenoid
M/T	Manual Transmission
Manifold	A device designed to collect or distribute fluid, air or the like
MAP	Acronym for Manifold Absolute Pressure. The absolute pressure of the intake manifold air
Module	A self-contained group of electrical/electronic components, which is designed as a single renewable unit
Multiplexing	the simultaneous transmission of two or more signals over a single circuit. The EEC-V uses multiplexing to communicate with the NGS
NC	Acronym for Normally Closed electrical Contact
NO	Acronym for Normally Open electrical Contact
NOx	Oxides of Nitrogen
OCV	Acronym for Oil Control Valve. Also known as a Camshaft Position Actuator. Used on the VCT to control oil pressure to the phaser.
OHC	Acronym for Overhead Camshaft. An engine configuration that uses a camshaft positioned above the valves Open Circuit - A circuit which does not provide a complete path for flow of current
OSS	Acronym for Output Shaft Speed Sensor. A sensor which provides driveshaft speed information
PCM	Acronym for Powertrain Control Module
PCS	Acronym for Power Control Solenoid
PCV	Acronym for Positive Crankcase Ventilation. Positive ventilation of crankcase emissions
Phaser	a mechanism used on VCT to vary camshaft angle
PID	Acronym for Parameter Identification. Identifies an address in memory which contains vehicle operating information
PIP	Acronym for Profile Ignition Pick-up. Provides crankshaft or camshaft position information for ignition synchronisation
Power Steering	A system which provides additional force to the steering mechanism, reducing the driver’s steering effort
Powertrain	The elements of a vehicle by which motive power is generated and transmitted to the driven axles
PSP	Acronym for Power Steering Pressure Switch. Indicates the pressure in the power steering system
Pulse Width Modulation (PWM)	a continually changing digital signal turned on and off or a percentage of the available on pulse off cycle time. A signal on for 30% and off 70% of the time is a 30% On PWM signal
PRIME	Acronym for the LPG PRIME solenoid.
Pump	A device used to raise, transfer, or compress fluids by suction, pressure or both
PWRGND	Power Ground. The main ground circuit in the EEC-V system
PWRSTN	Acronym for Power Sustain. A PCM output that powers the VPWR relay on for a short delay after the ignition is keyed OFF.
Relay	A generally electromechanical device in which connections in one circuit are opened or closed by changes in another circuit
RBS	Acronym for Redundant Brake Switch used for the cruise control feature
RGS	Acronym for the Reverse Gear Switch used on manual transmissions.
Rich	an inadequate amount of air (or too much fuel) in the air-fuel ratio being supplied to the combustion process
RPM	Engine speed in revolutions per Minute
SCRSA	Acronym for Speed Control Range Sensor (Analogue signal).
Short Circuit	An undesirable connection between a circuit and any other point

DIAGNOSIS AND TESTING (Continued)

SHRTFT	Acronym for Short Term Fuel Trim
Signal	A fluctuating electric quantity, such as voltage or current, whose variations represent information
SIGRTN	Acronym for Signal Return. A dedicated sensor ground circuit that is common to two or more sensors
Solenoid	A device consisting of an electrical coil which, when energised, produces a magnetic field in a plunger that is pulled to a central position. A solenoid may be used as an actuator in a valve or switch
Speed	The magnitude of velocity (regardless of direction)
SS x	Acronym for Shift Solenoid. A device that controls shifting in an automatic transmission
STRTEN	Acronym for Start Enable relay output.
Switch	A device for making, breaking, or changing the connections in an electrical circuit
System	A group of interacting mechanical or electrical components serving a common purpose
Tachometer	A meter that provides a measure of engine speed in RPM
TAS	Acronym for Travel Assistance Service, the signal recieved by the PCM from the Restraint Control Module, RCM, when it detects deployment level impact events.
TDC	Acronym for Top Dead Centre - relating to the position of the piston within the cylinder
Test	A procedure whereby the performance of a product is measured under various conditions
TFT	Acronym for Transmission Fluid Temperature. Indicates temperature of transmission fluid
Throttle	A valve for regulating the supply of a fluid, usually air or an air-fuel mix, to an engine
Timing	Relationship between spark plug firing and piston position usually expressed in crankshaft degrees before (BTDC) or after (ATDC) top dead centre of the compression stroke
T-MAP	Acronym for Temperature and Manifold Absolute Pressure Sensor
TP	Acronym for Throttle Position sensor. Indicates the position of the throttle plate. The TP sensor assembly has two independent sensor outputs
TPS_VREF	Acronym for Throttle Position sensor VREF. The 5V supply for the sensor
TPS_RTN	Acronym for Throttle Position sensor RTN. The 0V supply for the sensor
TRS-A1	Acronym for Transmission Range Sensor - (Analogue signal) 1. The transmission mounted sensor gear position.
TRS-A2	Acronym for Transmission Range Sensor - (Analogue signal) 2. The centre console mounted electronic Sport Shift sensor.
Transient	Remaining only for a brief time
Transmission	A device which selectively increases or decreases the ratio of relative rotation between its input and output shafts.
TURBO	Acronym for Turbocharger
Variable Reluctance	A process of passing a magnetic field through wire windings and inducing a voltage
Valve	A device by which the flow of liquid, gas, vacuum, or loose material in bulk may be started, stopped or regulated by a movable part that opens, shuts or partially obstructs one or more ports or passageways. A “Valve” is also the moveable part of such a device
VCT	Acronym for Variable Camshaft Timing
VPS	Acronym for Variable Pressure Control Solenoid 5
VPWR	Acronym for Vehicle Power. A switched circuit that provides power to the EEC system. Compare “Battery Positive Voltage (B+).”
VREF	Acronym for Reference Voltage. A dedicated circuit that provides a 5.0 volt signal used as a reference by certain sensors

DIAGNOSIS AND TESTING (Continued)

VSOUT	Acronym for Vehicle Speed Output. An output which provides speed information as a frequency signal proportional to vehicle speed
VSS	Acronym for Vehicle Speed Sensor. A sensor which provides vehicle speed information
WOT	Acronym for Wide Open Throttle. A condition of maximum airflow through the throttle body

The glossary is a list of technical terms or acronyms and their definitions. It is not intended to be a dictionary of components and their functions. If a detailed description of a specific component is desired, refer to the related Workshop Manual Group.

DIAGNOSIS AND TESTING (Continued)

Steering Wheel Switches

Inspection and Verification

1. Verify the customer concern by operating steering wheel switches.
2. Visually inspect the ignition switch and the steering column multifunction switch for damage. Refer to the following chart:

Visual Inspection Chart

Condition
. Cruise control switches . Radio control switches . Horn pad

3. If cause of the switch concern is not visually apparent, proceed to the Symptom Chart:

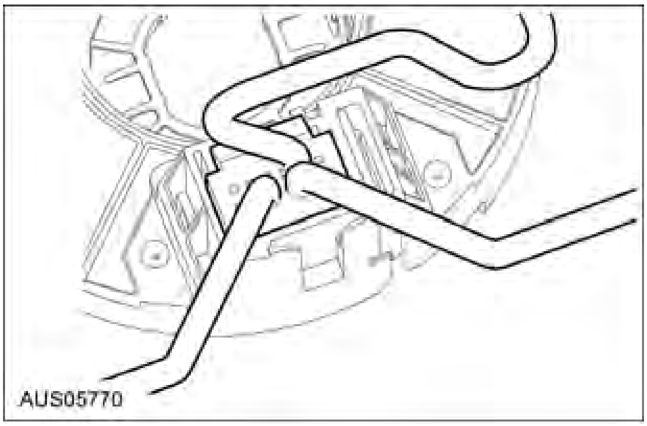
Steering Wheel Switch Symptom Chart

Condition	Source	Action
. Cruise control does not operate (after 40km/h)	. Cruise control buttons . Circuitry . Powertrain Control Module (PCM)	. Go to PinPoint Test A
. Radio controls do not operate	. Radio control buttons . Circuitry . Audio Control Module (ACM)	. Go to PinPoint Test B
. Horn does not operate properly	. Horn pad . Circuitry . Body Electronics Module (BEM)	. Section 413-06

DIAGNOSIS AND TESTING (Continued)

Connector Circuit Reference

C-167 View of steering wheel switch connector - harness side



Pinout Chart

Pin Numbers	Circuit Designation / Description
1	Horn Feed (Red)
4	Horn Return (Black)
8	Cruise Ground (Pink)
9	Cruise Return (Purple)
10	Radio Return (Green)
11	Radio Feed (Orange)

Outputs (Digital)

Switch Function	Resistance (ohms)
Cruise return	4180.00
. **On/Off**	0.00
. **Set -**	270.00
. **Set +**	660.00
. **Resume**	1480.00
Cruise return	604.00
. **Vol-**	51.10
. **Vol +**	119.20
. **Seek**	210.10
. **Mode**	334.10
. **Mute**	508.10

DIAGNOSIS AND TESTING (Continued)

Pinpoint Tests

Pinpoint Tests

Condition	Source	Action
. Cruise control does not operate (after 40km/h)	. Cruise control buttons . Circuitry . Powertrain Control Module (PCM)	. Go to PinPoint Test A
. Audio controls do not operate	. Radio control buttons . Circuitry . Audio Control Module (ACM)	. Go to PinPoint Test B

PINPOINT TEST A : Cruise control does not operate (after 40km/h)

Test Step		Result / Action to Take
A1	**Check cruise control switch response**	
	. **Using PDS/IDS, Is the SCCS (Steering Cruise Control Switch) DTC on PCM present?**	**Yes** If DTC present, proceed to step **3** **No** Proceed to next step
A2	**Check cruise control switch response**	
	. **Using PDS/IDS, are the PIDs on Datalogger of PCM responding to activation of cruise control switches?**	**Yes** There are no problems with the steering wheel switch **No** Proceed to next step
A3	**Check cruise control switch response**	
	. **Expose the steering wheel switch harness by removing horn-pad from the vehicle. Refer section 211-04**	
A4	**Check cruise control switch response**	
	. **With a multimeter, are the switch resistances (when activated) the same as the Output (Digital) table above?**	**Yes** Wiring problem between Clockspring and PCM **No** If resistances are incorrect, short or open circuited, replace switch

PINPOINT TEST B : Audio controls do not operate

Test Step		Result / Action to Take
B1	**Check audio control switch response**	
	. **Using PDS/IDS, Is the audio control switch DTC on ACM present?**	**Yes** If DTC present, proceed to step **3** **No** Proceed to next step

DIAGNOSIS AND TESTING (Continued)

Test Step		Result / Action to Take
B2	**Check audio control switch response**	
	. **Using PDS/IDS, are the PIDs on Datalogger of ACM responding to activation of audio control switches?**	**Yes** There are no problems with the steering wheel switch **No** Proceed to next step
B3	**Check audio control switch response**	
	. **Expose the steering wheel switch harness by removing horn-pad from the vehicle. Refer section 211-04**	
B4	**Check audio control switch response**	
	. **With a multimeter, are the switch resistances (when activated) the same as the Output (Digital) table above?**	**Yes** Wiring problem between Clockspring and ACM **No** If resistances are incorrect, short or open circuited, replace switch

GENERAL PROCEDURES

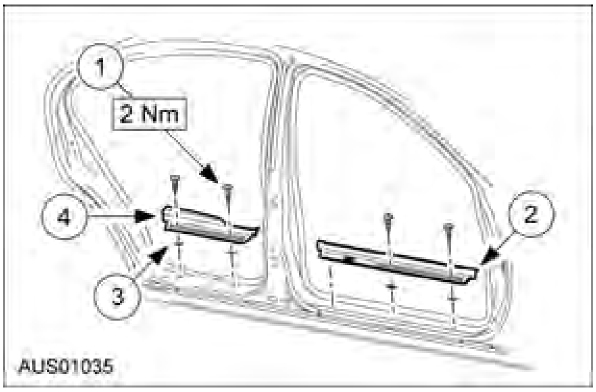
Powertrain Control Module

Accessing vehicle speed signal for installation of taximeters

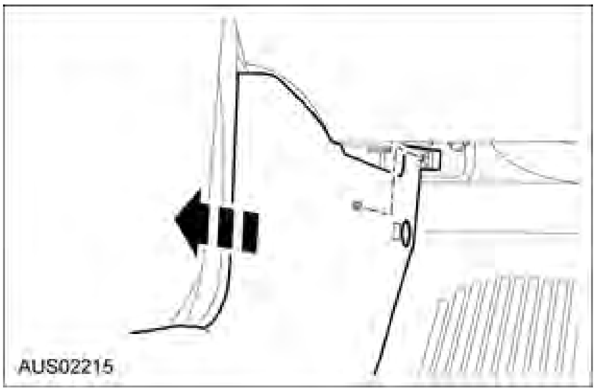
CAUTION: Vehicle speed signal must NOT be accessed via the ABS system as this may compromise system integrity.

NOTE: The Power Control Module (PCM) generates the vehicle speed signal which can be accessed by taximeters. The B36VSOUT is a pulsed 12V signal of approximately 5000 pulses/km which is used by SATNAV (Refer to chapter 419-07 for further SATNAV information) to measure speed. This outputted signal should be accessed by taximeters to monitor vehicle speed.

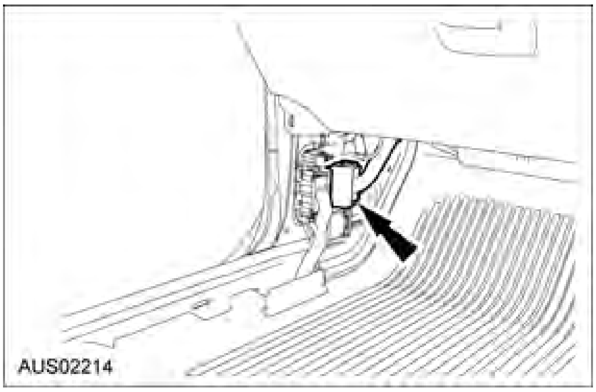
1. Remove outer front LHS scuff plate.



2. Remove inner front LHS scuff plate.
   This will expose the B36VSOUT wiring which includes the 565B-W wire and C-119 connector.



3. Locate 565B-W (Black wire with white stripe) and splice the wire at the back of connector C-119. Refer to Connector Views chapter 700-07-00.



4. Check integrity of taximeter. Taximeters to be used with the PCM should have an input resistance to ground of between 4.7kOhm and 15kOhm
5. Re-install scuff plates.

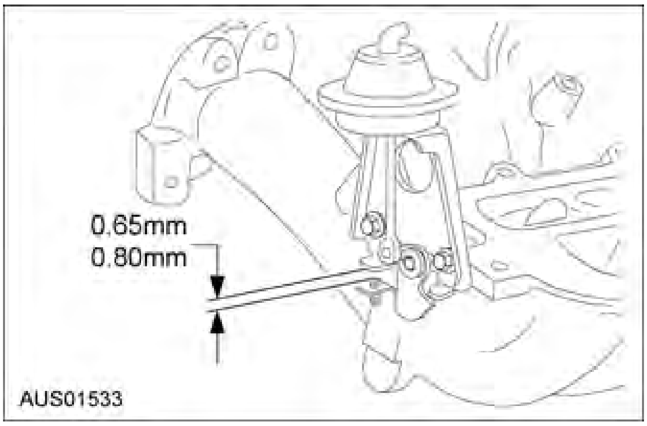
Intake Manifold Charge Control

Adjustment

1. Using a suitable vacuum pump and gauge, apply a 40kPa vacuum to IMCC actuator.
2. Adjust IMCC set screw to achieve the specified clearance between the set screw and the actuator arm.

IMCC Clearance Specification

1. 0.65 - 0.80 mm



VCT Solenoid Valve

Cleaning Procedure

Items required.

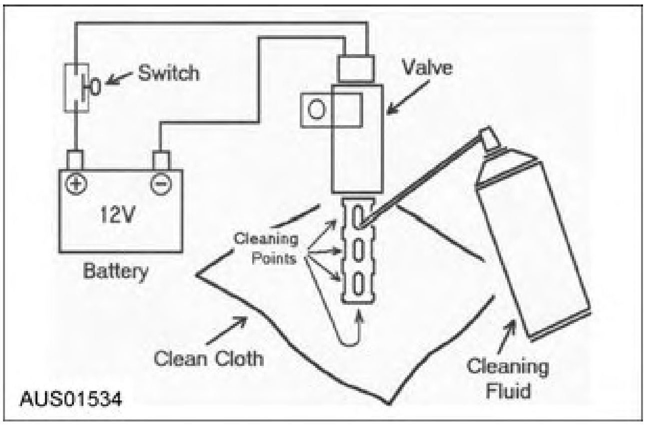
1. Aerosol can of suitable cleaning fluid such as CO electrical cleaning fluid, Compressed air or similar.
2. Clean Rag.
3. Wiring Loom.
4. 12V Vehicle Battery.

GENERAL PROCEDURES (Continued)

5. Safety Glasses.

Procedure.

1. Remove jammed Oil Control Valve (OCV) Ref. Engine Section 303-01a, b & c.
2. Place valve on a clean cloth.
3. Connect 12V onto valve through a push button momentary switch.
4. Hold valve upright on clean cloth.
5. Spray cleaning Fluid into ports of valve while pressing momentary switch 3 - 4 times per second.
6. Clean down the center of the valve using a similar process.
7. Repeat process until the obstruction is removed.
8. Re-fit valve and test.



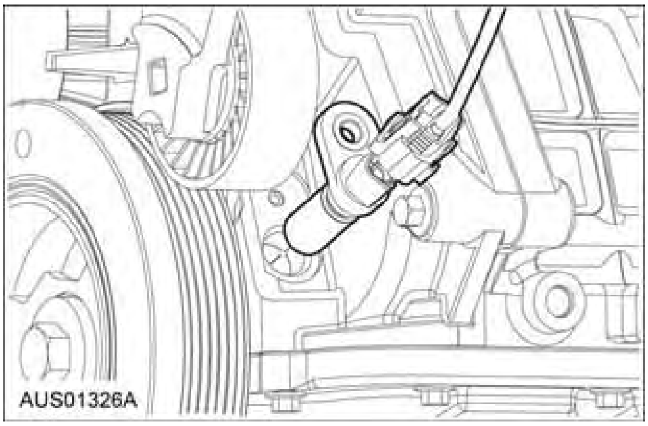
Login Tracking Code

REMOVAL AND INSTALLATION

Crankshaft Position (CKP) Sensor (I6 Engine)

Removal

1. Remove the crankshaft position (CKP) sensor.
    1. Disconnect the electrical connector
    2. Remove the retaining bolt
    3. Remove the sensor



NOTE: Be sure the sensor wiring is routed away from the battery cable.

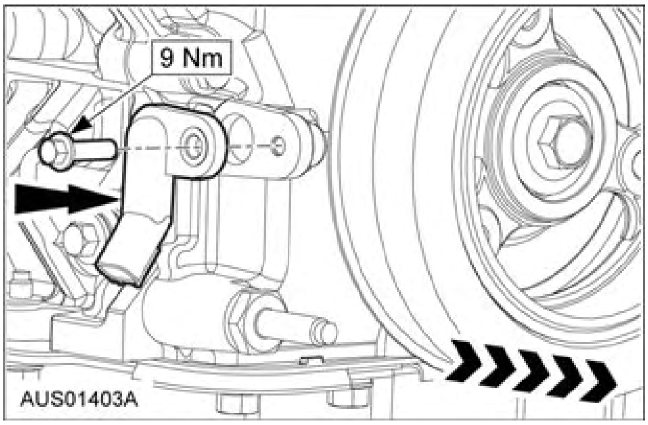
Installation

1. To Install, reverse the removal procedure.

Crankshaft Position (CKP) Sensor (V8 Engine)

Removal

1. Remove the A/C compressor. For additional information, refer to Section 412-03.
2. Remove the crankshaft position (CKP) sensor.
    1. Disconnect the electrical connector
    2. Remove the bolt
    3. Remove the sensor



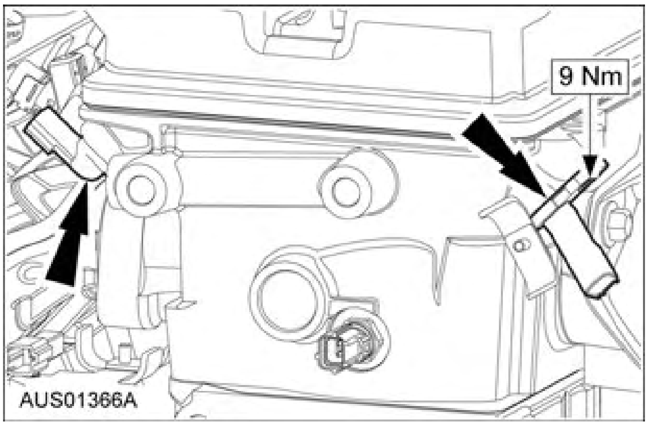
Installation

1. To Install, reverse the removal procedure.

Camshaft Position Sensor (I6 Engine)

Removal

1. Remove the camshaft position (CMP) sensor.
    1. Disconnect the electrical connector
    2. Remove the retaining bolt
    3. Remove the sensor



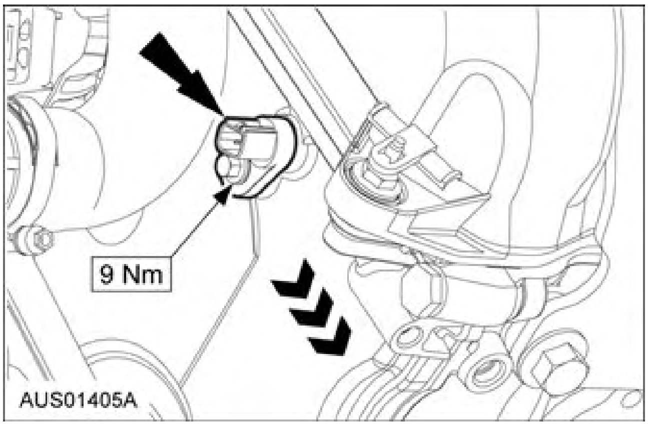
Installation

1. To Install, reverse the removal procedure.

Camshaft Position Sensor (V8 Engine)

Removal

1. Disconnect the battery ground cable. For additional information, refer to Section 414-01.
2. Disconnect the camshaft position (CID) sensor electrical connector.
3. Unscrew the retaining bolt and remove the CID sensor.



Installation

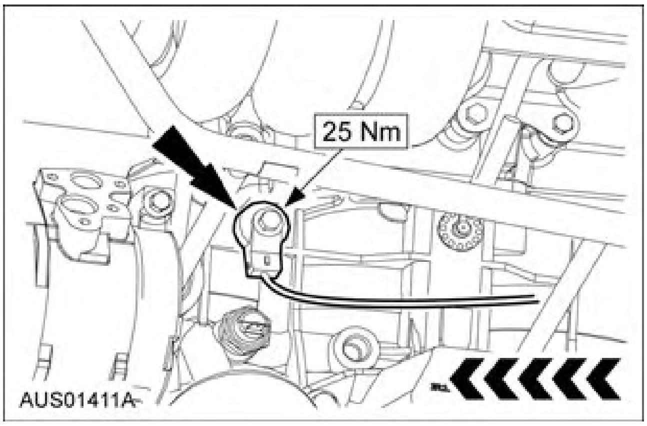
1. To Install, reverse the removal procedure.

REMOVAL AND INSTALLATION (Continued)

Knock Sensor (I6 Engine)

Removal

1. Disconnect the knock sensor (KS) electrical connector.
2. Remove the bolt and the KS.



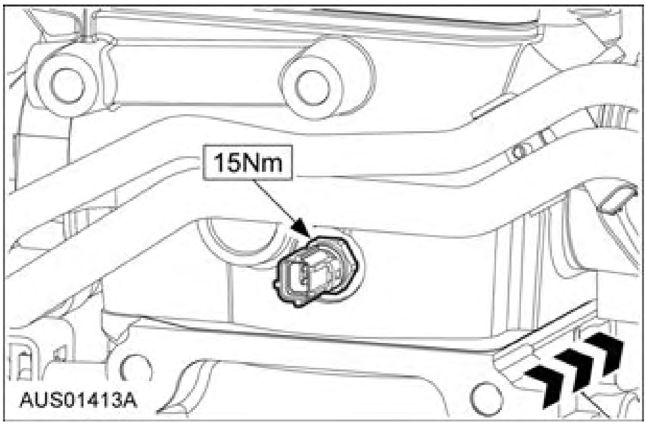
Installation

1. To Install, reverse the removal procedure.

Cylinder Head Temperature (CHT) Sensor (I6 Engine)

Removal

1. Disconnect the cylinder head temperature (CHT) sensor electrical connector.
2. Using a ring spanner, remove the CHT sensor.



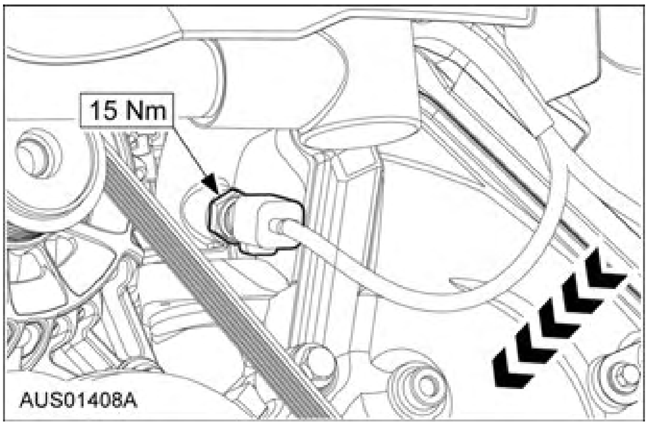
Installation

1. To Install, reverse the removal procedure.

Cylinder Head Temperature (CHT) Sensor (V8 Engine)

Removal

1. Disconnect the battery ground cable. For additional information, refer to Section 414-01.
2. Disconnect the electrical connector and remove the alternator.
3. Disconnect the CHT sensor electrical connector.
4. Remove the CHT sensor.



Installation

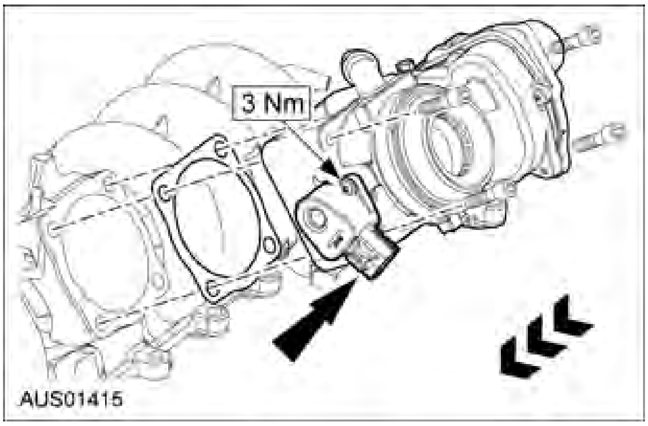
1. To Install, reverse the removal procedure.

Throttle Position (TP) Sensor (LPG Engines)

Removal

1. Ensure the ignition has been switched off and the battery disconnected. For additional information, refer to Section 414-01.
2. Remove the inlet duct from the throttle body.
3. Remove the TP sensor.

LPG Engine



1. Disconnect the electrical connector from the TP sensor by sliding the red locking tab out and pressing the clip release.
2. Remove the 2 TP sensor retaining bolts.
3. Remove the TP sensor from the throttle body.

Installation

1. Fit the new bolts provided with the new TP sensor and tighten them to 2 - 4Nm.
2. Reconnect the electrical connector ensuring there is a positive “click” as the safety clip engages.
3. Slide the red locking tab into position.
4. Refit the inlet duct to the throttle body.
5. Reconnect the battery.

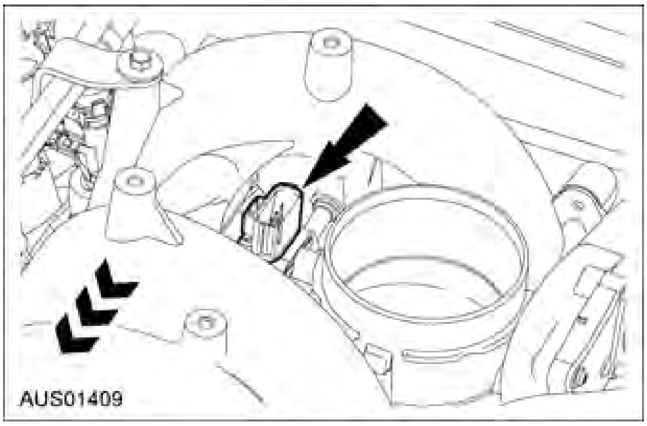
REMOVAL AND INSTALLATION (Continued)

6. Switch on the ignition then fully depress the accelerator pedal and release it.
7. Perform key-on, engine-off test to ensure no TP sensor codes are present.
8. Start the car and ensure normal operation.

Throttle Position (TP) Sensor (V8 Engine)

Removal

1. Ensure the ignition has been switched off and the battery disconnected. For additional information, refer to Section 414-01.
2. Remove the inlet duct from the throttle body.
3. Disconnect the 4 way electrical connector from the TP sensor by sliding the red locking tab out and pressing the clip release.
4. Disconnect the 2 way electrical connector from the throttle body motor by sliding the red locking tab and pressing the clip release.
5. Remove the 4 bolts retaining the throttle body to the inlet manifold.
6. Note the throttle body orientation, then remove the throttle body, being careful with the gasket.
7. Remove the throttle TP sensor.



   1. Remove the 2 TP sensor retaining bolts.
   2. Remove the TP sensor from the throttle body.

Installation

1. Fit the new TP sensor to the throttle body, ensuring that the locating pin on the TP sensor aligns with the hole in the throttle body.
2. Fit the new bolts provided with the new TP sensor and tighten them to 2 - 4Nm.
3. Refit the gasket and the throttle body to the inlet manifold and tighten the bolts to 8 -12Nm.
4. Reconnect both electrical connectors ensuring there is a positive “click” as the safety clips engage.
5. Slide the red locking tabs into position.
6. Refit the inlet duct to the throttle body.
7. Reconnect the battery.
8. Switch on the ignition then fully depress the accelerator pedal and release it.
9. Perform key-on, engine-off test to ensure no TP sensor codes are present.
10. Start the car and ensure normal operation.

NOTE: The TP sensor cannot be removed on I6 petrol engines. The throttle body must be replaced as an assembly.

Powertrain Control Module (PCM) (I6 Engine)

The PCM is installed in the engine compartment on the bracket over the front nearside strut tower. Three security bolts secure the PCM to the PCM bracket.

Removal

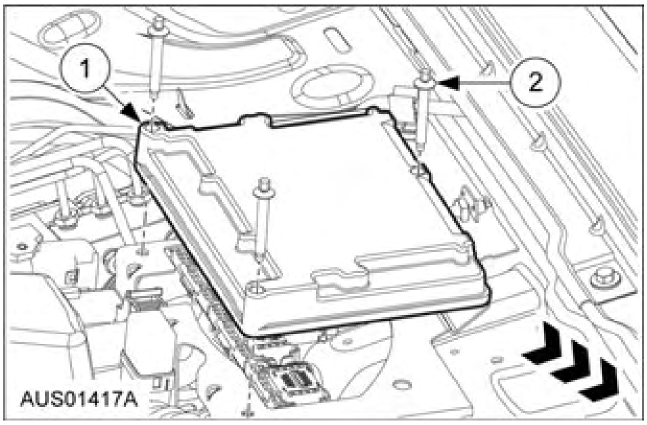
1. Ensure the ignition has been switched off and the battery disconnected. For additional information, refer to Section 414-01.
2. Use a small high-speed grinding tool with a small circular grinding disc to cut slots on the 3 security bolts holding the PCM to the bracket.

   ⚠ **CAUTION: This operation produces sparks and debris that can cause fire and personal injury.**

   - **Perform this operation in a well-ventilated area.**
   - **Ensure that that there are no fuel leaks in the engine compartment, the engine, fuel injectors and fuel lines.**
   - **Ensure that there are no flammable liquids and fumes present in the work area. Eg solvents, inks, paints, thinners, cleaning fluids, open fuel containers etc.**
   - **Use necessary precautions to confine debris from the grinder.**
   - **Use protective goggles and gloves for personal safety.**
3. Use a blade screwdriver to unscrew the security bolts.

REMOVAL AND INSTALLATION (Continued)

4. Release the wiring harness locking bar and remove the harness from the PCM.



Item	Description
1	PCM Module
2	Security bolt

5. Remove the PCM.

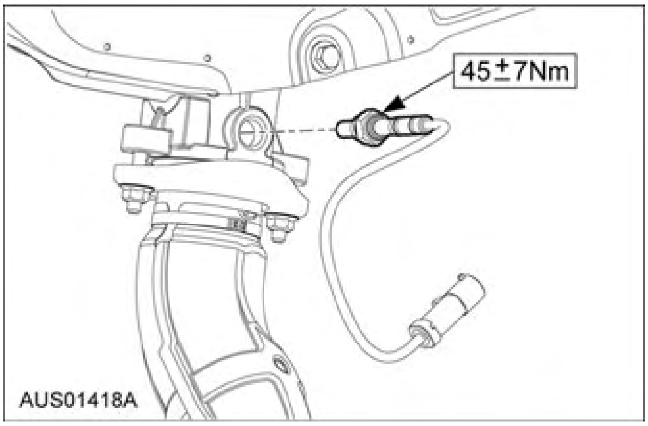
Installation

1. Secure the wiring harness to the correct PCM connector pockets. They are keyed so that they only fit one way and both the A and B pocket connectors are different.
2. For new PCMs, perform the Module Configuration operation in the "Module Programming" section.
3. For new PCMs, perform the Parameter Reset operation as detailed in this section to re-train the Smartshield security system.
4. For new PCMs, retrain the audio system to the new PCM ID code. This procedure can be carried out by using the IDS tester.
5. Temporarily secure the PCM to the bracket with new security bolts. DO NOT BREAK THE HEADS OFF YET.
6. Clear the PCM fault codes
7. Remove the IDS and test-drive the vehicle.
8. Reconnect the IDS tester and run a KOEO and KOER test on the PCM. Rectify faults if required.
9. Torque the security bolts on the PCM until the heads break off.

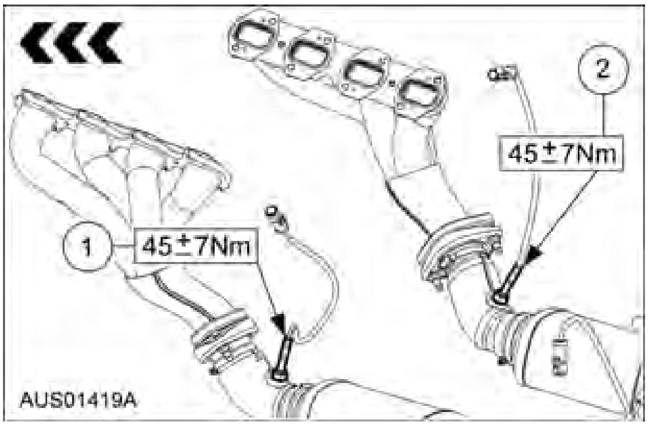
HEGO 11 (I6 Engines)

Removal

1. Disconnect the electrical connector.



V8 Engine



Item	Description
1	HEGO Sensor (LHS only)
2	HEGO Sensor (LHS & RHS)

2. Using a 22mm ring spanner, remove the sensor

Installation

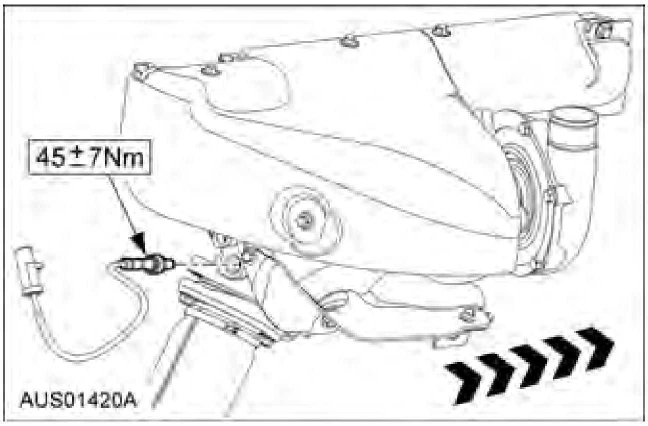
1. Make sure the thread is cleaned and that a suitable anti-seize compound is applied to the thread before installing the sensor.
2. Refit the sensor and ensure it is tightened to the correct torque (45Nm +/- 7Nm)
3. Ensure the sensor fly lead is secured correctly to avoid any moving parts, sharp edges on the vehicle body or exhaust heat shields and is not in contact with any part of the exhaust system.

REMOVAL AND INSTALLATION (Continued)

HEGO Sensor 11 (Turbo)

Removal

1. Disconnect the electrical connector



2. Using a 22mm ring spanner, remove the sensor

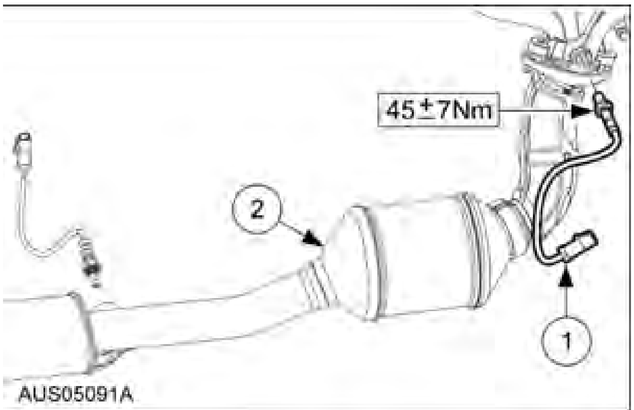
Installation

1. Make sure the thread is cleaned and that a suitable anti-seize compound is applied to the thread before installing the sensor.
2. Refit the sensor and ensure it is tightened to the correct torque (45Nm +/- 7Nm)
3. Ensure the sensor fly lead is secured correctly to avoid any moving parts, sharp edges on the vehicle body or exhaust heat shields and is not in contact with any part of the exhaust system.

HEGO Sensor 12 (I6 Engine)

Removal

1. Disconnect the electrical connector.



2. Using a 22mm ring spanner, remove the sensor

Installation

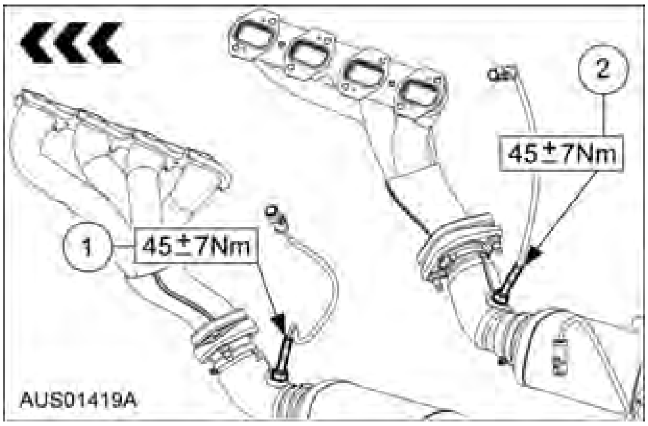
1. Make sure the thread is cleaned and that a suitable anti-seize compound is applied to the thread before installing the sensor.
2. Refit the sensor and ensure it is tightened to the correct torque (45Nm +/- 7Nm)
3. Ensure the sensor fly lead is secured correctly to avoid any moving parts, sharp edges on the vehicle body or exhaust heat shields and is not in contact with any part of the exhaust system.

HEGO 11 & 21 (V8 Engines)

Removal

1. Disconnect the electrical connector.

V8 Engine



Item	Description
1	HEGO Sensor (LHS only)
2	HEGO Sensor (LHS & RHS)

2. Using a 22mm ring spanner, remove the sensor

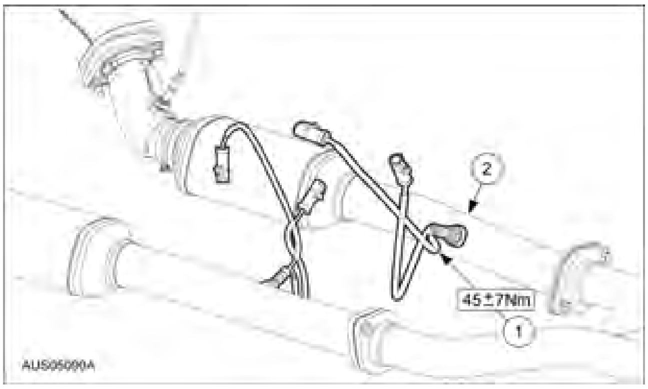
Installation

1. Make sure the thread is cleaned and that a suitable anti-seize compound is applied to the thread before installing the sensor.
2. Refit the sensor and ensure it is tightened to the correct torque (45Nm +/- 7Nm)
3. Ensure the sensor fly lead is secured correctly to avoid any moving parts, sharp edges on the vehicle body or exhaust heat shields and is not in contact with any part of the exhaust system.

HEGO 11 & 21 (V8 Engines)

Removal

1. Disconnect the electrical connector.



REMOVAL AND INSTALLATION (Continued)

2. Using a 22mm ring spanner, remove the sensor

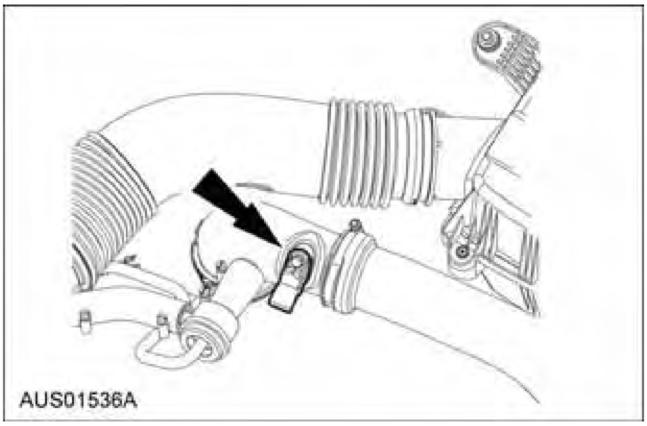
Installation

1. Make sure the thread is cleaned and that a suitable anti-seize compound is applied to the thread before installing the sensor.
2. Refit the sensor and ensure it is tightened to the correct torque (45Nm +/- 7Nm)
3. Ensure the sensor fly lead is secured correctly to avoid any moving parts, sharp edges on the vehicle body or exhaust heat shields and is not in contact with any part of the exhaust system.

Boost Pressure Sensor (Turbo Engine)

Removal

1. Disconnect the wire harness from the BPS connector.
2. Unscrew the retaining bolt.
3. Gently pull the sensor out vertically from the aluminum duct.



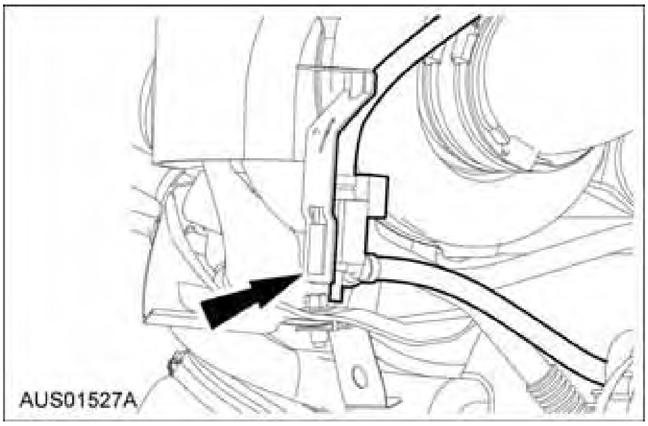
Installation

1. Push the BPS into the aluminum duct.
2. Refit the retaining bolt and tighten.
3. Reconnect the harness to the BPS.

Turbocharger Wastegate Control Solenoid

Removal

1. Remove the Wastegate Control Solenoid.
    1. Disconnect the electrical connector.
    2. Slide solenoid up and away from its retaining bracket.



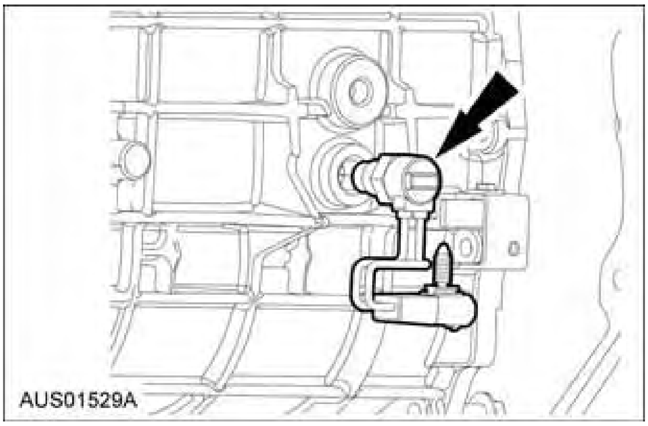
Installation

1. To Install, reverse the removal procedure.

Reverse Gear Switch

Removal

1. Remove the Reverse Gear Switch
    1. Disconnect the electrical connector
    2. Remove the retaining bolt
    3. Remove the sensor



Installation

1. To Install, reverse the removal procedure.

Temperature and Manifold Absolute Pressure (T-MAP) Sensor

Removal

1. Remove the Electronic Throttle Body and then disconnect the engine wiring harness from the T-MAP connector.
2. Remove the two screws securing the T-MAP sensor to the inlet manifold.
3. Carefully withdraw the sensor from the manifold.
4. Plug the aperture in the inlet manifold to prevent the ingress of foreign material.

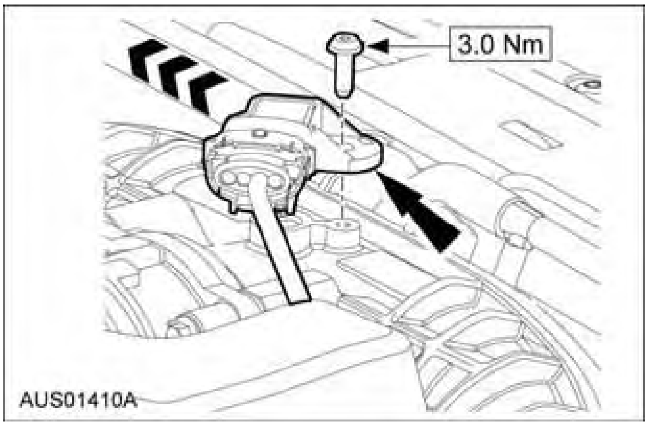
Installation

1. Install new o-rings on the T-MAP sensor, if necessary.

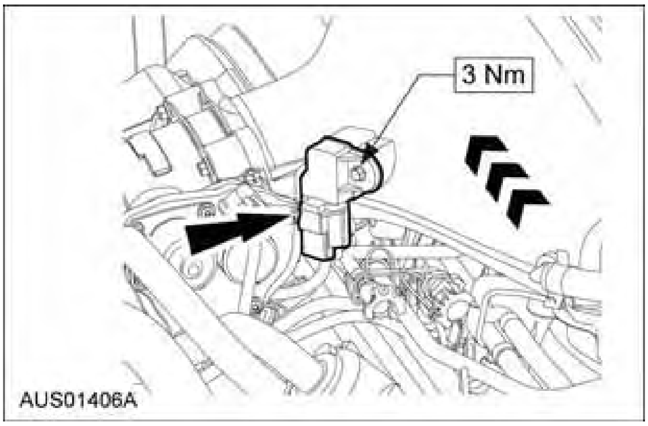
REMOVAL AND INSTALLATION (Continued)

2. Install the T-MAP sensor into the inlet manifold with the connector at the bottom.
3. Align the holes and install the T-MAP sensor retaining screws. Tighten the screws to 3Nm.
4. Reconnect the harness to the T-MAP sensor.
5. Run the engine and check for vacuum leaks around the sensor. Rectify any leaks found.

I6 Engine



V8 Engine



Fuel Rail (I6 Engine)

Removal

1. Ensure the area of the fuel rail and intake manifold injectors are clean of all dirt, grit etc. Prior to the removal of injectors.
2. Relieve fuel system residual pressure.
3. Remove intake air duct.
4. Disconnect the wiring harness from the fuel injectors at the connector.
5. Tag and disconnect fuel supply and return lines at the quick-connect fittings.
6. Disconnect vacuum hose from pressure regulator.
7. Disconnect the wiring loom from the fuel rail.
8. Remove the screws attaching the fuel rail brackets to the intake manifold.
9. Remove the fuel injector to fuel rail retaining clips and withdraw each injector. Place each injector in a clean plastic bag to prevent the injectors from being contaminated with foreign material. Number each bag according to injector position. Plug the apertures in the intake manifold to prevent the ingress of foreign material.

Installation

1. Ensure the fuel rail injector mounting apertures are clean, smear the fuel injector sealing rings with a light coating of engine oil. DO NOT use petroleum jelly. Insert the injectors into the fuel rail and install retaining clips.
2. Ensure the intake manifold injector apertures and the fuel injector tips are clean, smear the injector sealing rings with a light coating of engine oil. DO NOT use petroleum jelly. Insert the injectors into the manifold and position the fuel rail, install the retaining screws and torque screws to 19Nm.
3. Attach the injector wiring loom at the fuel rail and connect the injector clamp.
4. Reconnect the fuel supply and return lines as tagged.
5. Start and run engine. Check for any leaks. Rectify any faults found.

Fuel Rail (V8 Engine)

Removal

1. Ensure the area of the fuel rail and intake manifold injectors are clean of all dirt, grit etc. Prior to the removal of injectors.
2. Relieve fuel system residual pressure.
3. Remove intake air duct from the air cleaner and throttle body.
4. Disconnect wiring connectors from the Throttle Position Sensor (TP) <TPS> and Idle Air Control Valve (IAC) <ISC>sensors.
5. Disconnect vacuum hoses and lines from the PCV system and fuel pressure regulator.
6. Disconnect the throttle cable from the throttle linkage.
7. Remove the upper intake manifold.
8. Tag and is connect the fuel supply and return lines using quick-connect fittings.
9. Disconnect the fuel injector wiring connectors.
10. Remove the screws securing the fuel rail.
11. Remove the fuel rail and injectors as an assembly.
12. Remove the fuel injector from the fuel rail. Place each injector in a clean plastic bag to prevent the injectors from being contaminated with foreign material. Number each bag according to injector position. Plug the apertures in the intake manifold to prevent the ingress of foreign material.

REMOVAL AND INSTALLATION (Continued)

Installation

1. Ensure the fuel rail injector mounting apertures are clean, smear the fuel injector sealing rings with a light coating of engine oil. DO NOT use petroleum jelly. Insert the injectors into the fuel rail.
2. Ensure the intake manifold injector apertures and the fuel injector tips are clean, smear the injector sealing rings with a light coating of engine oil. DO NOT use petroleum jelly. Insert the injectors into the manifold and position the fuel rail, press down on the fuel rail and install the retaining screws. Torque screws to 12Nm.
3. Connect the fuel supply and return lines.
4. Install the upper intake manifold as described in Group 8-3, Eight Cylinder Engine.
5. Connect PCV hoses and all vacuum lines.
6. Connect throttle cable to the throttle linkage.
7. Connect wiring connectors to the TP and ISC sensors.
8. Install intake air duct to the air cleaner and throttle body.
9. Start and run engine. Check for any leaks. Rectify any faults found.

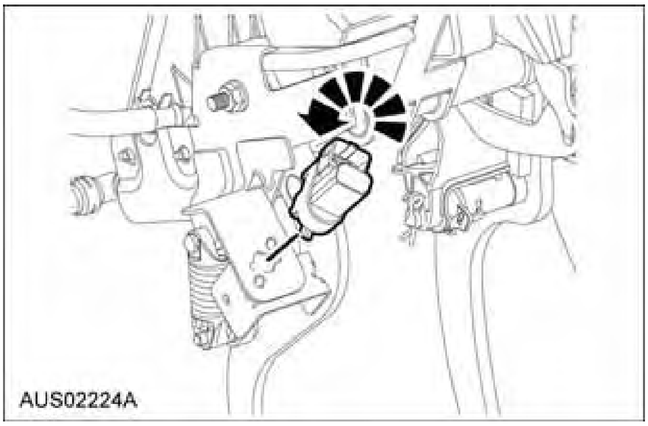
Brake Switches

Refer to Section 206-06 for more information.

Clutch Engagement Switch (Manual Transmission)

Removal

1. Gently twist the switch 45 degrees anti clockwise.
2. Withdraw the switch from the bracket.



3. Unplug the wire harness connector from the switch.

Installation

1. Plug the wire harness connector to the switch.
2. Insert the switch into to the bracket.
3. While pushing the switch home into the bracket, gently twist the switch 45 degrees clockwise to lock the switch into the bracket.

REMOVAL AND INSTALLATION (Continued)

Steering Wheel Audio and Cruise Control Controls

Pedal Position Sensor

Removal

Refer to Adjustable pedal section.

Installation

Refer to Adjustable pedal section.

Air Conditioning Relay

Refer to Sections 412-03 & 412-04.

Air Conditioner Pressure Transducer

Refer to Section 412-03.

Transmission Fluid Temperature Sensor

Refer to Section 307-01.

Fuel Pump

Refer to Section 310-00.

Transmission Range Sensor (TRSA1) (4-speed Automatic Transmission)

Refer to Section 307-01a.

Transmission Range Sensor (TRSA2) (4-speed Automatic Transmission)

Refer to Section 307-01a.

Transmission Range Sensor (TRSA1) (5-speed Automatic Transmission)

Refer to Section 307-01c.

Transmission Range Sensor (TRSA2) (5-speed Automatic Transmission)

Refer to Section 307-01c.

REMOVAL AND INSTALLATION (Continued)

Intake Manifold Charge Control

Refer to Section 307-01.

Phaser removal

Refer to Section 303-01a for more information.

OCV removal

Refer to Section 303-01a for more information.

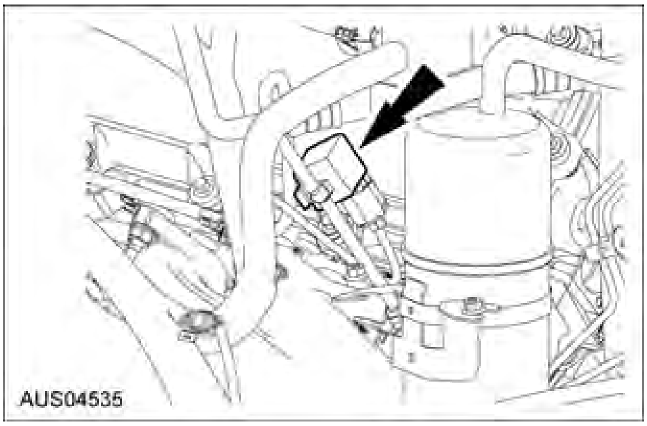
CID sensor removal

Refer to Section 303-01a for more information.

VCT oil filter removal

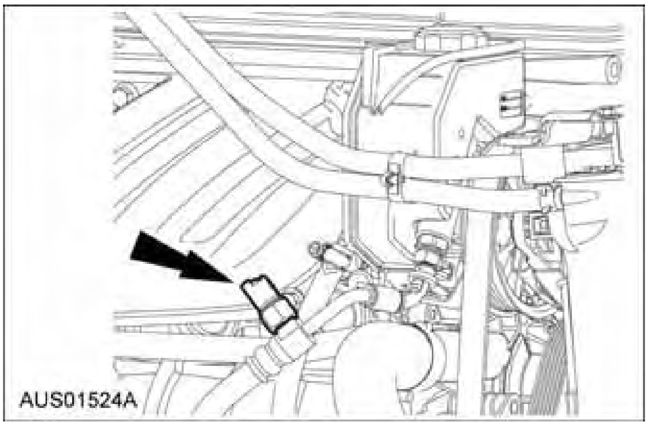
Refer to Section 303-01a for more information.

EVAP Canister Purge Solenoid



Power Steering Pressure Switch

PSP Switch Location, I6



PSP Switch Location, V8