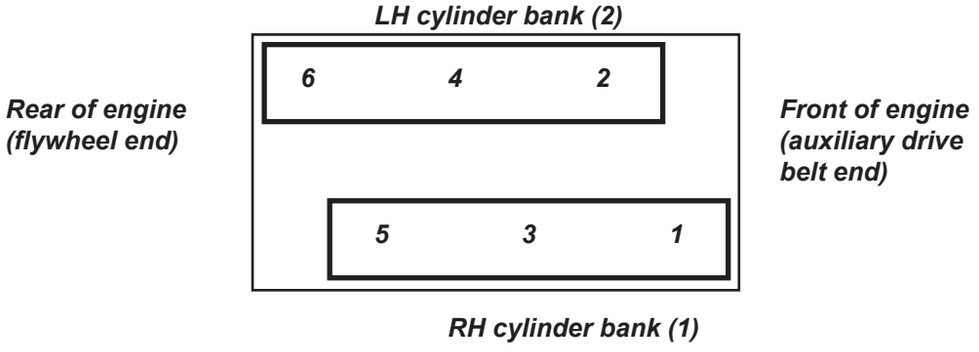
ENGINE MANAGEMENT

SECTION EMR

NOTES

Cylinder Numbering - viewed from above:



Firing order: 1 2 3 4 5 6

EMR.1 - DIAGNOSTIC TROUBLE CODE (DTC) LIST

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P0151	O2 Sensor Circuit Low Voltage (Pre Catalyst) – Bank2	25
P0152	O2 Sensor Circuit High Voltage (Pre Catalyst) – Bank2	25
P0153	O2 Sensor Circuit Slow Response (Pre Catalyst) – Bank2	25
P0154	O2 Sensor Circuit No Activity Detected (Pre Catalyst) – Bank2	25
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DTC	Fault description	Page
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P0448	Evaporative Emission System Vent Control Circuit Shorted	46
P0451	Evaporative Emission System Pressure Sensor/Switch Range/Performance	46
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DTC	Fault description	Page
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P2603	Coolant Pump Control Circuit High	69
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U0316	Software Incompatible with VDCM	80

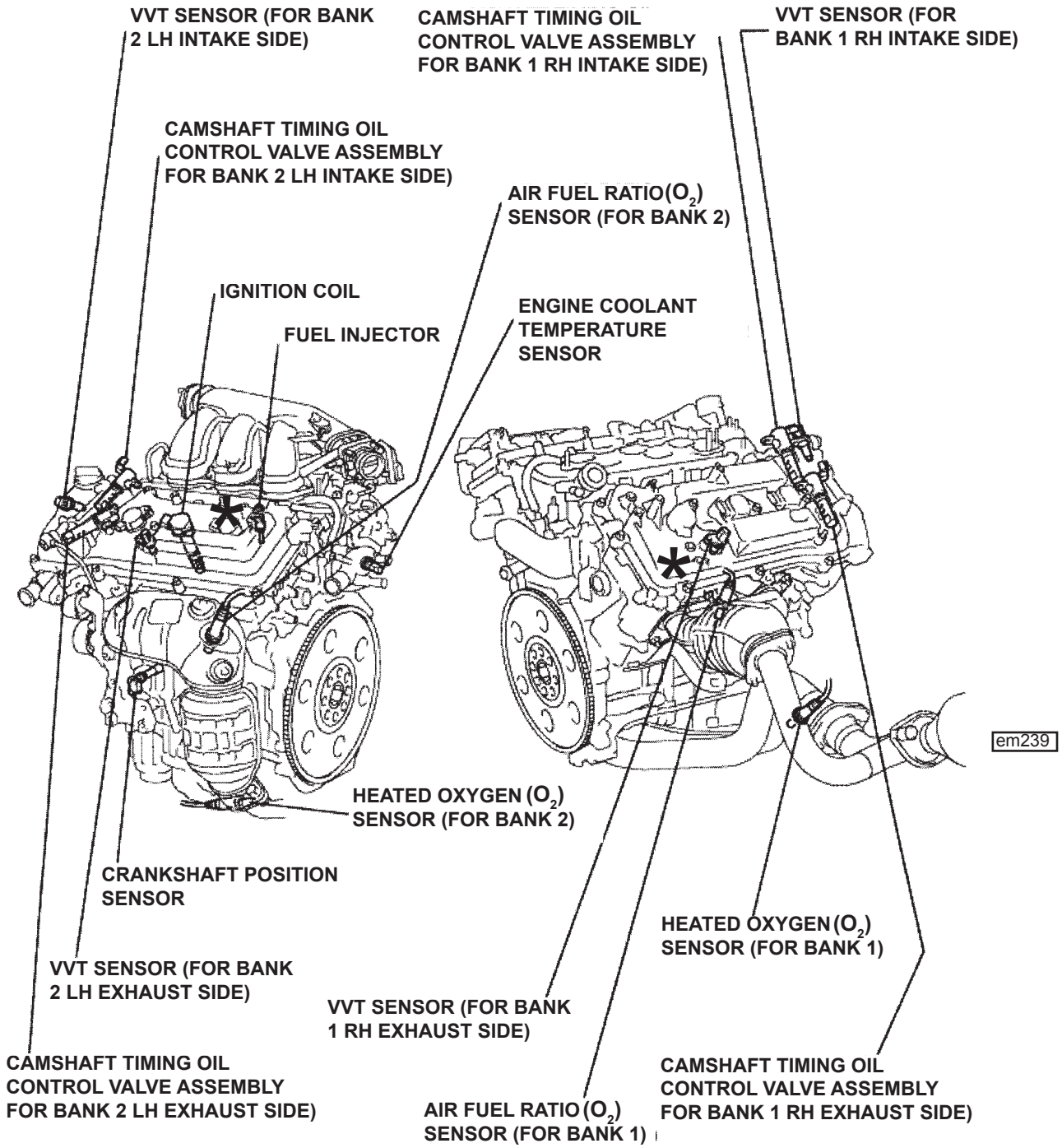
When applicable, reference may be made under the 'Notes' heading to a page in the Toyota service manual. This information should be used only for diagnosis and connection detail of the **sensor**. The Evora uses a Lotus ECU, the connections for which may be found in circuit diagrams in Section MR. Diagnostic Trouble Codes should be read using the Lotus TechCentre.

EMR.2 - COMPONENT FUNCTION

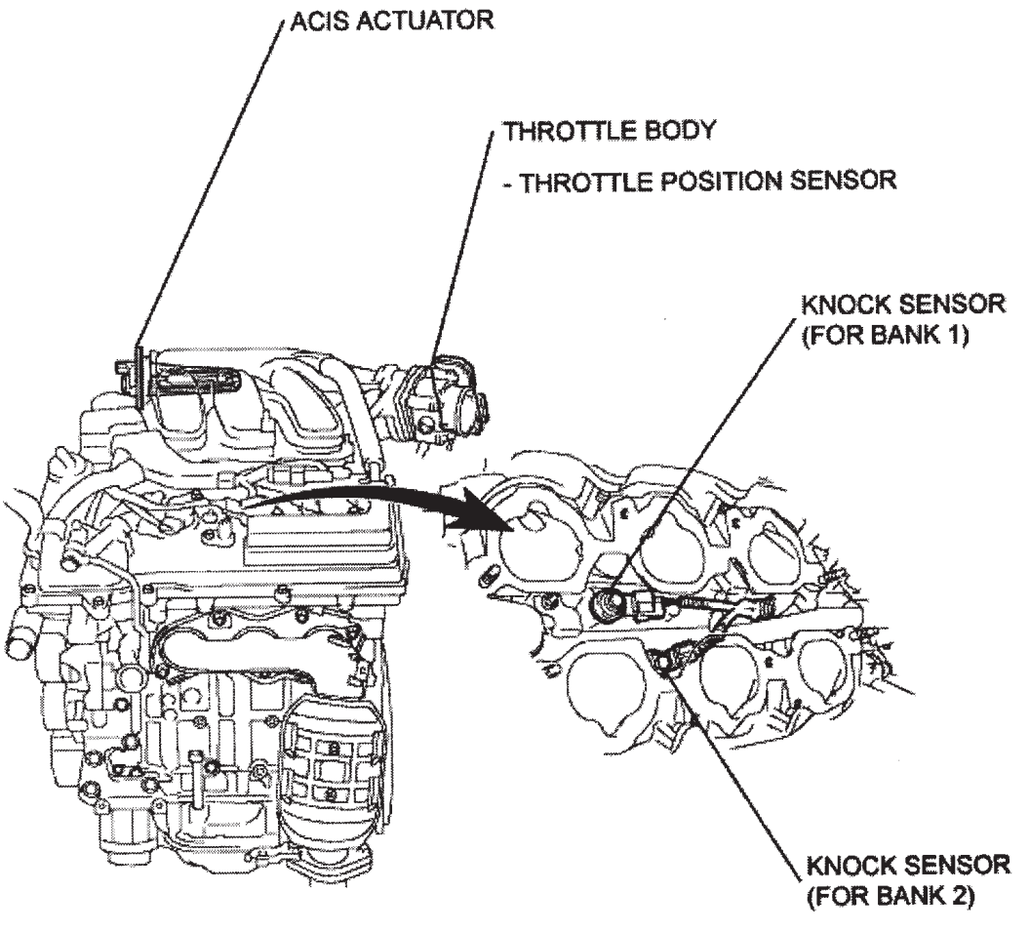
Component	Function
Mass Air Flow Meter	Engine load detection
Intake Air Temperature Sensor	Air temperature detection
Engine Coolant Temperature Sensor	Engine coolant temperature detection
Throttle Position Sensor	Determines engine throttle position
Pedal Position Sensor	Determines pedal position requested by driver
Barometric Pressure Sensor	Barometric pressure detection
O2 Sensor (Front) – Bank 1	Measures oxygen content in exhaust before bank 1 primary catalyst
O2 Sensor (Front) – Bank 2	Measures oxygen content in exhaust before bank 1 primary catalyst
O2 Sensor (Rear) – Bank 1	Measures oxygen content in exhaust after bank 1 primary catalyst
O2 Sensor (Rear) – Bank 2	Measures oxygen content in exhaust after bank 2 primary catalyst
Crankshaft Position Sensor	Determines crankshaft position
Camshaft Position Sensor (Inlet) – Bank 1	Determines bank1 inlet camshaft position
Camshaft Position Sensor (Inlet) – Bank 2	Determines bank 2 inlet camshaft position
Camshaft Position Sensor (Exhaust) – Bank 1	Determines bank 1 exhaust camshaft position
Camshaft Position Sensor (Exhaust) – Bank 2	Determines bank 2 exhaust camshaft position
Knock Sensor – Bank1	Determines bank 1 engine detonation
Knock Sensor – Bank2	Determines bank 2 engine detonation
Fuel Level Sensor	Determines fuel tank level
Air Conditioning Evaporator Temperature Sensor	Evaporator temperature detection
Clutch Pedal Position Sensor	Determines clutch pedal position
Brake Pedal Position Switch	Determines brake pedal position
Cruise Control Multi-function Input	Determines driver request for cruise control
Electronic Throttle Control Motor	Actuates engine throttle
Injector Circuit – Cylinder 1	Regulates fuel injected into cylinder 1
Injector Circuit – Cylinder 2	Regulates fuel injected into cylinder 2
Injector Circuit – Cylinder 3	Regulates fuel injected into cylinder 3
Injector Circuit – Cylinder 4	Regulates fuel injected into cylinder 4
Injector Circuit – Cylinder 5	Regulates fuel injected into cylinder 5
Injector Circuit – Cylinder 6	Regulates fuel injected into cylinder 6
Ignition Circuit – Cylinder 1	Actuates spark plug in cylinder 1
Ignition Circuit – Cylinder 2	Actuates spark plug in cylinder 2
Ignition Circuit – Cylinder 3	Actuates spark plug in cylinder 3
Ignition Circuit – Cylinder 4	Actuates spark plug in cylinder 4
Ignition Circuit – Cylinder 5	Actuates spark plug in cylinder 5
Ignition Circuit – Cylinder 6	Actuates spark plug in cylinder 6
Variable Valve Timing Actuator (Inlet) – Bank 1	Actuates bank 1 inlet camshaft timing control
Variable Valve Timing Actuator (Inlet) – Bank 2	Actuates bank 2 inlet camshaft timing control
Variable Valve Timing Actuator (Exhaust) – Bank 1	Actuates bank 1 exhaust camshaft timing control
Variable Valve Timing Actuator (Exhaust) – Bank 2	Actuates bank 2 exhaust camshaft timing control
Variable Intake Manifold Actuator	Actuates variable intake manifold
Primary Catalyst – Bank 1	Removes pollutants from exhaust
Primary Catalyst – Bank 2	Removes pollutants from exhaust
Secondary Catalyst	Removes pollutants from exhaust
Evaporative Emission Control System Purge Control Valve	Regulates fuel tank vapour flow into inlet manifold
Fuel Pump Relay	Actuates fuel pump
Starter Relay	Actuates engine starter motor

Component	Function
Cooling Fan 1 Relay	Actuates cooling fan 1
Cooling Fan 2 Relay	Actuates cooling fan 2
Air Conditioning Control Relay	Actuates air conditioning compressor
Air Conditioning Control Valve	Regulates air conditioning compressor load
Coolant Recirculation Pump	Actuates coolant recirculation pump
Noise Flap Solenoid	Actuates air intake flap vacuum control
ABS	Provides vehicle wheel speed information
Battery	Provides electrical power

EMR.3 - COMPONENT LOCATION



* Ignition coil noise suppression capacitor


ACIS ACTUATOR
THROTTLE BODY
- THROTTLE POSITION SENSOR
KNOCK SENSOR
(FOR BANK 1)
KNOCK SENSOR
(FOR BANK 2)

em240

EMR.4 - DIAGNOSTIC GUIDE

Camshaft Timing Control (VVT)

P0011 Camshaft Position – Inlet Timing Over-Advanced or System Performance (Bank 1)
P0012 Camshaft Position – Inlet Timing Over-Retarded (Bank 1)
P0014 Camshaft Position – Exhaust Timing Over-Advanced or System Performance (Bank 1)
P0015 Camshaft Position – Exhaust Timing Over Retarded (Bank 1)
P0021 Camshaft Position – Inlet Timing Over-Advanced or System Performance (Bank 2)
P0022 Camshaft Position – Inlet Timing Over-Retarded (Bank 2)
P0024 Camshaft Position – Exhaust Timing Over-Advanced or System Performance (Bank 2)
P0025 Camshaft Position – Exhaust Timing Over-Retarded (Bank 2)

Description
The Variable Valve Timing system (VVT) on the intake camshafts and the exhaust camshafts can vary the timing by approximately 35°. The camshaft relative position is varied by a system of vanes mounted on the drive end of the camshaft. Each VVT oil control valve modulates a spool valve position in accordance with the drive signal duty cycle, this in turns controls the oil pressure applied to the vanes. A 50% duty cycle applied to the valve will hold the valve current timing by preventing oil flow from the VVT controller housing, a duty cycle less than 50% will retard the valve timing, a duty cycle greater then 50% will advance the valve timing. The ECM regulates this duty cycle based on the feedback signal from the respective camshaft position sensor to optimise the camshaft timing.

Component connections

Sensor Connector	*Description*	*ECU Pin*	*ECU Connector*
1	Battery Voltage	-	-
2	VVT Control Valve Inlet (Bank 1)	B2	48 Way (Centre)
1	Battery Voltage	-	-
2	VVT Control Valve Exhaust (Bank 1)	A2	48 Way (Centre)
1	Battery Voltage	-	
2	VVT Control Valve Inlet (Bank 2)	A3	48 Way (Centre)
1	Battery Voltage	-	
2	VVT Control Valve Exhaust (Bank 2)	A4	48 Way (Centre)

Monitor:
- Continuous

Enable Criteria:
- Engine running > 30 secs
- Coolant temperature > 60°C (140°F)

Disable Criteria:
- P0116, P0117, P0118 – Coolant temperature fault codes

Malfunction Criteria:
- VVT error > 5 degrees for time > 2.5 secs

Potential failure modes:
- Static valve timing is incorrect
- VVT camshaft actuator failure
- VVT control valve stuck open / closed
- VVT control valve filter

Diagnostic Mask:
- The MIL will be illuminated if the faults are present for 2 consecutive trips

Crankshaft Position–Camshaft Position Correlation Error

P0016 Crankshaft position – camshaft position correlation – bank 1 sensor A (Inlet)
P0017 Crankshaft position – camshaft position correlation – bank 1 sensor B (Exhaust)
P0018 Crankshaft position – camshaft position correlation – bank 2 sensor A (Inlet)
P0019 Crankshaft position – camshaft position correlation – bank 2 sensor B (Exhaust)

Description
The crankshaft position sensor is used to identify engine position and speed via a pole wheel mounted on the front end of the crankshaft. The camshaft position sensor is used to determine camshaft position from a three vane reluctor on the rear end of the inlet and exhaust camshaft. Fault codes P0016, P0017, P0018, P0019 indicate a mechanical timing error such as incorrectly set, or 'jumped' cam timing.

Monitor:
- Continuous

Enable Criteria:
- Engine running (from cranking up to 4 seconds)

Disable Criteria:
- None

Malfunction Criteria:
- Camshaft out of phase with crankshaft > 16 degrees

Potential failure modes:
- Static valve timing is incorrect
- VVT camshaft actuator failure
- VVT control valve stuck open / closed
- VVT control valve filter

Diagnostic Mask:
- The MIL will be illuminated if the faults are present for 2 consecutive trips

Camshaft Timing Control (VVT)

P0076 Intake Valve Control Solenoid Circuit Low (Bank1)
P0077 Intake Valve Control Solenoid Circuit High (Bank1)
P0079 Exhaust Valve Control Solenoid Circuit Low (Bank1)
P0080 Exhaust Valve Control Solenoid Circuit High (Bank1)
P0082 Intake Valve Control Solenoid Circuit Low (Bank2)
P0083 Intake Valve Control Solenoid Circuit High (Bank2)
P0085 Exhaust Valve Control Solenoid Circuit Low (Bank2)
P0086 Exhaust Valve Control Solenoid Circuit High (Bank2)

Monitor:
- Continuous

Enable Criteria:
- Engine running

Disable Criteria:
- None

Potential failure modes:
- P0076, P0079, P0082, P0085 - VVT control valve open circuit or short to ground
- P0077, P0080, P0083, P0086 - VVT control valve circuit short to battery voltage
- ECU output circuit failure
- VVT control valve

Diagnostic Mask:
- The MIL will be illuminated if the faults are present for 2 consecutive trips

Intake Air Flow

P0101 Mass or Volume Air Flow Circuit Range/Performance
P0102 Mass or Volume Air Flow Circuit Low Input
P0103 Mass or Volume Air Flow Circuit High Input

Description
The Mass Air Flow (MAF) sensor is incorporated into the airbox, and measures both intake air flow rate and Intake Air Temperature (IAT). The MAF sensor uses a hot wire exposed to the airflow, which is maintained at a constant temperature by a constant current flow. This is achieved within the sensor unit by varying the voltage applied to the hot wire. This voltage is the output signal from the MAF sensor.

Sensor connections

Sensor Connector	Description	ECU Pin	ECU Connector
1	IAT Signal	J3	48 Way (Centre)
2	IAT Ground	E3	48 Way (Centre)
3	Battery Voltage	-	-
4	MAF Ground	J4	48 Way (Centre)
5	MAF Signal	G1	48 Way (Centre)

Sensor characteristics
0 – 330 g/sec
Typical values: 1.5 – 5.0 g/sec (idle), 5.0 – 15.0 g/sec (2500rpm elevated idle no load)

P0101
Monitor:
- Continuous.

Enable Criteria:
- Engine running
- Engine speed >1500rpm
- Engine speed < 3510rpm
- Fuel Learns enabled

Disable Criteria:
- P0122, P0123, P0222, P0223 – Throttle/Pedal position fault codes

Malfunction Criteria:
- Measured MAF is compared to a predicted MAF based on current engine conditions.
- Error > 40% for time > 1.5 secs

Potential failure modes:
- MAF meter
- Air induction system
- Air intake hose connections

Diagnostic Mask:
- The MIL will be illuminated if the faults are present for 2 consecutive trips

P0102
Monitor:
- Continuous.

Enable Criteria:
- Engine running

Disable Criteria:
- None

Malfunction Criteria:
- Voltage at ECU < 0.52V for time > 1.5 secs

Potential failure modes:
- MAF sensor circuit open
- MAF sensor circuit short to ground

Diagnostic Mask:
- The MIL will be illuminated if the faults are present for 2 consecutive trips

P0103
Monitor:
- Continuous.

Enable Criteria:
- Engine running

Disable Criteria:
- None

Malfunction Criteria:
- Voltage at ECU > 4.86V for time > 1.5 secs

Potential failure modes:
- MAF sensor circuit short to ECU supply voltage

Diagnostic Mask:
- The MIL will be illuminated if the faults are present for 2 consecutive trips

Barometric Pressure

P0106 Manifold Absolute Pressure/Barometric Pressure Circuit Range/Performance
P0107 Manifold Absolute Pressure/Barometric Pressure Circuit Low Input
P0108 Manifold Absolute Pressure/Barometric Pressure Circuit High Input

Description
The barometric pressure sensor is located internally within the ECU, and measures atmospheric pressure. This parameter is required to compensate the mass air flow when the vehicle is operated at higher altitudes.

P0106
Monitor:
- Continuous

Enable Criteria:
- Engine running
- Engine speed 2010 – 5490rpm
- TPS > 80%

Disable Criteria:
- P0101, P0102, P0103 – MAF Sensor fault codes
- P0121, P0122, P0123, P0222, P0223, P2135 – Throttle/Pedal position fault codes

Malfunction Criteria:
- Measured Baro is compared to a predicted Baro based on current engine conditions.
- Error > 150kPa for time > 4.5 seconds.

Potential failure modes:
- Sensor failure

Diagnostic Mask:
- The MIL will be illuminated if the faults are present for 2 consecutive trips

P0107, P0108
Monitor:
- Continuous

Enable Criteria:
- Engine running

Disable Criteria:
- None

Malfunction Criteria:
- P0107: Voltage at ECU < 1.08V for time > 1.5 secs
- P0108: Voltage at ECU > 4.98V for time > 1.5 secs

Potential failure modes:
- Sensor failure

Diagnostic Mask:
- The MIL will be illuminated if the faults are present for 2 consecutive trips

Intake Air Temperature

P0111 Intake Air Temperature Sensor 1 Circuit Range/Performance
P0112 Intake Air Temperature Sensor 1 Circuit Low
P0113 Intake Air Temperature Sensor 1 Circuit High

Description
The combined sensor which measures both Mass Air Flow (MAF) and Intake Air Temperature (IAT) is incorporated into the air box. The IAT sensor is a thermistor device which changes resistance with temperature. As air intake temperature decreases the thermistor resistance value increases, and conversely as air temperature increases so the thermistor resistance value decreases.

Sensor connections

Sensor Connector	Description	ECU Pin	ECU Connector
1	IAT Signal	J3	48 Way (Centre)
2	IAT Ground	E3	48 Way (Centre)
3	Battery Voltage	-	-
4	MAF Ground	J4	48 Way (Centre)
5	MAF Signal	G1	48 Way (Centre)

Sensor characteristics
IAT -20°C (-4°F) 13.6 – 18.4 kΩ
IAT 20°C (68°F) 2.21 – 2.69 kΩ
IAT 60°C (140°F) 0.50 – 0.67 kΩ

P0111
Monitor:
- Continuous

Disable Criteria:
- P0116, P0117, P0118 – Coolant temperature fault codes

Enable Criteria 1:
- Engine running < 30 secs
- Coolant temperature < 30°C (86°F)

Malfunction Criteria 1:
- Inlet air temperature > 38°C (100°F) for time > 1.5 secs

Enable Criteria 2:
- Engine running

Malfunction Criteria 2:
- Inlet air temperature erratic by more than 40°C (72°F) for time > 1.5 secs

Enable Criteria 3:
- Accumulated mass air flow > 10000g > 60secs
- Mass air flow >15g/s for 20secs
- Mass airflow change from 15g/s to 6g/s <20secs.
- Mass airflow <6g/s for 20secs

Malfunction Criteria 3:
- Failure to change temperature by 1.2˚C after the enable criteria tests have been completed.

Potential failure modes:
- P0112 – signal short circuit
- P0113 – signal open circuit
- Sensor failure

Diagnostic Mask:
- The MIL will be illuminated if the faults are present for 2 consecutive trips

P0112
Monitor:
- Continuous

Disable Criteria:
- None

Enable Criteria:
- Engine running

Malfunction Criteria:
- Inlet air temperature > 119°C (246°F) for time > 1.5 secs

Potential failure modes:
- Signal short circuit
- Sensor failure

Diagnostic Mask:
- The MIL will be illuminated if these faults are present for 2 consecutive trips.

P0113
Monitor:
- Continuous

Disable Criteria:
- None

Enable Criteria:
- Engine running

Malfunction Criteria:
- Inlet air temperature < –40°C (–104°F) for time > 1.5 secs

Potential failure modes:
- Signal open circuit
- Sensor failure

Diagnostic Mask:
- The MIL will be illuminated if these faults are present for 2 consecutive trips.

Engine Coolant Temperature

P0116 Engine Coolant Temperature Circuit Range/Performance
P0117 Engine Coolant Temperature Circuit Low
P0118 Engine Coolant Temperature Circuit High

Description
The engine coolant temperature sensor is a thermistor device which changes resistance with temperature. As coolant temperature decreases the thermistor resistance value increases, and conversely as coolant temperature increases so the thermistor resistance value decreases.

Sensor connections

Sensor Connector	Description	ECU Pin	ECU Connector
1	Ground	C3	48 Way (Centre)
2	Signal	G2	48 Way (Centre)

Sensor characteristics

-20°C (-4°F)	= 13.84 – 16.33 KΩ
20°C (68°F)	= 2.31 – 2.58 KΩ
80°C (176°F)	= 0.310 – 0.326 KΩ
110°C (230°F)	= 0.1399 – 0.1435 KΩ

P0116
Monitor:
- Continuous

Disable Criteria:
- None

Enable Criteria 1:
- Engine running > 1000 seconds

Malfunction Criteria 1:
- Engine coolant temperature < 40°C (104°F)

Enable Criteria 2:
- Engine running

Malfunction Criteria 2:
- Engine coolant temperature erratic by more than 30°C (54°F)

Potential failure modes:
- Sensor wiring
- Sensor failure
- Thermostat failure

Diagnostic Mask:
- The MIL will be illuminated if these faults are present for 2 consecutive trips.

P0117
Monitor:
- Continuous

Disable Criteria:
- None

Enable Criteria:
- Engine running

Malfunction Criteria:
- Coolant temperature > 119°C (246°F) for time > 1.5 secs

Potential failure modes:
- Signal short circuit
- Sensor failure
- Thermostat failure
- Cooling system problem

Diagnostic Mask:
- The MIL will be illuminated if these faults are present for 2 consecutive trips.

P0118
Monitor:
- Continuous

Disable Criteria:
- None

Enable Criteria:
- Engine running

Malfunction Criteria:
- Coolant temperature > -38°C (-36°F) for time > 1.5 secs

Potential failure modes:
- Signal open circuit
- Sensor failure

Diagnostic Mask:
- The MIL will be illuminated if these faults are present for 2 consecutive trips.

Throttle Position

P0122 Throttle Position Sensor 'A' Circuit Low
P0123 Throttle Position Sensor 'A' Circuit High
P0222 Throttle Position Sensor ‘B’ Circuit Low
P0223 Throttle Position Sensor ‘B’ Circuit High

Description
The throttle position sensor (TPS) is mounted on the throttle body, and detects the opening angle of the throttle valve. The TPS has 2 sensor circuits, each of which transmits a signal, VTA1 and VTA2. VTA1 is used to detect the throttle valve angle and VTA2 is used to detect malfunctions in VTA1. The sensor signal voltages vary between 0 V and 5 V in proportion to the throttle valve opening angle, and are transmitted to the VTA terminals of the ECU.

Sensor connections

Sensor Connector	Description	ECU Pin	ECU Connector
1	ETB -ve	M1	48 Way (Centre)
2	ETB +ve	L2	48 Way (Centre)
3	Ground	C4	48 Way (Centre)
4	TPS 1B Signal	F3	48 Way (Centre)
5	TPS 1A/B V Ref	E4	48 Way (Centre)
6	TPS 1A Signal	F2	48 Way (Centre)

Sensor characteristics
0% = 0.595 V ± 5%
100% = 4.148 V ± 5%

P0122
Monitor:
- Continuous.

Enable Criteria:
- None

Disable Criteria:
- None

Malfunction Criteria:
- Signal voltage < 0.635V

Potential failure modes:
- Signal short circuit
- Reference voltage open circuit
- Reference voltage short to ground
- Sensor failure

Diagnostic Mask:
- The MIL will be illuminated if fault is present.

P0123
Monitor:
- Continuous.

Enable Criteria:
- None

Disable Criteria:
- None

Malfunction Criteria:
- Signal voltage > 4.765V

Potential failure modes:
- Signal open circuit
- Reference voltage open circuit
- Reference voltage short to ground
- Sensor failure

Diagnostic Mask:
- The MIL will be illuminated if fault is present.

P0222
Monitor:
- Continuous.

Enable Criteria:
- None

Disable Criteria:
- None

Malfunction Criteria:
- Signal voltage < 2.146V

Potential failure modes:
- Signal short circuit
- Reference voltage open circuit
- Reference voltage short to ground
- Sensor failure

Diagnostic Mask:
- The MIL will be illuminated if fault is present.

Notes: A maximum throttle opening of 15% may be imposed due to this single code. In the case of multiple codes, a mechanically sprung 7% opening may be applied.

P0223
Monitor:
- Continuous.

Enable Criteria:
- None

Disable Criteria:
- None

Malfunction Criteria:
- Signal voltage > 4.985V

Potential failure modes:
- Signal open circuit
- Reference voltage open circuit
- Reference voltage short to ground
- Sensor failure

Diagnostic Mask:
- The MIL will be illuminated if fault is present.

Notes: A maximum throttle opening of 15% may be imposed due to this single code. In the case of multiple codes, a mechanically sprung 7% opening may be applied.

Coolant Thermostat (USA only)

P0128 Coolant Thermostat (Coolant Temperature Below Thermostat Regulating Temperature)

Description
The thermostat diagnostic is enabled after each cold engine start, and monitors the rate of temperature rise during warm up relative to the measured engine air flow to check thermostat functioning correctly (i.e not stuck open).

Monitor:
- Continuous

Disable Criteria:
- P0116, P0117, P0118 – Engine Coolant Temperature sensor faults

Enable Criteria:
- Engine running
- Start-up Coolant Temperature > -10°C (14°F)
- Start-up Coolant Temperature < 60°C (140°F)

Malfunction Criteria:
- Coolant Temperature does not reach 70°C (158°F) within specific total airflow, during which time the vehicle must be above 20mph for 50% of this warm up time.

Potential failure modes:
- Thermostat failure

Diagnostic Masks:
The MIL will be illuminated if the fault is present for 2 consecutive trips.

O2 Sensor (Pre Catalyst)

P0131 O2 Sensor 1 Circuit Low Voltage (Bank 1)
P0132 O2 Sensor 1 Circuit High Voltage (Bank 1)
P0133 O2 Sensor 1 Circuit Slow Response (Bank 1)
P0134 O2 Sensor 1 Circuit No Activity Detected (Bank 1)
P0135 O2 Sensor 1 Heater Circuit (Bank 1)
P0151 O2 Sensor 1 Circuit Low Voltage (Bank 2)
P0152 O2 Sensor 1 Circuit High Voltage (Bank 2)
P0153 O2 Sensor 1 Circuit Slow Response (Bank 2)
P0154 O2 Sensor 1 Circuit No Activity Detected (Bank 2)
P0155 O2 Sensor 1 Heater Circuit (Bank 2)

Description
The oxygen sensors separately monitor the oxygen content in the exhaust gases of each bank of the engine. Each sensor is electrically heated to improve response after start.
The sensor consists of a zirconia electrode between two platinum plates. When zirconia comes into contact with oxygen, it becomes an electrical conductor. The exhaust gases pass through louvers in the sensor. One plate is in contact with the outside air and the other plate is in contact with the exhaust gases. The platinum plate in contact with the air is electrically negative due to the oxygen in the atmosphere and the plate in contact with the exhaust gases is electrically positive. This will cause a difference in electrical potential to develop between the two plates. Thus the voltage across the platinum plates ranges approximately from 100 millivolts to 900 millivolts, depending on the oxygen content of the exhaust gases. Thus when the air/fuel mixture is rich, the oxygen sensor output will be high. If the air/fuel mixture is lean, the oxygen sensor output will be low.

Sensor connections

Sensor Connector	Description	ECU Pin	ECU Connector
1 Bank 1	Signal	G3	48 Way (Centre)
2 Bank 1	Ground	J2	48 Way (Centre)
3 Bank 1	Heater	H3	48 Way (Centre)
4 Bank 1	Battery Voltage	-	-
1 Bank 2	Signal	G4	48 Way (Centre)
2 Bank 2	Ground	J2	48 Way (Centre)
3 Bank 2	Heater	H4	48 Way (Centre)
4 Bank 2	Battery Voltage	-	-

Sensor characteristics
Normal operating range is 0 – 1000mV

P0131 (Bank1) or P0151 (Bank2)
Monitor:
- Continuous.

Disable Criteria:
- DFCO (Deceleration Fuel Cut Off)
- AE DE (Acceleration Enrichment Deceleration Enleanment)
- Misfire

Enable Criteria:
- Engine running

Failure Criteria:
- Sensor voltage < 15mV for more than 1.5 seconds consecutively for a specified number of times.

Potential failure modes:
- Low fuel pressure (Lean mixture)
- Malfunctioning sensor
- External water on sensor
- Sensor wire shorted to ground

Diagnostic Mask:
- The MIL will be illuminated if these faults are present for 2 consecutive trips.

P0132 (Bank1) or P0152 (Bank2)
Monitor:
- Continuous.

Disable Criteria:
- None

Enable Criteria:
- Engine running

Malfunction Criteria:
- Sensor voltage > 1200V for more than 1.5 seconds consecutively for a specified number of times.

Potential failure modes:
- High fuel pressure (Rich mixture)
- Leaking or shorted injector
- Purge valve fault
- Oxygen sensor contamination
- Engine oil contamination
- Sensor wire shorted to heater voltage

Diagnostic Mask:
- The MIL will be illuminated if these faults are present for 2 consecutive trips.

P0133 (Bank1) or P0153 (Bank2)
Monitor:
- Continuous.

Disable Criteria:
- P0116, P0117, P0118 – Coolant temperature sensor faults
- P0101, P0102, P0103 – MAF sensor faults
- P0335, P0500 – Crank or vehicle speed faults
- P0131, P0132, P0134, P0135 – Pre catalyst oxygen sensor faults for Bank1 checks
- P0151, P0152, P0154, P0155 – Pre catalyst oxygen sensor faults for Bank2 checks

Enable Criteria:
- Vehicle speed between 0 – 255 km/h (158.5 mph)
- MAF per stroke between 15 – 48 mg
- Engine speed between 1285 – 1818rpm
- Engine run time > 200 seconds
- Coolant temperature > 60°C (140°F)
- Closed loop fuelling enabled

Monitor:
- Monitored until the required amount of switches (30) in both directions has been achieved or 130 seconds has elapsed.

Malfunction Criteria:
• Set when the sensor fails to switch from a Lean to a Rich condition or switch from a Rich to a Lean condition in a sufficiently timely manner. A selection of switches is used to determine the average times.
“highlighted section removed”

Potential failure modes:
• Sensor connector and wiring should be checked for corrosion and loose connections
• Sensor contaminated, possibly from fuel, improper use of RTV, engine oil or coolant

Diagnostic Mask:
• The MIL will be illuminated if these faults are present for 2 consecutive trips.

P0134 (Bank1) or P0154 (Bank2)
Monitor:
• Until either passed or failed.

Enable Criteria:
• Engine run time > 30 seconds
• Engine is not at idle
• Engine is in closed loop fuel control
• O2 sensor ready

Malfunction Criteria:
• Set when the sensor fails to switch above 673mV and below 400mV within a 60 second period.

Potential failure modes:
• Sensor connector and wiring should be checked for corrosion and loose connections.
• Gas leak in exhaust system

Diagnostic Mask:
• The MIL will be illuminated if these faults are present for 2 consecutive trips.

P0135, P0155
Monitor:
• Continuous

Enable Criteria:
• Engine run time > 20 seconds

Malfunction Criteria:
• Set when the heater output is greater than 1900mA or less than 250mA for 1.5 seconds, for 40 consecutive checks.

Potential failure modes:
• Sensor connector and wiring should be checked for corrosion and loose connections.

Diagnostic Mask:
• The MIL will be illuminated if these faults are present for 2 consecutive trips.

O2 Sensor (Post Catalyst)

P0137 O2 Sensor Circuit Low Voltage (Bank 1)
P0138 O2 Sensor Circuit High Voltage (Bank 1)
P0139 O2 Sensor Circuit Slow Response (Bank 1)
P0140 O2 Sensor Circuit No Activity Detected (Bank 1)
P0141 O2 Sensor Heater Circuit (Bank 1)
P0157 O2 Sensor Circuit Low Voltage (Bank 2)
P0158 O2 Sensor Circuit High Voltage (Bank 2)
P0159 O2 Sensor Circuit Slow Response (Bank 2)
P0160 O2 Sensor Circuit No Activity Detected (Bank 2)
P0161 O2 Sensor Heater Circuit (Bank 2)

Description
The oxygen sensors separately monitor the oxygen content in the exhaust gases of each bank of the engine. Each sensor is electrically heated to improve response from start.
The sensor consists of a zirconia electrode between two platinum plates. When zirconia comes into contact with oxygen, it becomes an electrical conductor. The exhaust gases passes through louvers in the sensor. One plate is in contact with the outside air and the other plate is in contact with the exhaust gases. The platinum plate in contact with the air is electrically negative due to the oxygen in the atmosphere and the plate in contact with the exhaust gases is electrically positive. This will cause a difference in electrical potential to develop between the two plates. Thus the voltage across the platinum plates ranges approximately from 100 millivolts to 900 millivolts, depending on the oxygen content of the exhaust gases. Thus when the air/fuel mixture is rich, the oxygen sensor output will be high. If the air/fuel mixture is lean, the oxygen sensor output will be low. The post catalyst oxygen sensor performance is a good indicator of catalyst efficiency.

Sensor connections

Sensor Connector	Description	ECU Pin	ECU Connector
1 Bank 1	Signal	H1	48 Way (Centre)
2 Bank 1	Ground	K4	48 Way (Centre)
3 Bank 1	Heater	K1	48 Way (Centre)
4 Bank 1	Battery Voltage	-	-
1 Bank 2	Signal	H2	48 Way (Centre)
2 Bank 2	Ground	K4	48 Way (Centre)
3 Bank 2	Heater	K2	48 Way (Centre)
4 Bank 2	Battery Voltage	-	-

Sensor characteristics
Normal operating range is 0 – 1000mV

P0137, P0157
Monitor:
- Continuous

Enable Criteria:
- None

Disable Criteria:
- DFCO (Deceleration Fuel Cut Off)
- AE DE (Acceleration Enrichment or Deceleration Enleanment)
- Misfire

Malfunction Criteria:
- Set when the sensor operates below 15mV for more than 1.5 seconds consecutively for a specified number of times.

Potential failure modes:
- Check and rectify any pre catalyst sensor fault code, as they may be causing the fault code to be set
- Sensor wire shorted to ground
- Catalyst

Diagnostic Mask:
- The MIL will be illuminated if these faults are present for 2 consecutive trips.

P0138, P0158
Monitor:
- Continuous

Enable Criteria:
- Engine running

Disable Criteria:
- None

Malfunction Criteria:
- Set when the sensor operates above 1200mV for more than 1.5 seconds consecutively for a specified number of times.

Potential failure modes:
- Check and rectify any front sensor fault code, as they may be causing the fault code to be set
- Catalyst

Diagnostic Mask:
- The MIL will be illuminated if these faults are present for 2 consecutive trips.

P0139, P0159
"O2 Sensor, slow response" can be defined in two ways; 1) "Slow response" and 2) "Delayed response".

1) Slow Response
Set when the sensor fails to reach 600mV after 5 seconds of Fuel Enrichment or when the sensor fails to drop below 300mV after 5 seconds of DFCO.

Enable Criteria:
- Engine run time > 230 seconds
- > 15 g/sec MAF (only enable criteria when switching rich, > 600mV, in fuel enrichment state)
- DFCO for 'rich to lean' switch

Disable Criteria:
- P0116, P0117, P0118 – Coolant Temperature Sensor faults
- P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, P02777 – Injector faults
- P0300, P0301, P0302, P0303, P0304, P0305, P0306 – Misfire faults
- P1301, P1302 – Misfire faults causing emission or catalyst damage

Monitor:
- Continuous, until the test is either passed or failed

Potential failure modes:
- Check and rectify any pre catalyst sensor fault code, as they may be causing the fault code to be set
- Catalyst damage/leak/inefficiency

2) Delayed Response
Set when the sensor fails to switch between 300mV and 600mV within a specified time of the pre cat O2 sensor switch.

Enable Criteria:
- Engine run time > 230 seconds
- Rich for >3 seconds prior to switch lean
- Pre Cat O2 sensor must be rich for >0.5 seconds before post cat O2 sensor switch
- DFCO for 'rich to lean' switch

Disable Criteria:
- P0116, P0117, P0118 – Coolant Temperature Sensor faults
- P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, P02777 – Injector faults
- P0300, P0301, P0302, P0303, P0304, P0305, P0306 – Misfire faults
- P1301, P1302 – Misfire faults causing emission or catalyst damage

Malfunction Criteria:
- 3 consecutive switch times >700 ms.

Monitor:
- Continuous, until the test is either passed or failed

Potential failure modes:
- Check and rectify any pre catalyst sensor fault code, as they may be causing the fault code to be set
- Catalyst damage/leak/inefficiency

Diagnostic Mask:
- The MIL will be illuminated if these faults are present for 2 consecutive trips.

P0140, P0160
Monitor:
- Continuous

Enable Criteria:
- Engine run time > 30 seconds
- Engine is not at idle
- Engine is in closed loop fuel control
- Oxygen sensors ready

Disable Criteria:
- None

Malfunction Criteria:
- Set when the sensor fails to switch above 673mV and below 400mV within 60 seconds.

Potential failure modes:
- Check and rectify any front sensor fault code, as they may be causing the fault code to be set
- Sensor connector and wiring should be checked for corrosion and loose connections
- Catalyst
- Gas leak in exhaust system

Diagnostic Mask:
- The MIL will be illuminated if these faults are present for 2 consecutive trips.

P0141, P0161

Monitor:

- Continuous

Enable Criteria:

- Engine run time > 20 seconds

Disable Criteria:

- None

Malfunction Criteria:

- Set when the heater output is greater than 1900mA or less than 250mA for 1.5 seconds, for 40 consecutive checks.

Potential failure modes:

- Sensor connector and wiring should be checked for corrosion and loose connections

Diagnostic Mask:

- The MIL will be illuminated if a fault is present for two consecutive trips.

Fuel Control System Too Lean Or Rich

P0171 System Too Lean (Bank 1)
P0172 System Too Rich (Bank 1)
P0174 System Too Lean (Bank 2)
P0175 System Too Rich (Bank 2)

Description
The oxygen sensor sends a signal to the ECU corresponding to the exhaust gas oxygen content enabling the ECU to maintain a 14.7:1 air/fuel ratio under normal driving conditions. The ECU can make fuel corrections of ± 30% to the calculated fuel demand. This value is then learned by the ECU over time. If the ECU determines a rich condition exists (oxygen sensor above 450mV), it will decrease the calculated fuel demand to maintain a 14.7:1 ratio. If the ECU determines a lean condition exists (oxygen sensor below 450mV), it will increase the calculated fuel demand to maintain a 14.7:1 ratio.

Monitor:
- Continuous

Enable Criteria:
- Fuel Trim condition enabled
- Closed loop fuelling enabled
- MAF < 28 g/sec
- Altitude < 8000 ft (2438 m), Baro > 756 mbar

Disable Criteria P0171 & P0172:
- P0106, P0107, P0108 – Baro sensor faults
- P0131, P0135 – Oxygen sensor faults
- P0300, P0301, P0302, P0303 – Misfire faults
- P0111, P0112, P0113 – Intake air temperature faults

Disable Criteria P0174 & P0175:
- P0106, P0107, P0108 – Baro sensor faults
- P0151, P0155 – Oxygen sensor faults
- P0300, P0304, P0305, P0306 – Misfire faults
- P0111, P0112, P0113 – Intake air temperature faults

Malfunction Criteria P0171 & P0174:
- These codes will set when the relevant engine bank learned fuel correction has been increased to its maximum limit of 25% and the system still cannot maintain an air/fuel ratio of 14.7:1 under normal driving conditions.
- These codes will also be set if the relevant bank fuel learn injector dead time is greater than 450 micro seconds.

Potential failure modes:
- Fuel Pressure too low (restriction in fuel line)
- Air leak in induction system
- Water in fuel
- Exhaust leak / crack before front oxygen sensor
- Injector fault
- Sensor connector and wiring for signs of corrosion or loose connections
- MAF fault
- Vehicle has previously run out of fuel

Diagnostic Mask:
- The MIL will be illuminated if fault is present for two consecutive trips.

Malfunction Criteria P0172, P0175:

- These codes will be set when the relevant bank learned fuel correction has been decreased to its minimum limit of -25% and the system still cannot maintain an air/fuel ratio of 14.7:1 under normal driving conditions.
- These codes will also be set if the relevant bank fuel learn injector dead time is less than -450 micro seconds.

Potential failure modes:

- Fuel pressure too high
- Leaking fuel injector
- Restriction in the exhaust system or air intake / filter
- Erratic throttle position sensor
- MAF fault
- O2 sensor fault
- Ignition fault

Diagnostic Mask:

- The MIL will be illuminated if a fault is present for two consecutive trips.

Fuel Injection System

P0261 Injector Circuit low voltage – Cylinder 1
P0262 Injector Circuit high voltage – Cylinder 1
P0264 Injector Circuit low voltage – Cylinder 2
P0265 Injector Circuit high voltage – Cylinder 2
P0267 Injector Circuit low voltage – Cylinder 3
P0268 Injector Circuit high voltage – Cylinder 3
P0270 Injector Circuit low voltage – Cylinder 4
P0271 Injector Circuit high voltage – Cylinder 4
P0273 Injector Circuit low voltage – Cylinder 5
P0274 Injector Circuit high voltage – Cylinder 5
P0276 Injector Circuit low voltage – Cylinder 6
P0277 Injector Circuit high voltage – Cylinder 6

Description
The ECU has six injector driver circuits, each of which controls an injector. When the engine is running the ECU continuously monitors the injector circuit feedback signals. The monitored feedback signal should be low voltage when the injector is ON and high voltage when the injector is OFF.

Component connections

Injector	ECU Pin	ECU Connector
1	H4	32 Way (Left)
2	H3	32 Way (Left)
3	H2	32 Way (Left)
4	H1	32 Way (Left)
5	G4	32 Way (Left)
6	G3	32 Way (Left)

Monitor:
- Continuous

Enable Criteria:
- Engine running

Potential failure modes:
- Sensor connector or wiring corroded or loose connections

Diagnostic Mask:
- The MIL will be illuminated if these faults are present for 2 consecutive trips.

Limp home:
- Limit maximum engine speed to 4000rpm
- Return the fuel system of the affected bank to open loop fuel control

Notes:
If an injector goes short circuit it is likely that the ECU injector driver will be damaged.

Misfire

P0300 Random/Multiple Cylinder Misfire Detected
P0301 Cylinder 1 Misfire Detected
P0302 Cylinder 2 Misfire Detected
P0303 Cylinder 3 Misfire Detected
P0304 Cylinder 4 Misfire Detected
P0305 Cylinder 5 Misfire Detected
P0306 Cylinder 6 Misfire Detected

Description
A misfiring cylinder can be detected by analysing crank speed variation. As a result of a combustion event there will be a net acceleration of the crankshaft. Subsequent to a misfire event the engine will decelerate over the period following the missed cylinder event.
Speed changes can be characterised by observing changes in the time period for a fixed angle of rotation after firing events. A significant change in this period, assessed by comparison to previous periods, may be attributed to misfire on a known cylinder.

Component connections

Connector	Description	ECU Pin						ECU Connector
1	Supply Voltage	Coil 1	Coil 2	Coil 3	Coil 4	Coil 5	Coil 6	
2	Ignition Coil Feedback	D2	D2	D2	D2	D2	D2	32 Way (Left)
3	Coil Output (Logic)	F4	F3	F2	F1	E4	E3	32 Way (Left)
4	Ground							

Malfunction Criteria
The operation of all the misfire codes is the same, the last digit relates to the misfire involved i.e. a code P0303 indicates there is a problem with cylinder number 3.
P0300 indicates the misfire is random and not linked to one particular cylinder.

Monitor:
- Continuous

Enable Criteria:
- Battery voltage between 10 – 16 V
- Coolant temperature between -10 – 120°C (14 – 248°F)
- Engine speed between 480 – 8010rpm
- Engine speed transient > 15rpm
- Altitude < 8000 ft (2438 m) / Baro > 756mbar
- Fuel level > 5 litres (1.3 US gallons)
- Engine load greater than 14 – 25% depending on engine speed

Disable Criteria:
- DFCO enabled (Deceleration Fuel Cut Off)
- Rough road
- MAF faults

Malfunction Criteria:
- Individual cylinder misfire in excess of 10% of total engine misfire
- P300 set when more than one cylinder misfiring or when CAM error MIL requested

Limp home (depends on severity and number of cylinders affected):
- Throttle limited and engine continues to run on all cylinders
- Fuel system set to open loop control
- Affected bank shut down and engine speed limited to 4000 rpm

Potential failure modes:

- Injectors or related codes
- VVT system (clearance or timing) or related codes
- MAF meter or related codes
- Connectors and wiring for signs of corrosion or loose connections
- Spark plug / coil / cylinder compression
- PCV system / hoses
- Fuel pressure
- Coolant temperature sensor
- Vacuum hoses
- ECU

Diagnostic Mask:

- The MIL will be illuminated if a fault is present for two consecutive trips.

Knock Control System

P0327 Knock Sensor Circuit Low (Bank 1)
P0328 Knock Sensor Circuit High (Bank 1)
P0332 Knock Sensor Circuit Low (Bank 2)
P0333 Knock Sensor Circuit High (Bank 2)

Description
The knock sensor contains a piezoelectric element which generates a voltage when it becomes deformed. The piezoelectric element sends continuously sends a signal to the ECU, when the cylinder block vibrates due to engine knocking this signal increases. The ECU is able to identify each cylinder. If knock is detected then the ECU will retard the ignition of the relevant cylinder to suppress it.
The knock control sensor cannot differentiate between spark knock and other similar sounding noises.

Sensor connections

Sensor Connector	Description	ECU Pin	ECU Connector
1 Bank 1	Sensor input	D1	48 Way (Centre)
2 Bank 1	Ground	C1	48 Way (Centre)
3 Bank 2	Sensor input	D2	48 Way (Centre)
4 Bank 2	Ground	C2	48 Way (Centre)

Monitor:
- Continuous

Enable Criteria:
- Engine running

Malfunction Criteria:
- P0327 – This code is set when the bank 1 knock sensor signal is < 0.586 V
- P0328 – This code is set when the bank 1 knock sensor signal is > 2.932 V
- P0332 – This code is set when the bank 2 knock sensor signal is < 0.586 V
- P0333 – This code is set when the bank 2 knock sensor signal is > 2.932 V

Potential failure modes:
- Abnormal engine noise, i.e. damaged engine or exhaust system contacting vehicle
- Knock sensor fixing too tight
- Sensor connector / wiring corroded or loose connections
- ECU

Diagnostic Mask:
- The MIL will be illuminated if a fault is present for two consecutive trips.

Engine Speed / Position Sensors

P0335 Crankshaft Position Sensor “A” Circuit Range/Performance

Description
Engine speed is calculated by measuring the time between the ‘teeth’ of the crankshaft sensor trigger disc. The disc has 34 ‘teeth’ and 2 missing ‘teeth’, spaced at 10 degree intervals around the disc. The 2 missing ‘teeth’ are positioned at 225 degrees before cylinder No.1 and 4 TDC. The crankshaft sensor signal is also used to determine misfires events.

Sensor connections

Sensor Connector	Description	ECU Pin	ECU Connector
1	Sensor input	A4	32 Way (Left)
2	Ground	B2	32 Way (Left)

Monitor:
- Continuous

Enable Criteria:
- Engine running

Disable Criteria:
- None

Malfunction Criteria:
- 15 crank errors in succession. This can occur due to no crank signal occurring whilst the cams continue to count or if there is a measured consecutive crank error.

Potential failure modes:
- Sensor signal open circuit or short to ground
- Sensor ground open circuit
- Sensor failure
- Crankshaft sensor plate
- ECU

Diagnostic Mask:
- The MIL will be illuminated if this fault is present for two consecutive trips.

Notes:
If a sensor or sensor circuit failure occurs, the engine will not fire or start.

Engine Speed / Position Sensors

P0341 Camshaft Position Sensor “A” Circuit (Bank 1)
P0346 Camshaft Position Sensor “A” Circuit (Bank 2)
P0366 Camshaft Position Sensor “B” Circuit (Bank 2)
P0391 Camshaft Position Sensor “B” Circuit (Bank 2)

Description
The camshaft position input to the ECU is used to determine engine phase, enable sequential fuel injection control and to determine camshaft position for VVT control. The inlet camshaft has three ‘teeth’ spaced 90° apart, which are detected by the electromagnetic sensor. The valve timing setting is measured in the ECU by measuring time from a (fixed position) crankshaft tooth to a (variable position) camshaft tooth. As the engine speed and the position is known from the crankshaft sensor signal, the camshaft position can be calculated.

Sensor connections

Sensor Connector	Description	ECU Pin	ECU Connector
1 Inlet Bank 1	Signal	A3	32 Way (Left)
2 Inlet Bank 1	Ground	B3	32 Way (Left)
3 Supply voltage	5V	D1	32 Way (Left)
1 Exhaust Bank 1	Signal	D4	32 Way (Left)
2 Exhaust Bank 1	Ground	C3	32 Way (Left)
3 Supply voltage	5V	D1	32 Way (Left)
1 Inlet Bank 2	Signal	A2	32 Way (Left)
2 Inlet Bank 2	Ground	C2	32 Way (Left)
3 Supply voltage	5V	D1	32 Way (Left)
1 Exhaust Bank 2	Signal	D3	32 Way (Left)
2 Exhaust Bank 2	Ground	C4	32 Way (Left)
3 Supply voltage	5V	D1	32 Way (Left)

Monitor:
- Continuous

Enable Criteria:
- Engine running
- Engine speed > 600rpm
- Engine runtime > 4 secs

Disable Criteria:
- None

Malfunction Criteria:
- 15 revolutions of crankshaft without receiving camshaft signal

Potential failure modes:
- Sensor signal open circuit or short to ground
- Sensor ground open circuit
- Sensor failure
- Cam failure
- Camshaft position plate
- ECU

Diagnostic Mask:
- The MIL will be illuminated if a fault is present for two consecutive trips.

Notes:
Fault code P0341 will also be generated if the vehicle fails security checks on start up.

Ignition System

P0351 Ignition Coil “A” Primary/Secondary Circuit
P0352 Ignition Coil “B” Primary/Secondary Circuit
P0353 Ignition Coil “C” Primary/Secondary Circuit
P0354 Ignition Coil “D” Primary/Secondary Circuit
P0355 Ignition Coil “E” Primary/Secondary Circuit
P0356 Ignition Coil “F” Primary/Secondary Circuit

Description
A Direct Ignition System (DIS) is used on the engine. The DIS improves the ignition accuracy, reduces high-voltage loss, and enhances the reliability of the ignition system. The DIS is a 1-cylinder system that ignites one cylinder with one ignition coil. The ECU determines the ignition timing and outputs the ignition signals (IGT) for each cylinder. Based on IGT signals, the power transistors in the igniter cuts off the current to the primary coil, which induces a spark at the spark plug connected to the secondary coil. The igniter will also send an ignition confirmation signal (IGF) as a fail-safe measure to the ECU.

Component connections

Connector Pin	Description	ECU Pin						ECU Connector
1	Supply Voltage	Coil 1	Coil 2	Coil 3	Coil 4	Coil 5	Coil 6	
2	Ignition Coil Feedback	D2	D2	D2	D2	D2	D2	32 Way (Left)
3	Coil Output (Logic)	F4	F3	F2	F1	E4	E3	32 Way (Left)
4	Ground							

Monitor:
- Continuous

Enable Criteria:
- Engine running

Malfunction Criteria:
- No IGF signal to ECM while engine is running

Potential failure modes:
- Open or short in IGF1 – IGF6 circuits from ignition coil to ECU
- Coil failure
- ECU

Diagnostic Mask:
- The MIL will be illuminated if a fault is present for two consecutive trips.

Catalyst System Efficiency

P0420 Catalyst System Efficiency Below Threshold (Bank 1)
P0430 Catalyst System Efficiency Below Threshold (Bank 2)

Description
The ECU compares the waveform of the oxygen sensors located before and after the catalyst to determine whether or not the catalyst has deteriorated. If the catalyst is functioning normally the front oxygen sensor will be switching between rich and lean whilst the rear oxygen sensor should also be switching between rich and lean but more slowly. When both the oxygen sensor waveforms change at a similar rate, it indicates that the catalyst performance has deteriorated. The ECU counts the number of pre and post catalyst oxygen sensor switches and divides one by the other to determine a ratio. If this ratio is too high a fault will be indicated.

Sensor connections
Pre catalyst oxygen sensor

Sensor Connector	Description	ECU Pin	ECU Connector
1 Bank 1	Signal	G3	48 Way (Centre)
2 Bank 1	Ground	J2	48 Way (Centre)
3 Bank 1	Heater Supply	H3	48 Way (Centre)
4 Bank 1	Battery Voltage	-	-
1 Bank 2	Signal	G4	48 Way (Centre)
2 Bank 2	Ground	J2	48 Way (Centre)
3 Bank 2	Heater Supply	H4	48 Way (Centre)
4 Bank 2	Battery Voltage	-	-

Post catalyst oxygen sensor

Sensor Connector	Description	ECU Pin	ECU Connector
1 Bank 1	Signal	H1	48 Way (Centre)
2 Bank 1	Ground	K4	48 Way (Centre)
3 Bank 1	Heater Supply	K1	48 Way (Centre)
4 Bank 1	Battery Voltage	-	-
1 Bank 2	Signal	H2	48 Way (Centre)
2 Bank 2	Ground	K4	48 Way (Centre)
3 Bank 2	Heater Supply	K2	48 Way (Centre)
4 Bank 2	Battery Voltage	-	-

Monitor:
- Continuous

Enable Criteria:
- Closed loop fuel control enabled
- Coolant temperature > 60 °C (140 °F)
- Baro > 756 mbar
- Vehicle speed < 130 km/h (81 mph)
- MAF < 48 g/sec & MAF > 2 g/sec
- Air inlet temp > -10°C (14°F)
- Accumulated Mass Air > 2000-4080 grams depending on coolant temperature

Disable Criteria:

- P0101, P0102, P0103 – MAF faults
- P0107, P0108 – MAP / Baro Faults
- P0116, P0117, P0118 – Coolant temperature faults
- P0131, P0132, P0133, P0134, P0135, P0137, P0138, P0139, P0140, P0141 – Oxygen sensor faults B1
- P0151, P0152, P0153, P0154, P0155, P0157, P0158, P0159, P0160, P0161 – Oxygen sensor faults B2
- P0171, P0172, P0174, P0175 – Fuelling faults B1 / B2
- P0300, P0301, P0302, P0303, P0304, P0305, P0306 – Misfire faults
- P0500 – Speed sensor fault

Malfunction Criteria:

- Switch ratio between Pre & Post catalytic converter O2 sensors > 0.6

Potential failure modes:

- Exhaust system leak
- Oxygen sensor faults
- Oxygen sensor heater failure
- Catalyst failure

Diagnostic Mask:

- The MIL will be illuminated if these faults are present for 2 consecutive trips.

Evaporative Emission Control – Leak Detection System

P0441 Evaporative Emission System Incorrect Purge Flow
P0442 Evaporative Emission System Leak Detected (small leak)
P0455 Evaporative Emission System Leak Detected (large leak)
P0456 Evaporative Emission System Leak Detected (very small leak)

Description
During an Evaporative Emission System Leak Detection check, the vacuum in the system is monitored by ECU using the fuel tank pressure sensor. At the appropriate time, the ECU starts the test by closing the canister closure value and opening the purge solenoid with the appropriate duty cycle. This allows the engine to draw a vacuum on the entire evaporative emission system. After a calibrated vacuum level is achieved the purge solenoid is closed, sealing the system. A leak is detected by monitoring any decrease in vacuum level over a calibrated period of time.

Sensor / component connections
Vapour Pressure sensor

Connector Pins	Description	ECU Pin	ECU Connector
1	Ground	K3	48 Way (Right)
2	Signal	B3	48 Way (Right)
3	5V V. Ref	F4	48 Way (Right)

Purge Canister Closure Valve

Connector Pins	Description	ECU Pin	ECU Connector
A	Battery Voltage	-	-
B	CCV Output	B4	48 Way (Centre)

Purge Solenoid

Connector Pins	Description	ECU Pin	ECU Connector
1	Battery Voltage	-	-
2	Solenoid Output	B3	48 Way (Centre)

Enable Criteria:
- Altitude < 8000 ft (2438 m), Baro > 756 mbar
- SUTair (Start up air temperature) > - 10°C (14°F)
- Coolant > 45°C (113°F)
- Air temp < 80°C (176°F)
- Fuel level between 10 – 51 litres (2.64 – 13.5 US gallons)
- Vehicle must be stationary for leak check
- Subsequent checks are made with purge levels > 75% and vehicle moving with part throttle
- Closed loop fuelling control enabled
- Closed loop idle speed control enabled
- Ignition on

Disable Criteria:
- P0171, P0172, P0174, P0175 – Fuel trim too rich or lean soft code
- P0441, P0444, P0445 – Purge faults
- P0446, P0447, P0448 – Canister closure faults
- P0451, P0452, P0453 – Tank Pressure sensor faults
- P0461, P0462, P0463 – Fuel level sensor faults
- P0500 – Vehicle speed faults

Malfunction Criteria

P0441

This code can be caused by the purge value being either stuck closed or open. This test is also completed upon vehicle start up.

Purge valve stuck open: A purge valve that is unable to seal correctly will result in a tank evacuation during the sealing phase of the leak check sequence. In this phase, a pressure rise would normally be expected but when the purge valve is not sealing this causes depression in the tank. When the pressure is below -4mbar a purge valve fault is detected. Upon vehicle start up the tank pressure should not drop below -25mbar as the CCV and purge valve are closed. Is this does occur a fault is detected.

Purge valve stuck closed: A purge valve that is unable to open will not be able to achieve the required depression during the evacuation phase. A positive pressure rise during the leak check evacuation phase will be detected. Additional purge checks will set a purge valve fault code, these require normal driving to complete.

Monitor:

- Until leak check is completed

Diagnostic Mask:

- The MIL will be illuminated if these faults are present for 2 consecutive trips.

P0442

This code is set during the evaporative leak check process if the system calculates the measure of leak is above a specified value (3.1 – 5.7 mbar determined by a table related to fuel level) after the 6.6 second timer has expired.

Monitor:

- Until leak check is completed

Potential failure modes:

- Leak from pipes or connections
- Leaking or damaged seal on filler cap / not fitted correctly
- Canister Closure valve not fully closing

Diagnostic Mask:

- The MIL will be illuminated if these faults are present for 2 consecutive trips.

P0455

This code is set if during the evaporative leak check the system fails to reach the evacuation target pressure. The system will perform additional purge checks to determine the nature of the problem. The additional purge checks will also run if the leak check fails to complete because the calculated vapour concentration is above the limit.

Additional Purge Check Enable Criteria:

- Vehicle not stationary
- Engine Load > 27.3%
- Purge value >= 75%
- Conditions met for > = 7.5 seconds

Monitor:

- Until leak check is completed

Potential failure modes:

- Fuel filler cap not fitted, jammed or not fitted correctly
- Leak from pipes or connections
- Canister Closure valve stuck open

Diagnostic Mask:
- The MIL will be illuminated if these faults are present for 2 consecutive trips.

P0456
This code is set during the evaporative leak check process if the system calculates the measure of leak is above a specified value (2.4 – 4.3 mbar determined by a table related to fuel level) after the 19.7 second timer has expired.

Monitor:
- Until leak check is completed

Potential failure modes:
- Leak from pipes or connections
- Leaking or damaged seal on filler cap / not fitted correctly
- Canister Closure valve not fully closing

Diagnostic Mask:
- The MIL will be illuminated if these faults are present for 2 consecutive trips.

Evaporative Emission Control – Purge, Open / Closed Circuit

P0444 Evaporative Emission System Purge Control Valve Circuit Open
P0445 Evaporative Emission System Purge Control Valve Circuit Closed
P0446 Evaporative Emission System Vent Control Circuit
P0447 Evaporative Emission System Vent Control Circuit Open
P0448 Evaporative Emission System Vent Control Circuit Closed
P0451 Evaporative Emission System Pressure Sensor/Switch Range/Performance
P0452 Evaporative Emission System Pressure Sensor/Switch Low
P0453 Evaporative Emission System Pressure Sensor/Switch High

Description
When the engine is running the ECU continuously monitors the status of the evaporative emission components for open circuit or short. The feedback signal should be low when turned ON and high when turned OFF. The following codes will be set if the above conditions are not met: P0444, P0445, P0447, P0448, P0452, P0453

Sensor / component connections
Vapour Pressure sensor

Connector Pins	Description	ECU Pin	ECU Connector
1	Ground	K3	48 Way (Right)
2	Signal	B3	48 Way (Right)
3	5V V. Ref	F4	48 Way (Right)

Purge Canister Closure Valve

Connector Pins	Description	ECU Pin	ECU Connector
A	Battery Voltage	-	-
B	CCV Output	B4	48 Way (Centre)

Purge Solenoid

Connector Pins	Description	ECU Pin	ECU Connector
1	Battery Voltage	-	-
2	Solenoid Output	B3	48 Way (Centre)

P0444, P0445
Potential failure modes:
- P0444 Purge valve/wiring open circuit
- P0445 Purge valve short circuit

Diagnostic mask:
- The MIL will be illuminated if these faults are present for 2 consecutive trips.

P0446
This code can be caused by the canister closure valve (CCV) being either stuck closed or open.

CCV stuck open:
If the CCV is stuck open then there will be minimal tank depression when the leak test is performed. Addition check will be performed when the vehicle is being driven before the code is set.

CCV stuck closed:
Detection of a stuck closed CCV is implemented by detecting an excessively low tank pressure during normal purge (pressure < 25mbar). Detection of this fault will disable further purging
Additional checks for CCV stuck closed:
- Purge Value > 0%
- CCV Open - requested

Monitor:
- Until leak check is completed.

Diagnostic Mask:
- The MIL will be illuminated if these faults are present for 2 consecutive trips.

P0451, P0452, P0453
This code is set when the ECU detects abnormalities in the fuel tank vapour pressure sensor signal. The ECU analyses the filtered and unfiltered pressure signal at idle after a de-slosh period to determine if there is any difference; a big difference indicates as a fault. The ECU also monitors the signal on gear changes to see if there is any pressure rise as a result of the fuel sloshing around.
These codes are likely to indicate a pressure sensor fault.

Disable Criteria:
- P0500 – Wheel speed sensor fault

Monitor:
- Until leak check is completed

Diagnostic Mask:
- The MIL will be illuminated if these faults are present for 2 consecutive trips.

Fuel Level Sensor

P0461 Fuel Level Sensor “A” Circuit Range/Performance
P0462 Fuel Level Sensor “A” Circuit Low
P0463 Fuel Level Sensor “A” Circuit High

Description
When the engine is running the ECU continuously monitors the fuel level sensor feedback signals. The feedback signal should be low when turned ON and high when turned OFF. The following codes will be set if the above conditions are not meet.

Sensor connections

Sensor Connector	Description	ECU Pin	ECU Connector
1			
2	Fuel level sensor	A2	48 Way (Right)
3	Fuel level sensor ground.	K3	48 Way (Right)

P0462, P0463
Monitor:
- Continuous

Enable Criteria:
- Engine Running

Disable Criteria:
- None

Malfunction Criteria:
- P0462 – Voltage < 0.020V, P0463 – Voltage > 0.684V for 1.5 secs

Potential failure modes:
- Sensor open or short circuit
- Fuel level sensor

Diagnostic Mask:
- The MIL will be illuminated if these faults are present for 2 consecutive trips.

P0461
The ECU calculates the fuel usage and determines whether the fuel level sensor has responded correctly to this usage. The ECU also monitors the filtered and unfiltered signal at idle after a 20 second de-slosh period and compares the differences.

Monitor:
- Continuous

Enable Criteria 1:
- Vehicle Idling
- Vehicle stationary for 20 seconds

Disable Criteria 1:
- Fuel level < 3.3 litres (0.9 US gallons)

Malfunction Criteria 1:
- Signal fluctuation > 10 litres, 35 times over 7 second period

Enable Criteria 2:
- 12 litres fuel usage in upper region
- 10 litres fuel usage in lower region
- 5 litres fuel usage in mid region

Disable Criteria:
- Vehicle stopped for 30 secs

Malfunction Criteria:
- Checks for three conditions, stuck when full, stuck when empty or stuck midway. The ECU determines if the sensor is stuck by calculating the amount of fuel used during the test period. If the fuel level does not move by more than 1 litre a fault is flagged.

Potential failure modes:
- Fuel level sensor wiring or connector corroded
- Fuel level sensor stuck

Diagnostic Mask:
- The MIL will be illuminated if these faults are present for 2 consecutive trips.

Engine Cooling Fan Control

P0480 Fan 1 Control Circuit
P0481 Fan 2 Control Circuit

Component connections

Sensor Connector	Description	ECU Pin	ECU Connector
	Fan Relay 3	F1	48 Way (Right)
	Fan Relay 2	E2	48 Way (Right)

Monitor:
- Continuous

Enable Criteria:
- Engine running

Disable Criteria:
- None

Potential failure modes:
- Wiring harness problem
- Relay
- ECU

Diagnostic Mask:
- The service light will be illuminated for 30 seconds after engine start if the fault has been present for the previous two trips.

Vehicle Speed Sensor

P0500 Vehicle Speed Sensor “A”

Description
This input to the ECU is from the ABS module via CAN.

Monitor:
- Continuous

Enable Criteria:
- Following conditions must occur for 5 seconds
- Engine speed > 1800rpm and < 5010rpm
- Baro > 756 mbar
- Engine in a mode that indicates that the vehicle must be moving.

Malfunction Criteria:
- KMH < 5 kmh

Potential failure modes:
- ABS module failure
- CAN bus communication error to ABS controller

Diagnostic Mask:
- The MIL will be illuminated if a fault is present for two consecutive trips.

Idle Speed Control

P0506 Idle Air Control System RPM Lower Than Expected
P0507 Idle Air Control System RPM Higher Than Expected

Description
The ECM controls the engine idle speed using a combination of spark advance and throttle blade adjustment. If this control cannot attain the desired idle speed a fault is diagnosed.

Monitor:
- Continuous

Enable Criteria:
- Engine at idle speed
- Battery voltage between 10 V and 16 V

Malfunction Criteria 1:
- Idle air learn value on upper limit of +1.8g/s
- Idle speed more than 200 rpm above desired idle speed for more than 5 seconds.

Malfunction Criteria 2:
- Idle air learn value on lower limit of -1.8g/s
- Idle speed more than 100 rpm below desired idle speed for more than 5 seconds.

Potential failure modes:
- Induction system air leak
- Excessive engine load from front end accessory drive system, water pump, power steering, alternator
- Electronic Throttle Control

Diagnostic Mask:
- The MIL will be illuminated if a fault is present for 2 consecutive trips.

Notes:
There will be a different learn value for AC on and AC off. Either could trigger fault

A/C Evaporator temperature sensor

P0537 A/C Evaporator temperature sensor circuit low
P0538 A/C Evaporator temperature sensor circuit high

Description
The A/C system incorporates an evaporator temperature sensor for system control. This is a thermistor device that changes resistance with temperature. As the evaporator temperature decreases the thermistor resistance value increases, and conversely as the evaporator temperature increases so the thermistor resistance value decreases.

Sensor connections

Sensor Connector	Description	ECU Pin	ECU Connector
1	Sensor signal	A3	48 Way (Right)
1	Sensor ground	K3	48 Way (Right)

Monitor:
- Continuous

Enable Criteria:
- Vehicle Running

Disable Criteria:
- None

Malfunction Criteria:
- P0537 – Signal voltage < 0.049V for 1.5 seconds
- P0538 – Signal voltage > 4.399V for 1.5 seconds

Potential failure modes:
- Thermistor wiring open circuit or shorted
- Thermistor fault

Diagnostic Mask:
- The service light will be illuminated for 30 seconds after engine start if the fault has been present for the previous two trips.

Battery Voltage

P0562 System Voltage Low
P0563 System Voltage High

Description
With a battery and alternator functioning as normal the system voltage for a running engine should be around 14V. The ECM monitors this and will diagnose if the voltage is too high or too low.

Monitor:
- Continuous

Enable Criteria:
- Engine running

Disable Criteria:
- None

Malfunction Criteria:
- P0562 – Voltage Too Low < 10V for 10 seconds
- P0563 – Voltage Too High > 16V for 25.5 seconds

Potential failure modes:
- Alternator fault
- Battery fault

Diagnostic Mask:
- The MIL will be illuminated if a fault is present for two consecutive trips.

Cruise Control

P0564 Cruise control multi-function input signal
P0578 Cruise control multi-function input “A” circuit stuck
P0571 Brake switch “A” circuit

Description
Cruise control requests are made using a multi-function switch input. Each cruise control function switch selects a different resistive network to a single ECM input. From this input the ECM determines the driver request. In addition cruise control is cancelled by the application of either the brake pedal or the clutch pedal (see also P0806, P0807 and P0808).

Sensor connections

Sensor Connector	Description	ECU Pin	ECU Connector
1	Cruise control switch input	E3	48 Way (Right)
2	Cruise control ground	K3	48 Way (Right)
1	Brake Switch Ground	-	-
2	Brake Switch Input	C4	48 Way (Right)

P0564, P0578
Monitor:
- Continuous

Enable Criteria:
- None

Disable Criteria:
- None

Malfunction Criteria:
- P0564 – Cruise control multifunction switch open circuit or short circuit
- P0578 – Input other than OFF received for more than 100 seconds

Potential failure modes:
- Cruise switch wiring open circuit or shorted
- Cruise switch fault
- ECU input circuit fault

Notes:
- The service light will be illuminated for 30 seconds after engine start if the fault has been present for the previous two trips.

P0571
Monitor:
- Continuous

Enable Criteria 1:
- KMH > 10 kmh
- PPS > 0.488%

Enable Criteria 2:
- ABS communications working

Disable Criteria:
- None

Malfunction Criteria 1:
- Brake switch on for greater than 25.5 seconds

Malfunction Criteria 2:
- ABS indicating brakes are on but brake switch off for greater than 0.5 seconds

Potential failure modes:
- Brake switch wiring open circuit or shorted
- Brake switch fault

Diagnostic Mask:
- The service light will be illuminated for 30 seconds after engine start if the fault has been present for the previous two trips.

ECU Integrity

P0601 Checksum
P0606 Watchdog

Description
These codes are used by the ECU to check the integrity of the software and calibration data.
P0601 checks that on power up the checksum for calibration data is the same as checksum saved on the previous power down.
P0606 checks the watchdog timer after a defined period to see if it has reset. If the watchdog timer has not reset then the code has entered an unplanned loop or condition stopping it resetting the timer.

Monitor
- P0601 at ECU power up
- P0606 continuously while the engine running

Diagnostic Mask:
- The MIL will be illuminated if a fault is present.

Variant Code Not Programmed

P0610 Variant code not programmed

Description
The ECM programming process includes the Vehicle Variant Code. If a new ECM has been fitted, the relevant variant code needs to be programmed using the Lotus TechCentre tool.

Monitor
- During start up

Disable criteria
- None

Potential failure modes
- Variant code not programmed

Diagnostic mask
- The MIL will be illuminated if fault is present.

Crank Relay

P0616 Starter relay voltage low
P0617 Starter relay voltage high

Description
When the ignition key is in the crank position battery voltage is applied to the start request input of the ECM. The ECM will then energise the crank relay, via the immobiliser, to allow the starter motor to be engaged. ECM diagnosis is only carried out on the crank relay.

Component connections

Relay Connector	Description	ECU Pin	ECU Connector
2	Main relay via fuse R1	-	-
4	Crank relay control	G1	48 Way (Right)

Monitor:
- Continuous

Enable Criteria:
- Engine running

Disable Criteria:
- None

Potential failure modes:
- P0616 – Crank relay wiring open circuit or shorted to ground
- P0616 – Fuse R1
- P0617 – Crank relay wiring shorted to 12V
- Crank relay failure
- Immobiliser failure
- ECU output circuit failure

Diagnostic Mask:
- The service light will be illuminated for 30 seconds after engine start if the fault has been present for the previous two trips.

Fuel Pump Relay

P0628 Fuel Pump “A” Control Circuit Low Voltage
P0629 Fuel Pump “A” Control Circuit High Voltage

Description
The fuel system is of the non-return type. The fuel pump is incorporated into the fuel tank module, which also contains the level sensor, fuel pressure regulator and vapour pressure sensor. The ECM controls the fuel pump operation via a relay, because of this the only fault diagnosis is of the fuel pump relay.

Component connections

Relay connector	Description	ECU Pin	ECU Connector
1	Rear ignition relay (fuse R7)	-	-
2	Fuel pump relay control	H2	48 Way (Right)

Monitor:
- Continuous

Enable Criteria:
- Ignition on

Disable Criteria:
- None

Potential failure modes:
- P0628 fuel pump relay wiring open circuit or shorted to ground
- P0628 fuse R7
- P0629 fuel pump relay wiring shorted to 12V
- Fuel pump relay failure
- ECU output circuit failure

Diagnostic Mask:
- The MIL will be illuminated immediately if a fault is present.

VIN Not Programmed or Incompatible – ECU/PCM

P0630 Vin not programmed or incompatible

Description
The ECM programming process includes the Vehicle Identification Number (VIN). If a new ECM has been fitted this operation is performed using the Lotus TechCentre tool.

Monitor:
- During start up

Enable Criteria:
- Engine running (for up to 4 seconds)

Disable Criteria:
- None

Potential failure modes:
- VIN not programmed

Diagnostic Mask:
- The MIL will be illuminated if fault is present.

Throttle Actuator Control Range/Performance

P0638 Throttle actuator control range/performance

Description
The single throttle butterfly valve mounted at the inlet to the intake plenum is operated by a stepper motor under the command of the engine ECU. The valve moves through a range of nearly 90° and should display 100% at full throttle and around 2% at idle.

Monitor:
- Continuous

Enable Criteria 1:
- Engine running

Disable Criteria 1:
- Electronic throttle fault P2135, P0122, P0122, P0222 or P0223 present
- Throttle demand transient condition

Malfunction Criteria 1:
- TPS error > 3% for 7.5 secs

Enable Criteria 2:
- Ignition on

Disable Criteria 2:
- Electronic throttle fault P2135, P0122, P0122, P0222 or P0223 present

Malfunction Criteria 2:
- Throttle not able to find closed position during boot

Potential failure modes:
- Blocked throttle body
- Damage to throttle actuator

Diagnostic Mask:
- The MIL will be illuminated if fault is present.

Notes: A mechanically sprung 7% throttle opening may be imposed.

Air Conditioning System

P0646 A/C Clutch Relay Control Circuit Low
P0647 A/C Clutch Relay Control Circuit High

Description
The ECM controls the A/C clutch relay in response to the A/C driver request and ECM control logic.

Component connections

Relay Connector	Description	ECU Pin	ECU Connector
1	Ignition supply (fuse R11)		
2	AC clutch relay control	F2	48 Way (Right)

Monitor:
- Continuous

Enable Criteria:
- Engine running

Disable Criteria:
- None

Potential failure modes:
- P0646 – A/C compressor relay wiring open circuit or shorted to ground
- P0646 – Fuse R11
- P0647 – A/C compressor relay circuit shorted to 12V
- A/C compressor relay failure
- ECU output circuit failure

Diagnostic Mask:
- The service light will be illuminated for 30 seconds after engine start if the fault has been present for the previous two trips.

Variable intake manifold circuit

P0661 Variable intake manifold circuit voltage low
P0662 Variable intake manifold circuit voltage high

Description
This circuit opens and closes the variable intake manifold (VIM) in response to changes in the engine speed and load in order to increase the intake efficiency.
When the engine speed is less than 4200 rpm and the engine load is greater than 52%, the ECM turns on the VIM control valve to close the VIM. Under all other conditions, the VIM control valve is usually off and the VIM is open.

Component connections

Connector	Description	ECU Pin	ECU Connector
1	Ignition supply (fuse R8)	-	-
2	VIM control valve control	L4	48 Way (Central)

Monitor:
- Continuous

Enable Criteria:
- Engine running

Disable Criteria:
- None

Potential failure modes:
- P0661 – VIM wiring open circuit or shorted to ground
- P0661 – Fuse R8
- P0662 – VIM circuit, ECM side, shorted to battery voltage
- VIM control valve failure
- ECU output circuit failure

Diagnostic Mask:
- The MIL will be illuminated if a fault is present for two consecutive trips.

Clutch position sensor circuit

P0806 Clutch position sensor circuit range/performance
P0807 Clutch position sensor circuit low
P0808 Clutch position sensor circuit high

Description
The clutch position sensor is used to identify the position of the clutch (engaged, disengaged or slipping). This information is used to control features such as fuel cut during gear changes, cruise control deactivation and ensuring any torque increase requests from the ESP system only occur with the clutch engaged.
The ECM continuously monitors the clutch position sensor input for malfunctions.

Component connections

Connector	Description	ECU Pin	ECU Connector
A	Ground	K3	48 Way (Right)
B	Clutch position sensorsignal	B1	48 Way (Right)
C	Reference voltage	F4	48 Way (Right)

P0806
Monitor:
- Continuous

Enable Criteria:
- Maximum and minimum clutch position measured over 15 gear changes

Disable Criteria:
- None

Malfunction Criteria:
- Voltage difference between maximum and minimum of less than 2.101V

Potential failure modes:
- Clutch sensor failure
- Clutch pedal failure

Diagnostic Mask:
- The service light will be illuminated for 30 seconds after engine start if the fault has been present for the previous two trips.

P0807, P0808
Monitor:
- Continuous

Enable Criteria:
- None

Disable Criteria:
- None

Malfunction Criteria:
- P0807 – Sensor voltage < 0.098V
- P0808 – Sensor voltage > 4.790V

Potential failure modes:

- P0807 – Clutch sensor wiring open circuit or shorted to ground
- P0808 – Clutch sensor ECU input circuit shorted to 5V or 12V
- Clutch sensor failure
- Clutch pedal failure
- ECU input circuit failure

Diagnostic Mask:

- The service light will be illuminated for 30 seconds after engine start if the fault has been present for the previous two trips.

Air intake control valve circuit

P1113 Air intake control valve circuit

Description:
The air cleaner is equipped with 2 inlets, one of which is opened or closed by the Air Intake Control Valve (AICV). This system reduces intake noise and increases engine power.
When the engine is operating in the low-to-mid speed range, the ECM deactivates the Vacuum Solenoid Valve (VSV) and allows the AICV to close one of the air cleaner inlets. When the engine speed is greater than a specified value the ECM activates the VSV and the applied vacuum activates the AICV to open both of the air cleaner inlets.

Component connections

Connector	Description	ECU Pin	ECU Connector
1	Ignition supply (fuse R8)	-	-
2	VSV control	B1	48 Way (Central)

Monitor:
- Continuous

Enable Criteria:
- Engine running

Disable Criteria:
- None

Potential failure modes:
- VSV open circuit or short to ground
- VSV circuit short to ECU

Diagnostic Mask:
- The service light will be illuminated for 30 seconds after engine start if the fault has been present for the previous two trips.

Misfire

P1301 Misfire level causing emissions increase
P1302 Misfire level causing catalyst system damage

Description
When the engine misfire reaches a high enough percentage the engine emission output levels can exceed the allowed limits, this will produce the fault code P1301.
If the misfire percentage is high enough and there is a possibility that the catalyst may be damaged then code P1302 will be set. To prevent catalyst damage the ECM may take action to either shut down the engine bank containing the misfiring cylinder and limit the engine speed to 4000rpm, or limit the throttle opening if there is more than one cylinder misfiring.

See misfire faults P0300, P0301, P0302, P0303, P0304, P0305, P0306

Monitor:
- Continuous

Enable Criteria:
- Battery voltage between 10 – 16 V
- Coolant temperature between -10 – 120°C (14 – 248°F)
- Engine speed between 480 – 8010rpm
- Engine speed transient > 15rpm
- Altitude < 8000 ft (2438 m) / Baro > 756mbar
- Fuel level > 5 litres (1.3 US gallons)
- Engine load greater than 14 – 25% depending on engine speed

Disable Criteria:
- DFCO enabled (Deceleration Fuel Cut Off)
- Rough road
- MAF faults

Malfunction Criteria:
- P1301 Emissions Failure – Misfire percentage > 7% measured over 1000 engine revolutions.
- P1302 Catalyst Damage Failure – Misfire percentage > 16.6% - 40% depending on engine speed and load, measured over 200 engine revolutions.

Potential failure modes:
- Injector related codes, as these can cause misfire codes to be set.
- VVT codes set
- Sensor connector and wiring for signs of corrosion or loose connections
- Spark plug / cylinder compression
- Cam timing / damage to rocker arm assembly
- Fuel pressure

Diagnostic Masks:
- For a P1301 fault code the MIL will be illuminated immediately.
- For a P1302 fault code the MIL will be illuminated immediately and the ECM will take action to prevent catalyst damage.

Notes:
- Misfire learns are calculated during DFCO (Deceleration Fuel Cut Off)

Coolant Recirculation Pump

P2602 Coolant Pump Control Circuit Low
P2603 Coolant Pump Control Circuit High

Description
During a hot shutdown of the engine, the recirculation pump can continue to pump coolant around the engine. The recirculation pump will run after the engine has been turned off if the enable criteria are matched.
The recirculation pump will also run after a short period of idle to aid heater performance.

Component connections

Connector	Description	ECU Pin	ECU Connector
1	Recirc pump driver	M1	48 Way (Right)
2	Main relay via fuse R4	-	-

Monitor:
- Continuous

Enable Criteria:
- P2602 - continuous
- P2603 - engine running

Disable Criteria:
- None

Potential failure modes:
- P2602 – pump wiring open circuit or shorted to ground
- P2602 – fuse R4
- P2603 – pump circuit, ECM side, shorted to battery voltage
- Pump failure
- ECU output circuit failure

Diagnostic Mask:
- The service light will be illuminated for 30 seconds after engine start if the fault has been present for the previous two trips.

Throttle Actuator Control Motor Circuit/Open

P2100 Throttle actuator control motor circuit open

Description
The throttle actuator stepper motor operates on 12 volts.

Monitor:
- Continuous

Enable Criteria:
- None

Disable Criteria:
- None

Potential failure modes:
- Throttle actuator control motor open circuit

Throttle Actuator Control Motor Circuit/Low

P2102 Throttle actuator control motor circuit low

Monitor:
- Continuous

Enable Criteria:
- None

Disable Criteria:
- None

Potential failure modes:
- Throttle actuator control motor short to ground

Throttle Actuator Control Motor Circuit/High

P2103 Throttle actuator control motor circuit high

Monitor:
- Continuous

Enable Criteria:
- None

Disable Criteria:
- None

Potential failure modes:
- Throttle actuator control motor short to supply voltage

Throttle Actuator Control System – Forced Idle

P2104 Throttle actuator control system – forced idle

Description
If a problem is detected which could result in faster engine speed than commanded by the pedal, the actuator is switched out, allowing the throttle valve to default to a 6% mechanically sprung setting. This provides a fast idle speed which may be used to effect a 'limp home' mechanism.

Monitor:
- Continuous

Enable Criteria:
- Engine running

Disable Criteria:
- None

Potential failure modes:
- Electronic throttle fault

Note: This code indicates action taken by the ECU, and will always be accompanied by another code which has caused this action.

Throttle Actuator Control System – Forced Engine Shutdown

P2105 Throttle actuator control system – forced engine shutdown

Description
If a problem is detected which could result in engine speed runaway, or if sufficient control of engine speed is lost, the ECU switches off the fuel injectors in order to stop the engine.

Monitor:
- Continuous

Enable Criteria:
- Engine running

Disable Criteria:
- None

Potential failure modes:
- Electronic throttle fault

Note: This code indicates action taken by the ECU, and will always be accompanied by another code which has caused this action.

Throttle Actuator Control System – Forced Limited Power

P2106 Throttle actuator control system – forced limited power

Description
If a problem is detected which could result in engine speed control difficulties, the ECU will limit throttle opening to a maximum of 15%.

Monitor:
- Continuous

Enable Criteria:
- Engine running

Disable Criteria:
- None

Potential failure modes:
- Electronic throttle fault

Note: This code indicates action taken by the ECU, and will always be accompanied by another code which has caused this action.

Throttle Actuator Control Module Processor

P2107 Throttle actuator control module processor

Description
The ECU contains two processors dedicated to the throttle pedal and throttle valve potentiometers.

Monitor:
- Continuous

Enable Criteria:
- Engine running

Disable Criteria:
- None

Potential failure modes:
- ECU internal fault
- Incorrect ECU programming

Throttle Actuator Control Module Performance

P2108 Throttle actuator control module performance

Monitor:
- Continuous

Enable Criteria:
- Engine running

Disable Criteria:
- None

Potential failure modes:
- ECU internal failure
- Short circuit to throttle actuator

Pedal Position Sensor 'D' Circuit Low

P2122 Pedal position sensor ‘D’ circuit low

Description
Two potentiometers are built into the throttle pedal unit in order to provide a throttle demand signal to the ECU. Note that the potentiometers operate on 5 volts.

Enable Criteria:
- None

Disable Criteria:
- None

Potential failure modes:
- Signal short circuit (< 0.283 V)
- Reference voltage open circuit
- Reference voltage short to ground
- Sensor failure

Notes: A maximum throttle opening of 15% may be imposed due to this single code. In the case of multiple codes, a mechanically sprung 7% opening may be applied.

Pedal Position Sensor 'D' Circuit High

P2123 Pedal position sensor ‘D’ circuit high

Enable Criteria:
- None

Disable Criteria:
- None

Potential failure modes:
- Signal open circuit (> 4.487 V)
- Reference voltage open circuit
- Reference voltage short to ground
- Sensor failure

Notes: A maximum throttle opening of 15% may be imposed due to this single code. In the case of multiple codes, a mechanically sprung 7% opening may be applied.

Pedal Position Sensor 'E' Circuit Low

P2127 Pedal position sensor ‘E’ circuit low

Description
Two potentiometers are built into the throttle pedal unit in order to provide a throttle demand signal to the ECU. Note that the potentiometers operate on 5 volts.

Enable Criteria:
- None

Disable Criteria:
- None

Potential failure modes:
- Signal short circuit (< 0.283 V)
- Reference voltage open circuit
- Reference voltage short to ground
- Sensor failure

Notes: A maximum throttle opening of 15% may be imposed due to this single code. In the case of multiple codes, a mechanically sprung 7% opening may be applied.

Pedal Position Sensor 'E' Circuit High

P2128 Pedal position sensor ‘E’ circuit high

Enable Criteria:
- None

Disable Criteria:
- None

Potential failure modes:
- Signal open circuit (> 4.487 V)
- Reference voltage open circuit
- Reference voltage short to ground
- Sensor failure

Notes: A maximum throttle opening of 15% may be imposed due to this single code. In the case of multiple codes, a mechanically sprung 7% opening may be applied.

Throttle Position Sensor 'A'/'B' Voltage Correlation

P2135 Throttle position sensor ‘A/B’ voltage correlation

Description
Two potentiometers are built into the throttle actuator unit in order to provide a throttle position signal to the ECU. Two processors within the ECU compare the two output signals, which should match within a defined tolerance. Note that the potentiometers operate on 5 volts.

Enable Criteria:
- None

Disable Criteria:
- Throttle position greater than 60%

Potential failure modes:
- TPS1 reading incorrectly
- TPS2 reading incorrectly

Notes: A maximum throttle opening of 15% may be imposed.

Pedal Position Sensor/Switch 'D'/'E' Voltage Correlation

P2138 Pedal position sensor/switch ‘D/E’ voltage correlation

Description
Two potentiometers are built into the throttle pedal unit in order to provide a throttle demand signal to the ECU. Two processors within the ECU compare the two output signals, which should match within a defined tolerance. Note that the potentiometers operate on 5 volts.

Enable Criteria:
- None

Disable Criteria:
- None

Potential failure modes:
- PPS1 reading incorrectly
- PPS2 reading incorrectly

Notes: A maximum throttle opening of 15% may be imposed.

Throttle Actuator Control System – High Airflow Detected

P2173 Throttle actuator control system – high airflow detected

Description
The mass air flow is compared with the throttle position to determine whether an incorrect correlation exists.

Enable Criteria:
- None

Disable Criteria:
- MAF fault(s) present

Potential failure modes:
- Throttle plate damage
- Air leak in intake system

Notes: A mechanically sprung 7% throttle opening may be imposed, or the injectors may be shut off to stop the engine.

A/C Refrigerant Distribution Valve

P2612 A/C Refrigerant Distribution Valve Control Circuit Low
P2613 A/C Refrigerant Distribution Valve Control Circuit High

Description:
The A/C refrigerant flow is regulated by the ECM using the distribution valve to control the evaporator to the required temperature and prevent freezing.

Component connections:

Connector	Description	ECM Pin	ECM Connector
1	Control valve driver	K3	48 Way (Centre)
2	Ignition via rear ign relay	-	-

Monitor:
- Continuous

Enable Criteria:
- Engine running

Disable Criteria:
- None

Potential failure modes:
- P2612 – valve wiring open circuit or shorted to ground
- P2612 – loss of power from rear ignition relay
- P2613 – valve circuit, ECM side, shorted to battery voltage
- Valve failure
- ECM output circuit failure

Diagnostic Mask:
- The service light will be illuminated for 30 seconds after engine start if the fault has been present for the previous two trips.

A/C Compressor Lock Sensor Circuit

B1422 A/C Compressor Lock Sensor Circuit

Description:
The ECM monitors the A/C compressor speed. If this speed is lower than the engine speed the ECM will turn off the A/C compressor clutch. This is to prevent belt damage due to slippage.

Component connections:

Connector	Description	ECM Pin	ECM Connector
1	Lock sensor +ve	C1	32 Way (Left)
2	Lock sensor -ve	B1	32 Way (Left)

Monitor:
- Continuous

Enable Criteria:
- Engine running

Disable Criteria:
- P0646, P0647 A/C compressor clutch fault

Malfunction Criteria:
- A/C compressor speed error greater than 20%

Potential failure modes:
- A/C compressor clutch mechanism slipping or seized
- A/C compressor drive belt slipping
- Lock sensor wiring
- Lock sensor failure
- ECM input circuit failure

Diagnostic Mask:
- The service light will be illuminated for 30 seconds after engine start if the fault has been present for the previous two trips.

Lost Communications with TCM

U0101 Lost Communications with TCM

Description:
The ECM communicates with the Transmission Control Module (TCM) via the CAN bus.
If these CAN bus communications have been interrupted the ECM will register a diagnostic code.

Potential failure modes:
- CAN wiring
- TCM control module failure
- CAN bus corruption by another module on bus

Diagnostic Mask:
- The service light will be illuminated for 30 seconds after engine start if the fault was present on the previous trip.

Lost Communications with VDCM

U0122 Lost Communications with VDCM

Description:
The ECM communicates with the Vehicle Dynamic Control Module (VDCM) via the CAN bus.
If these CAN bus communications have been interrupted the ECM will register a diagnostic code.

Potential failure modes:
- CAN wiring
- VDCM control module failure
- CAN bus corruption by another module on bus

Diagnostic Mask:
- The service light will be illuminated for 30 seconds after engine start if the fault was present on the previous trip.

Lost Communications with TPMS

U0127 Lost Communications with TPMS

Description:
The ECM communicates with the Tyre Pressure Monitor System (TPMS) via the CAN bus.
If these CAN bus communications have been interrupted the ECM will register a diagnostic code.

Potential failure modes:
- CAN wiring
- TPMS control module failure
- CAN bus corruption by another module on bus

Diagnostic Mask:
- The service light will be illuminated for 30 seconds after engine start if the fault was present on the previous trip.

Software Incompatible with VDCM

U0316 Software Incompatible with VDCM

Description:
The ECM checks that the Vehicle Dynamic Control Module (VDCM) matches the vehicle variant code. If not the above code will be set and the ECM will not respond to torque requests from the VDCM.

Potential failure modes:
- The ECM has been programmed with an incorrect variant code which does not match vehicle VDCM level.
- VDCM error.

Diagnostic Mask:
- The service light will be illuminated for 30 seconds after engine start if the fault was present on the previous trip.

EMR.5 - CAN BUS DIAGNOSTICS; LOTUS TECHCENTRE

Controller Area Network (CAN) is an electronic standard to allow high speed communication between modules and controllers, via a serial data bus. The bus is a circuit linking the modules to the controller, consisting of a pair of cables, twisted together to reduce electromagnetic interference, and carrying a square wave voltage signal corresponding to '0's and '1's, coded in such a way as to identify and prioritise the individual messages. On the Evora, CAN based systems include; engine management, anti-lock braking and related features, tyre pressure monitoring, instrument pack, and onboard diagnostics.

A 'stand alone' lap top PC loaded with 'Lotus Techcentre' software allows the CAN based serial data to be read. A Vehicle Communication Device (T000T1472F) introduced for the Europa model is used to connect the vehicle to the laptop Lotus Techcentre. Engine programming, live data display and systems diagnosis are all carried out via the Lotus Techcentre.

The minimum specification of the laptop computer for installation of the Lotus Techcentre is as follows:

Processer 1.70 Ghz;
1 GB RAM;
40 GB HDD;
CDRW DVD ROM;
WIN XP PRO or VISTA;
USB interface;
Ethernet or Wireless LAN

Note that this laptop should be dedicated soley to the Lotus Techcentre, with no other software installed. This diagnostic software is designed primarily for use by trained Lotus technicians, and is available as a CD under part number T000T1510F (version 4) or later supercessions. A monthly (Lotus Dealers) or annual (non-Lotus dealers) licence and support fee will also be levied, providing access to Lotus TechCentre Technical Support phoneline on ***0870 9493 668***, and e-mail on ***lotus.support.uk@omitec.com***

Also required is a unique 18 character licence/registration key without which Techcentre will not function. This key is non transferable to other PC's.

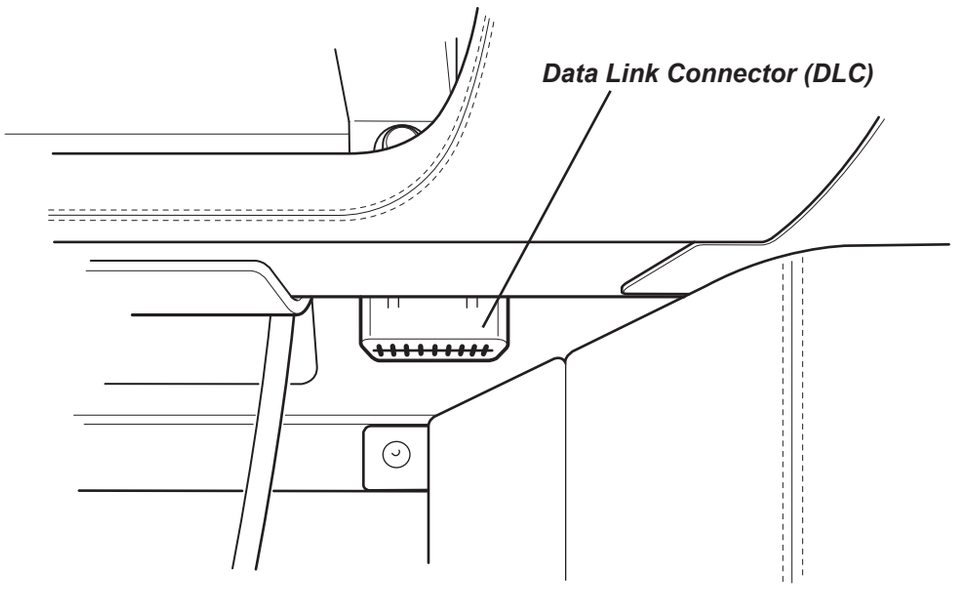
Scope of Lotus TechCentre

Model		Type of Electronic Control Unit					Engine ECU
		Communication compatible					Reprogrammable
		EMS	ABS	SRS	TPMS	IP	08 MY on
Elise	2004 on	**Y**	**Y**	**Y**	**Y**	**N**	**Y**
Exige	2004 on	**Y**	**Y**	**Y**	**Y**	**N**	**Y**
Europa	2006 on	**N**	**Y**	**Y**	**N/A**	**N**	**N**
2-11	2007 on	**Y**	**Y**	**N/A**	**N/A**	**N**	**Y**
Evora	2009 on	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**
Esprit	V8	**Y**	**Y**	**N**	**N**	**N**	**N**

Note that TechCentre has no connectivity to Rover powertrain Elise/Exige variants, and that only limited diagnostics are available for the V8 Esprit. No communication is available with the Europa powertrain. Diagnostics for these vehicles are accessible using the Lotus Scan 3 tool T000T1467F (U.K./EU).

TechCentre Connection

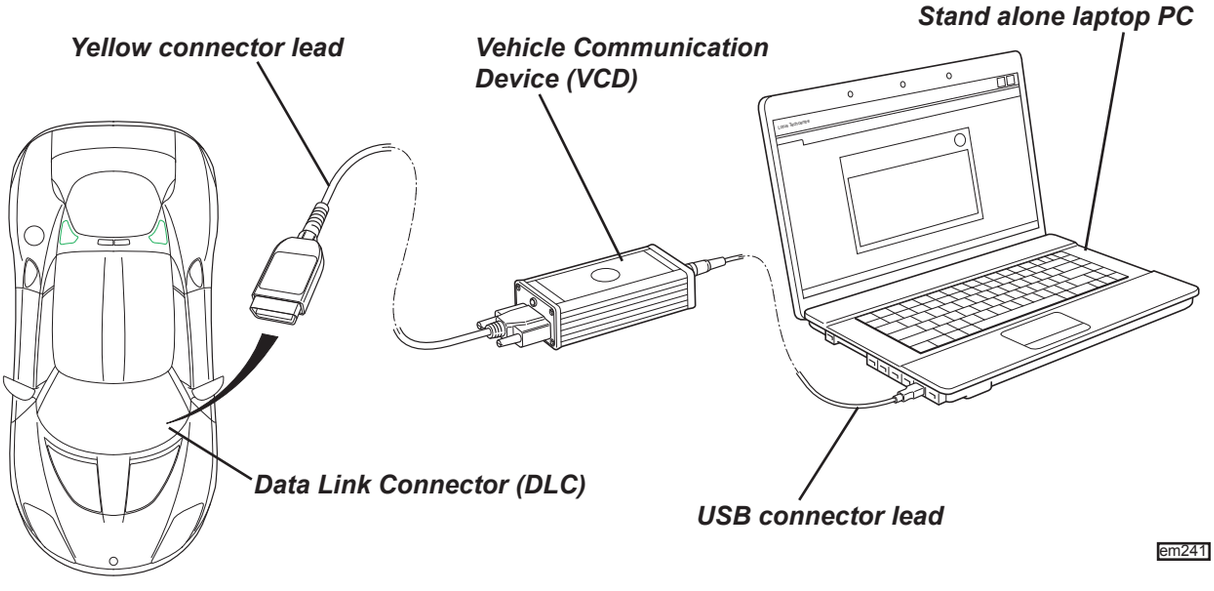
TechCentre connection to the car is made via the Vehicle Communication Device (VCD) and the Data Link Connector (DLC) located beneath the driver's side fascia at the outboard side of the footwell.



Power for the VCD is taken from the vehicle battery via the DLC and when powered a blue tell tale on the unit will light. Should updated firmware be available for the VCD (usually downloaded as part of an online update) TechCentre will automatically update the VCD and display a message to confirm.

The VCD, under part number T000T1472F is supplied in a black plastic carry case containing the following:

VCD
16 Pin Yellow connector lead (VCD to Vehicle)
USB lead (VCD to PC)
USB extension lead (VCD to PC) not illustrated



Use of TechCentre

Instructions for using the TechCentre are available in the 'Technical Information' section displayed on programme start up.