ON-BOARD DIAGNOSTICS
BOSCH M5.2.1 ENGINE MANAGEMENT

Vehicle Coverage:
Discovery Series II 1999 to 2004 MY
Range Rover 38A 1999 to 2002 MY

1 Contents

2 Introduction

The Engine Control Module (ECM) controls engine fuelling using sequential injection to all cylinders. Four double-ended ignition coils provide ignition. The ECM detects and corrects cylinder knock by advancing or retarding the ignition timing. In the event of a knock system failure a safe ignition map is used.

The ECM uses the inputs from sensors to control engine performance and restrict emissions in line with Onboard Diagnostics II (OBDII). These sensors include a Mass Air Flow (MAF) Sensor, Throttle Position (TP) Sensor, Engine Coolant Temperature (ECT) Sensor and Oxygen (O2) Sensors. The ECM also receives vehicle data, such as road speed from other control modules. The Central Processor Unit (CPU) within the ECM processes all of these inputs, applies correction factors, such as short and long term fuel trim, and issues commands to the engine actuators, injectors and coils.

On vehicles equipped with automatic transmissions the ECM is connected to the automatic Transmission Control Module (TCM) via the Controller Area Network (CAN) bus. The CAN bus conveys data, requests and messages between the control modules. Generally the automatic TCM passes OBD data and requests to the ECM, which stores freeze frame data and activates the Malfunction Indicator Lamp (MIL) when a fault occurs.

2.1 Diagnostic Trouble Codes and Freeze Frames

The ECM and automatic TCM software monitors each fault condition and allocates a mnemonic Diagnostic Trouble Code (DTC) to specific faults; e.g. P0170 fuel trim malfunction. The software also checks that the monitoring conditions are valid and the current status of the fault. There are common condition flags for each fault module.

Generally, an emission relevant fault is not reported as soon as it occurs, but only after it is flagged during a second valid drive cycle. A drive cycle is defined by a period of engine operation • •10 seconds and the diagnostic fault path in question having been completed at least once. If the fault is still present on the subsequent drive cycle, the OBD system logs the fault and freeze frame data and illuminates the MIL.

If the fault is not present in the subsequent driving cycle, the system holds it as a temporary fault and counts a number of drive cycles before deleting it from the fault memory providing it does not reoccur. A re-occurring fault will be immediately logged as a permanent emissions fault, and may illuminate the MIL according to the type of fault.

When an emissions fault is recognised, the system monitors over Warm Up Cycles (WUC). A warm up cycle is defined by a period of engine operation where the ECT has increased by 21°C (40°F) and exceeds 71°C (160°F).

Monitoring during warm up is also relevant to permanent faults. If the flagged fault is not present in a subsequent drive cycle, the warm up cycle counter is started. If the fault is not flagged again, the MIL remains illuminated but s extinguished after 3 fault free WUC. The fault is finally deleted from the fault memory after 40 fault free WUC.

In the case of misfire monitoring two levels of misfire are checked:

- Emission relevant misfire is monitored over 1000 engine revolutions and 2 drive cycles.
- Catalyst damage misfire is monitored over 200 engine revolutions. If the threshold is exceeded in any 200 engine revolutions segment the MIL is immediately flashed to signal the driver to reduce engine load. When the misfire decreases below the catalyst damage threshold or ceases altogether the MIL is permanently illuminated.

If the freeze frame memory is free the first occurring fault will store freeze frame data regardless of the source. If a subsequent fault occurs, the current freeze frame data is not overwritten unless this fault is of higher freeze frame priority. CARB faults, freeze frame data and other parameters can be read through the diagnostic port via a generic scan tool.

2.2 System Interfaces

The M5.2.1 ECM has some bi-directional (input and output) interfaces, and these are as follows:

- Diagnostics interface via K - Line.
- CAN interface to the automatic TCM.

There are also interactions between the M5.2.1 ECM and other vehicle systems such as the Anti-lock Braking System (ABS) system.

2.3 Inputs and Outputs

Inputs

- Ignition Switch (position II)
- TP Sensor
- Immobiliser interface
- Engine Speed and Position Sensor (Crankshaft Sensor)
- Camshaft Position Sensor
- ECT Sensor
- Intake Air Temperature (IAT) Sensor (integrated into the MAF Sensor)
- MAF Sensor
- Knock Sensors (2 off)
- O2 Sensors (4 off)
- Fuel Tank Pressure Sensor (Except Discovery LEV Phase II and ULEV)
- Fuel Level Sensor (Discovery Series II, NAS Tier I and LEV Phase I)
- Self Levelling, Anti Lock Braking System (SLABS) Vehicle Speed (Discovery Series II only)
- SLABS Rough Road signal (Discovery Series II only)
- ABS Vehicle Speed (Range Rover 38A only)
- ABS Rough Road signal (Range Rover 38A only)

- Transfer Box MIL request (Range Rover 38A only)
- Thermostat Monitoring - bottom hose temperature (LEV Phase II and ULEV only)
- Diagnose Module - Tank Leakage (DMTL) 0.020" (0.5mm) Leak Detection (Discovery LEV Phase II and ULEV only)
- Analogue Fuel Level (Range Rover 38A, Discovery LEV Phase II and ULEV)
- Air Conditioning Standby
- Air Conditioning Request (Range Rover 38A only)

Outputs

- MIL
- Fuel Injectors (8 off)
- Ignition coils (4 Double Ended)
- O2 Sensor Heaters (4)
- Fuel Pump Relay
- Air Conditioning Compressor enable
- Air Conditioning Condenser Fans Relay
- Evaporative Emission Canister Vent Valve
- Evaporative Emission Canister Purge Valve
- Idle Speed Control Valve
- Instrument Pack "ECT Signal" – Pulse Width Modulation (PWM) signal (Discovery Series II only)
- SLABS Hill Decent Control (HDC) - Multiplexed PWM signal (Discovery Series II only)
- Engine Speed signal
- Environmental-Box (E-Box) Cooling Fan (Range Rover 38A only)
- Fuel Used signal (Range Rover 38A only)
- DMTL Pump – 0.020" (Discovery LEV Phase II and ULEV only)
- DMTL Valve – 0.020" (Discovery LEV Phase II and ULEV only)
- Secondary Air Injection Pump Relay (LEV Phase I, Phase II and ULEV only)
- Secondary Air Injection Control Valve (LEV Phase I, Phase II and ULEV only)

3 Mode $06 Data – In accordance with SAE J1979

Mode $06 enables access to the most current diagnostic results and thresholds of non-continuous diagnostic routines. Each individual parameter is identified by a Component Identifier (CID).

Following a power fail or after a delete error memory (Mode 3) request all values will be set to $00.

Values are stored in the battery backed RAM. Additional diagnostic results are available for LEV phase I, Phase II and ULEV vehicles.

TID $00

Identifies the TID services supported by the ECM, 0 = No, 1 = Yes.

DATA 3: --> $FF (no significance)
Data is bit encoded across the remaining 4 data bytes
DATA 4: --> TID $01 .. TID $08 (Bit 7 corresponds to TID $01)
DATA 5: --> TID $09 .. TID $10
DATA 6: --> TID $11 .. TID $18
DATA 7: --> TID $19 .. TID $20 (Bit 0 corresponds to TID $20)

TIDs $20; $40; $60; $80; $A0; $C0 and $E0 respond similarly for their block of 32 TIDs.

For all supported TIDs the following applies: -

DATA 3: Bit 0 - 6: Number of the measuring path within the TID, i.e.; the component identifier (CID).
Bit 7: Type of test limit:
0 = Test limit is maximum value. The test fails if test value is greater than test limit
1 = Test limit is minimum value. The test fails if test value is less than test limit

DATA 4 + 5: 2- byte value of the measured value

DATA 6 + 7: 2- byte value of the threshold value

TID $01

Catalyst conversion

DATA 3 (TC6KATC/2): Bit 0 - 6: Number of the measuring path within the TID = CID.
Bit 7: Type of test limit:
0 = Test limit is maximum value. Test fails if test value > test limit
1 = Test limit is minimum value. Test fails if test value < test limit

DATA 4 + 5 (TC6KATW/2): 2- byte value of the measured value

DATA 6 + 7 (TC6KATS/2): 2- byte value of the threshold value

J1979 Mode $06 Data				
CID $ [h]	Fault Simulation	Test Value: Threshold	Indicated Fault	Display
05	B_szkat=0• ¶	ahkat > AHKATMX	Defective Catalyst Bank A	Pass/Fail
0A	B_szkat=0• ¶ AND B_fakat = true	ahkat > AHKTMXT	Defective Catalyst Bank A	Pass/Fail
08	B_szkat=0• ¶ AND (ahkat+ahkat2) >AHKATS AND ahkat>=ahkat2	ahkat > AHKATSB	Combined Fault Bank A	Pass/Fail
07	B_szkat=0• ¶ AND ahkat<=AHKATSB AND ahkat2<=AHKATSB	ahkat+ahkat2 >AHKATS	Combined Fault Banks A and B	Pass/Fail
06	B_szkat2=0• ¶	ahkat2 > AHKATMX	Defective Catalyst Bank B	Pass/Fail
0B	B_szkat2=0• ¶ AND B_fakat2 = true	ahkat2 > AHKTMXT	Defective Catalyst Bank B	Pass/Fail
09	B_szkat2=0• ¶ AND (ahkat+ahkat2) >AHKATS AND ahkat2>=ahkat	ahkat2 > AHKATSB	Combined Fault Bank B	Pass/Fail
07	B_szkat2=0• ¶ AND ahkat<= AHKATSB AND ahkat2<=AHKATSB	ahkat+ahkat2 >AHKATS	Combined Fault Banks A and B	Pass/Fail

TID $02

O2 Sensors
Not supported – covered by mode 5

TID $03

Secondary Air Injection System (Supported for LEV Phase I, Phase II and ULEV)

DATA 3 (TC6SLS/2): Bit 0 - 6:Number of the measuring path within the TID = CID.
Bit 7: Type of test limit:
0 = Test limit is maximum value. Test fails if test value > test limit
1 = Test limit is minimum value. Test fails if test value < test limit

DATA 4 + 5 (TC6SLSW/2): 2- byte value of the measured value

DATA 6 + 7 (TC6SLSS/2): 2- byte value of the threshold value

J1979 Mode $06 Data				
CID $ [h]	Fault Simulation	Test Value: Threshold	Indicated Fault	Display
05	AIOSLS = 55	ziosls < AIOSLS	Secondary Air Injection Functionality Fault Bank A	Pass/Fail
06	AIOSLS2 = 55	ziosls2 < AIOSLS2	Secondary Air Injection Functionality Fault Bank B	Pass/Fail
03	DFRMSLV = 0.05	dfrmsla > DFRMSLV	Control Valve Sealing Bank A	Pass/Fail
04	DFRMSLV = 0.05	dfrmsla2 > DFRMSLV	Control Valve Sealing Bank B	Pass/Fail
01	DFRMFC = 0.08	dfrmsla < DFRMFC	Flow Check Bank A	Pass/Fail
02	DFRMFC = 0.08	dfrmsla2 < DFRMFC	Flow Check Bank B	Pass/Fail

TID $04

Exhaust Gas Recirculation
Not fitted