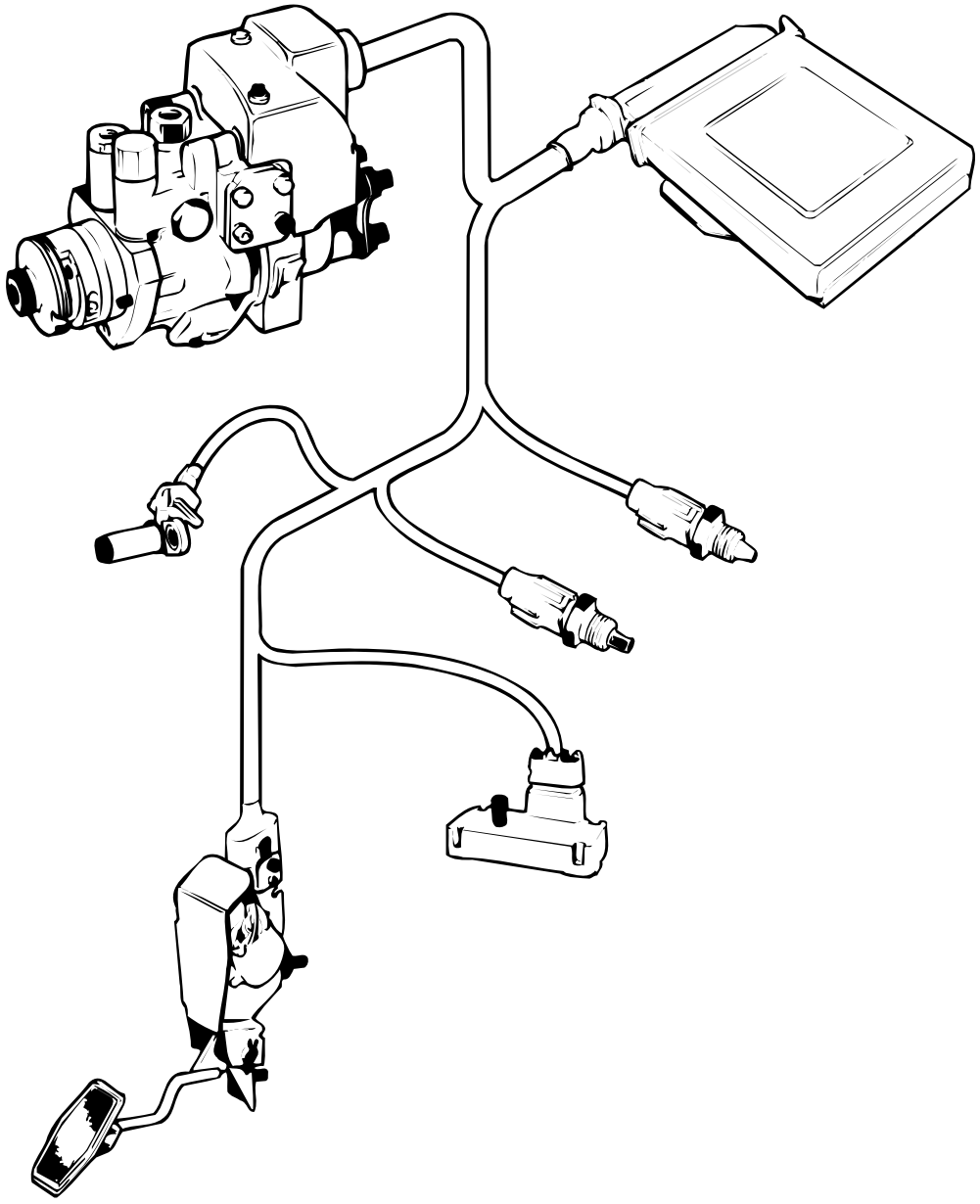
Service Workbook

EPIC D.I. Engine Management System



EPIC

ELECTRONIC PROGRAMMED INJECTION CONTROL

Service Workbook

This Service Workbook covers the EPIC engine fitted to LDV vehicles. It is primarily designed to assist skilled technicians in the efficient repair and maintenance of this system, but can also be used as a reference workbook for training purposes.
This Service Workbook should always be consulted prior to servicing or repair work.

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Notes

In some circumstances it may be possible for an electrical connector pin to become displaced axially, thus creating a poor connection or an open–circuit. That action is referred to in this Manual as “Backing off”.

The expression “ground” refers to any metallic part of the engine or vehicle structures which is electrically connected to the battery negative terminal.

Certain signals which may be displayed on the Laser 2000 screen are known as “internal variables”. For clarification, their names are shown in upper–case letters in this Manual e.g.: “EGR VALVE POSN” which represents the “feedback” from the EGR valve position sensor.

Abbreviations

BOB	– Break–Out–Box
CVT	– Current–to–Vacuum Transducer
EVR	– Electrical Vacuum Regulator
DCU	– Diesel Control Unit
EGR	– Exhaust Gas Recirculation
EMS	– Engine Management System
ESOS	– Electric Shut Off Solenoid
HPDS	– High Pedal Demand Switch
LPDS	– Low Pedal Demand Switch
NOx	– Nitrous Oxide
PATS	– Passive Anti–theft System
PDS	– Pedal Demand Sensor
PWM	– Pulse Width Modulation
SCP	– Standard Communications Protocol
TP	– Transfer Pressure
“Key on”	– The action of turning the ‘Ignition’ key
“Key off”	to the on/off positions
Precrank	– ‘Ignition’ key on, engine stationary prior to starting
Stalled	– Engine has stopped for reasons other than being switched off
OV	– Chassis Ground
+Bat	– Battery Voltage
“Wiggle Test”	– A test used to find intermittent wiring faults. It involves agitation of the wiring harness, particularly close to connections.

Contents

1.1 THE EPIC DI SYSTEM

The Lucas EPIC Diesel Fuel injection system provides electronic control of both the amount of fuel injected and the timing of injection in order to optimise exhaust emissions and fuel economy. The system comprises a rotary fuel injection pump (with electrical actuators and sensors), a Diesel Control Unit (DCU), various engine and vehicle sensors, a power hold relay, battery, key switch, and harness.

NOTE When a DCU is fitted to a vehicle/engine combination, it must be configured to suit that specific application. A DCU may not be transferred between vehicles fitted with Passive Anti–Theft (PATS).

The LDV 4EA 2.5TC engine is fitted, rated at 100 PS.

The Laser 2000 communicates with the DCU using the Standard Communications Protocol (SCP). The Laser 2000 requires hardware and software modules, diagnostic lead, and Break Out Box (BOB) to connect to the 55–pin DCU.

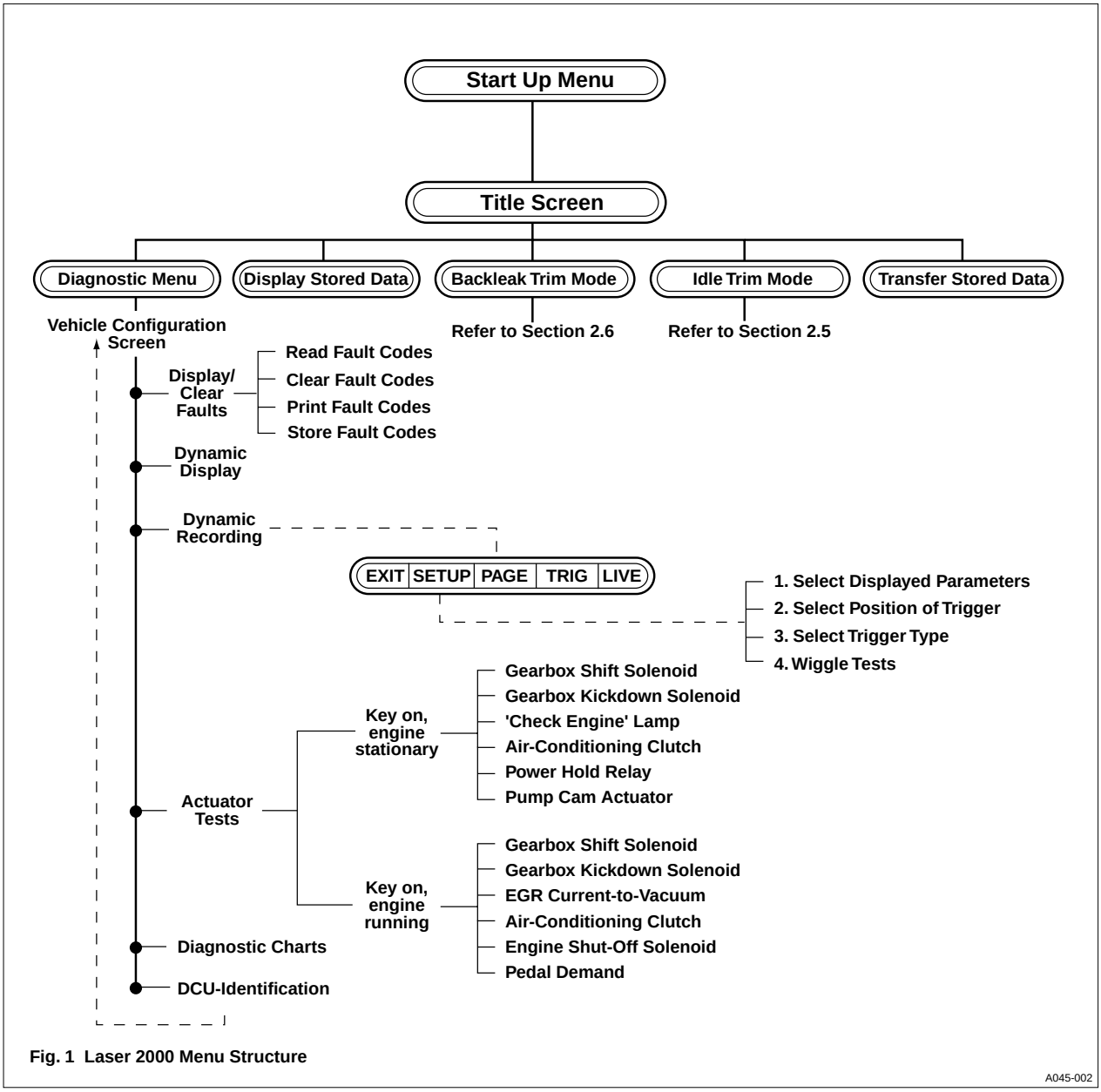

Fig. 1 Laser 2000 Menu Structure

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1.2 SAFETY PRECAUTIONS

1 For “on the road” tests using a LASER 2000, the vehicle must be driven by an assistant.

NOTE UNDER NO CIRCUMSTANCES MAY THE LASER 2000 BE LEFT CONNECTED TO THE VEHICLE SYSTEM FOR ANY TESTING BY THE OWNER/DRIVER. IT SHOULD ONLY BE USED BY AN EXPERIENCED TECHNICIAN.

2 Observe normal Health and Safety precautions when working with fuel systems, e.g. no smoking, no naked lights, and beware of the very high pressures generated within the injection system.

3 Ensure that the gear selector is in neutral and the parking brake is on when working on a stationary vehicle with the engine running.

4 If working in a confined area use exhaust fume extraction, or ensure adequate ventilation, whilst the engine is running.

5 Beware of moving engine parts when the engine is running.

6 Cleanliness should be observed at all times.

7 Ensure that any spilt fuel is thoroughly cleaned–up.

8 Incorrect electrical connections may damage sensitive electronic devices fitted to the vehicle.

9 Do not work on a vehicle whilst the battery is being charged from an external power source.

10 Ensure that all cables are clear of hot or moving parts. For on–the–road tests ensure that all cables and test equipment are secure and will not impede driving.

11 **DO NOT** disconnect the battery whilst the engine is running.

12 **DO NOT “**fast charge” the battery without disconnecting it from the vehicle’s electrical system.

13 Switch off the vehicle key switch before making or breaking electrical connections.

NOTE REFER TO THE PRECAUTIONS AND PRELIMINARY TESTS LISTED IN THE LASER 2000 OPERATING INSTRUCTIONS (Pub. No. XXB875).

2.1 TOOLS AND TRAINING

To enable fault–finding the following tools are required:

Laser 2000 Equipment

Laser 2000 kit **YWB700**
Diagnostic Cable **YWB776**
Software Module . . . . . **YDS120** (language)
Hardware Module **YWB722**

BOB Equipment

BOB **YWB741**
Adaptor Box **YDA200**
Pump–to–BOB Cable **YDA287**
Static Timing Device **YWB317**
Pressure & vacuum test kit . . **LDV141**

NOTE If a Laser 1500 is available, the BOB (YWB741) is not required but Adaptor Box YDA200 and Cable YDA287 are.

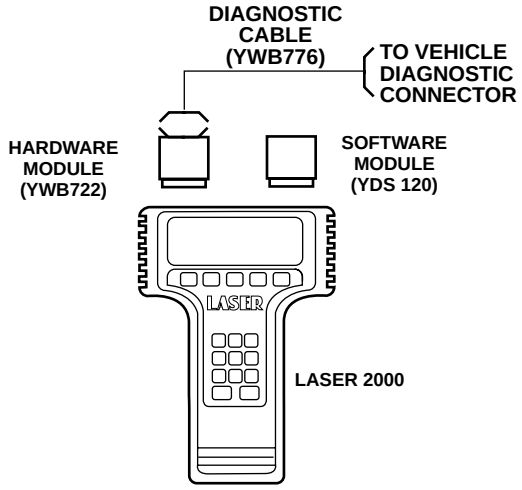

Fig. 2a Connection of the LASER

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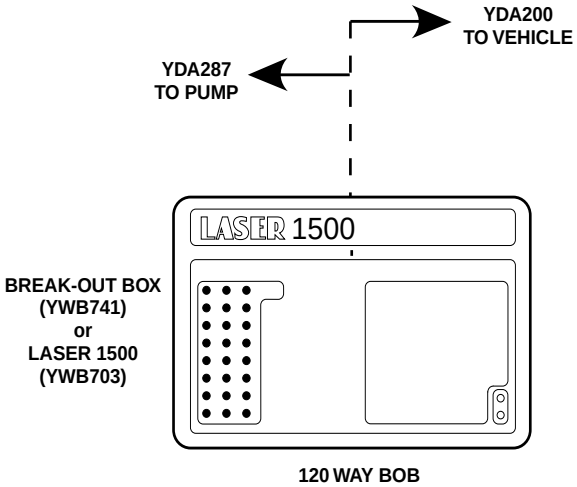

Fig. 2b Connection of the BOB

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During testing of the electrical and electronic equipment a digital multimeter is essential, preferably with the facility for measuring duty cycles (such as Lucas YWB208).

NOTE If the YWB208 multimeter is not available, any good quality digital multimeter may be used. However, if the instrument is not of the 'auto–ranging' type, ensure that its sensitivity is set to suit the range of the parameter being measured. (In addition, the meter must have a 'duty–cycle' measuring facility).

Users of this publication must have previously attended a LDV–approved training course and be fully conversant with the use of the Laser 2000 diagnostic equipment.

2.2 SYSTEM

The DCU controls all the major functions of the EPIC fuel injection system. It also detects when the system is not functioning correctly. When that happens, a 'faultcode' related to the fault is logged within the DCU and the Engine Management System (EMS) lamp on the dash board (see fig. 3) is illuminated. The logged code(s) may be retrieved using the Laser 2000. A fault which is recognised by the DCU is known as a 'coded fault'; any other faults are known as 'non–coded faults' and are not displayed by the Laser 2000.

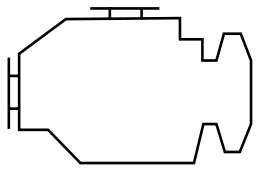

Fig. 3 EMS lamp Symbol

A045-007

2.2.1 Coded Faults

Coded Faults occur when:
An input is outside pre–programmed limits. That could be due to faulty connectors, wiring or sensor.

An input is within pre–programmed limits but is not changing as is expected by the DCU. A possible fault could be that of an actuator that is seized or worn.

Fault Codes are split into two types:

Current Faults The fault persists and continues during fault diagnosis. That could be due to a complete disconnection of a wire or connector.

Intermittent Faults The fault will be logged by the DCU but may not be apparent during subsequent diagnosis. That type of fault could be due to a loose or partially–damaged wire.

2.2.2 Non–Coded Faults

Not all faults which occur on the vehicle will be logged by the DCU. Those faults can be diagnosed with the aid of the Diagnostics Flowchart (see fig. 4) and section 3 of this Manual.

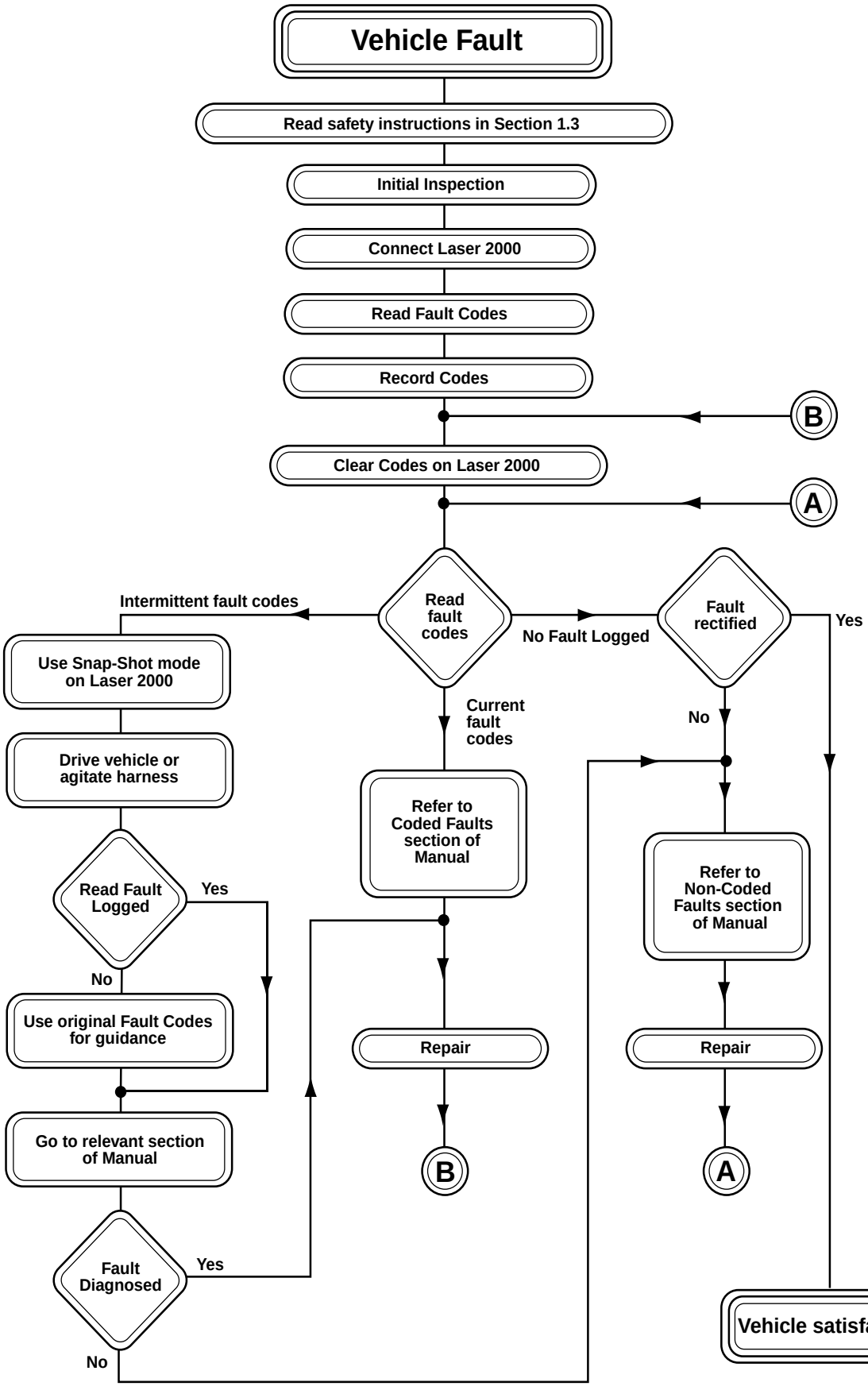

Fig. 4 Diagnostics Flowchart

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2.3 PROCEDURE

2.3.1 Initial inspection

Before connecting the Laser 2000 carry out an initial inspection of the vehicle to ensure that there is fuel in the tank, that there are no blocked airways, and no fuel leaks or loose pipes.

2.3.2 Flowchart

The Diagnostic Flowchart (see fig. 4) indicates the procedure which should be followed when diagnosing problems.

2.3.3 Laser 2000 and examination of Fault Codes

The Laser 2000 may display more than one fault code. If that is the case, investigate the codes in the sequence that the Laser 2000 displays them.

Remember that if a sensor is disconnected whilst the ignition is on, a fault code will be logged by the DCU. Fault codes could be induced by the driver tampering with engine components and disconnecting sensors. Clear these codes using the Laser 2000, then re–test the vehicle to ensure that only genuine fault codes are displayed.

For future reference, record all fault codes.

If coded faults are displayed, go directly to the section of this Manual relevant to that code using the index on the inside rear cover.

If the vehicle is not running correctly, and codes are not displayed by the Laser 2000, refer to the Non–Coded Fault section of this Manual.

'SNAP SHOT MODE' is of particular use when diagnosing intermittent faults. The Laser 2000 records data internally until a fault is identified. All the data is then stored in memory and can be examined later. When examining stored data after SNAP SHOT look for:

- Out–of–limits values.
- Sudden changes to the data.

Current faults cause all the dynamic data to lock at their default values when the engine is running. However the dynamic data is still valid during cranking. This is of use for fault–finding on engines which will not start.

2.3.4 Location of the DCU

See section 5.3 & 5.4 for the location of the DCU.

2.3.5 Electrical Testing

Only basic testing is required to determine if the electrical circuits are functional. The tests below describe the procedures:

(If the result of the test is the same as that described, there is a fault.)

a) Open–circuit.

Check the resistance between the pins specified in the diagnostic procedure. Infinite resistance indicates an open–circuit.

A resistance reading higher than specified, but less than infinity, indicates either corroded or loose connections, or a partial break in the wire strands.

b) Short–circuit.

Check the resistance between the pins specified in the diagnostic procedure. Measured resistances below infinity can indicate a partial short–circuit.

A resistance reading lower than specified indicates a short circuit.

c) Short–to–ground.

Check the resistance between the pin(s) specified in the diagnostic procedure and BOB connection 54.

A low resistance indicates a short–to–ground.

d) Short to +BAT.

Turn the ignition switch to position ll. Check the voltage between the pin(s) specified in the diagnostic procedure and BOB connection 54 (OV). If the meter reads battery voltage a short to +BAT exists.

Whilst carrying out these tests, agitate the harness close to the connections. If the results are unstable there is an intermittent break in the circuit.

2.3.6 Actuator Tests

Using the 'ACTUATOR TESTS' option, accessed from the Diagnostics Menu, individual actuators can be tested and their operation confirmed. The following items can be tested:

ENGINE RUNNING

Gearbox shift solenoid
Gearbox kickdown solenoid
EGR CVT
Air–conditioning clutch
ESOS
PDS

ENGINE STATIONARY ('KEYSWITCH' ON)

Gearbox shift solenoid
Gearbox kickdown solenoid
EMS lamp
Air–conditioning clutch
Power–hold relay
Advance actuator

2.4 REPAIR

After diagnosis it may be possible to repair a fault in the workshop. Procedures for all the possible workshop repairs are documented in the relevant Lucas Workshop Manual.

2.5 IDLE TRIM SETTING

Using the 'IDLE TRIM MODE' option, the idle speed can be adjusted within a range of ±50 rpm from the nominal idle speed to eliminate or reduce vehicle body vibrations. Check the following items before carrying out the idle setting procedure:

- There must be no CURRENT or INTERMITTENT faults.
- The engine must be running.
- The engine coolant temperature must be above 70 °C.
- The accelerator pedal must be fully released.
- If air–conditioning is fitted it must be switched off.
- The vehicle must be in neutral with the clutch engaged, or in 'PARK' if automatic.

1 Connect the LASER 2000 to the diagnostic plug in the vehicle fuse box (see Section 5.4).

Start the engine and allow it to idle.

2 Switch on the Laser 2000, select 'IDLE TRIM MODE' from the MAIN MENU.

3 Control the idle speed using the accelerator pedal (fully raised = minimum idle speed, fully depressed = maximum idle speed).

4 When the idle speed is correct, set it using key F5.

The revised idle speed will then be stored in the DCU.

2.6 BACKLEAK TRIM SETTING

Using the 'BACKLEAK TRIM' option, fine–tuning of the idling delivery can be achieved to eliminate or reduce body vibrations and improve other pump characteristics. Before carrying out this procedure

- There must be no CURRENT or INTERMITTENT faults.
- The engine must be running.
- The engine must be at normal operating temperature (i.e. coolant temperature must be above 77°C, or the pump temperature must be above 30°C).
- The accelerator pedal must be fully released.
- If air–conditioning is fitted it must be switched off.
- The vehicle must be in neutral with the clutch engaged, or in 'PARK' if automatic.

1 Connect the LASER 2000 to the diagnostic plug in the vehicle EPIC fuse box (see Section 5.3 & 5.4).

Start the engine and allow it to idle.

2 Switch on the Laser 2000, select 'BACKLEAK TRIM MODE' from the MAIN MENU.

3 The DCU will be set to the backleak trim mode; this will take approximately 10 seconds to execute.

On completion, LASER 2000 will display the status, i.e. 'BACKLEAK TRIM SUCCESSFUL' or 'UNSUCCESSFUL' and return to the MAIN MENU.

3.1 EMS WARNING LAMP FAILS TO SWITCH ON

Ensure that the EMS warning lamp is illuminated for a short period after key–on. If the bulb fails to illuminate then:

- Check for failed bulb
- Check that the EMS lamp is not obscured
- Check EMS lamp electrical connections.
- Check on BOB connector pins 44 and 47 for continuity of the lamp circuit, and pins 45 and 20, with key switch on, for battery voltage (+BAT).

3.2 ENGINE STOPS WHILST DRIVING OR IDLING, AND WILL NOT RESTART WHILST CRANKING

- Check for fuel in tank, and type i.e. not petrol.
- Check that the ducting to the air filter and turbocharger is clear.
- Ensure that there is no water in the fuel. If so:
  - Drain the fuel filter (and the tank if necessary),
  - Check that the water sensor is operating.
- Check for fuel leaks or loose fuel pipe connections.
- Check for restriction in the fuel tank vent causing the tank to implode, i.e. remove the filler cap.
- Fit a pressure/vacuum gauge in the fuel feed line to the pump, and crank the engine. The pressure should read positive. If it does not, check the following:
- Restriction in the fuel feed or return.
- The age of the fuel filter. Replace it if any doubt.
- Failed mechanical fuel pump.
- The key power circuit (refer to SCP fault code 1191).
- The power–hold relay circuit (refer to SCP fault code 1606) .
- The battery supply to the DCU (refer to SCP fault code 9671).
- Operation of the fuel injection pump by slackening the injector pipe at any injector and note the fuel discharge at the connector whilst cranking.

3.3 ENGINE WILL NOT START, OR IS DIFFICULT TO START AFTER NORMAL ENGINE STOP

- Check cranking speed and battery condition.
- Check operation of the fuel injection pump.
- Slacken the injector pipe at any injector and note fuel discharge at connector whilst cranking.
- If fitted, check the ‘Flamestart’ system (see fig. 5).
- Disconnect the fuel supply from the Flamestart heater element. Activate the system and check fuel flow to the element.
- Check the voltage supply to the element.
- Remove the element, reconnect the fuel supply and ensure that the voltage supply to the element is disconnected. Activate the system and if fuel does not flow from the element, rectify or replace the element.
- Remove the element, connect the voltage supply and earth, and ensure fuel supply is disconnected. Activate the system and renew the element if it does not glow.
- Check pump–to–engine timing.
- Follow procedures as for section 3.2.

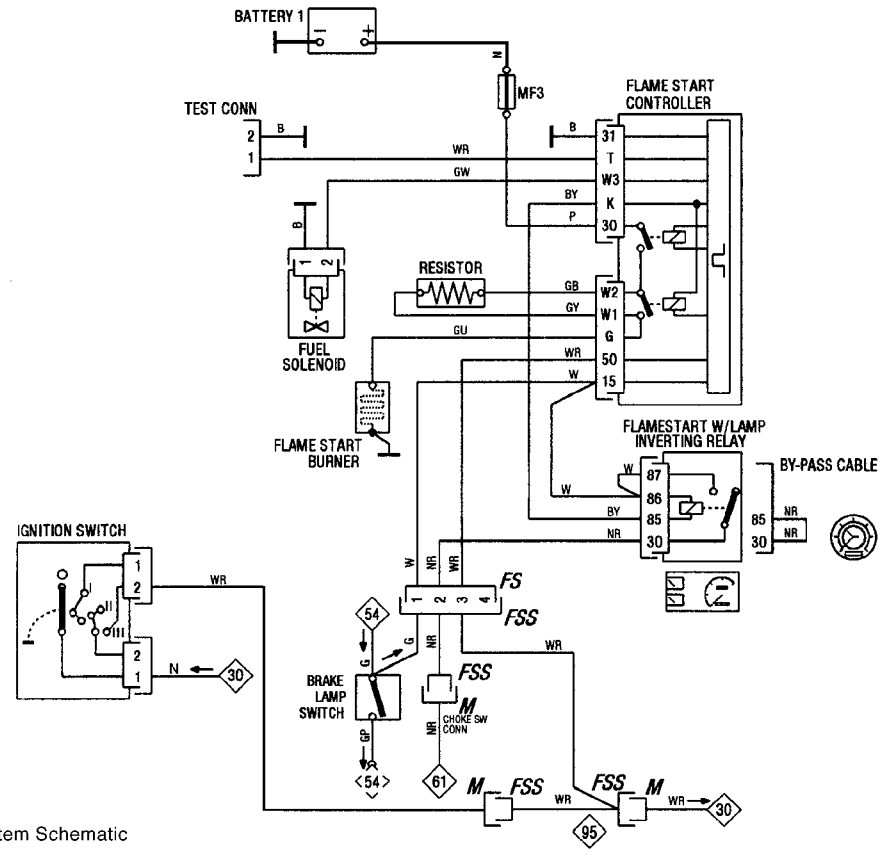

Fig. 5 Flamestart System Schematic

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3.4 UNSTABLE HOT IDLE, LOW POWER, SLOW ACCELERATION, STALLING OR POOR PULL AWAY

- Check that the air ducting to the air filter and turbocharger is clear.
- Read FUEL DEMAND on LASER 2000 whilst idling hot and carry out BACKLEAK TRIM.
- Check that correct grade of fuel is being used. If 'Winter grade' or 'City class' fuel is being used, carry out BACKLEAK TRIM.
- If CYL3 IDL FUEL, CYL1 OFFSET, CYL2 OFFSET, CYL4 OFFSET readings on the LASER 2000 show one value significantly different to the others, check the injectors and engine condition i.e. valve clearances etc.
- For a high mileage vehicle that has had no fuel injection pump or pump actuator changes, read and note the LASER 2000 DYNAMIC DISPLAY Values; If the ROTOR DELAY A value is greater than 35, change the pump horizontal actuator pair. If the ROTOR DELAY B value is greater than 50, change the pump vertical actuator pair.
- Check cylinder compressions.

3.5 REDUCED POWER (EXCESSIVE SMOKE)

- Check that the air ducting to the air filter and turbocharger is clear.
- Check that the throttle valve is operating.
- Check for restrictions in the exhaust system.
- Check that the boost sensor hose is attached, and for leaks from, and restrictions in, it.
- Check that the EGR valve is closing by removing the pipe to the valve, and noting if the valve makes a 'click' when it closes.
- If no faults are found, replace the boost sensor.

3.6 SMOKE AT LOW ENGINE SPEED (FULL LOAD)

- Carry out BACKLEAK TRIM (see Section 2.6).
- Check throttle operation.
- Replace the boost sensor.

3.7 REDUCED POWER (WITH NO SMOKE)

- Check that the ducting to the air filter and turbocharger is clear.
- Fit a pressure/vacuum gauge in the fuel feed line to the pump, and crank the engine. The pressure should read positive. If it does not, check the following:
  - Restriction in the fuel feed or return.
  - Age of the fuel filter. Replace if any doubt.
  - The mechanical pump.
  - For fuel leaks.
- Check that the EGR valve is closing by removing the pipe to the valve, and noting if the valve makes a 'click' when it closes.
- Check that the air–conditioning is not permanently operating.
- Check the fuel injection pump.

3.8 ENGINE DOES NOT STOP INSTANTLY ON 'KEY–OFF'

- DCU pin 38 shorted to +BAT (DCU pin 47). This will cause the fuel injection pump ESOS to over–heat and burn out.
- The spring–loaded plunger of the ESOS will not close– possibly due to debris contamination.

If the engine does not stop within 10 seconds then fault code 1170 will be logged by the DCU.

4.1 PUMP ROTOR CONTROL

Applicable codes : 1171, 1172, 1173, 1198

Description of Operation:

The 'Rotor A' and 'Rotor B' actuators control the axial displacement of the pump rotor, and hence the quantity of fuel injected. Opening Rotor A (feed) actuator decreases fuel, and opening Rotor B (drain) actuator increases fuel. The rotor sensor monitors the axial position of the rotor. Either rotor A or rotor B actuator is driven with a pulse from the DCU, whose duration is related to the difference between the required rotor position, (ROTOR DEMAND), and the measured rotor position, (ROTOR FEEDBACK) . Calculation of the required rotor position is based upon some or all of the following input signals:

- Throttle pedal demand
- Internal fuel 'mapping'
- Boost pressure
- Engine air inlet temperature
- Engine speed
- EGR valve position

The temperature compensation resistor is built into the rotor position sensor. Its thermal characteristic is in opposition to that of the sensor, thus eliminating 'drift' of the rotor position signal due to temperature changes.

Functions and Components Involved:

- Transfer pressure
- Rotor A (feed) actuator
- Rotor B (drain) actuator
- Rotor/drive shaft assembly
- Rotor position sensor (including the temperature compensation resistor)
- Backleak
- DCU
- Harness

1171 ROTOR POSITION

This fault code will be displayed if the DCU identifies either:

i) that the sensor resistance is outside limits e.g. open–circuit, short–circuited to ground or to +BAT.

ii) an accidental connection to ground or +BAT.

iii) that the temperature compensation resistor is outside limits e.g. open–circuit or short–circuit.

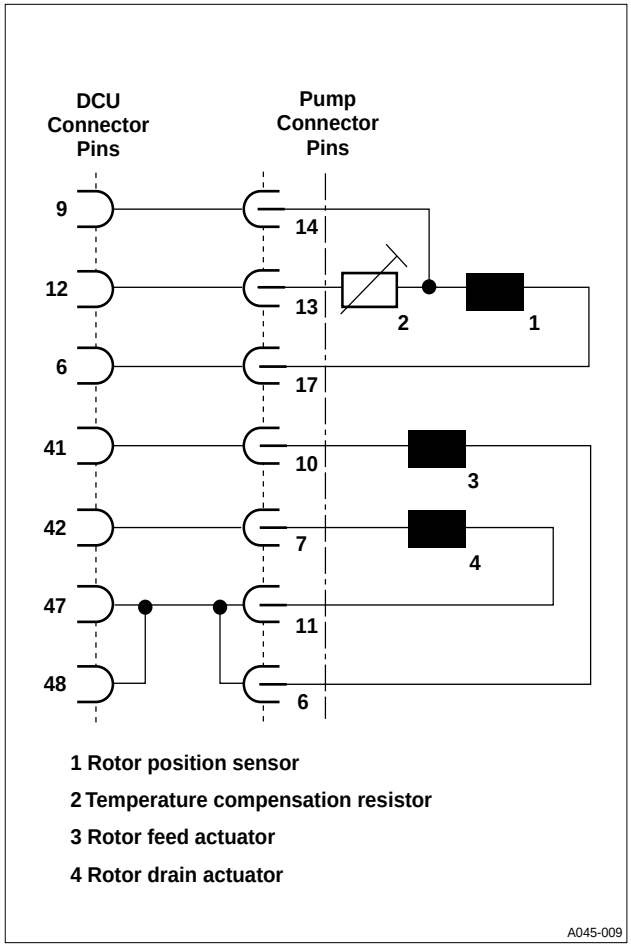
iv) that there is no feedback to the DCU.

The vehicle will show symptoms of greatly reduced power and impaired driveability.

Perform the following:

1 Ensure that the key–switch is off. Remove the connector from the DCU and check pins for damage, incorrect engagement etc.
If there are no faults, go to 3, otherwise, go to 2.

2 If damage is apparent, repair it and retest the vehicle.



1 Rotor position sensor

2 Temperature compensation resistor

3 Rotor feed actuator

4 Rotor drain actuator

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3 Fit the BOB. Test and record values for:

a) open–circuit
b) short–circuit
c) short–to–ground
d) short to +BAT

on BOB pins 9 & 6, and 9 & 12 (see table 1 in Section 5.6 for Rotor Position Sensor and Rotor Compensation Resistor values).
If there are no faults, go to 4, otherwise, go to 5.

4 Remove the BOB and reconnect the harness to the DCU . Clear any fault codes and retest the vehicle. If the fault(s) still occurs change the DCU.

5 Remove the connector from the pump and check the pins for damage, incorrect engagement etc.
If there are no faults, go to 7, otherwise, go to 6.

6 If damage is apparent, repair it, and retest the vehicle.

7 Fit the BOB, with the adaptor cable, to the pump connector. Test and record resistance values for:

a) open–circuit
b) short–circuit

on BOB pins 14 & 17, 14 and 13. (See table 1 in Section 5.5 for Rotor Position Sensor and Rotor Compensation Resistor values).
If there are no faults, go to 9, otherwise, go to 8.

8 There is a fault with the rotor sensor assembly. Repair the pump and retest the vehicle.

9 There is a fault with the vehicle harness. Repair it, and retest the vehicle.

1172 **PUMP ROTOR CONTROL OVERFUELLING**

1198 **PUMP ROTOR CONTROL UNDERFUELLING**

The vehicle symptoms are:

i) For code 1172 the engine will stop

ii) For code 1198 unstable idling and stalling.

For intermittent faults go to test 1.

For current faults go to test 2.

1 Start the engine and allow it to idle, connect the LASER 2000 and read the DYNAMIC DISPLAY values, ROTOR DEMAND, and ROTOR FEEDBACK. Note the difference between the two values. Use the SNAP SHOT facility to assist in this test.

If the DEMAND and FEEDBACK difference is 5 or less, go to test 2. If greater than 5, got to test 6.

2 Fit a pressure/vacuum gauge in the fuel feed line to the pump and run the engine. In neutral gear and at full throttle, the pressure should read positive, approx. 0.2 bar when warm and less when cold.

If there are no faults, go to 4, otherwise, go to 3.

3 If the pressure reading is below zero (i.e. a vacuum), check the fuel supply circuit from tank to pump e.g. filter and lift pump, and for imploded fuel tank or pipes etc., and rectify. Retest the vehicle.

4 Remove the 24 mm A/F blanking plug, situated beside the inlet and outlet connectors, and fit adaptor, 6408–64 with an O–ring. Fit, preferably, a 0 to 14.0 bar pressure gauge. At idle, the transfer pressure should read between 4.8 to 6.9 bar.

If there are no faults, go to 6, otherwise, go to 5.

5 If the pressure is low either the transfer pressure (TP) regulator is stuck open (see Workshop Manual XNB100 for repair) or the transfer pump is worn or broken (remove the pump assembly and replace it). If the TP is high, the TP regulator is stuck closed (see Workshop Manual XNB100 for repair). Remove the TP adaptor, refit the TP plug (ensure that the O–ring is fitted) and tighten it to 23 Nm (204 lb in). Retest the vehicle.

6 Ensure that the key–switch is off. Remove the connector from the DCU and check pins for damage, incorrect engagement etc.

If there are no faults, go to 7, otherwise, go to 8.

7 If damage is apparent, repair it and retest the vehicle.

8 Fit the BOB. Test and record values for:

a) Open–circuit

b) Short–circuit

c) Short–to–ground

d) Short to + BAT

Fit on BOB pins 41 & 47, and 42 & 47 (see table 1 in Section 5.5 for Rotor A and Rotor B actuator resistance values).

If there are no faults, go to 9, otherwise, go to 10.

9 Remove the BOB and reconnect the harness to the DCU. Clear any fault codes and retest the vehicle. If the 2 fault still occurs, go to 12.

10 Remove the connector from the pump and check pins for damage, incorrect engagement etc. If there are no faults, go to 12, otherwise, go to 11.

11 If damage is apparent, repair it and retest the vehicle.

12 Fit the BOB with the adaptor cable to the pump connector. Test and record values for:

a) open–circuit

b) short–circuit

on BOB pins 10 & 6, and 7 & 11 (see table 1 in Section 5.5 for Rotor A and Rotor B actuator resistance values).

If test 12 is correct and test 8 is incorrect go to 14; if both tests 12 and 8 are correct go to 15, if test 12 is incorrect go to 13.

13 Fault with an actuator. Identify which actuator from its resistance value (see Section 5.6). Repair the pump and retest the vehicle. If the fault is still present go to 1.

14 Fault with the vehicle harness. Repair and retest the vehicle. If the fault is still present go to 1.

15 Remove the BOB and refit the DCU. Use the LASER 2000 to read the DYNAMIC DISPLAY values; ROTOR DELAY A (feed) and ROTOR DELAY B (drain) and note the values. ROTOR DELAY A should be less than 35 and ROTOR DELAY B less than 50.

If there are no faults, go to 17, otherwise, go to 16.

16 If either of the DELAYS is above limits, the relevant actuator is at fault. Repair the pump and retest the vehicle. If the fault is still present go to 1.

17 Clear any fault codes present. Retest the vehicle and if the fault is still present, change the DCU.

1173 **PUMP ROTOR CALIBRATION**

This fault code will be displayed if:

i) In the 'pre–crank' state ('key–on'), the DCU indicates when the rotor sensor is above or below limits.

NOTE At rest, the rotor sensor core is on its end stop (maximum fuel).

ii) In the 'engine running' state, the DCU indicates, in the zero fuel condition, that the rotor sensor is outside an allowed range.

NOTE When the pedal is fully released, the rotor is driven to the zero fuel end–stop.

The cause may be due to the following:

- A fault in the harness or the rotor sensor connector
- Roller shoes tight in the drive shaft
- Misalignment of the drive shaft and rotor

The vehicle will show symptoms of greatly reduced power and impaired driveability.

For intermittent faults go to test 1.

For current faults go to test 6.

Fit the BOB and connect the Laser 2000.

1 Stop the engine. When it is stationary, key–on and note the ROTOR FEEDBACK value.

If the FEEDBACK value is within 212 to 240 go to test 2.
If it is outside those limits go to 3.

2 Whilst agitating the harness at the pump and the DCU, note any ROTOR FEEDBACK variation.

If the ROTOR FEEDBACK differs by more than +/– 2 go to test 5. If inside limits, go to test 6.

3 Ensure that the key switch is off. Rotate the engine clockwise manually through 90°, using a spanner or wrench on the front pulley bolt, and note the ROTOR FEEDBACK value.

If the FEEDBACK value has changed by more than 5 from that noted in test 1, go to 4. If no change, go to test 6.

4 Fault with the pump rotor. Repair the pump and retest the vehicle.

5 Start, stop and 'key–on' a couple of times and note the ROTOR FEEDBACK at 'key–on'.

If the ROTOR FEEDBACK varies by more than +/– 5 go to 4. If the FEEDBACK does not vary, go to test 6.

6 Drive the vehicle in third gear, down–hill. With the vehicle driving the engine (foot off the pedal), note the ROTOR FEEDBACK in this condition.

If the value is less than 5 go to 8. If the value is greater than 4, go to 7.

7 Fault with the pump rotor. Repair the pump and retest.

8 Ensure that the key–switch is off. Remove the connector from the DCU and check pins for damage, incorrect engagement etc. If there are no faults, go to 10, otherwise, go to 9.

9 If damage is apparent, repair it and retest the vehicle.

10 Fit the BOB. Test and record values for:

a) Open–circuit
b) Short–circuit
c) Short–to–ground
d) Short to + BAT

on BOB pins 9 & 6 (see table 1 in Section 5.5 for Rotor Sensor resistance values).

If there are no faults, go to 11, otherwise, go to 12.

11 Remove the BOB and reconnect the harness to the DCU. Clear any fault codes and retest the vehicle. If the fault still occurs change the DCU.

12 Remove the connector from the pump and check pins for damage, incorrect engagement etc. If there are no faults, go to 14, otherwise go to 13.

13 If damage is apparent, repair it and retest the vehicle.

14 Fit the BOB with the adaptor cable to the pump. Test and record values for:

a) open–circuit
b) short–circuit

on BOB pins 14 and 17 (see table 1 in Section 5.5 for Rotor Sensor resistance values).

If test 14 is correct go to test 16, if incorrect go to 15. If both tests 10 and 14 are correct go to 17.

15 Fault with rotor sensor assembly. Repair the pump and retest the vehicle.

16 Fault with the vehicle harness. Repair it and retest the vehicle.

17 Mechanical fault with the pump. Repair the pump and retest the vehicle.

4.2 ELECTRIC SHUT–OFF SOLENOID (ESOS)

Connector Applicable code: 1170

Description of Operation:

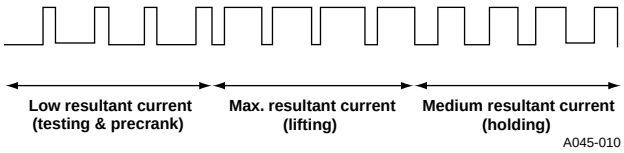
The ESOS plunger is held closed by a spring. Lifting of the plunger requires energisation of the ESOS coil. The supply to the ESOS is 'pulse–width modulated' (PWM). See Section 5.7 for an explanation of 'PWM'. The ratio of 'on' to 'off' periods is varied by the DCU to provide the current level required for the three modes in which the ESOS operates.

The modes are:

a) Engine stationary, key–switch on. The DCU supplies a small current to check the integrity of the ESOS circuit.

b) When, during cranking, the DCU is satisfied that the rotor is in the position required for starting it will supply maximum current for rapid opening of the ESOS.

c) When the ESOS is fully open, less current is required to maintain that position. The DCU will reduce the current accordingly.



To minimise black smoke on start–up above 0°C, the ESOS is not operated until the pump rotor is in the correct position for starting. Below 0°C, the ESOS is operated instantly on start–up.

Functions and Components involved:

Transfer pressure
Backleak value
ESOS
DCU
Harness

Failure may be due to one or more of the following:

Restricted fuel supply to the pump
Restricted backleak return to the filter
Air venting through the system after a filter change.

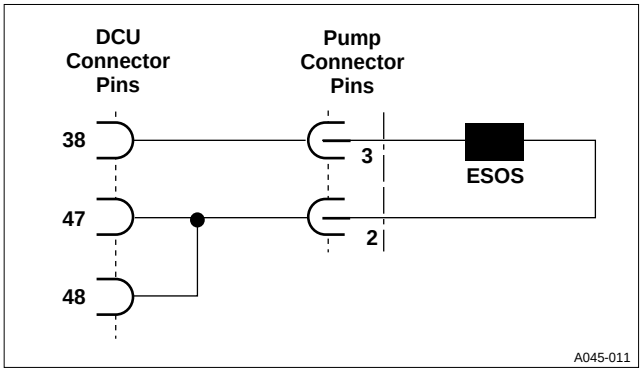
TP regulator fault
TP cassette fault
ESOS fault
Harness/connector fault

1170 ESOS DRIVE CURRENT

The vehicle symptoms are that the engine will not start, it stops, or it will not restart. If the engine does restart, only limited power 12 will be available

Perform the following:

1 If the engine stops and will not restart, go to 8.
If the engine stops and can be restarted, but runs either erratically with stalling or with reduced power, go to 2.



2 Connect the LASER 2000, start and idle the engine. Set the LASER 2000 to DIAGNOSTICS MENU/ACTUATOR TESTS/KEY ON ENGINE RUNNING/ENGINE SHUT OFF SOLENOID. Operate the ESOS by pressing STOP (F2). Restart the engine and allow it to idle. If in test 2 the engine does not stop, go to 3. If in test 2 the engine stops instantly but will not restart or starts sluggishly, go to test 4.

3 Fault with the ESOS. Repair it and retest the vehicle.

4 Fit a pressure/vacuum gauge in the fuel feed line to the pump and run the engine. In neutral gear and full throttle, pressure should read positive, approx. 0.2 bar when warm and less when cold.
If test 4 is correct go to 6, if incorrect go to 5.

5 If the pressure reading is below zero (vacuum), check the fuel supply circuit from tank to pump e.g filter, lift pump, collapsed fuel tank, pipes etc. and rectify. Retest.

6 Remove the 24 mm A/F blanking plug, situated beside the inlet and outlet connectors, and fit adaptor 6408–64, with an O–ring. Fit, preferably, a 0 to 14.0 bar pressure gauge. At idle, the transfer pressure should read between 4.8 to 6.9 bar.
If test 6 is correct go to 8, if incorrect go to 7.

7 If the pressure is low then either the transfer pressure (TP) regulator is stuck open (see Workshop Manual XNB100 for repair) or the transfer pump is worn or broken (remove the pump and repair). If the TP is high, the TP regulator is stuck closed (see Workshop Manual XNB100 for repair). Remove the TP adaptor, refit the TP plug (ensure that the O–ring is fitted) and tighten it to 23 Nm (204 lb in). Retest the vehicle.

8 Ensure that the key–switch is off. Remove the connector from the DCU and check pins for damage, backing–off etc. If test 8 shows no fault go to 10, if incorrect go to 9.

9 If damage is apparent, repair it and retest the vehicle.

10 Fit the BOB. Test and record resistance values for:

- **a)** Open–circuit
- **b)** Short–circuit
- **c)** Short–to–ground d) Short to +BAT

on BOB pins 38 & 47 (see table 1 Section 5.5 for ESOS resistance value). If test 10 is correct go to 11, if incorrect go to 12.

11 Remove the BOB, reconnect the harness to the DCU and retest the vehicle. If the fault is still present change the DCU.

12 Remove the connector from the pump and check pins for damage, backing–off etc. If test 12 shows no fault go to test 14, if incorrect go to test 13.

13 If damage is apparent, repair it and retest the vehicle.

14 Fit the BOB with adaptor cable to pump connector. Test and record resistance values for:

- **a)** Open–circuit
- **b)** Short–circuit

on BOB pins 3 & 2 (see table 1 in Section 5.5 for ESOS resistance value). If test 14 is correct go to 16, if incorrect go to 15.

15 Fault with the ESOS. Repair the pump and retest the vehicle. If the fault still present go to 1.

16 Fault with the vehicle harness. Repair it and retest the vehicle. If the fault is still present go to 1.

4.3 PUMP CAM CONTROL AND PUMP TEMPERATURE SENSOR

Applicable codes : 1174, 1175, 1176, 0185, 1185, 1186

Description of Operation:

The advance piston is engaged with the cam advance screw and rotates the cam ring. Injection timing is determined by the position of the cam ring, which is controlled by the DCU–driven cam actuator (CAM DEMAND). The position of the cam is determined from the cam sensor feedback (CAM FEEDBACK).

The current flowing through the actuator coil determines how far the plunger opens. The current is derived from a PWM supply (see Section 5.6 for explanation of PWM).

The DCU controls the cam position in such a way as to reduce any difference between CAM DEMAND and CAM FEEDBACK.

To resist 'cam reaction' during the pumping cycle, the cam ring is locked hydraulically by the lock–off ball assemblies. A small orifice is positioned in parallel with the lock–off assembly to allow the advance piston to retard, when required, during the non– pumping part of the cycle.

The pump temperature sensor is built into the cam position sensor and functions independently of it.

Functions and Components involved:

Transfer pressure
Pump cam control actuator
Pump cam position sensor
Pump cam position sensor core
Pump temperature sensor
Cam advance screw
Cam position sensor core drive pin.
Advance piston (includes control orifice)
Advance piston spring Lock–off assemblies and orifice plug
Backleak
DCU
Harness

1174 PUMP CAM POSITION

This fault code will be displayed if the DCU identifies either:

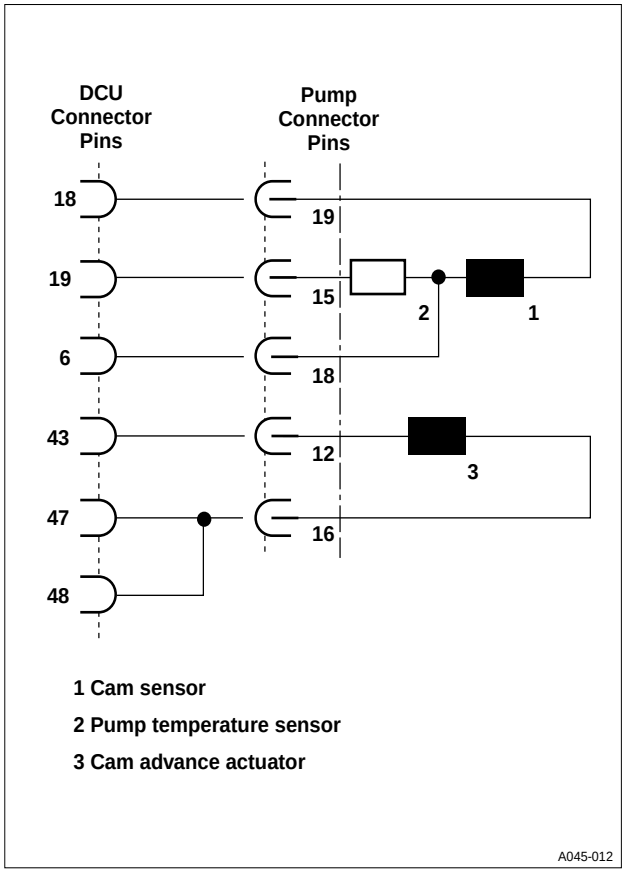
i) That the sensor resistance is outside limits e.g. open–circuit, short–circuit to ground or +BAT.
ii) That there is no feedback to the DCU.

The vehicle will show symptoms of reduced power and impaired driveability.

Perform the following:

1 Ensure that the key–switch is off. Remove the connector from the DCU and check pins for damage, backing–off etc. If there are no faults, go to 3, otherwise, go to 2.

2 If damage is apparent, repair it and retest vehicle.



3 Fit the BOB. Test and record resistance values for:

a) Short–circuit
b) Open–circuit
c) Short–to–ground
d) Short to +BAT

on pins 6 & 18 (see table 1 in Section 5.5 for Cam Sensor resistance value). If there are no faults, go to 4, otherwise, go to 5.

4 Remove the BOB and reconnect the harness to the DCU. Clear any fault codes and retest the vehicle. If the fault still occurs change the DCU.

5 Fit the BOB to the pump using the adaptor cable. Test and record resistance values for: a) Open–circuit b) Short–circuit on BOB pins 18 & 19 (see table 1 in Section 5.5 for Cam sensor resistance value). If no fault is apparent go to 7, if faulty then go to 6.

6 Fault with the cam sensor assembly. Repair the pump and retest the vehicle.

7 Fault with the vehicle harness. Repair it and retest the vehicle.

1175 PUMP CAM CONTROL

This code will also be displayed if the cam ring 'drifts' from its CAM DEMAND position.

Failure may be due to one or more of the following:

Restricted fuel supply to the pump
Restricted backleak return to the filter
Harness/connector fault
TP regulator fault
Transfer pump assembly fault
Actuator seat worn
Air venting through the fuel system after filter change.
Lock–off assemblies worn, damaged, missing, or incorrectly assembled.

Perform the following:

1 Fit a pressure/vacuum gauge in the fuel feed line to the pump and run the engine. In neutral gear and at full throttle, pressure should read positive (approx. 0.2 bar when warm and less when cold).

If there are no faults, go to 3, otherwise, go to 2.

2 If the pressure reading is below zero (i.e. a vacuum), check the fuel supply circuit from the tank to the pump e.g filter and lift pump, and for imploded fuel tank or pipes etc., and rectify. Retest.

3 Remove the 24 mm A/F blanking plug, situated beside the inlet and outlet connectors, and fit adaptor 6408–64, complete with an O–ring. Fit, preferably, a 0 to 14.0 bar pressure gauge. At idle, the transfer pressure should read between 4.8 to 6.9 bar.

If there are no faults, go to 5, otherwise, go to 4.

4 If the pressure is low either the TP regulator is stuck open (see SIN D047 for repair) or the transfer pump is worn or broken (replace the pump). If the TP is high, the TP regulator is stuck closed (see SIN D047 for repair). Remove the TP adaptor, refit the TP plug (ensure that the O–ring is fitted) and tighten it to 23 Nm (204 lb in).

Retest the vehicle.

5 Ensure that the key–switch is turned off. Connect the LASER 2000, turn the key–switch on, and set the LASER 2000 to ACTUATOR TESTS/ PUMP CAM ACTUATOR. Disconnect the harness from the pump. Using the DOWN (F2) key, set PUMP CAM PWM DRIVE to zero. Using the UP (F4) key set PUMP CAM PWM DRIVE to 1000. Using a multimeter set to milliamps (mA), measure and record the current on the harness connector pins 12 and 16.

If the value is between 70 and 80 mA, go to 6. If the value is outside these limits, go to 7.

6 Fault with the pump. Rectify it and retest.

7 Ensure that the key–switch is off. Remove the connector from the DCU and check both DCU and pump connector pins for damage, backing–off etc. If there are no faults, go to 9, otherwise, go to 8.

8 If damage is apparent, repair it and retest the vehicle.

9 Fit the BOB. Test and record resistance values for:

a) Open–circuit
b) Short–to–ground
c) Short to +BAT

between BOB pin 43 and harness connector pin 12, and BOB pin 47 and harness connector pin 16.

If there are no faults, go to 10, otherwise, go to 11.

10 DCU fault. Replace it and retest the vehicle.
11 Harness fault. Repair it and retest the vehicle.

NOTE If a LASER 2000 is not available, carry out continuity checks on:

i) DCU connector pins 43 and 47, via the BOB,

ii) Pump connector pins 12 and 16 (see table 1 in Section 5.6 for the Cam actuator resistance value)

1176 PUMP CAM CALIBRATION

This fault code will be displayed if, in the 'pre–crank' state (key–switch on), the DCU identifies that the cam calibration is above or below limits. Note that, at rest, the advance piston is on its end stop.

The vehicle symptoms are reduced power and impaired driveability.

Perform the following:

1 When the key–switch is turned on, CAM FEEDBACK should be between 8 and 16.

If CAM FEEDBACK value is outside limits, go to test 2.
If CAM FEEDBACK value is inside limits, go to 4.

2 Start the engine, stop it and turn the key–switch on twice, noting the CAM FEEDBACK values.

If the value changes to that in test 1, go to 3.
If the value does not change, go to 4.

3 Pump sensor, core, or cam ring fault.

4 Ensure that the key–switch is off. Remove the connector from the DCU and check the pins for damage, backing– off etc. If there are no faults, go to 6, otherwise, go to 5.

5 If damage is apparent, repair it and retest the vehicle.

6 Fit the BOB. Test and record resistance values for:

- **a)** Open–circuit
- **b)** Short–circuit
- **c)** Short–to–ground
- **d)** Short to +BAT

on BOB pins 6 & 18 (see table 1 in Section 5.5 for Cam sensor resistance values). If there are no faults, go to 8, otherwise, go to 7.

7 Remove the BOB and reconnect the harness to the DCU. Clear any fault codes and retest the vehicle. If the fault still occurs change the DCU.

8 Remove the connector from the pump and check pins for damage, backing–off etc. If there are no faults, go to 10, otherwise, go to 9.

9 If damage is apparent, repair it and retest the vehicle.

10 Fit the BOB to the pump using the adaptor cable. Test and record resistance values for:

- **a)** Open–circuit
- **b)** Short–circuit

between BOB pins 18 and 19 (see table 1 in Section 5.5 for Cam sensor resistance value). If there are no faults, go to 12, otherwise, go to 11.

11 Fault with the cam sensor assembly. Repair the pump and retest the vehicle.

12 Fault with the vehicle harness. Repair it and retest the vehicle.

0185 PUMP TEMPERATURE

1185 PUMP TEMPERATURE HIGH

1186 PUMP TEMPERATURE LOW

These fault codes will be displayed if the DCU identifies that the sensor is outside resistance limits.

The sensor is a negative temperature coefficient thermistor (its resistance is inversely proportional to temperature) i.e. low resistance = high temperature, high resistance = low temperature. An open–circuit failure (infinite resistance) will display a low temperature value and a short–circuit failure (low resistance) will display a high temperature value.

The vehicle will show symptoms of slightly reduced power.

Perform the following:

1 Ensure that the key–switch is off. Remove the connector from the DCU and check the pins for damage, backing– off etc.

If there are no faults, go to 3, otherwise, go to 2.

2 If damage is apparent, repair and retest vehicle.

3 Fit the BOB. Test and record resistance values for:

- **a)** Open–circuit
- **b)** Short–circuit
- **c)** Short–to–ground
- **d)** Short to +BAT

on pins BOB 6 & 19 (see table 1 in Section 5.5 for pump temperature sensor resistance values). If there are no faults, go to 4, otherwise, go to 5.

4 Remove the BOB and reconnect the harness to the DCU. Clear any fault codes and retest the vehicle. If the fault still occurs change the DCU.

5 Remove the connector from the pump and check the pins for damage, backing–off etc. If there are no faults, go to 7, otherwise, go to 6.

6 If damage is apparent, repair it and retest the vehicle.

7 Fit the BOB to the pump using the adaptor cable. Test and record resistance values for:

- **a)** Open–circuit
- **b)** Short–circuit

on BOB pins 15 & 18 (see table 1 in Section 5.5 for pump temperature sensor resistance values).

If test 7 shows no fault go to 9, if it is incorrect go to 8.

8 Fault with the cam sensor assembly. Repair the pump and retest the vehicle.

9 Fault with the vehicle harness. Repair it and retest the vehicle.

4.4 CALIBRATION RESISTOR

Applicable codes : 11 90

Description of Operation:

The calibration resistor is located in the pump connector. A range of resistances is used for production fuel setting.

The vehicle symptom is a slight loss of power.

Components involved:

Calibration resistor pump connector
(within the harness)
DCU

1190 **CALIBRATION RESISTOR**

This fault code will be displayed if either:

i) The measured value lies outside the tolerance band
ii) Apparent nominal resistor value differs from that measured on 'key–on'.

Perform the following:

Record the value of the calibration resistor which is fitted, by referringtotheLASER2000/DIAGNOSTICSMODE/DYNAMIC DISPLAY / CALIBRATION. (Refer to table 2 in Section 5.5 for Calibration Resistor values.)

1 Ensure that the key–switch is off. Remove the connector from the DCU and check the pins for damage, backing–off etc.
If there are no faults, go to 3, otherwise, go to 2.

2 If damage is apparent, repair it and retest the vehicle.

3 Fit the BOB. Test and record resistance values for:

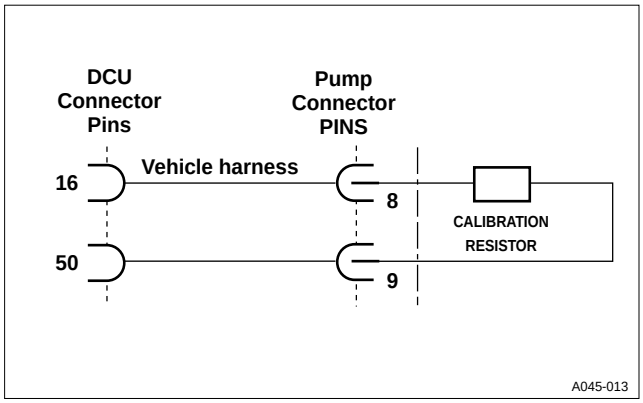
a) Open–circuit
b) Short–circuit
c) Short–to–ground
d) Short to +BAT

on BOB pins 16 & 50. (See table 2 in Section 5.5 for Calibration Resistor values.) If there are no faults, go to 4, otherwise, go to 5.

4 Remove the BOB and reconnect the harness to the DCU. Clear any fault codes and retest the vehicle. If the fault still occurs change the DCU.

5 Remove the connector from the pumpa nd check pins for damage, backing–off etc. If there are no faults, go to 7, otherwise, go to 6.

6 If damage is apparent, repair it and retest the vehicle.



7 Fit the BOB to the pump using the adaptor cable. Test and record resistance values for:

a) Open–circuit
b) Short–circuit

Between BOB pins 9 & 8 (using data from item 3 above, see table 2 in Section 5.6 for value). If there are no faults, go to 9, otherwise, go to 8.

8 Fault with the connector assembly. Repair the pump and retest the vehicle.

9 Fault with the vehicle harness. Repair it and retest the vehicle.

4.5 PUMP SPEED SENSOR (DRIVE SHAFT POSITION)

Applicable codes : 1644, 1189

Description of Operation:

The pump speed sensor is a 'Hall Effect' device, note that the 'period' is the time between identical points on successive cycles. There are four pulses per pump revolution.

The vehicle symptom is loss of power (reduced fuel).

Components involved:

Pump speed (drive shaft position) sensor
Harness and connectors
DCU

Test Equipment:

Use the static timing device YWB317 and the specified BOB.

1644	**PUMP SPEED SENSOR**
1189	**PUMP SPEED LOST**

These faults will be displayed if either:

i) The period is not within the allowed limit, or
ii) No pump speed signal is present.

The sensor detects the passage of 'flags' on the pump timing ring and supplies to the DCU a signal which is interpreted to provide the following:

i) Pump speed.
ii) Drive shaft angular position (basic timing).

Perform the following:

1 Ensure that the key–switch is off. Remove the connector from the DCU and check the pins for damage, backing– off etc.
If there are no faults, go to 3, otherwise, go to 2.

2 If damage is apparent, repair it and retest the vehicle.

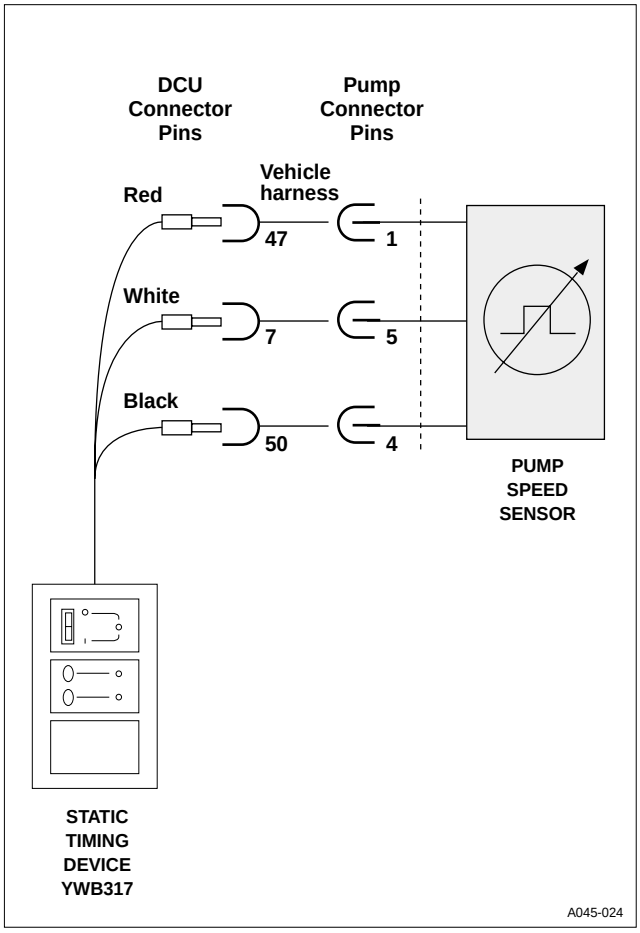
3 Fit the BOB. Plug the timing device into the BOB in the following order:

Red wire to pin 47
Black wire to pin 50
White wire to pin 7.

Crank the engine and note if the red and green LEDs on the timing device flash alternately and evenly.

NOTE Every fourth pair of flashes will be slightly shorter than the others.

If test 3 is correct go to 4, if it is incorrect i.e. uneven or no flashes, go to 5.



4 Remove the BOB and reconnect the harness to the DCU. Clear any fault codes and retest the vehicle. If the fault still occurs change the DCU.

5 Remove the connector from the pump and check the pins for damage, backing–off etc.

If there are no faults, go to 7, otherwise, qo to 6.

6 If damage is apparent, repair it and retest the vehicle.

7 Fit the BOB to the pump connector with the adaptor cable. Plug the timing device into the BOB in the following order:

Red wire to pin 1
Black wire to pin 4
White wire to pin 5.

Crank the engine and note if the red and green LED's on the timing device flash alternately and evenly.

NOTE Every fourth pair of flashes will be slightly shorter than the others.

If test 7 is correct go to 9, if it is incorrect go to 8.

8 Fault with the pump speed sensor. Repair the pump and retest the vehicle.

9 Fault with the vehicle harness. Repair it and retest the vehicle.

4.6 PEDAL SENSOR CONTROL

Applicable codes : 1180, 1181, 1182, 1183, 1184, 1252, 1253, 1254, 1255, 1256, 1257, 1258

Description of Operation:

The assembly comprises:

A 'reverse' twin–pack potentiometer (PDS1 & PDS2)
A 'low pedal–demand' (idling position) switch (LPDS)
A 'high pedal–demand' (kick–down position) switch (HPDS)

NOTE A 'reverse twin–pack potentiometer' comprises a pair of potentiometers mounted on the same shaft and arranged so that when one of the pair presents a high voltage at its output, the other presents a low voltage.

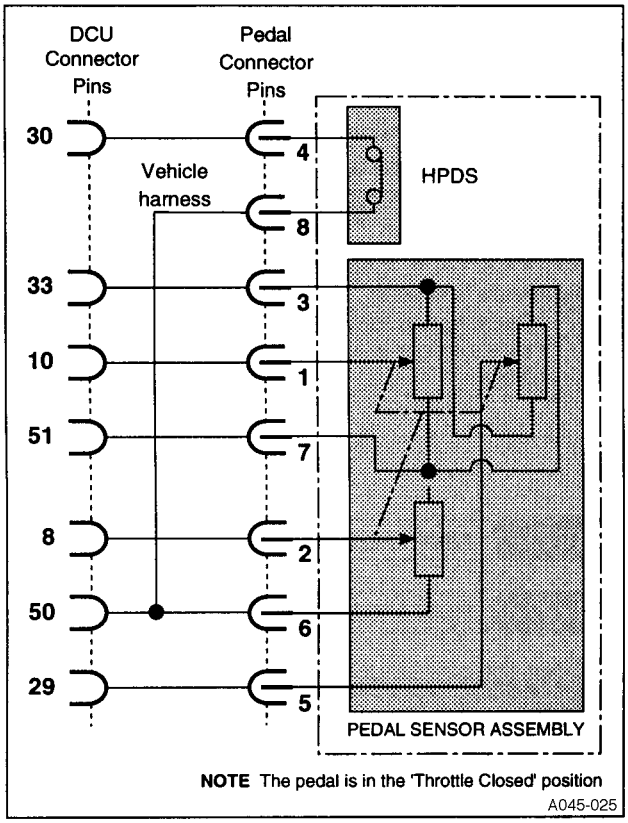
The two switches are for validating the pedal sensor values. With no throttle response i.e. engine stationary or at idle, LPDS is open and HPDS is closed. At part–throttle, both switches are closed. At full throttle, LPDS is closed and HPDS is open.

HPDS is also used to initiate automatic gearbox kick–down.

The potentiometer assembly is part of the LDV pedal assembly and is non–repairable. It must be replaced if faulty.

Components involved:

Pedal assembly
Harness and plugs
DCU



1180	**PEDAL DEMAND SENSOR FAILED**
1181	**PEDAL – PDS1 HIGH**
1182	**PEDAL – PDS1 LOW**
1183	**PEDAL – PDS2 HIGH**
1184	**PEDAL – PDS2 LOW**
1252	**PEDAL – CORRELATION BETWEEN PDS1 & LPDS HIGH**
1253	**PEDAL – CORRELATION BETWEEN PDS1 & LPDS LOW**
1254	**PEDAL – CORRELATION BETWEEN PDS2 & LPDS HIGH**
1255	**PEDAL – CORRELATION BETWEEN PDS2 & LPDS LOW**
1256	**PEDAL – CORRELATION BETWEEN PDS1 & HPDS**
1257	**PEDAL – CORRELATION BETWEEN PDS2 & HPDS**
1258	**PEDAL – CORRELATION BETWEEN PDS1 & PDS2**

Perform the following:

1 Ensure that the key–switch is off. Remove the connector from the DCU and check the pins for damage, backing–off etc.

If there are no faults, go to 3, otherwise, go to 2.

2 If damage is apparent, repair it and retest the vehicle.

3 Fit the BOB to the harness. With the pedal released and later fully depressed record resistance values for:

a) Short–to–ground

b) Short to +BAT

on BOB pins 8, 10, 29, 30, 33, 50 and 51.
If there are no faults, go to 6, otherwise, go to 4.

4 Remove the connector from the sensor and repeat test 3.

If the fault is still apparent go to 5, otherwise, go to 6.

5 Harness faulty. Repair and retest the vehicle.

6 Check for correct operation of the HPDS and LPDS switches.

Reconnect the harness to the sensor and measure the resistance across the BOB terminals listed in the table below, recording the results.

Pedal Position	BOB–		Result (ideal)
Released	8 30	50 50	open–circuit short–circuit
Depressed fully	8 30	50 50	1.0 k to 5.5 k Ohms short–circuit

If the test results differ from those listed go to 9, otherwise, go to 7.

7 Check for correct operation of the pedal sensor tracks. Measure the resistance across the BOB pins listed in the table below and record values.

Pedal Position	Grop	BOB pins	
Released	1a 1b	33 51	10 29
	2a 2b	10 29	51 33
Depressed	3a 3b	33 51	10 29
	4a 4b	10 29	51 33

If the following pairs of results: 1 a and 4a, 1 b and 4b, 2a and 3a, 2b and 3b differ by more than 400 Ω go to 9. Otherwise go to 8.

8 Reconnect the harness to the DCU. Connect the LASER 2000 and turn the key–switch on (do not start the engine). Set the LASER 2000 to read DYNAMIC DISPLAY items:
PEDAL POSN 1 and
PEDAL POSN 2, and record values for:

i) Pedal position 1: (a) foot–off, and (b) fully depressed

ii) Pedal position 2: (a) foot–off, and (b) fully depressed Also, note if the values ‘jump’, whilst moving the pedal position slowly.
If the values 1) (a) and 2) (a) are outside 7% to 11 %, and 1) (b) and 2) (b) are outside 87% to 93%, or the values change erratically (jump), go to 9. If otherwise, go to 10.

9 Fault with the pedal sensor assembly. Replace the assembly and retest the vehicle.

10 Clear all the fault codes and re–test the vehicle. If the fault still occurs go to 1.

4.7 ENGINE SPEED SENSOR (CRANKSHAFT POSITION)

Applicable codes: 0335, 0336 Description of Operation:

The engine speed sensor is an inductive device. The sensor detects the passage of holes drilled in the engine flywheel and supplies to the DCU a signal which is interpreted to provide:

i) Engine speed
ii) Engine crankshaft angular position

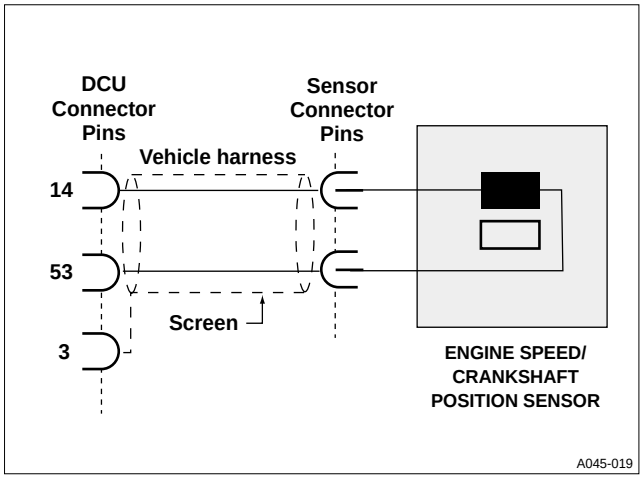
The vehicle symptom is loss of power (reduced fuel).

Components involved:

Engine speed sensor
Harness and connectors
DCU

These faults will be displayed if:

i) The interval between sequences of pulses is corrupted
ii) The interval between pulses is too small
iii) No engine speed signal is present



0335 **ENGINE SPEED SENSOR**

0336 **ENGINE SPEED LOST**

Perform the following:

1 Check to see if a shim is fitted between the sensor body and the bell housing.
If a shim is fitted go to 3, if not go to 2.

2 Clean the mounting faces, fit a new shim, refit the sensor to the engine, retest the vehicle.

3 Ensure that the key–switch is off. Remove the connector from the DCU and check the pins for damage, backing–off etc.
If there are no faults, go to 5, otherwise, go to 4.

4 If damage is apparent, repair it and retest the vehicle.

5 Fit the BOB. Test and record resistance values for:

a) Open–circuit
b) Short–circuit
c) Short–to–ground
d) Short to +BAT

on BOB pins 14 & 53 (see table 1 in Section 5.5 for the Engine Speed sensor resistance value). Also, test for open–circuit between BOB pins 3 & 14 and 3 & 53.
If no fault is apparent go to 6, if the screening tests are incorrect go to 7, if other tests incorrect go to 8.

6 Remove the BOB and reconnect the harness to the DCU. Retest the vehicle.

7 Fault with the harness screening. Repair it and retest.

8 Remove the connector from the sensor and check the pins for damage, backing–off etc.

If no fault is apparent go to 10, if it is incorrect go to 9.

9 If damage is apparent, repair it and retest the vehicle.

10 Test and record resistance values for:

a) Open–circuit
b) Short–circuit

on the sensor pins (see table 1 in Section 5.5 for engine speed sensor resistance value).

If there are no faults, go to 12, otherwise, go to 11.

11 Fault with the sensor. Replace it and retest the vehicle. If the fault is still present go to 1.

12 Fault with the vehicle harness. Repair it and retest the vehicle. If fault is still present go to 1.

4.8 ENGINE COOLANT TEMPERATURE SENSOR

Applicable codes: 0116, 0117, 0118

Description of Operation:

The sensor is a negative temperature coefficient thermistor (its resistance is inversely proportional to temperature) i.e. Low temperature = high resistance, high temperature = low resistance. The DCU will vary the amount of fuel injected and injection timing, dependent upon engine temperature.

This fault code will be displayed if the DCU identifies that the sensor is outside resistance limits.

The vehicle symptom is slightly reduced power.

Components involved:

Engine coolant temperature sensor
Harness and plugs
DCU

0116	**COOLANT TEMPERATURE**
0117	**COOLANT TEMPERATURE LOW**
0118	**COOLANT TEMPERATURE HIGH**

Perform the following:

1 Ensure that the key–switch is off. Remove the connector from the DCU and check the pins for damage, backing–off etc.

If there are no faults, go to 3, otherwise, go to 2.

2 If damage is apparent, repair it and retest the vehicle. Fit the BOB. Test and record resistance values for:

3 Test and record resistance values for:

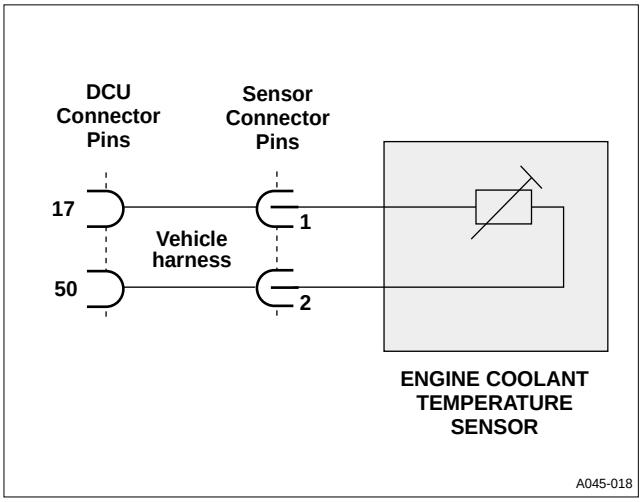
a) Open–circuit
b) Short–circuit
c) Short–to–ground
d) Short to +BAT

on BOB pins 17 & 50 (see table 3 in Section 5.5 for the Engine coolant temperature sensor resistance values).
If there are no faults, go to 4, otherwise, go to 5.

4 Remove the BOB and reconnect the harness to the DCU. Clear any fault codes and retest the vehicle. If the fault still occurs change the DCU.

5 Remove the connector from the sensor and check the pins for damage, backing–off etc.
If there are no faults, go to 7, otherwise, go to 6.

6 If damage is apparent, repair it and retest the vehicle.



7 Test and record resistance values for:

a) open–circuit
b) short–circuit

on sensor pins 1 & 2 (see table 1 in Section 5.5 for the Engine coolant temperature sensor resistance values).

8 Fault with the sensor. Replace it and retest the vehicle.

9 Fault with the vehicle harness. Repair it and retest the vehicle.

4.9 AIR CHARGE TEMPERATURE SENSOR

Applicable codes: 0110, 0112, 0113

Description of Operation:

The sensor is a negative temperature coefficient thermistor. (Its resistance inversely proportional to temperature) i.e. low temperature = high resistance, high temperature = low resistance. The DCU will vary the amount of fuel injected and injection timing, dependent upon air charge temperature.

This fault code will be displayed if the DCU identifies that the sensor is outside resistance limits.

The vehicle symptom is slight loss of power (reduced fuel).

Components involved:

Air charge temperature sensor
Harness and connectors
DCU

0110	**AIR TEMPERATURE**
0112	**AIR TEMPERATURE LOW**
0113	**AIR TEMPERATURE HIGH**

Perform the following:

1 Ensure that the key–switch is off. Remove the connector from the DCU and check the pins for damage, backing–off etc.
If there are no faults, go to 3, otherwise, go to 2.

2 if damage is apparent, repair it and retest the vehicle.

3 Fit the BOB. Test and record resistance values for:

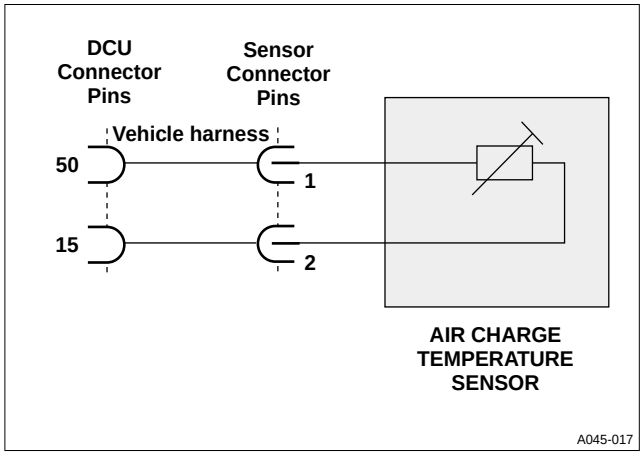
- **a)** open–circuit
- **b)** short–circuit
- **c)** short–to–ground
- **d)** short to +BAT

on BOB pins 15 & 50 (see table 4 in Section 5.5 for the air charge temperature sensor resistance values).
If there are no faults, go to 4, otherwise, go to 5.

4 Remove the BOB and reconnect the harness to the DCU. Clear any fault codes and retest the vehicle. If the fault still occurs change the DCU.

5 Remove the connector from the sensor and check the pins for damage, backing–off etc.
If there are no faults, go to 7, otherwise, go to 6.

6 If damage is apparent, repair it and retest the vehicle.



7 Test and record resistance values for:

- **a)** Open–circuit
- **b)** Short–circuit

on sensor pins 1 & 2. Air charge temperature sensor resistance values can be found in section 5.5.

If there are no faults, go to 9, otherwise, go to 8.

8 Fault with the sensor. Replace it and retest the vehicle.

9 Fault with the vehicle harness. Repair it and retest the vehicle.

4.10 EXHAUST GAS RECIRCULATION (EGR)

Applicable codes : 1402, 0401, 0402, 0400, 1193, 0122,0123,1122,1123,1224,1125

Description of Operation:

The LDV EGR system is designed to reduce nitrous oxide (NOx) emissions in the exhaust gases by limiting the amount of oxygen available for combustion at part–load. Reduction of oxygen is achieved by the admission of a controlled amount of exhaust gas into the engine inlet manifold, thus limiting combustion temperature, which is a controlling factor in the formation of NOx.

The system has a Current–to–Vacuum Transducer (CVT), controlled by a PWM current (EGR DEMAND) from the DCU, and which applies a variable vacuum to an EGR valve (connected to the exhaust manifold), and a throttle valve which is in the engine air intake system after the turbocharger compressor. The CVT is connected to the vehicle braking system vacuum Supply.

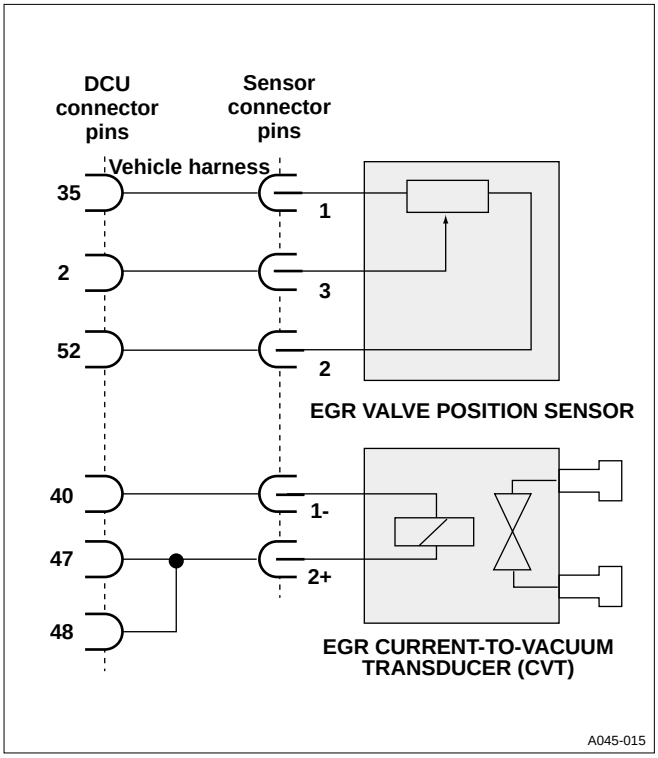
A position sensor built–in to the EGR valve provides a signal to the DCU (EGR VLVE POSN).

Model year 1997 vehicles have a system which uses an EVR instead of the CVT. These components are not interchangeable.

See section 5.6 for an explanation of 'PWM'.

Components involved:

CVT
Vacuum supply to CVT
EGR valve
EGR valve position sensor
Pipes
DCU
Harness and connectors



1402 **EGR VALVE POSITION SENSOR**

0401 **EGR SENSOR LOW**

0402 **EGR SENSOR HIGH**

These fault codes will be displayed if the DCU identifies that either:

i) The sensor value is above 'high limit' or below 'low limit'.
ii) EGR valve position does not show movement in th required direction.

Perform the following:

1 Check the vacuum supply (engine at idle) to the CVT or EVR by removing the pipe to the EGR valve, and noting if the valve makes a click when it closes. Check that all pipes are clear and not damaged.

If there are no faults, go to 3, otherwise, go to 2.

2 If damage is apparent, repair it and retest.

3 Ensure that the key–switch is off. Remove the connector from the DCU and check the pins for damage, backing– off etc.
If no fault is apparent go to 5, if there is a fault go to 4.

4 If damage is apparent, repair it and retest the vehicle.

5 Fit the BOB and disconnect the boost pressure sensor. Test and record resistance values for:
- **a)** Open–circuit
- **b)** Short–circuit
- **c)** Short–to–ground
- **d)** Short to +BAT

on BOB pins 35 & 52, and 2 & 52 (see table 1 in Section 5.5 for External supply EGR position, and EGR position sensor resistance values).
If no fault is apparent go to 6, if there is a fault go to 7.

6 Remove the BOB and reconnect the harness to the DCU. Clear any fault codes and retest the vehicle. If the fault still occurs change the DCU.

7 Remove the connector from the EGR valve position sensor and check the pins for damage, backing–off etc. If there are no faults, go to 9, otherwise, go to 8.

8 If damage is apparent, repair it and retest the vehicle.

9 Test and record resistance values for:
- **a)** Open–circuit
- **b)** Short–circuit

on pins 1 & 2, and 3 & 2 (see table 1 in Section 5.5 for External Supply, EGR position and EGR Position Sensor resistance values).
If there are no faults, go to 11, otherwise, go to 10.

10 Fault with the EGR position sensor. Repair it and retest the vehicle.

11 Fault with the vehicle harness. Repair it and retest the vehicle.

0400	**EGR CONTROL**
1193	**EGR DRIVE OVERCURRENT**
0122	**THROTTLE VALVE LOW**
0123	**THROTTLE VALVE HIGH**
1122	**THROTTLE CALIBRATION LOW**
1123	**THROTTLE CALIBRATION HIGH**
1224	**THROTTLE CALIBRATION**
1125	**THROTTLE POSITION FAULT**

Fault code 0400 will be displayed because:

i) The EGR VLVE POSN exceeds demand (EGR DEMAND) and has not reduced since the last reading

ii) EGR DEMAND exceeds EGR VLVE POSN and has not reduced since the last reading.

Fault code 1193 will be displayed because the DCU–supplied drive current exceeds a maximum limit.

Perform the following:

1 Clean the CVT or EVR filter located on the CVT or EVR, beneath the large removable disc. Ensure that the key–switch is off. Connect the LASER 2000, turn the key–switch on, start the engine and run at idle. Set the LASER 2000 to ACTUATOR TESTS/ EGR CURRENT TO VACUUM. Using the DOWN (F2) key, set EGR CVT DEMAND to zero. Using the UP (F4) key, gradually increase the value, noting whether the throttle valve (situated on the air inlet manifold) is moving.

If the throttle valve does not move, go to 2. Otherwise go to 3.

2 Ensure that the vacuum pipes are clear, and retest. Re–run 1 and, if the throttle valve still does not move, replace the CVT or EVR. Retest.

3 The vacuum supply is correct. At idle, remove the pipe from the EGR poppet valve, noting whether the valve closes with an audible 'click'.

If the valve does not operate correctly, go to 4. Otherwise go to 5.

4 Replace the EGR valve and retest.

5 Ensure that the key–switch is off. Remove the connector from the DCU and check the pins for damage, backing–off etc.

If there is a fault go to 6. If no fault is apparent, go to 7.

6 If damage is apparent, repair it and retest the vehicle.

7 Fit the BOB, and test and record resistance values for:
- **a)** Open–circuit
- **b)** Short–circuit
- **c)** Short–to–ground
- **d)** Short to +BAT

on BOB pins 40 and 47 (see table 1 in Section 5.5 for CVT or EVR resistance values). Also pins 49 and 47 for Model Year 97 vehicles.

It there is a fault, go to 8. If no fault is apparent, go to 9.

8 Remove the BOB and reconnect the harness to the DCU. Clear any fault codes and retest the vehicle. If the fault still occurs change the DCU. Retest.

9 Remove the connector from the CVT or EVR and check the pins for damage, backing–off, etc. If there is a fault, go to 10, otherwise go to 11.

10 If damage is apparent, repair it and retest the vehicle.

11 Test and record resistance values on CVT or EVR pins 1 and 2 (see the table 1 in Section 5.5 for CVT or EVR resistance values).

If there are no faults, go to 12, otherwise go to 13.

12 Fault with the vehicle harness. Repair it and retest the vehicle.

13 Fault with the CVT or EVR. Repair it and retest the vehicle.

4.11 BOOST PRESSURE SENSOR

Applicable codes : 0105, 1108, 1109, 1300, 1301, 1302

Description of Operation:

The boost pressure sensor is provided with a 4.75V reference voltage from the DCU. Its output voltage is proportional to boost pressure. The DCU adjusts the amount of fuel injected and the injection timing according to boost pressure.

Components involved:

Boost sensor
Turbocharger
DCU
Harness and connectors

0105 **BOOST SENSOR**

1108 **BOOST SENSOR HIGH**

1109 **BOOST SENSOR LOW**

These fault codes will be displayed if, whilst in 'precrank' or 'idle', the DCU identifies that the sensor output signal is:

i) Above the 'high–limit' threshold, or
ii) Below the 'low–limit' threshold

A failed turbocharger or blockage in the air inlet could restrict air flow and thus drop the air pressure below the 'low–limit' threshold. If the turbocharger wastegate fails to open, the boost pressure would exceed the 'high–limit' threshold.

1300 **BOOST CALIBRATION**

1301 **BOOST CALIBRATION > HIGH LIMIT**

1302 **BOOST CALIBRATION < LOW LIMIT**

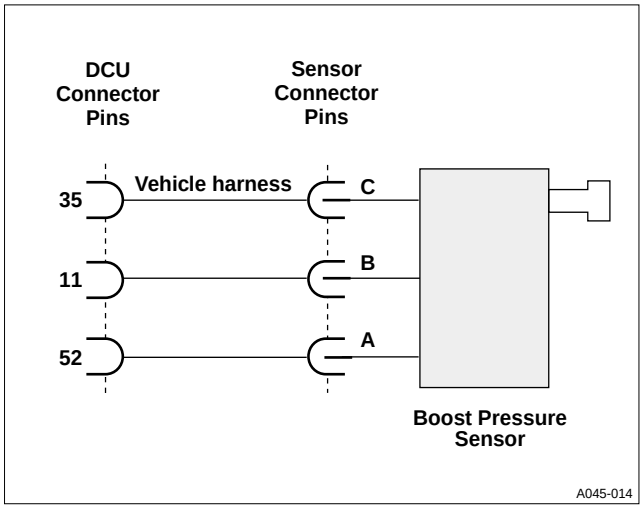
These fault codes will be displayed if, whilst in 'precrank' or 'idle', the DCU identifies that the sensor output signal is:

i) Above the 'high–limit' threshold, or
ii) Below the 'low–limit' threshold

The threshold range is less than for Boost Sensor fault codes.

Perform the following:

1 For BOOST CALIBRATION FAULTS go to test 3.
For BOOST PRESSURE LOW, check the air inlet for blockage; i.e. at the air filter or turbocharger compressor.
Also check that the turbocharger is rotating.
For BOOST PRESSURE HIGH, check that the turbocharger waste gate is operating.
If there are no faults, go to 3, otherwise, go to 2.



2 If blockage or damage is apparent, repair it and retest the vehicle.

3 Ensure that the key–switch is off. Remove the connector from the DCU and check the pins for damage, backing–off etc. If there are no faults, go to 5, otherwise, go to 4.

4 If damage is apparent, repair it and retest the vehicle.

5 Fit the BOB and disconnect the EGR position sensor.
Test and record resistance values for:
a) Open–circuit
b) Short–circuit
c) Short–to–ground
d) Short to +BAT
on BOB pins 35 & 52, and 11 & 52 (see table 1 in Section 5.5 for External supply (boost sensor) and Boost pressure sensor resistance values).
If there are no faults, go to 6, otherwise, go to 7.

6 Remove the BOB and reconnect the harness to the DCU and the EGR position sensor. Clear any fault codes and retest the vehicle. If the fault still occurs change the DCU.

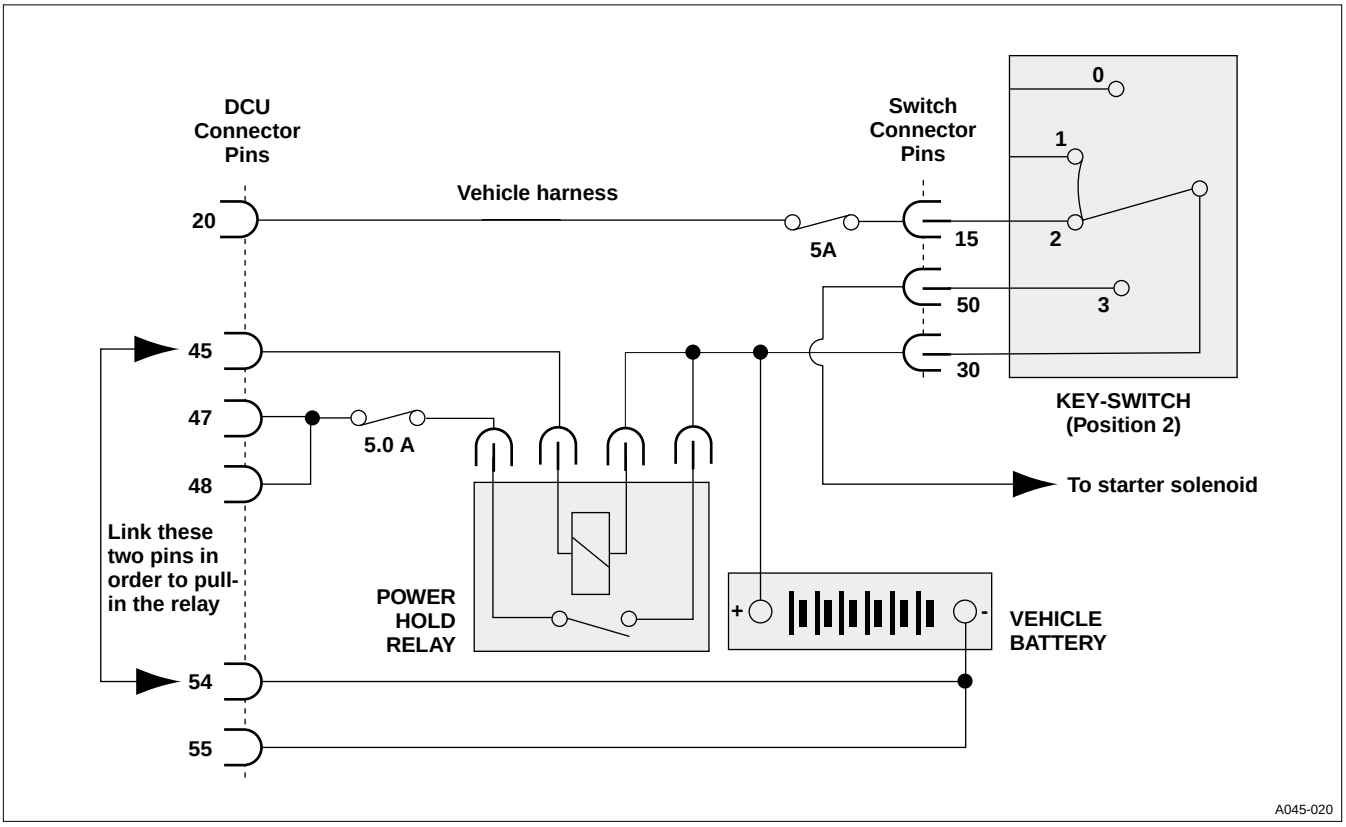
7 Remove the connector from the boost sensor and check the pins for damage, backing–off etc.
If there are no faults, go to 9, otherwise, go to 8.

8 If damage is apparent, repair it, reconnect the harness and retest the vehicle.

9 Test and record resistance values for:
a) Open–circuit
b) Short–circuit
on pins C & A, and B & A (see Section 5.4 for pin identification and table 1 in Section 5.5 for External supply, and boost pressure sensor resistance values). If no fault is shown then go to 11, if there is a fault go to 10.

10 Fault with the boost sensor. Replace it, reconnect the harness and retest the vehicle.

11 Fault with the vehicle harness. Repair it, reconnect the harness and retest the vehicle.



4.12 POWER HOLD RELAY, KEY–SWITCH, AND BATTERY CIRCUIT

Applicable codes : 1191, 1196, 1197, 9671, 9317, 9318, 1606

Description of Operation:

When the key–switch is turned to position ii ('key–on'), +BAT is applied to DCU pin 20. The DCU then takes DCU pin 45 to 'ground' potential, which energises the power hold relay. +BAT is then applied to the main DCU power pins 47 and 48.

During 'key–off' the ESOS is immediately de–energised by the DCU. The power hold relay is not de–energised until the engine has stopped. This means that DCU can take alternative action if the ESOS (De–energised) fails to stop the engine. (e.g. the DCU will ensure that the pump rotor is driven to the 'zero fuel' position.)

The DCU monitors its power supply and will record fault codes if +BAT falls outside set limits.

Components involved:

- Key switch
- Power hold relay
- Fuses
- Battery and cables
- Harness and connectors
- DCU

1191	**KEY LINE VOLTAGE**
1196	**KEY–OFF VOLTAGE HIGH**
1197	**KEY–OFF VOLTAGE LOW**

These fault codes will be displayed if the sensed voltage on the key–switch line (DCU pin 20) is below 8 Volts or above 16 Volts.

NOTE The battery voltage may drop whilst the engine is running if it is being used as a slave battery to start another vehicle, thus creating fault codes.

Action

Check the two fuses. Replace if faulty, and retest.

Perform the following:

1 Check that battery and earth–to–vehicle–body terminals/connectors are clean and tight. With the multimeter set to measure Volts DC, measure voltage across the battery terminals.

If below 10 Volts, go to test 2. If above 10 Volts, go to test 3.

2 Carry out battery Volt–drop test using a heavy discharge tester directly on the battery terminals ('key–off'). If it fails this test, recharge or renew the battery. Retest the vehicle.

3 Start the engine, using a slave battery if necessary, and allow it to idle. Ensure that the charge warning light goes out by increasing engine speed. Return the engine to idle speed and measure the voltage across the vehicle battery terminals.

If the voltage exceeds 14 Volts, or the charge warning light does not go out, go to 4. If the battery voltage is below 14 Volts, go to 5.

4 There is a fault with the charging circuit e.g. the alternator regulator has failed. Rectify it and retest vehicle.

5 Disconnect the plug from the DCU and check pins for damage, backing off etc.
If there are no faults, go to 6, otherwise, go to 7.

6 Rectify the fault and retest the vehicle.

7 Fit the BOB with the adaptor cable and turn on the key–switch. Test and record values for open–circuit between pin 20 and the battery positive terminal.
If the resistance is greater than 3 Ohms, go to 8. If the resistance is less than 3 Ohms go to 9.

8 Fault with the key switch; rectify or replace it and retest.

9 Test and record values for open–circuit between pin 54 and battery negative terminal, and between pin 55 and the battery negative terminal.
If, in test 9, the resistance is greater than 3 Ohms, go to 10. If the resistance is less than 3 Ohms go to 11.

10 Fault with the harness. Rectify it and retest.

11 Remove the BOB, reconnect the DCU and retest the vehicle. If the fault persists change the DCU.

9671 BATTERY VOLTAGE

9317 BATTERY VOLTAGE HIGH

9318 BATTERY VOLTAGE LOW

These fault codes will be displayed if the sensed voltage on the power line (DCU pins 47 and 48) is below 8 Volts or above 16 Volts.

For low voltage, the symptoms will be a noticeable drop in cranking speed when hot, and no crank when cold.

NOTE The battery voltage may drop if it is being used as a slave battery to start another vehicle, thus creating fault codes.

Perform the following:

1 With the engine at rest, check the condition of the following cables and connectors between the battery terminals and the vehicle electrical system:

- Battery positive to the starter motor
- Battery negative to the engine and the vehicle body/chassis

With the multimeter set to measure Volts DC, measure the voltage across the battery terminals.
If it is below 10 Volts, go to test 2. If it is above 10 Volts, go to test 3.

2 Carry out a battery 'Volt drop test' using a heavy discharge tester directly on the battery terminals ('key–off'). If it fails this test, recharge or renew the battery. Retest the vehicle.

3 Start the engine, using a 'slave' battery if necessary, and allow it to idle. Ensure that the charge warning light goes out by increasing engine speed. Return the engine to idle speed and measure the voltage across the vehicle battery terminals.
If the voltage exceeds 14 Volts or the charging warning light does not go out, go to test 4. If the battery voltage is below 14 Volts go to 5.

4 There is a fault with the charging circuit e.g. alternator regulator failed. Rectify it and retest the vehicle.

5 Disconnect the plug from the DCU and check pins for damage, backing off etc.
If there are no faults, go to 6, otherwise, go to 7. Rectify the fault and retest the vehicle.

7 Fit the BOB with the adaptor cable. Link BOB pins 54 and 45 (this action energises the power hold relay). Test and record values for open–circuit between BOB pin 47 and the battery positive terminal.

If the value is greater than 3 Ohms, go to test 8. If the value is less than 3 Ohms, go to test 9.

8 Fault with the power hold relay. Rectify or replace it and retest.

9 Test and record resistance values for:

a) Open–circuit
b) Short to +BAT

between BOB pin 54 and the battery negative terminal, and BOB pin 55 and the battery negative terminal.
If the resistance is greater than 3 Ohms, go to 10.
If resistance is less than 3 Ohms go to 11.

10 Fault with the harness. Rectify and retest.

11 Remove the BOB, reconnect the DCU and retest the vehicle. If the fault persists change DCU.

1606 ECU POWER HOLD RELAY

This fault will be recorded if the DCU is unable to switch off the power hold relay after key–off'.

Perform the following:

1 Fit the BOB to the harness. Test and record resistance values for an open–circuit between BOB pin 45 and the battery positive terminal. Power hold relay drive resistance values should be between 80 Ω and 100 Ω.
If the value is incorrect, go to 2. If the value is correct, go to test 3.

2 Fault with the power hold relay. Rectify it and retest.

3 Test and record resistance values for:
a) open–circuit
b) short to +BAT
between BOB pin 54 and the battery negative terminal, and BOB pin 55 and the battery negative terminal.
If, in test 3, the resistance is greater than 3 Ohms, go to 4. If the resistance is less than 3 Ohms go to 5.

4 Fault with the harness. Rectify it and retest.

5 Remove the BOB, reconnect the DCU and retest the vehicle. If the fault persists change the DCU.

4.13 ENGINE–TO PUMP SYNCHRONISATION (PUMP BOLT–UP LIMITS)

Applicable codes : 1177, 1178

1178 **PUMP BOLT–UP LIMITS**

This fault indicates that the bolt–up angle has exceeded a high or low threshold. The bolt–up angle is the difference between the positions of the pump and engine position sensors.

This fault is usually rectified by retiming the pump to the engine.

1177 **ENGINE–PUMP SYNCHRONISATION**

This fault indicates that there is a 'speed event' error, i.e. an error in synchronisation between the pump 'timing ring' and the flywheel drillings.

It is also displayed if the narrower of the four pump speed ring vanes is not detected once per revolution.

Perform the following:

The possible faults could be:

i) The pump has been incorrectly fitted to the engine. Re– time the pump.

ii) The pump timing wheel is loose or broken away. The pump must be repaired.

iii) The drive shaft position sensor is loose. The pump must be retimed using the method described in Page 18, Section 4.

NOTE A 'speed event' is the point at which a pump or engine speed signal is passed to the DCU.

4.14 DCU

Applicable codes : 1187, 1192, 1195, 0605, 1194, 1605, 1608

1187 **DCU VARIANT SELECTION**

This will indicate that the DCU was not configured when fitted.
Check the configuration using the LASER 2000 procedure.

1192 **EXTERNAL VOLTAGE (VEXT)**

1195 **SCP–HBCC FAILED TO INITIALISE**

0605 **DCU PROCESSOR ROM/RAM**

1194 **DCU A TO D CONVERTER**

1605 **DCU EEPROM**

1608 **DCU WATCHDOGS (SEE NOTE BELOW)**

If any of these codes are logged, change the DCU.

NOTE The DCU 'watchdog' is a section of the circuitry which maintains surveillance over all DCU operational activity and which has the authority to close down the system (stop the engine) in the event of a major malfunction.

To achieve a lower gear (kickdown) for faster acceleration or for driving uphill, the throttle pedal is fully depressed and the High Pedal Demand Switch (HPDS) instructs the DCU to operate the kickdown relay and the hold relay. The high current required by the kickdown solenoid is supplied by the kickdown relay. The lower current required to hold the solenoid in the kickdown position is supplied by the hold relay. The hold solenoid remains on until the throttle pedal is released or the vehicle achieves 100 kph.

NOTE Under no circumstances should the pull–in relay and solenoid be supplied from a power source other than the DCU.

ATX Solenoid

Failure of this circuit will result in poor/sluggish gear changes or higher vehicle speeds will have to be achieved before gear changes take place.

Kickdown pull–in circuit

Failure of this circuit will result in no kickdown.

Kickdown hold circuit

Failure of this circuit will result in no hold. Transmission will change and then release.

Incorrect DCU configuration

If the DCU is incorrectly configured, that is, if the vehicle has manual transmission but the DCU is programmed for automatic transmission, fault codes will be logged. Check the configuration using the LASER 2000.

Acceleration test

The DCU drives the electrical system which actuates the gearbox shift control and kickdown. The diagnostic facility only detects failures up to the gearbox control solenoid and the kickdown pull–in and hold relays. The outputs of these devices are not monitored.

Correct operation of the system will be confirmed by carrying out a full–throttle acceleration test without kickdown requested (approximately 95% throttle travel), and with kickdown requested (100% throttle travel). The transmission will shift between gears at the speeds defined by the table below.

Full throttle acceleration

1st to 2nd 2500 rpm. With kickdown operating at 3800 rpm.

2nd to 3rd 3300 rpm. With kickdown operating at 3950 rpm.

Direct drive engagement 4th gear 2900 rpm.

3rd to 4th 2900 rpm. With operating at 3900 rpm.

Any failure related to the transmission should be referred to a dealer.

4.15 PASSIVE ANTI THEFT SYSTEM (PATS)

Applicable codes: 9342

Description of Operation:

This is a vehicle immobilisation system. The introduction of Passive Anti–Theft means that vehicles are now fitted with a PATS module which communicates with the DCU upon vehicle 'key–on'. The module interrogates the DCU and if the code stored in the DCU does not match that of the ignition key used then the vehicle is put into a 'fail–safe' mode and will not start. An immobiliser diagnostic light can be found above the windscreen in the centre of the passenger compartment – in 'fail–safe' mode this will flash a LDV fault code (otherwise known as 'blink' code).

Functions and Components Involved:

DCU PATS Module
PATS NULL CODE

9342 **PATS NULL CODE**

When the 'ignition' is first switched on, a transponder on the key transmits a key code to the PATS module. This keycode is compared with both that held in the PATS module and that stored in the DCU . The above fault code appears when the code in the DCU and PATS module does not 'match'.

The fundamental question as to why the DCU and PATS module do not 'match' should be asked. Verify the vehicle history. Check the Vehicle Identification Number (VIN) against the engine number on the chassis; ensure that there is no evidence of theft.

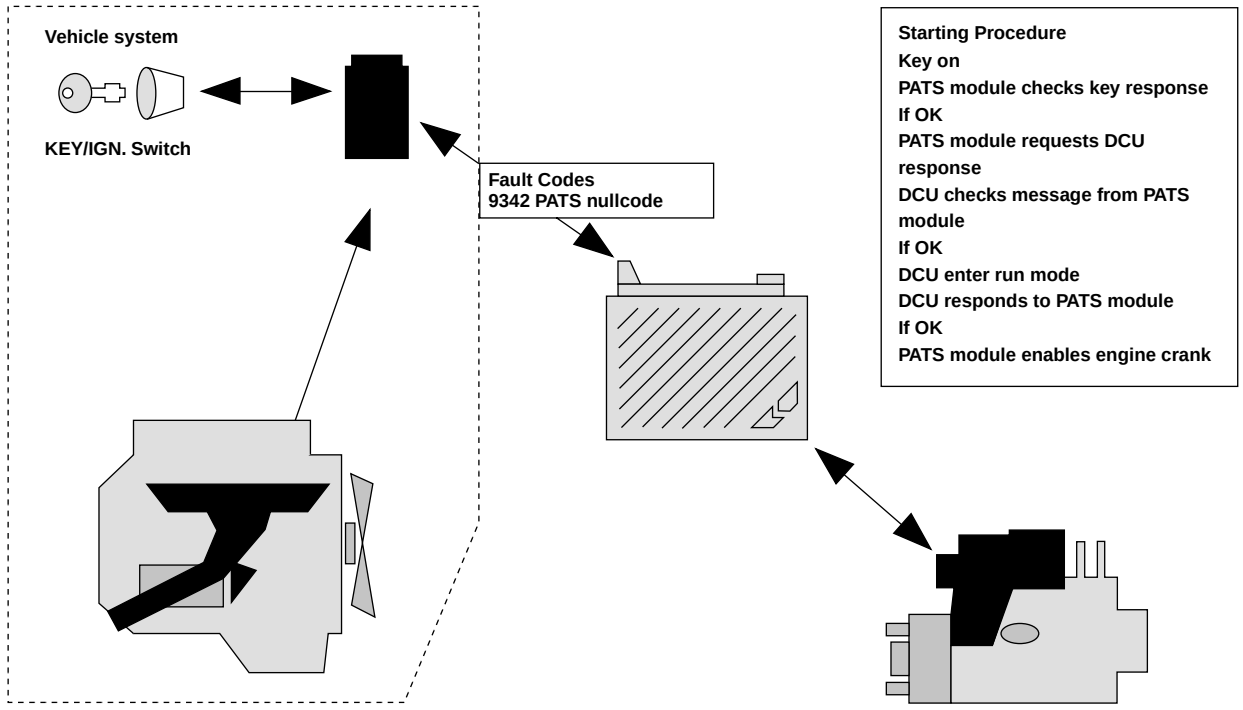
Check the 'blink' code flashed on the immobiliser diagnostic light. A two–digit number will be flashed:–

The first digit will be flashed followed by a one–second pause and then the second digit. After a three–second pause the code will be repeated.

Code 3.1 – Indicates a wrong code received from the DCU. Please contact a Lucas National Distributor for assistance.

Code 3.2 – Indicates a wiring fault in the PATS circuitry or faulty PATS module. No attempt should be made to investigate this; the vehicle must be referred to a LDV dealer.

Passive Anti-Theft System



5.1 DYNAMIC DATA

Screen Message	Units	Description
ENGINE SPEED	RPM	Input signal to the DCU from the engine speed sensor.
VEHICLE SPEED	kph	Input signal to the DCU from the vehicle speed sensor.
COOLANT	°C	Input signal to the DCU from the engine coolant temperature sensor.
AIR TEMP	°C	Input signal to the DCU from the air charge temperature sensor.
PUMP TEMP	°C	Input signal to the DCU from the pump temperature sensor.
BOOST	mbar	Input signal to the DCU from the boost pressure sensor.
PEDAL FUEL	mm3	Input signal to the DCU from the pedal position sensor.
MAX A/F DENS.	mm3	Maximum air/fuel ratio. Maximum fuel is limited by air density.
MAX FUEL	mm3	This is the maximum fuel permitted.
FUEL DEMAND	mm3	Above idle, the value displayed will be the lowest of PEDAL FUEL, MAX A/F DENS or MAX FUEL.
CYL 3 IDL FUEL	mm3	Idling fuel on cylinder 3.
CYL 1 OFFSET	mm3	This offset value plus the CYL3 IDL FUEL gives the idle fuel on cylinder 1.
CYL 2 OFFSET	mm3	This offset value plus the CYL3 IDL FUEL gives the idle fuel on cylinder 2.
CYL 4 OFFSET	mm3	This offset value plus the CYL3 IDL FUEL gives the idle fuel on cylinder 4.
IDLE REF	RPM	Target idle RPM (as set when in the IDLE TRIM mode).
IDLE REFT	RPM	Idle RPM for all temperatures.
ROTOR DEMAND	units	This is the desired rotor axial position.
ROTOR F/B	units	This is the measured rotor axial position. (If all the conditions are correct, ROTOR DEMAND and ROTOR FEEDBACK follow each other closely).
ROTOR DELAY –	units	These values determine the pulse width required to allow the actuators to achieve the
ROTOR DELAY +	units	rotor demand.
CALIBRATION	units	Refer to table 2 in Section 5.6 to obtain the calibration resistance value.
CAM DEMAND	units	This is the **desired** cam position.
CAM FEEDBACK	units	This is the **measured** cam position. (CAM FEEDBACK should follow CAM DEMAND closely).
CAM INTEGRAL	units	This value will be between 45 and 55.
BOLT – UP TRIM	Degrees	This is an indication of pump–to–engine timing. A change will result in a fault code being logged.
PEDAL POSN. 1	%	Pedal position potentiometer track 1. The value indivcates the position of the wiper on the track.
PEDAL POSN. 2	%	Pedal position potentiometer track 2. The value indivcates the position of the wiper on the track.
PEDAL	%	Relate this value to PEDAL FUEL.
EGR DEMAND	units	This is the desired EGR valve position.
EGR VLVE POSN	units	Result of processing by the DCU of the RAW position.
RAW EGR POSN	units	Actual EGR valve position.
BATTERY	Volts	Battery voltage as measured on DCU pins nos. 47 and 48 (+BAT).
KEYVOLTS	Volts	Battery voltage as measured on DCU pin 20 (switch line).
STATUS	Status	Engine staus; PRE CRANK, RUNNING or STALLED.
RECOVERY MODES		
ENGINE STOPS	ON/OFF	Engine stopped due to a major fault.
REDUCED FUEL	ON/OFF	Reduced fuel mode to a fault.
O/LOOP ROTOR	ON/OFF	Open–loop rotor control due to a fault.
OPEN LOOP CAM	ON/OFF	Open–loop cam control due to a fault.

5.2 VEHICLE WIRING DIAGRAM (MY97)

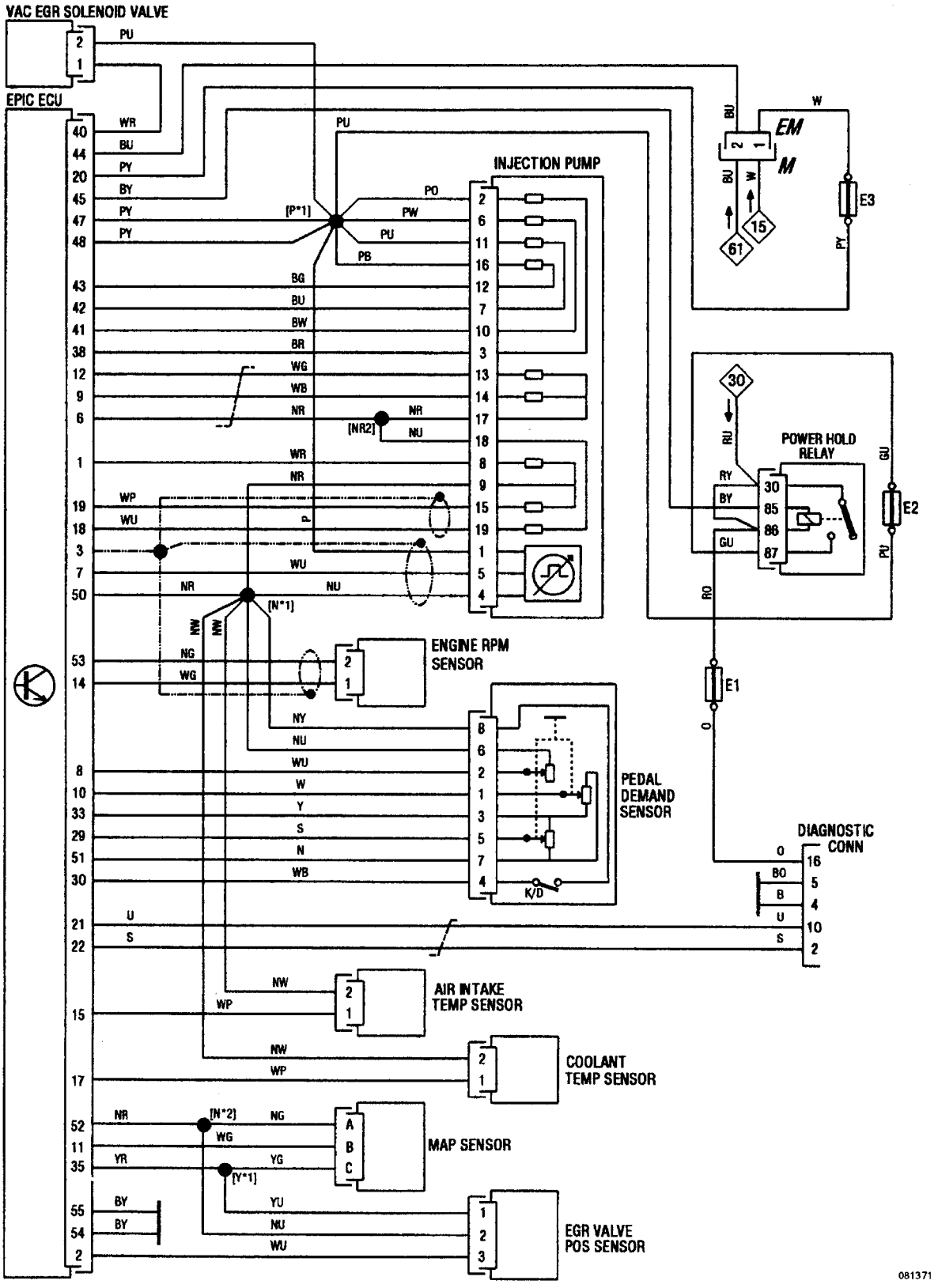
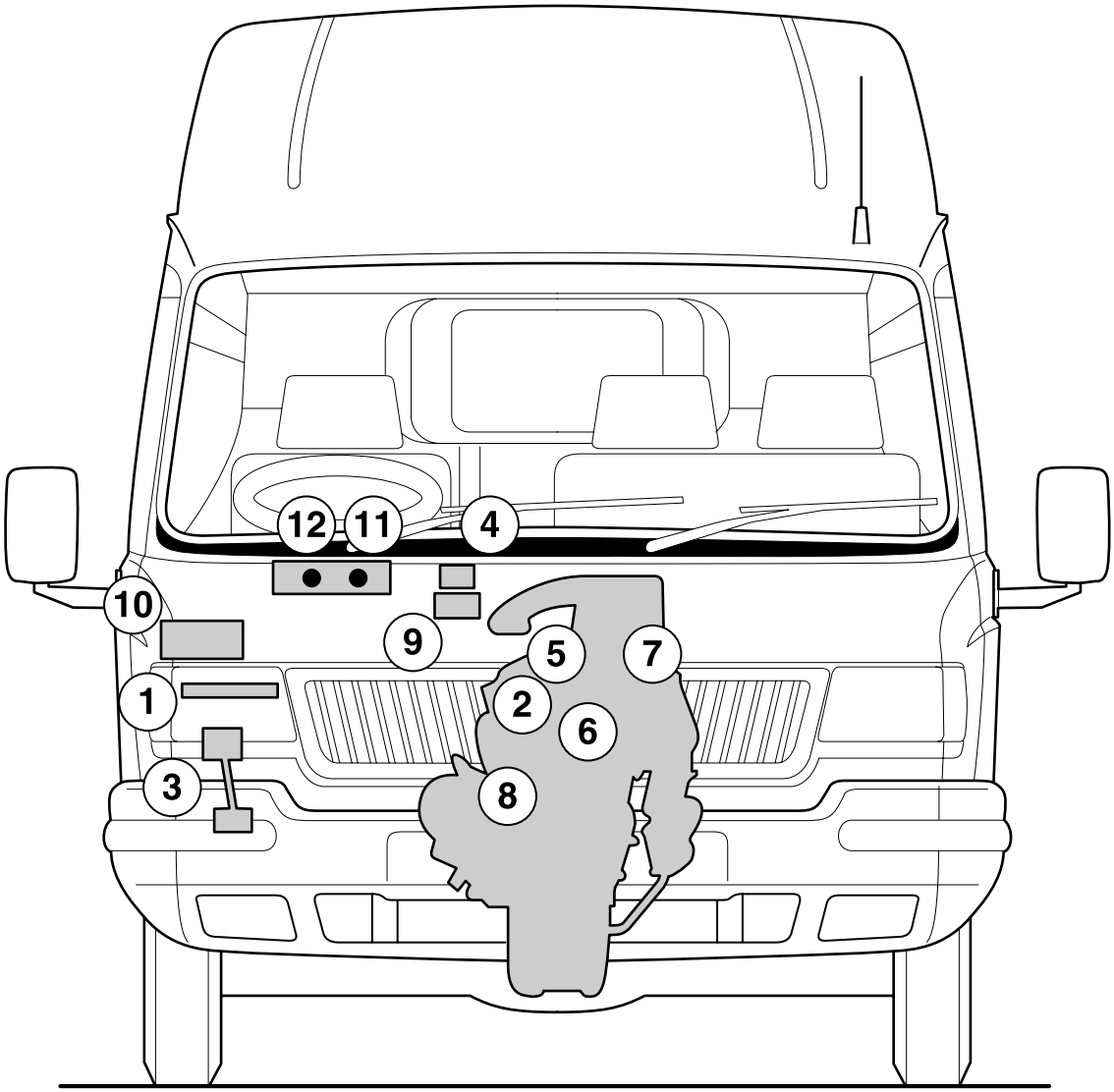


Fig. 7 – EPIC – System Wiring Diagram

5.3 COMPONENT LOCATION

Location of EPIC System Components

LDV 2.5 DI Turbo

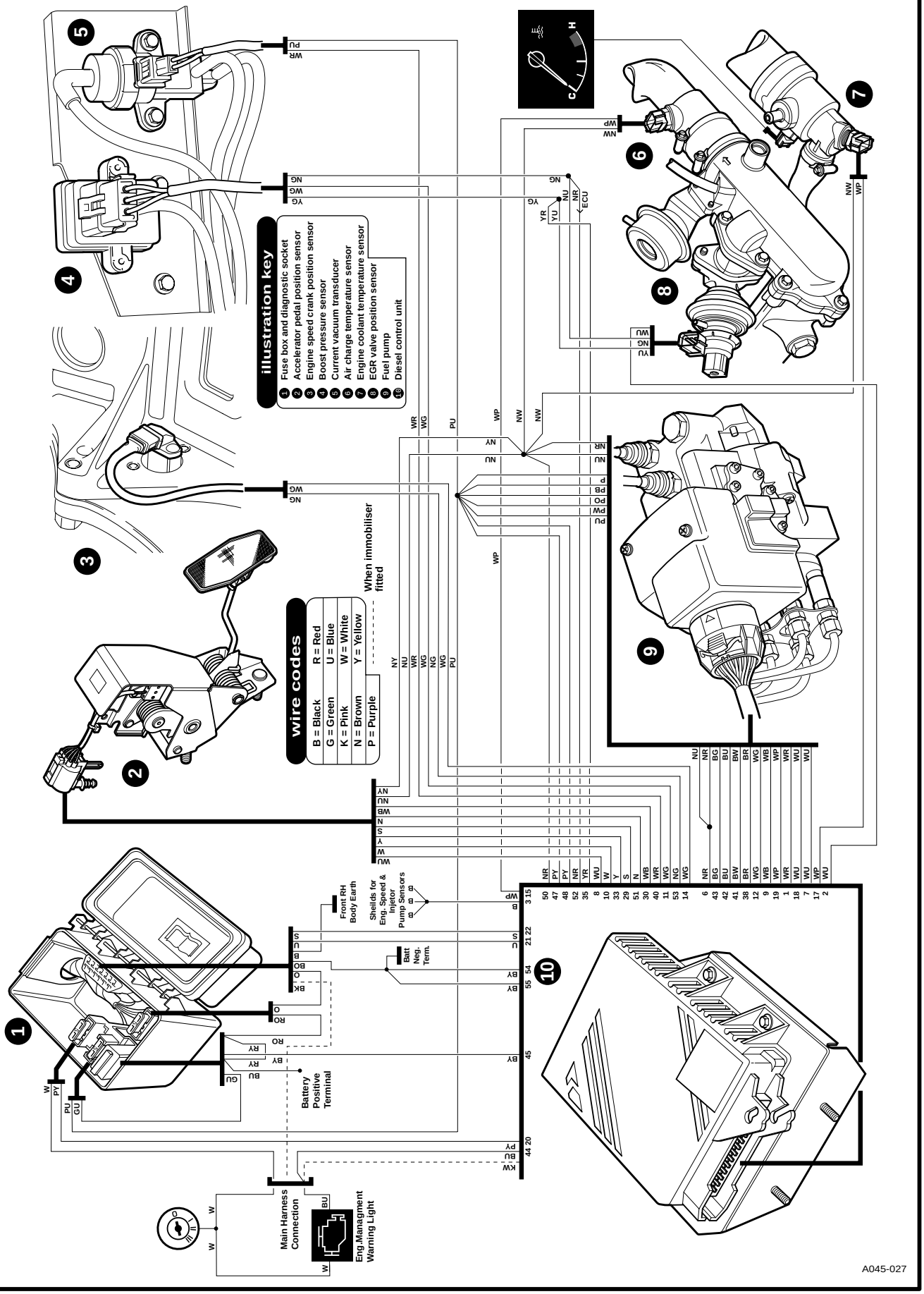


Key

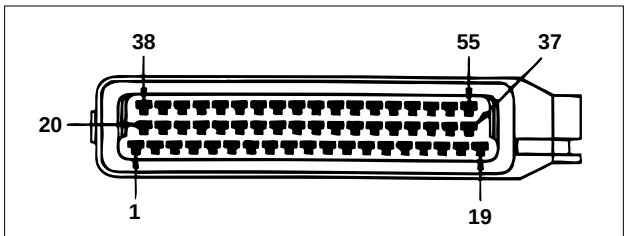
1	Diesel Control Unit (DCU)
2	EPIC fuel injection pump
3	Accelerator pedal position sensor
4	Manifold (boost) pressure sensor
5	Exhaust gas recirculation (EGR) sensor
6	Engine coolant temperature sensor
7	Air charge temperature sensor
8	Engine speed sensor (at rear of engine)
9	EGR flow regulator with EVR
10	Fuse box with power hold relay and Laser 2000 diagnostic connector
11	Engine management system (EMS) lamp
12	Fuel filter (water) warning lamp

A045-030

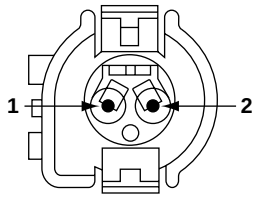
5.3 COMPONENT LOCATION



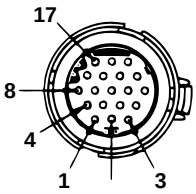
5.4 CONNECTOR PIN IDENTIFICATION



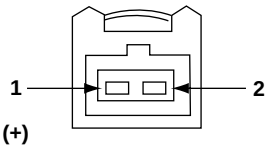
DCU



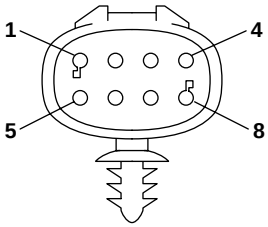
AIR CHARGE TEMPERATURE SENSOR



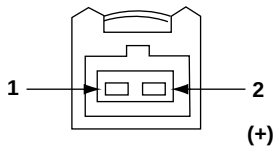
FUEL PUMP



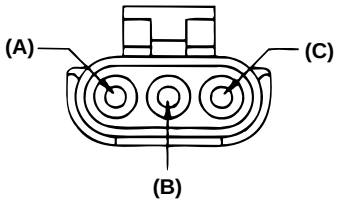
ENGINE SPEED SENSOR



PEDAL DEMAND SENSOR



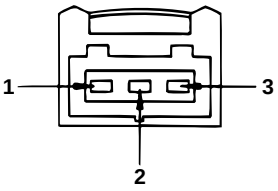
CURRENT-TO-VACUUM TRANSDUCER



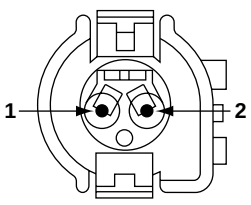
BOOST PRESSURE SENSOR

1	2	3	4	5	6	7	8
9	10	11	12	13	14	15	16

ON-BOARD DIAGNOSTICS CONNECTOR



EGR VALVE POSITION SENSOR



ENGINE COOLANT TEMPERATURE SENSOR

A045-022

Fig. 8

5.5 RESISTANCE VALUES

Table 1

CIRCUIT DESCRIPTION	BREAK–OUT BOX Pin +	Pin –	PUMP PIN Pin +	Pin –	RESISTANCE (Ω) Min +	Max –
Rotor A (feed) Actuator	41	47	6	10	25	35
Rotor B (drain) Actuator	42	47	11	7	25	35
Cam Actuator	43	47	16	12	25	35
ESOS	47	38	2	3	1	3
Rotor Position Sensor 20 °C	9	6	14	17	48	60
Pump Temperature Sensor	19	6	15	9	690	3.5k
Cam Position Sensor	18	6	18	19	45	55
Engine Speed Sensor	14	53	1	2	300	1.2k
Engine Coolant Temperature	17	50			See table 3	
Air Charge Temperature	15	50			See table 4 (MY97) >	
EGR Position Sensor (disconnect Throttle Sensor and Boost Pressure Sensor)	2 35	52 52			300 1.5k	1k 2k
EMS Lamp	44	47			12	55
EVR Valve Actuator (MY97)	47	40			28	38
EVR Throttle Actuator (MY97)	47	49			28	38
EVR CVT (MY95)	47	40			4	10
Boost Pressure Sensor (disconnect Throttle Sensor and EGR Position Sensor)	52 52	35 11			500 10k	3k 300k
LPDS (Idle)	8	50	2	8	Open–circuit (o/c)	
HPDS (Idle)	30	50	4	8	0	3
Pedal Demand Sensor 1 (Full throttle)	10	51	1	7	3k	7k
Pedal Demand Sensor 2 (Idle)	29	51	5	7	3k	7k
PATS Module	4	GND			4k	7k
Power GND	Batt–ve	GND			0	3
Power Supply	47, 48	Batt +ve			Open–circuit (o/c)	o/c

Abbreviations

LPDS – Low Pedal Demand Switch

HPDS – High Pedal Demand Signal

CVT – Current–to–vacuum Transducer

Table 2 – Calibration Resistor Range

Number	Resistance Value (Ohms)
0	8230 – 9090
1	6320 – 6980
2	4970 – 5490
3	3910 – 4330
4	3080 – 3400
5	2420 – 2680
6	1850 – 2150
7	1540 – 1700
8	1210 – 1330
9	950 – 1050
10	725 – 805
11	545 – 575
12	400 – 445
13	280 – 310
14	180 – 200
15	95 – 105

Table 3 – Engine Coolant Temperature Sensor

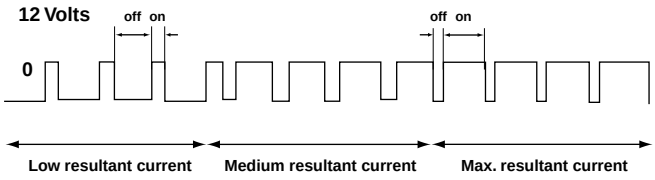
Temp °C	Resistance Value (Ohms)
10	58,750
20	37,300
30	24,270
40	16,150
50	10,970
60	7,600
70	5,370
80	3,840
90	2,800
100	2,070
110	1,550
120	1,180

Table 4 – Air change Temperature Sensor (MY97) >

Temp °C	Resistance Value (Ohms)
–40	965,530
–30	512,947
–20	283,651
–10	162,585
0	96,248
10	59,173
20	37,387
30	24,216
40	16,043
50	10,581
60	7,487
70	5,269
80	3,775
90	2,750
100	2,038
110	1,523
120	1,155
130	886,8

5.6 PULSE– WIDTH MODULATION

The EPIC Cam Control and ESOS actuators, and the EGR CVT, rely upon a fixed–frequency pulse–width–modulated (PWM) supply, generated within the DCU, for their operation. A PWM voltage supply consists of a series of ‘square–wave’ single–polarity pulses, the durations of which are varied by the DCU in response to demand.



A045-021

The current which results from the PWM voltage varies in proportion to the ‘Mark–Space Ratio’. The mark–space ratio is the relationship between the supply–on and ‘supply–off’ periods. This ratio may be expressed as a percentage, which is then referred to as the ‘Duty Cycle’.

FAULT CODE QUICK REFERENCE

SCP	Description	
0105	BOOST SENSOR	26
0110	AIR TEMPERATURE	23
0112	AIR TEMPERATURE LOW	23
0113	AIR TEMPERATURE HIGH	23
0116	COOLANT TEMPERATURE	22
0117	COOLANT TEMPERATURE LOW	22
0118	COOLANT TEMPERATURE HIGH	22
0122	THROTTLE VALVE LOW	25
0123	THROTTLE VALVE HIGH	25
0185	PUMP TEMPERATURE	16
0335	ENGINE SPEED SENSOR	21
0336	ENGINE SPEED LOST	21
0400	EGR CONTROL	25
0401	EGR–SENSOR LOW	24
0402	EGR–SENSOR HIGH	24
0605	DCU PROCESSOR, ROM/RAM	31
1108	BOOST SENSOR HIGH	26
1109	BOOST SENSOR LOW	26
1122	THROTTLE CALIBRATION LOW	25
1123	THROTTLE CALIRATION HIGH	25
1125	THROTTLE POSITION FAULT	25
1170	ESOS DRIVE CURRENT	12
1171	ROTOR POSITION	9
1172	PUMP ROTOR CONTROL OVERFUELLING	10
1173	PUMP ROTOR CALIBRATION	11
1174	PUMP CAM POSITION	14
1175	PUMP CAM CONTROL	15
1176	PUMP CAM CALIBRATION	15
1177	ENGINE PUMP SYNCHRONISATION	29
1178	PUMP BOLT UP LIMITS	29
1180	PEDAL DEMAND SENSOR FAILED	19
1181	PEDAL – PDS1 HIGH	19
1182	PEDAL – PDS1 LOW	19
1183	PEDAL – PDS2 HIGH	19
1184	PEDAL – PDS2 LOW	19
1185	PUMP TEMPERATURE HIGH	16
1186	PUMP TEMERATURE LOW	16
1187	DCU VARIANT SELECTION	31–32
1189	PUMP SPEED LOST	18
1190	CALIBRATION RESISTOR	17
1191	KEYLINE VOLTAGE	27

SCP	Description	
1192	V EXT (External Voltage)	31
1193	EGR DRIVE OVERCURRANT	25
1194	DCU A–D CONVERTER	31
1195	SCP–HBCC FAILED TO INITIALISE 11	31
1196	KEY–OFF VOLTAGE HIGH	27
1197	KEY–OFF VOLTAGE LOW	27
1198	PUMP ROTOR CONTROL UNDERFUELLING	10
1224	THROTTLE CALIBRATION	25
1252	PEDAL–CORRELATION BETWEEN PDS1 AND LPDS HIGH	19
1253	PEDAL–CORRELATION BETWEEN PDS1 AND LPDS LOW	19
1254	PEDAL–CORRELATION BETWEEN PDS2 AND LPDS HIGH	19
1255	PEDAL–CORRELATION BETWEEN PDS2 AND LPDS LOW	19
1256	PEDAL–CORRELATION BETWEEN PDS1 AND HPDS	19
1257	PEDAL–CORRELATION BETWEEN PDS2 AND LPDS	19
1258	PEDAL–CORRELATION BETWEEN PDS1 AND PDS2	19
1300	BOOST CALIBRATION	26
1301	BOOST CALIBRATION>HIGH LIMIT	26
1302	BOOST CALIBRATION<LOW LIMIT	26
1402	EGR VALVE POSITION SENSOR	24
1605	EEPROM	31
1606	POWER HOLD RELAY	28
1608	'WATCHDOGS'	31
1644	PUMP SPEED SENSOR	18
9317	BATTERY VOLTAGE HIGH	28
9318	BATTERY VOLTAGE LOW	28
9342	PATS NULLCODE FAULT	33
9671	BATTERY VOLTAGE	28
9682	PATS COMMUNICATION FAULT (REFER TO PATS WORKSHOP MANUAL)	

Note:	**PDS1** – Pedal Demand Sensor 1
	PDS2 – Pedal Demand Sensor 2
	LPDS – Low Pedal Demand Switch
	LPDS – High Pedal Demand Switch
NOTE	For non–coded faults refer to Section 3