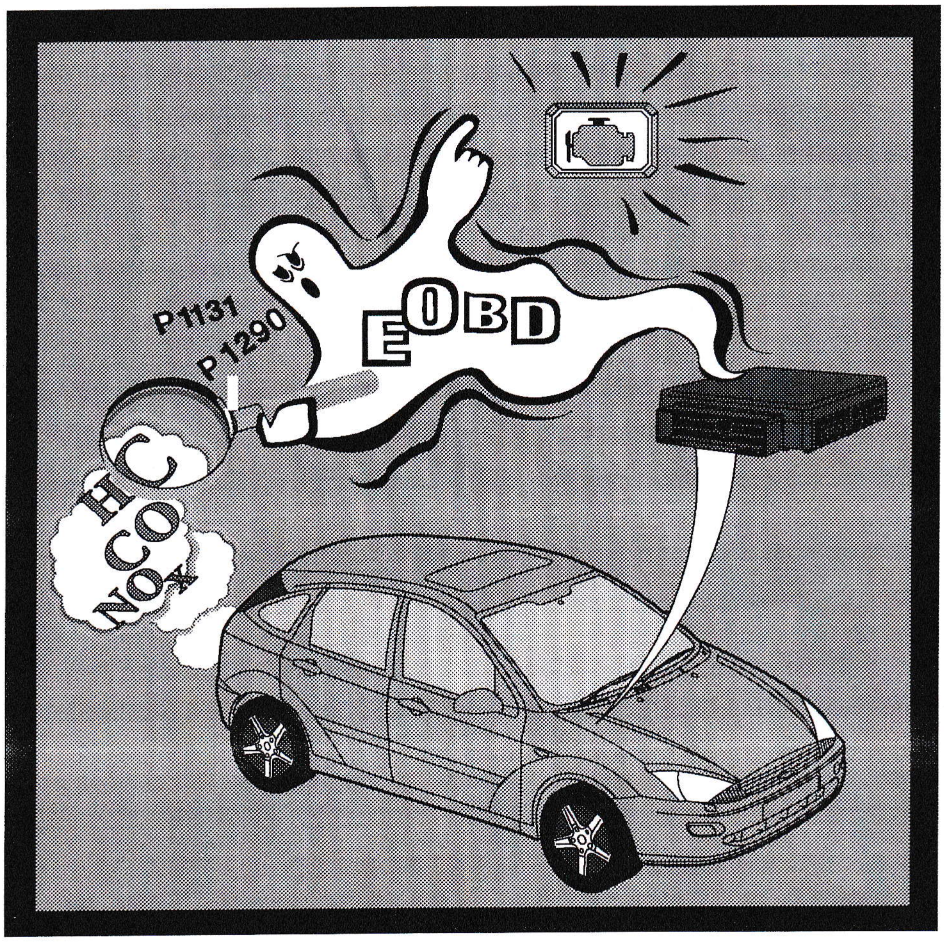
T8

Technical Service Training

Petrol Engine Management Systems

Curriculum Training TC3043027S

European On-Board Diagnostics
- EOBD -



Student Information

CG 7856/S en 12/1999

EOBD stands for European **On-Board Diagnostics**. This is a diagnostics system which is integrated in the powertrain control module (PCM) (on-board) and continuously monitors emission control systems and components of the powertrain.

The system includes an "emission control malfunction indicator lamp (MIL)" which comes on if there is a fault which affects emissions. Data stored in the fault memory of the module can be read out using a generic scan tool.

There is also a new "dealer test cycle" which must be carried out to make sure that a fault has been rectified by the repair.

EOBD is part of the Euro Standard Stage 3, which officially comes in for vehicles first registered from 01.01.2001. However, from 01.01.2000 (vehicle type approval) only new vehicles with petrol engines meeting the new EU directives (with EOBD) will be licensed in Europe.

The first Ford models equipped with EOBD and the emission control malfunction indicator lamp (MIL) but without the catalyst monitor are intended solely for the German market. These are the 2000 model year (third quarter of 1999) Focus 1.6L with automatic transmission, Focus 1.6L Zetec-SE, 1.8L Zetec-E and Fiesta 1.3L Endura-E developing 37kW (also for Austria). EOBD will be introduced Europe wide at 2001 model year.

In Europe, EOBD is only required for vehicles with diesel engines from 2003 and for alternative fuel vehicles from 2005.

This Student Information publication only describes the **EOBD for passenger cars with petrol engines** as applicable both to all manufacturers and specifically to Ford.

This Student Information publication is arranged in lessons. It is designed as a self-learning medium in line with the new Ford global training concept.

Each lesson starts with the objectives to be achieved in the course of the lesson and ends with test questions to check learning progress. The answers to these are to be found at the end of the Student Information publication.

PAGE

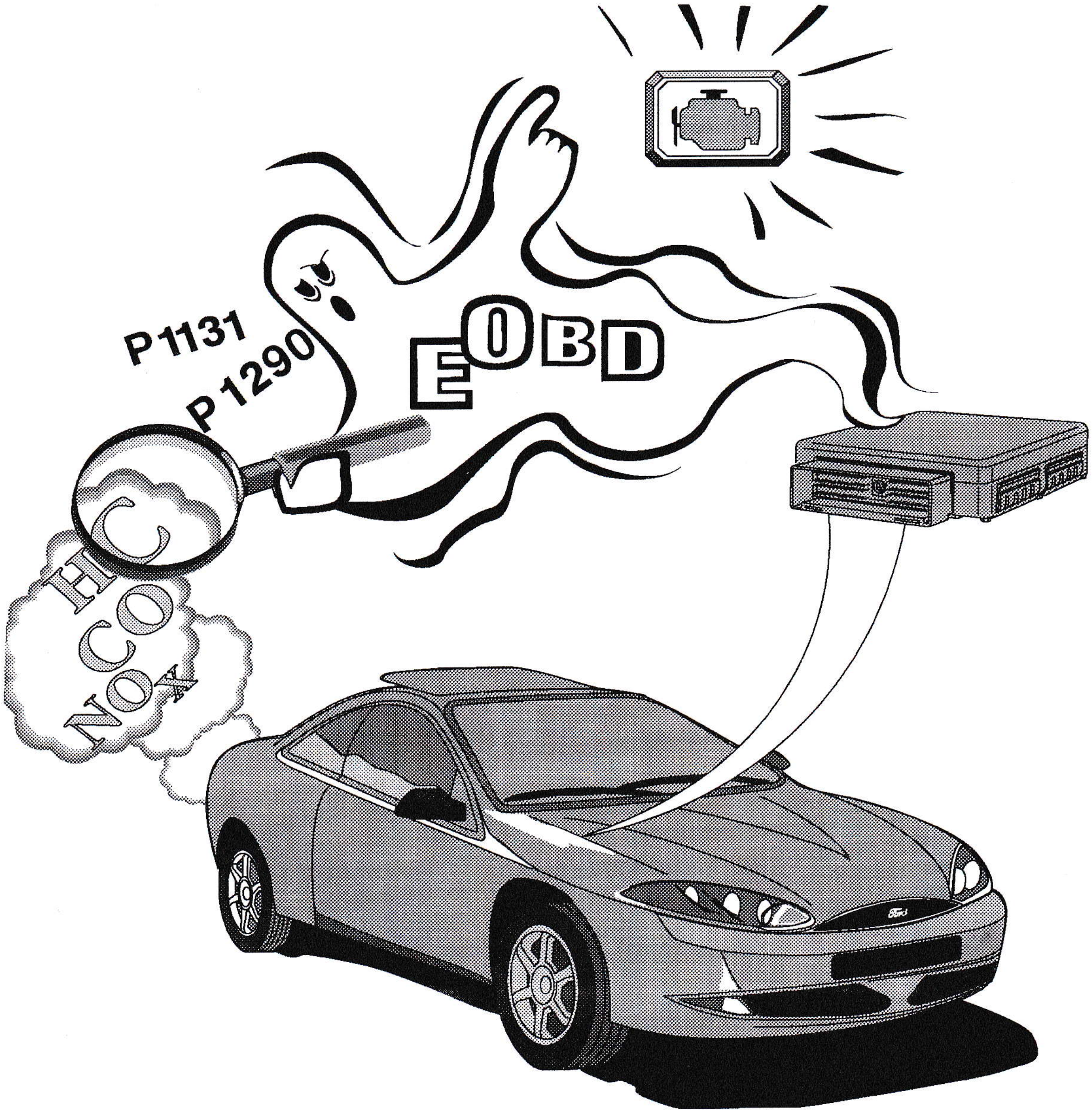
Contents

PAGE

Objectives

On completing this section, you will be able to:

- explain the function of EOBD
- explain the basic operation of EOBD
- differentiate between the individual monitoring systems
- explain the difference between EEC V, Euro Standard Stage 2 and EEC V, Euro Standard Stage 3 (EOBD)
- define EOBD in conjunction with the data link connector (DLC)
- explain how compliance with the exhaust emission limits is achieved with the aid of EOBD



7856/02/ESG

EOBD at a glance

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

7856/03/ESG

EOBD overview

- The European on-board Diagnostic system (EOBD) uses no additional sensors or actuators to measure the pollutants in the exhaust gas individually.
- The EOBD system is integrated in the EEC V PCM and generally uses the existing sensors and actuators of the EEC V system. In addition, only one catalytic converter monitoring sensor is fitted (for the downstream HO2S).
- These sensors and actuators and special software continuously check systems and components which affect emissions while the vehicle is travelling and derive the exhaust emissions accordingly.
- The check on systems and components which affect emissions is carried out with so called **monitoring systems** (monitors).
- The EOBD for European Ford petrol engines comprises 5 monitors from the 2000 model year onwards:
  - comprehensive component monitor (CCM) for emission control components
  - combustion misfire monitor
  - heated oxygen sensor (HO2S) monitor
  - fuel system (fuel) monitor
  - catalytic converter efficiency monitor
- The secondary air injection (AIR) monitor and the exhaust gas recirculation (EGR) monitor can also be introduced later.
- If a monitoring system detects a fault and this is confirmed, the emission control malfunction indicator lamp (MIL) is switched on.
- The fault protocols contain information about the nature of the fault and the distance travelled since the illumination of the malfunction indicator lamp (MIL).
- The emission control malfunction indicator lamp (MIL) ensures that a fault is recognized promptly so that repairs can be carried out quickly and high exhaust emissions avoided.
- In future, when a fault occurs which affects emissions and which is indicated by illumination of the emission control malfunction indicator lamp (MIL), the driver of the vehicle is obliged by law to go to a Ford workshop with the vehicle as quickly as possible to have the fault rectified.

EOBD overview (continued)

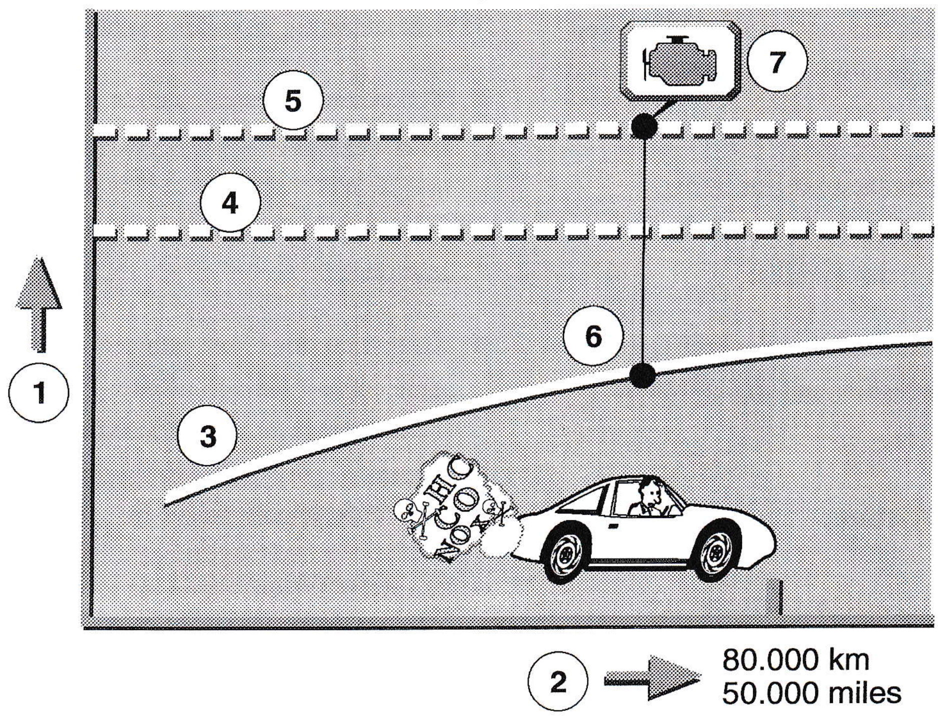
- The customer is recommended to take the vehicle to a Ford workshop as this alone has the necessary special tools and test equipment for systematic fault finding and rectification and also guarantees optimum service.
- Another part of the EOBD is the data link connector (DLC) which has been standardized for all makes of vehicle and through which the monitoring authorities can read faults which affect emissions which are recorded in the control module.
- The DLC is located in the front part of the passenger compartment, usually under the instrument panel or in the A-pillar.
- The diagnostic characteristics of the EOBD system depend on the manufacturer and engine variant.

Type approval and testing

- The operation of the EOBD system must be guaranteed over the entire life of the vehicle. To obtain type approval for the European market, vehicle manufacturers must guarantee compliance with the specified exhaust emission limits up to at least 80,000 km (50,000 miles) or 5 years:
  - CO 2.3 g/km
  - HC 0.2 g/km
  - NO_x 0.15 g/km
- The limit values named above apply to the Euro Standard Stage 3 (also refer to the publication entitled "Exhaust Emission and Noise Level Standards", curriculum training course TC3041015H).
- Compliance with the specified exhaust emission limits will be monitored in future by the authorities. To this end, vehicles will undergo random testing at various mileages.
- If these checks reveal that the specified limits are exceeded systematically, the vehicle manufacturer will be held responsible. This may lead to costly service operations or restrictions to the type approval.
- Apart from this, Ford vehicles will comply with the same exhaust emission limits over the entire life of the vehicle, even after 80,000 km (50,000 miles) or 5 years, i.e. the EOBD threshold values in the EEC V PCM will always be the same.
- The **EOBD limit values** are always slightly higher than the exhaust emission limit values of Euro Standard Stage 3, which means that minimal overshooting of the Euro Standard Stage 3 limit values still does not mean that the emission control malfunction indicator lamp (MIL) is inevitably actuated.

Type approval and testing (continued)

Limit values	CO [g/km]	HC [g/km]	NO_x [g/km]
Euro Standard Stage 3	2.3	0.2	0.15
EOBD	3.2	0.4	0.6



EOBD exhaust emission limits

1 Exhaust emissions
2 Mileage
3 Exhaust emissions from the vehicle
4 Exhaust emission limits of Euro Standard Stage 3
5 EOBD emission limits
6 System fault which affects emissions
7 Emission control malfunction indicator lamp (MIL) actuated

Comparison of EEC V, Euro Standard Stage 2, and EEC V, Euro Standard Stage 3 (EOBD)

- For years the software of the EEC V engine management system has included certain functions which could immediately be ascribed to the EOBD. However, these functions were not yet required by law.

EOBD Functions	**In EEC V Euro Standard Stage 2**	**In EEC V Euro Standard Stage 3 (EOBD)**
	From 1995 model year	From 1999 model year
Required by law	No	No (not until 2001)
MIL required	No	Yes
MIL **only** in relation to exhaust emissions *	No	Yes
Exhaust emission limits	No	Fixed values
Diagnostic Information		
Standardized fault or diagnostic trouble codes	Yes	Yes
Freeze frame data	Yes	Yes
SCP/DLC/diagnostic facility	Yes	Yes

Some Ford vehicles were previously equipped with a malfunction indicator lamp (MIL), but this was **not** actuated by emission related monitoring control systems.

Comparison of EEC V, Euro Standard Stage 2, with EEC V, Euro Standard Stage 3 (EOBD) (continued)

Diagnostic Test		
Comprehensive component monitor (CCM)	Yes	Improved
Combustion misfire monitor	No	Yes
Heated oxygen sensor (HO2S) monitor	Yes	Improved
Fuel monitor	Yes	Improved
Catalytic converter efficiency monitor	No	Yes
Exhaust gas recirculation (EGR) monitor	Yes	Improved (not present when introducted)
Secondary air injection (AIR) monitor	No	Yes (not present when introducted)
Evaporative emission system (EVAP) monitor	No	No
Failure mode effects management (FMEM)	Yes	Improved

Tick the correct answer or fill in the gaps.

1. What is the reason for EOBD?

- ☐ a) On-board diagnostic system which is integrated in the EEC V PCM and continuously monitors powertrain control systems and components which affect emissions.
- ☐ b) Economy on-board diagnostic system which measures the fuel consumption.
- ☐ c) Electric on-board diagnostics which monitors the electrical components and control systems of the vehicle.
- ☐ d) Emission control system which continuously checks the exhaust emissions and corrects deviations automatically.

2. How does the monitoring by the EOBD take place?

- ☐ a) By additional sensors and actuators in the exhaust system and software integrated in the EEC V PCM.
- ☐ b) By means of the existing sensors and actuators of the emission control systems in the vehicle and a separate control module with special software.
- ☐ c) By means of the existing sensors and actuators of the emission control systems in the vehicle and software integrated in the EEC V PCM.

3. After the emission control malfunction indicator lamp (MIL) is illuminated (due to future legal requirements)

- ☐ a) the driver of the vehicle should inform the service supervisor at the next inspection.
- ☐ b) the driver of the vehicle is obliged to take his vehicle to a Ford workshop as quickly as possible.
- ☐ c) the driver of the vehicle must stop the engine at once.
- ☐ d) the vehicle should be checked within one week.

For what mileage are the exhaust emission limits for the European market required by law?

- ☐ a) 120,000 km (75,000 miles)
- ☐ b) 40,000 km (25,000 miles)
- ☐ c) 80,000 km (50,000 miles)
- ☐ d) 180,000 km (112,500 miles)

5. In future, compliance with the exhaust emission limits

- ☐ a) will be monitored exclusively by the Ford workshops.
- ☐ b) will be monitored by law by the authorities by means of random testing.
- ☐ c) will be monitored regularly by the authorities.
- ☐ d) will be monitored exclusively by the EOBD on the vehicle.

Objectives

On completion of this lesson, you will be able to:

- explain the different trips and drive cycles which are necessary for fault detection and storage
- explain the functions of a monitoring system
- explain how a fault which switches on the emission control malfunction indicator lamp (MIL) materialises
- explain the meanings of the signals of the emission control malfunction indicator lamp (MIL) and thus reach conclusions as to the cause of the fault
- explain the meaning of “NON-MIL DTCs” and “MIL DTCs”

Fault detection and storage

- First, definitions of a few terms which are important for all the following explanations of the EOBD functions.
- A **drive cycle** begins when the engine is started (with the engine cold or warm) and ends when the engine is switched off. Therefore, this can be very short or very long.
- A **monitor trip** begins when the engine is started (with the engine cold or warm) and ends when the engine is switched off. During the trip the monitoring system can detect a fault.
- Therefore, this trip can relate to a single monitoring system.
- A **readiness trip** begins when the engine is started and is completed when all the monitoring systems have completed their tests. This can take place over a number of drive cycles.
- A **dealer test cycle** describes the drive cycle for carrying out one readiness trip as quickly as possible.

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

- When the ignition is switched on, the EEC V PCM continuously checks its inputs and outputs for discontinuity, short circuits and faulty sensors/actuators.
- The sensors/actuators can also be checked for plausibility, for example illogical combinations of signals.
- In addition, with the EOBD the control systems and components which affect emissions are also monitored by means of **monitoring systems**.
- The monitoring systems take the form of test routines initiated by the EEC V PCM to check systems which affect emissions such as for example heated oxygen sensor control, catalytic converter operation, etc.
- When a fault is detected, a fault or diagnostic trouble code (DTC) is stored in the keep alive memory (KAM).
- A **NON-MIL DTC** is a fault which does not affect emissions so the MIL is not actuated.
- An **MIL DTC** is a fault which affects emissions so the MIL can be illuminated.
- The **EOBD** and the following description relate **solely to MIL DTCs**.

Fault detection and storage (continued)

- The system detects a fault while the engine is running:
  - A fault occurring for the first time is stored in the KAM with the freeze frame data as a presumed fault (pending code).
  - If the fault is not confirmed during the next check, it is deleted.
  - Presumed faults which relate to combustion misfires or the fuel system are only deleted when the fault is not confirmed in similar conditions (defined as: engine speed ± 375 rpm, engine load ± 20% and the same warm-up status).
- However, if such a fault is confirmed during the **second drive cycle**, the presumed fault (pending code) is automatically changed to a **confirmed fault** (continuous code). The freeze frame data is not changed when this occurs, but remains the same as when the fault occurred for the first time.
- The emission control malfunction indicator lamp (MIL) only comes on when the fault is stored as a "confirmed fault".
- This means that the emission control malfunction indicator lamp (MIL) only comes on when the fault has been detected during the second trip.
- Exceptions to this are misfires which damage the catalytic converter.
- In the case of "misfires which damage the catalytic converter" (for example due to ignition or mixture), the emission control malfunction indicator lamp (MIL) **flashes** at once. With all other faults it **is illuminated continuously** during the second drive cycle.
- If the fault does not reoccur during three drive cycles, the emission control malfunction indicator lamp (MIL) is extinguished during the fourth drive cycle.
- The fault or diagnostic trouble code remains in the keep alive memory (KAM).
- Faults which no longer occur are automatically deleted from the KAM after 40 warm-up cycles.
- If a faulty signal is detected and the corresponding fault or diagnostic trouble code is stored during a trip, all the tests in which this signal is required as a reference are discontinued. This prevents storage of consequential faults.
- Fault or diagnostic trouble codes can be read out or deleted with a Ford diagnostic tool (WDS or FDS 2000) or with a generic scan tool.

Emission control malfunction indicator lamp (MIL)

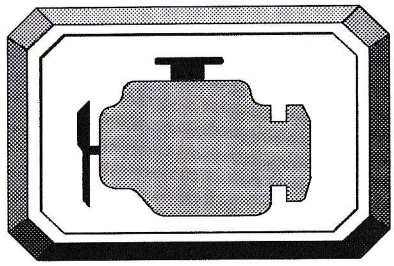
- The emission control malfunction indicator lamp (MIL) is located in the instrument cluster and takes the form of an engine symbol (international standard).
- The MIL alerts the driver when the EOBD system has found a component or system fault which affects emissions.
- Whenever the ignition is switched on, the instrument cluster actuates the MIL.
- If the EEC V system is in order, the instrument cluster receives a corresponding check message after the engine is started and the MIL is switched off (applies to SCP clusters only, on other systems the emission control malfunction indicator lamp (MIL) is controlled directly by the EEC V PCM).
- If the emission control malfunction indicator lamp (MIL) **does not go out** after the engine is started, this means that:
  - the emission control malfunction indicator lamp (MIL) has been actuated by the EEC V PCM due to a fault which affects emissions

or

  - the instrument cluster has actuated the emission control malfunction indicator lamp (MIL) because the EEC V PCM has not sent a check message to the instrument cluster

or

  - the EEC V PCM is in the limited operating strategy mode


7856/36/ESG

Emission control malfunction indicator lamp (MIL)

or

  - there is a short-circuit in the wiring of the emission control malfunction indicator lamp (MIL) - depending on the vehicle variant

or

  - there is a break in the wiring of the emission control malfunction indicator lamp (MIL) - depending on the vehicle variant.

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

Emission control malfunction indicator lamp (MIL) (continued)

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

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

- If the MIL flashes with an irregular frequency,

  - there is a break or short circuit in the wiring of the MIL

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

Tick the correct answer or fill in the gaps.

1. **What is a EOBD monitoring system?**

☐ a) The test routines which are initiated by the EEC V PCM and check the operation of all the components are described as a monitoring system.

☐ b) The signals emitted by a separate module for checking the EOBD system are described as a monitoring system.

☐ c) Test routines which are initiated by the EEC V PCM for emission control systems (for example heated oxygen sensor control) are described as a monitoring system.

2. **When is the emission control malfunction indicator lamp (MIL) switched on (other than in the case of misfires damaging the catalytic converter)?**

☐ a) Immediately after the occurrence of a fault.

☐ b) After repeated occurrence of a fault in the same conditions in one drive cycle.

☐ c) After repeated occurrence of a fault in the second drive cycle in the same conditions.

3. **Faults which no longer occur are**

☐ a) deleted after a maximum of 40 warm-up phases.

☐ b) deleted after a maximum of 200 km (125 miles).

☐ c) stored for the life of the vehicle.

☐ d) deleted immediately.

4. **The emission control malfunction indicator lamp (MIL) flashes with a regular frequency**

☐ a) when storing a fault or diagnostic trouble code.

☐ b) when a fault which affects emissions occurs during the second drive cycle.

☐ c) in the case of misfires which damage the catalytic converter (type A).

☐ d) immediately when a fault which affects emissions occurs during the first drive cycle.

5. **If the emission control malfunction indicator lamp (MIL) flashes with an irregular frequency,**

☐ a) the engine is suffering serious combustion misfires (type A).

☐ b) the engine is suffering serious combustion misfires (type B).

☐ c) the heated oxygen sensors are faulty.

☐ d) there is a break or short-circuit in the wiring of the emission control malfunction indicator lamp (MIL).

Objectives

On completing this lesson, you will be able to:

- explain the operation of the comprehensive component monitor (CCM) for emission control components
- describe the individual tests of the CCM:
  electronic ignition (EI) system, injector circuit, idle air control (IAC) mass air flow (MAF) sensor, temperature sensors, throttle position (TP) sensors, keep alive memory (KAM), temperature manifold absolute pressure (TMAP) sensor, variable camshaft timing (VCT) solenoid valve and automatic transmission
- explain the operation of the combustion misfire monitor and the types of misfire
- explain the operation of the upstream and downstream heated oxygen sensor (HO2S) monitor
- define the tests of the upstream and downstream heated oxygen sensors
- explain the operation of the fuel monitor
- explain the (short-term and long-term) fuel trim adjustment controlled by the upstream heated oxygen sensors
- explain the operation of the catalytic converter efficiency monitor
- explain the operation of the EGR monitor
- describe the order of the EGR monitoring tests
- explain the operation of the secondary air injection (AIR) monitor

Comprehensive component monitor (CCM) for emission control components

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

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

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

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

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

Comprehensive component monitor (CCM) for emission control components (continued)

- The CCM covers a number of components such as for example:
  - high speed electronically driven fan (HEDF), electronically driven fan (EDF)
  - electronic ignition (EI) system test
  - idle air control (IAC) solenoid valve
  - air conditioning (A/C) clutch
  - fuel pump (FP) monitor
  - intake manifold runner control (IMRC)
  - mass air flow (MAF) sensor
  - power steering (PS) sensor
  - maximum engine speed restriction fault code
  - smart generator
  - temperature sensors (ECT, IAT, CHT, TFT)
  - throttle position (TP) sensor
  - knock sensor (KS)
  - active carbon canister (CANP/SPV/VMV)
  - variable camshaft timing (VCT)
  - keep alive memory (KAM)
  - fuel injection circuit
  - temperature manifold absolute pressure (TMAP) sensor
  - fuel level (in tank) input (FLI)
  - automatic transmission (A/T)
- Some CCM tests can also be activated individually with a diagnostic tool.

NOTE: The following only describes the CCM tests which can lead to increased exhaust emissions or illumination of the emission control malfunction indicator lamp (MIL).

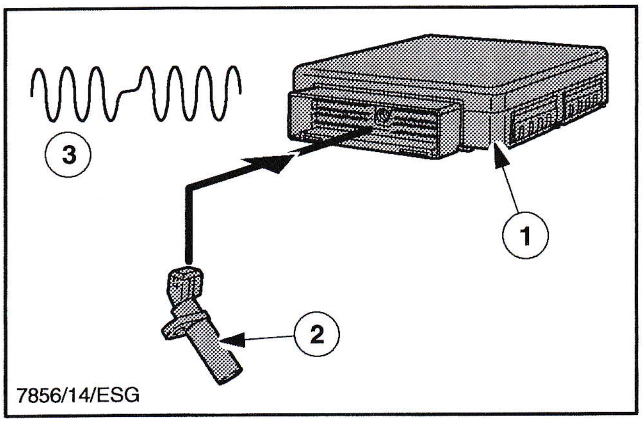
Comprehensive component monitor (CCM) for emission control components (continued)

Electronic ignition (EI) system test

- The following section describes the various tests involved in carrying out a comprehensive diagnostic check on the electronic ignition (EI), known more familiarly in Ford as IEDIS (integrated EDIS).

Crankshaft position (CKP) signal test (P0385)

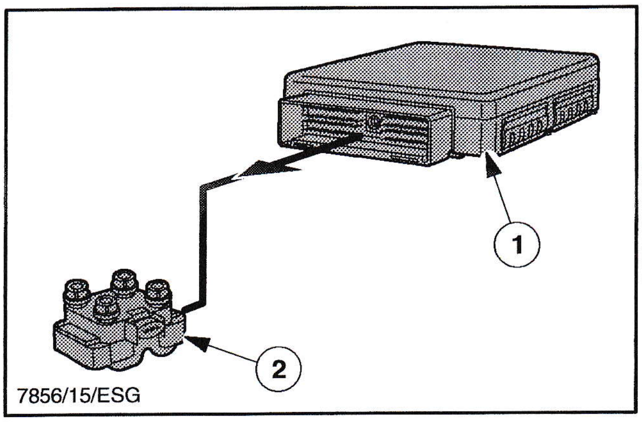
- When a certain maximum time is exceeded after the last CKP signal, a fault is deemed to be present (plausibility test). This test allows analysis of drive faults (stalling or dying of the engine).



1 EEC V PCM
2 CKP sensor
3 CKP signal

Ignition coil test (P0350 until P0360)

- Here, the time taken to half charge the ignition coils is monitored to detect any faults.
- The corresponding fuel injector or injectors are switched off.

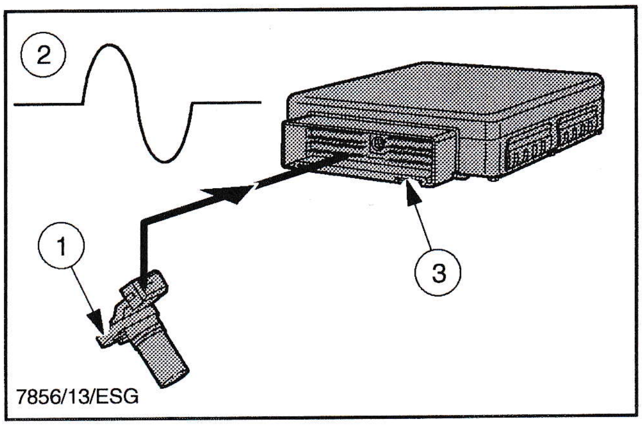


1 EEC V PCM
2 Ignition coils

Comprehensive component monitor (CCM) for emission control components (continued)

Camshaft position (CMP) signal test (P0340 and P0341)

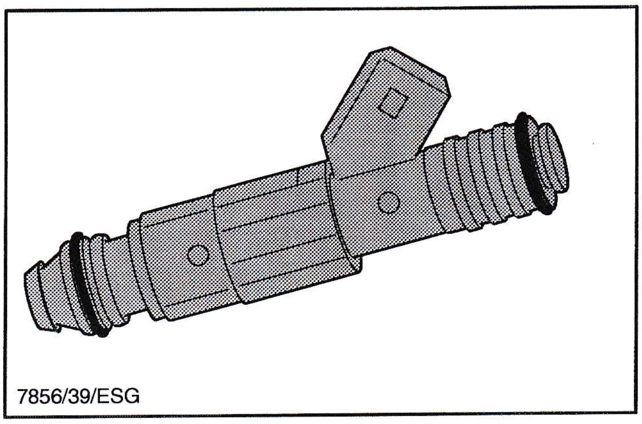
- The CMP signal occurs in parallel with the CKP signal. After a check has been made to ensure that the CKP signal is in order, it is possible to detect a fault in the CMP circuit.
- The EEC V PCM receives a CMP signal every second revolution of the crankshaft.



1 CMP sensor
2 CMP signal
3 EEC V PCM

Fuel injector circuit test (P0201 to P0210)

- This fuel injector circuit test operates on the low voltage side of the fuel injector circuit, together with a smart driver.
- The EEC V PCM will support engines up to 10 cylinders.
- The test is carried out while the fuel injector is switched off.
- An open circuit or a short circuit can be detected during this test.

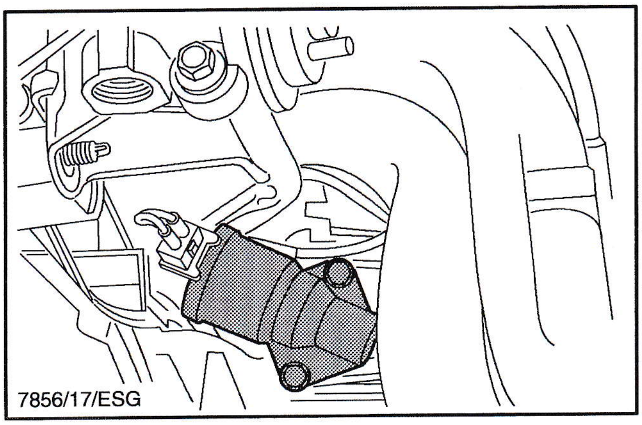


Fuel injector

Comprehensive component monitor (CCM) for emission control components (continued)

Idle air control (IAC) (P1504, P1506, P1507)

- The idle speed is controlled by varying the ignition and the quantity of bypass air.
- Since the ignition control is checked in all operating conditions, no additional tests are required in the idle control system.
- When the ignition is switched on, the circuit of the idle air control (IAC) valve is checked for short-circuits and continuity.



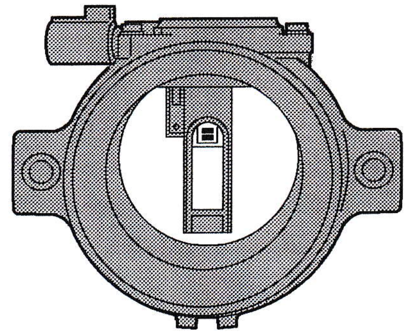
IAC valve in Mondeo

- The idle air control (IAC) valve regulates the bypass air in the idle range and has a damping function if the throttle is closed. However, the hardware is only checked when idling.
- During this test the engine speed is monitored continuously. If the idle speed changes too rapidly above or below the "required" speed, a diagnostic trouble code is stored. This test is susceptible to external factors (for example use of the clutch to hold the vehicle on a gradient or movement of the accelerator pedal with a foot when idling).
- The idle control is adaptive in that the quantity of bypass air can be adjusted to the engine (age, wear). This adjustment ensures that the idle speed is established as rapidly as possible after the change in operating conditions or change of load (for example when the air conditioning is switched on).
- While idling, the system learns to adapt to the changed conditions (learning process). The adjustment learnt is stored as a correction factor in an adaptive trim table (self-learning table) in the KAM.
- When this correction factor reaches its adaptation limit, the idle speed adjustments are stopped and a diagnostic trouble code is produced (NON-MIL).
- This test also compares the quantity of bypass air "demanded" with the quantity "supplied" (only in systems with an MAF sensor).

Comprehensive component monitor (CCM) for emission control components (continued)

Mass air flow (MAF) sensor test (P0102 and P0103)

- The MAF sensor is checked for short circuits and continuity. The signals from the sensor are monitored continuously to exclude any malfunctions.
- Various filters are used to eliminate intermittent signal deviations. A diagnostic trouble code is only produced (P1100 = NON MIL) when the signal deviations are present over a lengthy period.
- The moment a fault is recognized, other monitoring systems can be deactivated and the failure mode effects management (FMEM) activated (also refer to the lesson entitled "Diagnostics").

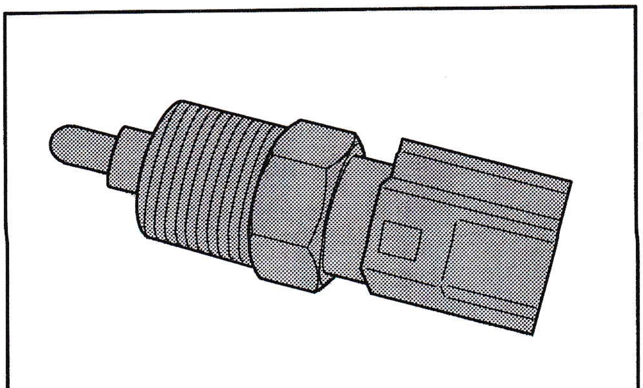

7856/19/ESG

MAF sensor

Comprehensive component monitor (CCM) for emission control components (continued)

Temperature sensor test

- Various temperature sensors are used in Ford engine management systems, for example:
  - intake air temperature (IAT)
  - engine coolant temperature (ECT)
  - cylinder head temperature (CHT)
  - transmission fluid temperature (TFT)
- These sensors are checked continuously for short-circuits and continuity. If a fault is found, the FMEM concerned is activated.



ECT sensor

- During starting the FMEM uses the value from another temperature sensor or a fixed value.
- If there is an ECT sensor malfunction, the TFT sensor (when fitted) or the IAT sensor takes over the function as a substitute. Then the temperature is gradually adjusted to the predetermined FMEM value.
- To avoid a fault preventing activation of another monitoring system, the IAT and ECT sensors are also checked for intermittent faults (NON-MIL).
- If the number of inhibiting faults exceeds a certain limit, the fault or diagnostic trouble code is stored (NON MIL).
- The time which the ECT signal requires from starting to reach a certain temperature is also checked (thermostat test) (NON-MIL).

Comprehensive component monitor (CCM) for emission control components (continued)

Temperature sensor test (continued)

- If the CHT sensor detects that the engine is over heating, the TCIL flashes and the engine is initially brought to a speed of less than 3000 rpm by switching off up to a maximum of three fuel injectors.

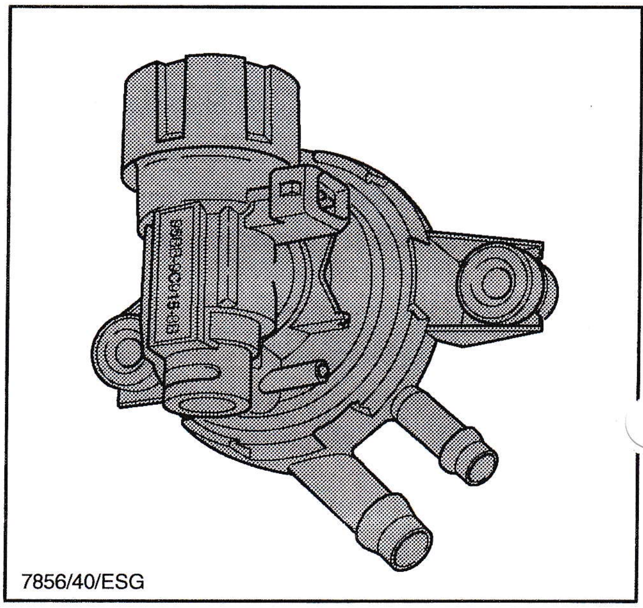
- When the engine speed is below 3000 rpm, the EEC V PCM always switches off two fuel injectors at a time after 100 crankshaft revolutions in each case.

- After approximately 30 seconds the fuel supply for all the cylinders is switched off. When the engine is operating in the "engine overheating safety function" mode, the EEC V PCM sets a fault or diagnostic trouble code.

- Once the engine has cooled down - after operating in the "engine overheating safety function" mode - to below 139°C (1.4L and 1.6L Zetec-SE) or 146°C (1.8L and 2.0L Zetec-E), the mode is no longer active, but can be reactivated if necessary.

Canister purge solenoid valve (CANP, SPV or VMV) (P0443)

- The CANP, SPV or VMV circuit is checked for short circuits and continuity.

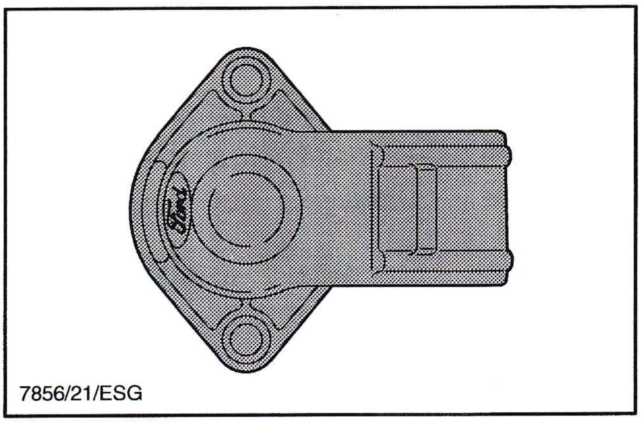


Fuel vapour management valve (VMV)

Comprehensive component monitor (CCM) for emission control components (continued)

Throttle position (TP) sensor test

- The throttle position (TP) sensor is a potentiometer which establishes the position of the throttle plate.
- This sensor registers the individual operating conditions (closed, partially opened, wide open throttle).
- The sensor circuit is checked for short-circuits and continuity and in addition must not drop below certain limit values (minimum voltage when the throttle is closed).



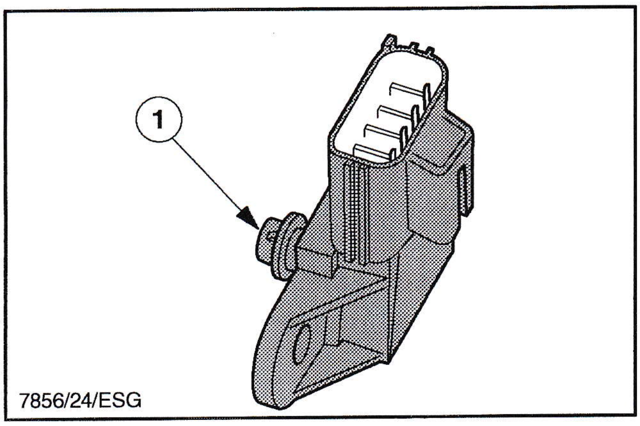
TP sensor

- If the TP voltage is not in range during starting, a fixed basic value is adopted. Otherwise, the last correct value is used, but only for a certain time. After this the FMEM reverts to a substitute value which is based on the MAF and RPM signal.
- This makes it possible to identify the different operating conditions.
- Then a rationality check is carried out during which the TP signal is compared with other sensor inputs (for example the MAF signal) (NON-MIL).

Comprehensive component monitor (CCM) for emission control components (continued)

Temperature manifold absolute pressure (TMAP) test (P0107, P0108)

- The TMAP sensor is a analog sensor which detects the intake manifold pressure. The higher the pressure, the higher the output voltage.
- This sensor is indicated as being faulty when:
  - the output voltage is too high or too low or
  - there is a short-circuit or discontinuity or
  - the output voltage is temporarily outside the limit values (NON-MIL).
- The integrated temperature sensor is checked in the same way as the IAT sensor described previously.



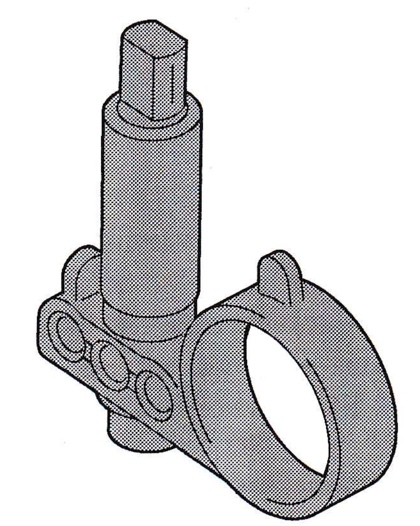
TMAP sensor

1 Pressure and temperature measurement

Comprehensive component monitor (CCM) for emission control components (continued)

Variable camshaft timing (VCT)
(P1380 to P1383)

- The circuit of the VCT solenoid valve is checked for short circuits and continuity.
- If the variable camshaft timing is overadvanced or overretarded, a fault is set and stored.



7856/41/ESG

VCT solenoid valve

Vehicle identification (VID) (P1635)

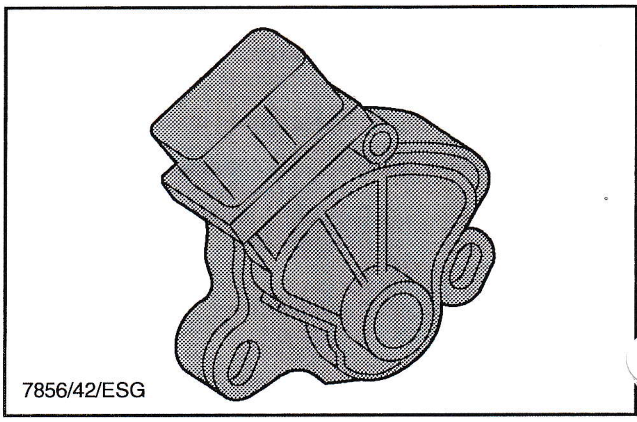
- The EOBD system checks whether the tire and axle ratio (TAR) are programmed correctly.

Comprehensive component monitor (CCM) for emission control components (continued)

Automatic transmission monitor

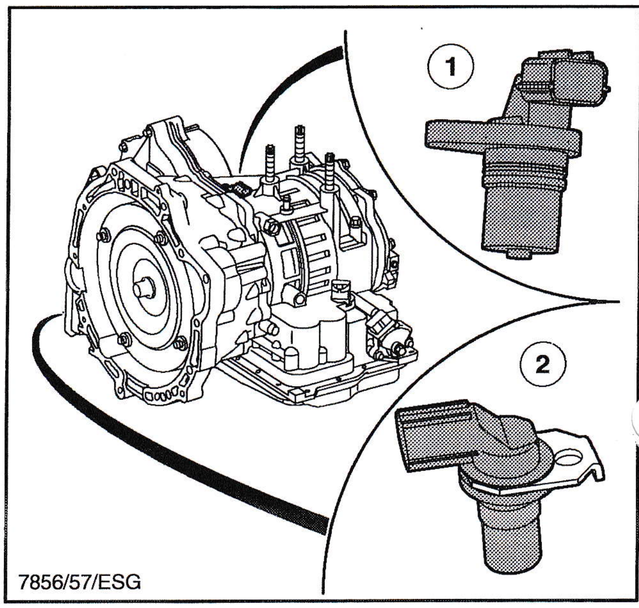
Transmission range (TR) sensor (P0705, P0707 and P0708)

- The transmission range (TR) sensor sends an input signal to the EEC V PCM. The voltage of the signal corresponds to the transmission range (selector lever position) at that time.
- The input signal of the TR sensor is checked for short circuits, continuity or output voltages lying outside the limit values.



Vehicle speed sensor (VSS), turbine shaft speed (TSS) sensor and output shaft speed (OSS) sensor

- The input signals from these sensors to the EEC V PCM are checked continuously for plausibility.
- If the output signal of one of these sensors is not in order, a malfunction is indicated by the following fault or diagnostic trouble codes:
  - VSS sensor = P0500
  - TSS sensor = P0715
  - OSS sensor = P0720



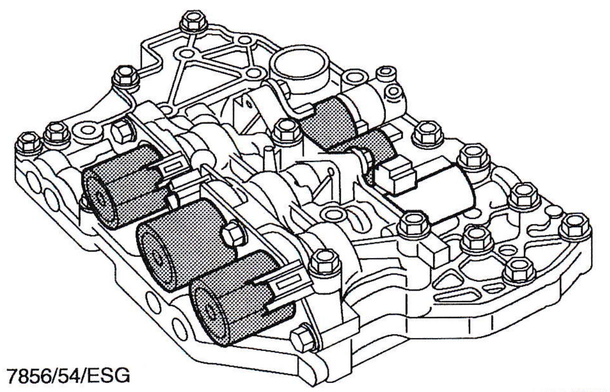
1 TSS sensor
2 OSS sensor

Comprehensive component monitor (CCM) for emission control components (continued)

Automatic transmission monitor (continued)

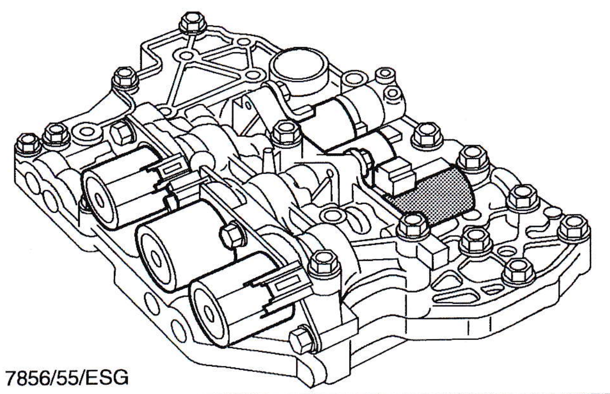
Solenoid valves 1 (SS1 = P0750), 2 (SS2 = P0755), 3 (SS3 = P0760), 4 (SS4 = P0765) and 5 (SS5 = P0770)

- The solenoid values are checked for short circuits and continuity.

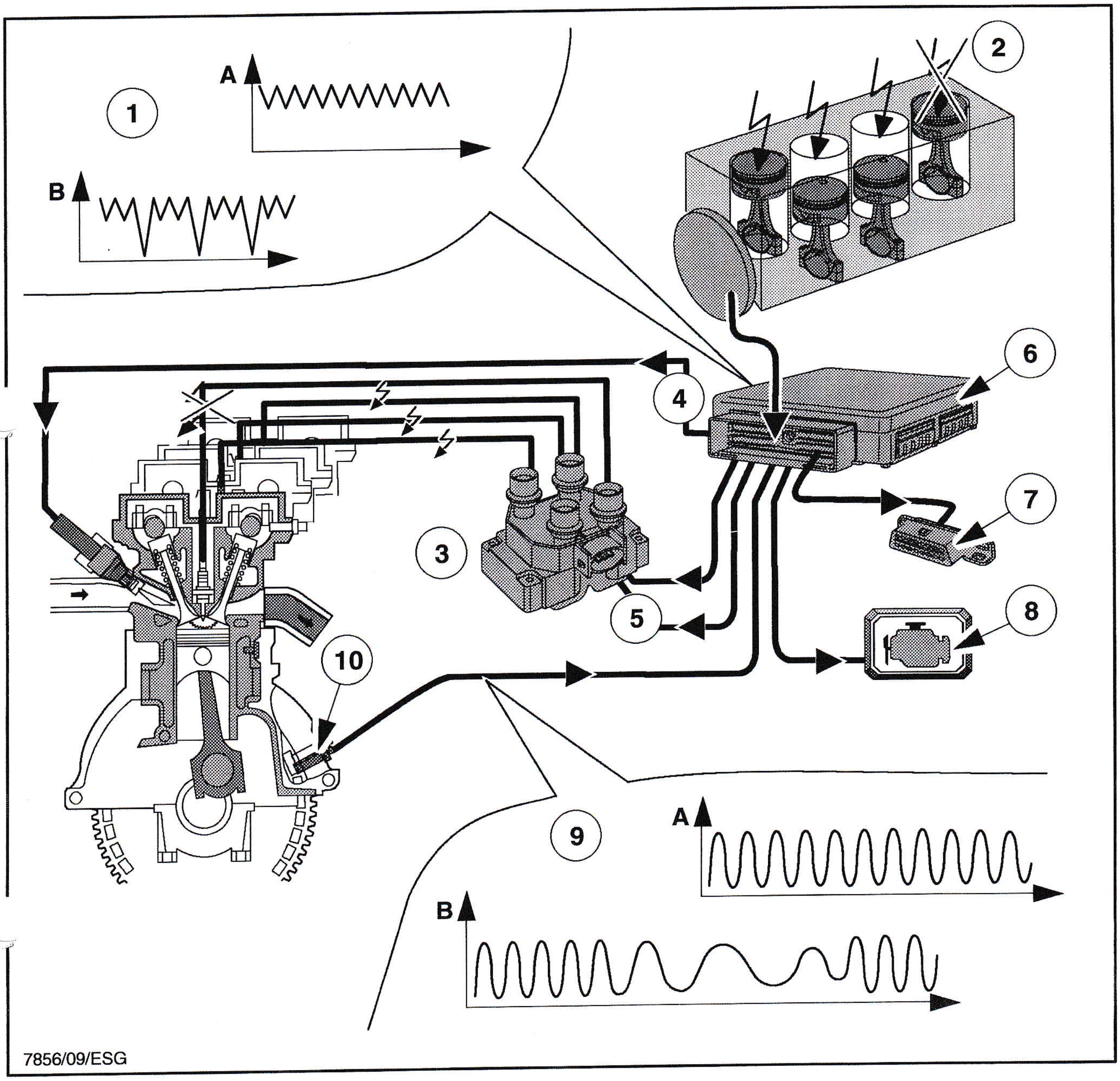

7856/54/ESG

Electronic pressure control (EPC) (P1747)

- The EEC V PCM controls the main line pressure solenoid valve (EPC solenoid valve).
- If there is a short in the circuit (low main line pressure), the engine torque can also be reduced to avoid damage.
- The transmission control indicator warning lamp (TCIL) is illuminated immediately a fault occurs.
- The emission control malfunction indicator lamp (MIL) is only switched on when the fault occurs again during the second trip.


7856/55/ESG

Combustion misfire monitor (P0300 until P0310)



A No misfires
B One cylinder misfiring
1 Acceleration of crankshaft
2 No spark
3 EI coil
4 Fuel injection signals
5 Actuation of EI coils
6 EEC V PCM
7 Data link connector (DLC)
8 Emission control malfunction indicator lamp (MIL)
9 Crankshaft position (CKP) signal
10 Crankshaft position (CKP) sensor

Combustion misfire monitor (P0300 until P0310) (continued)

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

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

- These misfires are identified

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

  - when the vehicle is moving from idle speed to 4500 rpm.

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

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

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

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

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

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

- Combustion misfires are caused by:

  - the ignition system

  - the fuel injection system

  - the fuel

  - the engine mechanical components

Combustion misfire monitor (P0300 until P0310) (continued)

- To make combustion misfire monitoring more reliable, there is a "learning mode" for the rotation of the engine. This is necessary since for example an irregular signal caused by an incorrectly mounted flywheel could lead to an incorrect error message.
- The learning mode logically becomes active while the fuel supply is shut off during overrun since no combustion misfires can occur in this mode.
- Therefore (after the KAM has been cleared) the combustion misfire monitor can only operate correctly when the vehicle has been travelling in overrun long enough (refer to the dealer test cycle).
- The data from the learning mode is stored in the KAM.

Type A combustion misfires

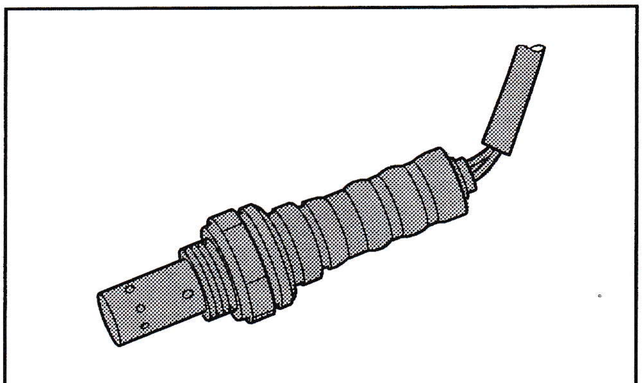
- Combustion misfires of Type A cause damage to the catalytic converter due to high temperatures.
- If a certain number of misfires are detected during these 200 revolutions, these are described as Type A misfires which damage the catalytic converter.
- If a Type A combustion misfire is detected, the emission control malfunction indicator lamp (MIL) flashes at once.
- In the case of vehicles with FMEM (not with 4-cylinder engines) which therefore cut out the fuel injection to avoid over-enrichment, the emission control malfunction indicator lamp (MIL) does not flash but comes on continuously.

Type B combustion misfires

- Combustion misfires of Type B lead to an increase in exhaust emissions above the EOBD threshold values.
- If a certain number of misfires are detected during these 1000 revolutions, these are described as Type B misfires which can lead to increased exhaust emissions.
- The emission control malfunction indicator lamp (MIL) only comes on when a Type B combustion misfire occurs during a second trip.
- If no more misfires occur - in identical conditions - during the following three trips, the emission control malfunction indicator lamp (MIL) goes out again.

Upstream and downstream heated oxygen sensor (HO2S) monitor

- The operation of the heated oxygen sensor or sensors (HO2S) upstream and downstream of the catalytic converter is monitored to detect sensor faults and deviations in the air/fuel supply or from the catalytic converter which exceed the EOBD threshold values and thus lead to increased exhaust emissions.
- The monitoring checks on the fuel system air/fuel ratio (by the fuel monitor) and on misfires must be completed before the heated oxygen sensors can be checked.



Heated oxygen sensor (HO2S)

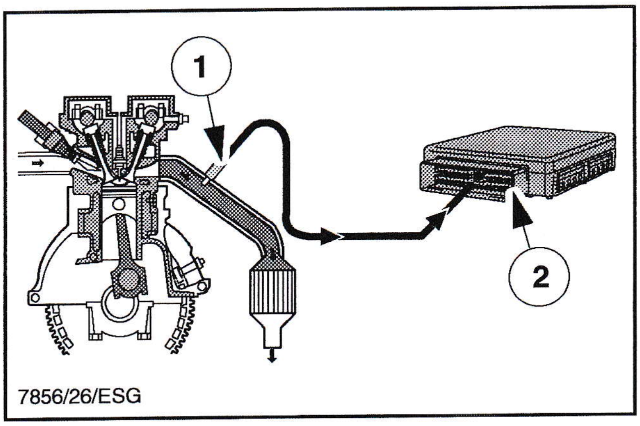
- The HO2S is able to determine the air/fuel ratio from the level of oxygen in the exhaust gases.
- The output voltage of the HO2S can vary between 0 and 1 V depending on the level of oxygen in the exhaust gas. 0 V means that a lot of oxygen is present in the exhaust gas (lean mixture); 1 V means that very little oxygen is present in the exhaust gas (rich mixture).
- The voltage usually fluctuates between 0.05 V (lean) and 0.9 V (rich) in the closed loop. The HO2S switches around 0.45 V, which corresponds to the stoichiometric fuel ratio of 14.7:1.
- The HO2S signals are evaluated by the EEC V PCM. Then the quantity of fuel to be injected is reduced or increased with a rich or lean mixture. This adjustment is called short term fuel trim (STFT).
- The fuel/air mixture should now fluctuate around the stoichiometric fuel ratio so as to optimize the catalyst efficiency.
- For this reason it is extremely important that the HO2S are in order since these have a direct influence on the exhaust emissions, driveability and fuel consumption.
- "SHRTFT1" and "SHRTFT2" (second upstream HO2S) are the parameters for a short-term fuel trim in the WDS/FDS 2000.
- "STFT" is indicated in percent (%). For example, a negative percentage means that a "rich mixture" is present at the HO_2S. The EEC V PCM tries to make the mixture leaner.
- Ideally the SHRTFT fluctuates around zero %.

Upstream and downstream heated oxygen sensor (HO2S) monitor (continued)

- To monitor the operation of the HO2S, the following tests are carried out while the engine is running:
  - upstream HO2S response test
  - downstream HO2S test
  - HO2S heater test
  - HO2S switching test
- Some of the tests named above run **only once per drive cycle.**

Upstream HO2S response test (P0133, P0153)

- This test checks intensively whether the upstream HO2S can switch fast enough and whether the voltage amplitude is in order.
- For this, the fuel system is actuated with a calibrated system frequency (1.5 Hz) for a few seconds while the vehicle is travelling in stable operating conditions. The system must have been in a closed loop for at least 10 seconds.
- During this test the mean amplitude is measured. When the system frequency is increased, this amplitude will reduce with deterioration from the HO2S (this means that the response of the HO2S is slower due to contamination/wear).
- In the case of V-engines with two different HO2Ss, in this test the leaning and enrichment of the mixture is dephased between the two banks of cylinders, which means than when the mixture for the left-hand bank of cylinders is leaned, the mixture for the right-hand bank of cylinders is enriched and vice versa. This reduces torque fluctuations. Thus, the driver of the vehicle feels nothing during this test.

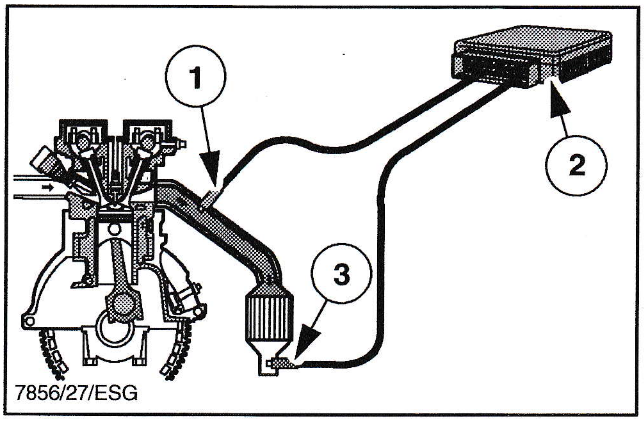


1 Upstream HO2S
2 EEC V PCM

- In the case of engines with only one HO2S, the ignition point is adapted to offset torque fluctuations. This is only carried out (depending on the vehicle) when it is programmed.

Downstream HO2S test (P0136, P0156)

- The test for the downstream HO2S is only activated when the test for the upstream HO2S has been completed successfully.
- Following the test for the upstream HO2S and once the heater for the downstream HO2S has been switched on, the maximum and minimum output voltages are compared with the limit values.
- If the minimum and maximum HO2S voltages are in order, the sensor is deemed to be in order. Thus, further tests are unnecessary.
- If the minimum and maximum HO2S voltages are not achieved, the fuel system is brought into an open loop and the system is controlled with either a rich mixture (0.85 V) or a lean mixture (0.15 V). Then the output voltage of the downstream HO2S is checked again.
- To avoid problematic operating situations in the case of vehicles with V-engines with two banks of cylinders, the mixture of one bank of cylinders is enriched and that of the other bank of cylinders is leaned.

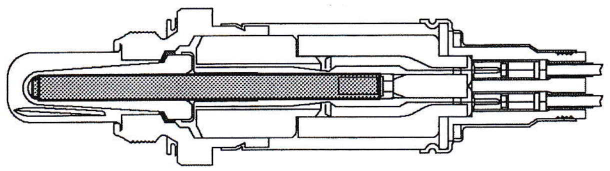


1 Upstream HO2S
2 EEC V PCM
3 Downstream HO2S

- If one bank of cylinders reaches the desired threshold value quicker, this is switched to a fixed mean value until the other bank of cylinders has reacted or the permitted time has elapsed.
- This test is discontinued when driving at full load or idle.
- The important point with the downstream HO2S is that the sensor signals are monitored continuously for peak voltages while the engine is running (NON-MIL)

HO2S heater test (P0135, P0141, P0155, P0161)

- The heater of the HO2S is not switched on until the temperature of the exhaust system in the area of the upstream HO2S has reached a minimum value. This allows the exhaust system to dry before the heater is switched on. Thus, thermal cracking is avoided.
- After the EEC V PCM has switched on the heater in the usual way, the heater test is activated.
- This heater test operates on the low voltage side of the circuit, together with an intelligent driver.
- When the heater of the HO2S is switched on, the voltage at the driver is low; when the heater is switched off, the voltage is high. If these voltages are not measured, there is a fault in the system.



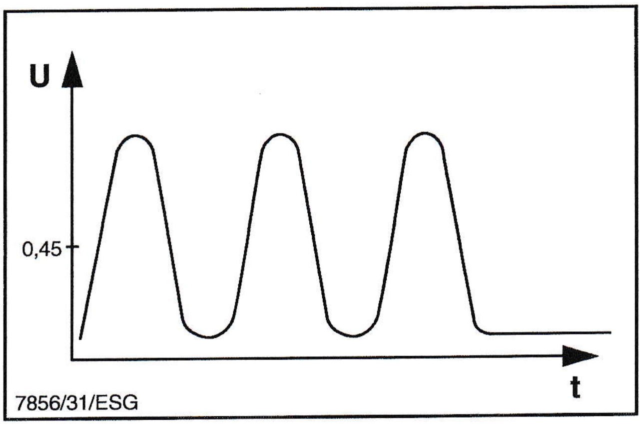
7856/28/ESG

Heater resistance

- When the temperature of the exhaust system exceeds a certain maximum value, the downstream HO2S heater is switched off to avoid overheating.

Continuous HO2S switching test (P1130, P1131, P1132, P1150, P1151, P1152)

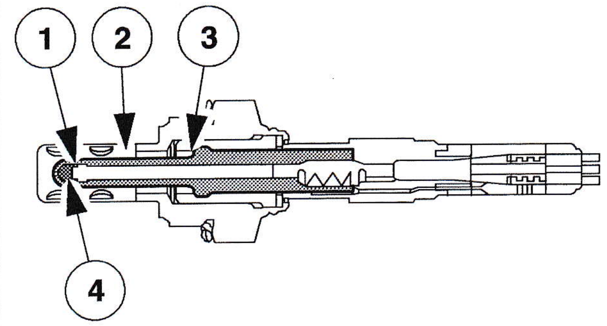
- This test locates major faults in the HO2S circuit, for example short circuits or discontinuity and sudden shifts in the fuel system (for example air leaks or sticking fuel injectors).
- This test only locates major faults as other EOBD tests can detect more specific faults.



- For this test the system must be in the closed loop, the exhaust gas recirculation must be switched off and sensors such as the ECT, IAT and TP sensors must be in order.
- To locate faults in the sensor or fuel system, three tests are carried out:
  - The number of HO2S switching operations is measured in a certain time. If an insufficient number of switching operations are detected after a certain time (with the sensor put in a position to switch), a fault is registered.
  - If the short term fuel trim (STFT) reaches the trim limit and remains there for a certain time, a fault is registered.
  - If the dwell time at a switching point within a normal signal exceeds a certain value, a fault is registered.
- This test makes allowance for the effects of the EVAP system or EGR system.

Characteristic shift downward (CSD)

- A characteristic shift downward (CSD) indicates a faulty HO2S when an output voltage of less than 0 V is measured. The downward shift is caused by contamination of the reference chamber in the sensor (due to ingress of water, exhaust gas or fuel).
- This contamination can be caused by:
  - cracked HO2S material or leakage at a seal
  - ingress of water through a faulty housing, connector or wiring insulation
  - a production fault
- An HO2S voltage below 0 V, due to a characteristic shift downward, will be detected by the EEC V PCM. The engine management system will then make appropriate adjustments. **No fault code is stored and the MIL is not actuated.**

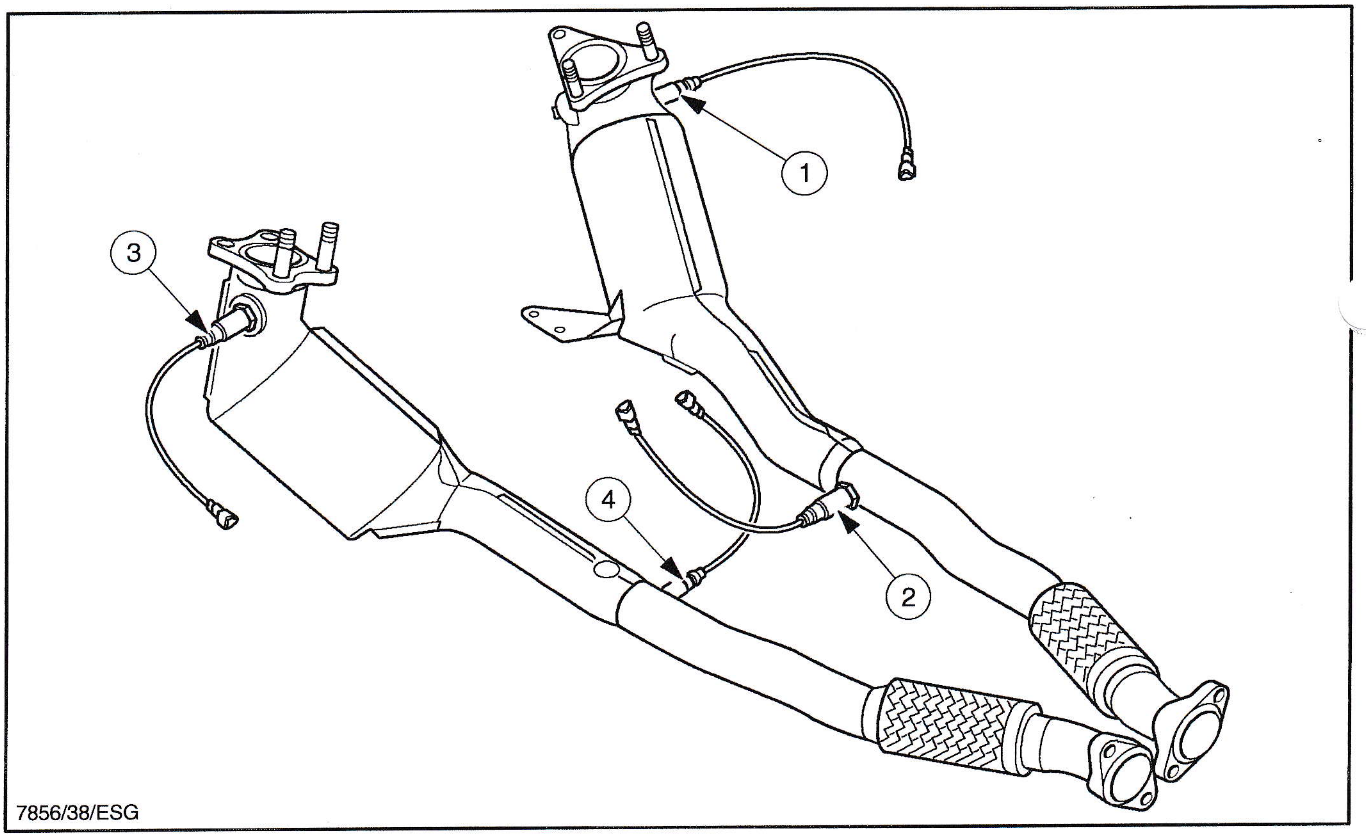


7856/30/ESG

1 Sensor ceramic material
2 Protective tube
3 Seal
4 Reference chamber

Identification of upstream and downstream heated oxygen sensors

- The upstream and downstream heated oxygen sensors are identified in each case by two numbers (prefix and suffix).

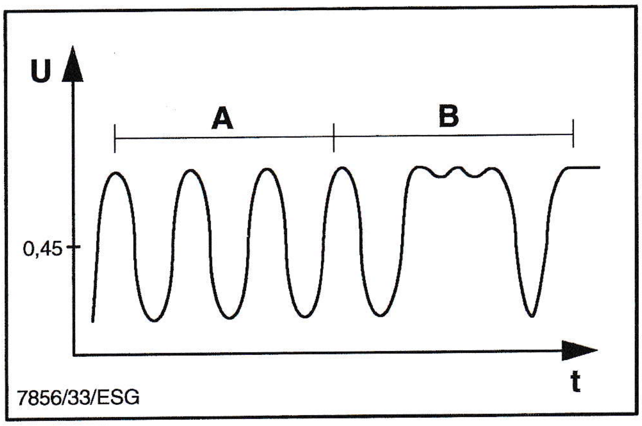


Location of heated oxygen sensors (V6 engine for example)

1 Upstream heated oxygen sensor for right-hand bank of cylinders (HO2S 11)
2 Downstream heated oxygen sensor for right-hand bank of cylinders (HO2S 12)
3 Upstream heated oxygen sensor for left-hand bank of cylinders (HO2S 21)
4 Downstream heated oxygen sensor for left-hand bank of cylinders (HO2S 22)

Fuel monitor (P0171, P0172, P0174, P0175)

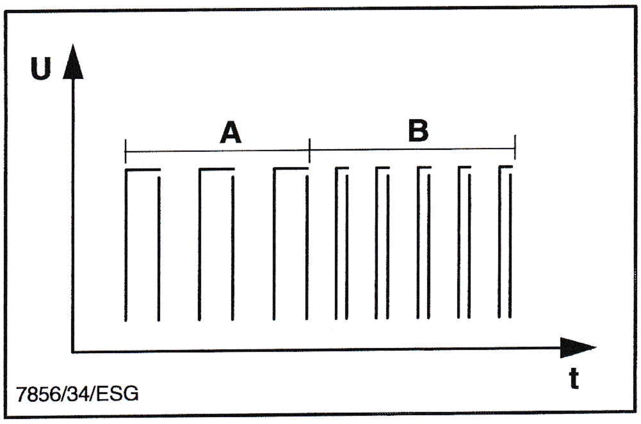
- The operation of the fuel system is monitored to detect faults which lead to high exhaust emissions and lie above the EOBD threshold values.
- A strategy was developed to monitor the **trim adjustments** made in the fuel system.
- The upstream HO2S measures the oxygen level in the exhaust gas (indicating a rich or lean mixture) and feeds a message back to the EEC V PCM.
- If the signal is **on average** at the "**rich limit**", too much fuel is being injected.



A Average mixture

B Rich mixture

- The EEC V PCM then makes a **trim adjustment to the opening times** of the fuel injectors (short term fuel trim = STFT) to lean the mixture (also refer to the section entitled "Upstream and downstream heated oxygen sensor (HO2S) monitor").
- If the same deviation is registered **a number of times** at a particular engine speed and load, the result is a **permanent correction factor** (long term fuel trim = LTFT). This is then stored in the **keep alive memory (KAM)**.



A Normal fuel injection

B Reduced fuel injection time (to lean)

Fuel monitor (P0171, P0172, P0174, P0175) (continued)

- The **keep alive memory (KAM)** contains an **adaptive fuel table** (self-learning table) for all engine speed/load combinations.
- The information which was collected at different engine speeds/loads, is used for calculating the mixture and stored in the cells of the adaptive fuel table.
- The value of the adjustment multiplier for the fuel calculation is 0.5 plus the corresponding value taken from the adaptive fuel table.

A

0,5	0,4	0,4	0,4
0,6	0,5	0,5	0,4
0,6	0,6	0,5	0,5
0,6	0,5	0,5	0,5

7856/35/ESG B

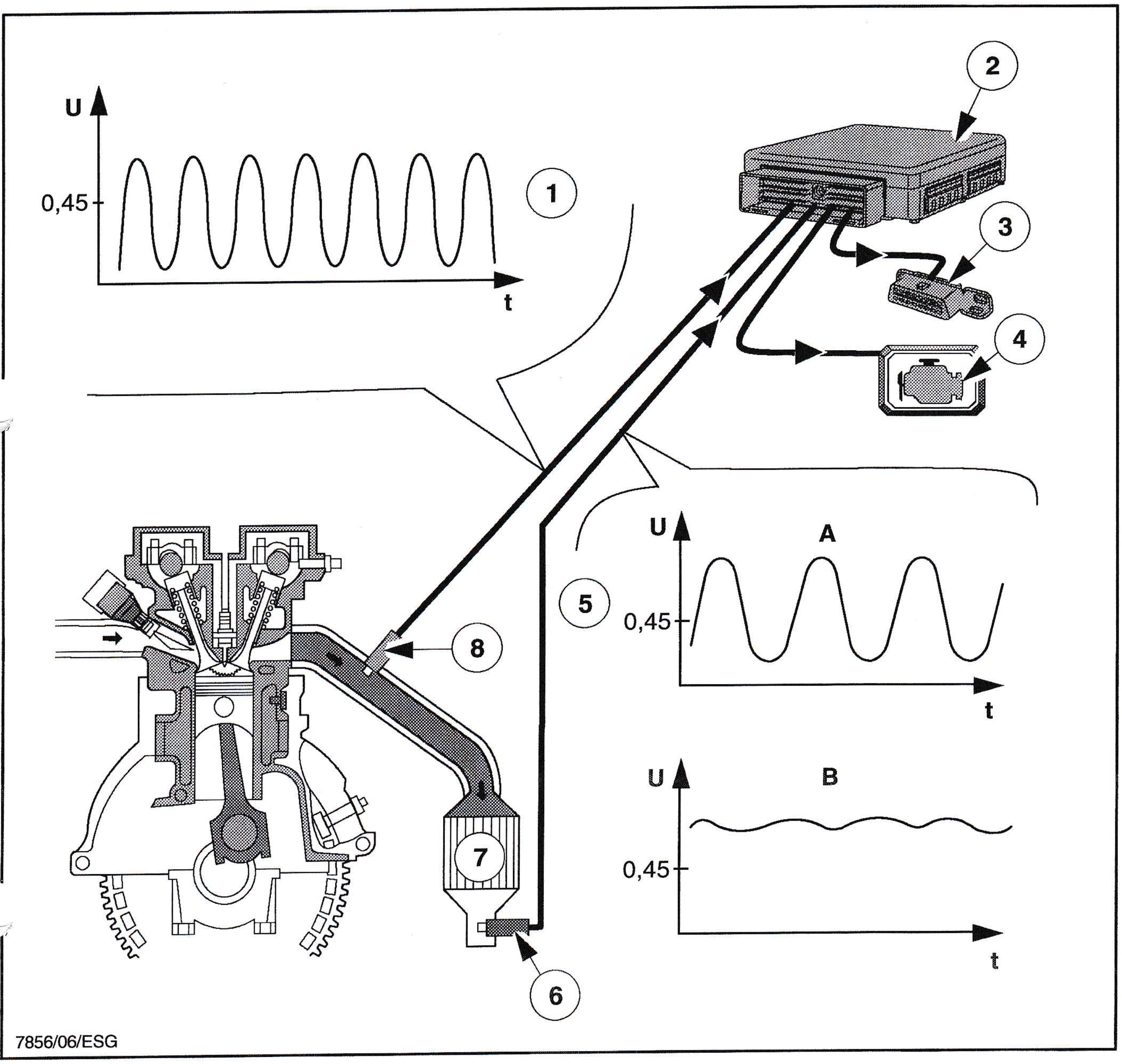
Example of an adaptive fuel table

A Load

B Engine speed

- The EEC V PCM calculates the LTFT from STFT information so as to ensure that switching takes place around the stoichiometric mixture of 14.7:1 while operating in closed loop.
- A fault is only registered when a correction factor has become so large that it exceeds a certain threshold value.
- This threshold value must be fixed so that a fault or diagnostic trouble code is produced before the exhaust emissions exceed one and a half times the permitted exhaust emission limits.
- The LTFT range is also expressed as a percentage (%).
- These threshold values can be adapted to changes in altitude or to high levels of fuel from the EVAP system without setting a fault.
- If a fault is located in the LTFT or the STFT, a fault code is set. If the fault is still present during the second trip, the emission control malfunction indicator lamp (MIL) is switched on.
- When the fuel system monitor has located a fault, it can switch off other monitors (for example the HO2S and air injection monitors) since this can affect their reliability.
- "Long FT1" and "long FT2" (second upstream HO2S) are the parameters for the permanent fuel adjustment in the WDS/FDS 2000.
- **The fuel monitor operates continuously** while the engine is running.

Catalytic converter efficiency monitor (P0420, P0430)



A Catalytic converter efficiency low
B Catalytic converter efficiency high
1 "Upstream HO2S" lambda signal
2 EEC V PCM
3 Data link connector (DLC)
4 Emission control malfunction indicator lamp (MIL)
5 "Downstream HO2S" lambda signal
6 Downstream HO2S
7 Catalytic converter
8 Upstream HO2S

Catalytic converter efficiency monitor (P0420, P0430) (continued)

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

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

- The catalyst has a ceramic honeycomb which is coated with catalytically active material.

- As the exhaust gases flow through the ceramic honeycomb, the catalytic material ensures that the HC and CO are oxidised and the NO_x are broken down. During this process the named gases are converted into water (H_2O), carbon dioxide (CO_2) and nitrogen (N_2).

- For this the catalytic converter requires a stoichiometric or chemically balanced mixture of HC and oxygen (O_2) for efficient conversion.

- This is achieved through the fuel mixture which fluctuates within tight limits around the stoichiometric mixture.

- Surplus fuel or a rich mixture reduces the conversion of HC and CO since this causes a shortage of oxygen (O_2) in the catalytic converter. In contrast, surplus oxygen reduces the conversion of NO_x.

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

- In addition, the catalytic converter helps to maintain the stoichiometric mixture. For this, when the mixture is “lean”, oxygen (O_2) is stored which is released again when the mixture is “rich”.

- The active surface of an efficient catalytic converter stores oxygen (O_2) and releases it again to offset deviations in the mixture.

- Contamination or premature ageing of this active surface reduces the ability to store oxygen (O_2). The result is lower catalytic converter efficiency.

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

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

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

Catalytic converter efficiency monitor (P0420, P0430) (continued)

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

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

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

  - When a catalytic converter is working badly, the signal from the downstream HO2S has a higher peak to peak amplitude and a higher switching frequency.

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

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

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

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

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

$$\textbf{Switching ratio} = \frac{\textbf{number of switching operations of downstream HO2S}}{\textbf{number of switching operations of upstream HO2S}}$$

$$\textbf{Switching ratio} = \frac{1}{5} = \textbf{0.2 (high catalytic converter efficiency)}$$

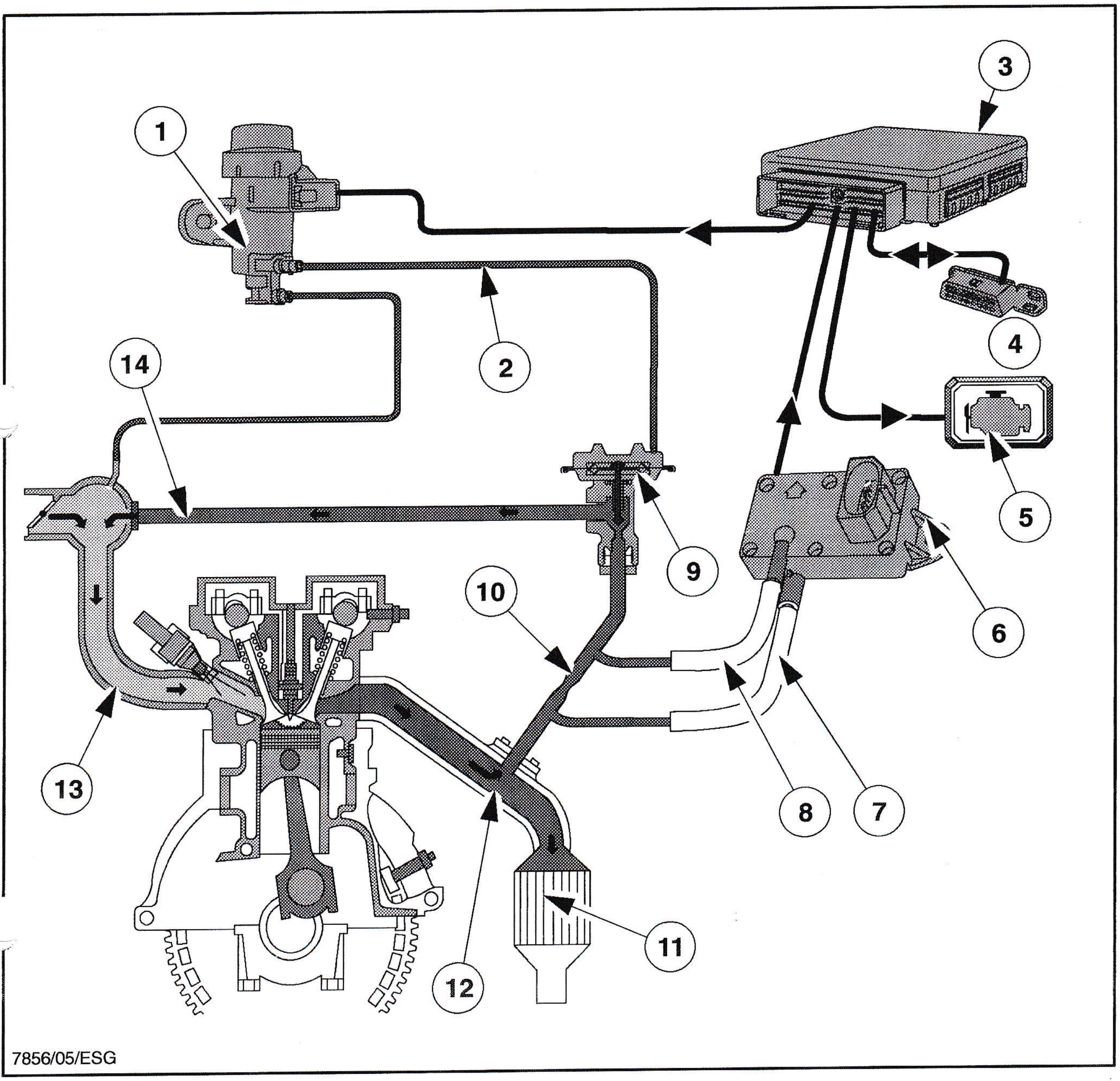
$$\textbf{Switching ratio} = \frac{4}{5} = \textbf{0.8 (low catalytic converter efficiency)}$$

Catalytic converter efficiency monitor (P0420, P0430) (continued)

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

- This means that when the catalytic converter is working badly, the signal of the upstream HO2S and the signal of the downstream HO2S are almost identical. From this it can be concluded that the exhaust gases flowing into the catalytic converter are flowing out again without any significant conversion process taking place.

Exhaust gas recirculation (EGR) monitor (P1400, P1401, P1402, P1405, P1406 und P1409)



1 EGR vacuum regulator
2 Regulated vacuum
3 EEC V PCM
4 Data link connector (DLC)
5 Emission control malfunction indicator lamp (MIL)
6 Exhaust differential pressure sensor
7 Upstream hose
8 Downstream hose
9 EGR valve
10 Venturi orifice (constriction)
11 Catalytic converter
12 Exhaust gases
13 Intake air with recirculated exhaust gases
14 Recirculated exhaust gases

Exhaust gas recirculation (EGR) monitor (P1400, P1401, P1402, P1405, P1406 und P1409) (continued)

- The operation of the EGR system is monitored to detect faults which could lead to increased exhaust emissions that may exceed the EOBD threshold values.
- When the EOBD system is introduced in Europe, the exhaust gas recirculation (EGR) monitor will not be included. However, it is possible that this monitoring system will be introduced at a later date.
- This monitoring system has been designed so that it can check the flow characteristics of the EGR system among other things.
- The main test of the EGR monitoring system generates a fault when no exhaust gas recirculation is detected (EGR system failure). This test is only carried out when the tests for the individual components have been completed.
- The tests on the individual components in the EGR system are as follows:
  - exhaust differential pressure sensor voltage too low
  - exhaust differential pressure sensor voltage too high
  - EGR valve sticking open
  - fault in EGR regulator circuit
  - upstream hose of exhaust differential pressure sensor disconnected/blocked
  - downstream hose of exhaust differential pressure sensor disconnected/blocked
- Following the engine start-up the EGR monitoring system is activated a few seconds before the EGR system switches on the exhaust gas recirculation. The exhaust gas recirculation is switched on while the vehicle is travelling after a certain time and only in certain engine operating conditions.
- As soon as the EGR monitoring system is activated and the particular engine operating conditions exist, the respective tests are carried out in a certain order.
- The EGR monitoring system is deactivated when all the tests have been completed successfully at least once.
- Should a fault occur in the EGR system after the EGR monitoring system has been deactivated, this will only be discovered during the next trip.
- If a fault is located in the EGR system during the EGR monitoring, the EGR system and the EGR monitoring system are **switched off until the next time the engine is started**. A presumed fault (pending code) is stored.
- This means that the complete **monitoring only takes place once per drive cycle**.

Exhaust gas recirculation (EGR) monitor (P1400, P1401, P1402, P1405, P1406 und P1409) (continued)

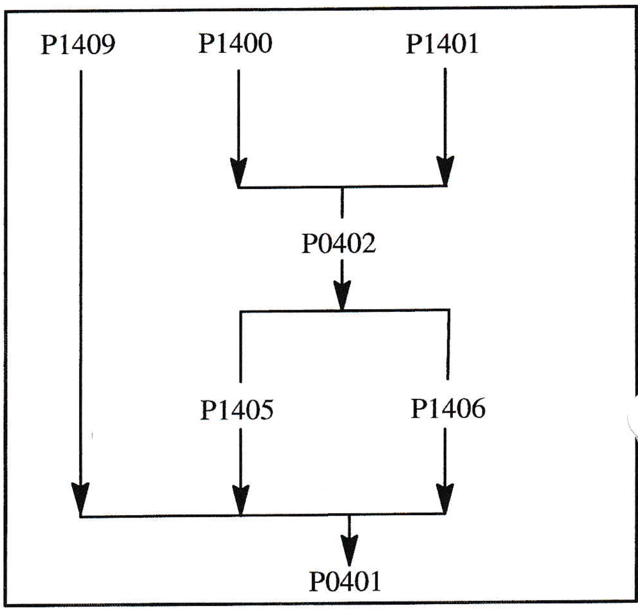
Order of EGR monitoring tests

- The EGR monitoring tests are carried out in a specific hierarchical order.
- This order ensures that the following tests can only be started when the previous tests have been completed without any faults.
- This hierarchical order is necessary to be able to exclude the possibility of diagnosing consequential faults.
- In this hierarchy the most fundamental malfunctions are tested first. If a fault is located, the following tests are no longer activated.

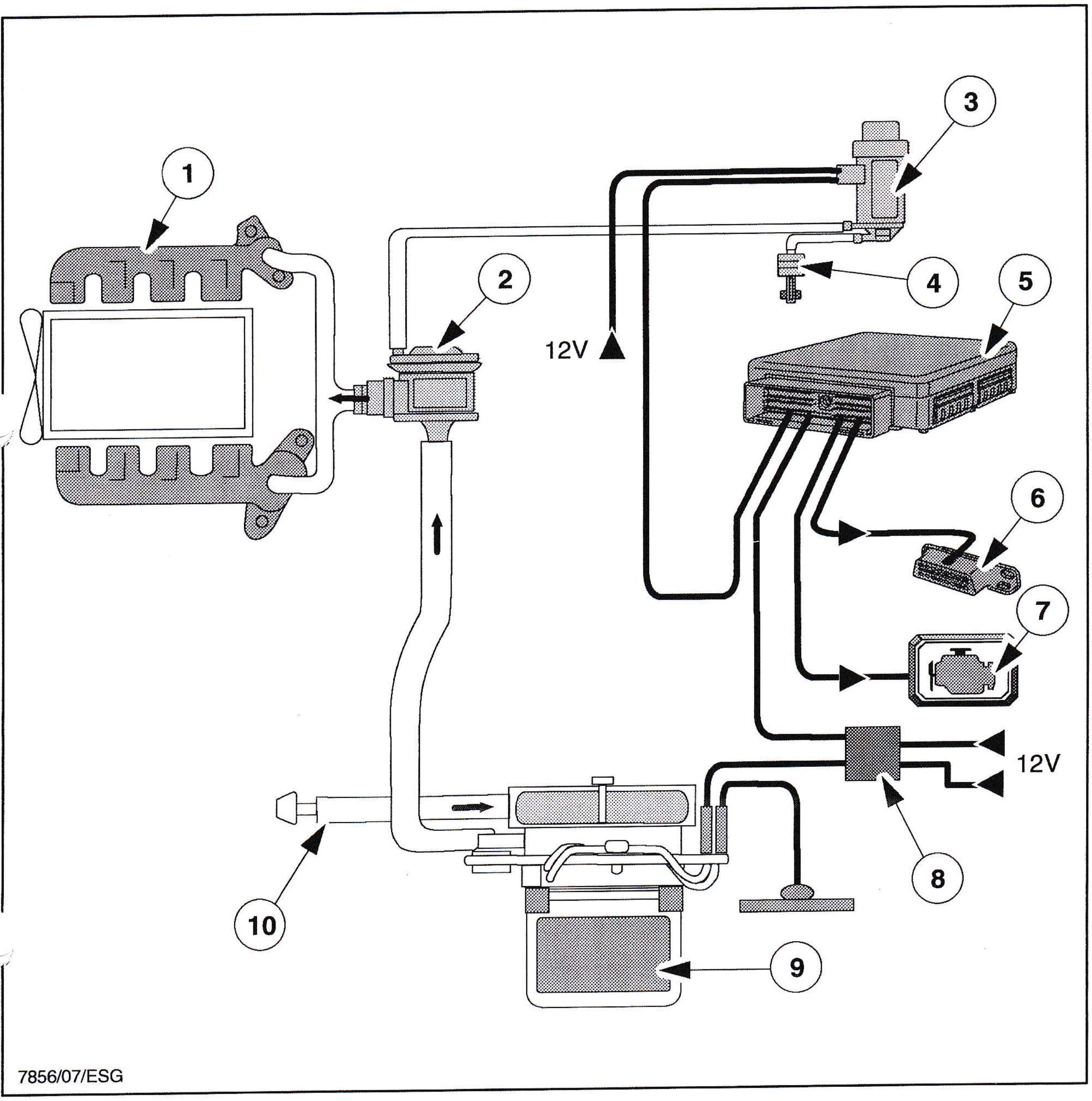
Description	Driving Conditions	Fault Code
Insufficient exhaust gas recirculation	EGR system switched on and in partial load range while driving constantly	P0401
EGR valve sticking open	EGR system switched off and engine in idling range	P0402
Voltage of exhaust differential pressure sensor too low	All	P1400
Voltage of exhaust differential pressure sensor too high	All	P1401
Upstream hose of exhaust differential pressure sensor disconnected/blocked	EGR system switched off during acceleration and once per journey	P1405
Downstream hose of exhaust differential pressure sensor disconnected/blocked	EGR system switched off during acceleration and once per journey	P1406
Fault in EGR pressure regulator circuit	EGR system switched on	P1409

Exhaust gas recirculation (EGR) monitor (P1400, P1401, P1402, P1405, P1406 und P1409) (continued)

- During normal engine operation the tests are carried out in the order shown in the illustration.
- If the test for the quantity of recirculated exhaust gas (code P0401) is also completed successfully, the EGR monitoring system is deactivated.
- If the monitoring system detects a fault, all the tests are stopped. Then the system starts the tests anew to make sure that the actual fault has been identified before a diagnostic trouble code is stored.
- An exception to this is the test for the quantity of exhaust gas recirculated (code P0401) as this test is only carried out once.



Secondary air injection (AIR) monitor (P0411 to P014 and P1413, P1414)



1 Exhaust manifold
2 Secondary air injection (AIR) combination valve
3 Secondary air solenoid valve
4 One-way vacuum valve
5 EEC V PCM
6 Data link connector (DLC)
7 Emission control malfunction indicator lamp (MIL)
8 Relay
9 Secondary air pump
10 Fresh air

Secondary air injection (AIR) monitor (P0411 bis P014 und P1413, P1414) (continued)

- The operation of the AIR system is monitored to detect faults which lead to increased exhaust emissions and lie above the EOBD threshold values.
- When the EOBD system is introduced in Europe, the secondary air injection (AIR) monitor will not be included. However, it is possible that this monitoring system will be introduced at a later date.
- For the sake of completeness, a brief description of the American OBD II system is given here.
- The AIR system monitor checks the secondary air solenoid valve and the air pump for continuity and short circuits.
- **Once in each trip a functionality test** is carried out to establish whether the system is able to pump air into the exhaust manifold.
- During a functionality test the fuel system is actuated to enrich the mixture during a warm idle phase.
- Then the secondary air system is switched on and the signal from the upstream heated oxygen sensor (HO2S) is evaluated.
- If a "rich" signal is still registered after a short time, this means that the secondary air system is not operating correctly.
- However, if a "lean" signal is registed, this means that the secondary air system is in order.
- This test takes approximately 20 seconds.

Tick the correct answer or fill in the gaps.

1. What is checked with the comprehensive component monitor (CCM) for emission control components?

- ☐ a) The interaction of all the components which affect emissions with the EEC V PCM
- ☐ b) The operation of the sensors and actuators within specific tolerances is checked at predetermined intervals of time while the vehicle is travelling
- ☐ c) The operation of the sensors and actuators which affect emissions within specific tolerances is checked continuously while the vehicle is travelling
- ☐ d) The operating ability of all the components which affect emissions in extreme conditions

2. A diagnostic trouble code is stored in the keep alive memory (KAM) when

- ☐ a) a sensor or actuator is outside the tolerance band
- ☐ b) the emission control malfunction indicator lamp (MIL) starts to flash
- ☐ c) a fault occurs again during the second trip in the same condition
- ☐ d) the system is unable to decide whether a fault is genuine, even after several trips

3. The CKP signal test indicates when a fault is present all the time when

- ☐ a) a certain maximum time is exceeded after the first CKP signal.
- ☐ b) the CKP signal is interrupted intermittently.
- ☐ c) the CKP signal is in order all the time.
- ☐ d) a certain maximum time is exceeded after the last CKP signal.

4. The IAC trim adjustments learnt while the vehicle is moving (learning process) are

- ☐ a) stored as a correction factor in an adaptive table in the KAM.
- ☐ b) stored as a correction factor in an adaptive table in the integrated EDIS.
- ☐ c) lodged as a correction factor in an external data memory.
- ☐ d) implemented for the instantaneous operating state and deleted again at once.

5. If the ECT sensor malfunctions, the following sensors perform the substitute function:

- ☐ a) TP or IAT
- ☐ b) CHT or TP
- ☐ c) TFT or IAT
- ☐ d) CHT and TP

6. **How are the EGR tests carried out?**

- ☐ a) In succession depending on the operating state of the engine
- ☐ b) Arbitrarily depending on the operating state of the engine
- ☐ c) At random in accordance with a programme-controlled pattern
- ☐ d) In a specific hierarchical order

7. **Why is the operation of the upstream and downstream heated oxygen sensors (HO2S) monitored?**

- ☐ a) To detect deviations in the composition of the toxic substances so that the EOBD system can make appropriate corrections.
- ☐ b) To detect deviations in the air/fuel supply or the catalytic converter which exceed the EOBD threshold values and thus lead to increased exhaust emissions.
- ☐ c) To be able to detect the toxic substance conversion capacity of the catalytic converter continuousl

8. **What is understood by "short term fuel trim"?**

- ☐ a) In the event of ignition misfires the fuel metering for the cylinder concerned is reduced temporarily by the signal of the HO2S through the EEC V PCM.
- ☐ b) If a deviation from the stoichiometric ratio (over-enrichment or over-leaning of the mixture) is detected while the vehicle is moving, a fuel trim adjustment is carried out at once.
- ☐ c) During acceleration an increased amount of fuel is injected into the combustion chamber.
- ☐ d) In the event of a change in load (for example when negotiating a gradient at constant engine speed), a short term fuel trim adjustment is made by the HO2S signal from the EEC V PCM.

9. **When is the EGR monitoring system activated?**

- ☐ a) A few seconds after reaching the normal engine operating temperature
- ☐ b) It is activated a few seconds before the EGR system switches off the exhaust gas recirculation
- ☐ c) It is activated a few seconds before the EGR system switches on the exhaust gas recirculation
- ☐ d) Immediately after the engine is started from cold

10. **When is the EGR monitoring found to be "in order"?**

- ☐ a) When all the tests have been completed successfully at least once
- ☐ b) Immediately after a fault has been detected during the trip
- ☐ c) Immediately after the EGR system has been switched off by a diagnostic trouble code
- ☐ d) After reaching the normal engine operating temperature

Objectives

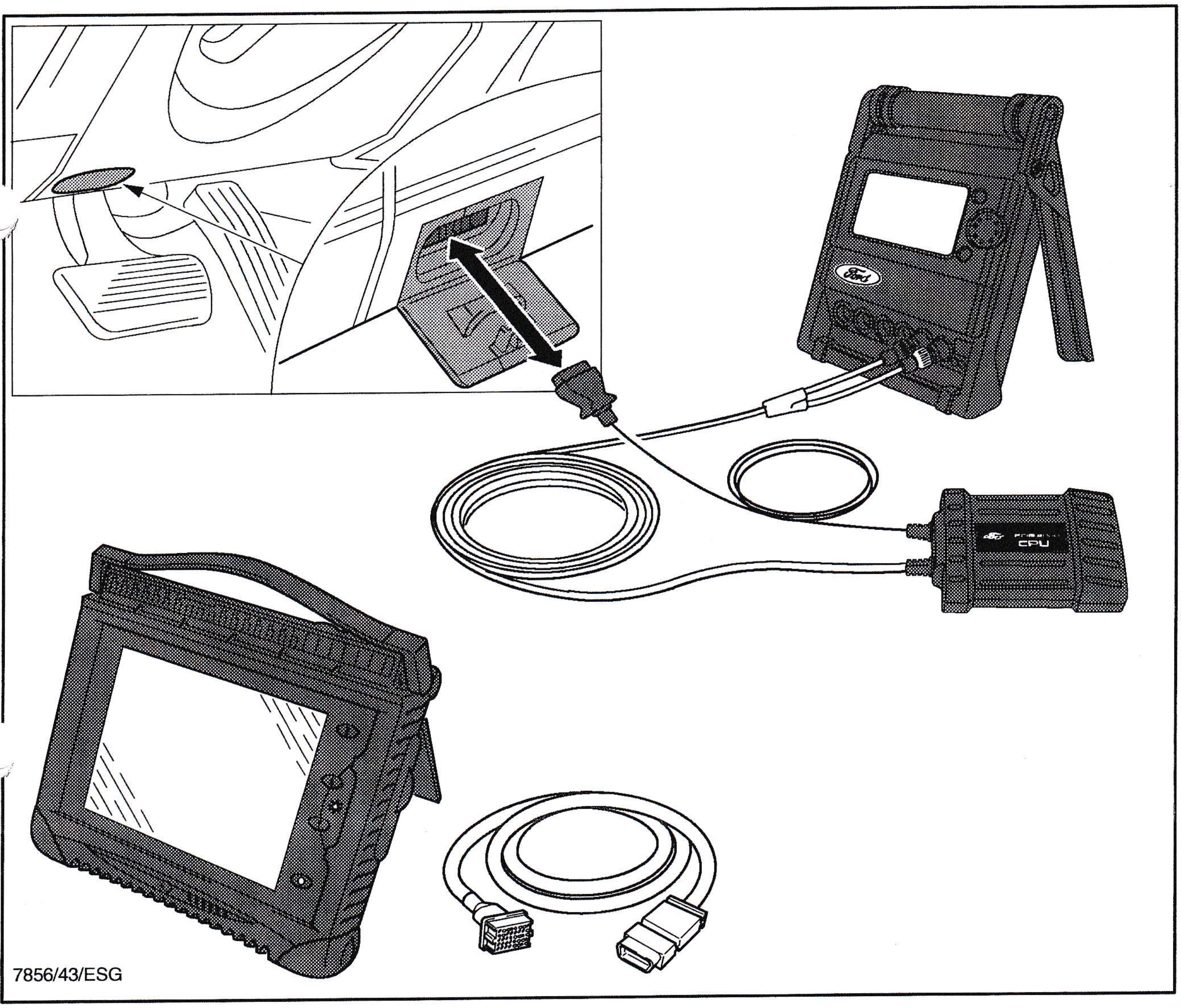
On completion of this lesson, you will be able to:

- explain the options for accessing the EOBD data through the data link connector (DLC)
- interpret the influence of the traffic-monitoring authorities on the EOBD system
- explain what is meant by "freeze frame data"
- explain why a fault can be deleted from the system
- define the functions of the readiness code
- explain when the readiness code is deleted
- interpret the meaning of the failure mode effects management (FMEM)
- name the systems and sensors which affect emissions which are self-learning or switched off in the event of a fault
- define the different FMEM strategies in the event of faulty components and systems

Data link connector (DLC)

- All vehicles are equipped with a standardized data link connector (DLC) to allow the traffic-monitoring authorities and the service personnel in the workshops to read data relating to the EOBD from the control module.

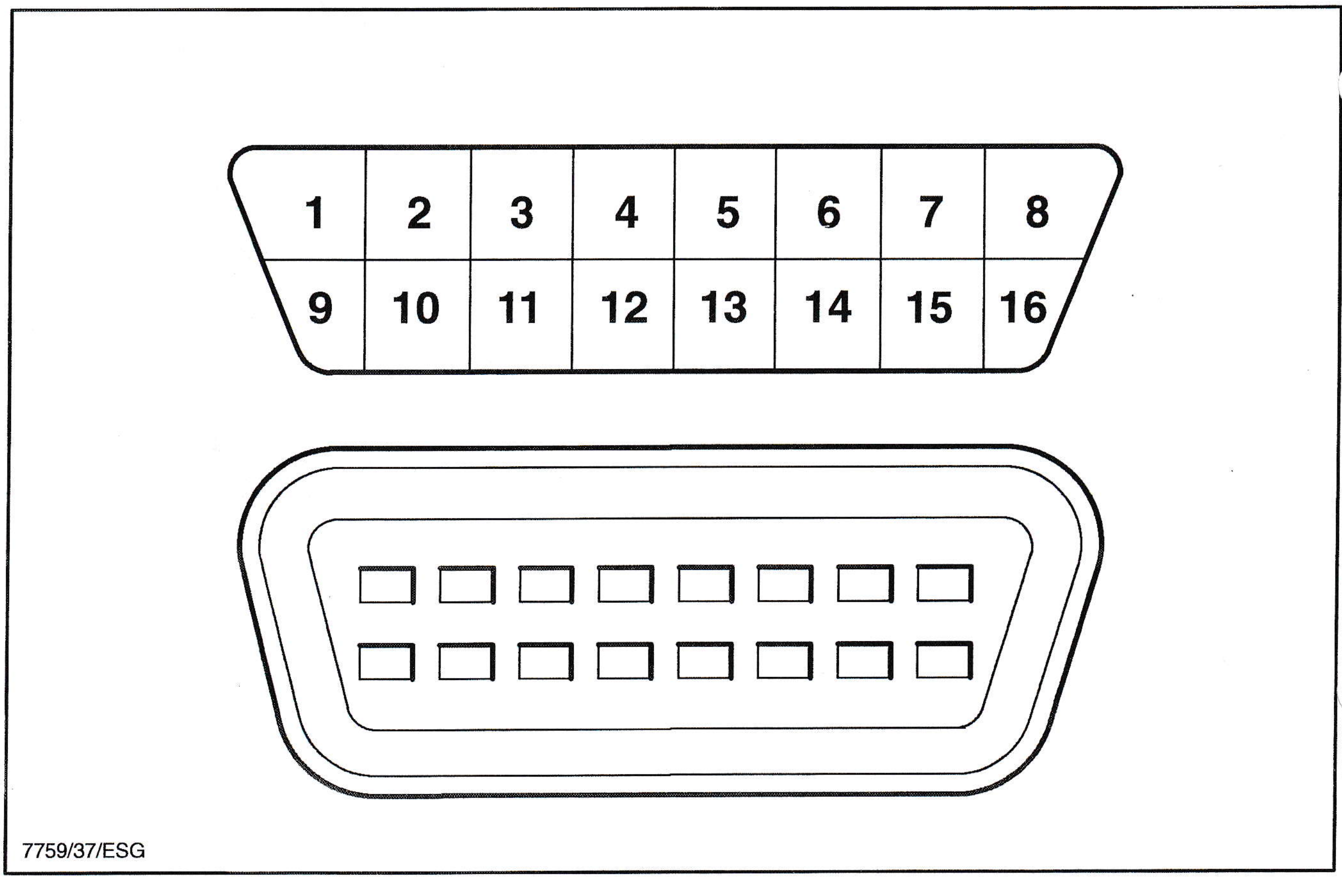
- This is the standardized 16-pin data link connector (DLC) which is used by all vehicle manufacturers and usually located under a cover in the area of the instrument panel or in the A-pillar.



Connection of FDS 2000 and WDS to the DLC

Data link connector (DLC) (continued)

- This EOBD interface (data link connector) allows the traffic-monitoring authorities to read data relating to the EOBD and the contents of the fault memory in any vehicle with the aid of a generic scan tool. Access is restricted to data on exhaust emissions and the associated information.
- Among other things, the traffic-monitoring authorities can establish when the fault detected by the EOBD first occurred, namely when the emission control malfunction indicator lamp (MIL) was switched on.
- This information could be used in future as a basis for determining the penalty for a vehicle keeper who uses his vehicle on the road in spite of the presence of a fault detected by the EOBD (with the MIL illuminated).



DLC pin assignment

1 Not in use
2 SCP +
3 Not in use
4 Chassis ground
5 Signal ground
6 CAN high
7 K wire Ford 9141
8 Not in use
9 Not in use
10 SCP -
11 Not in use
12 Not in use
13 FEPS
14 CAN low
15 L wire Ford 9141
16 Battery power supply

Freeze frame data

NOTE: The freeze frame data relates to the fault which first actuated the emission control malfunction indicator light (MIL).

Freeze frame data means data collected when the fault was **first** detected (presumed fault).

Freeze frame data is only overwritten when the fault relates to the mixture formation or misfires which damage the catalytic converter since these faults have a higher priority.

- The freeze frame data can be read out with a Ford diagnostic tool or with a generic scan tool and thus help with diagnostic operations.
- When a fault is detected, the following data is stored:

- MIL fault or diagnostic trouble code (DTC),
- vehicle speed,
- engine coolant temperature,
- engine speed,
- engine load,
- mixture formation trim value (STFT, LTFT)
- state of lambda control (open/closed loop),
- distance covered since the fault was first registered,
- intake manifold pressure (TMAP vehicles),
- fuel pressure (if measured).

Dealer test cycle

- When a fault has been rectified, the fault memory must be cleared. The fault memory is part of the KAM.

- Particularly after engine components have been changed, it is advantageous to clear the complete KAM which includes the adaptive trim tables (self-learning tables).

- When the fault memory has been cleared, the code P1000 is stored in the KAM. This code is called a readiness code.

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

- The readiness code is not deleted until all the tests of the monitoring system have been carried out during a drive cycle.

- The Ford workshop is **recommended** not to hand the vehicle over to the customer until the readiness code has been deleted. This makes sure that the vehicle is in order.

- To delete this code as rapidly as possible (for example after rectification of a fault in the workshop), a dealer test cycle must be conducted (refer to Lesson 5).

- If the system is not in order, the emission control malfunction indicator lamp (MIL) is actuated whe' the fault is confirmed during the second trip.

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

Standardized diagnostic trouble codes (DTCs)

- The fault or diagnostic trouble codes (DTCs) emitted by the EEC V PCM are standardized, which means that identical fault or diagnostic trouble codes are used by all manufacturers.
  - The fault code is always a 5-digit alphanumerical code, for example **"P0100"**.
  - All the **"P0xxx"** and **"P1xxx"** codes are standardized codes.
  - The **1st** digit of a code (letter) identifies the system which has set the code. Provision has been made for a total of four types of system:
    - B for the body
    - C for the chassis
    - **P for the powertrain**
    - U for network communications systems
  - Only the P code is required for the EOBD.
  - The **2nd** digit identifies the standard manufacturer code **"P1xxx"** or the standard ISO/SAE code **"P0xxx"**.
  - The **3rd** digit identifies the assembly in the system in which a fault occurred (refer to "Diagnostic Trouble Code Groups").

- The EOBD diagnostic trouble codes are standardized uniform industry codes for the powertrain control system. Some of the subsystems belonging to this group are integrated in the electronic control modules serving to control certain engine functions (fuel supply, ignition, idle speed and vehicle speed) or various transmission functions.

- The fact that a P-code is standardized does not mean that this is a emission related (MIL) code which is required by law.

- When an emission related (MIL) code which is part of the codes required by law occurs, the emission control malfunction indicator lamp (MIL) is activated.

Diagnostic trouble code (DTC) groups

P0xxx	-predetermined by the ISO/SAE
P01xx	-metering of fuel and air supply
P02xx	-metering of fuel and air supply
P03xx	-ignition system; combustion misfires
P04xx	-auxiliary emission control equipment
P05xx	-vehicle speed, idle setting and other inputs
P06xx	-trip computer and other outputs
P07xx	-transmission
P08xx	-transmission
P09xx	-reserved for the ISO/SAE
P00xx	-reserved for the ISO/SAE
P1xxx	-predetermined by the manufacturer
P11xx	-metering of fuel and air supply
P12xx	-metering of fuel and air supply
P13xx	-ignition system; combustion misfires
P14xx	-auxiliary emission control equipment
P15xx	-vehicle speed, idle setting and other inputs
P16xx	-trip computer and other outputs
P17xx	-transmission
P18xx	-transmission
P19xx	-category to be determined by the ISO/SAE
P10xx	-category to be determined by the ISO/SAE

Failure mode effects management (FMEM)

- With the first EEC IV systems, whenever a fault occurred, a substitute value was called up which took the place of the faulty signal. When an ECT sensor developed a fault, this sensor was attributed a fixed signal value of for example 70°C corresponding to the normal operating temperature of a warm engine.

- This meant that a vehicle with a cold engine with a faulty ECT sensor could no longer run normally.

- With the current EEC IV and EEC V systems special software is used which is designed to ensure the normal running characteristics of the vehicle in spite of faulty sensors.

- If a sensor value outside the calibrated threshold value is registered during the continuous self-test strategy, the FMEM will employ an alternative vehicle strategy.

- The FMEM uses strategies which ensure driving comfort and protect the catalytic converter.

- Many FMEM strategies provide a "safe" signal value to take the place of faulty sensor signals. For example, if an ECT sensor is faulty, the cooling fan is also operated continuously.

- If a fault occurs on the primary side of the EI coil, the EGR system and the air conditioning are switched off.

- In addition, the electronic ignition FMEM can disable the fuel injectors of faulty cylinders.

- The EEC V PCM now offers very comprehensive FMEM strategies. Most of the FMEM strategies will be explained later in the new engine management program. This publication only deals with the FMEM strategies with a bearing on the EOBD.

- There are FMEM strategies for all EOBD monitoring systems except for the catalytic converter.

FMEM strategy for faulty emission control components

- The FMEM action depends on the nature of the fault found in the CCM system. The following example describes a fault in the intake air temperature (IAT) sensor.

- If the CCM finds a fault in the IAT sensor, an FMEM substitute value is formed for the IAT sensor. This is based on ECT, CHT or TFT.

FMEM strategy for faulty emission control components (continued)

- The EOBD monitoring systems which use the IAT sensor as a source of an input signal are switched off. Among other things these include:
  - the control logic of the upstream/downstream HO2S,
  - the catalytic converter efficiency monitor,
  - the EGR system,
  - the AIR system monitor.
- After a certain time:
  - a fault or diagnostic trouble code is stored,
  - the fuel quantity trim adjustment logic is switched off,
  - an exhaust system temperature model in the FMEM is used,
  - the EGR system is switched off.

FMEM strategy for combustion misfires

- If the EOBD system registers combustion misfires, the fuel injector of the cylinder concerned is disabled (6-cylinder engines only).

FMEM strategy for faulty HO2S

- If the EOBD system finds a fault in the upstream or downstream HO2S,
  - the catalytic converter monitor is switched off,
  - the AIR system monitor is switched off,
  - the control logic of the upstream/downstream HO2S is switched off,
  - the system is forced into the “open” loop fuelling if the signal voltage is too high or too low or the number of the switching operations of the upstream HO2S is insufficient,
  - the self-learning memory (KAM) is cleared if the signal voltage of the upstream HO2S is too high or too low.

FMEM strategy for faulty fuel system

- If the EOBD system registers a fault in the fuel system,
  - the control logic of the upstream/downstream HO2S is switched off,
  - the air injection system monitor is switched off.

FMEM strategy for faulty catalytic converter

- None

FMEM strategy for faulty EGR system

- If the EOBD system registers a fault in the EGR system,
  - the control logic of the upstream/downstream HO2S is switched off,
  - the catalytic converter efficiency monitor is switched off,
  - the EGR system is switched off.

FMEM strategy for faulty AIR system

- If the EOBD system registers a fault in the air injection system,
  - the control logic of the upstream/downstream HO2S is switched off,
  - the catalytic converter efficiency monitor is switched off.

Tick the correct answer or fill in the gaps.

1. **Through the data link connector (DLC) the traffic-monitoring authorities can**

- ☐ a) read the data relating to the EOBD and the contents of the fault memory.
- ☐ b) read any vehicle program data and the contents of the fault memory (including ABS diagnostics for example).
- ☐ c) access the contents of the fault memory relating to the EOBD and adapt these as necessary.
- ☐ d) access the contents of the fault memory relating to the EOBD and rectify a fault.

2. **Freeze frame data means data**

- ☐ a) which is also collected whenever a fault is detected.
- ☐ b) which occurs during a readiness trip.
- ☐ c) which is collected when the fault is first detected (presumed fault).
- ☐ d) which is collected during the warm-up cycle.

3. **When is the readiness code set?**

- ☐ a) After a fault has been confirmed in the fault memory.
- ☐ b) After starting the engine.
- ☐ c) After clearing the fault memory.
- ☐ d) After all the monitoring systems have successfully completed their tests.

4. **The readiness code is deleted when**

- ☐ a) the complete keep alive memory (KAM) has been cleared.
- ☐ b) all the monitoring system tests have been carried out during a readiness trip.
- ☐ c) a fault has not recurred after a road test.
- ☐ d) a fault has not recurred after an extended period.

5. **What does failure mode effects management (FMEM) mean?**

- ☐ a) If there is an emission control malfunction the EEC V PCM switches to an emergency operating program.
- ☐ b) When a fault occurs, a lasting correction can be made by means of the EEC V PCM.
- ☐ c) If a fault develops in a sensor, this is ignored by the control system.
- ☐ d) The normal running characteristics of the vehicle are assured in spite of faulty sensors.

Objectives

On completion of this lesson, you will be able to:

- explain what a dealer test cycle is
- explain why the fuel tank should be between 20% and completely full for the dealer test cycle
- carry out a dealer test cycle in accordance with the specified test steps in the test report on the road or a rolling road after a fault has been rectified.

Why a dealer test cycle must be carried out

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

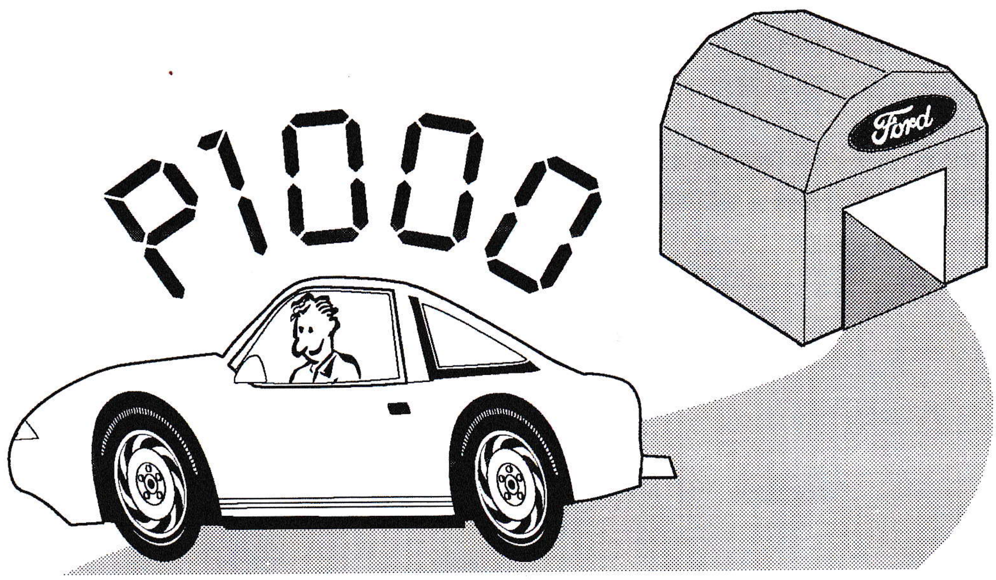
- This readiness code indicates that not **all** the monitoring systems have completed their tests since the KAM was cleared.

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

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

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

- This alone ensures that the vehicle is in order.



7856/46/ESG

General notes

- The tests of each monitoring system are carried out differently for the dealer test cycle described in the following.
- The readiness code P1000 is only **deleted after execution** of the complete dealer test cycle in the specified order.
- If the test of a **specific** monitoring system has **not been completed successfully**, the corresponding cycle must **be repeated only for this monitoring system without** clearing the KAM again and **without** switching off the ignition.
- If the test of a **specific** monitoring system is to be carried out and completed (after rectification of the fault), the **test preparations** and the test steps described in connection with the corresponding monitoring system must be carried out.
- It is important to make sure that the test alone is completed successfully, but not that the readiness code P1000 is not deleted.

Test recommendations

- Most of the tests of the EOBD monitoring systems can be completed faster if the accelerator pedal is moved evenly and not jerkily when driving at constant speed or when accelerating.
- Operating the accelerator pedal smoothly reduces the time required to complete an EOBD monitoring system test.
- The fuel tank should be between 20% and completely full.

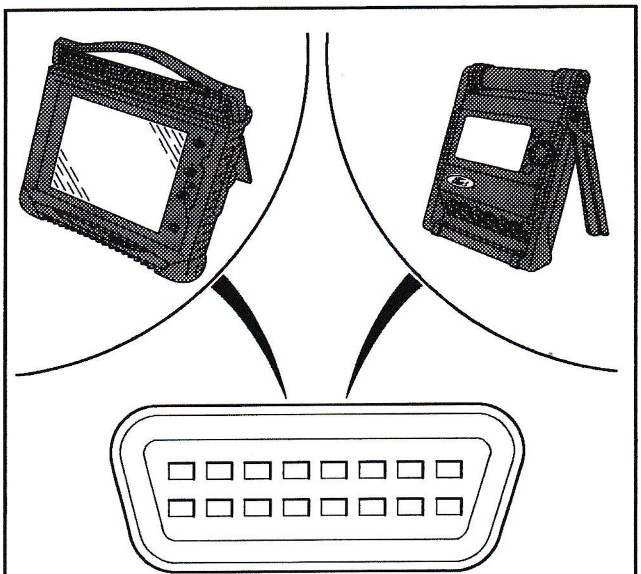
NOTE: If the fuel tank is less than 15% full (FLI = fuel level input to EEC V PCM), the combustion misfire monitor, HO2S monitor, catalytic converter efficiency monitor and fuel monitor are disabled.

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

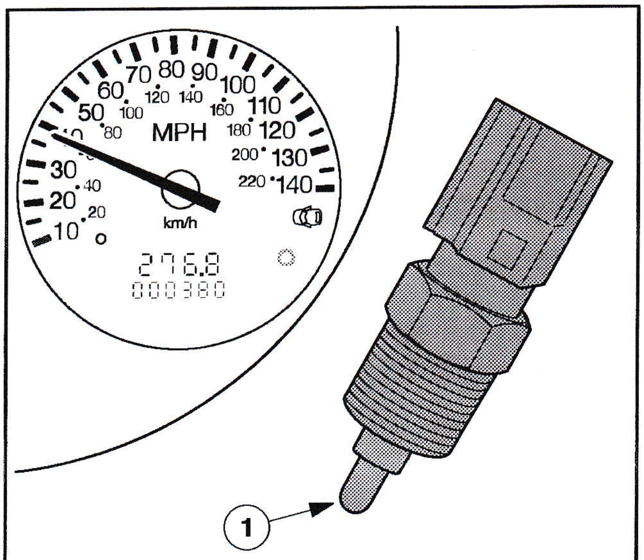
NOTE: If the test is carried out on the road, the road traffic regulations apply.

Test preparations

- Procedure:
  - Connect the WDS PTU or FDS 2000 PDU to the data link connector (DLC).
  - Switch on the ignition (do not start the engine).
  - Switch off the ignition, then switch it on again.
  - Select the correct vehicle and correct engine.
  - Clear the keep alive memory (KAM).
  - Start the engine.
  - Let the engine run at idle speed for 15 seconds.
  - Then drive the vehicle at a speed of 65 km/h (40 mph) until an ECT of at least 76.7°C (170°F) is indicated in the display of the diagnostic equipment.



7856/44/ESG



7856/45/ESG

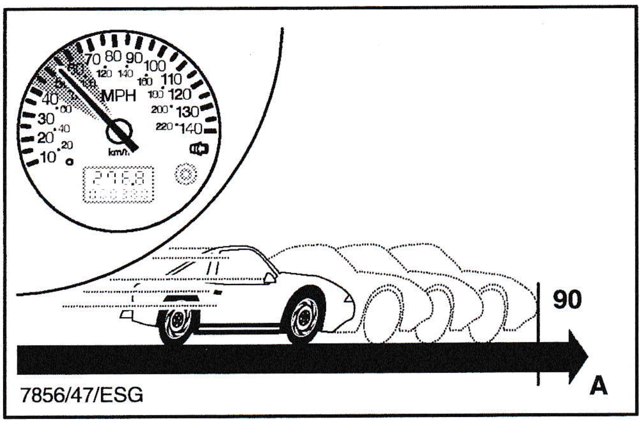
1 76.7 C (170°F)

Test procedure

Carry out the dealer test cycle in the following order:

1. HO2S monitoring system

- Accelerate the vehicle to a speed of 68 to 88 km/h (42 to 65 mph) and keep the vehicle at a constant speed in this range for 90 seconds.
- Purpose of this drive cycle:
  The upstream and downstream HO2S monitoring system completes its test.



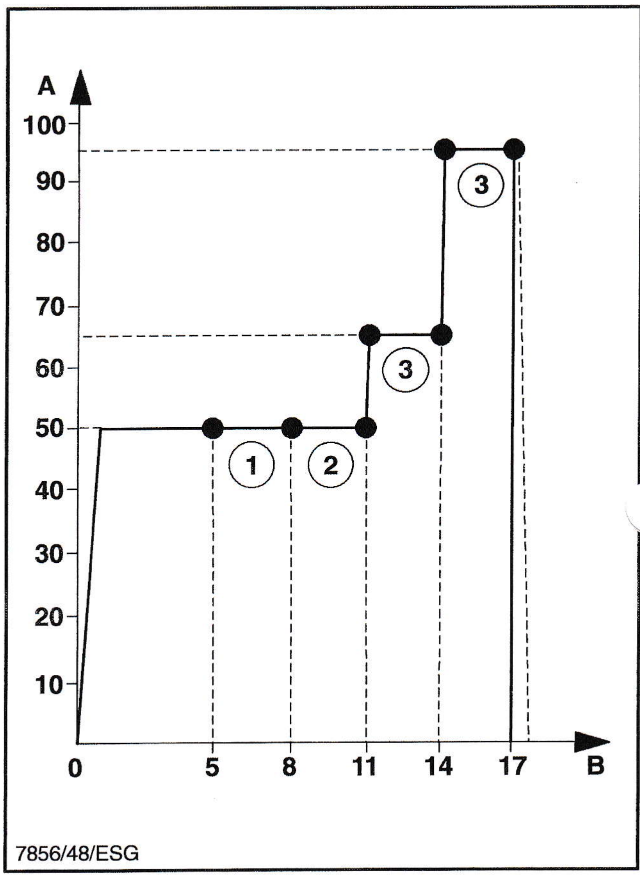
A Time (seconds)

2. Catalytic converter efficiency monitoring system

- Drive the vehicle in a "stop and start" fashion. This should include constant motoring at different speeds.
- The vehicle must be driven for five minutes before the catalytic converter monitoring system is activated.
- Drive at the following speeds for three minutes each time with the accelerator pedal in a constant position:

  - 50 km/h (30 mph) in 3rd gear
  - 50 km/h (30 mph) in 4th gear
  - 50 km/h (30 mph) in 5th gear
  - 95 km/h (60 mph) in 5th gear

- Purpose of this drive cycle:
  The catalytic converter efficiency monitoring system completes its test.



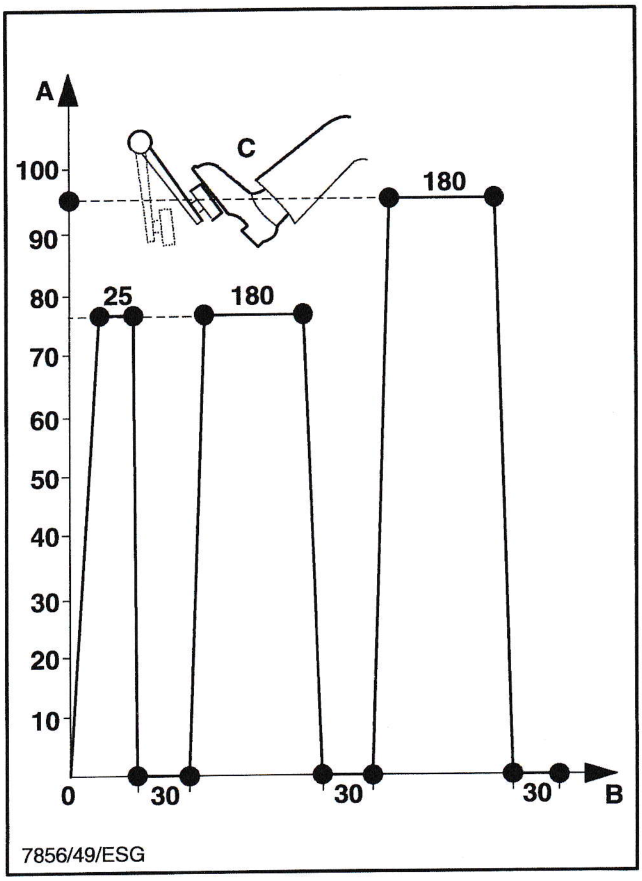
A Speed (km/h)
B Time (minutes)

1 3rd gear
2 4th gear
3 5th gear

Test procedure (continued)

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

- Accelerate the vehicle from "0" (standstill) to 75 km/h (45 mph) with the accelerator pedal depressed 75% and maintain this speed for 25 seconds. Stop the vehicle and let the engine idle for 30 seconds.
- Repeat the procedure described above twice:
  - accelerating to 75 km/h (45 mph) and driving for 180 seconds,
  - accelerating to 95 km/h (60 mph) and driving for 180 seconds.
- Purpose of this drive cycle:
  The exhaust gas recirculation system monitor completes its test.



A Speed (km/h)
B Time (seconds)
C Accelerator pedal position 75 %

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

- Stop the vehicle and let the engine idle for two minutes (manual transmission in neutral position, automatic transmission selector lever in position D).
- Purpose of this drive cycle:
  The comprehensive component monitor (CCM) completes the engine part of its test.

Test procedure (continued)

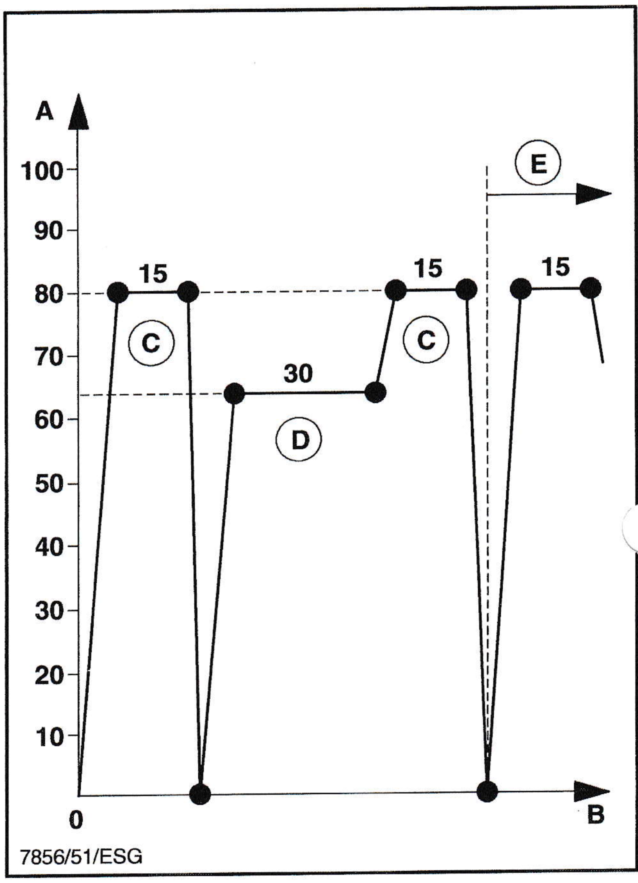
5. Monitor for emission control components (transmission)

Manual transmission:

- Accelerate the vehicle from a standstill to 80 km/h (0 to 50 mph), then continue with item 6.

Automatic transmission:

- Accelerate the vehicle moderately from a standstill to 80 km/h (0 to 50 mph) and maintain this speed for at least 15 seconds.
- Stop the vehicle and accelerate moderately to 64 km/h (40 mph) without using "overdrive", and maintain this speed for at least 30 seconds.
- Activate "overdrive" again at a speed of 64 km/h (40 mph), accelerate to 50 mph (80 km/h) and maintain this speed for at least 15 seconds.
- Stop the vehicle for at least 20 seconds and repeat item 5 five times.
- Purpose of this drive cycle:
  The comprehensive component monitor (ECM) for emission control components completes the transmission part of its test.

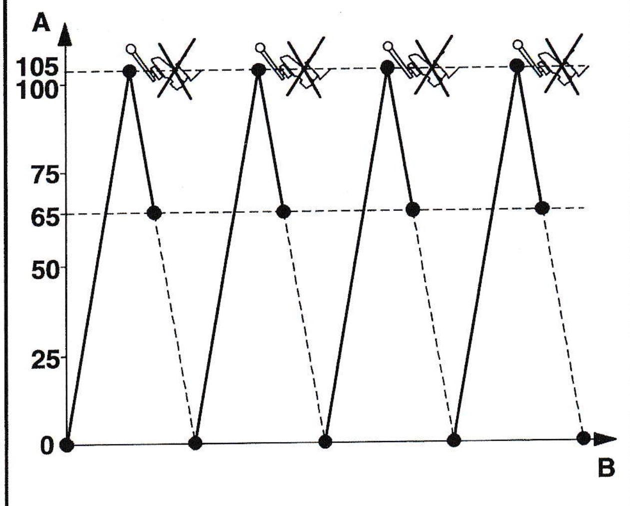


A Speed (km/h)
B Time (seconds)
C With overdrive
D Without overdrive
E Repeat drive cycle five times

Test procedure (continued)

6. Combustion misfire monitor and fuel monitor

- Accelerate the vehicle from a standstill to 105 km/h (65 mph).
- Release the accelerator pedal (close the throttle) and slow down to 65 km/h (40 mph) without applying the brakes (overrun fuel shut off).
- Repeat the operation three times.
- Purpose of this drive cycle:
  The "learning mode" for the combustion misfire monitor is activated.

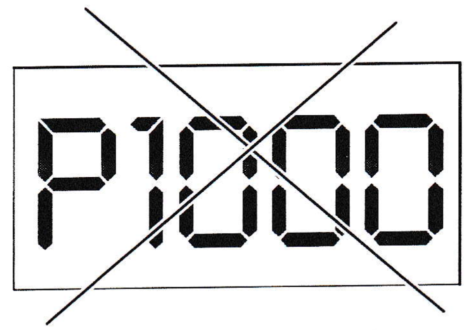


7856/52/ESG

A Speed (km/h)
B Distance

7. Readiness check

- Call up the "On-board system readiness " (EOBD monitor status) function on the diagnostic equipment.
- Make sure that all the non-continuous monitors have completed their tests.
- If not, continue with item 8.
- Purpose of this check:
  Establishes whether any monitoring system has not completed its test.



7856/53/ESG

Test procedure (continued)

8. Check for presumed fault (pending code)

- With the diagnostic equipment check for the presence of a presumed fault (pending code).
- If a presumed fault is present, carry out the appropriate fault rectification procedures.
- If necessary, repeat the uncompleted monitoring system test.

Tick the correct answer or fill in the gaps.

1. **The dealer test cycle must be carried out,**

- ☐ a) to check the operation of all the sensors and actuators of the EEC V system.
- ☐ b) to read out fault or diagnostic trouble codes (DTCs) for later fault rectification.
- ☐ c) so that all the monitoring systems can carry out and complete their tests and the readiness code P1000 is deleted.
- ☐ d) To clear the fault memory in the KAM together with the readiness code P1000.

2. **The dealer test cycle is**

- ☐ a) carried out on the workshop floor.
- ☐ b) carried out in the workshop on a lift.
- ☐ c) carried out anywhere as required.
- ☐ d) carried out either on the road or on a rolling road.

3. **For the dealer test cycle it is advisable that the fuel tank is**

- ☐ a) more than 50% full.
- ☐ b) more than 75% full.
- ☐ c) more than 20% full.
- ☐ d) less than 20% full

4. **Which statement is correct?**

- ☐ a) The dealer test cycle is a continuous road test.
- ☐ b) The dealer test cycle consists of different drive cycles for each monitoring system.
- ☐ c) The dealer test cycle is only carried out at a constant speed.
- ☐ d) The dealer test cycle is carried out at idle and partial-load throttle settings in alternation.

The abbreviations conform to standard SAE J1930 with the exception of those which are marked with an asterisk (*).

ABS*	Anti-lock Braking System
A/C	Air Conditioning
AFR*	Air/Fuel Ratio
AIR	Secondary Air Injection
A/T	Automatic Transmission
BARO	Barometric Pressure
CAN*	Controller Area Network
CCM*	Comprehensive Component Monitor
CHT*	Cylinder Head Temperature
CKP	Crankshaft Position
CMP	Camshaft Position
CSD*	Characteristic Shift Downward
DLC	Data Link Connector
DTC	Diagnostic Trouble Code
ECT	Engine Coolant Temperature
EDIS*	Electronic Distributorless Ignition System
EDF*	Electronic Driven Fan
EEC*	Electronic Engine Control
EGR	Exhaust Gas Recirculation
EI	Electronic Ignition
EOBD*	European On-Board Diagnostics
EPC*	Electronic Pressure Control
EU*	European Union
EVAP	Evaporative Emission

List of abbreviations

The abbreviations conform to standard SAE J1930 with the exception of those which are marked with an asterisk (*) (continued).

FDS*	Ford Diagnostic System
FEPS*	Flash Eeprom Power Supply
FLI*	Fuel Level Input
FMEM*	Failure Mode Effects Management
FP	Fuel Pump
HCS*	High Compression Swirl
HEDF*	High Speed Electronic Driven Fan
HO2S	Heated Oxygen Sensor
IAC	Idle Air Control
IAT	Intake Air Temperature
IMCC*	Intake Manifold Communication Control
IMRC*	Intake Manifold Runner Control
ISO*	International Organisation for Standardisation
KAM*	Keep Alive Memory
KS	Knock Sensor
LTFT*	Long Term Fuel Trim
LOS*	Limited Operating Strategy
MAF	Mass Air Flow
MIL	Malfunction Indicator Lamp
OBD	On Board Diagnostic
OSS	Output Shaft Speed
PCM	Powertrain Control Module
PDU*	Portable Diagnostic Unit
PS*	Power Steering
PTU*	Portable Test Unit
RAM	Random Access Memory
RPM	Engine speed

The abbreviations conform to standard SAE J1930 with the exception of those which are marked with an asterisk (*) (continued).

SAE*	Society of Automotive Engineers
SCP*	Standard Corporate Protocol
SHRTFT*	Short Term Fuel Trim
SPV*	Sonic Purge Valve
SS1*	Shift Solinoid 1
SS2*	Shift Solinoid 2
STFT*	Short Term Fuel Trim
TAR*	Tire and Axle Ratio
TCC	Torque Converter Clutch
TCIL	Transmission Control Indicator Lamp
TDC	Top Dead Centre
TFT	Transmission Fluid Temperature
TMAP*	Temperature Manifold Absolute Pressure
TP	Throttle Position
TR	Transmission Range
TSS	Turbine Shaft Speed
VCT*	Variable Camshaft Timing
VID*	Vehicle IDentification
VMV	Vapour Management Valve
VSS	Vehicle Speed Sensor
WDS*	World-wide Diagnostic System

Lesson 1 - Introduction to EOBD

1. a)

2. c)

3. b)

4. c)

5. b)

Lesson 2 - EOBD operation

1. c)

2. c)

3. a)

4. c)

5. d)

Lesson 3 - Monitoring systems

1. c)

2. a)

3. d)

4. a)

5. c)

6. d)

7. b)

8. b)

9. c)

10. a)

Lesson 4 - Diagnostics

1. a)

2. c)

3. c)

4. b)

5. d)

Lesson 5 - Dealer test cycle

1. b)

2. d)

3. c)

4. b)