

# Technical Service Training

## Petrol Engine Management Systems



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Electronic engine management systems are subject to continuous further development. Important reasons for this include more stringent exhaust emission standards and ever stricter legislative regulations. Other reasons are greater environmental awareness and customer requirements with regard to driving comfort, as well as the higher demands placed upon powerful engines in terms of low fuel consumption and running smoothness.

In this Student Information you will learn about the design of the various engine management systems (EEC V, engine management systems from Visteon, Siemens and Bosch) used in current vehicles and how they work.

Completion of the eLearning program "Petrol Engine Management Systems" (TC304 3 056C) is a prerequisite for the study of this Student Information.

At the end of each lesson there is a set of test questions which are designed to monitor the student's progress. The solutions to these test questions can be found at the end of the Student Information.

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## Engine management systems

### General

Increasingly higher demands are being placed on modern petrol engines. Today, the focus is not alone on environmental awareness but also on increasing exhaust emissions and the demand for ever better fuel economy and enhanced driving comfort.

Complex electronic systems are therefore vital for open- and closed-loop control of the petrol engine. The rapid progress in semiconductor technology means increasingly powerful modules, with the result that one module can handle the entire engine management system for the petrol engine.

### EEC engine management systems

In the mid 1980s, the EEC (Electronic Engine Control) IV module with MFI (Multiport Fuel Injection) and contactless transistor ignition system was introduced. This was followed in the early 1990s by central fuel injection and the fully electronic distributorless ignition system. From 1992, the first engines with SFI (Sequential Multiport Fuel Injection) were built, and no carburettor engines have been built by Ford since 1993. Since 1994, Ford engines have been controlled via a EEC V module.

EEC V engine management systems are used in vehicles with the following engines:

- Ka 1997 (09/1996-01/2003)
  - 1.3L Endura E (HCS)
- Fiesta 1996 (11/1995-02/2002)
  - 1.3L Endura E (HCS)
- Fiesta 1996 (11/1995-12/1999)
  - 1.25L Zetec SE (Sigma)
  - 1.4L Zetec SE (Sigma)
  - 1.6L Zetec SE (Sigma)
- Puma 1998 (06/1997-12/2001)
  - 1.4L Zetec SE (Sigma)
  - 1.6L Zetec SE (Sigma)
  - 1.7L Zetec S VCT (Sigma)
- Focus 1999 (08/1998-12/2004)
  - 1.4L Zetec SE (Sigma)
  - 1.6L Duratec 8V (Rocam)
  - 1.6L Zetec SE (Sigma)
  - 1.8L Zetec E (Zetec)
  - 2.0L Zetec E (Zetec)
  - 2.0L Duratec RS (Zetec)
- Mondeo 1997 (08/1996-09/2000)
  - 1.6L Zetec E (Zetec)
  - 1.8L Zetec E (Zetec)
  - 2.0L Zetec E (Zetec)
  - 2.5L Duratec VE (VE6)
- Cougar 1999 (08/1998-01/2001)
  - 2.0L Zetec E (Zetec)
  - 2.5L Duratec VE (VE6)
- Scorpio 1995 (10/1994-06/1998)
  - 2.0L DOHC-8V
  - 2.0L DOHC-16V
  - 2.3L DOHC-16V
  - 2.9L V6-24V
- Galaxy 1995 (02/1995-03/2000)
  - 2.0L DOHC
  - 2.3L DOHC-16V
- Windstar 1999 (08/1998-07/2000)
  - 3.0L V6
- Transit 2000.5 (01/2000-05/2006)
  - 2.3L DOHC-16V
- Transit/Tourneo Connect 2002.5 (06/2002-)
  - 1.8L Duratec DOHC (Zetec)
- Maverick 2001 (12/2000-12/2003)
  - 2.0L Zetec E (Zetec)
  - 3.0L Duratec VE (VE6)
- Explorer 1995 (08/1994-09/2000)
  - 4.0L SOHC

## Visteon engine management systems

The use of increasingly complex systems and the integration of completely new systems require ever more sophisticated strategies, ever more finely tuned calibrations and higher performance.

The main component of the Visteon engine management systems is a new PCM (Powertrain Control Module) with a high-performance microprocessor (MPC 555) with an operating frequency of 24 MHz.

Visteon engine management systems are used in vehicles with the following engines:

- Focus 1999 (08/1998-12/2004)
  - 2.0L Duratec ST (Zetec)
- Focus 2004.75 (07/2004-)
  - 1.8L Duratec HE (MI4)
  - 2.0L Duratec HE(MI4)
- Focus C-MAX 2003.75 (06/2003-)
  - 1.8L Duratec HE (MI4)
  - 2.0L Duratec HE(MI4)
- Mondeo 2001 (10/2000-02/2007)
  - 1.8L Duratec HE (MI4)
  - 2.0L Duratec HE(MI4)
  - 2.5L Duratec VE (VE6)
  - 3.0L Duratec ST (VE6)
- Mondeo 2007.5 (02/2007-)
  - 1.8L Duratec HE (MI4)
  - 2.0L Duratec HE(MI4)
  - 2.3L Duratec HE (MI4)
- Galaxy 2000.75 (04/2000-02/2006)
  - 2.0L DOHC-16V
  - 2.3L DOHC-16V
- S-MAX/Galaxy 2006.5 (03/2006-)
  - 2.0L Duratec HE(MI4)
  - 2.3L Duratec HE (MI4)
- Transit 2006.5 (04/2006-)
  - 2.3L Duratec HE (MI4)

- Maverick 2001 (12/2003-07/2004)
  - 2.3L Duratec HE (MI4)
  - 3.0L Duratec VE (VE6)
- Maverick 2005 (08/2004-)
  - 2.3L Duratec HE (MI4)
  - 3.0L Duratec VE (VE6)

## Siemens engine management systems

With these engine management systems, the ignition control module and PATS (Passive Anti-theft System) are integrated in the software of the PCM. The intake air module, used for the first time with the introduction of the Siemens engine management systems, integrates various engine management components as well as the intake manifold and air cleaner housing into a single component. The first Siemens engine management system used at Ford bears the designation SIM 19.

The SIM 19A und SIM 20 engine management systems feature generator load feedback.

The SIM 20 engine management system has been used since the launch of the Fiesta 1996 (02/2001-11/2001). At the same time as the SIM 20, the EOBD (European On-board Diagnostic) system which activates the MIL (Malfunction Indicator Lamp) if an emissions-related fault occurs was introduced. Various maps are stored in the SIM module to ensure optimum engine performance under all operating conditions in terms of torque output, fuel consumption and emission performance. This required the constant further development of the SIM modules, sensors and actuators.

The **SIM 19** engine management system is used in vehicles with the following engine:

- Fiesta 1996 (12/1999-08/2000)
  - 1.25L Zetec SE (Sigma)

The **SIM 19A** engine management system is used in vehicles with the following engine:

- Fiesta 1996 (09/2000-01/2001)
  - 1.25L Zetec SE (Sigma)

The **SIM 20** engine management system is used in vehicles with the following engine:

- Fiesta 1996 (02/2001-11/2001)
  - 1.25L Zetec SE (Sigma)



The **SIM 21** engine management system is used in vehicles with the following engine:

- Fiesta 2002.25 (11/2001-)
  - 1.3L Duratec 8V (Rocam)
- Fusion 2002.75 (06/2002-)
  - 1.3L Duratec 8V (Rocam)

The **SIM 22** engine management system is used in vehicles with the following engines:

- Fiesta 2002.25 (11/2001-)
  - 1.25L Duratec 16V (Sigma)
  - 1.4L Duratec 16V (Sigma)
  - 1.6L Duratec 16V (Sigma)
- Fusion 2002.75 (06/2002-)
  - 1.25L Duratec 16V (Sigma)
  - 1.4L Duratec 16V (Sigma)
  - 1.6L Duratec 16V (Sigma)

The **SIM 24** engine management system is used in vehicles with the following engines:

- Ka 1997 (01/2003-)
  - 1.3L Duratec 8V (Rocam)
  - 1.6L Duratec 8V (Rocam)
- Streetka 2003.5 (01/2003-)
  - 1.6L Duratec 8V (Rocam)

The **SIM 28** engine management system is used in vehicles with the following engines:

- Focus 2004.75 (07/2004-)
  - 1.4L Duratec 16V (Sigma)
  - 1.6L Duratec 16V (Sigma)
- Focus C-MAX 2003.75 (06/2003-)
  - 1.6L Duratec 16V (Sigma)

The **SIM 29** engine management system is used in vehicles with the following engine:

- Focus 2004.75 (07/2004-)
  - 1.6L Duratec 16V Ti-VCT (Sigma)
- Mondeo 2007.5 (02/2007-)
  - 1.6L Duratec 16V Ti-VCT (Sigma)

### Bosch engine management systems

The functions of these engine management systems correspond for the most part to those of the EEC IV and EEC V engine management systems.

The Bosch Motronic MED 7.8.1 regulates the 1.8L Duratec SCi (MI4). The 1.8L Duratec SCi (Smart Charge injection) is the first Ford engine with direct petrol injection. The engine is based on the 1.8L Duratec HE (MI4) with intake manifold fuel injection which was already introduced on the Mondeo 2001 (10/2000-02/2007).

The Bosch Motronic ME 9.0 is used in the 2.5L Duratec ST (VI5) engine.

- The installation position of the control module is different to that of the other versions. This is due to the greater sensitivity to temperature, vibration, moisture, etc.
- Processor performance and storage capacity have been increased to reduce the rate of utilisation and thus expand reserve capacity.
- The temperature requirement has increased to 105°C.

The **MED 7.8.1** engine management system is used in vehicles with the following engine:

- Mondeo 2001 (10/2000-02/2007)
  - 1.8L Duratec SCi (MI4)

The **ME 9.0** engine management system is used in vehicles with the following engines:

- Focus 2004.75 (10/2005-)
  - 2.5L Duratec ST (VI5)
- S-MAX 2006.5 (03/2006-)
  - 2.5L Duratec ST (VI5)
- Mondeo 2007.5 (02/2007-)
  - 2.5L Duratec ST (VI5)

## Overview

The ongoing development of engine management systems over the years has led to these systems being able to perform increasingly complex tasks. In order to

cope with these more complex tasks, the sensors and actuators have also had to undergo continuous further development. The tables below list the sensors and actuators in the individual engine management systems.

### Overview of the sensors/input signals connected to the modules

Sensors/input signals	EEC V	Visteon	Siemens	Bosch
CKP (Crankshaft Position) sensor	X	X	All	All
CMP (Camshaft Position) sensor, intake side	X	X	All	All
CMP sensor, exhaust side			29	ME 9.0
MAF (Mass Air Flow)/IAT (Intake Air Temperature) sensor (hot film)			29	MED 7.8.1
MAF/IAT sensor (hot wire)	X	X		
MAF sensor (hot film)				ME 9.0
MAPT (Manifold Absolute Pressure and Temperature) sensor	X	X	19, 19A, 20, 21, 22, 24	ME 9.0
MAP (Manifold Absolute Pressure) sensor				MED 7.8.1
TPS (Throttle Position Sensor) on the throttle body	X	X	19, 19A, 20, 21, 24	
TPS on the throttle control unit		X	22. 28. 29	All
APP (Accelerator Pedal Position) sensor (potentiometer)			22	MED 7.8.1
APP sensor (inductive)		X	28. 29	ME 9.0
HO2S (Heated Oxygen Sensor) (upstream)	X	X	All	
HO2S (broadband sensor)				All
HO2S (downstream)	X	X	20. 21. 22. 24. 28. 29	ME 9.0
HO2S (for NOX release)				MED 7.8.1
ECT (Engine Coolant Temperature) sensor	X	X	All	All
CHT (Cylinder Head Temperature) sensor	X	X		
KS (Knock Sensor)	X	X	22. 28. 29*	All*
OSS (Output Shaft Speed) sensor**	X	X	19, 19A, 20	
VSS (Vehicle Speed Sensor)	X	X	19, 19A, 20	
VSS***			21. 22. 24. 28. 29	
Smart Starting			19, 19A, 20, 21, 22, 24	
PNP (Park/Neutral Position) switch	X	X	19, 19A, 20	
BPP (Brake Pedal Position) switch	X	X	22	ME 9.0
PSP (Power Steering Pressure) switch	X	X	All	MED 7.8.1
EOP (Engine Oil Pressure) switch			28. 29	ME 9.0
Air conditioning high-pressure switch	X	X	19, 19A, 20, 21, 22, 24	MED 7.8.1
Air conditioning pressure transducer		X	28. 29	ME 9.0
Air conditioning low-pressure switch	X	X	21. 22. 24. 28. 29	ME 9.0
CPP (Clutch Pedal Position) switch	X	X	21. 22. 24	MED 7.8.1