N3 Motor Trade Theory

LOUIS OOSTHUIZEN

Pearson

Pearson South Africa (Pty) Ltd
4th floor, Auto Atlantic Building,
Corner of Hertzog Boulevard and Heerengracht,
Cape Town, 8001

za.pearson.com

First published in 2020

ISBN 978-1-485-71742-3 (print)
ISBN 978-1-485-71861-1 (epdf)

Publisher: Amelia van Reenen
Managing editor: Ulla Schüler
Editor: Miranda Cilliers
Artwork: Illana Dillon, John Dickin, Leon Brits, Ben Latham, James Whitelaw, Will Alves, Susan Abraham
Book design: Pearson Media Hub
Cover design: Pearson Media Hub
Cover artwork:
Typesetting: Charlene Bate

Printed by

Acknowledgements:

Contents

Module 11 Computer-based diagnostics

What is covered?

All modern-day automobiles are fitted with an electronic control unit (ECU), which is in actual fact a computer board providing modern vehicles that are compliant with on-board diagnostics (OBD) technology with warning signals when something is wrong. In this module, we look at the reasons for using an on-board diagnostics scan tool and we will look at its basic operations. The meaning of various fault codes a diagnostic machine can display and how to clear these faults also form part of this module.

Learning outcomes

After studying this module, you should be able to:

Unit 1

- Explain the reason for using the on-board diagnostic machine (scan tool)
- Describe the basic operations of an on-board diagnostic machine
- Interpret the meaning of the various fault codes
- Explain how to clear fault codes

Unit 1: Diagnostics

LEARNING OUTCOMES

- Explain the reason for using the on-board diagnostic machine (scan tool)
- Describe the basic operations of on-board diagnostic machine
- Interpret the meaning of the various fault codes
- Explain how to clear fault codes

Introduction

There are so many different systems under an automobile's hood and there should be something that monitors the proper operation of these systems and that ensures that all these systems work in harmony. On-board diagnostics is a system that has been designed to monitor the ignition and emission systems of a modern vehicle.

On-board diagnostics (OBD)

An automobile's OBD system is a computerised system that communicates with other systems in the automobile.

Figure 11.1 An automobile's on-board diagnostics dashboard interface

- It monitors the operation and performance of the engine, it checks the operation of the emission and transmission systems, it checks ignition functions and all other systems that rely on sensors for information.
- Based on the information from the sensors, the OBD can determine if all systems are working properly.
- If a sensor picks up an irregularity, it sends a warning to the OBD.

- The OBD reacts by switching on the appropriate warning signal on the dashboard interface.
- The OBD also stores a **diagnostic trouble code (DTC)** that can be picked up with an off-board diagnostic device.

Keywords

diagnostic trouble codes (DTCs) a series of codes used by automobile manufacturers to diagnose an automobile's problem

malfunction indicator light (MIL) the check engine light on the dashboard interface of vehicles

On-board diagnostic operation

An automobile's OBD system communicates with the ECUs of systems, such as, the anti-lock braking system, airbag, fuel injection. As soon as a sensor picks up a fault, it sends a signal to the OBD and a warning lights up on the dashboard.

These warning lights generally include the check engine light or the **malfunction indicator light (MIL)**. The light turns on if the operations of a system malfunctions or is not normal.

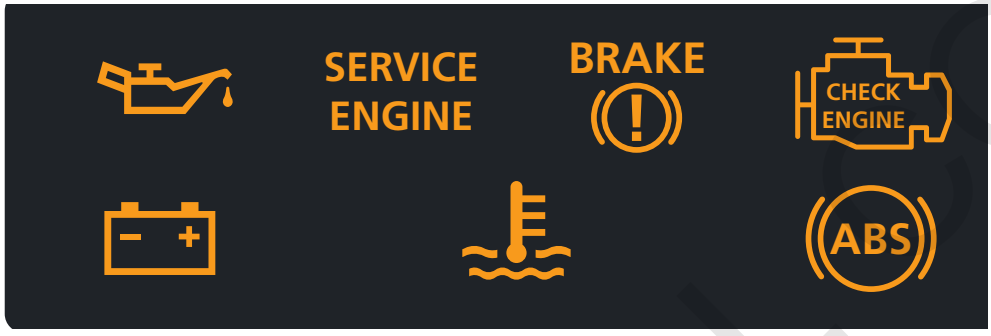


Figure 11.2 As soon as a sensor picks up and signals a problem to the OBD, a warning lights up on the dashboard.

Reasons for using OBD scanning

- The warning lights on an automobile's dashboard interface provide warnings before problems become serious.
- Fault codes make it easier to isolate faults as they indicate the system or area that needs checking.
- The diagnostics history allows for monitoring occurring problems.
- The device provides quick and accurate display of the vehicle's problem.

There are generic handheld devices on the market, but each automobile manufacturer has a diagnostic computer for reading fault codes, monitoring operations of systems and programming ECUs.

OBD diagnostic port

The OBD port allows you to plug in any OBD tool in order to get fault information about an automobile. There is normally an indicator under the bonnet to say if and automobile is OBD compliant. There port can be in an open space under the dashboard or it can be placed behind the ashtrays. In most South African automobiles, it is under the dashboard with a cover placed over it on the right side where the steering wheel is mounted.

Figure 11.3 An automobile's OBD port

Diagnostic devices

Figure 11.4 A programmed microcontroller for translating modern automobiles' on-board diagnostics

In order to read the DTC that the OBD picked up you must connect a device to the OBD port.

There are different devices on the market that read diagnostic trouble codes.

Handheld scan tools

A handheld diagnostic tool can be connected to the OBD port in order to read the DTCs that have been stored. These handheld tools include professional, manufacturer's tools, simple or basic code readers and DIY OBD scanners an automobile owner can use at home

Figure 11.5 A handheld diagnostic tool for automobiles

Mobile device-based tools and analysis

- Mobile devices like cellphones, smart phones and tables provide a way of easily analysing problems.
- The device can access the OBD via Bluetooth or it can be plugged into the OBD port by making use of USB adaptor cables.

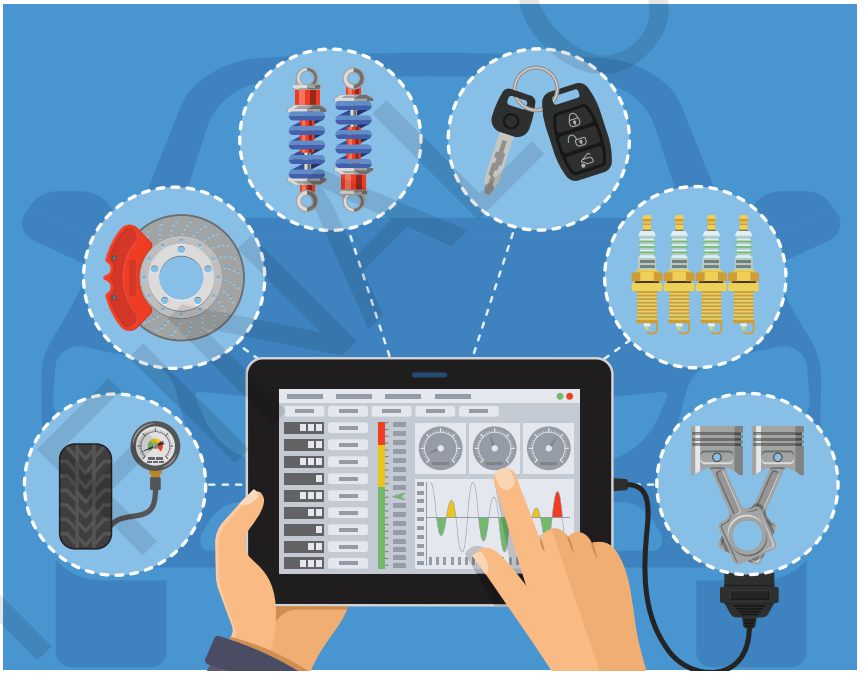


Figure 11.6 Easy fault analysis by means of mobile devices such as a tablet

Computer-based scan tools and programs

- A USB or serial port is connected to the OBD port inside the automobile.
- The signals from the OBD is converted to serial data.
- The computer software decodes the data to visual display.
- Computer-based diagnostics allows for data logging as well as additional functions because it has a larger storage capacity than other tools.
- The computer screen has a higher resolution screen and signals can be offered in colour codes as well.
- There are many software programs available for diagnostics and this allows for flexibility.

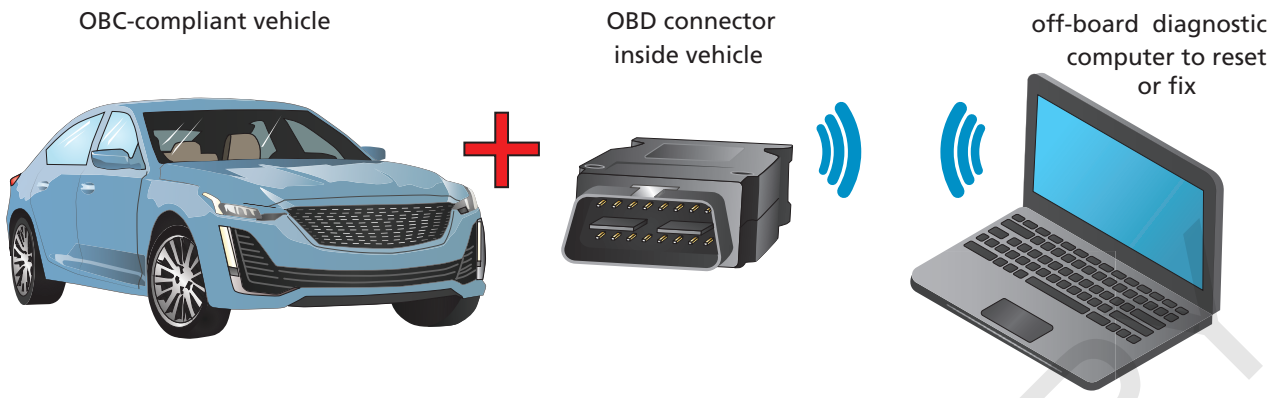


Figure 11.7 The elements needed for computer-based diagnostics

OBD port pinout arrangement

The OBD port has different pins (Figure 11.8) and the table below explains the arrangement.

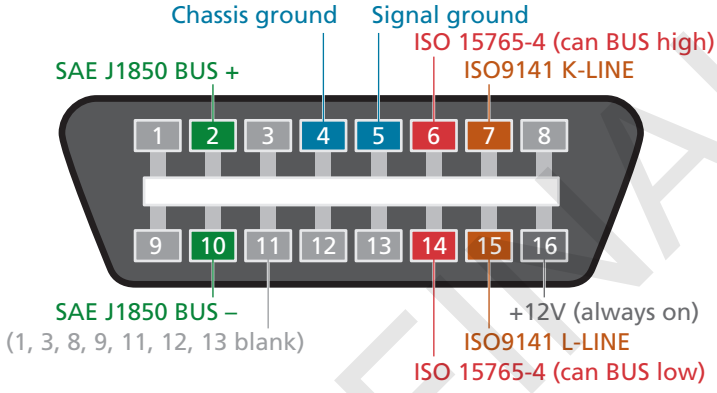


Figure 11.8 OBD port pinout arrangement

Table 11.1 Arrangement of OBD port pinout

No.	Description	No.	Description
1	blank	9	blank
2	SAE J1850 BUS +	10	SAE J1850 BUS –
3	blank	11	blank
4	Chassis Ground	12	blank
5	Signal Ground	13	blank
6	Can Bus High	14	Can Bus Low
7	K-Line	15	L-Line
8	blank	16	Battery Power

Fault codes or diagnostic tool codes

Diagnostic trouble codes logged by the OBD system all have one letter and four numbers. The alphanumerical arrangement of DTCs helps to locate faults.

- First digit: The letter, which precedes the numbers, gives a very general classification of the problem.
- Second digit: Either a generic (SAE - Society of Automotive Engineers) code (0) or a manufacturer-specific code (1) is given.
- Third digit: The area or system that has the fault. For example, 7 indicates a transmission problem and 3 an ignition problem.
- Fourth and fifth digits: These digits narrow the diagnosis down to the specific area where the malfunction is happening.

Always remember the following:

1. It is important to do visual inspections.
2. With irregular faults, problems with wiring and connectors are common.
3. When using a computer, a good sensor can be reflected as bad due to mechanical problems.
4. If the sensors send incorrect information, it can also cause the computer to manage the engine inaprropriately.

The figure below gives a user-friendly summary of generic code groups.

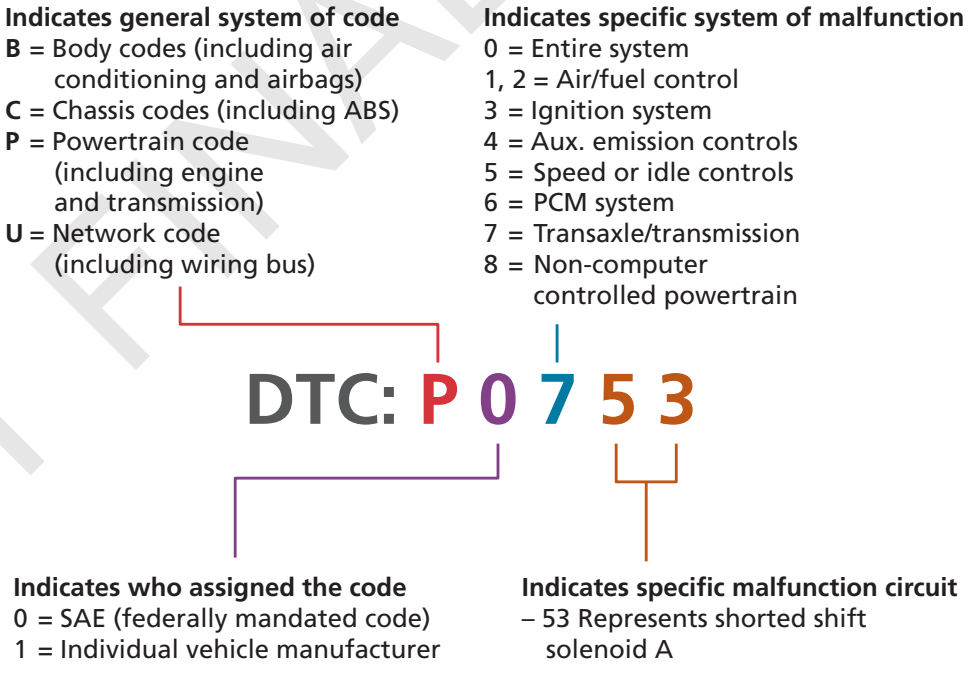


Figure 11.9 Format of fault codes

Table 11.2 Generic group codes

Powertrain codes		Chassis codes	
POXXX	Generic	COXXX	Generic
P1XXX	Manufacturer-specific	C1XXX	Manufacturer-specific
P2XXX	Generic	C2XXX	Manufacturer-specific
P30XX–P33XX	Manufacturer-specific	C3XXX	Generic
P34XX–P39XX	Generic		
Body codes		**Network communication codes**	
BOXXX	Generic	U0XXX	Generic
B1XXX	Manufacturer-specific	U1XXX	Manufacturer-specific
B2XXX	Manufacturer-specific	U2XXX	Manufacturer-specific
B3XXX	Generic	U3XXX	Generic

How to do a diagnostic reading

- Connect the OBD device to the port or link it up via Bluetooth to the OBD.
- Turn the key in the ignition to the On position without starting up the engine.
- Ensure that the external diagnostic device is switched on and select the system you need to monitor or repair.

Computer-based diagnostics

- The computer must be connected to the OBD device either by USB, serial port or Bluetooth.
- Open the diagnostic software on the computer.
- Look for the Trouble code or Fault diagnostics tab.
- Click on the tab to open it and the software will then display the DTCs.
- You can export and save the codes into another computer program to keep a data log or history of events.

Handheld device

- Plug the device into the OBD port and make sure that it fits snugly and makes good contact.
- Switch on the device.
- The device will communicate with the ECU of the vehicle and messages will start appearing on its screen.
- Depending on the type of device, the user will have to provide the automobile's VIN (Vehicle Identification Number), the make, engine type and model.
- A menu will open and, as with the computer menu, you need to select the Trouble Codes or Codes function.
- Depending on the system and the year of manufacture of the automobile, the device can provide different kinds of information.
- There are two or more types of codes and the most common codes are the Active and Pending codes.

- Active codes are malfunctions or live codes keeping the malfunction indicator light (MIL) on.
- Pending codes mean that the operation of one of the systems was registered once and the MIL light was not turned on. If there is a problem with the system more than once, it becomes an Active code.

Mobile applications

- A cell phone, smartphone or tablet can be used to do readings on the OBD by means of an OBD application.
- The device can be connected using USB cables or via Bluetooth.
- The mobile application will display the same codes that appear on other devices.
- The diagnostic information can be freeze-framed or even backed up to refer back to later.

Clearing DTC and resetting the malfunction indicator light

- Investigate, fix and resolve the problems causing the MIL to light up.
- Only once the problems have been fixed, is it possible to clear the DTC codes and reset.
- This option is available on all the diagnostic devices.
- Once the code has been cleared, run the engine of the vehicle again to make sure that the problem has been resolved.
- If the MIL lights up again, it means the problem is still unresolved and you will have to repeat the process.
- As soon as the problem has been fixed, resetting the MIL clears the trouble codes.

Here are some of the codes you may find by using one of the diagnostic devices.

Table 11.3 Examples of full OBD codes and the faults they represent

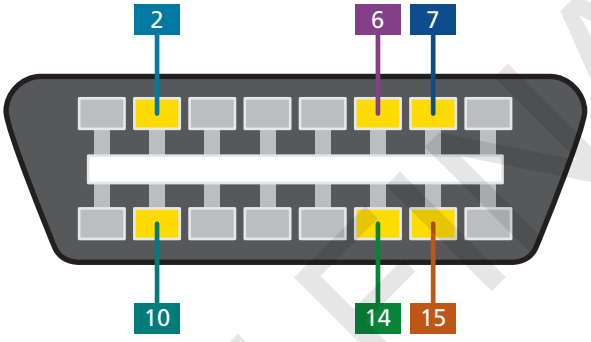
OBD code	Diagnostics
P codes	
P0016	Crankshaft Position – Camshaft Position Correlation (Bank 1 Sensor A)
P0038	HO2S Heater Control Circuit High (Bank 1 Sensor 2)
P0081	Intake Valve Control Solenoid Circuit (Bank 2)
P2158	Vehicle Speed Sensor 'B'
U0215	Lost Communication With 'Door Switch A'
U0231	Lost Communication With Rain Sensing Module
U0306	Software Incompatibility with Fuel Injector Control Module
U0312	Software Incompatibility with Battery Energy Control Module A

OBD code	Diagnostics
C codes	
C1116	Starter Motor Circuit Failure
C1137	ECU is Defective
C1155	Speed Wheel Sensor LF Input Circuit Failure
C1707	Left Rear Centre Sensor Circuit Fault
B codes	
B1201	Fuel Sender Circuit Failure
B1318	Battery Voltage Low
B1384	Oil Level Lamp Circuit Failure
B1806	Lamp Tail Output Circuit Failure

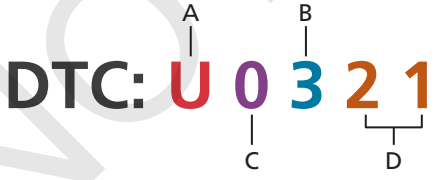
There is a range of diagnostic codes that can be displayed and a mechanic should use these codes in conjunction with the automobile's service manual to search which systems, components or circuits need testing.

ACTIVITY 11.1 OBD and fault finding

1. Identify the pins on the OBD port in this diagram.



2. The first digit of the diagnostic trouble codes starts with a letter. List the letters together with their explantions.
3. Study the DTC and give the explanations for the labels from A to D.



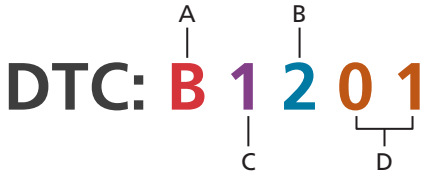
4. Explain what an OBD system is in your own words.

Module summary

- An automobile's OBD system is a computerised system that communicates with other systems in the automobile.
- It monitors the operation and performance of the engine, it checks the operation of the emission and transmission systems, it checks ignition functions and all other systems that rely on sensors for information.
- Based on the information from the sensors, the OBD can determine if all systems are working properly.
- If a sensor picks up an irregularity, it sends a warning to the OBD.
- There are various reasons for using OBD scanning:
  - The warning lights on an automobile's dashboard interface provide warnings before problems become serious.
  - Fault codes make it easier to isolate faults as they indicate the system or area that needs checking.
  - The diagnostics history allows for monitoring occurring problems.
  - The device provides quick and accurate display of the vehicle's problem.
  - There are generic handheld devices on the market, but each automobile manufacturer has a diagnostic computer for reading fault codes, monitoring operations of systems and programming ECUs.
- There are different devices on the market that read diagnostic trouble codes:
  - handheld scan tools
  - mobile devices with OBD applications
  - computer-based scan tools and software programs.

Exam questions

1. Study the DTC and give the explanations for the labels from A to D. (4 × 2 = 8)



2. Name a monitoring system that is used to detect an increase in vehicle emissions and also to monitor all emission-related components. (1)
3. What does it mean when the MIL is on? (1 × 2 = 2)
4. Explain the following DTC codes in full:
   a) P0442
   b) P0302 (2 × 2 = 4)
5. What does 'freeze frame' mean on a OBD reader? (1)
6. What is OBD and what are the advantages of making use of it? (6 × 2) (12)

[28]