Education Programme

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The Ultimate Driving Machine

BMW Young Academy

ZKE Systems

Lesson 1:
ZKE Systems - An Introduction

Teacher Workbook

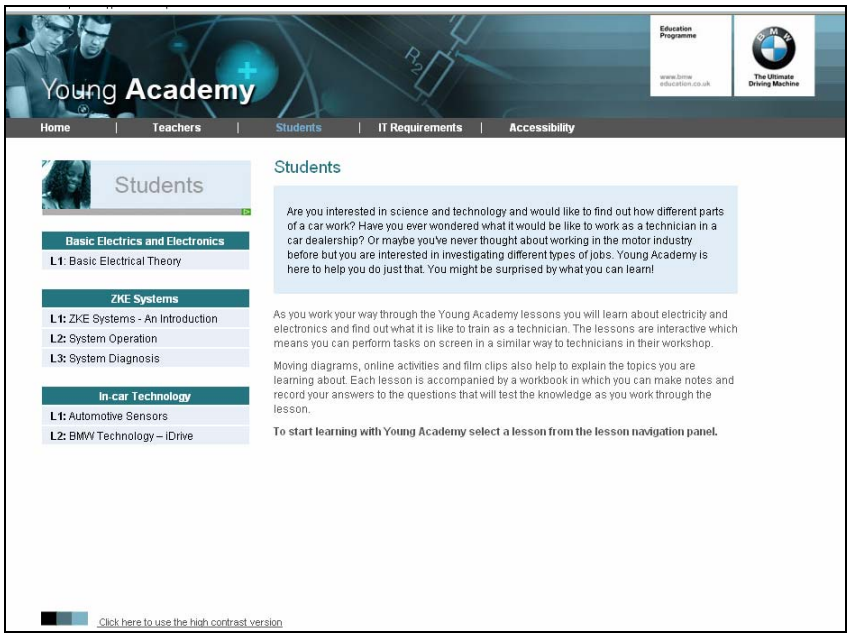
Jointly funded by the Quality Improvement Agency and BMW (UK) Ltd

About Young Academy

Discover the skills needed to work in the automotive industry and learn about the science and technology behind the cars with Young Academy, BMW Education's online resource for 14 to 16 year olds.

Young Academy is a series of online lessons based on BMW Academy's own award-winning apprenticeship programme. By working through the lessons, you will take a journey from learning about the principles of electrical theory, to developing an understanding of the skills and knowledge needed to become a motor industry technician. The **Young Academy** lessons incorporate the latest web-based training (WBT) techniques, which enable you to learn in the same way as the apprentices at the BMW Academy.

The Young Academy lessons are available from the BMW Education website at: **www.bmweducation.co.uk/YoungAcademy.**



About Lesson 1: ZKE Systems – An Introduction

Cars use a variety of electrical devices and components, such as windscreen wipers, central locking, air conditioning, entertainment systems and electric windows. Together, these are known as the central body electronics, or in BMW cars ZKE systems. These systems are important because they help to make a car safe and reliable and also improve the comfort for the driver and passengers.

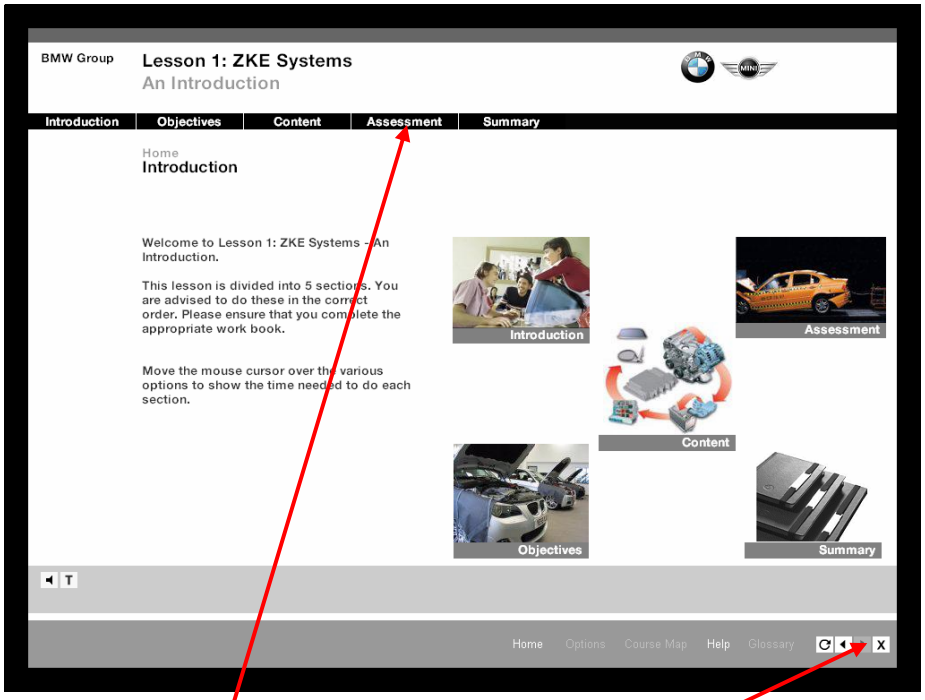
Lesson 1 looks at ZKE systems, how these systems operate and how they exchange data, using systems known as 'bus networks', to ensure that modern cars are reliable and safe.

Working through the online lesson

The online lesson is divided into five sections, which students should work through in turn:

- Introduction
- Objectives
- Content
- Assessment
- Summary

Once the lesson has been launched from the website, students can move through the pages using the 'next' or 'previous' navigation buttons at the bottom of the screen. There is also a 'replay' button, for repeating any of the activities or animations, and an 'exit' button to end the lesson. The menu at the top of the screen can be used to move from one section to another without going through all the pages.



Clicking on the 'help' button shows how to use the navigation in more detail.

Using the student workbook

Each lesson is accompanied by a workbook that students can fill in as they work through the lesson on the computer. The workbook can be used to make notes and record answers to questions. The workbook is their personal record of what they have learnt.

The teacher workbook contains the answers to the questions posed in the student workbook.

Lesson 1: ZKE Systems – An Introduction

Overview

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Objectives

At the end of this lesson you should be able to:

- Explain the requirement for bus systems
- Describe the decimal and binary systems
- Describe analogue transmission
- Describe digital transmission
- Identify BMW vehicles and major bus systems.

Lesson 1: ZKE Systems – An Introduction

Introduction

Bus systems and electronic communication networks are complex subjects.

This lesson has been designed as an introduction to the subject, enabling you to develop basic understanding of how these systems communicate. You will use the knowledge you have developed in Lesson 2: Testing Central Body Electronic Systems, when you will be testing the communications systems of a car. In Lesson 3: Diagnosis of Central Body Electronic Systems you will be diagnosing a customer concern.

This workbook should be used together with the web-based training.

Abbreviations and Meanings

There are lots of abbreviations used in the motor industry and indeed by BMW. Here are a few abbreviations you will encounter during the three ZKE Systems lessons:

BMW The abbreviation of the German words for Bavarian Motor Works (Bayerische Motoren Werke).

CAN Controller Area Network - A relatively high speed bus communication system used on many vehicles, designed and developed by BOSCH.

CD Compact Disc

DIS Diagnosis and Information Service - This is the touch screen laptop that contains all the technical information and diagnostic functions needed to maintain and repair BMW vehicles.

DVD Digital Versatile Disc

EKM The abbreviation of the German words for Electronic Body Module.

GM General Module – This allows communication between bus networks.

GT1 Group Tester 1 - This is BMW Groups diagnostic tester that contains the Diagnostic Information Service.

LIN Local Interconnect Network, an industry standard low speed bus network connecting items such as electric windows and door mirrors.

LKM The abbreviation of the German words for Lamp Check Module.

MID The abbreviation of the German words for Multi-Information Display - This displays information to the driver.

MOST Media Orientated System Transport - An industry standard for a fibre optic ring bus network.

TIS Technical Information System - This is part of the DIS touch screen laptop that contains detailed instructions and technical data about BMW vehicles.

ZKE The abbreviation of the German words for Central Body Electronics (Zentral Körper Elektronik) - This refers to electronic systems such as windscreen wipers, central locking and electric windows etc.

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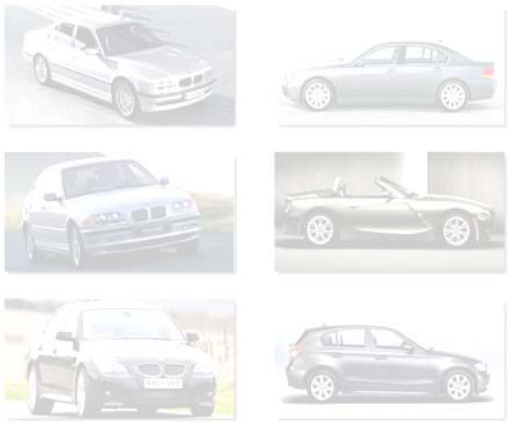
Bus Systems



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What are bus systems?

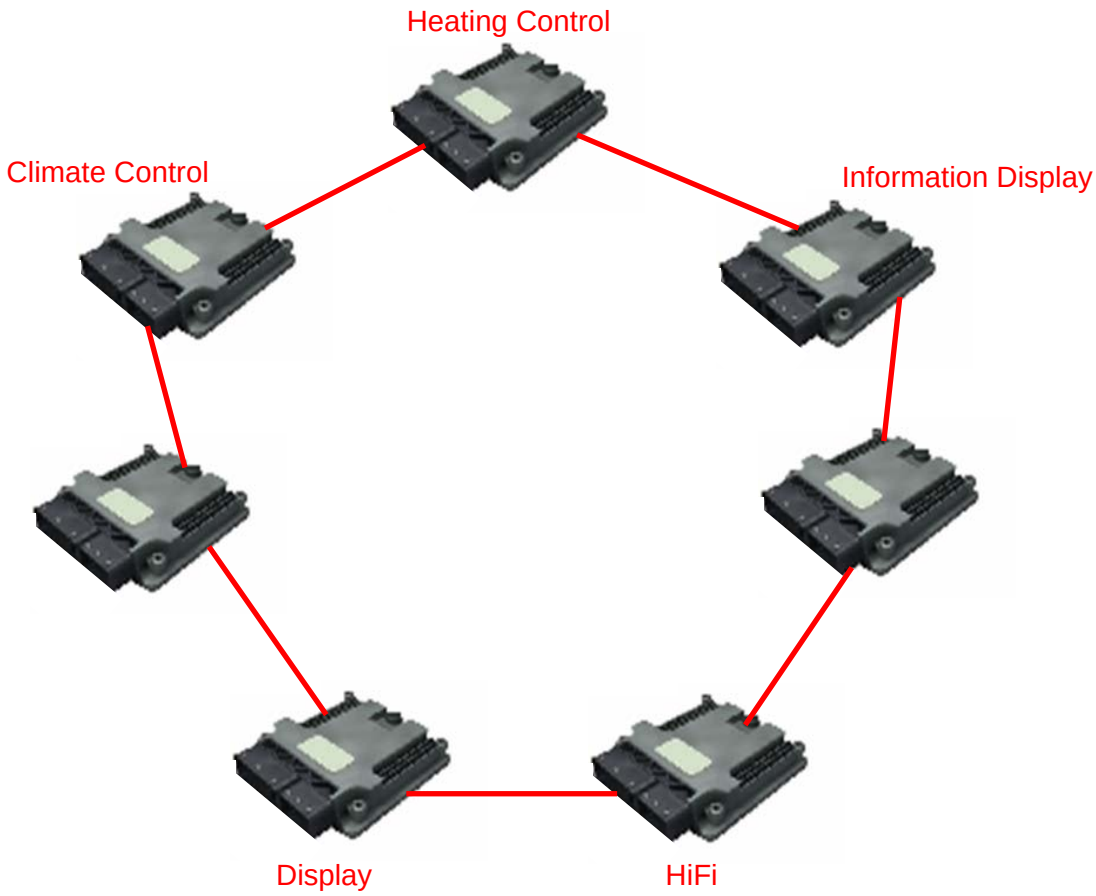
Bus systems can be best described as a method of connecting vehicle systems together so that they can share information and functions.

Why bus systems?

Today's motor vehicles, ranging from the small economy car through to the luxury class, contain a wide variety of electronic devices and components. The use of electronics in motor vehicles will increase substantially in the foreseeable future. Both legislation, as well as customers' demands, are driving this development. Legislation is interested in improving the quality of exhaust emissions and reducing fuel consumption. Customer requirements are focused on improving driving comfort and safety.

Question 1: Please complete the diagram below by labelling the parts:

Answer:



Question 2: In principle, a distinction is made between two groups of bus systems. These are:

Answer:

1. Main bus systems.

2. Main bus systems.

Main bus systems are responsible for cross-system data exchange, i.e. between the engine management system and the entertainment system.

Sub-bus systems exchange data within a specific system. These systems are used to exchange relatively small quantities of data in specific systems.

Number Systems

Question 3: Three important number systems are used in computer technology. These are:

Answer:

1. Decimal number system.

2. Binary number system.

3. Hexadecimal number system.

Decimal Systems

This number system has the base 10, i.e. it has ten different symbols for each individual numerical position. This results in ten different options of representing a single-digit number: 0,1,2,3,4,5,6,7,8 and 9.

Consequently there are 100 options of representing a two-digit number:

Ten options for the first position multiplied by ten options for the second position, i.e. $10^2 = 10 \times 10 = 10$

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Decimal Systems

Question 4: How would you represent three-digit numbers?

Answer: $10^3 = 10 \times 10 \times 10 = 1000$ options.

The base system therefore involves the power of 10. The place value is multiplied by 10 from place to place, from left to right.

Binary Systems

Question 5: How many states do binary systems recognise?

Answer: Two states only.

Question 6: Describe what happens when you press the interior light button.

Answer: The voltage has dropped from 12 volts (off) to 0 volts (on). This simple light circuit represents two states.

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Analogue Transmission

Question 7: In your own words describe the term analogue?

Answer: A signal that is infinitely variable between two values.

Question 8:

When listening to music, for example, the ear receives analogue signals, which are constantly changing sound waves.

What can cause interference on analogue transmissions?

Answer:

- The length of the cable.
- Line resistance of the cable.
- Radio waves.

What do you notice about the quality of the sound when the cable resistance is increased?

Answer: The quality of the sound decreased as cable resistance increased.

The analogue transmission of information in vehicle applications is not feasible for safety and reliability reasons.

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Digital Transmission

The term digital originates from the Latin word *digitus* and means finger or toe. Digital is therefore everything that can be counted on a few fingers or more accurately, everything that can be divided into discrete steps.

Digital representation involves representing constantly changing variables in numerical form.

Question 9: True or false - Data is represented as a sequence of ones and zeros in computers.

Please tick the correct answer.

Answer:

True ☑ False ☐

Coded Representation

Question 10

A code is a distinct set of rules for depicting a character set. An example of a code is the Morse Code.

Each letter of the alphabet and the numbers are represented, or encrypted, by signals of different lengths.

What is the name of the lamp?

Answer: Aldis lamp

What is the correct Morse Code message for SOS? Is the light on for a short or a long time?

Answer:

Short, Short, Short = S Long, Long, Long = O Short, Short, Short = S

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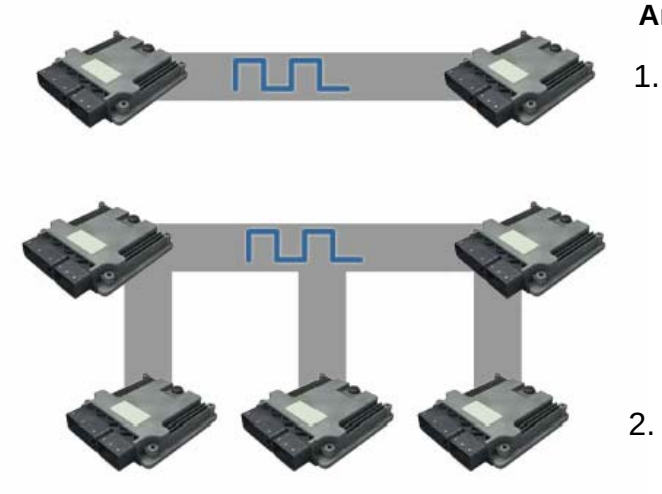
Coded Representation

Question 11: What is the binary sequence for the letter D?

Answer: 0100 0100

Interface Connections

Question 12: Please label the two diagrams below to show which is point-to-point and which is multipoint:



Answer:

1. Point to point connections.

2. Multipoint connections.

Serial Transmission

Question 13: What is meant by the term serial transmission?

Answer: This is where data is sent one bit at a time after each other. This can be likened to a train with lots of carriages, he carriages representing the data (bits).

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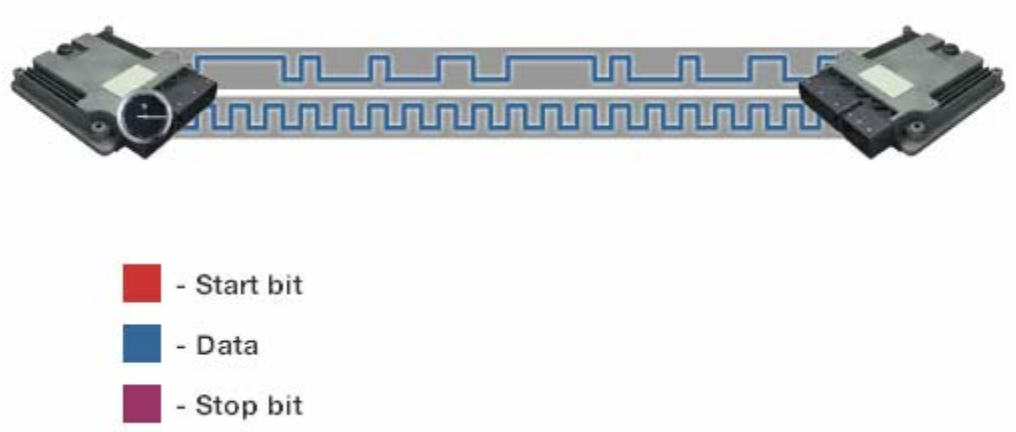
Synchronous Data Transmission

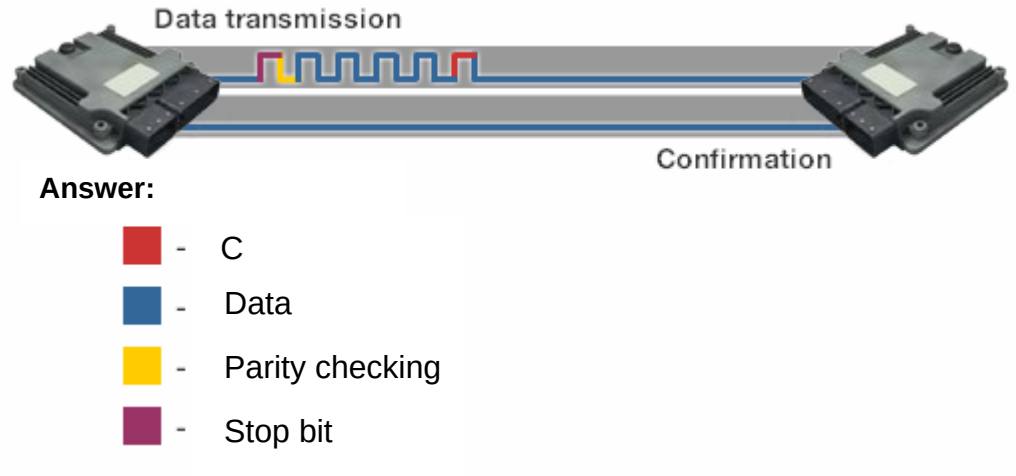
One way of keeping the time control the same or ‘synchronous’ in the transmitter and receiver is to use a common clock generator. This method is known as the synchronous transmission format. Here, only the clock generator of the transmitter is used. Its clock frequency must be sent via a separate line to the receiver.



Asynchronous Data Transmission

Question 14

Please label the diagram below:



Answer:

- C
- Data
- Parity checking
- Stop bit

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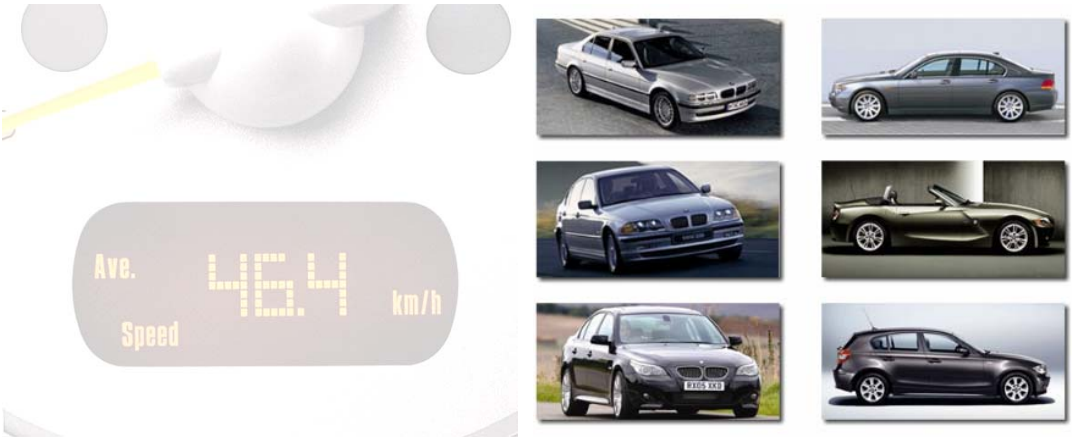
Bus Systems Development



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Question 15

1 

4 

2 

5 

3 

6 

Please name the vehicles above and make notes about the bus systems that each model has (number 1 has been completed for you):

1. 8 Series E31 — Ibus (instrument bus)
2. 3 series E46 — CAN
3. 5 series E60 — CAN, MOST, Byteflight, LIN
4. 7 series E65 — CAN, MOST, Byteflight, LIN
5. Z4 E85 — CAN, MOST, Byteflight, LIN
6. 1 series E87 — Distributed and independent function

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Question 16: Which was the first BMW vehicle to utilise fibre optics?

Answer: BMW 7 series E65

Question 17: List three advantages that automotive manufacturers have gained by using bus networks:

Answer:

1. Reduction in wiring harness complexity and weight
2. New functions can be retro fitted easily
3. Enhanced security for the transfer of information
4. Reduced spatial requirements in the car
5. Improved reliability
6. Multiple use of sensors (sensor information)
7. Reduced production costs

Additional Notes

Lesson 1: ZKE Systems – An Introduction

Summary

In this lesson you have covered the basic principles of digital systems that allow bus communications to take place within vehicles. You have also discovered the development of these systems on BMW products and the advantages that these technologies can bring.

In Lesson 2 you will be testing four of these systems on a BMW vehicle using BMW specific diagnostic tools.

Good luck!