

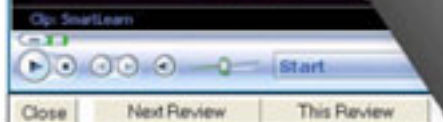
SmartLearn™

CompTIA A+

**Core Hardware &
Operating System
Technologies**

**STUDENT TRAINING
MANUAL**

**FOR USE WITH THE SmartLearn™
ONLINE TRAINING SYSTEM**



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1: Introduction to PC Hardware

Chapter Objectives

After this lesson, you will be able to:

- Understand the difference between Software, Hardware and Firmware
- Understand the importance of Binary to a computer
- Perform binary conversions
- Understand common computer size units, such as KB and MB

1.1: Definitions

The first section of this course focuses on the hardware components of a PC.

1.1.1: Hardware

Hardware refers to objects that you can actually touch, like disk drives, monitors, keyboards, printers, boards, and chips.

Common Hardware Components include:

Motherboard

The motherboard, (occasionally called the main board, system board or planar board) is the main circuit board in the PC. It holds the CPU, memory and expansion slots.

Central Processing Unit (CPU)

The CPU is the brain of the computer. It performs all the calculations required to run the PC.

Random Access Memory (RAM)

RAM holds all the information that the computer is currently using. For example, the application that is currently open. RAM is volatile, when the power is switched off, all data is lost.

Expansion Slots

Sockets attached to the Motherboard for adding extra hardware.

Hard Drive

These are high capacity magnetic storage devices, for permanent data storage. Normal sizes today are around 40-250GigaBytes (GB)

Floppy Drive

Floppy Drives are low capacity data storage, with removable disks. These are usually 3.5 inches in size, with a capacity of 1.44MegaBytes (MB).

CD-ROM

A high capacity optical storage device with a removable disk of 650-700MB in size.

Ports (Parallel, Serial, Video, Keyboard, Mouse, USB, Firewire)

These are used to connect external devices to the computer system through the motherboard.

1.1.2: Software

In contrast, software is something that cannot be touched, such as computer instructions or data. Anything that can be stored electronically is software. There are two main categories of software.

- **Systems Software:** Includes the operating system and all the utilities that enable the computer to function.
- **Applications Software:** Includes programs that do real work for users. For example, word processors, spreadsheets, and database management systems all fall under the category of applications software.

Software is discussed in more detail later in the course.

1.1.3: Firmware

Firmware is a combination of software and hardware. Components called 'Read Only Memory' or ROM Chips that have data or programs recorded on them are firmware.

Firmware is discussed in more detail later in the course.

1.2: The Binary Numbering System

A computer contains a large number of very fast electrical switches. These switches can either be on or off. This is the fundamental basis of every single computer process. It is therefore essential to understand the way that a computer can use these on/off signals to generate useful information. It does this by using a mathematical numbering system called binary.

Computers can only understand things in binary terms. Everything has to be reduced to a series of ON's and OFF's.

In binary: 1 corresponds to ON
 0 corresponds to OFF

1.2.1: Conversion to and from Decimal

Any decimal number can be represented in binary - for example, decimal 7 is binary 111.

To explain binary fully, it is better to first look at a numbering system we are more familiar with – decimal.

Decimal numbering works on the base of 10 available digits, (0,1,2,3,4,5,6,7,8,9), whereas binary only has 2 available digits (0,1). In decimal, the location of the digits refers to the amount of units you are trying to represent. See the table below.

Decimal number 469 is actually:

10,000's	1000's	100's	10's	1's
		4	6	9

Each column represents a certain value. The number you place in that column represents how many of that column you want to use. In the above example you wish to use:

4 x 100's (= 400), **6** x 10's (=60) and **9** x 1's (= 9).

As a result you add them together (400+60+9) and get **469**. Although this calculation is unnecessary with decimal, the calculation and process is identical with that of binary, the only differences are the value of the columns and the digits you have available. In binary, the first column on the right has a value of 1. The subsequent columns, going from right to left then double in value. Also, you can only use the characters 0 or 1 (i.e. OFF or ON) See the table below.

Binary number 1110 would be shown as:

16	8	4	2	1
	1	1	1	0

Remember the process is identical to that of the decimal calculation, it's just the column values that have changed. Therefore:

1 x 8 (= 8), **1** x 4 (= 4), **1** x 2 (= 2), and **0** x 1 (= 0)

As a result you add them together (8 + 4 + 2 + 0) = 14

Therefore 1110 in binary converts to 14 in decimal.

Using this numbering system, the computer can represent many different numbers. These numbers are used to represent everything a computer does.

Each single one or zero is known as a **Bit**. 8 bits, when combined are called a **Byte**. A bit is the most basic unit of information that can be stored by a computer.

A single byte of information can be interpreted in a number of different ways. It may represent a program instruction, a printable character, or data from an image.

For example, bytes can represent printable characters using the **ASCII code**, (American Standard Code of Information Interchange) where one byte equals one character:

Binary Number	Decimal Number	Character
10011100	156	£
01000000	64	@
01000001	65	A

In a byte, the right most bit is the Least Significant Bit (LSB), with a decimal value of 1 (2^0). The left most bit is the most significant bit (MSB) with a decimal value of 128 (2^7).

The largest number available in eight bits is 11111111 or **255**. The smallest is 00000000 or **0**. Therefore the maximum decimal number you can represent is **255**. Remember though that 00000000 is also a valid number therefore you have available **256** different numbers, as you can also make use of this number **0**.

It is also useful to know all the binary numbers that can be achieved using different bit lengths. The table below lists the common bit lengths.

Bits	Max Decimal Number	Numbers Available
8	255	256
16	65535	65536
24	16.7 Million (16,777,215*)	16.7 Million (16,777,216*)
32	4.29 Billion (4,294,967,295*)	4.29 Billion (4,294,967,296*)
64	18.4 Quintillion (18,446,744,073,709,551,615*)	18.4 Quintillion (18,446,744,073,709,551,616*)

* These larger numbers tend to be rounded up, and are just provided to complete the table. For 24, 32, and 64 Bit, there is no need to memorise the exact numbers.

The important point to take from this table is that, for example, a **64bit** system is not simply twice as good as a **32bit** system. In terms of the numbers it can handle, it is actually **4.29 billion** times more powerful!

1.2.2: Kilobytes and Megabytes

The binary numbering system will appear in many aspects of computing. For example, RAM is bought in units of binary, e.g. 16MB, 256MB etc.

The terms kilobyte (KB) and megabyte (MB) describe thousands and millions of bytes respectively. For example, when a computer is described as having a memory of **256MB** RAM, this means it can store 256 million bytes of data.

How Many Bytes?

8 bits	=	1 Byte
1024 Bytes	=	1 KB (Kilobyte)
1024 KB	=	1 MB (Megabyte)
1024 MB	=	1 GB (Gigabyte)
1024 GB	=	1 TB (Terabyte)
1024 TB	=	1 PB (Petabyte)
1024 PB	=	1 EB (Exabyte)

1.2.3: Use of Bits / Bytes

Bits and bytes are used to describe two things, **Capacity** and **Speed**.

Capacity is generally measured in multiples of a byte, for example a hard drive that is 40GB is actually 42,949,672,960 **Bytes** (40x1024x1024x1024). Remember that there are 8 bits in a byte so this means it can store 42,949,672,960 8 bit 'chunks' of data.

Speed can however be measured in **bits** per second depending on the interface that is being rated. For example a modem may have a speed rating of 56Kbps (kilo bits per second). This means it can transfer 56000 bits, i.e. individual 1's and 0's per second.

It is normally easy to spot when bits and bytes are being used. Bits are usually abbreviated as a lower case '**b**' and bytes are usually abbreviated as an upper case '**B**'.

It is therefore important to look at the speed ratings of components carefully. 56Kbps (Kilo bits per second) is very different to 56KBps (Kilo bytes per second)!

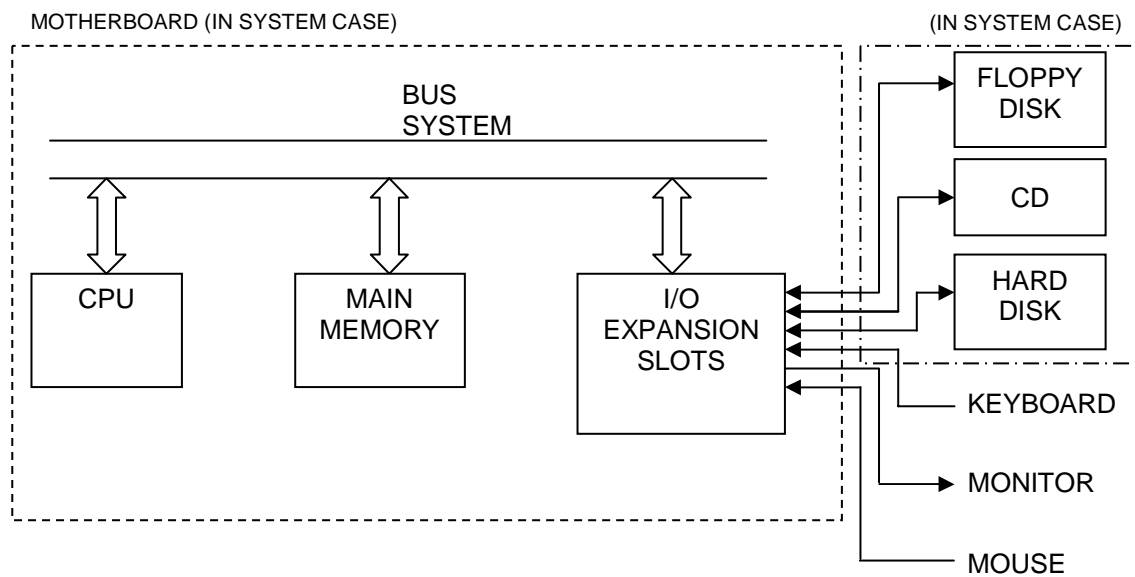
2: Computer Systems

Chapter Objectives

After this lesson, you will be able to:

- Describe the four basic hardware elements of a PC, and their roles
- Describe the three different Bus System types

2.1: A Basic Computer System



Simple Block Diagram of a Basic Computer System

A computer system contains four basic hardware elements:

- Central Processing Unit (CPU)
- Main memory
- Input/Output (I/O) expansion slots
- Bus system

2.1.1: Central Processing Unit (CPU)

The Central Processing Unit (CPU) contains billions of electronic switches on one silicon chip. It is designed to execute the instructions that control the software.

CPU's are given names by the manufacturer, for example a "2.8GHz Pentium" processor. 'Pentium' is the name of the processor, and the '2.8GHz' refers to the speed at which it can process data. (2.8 billion cycles every second).

You can purchase 32bit or 64bit processors. The bit width of a CPU determines the size of number that can be calculated in one cycle.

2.1.2: Main Memory

Your computer has a set amount of main memory, comprising of RAM (Random Access Memory) and ROM (Read Only Memory). RAM is used for the temporary storage of currently running programs and data, whereas ROM provides permanent, read only storage for a program called the BIOS, which enables your computer to 'boot' up.

2.1.3: Input/Output (I/O) Expansion Slots

The Input/output (I/O) Expansion slots allow external peripherals to be connected to the computer allowing communication with the outside world. These peripheral devices include keyboards, monitors, disk drives, mice, digital cameras etc.

The I/O expansion slots consist of a special interface circuit for each type of peripheral device. The interface circuits allow the computer to interpret the data from the devices, or send data to the devices. These circuits may be on the motherboard itself or on a circuit board (a 'card'), which is plugged into a slot on the motherboard.

It is also possible for the entire expansion slot interface to exist on a card. This is known as a riser card, and will be discussed in more detail in a later chapter.

2.1.4: Bus System

The Bus System is a set of wires in the form of copper tracks on the motherboard or a ribbon cable, which allows information to be exchanged between all elements in the computer system.

All buses consist of 3 parts:

- **Data Bus**
The data bus carries data between devices
- **Address Bus**
The address bus carries the location of the data
- **Control Bus**
The control bus specifies whether to read or write the data

The width of the data bus in-conjunction with the operating system will determine how much data can be transmitted at a given time.

The speed of the bus in MHz is also important and allows the data to be transferred faster, enhancing both application and system performance.

2.2: Summary

The four elements (**CPU**, **memory**, **input/output** and the **bus** system) are all equally important.

- Without a CPU, the computer cannot perform calculations
- Without memory, it can not store data and instructions
- Without input/output interfaces, the computer would not be able to communicate with its users
- The bus system is needed to connect all of these together

3: System Components

Chapter Objectives

After this lesson, you will be able to:

- Understand the importance of the system case
- Understand the function and importance of the PSU
- Describe the different PSU types and connectors
- Describe the different laptop PSU types, and their features
- Understand potential power problems

3.1: The Case



The main function of the case is to hold and protect the motherboard and peripherals from dust, dirt and foreign objects. The system would work without a case but could be easily damaged and would be unsightly.

Cases are categorised using three elements. Firstly, the size of the case, secondly the motherboard (AT, ATX, NLX, etc) and thirdly the PSU type that the case uses. These three factors determine the size, layout and general design of the case.

3.1.1: Sizes Available

There are various sizes in use. Whilst manufacturers may vary, the main categories are:

- Full Tower
- Mid Tower (or Midi Tower)
- Mini Tower
- Desktop
- Slimline
- Proprietary



The table below gives you a guide to the key features of the various case designs.

Case Type	Approx Size	5 ¼ bays	Cost	Cooling
Full Tower	>50cm (Height)	4+	££££	Excellent
Mid(i) Tower	40 – 50cm (Height)	3	£££	Very Good
Mini Tower	30 – 40cm (Height)	2	££	Good
Desktop	30 – 50cm (Width)	3	£	OK
Slimline	<30cm (Height)	1	££	Poor
Proprietary	Varies	Varies	£££	Varies

3.1.2: Case Cooling

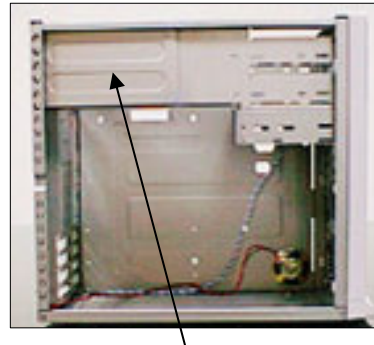
The system case is designed with airflow very much a high priority in order to ensure that the internal components are kept cool. On this basis, it is important that the case is used as designed – i.e. with all the panels attached, and specifically with all expansion card blanks fitted if the expansion card is not in use. If this is not the case, airflow can be disrupted and damage to components can occur.

The system case will sometimes also be supplied with fans in addition to those on the PSU and the CPU to assist in the cooling of the computer.

3.2: The Power Supply Unit (PSU)

3.2.1: The Function of the PSU

The power supply unit is used to convert AC 'mains' voltage into DC voltage, producing +3.3v DC, ±5v DC and ±12 volts DC. (Negative rating provides grounding element).



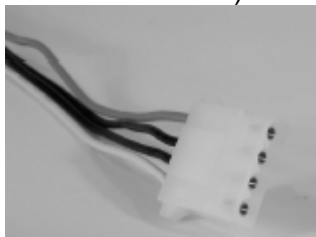
A typical power supply (as above) would be located here

NB Power supplies should never be opened or tampered with. They contain lethal electrical currents. They are not meant to be serviced or tampered with in any way. They are an example of a Field Replaceable Unit or FRU.

Generally components that have moving parts, such as Hard Drives, CDROM and DVD drives require two power ratings, 12v for the motors and 5v for the circuitry. These devices are powered by the PSU Molex connectors (large block connector with chamfered corners and 4 wires) or in the case of the Floppy Disk Drive a Berg (aka Mini-Molex) connector (smaller connector, again with 4 wires).

Molex Connector

(Used mainly for HDD, CD-ROM or DVD Drives)



Berg (Mini-Molex) Connector

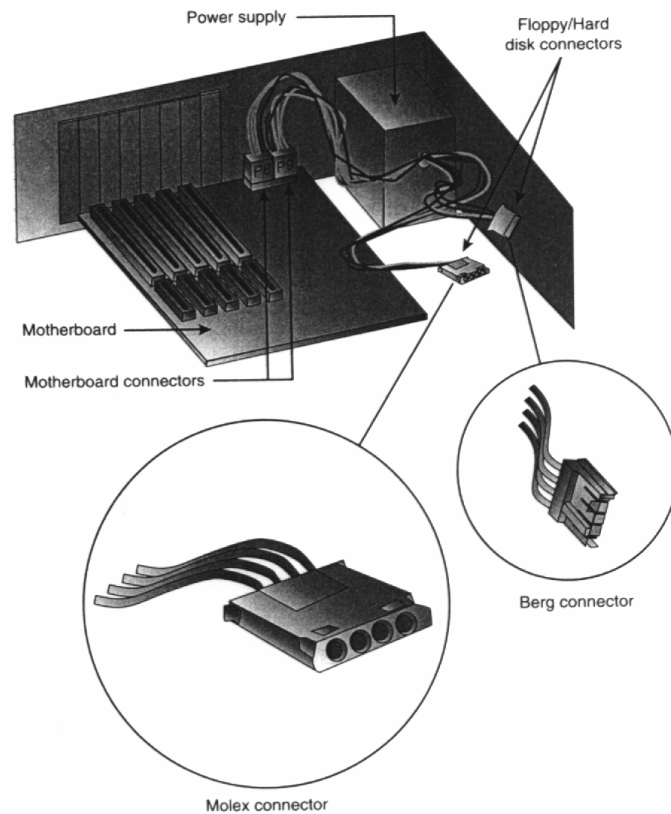
(Used mainly for FDD)



Whilst some manufacturers may differ, the wires are generally laid out as below.

Wire Colour	Voltage	Job
Red	+5V	Circuitry Power
Yellow	+12V	Motor Power
Blue (or Black)	-12V	Ground
White (or Black)	-5V	Ground

NB. If you are adding an extra device to your system and have no spare power connectors, you can purchase a 'Y' shaped splitter cable to provide an extra connector.



Generally components with no moving parts such as the CPU and RAM require only 3.3v or 5v. (New processor technologies use 3.3v or lower to reduce heat problems. This is discussed in more detail later in the course).

These components draw their power from the motherboard itself.

3.2.2: Power Supply Types

AT (Advanced Technology)

AT power supplies were used with older motherboards (up-to and including early Pentium), where few components were integrated or 'built in'.

AT power supplies used 2 block connectors called P8 and P9 to deliver power to the motherboard. Each connector comprised of 6 wires and connected side by side to the motherboard, with the black wires in the middle. AT PSU's provide 5V and 12V DC and around 240W power distribution. A watt is a unit of power, the higher the wattage, the more devices your computer can support.

AT power supplies were distinctive by their 'dualstate' or 'multistate' power switch. (i.e.) there was an **on** position and an **off** position that could only be altered physically by pressing the button. This limited the computer as there had to be physical contact in order to turn the computer on or off.

ATX (Advanced Technology – Extended)

ATX reduced overall system cost by integrating more devices onto the board, e.g. parallel port, serial ports, mouse port etc.