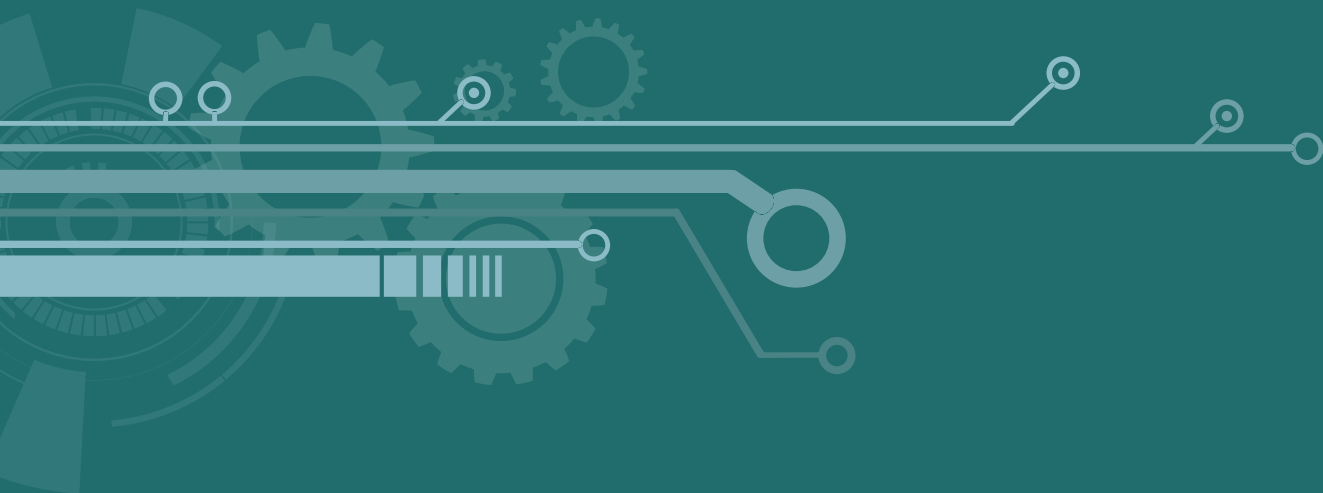


# Personal computer: hardware



# Computers

## Personal computer

A computer is an electronic machine that can process information.

Therefore, the following machines are computers:



And these others aren't, even though they process information, because they can't be programmed to process it in a different way.



But personal computers need something else.

A machine that processes information is a personal computer, or PC, when the person who uses it can be both the programmer and the user of its programs.

Although nowadays not many users make their own programs, it can still be done. Therefore, the following machines are personal computers:



On the other hand, these others are computers, but not PCs.



## Information

A computer processes two types of information:

- **Data**, which is processed to obtain results.
- **Instructions**, according to which data is processed.



Some kind of medium is needed in order for data to be input into a computer. In the seventies, some of the first programmable machines used punched cards. The data was registered via the presence or absence of holes placed in specific positions on the card. There were only two possible states: there was either a hole, or there wasn't. Each position contained a unit of binary data, called a **bit**. Nowadays, things have changed and CDs, DVDs, and BR are extensively used as a low cost way to store data. Nevertheless, information is still stored in binary units, or bits.

Computereeing is the study of the automatic treatment of information. In 1982, Philippe Dreyfus, a French physicist and professor of information technology at Harvard, coined the French term *informatics*, derived from the words information and automatic.

When we toss a coin, only two things can happen: heads or tails. As there are only two possible results, we can use the symbols 0 and 1 to represent them.

0 is tails                      and 1 is heads

The result of tossing a coin is a piece of binary data.

Things change when we roll a die because six different things can happen. Nevertheless, we can still write the results using the symbols 0 and 1:

1 is 001	4 is 100
2 is 010	5 is 101
3 is 011	6 is 110

Although the result of the roll is not binary data, we are expressing it in the binary system.

**A bit (Binary Digit) is the unit of binary information. It can only have two values, that are usually represented with the symbols 0 and 1.**

All the data processed by a computer have been converted into bits or bit combinations. If a piece of data can only take two values, like when we toss a coin, one bit will be sufficient to express it. On the other hand, if piece of data can take more than two values, like when we roll a die, several bits will be needed to express it.

## Types of information

Computers process different types of data:

- **Input data**

Input data is the information given to the computer.

A DVD movie is an example of input data.

- **Program instructions**

The program instructions codify the steps the computer needs to follow in order to process the input data.

Media players (e.g., VLC, Quicktime, Windows Media Player) are sets of program instructions.

- **Output data**

Output data are the results produced by the computer after it has processed the data.

The images that appear on a screen are an example of output data.



## Hardware

The hardware of a personal computer consists of its physical parts. There are two types of hardware:

- **The computer kernel**

The computer kernel processes the data and regulates the flow of information. In a desktop computer, it is inside the computer case. In a laptop, it is underneath the keyboard.

- **Peripherals**

Peripherals are devices that act as interfaces between the kernel and the outside world. There are three types:

- **Input peripherals** allow the input of data to the computer kernel.
- **Output peripherals** transport data from the kernel to the user.
- Input and output peripherals can carry out both tasks, according to the needs of the user.

In laptops, some peripherals (keyboard, screen, optical readers, Webcam, touchpad, etc.) are integrated into the computer casing, along with the kernel. But this does not mean they cease to be peripheral.

### The computer kernel

The computer kernel is made up of:

- **The motherboard**

The motherboard is probably the most important part of a personal computer. Its function is to allow communication between the other parts.

- **The processor**

The processor controls all the activity of the information system.

- **The memory**

The memory is the group of devices that temporarily store input data and the instructions used by the processor.

- **The BIOS**

The BIOS is a special type of memory that contains the first instructions that are executed when the computer is switched on.

Its main function is to find the nonvolatile storage systems and load them onto the memory of the operating system.

- **The power supply**

The power supply converts the alternating current from the power grid into the continuous current that powers the motherboard.

### The motherboard

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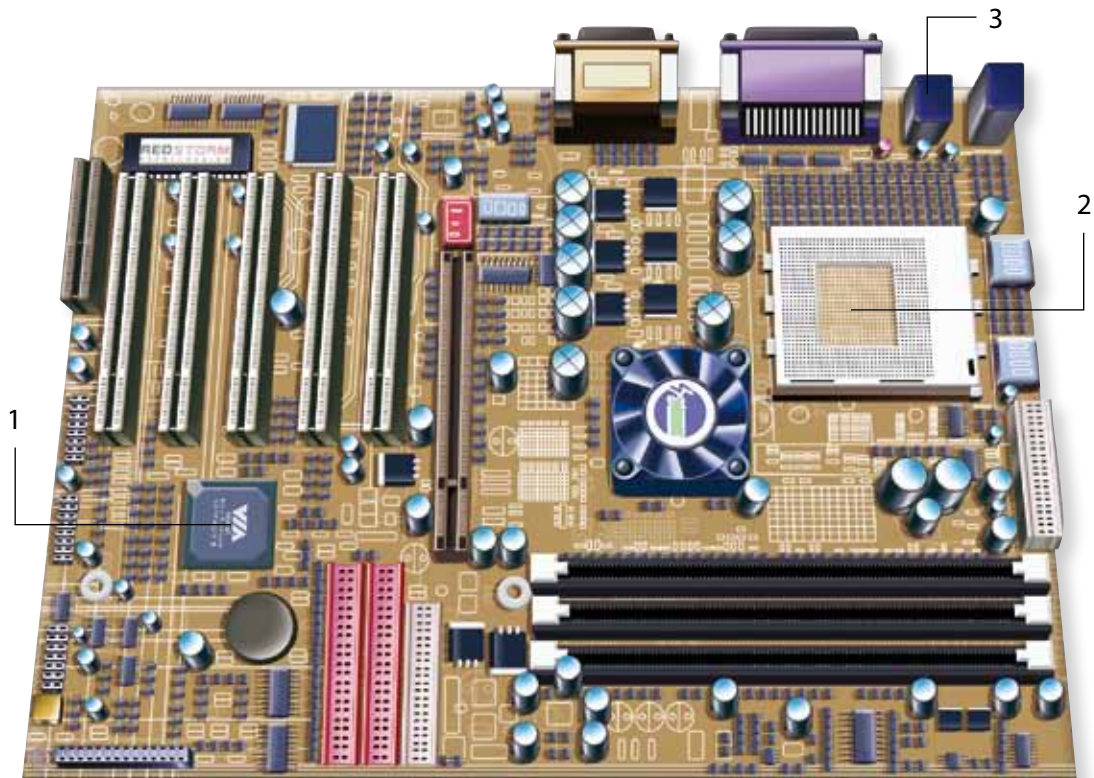
The motherboard acts as a support and means of communication between all the parts of the computer. It is also called the mainboard.

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This is a printed circuit board that provides connections between devices.

The devices are linked to the motherboard in different ways:

- The BIOS and some integrated chips (1) are soldered to the board and cannot be removed.
- The processor is located in the CPU socket (2).
- The peripherals use connections that are accessible from the computer case (3).



The motherboard

## The processor

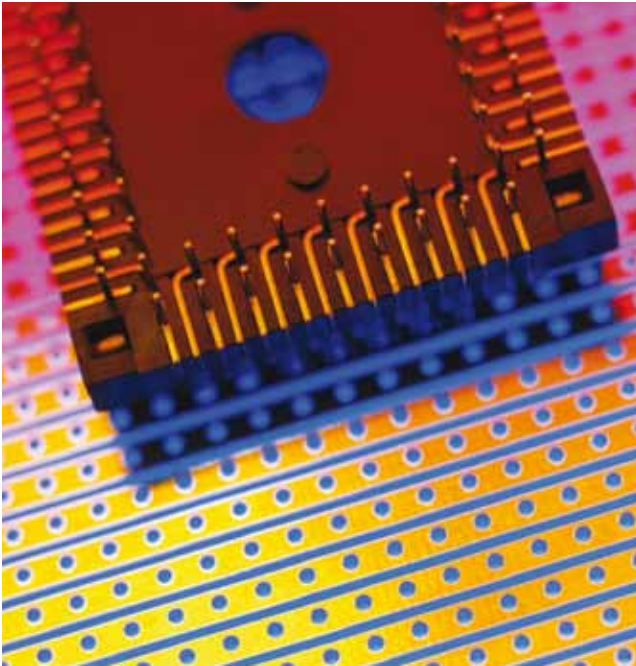
The processor or CPU (Central Processing Unit) is a chip with millions of tiny interconnected transistors. It is like the brain of the computer, controlling all of its activity. It processes input data and delivers output data.

Because it works at a high operating frequency, it gets very hot. However, excessively high temperatures could cause errors in the system and shorten the life of the component parts. To avoid this, there needs to be a heat sink and a fan.

Processors are integrated circuits made of semi-conductive material, generally silicon. This is why the Californian region where the majority of integrated circuit design companies are located is known by the pseudonym "Silicon Valley."

### *Operating frequency*

Programs are formed by a set of instructions.



Microprocessor

The processor executes the program instructions that are loaded onto the memory. The instructions are executed one after another. They follow the order established by the program and the rhythm marked by the clock signal. The processor requires a certain amount of time to execute each instruction. The smaller this amount of time, the more instructions it can execute in a given interval of time.

#### *Processor speed*

This is a colloquial, rather inaccurate term. It is related to the time it takes to run a program and the speed with which the computer responds to the instructions it receives.

#### *Processor frequency*

This is the formal, accurate term. It takes account of the number of basic operations the computer can carry out per second. It is measured in hertz (Hz) or in

any one of its multiples in the International System of Measurements.

A modern standard computer works at a speed of between 1 and 3 GHz.

The execution time of an instruction is measured in clock cycles. The system clock is a device located on the motherboard that records the task rate of the other components, including the processor.

## Memory

The memory is made up of the devices that temporarily store the input data and the instructions the processor is using.

The memory allows basic reading and writing operations to be carried out.

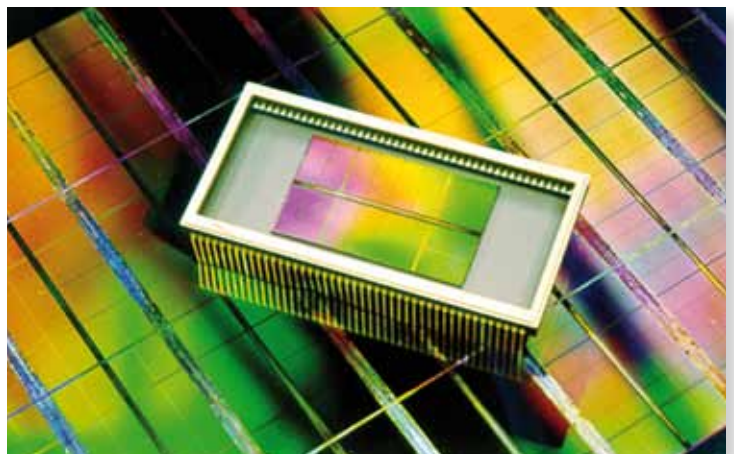
When the processor asks for information (data or instructions), the memory searches for it, stores it, and transfers it to the processor. This information is volatile. If we turn off the computer or there is a power outage, all of the data in the memory will be lost.

When we start to write a new document (for example, with the program OpenOffice.org Writer), the data we generate is only stored in the memory of the computer. To save the data indefinitely, we need to give the order.

### Types

#### • RAM

The RAM (*Random-Access Memory*) contains the computer's main memory reserves. The processor receives the input data and the instructions from the RAM, and saves its results here.



DRAM memory.

It is made up of one or more modules that fit into sockets on the motherboard. If there are any free sockets, the size of the RAM memory can be increased by adding more modules. Modules of RAM use DRAM (*Dynamic Random-Access Memory*) technology. This RAM is dynamic because to keep the data stored, every so often it has to be revised and reloaded.

#### • Cache memory

The cache memory is smaller than the RAM memory. It is integrated into the processor, and it saves a copy of the most frequently used data. As it is integrated into the processor, the access to the memory cache is quicker than the access to the RAM. Modern personal computers have at least 1 MB of cache memory.

The cache memory modules are produced using SRAM (*Static Random-Access Memory*) technology. It is static RAM because it stores data without the information having to be continuously updated.

#### • Virtual memory

Virtual memory technology increases the amount of memory space available. It consists in using the operating system to set aside a certain amount of space on the hard disk for the use of the processor.

The data and program instructions being executed have to be stored in the memory. Therefore, increasing its size allows more programs and data to be administrated at the same time.

All the same, the processor doesn't make use of virtual memory if there is RAM memory available, because accessing the hard disk is much slower. In the context of Web browsing, the cache is a space on the hard disk used by the Web browser to store pages we frequently visit.

When users visit a particular Web several times, they don't need to wait for the page to finish downloading from the Internet, because the computer saves a copy saved on the hard disk.



Memory sockets on a motherboard



DIMM memory modules

#### *Units of measure*

The storage capacity, or size, of the memory is measured in bytes.

**A byte is a group of eight bits (remember a computer stores and works with binary information).**

- the kilobyte (kB), equivalent to  $2^{10}$  B (1,024 B);
- the megabyte (MB), equivalent to  $2^{10}$  kB or  $2^{20}$  B (1,048,576 B);



- the gigabyte (GB), equivalent to  $2^{10}$  MB,  $2^{20}$  kB, or  $2^{30}$  B (1,073,741,824 B);
- the terabyte (TB), equivalent to  $2^{10}$  GB,  $2^{20}$  MB,  $2^{30}$  kB, or  $2^{40}$  B (1,099,511,627,776 B).

The size of the memory of modern personal computers is between 512 MB and 4 GB, approximately. However, hard disks can store up to terabytes worth of information. When we refer to the speed of an Internet connection, we normally use the word mega, meaning “megabits per second”, and not “megabytes per second.”

### *Shared memory space*

The memory space is shared between the operating system and the applications it is executing at any given moment.

Therefore, as well as the operating system, many programs can be loaded in the memory simultaneously. The larger the memory capacity, the more complex the programs that can be run, and the more programs that can be used at the same time.

## BIOS

The BIOS (*Basic Input-Output System*) is a data storage chip that is soldered to the motherboard base.

It contains the first instructions that are executed when the computer is turned on. These are necessary to:

- Check that certain components of the motherboard are working correctly when the computer starts running. This is a booting test called POST (*Power-On Self-Test*).
- Load the available data from storage devices connected to the motherboard (normally the hard disk) to the memory, in order to start up the system.

The BIOS chip is a nonvolatile memory, which saves the data it stores even if the computer crashes. The first BIOS were stored on ROM chips (*Read Only Memory*) and could not be altered by users. Nowadays, however, the current BIOS are flash type, meaning their content can be modified.

## Power supply

The power supply converts the alternating current it receives from the power grid into a continuous current that is used by the motherboard.

In desktop computers, it takes up a considerable amount of space in the computer case.

Laptops incorporate rechargeable batteries. They provide an uninterrupted power supply, even when the computer is unplugged. The most commonly used are made of lithium ion.

## Peripheral devices

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**A peripheral is a device that acts as an interface between the computer kernel and the outside world.**

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**P**eripherals are devices that act as interfaces between the computer kernel and the outside world. They allow the input and output of data. Users can use them to input, see, listen to, save, or print information. Some are installed directly in the motherboard, and are therefore hidden inside the computer case. Others are connected from outside by means of specialized port.

## USB connectors

USBs (Universal Serial Bus) are ports: that is, a type of connection that allows communication between the computer and the peripherals.

USBs were created in 1996 and they quickly became popular. Their most important characteristics are:

- They allow many peripherals to be connected to the same port.
- With a USB, peripherals of low consumption don't need an additional power supply.
- They can be connected and disconnected without having to shut down the system.



USB memory stick

Many devices use USB connectors: keyboards, mice, printers, cell phones, multimedia players, digital cameras, pen drives, PDAs...

When a new device is connected to a USB port, the computer recognizes it and installs it, unless a specific installation program is necessary, which is unavailable.

A key part of the success of devices that link the computer via USB connectors is due to the fact they can be installed without having to restart the system, as long as the corresponding controller (*driver*) is available to the operating system. This function is called *plug-and-play*.

## Nonvolatile storage devices

Nonvolatile storage devices allow to store data for an indefinite length of time. Even when there is no power supply.

However, the speed of writing to these devices is slower than writing to RAM memory. For this reason, they are not used to load programs that are executed by the processor.

Nowadays, there are three main types of nonvolatile storage devices:

- Magnetic hard disks
- Optical disks
- Solid devices, like flash

### *Magnetic hard disks*

**Magnetic hard disks** are devices with a great storage capacity and they can read and write data at a higher speed.

It is for this reason that they are used to store operating systems, programs, and data. They are permanently connected to the computer and act as the main system support. In desktop computers they are found inside the computer case. In laptops, they are located under the keyboard.

External hard drives that connect via USBs are also available. They are generally used to free space on the computer and to make backup copies. The name hard disk was coined in opposition to the old disks, some of which were flexible (*floppy disks*).

The main parts of the hard disk are:

- **Read-and-write heads (1)**

These read and write data on the disk. The majority of hard disks have read-and-write heads on both ends of the disk.

- **Disk platters (2)**

Disk platters are circular media of aluminum or glass covered by a thin layer of magnetic material.

- **Axis (3)**

The disk platters spin around the axis.



Hard disk

### Optical disks

**Optical disks** are circular plastic media covered by a reflective layer.

Optical readers with laser technology are used to read and write on the disks. These readers can be directly connected to the motherboard, located inside the computer case, or connected via USB as external devices. Optical disks can be produced very cheaply. They are also easy to transport and store because independent elements record and read the data. This makes them different to hard disks, where the reader and writer are inseparable. On the other hand, hard disks have a superior speed and storage space.

### Types

- **CD (Compact Disc)**

They have a capacity of approximately 700 MB.

The following types can be distinguished:

- CD-A (*Compact Disc Digital Audio*)

Stores up to 80 minutes of nonwritable audio.

- CD-ROM (*Compact Disc Read Only Memory*)

Stores nonwritable data.

- CD-R (*Compact Disc Recordable*)

Data can only be written once.

- CD-RW (*Compact Disc ReWritable*)

Allows rewriting after all the previous content has been deleted.

- **DVD (Digital Versatile Disc)**

They have a capacity of 4.38 GB or higher.

The following types can be distinguished:

- DVD-ROM (*Digital Versatile Disc Read Only Memory*)

Stores nonwritable data.

- DVD-R y DVD+R (*Digital Versatile Disc Recordable*)

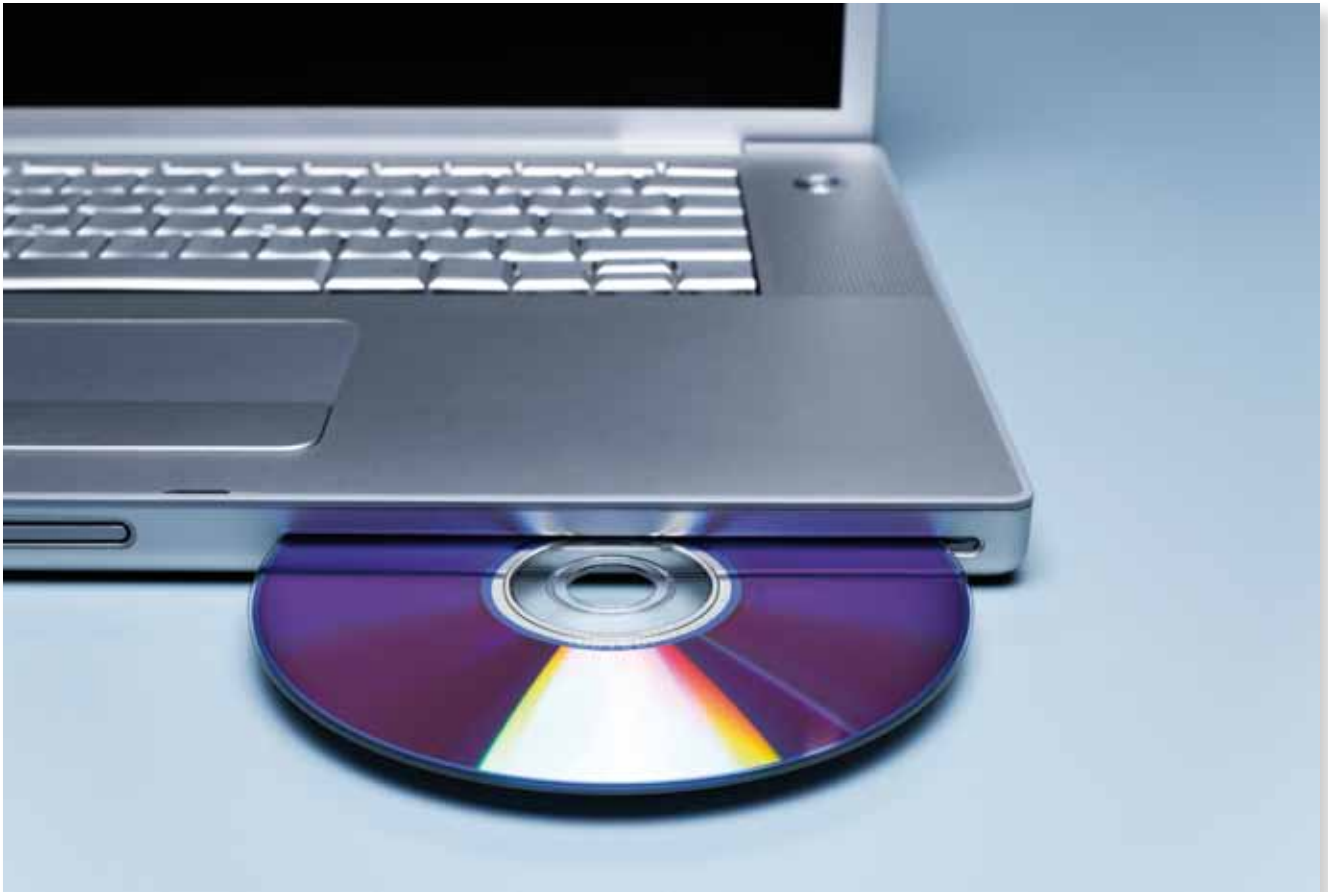
Data can only be written once.

- DVD-RW y DVD+RW (*Digital Versatile Disc ReWritable*)

Allows rewriting after all the previous content has been deleted.

- DVD-RAM (*Digital Versatile Disc Random Access Memory*)

Stores writable data.



#### • **BD (Blu-ray Disc)**

They have a capacity of 23.3 GB or higher.

The following types can be distinguished:

- BD-ROM (*Blu-Ray Disc Read Only Memory*)

Stores nonwritable data.

- BD-R (*Blu-Ray Disc Recordable*)

Data can only be written once.

- BD-RE (*Blu-Ray Disc Rewritable*)

Allows rewriting after all the previous content has been deleted.

*Solid state flash storage devices*



**Solid-state flash drives** use integrated circuits with no mechanical components or disks of any kind to permanently store data.

**Pros**

- They withstand vibrations better.
- They consume less energy and don't get as hot.
- They can read and write data at a higher speed.

**Cons**

- The storage capacity per unit of space is much lower.
- The price per byte is much higher.

*Types*

- **Solid-state drives**

Solid-state drives are flash memory devices designed as alternatives to magnetic hard disks, particularly for ultralight laptops. Their shape and connections are often identical to those of conventional hard disks. They typically have a capacity of a few tens of gigabytes.

- **USB flash drives**

USB flash drives are devices that use the same technology as flash drives. They are designed to be connected to the computer via USB. USB connections limit the speed of reading and writing, but they are still faster than using an optical disk. These devices are small and very easy to use, making them ideal for transferring files from one computer to another.

They typically have a capacity of tens of gigabytes.

USB flash memory drives are commonly known as pen drives, memory sticks, etc.

- **Flash memory cards**

Flash memory cards are designed for digital cameras and cell phones. They don't have USB connections but most computers have devices that can read their content. They typically have a capacity of around one gigabyte.

**Scanners and printers**

**Scanners** are devices that enable us to transfer content on paper to computers.

One of their principal variables is the maximum resolution of image that they can scan. This characteristic of images is traditionally measured in ppi; that is, "pixels per inch."

**Printers** are devices that enable us to transfer content on computers to paper.

There are two types of printers:

- **Inkjet printers**

- They are not expensive.
- They are designed for color printing.
- They use ink cartridges.

- **Laser printers**

- They are expensive.
- They are designed for grayscale printing (although some can print in color).
- They use toner.



## Monitor

The **monitor** is the main device that allows visual communication between the computer and the user.

Until only a few years ago all monitors communicated with the video card of the computer via SVGA (Super Video Graphics Array) and the corresponding VGA connectors. This analog system was useful with old monitors, but became a problem with the appearance of modern TFT (Thin Film Transistor) monitors that work with digital data.

Recently DVI (Digital Visual Interface) connectors have been developed to transfer digital data. This means modern monitors can process the data without having to convert them from analog to digital, and without the resulting loss of quality.

In general terms, an **analog signal** reproduces what it tries to represent (in this case, an image), whereas a **digital signal** codes its essential information.

Wall clocks are analog, as they reproduce the passing of time by moving their clock hands, whereas digital clocks code time numerically.

### *Characteristics*

#### **Pixel**

A pixel is the smallest unit that makes up the image on a screen. It has a particular color and intensity. The higher the number of pixels on a screen of a given size, the more detailed the full-screen image will be.

#### **Maximum resolution**

The screen resolution is defined by the product of the number of pixels in a column by the number of pixels in a row. A screen which works at a resolution of 800 × 600 has 480,000 pixels. The maximum resolution of a screen indicates the maximum number of pixels it can display, and therefore, the size of the largest full image it is capable of showing. If necessary, screens can be configured at resolutions lower than the maximum.

#### **Display aspect ratio**

The aspect ratio of a screen is expressed as the simplified quotient of the number of pixels in its width divided by the number of pixels in its height. A screen with an aspect ratio of 1:1 is square. Rectangular monitors have a classic aspect ratio of 4:3 or a panoramic aspect ratio of 16:9.



## Size

The length of the diagonal line across the screen indicates its size. The measurement is usually expressed in inches (one inch is equivalent to 25.4 mm). Ultralight laptop screens usually have 9-inch screens. If we combine the screen size with the display aspect ratio, we will be able to calculate the height and the width of the screen in inches.

## Mouse

**The mouse is a device that allows the user to move the cursor across the screen and give the computer instructions.**

The mouse usually has two side buttons and a central wheel. Instead of a mouse, laptops have a different device, called a *touchpad* or *trackpad*, built into their casing. The movement of a finger over its surface transmits a signal to the cursor.

The most common actions carried out with the mouse, and its most common uses (configurable in some systems) are:

- **Pointing**

Moving the mouse. To place the cursor over an icon or menu.

- **Single left-click**

Pressing the left button once. To select an icon or menu.

- **Double left-click**

Pressing the left button twice in a row. To activate an icon or menu.

- **Right click**

Pressing the right button once opens the context menu with a list of options.

- **Click and drag**

Pressing the left button and moving the mouse simultaneously. To move an icon or window across the screen, or to select text or a group of icons.

- **Scroll**

Turning the wheel in the center. To slide the content of a window in a vertical direction or to change the view-size in applications by zooming.



## Expansion cards

Expansion cards are devices that improve the functionality of computers by allowing peripheral hardware to be added.

We can highlight two elements:

- **Additional connectors**

These allow new peripherals to be connected to the computer.

- **Integrated circuits**

These help the processor to administer connected peripherals. They can be specialized in performing certain types of calculations.

#### *Types*

- **Video cards**

Tasks: video capture, television tuning and output, 2D and 3D video acceleration etc.

Video cards generate images that are displayed on the monitor or on similar analog devices, which are also connected to the card.

- **Sound cards**

Tasks: recording, the reproduction and synthesis of sound.

Sound cards have specialized connectors:

- Pink, for the analog audio input of microphones.
- Blue, for the analog audio input of sound reproducers that are more powerful than microphones.
- Green, for the analog audio output of front speakers.
- Black, for the analog audio output of rear speakers.
- DA-15, for connecting videogame *joysticks* or MIDI devices.

- **Network cards**

Tasks: connecting to the communication network.

The card must be appropriate for the network that is being accessed:

- Electrical network  
*Ethernet* with an electrical interface.
- Optical network  
*Wireless* network
- Wireless network  
*Wi-Fi* with a radio interface.

## Keyboard

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**The keyboard is a device that allows the input of commands or data to the computer via buttons called keys.**

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There are different types of keyboards. The most widely used in Spain is the IBM/Windows with 105 keys.

The keys form the following groups:

- **Multimedia keys**

Not all keyboards have these keys. They give direct access to applications, such as a email clients or a Web browser. They control the volume, audiovisual playing, etc.

- **Function keys**

They provide quick access to particular functions of each application.

Common functions include:

- <F1> To open the help menu.
- <F2> To change the name of a file.
- <F3> To open the Windows search function.
- <F4> To open the browser address bar.



- <F5> To update the browser window.
- <F6> To move between the elements of a window.
- <F7> To check the spelling in a word processor.
- <F10> To select the menu bar.
- <F11> To see the screen in full screen mode.

### • Editing keys

Among other things, these keys control the cursor in word processing applications.

- <Imp Pant> (Print Screen) To take screen shots.
- <Pausa> To pause the execution of some programs.
- <Ins> To activate or deactivate insert mode.
- <Inicio> (Start) To go to the start of the line.
- <RePág> (Previous Page) To go to the previous page.
- <Supr> (Delete) To delete characters after the cursor.
- <Fin> (End) To go to the end of the line.
- <AvPág> (Next Page) To go to the next page.
- <↑>, <←>, <↓>, <→> To move the cursor up, down, right, or left.



### • Alphanumeric keys

These allow alphanumeric characters to be entered into programs that accept them.

### • Number keys

These allow numbers to be inserted.

These keys have a second function when they are used in combination with the <Shift> key. Some even have a third function when used in combination with <Alt Gr> key or the <Ctrl> and <Alt> keys.

### • Alphabetic keys

### • Punctuation keys

### • Control keys

### • Number blocking keys

These allow us to enter numbers.

These keys have a second function when they are used in combination with the <Shift> key or are used with the <Bloq Num> deactivated:

- <0> To activate or deactivate insert mode.
- <.> <.> To delete characters after the cursor.
- <1> To go to the end of the line.
- <2> To go to the line below.
- <3> To go to the next page.
- <4> To move towards the left.
- <6> To move towards the right.
- <7> To go to the beginning of the line.
- <8> To go to the line above.
- <9> To go to the previous page.

The distribution of the keys or *layout* on Spanish keyboards (inherited from the North American system) is known as QWERTY. There are different types of key distribution: QWERTZ is used in German-speaking countries, and AZERTY is used in French-speaking countries. All of these names have come from the first six letters on the left hand side of the top row of keys.

