- Memory, such as RAM, ROM, Cache, and Flash
- Ports
- Expansion Slots

- Secondary Storage, such as hard disk drives, CD-ROMs, etc.
- Input / Output Devices
- Communications Devices

1.4.1 The System Unit

The **Motherboard** is the main circuit board for the computer, containing both soldered, nonremovable components along with sockets or slots for components that can be removed. The motherboard holds the CPU, RAM and ROM chips, etc.

The **Central Processing Unit (CPU)** is the "brain" of the computer. It executes instructions (from software) and tells other components what to do.

- The Intel Pentium is a popular processor for IBM-PCs.
- The PowerPC is a popular processor for Macintoshes.
- There are 2 parts of the CPU: The ALU and Control Unit.
- The **Arithmetic Logic Unit (ALU)** performs arithmetic operations (such as addition and subtraction) and logical operations (such as comparing two values).
- An optional **math co-processor** can take the place of the ALU. It performs the same operations, only it is faster.
- The **Control Unit** deciphers and carries out instructions.
- Different CPUs have different types of instructions, so software made for one type of CPU will not run on other kinds.
- The **word size** denotes how many bits of data a CPU can process at once. 32 bits is the standard word size for CPU's used in personal computers today. The higher the word size, the faster a CPU can execute instructions.

The **System Clock** is an "electrical pulse generator" that sends out a pulse of electricity at regular intervals. The electronic components of the computer need these electric pulses in order to perform work. The more pulses sent out by the system clock, the faster the computer. The first personal computers had clock speeds

of 8 MHz (8 million pulses per second); today's PC's have clock speeds greater than 3.2 GHz (3.2 billion pulses per second).

- **Bus Lines** are "electrical data roadways" (i.e. wires) through which bits of information are transmitted between the CPU and other components. The **bus size** denotes how many bits can be transmitted at once. In general, this should be the same as the CPU word size.
- **Memory Chips**
  - **Random Access Memory (RAM)**, also known as Main Memory or Primary Storage, is used to hold instructions *and* data *while they are being used*. RAM is volatile, meaning its contents are lost when the power goes off. RAM is more than 1000x faster than the fastest secondary storage (see below).
  - **Cache** memory is special high-speed memory that temporarily stores instructions and data the CPU is likely to use frequently. This speeds up processing. Level 2 or external caches generally range in size from 64 Kilobytes to 2 Megabytes.
  - **Read Only Memory (ROM)** chips are non-volatile memory that generally contains instructions for "booting" the computer (i.e. loading the operating system when th computer starts up).
  - **CMOS** chips are powered by a battery and contain so-called "flexible information" such as the type of hard drive your computer is using and the current date and time.
  - **Flash** chips do not require electricity or a battery yet are non-volatile. They are used in computers, cell phones, digital cameras, etc.
- **Expansion Slots** are sockets on the motherboard that you can plug *expansion cards* into. To plug a card into a slot, you must open the system unit. A card contain a socket on its end that sticks out from the system unit so a cable can be plugged into it. Common types of cards are graphics, sound, and network cards.
- **Ports** are sockets that are on the outside othe system unit, meaning you can easily plug a cable into a port without opening the system unit.
  - **Serial** ports transmit one bit of data at a time.
  - **Parallel** ports transmit 8 bits of data at a time.
  - **Universal Serial Bus (USB)** ports are *much* faster than serial or parallel ports and allow multiple devices to be connected to the same port.

1.4.2 Secondary Storage

Devices that "permanently" hold data and information (i.e. programs).

Non-volatile memory; when the power goes off, contents are still saved(unless there is an error).

Used to store instructions *and* data *while they are **not** being used.*

A **floppy disk** is a removable (i.e. portable) platter made of mylar plastic that is magnetized. Bits of information are stored in concentric rings called **tracks** on either side of the platter. The current floppy disk standard is a 3 1/2" platter in a hard plastic case that holds 1.44 Megabytes of information. A **Zip** disk, on the other hand, can hold up to 250 Megabytes.

A **hard disk** is similar to a floppy disk but uses metal platters to store information. Hard disks are not only much faster than floppy disks but can hold huge amounts of data (hundreds of gigabytes).

Both floppy and hard drives use a **read/write** head, which is basically a magnet, to read/write information from/to tracks on a platter. In a hard drive, the read/write head and platter(s) are enclosed together in an air-tight package, making hard drives less susceptible to damage. The read/write head hovers above the platter but should not touch it. If touched, the platter can be damaged, resulting in the loss of some or all the data on the platter. This is known as a *head crash*.

Magnetic tape is used mostly for backups. These are very slow because you have to fast forward or rewind to the right spot. However, they are very reliable.

Optical discs use optical technology (i.e. lasers) instead of magnetic technology to store information.

- **CD-ROM** stands for Compact Disc - Read Only Memory.
- **CD-R** stands for Compact Disc - Recordable and can be written to only once. (Also known as **CD-WORM**: Compact Disc - Write Once, Read Many.)
- **CD-RW** stands for Compact Disc - Re-writeable (or Read/Write).
- **DVD-ROM** stands for Digital Versatile Disc - Read Only Memory.
- **DVD-R** stands for Digital Versatile Disc - Recordable and can be written to only once. (Also known as **DVD-WORM**: Digital Versatile Disc - Write Once, Read Many.)
- **DVD-RW** stands for Digital Versatile Disc - Re-writeable (or Read/Write).
- CD's can hold approximately 650 Megabytes of data while DVD's can hold up to 17 Gigabytes.

1.4.3 Input / Output Devices

Input devices translate data into a form the computer can understand.

- The **keyboard** is the most common input device, but this type of data entry is very slow and error-prone.
- **Direct input** devices are much faster and less error-prone.
  - **Pointing devices** such as the *mouse*, *trackball*, and *touchpad* allow you to manipulate a cursor on the screen.
  - **Scanning devices** read data directly. For example, *OMR* (*Optical Mark Recognition*) devices (such as a scantron machine) can sense marks on paper. Even more advanced are *OCR* (*Optical Characgter Recognition*) devices, which attempt to read letters. *Bar Code Readers* are often used in grocery stores (i.e. with the UPC - Universal Product Code system) to scan items.

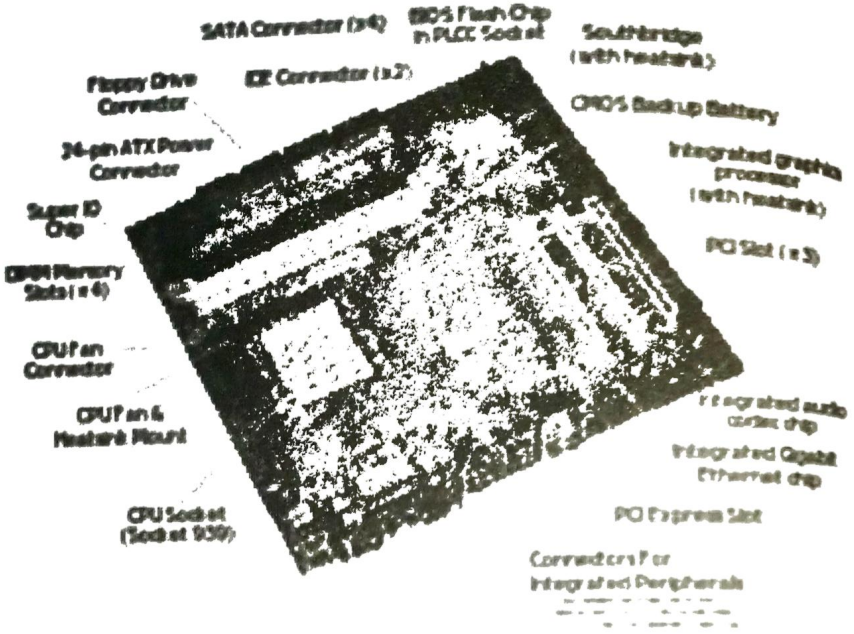
- **Output** devices translate information into a form humans can understand.
  - The **Monitor** (or Display Screen) is the most common type of output device. It produces *softcopy* (i.e. temporary) output on a screen.
  - The **Printer** is the most second most common type of output device. It produces *hardcopy* (i.e. "permanent") output on paper.
    - A **Laser Printer** uses a photoelectric drum and powdered ink, similar to a copying machine, to produce output.
    - An **Inkjet Printer** produces output by spraying droplets of liquid ink onto the paper from small nozzles. It is the most common type of printer in use today and is generally very inexpensive.

1.4.4 Communications Devices

- These allow your computer to send/receive data to/from other computers.
- A **modem** sends information over a phone line. Modems are slow and susceptible to problems such as phone line static.
- A **network card** sends information over a network cable. These can be used to hook up a computer to a local area network (LAN) or to an Internet Service Provider via a cable modem or DSL (for Internet access).

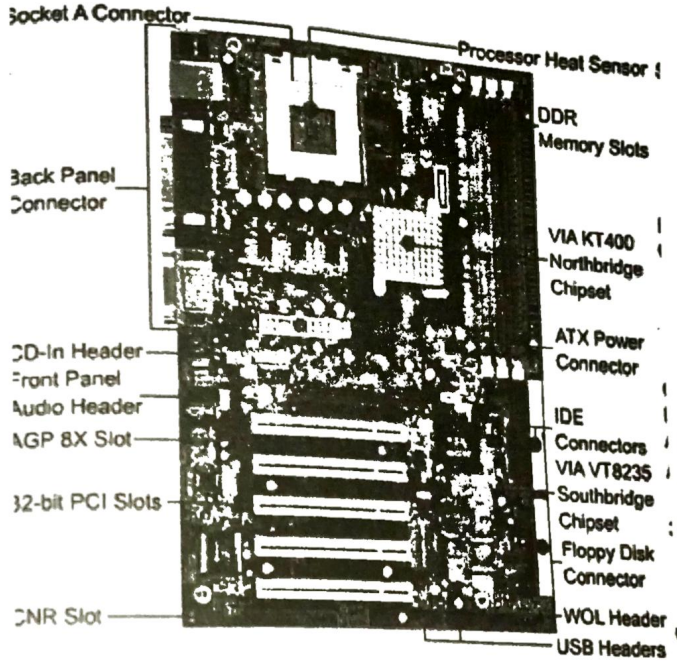
1.5. Motherboard

A **motherboard** (sometimes alternatively known as the **mainboard, system board, planar board** or **logic board**, or colloquially, a **mobo**) is the main printed circuit board (PCB) found in computers and other expandable systems. It holds and allows communication between many of the crucial electronic components of a system, such as the central processing unit (CPU) and memory, and provides connectors for other peripherals. Unlike a backplane, a motherboard contains significant sub-systems such as the processor and other components.



Motherboard for an Acer desktop personal computer.

Motherboard specifically refers to a PCB with expansion capability and as the name suggests, this board is often referred to as the "mother" of all components attached to it, which often include sound cards, video cards, network cards, hard drives, or other forms of persistent storage: TV tuner cards, cards providing extra USB or FireWire slots and a variety of other custom components (the term *mainboard* is applied to devices with a single board and no additional expansions or capability, such as controlling boards in televisions, washing machines and other embedded systems).



A motherboard provides the electrical connections by which the other components of the system communicate. Unlike a backplane, it also contains the central processing unit and hosts other subsystems and devices.

A typical desktop computer has its microprocessor, main memory, and other essential components connected to the motherboard. Other components such as external storage, controllers for video display and sound, and peripheral devices may be attached to the motherboard as plug-in cards or via cables, in modern computers it is increasingly common to integrate some of these peripherals into the motherboard itself. An important component of a motherboard is the microprocessor's supporting chipset, which provides the supporting interfaces between the CPU and the various buses and external components. This chipset determines, to an extent, the features and capabilities of the motherboard.

Modern motherboards include:

- Sockets (or slots) in which one or more microprocessors may be installed. In the case of CPUs in ball grid array packages, such as the

VIA C3, the CPU is directly soldered to the motherboard.

- Slots into which the system's main memory is to be installed (typically in the form of DIMM modules containing DRAM chips)
- A chipset which forms an interface between the CPU's front-side bus, main memory, and peripheral buses
- Non-volatile memory chips (usually Flash ROM in modern motherboards) containing the system's firmware or BIOS
- A clock generator which produces the system clock signal to synchronize the various components
- Slots for expansion cards (the interface to the system via the buses supported by the chipset)
- Power connectors, which receive electrical power from the computer power supply and distribute it to the CPU, chipset, main memory, and expansion cards. As of 2007, some graphics cards (e.g. GeForce 8 and Radeon R600) require more power than the motherboard can provide, and thus dedicated connectors have been introduced to attach them directly to the power supply.
- Connectors for hard drives, typically SATA only. Disk drives also connect to the power supply.

Additionally, nearly all motherboards include logic and connectors to support commonly used input devices, such as PS/2 connectors for a mouse and keyboard. Early personal computers such as the Apple II or IBM PC included only this minimal peripheral support on the motherboard. Occasionally video interface hardware was also integrated into the motherboard; for example, on the Apple II and rarely on IBM-compatible computers such as the IBM PC Jr. Additional peripherals such as disk controllers and serial ports were provided as expansion cards.

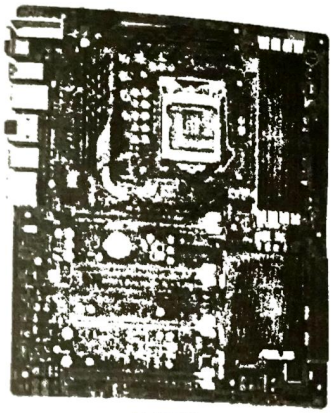
Given the high thermal design power of high-speed computer CPUs and components, modern motherboards nearly always include heat sinks and mounting points for fans to dissipate excess heat.

There are two chips on the motherboard which are known as South Bridge and North Bridge. The South Bridge and North Bridge are what manages what goes on within the computer and also helps the communication between multiple devices and chips. The North Bridge is responsible for communications between the CPU interface, the memory and many video

processes, whereas, the South Bridge communicates with all the remaining devices. The North Bridge is directly connected with the CPU, RAM and graphic controller, so it acts as a bridge for the South Bridge chip to communicate with these components.

Types of Motherboard

1.ATX



ATX

Features of ATX

- the size of ATX motherboards is generally around 12" x 9.6"
- can be easily build with a full-tower or mid-tower
- has plenty of heat sinks
- opportunity to use multiple graphics cards as ATX motherboards
- has 4 DIMM slots supporting dual or quad-channel memory
- plenty of expansion slots for video cards, sound cards, SATA ports, fan headers, and other adapters.

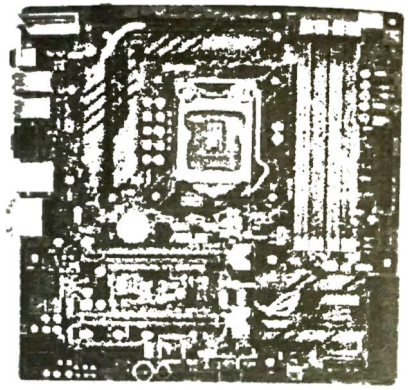
Pros

- IO section has plenty of ports
- Ideal for multi-GPU setups
- Room for expansion

Cons

- Not ideal for small PC cases
- A little expensive than smaller motherboards

2. Extended ATX (EATX)



XL-ATX

Features of XL_ATX

- these are the largest motherboards
- has dimensions around 13″ x 10.4″.
- support multiple PCIe slots
- support a multi-GPU setup for gaming
- offers a few extra expansion slots and RAM slots

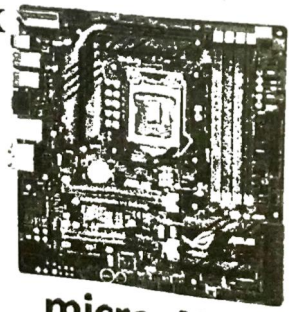
Pros

- Has more RAM slots
- Ideal for full-tower builds

Cons

- Expensive
- Not compatible with standard size PC cases

4. Micro ATX (mATX



micro-ATX

Features of micro-ATX

- Smaller than ATX
- Has only 2 RAM slots and fewer PCIe slots
- a few lesser ports
- more affordable cost
- support similar hardware components with ATX

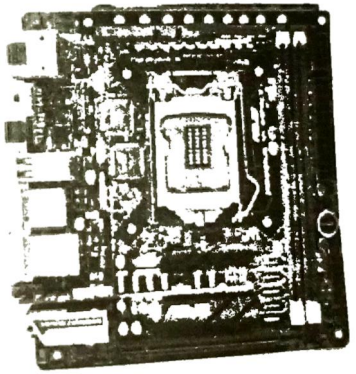
Pros

- Less pricey than larger models
- Ideal for smaller builds
- Also compatible with ATX cabinets

Cons

- Fewer expansion slots
- Not an ideal option for high overclocking

5. Mini-ITX



mini-ITX

Features of mini-ITX

- mini-ITX boards are actually the smallest motherboards
- Supports standard-sized hardware components
- size of these motherboards is generally around 6.7″ x 6.7″,
- has little VRM section, fewer heat sinks and 2 RAM slots
- use 4 pin power connectors

- they are cheap, and can fit easily inside a small-sized PC case.

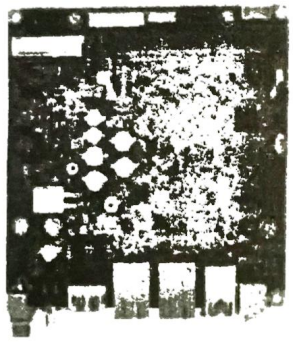
Pros

- Can help you build a compact PC build
- Can work with standard-sized hardware components
- Fit for small cabinets

Cons

- Limited VRM performance and Heatsinks
- Not a good choice for overclocking

6. Nano-ITX



NANO-ITX

Features of Nano-ITX

- smaller motherboards than the mini-ITX ones,
- measuring around 4.7″ x 4.7″
- consume very low power
- limited and only work with specific hardware components
- used to build small computers ideal for smart entertainment purposes like PVRs, smart TVs, or automation purposes.

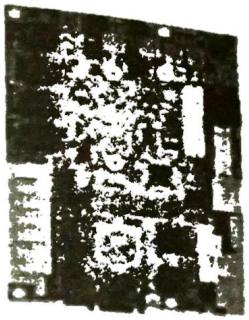
Pros

- Affordable
- Compact

Cons

- Not compatible with all types of standard PC components

7. Pico-ITX



Pico-ITX

Features of Nano-ITX

- around 3.9″ x 3.9″ and are smaller than the nano-ITX motherboards
- having lesser slots and features
- used in devices designed for IoT and automation purposes
- the power consumption is quite low
- can be implemented easily in industrial automation devices

Pros

- Ideal for small IoT devices
- Less complicated to use

Cons

- Compatible with a limited range of hardware

1.5.1 CPU sockets

A CPU socket (central processing unit) or slot is an electrical component that attaches to a Printed Circuit Board (PCB) and is designed to house a CPU (also called a microprocessor). It is a special type of integrated circuit socket designed for very high pin counts. A CPU socket provides many functions, including a physical structure to support the CPU, support for a

heat sink, facilitating replacement (as well as reducing cost), and most importantly, forming an electrical interface both with the CPU and the PCB. CPU sockets on the motherboard can most often be found in most desktop and server computers (laptops typically use surface mount CPUs), particularly those based on the Intel x86 architecture. A CPU socket type and motherboard chipset must support the CPU series and speed.

1.5.2 Integrated peripherals

With the steadily declining costs and size of integrated circuits, it is now possible to include support for many peripherals on the motherboard. By combining many functions on one PCB, the physical size and total cost of the system may be reduced; highly integrated motherboards are thus especially popular in small form factor and budget computers.

- Disk controllers for a floppy disk drive, up to 2 PATA drives, and up to 6 SATA drives (including RAID 0/1 support)
- integrated graphics controller supporting 2D and 3D graphics, with VGA and TV output
- integrated sound card supporting 8-channel (7.1) audio and S/PDIF output
- Fast Ethernet network controller for 10/100 Mbit networking
- USB 2.0 controller supporting up to 12 USB ports
- IrDA controller for infrared data communication (e.g. with an IrDA-enabled cellular phone or printer)
- Temperature, voltage, and fan-speed sensors that allow software to monitor the health of computer components.

1.5.3 Peripheral card slots

A typical motherboard will have a different number of connections depending on its standard and form factor. A standard, modern ATX motherboard will typically have two or three PCI-Express 16x connection for a graphics card, one or two legacy PCI slots for various expansion cards, and one or two PCI-E 1x (which has superseded PCI). A standard EATX motherboard will have two to four PCI-E 16x connection for

graphics cards, and a varying number of PCI and PCI-E 1x slots. It can sometimes also have a PCI-E 4x slot (will vary between brands and models).

Some motherboards have two or more PCI-E 16x slots, to allow more than 2 monitors without special hardware, or use a special graphics technology called SLI (for Nvidia) and Crossfire (for AMD). These allow 2 to 4 graphics cards to be linked together, to allow better performance in intensive graphical computing tasks, such as gaming, video editing, etc.

Motherboards are generally air cooled with heat sinks often mounted on larger chips, such as the Northbridge, in modern motherboards. Insufficient or improper cooling can cause damage to the internal components of the computer, or cause it to crash. Passive cooling, or a single fan mounted on the power supply, was sufficient for many desktop computer CPU's until the late 1990s; since then, most have required CPU fans mounted on their heat sinks, due to rising clock speeds and power consumption. Most motherboards have connectors for additional case fans and integrated temperature sensors to detect motherboard and CPU temperatures and controllable fan connectors which the BIOS or operating system can use to regulate fan speed. Alternatively computers can use a water cooling system instead of many fans.

Some small form factor computers and home theater PCs designed for quiet and energy-efficient operation boast fan-less designs. This typically requires the use of a low-power CPU, as well as careful layout of the motherboard and other components to allow for heat sink placement.

Motherboards use electrolytic capacitors to filter the DC power distributed around the board. These capacitors age at a temperature-dependent rate, as their water based electrolytes slowly evaporate. This can lead to loss of capacitance and subsequent motherboard malfunctions due to voltage instabilities. However, many manufacturers deliver substandard capacitors, which significantly reduce life expectancy. Inadequate case cooling and elevated temperatures easily exacerbate this problem. It is possible, but time-consuming, to find and replace failed capacitors on personal computer motherboards.

1.6 Processor

The processor is also known as the CPU which stands for Central Processing Unit and the Heart of the computer system which controls everything. The CPU is what functions most of your electronic products. What the CPU does is carry out most of the data processing by accepting input data and processing the data and then sending the information to the components that needs this information to carry out the action. In other words the CPU is what performs the commands and the CPU manages each command separately, even though the CPU is capable of processing multi commands in matter of seconds. This will all depend on how powerful your processor is because the more powerful it is, the faster your CPU can process commands.

How the Processor works?

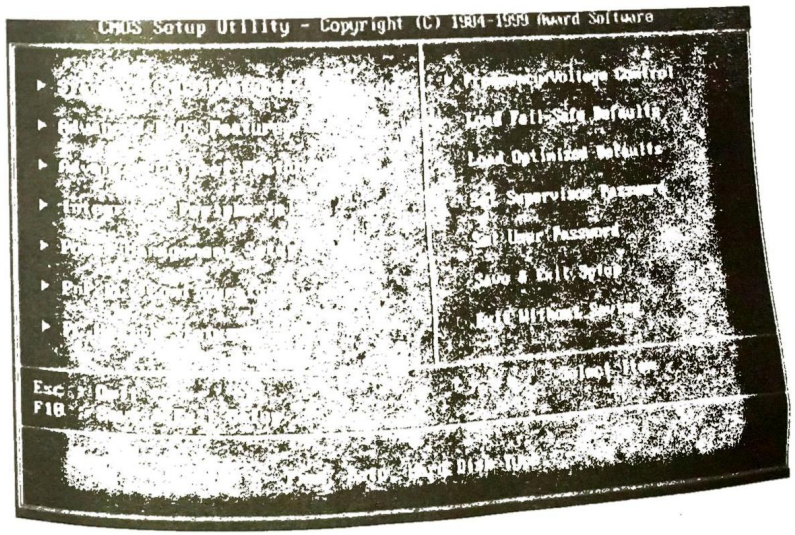
If you double click on an icon to run a program, the program that is stored inside the hard disk drive will get transferred to the RAM Memory. Using a circuit called memory controller, the CPU loads the program data from the RAM memory. Once the CPU has loaded the program data it will then get processed inside of the CPU. What happens next totally depends on what instructions are inside the program, as a program is a series of instructions for the CPU. The processed data may have instructions inside the program which tell the CPU to display certain information on the screen such as opening up word processor or a game.

1.7. BIOS

BIOS stand for Basic Input / Output System which allows the software and hardware to interact with one another. The BIOS is usually found on a ROM chip which comes with the computer and it is called the ROM BIOS. For starters let me explain what the BIOS do. The first thing that the BIOS do when you start your computer system is that it identifies all the system devices and makes sure that they are all in working order.

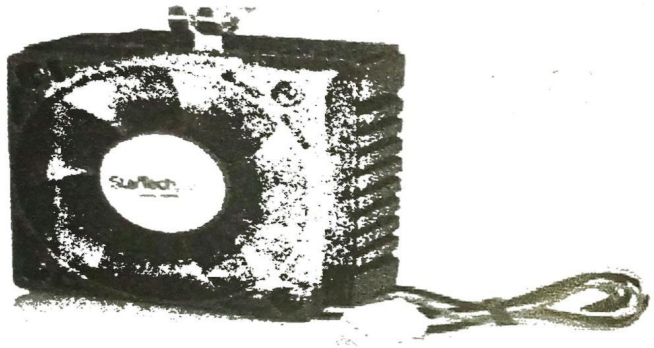
As the BIOS are on the ROM it is not affected by power failure and it also makes it possible for the computer to boot itself. So what the BIOS actually do is it boots up the PC such as starting up the computer system whenever it is turned On by the user. The BIOS then the actual hardware configurations are checked against the configuration data. It makes sure of the reliability of the computer system and proves to be the most important diagnostic tool available to you. The BIOS also allows the operating system to use particular features of hardware within the configuration by managing the input and output of the computer.

Bios communicate using a process called "POST". POST is like a test that runs as soon as you start your Computer System. What the POST does is it checks that all your hardware is functioning as it is designed to, and this takes place before the BIOS starts to boot up. The POST test is so fast that sometimes we wouldn't even realise it happened unless it detects a problem. If the POST test detects any faults then you will hear a beep sound



1.8 Fan and Heat Sink or Cooling

Heat sink is a device that is attached to the processor chip which serves a purpose to draw heat from the processor to make sure that the temperature of the processor is down. The heat sinks are made of an aluminium alloy and have fins to maximise the heat that is sucked in by the heat sink.
A Cooling Fan is a small fan that is fitted on to the heat sink to prevent it from overheating. So in other words most computer systems have a heat sink and a cooling fan together where they both work together to prevent components from overheating. So when the heat sink sucks in the heat, the air flow produced by the fan will lower the temperature of the heat sink in order to prevent it from overheating.



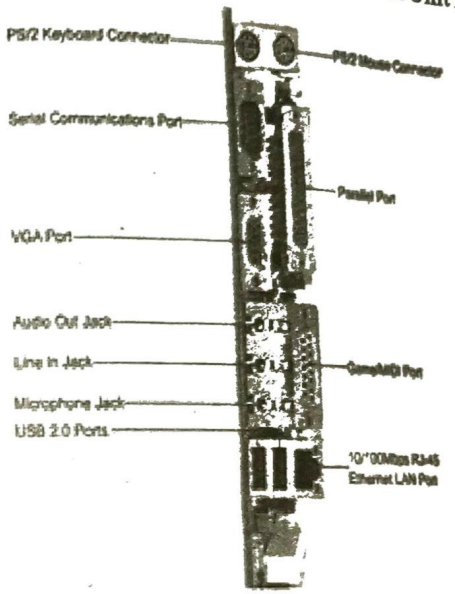
As certain components overheat it is necessary to have a heat sink and fan into to cool down the temperature of the components. It is important to prevent components overheating due to the fact that it can affect other components around it and that will those components around it will get damaged.

1.9 Ports

The functions of ports are to allow peripheral devices to connect to the computer. There are a variety of ports that are found on the back of the system unit in order to connect a range of peripherals to connect to the processor. Two types of Ports can be found on the system unit: Serial Port and a Parallel Port.

Serial Port: is an interface that can be used for serial communication. A Serial port only transmits 1 bit at a time and the cable is usually circular.

Parallel Port: Parallel Port allows the user to use devices side by side. Printers, USBs are all examples of peripherals that use Parallel Ports. These ports are used to transfer data from a peripheral device to the computer. Serial communication is done through a transmitter which then sends data to a receiver using a single communication. These types of methods are really suitable for transferring or sending and receiving data over a long distance. How do the ports on the System Unit look?



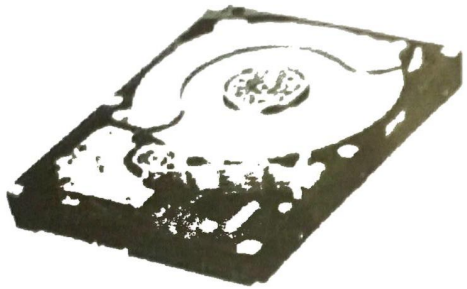
1.10 Hard Drive Configuration and Controllers

The most commonly used type of Hard Disk Drive controllers are SATA, IDE can also be used but are not used a lot. The hard drive for a computer can be located within the processor box and they are IDE devices which are controlled by an IDE controller. There are two types of IDE controllers: Primary and Secondary. The hard drive will be attached to the primary IDE controller, whereas, a CD drive will be attached to a secondary channel on the motherboard. Each IDE ribbon that is connected to any one of these controllers can support two drives. Each drive will be identified as either the master or the slave drive in order to know which data relates to which drive. This allows both devices to communicate with one another such as

by transferring data. If the Slave Drive wanted to transfer data it would have to communicate to the Master Drive and wait for a response whilst the Master Drive communicates with the computer and then the Slave Drive will get informed when it can transfer the data.

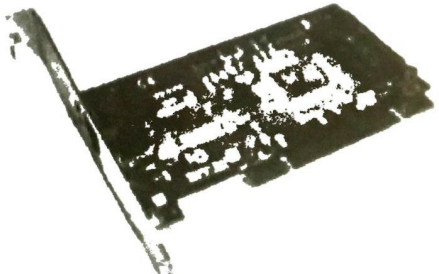
Master Drive: A Master Drive is what manages all the traffic on the IDE cable. A Master Drive's controller saves its own data and passes on data to the slave drive.

Slave Drive: The Slave Drive can only see the data that has been passed on to it by the Master Drive. There will be no slave drive if there is only one drive connected to the cable.



1.11 Specialised cards

The main function of a ***Network card*** is to provide a physical link to a computer network which allows the computers to communicate with the servers. Each and every Network Interface Card has a unique serial number, which is called a MAC address. Every computer that is connected to a network has to have a unique MAC Address. How a Network card works is by sending an electrical or radio signals to each other using an agreed upon MAC protocol and network cards can either be wired or wireless.



The main function of a ***Graphics card*** is to allow computers to produce graphics and images quickly with better detail. The Graphics card has its own Processor called the GPU which accelerates the speed of the process. Usually graphics cards will have its own cooling system as it heats up due to the amount of power it uses. The way Graphics card communicates is by sending data to the CPU on the motherboard. Then the data is sent to the graphics card where it gets converted into images and ready to be displayed on the monitor.