

## Chapter 3: Computer Hardware Components

### 3.1 Introduction:

The term computer hardware refers to the physical components of a computer, namely Keyboard, Monitor, Mouse and Printer including the digital circuitry. Computer hardware is an integral part embedded in all modern day automobiles, microwave ovens, electrocardiograph machines, compact disc players and other devices. The hardware of a computer is not changed frequently, in contrast with software and data. The present computers are much advanced in terms of processing speed and have an efficient memory structure. The present lesson aims at providing an insight into the hardware concepts of a Computer System.

### 3.2 Central Processing Unit (CPU):

CPU is the abbreviation for *central processing unit*. Sometimes referred to simply as the *central processor*, but more commonly called *processor*, the CPU is the brains of the computer where most calculations take place. In terms of computing power, the CPU is the most important element of a computer system.



On large machines, the CPU requires one or more printed circuit boards. On personal computers and small workstations, the CPU is housed in a single chip called a *microprocessor*. Since the 1970's the microprocessor class of CPUs has almost completely overtaken all other CPU implementations. A microprocessor is a semiconductor chip, which is manufactured using the Large Scale integration (LSI) or Very Large Scale Integration (VLSI), which comprises Arithmetic Logic Unit, Control unit and Central Processing Unit (CPU) fabricated on a single chip. Intel 8088, Motorola 68000 are few microprocessors.

The CPU itself is an internal component of the computer. Modern CPUs are small and square and contain multiple metallic connectors or pins on the underside. The CPU is inserted directly into a CPU socket, pin side down, on the motherboard.

Each motherboard will support only a specific type (or range) of CPU, so it is mandatory to check the motherboard manufacturer's specifications before attempting to replace or upgrade a CPU in your computer. Modern CPUs also have an attached heat sink and small fan that go directly on top of the CPU to help dissipate heat.

Two typical components of a CPU are the following:

- The *arithmetic logic unit (ALU)*, which performs arithmetic and logical operations.
- The *control unit (CU)*, which extracts instructions from memory and decodes and executes them, calling on the ALU when necessary.

### ***Speed of Processor:***

Processors come in a variety of speeds. The processor speed is the rate at which a computer can process a group of information (called a cycle) within one second. The higher the CPU speed, the more information can be processed in a second, meaning more data and applications can be used. Typically, smaller processors are faster because they require less energy and heat to run.

### ***Caches:***

A CPU uses a cache to store information that is often reused. Currently, there are 3 caches: L1, L2 and L3. The processor goes in order and uses the information from those caches to process information. The more information stored on the cache, the faster a CPU will be because it does not have to access that information for the first time. Typically, cache refers to L2 cache, but recently more processors are coming out with larger L3 caches as well.

### ***Multiple Cores:***

The unit of the CPU is called a core. There are many CPUs on the market that have dual or quad cores. This means that on one chip, there are two or four separate cores, which means the chip will act as though

multiple CPUs are installed. For instance, a 2.8 GHz dual core chip acts like it has 2 2.8 GHz CPUs. More cores do not necessarily mean better performance because the kind of core matters as well. The performance of the core can be affected by many things, such as size or cache.

### **32 bit vs. 64 bit:**

64-bit processing allows for a greater amount of data to be processed in the same amount of time as compared with a 32-bit processor. However, this depends on the operating system and the applications being 64-bit as well. 64-bit processors also handle more RAM than 32-bit systems, and therefore can run faster. This is because the CPU uses the RAM to run applications and access data.

### **3.3 Types of Memory:**

The memory is where data and instructions needed by the CPU to do its appointed tasks can be found. It is divided into several storage locations which have corresponding addresses. The CPU accesses the memory with the use of these addresses.

#### **a. Main Memory:**

The main memory is very closely connected to the processor. It is used to hold programs and data, that the processor is actively working with. It is not used for long-term storage. It is sometimes called the RAM (Random Access Memory). The computer's main memory is considered as **volatile** storage. This means that once the computer is turned off, all information residing in the main memory is erased.

#### **b. The Secondary Memory:**

The secondary memory is connected to main memory. It is used to hold programs and data for long term use. Examples of secondary memory are hard disks and CD-ROM. Secondary memory is considered as **non-volatile** storage. This means that information residing in secondary memory is not erased after the computer is turned off.

<b>Main Memory</b>	<b>Secondary memory</b>	<b>Property</b>
Fast	Slow	Speed
Expensive	Cheap	Price
Low	High	Capacity
Yes	No	Volatile

### **3.4 Input Devices:**

The foremost task of a computer is to accept data. An input device is used to accomplish this task. An input device is used to enter the data and instructions into the computer. Advancement in the computer technology has resulted in a variety of input devices being available in the market. Keyboard and mouse are the most commonly used input devices.

**a) Keyboard:** Keyboard is the most popular input device that allows users to type alphabets, numbers, and operators, and also to control the cursor on the screen. A simple keyboard layout is given here.



**Mouse:** Mouse is a pointing device that allows user to point to a specific position on the screen. It has two or three buttons on top for selecting/executing different operations. Pressing buttons of mouse is known as clicking of mouse. The mouse is placed on flat surface and moved around to move its controlling arrow on screen. The arrow showing the position of mouse on screen is known as mouse pointer. Left button of mouse is used execute the operation associated with it. Right button/Middle buttons are associated with special operations in different situations.



**Light Pen:** It is a device used for drawing pictures and for directly controlling screen operations.

**Microphone:** It is a device used to accept audio inputs from the user.

**Scanner:** It is a device used to capture digital images of printed documents, graphics or other printed media.

**Touch Screens:** It is a display device, which is touch-sensitive and allows user to interact with the computer system by touching an area on the screen.

**Bar Code Reader:** It is used to accept barcode inputs. A barcode is a series of vertical bars representing numbers and alphabets printed on product labels. One must have noticed all standard items like perfumes, greeting cards, books, cassettes available in the market have similar lines as shown in the

figure, known as bar codes. These can be read with the help of bar code readers.

**Web Camera:** It is an easy to connect low-resolution digital camera normally employed for transfer of images on the web-based conferencing.

**Digital Camera:** It is a high-resolution camera, which captures images and stores them in digital format. It has provision to connect to the computer using special computer communication cables (such as USB cables).

### **Output Devices:**

It is a device used to provide the processed data from the computer to the user. Monitor (VDU/Screen) and printer are the most commonly used output devices. The usage of some of the commonly used output devices is tabulated below:

**Monitor:** A Monitor is an output device, very similar to the television screen. It displays the information as it is typed and also displays the processed result or the output. It is available in many forms cathode ray picture tube based display, liquid crystal based display (LCD), plasma panel display, and touch panel display.



**Printer:** It is an output device to produce paper copy (hard copy) for a document, pictures etc. The job of a printer is to put on paper what is seen on the monitor. Printers vary mainly in cost, quality, speed and noise levels. Eg: Dot Matrix Printer, Inkjet / Deskjet / Bubblejet Printer, Laser Printer.

**Plotter:** Plotters are expensive output devices specially designed to produce outputs of diagrams, illustrations and other graphics.

### **Printers**

The printers are classified as under:

- Impact Printers - These printers have a mechanism that touches the paper in order to create an image. The Dot Matrix Printer is an example of this type.
- Non-impact Printers - These printers do not touch the paper when creating an image. The inkjet and laser printers are examples of this type.

### **Dot Matrix Printer**

Printers in this category print the characters / images using dots through inked ribbon. These printers are very economic and require very less maintenance cost. The print quality of the dot matrix printer is decided by the quantity of pins it has. The number of the pins can vary from nine to twenty four, depending on the kind of dot matrix printer. When compared to the other kind of printers, like the laser printers or the inkjet printer, the dot matrix printer is much more expensive. The dot matrix printer has a tendency to make a lot of noise when compared to the other kinds of printers. This is why the dot matrix printer is not very popular among customers. Quality of print in this category is not very high but is highly suitable for printing situations requiring multiple copies. These printers can print through hammering pattern of dots on the printing ribbon and can thus print multiple copies of document if multiple papers separated by carbon papers are inserted in it. Note that this feature is not available with any other category of printers.

### **Inkjet/Deskjet/Bubblejet Printer**

Printers in this category are most popular. These printers are very low priced with high running/maintenance cost. These printers work on liquid ink technology and print the image using circuit-controlled jet of ink. An inkjet sprays the ink onto the paper in tiny droplets to form text and graphics. Printing speed of these printers is not very high compared to Laser Printers. These printers are suitable for people having less printing jobs with a desirable print quality. These printers are available in 'Coloured' and 'Black & White' options.

Different companies have branded their products using the same technology with different names e.g.

- Hewlett Packard (hp) manufactures DeskJet Printers
- Epson manufactures Inkjet Printers
- Canon manufactures Bubble Jet Printers



*Dot Matrix Printer*



*Inkjet Printer*



*Laser Printer*

### **Laser Printer:**

These printers use a technique, which is a combination of laser and Xerox technology. The technology involves dry powder based ink, which is adhered to a drum through magnetic force, and when a paper is passed through the drum it releases ink on that paper. These are the fastest available printers in the category and are most suitable for uses involving high-speed quality prints.

### **Storage devices:**

Storing data is an important part of a computer system. The main concern of all computer designers is to create fast and efficient storage devices. As is commonly known, the primary memory inside the computer (Random Access Memory or RAM) is volatile i.e. whatever is stored in RAM is lost as soon as the computer is switched off. So if there is a need to save data from getting lost, it can be put on a storage device like floppy disk, hard disks and CD-ROMS before switching off the Computer.

### **Floppy Disk:**

It is a smaller capacity removable storage device. It is made up of thin and flexible plastic material. This thin plastic film is coated with a magnetic material known as iron oxide for recording data and is protected by a hard outer cover. It is very useful in transferring data from one computer to another.

Although technology has not changed substantially, floppy disks have certainly changed considerably in order to meet the very demanding needs of the marketplace. From an 8 inch size they have evolved to a much smaller size with larger capacities. Today's standard 3.5 inch diskettes hold a formatted capacity of about 1.44 megabytes. The evolution of the personal computer acted as a catalyst primary for designers to reduce the size and cost of floppies. Very quickly the floppy became the standard method of exchanging data between personal computers. It also became the popular method of storing moderate amounts of

information outside of the computer's hard drive. Diskettes are small, inexpensive, readily available easy to store, and have a good shelf life if stored properly.

### **Hard Disk Drive:**

It is a storage device with very large capacity, which ranges from 1 GB to Terabytes in the modern scenario. It is placed inside the cabinet of CPU (Although external hard drives are also available these days). It is not a removable drive in normal circumstances. A hard disk has a much larger storage capacity than a floppy disk. It is fitted inside the computer and cannot be seen by us. There can be one or more hard disk in the system unit of a computer. They were originally called "fixed disks" or "Winchesters". They later became known as "hard disks" to distinguish them from "floppy disks." Hard disks have a hard platter that holds the magnetic medium, as opposed to the flexible plastic film found in tapes and floppies. At the simplest level, a hard disk uses magnetic recording techniques just like the floppy disk. Major benefits of magnetic storage - the magnetic medium can be easily erased and rewritten, and it will "remember" the magnetic flux patterns stored onto the medium for many years. The working of a hard disk is similar to that of a floppy disk. In order to increase the amount of information the drive can store, most hard disks have multiple platters.

### **CD-ROM (Compact Disk Read Only Memory):**

It is a storage device with medium capacity i.e. to hold 650 MB/700 MB (60/80 Min. Audio/Video). Computer has special drive known as CD-Drive to provide support for placing and running CDs. It can store data, audio and video. It is made up of plastic with special surface having optical sensitivity. CD-Drive has a laser light source that reads data from the CD-ROM. The CD-ROM surface is a mirror covered with billions of tiny bumps that are arranged in a long, tightly wound spiral track of data, circling from the inside of the disc to the outside. The CD-Drive reads the bumps with a precise laser and interprets the information as bits of data. CD-ROMs are economical and easily available storage media. CDs are available in variations such as CD-R (Compact Disk Recordable) and CD-RW (Compact Disk Rewritable). The data on CD-R media can only be written once whereas CD-RW media allows multiple write/over-write operations on it. There are two types of CD Drives, one known as CD-R Drive that performs only read operation, and the other known as CD-RW Drive (or CD-Burner) that performs read as well write operations.

### **DVD (Digital Versatile Disc):**

Computer has special drive known as DVD-Drive to provide support for placing and running DVDs. A DVD is



very similar to a CD, but it has a much larger data storage capacity. A standard DVD media holds about seven times more data than a CD media. This huge capacity means that a DVD has enough room to store a full-length, MPEG-2-encoded movie, as well as other information.

A DVD can store data, audio and video. It is made up of plastic with special surface having optical sensitivity denser as compared to CDs. A DVD drive is capable of running a CD media also. The DVD media can store up to 4.7 GB of data as compared to 650-700 MB storage capacity of CD-ROMs.

DVDs are of the same diameter and thickness as CDs, and they are made using some of the same materials and manufacturing methods. Like a CD, the data on a DVD is encoded in the form of small pits and bumps in the track of the disc.

### **Pen Drive:**

This is a type of flash memory storage device of the size of a thumb and can plug into the USB port of the computer. USB flash drives are more compact, generally faster, hold more data, and are more reliable (due to their lack of moving parts) than disk storage. Most flash drives use a standard USB connector, which is connected directly to the USB port on a personal computer. Flash drive is nearly free from scratch and dust problems that exist in the other storage media, such as floppy disks and compact discs. This makes it ideal for transporting data or work files from one location to another, such as from home to school or office or work places. It also allows one to perform multiple read-write operations. Flash drives are also a relatively dense form of storage, where even the cheapest will store dozens of floppy disks worth of data. Some can hold more data than a CD (700 MB). Top of the line flash drives can store more data than a DVD. Flash drives often last for 500,000 or more erase/write cycles. Optical storage devices are also slower than their flash-based counterparts.

### **PC Ports and Connectors**

In a computer there are various connectors and ports, which help in establishing a communication path between the CPU and the various above mentioned Storage devices. Before learning about the various available connectors, it is essential to be familiar with the following terms:

1. Cable is a wire
2. Socket is the female side of a connector.
3. Pin is the male side of a connector.
4. Port is generally a place for physically connecting to some other device

usually with a socket.

## **PC Ports**

### **Parallel Port**

Parallel ports can be used to connect a host of popular computer peripherals like:

Printers, Scanners, CD burners, External hard drives, Omega Zip removable drives, Network adapters, Tape backup drives.

Parallel ports were originally developed by IBM as a way to connect a printer to PC. Parallel ports are also known as LPT ports. When a PC sends data to a printer or any other device using a parallel port, it sends 8 bits of data (1 byte) at a time. These 8 bits are transmitted parallel to each other all at once. The standard parallel port is capable of sending 50 to 100 kilobytes of data per second.

The original specification for parallel ports was unidirectional, meaning that data only traveled in one direction for each pin. With the introduction of the PS/2 in 1987, IBM offered a new bi-directional parallel port design. This mode is commonly known as Standard Parallel Port (SPP) and has completely replaced the original design. Bi-directional communication allows each device to receive data as well as transmit it.

### **Serial Port:**

Serial ports, also called communication (COM) ports, support sequential data transmission and are bi-directional. As explained above, bi-directional communication allows each device to receive data as well as transmit it. The name "serial" comes from the fact that a serial port "serializes" data. That is, it takes a byte of data and transmits the 8 bits in the byte one at a time serially one after the other. The main advantage is that a serial port needs only one wire to transmit the 8 bits (while a parallel port needs 8 because all 8 bits are sent in one go). The disadvantage is that it takes 8 times longer to transmit the data than it would if there were 8 wires. Serial ports lower cable costs and make cables smaller. A serial port is commonly used to connect external modems, scanners or the older computer mouse to the computer. It comes in two versions, 9-pin and 25-pin. 25-pin COM connector is the older version while the 9-pin connector is the current standard. Data travels over a serial port at 115 Kb per second. The following is a 9-pin serial port.

### **USB (Universal Serial Bus) Port:**

In the past, connecting devices to computers had been a real headache. Printers connected to parallel

printer ports, and most computers only came with one. Things like Zip drives, which need a high-speed connection into the computer, would use the parallel port as well, often with limited success and not much speed. The earlier version of Serial Port (COM Port) had 9 pins in it. Modems used the serial port, but so did some printers and a variety of odd things like Palm Pilots and digital cameras. Most computers have at most two serial ports, and they are very slow in most cases. Devices that needed faster connections came with their own cards, which had to fit in a card slot inside the computer's case. Unfortunately, the number of card slots is limited and a Ph.D. was needed to install the software for some of the cards. USB, introduced in 1997 is a plug and play peripheral connection, which was invented to solve all these headaches. It is used to connect various devices, for example, digital joystick, a scanner, digital speakers, digital cameras, or a PC telephone etc. to the computer. USB is generally a two-and-a half-inch long port on the back of computers or built into a hatch on the front of a computer. The Universal Serial Bus provides a single, standardized, easy-to-use way to connect up to 127 devices to a computer. Just about every peripheral made now comes in a USB version. A sample list of USB devices that you can buy today includes:

- Printer, Scanner, Microphone, Joystick, Flight yoke, Digital camera, WebCam, Scientific data acquisition device, Modem, Speaker, Telephone, Video phone, Storage device such as Zip drive, Network connection.

Connecting a USB device to a computer is as simple as finding the USB connector on the back of the machine and plugging the USB connector into it. If it is a new device, the operating system auto-detects it and asks for the driver disk. If the device has already been installed, the computer activates it and starts talking to it. USB devices can be connected and disconnected at any time.

Many USB devices come with their own built-in cable, and the cable has an "A" connection on it. If not, then the device has a socket on it that accepts a USB "B" connector.

The USB standard uses "A" and "B" connectors to avoid confusion: "A" connectors connect towards the computer while the "B" connectors connect to individual devices. By using different connectors it is impossible to ever get confused. Connect any USB cable's "B" connector into a device, and it is sure to work.

The Universal Serial Bus is the hottest product in the computer market because of the following features:

- The computer acts as the host.
- Up to 127 devices can connect to the host, either directly or by way of USB hubs.

- Individual USB cables can run as long as 5 meters; with hubs, devices can be up to 30 meters (six cables' worth) away from the host.
- With USB 2, the bus has a maximum data rate of 480 megabits per second.
- A USB cable has two wires for power (+5 volts and ground) and a twisted pair of wires to carry the data.

On the power wires, the computer can supply up to 500 milliamps of power at 5 volts.

Low-power devices (such as mice) can draw their power directly from the bus. High-power devices (such as printers) have their own power supplies and draw minimal power from the bus. Hubs can have their own power supplies to provide power to devices connected to the hub.

USB devices are hot-swappable, meaning you can plug them into the bus and unplug them any time.

Many USB devices can be put to sleep by the host computer when the computer enters a power-saving mode.

### **Firewire Port:**

This port was originally created by Apple and standardized in 1995 as the specification IEEE 1394 High Performance Serial Bus and is very similar to Universal Serial Bus (USB). The most important features of Firewire port are:

- Fast transfer of data - the latest version achieves speeds up to 800 Mbps. At some time in the future, that number is expected to jump to an unbelievable 3.2 Gbps
- Ability to put lots of devices on the bus It is possible to connect up to 63 devices to a FireWire bus. Windows operating systems (98 and later) and Mac OS (8.6 and later) both support it.
- Hot-pluggable ability - they can be connected and disconnected at any time, even with the power on.
- Provision of power through the cable - FireWire allows devices to draw their power from their connection.
- Plug-and-play performance - if you connect a new FireWire device to your computer, the operating system auto-detects it and asks for the driver disc. If you've already installed the device, the computer activates it and starts talking to it.

- Low cabling cost
- Low implementation cost
- Ease of use

The key difference between FireWire and USB is that FireWire is intended for devices working with a lot more data -- things like camcorders, DVD players and digital audio equipment. Implementing FireWire costs a little more than USB, which led to the adoption of USB as the standard for connecting most peripherals that do not require a high-speed bus. Speed aside, the big difference between FireWire and USB 2.0 is that USB 2.0 is host-based, meaning that devices must connect to a computer in order to communicate. FireWire is peer-to-peer, meaning that two FireWire cameras can talk to each other without going through a computer.

### **PS/2 Port**

IBM developed the PS/2 port. It is also called a mouse port. It is used to connect a computer mouse or keyboard. A PS/2 connector is a round connector with 6 pins. Nowadays few computers have two PS/2 ports, one for keyboard and one for mouse. A colour code is used to distinguish between the two ports the keyboard port is green and the mouse has a purple port.

### **Keyboard Socket**

In earlier computers the keyboard was connected using a 5-pin DIN connector with a small notch on one side. The purpose of keeping the notch was to avoid a wrong connection. With the advent of the PS/2, this socket has become obsolete.

### **Monitor Socket**

This connector is used to attach a computer display monitor to a computer's video card. The connector has 15 holes.

### **Audio/Speaker and Microphone Socket**

At the back of the computer system we can find three small sockets of blue, green and pink colours

used to connect speakers, audio input devices and microphones to the PC respectively. The connectors for microphone and speakers look like as shown in the adjacent figure. They are colour coded to help in trouble shooting.

### **Points to Remember:**

- The term hardware refers to the physical components of the computer.
- A Personal Computer is a single-microprocessor, single user system.
- An input device is used to enter the data and instructions into the computer.
- An output device is used to provide the processed data from the computer to the user.
- A printer is an output device to produce paper copy (hard copy) for a document, pictures etc.
- Printers are classified into two categories namely impact and non-impact printers.
- Floppy Disk and Hard Disk are popular magnetic storage devices.
- DVD - DVD also known as "Digital Versatile Disc" or "Digital Video Disc" refers to an optical disc storage media format that can be used for data storage, including movies with high video and sound quality.
- A Compact Disc (CD) is an optical disc used to store digital data, originally developed for storing digital audio.
- A serial port transmits data serially, one bit at a time.
- A parallel port transmits 8 bits in parallel, thereby transmitting 1 byte in one go.
- USB and FireWire ports are gaining popularity due to fast storage transfer and plug-and-play features.

### **List of Abbreviations**

1. ALU = Arithmetic Logic Unit
2. AMD =
3. CD = Compact Disk
4. CD-R = Compact Disk Read only
5. CD-RW = Compact Disk Rewritable
6. CPU = Central Processing Unit

7. CU = Control Unit
8. DOS = Disk Operating System
9. DRAM = Dynamic random access memory
10. DVD = Digital Versatile Disk
11. GHz = Giga Hertz
12. KB = Kilo Byte
13. LCD = Crystal based display
14. MB = Mega Bytes
15. OP = Operating System
16. RAM = Random access memory
17. ROM = Read only Memory
18. SDRAM = Synchronous DRAM
19. SPP = Standard Parallel Port
20. SRAM = Static RAM
21. USB Port = Universal Serial Bus Port