
UNIT 3: COMPUTER HARDWARE

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3.0 AIMS AND OBJECTIVES

After studying this unit, you will be able to explain

- what a hardware is
- the various components of a computer systems
- the various input devices
- the various output devices
- the various storage devices

3.1 INTRODUCTION

A contemporary computer system consists of a central processing unit, primary storage, secondary storage, input devices, output devices, and communication devices.

The central processing unit manipulates raw data into a more useful form and controls the other parts of the computer system.

Primary storage temporarily stores data and program instructions during processing, while secondary storage devices (magnetic and optical disks, magnetic tape) store data and programs when they are not being used in processing.

Input devices, such as keyboards or the computer "mouse", convert data and instructions into electronic form for input into the computer.

Output devices, such as printer, video display terminals, convert electronic data produced by the computer system and display it in a form that people can understand.

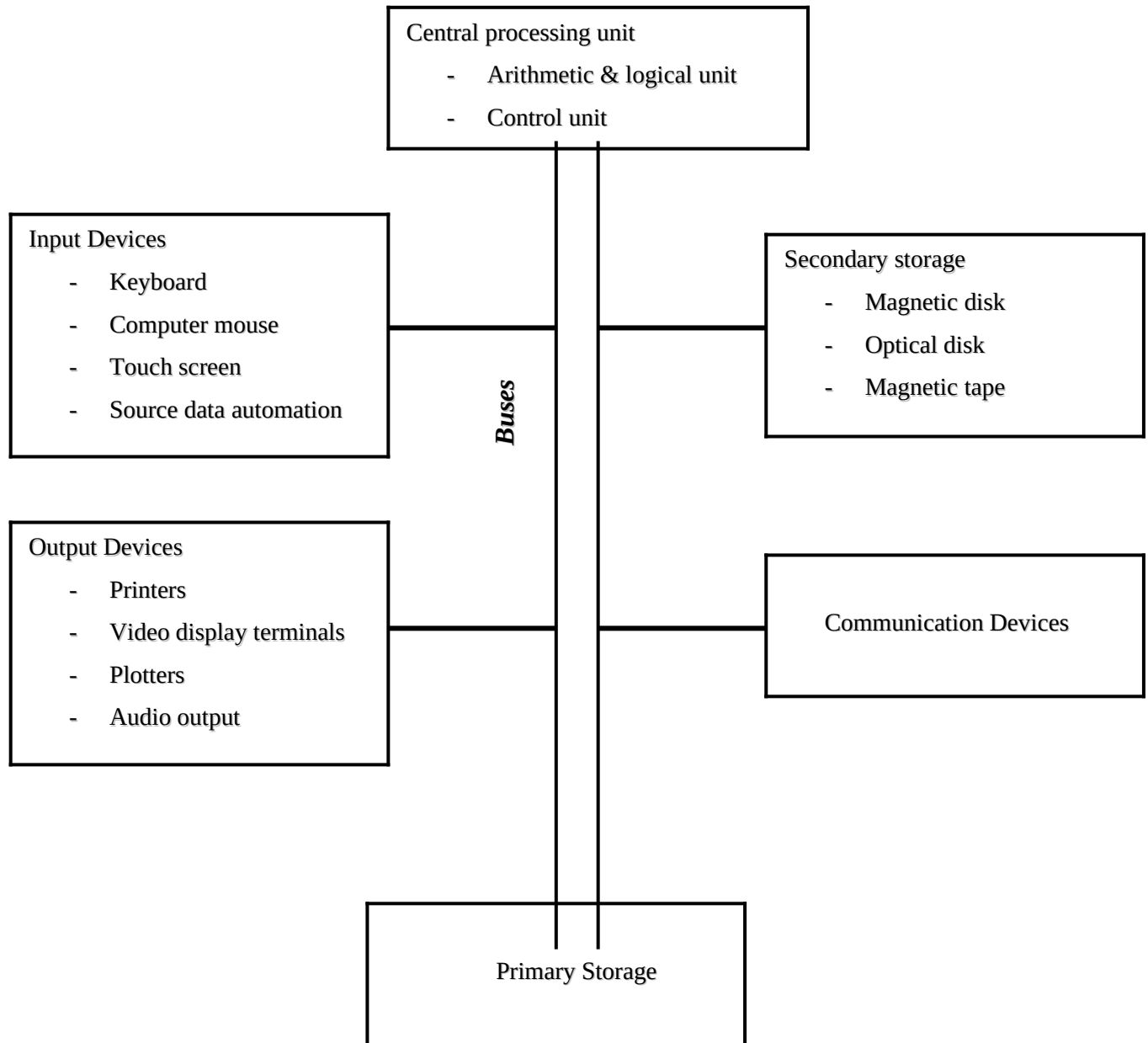
Communication devices provide connections between the computer and communication networks.

Buses are path for transmitting data and signals between the various parts of the computer system.

3.2 THE HARDWARE OF A COMPUTER SYSTEM

The hardware of a computer system consists of primary storage, central processing unit. Input devices, secondary storage devices, output devices and communication devices. The following figure represents the computer hardware.

Figure 3.1: Computer Hardware



3.2.1 Primary Storage

Primary storage has three functions. It stores all or part of the program that is being executed. Primary storage also stores the operation systems programs that manage the operation of the computer. Finally, the primary storage area holds data that are being used by the program. Data and program are placed in primary storage before processing, between processing steps, and after processing has ended, prior to being returned to secondary storage or released as output.

Internal primary storage is often called RAM, or Random Access Memory. It is called RAM because it can directly access any randomly chosen location in the same amount of time.

The advantage of electronic information storage is the ability to store information in a precise known location in memory and to retrieve it from that same location.

Most of the information used by a computer application is stored on a secondary storage devices such as disks, and tapes, located outside the primary storage area. In order for the computer to do work on information, information must be transferred into primary memory for processing. Therefore, data are continually being read into and written out of the primary storage area during the execution of a program.

Primary storage is actually composed of semi conductors. A semi conductor is an integrated circuit made by printing thousands and even millions of tiny transactions on a small silicon chip. There are several different kinds of semi conductor memory used in primary storage, RAM, or random access memory, is used for short term storage of data or program instructions. RAM is volatile: its contents will be lost when the computer's electric supply is disrupted by a power outage or when the computer is turned off.

ROM, or Read Only Memory, can be only be read from. It cannot be written to. ROM chips come from the manufacturer with programs already "burned in" or stored. ROM is used in general-purpose computers to store important or frequently used programs (such as computing routines for calculating the square root of numbers).

Other uses for ROM chips are the storage of manufacturer specific micro codes such as the Basic Input Output System (BIOS) chip used on IBM personal computer, which controls the handling of data within the machine.

There are two other subclasses of ROM chips: PROM, or programmable read only memory, and EPROM, or Erasable Programmable Read Only Memory.

PROM chips are used by manufacturers as control devices in their products. They can be programmed once. PROM chips, therefore can be made universally for many manufacturers in large production runs.

EPROM chips are used for device control, such as in robots, where the program may have to be changed on a routine basis with EPROM chips, the program can be erased and reprogrammed.

3.2.2 Central Processing Unit (CPU)

The central processing unit (CPU) is the part of the computer system where the manipulation of symbols, numbers, and letter occurs, and it controls the other parts of the computer system.

The CPU consists of central unit and an arithmetic logical unit. Located near the CPU is primary storage (sometimes called primary memory or main memory) where data and program instructions are stored temporarily during processing. Three kinds of buses link the CPU, primary storage, and the other devices in the computer system. The data bus moves data to and from primary storage. The control bus transmits signals specifying whether to "read" or "write" data to or from a given primary storage address, input device, or output device. The characteristics of the CPU and primary storage are very important in determining the speed and capability of a computer.

1. Arithmetic and Logical Unit

The arithmetic logical unit (ALU) performs the principal logical and arithmetic operations of the computer. It adds, subtracts, multiplies, and divides, determining whether a number is positive, negative, or zero. In addition to performing arithmetic function, and ALU must be able to determine when are quantity is greater than or less than another and when two

quantities are equal. The ALU can perform logical operations on the binary codes for letters as well as numbers.

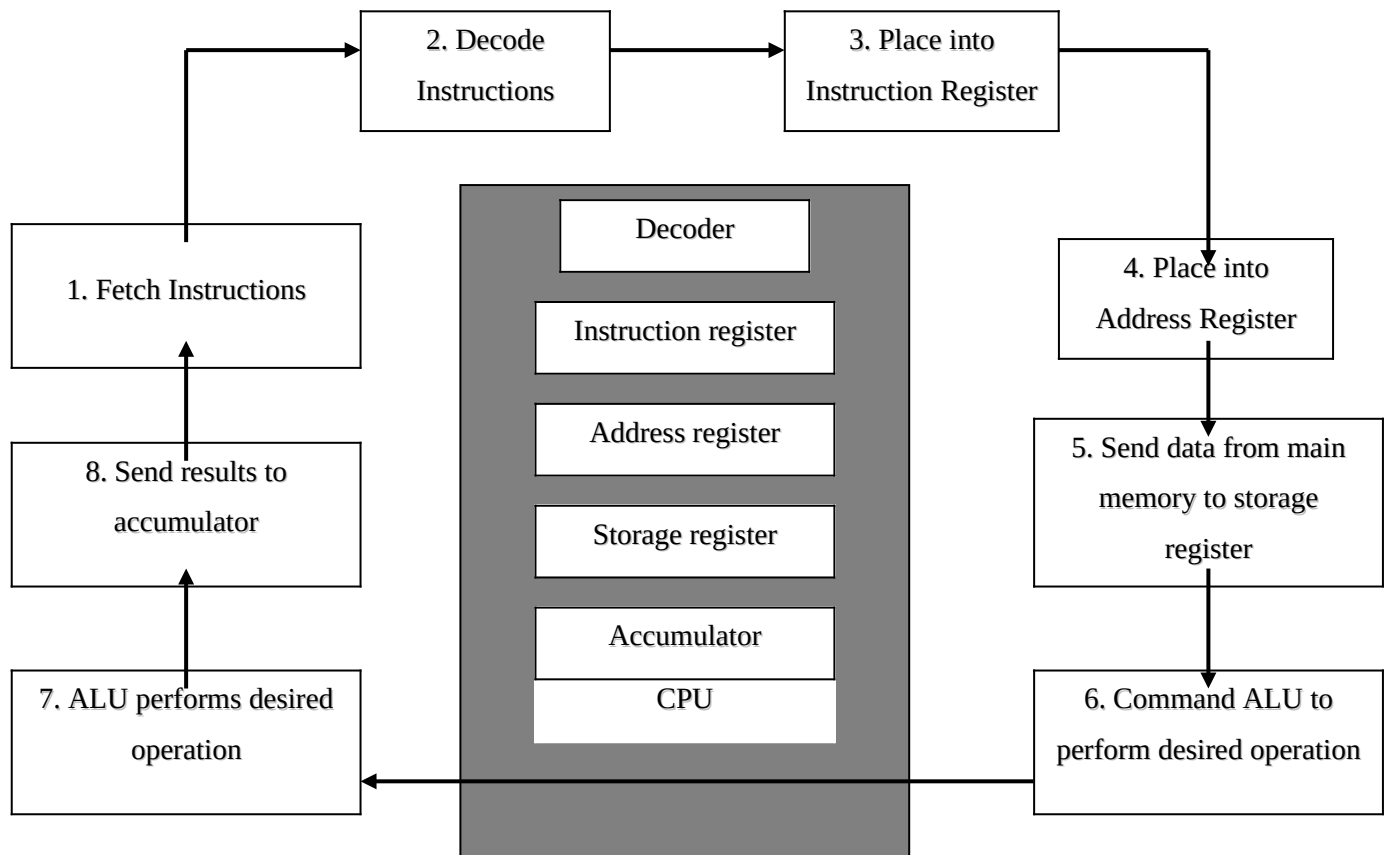
2. Control Unit

The control unit coordinates and control the other parts of the computer system. It reads a stored program, one instruction at a time, and directs other components of the computer system to perform the tasks required by the program. The services of operations required to process a single machine instruction is called the machine cycle. The machine cycle has two parts: an instruction cycle and an execution cycle.

During the instruction cycle, the control unit retrieves are program instruction from primary storage and decodes it. It places the part of the instruction telling the ALU what to do next in a special instruction register and places the part specifying the address of the data to be used in the operation into an address register.

During the execution cycle, the control unit locates the required data in primary storage, places it in a storage register, instructs the ALU to perform the desired operation, temporary stores the result of the operation in the accumulator, and finally places the result into primary memory. As the execution of each instruction is completed, the control unit advances to and reads the next instruction of the program.

Figure 3.2 : The various steps in the machine cycle (I – Cycle and E – Cycle)



3.2.3 Input Devices

The traditional method of data entry has been by keyboarding. Today most data are entered directly into the computer using a data entry terminal and they are produced online.

For instance, online-airline reservation and customer information systems have reservations clerks or salespeople enter transaction directly while dealing with the customer, and their systems are updated immediately. In this manner, a business can eliminate a separate data entry staff and the associated costs.

1. Keyboard

Keyboard is the most common input device. Depending on the number of function keys, keyboard can be categorized as a standard or enhanced. Standard keyboards have 10 function keys while the enhanced keyboards have 12 function keys.

2. The computer mouse

The "point and click" actions of the computer mouse have made it an increasingly popular alternative to keyboard and text-based commands. A mouse is a hand held device that is usually connected to computer by a cable. The computer user moves the mouse around on a desktop to control the position of the cursor on a video display screen. Once the cursor is in the desired position, the user can push a button on the mouse to select a command. The mouse can also be used to "draw" images on the screen.

3. Touch Screens

Touch screens are easy to use and are appealing to people who cannot use traditional keyboards. Users can enter limited amounts of data by touching the surface of a sensitized video display monitor with a finger or a pointer. With colorful graphics, sound, and simple menus, touch screen allow the user to make selections by touching specified parts of the screen.

4. Source data automation

Source data automation captures data in computer readable form at the time and place they are created. Point of sale systems, optical bar code scanners used in supermarkets, and other optical character recognition device are examples of source data automation. One of the advantages of source data automation is that the many errors that occur when people use keyboards to enter data are almost eliminated.

The principal source data automation technologies are magnetic ink character recognition, optical character recognition, pen based input, digital scanner, voice input, and sensors.

- ***Magnetic link character recognition (MICR)***

This technology is used primarily in cheque processing for the banking industry. The bottom portion of a typical cheque contains characters that are pre printed using a special ink.

A MICR reader translates the characters on cheques that have been cashed and sent to the bank for processing into digital form for the computer. The amount of the cheque, which is written in ordinary ink, must be keyed in by hand.

- ***Optical character recognition (OCR)***

This device translates specially designed marks, characters, and codes into digital form. The most widely used optical code is the bar code, which is used as a point of sale systems in supermarkets and retail stores.

- ***Pen based inputs***

Handwriting recognition devices such as pen-based "tablets" and "notebooks" are promising new input technologies, especially for people working in the sales or service areas or for those who have traditionally shunned computer key boards. These pen based input devices usually consist of a flat screen display tablet and a pen like stylus.

With pen-based input, users print directly on to the tablet sized screen. The screen is fitted with a transparent grid of five wires that detects the presence of the special stylus, which emits a faint signal from its tip. The screen can also interpret tapping and flicking gestures made with the stylus.

Pen based input devices transform the letters and numbers written by users on the tablet into digital form, where they can be stored, or processed and analyzed.

- ***Digital scanners***

Digital scanners translate images such as pictures or documents into digital form, and are an essential component of image processing system.

- ***Voice input devices***

Voice input devices converts' spoken word into digital form. Voice recognition software compares the electrical patterns produced by the speaker's voice to a set of pre recorded patterns. If the patterns match, the input is accepted. Most voice system still has limited "vocabularies" of several hundred to several thousand words and can accept only very simple commands.

- **Sensors**

Sensors are devices that collect data directly from the environment for input into a computer system. The sensors continuously measure emission and are linked to micro computers which send the data collected by the sensors to the central computer for analysis.

3.2.4 Output Devices

The major data output devices are cathode ray tube (CRT) terminals (sometimes called video display terminals, or VDTs, and printers.

1. CRT

The CRT is probably the most popular form of information output in modern computer system. It works much like a television picture tube, with an electronic "gun" shooting a beam of electrons to illuminate the pixels on the screen. The more pixels for screen, the higher the resolution. CRT monitor can be classified as monochrome or color and by their display capabilities. Some display only text, whereas others display both text and graphics. Typical CRT display 80 column and 24 lines of text data. Display devices for graphics often utilize bit mapping. Bit mapping allows each pixel on the screen to be addressed and manipulated by the computer. This requires more computer memory but permits finer detail and the ability to produce any kind of image on the display screen.

2 Printers

Printers produce a printed hard copy of information output. They include impact printers (a standard typewriter or a dot matrix) and non-impact printers (laser, inkjet, and thermal transfer printers). Most printers print one character at a time, but some commercial printers print an entire line or page at a time. Impact printers are slower than non-impact printers. Laser printers for micro computers can print 4 to 8 pages per minute. Laser printers in large computers center can print over 100 pages per minute.

3. Other devices

Microfilm and micro fiche have been used to compactly store output as microscopic filmed images, and they are mainly used by insurance companies or other firms that need to output and store large number of documents.

4. Plotters

Plotters are output device using multicolored pens to draw high quality graphic documents. Plotters are much slower than printers, but are useful for outputting large size charts, maps or drawings.

5. Voice output device

A voice output device converts digital output data back into intelligible speech, sounds are prerecorded, coded, and stored on disk, to be translated back as spoken words. For instance, when you call for information on the telephone, you may hear a computer "voice" respond with the telephone number you requested.

3.2.5 Secondary Storage

In addition to primary storage, where information and programs are stored for immediate processing, modern computer systems need to store information outside of the computer in a non-volatile state and to store volumes of data too large to fit into a computer of any size today. The relative long-term storage of data outside the CPU and primary storage is called secondary storage.

1. Magnetic tape

Magnetic tape is an older device that is still important for secondary storage of large volume of information. It is used primarily in manufacture batch application and for archiving data. Generally magnetic tape for large system comes in 14-inch reels that are up to 2400 feet long and 0.5 inches wide. It is the very similar to home cassette recording tape, but of higher quality.

The principal advantage of magnetic tape are that it is inexpensive, that it is relatively stable, and that it can store very large volumes of information. It is a reliable technology because of several self-checking features, and therefore is an ideal form of backup storage for other more volatile forms of memory. Moreover, magnetic tape can be used over and over again, although it does not age with time and computer users must handle it carefully.

The principal disadvantages of magnetic tape are that it stores data sequentially and is relatively slow compared to the speed of other secondary storage media. In order to find an individual record stored on a magnetic tape, the tape must be read from the beginning up to the location of the desired record. This means that the CPU must read each name from A-Z.

Hence, magnetic tape is not good medium when it is necessary to find information rapidly. Tape can also be damaged and is labor intensive to mount and dismount.

2. Magnetic Disk

The most widely used secondary storage medium today is magnetic disk. There are two types of magnetic disks: floppy disks and hard disks. Hard disks are thin steel plates with an iron oxide coating. In large systems, multiple hard disks are mounted together on a vertical shaft. Here the read write head (disk and drive) are sealed together. That is why these devices sometimes are called hard drives. A hard disk is found in the system unit. It is not removable.

Information is recorded on a read from the disk by read/write heads, which literally fly over the spinning disks.

The read/write heads move horizontally (from left to right) to any of 200 positions called cylinders. At any one of these cylinders, the read/write heads can read or write information to any of 20 different concentric circles at the disk surface areas (called tracks). The cylinder represents the circular tracks on the same vertical line within the disk pack. Read/write heads are directed to a specific record using an address consisting of the cylinder number, the recording surface number, and the data record number.

The speed of access to data on a disk is a function of the rotational speed of the disk and the speed of the access arms. The read/write heads must position themselves, and the disk pack must rotate until the proper information is located. More advanced and expensive disks have access speeds of 1.5 – 10 milliseconds.

The read write head of the hard drive will be suspended above disk with a very small amount (0.00001 inch) of distance between the disk and the head. During power failure, or if you bumping the system unit or even drop something on it, then the head can touch the disk and that will be a problem called head crash. Head crash may cause a damage of some data, byte or totally hard disk.

The advantage of having a hard disk is they have high storage capacity, and are faster. The storage capacity can exceed up to 50 GB. That means:

$$1 \text{ byte} = 1 \text{ character}$$

1 kilobyte	=	1024 characters
1 megabyte	=	1048576 characters
1 gigabyte	=	107341824 characters

3. Floppy disks

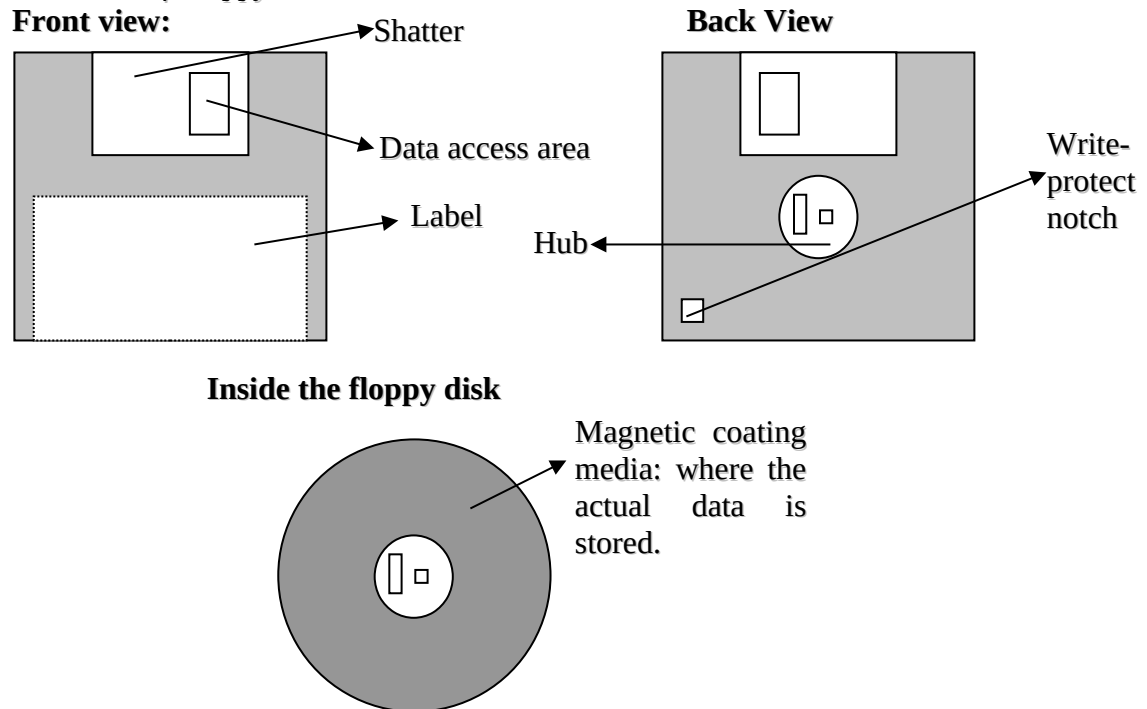
Floppy disks are a removable magnetic disks primarily used with microcomputers. The two most common standard sizes are 3.5 inch and 5.25 inch disks that are made up of polyester film with magnetic coating.

These disks have a storage capacity ranging from 360 k to 2.8 megabytes and a much slower access rate than hard disks. Floppy disks and cartridge and packs of multiple disks use a sector method for storing data. The disk surface is divided into pie-shaped pieces, the actual number of depending on the system used (some disks used 8 sectors others nine). In most types of floppy disks, each sector has the same storage capacity (data are recorded more densely on the inner disk tracks). Each sector is assigned a unique number. Data can be located using an address consisting of the sector number and an individual data record number.

Magnetic disks on both large and small computers have several important advantages over magnetic tape. First, they permit direct access to individual records. Each record can be given a precise physical address in terms of cylinders and tracks, and the read/write head can be directed to go to that address and access the information is about 10 to 60 milliseconds. This means that the computer system does not have to search the entire file, as in a tape file in order to find a record. This creates the possibility for online information system providing an immediate response, such as an airline reservation or customer information system. Disk storage is often referred to as a direct access storage device (DASD).

Floppy Disks (diskettes) are mobile storage devices (their special feature comparing with hard disks) and you need to have a floppy drive to use them. A floppy drive is the one that reads and writes data on the floppy disk. They are inexpensive but their storage capacity is only about 1.44MB. The following figures illustrate the structure and components of the floppy disks.

The Structure of Floppy Disks:



1. **Shutter:** is used to protect the data access area from the external environment. If there is any disturbance, then there will be data loss.
2. **The Data Access Area:** when the drive reads and writes data, then the data access area is the area where the read-write head scans the actual data medium, which is the magnetic film.
3. **Hub:** when inserting the disk to the disk drive, the hub will be fit to the drive spindle and the disk can be spin.
4. **Label:** part of the disk, just used to write labels for the disk to distinguish it from other diskettes.

5. *Write-Protect Notch*: is a hole used to make the floppy disk read only. If it is open, data cannot be recorded and the diskette is said to be write-protected. It is possible to open or close the notch by sliding a cover, which is found with the hole.
6. *Magnetic Film*: this is where data can be read or recorded. Usually iron oxide coated this part.

A formatted floppy is different from unformatted diskettes with one major thing: the presence or absence of tracks and sectors on the magnetic film.

A formatted (as a result ready to use) disk has its magnetic film divided into thin concentric circles, called *tracks* and the tracks themselves are divided into *sectors*. The drive can not read and write unless the disk has tracks and sectors.

In a floppy disk,

$$1 \text{ track} = 18 \text{ sectors}$$

$$1 \text{ sector} = 512 \text{ bytes}$$

Since floppy disks have two sides, in one side,

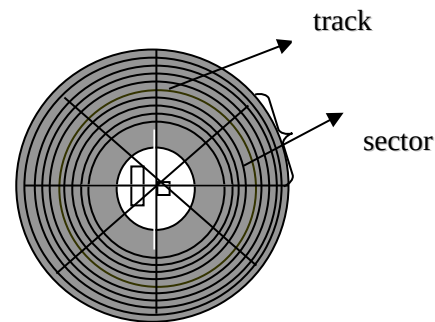
You have 80 tracks and as a result,

$$1 \text{ side} = 80 \text{ tracks}$$

$$2 \text{ sides} = 160 \text{ tracks}$$

$$2 \text{ sides} = 160 \times 18 = 2880 \text{ sectors} = 2880 \times 512$$

$$= 1474560 \text{ bytes}$$



4. Optical Disks

Optical disks, also called compact disks or laser optical disks, store data at densities many times greater than those of magnetic disks and are available for both micro computers and large computers. Data are recorded on optical disks when a laser device burns microscopic pits in the reflective layer of a spiral track. Binary information is encoded by the length of these pits and the space between them.

Optical disks can thus store massive quantities of data, including not only text but also pictures, sound, and full motion video, in a highly compact form. The optical disk is read by having a low power laser beam from an optical head scan the disk.

- ***Compact disk read only memory (CD-ROM)***

The most common optical disk system used with micro computers is called CR-ROM. A 4.75 inch compact disk can store up to 660 megabytes, nearly 300 times more than a high density floppy disks. Optical disks are most appropriate for applications where enormous quantities of unchanging data must be stored compactly for easy retrieval, or for storing graphic linkages and sounds.

CD-ROM is also less vulnerable than floppy disks to magnetism, dirt or rough handling. CD-ROM is read only storage. No new data can be written to it. It can only be read. CD-ROM has been most widely used for reference materials with massive amounts of data, such as encyclopedias, directories, or online database and for storing multimedia applications that combine text, sound and images.

- ***Write once/read many (WORM) (CD-R)***

WORM are optical disk systems that allow users to record data only once on an optical disk. Once written, the data cannot be erased but can be read indefinitely. WORM has been used as an alternative to micro film for archiving digitized document images. The disadvantages of CD-ROM and WORM optical disks are then contents cannot be easily erased and written and, as can be done with magnetic disks, and the access speed is lower than that of magnetic disks.

- ***Magneto optical disks (CD-RW)***

Re-writable magneto optical disks are starting to become cost effective for data storage. The disk surface is coated with a magnetic material that can change magnetic polarity only when heated. To record data, a high-powered laser beam heats tiny spots in the magnetic medium that allows it to accept magnetic patterns.

Data can be read by showing a lower powered laser beam at the magnetic layer and reading the reflected light. The magneto optical disk is erasable and can be written on nearly a million times. the access speed of optical disks, while slower than that of a magnetic disks, is continuing to improve, making the optical disk a very attractive storage technology incoming years.

3.2.6 Other Devices

In addition to the main hardware components, we have a number of parts of a computer that are not mentioned. To state some of them:

a) *Motherboard*

It is the main board containing the CPU, RAM, ROM and additionally different expansion slots.

Expansion Slots and Expansion Cards

Most PCs are expandable. Users are able to expand the power and speed of the computer. How? This is just by adding expansion cards (boards) into your hardware. There are different kinds of expansion cards and they will be plugged into the expansion slots found on the motherboard. Examples of expansion cards can be sound card, display adapters, modem, network cards.

b) *Power Supply*

Electrical power is needed almost for every components of the PC. And the components will get their need from the power supply which is found inside the system unit. The power supply has got usually two sockets at the back of the system unit where you can plug power cable for the system unit from outside main power source and the other a power cable from the monitor. Moreover the power supply contains fan to make things cool inside the system unit.

Devices used to Prevent Power Problems

- *UPS (Uninterruptible Power Supply):* will provide power to the computer for some period of time (from 5 to 30 minutes) when there is power failure. This is possible because the UPS has batteries that will be charged and hold electric power. That will give you time at least to save your data on RAM and shut down the PC properly.

- *Surge Protector (Surge Suppressor):*

Whenever there is a power fluctuation (especially when surges occur), these devices can protect the computer by absorbing the high voltage.

➤ *Line Conditioner (Voltage Regulator)*

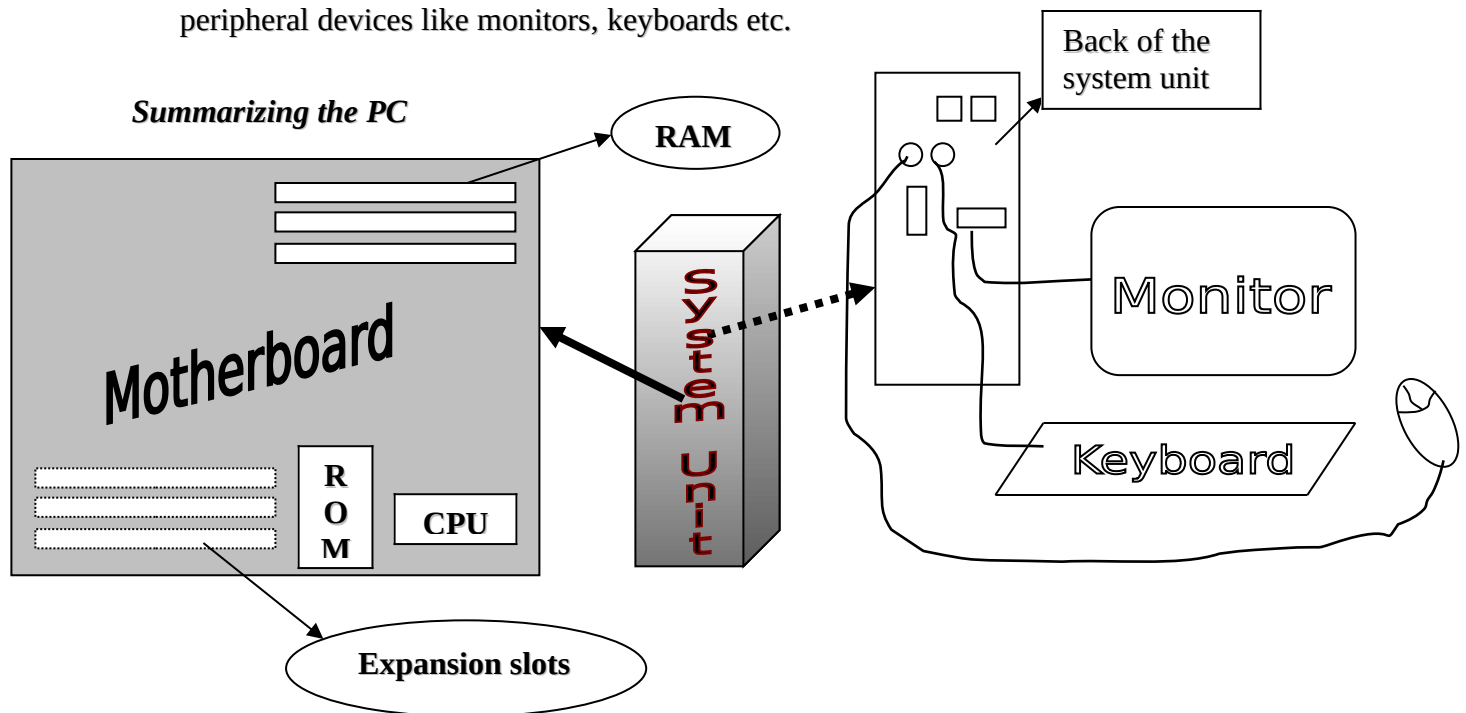
It protects the computer from insufficient power.

c) **Bus**

A bus is simply an electronic pathway between the CPU and other devices. It can transmit electronic information (in fact composed of bits) between devices.

d) **Port**

A port is a socket at the back of the system unit which can be used to plug a cable from peripheral devices like monitors, keyboards etc.



Check Your Progress Exercise

1. What are the components of a contemporary computer system?

2. Discuss the major components of the CPU.

3. Explain the difference between primary and secondary storage?

4. List and describe the major input device?

5. List and describe the major output devices?

3.3 SUMMARY

The modern computer system has six major components: a central processing unit (CPU), primary storage, input devices, output devices, and secondary storage and communication devices.

The CPU has two components: an arithmetic logic unit and control unit. The arithmetic and logic unit performs arithmetic and logical operations on data, while the control units controls and coordinates the other components of a computer.

The CPU is closely tied to primary memory, or primary storage, which stores data and program instructions temporarily before and after processing.

The principal input devices are keyboards, computer mouse, touch screens, magnetic ink and optical character recognition, pen based instruments, digital scanners, sensors and voice input.

The principal output devices are video displays, terminals, printers, plotters, voice output devices, and microfilm and microfiche.

The principal form of secondary storage is magnetic tape, magnetic disks, and optical disks.

3.4 ANSWER TO CHECK YOUR PROGRESS EXERCISE

1. Refer Section 3.2
2. Refer Section 3.2.2
3. Refer Section 3.2.1 & 3.2.5
4. Refer Section 3.2.3
5. Refer Section 3.2.4