Unit 1

Introduction to Computer System

1.1 Computer System

1.1.1 Introduction

The word computer comes from the work "compute" which means to calculate. So a computer is normally considered to a calculating device that can perform arithmetic operations at enormous speed.

In fact, the original objective for inventing the computer was to create a fast calculating machine. But more than 80% of the work done by computer today is of non-mathematical or non-numerical nature. Hence, to define a computer merely as calculating device is to ignore over 80% of its work.

More accurately, a computer may be defined as a device that operates upon information or data. Data can be anything like bio-data of various applicants when the computer is used for recruiting personnel, or the marks obtained by various students in various subjects when the computer is used to prepare results, or the details (name, age, sex, etc.) of various passengers when the computer is employed for making airline or railway reservations, or numbers of different types in case of application of computers for scientific research problems, etc.

Thus, data comes in various shape and sizes depending upon the type of computer application. A computer can store, process, and retrieve data as and when desired. The fact that computer process data is so fundamental that many people have started calling it a *data processor*.

The name data processor is more inclusive because modern computers not only compute in the usual sense but also perform other functions with the data that flow to and from them. For example, data processors may gather data from various incoming sources, merge (process of mixing or putting together) them all, sort (process of arranging in some sequence - ascending or descending) them in the desired order and finally print them in the desired format. None of these operations involve the arithmetic operations normally associated with a computing device but the term computer is often applied anyway.

1.2 Computer History & Architecture development

Computers have gone through 2 major stages of development :-

Mechanical **Electronic**

Earlier to 1945, computer were made with mechanical & electromechanical parts. The earliest mechanical computer can be traced back to 600 BC in the form of the abacus used in China. The abacus is manually operated to perform decimal arithmetic with carry propagation digit by digit.

This is an earliest device that qualifies as a digital computer "ABACUS" also known as "SOROBAN". This device permits the user to represent number by the position of beads on a rack. Simple addition and subtraction can be carried out rapidly and efficiently by positioning the beads appropriately. Although, the abacus was invented around 600 B.C., it is interesting to note that it is still used in the Far East and its user can calculate at amazing speeds.

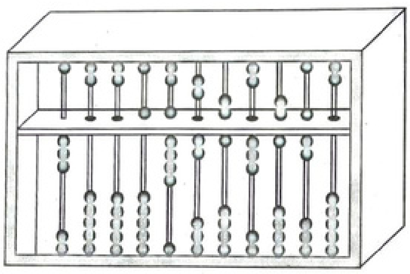


Fig. 1 : A thirteenth Century Abacus.

The first mechanical adding machine was invented by Blaise Pascal in 1642. Later, in the year 1671, Baron Gottfried Wilhelm von Leibniz of Germany invented the first calculator for multiplication. Keyboard machines originated in the United State around 1880 and are extensively used even today. Around this period only, Herman Hollerith come up with the concept of punched cards which are extensively used as input media in modern digital computers.

NOTE :- Charles Babbage, a 19th century professor at Cambridge University, is considered to be the father of modern digital computers.

Blaise Pascal built a mechanical adder/subtractor in France in 1642. Charles Babbage designed a difference engine in England for polynomial evaluation in 1827. Konrad Zuse built the first binary mechanical computer in Germany in 1941. Howard Aiken proposed the very first electromechanical decimal computer, which was built as the Harvard Mark I by IBM in 1944. Both Zuse's and Aiken's machines were designed for general-purpose computations.

Obviously, the fact that computing and communication were carried out with moving mechanical parts greatly limited the computing speed and reliability of mechanical computers. Modern computers were marked by the introduction of electronic components. The moving parts in mechanical computers were replaced by high-mobility electrons in electronic computers. Information transmission by mechanical gears or leavers were replaced by electric signals travelling almost at the speed of light.

1.2.1 Description of Some Early Computers

- THE MARK-I COMPUTER (1937-44)
- THE ATANASOFF-BERRY COMPUTER (1939-42)
- THE ENIAC (1943-46)
- THE EDVAC (1946-52)
- THE EDSAC (1947-49)
- THE MANCHESTER MARK (1948)
- THE UNIVAC (1951)

1.2.1.1 THE MARK-I Computer (1937-44) :- It is also known as Automatic sequence controlled, calculator, this was the first fully automatic calculating machine designed by Howard A. Aiken of Haward University in collaboration with IBM International Bussiness Machines) corporation. Its design was based on the techniques already developed for punched card machinery.

It was basically an electro-mechanical device since both mechanical and electronic components were used in its design. Although its operation were not controlled electronically, Aiken's machine is often classified as computer because its instructions, which were entered by means of punched paper tape, could be altered.

Although this machine proved to be extremely reliable, it was very complex in design and huge in size. It used over 3000 electrically actuated switches to control its operations and was approximately 50 feet long and 8 feet high. It was capable of performing five basic arithmetic operations : additions substraction, multiplication, division and table reference. A number as big as 23 decimal digits could be used in this machine. It took approximately 0.3 second to add two numbers and 4.5 seconds for multiplications of two number. Hence, the machine was very slow as compared to todays computers.

1.2.1.2 THE ATANASOFF-BERRY COMPUTER (1939-42) :- This electronic machine was developed by Dr. John Atanasoff to solve certain mathematical equation. It was called the Atanasoff-Berry Computer, or ABC, after its inventor's name and his assistant, Cliffore Berry. It used 45 vacuum tubes for internal logic and capacitors for storage.

1.2.1.3 THE ENIAC (1943-46) :- The electronic Numerical integrator and calculator (ENIAC) was the first a electronic computer. It was constructed at the Moore School of Engineering of the University of Pennsylvania, U.S.A. by a design team led by Professors J. Presper Eckert and John Mauchly.

ENIAC was developed as a result of military need. It took up the wall space in a 20 × 40 square feet room and used 18,000 vacuum tubes. The addition of two numbers was achieved in 200 microseconds, and multiplication in 2000 microseconds.

Although, much faster in speed as compared to Mark I computer, ENIAC had two major shortcomings : it could store and manipulate only a very limited amount of information, and its programs were wired on boards. These limitations made it difficult to detect errors and to change the programs. Hence its use was limited. However, whatever be the shortcomings of ENIAC, it represented an impressive feat of electronic engineering and was used for many years to solve ballistic problems.

1.2.1.4 THE EDVAC (1946-52) :- The operation of ENIAC was seriously handicapped by the wiring board. This problem was later overcome by the new concept of "stored program" developed by Dr. John Von Neumann. The basic idea behind the stored program concept is that a sequence of instructions as well as data can be stored in the memory of the computer for the purpose of automatically directing the flow of operations. The stored program feature considerably influenced the development of modern digital computers and because of this feature we often refer to modern digital computers as stored program digital computers. The Electronic Discrete Variable Automatic Computer (EDVAC) was designed on stored program concept. Von Neumann has also got a share of the credit for introducing the idea of storing both instructions and data in the binary form (a system that uses only two digits - 0 & 1 to represent all characters) instead of the decimal numbers or human readable words.

1.2.1.5 THE EDSAC (1947-49) : Almost simultaneously with EDVAC of U.S.A., the Britishers developed the Electronic Delay Storage Automatic calculator (EDSAC). The machine executed its first program in May 1949. In this machine, addition operations was accomplished in 1500 microseconds, and multiplication operation in 4000 microseconds. The machine was developed by a groups of scientists headed by professor Maurice Wilkes at the Cambridge University.

1.2.1.6 THE MANCHESTER MARK-I (1948) :- This computer was a small experimental machine based on the stored program concept. It was designed at Manchester University by a group of scientists headed by Professor M.H.A. Newman. Its storage capacity was only 32 words, each of 31 binary digits. This was too limited to store data and instructions. Hence, the Manchester Mark I was hardly of any practical use.

1.2.1.7 THE UNIVAC-I (1951) :- The Universal Automatic Computer (UNIVAC) was the first digital computer which was not "one of the kind". Many UNIVAC machine were produced, the first of which was installed in the Census Bureau in 1951 and was used continuously for 10 years. The first business use of a computer, a UNIVAC-I, was by General Electric Corporation in 1954.

Note :- In 1952, IBM (International Business Machines) corporation introduced the 701 commercial computer. In 1953, IBM produced IBM-650 and sold over 1000 of these computers.

1.2.2 COMPUTER GENERATION

"Generation" in computer talk is a step in technology. It provides a framework for the growth of the computer industry. Originally, the term 'generation' was used to distinguish between varying hardware technologies. But nowadays, it has been extended to included both the hardware and the software which together make up an entire computer system.

Over the past five decades electronic computers have gone through five generations of development. Table 1.1 provides a summary of the five generations of electronic computer development. Each of the first three generations lasted about 10 years. The fourth generation covered a time span of 15 years. We have just entered the fifth generation with the use of processors and memory devices with more than 1 million transistors on a signal silicon chip.

The division of generations is marked primarily by sharp changes in hardware and software technologies. The enteries in Table 1.1 indicate the new hardware and software features introduced

with each generation. Most features introduced in earlier generations have been passed to later generations. In other words, the latest generation computers have inherited all the nice features and eliminated all the bad ones found in previous generations.

Table 1.1 Generations of Electronic Computers

Generation	Technology and Architecture	Software and Applications	Representative Systems
First (1945-54)	Vacuum tubes and relay memories, CPU driven by PC and accumulator, fixed-point arithmetic.	Machine/assembly languages, single user, no subroutine linkage, programmed I/O using CPU.	ENIAC, Princeton IAS, IBM 701.
Second (1955-64)	Discrete transistors and core memories, floating-point arithmetic, I/O processors, multiplexed memory access.	HLL used with compilers, subroutine libraries, batch processing monitor.	IBM 7090, CDC 1604, Univac LARC.
Third (1965-74)	Integrated circuits (SSI/-MSI), microprogramming, pipelining, cache, and lookahead processors.	Multiprogramming and time-sharing OS, multiuser applications.	IBM 360/370, CDC 6600, TI-ASC, PDP-8.
Fourth (1975-90)	LSI/VLSI and semiconductor memory, multiprocessors, vector supercomputers, multicomputers.	Multiprocessor OS, languages, compilers, and environments for parallel processing.	VAX 9000, Cray X-MP, IBM 3090, BBN TC2000
Fifth (1991-present)	ULSI/VHSIC processors, memory, and switches, high-density packaging scalable architectures.	Massively parallel processing, grand challenge applications, heterogeneous processing.	Fujitsu VPP 500, Cray/MPP, TMC/CM-5, Intel Paragon.

1.2.2.1 The first Generation

From the architectural and software points of view, first generation computers were built with a signal *central processing unit* (CPU) with performed serial fixed-point arithmetic using a program counter, branch instructions, and an accumulator. The CPU must be involved in all memory access and *input/output* (I/O) operations. Machine or assembly languages were used.

Representative systems included the ENIAC (electronic Numerical Integrator and Calculator) built at the Moore School of the University of Pennsylvania in 1950; the IAS (Institute for Advanced Studies) computer based on a design proposed by John von Neumann, Arthur Burks, and Herman Goldstine at Princeton in 1946; and the IBM 701, the first electronic stored-program commercial computer built by IMB in 1953. Subroutine linkage was not implemented in early computers.

Advantages

1. Vacuum tubes were the only electronic components available during those days.
2. Vacuum tube technology made possible the advent of electronic digital computers.
3. These computers were the fastest calculating device of their time. They could perform computations in milliseconds.

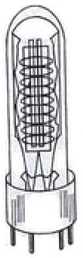


Fig. 2 : A vacuum Tube

Disadvantages

1. Too bulky in size.
2. Unreliable
3. Thousands of vacuum tubes that were used emitted large amount of heat and burnt out frequently.
4. Air conditioning required
5. Prone to frequent hardware failures
6. Constant maintenance required.
7. Nonportable
8. Manual assembly of individual components into functioning unit required.
9. Commercial production was difficult and costly
10. Limited commercial use.

Note :- Invention of vacuum tube (which was a fragile glass device, could control and amplify electronic signals.

1.2.2.2 The Second Generation (1955-64)

The transistor, a smaller and more reliable successor to the vacuum tube, was invented in 1947. However, computers that used transistors were not produced in quantity until over a decade later. The second generation emerged with transistors being the brain of the computer.

With both the first and second generation computers, the basic component was a discrete or separate entity. The many thousands of individual components had to be assembled by hand into functioning circuits. The manual assembly of individual components and the cost of labour involved at this assembly stage made the commercial production of these computers difficult and costly.

Index registers, floating-point arithmetic, multiplexed memory, and I/O processors were introduced with second-generation computers. High level languages (HLLs), such as Fortran, Algol, and Cobol, were introduced along with compilers, subroutine libraries, and batch processing monitor. Register transfer language was developed by Irving Reed (1957) for systematic design of digital computers.

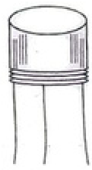


Fig. 3 : A transistor

Representative systems include the IBM 7030 (the Stretch computer) featuring instruction lookahead and error correcting memories built in 1962, the univac LARC built in 1959 and CDC built in 1960.

Advantages :-

1. Similar in size as compared to first generation computers.

2. More reliable.
3. Less heat generated.
4. These computer were able to reduce computational times from milliseconds to microseconds.
5. Less prone to hardware failures.
6. Wider commercial use.

Disadvantages :-

1. Air-conditioning required
2. Frequent maintenance required
3. Manual assembly of individual components into a functioning unit was required
4. Commercial production was difficult and costly.

1.2.2.3 The Third Generation (1965-74)

Advance in electronic technology continued and the advent of "microelectronic" technology made it possible to integrate large number of circuit elements into very small (less than 5 mm square) surface of silicon known as "chips". This new technology was called "integrated circuits" (ICs). The third generation was based on IC technology and the computer that were designed with the use of integrated circuits were called third generation computers.

The third generation was represented by the IBM/360-370 Series, the CDC 6600/7600 Series, Taxes Instruments ASC (Advanced Scientific Computer), and Digital Equipment's PDP-8 Series from the mid-1960s to the mid 1970s.

Fig. 4 :An IC chip

Microprogrammed control became popular with this generation. Pipelining and cache memory were introduced to close up the speed gap between the CPU and main memory. The idea of multiprograming was implemented to interleave CPU and I/O activities across multiple user programs. This led to the development of time-sharing *operating systems* (OS) using virtual memory with greater sharing or multiplexing of resources.

Advantages

1. Smaller in size as compared to previous generation computers.
2. Even more reliable than second generation computers.
3. Even lower heat generated than second generation computers.
4. The computers were able to reduce computational times from microseconds to nenoseconds.
5. Maintenance cost is low because hardware failures are rare.
6. Easily portable.
7. Totally general purpose. Widely used for various commercial applications all over the word.
8. Less power requirement than previous generation computers.
9. Manual assembly of individual components into a functioning unit not required. So human labour and cost involved at assembly stage reduced drastically.
10. Commercial production was easier and cheaper.

Disadvantages

1. Air conditions required in many cases.
2. Highly spohisticated technology required for manufacture of IC chips.

1.2.2.4 The Fourth Generation (1975-90)

Initially the integrated circuits contained only about ten to twenty components. This technology was named small scale integration (SSI) Later with the advancement in technology for manufacturing ICs, it became possible to integrate upto a hundred components on a single chip. This technology came to be known as medium scale integration (MSI). Then came the era of large scale integration (LSI) when ti was possible to integrate over 30,000 components onto a signal chip. Effort is still on for further miniaturization and it is expected that more than one million components will be integrate on a single chip known as very large scale integration (VLSI).

A fourth generation computer, which is what we has now, has LSI chips as its brain. It is LSI technology which has led to the development of very small but extremely powerful computers. It was the start of a social revolution. A whole computer circuit was soon available on a single chip, the size of a postage stamp. Overnight computer became incredibly compact. They become inexpensive to make and suddenly it became possible for anyone and every one to own a computer.

Parallel computers in various architectures appeared in the fourth generation of computers using shared or distributed memory or optional vector hardware. Multiprocessing OS, special languages, and compilers were developed for parallelism. Software tools and environments were created for parallel processing or distributed computing.

Representative system include the VAX 9000, Cray X-MP, IBM/3090 VF, BBN TC-2000, etc. During these 15 years (1975-1990), the technology of parallel processing gradually became mature and entered the production mainstream.

Advantages

1. Smallest in size because of high component density.
2. Very reliable
3. Heat generated is negligible
4. No air conditioning required in most cases.
5. Much faster in computation than previous generations.
6. Hardware failure is negligible and hence minimal maintenance is required.
7. Easily portable because of their small size.
8. Totally general purpose.
9. Minimal labour and cost involved at assembly stage.
10. Cheapest among all generations.

Disadvantage

1. Highly sophisticated technology required for the manufacture of LSI chips.

1.2.2.5 The Fifth Generation (1991-Present)

Fifth-generation computers have just begun to appear .These machines emphasize *massively parallel precessing* (MPP). Scalable and latency-tolerant architectures are being adopted in MMP system using VLSI silicon, GaAs technologies, high-density packaging, and optical

technologies.

Fifth-generation computers are targeted to achieve Teraflops (10^{12} floating-point operations per second) performance by the mid-1990s. *Heterogeneous processing* is emerging to solve large-scale problems using a network of heterogeneous computers with shared virtual memories. The fifth-generation MPP system are represented by several recently announced projects at Fujitsu (VPP500), Cray Research (MPP), Thinking Machines Corposration (the CM-5), and intel Supercomputer System (the Paragon).

Scientists are now at work on the firth generation computers, - a promise, but not yet a reality. They aim to bring us machines with genuine I.Q., the ability to reason logically, and with real knowledge of the world. Thus, unlike the last four generations which naturally followed its predecessor, the fifth generation will be totally different, totally novel, totally new.

In structure it will be parallel (the present ones are serial) and will be able to do multiple tasks simultaneously. In functions, it will not be algorithmic (step by step, with one step at a time). In nature, it will not do just data processing (number crunching) but knowledge processing. In inference, it will not be merely deductive, but also inductive. In application, it will behave like an expert. In programing, it will interact with humans in ordinary language (unlike BASIC, COBOL, FORTRAN, etc. which present computers need). And in architecture, it will have KIPS (Knowledge Information Processing System) rather than the present DIPS/LIPS (Data/Logic Information Processing System).

The odds of coming out with a fifth generation computer are heaviest for Japan. They have already started work in this direction few years back. Japan has chosen the PROLOG (Programming in Logic) language as its operating software and plans to have the final machine talk with human beings, see and deliver pictures and hear the normal, natural language.

1.2.3 Block Diagram of Computer

Computer is an automatic device which converts raw input data into useful information and presenting it to a user.

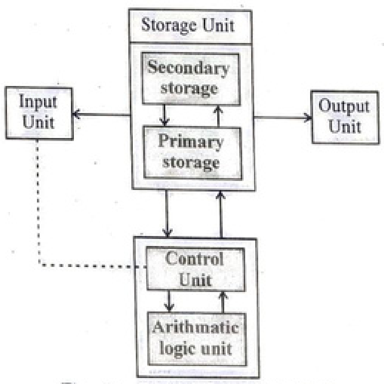


Fig. 5 : Control Processing Unit

The computer systems performs the following five basic operations -

1. **Inputting :-** Process of entering data and instroductions into a computer system.
2. **Storing :-** Saving data and instruction to make them readily available for initial or additional processing as and when required.
3. **Processing :-** Performing arithmatic operation or logical operation on data to convert them into useful information.
4. **Outputting :-** Process of producing useful information or results for a user,
5. **Controlling :-** Directing the manner and sequence in which the above operations are performed.

These five units correspond to the five basic operations performed by all computer systems.

1. **Input Unit :-** The input unit links the external environment with computer using the input interfaces. The functions of input unit.
   (a) It accepts instruction and data from outside world.
   (b) It converts these instructions and data in computer acceptable form.
   (c) It supplies the converted instructions and data to computer system for further processing.
2. **Output Unit :-** It is a reverse of input unit. It supplies information obtained from data processing to outside world. Hence it links a computer with its external environment using output interfaces. The functions of output unit.
   (a) It accepts the results produced by a computer.
   (b) It converts these coded resultrs into human acceptable form.
   It supplies the converted results to outside work.
3. **Storage Unit :** This unit stores the data and instructions entered into a computer, intermediate results for ongoing processing and result for output.
   There are two types of storage unit.
   (a) Primary storage :-
   (i) It is known as "Main memory".
   (ii) It can hold the information only while computer system is on (volatile memory).
   (iii) It has limited storage capacity because it is expensive.
   (iv) It is made up of semiconductor devices.
   (b) Secondary storage :-
   (i) It is known as "auxiliary storage".
   (ii) It is used to take care of the limitations of primary storage.
   (iii) It can hold the program instructions, data and information when computer system is off or reset.
   (iv) It has unlimited storage capacity because it is much cheaper than primary storage.
   (v) It holds the program instructions, data and information of those jobs on which computer system is currently not working but needs to hold them for processing later.

4. **Arithmetic logic Unit (ALU) :-** ALU is the place where actual execution of instructions take place during processing operations. ALU are designed to perform the arithmetic operations. Data and instruction, stored in primary storage before processing are transferred as and when needed to the ALU. where processing takes place. Intermediate results generated in the ALU are temporarily transferred back to primary storage until needed later.
5. **Control Unit :-** It acts as a central nervous system for other components of a computers system. It manages and coordinates the entire computer system. It tells the input that it is time for it to feed data to storage unit. It tells/instruct ALU that what should be done with the data once they are received. it obtains instructions from the program stored in main memory, interprets the instructions and positive signals causing other units of the system to execute them.
6. **Central Processing Unit :-** Control Unit (CU) and arithmatic logic unit (ALU) of a computer are together known as the central processing unit (CPU). The CPU is the brain of a computer system. All the major calculations and comparisons take place inside the CPU and CPU is responsible for activating and controlling the operations of other units of the computer systems.

1.2.4 Characteristic of Computer

1. **Automatic :-** Computers are automatic machines because once started on a job, they carry out the job until it is furnished. We need to instruct a computer using coded instructions and it works on a problem without any human interventions.
2. **Speed :-** A computer is a very fast device. It can perform in a few seconds, the amount of work that a human being can do in a entire year. While-talking about the speed of a computer we do not talk term of second or even milliseconds (10^{-3}) but in terms of microsecond (10^{-6}), nanosecond (10^{-9}) and even picosecond (10^{-12}).
3. **Accuracy :-** Accuracy of computer is consistently high and the degree of its accuracy depends upon its design. A computer performs every calculation with the same speed.
4. **Diligence :-** A computer is free from monotony tiredness and lack of concentration. It can continuously work for hours without creating any error and without grumbling. If then million calculations have to be performed, a computer will perform the last one with exactly the same accuracy and sped as the first one.
5. **Versatility :-** Versatility is one of the most wonderful things about a computer. One moment it is preparing results of an examination, next moment it is busy processing electricity bills of in between it may be helping one office secretary to trace an important letter is seconds.
6. **Power of Remembering :-** A computer can store and call any amount of information because of its secondary storage capability. It can return a piece of information as long as a user desires and the user can recall the information whenever required.
7. **NO I.Q. :-** A computer is not a magical derive. It posses no intelligence of its own. Its own is zero, at least until today. It has to be told what to do and in what sequence. Hence, only a user determines what tasks a computer will perform.

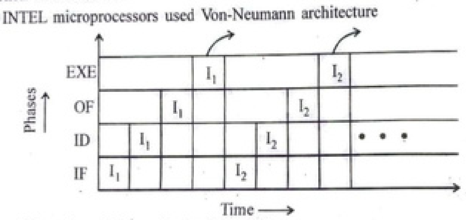
8. **No feeling is computer** are devoid of emot. They have feelings and no instincts because are machines.

1.3 Von-Neumann Architecture machine

In Von-Neumann Architecture the CPU executes instructions in a sequential order. The program is stored in the memory. The CPU fetches one instructions from the memory, decodes it and then gets data from the memory if any. After receiving data it executes the instruction. Then it fetches the next instruction from the memory for execution.

Unless it executes the instruction that already fetched, it does not fetch the next instruction from instruction buffer. Thus it executes instruction in a sequential order. Program counter (PC) is used to implement the sequential order. The program counter points (holds) the address of the next instruction to be executed.

Earlier INTEL microprocessors used Von-Neumann architecture



Where :- Phase 1 : IF → Instruction fetch
Phase 2 : ID → Instruction decode
Phase 3 : OF → Operand fetch
Phase 4 : EXE → Execute

1.3.1 Architectural Development Tracks

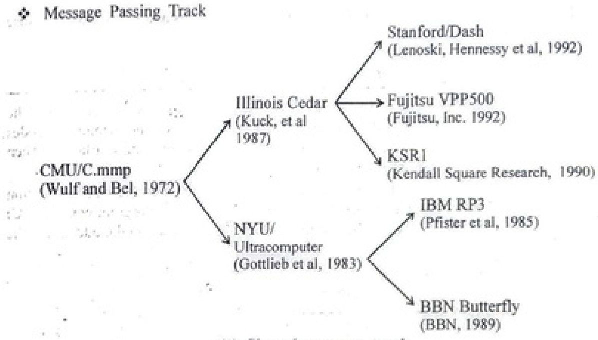
- Multiple Processor Tracks — Shared Memory track / Shared Passing track
- Multi vector and SIMD track — Multi vector track / SIMD Track
- Multithreaded and Dataflow track — Multithreaded Track / Dataflow Track

The architectures of most existing computers follow certain development tracks. These tracks are distinguished by similarity in computational models and technological bases.

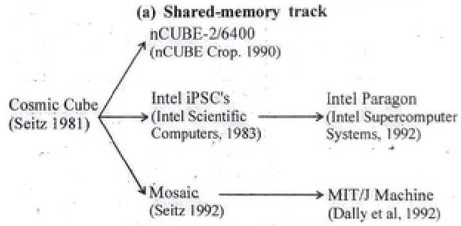
1.3.1.1 Multiple Processor Tracks

- Shared Memory Track

- Message Passing Track



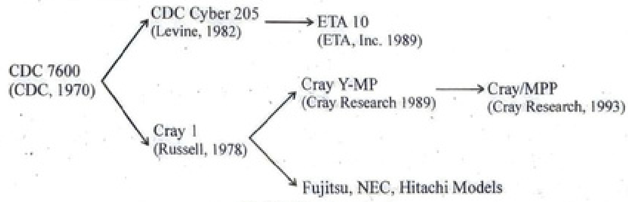
(a) Shared-memory track



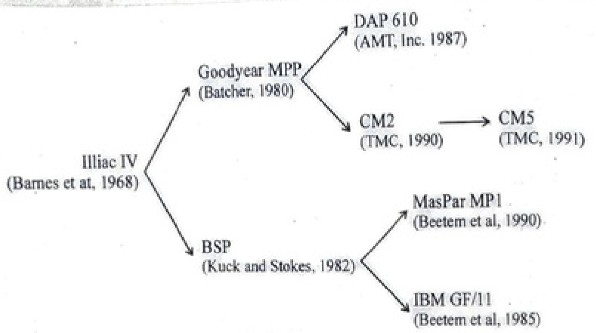
(b) Message-passing track

1.3.1.2 Multi vector and SIMD Track :-

- Multi vector Track
- SIMD Track



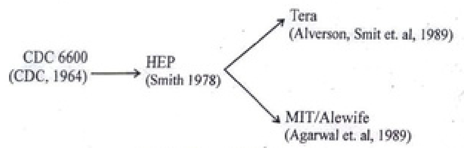
(a) Multivector track



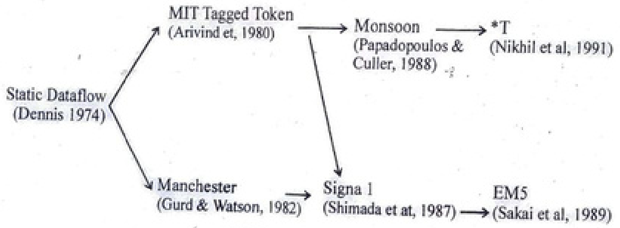
(b) SIMD track

1.3.1.3 Multithreaded and dataflow track

- Multithreaded Track
- Dataflow Track



(a) Multithreaded track



(b) Dataflow track

1.4 Motherboard

A motherboard is the central printed circuit board in some complex electronic systems, such as modern personal computers. The motherboard is sometimes alternatively known as the mainboard, system board, or, on Apple computers, the logic board It is also called sometimes mobo.

A motherboard is also known as a main board, system board and logic board. A common abbreviation is 'mobo'. They can be found in a variety of electrical devices, ranging from a TV to a computer and any other devices. Generally, they will be referred to as a motherboard or a main board when associated with a complex device such as a computer, laptop which is what we shall look at. Put simply, it is the central circuit board of your computer. All other components and peripherals plug into it, and the job of the motherboard is to relay information between them all. Despite the fact that a better motherboard will not add to the speed of your PC, it is none-the-less important to have one that is both stable and reliable, as its role is vital.

A motherboard houses the BIOS (Basic Input/Output System), which is the simple software run by a computer when initially turned on. Typically, the motherboard contains the following components:

- The CPU (Central Processing Unit)
- BIOS(Basic Input/Output System)
- graphics card
- sound card
- Memory
- Storage Devices(primary/secondary)
- hard-drive
- disk drives
- Parallel/seriol ports
- Integrated peripherals
- along with various external ports and peripherals.

And controllers, required for controlling standard peripheral devices, such as the display screen, keyboard, hard disk, magnet disk etc. There are a lot of motherboards on the market to choose from. The big question is, how do you go about choosing which one is right for you? Different motherboards support different components, and so it is vital you make a number of decisions concerning general system specifications before you can pick the right motherboard.

If you purchase your case before the rest of the components, the first factor to think about concerning motherboards is the size, or form factor. A form factor is a standardised motherboard size. If you think about fitting a motherboard in a case, there are a number of mounting holes, slot locations and PSU connectors. The most popular motherboard form factor today is ATX, which evolved from it's predecessor, the Baby AT, a smaller version of the AT (Advanced Technology) form factor. Generally speaking, nowadays a standard computer will have an ATX form factor motherboard: only special cases require different form factors.

So now you know which size you need, what comes next? The following are all factors you need to consider.

The first important differential is which CPU the board supports. Two of the biggest makes of CPUs at the moment are Intel and AMD, yet you cannot buy motherboards that support the use of either: it will support one or the other, due to physical differences in the connectors. This is often referred to as a type of platform; for example, an 'Intel platform motherboard' means a motherboard with an Intel CPU. Furthermore, you must choose a specific type of processor; for example, an AMD Athlon 64 or Pentium 4. Therefore, you must choose which CPU you want before you can choose your motherboard. Both Intel and AMD processors are capable of running the same applications, but there are differences in price and performance depending on which one you choose.

This fig.1 shown the structure of the motherboard.

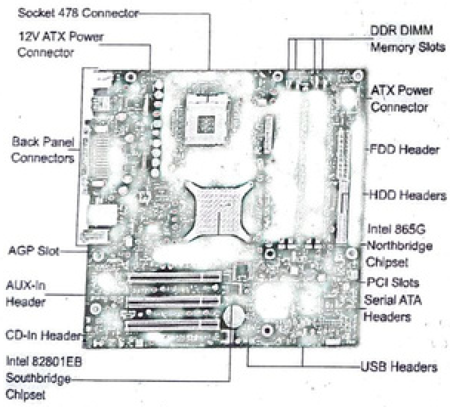


Fig. 6 : Layout of motherboard

We can also understand the structure of the motherboard with the help of a simplified block diagram which one is given below.

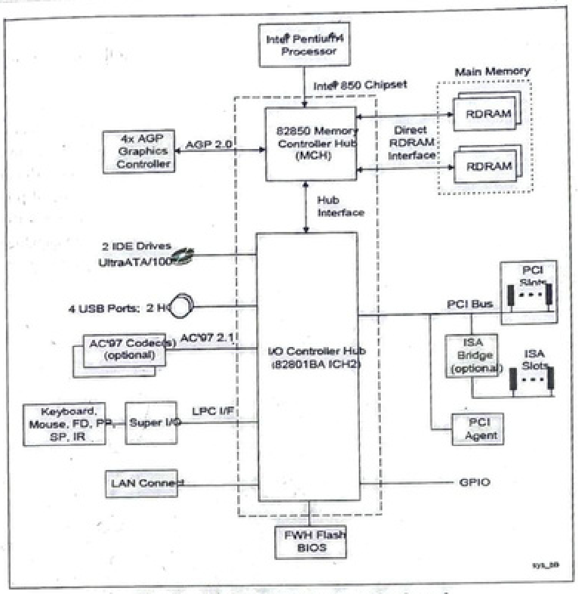


Fig. 7 : Block diagram of motherboard

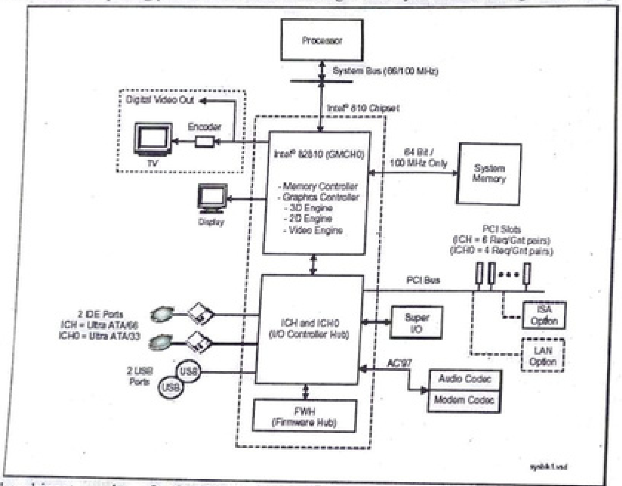
Some examples of motherbaords are as follows:

A typical motherboard of 2009 will have a different number of connections depending on its standard. A standard ATX motherboard will typically have 1x PCI-E 16x connection for a graphics card, 2x PCI slots for various expansion cards and 1x PCI-E 1x which will eventually supersede PCI.A standard Super ATX motherboard will have 1x PCI-E 16x connection for a graphics card. It will also have a varying number of PCI and PCI-E 1x slots. It can sometimes also have a PCI-E 4x slot. This varies between brands and models.

Some motherboards have 2x PCI-E 16x slots, to allow more than 2 monitors without special hardware or to allow use of a special graphics technology called SLI (for Nvidia) and Crossfire (for ATI). These allow 2 graphics cards to be linked together, to allow better performance in intensive graphical computing tasks, such as gaming and video-editing.As of 2007, virtually all motherboards come with at least 4x USB ports on the rear, with at least 2 connections on the board internally for wiring additional front ports that are built into the computer's case. Ethernet is also included now. This is a standard networking cable for connecting the computer to a network or a modem. A sound chip is always included on the motherboard, to allow sound to be output without the need for any extra components. This allows computers to be far more multimedia-based than before. Cheaper machines now often have their graphics chip built into the motherboard rather than a separate card.

1.4.1 INTEL® 810 Chipset

The Intel® 810 chipset is a high-integration chipset designed for the basic graphics/multimedia PC platform.Intel has developed technology that enhances the performance and exceptional value of PCs designed for Intel® Celeron® and Intel® Pentium® III processors based on .13 micron or .18 micron process technology. Built on the strong foundation of Intel® 440BX AGPset technology, the Intel® 810 chipset has re-engineered the PC platform, providing next-generation Features and great graphics performance at a lower cost.This integrated chipset offers innovative Features with compelling performance while lowering overall system costs through smart integration.



The chipset consists of a Graphics and Memory Controller Hub (GMCH) Host Bridge and anI/O Controller Hub (ICH/ICH0) Bridge for the I/O subsystem. The GMCH integrates a system memoryDRAM controller that supports a 64-bit 100 MHz DRAM array. The DRAM controller is optimized for maximum efficiency.

There are two versions of the GMCH (82810 and 82810-DC100). These two versions are pin compatible.

Figure 3 shows the block diagrams of typical platforms based on the Intel® 810 Chipset. this

is the block diagram of Intel 810 chipset with Intel 82810 GMCH. In this diagram we can see that there are many types of processors, system memory, buses, graphics controller PCI slots and buses are included.

Diagram 4 shows the intel chipset.

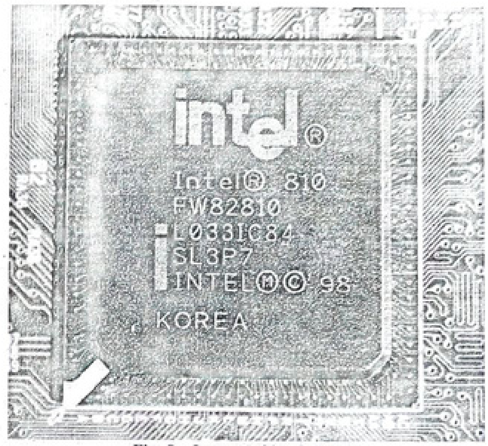


Fig. 8 : Layout of intel chipset

The features and advantage of the intel®810 chipset are as follows :

S.N.	FEATURES	ADVANTAGE
1	Intel® Hub Architecture	Increased Input-output performance allows better concurrency for richer multimedia applications
2	Intel® 3D graphics with Direct AGP	Vivid 2D and 3D graphics, BOM cost savings, efficient use of system memory for graphics, O/S, and applications
3	Integrated graphics / AC'97 controller	BOM cost savings, more flexibility and better audio quality
4	Intel® 3D graphics with Direct AGP	Vivid 2D and 3D graphics, BOM cost savings, efficient use of system memory for graphics, O/S, and applications
5	Low-power sleep modes	Energy and cost Savings

6	Optional 4MB of dedicated display cache video memory	Enables SKU differentiation with increased 3D graphics performance improvement over Direct AGP
7	One software driver code base	More stable platform, higher quality graphics, reduced OEM support costs
8	Digital Video Outport	Allows connection of traditional TV or new digital flat panel displays; compatible with DVI specification
9	66- and 100-MHz System Bus capable	Flexibility for performance headroom when used with Intel® Celeron® and Pentium® processors (.13 or .18 micron
10	Soft DVD MPEG-2* playback with Hardware Motion Compensation	Lifelike video and audio
11	Multiple Intel® 810 chipset SKUs for performance and value PC price poin	Lower platform and manufacturing costs with single motherboard design
12	2 USB ports	Plug and Play
13	Graphics driver	great graphics performance at a lower cost.

So these are the all features and advantages of the Intel® 810 Chipset motherboard.

1.5 System Clock

System time is measured by a system clock, which is typically implemented as a simple count of the number of ticks that have transpired since some arbitrary starting date, called the epoch. Every modern PC has multiple system clocks. Each of these vibrates at a specific frequency, normally measured in MHz (megahertz). A clock "tick" is the smallest unit of time in which processing happens, and is sometimes called a cycle; some types of work can be done in one cycle while others require many. The ticking of these clocks is what drives the various circuits in the PC, and the faster they tick, the more performance you get from your machine. The original

Device / Bus Clock	Speed (MHz)	Generated As
Processor	266	System Clock * 4
Level 2 Cache	133	System Clock * 2 (or Processor / 2)
System (Memory) Bus	66	
PCI Bus	33	System Clock / 2
ISA Bus	8.3	PCI Bus / 4

PCs had a unified system clock; a single clock (running at a very low speed like 8 MHz) drove the processor, memory (there was no cache back then) and I/O bus. As PCs have advanced and different parts have gained in speed more than others, the need for multiple clocks has arisen.

A typical modern PC now has either four or five different clocks, running at different (but related) speeds. When the "system clock" is referred to generically, it normally refers to the speed of the memory bus running on the motherboard.

The various clocks in the modern PC are created using a single clock generator circuit (on the motherboard) to generate the "main" system clock, and then various clock multiplier or divider circuits to create the other signals. The table below shows the typical arrangement of clocks in a 266 MHz Pentium II PC, and how they relate to each other:

1.5.1 System Clock Speed

The complete system is tied to the speed of the system clock. This is why increasing the system clock speed is usually more important than increasing the raw processor speed; the processor spends a great deal of time waiting on information from much slower devices, especially the system buses. While a faster processor will have greater performance, this increase in speed will not lead to nearly as much performance improvement if the processor is spending a great deal of time sitting idle waiting for other, slower parts of the system. Clock speeds are expressed in megahertz (MHz) or gigahertz (GHz).

1.6 System Bus

The CPU has to be able to send various data values, instructions, and information to all the devices and components inside your computer as well as the different peripherals and devices attached. If you look at the bottom of a motherboard you'll see a whole network of lines or electronic pathways that join the different components together. These electronic pathways are nothing more than tiny wires that carry information, data and different signals throughout the computer between the different components. This network of wires or electronic pathways is called the 'Bus'.

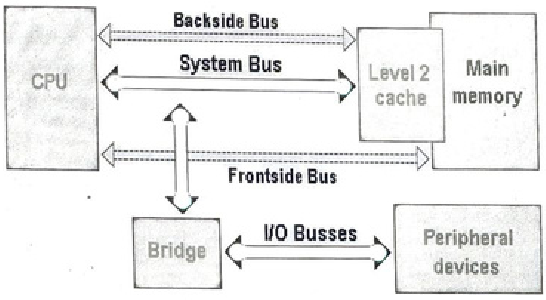


Fig. 9 : System Bus

All communication between the individual major components is via the system bus. The bus is merely a cable which is capable of carrying signals representing data from one place to another. The bus within a particular individual computer may be specific to that computer or may (increasingly) be an industry-standard bus. If it is an industry standard bus then there are advantages in that it may be easy to upgrade the computer by buying a component from an independent manufacturer which can plug directly into the system bus. For example most modern Personal Computers use the PCI bus.

A computer's bus can be divided into two different types, Internal and External. The Internal Bus connects the different components inside the case: The CPU, system memory, and all other components on the motherboard. It's also referred to as the System Bus. The External Bus connects the different external devices, peripherals, expansion slots, I/O ports and drive connections to the rest of the computer. In other words, the External Bus allows various devices to be added to the computer. It allows for the expansion of the computer's capabilities. It is generally slower than the system bus. Another name for the External Bus is the Expansion Bus.

After this study we can divide the system bus in three types. These are as follows:

1.6.1 Address bus

1.6.2 Data bus

1.6.3 Control bus

Now we can discuss one by one as in following way:

1.6.1 Address bus:

Data is stored, manipulated and processed in system memory at various locations. System memory is like a large sea of information full of fish (data). Our computer has to move information in and out of memory, and it has to keep track of which data is stored where. The computer knows where all the fishes are, but it has to transmit that information to the CPU and other devices. It has to keep a map of the different address locations in memory, and it has to be able to transmit and describe those memory locations to the other components so that they can access the data stored there. The info used to describe the memory locations travels along the address bus. The size or width of the address bus directly corresponds to the number of address locations that can be accessed. This simply means that the more memory address locations that a processor can address, the more RAM it has the capability of using. It makes sense, right? So An address bus is a computer bus that is used to specify a physical address. When a processor or DMA (Direct Memory Access)-enabled device needs to read or write to a memory location, it specifies that memory location on the address bus (the value to be read or written is sent on the data bus). The width of the address bus determines the amount of memory a system can address. For example, a system with a 32-bit address bus can address 232 (4,294,967,296) bytes, or 4 GB, of memory. Early processors used a wire for each bit of the address width. For example, a 16-bit address bus had 16 physical wires making up the bus. As the bus becomes wider, this approach becomes less convenient and more expensive to implement. Instead, some modern processors make the address bus faster than the data bus, and send the address in two parts. For example a 32-bit address bus can be implemented by using 16 wires and sending the first half of the memory address, immediately followed by the second half. For example A 286 processor with a 16 bit address bus can access over 16 million locations, or 16 Mb of RAM. A 386 CPU with a 32 bit address bus can access up to 4 GB of RAM. Of course, at the present time, due to space and cost limitations associated with the average home computer, 4GB of RAM is not practical. But, the address bus could handle it if it wanted to! **Address bus is also known as memory bus.**

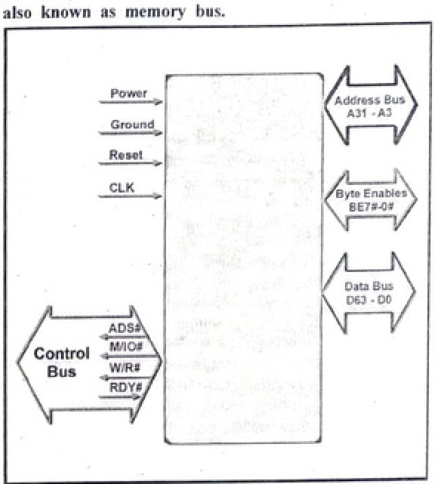


Fig.10 : Presentation of Address bus (Address bus A31-A3)

1.6.2 Data Bus

A data bus is a group of wires connecting different parts of a circuit with wire carrying a different signal. The data bus is connected to the inputs of several gates and to the outputs of several gates. A data bus may be time multiplexed to serve different functions at different times. At any time only one gate may drive information onto the bus line but several gates may receive it. In general, information may flow on the bus wires in both directions. This type of bus is referred to as a bidirectional data bus.

There are two types of data bus; they are address bus and a data bus. The data bus transfers data and address bus transfers information or address about where the data should go.A bus which allows data to be transferred faster, which makes applications run faster. The local bus is of high-speed that connects directly to the processor. Many military systems are compatible with the 1553, but most new commercial systems are not. This system is used for command and telemetry transfer between military spacecraft components, subsystems and instruments, and within complex components themselves.

The main work of the data bus is to carry digital information. A data bus can be viewed as a group or collection of wires connecting different parts of a circuit with wire carrying a different signal. The data bus is connected to the inputs of several gates and to the outputs of several gates. A data bus may be time multiplexed to serve different functions at different times. The ISA architecture which is also developed by IBM is used for defector standard, and is widely used for high performance. Thus, the main function of the data bus is to connect the system to the external devices. There are many types of data bus, which can connect the PC to the mobile and other external device in order to download software's. Thus data bus is a media which is transfer the data from one place to another.

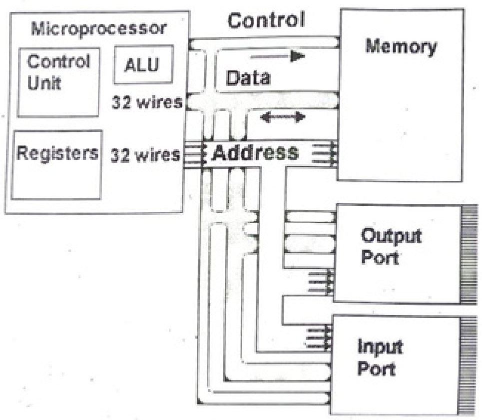


Fig. 11: Representation of Data Bus

1.6.3 Control Bus

A control bus is a computer bus, used by CPUs for communicating with other devices within the computer. While the address bus carries the information on which device the CPU is communicating with and the data bus carries the actual data being processed, the control bus carries commands from the CPU and returns status signals from the devices, for example if the data is being read or written to the device the appropriate line (read or write) will be active.

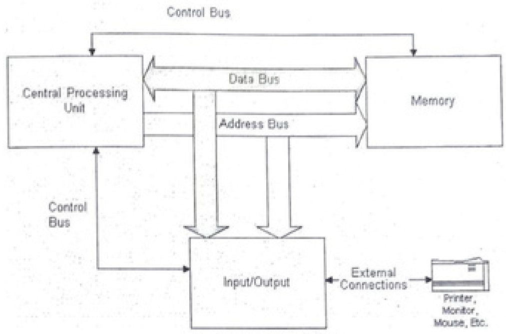


Fig. 12: Control Bus

1.7 Bus Architecture

There are many types of the bus architecture. Some of these are as follows:

1.7.1 Industry Standard Architecture (ISA)
1.7.2 Extended Industry Standard Architecture (EISA)
1.7.3 Micro Channel architecture (MCA)
1.7.4 Peripheral Component Interconnect (PCI)
1.7.5 Accelerated Graphics Port (AGP)

Now we can discuss one by one in detail as in following manner:

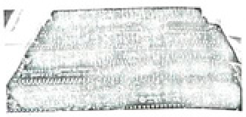
1.7.1 Industry Standard Architecture (ISA):

The ISA bus was developed by a team lead by Mark Dean at IBM as part of the IBM PC project in 1981. It originated as an 8-bit system and was extended in 1983 for the XT system architecture. The newer 16-bit standard, the IBM AT bus, was introduced in 1984. In 1988, the Gang of Nine IBM PC compatible manufacturers put forth the 32-bit EISA standard and in the process retroactively renamed the AT bus to "ISA" to avoid infringing IBM's trademark on its PC/AT computer. Therefore, the ISA bus was synchronous with the CPU clock, until sophisticated buffering methods were developed and implemented by chipsets to interface ISA to much faster CPUs.

ISA Designed to connect peripheral cards to the motherboard, ISA allows for bus mastering although only the first 16 MB of main memory are available for direct access. It was also available on some non-IBM compatible machines such as the short-lived AT&T Hobbit and later PowerPC based BeBox.

An example of the Industry stanard architecture is as follows:

Year of generation	1981
Created by:	IBM
Superseded by:	PCI (1993)
Width in bits:	8 or 16
Number of devices:	1 per slot
Capacity	8 MHz
Style:	Parallel
Hot plugging?	no
External?	no



Five 16-bit and one 8-bit ISA slots on a motherboard

The 16-bit ISA bus can be found in 286, 386, 486 and Pentium computers. Near the end of the 486's reign, the PCI bus was introduced and adopted. Late 486s and, of course, all Pentiums rely on the PCI bus, but so many legacy ISA cards are out there (and still being made) that most Pentium motherboards still have a couple of 16-bit ISA slots on them for compatibility with older expansion cards. ISA architecture also allowed for the fact that faster CPUs were now being developed. The CPU was given an internal clock or multiplier that was dissociated with the bus clock allowing each to run at its rated speed. Users of ISA-based machines had to know special information about the hardware they were adding to the system. While a handful of devices were essentially "plug-n-play," this was rare. Users frequently had to configure several parameters when adding a new device, such as the IRQ line, I/O address, or DMA channel. There are many use of the ISA bus architecture. Apart from specialized industrial use, ISA is all but gone today. Even where present, system manufacturers often shield customers from the term "ISA bus", referring to it instead as the "legacy bus".The PC/104 bus, used in industrial and embedded applications, is a derivative of the ISA bus, utilizing the same signal lines with different connectors. The LPC bus has replaced the ISA bus as the connection to the legacy I/O devices on recent motherboards; while physically quite different, LPC looks just like ISA to software, so that the peculiarities of ISA such as the 16 MiB DMA limit (which corresponds to the full address space of the Intel 80286 CPU used in the original IBM AT) are likely to stick around for a while. This architecture also used in the Windows Vista. Starting with Windows Vista, Microsoft is phasing out support for ISA cards in Windows. Vista still supports ISA-PnP for the time being, although it's not enabled by default. However, consumer market PCs discontinued the ISA port feature on their motherboards before Windows XP was released.

1.7.2 Micro Channel Architecture (MCA):

IBM came out with a new 32-bit bus architecture that had a speed of 10MHz. The Micro-Channel Architecture (MCA) bus was able of using multiple bus mastering devices and could be configured using software. A big improvement over jumpers and DIP switches. Actually you needed two disks. One was a "Reference" disk, which allowed access to the configuration program, and the other was an "Options" disk, which provided the options available.

Actually a very good bus, IBM didn't want to share, and the MCA bus was only available on IBM machines. Because of the millions of computers out there with ISA bus architecture,

manufacturers probably saw more money in developing a more 'reliable' expansion card that would fit in any mode, as opposed to manufacturing a highly proprietary card that would only fit in one type of machine. The number of makes, models, and types of devices for MCA was limited.

The MCA (Micro channel architecture) bus has some pretty impressive properties considering that it was introduced in 1987, a full seven years before the PCI bus made similar features common on the PC. In some ways it was ahead of its time, because back then the ISA bus really wasn't a major performance limiting factor:

- **32 Bit Bus Width:** The MCA bus features a full 32 bit bus width, the same width as the VESA and PCI local buses. It had far superior throughput to the ISA bus.
- **Bus Mastering:** The MCA bus supported bus mastering adapters for greater efficiency, including proper bus arbitration.
- **Plug and Play:** MCA automatically configured adapter cards, so there was no need to fiddle with jumpers. This was eight years before Windows 95 brought PnP into the mainstream!

MCA had a great deal of potential. Unfortunately, IBM made two decisions that would doom MCA to utter failure in the marketplace. First, they made MCA incompatible with ISA; this means ISA cards will not work at all in an MCA system, one of the few categories of PCs for which this is true. The PC market is very sensitive to backwards-compatibility issues, as evidenced by the number of older standards that persist to this day (such as ISA!) Second, IBM decided to make the MCA bus proprietary.

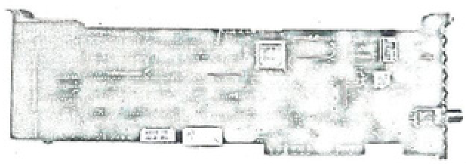


Fig. 13: 16-bit Network Interface Card IBM 83X9648

1.7.3 Extended Industry Standard Architecture (EISA):

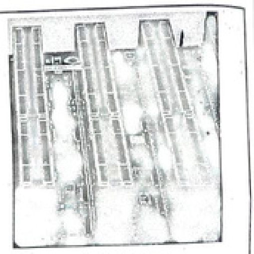
As a result of the advanced architecture of the MCA, several different companies put their heads together and came up with their own version, the EISA (pronounced 'ee-sah') bus. It was announced in late 1988 by PC clone vendors (the "Gang of Nine") as a counter to IBM's use of its proprietary MicroChannel Architecture (MCA) in its PS/2 series. It has a 32-bit data path and is able of using multiple bus mastering devices. The EISA bus has no need for interrupts or DMA (Direct Memory Access) channels and is configured with software, using a configuration utility and a device specific program. It still only has an 8 MHz bus speed.

The socket itself is taller than the 16-bit ISA. The EISA expansion cards have two horizontal rows of metal contacts on their edge connector, and there are two corresponding horizontal rows of metal 'fingers' in the socket. If you place an ISA card in an EISA socket, it doesn't fit all the way down, and its contacts only reach the top row of metal 'fingers'. It makes it completely backward compatible with the ISA cards. Although it wasn't completely proprietary, it was found mainly in brand name computers. I can't remember seeing one in a clone, or a custom built computer. As a result, there aren't a large number of EISA devices on the market.

EISA was much favoured by manufacturers due to the proprietary nature of MCA, and even IBM produced some machines supporting it. It was somewhat expensive to implement (though not as much as MCA), so it never became particularly popular in desktop PCs. However, it was reasonably successful in the server market, as it was better suited to bandwidth-intensive tasks (such as disk access and networking).

The example of EISA is as follows:

Year created:	1988
Created by:	Gang of Nine
Superseded by:	PCI (1993)
Width in bits:	32
Number of devices:	1 per slot
Capacity	8.33 MHz
Style:	Parallel
Hot plugging?	No
External?	No



EISA slots

EISA contained almost all of the technological benefits that MCA boasted, including bus mastering, burst mode, plug and play, ISA compatibility, software configurable resources, and 32-bit data/address buses. These brought EISA nearly to par with MCA from a performance standpoint, and EISA easily defeated MCA in industry support. The user could also enter information about ISA cards in the system, allowing the utility to automatically reconfigure EISA cards to avoid resource conflicts.

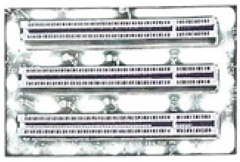
1.7.4 Peripheral Component Interconnect (PCI):

Conventional PCI is a computer bus for attaching hardware devices in a computer. These hardware devices can take either the form of an integrated circuit fitted onto the motherboard itself, called a planar device in the PCI specification or an expansion card that fits into a slot. The name PCI is an initialism formed from Peripheral Component Interconnect. The PCI bus was introduced with the Pentium computer. The 16-bit and 32-bit bus architecture would limit the performance of the 64-bit Pentiums. The PCI bus supports both 32 and 64-bit data paths and uses a chipset that will also support ISA and EISA architectures. This means that the PCI bus can be used for both 486 computers and Pentiums, and motherboards can have a combination of PCI and ISA or EISA slots.

The PCI bus communicates with the processor through a bridge or circuit, which acts kind of like an interpreter. This means that it can be processor independent. It can work with CISC or RISC technologies as long as it has the proper bridge circuit to interpret the information. PCI has a 33 MHz bus speed and can support multiple bus mastering devices. The cards are Plug-and-Play and come in two versions, 5Vdc and 3.3Vdc. The slots are keyed differently and will not allow the wrong voltage card to be inserted.

The PCI specification covers the physical size of the bus (including wire spacing), electrical characteristics, bus timing, and protocols. The specification can be purchased from the PCI Special Interest Group (PCI-SIG).Typical PCI cards used in PCs include: network cards, sound cards, modems, extra ports such as USB or serial, TV tuner cards and disk controllers. Historically video cards were typically PCI devices, but growing bandwidth requirements soon outgrew the capabilities of PCI. PCI video cards remain available for supporting extra monitors and upgrading PCs that do not have any AGP or PCI Express slots.

Year created:	July 1993
Created by:	Intel
Superseded by:	PCI Express (2004)
Width in bits:	32 or 64
Number of devices:	1 per slot
Capacity	133 MB/s (32bit)
Style:	Parallel
Hot plugging?	Optional
External?	no



Three 5V 32-bit PCI expansion slots on a motherboard

1.8 Expansion Slots and Cards

An expansion card (also expansion board, adapter card or accessory card) in computing is a printed circuit board that can be inserted into an expansion slot of a computer motherboard to add additional functionality to a computer system. One edge of the expansion card holds the contacts (the edge connector) that fit exactly into the slot. They establish the electrical contact between the electronics (mostly integrated circuits) on the card and on the motherboard or microprocessor.

For example, some expansion cards need two slots like some nVidia GeForce FX and newer GeForce graphics cards and there is often a space left to aid cooling on some high-end cards. Some cards are "low-profile" cards, meaning that they are shorter than standard cards and will fit in a lower height computer chassis. (There is a "low profile PCI card" standard. that specifies a much smaller bracket and board area). The group of expansion cards that are used for external connectivity, such as a network, SAN or modem card, are commonly referred to as input/output cards (or I/O cards).

The primary objective of an expansion card is to facilate or expand on features not offered by the motherboard. For example, the original IBM PC did not provide graphics or hard drive capability as the technology for providing that on the motherboard did not exist. In that case, a graphics expansion card and an ST-506 hard disk controller card provided graphics capability and hard drive interface respectively.In the case of expansion of on-board capability, a motherboard may provide a single serial RS232 port or Ethernet port. An expansion card can be installed to offer multiple RS232 ports or multiple and higher bandwidth Ethernet ports. In this case, the motherboard provides basic functionallity but the expansion card offers additional or enhanced ports. There are various types of cards like Video cards, Sound cards, Network cards, TV tuner cards, Video processing expansion cards, Modems and AGP. Now we will study one by one in great detail.

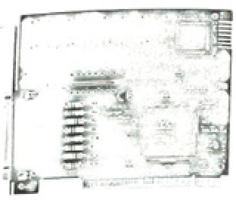


Fig. 14 :. Example of a PCI Digital I/O Expansion Card

Various types of expansion card are as follows:

(i) Network adapter cards (ii) SCSI card

(iii) Sound cards (iv) TV tuner cards

(v) PC card (vi) Video cards

Now we will cover all types of cards one by one in the following manner:

1.8.1 Network Adaptor Card

A network card also known as network adapter, network interface controller (NIC), network interface card, or LAN adapter. It is a computer hardware component designed to allow computers to communicate over a computer network. It works both on OSI layer 1 (physical layer) and layer 2 (data link layer). it provides physical access to a networking medium and provides a low-level addressing system through the use of MAC addresses. It allows users to connect to each other either by using cables or wirelessly.

Whereas network cards used to be expansion cards that plug into a computer bus, the low cost and ubiquity of the Ethernet standard means that most newer computers have a network interface built into the motherboard. These either have Ethernet abilities integrated into the motherboard chipset or implemented via a low cost dedicated Ethernet chip, connected through the PCI (Peripheral Component Interconnect) or the newer PCI express bus. A separate network card is not required unless multiple interfaces are needed or some other type of network is used. Newer motherboards may even have dual network interfaces built-in.

There are four techniques used to transfer data, the NIC (network interface controller) may use one or more of these techniques.

- Polling is where the microprocessor examines the status of the peripheral device under program control.
- Programmed I/O is where the microprocessor alerts the designated peripheral by applying its address to the system's address bus.

- Interrupt-driven I/O is where the peripheral alerts the microprocessor that it's ready to transfer data.
- DMA (Direct Memory Access) is where an intelligent peripheral assumes control of the system bus to access memory directly. This removes load from the CPU but requires a separate processor on the card.

A network card typically has a twisted pair, BNC socket where the network cable is connected, and a few LEDs to inform the user of whether the network is active, and whether or not there is data being transmitted on it. Network cards are typically available in 10/100/1000 Mbit/s varieties. This means they can support a notional maximum transfer rate of 10, 100 or 1000 Megabits per second.

A **network interface controller** (NIC) is a hardware device that handles an interface to a computer network and allows a network-capable device to access that network. The NIC has a ROM chip that contains a unique number, the multiple access control (MAC) Address burned into it. The MAC address identifies the device uniquely on the LAN. The NIC exists on both the 'Physical Layer' (Layer 1) and the 'Data Link Layer' (Layer 2) of the OSI model.

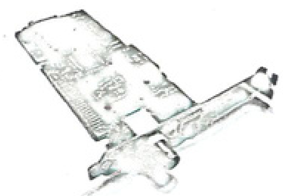


Fig. 15 : A 1990s Ethernet network interface controller card

1.8.2 SCSI Card

A SCSI card is a card that will control the interface between SCSI versions of hard drives, CD-ROM drives, CD-ROM burners, removable drives, external devices such as scanners, and any other SCSI components. Most fit in a PCI slot and there is a wide range of types. The three main types of connectors on these cards are 25-pin for SCSI-1, 50-pin for Narrow SCSI, and 68-pin for Wide SCSI.

SCSI controllers provide fast access to very fast SCSI hard drives. They can be much faster than the IDE controllers that are already integrated your computer's motherboard. SCSI controllers have their own advanced processing chips, which allow them to rely less on the CPU for handling instructions than IDE controllers do. A SASI controller provided a bridge between a hard disk drive's low-level interface and a host computer, which needed to read blocks of data. SASI controller boards were typically the size of a hard disk drive and usually mounted on top of them. SASI, which was used in mini- and microcomputers, defined the interface as using a 50-pin flat ribbon connector which was adopted as the SCSI-1 connector. SASI is a fully compliant subset of SCSI-1 so that many, if not all, of the then existing SASI controllers were SCSI-1 compatible. For the common user, SCSI controllers are overkill, but for high end servers and/or the performance freaks of the world, SCSI is the way to go. SCSI controllers are also much more expensive than the free IDE controller already included on your motherboard.

SCSI cards also have the ability to have up 15 devices or more per card, while a single IDE controller is limited to only 4 devices (some motherboards now come with more than one IDE controller though). SCSI cards allow these drives to be in a chain along the cable. Each drive on the cable has to have a separate SCSI ID (this can be set by jumpers on the drive). The last drive on the end of the cable (or the cable itself) has to "terminate" the chain (you turn termination on by setting a termination jumper on the drive - or use a cable that has a terminator at the end of it).

So this was the complete study of the expansion cards. Now we will study about the Ports. Port is a socket on the back of computer. There are many types of the port like as parallel port, serial port, AGP port, USB port etc. Now we will discuss one by one.

1.8.3 Sound Card

A sound card (audio card) is a computer expansion card that provides the input and output of audio signals to and from a computer under control of computer programs. Typical uses of sound cards include providing the audio component for multimedia applications such as music composition, editing video or audio, presentation, education, and entertainment (games). Many computers have sound capabilities built in, while others require additional expansion cards to provide for audio capability.

Sound cards usually feature a digital-to-analog converter, which converts recorded or generated digital data into an analog signal. The output signal is connected to an amplifier, headphones, or external device using standard interconnects..If the number and size of connectors is too large for the space on the backplate the connectors will be off-board, typically using a breakout box, or an auxiliary backplate. More advanced cards usually include more than one sound chip to provide for higher data rates and multiple simultaneous functionality.Digital sound reproduction is usually done with multi-channel DACs, which are capable of multiple digital samples simultaneously at different pitches and volumes, or optionally applying real-time effects like filtering or distortion. Most sound cards have a line in connector for signal from a cassette tape recorder or similar sound source. The sound card digitizes this signal and stores it (under control of appropriate matching computer software) on the computer's hard disk for storage, editing, or further processing. Another common external connector is the microphone connector, for use by a microphone or other low level input device. Input through a microphone jack can then be used by speech recognition software or for Voice over IP applications.

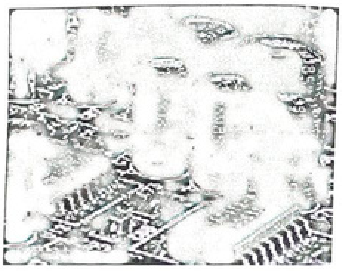


Fig. 16 : Diagram of a sound card PCB, showing electrolytic capacitors, SMT capacitors and resistors, and a YAC512 two-channel 16-bit DAC.

An important characteristic of sound cards is polyphony, which is more than one distinct voice or sound playable simultaneously and independently, and the number of simultaneous channels. For example, many sound chips could accommodate three voices, but only one audio channel (i.e. a single mono output) for output, requiring all voices to be mixed together. More recent cards, such as the AdLib sound card, have a 9 voice polyphony and 1 mono channel as a combined output.Professional soundcards are special soundcards optimized for real time multichannel sound recording and playback, including studio-grade fidelity. Their drivers usually follow the Audio Stream Input Output protocol for use with professional sound engineering and music software, although ASIO drivers are also available for a range of consumer-grade soundcards. On the other hand, certain features of consumer soundcards such as support for Environmental audio extensions, optimization for hardware acceleration in video games, or real-time ambience effects are secondary, nonexistent or even undesirable in professional soundcards, and as such audio interfaces are not recommended for the typical home user.

1.8.4 TV Tuner Card

A TV tuner card is a computer component that allows television (TV) signals to be received by a computer. Most TV tuners also function as video capture cards, allowing them to record television programs onto a hard disk.TV tuners are available in a number of different interfaces: as PCI bus expansion card, PCMCIA Express or USB devices also exist (hdhomerun) and (HAVA). In addition, some video cards double as TV tuners, notably the ATI All-In-Wonder series. The card contains a tuner and an analog-to-digital converter (ADC) (collectively known as the analog front end) along with demodulation and interface logic. Some very cheap cards lack an onboard processor and, like a Winmodem, rely on the system's CPU for demodulation. Fig. of simple TV tuner card is shown below:

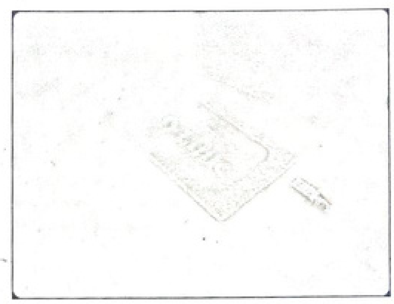


Fig. 17 : A Simple TV Tuner Card

At that time there are four types of TV tuner card in the market. These are as follows:

- **Analog TV tuners-** analog television cards output a raw video stream, suitable for real-time viewing but ideally requiring some sort of compression if it is to be recorded.
- **Digital TV tuners-** Digital TV is broadcast as an MPEG-2 stream, so no encoder is necessary

- **Hybrid tuners-** A hybrid tuner has one tuner that can be configured to act as an analog tuner or a digital tuner.
- **Combo tuners-** This is similar to a hybrid tuner, except there are two separate tuners on the card. One can watch analog while recording digital, or vice versa.

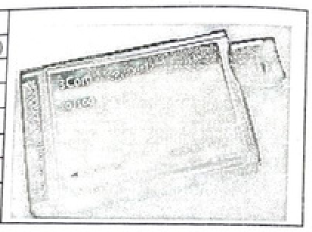
External TV tuner card attachments are available for mobile phone handsets like the iPhone, for watching mobile TV.

1.8.5 PC Cards

PC Card also known PCMCIA (Personal Computer Memory Card International Association). It is the form factor of a peripheral interface designed for laptop computers. The United States computer industry created the Personal Computer Memory Card International Association to challenge the Japanese JEIDA memory card devices by offering a competing standard for memory-expansion cards.

PC Card was originally designed for computer storage expansion, but the existence of a usable general standard for notebook peripherals led to many kinds of devices being made available in this form. Typical devices included network cards, modems, and hard disks. The cards were also used in early digital SLR cameras, such as the Kodak DCS 300 series. The original use, as storage expansion, is no longer common. A simple example of PC CARD is shown below:

Year created:	1991
Superseded by:	Express Card (2003)
Width in bits:	32
Number of devices:	1 per slot
Capacity	133 MB/s
Style:	Parallel
Hot plugging?	Yes
External?	Yes



All PC Card devices use an identical 68 pin dual row connecting interface. All are 85.6 mm long and 54.0 mm wide. This is the same size as a credit card. The form factor is also used by the Common Interface form of Conditional Access Modules for DVB broadcasts. The original standard was defined for both 5 volt and 3.3 volt cards. The 3.3 V cards have a key on the side to protect them from being damaged by being put into a 5 V-only slot. There are various types of the cards. Some of these are as follows:

Type I:

Cards designed to the original specification (version 1.x) are type I and feature a 16-bit interface. They are 3.3 mm thick. Type-I PC Card devices are typically used for memory devices such as RAM, OTP, and SRAM cards.

Type II:

Type-II PC Card devices feature a 16- or 32-bit interface. They are 5.0/5.5 mm thick. Type-II cards introduced I/O support, allowing devices to attach an array of peripherals or to provide connectors/slots to interfaces for which the host computer had no built-in support. For example,modem, network and TV cards use this form factor.

Type III:

Type-III PC Card devices are 16-bit or 32-bit. These cards are 10.5 mm thick, allowing them to accommodate devices with components that would not fit type I or type II height. Examples are hard disk drive cards, and interface cards.

Type IV:

Type-IV cards, introduced by Toshiba, have not been officially standardized or sanctioned by the PCMCIA(Personal Computer Memory Card International Association). These cards are 16 mm thick.

In the PC CARD there is a very important feature Card information structure (CIS).The Card Information Structure (CIS) is information stored on a PC card that contains information about the formatting and organisation of the data on the card.The CIS also contains information about:

- The type of card
- Supported power supply options
- Supported power saving features
- The manufacturer team
- Model number
- and so on.

When a card is unrecognized it is frequently because the CIS information is either lost or damaged.

1.8.6 Video Card

A video card, also known as a graphics accelerator card, display adapter, or graphics card, is an expansion card whose function is to produce and output images to a display. Some video cards offer added functions, such as video capture, video recording, TV tuner adapter, MPEG-2 decoding, FireWire, light pen, TV output, or the ability to connect multiple monitors.A misconception regarding high end video cards is that they are strictly used for video games. High end video cards have a much broader range of capability; for example, they play a very important role for graphic designers and 3D animators, who tend to need optimum displays as well as faster rendering.

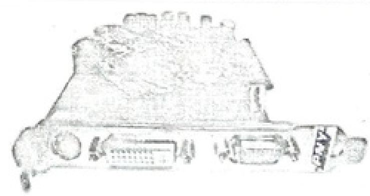


Fig. 18 : A video card

The first IBM PC video card, which was released with the first IBM PC, was developed by IBM in 1981. Video hardware can be integrated on the mainboard, as it often happened with early computers; in this configuration it was sometimes referred to as a video controller or graphics controller. A modern video card consists of a printed circuit board on which the components are mounted. These include:

- Graphics processing unit (GPU)
- Video BIOS (Firmware)
- Video memory
- Random Access Memory Digital-to-Analog Converter (RAMDAC)
- Outputs
- Motherboard interface
- Cooling devices (Heat sink, Computer fan, Water block)
- Power demand

So these are all the components of the video card. Here is no need to detail study of these components. The fig.7 of video card is as follows:

1.9 PORTS

1.9.1 SERIAL PORT

Serial port is a serial communication physical interface through which information transfers in or out one bit at a time (contrast parallel port). Throughout most of the history of personal computers, data transfer through serial ports connected the computer to devices such as terminals and various I/O device. While such interfaces as FireWire, and USB all send data as a serial stream, the term "serial port" usually identifies hardware more or less compliant to the RS-232 standard, intended to interface with a modem or with a similar communication device.

For its use to connect peripheral devices the serial port has largely been replaced by USB and Firewire. For networking, it has been replaced by Ethernet. For console use with terminals it was replaced long ago by MDA and then VGA. While nearly every server has a serial port connector, most non-poweruser workstations and laptops do not have an outwardly wired one as it is a legacy port, and superseded for most uses. Serial ports are commonly still used in legacy applications such as industrial automation systems, scientific analysis, shop till systems and some industrial and consumer products. Network equipment (such as routers and switches) often use serial console for configuration. Serial ports are still used in these areas as they are simple, cheap and their console functions (RS-232) are highly standardized and widespread.

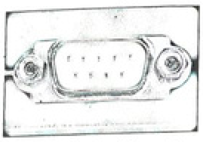


Fig. 19: Serial port

Many personal computer motherboards still have at least one serial port. Small-form-factor systems and laptops may omit RS-232 connector ports to conserve space, but the electronics are still there. RS-232 has been standard for so long that the circuits needed to control a serial port became very cheap and often exist on a single chip, sometimes also with circuitry for a parallel port.

1.9.2 PARALLEL PORT

A parallel port is a type of interface found on computers (personal and otherwise) for connecting various peripherals. It is also known as a **printer port.** The IEEE 1284 standard defines the bi-directional version of the port. the parallel interface was adapted to access a number of peripheral devices other than printers. Probably one of the earliest devices to use parallel were dongles used as a hardware key form of software copy protection. Zip drives and scanners were early implementations followed by external modems, sound cards, webcams, gamepads, joysticks and external hard disk drives and CD-ROM drives.Many manufacturers of personal computers and laptops consider parallel to be a legacy port and no longer include the parallel interface. USB to parallel adapters are available to use parallel-only printers with USB-only systems. However, due to the simplicity of its implementation, it is often used for interfacing with custom-made peripherals devices.

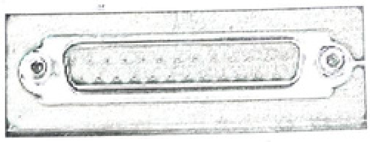


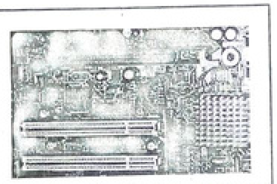
Fig. 20: Parallel port

1.9.3 ACCELERATED GRAPHICS PORT (AGP)

The Accelerated Graphics Port (AGP) (also called Advanced Graphics Port) is a high-speed point-to-point channel for attaching a video card to a computer's motherboard, primarily to assist in the acceleration of 3D computer graphics. Since 2004, AGP is being progressively phased out in favor of PCI Express. However, as of mid 2009 new AGP cards and motherboards are still available for purchase, though OEM driver support is minimal.

There are many advantages of the AGP over PCI.For example AGP is superior to PCI because it provides a dedicated pathway between the slot and the processor rather than sharing the PCI bus, allowing for faster communication.. In addition, to load a texture, a PCI graphics card must copy it from the system's RAM into the card's framebuffer, whereas an AGP card is able of reading textures directly from system RAM using the Graphics Address Remapping Table (GART).

Year created:	1997
Created by:	Intel
Superseded by:	PCI Express (2004)
Width in bits:	32
Number of devices:	1 device/slot
Capacity	up to 2133 MB/s
Style:	Parallel
Hot plugging?	no
External?	no



An AGP slot (having long size) and two PCI slots

There are many versions of the AGP like as :AGP 1x, AGP 2x, AGP 4x, AGP 8x. All new graphics processors are designed for PCI-Express. To create AGP graphics cards, those chips require an additional PCIe to AGP bridge chip to convert PCIe signals to and from AGP signals. This incurs additional board costs due to the need for the additional bridge chip and for a separate AGP-designed circuit board. As of 2009, several companies released AGP cards based on the mid-range Radeon HD3650, Radeon HD4650 and the mid-high end HD3850.

1.9.4 UNIVERSAL SERIAL BUS (USB) PORT

Universal Serial Bus (USB) is a serial bus standard to connect devices to a client computer. USB was designed to allow many peripherals devices to be connected using a single standardized interface socket and to improve plug and play capabilities by allowing hot swapping; that is, by allowing devices to be connected and disconnected without rebooting the computer or turning off the device. Other convenient features include providing power to low-consumption devices, eliminating the need for an external power supply; and allowing many devices to be used without requiring manufacturer-specific device drivers to be installed.

USB is intended to replace many varieties of serial and parallel ports. USB can connect computer peripherals such as mice, keyboards, PDAs, gamepads and joysticks, scanners, digital cameras, printers, personal media players, flash drives, and external hard drives. For many of those devices, USB has become the standard connection method. USB was designed for personal computers, but it has become commonplace on other devices such as PDAs and video game consoles, and as a power cord between a device and an AC adapter plugged into a wall plug for charging. The design of USB is standardized by the USB Implementers Forum (USB-IF), an industry standards body incorporating leading companies from the computer and electronics industries. USB was created by a core group of companies that consisted of Intel, Compaq, Microsoft, Digital, IBM, and Northern Telecom. USB devices are linked in series through hubs. There always exists one hub known as the root hub, which is built into the host controller. So-called "sharing hubs", which allow multiple computers to access the same peripheral device(s), also exist and work by switching access between PCs, either automatically or manually. They are popular in small-office environments. In network terms, they converge rather than diverge branches.

Year created:	January 1996
Created by:	Intel, Compaq, Microsoft, Digital, IBM.
Width in bits:	1
Number of devices:	127 per host controller
Capacity	1.5, 12, or 480 Mbit/s (1.5 or 60 MByte/s)
Style:	Serial
Hot plugging?	Yes
External?	Yes

Original USB Logo

Various versions exists of the usb port. Some of these are as follows:

- USB 0.7: Released in November 1994.
- USB 0.8: Released in December 1994.
- USB 0.9: Released in April 1995.
- USB 0.99: Released in August 1995.
- USB 1.0: Released in January 1996.
- USB 2.0: Released in April 2000
- USB 3.0 : currently in development

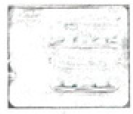


Fig. 21: USB port

1.9.5 FIREWIRE

The FireWire is a serial bus interface standard for high-speed communications and isochronous real-time data transfer, frequently used by personal computers, as well as in digital audio, digital video, automotive, and aeronautics applications.IEEE 1394 replaced parallel SCSI in many applications, because of lower implementation costs and a simplified, more adaptable cabling system. The 1394 standard also defines a backplane interface, though this is not as widely used.IEEE 1394 (FireWire) has been adopted as the High-Definition Audio-Video Network Alliance (HANA) standard connection interface for A/V (audio/visual) component communication and control. FireWire is also available in wireless, fiber optic, and coaxial versions using the isochronous protocols.Apple intended FireWire to be a serial replacement for the parallel SCSI (Small Computer System Interface) bus while also providing connectivity for digital audio and video equipment.FireWire can connect up to 63 peripherals in a tree chain topology.It allows peer-to-peer device communication - such as communication between a scanner and a printer - to take place without using system memory or the CPU. FireWire also supports multiple hosts per bus. It is designed to support Plug and play and hot swapping.

History of FireWire is shown below:

Year created:	1995
Created by:	Apple Inc.
Width in bits:	1
Number of devices:	63
Capacity	400-3200 Mbit/s (50-400 MB/s)
Style:	Serial
Hot plugging?	Yes
External?	Yes

FireWire

Comparision between FireWire and USB

USB was originally seen as a complement to FireWire (IEEE 1394), which was designed as a high-speed serial bus which could efficiently interconnect peripherals such as hard disks, audio interfaces, and video equipment. USB originally operated at a far lower data rate and used much simpler hardware, and was suitable for small peripherals such as keyboards and mice.The most significant technical differences between FireWire and USB include the following points:

- USB networks use a tiered-star topology, while FireWire networks use a tree topology.
- USB 1.0, 1.1 and 2.0 use a "speak-when-spoken-to" protocol; peripherals cannot communicate with the host unless the host specifically requests communication. USB 3.0 is planned to allow for device-initiated communications towards the host A FireWire device can communicate with any other node at any time, subject to network conditions.
- A USB network relies on a single host at the top of the tree to control the network. In a FireWire network, any capable node can control the network.
- USB runs with a 5 V power line, while Firewire can supply up to 30 V.
- USB ports can provide up to 500mA of current (2.5 watts of power), while FireWire can in theory supply up to 60 watts of power, although 10 to 20 watts is more typical.
- Fire wire interfaces are definitely faster than USB interfaces. In fact, Fire wire interfaces can transfer data at a rate of 50 megabytes (MB) of data per second, which is about 33 times faster than the USB 1.1 data transfer rate of 1.5 MB per second. USB 2.0 devices, which are more common, can achieve speeds of 40 MB per second.
- Another advantage of Fire wire over USB is that it reserves 3.5 MB per second of bandwidth to use with video equipment. This means that if you have additional Fire wire devices running when you are using your attached video equipment, the quality of your video image won't be affected.
- One more thing you should know about Fire wire technology is that it uses a peer-to-peer model in which the peripheral devices have the intelligence to resolve potential data transfer conflicts, which can result in much higher sustained transfer rates. USB uses a master-slave model which requires the computer to handle data flow issues, which tends to slow things down a bit.
- These and other differences reflect the differing design goals of the two buses: USB was designed for simplicity and low cost, while FireWire was designed for high performance, particularly in time-sensitive applications such as audio and video.

There are various uses of the FireWire. Some of these are as follows:

- In Aircraft: IEEE 1394b is used in military aircraft, where weight savings are desired. Developed for use as the data bus on the F-22 Raptor, it is also used on the F-35 Lightning II.
- In Automobiles: IDB-1394 Customer Convenience Port (CCP) is the automotive version of the 1394 standard.
- In Networking: FireWire can be used for ad-hoc (terminals only, no routers except where a FireWire hub is used) computer networks. Specifically, RFC 2734 specifies how to run IPv4 over the FireWire interface, and RFC 3146 specifies how to run IPv6.
- As Instrumentation & Industrial Digital Camera (IIDC): IIDC is the FireWire data format standard for live video, and is used by Apple's iSight Audio/Video (A/V) camera.
- As Digital Video (DV) : Digital Video (DV) is a standard protocol used by some digital camcorders. Formerly, all DV cameras had a FireWire interface (usually a 4-circuit), but recently many consumer brands have switched to USB.
- In Security: Devices on a FireWire bus can communicate by DMA, where a device can

use hardware to map internal memory to FireWire's "Physical Memory Space". The SBP-2 (Serial Bus Protocol 2) used by FireWire disk drives uses this capability to minimize interrupts and buffer copies. In SBP-2, the initiator sends a request by remotely writing a command into a specified area of the target's FireWire address space. This command usually includes buffer addresses in the initiator's FireWire "Physical Address Space", which the target is supposed to use for moving I/O data to and from the initiator.

So this was the complete study about the expansion ports. Now we will syudy about the cables.

1.10 Cables

A cable is two or more thick wires or ropes running side by side and bonded, twisted or braided together to form a single assembly. In mechanics, cables are used for lifting and hauling; in electricity they are used to carry electrical currents. An optical cable contains one or more optical fibers in a protective jacket that supports the fibers. Mechanical cable is more specifically called wire rope.Electrical cables may be made more flexible by stranding the wires. In this process, smaller individual wires are twisted or braided together to produce larger wires that are more flexible than solid wires of similar size. Bunching small wires before concentric stranding adds the most flexibility. Copper wires in a cable may be bare, or they may be coated with a thin layer of another material: most often tin but sometimes gold, silver or some other production material.

There are many types of cables. Some of these are as follows:

- Coaxial cable
- Multicore cable (consist of more than one wire and is covered by cable jacket)
- Ribbon cable
- Shielded cable
- Single cable
- Twisted pair
- Twisting cable

Here we will study the RS232 (Recommended Standard 232) standards.

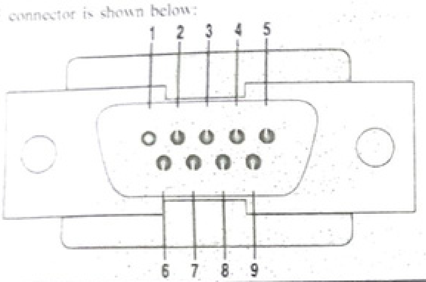
RS232 (Recommended Standard 232):

RS-232 is simple, universal, well understood and supported but it has some serious shortcomings as a data interface. The standards to 256kbps or less and line lengths of 15M (50 ft) or less but today we see high speed ports on our home PC running very high speeds and with high quality cable maxim distance has increased greatly. The rule of thumb for the length a data cable depends on speed of the data, quality of the cable.

The RS232 signals are represented by voltage levels with respect to a system common (power / logic ground). The "idle" state (MARK) has the signal level negative with respect to common, and the "active" state (SPACE) has the signal level positive with respect to common. RS232 has numerous handshaking lines (primarily used with modems), and also specifies a communications protocol. The RS-232 interface presupposes a common ground between the DTE and DCE. This is a reasonable assumption when a short cable connects the DTE (Data Terminal Equipment) to the DCE (Data Circuit-terminating Equipment), but with longer lines and connections between devices that may be on different electrical busses with different grounds, this may not be true.

RS-232 devices may be classified as Data Terminal Equipment (DTE) or Data Communications Equipment (DCE): this defines at each device which wires will be sending and receiving each signal. In general and according to the standard, terminals and computers have male connectors with DTE pin functions, and modems have female connectors with DCE pin functions. Other devices may have any combination of connector gender and pin definitions. Many terminals were manufactured with female terminals but were sold with a cable with male connectors at each end; the terminal with its cable satisfied the recommendations in the standard.

A simple DTE connector is shown below:



Pin	Signal	Pin	Signal
1	Data Carrier Detect	6	Data Set Ready
2	Received Data	7	Request to Send
3	Transmitted Data	8	Clear to Send
4	Data Terminal Ready	9	Ring Indicator
5	Signal Ground		

The RS-232 standard defines the voltage levels that correspond to logical one and logical zero levels for the data transmission and the control signal lines. Valid signals are plus or minus 3 to 15 volts - the range near zero volts is not a valid RS-232 level. The standard specifies a maximum open-circuit voltage of 25 volts.

1.11 Input Output Devices

1.11.1 Introduction

A **peripheral (Input/Output)** is a device attached to a host computer behind the chipset whose primary functionality is dependent upon the host, and can therefore be considered as expanding the hosts capabilities, while not forming part of the system's core architecture. These devices form the interface between the user and the system. Some of the more common peripheral devices are printers, keyboard, mouse, trackpad, joystick,scanners, disk drives, tape drives, microphones, speakers, and cameras. Peripheral devices can also include other computers on a

network system. So in this chapter we will study two types of peripheral devices i.e. input and output device.Input devices are used to enter data into primary storage and output devices accept result from the primary storage to supply them to clients or to store then on a other storage devices which one used for both input and output functions. The main objective of this chapter is to aware the students with the various types of Input/Output devices.

1.11.2 Input Devices

An input device is any peripheral (piece of computer hardware equipment) used to provide data and control signals to an information processing system (such as a computer). Input and output devices make up the hardware interface between a computer as a scanner. There are various types of input devices. List of these are as follows:

- Keyboard
- Trackball
- Joystick
- Touch screen
- Scanner
- Optical charactar reader (OCR)
- Video input
- Mouse
- Trackpad
- Light pen
- Bar code reader
- Optical mark reader/recognition (OMR)
- Voice input
- Digital canera

So this is the list of the input devices. Now we will discuss one by one in the following way.

1. Keyboard

A keyboard is an input device, partially modeled after the typewriter keyboard, which uses an arrangement of buttons or keys, which act as electronic switches. A keyboard typically has characters engraved or printed on the keys and each press of a key typically corresponds to a single written symbol. However, to produce some symbols requires pressing and holding several keys simultaneously or in sequence. While most keyboard keys produce letters, numbers or signs (characters), other keys or simultaneous key presses can produce actions or computer commands. In normal usage, the keyboard is used to type text and numbers into a word processor, text editor or other program. In a modern computer, the interpretation of key presses is generally left to the software. A

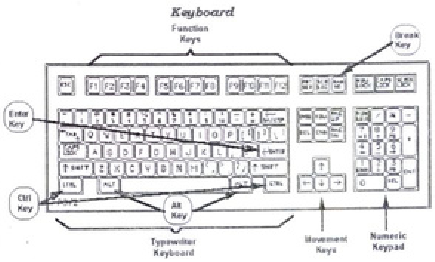
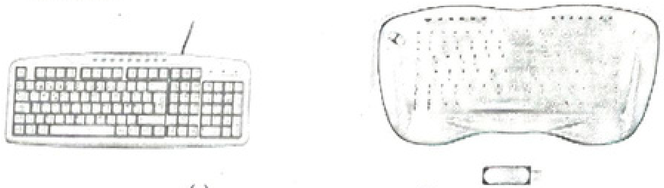


Fig. 22 : Simple layout of the keyboard

computer keyboard distinguish each physical key from every other and reports all key presses to the controlling software. Keyboards are also used for computer gaming, either with regular keyboards or by using keyboards with special gaming features, which can expedite frequently used keystroke combinations.

There are various types of the keyboard. Some of these are as follows:

- **Standard:** Standard keyboards, such as the 101-key US traditional keyboard 104-key Windows keyboards, include alphabetic characters, punctuation symbols, numbers and a variety of function keys.
- **Laptop-size:** Keyboards on laptops and notebook computers usually have a shorter travel distance for the keystroke and a reduced set of keys. As well, they may not have a numerical keypad, and the function keys may be placed in locations that differ from their placement on a standard, full-sized keyboard.
- **Gaming and multimedia:** Keyboards with extra keys, such as multimedia keyboards, have special keys for accessing music, web and other frequently used programs and featuresx, such as a mute button, volume buttons or knob and standby (sleep) button.
- **Thumb-sized:** Smaller keyboards have been introduced for laptops, PDAs, cellphones or users who have a limited workspace. The size of a standard keyboard is dictated by the practical consideration that the keys must be large enough to be easily pressed by fingers.
- **Numeric:** Numeric keyboards contain only numbers, mathematical symbols for addition, subtraction, multiplication, and division, a decimal point, and several function keys.
- **Chorded:** A keyset or chorded keyboard is a computer input device that allows the user to enter characters or commands formed by pressing several keys together, like playing a "chord" on a piano.
- **Virtual :** Virtual keyboards project an image of a full-size keyboard onto a surface. The iPhone uses a multi-touch screen to display a virtual keyboard.
- **Touchscreens:** Touchscreens, such as with the iPhone and the OLPC laptop, can be used as a keyboard. It can be used as a convertible Tablet PC where the keyboard is one half-screen.
- **Foldable:** Foldable (also called flexible) keyboards are made of soft plastic which can be rolled or folded on itself for travel. It can be connected to portable devices and smartphones.



(a) (b)

Fig. 23 : (a) Standard keyboard (b) wireless multimedia keobyard

There are various keys on the keyboard. Keys can be classified in some ways like as:

- **Alphabetical keys:** There are 26 alphabetical keys on the keyboad and they are marked A to Z.
- **Numeric keys:** There are 10 numeric key on the keyboard and they are marked 0 to 9.
- **Functional keys:** Function keys are placed at top most on the keyboard. These keys are marked F1 to F12. each kay contains some specific program to implementations. On the pressing these keys, it executes the related function for the program. For example F1 is used for the list of the document.
- **Special character keys:** There are some special keys on the keyboard like as #, @, $, %, ^, &, ! etc. this type of keys can be used by using the shift key.
- **Modifier keys:** Modifier keys are special keys that modify the normal action of another key, when the two are pressed in combination. For example, <Alt> + <F4> in Microsoft Windows will close the program in an active window. In contrast, pressing just <F4> will probably do nothing, unless assigned a specific function in a particular program. By themselves, modifier keys usually do nothing. The most widely-used modifier keys include the Control key, Shift key and the Alt key. The AltGr key is used to access additional symbols for keys, that have three symbols printed on them.
- **Navigation keys:** Navigation keys include a variety of keys which move the cursor to different positions on the screen. Arrow keys are programmed to move the cursor in a specified direction; page scroll keys, such as the 'Page Up keys and Page Down keys', scroll the page up and down. The Home key is used to return the cursor to the beginning of the page where the cursor is located; the End key puts the cursor at the end of the line. The Tab key advances the cursor to the next tab stop. The Insert key is mainly used to switch between overtype mode, The Delete key discards the character ahead of the cursor's position, The Backspace key deletes the preceding character. The Escape key (Esc) is used to initiate an escape sequenceThe Menu key or Application key is a key found on Windows-oriented computer keyboards. It is used launch a context menu with the keyboard rather than with the usual right mouse button.

There are several ways of connecting a keyboard using cables, including the standard AT connector commonly found on motherboards, which was eventually replaced by the USB connection. Wireless keyboards have become popular for their increased user freedom. A wireless keyboard often includes a required combination transmitter and receiver unit that attaches to the computer's keyboard port.

2. Mouse

A mouse is a very important input device. It is a pointing device that functions by detecting two-dimensional motion relative to its supporting surface. Physically, a mouse consists of an object held under one of the user's hands, with one or more buttons. It sometimes features other elements, such as "wheels", which allow the user to perform various system-dependent operations, or extra buttons or features can add more control or dimensional input. The mouse's motion typically translates into the motion of a pointer on a display, which allows for fine control of a Graphical User Interface (GUI).

There are various types of the mouse used in now a days. Some of these are as follows:

- Ball mouse
- Wireless mouse
- Mechnical mouse
- Optical mouse
- Laser mouse
- 3D mouse
- Tactile mouse
- Usb mouse

The simple fig. of mouse is shown below:

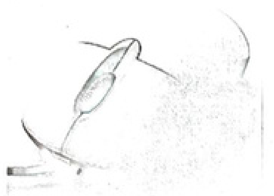


Fig. 24. A mouse, with two buttons and a scroll

Use of Mouse

Computer-users usually utilize a mouse to control the motion of a cursor in two dimensions in a graphical user interface. Clicking or hovering can select files, programs or actions from a list of names or through pictures called "icons" and other elements. For example, a text file might be represented by a picture of a paper notebook, and clicking while the pointer hovers this icon might cause a text editing program to open the file in a window. Mainly operation of mouse is like Click (single click, doubke click). Drag, Drag and Drop, Button chording etc. performed bu the user.

Operaion of Mouse

- moving the mouse turns the ball.
- X and Y rollers grip the ball and transfer movement.
- Click - pressing and releasing a button
- Drag - pressing and holding a button, then moving the mouse without releasing.
- Sensors gather light pulses to convert to X and Y velocities.

There are various button types mouse like as one button mouse, two button mouse, three button mouse, four button mouse etc. some fig. is shown below:

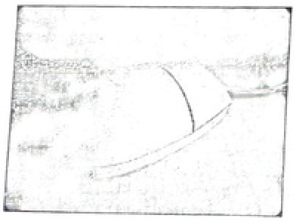


Fig. 25. Single button mouse

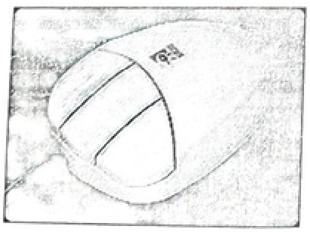


Fig. 26 Three-button mouse

3. Trackball

A trackball is a pointing device consisting of a ball held by a socket containing sensors to detect a rotation of the ball about two axes-like an upside-down-mouse with an exposed protruding ball. The user rolls the ball with the thumb, fingers, or the palm of the hand to move a cursor.

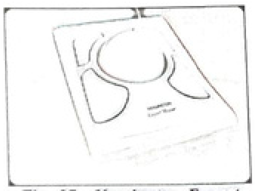
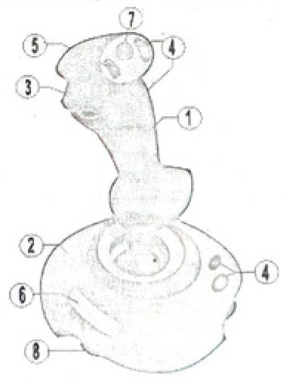


Fig. 27 Kensington Expert Mouse trackball

Large tracker balls are common on CAD workstations for easy precision. As with modern mouse, most trackballs now have an auxiliary device primarily intended for scrolling. Some have a scroll wheel like most mice, but the most common type is a "scroll ring" which is spun around the ball. Kensington's SlimBlade Trackball similarly tracks the ball itself in three dimensions for scrolling.Currently, the trackball has become extremely hard to find. Trackballs are provided as the pointing device in some public internet access terminals.Unlike a mouse, a trackball can easily be built into a console, and cannot be ripped away or easily vandalised.

4. Joystick

A joystick is an input device consisting of a stick that pivots on a base and reports its angle or direction to the device it is controlling. Joysticks are often used to control video games, and usually have one or more than one push-buttons whose state can also be read by the computer. A popular variation of the joystick used on modern video game consoles is the analog stick. Joysticks are used for controlling machines such as cranes, trucks, underwater unmanned vehicles and zero turning radius lawn mowers.



This is the fig. of the joystick. Here numbers are represented to: Joystick elements are as follows:

1. Stick
2. Base
3. trigger
4. Extra buttons
5. Autofire switch
6. Throttle
7. Hat Switch (POV Hat)
8. Suction Cup

Fig. 28: Joystick

Most joysticks are two-dimensional, having two axes of movement (similar to a mouse). A joystick is generally configured so that moving the stick left or right signals movement along the X axis, and moving it forward (up) or back (down) signals movement along theY axis. In joysticks that are configured for three-dimensional movement, twisting the stick left or right signals movement along the Z axis. An analog joystick is a joystick which has continuous states, i.e. returns an angle measure of the movement in any direction in the plane or the space and a digital joystick gives only on/off signals for four different directions, and mechanically possible combinations (such as up-right, down-left, etc.). Additionally joysticks often have one or more fire buttons, used to trigger

5. Trackpad :

A trackpad is an input device commonly used in laptpop computers. They are used to move curser, using motion's of the user movement. It lets users scroll in an arbitrary direction by touching the pad with two fingers instead of one, and then moving their fingers across the pad in the direction they wish to scroll. For comparison, many laptop touchpads instead set aside an area along the right edge and bottom edge of the pad, and moving a single finger in these areas performs a vertical or horizontal scroll operation, respectively.

The simple fig. of trackpad is shown below:

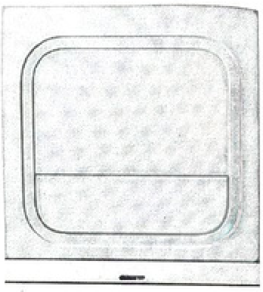


Fig. 29. Trackpad

6. Light Pen :

A light pen is a computer input device in the form of a light-sensitive wand used in conjunction with a computer's CRT TV set or monitor. It allows the user to point to displayed objects, or draw on the screen, in a similar way to a touch screen but with greater positional accuracy. A light pen can work with any CRT-based display, but not with LCD screens. A light pen is very easy to implement. The light pen works by sensing the sudden small change in brightness of a point on the screen when the electron gun refreshes that spot. By noting exactly where the scanning has reached at that moment, the X,Y position of the pen can be resolved. This is usually achieved by the light pen causing an interrupt, at which point the scan position can be read from a special

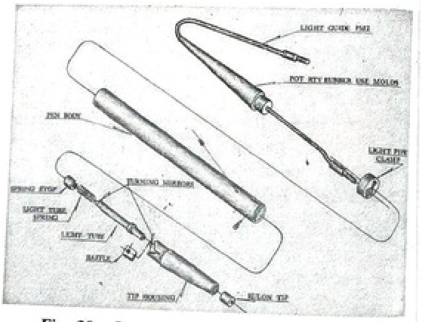


Fig. 30 : Layout diagram of Light Pen

register, or can computed from a counter or timer. The pen position is updated on every refresh of the screen.

The light pen became moderately popular during the early 1980s. The first light pen was created around 1952 as part of the Whirlwind project at MIT. Since light pens operate by detecting light emitted by the screen phosphors, some nonzero intensity level must be present at the coordinate position to be selected.

7. Touch Screen

A touchscreen is a display that can detect the presence and location of a touch within the display area. The term generally refers to touch or contact to the display of the device by a hand. Touchscreens can also sense other passive objects, such as a stylus. However, if the object sensed is active, as with a light pen, the term touchscreen is generally not applicable. The ability to interact directly with a display typically indicates the presence of a touchscreen.

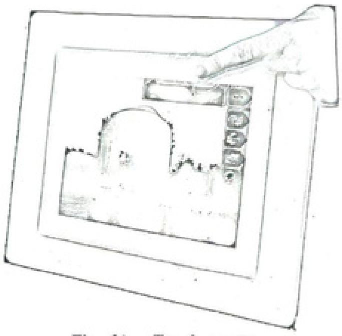


Fig. 31 : Touch screen

The touchscreen has two main attributes. First, it enables one to interact with what is displayed directly on the screen, where it is displayed, rather than indirectly with a mouse or touchpad. Secondly, it lets one do so without requiring any intermediate device, again, such as a stylus that needs to be held in the hand. Such displays can be attached to computers or, as terminals, to networks.

There are many types of touchscreen technology. Some of these are as follows:

- Resistive
- Capacitive
- Infrared
- Optical imaging
- Surface acoustic wave
- Projected capacitance
- Strain gauge

So these are the various technology of the touchscreen. There is no need to detail study of the each technology.

In the daily life we can see many example of the touchscreen, at the railway station we can see touch screen and get any information of the any train. There are very wide use of the touch screen in the every area.

8. Barcode Reader

Data can be coded in the form of light and dark bars with some specing and thickness. These are called barcodes. A barcode reader (or barcode scanner) is an electronic device for reading printed barcodes. Like a flatbed scanner, it consists of a light source, a lens and a light sensor translating optical impulses into electrical ones. Additionally, nearly all barcode readers contain decoder circuitry analyzing the barcode's image data provided by the sensor and sending the barcode's content to the scanner's output port.

There are various types of barcode reader are used. Some of these are as follows:

- **Pen readers:** requires the operator to swipe the pen over the code.
- Semi-automatic handled readers: The operator need not swipe, but must at least position the reader near the label
- Fix-mount readers for automatic reading: The reading is performed laterally passing the label over the reader. No operator is required, but the position of the code target must coincide with the imaging capability of the reader.
- Reader gates for automatic scanning: The position of the code must be just under the gate for short time, enabling the scanner sweep to capture the code target successfully.

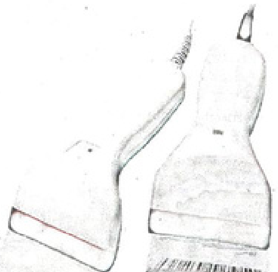


Fig. 32 : Barcode reader

9. Scanner

A scanner is a device that optically scans images, printed text, handwriting, or an object, and converts it to a digital image. Common examples found in offices are variations of the desktop scanner where the document is placed on a glass window for scanning. Modern scanners typically use a charge-coupled device (CCD) or a Contact Image Sensor (CIS) as the image sensor, whereas older drum scanners use a photomultiplier tube as the image sensor. A rotary scanner, used for high-speed document scanning, is another type of drum scanner, using a CCD array instead of a photomultiplier. Other types of scanners are planetary scanners, which take photographs of books and documents, and 3D scanners, for producing three-dimensional models of objects.

Fig. 33: Scanner

Another type of scanner is digital camera scanners, which are based on the concept of reprographic cameras. Due to increasing resolution and new

features such as anti-shake, digital cameras have become an attractive alternative to regular scanners. While still having disadvantages compared to traditional scanners (such as distortion, reflections, shadows, low contrast), digital cameras offer advantages such as speed, portability, gentle digitizing of thick documents without damaging the book spine.

There are various types of the scanner. Some of these are as follows:

- **Drum scanner** : Drum scanners takes images information with photomultiplier tubes (PMT), rather than the charge-coupled device (CCD) arrays found in flatbed scanners and inexpensive film scanners.The drum scanner gets its name from the clear acrylic cylinder, the drum, on which the original artwork is mounted for scanning. Depending on size it is possible to mount originals up to 11"x17", but maximum size varies by manufacturer. One of the unique features of drum scanners is the ability to control sample area and aperture size independently.
- **Flatbed scanner :** A flatbed scanner is usually composed of a glass pane, under which there is a bright light which illuminates the pane, and a moving optical array in CCD scanning.
- **Film scanner** "Slide" (positive) or negative film can be scanned in equipment specially manufactured for this purpose, which is known as film scanner.
- **Hand scanner :** Hand scanners come in two forms: document and 3D scanners. Hand held document scanners are manual devices that are dragged across the surface of the image to be scanned. And 3D scanners remains popular for many applications, including industrial design, reverse engineering, inspection & analysis, digital manufacturing and medical applications.

  Scanner art is art made by placing objects on a flatbed scanner and scanning them. There has been some debate as to whether scanner art is a form of digital photography. As the scanner has very little depth of field and a constant light all over the surface, it is different from photography.

10. Optical Mark Recognition (OMR)

Optical mark recognition is a input device which can detect the presence of a mark on the paper. Many traditional OMR devices work with a dedicated scanner device that shines a beam of light onto the form paper. The contrasting reflectivity at predetermined positions on a page is then utilized to detect the marked areas because they reflect less light than the blank areas of the paper.

One of the most familiar applications of optical mark recognition is the use of HB pencil bubble optical answer sheets in multiple choice question examinations. Students mark their answers, or other personal information, by darkening circles marked on a pre-printed sheet. Afterwards the sheet is automatically graded by a scanning machine. OMR is now used as an input device for data entry. Two early forms of OMR are paper tape and punch cards which use actual holes punched into the medium instead of pencil filled circles on the medium. The use of OMR is not only limited to schools or data collection agencies; many businesses and health care agencies use OMR to streamline their data input processes and reduce input error. OMR, OCR, and ICR technologies all provide a means of data collection from paper forms. OMR may also be done using an OMR (discrete read head) scanner or an imaging scanner.The format of OMR sheet is shown below:

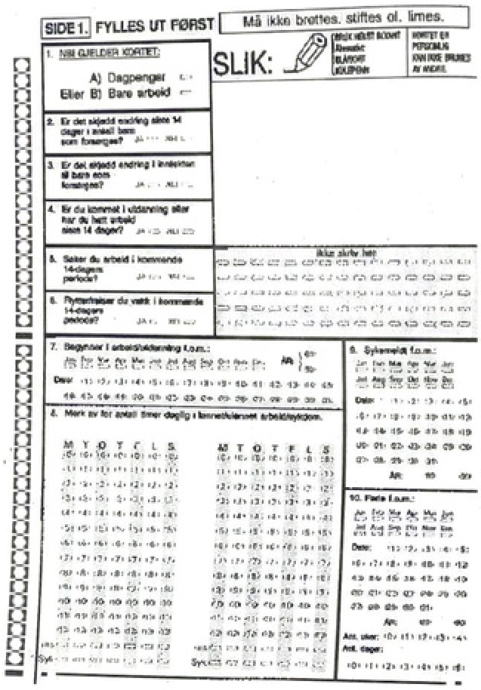


Fig.34 : Format of OMR

11. Optical Character Recognition (OCR):

Optical character recognition, usually known as OCR, is the mechanical or electronic translation of images of handwritten, typewritten or printed text (usually captured by a scanner) into machine-editable text.OCR is a field of research in pattern recognition, artificial intelligence and machine vision. Though academic research in the field continues, the focus on OCR has shifted to implementation of proven techniques. OCR is an instance of off-line character recognition, where the system recognizes the fixed static shape of the character. It is necessary to understand that OCR technology is a basic technology also used in advanced scanning applications. Due to this, an advanced scanning solution can be unique and patented and not easily copied despite being

based on this basic OCR technology. The working of OCR softwrare is shown below:

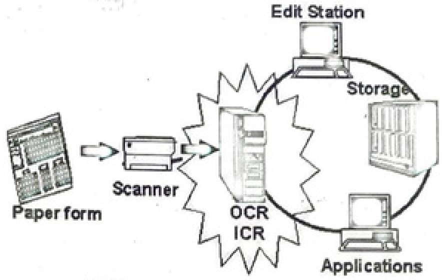


Fig.35 : working of OCR software

12. Voice Input

Direct Voice Input is a style of Human-Machine Interaction "HMI" in which the user makes voice commands to issue instructions to the machine. In this type of system any human can be input in the machine thrugh the microphone or any other voice input device.

Fig.36 : Voice input device

13. Video Input Device

In this system, videos, animated pictures, images, figure etc. can be send in the computer to display.there are many devices for the input. One is the webcam, Webcams are video capturing devices connected to computers or computer networks, often using USB or, if they connect to networks, ethernet or Wi-Fi. They are well known for their low manufacturing costs and flexible applications. Webcams typically include a lens, an image sensor, and some support electronics. As webcam capabilities have been added to instant messaging text chat services such as AOL Instant Messenger, one-to-one live video communication over the internet has now reached millions of mainstream PC users worldwide. Increased video quality has helped webcams encroach on traditional video conferencing systems.

Webcams are being used for security purposes. Software is available allowing PC-connected cameras to watch for movement and sound, recording both when they are detected; these recordings can be saved to the computer, e-mailed or uploaded to the internet. In one well-publicised case, a computer e-mailed out images as the burglar stole it, allowing the owner to give police a clear picture of the burglar's face even after the computer had been stolen. Special software can use the video stream from a webcam to assist or enhance a user's control of applications and games. Video features, including faces, shapes, models and colors can be observed and tracked to produce a corresponding form of control. A simple view of webcam is shown in figure 15.

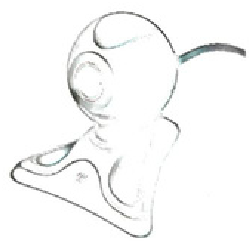


Fig.37 : A Typical webcam

14. Digital camera

A digital camera (digicam) is a camera that takes video or still photographs, or both, digitally by recording images via an electronic image sensor. Many compact digital still cameras can record sound and moving video as well as still photographs. In the Western market, digital cameras outsell their 35 mm film counterparts. Digital cameras can do things film cameras cannot: displaying images on a screen immediately after they are recorded, storing thousands of images on a single small memory device, recording video with sound, and deleting images to free storage space.Digital cameras are incorporated into many devices ranging from PDAs and mobile phones to vehicles. Compact cameras are designed to be small and portable and are particularly suitable for casual and "snapshot" use, thus are also called point-and-shoot camera. Since the first digital backs were introduced, there have been three main methods of capturing the image, each based on the hardware configuration of the sensor and color filters.The first method is often called single-shot. Single-shot capture systems use either one CCD with a Bayer filter mosaic, or three separate image sensors which are exposed to the same image via a beam splitter.The second method is referred to as multi-shot because the sensor is exposed to the image in a sequence of three or more openings of the lens aperture.The third method is called scanning because the sensor moves across the focal plane much like the sensor of a desktop scanner.

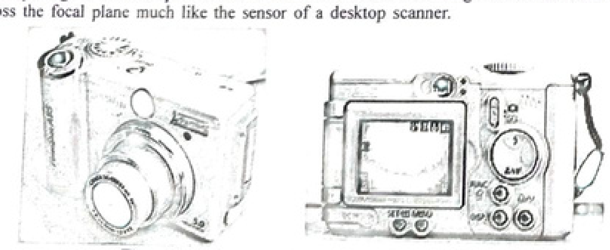


Fig. 38 : Front and back of a Digital Camera

So this is the complete study of the input devices. Now we will study the output devices.

1.11.3 Output Devices

An **output device** is any piece of computer hardware equipment used to communicate the results of data processing carried out by an information processing system (such as a computer) to the outside world.In computing, input/output, or I/O, refers to the communication between an information processing system (such as a computer), and the outside world. Inputs are the signals or data sent to the system, and outputs are the signals or data sent by the system to the outside.The most common outputs are monitors and speakers.

There are many output devices. Some of these are as follows:

- Monitors
- Color graphics adapter
- Super extended graphics array
- Super vedio graphics array
- Video controllor
- Display adapter
- Video graphics array
- Extended graphics array
- LCD monitors
- Video RAM (VRAM)

So this is the list of output devices. Now we will study one by one.

1.11.3.1 Monitor

Almost all computers have a monitor. Monitors are also known as Visual Display Units (VDUs). Most computers use this display as the main output device. A monitor is a piece of electrical equipment which displays images generated by devices such as computers, without producing a permanent record. The monitor comprises the actual display device, circuitry, and an enclosure. The display device in modern monitors is typically a thin film transistor liquid crystal display (TFT-LCD), while older monitors use a cathode ray tube (CRT). As with television, many different hardware technologies exist for displaying computer-generated output:

Fig. 39 : Standard Monitor

- Liquid crystal display (LCD).
- Cathode ray tube (CRT)
- Plasma display
- Surface-conduction electron-emitter display (SED)
- Organic light-emitting diode (OLED) display
- Penetron military aircraft displays.

The three most important features of a screen are its size, the colors it can display and its resolution. There is more information about these features below. They apply to both desktop monitors and LCDs.

- **Size:** How big is the screen? Typical sizes are 10" or 12" for LCDs and 14", 15" or 21" for desktop monitors. The size is measured along the diagonal from the bottom left hand corner to the top right hand corner of the screen.
- **Color:** Is the monitor color or black & white? Most new desktop computers have color screens as they are no longer that much more expensive than black & white ones and modern computer applications work better with a color monitor.
- **Resolution:** An image displayed on the screen is made up of lots of dots called pixels. If you look closely at the screen you may be able to see these pixels. The resolution of the screen is how many pixels there are up and down and from left to right across the screen. A variety of different resolutions are available. For PCs these resolutions have names. For e.g. VGA is 640 x 480. This means that there are 640 pixels in each row across the screen and 480 pixels in each column up and down the screen.

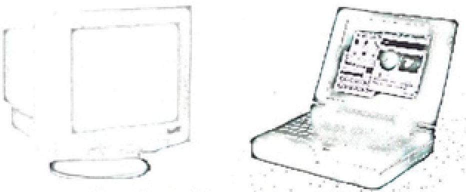


Fig. 40 : Desktop monitor and LCD

There are two terms related with the monitors.

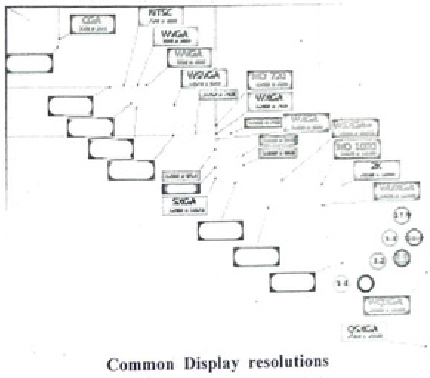
- Refresh rate
- Resolution

Refresh Rate : The refresh rate (most commonly the "vertical refresh rate", "vertical scan rate" for CRTs) is the number of times in a second that display hardware draws the data it is being given. This is distinct from the measure of frame rate in that the refresh rate includes the repeated drawing of identical frames, while frame rate measures how a video source can feed an entire frame of new data to a display.For example, most movie projectors advance from one frame to the next one 24 times each second. But each frame is illuminated two or three times before the next frame is projected using a shutter in front of its lamp. As a result, the movie projector runs at 24 frames per second, but has a 48 or 72 Hz refresh rate.On CRT displays, increasing the refresh rate decreases flickering, thereby reducing eye strain. However, if a refresh rate is specified that is beyond what is recommended for the display, damage to the display can occur. The refresh rate can be calculated from the horizontal scan rate by dividing by the number of horizontal lines multiplied by 1.05 (since about 5% of the time it takes to scan the screen is spent moving the electron beam back to the top). For instance, a monitor with a horizontal scanning

frequency of 96 kHz at a resolution of 1280 × 1024 results in a refresh rate of 96,000 / (1024 × 1.05) ? 89 Hz (rounded down).

Resolution : The display resolution of a digital television or display typically refers to the number of distinct pixels in each dimension that can be displayed. It can be an ambiguous term especially as the displayed resolution is controlled by all different factors in cathode ray tube (CRT) and flat panel or projection displays using fixed picture-element (pixel) arrays.

One use of the term "display resolution" applies to fixed-pixel-array displays such as plasma display panels (PDPs), liquid crystal displays (LCDs), or similar technologies, and is simply the physical number of columns and rows of pixels creating the display (e.g., 1280×1024). Note that the use of the word resolution here is misleading. The term "display resolution" is usually used to mean pixel dimensions (e.g., 1280×1024), which does not tell anything about the resolution of the display on which the image is actually formed. In digital measurement the display resolution would be given in pixels per inch. In analog measurement, if the screen is 10 inches high then the horizontal resolution is measured across a square 10 inches wide.



Common Display resolutions

The most common computer display resolutions are as follows:

Resolution	% of Internet Users
Higher than 1024×768	57%
1024×768	36%
800×600	2%
Lower than 800×600	< 1%
Unknown	5%

1.11.3.2 Colour Graphics Adapter (CGA):

The Color Graphics Adapter (CGA), introduced in 1981, was IBM's first color graphics card, and the first color computer display standard for the IBM PC.CGA card support several graphics and text modes. The highest resolution of any mode was 640×200, and the highest color depth supported was 4-bit (16 colors).

CGA offers four BIOS text modes:

- **40×25 characters** in up to 16 colors. Each character is a pattern of 8×8 dots. The effective screen resolution in this mode is 320×200 pixels. BIOS Modes 0 & 1 select 40 column text modes. The difference between these two modes can only be seen on a composite monitor; mode 0 disables the color burst, making colors appear in grayscale. Mode 1 enables the color burst, allowing for color.
- **80×25 characters** in up to 16 colors. Each character is again an 8×8 dot pattern (the same character set is used as for 40×25), in a pixel aspect ratio of 1:2.4. BIOS Modes 2 and 3 select 80 column text modes. As with the 40-column text modes, Mode 2 disables the color burst in the composite signal and Mode 3 enables it.

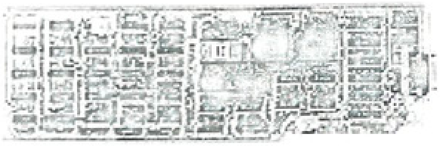


Fig. 41 : CGA card with Synertek SY6845

1.11.3.3 Video Grphic Array (VGA):

The term Video Graphics Array (VGA) refers specifically to the display hardware first introduced with the IBM PS/2 line of computers in 1987, but through its widespread adoption has also come to mean either an analog computer display standard, the 15-pin D-subminiature VGA connector or the 640×480 resolution itself. While this resolution has been superseded in the personal computer market, it is becoming a popular resolution on mobile devices.

Video Graphics Array (VGA) was the last graphical standard introduced by IBM that the majority of PC clone manufacturers conformed to, making it today (as of 2009) the lowest common denominator that all PC graphics hardware supports, before a device-specific driver is loaded into the computer. VGA was officially superseded by IBM's XGA standard, but in reality it was superseded by numerous slightly different extensions to VGA made by clone manufacturers that came to be known collectively as "Super VGA".

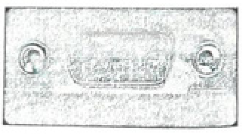


Fig. 42: VGA Port

VGA is referred to as an "array" instead of an "adapter" because it was implemented from the start as a single chip (an ASIC).

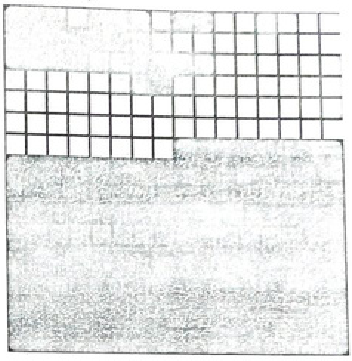


Fig. 43 : VGA 256 color palette scheme

The VGA color system is backwards compatible with the EGA and CGA adapters, and adds another level of configuration on top of that. CGA was able to display up to 16 colors, and EGA extended this by allowing each of the 16 colors to be chosen from a 64-color palette (these 64 colors are made up of two bits each for red, green and blue: two bits × three channels = six bits = 64 different values). VGA further extends this scheme by increasing the EGA palette from 64 entries to 256 entries. Two more blocks of 64 colors with progressively darker shades were added, along with 8 "blank" entries that were set to black.

1.11.3.4 SUPER VIDEO GRAPHICS ARRAY (SVGA)

Originally, it was an extension to the VGA (video graphics array) standard first released by IBM in 1987. Unlike VGA-a purely IBM-defined standard-Super VGA was defined by the Video Electronics Standards Association (VESA), an open consortium set up to promote interoperability and define standards. When used as a resolution specification, in contrast to VGA or XGA for example, the term SVGA normally refers to a resolution of 800 × 600 pixels.Though Super VGA cards appeared in the same year as VGA, it wasn't until 1989 that Super VGA was defined by VESA. In that first version, it called for a resolution of 800 × 600 4-bit pixels. Each pixel could

Fig. 44 : SVGA port

therefore be any of 16 different colours. It was quickly extended to 1024 × 768 8-bit pixels, and well beyond that in the following years the interface between the video card and the VGA or Super VGA monitor uses simple analog voltages to indicate the desired colour depth. In consequence, so far as the monitor is concerned, there is no theoretical limit to the number of different colours that can be displayed. Note that this applies to any VGA or Super VGA monitor. While the output of a VGA or Super VGA video card is analog, the internal calculations the card performs in order to arrive at these output voltages are entirely digital. To increase the number of colours a Super VGA display system can reproduce, no change at all is needed for the monitor, but the video card needs to handle much larger numbers and may well need to be redesigned from scratch. Even so, the leading graphics chip vendors were producing parts for high-colour video cards within just a few months of Super VGA's introduction.

1.11.3.5 Extended Graphics Array (XGA):

XGA, the Extended Graphics Array, is an IBM display standard introduced in 1990. Today, it is the most common appellation of the 1024×768 pixels display resolution. It was not a new and improved replacement for Super VGA, but rather became one particular subset of the broad range of capabilities covered under the "Super VGA" umbrella. The initial version of XGA expanded upon IBM's VGA, adding support for two resolutions:

- 800×600 pixels with high color (16 bits per pixel; i.e., 65,536 colors).
- 1024×768 pixels with a palette of 256 colors (8 bits per pixel)

Like its predecessor (the IBM 8514), XGA offered fixed function hardware acceleration to offload processing of 2D drawing tasks. XGA and 8514 could offload line-draw, bitmap-copy (bitblt), and color-fill operations from the host CPU. XGA's acceleration was faster than 8514's, and more comprehensive in that it supported more drawing primitives and XGA's 16 bits per pixel (65,536 color) display-mode.

1.11.3.6 Super Extended Graphics Araay (SXGA):

*SXGA is stands for **Super eXtended Graphics Array** referring to a standard monitor resolution of 1280x1024 pixels. This display resolution is the "next step" above the XGA resolution that IBM developed in 1990.A standard 4:3 monitor using this resolution will have rectangular rather than square pixels, meaning that unless the software compensates for this the picture will be distorted, causing circles to appear elliptical.* There is a less common 1280×960 resolution sometimes unofficially called "SXGA-" (to avoid confusion with the "standard" SXGA) that preserves the common 4:3 aspect ratio.SXGA is the most common native resolution of 17" and 19" LCD monitors. An LCD monitor with SXGA native resolution will typically have a physical 5:4 aspect ratio, preserving a 1:1 pixel aspect ratio.SXGA is also a popular resolution for cell phone cameras, such as the Motorola Razr and most Samsung and LG phones. Although being taken over by newer UXGA (2.0 megapixel) cameras, the 1.3 megapixel is the most common for the time being.

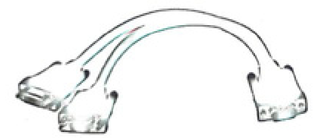


Fig. 45 : SXGA PORT

1.11.3.7 Liquid Crystal Display (LCD)

A liquid crystal display (LCD) is an electronically-modulated optical device shaped into a thin, flat panel made up of any number of color or monochrome pixels filled with liquid crystals and arrayed in front of a light source (backlight) or reflector. It is often used in battery-powered electronic devices because it requires very small amounts of electric power.Each pixel of an LCD typically consists of a layer of molecules aligned between two transparent electrodes, and two polarizing filters, the axes of transmission of which are (in most of the cases) perpendicular to each other. With no actual liquid crystal between the polarizing filters, light passing through the first filter would be blocked by the second (crossed) polarizer.

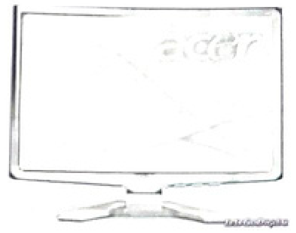


Fig. 46 : LCD screen

There are many features of the LCDs. Some of these are as follows:

- **Resolution:** The horizontal and vertical size expressed in pixels (e.g., 1024 × 768). Unlike CRT monitors, LCD monitors have a native-supported resolution for best display effect.
- **Response time:** The minimum time necessary to change a pixel's color or brightness.
- **Refresh rate:** The number of times per second in which the monitor draws the data it is being given.
- **Matrix type:** Active TFT or Passive.
- **Color support:** How many types of colors are supported.
- **Brightness:** The amount of light emitted from the display.
- **Contrast ratio:** The ratio of the intensity of the brightest bright to the darkest dark.
- **Input ports:** (e.g., DVI, VGA, LVDS, DisplayPort, or even S-Video and HDMI).

A simple fig. of LCD screen is shown below:

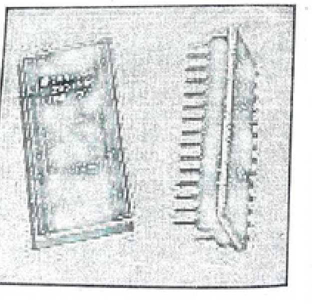
1.11.3.8 Video controller

A Video Display Controller or VDC is an integrated circuit which is the main component in a video signal generator. Some VDCs also generate a sound signal, but in that case it's not their main function.VDCs were most often used in the old home-computers of the 80s, but also in some early video game systems.The VDC is always the main component of the video signal generator logic, but sometimes there are also other supporting chips used, such as RAM to hold the pixel data, ROM to hold character fonts, or perhaps some discrete logic such as shift registers were necessary to build a complete system. In any case, it's the VDC's responsibility to generate the timing of the necessary video signals, such as the horizontal and vertical synchronisation signals, and the blanking interval signal.Most often the VDC chip is completely integrated in the logic of the main computer system, (its video RAM appears in the memory map of the main CPU), but sometimes it functions as a coprocessor that can manipulate the video RAM contents independently. There are various types of the video controllor. Some of these are as follows:

- Video shifters, or "Video shift register based systems" are the most simple type of video controllers; they are responsible for the video timing signals, but they normally do not access the Video RAM directly. They get the video data from the main CPU, a byte at a time, and convert it to a serial bitstream (hence the technical name "Video shifter"). This serial data stream is then used, together with the synchronisation signals, to output a video signal. Example of video shifter is Television Interface Adapter (TIA).
- A CRTC, or CRT Controller, generates the video timings and reads video data from a RAM attached to the CRTC, to output it via an external character generator ROM to the video output shift register. Because the actual capabilities of the video generator depend to a large degree on the external logic, video generator based on a CRTC chip can have a wide range of capabilities. From very simple systems to very high resolution systems supporting a wide range of colours. Sprites however are normally not supported by these systems. Example of CRTC controllor is Intel 8275 controllor. The Intel 8275 CRT controller was not used in any mainstream system, but was used in some S100 bus systems.
- Video interface controllers are much more complex than CRT controllers, and the external circuitry that is needed with a CRTC is embedded in the video controller chip. Sprites are often supported, as are (RAM based) character generators and video RAM dedicated to colour attributes and pallette registers for the high-resolution and/or text-modes. The Signetics 2636 and 2637 are video controllers best known for their use in the Interton VC 4000 and Emerson Arcadia 2001 respectively.
- Video coprocessors have their own internal CPU dedicated to reading (and writing) their own video RAM, and converting the contents of this video RAM to a video signal. The main CPU (central processing unit) can give commands to the coprocessor, for example to change the video modes or to manipulate the video ram contents. The video coprocessor also controls the (most often RAM based) character generator, the colour attribute RAM, Palette registers and the Spite logic. Example of video coprocessors is ANTIC (Alpha-Numeric Television Interface Circuit).

1.11.3.9 VRAM:

VRAM is a dual-ported variant of DRAM which was once commonly used to store the frame-buffer in some graphics adaptors.It was invented by F. Dill and R. Matick at IBM Research in 1980, with a patent issued in 1985 (US Patent 4,541,075). The first commercial use of VRAM was in the high resolution graphics adapter introduced in 1986 by *IBM with the PC/RT* system.VRAM has two sets of data output pins, and thus two ports that can be used simultaneously. *The first port, the DRAM port, is accessed by the host computer in a manner very similar to traditional DRAM. The second port, the video port, is typically read-only and is dedicated to providing a high bandwidth data channel for the*



graphics chipset. VRAM operates by not discarding the excess bits which must be accessed, but making full use of them in a simple way. If each horizontal scan line of a display is mapped to a full word, then upon reading one word and latching all 1024 bits into a separate row buffer, these bits can subsequently be serially streamed to the display circuitry. This will leave access to the DRAM array free to be accessed (read or write) for many cycles, until the row buffer is almost depleted. A complete DRAM read cycle is only required to fill the row buffer, leaving most DRAM cycles available for normal accesses.

VRAM can be represented as:

Comparision of varoius monitor standard:

Video standard	Full name	Description	Display resolution (pixels)	Aspect ratio	Color depth
MDA	Monochrome Display Adapter	The original standards on IBM PCs and IBM PC XTs with 4 KB video RAM. Introduced in 1981 by IBM. Supports text mode only.	720×350 (text)	72:35	1 bpp
CGA	Color Graphics Adapter	Introduced in 1981 by IBM, as the first color display standard for the IBM PC. The standard CGA graphics cards were equipped with 16 KB video RAM.	640×200 (128k) 320×200 (64k) 160×200 (32k)	16:5 16:10 4:5	1 bpp 2 bpp 4 bpp
EGA	Enhanced Graphics Adapter	Introduced in 1984 by IBM. A resolution of 640 × 350 pixels of 16 different colors (4 bits per pixel, or *bpp*), selectable from a 64-color palette (2 bits per each of red-green-blue).	640×350 (224k)	64:35	4 bpp
VGA	Video Graphics Array	Introduced in 1987 by IBM. VGA is actually a set of different resolutions, but is most commonly used today to refer to 640 × 480 pixel displays with 16 colors and a 4:3 aspect ratio. VGA displays and adapters are generally capable of Mode X graphics, an undocumented mode to allow increased non-standard resolutions.	640×480 (307k) 640×350 (224k) 320×200 (64k) 720×400 (text)	4:3 64:35 16:10 9:5	4 bpp 4 bpp 4/8 bpp 4 bpp
SVGA	Super VGA	A video display standard created by VESA for IBM PC compatible personal computers. Introduced in 1989.	800×600 (480k)	4:3	4 bpp
XGA	Extended Graphics Array	An IBM display standard introduced in 1990. XGA-2 added 1024 × 768 support for high color and higher refresh rates, improved performance, and support for 1360 × 1024 in 16 colors.	1024×768 (786k) 640×480 (307k)	4:3 4:3	8 bpp 16 bpp

XGA+	Extended Graphics Array Plus	Although not an official name, this term is now used to refer to 1152 x 864, which is the largest 4:3 array yielding under one million pixels. Variants of this were used by Apple Computer (at 1152x870) and Sun Microsystems (at 1152x900) for 21-inch CRT displays.	1152×864 (995k) 640×480 (307k)	4:3 4:3	8 bpp 16 bpp
SXGA	Super XGA	A widely used 32 bit True color standard, with an unusual aspect ratio of 5:4 (1.25:1) instead of the more common 4:3 (1.33:1), which means that 4:3 pictures and video will appear letterboxed on the narrower 5:4 screens. This is generally the physical aspect ratio & native resolution of standard 17" and 19" LCD monitors.	1280×1024 (1310k)	5:4	32 bpp
SXGA+	Super XGA +	Used on 14 inch and 15 inch notebook LCD screens and a few smaller screens.	1400×1050 (1470k)	4:3	32 bpp

1.11.4 PRINTERS

A printer is a peripheral which produces a hard copy of documents stored in electronic form, usually on physical print media such as paper or transparencies. Many printers are primarily used as local peripherals, and are attached by a printer cable or, in most newer printers, a USB cable to a computer which serves as a document source. Some printers, commonly known as network printers, have built-in network interfaces (typically wireless or Ethernet), and can serve as a hardcopy device for any user on the network. Individual printers are often designed to support both local and network connected users at the same time.In addition, a few modern printers can directly interface to electronic media such as memory sticks or memory cards, or to image capture devices such as digital cameras, scanners; some printers are combined with a scanners and/or fax machines in a single unit, and can function as photocopiers. Printers that include non-printing features are sometimes called Multifunction Printers (MFP), Multi-Function Devices (MFD), or All-In-One (AIO) printers. Most MFPs include printing, scanning, and copying among their features. Printers are designed for low-volume, short-turnaround print jobs; requiring virtually no setup time to achieve a hard copy of a given document. However, printers are generally slow devices and the cost per page is actually relatively high. The printing

Fig. 47 : Simple view of printer

press remains the machine of choice for high-volume, professional publishing. However, as printers have improved in quality and performance, many jobs which used to be done by professional print shops are now done by users on local printers; see desktop publishing.

There are various types of printers. Some of these are as follows:

- Dot matrix printer
- Inkjet printer
- Label printer
- Thermal wax transfer printer
- IRIS printer
- Daisy wheel printer
- Line printer
- Page printer
- Dye- submilation printer
- Laser printer

So these are the types of the printers. Now we will study one by one in following way:

1.11.4.1 DOT Matrix printer (DMP)

A dot matrix printer or impact matrix printer is a type of computer printer with a print head that runs back and forth, or in an up and down motion, on the page and prints by impact, striking an ink-soaked cloth ribbon against the paper, much like a typewriter. Each dot is produced by a tiny metal rod, also called a "wire" or "pin", which is driven forward by the power of a tiny electromagnet or solenoid, either directly or through small levers (pawls). the term dot matrix printer is specifically used for impact printers that use a matrix of small pins to create precise dots. The advantage of dot-matrix over other impact printers is that they can produce graphical images in addition to text; however the text is generally of poorer quality than impact printers that use letterforms.The moving portion of the printer is called the print head, and when running the printer as a generic text device generally prints one line of text at a time. Most dot matrix printers have a single vertical line of dot-making equipment on their print heads; others have a few interleaved rows in order to improve dot density.These machines can be highly durable. When they do wear out, it is generally due to ink invading the guide plate of the print head, causing grit to adhere to it; this grit slowly causes the channels in the guide plate to wear from circles into ovals or slots, providing less and less accurate guidance to the printing wires.

Dot-matrix printers can be broadly divided into two major classes:

- Ballistic wire printers
- Stored energy printers

Dot matrix printers can either be character-based or line-based (that is, a single horizontal series of pixels across the page), referring to the configuration of the print head.At one time, dot matrix printers were one of the more common types of printers used for general use - such as for home and small office use. Such printers would have either 9 or 24 pins on the print head. 24-pin print heads were able to print at a higher quality. Once the price of inkjet printers dropped to the point where they were competitive with dot matrix printers, dot matrix printers began to fall out of favor for general use.

Some dot matrix printers, such as the NEC P6300, can be upgraded to print in color. This is achieved through the use of a four-color ribbon mounted on a mechanism that raises and lowers the ribbons as needed. Color graphics are generally printed in four passes at standard resolution, thus slowing down printing considerably. As a result, color graphics can take up to four times longer to print than standard monochrome graphics, or up to 8-16 times as long at high resolution mode.Dot matrix printers are still commonly used in low-cost, low-quality applications like cash registers, or in demanding, very high volume applications like invoice printing.

The main use of Dot-Matrix Printers are in areas of intensive transaction-processing systems that churn out quite a lot of printing. Many companies who might have started off with dot-matrix printers are not so easily convinced to go for printers based on other technologies because of the speed advantage that they have with dot-matrix printers. A simple view of Dot matrix printer is shown in fig. 26.

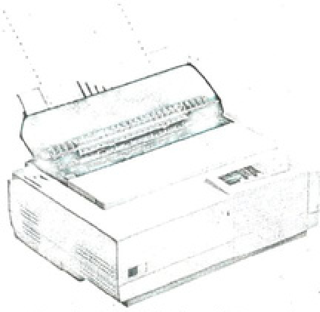


Fig. 48 : Dot Matrix printer

There are many types of dot matrix printer. Some of these are as follows:

- **LA180** -- 180 c/s line printer
- **LS120** -- 120 c/s terminal
- **LA120** -- 180 c/s advanced terminal
- **LA34** -- Cost-reduced terminal printer
- **LA38** -- An LA34 with more features
- **LA12** -- A portable terminal printer

There are various advantage and disadvantage of the printer. First we will discuss advantage then we will discuss the disadvantage.

Advantage:

Dot matrix printers, like any impact printer, can print on multi-part stationery or make carbon-copies. Impact printers have one of the lowest printing costs per page. As the ink is running out, the printout gradually fades rather than suddenly stopping partway through a job. it could print to wider (132 column) paper. Standard-carriage printers printed on letter-width (8.5") paper. They are able to use continuous paper rather than requiring individual sheets, making them useful for data logging. This type of printer allowed user control of a font's printed-size. Unlike the traditional bitmap representation of typeface data, scalable typefaces used a vector-based definition.They are good, reliable workhorses ideal for use in situations where printed content is more important than quality. The ink ribbon also does not easily dry out, including both the ribbon stored in the casing as well as the portion that is stretched in front of the print head; this unique property allows the dot-matrix printer to be used in environments where printer duty can be rare, for instance, as with a Fire Alarm Control Panel's output.

Disadvantage:

Dot matrix or Impact printers are usually noisy, to the extent that sound dampening enclosures are available for use in quiet environments. They can only print low resolution graphics, with limited color performance, limited quality and comparatively low speed. While they support fanfold paper with tractor holes, single-sheet paper usually has to be wound in and aligned by hand, which is relatively inconvenient and time-consuming. While far better suited to printing on labels than a laser printer or an inkjet printer, they are prone to bent pins (and therefore a destroyed printhead) caused by printing a character half-on and half-off the label.

1.11.4.2 Daisy Wheel Printer

Daisy wheel printing is an impact printing technology invented in 1969 by David S. Lee.It uses interchangeable pre-formed type elements, each with 96 glyphs, to generate high-quality output comparable to premium typewriters such as the IBM "Golfball" Selectric, but three times faster. Daisy-wheel printing was used in electronic typewriters, word processors and computer systemsfrom 1972.In early days daisy-wheel printers had become the dominant technology for high-quality print. Dot-matrix impact or thermal printers were used where higher speed was required and poor print quality was acceptable. Both technologies were rapidly superseded for most purposes when dot-based printers-in particular laser printers-that could print any characters or graphics rather than being restricted to a limited character set became able to produce output of comparable quality. Daisy-wheel technology is now found only in some electronic typewriters. Like all other impact printers, daisy wheel printers are noisy. Although the daisy wheel principle is basically inappropriate for printing bitmap graphics, there were attempts to enable them to do so. Most daisy wheel printers supported a relatively coarse and extremely slow graphics mode by printing the image entirely out of full stops.

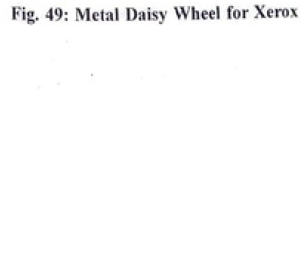


Fig. 49: Metal Daisy Wheel for Xerox

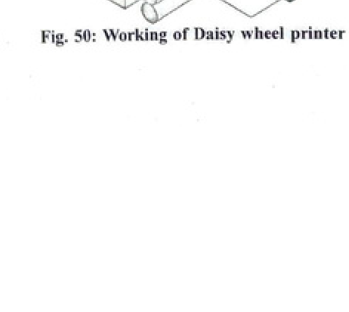


Fig. 50: Working of Daisy wheel printer

1.11.4.3 Inkjet Printer

Inkjet printers operate by propelling variably-sized droplets of liquid or molten material onto almost any sized page. They are the most common type of computer printer for the general consumer due to their low cost, high quality of output, capability of printing in different colors, and ease of use.Like most modern technologies, the present-day inkjet has built on the progress made by many earlier versions. Among many contributors, Epson, Hewlett-Packard and Canon can claim a substantial share of the credit for the development of the modern inkjetThe emerging ink jet material deposition market also uses ink jet technologies.There are three main technologies in use in contemporary inkjet printers: thermal, piezoelectric, and continuous.The ink used is known as aqueous (i.e. water-based inks using pigments or dyes) and the print head is generally cheaper to produce than other inkjet technologies.

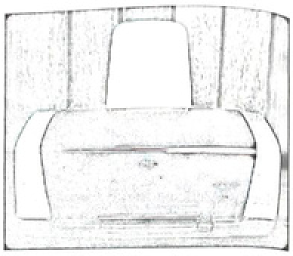


Fig. 51: Inkjet printer

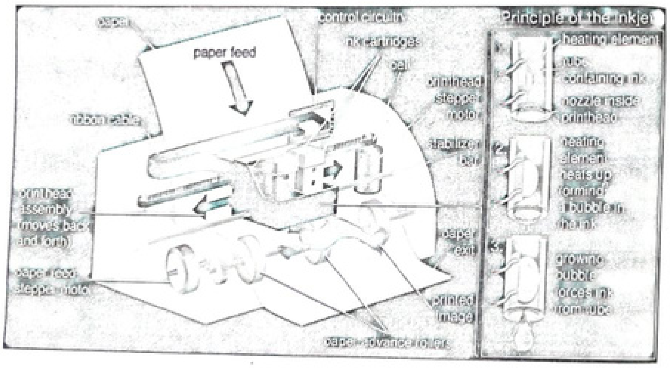


Fig. 52: Block Diagram Inkjet printer

Advantages

Compared to earlier consumer-oriented color printers, inkjets have a number of advantages. They are quieter in operation than impact dot matrix or daisywheel printers. They can print finer, smoother details through higher printhead resolution, and many consumer inkjets with photographic-quality printing are widely available.In comparison to more expensive technologies like dye sublimations, and laser printers, inkjets have the advantage of practically no warm up time and lower cost per page. For some inkjet printers, monochrome ink sets are available either from the printer manufacturer or third-party suppliers. These allow the inkjet printer to compete with the silver-based photographic papers traditionally used in black-and-white photography.

Disadvantages

There are various advantages of the inkjet printer. The ink is often very expensive. (For a typical OEM cartridge priced at $15, containing 5 mL of ink, the ink effectively costs $3000 per liter--or $8000 per gallon.) According to the BBC (2003.Many "intelligent" ink cartridges contain a microchip that communicates the estimated ink level to the printer; this may cause the printer to display an error message, or incorrectly inform the user that the ink cartridge is empty. In some cases, these messages can be ignored, but some inkjet printers will refuse to print with a cartridge that declares itself empty, in order to prevent consumers from refilling cartridges. The lifetime of inkjet prints produced by inkjets using aqueous inks is limited; they will eventually fade and the color balance may change. On the other hand, prints produced from solvent-based inkjets may last several years before fading, even in direct sunlight, and so-called "archival inks" have been produced for use in aqueous-based machines which offer extended life. Because the ink used in most consumer inkjets is water-soluble, care must be taken with inkjet-printed documents to avoid even the smallest drop of water, which can cause severe "blurring" or "running." Similarly, water-based highlighter markers can blur inkjet-printed documents. The ink consumed cleaning them - either during cleaning invoked by the user, or in many cases, performed automatically by the printer on a routine schedule - can account for a significant proportion of the total ink installed in the machine.

Even with many available options for cost-reduction, inkjet printing using desktop printers is costly over time due to expensive replacement ink cartridges with much lower capacity than laser-printer cartridges. Major applications where these printers are used are for outdoor settings for billboards, truck sides and truck curtains, building graphics and banners, while indoor displays include point-of-sales displays, backlit displays, exhibition graphics and museum graphics.

1.11.4.4 Line Printer

The line printer is a form of high speed impact printer in which one line of type is printed at a time. They are mostly associated with the early days of computing, but the technology is still in use. Print speeds of 600 to 1200 lines-per-minute were common.

There are Four principal of designs existed:

- Drum printers
- Chain (train) printers
- Bar printers
- Comb printers

In a typical **drum printer** design, a fixed font character set is engraved onto the periphery of a number of print wheels, the number matching the number of columns (letters in a line) the printer could print. Chain printers (also known as **train printers**) placed the type on moving bars. As with the drum printer, as the correct character passed by each column, a hammer was fired from behind the paper. Compared to drum printers, chain printers had the advantage that the type chain could usually be changed by the operator. **Band printers** are a variation of chain printers, where a thin steel band is used instead of a chain, with the characters embossed on the band. **Bar printers** were similar to chain printers but were slower and less expensive. Rather than a chain moving continuously in one direction, the characters were on fingers mounted on a bar that moved left-to-right and then right-to-left in front of the paper. An example was the IBM 1443.

Comb printers, also called line matrix printers, represent the fourth major design. These printers were a hybrid of dot matrix printing and line printing. In these printers, a comb of hammers printed a portion of a row of pixels at one time. By shifting the comb back and forth slightly, the entire pixel row could be printed (continuing the example, in eight cycles). The paper then advanced and the next pixel row was printed.

All line printers used paper provided in boxes of continuous fan-fold forms rather than cut-sheets. The paper was usually perforated to tear into cut sheets if desired and was commonly printed with alternating white and light-green areas, allowing the reader to easily follow a line of text across the page. This technology is still in use in a number of applications. It is usually both faster and has lower total cost of ownership, including purchase price, consumables, paper, and maintenance, than laser printers. Line printers continue to be used for printing box labels, medium volume accounting and other large business applications.. Multi-part paper forms printed in one operation are sometimes useful. The the limited character set, fixed character spacing, and relatively poor print quality make impact line printers unsuitable for correspondence, books, and other applications requiring high print quality.

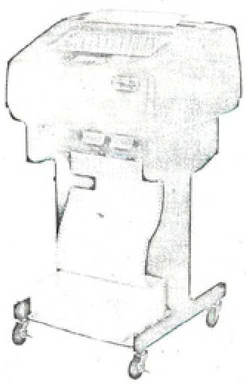


Fig. 53: Line Printer

1.11.4.5 Label Printer

A **label printer** is a computer printer that prints on self-adhesive label material and/or card-stock (tags). Label printers with built-in keyboards and displays, for stand-alone use (without a computer), are often called label makers. Label printers are different from ordinary printers because they need to have special feed mechanisms to handle rolled stock, or tear sheet (fanfold) stock. Common connectivity for label printers include RS-232 serial, Universal Serial Bus, parallel, Ethernet.Label printers have a wide variety of applications, including supply chain management, retail price marking, packaging labels, blood and laboratory specimen marking, and fixed assets management.

Types of Label Printers

- **Desktop label printers** are generally designed for light- to medium-duty usage with a roll of stock up to 4" wide. They are quiet and inexpensive.
- **Commercial label printers** can typically hold a larger roll of stock (up to 8" wide) and are geared for medium-volume printing.
- **Industrial label printers** are designed for heavy-duty, continuous operation in warehouses, distribution centers, factories and large organization.
- **Industrial portable label** printers are designed for heavy-duty operation on location. Examples of applications are labeling for electrical installations, construction sites, where there are no computers.

- **RFID readers** are specialized label printers that print and encode at the same time on RFID transponders (tags) enclosed in paper or printable synthetic materials. RFID tags need to have printed information for backwards compatibility with barcode systems, so humans can identify the tag.
- **Personal label printers or label makers** are handheld or small desktop devices. They are intended for home office, small office, or small businesses use. The cost of the printers is generally very low, making them popular with low volume users.

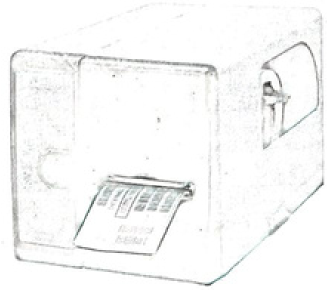


Fig. 54: Label Printer

1.11.4.6 Laser Printer

The laser printer was invented at Xerox in 1969 by researcher Gary Starkweather.**A laser printer** is a common type of computer printer that rapidly produces high quality text and graphics on plain paper. As with digital photocopiers and multifunction printers (MFPs), laser printers

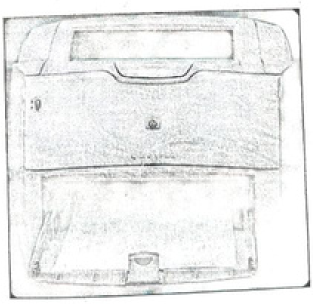


Fig. 55: LASER Printer

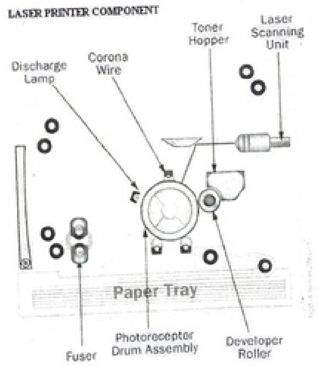


Fig. 56: Component of LASER Printer

employ a xerographic printing process but differ from analog photocopiers in that the image is produced by the direct scanning of a laser beam across the printer's photoreceptor. Laser printers have many significant advantages over other types of printers. Unlike impact printers, laser printer speed can vary widely, and depends on many factors, including the graphic intensity of the job being processed. In comparison with the laser printer, most inkjet printers and dot-matrix printers simply take an incoming stream of data and directly imprint it in a slow lurching process that may include pauses as the printer waits for more data. A laser printer is unable to work this way because such a large amount of data needs to output to the printing device in a rapid, continuous process.

Most consumer and small business laser printers use a toner cartridge that combines the photoreceptor (sometimes called "imaging drum") with the toner supply bin, the waste toner hopper, and various wiper blades. When the toner supply is consumed, replacing the toner cartridge automatically replaces the imaging drum, waste toner hopper, and wiper blades.Some laser printers maintain a page count of the number of pages printed since last maintenance. On these models, a reminder message will appear informing the user it is nearing time to replace standard maintenance parts.

1.11.4.7 Thermal Wax Transfer Printer

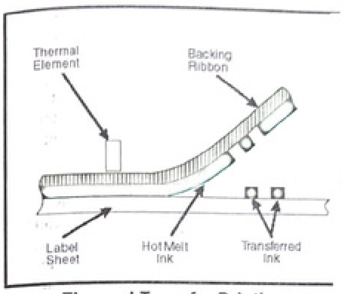
A thermal transfer printer is a printer which prints on paper by melting a coating of ribbon so that it stays glued to the material on which the print is applied. It contrasts with Direct Thermal printing where no ribbon is present in the process. It was invented by SATO corporation around the late 1940s.Usage of TT printers in industry includes:

- barcode labels (as labels printed with thermal printer tend not to last long), or for marking clothing labels (shirt size etc)
- Printing plastic labels for chemical containers (because the cheaper types of plastic would melt in a laser printer)

Barcode printers typically come in fixed sizes of 4 inches, 6 inches or 8 inches wide etc. Although a number of manufacturers have made differing sizes in the past, most have now standardised on these sizes. The main application for these printers is to produce barcode labels for product and shipping identification.The printers use a fixed width thermal print head, pressing onto a paper or plastic label, over a driven rubber roller called a platen.

Between the print head and the label is sandwiched a very thin thermal transfer ribbon (or sometimes called "foil"), which is a polyester film which has been coated on the label side with a wax, wax-resin or pure resin "ink". Thermal printing technology can be used to produce color images by adhering a wax-based ink onto paper. As the paper and ribbon travel in unison beneath the thermal print head, the wax-based ink from the transfer ribbon melts onto the paper. When cooled, the wax is permanently adhered to the paper. This type of thermal printer uses a like-sized panel of ribbon for each page to be printed, regardless of the contents of the page.

A working diagram of thermal wax printer is as follows:



Thermal Transfer Printing

Fig. 57

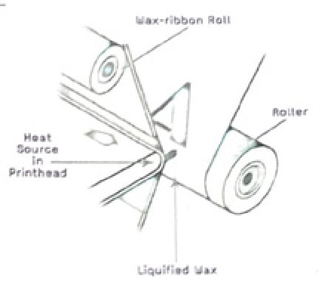


Fig. 58: Working diagram of thermal wax printer

1.11.4.8 IRIS Printer

An Iris printer is a large format color inkjet printer manufactured by the Graphic Communications Group of Eastman Kodak, which is used for digital prepress proofing. Iris printers use a continuous flow ink system to produce continuous-tone output on various media, including paper, canvas, silk,

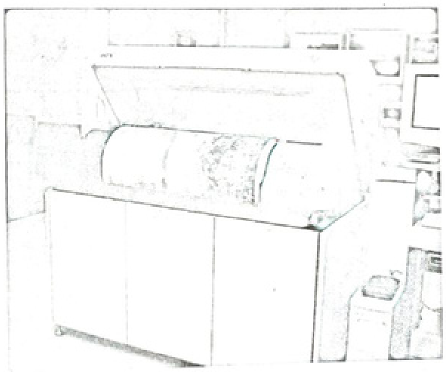


Fig. 59: IRIS PRINTER

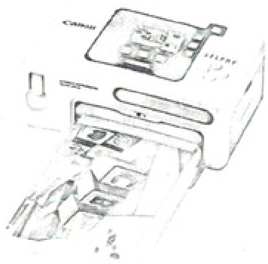
linen and other textiles. the Iris printers' four 1 micrometre glass jets operate continuously under high pressure, vibrated by a piezoelectric crystal to produce drops at a 1 mHz rate. The prints are noted for their accurate color reproduction. Iris printers are also noted for the low cost of their consumables compared to other printing technologies. Prints produced by an Iris printer are commonly called "Iris prints", "Iris proofs", or simply "Irises".The Iris printer was originally developed by Iris Graphics. Iris printers are used in prepress proofing for color on printing jobs where color match is critical, such as commercial product packaging and magazine layout. Their output is used to check (proof) what the colors will look like before mass production begins. The Iris printer's connection with industrial printing meant the name "Iris print" was synonymous with a disposable prepress proof. Nash and Holbert came up with the name "digigraph" to try to distinguish their work from the industrial process.

1.11.4.9 DYE-SUBLIMATION PRINTER:

A **dye-sublimation printer** (or dye-sub printer) is a computer printer which employs a printing process that uses heat to transfer dye to a medium such as a plastic card, paper, or fabric. The process is usually to lay one color at a time using a ribbon that has color panels. Most dye-sublimation printers use CMYO colors which differs from the more recognized CMYK colors in that the black dye is eliminated in favour of a clear overcoating. Many consumer and professional dye-sublimation printers are designed and used for producing photographic prints.

Sublimation is when a substance transitions between the solid and gas states without going through a liquid stage; the action of dry ice exposed to room temperature is a common example. In a dye-sublimation printer the printing dye is heated up until it turns into a gas, at which point it diffuses onto the printing media and solidifies. Prior to printing, the dye is stored on a cellophane ribbon. The ribbon is made up of three colored panels (cyan, magenta, and yellow) and one clear panel which holds the lamination material for the overcoating. During the printing, the printer rollers will move the media and one of the colored panels together under a thermal printing head, which is usually the same width as the shorter dimension of the print media. Tiny heating elements on the head change temperature rapidly, laying different amounts of dye depending on the amount of heat applied. After the printer finishes covering the media in one color, it winds the ribbon on to the next color panel and partially ejects the media from the printer to prepare for the next cycle. The entire process is repeated four times in total: the first three lay the colors onto the media to form a complete image, while the last one lays the laminate over top.

The advantage of dye-sublimation printing has been the fact that it is a continuous-tone technology, where each dot can be any color. In contrast, inkjet printers can vary the location and size of ink droplets, a process called dithering, but each drop of ink is limited to the colors of the inks installed.Dye sublimation offers advantages over inkjet printing. For one, the prints are dry and ready to handle as soon as they exit the printer. Since the thermal head doesn't have to sweep back and forth over the print media, there are fewer moving parts that can break down. As the dye never enters a liquid phase, the whole printing cycle is extremely clean; there are no liquid inks to clean up and no print heads to get clogged. These factors make dye-sublimation generally a more reliable technology over inkjet printing. Dye-sublimation printers have some drawbacks compared to inkjet printers. Each of the colored panels of the ribbons; and the thermal head itself, must match the size of the media that is being printed on. Furthermore, only specially-coated paper can accept the sublimated ink. This means that dye-sublimation printers cannot match the flexibility of inkjet printers in printing on a wide range of media.



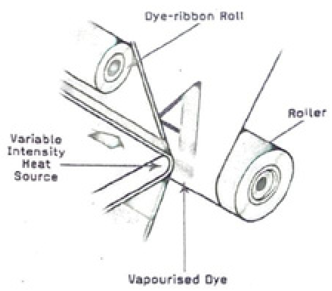


Fig. 60 : (A) Dye-Sublimation printer (B) Working diagram of Dye -Sublimation Printer

1.11.4.10 Fiery Printer

"Fiery" is usually software that is used for graphics processing to a production printer or plotter. Printers using fiery software are usually in the $1,500.00 and up bracket all the way to production presses at 100's of thousands each.

Fiery isn't really the printer but actually a software to drive a printer. Better systems are actually provided on a server that is dedicated and hooked to whichever machine the software is going to control.

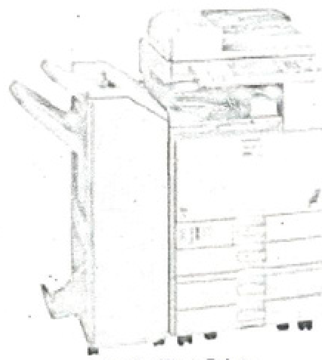


Fig. 61 : Fiery Printer

1.11.5 PLOTTERS

A plotter is a vector graphics printing device to print graphical plots, that connects to a computer. There are two types of main plotters. Those are pen plotters and electrostatic plotters. Early plotters worked by placing the paper over a roller which moved the paper back and forth for X motion, while the pen moved back and forth on a single arm for Y motion. Plotters were also used in the Create-A-Card kiosks that were available for a while in the greeting card area of supermarkets that used the HP 7475 6 pen plotter. Plotters are used primarily in technical drawing and CAD applications, where they have the advantage of working on very large paper sizes while maintaining high resolution. Another use has been found by replacing the pen with a cutter, and in this form plotters can be found in many garment and sign shops.

There are various types of the plotters. Some of these are as follows:

- Pen Plotter
- Inkjet plotter
- Electrostatic plotter

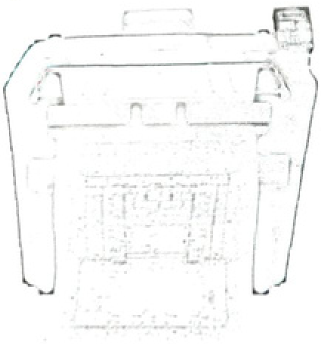


Fig. 62: Plotter

1.11.5.1 PEN PLOTTER

Pen plotters print by moving a pen across the surface of a piece of paper. This means that plotters are restricted to line art, rather than raster graphics as with other printers. Pen plotters can draw complex line art, including text, but do so very slowly because of the mechanical movement of the pens. Pen Plotters are incapable of creating a solid region of color; but can hatch an area by drawing a number of close, regular lines. Pen plotters have essentially become obsolete, and have been replaced by large-format inkjet printers and LED toner based printers. Such printers are often still known as plotters, even though they are raster devices rather than pen based plotters by the definition of this article. A pen plotter's speed is primarily limited by the

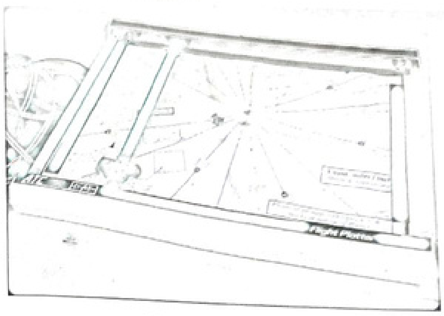


Fig. 63 : Pen Plotter

type of pen used. The typical plotter pen uses a cellulose fiber rod inserted through a circular foam tube saturated with ink, with the end of the rod sharpened into a conical tip. As the pen moves across the paper surface, capillary wicking draws the ink from the foam, down the rod, and onto the paper.

1.11.5.2 Electrostatic Plotter

An Electrostatic Plotter produces a raster image by charging the paper with a high voltage. This voltage attracts toner which is then melted into the paper with heat. This type of plotter is fast, but the quality is generally considered to be poor when compared to pen plotters.

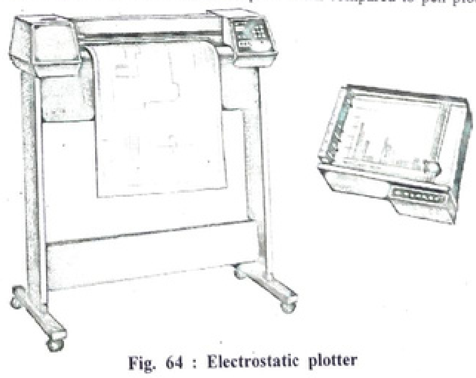


Fig. 64 : Electrostatic plotter

1.11.6 Voice Output Device

Those devices which produce voice after input are called voice output devices. You can see many examples around you of voice output devices. For example television is the example of voice output device when you listen different kinds of sound from your television. Similarly another example is radio which gives you output in the form of different voices so radio is also a good example of voice output device. There are several other examples of voice output devices as well. In these examples the speakers of your tape or deck can not be neglected. Similarly if you've some multimedia gadget and it give you output in the form of voice it would be considered as voice output device.

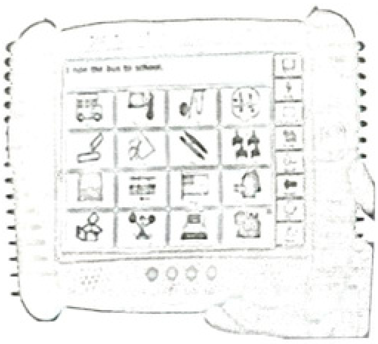


Fig. 65 : Voice Output Device

1.12 Storage Devices

Computer data storage, often called **storage** or **memory**, refers to computer components, devices, and recording media that retain digital data used for computing for some interval of time. Computer data storage provides one of the core functions of the modern computer, that of information retention. It is one of the fundamental components of all modern computers, and coupled with a central processing unit (CPU, a processor). In contemporary usage, memory usually refers to a form of semiconductor storage known as random access memory (RAM) and sometimes other forms of fast but temporary storage. Similarly, storage today more commonly refers to mass storage - optical discs, forms of magnetic storage like hard disks, and other types slower than RAM, but of a more permanent nature.

Many different forms of storage, based on various natural phenomena, have been invented. So far, no practical universal storage medium exists, and all forms of storage have some drawbacks. Therefore a computer system usually contains several kinds of storage, each with an individual purpose.

In practice, almost all computers use a variety of memory types, organized in a storage hierarchy around the CPU, as a tradeoff between performance and cost. Generally, the lower a storage is in the hierarchy, the lesser its bandwidth and the greater its access latency is from the CPU. This traditional division of storage to primary, secondary, tertiary and off-line storage is also guided by cost per bit.

1.12.1 Types of Storage

There are various types of the storage like as :

- Primary storage
- Secondary storage
- Tertiry storage
- Off line storage

Hierarchy of storage is shown in the given diagram:

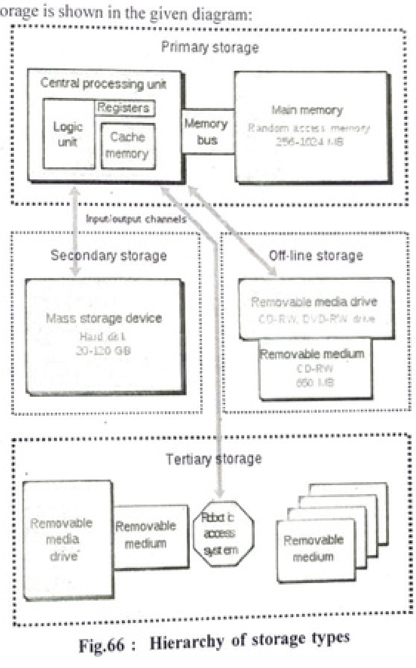


Fig.66 : Hierarchy of storage types

Primary storage, presently known as **memory**, is the only one directly accessible to the CPU. The CPU continuously reads instructions stored there and executes them as required. This led to a modern random access memory (RAM). It is small-sized, light, but quite expensive at the same time. The particular types of RAM used for primary storage are also volatile, i.e. they lose the information when powered not on. In the primary storage the main memory is connected with the CPU through the address and data bus. **Secondary storage** in popular usage, differs from primary storage in that it is not directly accessible by the CPU. The computer usually uses its input/output channels to access secondary storage and transfers the desired data using intermediate area in primary storage. Secondary storage does not lose the data when the device is powered down-it is non-volatile. it is typically also an order of magnitude less expensive than primary storage. In modern computers, hard disks are usually used as secondary storage. Some other examples of secondary storage technologies are: flash memory (e.g. USB sticks or keys), floppy disks, magnetic tape, paper tape, punch cards, standalone RAM disks, and Zip drives. **Tertiary storage** or **tertiary memory**, provides a third level of storage. Typically it involves a robotic mechanism which will mount (insert) and dismount removable mass storage media into a storage device according to the system's demands; this data is often copied to secondary storage before use. It is primarily used for archival of rarely accessed information since it is much slower than secondary storage. Off-line storage, also known as disconnected storage, is a computer data storage on a medium or a device that is not under the control of a processing unit. The medium is recorded, usually in a secondary or tertiary storage device, and then physically removed or disconnected. It must be inserted or connected by a human operator before a computer can access it again.

In modern personal computers, most secondary and tertiary storage media are also used for off-line storage. Optical discs and flash memory devices are most popular, and to much lesser extent removable hard disk drives. In enterprise uses, magnetic tape is predominant.

1.12.2 Characteristics of Storage

- Volatility
- Mutability
- Addressability
- Performance
- Differentiation
- Accessibility
- Capacity
- Environmental Impact

So these are the various characteristics of the storage. So after that we can start the study of the storage device.

1.12.3 Storage Device

A **data storage device** is a device for recording (storing) information (data). Recording can be done using virtually any form of energy, spanning from manual power in handwriting, to acoustic vibrations in phonographic recording, to electromagnetic energy modulating magnetic tape and optical discs. A storage device may hold information, process information, or both. A device that only holds information is a recording medium. Devices that process information may either access a separate portable recording medium or a permanent component to store and retrieve information. Many data storage devices are also media players. Any device that can store and playback multimedia may also be considered a media player such as in the case with the HDD media player. Designated hard

drives are used to play saved or streaming media on home theatare systems.

There are various types of storage device. Some of these are as follows:

- Magnetic
- Magneto- optical
- Optical
- Solid state

1.12.3.1 Magnetic Storage Device

Magnetic storage are terms from engineering referring to the storage of data on a magnetized medium. Magnetic storage uses different patterns of magnetization in a magnetizable material to store data and is a form of non-volatile memory. The information is accessed using one or more read/write heads. As of 2009, magnetic storage media, primarily hard disks, are widely used to store computer data as well as audio and video signals. In the field of computing, the term magnetic storage is preferred and in the field of audio and video production, the term magnetic recording is more commonly used. The distinction is less technical and more a matter of preference. Magnetic storage media can be classified as either sequential access memory or random access memory although in some cases the distinction is not perfectly clear. In the case of magnetic wire, the read/write head only covers a very small part of the recording surface at any given time. common uses of magnetic storage media are for computer data mass storage on hard disks and the recording of analog audio and video works on analog tape. Since much of audio and video production is moving to digital systems, the usage of hard disks is expected to increase at the expense of analog tape.

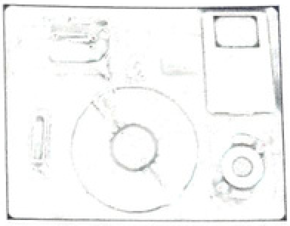


Fig. 67 : Magnetic storage device

1.12.3.2 Optical Storage Device

Optical storage is a term from engineering referring to the storage of data on an optically readable medium. Data is recorded by making marks in a pattern that can be read back with the aid of light. A common modern technique used by computers involves a tiny beam of laser light precisely focused on a spinning disc. An older example, that does not require the use of computers, is microform. There are other means of optically storing data and new methods are in development..The term optical drive usually refers to a device in a computer that can read CD-ROMs or other optical discs. Optical storage devices provide direct-access secondary storage that is faster than tape and less expensive than disk. Optical storage offers you additional flexibility in determining how much data to store for how long. The data stored on optical devices is accessed just like data on magnetic disks. Although the access time is

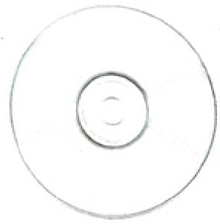


Fig. 68 : Optical Storage (Blank CD)

longer, the cost is significantly less. Optical devices are a good choice for infrequently accessed data that you neither want to relegate to tape archives nor want to store on magnetic disks (because they are more expensive).

1.12.3.3 Magneto-Optical Storage Device

A magneto-optical drive is a kind of optical disc drive capable of writing and rewriting data upon a magneto-optical disc. Both 130 mm (5.25 in) and 90 mm (3.5 in) form factors exist. The technology was introduced at the end of the 1980s. Although optical, they appear as hard disk drives to the operating system and do not require a special filesystem (they can be formatted as FAT, NTFS, etc.). This type of disc consists of a ferromagnetic material sealed beneath a plastic coating. There is never any physical contact during reading or recording. During recording, the laser power is increased so it can heat the material up to the Curie point in a single spot.

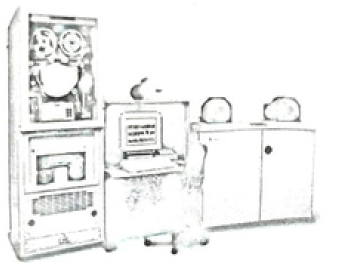


Fig. 69 : Magneto-optical storage device

1.12.3.4 Solid State

A **solid-state drive (SSD)** is a data storage device that uses solid-state memory to store persistent data. An SSD emulates a hard disk drive interface, thus easily replacing it in most applications. An SSD using SRAM (static random access memory)or DRAM (dynamic random access memory) is often called a RAM-drive, not to be confused with a RAM disk. *The original usage of the term solid-state (from solid-state physics) refers to the use of semiconductor devices rather than electron tubes, but in this context, has been adopted to distinguish solid-state electronics from electromechanical devices as well. Most SSD manufacturers use non-volatile flash memory to create more rugged and compact devices for the consumer market. These flash memory-based SSDs, also known as flash drives, do not require batteries. They are often packaged in standard disk drive form factors. In addition, non-volatility allows flash SSDs to retain memory even during sudden power outages, ensuring data persistence. SSDs are slower than DRAM and some designs are slower than even traditional HDDs on large files. Fig. of solid state drive is shown in fig. 5.*

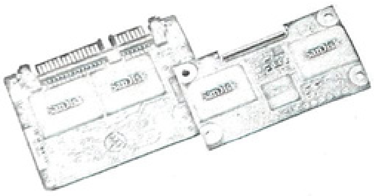


Fig. 70 : Solid state storage (sandisk)

1.13 Random and Sequential Access

Random access (direct access) is the ability to access an arbitrary element of a sequence in equal time. The opposite is sequential access, where a remote element takes longer time to access.

An example of the random access is a cassette tape (sequential-you have to fast-forward through earlier songs to get to later ones) and a compact disc (random access-you can jump right to the track you want). The term random access memory (RAM), however, is used for semiconductor chip memory circuits used in computers. In data structures, random access implies the ability to access the Nth entry in a list of numbers in constant time. Very few data structures can guarantee this, other than arrays (and related structures like dynamic arrays). Random access is critical to many algorithms such as quicksort and binary search. Other data structures, such as linked lists, sacrifice random access to make for efficient inserts, deletes, or reordering of data.

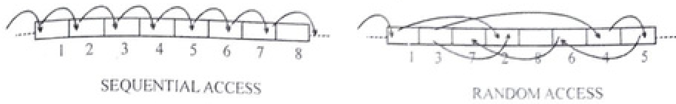


Fig.71 : Comparision between Random access and sequential access.

Formatting

Before a magnetic disk can be used, it must be formatted. A process that maps the disk's surface and determines how data will be stored. During formatting, the drive creates circular tracks around the disk's surface, and then divides each track into sectors. The OS organizes sectors into groups, called clusters, and then tracks each file's location according to the clusters it occupies. Or in another word.

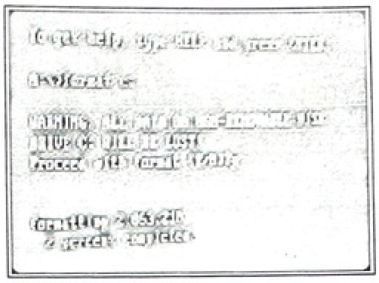


Fig. 72 : Formatting a hard drive using MS-DOS

Disk formatting is the process of preparing a hard disk or other storage medium for use, including setting up an empty file system. Large disks can be partitioned, that is, divided into distinct sections that are formatted with their own file systems. This is normally only done on hard disks because of the small sizes of other disk types, as well as compatibility issues.A corrupted operating system can be reverted to a clean state by formatting the disk and reinstalling the OS, as a drastic way of combating a software problem. There are two type of the formatting known as low-level and high-level formatting.

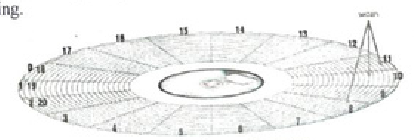


Fig. 73 : Formatted disk

The low-level format of floppy disks (and early hard disks) is performed by the disk drive hardware.The process is most easily described with a standard 1.44 MB floppy disk in mind. Low-level formatting of the floppy normally writes 18 sectors of 512 bytes each on each of 160 tracks (80 on each side) of the floppy disk, providing 1,474,560 bytes of storage on the disk.

High-level formatting is the process of setting up an empty file system on the disk, and installing a boot sector. This alone takes little time, and is sometimes referred to as a "quick format". In the case of floppy disks, both high- and low-level formatting are customarily done in one pass by the software.

When a disk is formatted, the OS creates four Areas on its surface:

- **Boot sector** - stores the master boot record, a small Program that runs when you first start (boot) the Computer.
- **File allocation table (FAT)** - a log that records each file's location and each sector's status.
- **Root folder** - enables the user to store data on the disk in a logical way.
- **Data area** - the portion of the disk that actually holds Data.

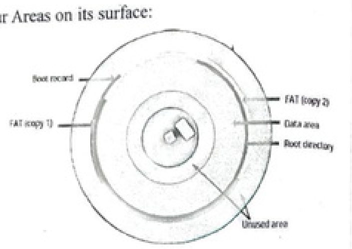


Fig. 74 : Formatted disk

Storage Capacity

The storage capicity of the large computer systems is nornally more than the small system or machines.capicity is in terms of bytes and words. There are mainly two types of the capicity.

- **Raw capacity** : The total amount of stored information that a storage device or medium can hold. It is expressed as a quantity of bits or bytes.
- **Density** : The compactness of stored information. It is the storage capacity of a medium divided with a unit of length, area or volume (e.g. 1.2 megabytes per square inch).

1.14 Tracks and Sectors

A sector is a subdivision of a track. on a magnetic disk or optical disc. Each sector stores a fixed amount of data. The typical formatting of these media provides space for 512 bytes (for magnetic disks) or 2048 bytes (for optical discs) of user-accessible data per sector.Mathematically, the word sector means a portion of a disk between a center, two radii and a corresponding arc shaped like a slice of a pie. Thus, the common disk sector actually refers to the intersection of a track and mathematical sector.

Platters are organized into specific structures to enable the organized storage and retrieval of data. Each platter is broken into tracks--tens of thousands of them--which are tightly-packed concentric circles. These are similar in structure to the annual rings of a tree. A track holds too much information to be suitable as the smallest unit of storage on a disk, so each one is further broken down into sectors. A sector is normally the smallest individually-addressable unit of information stored on a hard disk, and normally holds 512 bytes of information. The first PC hard disks typically held 17

sectors per track. Today's hard disks can have thousands of sectors in a single track.

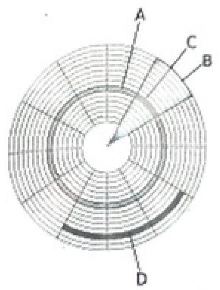


Fig. 75. Disk structures : A-Track, B- Geometrical sector, C-Track sector

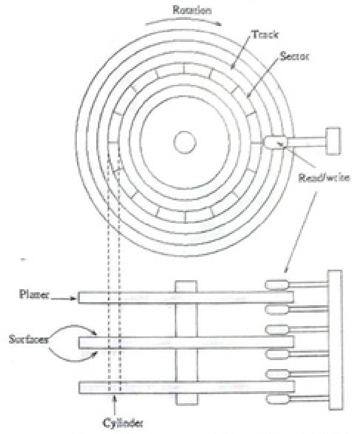


Fig. 76. Representation of track and sectors

1.15 Floppy Disk Drive

A **floppy disk** is a data storage medium that is composed of a disk of thin, flexible ("floppy") magnetic storage medium encased in a square or rectangular plastic shell. Floppy disks are read and written by a floppy disk drive or FDD.floppy disks in 8-inch (200 mm), 5¼-inch (133.35 mm), and 3½-inch (90 mm) formats enjoyed many years as a popular and ubiquitous form of data storage and exchange, from the mid-1970s to the late 1990s. While floppy disk drives still have some limited uses, especially with legacy industrial computer equipment. Before hard disks became affordable, floppy disks were often also used to store a computer's operating system (OS), in addition to application software and data. Most home computers had a primary OS stored permanently in on-board ROM, with the option of loading a more advanced disk operating system from a floppy, whether it be a proprietary system, CP/M, or later, DOS. The 5¼-inch disk had a large circular hole in the center for the spindle of the drive and a small oval aperture in both sides of the plastic to allow the heads of the drive to read and write the data. The magnetic medium could be spun by rotating it from the middle hole. A small notch on the right hand side of the disk would identify whether the disk was read-only or writable, detected by a mechanical switch or photo transistor above it. The 8-inch, 5¼-inch and 3-inch formats can be considered almost completely obsolete, although 3½-inch drives and disks are still widely available. Floppies are still used for emergency boots in aging systems which may lack support for other bootable media such as CD-ROMs and USB devices. They are also still often required for setting up a new PC from the ground up, since even comparatively recent operating systems like Windows XP and Windows Server 2000 rely on third party drivers shipped on floppies. A simple FDD is shown below:

Fig. 77 : FLOPPY DISC

Fig. 78 : Floppy disk Drive

Floppy Disk Drive

Date invented	1969 (8-inch),
	1976 (5¼-inch),
	1982 (3½-inch)
Invented by	IBM team led by David L. Noble
Connects to	Cable

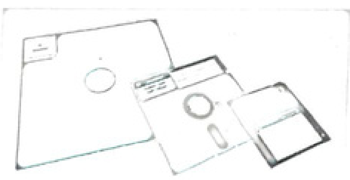


Fig. 79 : 8-inch, 5¼-inch, and 3½-inch floppy disks

There are various types of the floppy disc drive. Some of these are as follows:

- Sony HiFD
- 5¼-inch floppy disk
- 3½-inch floppy disk
- Zip drive
- 2HD
- super disc floppy

So these are the types of the floppy disc. Now we will cover one by one as in following manner:

Hi Floppy Disk :

The HiFD (High capacity Floppy Disk) was an attempt by Sony to replace their own aging 3.5 inch floppy disk.The first HiFD was launched in late 1998, boasting a capacity of 150MB and backwards compatibility with 3.5 inch floppy disks. It was available in Parallel port and ATA versions with a SCSI version planned, but never launched. A few months after launch it emerged that the HiFD suffered from frequent crashes during read/write operations, and had a tendency of having its read rate drop into the low kilobyte per second range, effectively rendering it unusable. Initially it was thought that a new driver could solve these problems - instead, Sony issued a full recall at the start of the following year.The HiFD was re-released in November 1999, now sporting a 200MB capacity and using a USB connection for the external drive.Sony

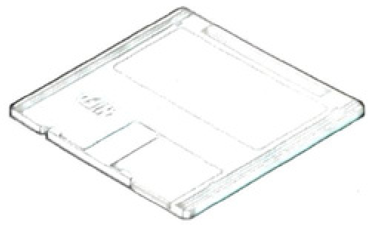


Fig. 80 : The HiFD

3½-Inch Floppy Disk:

The three densities of 3½-inch floppy disks are partially compatible. Higher density drives are built to read, write and even format lower density media without problems, provided the correct media are used for the density selected. Still, a fresh diskette that has been manufactured for high density use can theoretically be formatted as double density, but only if no information has ever been written on the disk using high density mode. The magnetic strength of a high density record is stronger and will "overrule" the weaker lower density, remaining on the diskette and causing problems. The holes on the right side of a 3½-inch disk can be altered as to 'fool' some disk drives or operating systems (others such as the Acorn Archimedes simply do not care about the holes) into treating the disk as a higher or lower density one, for backward compatibility or economical reasons. Fig. of floppy is shown below:

Fig. 81 :3.5 inch floppy disc

5¼-inch floppy disk:

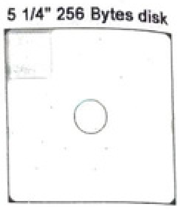


Fig. 82 : 5.25 inch floppy disc

In 1976 Shugart Associates introduced the first 5¼-inch FDD and associated media. By 1978 there were more than 10 manufacturers producing 5¼-inch FDDs, in competing physical disk formats: hard-sectored and soft-sectored. The 5¼-inch formats quickly displaced the 8-inch for most applications, and the 5¼-inch hard-sectored disk format eventually disappeared.Originally designed to be smaller and more practical than the 8-inch format, the 5¼-inch system was itself too large, and as the quality of the recording media grew, the same amount of data could be placed on a smaller surface. The 5.25-inch diskettes did not have a hard shell and were flimsy. The 5.25-inch diskettes were available in a capacity of 360kb low-density and 1.2MB high-density size; by 1994 the 5.25-inch disk was extinct and was replaced by the popularity of the 3.5-inch disks.

SUPER DISC FLOPPY:

The SuperDisk, sometimes marketed by as LS-120 and a later variant LS-240, is a high-speed, high-capacity alternative to the 90 mm (3.5 in), 1.44 MB floppy disk. The Superdisk hardware was introduced by 3M's storage products groupcirca. SuperDisk should not be confused with SuperDrive, which is a trademark used by Apple Computer for various disk drive products. The SuperDisk's format was designed to supersede the floppy disk with its higher-capacity media that imitated the then ubiquitous format with its own 120MB disk storage while the SuperDisk drive itself was backwards compatible with 1.44 MB and 720 KB floppy formats. Superdisk drives seemed to read and write faster to these sorts of disks than conventional 1.44 MB or 720 KB floppy drives.

Fig. 83 : Super Disc Floppy

ZIP DRIVE:

Iomega company introduced the Zip drive. Although it's not true to the 3½-inch form factor, it still became the most popular of the "super floppies". It boasted 100 MB, later 250 MB, and then 750 MB of storage. Though Zip drives gained in popularity for several years they never reached the same market penetration as standard floppy drives, since only some new computers were sold with the drives. A major reason for the failure of the Zip Drives is also attributed to the higher pricing they carried. Zip drive media were primarily popular for the excellent storage density and drive speed they carried, but were always overshadowed by the price.

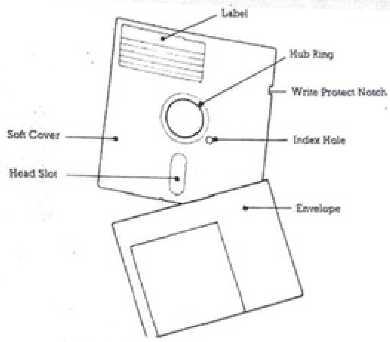


Fig. 84 : Block diagram of the FDD

HARD DISK:

A **hard disk drive** ("hard disk",or "HDD"), is a non-volatile storage device which stores digitally encoded data on rapidly rotating platters with magnetic surfaces. Strictly speaking, "drive" refers to a device distinct from its medium, such as a tape drive and its tape, or a floppy disk drive and its floppy disk. Early HDDs had removable media; however, an HDD today is typically a sealed unit (except for a filtered vent hole to equalize air pressure) with fixed media. A typical hard drive has two electric motors, one to spin the disks and one to position the read/write head assembly. The disk motor has an external rotor attached to the platters; the stator windings are fixed in place. The actuator has a read-write head under the tip of its very end. a thin printed-circuit cable connects the read-write head to the hub of the actuator. A flexible, somewhat 'U'-shaped, ribbon cable, seen edge-on below and to the left of the actuator arm in the first image and more clearly in the second, continues the connection from the head to the controller board on the opposite side.

There are many characteristics of the hard disk. It have very high data transfer rate i.e. 70 megabytes per seconddata transfer rate depends on the track location, so it will be highest for data on the outer tracks (where there are more data sectors) and lower toward the inner tracks (where there are fewer data sectors); and is generally somewhat higher for 10,000rpm drives. Secondly it take very less time to complete a task. currently ranges from just under 2 ms for high-end server drives, to 15 ms for miniature drives, with the most common desktop type typically being around 9 ms. Third one is power consuption. There is very less power ponsuption. Smaller form factor drives often use less power than larger drives. A simple view of hard disk is shown in fig. 20.

In this fig. we can see that Each surface is divided into tracks (and sectors) in the same way. This means that when the head for one surface is on a track, the heads for the other surfaces are also on the corresponding tracks. All the corresponding tracks taken together are called a cylinder. It takes time to move the heads from one track (cylinder) to another, so by placing the data that is often accessed together (say, a file) so that it is within one cylinder, it is not necessary to move the heads to read all of it. This improves performance. The number of surfaces (or heads, which is the same thing), cylinders, and sectors vary a lot; the specification of the number of each is called the geometry of a hard disk. History of hard disk is shown below.

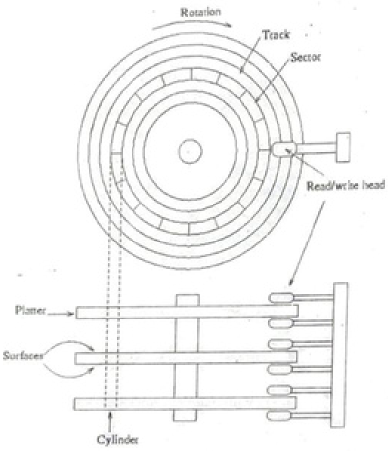
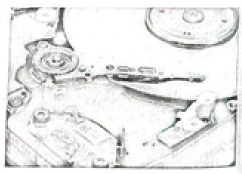


Fig. 85 : A Simple view of hard disk

Date invented	December 14, 1954	 A HARD DISK DRIVE
Invented by	Rey Johnson	
Connects to interface	Host adapter of system, in PCs typically integrated into motherboard. via one of: • PATA (IDE) interface • SATA interface • SAS interface • SCSI interface • FC interface	
Market Segments	Desktop computers Mobile computing	

Each hard disk is represented by a separate device file. There can (usually) be only two or four IDE hard disks. Hard disks use multiple platters, stacked on a spindle. Each platter has two read/write heads, one for each side. Hard disks use higher-quality media and a faster rotational speed than diskettes. Removable hard disks combine high capacity with The convenience of floppy disks.

Cylinder

Cylinder-head-sector, also known as CHS, was an early method for giving addresses to each physical block of data on a hard disk drive (HDD). In the case of floppy drives, for which the same exact floppy medium can be truly low-level formatted to different capacities, this is still true.Though CHS valdes no longer have a direct physical relationship to the data stored on disks, pseudo CHS values are still being used by many utility programs. In other words A cylinder comprises the same track number but spans all such tracks across each platter surface that is able to store data. Thus, it is a three-dimensional object. Any track that comprises the same cylinder can be written to and read from while the actuator assembly remains stationary. One way drive makers have been able to increase drive speed is by increasing the number of platters that can be read at a given time.

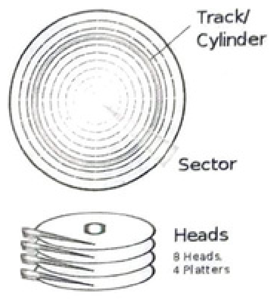


Fig. 86 : Representation of cylinders

Comparision among hard disk sectors, tracks and cylinder:

A hard disk is usually made up of multiple platters, each of which use two heads to record and read data, one for the top of the platter and one for the bottom, All information stored on a hard disk is recorded in tracks, which are concentric circles placed on the surface of each platter, much like the annual rings of a tree. A cylinder is basically the set of all tracks that all the heads are currently located at. So if a disk had four platters, it would (normally) have eight heads, and cylinder number 720 (for example) would be made up of the set of eight tracks, one per platter surface, at track number 720. The fig. 22 also explains the difference all of these:

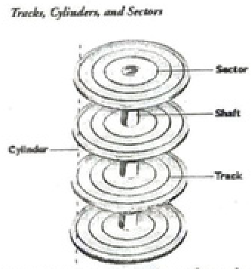


Fig. 87 : Representation of tracks, cylinder, and sectors

Hard Disk Interfaces

There are many types of the hard disk interfaces. Some of these are as follows:

- Integrated drive electronics (IDE)
- Enhanced Integrated drive electronics (EIDE)

- Small computer system interface (SCSI)

So these are all the hard disk interfaces. Now we will study one by one in the following manner.

Integrated Disk Interfaces

Integrate disk interface (IDE) is also known as Parallel ATA (PATA). It is an interface standard for the connection of storage devices such as hard disks, solid-state drives, and CD-ROM drives in computers. It uses the underlying AT Attachment and AT Attachment Packet Interface (ATA/ATAPI) standards.The current Parallel ATA standard is the result of a long history of incremental technical development. As a result, many near-synonyms for ATA/ATAPI and its previous incarnations exist, including abbreviations such as IDE which are still in common informal use. Parallel ATA only allows cable lengths up to 18 in (460 mm). Because of this length limit the technology normally appears as an internal computer storage interface. For many years ATA provided the most common and the least expensive interface for this application. By the beginning of 2007, it had largely been replaced by Serial ATA (SATA) in new systems. History of IDE is as follows:

Type	Internal storage device connector	
	Production history	
Designer	Western Digital, subsequently amended by many others	
Designed	1986-87	
Superseded by	Serial ATA	
	Specifications	
Hot pluggable	No	
External	No	
	Width	16 bits
	Bandwidth	16 MB/s originally
	Max. devices	2 (master/slave)
	Protocol	Parallel
Cable	40 or 80 wires ribbon cable	
Pins	40	

Parallel ATA

A simple diagram of the IDE or ATA is shown below:

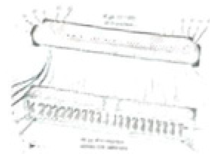


Fig. 88 : IDE connector

There are mainly two versions of the IDE or ATA connecter. The first version of what is now called the ATA/ATAPI interface and second one is ATA-2.

Enhanced Integrated Disk Interfaces (EIDE)

Modern computers come with EIDE (enhanced IDE) built into the main board. This is perfectly adequate for personal workstations. A high performance SCSI controller can be added to a new

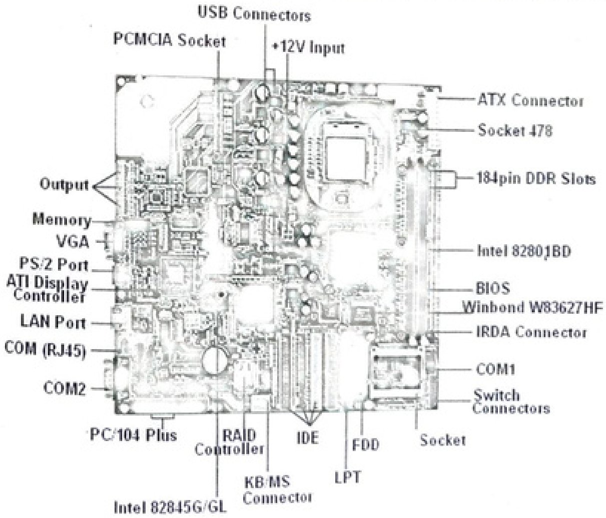


Fig. 89 : Enhanced integrated disk interfaces

system for an extra $220. IDE and SCSI disks operate at the same speed, but SCSI has advantages for a multitasking server because it allows many devices to be performing operations at the same time. When they designed the EIDE standard, they needed compatibility with all the existing IDE devices. So they didn't change the rules on the cable. An EIDE interface chip can support four devices, but it has two interface cables each connecting two devices. The EIDE chip looks and acts like two IDE chips. An old IDE disk can be connected to a new EIDE connector. A EIDE connecter is shown below:

Comparison between EIDE and IDE:

- IDE supports only disks. EIDE supports a mixture of disks, tapes, and CDROM drives.
- IDE supports only two devices. EIDE supports up to four devices on the same controller chip although it uses two cables.
- EIDE allows disks up to 1 gigabyte. Larger disks may also work, but that is up to the vendor. IBM, for example, doesn't officially support EIDE disks larger than one gigbyte
- IDE disks are cheaper and EIDE disks are expensive.

Small Computer System Interface

Most popular hard disk interface used in PCs today is the Small Computer Systems Interface, abbreviated SCSI and pronounced "skuzzy". SCSI is a much more advanced interface than its chief competitor, IDE/ATA, and has several advantages over IDE that make it preferable for many situations, usually in higher-end machines. It is far less commonly used than IDE due to its higher cost and the fact that its advantages are not useful for the typical home or business desktop user. SCSI is a much higher-level protocol than IDE is. In fact, while IDE is an interface, SCSI is really a system-level bus, with intelligent controllers on each SCSI device working together to manage the flow of information on the channel. SCSI supports many different types of devices. The SCSI standards define commands, protocols, and electrical and optical interfaces. SCSI is most commonly used for hard disks and tape drives, but it can connect a wide range of other devices, including scanners and CD drives. The SCSI standard defines command sets for specific peripheral device types. A SCSI cable is shown below in fig.25..

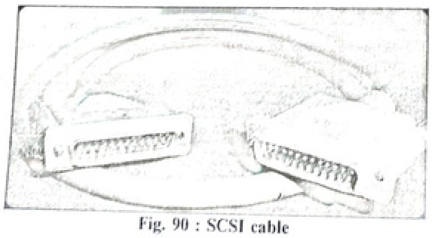


Fig. 90 : SCSI cable

There are many types of SCSI cable. Some of these are as follows:

- Fast SCSI
- Fast / Wide SCSI
- Ultra SCSI

These SCSI interfaces can compare in concern of the data width, transfer rate, internal device, external device etc. in the following table:

TYPE	Data width	Transfer rate	Internal disk drive connector	External device connector	No. of devices	Max. cable length
SCSI-1	8 bits	5 MB/s	50-pin or 68-pin + MOLEX Power Connector	50-pin Centronics	7	6 meters (SE) or 12 meters (LVD)
Fast SCSI	8 bits	10 MB/s	50-pin or 68-pin + MOLEX Power Connector	50-pin high-density	7	3 meters (SE) or 12 meters (LVD)
Fast Wide SCSI	16 bits	20 MB/s	68-pin + MOLEX or 80-Pin SCA (Single-Connector-Attachment)	68-pin high-density	15	3 meters (SE) or 12 meters (LVD)
Ultra SCSI	8 bits	20 MB/s	50-pin or 68-pin + MOLEX Power Connector	50-pin high-density	7	1.5 meters (SE) or 12 meters (LVD)

An example of ultra SCSI is shown below:

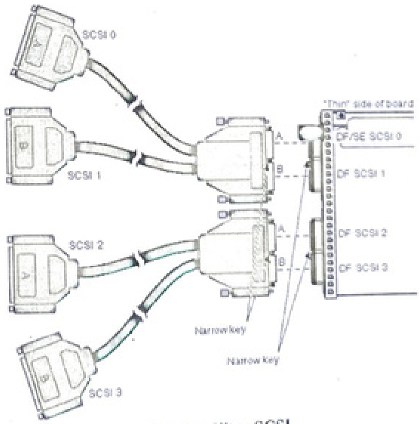


Fig. 91 : Ultra SCSI

Hard Disk Cartridges :

Disk cartridge is a single hard disk platter encased in a protective plastic shell. When the removable cartridge was inserted into the **cartridge drive** peripheral device, the read/write heads of the drive could access the magnetic data storage surface of the platter through holes in the shell. The disk cartridge is a direct evolution from the disk pack drive, or the early hard drive. As the storage density improved, even a single platter would provide a useful amount of data storage space, with the benefit being easier to handle than a removable disk pack. An example of a cartridge drive is the IBM 2310. Some more recent removable disk storage media are referred to as **disk cartridges.** This is most common with Zip disks. It is very rare, but not unheard of, to refer to the 3½-inch floppy as a disk cartridge

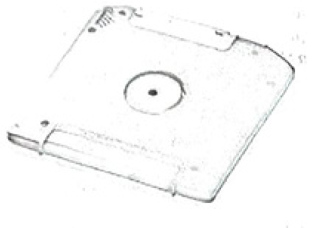


Fig. 92: Disk Cartridge

Redundant Array of Indpependent Disk (RAID)

RAID is stands for redundant array of inexpensive disks, a technology that allowed computer users to achieve high levels of storage reliability from low-cost and less reliable PC-class disk-drive components, via the technique of arranging the devices into arrays for redundancy.More recently, marketers representing industry RAID manufacturers reinvented the term to describe a redundant array of independent disks as a means of disassociating a "low cost" expectation from RAID technology. RAID is now used as an umbrella term for computer data storage schemes that can divide and replicate data among multiple hard disk drives. The different architectures are named by the word RAID followed by a number, as in RAID 0, RAID 1, RAID 2, RAID 3 etc. RAID's various designs all involve two key design goals: increased data reliability or increased input/output performance. RAID systems with redundancy continue working without interruption when one disks of the array fail, although they are then vulnerable to further failures. When the bad disk is replaced by a new one the array is rebuilt while the system continues to operate normally. RAID is not a good alternative to backing up data. Data may become damaged or destroyed without harm to the drive on which they are stored. RAID combines two or more physical hard disks into a single logical unit by using either special hardware or software. There are three key concepts in RAID: mirroring, the copying of data to more than one disk; striping, the splitting of data across more than one disk; and error correction, where redundant data is stored to allow problems to be detected and possibly fixed (also known as fault tolerance).

There are various problem with the RAID. Some of these are as follows:

- Correlated failures
- Atomicity
- Write cache reliability
- Equipment compatibility
- Data recovery in the event of a failed array
- Drive error recovery algorithms

- Other Problems and Viruses

So these are the problems with the RAID. There is no need to detail study of each problem. There are various types of the RAID. Some of these are as follows:

RAID-0: It is the Stripped Disk Array with no fault tolerance and it requires at least 2 drives to be implemented. Due to no redundancy feature, RAID 0 is considered to be the lowest ranked RAID level. RAID 0 is useful for setups such as large read-only NFS servers where mounting many disks is time-consuming or impossible and redundancy is irrelevant.

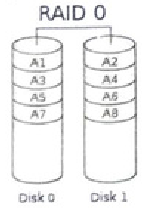


Fig. 93

RAID-1: A RAID 1 creates an exact copy of a set of data on two or more disks. This is useful when read performance or reliability are more important than data storage capacity.RAID 1 controller is able to perform 2 separate parallel reads or writes per mirrored pair. It also requires at least 2 drives to implement a non-redundant disk array. High level of availability, access and reliability can be achieved by entry-level

RAID 1 array. RAID 1 has many administrative advantages. For instance it is possible to "split the mirror": declare one disk as inactive, do a backup of that disk, and then "rebuild" the mirror.

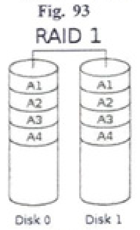


Fig. 94

RAID-2: It is the combination of Inherently Parallel Mapping and Protection RAID array. It's also known as ECC RAID because each data word bit is written to data disk which is verified for correct data or correct disk error when the RAID disk is read. It uses a Hamming code for error correction.Due to special disk features required, RAID 2 is not very popular among the corporate data storage masses.

RAID-3: RAID 3 works on the Parallel Transfer with Parity technique. The least number of disks required to implement the RAID array is 3 disks. In the RAID 3, data blocks

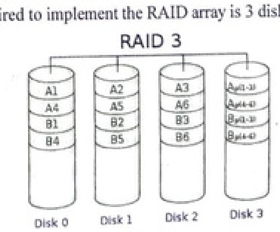


Fig. 95

are striped and written on data drives and then the stripe parity is generated, saved and afterwards used to verify the disk reads. Read and write data transfer rate is very high in RAID 3. it is very rare in practice. One of the side effects of RAID 3 is that it generally cannot service multiple requests simultaneously. Example of RAID-3 is shown in fig. 30.

RAID-4: RAID 4 requires a minimum of 3 drives to be implemented. It is composed of independent disks with shared parity to protect the data. Data transaction rate for Read is exceptionally high and highly aggregated.

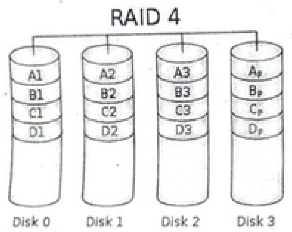


Fig. 96

RAID-5: *A RAID 5 uses block-level striping with parity data distributed across all member disks.it is Independent Distributed parity block of data disks with a minimum re*

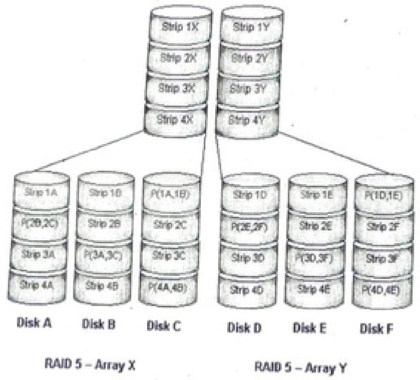


Fig. 97 : RAID 5 Setup

quirement of at least 3 drives to be implemented and N-1 array capacity. It helps in reducing the write inherence found in RAID 4. RAID 5 array offers highest data transaction Read rate, medium data transaction Write rate and good cumulative transfer rate. Example of RAID-5 is shown in fig. 32.

RAID 5 implementations suffer from poor performance when faced with a workload which includes many writes which are smaller than the capacity of a single stripe.

RAID- 6: It is Independent Data Disk array with Independent Distributed parity. It is known to be an extension of RAID level 5 with extra fault tolerance and distributed parity scheme added. RAID 6 is the best available RAID array for mission critical applications and data storage needs, though the controller design is very complex and overheads are extremely high.

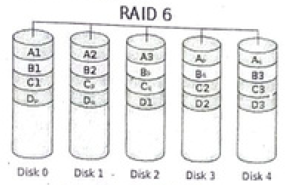


Fig. 98 : RAID 6 Setup

RAID-7: RAID 7 is the Optimized Asynchrony array for high I/O and data transfer rates and is considered to be the most manageable RAID controller available. RAID 7 is registered as a standard trademark of Storage Computer Corporation.

RAID-10: RAID 10 is classified as the futuristic RAID controller with extremely high Reliability and performance embedded in a single RAID controller. The minimum requirement to form a RAID level 10 controller is 4 data disks. The implementation of RAID 10 is based on a striped array of RAID 1 array segments. RAID 10 controllers and arrays are suitable for uncompromising availability and extremely high throughput required systems and environment.

With all the significant RAID levels discussed here briefly, another important point to add is that whichever level of RAID is used regular and consistent data backup maintenance using tape storage is must as the regular tape storage is best media to recover from lost data scene. RAID can involve significant computation when reading and writing information. With traditional "real" RAID hardware, a separate controller does this computation. In other cases the operating system or simpler and less expensive controllers require the host computer's processor to do the computing, which reduces the computer's performance on processor-intensive tasks.

Optical Disk

An optical disc is a flat, generally circular disc which can contain data encoded in microscopic pits.The encoding material sits atop a thicker substrate which makes up the bulk of the disc. The encoding pattern follows a continuous, spiral path covering the entire disc surface and extending from the innermost track to the outermost track. The data is stored on the disc with a laser or stamping machine, and can be accessed when the data path is illuminated with a laser diode in an optical disc drive which spins the disc at speeds of about 200 RPM up to 4000 RPM. The reverse side of an optical disc usually has a printed label, generally made of paper but sometimes printed or stamped onto the disc itself. This (non-encoded) side of the disc is typically coated with a transparent material, usually lacquer. Unlike the 3½-inch floppy disk, most optical discs do not have an integrated protective casing and are therefore susceptible to data transfer problems due to scratches, fingerprints, and other environmental problems.

Optical discs are usually between 7.6 and 30 cm (3 to 12 inches) in diameter, with 12 cm (4.75 inches) being the most common size. A typical disc is about 1.2 mm (0.05 inches) thick, while the track pitch is typically 1.6 µm (microns). An optical disc is designed to support one of three recording types:

- read-only (CD and CD-ROM)
- recordable (write-once, CD-R)
- re-recordable (rewritable, CD-RW).

Optical discs are most commonly used for storing music (e.g. for use in a CD player), video (e.g. for use in a DVD player), or data and programs for personal computers. The Optical Storage Technology Association (OSTA) promotes standardized optical storage formats.

A simple view of the optical disk is shown below:

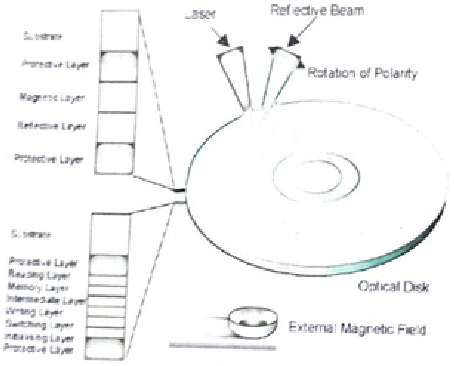


Fig. 99 : Optical disk

Compact Disk

A Compact Disc (CD) is an optical disc used to store digital data. It was developed to store music at the start, but later it also allowed to store other kinds of data. Standard CDs have a diameter of 120 mm and can hold up to 80 minutes of audio (700 MB of data). The Mini CD has various

diameters ranging from 60 to 80 mm; they are sometimes used for CD singles or device drivers, storing up to 24 minutes of audio.

The technology was later adapted and expanded to include data storage CD-ROM, write-once audio and data storage CD-R, rewritable media CD-RW, Video Compact Discs (VCD), Super Video Compact Discs (SVCD).

Fig. 100 : (A) Front portion of CD (B) Back side of the CD

There are three category of the compact disk (CD):

- CD- ROM
- CD- R
- CD- RW

Now we will study one by one in th following manner:

Compact disc- read only memory(CD-ROM)

CD-ROM is a pre-pressed compact disc that contains data accessible to, but not writable by, a computer. While the compact disc format was originally designed for music storage and playback. Five years later CD-ROM drives were being introduced on to computers. In 1994, they called a computer with a CD-ROM a Multimedia computer since it could play music and specially coded videos. CD-ROMs are popularly used to distribute computer software, including games and multimedia applications, though any data can be stored (up to the capacity limit of a disc). Although many people use lowercase letters in this acronym, proper presentation is in all capital letters with a hyphen between CD and ROM. It was also suggested by some, especially soon after the technology was first released, that CD-ROM was an acronym for "Compact Disc read-only-media". This was not the intention of the original team who developed the CD-ROM, and common acceptance of the "memory" definition is now almost universal. Simple view of CD-ROM is as follows:

Fig. 101 :

Compact Disc-Recordable (CD- R):

A **CD-R** (Compact Disc-Recordable) is a variation of the Compact Disc invented by Philips and Sony. CD-R is a Write Once Read Many (WORM) optical medium, though the whole disk does not have to be entirely written in the same session. The word "recordable" is used because CD-R are often used to record audio, which can be played back by most CD players. However, many other kinds of data can also be written to a CD-R, so the discs are also referred to as "writable CDs."CD-R retains a high level of compatibility with standard CD readers. A standard CD-R is a 1.2 mm thick disc made of polycarbonate with a 120 mm or 80 mm diameter. The 120 mm disc has a storage capacity of 70 minutes of audio or 650 MB of data. The data burned onto a CD-R disc is permanent, meaning it can not be altered or erased like the data on a hard drive. Typically, once a CD has been burned, it will not be able to record any more data. Some CD burning programs can record data as "sessions," allowing a disc to be written to multiple times until it is full. Each session creates a new partition on the disc, meaning a computer will read a disc with multiple sessions as multiple discs. Speed of the CD-R is shown below in the table:

Drive speed	Data rate	Write time for 80 minute/700 MB CD-R
1X	150 KiB/s	80 minutes
4X	600 KiB/s	20 minutes
8X	1200 KiB/s	10 minutes
12X	1800 KiB/s	6.7 minutes
32X	4800 KiB/s	2.5 minutes
52X	7800 KiB/s	1.5 minutes

Compact Disc Re-Writable (CD-RW):

CD-WR Stands for "Compact Disc Re-Writable." A CD-RW is a blank CD that can be written to by a CD burner. Unlike a CD-R (CD-Recordable), a CD-RW can be written to multiple times. The data burned on a CD-RW cannot be changed, but it can be erased. Therefore, you have to completely erase a CD-RW every time you want to change the files or add new data.CD-RW discs are usually produced in the most common CD-R disc capacities such as 650 and 700 MB, while smaller and larger capacities are rarer. CD-RW recorders typically handle the most common capacities best. In theory a CD-RW disc can be written and erased roughly 1000 times, although in practice this number is much lower. CD-RW recorders can also read CD-R discs.

CD-RW discs never gained the widespread popularity of CD-R, partly due to their higher per-unit price, lower recording and reading speeds, and compatibility issues with CD reading units, as well as between CD-RW formats of different speeds specifications. Also, compared to other forms of rewritable media such as Zip drives, Magneto-optical and flash memory based media, the CD-RW format uses the standard CD-ROM and CD-R file systems and storage strategies.

Digital Versatile Disc (DVD):

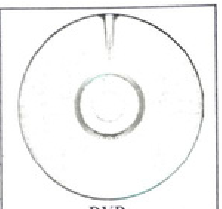
DVD, also known as "Digital Versatile Disc", is an optical disc storage media format. Its main uses are video and data storage. DVDs are of the same dimensions as compact discs (CDs), but store more than six times as much data. There are many variation of the DVD. Such as:

- DVD-ROM
- DVD-R
- DVD-RW

The term DVD often describe the way data is stored on the discs: DVD-ROM (Read Only Memory) has data that can only be read and not written; DVD-R and DVD+R can record data only once. DVD-RW can both record and erase data multiple times. The wavelength used by standard DVD lasers is 650 nm.DVD Video and DVD Audio discs refer to properly formatted and structured video and audio content, respectively. History of DVD is shown in table below:

History of DVD

Media type	Optical disc
Capacity	4.7 GB (single-sided, single-layer) 8.54 GB (single-sided, double-layer) 17.08 GB (double-sided, double-layer-rare)
Read mechanism	650 nm laser, 10.5 Mbit/s
Write mechanism	10.5 Mbit/s
Usage	Data storage, video, audio.


DVD

DVD-R:

DVD-R is a DVD recordable format. A DVD-R typically has a storage capacity of 4.71 GB, although the capacity of the original standard developed by Pioneer was 3.95 GB. Both values are significantly larger than the storage capacity of its optical predecessor, the 700 MB CD-R - a DVD-R has 6.4 times the capacity of a CD-R. Data on a DVD-R cannot be changed. Recording speed is generally denoted in values of X (similar to CD-ROM usage), where 1X in DVD usage is equal to 1.321 MB/s. A simple view of the DVD-R is shown in figure 39.

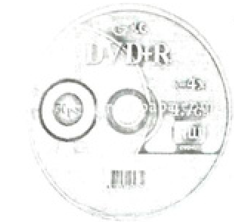


Fig. 104 : Simple view of DVD-R

DVD recorders have several technical advantages. Some of these are as follows:

- Superior video and audio quality
- Easy-to-handle smaller form-factor disc media, and more durable than magnetic tape.
- Reduced playback wear and tear
- High-quality digital copying.

- Improved editing, at least on rewritable media
- Playlisting
- No risk of accidentally recording over existing content or unexpectedly running out of space during recording
- Easy to find recordings due to chapter menu.

DVD-RW:

A **DVD-RW** disc is a rewritable optical disc with equal storage capacity to a DVD-R, typically 4.7 GB. The format was developed by Pioneer in November 1999.Unlike DVD-RAM, it is playable in about 75% of conventional DVD players.The primary advantage of DVD-RW over DVD-R is the ability to erase and rewrite to a DVD-RW disc. According to Pioneer, DVD-RW discs may be written to about 1,000 times before needing replacement, making them comparable with the CD-RW standard. DVD-RW discs are commonly used for volatile data, such as backups or collections of files. They are also increasingly used for home DVD video recorders. One benefit to using a rewritable disc is if there are writing errors when recording data, the disc is not ruined and can still store data by erasing the faulty data.The current fastest speed a DVD-RW disc can be written to is 6x speed, with many at this speed having DVD-RW2 capabilities. A simple fig. of DVD-RW is shown in fig. 40.

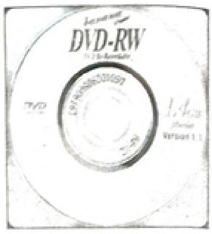
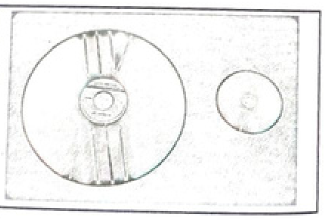


Fig. 105 : Simple view of DVD-RW

Laser CD:

The Laserdisc (LD) is an obsolete home video disc format, and was the first commercial optical disc storage mediumThe technology and concepts provided with the Laserdisc would become the forerunner to Compact Discs and DVDs.The standard home video laserdisc is 30 cm in diameter and made up of two single-sided aluminum discs layered in plastic. Although read and featuring properties similar to a compact disc or DVD. History of laser CD is shown below:

Media type	Optical disc
Encoding	NTSC
Capacity	60 minutes per side CLV
Developed by	Philips & MCA
Usage	Home video Data Storage



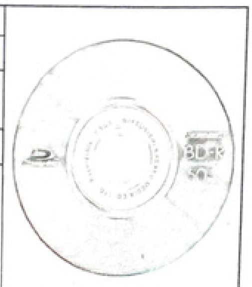
A simple view of the laser disc is shown below:

Fig. 106 : LASER DISC

BLUE-RAY DISC:

Blue-ray Disc is an optical disc storage medium to supersede the standard DVD format. Its main uses are for storing games, high-definition video and data storage with up to 50GB per disc. The disc has the same physical dimensions as standard DVDs and CDs.The name Blu-ray Disc derives from the blue-violet laser used to read the disc. While a standard DVD uses a 650 nanometre red laser, Blu-ray uses a shorter wavelength, a 405 nm blue-violet laser, and allows for almost six times more data storage than on a DVD.Blu-ray Disc uses a "blue" (technically violet) laser operating at a wavelength of 405 nm to read and write data. Conventional DVDs and CDs use red and near infrared lasers at 650 nm and 780 nm respectively. History of blue ray disc is shown below:

Media type	High-density optical disc
Encoding	MPEG-2, MPEG-4 AVC, and VC-1
Capacity	25 GB (single layer) 50 GB (dual layer)
Block size	64kb ECC
Read mechanism	405 nm laser: 1× at 36 Mbit/s 2× at 72 Mbit/s 4× at 144 Mbit/s 6× at 216 Mbit/s 8× at 288 Mbit/s
Usage	Datastorage, High-definition video, games



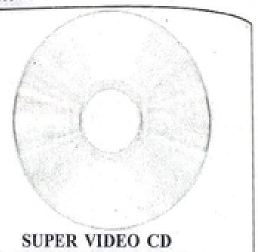
Blue Ray disk

Super Video CD (SVCD):

Super Video CD (Super Video Compact Disc or SVCD) is a digital format for storing video on standard compact discs. SVCD was intended as a successor to Video CD and an alternative to

DVD-Video, and falls somewhere between both in terms of technical capability and picture quality and good performance. History of super video cd is shown below:

Media type	Optical disc
Encoding	MPEG-2 video+audio
Capacity	Up to 800 MB
Read mechanism	780 nm wavelength semiconductor laser
Standard	IEC 62107
Usage	audio and video storage



SUPER VIDEO CD

Magnetic Tape

Magnetic tape is a medium for magnetic recording generally consisting of a thin magnetizable coating on a long and narrow strip of plastic. Nearly all recording tape is of this type, whether used for recording audio or video or for computer data storage. Devices that record and playback audio and video using magnetic tape are generally called tape recorders and video tape recorders respectively. A device that stores computer data on magnetic tape can be called a tape drive, a tape unit, or a streamer. The use of magnetic tape for computer data storage has been one of the constants of the computer industry. In all formats, a tape drive uses precisely-controlled motors to wind the tape from one reel to another, passing a tape head as it does.A simple magnetic tape is shown in fig. 42.

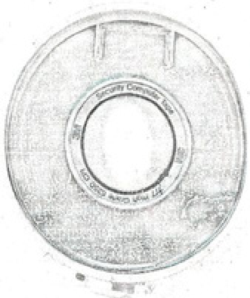


Fig. 107 : Magnetic tape

There are various types of the magnetic tape. Some of these are as follows:

- Reels
- Streamers.
- Digital audio tape(DAT)
- Digital linear tape(DLT)
- Magnetic stripe
- Smart card

So these are all the types of the magnetic tape. Now we will study one bu one in the following manner:

REELS:

A reel is an object around which lengths of another material are wound for storage. Generally a reel has a cylindrical core and walls on the sides to retain the material wound around the core. In

some cases the core is hollow, although other items may be mounted on it, and grips may exist for mechanically turning the reel. The size of the core is dependent on several factors. A smaller core will obviously allow more material to be stored in a given space. However, there is a limit to how tightly the stored material can be wound without damaging it and this limits how small the core can be.

Other issues affecting the core size include:

- Mechanical strength of the core (large reels).
- Acceptable turning speed (for a given rate of material moving on or off the reel a smaller core will mean that an almost empty reel has to turn faster)
- Any functional requirements of the core.

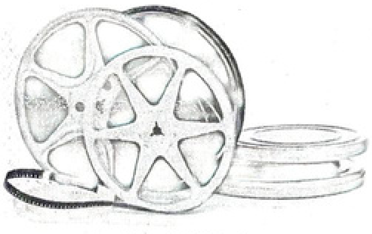


Fig. 108 : Reel

STREAMERS:

A streamer is a data storage device that reads and writes data stored on a magnetic tape. It is typically used for archival storage of data stored on hard drives. Tape media generally has a favorable unit cost and long archival stability. Instead of allowing random-access to data as hard disk drives do, streamers only allow for sequential-access of data. A hard disk drive can move its read/write heads to any random part of the disk platters in a very short amount of time, but a streamer must spend a considerable amount of time winding tape between reels to read any one particular piece of data. As a result, streamer has very slow average seek times. Despite the slow seek time, tape drives can stream data to tape very quickly.

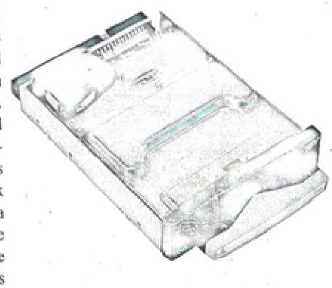


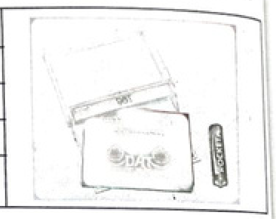
Fig. 109 : Reel

Digital Audio Tape (DAT) :

Digital Audio Tape (DAT) is a signal recording and playback medium. In appearance it is similar to a compact audio cassette, using 4 mm magnetic tape enclosed in a protective shell, but is roughly half the size at 73 mm × 54 mm × 10.5 mm. As the name suggests, the recording is digital rather than analog. DAT has the ability to record at higher, equal or lower sampling rates than a CD. If a digital source is copied then the DAT will produce an exact clone, unlike other digital media such as Digital Compact Cassette or non-Hi-MD MiniDisc, both of which use lossy data compression.Like most formats of videocassette, a DAT cassette may only be recorded on one side, unlike an analog compact audio cassette. History of DAT is shown below:

Fig. 110. Digital Audio Tape(DAT)

Media type	Magnetic tape
Capacity	120 minutes
Read mechanism	Rotating head
Write mechanism	Rotating head, helical scan
Usage	Audio storage



Digital Linea Tape (DLT)

Digital Linear Tape (DLT) is a magnetic tape data storage (drive) technology developed by Digital Equipment Corporation (DEC) from 1984 onwards. In 1994 the technology was purchased by Quantum Corporation, who currently manufactures drives and licenses the technology and trademark. A variant with higher capacity is called **Super DLT (SDLT).** DLT uses linear serpentine recording with multiple tracks on half-inch (12.7 mm) wide tape. The cartridges contain a single reel and the tape is pulled out of the cartridge by means of a leader tape attached to the takeup reel inside the drive. The drive leader tape is buckled to the cartridge leader during the load process. The tape is guided by 4 to 6 rollers that touch only the back side of the tape.

All DLT drives support hardware data compression. Note that drive compression applied to pre-compressed data can actually make the written data larger than having compression turned off in the tape drive.Media are guaranteed for 30 years of data retention under specified environmental conditions.Current manufacturers of cartridges for the DLT/SDLT market are Fujifilm, Hitachi/Maxell.All other companies/brands (even Quantum) are contractors and/or resellers of these companies.DLT includes Write Once Read Many (WORM) capability.fig. of DLT is shown below:

Fig. 111 : Data Linear Tape(DLT)

Magnetic Strip

A magnetic stripe card is a type of card capable of storing data by modifying the magnetism of tiny iron-based magnetic particles.The magnetic stripe, sometimes called a magstripe, is read by physical contact and swiping past a reading head. Magnetic stripe cards are commonly used in credit cards, identity cards, ATM cards and transportation tickets. They may also contain an RFID tag, a transponder device and a microchip mostly used for business premises or electronic payement. An International Organization for Standardization standards, define the physical properties of the card, including size, flexibility, location of the magstripe, magnetic characteristics, and data formats. They also provide the standards for financial cards, including the allocation of card number ranges to different card issuing institutions.

Fig. 112 : Magetic stripe card

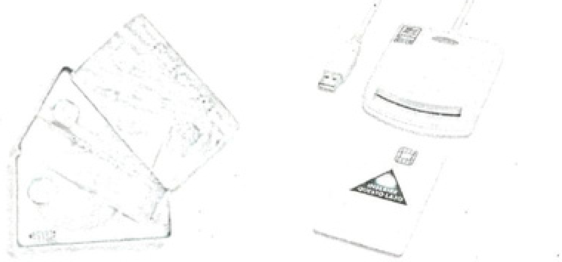
In most magnetic stripe cards, the magnetic stripe is contained in a plastic-like film. The magnetic stripe is located 0.223 inches from the edge of the card, and is 0.375 inches wide. The magnetic stripe contains three tracks, each 0.110 inches wide. Tracks one and three are typically recorded at 210 bits per inch, while track two typically has a recording density of 75 bits per inch . Each track can either contain 7-bit alphanumeric characters, or 5-bit numeric characters. A fig. of magnetic stripe is shown in figure 47.

Magstripes come in two main varieties: high-coercivity (HiCo) and low-coercivity (LoCo). High-coercivity magstripes are harder to erase, and therefore are appropriate for cards that are frequently used or that need to have a long life. Low-coercivity magstripes require a lower amount of magnetic energy to record, and hence the card writers are much cheaper than machines which are capable of recording high-coercivity magstripes.

Smart Card

A smart card is any pocket-sized card with embedded integrated circuits which can process data. Smart card also known as chip card or integrated circuit card (ICC).This implies that it can receive input which is processed - by way of the ICC applications - and delivered as an output. There are two broad categories of ICCs. Memory cards contain only non-volatile memory storage components, and perhaps some specific security logic. Microprocessor cards contain volatile memory and microprocessor components. The card is made of plastic, generally PVC.The card may embed a hologram to avoid any duplicacy .Using smartcards also is a form of strong security authentication for single sign-on within large companies and organizations.

Smart card Dimensions are normally credit card size. It Contains a security system with tamper-resistant properties and is capable of providing security services (confidentiality of information in the memory). Card data is transferred to the central administration system through card reading devices, such as ticket readers, ATMs etc. Smart cards can be used for identification, authentication, and data storage. Smart cards provide a means of effecting business transactions in a flexible, secure, standard way with minimal human intervention. The international payment brands MasterCard, Visa, and Europay agreed to work together to develop the specifications for the use of smart cards in payment cards used as either a debit or a credit card. A smart card and smart card reader is shown below:



(A) (B)

Fig. 113 : (A) Smart cards (B) Smart card reader

There are various application of the smart card. Like in computer security, Some disk encryption systems, such as TrueCrypt, can use smart cards to securely hold encryption keys, and also to add another layer of encryption to critical parts of the secured disk.Smartcards are also used for single sign-on to log on to computers. In financial sector, The applications of smart cards include their use as credit or ATM cards, in a SIMs for mobile phones, authorization cards for pay television, pre-pay utilities in household, high-security identification and access-control cards, and public transport and public phone payment cards. In identity, A quickly growing application is in digital identification cards. In this application, the cards are used for authentication of identity.

There are various problem also included with the smart card. Smart cards can be physically disassembled by using acid, abrasives, or some other technique to obtain direct, unrestricted access to the on-board microprocessor. smart cards have the failure rate. The plastic card in which the chip is embedded is fairly flexible, and the larger the chip, the higher the probability of breaking. Smart cards are often carried in wallets or pockets - a fairly harsh environment for a chip. However, for large banking systems, the failure-management cost can be more than offset by the fraud reduction.

Modem

Modem (modulator-demodulator) is a device that modulates an analog carrier signal to encode digital signal, and also demodulates such a carrier signal to decode the transmitted information. The goal is to produce a signal that can be transmitted easily and decoded to reproduce the original digital data. Modems are generally classified by the amount of data they can send in a given time, normally measured in bits per second, or "bps". They can also be classified by Baud, the number of times the modem changes its signal state per second.Baud is not the modem's speed in bit/s, but in symbols/s.

The baud rate varies, depending on the modulation technique used. Faster modems are used by

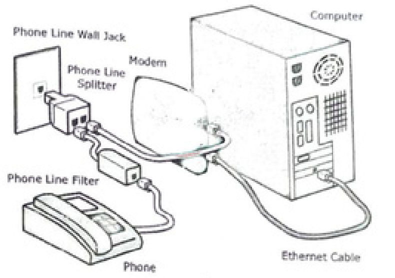


Fig. 114 : Setup of modem

Internet users every day, notably cable modems and ADSL modems. Optical modems transmit data over optical fibers. A standard modem of today contains two functional parts: an analog section for generating the signals and operating the phone, and a digital section for setup and control. This functionality is actually incorporated into a single chip, but the division remains in theory. In operation the modem can be in one of two "modes", data mode in which data is sent to and from the computer over the phone lines, and command mode in which the modem listens to the data from the computer for commands, and carries them out. Setup of the modem is shown in figure 49.

There are mainly two types of the modem:

- Internal modem: this type of modem is attached to the expansion slot on the motherboard of a computer or machine. It is cheaper than the external modem.
- External modem: this type of modem is attached to the computer serial port tgrough a cable. It is very easy to install. There are many example in our daily life of the external modem. A very famous example of the BSNL network which provide the internet facility through the MODEM.

In this section we will study various type of MODEM like as:

- Fax modem
- Data modem
- Voice modem
- Dial up modem

FAX MODEM:

A fax modem is a converged device, a modem with the capability of handling fax transmissions. Computer users may set up a PC fax modem with card, phone line access and software, or use a service similar to printing from a PC or sending an E-mail message.small business PCs commonly had a PC-based fax/modem card and fax software. Now largely replaced by E-mail, PC-based faxing with a fax modem is more-and-more a rarity. Where faxing from a PC is required there are a number of Internet-based faxing alternatives. So, while it's still common to see businesses with a one or more traditional fax machines churning out pages. A simple fax modem is shown in fig. 50.

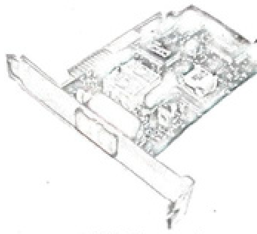


Fig. 115 : Fax modem

DATA MODEM:

Data Modem is designed in a flexible, programmable "soft-modem" architecture, in which the basic modulation-demodulation protocols are implemented. This technology implements a wide range of ITU-T modulation protocol standards for Data Modem. It has been exhaustively tested on a telephone network emulator for various line impairments and for inter-working against various off-the-shelf modems. These modem solutions and its accessories have been optimized to various DSP, embedded and digital signal controller platforms.

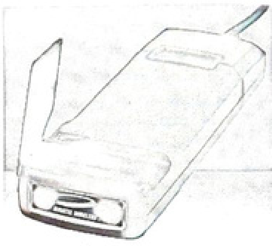


Fig. 116 : Data Modem

VOICE MODEM:

Voice modem means that the modem is capable, with appropriate software, of supporting telephone answering machine functions: the modem can 'record' and 'play' to the Windows wave device. The answering machine software will also use the sound card on the machine to play and record. The software may also include functions to dial or answer calls using your sound card's microphone and speakers or headphones. Windows comes with a Phone Dialer. This utility will dial a number with any type of modem; after Phone Dialer dials a number, you use any normal phone to complete a voice call.All modems are also capable of supporting voice functions provided by 'Internet Telephony' - the modem is connected to your ISP in data mode, and software on your system sends and receives voice-encoded data to a compatible

Fig. 117 : Voice Modem

telephony server to complete a call.A modem that includes speakerphone capability will have additional audio components on the modem to provide an interface for a microphone and speaker or headset. This allows the modem to dial or answer and provide high-quality full-duplex voice functionality. Full duplex means you can talk and hear at the same time. Voice modem chipset makers include in the driver or firmware code to interface to the wave device, but do not develop the software that provides voice functionality. A fig. is shown below of the voice modem:

CABLE MODEM:

A cable modem is a type of modem that provides bi-directional data communication via radio frequency channels on a cable television (CATV) infrastructure. Cable modems are primarily used to deliver broadband Internet access in the form of cable Internet, taking advantage of the high bandwidth of a cable television network.

Fig. 118 : Cable Modem

EXERCISES

Very Short Answer Type Questions (2 Marks each)

1. Data bus is used in .... (Raj. B.C.A. 2013, 2010)
2. A CPU consists of .... (Raj. B.C.A. 2013)
3. USB stands for .... (Raj. B.C.A. 2013)
4. EISA stands for .... (Raj. B.C.A. 2012)
5. Address bus is also known as .... (Raj. B.C.A. 2012, 2013)

Short Answer Type Questions (4 Marks each)

1. Define Bus architecture in detail ?
2. Define cables ? Explain different types of cables.
3. Define inputs and output devices used in computer system ?
4. What is Network adapter card ? Define in brief.
5. Define system bus ? Explain different types of bus system.

Long Answer Type Questions (12 Marks each)

1. What is an IC ? How does it help in reducing the size of computer ?(Raj. B.C.A. 2012)

2. Explain generations of computers with characteristic. **(Raj. B.C.A. 2012)**
3. Define Von Numann Architecture machine ?
4. What do you mean by motherboard ? Explain its characteristics with 810 chipset ? **(Raj. B.C.A. 2012, 2012)**
5. Write short notes on :
   (a) BarCode reader
   (b) CRT
   (c) OMR
   (d) Motherboard
6. What do you mean by printer ? Explain different types of printer ? **(Raj. B.C.A. 2011)**
7. Define Hard disk drive interface and Auxiliary device? Explain in detail.
8. Explain the concept of optical disk, magnetic tape and modem ? **(Raj. B.C.A. 2011)**

■■■