
Yashwantrao
Chavan
Maharashtra
Open University

**CMP510**
**Computer**
**System**
**Architecture**

# Computer System Architecture

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**Course Objectives:**

- The objective of this course is to study the basics of Computer System and to learn how to configure computer devices.
- To understand the structure, function and characteristics of computer systems.
- To understand the design of the various functional units and components of computers like Motherboard, storage devices, display devices and input output devices.
- To understand the peripheral devices and their applications.
- To understand PC Troubleshooting and Maintenance Tools.
- To understand the concept of Power supply and it's working.
- To understand the concept of parallel processing and pipelining in detail and its applications.

**Learning Outcome:**

After completion of this course, the student will be able to

- Understand Motherboard & Its Components working.
- Understand Cache memory and its working, role in OS.
- Understand the roles and working of Storage Devices and how the data is stored on these devices.
- Understand how different storage, peripheral and input output devices are connected to computer and their working.
- Understand and demonstrate PC Troubleshooting use of different Maintenance Tools.
- Understand the concept of parallel processing ,pipelining and Programming aspects for Intel Itanium Processor.

| Unit No. and Name | Details | Counseling Sessions | Weightage |
|---|---|---|---|
| Unit 1: Motherboard & Its Component Objectives | • CPU – Concept like address lines, data lines, internal registers.<br>• Modes of operation of CPU – Real mode, IA-32 mode, IA-32<br>• Virtual Real Mode.<br>• Process Technologies, Dual Independent Bus Architecture, Hyper<br>• Threading Technologies & its requirement.<br>• Processor socket & slots.<br>• Chipset basic, chipset Architecture, North / South bridge & Hub<br>• Architecture.<br>• Latest chipset for PC<br>• Overview & features of PCI, PCI –X, PCI express, AGP bus.<br>• Logical memory organization conventional memory, extended<br>• memory, expanded memory.<br>• Overview & features of SDRAM, DDR, DDR2, DDR3.<br>• Concept of Cache memory:<br>• L1 Cache, L2 Cache, L3 Cache, Cache Hit & Cache Miss.<br>• BIOS – Basics & CMOS Set Up.<br>• Motherboard Selection Criteria. | 4 | 10 |

| | | | |
|---|---|---|---|
| Unit 2 : Storage Devices & Interfacing. Objectives | • Recording Techniques: FM, MFM , RLL, perpendicular recording<br>• Hard Disk construction and working.<br>• Terms related to Hard Disk.<br>• Track, sector, cylinder, cluster, landing zone, MBR, zone recording, write pre-compensation.<br>• Formatting: Low level, High level & partitioning.<br>• FAT Basics: Introduction to file system, FAT 16, FAT 32, NTFS<br>• Hard Disk Interface: Features of IDE, SCSI, PATA, SATA, Cables and Jumpers.<br>• CD ROM Drive: Construction, recording.(Block diagram)<br>• DVD: Construction, Recording. (Block Diagram)<br>• Blue-ray Disc specification. | 4 | 10 |
| Unit 3: Display Devices & Interfacing | • CRT: - Block diagram & working of monochrome & colour Monitor<br>• Characteristics of CRT Monitor :- DOT Pitch, Resolution, Horizontal Scanning frequency, Verticalscanning frequency, Interlaced Scanning, Non-Interfaced scanning,<br>• Aspect ratio.<br>• LCD Monitor: - Functional Block Diagram of LCD monitor, working principle, Passive matrix, Active matrix LCD display.<br>• Touch Screen Display – The construction and working principle<br>• Plasma Display Technology: - Construction & working principle.<br>• Basic Block Diagram of Video Accelerator card | 4 | 10 |
| Unit 4: Input and Output Devices | • Keyboard: Types of key switches: Membrane, Mechanical, Rubber dome, Capacitive, optoelectronic and interfacing.<br>• Mouse: Opto-mechanical, optical ( New design)<br>• Scanner: Flat Bed, Sheet-fed, Handheld: Block diagram of flat Bed and specifications, OCR, TWAIN, Resolution, Interpolation.<br>• Modem: Internal and External: Block diagram and specifications.<br>• Printer: Printer Characteristics, Dot matrix, Inkjet, Laser: block diagram and specifications | 3 | 10 |
| Unit 5: Power Supplies | • Block diagram and working of SMPS.<br>• Signal description and pin-out diagram of AT and ATX connectors<br>• Power supply characteristics: Rated wattage, Efficiency, Regulation, Ripple, Load regulation, Line regulation.<br>• Power problems: Blackout, Brownout, surges and spikes.<br>• Symptoms of power problems.<br>• Protection devices: circuit breaker, surge suppressor. | 4 | 10 |

| | | | |
|---|---|---|---|
| | • Uninterrupted Power Supply, Online and Offline UPS, working of UPS: Block diagram, advantages and disadvantages, Ratings | | |
| Unit 6: Interfaces | • SCSI, SCSI cables and connectors, SCSI drive configuration.<br>• USB features.<br>• RS 232 : (Voltages and 9 pin description)<br>• Centronics (interface diagram, important signals and timing waveform)<br>• Firewire features<br>• Blue tooth | 4 | 10 |
| Unit 7: PC Troubleshooting, Maintenance and Tools | • POST: POST sequence, Beep codes, visual display codes.<br>• Preventive maintenance: Active, Passive, periodic maintenance procedure<br>• Diagnostic Tools: logic Analyzer, logic probe.<br>• Diagnostic software for trouble shooting PC<br>• BGA workstation and its applications for reballing of north bridge and south bridge | 3 | 10 |
| Unit 8: Overview of Parallel Processing and Pipelining Processing | • Study and comparison of uniprocessors and parallel processors. Conventional and EPIC architecture<br>• Evolution of parallel processors<br>• Future trends and there architecture<br>• Overview of Parallel Processing and Pipelining Processing. Necessity of High Performance<br>• Constraints of conventional architecture<br>• Parallelism in uniprocessor system<br>• Architectural Classification<br>• Applications of parallel Processing<br>• Instruction level Parallelism and Thread Level Parallelism<br>• Explicitly Parallel Instruction Computing (EPIC) Architecture<br>• Case Study of Intel Itanium Processor<br>• Principles of scalable performance: Performance Metrics and Measures, Speedup Performance Laws<br>• Programming aspects for Intel Itanium Processor. | 4 | 10 |
| | | 30 | 80 |

**Reference Books:**

1. Computer organization and architecture by william stallings
2. “Computer Organization” by Zvonco Vranesic and Safwat Zaky

Note: This Study material is still under development and editing process. This draft is being made available for the sole purpose of reference. Final edited copies will be made available once ready.

# Chapter 1: Motherboard & Its Component

## Specific Objectives

- To understand the various components of Motherboard.
- To know about the different memories in PC & their usage.
- To understand the selection of different components of PC.

1.1 CPU – Concept like address lines, data lines, internalregisters.

1.2 Modes of operation of CPU – Real mode, IA-32 mode, IA-32 Virtual RealMode.

1.3 Process Technologies, Dual Independent Bus Architecture, Hyper Threading Technologies & itsrequirement.

1.4 Processor socket &slots.

1.5 Chipset basic, chipset Architecture, North / South Bridge & Hub Architecture.

1.6 Latest chipset forPC

1.7 Overview & features of PCI, PCI –X, PCI express, AGPbus.

1.8 Logical memory organization conventional memory, extended memory, expandedmemory.

1.9 Overview & features of SDRAM, DDR, DDR2,DDR3.

1.10 Concept of Cachememory:

1.11 L1 Cache, L2 Cache, L3 Cache, Cache Hit & CacheMiss.

1.13 BIOS – Basics & CMOS SetUp.

1.14 Motherboard SelectionCriteria.

## ➢ Central Processing Unit(CPU):-

The **CPU** is the hardware device in a computer that executes all of the instructions from the software.

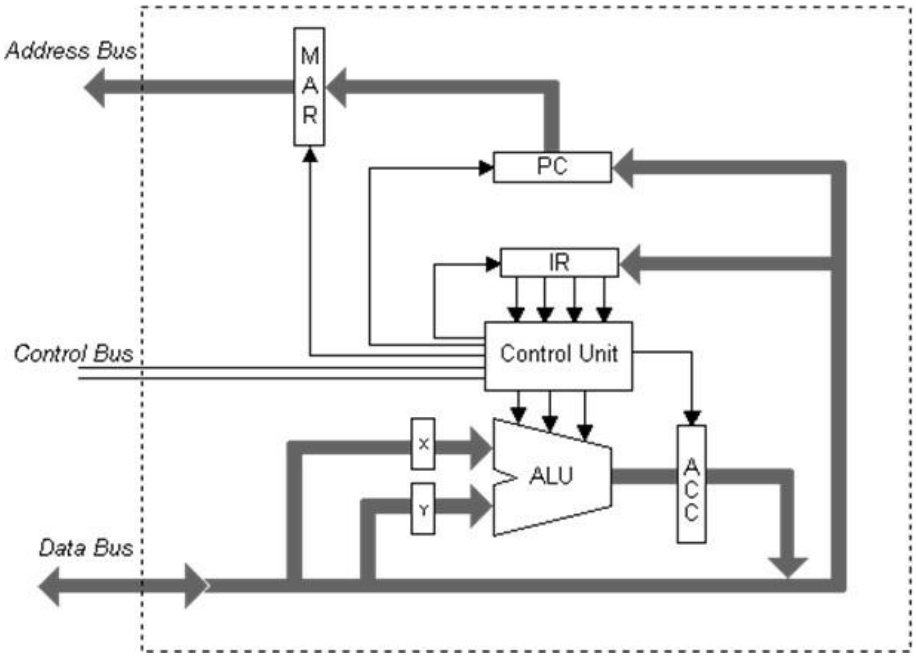



*Fig: 1 - A simple CPU design*

- **<u>Composition of aCPU</u>**

1. ***ControlUnit***

- ✓ Generates control/timingsignals
- ✓ Decides which way data is going(in/out)
- ✓ Controls decoding/execution ofinstructions

2. ***Arithmetic LogicUnit***

- ✓ Execution ofinstructions
- ✓ Mathematical operations (* / + -etc.)
- ✓ Logical Operations: and/or/xnoretc as well as shift/rotate

3. ***Registers***

- ✓ Small amount of very fastmemory
- ✓ Program counter – address of next instruction to beexecuted
- ✓ Instruction register – Holds instruction while it isdecoded
- ✓ Accumulator – holds result of ALUoperations
- ✓ Other general purpose registers (e.g. stackpointer)

- **Buses – Masters andSlaves**
  - ✓ Active devices attached to the bus that can initiate bus transfers are called**masters**
  - ✓ Passive devices that wait for requests are called **slaves**
  - ✓ Some devices may act as slaves at some times and masters atothers
  - ✓ Memory can never be a masterdevice.

## ➢ Modes of operation ofCPU

Processor modes refer to the various ways that the processor creates an operating environment for itself. Specifically, the processor mode controls how the processor sees and manages the system memory and the tasks that useit.

### RealMode:

- ✓ The original IBM PC could only address 1 MB of system memory, and the original versions of DOS created to work on it were designed with this inmind.
- ✓ DOS is by its nature a single-tasking operating system, meaning it can only handle one program running at atime.
- ✓ The decisions made in these early days have carried forward until now, and in each new processor, care had to be taken to be able to put the processor in a mode that would be compatible with the original Intel 8088 chip. This is called *realmode*.
- ✓ When a processor is running in real mode, it acts like an "8088 on steroids". What this means is that it has the advantage of speed, but it otherwise accesses memory with the same restrictions of the original 8088: a limit of 1 MB of addressable RAM, and slow memory access that doesn't take advantage of the full 32-bit processing of modernCPUs.
- ✓ All processors have this real mode available, and in fact the computer normally starts up in realmode.

- **IA-32 (Protected)Mode:**
  - ✓ This mode is the native state of theprocessor.
  - ✓ In this mode all instructions and architectural features are available, providing the highest performance and capability. This is the recommended mode for all new applications and operatingsystems.
  - ✓ Among the capabilities of protected mode is the ability to directly execute “real-

address mode" 8086 software in a protected, multi-taskingenvironment.

- ❖ The advantages of **protected mode** (compared to real mode)are:

- Full access to all of the system's memory. There is no 1 MB limit in protectedmode.
- Ability to multitask, meaning having the operating system manage the execution of multiple programssimultaneously.
- Support for virtual memory, which allows the system to use the hard disk to emulate additional system memory whenneeded.
- Faster (32-bit) access to memory, and faster 32-bit drivers to do I/Otransfers.

- **IA-32 Virtual RealMode**

✓ The key to the backward compatibility of the Windows 32-bit environment is the third mode in the processor: virtual real mode. *Virtual real* is essentially a virtual real mode 16-bit environment that runs inside 32-bit protected mode. When you run a DOS prompt window inside Windows, you have created a virtual real mode session. Because protected mode enables true multitasking, you can actually have several real mode sessions running, each with its own software running on a virtual PC. These can all run simultaneously, even while other 32-bit applications arerunning.

✓ Note that any program running in a virtual real mode window can access up to only 1MB of memory, which that program will believe is the first and only megabyte of memory in the system. In other words, if you run a DOS application in a virtual real window, it will have a 640 KB limitation on memory usage. That is because there is only 1 MB of total RAM in a 16-bit environment, and the upper 384KB is reserved for system use. The virtual real window fully emulates an 8088 environment, so that aside from speed, the software runs as if it were on an original real mode–only PC. Each virtual machine gets its own 1 MB address space, an image of the real hardware basic input/output system (BIOS) routines, and emulation of all other registers and features found in realmode.

✓ One interesting thing to note is that all Intel and Intel-compatible (such as AMD and VIA/Cyrix) processors power up in real mode. If you load a 32-bit OS, it automatically switches the processor into 32-bit mode and takes control fromthere.

Q.1 Enlist & Explain Modes of Operation of CPU ?

- ➢ **Processor Sockets &Slots:**

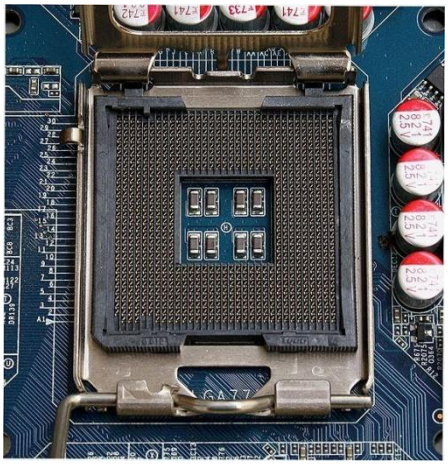


**Fig:** CPU Socket 775

- A CPU socket or CPU slot is a mechanical component(s) that provides mechanicaland electrical connections between a microprocessor and a printed circuit board(PCB).
- This allows the CPU to be replaced withoutsoldering.
- A CPU socket is made of plastic, a lever or latch, and metal contacts for each of the pins or lands on theCPU.

## ➢ Process Technologies: Dual Independent BusArchitecture:

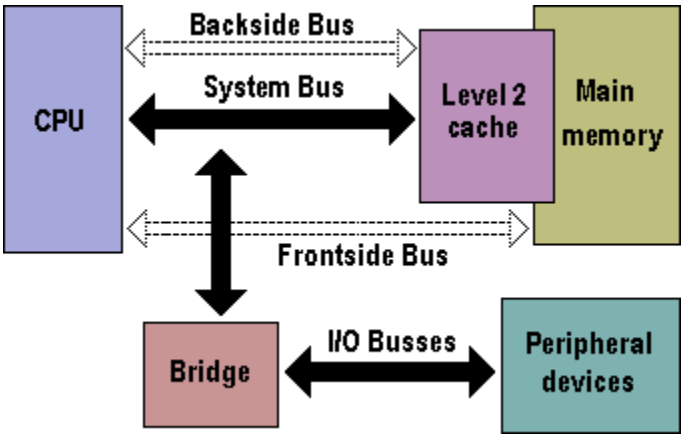



**Fig:** Dual Independent Bus Architecture

- DIB uses twobuses:

- One from the processor to main memory,and
- The other from the processor to the L2cache.

- The processor can access both buses simultaneously, which increases**throughput**.

## ➢ Hyper-Threading Technology:

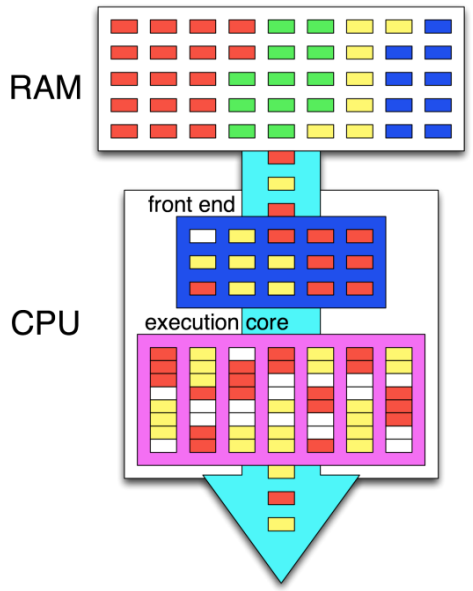



**Fig:** Hyper-Threading Technology

1. HT Technology enables a single processor to execute 2 separate code streams (called *threads*) concurrently.
2. HT technology allows 1 physical processor to appear as 2 "logical" processors to software (O/S andapplications).
    - Each logical processor has its own architecture state with its own set of general-purpose and control registers
    - Some resources are shared (caches, exe units, buses,etc)

Q. Explain Hyper-Threading Technology?

## ➢ Chipset Basic, Chipset Architecture, North/South bridge & Hub Architecture:

A **chipset** is a set of electronic components in an integrated circuit that manages the data flow between the processor, memory and peripherals. It is usually found in the motherboard of a computer.

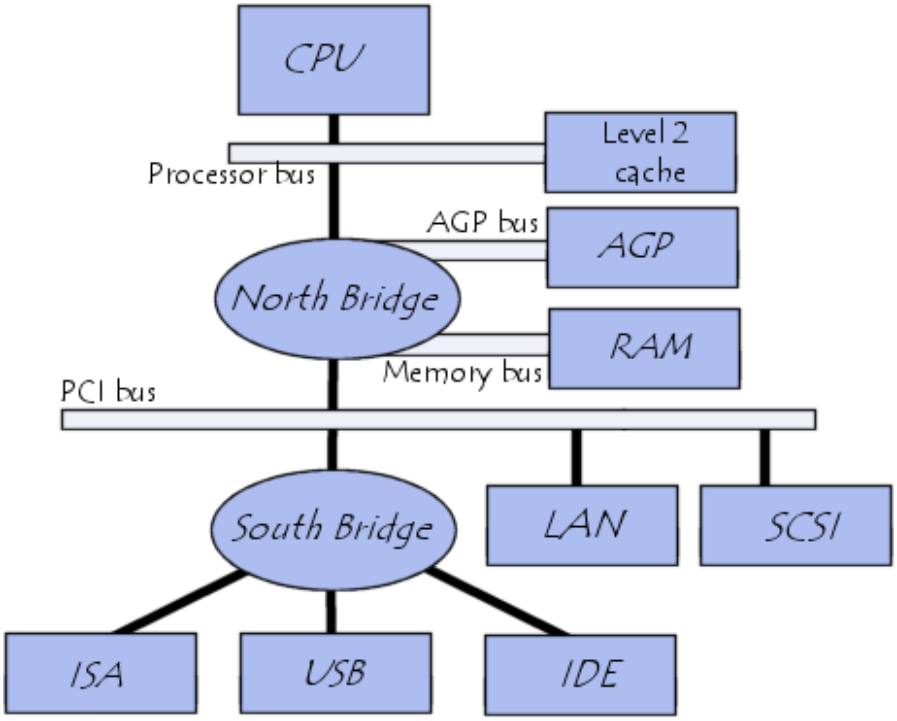



**Fig:** Northbridge & Southbridge Architecture

## Northbridge:

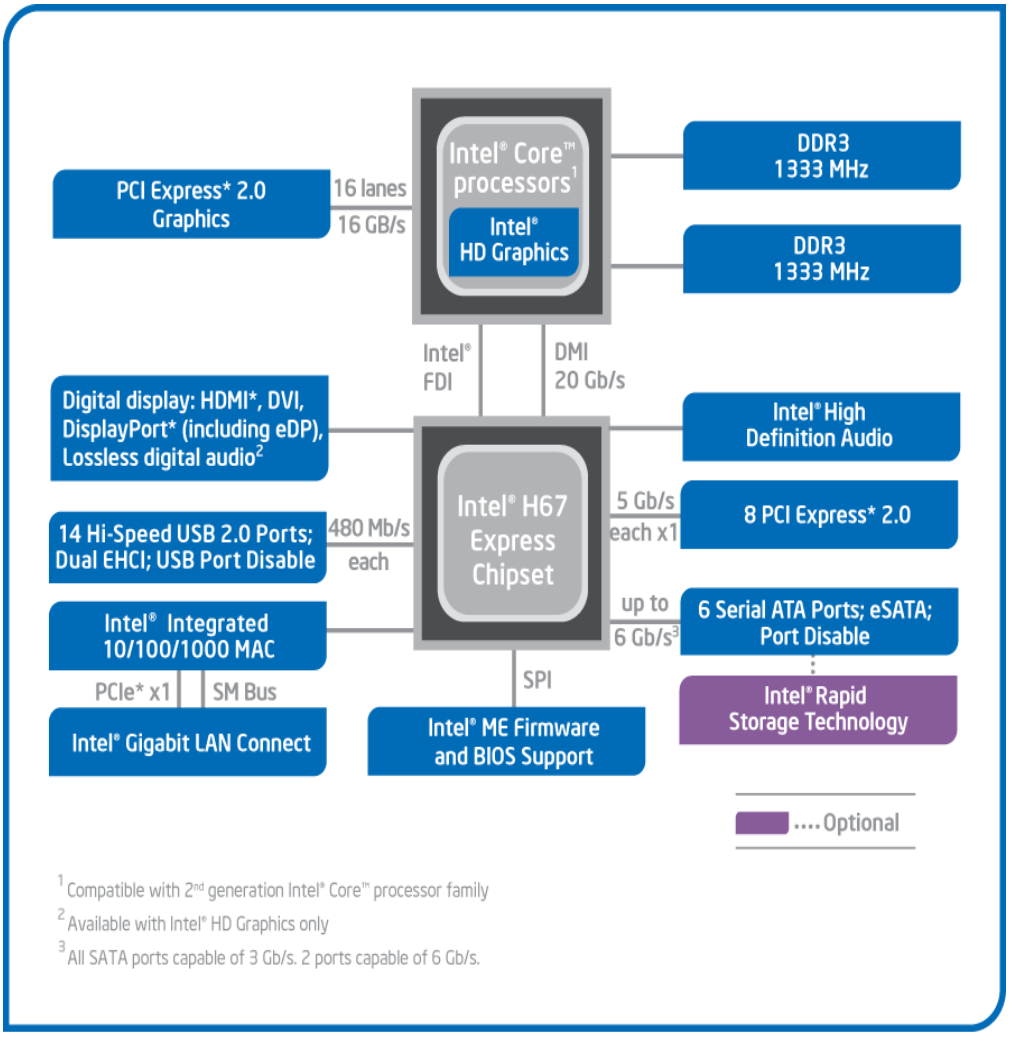
- MCH – Memory ControllerHub
- Bridges connection from CPU to RAM and Video Bus(AGP/PCI-X)
- Connects to SouthBridge
- A Northbridge with integrated video is called a GMCH – Graphics and Memory ControllerHub

## Southbridge:

- ICH – I/O ControllerHub
- Bridge connection from Memory Controller Hub to slower devices like USB devices, PCI-X, IDE(SATA/PATA), Real Time Clock, BIOS, onboard sound andmore

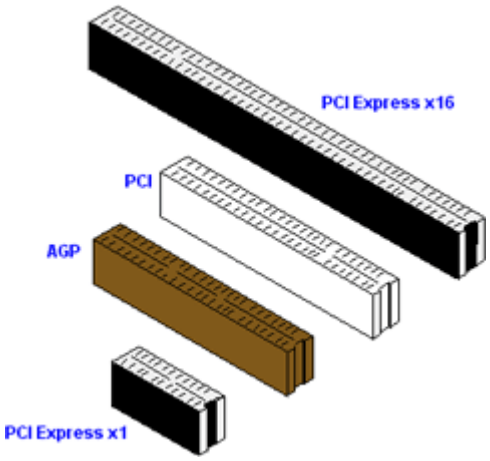
Q. Explain Northbridge & Southbridge Architecture

## ➢ Latest chipset forPC




Intel® H67 Express Chipset Platform Block Diagram

## ➢ Overview & features of PCI, PCI –X, PCI express, AGPbus:




**Dig: PCI, PCI-X, PCI-E, AGP Slots**

### ➢ PCI(Peripheral ComponentInterconnect):

It is high performance Bus that is used to integrate chips, processor, memory subsystems and expansion boards.

**Features of PCI bus:**

1. **Extremely High-speed data transfer:** 32 bit wide data transfer @33 MHz gives a maximum throughput of 132 mbps. Data transfer @66 MHz with 64 bit wide data is now beingoffered.
2. **Plug & play facility:** A PCI board inserted in any PCI slot is automatically detected & the required i/o & memory resources are allotted by thesystem.
3. **New Approach:** It moves peripherals of the i/o bus & places them closer to the system processor bus. Thereby providing faster data transfer between the processor &peripherals.
4. **Processor Independent:** The PCI local bus fulfills the need for the local bus standard that is not directly dependent on the speed & structure of processor bus, and that is both reliable andexpandable.
5. **Full multi master capability:** This allows any PCI master to communicate directly with other PCI masterslave.
6. **Parity on both data & address line:** This allows implementation of robust systems (*Robustness* is *defined* as "the ability of a *system* to resist change without adapting its initial stable configuration") support for both 5 V & 3.3 V operated logic.
7. Forward & backward compatibility between 66MHz & 33MHzPCI

Q. What is PCI & Explain the Features of PCI?

- **PCI-X:** PCI-X (Peripheral Component Interconnect Extended) is a computer bus technology that increases the frequency of the data bus from 66MHz to133MHz.

## Features of PCI-X bus:

1. Upto 133MHz busspeed
2. 64 bitbandwidth
3. 1 Gbpsthroughput
4. More efficient bus operation for easierinterface.
5. Split transaction allows & indicator device to make only one data request & release the bus, instead of constantly needing to poll the bus forresponse.
6. Byte count that enables indicators to specify in advanced, the specific number of bytes requested, eliminating the inefficiency of involving a high risk of loss prefetches.
7. Backward compatibility.

Q. What is the features of PCI-X Bus?

- **PCI-Express(Peripheral Component Interconnect Express(PCIe)):**

It is a scalable Input/output (I/O) serial bus technology that largely replaced earlier PCI slots on motherboards.

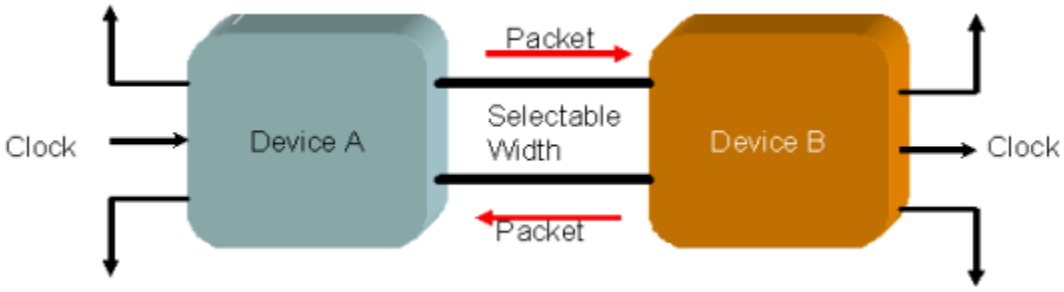



**Diagram:** PCI Express Physical Link Diagram

**Features of PCI Express**

- **Point-to-Point connection:** PCI Express is a point-to-point connection, which means it does not share bandwidth but communicates directly with devices via a switch that directs dataflow.
- **Hot Swapping & Plugging:** This allows for "hot swapping" or "hot plugging," which means cards in PCIe slots can be changed without shutting down thecomputer.
- **Less Power Consumption:** It consumes less power than previous PCItechnology.
- **Scalable:** One of the most promising features of PCI-Express is that it is scalable, which

means greater bandwidth can be achieved through adding more"lanes.

**Advantages of PCI-E over PCI-X:**

- **Interface:** PCI Express is a serial interface format, unlike PCI and PCI-X, which are parallel interfaceformats.
- **High Speed:** The 32-bit **PCI** bus has a maximum speed of 33 MHz, which allows a maximum of 133 MB of data to pass through the bus per second. Different PCI Express specifications allow different rates of data transfer, anywhere from 400 MB to 8000 MB of data per second and beyond.
- **Point to Point Communication:** PCI Express is designed to support chip-to-chip connections, board-to-board connections, and hot pluggable devices.
- **Superior Performance and Scalability:** Another advantage of PCI Express over PCI and PCI-X is the amount of bandwidth the former can support while using significantly fewer pins and traces. The PCI Express Specification defines the initial signaling rate for PCI Express as 2.5 gigahertz. This means that each Lane can carry 2.5 gigabits of data simultaneously in each direction using only eighttraces.
- **Full Compatibility with the PCI Software Model:** PCI Express uses the same load/store I/O architecture as PCI and PCI-X. This similarity makes PCI Express fully compatible with the PCI softwaremodel.

➢ **AGP (Advanced GraphicsPort):**

The Accelerated Graphics Port (often shortened to AGP) 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.

**Features of AGP bus:**

- Probably the most important feature of AGP is DME (direct memory execute). This gives AGP chips the capability to access main memory directly for the complex operations of texturemapping.
- AGP provides the graphics card with two methods of directly accessing texture maps in system memory: pipelining and sidebandaddressing.
- AGP makes multiple requests for data during a bus or memory access, while PCI makes one request, and does not make another until the data it requested has beentransferred.
- AGP doesn't share bandwidth with other devices, whereas the PCI bus does share bandwidth.

Q. What is AGP & Features of AGP.

**Comparison between AGP & PCI:**

- AGP is a port (it only connects two nodes) while PCI is abus.
- AGP can access the system memory via complex operations while PCI can only access the memory inside the actualcard.
- AGP also doesn't share bandwidth with other local devices while PCIdoes.
- AGP does not replace the PCI bus, it is a dedicated connection that can be used only by the graphicssubsystem.
- AGP transaction are multiples of 8 bytes in length and are aligned on 8 byte boundaries, while PCI transactions must be multiples of 4 bytes and are aligned on 4 byteboundaries.

## ➢ Logical memoryorganization:

### Conventional Memory (or Base RAM):

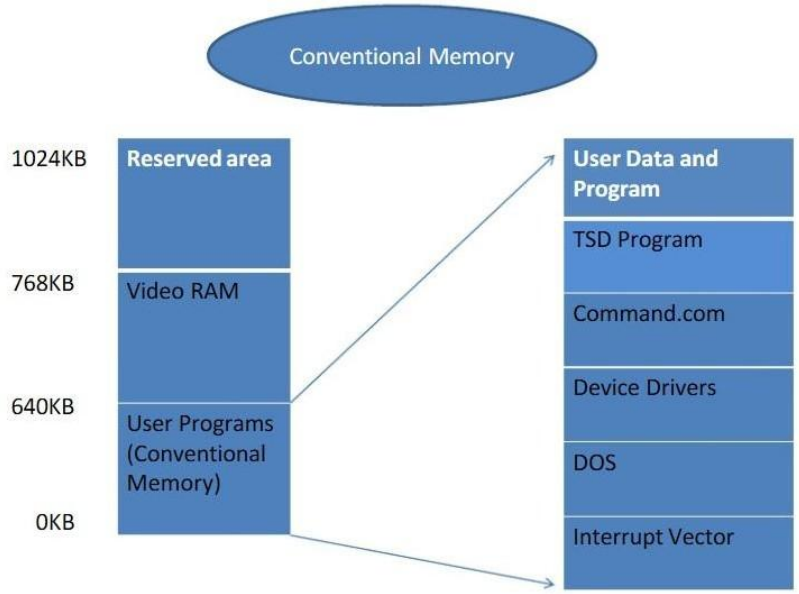


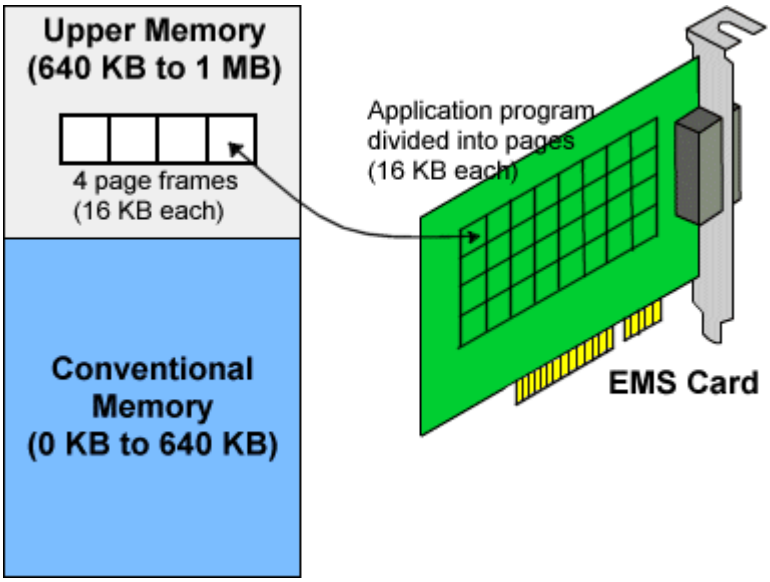

**Fig:** Conventional Memory

1. The first 640Kb of system memory is called as the conventionalmemory.
2. This area is used for standard DOS programs along with many drivers, memoryresident programs.

**Upper Memory Area:** This is 384Kb of above conventional memory. It is specially reserved for use by system devices & special use such as ROM shadowing & drivers.

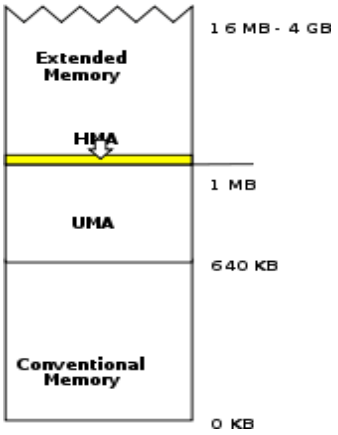
**High Memory Area:** First 64Kb of 2nd Mb used in real mode. It is used for DOS.

## ➢ ExpandedMemory:




- An expanded memory specification (EMS) was a technique introduced in about 1984 for expanding the conventional or main memory beyond 1 MB in IBM XT compatible computers.
- The process was known as bank switching and involved expanding memory beyond that which was directly addressed by theprocessor.
- EMS was designed for disk operating system (DOS) software programs requiring the additionalmemory.
- It was designed to overcome 1 Mb of addressing limitations of first generation 8088 & 8086 PC.
- Expanded memory cannot accessible by processor instead it is access with high memory area 64 Kb segment on board combine with special switching & mappinghardware.

➢ **ExtendedMemory:**



- All above the 1 Mb is called extendedmemory.
- Extended memory refers to any amount of memory that is available for use over the main memory that is inherent in most DOSsystems
- In most cases, this means that any memory over the 1 megabyte (MB) that is supported by DOS would be considered extendedmemory.
- This is all above the high memory area until the end of systemmemory.
- Memory of this type is supported by the use of certain types of microprocessors that allow loading and access to the extended memory.
- It is best for windows & multitasking operatingsystem.

Q. Compare Conventional Memory, Expanded Memory & Extended memory.

## ➢ Overview & features of SDRAM, DDR, DDR2,DDR3

RAM (Random Access Memory) is where data is stored that's being accessed by the CPU.

**Types of RAM:**

1. **StaticRAM:**

Static Random Access Memory (Static RAM or SRAM) is a type of RAM that holds data in a static form, that is, as long as the memory has power. Unlike dynamic RAM, it does not need to be refreshed. SRAM stores a bit of data on four transistors using two cross-coupled inverters.

Static RAM is faster and less volatile than dynamic RAM, but it requires more power and is more expensive.

2. **Dynamic RAM:**

DRAM stores each bit in a storage cell consisting of a capacitor and a transistor. Capacitors tend to lose their charge rather quickly; thus, the need for recharging or refreshing.

**Types of DRAM:**

1. **FPM (Fast Page Mode):** It was traditional RAM for PC. It was mounted in single inline memory module (SIMM) of 2MB, 4MB, 8MB, 16MB,32MB.
2. **EDO (Extended Data Out):** It is faster than FPM RAM. EDO have improvement in performance 2% to 5% compared withFPM.
3. **ECC (Error Correcting Code):** It is special error correcting RAM used inserver.
4. **SDRAM (Synchronous Dynamic RAM):** SDRAM replaced DRAM, FPM, and EDO. SDRAM is an improvement because it synchronizes data transfer between the CPU and memory. SDRAM allows the CPU to process data while another process is beingqueued.

Q. Explain the types of DRAM

**Features of SDRAM:**

- All SDRAM chips for desktop PC have 168pins
- Speed of SDRAM is 100 MHz & 133MHz
- Available in sizes 32MB, 64MB, 128MB, 256MB, 512MB, &1GB
- Operating Voltage 3.3V
- Architecture usedSynchronous
- Operating Max Temperature is85$^{o}$C
- It pre-fetches 1 bit at atime.

**DDR (Double Data Rate SDRAM):** also called DDR1 SDRAM.

DDR SDRAM (double data rate SDRAM) is synchronous dynamic RAM (SDRAM) that can theoretically improve memory clock speed to at least 200 MHz.

**Features of DDR SDRAM:**

- All DDR RAM Chips have 184pins.
- DDR RAM comes in different speeds *i.e.*100Mhz, 133MHz, 166MHz,200MHz
- DDR is twice as fast as SDRAM
- Operating Voltage 2.5V
- Architecture used is Source Synchronous (it refers to the technique of having the transmitting device send a clock signal along with the datasignals.)
- Operating Max Temperature –85$^{o}$C
- It Pre-fetches 2 bit at atime

**DDR2 (Double Data Rate 2 SDRAM):**

**Features of DDR2:**

- The DDR2 RAM chip has 240pins
- DDR2 operate at data rates of 400MHz, 533MHz, 667MHz, &above
- HigherBandwidth
- Lower power1.8V
- Architecture used sourcesynchronous
- It pre-fetches 4 bits at atime
- Operating Max

Tempeature – 95$^{o}$C **DDR3**

**(Double Data Rate 3 RAM):**

**Features of DDR3:**

- Introduction to asynchronous RESETpin.

- Support system level same delaycompensation.
- On DIMM (dual in-line memory module) mirror friendly DRAM pinout.
- Introduction of CWL (CAS Write Latency) per Speedbin.
- On-die I/O calibrationengine.
- READ & WRITEcalibration.
- It works on very low power*i.e.*1.5V
- DDR3 operate at data rates of 800MHz, 1066MHz, 1333MHZ, 1600MHz, &above.
- It pre-fetches 8 bits at atime.

## ➢ Concept of Cachememory:


**Fig: Cache Memory**

- Recently used instructions and data are kept in a very fast memory so that the CPU does not have to access the main memory every time it requires access todata.
- Cache memory is random access memory (RAM) that a computer microprocessor can access more quickly than it can access regularRAM.
- As the microprocessor processes data, it looks first in the cache memory and if it finds the data there (from a previous reading of data), it does not have to do the more time- consuming reading of data from largermemory.
- **Cache** is a smaller, faster, memory which stores copies of data from most frequently used main memorylocation.
- **Cache memory** is a high speed memory buffer that processor need allows processor to retrieve data faster than it will come from mainmemory.
- The advantage of cache memory is that CPU does not have to use the motherboard bus for datatransfer.

## ➢ Types of CacheMemory:

### L1 (Level 1 or Internal or Primary) Cache:

Level 1 cache, often called primary cache, is a static memory integrated with processor core that is used to store information recently accessed by a processor. Level 1 cache is often abbreviated as L1 cache. The purpose of level 1 cache is to improve data access speed in cases when the CPU accesses the same data multiple times. For this reason access time of level 1 cache is always faster than access time of system memory. The processor may have additional level 2 and level 3 caches, albeit those caches are always slower then the L1 cache.

The L1 cache typically ranges in size from 8KB to 64KB and uses the high-

speed SRAM (static RAM) instead of the slower and cheaper DRAM (dynamic RAM) used for main memory.

**L2 (Level2 or External or Secondary) Cache:**

Level 2 cache, also called secondary cache, is a memory that is used to store recently accessed information. The goal of having the level 2 cache is to reduce data access time in cases when the same data was already accessed before. In modern microprocessors that incorporate data prefetching feature the level 2 cache may also be used to buffer program instructions and data that the processor is about to request from memory. This also reduces data access time. Please note that the level 2 cache is secondary to the CPU - it is not as fast as the level 1 cache, although it is usually much larger. All data that is requested from level 2 cache is copied to level 1 cache. Requested data stays in the secondary cache if it's an inclusive cache, and is removed from secondary cache if it's an exclusive cache.

L2 cache comes between L1 and RAM(processor-L1-L2-RAM) and is bigger than the primary cache (typically 64KB to 4MB).

**L3 Cache:**

L3 cache is not found nowadays as its function is replaced by L2 cache. L3 caches are found on the motherboard rather than the processor. It is kept between RAM and L2 cache.

**Cache Hit:** A request to read from memory which can satisfied from the cache without using the main memory.

**Cache Miss:** A request to read from memory which cannot be satisfied from the cache, for which the main memory has to be consulted.

The percentage time cache hit is called as Cache Hit Ratio

Q. Explain Cache memory & its types

Q. Explain the following terms

1. Cache Hit 2. Cache Miss

## ➢ BIOS – Basics & CMOS Set Up:

**Definition: Basic Input/output System**, the **BIOS**, **ROM BIOS**, or **System BIOS** is a chip located on all motherboards that contain instructions and setup for how your system should boot and how it operates.

The main function of BIOS in a computer is to offer a small library of basic input/output functions that are used to run and manage computer peripherals.

Some common tasks/functions that the BIOS perform include:

- A power-on self-test (POST) for all of the different hardware components in thesystem to make sure everything is working properly
- Activating other BIOS chips on different cards installed in the computer -

For example, SCSI and graphics cards often have their own BIOSchips.

- Providing a set of low-level routines that the operating system uses to interface to different hardware devices - It is these routines that give the BIOS its name. They manage things like the keyboard, the screen, and the serial and parallel ports, especially when the computer is booting.
- Managing a collection of settings for the hard disks, clock,etc.

The BIOS is special software that interfaces the major hardware components of your computer with the operating system. It is usually stored on a Flash memory chip on the motherboard, but sometimes the chip is another type of ROM.

When you turn on your computer, the BIOS does several things. This is its usual sequence:

1. Check the CMOS Setup for customsettings
2. Load the interrupt handlers and devicedrivers
3. Initialize registers and powermanagement
4. Perform the power-on self-test(POST)
5. Display systemsettings
6. Determine which devices arebootable
7. Initiate the bootstrapsequence

The CMOS setup utility is used to setup the hardware configuration of your computer's motherboard. It's the same function as the BIOS utility. It has things like disk boot order, RAM settings, and system clock settings (so your computer knows what time it is).

“There are some differences between a **warm and cold booting**. A **warm boot** is what happens when a computer is running and it is restarted. A **cold boot** is when the computer is already off and the power is turned on.”

To **boot** (also "to boot up") a computer is to load an operating system into the computer's main memory or random access memory (RAM).

A **bootstrap** is the process of starting up a computer. It also refers to the program thatinitializes the operating system (OS) during start-up.

## ➢ Motherboard Selection Criteria (Knowing What to LookFor)

It helps to think like an engineer when you make your selection. Consider every aspect and detail of the motherboards in question. For instance, you should consider both present usage as well as any future uses and upgrades. Technical support at a professional (as opposed to a user) level is extremely important.

The following list includes some of the most important criteria to consider when selecting a motherboard:

- ✓ **Motherboardchipset**:

The motherboard chipset is the backbone of a system and is perhaps the single most important part you'll consider. Compare the features of the available chipsets to ensure that the board will do what you want. For example, some chipsets include support for faster memory, PCIe 2.x cards, SATA 3Gbps drives, and optional RAID capabilities. I spend the most time deciding on my next chipset because it affects and influences virtually every other component in thesystem.

- ✓ **Processorsocket**:

The processor socket on a motherboard dictates the specific processor makes and models you will be able to install. In most cases you will have a given processor in mind, so choose a motherboard with a socket that supports the processor you wish to use. The main sockets in use today on new systems include Socket AM2 and AM3 for AMD processors, and Sockets LGA775, LGA1156, and LGA1366 for Intel processors. Also check the motherboard specifications for what specific processors are supported by a givenmotherboard.

- ✓ **Memory**:

The type and amount of memory compatible with a system depends on the motherboard you choose. Most motherboards today support either DDR2 or DDR3 memory, in single, dual, or triple-channel operation. The number of memory sockets, supported speeds, and other variables also depend on the motherboard, so check the board specifications to see exactly what is supported.

- ✓ **Formfactor**:

The form factor indicates the size and shape of the board, and must be compatible with the chassis or case and power supply. For maximum flexibility, performance, reliability, and ease of use, I recommend motherboards based on the ATX and microATX form factors. Larger form factors such as ATX offer more slots and room for additional integrated components and features. Smaller variations on ATX are also available, but in the end you need to be sure that the motherboard is

compatible with the case and power supply you have chosen.

- ✓ **Bus slots**:

Current systems offer one to five or more PCI and PCI Express slots (depending on the form factor). Some boards have more than one PCIe x16 (video card) slots, which you may want if you are running multiple video cards in an SLI or CrossFire arrangement. Make sure the board you choose has the number and types of slots you require.

- ✓ **Onboard ATAinterfaces**:

All motherboards on the market have included onboard Serial and Parallel ATA interfaces for some time now, but not all are equal. Look for boards that include at least four to six SATA connectors, with support for 3Gbps operation as well as optional RAID functionality (if desired).

- ✓ **Other built-ininterfaces**:

Ideally, a motherboard should contain as many built-in standard controllers and interfaces as possible. Most boards feature integrated USB, sound, and LAN (look for those offering gigabit Ethernet), whereas others also have integrated video, FireWire, eSATA, dual LAN adapters, and more.

- ✓ **Documentation**:

Good technical documentation is important. Documents should be easy to download from the manufacturer's site, and should include information on any and all jumpers and switches found on the board, connector pinouts for all connectors, specifications for other plug-in components, and any other applicable technical information. Most vendors provide this information in electronic form (using the Adobe Reader PDF format) on their websites, so you can preview the information available for a given motherboard before you buy.

- ✓ **Technicalsupport**:

Good online technical support goes beyond documentation. It includes easily downloadable driver and BIOS updates, FAQs, updated tables of processor and memory compatibility, and utility programs to help you monitor the condition of your system. In addition to these online support features, make sure the vendor can be contacted through email and by phone.

Unit 2

**STORAGE DEVICES & INTERFACING.**

**Objectives**

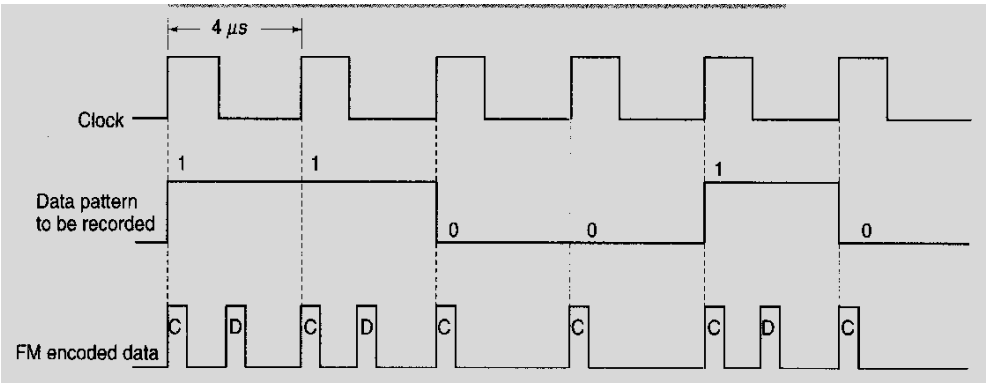
- To understand the Recording techniques in storage devices.
- To understand the working of storage devices.

Three most common encoding methods are:

1. FM encoding method
2. MFM encoding method
3. RLLencodingmethod

## 1. FMEncodingScheme:

- FMorFrequency Modulation was the original data-encoding scheme used for storing the data on the magnetic recording surface.
- This method of data encoding is also known as the"Single density recording".
- In this method,a clock signal is put with every data signal on there cording surface.
- This clock signal is used for synchronizing the read operation,as there will always be a clock signal, whether the data signal is there or not.
- In this FM method of data recording a 1 bit is stored as two pulses (one clock pulse and onedata pulse),and aobitis stored as a one pulse and one gap or no pulse.
- For example, abinarynumber1011 willbestoredas PP PN PPPP

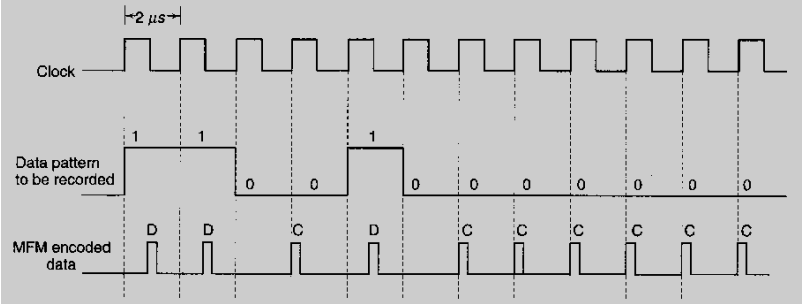



## 2. MFM Encoding Scheme:

- More data can be stored on the same surface or the data storage density can be increased, if the number of pulses required to store the data can be minimized.
- When minimizing the pulses, one should be careful that the number of no pulses together should not be very long; otherwise the disk controller may go out of synchronization with the data.
- TheMFM(modified frequency modulation)method of data storage,by reducing the number of pulses,is able to store more data without any data and synchronization number of pulses,is able to store more data without any data

and synchronization loss.In MFM recording the 0s and 1s are encoded as given below

- 1 is always stored as no pulse, and a pulse(NP)
- 0, when preceded by another 0, is stored as a pulse, and no pulse(PN)
- 0, when preceded by a1,is stored as two no pulses(NN)
- If you store 1001 on the disk surface using the MFM storage method, it would be stored as NP NNPN NP.




## 3. RLL EncodingScheme

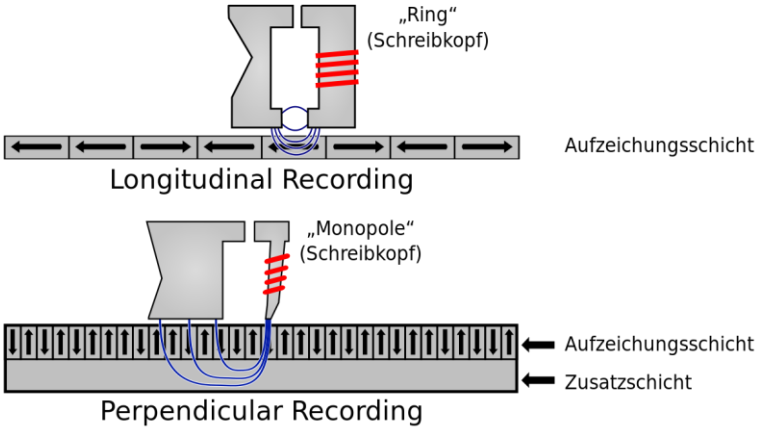
- The RLL is encoding or the run length limited encoding is the most common encoding scheme used in the harddisk storage.
- This encoding scheme can be more accurately called as 2,7 RLL encoding because in this scheme in a series or in a running length the minimum number of0s next to each other is two, and the maximum number of 0s together cannot be more than seven.
- The RLL encoding scheme can store 50 percent more information than MFM encoding scheme on a given surface and it can store three times as much information as theFM encoding scheme.The Run length Limited name comes from the minimum number (run Length)and maximum number (runLimit) of "no pulse" values allowed between two pulses.
- For the RLL encoding, an encoder/decoder (Endec) table is used to find the pulse signalto be used for different data bit groups. Endec table used by the IBM to convert bit information to the pulse signal is shown below

| **Data Bit** | **Pulse Encoding** |
|---|---|
| 10 | NPNN |
| 11 | PNNN |
| 000 | NNNPNN |
| 010 | PNNPNN |
| 011 | NNPNNN |
| 0010 | NNPNNPNN |
| 0011 | NNNNPNNN |

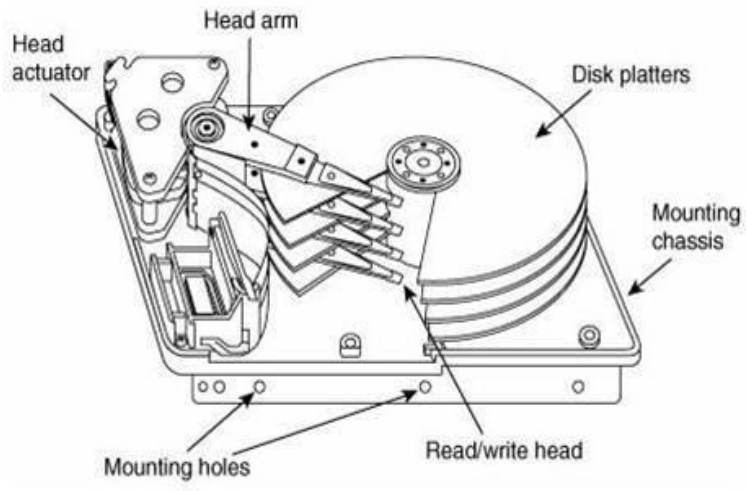
- For example, if you want to encode a byte 100011 to proper RLL pulse signal then theBit10 can be encoded as NPNN
- Bit 0011 can been codeda s NNNNPNNN

## 4. Perpendicular Encoding

- Perpendicular recording (or perpendicular magnetic recording, PMR) is a technology for data recording on magnetic media, particularly hard disks.
- Perpendicular recording can deliver more than three times the storage density of traditional longitudinal recording.
- In 1986, Maxell announced a floppy disk using perpendicular recording that could store 100 kB per inch (39 kB/cm).
- Perpendicular recording was later used by Toshiba in 3.5" floppy disks in 1989 to permit 2.88 MB of capacity (ED or extra-high density), but they failed to succeed in the marketplace.




# Hard Disk Construction



A hard disk drive is made up of several physical components

1) Disk platters
2) Read/write heads
3) Head actuator mechanism
4) Spindle motor
5) Logic board
6) Cables and connectors
7) Bezel /Front Plate
8) Air Filter

## Hard DiskPlatters (Disks)

- The platters stores information.It comes in varying sizes like 5.12", 3.14", 0.85"etc
- The physical size of a drive is expressed as the sizeof the platters
- Mosthard disk have two or more platters
- Platters were originally made from an aluminium/magnesium alloy which provides both strength and lightweight
- All modern drives use glass or glass ceramic plates.

## Read/Write Heads

- A harddisk drive usually has one read/write head for each platter surface(meaning that each platter has two sets of read/write heads-one for topside and one for bottom side
- These heads are connected on a single movement mechanism so heads across the platters in unison.
- TheHDD uses various types of heads for read/write purpose.
    - Ferrite head
    - Metal-In-Gap Head,Thin Film Head
    - Magneto ResistiveHead
    - Giant MagnetoResistiveHead

## Head Actuator Mechanism

- Thismechanismmovestheheadsacrossthediskandpositionsthemaccuratelyabove the desired cylinder.
- Two basic Categories are used
    - Stepper Motor Mechanism
    - VoiceCoilActuator
- StepperMotoractuatorswerecommonlyusedonharddrivesmadeduringthe1980s and early1990s with capacities of100MBor less
- Floppy disk drives position their head by using as Stepper motor actuator
- All hard disk drives being manufactures today use voice coil actuator.

## Voice

## CoilActuator

The two main types of voice coil positioner mechanisms are

- Linear Voice Coil Actuators
- Rotary Voice Actuators

## Spindle Motor

- The spindle motor spins the platters connected to spindle. The motor is directly connected to the spindle of platters. These platters revolve at exactly 3600 rpm to 1500 rpm. The speed of motor has to be controlled very precisely.
- Normally a feedback loop is employed in the control electronics to monitor the speed. The speed control is fully automatic.

## Logic Boards

- A disk drive will have a board containing the electronics that control the drive's spindle and head actuator systems These are called logic boards.
- They present data to the controller in a planned format.
- They may be removed and replaced to rectify a logic board problem.

## Cable and Connectors

- Cable and connectors are used to connect HDD to the main computer system.
- AllharddiskdrivecontainsconnectionsforData/Control interface connector, Power connector.

## Bezel/Front Faceplate

- Bezel is the front faceplate provided on most of the hard disk drives.
-

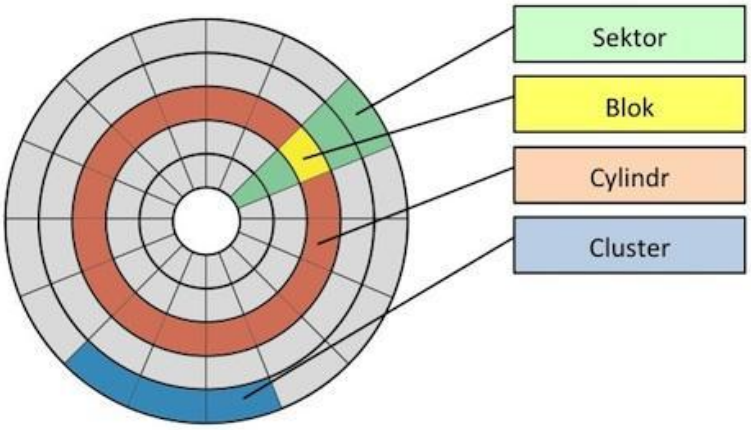
## Air Filters

- Nearly all hard disk drives have two air filter. One is called there circulating filter and the other is called either a barometric or breather filter.
- These filters are permanently sealed inside the drive and are designed never to be changes for the life of the drive.
- A hard disk on a PC system does not circulate air from inside to outside the

HDD or viceversa.

- There circulating filter permanently installed inside HD A is designed to filter only small particles. Scraped off platters during head take-offs and landings.

# Terms Related to Hard disk




- When OS writes some information on the harddisk, it does not allocate the space sector wise,instead uses a new unit of storage called “Cluster”.
- Clusters are the minimum space allocated by DOS when storing any information on the disk
- Even to store only one byte long information on the disk requires minimum one cluster area on the disk surface
- A cluster can be made up of one or more sectors, it depends on disk type being used.
- This reduces the size of FAT that DOS uses to keep track of the used and the empty disk space
- First cluster no.is taken as 2
- Clusters are used to allocate the storage area for data area only, FAT and directory are as are not allocated according to the cluster size

## Cylinder

- Same tracks of different platters form an imaginary cylinder likestructureData is stored cylinder by cylinder
- All tracks on a cylinder are written and then theR/W head moves to the next cylinder.
- This reduces movement of R/Whead and increases the speed of read and write operation

## Sector

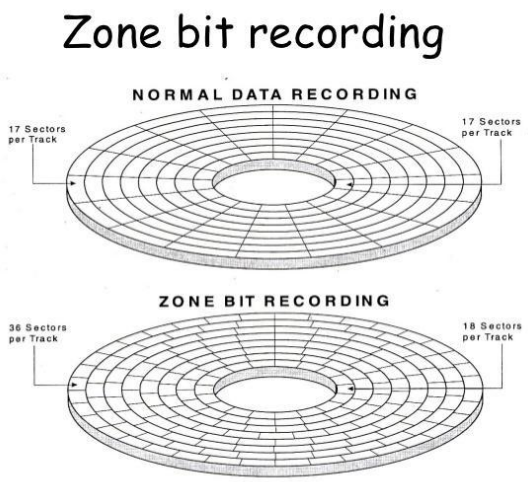
- A track is a bigareatostoredata( 5000 bytes). Hence tracks are divided into sectors
- Theformattingprogramdividesdisksurfaceintosectorsbywritingmagneticpatternon disk surface
- Different HDDcapacities have different number of tracks
- 512 byte data can be stored in each sector. Sectorno. starts from 1

## Landing Zone

- This setting specifies the cylinder to which the BIOS should send the heads of the hard disk when the machine is to be turned off. This is where the heads will "land" when they spin down. Modern drives automatically park the heads in a special area that contains no data when the power is turned off. Therefore this setting is meaningless and is typically ignored.
- Most BIOS set this value to be the largest cylinder number of the logical geometry specified for the disk when auto detection takes place. So if the drive has 6,136 logical cylinders, the landing zone will be set to 6,135. In any event a modern IDE drive will ignore this setting and auto-park by itself.

## Zone Recording

- One way to increase the capacity of a hard drive during the low level format is to create more sectors on the disks Outer cylinders than on the inner ones.
- Becausetheyhavealargercircumferencetheoutercylinderscanholdmoredata.Drives that use zoned recording split the cylinders into groups called zones, with each successive zone having more sectors per track as you move outward from the center of disk.



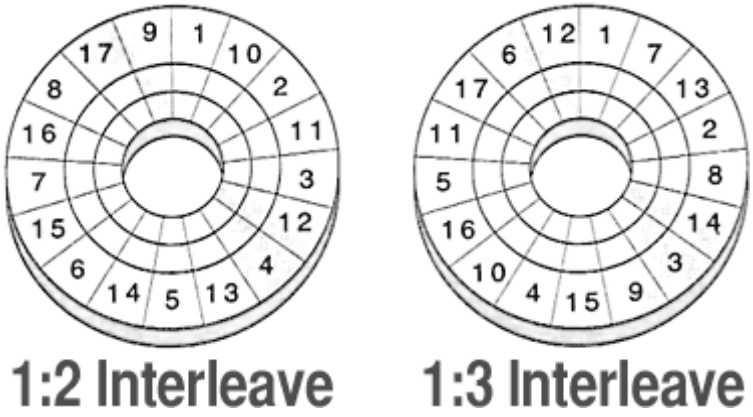

## Write Precompensation

- It is useful for drives using standard track, sector format
- Drives using zone bit recording do not require any write pre-compensation
- The magnetic particles used to write on the disk surface have north and south poles
- Like poles repel and unlike poles attract
- In outer surface of hard disk platter, magnetic particles are far apart to be affected by the attraction and repulsion of magnetic particles.
- In the inner tracks of the disk drive, the density of the magnetic are very high and adjacent particles start to attract and repel.
- This will force to change the information written on the disk
- To compensate for this shift of data particles due to attraction and repulsion, the drive can write the data a part or closerthan the required position
- The particles will slowly shift to the required position because of attraction and repulsion
- This process of writing the data closer or farther to compensate for attraction nor repulsion of magnetic particles is called Write pre-compensation

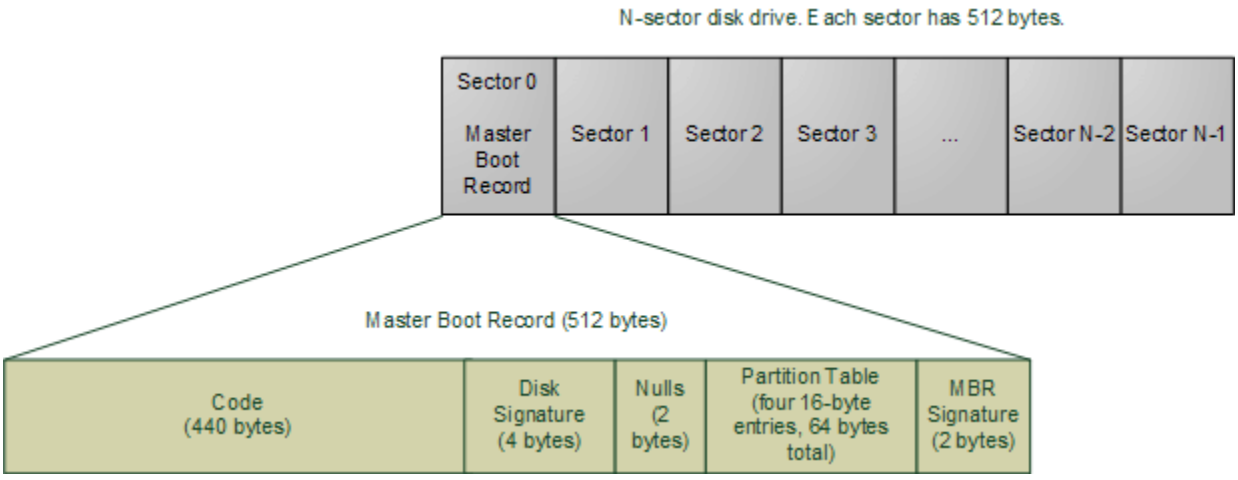
- The cylinder from which this pre-compensation is started is called pre-compensation cylinder. This value will be used by all the cylinders that are towards the centre of the drive.

## Interleave and Interleave factor

- Although traditionally interleaving was more a controller performance issue than drive issue modern hard disk drives with built-in controllers are fully capable of processing the data as fast as the drive can send it All modern drives are formatted with no interleave sometimes expressed as 1:1 interleave ratio.
- Interleave factor- the number of sectors that pass beneath the read/write heads before the next numbered sector arrives eg 1:3




## Master Boot Record (MBR)




**M***aster* **B***oot* **R***ecord,* a small program that is executed when a computer boots up.

- Typically, the MBR resides on the first sector of the hard disk or diskette that identifies how and where an operating system is located so that it can be boot (loaded) into the computer's main storage or random access memory.
- The program begins the boot process by looking up the partition table to determine which partition to use for booting.
- It then transfers program control to the *boot sector* of that partition, which continues

the boot process. In DOS and Windows systems, you can create the MBR with the FDISK

/MBR command

**The MBR contains two elements;**

1. Executable code and
2. A partition table,

- Which identifies each partition residing on the hard drive? The MBR executable code or program begins the boot process by looking up the partition table to determine what partition holds the operating system.
- This program looks for two hidden program files IO.SYS and MSDOS.SYS for DOS and executes IO.SYS program first. This program in turn loads MSDOS.SYS and COMMAND.COM into RAM to complete the process of booting.
- From the above figure, you can see that a disk drive is composed of N sectors and each sector is of 512 bytes.
- Out of the N sectors, the first sector is assigned to the Master Boot record. The first 512 bytes of the BIOS is the Master Boot Record. MBR is composed of two components: a Bootsrapping program and the partition table. The code can be Windows loader, Unix loaders, or a virus.
- Next, comes the partition table. The partition table is of 64 bytes and a 16 byte part which tells about the partition of the disk.
- The MBR is very small in size. Its machine code just helps to load that sector which is responsible for booting the associated partition

## Formatting

1. It prepares a blank hard disk for a particular OS.
2. It puts magnetic marks of tracks and sectors on the platter surface.
3. The storage capacity of formatted hard disk is always less than the capacity of unformatted disk.
4. A typical sector has 3 standard components.

a. Identification field which contains the address of the sector i.e. the track head and the sector number.

b. Data field which contains data recorded at a particular location. It also contains error detection and correction codes.

c. Number of gaps**.**

5. FAT and root directory are also put on the platter at the time of formatting. Hard Disk requires a low level formatting and a high level formatting to make it useful for data storage
6.

### Low Level Formatting (Physical or true formatting)

- It is done at the factory level. (In low level formatting all the data stored on the disk is lost as the disk is physically formatted)
- It magnetically divides the disk into tracks and sector.
- Basic addressing information is written to each sector of each cylinder.
- It checks for bad sectors and maps them out.

### High Level Formatting

- It is done with the help of OS.
- High level Format program scans the disk for tracks and sectors marked bad during low level formatting. The scanning program performs five retries to read the tracks or sectors. If the tracks are still unreadable, the area is noted as bad cluster in FAT.
- After scanning the entire disk, the drive heads return to the first sector of the partition and write MBR. Immediately in the next sector 1st copy of FAT is written and after that 2nd copy of FAT is written. Initially FATS are blank except for the bad cluster marks found in the initial scan.
- After the 2nd copy of FAT blank root directory is created.

### What is FAT? List two features of FAT 32

- The file system in storage devices starts with **FAT (File allocation Table).**
- FAT refers to a data table that holds information about how and where files are stored in any partition
- It is a kind of index used by operating system to keep track of information stored on the hard disk

### FAT 32 (Any Two)

- Introduced with Microsoft windows 95, supports drives up to 2 TB
- Since it can space more efficiently, it uses smaller clusters( 4 KB clusters for drives up to 8 GB) fetch
- No compression or encryption available on FAT 32 file system

## Partitioning

- Creating a partition on a hard disk drive enables it to support file systems each in its own partition. Three common file systems are used by PC operating today:/

### FAT (File Allocation Table)

- Developed by Microsoft for MS-DOS, MS-Windows 95,98,Me
- FAT located in MBR sector of bootable disk

- 2 Important Functions of FAT;

  Contains allocation information (in the form of linked list)

  Indicate which allocation units are free.
- It is simple and reliable. Two identical copies of FAT are used.

## Structure of FAT

| Partition | FAT 1 | FAT 2 | Root Folder | Other |
|---|---|---|---|---|
| Boot Sector | | (Duplicate) | | Folders and All Files |

## NTFS (New Technology File System)

**Structure**

| Partition Boot Sector | Master File Table | System File | File Area |
|---|---|---|---|

- Used by Windows NT, XP, 2000 , Server 2003, Server 2008, Windows Vista
- NTFS provides better performance, security compatibility and extendibility than FAT
- Read, Search, Write, Recovery are done fast.
- Master File Table (MFT) contains information about all files and folders. First file on NTFS volume.
- Partition Boot Sector Start at Sector 0 to 16. First Info on an NTFS volume.

### Features

- It allows you to encrypt files and automatically decrypt them as they are read.
- Supports long file names upto 255 characters
- Supports File Size upto 2 TB
- For keeping track of clusters it uses a B- tree directory
- Reliable File System as compared to FAT
- Allows Large partition sizes i.e more than 4 GB
- Built-in file compression facility
- Improved Security And access control deciding who can perform what sorts of operations on various data within the file system

## *Compare FAT 16, FAT 32, NTFS*

:

| Criteria | NTFS | FAT 32 | FAT16 |
|---|---|---|---|
| OS | **Windows 2000, XP, 2003 server** | **DOS V7, Win 2000,98,XP** | **Dos , All version of Windows** |
| Maximum Vol Size | 2TB | 32GB | 2GB |
| Max. Files on Vol | Unlimited | **4194304** | 65536 |
| **Max file size** | **Limited by vol size** | 4GB | 2 GB |
| Max Cluster number | Unlimited | **4177918** | 65524 |

| Boot sector Location | 1st and last | First sector and copy in sector No 6 | First sector |
|---|---|---|---|
| **Compression** | Yes | NO | NO |
| **Built in security** | Yes | NO | NO |
| **Recoverability** | Yes | NO | NO |
| **Performance** | **High on large vol Low on small vol** | **Good on small vol, Low on large** | **Good on small vol, Low on large** |
| **Security** | **Folder and fie access can be controlled individually** | **Very little** | **Very little** |

# HDD Interface Types

Interfacing means connecting the hard disk drive to the main computer system.

## 1) PATA Parallel Advanced Technology Attachment(IDE)

IDE stands for integrated Drive/Device Electronics In ST-506/412 interfaces the controller card was with the expansion slot and the drive was connected through cables.

### Features

1. Proven and reliable technology integration
2. Upto 133 MB/s interface transfer rate
3. PATA allows cable lengths upto 18 inches(46 cms)
4. Designed for desktop PCs and Notebook PCs with usage in entry servers and consumer electronics as well
5. PATA is based on the original IBM PC ISA bus

## 1) SCSI(pronounces as scuzzy) Small Computer System Interface

1. This interface is not a drive level interface but it a system level interface. SCSI is not a controller for a single device.
2. SCSI interface is used in high end configurations IDE is used in low end configuration

**Features**

1. Fast and wide Data Path
2. Supports upto 7 peripheral Devices such as CD-Rom, scanner that can attach to a single SCSI port
3. Faster than the average parallel interface

4. It will allow data transfer upto 100 MB/s to 160 MB/s
5. SCSI is now plug and play in nature such as automatic SCSI ID assigning and termination

**2) <u>SATA (Serial Advanced Technology Attachment)</u>**

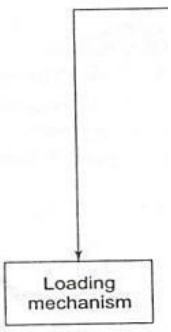
- Is a computer bus primarily designed for transfer of data between a computer and mass storage devices such as hard disk drives and optical drives.

**Features**

1. SATA is better more efficient interface than the dated PATA standard.
2. It supports hot swapping
3. Serial ATA uses only 7 conductors while PATA uses 40.
4. Data Transfers at the rate of 1.5 Gbit/s, 3 Gbit/s and 6 Gbit/s

# CD ROM Recording

**Working of CD-ROM drive with block diagram**



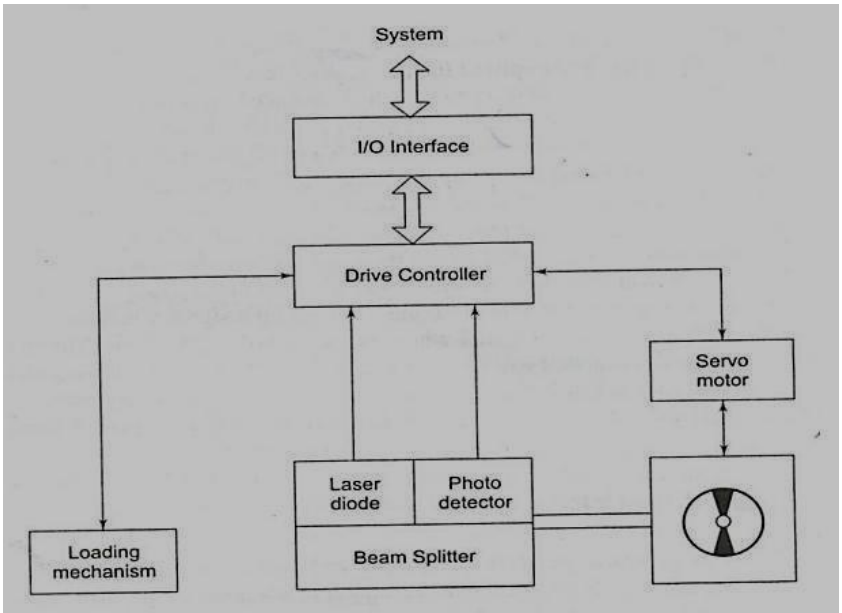



**Fig: Block Diagram of CDROM drive**

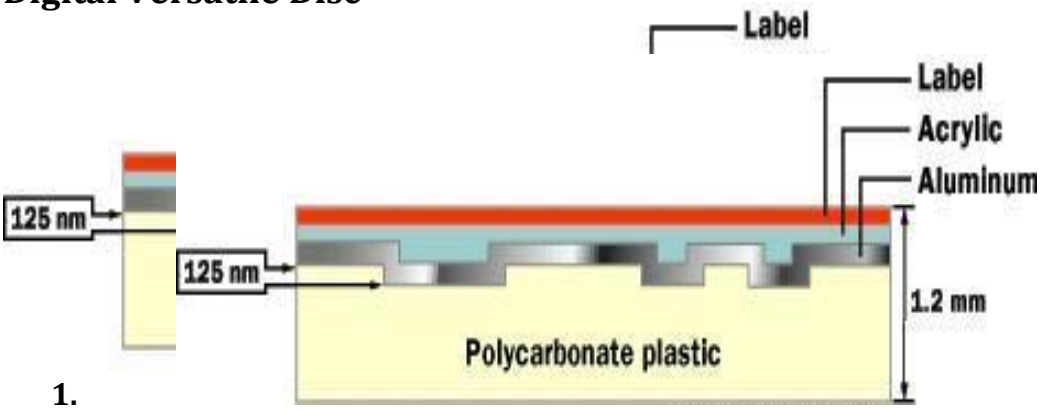
1. The laser diode emits a low –energy infra red beam towards the reflecting mirror
2. The servo motor positions the beam onto the correct track on the CD ROM by moving the reflecting mirror
3. When the beam hits the disc, its reflected light is gathered and focused through the first lens beneath the platter, bounce off the mirror and sent towards the beam splitter
4. The beam splitter directs the returning laser light towards another focusing lens
5. The last lens direct the light beam to a photo detector and convert the light into electric impulses

These incoming impulses are decoded by the microprocessor and sent along to the host computer as data.

**Recording of CDROM Drive**

- EFM (Eight to Fourteen Modulation) is an encoding technique used by CDs and provides a way of countering errors by encoding a byte into 2 bytes.
- Using EFM data is broken into 8 bit blocks (bytes)
- Each 8 bit block is translated into a corresponding 14 bit codeword using a predefined lookup table.

## Digital Versatile Disc




1. Optional storage media for storing data
2. Uses primary for movies softwares and data backup purpose
3. DVD holds about 7 times more data than CD Data
4. DVDs can store more data than CDs for a few reasons:

Higher-density data storage Less overhead, more area Multi-layer storage

## Comparison of CD and DVD

| Parameter | CD | DVD | Remarks |
|---|---|---|---|
| Sides | 1 | 1 or 2 | |
| Layers | 1 | 1 or 2 | |
| Capacity (GB) | 0.68 GB | 4.7-17 GB | |
| Track pitch(μ) | 1.6 | 0.74 | |
| Minimum pit length(μ) | 0.83 | 0.4 | |
| Wavelength(nm) | 780 | 650 | Of laser diode pickup |
| Tracks | Yes | No | DVD uses files not tracks |

**DVD physical disc formats**

| Sr. No | Format | Capacity | Layers | Sides |
|---|---|---|---|---|
| 1 | DVD 5 | 4.7 GB | 1 | 1 |
| 2 | DVD 9 | 8.54 GB | 2 | 1 |
| 3 | DVD 10 | 9.4 GB | 1 | 2 |
| 4 | DVD 18 | 17.08 GB | 2 | 2 |

# Blu –Ray Disc

- **Blu ray also known as Blu-ray Disc(**BD is a next generation optical disc format jointly developed by members of the **Blu-ray Disc Association(BDA)** – a group of the world's leading consumer electronics, personal computer and media manufactures (including Apple, Dell, Hitachi, HP, JVC, LG, Mitsubishi, Panasonic, Pioneer, Philips, Samsung, Sharp, Sony, TDK and Thomson)
    - The format was developed to enable recording, rewriting and playback of High Definition Video (HD) as well as storing large amounts of data.

    - The format offers more than five times the storage capacity of traditional DVDs and can hold upto 25 GB on a single layer disc and 50 GB on a dual

layer disc.

- A blue laser is used to read the media. Blue light has a shorter wavelength than red used by previous technologies. This makes it possible to read data with greater precision.

## Blu –Ray Disc Specification

●

| Specification | Value | Specification | Value |
|---|---|---|---|
| **Capacity (Single Layer)** | 23.3 GB/25 GB/27 GB | **Tracking Pitch** | 0.32µm |
| **Capacity (Dual Layer)** | 46.6 GB/50 GB/54 GB | **Shortest pit length** | 0.160/0.149/0.138 µm |
| **Laser Wave Length** | 405 nm (blue-violet) | **Recording Density** | 16.8/18.0/19.5 Gb/sq.in |
| **Lens Numerical Aperture** | 0.85 | **Data transfer Rate** | 36 Mbps |
| **Disc Diameter** | 120 mm | **Recording format** | Phase Change Recording |
| **Disc thickness** | 1.2 mm | **Tracking format** | Groove Recording |
| **Optical Protection Layer** | 0.1 mm | **Video Format** | MPEG2 |

UNIT 3

# DISPLAY DEVICES & INTERFACING

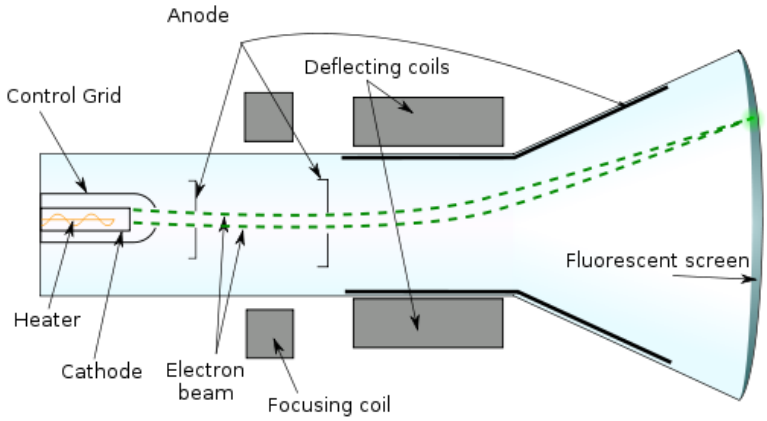
## CRT( Cathode Ray Tube)

- **CRT** works by moving an **electron beam** back and forth across the back of the screen.
- Common in early 1960s through the 1980s.
- Green screen was the common name using green "P1"

### Parts of a CRT

The features of a CRT can be split into 3 main sections: The electron gun, the deflection system and the fluorescent screen.

1. **Electron Gun**
   - The role of this section is to produce electrons at a high, fixed, velocity.
   - This is done through a process known as thermionic emission.
   - A filament in the cathode is heated to the point where its electrons become loose.
   - An anode with a high voltage applied to it accelerates the electrons towards the screen due to electrostatic attraction.
   - On the way, the electrons pass through a series of control grids which control the brightness of the image produced.
   - The more negative the grid, the darker the image and vice versa.
2. **Deflection system**
   - The role of the deflection system is to control the image produced by controlling the position that the electrons hit the screen.
   - It consists of Two PERPENDICULAR sets of Electric/Magnetic fields.
   - This allows control over both horizontal and vertical axes.
   - By controlling the Voltage applied to the fields, it is possible to vary the deflection through Electrostatic force/Motor effect.
3. **Fluorescent screen**
   - The role of this part is to display where the electrons are hitting the CRT.
   - It is a screen coated with a material that emits light when struck by electrons.
   - Zinc sulfide or Phosphorus are two commonly used materials.




## Working of CRT Monitor

1. An electron gun consists of a series of electrodes producing a narrow beam of highvelocity electrons.

2. When voltage is applied to the heater coil the cathode energizes the electrons and starts the emission of electrons

3. The intensity of the beam is controlled by variation of the negative potential of the cylindrical control grid surrounding the cathode.

4. The control grid has a hole in the front to allow passage of the electron beam.

5. The focus grid adjust its potential to achieve the desired focus. The electrons are accelerated and focused on the fluorescent screen In order to eliminate flicker, most monitors refresh the screen at a 60 Hz rate.

### Characteristics of CRT Monitor

**1. Pixel or picture element:** It is the smallest are of the monitor screen that can be turned on or off to help create an image.

**2. Dot Pitch:** Measurement of how close the holes (in the mask) are to each other. The closer the holes, smaller is the dot pitch and sharper is the image.

**3. Resolution:** Amount of detail a monitor can show. It is expressed in terms of number of horizontal and vertical pixels contained in the screen.

**4. Video Bandwidth:** It is the maximum input frequency that a monitor can handle. It helps in determining the resolution capability of the monitor.

**5. Horizontal Scanning Frequency:** frequency at which monitor redraws the horizontal lines that make up the image. For VGA monitor – 31.5 KHz For SVGA monitor – 35 to 48 KHz

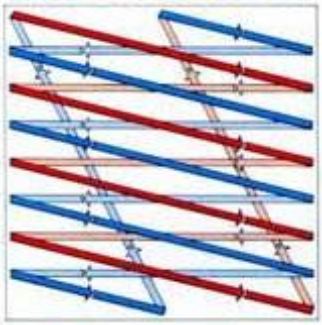
**6. Vertical Scanning Frequency:** (Vertical Refresh Rate) (Frame Rate) Frequency at which hole screen is redrawn. Higher the refresh rate, lesser will be the flicker.

### Interlace and non- interlaced

### Interlaced scanning:

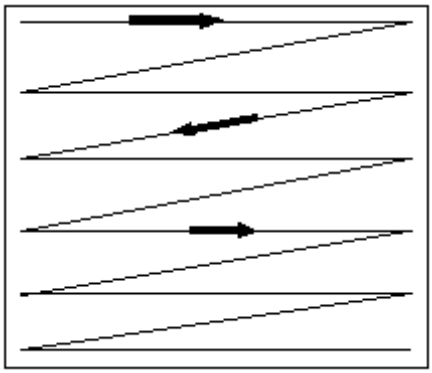
- A interlace displays draws an image as two passes. Once the first pass is complete a second pass fills in the rest of the image.
- In order to avoid a flickering image, some adapters force the monitor to create an interlaced image.

- Instead of the electron gun scanning from top to bottom in a continuous manner, on the first pass it will skip every next line.
- On the second pass, it will scan the lines that it skipped during the first pass, thus creating full image in two scans instead of one.
- The odd raster starts at the top left edge and the even raster at the middle of the CRT.



**Non Interlaced scanning:**

- A non interlaced monitor draws all of the lines that compose an image in one pass
- The entire image is first refreshed at the vertical scanning frequency.
- The effective image refresh rate is only half the stated vertical scanning rate.



| Sr. No | Interlaced Scanning | Non Interlaced Scanning |
|---|---|---|
| 1 | Scan every other line of image in one pass & remaining line in other Pass | Scan all lines in one Pass |
| 2 | Difficult on eyes | Easy on eyes |
| 3 | Flicker is more | Flicker is less |
| 4 | Effective image refresh rate is half of vertical scanning rate | Entire image is refresh at vertical scanning rate. |

Advantages of CRT display over LCD display

1. CRT monitors cost less than LCDs.
2. CRT monitors represent colors and different generations of colors better than LCD monitors.
3. CRT monitors have fewer problems with ghosting and blurring because they redraw screen image faster than LCD monitors.
4. CRT monitors can handle multiple resolutions, LCD monitors do not.
5. CRT monitors are more rugged than LCD monitors.

**Construction and Working Principle of LCD Display**

# What is a LCD(Liquid Crystal Display)?

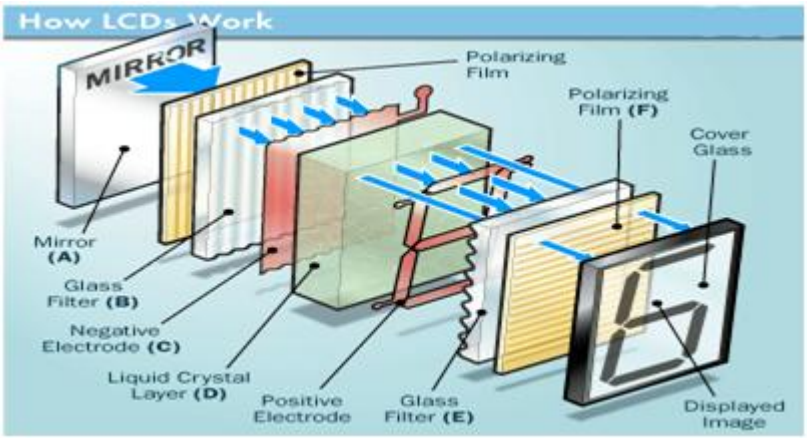
A liquid crystal display or LCD draws its definition from its name itself.
It is combination of two states of matter, the solid and the liquid. LCD uses a liquid crystal to produce a visible image.
Liquid crystal displays are super-thin technology display screen that are generally used in laptop computer screen, TVs, cell phones and portable video games.
LCD's technologies allow displays to be much thinner when compared to cathode ray tube (CRT) technology.
Liquid crystal display is composed of several layers which include two polarized panel filters and electrodes.

LCD technology is used for displaying the image in notebook or some other electronic devices like mini computers.

Light is projected from a lens on a layer of liquid crystal. This combination of colored light with the grayscale image of the crystal (formed as electric current flows through the crystal) forms the colored image. This image is then displayed on the screen.

Liquid crystal display screen works on the principle of blocking light rather than emitting light. LCD's requires backlight as they do not emits light by them. We always use devices which are made up of LCD's displays which are replacing the use of cathode ray tube. Cathode ray tube draws more power compared to LCD's and are also heavier and bigger.

**How LCDs are constructed?**




Simple facts that should be considered while making an LCD:

1. The basic structure of LCD should be controlled by changing the applied current.
2. We must use a polarized light.

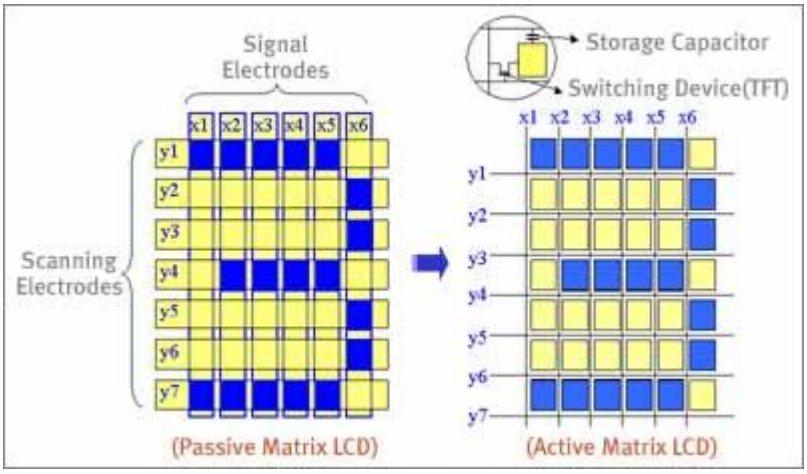
3. Liquid crystal should able be to control both of the operation to transmit or can also able to change the polarized light**.**

## How LCDs Work?

The principle behind the LCD's is that when an electrical current is applied to the liquid crystal molecule, the molecule tends to untwist. This causes the angle of light which is passing through the molecule of the polarized glass and also cause a change in the angle of the top polarizing filter. As a result a little light is allowed to pass the polarized glass through a particular area of the LCD. Thus that particular area will become dark compared to other. The LCD works on the principle of blocking light. While constructing the LCD's, a reflected mirror is arranged at the back. An electrode plane is made of indium-tin oxide which is kept on top and a polarized glass with a polarizing film is also added on the bottom of the device. The complete region of the LCD has to be enclosed by a common electrode and above it should be the liquid crystal matter.

Next comes to the second piece of glass with an electrode in the form of the rectangle on the bottom and, on top, another polarizing film. It must be considered that both the pieces are kept at right angles. When there is no current, the light passes through the front of the LCD it will be reflected by the mirror and bounced back. As the electrode is connected to a battery the current from it will cause the liquid crystals between the common-plane electrode and the electrode shaped like a rectangle to untwist. Thus the light is blocked from passing through. That particular rectangular area appears blank.

**Passive-matrix and active-matrix driving of LCD Monitors**




**Passive matrix LCDs-** use a simple grid to supply the charge to a particular pixel on the display. The liquid crystal material is sandwiched between the two glass subtrates and a polarizing film is added to the outer side of each substrate. To turn on a pixel, the integrated circuit sends a charge down the correct column of one substrate and a ground activated on the correct row of the other.

The row and column intersect at the designated pixel, and that delivers the voltage to untwist the liquid crystals at that pixel.

To address a pixel the column containing the pixel is sent a charge, the corresponding row is connected to ground. When sufficient voltage is placed across the pixel, the liquid crystal molecules align parallel to the electric field.

In passive matrix LCDs (PMLCDs)there are no switching devices, and each pixel is addressed for more than one frame time.

**Active matrix LCDs-** In active matrix LCDs, a switching device and a storage capacitor are integrated at the each cross point of the electrodes.

The active addressing removes the multiplexing limitations by incorporating an active switching element. In contrast to passive matrix LCDs, active matrix LCDs have no inherent limitation in the number of scan lines, and they present fewer cross talk issues.

**Advantages of an LCD's:**

- LCD's consumes less amount of power compared to CRT and LED
- LCD's are consist of some microwatts for display in comparison to some mill watts for LED's
- LCDs are of low cost
- Provides excellent contrast
- LCD's are thinner and lighter when compared to cathode ray tube and LED

**Disadvantages of an LCD's:**

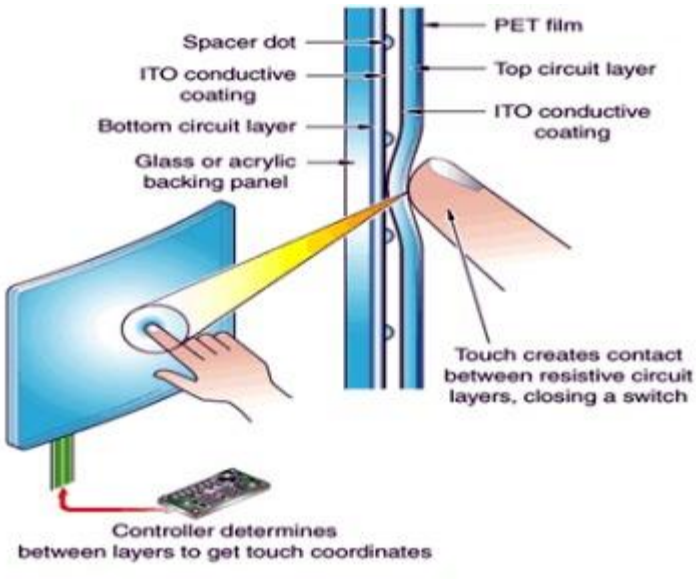
- Require additional light sources
- Range of temperature is limited for operation
- Low reliability
- Speed is very low
- LCD's need an AC drive

**Applications of Liquid Crystal Display**

Liquid crystal technology has major applications in the field of science and engineering as well on electronic devices.

- Liquid crystal thermometer
- Optical imaging
- The liquid crystal display technique is also applicable in visualization of the radio frequency waves in the waveguide
- Used in the medical applications

**Touch Screen Display**

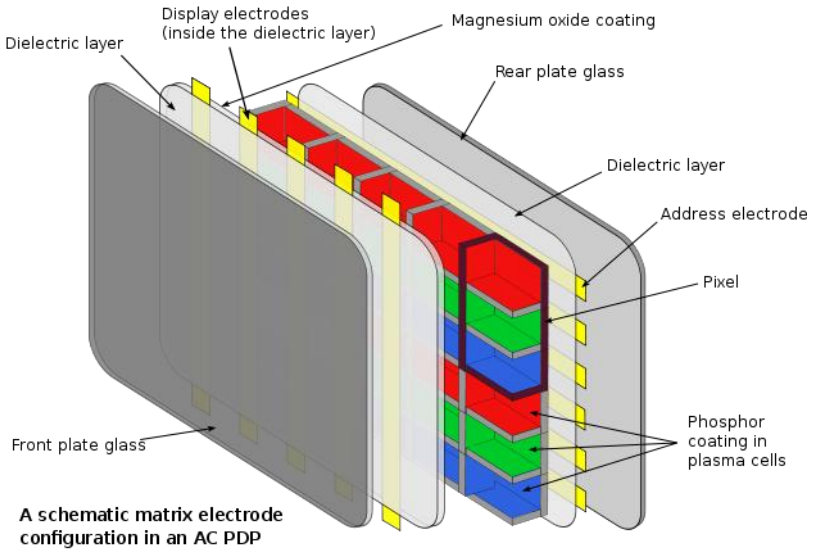



The touch sensor is a panel, usually made of glass that has a touch responsive surface. Different touch screens are built based on different types of sensors. The most common sensors are resistive, capacitive , and acoustic wave sensors. In general, sensors function with an electrical current running through them. Touching the screen causes a voltage change, which signals the location of the touch**.**

A **plasma display panel** (PDP)

A **plasma display panel** (PDP) is a type of flat panel display often used for large televisiondisplays (typically above 37 inches or 940 millimeters (mm)). Many tiny cells located between two panels of glass hold an inert mixture of noble gases (neon and xenon). The gas in the cells is electrically turned into a plasma, which then excites phosphors to emit light. Plasma displays should not be confused with LCDs (liquid crystal displays), which are also lightweight, flat screen displays but are produced by a very different technology.

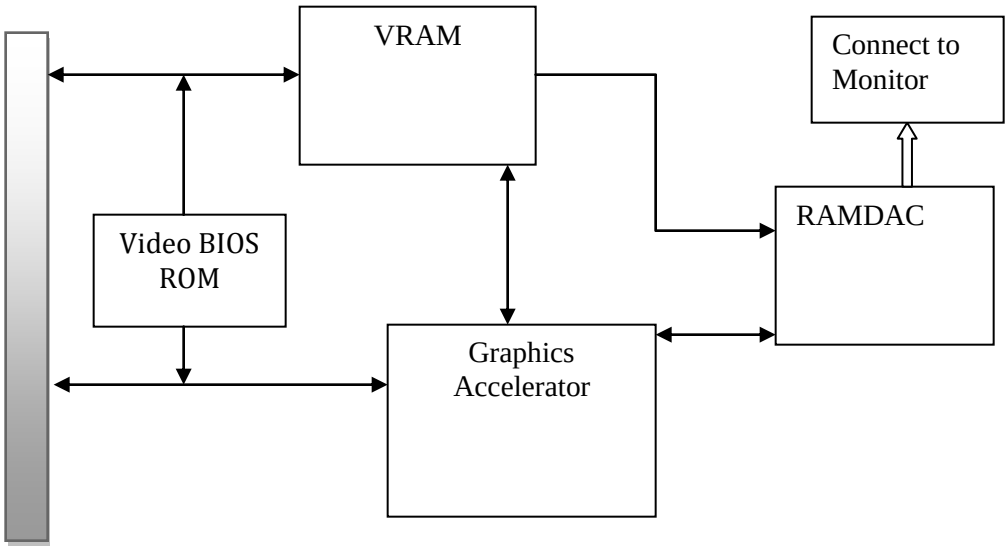
Plasma display technology offers the advantages of producing displays with large, very thin screens and bright images with wide viewing angles. With the advent of "seamless" plasma display technology, it has become possible to display more than one image on the video wall simultaneously, to adjust color balance, and to switch between contents from multiple inputs in the video wall.



A schematic matrix electrode configuration in an AC PDP

**Video Accelerator card**

The core of the accelerator is the graphics chip (or Video chipset). The graphics chip connects directly with the PC expansion bus. Graphics command and data are transmitted into pixel data and stored in Video memory offers a second data bus that is routed directly to the Video board's RAM DAC (Random Access Memory Video to Analog Converter). The graphics chip directs RAM DAC operation and ensures that VRAM data is available. The RAM DAC then translates Video data into red, green and horizontal and vertical synchronization signals output signals generated by the monitor. This architecture may appear simple, but this is due to high level of integration provided by the chipsets being used.



# UNIT 4

# Input and Output Devices

Objectives

- **To understand the construction and working of Input /Output Devices.**
- **To understand the Interfacing of the above peripherals.**

## 4.1 Keyboard:

**When buying a new desktop computer, no components are given less consideration when evaluating the machine than the keyboard and mouse. Keyboard is the most common and very popular input device which uses to input text data to the computer. The layout of the keyboard is like that of traditional typewriter, although there are some additional keys provided for performing additional functions. The basic functionality of the PC keyboard has changed little in the almost 20 years since the release of the original IBM PC. The number of keys increased 83 to 101 and now there is 104 and most of keyboard manufacturers provide special faction keys like multimedia functionality.**

### 4.1.1. Keyboard layouts

**A keyboard layout is any specific arrangement of keys considering the mechanical, visual, or functional keys, legends, or key-meaning associations of a computer, typewriter, or other typographic keyboard. The four keyboard layout used for most desktop PCs are as follows:**

- **83-key PC/AT keyboard**
- **84-key AT keyboard**
- **Enhance 101-key keyboard**
- **Windows 104-key keyboard**

| S.No | Keys & Description |
|---|---|
| **1** | Typing Keys<br>**These keys include the letter keys (A-Z) and digit keys (09) which generally give the same layout as that of typewriters.** |
| **2** | Numeric Keypad<br>**It is used to enter the numeric data or cursor movement. Generally, it consists of a set of 17 keys that are laid out in the same configuration** |

| | |
|---|---|
| | **used by most adding machines and calculators.** |
| **3** | Function Keys<br>**The twelve function keys are present on the keyboards which are arranged in a row at the top of the keyboard. Each function key has a unique meaning and is used for some specific purpose.** |
| **4** | Control keys<br>**These keys provide cursor and screen control. It includes four directional arrow keys. Control keys also include Home, End, Insert, Delete, Page Up, Page Down, Control(Ctrl), Alternate(Alt), Escape(Esc).** |
| **5** | Special Purpose Keys<br>**Keyboard also contains some special purpose keys such as Enter, Shift, Caps Lock, Num Lock, Space bar, Tab, and Print Screen.** |

**Table: Basic keyboard keys and description**

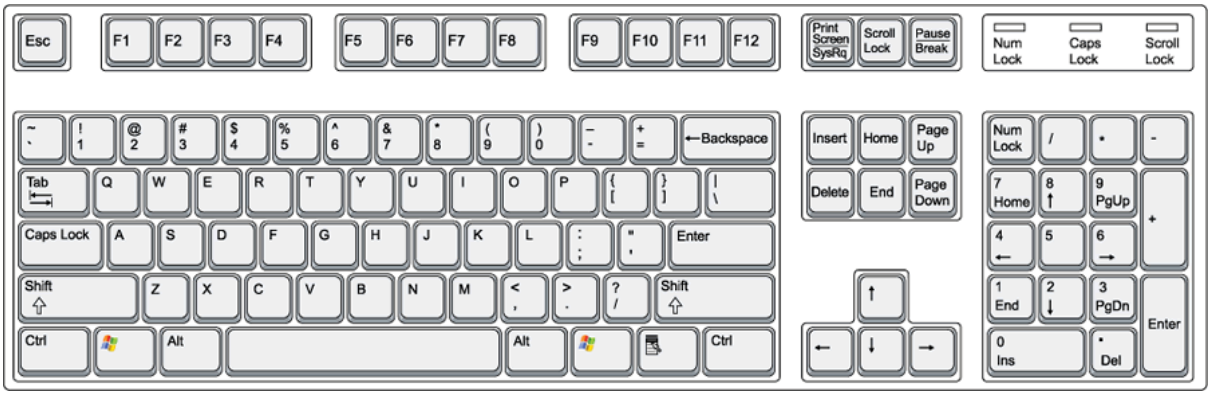



**Fig. 101-key PC keyboard**

### 4.1.2 Laptop Keyboards

**On portable system like laptop and notebook, keyboard is one of an internal part of system. A laptop keyboard is arranged differently than a desktop keyboard to accommodate the laptop's narrower footprint. Most laptop keyboards are made smaller by placing the keys closer and by including an function key. Each function key has a unique meaning and is used for some specific purpose and it used with other keys to perform special functions. For example, pressing the function key and the up or down arrow on the keyboard shown below, increases and decreases the brightness of the screen. Furthermore, many laptop keyboards omit the numeric keypad to save space.**

**Laptops use internal connectors. Regardless of which type of connector is used, the cable must carry power to the keyboard, and it must carry signals from the keyboard back to the computer.**

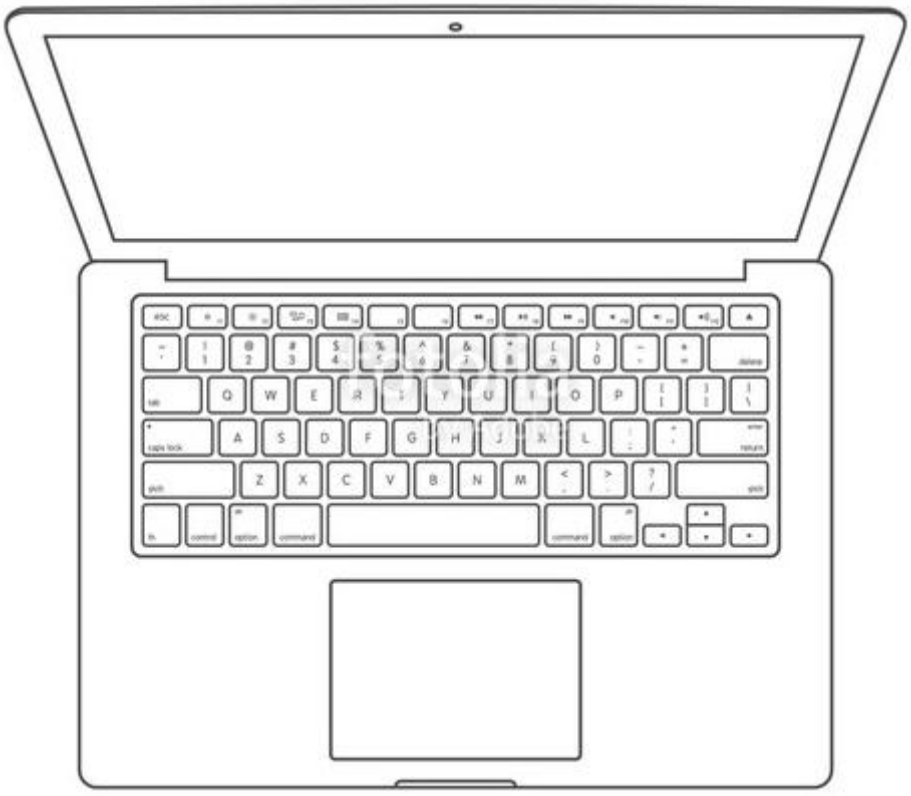


**Fig. Integrated keyboard in portable system**

### 4.1.3 Keyboard Connection Types

**PC keyboard connects to the motherboard on the computer using different connector. Wired keyboards connect to the motherboard via a USB cable, using the USB Type A connector. Older keyboards connect via a 5-pin DIN connector which is use to connect motherboard that use Baby-AT form factor. The 6-pin mini DIN connector also called PS/2 connector. Keyboards on laptops are of course integrated, but technically would be considered "wired" since that's how they are connected to the computer. Now days many keyboards are wireless, communicating with the computer via Bluetooth or an RF receiver.**

**Both wireless and wired keyboards require a specific device driver in order to be used with the computer. Drivers for standard, non-advanced keyboards usually don't need to be downloaded because they're already included in the operating system.**

### 4.1.4 Types of key switches

**Computer keyboards can be classified by the switch technology that they use.**

**a)** Mechanical Switch Keyboard

**These keyboards use standard spring-loaded momentary-on switches. Pressing a key**

**compresses a spring and causes a plunger on the bottom of the key to make physical contact to close the connection. When the key is released, the spring forces it back into rest position. Mechanical keyboards also have a longer lifespan than membrane or dome-switch keyboards, with an expected lifespan of 50 million clicks.**

**b)** Capacitive Keyboard

**These keyboards are unique in that pressing a key does not make electrical contact to complete the circuit. Instead, movement of the plunger on the bottom of a key alters the state of a capacitive circuit, which the keyboard controller recognizes as a key press. Keyboards with capacitive switches provide clacky feedback, are even more durable than mechanical keyboards.**

**c)** Membrane keyboard

**Most current keyboards use membrane switches. Unlike mechanical and capacitive keyboards, which use discrete physical switches for each key and are correspondingly expensive to produce, a membrane keyboard combines all key switches into one unit comprising three membrane layers. The bottom layer has printed conductive traces that correspond to the individual key switches. The middle layer is a spacer, with holes that expose each underlying switch. The top layer is an array of rubber domes, against each of which the bottom of a key impinges. When a key is pressed, it forces the conductive bottom of the rubber dome through the spacing layer and into contact with the switch traces on the bottom layer, completing the circuit. When the key is released, the rubber dome forces it back into rest position.**

d) Dome-switch keyboard

**There's also a hybrid type that combines elements from the category of flat-panel membrane or mechanical-switch. Known dome-switch, it uses two circuit board traces under a flexible keypad using either metal or polyurethane formed dome. They bring two circuit board traces together under a rubber or silicone keypad using either metal "dome" switches or polyurethane formed domes. The metal dome switches are formed pieces of stainless steel that, when compressed, give the user a crisp, positive tactile feedback.**

**This type of switch technology happens to be most commonly used in handheld controllers, mobile phones, automotive, consumer electronics and medical devices. Dome-switch keyboards are also called direct-switch keyboards.**

### 4.1.5 Keyboard Interface

**The PC's keyboard interface consist of two separate controller chip more precisely, to its keyboard, there are several ways of connecting a keyboard to a system unit using**

**wire, including the standard AT connector commonly found on motherboards, which was eventually replaced by the PS/2 and the USB connection. Prior to the iMac line of systems, Apple used the proprietary Apple Desktop Bus for its keyboard connector.**

**a)** PS/2 port Keyboard

**The PS/2 port is a 6-pin mini-DIN connector used for connecting keyboards and mouse to a PC compatible computer system. The PS/2 platform introduced a second port with the same design as the keyboard port for use to connect a mouse; thus the PS/2-style keyboard and mouse interfaces are electrically similar and employ the same communication protocol.Original PS/2 connectors were black or had the same colour as the connecting cable (mainly white). The keyboard port, and the plugs on compliant keyboards, was purple; mouse ports and plugs were green.**

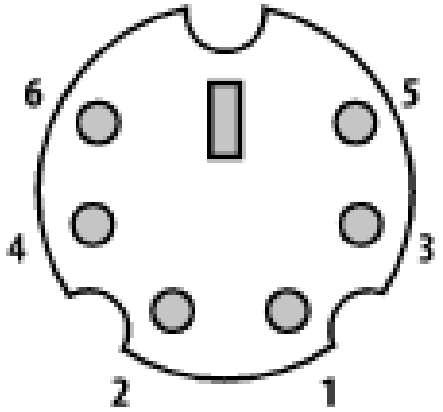



**Fig. The PS/2 keyboard connector**

| Pin | Signal name | Description |
|---|---|---|
| | yboard data | yboard data |
| | served | connection |
| | ound | nal ground |
| | c +5V | VDC |
| | yboard Clock | yboard clock |
| | served | connection |
| ield | | ound |

**Table: The 6-pin Mini-DIN connector Pin layout**

**b)** USB Keyboard Interface

The Universal serial bus is a multifunction peripheral bus that is growing rapidly in popularity. Now days Keyboards can be connected to a USB port. To use a USB keyboard, the PC BIOS must support USB keyboards, and you must run an operating system. BIOS support is needed so that the keyboard can be used before the operating system loads to do such things as changing setting of computer system input output system or choosing boot sequence options from a boot menu. Operating system support is required for the keyboard to be accessible after the system boots.

c) Wireless Keyboard Interface

Wireless keyboards have become popular for their increased user freedom.Wireless keyboards, on the other hand, connect to the computer through infrared (IR), radio frequency (RF) or Bluetooth connections. A wireless keyboard often includes a required combination transmitter and receiver unit that attaches to the computer's keyboard port. The wireless aspect is achieved either by radio frequency (RF) or by infrared (IR) signals sent and received from both the keyboard and the unit attached to the computer. Wireless keyboards based on infrared technology use light waves to transmit signals to other infrared-enabled devices. But, in case of radio frequency technology, a wireless keyboard communicates using signals which range from 27 MHz to up to 2.4 GHz. Most wireless keyboards today work on 2.4 GHz radio frequency.

## 4.2 Mouse

Mouse was not part of original PC configuration till the Graphical User Interface (GUI) had not been introduced. But in mouse became essential input device as keyboard. Mouse is the most popular pointing device. It is a very famous cursor-control device having a small palm size box with a round ball at its base, which senses the movement of the mouse and sends corresponding signals to the CPU when the mouse buttons are pressed.

Generally, it has two buttons called the left and the right button and a wheel is present between the buttons. A mouse can be used to control the position of the cursor on the screen, but it cannot be used to enter text into the computer. The optical mouse is a computer mouse first introduced by Microsoft on April 19, 1999, that utilizes LEDs (light-emitting diodes) or a laser to track movement. These differing technologies are identified by examining the bottom of the mouse.

The Pointing devices come in many forms, all of which are the permutations o the

**original mouse design. The following sections examine some of these pointing devices and how they work.**

### 4.2.1 Mechanical Mouse

**The ball mouse was the first type of mouse created and this device is integrated with a metal or rubber ball. The ball mouse has two freely rotating rollers. These are located 90 degrees apart. One roller detects the forward-backward motion of the mouse and other the left-right motion. The biggest draw back in a mechanical mouse is the regular cleaning they will require due to the accumulation of dirt which will hinder with the cursor movement.**

### 4.2.2 Opto-mechanical mouse

**Alternatively referred to as the ball mouse, the optical-mechanical or opto-mechanical mouse consists of a ball that rolls one of two wheels inside the mouse. Each wheel contains a circle of holes or notches, an LED light through and be detected by a sensor. As the wheel rotates these lights represent an x-axis or y-axis for the mouse pointer on your screen. This mouse is more accurate than a mechanical mouse that uses only wheels and rollers, however, is not as good as an optical mouse.**

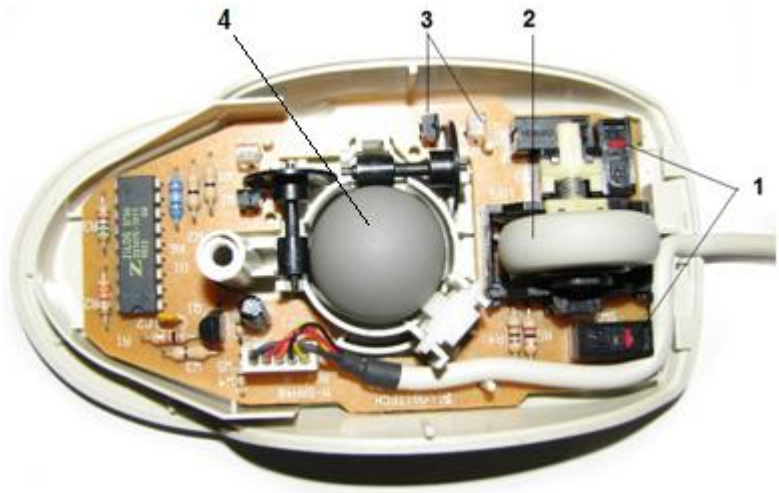



**Fig. The Standard opto-mechanical mouse mechanism**

1. **Switch detects clicks of left and right mouse button.**
2. **Scroll wheel and click button**
3. **X-axis and Y-axis optical sensors.**
4. **Rubber ball**

**The rotating ball of an opto-electronic mouse is metal made for weight and rubber-coated**

for grip. When the mouse is moved, the ball rotates, and as it does so it drives two rollers, one each an x-axis or y-axis displacement. A third spring-loaded roller holds the ball in place against the other two. These rollers then turn two disks with radial slots cut in them. Each disk rotates between a photo-detector cell, and each cell contains two offset light emitting diodes (LEDs) and light sensors. As the disk turns, the sensors see the light appear to flash, showing movement, while the offset between the two light sensors shows the direction of movement.

### 4.2.3 Optical Mouse

Optical mouse use a different method for determining the position of the cursor. Early optical mouse used an infrared LED to detect the movement the mouse pad, rather relying on the traction between the mouse ball and the rollers. While this type of mouse was more accurate than an optical mechanical mouse, and avoided the maintenance problems associated with the moving parts of an optical mechanical mouse, it did have its drawbacks. The most obvious one was reliance on a special grid-patterned mouse pad. Another was that performance could be compromised by bright lights.

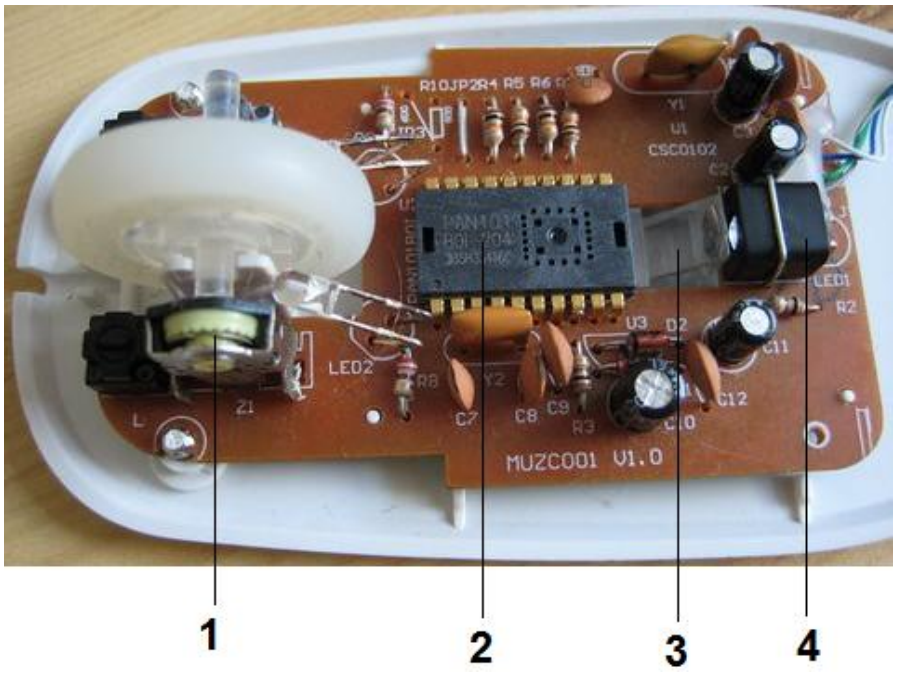



Fig. Optical mouse mechanism

1. The scroll wheel to detect rotation and switch mechanism detects button press.
2. A light-detector sensor detects the reflected light from surface for movements.
3. Desk surface to light-detector angular guided channels.
4. LED light generator to detect movement.

**In optical mouse a LED glow the surface below the mouse. The light from the LED reflects off microscopic textural features in the area of traverse, a plastic lens collecting the reflected light and forming images on a sensor. The presence of optical light is an added advantage because there is no case of a mechanical failure in the mouse which affects the movement. Optical mouse have a standard DPI of 800 and it increases depending on the need of the mouse. Gaming mouse go up to 12,000 DPI as it requires extreme precision.**

### 4.2.4 Trackball Mouse

**The trackball mouse is a pointing device consisting of a ball held by a socket containing sensors to detect the rotation of the ball. The user can roll the ball with the help of the thumb or the palm to when moving the pointer. Unlike the movement limitations in a normal mouse, there are no limits for effective travel in a trackball mouse. Trackball mouse also have a low friction which helps with the fast and limitless movement across the screen. Trackball mouse are common in CAD work stations and radar consoles at air traffic control room for precise movements. Trackball can be used when playing a few games which require hassle free movement.**

**Fig. Standard Trackball**

### **4.2.5** Touch Pad

**Another pointing innovation that came from the needs of portable computer user is touch pad. The touchpad is the most common mouse for laptops. It works much like a touch screen, with your finger moving the on-screen cursor. click by tapping the screen or using a physical button, depending on the design of the touchpad. Modern versions support a range of tapping and swiping gestures using multiple fingers, making them arguably even more versatile than the mouse itself.**

4.2.6 Differences in Connection Options

**There's been a similar evolution in how the different kinds of computer mouse attached to the computer itself. Before the IBM PC made personal computers a business tool, the mouse was often designed to connect to a joystick port**

**a)** Serial Mouse

**The IBM PC didn't have a joystick port, but it did have an RS-232C or serial port for communicating with other devices. Early models from Microsoft and Mouse Systems were often designed to attach to this port. Serial ports came in 9-pin and 25-pin versions, but a serial mouse would work on either of those connections with an appropriate adapter.**

**b)** PS/2 Mouse

**When IBM introduced its PS/2 series of personal computers, We already discussed in keyboard, The PS/2 port is a 6-pin mini-DIN connector used for connecting keyboards and mouse to a PC compatible computer system.**

**Original PS/2 connectors were black or had the same colour as the connecting cable (mainly white). Later the PC 97 standard introduced a colour code: the keyboard port, and the plugs on compliant keyboards, was purple colour while mouse ports and plugs were green.**

**c)** USB Mouse

**When the USB interface was first defined in the 1990s, they provide a single port that could be used for any peripheral device including a mouse. Any types of mouse that still use a cord typically continue to use a USB connector.**

d) Wireless Mouse

**Cords can be inconvenient, so wireless mouse were introduced. Some conventional designs plug a small wireless dongle into the USB port and use that to communicate between the mouse and the computer. Cordless mouse use infrared or other technologies to transmit their signal to a receiver connected to computer.**

**Modern laptops and tablets typically have Bluetooth built in, so a Bluetooth mouse doesn't require a dongle.**

## 4.3 Scanner

**A scanner is an input device that scans physical documents such as photographs and pages of text. When a document is scanned, it is converted into a digital format. This creates a digital version of the document that can be viewed and edited using computer.**

**Some scanners are flat scanning surface it call flat bed scanner. This is ideal for photographs, magazines, and various documents. Another type of scanner is a sheet-feed scanner, which can only accept single paper documents at one time. While sheet-feed scanners cannot scan books, some models include an automatic document feeder, which allows multiple pages to be scanned in sequence.**

**Scanners can access using computer software programs, which acquire data from the scanner. Most scanners include basic scanning software that allows the user to configure, initiate, and import scans. Scanning plug-ins can also be installed, which allow various graphical editing software programs to import scanned images directly.**

### 4.3.1 Flatbed Scanner

**A flatbed scanner is made up of a glass pane and a moving optical CIS or CCD array that is Contact image sensors (CIS) are image sensors used in flatbed scanners almost in direct contact with the object to be scanned. Charge-coupled devices (CCDs), often used for this application, use mirrors to bounce light to a stationary sensor. The pane is illuminated with the help of bright light planted below it. The sensor and source of light move across the glass pane to scan the document and produce its digital copy.**

**The optic information from a scanner sensor is turned into digital pixel information in order to be saved as a digital file, such as a JPG, PNG or TIFF. A scanner transfers this information to a computer through a wireless or connecting cable connection to save the digital file. After the transfer, the image file of the document is accessible on the computer and can be opened, saved, edited or deleted just like any other digital picture file.**

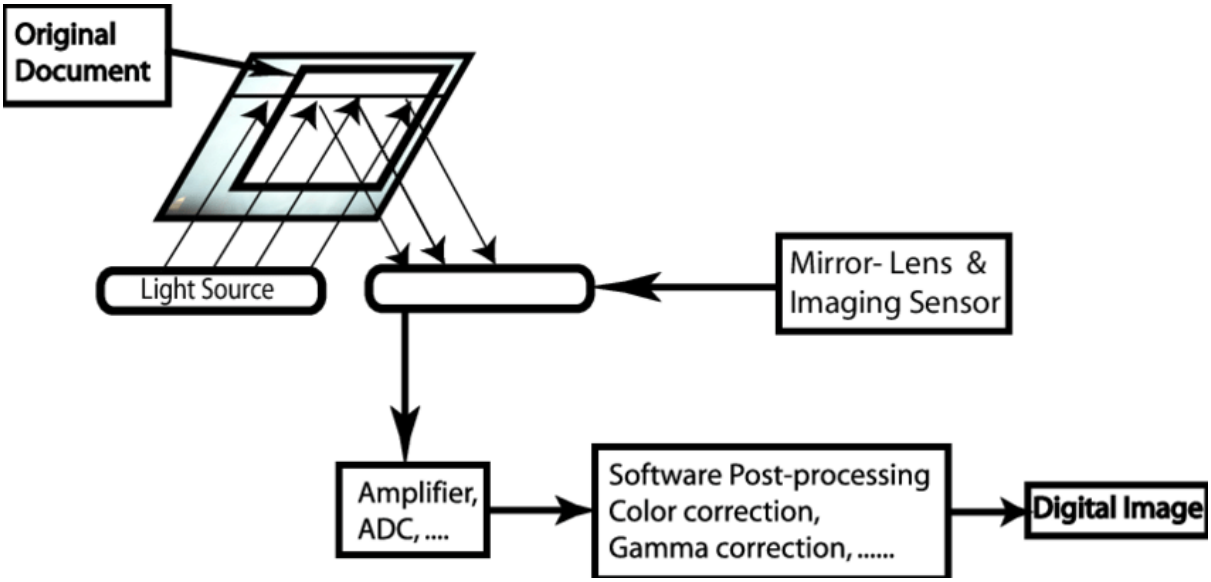



**Fig. Block diagram of flat Bed scanner**

### 4.3.2 Sheet fed Scanner

**In this type of scanner, the document is feed into the horizontal or vertical slot provided in it. The prominent components of a sheet fed scanner include the sheet-feeder, scanning module, and calibration sheet. While the sensor and source of light move across the glass pane in flatbed scanners, in sheet fed scanners, they are stationary. Instead, the document moves through the scanner. Ideal for scanning single page documents, these scanners cannot scan thick objects, like books, and that, perhaps, is their major drawback.**

### 4.3.3 Handheld Scanner

**In flat bed and sheet fed scanners, you put the document that is to be scanned inside the device. A handheld scanner is a small manual scanning device which is moved over the object that needs to be scanned. Using a handheld scanner can be a cumbersome task as the hand needs to be steady all the time. Even a slight movement of hand can lead to distortion of the image. Experience is required to operate and handle the device since it is very important to keep the scanner straight so that a distortion-free scan is possible. One of the most-utilized handheld scanners is the barcode scanner, typically used in shopping stores to valuate goods.**

**Some handheld scanners are now available with added features and functionalities such as definitions, translations and reading printed text aloud, as well as storing and sending scanned content to computers and other devices.**

### 4.3.4 Drum Scanner

**A drum scanner is the one which uses a photomultiplier tube (PMT) to scan images. Photomultiplier tubes are vacuum tubes which are extremely sensitive to light. In drum scanners, the image is mounted on the glass tube. When the beam of light moves across the image, its reflection is picked up by the PMT and processed. Where this light is split, passed through red, green and blue filters, and picked up by a photomultiplier tube, which analyzes each row, pixel by pixel, storing the particular colour or gray scale information for each pixel in a digital file.**

**Drum scanners are known for their high resolution, which makes them apt for detailed scans. If they are not as popular as flatbed scanners, it is because of their cost and large size.**

### 4.3.5 Film Scanner

**A film scanner is utilized to scan photographic films directly into a computer. Slide or negative film strips are placed in a carrier inside the film scanner. This carrier is moved with the help of a motor along a lens and a CCD sensor and digital information of image has captured.**

**The photographer has direct control over certain aspects, such as cropping, ratio of original image on the film, etc. Some film scanners available today have specialized software through which it is possible to minimize scratches and improve colour quality. Low-end film scanners most often accept 35 mm film strips, while high-end scanners—armed with interchangeable film loaders—can accept 35 mm or 120 mm strips and even individual slides**

### 4.3.6 OCR (optical character recognition)

**OCR (optical character recognition) is the use of technology to distinguish printed or handwritten text characters inside digital images of physical documents, such as a scanned paper document. The basic process of OCR involves examining the text of a document and translating the characters into code that can be used for data processing. OCR is sometimes also referred to as text recognition.**

**OCR systems are made up of a combination of hardware and software that is used to convert physical documents into digital format. Optical scanner or specialized circuit board is used to copy or read text while software typically handles the advanced processing. Software can also take advantage of artificial intelligence (AI) to implement more advanced methods of intelligent character recognition (ICR), like identifying languages or styles of handwriting.**

#### How optical character recognition works

**The first step of OCR is using a scanner to process the physical form of a document.**

**Once all pages are copied, OCR software converts the document into a two-colour, or black and white, version. The scanned-in image or bitmap is analyzed for light and dark areas, where the dark areas are identified as characters that need to be recognized and light areas are identified as background.**

**The dark areas are then processed further to find alphabetic letters or numeric digits. OCR programs can vary in their techniques, but typically involve targeting one character, word or block of text at a time. There are two basic types of core OCR algorithm,**

Pattern recognition- **OCR programs are feed examples of text in various fonts and formats which are then used to compare, and recognize, characters in the scanned document.**

Feature detection- **OCR programs apply rules regarding the features of a specific letter or number to recognize characters in the scanned document. Features could include the number of angled lines, crossed lines or curves in a character for comparison. For example, the capital letter "A" may be stored as two diagonal lines that meet with a horizontal line across the middle.**

### 4.3.7 TWAIN

**TWAIN is a widely-used program scan an image using a scanner directly into the application. Otherwise we have to switch between photo editor application and scanner application to receive the image, and then move the image to the application where you wanted to work with it. The TWAIN driver runs between an application and the scanner hardware. TWAIN usually comes as part of the software package with scanner.**

**The software was developed by a work group from major scanner manufacturers and scanning software developers and is now an industry standard. In several accounts, TWAIN was an acronym developed playfully from "Technology Without An Important Name."**

### 4.3.8 Resolution

**Scanners simply read colour information from a photograph or piece of film and record this information as a grid of pixels. The amount of detail captured with a scanner is determined by something called scanning resolution. Resolution is measured in samples per inch or SPI. Many times people refer to resolution with the term DPI, "dots per inch", or with PPI, "pixels per inch". So before we define pixel resolution, it is necessary to define a pixel. Pixel defines as the smallest element of an image. A pixel can store a value proportional to the light intensity at that particular location.**

**The resolution can be defined in many ways. Such as pixel resolution, spatial resolution, temporal resolution, spectral resolution. Out of which pixel resolution is mostly used to define the resolution of digital image. In pixel resolution, the term resolution refers to the total number of count of pixels in an digital image. If an image has M rows and N columns, then its resolution can be defined as M X N.**

**The higher is the pixel resolution, the higher is the quality of the image.**

## 4.4 Modem

**Modem is short for "Modulator-Demodulator." It is a hardware component that allows a computer or another device, such as a router or switch, to connect to the Internet. It converts or "modulates" an analog signal from a telephone or cable wire to digital data or machine understandable language. Similarly, it converts digital data from a computer into an analog signal that can be sent over standard telephone lines.**

**Modem ware introduce as dial-up type meaning they had to dial a phone number to connect to an ISP. These modems operated over standard analog phone lines and used the same frequencies as telephone calls, which limited their maximum data transfer rate to 56 Kbps. Dial-up modems also required full use of the local telephone line, meaning voice calls would interrupt the Internet connection.**

**Modern type modems are typically DSL Digital Subscriber Line or cable modems, which are considered "broadband" devices. DSL modems operate over standard telephone lines, but use a wider frequency range. This allows for higher data transfer rates than dial-up modems and enables them to not interfere with phone calls. Cable modems send and receive data over standard cable television lines, which are typically coaxial cables. Most modern cable modems support DOCSIS (Data Over Cable Service Interface Specification), which provides an efficient way of transmitting TV, cable Internet, and digital phone signals over the same cable line.**

### DSL

**DSL stands for Digital Subscriber Line, and it's one of the many technologies used to bring an Internet connection and information into homes and businesses. DSL is a communications medium used to transfer digital signals over standard telephone lines. Along with cable Internet, DSL is one of the most popular ways ISPs provide broadband Internet access. Because it has more convenient than dial-up modem such as Internet connection open and still use the phone line for voice calls,The speed is much higher than a regular modem and DSL doesn't necessarily require new wiring; it can use the phone line you already have. DSL modem has so**

### Broadband

**Broadband refers to telecommunication in which a wide band of frequencies is available to transmit information. Due to high-speed data transmission in which a single cable can carry a large amount of data at once. Because a wide band of frequencies is available, information can be multiplexed and sent on many different frequencies or channels within the band concurrently, allowing more information to be**

transmitted in a given amount of time.

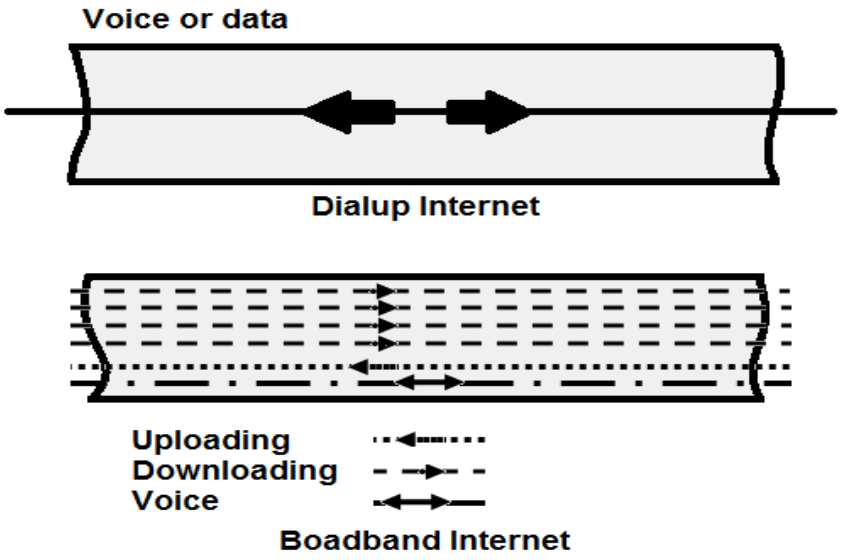



**Fig. Dial-up v/s Broadband Internet**

Internal Modem

**An internal modem is a modem which in installed inside of a computer. Internal modems typically come with the computer and come pre-installed. However, some computers may not have modems or the internal modem that came with the computer might be damaged or corrupt. In either case, using an internal modem does not take up any additional space outside the computer, and can be powered using the computer's own power supply. Basically it is as PCI add-on card type and installed in PCI, ISA, AMR, or CNR slot on IBM compatible computers.**

**Fig. Internal PCI Modem**

External Modem

**The external modem connects computer with serial or USB cable. The modem typically connects to the computer via a serial or USB cable, and is usually powered by an external source, rather than the computer. Modem perform basically three type of role i.e Data compression, for reducing the amount of time, it takes for sending**

**data and for cutting down on the amount of error in the signal, modems need to employ data compression. Another role is Error Correction, This is the process in which the Modem checks the information they have received is undamaged. Sometimes damage of data is being noticed in the form of altered or lost data. Next is Flow Control, the speed of sending information differs from modem to modem. There is a huge necessity of slowing down the speed of the fast modems so that the slow ones can work properly.**


**Fig. External Broadband Modem**

# Printer

**A printer is an output device that prints paper documents. This includes text documents, images, or a combination of both. The two most common types of printers are inkjet and laser printers. Inkjet printers are commonly used by consumers, while laser printers are a typical choice for businesses. Dot matrix printers, which have become increasingly rare, are still used for basic text printing.**

**The printed output produced by a printer is often called a hard copy, which is the physical version of an electronic document. While some printers can only print black and white hard copies, most printers today can produce colour prints. In fact, many home printers can now produce high-quality photo prints that rival professionally developed photos. This is because modern printers have a high DPI (dots per inch) setting, which allows documents to printed with a very fine resolution.**

**In order to print a document, the electronic data must be sent from the computer to the printer. Many software programs, such as word processors and image editing programs include a "Print..." option in the File menu. When you select "Print," you will typically present with a Print dialog box. This box allows you to select the print output settings before sending the document to the printer. After choosing the appropriate settings, you can hit the Print button, which will send the document to the printer.**

**Most modern printers are connected using a standard USB cable. However, some printers can be wirelessly connected to one or more computers over a Wi-Fi network or using Bluetooth technology. We can also use more than one printer on a single computer, as long as the correct drivers are installed.**
**Printer Characteristics**

**Types of Printer**

**Printer are categorised by the technology used in printer. This may vary the speed; quality and feasibility of printer. Printers are available in following types.**

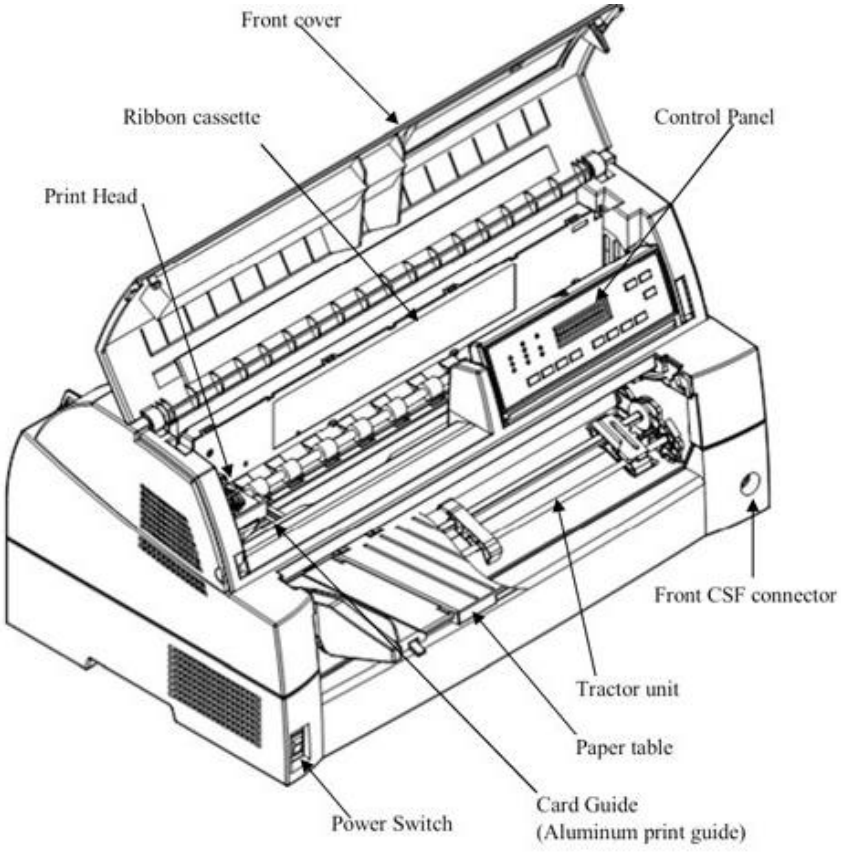
- **Laser Printers**
- **Solid Ink Printers**
- **LED Printers**
- **Business Inkjet Printers**

- **Home Inkjet Printers**
- **Multifunction Printers**
- **Dot Matrix Printers**
- **3D Printers**

### 4.5.1 Dot matrix

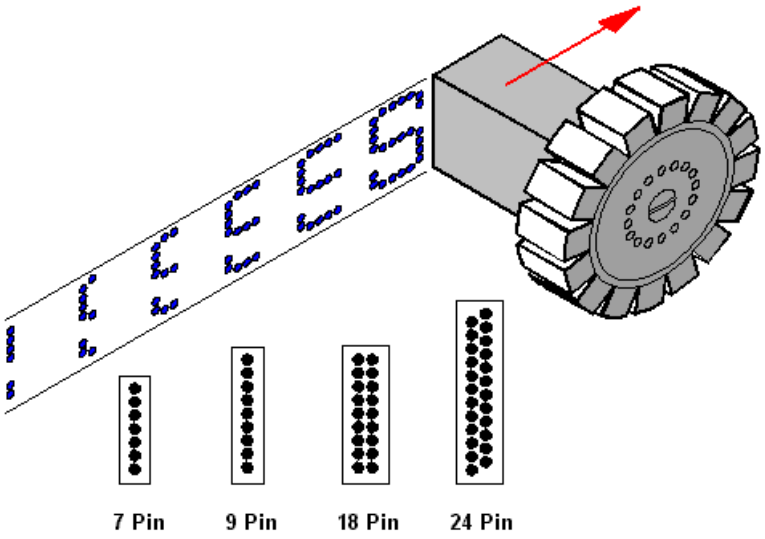
**Dot matrix printing,[1] sometimes called impact matrix printing, A dot matrix is a 2D matrix of dots that can represent images, symbols, or characters. They are used for electronic displays, such as computer monitors and LED screens, as well as printed output.**

**Impact dot matrix printing uses a print head that moves 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 the print mechanism on a typewriter. In a dot matrix display, the images are estimated using a discrete set of dots instead of lines and shapes. Therefore, the more dots that are used, the more clear and accurate the image representation will be. For example, a 16x16 dot matrix can represent the letter "R" more accurately than a 8x8 matrix. If enough dots are used, the image will appear as a contiguous display rather than a group of dots. This is because the human eye blends the dots together to create a coherent image.**



Working

**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. They are able to use continuous paper rather than requiring individual sheets, making them useful for data logging. Dot matrix printers are having two important characteristics that in clued speed which is given character per second (cps). The speed might get varied from 50 to over 500 cps. The dot matrix printer uses a ribbon that is covered with ink. The pins strike the ribbon in order to transfer the ink onto the paper in response to the computer's command when the paper feeder moves the paper in to position. Colour ink ribbon consists of three bans corresponding to the three primary colours. Colour image need to be printer with several pin strikes so that you can the proper tone.**




**The advantages are: low purchase cost, can handle multipart forms, cheap to operate, rugged and low repair cost. The disadvantages are: noise, lower resolution, and colour looks faded and streaky, speed.**

## 4.5.2 Inkjet

**Inkjet printers are the most common type of consumer printers. The inkjet technology works by spraying very fine drops of ink on a sheet of paper. These droplets are "ionized" which allows them to be directed by magnetic plates in the ink's path. As the paper is feed through the printer, the print head moves back and forth, spraying thousands of these small droplets on the page.**

**While inkjet printers used to lack the quality and speed of laser printers, they**

**have become almost as fast as laser printers and some can even produce higher-quality images. Even low-budget inkjet printers can now print high-resolution photos. The amazing thing is, as the quality of inkjet printers has improved, the prices have continued to drop. However, for most people, refilling the inkjet cartridges a few times will often cost more than the printer. Most consumer inkjet printers use the thermal inkjet process.**

**The major part of an ink jet printer are a microscopic nozzles which eject ink onto the paper. These nozzles are typically about 10 micrometers in diameter. It is not unusual for a home ink jet printer to contain thousands of nozzles in all, several hundred for each colour of ink. The diameter of each of these nozzles is fabricated with sub-micrometer accuracy to achieve consistent and uniform ink drop volume, which is essential for consistent and uniform colour density on the page. The ink jet nozzles are all mounted together on a moving carriage assembly that moves at high velocity. The nozzles are mounted about 1 mm from the paper, and ink ejection velocities are in the range of 5 to 10 meters per second.**

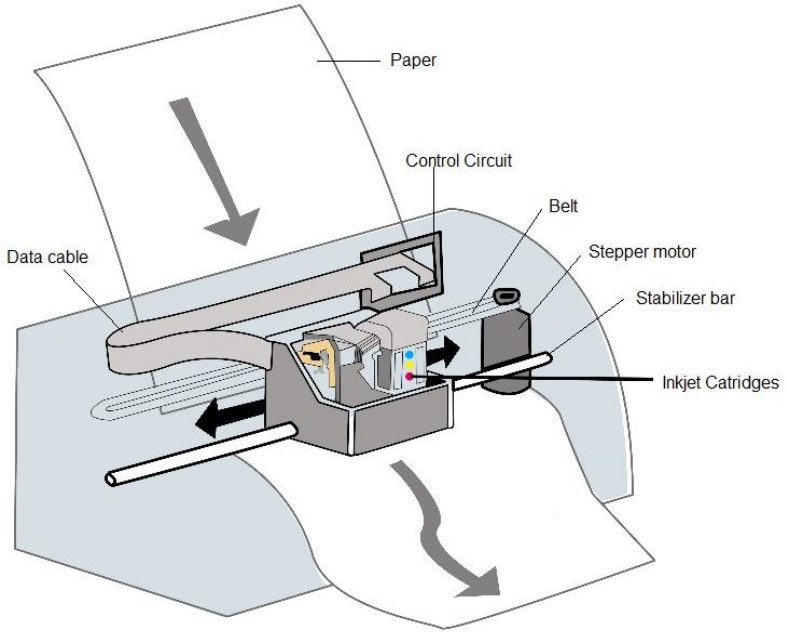



**Fig. Inkjet printer**

## 4.5.3 Laser

**Laser printing is digital printing process to produces high-quality text and graphics by repeatedly passing a laser beam back and forth over a negatively charged cylinder called a "drum" to define a differentially charged image. Invented at Xerox PARC in the 1970s, laser printers were introduced for the office and then home markets. Over the decades, quality and speed have increased as price has fallen, and the once cutting-edge printing devices are now ubiquitous.**

Working

**Though contrary to popular belief, the laser does not actually burn the images onto the paper. Instead, as paper passes through the printer, the laser beam fires at the surface of a cylindrical drum. This drum has an electrical charge (typically positive), that is reversed in areas where the laser beam hits it. By reversing the charge in certain areas of the drum, the laser beam can print patterns (such as text and pictures) onto the photoreceptor.**

**Once the pattern has been created on the drum, it is coated with toner from a toner cartridge. The toner is black in most cartridges, but may be cyan, magenta, and yellow in colour laser printers. The positively charged toner clings to areas of the drum that have been negatively charged by the laser. When the paper passes through the printer, the drum is given a strong negative charge, which allows the toner to transfer and stick to the paper. The result is a clean copy of the image written on the paper.**

**Laser printers do not use ink so they have less image smearing problems than inkjet printers and are able to print pages faster. While laser printers and toner cartridges typically cost more than inkjet printers and ink cartridges, most laser toner cartridges last several times longer than ink cartridges, which make their cost per page about equal. For this reason, businesses tend to use laser printers, while consumers are more likely to use inkjet printers. Laser printers typically have a resolution of 600 dpi (dots per inch) or higher.**

**Advantages of laser printers are laser printer produce high quality printouts - better than ink-jet or dot-matrix, faster than ink-jet or dot-matrix. While disadvantages of laser printers are this printer are most expensive printer type to buy, especially colour lasers as well as toner is more expensive than ink-jet cartridges, due to lots of complex equipment inside it is expensive to repair. Block diagram and specifications.**

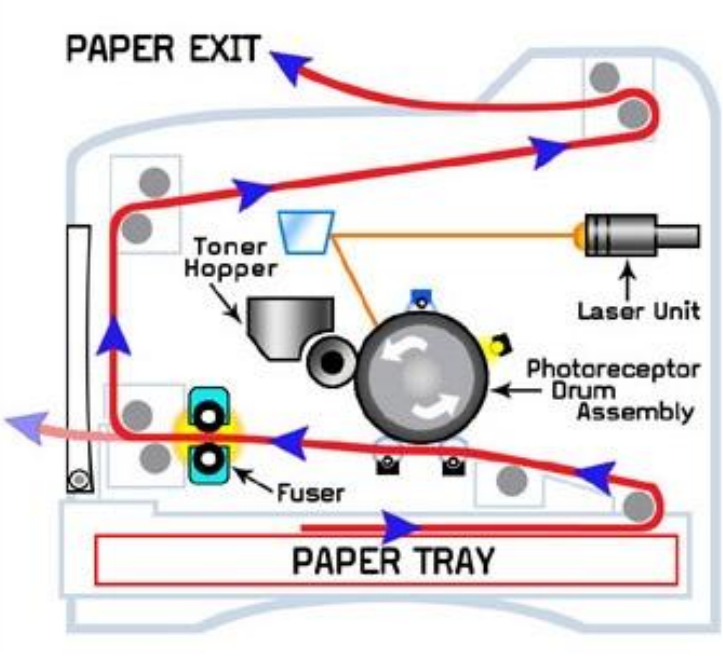



**Fig. Laser printer assembly**

## Unit 5.Power Supplies

**Objectives**

- To understand the working of SMPS.
- To understand the power problems.

5.1 Block diagram and working of SMPS.
5.2 Signal description and pin-out diagram of AT and ATX connectors
5.3 Power supply characteristics: Rated wattage, Efficiency, Regulation,

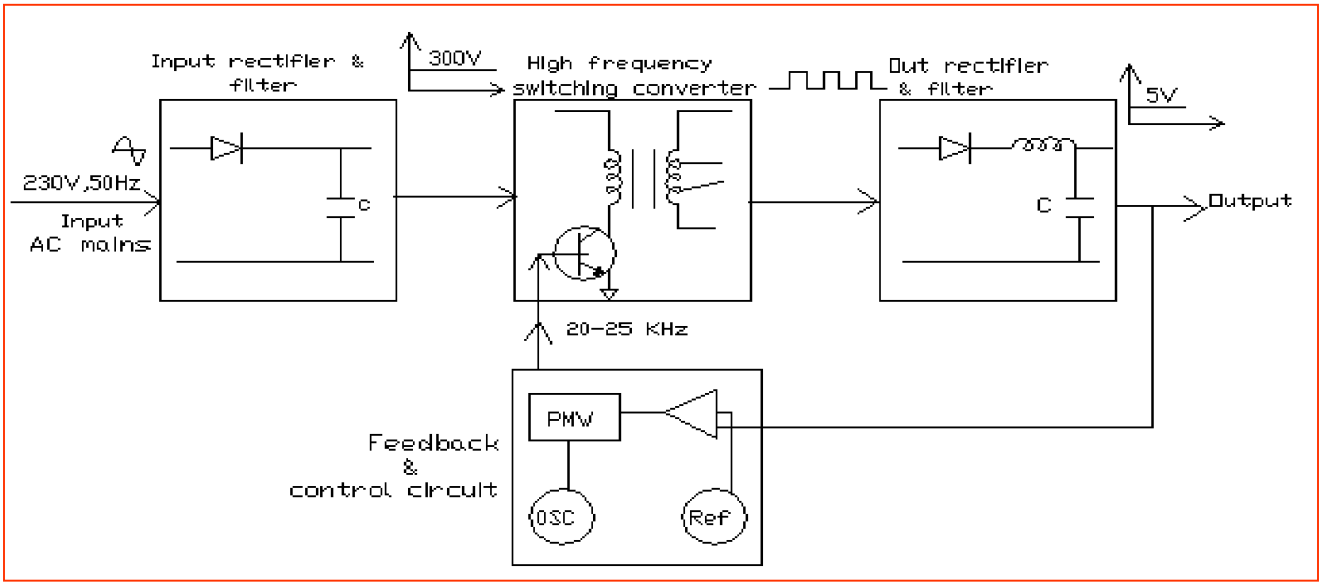
Ripple, Load regulation, Line regulation.
5.4 Power problems: Blackout, Brownout, surges and spikes.
5.5 Symptoms of power problems.
5.6 Protection devices: circuit breaker, surge suppressor.
5.7 Uninterrupted Power Supply, Online and Offline UPS, working of UPS: Block diagram, advantages and disadvantages, Ratings

- **Block diagram and working of SMPS**

**SMPS-**

Switch mode power supplies (SMPSs) are used in a range of applications as an efficient and effective source of power. This is in major part of their efficiency. For anybody still working on a desktop, look for the fan output in the central processing units (CPU). That's where the SMPS is. SMPS offers advantages in terms of size, weight, cost, efficiency and overall performance. These have become an accepted part of electronics gadgets. Basically, it is a device in which energy conversion and regulation is provided by power semiconductors that are continuously switching "on" and "off" with high frequency.

## Functional Block Diagram of SMPS




Basic working concept of an SMPS

A switching regulator does the regulation in the SMPS. A series switching element turns the current supply to a smoothing capacitor on and off. The voltage on the capacitor controls the time the series element is turned. The continuous switching of the capacitor maintains the voltage at the required level.

**Design basics-**

AC power first passes through fuses and a line filter. Then it is rectified by a full-wave bridge rectifier. The rectified voltage is next applied to the power factor correction (PFC) pre-regulator followed by the downstream DC-DC converter(s). Most computers and small appliances use the International Electrotechnical Commission (IEC) style input connector. As for output connectors and pinouts, except for some industries, such as PC and compact PCI, in general, they are not standardized and are left up to the manufacturer.

Why SMPS

Like every electronic gadget, SMPS also involve some active and some passive components. And like each of those gadgets, it has its own advantages and disadvantages.

Q. What is SMPS & Explain its working

- **Signal description**

## Signals-

The variation of dependent parameter with respect to independent parameter constitutes a signal. Signal can be also defined as a singled value function of time that conveys information. It may be of real value or complex value. Signals may be of different types, eg. audio signal, video signal or data signal etc.

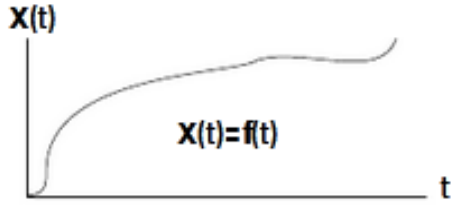


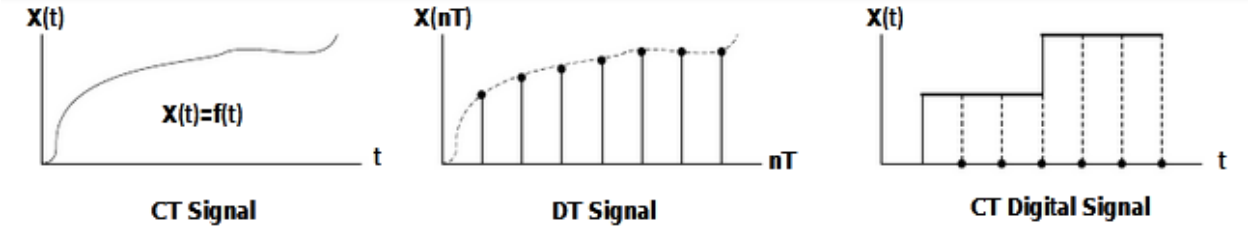

**Fig: Illustration of Sigal**

**Classification Of Signals**

Signals may describe a wide variety of physical phenomena. Although signals can be represented in many ways, in all cases, the information in a signal is contained in a pattern of variations of some form. Signals are classified into following categories:

**1. Continuous Time & Discrete Time Signal-**

In continuous time signal, the independent variable is a continuous function. Therefore, the amplitude of the signal exists continuously over the range of time.




**CT Signal** **DT Signal** **CT Digital Signal**

In discrete time signal, the independent variable is a discrete in type. Therefore they are just defined only at discrete interval of time. A discrete time signal is a sampled form of continuous time signal. When each sample is quantized into a finite series of value, we get a digital signal.

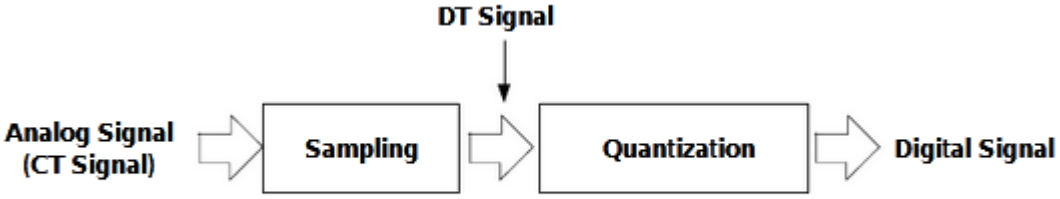



**Fig: Process of Analog to Digital Converstion**

The process of representing a continuous or analog signal by a finite number of discrete states is called quantization.

**2. Deterministic & Random Signal-**

Deterministic signals are those which can be determined by a simple algebraic equation or tabular form or by graphical representation. That is the solution of which are consistent.
Random signals are those which cannot be determined by a simple algebraic equation or tabular form or graphical representation. They are non deterministic and inconsistent. For example: noise signals

**3. Periodic & Non Periodic Signal-**

Periodic signal is that which repeats itself over a certain interval of time regularly. A signal $x(t)$ is said to be periodic with T: If $x(t + T) = x(t)$
If the signal violates the above condition, then it is called non periodic signal. i.e. $x(t + T) \neq x(t)$

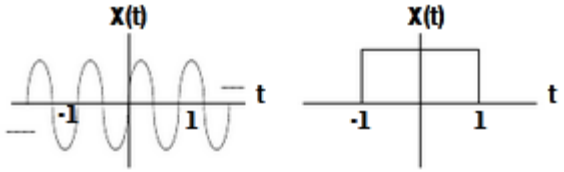



Fig: Periodic Signal  Fig:Non Periodic Signal

**4. Real & Complex Signal-**

Any signal x(t) is said to be real signal xR(t) if it takes the real number system.

$x(t) \rightarrow xR(t) \in R$ (Real Number)

Complex signals take the value in complex number system.

$x(t) \rightarrow xC(t) \in C$ (Complex Number)

- **<u>pin-out diagram of AT and ATX connectors</u>**

| Pin | Name | | Color | Description |
|---|---|---|---|---|
| 1 | 3.3V | | Orange | +3.3 VDC |
| 2 | 3.3V | | Orange | +3.3 VDC |
| 3 | COM | | Black | Ground |
| 4 | 5V | | Red | +5 VDC |
| 5 | COM | | Black | Ground |
| 6 | 5V | | Red | +5 VDC |
| 7 | COM | | Black | Ground |
| 8 | PWR_OK | | Gray | Power Ok is a status signal generated by the power supply to notify the computer that the DC operating voltages are within the ranges required for proper computer operation (+5 VDC when power is Ok) |
| 9 | 5VSB | | Purple | +5 VDC Standby Voltage (max 10mA) |
| 10 | 12V | | Yellow | +12 VDC |
| 11 | 12V | | Yellow | +12 VDC |
| 12 | 3.3V | | Orange | +3.3 VDC |
| 13 | 3.3V | | Orange | +3.3 VDC |
| 14 | -12V | | Blue | -12 VDC |
| 15 | COM | | Black | Ground |
| 16 | /PS_ON | | Green | Power Supply On (active low). Short this pin to GND to switch power supply ON, disconnect from GND to switch OFF. |
| 17 | COM | | Black | Ground |
| 18 | COM | | Black | Ground |
| 19 | COM | | Black | Ground |
| 20 | -5V | | White | -5 VDC (this is optional on newer ATX-2 supplies, it is for use with older AT class expansion cards and can be omitted on newer units) |
| 21 | +5V | | Red | +5 VDC |
| 22 | +5V | | Red | +5 VDC |
| 23 | +5V | | Red | +5 VDC |
| 24 | COM | | Black | Ground |

- **<u>Power supply characteristics</u>: Rated wattage, Efficiency, Regulation, Ripple, Load regulation, Line regulation.**

**Efficiency:** Ratio of output-to-input power (in percent), measured at a given load current with nominal line conditions (Pout/Pin).

**Line regulation:** Change in value of dc output voltage resulting from a change in ac input voltage, specified as the change in ± mV or ± %.

**Load regulation:** Change in value of dc output voltage resulting from a change in load from open-circuit to maximum-rated output current, specified as the change in ± mV or ± %.

**Rated Wattage:** This is the nominal wattage that the power supply can deliver. Nominal wattage is a composite figure, determined by multiplying the amperages available at each of the several voltages supplied by a PC power supply by those voltages. Nominal wattage is mainly useful for general comparison of power supplies. What really matters are the individual wattages available at different voltages, and those vary significantly between nominally similar power supplies.

**Ripple:** Rectifying and filtering a switching power supply's output results in an ac component (ripple) that rides on its dc output. Ripple frequency is some integral multiple of the converter's switching frequency, which depends on the converter topology. Ripple is relatively unaffected by load current, but can be decreased by external capacitor filtering.

Q. Enlist the Power Supply Characteristics.

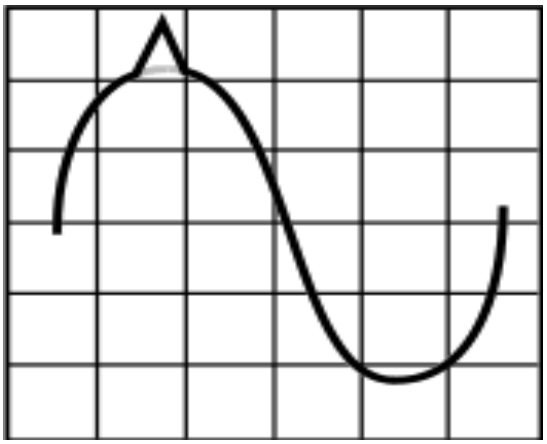
## ➢ Power problems: Blackout, Brownout, surges and spikes

**1.** Surge /Spike

**Surges and spikes are short-term voltage increases. They are typically caused by lightning strikes, power outages, short circuits or malfunctions caused by power utility companies. They cause data corruption, catastrophic and costly equipment damage and incremental damage that degrades equipment performance and shortens its useful lifespan.**

**Common causes ofsurges/spikes:**

- Utility company loadshifting
- Miswired electricalsystems

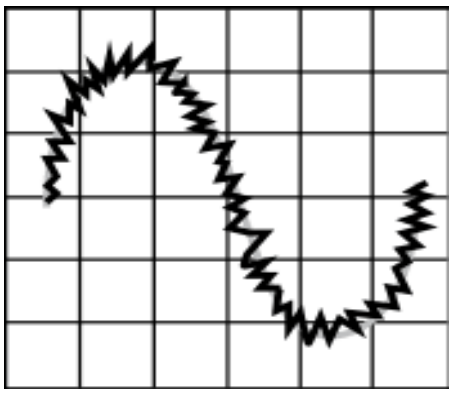


**Problems caused by surges/spikes:**

Systemlockups
Incremental or catastrophic equipmentdamage
Lostproductivity

## 2. LineNoise

**Line noise refers to distortion on AC, telephone/DSL, network or coaxial lines caused by Electromagnetic Interference (EMI) and Radio Frequency Interference (RFI). Line noise is unavoidable and will appear on every signal at some point, though it is not always detrimental, or even noticeable. It causes incremental electronic circuit damage, data corruption, audio/video quality problems and confusion between system components.**
**Line noise generated by electronic devices varies greatly and can be produced by energy disturbances from a variety of sources, both natural and man-made.**



**Common causes of line noise:**

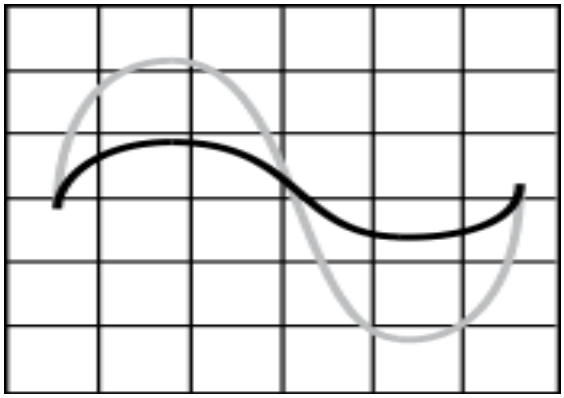
- Radiotransmissions
- High voltage powerlines
- Severeweather
- Fluorescentlights

**Problems caused by line noise:**

- Systemlockups
- Audiostatic
- Video"snow"
- Slow electronicdegradation

## 3. Brownout / Undervoltage /Sag

**A brownout is a voltage deficiency that occurs when the need for power exceeds power availability. Brownouts typically last for a few minutes, but can last up to several hours, as opposed to short-term fluctuations like surges or spikes. They are caused by the disruption of an electrical grid and may be imposed by utility companies when there is an overwhelming demand for power.**
**Brownouts, more common than blackouts, cause equipment failures, incremental damage, decreased equipment stability and data loss.**



Common causes of brownouts/undervoltages/sags:

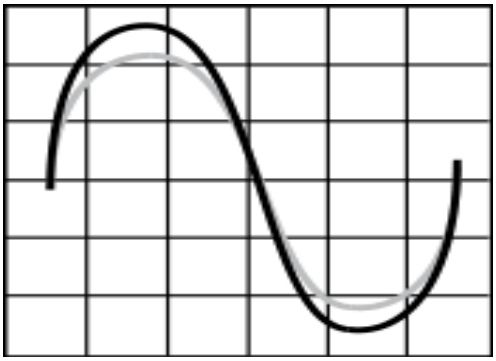
- Inadequate utilityservice
- Heavy power draw inarea/facility
- Poor electrical circuitdesign

Problems caused by brownouts/undervoltages/sags:

- Active dataloss
- Systemlockups
- Lostproductivity
- Slow electronicdegradation

## 1. Swell /Overvoltage

**Swells are basically the opposite of a brownout: instead of a voltage deficiency, or**



**sag, a swell is a voltage increase for a long duration (seconds to a minute), as opposed to a brief increase, like a surge/spike. A swell is caused when the power being provided outweighs the power accepted by connected equipment, resulting in an increase in voltage. Much like sags, deterioration may not be apparent until it's too late, resulting in lost data and damaged equipment.**

**Common causes of swells/overvoltages:**

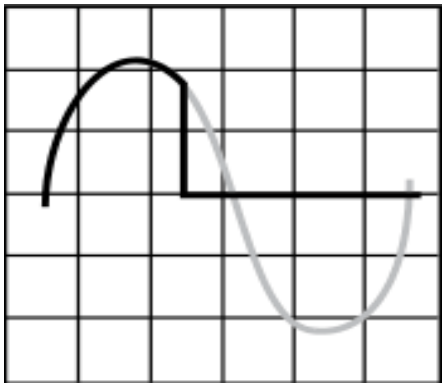
- Sudden/large loadreductions
- Oversupply of power from utilitysource
- Fault on a 3-phasesystem

**Problems caused by swells/overvoltages:**

- Slow electronicdegradation
- Flickeringlights
- Overheating and stress onequipment

**2. Blackout / PowerOutage**

**A blackout, or power outage, is a complete loss of utility power, whether short- or long-term. Blackouts cause reduced productivity, lost revenue, system crashes and data loss. Unplanned outages may occur as aging electrical grids and building circuits are overwhelmed by high demand. Blackouts are particularly dangerous at sites where safety or life support rely on power, such as hospitals, treatment centers and power plants.**



Common causes of blackouts/power outages:

- Utility companyfailure
- Accidental AC linedisconnection
- Tripped circuitbreakers
- Severeweather

**Problems caused by blackouts/power outages:**

- Dataloss
- Systemdowntime
- Lostproductivity
- Lostrevenue

Q. Enlist and Explain Power Problems in details.

## ➢ Symptoms of power problems

- ✓ The power light is off and/or the device won't turn on.
- ✓ The power supply fan does not turn when the computer is powered on.
- ✓ The computer sounds a continuous beep. (This could also be a bad motherboard or a stuck key on the keyboard.)
- ✓ When the computer powers on, it does not beep at all. (This could also be a bad motherboard.)
- ✓ When the computer powers on, it sounds repeating short beeps. (This could also be a bad motherboard.)
- ✓ During POST, a 02*X* or parity POST error code appears (where *X* is any number); one of the POST checks is a power good signal from the power supply; a 021, 022, . . . error message indicates that the power supply did not pass the POST test.
- ✓ The computer reboots or powers down without warning.
- ✓ The power supply fan is noisy.
- ✓ The power supply is too hot to touch.
- ✓ The computer emits a burning smell.
- ✓ The power supply fan spins, but there is no power to other devices.
- ✓ The monitor has power light, but nothing appears on the monitor, and no PC power light illuminates.

Q. Explain the Symptoms of Power Problems.

## ➢ Protection devices: circuit breaker, surge suppressor

### 1. Low Voltage Circuit breakers

**A circuit breaker is an automatically-operated electrical switch designed to protect an electrical circuit from damage caused by overload or short circuit. Unlike a fuse, which operates once and then has to be replaced, a circuit breaker can be reset (either manually or automatically) to resume normal operation. Circuit breakers are made in varying sizes, from small devices that protect an individual household appliance up to large switchgear designed to protect high voltage circuits feeding an entirecity.**

**Types of circuit breaker**

**There are many different technologies used in circuit breakers and they do not always fall into distinct categories. Types that are common in domestic, commercial and light industrial applications at low voltage (less than 1000 V) include:**

- **MCB (Miniature Circuit Breaker)-rated current not more than 100 A. Trip characteristics normally not adjustable. Thermal or thermal-magnetic operation. Breakers illustrated above are in thiscategory.**
- **MCCB (Moulded Case Circuit Breaker)—rated current up to 1000 A. Thermal or thermal-magnetic operation. Trip current may beadjustable.**
- **ACB (Air circuit breaker) – rated current up to 4000 A .Thermaland magnetic operation . Trip currentadjustable.**

## ➢ Protection devices: surge suppressor

Power surges are very common occurrences, and they can be caused by any number of things. In addition to the turning-on and shutting-off of high-power electronic devices, a few other power surge culprits include nearby lightning strikes, power line disturbances, and high-frequency electromagnetic noise.

Over the years, as technology has progressed, electronics have grown more and more sensitive to fluctuations in the electrical currents powering them. The microprocessors and other fragile components in computers and home theater equipment can be compared to temperamental little divas: they perform like a dream, but if working conditions become unfavorable, they'll blow up on you! Because of this, it's more crucial than ever to invest in surge protection.

Key Features of surge suppressor

**Indicator Lights:** Indicator lights on surge protectors can keep you informed of two things: when a power surge is actually taking place, and the status of your surge protectors MOV. It's important to keep tabs on the condition of an MOV, because after a few good surges it can become less effective. With an indicator light letting you know what's going on inside your surge suppressor, you'll never have to guess whether or not your electronics are receiving the protection they need!

**UL Listing:** A UL Listing is a great way to know that the product you're purchasing is safe and up to standard. But with items like surge protectors, it's important to pay attention to exactly *which* UL standard the device is listed for! There are some surge suppressors on the market that are UL-listed for their power cords only. If you want to avoid ending up with one of these, make sure that any surge-protection device you're interested in is listed in accordance with **UL 1449**, the Underwriters Laboratories standard for surge suppressors.

Q. Explain the following Protection devices circuit breaker, surge suppressor

- **Uninterrupted Power Supply, Online and Offline UPS, working of UPS: Block diagram, advantages and disadvantages, Ratings**

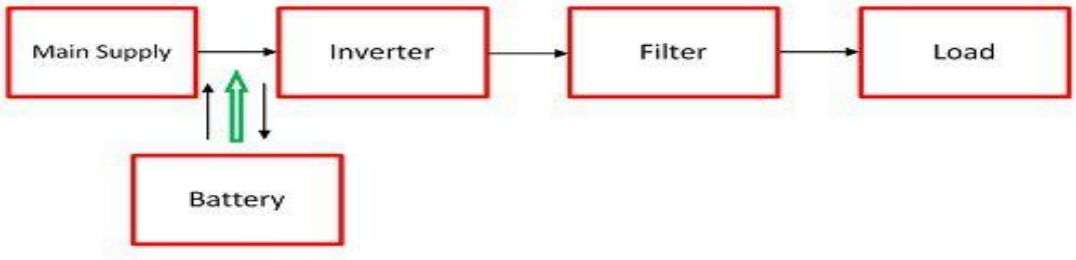
## Uninterrupted Power Supply

An uninterruptible power supply (UPS) is a device that allows a computer to keep running for at least a short time when the primary power source is lost. UPS devices also provide protection from power surges.

A UPS contains a battery that "kicks in" when the device senses a loss of power from the primary source. If an end user is working on the computer when the UPS notifies of the power loss, they have time to save any data they are working on and exit before the secondary power source (the battery) runs out. When all power runs out, any data in your computer's random access memory (RAM) is erased. When power surges occur, a UPS intercepts the surge so that it does not damage the computer.

**UPS in the data center**

Every UPS converts incoming **AC** to **DC** through a rectifier and converts it back with an inverter. Batteries or flywheels store energy to use in a utility failure. A bypass circuit routes power around the rectifier and inverter, running the IT load on incoming utility or generator power.

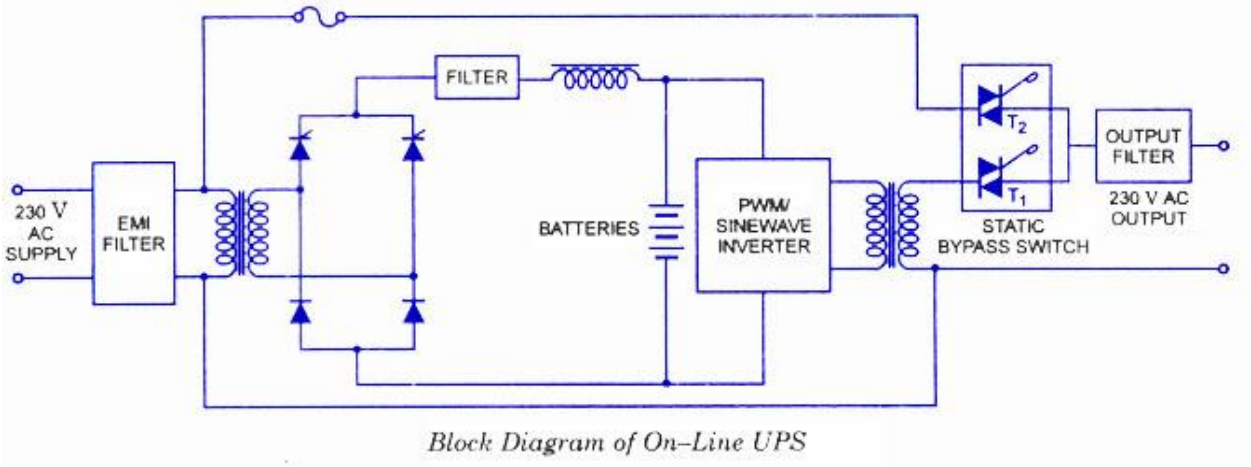



Block Diagram of UPS Circuit Globe

**There are three distinct types of uninterrupted power supplies, namely, (£) on-line UPS (ii) off-line UPS, and (Hi) electronic generators. In the on-line UPS, whether the mains power is on or off, the battery operated inverter is on all the time and supplies the ac output voltage. When the mains power supply goes off, the UPS will be on only until the battery gets discharged. When the main power resumes, the battery will get charged again. In off-line UPS and electronic generators, there inverter is off when the mains power is present and the output voltage derived directly from the mains is**

**the same as the mains supply voltage. The inverter turns on only when the mains supply goes off. The block diagrams of on-line UPS, off-line UPS and electronic generators are given in figs. The ever increasing importance of computers in industry and commerce will increase the need for quality, high stability and interruption free power supplies.**

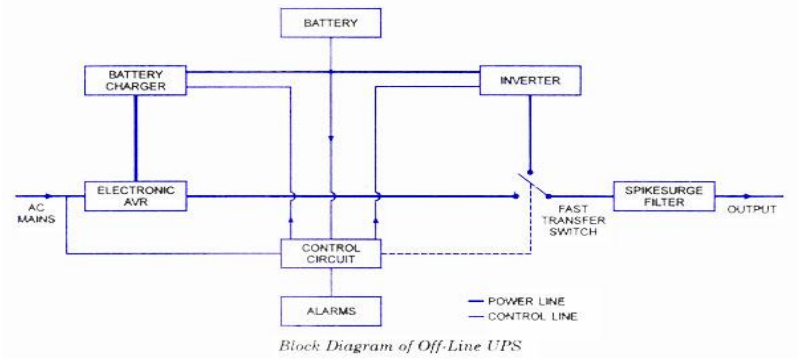
- Online UPS:




*Block Diagram of On–Line UPS*

**In case of On-line UPS, the battery operated inverter works continuously whether the mains supply is present or not. Triac T1is on for all the times while TriacT2has been provided to bypass the UPS inverter, only when a fault develops in the UPS inverter. When the mains supply fails, the UPS supplies power only until the batteries get discharged. However, once the mains powerresumes, the batteries will get charged again. The switching times of these supplies is considered to be zero. Usually sealed maintenance free batteries are used and the running time of the inverter is low (approximately 10 to 30 minutes).**

- Off Line UPS:




*Block Diagram of Off-Line UPS*

**In the case of Off-Line UPS, the inverter is off when the mains power is on and the output voltage is derived directly from the mains. The inverter turns on only when the mains supply fails. Its switching time is less than 5 ms. These UPS are generally used with PCs or computers or other appliances where a small duration (5 ms or less) interruption in power supply can be tolerated. Usually, sealed**

**batteries or lead-acid batteries are used. The running time of these supplies is also low (about 10 to 30 minutes).**

## How does an Uninterruptible Power Supply (UPS) work?

An uninterruptible power supply (UPS), also known as a battery backup, provides backup power when your regular power source fails or voltage drops to an unacceptable level. A UPS allows for the safe, orderly shutdown of a computer and connected equipment. The size and design of a UPS determine how long it will supply power.

### UPS Topologies

Different UPS topologies provide specific levels of power protection. A Cyber Power UPS will belong to one of these three topologies: standby, line interactive, and double-conversion.

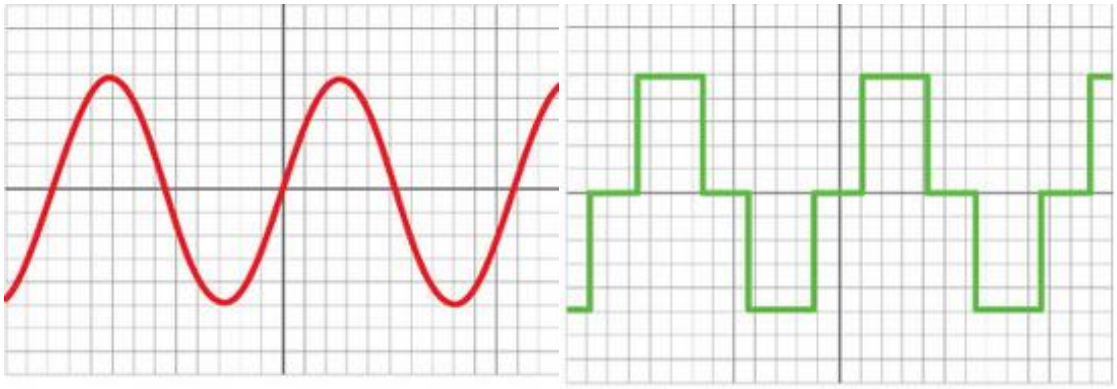
**Standby** is the most basic UPS topology. A standby UPS resorts to battery backup power in the event of common power problems such as a blackout, voltage sag, or voltage surge. When incoming utility power drops below or surges above safe voltage levels, the UPS switches to DC battery power and then inverts it to AC power to run connected equipment. These models are designed for consumer electronics, entry-level computers, POS systems, security systems, and other basic electronic equipment.

A **line interactive** UPS incorporates technology which allows it to correct minor power fluctuations (under-voltages and over voltages) without switching to battery. This type of UPS has an autotransformer that regulates low voltages (e.g., brownouts) and over voltages (e.g., swells) without having to switch to battery. Line interactive UPS models are typically used for consumer electronics, PCs, gaming systems, home theater electronics, network equipment, and entry-to-mid-range servers. They provide power during such events as a blackout, voltage sag, voltage surge, or over-voltage.

A **double-conversion (online)** UPS provides consistent, clean, and near perfect power regardless of the condition of incoming power. This UPS converts incoming AC power to DC, and then back to AC. UPS systems with this technology operate on isolated DC power 100 percent of the time and have a zero transfer time because they never need to switch to DC power. Double-conversion UPS systems are designed to protect mission-critical IT equipment, data center installations, high-end servers, large telecom installations and storage applications, and advanced network equipment from damage caused by a power blackout, voltage sag, voltage surge, over voltage, voltage spike, frequency noise, frequency variation, or harmonic distortion.

### UPS output waveforms

Cyber Power UPS systems have either sine wave or simulated sine wave output, depending upon the model.



Sine Wave

Simulated Sine Wave

**Sine wave output:** The highest quality waveform output is sine wave, which is a smooth, repetitive oscillation of AC power. Enterprise-level UPS systems produce sine wave power to operate sensitive electronic equipment. Sine wave output ensures that equipment utilizing Active PFC power supplies do not shut down when switching from utility power to battery power.

**Simulated sine wave output:** An approximated sine wave output waveform. It uses pulse wave modulation to generate a stepped, approximated sine wave to supply more cost-effective battery backup power for equipment that does not require sine wave output. The technology used to produce this type of power output is less expensive to manufacture and is common in standby and line interactive UPS systems.

Q. What is UPS & Explain its types.
Q. Explain the UPS with the help of block diagram.

## ➢ Advantages and disadvantages of UPS

Advantages to using uninterruptable power supplies include:

- No delay between switching from the primary power source to the UPS.
- Can better support critical instruments compared to generators.
- Consumers can choose the type and size of UPS, depending on the amount of power they need to supply to a device.
- UPSs are silent.
- Maintenance of UPS systems is cheaper compared to generators.

Disadvantages to using uninterruptable power supplies include:

- The inability to run heavy appliances- because UPSs are run off of batteries.
- If substandard batteries are used, users may end up replacing the batteries often.
- UPSs may need professional installations.

## ➢ Rating

A UPS's rating is the amount of load, in volt-amperes (VA), that it's designed to support. UPSs are available with ratings as low as 300 VA and as high as 5,000,000 VA or more. Use this very basic procedure to determine the approximate UPS rating your

organization requires:
Make a list of all the equipment your UPS will be protecting.2. Determine how many volts and amps every device on the list draws.3. For each device, multiply volts by amps to arrive at a VA figure.4. Add all of the VA figures together.5. Multiply that sum by 1.2, to build in room for growth. The UPS you buy should have a rating equal to or greater than the final number you arrived at in step 5, unless you have more precise load data for the equipment you are protecting. Here are a few additional considerations to keep in mind: Relying solely on nameplate ratings may lead you to oversize the UPS system, so always use your equipment manufacturer's sizing calculator tools as well, if available. Most major manufacturers have Web-based or downloadable sizing tools that can closely estimate your equipment's power draw based on the configuration you are using. When deploying a centralized power protection architecture, you typically deploy larger kVA UPSs than you would deploy using a distributed power protection scheme. If your UPS will be supporting motors, variable-speed drives or laser printers, add more VA capacity to your requirements to account for the high power inrush that occurs when those devices startup. Your UPS vendor can assist in applying the proper UPS and rating for these types of applications. Companies that anticipate rapid near- or medium-term growth should use a multiple higher than 1.2 when building in room for growth in the procedure above. So should organizations that expect to upgrade their server hardware soon, as newer servers tend to have higher power requirements than older models.

Q. Explain the Advantages & Disadvantages of UPS.

## Chapter No.6INTERFACES(10Marks)

- **To understand the ports of PC.**
- **To understand interfacing techniques of devices to ports**

### 6.1 SCSI:-

- **Smallcomputersystemsinterface** abbreviated SCSI&pronounced "Skuzzy".
- Itshigh speed standard for physicallyconnecting &transferringdata between computers
  &peripheral devices.
- It is veryhigh speed parallel/serial interface, which is used to connect up to7 devices to the computer system usingonlyoneinterfacecard.
- SCSIis basicallyabus into which different peripherals are connected in adaisychain.

### SCSI Standard:-

There are3 different SCSIstandards,

1. SCSI-1
2. SCSI-2
3. SCSI-3

1. **List Features SCSI-1:-**
   1. 8 bitparallel bus.
   2. 5MHzasynchronous &synchronous operation.
   3. 4MBPS(asynchronous)5MBPS(synchronous) throughput.
   4. 50 pin cable.
   5. Passivetermination.
   6. Optional bus parity.
2. **List Features SCSI-2:-(improvedversionof SCSI-1)**
   1. Fast SCSI(10MHz)
   2. Wide SCSI(16 bittransfers)
   3. New Commands.
   4. High density, 50 pin cable connectors.
   5. Activetermination for improved singleended transmission.
3. **List Features SCSI-3:-**
   1. Ultra2 (fast-40) SCSI.
   2. Ultra3 (fast-80DT) SCSI.
   3. Ultra4 (fast-160DT) SCSI.
   4. Ultra5 (fast-320DT) SCSI.
   5. New low voltagedifferential signaling.
   6. Elimination of high voltagedifferential signaling.

### SCSICables:-

- It refers to a completecable, includingthe wire, connectors&possiblyaterminator as well.
- SCSIcablescome in two distinct varieties:
  1. External
  2.Internal

**Q. What is SCSI connector?**

**SCSI Connectors:-**

- Connectors arethe physical devices that areusedto attach aSCSIcable toSCSIdevice.
- External &Internal devices usedifferent connectors. Each has 4 different alternatives.

**Q. Explain following external SCSI connectors.**

**Externalconnector types:-**

1. D-Shell
2. Centronics
3. High Density(HD)
4. Veryhigh densitycableinterconnect(VHDCI)

**Q. Explainthe following external SCSI connectors D-Shell.**

**1. D Shell(D-sub, DD)**

- SCSI1 defineda50 pin D-Shellconnectorfornarrow SCSIimplementation.
- It hasaD Shaped metal shellwhich goes aroundthepins of themalehalfconnector, hencethe name.
- Thedisadvantageof thisconnector is its size&bulkiness.
- It was verylarge&not widelyused.


Fig.D Shell 25Pin &50 Pin

**Q. Explainthe following external SCSI connectors Centronics.**

**2. Centronics:-**

- Another externaltype, SCSI1 which is a 50 pin connector called the centronicsconnector.
- It uses tworows of flat contacts instead of thin pins.
- Two latches arepresent on either sideof theconnector to hold itat appropriate place.
- It is stillused in printer interfaces (cables),attheend which attaches to theprinter.
- These50 pin connectorsarestillpresent in the current SCSIspecifications&arecalled as“Alternative -2”external connectors.


Fig.Centronics

**Q. Explainthe following external SCSI connectors HighDensity.**

**3. HighDensity:-**

- TheD Shell connectors defined in theSCSI-1 standard arereplaced byHigh

Density shielded connectors in SCSI-2.

- Thespacebetween pins are reduced, makingthe older connectors smaller, cheaper to make&easier to use.
- It usesa “squeezeto release“latchingmechanisminstead of centronics stylelatches.
- A narrow 50 pinconnector is called “Alternative1”,&thewide68 pin version “Alternative-3”

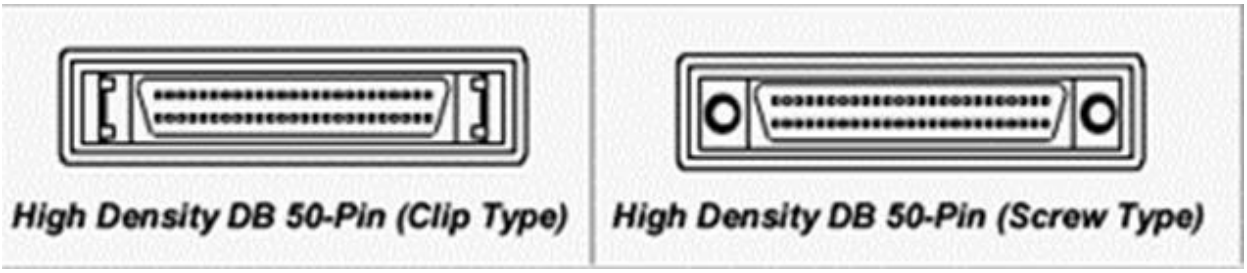



Fig.HighDensity

**Q. Explainthe following external SCSI connectors Very HighDensity Cable Interconnect(VHDCI).**

**4. Very HighDensityCableInterconnect(VHDCI):-**

- It is awide only(68 pin)&also called as “micro centronics”, becauseituses the same designas theCentronicsinterface. Thecontacts aremuch smaller&close to each other.
- Becauseof its small sizeitis beingusedwidely, also known as “Alternative-4”

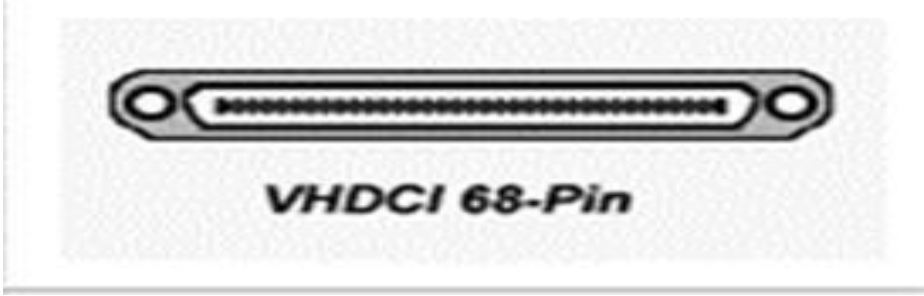



Fig.VeryHighDensityCableInterconnect (VHDCI)

**Internal SCSI Connectors (Unshielded):-**

1. **Regular Density**

- It is used for narrow(8 bit) devices.
- It is arectangular connector with two rows of25 pins.
- This connector isverysimilartoIDE/ATA connector. (Except5 extrapins on each row.)
- It is widelyused in olderdevices (Slower.).
- In thecurrent standard itis called as“Alternative2”.


Fig.RegularDensity

**2. HighDensity**

- Thepin spacingin high densityis half of theolder SCSI-1 connector, makingthem much smaller.
- It is the mostcommon connector used in todaysystems.
- Thenarrow 50 pin versions is unshielded connector “Alternative1”&the68-pin version
  is “Alternative3”.


Fig.HighDensity

**3. Single ConnectorAttachment (SCA)**

- “Alternative4”in theSCSIstandards for unshielded connectors.
- The connector used for thesingleconnector attachment system forbackplane-connecting of SCSIdrives.


Fig.Single Connector Attachment

**Q. Explain SCSIdrive Configuration.**

**SCSI Drive Configuration:-**

- Configuringthe SCSIdriveis a bit critical than configuringtheIDE.
- Followingparameters must be set beforeconfiguringthe SCSIdrive.

**1. SCSI DeviceID:**

- For narrow SCSI3 jumpers areused.
- For wide SCSI4 jumpersareused.

**2. Termination Activate:**

- End deviceon SCSIchain must be terminated forthe bus to function properly.
- IfHDD is thelast devicethen thejumper settingswillcauseitto terminatethe bus.

**3. Disable Auto Start**

**4. Delay Auto Start**

**5. Staggerspin:**

- Enhanced version of“DelayAuto Start”.
- When asystem with manyHDD has this option set for each unit,the drives stagger their start up timebymultiplyingauser defined constant times theirSCSI ID.

**6. Narrow/ Wide:**

- Thedriveto function innarrow or wide mode.

7. **ForceSE(single ended):**
   – Allows newer drives [Ultra2 or more]to be forcedto usesingle ended operation.
8. **Disable Parity:-** Turns offparitycheckingon the SCSIbus.

## 6.2 USB (UniversalSerialBus):-

- It is aserial bus standardto connect devices or interfacedevices.
- Improves plug&playfacilities.
- Allows Hot Swapping:(No need to reboot thesystem.)
- Consumes low power, does not requireexternalpower supply.
- USB canconnect computerperipherals suchas mouse, devices, keyboards,PDAs, game pads, scanners, digitalcameras, Printers etc.
- Thedesign of USBis standardized bytheUSBImplementersforum (USB-IF).It is an industrystandards bodyincorporatingleading companies from Computer&electronics industries.

**HowUSBis betterthanRS 232**

1 .Easy Installation.
2 .FasterTransfer Rate.
3. Simple Cabling.
4. Multipledevice connections.

**Data Rates SupportedBy USB**

- USB1.0 : 1.5 Mbps Low Speed
- USB1.1 : 2 Mbps Full Speed
- USB2.0 : 480 Mbps Hi Speed
- USB3.0 : 4.8 Gbps Super Speed.

**Q. State&explainthefeatures ofUSB.**

**USBFeatures:-**

1. **Host:-**Thecomputer acts as ahost machine.
2. **Multiple Devicesupport: -**Up to 127 devices canconnect to host.
3. **USBCableLength:-**as longas 5 meters.
4. **Transfer rate:-**USB1.0supported 12mbps, USB2.0 supported 480 Mbps.
5. **EaseofInstallation:-**USB cablehas two wires forpower (+5V&GND).
6. **PowerAllocation:-**computer can supplyup to 500 milliamps of power at 5V.

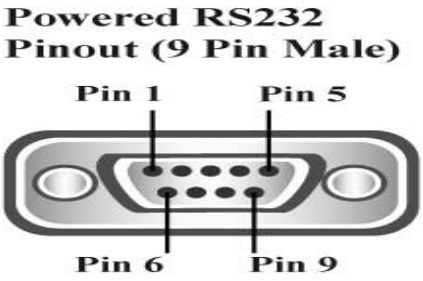
7. **Hot Swappable: -**USBdevicecan directlyplug &unpluganytime.
8. **Hot Pluggability:-**No need to reboot thesystem.
9. **HubArchitecture:-**Nouseof daisychain manner.
10. **Powersaving:-**ManyUSBdevices can beput to sleep bythe host computerwhen computer enters apowersavingmode.
11. **Support forWideRange ofPeripherals:-**keyboard, mouse, joystick, game pad, printer, scanneretc.

## 6.3 RS232(Recommended standard):-

- It is standard interfacedeveloped bythe electronics industriesassociation (EIA).
- Communication as defined in theRS232 standard is an asynchronous serial communication method.
- Serial: -means that theinformation is sent onebitat a time.
- Asynchronous: -information is not sent in predefined time slots.
- RS232 is astandard for serial binarydata signals connectingbetween aDTE (data terminal equipment) &DCE (data circuitterminatingequipment).
- It is commonlyused in computer serial ports.
- TheRS232 interface expects a modem to be connected to both thereceiving&the transmittingend.

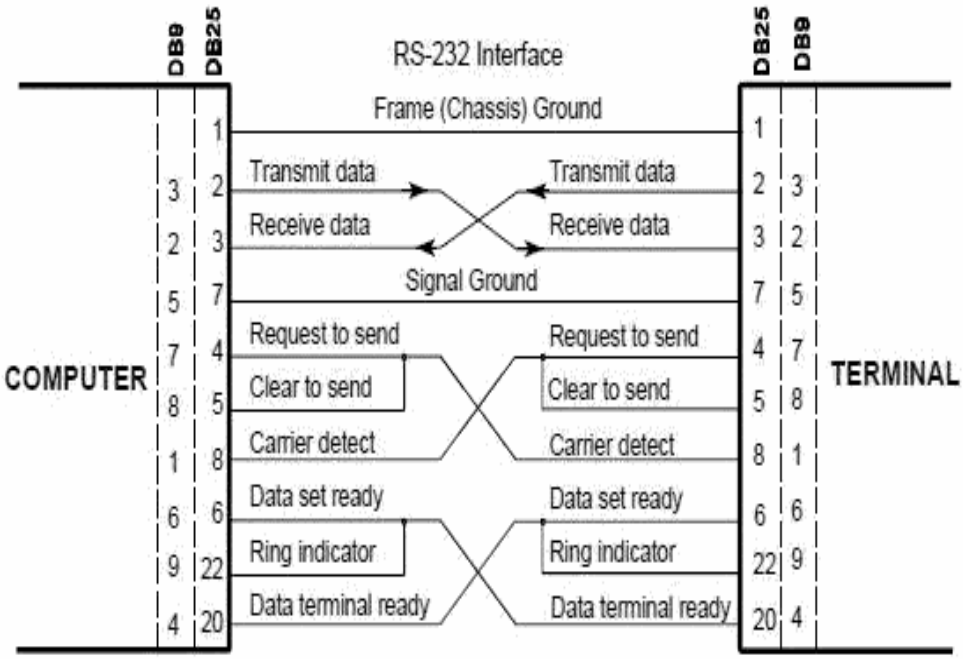
Powered RS232

| | |
|---|---|
| Pin 1 | DCD/12V/GND |
| Pin 2 | RXD |
| Pin 3 | TXD |
| Pin 4 | DTR |
| Pin 5 | GND |
| Pin 6 | DSR |
| Pin 7 | RTS |
| Pin 8 | CTS |
| Pin 9 | RI/12V/5V |




**Q. Drawthe block diagramofRS232 connector&give thefunction ofthesignals.**

**RS232 Signal Description: -**




- **CD (carrierDetect orData carrierdetect):-**itisused bycomputer to know that the modem connected to theserial port has madeaproper connection with themodem on the otherside.

- **RxD (ReceiveData):-**device connected to the serial port to send data to the computer.

  Data sent fromDCE to DTE.

- **TxD(Transmit Data):-**computer to send data to adevice connected to theserial port or data sent from DTE to DCE.

- **DTR (data terminal ready):-**To inform that computeris readyfor communication.

- **GND(ground):-** this wireprovides return path forboth signals.

- **DSR (data set ready):-**device connected to thecomputer to inform thatthe deviceis readyfor communication.

- **RTS(request to send):-**the computer send request tosend (RTS) signaltothe device connected to inform that computeris also readyto start thedata transmission.

- **CTS(clearto send):-**CTS signal is used bythe device connected to informto the computer that the computer can start thedata transmission.

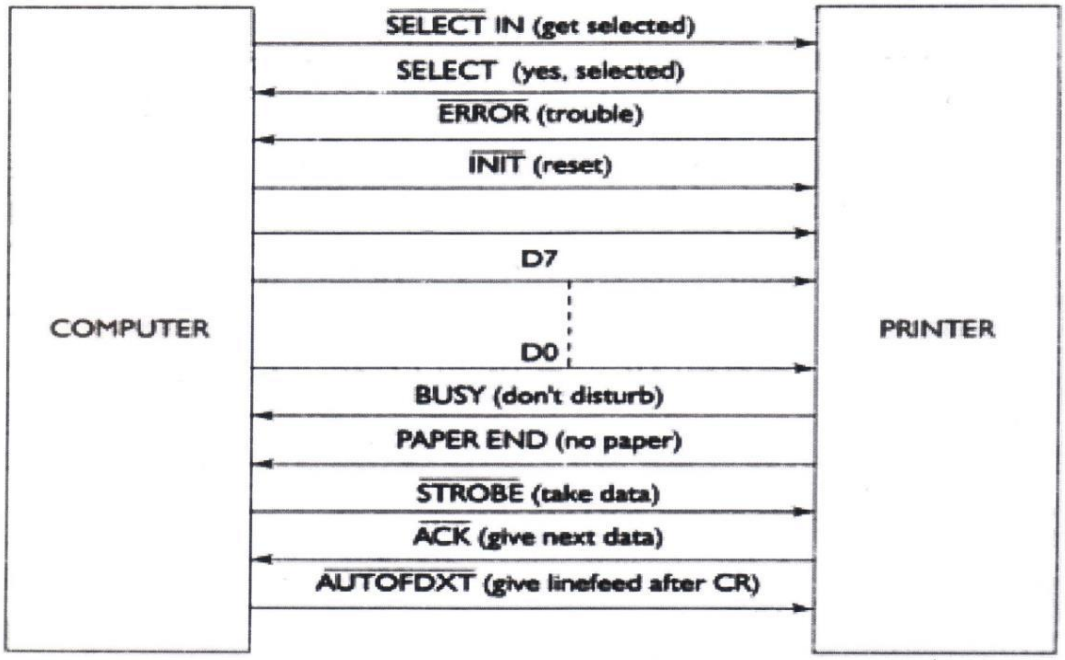
- **RI (ring indicator):-**itis used bythedeviceconnected to the serial port to inform to the computer that it has detected aringingvoltageonthe telephoneline.

**6.4 Centronics:-**

- It is an oldI/O interfacestandard used for connectingprinters.

- It is also called parallel interface&itwas used for connectingold printers.
- It uses 36 pin male& female connector cableto connect theprinteror other device.
- Theoriginal centronicsparallel interfacefordot matrixprinters.

**CentronicsInterface Signals: -**




**Q. Drawdiagramofcentronic interface& explainfunction ofanyfoursignals.**

**SignalsfromPC toPrinter:-**

- There are12 signals from PC to printer. Out of these8 signals aredata bits &4 signals arecontrol signals.

1. **STROBE:**-this becomes low. Whenever thePC sends abyteof data to printer.This low voltagetells the printer that datais beingsent.
2. **INIT:**-when itis low, the printer resets its electronics logic&clears the printer buffer.
3. **SELECT IN**:-it is an interfaceenable signal, when this signal is low, theprinter responds to signals fromthe controller.
4. **AUTOFEEDXT**:-after printingeveryline, the printerwillprovide onelinefeed automaticallyif signalislow.

**Q. Explainthe signalsfromprintertoPC incentronics interface.**

**SignalsfromprintertoPC:-**

1. **$\overline{\text{ACK}}$**:-when this low indicate that the characterhas been accepted&theprinteris readyfor the next character.

2. **BUSY:**-when thissignal is high ifforsomereason suchas beingoutof paper, theprinter is notready.

3. **PE (PaperEnd)**:-if this signal is high means no paper in theprinter.

4. **SELECT:-**this signal is indicates that theprinteris selected&logicallyconnected to the computer.

5. **$\overline{\text{ERROR}}$**:-this signal goes low for variousanerrorcondition of theprinter.

**6.5 Firewire(IEEE 1394):-**

- It is brand name for theIEEE 1394 high speed serial bus interface.
- The1394 interfaceis also known bythe brandI.Link (Sony)
- It was developed in thelate1980s and early1990s byApple, who called itFireWire.
- IEEE 1394 is a serialbusarchitecturefor high-speed data transfer.FireWireis aserialbus, meaningthatinformation is transferred onebitat a time.
- IEEE 1394 fullysupports bothisochronousand asynchronousapplications.
- It is used in modern PCs.

**USB 2.0vs. FireWire (IEEE1394)**

| Sr. No. | USB2.0 | FireWire(IEEE1394) |
|---|---|---|
| 1. | 1.5 Mbps, 12Mbps, 480 Mbps supported. | 100 Mbps, 200Mbps, 400 Mbps supported. |
| 2. | USB controller is required to control the bus and data transfer. | Works without control, devices communicate peer-to-peer. |
| 3. | Cable up to 5m. | Cable up to 4.5m. |
| 4. | Up to 127 devices supported. | Up to 63 devices supported. |
| 5. | Power supplyto externaldevices is 500 mA/5V (max). | Power supplyto externaldevices is 1.25A/12V (max). |
| 6. | Fullcompatibilitywith USB1.1 devices. | Theonlycomputer bus used in digital videocameras. |
| 7. | **Application**:<br><br>USBis a small and medium bandwidth connection for telephonyproducts, digital cameras, monitors, keyboards, mice, and othersimilarI/O devices. | **Application:**<br><br>IEEE 1394 is a high-speed bus designed fordigital videocameras,DVD players, mass storagedevices, and other peripherals that requiregreater bandwidth. |

6.6 Bluetooth

A Bluetooth technology is a high speed low powered wireless technology link that is designed to connect phones or other portable equipment together. It is a specification (IEEE 802.15.1) for the use of low power radio communications to link phones, computers and other network devices over short distance without wires. Wireless signals transmitted with Bluetooth cover short distances, typically up to 30 feet (10 meters).

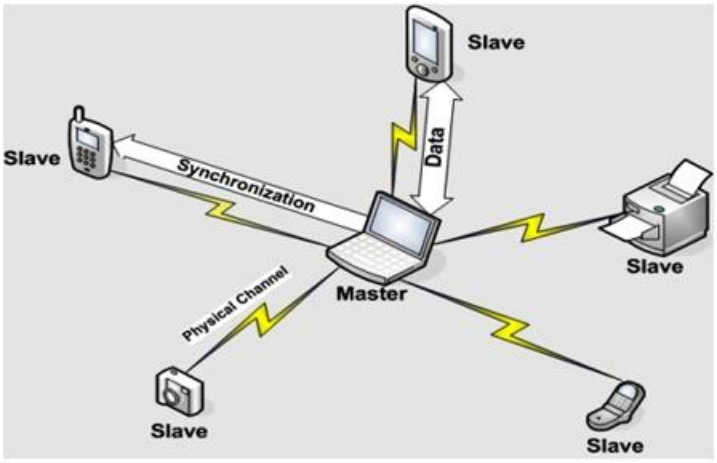
Bluetooth can connect up to “eight devices” simultaneously and each device offers a unique 48 bit address from the IEEE 802 standard with the connections being made point to point or multipoint.

The first version was 1.2 standard with a data rate speed of 1Mbps. The second version was 2.0+EDR with a data rate speed of 3Mbps. The third was 3.0+HS with speed of 24 Mbps. The latest version is 4.0.

**How Bluetooth Works:**

Bluetooth Network consists of a Personal Area Network or a piconet which contains a minimum of 2 to maximum of 8 bluetooth peer devices- Usually a single master and upto 7 slaves. A master is the device which initiates communication with other devices. The master device governs the communications link and traffic between itself and the slave devices associated with it. A slave device is the device that responds to the master device. Slave devices are required to synchronize their transmit/receive timing with that of the masters. In addition, transmissions by slave devices are governed by the master device (i.e., the master device dictates when a slave device may transmit). Specifically, a slave may only begin its transmissions in a time slot immediately

following the time slot in which it was addressed by the master, or in a time slot explicitly reserved for use by the slave device.




Bluetooth Master Slave Configuration

**PC Troubleshooting, Maintenance and Tools.**

**Objectives**

- To understand the preventive maintenance of PC
- To understand the diagnostic tools of PC

7.1 POST: POST sequence, Beep codes, visual display codes.
7.2 Preventive maintenance: Active, Passive, periodic maintenance procedure.
7.3 Diagnostic Tools: logic Analyzer, logic probe.
7.4 Diagnostic software for trouble shooting PC.
BGA workstation and its applications for reballing of north bridge and south bridge
7.1 POST: POST sequence, Beep codes, visual display codes.

## Need of Computer Diagnostic Tools:

if a computer serves for a long time, it may have various issues, which will slow down the computer or make it unbootable. Does your computer encounter these problems? If so, you should run a computer diagnostic to detect and fix errors.

Some users would like to run a PC health check. However, this check can't help you identify specific hardware problems or give you solutions. To identify the specific hardware problem, you need hardware diagnostic tools.

The types of diagnostic software are as follows:

1. Intel Processor Diagnostic Tool
2. CPU-Z
3. Windows Memory Diagnostic
4. QAPlus,
5. Norton Utilities,
6. PCtools

### 7.1 POST: POST sequence, Beep codes, visual display codes.

The computer POST (power-on self-test) checks a computer's internal hardware for compatibility and connection before starting the remainder of the boot process. If the computer passes the POST, the computer may give a single beep (some computers may beep twice) as it starts and continue to boot. However, if the computer fails the POST, the computer will either not beep or generate a beep code that tells the user the source of the problem.

POST Sequence:

A **power-on self-test** (**POST**) is a process performed by firmware or software routines immediately after a computer or other digital electronic device is powered on.

he principal duties of the main BIOS during POST are as follows:

- verify CPU registers
- verify the integrity of the BIOS code itself
- verify some basic components like DMA, timer, interrupt controller

- find, size, and verify system main memory
- initialize BIOS
- pass control to other specialized extension BIOSes (if installed)
- identify, organize, and select which devices are available for booting

The functions above are served by the POST in all BIOS versions back to the very first. In later BIOS versions, POST will also:

- discover, initialize, and catalog all system buses and devices
- provide a user interface for system's configuration
- construct whatever system environment is required by the target operating system
- **Generic error codes**
  Note that different BIOS manufacturers generate different error codes you must use the guidelines provided by these manufacturer to troubleshoot your computer, provided below are generic error codes provided by a typical computer.

- **POST visual Errors**

  This will show up on your computer as visual error codes

  Error Range Component with Error

  100-199 Motherboard
  200-299 RAM or Memory
  300-399 Keyboard
  400-499 Video Mono
  500-599 Video Color
  600-699 Floppy Drive
  700-799 Math Co-Processor
  900-999 LPT1
  1000-1099 LPT2
  1100-1199 COM 1
  1200-1299 COM 2
  17xx Hard Disk Controller
  3xxx NIC
  86xx Mouse

- **POST audio Errors**
  Your will hear these error codes when your computer boots up

  Error Code Faulty Component

**1 Short Beep** None (Normal Boot)
**2 Short Beeps** POST error
**None Speaker broken**, turned off, Power Supply or Motherboard
**Non Stop Beep** Power Supply or Motherboard
**Non-Stop short beeps** Power Supply, Motherboard or Keyboard with something stuck or something on top of it
**1 short beep**, nothing on screen video card failure
**1 short beep**, video present, but system won't boot Bad floppy drive, cable or controller
**1 Long Beep and 1 Short Beep** Motherboard
**1 Long Beep and 2 Short Beeps** Video Card
**1 Long Beep and 3 Short** Beeps Memory

### 7.2 Preventive maintenance: Active, Passive, periodic maintenance procedure

**PreventiveMaintenance**

Preventivemaintenanceis thekey toobtainingyearsoftrouble-freeservicefromyour computersystem.

**Thetwotypesof preventivemaintenanceproceduresareactiveandpassive.**

- Anactivepreventivemaintenanceprogramincludesprocedures thatpromotealonger, trouble-freelifeforyourPC.
- Thistypeof preventivemaintenanceprimarilyinvolvestheperiodiccleaningofthesystem anditscomponents.
- Theactivepreventivemaintenanceproceduresincludecleaningandlubricatingall major components,reseatingchipsandconnectors,andreformattingharddisks.

**ActivePreventive MaintenanceProceduresTools**

a. Contactcleaningsolution
b. Cannedair
c. Asmallbrush
d. Lint-freefoamcleaningswabs
e. Antistaticwrist-groundingstrap
f. Foamtape
g. Computervacuumcleaner
h. Chemicals

**PassivePreventiveMaintenance**

Passivepreventivemaintenanceincludesstepsyoucantaketoprotectasystemfromthe environment,suchas

i) Usingpower-protectiondevices;
ii) Ensuringaclean,temperature-controlled environment;and
iii) Preventingexcessivevibration.

Inotherwords, passivepreventivemaintenancemeanstreatingyoursystemwell.

**PassivePreventiveMaintenanceProcedures**

Passivepreventivemaintenanceinvolvestakingcareofthesystem byprovidingthebest possibleenvironment—both physicalandelectrical—forthesystem.Physicalconcernsare conditionssuchas

a)Ambienttemperature,
b)Thermalstressfrompowercycling,
c)Dustandsmokecontamination,and
d)Disturbancessuchasshockandvibration.

**PreventiveMaintenanceofKeyboard:**

i) Donotspillliquidsonthekeyboard.

ii) Periodicallycleaninteriorofkeyboardwithvacuumcleaner
iii)Press thekeysgentlywithoutapplyingforce.

iv) Usedustcoverforkeyboardwhennotused.

**PreventiveMaintenanceofHDD:**

i) Defragmentharddiskatleastoncea monthtomaintaindiskefficiencyandspeed.

ii) Deletealltemporaryfilessuchas*.temp,~*.*,*.chkandwebbrowserhistoryand temporaryinternetfiles.

iii)Makeperiodicbackupofyourdataandcritical areassuchasbootsectors,FATand directorystructureondisk.

**PreventiveMaintenanceofFDD**

i) Cleanread/writeheadsensitivityusingspecialdiagnosticdiskettes.

ii) Checkrotatingspeedofdriveifitmustbeconstant.

iii)Clean&lubricatethemechanicalpart of drive

iv)Clean read/writeheadusingahead cleaningdiskorcleanheadmanually.

**PreventiveMaintenanceof Monitor:**

1. Usedustcoverformonitorwhenmonitorisoff.
2. Donotputmonitorneartistrongmagneticfieldwhichmaycauseimproperdeflection.
3. Cleanthedisplayscreensothatitisdustfree.
4. Provideproperventilationsuchascoolingfanforheatdissipationtoavoidintermittent failures.
5. Donotputpaperofanythingontopofmonitor.

**PreventiveMaintenanceofPrinter**

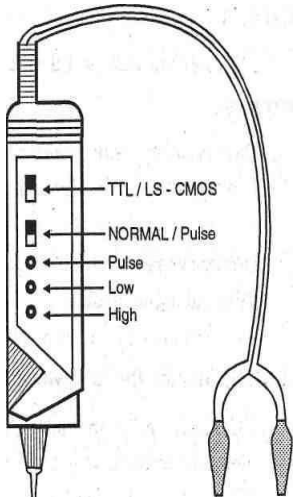
1. Donotplaceprinternearheatgeneratingmachinessuchasheatersandfurnaces

2. Cleanexteriorof printerusingsoftclothwithmildorganicsolvent
3. Periodicallycleanoutdust,paperfragmentsanddirtfromitsmechanismusingsoft brush
    i) Usequalityribbontoavoiddamagetoprinthead
    ii) Usedustcoverforprinterwhennotused
    iii) Checkpaperfeedpathis freeof jam
    iv) Lubricatemechanicalparts.

**7.3 Diagnostic Tools :**

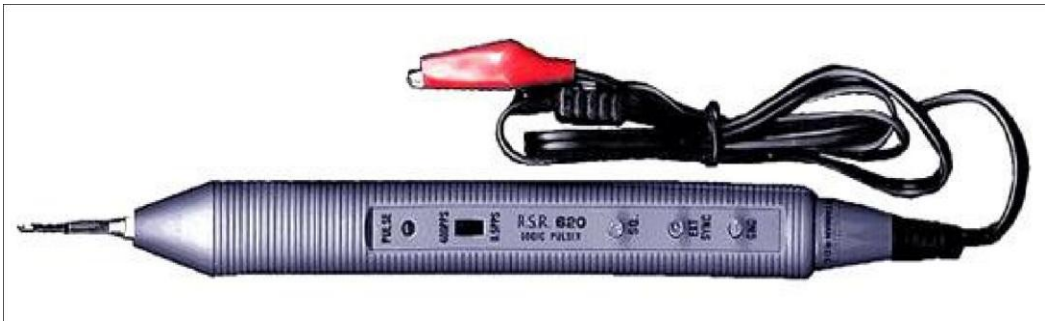
### 7.3.1 LogicProbe:

- Alogicprobecanbeusefulfordiagnosingproblemsindigitalcircuits.
- Inadigitalcircuitasignalisrepresentedaseitherhigh (+5V)orlow(0V) Logicprobesareespeciallyusefulfortroubleshooting adeadsystem.
- Byusingtheprobe,youcandeterminewhetherthebasicclockcircuitryisoperatingand whetherthebasicclockcircuitryisoperatingandwhetherothersignalsnecessaryforsystem operationarepresent.
- Logicprobescanbeusefulfortroubleshooting.

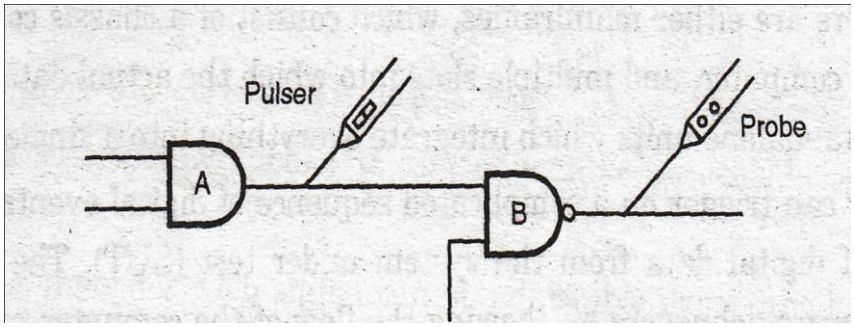


**LogicPulser**

1. Thelogicpulserisahandheldtool usedtoinjectpulsesattheinputofagateundertest.A singlepulseorastreamof pulsesatdifferentfrequenciesisissuedasperuser'schoice.
2. Apulserisdesignedtotestcircuitreactionbyalogicalhigh(+5V)pulseintoacircuitusually lastingfrom1½to10millionthofasecond.Comparethe reactionwiththatofaknown functionalcircuit.
3. Itcanbehelpful fortestingacircuit.

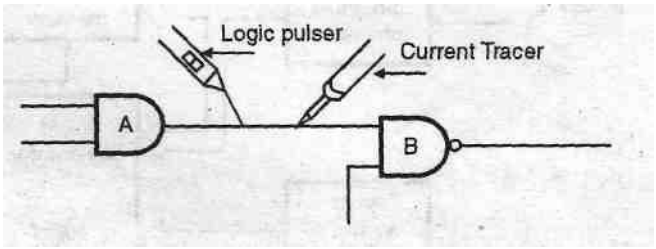



LogicPulser




**Current Tracer**:

Itisahandheldtoolwhichdetectscurrentflow inelectroniccircuits.Itisusefulinlocating shortedcomponents,trackshorts,solderbridges,Vcc togroundshortsetc.



**BlockDiagramandWorkingofLogicAnalyser:**

**LogicAnalyser:**

- **Alogicanalyzer**isanelectronicinstrumentthatdisplayssignalsinadigital circuitthatare toofasttobeobservedandpresentsittoausersothattheusercan moreeasilycheck correct operationofthedigitalsystem
- Alogicanalyzercantriggeronacomplicatedsequenceofdigital events,andthencapture a largeamountofdigitaldata from thesystemundertest(SUT).Thebestlogicanalyzers behavelike software debuggers by showing the flow of the computer program and decodingprotocolstoshowmessagesandviolations

Fig.showsfunctionalblockdiagram oflogicanalyser.Alogicanalyserisadevice,which allowsyou toseethesignalson 16to64signallinesatonce.Itisalsocalledmultitracedigital oscilloscope.

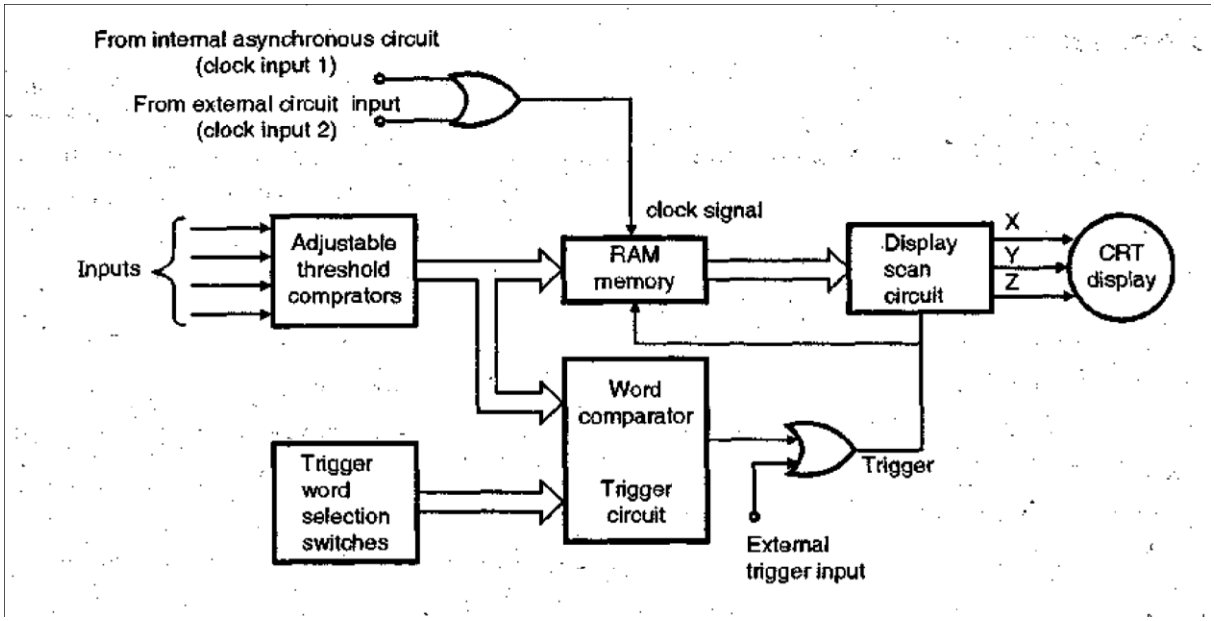



**Fig.7.5**:**Blockdiagramoflogicanalyser**

Itcapturesandstoresseveraldigitalsignals,lettingyouviewthesignalssimultaneously Blockdiagramdescription:

(a) **Adjustablethresholdcomparator**:Theinputsignalsarefirstappliedtotheadjustable thresholdcomparatoroneforeachchannel.

(b) **Memory**:ItisusuallyRAMmemorywheresamplesofinputsignalsaretakenandstored anddisplayedwhen required.

(c) **Displayscancircuit**:Samplesofsignal(around256to1024samplesofeachsignal) whicharestoredinmemorycanbedisplayed.

(d) **Triggerwordselectionswitches**:Itisusedtogivecodewhichwewanttotestwithinput signalappliedtoadjustablethresholdcomparator.

(e) **Wordcomparatorandtriggercircuit**:Wordcomparatorcomparesinputsignalwith binarycodeenteredwiththehelpoftriggerselectionswitchesorkeyswitches.

**Software Diagnostic Tool**

Diagnosing Windows is not only something IT analysts need to worry about. Anyone who owns a computer should be comfortable using Windows diagnostics tools to do basic troubleshooting.

Believe it or not, you can fix most problems yourself if you have the right tools available and know how to use them.

1. Process Explorer

Process Explorer also includes all the following diagnostics features:

- Real-Time CPU, Memory, I/O, and GPU charts.
- Color coding to see most active processes.
- Get detailed properties about processes like memory, priority, handles, and more.
- Customize multiprocessor CPU load and process priority.

2. CPUID:

CPUID is a powerful tool to view everything you need to know about your CPU. It can also help gather GPU or memory card information if you're looking to upgrade your system and want to find a perfect match.

It's free to download and use and works on both 32-bit and 64-bit systems. The amount of information it shows you about your CPU and other system information is impressive.

1. Processor brand and all specifications
2. Cache sizes
3. Motherboard brand and version.
4. Current memory size and timings
5. Specs for memory cards in each slot
6. GPU brand, clock speed and memory
7. CPU benchmarking and stress testing tools

3. Wi-Fi Analyzer

It provides the current strength of available Wi-Fi signals. It also shows you a breakdown of details for the network you're currently connected to. These include the channel, frequency, bandwidth, and more.

Other features of the free version include:

- Realtime graph of all local Wi-Fi signals and their strength
- Filter Wi-Fi graphs based on wireless frequency
- Bar chart of the strength of all available wireless networks
- Link speed of your currently connected network

## BallGridArray(BGA)

1. A**ballgrid array**(**BGA**)is a typeofsurface-mounttechnology(SMT) thatisusedfor packagingintegratedcircuits.
2. BGApackagesare usedtopermanentlymountdevicessuch asmicroprocessors.
3. A BGAcanprovidemore interconnectionpinsthancanbe putona dual in-lineorflat package.
4. Thewholebottomsurfaceofthedevicecanbe used,instead ofjusttheperimeter.The leadsare alsoonaverageshorterthanwithaperimeter-onlytype,leadingtobetter performance athighspeeds.

**Bottomviewof anIntelEmbedded Pentium MMX, showing theblobsof solder**

## Featuresof BGA

1. Smallpackagearea
2. Greaterfunctions andmorepins
3. More Reliable
4. Goodconductivityandlowoverall cost

## BGAWorkstationApplications

1. Itis usedtoreplacethefaultyNorth Bridgeor South Bridge IC or Re-balling ofthese ICs.

2. Itis alsoused torepairMobile,Laptop,Servers , DesktopBoards.
3. Itis safelyremoved anyIC from motherboard without damaginganything.

Itis usedmost ofthetimefor upgradationofon-board ormotherboardfunctionality

**BGARe-Workstation**

1. Rework is the termfortherefinishingoperation or repair of anelectronic printedcircuit board (PCB)assembly, usuallyinvolvingdesolderingandresolderingofsurface mounted electronic components(SMD).
2. Specializedmanual techniques byexpert personnel usingappropriate equipment are required toreplace defectivecomponentsand ball grid array(BGA)devices particularly require expertise and appropriate tools thatare calledBGARe-workstation.
3. A hotair gunor hotairstationis usedto heatdevices and melt thesolder and specialized toolsare usedto pickupandpositionoften tinycomponents**.**

**BGAReworkprocess**

1. Mostofthesemiconductor device's heat-resistanttemperaturesarebetween$240^0$ C and$600^0$C. Thereforethecontrolofthetemperatureanduniformityare veryimportant to BGARework systems.

**BGARemovalfrom Circuit Board**

1. Prior toremoval, PCBpreheatingis necessary.Bysaturatingthecopper withinPCB, thenapplyingtop heatto thecomponenttoberemoved,theheatbecomeslocalized at thecomponentandnotdistributedthroughoutthethermallyconductivematerial ofthe PCB.
2. Processfor saferemoval oftheBGAcomponentis completedwithaHotGas Rework Station.
3. Thecircuit boardmayrequire additionalpreparationsuch asbakingandmaskingthe

areaoffadjacenttothere-work site.

4. Topreventdamagethe temperatureofthecircuit board andcomponentmustbeclosely monitoredwith thermocouplesduringtheremoval cycle.

**2.Circuit BoardSiteCleaning**

1. After componentremoval, thenextstepis sitecleaningalsoreferred toas residual solder removal.
2. Thisprocesshasbeendoneoff-line typicallywith an operator usinga handsoldering iron andcopperbraid.
3. Circuit boardandcomponentsitecleaningiscompletedwithvacuumde-soldering nozzlethatremoves allresidual solderfromthesites.

**3.BGAReballing**

1. The placementofsolder balls on theworkstationandre-ballingtheBGAcomponent mustbecompletedprior to placementon thecircuit board.
2. For this process aspeciallydesigned toolforre-ballingis usedalongwithspecific stencils andsolderballs tomatch thelayout oftheworkstationandBGAcomponent.

**4.ComponentAttach/Re-soldering**

1. This stepshouldbesimilar toremovingthedevicefromthe PCB.
2. ThemaindifferencenowthatthedeviceIs removedfromthePCB,is thatthere is sufficientaccesstoeither printsolderonto the device or PCBbefore the BGAis soldered.

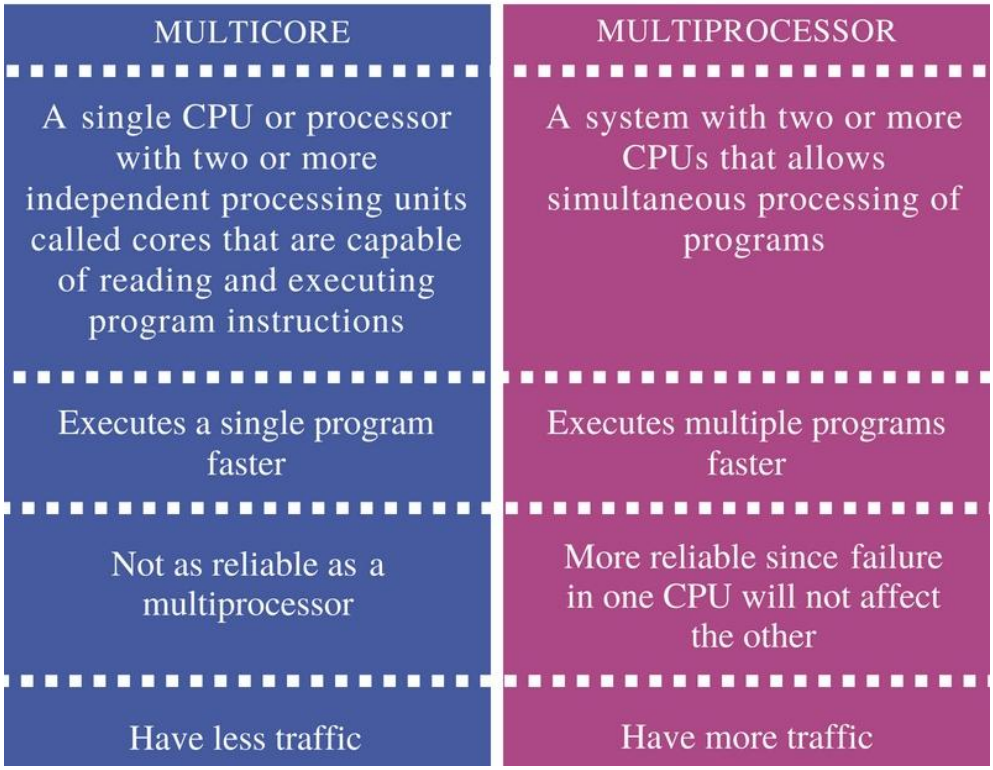
## CHAPTER 8

**OVERVIEW OF PARALLEL PROCESSING AND PIPELINING PROCESSING:**

- Study and comparison of uniprocessors and parallel processors.
- Conventional and EPIC architecture.
- Evolution of parallel processors, Future trends and their architecture.
- Overview of Parallel Processing and Pipelining Processing.
- Necessity of High Performance, Constraints of conventional architecture, Parallelism in uni-processor system,
- Evolution of Parallel processors, Future trends, Architectural Classification, Applications of parallel Processing, Instruction level Parallelism and Thread Level Parallelism, Explicitly Parallel Instruction Computing (EPIC) Architecture, Case Study of Intel Itanium Processor.
- Principles of scalable performance: Performance Metrics and Measures, Speedup Performance Laws. Programming aspects for Intel Itanium Processor.

### 1. STUDY AND COMPARISON OF UNIPROCESSORS AND PARALLEL PROCESSORS.

1. **A uniprocessor system** is defined as a computer system that has a single central processing unit that is used to execute computer tasks.
2. As more and more modern software is able to make use of multiprocessing architectures, such as SMP and MPP, the term uniprocessor is therefore used to distinguish the class of computers where all processing tasks share a single CPU.
3. Most desktop computers are now shipped with multiprocessing architectures. As such, this kind of system uses a type of architecture that is based on a single computing unit. All operations (additions, multiplications, etc.) are thus done sequentially on the unit.
4. **Parallel processing** is a method in computing of running two or more processors (CPUs) to handle separate parts of an overall task.
5. Breaking up different parts of a task among multiple processors will help reduce the amount of time to run a program.
6. Any system that has more than one CPU can perform parallel processing, as well as multi-core processors which are commonly found on computers today.




**EPIC (EXPLICITLY PARALLEL INSTRUCTION COMPUTING)**

EPIC (Explicitly Parallel Instruction Computing) is a 64-bit microprocessor instruction set which is an improvement to the VLIW (Very Large Instruction Word) architecture. It provides up to 128 general and floating point unit registers and uses speculative loading, predication, and explicit parallelism to accomplish its computing tasks.

It has been, originally, developed by Intel and Hewlett Packard.

By comparison, current 32-bit CISC and RISC microprocessor architectures depend on 32-bit registers, branch prediction, memory latency, and implicit parallelism, which are considered a less efficient approach in microarchitecture design.

Origin

By 1989, researchers at HP recognized that reduced instruction set computer (RISC) architectures were reaching a limit at one instruction per cycle. They began an investigation into a new architecture named EPIC. The basis for the research was VLIW, in which multiple operations are encoded in every instruction, and then processed by multiple execution units.

One goal of EPIC was:

- to move the complexity of instruction scheduling from the CPU hardware to the software compiler
- exploit instruction level parallelism (ILP) by using the compiler to find and exploit additional opportunities for parallel execution

The idea is that a compiler can do the instruction scheduling statically (with help of trace feedback information). This results in:

- no need of complex scheduling circuitry in the CPU
- frees up space and power for other functions, including additional execution resources.

## Evolution of parallel processors, Future trends and their architecture

Parallel processing is a form of information processing involving concurrency techniques to achieve more efficient computing systems.

The evolution of computer systems is most famously described in terms of computer generations. There are five generations till now, beginning from 1940s.

**First Generation (1939-1954):** The first generation marks the development of computer systems utilizing a technology of vacuum tubes. This generation was marked with several developments because of the ongoing World War II. ENIAC, Mark III, UNIVAC, Clyde (tube computers) were built in this time.

**Second Generation (1954-1959):** The second generation saw the development of transistor technology, and IBM introduced the first solid state computers. It was also the generation of SSI and MSI (Small and Medium Scale Integrated) circuits.

**Third Generation (1959-1971):** Texas Instruments patented first integrated circuits. The first minicomputer, PDP-8 was introduced. Project ARPANET was introduced. Intel developed first Large Scale Integrated (LSI) circuits.

**Fourth Generation (1971-1991):** VLSI (Very Large Scale Integrated) circuits were introduced. This helped reduce cost of computers greatly. Microprocessors were developed. This generation also marked the rise of Apple, Microsoft and Nintendo.

**Fifth Generation (1991-Present):** World Wide Web (by Tim Berners Lee, CERN) and browsers (Mosaic, Netscape Navigator, Explorer) were introduced.

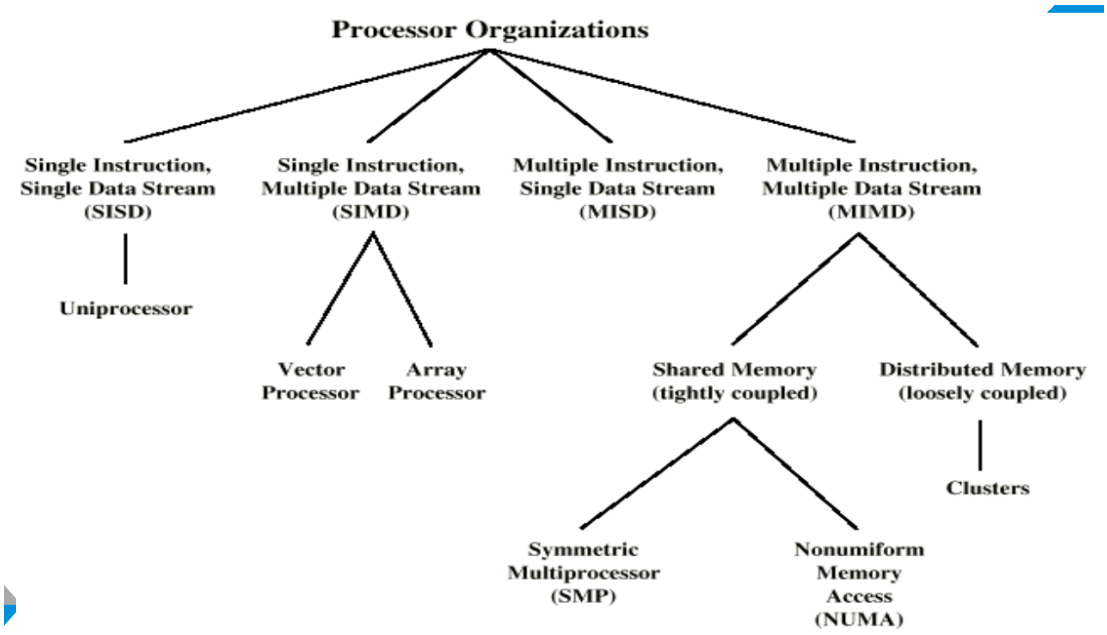
**PARALLEL PROCESSING ARCHITECTURE**

There are multiple types of parallel processing, two of the most commonly used types include SIMD and MIMD. SIMD, or single instruction multiple data, is a form of parallel processing in which a computer will have two or more processors follow the same instruction set while each processor handles different data. SIMD is typically used to analyze large data sets that are based on the same specified benchmarks.

MIMD, or multiple instruction multiple data, is another common form of parallel processing which each computer has two or more of its own processors and will get data from separate data streams.

Another, less used, type of parallel processing includes MISD, or multiple instruction single data, where each processor will use a different algorithm with the same input data.

Classification of Parallel Processor Architecture:

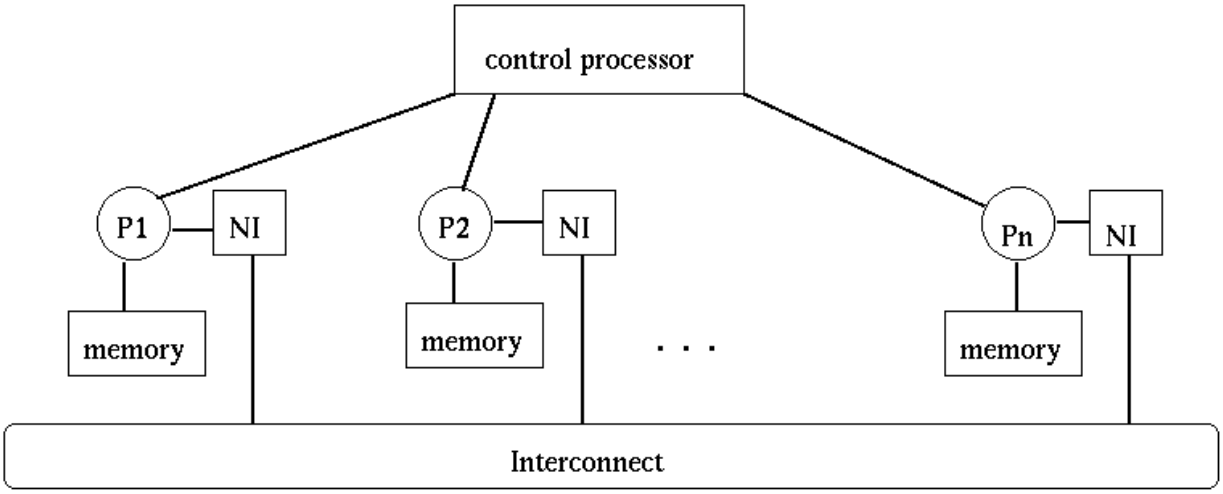



## 1. SIMD (SINGLE INSTRUCTION STREAM, MULTIPLE DATA STREAM) ARCHITECTURE

**Main Feature of the architecture**:

- Large number of small or simple processors.
- Each processor has its own memory.
- Typically, only connected to its neighbors (NEWS), and usually customized (not off-the-shelf) processors.
- A single "control processor" issues each instruction, in turn, every processor executes the same instruction on its local data at the same time.
- Some processors may be turned off on any instruction. This allows certain logical operations to be performed.

A schematic view of the architecture is shown below.

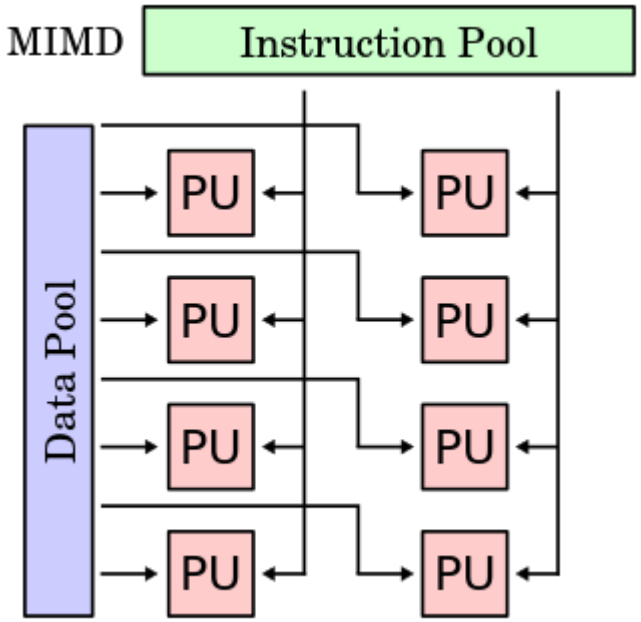


- Main advantage of these machines is the ease of programming. The disadvantage is that they are specialized machines and not suited to all applications.
- These architectures support the interesting model of data-parallelism.

**2. MIMD (MULTIPLE INSTRUCTION, MULTIPLE DATA)**

- In computing, **MIMD** (**multiple instruction, multiple data**) is a technique employed to achieve parallelism.
- Machines using MIMD have a number of processors that function asynchronously and independently.
- At any time, different processors may be executing different instructions on different pieces of data.
- MIMD architectures may be used in a number of application areas such as computer-aided design/computer-aided manufacturing, simulation, modeling, and as communication switches.
- MIMD machines can be of either shared memory or distributed memory categories.
- These classifications are based on how MIMD processors access memory. Shared memory machines may be of the bus-based, extended, or hierarchical type. Distributed memory machines may have hypercube or mesh interconnection schemes.

A schematic view of the architecture is shown below.




Overview of Parallel Processing and Pipelining Processing

**Parallel Processing:**

Parallel processing is a method in computing of running two or more processors (CPUs) to

handle separate parts of an overall task. Breaking up different parts of a task among multiple processors will help reduce the amount of time to run a program. Any system that has more than one CPU can perform parallel processing, as well as multi-core processors which are commonly found on computers today.

Multi-core processors are IC chips that contain two or more processors for better performance, reduced power consumption and more efficient processing of multiple tasks. These multi-core set-ups are similar to having multiple, separate processors installed in the same computer. Most computers may have anywhere from two-four cores; increasing up to 12 cores.

Parallel processing is commonly used to perform complex tasks and computations. Data scientists will commonly make use of parallel processing for compute and data-intensive tasks.

**HOW PARALLEL PROCESSING WORKS**

Typically, a computer scientist will divide a complex task into multiple parts with a software tool and assign each part to a processor, then each processor will solve its part, and the data is reassembled by a software tool to read the solution or execute the task.

Typically, each processor will operate normally and will perform operations in parallel as instructed, pulling data from the computer's memory. Processors will also rely on software to communicate with each other so they can stay in sync concerning changes in data values. Assuming all the processors remain in sync with one another, at the end of a task, software will fit all the data pieces together.

Computers without multiple processors can still be used in parallel processing if they are networked together to form a cluster.

Pipelining Processing:

- Pipelining is the process of accumulating instruction from the processor through a pipeline.
- It allows storing and executing instructions in an orderly process. It is also known as **pipeline processing**.
- Pipelining is a technique where multiple instructions are overlapped during execution.
- Pipeline is divided into stages and these stages are connected with one another to form a pipe like structure. Instructions enter from one end and exit from another end.
- Pipelining increases the overall instruction throughput.

**How Pipelining Works:**

The processor execute the program by fetching and executing instructions. One after the other.

Let Fi and Ei refer to the fetch and execute steps for instruction I

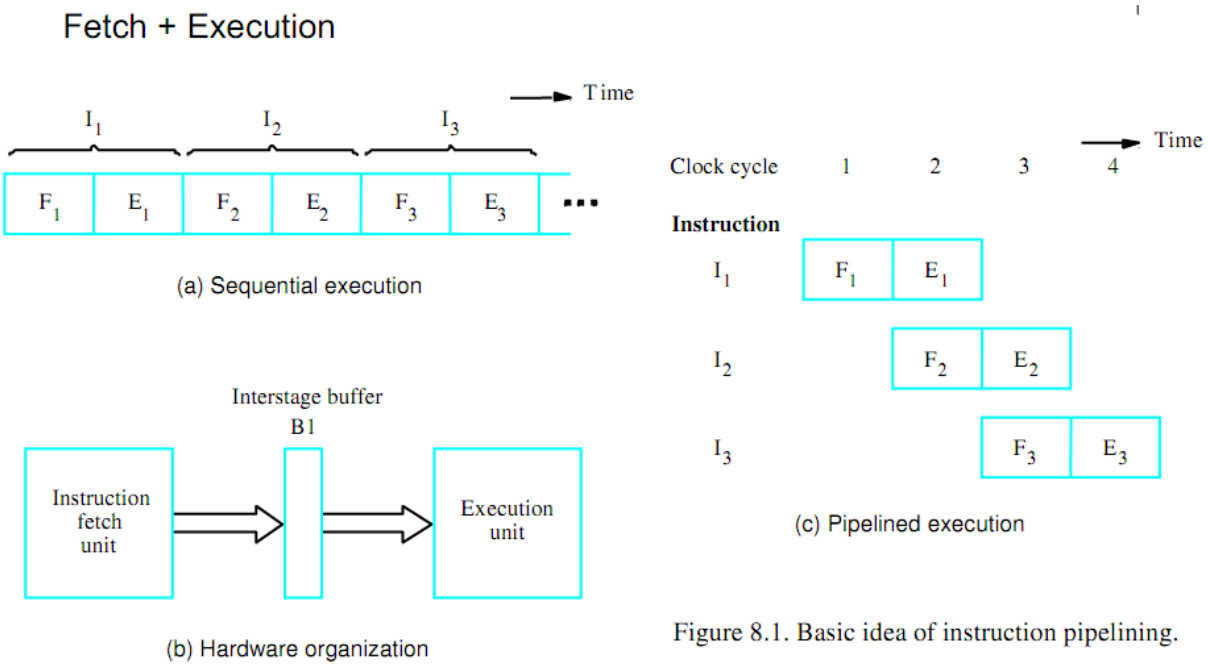


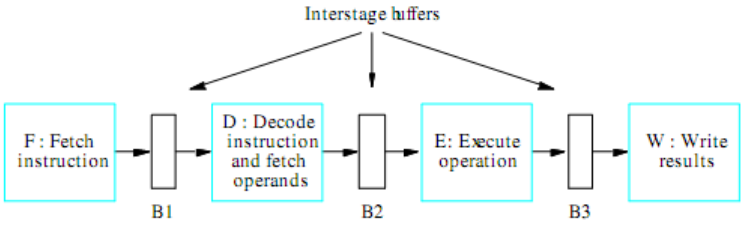

Figure 8.1. Basic idea of instruction pipelining.

- Computer that has two separate hardware units, one for fetching and another for executing them.
- the instruction fetched by the fetch unit is deposited in an intermediate buffer B1.
- This buffer needed to enable the execution unit while fetch unit fetching the next instruction.
- The computer is controlled by a clock.
- Any instruction fetch and execute steps completed in one clock cycle.

**Use the Idea of Pipelining in a Computer**

Fetch + Decode
+ Execution + Write


(a) Instruction execution divided into four steps




(b) Hardware organization

**HIGH PERFORMANCE COMPUTING**

- High-performance computing (HPC) evolved due to meet increasing demands for processing speed.
- HPC brings together several technologies such as computer architecture, algorithms, programs and electronics, and system software under a single canopy to solve advanced problems effectively and quickly.
- A highly efficient HPC system requires a high-bandwidth, low-latency network to connect multiple nodes and clusters.

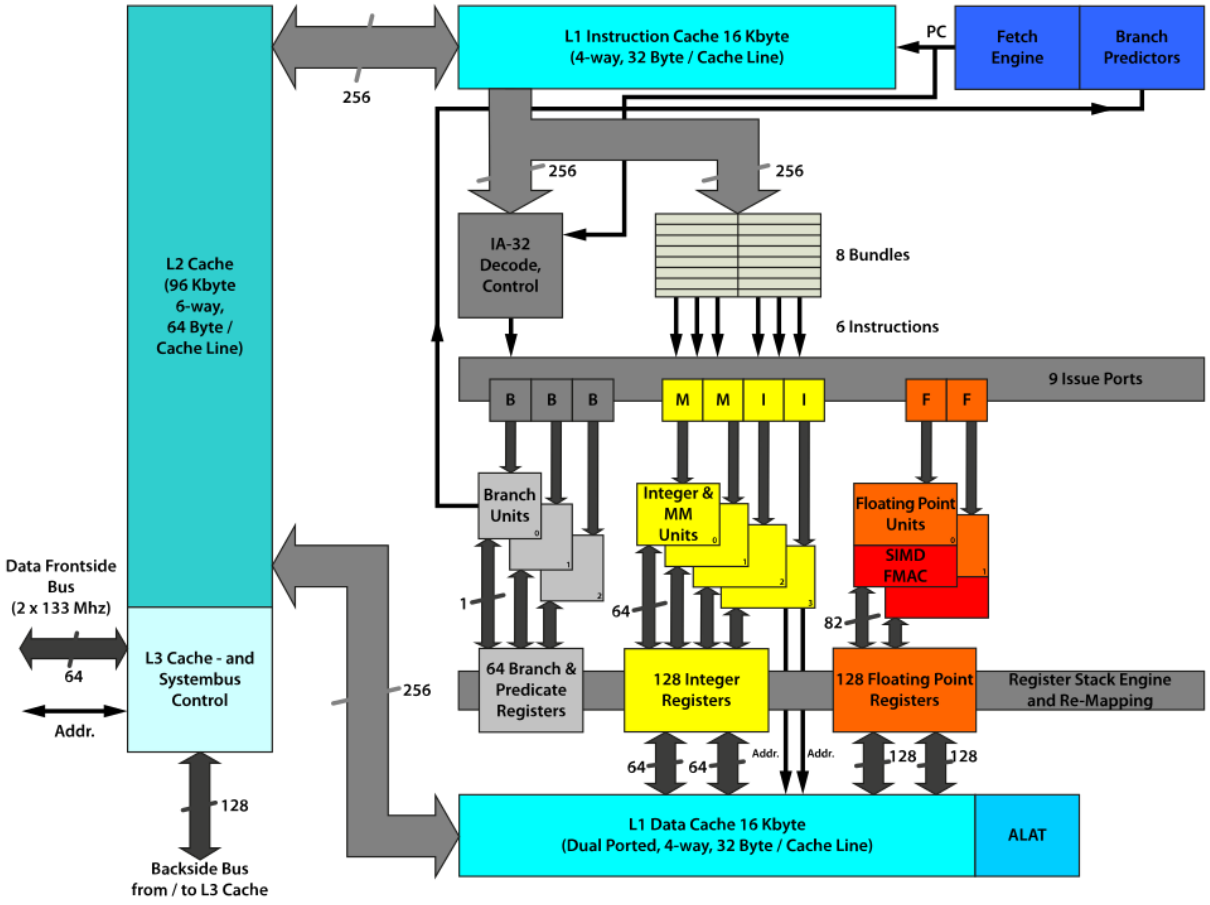
HPC technology is implemented in multidisciplinary areas including:

- Biosciences
- Geographical data
- Oil and gas industry modelling
- Electronic design automation
- Climate modelling
- Media and entertainment

**INTEL ITANIUM ARCHITECTURE**

- IA-64 (also called Intel Itanium architecture) is the instruction set architecture (ISA) of the Itanium family of 64-bit Intel microprocessors.

- The basic ISA specification originated at Hewlett-Packard (HP), and was evolved and then implemented in a new processor microarchitecture by Intel with HP's continued partnership and expertise on the underlying EPIC design concepts.
- In order to establish what was their first new ISA in 20 years and bring an entirely new product line to market, Intel made a massive investment in product definition, design, software development tools, OS, software industry partnerships, and marketing.
- To support this effort Intel created the largest design team in their history and a new marketing and industry enabling team completely separate from x86.
- The first Itanium processor, codenamed Merced, was released in 2001.
- The Itanium architecture is based on explicit instruction-level parallelism, in which the compiler decides which instructions to execute in parallel.
- This contrasts with superscalar architectures, which depend on the processor to manage instruction dependencies at runtime.
- In all Itanium models, up to and including Tukwila, cores execute up to six instructions per clock cycle.
- In 2008, Itanium was the fourth-most deployed microprocessor architecture for enterprise-class systems, behind x86-64, Power ISA, and SPARC



It is a 64-bit register-rich explicitly parallel architecture. The base data word is 64 bits, byte-addressable. The logical address space is $2^{64}$ bytes. The architecture implements predication, speculation, and branch prediction. It uses variable-sized register windowing for parameter passing. The same mechanism is also used to permit parallel execution of loops. Speculation, prediction, predication, and renaming are under control of the compiler: each instruction word includes extra bits for this. This approach is the distinguishing characteristic of the architecture.

The architecture implements a large number of registers:[36][37][38]

- 128 general integer registers, which are 64-bit plus one trap bit ("NaT", which stands for "not a thing") used for speculative execution. 32 of these are static, the other 96 are stacked using variably-sized register windows, or rotating for pipelined loops. $gr_0$ always reads 0.
- 128 floating point registers. The floating point registers are 82 bits long to preserve precision for intermediate results. Instead of a dedicated "NaT" trap bit like the integer registers, floating point registers have a trap value called "NaTVal" ("Not a Thing Value"), similar to (but distinct from) NaN. These also have 32 static registers and 96 windowed or rotating registers. $fr_0$ always reads +0.0, and $fr_1$ always reads +1.0.
- 64 one-bit predicate registers. These also have 32 static registers and 96 windowed or rotating registers. $pr_0$ always reads 1 (true).
- 8 branch registers, for the addresses of indirect jumps. $br_0$ is set to the return address when a function is called with br.call.
- 128 special purpose (or "application") registers, which are mostly of interest to the kernel and not ordinary applications. For example, one register called bsp points to the second stack, which is where the hardware will automatically spill registers when the register window wraps around.