

Chapter No. 4 Input Output Devices

KEYBOARDS:-

Introduction:

- I/O is the communication between the CPU of the computer system and the outside world, it may be any device like keyboard, mouse, monitors, printers etc.
- I/O device is used to feed the data into the computer system & output device is required by the computer, to show the result to the user
- Devices for communication between computers, such as modems and network cards typically serves for the both Input & Output.

Keyboard:

- Keyboards are the classical I/P device for computers, by manipulating a MATRIX of individual electrical switches, commands & instructions can be entered into the computer one character at a time.

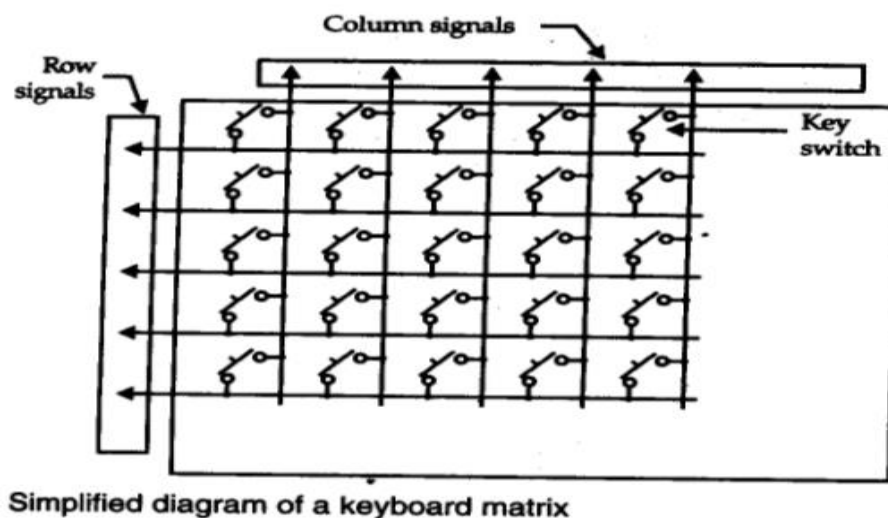


Fig. Structure of Key Switch

Types of key switches:

Q. List any four types of key switches.

S-09, 10,11,12,13 W-09, 15

- Capacitive switch
- Hall-Effect key switch
- Opto-electronic key switch
- Mechanical key switch
- Membrane key switch
- Rubber Dome

1. Capacitive Key Switch

Q. With neat diagram, explain capacitive switch.

W-08

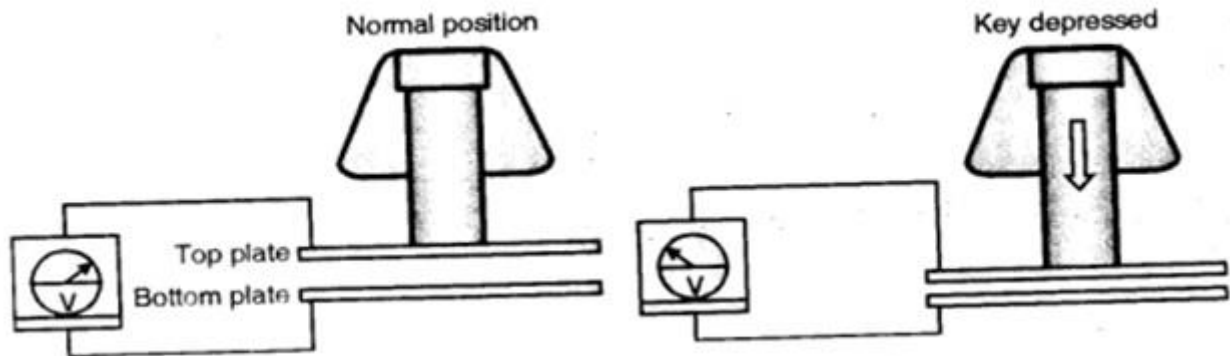


Fig. capacitive switch

Explanation:-

- As shown in fig., a capacitive key switch has two small metal plates on the printed circuit board and another metal plate on the bottom of a piece of foam.
- When you press the key, the movable plate is pushed closer to the fixed plate.
- This changes the capacitance between the fixed plates.
- Sense amplifier circuitry detects this change in capacitance and produces a logic level signal that indicates a key has been pressed.
- The big advantage is the specialized circuitry needed to detect the change in capacitance.
- Capacitive key switches typically have a rated lifetime of about 20 million keystrokes.

2. Hall Effect Switch

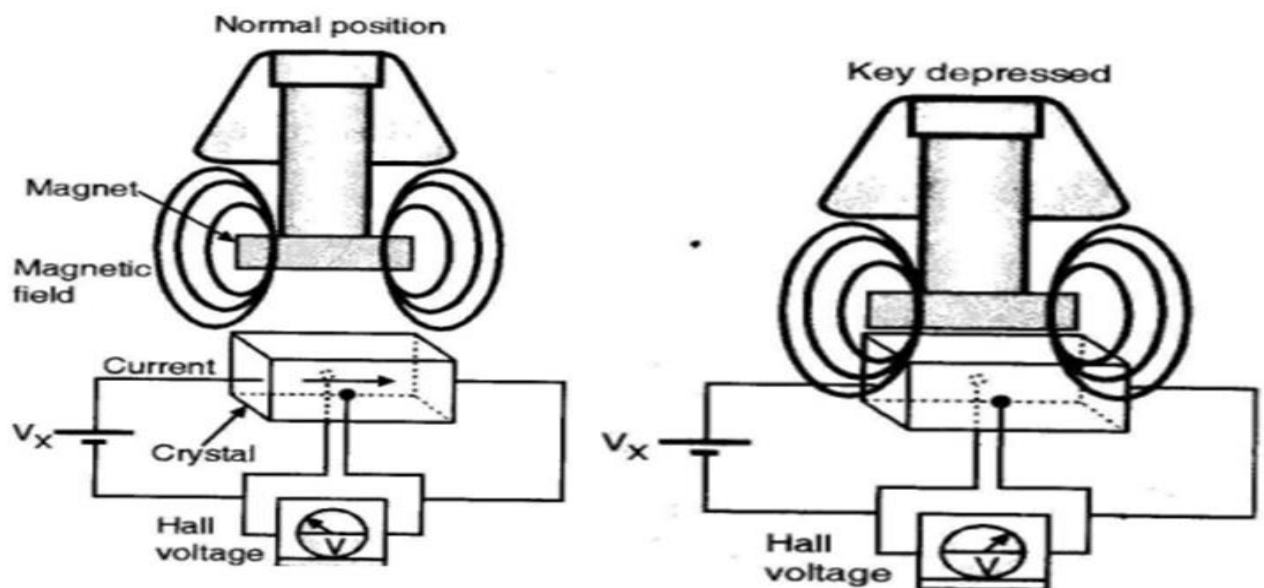
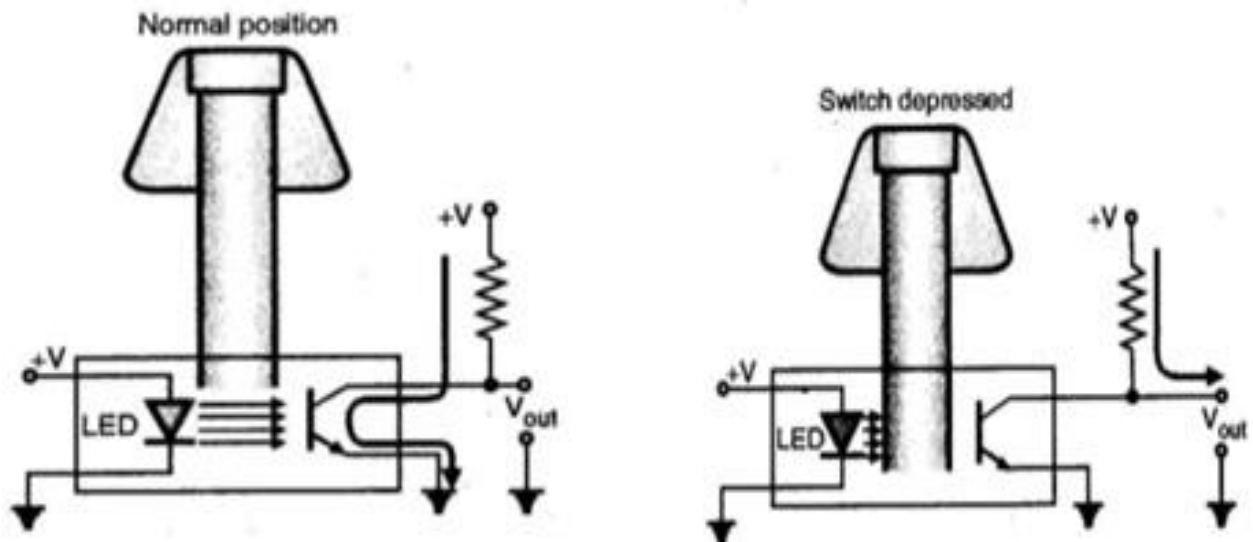


Fig. Hall Effect Switch

Explanation:-

- Hall Effect specifies that when a magnetic field is applied to any device perpendicular to the direction of the current flow inside the device the resistance of the device increases & when this magnetic field is removed the resistance decreases or the current starts to flow without any resistance.
- This effect can be used as a switch to turn the current flow ON & OFF.
- The current flow can be turned OFF by applying a very strong magnetic field to completely block the current flow through the device.
- It does not contain any mechanical contacts.
- Normal Lifespan 100 million keystrokes.

3. Opto –Electronic key Switch**Fig. Opto –Electronic key Switch****Explanation:-**

- It has LED's which generates lights when power is applied.
- A photo transistor is used opposite to LED's.
- A photo transistor allows the current to flow as long as light is applied to it.
- In this, when the key is not pressed light from LED fall on to the Photo transistor.
- It produces low O/P voltage V_{out} .
- When key is depressed light from LED is blocked & no current will flow. (Cut off condition.)
- In this condition the current cannot flow through the photo-transistor & different value will be produced at the output V_{out} .

4. Mechanical Key Switch

Q. Write working principle of mechanical key switch with neat diagram. S-08, 13

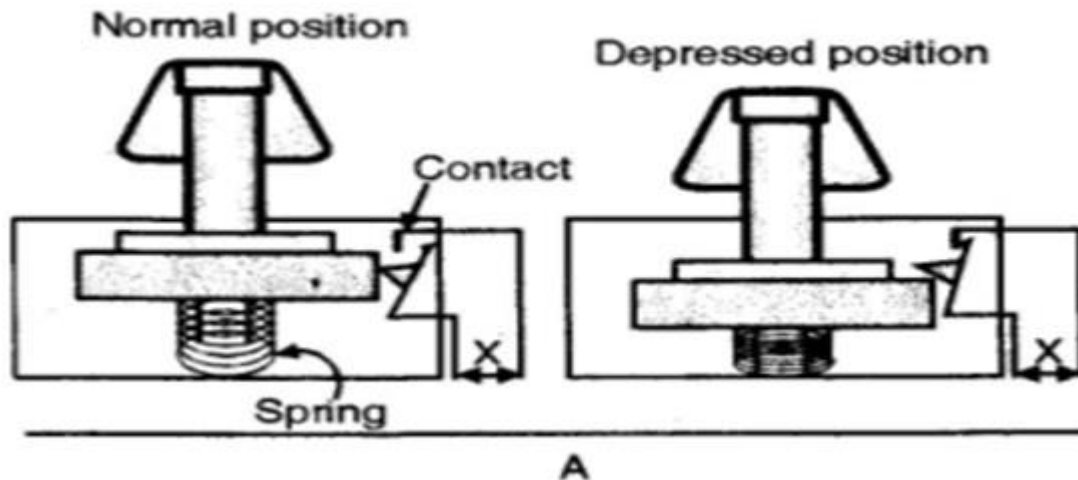


Fig. Mechanical Key Switch

Explanation:-

- Most common type of key switches.
- Two metal pieces are kept in open position & moved in to closed position when switch is depressed.
- When switch is in normal position the contact is open.
- When switch is pushed (some mechanical action) it closes the switch & it is sensed by the keyboard interface at Location "X" in fig.
- This type of switches works when contact closed, these contact become oxidized or dirty & make the switch useless.
- Life Span around 1 million keystrokes.

5. Membrane Key Switch

Q. With neat diagram, explain membrane switch.

W-08, 11

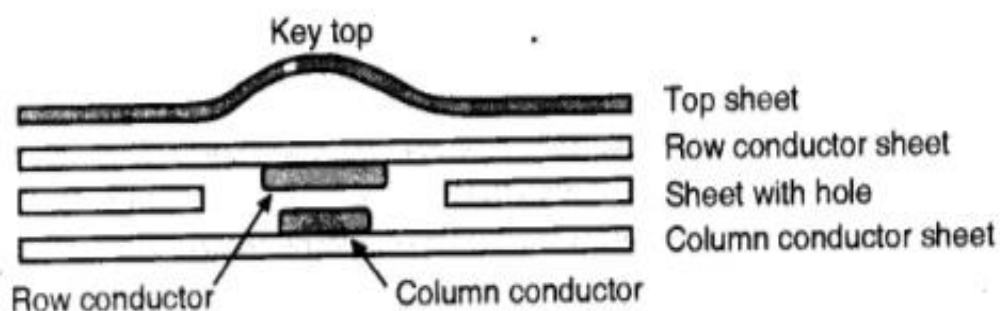


Fig. 4.5 : Membrane type keyboard switch

Explanation:-

- It is a multi-layer plastic or rubber assembly.

- Two plastic/rubber sheets are used as row conductor sheet & column conductor sheet.
- These sheets are separated by another sheet with holes at key top position.
- When key top is pressed it forces row conductor sheet through the hole to touch the column conductor sheet.
- When row lines touches the column line, key contact is made.
- This is interpreted by keyboard interface as key closure.

6. Rubber Dome

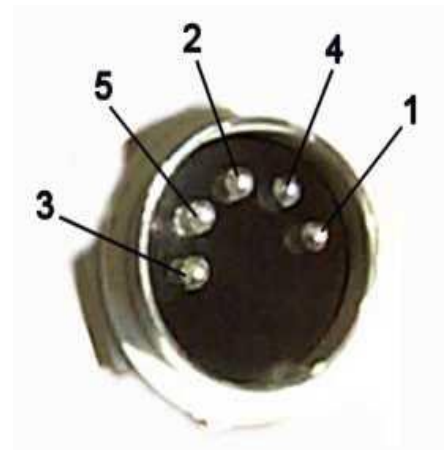
- Very common now days.
- It also polydom switches.
- It is formed by using polyester domes where inside bubble is coated in graphite.
- Not suitable for gaming purpose.
- This type of switch technology is commonly used in hand held controllers, mobile phones, automotive, consumer electronics & medical devices.

Keyboard Connector

1. AT keyboard Connector(DIN5)
2. PS/2 keyboard Connector or (MINI-DIN6)
3. USB keyboard Connector

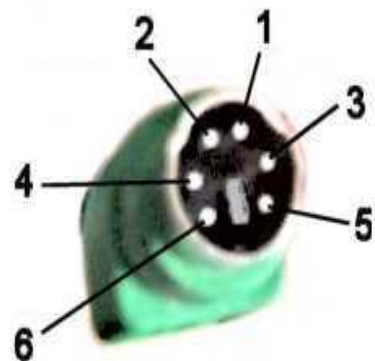
1. AT keyboard Connector (DIN5)

Connector Pin #	Purpose
Pin 1	KBDCLK (clock)
Pin 2	KBDAT (data)
Pin 3	KBRST (reset, not used)
Pin 4	GND
Pin 5	VCC (+5V)



2. PS/2 keyboard Connector or (MINI-DIN6)

Connector Pin #	Purpose
Pin 1	KBDAT (data)
Pin 2	Not used
Pin 3	GND
Pin 4	VCC (+5V)
Pin 5	KBDCLK (clock)
Pin 6	Not used



MOUSE

- The most common input device used in computer field.
- It is one of the pointing devices which use a combination of h/w & s/w to control the position of a graphical cursor.
- The driver s/w generates the cursor & keeps track of its position.
- As the mouse is moved, the mouse driver interprets the signals from the mouse & accordingly moves the cursor.

Components of a Mouse:-

- **A roller ball** – which signals movements to the system.
- **Buttons** – For making the selection.
- **Cable** – For connecting the mouse to the system.
- **Connector** – For interfacing mouse to the system.

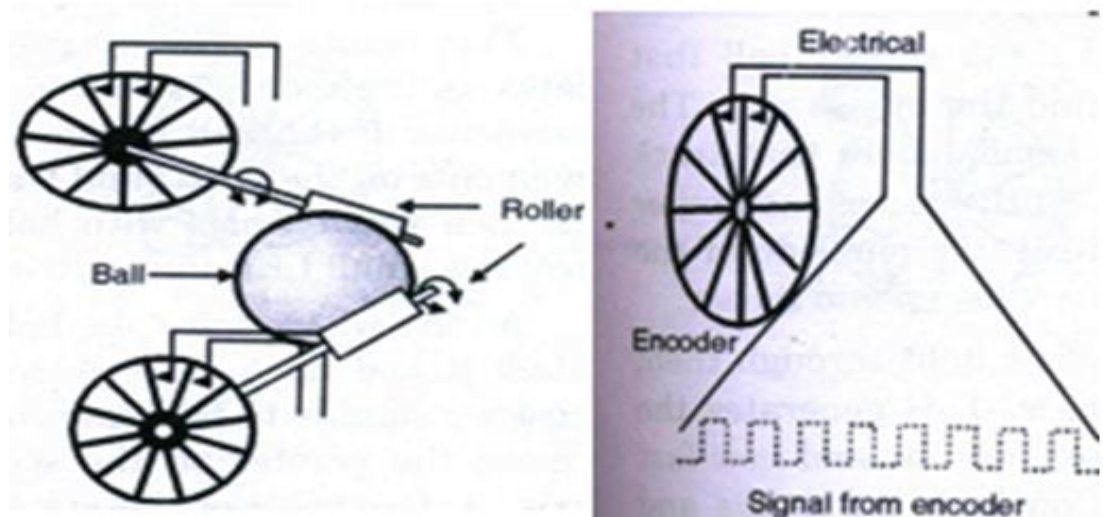
Types of Mouse: - (Based on Technology)

1. Mechanical
2. Opto Mechanical
3. Optical

Working Principle of Mouse

- When a mouse is rolled across a flat surface, X & Y rollers inside a mouse moves & generates electric signals.
- The signals are given to computer & computer converts them into proper action on the screen.

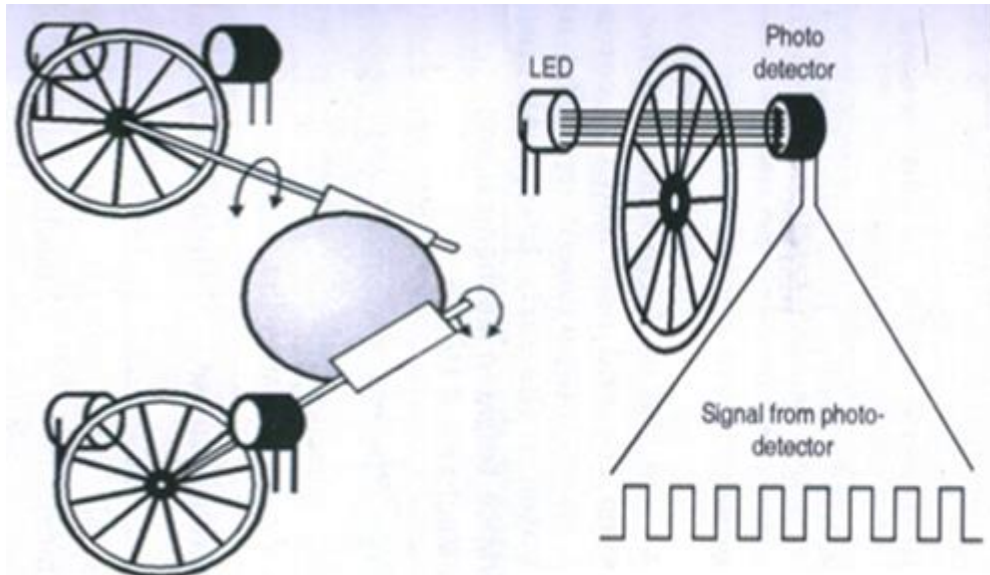
1. Mechanical Mouse:-



- A rubber ball rotates as a mouse is moved across a table top & the rubber ball turns vertical & horizontal wheels inside the mouse.
- The ball rotates the wheels in the direction of movement of mouse.
- The ball in turn will rotate the rollers inside a mouse
- These rollers are mounted at a 90 degree angle to each other. One for vertical movement & other for horizontal.
- Each roller is attached to an encoder which is having a wheel like structure.
- As the roller turns, the encoder rotates with them.

- Two pair of contact bars touches the small metal contact points & generates a signal.
- The direction can be found out by finding no of signals from these two vert. & horizontal. Rollers.
- These signals are sent to PC serially & are converted in Distance, Direction & Speed Necessary to move cursor on screen.
- Also the button press will send a signal to PC.

2. Opto Mechanical Mouse:-



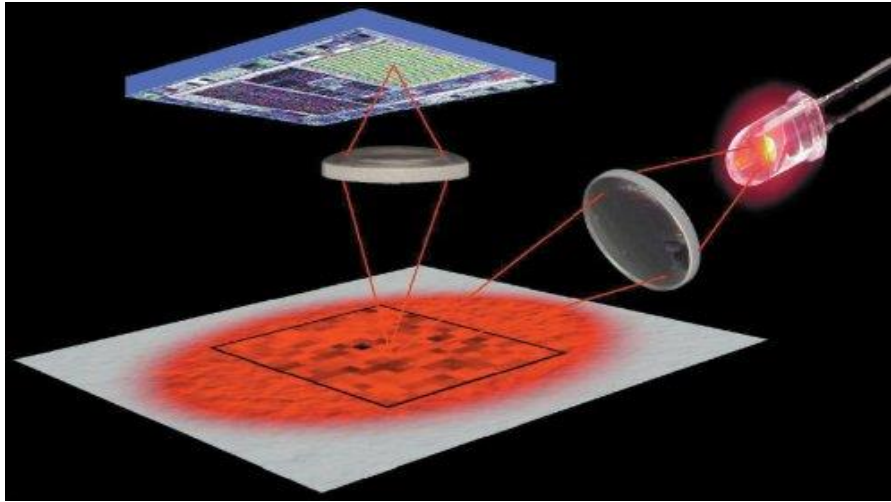
1. When mouse is moved, the ball of mouse moves & it turns two separate rollers fixed at 90 degree to each other. One roller is used for vertical movement of cursor & other for horizontal movement.
2. Each roller is connected with a wheel. These wheels are rotated by the corresponding movement of the rollers.
3. There are small opening on the rim of the each wheel. As the wheel rotates a pair of LED & photo detector detects the no. of opening on the wheel allows the light from the LED to fall on the photo detector & generate an electric signal.
4. These signals are then passed to the system along with button press (if any)

3. Optical Mouse

Inside an optical mouse is a small (camera) photo detector. A small LED provides light underneath the mouse, helping to highlight slight differences in the surface. These differences are reflected back to the photo detector where digital processing is used to compare the pictures & determine the speed & direction of movement.

WORKING:-

1. The LED produces a light (usually red color) is emitted onto a surface. The light is reflected off the surface back to the CMOS sensor.
2. The CMOS sensor sends each image that is reflected back to a Digital signal processor for analysis.
3. Using these thousands of images, the CMOS sends it to DSP for analysis; the DSP is able to detect both patterns & images & can determine the position.



ADVANTAGES:-

1. Less affected by dust.
2. Less chances of failure(no mech. Parts)
3. Increased tracking resolution gives smoother response.
4. Does not require special surface(mouse pad)
5. More accurate & sensitive.

DISADVANTAGE:-

1. Costly.

SCANNERS

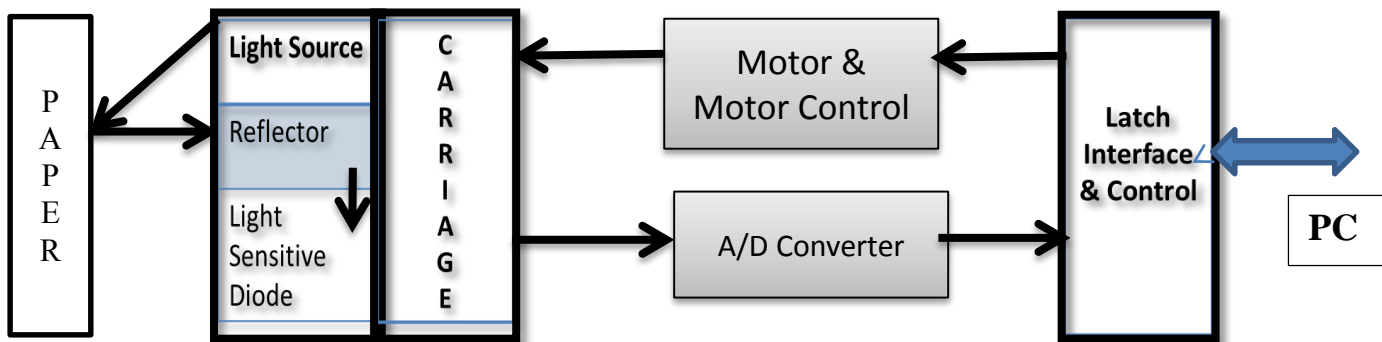
- A special input device which converts both pictures & text into stream of data.
- Scanner is also useful for OCR (Optical Character Recognition).
- By using OCR user can convert their scanned docs. In the format that word processing s/w (MS WORD) can understand.

Scanner Types:-

1. Based on type of image that it can scan & store
 - i. B & W ii. Gray Scale iii. Color
2. Based on working
 - i. Flat Bed ii. Sheet Fed iii. Hand Held iv. Drum

1. Flat Bed Scanner:-

- It is also known as a desktop scanner.
- Place a sheet of paper on the glass top & the scanner copies your image to the computer.



Working Principle:

- A light source fetches the paper on the glass top.
- A motor moves the scan head which is placed below the glass top & the scan head captures the light reflected from individual areas of the page.
- A light from the page is reflected through a system of mirrors. A lens then converts this amount of light reflected in to electrical signals.
- White spaces reflect more light causing a high voltage to produce.
- The A to D converter converts each analog signal in to digital pixels.
- Monochrome scanner stores only 1 bit per pixel on/off (Black / White).
- Color scanner needs 3 passes & each pass is directed to color filter.
- The reflected signals from these passes are converted to digital form & are then send to the PC.

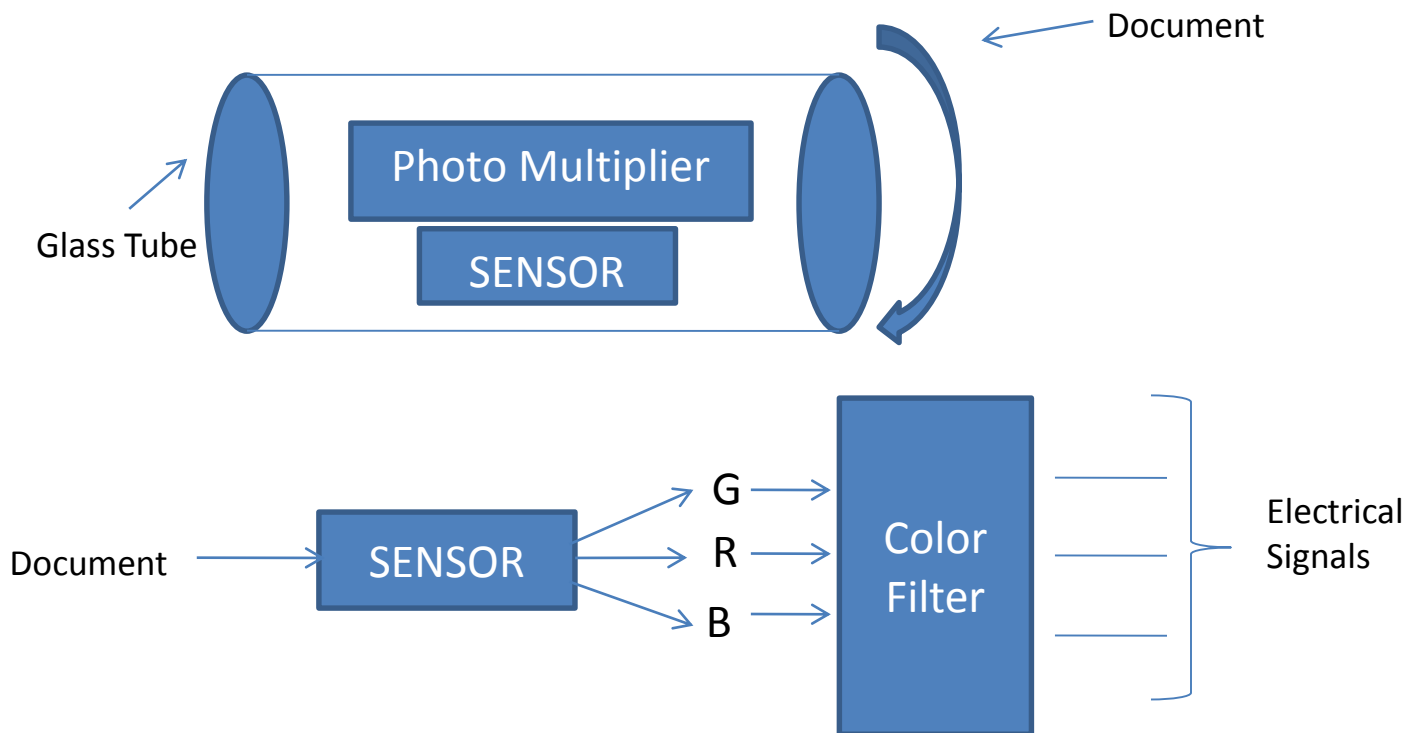
2. Sheet Fed Scanner:-

- It used to scan paper documents & photos.
- In sheet fed scanner instead of the head moving over the page, the paper is pulled over the scan head.

- In this scan head is fixed & the original document moves across the head like a fax machine.
- It can scan only a flat piece of paper.
- **Advantages:** - Small Size.
- **Disadvantage** - : Improper mechanism can skew the paper being scanned.

3. Hand Held Scanner:-

- Use the same basic tech as a flatbed scanner.
- It relies on user to move the scan head on objects instead of moving with a motorized belt.
- It doesn't have mechanism to move the paper or the scanning head.
- It is held in hand & moved over the document sliding over it.
- **Advantages:** Low Cost & Portability.
- **Disadvantages:** Poor Quality.



4. Drum Scanner:-

- It uses a photomultiplier tube (PMT).
- In PMT the doc. To be scanned is mounted on the glass cylinder along with a sensor present at the center of the tube.
- Sensor splits the light bounced from the doc. In to three beams.
- Each beam is then passed to a color filter where light is changed into an electrical signal.
- PMT is highly sensitive & has the capability to reduce the noise.

Q. Define following terms**1. OCR (Optical Character Recognition):-**

- OCR is a process of scanning the printed pages as image & then using OCR s/w to recognize the letters as ASCII code.
- OCR s/w has tools for both capturing the image & recognizing the text.
- This technology used by libraries & government agencies.

Sources of OCR:

- Original document copies with mono spaced font.
- Ideal font sources : 12 points font or greater
- Black text on white background.

2. TWAIN:-

- It is a standard s/w protocol & API (application Programming interface) that regulates communication between s/w application & imaging device such as scanner & digital cameras.
- The TWAIN is standard of communication between the computer & scanner that allow images to be directly scanned from an image editing program.

TWAIN SPECIFICATIONS:-

1. Multiple platform support: - Work across many Operating System.
2. Multiple device support. (Scanners & cameras.)
3. Multi data capacity: - general data interchange mechanism must be able to transmit data. (From standard format to native format)
4. Easy Implementation.
5. Widespread acceptance.

3. Resolution: -

Scanner varies in resolution & sharpness. Most Flatbed scanners have a true hardware resolution of at least 300*300 dots per inch (dpi).

4. Interpolation:-

- It is a process that the scanning software uses to increase the perceived resolution of an image.
- It does this by creating extra pixels in between the ones actually scanned by the CCD array.

MODEM (MOdulate/DEModulate)

- An input/output device that converts digital data from a computer to analog data for transmission over the telephone lines by modulating it into waves.
- Other end the modem converts the analog data back to digital form so that it can be read by the computer.
- It is the communication equipment used for long distance data transfer through a telephone line.
- **Specifications of Modem:-**

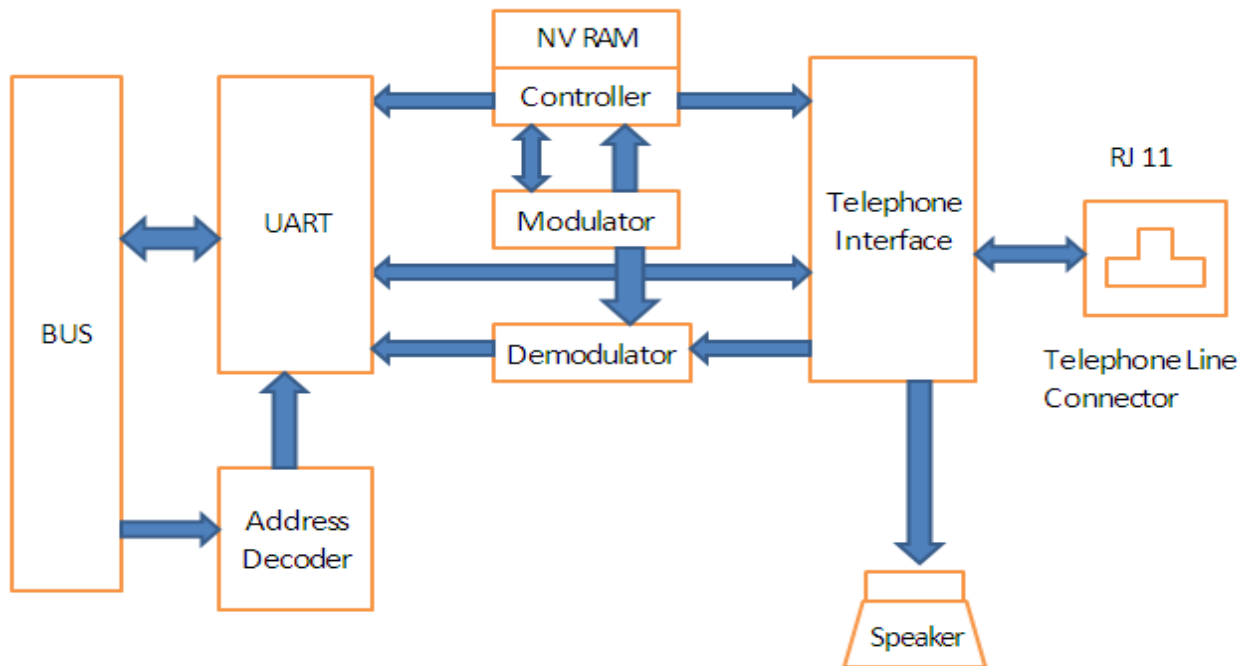
1. Operating Voltage & Current	+5V at 435mA(mill amperes) +12V at 30mA
2. Operating Temperature	0 A° C to 40 A° C.
3. Operating Humidity	20% to 90%
4. Operating Altitude	0 to 3084 meters
5. Storage temperature	-40 A° C to +65 A° C
6. Data Communication Standards	56000 bits per second(bps)
7. Data transmission & format	Full or half-duplex operation
8. Dialing capability	Tone or pulse dialing, automatic dialing

Types of modem:-

1. **Internal Modem**
2. **External Modem**

1. Internal Modem:-

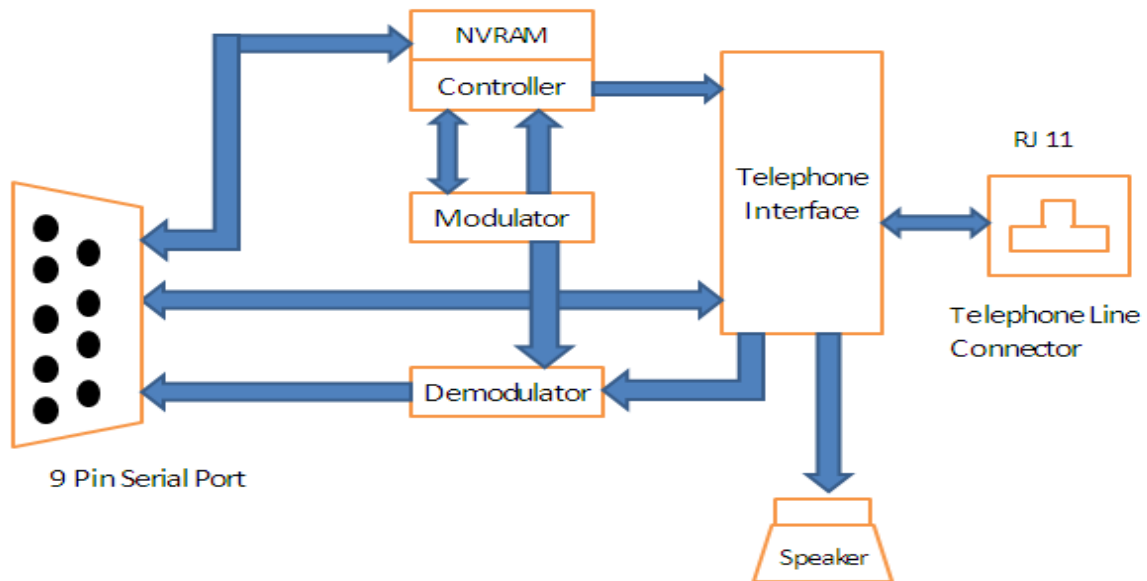
- This particular modem goes inside your PC in a PCI expansion slot. (compare the Pro and Cons)
- + Usually supply its own port
- + Provides own high-speed UART
- + Slightly Less Expensive
- Occupy an internal expansion slot
- Some Models offers a windows display of progression for connectivity.

Block Diagram & Working of Internal Modem:-**Block Diagram of Internal Modem**

- The internal modem contains its own universal asynchronous receiver/transmitter (UART).
- When installing an internal modem care should be taken that the IRQ (interrupt request) number & I/O address port number do not conflict with inbuilt motherboard serial ports. (i.e. COM1 & COM2).
- Modulator circuit converts the serial digital data from the computer into analog signals to be transmitted over telephone line.
- Then analog signal passes to the telephone line through a telephone jack (RJ-11 connector socket).
- On receiver side serial signals received from the telephone line. The telephone interface separate received signals & passes them to the demodulator. & demodulator converts analog signals into digital form & send this serial data to the UART.
- UART convert serial bit data into parallel byte & placed on system data bus.
- The speaker is used to hear a dial tone, dialing signals& audio negotiating a connection.
- A controller circuit manages the overall operation of the modem.
- NVRAM is non-volatile RAM, it is used to store modem parameters.

2. External Modem:-

- This particular modem uses a serial interface (connection):
- + Easy to install with serial cable
- + Does not occupy internal slot
- + Does not draw from computer's power supply
- + Has LED indicator light, which make it easier to diagnose problem
- + Can be turned off without turn off the computer
- Uses a serial port for connectivity



Block Diagram of External Modem

Working of External Modem:-

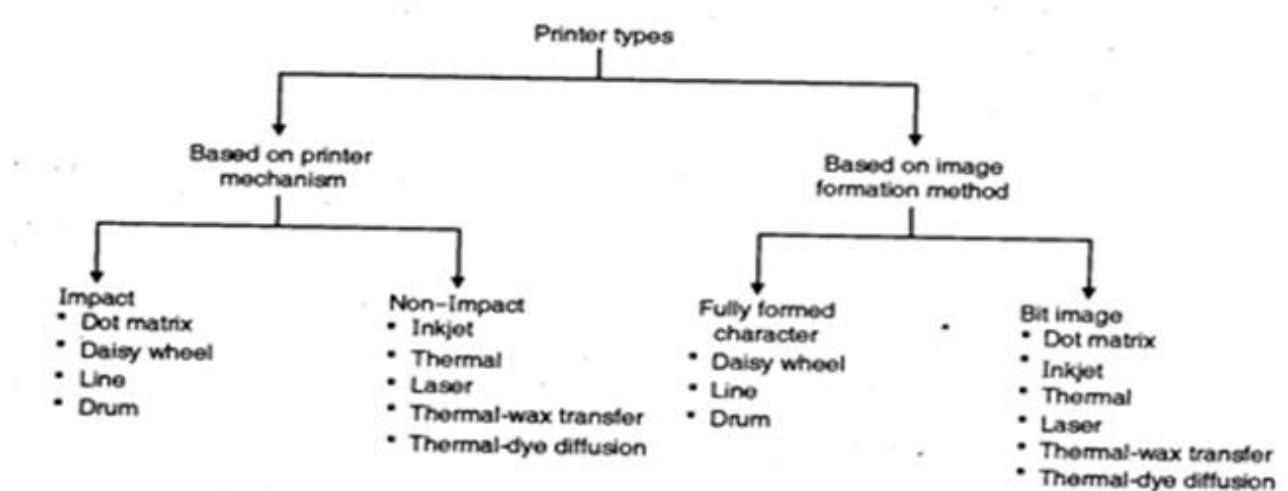
- External modem is a standalone device connected to serial port (COM1 or COM2) of system.
- Working of external modem is same as internal modem.
- The difference is that it uses standard serial interface RS-232, so that it uses motherboard UART for serial bit to parallel byte or parallel byte to serial bit conversion.
- **Advantages:-**
 1. Installation is easy.
 2. Not required/needed to open the system.
 3. No worry about IRQ & I/O address conflicts.
 4. Front panel LEDs shows status of communication.

Compare Internal Modem & External Modem:-

Features	External Modem	Internal Modem
1. Built in UART	No	Yes
2. Price comparison	Higher	Lower
3. Easy to move to another computer	easy	Difficult
4. Power supply	Plugs into wall	None- powered by PC
5. Reset if modem hangs	Turn modem OFF, then ON again	Restart computer
6. Interface type	RS 232 serial or USB port	PCI or ISA

PRINTERS

Types of Printers:-



Impact vs. Non-Impact:-

- **Impact:-**
- Printers physically transfer a dot or shape to the paper.
- To create an image on o/p media.
- Of those in the preceding slide, only dot-matrix uses impact printing.
- **Non-impact:-** do not strike any ribbon or paper to produce the image, instead they use ink spraying, or heat process to produce the required image on the paper.

Printer Characteristics:-

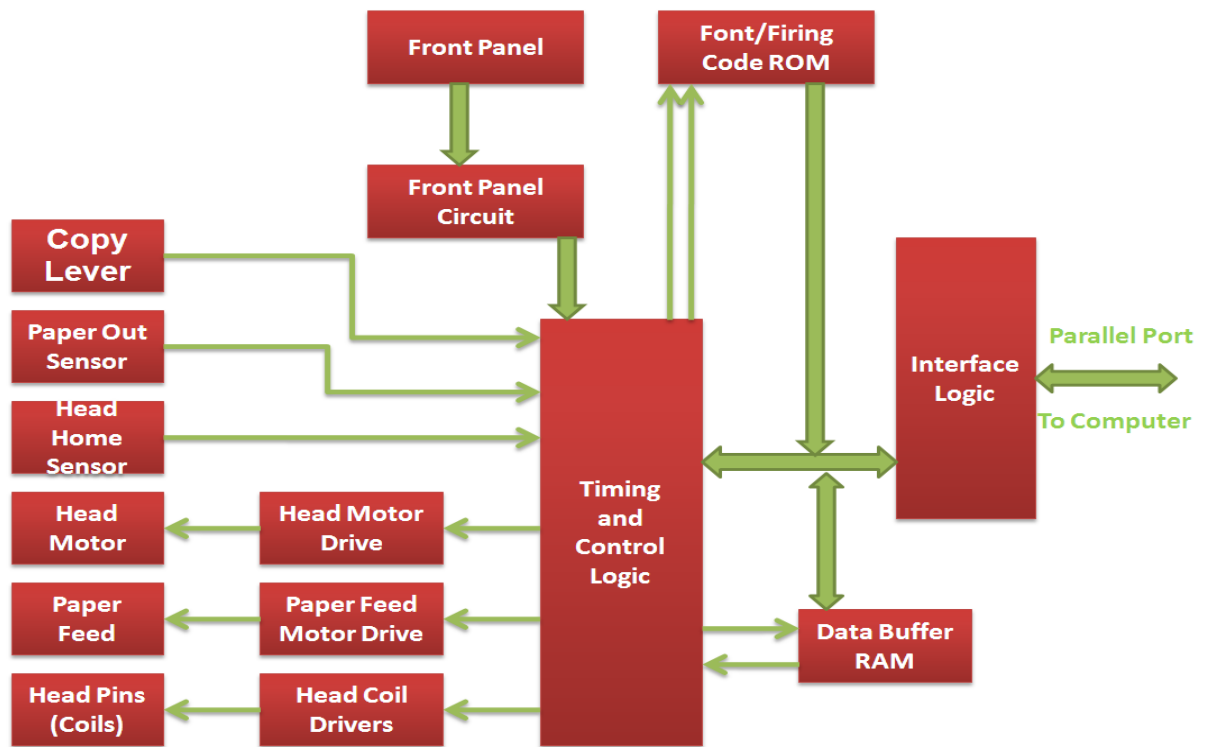
1. **Speed:** specified in character per second (CPS), Lines per minute (LPM), Pages per minute (PPM).
2. **Quality:** shows shape of printed character, specified in terms of DRAFT, NLQ (Near Letter Quality) or LQP (Letter quality paper).
3. **Buffer Size:** How many printer chars can be stored in buffer before printing.
4. **Character Set:** Total no of data chars & control chars recognized by printer.
5. **Print Mode:** Serial or Parallel.
6. **Print Size:** char size & no of chars in a line.
7. **Interface:** Specifies how printer receives data (serial or parallel.)
8. **Print direction :** Unidirectional, bi-dir. ,
9. **Print Mechanism:** specified as dot matrix, daisy wheel, inkjet or laser.

1. DOT MATRIX PRINTER

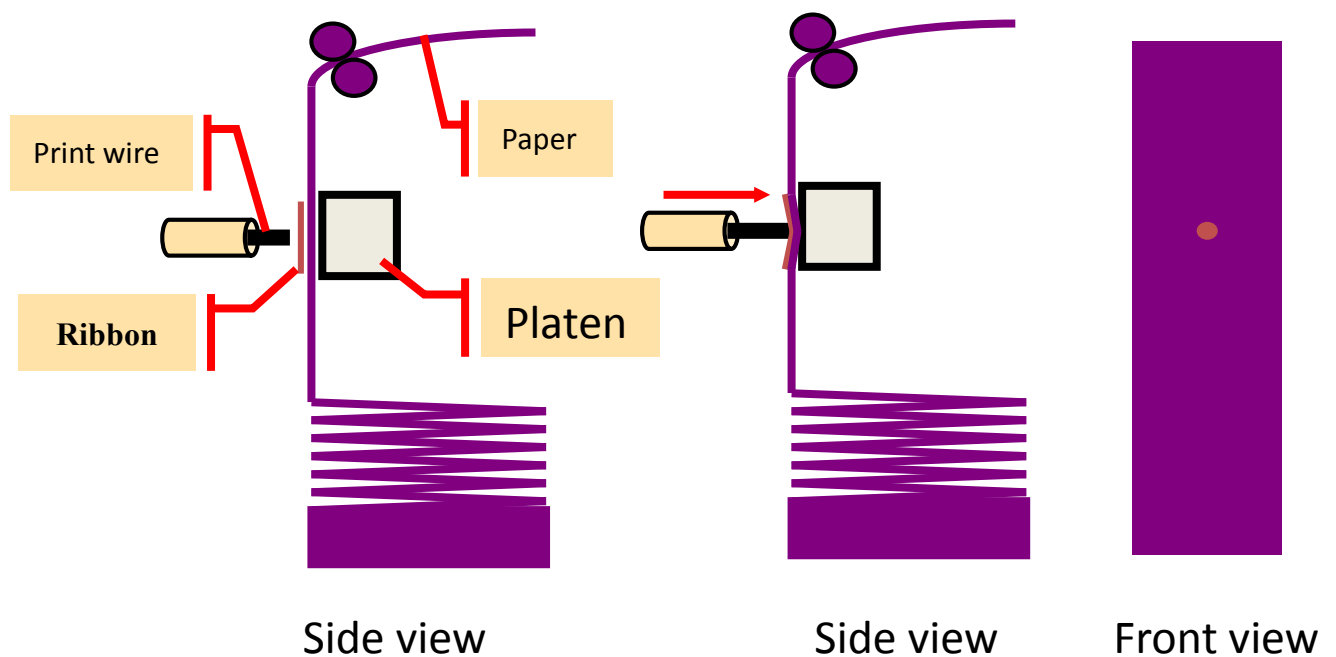
It forms text & images by placing pattern of dots on paper by striking inked ribbon with a no of small pins.

Specifications: -

- **Printing Method:** 9 pin / 24 pin impact dot matrix.
- **Speed:** Speed is different for each mode.
- **Line Spacing:** 1/6 or 1/8 inch.
- **Print head life :** 400 million stroke
- **Graphics Resolution :** 72 – 360 DPI
- **Print Direction :-** Text – Bidirectional, Graphics – Unidirectional

Block Diagram Dot Matrix Printer:-**Block Diagram of Dot-Matrix Printer**

- **Interface logic:** - Takes signals from PC. i.e. data signal & control signal.
- **Data buffer:** - it stores data from PC. Then send to ROM for getting dot information of particular character then send dot pattern to the print head.
- **Front panel & front panel circuit:** - used to select print mode & perform self-test.
- **Timing & control Logic:** - used to generate control signals for print mechanism & interface logic.



Working Of Dot Matrix Printer

- PC sends a series of ASCII code to the printer through serial or parallel cable.
- The ASCII code received by printer is stored inside a buffer, i.e. RAM of the printer.
- After that dot pattern stored into inside printer ROM.
- Processor of printer selects a particular dot pattern from printer ROM & sends the signals to the to the print head.
- Based on this information print head fires different pins on the print head.
- The print head contains 9 / 18 / 24 wires to fire against the ribbon & paper.
- The force of impact transfers ink to paper on other side of ribbon.
- After the pin fires the spring pulls print pin back to its original position.

Advantages:-

1. Dot matrix printers are inexpensive.
2. Small in size.
3. Light weight.
4. It is very versatile. i.e. print graph, charts, pictures.

Disadvantages:-

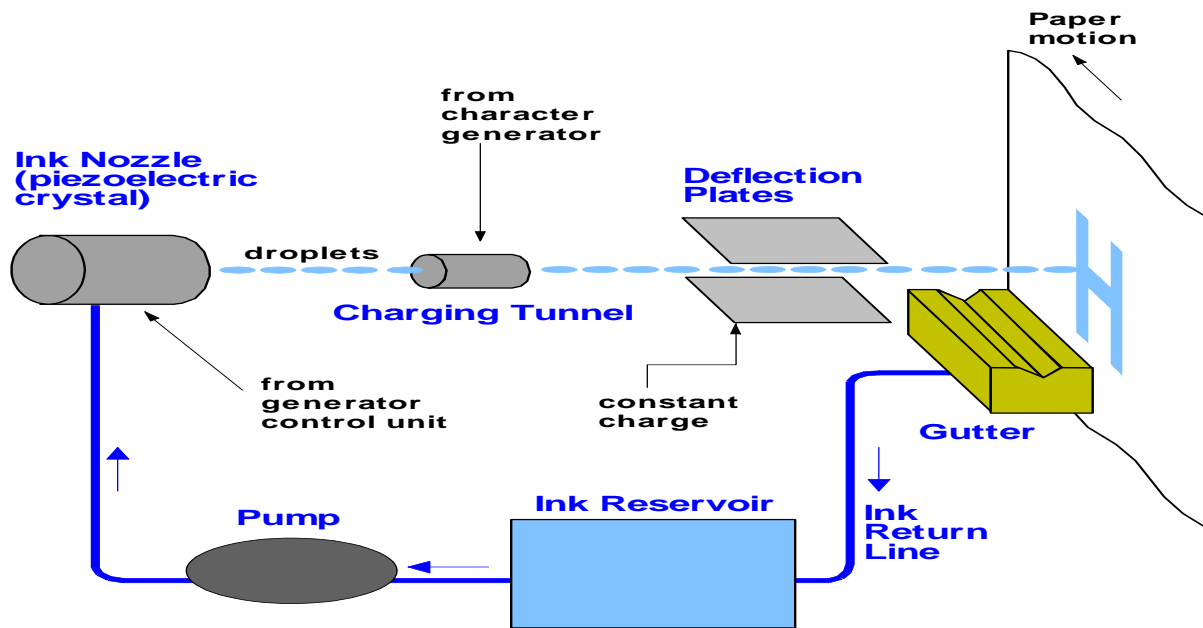
1. Quality is not so good.
2. These are noisy.
3. Requires more servicing.

2. INK JET PRINTERS

- Inkjet printers are bit image non impact type of printer.
- Produces characters, shape & images by spraying the ink from tiny nozzles on to the paper.

Specifications: -

- **Speed :** Up to 30 PPM
- **Print Technology:** Thermal Inkjet
- **Memory:** 2 MB to 4 MB
- **Interface:** USB
- **Max Resolution:** 600 * 600 DPI (B/W), 4800 * 1200 DPI (Color)
- **Media type supported:** Paper, envelopes, transparencies.

Block Diagram of inkjet Printer:-

- It works by directing tiny droplets of ink on paper.
- The head doesn't physically touch the paper. It forces the ink through the nozzles & spray it on the paper.
- Depending on printer & its technology there can be 21 & 150 nozzles for each of the 4 colors (cyan, yellow, magenta, black)
- By mixing the colors printer can produce almost any color.
- Depending on the technology used for forcing the ink on the paper, inkjet printers are categorized into 2 types:
 - Thermal printer
 - Piezo printing.

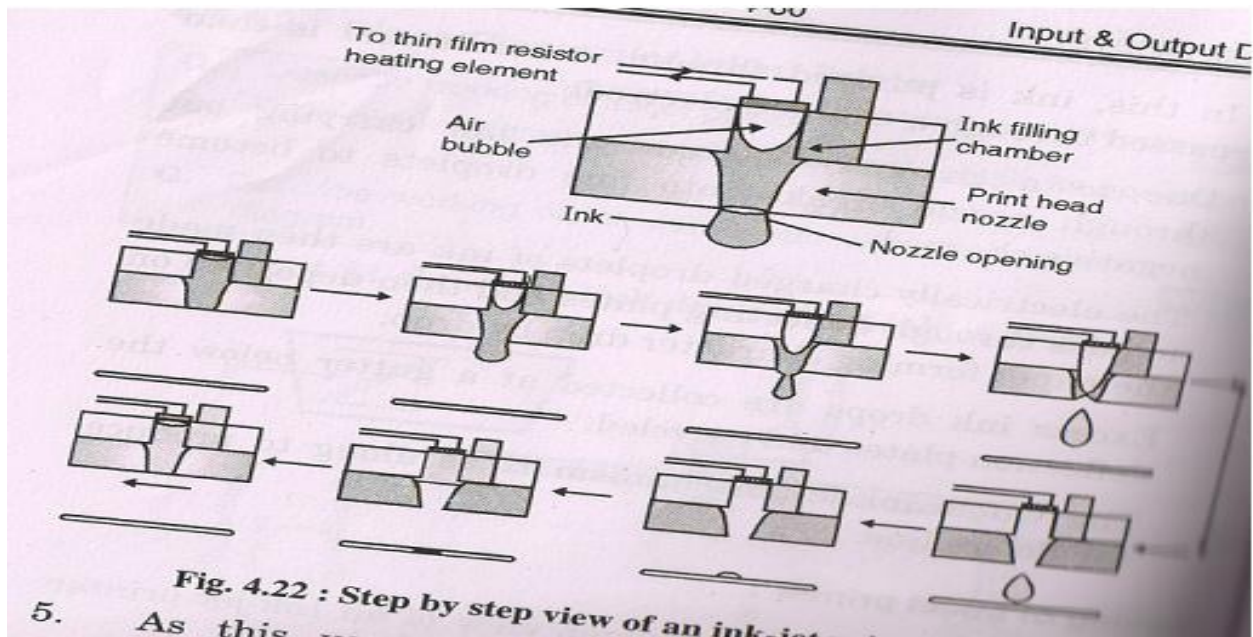
1. Thermal Printing:

- It heats the ink in the cartridge causing vapour bubbles in the cartridge that rise to the top & force the ink out through the nozzle. The vacuum caused by the expelled ink draws more ink down in to the nozzles making a constant stream.

2. Piezo Printing:

- Uses an electric charger instead of heat. It charges piezoelectric crystals in the nozzle which vibrates in response to the electrical charge, forcing ink out through the nozzle.

- The o/p of both the technologies is same.



- An ink-filled print cartridge attached to the inkjet print head moves sideways.
- Print head is made up of small ink filled chambers each attached to nozzle.
- An electrical pulse flows through a heating element.
- The vapor bubble expands it pushes the ink through the nozzle to form a droplet at the tip of the nozzle.

Advantages:

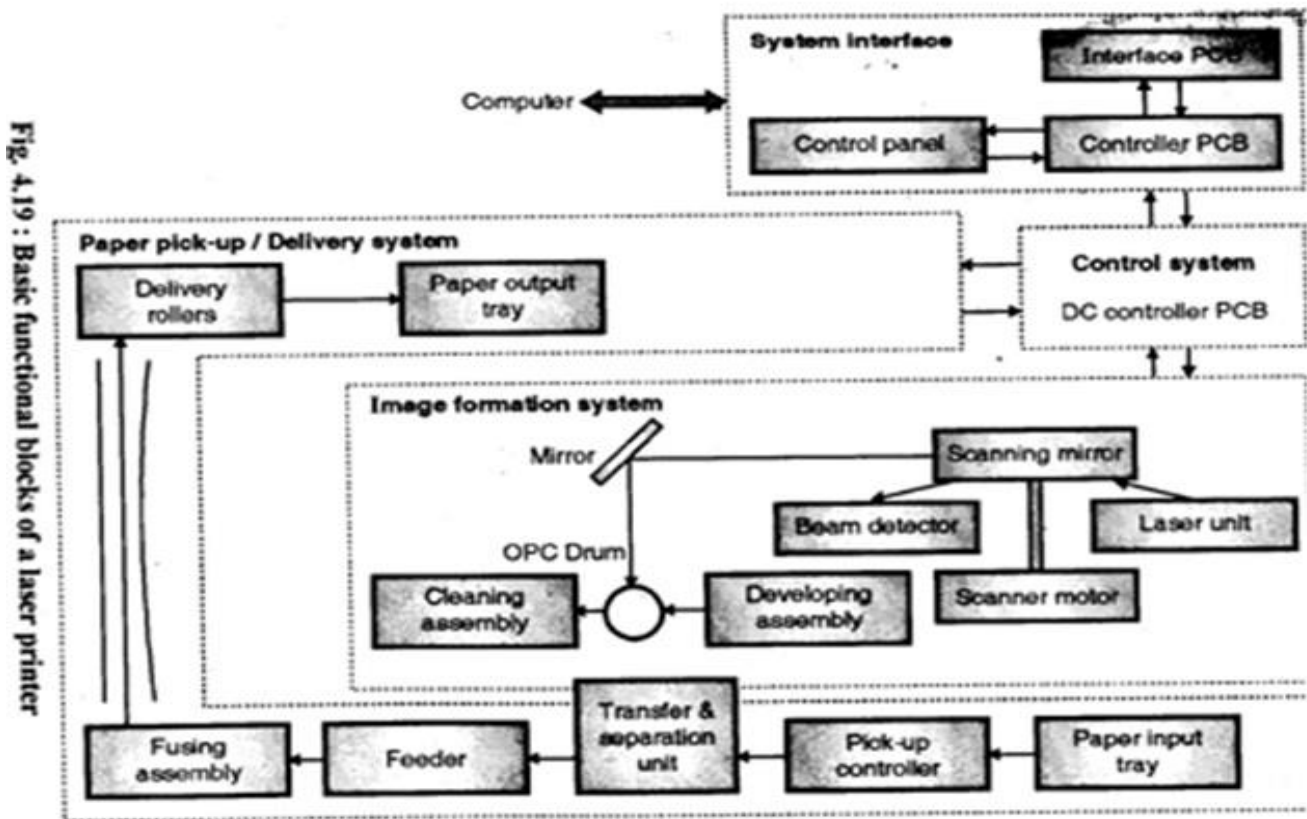
- Doesn't make noise
- High quality o/p
- Supports color printing.
- High speed.

Disadvantages:

- High cost
- Requires periodic maintenance
- Cost of cartridge is high
- Doesn't support multipart stationery.

LASER PRINTERS

- It very popular as a high end printer because of its exceptionally clear & sharp images.



- **Block diagram has 4 Sections:-**

1. System interface
2. Control System
3. Image Formation System
4. Paper Pick-up/Delivery System

1. System Interface:

- Communicate with host computer through I/O ports.
- Displays printer status to user.
- It stores configuration information & font information.
- It converts incoming data (From PC) in proper format that printer can use to create image on photo conductive drum.
- Communicating with the DC controller assembly.

2. Control System /Machine Control Systems

- It coordinating all the activities of printer.
- It drives the laser beam.
- Controls & monitors paper motion, the high voltage system, fuser temp & all motors.

- It also shares status info so that proper diagnostic message is displayed on control panel.

3. Image Formation System :

- To form an image on paper a laser requires or using electronics, mechanical, optical, electro-photographical techniques.
- Process of image formation steps:-
- Clears the OPC(organic photo conductive) drum
- Electro statically writing image on drum.
- Developing image on OPC drum
- Transform image to the paper.

The complete image formation process Consists of the SIX steps:-

- a. Cleaning of the OPC drum:** - before transferring any image to OPC Drums surface need to be cleaned.
- b. Conditioning of the OPC Drum:-** Once the surface is cleaned, then uniform charge of -600 V is applied to the complete surface of the OPC drum.
- c. Electro statically writing image on drum:-**To write any info. On this drum, laser beam is focused on the selected areas of the drum.(this image is called latent electrostatic image).
- d. Developing image on OPC drum:-** Once the writing of the electrostatic image on the OPC drum is over, next to develop this latent image into a visible image.
- e. Transfer of the image from OPC drum to the paper:-**Image is developed or generated on the OPC drum using toner particles, and then this image is to be transferred to the paper or some other medium.
- f. Fusing of the image to the paper:-**fusing section melts the toner ink & fuses it on the printing media (paper) by applying heat & pressure. This makes image permanent & print paper outputted.

4. Paper Pick up Delivery System :

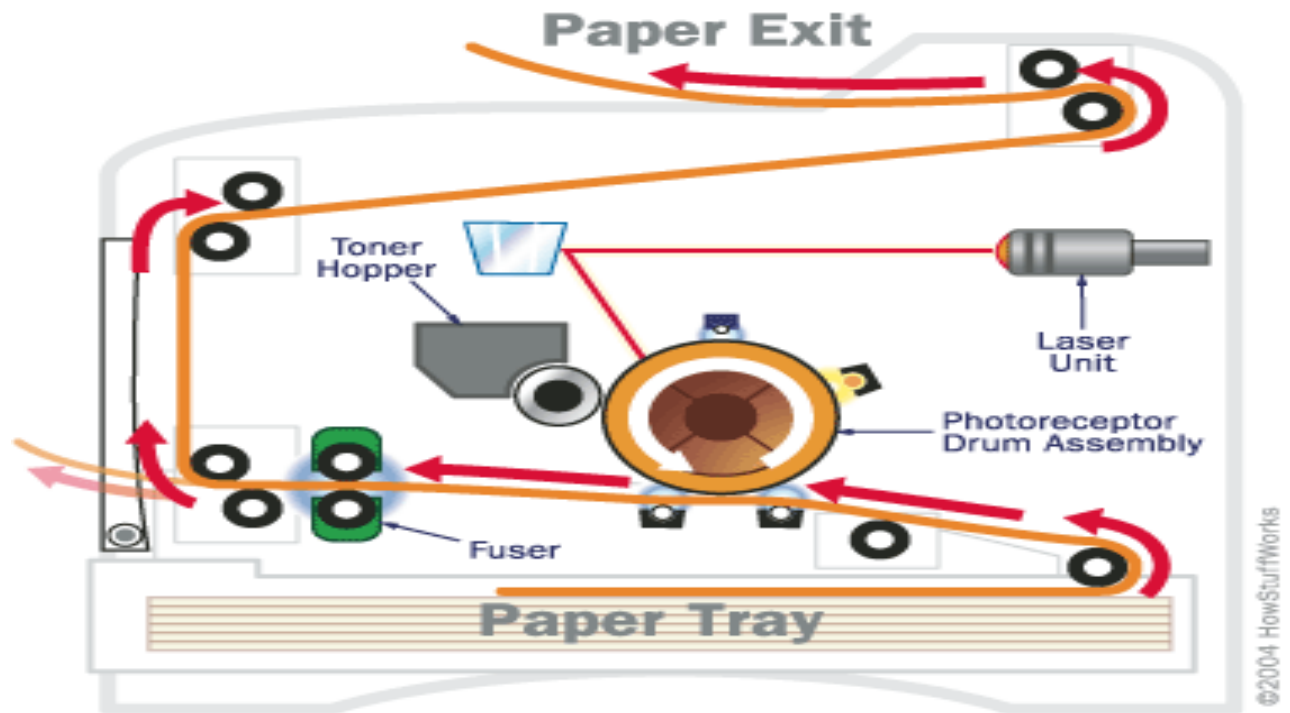
- Picking the paper from i/p tray.
- Delivering paper to the image formation system at the right time.
- Deliver the paper to o/p tray.

Advantages:

- High quality printing
- High speed
- Supports text & graphics
- No mechanical motion so silent in operation.

Disadvantages:

- Cost
- Need experts for maintenance.



Q. Compare the all above printer(S-09, 11, W-09)

Features	Dot matrix	Inkjet	Laser
Print Mechanism	Impact	Non-Impact	Non-Impact
Image Formation Method	Bit Image	Bit Image	Bit Image
Multi-part Stationary	Support	No	No
Print Quality	Good	Better	Best
Cost	Low	Moderate	High
Cost of cartridge	Low	High	Highest
Noise Generated	Yes	No	No
Speed	Low	High	Good
Support color Printing	No	Yes	Yes