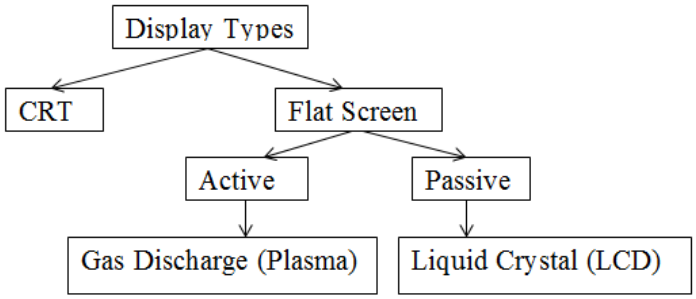
Chapter No. 3 Display Devices and Interfacing

Introduction

- A computer monitor is an electrical device looks like television.
- VDT (video display terminal) or VDU (visual display unit)is component of computer s/m that displays the messages & data.
- Display Technologies:-



- **CRT** works by moving an electron beam back and forth across the back of the screen.
- **LCD:** LCD displays utilize two sheets of polarizing material with a liquid crystal solution between them.
- **PLASMA:** Plasma is flat-panel display that works by sandwiching a neon/xenon gas mixture between two sealed glass plates with parallel electrodes deposited on their surfaces.
- Types of monitor technologies available to consumers are CRT monitors, LCD monitors and LED monitors.

Q. Write difference between CRT, LCD & LED.

Parameters	CRT	LCD	LED
Technology	Mature	New	Latest
Visual performance	Slower	Faster	Faster
Image flicker	Yes	No	No
Image brightness	Variable uneven	Bright, uniform	More bright, uniform
Image sharpness	Moderate	High	High
Electromagnetic emissions	High	Low	Low

Image geometry	Distorted	High	High
Power consumption	High	Low	Lowest
Weight	Heavy	Light	Light
Heat emissions	High	Minimum	Low
Color range	Excellent	Very good	Excellent
Cost	Low	Moderate	High

1. 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"

Phosphor screen

- There are two types of CRT Monitor:-

1. Monochrome CRT Monitor
2. Color CRT Monitor

- CRT Monitor uses 3 signals from video adaptor
  - Video Signal
  - Horizontal Synchronization Signal
  - Vertical Synchronization Signal

Monochrome CRT Monitor:-

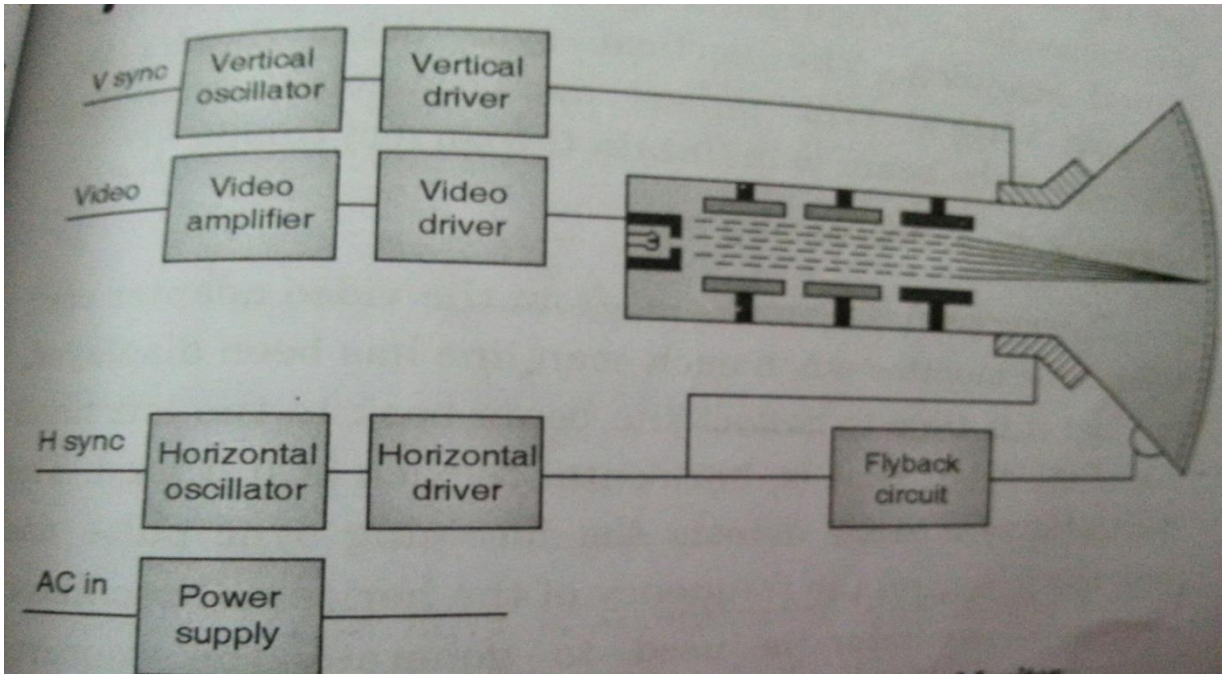


Fig. Block Diagram of Monochrome CRT Monitor

Main Four Blocks of Monochrome CRT

1. Video Processing
2. Horizontal Sync Processing
3. Vertical Sync Processing
4. Power supply

Working of CRT Monitor:-

1. **Video Processing Circuit**

- Video Signal from the display adapter.
- The signal is passed to amplifier to boost the signal
- The video signal controls the brightness of the beam of level – ON , OFF determined by pattern of characters stored in memory on video adapter card
- The signal is sent to video driver.
- Video driver drives the cathode and controls the emission of number of electrons that reach the screen

2. **Vertical Sync Processing**

- Vertical Sync Signal from the display adapter.
- Informs the monitor - entire screen is displayed and time to deflect the beam back at top of the screen.
- The Vsync signal to vertical oscillator.
- The oscillator maintains the required frequency for vertical scanning.
- Vertical Sync stages detects Vsync Signal and deflects the screen at correct timing.

3. **Horizontal Sync Processing**

- Horizontal Sync Signal from the display adapter.
- Informs the monitor – each scan line displayed and time to deflect the beam back to left side of tube.
- The horizontal flyback circuit gets initiated.
- The Hsync signal to horizontal oscillator.
- The oscillator maintains the required frequency for horizontal scanning.
- Vertical Sync stages detects Hsync Signal and deflects the screen at correct timing.
- Oscillator used to generate **extra high tension** (EHT).

4. Power Supply Section

- It generates the different voltages for different circuit.

Color CRT Monitor:-

- Working of color monitor is same as monochrome monitor, only difference is that is 3 electron guns for 3 colors.
- Entire circuitry the monitor can be grouped into 3 main categories:
- 1. Video signal processing & amplification
- 2. Vertical deflection & synchronizing
- 3. Horizontal deflation & synchronizing

- 4. Power supply

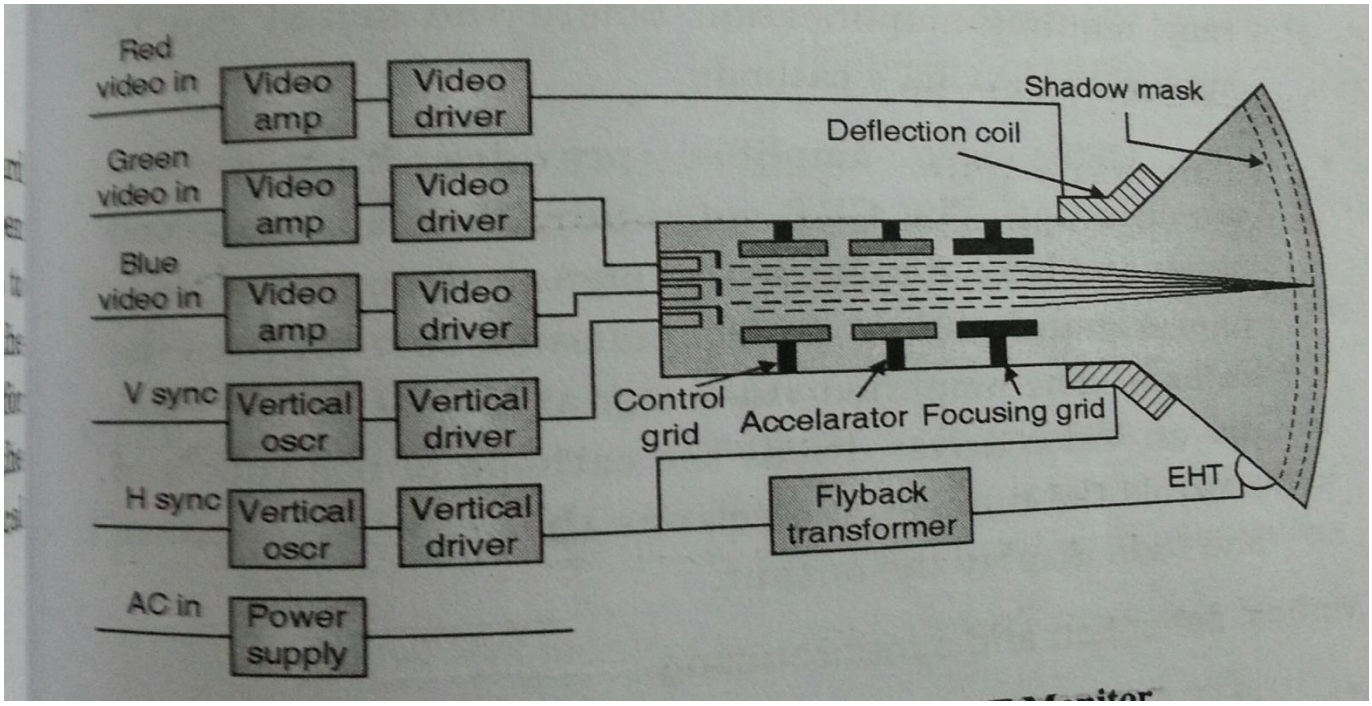


Fig. Block Diagram of Color CRT

Working of CRT Color Monitor:-

1. Video signal processing & amplification:-

- A transmission line or coaxial cable carries the video signal such as red, green, blue (RGB) from the host of computer to the monitor.
- CRT video amplifier provides high voltage amplification.
- Video amplifier is the 2nd storage amplifier amplifies signal strong enough to approximately 40v to control emission current from cathode.
- The amplified video signal is sent to the video driver.
- Video driver drives the cathode of the tube & controls the no of electrons that reach the screen, & then display the output.

2. Vertical deflection & synchronizing:-

- Vertical sync signal from the video adapter card informs the monitor that an entire screen has been displayed.
- Vsync pulses are given to the vertical oscillator which generates the required frequency for vertical scanning.

3. Horizontal deflation & synchronizing:-

- Horizontal sync signal from the video adapter card informs the monitor when each scan line has been displayed.
- Hsync stage detects the incoming synchronization pulse & uses this control the frequency of the horizontal oscillator.
- Output of H oscillator is used to generate the high voltage needed by the picture tube.

4. Power supply:-

- It generates the different voltages for different circuits.

Characteristics of CRT Monitor:-

1. Dot pitch:-

- Pixel pitch that defines the sharpness of the monitor display.
- It measures the distance between dots.
- The distance is small and it denotes the quality of CRT monitor.
- Most of computer displays have a dot pitch between 0.25mm & 0.25mm.

2. Resolution:-

- Number of horizontal and vertical pixels
- More resolution means quality of image is good.
- Resolution = Width * Height
- E.g. "1024*768"

3. Horizontal Scanning frequency

- The frequency at which the monitor rewritten the horizontal lines that make up the image.
- It moves electron beam from left side of display to the right & returns to the beginning.
- Number of horizontal lines displayed per second.
- Refresh Rate depends on this frequency.
- Measure in kHz.

4. Vertical Scanning frequency or refresh rate

- Number of frames displayed per second.
- Also known as refresh rate.
- Flickering display shows the intervals.
- Measured in Hz.

5. Interlaced Scanning

- Used in normal TV , Video Systems
- It was designed to reduce bandwidth & flicker while maintaining resolution.
- Image broken in 2 fields : Even , Odd lines
- Only odd lines first then even lines are drawn
- CRT gun scans from top to bottom, left to right with each complete scan displaying a "Frame".
- To avoid flickering & get better resolution monitor uses interlaced scanning.
- Less stable

6. Non-Interlaced Scanning

- Also called Progressive scanning.
- Lines are scanned sequentially from top to bottom of the screen in a single scan.
- More stable picture & are more expensive.

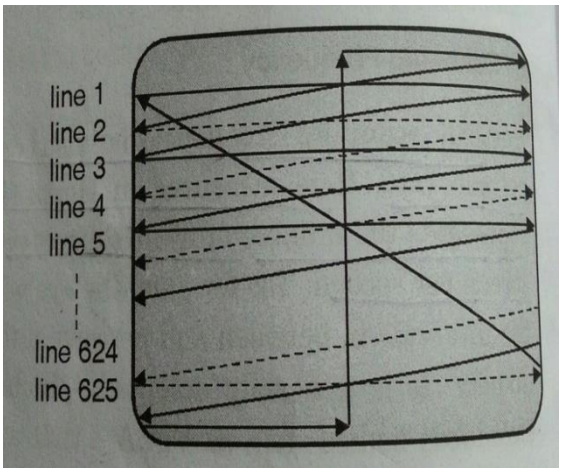


Fig. a. Interlaced Scanning

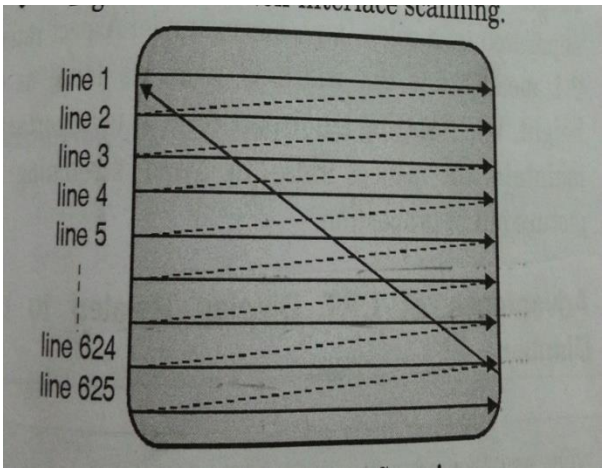


fig. b. Non- Interlaced Scanning

Q. Distinguish between interlaced & non-interlaced

Sr. No.	Interlaced	Non-Interlaced
1.	Image flickering is there.	Less chance of image flickering.
2.	It production less stable picture.	It produces a more stable picture.
3.	The cost is less.	The cost is more.
4.	It uses two passes to generate image.	It uses only one pass to generate image.
5.	Image quality is not good.	The image quality is good.

7. Aspect Ratio

- It is a display of Proportional relation between width and height of display.
- Denoted by x:y
- Aspect ratio of 2:1 means width is twice as large as the height.
- To avoid horizontal stretching and vertical stretching we set aspect ratio

Advantages of CRT display related to LCD display:-

- Lower cost compared to LCD.
- Color fidelity.
- Ability to adjust images.
- Work better at multiple resolutions.
- Displays full motion video better.
- Screen images viewed from side angle are as good as.

- **Disadvantages:-**
- Large size takes up more desk space.
- Heavy weight.

2. LCD(Liquid Crystal Display):-

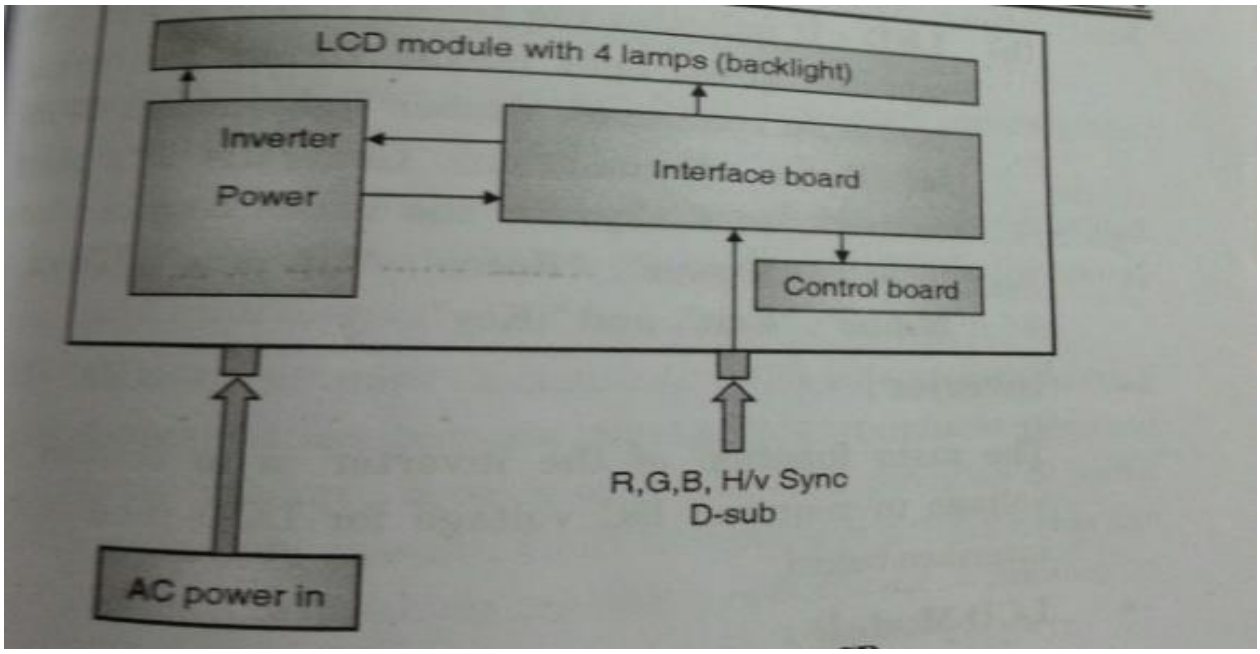


fig. Block Diagram LCD Monitor

Working of LCD Monitor:-

1. Interface Board:-

- Function of interface board is to convert an i/p analog RGB signal into digital RGB signal with help of ADC (Analog to digital converter) .
- Output data are sent to the LCD module.

2. Control Board:-

- It controls the user operation.
- There are two main parts of control board.

a. PUSH button: - it's a simple switch function, pressing it for "ON" to do the auto adjustment function releasing it for "OFF" to do nothing.

b. LED: - it indicates status of this LCD monitor.

Green light means: - Normal is operating condition.

Amber light means: - Power OFF condition.

3. Inverter:-

Main function of inverter is to convert AC voltage in required DC voltage for LCD module & interface Board.

4. LCD Module:-

- The function of this is to display image, data or text on screen.
- It is used to control of the backlight of the LCD.

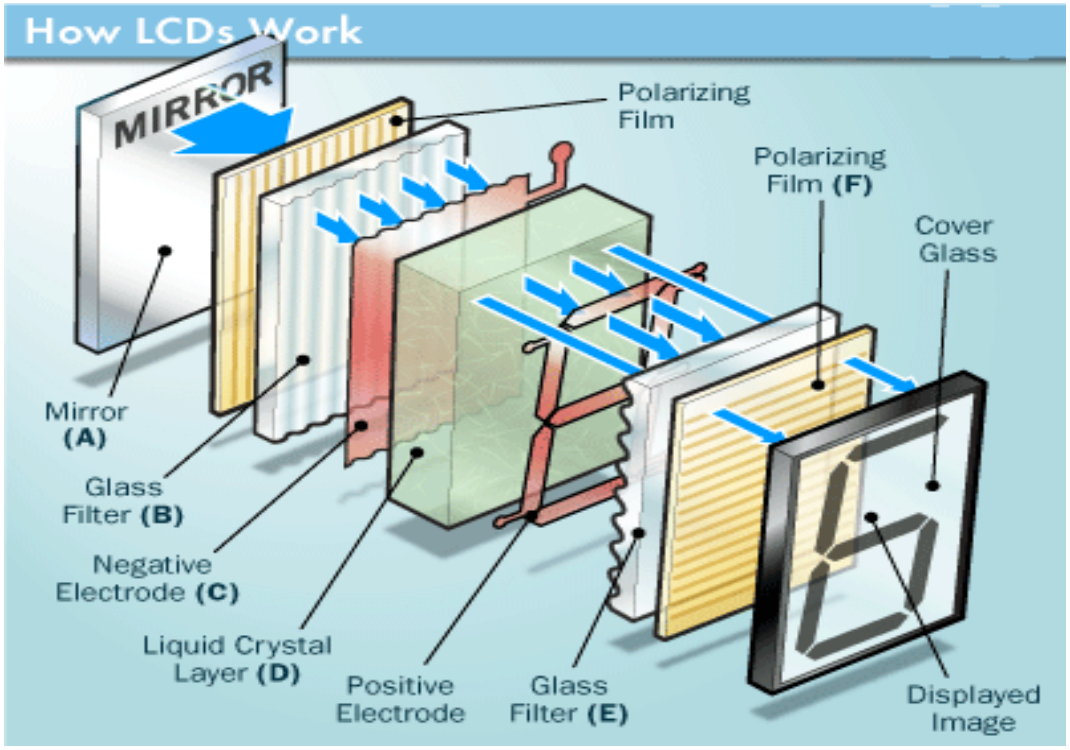


Fig. LCD Monitor

Advantages:-

- Light Weight
- Smaller footprint on desk leaving.
- Flicker free screen.
- More usable display area than on a comparably sized CRTs.
- Low frequency radiation is practically eliminated.
- Easy adjustment, storage & movement.
- Energy efficient they don't generate heat.
- Potentially less eye strain due to reduced screen glare.

Disadvantages:-

- Backlight is the potential weak link & its failure can be costly.
- Designed only for one optimum resolution cannot adjust images.
- Contrast ratio darkness to not be displayed true.
- Fragile screen may result both screen & back light lamp damage if touched or handled.

LCD Types:-

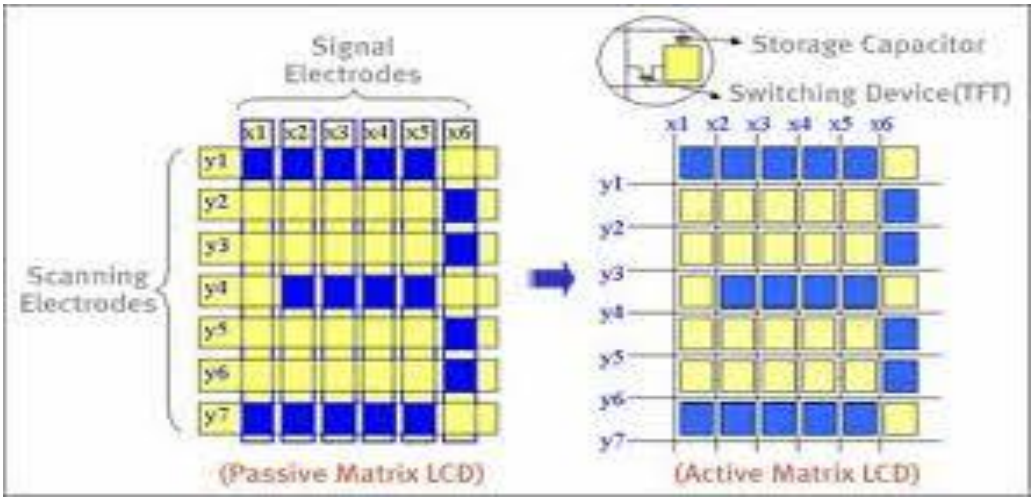
- LCD display uses two types of matrix:

1. Passive Matrix

- It is an older, simple to produce and inexpensive type.
- It uses grid of horizontal & vertical wires to display and images on the screen
- Horizontal wires (rows) of electrode on one half of the display glass is called as scan lines or scanning electrodes.
- vertical wires(columns) of electrode on the other is called data line or signal electrode
- When two pieces of the glass are assemble into the display, the intersection of row & column from a pixel control by two transistors.
- They are no switching devices & each pixel is address for more than one frame time.

2. Active Matrix

- Passive matrix display suffers from fundamentals problem leading to poor problems.
- Active matrix solve this problem
- By placing electronic switch devices in each LC (liquid crystal) pixel shown in above fig. controlling the charging of the LC cell to the desired gray level.
- It uses matrix of thin film transistors(TFTs) & capacitors to control the image produce by the display
- The brightness of each pixel is control by modifying the electrical charge of corresponding capacitors.



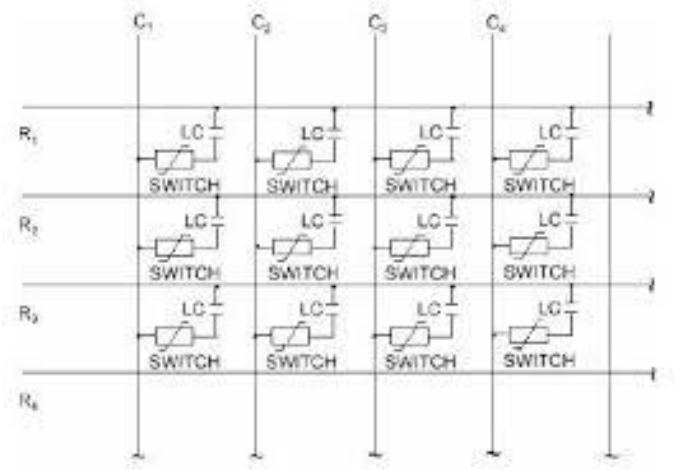


Fig. Active Matrix Switches

Comparison of Passive & Active matrix:-

Parameter	Passive	Active
Contrast	10-20	100+
Viewing scale	Limited	Wide
Gray Scale	16	256
Response time	100-200ms	<50MS
Multiplex ratio	480	>1000
Size	Up to 17''	<14''
Manufacturability	Simple	Complex
Cost	Moderate	high

Important characteristics of LCD:-

1. **Resolution:-**
   - Number of horizontal and vertical pixels
   - More resolution means quality of image is good.
   - Resolution = Width * Height
   - E.g. "1024*768"
2. **Refresh rate:-**
   - It is rate at which the electronics in the monitor addresses the brightness of the pixels on the screen (typically 60 to 75Hz)
   - Each pixel maintains constant light output from one addressing cycle to next.

- There should be no need to set a high refresh rate to avoid flickers on LCD.

3. **Response time:-**The minimum time necessary to change a pixel color or brightness.
4. **Dot pitch:-**Distance between the centers of two adjacent pixels.
5. **Viewable size:-**Size of an LCD panel measured on the diagonal.
6. **Matrix type: -** Active or Passive
7. **Color supports: -** How many types of color supports.
8. **Brightness: -** Amount of light emitted from the display.
9. **Aspect Ratio: -** Ratio of the width to height. e.g. 4:3

Touch Screen Display:-

Introduction

- Electronic visual display that detect presence and location of a touch
- **Touch Sensor** – Detects location of touches within display area
- It generally has electrical current going through and cause a change in voltage or resistance in signal
- **Controller** – PCB printed circuit board Takes input from sensor and translates into the information understandable by processing unit
- **Software Driver** – Program allows to communicate operating system and controller

Touch Screen Technologies

1. **Resistive**
2. **Capacitive**
3. **Surface acoustic wave**
4. **Infrared**

1. Resistive Touch Screen Technologies:-

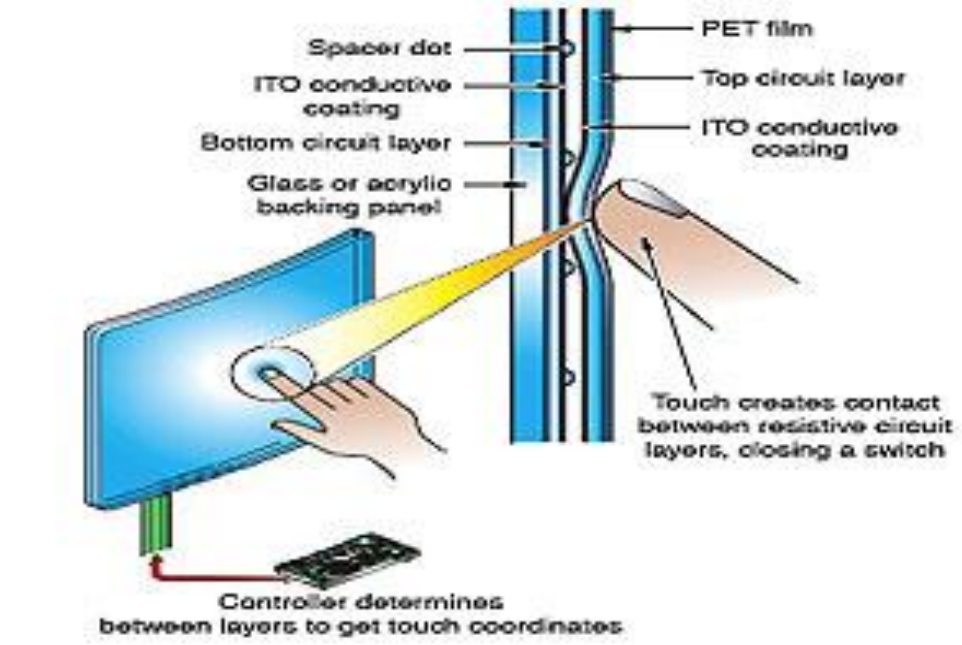


Fig. Resistive touch Screen

Construction & working:-

- It consists of a flexible top layer made of polyethylene (PET) & rigid bottom layer made of glass.
- Both layer are coated with a conducting compound called Indium Tin Oxide (ITO) & then spaced with spacers. An electric current flows between two layers.
- When touch is made, the flexible screen presses down & touches the bottom layer
- A change in electric current is hence detected & the coordinate of the points of touch are calculated by the controller & passed into readable signals for the OS to react accordingly.

- **Advantages:-**

- Low cost technology
- The hand can be used with or without gloves.
- Low power requirements.
- Activated by any object.
- High resistance to dust & water.
- Accurate.

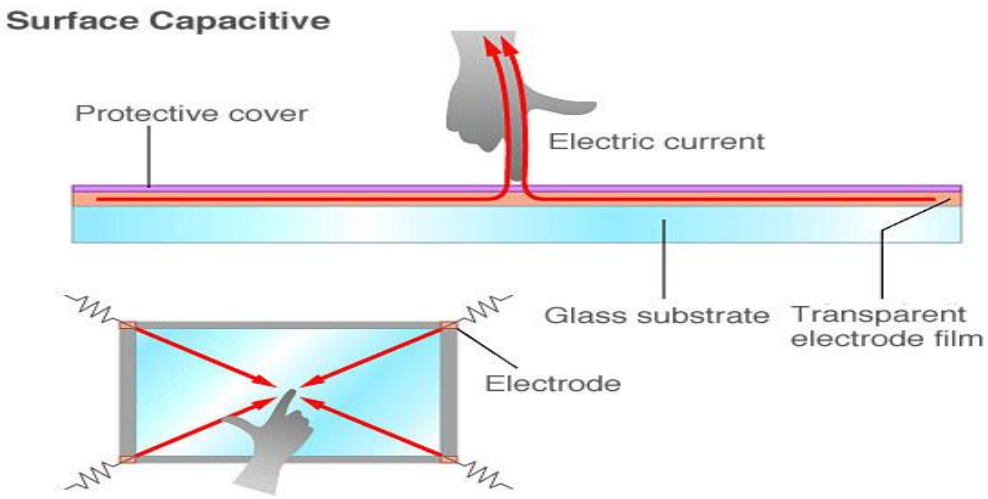
- **Disadvantages:-**

- They do not support "drag & drop" movements.
- Polyester surface can be damaged.
- Only 75% light transmission.
- Does not support multi-touch

2. Capacitive Touch Screen Technologies:-

- It is most popular & durable touch screen technology use all over world at most.
- It consists of glass panel coated with capacitive material Indium Tin Oxide(ITO)
- Capacitive systems transmit almost 90% of light from the monitor.
- Using sensors to sense minor changes in electrical current generated by contact with the fingers or changes in electrostatic capacity (load).
- Two types of touch panels use this methods

1. **Surface capacitive**
2. Projective capacitive



Construction & working of surface capacitive touch panels

- This panel is often used in relatively large panels.
- Inside these panels, a transparent electrode film is placed a top of glass substrate, covered by a protective cover shown in above fig.
- Electric voltage is applied to electrodes positioned in 4 corners of the glass substrate, generating a uniform low voltage electrical field across the entire panel.
- The coordinates of the position at which the finger touches the screen are identified by measuring the resulting changes in electrostatic capacity at the 4 corners of the panel.

Advantages:-

- Capacitive touch screen has glass layer instead of plastic, it looks brighter & sharper.
- Highly touch sensitive.
- Supports multi touch
- Durable surface material
- Good optical quality
- Very Accurate.

Disadvantages:-

- Having a complex structure, quite expensive.
- It doesn't work if the user is wearing gloves.

2. Projective capacitive

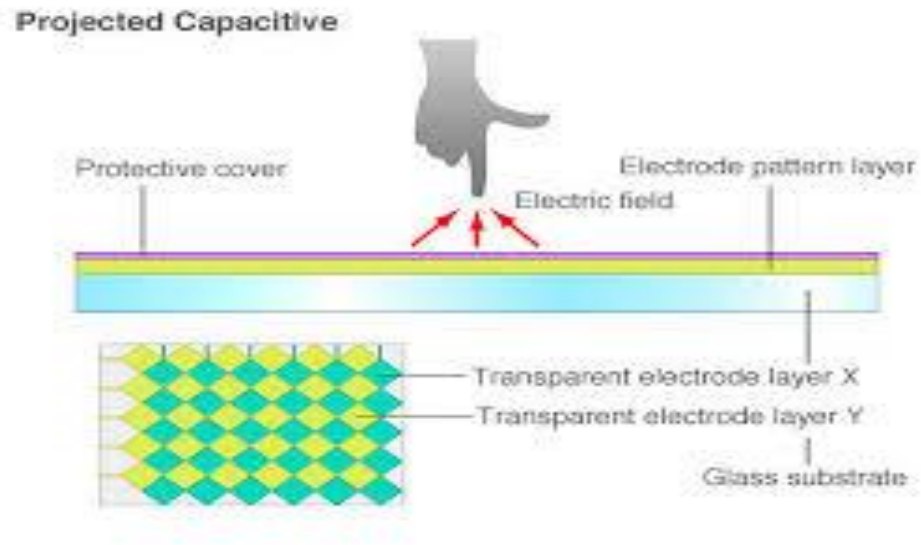


Fig. Projective Capacitive touch screen technologies

Construction & working of projected capacitive touch panels:-

- It touch panels are often used for smaller screen sizes than surface capacitive touch panels. They have attracted significant attention in mobile devices.
- To achieve high precision multi touch functionality & high response speed.
- **Internal structure:** - it consists of substrate incorporating over which is layer of numerous transparent electrodes is positioned in specific patterns shown in above fig.
- The surface is covered with an insulating glass or plastic cover. When a finger approaches surface, electrostatic capacity among multiple electrodes changes simultaneously, & the position where contact occurs cab be identified precisely by measuring the ratios between these electrical currents.

3. Surface Acoustic Wave Technology (Touch Screen Technologies:-)

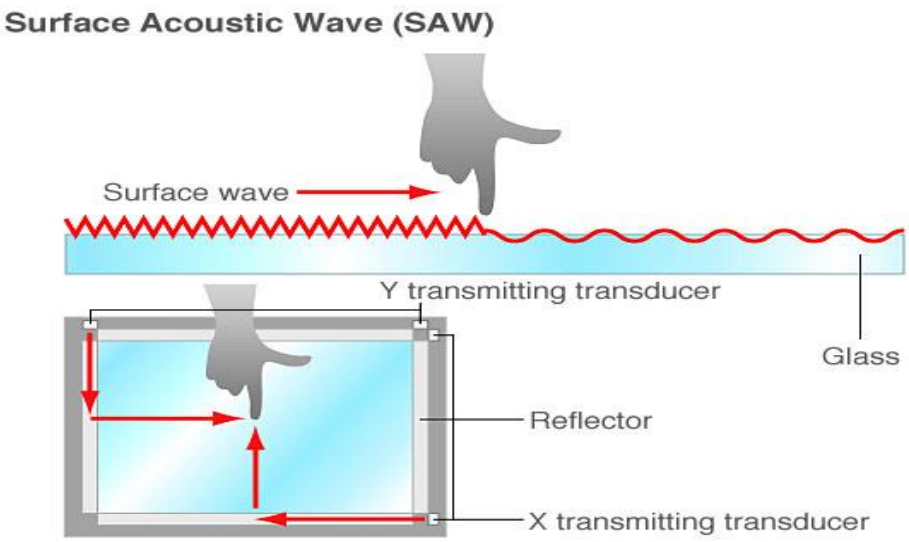


Fig. Surface Acoustic Wave Technology

Construction & working of Surface Acoustic Wave Technology:-

- It developed mainly to address the drawbacks of low light transmittance in resistive film touch panels that is, to achieve bright touch panels with high levels of visibility. These are also called surface wave or acoustic wave touch panels.
- It used LCD monitors, & public spaces, like ATMs, electronic, kiosks etc.
- It contains 2 transducers (transmitting & receiving) places along the X-axis & Y-axis of the monitors' glass plate along with some reflectors shown in above fig.
- The waves propagate across the glass & are reflected back to the sensors. When the screen is touched, the waves are absorbed & a touch is detected at that point. These reflectors reflect all electrical signals sent from one transducer to another.
- This technology provides excellent throughput & image clarity.
- **Advantages:-**
- Best optical quality.
- High surface durability & seal
- Activated by multiple sources.
- **Disadvantages:-**
- Expensive

4. Infrared Touch Screen Technologies:-

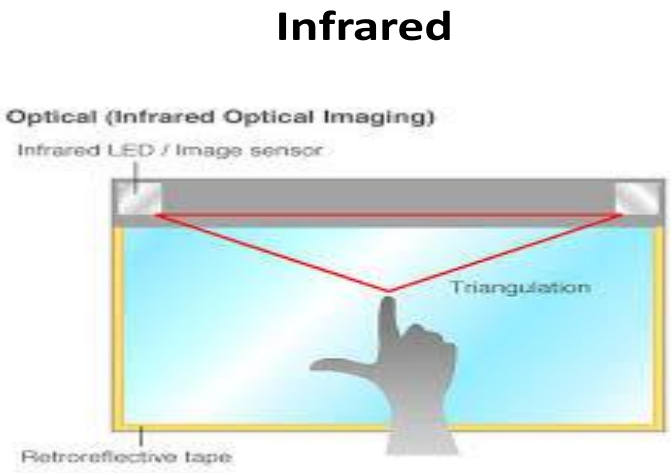


Fig. Infrared Touch Screen Technologies:-

Plasma Display:-

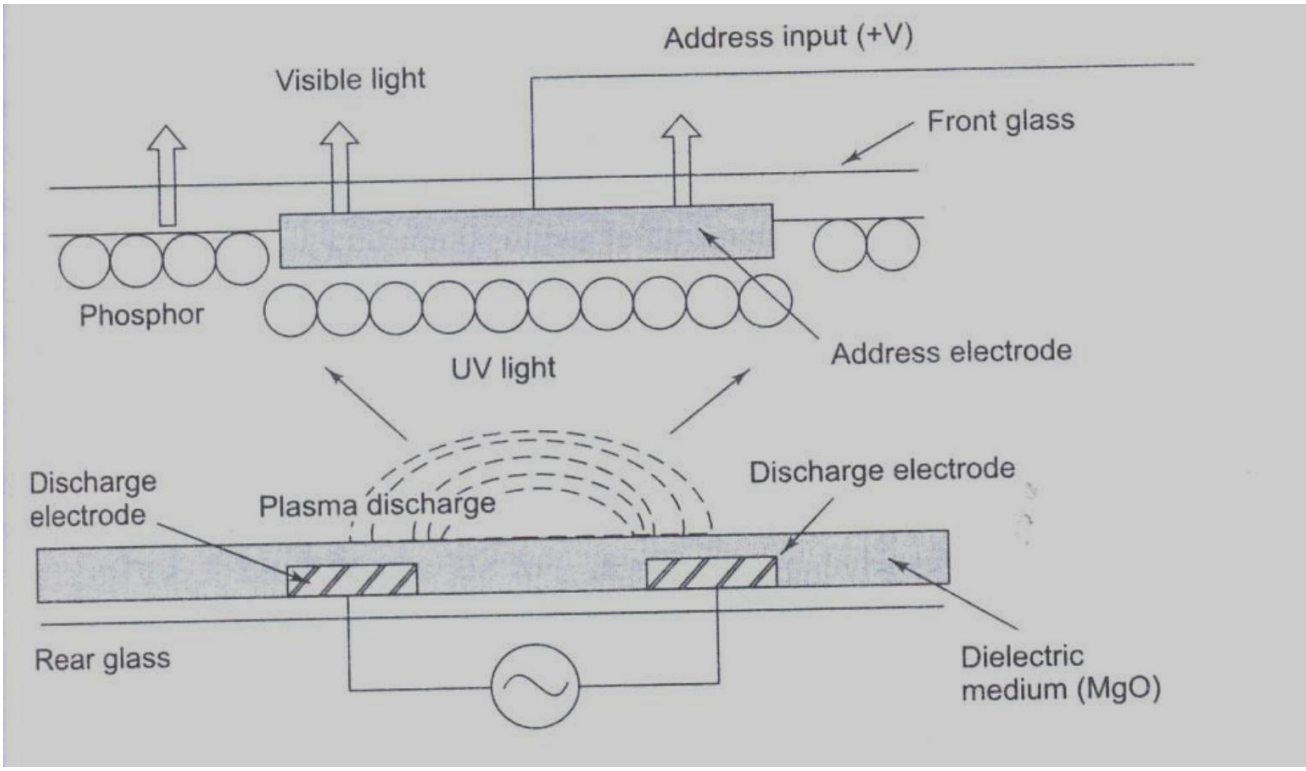


Fig. Working Diagram of Plasma display

Working of Plasma Display

- In a plasma TV, the cells are a bit like tiny CFLs only coated with phosphors that are red, blue, or green. Their job is to take the invisible ultraviolet light produced by the neon or xenon gas in the cell and turn it into red, blue, or green light we can actually see.

Step by step

- Plasma is a slate of gas made up of free flowing ions (+ve) and electrons. Under normal conditions a gas is made up of uncharged particles.
- In plasma display xenon and neon atoms are used.
- When an electric current is passed through plasma, the electrons rush towards the positive electrode and ions rush towards the negative electrode.
- During this rush they collide with each other.
- These collisions excite the gas atoms in the plasma, causing them to release photons of energy.
- These are ultraviolet photons invisible to human eye.
- The released ultraviolet photons interact with phosphor material on the inside wall of the cell and phosphors give off colored light.
- Each phosphor has three separate cells, a red, a blue and a green phosphor.
- These colors blend together to create the overall color of the cell.
- The xenon and neon gas in plasma contain hundreds of thousands of tiny cells positioned between two plates of glass.
- Long electrodes are sandwiched between the glass plates on both the sides of the cells.
- The address electrodes are at the rear glass plate and the discharge electrodes are transparent and mounted along the front glass plate.
- Both sets of electrodes extend across the entire screen.
- To ionize the gas in a particular cell, the electrodes that intersect at that cell are charged.
- When an electric current flows through the gas in the cell, the gas atoms are stimulated sad they release ultraviolet photons.

Video Accelerator Card:-

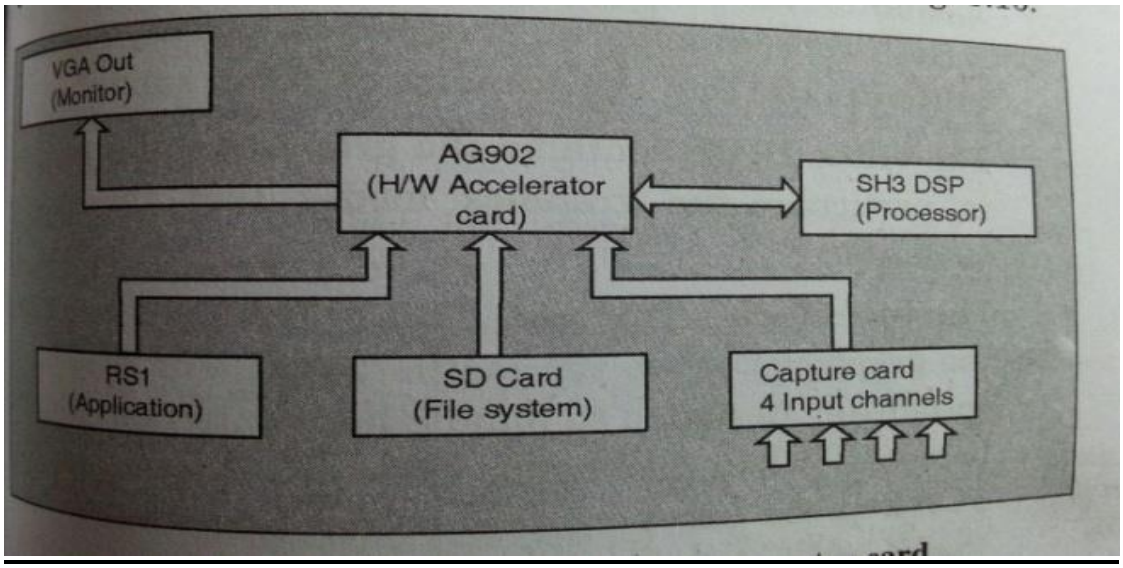


Fig. Block diagram of Video Accelerator Card:-

- A Video adapter that contains its own processor to boost performance levels.
- VAC is an expansion card whose function is to generate output images to a display or it converts digital data into a graphical form which can be displayed on monitor.
- The core of the accelerator is the graphics chip (or Video chipset).
- The graphics chip connects directly with the PC expansion bus.

Main components are:-

1. Graphical processing unit (GPU):-

- The heart of graphics card, which processes images based on encoding being used.
- It is specialized processor with advanced image processing capabilities(for 3D graphics)

2. Video memory is to store images processed by the GPU before they are displayed by the Monitor.

3. RAM DAC

- 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.

4. Video BIOS:-It contains the graphics card settings in particular graphics modes.

5. Interface: - This kind of bus used to connect the graphics card to motherboard.

----------End of Chapter----------