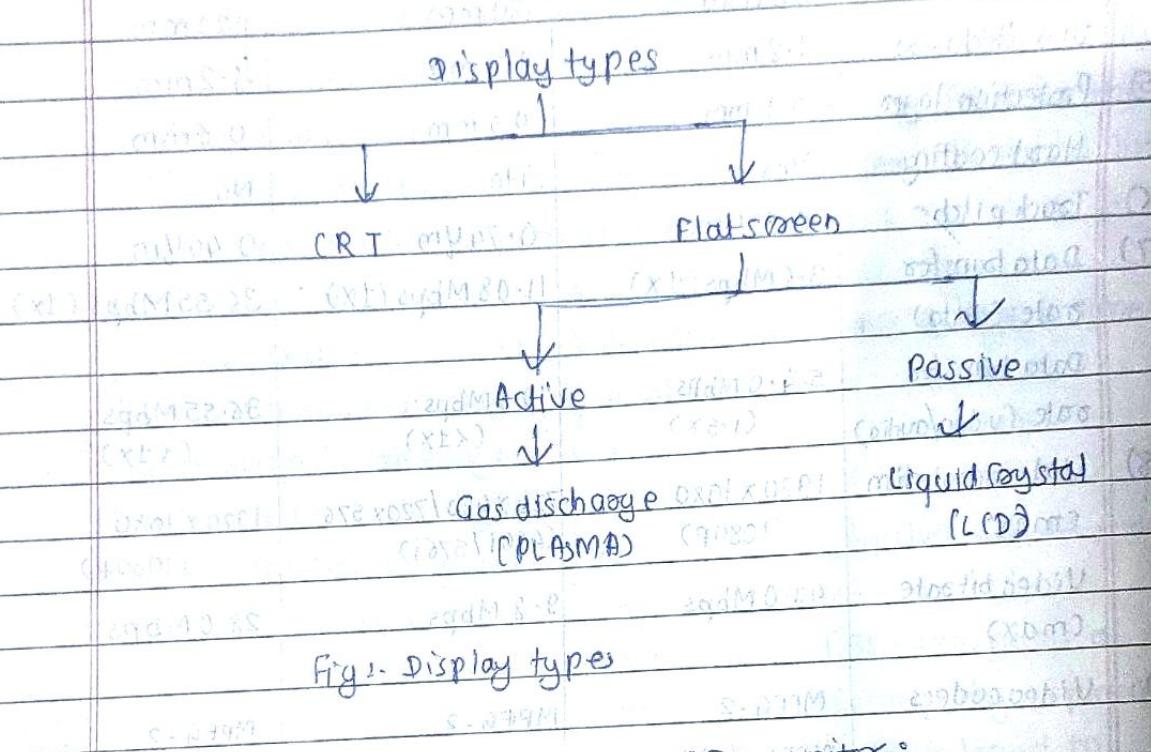


Page No.	68
Date	

3) Display devices and interfacing

A computer monitor, usually we called a monitor is an electrical device looks like a television. A display screen, a video display unit (VDU) or video display terminal (VDT), the monitor is a component of a computer system that displays the messages and data being processed and utilized by the computer's CPU.



S-09 W-14 Comparison between CRT, LCD and LED monitors:

Parameters	CRT	LCD	LED
1) Technology	Mature	Newest	Latest
2) Visual Performance	Slower	Faster	Faster
3) Image flicker	Yes	No	No
4) Image brightness	Variable, uneven	Bright, uniform	More Bright, Uniform
5) Image sharpness	Moderate	High	High
6) Power consumption	High	Low	Lowest
7) weight	Heavy	Light	Light
8) cost	Low	Moderate	High

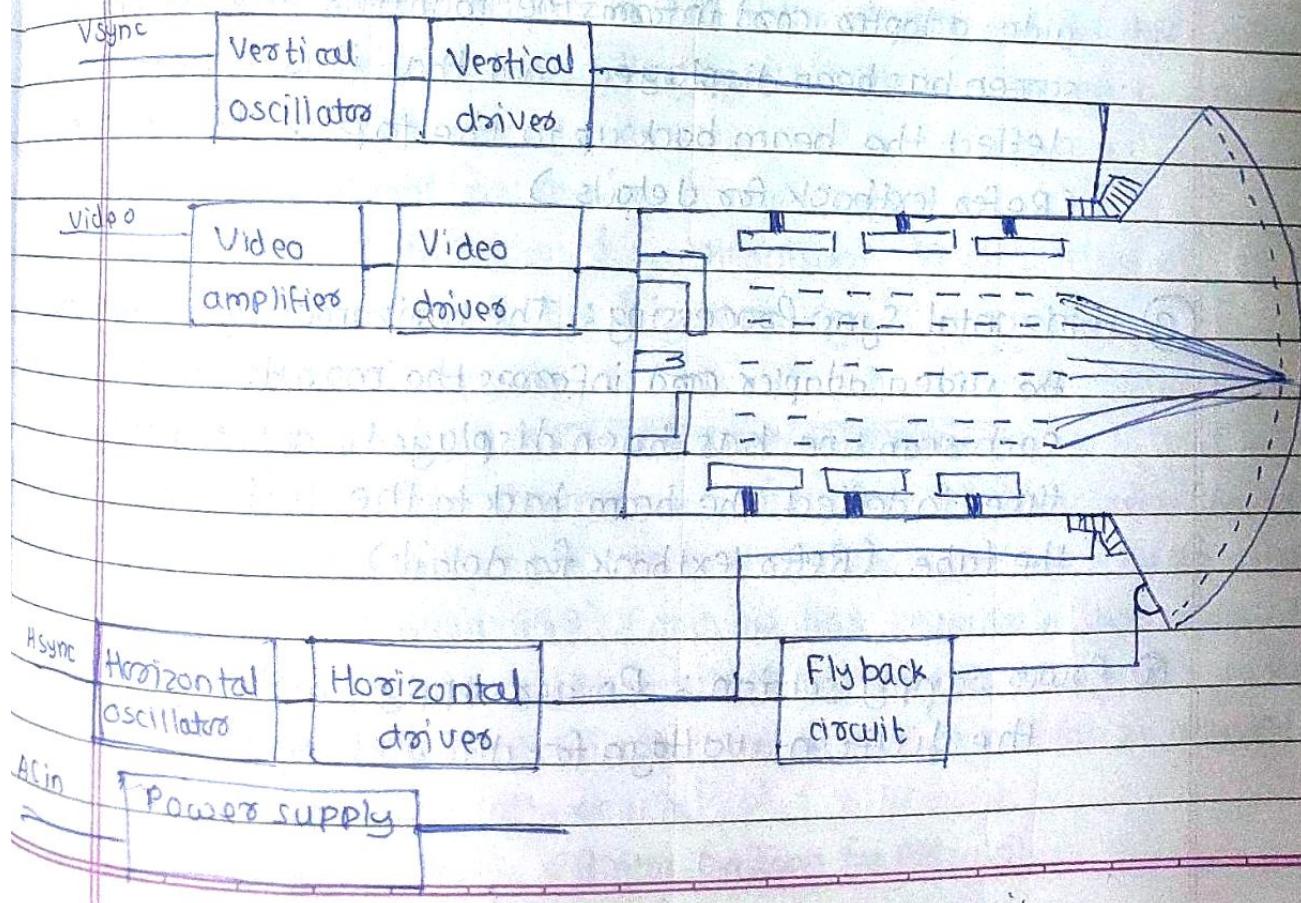
① CRT monitors : A Cathode Ray Tube (CRT) monitor is an analog computer display with a large, deep casing. This type of monitor uses streams of electrons that activate dots or pixels on the screen. There are two types of computer monitors:

1] Monochrome CRT monitor

2] Colour CRT monitor

1] Monochrome CRT monitor :- A monochrome monitor is a type of CRT computer display which was very common in the early days of computing, from the 1960's through the 1980's, before the color monitors became popular. They are still widely used in applications such as computerised cash register systems. Green screen was the common name for a monochrome monitor using a green "P1" phosphor monitor.

Block diagram of CRT:



Block diagram of Monochrome monitor

In the block diagram, the video adapter giving three signals to a monochrome monitor are :-

- 1] Video signal
- 2] Horizontal synchronisation
- 3] Vertical synchronisation.

It has following main blocks:-

- ① Video processing
- ② Vertical Sync Processing
- ③ Horizontal Sync Processing
- ④ Power Supply Section

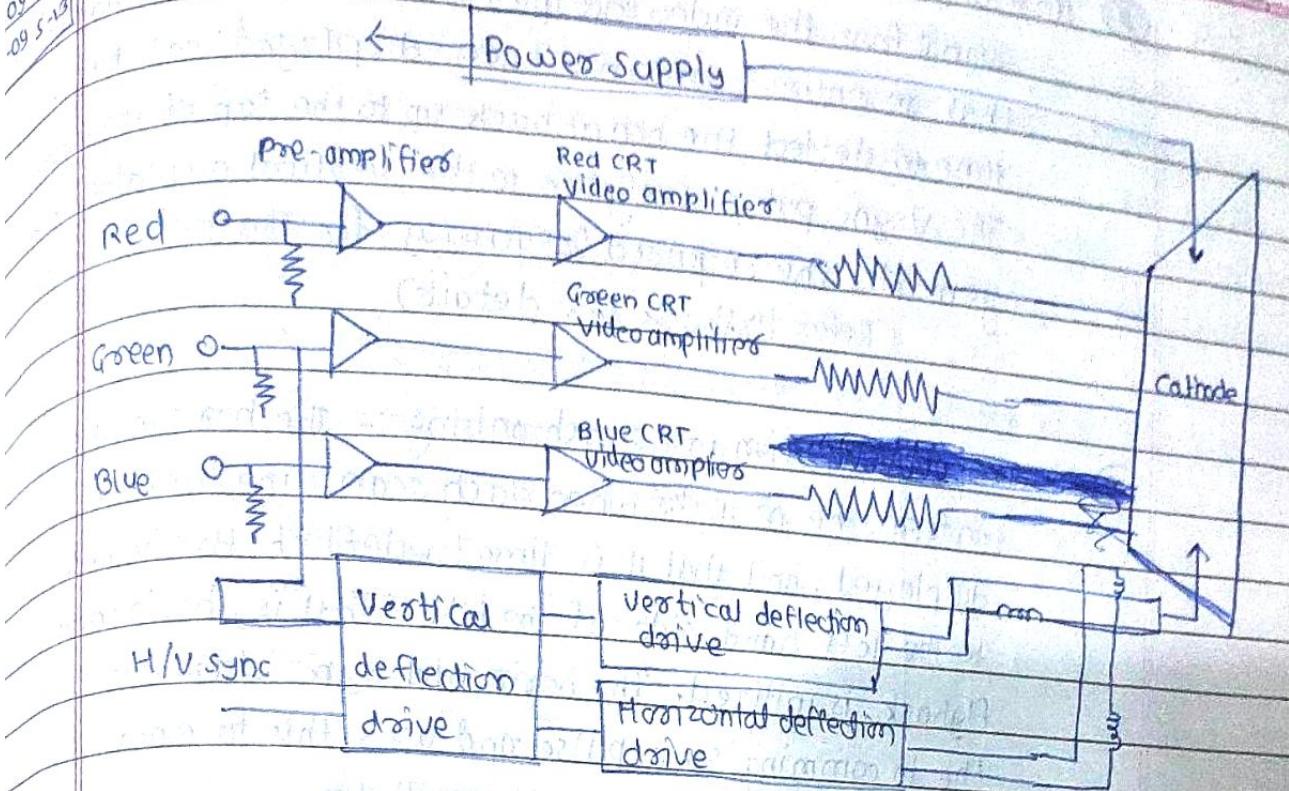
① Video Processing circuit : This contains video signal from the display adapter card fed to the video amplifier circuit. The video signal controls the brightness of the beam as it is scanned across and down the screen. (Refer textbook for details.)

② Vertical Sync Processing : The vertical sync signal from the video adapter card informs the monitor that an entire screen has been displayed, and that it is time to deflect the beam back up to the top of the screen. (Refer textbook for details.)

③ Horizontal Sync Processing : The horizontal sync signal from the video adapter card informs the monitor when each scan line has been displayed, and that it is time to deflect the beam back to the left hand side of the tube. (Refer textbook for details.)

④ Power Supply Section : Power supply section generates the different voltage for different circuits

2] Colour CRT monitor:



Block diagram and function of each block:

Working of colour monitors is as same as monochrome monitors, only difference is that there are three electron guns for three different colours! The entire circuitry within the monitors can be grouped into three main categories:

- ① Video signal processing & amplification
- ② Vertical deflection & synchronising
- ③ Horizontal deflection & synchronising
- ④ Power supply

① Video signal processing & amplification: A transmission line or a coaxial cable carries the video signal such as Red, Green and Blue (RGB) from the host computer to the monitor. The RGB video signals are Voltage peak to peak signal, so they require amplification before the signal can be applied to CRT's cathode.

(Refer textbook for details)

(2) Vertical deflection and synchronising :- The vertical sync signal from the video adapter card informs the monitor that an entire screen has been displayed, and that it is time to deflect the beam back up to the top of the screen. The Vsync pulses are given to the vertical oscillator which generates the required frequency for vertical scanning.
 (Refer textbook for details)

(3) Horizontal deflection and synchronising :- The horizontal sync informs the monitor when each scan line has been displayed, and that it is time to deflect the beam back to the left hand side of the tube. That is, horizontal flyback is initiated. The horizontal sync stage detects the incoming sync pulse and uses this to control the frequency of the horizontal oscillator.
 (Refer textbook for details)

(4) Power Supply Section : Power supply section generates the different voltages for different circuits.

(2)

Characteristics of CRT monitors:

S-08 W-10
S-11 W-11
S-11 S-12
W-12 S-14
S-15

1] Dot pitch or pixel pitch is a measurement that defines the sharpness of a monitor's display. It measures the distance between the dots that display the image on the screen.

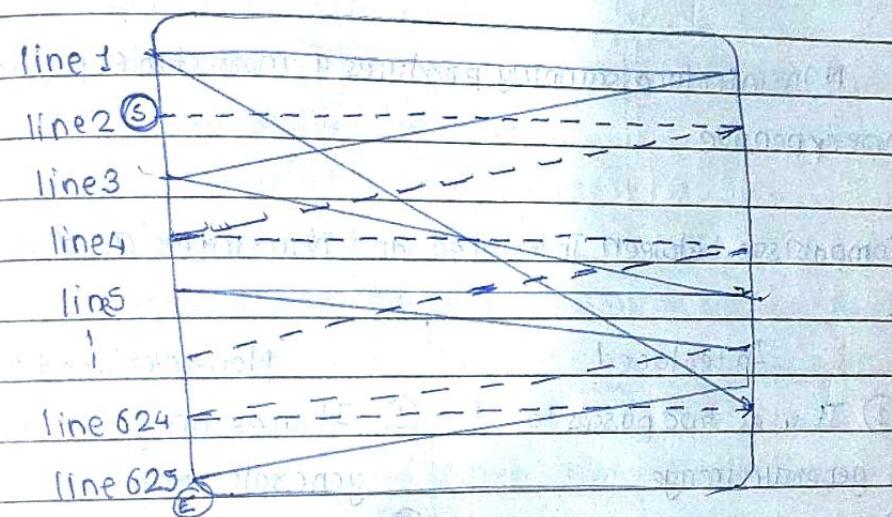
2] Resolution : Resolution is expressed in the number of horizontal and vertical picture elements, or pixels. More resolution means quality of image is good.

$$\text{Resolution} = \frac{\text{Total number of Horizontal pixels}}{\text{Total number of vertical pixels}}$$

3] Horizontal scanning frequency :- The frequency at which the monitor rewrites the horizontal lines that make up an image is called horizontal scanning frequency. It moves the electron beam from the left side of the display to the right and back, and thereby described the number of horizontal lines displayed per second.

4] Vertical scanning frequency :- Vertical scanning frequency is called as refresh rate. It is measured in Hertz (Hz) and represents the number of frames displayed on the screen per second.

5) Interlaced scanning :

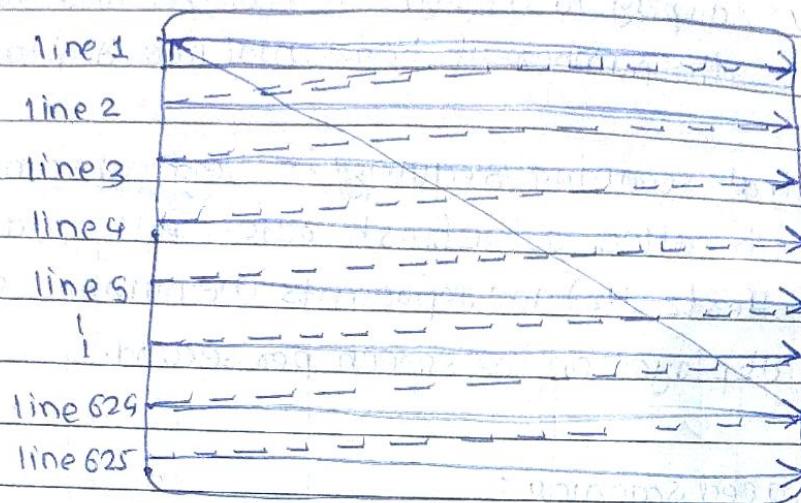


Interlaced scan is used in normal TV and video systems - It was designed to reduce bandwidth and flicker while maintaining resolution.

In interlaced scanning image is broken up into two fields: all odd lines (line 1-3-5-7...) are imaged in first field and all even lines (line 2-4-6-8...) are imaged in second field.

CRT guns scans all even lines are scanned first from top to bottom and left to right. Once they are over odd lines are scanned in same manner. It displays "frame" as shown in figure.

6] Non-interlaced scanning: It is also called as Progressive scanning. A non-interlaced cathode display is a CRT tube display in which the lines are scanned sequentially from the top to the bottom sequentially in a single scan.



Non-interlace scanning produces a more stable picture and a more expensive.

W-08 S-10
W-12 S-14

Comparison between Interlaced and Non-interlaced scanning:

In interlaced	Non-interlaced display
① It uses two passes to generate image	① It uses only one pass to generate image
② Image quality is not good	② Image quality is good
③ Image flickering is there.	③ Less chances of image flickering
④ It produces less stable picture	④ It produces a more stable picture
⑤ The cost is less	⑤ The cost is more

7] Aspect ratio: The aspect ratio of a display is the proportional relationship between width of display and its height. The aspect ratio is expressed as numbers separated by a colon ($x:y$).

For ex:- Aspect ratio of $2:1$ means that the width is twice as large as the height.

While setting the aspect ratio, it is important to avoid stretching of picture by setting a ~~permitted~~ aspect ratio.

Advantages of CRT display related to LCD display:

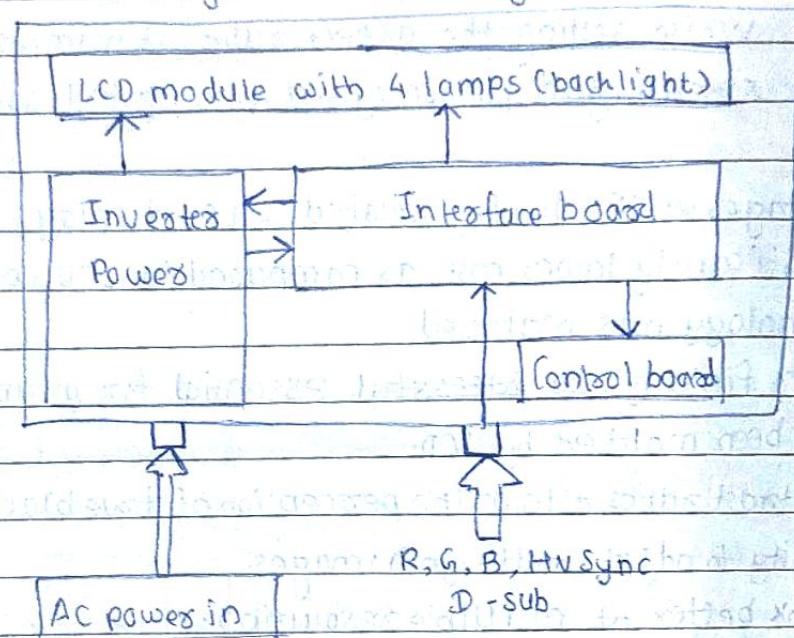
- ① Significantly lower cost as compared to LCD, because the technology has matured.
- ② Color fidelity, so ~~successful~~ essential for graphics artists, has not been matched by LCD.
- ③ Contrast ratios allows the perception of true black, Darks are darker.
- ④ Ability to adjust (multi-sync) images.
- ⑤ Work better at multiple resolution.
- ⑥ Display full motion video better.
- ⑦ Modern version may include sleep-mode for energy efficiency.
- ⑧ Many now available with flat viewing screens for less storage, viewing conveniences.
- ⑨ Strong glass screen can withstand routine handling, and is not easily damaged by casual touch.

Disadvantages of CRT's over LCD:

- ① Radiation Emission ; ELF from 60Hz to 75Hz and VLF from 10KHz to 30Hz.
- ② Larger size takes up more desk space; bigger the screen bigger the footprint.
- ③ Heavier weight, 40 lbs or more.
- ④ Heavier size limits easy and convenient movement.
- ⑤ Expend more energy and throws off heat.

③ LCD monitor: A Liquid Crystal Display is a thin, flat display device made up of any number of colors or monochrome pixels arrayed in the front of light source or reflector. (Refer textbook for detail.)

S-11 S-15 Functional block diagram and working of LCD monitors:



Description:

* **Interface board:** The function of interface board is to convert an input signal into a digital R, G, B signal. With the help of ADC (Analog to Digital Converter) along RGB signal is converted into digital RGB signal. Output data is sent to the LCD module.

* **Control board:** The control board controls the user operation. The main parts of the control board are push button and an LED.

(a) Push button : Its 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 the DPMS status of this LCD monitor ; green light mean DPMS on (Normal operating condition). Amber light mean DPMS off (Power off condition).

* Inverter : The main function of the inverter is to convert AC voltage in required DC voltage for LCD module and interface board.

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

Advantages of LCD :

- ① Light weight ; can be about 15 lbs for a thin LCD.
- ② Smaller footprint on desk leaving , freeing up the work area on the user's desk.
- ③ Flicker free screen.
- ④ More usable display area than on a comparably size CRTs.
- ⑤ Low frequency radiation is practically eliminated.
- ⑥ Easy adjustment , storage and movement .
- ⑦ Energy efficient, using only $\frac{1}{3}$ to $\frac{1}{2}$ the electricity of CRTs and they do not generate heat.
- ⑧ Potentially less eye strain due to reduced screen glare . Good for basic web surfing.

S-09 W-10

Disadvantages of LCD:

- ① Fragile screen; may result in both screen and backlight lamp damage if touched or handled.
- ② Contrast ratio causes darkness not to be displayed true. Darkest area may be viewed as dark gray rather than black.
- ③ Designed only for one optimum resolution; can not adjust images.
- ④ Best view of screen is straight on, limiting clarity and colors of information from those viewing from an angle.
- ⑤ The backlight is the potential weak link and its failure can be costly. Many warranties cover it for 1 year.

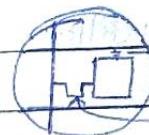
S-09 W-11

LCD Types: LCD display uses two types of matrix:

① Passive matrix

② Active matrix

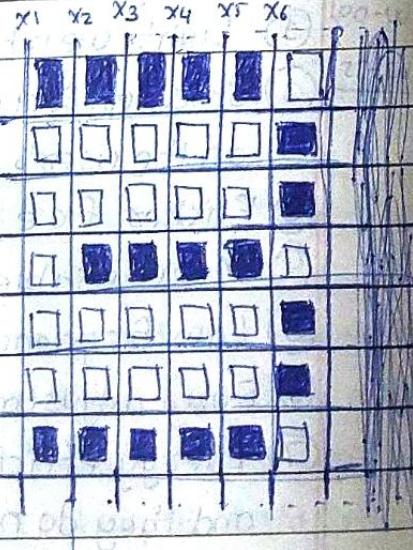
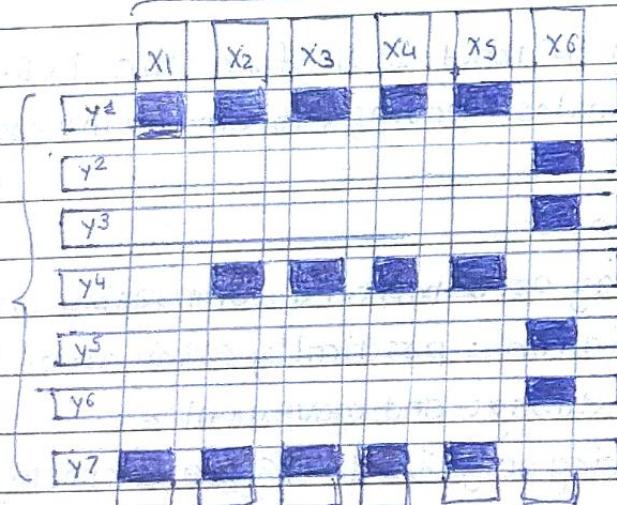
signal electrodes



storage capacitors

switching device TFT

Scanning
electrodes



Passive matrix LCD Active matrix LCD

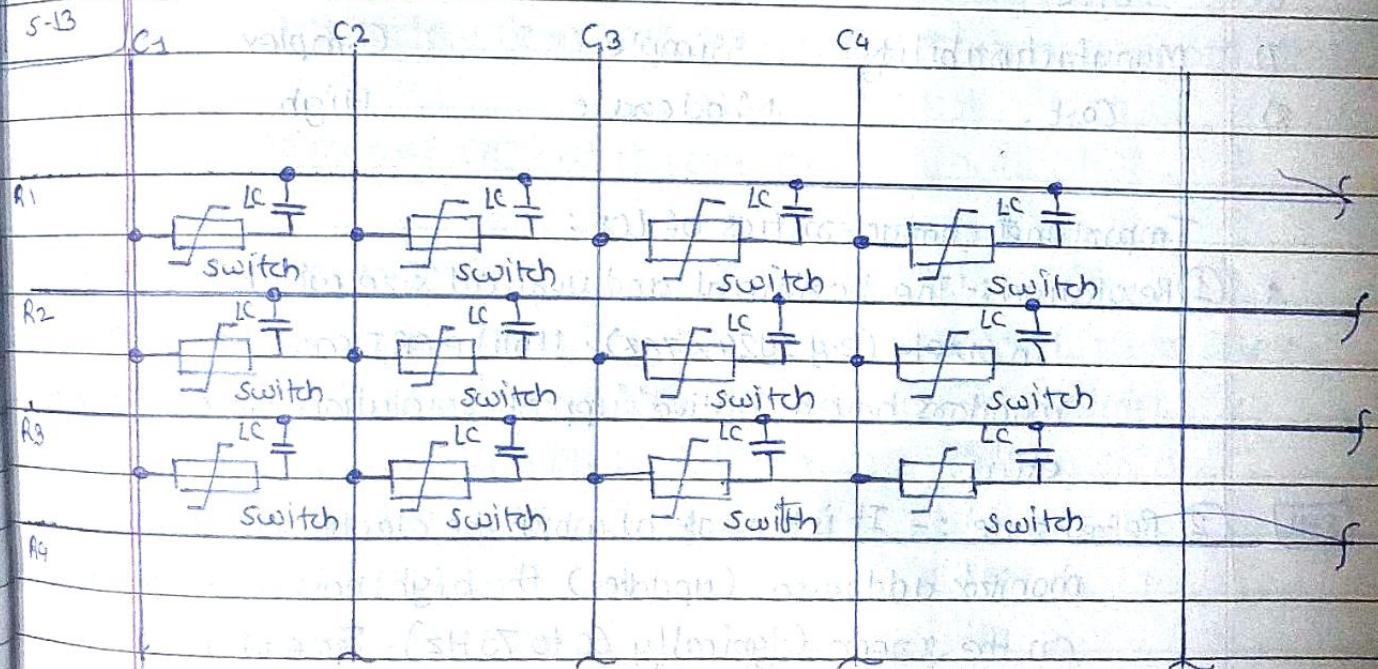
J-08 S-12
S-13

① Passive matrix: Passive matrix is an older, simple to produce and inexpensive type. It uses a grid of vertical and horizontal wires to display an image on the screen. Horizontal wires (rows) of electrodes on one half of the display of the glass is called scanning electrode and vertical wires (column) of electrodes are known as signal electrodes.

When two pieces of glass are assembled into a display, the intersection of a row and column form a pixel controlled by two transistors. When a voltage is applied between the two points, changes the light transmission properties of the liquid crystal. By repeating this process, scanning through the pixels an image can be formed on the display.

WOS S-12
S-13

② Active matrix:



Passive matrix displays suffers from fundamental problems leading to poor performance. Active matrix addressing solves these problems. By placing an electronic switch device in each LC (Liquid Crystal) pixel as shown in figure. ↑

It uses matrix of thin film transistors (TFT's) and capacitors to control the image produced by the display. Brightness of each pixel is controlled by modifying the electrical charge of its corresponding capacitors. Each pixel's color is controlled by altering the charge of individual capacitors that emit red, green and blue (RGB) light.

[W-14] Comparison of Active and Passive matrix LEDs :

Parameters	Passive	Active
1) Contrast	10 - 20	100 +
2) Viewing angle	Limited	Wide
3) Gray scale	16	256
4) Response time	100 - 200 ms	< 50 ms
5) Multiplex ratio	480	> 1000
6) Size	Upto 17"	< 14"
7) Manufacturability	Simple	Complex
8) Cost	Moderate	High

Important characteristics of LCD :

- ① Resolution :- The horizontal and vertical size which is expressed in pixels (e.g 1024 x 768). Unlike CRT monitors, LCD monitors have a native support resolution for best display effect.

- ② Refresh rate :- It is the rate at which the electronics in the monitor addresser (updates) the brightness of the pixels on the screen (typically 60 to 75 Hz). For each pixel, an LCD monitor maintains a constant light output from one addressing cycle to the next so the display has no refresh dependent flicker. There should be no need to set a high refresh rate to avoid flicker on the LCD.

5-11

③ Response time :- The minimum time necessary to change pixels' colors or brightness.

④ Dot pitch :- The distance between the centers of two adjacent pixels. The smaller the dot pitch size, the less granularity is present, resulting in the sharper image. Dot pitch may be same both vertically and horizontally, or different (less common).

⑤ Viewable size :- The size of an LCD panel measured on the diagonal (more specifically known as active display area).

⑥ Matrix type :- Active or Passive.

⑦ Colour support :- How many types of colors are supported.

⑧ Brightness :- The amount of light emitted from the display.

⑨ Contrast ratio :- The ratio of the intensity of the brightest bright to the darkest dark.

⑩ Aspect ratio :- The ratio of the width to the height.

⑪ Input ports :- (e.g.: DVI, VGA, LVDS, or even S-Video and HDMI).

Comparison of CRT and LCD display:

Parameters	CRT	LCD
1) Stands for	Cathode Ray Tube	Liquid Crystal Display
2) Size	Weighted, bulky & large	Light, compact & thin
3) Power consumption	High	Low
4) Image Flickering	Yes	No
5) Image Retention	No	Yes
6) Image forming	Electron gun is used	Liquid crystals are used
7) Response	Good	Slow
8) Radiation	Significant	Small
9) Cost	Less	More
10) Where used	Televisions & old computer monitors	Flat screens

4) Touch Screen Display : A touch screen is an Electronic Visual display that can detect the presence and location of a touch within the display area. It refers to the touch or contact to the display of the device with a finger or hand. Touch screen can also sense other passive objects, such as a stylus.

5-15 Difference between Touch screen monitors and LCD monitor:

Touch screen monitor

- ① Touch screen monitor is a standard LCD/LED monitor and it adds another screen or clear layer to the front of it.
- ② A touch screen is an addition to the Electronic Visual Display that can detect the presence and location of a touch within the display area.
- ③ It works as input and output device.
- ④ For touch or contact to the display of the device with a finger and passive objects such as stylus.

LCD monitors

- ① LCD monitors have liquid Crystal Display and a backlight layer.
- ② This facility is not available in LCD monitors.
- ③ It works as only output device.
- ④ Give the input through interface.

Components of Touch screen: A basic touch screen has three main components:

- 1] Touch sensor
- 2] Controller
- 3] Software drivers

1] Touch sensor: A touch sensor detects the location of touches within the display area. It is a clear touch sensor panel with a touch responsive surface placed over the display. The sensor generally has an electrical current or signal going through it and touching a screen can cause a voltage or signal change. This change is used to determine the location of the touch to the screen.

2] Controller: The controller is a printed circuit board (PCB) that is the interface between the sensor and the display. The controller takes information from the touch screen and translates it into information a computer or microprocessor can understand, such as cursor control, right and left clicks, etc.

3] Software drivers: A computer program that allows the computer operating system and the controller to communicate and helps the controller recognise input.

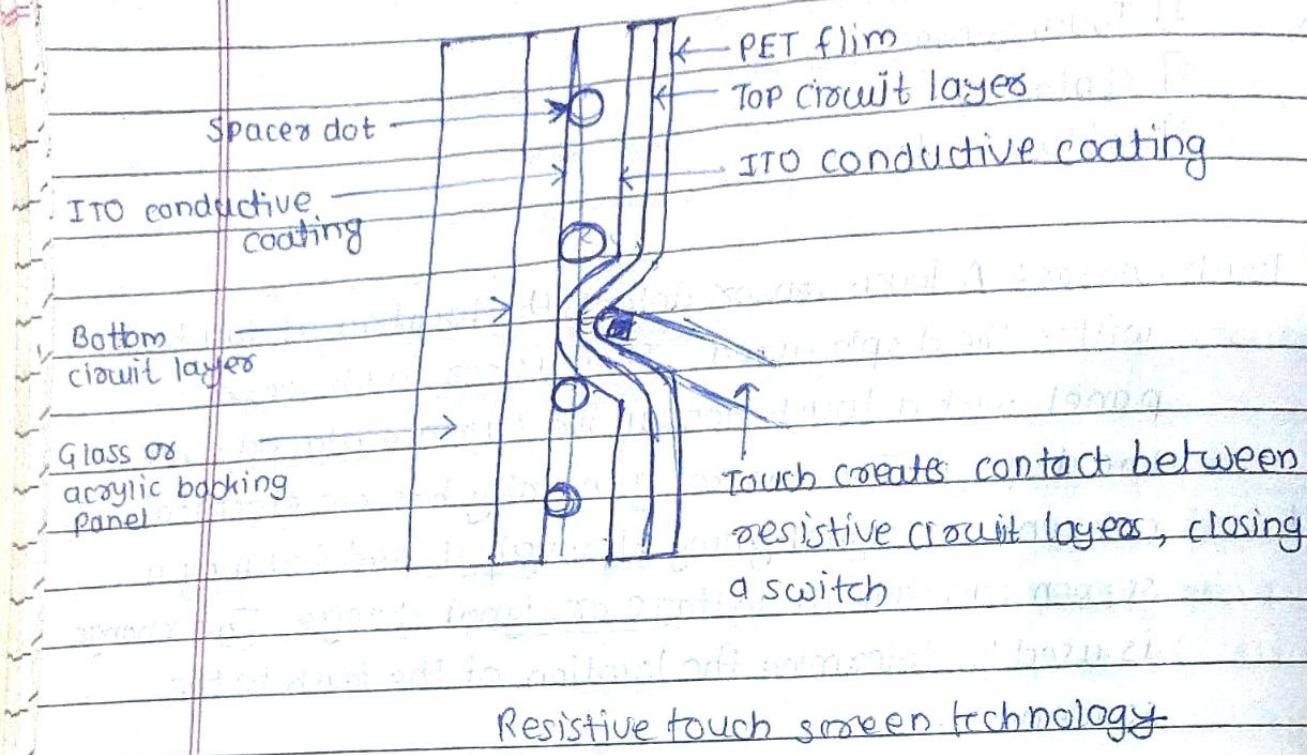
Touch screen technologies:

The following are the main touch screen technologies:

- ① Resistive
- ② Capacitive
- ③ Surface Acoustic Wave
- ④ Infrared

S-14

Construction and working of Resistive Touch Screen Technology



Resistive touch screen technology

The resistive touchscreen consists of a flexible top layer made up of ~~Polythene~~ Polyethylene (PET) and a rigid bottom layer made up of glass as shown in figure. Both the layers are coated with a conducting compound called Indium Tin Oxide (ITO) and then spaced with spacers. While the monitor is operational, an electric current flows between the two layers.

When the touch is made, the flexible screen touches down and touches the bottom layer. A change in electrical current is hence detected and the coordinates of the point of touch are calculated by the controller and passed into readable signals for a operating system to react accordingly.

Advantages:

- ① Low cost technology
- ② A hand can be used with or without gloves, and with other objects such as stylus.
- ③ Low power requirements
- ④ Activated by any object
- ⑤ High resistance to dust and water
- ⑥ Accurate.

Disadvantages:

- ① These sensors function with only one point of touch resulting in a shorter lifespan in comparison with glass surface touch screens.
- ② They do not support "drag and drop" movements.
- ③ Polyester surface can be damaged.
- ④ Only 75% light transmission.
- ⑤ Not too sensitive, you have to press down harder.
- ⑥ Does not support multi-touch.
- ⑦ Lower endurance (~35 million touches).

Construction and working of Capacitive touch screen technology:

The Capacitive Touch screen Technology is the most popular and durable touch screen technology used all over the world at most. It consists of a glass panel coated with a capacitive (conductive) material Indium Tin Oxide (ITO). The capacitive systems transmit almost 90% of the light from the monitor.

With this method, the point at which the touch occurs is identified using sensors to sense minor changes in electrical current generated by contact with a finger or change electrostatic capacity (load).

Advantages:

- ① Because capacitive touch screen has glass layer instead of plastic, it looks brighter and sharper.
- ② Highly touch sensitive and doesn't need a stylus.
- ③ Supports multi-touch.
- ④ Durable surface material.
- ⑤ High endurance (~ 255 million touches).
- ⑥ Very accurate.
- ⑦ Good optical quality.

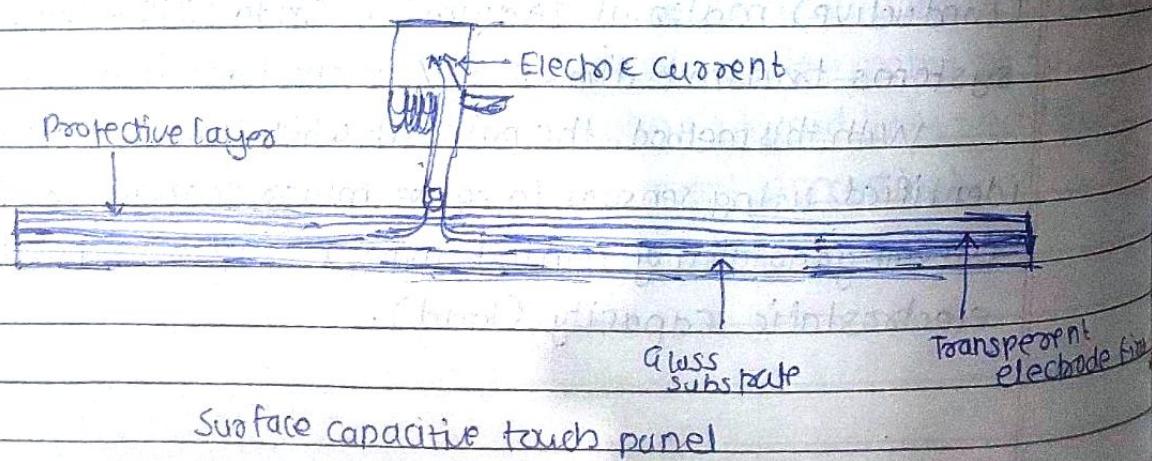
Disadvantages:

- ① Because the technology is not dependent on the conductive nature of the human body, it doesn't work if the user is wearing gloves.
- ② Because of having a complex structure, they are expensive.
- ③ Glass is more prone to breaking.
- ④ Triggered only by bare fingers or active stylus.

Two types of touch panels use this method:

- 1] Surface capacitive touch panels
- 2] Projective capacitive touch panels.

1] Construction and working of Surface capacitive touch panels

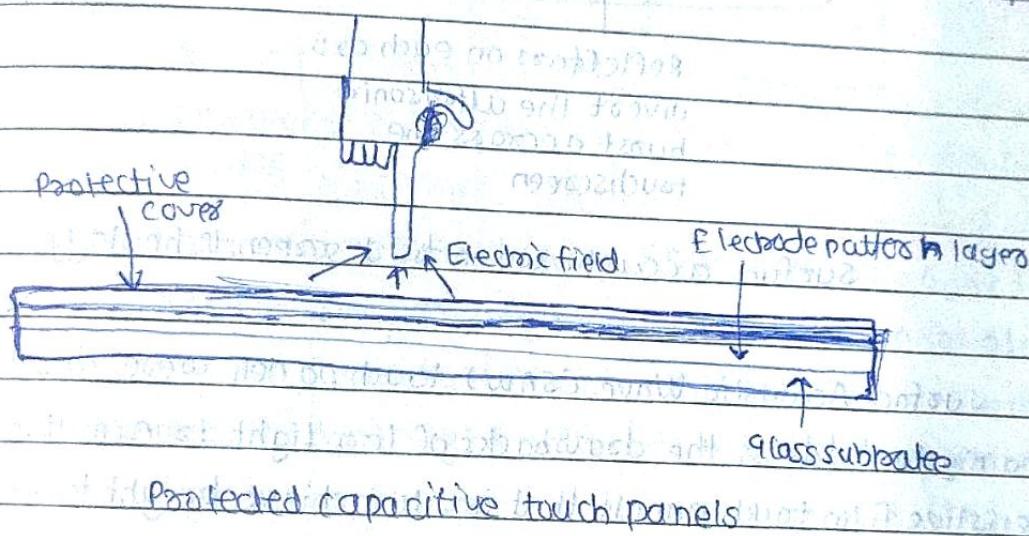


Date _____
Page _____

Surface capacitive touch panels are often used in relatively large panels. Inside these panels, a transparent electrode film (electrode layer) is placed atop a glass substrate, covered by a protective cover as shown in Figure on pg. 86.

Electric voltage is applied to electrodes positioned in four 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 four corners of the panel.

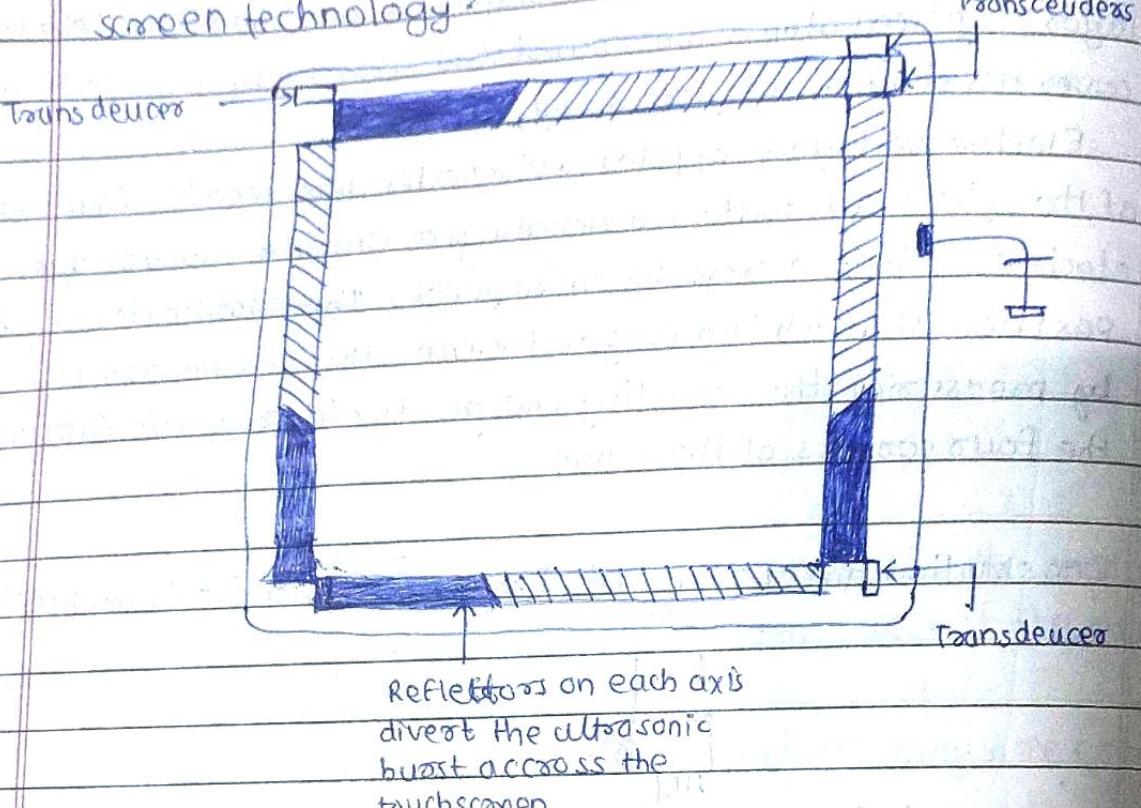
Construction and Working of Projected capacitive touch panels



Projected capacitive touch panels are often used for smaller screen sizes than surface capacitive touch panels. They have attracted significant attention in mobile devices. Use this method in mobile devices or small displays to achieve high precision multi-touch functionality and high response speed. Its structure is as shown in above figure.

The surface is covered with an insulating glass or plastic cover. When a finger approaches the surface, the electrostatic capacity among multiple electrodes change simultaneously, and the position where contact occurs can be identified precisely by measuring the ratios between these electrical currents.

construction and working of surface Acoustic Wave touch screen technology



surface acoustic wave touch screen technology

Surface Acoustic Wave (SAW) touch panels were developed ~~initially~~ mainly to address the drawbacks of low light transmittance in resistive film touch panels that is, to achieve bright touch panels with high level of visibility.

The waves propagate across the glass and are reflected back to the sensors. When the screen is touched, the waves are absorbed and a touch is detected at that point. The reflectors reflect all electrical signals sent from one transducer to another. This technology provides excellent throughput and image clarity.

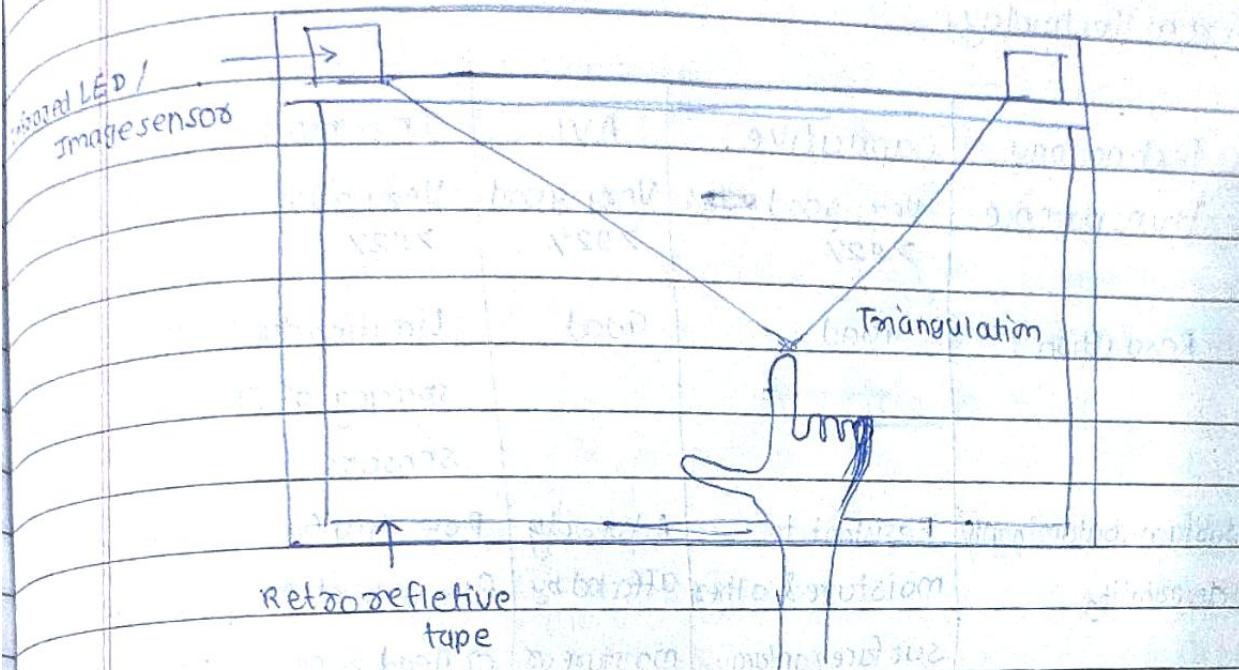
Advantages:

- ① Best optical quality
- ② High durability surface and seal
- ③ Activated by multiple sources

Disadvantages:

- ① Expensive
- ② Contaminates an screen can cause false touches.

Infrared / Optical Imaging Touch Panel:



A touch panel in this category features one infrared LED each at the left and right ends of the top of the panel along with an image sensor (camera) shown in figure. Retroreflective tape that reflects incident light along the axis of incidence is affixed along the remaining left right and bottom side. When a finger or object touches the screen, the image sensor captures the shadows formed when the infrared light is blocked. The coordination of the location of contact are derived by triangulation.

Advantages:

- ① High optical clarity
- ② Durable surface
- ③ supports multi-touch
- ④ Can scale to large sizes.

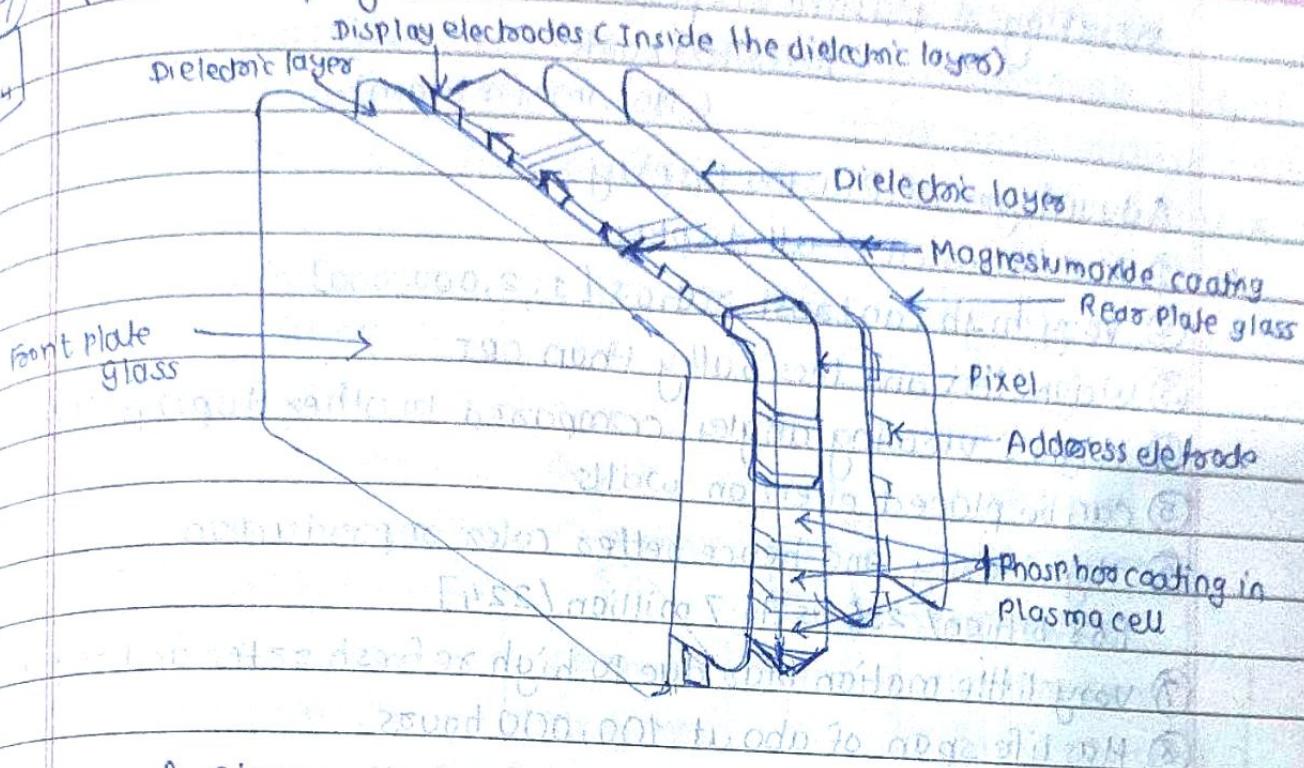
Disadvantages:

- ① Expensive
- ② cameras can get out of alignment.

Comparison between Capacitive, SAW, Infrared and Resistive Touch Screen Technology:

	Technology	Capacitive	SAW	Infrared	Resistive
1)	Transparency	Very good >92% >>92%	Very good >92%	Very good >92%	75 & ~85%
2)	Resolution	Good	Good	Limiting due to spacing of IR sensors	Good
3)	Surface contamination/ durability	Resistant to moisture & other surface contami- nants	Adversely affected by moisture & surface contami- nants	Potential for fuse activation from surface contaminants	Unaffected by surface contamination. The polyester top sheet is easily scratched
5)	Sensor substrate	Glass with ITO coating	Glass with ITO coating	Any substrate	Polyester top sheet, glass substrate with ITO coating
6)	Display size	8.4" - 21"	10.4" - 30"	10.4" - 60"	Upto to 19"
7)	Touch method	Human touch	Finger, gloved hand or soft tip	Can cause any painting device	Can cause any painting device

7 Plasma Display:



A plasma display is a computer video display in which each pixel on the screen is illuminated by a tiny bit of plasma or charged gas, somewhat like a tiny neon light. Plasma displays are thinner than CRT and brighter than LCD.

Features:

- ① Plasma displays can be made upto large sizes like 150 inches diagonal.
- ② Very low - luminance "dark-room" black level.
- ③ Very high contrast ratio.
- ④ The plasma display panel has thickness of about 2.5 inches, which makes the total thickness not more than 4 inches.
- ⑤ For 50 inch display, the power consumption increases from (50-400) watts in accordance with images having darker colours.
- ⑥ All displays are sold out in shop mode which consumes more power than the above described. It can be changed to home mode.
- ⑦ Has a life time of almost 100,000 hours. After this period, the brightness of TV reduces to half.

Working of plasma display (Refer textbook) (Not imp for exam)

Advantages of Plasma Display :-

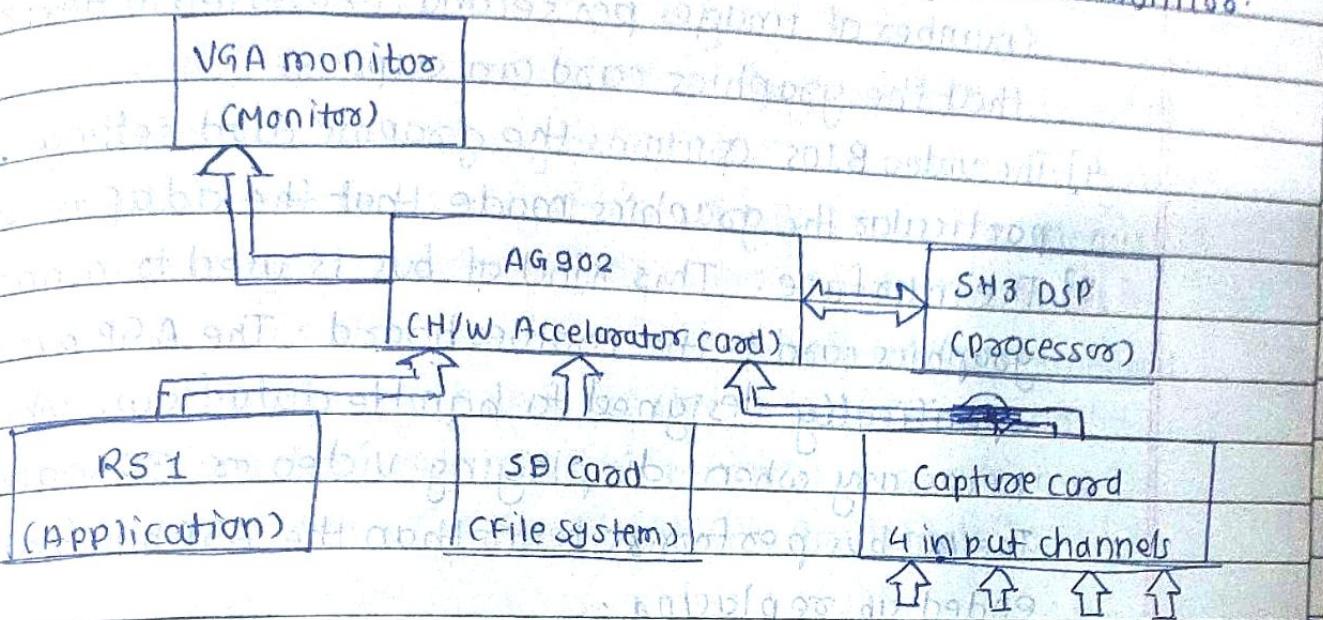
- ① The slimmest of all displays
- ② Very high contrast ratios [1: 2,000,000]
- ③ Weighs less and less bulky than CRT
- ④ Higher viewing angles compared to other displays (178 degrees)
- ⑤ Can be placed even on walls.
- ⑥ High clarity and hence better color reproduction
[68 billion/ 236 vs 16.7 million / 224]
- ⑦ Very little motion blur due to high refresh rates and response time
- ⑧ Has life span of about 100,000 hours.

Disadvantages of plasma display :-

- ① The cost is much higher compared to other displays
- ② Energy consumption is more.
- ③ Produces glares due to reflection
- ④ These displays are not available in small sizes than 32 inches.
- ⑤ Though the display doesn't weigh much, when the glass screen, which is needed to protect the display, is included, weighs more.
- ⑥ Cannot be used in high altitudes. The pressure difference between the gas and the air may cause temporary damage or a buzzing noise.
- ⑦ Area flickering is possible.

6
08 W-09
10 W-11
12 S-13
14 W-14

Video Accelerator Card:- A video accelerator card is an expansion card whose function is to generate output images to a display as it converts digital data into a graphical form which can be displayed on a monitor.



Block diagram of VGA
Video Accelerator card

The main components of VGA card are:

- 1] A Graphical Processing Unit (GPU), the heart of a graphics card, which processes images based on the encoding being used. The GPU is a specialized processor with advanced image processing capabilities especially for 3-D graphics. Because of the high temperatures that the graphics processor can reach, a radiator and fan are mounted on it.
- 2] The video memory is used to store images processed by the GPU before they are displayed on the monitor. The larger the video memory, the better the graphics card can handle textures when displaying 3D-scenes.

→ PTO

3] The RAMDAC (Random Access Memory Digital-Analog Converter) is used for converting digital images stored in the frame buffer as analog signals to send the monitor. The RAMDAC's frequency determines the refresh rate (number of images per second, expressed in Hertz-Hz) that the graphics card can support.

4] The video BIOS contains the graphic card settings, in particular the graphics mode that the adapter supports.

5] The interface: This kind of bus is used to connect the graphics card to the motherboard. The AGP bus is specifically designed to handle data flow, which is necessary when displaying video or 3D sequences.

The PCI bus performs better than the AGP bus that it has ended up replacing.

