

Display Devices & its Interfacing

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Display systems are available in various technologies such as

- i) Cathode ray tubes (CRTs),
- ii) Liquid crystal displays (LCDs),
- iii) Plasma displays, and
- iv) Light emitting diodes (LEDs).
- v) Touch Screen

Sr No	Advantages of LCD	Disadvantages of LCD
1	The sharpness of a LCD Display is at maximum tweakness	After a while the LCD Display some of the pixels will doe you will see a discoloured spot and black spot on the display
2	Zero geometric distortion at the native resolution of the panel	Cost of LCD is considerably at a high price
3	High peak intensity produces very bright images. Best for brightly lit environments.	The LCD Display will have slow response times
4	Screens are perfectly flat	LCD Display has a fixed resolution display and cannot be changed
5	Thin with a small footprint. Consume little electricity and produce the heat	LCDs use analog interface making careful adjustment of pixel tracking/phase in order to reduce or eliminate digital noise in the image
6	LCD Display unit is very light and can be put anywhere or moved anywhere in the house	The viewing angle of a LCD display is very limited due to automatic pixl tracking/phase controls
7	Lack of flicker and low glare reduce eyestrain	Response time-25 milliseconds
8	Complete Viewable region	Smaller viewing angle
9	Less Weight : 15 lbs	
10	e.g Notebooks, Pagers, phones	

Feature	CRT	LCD
Viewing Angle	180 degrees, almost all angles	150 degrees, Not all angles
Weight	Heavy	Lighter
Resolution	Better compared to LCD	Low resolution
Size	Much larger than LCD	Thinner
Glare	Since this has glass screen, it has glare	No glare
Power	On an average a 17" monitor uses 80 watts	For 19" LCD takes 17- 31 Watts
Viewable screen	The viewable area is always about 0.9 - 1.1 inch smaller than the size specified on paper.	A 15 inch LCD always has a same size of viewable area as the specifications say.
Radiation	CRTs emit electromagnetic radiation. Much of it is filtered by the lead heavy glass front	LCDs emit a very small amount of radiation compared to CRTs.

Sr No	Advantages of CRT	Disadvantages of CRT
1	Cathode Ray Tube can easily increase the monitor's brightness by reflecting the light.	They are bulky and take up space on desk
2	They produce more colours	The electromagnetic fields emitted by CRT monitors constitute a health hazard to functioning of living cells
3	CRT Monitors have lower price rate than LCD Display or Plasma Display	Constant refreshing of CRT monitors can result in headache
4	Quality of image displayed on a CRT is superior to LCD and Plasma monitors.	CRTs operate at very high voltage which can overheat system or result in an implosion
5	The contrast features of CRT monitor are considered highly excellent	Within a CRT a strong vacuum exists in it and can result in implosion
6	Response Time-13 milliseconds	They are heavy to pick up and carry around.
7	Large Viewing angle	Viewable region of 17" monitor is 16.1"
8		Weight: 40 lbs

Characteristics of CRT Monitor

1. Dot Pitch

Dot Pitch is the distance between each group of red, green and blue(RGB) phosphors. A smaller dot pitch helps sharper, clearer images.

2. Resolution

This quantity is expressed in the number of horizontal and vertical picture elements or pixels. The greater the number of pixels, the more detailed the images.

3. Interlacing and Non interlacing

In non-interlaced, the electron beam sweeps the screen in lines from top to bottom, one line after the other, completing the screen in one pass.

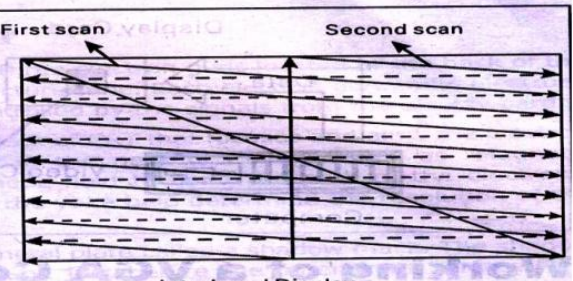
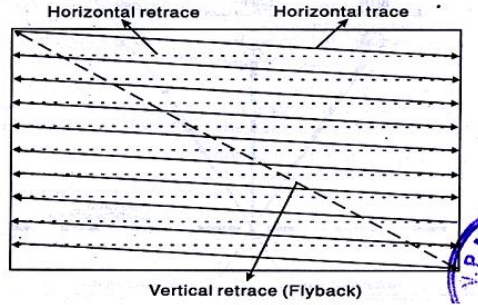
In interlaced mode, the electron beam sweeps the screen from top to bottom but it does so in two passes-sweeping the odd lines first and even lines second. Each pass takes half the time of a full pass in non-interlaced mode.

4. **Refresh Rate (Vertical Scan Frequency)** is the rate at which the screen display is rewritten. This is measured in hertz. A refresh rate of 72 Hz means the screen is refreshed 72 times per second

5. **Horizontal Scan Frequency** The frequency at which the monitor rewrites the horizontal lines that make up an image is called horizontal scan frequency.

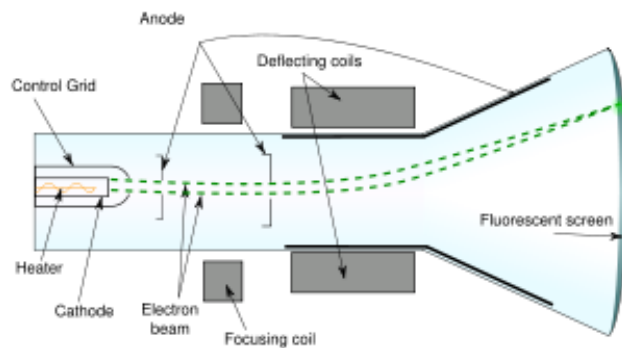
6. **Video bandwidth** Max Rate at which pixels can be sent to monitor.

7. **Contrast Ratio**: Is the difference in light intensity between the brightest white and the darkest black that an LCD can produce.

Interlaced	Non - interlaced
1. Scans every other line of the image in one pass & the remaining lines in other pass	Scans all lines in single pass
2. Difficult on the eyes	easy on the eyes
3. Flicker is more	Flicker is less
4. Effective image refresh rate is half the vertical scanning rate	Entire image is refresh at vertical Scanning rate
5.	
	

Understanding The Operation of a CRT Monitor

The operation of a CRT monitor is basically very simple.



A cathode ray tube (CRT) contains four basic parts:

- Electron gun,
- Focusing and accelerating systems,
- Deflecting systems, and
- Evacuated glass envelope with a phosphorescent screen that glows visibly when struck by the electron beam.

Working of CRT Monitor:

1. An electron gun consists of a series of electrodes producing a narrow beam of high-velocity 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.

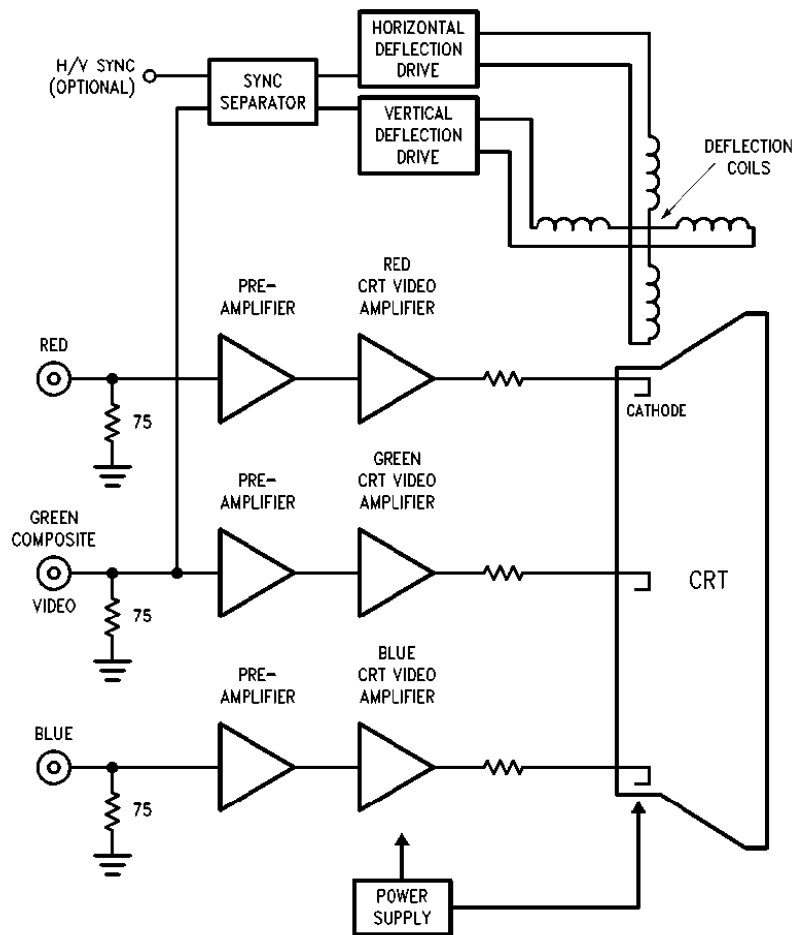
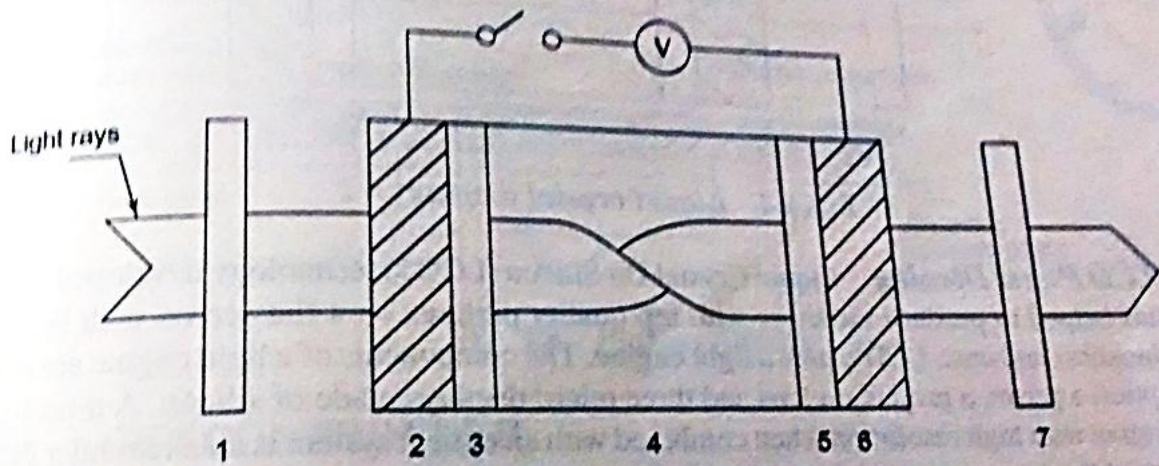


FIGURE 1. Simplified Block Diagram of an RGB(Color) Monitor

How LCD Displays work

- In an LCD, polarizing filter allow only light waves that are aligned with the filter to pass through
- After passing through one polarizing filter, the light waves are all aligned in same direction
- By aligning a second polarizing filter at right angle to first, all those waves are blocked
- By changing the angle of second polarizing filter, the amount of light allowed to pass can be changed accordingly
- It is the role of the liquid crystal cell to act as a polarizing filter that can change the angle of polarization and control the amount of light that passes.
- The liquid crystals are tiny rod-shaped molecules that flow like a liquid. They enable light to pass straight through, but an electrical charge alters their orientation which subsequently alter the orientation of light passing through them.
- In a color LCD, there are three cells for each pixel one each for displaying Red, Green and Blue. The red, green and blue cells that make up a pixel are sometimes referred to as subpixels.



- | | |
|------------------------------------|-------------------------------|
| 1. Front Polariser | 2, 6 Glass Plate / Electrodes |
| 3,5 Liquid Crystal Alignment Layer | 4 Liquid Crystal |
| 7 Rear Polariser and Reflector | |

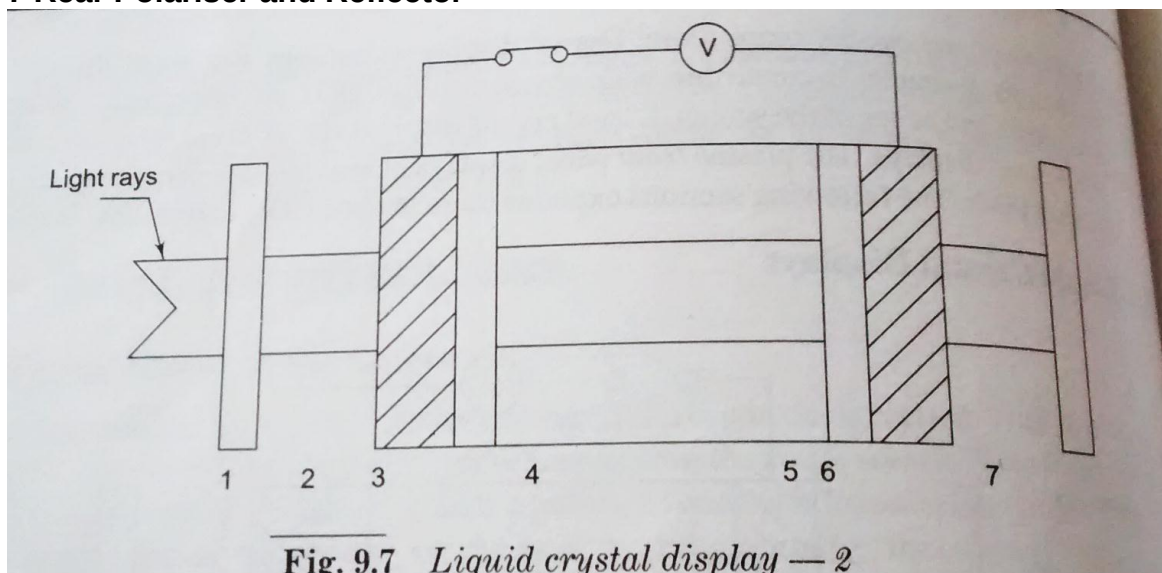
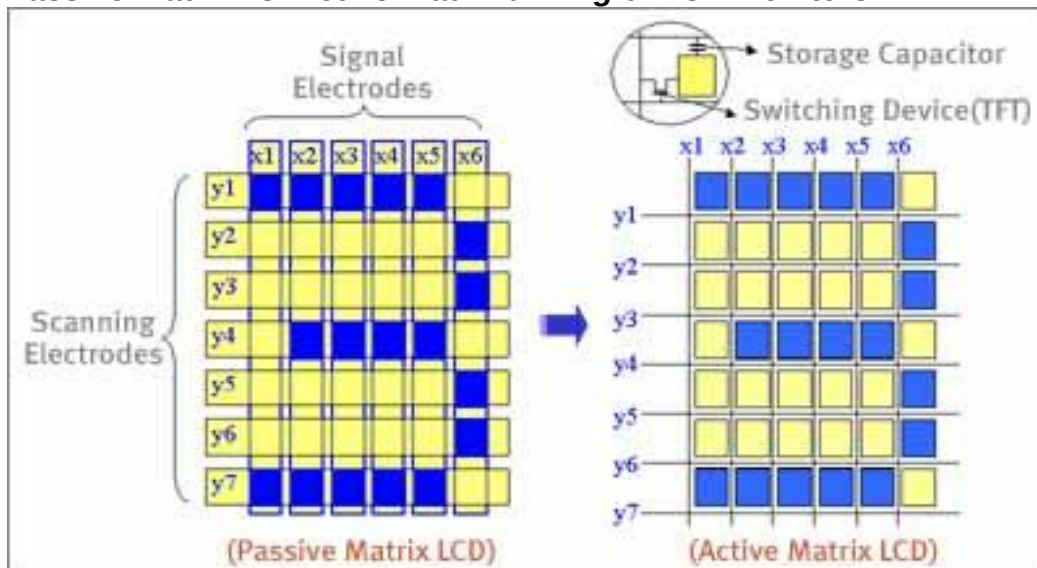


Fig. 9.7 *Liquid crystal display — 2*

Passive-matrix vs. Active-matrix driving of LCD Monitors.



Bad Pixels

A bad pixel is one in which the red, green or blue sub pixel cell remains permanently on (stuck pixel) or off (dead pixel).

Passive Matrix LCD

- Passive-matrix is a technology that uses a grid of vertical and horizontal wires to display an image on the screen.
- Each pixel is controlled by an intersection of two wires in the grid.
- The liquid crystal material is sandwiched between the two glass substrates 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.
- By altering the electrical charge at a given intersection, the color and brightness of the corresponding pixel can be changed.
- Since the charge of two wires (both vertical and horizontal) must be altered in order to change a single pixel, the response time of passive-matrix displays is relatively slow.
- In passive matrix there are no switching devices, and each pixel is addressed for more than one frame time.

Active Matrix LCD

- Active Matrix LCDs depend on thin film transistor (TFT).
- Basically TFTs are tiny switching transistors and capacitors.
- They are arranged in a matrix on a glass substrate.
- To address a particular pixel the proper row is switched on and then a charge is sent down the correct column.
- Since all of the other rows that the column intersects are turned off, only the capacitor at designated pixel receives a charge.
- The capacitor is able to hold the charge until the next refresh cycle.

Plasma Display

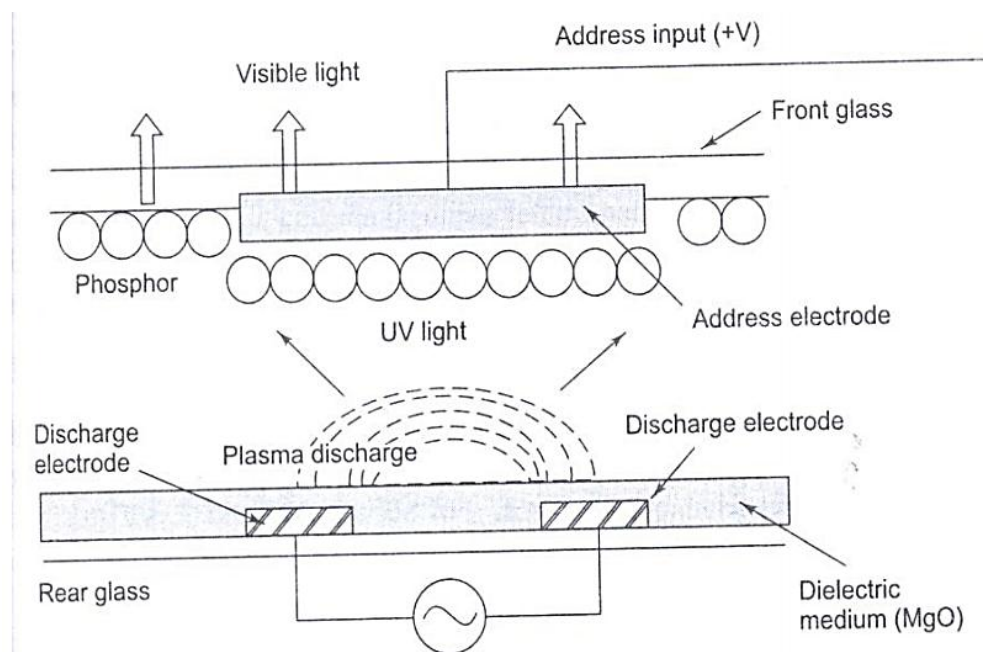
Plasma is a state of gas made up of free flowing ions (+ve) and electrons. Under normal conditions a gas is made up of uncharged particles.

Construction:

- 1) Xenon and Neon Gas
- 2) Address Electrodes
- 3) Display/Discharge Electrodes
- 4) Dielectric Medium (MgO Magnesium Oxide)
- 4) Phosphor (Red, Green and Blue Triad)

Working:

- In plasma display xenon and neon atoms are used.
- The address electrodes are at the front glass plate and the discharge electrodes are transparent and mounted along the rear glass plate.
- Both sets of electrodes extend across the entire screen.
- 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.



- By varying the pulses of current flowing through the different cells intensity of each subpixel color can be varied to create hundreds of different combinations of red, green and blue.

Touch-Screen

- An input/output device that input directly from the monitor, user touches words, graphical or symbols displayed on screen activate commands.
- A touch screen is a computer screen that is sensitive to human allowing a user to interact with computer by touching pictures or on the screen



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words

A basic Touchscreen has three main components:

- A Touch sensor
- A Controller
- A Software driver.

A Touch sensor

- A touch screen sensor is a clear glass panel with a touch responsive surface.
- The sensor generally has an electrical current or signal going through it and touching the screen causes a voltage or signal change.
- This voltage change is used to determine the location of the touch to the screen.

A Controller

- The controller is a printed circuit board(PCB) that connects between the touch sensor and the display.
- It takes information from the touch sensor and translates it into information that microprocessor or PC can understand.
- The controller determines what type of interface/connection you will need on the PC.

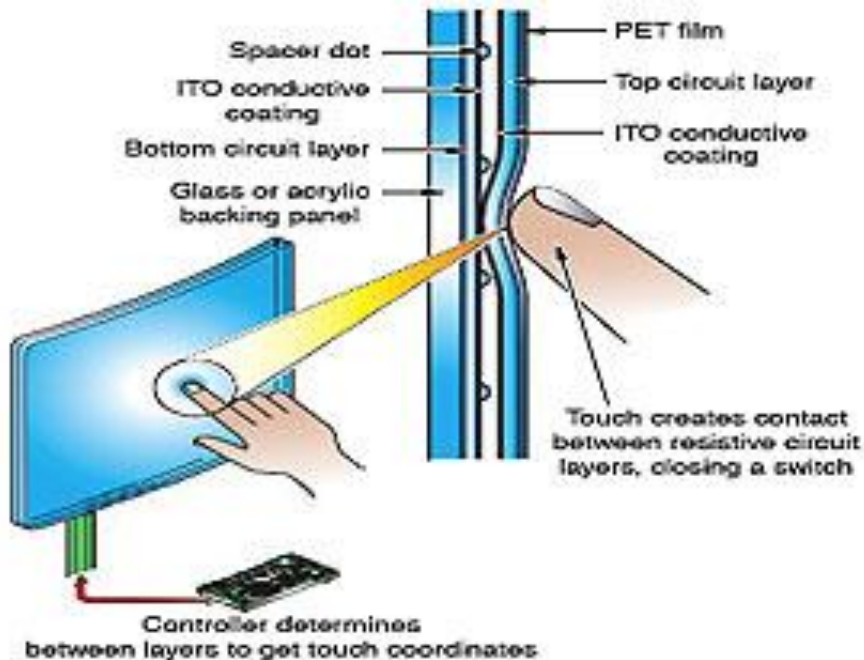
A Software driver

- The driver is a software that allows the touch screen and computer to work together
- It tells the computer's operating system how to interpret the touch event information that is sent from the controller.
- Most touch screen drivers today are a mouse-emulation type driver. This makes touching the screen the same as clicking your mouse at the same location on the screen.

There are basically four types of touch screen technologies:-

1. Resistive Touch Screen
2. Capacitive Touch Screen
3. Surface wave Touch Screen (SAW)
4. Infra Red Touch Screen

1. Resistive Touch Screen



Polyethylene terephthalate commonly refer as PET
Indium Tin Oxide (ITO)

- Two layers of conductive material is there.
- Touch creates contact between resistive layers completing circuit
- Voltage in circuit changes based on position
- Controller determines location based on voltages

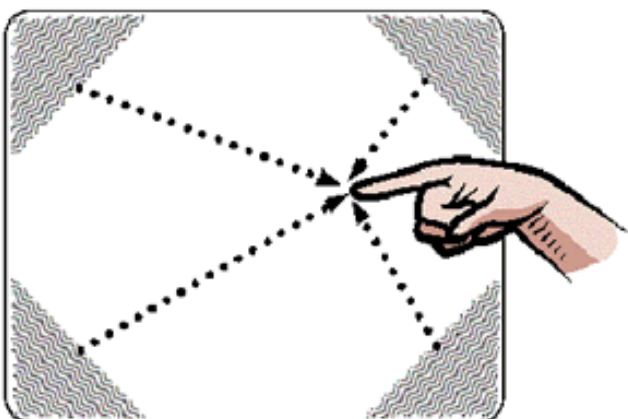
2. Capacitive Touch Screen

In the **capacitive system**, a layer that **stores electrical charge** is placed on the glass panel of the monitor.

When a user touches the monitor with his or her finger, some of the charge is transferred to the user, so the charge on the capacitive layer decreases. a finger touch draws current from each corner.

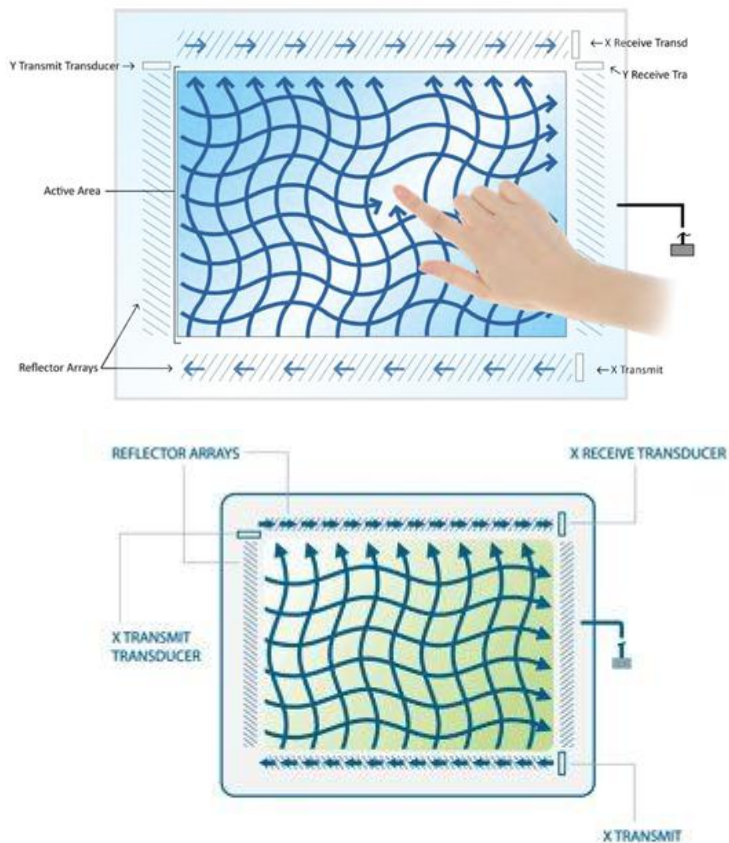
This decrease is measured in **circuits** located at each corner of the monitor.

The controller calculates, from the relative differences in charge at each corner, exactly where the touch event took place and then relays that information to the touch-screen driver software.

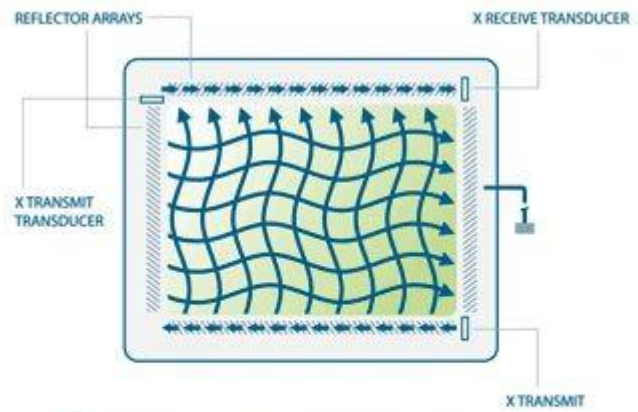


One advantage that the capacitive system has over the resistive system is that it transmits almost 90 percent of the [light](#) from the monitor, whereas the resistive system only transmits about 75 percent. This gives the capacitive system a much clearer picture than the resistive system.

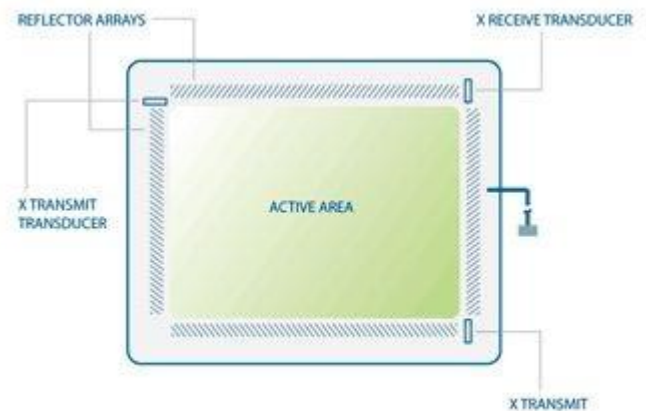
3. Surface Acoustic Wave (SAW)



The controller sends a five-megahertz electrical signal to the transmitting transducer, which converts the signal into ultrasonic waves within the surface of the glass. These waves are directed across the touch screen by an array of reflectors. Reflectors on the opposite side gather and direct the waves to the receiving transducer, which reconverts them into an electrical signal. The process is repeated for each axis.



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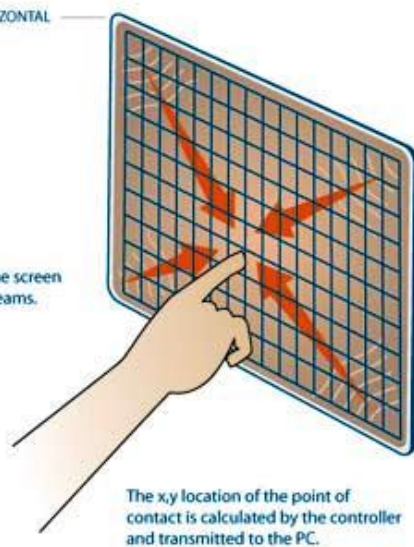
The Touch surface wave touchscreens consist of a glass overlay with transmitting and receiving piezoelectric transducers for the x and y axes.

- On the monitor of a **surface acoustic wave system**, two **transducers** (one receiving and one sending) are placed along the x and y axes of the monitor's glass plate.

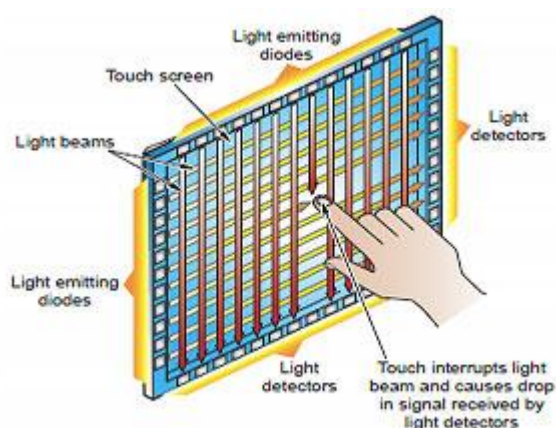
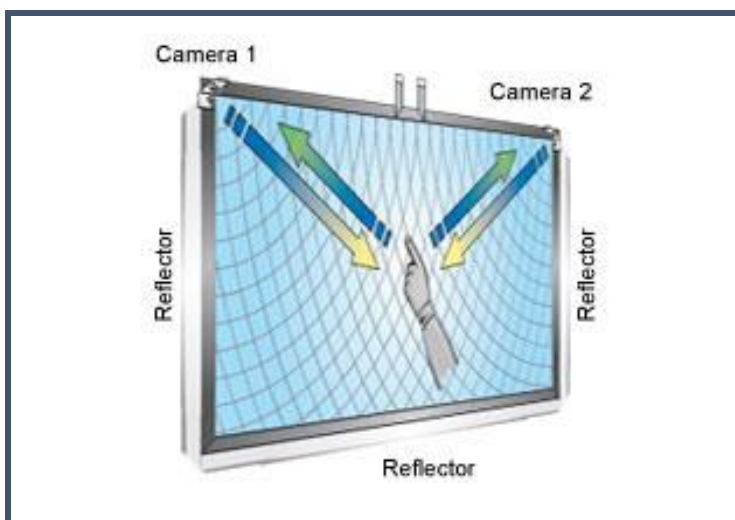
Subject : Computer Hardware and Maintenance (17428)

- Also placed on the glass are **reflectors** -- they reflect an electrical signal sent from one transducer to the other.
- Electrical signals sent to the transmitting transducers converts to ultrasonic waves
- Waves are directed across screen by reflectors then directed to receiving transducers
- When finger touches screen it absorbs waves
- Received values are compared to stored digital maps to calculate x and y coordinates

{A transducer is an electronic device that converts energy from one form to another. Common examples include microphones, loudspeakers, thermometers, position and pressure sensors, and antenna. Although not generally thought of as transducers, photocells, LEDs (light-emitting diodes), and even common light bulbs are transducers. For example, a stereo speaker converts the electrical signals of recorded music into sound.}

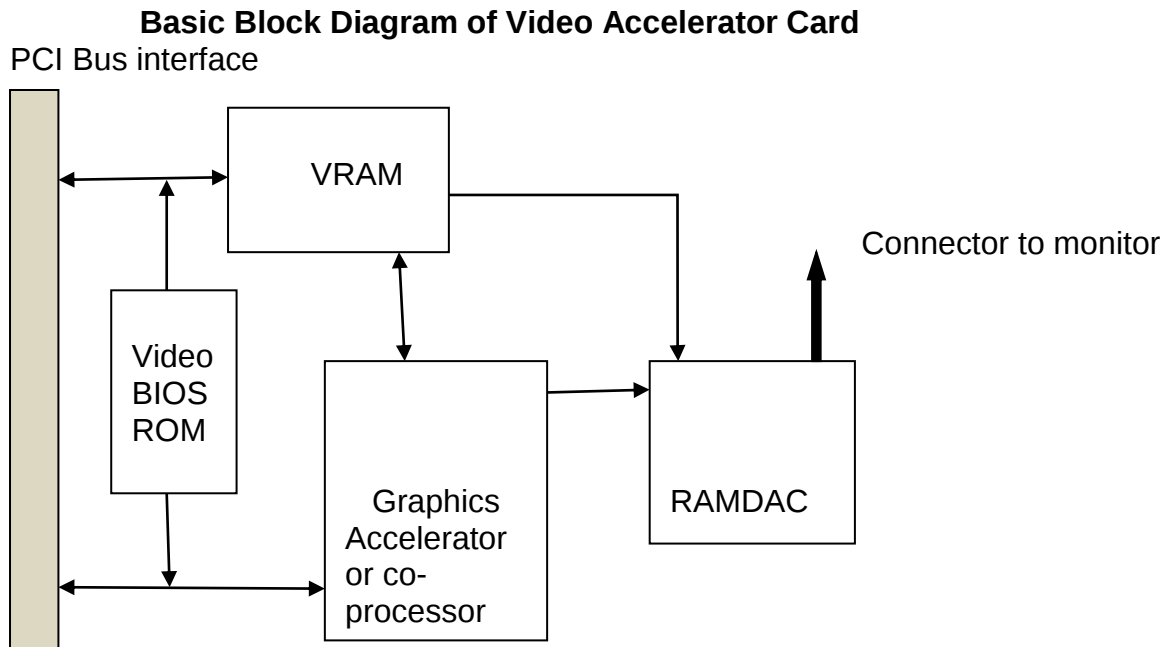


4. Infrared Touch Screen



- Uses infrared LEDs and matching photodetectors
- Touching screen interrupts LEDs
- Cameras detect reflected LED caused by touch

- Controller able to calculate coordinates from camera data.



Video designers seek to overcome the limitations of conventional video adapters by incorporating processing power onto the video board itself rather than relying on the system CPU for graphic processing.

Graphics co-processors are the most sophisticated type of accelerator. The co-processor acts as a CPU that is dedicated to handling image data

The graphics chip connects directly with the PC expansion bus.

It consists of

- 1) **Video BIOS ROM:** Video BIOS provides a set of video related functions that are used by the programs to access the video hardware.
- 2) **Video RAM (Frame Buffer):** Video Memory is to store images processed by the GPU before they are displayed by the monitor. The larger the video memory, the better the graphics card can handle textures when displaying 3D scenes.
- 3) **Graphic Accelerator or co-processor (GPU-Graphical Processing Unit)**
GPU is a specialized processor with advanced image processing capabilities especially for 3D graphics
- 4) **RAMDAC (Random Access Memory Digital-Analog Converter):**
It is used for converting digital images stored in the frame buffer as analog signals to send to the monitor.