

Chapter 3

Display Devices & Interfacing

Introduction

- ▶ What is CRT?
- ▶ A display screen, a video display terminal (VDT) or video display unit (VDU), the monitor is the component of computer system that displays messages, & data being processed & utilized by computer's CPU.
- ▶ Display technologies:-
 - ▶ CRT
 - ▶ Flat Screen
 - ▶ Active (Gas discharge(Plasma))
 - ▶ Passive (LCD)

► CRT:-

A CRT works by moving an electron beam back & forth across the screen.

Each time the beam makes a pass across the screen, it lights up phosphor dots on the inside of the glass tube, thereby illuminating the active portions of screen.

► LCD:-

LCD displays utilize two sheets of polarizing material with a liquid crystal solution between them.

An electrical current passed through the crystals to align so that light cannot pass through 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.

When a voltage pulse passes between two electrodes, the gas breaks down & produces weakly ionized plasma, which emits UV radiation.

The UV radiation activates color phosphors & visible light are emitted from each pixel.

Comparison 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
Power Consumption	High	Low	Lowest
Weight	Heavy	Light	Light
Color Range	Excellent	Very Good	Excellent
Cost	Low	Moderate	High

CRT Monitor

- ▶ A CRT monitor is an analog computer display with a large, deep casing.
- ▶ This type of monitor uses streams of electrons that activates dots or pixels on screen to full image.
- ▶ There are two types of CRT monitors:
 - ▶ Monochrome CRT Monitor
 - ▶ Colour CRT Monitor.

Block Diagram of Monochrome CRT Monitor

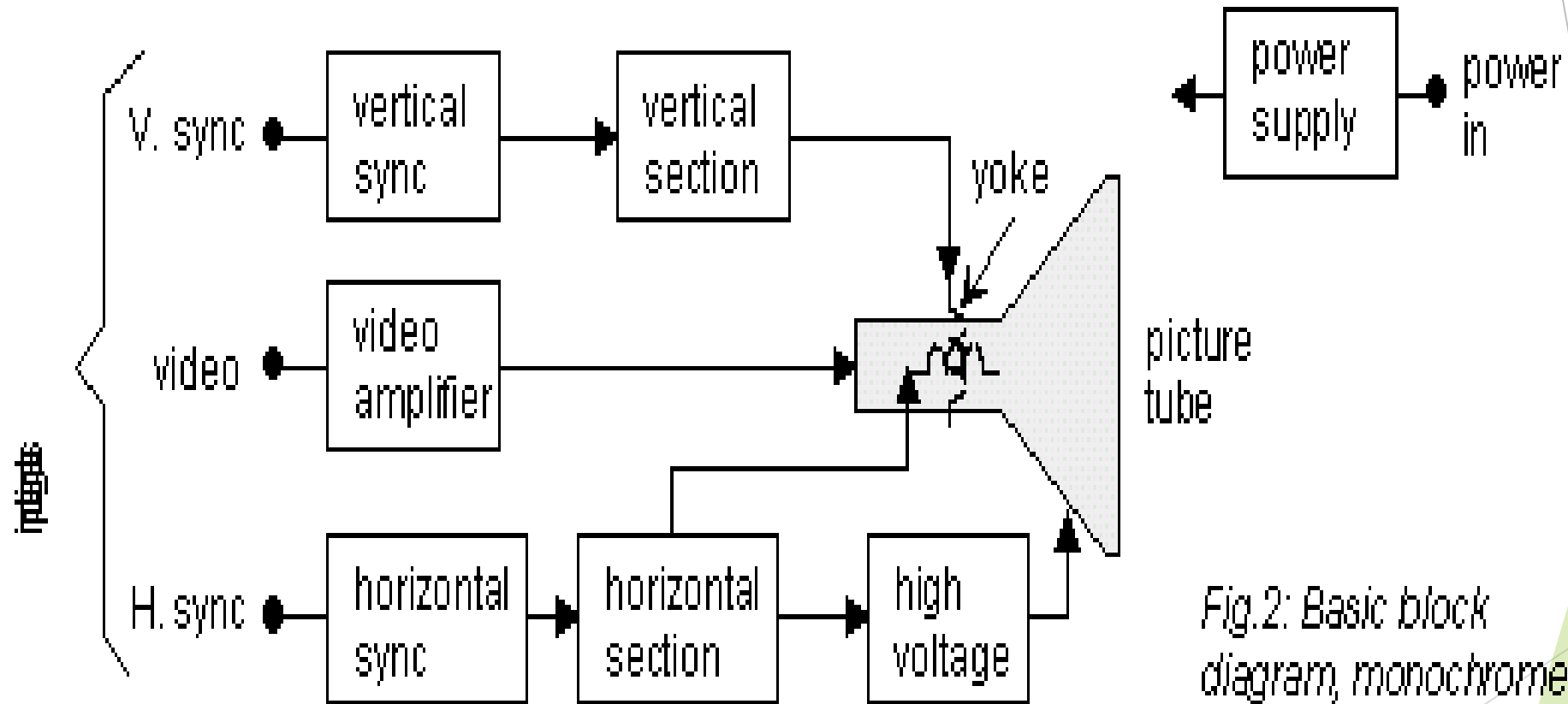


Fig.2: Basic block diagram, monochrome computer VDU

- ▶ In block dig the video adapter giving three signals to a monochrome monitor are:
 - ▶ Video Signal
 - ▶ Horizontal Synchronization (horizontal sync.)
 - ▶ Vertical Synchronization (vertical sync.)
- ▶ Block dig has following main blocks:
 - ▶ Video Processing
 - ▶ Vertical Sync Processing
 - ▶ Horizontal Sync Processing
 - ▶ Power Supply Section

▶ Video Processing Circuit

- ▶ Contains video signal from display adapter card fed to video amplifier circuit
- ▶ Video signal controls the brightness of the beam as it is scanned
- ▶ Signal have only two brightness levels ON or OFF
- ▶ Video signal is sent to the video amplifier where the signal is boosted so it can drive tube
- ▶ The amplified video signal is sent to video driver
- ▶ Video drive drives cathode of tube & controls the number of electrons that reach the screen & display the output

▶ Vertical Sync Processing

- ▶ Vertical sync signal informs the monitor that an entire screen has been displayed & that it is time to deflect the beam back up to top of the screen
- ▶ Vsync pulses are given to vertical oscillator which generates the required frequency for vertical scanning
- ▶ Vertical sync stage detects the incoming vertical sync pulses & controls the vertical deflection of beam to maintain the correct timing

▶ Horizontal Sync Processing

- ▶ Horizontal sync signal from the video adapter card informs the monitor when each scan line has been displayed & that it is time to deflect the beam back to the left hand side of the tube.
- ▶ Detect the incoming sync pulse & uses this to control the frequency of the horizontal oscillator.
- ▶ Horizontal oscillator is used to generate the required frequency for horizontal scanning.
- ▶ The output of horizontal oscillator is used to generate the high voltage needed by the picture tube.
- ▶ This high voltage is called the Extra High Tension (EHT).



- ▶ Power Supply Section

- ▶ This section generates the different voltages for different circuits

Block Diagram of Colour CRT Monitor

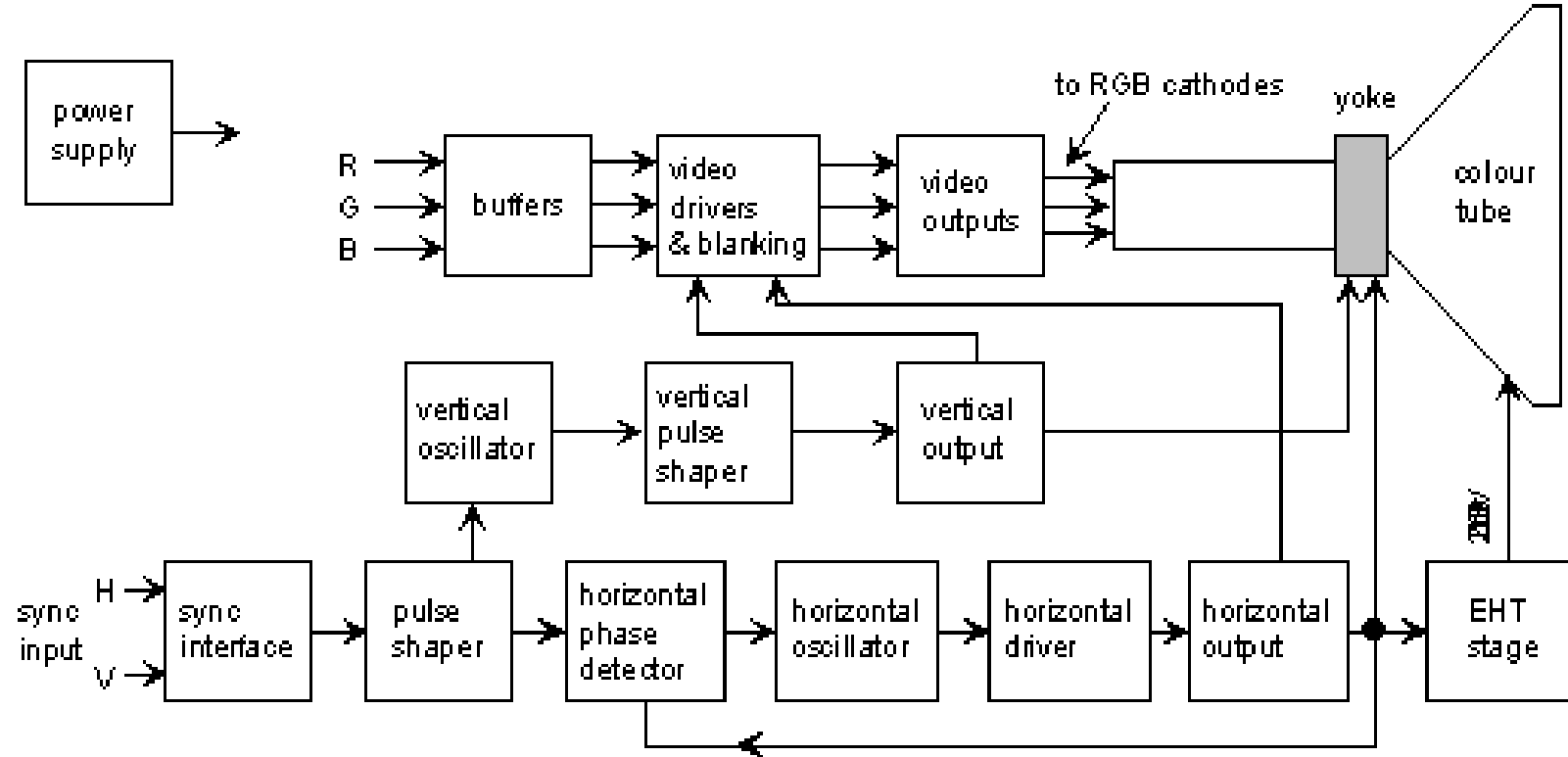


Fig.1: Detailed block diagram of a VGA monitor

Working of Colour CRT Monitor

- ▶ Working of Colour CRT Monitor is same as monochrome CRT monitor, only difference is three electron guns for three colours.
- ▶ Circuitry within the monitor is grouped into 3 categories :
 - ▶ Video signal processing & amplification
 - ▶ Vertical deflection & synchronizing
 - ▶ Horizontal deflection & synchronizing
 - ▶ Power Supply

▶ Video Processing & Amplification

- ▶ Transmission lines carries video signal such as RGB from host computer to the monitor.
- ▶ RGB video signals are voltage peak to peak signal, so they requires amplification before the signal can be applied to the CRT's cathode.
- ▶ The CRT video amplifier is second stage amplifier amplifies the signal strong enough to approximately 40V to control emission current from the driver.
- ▶ Video driver drives the cathode of the tube & controls the number of electrons that reach the screen, & then display the output

▶ Vertical Deflection & Synchronizing

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Characteristics of CRT Monitor

▶ Dot pitch

- ▶ It 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

▶ Resolution

- ▶ It is expressed in number of horizontal & vertical picture elements or pixels.

▶ Horizontal Scanning Frequency

- ▶ The frequency at which the monitor rewritten the horizontal lines that make up an image.

▶ Vertical Scanning Frequency

- ▶ It is also called as refresh rate. It represent number of frames displayed on the screen per second.

▶ Interlaced Scanning

- ▶ In this image is broken up into two fields: all odd lines (lines 1,3,..) are imaged in the first field & all even lines (lines 2,4,..) are imaged in the second field.
- ▶ This method of scanning is called 2:1 interlaced.
- ▶ The CRT gun scans from top to bottom, left to right with each complete scan displaying 'frame'.

▶ Non-Interlaced Scanning

- ▶ A non-interlaced scanning display is a cathode-ray tube display in which the lines are scanned sequentially from top to bottom of the screen in a single scan.
- ▶ Non-interlaced scanning produces a more stable picture & more expensive.

Difference between Interlaced & Non-Interlaced

Interlaced	Non- Interlaced
It uses two passes to generate image	It uses only one pass to generate image
Image quality is not good	Image quality is good
Image flickring is there	Less chance of image flickring
It produces less stable picture.	It produce a more stable picture
The cost is less	The cost is more

▶ Aspect Ratio

- ▶ The aspect ratio of display is the proportional relationship between the width of a display & its height.
- ▶ The aspect ratio is expressed as two numbers separated by colon (x:y).

Advantages of CRT related LCD

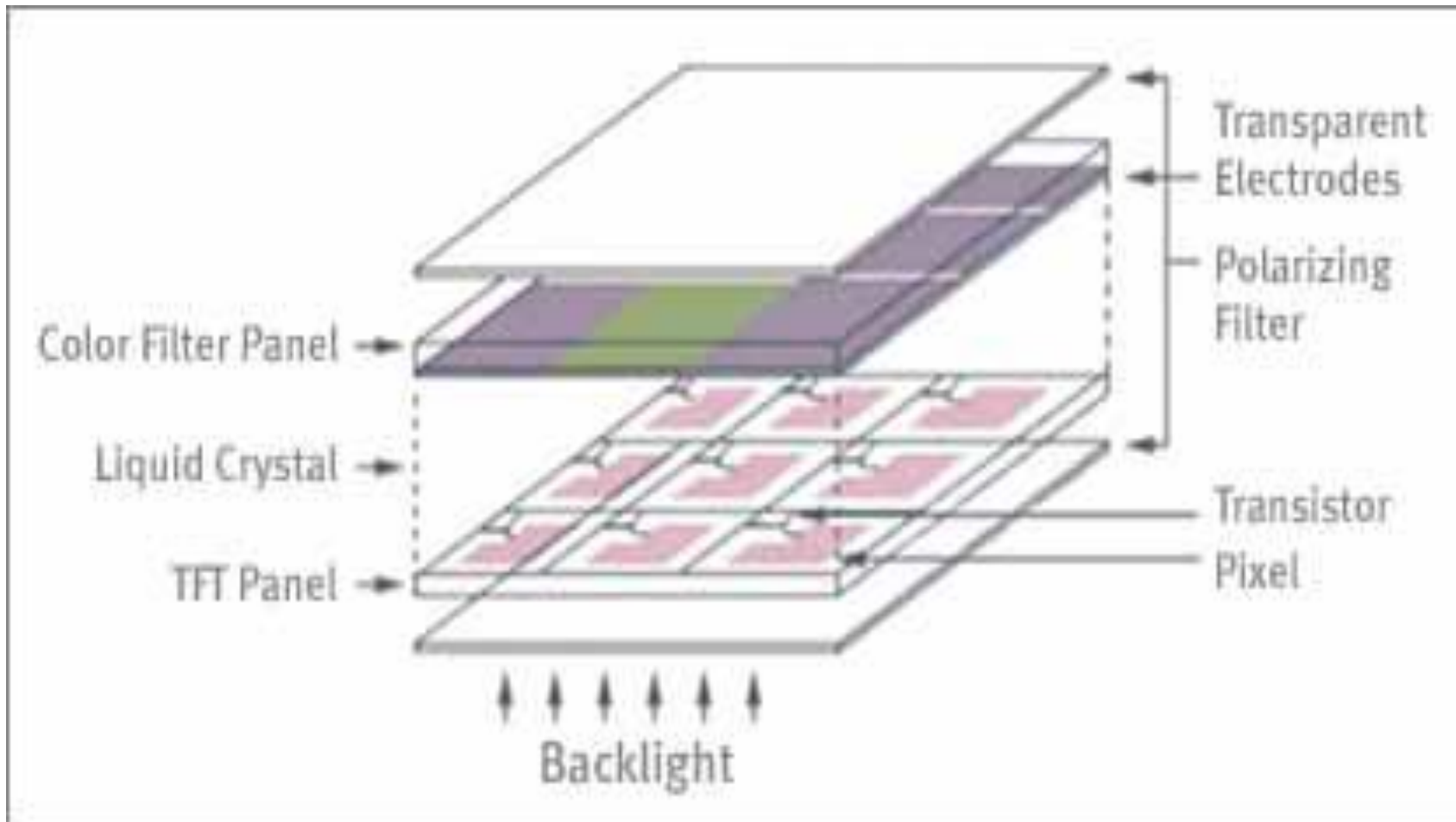
- ▶ Lower cost compared to LCD.
- ▶ Contrast ratio allows the perception of true black. Darks & darker.
- ▶ Ability to adjust image.
- ▶ Work better at multiple resolution.
- ▶ Displays full motion video better.
- ▶ Strong glass screen can withstand routine handling, & is not easily damaged by causal touch.

Disadvantages of CRT over LCD

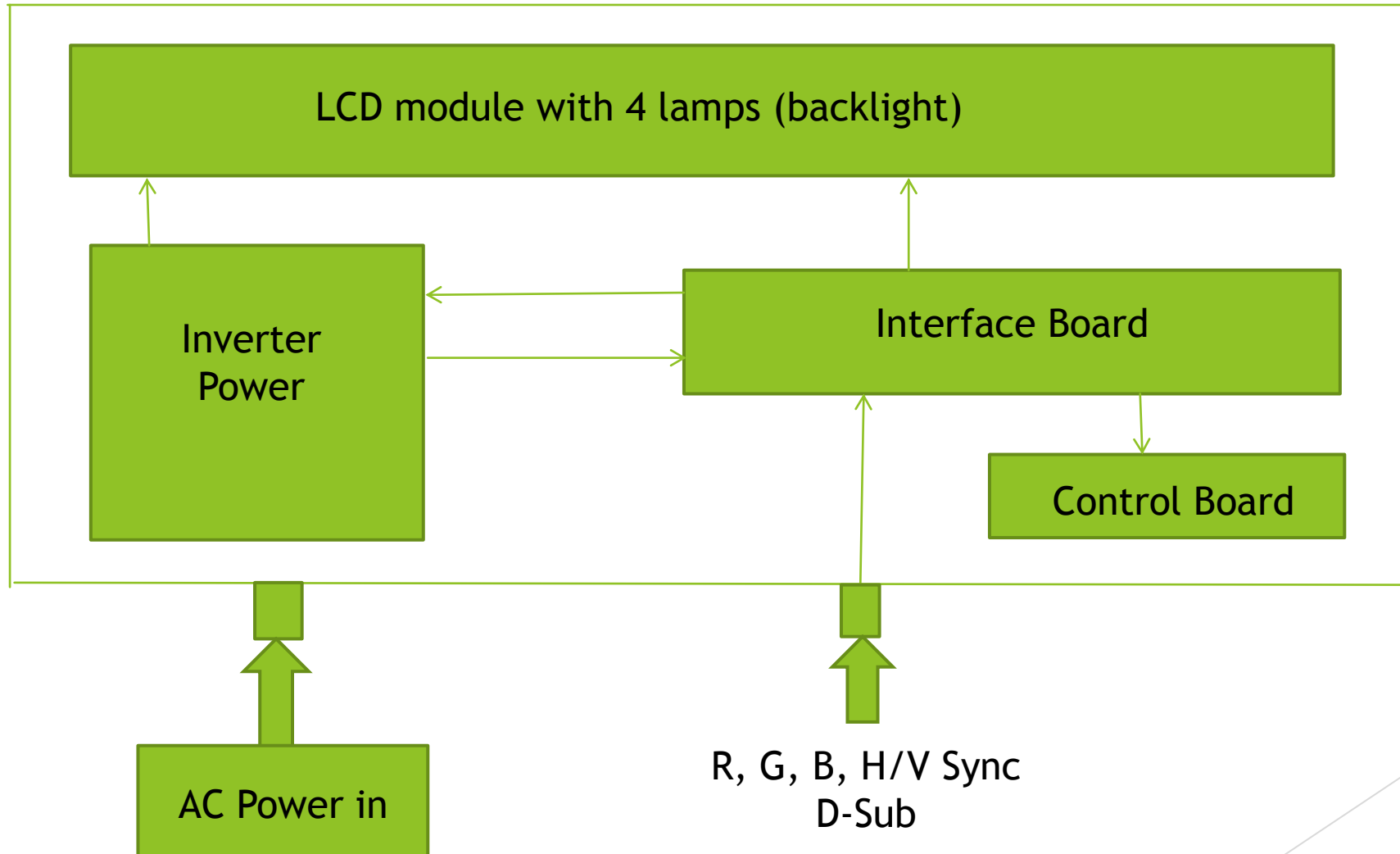
- ▶ Larger size takes up more desk space; the bigger the screen, the bigger footprint.
- ▶ Heavy weight.
- ▶ Heavier size limits easy & convenient movement.
- ▶ Expend more energy & throws off heat.

LCD Monitor

- ▶ A LCD is a thin, flat display device made up of any number of color or monochrome pixels arrayed in front of a light source or reflector.
- ▶ Each pixel of LCD typically consists of a layer of molecules aligned between two transparent electrodes, & two polarizing filters.
- ▶ The surface of electrodes that are in contact with liquid crystal material are treated so as to align the liquid crystal molecules in particular direction.



Functional Block diagram of LCD



▶ **Interface Board:-**

- ▶ Function of interface board is to convert an input signal into a digital RGB signal with the help of ADC.

▶ **Control Board:-**

- ▶ It controls the user operation. Main part of control board are push button, & LED.

▶ **Push Button**

- ▶ It is a simple switch function pressing it for “ON” to do auto adjustment, releasing it for “OFF” to do nothing.

▶ **LED**

- ▶ It indicates the DPMS (Display Power Management Signaling) status of LCD.
- ▶ (enables power saving behaviour of monitors when the computer is not in use)

▶ **Inverter:-**

- ▶ Function of inverter is to convert AC voltage in required DC voltage for LCD module & interface board.

▶ **LCD module:-**

- ▶ Function of this is to display image, data, or text on screen.
- ▶ It is used to control of backlight of LCD

Advantages of LCDs:-

- ▶ Light weight.
- ▶ Smaller footprint on desk leaving, freeing up the work area on the user's desk.
- ▶ Flicker free screen.
- ▶ Easy adjustment, storage & movement.
- ▶ Energy efficiency using only $1/3$ to $1/2$ the electricity of CRTs & they do not generate heat.

Disadvantages of LCDs:-

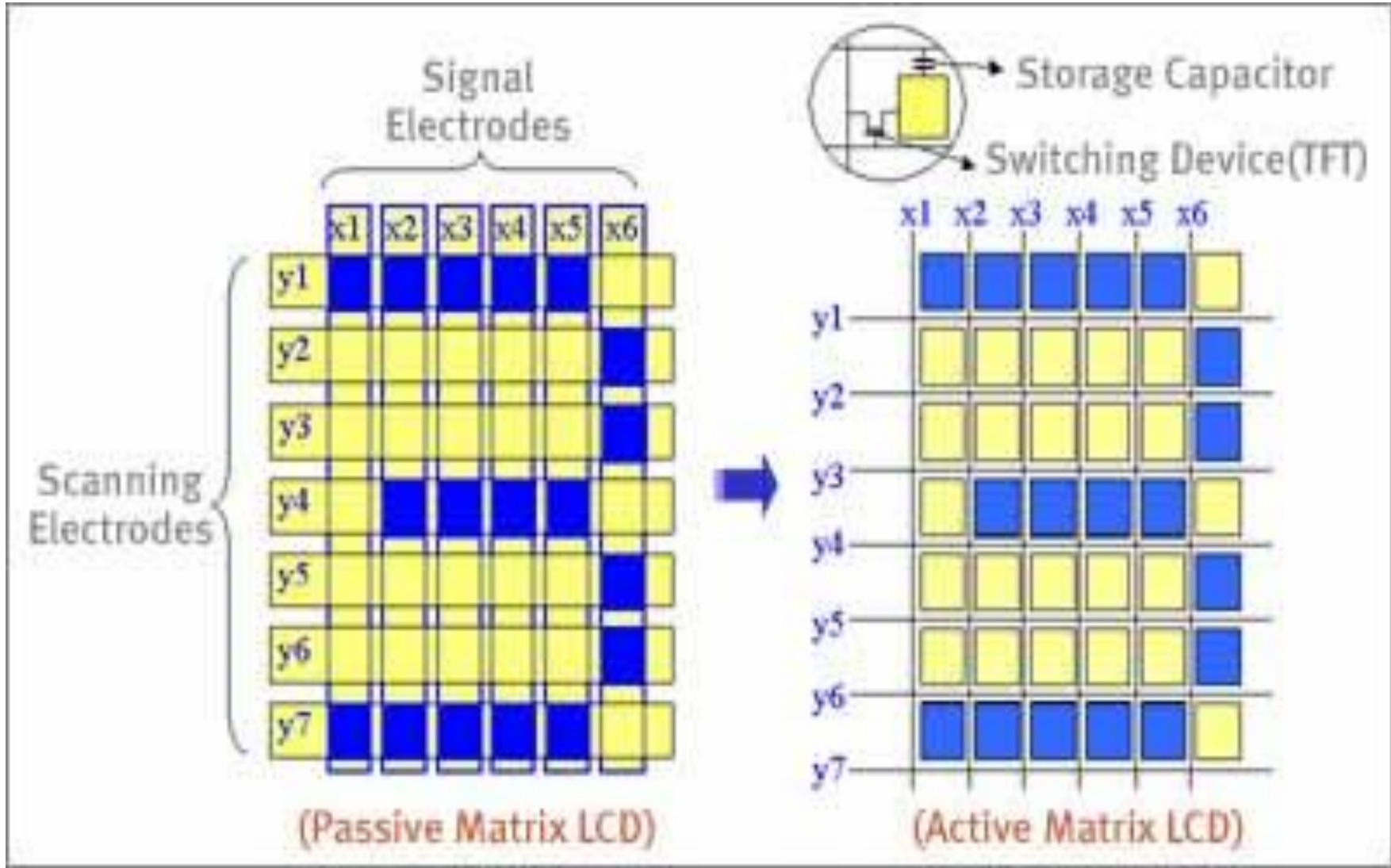
- ▶ Fragile screen; may result in both screen & backlight lamp damage if touched or handled.
- ▶ Contrast ratio causes darkness to not be displayed true.
- ▶ Designed only for one optimum resolution; can not adjust images.
- ▶ Best view of screen is straight-on, limiting clarity & colors of information for those viewing from an angle.
- ▶ Backlight is the potential weak link & its failure can be costly.

LCD Types:-

▶ LCD display uses two types of matrix:

1) Passive Matrix

2) Active Matrix



Passive Matrix:-

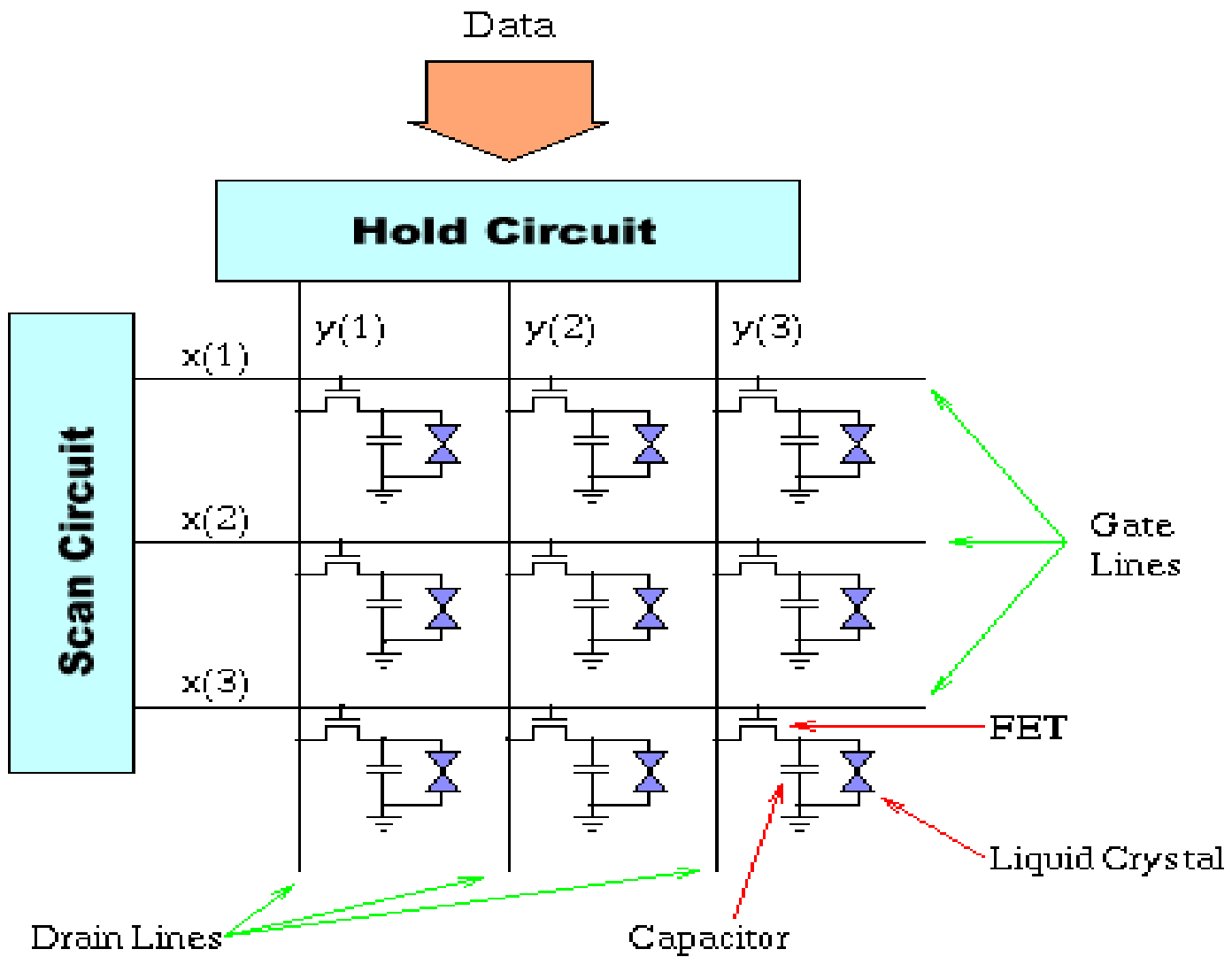
- ▶ It uses grid of vertical & horizontal wires to display an image on screen.
- ▶ Horizontal wires of electrodes on display glass is called scan lines or scanning electrodes. & vertical wires of electrodes is called data lines or signal electrodes.
- ▶ When two pieces of glass are assembled into a display, the intersection of row & 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 pixel an image can be formed on display.

Drawback:-

- ▶ Notably slow response time & imprecise voltage control.
- ▶ Response time refers to the LCD's ability to refresh the image displayed.
- ▶ Imprecise voltage control hinders the passive matrix ability to influence only one pixel at a time.
- ▶ When voltage is applied to untwist one pixel, the pixels around it also partially untwist, which makes images appear fuzzy & lacking in contrast.

Active Matrix:-

- ▶ Passive matrix display 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.



- ▶ It uses a matrix of thin film transistors(TFTs) & capacitors to control the image produced by the display.
- ▶ The brightness of each pixel is controlled by modifying the electrical charge of the corresponding capacitors.
- ▶ Each pixel's color is controlled by altering the charge of individual capacitors that emit red, green, blue light.
- ▶ Active matrix is active in nature due to the capacitors in display.
- ▶ Unlike passive matrix display, which must charge full rows of wires to alter individual pixels, an active matrix display can control each pixel directly.
- ▶ Due to this pixels can change state much more rapidly.

Important characteristics of LCD:-

▶ Resolution:-

- ▶ The horizontal & vertical size expressed in pixels (e.g., 1024x768).

▶ Refresh rate:-

- ▶ It is the rate which the electronics in the monitor addresses (update) the brightness of the pixel on the screen.

Terms related to LCD monitor:-

- ▶ Response time:-
 - ▶ The minimum time necessary to change a pixel's color or brightness.
- ▶ Dot pitch:-
 - ▶ Distance between the centers of adjacent pixels.
- ▶ Viewable size:-
 - ▶ The size of an LCD panel measured on the diagonal.
- ▶ Matrix type:-
 - ▶ Active or Passive.
- ▶ Color support:-
 - ▶ How many types of colors are supported.

▶ **Brightness:-**

- ▶ The amount of light emitted from the display.

▶ **Contrast ratio:-**

- ▶ The ratio of the intensity of the brightest bright to darkest dark.

▶ **Aspect ratio:-**

- ▶ The ratio of the width to the height.

▶ **Input ports:-**

- ▶ E.g., VGA.

Touch screen display:-

- ▶ A touch screen is an Electronic Visual Display that can detect the presence & location of a touch within display area.
- ▶ Or it is a display that responds when it detects a touch on its surface.

- ▶ **Components of touch screen:-**
 - ▶ A basic touch screen has three main components:
- ▶ Touch sensor
- ▶ Controller
- ▶ Software driver

▶ Touch Sensor:

- ▶ It detects the location of touches within display area.
- ▶ It is a clear touch sensor panel with a touch responsive surface placed over the display.
- ▶ Sensor generally has an electrical current or signal going through it & touching the screen can cause a voltage or signal change.
- ▶ This change is used to determine the location of touch to the screen.

▶ **Controller:-**

- ▶ The controller is a printed circuit board (PCB) that is the interface between the sensor & the display.
- ▶ The controller takes information from the touch screen & translate it into information a computer or microprocessor can understand, such as cursor control, right & left clicks etc.
- ▶ The controller is usually installed inside the monitor.

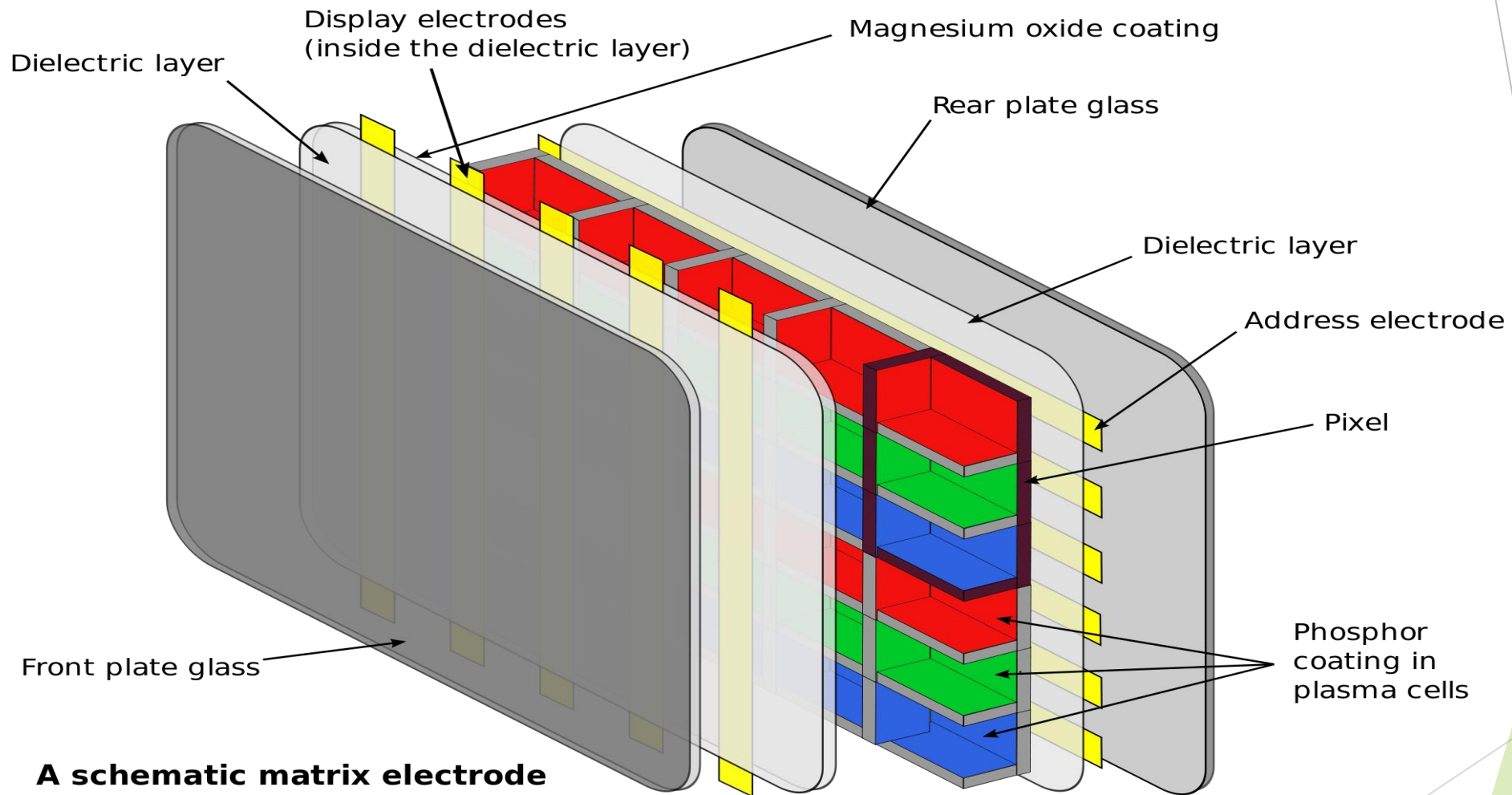
▶ **Software Driver:-**

- ▶ A computer program that allows the computer OS & the controller to communicate & helps the controller recognize input.

Plasma Display:-

- ▶ In plasma display each pixel on screen is illuminated by a tiny bit of plasma or charged gas.
- ▶ **Features of Plasma Display:-**
- ▶ Plasma displays can be made upto large sizes like 150 inches diagonal.
- ▶ Very low luminance “dark-room” black level.
- ▶ Very high contrast.
- ▶ These display panel has a thickness of about 2.5 inches, which makes the total thickness not more than 4 inches

Working of Plasma Display



A schematic matrix electrode configuration in an AC PDP

Fig:- Structure of Plasma display