Unit:-1
Introduction to Computer Graphics

Introduction

- Computer Graphics involves technology to access.
- The Process transforms and presents information in a visual form.
- The role of computer graphics insensible.
- In today life, computer graphics has now become a common element in user interfaces.
- Computer Graphics is the creation of pictures with the help of a computer.
- The end product of the computer graphics is a picture it may be a business graph, drawing, and engineering.
- Definition:---
- It is the use of computers to create and manipulate pictures on a display device. It comprises of software techniques to create, store, modify, represents pictures.

Refresh and raster scan display system

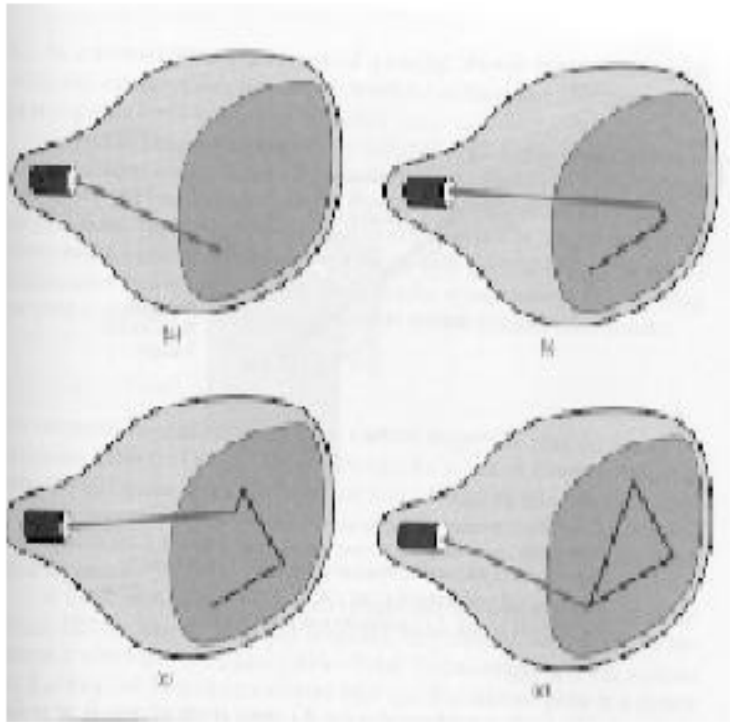
- **Raster Scan Displays** are most common type of graphics monitor which employs CRT.
- It is based on television technology. In raster scan system electron beam sweeps across the screen, from top to bottom covering one row at a time.
- A pattern of illuminated pattern of spots is created by turning beam intensity on and off as it moves across each row.
- A memory area called refresh buffer or frame buffer stores picture definition.
- This memory area holds intensity values for all screen points. Stored intensity values are restored from frame buffer and painted on screen taking one row at a time.
- Each screen point is referred to as pixels.

vector display

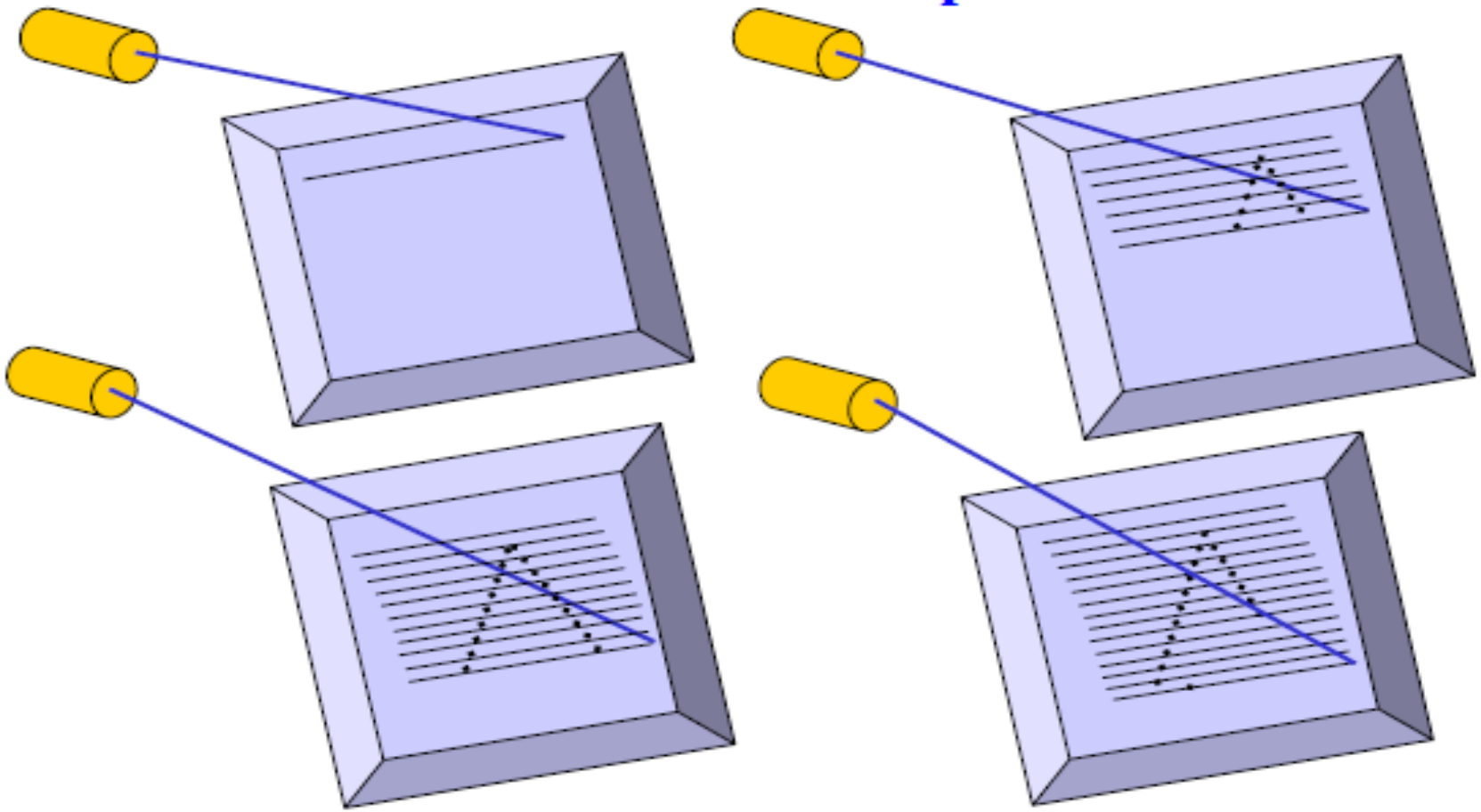
- In this technique, the electron beam is directed only to the part of the screen where the picture is to be drawn rather than scanning from left to right and top to bottom as in raster scan.
- It is also called **vector display, stroke-writing display,** or **calligraphic display**.
- Picture definition is stored as a set of line-drawing commands in an area of memory referred to as the **refresh display file**.
- To display a specified picture, the system cycles through the set of commands in the display file, drawing each component line in turn. After all the line-drawing commands are processed, the system cycles back to the first line command in the list.

Vector Displays

- Random scan display
  - Also called
    - vector,
    - stroke-writing,
    - or calligraphic displays.
- The electron beam directly draws the picture in any specified order.
- A pen plotter is an example of such a system



Raster-scan display system draws a discrete set of points



Raster Scan Display and Random Scan Display:

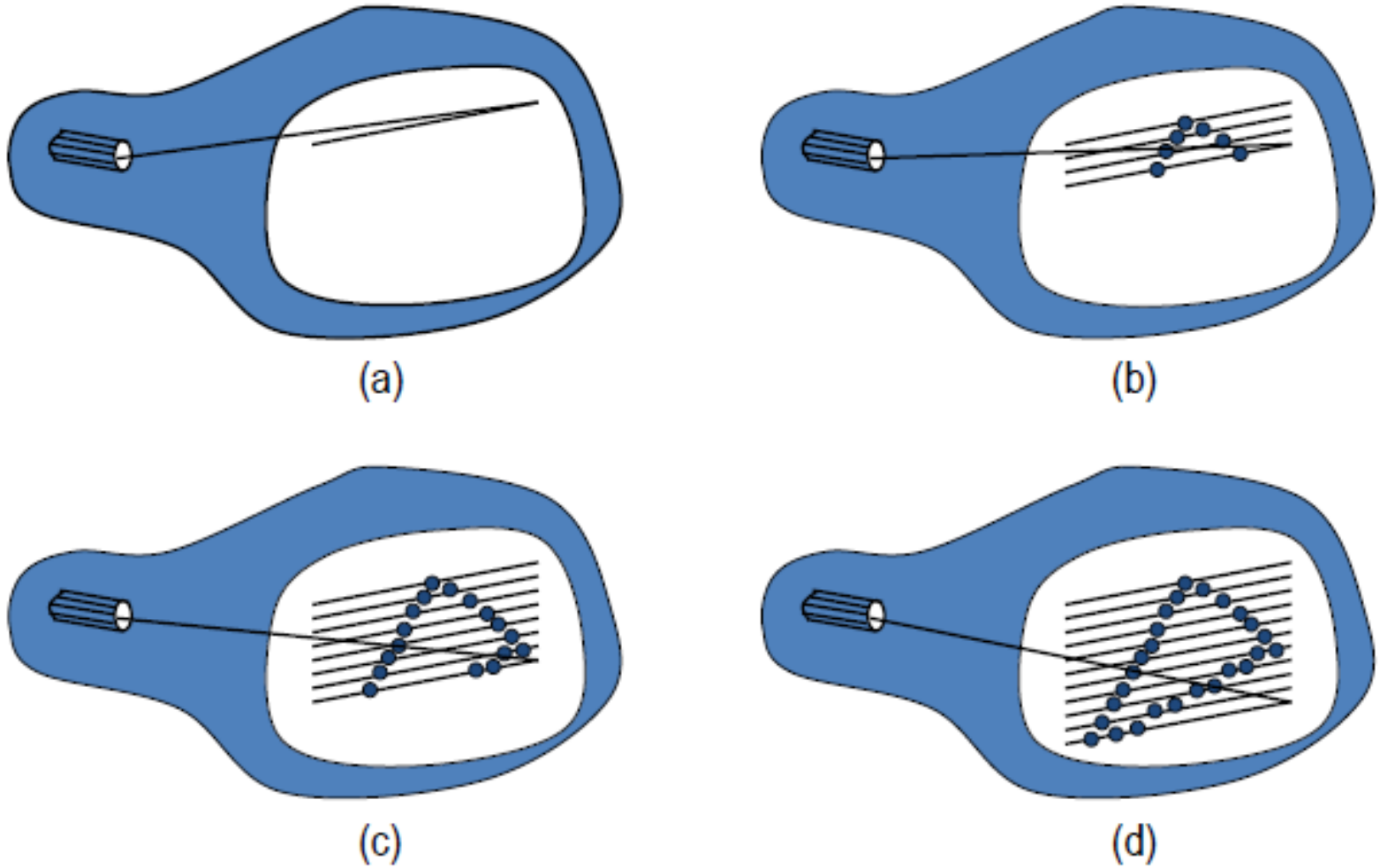
- Basically there are two types of CRT's- *Raster Scan type and Random Scan type.*

- The main difference between the two is the technique with which the image is generated on the phosphor coated CRT screen.

- In Raster scan type the electron beam sweeps the entire screen from left to right, top to bottom, in the same fashion as we write on a notebook, word by word.
- In Random Scan type the electronic beam is directed straightway to the particular point(s) on the screen where the image has to be produced. This technique is also called vector drawing or stroke writing or calligraphic display.

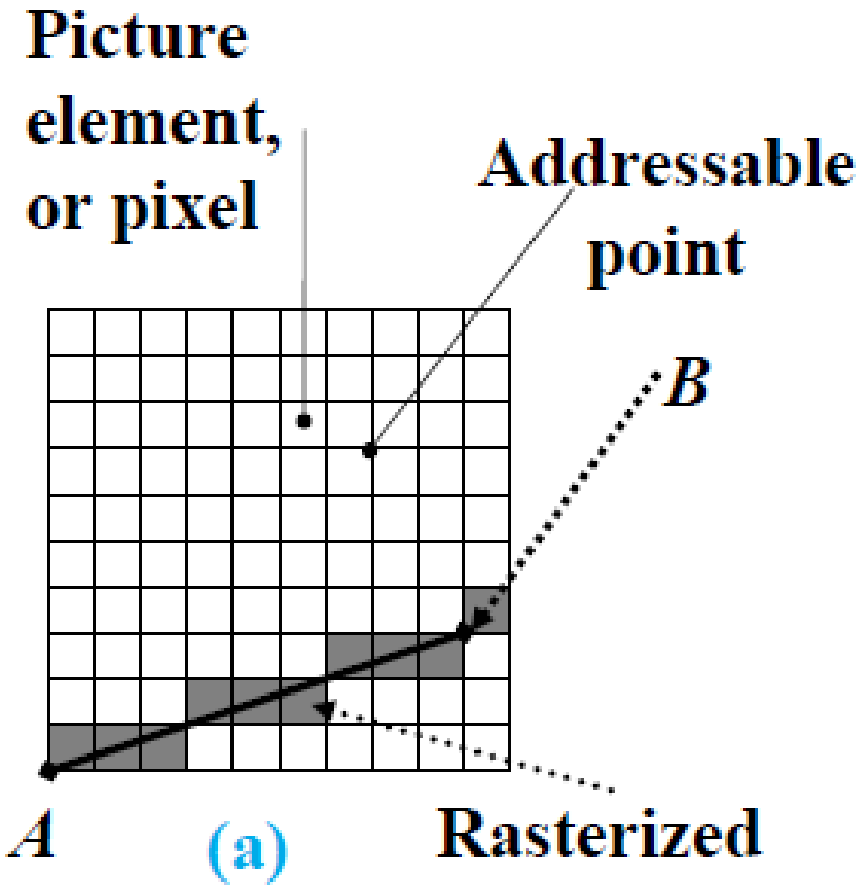
Raster Displays

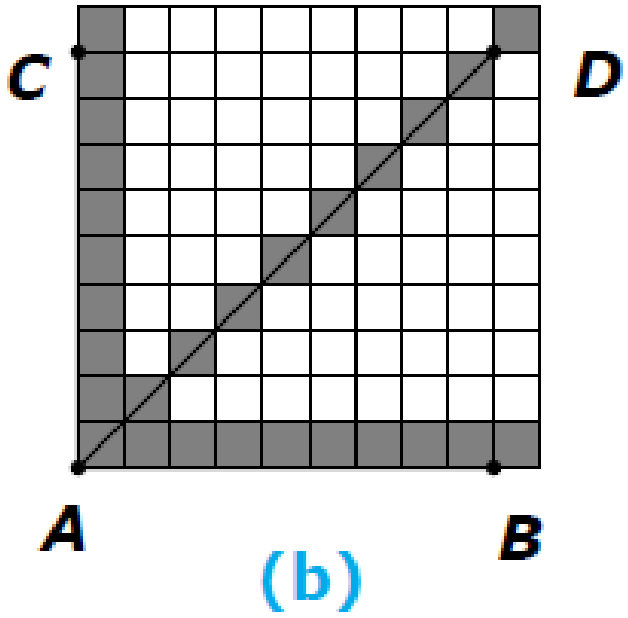
- The image is stored in a frame buffer containing the total screen area and where each memory location corresponds to a pixel.
- In a monochrome system, each bit is 1 or 0 for the corresponding pixel to be on or off (**bitmap**).
- Image is represented as a bitmap (1 bit/pixel) or as a **pixmap** (8 or 24 bits/pixel)



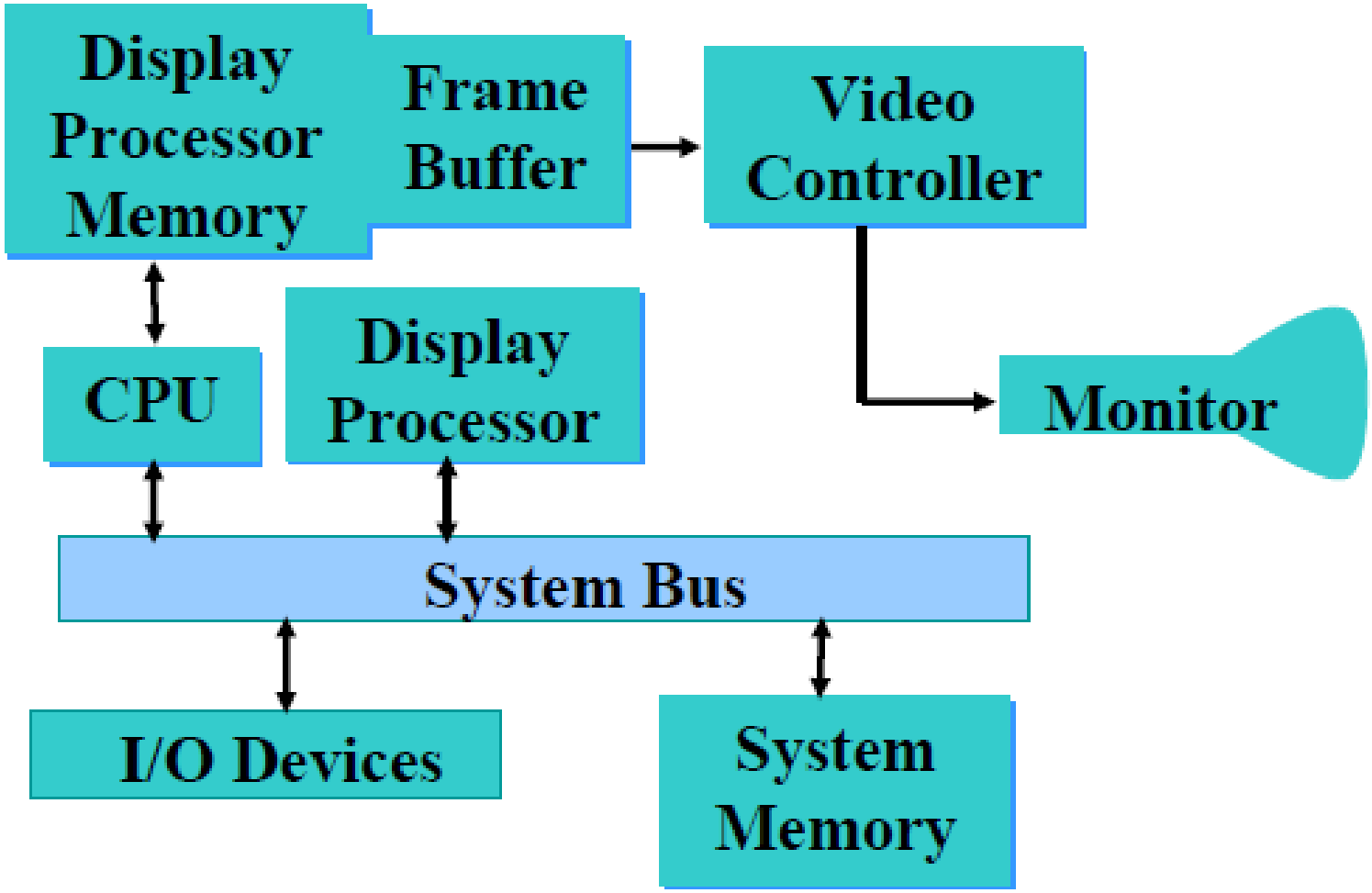
A raster-scan system displays an object as a set of points across each screen scan line

Rasterization: (a) General line ; (b) special cases

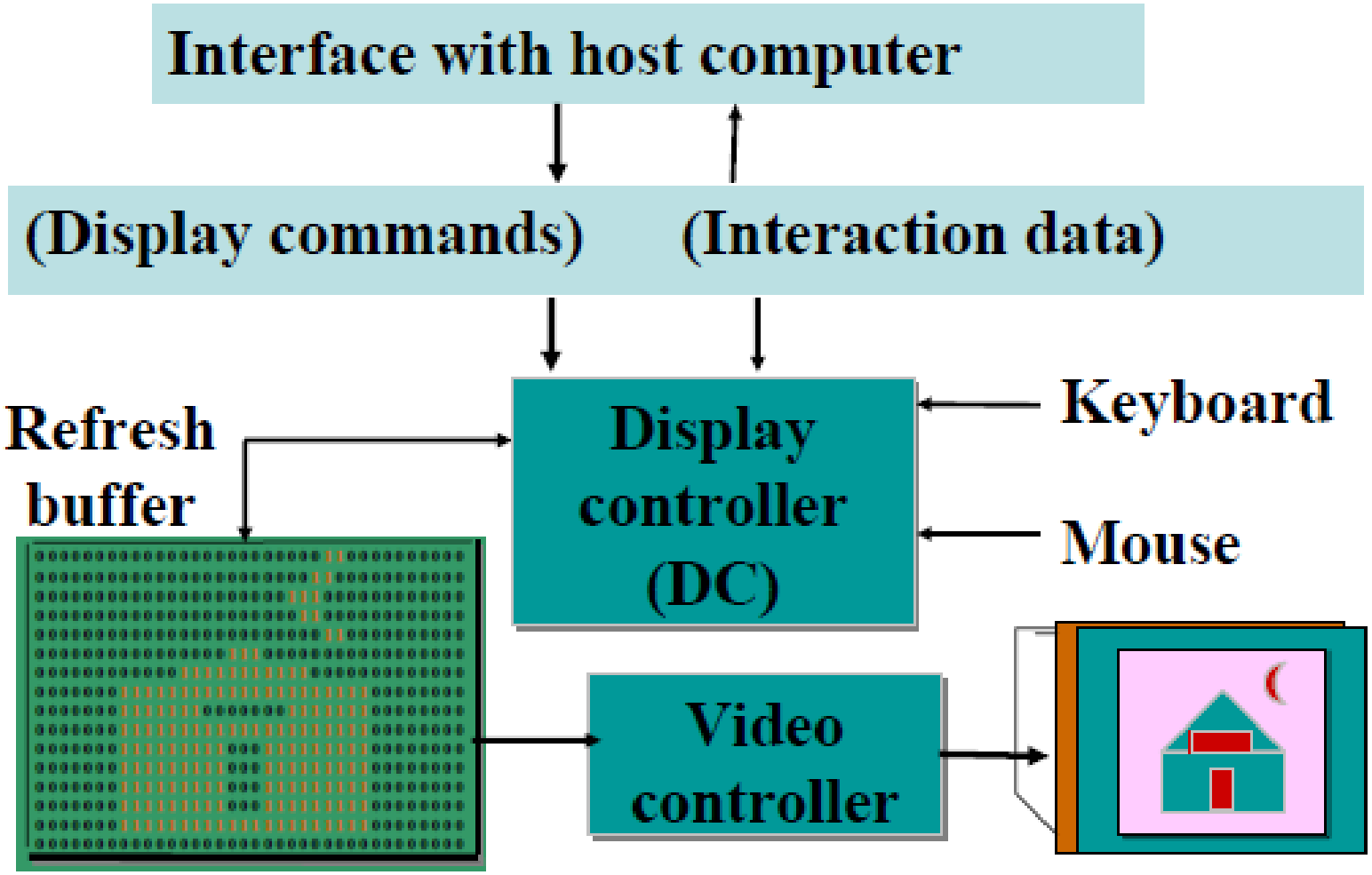




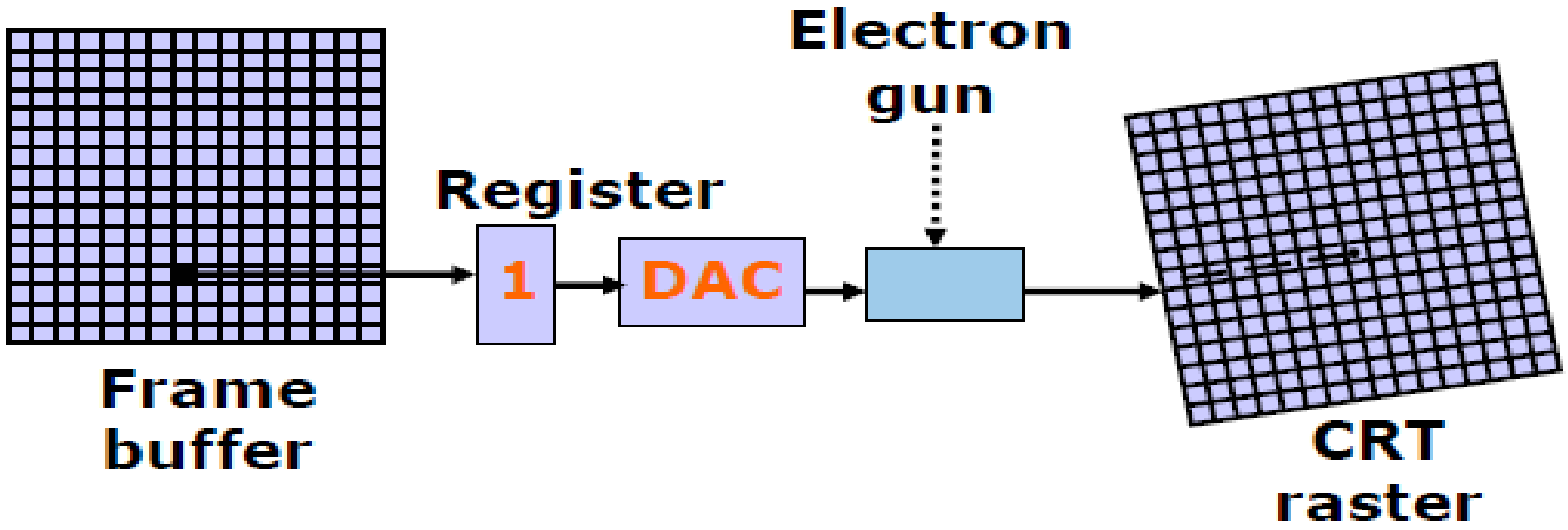
Architecture of a raster-graphics system with a display processor



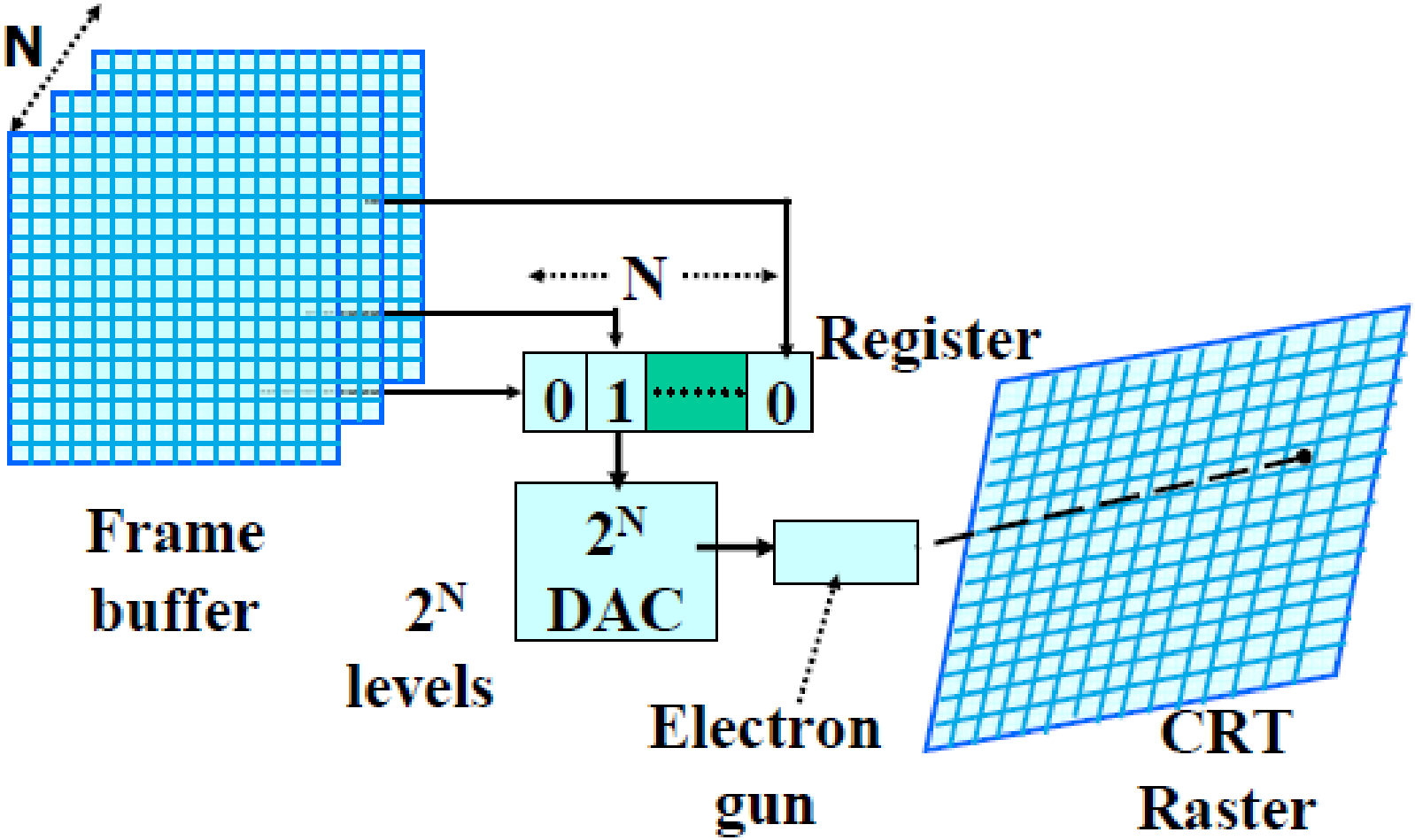
Architecture of a raster display



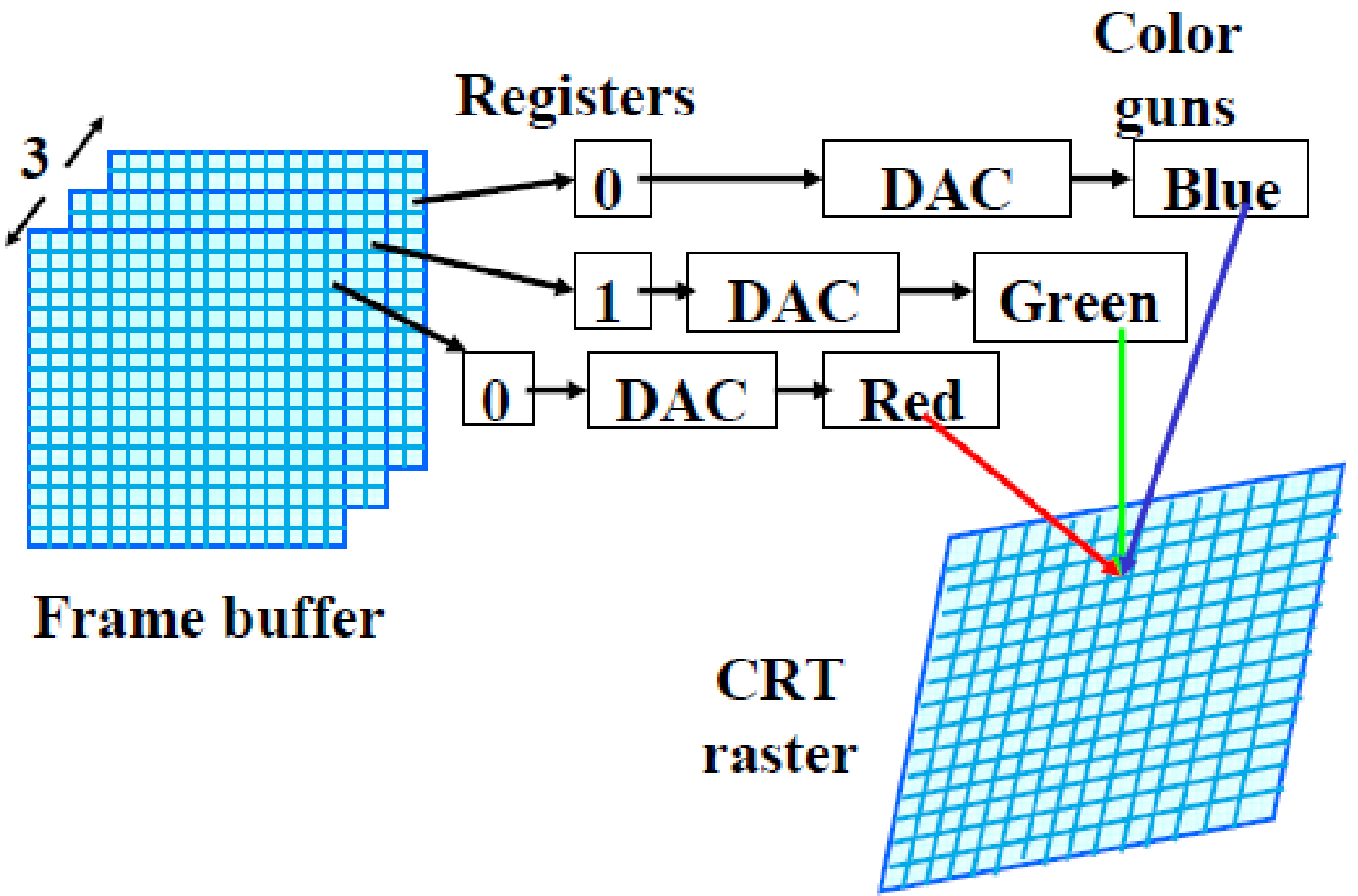
A single bit-plane black&white frame buffer raster CRT graphics device.



An N-bit plane gray level frame buffer



Simple color frame buffer



N-bit plane gray level Frame buffer (Contd.)

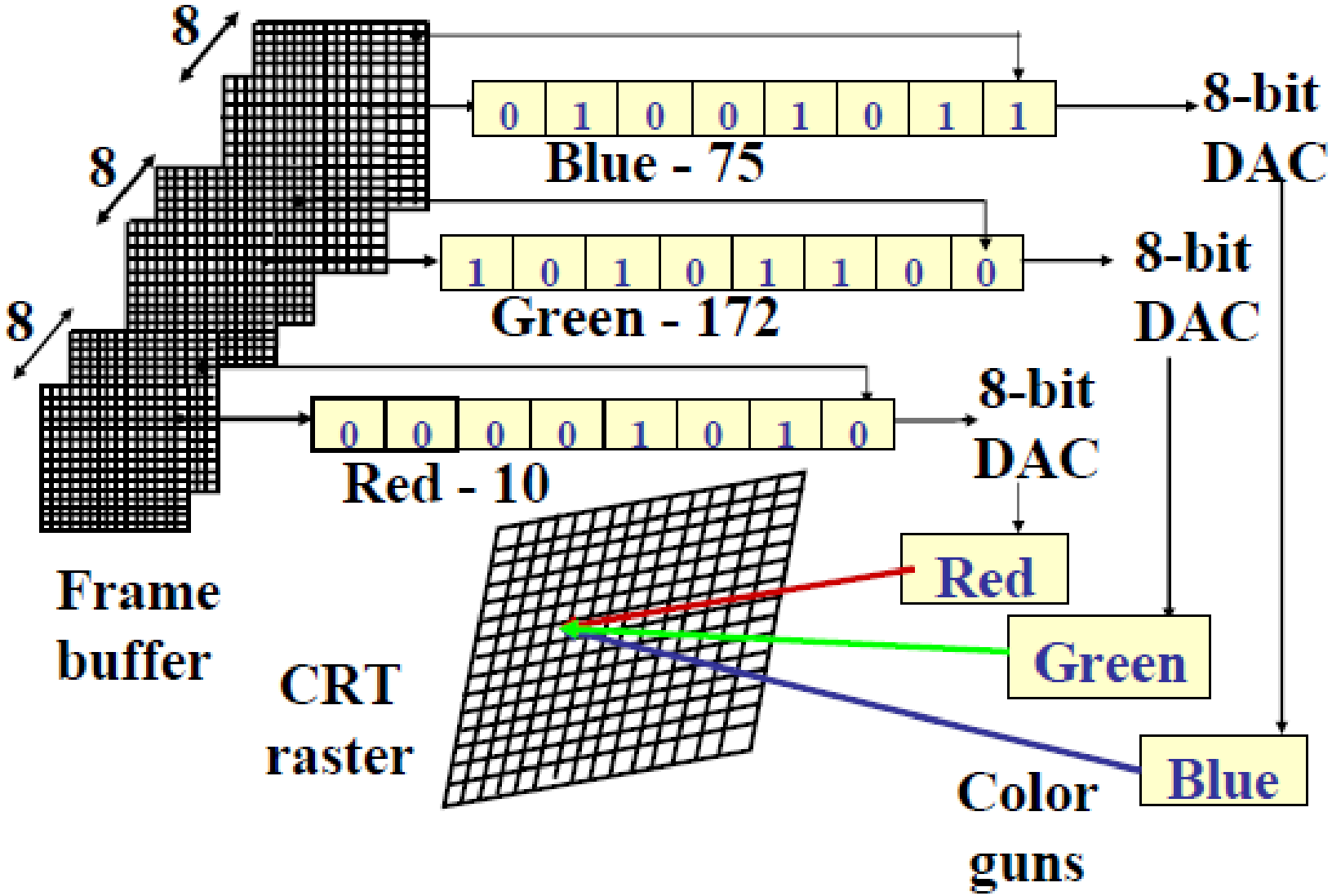
- In case of one-bit for each color frame buffer, we get 8 colors as:

COLOR	RED	GREEN	BLUE
BLACK	0	0	0
BLUE	0	0	1
GREEN	0	1	0
CYAN	0	1	1
RED	1	0	0
MAGENTA	1	0	1
YELLOW	1	1	0
WHITE	1	1	1

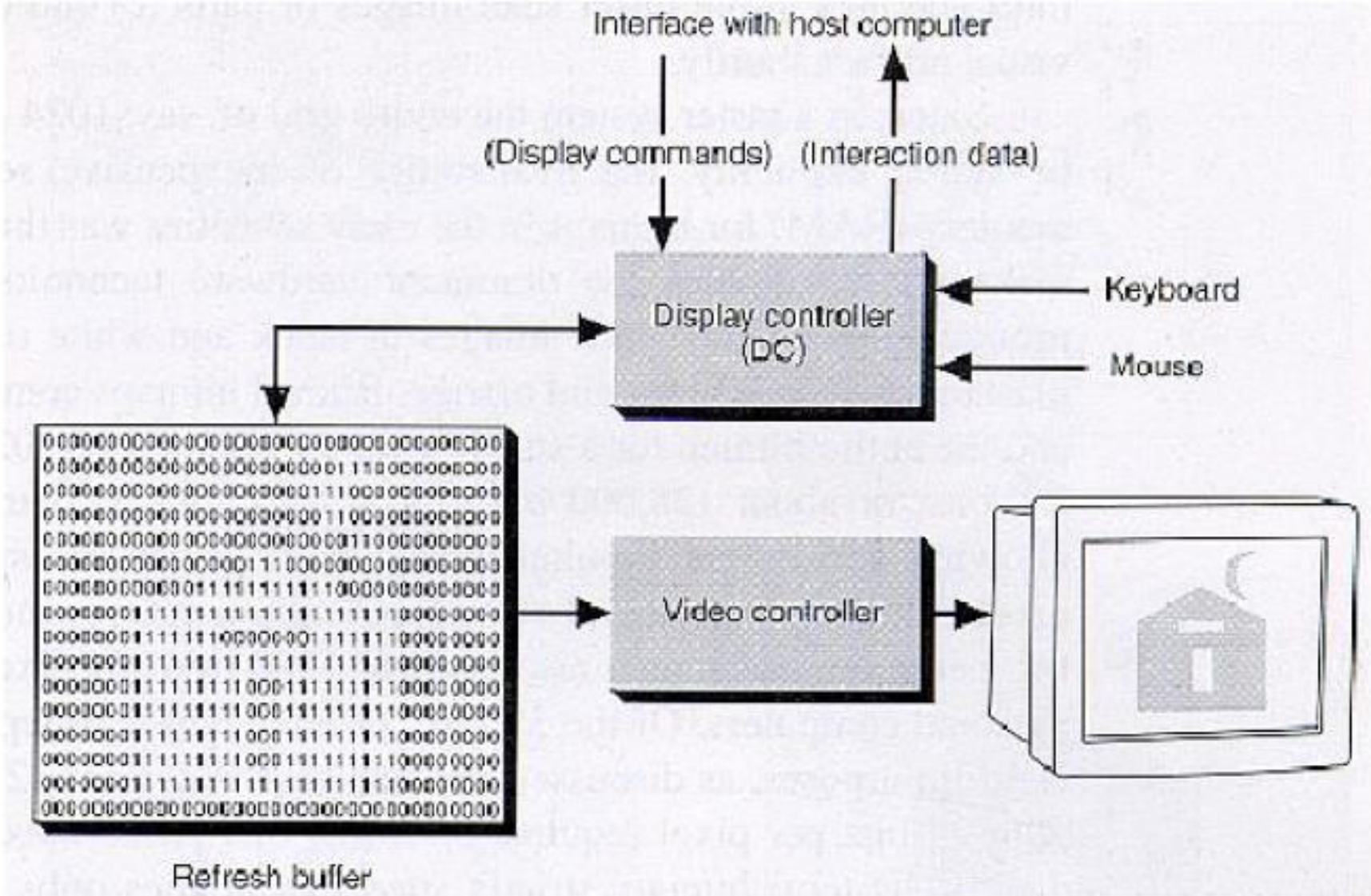
N-bit plane gray level Frame buffer (Contd.)

- Typically 8-bit planes per color is used, which gives a 24-bit plane frame buffer
- Each group of bit-planes drives an 8-bit DAC
- Each group generates 256 shades of intensities of red, green or blue
- Hence we obtain $2^{24} = 16,777,216$ possible colors.
- This is called a FULL COLOR FRAME BUFFER

A 24-bit-plane color frame buffer

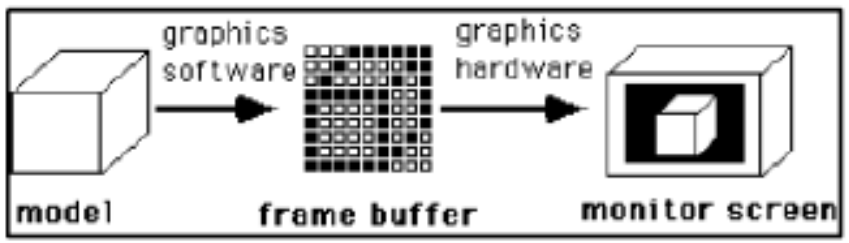


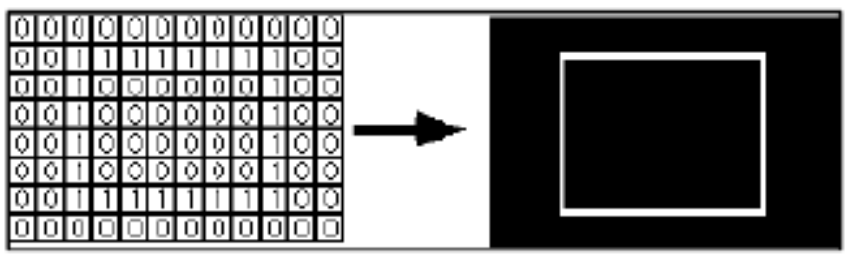
Raster Displays



Buffers in Raster Display

- Pretty much all CG is done using **raster displays**
- **Frame buffer** - array used to store the image to be displayed

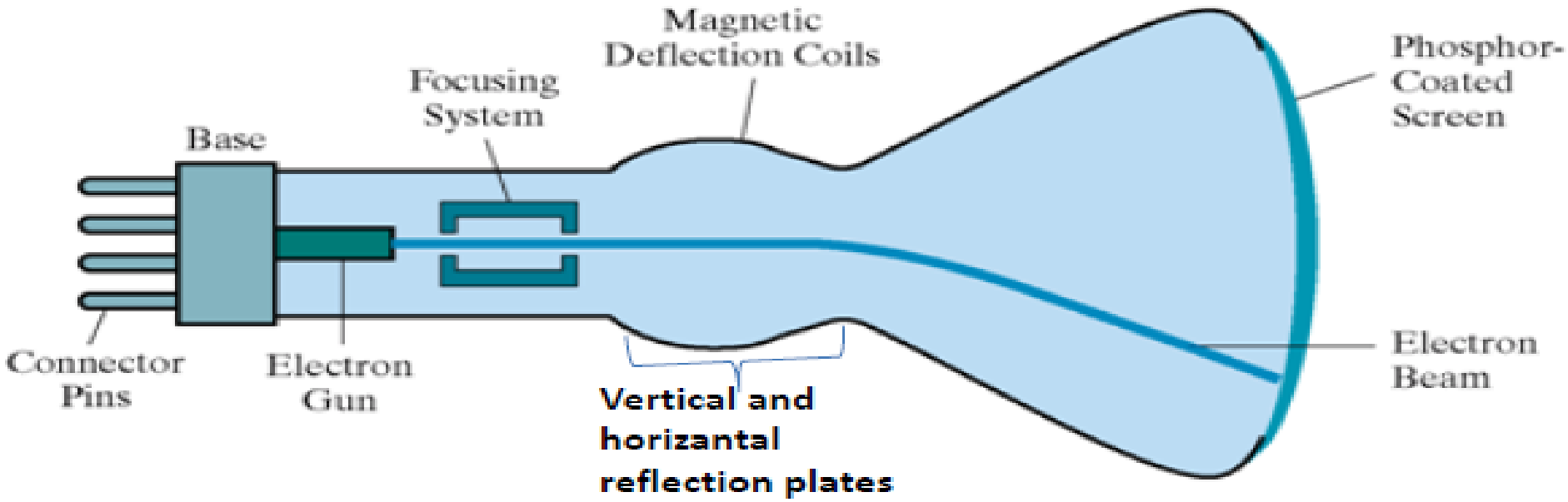


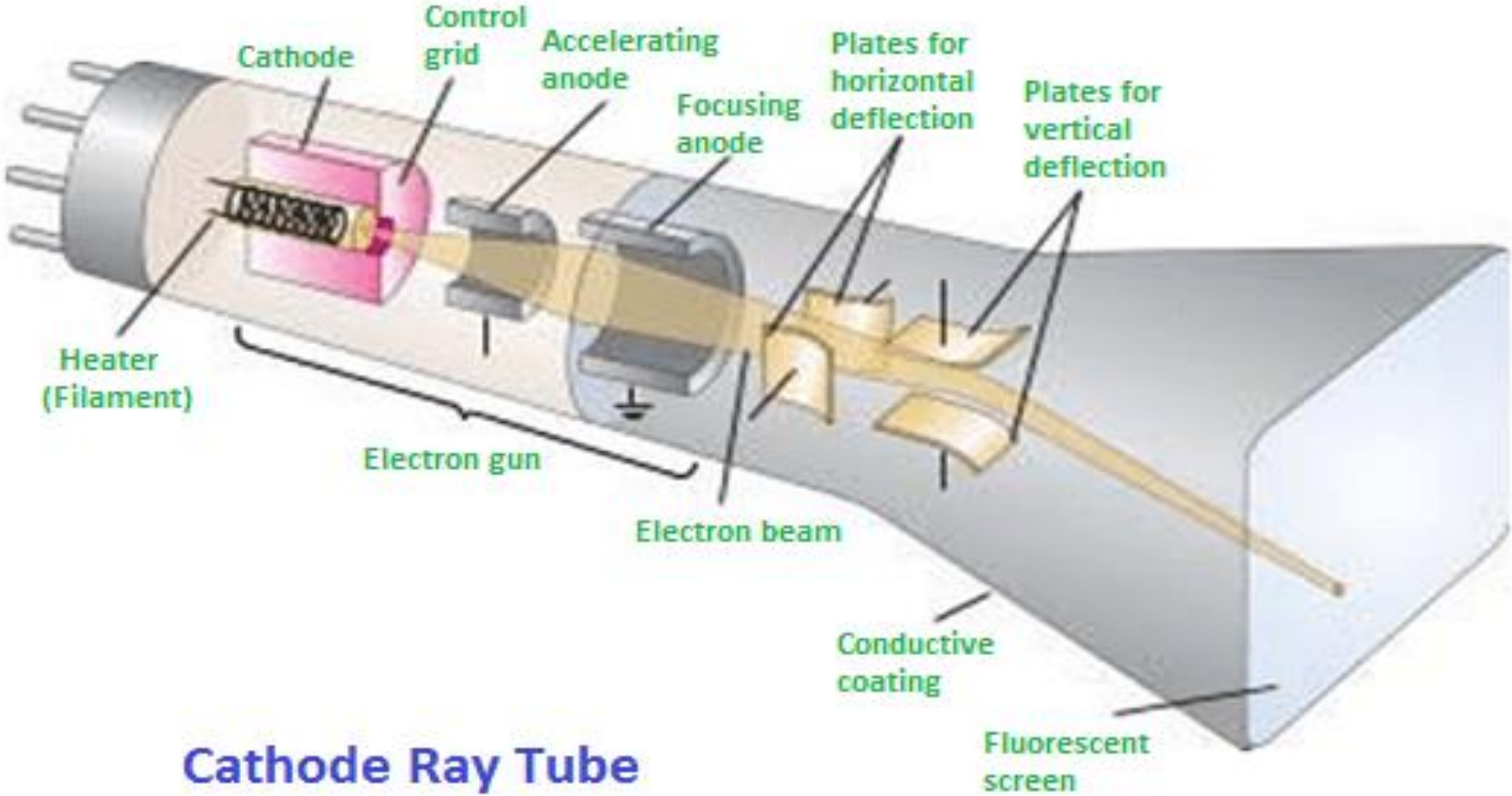


User manipulates values in frame buffer
Frame buffer is copied onto display device, 60 times per second

CRT

- Cathode Ray Tube
- Enclosed vacuum tube; electron beam is focused toward front surface of the tube, which is coated in phosphor
- Single gun for monochrome and three guns for color
- High voltage reduces the electron density and thus brightness



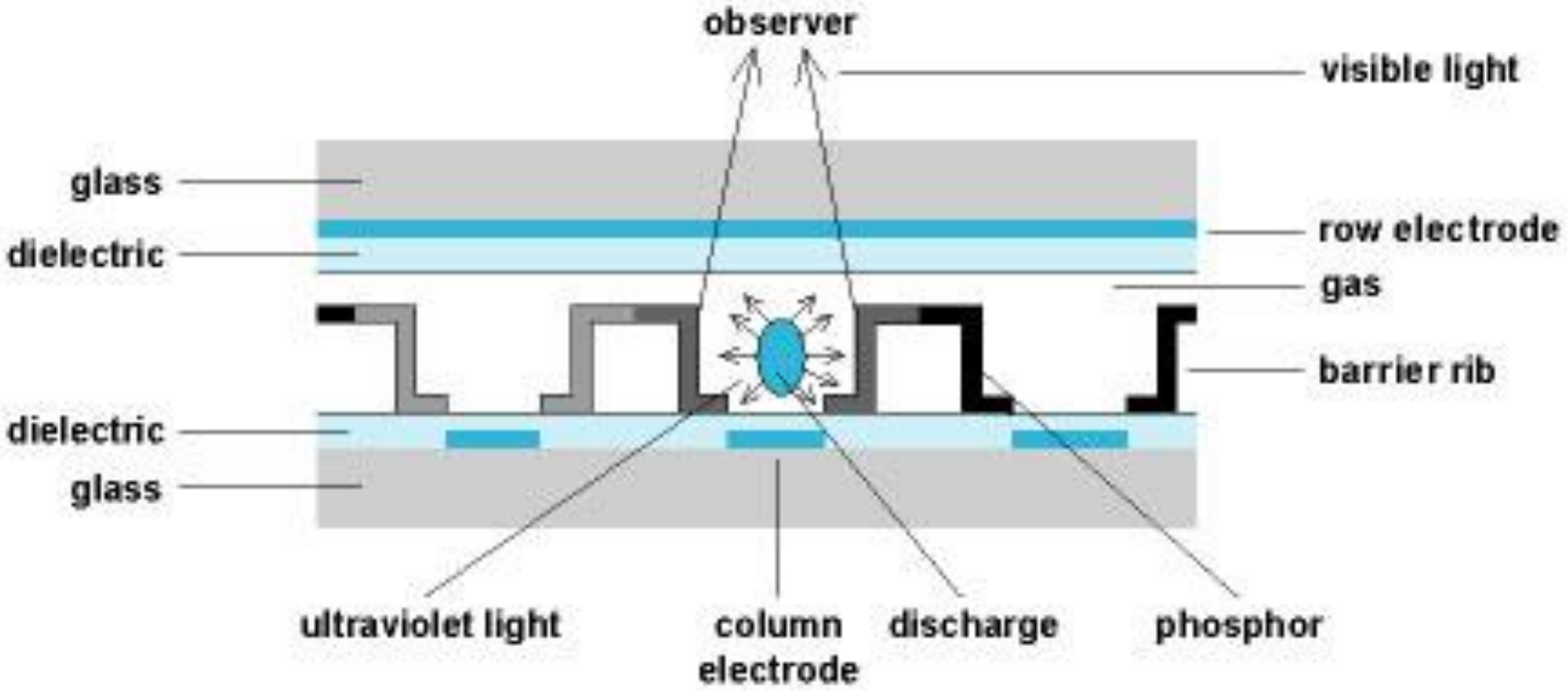


Cathode Ray Tube

PLASMA Display

- Plasma technology is another technology used in display devices.
- The basic idea behind the plasma technology is to illuminate tiny colored fluorescent lights to create image pixels.
- Each pixel is made of three such fluorescent lights – red, green and blue lights.
- To create a wide range of colors, intensity of these lights is varied accordingly.
- The heart of plasma displays is plasma which is basically a gas (generally Xenon and Neon) made up of free flowing electrons and ions.
- When the electrical current flows through the plasma, negatively charged particles move towards the positively charged area of the plasma and vice versa.
- This makes collisions which resultantly excite the gas atoms in the plasma and then release the energy as photons of light.

- There are millions of tiny cells filled with the gas like xenon and neon.
- They are positioned between two plates of glass known as front plate glass and rear plate glass.
- Two transparent electrodes covered by an insulating dielectric material and a magnesium oxide protective layer are also sandwiched between the glass plates on both sides of the cells on the entire screen.
- When the CPU sends the signals to the Plasma monitor, the corresponding electrodes are charged which ionizes the gas in the intersecting cells by passing an electric current.
- Due to the collisions between the gas ions they release energy in the form of the photons of light which illuminate the respective cells.
- This process occurs thousands of times in a small fraction of second making the display faster.
- The released ultraviolet photons strike the phosphor material coated on the inner wall of the cell and hence phosphor electrons jump to the higher energy level.
- When the electron falls back to its normal state, it releases the energy as a visible light photon. Every pixel on the screen is made of three different colored phosphors – red, green and blue.



A Diagram Showing Working of the Plasma Technology

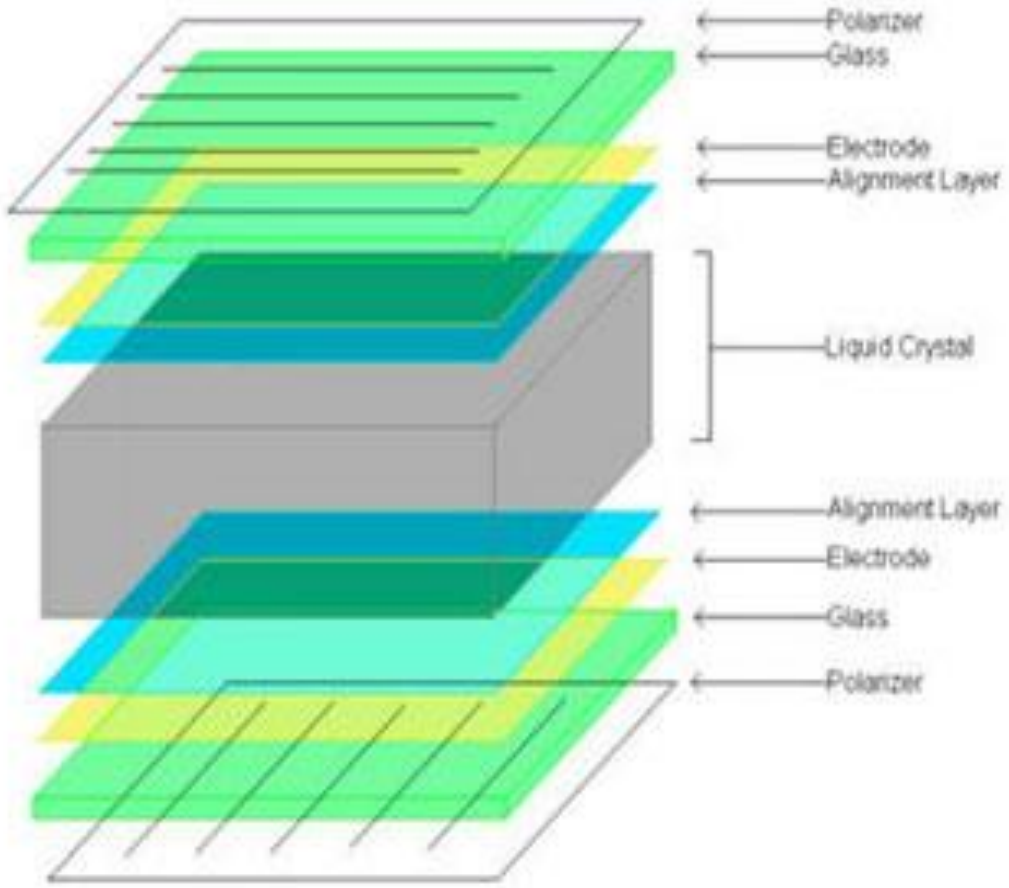
- **Characteristics of Plasma Display**
- Plasma displays can be made upto large sizes like 150 inches diognal.
- Very low-luminance “dark-room” black level.
- Very high contrast.
- The plasma display panel has a thickness of about 2.5 inches, which makes the total thickness not more than 4 inches.
-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

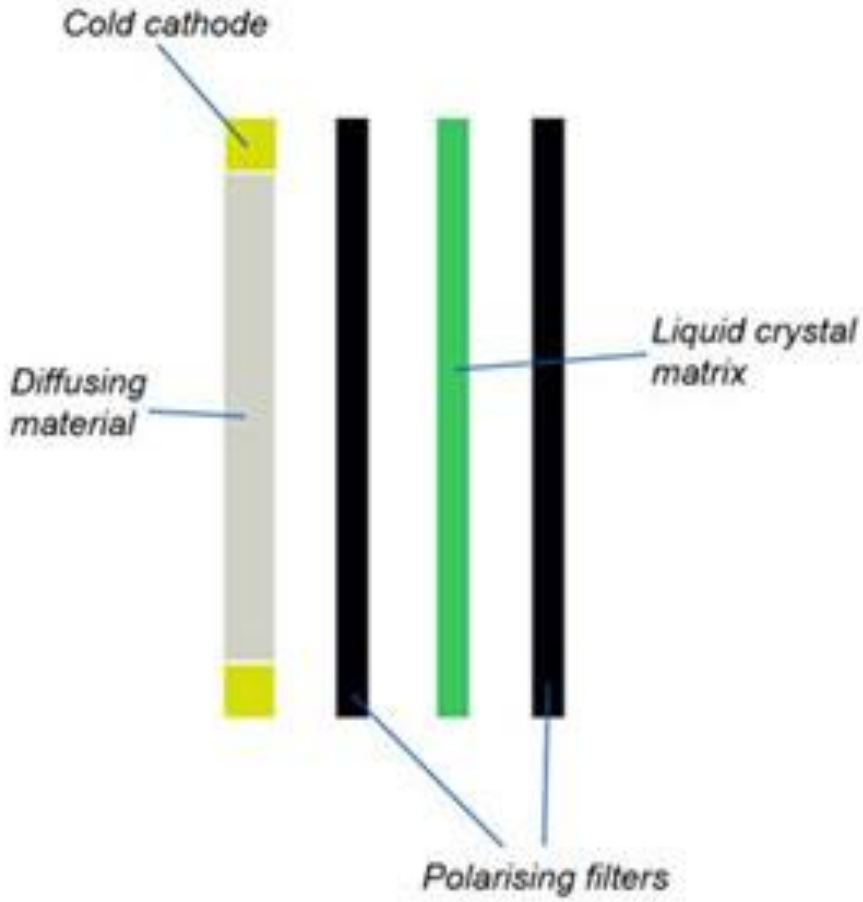
LCD Monitor

- LCD, Liquid Crystal Display or also known as Liquid Crystal Diode is one of the most popular display technologies currently.
- LCD monitors are lightweight, compact, occupy less space, consume low power and are available in a reasonable price.
- Currently there are two types of LCD technology in use – Active matrix LCD technology or TFT and Passive matrix technology.
- The TFT technology is more reliable with better image quality while the passive matrix technology has a slower response and gradually becoming outdated.
-
- As the name indicates, liquid crystals are the key elements of the display screen.
- By manipulating the crystal we can change the way they interacts with the light.
- There is a display controller in the monitor which receives the display signals from the video adaptor in the motherboard.
- The display controller controls two things – the electric signals to the liquid crystals and the back light. Structure of an LCD is shown in the below images

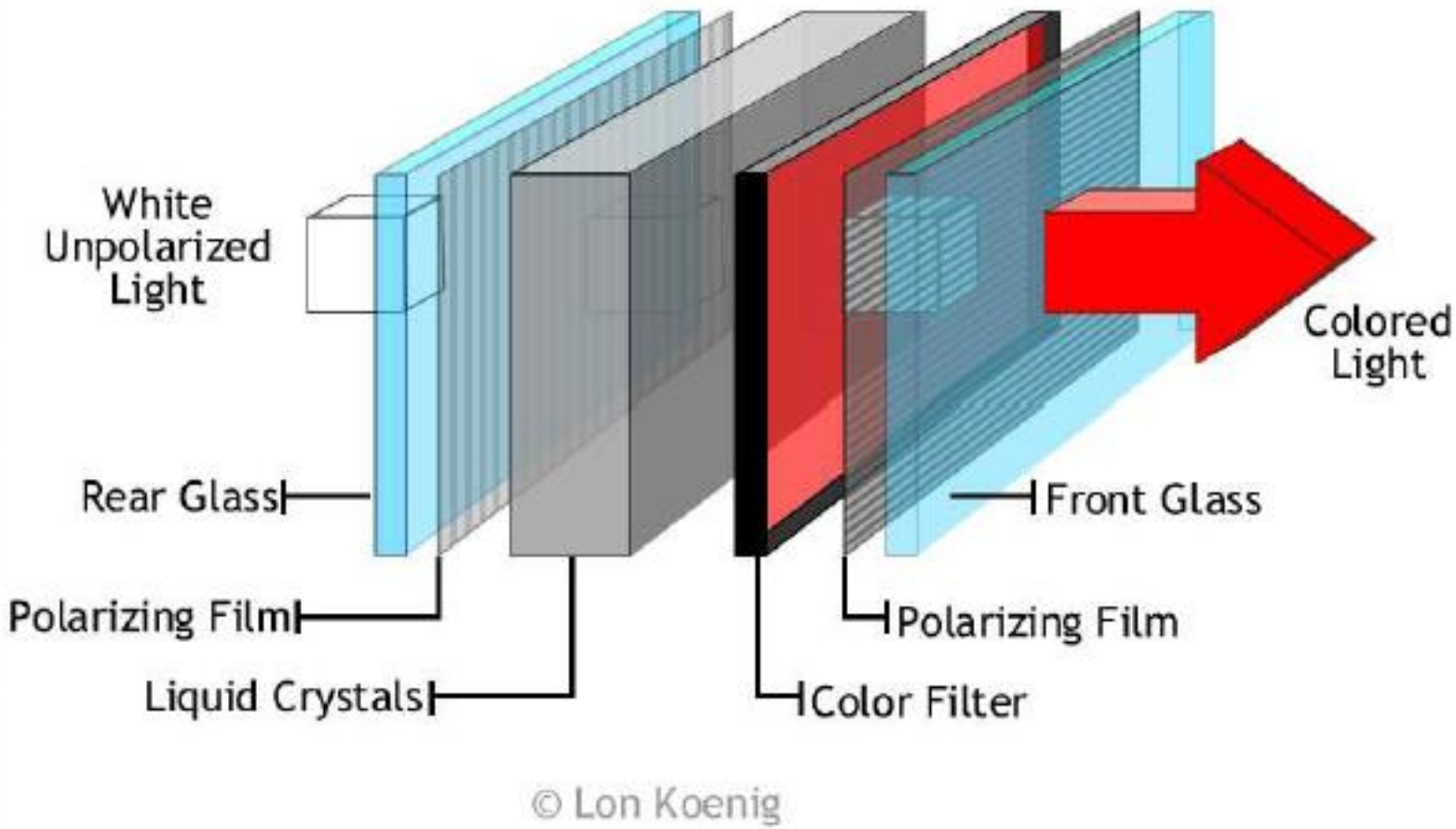
- The liquid crystals used in the LCD are Twisted Nemantic (TN), a type of liquid crystals that are twisted at 90^{o} with the surface.
- In this state, crystals allow the light to pass through the polarizer but on applying a voltage, they get untwisted and block the light to passing through the polarizer.
- The display controller starts the backlight that passes through the first piece of the glass.
- At the same time the display controller also send the electrical currents to the liquid crystal molecules to align and allowing the varying level of light to pass through the second piece of glass, forming the desired picture on the screen.
- In color monitors, each pixel is made of three liquid crystal cells fronted with red, green and blue filters.
- The light passing through the filtered screen forms the color what you see on the monitor.
- A wide range of colors are formed by varying the intensity of colored pixels.
- The backlight is made of cathodes, and depending on the quality of the monitor, there may be a single cathode at the top or one at the top and one at the bottom, or two at the top and two at the bottom to improve the brightness and clarity of the monitor.
- These cathodes are diffused through a layer of plastic and diffusing materials.

- <u>Resolution</u> - Unlike the CRT monitors there is no complex equation for the dot pitch and the resolution. The resolution of a monitor is simply the number of pixels contained in the matrix. Typically a 17 inch monitor has a resolution of 1280 x 1024 pixels.

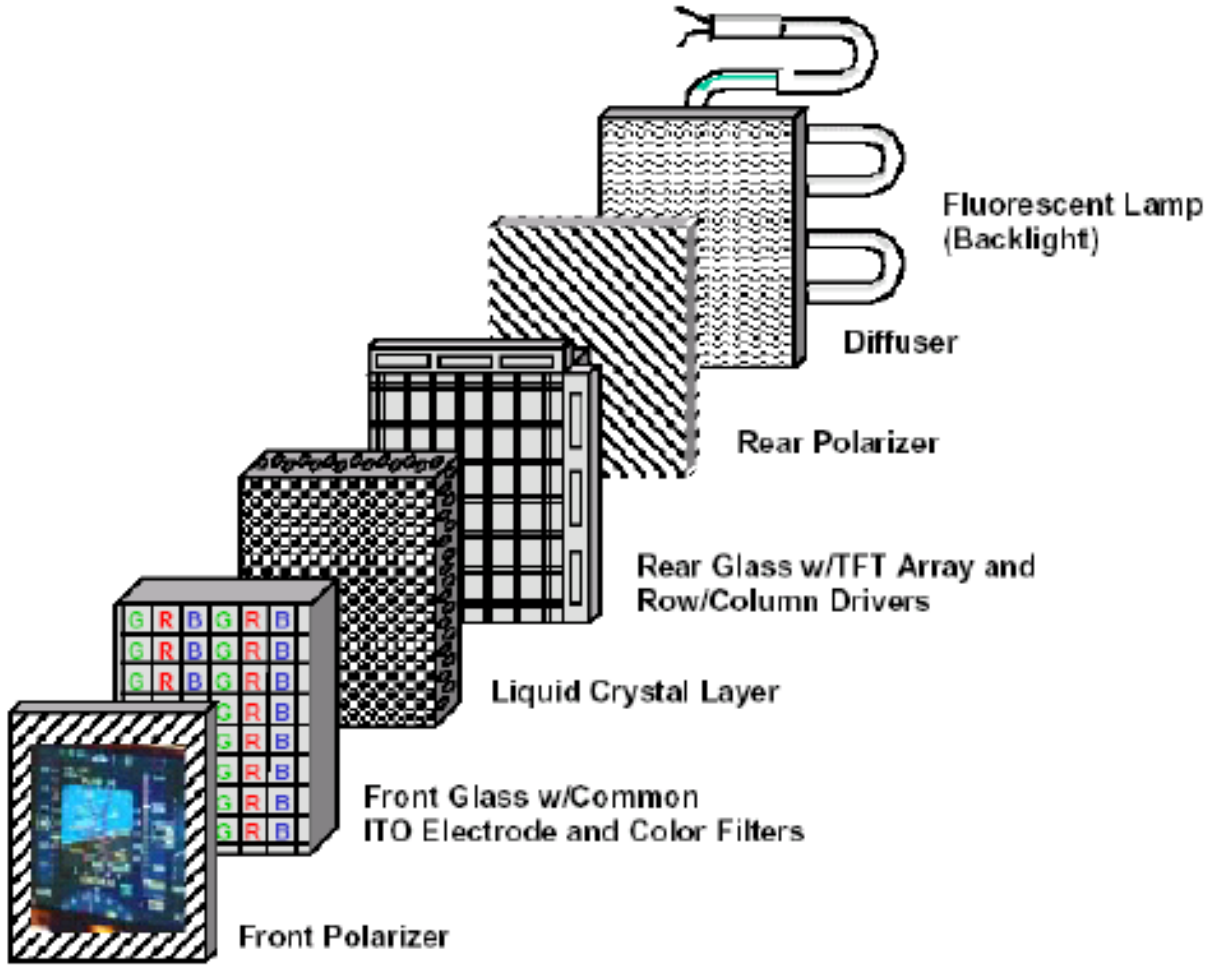




LCD working

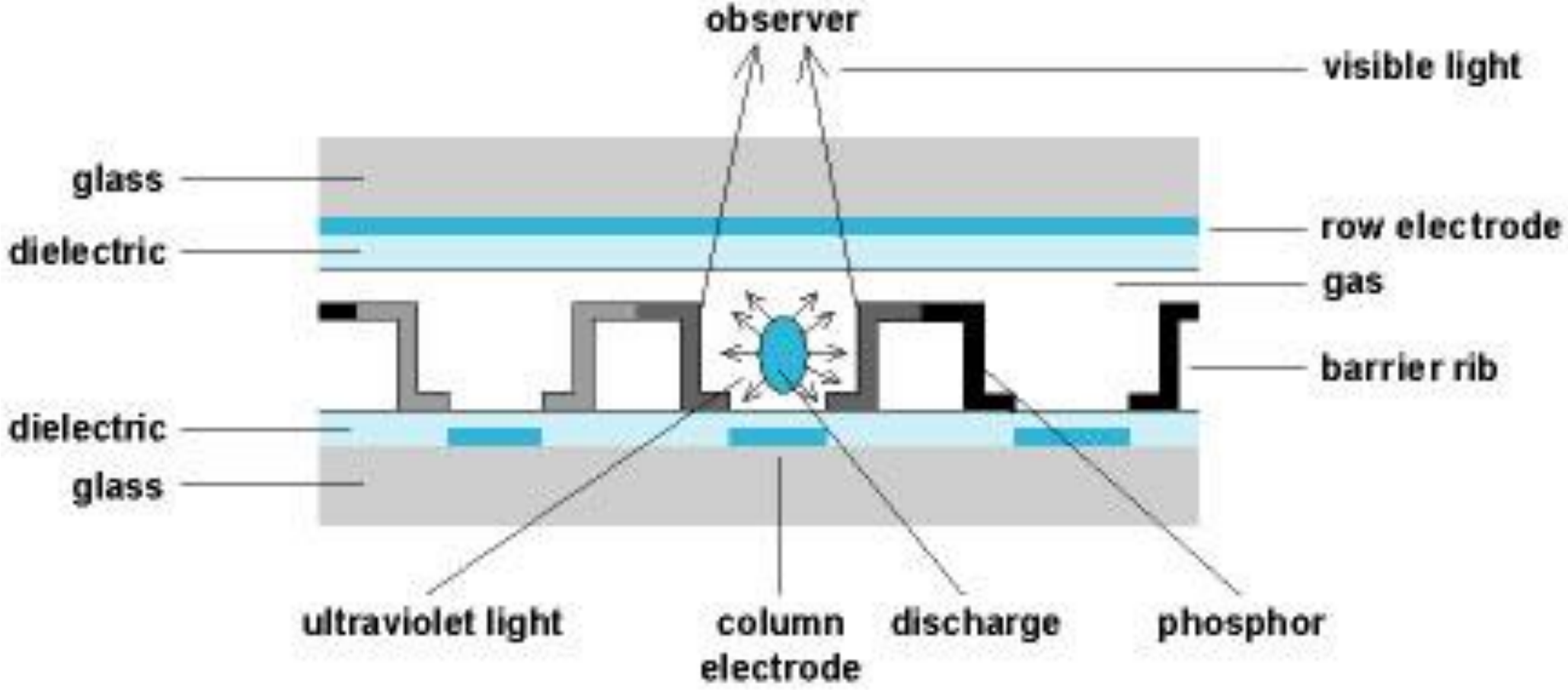

White
Unpolarized
Light
Colored
Light
Rear Glass
Front Glass
Polarizing Film
Polarizing Film
Liquid Crystals
Color Filter
© Lon Koenig

LCD working

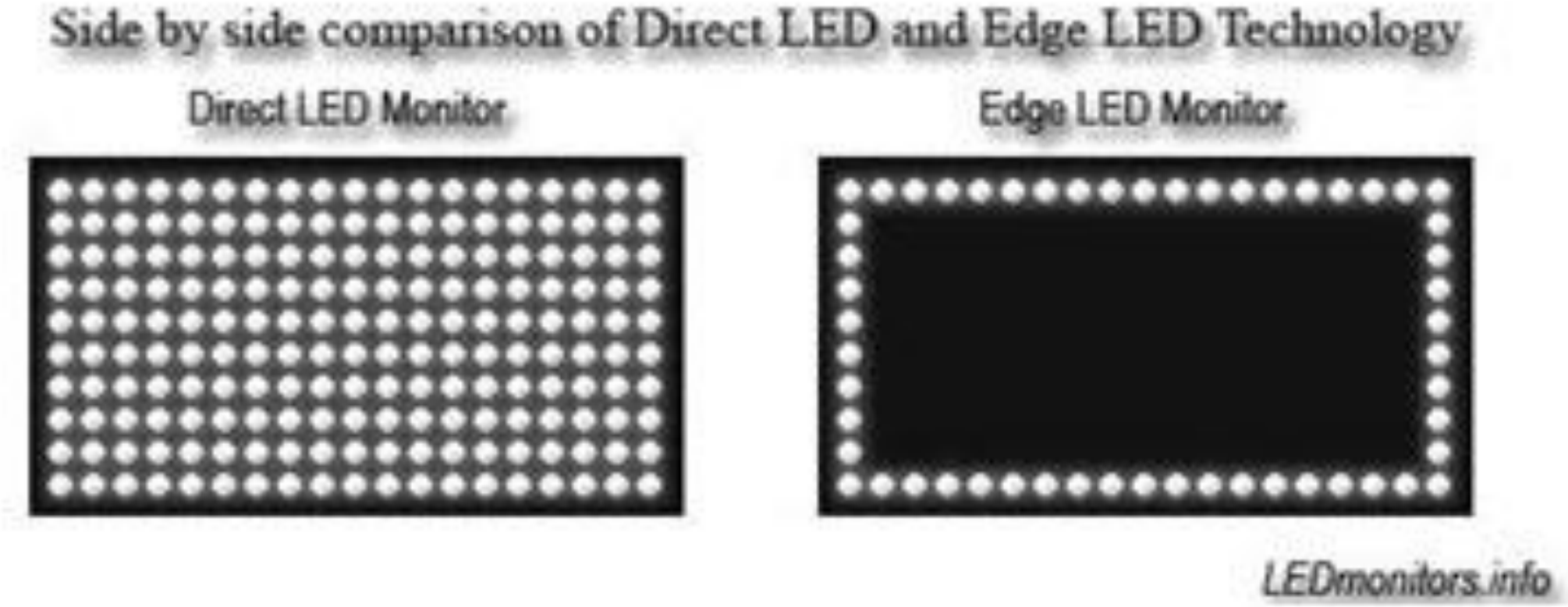

Fluorescent Lamp
(Backlight)
Diffuser
Rear Polarizer
Rear Glass w/TFT Array and
Row/Column Drivers
Liquid Crystal Layer
Front Glass w/Common
ITO Electrode and Color Filters
Front Polarizer

LED Monitors

- In the previous decade, the display technology has changed significantly. LED displays are one of the latest developments.
- LED monitors use light emitting diodes that acts as a performance booster in the monitors. Basically LED monitors are the LCD monitors with a LED backlight to power up the LCD panel. It means that LEDs are placed behind or around the LCD panel to enhance the luminosity and video definition of the monitor screen.
- As we have seen in the above section of LCD monitors, they use a cold cathode light as backlight. In the LED monitors all the concepts are same except this backlight, which is replaced by LEDs.
- There are three different types of LED monitors available based on the manner how the diodes are arranges in the monitor. These are – Direct LEDs, Edge LEDs and RGB LEDs. Both Edge and Direct LED display monitors use white diodes that are used to illuminate the LCD panel to produce the improved picture quality. The arrangement of LEDs in the monitor is



A Representational Image of a LED Monitor



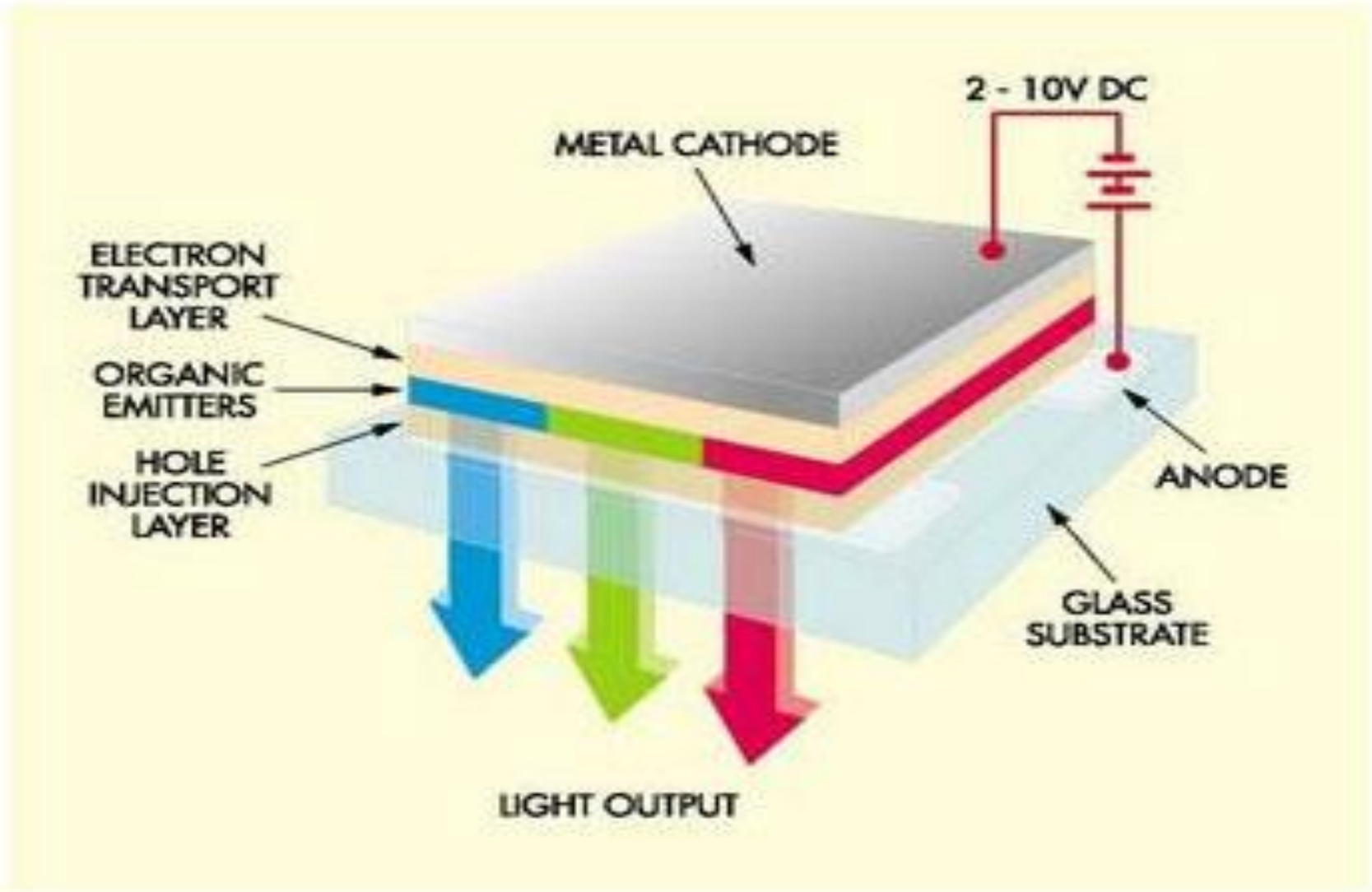
An Image Showing Comparison of Direct LED and Edge LED Technology

- In the Direct LEDs display, white diodes are placed all over the panel to produce higher quality image while the Edge LEDs display uses LEDs only on the borders of the LCD panel.
- Direct LEDs are generally used in the production of high definition TV whereas the Edge LEDs is mainly used in the production of computer screens.
- RGB LEDs display is better among the three types of LED monitors as it uses red, green and blue diodes to produce the lifelike images with amazing contrast ratio.

OLED Monitors

- OLED, short for Organic Light Emitting Diode is the latest technology for display devices.
- As the name suggests there are some organic material (containing carbon, like wood, plastic or polymers.) that is used to convert the electric current into light.
- Since the LEDs are capable of producing different colored light, they are directly used to produce the correct color and there is no need of a backlight which saves power and space.
- With fast response time, wide viewing angles, outstanding contrast levels and perfect brightness, OLED displays are surely better than the existing other display technologies.

- The heart of the OLED display is a stack of thin organic layers which is sandwiched between two conductors - a transparent anode and a metallic cathode, which in turn are sandwiched between two glass plates known as seal and substrate.
- The organic layer consists of a hole-injection layer, a hole-transport layer, an emissive layer and an electron-transport layer.
- When an appropriate voltage is applied, an electric current flows from cathode to anode through the organic layers.
- The cathode give electrons to the emissive layer of organic molecules while the anode takes equivalent electrons from the conducting layer of organic molecules.
- At the boundary of emissive and conductive layers, electrons and the holes are gathered.
- Here electrons are recombined with the holes by releasing energy in the form of photon of light. Hence the organic layer emits the light to produce the display.
- The color of the light depends on the type of organic molecules while the brightness depends on the amount of the current applied.
- By maximizing the recombination process in the emissive layer the output light can be improved in OLED devices.
- Thus the emissive layer is slightly doped with highly fluorescent molecules to enhance the electro-luminescent efficiency and control of color.



A Diagram Illustrating Structure and Working of a OLED Display

Display adapters

VIDEO DISPLAY ADAPTERS

- The video display adapter is a circuit card that plugs into the personal computer to drive the monitor.
- Video adapter cards play a major role in how many colors are displayed and the speed with which display is updated. Common video adapters are

- MDA (Monochrome Display Adapter)
- CGA (Color Graphics Adapter)
- EGA (Enhanced Graphics Adapter)
- VGA (Video Graphics Array)
  SVGA (Super Video Graphics Array)
- XGA (Extended Graphics Array)

- **Monochrome Display Adapter (MDA)**
- The monochrome display adapter (MDA) was the first display adapter available.
- It is designed to work with a monochrome **transistor transistor logic** (TTL) monitor.
- It is a text-only system that cannot display graphics or color.
- The MDA uses a 9 x 14 dot character box that provides clean sharp characters.

- **Color Graphics Adapter(CGA)**
- Introduced in 1981, was IBM's first graphics card and first color display card for the IBM PC
- The color graphics adapter (CGA) was, at one time, the most common graphics adapter available.
- It supports an RGB monitor with a maximum resolution of 640 x 200 pixels.
- The CGA card has two modes of operation: alphanumeric alphanumeric (A/N) and all points addressable (APA).
- In both modes, the basic character set is formed with a resolution of 8 x 8 pixels
- The CGA card displays either 40 or 80 columns with 25 lines of text

- In the A/N mode, the CGA card can display up to 16 colors. The all points addressable mode of operation can address each pixel individually.
- The CGA APA mode supports two resolutions on the screen: medium and high.
- The medium resolution is capable of addressing 320 x 200 pixels with 4 colors.
- The high resolution is capable of a 640 x 200 display using 2 colors.

- **Enhanced Graphics Adapter (EGA)**
- The enhanced graphics adapter (EGA) takes the place of CGA adapter and drives an RGB monitor.
- The EGA provides 16 colors at a resolution of 320 x200 or 640 x 200. The character box for text is 8 x14 instead of the 8 x 8 used with the CGA card.
- The EGA card comes with 64K of video memory that is expandable to 256K using a graphics memory expansion card.
- This card adds an additional 64K of video memory. The EGA card also uses 128K of RAM from the computer's RAM.
- The video is stored just above the 640K boundary.

- **Video Graphics Array(VGA) :-**
- The video graphics array (VGA) adapter card overcame the limitations earlier adapters had in displaying high quality color.
- The earlier adapters used digital signals to control the three electron guns of the CRT.
- Each gun was either turned on or off by these signals and limited the display to 8 colors.
- By adding a high and a low intensity signal, the number of colors that could be displayed was doubled to 16.
- The VGA card generates analog signals to control the electron guns and, therefore, can control the intensity of each gun at varying levels.
- Current VGA cards are capable of displaying 256 colors and generating 262,144 (256K) colors.

- The VGA card displays text in a 9 x 16 character box and has a resolution of 640 x 480.

- **Super Video Graphics Adapter (SVGA)**
- Super video graphics array (SVGA) is a term used to describe graphic adapters that have exceeded those of the VGA system.
- This standard was developed by a consortium of monitors and graphics manufacturers called VESA (Video Electronics Standards Association).
- SVGA arrived in the late 1980s.
- Resolutions for SVGA vary by manufacturer but 800x600, 1024x768, 1280x1024, 1600x1200 are common.
- Once an SVGA card is installed, a software driver that describes the specifications of that card needs to be installed.

- **Extended Graphics Array (XGA)**
- A high resolution graphics standard introduced in 1990.
- It was designed to replace the older 8514/A video standard. It provides the same resolution as 8514/A but supports more colors.
- The extended graphics array (XGA) is a refinement of the VGA standard.
- The XGA system also provides greater resolution and more colors than the VGA system.
- The XGA can hold up to 1 MB of video memory. Resolution is variable, depending on the mode selected. Maximum resolution is 1024 x 768, with the capability of displaying 256 colors from a palette of 262,144 colors.
- The XGA can also display 65,536 colors at a resolution of 640 x 480, providing almost photographic quality color.

- **Widescreen Extended Graphics Array (WXGA)**
- EXGA is an extension of XGA found on recent laptops.
- It provides pixel resolutions of 1280 x 800, 1366 x 768, and 1300 x 768.
- Depending upon the X & Y of the pixel resolutions, you get different screen aspect ratios.
- For example: 1280 x 800 gives an aspect ratio of 16:10 whereas 1366 x 768 gives an aspect ratio of 16:9.
- Pixel resolution of 1300 x 768 gives an aspect ratio of 17:10, which is a narrower aspect ratio and is often found in 26" LCD television screens.

- **Super XGA (SXGA)**
- SXGA is also referred as XVGA (Extended VGA). SXGA provides a screen resolution of 1280 x 1024 pixels (5:4 aspect ratio). This is commonly found in 17" and 19" LCD monitors.
- **Super XGA Plus (SXGA+)**
- SXGA+ is commonly found in 14" & 15" screens that are generally used in laptops/notebooks. SXGA+ provides a resolution of 1400 x 1050 at 4:3 aspect ratio.
- **Widescreen Extended Graphics Array Plus (WXGA+ or WSXGA)**
- WXGA+ a non-standard adapter technology that provides display resolution of 1440 x 900 pixels at 16:10 aspect ratio. It is commonly found in 19" widescreen LCD monitors

- **Ultra XGA (UXGA)**
- The UXGA standard provides a resolution of 1600 x 1200 pixels at 4:3 aspect ratio of 4:3. This ia a native resolution for 20" & 23" LCD monitors.
- **Widescreen SXGA (WSXGA)**
- WSXGA provides screen resolution of 1680 x 1050 pixels at 16:10 aspect ratio, and is commonly found in 22" monitors.
- **Widescreen UXGA (WUXGA)**
- The WUXGA standard provides a resolution of 1920 x 1200 pixels at 16:10 aspect ratio. This adapter standard is used in high-end notebook computers and generally in 23" - 27" widescreen LCD monitors.