

## **1.8 Type of graphics devices**

### **1- Storage Tube Graphics Displays**

This storage tube display, also called a bistable storage tube, can be considered a CRT with a long persistence phosphor. A line or character will remain visible up to a hour until erased. To draw a line on the display the intensity of the electron beam is increased sufficiently to cause the phosphor to assume its permanent bright “storage”. The display is erased by flooding the entire tube with a specific voltage which causes the phosphor to assume its dark state.

Features of storage tube graphics display

- 1- Storage tube display is flicker free
- 2- Capable of displaying an unlimited number of vectors
- 3- Resolution is typically 1024 X 1024 addressable points on an 8 X 8 inch square or 4096 X 4096 on either 14 X 14 or an 18 X 18 inch square.
- 4- Display of dynamic motion or animation is not possible.
- 5- A storage tube display is a line drawing or random scan display. This means that a line (vector) can be drawn directly from any addressable point to any other addressable point. This device plots continuous lines and curves rather than separate pixels.
- 6- A storage tube display is easier to program than a calligraphic or raster scan refresh display.
- 7- The level of interactivity is lower than with either a refresh or raster scan display.

### **2- The Calligraphic Refresh graphics display**

A Calligraphic (line drawing or vector) refresh CRT display uses a very short persistence phosphor. These displays are frequently called random scan display. Because of the short persistence of the phosphor, the picture painted on the CRT must be repainted or refreshed many times each second. The minimum refresh rate is at least 30 times each second. Refresh rates much lower than 30 times each second result in a flickering image.

The basic calligraphic refresh display requires two elements in addition to the CRT. These are the display buffer and the display

controller. The display buffer is contiguous memory containing all the information required to draw the picture on the CRT. The display controller's function is to repeatedly cycle through this information at the refresh rate. Two factors which limit the complexity (number of vectors displayed) of the picture are the size of the display buffer and the speed of the display controller. A further limitation is the speed at which picture information can be processed.

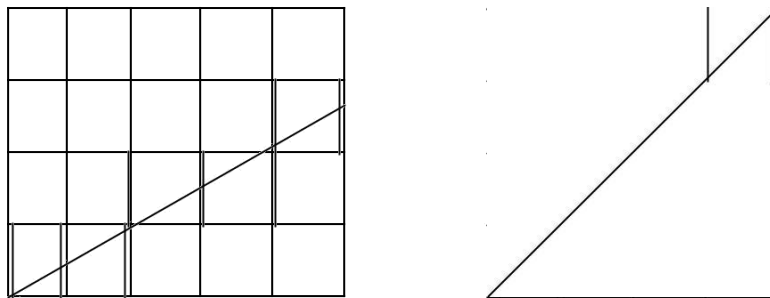
#### Features of calligraphic refresh displays

- 1- It is a vector graphics display
- 2- Resolution is the same as storage tube display
- 3- Emulate the concept of picture segmentation that support the interactive graphics programs

### 3- Raster refresh graphics display

A raster CRT graphics devices can be considered a matrix of discrete cells each of which can be made bright. Thus it is a point plotting devices.

It is not possible except in special cases to directly draw a straight line from one addressable point, or pixel in the matrix to another addressable point, or pixel. The line can only approximated by a series of dots (pixels) close to the path of the line.



Only in the special cases of completely horizontal, vertical or 45 degree lines will a straight line result. All other lines will appear as a series of stair steps. *This is called aliasing.*

The most common method of implementing a raster CRT graphics device utilize a frame buffer. A frame buffer is a large, contiguous piece of computer memory. As a minimum there is one memory bit for each location or pixel in the raster. This amount of memory is called a bit plane.

A 512 X 512 element square raster requires  $2^{18}$  memory bits in a single bit plane. The picture is built up in the frame buffer 1 bit at a time.

Since a memory bit has only two states (0 or 1), a single bit plane yields a black and white display. Color or gray levels can be incorporated into a frame buffer raster graphics device by using additional bit planes.

The capacity of the frame buffer depends on the number of bits representing each pixel, on the number of pixels per scan line and on the number of the scan lines.

The CRT must be refreshed by repeatedly passing to it the image to be displayed. The image must be transmitted to the display point by point. Unless the entire image can be transmitted at least 25 times a second, it will begin to flicker.

## **1.9 Pixels and Frame buffer**

We can not represent an infinite number of points (pixels) on a computer, just as we can not do that with numbers. The machine is finite, and we are limited to a finite number of points making up each line. The maximum number of points (pixels) which a line can have is a measure of the resolution of the display device. The greater the number of points, the higher the resolution.

Resolution is the number of visibly distinct dots that can be displayed in a given area of the screen

