Understanding of Cathode Ray Tube – CRT

Computer technology is going to see major advances in sophisticated 3-dimensional modeling and image processing; the users will see desktop computers with the computational power of today's super-computers. Even graphics capabilities would be available to the average user at a reasonable cost. To make this, ultra-high-resolution monitors will be required. There are different display systems like cathode ray tubes (CRTs), liquid crystal displays (LCDs), electroluminescent displays (ELDs), plasma displays and light-emitting diodes (LEDs) are available in the present technology. Here we are going to discuss the Cathode Ray Tube (CRT).

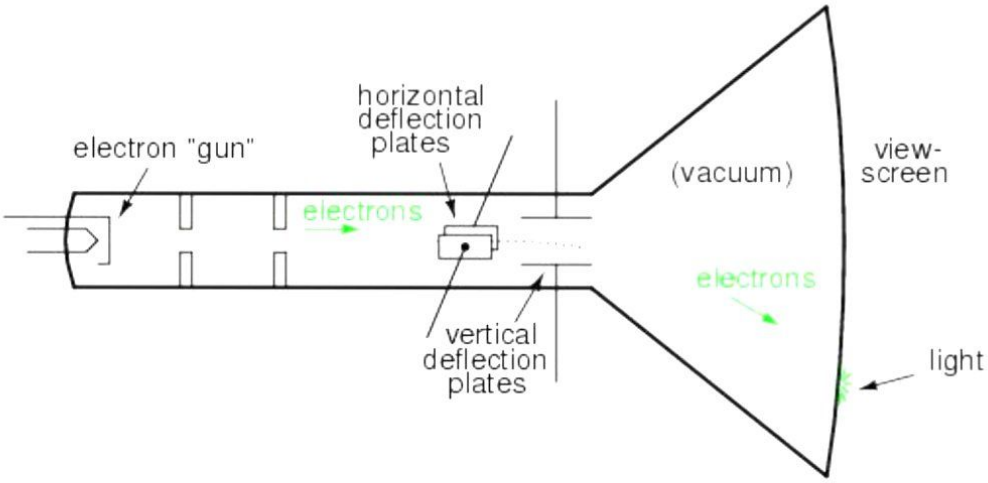
Principle of Workingtage

When the two metal plates are connected to a high voltage source, the negatively charged plate called the cathode emits an invisible ray. The cathode ray is drawn to the positively charged plate, called the anode, where it passes through a hole and continues traveling to the other end of the tube. When the ray strikes the specially coated surface, the cathode ray produces a strong fluorescence or bright light. When an electric field is applied across the cathode ray tube, the cathode ray is attracted by the plate bearing positive charges. Therefore a cathode ray must consist of negatively charged particles. A moving charged body behaves like a tiny magnet, and it can interact with an external magnetic field. The electrons deflected by the magnetic field. And also when the external magnetic field is reversed, the beam of electronics is deflected in the opposite direction.

In a cathode ray tube, the cathode is a heated filament and it placed in a vacuum. The ray is a stream of electrons that naturally pour off a heated cathode into the vacuum. Electrons are negative. The anode is positive, so it attracts the electrons pouring off the cathode. In a TV's cathode ray tube, the stream of electrons is focused by a focusing anode into a tight beam and then accelerated by an accelerating anode. This tight, high-speed beam of electrons flies through the vacuum in the tube and hits the flat screen at the other end of the tube. This screen is coated with phosphor, which glows when struck by the beam.

Operation of CRT

Cathode Ray Tube (CRT) is a computer display screen, used to display the output in a standard composite video signal. The working of CRT depends on the movement of an electron beam which moves back and forth across the back of the screen. The source of the electron beam is the electron gun; the gun is located in the narrow, cylindrical neck at the extreme rear of a CRT which produces a stream of electrons through thermionic emission. Usually, A CRT has a fluorescent screen to display the output signal. A simple CRT is shown below.



Cathode Ray Tube

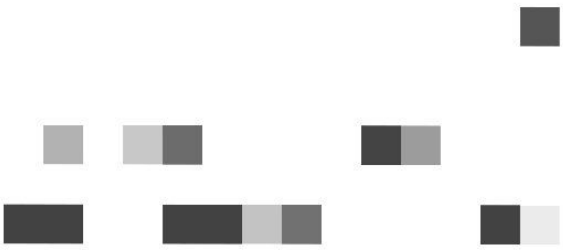
The operation of a CRT monitor is very simple. A cathode-ray tube consists of one or more electron guns, possibly internal electrostatic deflection plates, and a phosphor target. CRT has three electron beams – one for each (Red, Green, and Blue) is clearly shown in the figure. The electron beam produces a tiny, bright visible spot when it strikes the phosphor-coated screen. In every monitor device, the entire front area of the tube is scanned repetitively and systematically in a fixed pattern called a raster. An image (raster) is displayed by scanning the electron beam across the screen. The phosphor's targets are beginning to fade after a short time, the image needs to be refreshed continuously. Thus CRT produces the three color images which are primary colors. Here we used a 50 Hz rate to eliminate the flicker by refreshing the screen.

The main parts of the cathode ray tube are cathode, control grid, deflecting plates and screen.

Cathode

The heater keeps the cathode at a higher temperature and electrons flow from the heated cathode towards the surface of the cathode. The accelerating anode has a small hole at its center and is maintained at a high potential, which is of positive polarity. The order of this voltage is 1 to 20 kV, relative to the cathode. This potential difference creates an electric field directed from right to left in the region between the accelerating anode and the cathode. Electrons pass through the hole in the anode travel with constant horizontal velocity from the anode to the fluorescent screen. The electrons strike the screen area and it glows brightly.

The Control Grid



The control grid regulates the brightness of the spot on the screen. By controlling the number of electrons by the anode and hence the focusing anode ensures that electrons leaving the cathode in slightly different directions are focused down to a narrow beam and all arrive at the same spot on the screen. The whole assembly of cathode, control grid, focusing anode, and accelerating electrode are called the electron gun.

Deflecting Plates

Two pairs of deflecting plates allow the beam of electrons. An electric field between the first pair of plates deflects the electrons horizontally, and an electric field between the second pair deflects them vertically, the electrons travel in a straight line from the hole in the accelerating anode to the center of the screen when no deflecting fields are present, where they produce a bright spot.

Screen

This may be circular or rectangular. The screen is coated with a special type of fluorescent material. Fluorescent material absorbs its energy and re-emits light in the form of photons when the electron beam hits the screen. When it happens some of them bounces back just like bouncing off a cricket ball from a wall. These are called secondary electrons. They must be absorbed and returned to the cathode if it is not so they accumulate near the screen and produce space charge or electrons cloud. To avoid this, aqua day coating is applied on the funnel part of CRT from inside.

Advantages of CRT

1. CRT's are less expensive than other display technologies.
2. They operate at any resolution, geometry and aspect ratio without decreasing the image quality.
3. CRTs produce the very best color and gray-scale for all professional calibrations.
4. Excellent viewing angle.
5. It maintains good brightness and gives long life service.

Features of CRT

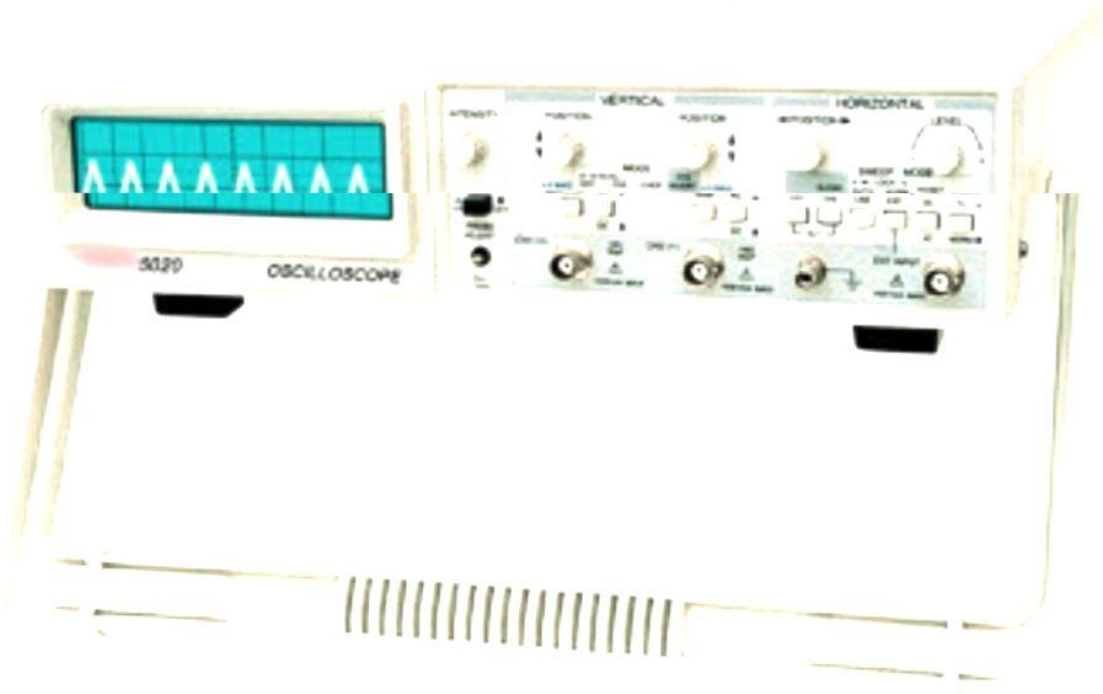
The use of CRT technology has quickly declined since the introduction of LCDs but they are still unbeatable in certain ways. CRT monitors are widely used in several electrical devices such as computer screens, television sets, radar screens, and oscilloscopes used for scientific and medical purposes.

Tutorial On CRO (Cathode Ray Oscilloscope) Working and Applications

The CRO stands for a cathode ray oscilloscope. It is typically divided into four sections which are display, vertical controllers, horizontal controllers, and Triggers. Most of the oscilloscopes are used the probes and they are used for the input of any instrument. We can analyze the waveform by plotting amplitude along with the x-axis and y-axis. The applications of CRO's mainly involve in the radio, TV receivers, also in laboratory work involving research and design. In modern electronics, the CRO plays an important role in the electronic circuits.

What is a CRO?

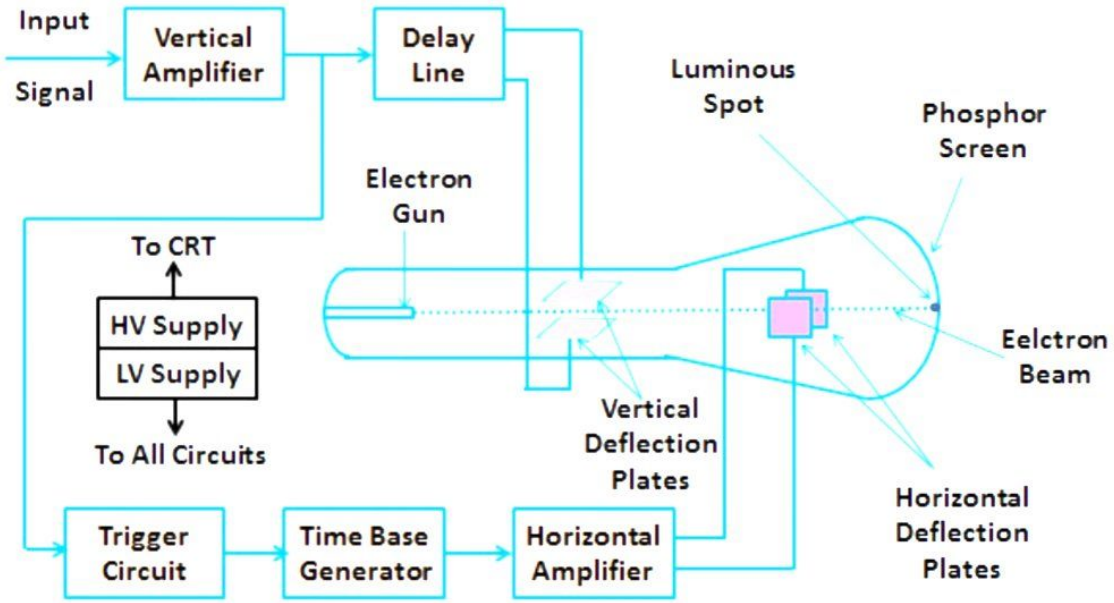
The **cathode ray oscilloscope is an electronic test instrument**, it is used to obtain waveforms when the different input signals are given. In the early days, it is called as an Oscillograph. The oscilloscope observes the changes in the electrical signals over time, thus the voltage and time describe a shape and it is continuously graphed beside a scale. By seeing the waveform, we can analyze some properties like amplitude, frequency, rise time, distortion, time interval and etc.



Cathode Ray Oscilloscope

Block Diagram of CRO

The following **block diagram shows the general purpose CRO contraction**. The CRO recruit the cathode ray tube and acts as a heat of the oscilloscope. In an oscilloscope, the CRT produces the electron beam which is accelerated to a high velocity and brings to the focal point on a fluorescent screen. Thus, the screen produces a visible spot where the electron beam strikes with it. By detecting the beam above the screen in reply to the electrical signal, the electrons can act as an electrical pencil of light which produces a light where it strikes.



Block Diagram of Cathode Ray Oscilloscope (CRO)

Block Diagram of CRO

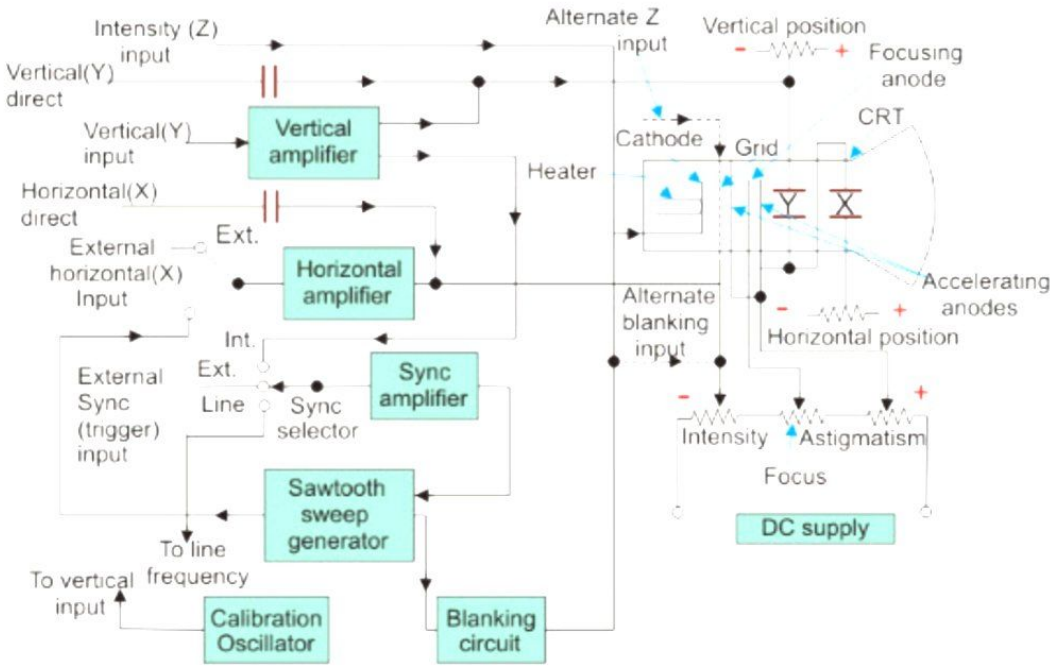
To complete this task we need various electrical signals and voltages. This provides the power supply circuit of the oscilloscope. Here we will use high voltage and low voltage. The low voltage is used for the heater of the electron gun to generate the electron beam. The high voltage is required for the cathode ray tube to speed up the beam. The normal voltage supply is necessary for other control units of the oscilloscope.

The horizontal and vertical plates are placed between the electron gun and the screen, thus it can detect the beam according to the input signal. Just before detecting the electron beam on the screen in the horizontal direction which is in X-axis a constant time-dependent rate, a time base generator is given by the oscillator. The signals are passed from the vertical deflection plate through the vertical amplifier. Thus, it can amplify the signal to a level will be provided the deflection of the electron beam.

If the electron beam is detected in the X-axis and the Y- axis a trigger circuit is given for the synchronizing these two types detections. Hence the horizontal deflection starts at the same point of the input signal.

Working of CRO

The following circuit diagram shows the ***basic circuit of a cathode ray oscilloscope***. In this, we will discuss important parts of the oscilloscope.



Working of CRO

Vertical Deflection System

The main function of this amplifier is to amplify the weak signal so that the amplified signal can produce the desired signal. To examine the input signals are penetrated to the vertical deflection plates through the input attenuator and number of amplifier stages.

Horizontal Deflection System

The vertical and horizontal system consists of horizontal amplifiers to amplify the weak input signals, but it is different to the vertical deflection system. The horizontal deflection plates are penetrated by a sweep voltage that gives a time base. By seeing the circuit diagram the sawtooth sweep generator is triggered by the synchronizing amplifier while the sweep selector switches in the internal position. So the trigger saw tooth generator gives the input to the horizontal amplifier by following the mechanism.Here we will discuss the four types of sweeps.

Recurrent Sweep

As the name, itself says that the saw tooth is respective that is a new sweep is started immodestly at the end of the previous sweep.

Triggered Sweep

Sometimes the waveform should be observed that it may not be predicted, thus the desired that the sweep circuit remains inoperative and the sweep should be initiated by the waveform under the examination. In these cases, we will use the triggered sweep.

Driven Sweep

In general, the drive sweep is used when the sweep is a free running but it is a triggered by the signal under the test.

Non-Saw Tooth Sweep

This sweep is used to find the difference between the two voltages. By using the non-sawtooth sweep we can compare the frequency of the input voltages.

Synchronization

The synchronization is done to produce the stationary pattern. The synchronization is between the sweep and the signal should measure. There are some sources of synchronization which can be selected by the synchronization selector. Which are discussed below.

Internal

In this the signal is measured by the vertical amplifier and the trigger is abstained by the signal.

External

In the external trigger, the external trigger should be present.

Line

The line trigger is produced by the power supply.

Intensity Modulation

This modulation is produced by inserting the signal between the ground and cathode. This modulation causes by brightening the display.

Positioning Control

By applying the small independent internal direct voltage source to the detecting plates through the potentiometer the position can be controlled and also we can control the position of the signal.

Intensity Control

The intensity has a difference by changing the grid potential with respect to the cathode.

Applications of CRO

- Voltage measurement
- Current measurement
- Examination of waveform
- Measurement of phase and frequency

Uses of CRO

In laboratory, the CRO can be used as

- It can display different types of waveforms
- It can measure short time interval
- In voltmeter, it can measure potential difference