



# ROHINI

COLLEGE OF ENGINEERING AND TECHNOLOGY

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## DEPARTMENT OF BIOMEDICAL ENGINEERING

### III Semester

### BM3301 SENSORS AND MEASUREMENTS

### UNIT – 5

#### 5.1 CRO-Block Diagram, CRT – vertical & horizontal deflection system

##### 5.1.1 Cathode Ray Oscilloscope (CRO):

The cathode ray oscilloscope (CRO) is a very useful and versatile laboratory instrument used for display, measurement and analysis of waveforms and other phenomena in electrical and electronic circuits.

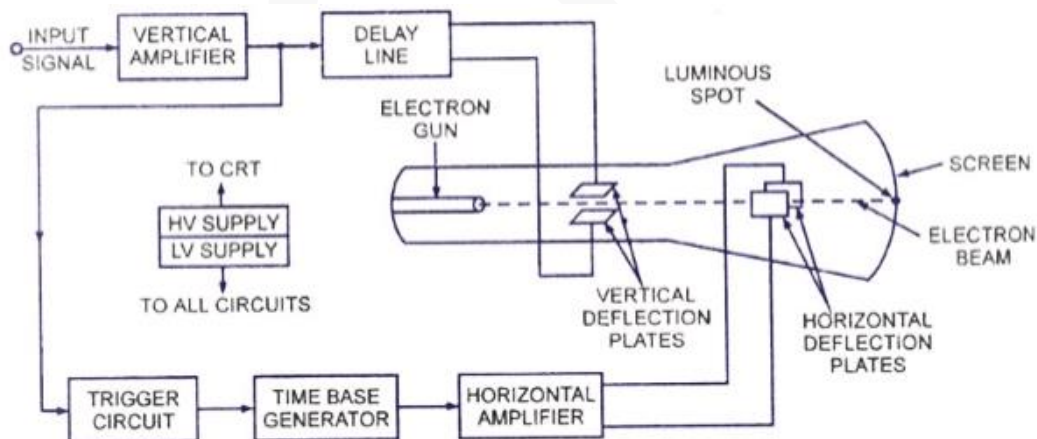


Figure - Block Diagram of General Purpose CRO

A general-purpose oscilloscope consists of the following parts:

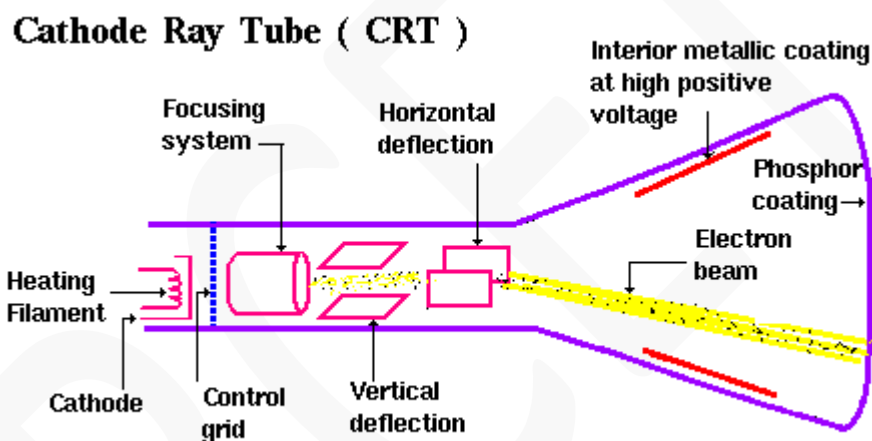
1. Cathode ray tube
2. Vertical amplifier
3. Delay line
4. Time base generator
5. Horizontal amplifier
6. Trigger circuit

## 7. Power supply

### Cathode Ray Tube:

The CRT is the heart of the oscilloscope. It consists of an electron gun that emits a focused electron beam. This beam is directed onto a phosphor-coated screen, producing a visible trace when it strikes the screen.

CRT stands for Cathode Ray Tube. It is a vacuum tube containing one or more electron guns and a phosphorescent screen, which is used in traditional computer's display and in Television. It works by moving electrons from the back of the tube towards the display screen where it collides with the phosphorous. When the electrons hit the phosphorous, they light up and are projected on the screen.



### Basic Components of CRT:

- **Electron Gun:** It generates the beam of electrons.
- **Anodes:** They accelerate the electrons.
- **Horizontal and Vertical Deflection Plates:** These plates produce the low frequency electromagnetic field required to adjust the direction of beam of electrons.
- **Fluorescent Screen:** It is made up of phosphor. It emits light when the electrons strike on it.

**Evacuated Glass Envelope:** It assembles or holds the whole cathode ray tube

**Vertical Amplifier:**

The vertical amplifier controls the vertical deflection of the electron beam on the screen. It allows the user to adjust the sensitivity and scale of the vertical axis, representing the amplitude or voltage of the input signal.

#### **Horizontal Amplifier:**

The horizontal amplifier controls the horizontal deflection of the electron beam. It determines the time base and allows the user to adjust the time scale along the horizontal axis.

#### **Time Base Generator:**

The time base generator controls the rate at which the electron beam moves horizontally across the screen. It determines the time duration represented by each horizontal division on the display.

#### **Trigger Circuit:**

The trigger circuit is responsible for synchronizing the horizontal sweep of the electron beam with the input signal. This ensures a stable and repetitive display of waveforms.

#### **Delay Line:**

As the name suggests, this circuit is used to delay the signal for a period of time in the vertical section of CRT. The input signal is not applied directly to the vertical plates because the part of the signal gets lost, when the delay time is not used. Therefore, the input signal is delayed by a period of time.

#### **Power Supply:**

The voltages required by CRT, horizontal amplifier, and vertical amplifier are provided by the power supply block. It is classified into two types -

(1) Negative high voltage supply

(2) Positive low voltage supply

The voltage of negative high voltage supply is from -1000V to -1500V. The range of positive voltage supply is from 300V to 400V

### Glass Envelope:

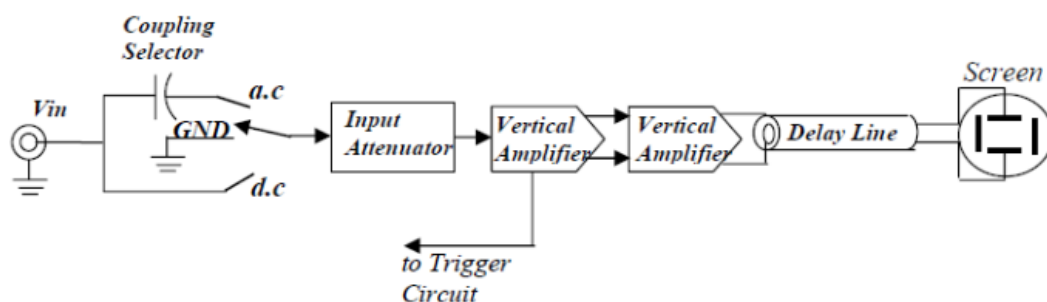
It is an extremely evacuated conical form of construction. The inside faces of the CRT among the neck as well as the display are covered through the aquadag. This is a conducting material that acts like a high-voltage electrode. The surface of the coating is connected electrically toward the accelerating anode to help the electron to be the center.

### Working Principle:

- The signal is to be viewed on the screen being applied across the Y-plates of CRT.
- To see the waveform of the input signal, it is essential to spread it horizontally from left to right, which is done by applying a saw-tooth voltage wave to X-plates.
- Under these conditions, the electron beam would move uniformly thereby graphing vertical vibrations of input signal with respect to time.
- Due to repetitive tracing of the viewed waveform, a continuous display is obtained because of persistence of vision.
- To get a stable stationary display on the screen, the input signal across the Y-plates must be synchronised with the horizontal sweeping of the beam.

### Vertical Deflection System:

The function of vertical deflection system is to provide an amplified signal of the proper level to drive the vertical deflection plates without introducing any appreciable distortion into the system. vertical amplifier is required to provide this desired gain from millivolt input to several hundred volt (peak-to-peak) output. Also, the vertical amplifier should not distort the input waveform and should have good response for entire band of frequencies to be measured.



This system is consists of the following elements:

- 1- Input coupling selector.
- 2- Input attenuator.
- 3- Preamplifier.
- 4- Main vertical amplifier.
- 5- Delay line.

### **Input Coupling Selector:**

Its purpose is to allow the oscilloscope more flexibility in the display of certain types of signals. For example, an input signal may be a d.c signal, an a.c signal, or a.c component superimposed on a d.c component.

There are three positions switch in the coupling selector (d.c, a.c, and GND). If an a.c position is chosen, the capacitor appears as an open circuit to the d.c components and hence block them from entering.

While the GND position ground the internal circuitry of the amplifier to remove any stored charge and recenter the electron beam.

### **Input Attenuators and Amplifiers:**

The combine operation of the attenuator, preamplifier and main amplifier together make up the amplifying portion of the system.

The function of the attenuator is to reduce the amplitude of the input signal by a selected factor and verse varies amplifier function.

### **Delay Line:**

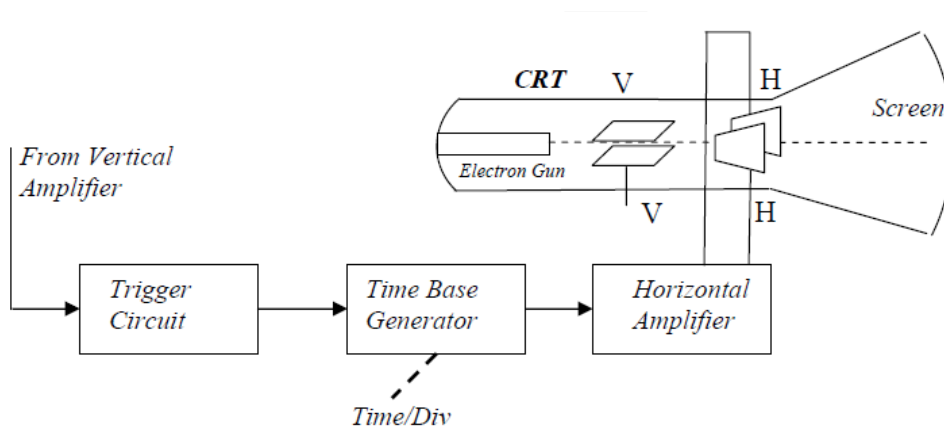
Since part of the input signal is picked off and fed to the horizontal deflection system to initiate a sweep waveform that is synchronized with the leading edge of the input signal.

So the purpose of delay is to delay the vertical amplified signal from reaching the vertical plates until the horizontal signal reach the horizontal plates to begin together at the same time on CRT screen.

### Horizontal Deflection System:

The horizontal deflection system of OSC consist of :

- 1- Trigger circuit.
- 2- Time base generator.
- 3- Horizontal amplifier.



*Horizontal Deflection System*

### Trigger and Time Base Generator:

- The most common application of an oscilloscope is the display of voltage variation versus time.
- To generate this type of display a saw tooth waveform is applied to horizontal plates.
- The electron beam being bent towards the more positive plate and deflected the luminous spot from left to right of the screen at constant velocity whilst the return or fly back is at a speed in excess of the maximum writing speed and hence invisible.
- The saw tooth or time base signal must be repetitively applied to the horizontal plates so that; the beam can retrace the same path rapidly enough to make the moving spot of light appear to be a solid line.

- To synchronise the time base signal applied to (X-plates) with input voltage to be measured which applied to vertical or (Y-plates) a triggering circuit is used.
- This circuit is sensitive to the level of voltage applied to it, so that when a predetermined level of voltage is reached a pulse is passed from the trigger circuit to initiate one sweep of the time base.
- In a practical oscilloscope the time base will be adjustable from the front panel control of scope.

### **Horizontal Amplifier:**

The horizontal amplifier is used to amplify the sweep waveform to the required level of horizontal plates operation.

### **Advantages of CRO:**

The **advantages of CRO** include the following.

- i. Cost and Timeline
- ii. Training requirements
- iii. Consistency & quality
- iv. Time efficiency
- v. Expertise & experience
- vi. Capacity for problem-solving
- vii. Hassle-free
- viii. Assurance for regulatory compliance
- ix. Voltage measurement
- x. Current measurement
- xi. Examination of waveform
- xii. Measurement of phase and frequency

### **Disadvantages of CRO:**

- i. These oscilloscopes are expensive as compared with other measuring devices like multimeters.
- ii. They are complicated to repair once it gets damaged.
- iii. These devices need complete isolation
- iv. These are huge, heavy and uses more power

- v. A lot of control terminals which is not so easy to understand at one instance But for easy of use, multiple channel capture and screen and waveform clarity one could go for Digital Storage Oscilloscope.

**Applications of CRO:**

- i. It can display different types of waveforms
- ii. It can measure the short time interval
- iii. In voltmeter, it can measure the potential difference.
- iv. Measurement of frequency
- v. CRO is used for research purposes. When scientists design a new circuit, they check the voltage, and current waveforms of each part of the circuit using the Cathode Ray Oscilloscope.

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