

Quadrant II – Transcript and Related Materials

Programme: Bachelor in Science (Third Year)

Subject: Physics

Paper Code: PYC 109

Paper Title: Instrumentation-Section II

Unit: 2

Module Name: CRT, CRO block diagram, vertical deflection system, vertical amplifier.

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Notes

CRT (Cathode Ray Tube)

The heart of the oscilloscope is the Cathode Ray Tube (CRT) which makes the applied signal visible by the deflection of a thin electron beam. The CRT consists of an electron gun that generates a narrow beam of electrons, vertical deflection plates V_1 and V_2 for deflecting the beam vertically, horizontal deflection plates H_1 and H_2 for deflecting the beam horizontally and a phosphor screen as seen in Fig.1 below.

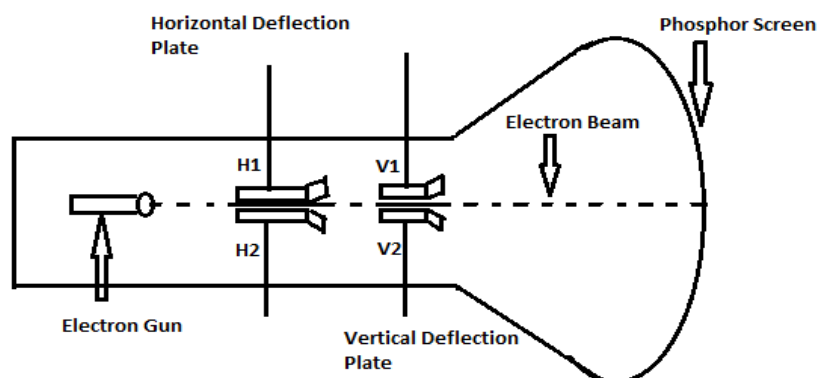


Fig.1: Basic diagram of a CRT.

When the plates are at zero voltage, the beam is midway between them and the spot is in the centre of the screen. When H_1 is made positive with respect to the cathode, it attracts the beam and the spot moves horizontally to the left. When H_2 is made positive with respect to the cathode, it attracts the beam and the spot moves horizontally to the right. When V_1 is made positive, the spot moves vertically upward and when V_2 is made positive, the spot moves vertically downward. In each of these deflections, the displacement of the beam and therefore the distance travelled by the spot is proportional to the voltage applied at the plates.

Basic CRO block diagram:

The block diagram of a general purpose CRO is as shown in Fig.2 below.

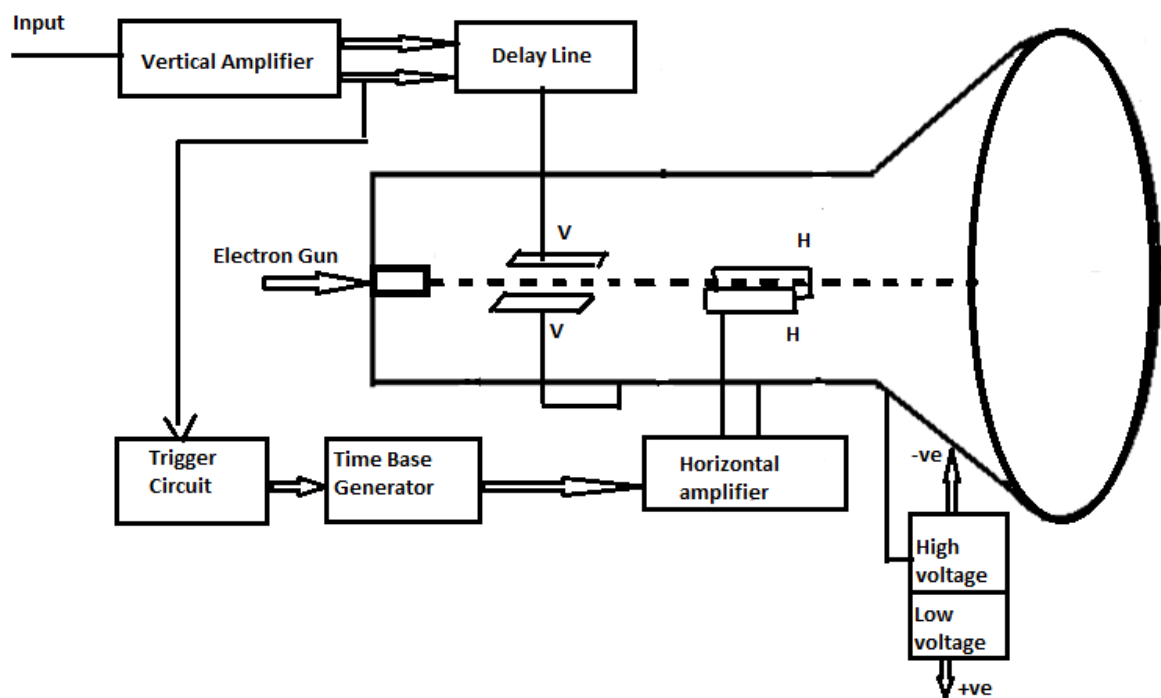


Fig.2: Basic CRO block diagram.

It consists of the following:

1. CRT
2. Vertical amplifier
3. Delay line
4. Time base
5. Horizontal amplifier
6. Trigger circuit
7. Power supply.

The function of each of the blocks is as follows:

1. CRT: This is a cathode ray tube which emits a thin beam of electrons that strikes a phosphor screen to provide a visual display of the signal.
2. Vertical amplifier: It is a wide band amplifier used to amplify signals in the vertical section.
3. Delay Line: It is used to delay the signal by a certain time in the vertical section.
4. Time Base: It is used to generate a sawtooth voltage required to deflect the beam in the horizontal section.
5. Horizontal amplifier: It is used to amplify the sawtooth voltage before it is applied to the horizontal deflection plates.
6. Trigger circuit: It is used to convert the incoming signal into trigger pulses so that the input signal and the sweep frequency are synchronized.
7. Power supply: Consists of a high voltage supply to the CRT and a lower voltage supply to the rest of the circuitry.

Vertical Deflection System:

The function of the vertical deflection system is to provide an amplified signal of a proper level to drive the vertical deflection plates. Such a system can be seen in Fig. 3 below. The input signal may be an ac or dc.

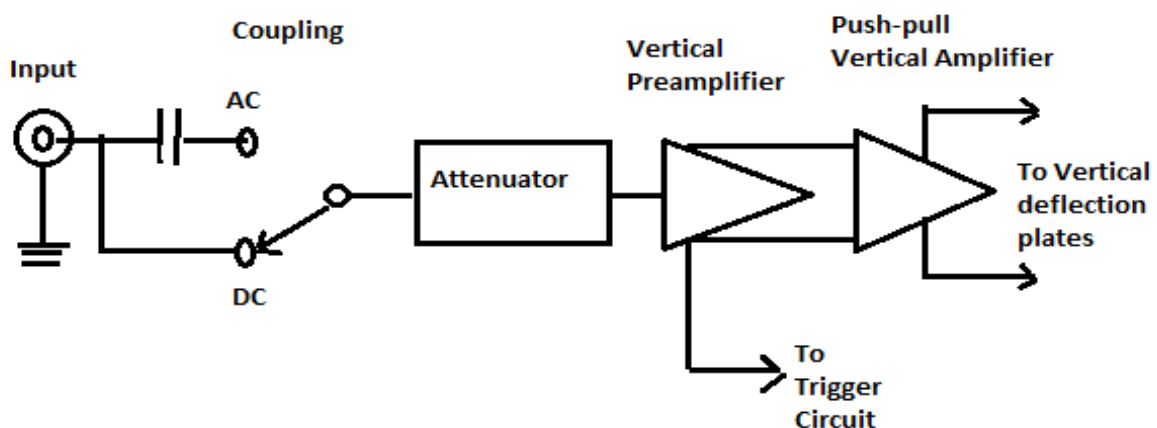


Fig.3: Vertical deflection system.

The attenuator sets the sensitivity of the oscilloscope in the common 1-2-5 sequence. As an example, it can provide for 10, 20, 50, 100, 200mV per centimetre. The input attenuator must provide the correct 1-2-5 sequence

attenuation while maintaining constant input impedance as well as maintaining both, the input impedance and attenuation over the frequency range for the oscilloscope is designed for. Different types of attenuators exist such as a resistive divider attenuator, compensated attenuator etc. The vertical amplifier consists of several stages with a fixed overall sensitivity or gain expressed in V/div. The fixed gain has an advantage that the amplifier can be easily designed to meet the requirements of stability (gain) and bandwidth. In the figure shown above, the vertical amplifier may consist of a vertical preamplifier and a push-pull vertical amplifier. A part of the input signal is directed towards the vertical deflection plates while the remaining part of the signal is directed towards the trigger circuit in the horizontal deflection system.

Vertical amplifier:

The sensitivity (gain) and frequency bandwidth (BW) response characteristics of the oscilloscope are mainly determined by the Vertical Amplifier. Since the gain bandwidth product is constant, to obtain a greater sensitivity, the bandwidth is narrowed and vice-versa. The block diagram of a vertical amplifier is shown in Fig. 4 below.

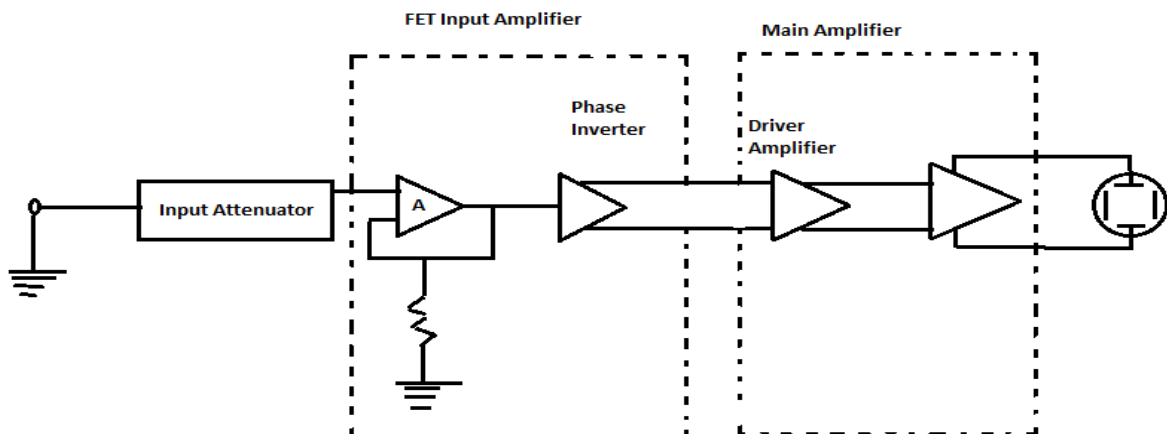


Fig.4: Vertical amplifier.

The vertical amplifier consists of several stages, with fixed overall sensitivity or gain expressed in V/div. The first element of the preamplifier is the input stage, often consisting of a FET source follower whose high input impedance isolates the amplifier from the attenuator.

The push-pull amplifier stage delivers equal voltages of opposite polarity to the vertical deflection plates of the CRT.