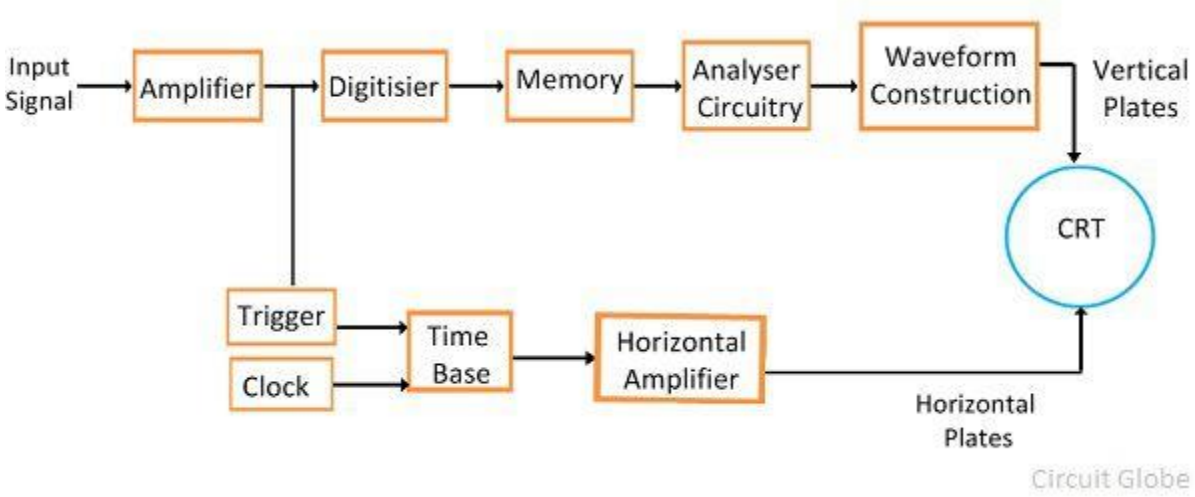
Digital Storage Oscilloscope

Definition: The **digital storage oscilloscope** is defined as the oscilloscope which **stores and analysis the signal digitally**, i.e. in the form of 1 or 0 preferably storing them as **analogue signals**. The digital oscilloscope takes an input signal, store them and then display it on the screen. The digital oscilloscope has advanced features of storage, triggering and measurement. Also, it **displays** the signal **visually** as well as **numerically.**

Working Principle of Digital Storage Oscilloscope

The digital oscilloscope digitises and stores the input signal. This can be done by the use of **CRT** (Cathode ray tube) and **digital memory**. The block diagram of the basic digital oscilloscope is shown in the figure below. The digitisation can be done by taking the sample input signals at periodic waveforms.



The maximum frequency of the signal which is measured by the digital oscilloscope depends on the two factors. Theses factors are the

1. Sampling rate
2. Nature of converter.

Sampling Rate – For safe analysis of input signal the sampling theory is used. The sampling theory states that the sampling rate of the signal must be twice as fast as the highest frequency of the input signal. The sampling rate means analogue to digital converter has a high fast conversion rate.

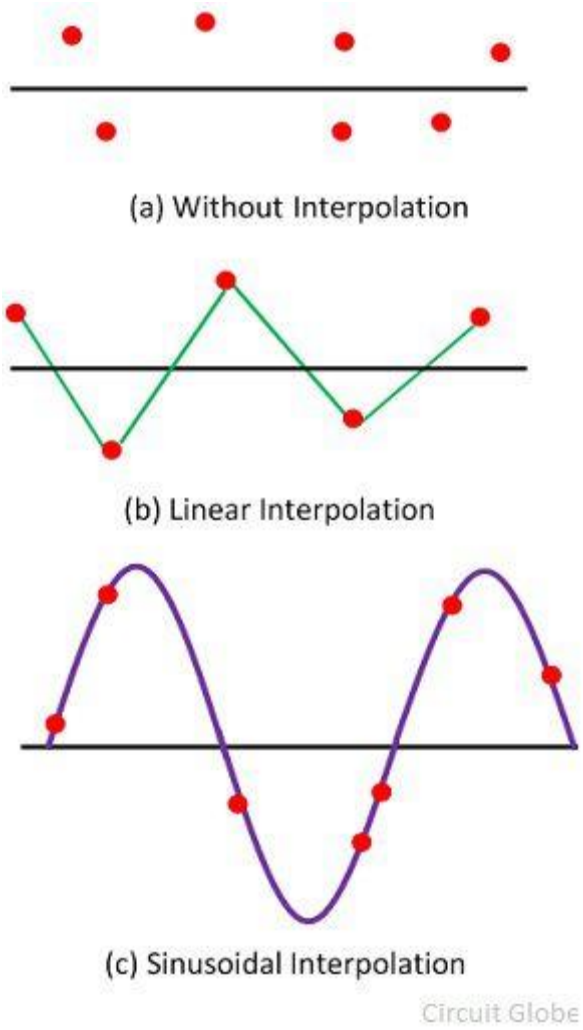
Converter – The converter uses the expensive flash whose resolution decreases with the increases of a sampling rate. Because of the sampling rate, the bandwidth and resolution of the oscilloscope are limited.

The need of the analogue to digital signal converters can also be overcome by using the shift register. The input signal is sampled and stored in the shift register. From the shift register, the signal is slowly read out and stored in the digital form. This method reduces the cost of the converter and operates up to 100 megasample per second.

The only disadvantage of the digital oscilloscope is that it does not accept the data during digitisation, so it had a blind spot at that time.

Waveform Reconstruction

For visualising the final wave, the oscilloscopes use the technique of inter-polarization. The inter-polarization is the process of creating the new data points with the help of known variable data points. Linear interpolation and sinusoidal interpolation are the two processes of connecting the points together.



In interpolation, the lines are used for connecting the dot together. Linear interpolation is also used for creating the pulsed or square waveform. For sine waveform, the sinusoidal interpolation is utilised in the oscilloscope.

Applications

The applications of the DSO are

- It checks faulty components in circuits
- Used in the medical field
- Used to measure capacitor, inductance, time interval between signals, frequency and time period
- Used to observe transistors and diodes V-I characteristics
- Used to analyze TV waveforms

- Used in video and audio recording equipment’s
- Used in designing
- Used in the research field
- For comparison purpose, it displays 3D figure or multiple waveforms
- It is widely used an oscilloscope

Advantages

The advantages of the DSO are

- Portable
- Have the highest bandwidth
- The user interface is simple
- Speed is high

Disadvantages

The disadvantages of the DSO are

- Complex
- High cost

CRO Probes

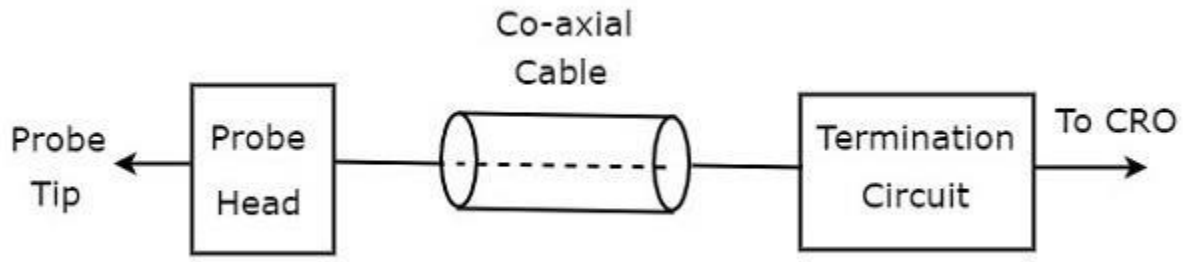
We can connect any test circuit to an oscilloscope through a probe. As CRO is a basic oscilloscope, the probe which is connected to it is also called **CRO probe**.

We should select the probe in such a way that it should not create any loading issues with the test circuit. So that we can analyze the test circuit with the signals properly on CRO screen.

CRO probes should have the following **characteristics**.

- High impedance
- High bandwidth

The **block diagram** of CRO probe is shown in below figure.



As shown in the figure, CRO probe mainly consists of three blocks. Those are probe head, co-axial cable and termination circuit. Co-axial cable simply connects the probe head and termination circuit.

Types of CRO Probes

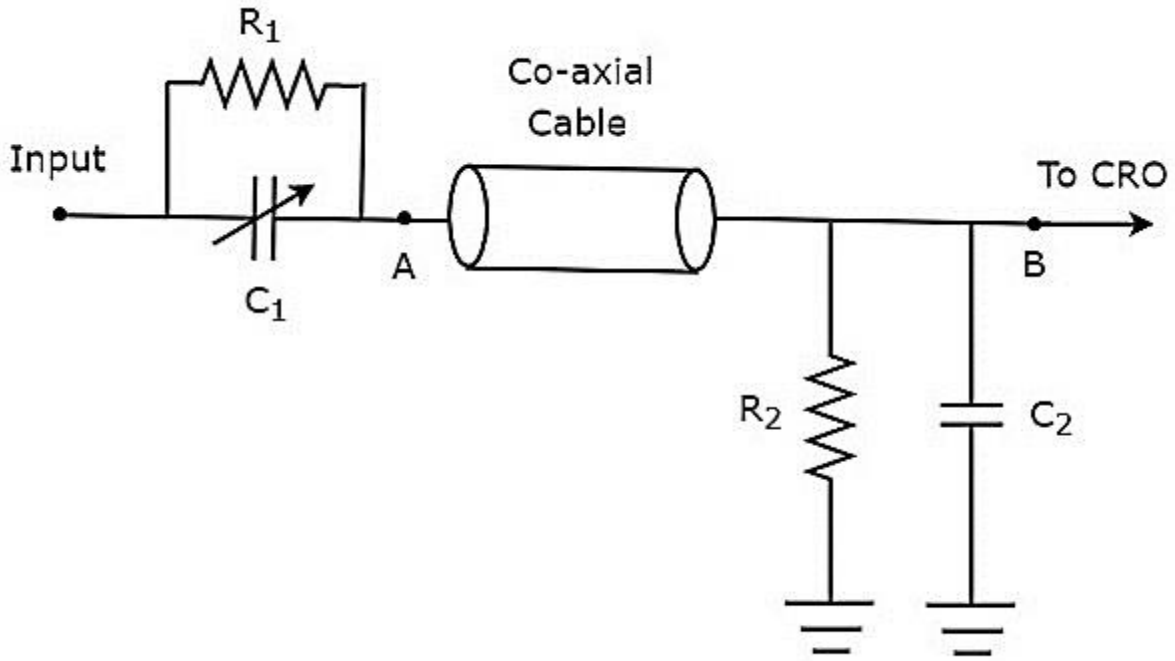
CRO probes can be classified into the following **two types**.

- Passive Probes
- Active Probes

Now, let us discuss about these two types of probes one by one.

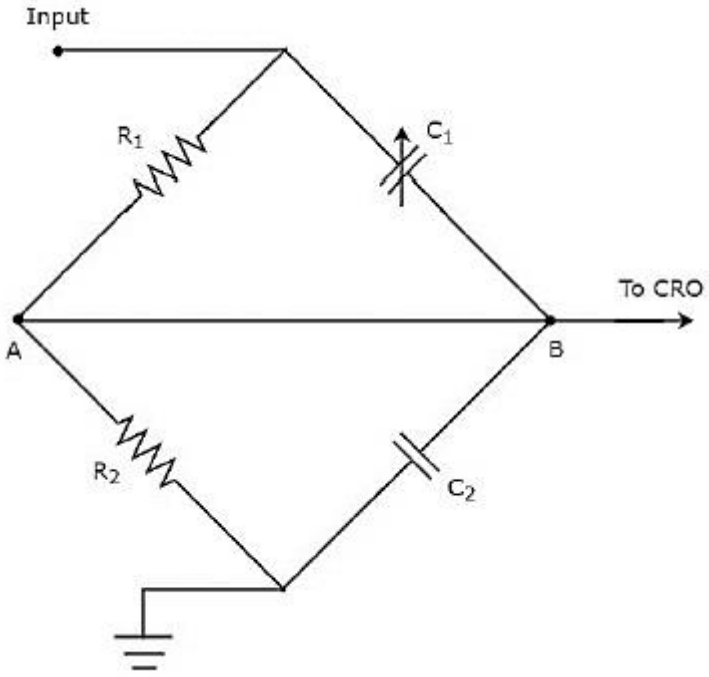
Passive Probes

If the probe head consists of passive elements, then it is called **passive probe**. The circuit diagram of passive probe is shown in below figure.



As shown in the figure, the probe head consists of a parallel combination of resistor, R_1 and a variable capacitor, C_1. Similarly, the termination circuit consists of a parallel combination of resistor, R_2 and capacitor, C_2.

The above circuit diagram is modified in the form of **bridge circuit** and it is shown in below figure.



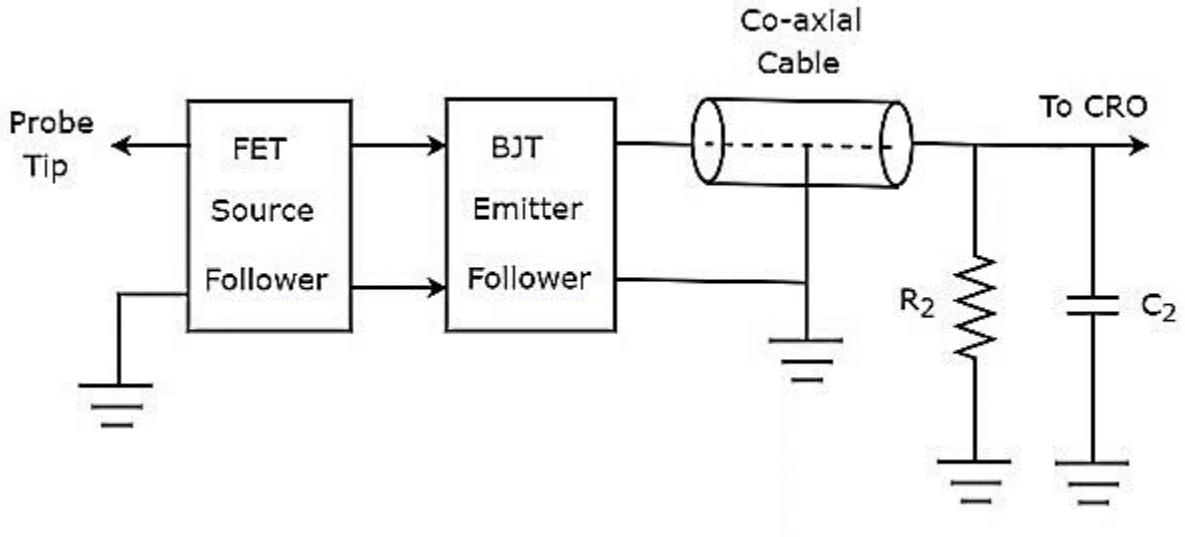
We can balance the bridge, by adjusting the value of variable capacitor, C_1.

consider the following **balancing condition of AC bridge**.

$$Z_1Z_4=Z_2Z_3$$

Active Probes

If the probe head consists of active electronic components, then it is called **active probe**. The block diagram of active probe is shown in below figure.



As shown in the figure, the probe head consists of a FET source follower in cascade with BJT emitter follower. The FET source follower provides high input impedance and low output impedance. Whereas, the purpose of BJT emitter follower is that it avoids or eliminates the impedance mismatching.

The other two parts, such as co-axial cable and termination circuit remain same in both active and passive probes.