UNIT 5 **OSCILLOSCOPES**

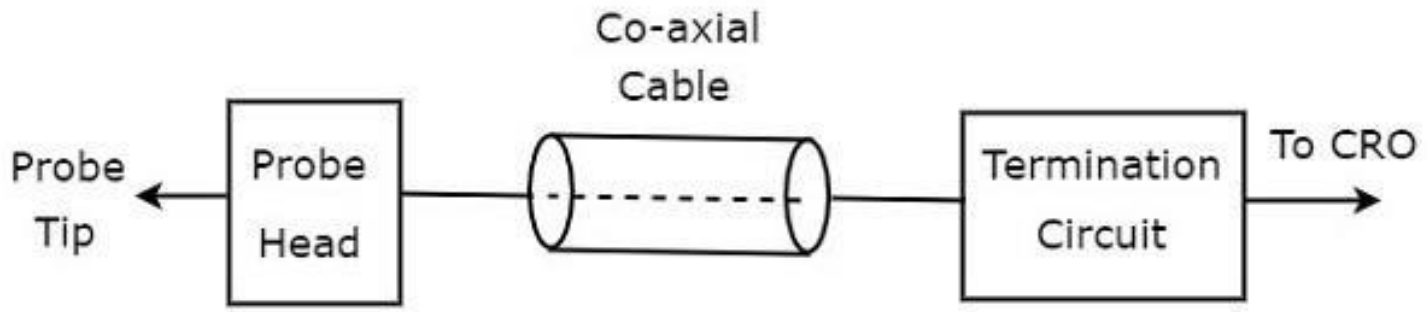
Cathode ray oscilloscopes - block diagram, Cathode ray tube, CRT circuits, Vertical Deflection system, Delay line, Multiple trace, Horizontal Deflection system, Oscilloscope probe and transducers, Oscilloscope technique, Special oscilloscopes- Analog and Digital Storage oscilloscope.

Oscillation Probes

Oscillation Probes

- **Any test circuit can be connected to an oscilloscope through a probe.**
- As CRO is a basic oscilloscope, the probe which is connected to it is also called **CRO probe**.
- The probe shall be selected in such a way that it should not create any loading issues with the test circuit.
- So that we can analyse 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.

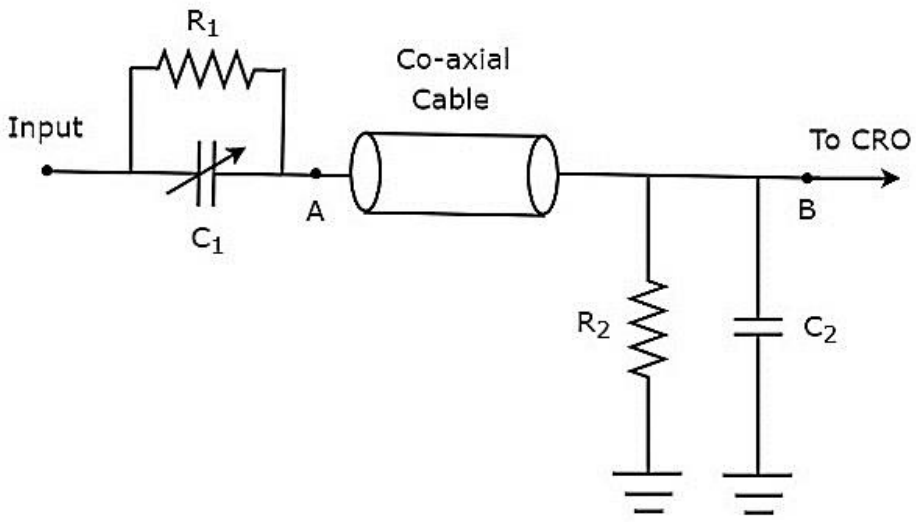
Types of CRO Probes

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

- Passive Probes
- Active Probes

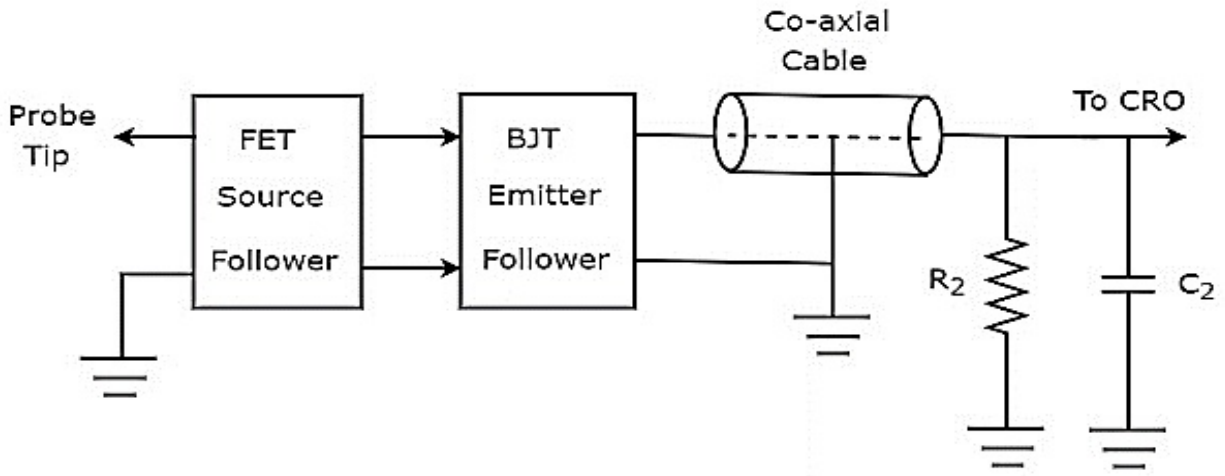
Passive Probes

- **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.**



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.

Transducers

- The CRO is mainly operated on voltages.
- Thus, **the other physical quantity like current, strain, acceleration, pressure, are converted into the voltage with the help of the transducer and thus represent on a CRO.**
- It is also used for knowing the waveforms, transient phenomenon, and other time-varying quantity from a very low-frequency range to the radio frequencies.

A transducer is an electronic device that converts energy from one form to another. Common examples include microphones, loudspeakers, thermometers, position and pressure sensors, and antenna. Although not generally thought of as transducers, photocells, LEDs (light-emitting diodes), and even common light bulbs are transducers.

1. Loudspeakers, earphones – converts electrical signals into sound (amplified signal → magnetic field → motion → air pressure)

2. Microphones – converts sound into an electrical signal (air pressure → motion of conductor/coil → magnetic field → electrical signal)[2]

3. Thermocouples – converts relative temperatures of metallic junctions to electrical voltage

4. Antennae – converts propagating electromagnetic waves to and from conducted electrical signals

5. Light-emitting diodes – converts electrical power into incoherent light

Special Oscilloscopes – Analog and Digital Storage Oscilloscope

Oscilloscope

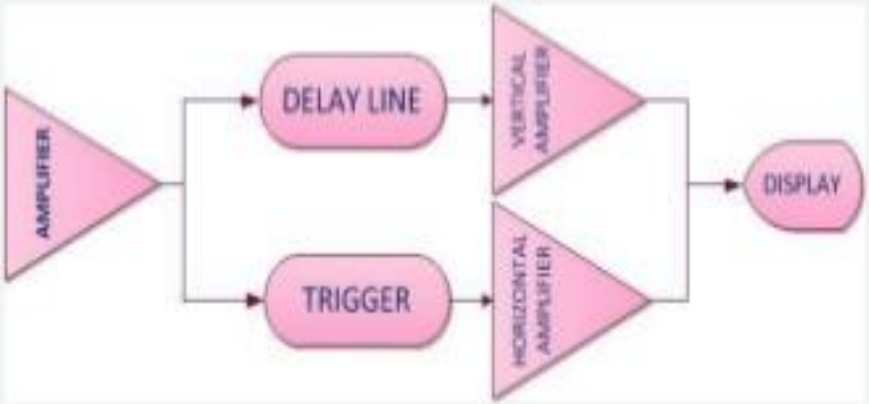
The oscilloscope is the most powerful instrument in our arsenal of electronic instruments. It is widely used for measurement of time-varying signals. Any time you have a signal that varies with time - slowly or quickly - you can use an oscilloscope to measure it - to look at it, and to find any unexpected features in it.

There are various types and models available. But we discuss here about two types of Oscilloscope. Analog and Digital oscilloscope.

Analog Oscilloscope

In analog technology, a wave is recorded or used in its original form. Analog oscilloscope uses the cathode ray tube (CRT). This form of display was for many years the only viable form of display that could be used to display images.

Accordingly it was used in television sets for many years, although other forms of display including LCDs, LEDs and many other format are now used, but these all require digital signal inputs to the display.



Analogue Scope

Works: The analogue scope uses the cathode ray tube to display signals in both X (horizontal) and Y (vertical) axes. Typically the Y axis is the instantaneous value of the incoming voltage and the X axis is ramp waveform.

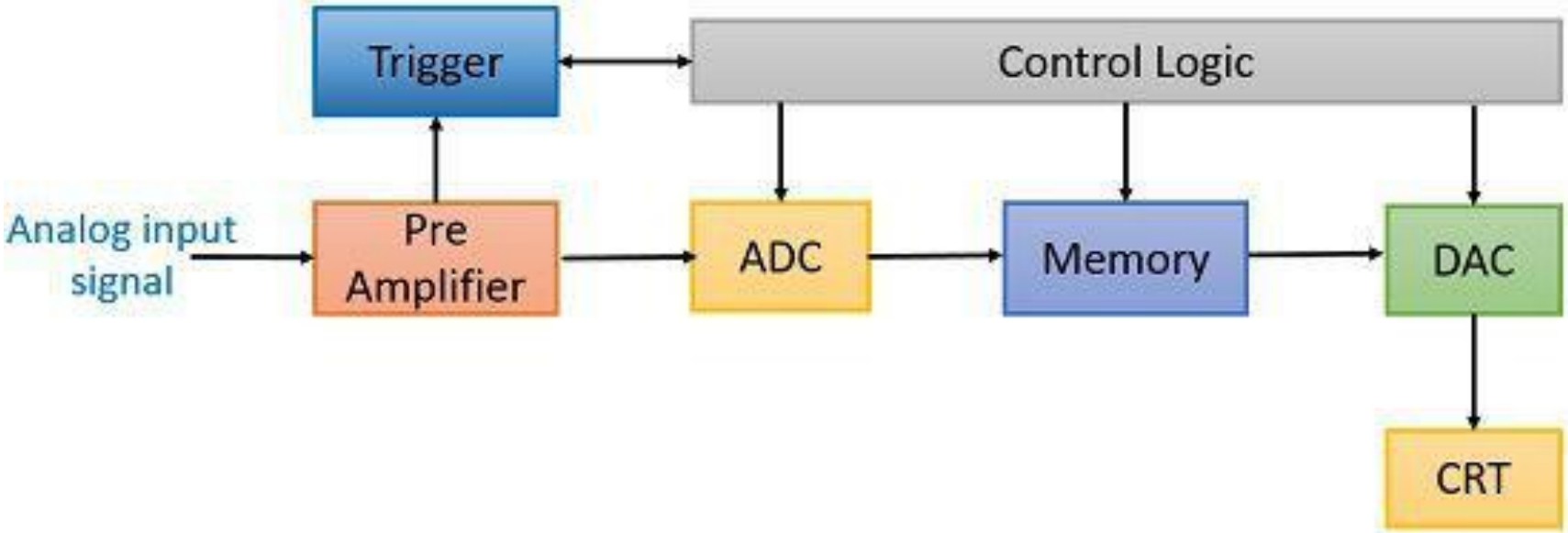
As the ramp waveform increases in voltage so the trace moves across the screen in a horizontal direction. When it reaches the end of the screen, the waveform returns to zero and the trace moves back to the beginning.

Advantages: Analog scopes are generally much less expensive than their digital counterparts. The technology is well established and is therefore less expensive than leading edge technologies where large levels of development costs have to be recovered in addition to the component and production costs being higher

Analog oscilloscopes are able to provide a good level of performance that is more than adequate for many laboratory and service situations. It is often found that analog oscilloscopes may be available in an equipment store when all the other digital scopes are in use. Provided that their performance is satisfactory, the analogue option may provide an ideal way forwards.

Digital Storage Oscilloscope

Digital Storage Oscilloscope is an instrument that analyses the signal digitally and stores the data in the electronic digital memory. By examining the stored traces in memory, it can display visual as well as numerical values.



Block diagram of Digital Storage Oscilloscope

Electronics Coach

Working of DSO

- From the figure shown , we can see that an analog input signal is fed into the pre-amplifier unit. This unit amplifies the input so as to raise the level of the amplitude of the signal.
- This signal is then fed to an analog to digital converter (ADC) and the trigger detector. As the voltage crosses the **threshold value**, the device starts recording on the application of the signal sent by the trigger unit.
- The output of the pre-amplifier is sampled by the ADC at regular intervals. The **digital output** provided by the ADC is **stored in memory** at consecutive locations. The recording of signal continues until the memory is full.
- The **DAC** employed in the circuit **produces analog signal** to be displayed in CRT.

- Any further changes in the applied input, re-triggers the oscilloscope which causes the memory to reset. That means the memory is overwritten with the new upcoming data unless the system is in **HOLD mode**.
- By the application of **HOLD mode**, the signal traces can be analysed by the user according to the user's choice.
- The **size of the memory** unit determines the **number of samples stored** in it. One can alter the length of recording by changing the sampling frequency of ADC.
- In the case of the digital oscilloscope, many different input channels are used. But, the memory available to each channel gets reduced. When all the channels share a common store. This is done through multiplexing.

Advantages of DSO

1.They possess infinite storage time.

2.It can be easily operated.

3.Digital storage oscilloscope allows flexible display property.

Applications of DSO

1.It is used in audio and video recording.

2.It is used in radio broadcasting for signal testing.

3.In circuit debugging, it is used for testing of the voltage of the signal.

In case of digital storage oscilloscope, the replacement of internal equipment is more **economical**. This is so because it employs CRT which is cheaper than analog storage oscilloscope.

Analog Oscilloscope

Vs

Digital Oscilloscope

S. No.	Digital Storage Oscilloscope (DSO)	Analog Oscilloscope (Simple CRO)
1	DSO stores and analyzes the signals digitally.	Analog oscilloscope cannot store signals.
2	DSO has advanced triggering circuit.	Analog oscilloscope used normal triggeri circuit.
3	DSO has memory.	Simple analog oscilloscope does not ha any memory.
4	Manipulations are possible at any time because of read out memory is available.	Manipulations are not possible at any ti because there are no read out memory.
5	DSO has USB 2.0 port.	It does not have USB 2.0 port.
6	Computer and Printer is attached using USB port.	Not applicable.