UNIT-4

1. Explain briefly the Basic Features of a CRT?

Ans:

Electrostatic CRTs are available in a number of types and sizes to suit individual requirements. The important features of these tubes are as follows.

1. Size: Size refers to the screen diameter. CRTs for oscilloscopes are available in sizes of 1, 2, 3, 5, and 7 inches. 3 inches is most common for portable instruments

For example a CRT having a number 5GPI . The first number 5 indicates that it is a 5 inch tube.

Both round and rectangular CRTs are found in scopes today. The vertical viewing size is 8 cm and horizontal is l0 cm.

2. Phosphor: The screen is coated with a fluorescent material called phosphor. This material determines the color and persistence of the trace, both of which are indicated by the phosphor.

The trace colors in electrostatic CRTs for oscilloscopes ale blue, green and But green. White is used in TVs. and blue-white, orange, and yellow are used for radar Persistence is expressed as short, medium and long. This refers to the length of time the trace remains on the screen after the signal has ended.

The phosphor of the oscilloscope is designated as follows.

Pl --Green medium

P2--Blue green medium

P5--Blue very short

P11--Blue short

These designations are combined in the tube type number. Hence 5GPl is a 5 inch tube with a medium persistence green trace.

Medium persistence traces are mostly used for general purpose applications

Long persistence traces are used for transients, since they keep the fast transient on the screen for observation after the transient has disappeared.

Short persistence is needed for extremely high speed phenomena, to prevent smearing and interference caused when one image persists and overlaps with the next one.

P11 phosphor is considered the best for photographing from the CRT screen.

3. Operating Voltages: the CRT requires a heater voltage of 6'3 volts ac or dc at 600mA.

Several dc voltages are listed below. The voltages vary with the type of tube used.

(i) Negative grid (control) voltage 14 V to - 200 V.

(ii) Positive anode no. 1 (focusing anode) -100 V to - ll00 V

(iii) Positive anode no. 2 (accelerating anode) 600 V to 6000 V

(iv) Positive anode no. 3 (accelerating anode) 200 v to 20000 V in some cases

4. Deflection Voltages: Either ac or dc voltages will deflect the beam. The distance through which the spot moves on the screen is proportional to the dc, or peak ac amplitude. The deflection sensitivity of the tube is usually stated as the dc voltage (or peak ac voltage) required for each cm of deflection of the spot on the screen

5. Viewing Screen: The viewing screen is the glass face plate, the inside wall of which is coated with phosphor. The viewing screen is a rectangular screen having graticules marked on it. The standard size used nowadays is 8 cm x l0 cm (8 cm on the vertical and 10 cm on horizontal). Each centimeter on the graticule corresponds to one division (div). The standard phosphor color use d nowadays is blue

2. Explain about Triggered Sweep CRO?

Ans: The continuous sweep is of limited use in displaying periodic signals of constant frequency and amplitude. When attempting to display voice or music signals, the pattern falls in and out of sync as the frequency and amplitude of the music varies resulting in an unstable display.

A triggered sweep can display such signals, and those of short duration, e.g. narrow pulses. In triggered mode, the input signal is used to generate substantial pulses that trigger the sweep. Thus ensuring that the sweep is always in step with the signal that drives it. As shown in Fig. 2.1

resistance R3 and R 4 form a voltage divider such that the voltage Vo at the cathode of the diode is below the peak voltage i/o for UJT conduction. When the circuit is switched on, the UJT is in the non-conducting stage, and C, charges exponentially through RT. towards VBB until the diode becomes forward biased and conducts; the capacitor voltage never reaches the peak voltage required for UJT conduction but is clamped at Vo. If now a –ve pulse of sufficient amplitude is applied to the base and the peak voltage Vp is momentarily lowered, the UJT fires. As a result, capacitor C. discharges rapidly through the UJT until the maintaining voltage of the UJT is reached; at this point the UJT switches off and capacitor CT charges towards VBB, until it is clamped again at V_D fig 2.2 shows the output waveform

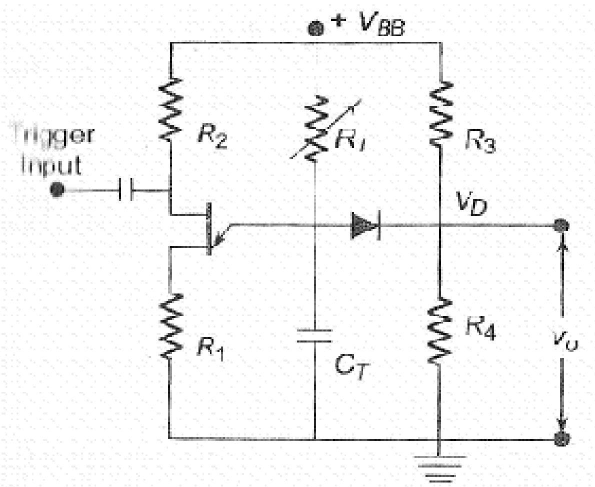


fig 2.1 Triggered sweep

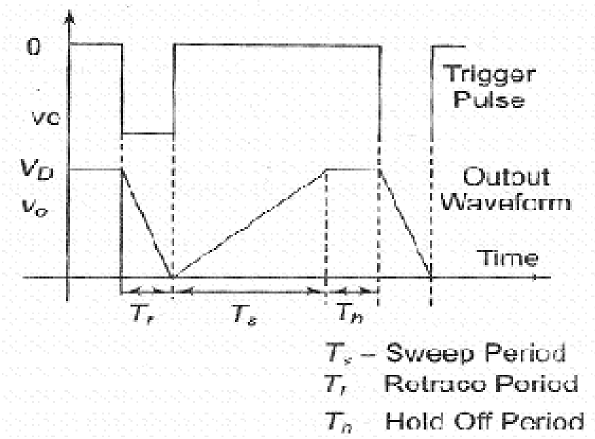
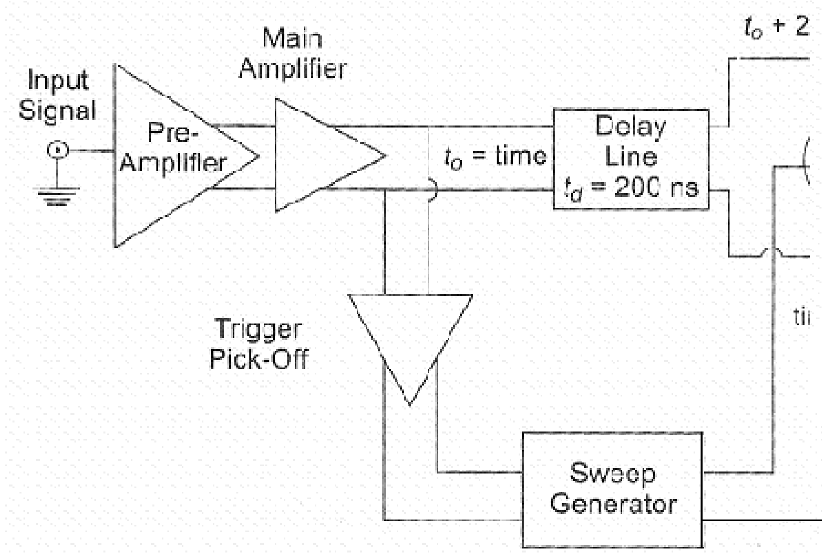


fig 2.2 Ouput Wave form

3. Explain briefly about delay line in triggered sweep circuit?

Ans: Fig 3.1 indicates the amplitude of the signal raise time and the relative position of the sweep generator output signal.



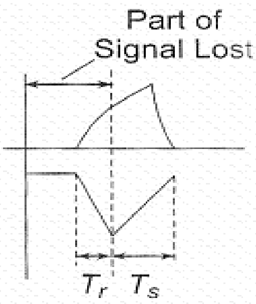


fig 3.2 Delay Line Wave Form

fig 3.1 Delay Line Circuit

The diagram shows that when the delay line is not used, the initial part of the signal is lost and only part of the signal is displayed. To counteract this disadvantage the signal is not applied directly to the vertical plates but is passed through a delay line circuit, as shown in Fig.7.13. This gives time for the sweep to start at the horizontal plates before the signal has reached the vertical plates. The trigger pulse is picked off at a time t0 after the signal has passed through the main amplifier. The sweep generator delivers the sweep to the horizontal amplifier and the sweep starts at the HDP at time t0 + 80 ns. Hence the sweep starts well in time, since the signal arrives at the VDP at time t0 + 200 ns

4. Explain briefly about the Vertical amplifier and Horizontal deflecting system?

Ans: The sensitivity (gain) and frequency bandwidth (B.W) response characteristics of the oscilloscope are mainly determine by the vertical amplifier .Since the gain-B W. product is constant, to obtain a greater sensitivity the B.W. is narrowed, or vice-versa.

Some oscilloscopes give two alternatives, switching to a wide bandwidth position, and switching to a high sensitivity position.

Block Diagram of a Vertical Amplifier The block diagram of a vertical amplifier is a shown fig

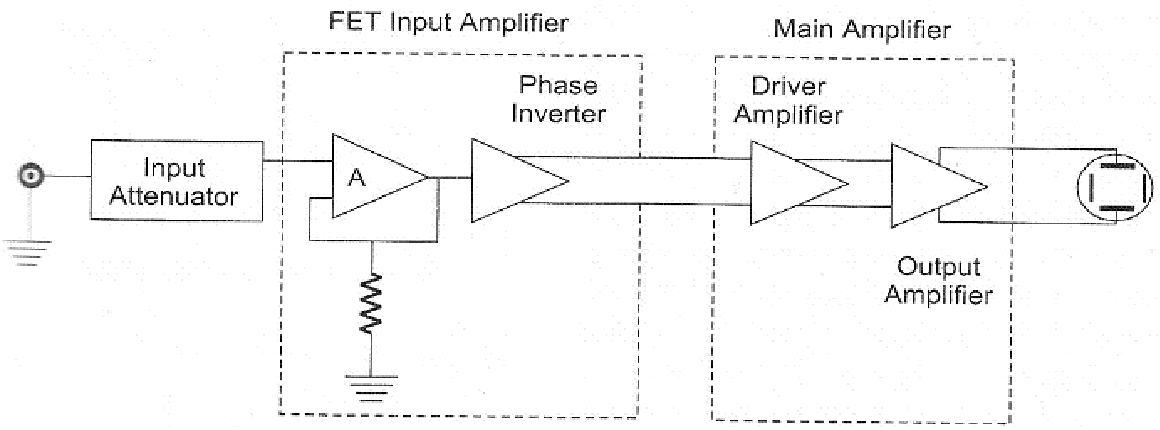


fig 4.1 Vertical Amplifier

4.1

The vertical amplifier consists of several stages, with fixed overall sensitivity gain expressed in V/div. The advantage of fixed gain is that the amplifier can be more easily designed to meet the requirements of stability and B.W. The vertical amplifier is kept within its signal handling capability by proper selection the input attenuator switch. The first element of the pre-amplifier is the input stage, often consisting of a FET source follower whose high input impedance isolates the amplifier from the attenuator.

This FET input stage is followed by a BJT emitter follower, to match the medium impedance of FET output with the low impedance input of the phase inverter.

This phase inverter provides two anti phase output signals which are required operate the push-pull output amplifier. The push-pull output stage delivers equal signal voltages of opposite polarity to the vertical plates of the CRT. The advantages of push-pull operation in CRO are similar to those obtained from push-pull operation in other applications; better voltage cancellation ran the source or power supply (i.e. dc), even harmonic suppression, especially large

2nd harmonic is cancelled out, and greater power output per tube as a suit of even harmonic cancellation. In addition, a number of defocusing and non linear effects are reduced, because neither plate is at ground potential.

HORIZONTAL DEFLETING SYSTEM: The horizontal deflecting system consist of a time base Generator and an output amplifier.

Sweep or Time Base Generator

A continuous sweep CRO using a UJT as a time base generator is shown in Fig. 7.8. The UJT is used to produce the sweep. When the power is first applied, the UJT is off and the CT charges exponentially through RT. The UJT emitter voltage VE rises towards VBB and when VE reaches the peak voltage VP, as shown in Fig. 4.3, the emitter to base '1' (B1) diode becomes forward biased and the UJT triggers ON. This provides a low resistance discharge path and the capacitor discharges rapidly. The emitter voltage VE reaches the minimum value rapidly and the UJT goes OFF. The capacitor recharges and the cycle repeats.

To improve sweep linearity, two separate voltage supplies are used, a low voltage supply for UJT and a high voltage supply for the RTCT circuit.

RT is used for continuous control of frequency within a range and CT is varied or changed in steps for range changing. They are sometimes called as timing resistor and timing capacitor respectively.

The sync pulse enables the sweep frequency to be exactly equal to the input signal frequency, so that the signal is locked on the screen and does not drift.

5. Explain the Basic principal involved in Signal Display Unit?

Ans: The amplitude of a voltage may be directly measured on a calibrated viewing screen from the length of the straight line trace it produces .This is entirely satisfactory for dc voltage.

But the straight line tells little, or practically nothing, about the waveform of an ac voltage, pulsating voltage or transient. What is required is a graph of the voltage traced on the screen by the ac spot (a graph of amplitude versus time)

To obtain such a display the signal voltage is applied to the vertical plates (directly or through the vertical amplifier) and it moves the spot vertically I positions, corresponding to the instantaneous values of the signal. Simultaneous the spot is moved horizontally by a sweep voltage applied to the horizontal plates .The combined action of these two voltages causes the spot to produce a trace on the screen. The horizontal sweep voltage produces the time base by moving the spot horizontally with time, while the signal moves the spot vertically in proportional to the voltage at a particular instant of time.

There are two important sweep generator requirements:

1. The sweep must be linear (the sweep voltage must rise linearly to the maximum value required for full screen horizontal deflection of the spot).

2. The spot must move in one direction only, i.e. from left to right only, else the signal will be traced backwards during the return sweep. This means that the sweep voltage must drop suddenly after reaching its maximum value. These requirements call for a sweep voltage having a linear saw tooth waveform, as shown in Fig. 5.1.

Now at time t0, the sweep voltage is - E2, and the negative horizontal voltage moves the spot to point 1 on the screen. At this instant, the signal voltage is 0, so the spot rests at the left end of the zero line on the screen.

At time t1 the linearly increasing saw tooth reaches – E1 which, being more positive than - E2, moves the spot to the screen, point 2. At this instant, the signal voltage is e, the +ve peak value, so the point represents its maximum upward deflection of the spot. At time t2, the saw tooth voltage is 0, there is no horizontal deflection and the spot is at the centre, point 3. At this instant the signal voltages is 0V.so, there is no vertical deflection either. At time t3, the saw tooth voltage is +E1 moving the spot to point 4.

At this instant, the signal is - e, the -ve peak value, so point 4 is the maximum downward deflection of the spot. At time t4, the saw tooth voltage is + E2, moving the spot to point 5. Now the signal voltage is 0, so the spot is not vertically reflected. Between t4 and t5, the saw tooth voltage falls quickly

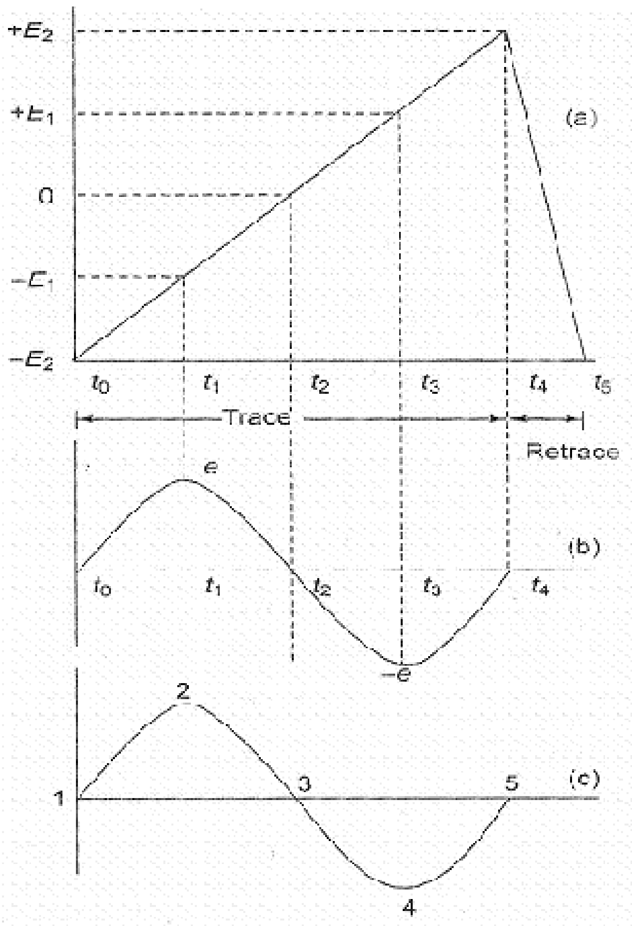


fig 5.1 Waveform of sweep voltage

through 0 to its initial value of - E2, snapping the spot back to point 1, in time to sweep forward on the next cycle of signal voltage. When sweep and signal frequencies are equal, a single cycle appears on the screen, when the sweep is lower than the signal, several cycles appear (in the ratio of the two frequencies), and when sweep is higher than signal, less than one cycle appears. The display is stationary only when the two frequencies are either equal or integral multiples of each other. At other frequencies the display will drift horizontally. A saw tooth sweep voltage is generated by a multi vibrator, relaxation oscillator or pulse generator. The upper frequency generated by internal devices in the oscilloscope is 50-100 kHz in audio instruments, 500-1000 kHz in TV service instruments and up to several MHz in high quality laboratory instruments. In some oscilloscopes the sweep is calibrated in Hz or kHz, and in others it is calibrated in time units (us, ms, and s). The different types of sweep generated are as follows:

1. Recurrent Sweep: When the saw tooth, being an ac voltage alternates rapidly, re display occurs repetitively, so that a lasting image is seen by the eye. This -treated operation is recurrent sweep.

2. Single Sweep: The signal under study produces a trigger signal, which in turn produces a single sweep.

3. Driven Sweep: The saw tooth oscillator is a free running generator when p crated independently. There is a chance that the sweep cycle may start after the signal cycle, thereby missing a part of the signal. Driven sweep removes this possibility because it is fixed by the signal itself. The sweep and signal cycles start at the same time.

4. Triggered Sweep: In a recurrent mode, the pattern is repeated again and again. In this mode the voltage rises to a maximum and then suddenly falls to a minimum. Electron beam moves slowly from left to right, retraces rapidly to the left and I, pattern is repeated. The horizontal sweep action takes place whether the input signal is applied to the oscilloscope or not, and a horizontal line is displayed on the scope screen. A triggered sweep, on the other hand, does not start unless initiated by a trigger voltage, generally derived from an incoming signal. In the absence of the input signal the sweep is held off and the CRT screen is blanked.

The continuous or recurrent sweep uses a free running multi vibrator (m/v) which covers a wide frequency range and can be locked into synchronization by input signal. Sync takes place when the sweep frequency and the input signal frequency are the same or when the former is a multiple of the latter.

A triggered scope does not use a continuous or recurrent sweep, but uses a mono stable multi vibrator which is in its off state until a trigger pulse arrives; hence there is no deflection on the screen.

When an input signal is applied, a trigger pulse is generated and applied to the multi vibrator, which switches on and produces a sweep signal, and a trace appears on the screen. After a specific voltage, depending on the CRT beam arriving on the RHS, the multi vibrator switches back to its off state, causing the beam to return rapidly to the LHS. (The basic difference between recurrent and triggered scopes is that the recurrent sweep locks at the frequency of the input signal, while the triggered scope displays a trace for a specific period of time. Hence, the triggered scope is ON during a specific time interval and will display a waveform or a segment of waveform (e.g. a one shot waveform) regardless of the signal frequency. Hence transients or single clamped oscillations can be observed on the screen.)

Most triggered scopes use a convenient feature of calibrating the sweep speed, in time per cm or division. Sweep frequency is the reciprocal of the time period.

5. Intensity Modulation In some applications an ac signal is applied to the control electrode of the CRT. This causes the intensity of the beam to vary in step with signal alternations. As a result, the trace is brightened during the +ve half cycles and diminished or darkened during —ve half cycles. This process is called intensity modulation or Z-axis modulation (in contrast to X-axis for horizontal and y-axis for vertical). It produces bright segments or dots on the trace in response to positive peak or dim segments or holes in response to negative peaks.

6. Explain the measurement of frequency using CRO?

Ans: The frequency of a signal is measured using oscilloscope in two methods. They are,

1. Using calibrated oscilloscope
2. Using uncelebrated oscilloscope.

Measurement of Frequency using Calibrated Oscilloscope

It is the indirect method of measurement of frequency. In this method, the frequency of unknown signal is measured by measuring its time period.

Initially, the unknown frequency signal is applied to the vertical inputs of the CRO. Now the horizontal sweep is turned ON and the display appealing on the screen is adjusted by varying different control knobs provided on the front panel of CRO, till the signal is suitably displayed on the screen. After obtaining the display of good deflection, count the number of horizontal division for a complete cycle. From the counted horizontal divisions, the time period is computed as,

$$T=m*n$$

Where

m=Number of division in one complete cycle

n=Setting of time base =Time/Division

From the measured time period of the signal, the unknown frequency is calculated as,

$$f = 1/T$$

2. Measurement of Frequency using Uncelebrated Oscilloscope?

It is the direct method of measurement of frequency. In this method, initially a signal whose frequency is known is applied to the horizontal input terminals whereas a signal whose frequency is to be known is applied to the vertical input terminals of CRO. Now different control knobs provided on the CRO are adjusted till a pattern of loops appear on the CRT screen. Here, the displayed pattern of loops cut by horizontal line and also vertical line. The number of loops that are cut by horizontal line gives the frequency of signal applied to vertical plate (f_v), whereas, the number of loops cut by vertical line gives the frequency of signal applied to horizontal plates (f_h).

Therefore we have.

$f_v / f_h =$ Number of loops cut by horizontal line/Number of loops cut by vertical line

If the frequency of the signal applied to the horizontal input is 100 Hz. For the 100 Hz frequency signal, say the number of loops cut by horizontal line is 1 and the numbers of loops cut by vertical line are 2.

7. How is the vertical oscilloscope deflected? How does this differ from horizontal axis?

Ans:

Deflection of the vertical axis of an oscilloscope is actually the deflection of electron beam in the vertical direction. To deflect the electron beam vertically, a pair of parallel plates is used. One vertical deflection plate (V1) is placed above the electron beam and the other vertical deflection plate is placed below the electron beam.

The vertical axis is deflected by applying vertical deflection voltages to the vertical deflection plates. The vertical deflection voltage is derived from the input signal to be analyzed by the oscilloscope. Usually, high Voltages are required to drive the deflection plates. Hence, a vertical amplifier is used to amplify the input signal to such an extent that it can deflect the electron beam.

The vertical amplifier amplifies the input signal and produces a two ended signal i.e., two signal voltages of equal amplitude but of opposite polarities. These two signal voltages are fed to the vertical deflection plates V1 and V2 (Y-plates) of CRO. The electron beam is a negatively charged beam because it contains electrons (negative charge particles).

When the voltage at V1 is negative then the voltage at V2 will be positive. The positive deflection voltage at V1 attracts the electron beam to V2 and the negative voltage at V2 repels the electron beam from V1. As a result the electron beam is deflected vertically downwards (i.e., towards V2 plate).

When the voltage at V_1 is positive, then the voltage at V2 will be negative. The positive voltage at V1 attracts the beam to V1 and the negative voltage at V2 repels the beam from V2. As a result the electron beam is deflected vertically upwards (i.e., towards V1).

The horizontal axis of an oscilloscope is deflected by applying horizontal deflection voltage to the horizontal deflection plates. The horizontal deflection voltage is derived from a saw-tooth signal.

A pair of parallel plates (H1, and H2) placed vertically on either side of the electron beam in the CRT, serve as horizontal deflection plates (X-plates). One plate H1 is kept on left side and other plate R2 is kept on right side of the electron beam.

A saw-tooth signal is amplified by the horizontal amplifier (identical to the vertical amplifier). The horizontal amplifier also produces two signal voltages of equal amplitude but of opposite polarities. These two voltages are fed to the horizontal deflection plates.

When the deflection voltage at H_1 is negative then the deflection voltage at H_2 will be positive. The positive voltage at H_2 attracts the electron beam to H_2 and the negative voltage at H_1 repels the electron beam from H_1. As a result, the beam is deflected horizontally to the right.

Similarly, the beam is deflected horizontally to the left when the voltage at H_1 is positive and the voltage at H_2 is negative.

The difference in the deflection of vertical and horizontal axis lies in the voltages that drive the respective deflection plates. The vertical deflection plates are driven by the amplified input signal whereas the horizontal deflection plates are driven by an amplified saw-tooth signal which serves as a time-base signal.

8. Mention the advantage of general purpose oscilloscope ?

ANS: Advantages of General Purpose Oscilloscope

1. It provides a graphical display of the amplitude of a signal as a function of time. Hence, it is used to measure various electrical parameters.

2. Amplitude of signals like voltage, current, power etc., can be measured by the oscilloscope.

3. Apart from amplitude measurement, it can measure frequency, phase angle, time delay of the signal, time between two events, and relative timing of two related signals.

4. It has an advantage over electro-mechanical measuring devices that it can respond very well to high frequency signals because it is completely an electronic device.

5. General purpose CRO's are used for maintenance of electronic equipment and laboratory work.

6. It can also be used to measure capacitance, inductance, etc.

9. Draw the Block diagram of a general purpose oscilloscope and explain its Basic operation ?

Ans: Figure shows the basic block diagram of a general purpose oscilloscope.

A general purpose oscilloscope consists of following parts.

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

1. Cathode Ray Tube

It is the heart of the oscilloscope. When the electrons emitted by the electron gun strikes the phosphor screen of the CRT, a visual signal is displayed on the CRT.

2. Vertical Amplifier

The input signals are amplified by the vertical amplifier. Usually, the vertical amplifier is a wide band amplifier which passes the entire band of frequencies.

3. Delay Line

As the name suggests that, 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 not used. Therefore, the input signal is delayed by a period of time.

4. Time Base Circuit

Time base circuit uses a uni junction transistor, which is used to produce the sweep. The saw tooth voltage produced by the time base circuit is required to deflect the beam in the horizontal section. The spot is deflected by the saw tooth voltage at a constant time dependent rate.

5. Horizontal Amplifier

The saw tooth voltage produce by the time base circuit is amplified by the horizontal amplifier before it is applied to horizontal deflection plates

6. Trigger Circuit

The signals which are used to activate the trigger circuit are converted to trigger pulses for the precision sweep operation whose amplitude is uniform. Hence input signal and the sweep frequency can be synchronized.

7. Power supply:

The voltages require by CRT, horizontal amplifier and vertical amplifier are provided by the power supply block. Power supply block of oscilloscope is classified in to two types

(1) Negative high voltage supply

(2) Positive low voltage supply

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

10. What are the advantages of dual beam for multiple trace oscilloscopes?

Ans:

Advantages of Dual Beam for Multiple Trace Oscilloscopes

1. A multiple trace oscilloscope making use of dual beam provides a simultaneous display of the two input waveforms on the CRO screen. Hence dual beam CRO is used to compare one signal with another signal.
2. It can capture two fast transient events.
3. It also provides a continuous display of the signals, whereas the display of the two signals provided by a dual trace oscilloscope consists of small gaps in the trace.
4. It has two separate vertical channels for two input signals.
5. It can also have two separate time base circuits (i.e. horizontal deflection systems). Hence, in dual beam CRO two input signals can be swept horizontally at different rates. Due to this feature, a fast signal can be graphically compared with a slow signal simultaneously on the CRO screen.