Unit 2: Signal Generators

Introduction:

Signal generator provides variety of different signals for testing various electronic circuits at low powers. The signal generator is an instrument which provides several different output waveforms including sine wave, square wave, triangular wave, pulse train and an amplitude modulated waveform.

Requirements of Laboratory Type Signal Generator:

There are different types of signal generator. But the requirements are common to all the types.

i) The output frequency of signal generator should be very stable .

ii)The amplitude of output signal of signal generator should be controllable from low values to relatively large values.

iii) The amplitude of output signal must be stable. the harmonic contents in the output should be as low as possible. The output signal should be distortion free.

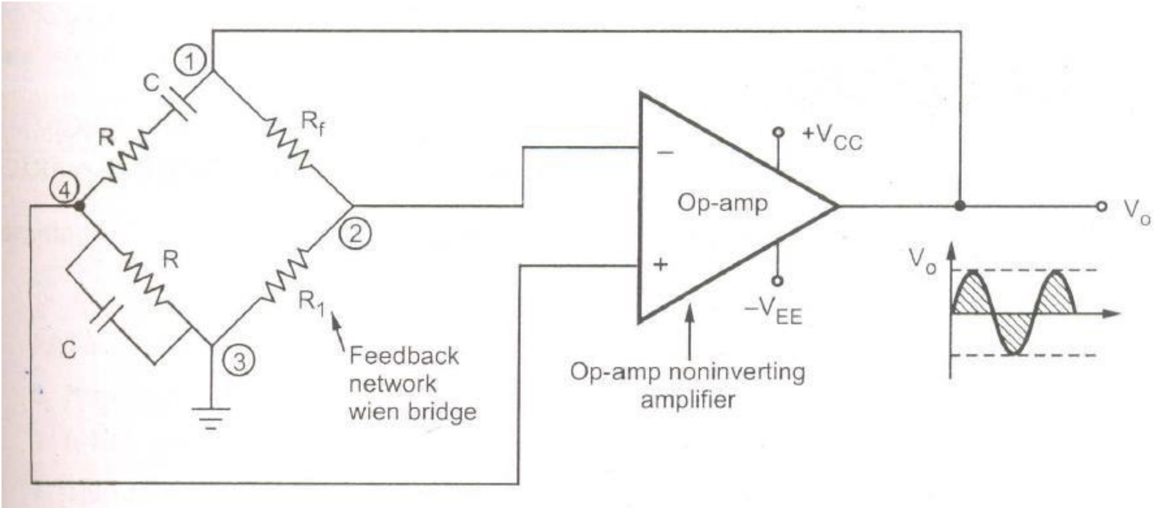
v) The signal generator should provide very low spurious output; that means effect of hum, noise, jitter and modulation should be negligible.

A F oscillator:

The signal generators which provide sinusoidal waveforms in the frequency range of 20 Hz to 20 kHz are called audio frequency(A.F.) signal generator. Depending upon the load, in modern AF signal generators a provision is made to select output impedance either 50 n or 600 n. To generate audio frequency signals, in practice RC feedback oscillators are used. The most commonly used RC feedback oscillators are Wien Bridge oscillator and RC phase shift oscillator. Let us discuss both the types of oscillators in detail.

Wien Bridge Oscillator using Op-amp:

The Fig shows the Wien bridge oscillator using an op-amp.



nle resistance R and capacitor C are the components of frequency sensitive arms of the bridge. The resistance Rf and R1 form the part of the feedback path. The gain of noninverting op-amp can be adjusted using the resistance Rf and R1. The gain of op-amp is,

$$A = 1 + \frac{R_f}{R_1}$$

Standard signal generator:

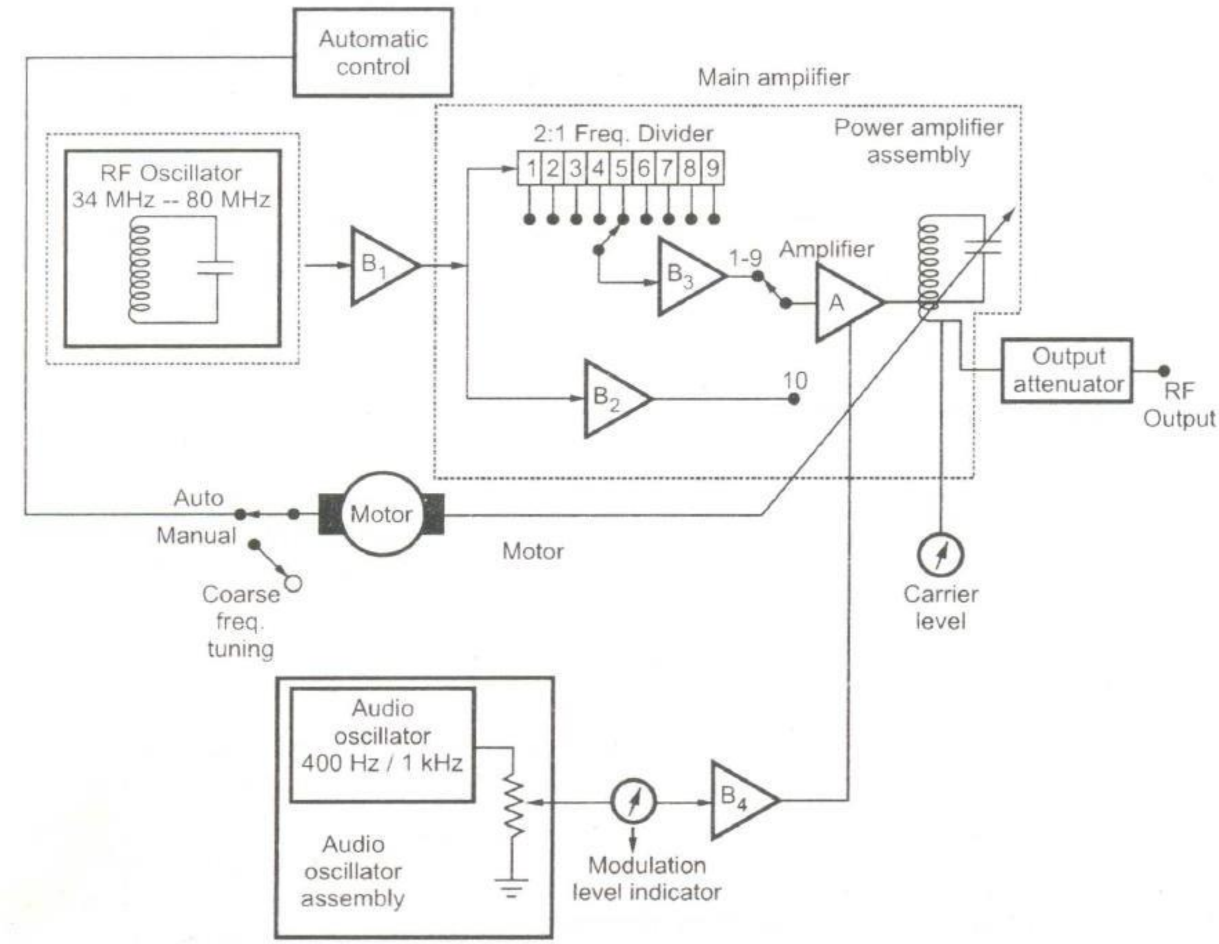
It is extensively used in the testing of radio receivers and transmitters. This is basically a radio frequency (RF) signal generator. The standard signal generator produces known **and controllable voltages.**

Principle of working:

The output of the generator is amplitude modulated or frequency modulated. The frequency modulation is possible using a carrier signal from RF oscillator. The amplitude modulation can be done using internal sine wave oscillator. The modulation may be done by a sine wave, square wave, triangular wave or a pulse also. The setting on the front pane1 indicates the carrier frequency to be used for modulation.

Block Diagram:

The block diagram of conventional standard signal generator is shown in the Fig.



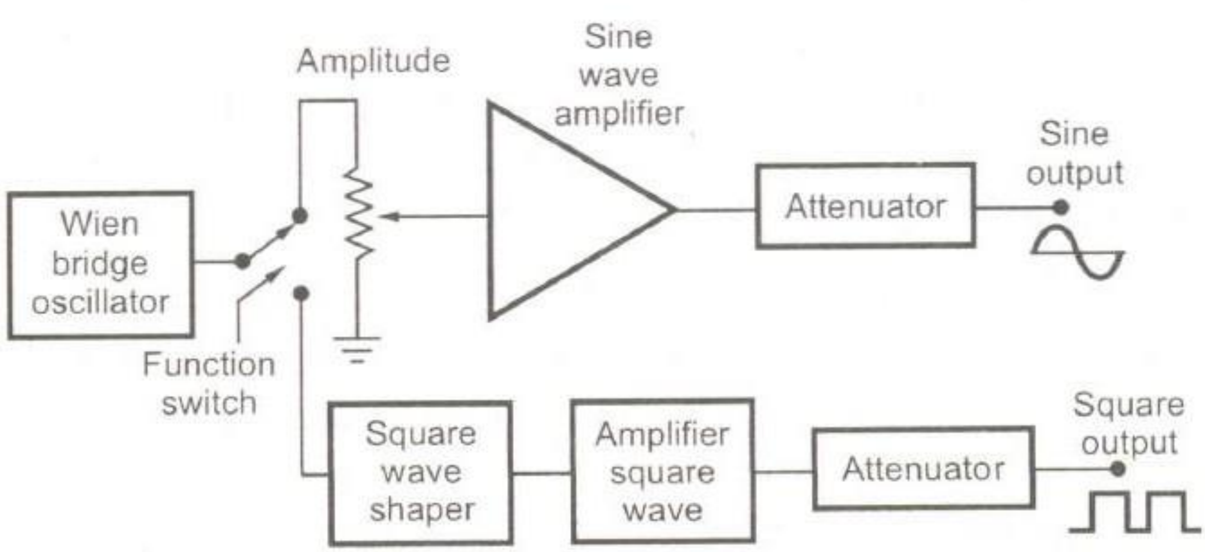
Signal for modulation is provided by an audio oscillator. The frequency given by this oscillator is in the range of 400 Hz to 1 kHz The modulation takes place in main amplifier, in power amplifier stage. The level of modulation can be adjusted upto 95% by using control devices.

The lowest frequency range obtained by using frequency divider is the highest frequency range divided 29 or 512. Thus, frequency stability of highest range is imparted to the lowest frequency range. The effects of frequency range selection is eliminated as same oscillator is used for all frequency bands. The master oscillator is tuned automatically or manually. **In** automatic controller for tuning master oscillator, a motor driven variable capacitor used. This system is extensively used in programmable automatic frequency control devices. The oscillator can be fine tuned by means of a large rotary switch with each division corresponding to 0.01 % of main dial setting.

The internal calibration is provided by 1 MHz crystal oscillator. The small power consumption of the instruments makes output with very low ripple. The supply voltage of the master oscillator is regulated by temperature compensated reference circuit. The output of the main amplifier is given to an output attenuator. The attenuator controls the amplitude level and provides the required stable **RF** output.

AF sine and square wave generator:

The block diagram of an AF sine-square wave generator is as shown in the Fig

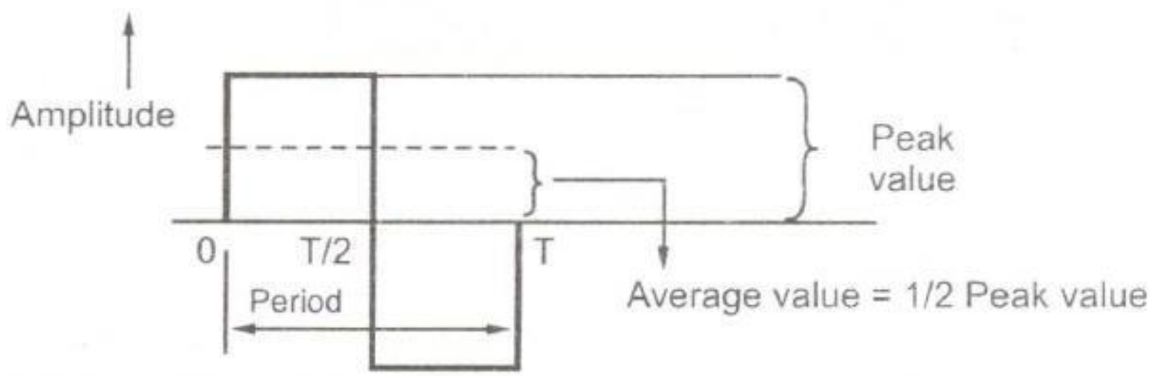


As per our previous discussion, Wien bridge oscillator is the heart of an AF sine-square wave generator. Depending upon the position of switch, we get output as square wave output or sine wave output. The Wien bridge oscillator generates a sine wave. Depending upon the position of switch, it is switched to either circuit. In the square wave generation section, the output of the Wi en bridge oscillator is fed to square wave shaper circuit which uses schmitt trigger circuit. The attenuators in both the sections are used to control output signal level. Before attenuation, the signal level is made very high using sine wave amplifier and square wave amplifier.

Square wave and pulse generator:

The square wave generator and pulse generator are generally used as measuring devices in combination with the oscilloscope. The basic difference between square wave generator and pulse generator is in the duty cycle. The duty cycle is defined as the ratio of average value of a pulse over one cycle to the peak value. It is also defined as ratio of the pulse width to the period of one cycle.

$$\text{Duty cycle} = \frac{\text{Pulse width}}{\text{Pulse period}}$$



The average value is half of peak value. Both the average value and peak value are inversely proportional to time duration. The average value of a pulse is given as,

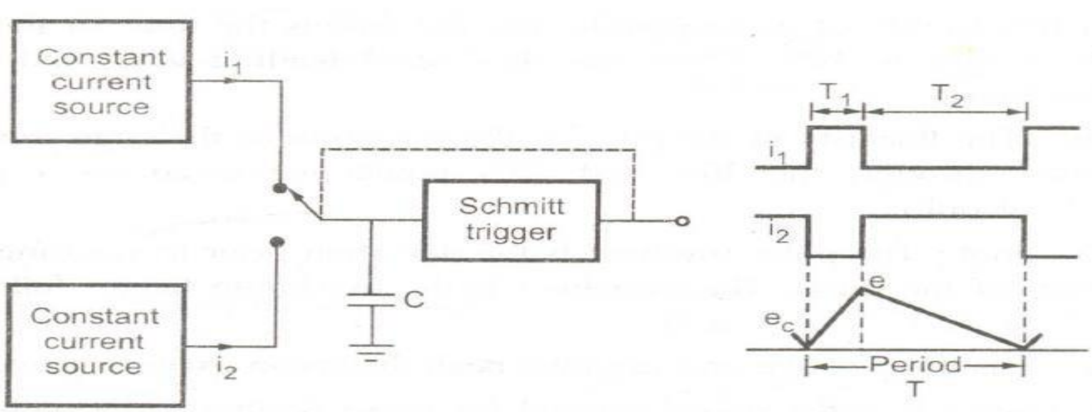
1

Average value = 1/2 Peak value

Duty cycle of square wave = 0.5

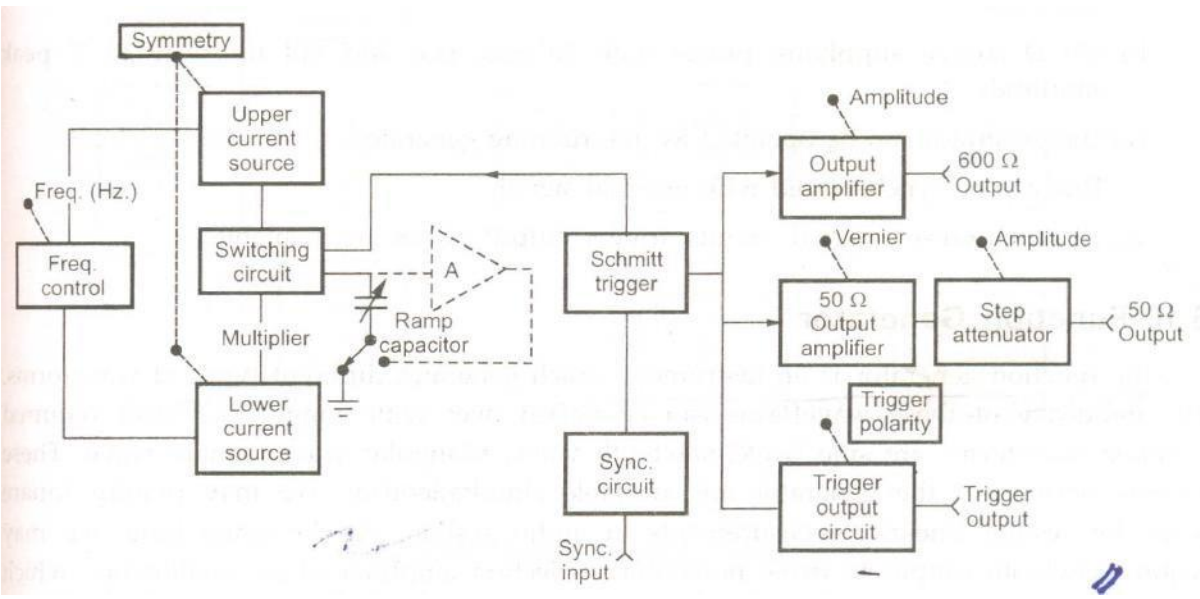
Thus square wave generator produces an output voltage with equal ON and OFF periods as duty cycle is 0.5 or 50% as the frequency of oscillation is varied. Then we can state that irrespective of the frequency of operation, the positive and negative half cycles extend over half of the total period

Laboratory type square wave and pulse generator:



The circuit consists of two current *sourcesJ* a ramp capacitor, and schmitt trigger circuit as well as curr~wit~ht!!g 9,rcuit. The two current sources provide a constan Cllr.ITn~to aJamp c:apaci tor for charging and discharging. The ratio of tnese charging and discharging current is' determined by setting of symmetry control. The symmetry control determines duty cycle of output waveform. In the current source, an appropriate control voltage is applied to current control transistors which controls the frequency i.e. sum of two currents. The multiplier switch provides decade switching control output frequency. While frequency dial provi.des continuous vernier control of output frequency.

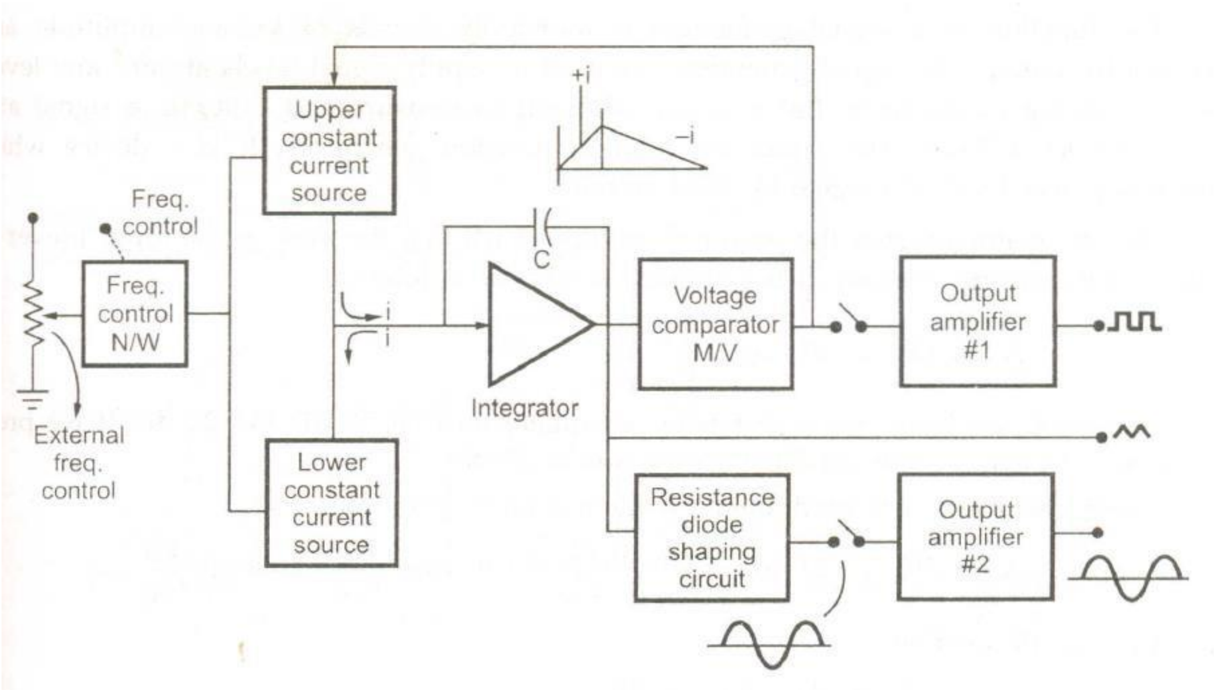
The block diagram of laboratory type square wave and pulse generator is as shown in fig:



Function generator:

The function generator is an instrument which generates different types of waveforms The frequency of these wave orms can be vane over wide range. le most required common waveforms are sine wave, sawtooth wave, triangular wave, square *wave.* These various OlltputS of the generator are available simultaneously. We may require square wave for testing linearity measurements in audio system. At the same time, we mal' require!"~awtooth output to drive horizontal deflection amplifier of an oscilloscope which gives visual display of the measurements. The purpose of providing simultaneous wavesis flllfilled by the function generator.

Block Diagram:



The frequency controlled voltage is used to regulate two current sources namely upper current source and lower current source. The upper current source supplies constant current to an integrator. The output voltage of integrator then increases linearly with time. If the current, charging the capacitor increases or decreases, the slope of output voltage increases or decreases respectively. Hence this controls frequency. The voltage comparator multivibrator circuit changes the state of the network when the output voltage of integrator equals the maximum predetermined upper level. Because of this change in state, the upper current source is removed and the lower current source is switched ON. This lower current source supplies opposite current to the integrator circuit. The output of integrator decreases linearly with time. When this output voltage equals maximum predetermined upper level on negative side, the voltage comparator multivibrator again changes the condition of the network by switching OFF the lower current source and switching ON the upper current source.

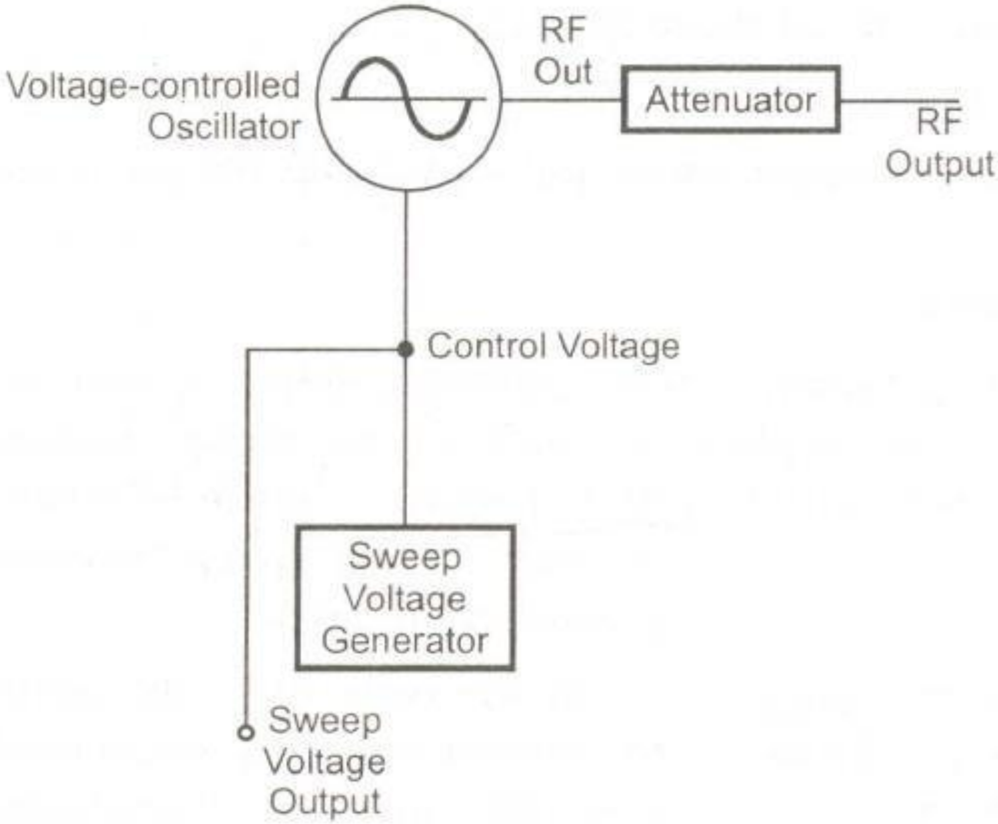
The output voltage of the integrator has triangular waveform. The frequency of this triangular waveform is determined by the magnitudes of the currents supplied by upper current source and lower current source. To get square wave, the output of the integrator

is passed through comparator. The voltage comparator delivers square wave output voltage·of same frequency as that of input triangular waveform. The sine wave is derived from triangular wave. The triangular wave is synthesised into sine wave using diode resistance network. **In** this shaper circuit, the slope of triangular wave is changed as its arr'plitude changes. This results in a sine wave with less than 1% distortion.
The two output amplifiers provide two simultaneous, individually selected outputs of any of the waveform functions.

The function of a signal generators is to supply signals of known amplitude and known frequency. The signal generators are used to supply signal levels at very low levels for the testing of receivers. But it is very difficult to measure and calibrate a signal at a very low level. Thus attenuators are used in function generators. It is a device which reduces power level of a signal by fixed amount.

Sweep-Frequency Generators:

The sine wave generator discussed in earlier sections generates output voltage at a known and stable frequency.



The development of solid state variable capacitance diode (varicap diode) helps in building sweep frequency genera tors. These are extensively used than any other electronic devices. These varicap diodes provide the method of electronically tunning an oscillator. The block diagram of simple sweep frequency generator is as shown in Fig

The sweep generator is very much similar to the simple signal generator. Tn the simple signal genera tor, an oscilla tor is tuned to fixed single frequency.

Tn the sweep generator, an oscillator is electronically tuned and by using voltage controlled oscillator variable frequency is obtained. As name indicates, a sweep voltage generator provides voltage, known as control voltage, to the voltage controlled oscillator (VeO). The function of voltage controlled oscillator is to provide various frequency sweeps according to voltage provide by sweep voltage generator.

Frequency Synthesizers:

The frequency generators are of two types.

1. One is free running frequency generators in which the output can be tuned continuously either electronically or mechanically over a wide frequency range. The generators discussed uptill now are of this type.
2. The second is frequency generator with frequency synthesis technique. The synthesis means to use a fixed frequency oscillator called reference oscillator or *clock* and to derive the wide frequency range in steps from the output of the reference oscillator.

   The stability and accuracy of free running frequency generator is poor while frequency synthesizers provide output which is arbitrarily selectable, stable and accurate frequency. The reference oscillator used in frequency synthesizers is generally precision crystal oscillator with an output at some cardinal frequency such as 10 MHz. Various signal processing circuits then operate in synchronism to provide a large choice of the output frequencies.

Unit 3: **Oscilloscopes** **06 Hours**

Introduction:

In studying the various electronic, electrical networks and systems, signals which are functions of time, are often encountered. Such signals may be periodic or non periodic in nature. The device which allows, the amplitude of such signals, to be displayed primarily as " function of time, is called **cathode ray** oscilloscope, commonly known as C.R.O. The CR.O gives the visual representation of the time varying signals. The oscilloscope has become an universal instrument and is probably most versatile tool for the development of electronic circuits and systems. It is an integral part of electronic laboratories.

The oscilloscope is, in fact, a voltmeter. Instead of the mechanical deflection of a metallic pointer as used in the normal voltmeters, the oscilloscope uses the movement of an electron beam against a fluorescent screen, which produces the movement of a visible spot. The movement of such spot on the screen is proportional to the varying magnitude of the signal, which is under measurement.

Basic Principle:

The electron beam can be deflected in two directions : the horizontal or x-direction and the vertical or y-direction. Thus an electron beam producing a spot can be used to produce two dimensional displays, Thus CRO. can be regarded as a fast x-y plotter. The x-axis and y-axis can be used to study the variation of one voltage as a function of another. Typically the x-axis of the oscilloscope represents the time while the y-axis represents variation of the input voltage signal. Thus if bhe input voltage signal applied to the y-axis of CRO. is sinusoidally varying and if x-axis represents the time axis, then the spot moves sinusoidally, and the familiar sinusoidal waveform can be seen on the screen of the oscilloscope. The oscilloscope is so fast device that it can display the periodic signals whose time period is as small as microseconds and even nanoseconds. The CRO. Basically operates on voltages, but it is possible to convert current, pressure, strain, acceleration and other physical quantities into the voltage using transducers and obtain their visual representations on the CRO.

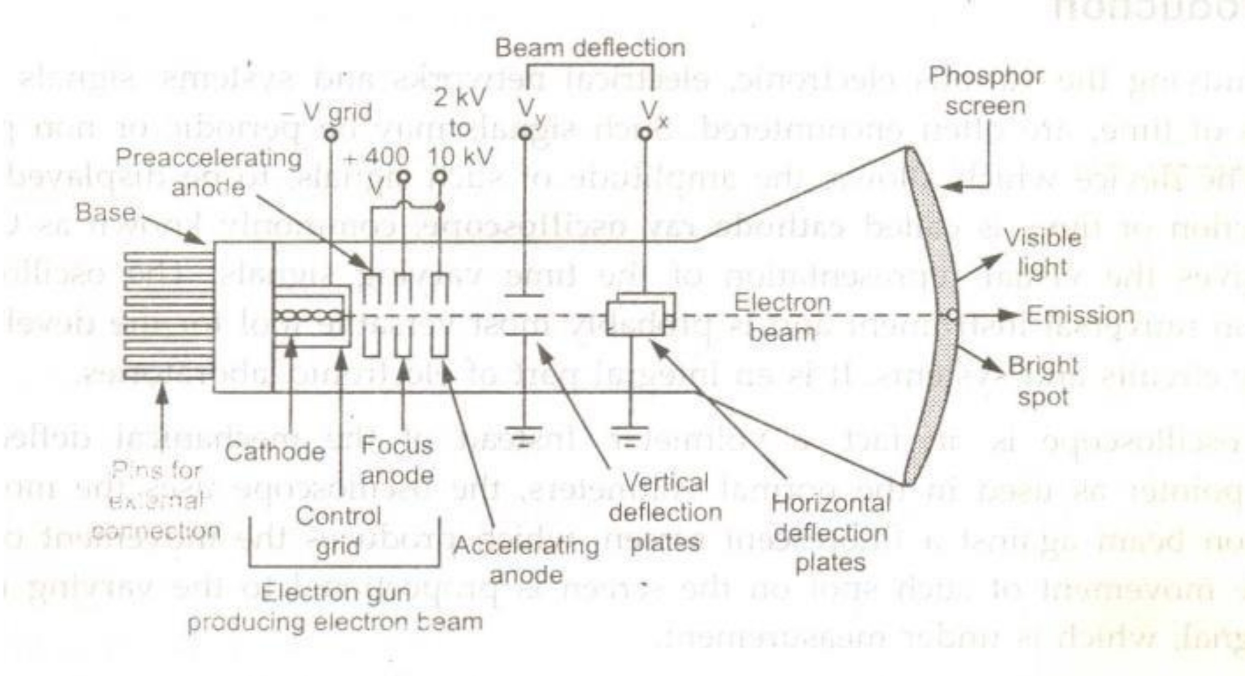
Cathode Ray Tube (CRT):

The cathode ray tube (CRT) is the heart of the CR.O. the CRT generates the electron beam, ,accelerates the beam, deflects the beam and also has a screen where beam becomes visible ,as a spot. The main parts of the CRT are:

i) Electron gun ii) Deflection system iii) Fluorescent screen

iv) Glass tube or envelope v) Base

A schematic diagram of CRT, showing its structure and main components is shown in the Fig.



Electron Gun:

The electron gun section of the cathode ray tube provides a sharply focused electron beam directed :towards the fluorescent-coated screen. This section starts from theql1ally heated cathode, limiting the electrons. The control grid is given negative potential with respect to cathode dc. This grid controls the number of electrons in the beam, going to the screen.

The momentum of the electrons (their number x their speed) determines the intensity, or brightness, of the light emitted from the fluorescent screen due to the electron bombclrdl1lent. The light emitted is usually of the green colour. Because the electrons are negatively charged, a repulsive force is created by applying a negative voltage to the control grid (in CRT, voltages applied to various grids are stated with respect to cathode, which is taken as common point). This negative control voltage can be made variable.

Deflection System:

When the electron beam is accelerated it passes through the deflection system, with which beam can be positioned anywhere on the screen. The deflection system of the cathode-ray-tube consists of two pairs of parallel plates, referred to as the vertical and horizontal deflection plates. One of the plates' in each set is connected to ground (0 V), To the other plate of each set, the external deflection voltage is applied through an internal adjustable gain amplifier stage, To apply the deflection voltage externally, an external terminal, called the Y input or the X input, is available.

As shown in the Fig. , the electron beam passes through these plates. A positive voltage applied to the Y input terminal (Vy) Causes the beam to deflect vertically upward due to the attraction forces, while a negative voltage applied to. the Y input terminal will cause the electron beam to deflect vertically downward, due to the repulsion forces. When the voltages are applied simultaneously to vertical and horizontcl1 deflecting plates, the electron beam is deflected due to the resultant-of these two voltages.

Fluorescent Screen:

The light produced by the screen does not disappear immediately when bombardment by electrons ceases, i.e., when the signal becomes zero. The time period for which the trace remains on the screen after the signal becomes zero is known as "persistence". The persistence may be *jS* short as a few microsecond, or as long as tens of seconds ~en minutes.

Long persistence traces are used in the study.. of transients. Long persistence helps in the study of transients since the trace is still seen on the screen after the transient has disappeared.

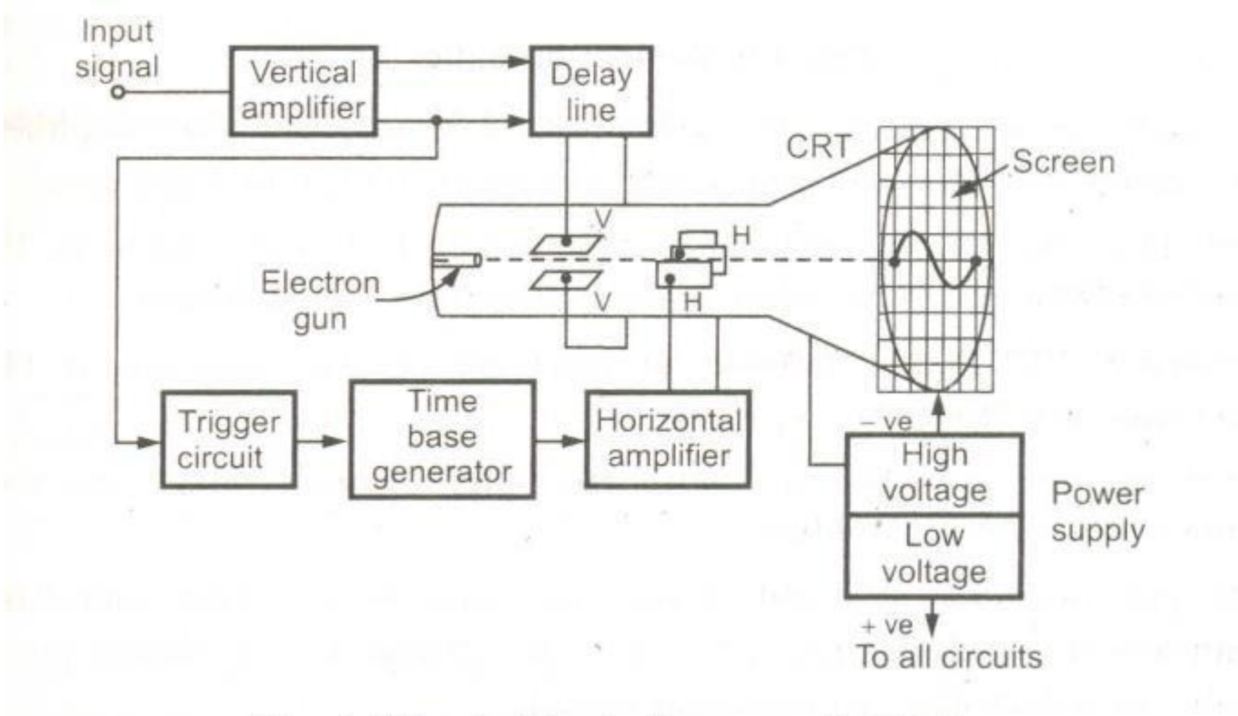
Phosphor screen characteristics:

Many phosphor materials having different excitation times and colours as well as different phosphorescence times are available. The type PI, P2, PI1 or P3I are the short persistence phosphors and are used for the general purpose oscilloscope

Medical oscilloscopes require a longer phosphor decay and hence phosphors like P7 and P39 are preferred for such applications. Very slow displays like radar require long persistence phosphors to maintain sufficient flicker free picture. Such phosphors are P19, P26 and, P33.

The phosphors P19, P26, P33 have low burn resistance. The phosphors PI, P2, P4, P7, Pll have medium burn resistance while PIS, P3I have high burn resistance.

Block diagram of simple oscilloscope:

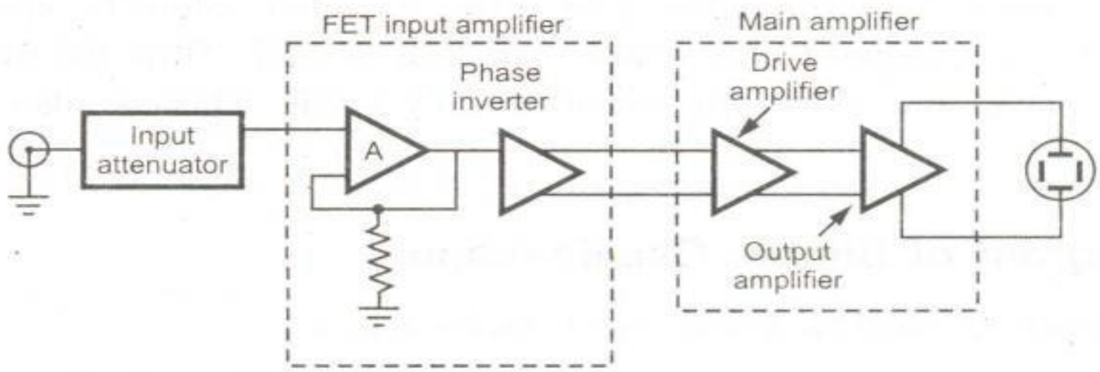


CRT:

This is the cathode ray tube which is the heart of CR.O. It is' used to emit the rlectrons required to strike the phosphor screen to produce the spot for the visual display of the signals.

Vertical Amplifier:

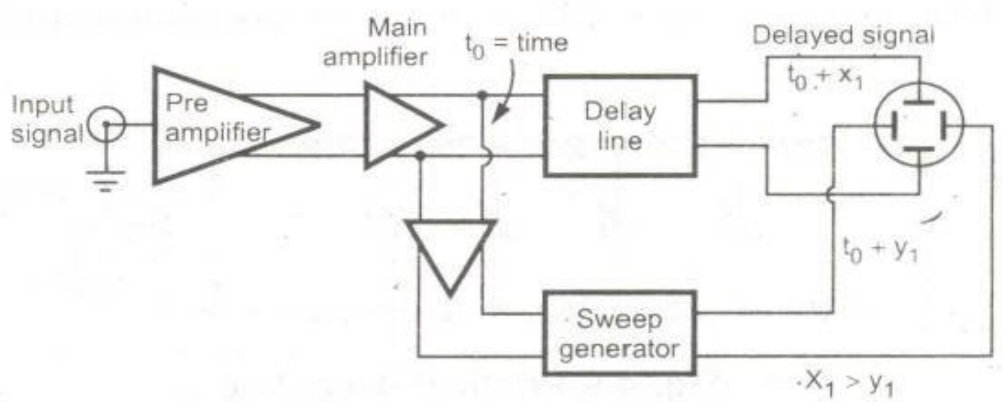
The input signals are generally not strong to provide the measurable deflection on the screen. Hence the vertical amplifier. stage is used Jo amplify the input signals. The amplifier stages used are generally wide band amplifiers so as to pass faithfully the entire band of frequencies to be measured. Similarly it contains the attenuator stages as well. The attenuators are used when very high voltage signals are to be examined, to bring the signals within the proper range of operation.



It consists of several stages with overall fixed sensltivity. The amplifier can be designed for stability and required bandwidth very easily due to the fixed gain. The input stage colrtsists of an attenuator followed by FET source follower. It has vel' high input impedance required to isolate the amplifier from the attenuator. It is followed by BJT emitter follower to match the output impedance of FET output With input of phase inverter. The phase inverter provides two antiphase output signals which are required to operate the push pull output amplifier. The push pull operation has advantages like better hum voltage cancellation, even harmonic suppression especially large 2nd harmonic, greater power output per tube and reduced number of defocusing and nonlinear effects.

Delay line:

The delay line is used to delay the signal for some time in the verticClI sections. When the delay line is not used, the part of the signal gets lost. Thus the input signal is not applied directly to the vertical plates but is delClyed bv some time using a delay line cu-cuit as shown in the Fig.



If the trigger pulse is picked off at a time t = to after the signal has passed through the main amplifier then signal is delayed by XI nanoseconds while sweep takes YI nanoseconds to reach. The design of delay line is such that the delay time XI is higher than the time YI' Generally XI is
200. nsec while tl;1.eYI is 80 ns, thus the sweep starts well in time and no part of the signal is lost.
There are two types of delay lines used in CR.O. which are:
i) Lumped parameter delay line
ii) Distributed parameter delay line

Trigger circuit:

It is necessary that horizontal deflection starts at the same point of the input vertical signal, each time it sweeps. Hence to synchronize horizontal deflection with vertical deflection a synchronizing or triggering circuit is used. It converts the incoming signal into the triggering pulses, which are used for the synchronization.

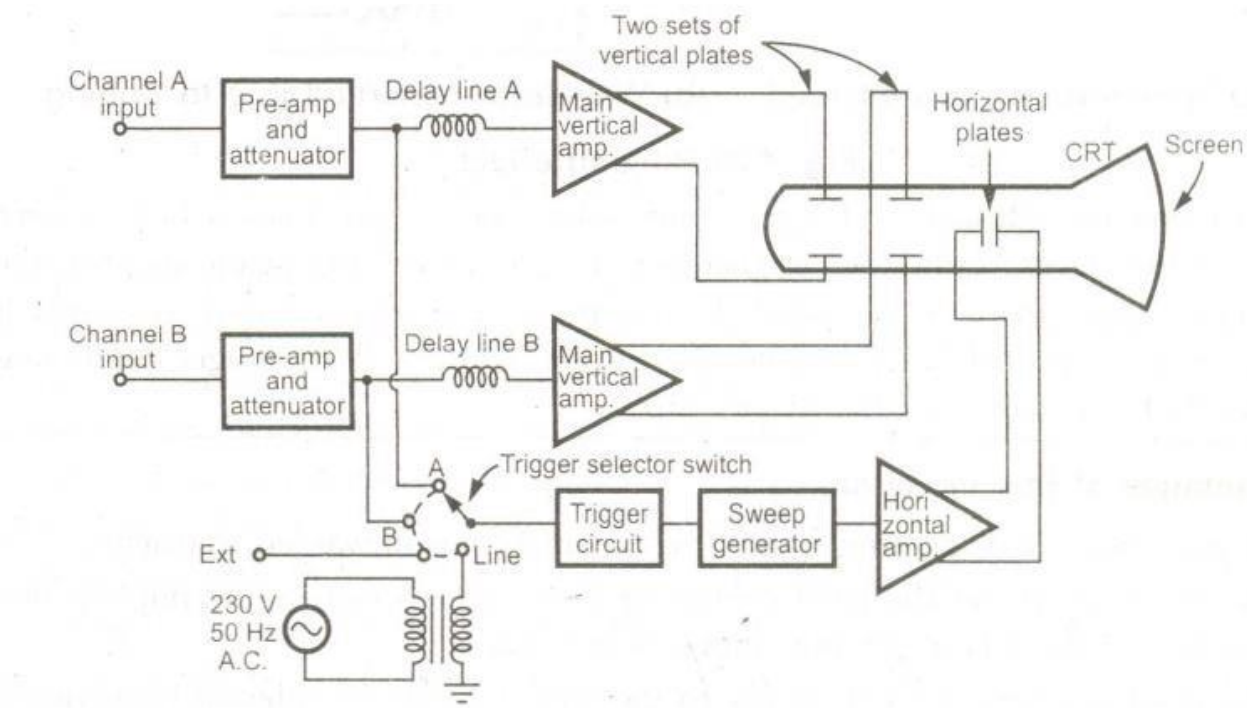
Time base generator:

The time base generator is used to generate the sawtooth voltage, required to deflect the beam in the horizontal section. This voltage deflects the spot at a constant time dependent rate. Thus the x- axis' on the screen can be represented as time, which, helps to display and analyse the time varying signals.

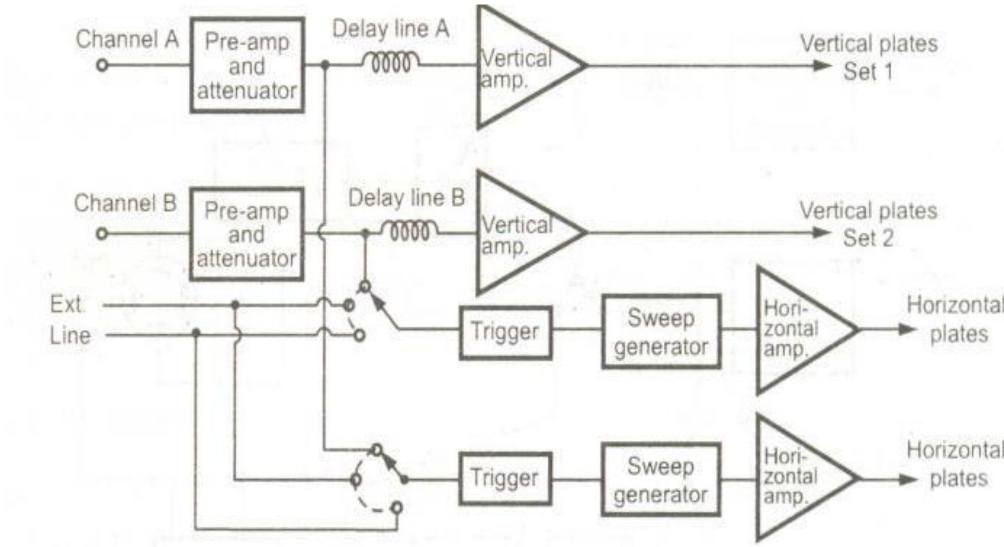
Dual Beam Oscilloscope:

Another method of studying two voltages simultaneously on the screen is to u special cathode ray tube having two separate electron guns generating two separate beami Each electron beam has its own vertical deflection plates.

But the two beams are deflected horizontally by the common set of horizontal plate\ The time base circuit may be same or different. Such an oscilloscope is called **Dual** Beam Oscilloscope.



The oscilloscope has two vertical deflection plates and two separate channels A and B for the two separate input signals. Each channel consists of a preamplifier and an attenuator. A delay line, main vertical amplifier and a set of vertical deflection plates together forms a single channel. There is a single set of horizontal plates and single time base circuit. The sweep generator drives the horizontal amplifier which inturn drives the plates. The' horizontal plates sweep both the beams across the screen at the same rate. The sweep generator can be triggered internally by the channel A signal or .channel B signal. Similarly it' can also be triggered from an external signal or line frequency signal. This is possible with the help of trigger selector switch, a front panel control. Such an oscilloscope may have separate timebase circuit for separate channel. This allows different sweep rates for the two channels but increases the size and
weight of the oscilloscope.



Dual beam CRO with separate time bases

Multiple beam oscilloscopes:

Multiple beam oscilloscope has a single tube but several beam producing systems inside. Each system has separate vertical deflecting pair of plates and generally (l common time base system. The triggering can be done internally using eith.er of the multiple inputs or externally by an external signal or line voltages.

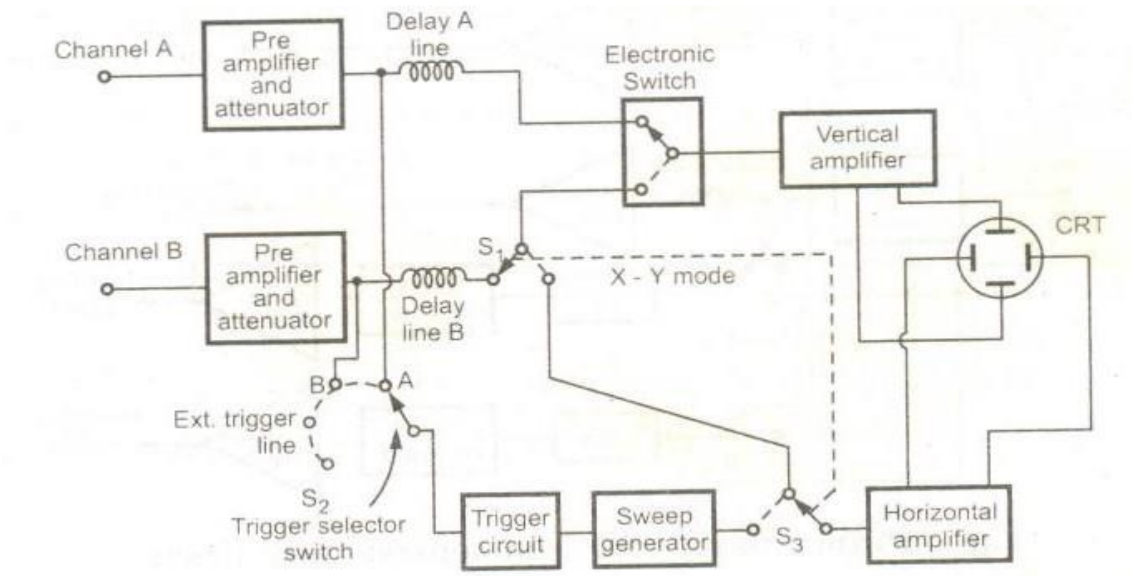
Dual trace oscilloscope:

The comparison of two or more voltages is very much ,necessary in the analysis and study of many electronic circuits and systems. This is possible by using more than one oscilloscope but in such a case it is difficult to trigger the sweep of each oscilloscope precisely at the same time. A common and less costly method to solve this problem is to use dual trace or multitrace oscilloscopes. In this method, the same electron beam is used to generate two traces which can be deflected from two independent vertical sources. The methods are used to generate two independent traces which the alternate sweep method and other is chop method.

The block diagram of dual trace oscilloscope is shown in the Fig

There are two separate vertical input channels A and B. A separate preamplifier and - attenuator stage exists for each channel. Hence amplitude of each input can be individually controlled. After preamplifier stage, both the signals are fed to an electronic switch. The switch

has an ability to pass one channel at a time via delay line to the vertical amplifier. The time base circuit uses a trigger selector switch 52 which allows the circuit to be triggered on either A or B channel, on line frequency or on an external signal. The
horizontal amplifier is fed from the sweep generator or the B channel via switch 5! and 51. The X-Y mode means, the oscilloscope operates from channel A as the vertical signal and the channel B as the horizontal signal. Thus in this mode very accurate X-Y measurements can be done.



Recommended questions:

1. State the various characteristics of P31 phosphor .

.J. Draw the block diagram of general purpose CRO. Explain the functions of various blocks..

2. Draw alld Explain the block diagram of the vertical amplifier used III oscilloscopes.

3. Explain the functions of delay lille ill oscilloscopes. WllIch are the two types of delay lilies 7

4. State and Explain vorlous front panel controls of a Simple CRO. **[all years asked till now]**

5. Explaill the followll1g modes of operatioll of time base generator [**jan 06, 05, jul 07]**

i) Free run mode

ii) Auto mode

iii) single sweep mode

6. Draw the block diagram of a trigger generator. Explain the various controls associated With It.

7. What is the use of ACs and ACF controls?

8. Which are the typical trigger sources 7 Explain their sigl1lficol/cl'.

16. Explain the use of following controls

I) INT 11') EXT III) LINE

Unit:IV **Hrs: 06**

Syllabus:

Special Oscilloscopes

Delayed time-base oscilloscopes, Analog storage, Sampling and Digital storage oscilloscopes (Text 2: 10.1 to 10.4)

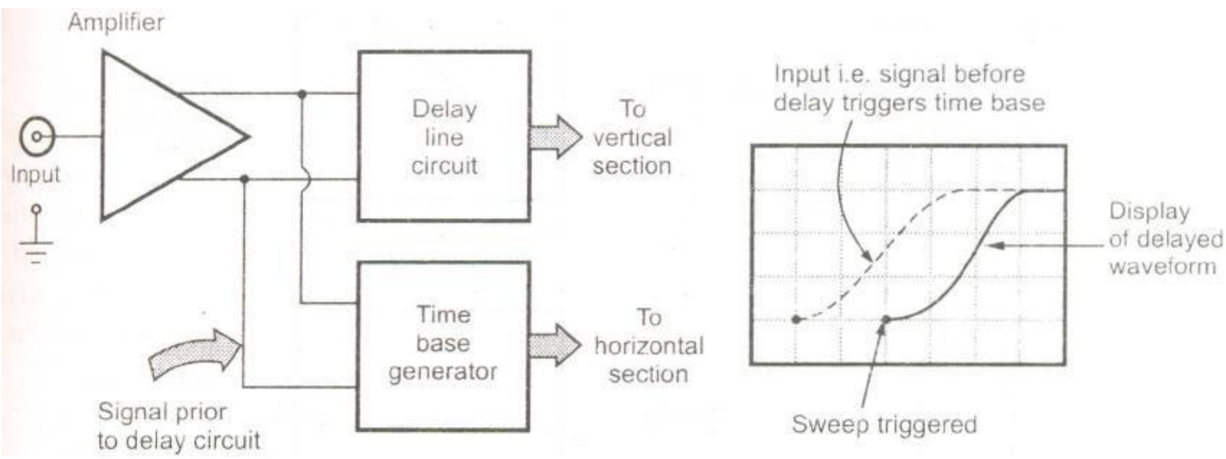
Recommended readings:

1. **"Electronic Instrumentation",** H. S. Kalsi, TMH, 2004
2. **"Electronic Instrumentation and Measurements",** David A Bell, PHI / Pearson Education, 2006.

Unit 4: Special Oscilloscopes 06 Hours

Delayed time base oscilloscope:

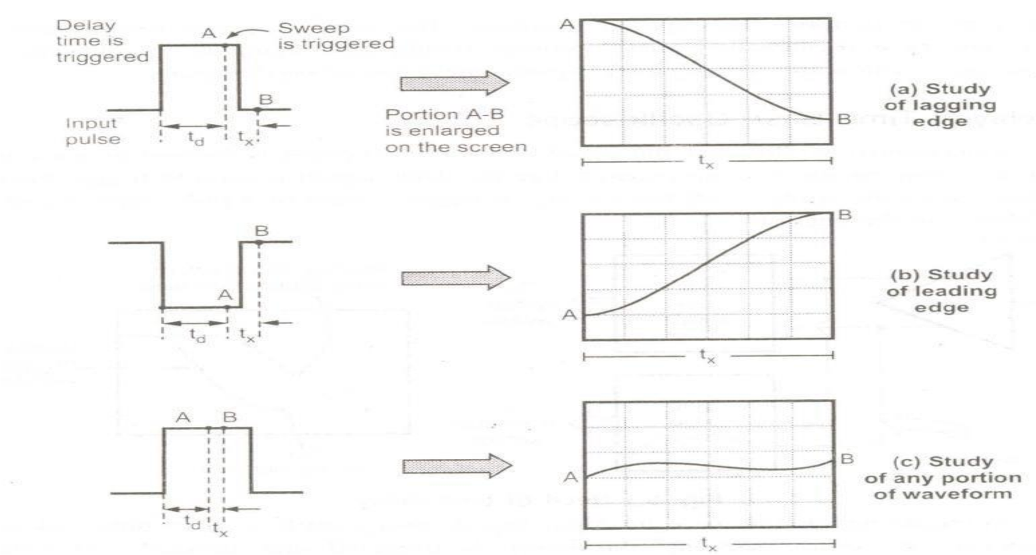
In a conventional oscilloscope, the signal to the vertical plates is delayed by sOllle time, using ,1 delay line circuit. The waveform before the delay circuit is used to trigger the time base. This allows the study of all the leading or lagging edges of a pulse type waveform. This i~ shown in the Fig



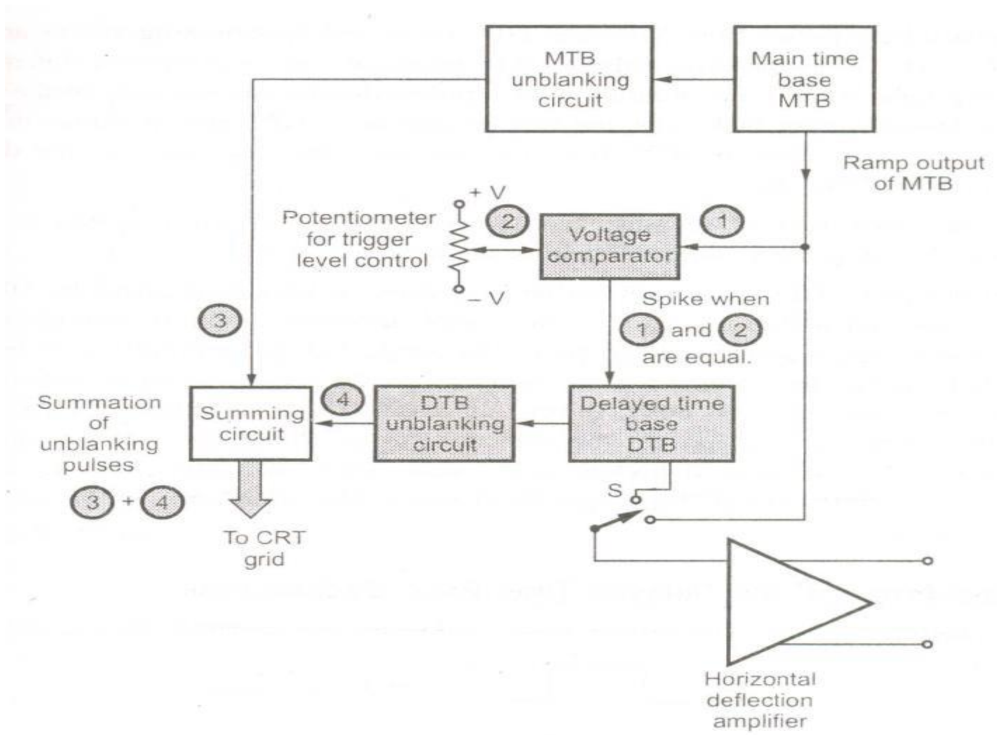
Due to triggering of time base by input signal, sweep starts well in time and when input appears at vertical sections, the sweep is triggered and delayed W(l\ dorm is displayed. The delay ensures that no part of the waveform gets lost.

In c1 delayed time base oscilloscope, a variable time delay circuit is used in the basic time base circuit. This allows the triggering of sweep time after the delay time. Thus the delay time is variable. This time is denoted as td. After this, the sweep is triggered for the time t,. Then the portion of the waveform for the time t x gets expanded on the complete ()scillo~cope screen, for the detail study.

If inpu,t is pulse waveform and leading edge is used to trigger the delay time, then bgging edge can be displayed to fill the entire oscilloscope screen. This is shown in the Fig (a). Similarly jf the lagging edge is used to trigger the delay time then leading edge Gln be displayed on the entire screen for the time tx. This is shown in the Fig.(b). If the time delay is perfectly adjusted, then any portion of the waveform can be extended to fill the entire screen. This is shown in the Fig. (c).



Use of additional time delay



Delayed time base oscilloscope

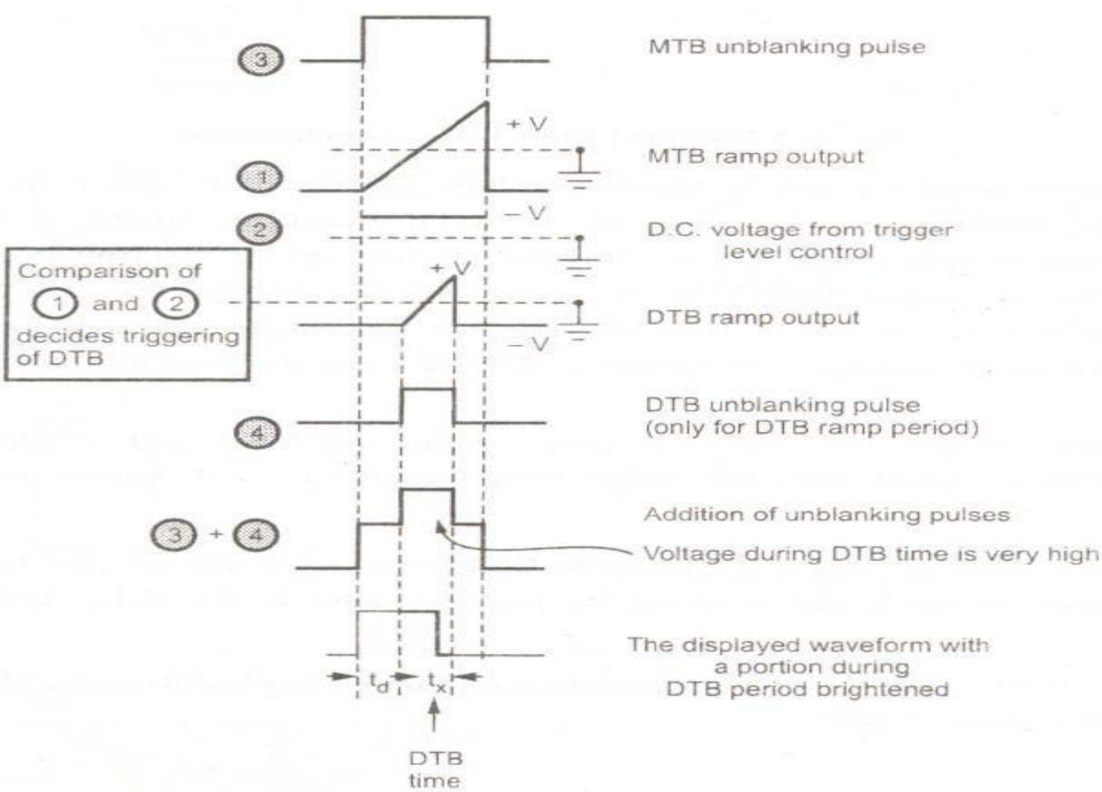
The normal time base circuit is main time base (MTB) circuit which functions same as c1 conventional oscilloscope. The function of MTB blanking circuit is to produce an unblanking pulse which is applied to CRT grid to turn on an electron beam in the CRT, during the display sweep time. The ramp output of MTB is given to the horizontal deflection amplifier via switch S. It is also given as one input to the voltage comparator. The other input to the voltage comparator is derived from the potentiometer whose level is adjustable.

The unblanking pulses from MTB and DTB are added by **summing circuit** and given to the CRT grid. The unblanking pulse of MTB produces a trace of uniform intensity. But during ramp time of DTB, the addition of two pulses decides the intensity of the trace on the screen. Hence during DTB time, the voltage applied to CRT grid is almost twice than the voltage corresponding to MTB time. This increases the brightness of the displayed waveform for the DTB time.

When the part of the waveform to be brightened is identified, then the DTB ramp output is connected to the input of the horizontal deflection amplifier through switch S. The DTB ramp time is much smaller than MTB period but its amplitude (- V to + V) is same as MTB ramp. 1Ience it causes the oscilloscope electron beam to be deflected from one side of the screen to the other, during short DTB time. By adjusting DTB time/ div control, the brightened portion can be extended, so as to fill the entire screen of the oscilloscope. The horizontal deflection starts only after the delay time t d from the beginning of the MTB sweep. Thus very small part of the waveform can be extended on the entire screen.

Waveforms of the Delayed Time Base Oscilloscope

The waveforms of the delayed time base oscilloscope are shown **in** the Fig



Analog storage oscilloscope:

The conventional cathode ray tube has the persistence of the phosphor ranging from a Few millisecond to several seconds. But sometimes it is necessary to retain the image for much 'longer periods, upto several hours. It requires storing of a waveform for a certain duration,' independent of phosphor persistence. Such a retention property helps to display the waveforms of very low frequency.

Mainly two types of storage techniques are used in cathode ray tubes which are:

i) Mesh storage and ii) Phosphor storage

Sampling Time Base:

The time base circuit of the sampling oscilloscope is different than the conventional oscilloscope. The time base of sampling oscilloscope has two functions:

i) To move the dots across the screen

ii) To generate the sampling command pulses for the sampling circuit.

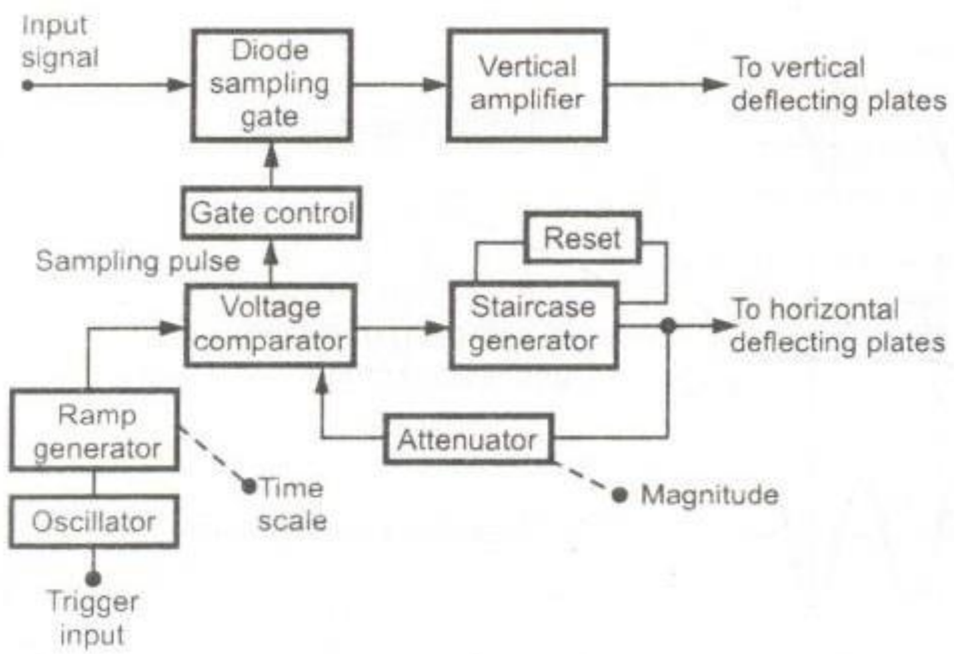
It consists of synchronous circuit, which determines the sampling rate and establishes a reference point in time with respect to the input signal. The time base generates a triggering pulse which activates the oscillator to generate a ramp voltage. Similarly it generates a stair case waveform. The ramp generation is based on the output of the synchronizing circuit.

Both the ramp as well as staircase waveforms are applied to a voltage comparator. This comparator compares the two voltages and whenever these two voltages are equal, it generates a samppng pulse. This pulse then momentarily bias the diodes of the sampling gate in the forward direction and thus diode switch gets closed for short duration of time.

The capacitor charges but for short time hence, it can charge to only a small percentage of the input signal value at that instant. This voltage is amplified by the vertical amplifier and then applied to the vertical deflecting plates. This is nothing but a sample. At the same time, the comparator gives a signal to the staircase generator to advance through one step. This is applied to horizontal deflecting plates, thus during each step of the stair case waveform, the spot moves across the screen. Thus the sampling time base is called a staircase-ramp generator in case of a sampling oscillosope.

Block diagram of Sampling Oscilloscope:

The block diagram of sampling oscilloscope is shown in the Fig.



The input signal is applied to the diode sampling gate. At the start of each sampling cycle a trigger inpu t pulse is generated which activates the blocking oscillator. The oscillator output is given to the ramp generator which generates the linear ramp signal. Since the sampling must be synchronized with the input signal freq\,lency, the signal is delayed in the vertical amplifier.

The staircase generator produces a staircase waveform which is applied to an attenuator. The attenuator controls the magnitude of the staircase signal and then it is applied to a voltage comparator. Another input to the voltage comparator is the output of the ramp generator. The voltage comparator compares the two signals and produces the output pulse when the two voltages are equal. This is nothing but a sampling pulse which is applied to sampling gate through the gate control circuitry.

This pulse opens the diode gate and sample is taken in. This sampled signal is then applied to the vertical amplifier and the vertical deflecting plates. The output of the staircase generator is also applied to the horizontal deflecting plates.

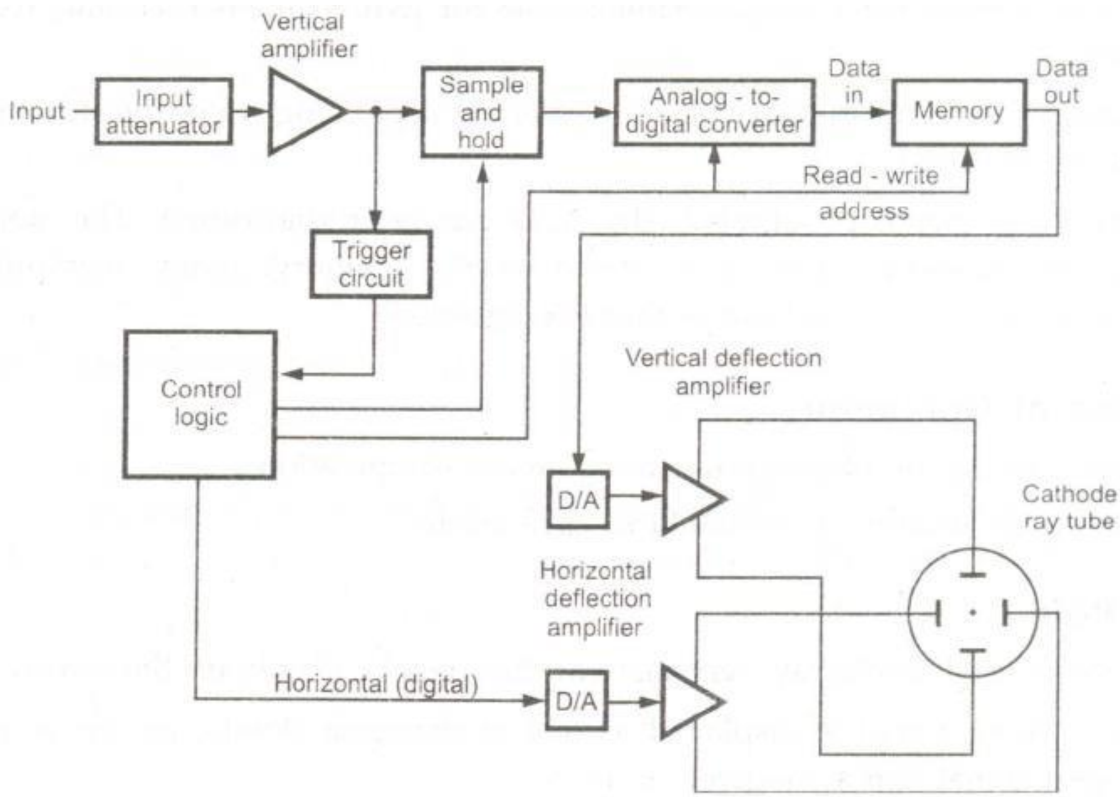
During each step of staircase the spot moves on the screen. The comparator output advances the staircase output through one step. After certain number of p\llses about thousand or so, the staircase generator resets. The smaller the size of the steps of the staircase generator, larger is the number of samples and higher *is* the resolution of the image.

Digital Storage Oscilloscope:

In this digital storage oscilloscope, the waveform to be stored is digitised ,md then stored in a digital memory. The conventional cathode ray tube is used in this oscilloscope hencethe cost is less. The power to be applied to memory is small and can be supplied by small battery. Due to this the stored image can be displayed indefinitely as long ,15 power is supplied to memory. Once the waveform is digitised then it can be further loaded into thecomputer and can be ana lysed in detail.

Block Diagram:

The block diagram of digital storage oscilloscope is shown in the Fig.



As done in all the oscilloscopes, the input signal is applied to the amplifier and attenuator section. The oscilloscope uses same type of amplifier and attenuator circuitry as used in the conventional oscilloscopes. The attenuated signal is then applied to the vertical amplifier.

The vertical input, after passing through the vertical amplifier, is digitised by an analog to digital converter to create a data set that is stored in the memory. The data set is processed by the microprocessor and then sent to the display.

To digitise the analog signal, analog to digital *(AID)* converter is used. The output of the vertical amplifier is applied to the *AID* converter section. The main requirement of *AID* converter in the digital storage oscilloscope is its speed, while in digital voltmeters accuracy and resolution were the main requirements. The digitised output needed only in the binary form and not in BCD. The successive approximation type of *AID* converter is most oftenly used in the digital storage oscilloscopes.

Modes of operation:

The digital storage oscilloscope has three modes of operation:

1. Roll mode ii) Store mode iii) Hold or save mode.

Roll mode:

This mode is used to display very fast varying signals, clearly on the screen. The fast varying signal is displayed as if it is changing slowly, on the screen. In this mode, the input signal is not triggered at all.

Recommended questions:

1. *Explain why time delay* is *necessary in oscilloscopes?*
2. *Sketch and explain the block diagram of delayed time base oscilloscope.*
3. *Explain with the help of waveforms, how a portion to be studied* is *brightened in delayed time base oscilloscope.*
4. *Describe the following storage techniques used in storage oscilloscopes:**[jun 09]***
   i) Mesh storage ii)Phosphor storage
5. *Compare the mesh and phosphor storage techniques.*
6. *Draw and explain the block diagram of digital storage oscilloscope.**[jul 07]***
7. *State the advantages of sampling oscilloscope*
8. *Explain the expanded mode operation of sampling oscilloscope*
9. *Explain the special function which can be performed by digital storage oscilloscope. Explain the applications of digital storage oscilloscope.**[jul08]***