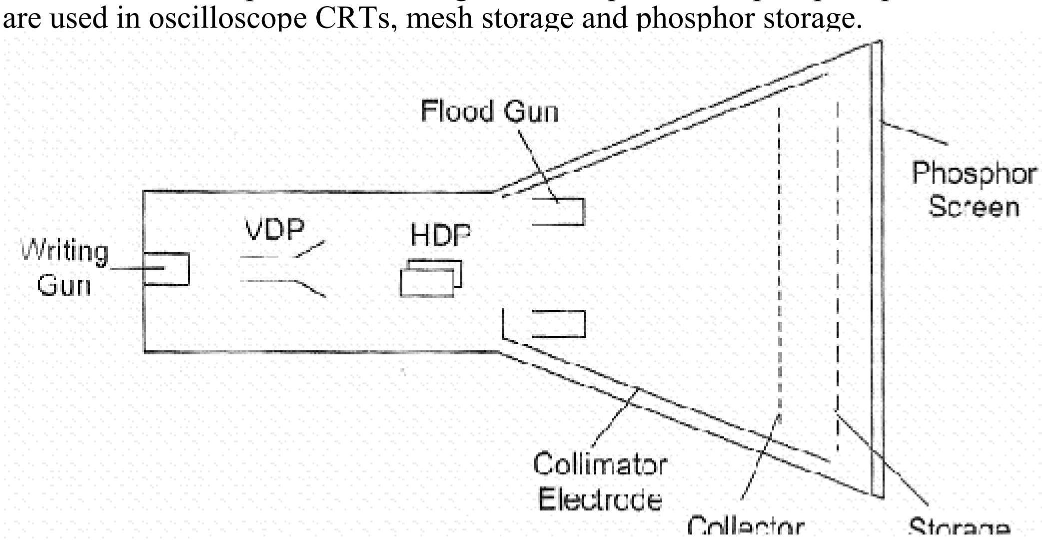
UNIT-5

1: Explain about storage oscilloscope with block diagram?

Ans:

Storage targets can be distinguished from standard phosphor targets by their ability to retain a waveform pattern for a long time, independent of phosphor persistence. Two storage techniques are used in oscilloscope CRTs, mesh storage and phosphor storage.



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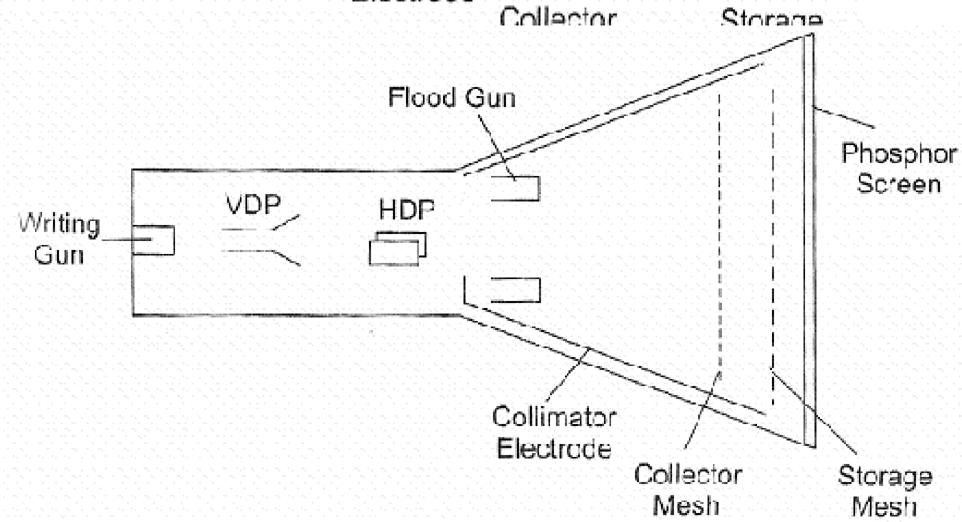

fig 1.1 Basic Elements of storage mesh CRT

A mesh storage CRT, shown in Fig. 1.1, contains a dielectric material deposed on a storage mesh, a collector mesh, flood guns and a collimator, in addition BO all the elements of a standard CRT. The storage target, a thin deposition of a dielectric material such as Magnesium Fluoride on the storage mesh, makes use of a property known as secondary emission. The writing gun etches a positively charged pattern on the storage mesh or target by knocking off secondary emission electrons. Because of the excellent insulating property of the Magnesium fluoride coating, this positively charged pattern remains exactly in the position where it is deposited. In order to make a pattern visible, a special electron gun, called the flood gun, is switched on (even after many hours). The electron paths ire adjusted by the collimator electrode, which constitutes a low voltage electrostatic lens system (to focus the electron beam), as shown in Fig. 1.2. Most of the electrons are stopped and collected by the collector mesh. Only electrons near the stored positive charge are pulled to the storage target with sufficient force to hit the phosphor screen. The CRT will now display the signal and it will remain visible as long as the flood guns operate. To erase the pattern on the storage mesh, a negative voltage is applied to neutralize the stored positive charge.

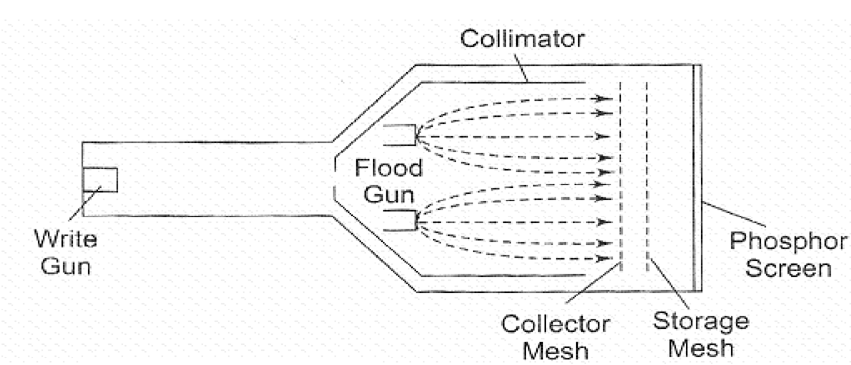

fig 1.2 Storage mesh CRT

Since the storage mesh makes use of secondary emission, between the first and second crossover more electrons are emitted than are absorbed by the material, and hence a net positive charge results.

Below the first crossover a net negative charge results, since the impinging electrons do not have sufficient energy to force an equal number to be emitted. In order to store a trace, assume that the storage surface is uniformly charge; and write gun (beam emission gun) will hit the storage target. Those areas of the storage surface hit by the deflecting beam lose electrons, which are collects by the collector mesh. Hence, the write beam deflection pattern is traced on the storage surface as a positive charge pattern. Since the insulation of the dielectric material is high enough to prevent any loss of charge for a considerable length of time, the pattern is stored. To view, the stored trace, a flood gun is used when the write gun is turned off. The flood gun, biased very near the storage mesh potential, emits a flood of electrons which move towards the collector mesh, since it is biased slightly more positive than the deflection region. The collimator ,a conductive coating on the CRT envelope with an applied potential, helps to align the flood electrons so that they approach the storage target perpendicularly When the electrons penetrate beyond the collector mesh, they encounter either a positively charged region on the storage surface or a negatively charged region where no trace has been stored. The positively charged areas allow the electrons to pass through to the post accelerator region and the display target phosphor. The negatively charged region repels the flood electrons back to the collector mesh. Thus the charge pattern on the storage surface appears reproduced on the CRT display phosphor just as though it were being traced with a deflected beam.

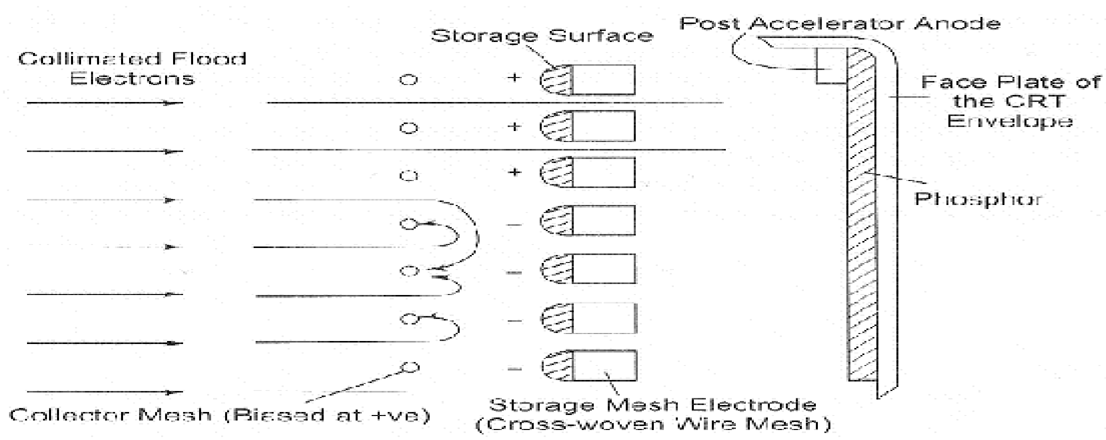

fig 1.3 Display of stroed charge pattern on a mesh

2. Draw the block Diagram of a Dual Trace CRO and explain it?

Ans:

Dual Trace Oscilloscope

Figure 2.1 shows the block diagram of dual trace oscilloscope which consist of following steps,

1. Single electron gun
2. Two separate vertical input channels
3. Attenuators and pre-amplifiers
4. Electronic switch.

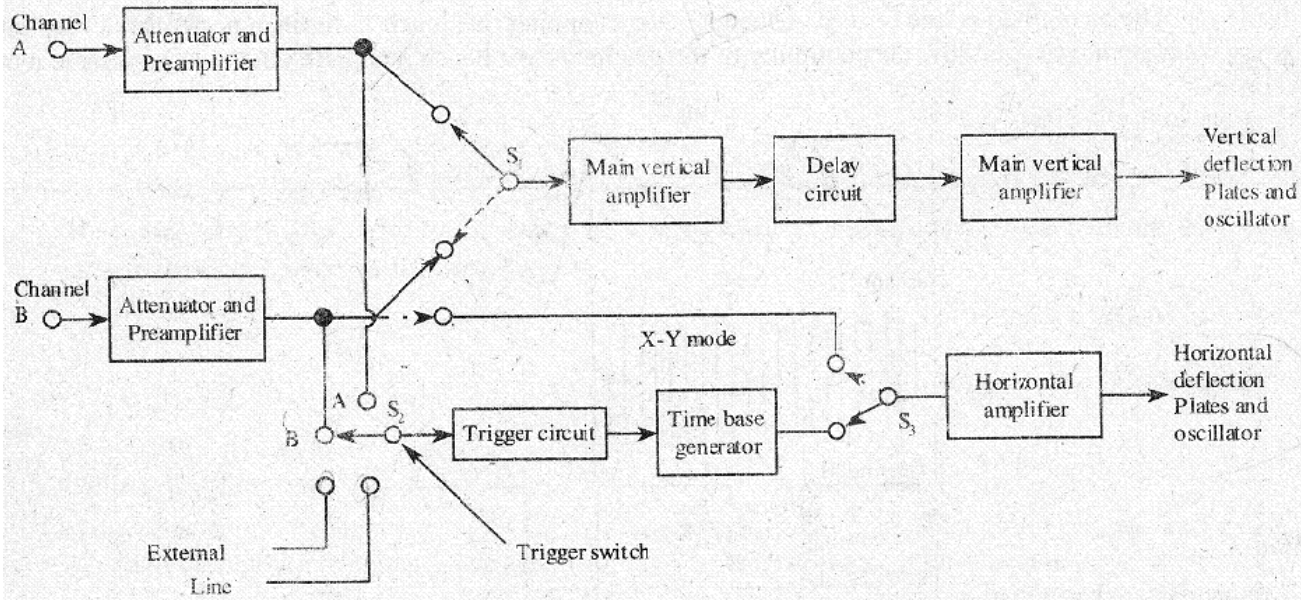

fig 2.1 Block Diagram of Dual Trace Oscilloscope

With the help of electronic switching the two separate input signals can be applied to single electron gun. Produces a dual trace display .Each separate vertical input channel uses separate attenuators and pre-amplifier stages, so, that the amplitude of each signal can be independently controlled. Output of the pre-amplifiers is given to the electronic switch, which passes one signal at a time into the main vertical amplifier of the oscilloscope. The time base-generator is similar to that of single input oscilloscope. By using switch S_2 the circuit can be triggered on either A or B channel, waveforms, or an external signal, or on line frequency. The horizontal amplifier can be fed from sweep generator or from channel B by switching S_1. When switch S, is in channel $B,$ its oscilloscope operates in the X-Y mode in which channel A acts as the vertical input signal and channel B as the horizontal input signal.

From the front panel several operating modes can be selected for display, like channel B only, channel A only, channels B and A as two traces, and signals A + B, A - B, B ~ A or - (A + B) as a single trace. Two types of common operating mode are there for the electronic switch, namely,

1. Alternate mode
2. Chop mode.

1. Alternate Mode

In case of alternate mode, electronic switch alternately connects the main vertical amplifier to channel A and B and adds a different D.C. component to each signal. Due to this D.C. component the beam alternately goes to the upper and lower half of the screen.

Switching is carried out at the start of each new sweep of the time base generator. To obtain the cathode ray tube spot it traces the channel A signal on one sweep and the channel B signal on the succeeding sweep. The switching rate of the electronic switch is synchronized to the sweep rate.

The alternate mode cannot be used for displaying very low frequency signals.

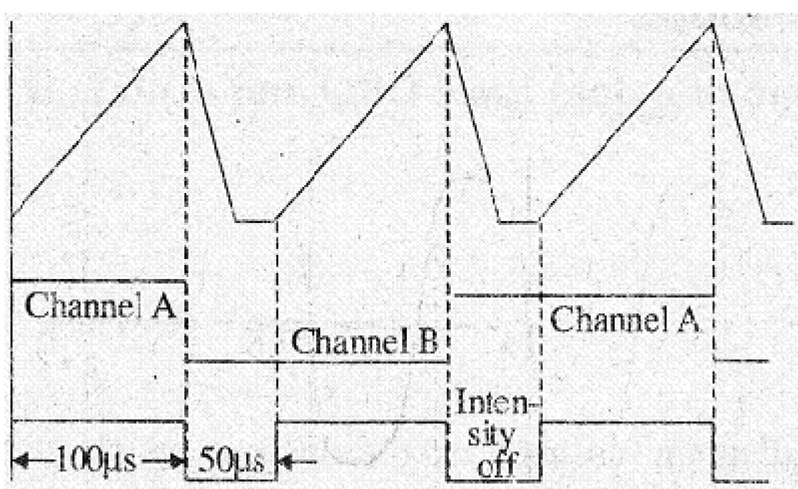

fig 2.2 Wae form of Dual trace oscilloscope in Alternate mode

2. Chop Mode

In chop mode electronic switch runs at a very high frequency of the order of 100-500 kHz. This results in connecting small segment of waveform A and waveform B, alternately to vertical amplifier to display it on the screen. The display will be a continuous line for each channel when chopping rate much faster than horizontal sweep rate. In case when the chopping rate is slow the continuity of the display is lost hence it is preferable to use alternate mode of operation.

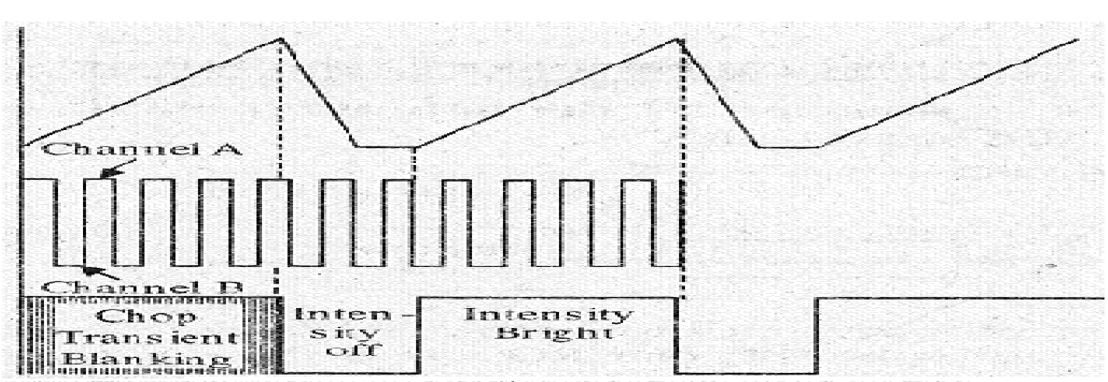

fig 2.3 Wave form of a Dual trace oscilloscope in chope mode

3. Explain with Neat Block Diagram of Digital Storage oscilloscope?

Ans:

Digital Storage Oscilloscope

Storage cathode ray tube has several limitations. They are as follows,

1. There is a short duration of time, in which it can preserve a stored waveform, so the waveform may lose.
2. Trace of storage tube is not as fine as that of a normal CRT.
3. Writing rate of the storage tube is less than that of a conventional CRT which in turn limits the speed of the analog storage oscilloscope.
4. It is more expensive than a conventional CRT and requires additional power supplies.
5. Only one image can be stored. For comparing two traces they are to be superimposed on the same and displayed together.

Digital storage oscilloscope is used to limit these limitations. In DSO, the waveform to be stored is digitized, stored in a digital memory and retrieved for display on the storage oscilloscope.

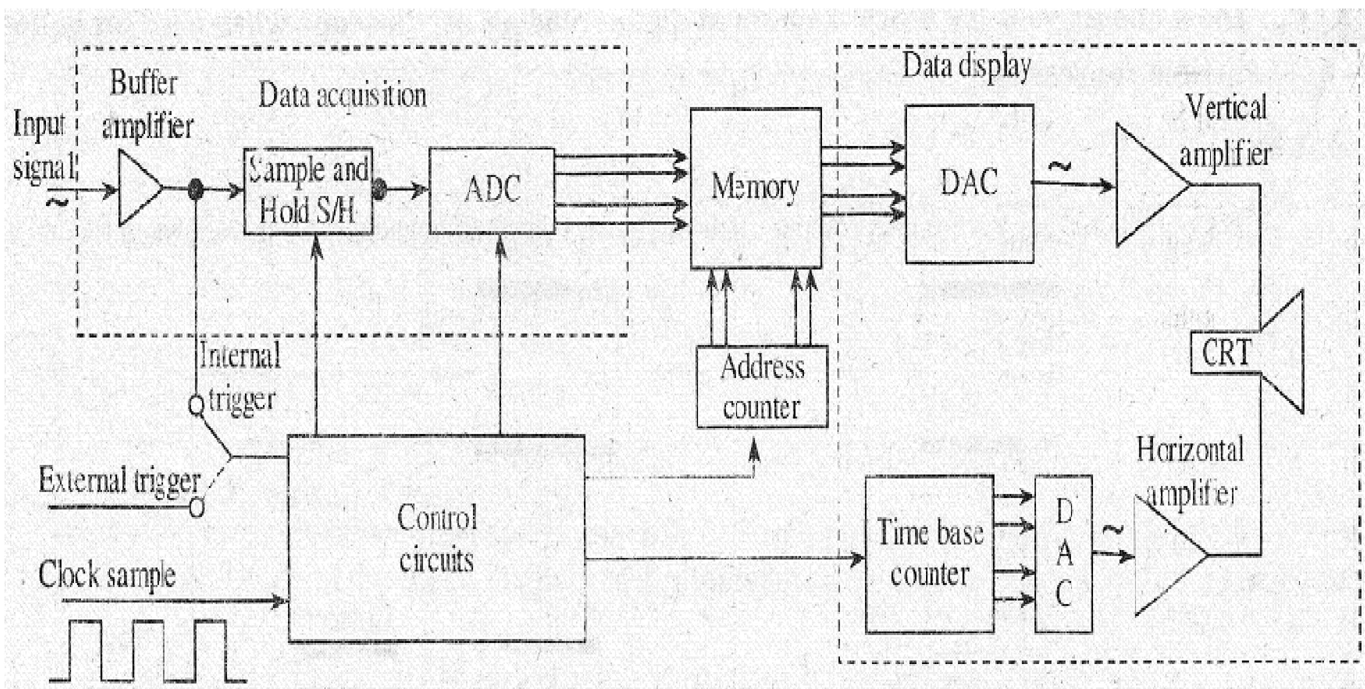

fig 3.1 Block diagram DSO

Stored waveform is continuously displayed by repeatedly scanning it. Therefore a conventional CRT can also be used for the display. The stored display can be displayed continuously as long as the power is applied to the memory which can be supplied from a small battery.

Digitized waveform can be analyzed by oscilloscope or by reading the contents of the memory into the computer. Display of the stored data is possible in both amplitude versus time and x-y modes. In DSO, fast memory readout is used for CRT display in addition to this a slow readout is also possible which is used for development of hard copy externally.

Figure shows the block diagram of DSO which consists of,

1. Data acquisition
2. Storage
3. Data display.

Data acquisition is earned out with the help of both analog to digital and digital to analog converters, which is used for digitizing, storing and displaying analog waveforms. Overall operation is controlled by control circuit which is usually consists of microprocessor.

Data acquisition portion of the system consist of a Sample-and-Hold (S/H) circuit and an analog to digital converter (ADC) which continuously samples and digitizes the input signal at a rate determined by the sample clock and transmit the digitized data to memory for storage. The control circuit determines whether the successive data points are stored in successive memory location or not, which is done by continuously updating the memories.

When the memory is full, the next data point from the ADC is stored in the first memory location writing over the old data.

The data acquisition and the storage process is continues till the control circuit receive a trigger signal from either the input waveform or an external trigger source. When the triggering occurs, the system stops and enters into the display mode of operation in which all or some part of the memory data is repetitively displayed on the cathode ray tube.

In display operation, two DACs are used which gives horizontal and vertical deflection voltage for the CRT Data from the memory gives the vertical deflection of the electron beam, while the time base counter gives the horizontal deflection in the form of staircase sweep signal. The screen display consist of discrete dots representing the various data points but the number of dot is very large as 1000 or more that they tend to blend together and appear to be a smooth continuous waveform. The display operation ends when the operator presses a front-panel button and commands the digital storage oscilloscope to begin a new data acquisition cycle.

4. Draw the simplified block diagram of the oscilloscope and explain in detail?

Ans: SAMPLING OSCILLOSCOPE

An ordinary oscilloscope has a B.W. of 10 MHz the HF performance can be improved by means of sampling the input waveform and reconstructing its shape from the sample, i.e. the signal to be observed is sampled and after a few cycles sampling point is advanced and another sample is taken. The shape of the wave form is reconstructed by joining the sample levels together. The sampling frequency may be as low as 1/10th of the input signal frequency (if the input signal frequency is 100 MHz, the bandwidth of the CRO vertical amplifier can be as low as 10 MHz). As many as 1000 samples are used to reconstruct the original waveform.

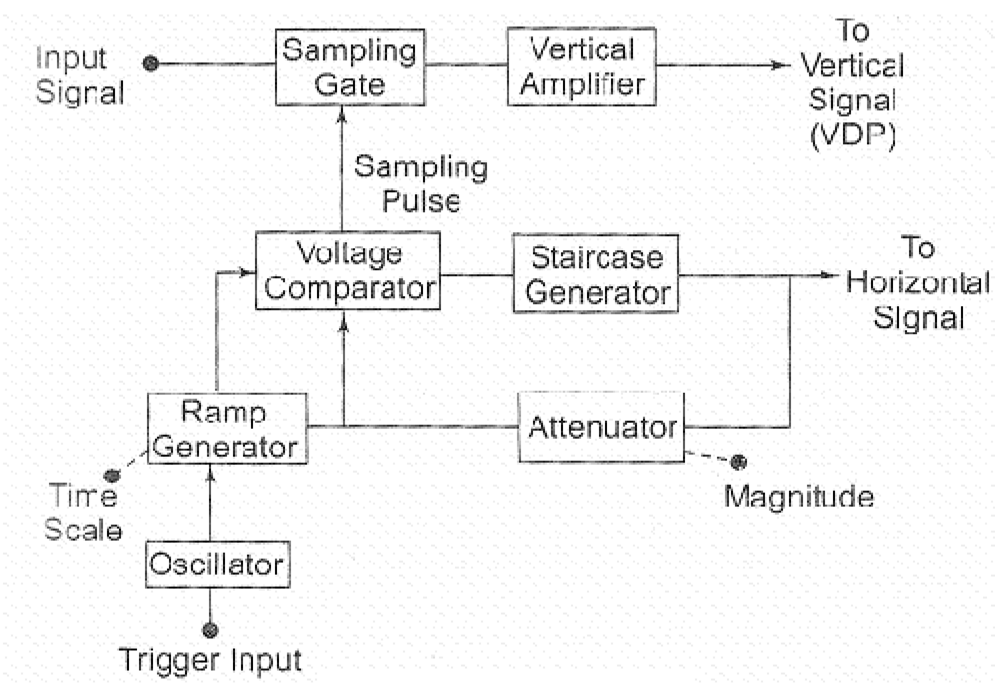

fig 4.1 Sampling Oscilioscope

Fig 4.1 shows a block diagram of a sampling oscilloscope. The input is applied to the sampling gate. The input waveform is sampled whenever a sampling pulse opens the sampling gate. The sampling must be synchronized with the input signal frequency. The signal is delayed in the vertical amplifier, allowing the horizontal sweep to be initiated by the input signal. The waveforms are shown in fig 4.2

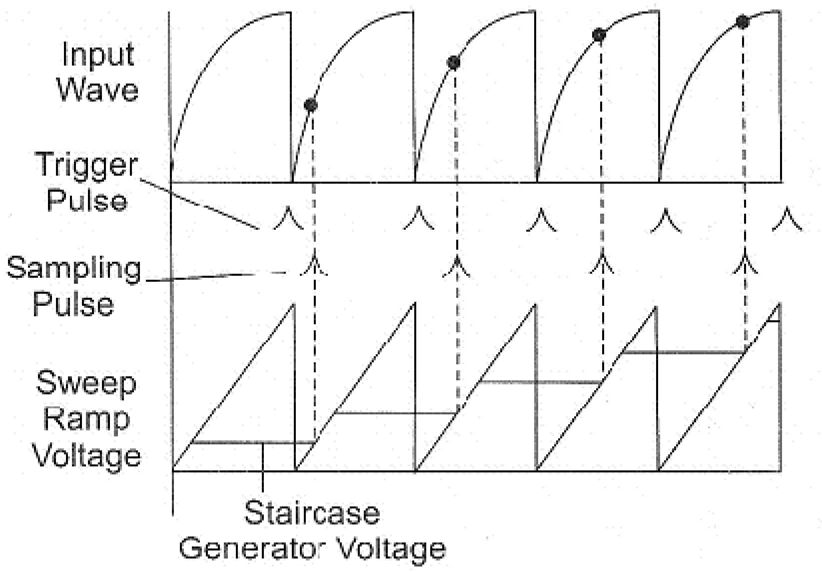

fig 4.2 Various Wave Forms at each block of oscilloscope

At the beginning of each sampling cycle, the trigger pulse activates an oscillator and a linear ramp voltage is generated. This ramp voltage is applied to a voltage comparator which compares the ramp voltage to a staircase generate-When the two voltages are equal in amplitude, the staircase advances one step and a sampling pulse is generated, which opens the sampling gate for a sample of input voltage.
The resolution of the final image depends upon the size of the steps of the staircase generator. The smaller the size of the steps the larger the number of samples and higher the resolution of the image

5. What are the difference between digital storage oscilloscope and conventional storage oscilloscope?

Ans:

Digital Storage Oscilloscope (DSO)	**Conventional Storage Oscilloscope (Analog Storage Oscilloscope (ASO))**
1. It can store the given signal indefinitely as long as the small amount of power is supplied to the memory.	1. In this oscilloscope heavy amount-of power is to be supplied to the storage CRT.
2. It always collects the data and stops when triggered.	2. It collects the data only after triggering.
3. It employs normal CRT, hence the cost of the tube is much cheaper than the storage tube used in ASO.	3. The cost of the tube is costlier than the storage tube used in DSO.
4. It can produce bright image even for high frequency signals.	4. It cannot produce bright image for high frequency signals.
5. In this oscilloscope, time base is generated, by a crystal clock.	5. In this oscilloscope, time base is generated by a ramp circuit.
6. It has higher resolution than ASO.	6. It has lower resolution than DSO.
7. It has less operating speed than ASO.	7. It has high operating speed than DSO.
8. Because of aliasing effect the useful storage ' bandwidth is limited.	8. It doesn't have aliasing effect.

9. It cannot function under variable persistence storage mode.	9. It can function under variable persistence storage mode.

6. Explain the method of finding phase, frequency relation ship of two waveforms using Lissajous figures?

Ans: Phase Measurement

When sinusoidal voltages simultaneously applied to vertical and horizontal plates, the pattern, appearing on the CRT is called as Lissajous pattern in this method the standard known frequency is applied to X-plate or horizontal plate. The resulting pattern appeared on the screen depends on phase relationship between the two frequencies.

Equal voltages of same frequency but of different phase angles- cause the pattern to vary from a straight diagonal line to ellipses of different eccentricities. The sine of the phase angle between the voltages is given by equation,

$$\sin\varphi = y_1/y_2 = x_1/x_2$$

As shown in figure 6.1 the gains of horizontal or vertical amplifiers are adjusted so that ellipse fits exactly into a square marked by lines on the screen.

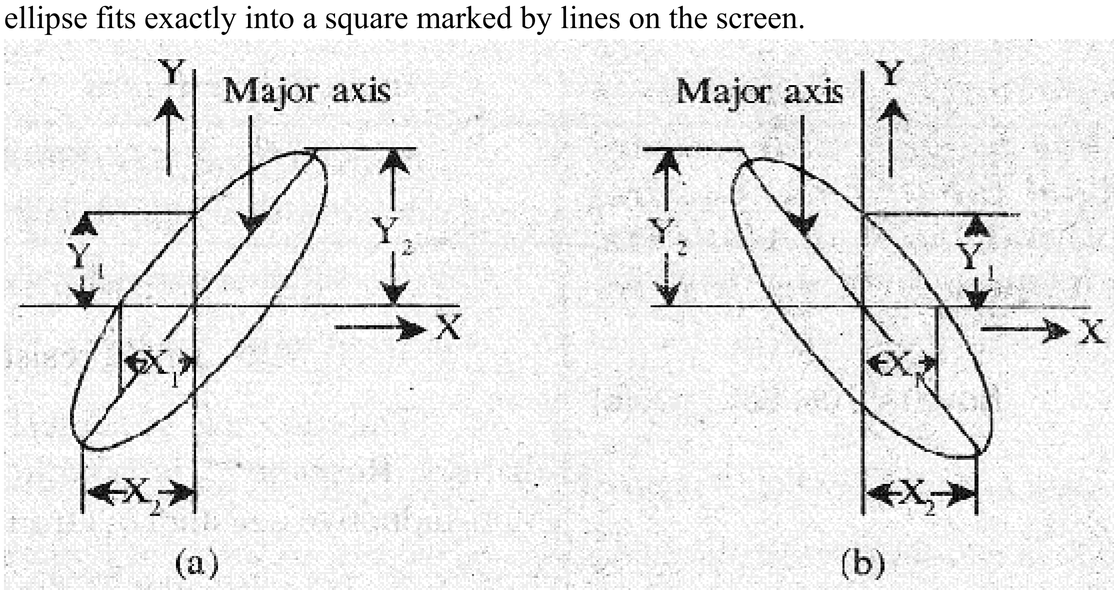

fig 6.1 Determinig Angle of phase shift

Frequency Measurement

Lissajous pattern also helps to measure frequency. The signal whose frequency is to be measured is given I F-plates or vertical plates and the signal whose frequency is given to X-plates or horizontal plates. Now the know frequency or standard frequency is adjusted so Lissajous patterns can be obtained on the screen which depends on the ratio of two frequencies. In the given figure (2),

Let, f_v - Unknown frequency signal applied to vertical plates.

f_h - Known frequency signal applied to horizontal plates.

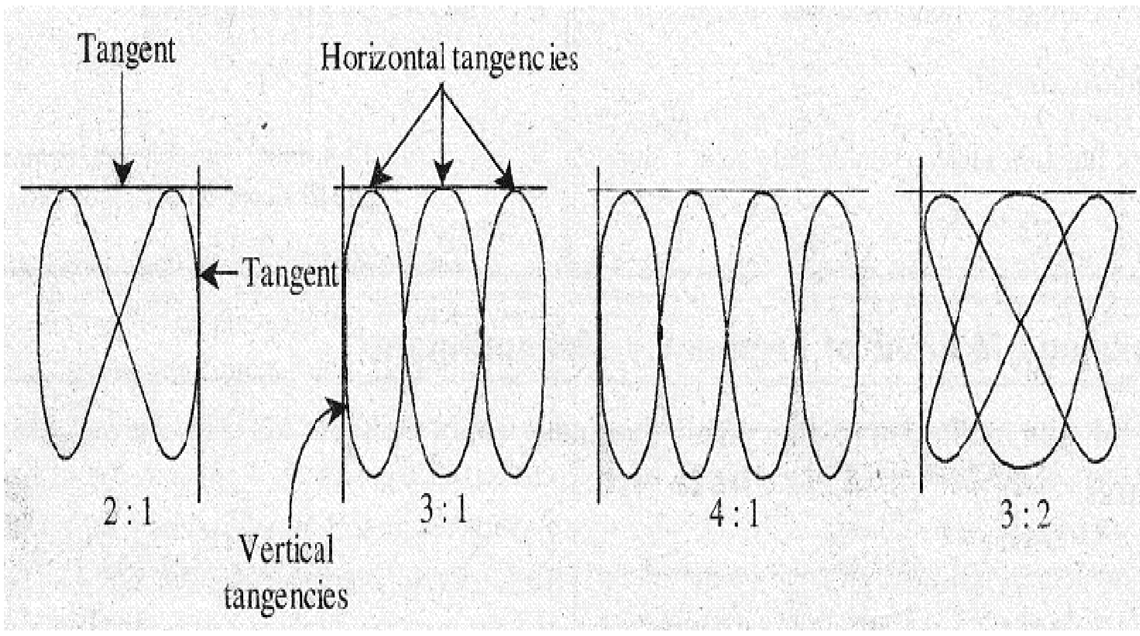

fig 6.2 Lissajous patterns allowing different frequencies ratios

Two lines are drawn, one vertical and one horizontal so that they do not pass through any intersection o Lissajous pattern. Then the number of intersections of the horizontal and vertical lines with the Lissajous patterns and counted separately.

So after finding the tangencies if we know we can easily calculate the unknown frequency applied to vertical plate.

All electronic circuits in the oscilloscope like attenuators, time base generators, amplifiers cause some amount of time delay while transmitting signal voltage to deflection plates.

We also know that horizontal signal is initiated or triggered by some portion of output signal applied to vertical plates of CRT. So the delay line is used to delay the signal for some time in the vertical section of CRT.

7. Explain the logic of a time base of a frequency counter?

Ans:

The logic diagram of a time base for a frequency counter is shown in figure, the expected output from the time base are,

(i) Reset pulse
(ii) Gating pulse
(iii) Store pulse.

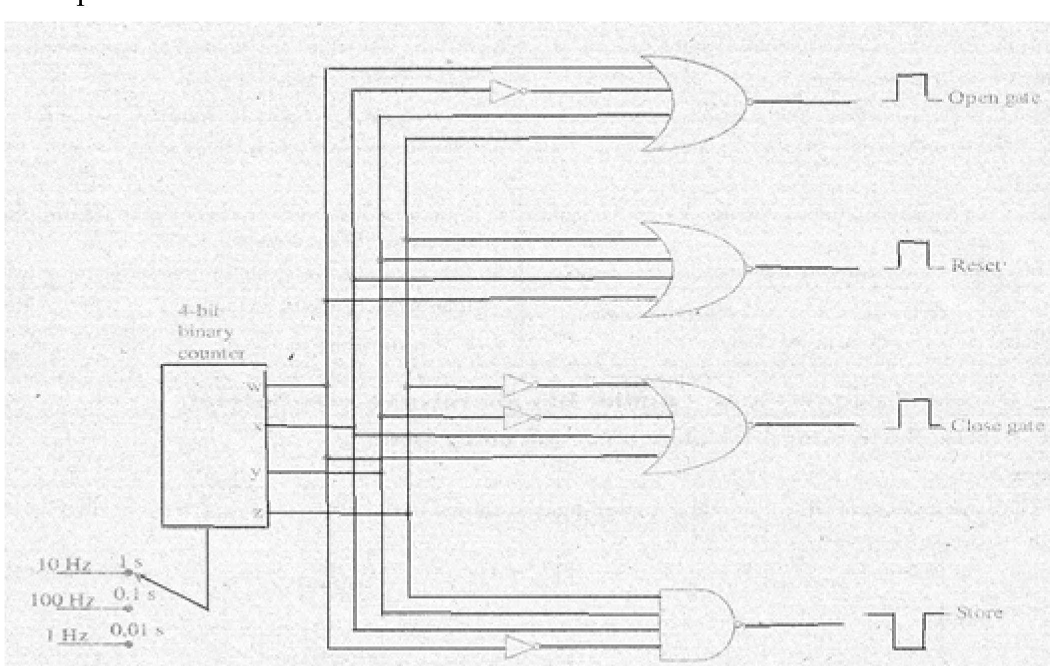

fig 7.1 Time Base of Frequency Conuter

The above pulses must be produced without overlap. If the wanted gate pulse duration is larger than the frequency period of the crystal then the frequency of crystal oscillator is divided by powers of ten. The binary counter consist of 1 6 states since it is a 4 bit counter The reset pulse is provided by the decoded zero state of the binary counter. To produce open gate pulse the 2^{nd} state of the binary counter is decoded. To produce a delay period after the reset pulse the 1^{st} state of the binary counter was not .used. The gate remains, open In between 2^{n} state and 1 2^{1}' state of the binary counter. Therefore, the close gate pulse is produced by the decoded 1 2 state of the binary counter. To produce a delay before storing the counter is latch during 14^{th} state of the binary counter; the 1 3 ' state i» not decoded The non overlap between the reset and store pulses can provided-by the non decoded 15^{th} state of the binary counter. A switch is used in this arrangement, to select the, gate time intervals of the frequency counter. In the above figure 1 sec, 0.1 sec, 0.01 sec are the available gate time intervals and 1 Hz, 1 0 Hz, 100 Hz are the available input frequencies

8. Explain in detail about various types of attenuators?

Ans:

ATTENUATORS

Attenuators are designed to change the magnitude of the input signal seen at input stage, while presenting constant impedance on all ranges at the attenuator input.

A compensated RC attenuator is required to attenuate all frequencies equal without this compensation, HF signal measurements would always have to take the input circuit RC time constant into account.

The input attenuator must provide the correct 1 -2-5 sequence while maintaining a constant input impedance, as well as maintain both the input impedance a: attenuation over the frequency range for which the oscilloscope is designed.

Uncompensated Attenuators

The circuit diagram shown in Fig. 8.1 gives a resistive divider attenuator connected to an amplifier with a 10 pf input capacitance. If the input impedance of the amplifier is high, the input impedance of the attenuator is relatively constant immaterial of the switch setting of the attenuator.

The input impedance, as seen by the amplifier, changes greatly depending on the setting of the attenuator. Because of this, the RC time constant and frequency response of the amplifier are dependent on the setting of the attenuator, which an undesirable feature.

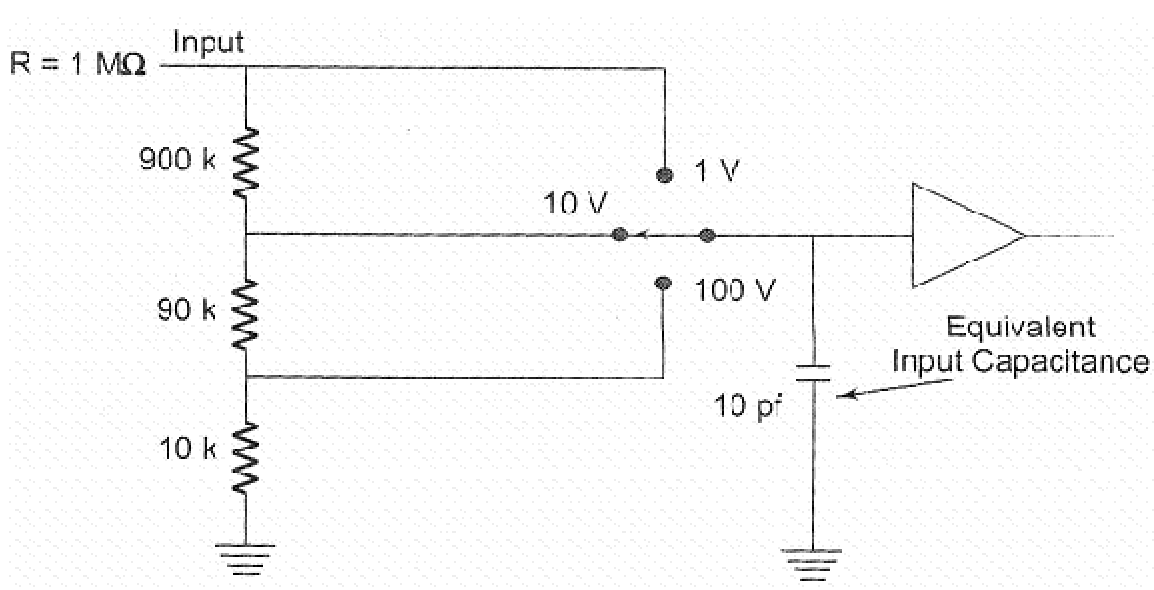

fig 8.1 Uncompensated atteuntor

Simple Compensated Attenuator

The diagram in Fig.8.1 shows an attenuator with both resistive and capacitive voltage dividers. The capacitive voltage dividers improve the HF response of the attenuator. This combination of capacitive and resistive voltage dividers is known as a compensated attenuator. For oscilloscopes where the frequency range extends to 100 MHz and beyond, more complex dividers are used.

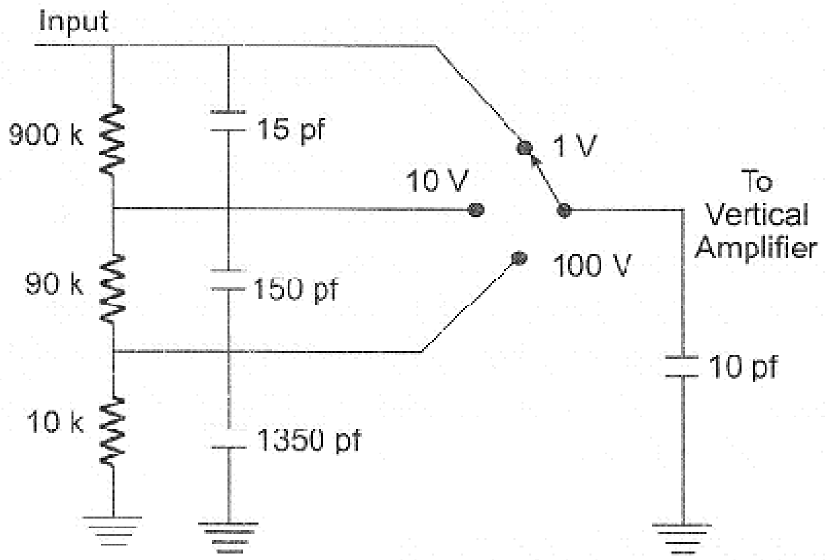

fig 8.2 Simple Compensated Attenuator

Fig 8.2 shows an attenuator divider between the input and output of the vertical deflection pre-amplifier. The input attenuator provides switching powers of 10, while attenuator at the output of the vertical preamplifier provides 1-2-5 attenuation.

Practically all oscilloscopes provide a switchable input coupling capacitor, as shown in Fig. 8.2

The input impedance of an oscilloscope is 1 MΩ which is shunted with an input capacitance of 10-30 pf. If a probe were connected to the oscilloscope, the input impedance at the probe tip would have a greater capacitance because of the added capacitance of the probe assembly and of the connecting shielded cable. If it is desired for HF oscilloscopes to have an input capacitance of much less than 20-30 pf, an attenuator probe is used. Figure 8.1 shows a 10 to 1 attenuator probe connected to the input of the oscilloscope.

Within the probe tip is a 9MΩ resistor and shunted across this resistor is a capacitor .This capacitor is adjusted so that the ratio of the shunt capacitance to the series capacitance is exactly 10 to 1.

The attenuator probe often called a 10 to 1 probe provides an approximately 10 to 1 reduction in the input capacitance. However, it is also gives a 10 to 1 reduction in overall oscilloscope sensitivity.

The input capacitance is not constant from one oscilloscope to another hence the probe is provided with an adjustable compensating capacitor .If the ratio of the series to shunt is not adjusted precisely to 10 to 1; the frequency response of the oscilloscope will be flat.

9. Explain in detail about Digital read out oscilloscope?

Ans: The digital read out oscilloscope instrument has a CRT display and a counter display. The diagram shown is of an instrument where the counter measures the time (Fig. 9.1)

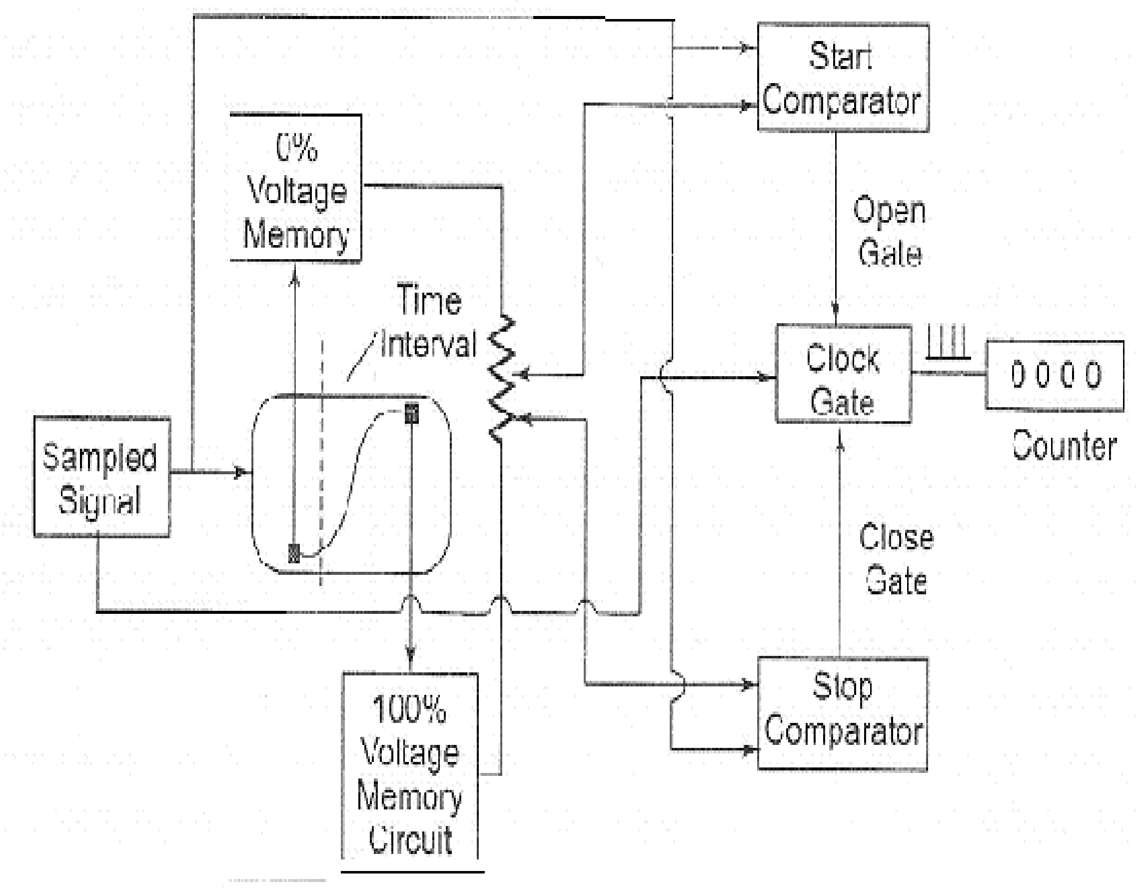

fig 9.1 Block diagram of a digital readout oscillscope when measuring voltage

The input waveform is sampled and the sampling circuit advances the sampling position in fixed increments, a process called strobing. The equivalent me between each sample depends on the numbers of sample taken per cm and the sweep time/cm, e.g. a sweep rate of 1 nano-sec/cm and a sampling rate of J samples/cm gives a time of 10 pico-sec/sample.

Figure 9.1 shows a block diagram of a digital read out oscilloscope when measuring voltage.
Two intensified portions of the CRT trace identify 0% and 100% zones position. Each zone can be shifted to any part of the display. The voltage divider Bps between the 0% and 100% memory voltage

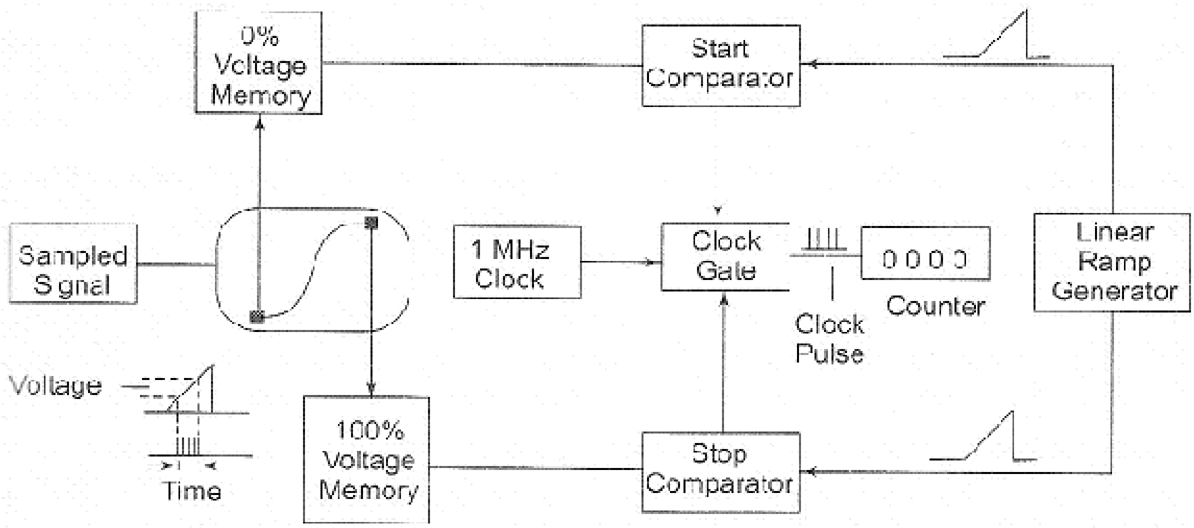

fig 9.2 Voltage to time conversion

are set for start and stop timing, The coincidence of any of the input waveforms with the selected percentage point is sensed by this voltage comparator. The numbers of the clock pulse which correspond to the actual sample taken are read out digitally in a Nixie display tube in ns, µs, ms or seconds.
Figure 9.2 shows a block diagram of a digital readout CRO when used for voltage to time conversion.

The CRT display is obtained by sampling the 0% reference voltage as chosen by the memory circuit. A linear ramp generator produces a voltage; when the ramp voltage equals the 0% reference the gate opens. When the ramp equals 100% reference the gate closes. The number of clock pulses that activate the counter is directly proportional to the voltage between the selected references and is read out in mV or volts by the Nixie tube display.

10. Discuss in detail about
(i) A and B chopped
(ii) A and B alternate?
Ans:

(i) A and B Chopped Display Mode

In chopped display mode of dual-trace oscilloscope, the electronic switch switches between the channels A and B at very high frequency (usually at 100-500 kHz). Due to very fast switching between the input channels, small segments (of about 1 us duration) of each input waveform get coupled alternately to the vertical amplifier and get traced on the screen. Thus, the display of input signal waveform will be a dashed-line trace of the actual input waveform, with small gaps between its segments. The continuity of the trace of the waveform depends on chopping (i.e., switching) frequency and the frequency of the input signal. Usually, the chopping frequency must be higher than the input signal frequency and sweep frequency. In chop mode, the traces of high frequency signals do not appear continuously as shown in fig 10.1. Whereas in case of low frequency signals, the gaps between the

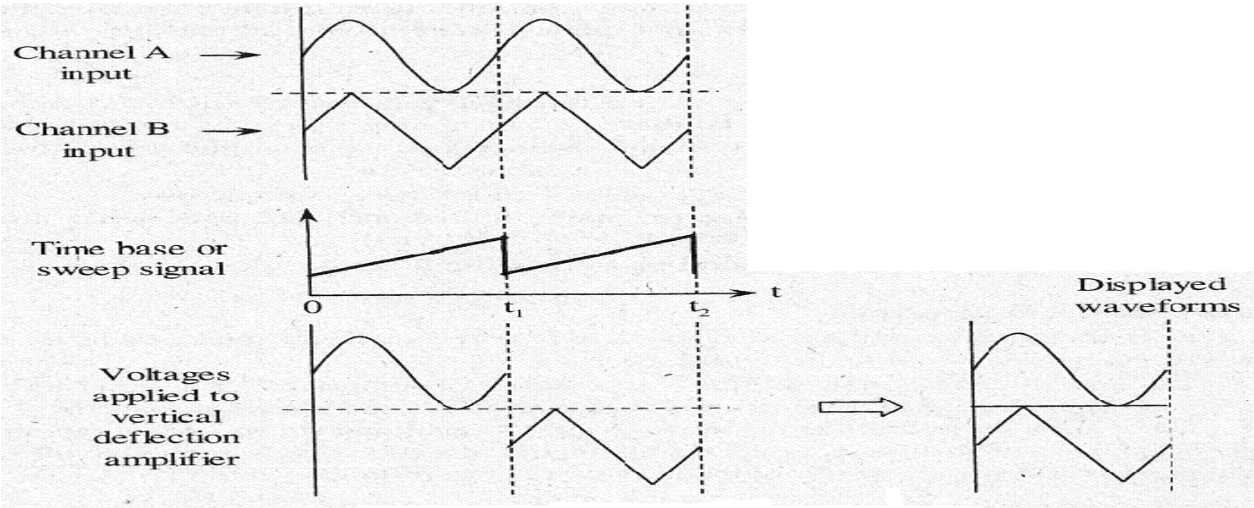

fig 10.1 A and B chopped mode

segments are so small that the trace of low frequency signal appears to be a continuous waveform. Hence, chop mode display is usually preferred for low frequency signals.

(ii) A and B Alternate Display Mode

The alternate display mode also involves alternate switching of the input signals to the vertical amplifier with the help of an electronic switch but at low switching rates.

In this mode, the electronic switch is allowed to switch between the input channels at a frequency equal to the sweep frequency. Due to this, the signal on channel A gets connected to the vertical amplifier and is traced on the CRO screen during one sweep. Similarly, the signal on channel B gets traced during the succeeding sweep, as shown in fig 10.2. As the two input waveforms are traced at different times, they do not appear to be displayed simultaneously on the screen.

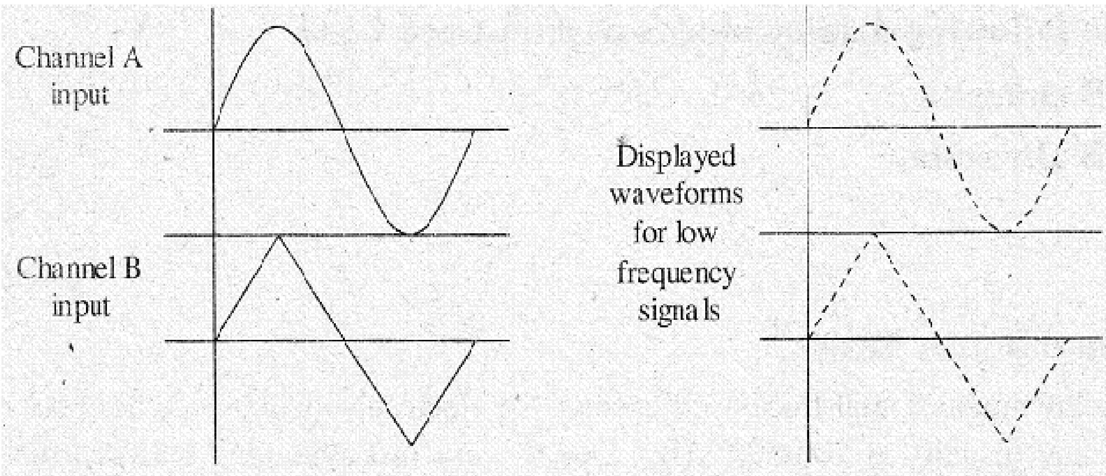

fig 10.2 A and B Alterative mode

The alternate mode is preferred for high frequency signals (rather than low frequency signals) because the waveform traces appear to be continuous and displayed simultaneously due to high repetition frequency.

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