UNIT 4
Electronic Instruments

Instrumentation is the technology of measurements which serves not only science but all branch of engineering medicine, and almost every human endeavour. The knowledge of any parameter largly depend on the measurments. The instruments which are used to measure various quantities such as temperature, pressure, and electrical ~~quantities~~ parameters are known as measuring instruments. There are three basic electrical quantities in the electronic measurement are current, Voltage and Power. The instrument which are use to measure current called ammeter, while the instruments used to measure Voltage called Voltmeter. The instruments which are used to measure power is called Power meter or wattmeter.

There are two types of measuring instruments available in the laboratory, scientific organization or industries namely Analog Instruments and Digital Instruments. Analog meter requires no power supply, they give a better visual indication of changes and suffer less from electric noise and isolation Problem. These meters are simple and inexpensive.

Digital meters are on the other hand offer high accuracy, have a high input impedance and smaller in size. They give an unambigious reading at greater viewing distances. The output can be easily interface with external equipment in addition to a visual readout.

Digital instruments are rapidly replacing their analog counterparts. Our parameter of interest in a laboratory environment are (I) Voltage (II) current (III) Power (IV) frequency (V) logic. The block diagram of an digital instruments are as shown in the figure (1).

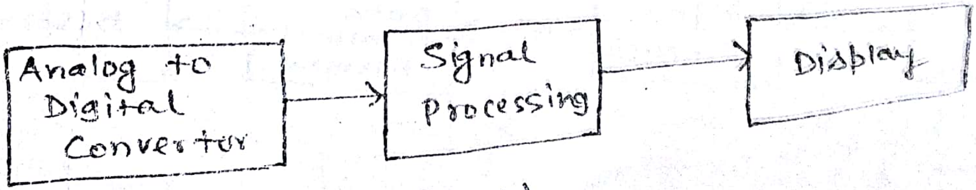


Fig (1)

Every digital instruments Consists of a Analog to digital converter in its input stage. It is used to change analog input signals into equivalent digital signals. It is an integral part of any digital instruments.

The digital form of measurement can be used to display the measured quantity numerically instead of deflection in conventional analog meters. Data in digital form facilitate various operations that are normally required in signal processing.

Digital Voltmeters (DVM)

DVMs are measuring instruments that converts analog voltage signal into into a digital or numeric readouts. The digital readout can be displayed on the front pannel and also used as an electrical digital output signal. A DVM is capable of measuring analog DC voltages. However with appropriate signal conditioners preceeding the input of the DVM quantities such as ac voltages, ohms, dc and ac currents, temperature and pressure can be measured. There are several varieties of DVM which differs in various ways such as Number of digits, accuracy, speed and output types. A DVM having outstanding operating and performance characteristics over analog meters, as listed below.

(1) Input ranges from + 1.000 V to +1000 V with automatic range selector.

(2) Accuracy is as high as ± 0.005 % of the reading.

(3) Resolution 1 part in million (1 μV can be measured on 1V range).

(4) Input resistance typically 10 MΩ to avoid loading effect.

5) Reading speed is very high due to digital display.

6) It size is small and portable.

7) output in BCD form capable to print output and processing.

The basic block diagram of DVM is as shown in fig (2)

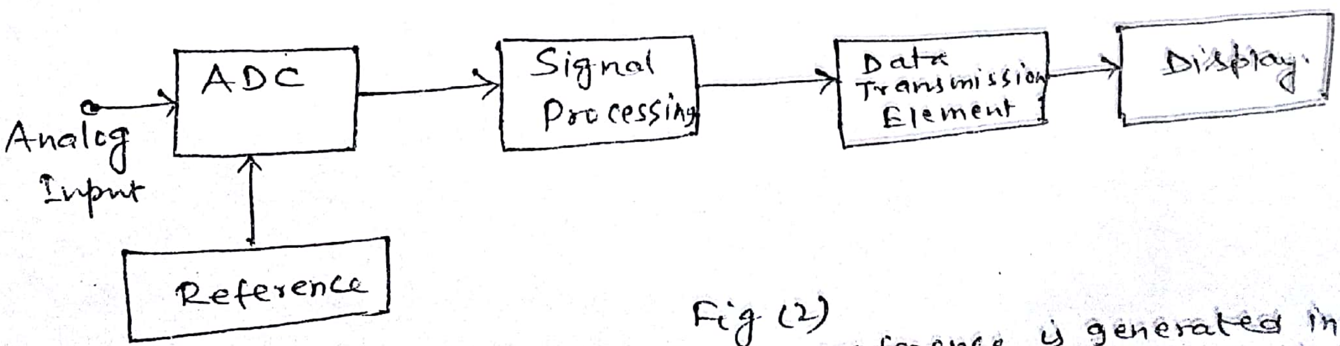


Fig (2)

Every ADC require a reference. The reference is generated internally and it depend on type of ADC. The output of ADC is decoded and signal is processed in the decoding stage. Such decoding stage is necessary to seven segment display. The data from decoder is then transmitted to the display. A data transmission may be latch, counter etc as per requirements.

RAMP TYPE DVM

The operating principle is to measure the time that a linear ramp takes to change the input level to the ground level or vice versa. This time period is measured with ~~the~~ an electronic time interval counter and the count is displayed as a number of digits on an indicating display unit. The operating principle and block diagram of a ramp type DVM is shown below, fig (1) & fig (2).

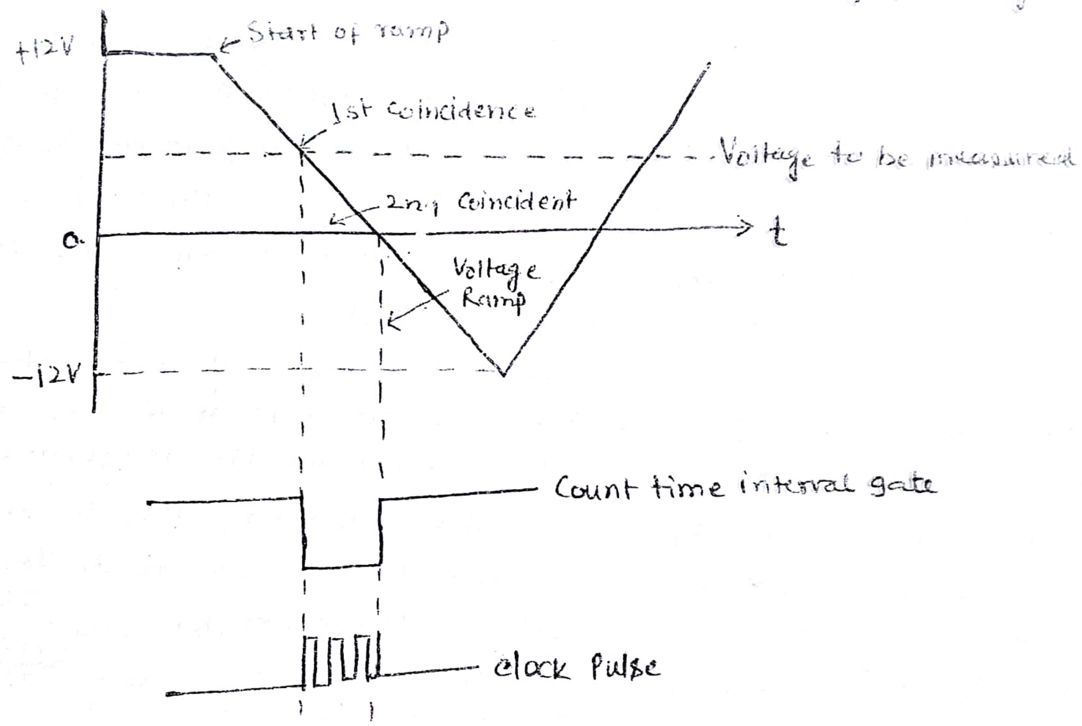


Fig (1)

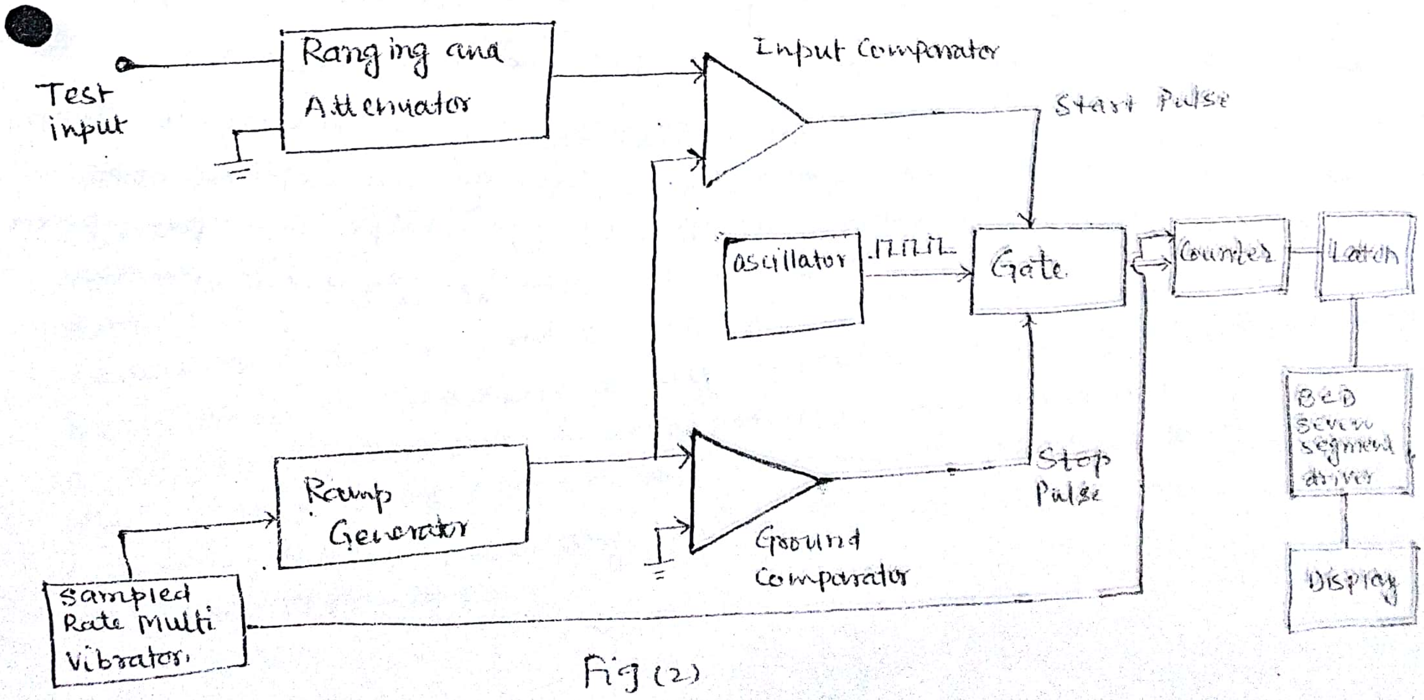


Fig (2)

The ramp may be Positive and negative. In this case negative ramp has been selected. At the start of the measurement ramp voltage is initiated (Counter is reset to zero). The ramp voltage is continuously compared with the voltage that is being measured. At the instant when two voltage becomes equal, a coincidence generates a Pulse which opens a gate, i.e. the input comparator generates start pulse. The ramp continues until the 2nd comparator circuit senses that the ramp has been reached zero value. The ground comparator compare the ramp with ground when the ramp voltage equal to zero or reaches ground potential, the ground comparator generates a stop pulse. The output pulse from this comparator close the gate. The time duration of the gate opening is proportional to the input voltage value.

In the time interval between the start and stop pulses, the gate opens and oscillator circuit drives the counter. The magnitude of ~~counter~~ the count indicates the magnitude of input voltage, which is displayed by readout. Therefore, the voltage is converted into time and the time count represents the magnitude of the voltage. A sample rate multivibrator determine the rate of cycle of measurements. The sample rate circuit provides an initiating pulse for the ramp generator to start the next ~~[illegible]~~ ramp voltage. At the same time a reset pulse is generated which reset the counter to the zero state. Any DVM has a fundamental cycle sequence which involves sampling, displaying and reset sequence.

A ramp technique circuit is easy to design and its cost is low. Also the output pulse can be transmitted over long feeder lines. Large errors are possible when noise is superimposed on the input signal. Input filters are usually required with this type of convertor.

(*) and sampled rate multivibrator gives a pulse which initiates the ramp generator.

Digital Multimeters

All digital meters employ some kind of Analog to digital (A/D) Converters and have a visible readout display at the Converter output. A digital meters offers high accuracy, have a high input impedance and are small in size. They gives an unambigious reading at greater viewing distances. The output available is electrical for interfacing with external equipment to a visual readout.

A basic digital Multimeter (DMM) is made up of several A/D converters, circuitry for counting and an attenuation circuit. A basic diagram of a DMM is shown in fig (1).

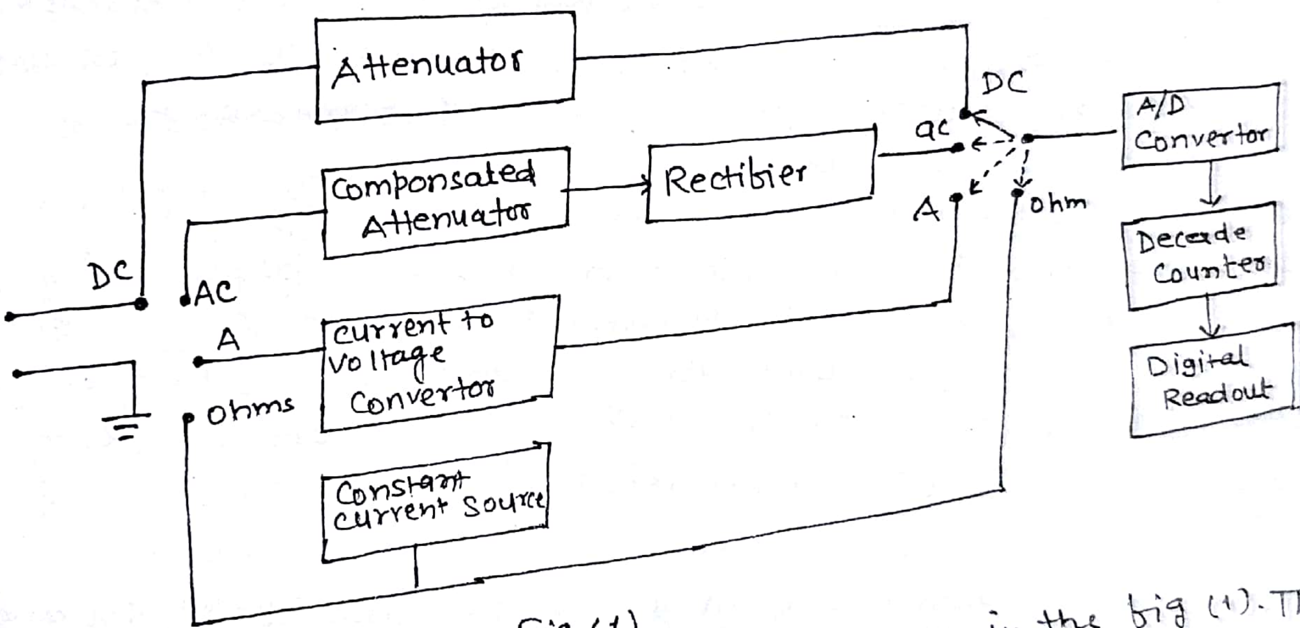


Fig (1)

The current to voltage Converter is shown in the fig (1). The current is measured Causes a voltage drop which is perportional to the current, to be developed across the resistor. This voltage drop is the input to the A/D converter, thereby providing a reading that is proportional to the unknown current.

Resistance is measured by passing a known current, from a constant current source, through an unknown resistance. The Voltage drop across the resistor is applied to the A/D Converter, thereby producing an indication of the value of the unknown resistance.

Cathode Ray Oscilloscope (CRO)

The CRO is Probably the most versatile tool for the development of electronic circuits and Systems. The CRO allows the amplitude of electrical signals, whether they are voltage, current, or Power to be displayed as a function of time. The CRO depends on the movement of an electron beam which is bombarded on a screen Coated with a fluorescent material to Produce a visible spot. The heart of the oscilloscope is the Cathode Ray Tube (CRT) which makes the applied signal Visible by the deflection of a thin beam of electrons. Since the electron has practically no weight, and hence no inertia, therefore the beam of electrons can be moved to follow waveforms varying at the rate of millions of time/second.

The electron beam may be deflected transversely by means of an electric field or magnetic field. Most oscilloscope uses electrostatic deflection, since it permits high frequency operation and requires negligible Power. Electromagnetic deflection is most common in TV picture tubes.

Electrons are negatively charge Particles, they are attracted by the Positive charge or field and repelled by a negative charge. Since the electron beam is a stream of electrons, a Positive field will divert it in one direction and the negative field in the opposite direction. To move the beam in up and direction in CRT, deflection Plates are mounted inside the tube and suitable deflecting voltages are applied to them.

These plates are arranged in the two Pairs; H_1 and H_2 for deflecting the beam horizontally, and V_1 and V_2 for deflecting it vertically. Leads are taken out for external connections. The beam passes down the tube between the four plates, as shown in fig (2) below.

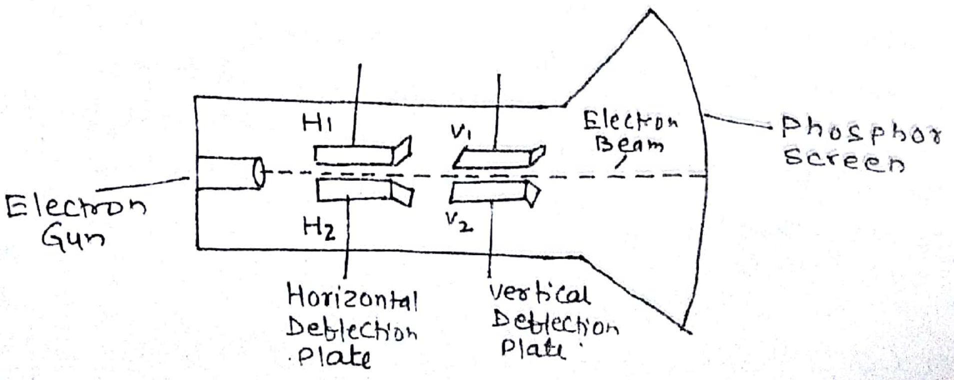


Fig (2)

when the Plates are at zero potential the beam is midway between them and the spot is in the centre of the screen. when H_1 is made positive with respect to the cathode (all other plates are at zero), it attracts the beam and spot moves horizontally to the left. when H_2 is made positive, it attracts the beam and the spot moves horizontally to the right. Similarly when V_1 is made positive, the spot moves vertically upwards and when V_2 is made positive it moves vertically downwards. In each of the deflections, the displacement of the beam, and therefore, the distance travelled by the spot, is perportional to the voltage applied at the plate.

CRT Features

CRTs are available in a number of types and sizes to suit individuals requirements. The important features are as follows

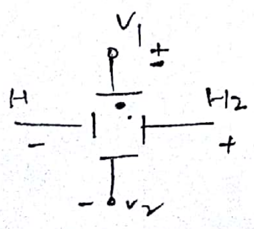
1) **Size** - Size refers to the screen dimensions. A CRT having a number 5GP1. The first number 5 indicates that it is a 5 inch tube.

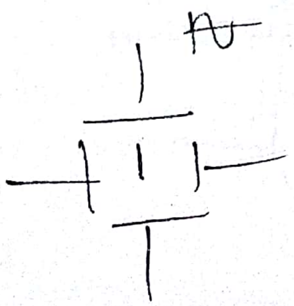
2) **Phosphor** :- The screen is coated with a fluroscent material called phosphor. This material determine the colour of trace. A CRT number 5GP1 is a 5 inch tube with a medium persistance green trace.

3) **operating Voltage** .- A CRT require a heater voltage of 6.3V ac or dc at 600mA.

4) **Deflection voltages** - Either ac or dc voltage will deflect the beam. The distance through which the spot moves on the screen is perportional to the dc, or peak ac amplitude.

5) **viewing screen** - The viewing screen is the glass face plate, the inside wall of which is coated with phosphor. The standard size used now a days is (8 x10) cm.





Basic Principle of Signal Display (As sweep Generator)

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

To obtain ac signal display the signal voltage is applied to the vertical plates (directly or through the vertical amplifier) and it moves the spot vertically to positions, corresponding to the instantaneous values of the signal. Similltaneously, spot moved horizontally by a sweep voltages applied to 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 perportional to voltage at a particular instant of time.

There are two important sweep generator requirements.

1. The sweep must be linear.
2. The spot must move in one direction only i.e. from left to right only, else the signal will be traced backward during the return sweep.

A linear sawtooth waveform as shown in fig (3).

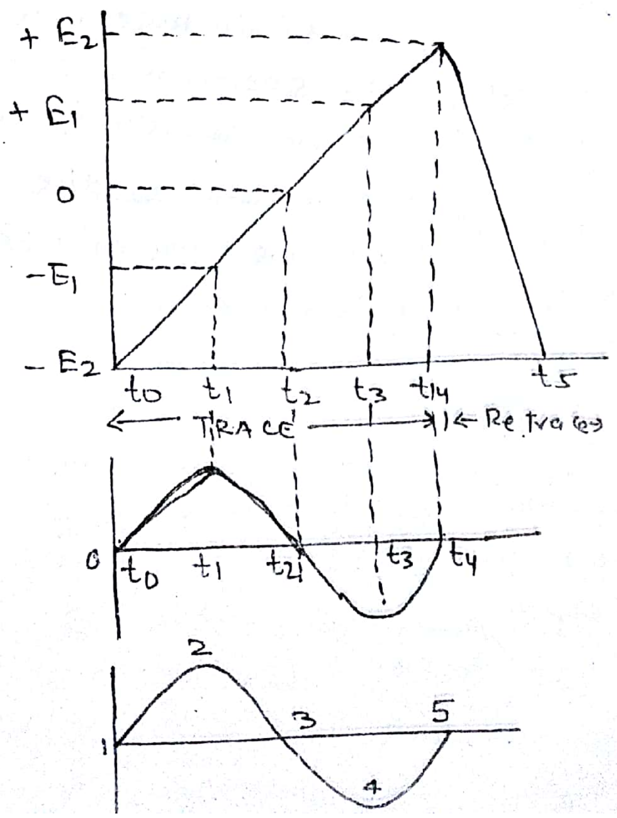


Fig (3)

Now the time t_0, the sweep voltage is $-E_2$ and the negative horizontal voltage moves the spot to point 1 on the screen. At this stage, the signal voltage is zero, so the spot rest at the left end of zero line on the screen.
At time t_1, the linearly increasing sawtooth reaches $-E_1$, which being more positive than $-E_2$ 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 t_2, the sawtooth voltage is zero, there is no horizontal deflection and the spot is at the centre point 3. At this stage the signal voltage is zero, So there is no vertical deflection either. At time t_3, the saw-tooth voltage is $+E_1$ 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 t_4, the sawtooth voltage is $+E_2$, moving the spot to point 5. Now the signal voltage is zero, so the spot is not vertically deflected. Between t_4 and t_5, the sawtooth voltage falls quickly through zero to its initial value of $-E_2$.

Block Diagram of oscilloscope

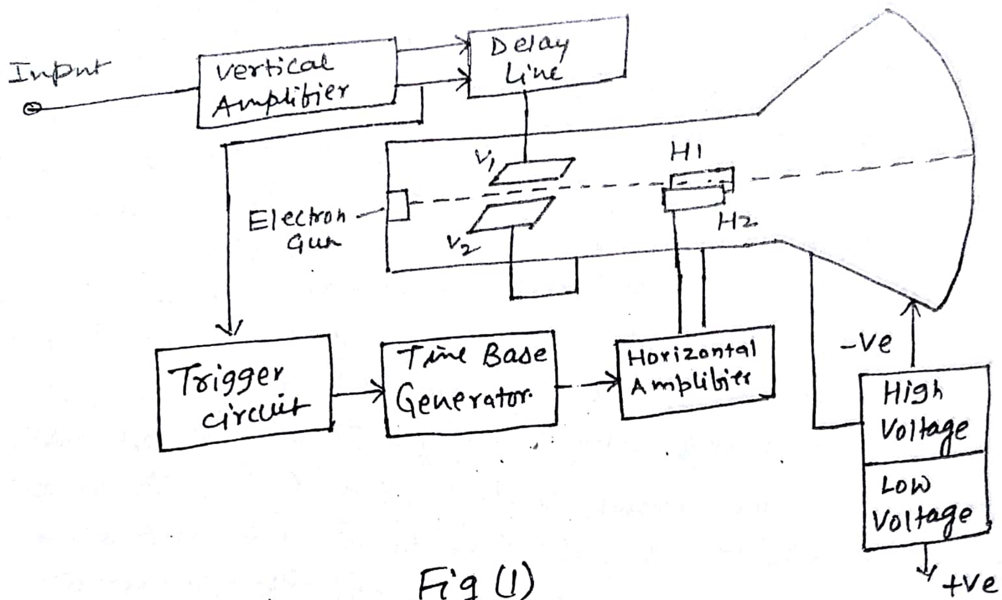


Fig (1)

The major block circuit shown in fig (1) of a general Purpose CRO is as follows

(1) CRT (2) vertical Amplifier (3) Delay line (4) Time base (5) Horizontal Amplifier (6) Trigger circuit (7) Power supply.

The function of the various block are as follows

(1) CRT - The CRT that emits electrons that strikes the Phosphor screen internally to Provide a visual display of signals

(2) Vertical Amplifier:- This is the wide band amplifier used to amplify ~~the~~ Signals in the vertical section.

(3) Delay Line:- It is used to delay the Signals for some time in the vertical sections.

4) Time Base:- It is used to generate the sawtooth voltage require to deflect the beam in the horizontal section.

5) Horizontal Amplifier:- This is used to amplify the sawtooth Voltage before it is applied to horizontal deflection Plates.

6) Trigger circuit:- This is used to convert the incoming signal into trigger Pulses So that the input Signal and the

sweep frequency can be Synchronised.

:) Power Supply:- There are two Power supply, a -ve high voltage (HV) and a Positive low Voltage supply. Two voltages are generated in the CRO. The positive voltage Supply is from +300V to 400V. The negative voltage supply is from -1000V to -1500V.

Scanned by CamScanner