ELECTRICAL MEASUREMENTS

Electronic Measuring Instruments

Introduction:

Oscilloscope refers to the total instrument including the CR tube, amplifiers, controls and power supplies. It is a self-contained instrument easily portable by hand or trolley. The heart of the oscilloscope is the Cathode Ray Tube, as it is this which converts the signal to image. The image is traced and illuminated on its screen in the x-y plane. On the z - axis is the electron beams whose speed and intensity can be controlled and modulated. Capture, display, analyze are the three functions of an oscilloscope.

Oscilloscopes got a big boost with the advent of computers as any stored data can be immediately displayed and analyzed.

Parts of an Oscilloscope:

1. Cathode Ray Tube (CRT) for display
2. Vertical amplifier including probe or transducer
3. Time base
4. Horizontal amplifier
5. Trigger or sync circuit
6. Gate amplifier
7. Power supplies

Cathode Ray Tube: The Cathode ray tube may be divided into five sections.

1. Beam generation
2. Beam focusing
3. Beam deflection
4. Beam post – acceleration
5. Beam target or screen

Parts of CRT:

1. Filament heating
2. Indirect cathode
3. Grid
4. Pre-accelerating anode
5. Focusing anode plate
6. Accelerating anode
7. Vertical deflection
8. Horizontal deflection plate
9. Aquatic coating
10. Fluorescent screen

For electrostatic deflection

Deflection, D $= \frac{L L_d E_d}{2dE_a}$

D – Deflection, m

L – Distance from centre of deflection plates to screen, m

Ld – Effective length of deflection plates, m

Ed – Deflection Voltage, Volts D – Separation between the plates, m

Ea – Accelerating voltage, Volts

Deflection sensitivity is

S $= \frac{D}{E_d} = \frac{LI_d}{2dE_a}$ m/V

Deflection factor G is

G $= \frac{1}{s} = \frac{2dE_a}{LI_d}$ V/m

Oscilloscope Specifications:

1. **Sensitivity:** It means the vertical sensitivity. It refers to smallest deflection factor G = (1 / s) and expressed, as mV / div. The alternator of the vertical amplifier is calibrated in mV / div
2. **Band Width:** It is the range of frequencies between ± 3 dB of centre frequency
3. **Rise Time:** Rise time is the time taken by the pulse to rise from 10% to 90% of its amplitude.

B.W.=$\frac{1}{2\prod RC} = \frac{2.2}{2\prod T_r} = \frac{0.35}{2\prod T_r}$ T_r = Rise time in μ sec.

Synchronization means the frequency of vertical signal input as an integral multiple of the sweep frequency.

$F_{in} = nFs$

Measurement of Phase Difference and Frequency:

Let V_x and V_Y be the instantaneous values and of voltages applied to the deflection plates x and y and let them be expressed as

$V_x = V_x \sin \omega_x t$ $V_y = V_y \sin (\omega_y t - \phi)$

By adjusting the values of $\omega_x, \omega_y, V_x, V_y$ and ϕ suitably, various patterns may be obtained on the screen.

1.When $\omega_x = \omega_y = \omega, \phi = 0$,then $(V_x / V_y) = K$

I_s an equation of straight line passing through origin and making an angle of tan $\theta = (V_y/V_x)$ with horizontal

2.$\omega_x = \omega_y = \omega_y \phi = (\pi/4)$ => an ellipse whose major axis has a slope of (V_x / V_y)

3.$\omega_x = \omega_y = \omega \phi = (\pi/2)$ radians => a circle

4.When $\omega_x = 2\omega_y$,we get Fig (i).When $\omega_y = 2\ \omega_x$ we get Fig (ii)