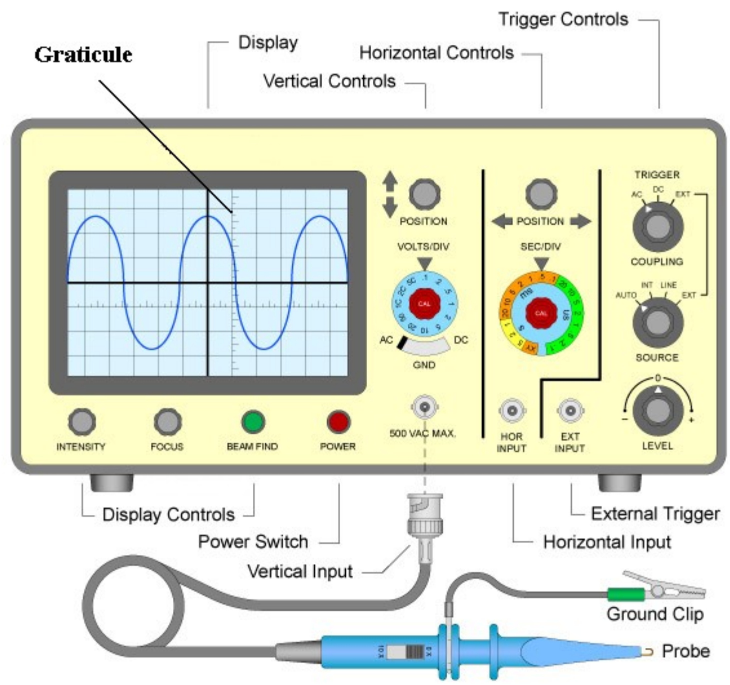
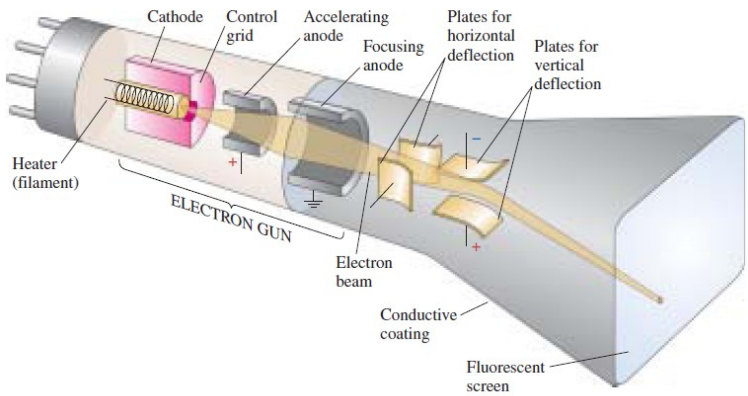
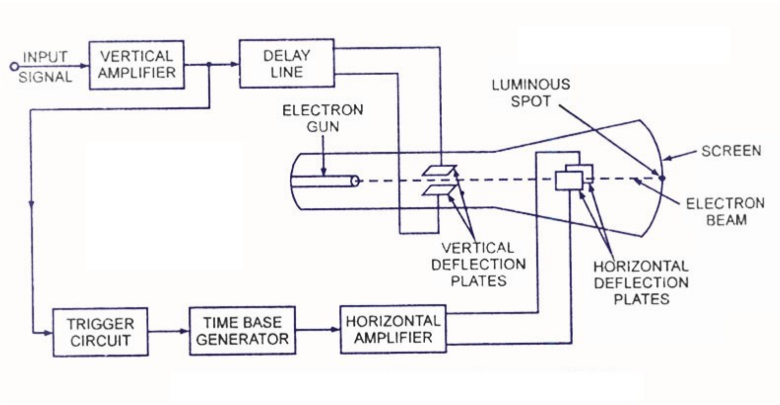
Cathode Ray Oscilloscope (CRO)





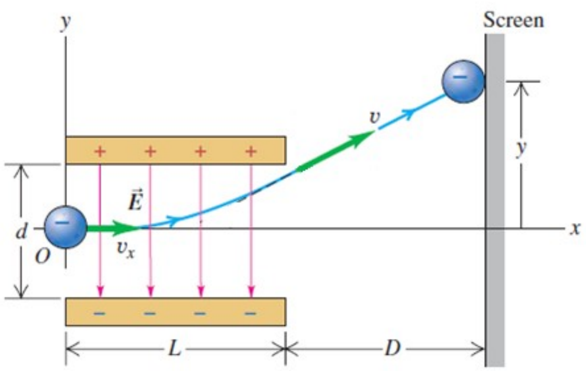


CRO is made of the following functional parts

- cathode ray tube (CRT)
- vertical input and amplifier
- horizontal amplifier
- time base generator
- trigger
- Delay line

1. Cathode Ray Tube (CRT): The heart of the CRO is the Cathode Ray Tube which generates the electron beam, accelerates it to a high velocity and deflects it to create the image. The CRT contains the Phosphor screen where the beam becomes visible. To accomplish these tasks, various electrical signals and voltages are required which are generated by the remainder of the blocks. Before striking the screen the electron beam passes between a set of deflection plates. The vertical and horizontal movements are independent of one another so that the spot on the screen can be positioned anywhere on the screen by the simultaneous application of appropriate vertical and horizontal voltage inputs.

2. Vertical Input and Amplifier: The signal to be viewed is fed to the vertical amplifier, which is a wideband amplifier used to increase the potential of the input signal to a level that will provide a deflection of the electron beam.

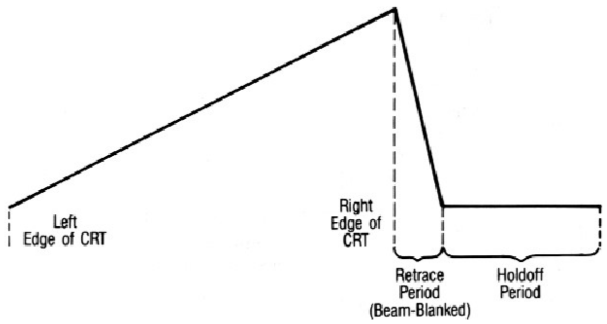


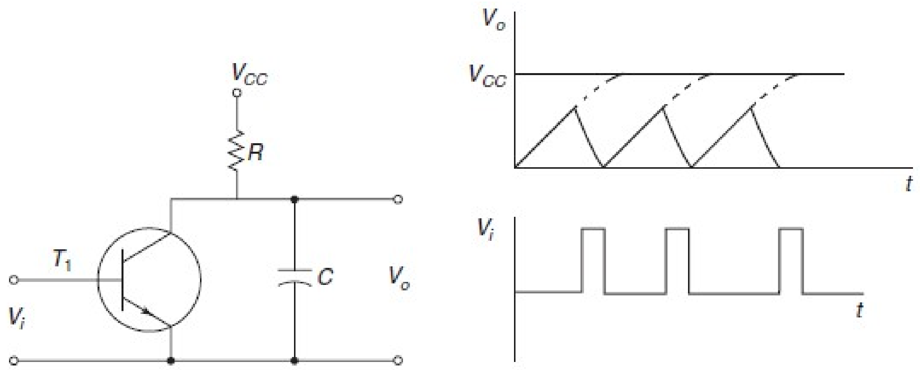
$$y = \frac{V_y L (D + \frac{L}{2})}{V_{acc}(2d)}$$ and **Deflection sensitivity** = $$\frac{y}{V_y} = \frac{L(D + \frac{L}{2})}{V_{acc}(2d)}$$

3. Time base generator (sweep generator): If we apply a sawtooth signal $V_x(t) = kt$ to the horizontal input, the horizontal screen axis will be proportional to time t. In this case a signal $V_y(t)$ applied to the vertical input, will depict on the oscilloscope screen the time variation of the signal.

The internal ramp signal is generated by the instrument; with an amplification stage that allows changes in the gain factor *k* and in turn the interval of time shown on the screen. This amplification stage and the ramp generator are called the *time base generator.*

Visualization of signal time variation is the most common use of an oscilloscope.



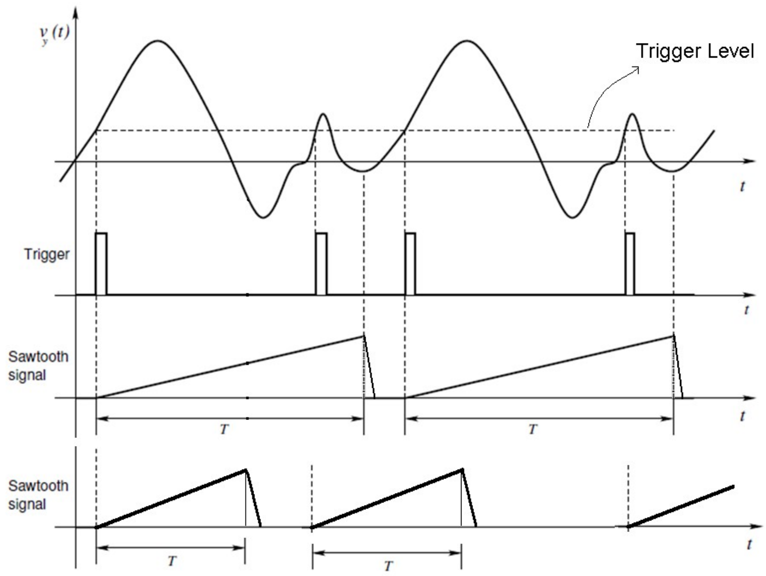


4. Horizontal Amplifier: The horizontal amplifier is similar to the vertical amplifier and it increases the amplitude of the signals generated in the sweep generator to the level generated by the horizontal deflection plates of the CRT.

5. Triggering Circuit: To study a periodic signal $V_y(t)$ with the oscilloscope, it is necessary to synchronize the horizontal ramp $V_x(t) = kt$ with the signal to obtain a steady plot of the periodic signal. The trigger is the electronic circuit which provides this function.

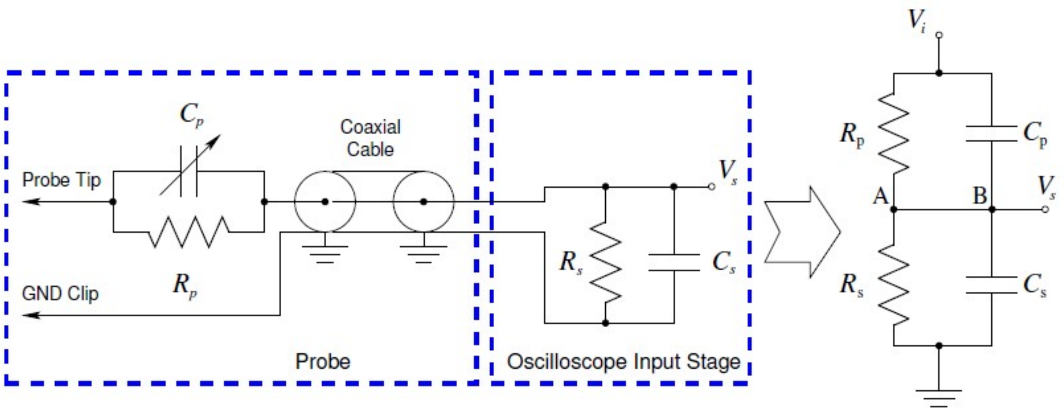
   The trigger circuit compares $V_y(t)$ with a constant value and produces a pulse every time the two values are equal and have the same slope sign.

   The first pulse triggers the start of the sawtooth signal of period T , which will linearly increase until it reaches the value $V = kT$, and then is reset to zero. During this time, the pulses are ignored and the signal $V_y(t)$ is indeed plotted for a duration time T. After time T, the next pulse that triggers the sawtooth signal occurs for the same previous value and slope of $V_y(t)$ and the same portion of the signal will be re-plotted on the screen.



6. <u>Delay line</u>: All electronic circuitry in the oscilloscope cause a certain amount of delay in the transmission of signal voltages to the deflection plates. Comparing the vertical and horizontal deflection circuits in the oscilloscope block diagram, it can be observed that signal propagation in the horizontal channel involves trigger circuit, time base generator, and horizontal amplifier whose output is fed to the horizontal deflection plates. This whole process takes time. To allow the operator to observe the leading edge or the initial portion of the waveform, the signal-drive for the vertical CRT plates must be delayed by at least the some amount of time. This is the function of the delay line.

OSCILLOSCOPE PROBE

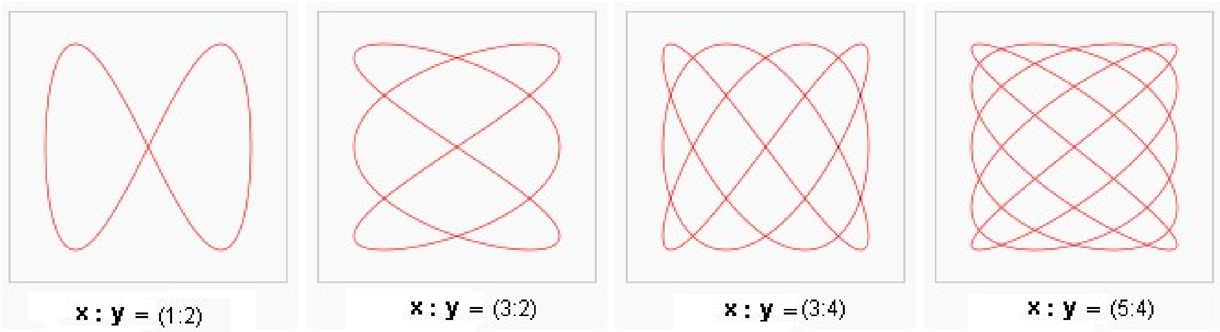


Under proper compensation

$$\frac{R_s}{R_p} = \frac{C_p}{C_s}$$

Applications of CRO

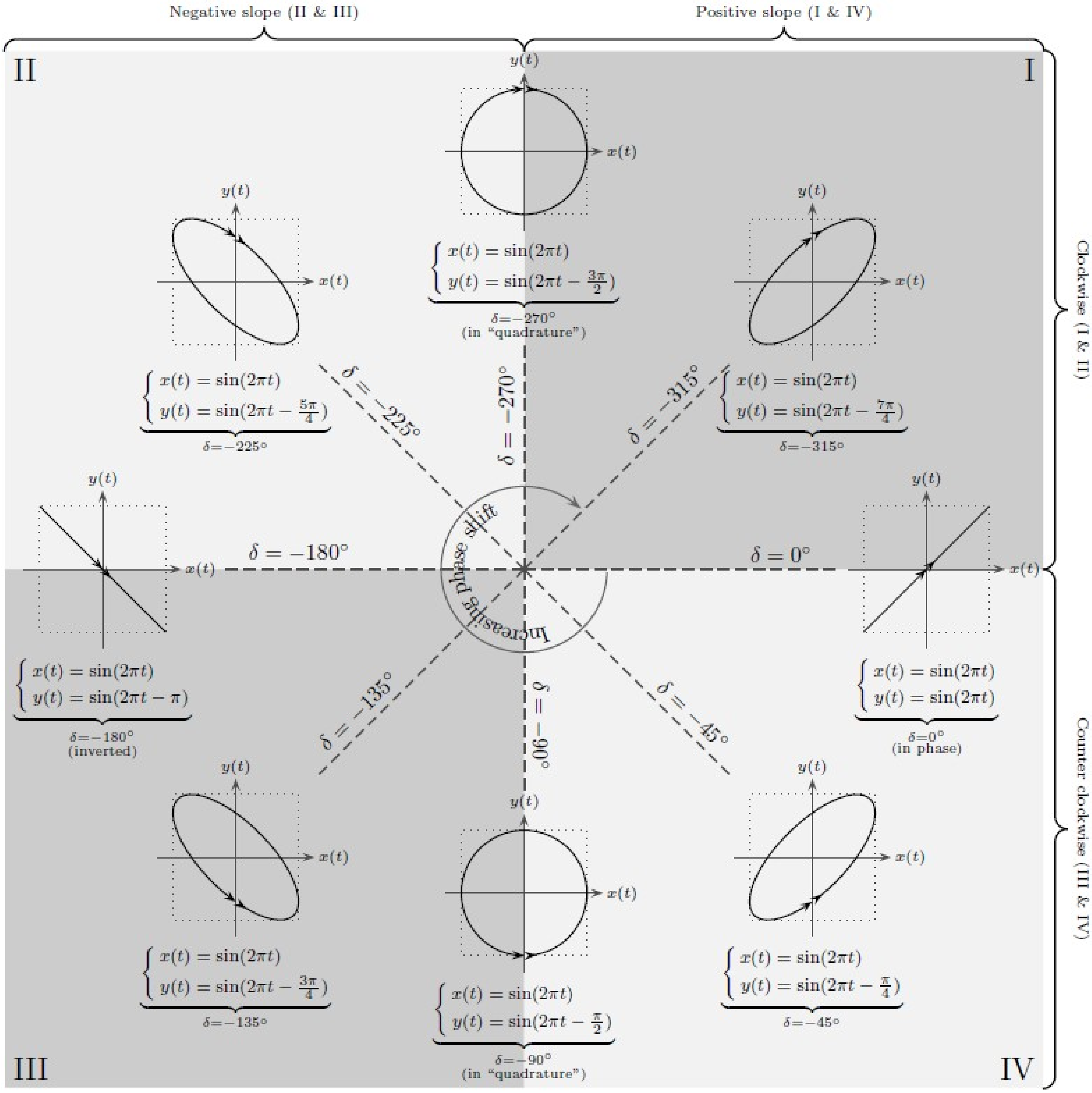
Frequency Measurement from Lissajous figures



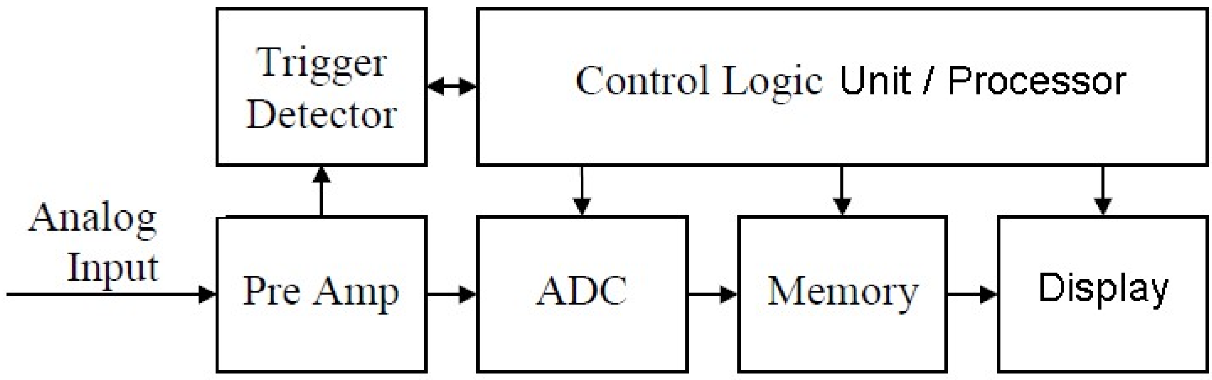
(Frequency of X input) : (Frequency of Y input) = (No. of tangents to y axis) : (No. of tangents to x axis)

i.e., $$\frac{\text{frequency}_{\text{horizeontal i/p}}}{\text{frequency}_{\text{vertical i/p}}} = \frac{\text{No. of tangencies (vertical)}}{\text{No. of tangencies (horizontal)}}$$

Phase difference Measurement



Digital Storage Oscilloscope



A Digital Storage Oscilloscope (DSO) uses digital memory to store a waveform. In order to do this the incoming signal must first be digitized, once this is complete the data in the memory can be continuously replayed through a digital to analogue converter and displayed on a CRT. Unlike analogue storage scopes the captured waveform does not decay over time.

The analog signal being monitored is fed into a pre amp, which changes it's amplitude so that it falls within the input range of the Analogue to Digital Converter (ADC) and the trigger detector. When the resulting voltage crosses a threshold set by the user the trigger unit signals the device to start recording. The ADC samples the output of the pre-amplifier at regular intervals and the digital output from the ADC is then stored in consecutive locations in the memory. When the memory is full the recording is stopped.

If the DSO is re-triggered then the memory is overwritten with a new recording unless the user puts the system into HOLD mode, Hold mode allows the user to analyze the signal trace for as long he/she requires.