كلية الهندســـة بشبرا
FACULTY OF ENGINEERING- SHOUBRA

BENHA UNIVERSITY

Optical Communications
ECE423/ELE424/CCE507/ELE480

LEC (02)
Cathode Ray Tube (CRT)

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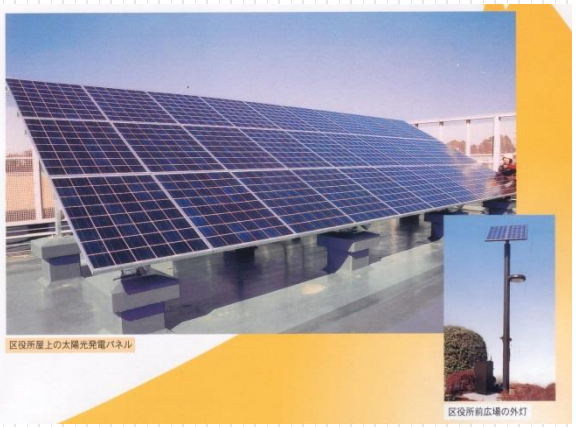
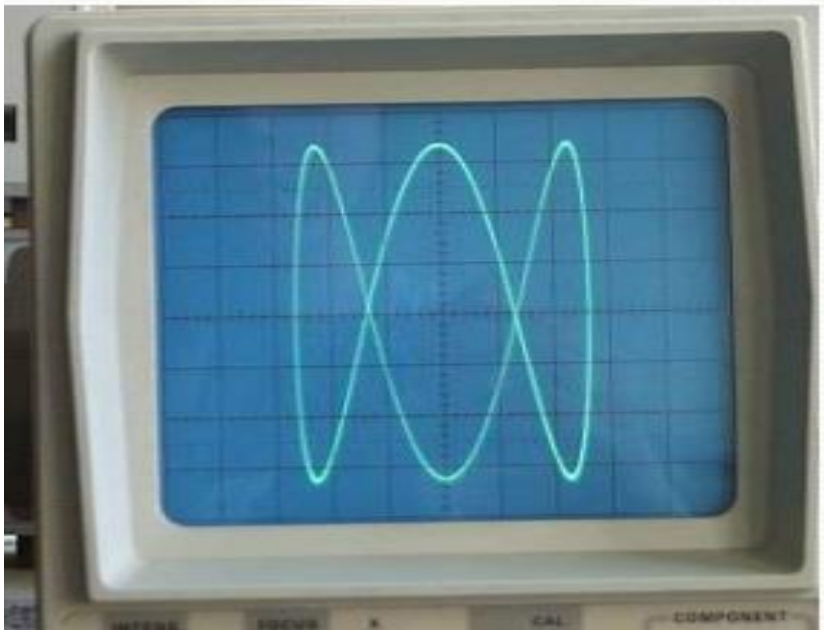


LECTURE OUTLINES

PART II

1 - Oscilloscope
2 -CRT
3 - CRT Monitor
4 - Phosphor persistence
5 - Micro channel plate
6 - Color CRTs
7 - Applications of CRT
8 - Advantages and Disadvantages of CRT
9- Analog Vs Digital Oscillscope
10-Measurements Errors
11 - introduction to LCD (Next Lec)

1 - Oscilloscope



OSCILLOSCOPES

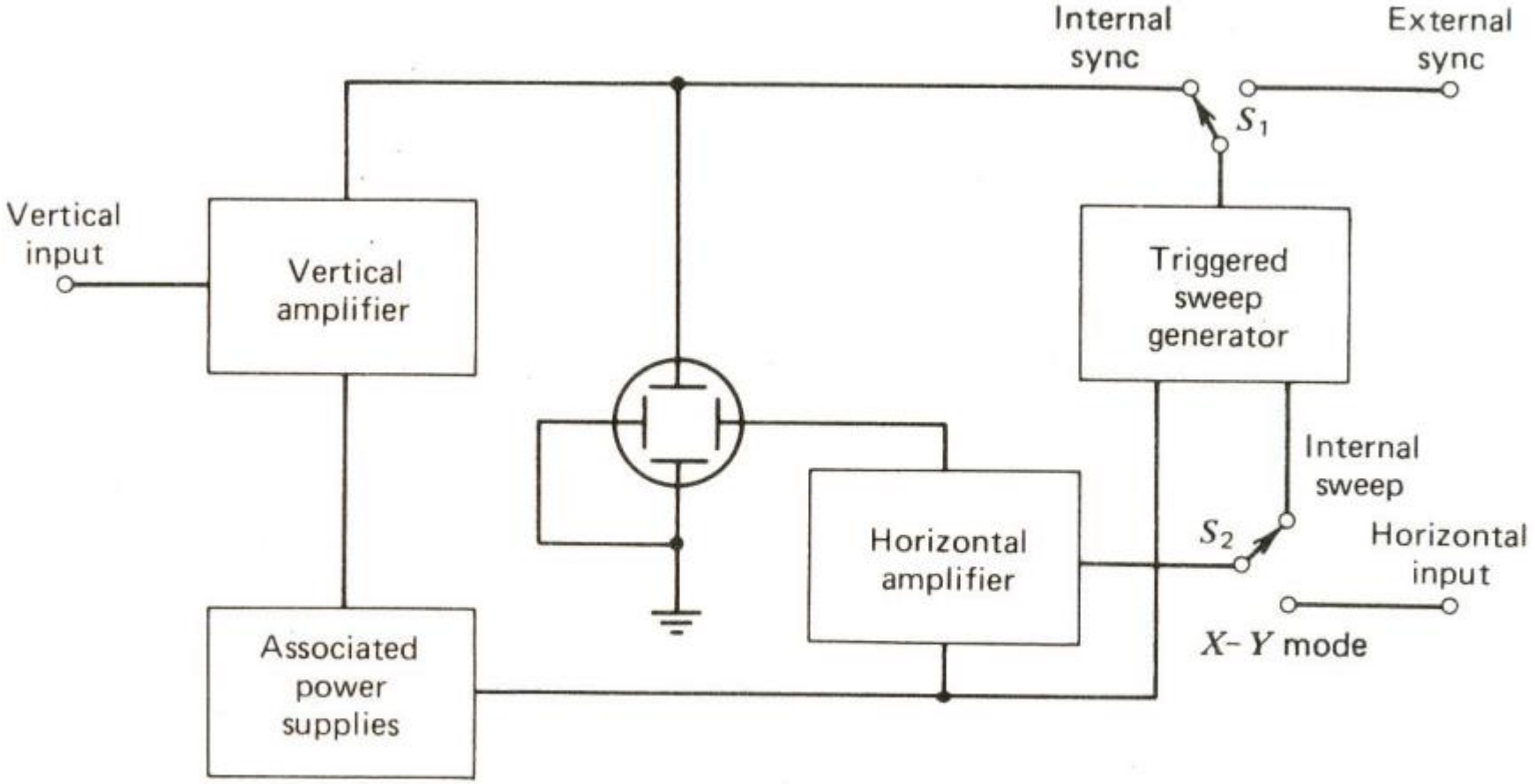


Figure 1: Block diagram of a basic cathode-ray oscilloscope

A Cathode Ray Oscilloscope (CRO) is a diagnostic device that allows one to "see" voltage.

OSCILLOSCOPES

- the left horizontal deflection plate and the lower vertical deflection plate are sometimes connected to ground.
- The beam is deflected upward and to the right by signals applied to the upper vertical deflection plate or to the right horizontal deflection plate.
- A signal to be displayed on the CRT screen is applied to the vertical input terminal where it is fed into the vertical amplifier.
- the output of the vertical amplifier is applied to the sweep generator. This signal triggers the sweep generator. The purpose of the sweep generator is to develop a voltage at the horizontal deflection plate that increase linearly with time (ramp/sawtooth), causes the beam to be deflected equal distance horizontally per unit of time.

OSCILLOSCOPES

- Amplifier circuits are needed to increase the input signal to the voltage levels required to operate the tube because the signals measured using CRO are typically small. There are amplifier sections for both vertical and horizontal deflection of the beam.

- Vertical Amplifier – amplify the signal at its input prior to the signal being applied to the vertical deflection plates

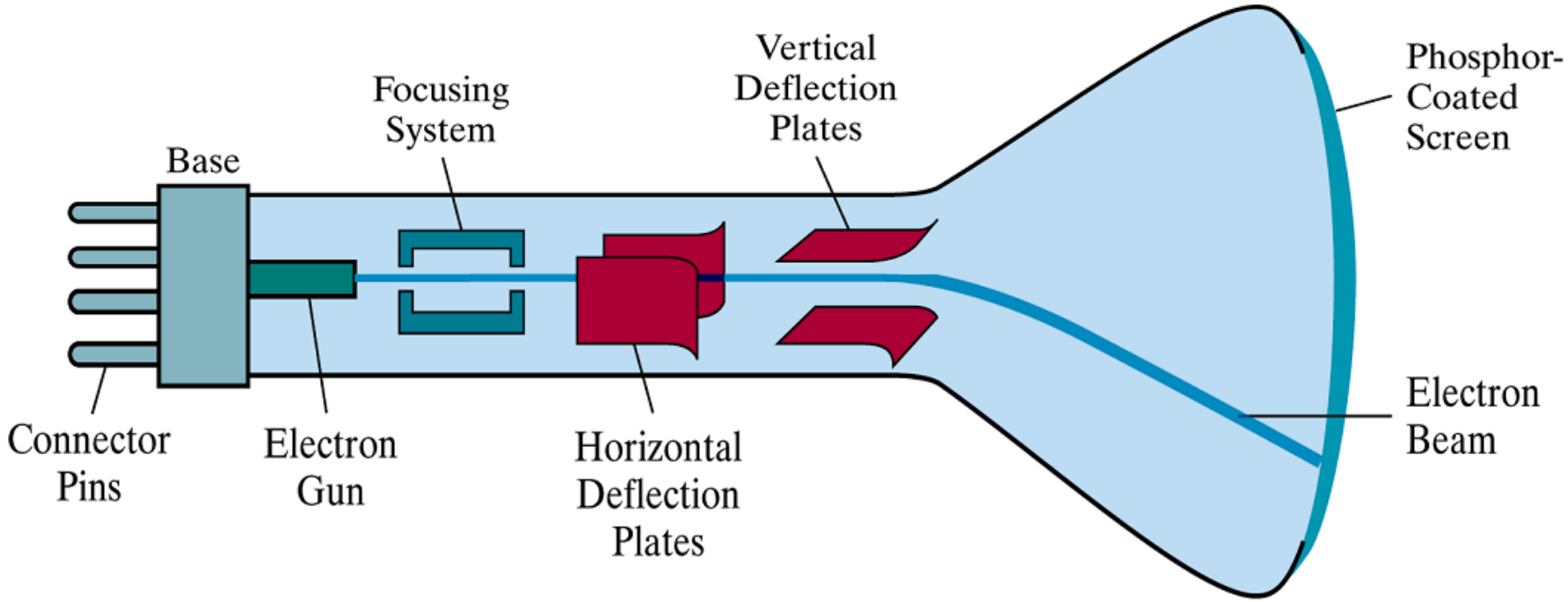
- Horizontal Amplifier – amplify the signal at its input prior to the signal being applied to the horizontal deflection plates.

- Sweep Generator – develop a voltage at the horizontal deflection plate that increase linearly with time

2 - CRT

CRT

The CRT uses an evacuated glass envelope which is large, deep, heavy, and relatively fragile. هش قابل للكسر



CRT

- **CRT:** The cathode ray tube (CRT) is a vacuum tube containing an electron gun (a source of electrons) and a fluorescent screen, with internal or external means to accelerate and deflect the electron beam, used to create images in the form of light emitted from the fluorescent screen. The image may represent electrical waveforms (oscilloscope), pictures (television, computer monitor), radar targets and others.
- The role of this section is to produce electrons at a high, fixed, velocity.
- This is done through a process known as thermionic emission.

CRT

- **The Previous Figure** shows the basic construction of CRT. A cathode containing an oxide coating is heated indirectly by a filament resulting in the release of electrons from the cathode surface.
- **The control grid** which has a negative potential, controls the electron flows from the cathode and thus controls the number of electron directed to the screen. Once the electron passed the control grid, they are focused into a tight beam and accelerated to a higher velocity by focusing and accelerating anodes. The high velocity and well-defined electron beam then passed through two sets of deflection plates.

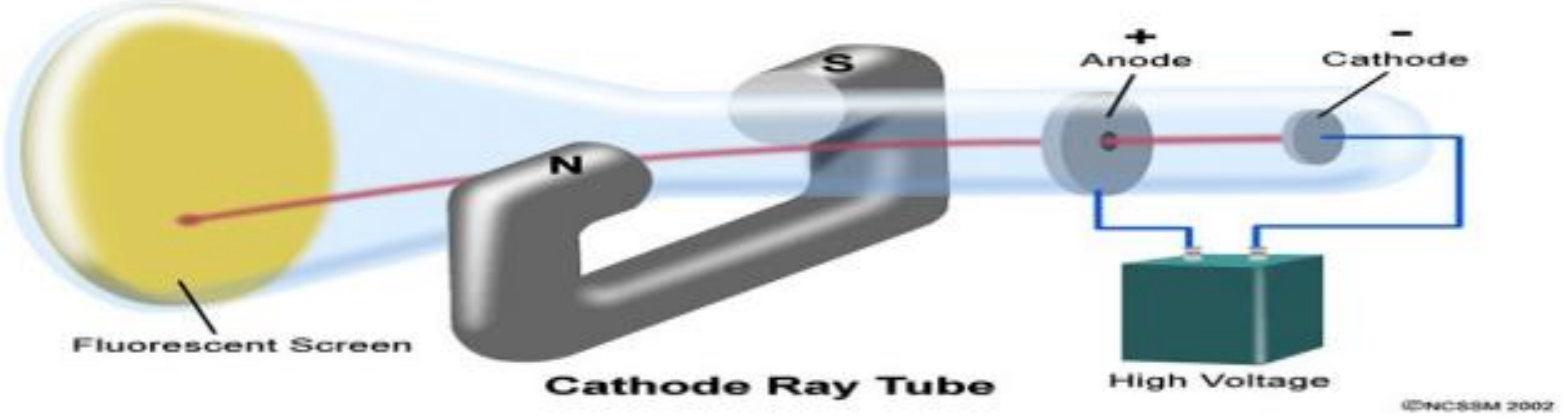
CRT

- The first set of plates is oriented to deflect the electron beam vertically. The angle of the vertical deflection is determined by the voltage polarity applied to the deflection plates. The electron beam is also being deflected horizontally a voltage applied to the horizontal deflection plates.
- The deflected beam is then further accelerated by very high voltages applied to the tube with the beam finally striking a phosphorescent material on the inside face of the tube. The phosphor glows يشع when struck by the energetic electrons – the visible glow will be seen continue to emit light for a period of time after the source of excitation is removed.

3 – CRT Monitor

CRT Monitor

- A CRT monitor contains millions of tiny red, green, and blue phosphor dots that glow when struck by an electron beam that travels across the screen to create a visible image. In a CRT monitor tube, the cathode is a heated filament. The heated filament is in a vacuum created inside a glass tube. The electrons are negative and the screen gives a positive charge so the screen glows.



4 - Phosphor persistence

Phosphor persistence ثبات

- Various phosphors are available depending upon the needs of the measurement or display application. The brightness, color, and persistence of the illumination depends upon the type of phosphor used on the CRT screen. Phosphors are available with persistence's ranging from less than one microsecond to several seconds. For visual observation of brief transient events, a long persistence phosphor may be desirable. For events which are fast and repetitive, or high frequency, a short-persistence phosphor is generally preferable.

5 - Micro channel plate

Micro channel plate

- When displaying fast one-shot events the electron beam must deflect very quickly, with few electrons impinging on the screen; leading to a faint or invisible display.
- Oscilloscope CRTs designed for very fast signals can give a brighter display by passing the electron beam through a micro-channel plate just before it reaches the screen. Through the phenomenon of secondary emission, this plate multiplies the number of electrons reaching the phosphor screen, giving a significant improvement in writing rate (brightness), and improved sensitivity and spot size as well.

6 - Color CRTs

Color CRTs

- Color tubes use three different phosphors which emit red, green, and blue light respectively. Color CRTs have three electron guns, one for each primary color, arranged either in a straight line or in a triangular configuration (the guns are usually constructed as a single unit). A grille or mask absorbs the electrons that would otherwise hit the wrong phosphor. A shadow mask tube uses a metal plate with tiny holes, placed so that the electron beam only illuminates the correct phosphors on the face of the tube.
- The three beams in color CRTs would not strike the screen at the same point without convergence calibration. Instead, the set would need to be manually adjusted to converge the three color beams together to maintain color accuracy

7 - Applications of CRT

Applications of CRT

- In televisions
- In computer monitors
- As a display device in radar
- In cathode ray oscilloscope

8 – Advantages and Disadvantages of CRT

Advantages of CRT

- The cathode rayed tube can easily increase the monitor's brightness by reflecting the light.
- They produce more colours
- The Cathode Ray Tube monitors have lower price rate than the LCD display or Plasma display.
- The contrast features of the cathode ray tube monitor are considered highly excellent.

Disadvantages of CRT

- They have a big back and take up space on desk.
- The electromagnetic fields emitted by CRT monitors constitute a health hazard to the functioning of living cells.
- CRTs emit a small amount of X-ray band radiation which can result in a health hazard.
- Constant refreshing of CRT monitors can result in headache.
- CRTs operate at very high voltage which can overheat system or result in an implosion
- Within a CRT a strong vacuum exists in it and can also result in a implosion
- They are heavy to pick up and carry around

PART II

1- Analog Vs Digital Oscillscope

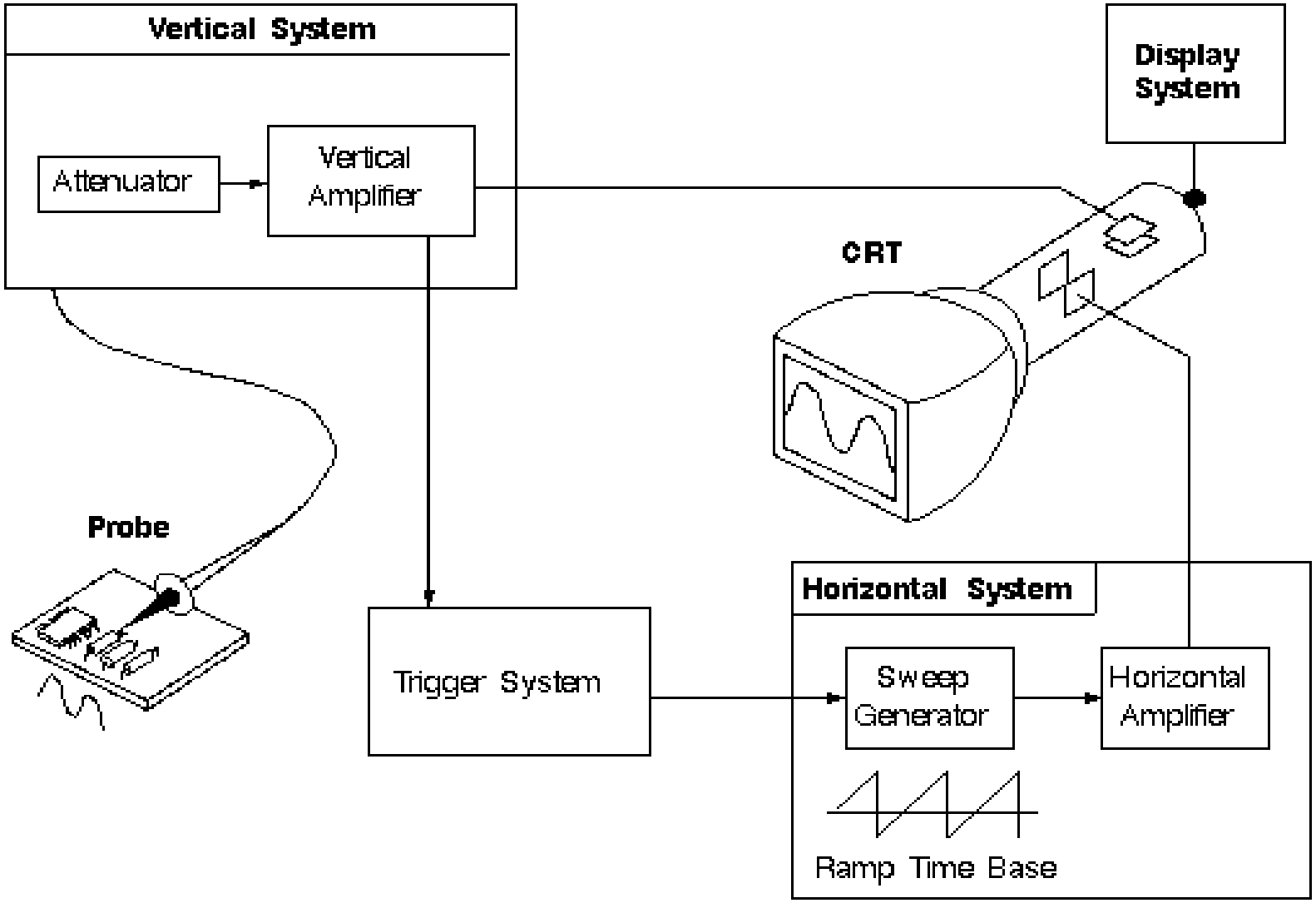
2-Trigger Level & Sweep Time

3-Oscilloscope Measurements

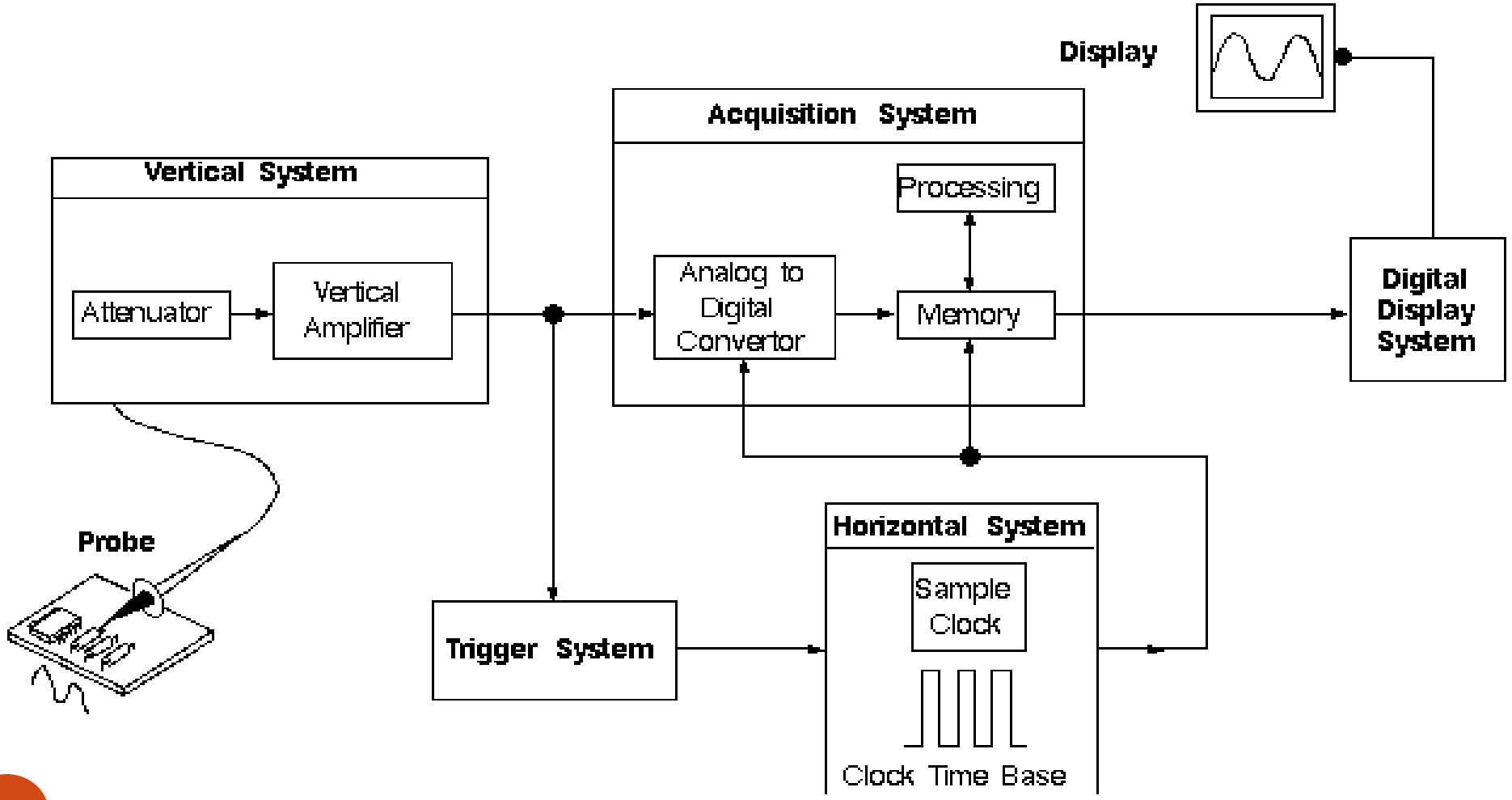
4-Measurements Errors

5-Phase shift measurement & Lissajou Figure

How does an Analog Scope work?



How does a Digital Scope work?

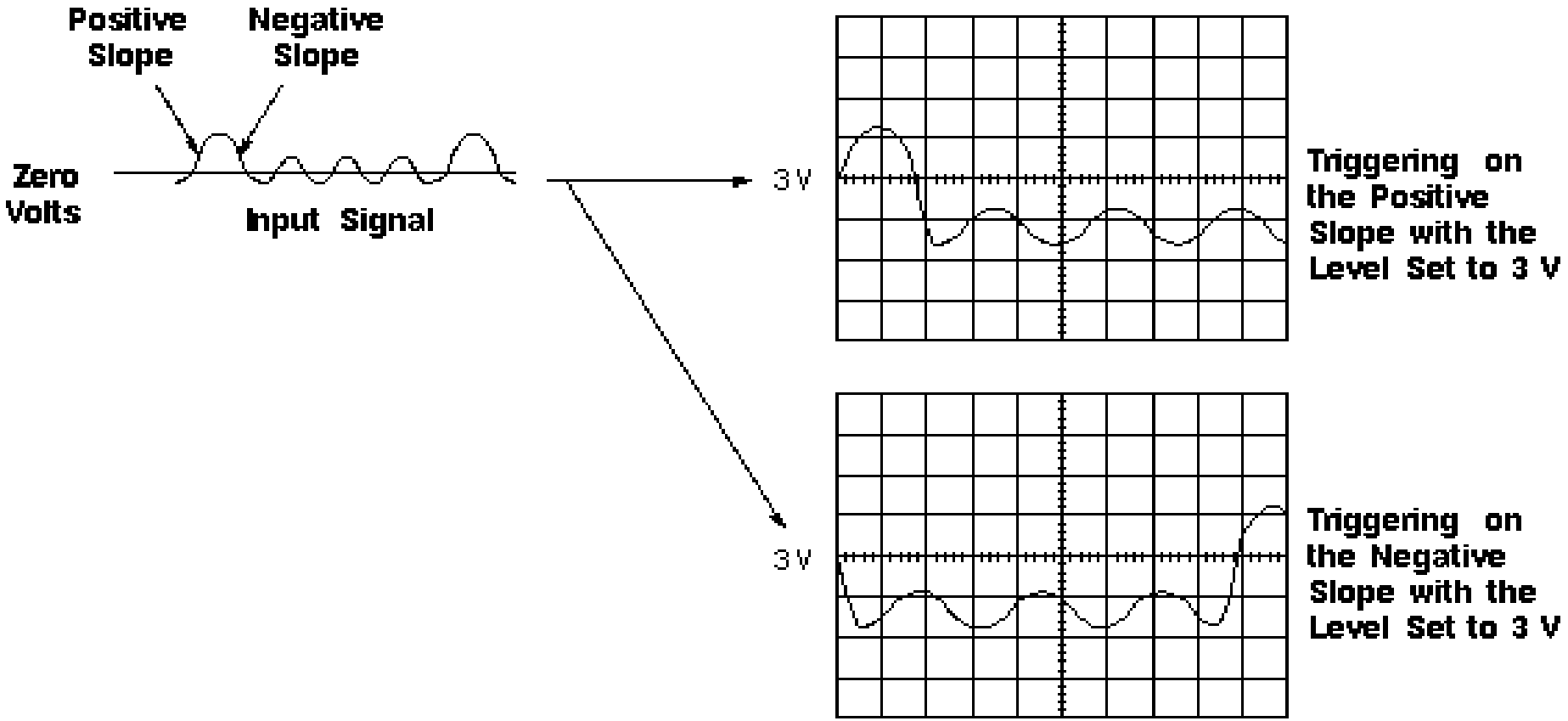


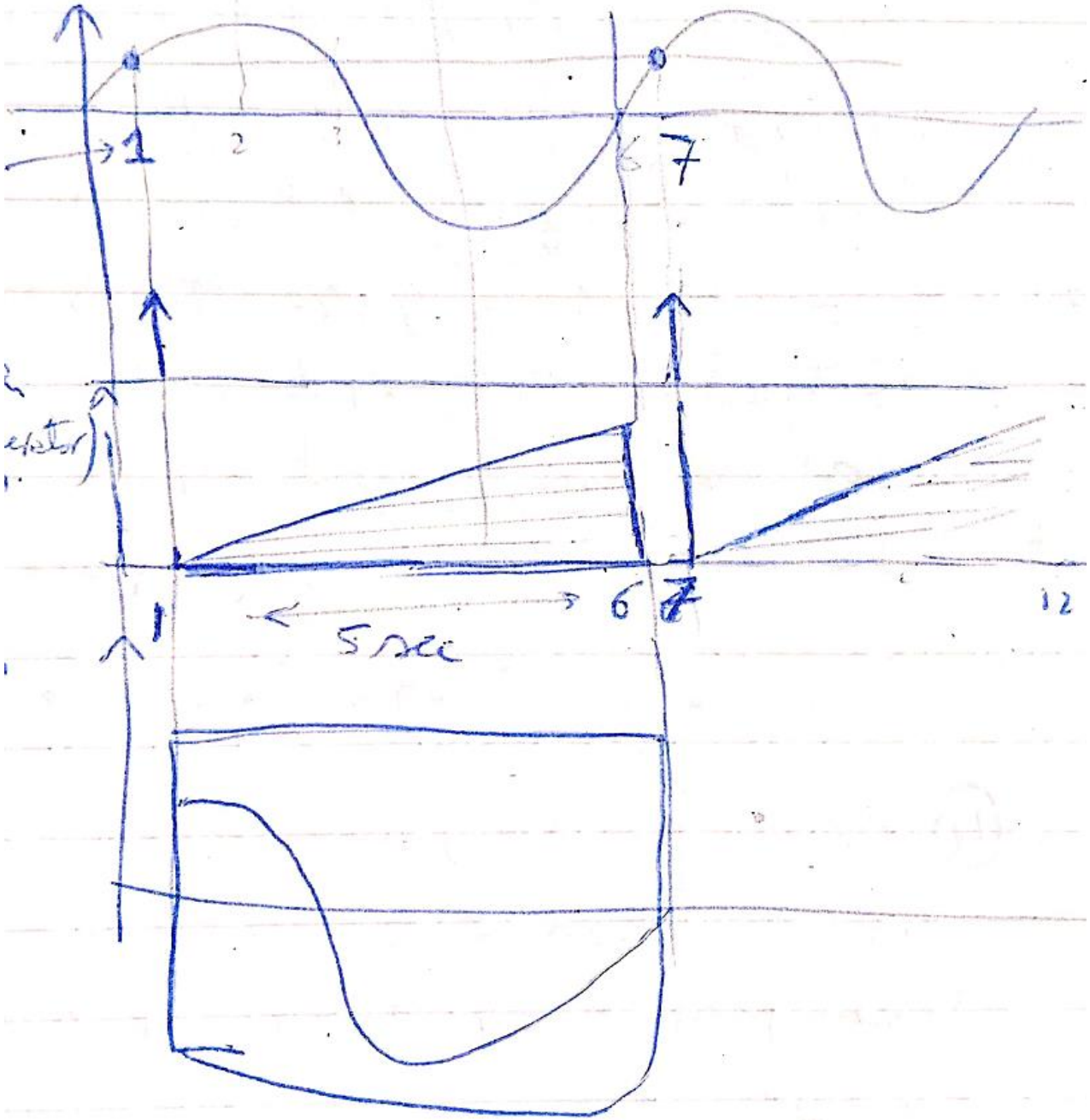
Advantage of Digital Scope

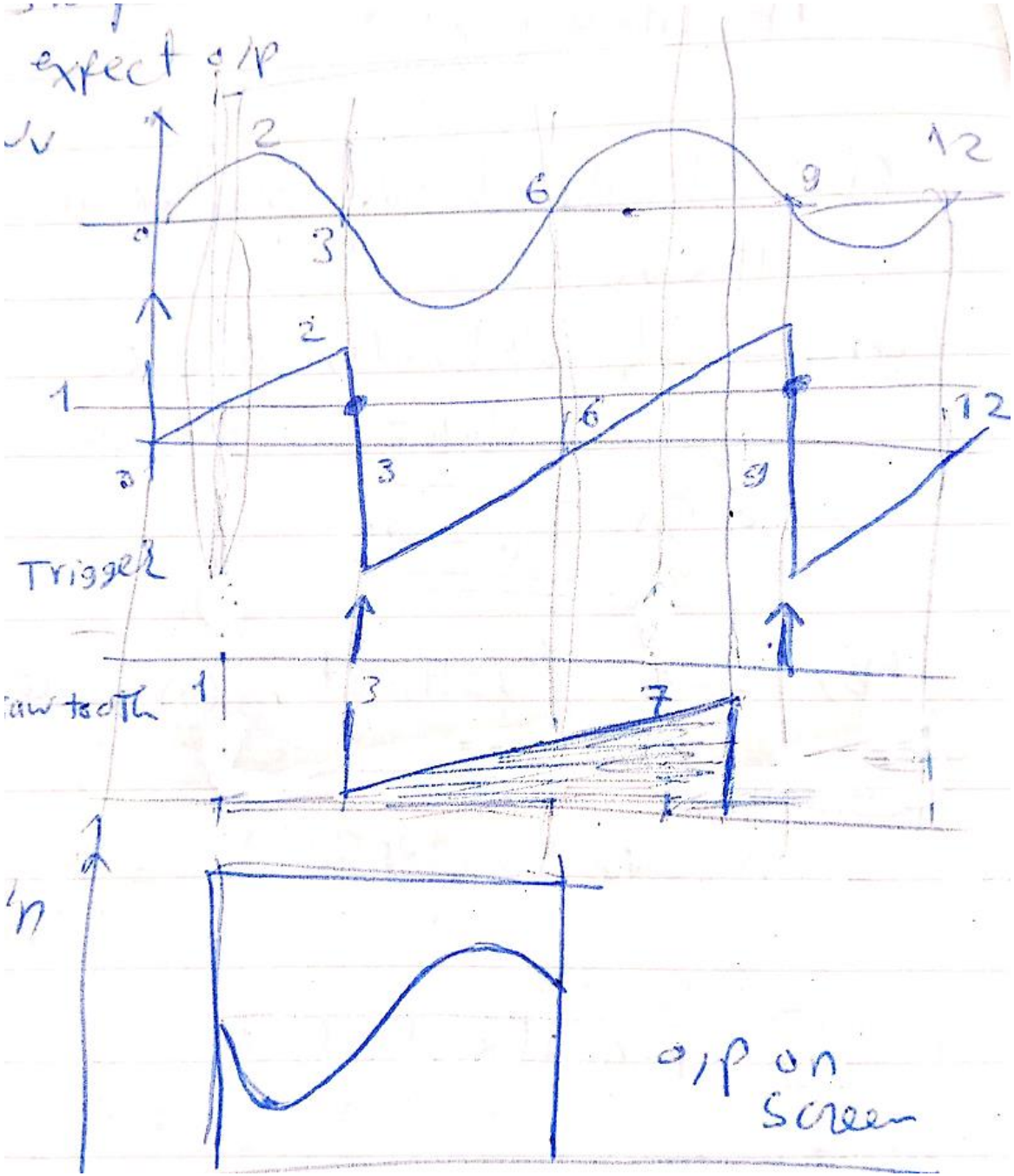
- Easy to use.
- One-shot measurement
- Recoding
- Digital Processing & Triggering
- Data reuse

1 - Trigger Level & Sweep Time

Trigger Controls (con't)




1
2
7
1
6
7
12
5 sec


expect o/p
Trigger
o/p on screen

2 - Oscilloscope Measurements

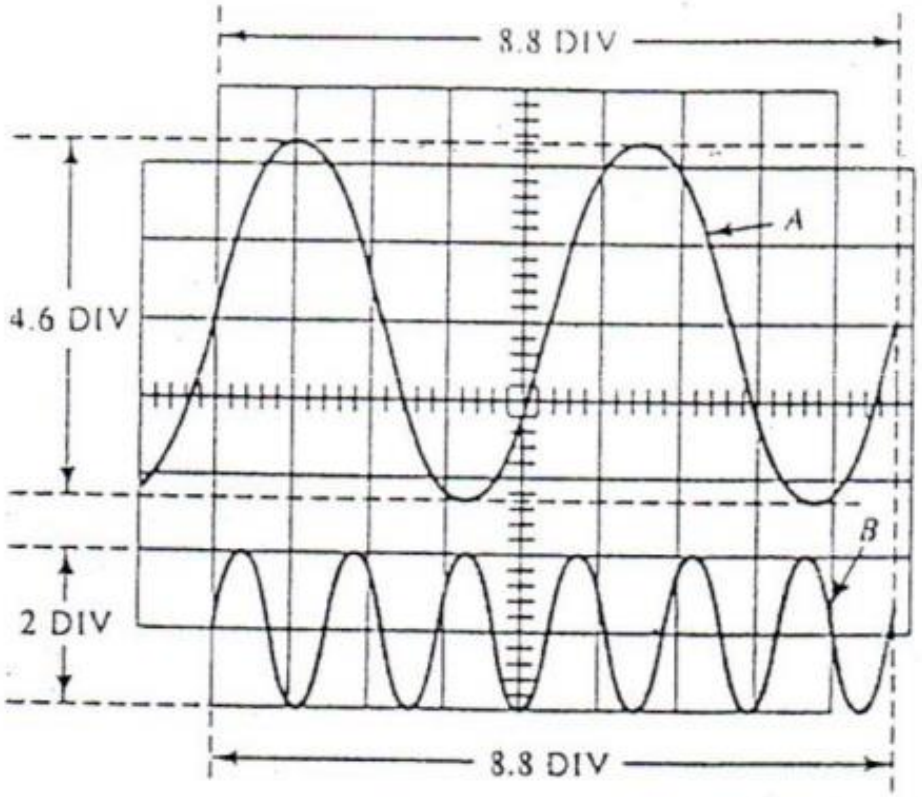
CRO Measurements

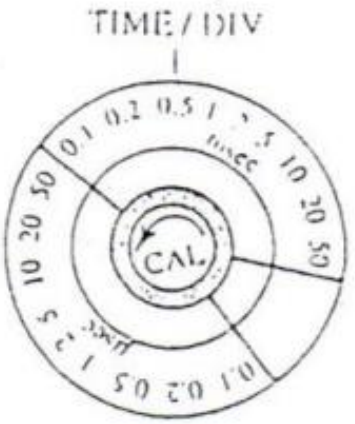
(a) Voltage Measurement

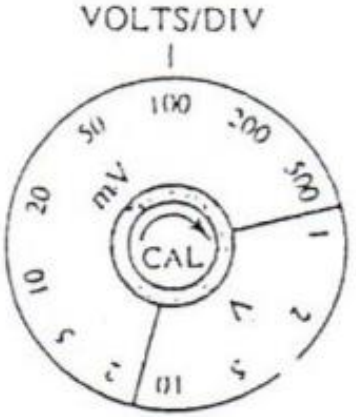
The most direct voltage measurement made with an oscilloscope is the peak-peak value. The rms value of the voltage can easily be calculated from the peak to peak measurement if desired. The peak to peak value of voltage is compute as

$$V_{p\text{-}p} = (\text{vertical p-p division}) \times \text{volts/div}$$

Example 1







V_A = (4.6 DIV) × 100 mV/DIV
V_B = (2 DIV) × 100 mV/DIV
$2T_A$ = (8.8 DIV) × 0.5 ms/DIV
$6T_B$ = (8.8 DIV) × 0.5 ms/DIV

(b) Period and frequency measurement

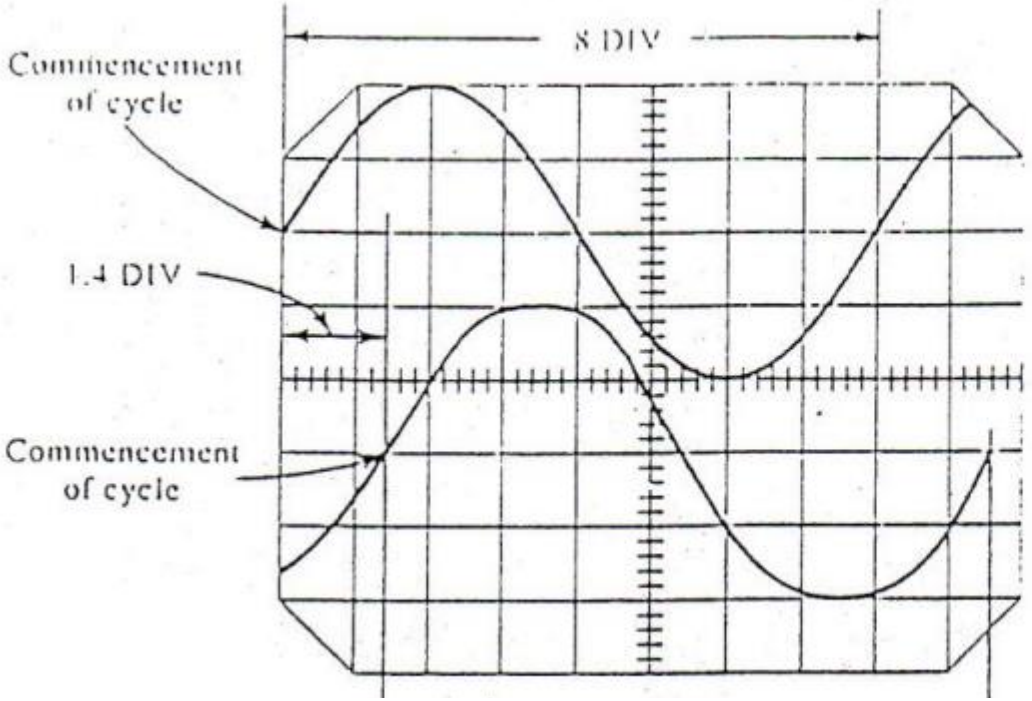
The time period of a sine wave is determined by measuring the time for one cycle in horizontal divisions and multiplying by setting of the time/div control Period, T = (horizontal divisions / cycle) (time / div)

Frequency, f = 1 / T

(c) Phase difference measurement

Phase difference, θ = (phase difference in divisions) x (degree/div)

Example 2 .. Calc. Phase Shift



8 DIV = 360°

$$1.4\ \text{DIV} = \left[\frac{360^\circ}{8}\ \text{DIV} \times 1.4\ \text{DIV}\right]\ \text{degrees/div}$$

Each wave has a time period of 8 horizontal divisions, and the time between commencements of each cycle is 1.4 div

one cycle = 8 div = 360°

$\therefore$ 1 div = 45°

Thus, the phase different is

$\theta = (1.4)(45^\circ/\text{div})$

$= 63^\circ$

3- Measurements Errors

Measurements Errors

1 - Reading Error (+/- 1/20)

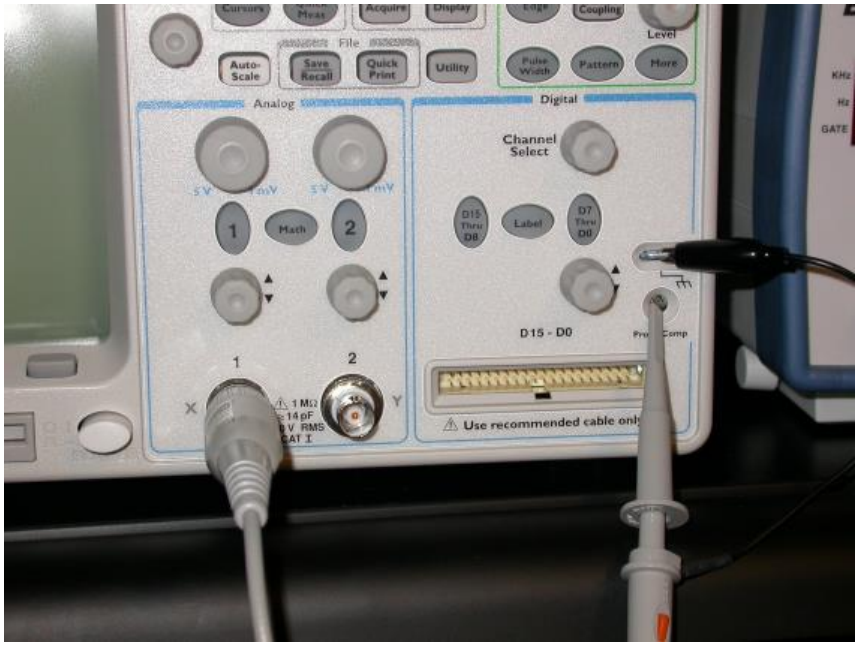
2 - Parallax error (Normal View to Screen)

3 - Loading Error (using Probe)

4- calibration error (Sv = Sv +/- 3% of Sv)

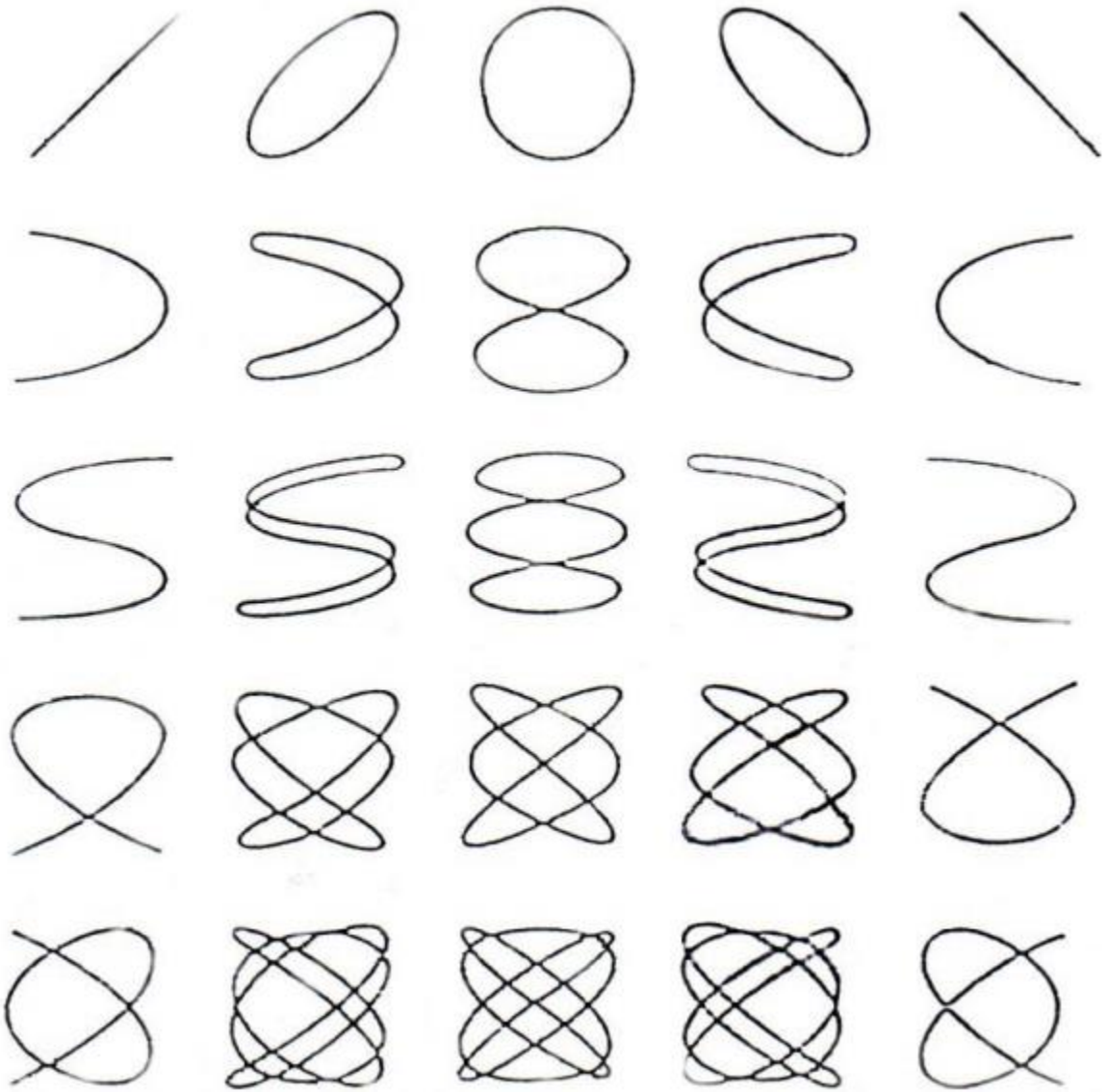
5- High frequency error (freq. range doesn't exceed 10^5Hz)

Probe



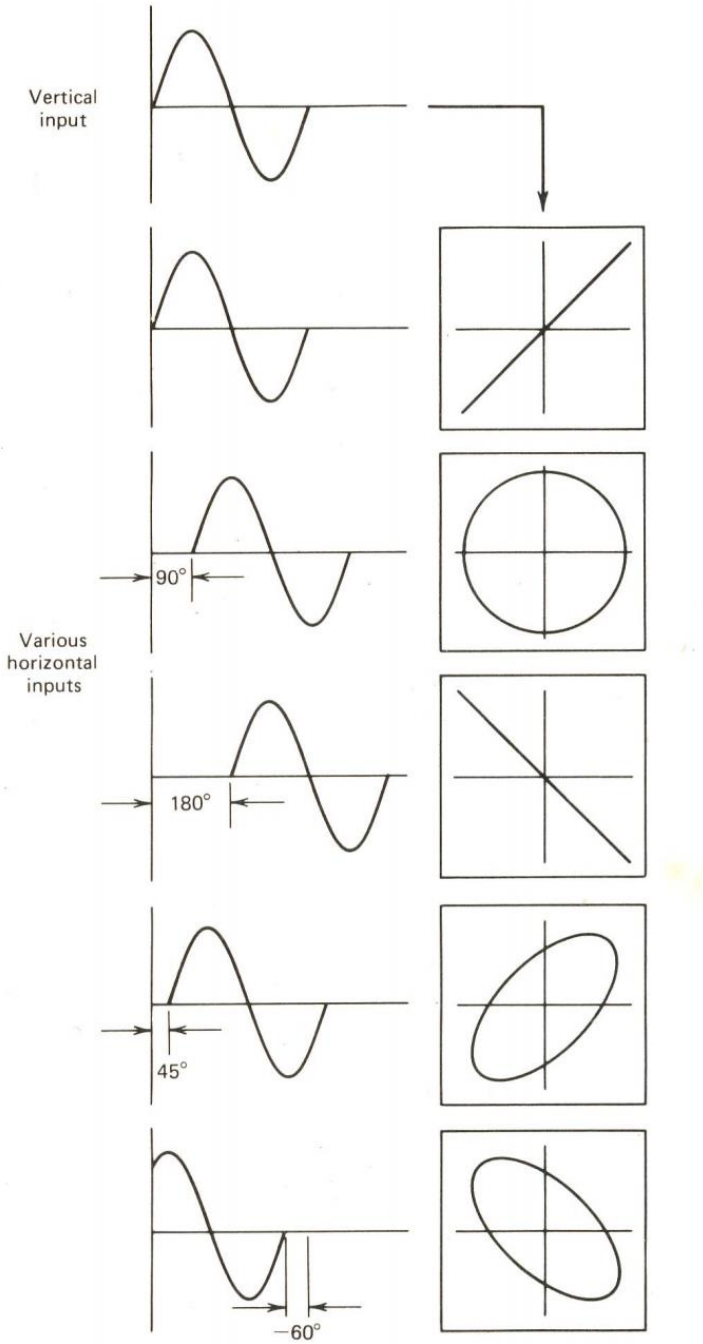
4 - Phase shift measurement & Lissajou Figure

Lissajou Patterns

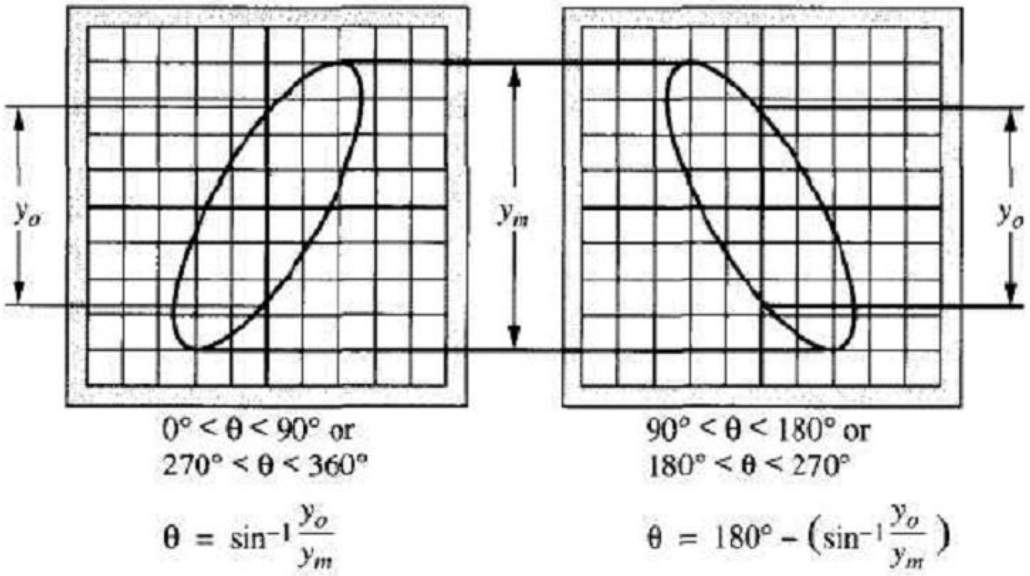


Lissajou Patterns

If we apply input signal to both horizontal and vertical deflection plates of x-y oscilloscope and time base generator is disconnected, it forms a vector pattern that allows us to discern the relationship between the two signals. Such diagram are called Lissajous pattern.



Determination of angle of phase shift



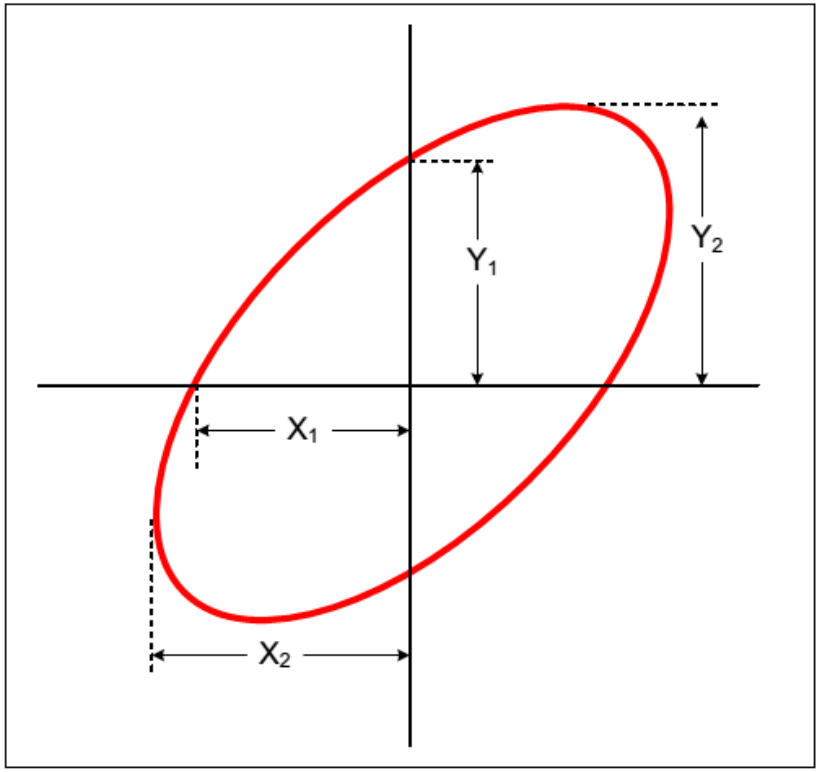


Figure 8: Determination of angle of phase shift

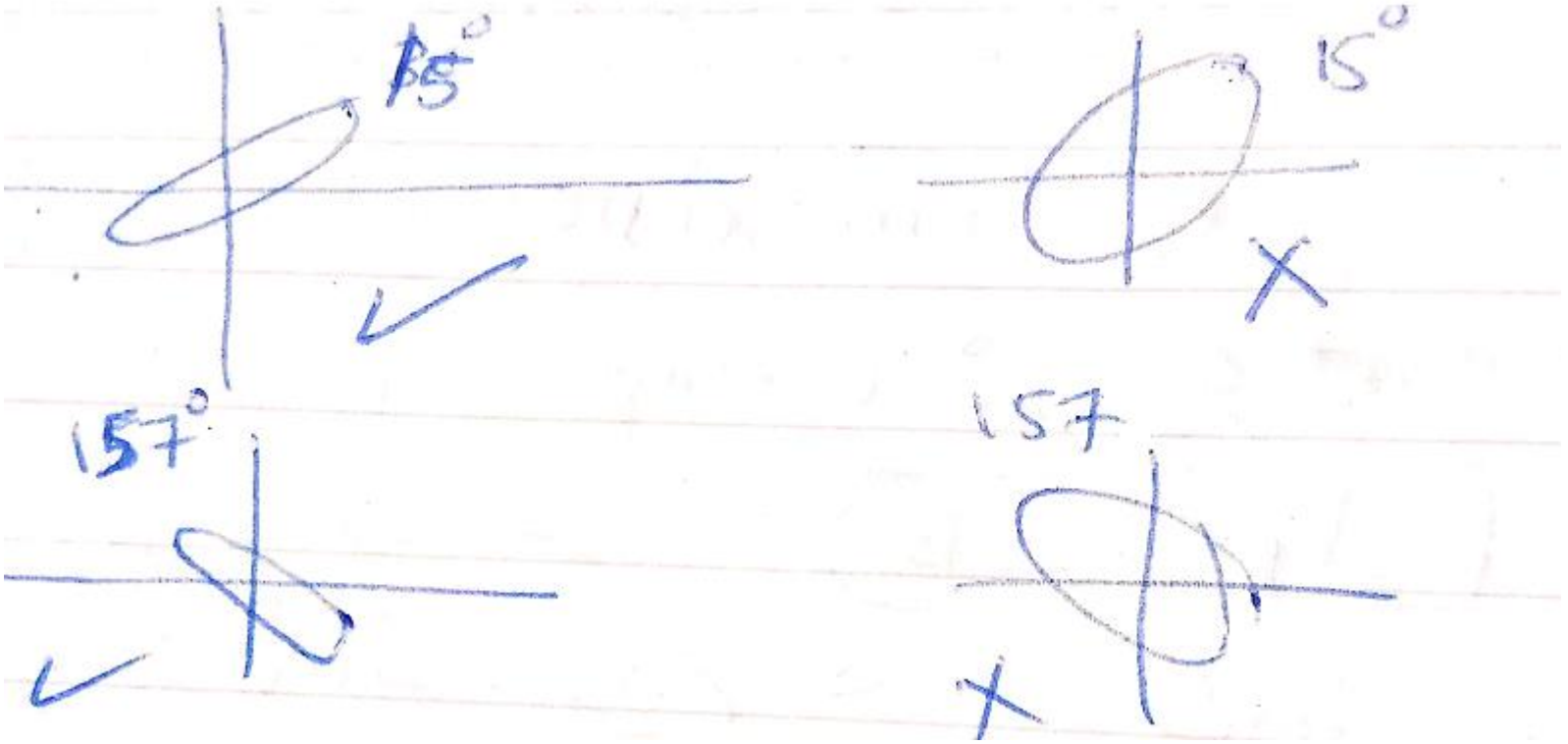
The phase angle:

$$\sin\theta = \frac{Y_1}{Y_2} = \frac{X_1}{X_2}$$

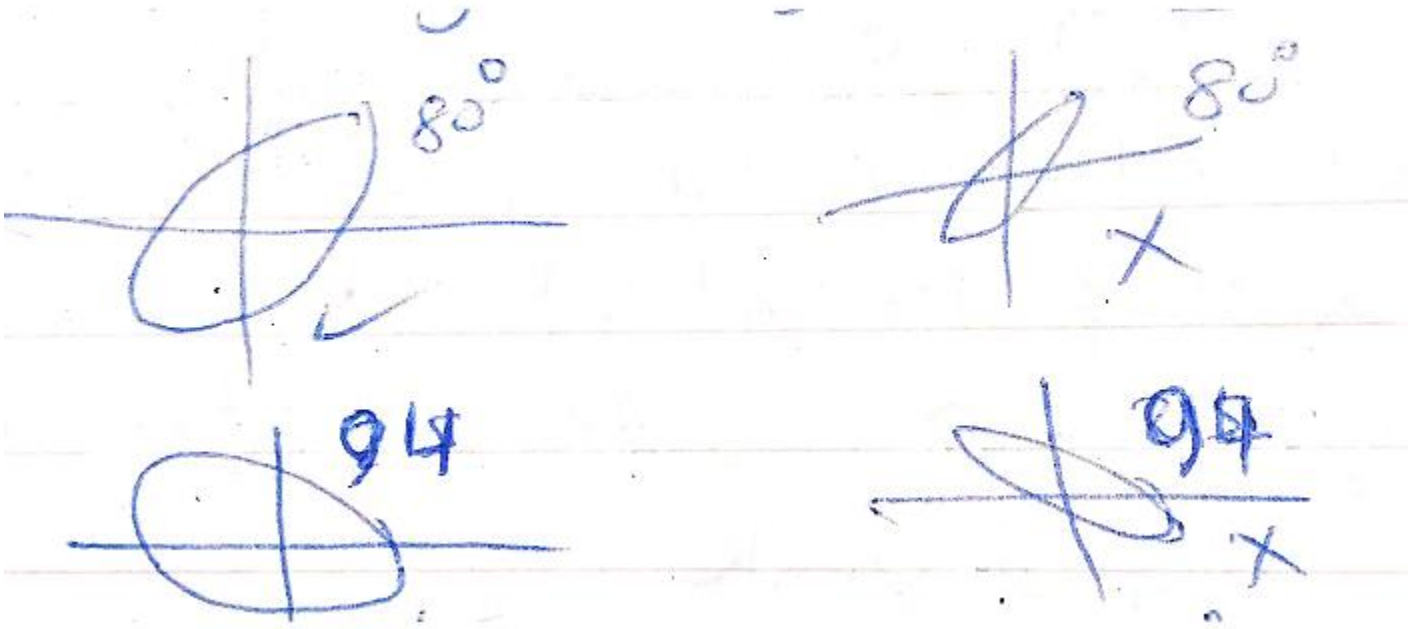
where:

θ	= phase angle in degrees
y_1	= Y-axis intercept
y_2	= maximum vertical deflection

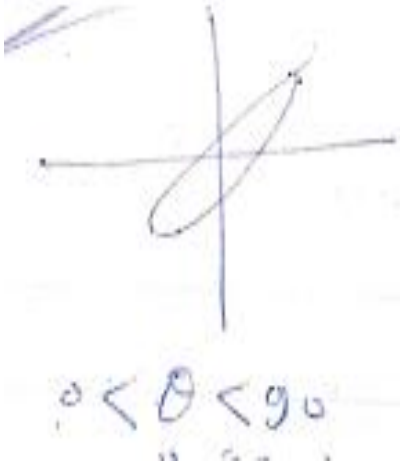
Examples

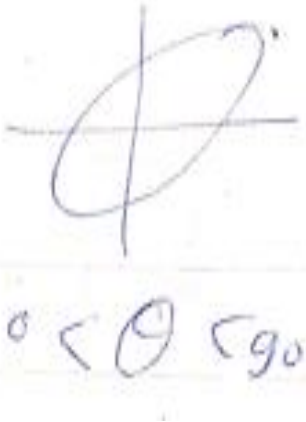


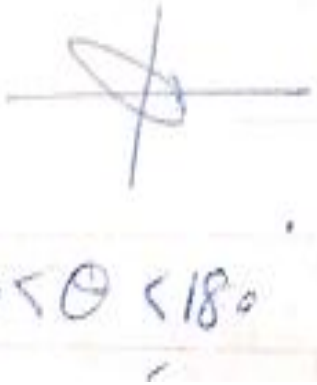
Examples

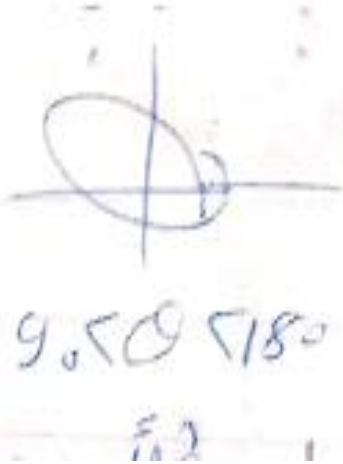


Examples



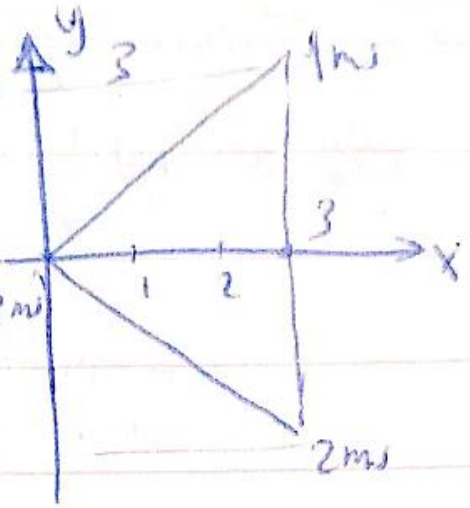






Examples

① given



find V_v, V_h

for $S_v = S_h = 1V/cm$

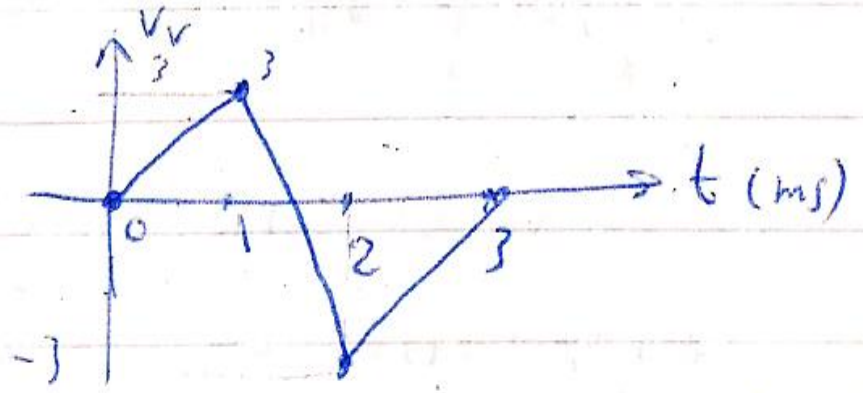
① to find V_v $\quad y = V_v/S_v = V_v$

at $t=0 \Rightarrow y=0 \therefore V_v=0$

$t=1ms \Rightarrow y=3 \therefore V_v=3$

$t=2ms \Rightarrow y=-3 \therefore V_v=-3$

$t=3ms \Rightarrow y=0 \therefore V_v=0$



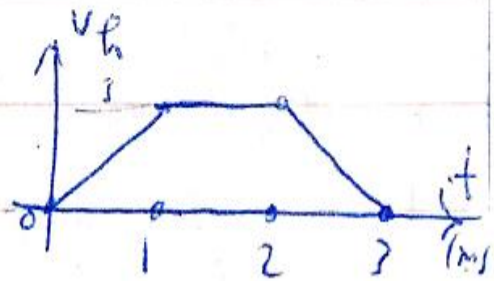
② to find V_h $\quad x = V_h/S_h = V_h$

at $t=0 \Rightarrow x=0$

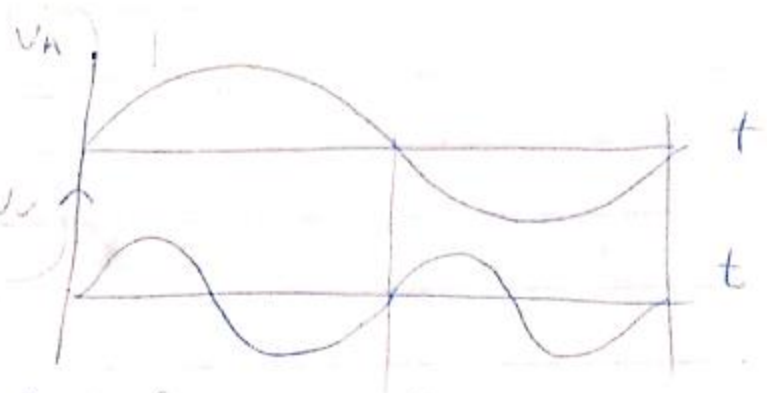
$t=1ms \Rightarrow x=3$

$t=2ms \Rightarrow x=3$

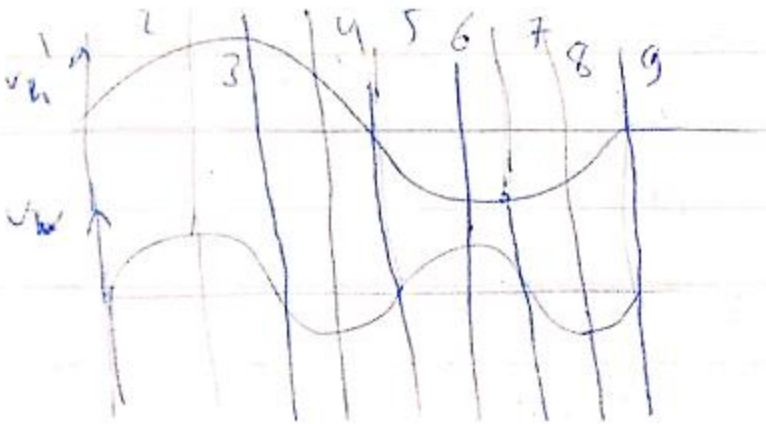
$t=3ms \Rightarrow x=0$

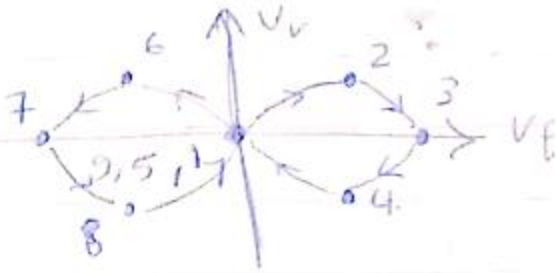


Examples



Find Lamajor figure





0 = V_V = V_R 1

(+) V_V ((+) V_R 2

+) V_R 3

0 = V_V (

-ve = V_V (0 = V_R)

(the same peeric

$V_0 = V_R = V_V$

Introduction

Typical LCD Applications

1. Computer monitors
2. I-pods, calculators, clocks, watches
3. Flat screen television sets
4. Instrument panels

LCDs

Introduction

Difference between LCD and LED monitors

- The LED (light emitting diode) monitors also uses liquid crystals, so the name is somewhat misleading. Technically, an “LED monitor” should really go by the name, “LED LCD monitor.”

- Both types of LCD and LED displays use liquid crystals to create an image.
- The difference is in the backlights:
  - A standard LCD monitor uses fluorescent backlights.
  - An LED monitor uses light-emitting diodes for backlights. LED monitors usually have superior picture quality.

Thank you for your attention