AMERICAN INTERNATIONAL UNIVERSITY–BANGLADESH (AIUB)

FACULTY OF SCIENCE & TECHNOLOGY

DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

ELECTRICAL CIRCUIT LAB - 1

SUMMER 2022-2023

Section: W, Group: 2

LAB REPORT ON

To be familiar with the operations of an oscilloscope and measuring corresponding

Supervised By

DR. MD. KABIRUZZAMAN

Submitted By

Name	ID	Contribution
1. SK MUKTADIR HOSSAIN	21-44989-2	Precautions, Experimental Procedure, Simulation and Measurements, Apparatus
2. PRANTO BISWAS	21-45026-2	Theory and Methodology, Calculation, Simulation and Measurements
3. KAZI ABDULLAH JARIF	22-46386-1	Calculation, Discussion, Conclusion, Experimental Procedure
4. MD. NESAR UDDIN	22-46313-1	Precautions, Theory and Methodology, Conclusion, Apparatus

Date of Submission: **June 23, 2022**

Table of contents

1.Introduction:

The purpose of the experiment is:

- To become familiar with the Function Generator and Oscilloscope.
- To measure peak value, peak-to-peak value, average value, rms value, time period, frequency and phase difference using oscilloscope.

2.Theory and Methodology:

i) Function Generator: A function generator is usually a piece of electronic test equipment used to generate different types of electrical waveforms over a wide range of frequencies. Some of the most common waveforms produced by the function generator are the sine, square, triangular, and sawtooth shapes. These waveforms can be either repetitive or single shot (which requires an internal or external trigger source). Integrated circuits used to generate waveforms may also be described as function generator ICs. Function generators cover both audio and RF frequencies.

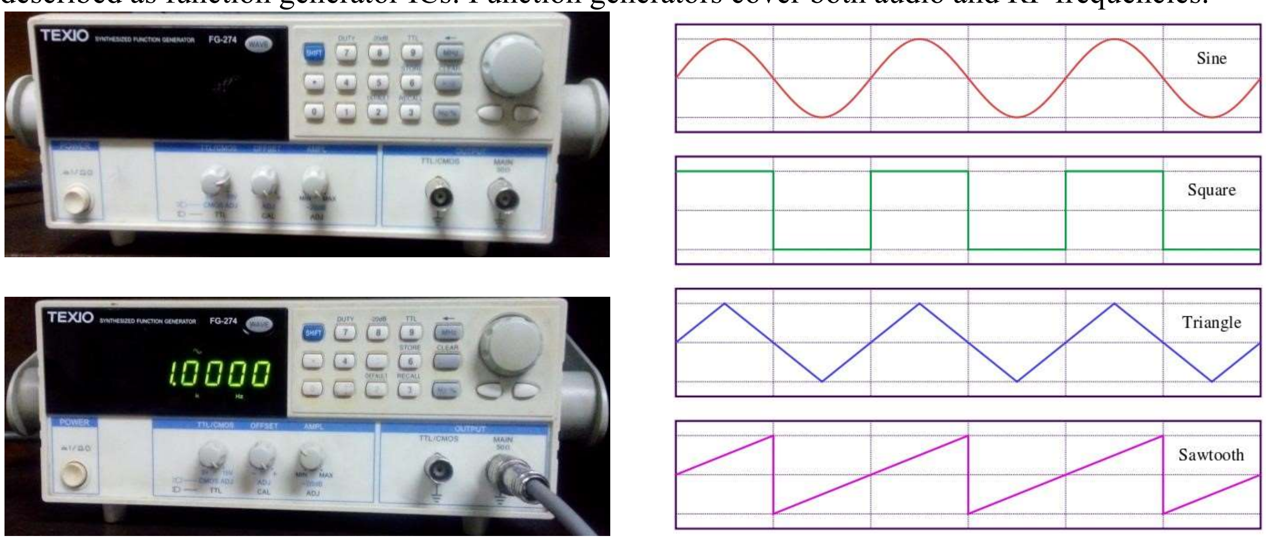


Figure-1: Typical Function Generator and Different Wave shapes

ii) Oscilloscope: The oscilloscope is a device for observing and taking measurements of electrical signals and waveforms. The analog oscilloscope consists of a cathode ray tube (CRT) which displays a graph, primarily voltage versus time. It also has one or more amplifiers to supply voltage signals to the CRT and a time base system for generating the time scale. Some of the modern digital oscilloscopes use liquid crystal display screen for the same purpose. There are three controls for the screen, which are focus, intensity, and beam finder knobs. Besides the screen, there is also a vertical section and a horizontal section.

This device allows real time graphs of voltage versus time to be drawn on the screen. This allows studying and comparing various voltage waveforms in circuits. Usually, two waveforms can be displayed simultaneously. There are two channels for taking input voltage waveform. The oscilloscope shows amplitude of voltage waveform along Y axis and time along X axis.

Figure-2: An Oscilloscope

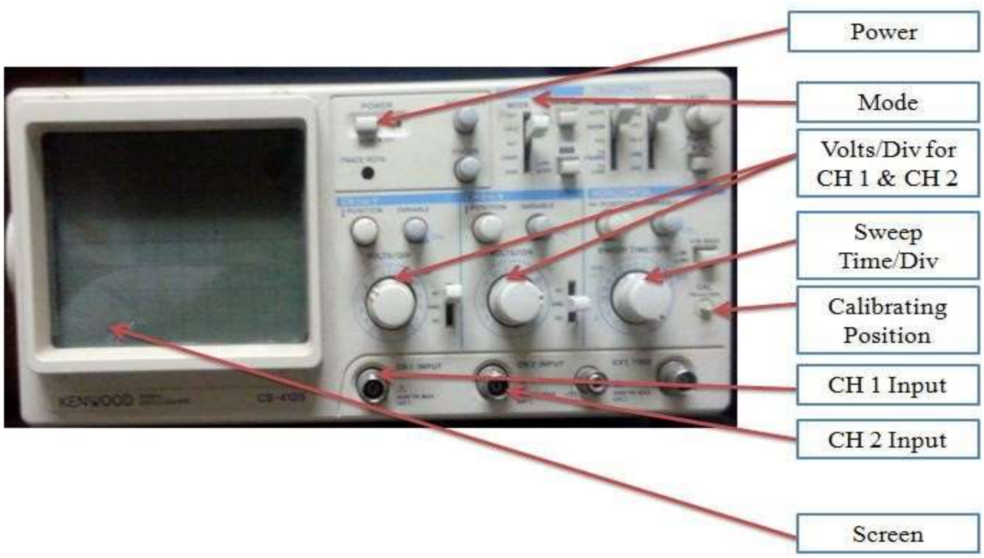


Figure-3: Different Parts of an Oscilloscope

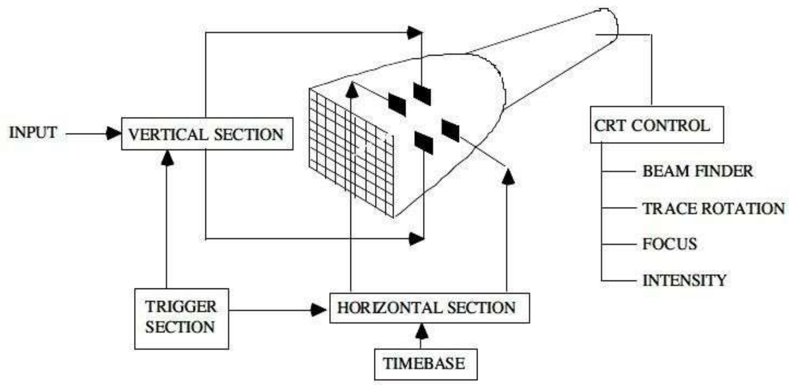


Figure-4: Functional Diagram of Oscilloscope

iii) Oscilloscope Probe: An oscilloscope probe is a high quality connector cable that has been carefully designed not to pick up stray signals originating from radio frequency (RF) or power lines. They are especially useful when working with low voltage signals or high frequency signals which are susceptible to noise pick up.

Figure-5: Oscilloscope Probe

iv) Basic Operations of an Oscilloscope:

The Trace: The trace is one of the most basic operations of an oscilloscope. The oscilloscope draws a trace, which is a horizontal line, across the screen. The time base control determines how quickly the trace (also called a sweep) is drawn. When the voltage becomes negative or positive, the viewer displays a correspondingly positive or negative jump in the trace on screen.

Vertical and Horizontal Sensitivity Controls: These controls allow the user to determine manually the sensitivity, both vertically and horizontally. This allows oscilloscopes to accommodate a wide range of input amplitudes.

Focus Control: This allows users to adjust the sharpness of the trace. New flat panel models do this automatically.

Beam Finder: This control prevents the trace from deflecting off screen or otherwise being blocked. Because the beam finder prevents the trace from deflecting off screen, it may temporarily distort the trace.
Time base Control: This control determines how quickly the oscilloscope draws the trace. This control allows users to manually select the sweep speed, which is in seconds per unit on the square grids (graticule) seen on the oscilloscope display.

Intensity Control: The intensity control determines how intensely the trace is drawn. For CRT models, a high intensity is desirable for fast traces, and for low-speed lower intensity. Speed is unimportant for LCD models.

Types of Sweeps: There are four types of sweeps: triggered, recurrent, single, and delayed. Triggered sweeps reset the screen every time the trace reaches the right end of the screen and are useful for periodic signals like sine waves. Recurrent and single sweeps are more common on older models and are less useful for qualitatively observing signals. Delayed sweeps allow users to get a very detailed look at voltage.

AC Fundamentals:

Wave shape: The shape of the curve is obtained by plotting the instantaneous values of voltage or current as the ordinate against time as an abscissa (X-axis value) is called waveform or wave shape [1].

Cycle: One complete set of positive and negative values of an alternating quantity is called a cycle. One complete cycle is 2π or 360^0 [1].

Time Period: The time required to complete one cycle of the alternating quantity is called a period, expressed by the symbol T [1].

Frequency: The no. of cycle per second is called the frequency of the alternating quantity. Unit is Hertz (Hz). Frequency, $f = (1/T)$ Hz [1].

Peak Value: The maximum instantaneous value of a function or waveform is called the peak amplitude [2].

Peak to Peak Value: It is the sum of the magnitude of the positive peak and negative peak of a given wave form [2]. For a voltage waveform it is denoted by $V_{P-P} = |V_m| + |-V_m| = 2V_m$.

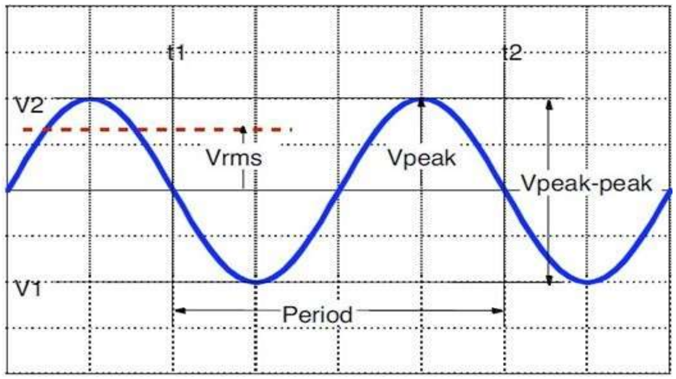


Figure-6: Characterization of sinusoidal time varying signal

Average Value: The steady current that transfers across any circuit the same charge as is transferred by that alternating current during the same time expresses the average value of a sinusoid [3]. $V_{avg} = 0.636V_m$, where V_m is the maximum value of the sinusoid.

RMS Value: The Root Mean Square (RMS) value is the DC equivalent value of an alternating quantity which is given by that steady current which when flowing through a given circuit for a given time produces the same heat as produced by the alternating current when flowing through the same circuit for the same time [3]. $V_{rms} = 0.707V_m$, where V_m is the maximum value of the sinusoid.
The digital multimeter (DMM) is used to measure DC currents and voltages. The DMM in the AC Mode can also be used to measure the RMS value of an AC waveform.

Phase Difference: Phase difference is the difference of phases corresponding to similar point of two alternating wave (if frequency of both waves must be same).

Leading & Lagging Waves: In figure 7, there are two waves, Wave I_1 and Wave I_2. Wave I_1 leads Wave I_2 by angle α or Wave I_2 lags Wave I_1 by angle α.

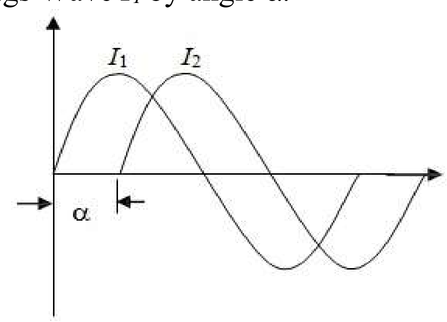
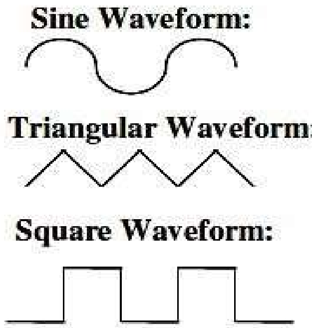


Figure-7: The phase difference between two waves

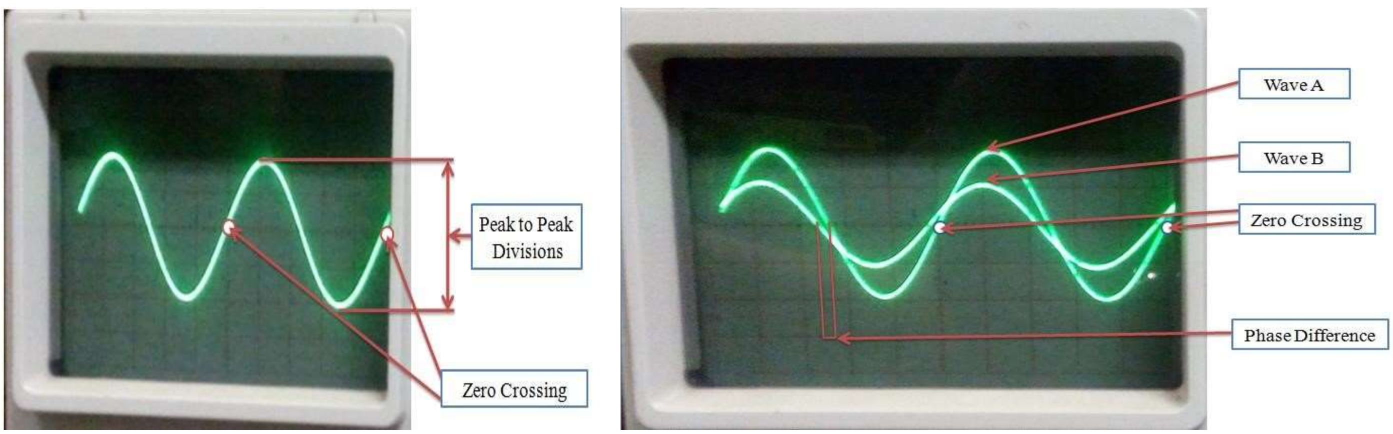


<u>Sine:</u> $V_{p\text{-}p} = 2\,V_p = 2\sqrt{2}\ V_{rms}$ or $V_{rms} = \dfrac{V_m}{\sqrt{2}} = \dfrac{V_p}{\sqrt{2}} = \dfrac{V_{pp}}{2\sqrt{2}}$

<u>Triangle:</u> $V_{p\text{-}p} = 2\,V_p = 2\sqrt{3}\ V_{rms}$ or $V_{rms} = \dfrac{V_m}{\sqrt{3}} = \dfrac{V_p}{\sqrt{3}} = \dfrac{V_{pp}}{2\sqrt{3}}$

<u>Square:</u> $V_{p\text{-}p} = 2\,V_p = 2V_{rms}$ or $V_{rms} = V_m = V_p = \dfrac{V_{pp}}{2}$

Measurements from Oscilloscope:



(a) (b)

Figure-8: Waveform(s) in oscilloscope in: (a) single mode and (b) dual mode

In figure-8 (a), Vertical: 2Volts/Div and Horizontal: 0.2ms/Div. 4 divisions peak to peak times 2V/Div. Peak to Peak Value, $V_{P\text{-}P}$ = (4Div) x (2V/Div) = 8V. Peak Value, V_P =4V. Average Value, V_{avg}= 0.636 x (4V) = 2.544V. RMS Value, V_{rms} = 0.707 x (4V) = 2.828V. 5 divisions between "zero crossing". Time Period, T = (5Div) x (0.2ms/Div) = 1ms. Frequency, f = (1/T) = (1/1ms) = 1kHz.

In figure-8 (b), there are two waves, Wave A and Wave B. The phase difference can be calculated by the equation, θ = [{Phase Shift (no. of div.)/T (no. of div.)} x 360˚]. 1 division = 5 small divisions, Phase Shift = 1 small division and T = 25 small divisions. θ = [{(1 small div.)/(25 small div.)} x 360˚] = 14.4˚. Wave B leads Wave A by 14.4˚ or Wave A lags Wave B by 14.4˚.

<u>3.Apparatus:</u>

1. Function Generator
2. Oscilloscope
3. Probes and Connecting Wires

4.Precautions:

The oscilloscope must be calibrated correctly before the start of the experiment. The frequency and waveform mode of the function generator must be set as per requirement of the experiment.

5.Experimental Procedure:

1.Firstly, we Connected the output of the function generator directly to the channel 1 of the oscilloscope. We set the amplitude of the wave 10V peak to peak and the frequency at 1kHz. Select sinusoidal wave shape.
2Then we Sketched the wave shape observed in the oscilloscope and determined the time period of the wave and calculate the frequency.
3.Then we Changed the frequency to 2.5kHz then 1.5 kHz, then 2 kHz and 12kHz and note what happens to the display of the wave. Repeated when frequency is increased 10kHz after 2 kHz. Draw the wave shapes for both cases.
4.Lastly, we Measured the peak value, peak-to-peak value, average value, rms value for all the five frequencies and filled the following table with necessary calculations.

Data Table:

Table-1

Frequency (KHz)	Time Period (ms)	V_{P-P} (Volts)	V_P (Volts)	V_{avg} (Volts)	V_{rms} (Volts)
1	0.996	10	4.94	3.145	3.49
2.5	0.4	12	5.91	3.76	4.18
1.5	0.665	14	6.95	4.424	4.19
2	0.5	16	7.96	5.067	5.629
12	0.084	18	9.01	5.735	6.37

6.Calculation:

For frequency 1kHz,
$V_{p-p} = 10V$
$V_p = 10/2 = 4.94V$
$V_{avg} = 0.636 \times 4.94 = 3.145V$
$V_{rms} = 0.707 \times 4.94 = 3.49V$

For frequency 2.5kHz,
$V_{p-p} = 12V$

V_p=12/2 = 5.91V
V_{avg} = 0.636×5.91 = 3.76V
V_{rms} = 0.707×5.91 = 4.18V

For frequency 1.5kHz,
Vp-p = 14V
V_p=14/2 = 6.95V
V_{avg} = 0.636×6.95 = 4.424V
V_{rms} = 0.707×6.95 = 4.19V

For frequency 2kHz,
Vp-p = 16V
V_p=16/2 = 7.96V
V_{avg} = 0.636×4.94 = 5.067V
V_{rms} = 0.707×4.94 = 5.629V

For frequency 12kHz,
Vp-p = 18V
V_p=18/2 = 9.01V
V_{avg} = 0.636×4.94 = 5.735V
V_{rms} = 0.707×4.94 = 6.37V

The measured value and calculated value of Vp is almost similar and we can see that when the frequency increased from 2 to 12 the value of Vavg and Vrms also increased.

Discussion:

- The trainer board and the oscilloscope were checked before the start of the experiment.
- The value of the voltage was increased gradually as applying a large voltage can damage the resistors.
- Finally, all the data was placed in the data table. For the given equation, a result was obtained.

Conclusion:

In this experiment the data/findings were interpreted and determine to the extent to which the experiment was successful in complying. The goal was initially set. The ways of the study were improved, investigated, and described by measuring, converting, and calculation.

Reference:

[1] Russell M. Kerchner, George F. Corcoran, ″Alternating Current Circuits″, 4th Edition, Wiley, New York, 1960, pp. 48-50.

[2] Robert L. Boylestad, ″Introductory Circuit Analysis″, 10th Edition, Prentice Hall, New York, 2005-2006, p. 524.

[3] Er. R.K. Rajput, ″Alternating Current Machines″, 3rd Edition, Laxmi Publications, New Delhi, 2002, p. (xi).