

Oscillators and Oscilloscope

OBJECT: To study the features and operation of the oscilloscope; to use the oscilloscope to measure the frequency and amplitude for various sources; to display and study Lissajous figures.

THEORY: The oscilloscope is one of the most widely used and versatile instruments. It is a standard piece of instrumentation in scientific laboratories of all kinds. By moving a n image across a LCD (liquid crystal display) screen, it can be used to draw graphs of y (vertical) versus x (horizontal). The values of y and x which are provided to the oscilloscope are voltages. The y voltage is usually the dependent variable. The independent variable is time, t . The equations for the waves follow the form:

$$\begin{aligned}y &= A \sin (\omega t) \\ &\text{or} \\ y &= A \cos (\omega t)\end{aligned}\tag{6.1}$$

where A is the amplitude, ω is the frequency, and t is the time. The oscilloscope has an internal device, called a sweep oscillator, which moves the beam across the screen at a constant rate. Hence, we can think of the oscilloscope as plotting y versus t .

Lissajous figures are graphs of complex harmonic motion between parametric equations. The motion is described by equations of the form:

$$\begin{aligned}x &= A \sin (a t + \delta) \\ &\text{and} \\ y &= B \sin (b t)\end{aligned}\tag{6.2}$$

with A and B being the amplitudes, a and b are the frequencies, t is the time, and δ is the phase shift.

APPARATUS: Oscilloscope (OWON PD55022S Dual Channel Digital Color), two audio oscillators (Global Specialties 200 kHz Function Generator 2001A), connectors, computer interface, USB A-Male to A-Male cable.

PROCEDURE:

1. First, study the controls and setup of the oscilloscope as shown in Fig 6.1.

POWER: The power button is located on the top left side of the unit.

USB PORT: Located on the back of the unit, this port allows the oscilloscope to be connected to the computer interface.

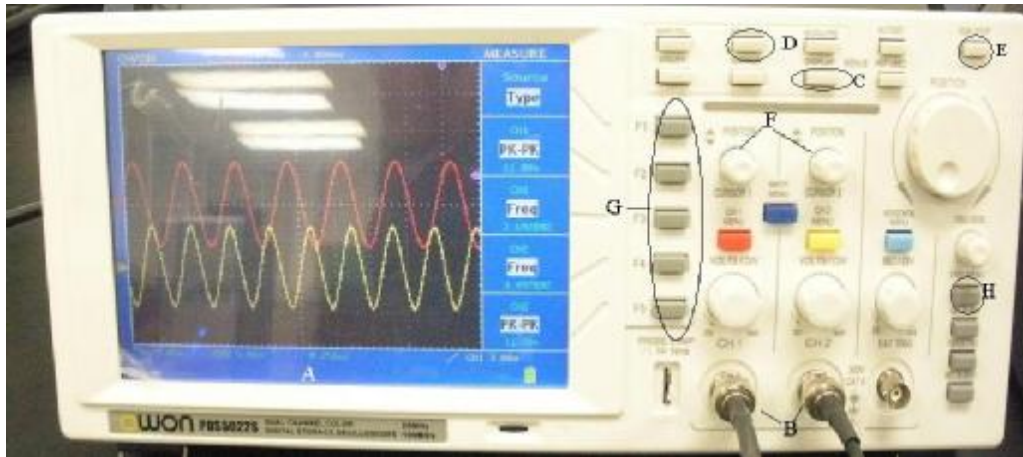


Figure 6.1

A: SCREEN: The area shows the wave patterns produced by the audio oscillators and is located on the left front of the unit.

B: SIGNAL INPUT: The connection ports on the bottom right front of the unit that allow the audio oscillators to connect to the oscilloscope.

C: DISPLAY: Changes to the display menu where the axis can be changed from XY to YT.

D: MEASURE: Measures the peak-to-peak and frequency values of the waves.

E: RUN/STOP: Toggles between freezing the on screen image in place and allowing the waves to oscillate.

F: HORIZONTAL and VERTICAL POSITION: Controls the horizontal and vertical positions respectively.

G: MENU OPTIONS: Located next to the screen, the menu options range from F1 -F5, giving specific settings for each selected menu.

H: TRIGGER/ TRIGGER MENU: This selects internal, external, or line modes for triggering the sweep. Once in one of these modes, you can select automatic or some level to trigger on, and you can select either positive or negative slope.

2. Connect the two audio oscillators 600 Ω ports (6 in Figure 6.2) into the oscilloscope's channel 1 and channel 2 ports (B from Figure 6.1) using the connectors. Make sure that the voltage on the oscillators is set on the 1V-10V range (5 in Figure 6.2), the DC offset is set to off (4 in Figure 6.2) since the oscilloscope is set to AC coupling, the frequency (1 in Figure 6.2) is set to \sim 2kHz (set the frequency at \sim 2 and the frequency mult. (2 in Figure 6.2) at 1K), and the function (3 in Figure 6.2) is set to sine wave. Plug in the oscillators and oscilloscope and turn the units on.



Figure 6.2

3. Adjust the various triggering controls until stable wave patterns are obtained. The trigger level control selects the value of the voltage signal or threshold at which the sweep will be initiated. The level control is continuously variable from negative values at one extreme, through zero somewhat in the middle to positive values at the other extreme. The automatic AUTO setting triggers the sweep when the level crosses zero voltage. The slope control allows you to select whether triggering will take place while the voltage is increasing or decreasing. A positive slope means that triggering can take place only on an increasing voltage, even if the level or value is negative. A negative slope allows triggering to take place only when the voltage is decreasing. By selecting appropriate slope and level you can trigger the sweep at any point like on the input signal. Trigger on channel 1 by selecting the trigger menu and ensuring the selected source is channel 1 (if not, use the F3 button to select CH1).

4. Select the Measure menu to obtain the peak-to-peak amplitude of the voltage from the audio oscillator. The amplitude of the voltage is half the peak-to-peak amplitude. Also, obtain the voltage.

5. Use the Measure menu to obtain the frequency of each wave pattern. Compare the oscilloscope's measured value, to the value set on the oscillator. Use Run/Stop to freeze the image on screen. Open Data wave on the computer interface. Go to the communication menu and select get data. Print a copy of the waves. Repeat the experiment at ~5 kHz, ~8 kHz, and ~10 kHz. Each member of the group should lead a trial and print his/her own results.

6. Set the first oscillator to approximately 100 Hz. Vary the input frequency of the second oscillator (by one half the frequency of the first oscillator and twice the frequency of the first oscillator) until you obtain stable wave patterns. Using the Display menu change the display to XY. Using Run/Stop and the computer interface, capture the display screen image. Print a copy of the images for each group member. Indicate

the oscillator frequencies to which each pattern corresponds. Do you see any systematic relationship between the oscillator frequencies? The patterns displayed on the scope in this exercise are called Lissajous figures. Repeat setting the oscillator at 150 Hz.



Figure 6.3

In the lab report include: the Lissajous figures and a write up for what each means, a copy of the wave patterns and a comparison of the set and measured frequencies, and the amplitudes of the voltages.