

# Experiment 24

## The Oscilloscope

### Equipment:

- 1 oscilloscope
- 1 BNC cable
- 1 sound level meter
- 1 phono-BNC adapter
- 1 BNC to banana plug adapter
- 2 tuning forks of different frequencies
- 1 BK oscillator
- 1 Oscilloscope video
- 1 Kelvin 200 DMM

### Objective:

The object of this experiment is to learn how to use the oscilloscope by measuring the periods and amplitudes of various waveforms as well as analyzing a sound wave.

### Theory:

The oscilloscope is an electronic instrument widely used in making electronic measurements. *The most noteworthy attribute of an (ideal) oscilloscope is that it does not affect the quantity being measured.* The main component of the scope is the cathode-ray tube, or CRT. The CRT consists of a vacuum tube in which electrons are "boiled off" a cathode and accelerated, using an electric field, towards a phosphorescent screen. When the electrons strike the screen, a burst of light is given off. The beam is deflected along the way by vertical and horizontal plates that use electric fields to deflect the electrons.

The screen of the oscilloscope has a grid on it called a gradecule. The gradecule is used to read information from the screen of the oscilloscope. The dials on the oscilloscope give the scale of the gradecule in VOLTS/DIVISION in the vertical direction and SECONDS/DIVISION in the horizontal direction (see figure 24-2).

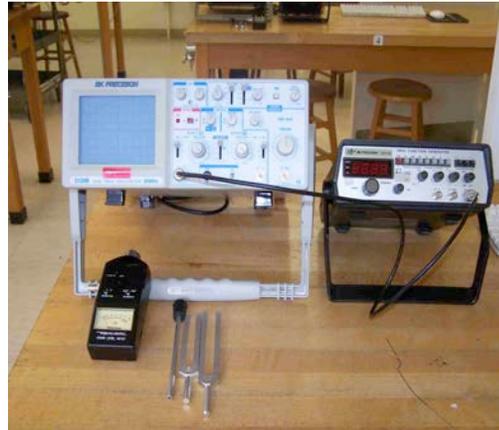


Figure 24-1

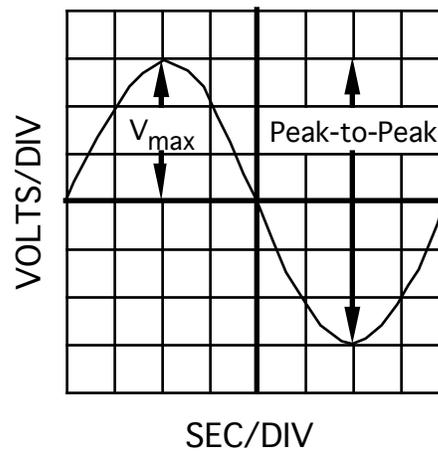


Figure 24-2

### Procedure:

#### Part 1: Learning the oscilloscope control switches

1. The oscilloscope should be connected to an oscillator by a BNC cable. Turn on the oscillator and the oscilloscope. You should see a sine wave on the screen.
2. In the following section, manipulate the various controls on the scopes and answer the questions.
  - (a) What happens when you turn the INTENSITY control?
  - (b) What happens when you turn the FOCUS control?

(c) What do the VERTICAL and HORIZONTAL POSITION controls do?

(d) What happens when you change the SEC/DIV control?

(e) What happens when you change the VOLT/DIV control?

(f) What happens when the AC-GND-DC switch is switched to the center position?

(g) What happens when you move the trigger level control?

(h) What happens when the slope switch is pushed in?

(i) Why are there two VOLT/DIV controls?

## Part 2: Measurement of frequency

3. Measure the period of the sine wave signal from the oscillator and calculate the frequency using the relationship  $period = 1/frequency$ .

4. Disconnect the BNC cable from the oscillator and connect it to the sound level meter. Turn on the sound level meter by rotating the dial on the front to the 70 or 80 dB position. The response switch should be on "slow," and the weighting switch on "A".

5. Strike one of the tuning forks with the rubber mallet, and hold it in front of the sound level meter. Adjust the trace on the screen until at least one whole period appears on the screen and the size of the wave form on the screen is as large as it can be.

6. Measure the period of the tuning fork and calculate the frequency. Calculate the percent difference between the frequency printed on the side of the tuning fork and the experimental value. Repeat for the other tuning fork.

## Part 3: Measurement of AC voltages.

7. Reconnect the oscillator to the oscilloscope. Adjust the frequency of the signal from the oscillator so that it is close to 60 hertz. Measure the peak-to-peak voltage of a sine wave from the signal generator using the oscilloscope.

8. Calculate the RMS voltage of the sine wave from the scope. The RMS voltage is the root-mean-square of the voltage and is given by:

$$V_{\text{rms}} = \sqrt{\frac{(V_{\text{max}})^2}{2}} = .707V_{\text{max}}$$

where  $V_{\text{max}}$  is the amplitude of the wave or half of the peak-to-peak voltage. Measure the voltage of the signal with the DMM. Remember that you are now measuring the voltage of a sine wave, so you need to use AC volts instead of DC volts. Calculate the percent difference between the two.

9. Adjust the amplitude of the signal and repeat steps 7 and 8.

10. Change the frequency of the signal generator by **sequentially pushing** the frequency buttons to the highest level (i.e., frequency). What (do you observe) happens to the voltage displayed by the DMM as the AC frequency increases?

11. Each person needs to know how to operate the oscilloscope, so test each other by changing the waveforms and reading the peak-to-peak voltages, amplitudes, and frequencies.

## Part 4: The test

12. On the front table, your lab instructor has an oscilloscope and oscillator. Find the signal and record the peak-to-peak voltage and the frequency. Have your lab instructor verify your answer before leaving lab.

## Questions/Conclusions:

1. Why should you maximize the size of the displayed waveform by adjusting the volts/div knob when you determine its amplitude?

2. What effect does changing the volts/division scale from 1 volt per division to 5 volts per division have on the incoming wave? Does the *measured amplitude* of the wave increase, decrease or remain the same?

3. Explain the function of an oscilloscope trigger. See following website:

**[http://www.hobbyprojects.com/oscilloscope\\_tutorial/oscilloscope\\_trigger\\_controls.html](http://www.hobbyprojects.com/oscilloscope_tutorial/oscilloscope_trigger_controls.html)**

4. What is the electric generator frequency in the U.S.? (“Google” this answer). What is the angular frequency (of this frequency)?

Why did you set your signal generator to 60 Hz when using the DMM to measure voltage? Refer back to what you observed in step 10 above. You may also want to “google” to explain.