

# Experiment 24

## The Oscilloscope

### Advanced Reading:

(Serway) Chapter 16, section 16-7. Chapter 33, sections 33-1 through 33-3. You need to understand what is meant by wavelength, frequency, and period

### Equipment:

- 1 oscilloscope
- 1 BNC cable
- 1 sound level meter
- 1 phono-BNC 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.

### Theory:

The oscilloscope is an electronic instrument widely used in making electronic measurements. 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.

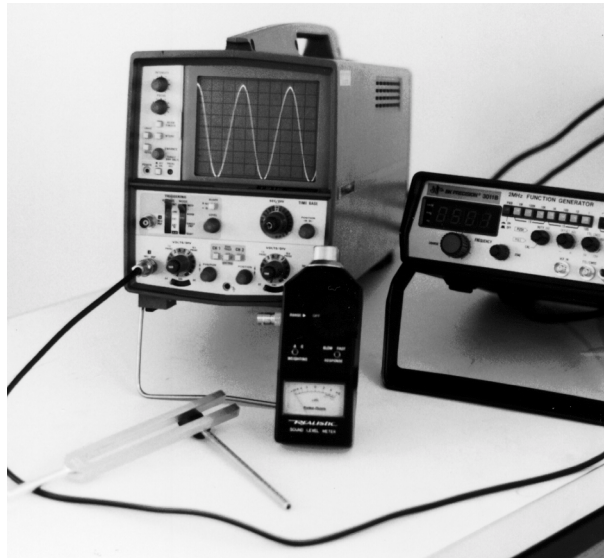


figure 24-1

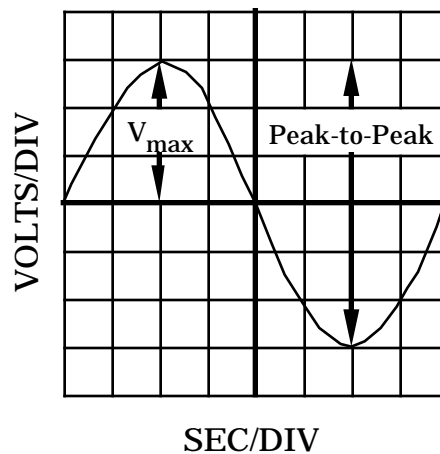


figure 24-2

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 15-2).

At the beginning of this lab, a videotape on the operation of the oscilloscope may be shown. This

tape explains some of the theory of the oscilloscopes operation.

**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 oscillator 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. Each person needs to know how to operate the oscilloscope, so test each other by giving sample wave forms and reading the peak-to-peak voltages, amplitudes, and frequencies. Have your lab partner "mess-up" the screen and then you locate the trace. When each person can do this, proceed to the next part.

#### **Part 4: The test**

11. 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 volts/division scale on the gradecule when determining the amplitude of the wave form?

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 wave amplitude increase, decrease or remain the same?