PHY 152/252

The Oscilloscope – Laboratory 5

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 oscilloscope is used in almost every physics and electrical engineering laboratory, and familiarity with its uses is vital in the study of electronics. Some examples of its use are to determine the frequency of an alternating current or to detect potential differences. 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 TIME/DIVISION in the horizontal direction.

Procedure

Part 1: Setting up the oscilloscope

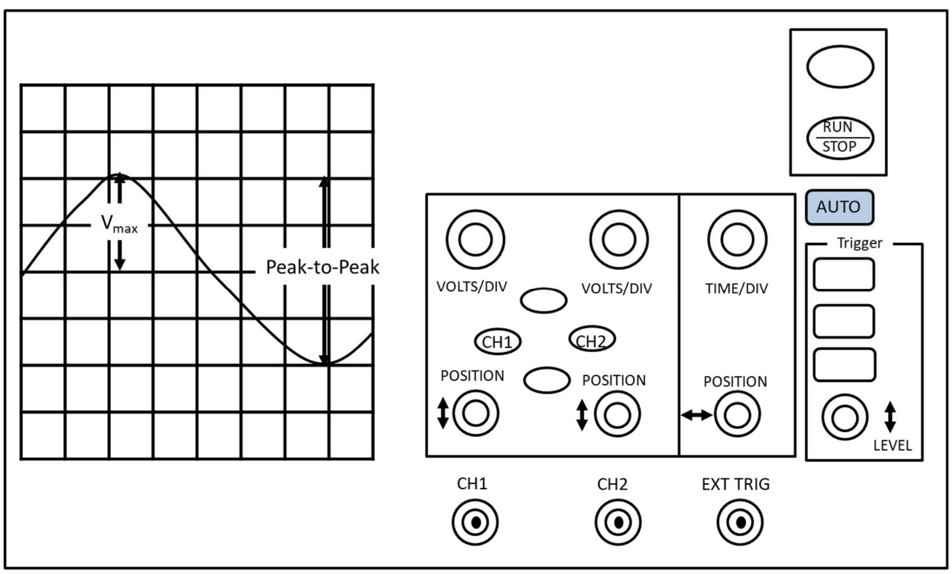


Figure. Diagram of the oscilloscope (only mattered knobs and buttons in this lab are shown)

1. Plug in the oscilloscope and turn on the power.
2. Plug in the function generator and turn on the power.
3. Set the function generator's frequency to an around 1000 Hz (1kHz); set the frequency range to 5K and adjust the coarse and fine control knob until LED's display an around 1000. It doesn't need to be exact.
4. Set the function generator's wave form to sine wave (∿).
5. Connect the function generator to the oscilloscope by connecting the output on the function generator to CH1 BNC port on the oscilloscope with BNC cable provided.

6. Set VOLTS/DIV in CH1 to 2.00V. You can see this setting on the bottom of the display.
7. Set TIME/DIV in CH1 to 100μs (100 x 10^{-6} sec). You can see this setting on the bottom of the display.
8. If necessary, use the vertical position control to center the line on the screen.
9. Adjust the trigger level control to the center of the horizontal scale (you can know this with the value on the display, i.e. TRIGLVL=0.00mV).

Part 2: Measurement of frequency

10. Record the horizontal distance for one cycle of the sine wave, in division, and the time setting in the table below. Compute the period of the wave using the following formula:

period = (horizontal distance in division)(Time/Div)

11. Compute the frequency of the wave form using the following formula.

frequency = 1 / period

12. Change the time base setting until two cycles of the wave are shown. Record the horizontal distance for one cycle of the wave. Again compute the period and the frequency.
13. Repeat the above for five cycles of the wave

Number of cycles	Horizontal distance for one wave (div.)	Time base setting (sec/div)	Period (s)	f (Hz)
1				
2				
5				

14. Compute the average frequency. Compute the percent error between your average value and the value set by the function generator (1000Hz)

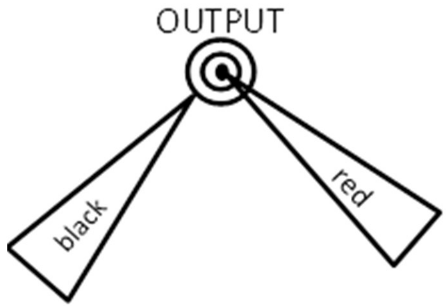
f_{avg}: ______________________ %error: ______________________

Part 3: Measurement of AC voltage

15. Adjust the output level control knob on the function generator until a 4 divisions of peak-to-peak wave pattern is on the oscilloscope.
16. Compute the peak-to-peak voltage using the following formula.

Voltage peak-to-peak: V_{pp} = (height in div)(volts/div)= ______________________V

17. Measure the voltage of the signal with the multimeter (EXTECH). Remember that you are now measuring the voltage of a sine wave, so you need to set the multimeter to V_{ac}. (To measure the voltage with the multimeter, disconnect the BNC cable from the function generator and make the two multimeter probes contact to the BNC port as shown in the diagram)



Voltage from the multimeter: ___________________V

18. Do you know why the measured voltage from the multimeter was different from V_{pp}? The voltage measured from the multimeter gives the root-mean-square (RMS) value. The RMS values for a sine wave are following:

$$V_{rms} = \frac{1}{2\sqrt{2}}V_{pp} = 0.354V_{pp}$$
$$V_{rms} = \frac{1}{\sqrt{2}}V_{max} = 0.707V_{max}$$

where V_{max} is the amplitude of the wave or half of the peak-to-peak voltage.

Calculate the root-mean-square (rms) values.

$V_{rms} = 0.354V_{pp}$ = ________________V
$V_{rms} = 0.707V_{max}$ = ________________V

19. Find the percent errors for the calculated and measured rms voltages (you have one measured rms value from the multimeter and two calculated rms values from V_{pp} and V_{max}. compare the measured value with two calculated values)