Experiment 2
Lab Activity

Pre-Lab Activity

Study the Signal Basics Unit and complete its Pre-Lab activity (solve associated problems and submit to your instructor). Also, read the material in this Unit before coming to the Laboratory. Read the laboratory activity and the post-lab activity.

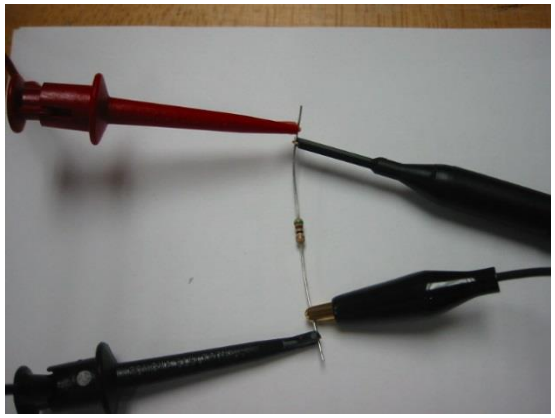
Laboratory Activity

Required components:

One 50Ω resistor (1%, 1W rated)

One 100Ω resistor (1%, 1W rated)

1. In this step, you will be measuring the default 2V peak-to-peak, 1kHz sine voltage signal that the function generator outputs upon power up. While power is off, connect the output connector of the Rigol function generator across a (1% tolerance, 1Watt rated) 50Ω resistor. Connect the 10x probe to Channel 1 of your scope. Connect the probe's clip (hook) to the resistor terminal which is also connected to the positive (red) clip of the BNC-to-clip test cable. Connect the probe's mini alligator clip (black ground wire) to the other end of the resistor. The resulting connection (see figure below) MUST have the ground of the function generator connected to that of the scope. Ask your instructor to check your connections before you continue.



Power-up the function generator. Wait few seconds and then power up the scope. The function generator output is (by default) a 1kHz sine wave with 2V peak-to-peak voltage (assuming a 50Ω load). Select Channel 1 on the scope and press the **Auto** key followed by the **Measure** key. Next, apply averaging, with **# Avgs** = 8. The number in **# Avgs** can be adjusted by turning the knob (refer to the Oscilloscope experiment for details). Use the soft keys on the scope to display and record the signal's peak-to-peak voltage and frequency. Save the display to disk (as a .TIF file). Compare those measurements to the Vpp and frequency values displayed by the function generator.

2. Turn off the function generator. Remove the 50Ω resistor, but keep the same connections between the function generator and scope, as in Step 1. Make sure you never short the function generator output. Turn on the function generator. Wait few seconds. Press the **scale** key on the scope followed by the **Measure** key. Apply averaging, with **# Avgs** = 8. Use the soft keys on the scope to display and record the signal's peak-to-peak voltage and frequency. Save the display to disk. Compare those measurements to the Vpp and frequency values displayed by the function generator.

3. Repeat Step 1 with a (1%, 1W rated) 100Ω resistor.

4. Replace the 100Ω resistor by the 50Ω resistor, for the rest of the experiment. Set up the function generator to display the waveforms of the following signals on the scope. For each signal, press the **scale** key on the scope followed by the **Measure** key. Next, apply averaging, with **# Avgs** = 8. Use the soft keys to display peak-to-peak voltage, average, and frequency for all sine signals. Display the peak-to-peak voltage, average, and duty cycle for square waves.

   a. $v(t) = 2\sin(2{,}000\pi t)$ Volts. (Note, here: $f = \omega/2\pi = 2{,}000\pi/2\pi = 1{,}000$Hz and Vpp = 4V.)
   b. $v(t) = 3.2\sin(5{,}000\pi\, t) + 1$ Volts. Note the displayed waveform's ground level.
   c. A triangular signal with Vpp = 3V, f = 500Hz and zero offset.
   d. A square signal with Vpp = 4, f = 2,000Hz and 50% duty cycle. Make sure to calibrate the probe if the corners of the pulse appear deformed.
   e. The signal in Part d with a 70% duty cycle.
   f. The signal in Part e with a +2V dc bias (offset).

5. Try to change the offset of the signal in Step 4-f from +2V to +4V. Repeat for a -4V offset. Record your observations.

6. Use the function generator to output the following three individual signals. Make sure to reset the function generator back to zero offset for Part a. Use the scope to display and measure the RMS value of each signal. Apply signal averaging, with **# Avgs** = 8, before making the RMS measurements.

   a. $v(t) = 2\sin(2{,}000\pi\, t)$ Volts.
   b. $v(t) = +1$ Volts (*dc* signal)
   c. $v(t) = 2\sin(2{,}000\pi\, t) + 1$ Volts.

Post-Lab Activity

Write a technical report that discusses your observations and includes analysis and justifications of all steps in this activity. Include in your report all scope display captures that you generate in the Lab. Tabulate experimental results whenever possible. More specifically, your report should address the following points:

- The effect of the load resistor on the consistency between the displayed function generator Vpp and that of the actual voltage at the load (as measured by the oscilloscope). Tabulate the results from Steps 1-3.
- Tabulate the measurement errors (in percent) for all measurements and all signals in Step 4. Include the figures of the captured scope waveforms in your report.
- Justify, analytically the results from Step 5 (hint: refer to the section entitled “DC Offset”).
- Compare the RMS value of the signal in Step 6-c to the theoretical value obtained based on the RMS values of its components (i.e., the sinusoid and the *dc* signal). Refer to the section entitled “Bias Effects on Average and RMS Values” in the Unit on Signal Basics.