Experiment 2

AC Powered Circuits

EGT 243 - AC Circuit Analysis

Johnny Rivera & Mason Milburn

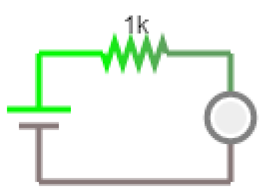
Northern Kentucky University

Fall 2021

Introduction
The purposes of this experiment are as follows: allow students to build a physical circuit using multiple different components, build familiarity with lab equipment and the mentioned components, and utilize the learned formulae to compute theoretical circuit values, then test those values against real-world models.

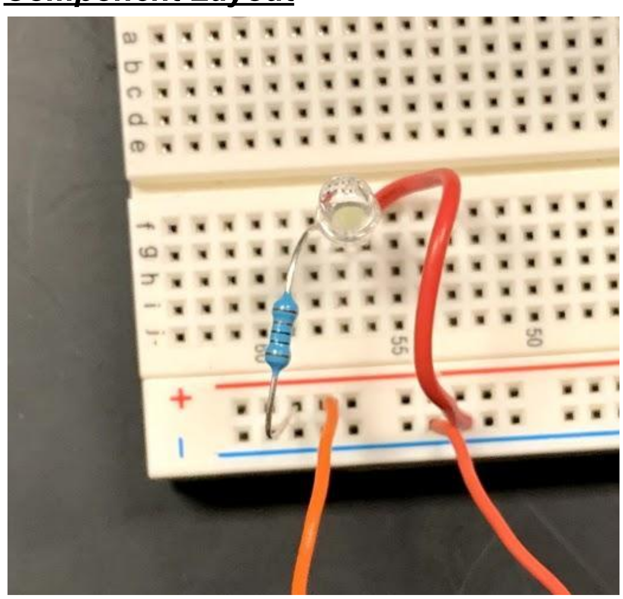
Required Components
- 1KΩ resistor
- White LED
- Breadboard with Jumper Wires
- Multimeter
- Oscilloscope
- Function Generator

Schematic Design



^ *Used in part 2 and 4*

Component Layout



Procedure

Part 1:

1. Calculate the VRMS for Square Wave and Sine Wave using the values 20V for amplitude and 40Hz for frequency.
2. Using a voltmeter read the tested values using the prior values unless otherwise instructed by the instructor.

Part 2:

1. Build the given circuit with a 1k resistor and a white LED.
2. Connect the circuit to the function generator and test the difference between the square wave and sine waveforms.
3. Record our results, then test different sets of frequencies to see the results.
4. Record our findings and show them to the instructor.
5. Lastly, switch the function generator to pulse mode, frequency to 500mHz, and the duty cycle to 80%/20% and then 20%/80%
6. Record our findings and show them to the instructor.

Part 3:

1. Check to see if the function generator and oscilloscope work together.
2. Power both tools on, using a BNC-BNC cable connect them to their respective outputs.
3. Press the “Sine” button and press the “Continuous” button on the function generator to select the waveform.
4. Press the “Output on” button on the function generator to enable the output.
5. Press the “Autoset” button on the oscilloscope to automatically get it configured.
6. Follow the steps written on the lab sheet and check with the instructor.

Part 4:

1. Using the circuit from part 2, connecting two additional probes to connect the circuit to the oscilloscope.
2. Using channel 1 on the device to read the true waveform while channel 2 shows the waveform across the LED.
3. Set the amplitude to 20V and frequency to 40HZ
4. Switch between the square and sine wave to see the results, record the findings with pictures.
5. Change the frequency to 1HZ then 1MHZ, record the results with pictures.
6. Change the frequency back to 1HZ then go into pulse mode and set the duty cycle to 80%/20%, report the findings with pictures.

Calculations

Part 1:

- $VRMS\ Square = VPeak = 10V$
- $VRMS\ Sine = (VPeak / \sqrt{2}) = 7.071V$

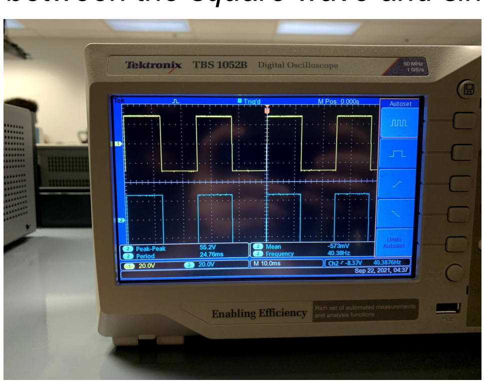
Experimental Results

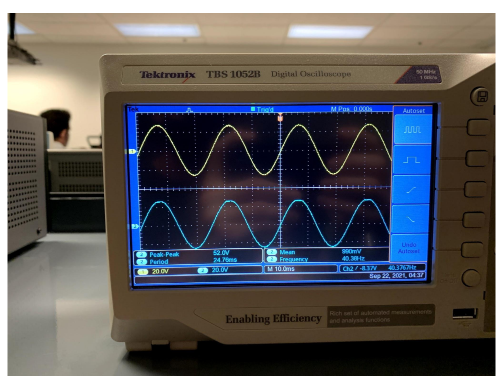
Part 1: RMS Values	Calculated	Measured
V_{RMS} (Square Wave)	10V	9.74V
V_{RMS} (Sine Wave)	7.071V	6.93V

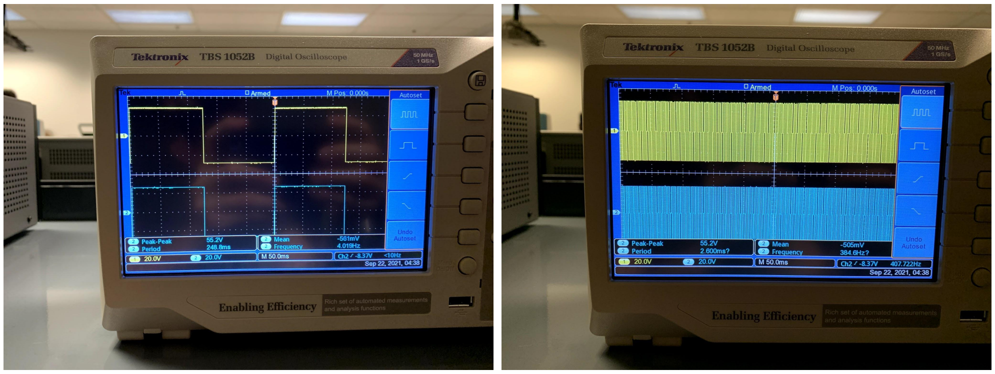
Part 2:

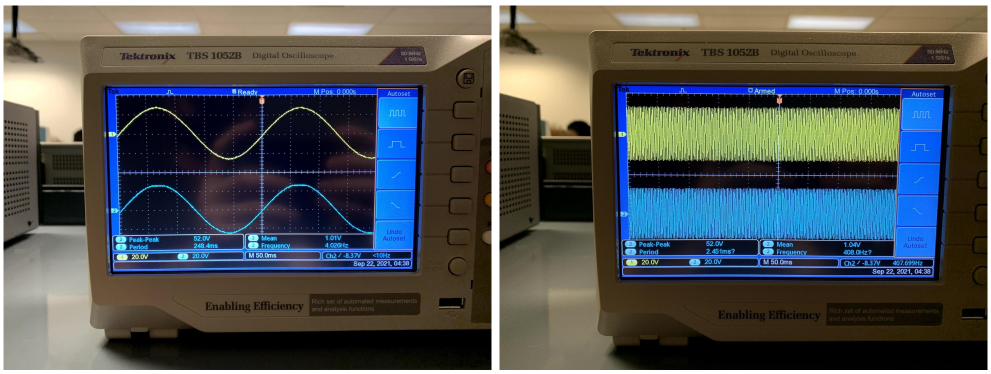
1. *Switch between the square wave and the sine waveforms and see the result, can you see any difference?*
    a. From our observations, the square wave looked to be instantaneous on/off switching of the LED. When we observed the sine wave, the on/off switching became a smooth transition between states.
2. *Change the frequency to 1MHz, 10Hz, and 1Hz. Switch between the square wave and the sine waveforms when your frequency is 1Hz. Can you see any difference?*
    a. At 1MHz, the LED looked to be continuously on as it was switching much too quickly to visualize. At 10Hz and 1Hz, the LED was visually turning on and off. The square wave produced a sharper transition than the smooth sine wave.
3. *Skip*
4. *Switch to pulse mode, set the frequency to 500mHz. First, change the duty cycle to 80% and then to 20% and see the results.*
    a. At 80% duty cycle the LED is much brighter and on for longer than at 20%.

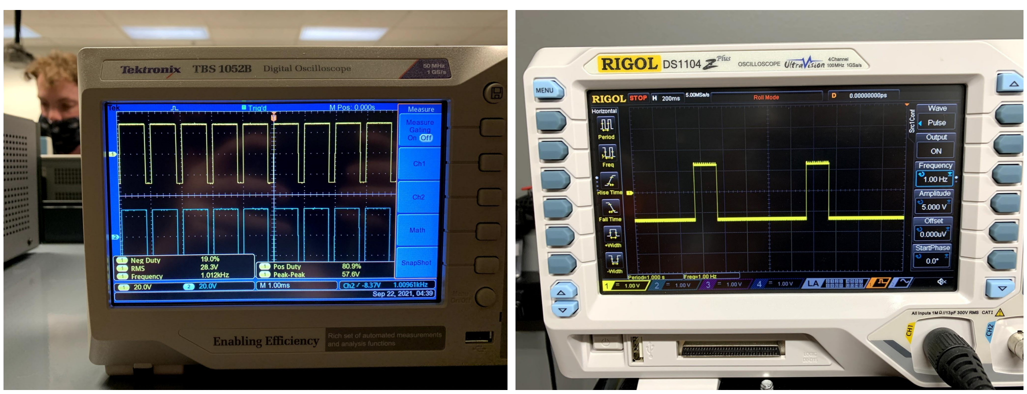
Part 4:

1. *Switch between the square wave and sine wave.*
    a. 



2. *Change the frequency to 1Hz and 1MHz. (Photos at the same scale)*
    a. 

    b. 

3. *Skip*
4. *Change the frequency to 1Hz, switch to pulse mode, and change the duty cycle to 80% and 20%.*
    a. 

Discussion
The measured values throughout the first part of our experiment were relatively accurate since it was close to the accepted value (Calculated). Our hypothesis between the first part was that there was room for error and it shows, the device we used was new to us, and configuring it was rather tricky. In the second part, we speculated that the sine and square waveforms were going to produce differing results, the square waveform dipped straight down so we hypothesized that it would be an instant on and off from the LED. As for parts 3 and 4, it was a bit new to us but rather interesting to see how there was barely a difference between the true waveform and the waveform across the LED. Possible areas for improvement would be getting more familiar with the equipment or trying to use a less troublesome function generator. The LED did not light up with the mentioned voltage but we were able to see the visual changes of frequency at a higher voltage value.

Conclusion
In summary, we were able to get a better understanding of finding the RMS values of sine and square waveforms using theoretical and experimental methods. We also were able to learn more about the purpose of function generators and oscilloscopes, the different types of results that one may obtain using different frequencies and voltages. Through this testing, we were able to put the calculations to practical use by building a circuit and measuring the values for ourselves. There is room for improvement with getting familiar with the equipment and having a more refined form of testing to produce better results. Overall I believe that we were able to achieve the main objective of this lab by getting experience.

References
Principles of Electric Circuits: Conventional Current Version, 10th Edition, Thomas L. Floyd, Pearson, 2019. (ISBN-13: 9780134879482)

Appendices
1A. Ohm's Law - a law stating that electric current is proportional to voltage and inversely proportional to resistance. (Oxford Languages, 2021)
1B. Breadboard - a construction base for practicing electronic circuits.
1C. Falsad Online Circuit Simulator: https://www.falstad.com/circuit/