Lab 2: Diodes

2.0 Objectives

By completing the research, design, and experimental requirements of this lab, the student should be able to:

a. Construct, characterize, and explain the behavior of a clipper circuit using diodes
b. Construct and characterize a full wave rectifier circuit with dual supply
c. Simulate and explain the behavior of a full wave rectifier circuit with dual supply
d. Add a capacitive filter to a rectifier circuit and measure, simulate, and explain its behavior
e. Determine the value of a required capacitor filter for a full wave rectifier
f. Determine the line regulation and load regulation of a Zener diode circuit

2.1 Prelab

0. Read Sections 4.5 and 4.6 in the textbook.
1. Do Problems 4.69 and 4.76 in the textbook.
2. For the circuit shown in Figure 2.2, calculate the value of capacitance needed to limit the ripple to 1Vpp. Assume *R* = 10kΩ and the diode forward drop is 0.7V. Each source shown has an amplitude of 5V and a frequency of 1kHz.

2.2 Components

Analog Discovery 2 module
Resistors: 240 Ω, 1 kΩ, and 10 kΩ
Capacitors: as calculated
Two 1N4148 diodes
1N5225B Zener diode

2.3 Task 1: A clipper circuit

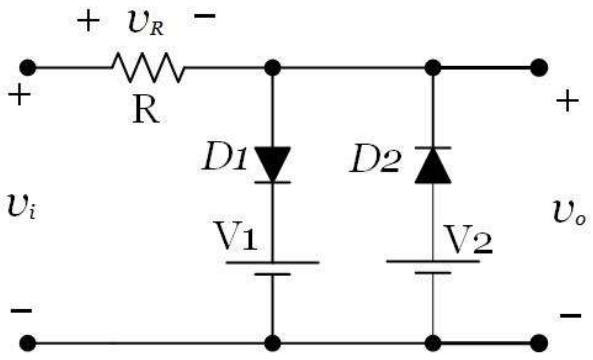

Figure 2.1. Measuring iv-characteristics of a diode.

3. Build the circuit in Figure 2.1. Use *R* = 1kΩ. V1 = +1V and V2 = -1V.
4. Set v_i to be a sinusoid with 1kHz frequency and 5V amplitude.
5. Measure v_i and v_o and display them as a function of time and as a transfer function (v_i vs. v_o). Record the output as a screenshot.

2.4 Task 2: Full wave rectifier with 2-phase input

6. Construct the shown in circuit to create the circuit of Figure 2.2 with R_L = 10kΩ.
7. On the wavegen tab configure v_1 and v_2 to be sinusoids with 0V offset, 5V amplitude, 1kHz frequency, and 180° phase difference.
8. Display v_1 and v_O on the oscilloscope. Compare the results with what is expected from theory.
9. Connect a capacitor in parallel with R_L. Choose the value of the capacitor to be as close as possible to the value you estimated in the prelab calculations to obtain a 1Vpp ripple. Calculate the expected peak-to-peak ripple for the actual value of capacitance that you use. Record the actual peak-to-peak ripple obtained.

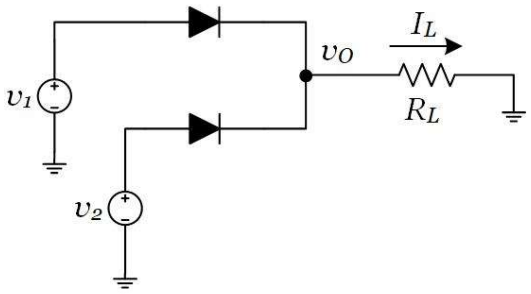

Figure 2.2. Full-wave rectifier with dual supply.

2.5 Task 3: Voltage regulation

10. Construct the circuit shown in Figure 2.3. Use *R* = 240Ω and RL = 1kΩ.
11. Use W1 as the voltage source E. Set E to be a triangular waveform with a minimum voltage of 4V and a maximum of 5V (to simulate a dc source with ripple).
12. Display the voltage v_L on the oscilloscope.
13. Remove the load resistor and measure the average value of v_L with *E* = 4.5V.

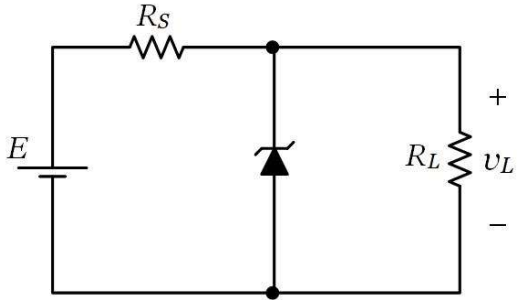

Figure 2.3. Zener voltage regulator.

14. From the measurements, determine the line and load regulation of the circuit (see below).

- Line regulation measures the ability of a circuit to keep the output constant in response to variations at the input and is given by $\frac{\Delta v_O}{\Delta v_I} \times 100\%$; and
- Load regulation measures the ability of the circuit to keep the output constant in response to variations in the load and is given by $\frac{V_{O,NL} - V_{O,FL}}{V_{O,FL}} \times 100\%$, where the capital V in the formula indicates that we are concerned with the dc (average) value and the subscripts NL and FL stand for No Load (open circuit) and Full Load, respectively.

2.6 Task 4: Simulation

15. Simulate the circuit that you built (with the capacitive filter) in Task 2. Compare the simulated ripple voltage and diode current with theory and measurement.
16. Simulate the circuit that you built in Task 3. Compare the simulated line and load regulation with measurement.