

ECE 2274
Pre-Lab for Experiment # 4
Diode Basics and a Rectifier
Completed Prior to Coming to Lab

Part I – I-V Characteristic Curve

1. Construct the circuit shown in figure 4-1. Using a DC Sweep, simulate the current-to-voltage characteristic of a diode.
 - a. Select VDC for your input voltage supply.
 - b. Select diode D1N4002 from the parts list.
 - c. Place a current probe in series with the diode, so that you can measure the diode current as a function of diode voltage.
 - d. Set the start value to 0V and the end value to 800mV for the DC Sweep analysis. The plot obtained is called the I-V characteristic curve.
 - e. Print and label your graph to turn in as part of your pre-lab.
 - f. Click on the diode symbol in your schematic to highlight it. Then, go to EDIT/Pspice Model. Determine V_j , N , and R_s , which are the turn-on voltage, non-ideality factor, and forward-bias series resistance. Record these values.
2. Change the diode to a D1N914 model. Repeat the DC Sweep simulation. Print and label your graph to turn in. What changes do you notice and explain how the different values for V_j , N , and R_s influence the I-V characteristics?

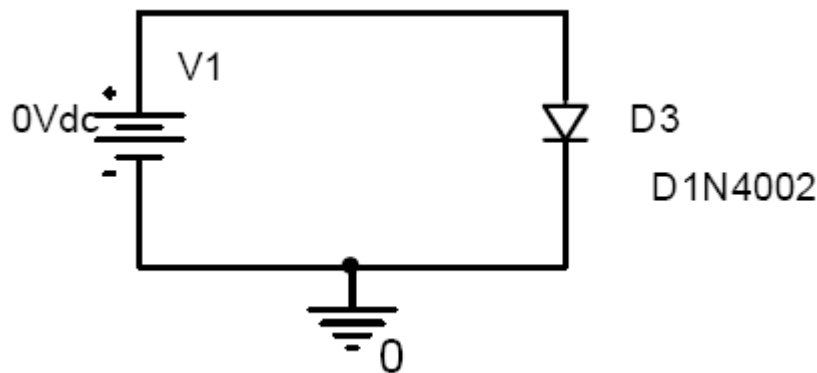


Figure 4 – 1

Part II – Half-Wave Rectifier

3. Figure 4-2 shows a half-wave rectifier. Build a half-wave rectifier in PSpice using the D1N4002 diode.
 - a. Set the attributes to the source, part VSIN, as follows:
 - i. VOFF = 0V
 - ii. VAMPL = 5V
 - iii. FREQ = 60 Hz
 - b. Choose a resistor value that is relatively large ($>500\Omega$) from the list of 5% tolerance resistors. Do not use the default value of $1k\Omega$ for the resistance value.
4. Run a transient simulation to measure the voltage across the source and the resistor using a time span equal to at least one full cycle of the input voltage.
 - a. Does the output voltage across the resistor match the input voltage in the positive domain? Why or why not?
 - b. Find and record the maximum value of the voltage over the resistor.
 - c. Print and label your graph to turn in.

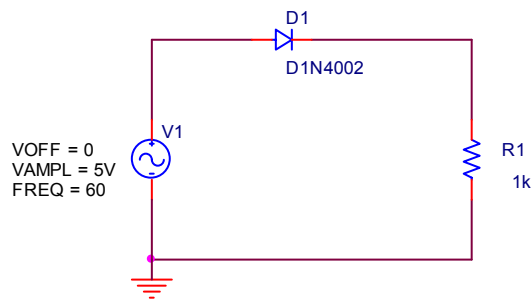


Figure 4-2: A half-wave rectifier

5. Using a DC Sweep, simulate the output voltage of a half-wave rectifier. Run the sweep over the part VSIN from -5V to +5V. The plot obtained is called the voltage transfer function. Print and label your graph to turn in.
6. Using the half wave rectifier Fig 4-3, design a circuit in which a capacitor is in parallel with R1 such that the ripple voltage, V_r , is 0.5V. Assume that $V_{on} = 700mV$ for the D1N4002. Be sure to show all your work.

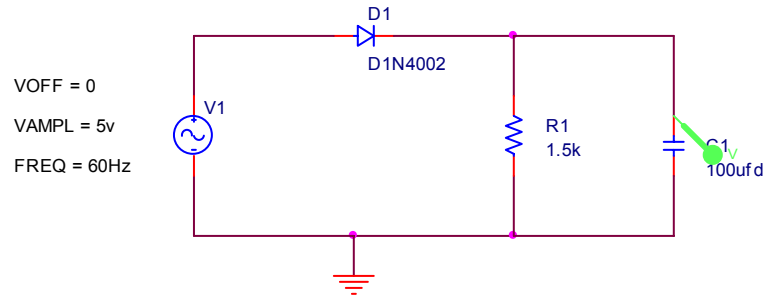


Fig. 4-3

- a. Verify your design using a transient simulation.
- b. Print out the simulation results to turn in.

Part III – Full-Wave Rectifier

7. Build a full wave rectifier as shown in figure 4-4
 - a. Assume $V_r = 200\text{mV}$, how does the voltage compare to that of the half-wave rectifier? Why has the ripple voltage changed?
 - *HINT: Try taking the capacitor out and seeing how the rectified signal has changed.
 - b. How does the maximum voltage output compare to that of part 6? Why has the maximum output voltage changed?

Figure 4-4: Full-Wave Rectifier

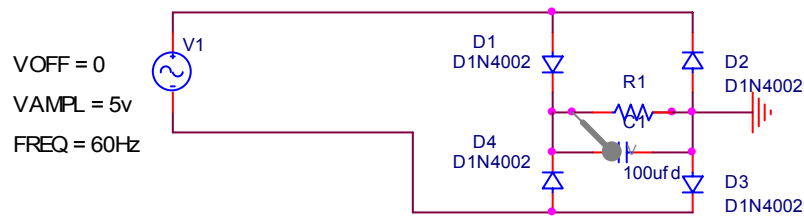


Fig. 4-4 Full-Wave Rectifier

Pre-Lab Answer Sheet:

1. f. V_j _____ N _____ R_s _____
2. V_j _____ N _____ R_s _____

What differences did you notice?

4. a. Does input match output voltage? Why?
4. b. Maximum voltage across resistor. _____
6. Capacitor which gives 0.5V ripple _____
7. a. How do the half-wave and full wave rectifier ripple voltages compare? Why?
7. b. How do the half-wave and full wave rectifier maximum voltages compare? Why?

**Lab Exercise
Experiment # 4
Diode Basics and a Rectifier**

Part I – I-V Characteristic Curve

1. Using a curve tracer, determine the I-V characteristic of the diode that you actually use in the lab. Print out the characteristic curve to turn in with your Data Sheet.

Part II – Half-Wave Rectifier

2. Build the half-wave rectifier you designed in the pre-lab. Use the Varic and the 10:1 isolation transformer to create a $\pm 5V$ sinusoidal source. Use the closest value resistor that is available in the lab. Record the resistor value in your Data Sheet.
 - a. Measure the ripple voltage (V_r).
 - b. Determine your percent error between your measured ripple voltage and the one expected from your design in pre-lab.
3. Remove the capacitor from the circuit. Determine the maximum voltage across the resistor and compare it with the value you found in the pre-lab.
4. Using a digital multimeter, capacitance meter, and curve tracer determine the actual values for R1, C, and V_{on} .
 - a. Using these values, recalculate the ripple voltage. Be sure to show all your work.
 - b. Determine your percent error between your measured ripple voltage and the one that you just calculated.

*Note: One method to calculate V_{on} is to extrapolate the linear section of the forward I-V characteristic to find the intersection of the linear portion of the I-V with the x-axis. The voltage at this intersection is V_{on} .

Part III – Full-Wave Rectifier

5. Using the same valued capacitor and load, construct the full wave rectifier designed in the Pre-Lab. Again, use the Varic and the 10:1 isolation transformer to create a $\pm 5V$ source.
 - a) Measure the ripple voltage(V_r) and maximum voltage output
 - b) How does it compare with the Pre-+Lab?
 - c) Again recalculate the ripple voltage using the actual values of C, R1, and V_{on} .

d) Determine your percent error between your measured ripple voltage and the one that you just calculated

6. What would be a benefit of using a half wave rectifier instead of a full wave? What would be a benefit of using a full-wave rectifier instead of a half wave? List a few of the pro's and con's to each design.

Data Sheet
Experiment # 4
Diode Basics and a Half-wave Rectifier

Part I – I-V Characteristic Curve

1. Print out the characteristic curve to turn in with your Data Sheet.

Part II – Half-Wave Rectifier

2. Standard capacitance nominal value: $C =$ _____

a. V_{ripple} (measured) = _____

b. % error = _____

3. Voltage without capacitor in circuit: $V_{\text{max}} =$ _____

% error = _____

4. Measured values:

$R1 =$ _____

$C =$ _____

$V_{\text{on}} =$ _____

a. V_{ripple} (calculated) = _____

b. % error = _____

Part III – Full-Wave Rectifier

5. a. Ripple voltage _____

% error: _____

c. Calculated ripple voltage: _____

d. % error _____

6. Discuss Pro's and Con's to each the Full-Wave and Half-Wave rectifier