

Lab Activity: Rectifier Circuits

Preparation:

Class will be divided randomly in to groups of two to three students. Each student should have read the preparation sections of experiments #4, 5, 6, and 7 in the Berube lab book. Before beginning the lab activity, each group must discern if all team members are prepared to continue. In order to do this, perform the following steps:

- (1) Using both experiment #4 and the text book, collect equations to calculate the average output voltage, V_{dc} , given the peak output voltage, V_{pout} , and the output ripple frequency, f , for the half-wave rectifier.
- (2) Using both experiment #5 and the text book, collect equations to calculate the average output voltage, V_{dc} , given the peak output voltage, V_{pout} , and the output ripple frequency, for the full-wave rectifier.
- (3) Using both experiment #6 and the text book, collect equations to calculate the average output voltage, V_{dc} , given the peak output voltage, V_{pout} , and the output ripple frequency for the bridge rectifier.

Objective:

To study the half-wave, full-wave, and bridge rectifier circuits so that comparisons can be made.

To explore the use of capacitor filters in rectifier circuits.

Procedure: (Take notes on all your observations)

1. Using Multisim and the disk supplied with the lab book (Berube), open the file FIG4-1 in the diode folder. This is a half-wave rectifier. Click the On/Off switch to run the analysis. The blue curve plot on the oscilloscope is the output and the red is the input. Sketch the traces. Record the peak voltage for each. Calculate the average (dc) output voltage, V_{dc} . Using the circuit alone, calculate the expected peak output voltage and dc output voltage. Measure the period of the output and use it to calculate the output ripple frequency.
2. Open the file FIG5-1 in the diode folder. This is a full-wave rectifier. Click the On/Off switch to run the analysis. The blue curve plot on the oscilloscope is the output and the red is the input. Sketch the traces. Record the peak voltage for each. Calculate the average (dc) output voltage, V_{dc} . Using the circuit alone, calculate the expected peak output voltage and dc output voltage. Measure the period of the output and use it to calculate the output ripple frequency.
3. Open the file FIG6-1 in the diode folder. This is a bridge rectifier. Click the On/Off switch to run the analysis. The blue curve plot on the oscilloscope is the output and the red is the input. Sketch the traces. Record the peak voltage for the output only. Calculate the average (dc) output voltage, V_{dc} . Using the circuit alone, calculate the expected peak output voltage and dc output voltage. Measure the period of the output and use it to calculate the output ripple frequency.

- The capacitor can be used to “hold up” the output of a rectifier. Larger values of load resistance and filter capacitance result in a flatter output response. To observe this, first run the analysis on file FIG7-1. Observe and sketch the input and output traces. From the output trace, find the average output voltage, V_{dc} , and then change the filter capacitance to $100\mu\text{F}$ and recalculate V_{dc} . Take note of the effect on the traces. Change the capacitor value back to $470\mu\text{F}$ and change the load resistor to 200Ω and again calculate V_{dc} . Open FIG7-2 to see the filtered output of the full-wave rectifier. Observe and sketch the traces. Record the average output voltage reading on the multimeter, V_{dc} , and then change the filter capacitance to $100\mu\text{F}$ and record the meter reading again. Then change the capacitor value back to $470\mu\text{F}$ and change the load resistor to 200Ω and again record the meter reading. Take note of the effect on the traces.

Questions

Questions AND answers are to be typed directly in to Microsoft Word.

- Create a table that compares Multisim recorded (measured) values and theoretical values for the three rectifier circuits (experiments 4-6). The values you are to include are: frequency of the rectified output voltage and average value of the rectified output voltage (V_{dc}). You will need to enter each of the values and calculate percent differences using the formula provided below.

$$\% \text{ difference} = \frac{\text{measured} - \text{theoretical}}{\text{theoretical}}$$

- What measurable effect does the diode’s barrier potential have on the output voltage for each of the rectifier circuits? Explain.
- What is the frequency of the rectified output voltage for each of the rectifier circuits and how does it compare to the frequency of the input?
- Compare Multisim values to theoretical values. What was the typical and highest percent difference you found? Explain these differences.
- By recognizing that all three circuits derived their voltage from the SAME ac supply and transformer and that the objective of the rectifier is to produce a dc voltage, which rectifier circuit would you recommend and why.
- How did the average output voltage, V_{dc} , for the filtered half-wave rectifier compare with the unfiltered version?
- What did reducing capacitance do to the ripple and V_{dc} for the filtered rectifier? What did increasing resistance do to the ripple and V_{dc} for the filtered rectifier? Be specific, supply data from the lab to support your statements.

To Be Submitted

- Each group must submit their answers to the lab questions given above within one week of completing the lab. Your team is solely responsible for those answers and you may not work with another team to produce those answers. If you have any questions that your team can not figure out, you may confer with another team or the instructor. However, paraphrasing or copying from ANY source without identifying

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the source is considered plagiarism which has serious consequences. If your team submits electronically, the graded document will be returned to you electronically, saving paper and time. Students who submit electronically must include the email address of each team member on the submitted document.

- ◆ Individual Team Assessment Forms must be **fully completed** or your grade will be affected. A participation grade is determined from these assessment forms and represents an average of your self-assessment and peer-assessment. If you do not **completely** fill out the form then you will automatically get a zero. Please submit assessment forms electronically or hard copy no later than during class one week after the lab is performed. In this way you can more effectively assess team members' participation in answering lab questions.

Late submissions are not accepted and a grade of zero is recorded.