Diodes

Spring 2015

Objectives

- Gain practical experience with the behavior of silicon diodes under forward and reverse bias.
- Explore the use of diode devices in rectifying, limiting, and DC restoration circuits.

Parts and Equipment Required

Components and Materials Needed:

- 10kΩ resistor (1).
- 10nF capacitor (1).
- 1N914 diodes (4).

Equipment to be Used:

- Banana cable sets (5).
- Oscilloscope probes (2).
- BNC-to-BNC cable (1).
- BNC-to-alligator cable (1).

1 Pre-Lab Exercises

In this lab we will perform experiments on six circuits, which are shown below. In each circuit, assume that R is 10k ohms, and C is 10nF. The 1N914 diode has n=2 and a forward voltage drop of 655mV at a forward current of 1mA.

Exercise 1. For both of the circuits shown in Fig. 1, identify the logical function (if V_1 and V_2 represent binary signals). Determine the value of v_{out} when $V_1 = 3$V and $V_2 = 2$V. Determine the value of v_{out} when $V_2 = 2.8$V, 3.2V and 4V.

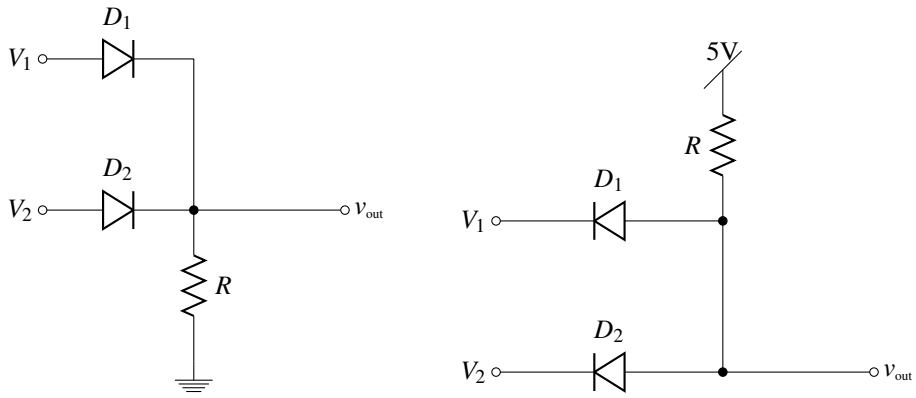

Figure 1: Diode logic circuits.

Exercise 2. Figure 2 shows the schematic diagram for a half-wave rectifier circuit. If v_{in} is a 1kHz sinusoid with zero offset and a zero-to-peak amplitude of 2V, predict the waveform of v_{out} as accurately as possible without using iterative analysis or SPICE simulations. Sketch the predicted waveform in your lab book.

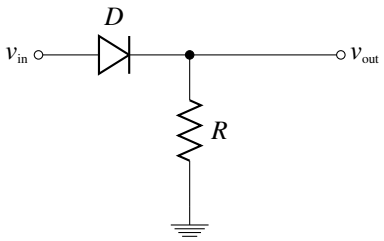

Figure 2: Half-wave rectifier circuit.

Exercise 3. Fig. 3 shows the schematic diagram for a half-wave peak rectifier circuit. Again assume that v_{in} is a sinusoid with zero offset and zero-to-peak amplitude of 2V. Predict the output waveforms when v_{in} has a frequency of 1kHz, 10 kHz, and 100kHz. Sketch the predicted waveforms in your lab book.

Exercise 4. Fig. 4 shows the schematic diagram for a voltage-limiting circuit. Assume that v_{in} is a 1kHz sinusoid with zero offset and zero-to-peak amplitude of 3V. Using the constant voltage- drop model, predict the output waveform as accurately as possible, and sketch the prediction in your lab book.

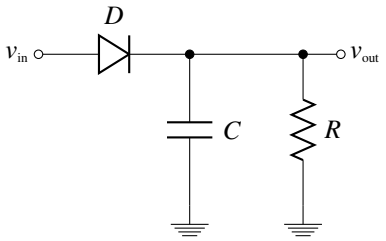

Figure 3: Peak rectifier circuit.

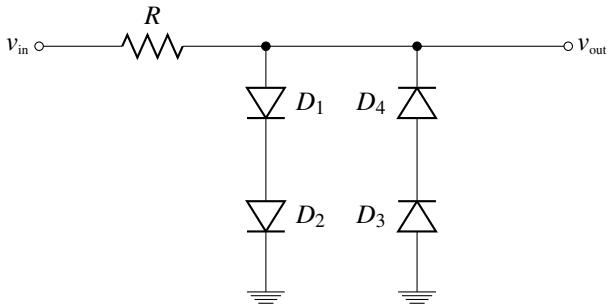

Figure 4: Voltage limiter circuit.

Exercise 5. Fig. 5 shows the schematic diagram for a DC restoration circuit (a.k.a. a clamped capacitor circuit). Assume that v_{in} is a 1kHz sinusoid with a 1V offset and a zero-to-peak amplitude of 3V. Using the constant voltage drop model, predict the output waveform as accurately as possible. Also predict the offset of the output waveform. Sketch the predicted waveform in your lab book.

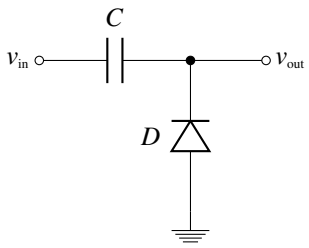

Figure 5: DC restoration circuit.

2 Physical Experiments

Procedure 1. Repeat the following procedures for both of the diode gates described in Fig. 1.

Step A. Holding V_1 fixed at 3V, adjust V_2 from 2V to 4V in steps of 0.5V.

Step B. Plot the results in your lab book. How do the measured results compare with your predictions?

Procedure 2. Set up the half-wave rectifier circuit. Use the function generator to supply v_{in} as specified in the prelab.

Step A. Measure and record the output waveform, and sketch the result in your lab book. Be sure to accurately measure the duration of forward bias, the peak output voltage, and the output voltage under reverse bias.

Step B. How do the measured results differ from your predictions?

Procedure 3. Set up the half-wave peak rectifier circuit. Use the function generator to supply v_{in} as specified in the prelab.

Step A. Carefully measure and record the output waveforms for v_{in} at 1kHz, 10kHz and 100kHz.

Step B. Measure and record the peak-to-peak amplitude of the ripple in the output waveform at 1kHz, 10kHz and 100kHz.

Procedure 4. Set up the limiter circuit as specified in the prelab.

Step A. Measure and record the output waveform when v_{in} has a peak-to-peak voltage of 1 V.

Step B. Repeat the above measurement when v_{in} has a peak-to-peak voltage of 4 V.

Step C. How do the results compare to your expectations? Did you accurately predict the clipping voltage? If not, suggest reasons for the discrepancy.

Procedure 5. Set up the DC restoration circuit as specified in the prelab.

Step A. Measure and record the output waveform. Make sure you have `DC Coupling` in `Channel 1` and `Channel 2` settings. Ideally, the output offset should equal half its amplitude (i.e. the low peak of the sinusoid should be at ground).

Step B. Measure the actual minimum value of the output waveform. This value is expected to be slightly lower than the minimum value of the input waveform. Explain the measured result.

3 Post-Lab

In your lab book, write a summary of your findings, and write a brief report describing your objectives, methods and major findings. Submit this report to the TA or Instructor along with your Lab Book.