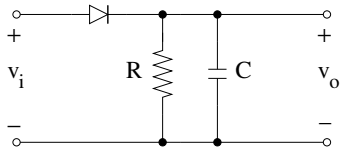
UC San Diego, ECE65

Lab 4, Diode waveform shaping circuits

Experiment 1: Rectifier & Peak Detector Circuit

Consider the circuit below with a 1N4148 general purpose diode and $R = 100$ kΩ.



Prelab:

1. Construct the circuit without the capacitor. Apply a sinusoidal wave with an amplitude of 5 V, zero DC offset, and frequency of 2 kHz as input. Create a plot showing v_o and v_i on the same graph using Transient simulation. Make sure your step size is small enough. (You should see smooth curves.) Show two full periods on your plot.

2. Construct a peak detector circuit by adding a capacitor to the rectifier circuit (as shown in the given circuit diagram.) Select three capacitor values in the range of 1 nF to 100 nF such that the circuit would represent a good, mediocre, and not good practical peak detector. Explain how you chose the capacitor values.

3. Create a plot showing v_o and v_i on the same graph for each one of your practical peak detector circuits.

4. Do the plots match your expectations?

Lab Exercise:

1. Assemble the circuit without the capacitor. Take a picture of the setup and include it in your report.

2. Set the function generator to produce a sinusoidal wave with an amplitude of 5 V, zero DC offset, and frequency of 2 kHz. Attach the function generator to v_i. Attach scope channel 1 to v_i and scope Channel 2 to v_o, and have both traces be "triggered" by channel 1.

3. Adjust the volt per division knob such that the signal is as large as possible (*i.e.,* fills the display). Ensure that both channels have the same volt per division setting.

4. Move the two traces such that the zero voltage values for both channels are in the middle of the display.

5. Expand the time selection so that only 2 to 4 periods of the waveform are shown.

6. Disconnect the function generator without changing the function generator and scope settings. Attach a 10 nF capacitor (see circuit diagram above). Attach the function generator to the circuit and print out v_o and v_i.

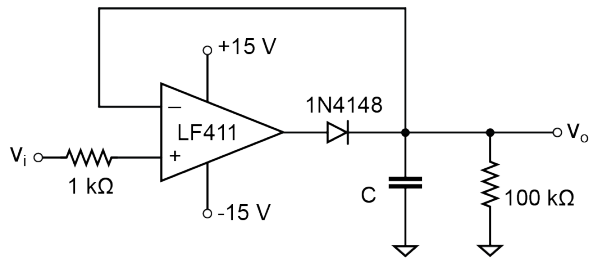
7. Take a picture of the oscilloscope display and include it in your report.

8. Repeat the previous two parts with the capacitor values you selected in the circuit analysis section.

9. Compare the output voltage traces for three peak detector circuits. What are your conclusions?

Experiment 2: Op-amp Peak Detector

Consider the circuit below with a 1N4148 general purpose diode, and $C = 10\ nF$.



Prelab:

1. Construct the circuit in Experiment 2. Input a sinusoidal wave with an amplitude of 5 V, zero DC offset, and frequency of 2 kHz. Create a plot showing v_o and v_i on the same graph

using Transient simulation. Make sure your step size is small enough. (You should see smooth curves.) Show two full periods on your plot.

2. Explain how the circuit works and the difference between this peak detector and the one in experiment 1. Make sure to simulate the circuit in experiment 1 with $C = 10\ nF$ to compare the results.

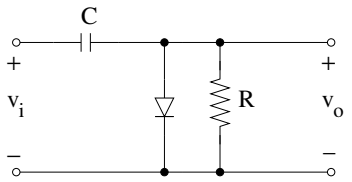
Lab Exercise:

1. Assemble the circuit. Set the function generator to produce a sinusoidal wave with an amplitude of 5 V, zero DC offset, and frequency of 2 kHz. Attach the function generator to v_i. Attach the scope channel 1 to v_i and the scope Channel 2 to v_o.

2. Take a picture of the oscilloscope display and include it in your report.

Experiment 3: Clamp Circuit

Consider the circuit below with a 1N4148 general purpose diode, $R = 100$ kΩ, and $C = 100$ nF.



Prelab:

1. Build the circuit. Input a sinusoidal wave with an amplitude of 5 V, zero DC offset, and frequency of 2 kHz. Create a plot showing v_o and v_i on the same graph using Transient simulation. Make sure your step size is small enough. (You should see smooth curves.) Show two full periods on your plot.

2. Now, replace the 100 nF capacitor with a 1 nF one. Print out v_o and v_i.

3. Compare the two cases. What are your conclusions?

Lab Exercise:

1. Assemble the circuit. Set the function generator to produce a sinusoidal wave with an amplitude of 5 V, zero DC offset, and frequency of 2 kHz. Attach the function generator to v_i. Attach the scope channel 1 to v_i, and the scope Channel 2 to v_o. Take a picture of the oscilloscope display and include it in your report.

2. Disconnect the function generator without changing the function generator and scope settings. Replace the 100 nF capacitor with a 1 nF one. Take a picture of the oscilloscope display and include it in your report.

3. Compare the two cases. What are your conclusions?