ECE 214 - Lab #7 — Boost Converter #1

28 March 2017

Introduction: A block diagram of a boost converter is shown in Figure 1. A boost converter is used in many applications to increase the DC voltage from a low voltage source, such as from a battery. The properties of the diode, and the Villard voltage multiplier circuit, are discussed in class. The Villard voltage multiplier is used to combine a DC (V_{DC}) and a sinusoidal ($V_a \cos(2\pi ft)$) voltage to produce a DC output voltage (V_{OUT}). A filter is used to reduce the ripple on the output.

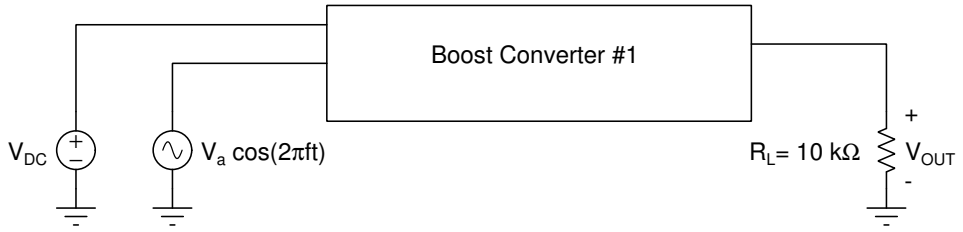

Figure 1: Block diagram of a boost converter.

Design Specifications:

1. Inputs: $V_{DC} = +10.0$ V and $V_a \cos(2\pi ft)$ with $V_a \leq 10$ V and $f \leq 250$ kHz
2. Output: $V_{OUT} = 25 \pm 0.1$ V_{DC} with ripple ≤ 10 mVpp
3. Load: 10 kΩ resistor

Pre Lab:

1. The Villard voltage multiplier is shown in Figure 2. Describe how this circuit functions.
2. Design a boost converter, incorporating a Villard voltage multiplier and a low pass filter, to satisfy the design specifications. Describe the details of your design process.
3. Use NGspice to simulate the boost converter design. Verify the design satisfies all of the requirements in the design specification.
4. How long does it take for the output voltage to reach a steady-state value? Run an extra long simulation (~ 200 ms) to verify you have reached the steady-state output voltage.
5. What is the simulated output voltage and the amplitude and frequency of the "ripple?" Record these in your notebook.

Lab Procedure:

1. Build the boost converter circuit you designed and simulated in the Pre Lab.
2. Measure and record the DC output voltage. Does it meet the design specification? If not, adjust V_a to obtain the specified output voltage.

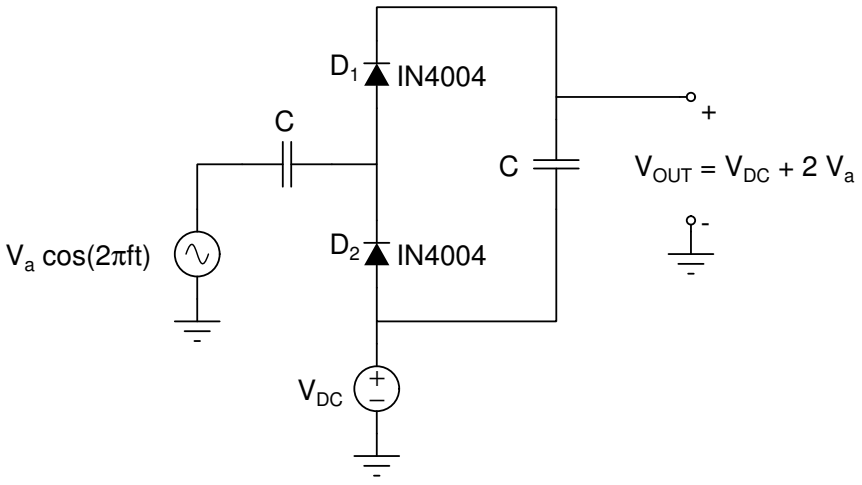

Figure 2: Villard voltage multiplier circuit.

3. Measure and record the "ripple" at the output. What is the amplitude and fundamental frequency of the "ripple?" Does the ripple meet the design specification?

Post Lab:

1. Provide a schematic of the final boost converter design.
2. Use NGspice to simulate this circuit using the measured values of the capacitors used in lab.
3. Compare the measured results with the simulated results.
4. Can the output voltage be increased by cascading voltage multiplier stages? Which component in your design will limit the maximum output voltage that can be obtained?
5. Reference this Post Lab in the table of contents of your notebook.