

Pràctica 3. Boost Converter

Test and measurement of a boost converter.

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In this lab session we are going to implement the circuit we simulated on our last session. We will be able to generate a DC voltage several times higher than the voltage given by our power supply.

ATTENTION: Paragraphs like this one indicate work that must be completed as individual preliminary work. You may discuss it with classmates, but everyone must fully understand the preliminary work.

AI tools may not be used to solve the exercises. They may only be used for specific queries, occasional calculations, or to check results. In these cases, the corresponding screenshot must be attached.

The solution of the exercises must include:

- The circuits redrawn at each step, clearly showing any transformations carried out, where applicable.
- Explicit indication of voltage polarities and current directions.
- An orderly and justified solution so that the reasoning can be followed.

Remember that, in order to enter the laboratory and carry out the session, the preliminary report must have been submitted on Atenea before the session. At the beginning of the laboratory session, **you will be asked to orally justify your preliminary work**, and this will be taken into account in its assessment. Finally, remember to bring the required laboratory equipment and make sure that it is in good condition.

1 The boost converter

On the last session we already simulated the circuit in figure 1. The circuit is called a *boost converter* and we learned that this circuit is able to produce an output DC voltage higher than the input DC voltage.

To analyze the circuit use $L = 47 \text{ mH}$, $C = 470 \text{ nF}$, $R = 10 \text{ }\Omega$. You may consider R_O as an open circuit. The diode is ideal.

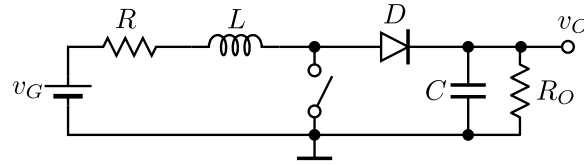


Figure 1: The boost converter schematic.

Previous Work 1. Find out the inductor current and the output voltage waveforms after the instant when the switch is closed. Draw a detailed sketch of both signals. Take into account the possible existence of an initial inductor current (i_A) and capacitor voltage (v_A) (which might be left over from the previous state).

Some time after the switch is closed, the switch becomes open and part of the energy stored in the inductor is transferred to the capacitor.

Previous Work 2. Find out the inductor current and the output voltage waveforms after the instant when the switch is opened. Take into account the initial inductor current (i_A) and capacitor voltage (v_A) from the previous analysis to analyze the circuit. Hints: Use octave to calculate the poles and the residues. Draw a detailed sketch of both signals and find the position and the value of the maximum of $v_O(t)$ for the initial value of i_A calculated in Previous Work 1 and taking $v_A = 0$. You can also use octave to plot the output voltage and the current.

2 Laboratory work

Task 1. Adjust the power supply to 5 V. Find out the DC coil resistance R (using the multimeter) and limit the maximum power supply current to twice $5/R$ or 500 mA, whichever is less.

Task 2. Build the boost converter on your prototyping board. Use the provided pushbutton as a switch. With the multimeter, observe how the output voltage rises progressively.

Task 3. We will provide you with a neon bulb, which lights up for voltage around 95 V. Try to get a flash from the bulb. Try changing the power supply voltage. Investigate what happens if you insert an additional resistor in series with the inductor.

Task 4. Make use of a ZVN4424A MOSFET to replace the switch. Use the function generator to provide a square gate signal between 0 and 5 V and adjustable frequency. Initially, we will choose a frequency of 1 kHz. Once you are able to obtain a steady voltage, you may check the output waveform with the oscilloscope.

Task 5. Slightly adjust the frequency, increasing and decreasing it. Observe how the signal on the oscilloscope changes. Finally, lower the frequency to 200 or 300 Hz. Observe the signal and the neon lamp. Try to explain what is happening.