# Experiment No.1

# DC-Dc Boost Converter

Email: Hasan.muwafaq.gheni@uomus.edu.iq

## 1. Introduction

In this lab, we are going to design and test a typical kind of switching power supply called boost converter that boosts the input voltage to a higher value by using it to generate a 15V output from a 5V input. Figure 1 shows the schematic diagram. The device labeled IRF510 is a transistor. It will be turn on when a high voltage like 5V is applied to it. The diode conducts current only in the direction of the arrow.

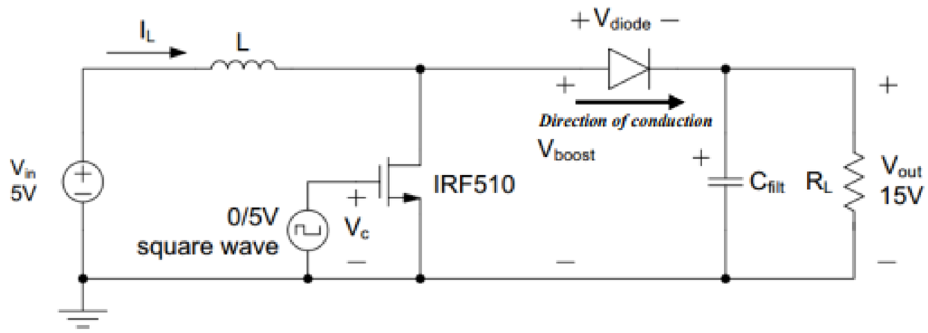


Figure.1: Boost Converter

Here we will give a simple analysis of this circuit. To do that, we first assume that the circuit is working correctly, which means a voltage of 15V is produced on the output side. The voltage $Vc$ is a pulse train and varies between 0V and 5V.

When $Vc = 5V$ the transistor (IRF510) is on and behaves essentially like a short circuit. Then $Vboost = 0V$ and $Vdiode = Vboost - Vout = -15V$ . Since $Vdiode$ is negative, the diode does not conduct any current, i.e. it behaves like an open circuit. With $Vc = 0V$ the situation reverses: now the transistor is off and the diode conducts.

Email: Hasan.muwafaq.gheni@uomus.edu.iq

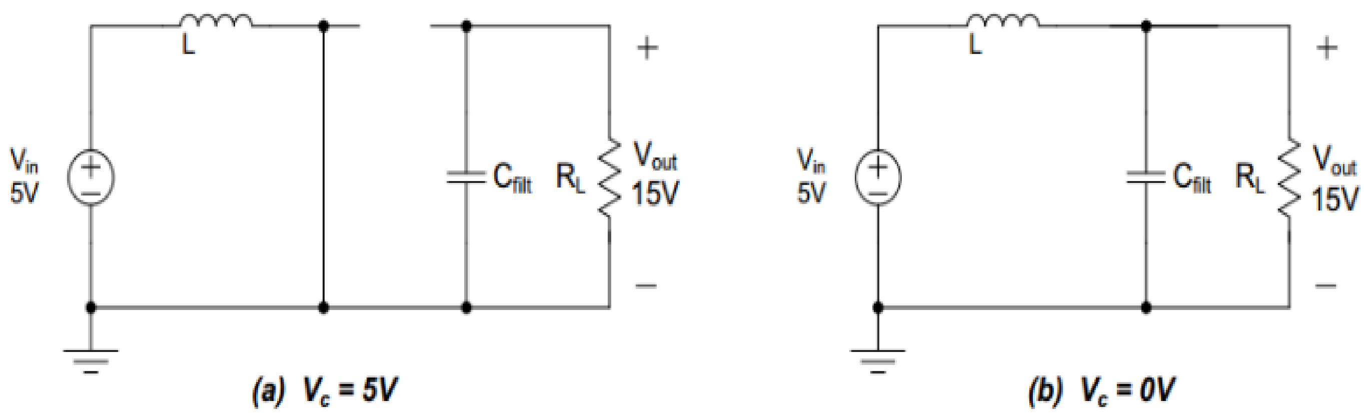


Figure.2: Operation modes of the boost converter

Fig. 2 illustrates both operation modes: In mode (a), $Vin = 5V$ is the input voltage that appears across the inductor. From the differential equation of inductor $v = L\ di/dt$, we can observe that the inductor current is a ramp with a slope determined by the values of $Vin$ and $L$. In mode (b), the slope of the inductor current ramp is changed due to a changed voltage across the inductor. The detailed current waveform is shown in Fig.3. It should be noted that the increase and decrease of the current in each period is identical, otherwise the average current would continually increase or decrease.

Since the slope of the current is proportional to the voltage across the inductor, we note intuitively that reducing the ratio of Toff/Ton will results in higher output voltage $Vout$. This is because the positive slope of increasing current is proportional to $Vin$ and the negative slope of the decreasing current is proportional to $Vout - Vin$. In the lab, we will analyze this relationship quantitatively.

Email: Hasan.muwafaq.gheni@uomus.edu.iq

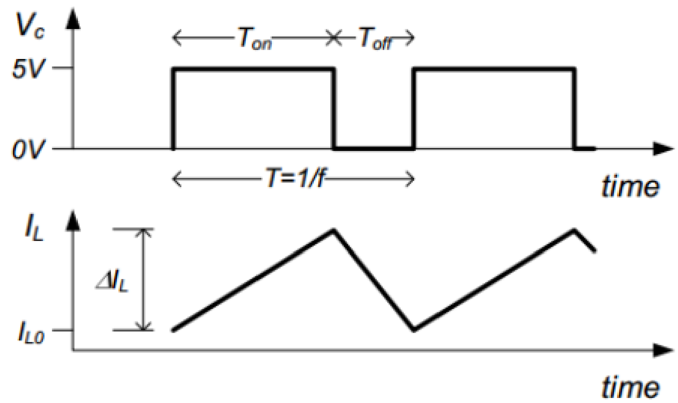


Figure.3: Boost converter timing diagram

## 2. Learning Objectives

- Characteristics of boost converter
- Capacitor and inductor selection
- Output voltage and current
- Continuous and discontinuous mode

## 3. Materials and Equipment

- Power Supply
- Capacitor
- Inductor
- MOSFET
- Diode
- Resistor

## 4. Discussion

1. What is the main function of a boost converter in a DC-DC power system?
2. Explain how the inductor stores and releases energy during the switching cycle.
3. How does the duty cycle affect the output voltage?
4. What happens if the duty cycle is set too high (close to 100%)?
5. What are the main sources of loss in a boost converter circuit?
6. How does the load resistance affect the efficiency and voltage gain?
7. Why is efficiency lower at very high or very low duty cycles?
8. Where are boost converters used in real-life applications?
9. What advantages and limitations do boost converters have compared to buck or buck-boost converters?