Experiment No.3

DC-Dc Buck-Boost Converter

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

1. Introduction

In this laboratory experiment, we will design and analyze a **DC–DC buck-boost converter**, which is a switching power converter capable of producing an output voltage **either higher or lower** than the input voltage, and with **opposite polarity**. This converter topology is widely used in systems where the input source voltage varies but a regulated output is required, such as battery-powered devices and renewable energy systems.

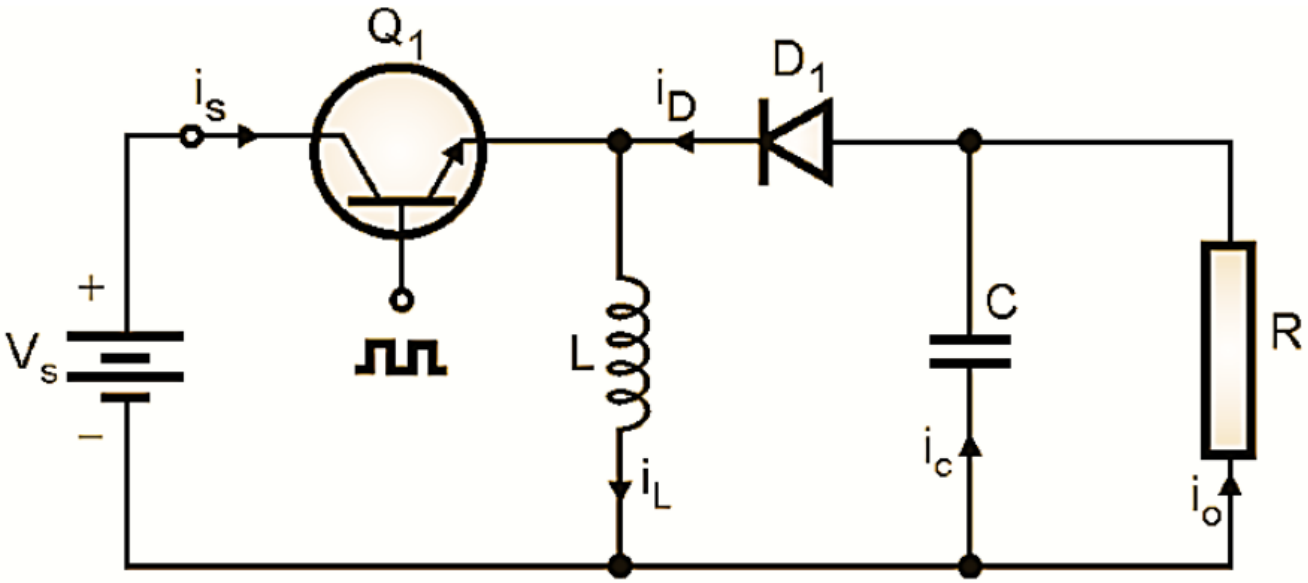

Figure.1: Buck-Boost Converter

Figure 1 shows the schematic of a typical buck-boost converter. The main components include an inductor, power MOSFET (switch), diode, capacitor, and load resistor. When the MOSFET is turned on (switch closed), energy is stored in the inductor. When the MOSFET is turned off (switch open), the energy stored in the inductor is released to the load through the diode, creating an inverted (negative) output voltage.

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

2. Circuit Operation

The converter operates in two switching modes

a) Switch ON (Transistor ON)

- The MOSFET conducts and current builds up through the inductor.
- The diode becomes reverse-biased and isolates the load from the source.
- The inductor stores energy, and its current increases linearly.

b) Switch OFF (Transistor OFF)

- The MOSFET is open and the inductor current flows through the diode to the capacitor and load.
- Stored energy in the inductor is delivered to the output.
- Output voltage becomes negative and can be higher or lower in magnitude than the input.

3. Learning Objectives

- Understand the operating principle of the buck-boost converter
- Examine the effect of duty cycle on output voltage polarity and magnitude
- Analyze continuous and discontinuous conduction modes
- Observe inductor current and capacitor voltage waveforms
- Study the selection criteria for power components (MOSFET, diode, inductor, capacitor)

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

4. Materials and Equipment

- DC Power Supply
- Inductor
- Capacitor
- MOSFET (Switch)
- Diode (Fast switching)
- Resistor (Load)
- Oscilloscope
- Function Generator / PWM Source

5. Discussion

1. What is the main function of a buck-boost converter?
2. Why does the buck-boost converter output have reverse polarity?
3. Explain the role of the inductor in storing and releasing energy during switching.
4. How does the duty cycle affect the output voltage?
5. What happens when the duty cycle approaches 1 (100%)?
6. Compare continuous and discontinuous conduction modes in this converter.
7. What are the major loss sources in a buck-boost converter?
8. In what real-world applications is a buck-boost converter preferred over buck or boost converters?
9. Discuss the disadvantages of the traditional buck-boost converter (voltage polarity inversion, higher ripple, etc.