DC TO DC BUCK CONVERTER USING eSim

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ABSTRACT

In a variety of low-power applications, a step-down dc-dc converter is used to reduce the voltage from a higher level. The two types of dc-dc converters are a regular buck and synchronous buck. The synchronous buck utilizes two switches and one diode, whereas the regular buck uses one switch and one diode. Many converters rely on the power components' switching qualities to work. A second MOSFET is required due to the diode's higher conduction losses. Because of the diode's conduction losses, the converter's efficiency maybe reduced. The use of a synchronous buck converter improves efficiency by reducing diode losses. The main goal of this study is to compare and contrast these two low-power step-down converters. The simulation in this work was performed using the LTSPICE program

INTRODUCTION

Power electronics have become increasingly vital in various aspects of electrical systems today. Many devices operate at low DC voltages; for example, multiple components within a computer require voltages ranging from about 1V to 10V. Since the power grid supplies AC voltage, there is a need to convert AC to DC. After converting 120V AC to DC, a step-down DC-DC converter is commonly used to lower the voltage level further.

A typical step-down converter consists of semiconductor devices along with other components, including at least one or two capacitors, an inductor, a switch, and a diode. In certain buck converters, a second switch replaces the diode to minimize losses—this type is known as a synchronous DC-DC converter. The buck converter, a common step-down type, efficiently reduces the voltage to meet the requirements of low-power applications.

The synchronous buck converter offers higher efficiency by using a MOSFET in place of the diode, reducing the voltage drop from approximately 0.7V to 0.2V, which significantly boosts the converter's efficiency.

WORKING PRINCIPAL

A buck converter reduces a higher DC input voltage to a lower DC output voltage by rapidly switching a transistor on and off. When the switch is on, current flows through an inductor to the load, storing energy in the inductor. When the switch turns off, the inductor releases this energy to the load through a diode, maintaining a steady output current. By adjusting the switch’s on-time (duty cycle), the output voltage is controlled, with the capacitor filtering out ripples to produce a smooth DC output. This design achieves high efficiency, as the switch operates with minimal power loss.

Circuit Schematic

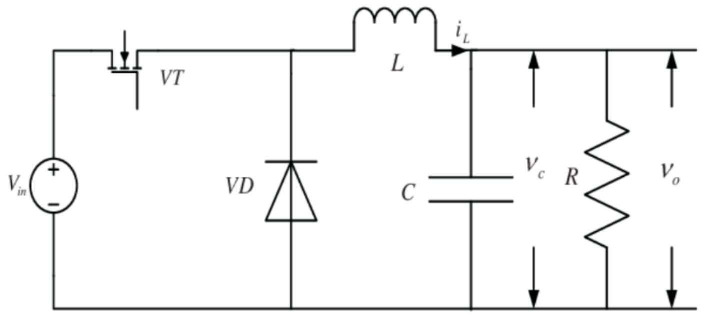

Figure 1: DC to DC Buck Converter

LtSpice Schematic:

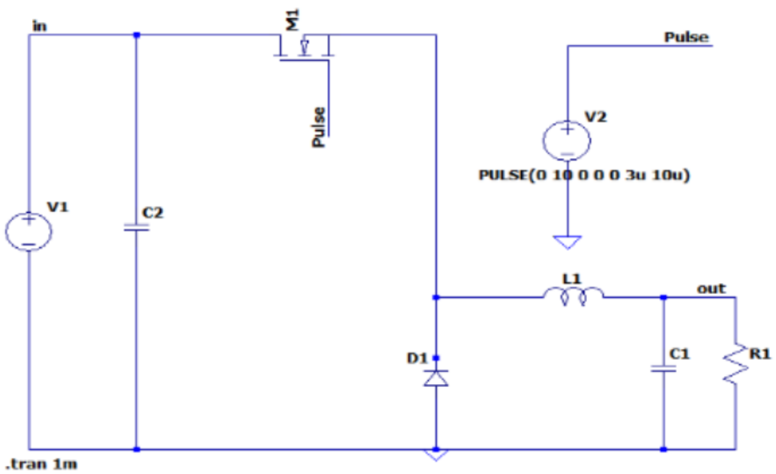

Figure 2: DC-DC Buck converter

eSim Schematic

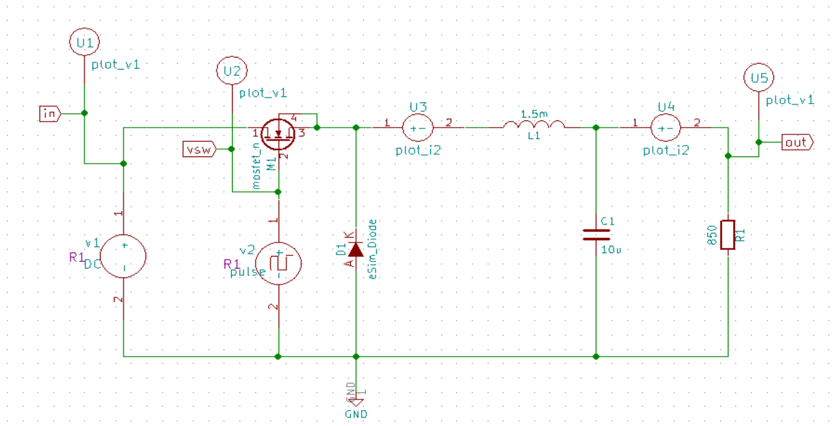

Figure 3: DC to DC Buck Converter Using eSim

Input Waveform

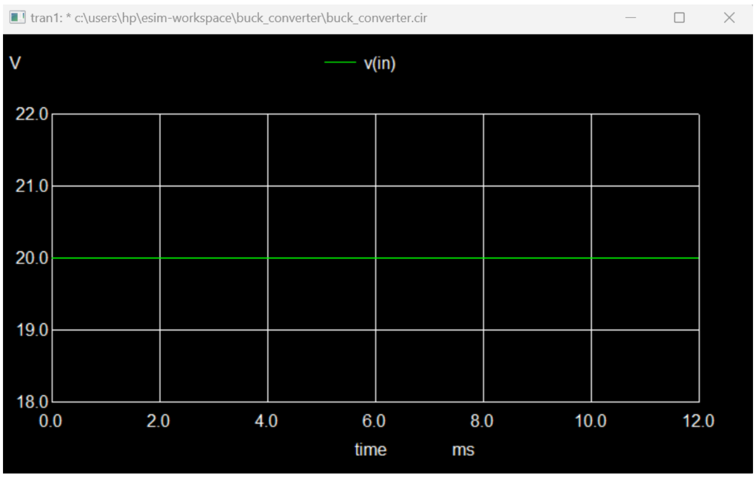

Figure 4: Input waveform of DC to DC Buck Converter

Output Waveform

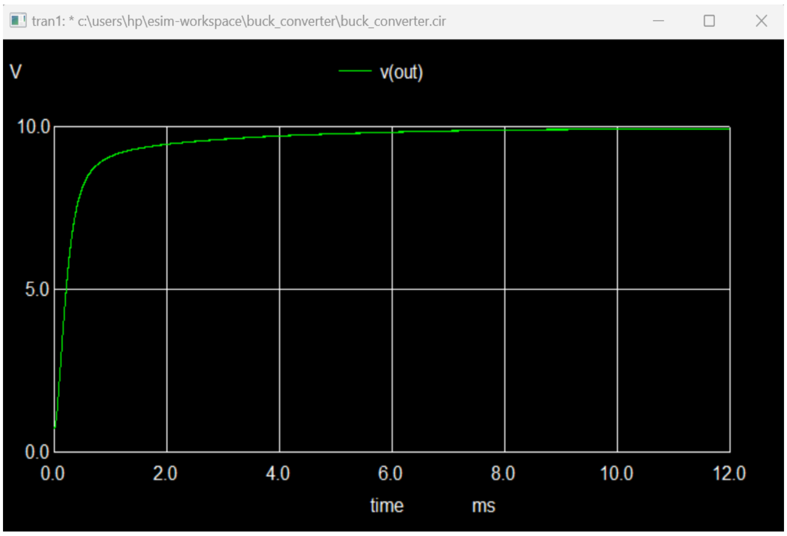

Figure 5: Output Waveform of DC to DC Buck Converter

Vin = 20

Duty ratio = 0.5

Vout = vin*duty ratio

So here we get, **Vout = 10v**

Pulse Waveform

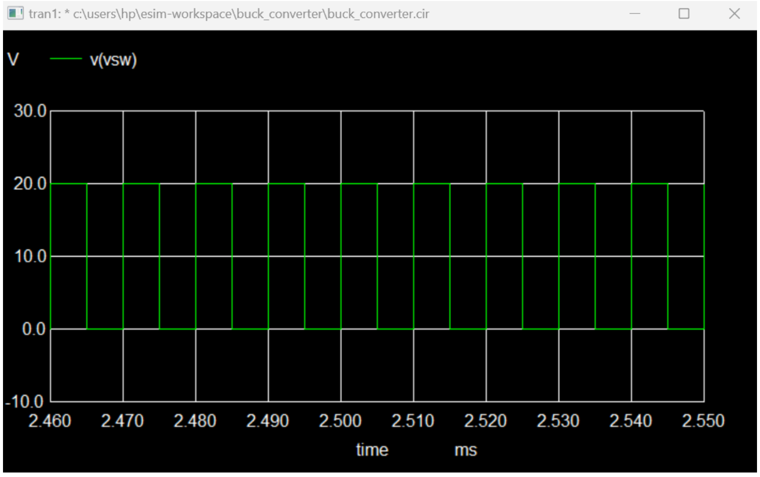

Figure 6: Pulse Waveform of DC to DC Buck Converter

Current Waveform

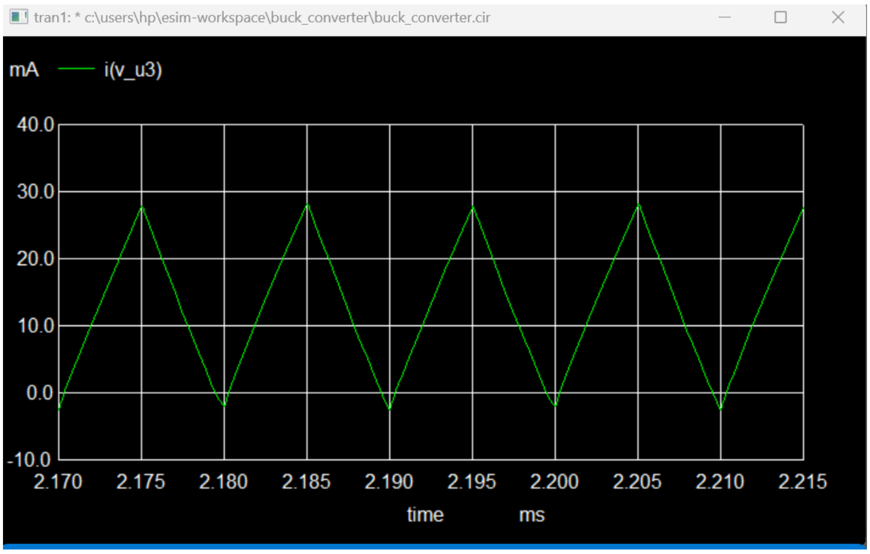

Figure 7: Current Waveform of DC to DC Buck Converter

Conclusion:

In conclusion, a DC-DC buck converter is an efficient and reliable solution for stepping down a high input DC voltage to a lower output DC voltage, making it ideal for powering low-voltage devices from higher voltage sources. Its design, which uses a switch, inductor, diode, and capacitor, enables precise voltage control through pulse-width modulation of the switch. This efficient operation, with minimal power loss, makes buck converters widely used in applications like battery-operated devices, power supplies, and embedded systems. The converter's ability to provide stable, smooth DC output ensures the safe operation of sensitive electronic components, making it a fundamental component in modern power electronics.

References:

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