**Advanced Engineering Days**

aed.mersin.edu.tr

# 24V Input 12V AND 36V Output Buck-Boost Converter Design

**Muslime Altun*1, Mehmet Rida Tur 2 Fevzi Çakmak3**

[1] *Batman University, Energy Coordination Center, Batman, Türkiye, muslime.altun@batman.edu.tr*
[3] *Batman University, Department of Electrical & Energy Engineering, Batman, Türkiye, mrida.tur@batman.edu.tr*
[3] *Mardin Artuklu University, Midyat Vocational School, Mardin, Türkiye, fcakmak72@hotmail.com*

Cite this study: Altun, M., Tur, M. R. & Cakmak, F. (2022). 24V Input 12V AND 36V Output Buck-Boost Converter Design. 2nd Advanced Engineering Days, 90-92

**Keywords**
Buck-boost converter
Voltage deviation
Pulse Width Modulation

**Abstract**

In this modern era of electronic technologies, all the appliances require a separate power supply. To overcome this drawback, the concept of a single converter with multiple power supply has been proposed. Furthermore, the proposed research work clarifies about multipurpose charger, which alters and uses a boost topology to supply different outputs as required for different applications. Proposed method consists of multiple PWM duty cycles to produce multiple regulated power supply voltages, and so it is also referred as multi power boost converter. It uses one converter for obtaining various outputs. For example, mobile, laptop, electric vehicle, or any other electronic appliances can be charged using multi power boost converter.

## Introduction

Nowadays, most of DC power supply uses are needed in electronic devices. This utilization is required in order to be able to convert DC voltages from certain voltage to desired voltage. Buck-boost converter is a type of switching converter that is able to produce voltage levels greater or smaller than the input voltage. Voltage regulation is carried out by adjusting the duty cycle of Pulse Width Modulation (PWM) [1]. Buck-boost converters are widely used in alternative and renewable energy power plants, portable devices and industrial installations [2].

## 1. Buck-Boost Transducer Design, Modeling and Control

Switched power supplies are widely used today, especially in electric vehicles, renewable energy systems, computers, televisions, mobile phones and many electrical household appliances. The advantage of switch-mode power supplies over other conventional power supplies is that they are quite light, smaller and therefore take up less space. [3]

Dc-dc converters are structures that are used to transform the unregulated or the regulated voltage at the output of a rectifier, battery or solar cell. Buck-boost converter can generally be in two different structures as isolated and non-isolated. However, non-insulated structure is more widely used. [4,5] The output voltage value of the buck-boost converter can be greater or less than the input voltage value depending on the value of the duty period. In addition, the polarity of the output voltage is opposite to the polarity of the input voltage. [6]

### 1.1. Buck-Boost Converter

The circuit diagram of the buck-boost converter is shown in Figure 1.

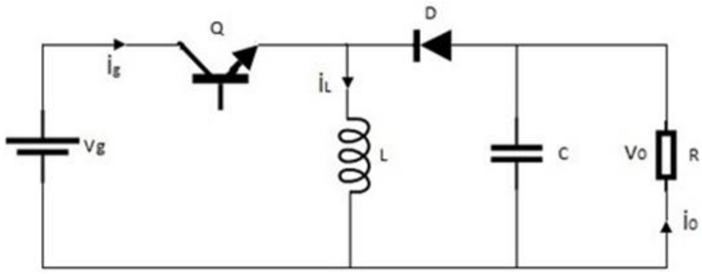


**Figure 1.** Buck-boost converter circuit

To analyze the buck-boost circuit, it is necessary to consider two cases where switch Q is on (Qon) and switch Q is on cut (Qoff).

If the duty period of the switch is d;

$$d = \frac{t_{on}}{t_{on} - t_{off}} - \frac{t_{on}}{T_s} \tag{1}$$

Here $t_{on}$ and $t_{off}$ are the on and off times of the switch, respectively. $T_s$ is the switching period.
The output voltage of the converter under ideal conditions;

$$V_o = \frac{d}{1-d} * V_g \tag{2}$$

changes to. Here, the duty period d varies in the range of 0-1. Different output voltage values can be obtained for different d values. Output voltage; If d<0.5 it becomes buck (reducer), if d>0.5 it becomes boost. The current is also intermittent, as the output of the Buck-Boost converter is a bit too fluctuating.

$$\frac{d\dot{I}_L}{d_t} = \frac{V_g}{L}.d + \frac{V_C}{L}.(1-d) \tag{3}$$

$$\frac{dV_C}{d_t} = -(1-d)\frac{I_L}{C} - \frac{V_C}{RC} \tag{4}$$

### 1.2. Proteus Model of Buck-Boost Converter

Equations in equality (3) and (4) are modeled as in Figure 2 using the Proteus program.

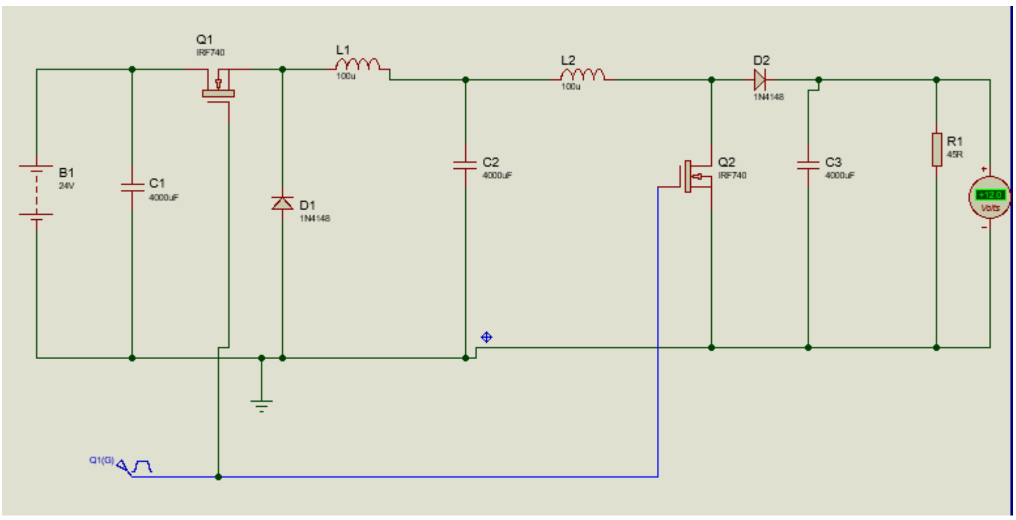


**Figure 2.** Proteus Model of buck-boost converter

In Figure 2, if the desired output voltage is entered into the model as Vo value, the duty period that will provide this output is calculated and applied as an input to the model.

The model in Figure 2 was operated for different reference output voltage (Vo) values by taking Vg=24 V, C=100 μF, L=4000 μH, R=45 ohm and switching frequency fs=75 kHz, and the following results were obtained. The created model calculates the duty period value of the converter according to the entered reference voltage.

In order to calculate the desired reference output voltage as Vo=36.8 V, when the signal width is entered as PW=66, the duty period, output voltage and inductance current of the buck-boost converter are as seen in Figure 3. In this case, the model calculated the duty period as d=0.454.

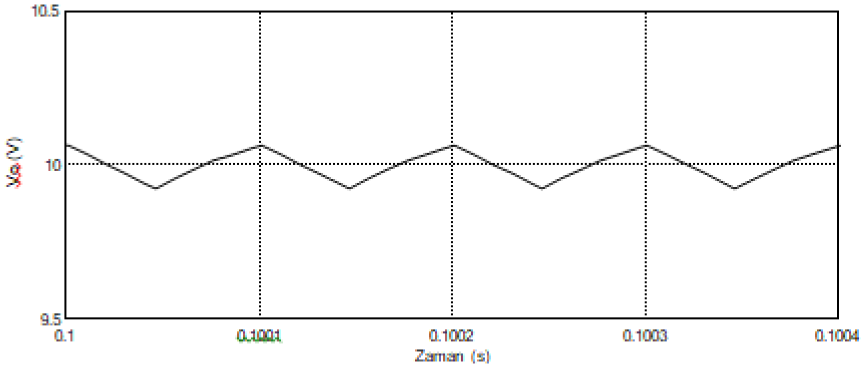


**Figure 3.** Variation of output voltage with time for Pw=66 in buck-boost converter

When the signal width is entered as PW=37 to calculate the desired reference output voltage as Vo=12 V, the duty period, output voltage and inductance current of the buck-boost converter are as seen in Figure 4. In this case, the model calculated the duty period as d=0.625.

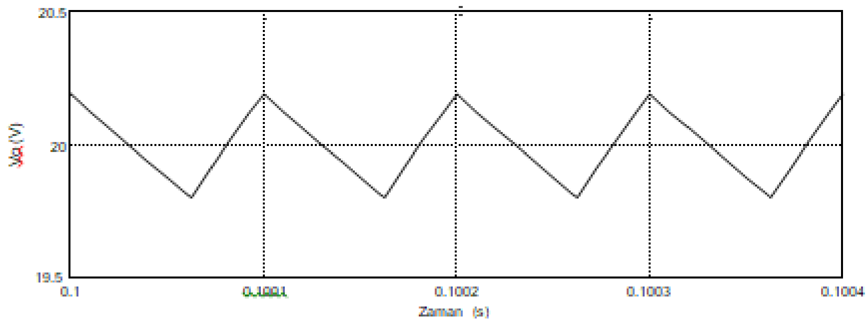


**Figure 4.** Variation of output voltage with time for Pw=37 in buck-boost converter

## Conclusion

In this study, the design, modeling and control of da-da Buck-Boost transducer are examined. The Proteus model of the controlled da-da Buck-Boost converter, which provides the desired output voltage according to different reference voltages, has been realized and the results regarding this situation are presented in detail.

## References

[1] Ardhenta, L., Ansyari, M. R., Subroto, R. K. & Hasanah, R. N. (2020). DC Voltage Regulator using Buck-Boost Converter Based PID-Fuzzy Control. Electrical Power, Electronics, Communications, Controls and Informatics Seminar (EECCIS), 117-121, Malang, Indonesia.

[2] Gayathri, A., Manimegalai, V., Anusha, A., Brindha, S., Harini S. & Harini, T. (2021). Switchingbased Single Input Multi Power Boost Converter. 5th International Conference on Computing Methodologies and Communication (ICCMC), 700-706, Erode, India.

[3] Sabati, A., Bayindir, R., Padmanaban, S., Hossain, E. & Tur, M. R. (2019). Small Signal Stability with the Householder Method in Power Systems. Advanced Signal Processing Techniques Applied to Power Systems Control and Analysis, Revised: 27 August 2019, Istanbul, Turkey. 1.

[4] Garcia, M. J. P., Gutierrez, G., Normey-Rico, J. E., Prada, C. (2009). Integrated Design & Control of a Buck Boost Converter. Revista Controle & Automaçao, 20(3).

[5] Rashid, M. H., Subhajit, S., Tanya, T., Vijayakumar, D. (2014). Design and simulation of speed controller using ac-dc buck boost converter for dc motor drive with soft starter. 978-1-4673-6150-7/ 13/$31.00, 2013 IEEE

[6] Çalişkan, A., Ünal, S., Orhan, A. (2017). Buck-Boost Transducer Design, Modeling and Control.