

Design and Simulation of Dc to Dc Boost Converter

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Abstract -

This paper presents a design and simulation of DC/DC boost converter. This system has a nonlinear dynamic behavior, as it work in switch-mode. Moreover, it is exposed to significant variations which may take this system away from nominal conditions, due to changes on the load or on the line voltage at the input. The input usually is obtained by PV array and therefore the design and simulation in this paper covers the whole range of radiations and temperature. In this paper we analyze the equations of a boost converter and propose a design components and simulation of DC/DC boost converter. This work is applied to photovoltaic system for tracking the point of maximum power.

Keywords ; Converters, Power Regulator, Simulation etc.

1. Introduction

The DC/DC converters are widely used in regulated switch mode DC power supplies. The input of these converters is an unregulated DC voltage, which is obtained by PV array and therefore it will be fluctuated due to changes in radiation and temperature. In these converters the average DC output voltage must be controlled to be equated to the desired value although the input voltage is changing. From the energy point of view, output voltage regulation in the DC/DC converter is achieved by constantly adjusting the amount of energy absorbed from the source and that injected into the load, which is in turn controlled by the relative durations of the absorption and injection intervals. These two basic processes of energy absorption and injection constitute a switching cycle. Intuitively speaking, if the energy storage capacity of the converter is too small or the switching period is relatively too long, then the converter would have transmitted all the stored energy to the load before the next cycle begins. This introduces an idling period immediately following the injection interval, during which the converter is not performing any specific task [1,2,3]. The converter can therefore operate in two different modes depending upon its energy storage capacity and the relative length of the switching period. These two modes are known as the discontinuous conduction and continuous modes. Graphically model of the boost converter is shown in Fig. 1. The full details of the boost converter topology have been already discussed in [4,5,6]. The DC/DC boost converter only needs four external components: Inductor, Electronic switch, Diode and output capacitor. The converter can therefore operate in the two different modes depending on its energy storage capacity and the relative length of the switching period. These two operating modes are known as the discontinuous conduction mode, DCM, and

continuous conduction mode, CCM, corresponding to the cases with and without an idling interval respectively [6,7].

2. Objective

- Efficiency, size, and cost are the primary advantages of switching power converters when compared to linear converters.
- The switching power converter efficiencies can run between 70-80%, whereas linear converters are usually 30% efficient.
- The DC-DC Switching Boost Converter is designed to provide an efficient method of taking a given DC voltage supply and boosting it to a desired value.

3. Block Diagram

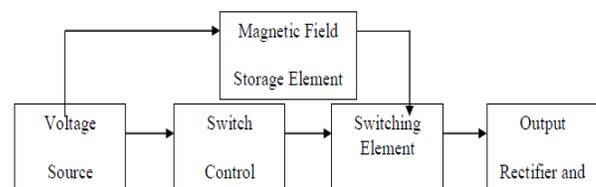


Fig. 1 shows the basic blocks of building a boost converter circuit:

4. Working

The voltage source provides the input DC voltage to the switch control, and also to the magnetic field storage element. The block which contains switch control directs the action of the switching element, whereas the output rectifier and filter deliver an acceptable DC voltage to the output. [6]

In this project, we are increasing the level of the input voltage by innovative technology. Any electronic circuit need

to be DC power supply. So we use the battery for 6V supply as input side source voltage that voltage is to be boosted. Some fluctuation and harmonics are introduced in the circuit this is removing by using of electrolytic capacitor. After that the input voltage is passing through the voltage regulator (7805). A voltage regulator is a device which converts the varying input voltage into a constant voltage supply. The voltage regulates the input supply 6V to 5V which is suitable for our circuit and microcontroller. After the regulation some fluctuation and ripple are also introduced in the circuit. So it removes by using of electrolytic capacitor and provides continues supply to the circuit.

Engineers working in today’s high tech environment have to deal with a rapidly changing market of electronic products and equipments. As new technologies are invented, integrated circuits function faster and are smaller in size and shape. But, many integrated circuits still require a voltage of 15 volts to function. The DC-DC Switching Boost Converter will take a 5 Volt DC voltage supply with $\pm 10\%$ tolerance and deliver 15 Volts to the load. The maximum current delivered to the load will be 0.4 A. The circuit will operate with a minimum efficiency of 94.16%. [7]

5. Application of DC-DC Converters

In many industrial applications, it is required to convert a fixed-voltage dc source into a variable-voltage dc source. A dc-dc converter converts directly from dc to dc and is simply known as a dc converter [4]. A dc converter can be considered as dc equivalent to an ac transformer with a continuously turns ratio. Like a transformer, it can be used to step down or step up a dc voltage source.

The dc-dc converters are widely used for traction motor control in electronic automobiles, trolley cars, marine hoists, forklift trucks, and mine haulers. They provide smooth acceleration control, high efficiency, and fast dynamic response. DC-DC converters can be used in regenerative braking of dc motors to return energy back into the supply, than this feature results in energy savings for transportation systems with frequent stops [5]. DC converters are used in dc voltage regulators and also are used in conjunction with an inductor, to generate a dc current source, especially for the current source inverter.

6. Matlab Simulation Results

Given below is a circuit diagram used for MATLAB simulation of boost converter. The purpose of this circuit is to measure output voltage and current waveform.

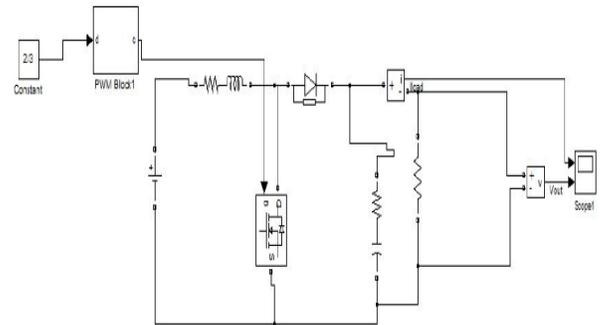


Fig. 2 Circuit Diagram of Boost Converter used in MATLAB.

Given below is the output current waveform obtained from MATLAB simulation,

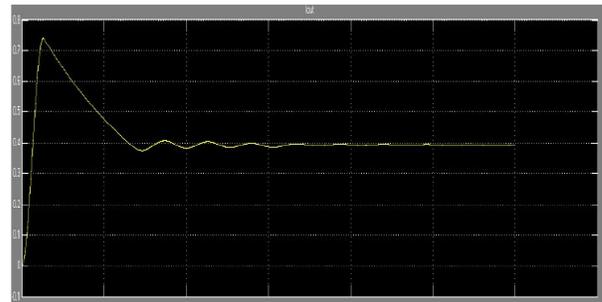


Fig. 3 (IO(output current) vs Time) in MATLAB.

Given below is the output voltage waveform obtained from MATLAB simulation

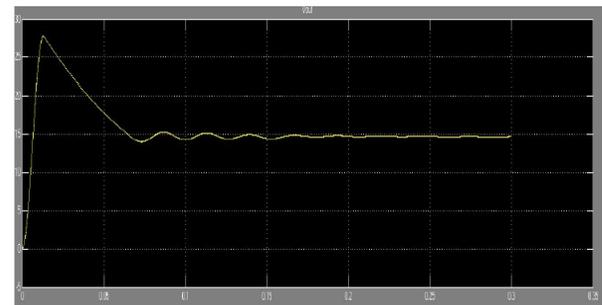


Fig. 3 (IO(output voltage) vs Time) in MATLAB.

7. Pspice Simulation Results

Given below is a circuit diagram used for PSPICE simulation of boost converter. The purpose of this circuit is to measure output voltage across the resistor R1.

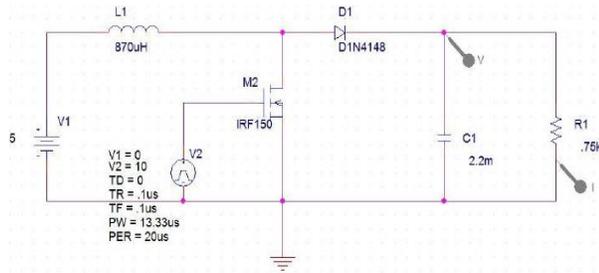


Fig. 4. Circuit Diagram of Boost Converter used in PSPICE

Given below is the output voltage waveform obtained from PSPICE simulation

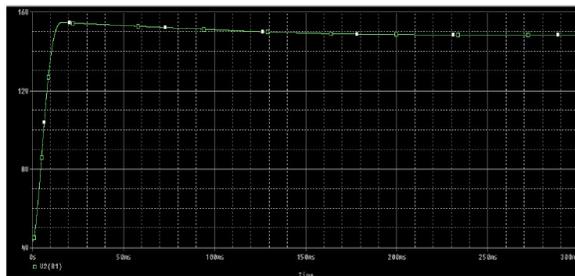


Fig. 5. VOUT(output voltage) vs Time in PSPICE.

The above figure shows that the output voltage across the resistor R1 (37.5 Ω) becomes stable after sometime, and remains at 15 V.

8. Observations

From the results obtained, it is clearly observed that the boost converter steps up the voltage from 5 to 15 volt in accordance with the parameters derived earlier, fulfilling the desired conditions of output current being 0.4 A at frequency 50kHz. The efficiency of the boost converter is 94.16%.

9. Conclusion

All of the specifications stated previously have been met by this boost converter design. MATLAB and PSPICE simulations using calculated parameters were performed and corresponding waveforms were obtained. The output voltage across the output capacitor is 15V with a maximum output ripple of 1.6%. The power efficiency of the circuit exceeds 94%. However an additional constraint needs to be put on the load. The load must not exceed 0.75k Ω . This will cause the efficiency to fall below the specified value of 94.16%. Hardware design of BOOST CONVERTER was done. It is observed, by varying duty cycle output voltage also changes.

From the simulation results it is found that in case of the buck, boost and buck-boost converters, the desired output voltages can be obtained by selecting proper values of inductor, capacitor and switching frequency. All of these individual theories were difficult for anyone to grasp primarily and putting them collectively in the simulator which was extremely puzzling. But it has been done most excellent to

formulate an outstanding scheme dissertation with affluent in its contest. At each stage, targets were set to acquire the necessary skills to meet the criteria of the research and design the circuits for implementation into the software simulation. This research gives the opportunity to study new skills and raise valuable knowledge in circuit designing and problem solving skills which has greatly enriched knowledge and understanding through the erudition route which may help one in for the further progression.

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