Variable Input Constant Output Voltage Regulator

Functional Description & System Block Diagram

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Date:

September 24, 2013

I. Introduction

The need to create a more efficient form of transportation while also considering the ecosystem has led to the development and use of electric vehicles. The primary goal of the "Variable Input Constant Output Voltage Regulator" (VICOVR) project is to redesign the power electronics developed by a 2012-13 capstone project group to significantly increase output current capacity. A secondary goal will be to design a simple closed loop control system capable of maintaining a constant output voltage over a wide range of input voltages. Although not included in the goals for this senior capstone project, the VICOVR is ultimately intended to provide a controlled DC voltage to charge the battery bank in an electric vehicle during regenerative braking.

II. Functional Description

The need for the VICOVR is due to the fact that at higher vehicle speeds the wheel-driven generator provides adequate voltage to charge the storage battery, but as the vehicle speed decreases the generator output voltage falls to a level less than sufficient to effectively recharge the battery. It is anticipated that the VICOVR control system will maintain adequate battery charging voltage and current as the vehicle speed decreases to recover as much energy as possible. If this year's VICOVR successfully increases the amount of energy recovered as the input voltage decreases from its maximum to 5% of its maximum, it could lead to greater distances per charge cycle.

III. Block Diagram

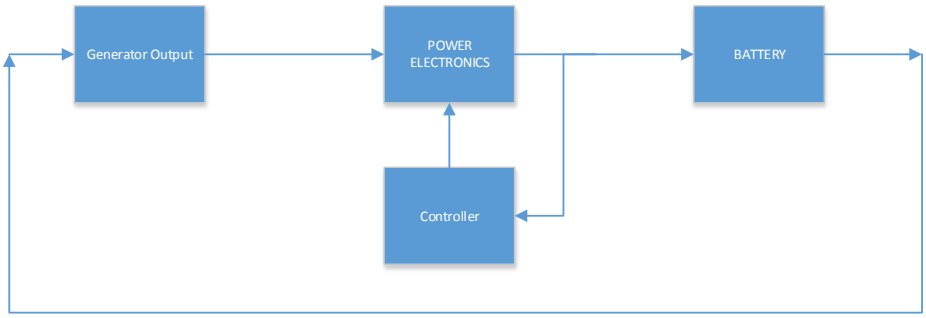

Figure 1: High Level Block Diagram

Figure 1 represents a high-level block diagram of the Variable Input Constant Output Voltage Regulator. The power electronics will convert the widely varying generator (or source) output voltage to a narrow voltage range capable of recharging the battery as the available power decreases with input voltage. The fundamental concepts related to the power electronic circuits to be used in the project are shown in figure 2 below.

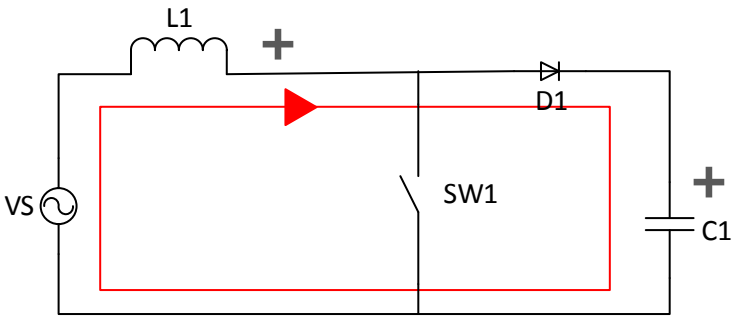

Figure 2a: Basic Boost Converter Operation with Switch Opened

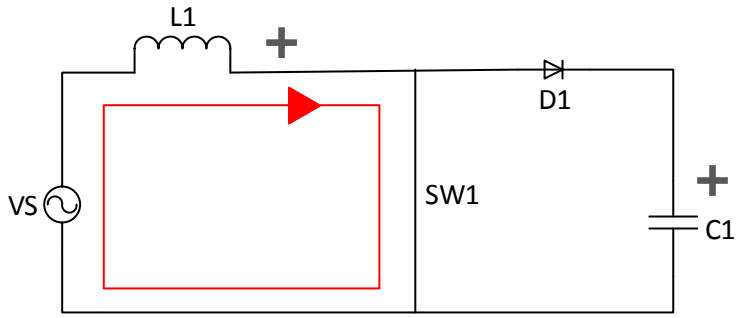

Figure 2b: Basic Boost Converter Operation with Switch Closed

When SW1 is open the supply current flows as shown in figure 2a, and due to the energy stored in the inductor the diode is forward biased and provides a current path to the load. When the switch closes as shown in figure 2b, the filter capacitor helps maintain the output voltage while the input voltage source supplies additional energy to the inductor in preparation for the next switching cycle. When the switch opens again, the increased inductor energy is channeled through the diode and to the filter capacitor, thereby maintaining the output voltage for a specified load and switching duty cycle.

IV. Goals

1. Evaluate the power electronics of the past project
2. Redesign the power electronics increase current capacity
3. Perform multiple simulations of the design
4. Design and implement the control system
5. If the items 1 - 4 are completed and time permits, an attempt will be made to test the design with a motor/generator in the laboratory

V. Conclusion

Society's increased concern for the environment has led to the pursuit of an efficient electric vehicle. The desire to continue the improvement of their efficiency has led to the study of power electronics that will be used in the VICOVR project. The VICOVR will begin with an evaluation of previous power electronics, then lead to their redesign and if time permits allow the testing with a motor. The VICOVR would be implemented to produce a longer travel distance per charge.