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Design and Analysis of Battery Management System for Electric Vehicles

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ABSTRACT

This Paper Battery driven at the control Bi- Directional DC-DC Converter Fed Dc machine is implemented by Using MATLAB Software.The Overall Simulation Circuit is designed and Simulated under Power GUI Environment.The Proposed circuit configuration than perform both forward mode and regenerative mode of operation. The charge and discharge conditions of batteries have been controlled regarding to operating modes of dc machine. The bi-directional dc-dc converter is controlled with fuzzy logic controller in both modes. The proposed converter and controller are designed to meet charge control and motor drive requirements of an all-electric vehicle.

INTRODUCTION

Transportation sector occupies a fundamental place in the world. Fossil fuels used in conventional vehicles technology emit greenhouse gases such as carbon dioxide, carbon monoxide and methane. The excessive consumption of these gases causes air pollution, climate change and global warming. In order to reduce these effects, there is a tendency to electric vehicle (EV) technology. The EV has much lower fuel cost according to fossil fueled car since they are mainly composed of battery system, power electronic circuits and electric machine. The battery system in an EV is the most crucial component in charge control time and determining distance [1,2]. The electric machines of an EV are operated in both motor and generator modes due to regenerative breaking feature that enables electric machine to be operated in generator mode which is impossible in conventional internal combustion engine (ICE) vehicles. Therefore, electric machine charges the battery by operating in generator mode during the regenerative braking and it ensures recharging the batteries [3,4]. EV are classified into two types as hybrid EVs (HEVs) and all-electric vehicles. The HEV technology is used in conjunction conventional vehicle technology. The main system in HEV technology includes fuel tank and ICE such as diesel or gasoline engine, and auxiliary system which is comprised by electric machine, power electronic circuits and battery. HEVs are classified as parallel and series hybrid vehicles [5] that the parallel HEV consists ICE and electrical machine together as shown in Fig.1. As the parallel electric vehicles operates at electric mode during the acceleration of electric machine, the motor operation is supplied from battery.The designed EV motor driver is comprised by four sections such as battery, bi-directional dc-dc converter, FLC and dc machine as shown In this study, the starting voltage of battery is set to 378 V while the operating voltage

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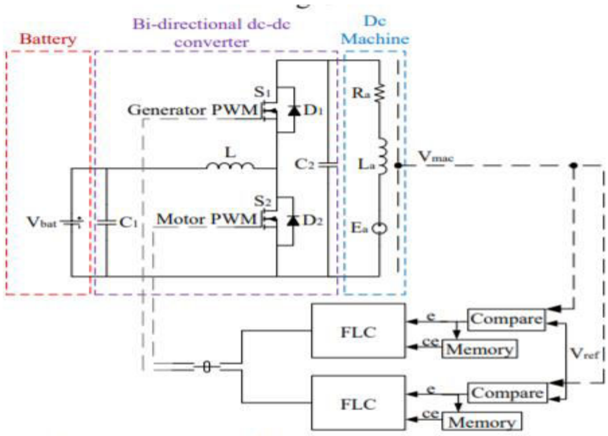
of dc machine used in traction system is 500 V dc. The battery voltage is increased up to 500 V with bi-directional dc-dc converter in generator mode. The battery is discharged when dc machine is started acceleration. The motor mode simulation with various torque values are performed to observe battery parameters such as state of charge (SoC), current, voltage and voltage of the dc machine. The voltage of the dc machine is decreased to 500 V with bidirectional dc-dc converter which is controlled with FLC. The battery is charged during the generator mode operation of dc machine. The FLC determines duty cycle of S1 and S2 to ensure charge and discharge of battery. The dc machine is comprised by brushes, armature core and windings, commutator, field core and windings. Armature circuit is comprised by series structure with inductor, resistance and counter-electromotive source. Similarly, battery parameters such as SoC, current, voltage and voltage of the dc machine are observed in the generator mode simulation regarding to various torque values applied to dc machine.

The electrical energy is converted to mechanical energy or vice versa by dc machine that operates regarding to electromechanical energy conversion theory [7]. If a conductor is moved within the magnetic field, the voltage is induced on it which is known as generator operating mode. If alternating current passes through the conductor, magnetic field is created around it which explains the motor mode operation. When the dc machine is started acceleration, the resultant positive torque is achieved. On the other hand, negative torque is generated at the dc machine when it is operated in generator mode

FLC is comprised by fuzzification, rule base, interface mechanism, defuzzification. Fuzzification is used to convert digital signals received through the system into linguistic variable. Rule base is comprised by the conditions to set for controlling the system at desired location. Interface mechanism makes inferences according to the rules of system by establishing a relationship between inputs. Defuzzification is used to convert linguistic variable received through the system into digital signals.



Proposed circuit configuration

PROPOSED DC DC CONVERTER

buck–boost converter is a type of DC-to-DC converter that has an output voltage magnitude that is either greater than or less than the input voltage magnitude. It is equivalent to a flyback converter using a single inductor instead of a transformer. Two different topologies are called buck–boost converter. Both of them can produce a range of output voltages, ranging from much larger (in absolute magnitude) than the input voltage, down to almost zero.

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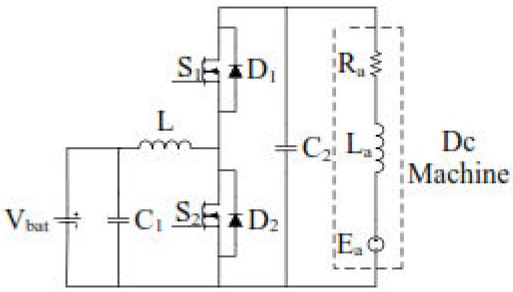

Proposed converter

The output voltage is of the opposite polarity than the input. This is a switched-mode power supply with a similar circuit topology to the boost converter and the buck converter. The output voltage is adjustable based on the duty cycle of the switching transistor. One possible drawback of this converter is that the switch does not have a terminal at ground; this complicates the driving circuitry. However, this drawback is of no consequence if the power supply is isolated from the load circuit (if, for example, the supply is a battery) because the supply and diode polarity can simply be reversed. When they can be reversed, the switch can be on either the ground side or the supply side

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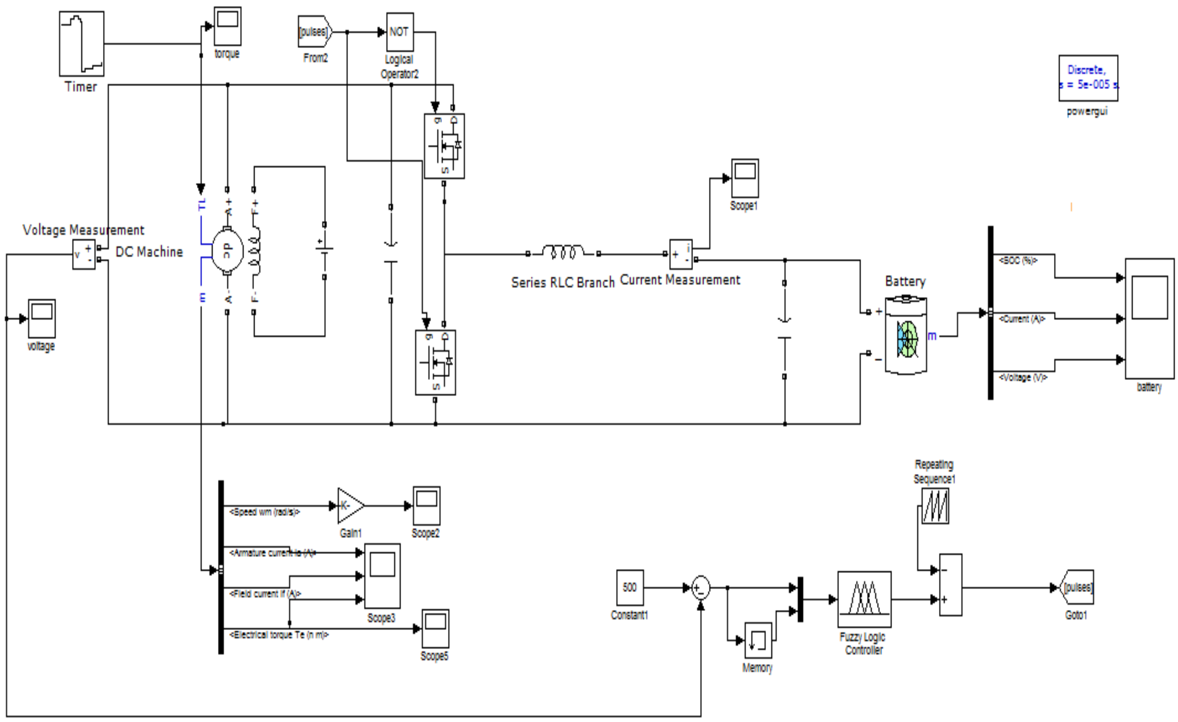
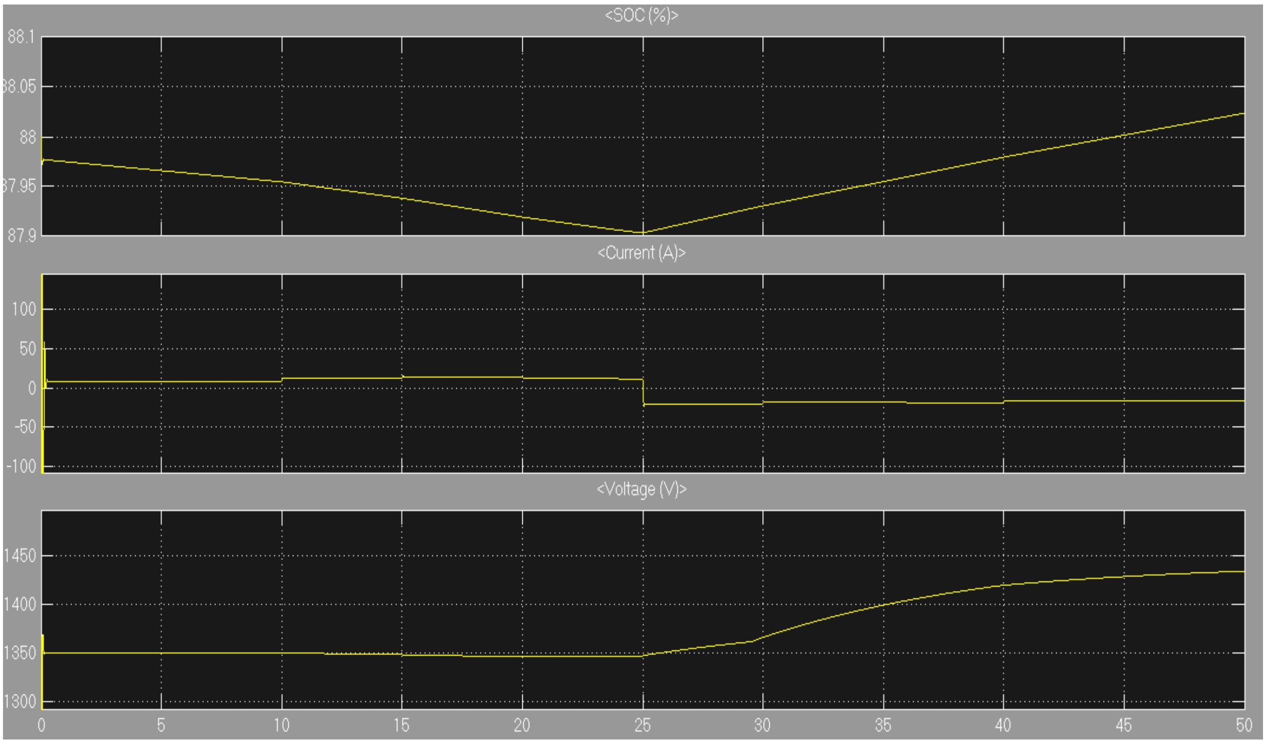
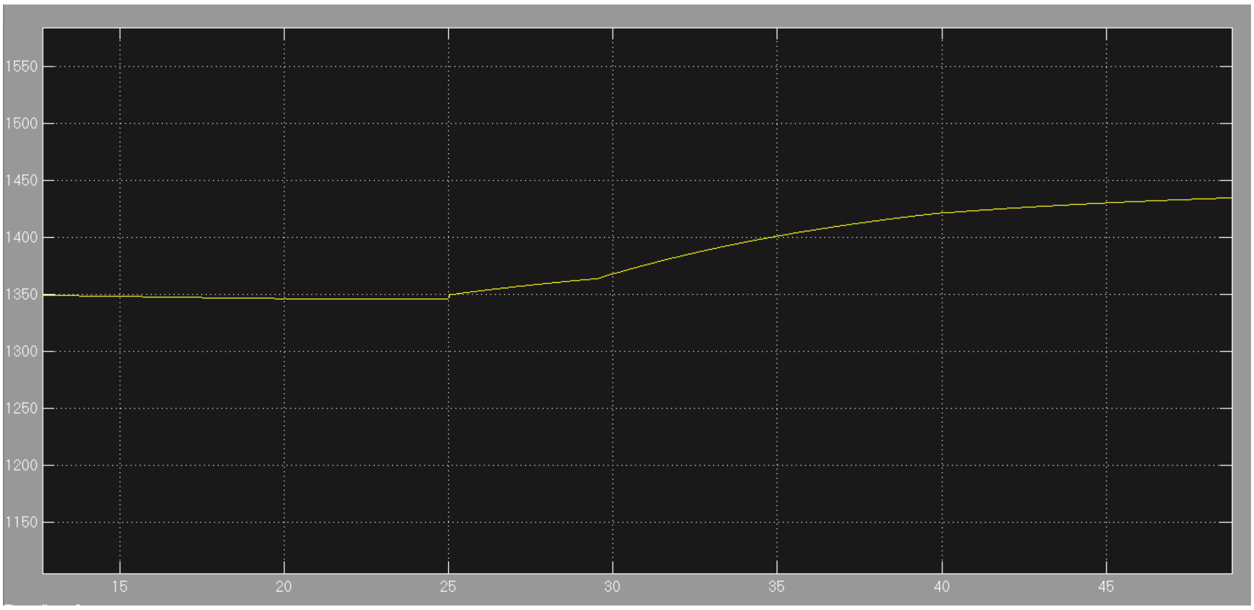
SIMULATION RESULTS



Proposed circuit configuration



Proposed system Battery SOC, current, voltage



Proposed Dc machine across voltage

CONCLUSION

This project presents design and control bi-directional dcdc converter for all-electric vehicle. The bi-directional dc-dc converter is controlled with FLC according to rules. When the battery is discharged, the dc machine is operated in motor mode and bi-directional dc-dc converter is operated in boost mode. Variable positive torque values are applied

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to the dc machine and condition of the battery is observed. According to simulation result, the battery SoC is reduced from %88 to %87.337 and voltage of the dc machine is constant at 500 V. When the battery is charged, the dc machine is operated generator mode and bi-directional dc-dc converter is operated in buck mode. Variable negative torque values are applied to the dc machine and effect on the battery is observed. According to simulation result, the battery SoC is increased from %87.337 to %87.445. In all-electric vehicle, regenerative breaking is occurred in this state. Charge and discharge states of the battery are the most essential for distance to determining.

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