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Soft Switching Technique in Bidirectional DC-DC Converter for Hybrid Electric Vehicle

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ABSTRACT

The voltage at halfway should be equal for optimum voltage gain and energy transfer in order to achieve gentle switching in the bidirectional converter. Both from the side of high voltage to the side of low voltage. But,It is challenging to charge the battery during soft switching. Due to the same voltage level but a larger charging current in the middle. The battery split that is feasible for grid-to-vehicle (G2V) mode of operation when a vehicle's battery splits in two equal voltage part by using relay or breaker circuit configuration. [The forward converter is based on buck topology, the flyback converter is based on buck-boost topology, and both full-bridge and half-bridge converters can be formed from buck and boost topologies. In addition, converter types can be divided into using transformer cores . A net DC current flows in the forward and flyback topologies.

Keywords: *Converter; Switching; Half-Bridge; Buckboost; Voltage Level; Battery Split.*

1.0 Introduction

The power electronic circuits, which in an electric vehicle comprise DC-AC inverters and DC-DC converters, are crucial. DCDC converters are utilised to supply low power, low voltage loads, while DC-AC inverters are used to supply high power electric motors. Bidirectional high-power DC-DC converters have been designed using cutting-edge topologies specifically for use in hybrid automobiles.[1] The non-isolated bidirectional dc-dc converter model in this paper has a half-bridge topology.

Electric vehicles (EVs) engage in continuous charge-discharge cycles when they connect to the grid to carry out various V2G services. The expense related to the EV batteries' deterioration needs to be examined and assessed, therefore these cycles may be of major concern to the owners of the vehicles[2]. In light of this, the battery cycle life (CL) must be taken into account while talking about the battery's deterioration. The non-isolated bidirectional dc-dc converters that are used to charge and discharge the batteries have a straightforward structural design that is highly efficient, affordable, and dependable.

Voltage is changed by adjusting the converter output, which operates in buck and boost mode [9], to improve the effectiveness of battery charging and discharging.The battery is charged by the bidirectional converter, which also transfers energy to the battery as needed and recovers energy

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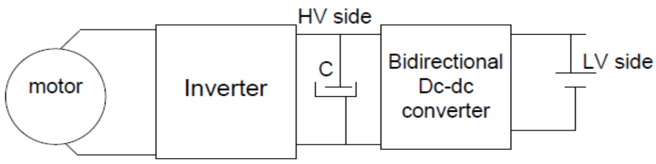
during regenerative braking[3]] To control the charging and draining of the battery as well as the flow of power, a bidirectional power converter is required[4].

2.0 Converter Design

In order to control the charging and discharging modes, a battery is employed in this research as energy storage with a bidirectional dc-dc converter. Using a PID controller, the converter is controlled. When more power is needed, the energy storage will take over, and during regenerative braking, the generated energy is returned to the battery. Buck and boost are two of the converter's two operating modes[5-6].



3.0 Vehicle Modeling

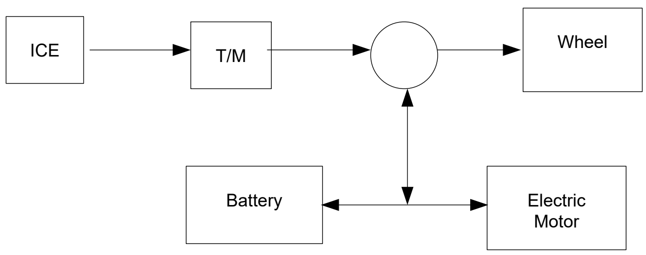
Parallel HEV is used for the study. The electric motor and the engine is coupled with the transmission[7].The wheel torque requirement is calculated by the equation[8]-

$$T_r = r_w(0.5\rho CdAv^2 + m_e a + mg(fr\cos\theta + \sin\theta)) \quad \ldots(1)$$

$$T_p = \eta_f r_f (T_m + \eta_{gb}, ir_{gb}, iT_e) + T_b \quad \ldots(2)$$

$$g = c_f(c_0(w_e)T_e + c_1(w_e))e_{on} \quad \ldots(3)$$

Figure 2: Schematic of Parallel HEV



It suggests that a parallel HEV system's performance is significantly influenced by how this power split is managed. Simple rule-based or map-based heuristic control strategies seem to be falling behind controllers that are oriented on minimising fuel consumption[9]. The latter, commonly known as optimal controllers, actually provides more generality and reduces the need for significant adjustment of the control parameters[10].

4.0 Simulation Results

Internal resistance falls off as a result of discharge and reaches its minimum level at half charge. The resistance reading is higher after a full charge and discharge. A Li-ion battery's internal

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resistance value is basically flat while it is charged from empty to full. The battery power decreases when SOC is between 0 and 70%, with the biggest loss occurring between 0 and 30% of SOC.

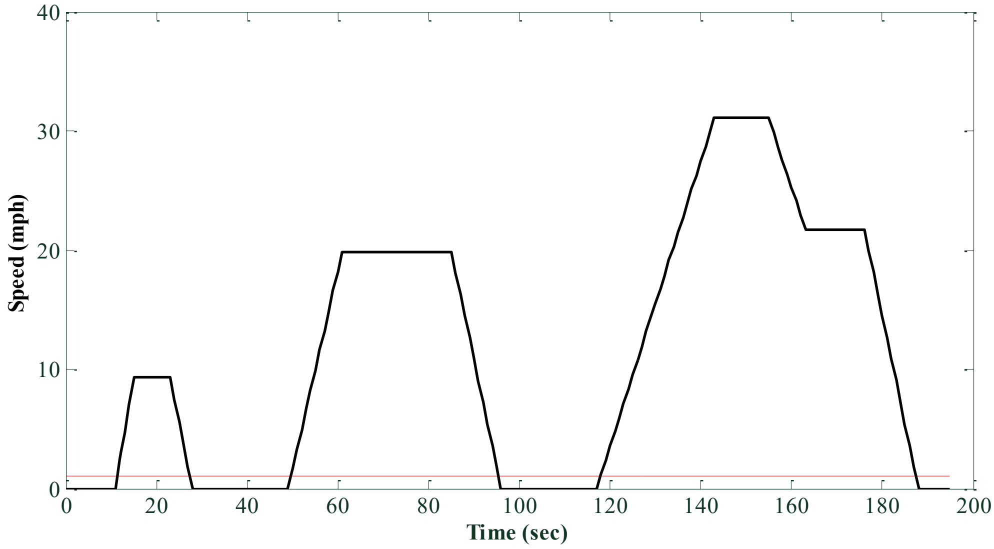
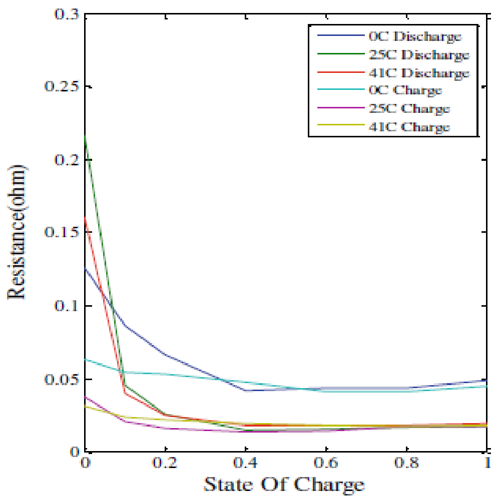


Figure 4: Charge /Discharge Condition Variation with SOC



EVs, HEVs, FCHVs, and PHEVs have successfully handled current energy and environmental challenges. Thanks to ground-breaking power electronics and ESSs, electric drive trains totally or largely replace ICEs in these cars. In order to supply hybrid power trains with the energy they require, sophisticated ESSs are used. Currently, hybrid ESSs are absent from the bulk of commercially available EVs and hybrid vehicles.

5.0 Conclusion

Electric vehicles (EVs) engage in continuous charge-discharge cycles when they connect to the grid to carry out various V2G services. The expense related to the EV batteries' deterioration needs to be examined and assessed, therefore these cycles may be of major concern to the owners of the vehicles. In light of this, the battery cycle life (CL) must be taken into account while talking about the battery's deterioration. The state of charge parameter is used in this study to test the sequential simulation findings for the different drive cycles. When there is a low demand for electricity, energy storage devices are charged, and when there is a large demand, they are discharged. The ESS is the element that regulates the electric range and fuel economy. The two ESSs for automobiles that are currently most in demand are batteries and ultra-capacitors. Batteries, which have high energy densities, are where the majority of onboard electric energy is kept in reserve.

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