Design and Development of Novel Sliding Mode Boost Converter for Automotive Applications

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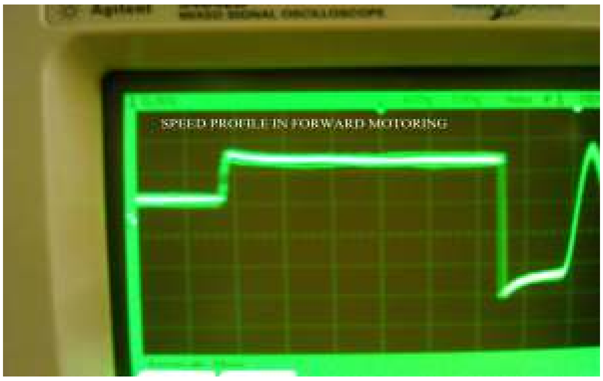
Abstract:

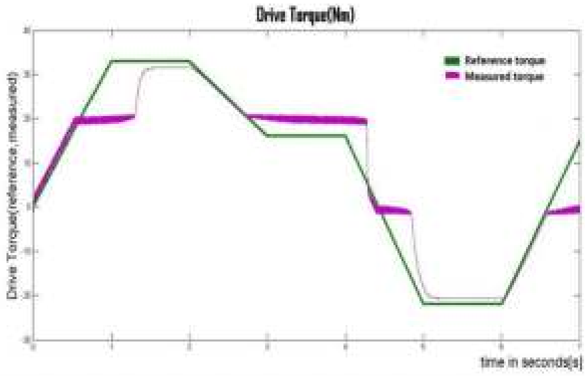
Energy Demand is continuously increasing worldwide for economic growth. The emissions and also the depletion of fossil fuel suggest that fuel cell is becoming one of the promising future energy sources due to direct energy conversion and environmental friendly. Fuel cell is good for steady and base load applications. However, load changes in automotive and power sector demands the usage of boost converter, battery pack and controllers are needed. This project work demonstrates modelling and simulation aspects of the fuel cell hybrid electric vehicle drive with special focus on design and development of sliding mode controller for boost converter

Mathematical modeling of each component in the fuel cell hybrid electric drive is considered in this study with the help of MATLAB/Simulink. The inbuilt models for fuel cell, electric drive are directly used in the simulations. The main aim of the study is to design a sliding mode controller for boost converter which interfaces with the fuel cell. It is designed with PI and PID controller to regulate voltage and current error, which is used to develop a control law to generate pulses to conventional boost converter. In addition, bidirectional DC-DC converter is modelled and compared with other converters on the battery pack side. Finally, the integrated system with DC Motor drive is modelled and simulated.

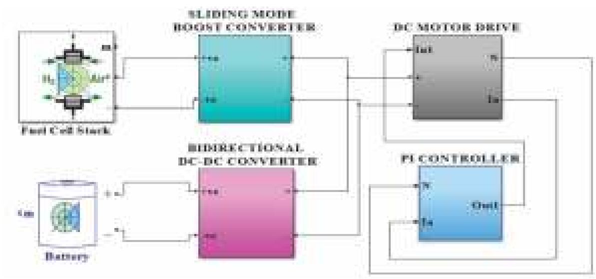
The simulations of sliding mode boost converter have shown that the output responses are ripples free as compared with conventional boost converter. The settling time is 0.005 s for SMBC and 0.02 s for PI controller. The steady state error is less in SMBC compared with PI controller. The four-phase interleaved bidirectional DC-DC converter has shown more efficient (99.05%) than conventional bidirectional DC-DC converter (88.9%). The integrated system simulation has shown main functional aspect of Fuel Cell Hybrid Electric Vehicle (FCHEV).



Hardware result: Drive torque



Simulink result of drive torque (Measured and reference)



Simulink model of Fuel Cell Hybrid Electric Vehicle