Modeling and Control of Multiphase Interleaved Fuel Cell Boost Converter based on Hamiltonian Control Theory for Transportation Applications

Abstract

This work presents a multi-phase interleaved boost converter supplied by a fuel cell/reformer power source for high-dynamics transportation applications. A control theory based on the Hamiltonian Lyapunov energy control approach is considered. Using the port-controlled Hamiltonian system, we advance in simple solutions to the dynamics performance and convergence problems when there is an interaction between power sources and constant power loads (CPLs). To corroborate the proposed control law, an FC boost converter (2.5-kW two-phase interleaved converters) is implemented in the laboratory. The methanol FC system composes of a fuel reformer reactor that transforms water and methanol liquid fuel into hydrogen gas to polymer electrolyte membrane FC (PEMFC) stack (2.5-kW, 50 V). The studied control approach is realized with a digital calculation in a MicroLabBox controller board (dSPACE platform). The simulation with Matlab/Simulink program and experimental results authenticate that this is an excellent calculation algorithm during high-dynamics power load cycles.