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Robust high order sliding mode control for performance improvement of PEM fuel cell power systems (Article)

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Abstract

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In this paper, an efficient algorithm is applied to high step-up power converter for performance improvement of Polymer Electrolyte Membrane (PEM) Fuel Cells. The action is done on forcing the fuel cell to operate at an adequate power point by tuning the power converter duty cycle. Due to inherent nonlinearities in the fuel cell dynamics and variations of the system parameters, a nonlinear sliding mode control (SMC) is suggested. However, the SMC causes severe changes in the PEM fuel cell output power, which lead to serious life-shortening and acute cell degradation. To overcome these shortcomings, a robust high order SMC based on "Twisting Algorithm" (HOSM-TA) is designed to improve the power quality and to keep the fuel cell operating at an adequate power point. The stability of both SMC and HOSM-TA is demonstrated via Lyapunov analysis. To demonstrate the effectiveness of the proposed HOSM-TA control scheme, a hardware setup is carried out on a real PEMFC stack. The implementation of the control system and the data acquisition are done on a dSPACE real-time digital control platform. It is deduced that the proposed HOSM-TA with high robustness, fast convergence (1s), and chattering reduction of 82.7% can be used to achieve great improvements in fuel cell power system. © 2020 Hydrogen Energy Publications LLC

SciVal Topic Prominence

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