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Battery Management Systems of Electric and Hybrid Electric Vehicles

Edited by

Nicolae Tudoroiu

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Contents

About the Editor

Nicolae Tudoroiu In 1976 he received his B.Eng. degree in Electrical and Computer Engineering from the University of Craiova, Romania, and in 1981 received his B.Sc. in Mathematics from the West University of Timisoara, Romania. In 1990 obtained his Ph.D. degree in Automation in Romania and in, 2001, he also received a Ph.D. degree in Electrical and Computer Engineering, from Concordia University, Montreal, Canada. During the period 1979–1994, he joined the departments of Automation and Control of the University of Craiova, Romania (1979–1990), and West University "Politehnica" Timisoara, Romania (1991–1994), as an assistant and associate professor, respectively. In the period 2001–present he joined as tenure professor the Engineering Technologies department of John Abbott College, Sainte-Anne-de-Bellevue, Canada. He presently serves on the editorial board as Guest editor of the International Journal '*Advance in Science, Technology and Engineering Systems*' (*ASTESJ*). His interest in academic research includes system modelling and identification, process control, state and parameter estimation techniques, fault detection and isolation, neural networks, adaptive and optimal control systems.

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Article

SOC Estimation of a Rechargeable Li-Ion Battery Used in Fuel-Cell Hybrid Electric Vehicles—Comparative Study of Accuracy and Robustness Performance Based on Statistical Criteria. Part I: Equivalent Models

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Abstract: Battery state of charge (SOC) accuracy plays a vital role in a hybrid electric vehicle (HEV), as it ensures battery safety in a harsh operating environment, prolongs life, lowers the cost of energy consumption, and improves driving mileage. Therefore, accurate SOC battery estimation is the central idea of the approach in this research, which is of great interest to readers and increases the value of its application. Moreover, an accurate SOC battery estimate relies on the accuracy of the battery model parameters and its capacity. Thus, the purpose of this paper is to design, implement and analyze the SOC estimation accuracy of two battery models, which capture the dynamics of a rechargeable SAFT Li-ion battery. The first is a resistor capacitor (RC) equivalent circuit model, and the second is a generic Simscape model. The model validation is based on the generation and evaluation of the SOC residual error. The SOC reference value required for the calculation of residual errors is the value estimated by an ADVISOR 3.2 simulator, one of the software tools most used in automotive applications. Both battery models are of real interest as a valuable support for SOC battery estimation by using three model based Kalman state estimators developed in Part 2. MATLAB simulations results prove the effectiveness of both models and reveal an excellent accuracy.

Keywords: SAFT lithium-ion battery; Simscape model; 3RC ECM Li-ion battery model; state of charge; ADVISOR estimate

1. Introduction

1.1. Literature Review

Nowadays the new technologies applied in batteries manufacturing industry "often demand more compact, higher capacity, safe and rechargeable batteries" [1]. The batteries vary by different chemistries and "generate the basic cell voltages typically in the 1.0 to 3.6 V range" [1]. The required voltages and the currents of a battery pack are obtained by adding up the number of the cells in a series connection to increase the voltage and parallel connection to enhance the current. It is important to