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Battery Response Analyzer using a high current DC-DC converter as an electronic load

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Abstract. This paper presents a battery response analyzer for high current levels. This system represents a very useful method to characterize simple battery and supercapacitor models, which commonly aid designers in the DC-DC converter development for electric vehicles (EV). A DC-DC converter is used to discharge batteries at a controlled current. The current is governed by a control unit which imposes a 100A pulse signal for the device under test (DUT). The response for the discharge pulse current is evaluated and then, a simple battery model is extracted. A complete low-cost test bench was developed in order to extract experimental data from batteries and super capacitors. Obtained measurements include high current pulse analysis and charge/discharge cycle to study the ageing of the device.

Key words

High Current, DC-DC Converter, Battery Response, Electronic Load, Battery Electrical Model.

1. Introduction

Energy storage devices should be studied in detail for the development of electrical systems such as electrical vehicles or uninterruptible power supplies (UPS). If the load current varies softly, the manufacturer datasheet and classical electrochemical models give enough information to estimate the voltage values of the batteries for electronic design purposes [1]. But, when the batteries have to deliver high current peaks, for example, while turning on an engine, a transient model [2], [3] is useful to predict the voltage drop and the number of current peaks that the battery can stand before reaching a minimum threshold voltage.

Furthermore, there exist many other battery models which are useful for studying different aspects of an electrochemical cell. Impedance-based models characterize internal chemical process; hence it is used in the design of the electrochemical cell. Each parameter is related to an internal chemical process. The method consists on an AC sweep at very low frequency, from 1 kHz down to less than 1 mHz [4].

A run-time model [5] correctly describes the self discharge and DC analysis such as: constant current or constant voltage charges, constant current discharges, and other tests with slowly variation in electrical magnitudes. However, it is not accurate for transient response. Finally, a mixture of several types of models can be implemented in order to achieve a general model for different processes [6].

The low-cost bench presented in this paper allows carrying out several measurements so that, an electrical model of a battery can be extracted. It also allows cycling batteries with discharge pulse patterns for particular ageing measurements.

The key block of the system is the electronic load (e-load) based on a DC-DC converter. It performs high current discharges and its cost is cheaper than a commercial e-load of these characteristics.

This bench is part of a project which objective is the study of different energy storage devices to be used in powering catenary-free tramways.

2. Objective

The main objective of this paper is to use a DC-DC converter as an electronic load for high current and low voltage applications [7].

The battery discharge current will be controlled by means of a reference signal generated by a software application.

In addition, the parameters for simple battery models will be extracted at different states of charge. In order to demonstrate the capabilities of the bench, a lead-acid battery will be tested.