Electric Power Systems Research 80 (2010) 363–371

Contents lists available at ScienceDirect

Electric Power Systems Research

journal homepage: www.elsevier.com/locate/epsr

Review

A new parameters identification procedure for simplified double layer capacitor two-branch model

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ARTICLE INFO

Article history:
Received 13 March 2008
Received in revised form 31 July 2009
Accepted 22 October 2009
Available online 2 December 2009

Keywords:
Supercapacitor
Double layer capacitor
Supercapacitor identification method
Experimental validation
Energy storage device

ABSTRACT

Supercapacitors are electrical energy storage devices that offer high power density and a high number of charge and discharge cycles. Even though the amount of stored energy they maintain is not comparable that of classical batteries, supercapacitors can offer advantages in several industrial applications. This paper introduces a simplified model, named the "two-branch" model, to characterize the electrical behaviour of double layer capacitors (DLCs). This model is similar to some models in literature from a circuit point of view (e.g. three-branch model), but the parameters identification process is easier and faster. Experimental charge and charge–discharge tests have been executed on supercapacitors of two different makes (Epcos and Maxwell) and for several different sizes (between 110 F and 600 F). Moreover a new identification procedure, for describing short-term behaviour, is proposed for the new simplified two-branch model. This new procedure is simpler than for the other lumped models therefore it can be adopted fruitfully also from them. The experimental results and the performed simulations are reported in order to verify the validity of the new simplified proposed model and of the new parameter identification process.

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1. Introduction

The recent discovery of supercapacitors has sparked considerable research interest in understanding these circuit components. Although associated with low levels of stored energy, they nonetheless afford high peak power and a large number of charge–discharge cycles [1].

Even though the amount of stored energy in a supercapacitor is not directly comparable to that of a classical battery, supercapacitors can offer advantages in a wide range of industrial applications, from telecommunications [2] to computers (e.g. compact flash memory, notebook batteries, computer memory backup systems, etc.) [3,16–17]. Storage systems based on these devices are already being used within electric traction systems for the recovery of braking energy [1] or in conjunction with batteries to reduce battery current variation during the discharging phase [4]. Furthermore, thanks to recent increases in the double layer capacitor (DLC) size, higher power applications have become a real possibility. Fixed storage systems based on these devices that are opportunely interfaced to the network could be used, for example, as network support to reduce load power peak demand [5,6].

However the potential of this technology is still partially unknown. To take advantage of the full potential of these devices, it is important to understand their electrical behaviour in advance. For this reason, it is necessary to develop an equivalent circuit element that is sufficiently easy to model and offers very accurate results.

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doi:10.1016/j.epsr.2009.10.024