Investigation of the supercapacitor mathematical model by means of LTspice IV

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Abstract – **In this paper the supercapacitor mathematical model was researched by means of the Linear Technology SPICE simulator.**

Keywords – **Supercapacitor mathematical model, equivalent circuit, analog circuit simulation, electrical parameters.**

I. INTRODUCTION

The supercapacitors are passive electrostatic energy storage device that are composed of complementary porous carbon electrodes immersed in an organic electrolyte and are capable of fast charge/discharge [1]. These advantageous properties of the supercapacitors make them suitable for use in many applications such as in hybrid-electric vehicles, military applications and telecommunications systems [2].

In high current drain applications, the supercapacitor will be subjected to a highly dynamic performance behavior which efficiency is of primary concern. It is important to be able to predict the dynamic behavior of the supercapacitor under various environmental constraints over short periods. In this paper we evaluate the performance of the supercapacitor during the impulse operation by means of the Linear Technology SPICE simulator (LTspice IV).

II. SUPERCAPACITOR SPICE MODEL

Ideally, the mathematical model for the supercapacitor should be based on its physical structure. In [3, 4], the authors presented the supercapacitor equivalent circuit that is based on the activated carbon electrode structure. The supercapacitor SPICE model is shown in Fig. 1 and simulated in the Linear Technology SPICE simulator (LTspice IV).

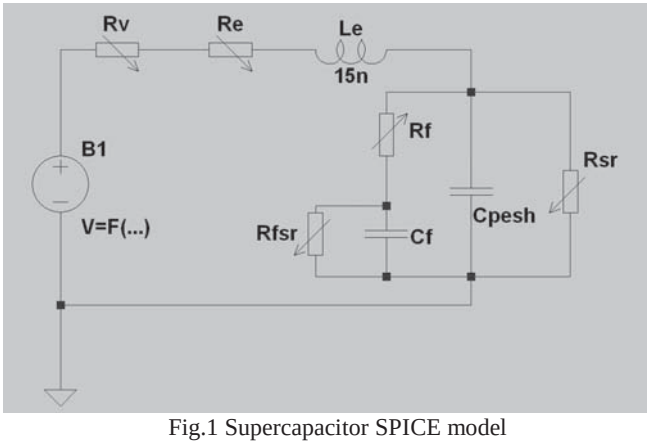

Fig.1 Supercapacitor SPICE model

The supercapacitor SPICE model consists of next elements: B1 is the voltage source; Rv is the voltage source equivalent resistance; Re is the active specific electrode resistance, Le is the active specific electrode inductance, Rf is the active specific electrolyte resistance, Cpesh is the specific capacitance of the large diameter pores (fast capacitance), Cf is the specific capacitance of the small diameter pores (slow capacitance), Rfsr is the active specific self discharge conductance of the small diameter pores (slow conductance) and Rsr is the active specific self discharge conductance of the large diameter pores (fast conductance).

By using of the direct pulse generator SPICE model with the supercapacitors the current impulses that pass through supercapacitors were obtained and shown in Fig. 2.

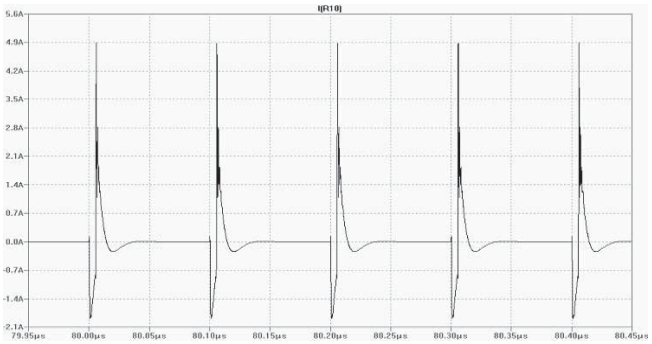

Fig.2 Current impulses in the direct pulse generator SPICE model

III. CONCLUSION

The performed supercapacitor simulation allows researching the supercapacitor current impulses for various operation modes. The simulation results are coincided with experimental results conducted by means of the special measurement system.

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