Study Of Active Voltage Balancing Circuits For Higher Voltage Supercapacitor Modules

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Abstract- *Series connected Supercapacitors (SC) having voltage imbalance causes ageing and deterioration in energy storage capability of SC cells, reduces its efficiency and cycle life. Individual SC cells are capable of withstanding only 1 to 3 V. In higher voltage SC modules for various applications, Voltage balancing is necessary to have better cycle life and efficiency. This paper presents various voltage balancing circuits used for voltage balancing, advantages of active balancing circuits over passive balancing circuits. Design of Buck boost converter circuit is discussed in detail; MATLAB simulation results from literature are discussed.*

Keywords: Supercapacitor, Active/passive Voltage balancing, Buck boost converter, MATLAB.

I. INTRODUCTION

Single SC can only withstand very low voltage, 1 to 3 volt maximum. For high voltage applications SC cells to be connected in series and parallel based on application. Balancing circuit is necessary to maintain constant voltage across individual cell to its rated voltage. SC manufacturing offers tolerance on capacitance, this leads to voltage unbalance at the time of charging and discharging. Unbalanced voltage within the module reduces its efficiency and overloading of low capacitance cell. This overloading leads to ageing of SC cell. Ageing results into fatal failure of SC module. Literature review is carried out to study the various voltage balancing circuits. Voltage balancing is nothing but dissipating the extra energy in the form of heat or exchanging the energy between mismatched SC cells.

Voltage balancing circuits are broadly classified as passive voltage balancing and active voltage balancing circuits. This classification is based on the components used within the balancing circuit. Passive balancing circuits remove extra charge from SC cell with help of passive elements i.e. resistor. This ensures balancing of voltage between the SC cells connected within module with respect to module voltage or reference set. Resistor may be fixed resistor and switched resistor based on the system requirement. Active voltage balancing methods extract charge form higher energy cell and supply it to lower energy cell. Various active balancing circuits are used based on the energy storage element used i.e. capacitor or inductive device and converter topologies used for switching.

Passive voltage balancing methods are loss making for the system. Active voltage balancing methods are efficient. In order to achieve higher system voltage with better efficiency and performance of SC modules, various active voltage balancing methods are proposed.

II. VOLTAGE BALANCING CIRCUITS FOR SC MODULE

Detail classification voltage balancing methods is shown in fig 2. Voltage balancing circuits are classified as passive voltage balancing and active voltage balancing. Passive balancing can be further classified as fixed resistor balancing and switched resistor balancing circuits. Active voltage balancing circuits are classified according to active element used such as inductor/transformer based, capacitor based and converter based active balancing circuits. [1-5].

A. Passive Voltage Balancing Circuit for SC module:

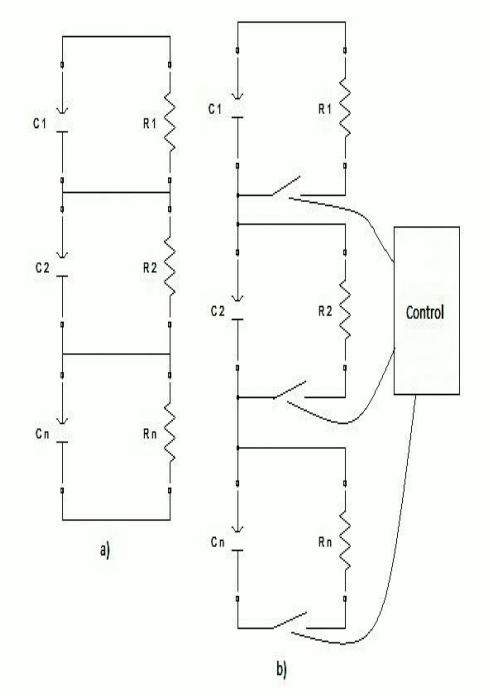

Fig.1: Passive Balancing Circuits [1] [3]