An Efficient Cell Balancing Strategy for Plug-in Hybrid Electric Vehicle

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Dedicated to

My Respectable Parents

AND

Sweet Siblings

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*In the name of **ALLAH**, Most Merciful, the most beneficent and the most gracious and countless salaam to **Holy Prophet Muhammad (Peace be Upon Him)**. Prior to anyone else, all gratitude and praises are due to the almighty **ALLAH**, who gave me health to achieve this goal.*

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Abstract

Cost and shortage of fuel oil is one of the major problems for the customers. Parallel Hybrid Electric Vehicle (PHEV) has ability to overcome these difficulties and minimize the fuel cost because such electric vehicles contain number of batteries that help to minimize the use of conventional fuel sources. The aim of the thesis is to introduce a battery cell balancing strategy that uses the battery in efficient way to maximize the drive of electric vehicle.

Battery management system (BMS) is an imperative feature for the al range of electrical vehicle and electrical energy storage system as it accomplish lot of features. Battery cell balancing hinders electric vehicle performance, due to the mismatch in the state of charge (SoC) difference among the cells. In many cases, such mismatch even leads to the failure of the whole battery pack. In order to avoid this disaster, many cell balancing strategies has been proposed such as resistive shuttling, capacitor shuttling, transformer/inductor based and converter based. Shuttling capacitor has many advantage over the resistive one due to its high efficiency and less energy dissipation while transferring charge from higher SoC cell to the lower SoC cell. However, after the certain SoC difference of the cells, this capacitor shuttling technique lot of time to eliminate this SoC difference which eventually increases the time to balance the battery pack. Keeping this problem in mind, a hybrid strategy is proposed in this thesis which uses two technique to work after one another. When the SoC difference goes higher than a certain number (4%), double tiered shuttling capacitor (DTSC) will be used to lower the difference till it reaches to the SoC difference of 4%. From here, the passive balancing (resistor shuttling) will take the control and remove the SoC difference using the resistor to dissipate extra energy in the form of heat. This lead to a new regulator strategy for balancing the SoC of the cells. In addition to this, such system is cost effective, less heat dissipation as compared to individual resistive shuttling method for large SoC difference. In this way, we can use the complete capacity of the battery pack.

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LIST OF ABBREVIATIONS

Ah	Ampere-hour
EV	Electric Vehicle
D.C.	Direct Current
A.C.	Alternating Current
T/F	Transformer
HEV	Hybrid Electric Vehicle
SOC	State of Charge
SSC	Single Switched Capacitor
ZVS	zero-voltage turn-off switching
FET	Field Effect Transistors
I.C.E	Individual Cell Equalizer
I.C.E	Internal Combustion Engine
BMS	Battery Management System
SMD	Surface Mount Device
PWM	Pulse Width Modulation
SPST	Single Pole Single Throw
SPDT	Single Pole Double Throw
Li-ion	Lithium ion
DTSC	Double Tiered Switched Capacitor
VRLA	Valve Regulated Lead Acid
HCBA	Hybrid Charge Balancing Algorithm
Ni-MH	Nickel Metal Hydride
PHEVs	Plug-in Hybrid Electric Vehicle
MATLAB	MATrix LABoratory
MOSFETs	Metal Oxide Field Effect Transistors

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