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



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Master of Sciences

In

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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.

LIST OF FIGURES

Fig. 1.1 Charge Mismatch & Capacity Mismatch	5
Fig. 1.2 Passive Cell Balancing	6
Fig. 2.1 Passive and Active Cell Balancing Topologies	13
Fig. 2.2 Different Net Current drawn by Cells	15
Fig. 2.3 Fixed Shunting Resistor Cell Balancing	16
Fig. 2.4 Switching Shunting Circuit Topology	18
Fig. 2.5 Single Switched Capacitor Cell Balancing Topology	19
Fig. 2.6 Switched Capacitor Cell Balancing Topology	20
Fig. 2.7 Double Tiered Cell Balancing Method	21
Fig. 2.8 Single Inductor Cell Balancing	22
Fig. 2.9 Multi Inductor Battery Balancing Method	23
Fig. 2.10 Single Winding T/F Balancing Method	24
Fig. 2.11 Multi Winding Transformer Cell Balancing Topology	25
Fig. 2.12 Cuk Converter Cell Balancing	25
Fig. 2.13 Buck-Boost Energy Converter Cell Balancing Topology	26
Fig. 2.14 Fly-Back Converter Cell Balancing Topology	27
Fig. 3.1 SoC vs OCV for VRLA batteries	33
Fig. 3.2 Generic Battery Model Implementation in MATLAB	34
Fig. 3.3 Two R-C Equivalent Model of Lithium ion Cell	35
Fig. 3.4 Charging and Discharging Waveform of Lithium ion Battery	36
Fig. 3.5 Discharge Characteristics of Battery	38
Fig. 3.6 Discharge Characteristics Curve for Three Different Currents	38
Fig. 3.7 Simulink Model of Battery Discharge	40
Fig. 3.8 Step input to the Load	40
Fig. 3.9 Response of SoC and Terminal Voltage for Step input to Load	41
Fig. 3.10 Behavior of SoC and Terminal Voltage with Load	41
Fig. 4.1 Double Tiered Capacitive Shuttling Method	46
Fig. 4.2 Flow Chart of Active Balancing (Double Tiered Capacitor)	47
Fig. 4.3 Simulink Model of Double Tiered Capacitive Shuttling Method	48

Fig. 4.4 Flow Chart of Passive Balancing (Resistor Shuttling Topology)	52
Fig. 4.5 Simulink Model of Resistive Shuttling Method	53
Fig. 4.6 Flow Chart of Hybrid Charge Balancing Algorithm (HCBA)	55
Fig. 4.7 Hybrid Charge Equalization Topology	56
Fig. 5.1 Active Balancing	59
Fig. 5.2 Passive Balancing	59
Fig. 5.3 Hybrid Charge Balancing Topology	60
Fig. 5.4 Cell Terminal Voltage and Current	62
Fig. 5.5 Energy Dissipation in HCB Topology	60

LIST OF TABLES

Table 2.1	27
Table 3.1	39

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

TABLE OF CONTENTS

1. Introduction	1
1.1. Introduction	3
1.2. Background to Problem	5
1.2.1. Purpose of Study	6
1.2.2. Importance of Study	7
1.3. Problem Statement	8
1.3.1. Research Questions	8
1.4. Scope of Study	8
1.5. Assumptions	8
1.6. Limitations	9
1.7. Thesis Structure	9
2. Literature Survey	10
2.1. Passive Balancing	16
2.1.1. Fixed Shunting Resistor	16
2.1.2. Switching Shunting Resistor	16
2.2. Active Balancing	18
2.2.1. Capacitor Based	18
2.2.1.1. Switched Capacitor	18
2.2.1.2. Single Switched Capacitor	20
2.2.1.3. Double-Tiered Switched Capacitor	21
2.2.2. Inductor/Transformer Based	22
2.2.2.1. Single/Multi Winding Inductor	22
2.2.2.2. Single Windings Transformer	23
2.2.2.3. Multi/Multiple Winding Transformer	24
2.2.3. Converter Based	25
2.2.3.1. C \hat{u} k Converter	25

2.2.3.2	Buck-Boost Energy Converter	26
2.2.3.3	Fly-Back Converter	26
2.3	Summary	27
3.	BATTERY PACK CHARACTERISTICS	29
3.1.	Batter Package	31
3.1.1.	Lithium-ion Batteries	31
3.1.2.	Nickel Metal Hydride Batteries (NiMH)	32
3.1.3.	Valve Regulated Lead Acid (VRLA) Batteries	33
3.2.	Single Lithium-ion Battery Model	33
3.2.1.	Equivalent Circuit Model of Lithium ion Cell	33
3.2.2.	Two Time Constant Model of Lithium ion Cell	35
3.2.3.	Estimation of Parameters	36
3.3.	Discharge Curve of Battery	37
3.3.1.	Current Profile and SoC Response	39
4.	Hybrid Charge Equalization Algorithm	42
4.1.	Active Balancing	44
4.1.1.	Double Tiered Capacitive Shuttling Method	45
4.2.	Passive Balancing	50
4.2.1.	Resistive Shuttling Method	50
4.3.	Hybrid Charge Balancing Algorithm	54
5.	Results	57
6.	References	65
