

Contents

Abstract.....	v
Acknowledgement	ix
List of Figures	xiii
List of Table.....	xix
List of Acronyms	xxi
Symbols Used	xxiii
Chapter 1. Introduction	1
1.1 Background.....	1
1.2 Motivation.....	3
1.3 Literature Survey.....	5
1.3.1 Standard On-Board Charger with Minimum Number of Switch Count	5
1.3.2 Integrated Chargers for Both Motoring and Charging.....	8
1.3.3 Wireless Battery Charger	10
1.3.4 Reconfigurable Power Processor with Wired and Wireless Charging	15
1.4 Challenges with the Existing System.....	17
1.5 Objective of the Thesis	19
1.6 Organization of the Thesis	20
Chapter 2. Standard Two-Stage On-board EV Charger with Minimum Switch Count.....	23
2.1 Introduction.....	23
2.2 The Proposed Two-stage EV charger	24
2.3 Operation and Analysis of the Proposed EV Charger.....	25
2.3.1 Operation of AC-DC Boost Converter.....	25
2.3.2 Operation of Half-Bridge LLC Resonant Converter.....	28
2.4 Single Controlled PWM Technique (SCPT).....	30
2.4.1 Background of SCPT	30

2.4.2	Implementation of SCPT	32
2.5	Verification	36
2.5.1	Proposed charger with resistive load	38
2.5.2	Proposed charger for charging 24 V, 30 Ah lead acid battery	40
2.5.3	Efficiency Analysis	44
2.6	Conclusion	45
Chapter 3.	A Reconfigurable On-Board Power Converter for Electric Vehicles	47
3.1	Introduction	47
3.2	Derivation of the Topology	50
3.3	Modes of Operation	53
3.3.1	Propulsion Mode	53
3.3.2	Charging Mode	54
3.4	Control and Design Analysis	56
3.4.1	Control Scheme for Propulsion Model	56
3.4.2	Control Scheme for Charging Mode	57
3.5	Experimental Validation	63
3.5.1	Experimental validation	66
3.5.2	Impact of Reconfiguration	74
3.6	Conclusion	76
Chapter 4.	Single Phase Wireless Electric Vehicle Charger Using EF ₂ Inverter	79
4.1	Introduction	79
4.2	Proposed Wireless EV Charger	81
4.3	Operation and Design of Proposed Wireless EV Charger	82
4.3.1	Stage I: AC-DC Boost Converter	82
4.3.2	Stage II: High Frequency EF ₂ Inverter	82
4.3.3	Stage III: Wireless Power Transfer Scheme	83
4.3.4	Stage IV: Rectifier Unit	83

4.4	Mathematical Analysis of EF ₂ Inverter.....	83
4.4.1	During $0 \leq \omega t \leq 2\pi D$ (Sinv is ON).....	83
4.4.2	During $2\pi D \leq \omega t \leq 2\pi$ (Sinv is OFF).....	85
4.4.3	ZVS and ZVDS and Boundary Conditions.....	88
4.5	Control Scheme for the Proposed Wireless EV Charger	91
4.5.1	CC Mode.....	92
4.5.2	CV Mode.....	92
4.6	Experimental Verification.....	94
4.6.1	Operation of EF ₂ Inverter.....	100
4.6.2	Proposed Charger with Resistive load	100
4.6.3	Charging a 12 V Lead Acid Battery.....	102
4.6.4	Charging a 24 V Lead Acid Battery.....	104
4.7	Conclusion	110
Chapter 5. Reconfigurable On-board Power Processor with Wired and Wireless Charging for Electric Vehicle.....		
5.1	Introduction.....	111
5.2	Derivation of the Topology.....	112
5.2.1	Derivation of Wired Charger	114
5.2.2	Derivation of Wireless Receiver	114
5.3	Operation and Control of the Proposed RPP in Different Modes.....	115
5.3.1	Propulsion Mode	115
5.3.2	Wired Charging Mode	117
5.3.3	Wireless Charging Mode	121
5.4	Realization of a Four-Point Contactor	123
5.5	Experimental Verification.....	124
5.5.1	Validation of Propulsion Mode.....	125
5.5.2	Validation of Wired Charging Mode	126

5.5.3	Validation of Wireless Charging Mode	131
5.6	Merit Indices	135
5.6.1	Component Utilization Factor.....	135
5.6.2	Savings in Cost.....	136
5.7	Conclusion	137
Chapter6.	Conclusion and Scope of Future Work	139
6.1	Introduction.....	139
6.2	Conclusion	139
6.3	Scope of Future Work.....	142
Bibliography	143
List of Publications	155