

Contents

Abstract	v
List of Tables	xiii
List of Figures	xv
Nomenclature	xxiii
1 Introduction	1
1.1 DC/DC converters	4
1.1.1 Switched inductor/Voltage Lift	6
1.1.2 Voltage multiplier	7
1.1.3 Switched capacitor	8
1.1.4 Magnetic coupling	9
1.1.5 Multistage/-Level	10
1.2 DC/AC converters	11
1.3 Hybrid converters	15
1.4 Motivation	17
1.5 Structure of the thesis	18
2 An Ultra High Gain DC-DC Converter	21
2.1 Introduction	21
2.2 Proposed topology	22
2.2.1 Mode 1, $t_0 < t < t_1$	25
2.2.2 Mode 2, $t_1 < t < t_2$	26
2.3 Design guidelines	28
2.3.1 Inductor design	28

2.3.2	Capacitor design	29
2.3.3	Voltage stress across semiconductor devices	30
2.4	Comparison with non isolated converters	30
2.5	Experiment results	32
2.6	Conclusion	35
3	Modified Switched Boost Inverter For wide Duty Cycle Operation	37
3.1	Introduction	37
3.2	Operation of the SBI and its limitation	38
3.2.1	Operation	38
3.2.2	Steady state analysis	40
3.2.3	Inductor ripple current calculation:	41
3.2.4	Design of capacitor	42
3.2.5	Design of inductor	43
3.3	Proposed converter and its Operation	48
3.3.1	Modified active state 2	49
3.4	PWM control pulses of proposed converter	50
3.5	Comparative analysis between SBI and PSBI	51
3.5.1	Inductor design	51
3.5.2	Efficiency analysis	52
3.5.3	Comparison of passive components and voltage stress analysis	55
3.6	Simulation and experimental results	57
3.6.1	Continuous mode analysis	60
3.6.2	Redemption of NZ-DCM with FCCM	60
3.7	Conclusion	65
4	Quasi Mutually Coupled Active Impedance Source Converter	67
4.1	Introduction	67
4.2	Working principle of proposed converter	69
4.3	Operation and steady state analysis of the converter	70
4.4	Experimental study	74
4.4.1	Dynamic response analysis	76
4.5	Conclusion	78

5	Generalized Switched Inductor Cell Multilevel Converter	81
5.1	Introduction	81
5.2	Revisiting Z-Source converter and motivation	83
5.3	Topology and operation of proposed converter	83
5.3.1	Topology introduction	83
5.3.2	Operation	84
5.4	Steady state analysis of SL-MLI	87
5.4.1	Boosting under CCM	88
5.4.2	Boosting under DCM	89
5.5	Control of proposed converter	91
5.6	Simulation results	91
5.7	Conclusion	93
6	Modified Boost Derived Hybrid Converter	95
6.1	Introduction	95
6.2	BDHC: Operating modes and limitation	97
6.2.1	Operation	97
6.2.2	Steady state analysis	99
6.3	Modified BDHC and its control	102
6.4	Comparative efficiency analysis	103
6.4.1	Cascaded boost inverter	104
6.4.2	BDHC	105
6.4.3	MBDHC	105
6.5	Design of passive component and stress analysis	106
6.5.1	Selection of inductor for boost stage	106
6.5.2	Selection of capacitor for boost stage	109
6.5.3	Switch stress analysis	109
6.6	Experimental results	111
6.6.1	Simultaneous AC and DC load in CCM	112
6.6.2	Simultaneous AC and DC load in NZ-DCM	112
6.6.3	Modified BDHC for simultaneous AC and DC voltage in FCCM	114
6.6.4	AC standalone operation	116

6.6.5	DC standalone operation	117
6.6.6	Experimental efficiency	117
6.7	Conclusion	119
7	Hybrid L-Z Source Inverter: CCM, NZ-DCM and DCM	121
7.1	Introduction	121
7.2	Circuit diagram and operation	122
7.2.1	Circuit diagram	122
7.2.2	Operation	122
7.3	Improved analysis of HLZSI/MHLZSI	124
7.3.1	Steady state analysis	125
7.3.2	Boundary condition for NZ-DCM	126
7.3.3	Capacitor voltage during NZ-DCM	128
7.3.4	Generalized principle for achieving high voltage during DCM	128
7.4	PWM control pulses of proposed converter	131
7.5	Design guidelines	134
7.5.1	Inductor selection	134
7.5.2	Capacitor selection	135
7.5.3	Switch stress analysis	135
7.6	State space modelling	135
7.6.1	Modelling for DC bus voltage	136
7.6.2	AC voltage controller	142
7.7	Closed loop of hybrid LZSI	144
7.8	Simulation and experimental results	146
7.8.1	CCM	148
7.8.2	NZ-DCM	149
7.8.3	Forced continuous current mode(FCCM)	150
7.8.4	DCM	151
7.8.5	Closed loop analysis	154
7.8.6	Efficiency	158
7.9	Conclusion	158

8	Non-Zero DCM in Buck-Boost Derived Hybrid Converter	161
8.1	Introduction	161
8.2	Evolution of MBBDHC	162
8.2.1	Operation of MBBDHC	163
8.2.2	Steady state analysis	165
8.3	Condition for NZ-DCM and effects	168
8.4	NZ-DCM mitigation: Modified BBDHC	170
8.5	Design of MBBDHC controller	171
8.5.1	DC voltage controller	171
8.5.2	AC voltage controller	173
8.6	Control of proposed converter	175
8.7	Design of passive component, stress analysis and comparison among different topology	175
8.7.1	Selection of inductor for Buck-Boost stage	176
8.7.2	Selection of capacitor for Buck-Boost stage	176
8.7.3	Switch stress analysis	176
8.7.4	Comparison among different topology	178
8.8	Result analysis	180
8.8.1	Open loop analysis	181
8.8.2	Closed loop analysis	185
8.9	Conclusion	188
9	Conclusion and Future Work	189
9.1	Conclusion	189
9.2	Future work	192
A	List of Publications	195
A.1	Journal papers	195
A.2	Conference papers	196