List of Figures

Figure	Caption	Page No.
1.1	Schematic of a two-stage AC residential distribution system	3
1.2	A conventional boost DC-DC converter	3
1.3	A cascaded boost DC-DC converter consisting of two CBCs	4
1.4	A step-up DC-DC converter using a VM cell	5
1.5	An SL based step-up DC-DC boost converter	5
1.6	An SC based step-up DC-DC converter	6
1.7	A two-phase interleaved boost converter	6
1.8	A flyback DC-DC converter	7
1.9	A Z-source DC-DC converter	7
1.10	A single-phase VSI	9
1.11	A single-phase CSI	9
1.12	Schematic of a single-stage AC residential distribution system	10
1.13	A single-phase Z-source inverter (ZSI)	11
1.14	A single-phase quasi-Z-source inverter (qZSI)	11
1.15	A single-phase SL based ZSI	13
1.16	A single-phase SL based SL-qZSI	13
1.17	A single-phase ripple input current SL-qZSI (rSL-qZSI)	14
1.18	A single-phase continuous input current SL-qZSI (cSL-qZSI)	14
1.19	Schematic a hybrid AC/DC system for supplying AC and DC loads using separate power converters	15
1.20	Hybrid AC/DC system using separate PECs for supplying AC and DC loads	16
1.21	Schematic of a hybrid AC/DC system for supplying AC and DC loads using a hybrid power converter	16
1.22	A single-phase switched boost inverter	17
1.23	A single-phase boost-derived hybrid converter	17
1.24	A single-phase single-switch quadratic boost derived hybrid converter	18
1.25	A single-phase current fed source inverter	18

1.26	A single-phase transformerless hybrid converter for simultaneous AC and DC outputs at reduced leakage current	19
2.1	A two-switch high gain DC-DC converter (TSHGC)	24
2.2	Operating waveforms of TSHGC	24
2.3	Equivalent circuits of TSHGC	25
2.4	Normalized maximum current and voltage stresses on the elements of TSHGC with respect to D	27
2.5	Variation in voltage gain of TSHGC with respect to D in comparison to some reported high gain DC-DC converters	30
2.6	Normalized total voltage stress on the elements (C, $Di.$, and $Sw.$) of TSHGC and some reported high gain DC-DC converters with respect to D	32
2.7	Simulation results of TSHGC	34
2.8	A photograph of the experimental set-up of TSHGC	35
2.9	Experimental results of TSHGC	36
2.10	Power loss distribution among the elements and variation in efficiency of TSHGC	39
3.1	A high gain interleaved boost converter (HGIBC)	42
3.2	Operating waveforms of HGIBC in the operating region 1 ($0 \leq D \leq 0.5$)	43
3.3	Equivalent circuits of HGIBC at different switching states	44
3.4	Operating waveforms of HGIBC in the operating region 2 ($0.5 \leq D \leq 1$)	46
3.5	Operating waveforms of HGIBC in the operating region 3 ($0 \leq D \leq 1$)	47
3.6	Normalized maximum current and voltage stresses on the elements of HGIBC in the operating region 1 ($0 \leq D \leq 0.5$)	48
3.7	Normalized maximum current and voltage stresses on the elements of HGIBC in the operating region 2 ($0.5 \leq D \leq 1$)	50
3.8	Normalized maximum current and voltage stresses on the elements of HGIBC in the operating region 3 ($0 \leq D \leq 1$)	50
3.9	Voltage gain variation of HGIBC with respect to D in comparison to some reported high gain DC-DC converters	53

3.10	Normalized total maximum voltage stress on the elements ($Sw.$, $Di.$, and C) of HGIBC and some reported converters with respect to D	57
3.11	Simulation results of HGIBC at $D = 0.4$ in the operating region 1 ($0 \leq D \leq 0.5$)	59
3.12	Simulation results of HGIBC at $D = 0.6$ in the operating region 2 ($0.5 \leq D \leq 1$)	60
3.13	Simulation results of HGIBC at $D = 0.3$ in the operating region 3 ($0 \leq D \leq 1$)	61
3.14	A photograph of the experimental set-up of HGIBC	62
3.15	Experimental results of HGIBC at $D = 0.4$ in the operation region 1 ($0 \leq D \leq 0.5$)	63
3.16	Experimental results of HGIBC at $D = 0.6$ in the operating region 2 ($0.5 \leq D \leq 1$)	64
3.17	Experimental results of HGIBC at $D = 0.3$ in the operating region 3 ($0 \leq D \leq 1$)	65
3.18	Power loss distribution among the elements and variation in efficiency of HGIBC in the three operating regions	68
4.1	A single-phase Type 1 SLC-ZSI	72
4.2	Simplified circuit of Type 1 SLC-ZSI for analysing its operation	72
4.3	Operating waveforms of Type 1 SLC-ZSI	73
4.4	Equivalent circuits of Type 1 SLC-ZSI	75
4.5	Graphical representation of the correlation among G, D_{st} and M of Type 1 SLC-ZSI	77
4.6	Normalized maximum current and voltage stresses on the elements of Type 1 SLC-ZSI	78
4.7	A single-phase Type 2 SLC-ZSI	80
4.8	Simplified circuit of Type 2 SLC-ZSI for analysing its operation	80
4.9	Operating waveforms of Type 2 SLC-ZSI	81
4.10	Equivalent circuits of Type 2 SLC-ZSI	83
4.11	Graphical representation of the correlation among G, D_{st} and M of Type 2 SLC-ZSI	85

4.12	Normalized maximum current and voltage stresses on the elements of Type 2 SLC-ZSI	86
4.13	Modified unipolar SPWM technique of proposed single-phase SLC-ZSIs	89
4.14	Boosting ability and voltage gain of proposed SLC-ZSIs as compared to reported ZSIs	91
4.15	Maximum total voltage and current stresses on the elements of proposed SLC-ZSIs and some reported SL based ZSIs	94
4.16	Simulation results of Type 1 SLC-ZSI at $D_{st} = 0.2$ and $M = 0.8$ for R and RL loads	96
4.17	Simulation results of Type 2 SLC-ZSI at $D_{st} = 0.2$ and $M = 0.8$ for R and RL loads	98
4.18	A photograph of the experimental set-up of proposed SLC-ZSIs	99
4.19	Experimental gating signals of proposed SLC-ZSIs at $D_{st} = 0.2$ and $M = 0.8$	99
4.20	Experimental results of Type 1 SLC-ZSI at $D_{st} = 0.2$ and $M =$ 0.8 for R and RL loads	100
4.21	Experimental results of Type 2 SLC-ZSI at $D_{st} = 0.2$ and $M =$ 0.8 for R and RL loads	102
4.22	Power loss distribution among the elements of proposed SLC-ZSIs	108
4.23	Variation in efficiency of proposed SLC-ZSIs at different loading conditions	109
5.1	A single-phase enhanced high gain SLC-ZSI	112
5.2	Operating waveforms of eSLC-ZSI	112
5.3	Simplified circuit of eSLC-ZSI for investigating its operation	113
5.4	Equivalent circuits of eSLC-ZSI	114
5.5	Graphical representation of the correlation among G, D_{st} and M of eSLC-ZSI	117
5.6	Normalized maximum voltage stresses on the elements of eSLC-ZSI	118
5.7	Modified unipolar SPWM technique of eSLC-ZSI	121

5.8	Boosting ability and voltage gain of eSLC-ZSI in comparison to some reported high gain ZSIs	122
5.9	Comparison between eSLC-ZSI and reported ZSIs in terms of volume of energy storage elements	122
5.10	Comparison between eSLC-ZSI and reported ZSIs in terms voltage and current stresses on the elements	127
5.11	Variation of input current ripple factor, $rf_{in} = \frac{L\,\Delta i}{V_{inv}T_s}$ with respect to D_{st}	128
5.12	Variation of capacitor voltage ripple factor, $rf_C = \frac{C\,\Delta v}{i_{dc}T_s}$ with respect to D_{st}	129
5.13	Simulation results of eSLC-ZSI at $D_{st} = 0.2$ and $M = 0.78$	131
5.14	A photograph of the experimental set-up of eSLC-ZSI	132
5.15	Experimental results of eSLC-ZSI at $D_{st} = 0.2$ and $M = 0.78$	133
5.16	Experimental results of the eSLC-ZSI at $D_{st} = 0.2$ and $M = 0.78$	134
5.17	Power loss distribution among the elements and variation in efficiency of eSLC-ZSI	139
6.1	An interleaved hybrid converter for AC and DC outputs	142
6.2	Equivalent circuits of IHC	143
6.3	Operating waveforms of IHC during mode 1 operation	144
6.4	Equivalent circuits of IHC when S_a is ON and S_b is OFF	146
6.5	Equivalent circuits of IHC when both S_a and S_b are OFF	147
6.6	Equivalent circuit of IHC when S_a is OFF and S_b is ON	148
6.7	Operating waveforms of IHC during mode 2 operation	149
6.8	Operating waveforms of IHC during mode 3 operation	150
6.9	Equivalent circuit of IHC when both S_a and S_b are ON	150
6.10	Analog representation of shoot-through SPWM switching logic of IHC	154
6.11	Simulation results of IHC during mode 1 operation	156
6.12	Simulation results of IHC during mode 2 operation	157
6.13	Simulation results of IHC during mode 3 operation	159
6.14	A photograph of the experimental set-up of IHC	160
6.15	Experimental results of IHC during mode 1 operation	161

6.16	Experimental results of IHC during mode 1 operation consisting of voltage and current stresses on the elements	162
6.17	Experimental results of IHC during mode 2 operation	163
6.18	Experimental results of IHC during mode 2 operation consisting of voltage and current stresses on the elements	164
6.19	Experimental results of IHC during mode 3 operation	165
6.20	Experimental results of IHC during mode 3 operation consisting of voltage and current stresses on the elements	166
6.21	Power loss distribution among the elements and variation in efficiency of IHC as compared to BDHC and CFSI	167
6.22	Verification of IHC for practical ratings of Hybrid AC/DC Microgrid	167
A.1	Single-phase modified Type 1 SLC-ZSI	186
A.2	Equivalent circuits of modified Type 1 SLC-ZSI	187
A.3	Gating pulses of modified Type 1 SLC-ZSI	189
A.4	Experimental results of modified Type 1 SLC-ZSI	190
B.1	Extendable single-phase Type 1 SLC-ZSI	191
B.2	Boosting ability of extendable Type 1 SLC-ZSI, B versus D_{st}	192