

Contents

1	Introduction	1
1.1	EMI and EMC	1
1.2	EMC Standards	4
1.3	Conventional EMI Suppression Techniques	5
1.3.1	EMI Filtering	5
1.3.2	Electromagnetic Shielding	6
1.3.3	Soft Switching	6
1.3.4	Random Modulation	6
1.4	Motivation	8
1.5	About this Dissertation	8
2	Chaos Control of EMI	10
2.1	Chaos in DC-DC Converters	10
2.1.1	System Description	10
2.1.2	Experimental Observations	11
2.1.3	Chaos Control	11
2.2	Approaches of Chaos Control for EMI Suppression	13
2.2.1	Chaos Control via Parameter Modulation	13
2.2.2	Chaotic PWM Control	19
2.3	Summary	19
3	Chaotic Peak Current Mode Boost Converters	20
3.1	Introduction	20
3.2	Chaotic Current Mode Boost Converter Model	21
3.3	Characteristics of the Chaotic Mapping	24
3.3.1	Spectrum Analysis	24
3.3.2	Bifurcation and Lyapunov Exponents	24
3.3.3	EMC Performance	27
3.4	Experimental Verification	28
3.5	Summary	30
4	Chaotic Pulse Width Modulation	33
4.1	Introduction	33
4.2	Design Considerations	34
4.3	CPWM with Varying Carrier Frequencies	34
4.3.1	Simulations	35
4.3.2	Experiments	36
4.4	CPWM with Varying Carrier Amplitudes	37
4.4.1	Simulations	38
4.4.2	Experiments	41
4.5	Summary	41

5 Analogue Chaotic PWM	43
5.1 Introduction	43
5.2 Analogue Chaotic Carrier	44
5.2.1 Circuit Design	44
5.2.2 Chaotic Oscillator	45
5.3 Analogue Chaotic PWM	47
5.3.1 A Boost Converter	47
5.3.2 Simulations	48
5.4 Experiments	48
5.4.1 Chua's Diode	51
5.4.2 Experimental Results	51
5.5 Summary	55
6 A Chaotic Soft Switching PWM Boost Converter	56
6.1 Introduction	56
6.2 Circuitry and Control	57
6.2.1 Circuit Description	57
6.2.2 Chaotic Soft Switching PWM Control	60
6.3 Simulations and Performance Evaluation	62
6.4 Summary	65
7 Invariant Densities of Chaotic Mappings	66
7.1 Introduction	66
7.2 1-D Mapping for a Boost Converter	67
7.3 Invariant Density of a Chaotic Mapping	68
7.4 Eigenvector Method	68
7.5 Invariant Density of the Boost Converter's Chaotic Mapping	69
7.6 Examples of Applying Invariant Densities	70
7.6.1 Power Spectral Density of a DC-DC Converter's Input Current	70
7.6.2 Average Switching Frequency	73
7.6.3 Parameter Design with Invariant Density	74
7.7 Summary	75
8 Stability of a Chaotic PWM Boost Converter	76
8.1 Introduction	76
8.2 Chaotic PWM Boost Converters	77
8.3 Estimation of the Mean State Variables	77
8.4 Ripple Estimation of the Input Current	80
8.5 Stability	82
8.5.1 Two Operation Modes of the Boost Converter	82
8.5.2 Stability	83
8.6 Summary	84
9 Chaotic Spectra Analysis Using the Prony Method	85
9.1 Introduction	85
9.2 Prony Method	86
9.3 Deriving the Power Spectral Density	87
9.4 Chaotic Spectral Estimation of DC-DC Converters	89
9.5 Summary	92
10 Conclusion	93
References	96