

Contents

Certificate	i
Declaration by the Candidate	ii
Copyright Transfer Certificate	iii
Acknowledgement	v
Preface	vii
Contents	ix
List of Figures	xv
List of Tables	xxii
List of abbreviations	xxiv
List of symbols	xxvi
Chapter 1: Introduction	1
1.1. Motivation.....	1
1.1.1. SSPS as base-load power plants	4
1.2. Literature review	7
1.2.1. SSPS research worldwide.....	7
1.2.2. Literature Survey of Rectenna.....	10
1.3. Thesis outline	15

Chapter 2: SSPS concept and features.....19

2.1. Introduction	19
2.1.1. Basic Concept.....	19
2.1.2. Green energy source	20
2.1.3. Comparison with terrestrial	21
2.2. SSPS Key Technology	23
2.2.1. Space-based photovoltaic conversion.....	23
2.2.2. DC- microwave.....	25
2.2.3. Launch and transportation	26
2.3. Wireless power transfer via microwave	27
2.3.1. High power transmission for large distance	28
2.4. SSPS Microwave Power Transmission Effects on the Atmosphere and Space...32	
2.5. SSPS cost minimization method	34
2.5.1. SSPS estimated economic modeling	34
2.5.2. Derivation for cost minimization.....	37
2.5.3. SSPS prototype estimated cost	38

2.5.4. Levelized cost of Energy (LCOE) estimation	39
2.5.5. Least cost per kW derivation.....	40
2.6. Summary.....	41
Chapter 3: Design and analysis of rectenna	43
3.1. Introduction.....	43
3.2. Rectenna operation	44
3.2.1. Equivalent circuit model of a rectenna system.....	46
3.2.2. Antenna matched to the rectifier	48
3.2.3. Maximizing the output voltage.....	50
3.3. Schottky diode	51
3.3.1. Schottky Diode Equivalent Circuit Model	51
3.4. Rectenna element design	55
3.4.1. Circularly polarized truncated patch antenna	56
3.4.2. Rectifier circuit and impedance matching.....	59
3.4.3. Rectenna Measurement	61
3.5. Summary.....	62
Chapter 4: Design of differential source fed circularly polarized rectenna with embedded slots for harmonics suppression.....	65

4.1. Introduction	65
4.2. Antenna design	67
4.2.1. Circular polarization	68
4.2.2. Harmonics blocking.....	69
4.3. Parametric study.....	71
4.3.1. Effect of isosceles right triangle projection	72
4.3.2. Effect of the radial slot	73
4.3.3. Effect of slot gap.....	73
4.3.4. Results and Discussion	74
4.4. RF-DC conversion.....	76
4.4.1. SSFR.....	76
4.4.2. Proposed DSFR	78
4.4.3. Experimental results	84
4.5. Summary	87
Chapter 5: Design of an improved differentially fed antenna array for RF energy harvesting	89
5.1. Introduction	89

5.2. Differentially fed antenna design	91
5.3. Results and discussion	94
5.4. RF energy harvesting	96
5.4.1. Rectifier design.....	97
5.5. Experimental results	100
5.6. Summary	103

Chapter 6: High-efficiency harmonic harvester rectenna for energy storage application **105**

6.1. Introduction.....	105
6.2. Requirement of Harmonics harvester Rectenna	106
6.3. Harmonic harvester rectenna	108
6.4. Harmonic harvester rectenna power management circuit for battery charging .	109
6.4.1. Circuit topology.....	111
6.4.2. Buck-Boost converter switching (DCM mode) and analysis	111
6.5. Hardware fabrication	114
6.6. Summary	118

Chapter 7: Conclusion and Future Scope..... **119**

7.1. Conclusion.....	119
7.2. Future scope	121
References	123
List of publications	135