



AIN SHAMS UNIVERSITY
FACULTY OF ENGINEERING
Electronics Engineering and Electrical Communications

Large Scale Multiple Antenna System

A Thesis submitted in partial fulfillment of the requirements of
Doctor of Philosophy
(Electrical Engineering)

by

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Master of Science

(Electrical Engineering)

Faculty of Engineering, AASTMT Cairo Branch, 2013

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Cairo, June 2019



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Statement

This thesis is submitted as a partial fulfillment of Doctor of Philosophy in Electrical Engineering, Faculty of Engineering, Ain shams University. The author carried out the work included in this thesis, and no part of it has been submitted for a degree or a qualification at any other scientific entity.

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and Radar applications**

Abstract

Faculty of Engineering – Ain Shams University
Electronics and Communication Engineering Department

Thesis title: **“Large Scale Multiple Antenna System”** Submitted by: **Mohamed Fathy Mohamed Abo Sree Ali**

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Providing inexpensive high data rate access presents many challenges to satisfy the ever-increasing capacity demand and quality of service. Large-Scale Antenna Systems has a potential to realize cost effective high data rate access solution to User terminals.

Various designs of antennas operating at different frequency ranges are proposed, and studied to serve a large scope of applications including the 4G, Radar and other potential applications. A study of the evolution of the modern mobile technology will take place, starting with the 1st generation of mobile communication and going on through with the Second, third and fourth generation of mobile technology, reaching the new and futuristic technology of the 5th Generation. Also, studying the metamaterials, their classifications, the approached designs, the various applications and their advantages will take place. Besides that, the different feeding techniques of the microstrip is discussed.

The design, implementation and analysis of a Patch antenna with Different Fractal Shapes is proposed. Where a conventional patch antenna having a rectangular shape, and with dimension of 9.2 mm x 6.94 mm is fabricated. It is implemented on a FR-4 lossy substrate material with relative permittivity $\epsilon_r = 4.3$, thickness of 1.6 mm and loss tangent of 0.025. It is fed using a microstrip line excitation technique with dimension of 6 mm x 3.11 mm. It operates over a frequency band from 8 GHz to 12 GHz with central frequency 10 GHz. The performance properties of the antenna such as resonant frequency, radiation pattern, and gain were examined by simulation. The design is implemented through CST microwave studio and measured through network analyzer.

In Addition, a design and fabrication of ultra-wideband leaky wave metamaterial antennas are suggested and reviewed. The design, analysis and fabrication of

conventional and Metamaterial leaky wave antennas and the effects of utilizing composite right/left handed structure on bandwidth, gain and beam steering are reflected. The antennas are simulated using the CST microwave studio, fabricated on Roger 5880 and measured using the network analyzer. There is a good agreement between the measured and simulated results, showing that the antenna could be used for radar applications and broadband wireless communications. A large bandwidth was attained. Thus, broadband leaky wave antennas are very attractive and useful for radar systems and future broadband wireless communications.

Moreover, an ultra-wideband microstrip antenna for 4G applications is presented. The antenna consists of dual elements, with a total size of 58 mm X24 mm. A decoupling circuit is added to the design; afterwards the spacing between the elements is adjusted.

An element covers the range between 3.29 and 6.9 GHz, while the other covers the frequency range from 8.76 GHz to 13.27 GHz using defective ground. A total bandwidth of approximately 8.2 GHz was achievable and the minimum value of the return loss measured was around the -18 dB. The antenna's structure and the parametric study, including the reflection coefficients, gain, coupling and decoupling, will be discussed further in this work.

Finally, an inverted-F antenna is discussed to be implemented in the Radar application operating at the millimeter wave range. The design and analysis of the antenna is done using the CST software to study its parameters. Also, a scaled version of it is proposed in order to implement at lower frequencies, and measure it through the network analyzer. The feeding of the simulated Inverted-F antenna is done using a coaxial cable, while the antenna is executed on a Rogers 5880 Substrate, with height 0.381.

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Contents

Abstract	xii
Contents	xiv
List of Figures	xviii
List of Tables	xxii
Abbreviations	xxiii
Symbols	xxv
1 Introduction	1
1.1 Introduction	1
1.2 Objective	1
1.3 Problem statement	2
1.4 Thesis Organization	2
2 Evolution of Generations, Feeding Techniques of Microstrip and Meta-material structure	3
2.1 Introduction on Evolution	3
2.1.1 1G technology	3
2.1.1.1 Public switched telephone network	4
2.1.1.2 Features of 1G	4
2.1.1.3 Standards	4
2.1.1.4 Disadvantages	5
2.1.2 2G technology	6
2.1.2.1 Standards	6
2.1.2.2 GSM	7
2.1.2.3 CDMA IS-95	8
2.1.2.4 General packet radio service	8
2.1.3 3G technology WCDMA CDMA 2000	8
2.1.3.1 Standards	9
2.1.3.2 3GPP	9
2.1.3.3 3GPP2	9
2.1.4 4G technology	9
2.1.4.1 Features	10
2.1.4.2 OFDM	10

2.1.4.3	MIMO	10
2.1.4.4	Handover and coverage	11
2.1.4.5	Disadvantages	11
2.1.5	5G technology	12
2.1.5.1	Millimeter waves	12
2.1.5.2	Micro cells	13
2.1.5.3	Massive MIMO	13
2.1.5.4	Device to device communication	14
2.1.5.5	Network virtualization	15
2.1.5.6	5G future	16
2.2	Some feeding techniques of microstrip	17
2.2.1	Introduction	17
2.2.2	Feeding Techniques to Microstrip Antennas	18
2.2.2.1	Microstrip (offset microstrip) line feed	18
2.2.2.2	Coaxial feed	19
2.2.2.3	Aperture coupled feed	20
2.2.2.4	Proximity coupled feed	21
2.2.3	Comparison of different feeding techniques	22
2.3	Metamaterial	23
2.3.1	Definition of Metamaterials	23
2.3.2	Classification of Metamaterials	23
2.3.2.1	Types	24
2.3.3	Background on construction	24
2.3.4	Design approaches of Metamaterials	25
2.3.5	Metamaterial applications	25
2.3.5.1	WMD detectors	25
2.3.5.2	Invisible subs	25
2.3.5.3	Revolutionary electronics	26
2.3.5.4	Light and sound filtering	26
2.3.5.5	Biosensor	26
2.3.5.6	Metamaterials absorber	26
2.3.6	Metamaterial advantages	27
2.3.6.1	Directivity enhancement	27
2.3.6.2	Bandwidth enhancement	27
2.3.6.3	Radiated power enhancement	27
2.3.6.4	Beamwidth and side lobes	27
3	Design and Implementation Patch antenna with Different Fractal Shape	28
3.1	Introduction	28
3.2	Microstrip Feeding	29
3.3	Fractal Shapes	30
3.4	Antenna Design	30
3.4.1	Design.	30
3.4.2	Results.	33
3.5	Summary	38

Table of Contents

4 Design and Fabrication of Ultra-Wideband Leaky Wave Metamaterial Antennas	39
4.1 Introduction.....	39
4.2 Array of 2X2 elements	40
4.2.1 Design	40
4.2.2 Results	42
4.3 Array of 9X11 elements	45
4.3.1 Design	45
4.3.2 Results	47
4.4 Summary.....	50
5 Design an UWB microstrip Antenna for 4G applications	51
5.1 Introduction.....	51
5.2 Antenna Structure and Design.....	52
5.3 Antenna Results	56
5.3.1 S-parameters.....	57
5.3.2 VSWR	60
5.3.3 Gain.....	61
5.3.4 Total Efficiency of Antenna.....	62
5.3.5 Radiation Pattern	62
5.4 Comparison.....	64
5.5 Summary.....	65
6 Design,simulation and fabrication of multi band- inverted F antenna	66
6.1 Introduction.....	66
6.2 Analysis.....	66
6.3 Design and construction of an inverted F antenna	67
6.4 simulation	68
6.4.1 1st design	68
6.4.2 Microstrip Line feeding	70
6.4.3 Coaxial fed inverted F antenna	72
6.5 Triple band output	74
6.6 Quad band Inverted-F antenna.....	78

6.7 Scaled quad inverted F antenna.....	84
6.7.1 Fabrication and measurements	90
7 Conclusion & Future Work.....	105
7.1 Conclusion	105
7.2 Future work.....	106
Bibliography	108

List of Figures

2.1	AMPS.....	6
2.2	GSM network architecture. [4]	8
2.3	MIMO antennas. [8]	11
2.4	Spectrum range for 5G wireless communication. [10]	12
2.5	Proposed 5G wireless architecture [10].	13
2.6	Device to device communication scheme [10].	15
2.7	Microstrip patch antenna.	17
2.8	Microstrip Line Feed.	19
2.9	Coaxial feed.	19
2.10	Aperture coupled feed.....	20
2.11	Proximity coupled feed.	21
2.12	Comparison of different feeding techniques [13].	22
2.13	Classification of Metamaterials.	23
3.1	Fractal Shape Proposed.....	29
3.2	Pythagorean tree, Sierpinski gasket, and Koch curve.....	30
3.3	Conventional patch antenna.	31
3.4	(a)First iteration Pythagorean (b)Second iteration Pythagorean Pythagorean first and second iteration applied on the conventional patch.	31
3.5	the Sierpinski gasket iterations applied on the Pythagorean iterations. ..	32
3.6	Conventional patch with Koch on the sides.	33
3.7	Return loss of the conventional patch	33
3.8	Return loss of first and second Pythagorean iterations, the red is iteration one and the orange is iteration two	34
3.9	Return loss of first and second Pythagorean iterations, the red is iteration one and the orange is iteration two	34
3.10	Return loss of first, second, third of Sierpinski applied on the second iteration Pythagorean.	35
3.11	Return loss of conventional patch with Koch on sides	35
3.12	Top and Perspective View of first iteration Pythagorean antenna designed on CST	36
3.13	S11 for simulated and measured return loss.	36
3.14	2D radiation pattern of first iteration Pythagorean at resonant frequency of 10 GHz	37
3.15	Top and bottom fabricated antenna.	37
3.16	surface current at frequency 10 GHz.	38
4.1	The structure of the proposed 2x2 array LWA top and bottom view....	42
xviii		
4.2	fabricated of the proposed 2x2 array LWA top and bottom view.....	42
4.3	The mushroom ground structure Top and Bottom view.....	43
4.4	The fabricated 2x2 array LWA with mushroom ground Top and Bottom view.....	43

4.5	The return loss of the proposed 2x2 array LWA.....	44
4.6	The return loss of the proposed mushroom grounded LWA.	45
4.7	Maximum gain over frequency for 2x2 array LWA and 2x2 mushroom grounded LWA.....	45
4.8	Radiation patterns in E-plane of the proposed mushroom grounded LWA from frequencies 6.5 GHz to 16.1 GHz.....	46
4.9	The structure of the proposed 9x11 array LWA top and bottom view.	47
4.10	The structure of via tuned 9x11 array LWA Top and Bottom view.....	47
4.11	The return loss of the proposed 9x11 array LWA.....	48
4.12	The return loss of the proposed 9x11 with via tuning.	48
4.13	The return loss of the gap tuned 9x11 array LWA.	49
4.14	Maximum gain over frequency of 9x11 array LWAsA.....	49
4.15	Radiation patterns of via tuned 9x11 array LWA for frequencies of 6 GHz to 11.9 GHz.	50
4.16	The structure of 9x11 absorber with via tuningA.....	50
4.17	The return loss of the 9x11 absorber array LWA.....	51
5.1	The front view for the first antenna.	54
5.2	Ground of the first antenna.	54
5.3	The Total dimensions of the second antenna.	55
5.4	The front view of the microstrip antenna.	55
5.5	dimensions of the decoupling.....	56
5.6	The front view of the antenna.	57
5.7	The back view of the antenna.	58
5.8	s11 simulated and measured bandwidth of the second element.	58
5.9	s22 simulated and measured bandwidth of the second element.	59
5.10	Simulated and measured coupling effect (S1,2).....	59
5.11	Simulated and measured coupling effect (S2,1).....	60
5.12	Simulated overall S-parameter.....	60
5.13	measured overall S-parameter.....	61
5.14	Simulated and measured overall VSWR.....	62
5.15	Gain from port1.....	63
5.16	Gain from simulated and measured at port 2.....	63
5.17	Total efficiency simulated and measured at port1.....	64
5.18	Total efficiency simulated and measured at port2.....	64
5.19	E-Plane radiation patterns from port1.....	65
5.20	H-Plane radiation patterns from port1.....	65
5.21	E-Plane radiation patterns at port2.....	66
5.22	H-Plane radiation patterns at port2.....	66
6.1	Inverted F with loaded feed lines at 60 GHz top view.....	71
6.2	Bottom view coaxial feed inverted F.	71
6.3	S ₁₁ return loss of original inverted F antenna.	72
6.4	Height of layers of original inverted F antenna.....	72