

A DESIGN OF SLOTTED ELLIPTICAL ANTENNA FOR WIDEBAND
APPLICATIONS

ADZNINA BT EBERAHIM

This thesis is presented in partial fulfillment of the
requirements for the award of the degree of Master of Science
(Information and Communication Engineering)

Faculty Electrical Engineering
UNIVERSITI TEKNOLOGI MARA

MAY, 2011

ACKNOWLEDGEMENTS

In the name of Allah, The Most Gracious, -The Most Merciful and The Most Beneficent. Praise in only Allah S.W.T for His bounty and blessing upon us. It is with deepest sense of gratitude to Allah who has given the strength and ability to complete this project as it is today.

I would like to convey my appreciation to my supervisor, Dr.Mohd Tarmizi Bin Ali for his guidance, advices, supervision, encouragement and faith to me in accomplishing this project.

My special thanks to Sarah Yasmin Bt Mohamad and to those who have devoted their time either directly or indirectly; especially my colleagues for their ideas, supports and a lot of contribution towards the success of this project.

Lastly and by no means least I would like to give a very special thanks and love to my family for their encouragement and moral support throughout the duration of my study.

ABSTRACT

In choosing an antenna topology for wideband design, several factors must be taken into account including physical profile, compatibility, impedance bandwidth, radiation efficiency, and radiation pattern. In this paper, a slotted elliptical wideband antenna is presented. It originates from conventional ellipse shape and is realized by adding a slot for patch. The wideband behavior is due to the fact that the currents along the edges of the slots introduce an additional resonance, which, in conjunction with the resonance of the main patch, produce an overall wideband frequency response characteristic. The slots also appear to introduce a capacitive reactance which counteracts the inductive reactance of the feed. Thus, the bandwidth broadening comes from the patch and the slot, coupled together to form two resonances. The characteristic and performance of the slotted elliptical antenna was simulated by using the commercially available CST Microwave. This antenna is fed by 50 Ω micro strip-line feed and was fabricated using FR4 with the dielectric constant, ϵ_r equal to 4.7, tangent delta electric, $\tan \delta$ is 0.019 and the height of the substrate, h is 1.6 mm. A Vector Network Analyzer (VNA) was used to analyze the prototype antenna. The measured return loss (S_{11}) of this proposed antenna is also presented as well. This antenna was a good choice since it exhibited a return loss less than -10 dB within wideband frequency range of 2.5 GHz to 6.5 GHz, voltage standing wave ratio (VSWR) less than 2, provided omnidirectional radiation pattern at 3.97 GHz, directional radiation pattern at 5.5 GHz and value of radiation efficiency is more than 70%. Furthermore, it was low-profile and compact antenna.

TITLE	i
DECLARATION	ii
ACKNOWLEDGEMENT	iii
ABSTRACT	iv
TABLE OF CONTENTS	v
LIST OF FIGURES	vii
LIST OF TABLES	X
LIST OF ABBREVIATIONS	xi
INTRODUCTION	1
1.1 Microstrip antenna	1
1.2 Wideband antenna	2
1.3 Problem statement	3
1.4 Objectives	3
1.5 Scope of work	4
1.6 Thesis organization	6
LITERATURE REVIEW	7
2.1 Literature review	7
ANTENNA THEORY	13
3.1 Introduction to microstrip patch antenna (MPA)	13
3.1.1 Microstrip patch antenna configurations and characteristics	14
3.1.2 Advantages of microstrip antenna	15
3.2 Feeding technique	16
3.2.1 Microstrip line	16
3.2.2 Coaxial feed	17
3.2.3 Aperture coupled feed	17
3.3 Antenna parameters	18
3.3.1 Return loss (SI 1)	18
3.3.2 Voltage standing wave ratio (VSWR)	19
3.3.3 Input impedance (Z_{in})	21
3.3.4 Radiation pattern	22
3.3.5 Efficiency	24
3.3.6 Gain	25
3.3.7 Polarization	26
3.3.8 Bandwidth (BW)	28
MICROSTRIP DESIGN	29
4.1 Design of antenna	29
4.1.1 Calculation to design a slotted ellipse	32
4.1.2 The value of width for the feed line	32
4.2 Designing the antenna by using CST	34
4.2.1 Set the working plane type	34
4.2.2 Set working planes properties	35
4.2.3 Draw the substrate brick	35
4.2.4 Model the patch antenna	35
4.2.5 Model the line feed	37
4.2.6 Model the ground plane	38
4.2.7 Model the slot	40
4.3 Simulation process	41
4.3.1 Define the waveguide port	41
4.3.2 Define the frequency range	43
4.3.3 Define farfield monitor	44
4.3.4 S-parameter and farfield calculation	45
4.3.5 Transient solver	45
4.4 Optimization process	47

4.4.1	Define variables	47
4.4.2	Optimize by setting a goal	48
4.4.3	Run the optimizer	49
4.5	Producing antenna layout by using Autocad	51
4.6	Creating the antenna prototype(Fabrication process)	52
4.6.1	UV exposure	52
4.6.2	Developing	53
4.6.3	Etching	54
4.6.4	Antenna prototype	55
4.7	Measurement of the antenna prototype by using Vector Network Analyzer (VNA)	56
4.7.1	Calibration	56
4.7.2	Measure antenna prototype	59
RESULTS AND DISCUSSION		60
5.1	Introduction	60
5.2	Simulation results	61
5.2.1	Slotted elliptical antenna without a switch	61
5.2.2	Slotted elliptical antenna with a switch	62
5.3	Comparison between simulation and measured results	66
5.3.1	Slotted elliptical antenna without a switch^	66
5.3.2	Slotted elliptical antenna with a switch	67
CONCLUSION AND FUTURE DEVELOPMENT		68
6.1	Conclusion	68
6.2	Future development	68
References		69
Appendix		72