

WIDEBAND ANTENNA DESIGN FOR FREQUENCY BAND BETWEEN 2.4
AND 11 GHZ

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*My beloved parents, Siblings and friends.
To my colleagues in Sudan and Malaysia.*

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ABSTRACT

The continuous demand for high bit rate wireless communication links is growing dramatically, due to the technical requirements of this high bit rates link the data should be spread over relatively wide frequency band, however these wide frequency bands have to be supported by suitable antennas, in this project wideband antenna is designed to operate between 2.4 and 11 GHz, in the design the overall dimensions and the structure of the antenna had been taken into account in order to insure that the design is compact in size as well as increasing to possibility of impeded it into portable devices. Due to the size and configuration requirements microstrip planar antenna structure is chosen and many techniques had been employed in order to enhance the antenna bandwidth. The design had been performed using computer simulation technology software CST, after that the antens had been fabricated.

ABSTRAK

Permintaan yang tinggi dan berterusan terhadap komunikasi tanpa wayar berkelajuan tinggi telah meningkat dengan mendadak. Merujuk kepada keperluan teknikal pada kelajuan tinggi ini dimana data perlu dirambat pada jalur frekuensi lebar, antena yang bersesuaian diperlukan bagi menyokong keperluan ini. Projek ini memperihalkan rekabentuk antena jalur lebar yang beroperasi pada frekuensi 2.4 hingga 11 GHz. Didalam proses rekabentuk, keseluruhan dimensi dan struktur antena telah dipertimbangkan bagi memastikan rekebetuk yang kecil dan bersesuaian untuk alat mudah alih. Bersesuaian dengan saiz dan keperluan konfigurasi, antena planar berjalur mikro telah dipilih dan perlbagai teknik telah digunakan bagi meningkatkan keupayaan saiz jalur. Semua hasil keputusan simulasi yang diperolehi menggunakan perisian CST Studio Suite dan akhirnya antena difabrikasi.

TABLE OF CONTENTS

CHAPTER	TITLE	PAGE
	DECLARATION	ii
	DEDICATION	iii
	ACKNOWLEDGEMENT	iv
	ABSTRACT	v
	ABSTRAK	vi
	TABLE OF CONTENTS	vii
	LIST OF TABLES	x
	LIST OF FIGURES	xi
	LIST OF ABBREVIATIONS	xiii
	LIST OF SYMBOLS	xiv
1	INTRODUCTION	1
	1.1 Project background	1
	1.2 Problem Statement	2
	1.3 Objectives	2
	1.4 Scope of work and methodology	3
	1.5 Organizations of thesis	3
	1.6 Summary	4
2	BASIC THEORIES	5
	2.1 Radiation pattern	5
	2.2 Directivity efficiency and gain	5
	2.3 Impedance Bandwidth	6
	2.4 Polarization	8
	2.5 Half power beam width	8
	2.6 Bandwidth	9
3	LITERATURE REVIEW	10
	3.1 Background	10

3.2	overview of microstrip planar antenna	10
3.2.1	Radiator shape	11
3.2.2	Substrate	13
3.2.3	Feeding structure	14
3.3	Advantages of planar antennas	15
3.4	Applications	16
3.5	Matching technique	16
3.5.1	Lowering the Q	16
3.5.2	Using an impedance matching network	17
3.6	Research background	17
3.6.1	Historical progress in wideband antennas	17
3.6.2	Recent progress in wideband antennas	18
4	DESIGN METHODOLOGY	22
4.1	Introduction	22
4.2	Design specification	22
4.3	Design flow	23
4.3.1	Dimension and formula	23
4.3.2	Design process	26
4.3.3	Fabrication process	26
4.3.4	Testing process	28
5	RESULTS AND DISCUSSION	29
5.1	Antenna structure	29
5.1.1	The non slotted design	29
5.1.2	The slotted design	33
5.2	Return loss results	36
5.2.1	Simulated and measured return loss for the non-slotted design	36
5.2.2	Simulated and measured return loss for the slotted design	37
5.2.3	Comparison between the slotted and non-slotted design.	37
5.3	Radiation pattern results	39
5.3.1	Radiation pattern for the non slotted designs	39
5.3.2	Radiation pattern for the slotted designs	40

6	CONCLUSION AND FUTURE WORK	45
6.1	Future work	45
6.2	Summary	46
	REFERENCES	47
	Appendices A – 6	?? – ??

LIST OF TABLES

TABLE NO.	TITLE	PAGE
4.1	Design specifications.	22
4.2	Width of the antenna at different sample frequencies.	24
4.3	Values of the effective dielectric constant at different sample frequency when h equal to 1.6 m.	24
4.4	Values of the effective dielectric constant at different sample frequency when h equal to 0.8 mm.	24
4.5	The value of the effective length at 1.6 mm FR4.	25
4.6	The value of the effective length at 0.8 mm FR4.	25
4.7	The extension length of the patch at different sample frequencies on 1.6 mm FR4.	25
4.8	The extension length of the patch at different sample frequencies on 0.8 mm FR4.	25
4.9	The actual length of the patch L at 1.6 mm FR4 at different sample frequencies.	26
4.10	The actual length of the patch L at 0.8 mm FR4 at different sample frequencies.	26
4.11	FR4 characteristics.	28

LIST OF FIGURES

FIGURE NO.	TITLE	PAGE
3.1	printed dipole antenna [7].	11
3.2	Printed slot antenna [7].	12
3.3	Printed traveling-wave antenna [7].	12
3.4	A microstrip patch antenna with a radiator of an arbitrary shape [7].	13
3.5	Shapes of the radiator [7].	13
3.6	Types of feeding structure used in microstrip antennas.	15
4.1	Design flow	23
4.2	Design process	27
4.3	Fabrication flow	27
4.4	S-Parameters analyzer	28
5.1	Front and back view of build on 0.8 mm substrate	30
5.2	Front and back view of build on 1.6 mm substrate	30
5.3	The effects of variable values of ϵ on the return loss of the antenna on 0.8 mm substrate	30
5.4	The effects of variable values of F on the return loss of the antenna on 0.8 mm substrate	31
5.5	The effects of variable values of G on the return loss of the antenna on 0.8 mm substrate	31
5.6	The effects of variable values of ϵ on the return loss of the antenna on 1.6 mm substrate	32
5.7	The effects of variable values of F on the return loss of the antenna on 1.6 mm substrate	32
5.8	The effects of variable values of G on the return loss of the antenna on 1.6 mm substrate	33
5.9	Front and back view of slotted wideband antenna build on 1.6 mm substrate	33
5.10	Front and back view of slotted wideband build on 0.8 mm substrate	34

5.11	The effects of variable values of S on the return loss of the antenna on 1.6 mm substrate	34
5.12	The effects of variable values of G on the return loss of the antenna on 1.6 mm substrate	35
5.13	The effects of variable values of S on the return loss of the antenna on 0.8 mm substrate	35
5.14	The effects of variable values of G on the return loss of the antenna on 0.8 mm substrate	35
5.15	Simulated and measured return loss of a wideband antenna build on 0.8 mm substrate	36
5.16	Simulated and measured return loss of a wideband antenna build on 1.6 mm substrate	37
5.17	Simulated and measured return loss for the slotted wideband antenna build on 0.8 mm substrate	38
5.18	Simulated and measured return loss for the slotted wideband antenna build on 1.6 mm substrate	38
5.19	Measured results of the slotted and non-slotted wideband antennas build on 0.8 mm substrate	39
5.20	Measured results of the slotted and non-slotted wideband antennas build on 1.6 mm substrate	40
5.21	E-Plane and H-Plane for the non-slotted design on 0.8 mm substrate.	41
5.22	E-Plane and H-Plane for the non-slotted design on 1.6 mm substrate.	42
5.23	E-Plane and H-Plane for the slotted design on 1.6 mm substrate.	43
5.24	E-Plane and H-Plane for the slotted design on 0.8 mm substrate.	44

LIST OF ABBREVIATIONS

WB	–	Wide Band
IEEE	–	Institute of Electrical Electronics Engineer
dBi	–	Disible isotropic
dBd	–	Disible Dipole
VSWR	–	Voltage Standing Wave Ratio
BW	–	Band Width
HPBW	–	Half Power Beam width
MSPA	–	Microstrip Strip Planar Antenna
GPS	–	Global Positioning System
GSM	–	Global System of Mobile communication
RCA	–	Radio Corporation of America
UHF	–	Ultra High Frequency
UWB	–	Ultra Wide Band
FR4	–	Flame Resistant 4
W	–	Width of the radiator
L	–	Length of the radiator
h	–	Thickness of the Substrate
PCB	–	Printed Circuit Board
	–	

LIST OF SYMBOLS

Γ	–	Reflection Coefficient
e_r	–	Reflection Efficiency
e_{rad}	–	Radiation Efficiency
P_{rad}	–	Radiated Power
p_{in}	–	Input Power at The Antenna
Z_{in}	–	Input Impedance
Z_o	–	Characteristic Impedance
f_h	–	Higher End of Frequency
f_l	–	Lower End of Frequency
λ_o	–	Wavelength
ϵ_r	–	Dielectric Constant Of The Substrate
$\tan\delta$	–	Tangent loss Of The Substrate
ϵ_{eff}	–	Effective Dielectric Constant of The Substrate
l_{eff}	–	Effective Length
	–	

CHAPTER 1

INTRODUCTION

This thesis present and describe the design of wideband planar antenna that can be used to cover the frequency from 2.4 to 11 GHz, in the first chapter, the background of the project is discussed providing the objective and scope of this work.

1.1 Project background

Previously and in the future, there is a great interest in short range high-speed data transmissions, high-resolution sensing and ranging using the wide band technology (WB) which allow the information to spread over a large operating bandwidth. Unlike traditional narrowband systems, the WB counterparts operate by employing very short electrical pulses of nanosecond and sub nanosecond duration resulting in very wide transmission bandwidths ranging from several hundred megahertz up to several gigahertz. Such huge bandwidths must be supported with suitable antennas that have an operating bandwidths up to greater than hundred percent of the center frequency.

As a result, WB antennas had been attractive and challenging areas in the research of the system design. And must be properly designed to enhance the potential advantages of short-pulse signaling for communication, ranging, sensing and other applications.

The objective of this project is to design and construct an antenna that transmits and receives WB signals for WB band range from 2.4 GHz to 11 GHz. In general, this antenna should have sufficiently broad operating bandwidth for impedance Matching and high-gain radiation in desired directions. After that we will fabricate our design and compare the measurements of simulation and fabrication.

So in this project there are four main considerations that that have to be satisfied. These parameters are the bandwidth of the antenna, the return loss of the antenna, the efficiency of the antenna, and the radiation pattern of the antenna. These parameters will help us decide if the antenna the proposed antenna will be the optimal design for our application.

1.2 Problem Statement

Microstrip planar antenna in their basic forms suffer from some disadvantages such as narrow impedance bandwidth and low radiation efficiency, this essentially limits the application of this type of antenna.

The disadvantages can be overcome by using some of the broadband technique, which play a big role in increasing the impedance bandwidth so as to achieve the desired bandwidth.

1.3 Objectives

The objective of this project is to design a wideband antenna that covers the frequency band from 2.4 to 11 GHz, then the proposed antenna will be fabricated on FR4 board, after all a comparison will be conducted between the simulation and the fabrication .

1.4 Scope of work and methodology

The project is focusing on microstrip antenna design which provide a wideband frequency from 2.4 to 11 GHz, the design will be conducted using CST (Computer Simulation Technology).

In our design some microstrip broadband technique such as reducing the Q factor by selecting an optimum shape for our radiator and controlling the dimensions of the ground plane and radiator will be used to achieve the desired bandwidth. In order to achieve our objectives, a number of steps had to be identified , as out lined below:

- Investigating the characteristic of wideband antenna.
- Understand the concept of planar antennas and how to implement the broadband technique to achieve the desired bandwidth.
- Simulate the designed antenna using CST (Computer Simulation Technology) before the actual prototype built.
- Compare the simulation design and the fabrication to evaluate the antenna performance and optimization.

1.5 Organizations of thesis

This thesis is organized in six chapters. The first chapter is an introduction, which provides information regarding the project background, problem statement, objective and scope of work and the layout of the thesis. The second chapter present the basic theoretical parameters which will be used to analyze the design.

The third chapter present historical introduction on wideband antenna and overview on the planar antenna. Some of the literature review on microstrip planar antenna such as features, broadband technique, advantages is discussed.

In the fourth chapter, is the methodology, in which the methods employed and the software's needed as well as basic design formulas and design steps for this project are explained.

In the fifth chapter, the simulation and measurement results are presents for different design structure on different substrate thickness.

In the sixth chapter, which is conclusion and recommendations, this chapter concludes the finding of the project and provides recommendations for future work.

1.6 Summary

Brief introduction on the project and its scopes have been presented. Some relevant project backgrounds have also been presented to give a clear view on the direction of the project. The outline of this thesis has also been described.