DESIGN OF SLOTTED MEANDER LINE ANTENNA WITH PROBE FEED METHOD FOR ISM BAND APPLICATION

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This report is submitted in partial fulfillment of the requirements for the award of Bachelor of Electronic Engineering (Telecommunication Engineering) With Honours

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For my beloved father, mother and brothers

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ABSTRACT

Nowadays, the development of wireless communication is become more important and antennas are the essential of wireless communication. Currently, users demand to have small size of device that can be brought anywhere without the use of wire and to fulfill the demand, small size of antenna is needed. Therefore it has become the objective for this project to design, simulate and fabricate slotted meander line antenna which operates at 2.4GHz where meander line technique is used for miniaturization purpose. However, meander line produces narrow bandwidth and to overcome the problem, slots are introduced to the meander line antenna because the bandwidth of antenna with slots is wider. Many designs of slotted meander line antenna are produced and they are analyzed based on the number of slotted meander line used. Antenna with 2 slotted meander lines produces the highest simulation return loss of -24.54 dB but has a low gain of 1.46 dB. Antenna with 3 slotted meander lines produced highest gain among all designs with 4.02 dB but the widest bandwidth is produced by antenna with 6 slotted meander lines with 43.01 MHz.The results also shows that the resonant frequency for all slotted meander line antenna designed, is shifted backward. The size reduction of the patch has made the resonant frequency shifted forward until reaching 2.4GHz. Antenna with 2 slotted meander line has the most size reduction of approximately 23% from the original size.3 designs are chosen to be fabricated and the result of simulation and measurement process is compared. Computer Simulation Tools (CST) Studi Suite 2010 is used for the simulation of designed process.

ABSTRAK

Pada masa kini, pembangunan sistem komunikasi tanpa wayar adalah sangat penting dan antena adalah sangat berguna dalam pelbagai aplikasi dan ia merupakan asas kepada komunikasi tanpa wayar. Pada masa kini, pengguna lebih memilih untuk mempunyai peranti yang bersaiz kecil yang boleh dibawa kemana-mana sahaja tanpa penggunaan wayar. Oleh itu, objektif bagi projek ini adalah untuk mereka, mensimulasi, dan menfabrikasi antena yang berbentuk garisan berliku dan beralur yang berfungsi dan beroperasi pada frekuensi 2.4GHz dimana antenna berbentuk garisan berliku digunakan untuk mendapatkan antenna bersaiz kecil. Namun begitu, oleh kerana teknik ini menghasilkan lebar jalur yang kecil, antenna ini akan dialurkan memandangkan antena yang beralur menghasilkan lebar jalur yang tinggi. Pelbagai rekaan bagi antenna garisan berliku dan beralur telah dihasilkan dan dianalisa berdasarkan jumlah garisan berliku yang beralur yang digunakan. Tiga rekaan telah dipilih untuk difabrikasikan bagi membandingkan keputusan simulasi dan keputusan ukuran. Computer Simulation Tool (CST) Studio Suite 2010 adalah perisian yang digunakan bagi proses simulasi antena.

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LIST OF ABBREVIATION AND SYMBOLS

RF	-	Radio Frequency
ISM	-	Industrial, Science and Medical (Band)
CST	-	Computer Simulation Technology
FR-4	-	Flame Retardant (Type 4 – made of woven glass reinforced epoxy resin)
UV	-	Ultra Violet
VSWR	-	Voltage Standing Wave Ratio
PC	-	Personal Computer
Wi-Fi	-	Wireless Fidelity
ITU	-	International Telecommunication Union
Z_o	-	Characteristic Impedance
λ_g	-	Guide Wavelength
TEM	-	Transverse Electro-Magnetic
ε_{reff}	-	Effective Dielectric Constant
ε_r	-	Relative Dielectric Constant
L	-	Length of Patch Antenna
W	-	Width Of Patch Antenna
h	-	Height Of Patch Antenna
f	-	Frequency
c	-	Light Speed Constant
d	-	Substrate Thickness
IEEE	-	Institute of Electrical and Electronic Engineers
Std	-	Standard
CPW	-	Coplanar Waveguide
MIC	-	Microwave Integrated Circuits
MMIC	-	Monolithic Microwave Integrated Circuits
CMOS	-	Complementary-Symmetry Metal–Oxide

PIFA	-	Planar Inverted-F Antenna
RL	-	Return Loss
D	-	Directivity
BW	-	Bandwidth
G	-	Gain
HPBW	-	Half Power Beam Width
FNBW	-	First Null Beam Width
tan δ	-	Dielectric Loss / Tangent Loss
μ_r	-	Permittivity
W_c	-	Copper thickness
RCS	-	Radar Cross Section
N	-	Number of Turn
AUT	-	Antenna Under Test
Sim.	-	Simulation
Mea.	-	Measurement
dB	-	Decibel
dBi	-	Decibel Isotropic

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CHAPTER I

INTRODUCTION

1.0 Introduction

An antenna is a transducer that transmits or receives electromagnetic waves. In other words, antennas convert electromagnetic radiation into electrical current or vice versa. Antennas generally deal in a transmission and reception of radio waves and are a necessary part of all radio equipment. Based on another source, antenna is defined as an electrical conductor or system of conductors. Antenna can be used in two ways communication, transmitting and receiving. An antenna is a circuit element that provides a transition from a guided wave on a transmission line to a free space wave and it provides for the collection of electromagnetic energy [1].

In transmitting system the RF signal is generated, amplified, modulated and applied to the antenna. Meanwhile, in receive systems the antenna collects electromagnetic waves that are 'cutting' through the antenna and induce alternating currents that are used by the receiver. An antenna ability to transfer energy from the

atmosphere to its receiver with the same efficiency as it transfers energy from the transmitter into the atmosphere. Antenna characteristics are essentially the same regardless of whether an antenna is sending or receiving electromagnetic energy [2].

1.1 Problem Statement

The modernization of telecommunication system had brought many benefits to people nowadays. Previously people need to be at a specified place only to communicate with each other. For instance, people can only be connected or communicate using wired phone at home or public phone at certain places.

The need and trend to be in touch whenever and wherever they want has come to a huge demand of wireless devices with mobility and low profile to make the communication method and process become easier. Antenna is a crucial part of devices that allows the device itself to operate by transmitting and receiving signals. Small size device came with small size antenna. Therefore, for a compact device, a compact and low profile antenna that can operate at desired frequency range is needed.

There are many aspects need to be considered in designing an antenna. The problem that usually found in existing antennas is referred to the size of the antenna. Users prefer to have small size of device that can be carried anywhere without connected to wires.

Common design of antenna faced some issues regarding the size because a bigger size of antenna will not only make it costly, but also have difficulties to fit in a device. In order to overcome the problem, a meander line antenna would be one of the suitable methods to be used to design a low profile antenna. Meander line antenna is chosen because it is able to reduce or miniaturize the size of antenna. It is smaller in size and very flexible to be shifted or relocated [3].

However meander line structures alone did not optimize the requirement of antenna because it has a narrow bandwidth despite of its advantage to miniaturize antenna [4]. One of the ways to overcome this problem is to use slots in particular

meander line antenna due to the wide bandwidth characteristic that slotted antenna have.

1.2 Objective

The main objective of this project is to design, simulate and fabricate a slotted meander line antenna to be used at ISM band (2.4 – 2.5 GHz). It is designed to be smaller in size compared to existing antennas and consistently reducing the cost of design. The meander line antenna has been designed to operate at 2.4 GHz as it approaches the industrial, scientific and medical radio bands.

1.3 Scope of project

Firstly a meander line antenna will be designed specifically for ISM band application. The meander line technique is used to miniaturize the antenna and it will be slotted to get wider bandwidth.

The meander line antenna will be simulated with CST software to observe the result of antenna parameters such as return loss, bandwidth, gain, and directivity.

After that the antenna will be fabricated by using FR-4 board and chemical etching technique. The fabricated antenna will be measured to observe the result of return loss, bandwidth, gain and directivity of the antenna.

1.4 Methodology

First of all, antenna system will be reviewed, focusing on meander line and slotted antenna through variety kind of sources and references such as journals, books and through internet. Variety types of antenna will be designed, for instance microstrip patch antenna, microstrip meander line antenna, microstrip slot antenna, and slotted meander line antenna by using CST Studio Suite 2010. After that all the

designed antenna will be simulated to observe the antenna parameters such as return loss, bandwidth, gain and directivity.

Fabrication process will be done but before that, the antenna layout must be designed. As for material, FR-4 board will be used. UV Litography and chemical etching technique will be used to fabricate the antenna. A probe feed will be soldered to the antenna as a connector.

The fabricated antenna will be measured to observe the result of return loss, bandwidth, gain and directivity of the antenna. Report writing will be done to record all the results and discussions. Figure 1.1 below shows the overall flow of this project.

1.5 Thesis Outline

This thesis consists of five chapters describing all the work done in the project. The thesis outline is generally described as follows.

Chapter I of this report will cover the introduction of the project. Brief general background is presented and this chapter also includes the objective, scope of project and methodology. Chapter II will cover about literature review of antennas. For this purpose, the review is made by referring to many sources, mostly from related technical papers. Chapter III gives an overview of the antenna design methodology with the fundamental process in the design, simulate, fabricate and measurement procedures.

For Chapter IV, it will cover the results obtained from the simulation and measurement process. All the data obtained will be analyzed and discussion regarding the results will be made. Lastly Chapter V will cover the conclusion of overall project. Suggestions to improve this project are also be presented in the same chapter.

Flowchart of project:

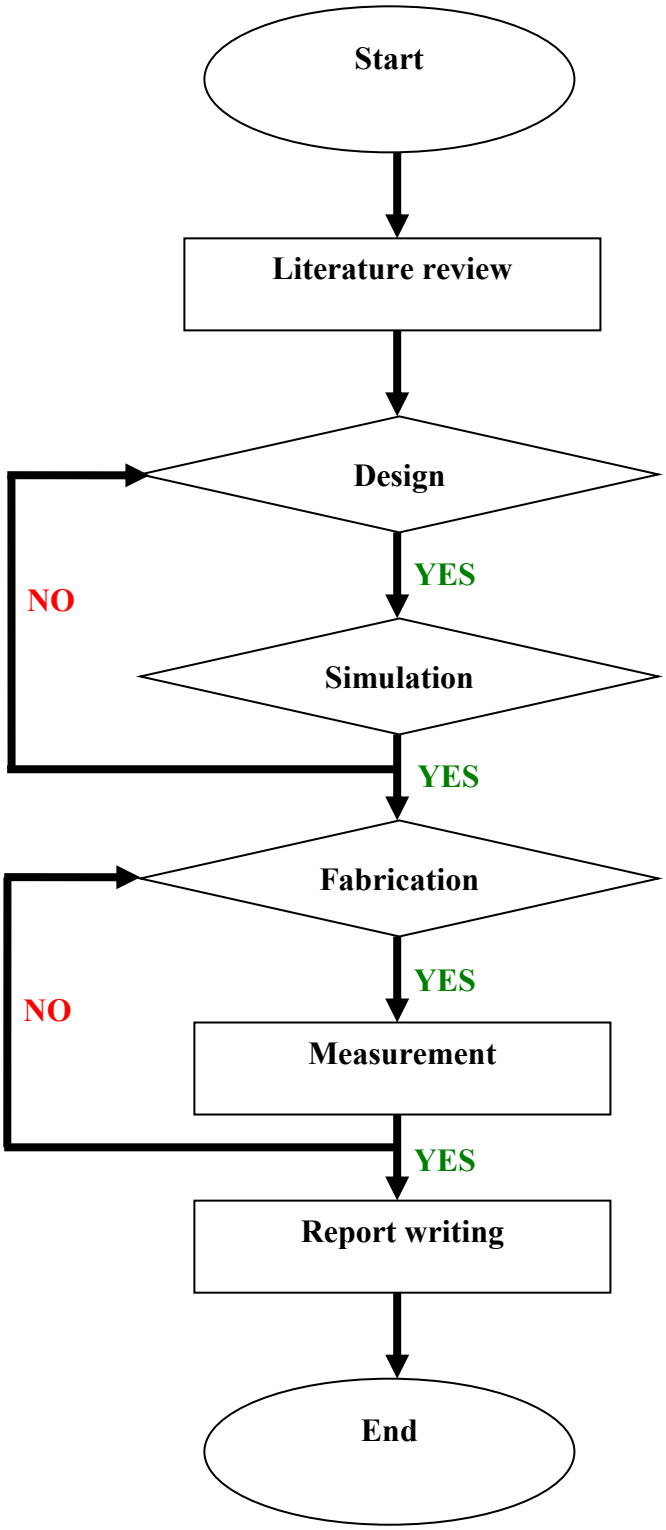

Figure 1.1: Project Flow