BROADBAND X-POLARIZED MICROSTRIP PATCH ANTENNA

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ABSTRACT

With the wide spread proliferation of wireless communication technology nowadays, the demand for compact, low profile and broadband antennas has increased dramatically. The best choice that can meet the requirement in microstrip patch antenna. This is because of it is low profile, light weight and low cost. However, the microstrip antenna has inherently narrow bandwidth. To overcome its inherent limitation of bandwidth, many techniques have been suggested such as slotted, stacked, increase substrate, pin loading and proximity coupled. Stack method has been chosen because it is easy to design and easy to be adjusted. Beside bandwidth, world nowadays requires the high performance antenna in term of transmission efficiency, multitask and many more factors. So, the X-polarized antenna design is proposed in order to overcome this problem. The conventional antennas suffer poor performance of point to multipoint application. This is because by the attendance of the obstacles in between the transmitting antenna and receiving antenna, the loss will be high. By using the X-polarized antenna; multilinear polarized antenna, 4 patches will send the same signal at a time and this will increase efficiency of the transmission system. This project is about design, simulate and fabricate the Broadband X-polarized Microstrip Patch Antenna that will operate at 2.4GHz. The antenna will operate at broadband frequency and will radiate the X-polarized EM wave. From the results obtained, the bandwidth of the antenna is successfully increased until 3 times its actual bandwidth.

ABSTRAK

Sejajar dengan perkembangan teknologi tanpa wayar, permintaan untuk antenna yang berprofil rendah, kompak dan berjalur lebar telah menigkat dengan mendadak. Pilihan terbaik untuk memenuhi permintaan ini adalah dengan menggunakan antenna jenis mikrostrip. Namun, antenna jenis ini bermasalah dari segi lebar jalur yang kecil. Untuk mengatasi masalah ini, beberapa teknik telah dicadangkan seperti *slotted, stacked, increase substrate, pin loading* dan *proximity coupled.*teknik *stacked* telah dipilih kerana ia mudah direka dan mudah di ubah-ubah. Selain dari lebar jalur, permintaan dunia hari ini juga tertumpu kepada antenna yang efisien, pelbagai guna dan macam-macam lagi factor lain. Jadi, antenna X-polarisasi telah dicadangkan untuk mengatasi masalah ini kerana ia efisien dan dapat mengatasi masalah hubungan *point to multipoint application.* Projek ini adalah tentang mereka, membuat simulasi dan menghasilkan Mikrostrip Antenna Berjalur Lebar dengan X-polarisasi yang akan beroperasi pada 2.4GHz. Antenna jenis ini akan beroperasi pada frekuensi 2.4GHz dan akan memancarkan gelombang elektromagnetik berpolarisasi-X.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

CST	-	Computer Simulation Technology
RL	-	Return Loss
S-parameter	-	Scattering Parameter
MWO	-	Microwave Work Office
MSA	-	Microstrip Antenna
Z_L	-	Impedance load
Z_o	-	Characteristic Impedance 50Ω
GHz	-	GigaHertz
MHZ	-	MegaHertz
dB	-	Decibel
mm	-	Millimeter
Hz	-	Hertz
Ω	-	Ohms
V	-	Voltan
λ	-	Wavelength
ε_{eff}	-	Effective Dielectric Constant
P_{RX}	-	Received power
P_{TX}	-	Transmitted power

η	-	Efficiency of the antenna
D	-	Directivity
G	-	Gain
G_T	-	Gain transmitted
G_R	-	Gain received
C	-	Capacitance
S	-	Plate area
d	-	Distance between plate
ε_0	-	Constant
ε_r	-	Dielectric constant

LIST OF APPENDICES

CHAPTER 1

INTRODUCTION

1.1 Background

With the rapid growth of the wireless mobile communication technology, the future technologies need very small antenna and also need the wide band antenna is increased to avoid using two antennas and to allow video, voice, and data information to be transmitted. Microstrip patch antenna is promising to be a good candidate for the future technology. Microstrip patch antenna consists of a dielectric substrate, with a ground plane on the other side.

Due to its advantages as low profile planar configuration, low fabrication costs anda capability to integrate with microwave integrated circuits technology, the microstrip patch antenna is very well suited for applications such as wireless communications system, cellular phones pagers, radar systems and satellite communications systems[1].

There are numerous and well known methods to increase the bandwidth of antennas. However, the bandwidth and the size of antenna are mutually conflicting properties that is improvement of one of the characteristics normally results in degradation of the other[2].

1.2 Problem statement

With the development of microwave integrated circuit (MIC) and high frequency semiconductor devices, microstrip has drawn the maximum attention of the antenna community in recent years. In spite of its various attractive features like, light weight, low cost, easy fabrication, conformability on curved surface and so on, the microstrip element suffers from an inherent limitation of narrow impedance bandwidth. Broad bandwidth has become major demand in these recent years.

A wide bandwidth is needed because with a wide bandwidth, a lot of application can be include with the antenna as nowadays a lot of applications are using wireless medium to transmit and receive data. So, many things can be done at a time with broad bandwidth. Therefore, along with other developments, widening the bandwidth of microstrip elements, in general, has become a major branch of activities in the field of printed antennas.

The conventional linear polarized antenna suffered of poor performance point to point or point to multipoint application. This is because by the attendance of the obstacles in between the transmitting antenna and receiving antenna, the loss will be high. By using the X-polarized antenna; multilinear polarized antenna, 4 patches will send the same signal at a time and this will increase efficiency of the transmission system. The X-polarized antenna is the answer to enhance the performance quality whether for point to point or point to multipoint application.

1.3 Objective

Design, simulate and fabricate the broadband X-polarized microstrip patch antenna that will operate at 2.4GHz. The antenna will operate at broadband frequency and will radiate the X-polarized EM wave.

1.4 Scope of work

This project will be focusing on the broadband X-polarized microstrip patch antenna using stacked method. The designed was first calculated and then simulated using the CST 2009 software.

The designed was done by using the FR4 with 1.6mm thickness, 0.018 tangent loss and 4.4 dielectric constant as the substrate. During the simulation, the return loss, radiation pattern, gain, directivity and bandwidth was obtained for simulation results.

After the designed was finalized, the designed was fabricated using the chemical etching process. Then, the antenna will be measured in lab. The measurement was focusing on finding the antenna's center frequency, return loss, bandwidth, gain, directivity, and radiation pattern.

The last part of work is the analysis part. In this part, the result of simulation and the actual result were compared and analyzed.

1.5 Methodology

Methodology used in order to achieve the objective of this project is as follow:

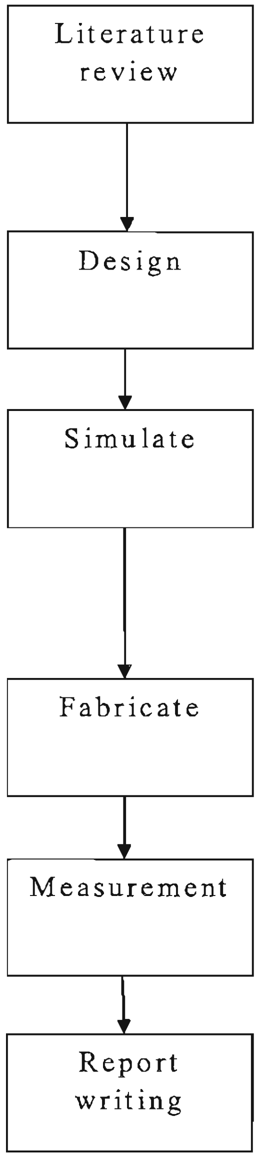

Figure 1.1: Methodology flow chart

Literature review is done by gathering the information from books, journals and papers in order to study the details about the antenna and the design. The literature review was focusing on the methods to enhance the microstrip patch antenna's bandwidth such as slot, stacked, segmentation and electromagnetic coupling. After the antenna's design method has been studied, the design process started; using the chosen method, stacked method.

Designing process is calculating the dimension for the patch including upper patch and lower patch for stacked design. Using the calculated design, the antenna was draw and simulated using the CST 2009 software. Then, the design was fabricated. The fabrication process is the process to develop the patch design on the FR4 board. There are some procedures to be followed in order to get the desired patch.

The fabricated patches were then being measured the measurement was focusing on measuring the antenna's center frequency, bandwidth, radiation pattern, gain and directivity. The measurement results were then being analyzed and troubleshoot. Lastly, from all the information gathered, the report is wrote.

CHAPTER 2

LITERATURE REVIEW

This chapter explains about the microstrip patch antenna and the way to enhance the bandwidth. The principle ideas are established before the design being done. The previous research work also been described in this chapter.

2.1 Antenna

The antenna is the transitional structure between free-space and guiding device. Its main purpose is to convert the energy of a guided wave into the energy of a free space wave (or vice versa) as efficiently as possible, while in the same time the radiated power has a certain desired pattern of distribution in space.

2.1.1 Fundamental of Antenna Parameter

In order to describe the performance of an antenna, definitions of various parameters are necessary. Some of the parameters are interrelated and not all of them need be specified for complete description of the antenna performance.

(a) Resonance Frequency

The resonance frequency for the (1, 0) mode is given by

$$f_o = \frac{c}{2L_e\sqrt{\varepsilon_r}} \tag{2.1}$$

Where c is the speed of light vacuum To account for the fringing of the cavity fields at the edges of the patch, the length, the effective length Le is chosen as

$$Le = L + 2\Delta L \tag{2.2}$$

The Hammers tad formula for the fringing extension is like equation shown in (2.3):

$$\Delta L = 0.412d \frac{(\varepsilon_{eff} + 0.3)\left(\frac{W}{d} + 0.264\right)}{(\varepsilon_{eff} - 0.258)\left(\frac{W}{d} + 0.8\right)} \tag{2.3}$$

Where the effective dielectric constant, ε_{eff} :

$$\varepsilon_{eff} = \frac{\varepsilon_r + 1}{2} + \left(\frac{\varepsilon_r - 1}{2} \frac{1}{\sqrt{1 + 12\frac{d}{W}}}\right) = 4.5276 \tag{2.4}$$

(b) Radiation Pattern

Radiation pattern of an antenna is defined as a graphical representation of the radiation properties of the antenna as a function of space coordinates. In most cases, the radiation pattern is determined in the far-field region. It is represented as a function of the directional coordinates.