BROADBAND PLANAR ANTENNA DESIGN

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ABSTRACT

Broadband wireless communications require wideband antennas to support large number of users and higher data rates. Many existing wideband antennas are large in size and some have only circular polarization. On the other hand low-profile, dual-polarized antennas frequently have limited bandwidth. Planar antenna was designing to solve the problem of microstrip antenna. The main problem of microstrip antenna is, it has narrowband characteristic up to 3%. So firstly, the parameter to designing the planar antenna should be known. The planar antenna is designing for Broadband application for 2.4GHz frequency in range of 0-10 GHz. Microwave Office software was used for design and simulation to see the results. Simulation process should be shows the return loss of planar antenna ≤ -10dB, gain, radiation pattern, percentage bandwidth achieved, SWR, and others for the planar antenna.

ABSTRAK

Komunikasi jalurlebar tanpa wayer memerlukan antenna jalurlebar yang dapat menyokong bilangan pengguna yang ramai dan maklumat dengan tinggi. Kebanyakkannya antenna jalur lebar yang wujud adalah besar dan sesetengahnya hanya mempunyai pengutuban keliling. Yang lain kecil, dwipengutuban antenna pula kerapkali mempunyai jalurlebar terhad. Antena jenis planar direkabentuk bagi menyelesaikan masalah antena mikrojalur. Masalah utama antena mikrojalur ialah mempunyai sifat jalur sempit sehingga 3 %. Oleh itu, pertamanya, parameter untuk mereka antena planar ini mesti diketahui. Planar antena ini direka untuk aplikasi jalurlebar 2.4GHz yang beroperasi dalam julat frekuansi 0-10GHz. Perisian Microwave Office digunakan untuk simulasi dan rekaan bagi mendapatkan keputusan. Proses simulasi mestilah mennjukkan kehilangan balikan bagi antena planar $\leq$ -10 dB, gandaan, bentuk radiasi, peratusan jalur lebar dicapai, SWR dan sebagainya bagi antenna planar.

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LIST OF ABBREVIATIONS

BW	Bandwidth
CAD	Computer Aided Design
CP	Circular polarization
CPW	Coplanar waveguide
DCS	Digital Communication System
dB	a logarithmic unit of measurement power.
ε_r	Dielectric constant
FR4	Flame Retardant 4
FNBW	Full Null Bandwidth
f_L	Frequency lower
fr	Frequency response
fu	Frequency upper
GSM	Global System for Mobile
GPS	Global Position System
GHz	Giga Hertz
h	height
HPBW	Haft Power Bandwidth
IMT	International Mobile Telecommunication
ISP	Internet Service Provider.
L	Length
LAN	Local Area Network
MHz	Mega Hertz
MIC	Microwave integrated circuit
mm	millimeter
MSA	Microstrip antenna

PCS	Personal Communication System
PDA	Personal Digital Assistants
PIFA	Planar Inverted-F
PILA	Planar Inverted-L
RMSA	Rectangular Microstrip antenna
RM	Rectangular monopoles
RL	Return Loss
SM	Square monopole
SMA	Square Monopole Antenna
SWR	Signal Wave Ratio
tan δ	Loss Tangent
TE	Transverse Electric
TM	Transverse Magnetic
UMTS	Universal Mobile Telecommunication System
W	Width
WDCMA	Wideband Code Division Multiple Access
WLAN	Wireless local area network
WPAN	Wireless Personal Area Networks
VHF	Very High Frequency
VSWR	Voltage standing-wave ratio
λ/2	half wavelength
λ/4	quarter wavelength

CHAPTER 1

PROJECT INTRODUCTION

1.1 Introducton

Today, wireless communications have progressed very rapidly and many mobile units are becoming smaller. Of the many factors that determine the quality of wireless communication, the characteristic of the antenna is one of the most important factors to be considered. Patch antennas are widely used for antenna elements because they can be manufactured easily [1]. However, their bandwidth is narrow and we cannot achieve a wider bandwidth. Their narrowband is up to 3%. Also, the size of the antenna has a problem at a low frequency band [2]. Such problems can be resolved by using substrate materials, advancing the manufacturing technology and varying design method. In others hands, for that the rapid development needs the new technology in antenna design to solve the problem.

Planar antennas, such as microstrip have the attractive features of low profile, small size, and conformability to mounting hosts and are very promising candidates for satisfying this design consideration. For this reason, compact and broadband design techniques for planar antennas have attracted much attention. Very recently, especially after the year 2000, many types planar antenna was designed to satisfy specific bandwidth specifications of present-day mobile cellular communication systems growing very faster.

Types of planar antenna design can influence the percent of bandwidth. It is because compare to the microstrip antenna, planar antenna can offer a wider bandwidth and for that they can support more bandwidth. In this project, monopole planar antennas have been designing. It is having been popular for a variety of applications because of their simple structures but powerful performance and some planar elements have replaced the wire elements because of their broadband characteristics and simple structures. The dimension of ground at the bottom substrate has been compare in different dimension to see and achieved the broadband frequency of the planar antenna design.

For frequency range between 0GHz-10GHz, the planar antenna be can used for application including the digital communication system (DCS: 1710–1880 MHz), the personal communication system (PCS: 1850–1990MHz), and the universal mobile telecommunication system (UMTS: 1920–2170MHz). Also planar antennas are very attractive for applications in communication devices for wireless local area network (WLAN) systems in the 2.4 GHz (2400–2484MHz) and 5.2 GHz (5150–5350MHz) bands. Lastly the results in simulation and measurement should be fulfilling requirement for broadband application.

1.2 Objective Project

The alternative solution that can solve the microstrip antenna is by designing a planar antenna. For that, the objective planar antenna was design is, to be operating for broadband application. The designing antenna, used Microwave Office as a software to simulate the parameter likes return loss that must be achieved ≤ -10dB, radiation pattern that can show the power radiation from antenna, gain the antenna provide, bandwidth offered and also signal wave ration (SWR) that the antenna provide. For fabrication process, the antenna was fabricated above RF4 board by using etching technique. Lastly, the comparison between simulation and measurement result for antenna parameter that simulate by using Microwave software was done.

1.3 Problem Statement

Today, modern and future wireless systems are placing greater demands on antenna designs. Microstrip antenna is the one of that kind of antenna and have several advantages but not for their bandwidth. But the main problem of microstrip is, it has narrowband characteristic up to 3% [2]. For that, the alternative solution that can solve the microstrip antenna problem is by design planar antenna that can achieve greater bandwidth. Also the applications for antenna in previous design it is only limited to certain frequency and for that their application also limited. So, designing the antenna for various applications should be more attractive, especially for broadband applications.

1.4 Scope of the Project

The scopes that cover this project are designing the planar antenna to be operating at 2.4GHz for frequency range 0GHz -10GHz, which can offer broadband application for the antenna. Get some requirement for physical dimension for width, length, and ground dimension to design, and simulate the planar antenna by using Microwave Office software. The parameter and analysis of antenna design has been done to see their return loss, radiation pattern, gain, SWR, and others. Also, the antenna design was fabricate above RF4 board by using etching technique. And lastly, the comparison between simulation and measurement results has been done.

1.5 Method of Project

The project to design planar antenna involved some method to be followed. The first step is doing the literature review. The information about the project via internet, journals, magazines, published work and reference books was getting. Then, study the characteristic of planar antenna and convenient with the software that use in this project to design and for simulation purpose. After that, the designing process involved the analysis, and gets all the parameters related to design the planar antenna especially the size and what types and shapes of planar antenna to be design. All the shape that has been design are different and gives the difference performance especially for the antenna parameter like return loss, gain, and percent of bandwidth achieved.

Then, after the design of antenna has been selected with some dimension, the antenna was simulating by using Microwave Office software. The characteristics for the antenna likes return loss $\leq$ -10dB, radiation pattern, gain, SWR, bandwidth achieve must be finding. If any problems occur, the design of the planar antenna was checked. After that, did the fabrication process of planar antenna after the simulation result from Microwave Office make some requirement parameter that we want. The planar antenna was fabricated above Flame Retardant 4 board (RF4 board) by using chemical etching technique. The fabricated then repeat again if the fabrication process does not fulfill the requirement.

Lastly, after all the parameter has been achieved and fulfill the requirement, the planar antenna then tested to measure the results and compare between simulation results.

CHAPTER 2

LITERITURE REVIEW

2.1 Research Background

The history of antennas dates back to James Clerk Maxwell who unified the theories of electricity and magnetism, and eloquently represented their relations through a set of profound equations best known as Maxwell's equations. His work was first published in 1873. He also showed that light was electromagnetic and that both light and electromagnetic waves travel by wave disturbances of the same speed. In 1886, Professor Heinrich Rudolph Hertz demonstrated the first wireless electromagnetic system. It was not until 1901 that Guglielmo Marconi was able to send signals over large distances. He performed, in 1901, the first transatlantic transmission from Poldhu in Cornwall, England, to St. John's, Newfoundland. From Marconi's inception through the 1940's, antenna technology was primarily centered on wire related radiating elements and frequencies up to about UHF.

It was not until World War II that modern antenna technology was launched and new elements were primarily introduced. While World War II launched a new era in antennas, advances made in computer architecture and technology during the 1960-1980's have had a major impact on the advance of modern antenna technology, and they are expected to have an even greater influence on antenna engineering in the 1990's and beyond [3] because the development of an antenna design was growing faster to meet some requirement for certain applications.

The rapid development of wireless communication systems is bringing about a wave of new wireless devices and systems to meet the demands of multimedia applications. Multi-frequency and multi-mode devices such as cellular phones, wireless local area networks (WLANs) and wireless personal area networks (WPANs) place several demands on the antennas. Primarily, the antennas need to have high gain, small physical size, broad bandwidth, versatility, embedded installation, and so on.

In particular, as we shall see, the bandwidths for impedance, polarization or axial ratio, radiation patterns and gain are becoming the most important factors that affect the application of antennas in contemporary and future wireless communication systems. Table 2.1 shows the operating frequencies of some of the most commonly used wireless communication systems. The most importantly, the antennas should be well impedance-matched over the operating frequency range. More often than not, the antennas are electrically small in size, which significantly narrows the impedance bandwidth and greatly reduces radiation efficiency or gain [4].