DESIGN OF A CIRCULAR POLARIZATION MICROSTRIP ANTENNA AT 2.4GHZ

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In the loving memory of my father…..

To my beloved family…..

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ABSTRACT

Microstrip patch antennas represent one family of compact antennas that offer a conformal nature and the capability of ready integration with communication system's printed circuitry. In this project, a 2.4 GHz circular polarization microstrip antenna is designed, constructed and measured. The microstrip antenna chose is a dual –fed circular polarized microstrip antenna. The antenna consists of rectangular patch and 3 dB hybrid. The dual – fed circular polarized microstrip antenna is etched on a FR4 with dielectric substrate of 4.5 with the height of 1.6 mm. Circular polarization is obtained when two orthogonal modes are equally excited with 90° phase difference between them. Circular polarization is important because regardless of the receiver orientation, it will always able receiving a component of the signal. This is due to the resulting wave having an angular variation.

ABSTRAK

Antena mikrojalur mewakili salah satu kumpulan antena termampat yang mempunyai sifat penyesuaian dan kebolehan untuk berintegrasi degan litar bercetak di dalam sistem komunikasi. Dalam projek ini, antena mikrojalur polarisi bulat pada frekuensi 2.4 GHz direka, difabrikasi dan diukur. Antena mikrojalur yang dipilih untuk projek ini ialah antena mikrojalur dua – suapan polarasi bulat. Antena ini terdiri daripada bahagian segiempat tepat dan 3 dB hibrid. Antena mikrojalur dua – suapan polarasi bulat difabrikasikan di atas FR4 dengan pemalar dielektrik 4.5 dan tinggi 1.6 mm. Polarasi bulat diperolehi apabila dua mod bertentangan diuja bersama dengan 90° perbezaan fasa di antara mereka. Polarasi bulat sangat penting kerana tidak kira kedudukan antena penerima, ia akan sentiasa dapat menerima komponen isyarat. Ini kerana, gelombang yang dihasilkan mempunyai variasi bersudut.

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mm	-	milimeter
dB	-	decibel
Hz	-	hertz
K	-	kilo
d	-	diameter
h	-	height
L	-	length
W	-	width
Γ	-	reflection coefficient
Z_0	-	characteristic impedance
λo	-	free-space wavelength
ε_r	-	dielectric constant of the substrate
t	-	patch thickness
c	-	speed of light 3x 10^{-8} m/s

CHAPTER 1

INTRODUCTION

1.1 Introduction

Microstrip antenna technology began its rapid development in the late 1970s. By the early 1980s basic microstrip antenna elements and arrays were fairly well establish in term of design and modeling [1]. In the last decades printed antennas have been largely studied due to their advantages over other radiating systems, such as light weight, reduced size, low cost, conformability and possibility of integration with active devices.

Therefore, this project is aimed to design a circularly polarized antenna at 2.4 GHz. The main advantage of using circular polarization is that regardless of receiver orientation, it will always receive a component of the signal. This is due to the resulting wave having an angular variation [2].

This microstrip antenna consists of a radiating patch on the dielectric substrate. There are various shapes that can be used as the radiating patch. However, for this project, square patch with 3 dB hybrid will be designed. With dual feeding methods, two orthogonal modes are equally excited with 90° phase difference

between them, thus the antenna will polarize circularly. The microstrip antenna is simulated and tested using Microwave Office, where electromagnetic analysis tools will be used.

The designed is fabricated and tested with network analyzer. Both simulated and measured results will be compared.

1.2 Wireless Local Area Network (WLAN) System

Wireless LAN can be used either to replace wired LAN, or as an extension of the wired LAN infrastructure. There are in general two types of antennas for WLAN applications, fixed WLAN base stations or access points, and the other is for mobile communication terminals.

For base station applications, impedance matching for WLAN bandwidth should be better than 1.5:1 VSWR or about 14 dB return loss [3], similar to the cellular system base station. Antenna that capable to excite circular polarization is very attractive because it can overcome the multipath fading problem, thus enhance the system performance, especially indoor WLAN operation [3].

Currently, the most commonly used WLAN system is the IEEE 802.11b system [4]. A key requirement of WLAN system is that it should be low profile, where it is almost invisible to the user. For this reason, the microstrip patch antennas are the antennas of choice for WLAN use due to their small real estate area and the ability to be designed to blend into the surroundings.

1.3 Objective

The objective of this project is to design, simulate, and fabricate a circular polarization microstrip antenna at 2.4 GHz frequency. The microstrip antenna uses dual feed techniques. The microstrip antenna is then simulated, fabricated and measured.

1.4 Scope of work

The project started with designing the microstrip antenna. Then, the microstrip antenna is simulated using the Microwave Office software. After the simulation, the microstrip antenna is fabricated using FR4, with dielectric constant (ε_r) 4.5 and height of 1.6 mm. Finally the microstrip antenna is measured using the network analyzer and the measured values are compared with the simulated values.

1.5 Outlines of thesis.

The outlines of the thesis are as follows:

Chapter 1: This chapter provides the introduction to the project, objective and scope of work.

Chapter 2: This chapter covers the literature review on the microstrip antenna, the antenna properties, and the feeding methods.

Chapter 3: This chapter covers polarization topic, such as linear and circular polarization. This chapter also covers the available microstrip antenna that excites circular polarization.

Chapter 4: Chapter 4 consists of the microstrip design, simulation and fabrication process of the microstrip antenna.

Chapter 5: This chapter provides the results that are obtained from the simulation as well as from the measurement.

Chapter 6: This chapter gives the conclusion and future work for this project.

1.6 Summary

This chapter provides introduction of the project, followed by a brief explanation about wireless local area network (WLAN). This chapter also covers the objective of the project, as well as scope of work that involved. Finally, a summation of each chapter is briefly outlined.

CHAPTER 6

CONCLUSION

6.1 Conclusion

There is various type of microstrip antenna that is able to excite a circular polarization. For this project, dual – fed circular polarization microstrip antenna is chosen. The microstrip antenna is design to operate at 2.4 GHz frequency. The dual –fed circular polarization microstrip antenna is successfully implemented and fabricated. The microstrip antenna resonates at 2.47 GHz and gives a good return loss, which is -23.25 dB. This is a good value because only 0.47 % power is reflected and 99.53 % power is transmitted. The VSWR of the microstrip antenna is 1.2:1, which shows that the level of mismatched for the microstrip antenna is not very high. High VSWR means that the port is not properly matched. The bandwidth of this microstrip antenna is also good, which is 17.04 % and the maximum radiation occurs at -40° with gain of 4.28 dB. The microstrip antenna is said to be circular if the axial ratio is 0 dB. From the calculation of axial ratio, most of the angles give 0 dB value, thus prove that the microstrip antenna polarize circularly.

6.2 Future work

There is various type of antenna that can excite circular polarization. In dual feed circular polarization, the rectangular patch can be changed to circular patch. There is also off line feeding method in dual –fed circular polarization microstrip antenna. Besides dual fed, there is also a singly – fed circular polarization. Therefore, in future work, different type of circular polarization can be designed and studied, so that, a comparisons can be made to the antennas, thus better microstrip antenna that excites circular polarization can be obtained.

The dual – fed circular polarization microstrip antenna can also be arranged in an array and become the phase array antenna. This phase array antenna can steer the radiation without physically moving the antenna. This antenna can be applied to satellite communication. The circular polarization is particularly desired since the polarization of linear polarized radio wave may be rotated the signal passes any anomalies (such as Faraday rotation) in the ionosphere. Furthermore, due to the position of the Earth with respect to the satellite, geometric differences may vary especially if the satellite appears to move with respect to the fixed Earth bound station. Circular polarization will keep the signal constant regardless of these anomalies.

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