

DESIGN A CIRCULAR POLARIZATION PATCH ANTENNA WITH THE
PRESENCE OF AIR LAYER SUBSTRATE AT 2.45 GHz

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Tajuk Projek : DESIGN A CIRCULAR POLARIZATION PATCH
ANTENNA WITH THE PRESENCE OF AIR LAYER
SUBSTRATE AT 2.45 GHz

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For the most beloved and supporting parents,

AHAMAD ASBANI BIN JIMAN

BAHAYUM BINTI SALLEH

Dedicated, in thankful appreciation for the support, encouragement, love and understanding.

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ABSTRACT

The project purpose is to design and develop the circular polarization patch antenna with the presence of air layer substrate at 2.45 GHz. The development is based on circular polarization for patch antenna focus on reader RFID application at 2.45 GHz. However, with the presence of air layer substrate, it able to wider the bandwidth so several application in area of 2.45 GHz also should be considered. Patch antenna is used because it provides light weight and low cost suitable with the small antenna types other than the used of this technology is already for several decades. Then, the antenna is design through the CST software and fabricated at the FR-4 board. The performance of the antenna will be measure regarding the parameter characteristics suitable with the performance of the design. Regarding the polarization, circular polarization is obtained when two orthogonal modes are equally excited with 90° phase difference between them. Here, the project have been done by simulation and measurement. The design was start by done the simulation in order to gain resonance frequency or center frequency at 2.45 GHz with the dimension of patch that characterizes first. Then, when the simulation results gave the targeted results, so it proceeded by fabrication process and finally the measurement test was obtain through the fabricated patch antenna. Next, the comparison have been made between the simulation and measurement results.

ABSTRAK

Projek ini dirancang bertujuan untuk membina antenna tampal (patch) berpolarisasi bulat dengan kehadiran lapisan udara pada frekuensi 2.45 GHz. Pembangunan ini disasarkan kepada polarisasi bulat untuk antenna tampal yang memberi tumpuan kepada aplikasi Pengenalalan Frekuensi Radio (RFID) di frekuensi 2.45 GHz. Namun, dengan kehadiran lapisan udara, ia mampu melitupi lebar pita yang lebih luas sehingga beberapa aplikasi dalam ruangan sekitar 2.45 GHz juga harus dipertimbangkan. Antenna tampal digunakan kerana ianya ringan dan murah sesuai dengan jenis antenna kecil yang lain dari pemanfaatan teknologi ini kerana telah digunakan sejak beberapa dekad yang lalu. Kemudian, antenna direka bentuk melalui perisian CST dan direka cipta di atas papan FR-4. Seterusnya, tahap prestasi antenna yang telah direka cipta tersebut diukur dengan berpandukan penentuan yang bersesuaian dengannya. Polarisasi bulat diperoleh apabila dua mod bertentangan diuja bersama dengan 90° perbezaan fasa di antara mereka. Reka bentuk ini bermula dengan melakukan simulasi dengan mereka dimensi untuk saiz antenna tampal untuk mendapatkan frekuensi pusat pada 2.45 GHz. Kemudian, apabila hasil simulasi daripada reka bentuk melalui perisian yang digunakan memberikan keputusan seperti yang dijangka, antenna tampal tersebut akan melalui proses pembuatan dan akhirnya proses pengukuran dan uji kaji dijalankan untuk memperoleh keputusannya. Selanjutnya, perbandingan dilakukan untuk membandingkan keputusan antara hasil simulasi dan uji kaji.

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LIST OF ABBREVIATIONS

CST – Computer Simulation Technology

RFID – Radio Frequency Identification

FR-4 – Fire Retardant 4

WiMAX – Worldwide Interoperability for Microwave Access

Wi-Fi – Wireless Fidelity

WLAN – Wireless Local Area Network

VSWR – Voltage Standing Wave Ratio

UV – Ultra Violet

UHF – Ultra High Frequency

dB – decibels

IEEE – International Electrics and Electronics Engineering

BW – Bandwidth

HPBW – Half Power Beamwidth

FNBW – First Null Beamwidth

ϵ_r - dielectric constant of the substrate

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CHAPTER 1

INTRODUCTION

1.1 Project Background

The patch antenna is one type of radio antenna that mounted on the flat surface with low of profile [1]. The flat surface consists a sheet of metal or normally known as patch is mounted over the larger sheet metal called ground plane. The patch antenna normally easy to fabricate, modify and also customize. Other than that, it also small in size compare with other large antenna and light weight so easy to carry everywhere depends on the application. The patch antenna is one of the microstrip antenna with the wavelength is one-half of the radio wave. The patch antenna normally needed the presence of dielectric substrate on the same board in order to enhance the radiation mechanism during transmission and reception process. The technology of microstrip antenna is develop start on the late 1970s and in the early 1980s, the basic mirostrip antenna element in term of design and modeling is established [2].

Therefore, this project was aim to design and develop a circular polarization patch antenna at frequency of 2.45 GHz with the presence of air layer substrate as the dielectric constant. The development is then needed to observe and analyze about the effect of air layer substrate on that antenna. The main advantage of using circular polarization is because of it as a receiver orientation so that it can always receive a

signal even from different axis of transmission. This is due to the resulting wave that having an angular variation which can detect the signal in different angle.

This project used the truncated corner patch antenna in order to enhance the circular polarization effect. Other than that, the different thickness of air layer is also varied to observe the bandwidth that cover at frequency of 2.45 GHz. The antenna is simulated and tested using CST software and then fabricated on FR-4 board based on the dimension resulting from simulation. After that, the results of an antenna is measured at the network analyzer and other antenna test equipment to compare simulation and measured findings.

1.2 Problem Statement

The main reason to design this type of antenna is because of improvement in bandwidth. Some of the problem happen to the patch antenna is it provide narrow bandwidth and this make the antenna less practical for other application in one patch antenna. So, by the improvement in bandwidth with the presence of air layer substrate, the patch antenna can be used at different application because the bandwidth is wider. Other than that using the circular polarization for the patch antenna it can better in detect the signal in different angular variations.

1.3 Objectives

The objectives of this project were to:

1. Design and develop microstrip patch antenna at 2.45 GHz with presence of air layer substrate.
2. Fabricate the antenna with the specified characteristics based on simulation results.
3. Perform measurement regarding the appropriate characteristics in order to compare simulation and measurement results.

1.4 Project Scope

This project requires the use of hardware and software related to the antenna design in order to gain the centre frequency at 2.45 GHz. Here, the software tools used is Computer Simulation Technology (CST) software. The CST software commonly used to design and test the antenna design. The related software should be understood to improve the knowledge before start the designing process using that software. The first part was need to be design the efficient antenna with consideration of their characteristics. Before that, the size and frequency of the antenna will decide first to make sure the design can operate better at 2.45 GHz. Then, the design should be simulated and fabricated using FR-4 board with the permittivity ϵ_r is 4.3. The antenna was then test using network analyzer, spectrum analyzer and other antenna test equipment to compare the simulation results with the measurement results. The radiation pattern of patch antenna is measured with different axis which is horizontal and vertical axis to observe the polarization and different angle to get which angle will provide less power losses for the design.

CHAPTER 2

LITERATURE REVIEW

2.1 Small Size Antenna

The antenna is an equipment that function to transmits or receives the electromagnetic waves. In other words, antenna converts electromagnetic radiation into electric current. From Webster's Dictionary, the antenna is a metallic device that function for radiating or receiving radio waves and by the description of IEEE Standard, it is a means for radiating or receiving radio waves. So, the antenna is the transitional structure between free-space and a guiding device [1].

Antennas generally work in the transmission and reception of radio waves, and are a necessary part of all radio waves equipment and communication [1]. Antennas are used in several system such as radio and television broadcasting which both of this contributed most antenna application. Other than that, antenna also used in point-to-point radio communication, wireless LAN, cell phones, and radar applications. The antenna physically is an arrangement of one or more conductors called as elements. In transmission system, the voltage applied at antenna terminals causing the element to radiated an electromagnetic field. In the receiver or reception part, the electromagnetic field that produce from the transmission part is induced the alternating current in the elements and next communicate the voltage for the antenna terminals. However, for some receive antenna such as parabolic and horn antenna are

integrated shaped reflective surface in order to collect the radio waves. Both types of antenna is focus and strike onto the actual conductive elements.

Based on the design specification for this project, the researchers is focus on the small antenna types. The small antenna means the small in size of antenna compare with the other huge antenna out there in market. When deal with small antenna types, the key point to consider is when it was a small antenna, there is no magic cure to make it act like a large antenna types. The small antenna types is required higher ability to take care in order to obtain higher efficiency same as the large one. This kind antenna can work more efficient when the current is considered as uniform as possible over the length of antenna using as much as capacitance at the ends of antenna. The other things should be consider is loss which is the size, length and diameter for the small size antenna contributed low loss so that it can work like the large type of antenna.

2.1.1 Microstrip Antenna

The microstrip antenna is one of small type antenna. Because of this project which focuses on the small antenna types, the microstrip type is one of the choices can be consider for the project design. The microstrip antenna also known as printed antenna and the most popular types is microstrip patch antenna or patch antenna [1]. A patch antenna normally is a flat sheet of metal that mounted over a larger sheet metal named as ground plane. The patch antenna normally radiated perpendicular to the ground plane. The common shapes for the microstrip patch is square, rectangular, circular, truncated corner and elliptical.

Microstrip patch antenna is more interested because of the compact size, light weight and low cost for manufacturing by the used of printed circuit technology[1]. The microstrip technique is used to produce lines that contributed signals for the transmission waves. The patch element that formed on the top surface of a thin dielectric substrate separate them from the conductive layer at the bottom of substrate and the top bottom layer is the ground plane thus constitute a line of transmission and radiation of antenna. For the patch antenna, the dimension and