RECTANGULAR SLOT ANTENNA FOR UWB APPLICATIONS

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To,

My beloved husband, Mohd Fakrul Razi, both parents and parents in law and all my family's member for their unwavering love, sacrifices and inspirations.

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ABSTRACT

Design and construction of rectangular slot antenna for Ultra wideband (UWB) applications is proposed. The proposed antenna has capability of operating frequencies in the range of UWB system which is 3.1GHz to 10.6GHz. The design is demonstrated assuming FR4 substrate with a relative dielectric constant of 4.4 and thickness of 1.6mm. The simulation base antennas are constructed and parametric study has been carried out on ground patch, cutting slot and patch size in order to optimize the performance. Final design rectangular antenna with slot has been fabricated The presented results shows that the designed antenna of 30mm x 30mm rectangular antenna has overall bandwidth within acceptable range in order to compromise UWB applications within 3,1GHz to 10.6GHz. Measured return loss in (dB) demonstrates that the rectangular patch with slot provides better impedance bandwidth compare to conventional antenna.

ABSTRAK

Reka bentuk segiempat sama “slot antenna” telah dicadangkan untuk “Ultra wideband (UWB)” aplikasi. Antena yang dicadangkan mempunyai keupayaan beroperasi pada frekuensi “UWB” iaitu daripada 3.1GHz sehingga 10.6GHz. Reka bentuk antenna ini menggunakan material “FR4” dengan spesifikasi ketebalan 1.6mm dan keupayaan pengalir elektrik 4.4. Pelbagai teknik dkaji seperti pengubahsuaian saiz antenna bagi mendapatkan antenna yang bagus. Hasil antenna yang direka adalah 30mm x 30mm saiz dan berkeupayaan beroperasi dalam linkungan frekuensi yang ditetapkan oleh “UWB” system.

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LIST OF SYMBOLS

ε_r	-	Dielectric constant/permittivity
h	-	Conductor thickness
f	-	Frequency
f_H	-	High frequency
f_L	-	Low frequency
λ	-	Wavelength
Γ	-	Reflection coefficient
tan δ	-	Conductor loss
Z_L	-	Load impedance a
Z_0	-	Characteristic impedance.
ω	-	Radian frequency
Pr	-	Radiated power
Pt	-	Transmitted power
H	-	Efficiency
Rr	-	Radiation resistance
R_L	-	Conductor Loss
D	-	Directivity
D o	-	Maximum directivity
U	-	Radiation intensity
Umax	-	Maximum radiation intensity
Uo	-	Radiation intensity of isotropic source
Prad	-	Total radiated power

LIST OF ABBREVIATIONS

CPW	-	Co-planar waveguide
D	-	Directivity
dB	-	Decibels
FCC	-	Federal Communication Commission
HPBW	-	Half Power Beamwidth
RL	-	Return loss
UWB	-	Ultra wideband
VSWR	-	Voltage standing wave ratio

CHAPTER 1

INTRODUCTION

1.1 Project Background

An antenna is defined as a device between free space and electronic circuitry which is very useful for transmitting and receiving radio waves that contain information. After late 1888, antenna becomes a part of electrical devices in wireless communication and Heinrich Hertz (1857-1894) was the person who demonstrated the existence of radio waves [1]. From those early days until now antenna used as transducer, transformer, radiator and energy converter in wireless communication system. Antennas are regarded as magical, yet ultra wideband (UWB) antenna [2] must surely be the most arcane and darkest of black magic.

Since the current wireless system increasing exponentially, the UWB technology can open new door for wireless communication system. UWB system plays a major role in communication system where the antennas are highly possible to become one of the wireless communications. The transmitting information or energy from transmission line converts into electromagnetic energy or waves, and spreads it into free space. At the receiving end, the incident electromagnetic energy strikes on antenna will be converted back to electrical signal for further process. The design of transmitters (Tx) and receivers (Rx) antenna for wireless communication can be in many different shapes and types which is based on application.

UWB technology has been introduced for imaging radar, communications, and localization applications. In 2002 Federal Communication Commission (FCC) authorized unlicensed use of UWB band starting from 3.1GHz to 10.6GHz. Start from that, the design of broadband antenna has become significantly important.

1.2 Problem Statement

There are so many shape and type of UWB antenna are available which cover wider bandwidth and also with a stop band notch capability [18-22]. Conventional antenna has some limitations which are operating bandwidth and gain. To overcome limitations of operating bandwidth, cutting slots has been explored. [1]. Slotting is a method where a part of the radiating element in a printed antenna is removed. By introducing slots, the bandwidth, resonance frequency and the return loss could be affected. [2]. Parametric study also has been focused instead of its limitations.

In this report, rectangular slot antenna for UWB applications has been introduced. The proposed rectangular slot antenna is designed based on microstrip patch calculation using transmission line model and cavity model analysis. [4]. The simulation is performed using commercially available simulation software CST Microwave Studio. The suggested antenna is successfully implemented on FR4 substrate PCB with dielectric constant 4.4 and thickness of 1.6mm in low-end PCB fabrication facilities. Thus, it will also affect the overall performance of the designed antenna. The rectangular patch antenna with slot provides the frequency range of UWB frequency range.

1.3 Objective

- Design and construct Ultra Wideband Antenna for UWB application
- To study the effect of the slotting technique on the proposed antenna.
- To extend the capability of the proposed antenna in various application such as biomedical imaging, GPS, and wireless communication.
- To design a small size, low cost, and low profile antenna.
- Utilize microstrip base PCB with FR4 substrate for patch type antenna
- Simulate design antenna using commercially available 3-D EM CAD tool
- Measure designed antenna characteristic.

1.4 Scope of the Project

This project will involve with designing small size and simple shape of slot antenna with operating frequency of 3.1-10.6 GHz. The challenges are in terms of:

- Broadband operation
- Return loss S11) <-10dB
- Constant Radiation Pattern across the frequency
- Maximum Gain and Good Efficiency
- Small in size
- Low cost

The performances of proposed antenna are measured by its return loss, radiation pattern and gain. The antenna will be simulated and optimized using electromagnetic simulation software, CST. Final task involve fabrication and measurement.

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