DESIGN OF STEP IMPEDANCE HAIRPIN RESONATOR

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This report is submitted in partial fulfillment of requirements for the award of Bachelor Degree of Electronic Engineering (Telecommunication Electronic Engineering) with honours

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Universiti Teknikal Malaysia Melaka

MAY 2007

UNIVERSITI TEKNIKAL MALAYSIA MELAKA
FAKULTI KEJURUTERAAN ELEKTRONIK DAN KEJURUTERAAN KOMPUTER

BORANG PENGESAHAN STATUS LAPORAN
PROJEK SARJANA MUDA II

Tajuk Projek : DESIGN OF STEP IMPEDANCE HAIRPIN RESONATOR

Sesi Pengajian : 2006-2007

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Specially for my loving mum, dad and to all my sisters and brothers.

ACKNOWLEDGEMENT

First and foremost, I would like to give Thanks to ALLAH SWT, for helping me through all the obstacles that I encountered during the work of this project.

I would like to express my appreciation to my supervisor, Mr Abd Shukur Bin Ja'afar for his support and guidance throughout this whole project. His wisdom, insight and knowledge, the social grace with witch he delivers his idea are a constant inspiration. He guided me so that I will continue to be in the correct path during the development of this draft. He provided a motivating and enthusiastic atmosphere during the many discussions we had. It was a great pleasure to do this thesis under his supervision.

I would like to thank my beloved family for their encouragement and never ending support. Their support and lovely companionship is another important source of strength for me. They spend all their time and effort on me. Without their devoted love and sacrifices, none of this would have been possible. My deepest appreciation goes to all my fellow friends for the companionship, fruitful suggestion, proof reading and wishes.

Lastly, I would like to acknowledgement every individual who give me a helping hand in order to achieve this accomplishment.

ABSTRACT

This project presents the design of a six order microstrip hairpin resonator filter. The hairpin filter is one of the most popular microwave frequency filters because of it is compact and does not require grounding The design is based on the edge parallel coupled regarding to the Chebyshev response. The initial procedure involves the development of a low pass prototype with cross couplings between non-adjacent resonators. The filter is designed at a center frequency of 2.44 GHz with a fractional bandwidth of 3.42%. This frequency is presenting for wireless LAN application and operates in the ISM (Industrial, Scientific and Medical) band which is covering from 2.4 GHz to 2.4835GHz. There are several steps to design this filter that are including by determine filter specifications, order of filter, low pass filter prototype elements, low pass to band pass transformation, physical dimension (width, spacing, length) and wavelength guide. The EM simulation of the filter design was completed on Microwave Office software and fabricated on FR4 substrate by using etching process. The explanation details for design procedure, simulated results, methods and techniques are discussed in this report.

ABSTRAK

Projek ini menampilkan rekabentuk mikro jalur penapis penyinar untuk 6 peringkat. Penapis Hairpin ini adalah salah satu diantara penapis gelombang mikro frekuensi rendah paling popular kerana bentuknya sangat padat dan tidak memerlukan penamatan bumi. Rekabentuk ini berdasarkan pada penapis sisi sepadan selari . Prosedur yang melibatkan pembinaan prototaip penapis lebar jalur dengan silangan pasangan antara tiada penyinar sebelahan. Penapis ini adalah direkabentuk pada frekuensi 2.44 GHz dengan jalur lebar 3.42%. Frekuensi jalur penapis ini adalah untuk aplikasi LAN tanpa wayar dan beroperasi dalam jalur ISM di mana ia merangkumi frekuensi dari 2.4GHz ke 2.4835GHz. Kaedah pengiraan mempunyai beberapa langkah-langkah untuk mereka bentuk filter ini, di antaranya adalah tentukan spesifikasi penapis, bilangan peringkat, penukaran lulus bawah ke lulus jalur, elemen penapis lulus bawah prototaip, dimensi fizikal (lebar, jarak dan panjang) dan panjang gelombang berpandu. EM (Elektromagnetik) simulasi pada rekabentuk adalah lengkap dengan menggunakan perisian Microwave Office dan di fabrikasi pada papan substratum FR4 dengan menggunakan proses goresan. Sebarang penerangan secara terperinci terhadap prosedur untuk proses rekabentuk, keputusan simulasi, kaedah dan teknik telah dibincangkan dalam bahagian laporan ini

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A	-	Worsening
BW	-	Bandwidth
fo	-	Center Frequency
f_L	-	Lower Cut-off Frequency
f_H	-	Higher Cut-off Frequency
Z_{in}	-	Input Impedance
Z_o	-	Characteristics Impedance
R_{in}	-	Input Resistance
R_o	-	Characteristic Resistance
ε_r	-	Relative Dielectric Constants
ε_{eff}	-	Dielectric
ε_o	-	Wavelength
h	-	Substrate Height
t	-	Thickness
L	-	Length
w	-	Width
s	-	Space
Gaps	-	Internal Between
Lumped	-	Lumped of Earth
PCB	-	Printer Board Circuit

CHAPTER I

INTRODUCTION

1.1 Introduction

The hairpin resonator filter is one of the most popular microstrip filter configurations used in the lower microwave frequencies. It is easy to manufacture because it has open-circuited ends that require no grounding [1]. Step impedance hairpin resonator that proposed filter designed for 2.442 GHz operating frequency which is suitable for ISM (Industry, Scientific and Medical) band application with 0.0835 GHz operating bandwidth [2]. Actually the hairpin resonator has get an intention and interest of many researcher and scientist to discover and develop this hairpin resonator because of its unique characteristics and widely used in telecommunication systems for filtering out unwanted frequencies [3]. To appreciate the concepts behind the hairpin filter, it would be helpful to have a background about the edge-coupled filter. A detailed procedure of the design of the edge-coupled filter can be found in [10].

The hairpin filter configuration is derived from the edge-coupled filter. To improve the aspect ratio, the resonators are folded into a "U" shape [2]. To design smaller resonator size, higher frequency is used as initial design references. Consequently, a resonator that resonates at lower frequency but with overall size of shorter than its half- wavelength can be achieved. [7] The basic design of this filter is using gaps to couple the 50 ohms half wavelength resonator together.[10] The coupling from one resonator to the other is through the gap between the two adjacent open ends, and hence is capacitive.[9]

In this project, a six pole microstrip hairpin filter for wireless LAN application is presented. WLAN operates in the ISM frequency band covering 2.4 GHz to 2.4835 GHz. The design specifications of the filter include a pass band ripple of 0.2 dB and a minimum attenuation of -25dB at 2.5 GHz. The minimum attenuation of -25dB at 2.5 GHz is chosen to prevent interference from Broadband Radio Service (BRS). BRS operates in the frequency range 2.5 GHz to 2.69 GHz.

The hairpin resonator filter is one of the most popular microstrip filter configurations used in the lower microwave frequencies. It is easy to manufacture because it has open-circuited ends that require no grounding. Its form is derived from the edge-coupled resonator filter by folding back the ends of the resonators into a "U" shape. This reduces the length and improves the aspect ratio of the microstrip significantly as compared to that of the edge-coupled configuration. The most popular microstrip filter in low microwave frequencies is the hairpin resonator filter. It does not require a large real estate as the edge-coupled filter. It also does not require critical grounding thus making manufacturing easier. There is however, very little literature that discusses the design of this filter. Microstrip filters play an important role in many RF applications. As technologies advances, more stringent requirements for filters are required. One of the requirements is compactness of filters.

1.2) Problem Statements

The problem nowadays are conventional filters are the physical size problems. To overcome these problem is designed the hairpin filters that are better performance and will be compact filter when have size reduction before previous filter

The second design problem is then reduced to a two stage process. First, circuit element values are found that yield the desired response. Second, dimensions are determined for the physical realization. If the resulting structure is not practical, new circuit values are obtained by redesign or by equivalent circuit transformations. The convenient feature of the above process is that the circuit design and realization problems are not a constrained type of problem and can be carried out essentially independent of each other. In effect, each element in the equivalent circuit is related to a specific part of the physical structure. The physical dimensions obtained for a given circuit design may not be desirable or practical, but in general they are uniquely determined by the above design process.

The third problem is several possible ways to approach the design problem. The experimental design approach based on measured coupling coefficients completely eliminates any consideration of complex equivalent circuits, dispersion, mode velocities, and parasitic elements, a wide variety of resonator structures can be accommodated with excellent results. Two negative aspects of this approach area dependence on the quality and expediency of the experimental measurements and the difficulty of predicting stop band selectivity spurious responses. In addition, each new frequency range and resonator construction may require additional experimental models and measurements.