WIDE BAND MICROSTRIP BANDPASS FILTER

THANALETCHUMI MOHAN

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CHAIRULSYAH WASLI
Lecturer
Faculty Electronics and Computer Engineering (FKEKK)
Universiti Teknikal Malaysia Melaka (UTeM),
Locked Bag 1200,
Ayer Keroh, 75450 Melaka

Tarikh: 9 / 5 / 2008

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Supervisor's Name : MR. CHAIRULSYAH BIN WASLI

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This project and research work is dedicated to my beloved parents for their loving caring throughout my life, my loving brother and sisters and my friends for their encouragement and love.

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ABSTRAK

Tesis ini membincangkan secara terperinci mengenai analisis, reka bentuk, simulasi, proses fabrikasi and pengujian penapis lulus jalur gelombang mikro. Penapis lulus jalur digunakan sebagai alat frekuensi pemilihan di kebanyakkan aplikasi gelombang mikro. Terdapat beberapa aplikasi untuk penapis lulus jalur. Sebagai contoh ia digunakan di bahagian keluaran pengayun elektronik untuk megambil keluar frekuensi ataupun di bahagian masukkan pengayun elektronik dan penguat untuk membenarkan frekuensi tertentu. Untuk tesis ini, pilihan selari pasangan topologi dipilih. Perisian MATLAB dan Advanced Design System digunakan untuk pengiraaan manakala Microwave Office Software digunakan untuk simulasi. Projek ini akan digunakan untuk mencari lebar jalur yang maksima yang boleh dicapai oleh turas dan selain itu ia digunakan untuk membandingkan pretasi lebar jalur yang berlainan, sebagai contoh pada 10%, 20% dan pada lebar jalur maksima. Turas ini direka pada pusat frekuensi 2.4GHz dengan 12% lebar jalur. Turas ini menggunakan FR4 sebagai substrat. Penapis lulus jalur ini merupakan calon terbaik untuk aplikasi perhubungan mikro.

ABSTRACT

This thesis report discusses analysis, design, simulation, fabrication and testing of a band pass filter by using microstrip technology. Bandpass filters are used as frequency selective devices in many RF and microwave applications. There is several application of a bandpass filter. For example it is used at the output of the oscillator to take out the required frequency or at the input of the receiver and the amplifier to pass the required frequency. In this report, the choice of parallel coupled line filter topology is discussed. MATLAB and Advanced Design System Software is use for calculation while Microwave office software is use for simulation. The project will be use to find the maximum bandwidth that be can achieve by the filter and beside that it also use to compare the performances of a different bandwidth for example bandwidth at 10%, 20% and at maximum bandwidth. The filter is designed at a center frequency of 2.4GHz with 12% bandwidth and using FR4 as a substrate. This filter can be good candidate for applications in the microwave communication.

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LIST OF TERMS

FR4	-	Flame Resistant 4
ADS	-	Advanced Design System
BW	-	Bandwidth
L	-	Length
S	-	Space
W	-	Width
ε_r	-	Relative Dielectric Constant
t	-	Thickness
ε_{ff}	-	Effective Dielectric Constant
Z_0	-	Characteristics Impedance
λ_g	-	Guide Wavelength
α	-	Attenuation Constant
α_d	-	Dielectric Attenuation Constant
α_c	-	Ohmic Attenuation Constant
$\tan \delta$	-	Dielectric Loss Tangent
Z_{oe}	-	Even Mode
Z_{oo}	-	Odd Mode
LAN	-	Local Area Network
GPS	-	Global Positioning System
RF	-	Radio Frequency
Z_L	-	Load Impedance
Z_s	-	Source Impedance
V_{in}	-	Incident Voltage
V_{rn}	-	Reflected Voltage

S_{11}	-	Return Loss
S_{21}	-	Insertion Loss
a_m^2	-	Ripple Height
a	-	Attenuation Height

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CHAPTER I

INTRODUCTION

1.1 INTRODUCTION

Bandpass filters are used as frequency selective devices in many RF and microwave applications. Filters are realized using lumped or distributed circuit elements. However with the advent of advanced materials and new fabrication techniques, microstrip filters have become very attractive for microwave applications because of their small size, low cost and good performance. There are various topologies to implement microstrip bandpass filters such as end-coupled, parallel coupled, hairpin, interdigital and combline filters.

This paper presents the design of a wide band microstrip bandpass filter with 12 % bandwidth centered at 2.4GHz. The filter design is concentrated on the parallel coupled microstrip filter using Flame Resistant 4 (FR4) as substrate. The FR4 board was chosen for this project because it is cheap and efficient. Parallel-coupled microstrip filters have been widely used in the RF front end of microwave and wireless communication systems for decades. Major advantages of this type of filter include an easy synthesis procedure, good repetition, and a wide range of filter fractional bandwidth.

The approaches used to achieve this project are through analysis, design, simulation, fabrication and testing. Computer simulation Microwave Office 2004 is used for designing the filter. Beside that, Matlab and Advanced Design System (ADS) software is used for calculation where it is used to determine width, space and length.

1.2 OBJECTIVES

The objectives of this project are:-

1. To design wide band microstrip bandpass filter with 2.4GHz operating frequency.
2. To achieve the maximum bandwidth of the filter.
3. To compare the performance of the filter by using different value of bandwidth and explain its trade off.

1.3 PROBLEM STATEMENT

The problem nowadays are most of the microstrip bandpass filters in the market has a limited bandwidth. To overcome this problem, wide band microstrip bandpass filter is designed. These wide bands are not easily obtainable with conventional filter implementations. The second problem is most of the filter with wide bandwidths is expensive. This project will develop a wide band filter with lower cost and higher performances.

1.4 SCOPE OF WORKS

The scopes of works in this project are:

1. To determine width, spacing and length of the bandpass filter.
2. Design the filter using Microwave Office software and simulate the designed filter to get the properties or specification of the filter.
3. To fabricate the wide band microstrip bandpass filter on the Microstrip Board.
4. To compare the simulation and the measurement value.

1.5 PROJECT METHODOLOGY

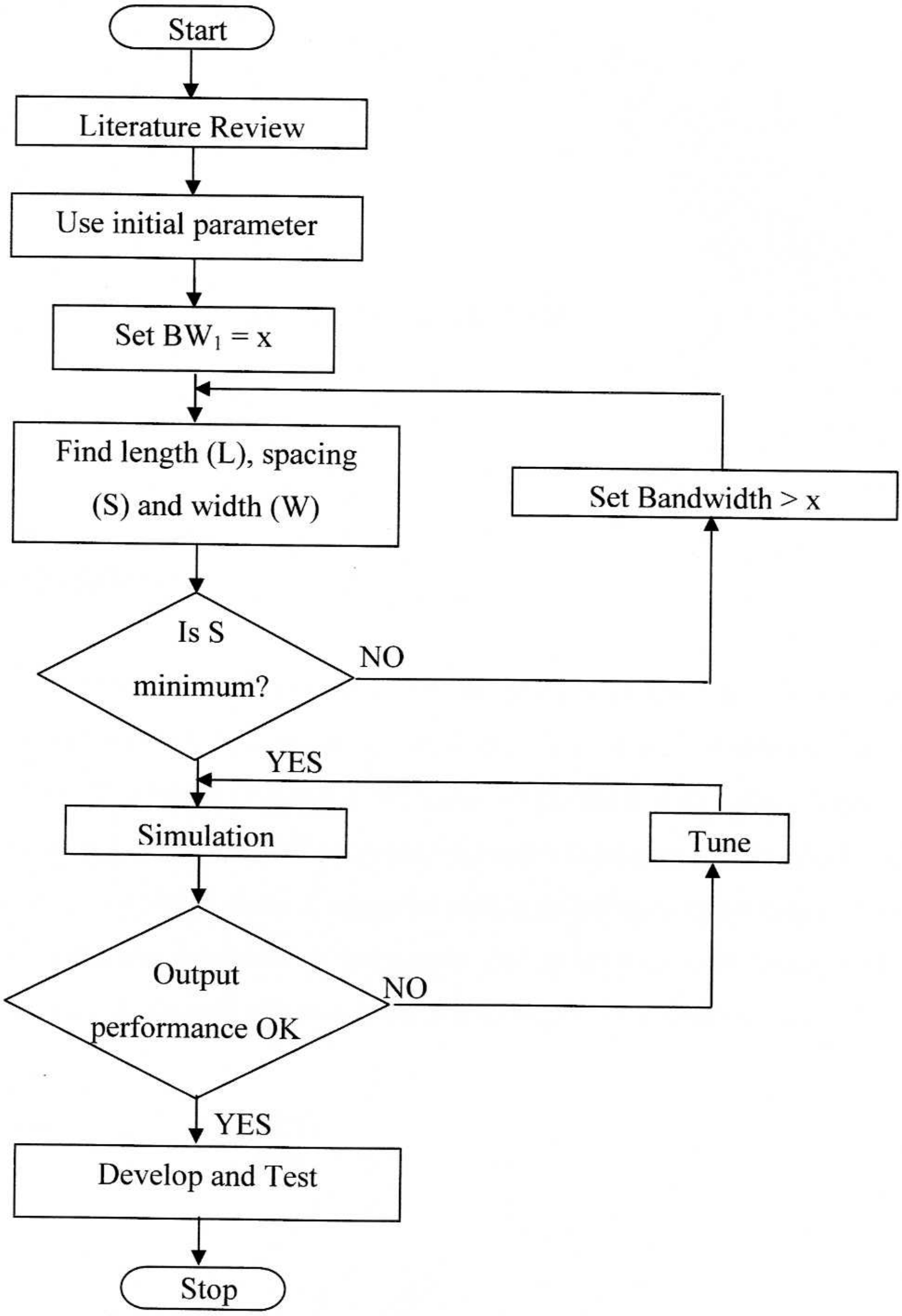

Figure 1.1: Flow Chart of Project Methodology

CHAPTER II

LITERATURE REVIEW

2.1 MICROSTRIP

Microstrip line is one of the most popular types of planar transmission lines. A microstrip transmission line is shown in Figure 2.1. It is a single conducting microstrip line with a width (w) and a thickness (t) on the top of a sheet dielectric substrate that has a relative dielectric constant (ε_r) and a thickness (h), and the bottom of the substrate is a ground plane. Compared with a stripline, a microstrip line uses only a single dielectric substrate. A microstrip line is dispersive in nature and its characteristics impedance and effective dielectric constant vary with frequency [1].

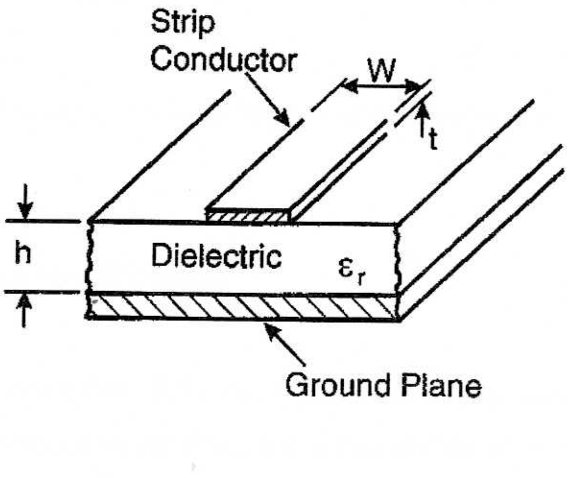

Figure 2.1: Microstrip Layout

2.1.1 Microstrip Lines

A microstrip lines consists of a single ground plane and thin strip conductor on a low loss dielectric substrate above the ground plane. Since the size of the microwave solid-state devices is very small (of the order 0.008-0.08mm^3), the technique of signal input to these devices and extracting output power from them uses microstrip lines on the surfaces on which they can be easily mounted. Figure 2.2 shows a typical cross-section of a microstrip lines. Due to absence of top ground plate and the dielectric substrate above the strip, the electric field remains partially in the air and partially in the lower dielectric substrate. Due to open structure and any presence of discontinuity, the microstrip line radiates electromagnetic energy. The radiation loss is proportional to the square of the frequency. The use of thin and high dielectric materials reduces the radiation loss to the open structure where the fields are mostly confined inside the dielectric [2].

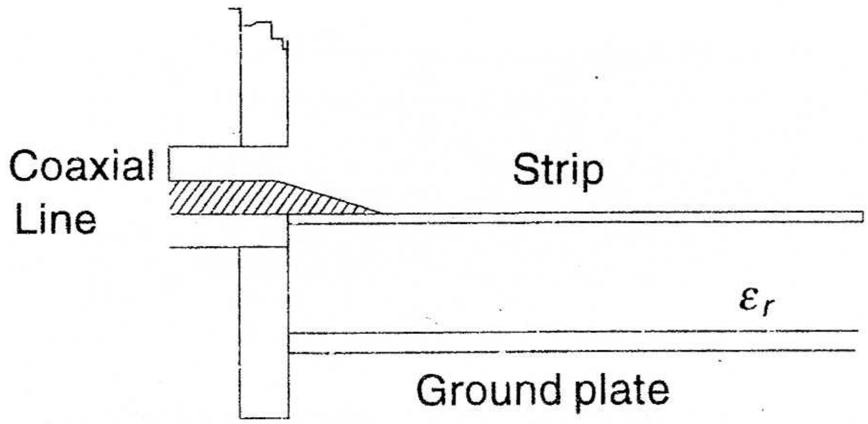

Figure 2.2: Cross Section of Microstrip Lines

2.1.2 Effective Dielectric Constant

Since the propagation field lines in a microstrip lies partially in air and partially inside the homogeneous dielectric substrate, the propagation delay time for a quasi-TEM mode is related to an effective dielectric constant ε_{eff} given by: