THE MINIMIZATION OF 5.75GHZ CHEBYSHEV BAND PASS FILTER

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Tajuk Projek : The Minimization of 5.75GHz Chebyshev Band Pass Filter

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Dedicated to my beloved parents

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ABSTRACT

This project presents the minimization of the conventional Chebyshev 9^{th} order band pass filter at center frequency of 5.75GHz. The minimization of the band pass filter has taken considerations on the same design specification and performances. This thesis compares the simulations of Chebyshev band pass filter designed on two different dielectric substances which are the TLY-5A and FR4. Besides, the differences between two miniaturized band pass filters and the conventional based on each dielectric substance can be evaluated in this project simulations. The fabrication of the miniaturized band pass filters are realized using the FR4 dielectric substance. The miniaturized band pass filters are named as V-Type Chebyshev 9^{th} order band pass filter and S-Type 9^{th} order Chebyshev band pass filter. The insertion loss of V-Type band pass filter fabricated on FR4 with dielectric constant of 5.2 is -10.852dB whereas the bandwidth is 294MHz at 5.75GHz. On the other hand, the insertion loss of S-Type band pass filter fabricated on FR4 is -12.56dB whereas the bandwidth is 290MHz at 5.75GHz. With this research, smaller band pass filter can be used in application such as RF front end receiver and other communication systems in the future.

ABSTRAK

Projek ini membentangkan tentang minimalisasi penapis lulus jalur konvensional Chebyshev 9 turutan pada frekuensi 5.75GHz. Pada masa yang sama, proses minimalisasi ini mempertimbangkan spesifikasi rekaan dan keberkesanan penapis tersebut. Tesis ini membandingkan simulasi penapis lulus jalur Chebyshev yang direka pada dua bahan dielektrik yang berbeza iaitu TLY 5A dan FR4. Selain itu, perbezaan antara dua penapis lulus jalur yang telah diminimalisasikan dengan penapis konvensional berdasarkan setiap bahan dielektrik boleh dinilai dalam simulasi projek ini. Penapis lulus jalur yang telah diminimalisasikan akan difabrikasi dengan menggunakan FR4. Penapis lulus jalur yang diminimalisasi terbahagi kepada dua jenis iaitu penapis lulus jalur Chebyshev 9 order jenis V dan penapis lulus jalur Chebyshev 9 turutan jenis S. Kehilangan sisihan penapis lulus jalur jenis V yang difabrikasi pada FR4 dengan pemalar dielektrik 5.2 ialah -10.852dB manakala lebar jalur ialah 294MHz pada 5.75GHz. Di samping itu, kehilangan sisihan penapis lulus jalur jenis S yang difabrikasi pada FR4 ialah -12.56dB manakala lebar jalur ialah 290MHz pada 5.75GHz. Dengan kajian ini, penapis lulus jalur yang lebih kecil boleh digunakan dalam aplikasi seperti penerima hadapan RF dan sistem komunikasi yang lain pada masa akan datang.

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NOMENCLATURE

1.	DGS	Defected Ground Structure
2.	EBG	Electromagnetic Band gap
3.	FR4	Flame Retardant Type 4
4.	GHz	Giga Hertz
5.	IEEE	Institution of Electrical and Electronic Engineer
6.	IL	Insertion Loss
7.	MHz	Mega Hertz
8.	MIC	Microwave Integrated Circuit
9.	MMR	Multimode Resonator
10.	PCB	Printed Circuit Board
11.	P_{LR}	Power Loss Ratio
12.	PTFE	Polytetrafluoroethylene
13.	RF	Radio Frequency
14.	SIR	Stepped-Impedance Resonator
15.	TEM	Transverse Electromagnetic Wave
16.	TLY-5A	Taconic TLY model 5A
17.	UV	Ultra Violet
18.	UWB	Ultra Wideband
19.	WLAN	Wireless Local Area Network

SYMBOLS

1.	%	Percentage
2.	ε_e	Effective Dielectric Constant
3.	ε_r	Dielectric Constant/ Relative Permittivity
4.	Δ	Fractional Bandwidth
5.	C	Capacitance
6.	d	Substrate Thickness
7.	dB	Decibel
8.	E	Electrical Phase
9.	g	Element Value
10.	J	Inverter Constant
11.	K_0	Wave Number
12.	L	Inductance
13.	m	M-Derived Constant
14.	N	Number of Order
15.	n	Number Of Order
16.	P	Physical Length
17.	P_{inc}	Incident Power
18.	P_{load}	Load Power
19.	R	Input Termination Resistance
20.	R_o	Source Impedance
21.	S	Space
22.	S_{11}	Return Loss
23.	S_{21}	Insertion Loss

24.	V_p	Phase Velocity
25.	W	Width
26.	Z0e	Even Impedance
27.	Z0o	Odd Impedance
28.	Z_o	Characteristic Impedance
29.	βl	Electrical Length
30.	λ	Wavelength
31.	Π	Pi
32.	Ω	Ohm
33.	β	Propagation Constant

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CHAPTER 1

INTRODUCTION

1.1 Filters

Radio frequency (RF) filter or microwave filter is a type of passive device with two ports network because it passes the desired signal and block the unwanted signal. Filters are commonly employed in microwave and millimeter-wave transceivers as channel separators. Basically, it have four types of frequency responses which are low pass, high pass; band pass and band stop characteristics.

Size reduction has becoming a major design consideration for practical applications in broadband wireless access communication system. As the size of the RF filter decrease, the application system will become smaller in size. Therefore, there is an increasing demand for low cost, light weight and compact size filters [1].

Current generation of miniature surface-mount RF and microwave filters based on variety of technologies to achieve small size while maintaining low pass band insertion loss with high out-of-band rejection. Nevertheless, the performances of the filter must not be influenced by the size and the design of compact filter should achieve fine system performances such as good bandwidth, low return loss and exact center frequency.

1.2 Objective

The objective of this project is to minimize and reduce the size of the conventional Chebyshev band pass filter at 5.75GHz.

1.3 Research Background

Filter is the most significant passive component used in microwave subsystem which is also the narrowest bandwidth components in the system. Thus, filter usually is the component which limits such system parameters as gain and group delay flatness over frequency [2]. The development of microwave filter had commenced since 1937, during the period of World War II, where the microwave filter had been widely developed [3]. A lot of researches demonstrated on variety of filter structures to realize both filter compactness and selectivity improvement. The most popular band pass and band stop filter configurations are parallel coupled line, combline, interdigital and hairpin line.

Andrew Elvis Simon and Lim Kuang Yaw stated that although traditional filter structures, like coupled lines, inter digital filters and hairpin filters do have good response over the microwave frequency range, yet, a more robust and efficient filter structure search is still desired [4]. This means that filter size reduction, selectivity improvement and spurious response control are the most recent research intentions. Over the years, the rapid development of Microwave Integrated Circuit (MIC) in radar, satellite, and mobile communications tends to evolve in term of bandwidth, size and cost. Wideband applications required coupled line microstrip and stripline filters because the demand on selectivity is not strict. On the other hand, wireless applications need miniature filters due to space and cost constraints [2].