Faculty of Electronic and Computer Engineering

DESIGN OF SWITCHABLE DUAL-BAND BANDPASS FILTER FOR WIRELESS COMMUNICATION

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Master of Science in Electronic Engineering

2018

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A thesis submitted
in fulfillment of requirements for the degree of Master of Science
in Electronic Engineering

Faculty of Electronic and Computer Engineering

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

2018

DECLARATION

I declare that this thesis entitled “Design of Switchable Dual-Band Bandpass Filter for Wireless Communication” is the result of my own research except as cited in the references. The thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

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APPROVAL

I hereby declare that I have read this thesis and in my opinion this thesis is sufficient in terms of scope and quality for the award of Master of Science in Electronic Engineering.

Signature	:	……………………………………………………….
Supervisor Name	:	PROFESSOR DR ZAHRILADHA BIN ZAKARIA
Date	:	……………………………………………………….

DEDICATION

Dedicated to ALLAH Almighty, my loving parents and my sister for your infinite and unfading love, sacrifice, patience, encouragement and best wishes

ABSTRACT

Due to the progression growth of multiservice wireless communication systems in a single device, multiband bandpass filter has attract a great attention to the end user. Therefore, multiband bandpass filter is a crucial component in the multiband transceivers systems which can support multiple services in one device. Multiband bandpass filter with wideband passband has been drawing a lot of interests of researcher to carry out innovative synthesis and techniques designing the multi-band bandpass filters with less complexity, minimal cost and high performance. Therefore, this thesis presents new technique in designing the switchable dual-band bandpass filter at 2.4 GHz and 3.5 GHz for WLAN and WiMAX applications. Firstly, the wideband bandpass filter was designed centred at frequency of 3 GHz. This filter was constructed by employing the topology of stepped impedance resonator (SIR). This method offer various benefits for instance minimizing the number of elements and transmission zeroes are achieved. As a way to eliminate the interference from existing system that operates in the frequency band, a defected microstrip structure (DMS) was applied and implemented to produce a wide notch band. As the DMS was integrated to the bandpass filter, the dual passband was produced centred at 2.55 GHz and 3.48 GHz with 3 dB bandwidth of 19.6 % and 18.7 %, respectively. In order to generate the switchable characteristic, the PIN diode was introduced at the dual-band bandpass filter. It exhibits that the measured results for switchable attributes when the diode is at OFF state, the wide passband is produced with the fractional bandwidth of 62.1 % centred at 2.9 GHz. Meanwhile, for the diode in ON state, the dual-passband has produced which centred at 2.5 GHz and 3.45 GHz. The first passband possess the fractional bandwidth of 24 % while the second passband is 20.3 %.This structure is very useful for wireless communication systems and applications as it can be easily integrated with other planar devices. Advanced Design System (ADS) software was used to simulate the design from circuit element to physical momentum realization. The experimental results showed good agreement with the simulated results. The benefits of the integrated band-pass filter and defected structure are the reduction of the overall size and ease to fabricate.

ABSTRAK

Disebabkan oleh perkembangan pelbagai servis sistem komunikasi tanpa wayar dalam satu peranti tunggal, pelbagai laluan jalur penapis telah mampu mendapat perhatian dari pengguna akhir. Oleh itu, pelbagai laluan jalur penapis merupakan komponen penting dalam sistem penghantar terima pelbagai jalur yang boleh menyokong pelbagai servis dalam satu peranti. Pelbagai jalur laluan jalur penapis dengan berjalur lebar tinggi laluan lulus telah menarik minat penyelidik untuk menjalankan sintesis yang inovatif dan teknik-teknik baru dalam menghasilkan pelbagai jalur penapis yang kurang kompleks, kos minima dan mempuyai prestasi yang tinggi. Oleh itu, kajian projek ini membincangkan teknik-teknik baru dalam mereka-bentuk suis dwi-jalur laluan jalur penapis pada 2.4 GHz dan 3.5 GHz untuk aplikasi WLAN dan WiMAX. Pertama, penapis laluan jalur berjalur tinggi direka berpusat di frekuensi 3 GHz. Penapis ini dibina dengan menggunakan topologi langkah galangan penyalun. Kaedah ini menawarkan pelbagai manfaat seperti mengurangkan bilangan unsur dan mencapai sifar penghantaran. Salah satu cara untuk menghapuskan gangguan dari sistem sedia ada yang beroperasi dalam jalur frekuensi, struktur mikrostrip yang telah dirosakkan telah digunakan dan dilaksanakan untuk menghasilkan jalur takuk yang luas. Apabila struktur yang dirosakkan disatukan bersama laluan jalur penapis, dua penapis laluan lulus terhasil pada 2.55 GHz dan 3.48 GHz dengan 3 dB jalur lebar untuk 19.6 % dan 18.7 %. Untuk menghasilkan ciri-ciri yang boleh suis, PIN diod diperkenalkan di dwi-jalur penapis laluan jalur. Ia mempamerkan bahawa keputusan ukuran bagi ciri-ciri boleh suis apabila diod adalah pada keadaan 'OFF', laluan lulus luas dihasilkan dengan lebar jalur pecahan 62.1% berpusat pada 2.9 GHz. Sementara itu, bagi keadan 'ON', dwi-jalur laluan telah dihasilkan dan berpusat di 2.5 GHz dan 3.45 GHz. Jalur laluan yang pertama mempunyai lebar jalur pecahan 24 % manakala jalur laluan kedua adalah 20.3 %. Struktur ini sangat berguna untuk sistem tanpa wayar kerana dengan mudah dapat dintegrasikan bersama peranti satah lain. Perisian Advanced Design System (ADS) telah digunakan untuk simulasi reka bentuk daripada elemen litar bagi merealisasikan momentum fizikal. Keputusan eksperimen menunjukkan kesepadan yang baik dengan keputusan simulasi. Manfaat penapis jalur bebas bersepadu dan struktur yang telah dirosakkan adalah berjaya menguranganKan saiz keseluruhan dan memudahkan untuk di fabrikasi.

ACKNOWLEDGMENTS

Alhamdulillah, first of all, I would like to express my gratitude to Almighty for blessing me with strength and courage to complete this thesis. From the beginning till the end of this thesis, I have so many people who stand by me; given me guidance for every obstacle that stand in my way. Therefore, I would like to express my deepest appreciation to those involved in this report.

Words cannot express my gratitude towards my supervisor, Professor Dr. Zahriladha Bin Zakaria for the patience and humble supervision in the course of his project. May the sky be your limits in all your future endeavours and may jannatul-firdaus be your abode in the hereafter.

Last but not least, I would like to express my appreciation to my beloved parents Madam Rabiah Binti Hussein and my late father Mr Masrukin Bin Ideris as well as my sister and grandmother for the unconditional love and support that let me through the toughest days in my life. To all my friends who shared ideas to make my thesis better especially Nur Shaheera Alia, I hope we can have a good grade for our effort. For those whom not stated here, I would like to thank for their help, friendship and countless support to me. May Allah S.W.T. bless all of them for their support and kindness.

Thank you.

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LIST OF ABBREVIATIONS

ADS	-	Agilent Technology Advanced Design System
BB	-	Baseband
BPF	-	Bandpass Filter
CDMA	-	Code Division Multiple Access
CRLH	-	Composite Right/Left-Handed
DGS	-	Defected Ground Structure
DMS	-	Defected Microstrip Structure
EM	-	Electromagnetic
EBG	-	Electromagnetic Band Gap
FM	-	Frequency Modulation
GSM	-	Global System for Mobile communication
LNA	-	Low Noise Amplifier
MEM		Microelectromechanical
NB-SRR	-	Non-Bianisotropic Split-Ring Resonator
OCSR		Open Circuit Stub Resonator
PBG	-	Photonic Band Gap
RF	-	Radio Frequency
RX	-	Recieve

SDR	-	Software Defined Radio
SEWBPF	-	Single-Ended Wideband Bandpasss Filter
SICL	-	Substrate Integrated Coaxial Line
SILPF	-	Stepped-Impedance Low Pass Filter
SIR	-	Stepped Impedance Resonator
SR	-	Software Radio
TEM	-	Transverse Electromagnetic
TX	-	Transmit
UE	-	Unit Element
UHF		Ultra High Frequency
UIR		Uniform Impedance Resonator
UWB	-	Ultra-Wideband
VHF		Very High Frequency
VNA	-	Vector Network Analyzer
WCDMA		Wideband Code Division Multiple Access
WiMAX	-	Worldwide Interoperability for Microwave Access
WLAN	-	Wireless Local Area Network

LIST OF SYMBOLS

C	-	Capacitance
L	-	Inductance
R	-	Resistance
ω	-	Angular frequency
ω_c	-	Angular cut-off frequency
ω_o	-	Angular centre frequency
α	-	Bandwidth scaling factor
c	-	Speed of light
λ	-	Wavelength
λ_o	-	Centre frequency wavelength
λ_g	-	Centre guide wavelength
N	-	Number of order(s)
f_o	-	Centre frequency
f_c	-	Cut-off frequency
f_r	-	Resonant frequency
BW	-	Bandwidth
FBW	-	Fractional Bandwidth
ε_o	-	Permittivity of free space