TUNABLE MICROSTRIP BANDSTOP FILTER DESIGN

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Date : 7/05/09

To my beloved parent

Thank you for all that you have done

ACKNOWLEDGEMENT

Thanks to God for giving me full of patient to finish this project with success. I also want to take this opportunity to thanks all that help me al the times I do this project. All your goodness, only God will pay back. Thank you.

ABSTRACT

In communication system, wireless communication system environments will be constructed in term to bring together the benefits from various services. RF circuit as filter is design and be used for this environment to handle such different frequency and bandwidths. This project presents the design of tunable band stop filter. Then, continue by designing tunable filter that can be tuning in frequency range 2.34GHz-2.52GHz. The filter will reject frequencies between its lower and upper critical frequencies and passes all other. The step-impedance filter type was chosen in this design and varactor diode was selected for tuning element device. Varactor diodes are typically used in a reverse bias configuration compared to other diode. The design is simulate by using Microwave Office 2006 to simulate the S parameter which are the input return loss (S_{11}), output return loss (S_{22}) and forward transmission (S_{21}). The resonant frequencies will changes when the different value of voltage is supplied. When the voltage increase from 0V to 30V, the resonant frequency will increase from 2.34 GHz to 2.52 GHz. The return loss is decrease from -11.09 dB to -20.77 dB when the number of filter element (*N*) increase from 2 till 4.

ABSTRAK

Dalam sistem komunikasi, kemudahan bagi sistem perhubungan tanpa wayar boleh di hasilkan untuk memberi manafaat yg sama dari pelbagai perkhidmatan. Litar RF sebagai contohnya penuras, boleh di hasilkan dan digunakan untuk kemudahan untuk mengawal frekuansi dan lingkungan lebar yg berbeza-beza bagi sistem perhubungan tanpa wayar. Projek ini adalah bertujuan untuk membina sebuah penuras yang boleh dilawal mengikut julat frekuansi 2.34GHz-2.52GHz. Penuras tersebut akan menolak frekuansi yang berada di atas dan di bawah frekuensi kritikal dan membenarkan semua frekuensi yang selainnya. Cara yang digunakan untuk mengawal penulas tersebut ialah dengan menggunakan diod boleh laras dengan membekalkan nilai voltan yang berbeza. Diod ini adalah sejenis diod yang berfungsi dengan kecondongan yang terbalik. Rekaan ini seterusnya dilakukan proses penyerupaan untuk mendapatkan nilai S_{11}, S_{22}, S_{12} dan S_{21}. Dengan membekalkan nilai voltan yang berbeza, nilai frekuensi bersalun yang berbeza akan memperolehi. Apabila voltan meningkat dari 0V ke 30V, nilai frekuensi juga akan meningkat dari 2.34GHz-2.52GHz. Kemudian, apabila bilangan penuras bertambah, kehilangan berbalik akan berkurang dari -11.09 dB kepada -20.77 dB.

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LIST OF SYMBOLS

RF	-	Radio Frequency
TV	-	Television
GHz	-	Giga Hertz
IEEE	-	Institute of Electrical and Electronic Engineers
f_c	-	Cutoff Frequency
HPF	-	High Pass Filter
BPF	-	Band Pass Filter
TEM	-	Transverse Electromagnetic Wave
ε_{eff}	-	Effective Relative Dielectric Constant
ε_r	-	Board Material
IC	-	Integrated Circuit
g_0	-	Generator Resistance or Generator Conductance
g_K	-	Inductance for Series Inductors, Capacitance for Shunt Capacitors
g_N	-	Series Inductor
L	-	Inductor
C	-	Capacitor
ω	-	Frequency Cutoff
LED	-	Light Emitting Diode
I-V	-	Current-Voltage
p-n	-	hole and electron

I-V	-	Current-Voltage
p-n	-	hole and electron
V_d	-	Forward Voltage Drop
V_f	-	Forward Voltage Drop
I_f	-	Forward Current
DC	-	Direct Current
PLL	-	Phase Lock-Looped
pF	-	Pico Farad
nH	-	Nano Hendry
SIR	-	Step-Impedance Resonator
l	-	Length
W	-	Width
c	-	Speed of Light
Z_H	-	High Impedance
Z_L	-	Low Impedance
Ω	-	Ohm
f_o	-	Center Frequency
θ_0	-	Electrical Length at Center Frequency
Attn	-	Attenuation
$\Delta\omega_0$	-	Filter Bandwidth at Center Frequency
Cs_0	-	The Varactor Capacitance at Center Frequency
Q	-	Quality Factor
dB	-	Decibel
N	-	Number of Filter Element
V	-	Voltage

E	-	Electric Field
H	-	Magnetic Field
b	-	Distance of Ground Plane
λ	-	Wavelength
VLSRR	-	Varactor-Loaded Split Ring Resonators
VLCSRR	-	Varactor-Loaded Complementary Split Ring Resonators
S_{11}	-	Input Return Loss
S_{22}	-	Output Return Loss
S_{12}	-	Backward Transmission
S_{21}	-	Forward Transmission
SRR	-	Split Ring Resonators
BW	-	Bandwidth
IL	-	Insertion Loss
RL	-	Return Loss
TM	-	Transverse Magnetics Wave
TE	-	Transverse Electric Wave
LPP	-	Low Pass Prototype
MMICs	-	Monolithic Microwave Integrated Circuits
CPW	-	Coplanar Waveguide
UV	-	Ultra Violet
UHV	-	Ultra High Vacuum
FR 4	-	Flame Retardant 4
G-10	-	Group of Ten
PCB	-	Printed Circuit Board
ADS	-	Advance Design System

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CHAPTER I

INTRODUCTION

1.1 INTRODUCTION

Wireless communication application is one of the demand high-performance and reconfigurable RF subsystems. In the consumer electric field, tunable filters have a potential application in the reception of terrestrial television signals. As an effect, the development of advanced and low-cost receiver subsystems offering a dual operation for analog and digital terrestrial TV channels is in great demand [1].

This project proposed a tunable microstrip band-stop filter for frequency 2.4GHz. The filter will be tune for frequency range 2.34GHz till 2.52GHz and reject the frequency between 2.34GHz-2.52GHz and will pass frequency lower 2.34GHz and more than 2.52GHz with bandwidth range 0.5GHz till 1GHz. All the simulation in this project is done using microwave office.

Filter is a two-port network used to control the frequency response at certain point in a microwave system by providing transmission at frequencies within the band-pass of the filter and attenuation in the stop-band of the filter [2]. There are 4 types of filter, which are high pass filter, low pass filter, band-pass and band-stop.

1.4 PROJECT SCOPE

This project is to design a microstrip band-stop filter that can be tune for frequency range 2.34GHz-2.52GHz by using step-impedance resonator filter and using varactor diode as the elements to tune the filter. Then is simulate the design using microwave office to get the insertion loss and return loss and finally analyze the relationship of the different supplied voltage with the resonant frequency and the bandwidth for the difference number of filter elements.

1.4 METHODOLOGY FLOWCHART

The information for this project is searching from the internet, books, journal, and thesis and also from my supervisor. The first thing is trying to understand the concept for the microstrip band stop filter which is the operation of the frequency for band stop filter. Band-stop is reject frequencies between its lower and upper critical frequencies and passes all other.

After that, try to get some journal from internet especially from IEEE explorer. From internet besides IEEE explorer, find the information from Microwave journal and so on. Books that used for extra information are Microwave Engineering by David M. Pozar [2], Foundation for Microwave Engineering by Robert E. Collin [5].

Then, find the method to tune the filter. For this project, the method that chooses is step-impedance filter. Then, for the element to tune the filter, varactor diode is choose as the devices.

After that, find the tunable step-impedance resonator circuit and make calculation that needed to complete the circuit before do simulation. The simulation is by using microwave office 2006. From the simulation, the parameters that we found are the insertion loss, return loss and forward transmission for the difference voltage and the different number of filter elements. As the theory, when we change the value of voltage, the resonant frequency will be change too. Then, show the completely design with the calculation to the supervisor for approval.

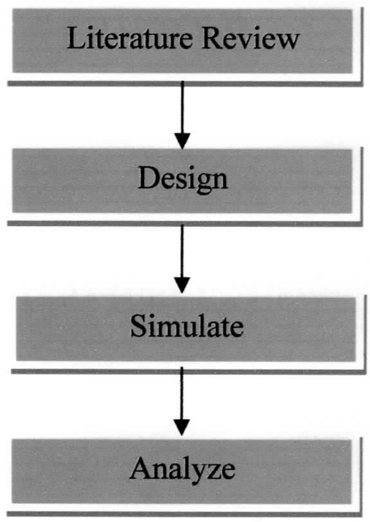

Figure 1.1 Methodology Flowchart

CHAPTER II

LITERATURE REVIEW

2.1 INTRODUCTION

Filters are usually used to transmit a particular thing and stop the whole thing else. It is similarly with the electrical filters which also transmit the desired signal or band of signals required for an electrical system and reject spurious signals or harmonics. Electrical filters have been employed in practical applications for more than eight decades and are currently used in all frequency ranges to provide as nearly perfect transmission as possible for signals falling within desired pass band frequency ranges, together with rejection of those signals and noise outside the desired frequency bands [6].

RF and microwave systems often require means of suppressing unwanted signals and or separating signals having different frequencies in the microwave region. Naturally, these functions also are performed by electrical filters. RF/microwave filter technology stimulates many microwave applications such as equalizers, impedance-matching networks, transformers, power dividers and directional couplers. In addition, they are fundamental components in a variety of RF/microwave systems such as cellular radio communications, satellite communication, military applications and radar.

Filters may be classified into several main categories in terms of their general response types which are high pass filter, low pass filter, band-pass and band-stop.

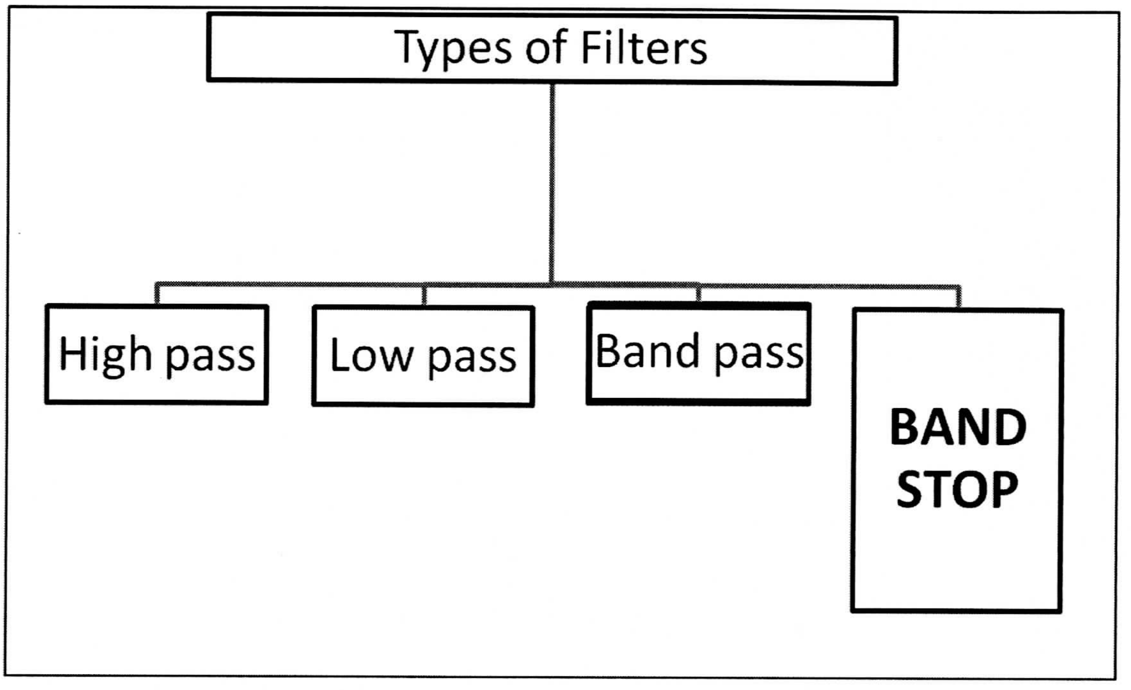

Figure 2.1 Types of Filter

2.1.1 High Pass Filter

High-pass filter is a filter that passes high frequencies well, but attenuates (reduces the amplitude of) frequencies lower than the cutoff frequency. High-pass filter has a characteristic that blocks the low frequency signals and transmits only the radio frequency signals higher than the necessary bandwidth (higher than the block frequency). The biggest problem of the HPF is that it cannot be formed using the distributed element [2].

High-pass filter also have insertion losses and certain specified rejection frequencies. A high-pass filter will not pass frequencies up to blue light. It will have a low loss up to a certain point but will start to pick up attenuation as the frequency gets higher and higher. High-pass filter do not have as many applications as low pass and band pass filters. One of the main applications is when low-frequency signals cause problems in a system. A high pass filter will attenuate those signals and help the system operate properly [7].

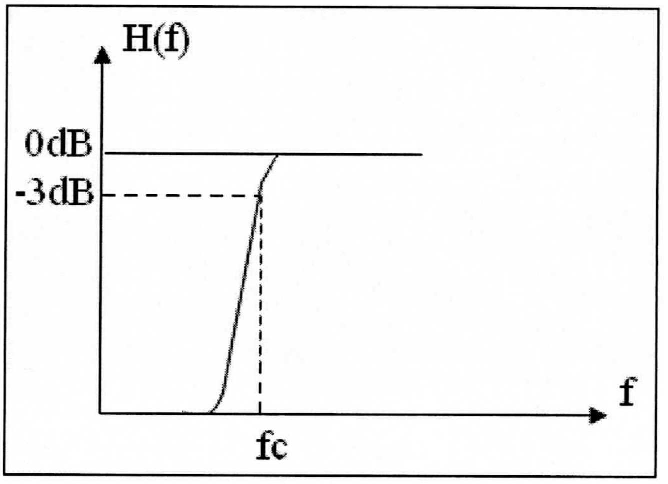

Figure 2.2 High pass filter

2.1.2 Low Pass Filter

Low-pass filter is a filter that passes low frequency signals but attenuates reduces the amplitude of signals with frequencies higher than the cutoff frequency. Figure 3 is shows the response of such a filter. This cutoff frequency, f_c is the point where the response curve falls 3 dB below the insertion loss of the filter [2].

A lowpass filter can also have rejection point. As with band-pass filter, lowpass filter can have specific frequencies called out with rejection values. Once again, the specifics point and attenuation values depend on the particular application and the number of rejection point also controlled by the applications [7].