Design of Bandpass filter for Wireless Application

M.Madhumitha
M.E II[nd] year, Dept of ECE,
K.Ramakrishnan College of Engineering,
Trichy, India
madhumanigandan93@gmail.com

U.Surendar
Assistant Professor,Dept of ECE,
K.Ramakrishnan college of Engineering,
Trichy, India
Suren048@gmail.com

Dr.M.Maheshwari
Professor, Dept of ECE,
K.Ramakrishnan College of Engineering,
Trichy, India
kousi.rhithi@gmail.com

***Abstract*— In advanced wireless and mobile communication systems filters play a crucial role. The microwave Bandpass filter passes the frequencies within certain range and rejects the frequency outside the range. Based on resonance characteristics, the tuning of the resonant frequency can be done over a wide range by adjusting its structure paramaters. The filter is characterized by analyzing the parameters such as return loss and insertion loss. The proposed filter is designed by using HFSS software. The square ring resonator (SRR) and T-type stub loaded resonator inserted inside-wall of the loop resonator is employed to design BPF and it is implemented on FR-4 substrate with thickness of 1.6mm. The simulated results have good return loss and the passband frequency obtained covers the GSM and WLAN applications. The compact and light-weight size makes this filter applicable for the above mentioned wireless applications and this filter can be easily fabricated at low cost.**

Keywords:Bandpass filter, WLAN, Return loss, SRR

I. INTRODUCTION

In advanced wireless communication systems, bandpass filters are required basically to increase the performance of the system because of its small size and high performance. The needed microwave devices which are operating in various separated frequency bands such as GSM (Global System for Mobile communication), WLAN (Wirelss LAN protocols), and the RF transceiver should be capable of transmitting and receiving the specific signals. So, the bandpass filter as a major component filters the unwanted frequencies [1], and it involves two or more frequency bands. Microstrip resonators are used widely to achieve various band characteristics. Two asymmetric resonators are cascaded to form two bands [2], the even-mode and odd-mode method is used to deduct the resonant frequencies of two bands. Moreover, various filters have been pulled in with the basic SIR and their variety to exhibit tri-band responses [3, 4].Recently, the stub-loaded resonators (SLR) and half-wavelength resonators were presented for tri-band filter design [5]. One useful method to achieve a compact size in filter design is to have its different parts bended. This could be an optimum solution to get more compact in sizes particularly for filters with stubs and long straight transmission lines [6].On the other hand, some of the techniques used for minimizing the structure of microstrip filter is to use dual-mode ring or square loop resonators. In this paper a compact bandpass filter has been realized using square ring resonator with loaded T-shaped stub and the desired simulation results are obtained.

A. FILTER

Filters are two-port networks which are used to vary the amplitude (or) phase characteristics of a signal with respect to frequency and they provide transmission within the passband and attenuation in the stopband of the filter. The goal of filter design is to obtain a ideal characteristics requisites within an acceptable tolerance. Filters are employed in all frequency ranges and they are categorized into four types, Low pass filter (LPF), High pass filter (HPF), Band pass filter (BPF), Band stop filter (BSF). Frequency, Bandwidth, Return loss, Insertion loss, and Group delay are the various parameters of the filter. Filters find their application in many places such as in Communication systems, Satellite systems, Mobile and cellular systems, Radar systems, etc. Among these different types of filter, Bandpass filter is proposed and the parameters such as return loss, group delay are measured.

B. BANDPASS FILTER

A band-pass filter is the one that allows to pass the frequencies within a certain range and rejects frequencies outside that range. It is used in wireless transmitters and receivers. In transmitter, it is used to limit the bandwidth of the output signal and in receiver it allows signals within a selected range of frequencies and forbid the unwanted frequencies passing through. An example of analogue band-pass filter is an RLC circuit, this can be implemented by the combination of a low-pass and high-pass filter. For eg, the equivalent circuit of bandpass filter and it's response is shown in figure 1 and 2.

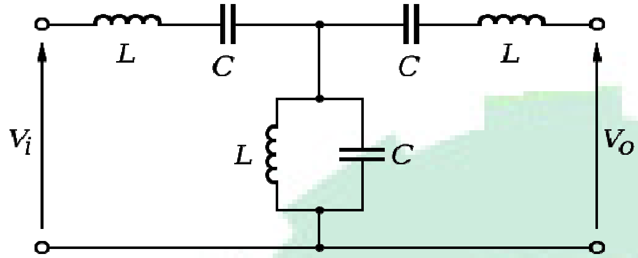

Figure 1 Bandpass filter circuit

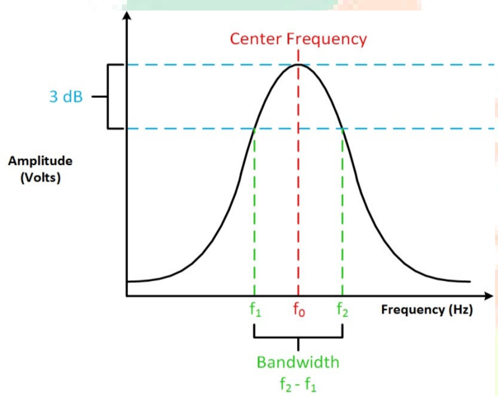

Figure 2 Frequency response of bandpass filter

II. PROPOSED SYSTEM

The main idea is to design a bandpass filter for wireless applications by using stub loaded resonator with compact size. The bandpass filter is designed by using FR4 substrate and it is simulated using HFSS tool. The square loop resonators (SLRR's) are used and these loop resonators are equivalent to LC tank circuits which resonate at a particular frequency looking on its dimension when properly excited by the electromagnetic fields.

The designed filter is estimated to have a circuit size of (50 x 50) mm^2, implemented on FR-4 substrate with the thickness of 1.6mm.

A. Iteration 1

The design process was first implemented by using a single square loop ring on the top layer of the structure. The simulated design of the proposed filter is shown in figure 3. The ring in the structure has an inner radius of 36mm and the outer radius of 44mm . The width of the ring was taken as 8mm. The two T-shaped resonators were placed facing opposite to each other on the strip. The width of the resonators and the gap between the conducting plane and the resonators

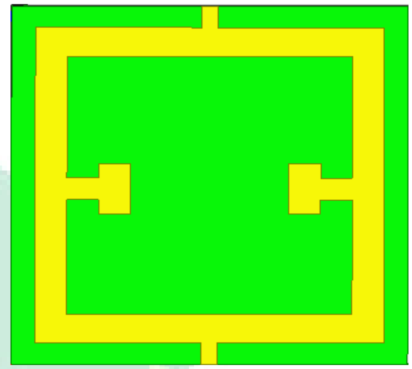

Figure 3 Structure of the filter

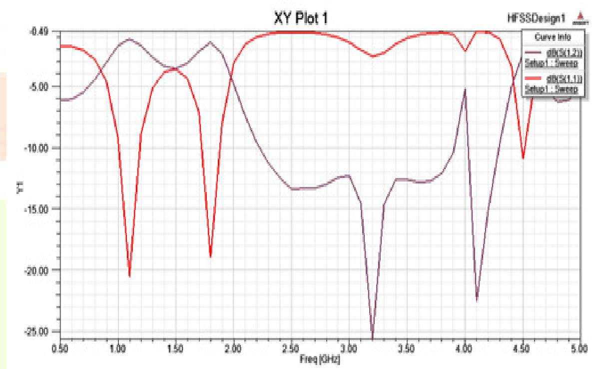

Figure 4 Simulated result of the filter given in figure 3

were taken in such a way of increasing the capacitive and inductive effect of the filter. The above design was simulated using the High frequency structural simulator. The simulated result is shown in figure 4. This structure resulted in covering a band of 0.8-2 GHz. The return loss was lesser than -10dB. So the above structure finds it application in GSM (Global System for Mobile communication) devices.

B. Iteration 2

Here the filter design was implemented using two square loop rings on the structure. The outer ring is designed with a size of 44mm and the inner ring at 32mm. The width of outer ring is 8mm and the inner ring is 6mm. The two square loops are separated by a gap distance of 4mm. The structure is shown in figure 5. The above structure was simulated by using the same simulator software. The output of the design was simulated and is shown in figure 6. The simulated result showed that it had a coverage ranging from 1.2GHz-2GHz. It had a return loss of -10dB. The resonances occurred at 2.2GHz. Compared to the design in iteration 1, this filter structure provides a better coverage and less return loss.

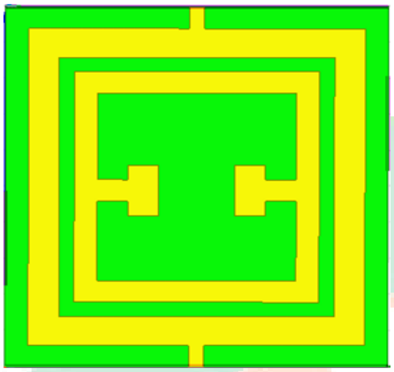

Figure 5 Structure of the filter

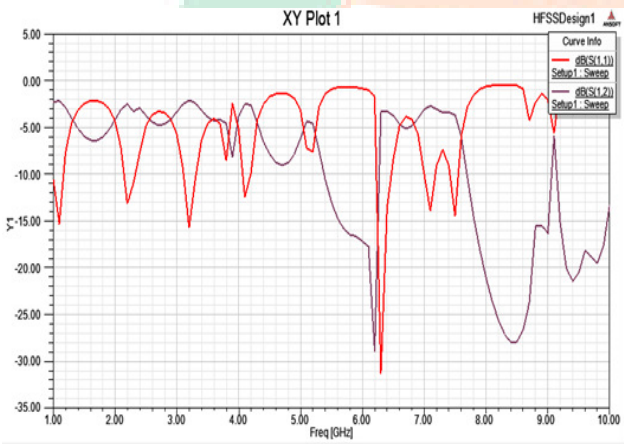

Figure 6 Simulated result of the filter

C. Iteration 3

The design was now considered by using two square loop rings similar to the second iteration but with a wider inner ring structure. The dimension from the outer ring are as follows : 1st ring's inner radius is 36mm and the outer radius is 44mm. The 2nd ring's inner radius is 24mm and the outer radius is 32mm. The width of outer and inner ring is 8mm. Thus, by altering the width of the ring when compared to design in second iteration, we are able to obtain the resonance of the filter for the specific application. The two square loops are separated by a gap distance of 4mm. Two stepped impedance resonators (T- shaped) are placed facing opposite to each other. The simulated result is shown below in figure 8.The resonance is obtained at 2.4 GHz. This structure resulted in covering a band of 2GHz - 2.5GHz. The return loss was lesser than -10dB.

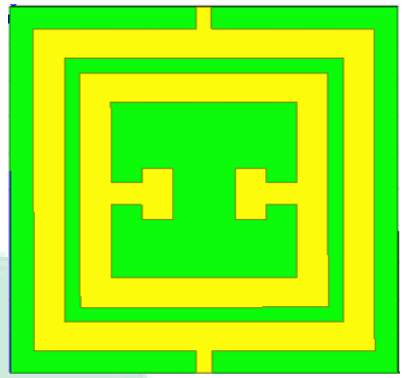

Figure 7 Structure of the filter

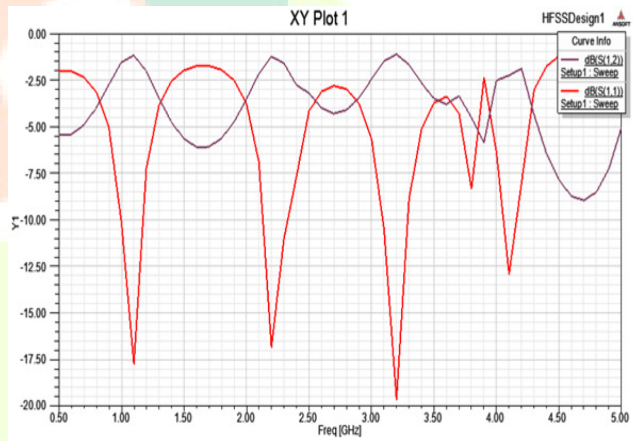

Figure 8 Simulated result of the filter given in figure 7

III. RESULTS AND CONCLUSION

The above filter which is discussed in iteration 3 is simulated using the High Frequency Structural simulator. The simulated result shows that the designed filter cover the frequency 2 Ghz - 2.5 GHz, and the RL was found to be -10dB. This design is applicable for Wi-Max application. Hence from this result, the proposed Bandpass filter operates in various wireless applications such as GSM, WLAN and Wimax within the covered band 0.8 within the covered band 0.8 Ghz and 2Ghz -2.5GHz with a return loss of -16.5dB. This compact structure of the filter provides good performance and coverage.

REFERENCES

[1] Xiao, J. K. and Y. Li, “Novel compact microstrip square ring bandpass filters,” Journal of Electromagnetic Waves and Applications, Vol. 20, No. 13, 1817-1826, 2006.

[2] Kun Deng, Shuai Yang, Shoujia Sun, Bian Wu, and Xiaowei Shi, “Dual-mode dual-band bandpass filter based on square loop resonator,” Vol. 37, 119-130, 2013.

[3] Chen, F. C., Q. X. Chu, and Z. H. Tu, “Tri-band bandpass filter using stub loaded resonators,” Electronics Letters, Vol. 44, No. 12, 747-749, 2008.

[4] Chen, F. C. and Q. X. Chu, “Design of compact tri-band Bandpass filters using assembled resonators,” IEEE Trans. Microw. Theory Tech., Vol. 57, No. 1, 165-171, 2009.

[5] Zhang, X. Y., Q. Xue, and B. J. Hu, “Planar tri-band Bandpass filter with compact size,” IEEE Microw. Wireless Compon. Lett., Vol. 20, No. 5, 262-264, 2010.

[6] Babak Kazemi Esfeh, “Narrowband Elliptic Bandpass Filter Using Dual-Mode Microstrip Square Loop Resonator for WiMax Application,” Vol 3,No. 9 September 2009.

[7] Kuo, J.-T., T.-H. Yeh, and C.-C. Yeh, “Design of microstrip bandpass filters with a dual-passband response,” IEEE Trans Microw. Theory Tech., Vol. 53, No. 4, 1331-1337, Apr. 2005.

[8] Liu, C.-Y., B.-H. Zeng, J.-C. Liu, C.-C. Chen, and D.-C. Chang, “Dual-mode CPW-FED double square-loop resonators for WLAN and WiMAX tri-band design,” Progress In Electromagnetics Research C, Vol. 23, 83-93, 2011.

[9] Liu, J. C., J. W. Wang, B. H. Zeng, and D. C. Chang, “CPW-fed dual-mode double-square-ring resonators for quad-band filters,” IEEE Microw. Wireless Compon. Lett., Vol. 20, No. 3, 142-144, 2010.

[10] Luo, S., L. Zhu, and S. Sun, “A dual-band ring-resonator Bandpass filter based on two pairs of degenerate modes,” IEEE Trans. Microw. Theory Tech., Vol. 58, No. 12, 3427-3432, Dec. 2010.

[11] Ma, D.-C., Z.-Y. Xiao, L.-L. Xiang, X.-H. Wu, C.-Y. Huang, and X. Kou, “Compact dual-band bandpass filter using folded SIR with two stubs for WLAN,” Progress In Electromagnetics Research, Vol. 117, 357-364, 2011.

[12] Matsuo, M., H. Yabuki, and M. Makimoto, “Dual-mode stepped- impedance ring resonator for bandpass filter applications,” IEEE Trans. Microw. Theory Tech., Vol. 49, No. 7, 1235-1240, Jul. 2001.

[13] Radonic, V. and V. Crnojevic-Bengin, “Multilayer dual-mode dual-band filter using square loop resonators,” in Microwave Conference (EuMC), 2010 European. 2010.

[14] Wang, Y.-X., B.-Z. Wang, and J. Wang, “A compact square loop dual-mode bandpass filter with wide stop-band,” Progress In Electromagnetics Research, Vol. 77, 67-73, 2007.

[15] Wolff, I. and N. Knoppik, “Microstrip ring resonator and dispersion measurements on microstrip lines,” Electron. Lett., Vol. 7, 779–781, 1971.

[16] WU, B., LIANG, C.-H., QIN, P.-Y., LI, Q. “Compact dual-band filter using defected stepped impedance resonator,” IEEE Microwave and Wireless Components Letters, vol. 18, no. 10, p. 674-676, 2008.