International Journal of Future Innovative Science and Engineering Research (IJFISER)
Volume - 2, Issue - I ISSN (Online): 2454- 1966

Research Manuscript Title

Design and Implementation of Hairpin Bandpass Filter Using Defected Microstrip Structures (DMS)

S.A.Vijaya Lakshmi, P.Muthukumaran,

PG student, Assistant Professor,

Dept of Electronic and Communication Engineering,

Sri Venkateswara College Of Engineering, Sriperumbudur,

E-Mail: ***vijiwith@gmail.com, pmuthu@svce.ac.in***

March – 2016

www.istpublications.com

Design and Implementation of Hairpin Bandpass Filter Using Defected Microstrip Structures (DMS)

S.A.Vijaya Lakshmi, P.Muthukumaran,

PG student, Assistant Professor,

Dept of Electronic and Communication Engineering,

Sri Venkateswara College Of Engineering, Sriperumbudur,

E-Mail: ***vijiwith@gmail.com, pmuthu@svce.ac.in***

ABSTRACT

Radio frequency and microwave filters represent a class of electronic filter, designed to operate in the frequency range between megahertz to gigahertz. This frequency range is used to broadcast radio, television, wireless communication and most of the RF and microwave devices will include some kind of filtering on the signal transmitted or received. In this project, the construction of a Hairpin Bandpass filters using Defected Microstrip Structures (DMS). Two basic configurations named are short–open–short (SOS) and open–short–open (OSO) model are studied for the realization of band pass filter. The floating ground equalizes the even and odd mode phase velocities and solves the difficulties arises in the fabrication process as it relaxes the requirements on physical dimensions like coupled gaps between lines. The hairpin structure makes the filter structure more compact in size. The Bandpass filter having bandwidth of 0.9 GHz for OSO model and 0.1 GHz for SOS model are obtained. Finally, the simulation is done using the Advanced Design System software and simulated on FR4 substrate as the dielectric material with the thickness of 1.6 mm and the conductor thickness of 45 µm. Those filters have wide application in modern wireless communication system.

Keywords : Bandpass filter, Floating slot, Hairpin structure, Defected Microstrip Structures (DMS)

I INTRODUCTION

A filter is a two port network used to control the frequency response at a certain point in a system by providing transmission at frequencies within the pass band of the filter and attenuation in the stop band of the filter. Typical frequency response include low pass, high pass, band pass and band reject characteristics. A band pass filter is an electronic device or circuit that allows signals between two specific frequencies to pass, but that discriminates against signals at other frequencies. Some band pass filters require an external source of power and employ active components such as transistors and integrated circuits , these are known as active band pass filters. Other band pass filters use no external source of power and consist only of passive components such as capacitors and inductors; these are called passive band pass filters. Microstrip Band pass filters plays important role in all communication systems.

Microstrip is a popular type of planar high frequency due to ease of fabrication and its ability to integrate with the other devices. The basic structure of Microstrip line consists of a conductive strip separated from ground plane by dielectric. The microstrip circuits has their own advantages compare to other microwave transmission like waveguide, coaxial cable, strip line as Filter realized with wide bandwidth, compact size, easy to fabricate, good reliability and reproducibility. The filter is designed, simulated in ADS (Agilent’s Advanced Design systems) with the bandwidth 0.5 GHz. Microstrip filter based on printed circuit board (PCB) offers the advantages as easy and cheap in mass production with different Dielectric constants.

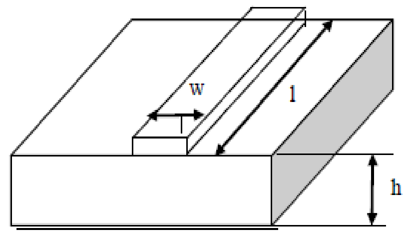


Fig.1 Structure of microstrip line

In order to show the difference and do a comparison, the simulated results are got by using a 50-ohm microstrip line. Microstrip Band pass filters plays important role in all communication systems. Microstrip is a popular type of planar high frequency due to ease of fabrication and its ability to integrate with the other devices. The basic structure of Microstrip line consists of a conductive strip separated from ground plane by dielectric. High-Performance microwave filters are essential circuits in many microwave systems where they serve to pass the wanted signals and suppress unwanted ones in the frequency domain. Parallel coupled microstrip filters are widely used in microwave circuits due to their insensitivity to fabrication tolerances, wide realizable bandwidth, and simple synthesis procedures.

Defected microstrip structure (DMS) consists of a horizontal slot and a vertical slot in the middle of conductor line. Similar to the defected ground structure (DGS), DMS increases the electric length of microstrip line, and disturbs its current distribution, and the effective capacitance and inductance of a microstrip line increase. Accordingly, the DMS has stopband and slow-wave characteristics and new microwave components especially bandstop filters and low pass filters can be designed by using these characteristics. In order to show the difference and do a comparison, the simulated results are got by using a 50-ohm microstrip line. Microstrip Band pass filters plays important role in all communication systems. Microstrip is a popular type of planar high frequency due to ease of fabrication and its ability to integrate with the other devices. The basic structure of Microstrip line consists of a conductive strip separated from ground plane by dielectric.

High-Performance microwave filters are essential circuits in many microwave systems where they serve to pass the wanted signals and suppress unwanted ones in the frequency domain .Parallel coupled microstrip filters are widely used in microwave circuits due to their insensitivity to fabrication tolerances, wide realizable bandwidth, and simple synthesis procedures.

II DESIGN OF HAIRPIN BANDPASS FILTER

The normal-modes of symmetrical coupled lines are normal & coupled mode. Normal modes are classified as even and odd mode. The coupling between two microstrip lines can be described using homogeneous dielectric medium equations, where the electrical lengths are same for both the modes. Homogeneous symmetrical coupled lines, a four port

Network, may be described by the impedance matrix [Z]. The sixteen elements of the impedance matrix [Z] are given as,

$$Z_{11} = Z_{22} = Z_{33} = Z_{44} = -j(Z_{0e} + Z_{0o})cot\theta/2$$

$$Z_{12} = Z_{21} = Z_{34} = Z_{43} = -j(Z_{0e} - Z_{0o})cot\theta/2$$

$$Z_{13} = Z_{31} = Z_{24} = Z_{42} = -j(Z_{0e} - Z_{0o})csc\theta/2$$

$$Z_{14} = Z_{41} = Z_{23} = Z_{32} = -j(Z_{0e} + Z_{0o})csc\theta/2$$

Consider the four port network, Voltages and currents on the four ports are related by, **V = ZI.** The design equations for the OSO and the SOS terminating impedance ($Z_0 = 50\ ohm$)

$$Z_{0e} = Z_0[1 + JZ_0 + (JZ_0)^2]$$

$$Z_{0o} = Z_0[1 - JZ_0 + (JZ_0)^2]$$

$$Z_0^2 = Z_{0e}Z_{0o}\left(\frac{Z_{0e}-Z_{0o}}{Z_{0e}+Z_{0o}}\right)^2 \quad \text{for OSO model}$$

$$Z_0^2 = Z_{0e}Z_{0o}\left(\frac{Z_{0e}+Z_{0o}}{Z_{0e}-Z_{0o}}\right)^2 \quad \text{for SOS model}$$

Where Z_{0e} is the even mode characteristic impedance, Z_{0o} is the odd mode characteristic impedance and Z_0 is the characteristic impedance.

III IMPLEMENTATION OF HAIRPIN BANDPASS FILTER

To get the high coupling, the floating slot on ground plane is used, while the hairpin model is used to achieve the compactness. As, the bandpass filter with wide bandwidth for both the models. Here, the gap between two coupled lines S_g = 0.5 mm is considered. To realize Zoe = 185.46 ohm and Zoo = 72.7 ohm, the values of W = 0.68mm, S_g = 0.5mm and the gap between slots Ss = 5 mm are obtained. The length of the coupled line of the unit cell is taken as 26.25 mm and length of the floating slot as 25.75 mm for both the SOS and OSO model as illustrated in Fig 2 . The proposed structure is simulated by ADS (Agilent's Advanced Design systems) software and the S-parameters curves are plotted in Fig.3. Figure 3a shows for OSO model, where Fig 3b shows for SOS model. The centre frequency at 2.4 GHz and 3 dB bandwidth of 0.9 GHz is observed in OSO model. Also the centre frequency at 1.86 GHz and 3 dB bandwidth of 0.1 GHz is obtained in SOS model. The prototype filter for both models has been fabricated on FR-4 substrate. It is found that OSO model provides wide bandwidth whereas the SOS model as narrow bandwidth. So, it is very much obvious that one may use OSO model of unit CRLH cell for wider bandwidth and SOS model for narrow bandwidth filter design requirement.

IV SIMULATION AND RESULTS

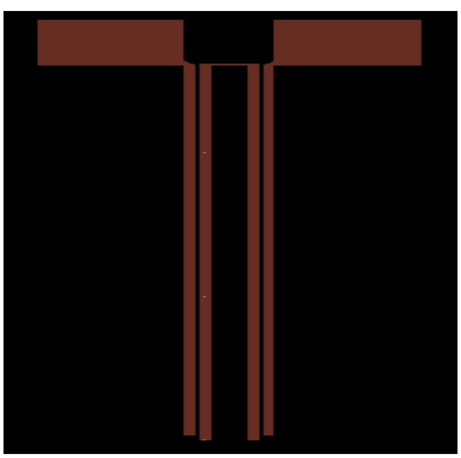
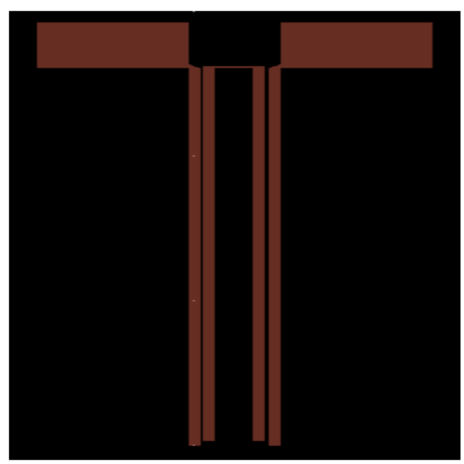


Fig.2 Schematic diagram of the **a.** OSO Hairpin bandpass filter,



b. SOS hairpin bandpass filter

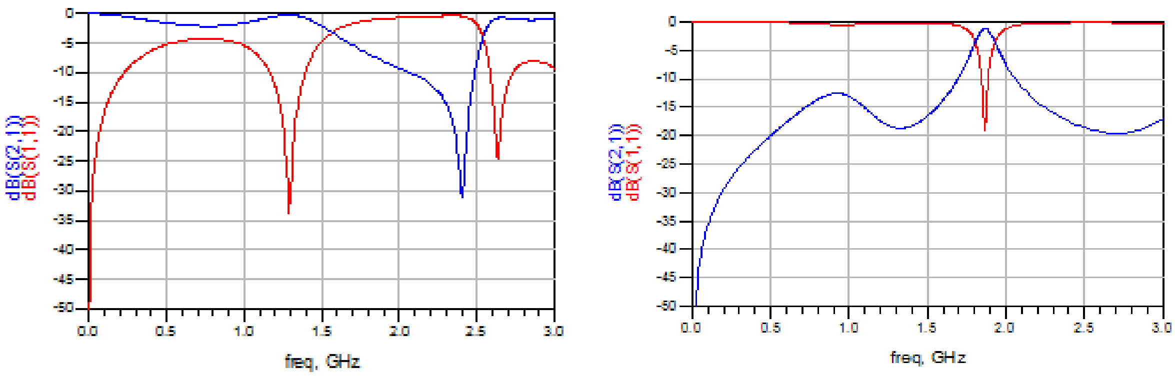


Fig. 3 S parameters of hairpin bandpass filter **a.** OSO coupled **b.** SOS coupled

V DEFECTED MICROSTRIP STRUCTURES (DMS)

The performance of microstrip transmission lines can be improved with the help of making slots in microstrip line and this structure may be introduced as Defected microstrip structure (DMS). The DMS is an attractive solution for achieving a finite passband, rejection band and slow wave characteristics. The slow wave factor over the microstrip is increased since the current distribution in the microstrip line is perturbed due to the trajectory followed around the slot line which introduce high line inductance and capacitance.

Defected Microstrip Structure produces rejection band depends on its total length and width of the slot. For narrow slot we observe a very sharp and narrow width stopband. Here we have proposed U shaped DMS unit, which are illustrated in Fig. The width (w) of the microstrip line is obtained as 3 mm corresponding to 50 Ohm characteristics impedance for substrate with a dielectric constant of 4.4 and thickness of 1.6 mm. The other dimensions are taken for simulation as a = 1.9, b = 2.6, c = 2.3, w = 2.5 and length l = 0.3 as shown in fig.4

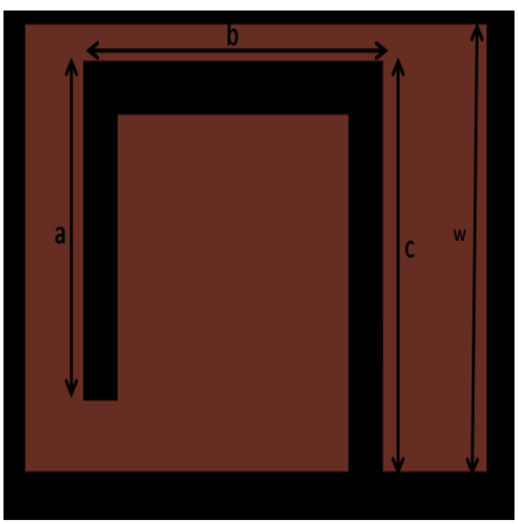


Fig. 4 Schematic diagram of U-DMS cell

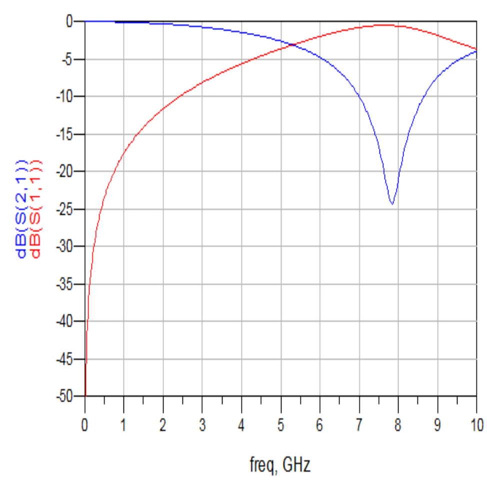


Fig. 5 S parameters of U-DMS cell

VI FUTURE WORK

In future, the U- DMS structure can be combined with the hairpin bandpass filter in order to achieve better results. The harmonics of the filter are reduced by U-shaped DMS cell on the feed lines and improved the stopband performances.

VI CONCLUSION

A new design methodology of hairpin bandpass is simulated. The layout of the final filter design with all the determined dimensions is illustrated. It is observed that OSO model of the proposed filter have wider bandwidth compare to the SOS model. Both the design are simple, one may be changes to other by altering the position of vias. The proposed floating slot arrangement in ground plane, which results low passband insertion loss of the bandpass filter. The filter are reduced by using U-shaped DMS cell on feed lines and improve the stopband performance. Such bandpass filters may be found suitable in wireless applications like WLAN, UWB and ISM band.

VII REFERENCES

[1] Pratik mondal. Design of a unit composite right/left-handed cell based bandpass filter with floating slot approach and suppression of spurious using defected microstrip structures. *J.Computer Electron* (2015)

[2] Alaydrus,M. Designing microstrip bandpass filter at 3.2 GHz. *Int. J. Electr. Eng.* Inform. 2(2), 71–83 (2010)

[3] Tiwary, A.K., Gupta, N. Design of compact coupled microstrip line bandpass filter with improved stopband characteristics. *Prog. Electromagn. Res*. C 24, 97–109 (2011)

[4] Mirzaee, M. A novel small ultra-wideband (UWB) bandpass filter including narrow notched band utilizing folded T-shaped stepped impedance resonator (SIR). *Prog. Electromagn. Res*. C 22, 85–96(2011)

[5] Tirado-Mendez, A., Jardon-Aguilar, H., Flores-Leal,R. Improving frequency response of microstrip filters using defected ground and defected microstrip structures. *Prog. Electromagn. Res*. C 13, 77– 90 (2010)

[6] Wahab, N.A., Muharnad, W.N.W., Harnzah, M.M.A.M., Nairn, N.F. Design of a microstrip hairpin band-pass filter for 5 GHz unlicensed WIMAX. In: *International Conference on Networking and Information Technology*, pp. 183–186 (2010)

[7] Mondal, P., Roy A., Parui, S.K. Wide-band bandpass filter using CRLH transmission line and floating slot approach. In: *International Conference on Computer, Communication, Control and Information Technology* (C3IT) 2012, AOT (2012)

[8] Roy, Arabinda Pratik Mondal and SusantaKumar parui. Designing of bandpass filter using CRLH transmission line and floating slot. *Int. J. Emerg. Technol. Adv. Eng.* 2(2), 269–274 (2012)

[9] Abdelaziz, Aya F., Abuelfadl, Tamer M., Elsayed, Osman L. Realization of composite right/left-handed transmission line using broadside coupled coplanar waveguides. In: *IEEE Antennas and Propagation Society International Symposium*, pp. 1–4 (2009)

[10] Abdelaziz, A.F., Abuelfadl, T.M., Elsayed, O.L. Realization of composite right/left-handed transmission line using coupled lines. *Prog. Electromagn. Res*. (PIER) 92, 299–315 (2009)

[11] Bongard, F., Perruisseau-Carrier, J., Mosig, J.R.: Enhanced CRLH transmission line performances using a lattice network unit cell. *IEEE Microw. Wirel. Compon. Lett.* 19, 431–433 (2009)

[12] Kazerooni, M., Rad, G. Rezai., Cheldavi, A. Behavior study of simultaneously defected microstrip and ground structure (DMGS) in planar circuits. In: *Progress Electromagnetics Research Symposium*, Beijing, March 23–27 (2009)