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PERFORMANCE OF LOW PASS FILTER USING GROUND DEFECTED STRUCTURE

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ABSTRACT

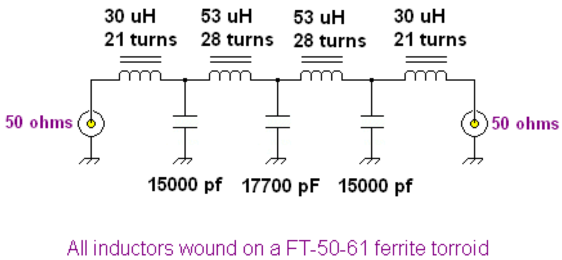
The low pass filter is used in many application of microwave communication. Therefore its necessary to design a good low pass filter for the faithful reproduction of wanted signals. Previously methods used to design the low pass filter using insertion loss method don't give a very good flat response. So, a new method has been proposed for the filter design which gives a good response as compared to the conventional designs. A new DGS (Defected Ground Structure) technique to design a low pass filter is proposed here, ground is defected or cut in a desire shape which improves its performance. The size of filter is also reduced.

I. INTRODUCTION

Microwave system often requires means for suppressing unwanted signals and/or separating signals having different frequencies. These functions are performed by electric filters. Filters are usually categories by their frequency characteristics, namely low-pass, high-pass, bandpass, and bandstop.
The first objective is to study about the conventional microwave Low Pass Filter (LPF).
The second objective is to study about Low Pass Filter using Defected Ground Structure (DGS). When a conventional low pass filter (using capacitor, inductor etc.) is used for suppressing unwanted signals and/or separating signals having different frequencies convention LPF filter have discontinuity elements and repeated high impedance.
A defective ground structure (DGS) is a internally design defect on a ground plane that creates additional effective inductance capacitance .The technique can be used to design microstrip line with desired characteristic, thus significantly reducing the foot print of the microstrip structure.

II. CONVENTIONAL LOW PASS FILTER

A low pass filter has only one pass band and a single cut-off frequency. Which passes all frequencies up to the cut off level and attenuates all frequencies above. The equivalent circuit this is a shown in fig (a)



Fig(a)

However the frequency response characteristics of LPF is shown in fig (b)

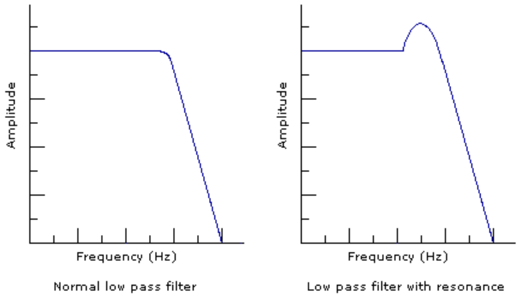


Fig (b)

III. PROPOSED DESIGN TECHNIQUE

The lumped-element filter design generally works well at low frequencies, but two problems arise at microwave frequencies. First, lumped elements such as inductors and capacitors are generally available only for limited range of values and are difficult to implement at microwave frequencies, and hence must be approximated with distributed components. In addition, distance between filter components is not negligible. Richard's transformation is used to convert lumped elements to transmission line sections, where as kuroda's identities can be used to separate filter elements to transmission line sections. Since such additional transmission line sections do not affect the filter response, this type of design is called redundant filter synthesis. It now is possible to design microwave filters that take advantage of these section to improve the filter response.

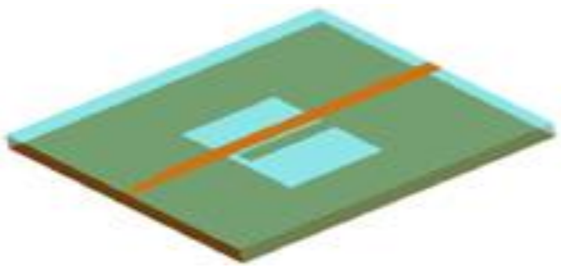


Fig of DGS

A Defective Ground Structure (DGS) is an intentionally designed defect on a ground plan, that creates additional effective inductance and capacitance. This technique can be used to design microstrip lines with desired characteristics such as higher impedance, band rejection and slow-wave characteristics, which reduces the footprint of the microstrip structure. DGS structures are used in RF/microwave components (filters, dividers, amplifiers and high-speed digital designs.

IV. CHARACTERIZATION OF POWER LOSS RATIO

In the insertion loss method, a filter response is defined by its insertion loss or power loss ratio, $\boldsymbol{P_{LR}}$

given by

$$P_{LR} = \frac{\text{power available from sourse}}{\text{power delivered to load}} = \frac{P_{inc}}{P_{load}} = \frac{1}{1-|\Gamma(\omega)|^2}$$

Observe that this quantity is the reciprocal of $|\boldsymbol{S}_{12}|^2$ if both load and source are matched.

Insertion loss (IL) in dB is

$$IL= \log P_{LR}$$

Since $|\Gamma(\omega)|^2$ is an even function of ω; can be expressed as a polynomial in ω^2. Hence , it can be written as

$$|\Gamma(\omega)|^2 = \frac{M(\omega^2)}{M(\omega^2)+N(\omega^2)}$$

With M and N as real polynomial in ω^2 .

Hence, find expression can be expressed as

$$P_{LR} = 1 + \frac{M(\omega^2)}{N(\omega^2)}$$

Thus, for a filter to be physically realizable, its power loss ratio must be of the form in above equation.

V. PROPOSED MICROSTRIP STRUCTURE AND DESIGN SPECIFICATION

General structure of a microstrip is illustrated in Figure (c) Conducting strip (microstrip line) with a width *W* and a thickness *t* is on the top of a dielectric substrate that has a relative dielectric constant ε_r and a thickness *h*, and the bottom of the substrate is a ground (conducting) plane.

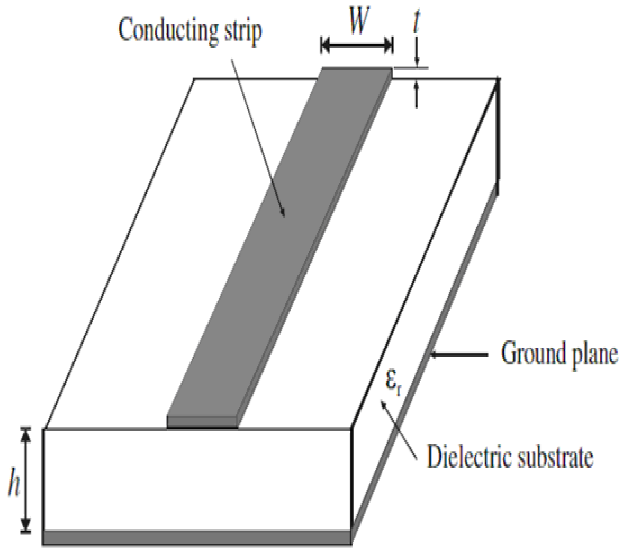


Fig (c)

- First we define length and width of microstrip.
- Take a ground plane whose width is generally five times of the microstrip width and length remains same.
- Place a dielectric on the ground.
- Place a microstrip on the middle of dielectric.
- Place the waveguide port on the both side of microstrip ends.
- Set frequency and match the wave and line impedance of the microstrip and waveguide ports.
- Cut the ground plane to make it defected as desired shape.

Run the program to get the output.

Length of the strip		8.8mm
Dielectric Thickness	h	0.8mm
Conductor Thickness	t	0.035mm
Width of strip	w	1.5mm
Substrate		FR4
ε_r		4.
Area of DGS	A	27.035mm^2
Width of the substrate	w	16mm

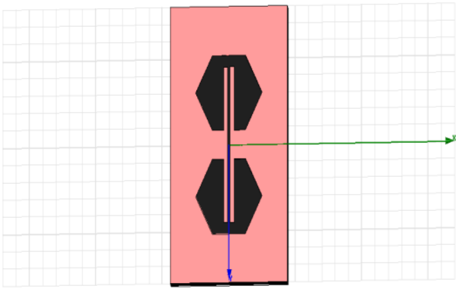


Figure-Bottom view of Low pass filter

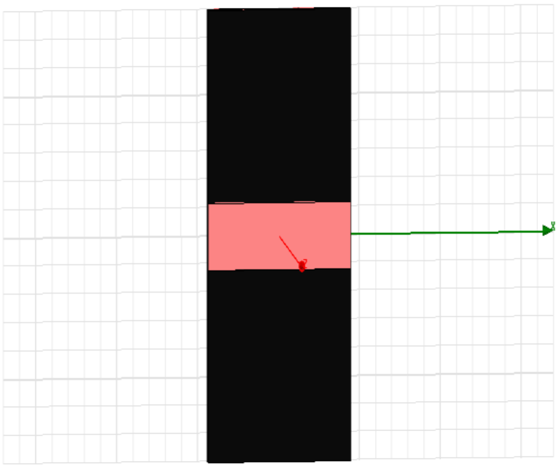


Figure-Top view of Low pass filter

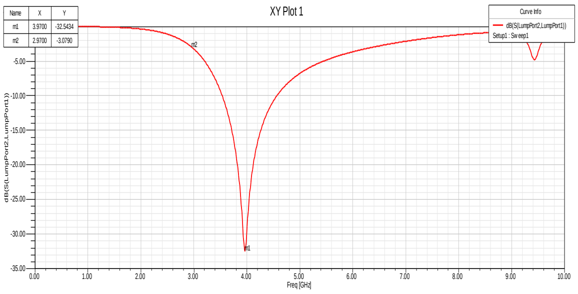


Fig- Frequency response of low pass filter (f=4 Ghz)

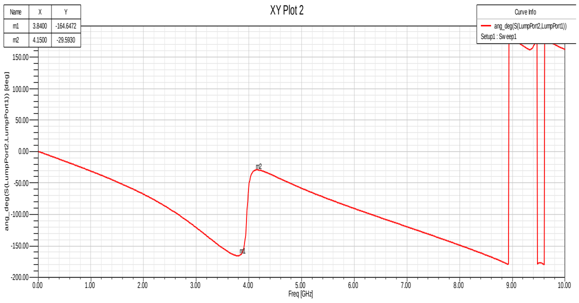


Figure- jumping phenomenon of low pass filter

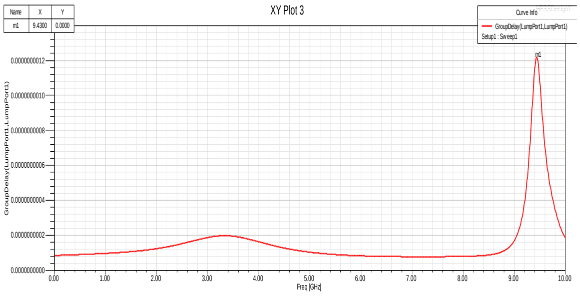


Figure- Group delay of low pass filter

After so many iterations the size becomes very small. Simulation result shows that there is a sharp cut-off occurs from 3dB (2.95 GHz) to 30 dB (4 GHz) frequency and the resonant frequency is 4 GHz, which is required frequency.

VI. RESULT

The proposed method is better than the conventional low pass filter because it does not have any discontinuity elements and repeated high- low impedance line which are essential for design of conventional low pass filter. Only defected ground structure pattern is used for the design proposed low pass filter.

VII. CONCLUSIONS AND FUTURE ADVANCEMENT

The method to calculate the cutoff frequency of the LPF has been developed based on the modeled equivalent inductance and capacitance, which depends o n the dimension of the DGS pattern. In addition, the method to determine the size of the DGS pattern, which exactly realizes the required transformed inductance, has been proposed by curve fitting with excellent accuracy. Furthermore, the equivalent inductance and capacitance of the microstrip line have been considered to adjust the size of the DGS pattern to get an exact dimension of the DGS.

Due to DGS We got sharp rejection after 3dB cutoff frequency and simple structure without design of distributed L & C line in conventional filter. We got good performance by designing microstrip line with DGS. But in future by using the concept of magnetic coupling we may got large band stop characteristics. For this we will have to design microstrip line of same dimension with two DGS (our proposed structure). This type of filter can be used to design Diplexer.

REFERENCES

1. Microwave Engineering (Third Edition) by David M. Pozar
2. Microwave Engineering Passive circuits by Peter A. Rizzi
3. Microstrip Filters for RF/Microwave Applications by JIA-SHENG HONG M. J. LANCASTER

4. Kumar, P.; Kishor, J.; Shrivastav, A.K.; "Formulation of size reduction technique in microstrip circuits using DGS and DMS", Recent Advances in Microwave Theory and Applications, 2008. MICROWAVE 2008. International Conference on 21-24 Nov. 2008 Page(s):861 - 864 Digital Object Identifier 1109/AMTA.2008.4763173

5. Kumar, P.; Jagadeesh, C.; Baral, R.N.; Singhal, P.K.; "Design and fabrication of six pole microstrip elliptical low pass filter" Recent Advances in Microwave Theory anApplications, 2008. MICROWAVE 2008. International Conference on 21-24 Nov. 2008 Page(s):116 - 118 Digital Object Identifier 0.1109/AMTA.2008.4763111

6. Kumar, P.; Kishor, J.;Shrivast,A.K.;"Theoretical analysis of slow wave p lanner structure Volume 50 Issue 12 , Pages 3007 - 3280 (December 2008), MOTL Published Online: Dec. 17 2008 3:20PM;DOI: 10.1002/mop.24439

7. Anand K. Verma, Adel B. Abdel-Rahman, Ahmed Boutejdar , & A.S. Omar "Control of Bandstop Response of Hi-Lo Microstrip Low Pass Filter Using slot in Ground Plane"IEEE, Transactions on MTT,Vol.52,No3,March 2004.

8. J.S. Lim, C.S. Kim, Y.T. Lee, D. Ahn and S. Nam, "Design of Low Pass *filters* Using Defected Ground Structure and Compensated Microstrip Line," *IEE Electronics Letters,* Vol. 38, No. 22, 24 October 2002, pp. 1357–1358

9. A. Abdel-Rahman, A.k. Verma, A. Boutejdar and A. S. Omar " Compact stub Type Microstrip Bandpass Filter Using Defect Ground Plane," IEEE Microwave and wireless components Letters, Vol 14, No 4 April 2004.