SHARP REJECTION LPF USING DEFECTED GROUND STRUCTURE

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Abstract-

For the sharp rejection the DGS is widely used. In this paper we have designed a LPF that is having a sharp rejection using DGS .In this project a compact microstrip low pass filter is designed with sharp rejection using a defected ground structure (DGS) with compensated microstrip. The equivalent circuit for the DGS and its corresponding L-C parameters are extracted by using its S parameters response (EM simulation) and a simple circuit analysis method. The low pass filter is realized and optimized using cascaded DGS to provide a portable size, excellent sharpness in transition with low insertion loss in pass band and wide rejection in the stopband. Observed results show good agreement with the theoretical results. The results are validated by using CST.

Keywords: LPF, DGS, sharp-rejection, EM simulation.

I. Introduction:

The low pass filter is designed using high and low impedance transmission line sections. The low pass filter prototype element values are calculated for chebyshev response. These lumped element values are translated into distributed element values using standard formulas. The filter is designed in the microstrip configuration, but with air cavities under the inductive lines. The purpose of introducing cavities under the inductive line is to reduce the effective dielectric constant, such that the line widths are convenient to fabricate.

Radio frequency (RF) and microwave wireless applications demand sharp-rejection compact planar lowpass filters (LPFs), for suppression of noise and interference Sharp-rejection achieved by increasing the filter order results in increased filter size and insertion loss.

I.A. Filter design by insertion loss method:

As we know that in a perfect filter the insertion loss should be zero in pass band and infinite in stop band. This method allows high degree of control over the pass band and stop band. Number of reactive element decides the order of filter.

Here a filter response is defined by its insertion loss or power loss ratio as:-

$$P_{LR} = \frac{SourcePower}{LoadPower} = \frac{P_{IN}}{P_{OUT}} = \frac{1}{1-|\Gamma(\omega)|^2} \quad (1)$$

As we know that $|\Gamma(\omega)|^2$ is an even function of ω; therefore it can be expressed as a polynomial in ω . Thus we can write

$$|\Gamma(\omega)|^2 = M(\omega^2)/(M(\omega^2)+N(\omega^2)) \quad (2)$$

Where m and n are real polynomials in ω^2 . Substituting this form in above equation we have:

$$P_{LR} = 1+(M(\omega^2)/N(\omega^2)) \quad (3)$$

Thus for a filter to be physically realizable its power loss ratio must be of the form as given in above equation. Notice that specifying the power loss ratio simultaneously constrains the reflection coefficient, $\Gamma(\omega)$.

I.B. Brief discussion about Microstrip line:

Microstrip line is a type of planar transmission line, which is the most popular one and used to convey microwave-frequency signals. It is popular due to the fact that it can be fabricated by the photolithography process and easily integrated with other microwave devices. Also microstrip is much less expensive than the traditional wave guide technology, as well as lighter and more compact. Microstrip is now a recognized technology for the realization of miniature devices for numerous applications. These include accelerometers, pressure sensors, flow sensors, switches and filters. Microstrip also finds wide application in the area of microwave and millimeter wave components.

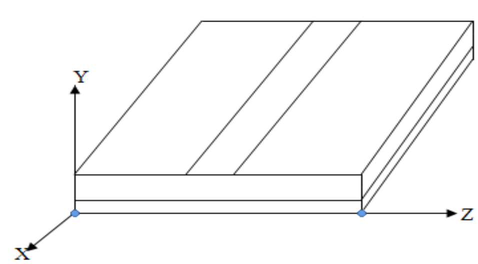

Fig.:1 Geometry of Micro strip transmission line

II.Analysis of the proposed DGS cell:

Fig.2(b) shows the proposed DGS cell where transmission line is printed on the GML1000 substrate with a relative dielectric constant ε_r = 3.2mm and thickness of h=.762mm. The width of the 50Ω transmission line is 0.5mm, and A,B,C and D are given be 1,0.2,1 and 3.405 mm, respectively. The novel DGS can equivalent to a simple parallel resonance circuit shown in Fig.2(a), where the equivalent capacitance Cp and equivalent inductance Lp can be obtained follows:

$$L_P = 250/C_P\,(\pi f_0)^2 \text{ nH} \qquad (4)$$

$$C_p = 5f_c/\pi(f_0^2 - f_c^2) \text{ pF} \qquad (5)$$

Where LP = Equivalent Inductance
Cp = Equivalent Capacitance
Fc = Cutoff Frequency
F0 = Center Frequency

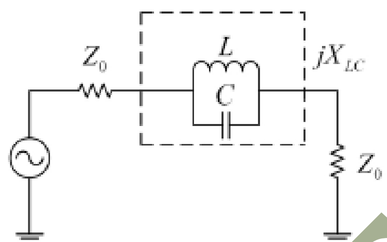

Fig.:2 (a) Equivalent circuit of novel DGS cell.

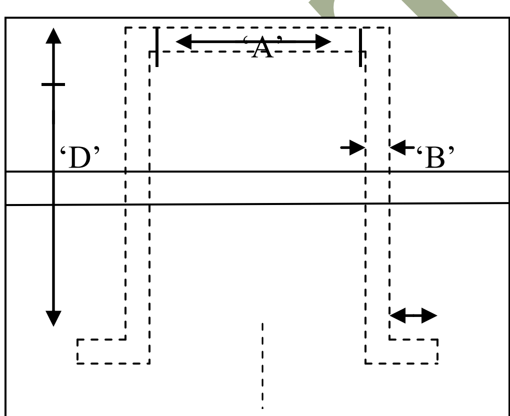

Fig.:2 (b) Layout of the novel DGS cell.

For a line with air above the substrate and the effective dielectric constant has a value in the range of $1 < \varepsilon_{reff} < \varepsilon_r$. For most applications where the dielectric constant of the substrate is much greater than unity $\varepsilon_r >> 1$, the value of ε_{reff} will be closer to the value of the actual dielectric constant ε_r the effective dielectric constant is also a function of frequency.

As the frequency of operation increases, most of the electric field lines concentrate in the substrate. Therefore the microstrip line behaves more like a homogeneous line of one dielectric (only the substrate), and the effective dielectric constant approaches the value of the dielectric constant of the substrate.

For low frequencies the effective dielectric constant is essentially constant. At intermediate frequencies its values begin to monotonically increase and eventually approach the values of the dielectric constant of the substrate. The initial values (at low frequencies) of the effective dielectric constant are referred to as the static values, and they are given by

$$\varepsilon_{reff} = \frac{\varepsilon_r + 1}{2} + \frac{\varepsilon_r - 1}{2}\left[1 + 12\frac{h}{W}\right]^{-1/2} \qquad (6)$$

For given dimension of microstrip line, the characteristic is given as :-

$$Z_o = 60/\sqrt{\varepsilon_{eff}}\,\ln[(8h/W) + (W/4h)]$$

for $W/h \leq 1$ (7)

$$= 120/\{\sqrt{\varepsilon_{eff}}\,[W/h + 1.393 + .667\ln(W/h + 1.444)]\}$$

for $W/h > 1$ (8)

Size of each DGS in :
D=3.405mm
C=1mm
B=0.2mm
A=1mm
And spacing between each DGS=4.8mm

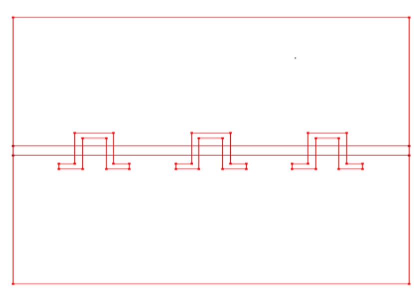

Fig.:3 Proposed Designs.

III.Simulation Result:

Fig:4 (a)&(b) shows the simulated result of the proposed work. The result is realized as given in the table:

Characteristics	Return1	Return2
Frequency	6.093GHz	6.074GHz
Attenuation	45.038dB	49.433dB

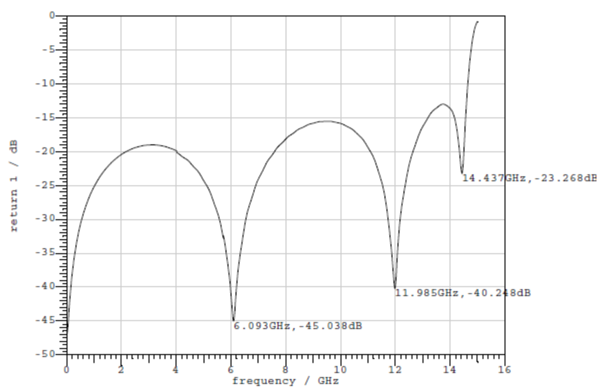

Fig.:4 (a) Plot between Return1& frequency.

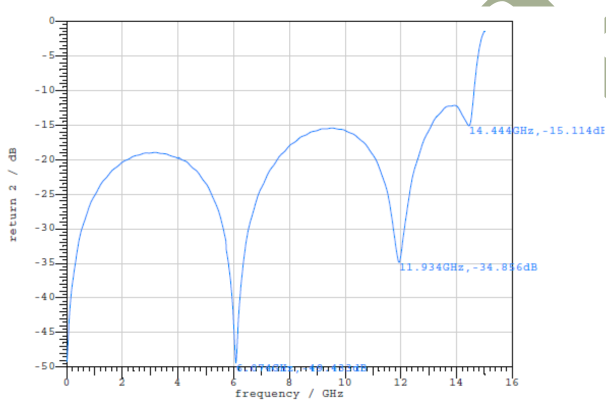

Fig.:4 (b) Plot between Return2 & frequency.

IV.Conclusion:

A LPF with sharp rejection is proposed in this paper.The size is decreased as compared to novel DGS[1].A LPF with Sharp-rejection is designed and simulated.The simulation shows high-frequency selectivity.

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