Miniaturized Band-Stop Filter Using Triangular Shape DGS Resonators

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Abstract

*This paper present a novel design of Band-stop filter using triangular shaped DGS (Defected Ground Structure) resonators. This band stop filter has stop band of 2.28GHz (from 8.49GHz to 10.77GHz) and miniaturised dimension (6mm*10mm) with very high sharpness factor (0.94 and 0.96). Simulation of design is done using Ansoft – HFSS. Various parameters' curve (Insertion loss, return loss, VSWR, Group delay and Phase characteristic) is obtained and analysed.*

This proposed filter application can be found in communication systems, robotics, and virtually in any test and measurement systems.

***Keywords**: Band Stop Filter, DGS. DGS - Resonators**,** PCB Filters*

Introduction

This Band stop circuits are one of the most important parts of many passive and active microwave and millimetre-wave devices employed to suppress the harmonics. In signal processing, a band-stop filter or band-rejection filter is a filter that passes most frequencies unaltered, but attenuates those in a specific range to very low levels. It is the opposite of a band pass filter. Band stop filters are also known as band-elimination, band-reject, or notch filters, this kind of filter passes all frequencies above and below a particular range set by the component values. Not surprisingly, it can be made out of a low-pass and a high pass filter, just like the band pass design, except that this time we connect the two filter sections in parallel with each other instead of in series.

DGS, which is realized by etching off a defected pattern or periodic structures from the backside metallic ground plane, has been known as providing rejection of certain frequency band, namely, band-gap effects. The stop-band is useful to suppress the unwanted surface waves, spurious and leakage transmission. Therefore, a direct application of such frequency selective characteristics in microwave filters is becoming a hotspot research recently.

DGS combined with micro strip line causes a resonant character of the structure transmission with a resonant frequency controlled by changing the shape and size of the slot. The shape of the slot is modified from a simple hole to a more complicated shape [2-3]. Many novel types of micro strip filters have been proposed and designed. Periodic or non-periodic DGS are realized by etching a slot in the backside metallic ground plane. The etched slot disturbs effectively the current distribution in the ground plane of micro strip line and the results in resonant characteristics..

I. Design and Simulation

This paper present a novel triangular shaped DGS (Defected Ground Structure) resonator. The increased width of micro strip line used to increase the capacitance of resonators under it. Here, we have created two triangular shaped DGS resonators making defect or etching on the ground plane.

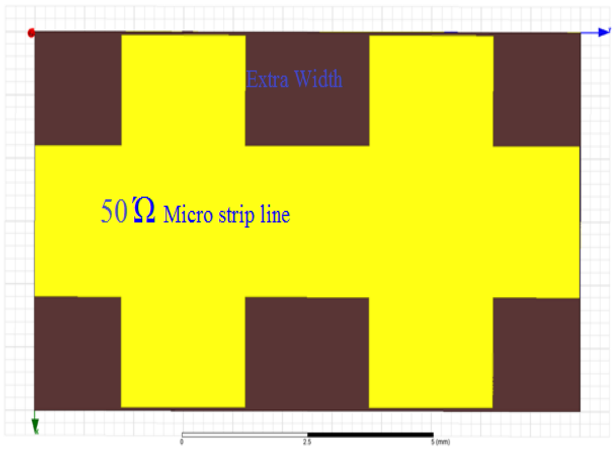

Fig 1 Top view of band Stop filter

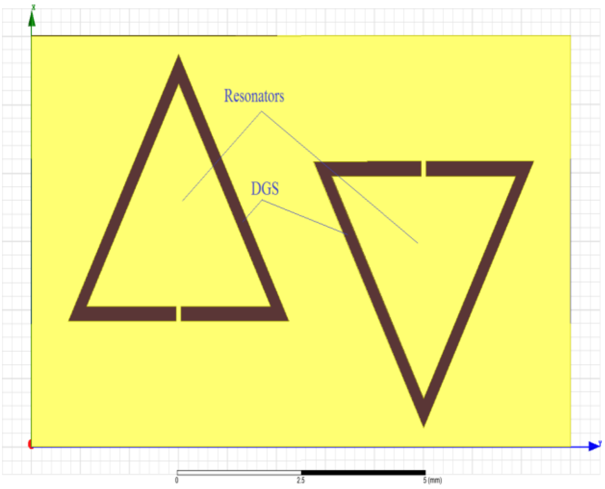

Fig 2 Bottom View of Band Stop Filter

Equivalent circuit model of the filter can be drown keeping two symmetrical resonators under consideration.

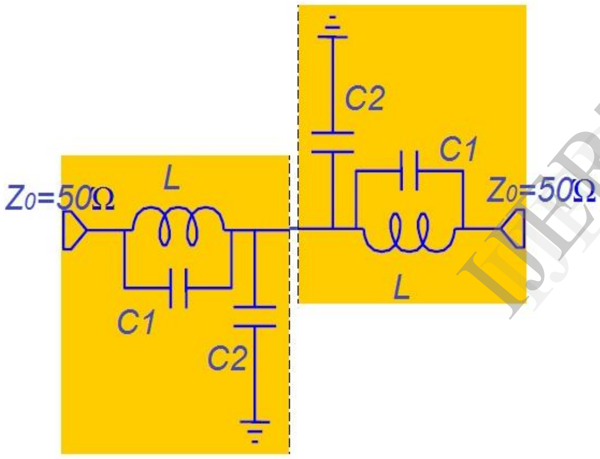

Fig 3 Equivalent Circuit model

II. INVESTIGATION OF FREQUENCY RESPONSE AND PERFORMANCE

Fig-4, shows the frequency response of the proposed band stop filter. It has stop band of 2.2GHz (Lower cut off frequency 8.5GHz and Higher cut off frequency 10.7GHz). Sharpness factor gives the steepness of the curve and it is defined by cut-off frequency divided by its corresponding resonant frequency i.e fc/f_0. From graph, we can conclude that the filter has very good sharpness factor 0.94 and 0.96 for both resonant frequencies 9GHz and 10.7GHz respectively.

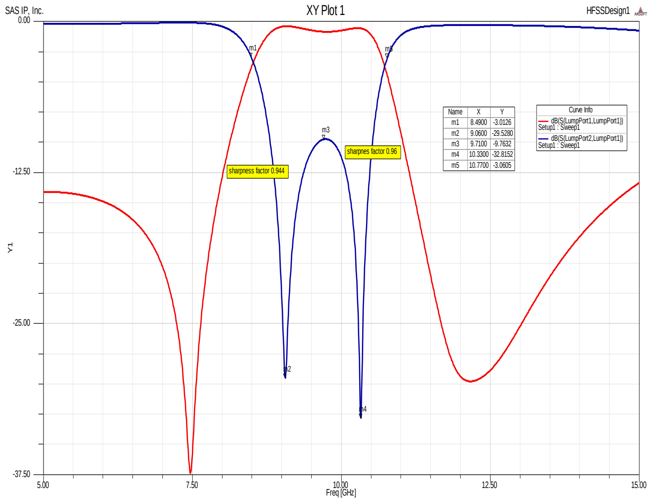

Fig 4 Frequency response Filter

For illustration the level of suppression in band-stop region, the VSWR parameter is shown in “Fig.5” As can be seen, the VSWR value is very low till pass band region and sharply increased at resonant frequency and then gradually decreases after that. This shows that even high power harmonics can be completely rejected within the resonant frequency.

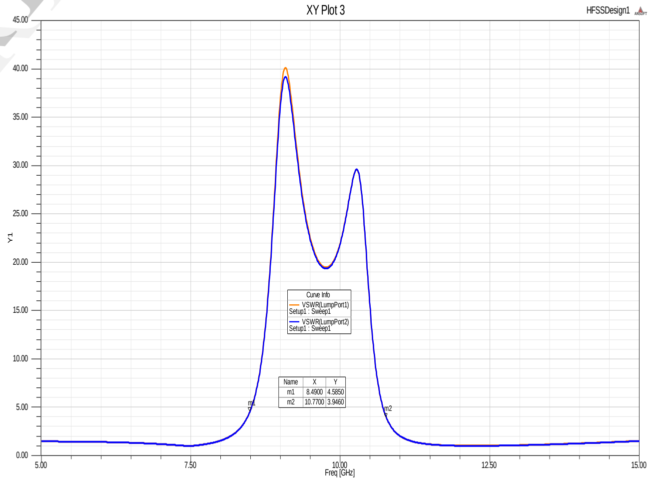

Fig 5 VSWR response

For investigation of the linear distortion of the filter, we plot the group delay in “Fig.6” It is revealed that the delay is almost constant up to the 8.5GHz but there is a sudden abrupt after -3dB cut-off frequency 8.5GHz . This problem is not important because this frequency falls in band stop region of proposed band stop filter and not affects the signal passing in operating frequency.

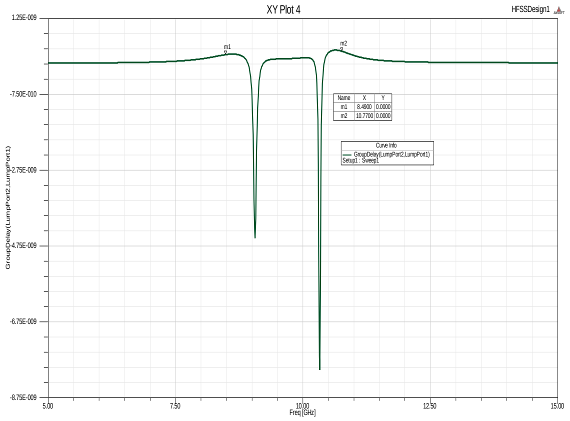

Fig 6 Group Delay Resonse

The phase characteristics of the microstrip line with DGS unit as shown in ''Fig 7''. After inserting DGS on ground plane of microstrip line the phase and magnitude of S21 is changed due to slow wave factor.

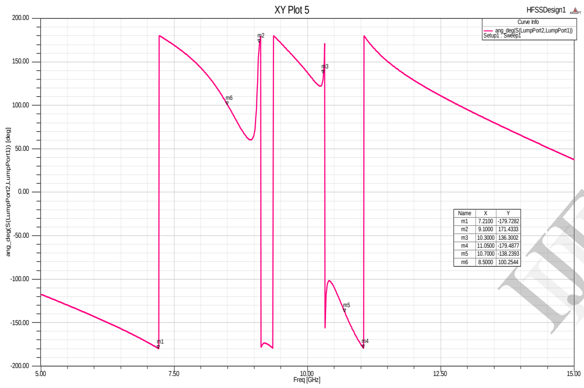

Fig 7 The phase characteristics of S21

III. Conclusion

This proposed band stop filter provides a good stop band of 2.27GHz (from 8.49GHz to 10.77GHz) with very high sharpness factor (0.94 and 0.96). It has miniaturised size (Area = 6mm*10mm). VSWR response shows that it has very good harmonic rejection property in stop band region. Group delay response shows its linear characteristic in out of stop band. With having extra width of micro strip line and resonators with small slit area, it is expected that it will have better power handling capacity.

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