JOURNAL OF INFORMATION, KNOWLEDGE AND RESEARCH IN ELECTRONICS AND COMMUNICATION

Analysis of Microwave Filter Design by using Array of DGS with DMS technique

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ABSTRACT: *A filter is a device that passes electric current at certain frequencies while preventing the passage of others. These are mainly frequency selective elements. Based on the frequencies they pass, the filters are classified as low pass filter (LPF), high pass filter (HPF), band pass filter (BPF), band stop filter (BSF). A microwave filter is a two port network which is used to control the frequency response at a definite point in a microwave system by providing transmission at frequencies within the pass-band of the filter and attenuation in the stop-band of the filter. This paper presents a tutorial overview of the new approach for designing compact filters like low pass and band stop having several advantages than Photonic Band Gap (PBG).A new technique to design a low pass filter and a band stop filter is proposed here, ground is defected or cut in a desire shape which improves their performance. The filter size is also reduced. This technique is termed as Defected Ground Structure (DGS).This novel design consist of array of triangular shaped defected ground structure (DGS) with rectangular shaped defected microstrip structure (DMS). This proposed filter design have very high sharpness factor. The traditional triangular DGS structure is also elaborated in order to show the worthiness of proposed design. A novel compact band-stop filter having low insertion loss and low radiation loss is also proposed in this thesis.*

KEYWORDS: *Microwave Filter's, DGS, DMS*

1. INTRODUCTION

Filters are mainly frequency selective elements. A network that is designed to attenuate certain frequencies but pass other frequencies without any loss is called a filter. The filtering behavior results frequency dependent reactance providing by inductors and capacitors. Typically frequency response include low-pass, high pass, band pass and band stop characteristics.

Microwave filters are the most important components in receivers. The main functions of the filters are: to reject unwanted signals outside the filter pass-band and to separate or combine signals according to their frequency [1].Microwave system often requires means for suppressing undesirable 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, band-pass, and band-stop. 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 prints of microstrip structure [2].

There are two different types of generic structure used to design the compact and high performance microwave components, named as defected ground structure (DGS) and the Electromagnetic band gap (EBG) structures generally known as the photonic band gap structures (PBG) . These structures have been attractive to obtain the function of unwanted frequency rejection and circuit size reduction. DGS cells have inherently resonant property; many of them have applied to filter circuits. However, it is difficult to use a PBG structure for the design of the microwave or millimeter wave components due to the difficulties of the modeling. Another difficulty in using the PBG circuit is caused by the radiation from the periodic etched defects. Recently a defected ground structure (DGS) have been introduced, DGS is realized by etching off a simple shape on the ground plane, depending on the shape and dimensions of the defect, the shielded current distribution in the ground plane is disturbed, resulting a controlled excitation and propagation of the EMT waves through the substrate layer. The shape of the defect may be changed from the simple shape to the complicated shape for the better performance [3].

DGS 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. Hence DGS structures are used in RF/microwave components (filters, dividers, amplifiers and high-speed digital designs) and direct application of such frequency selective characteristics is found in microwave filters. Many active and passive microwave circuits have been developed by using DGS or PBG (Photonic band-gap) patterns to suppress harmonics and realize the compact size [4-6].

Defected (or distorted) microstrip structure (DMS) used here is having extra width (rectangular shaped

2 Proposed Design's:

A. Mathematical equation's:-

Sharpness factor fcl/fo	
Bandwidth BW	fcu-fcl
Quality factor Q	fo/BW
Capacitance C	5fcl/pi(f02-fc2)pF
Inductance L	250/c(pi f0)2 Nh

Various shapes of DGS has been discusses [7-12]. The triangular DGS elements have been shown to have the sharpest responses among several DGS shapes. In order to design an array, we start with conventional single triangular DGS structure and then proceed towards array of the same. The proposed design is shown in "Fig.1"

B. Traditional single triangular DGS and its frequency response:-

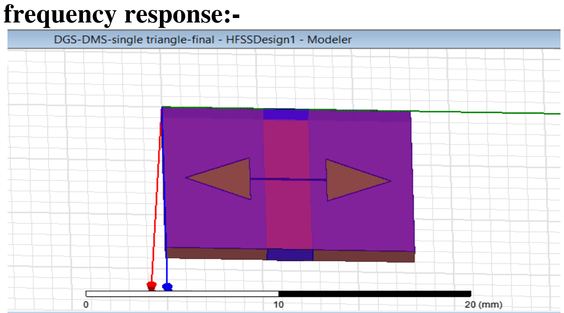


Fig 1. Single triangle traditional DGS LPF

B. Frequency response of proposed lpf design by using DGS without DMS:

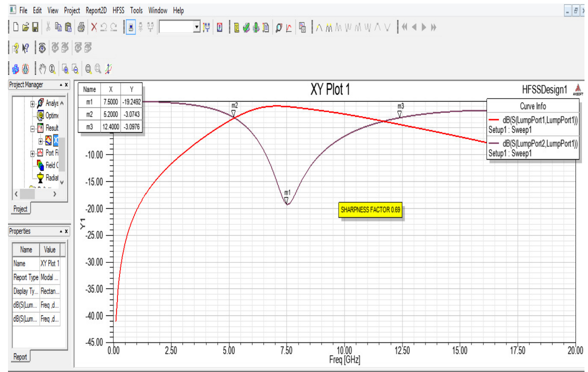


Fig 2.frequency response of traditional LPF

C. Low pass filter by using array of DGS with DMS:

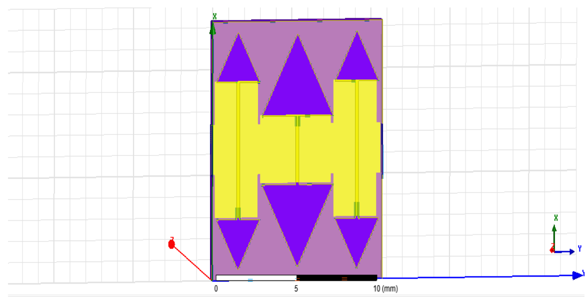


Fig.3. Proposed array of three triangular DGS with DMS

This design consists of array of three triangular DGS. In this design defected micro-strip structure (DMS) is also proposed by which we get the sharpest frequency response. Defected micro-strip structure (DMS) is made by etching of a certain slot patterns in the micro-strip line, and it exhibits the properties of slow-wave, rejecting microwaves in certain frequencies that are similar to the defected ground structure (DGS) but without any manipulation of the ground plane. DMS is more easily integrated with other microwave circuits, and it has an effectively reduced circuit size as compared to DGS. DMS increases the electric length of the micro-strip line and makes the effective capacitance and inductance increases. By using so many iterations [13], the resonant frequency shifted to 6.8GHZ and also reduces the size of the DGS [14]. Thus by using etching geometry and size reduction techniques [15], we get the final design of DGS array. The design is shown in “Fig.3” and corresponding simulated result is shown in “Fig.4”

E. Frequency response of proposed LPF:

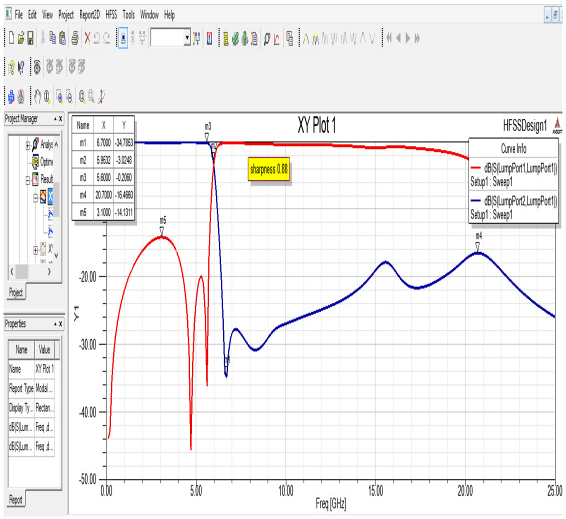


Fig 4. Frequency response of proposed LPF having array of three triangular DGS

G. VSWR parameter of proposed three triangular DGS LPF:

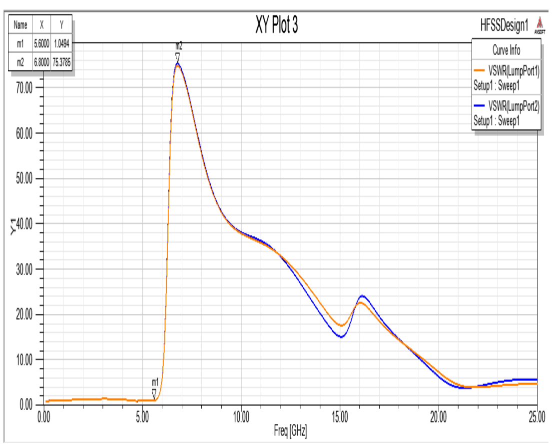


Fig 4.VSWR parameter of proposed design

From the observation of frequency response it is clear that for the same resonant frequency 6.8GHz, the array of DGS has more sharpness factor, wide stop bandwidth and less area of the etched DGS than the conventional single triangular DGS - LPF. It can be seen, that the VSWR value is very less till pass band region and sharply increased at resonant frequency and then gradually decreases after passing the resonant frequency. This shows that even high power harmonics are also rejected after the resonant frequency.

G. Array of triangular DGS band stop filter:-

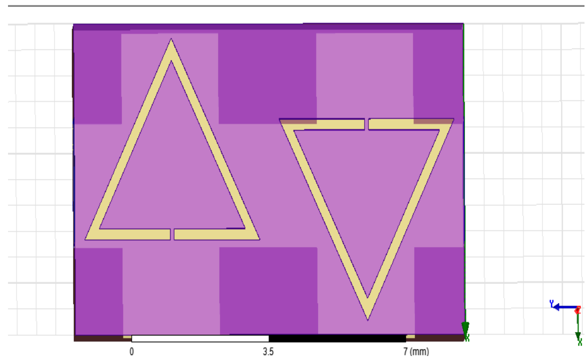


Fig 5. Proposed array of triangula DGS band stop filter

H. Frequency response band stop filter by using triangular DGS:-

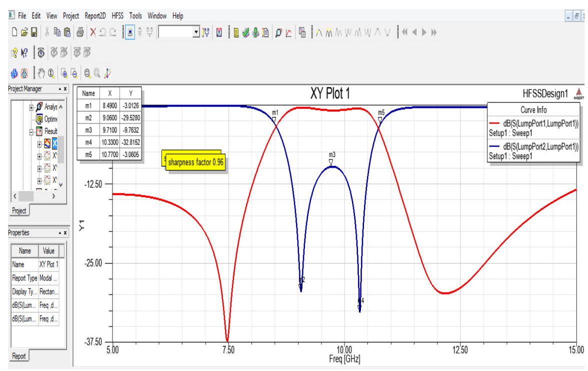
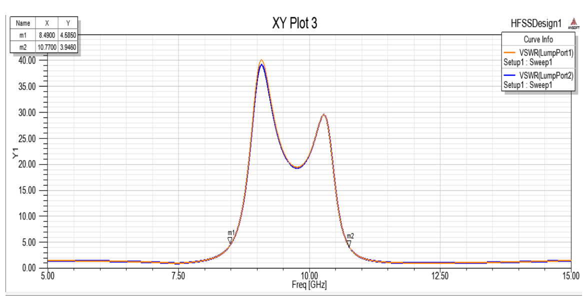


Fig 6. Frequency response band stop filter (BSF)

I. VSWR response of band stop filter:



3 CONCLUSIONS:

A compact LPF using three triangular shaped DGS has been proposed and a novel band stop filter by using DGS technique is also proposed in this thesis. Several low pass filters are developed and EM simulated results are obtained using HFSS v 13. By changing the dimensions of the filter, frequency response of the filter, can be easily controlled. Thus it has a big advantage as compared to the traditional single triangle DGS i.e.the array of DGS has more sharpness factor, wide stop bandwidth and less area of the etched DGS than the conventional single triangular DGS - LPF.

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