

Novel Compact CPW LowPass Filter Integrating Periodic Triangle DGS Cells

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ABSTRACT

In this paper, we introduce a new periodic structure for CPW of a low pass filter based on the DGS technique with triangle slot cell forme. The proposed structure is a minuatere low pass filter that exhibits low insertion loss in the passband, simple fabrication, and easy to integrate with microwave planar circuits.

A Lowpass filter (LPF) has been designed with flat response at a selected frequency by cascading three DGS cells.

Keywords—cpw lowpass filter; triangle DGS; periodic cells; wide passband;

1 Introduction

Periodic structures of various types in coplanar wave guide (CPW) technologies has a potentially high volume demands in microwave and millimetre-wave domains to their filtering properties or inhibition of signal propagation in certain frequency bands. Also, Defected Ground Structures (DGS) have been developed to improve response and characteristics of microwave components. So when both of them combined in the same structure will give excellent performance in terms of response as bandwidth, quality factor and the parasite rejection, also the level of integration as the size, the development and integration of other components. The microwave circuits such as filters design[1], antennas [2], phase shifters [3], and other are of much application domain of CPW with DGS structure.

All this attractive of CPW-DGS structures because of useful for fabrication, characterisation and manufacture of a small, low-cost and highly integrated transceiver. However, promising application of CPW in microwave integrated circuits (MICs), monolithic microwave integrated circuits (MMICs), and microelectromechanical systems (MEMS) devices[4, 5].

In transmission and reception channels of modern microwave systems, such a wireless and mobile communications, the harmonics and spurious responses are caused by the caractiristic response of some no-linear devices like oscillator. So, it is necessaire to suppress harmonics and spurious signals in the bandpass signal. For this purpose, a compact CPW Low-pass filter (CPW-LPF) using DGS periodics structure is a good condidate to improve passband performances.

In this paper, a novel compact low pass filter meeting these requirements (CPW , DGS , Periodic cells) with high performances : Harmonic-suppressed, sharp attenuation and wide stop-band.

2 Initial DGS LPF Design

2.1 CPW line based on one Triangle DGS

The geometry of the proposed Low Pass filter using Triangle DGS filter is depicted in Figure 1. The design started with one conventional cell, the DGS configuration in this structure is an Isosceles triangle slot etched in the ground

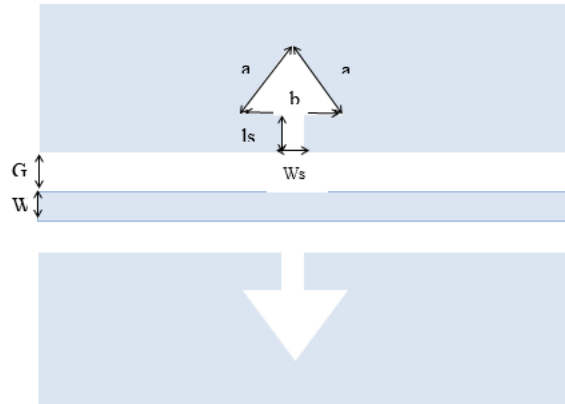


Figure. 1. CPW line with Triangle DGS structure

The coplanar waveguide line is designed to have a characteristic impedance $Z_0=50 \Omega$, and built on standard 25-mil Duroid substrate with dielectric constant $\epsilon_r = 10.2$, [6]. The central signal line width of $W=1.2$ mm, and the gap width is $G= 0.42$ mm. Also the parameters of the triangle DGS are $a=1.1181$ mm, $b=1.0004$ mm, and $l_s=w_s=0.42$ mm. The overall dimensions of the simulated device measures 20×14.04 mm². The parametric studies and simulation of the filter's electrical performances were performed using Momentum (an EM solver integred in ADS Agilent).

2.2 Response of CPW DGS Triangle

The Tringle DGS element etched in the ground plane has the effective capacitance (C) and inductance (L). The simulation insertion and return losses of the proposed topologie filter is depicted in Figure 2.

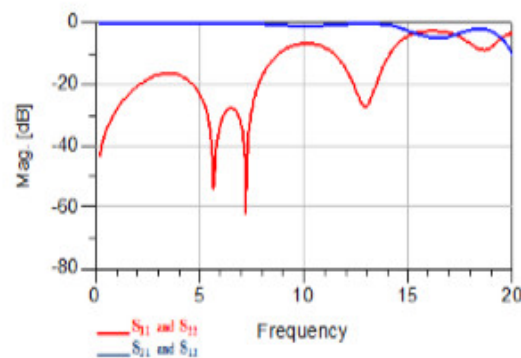


Figure. 2. Simulated S-parameters versus frequency for the CPW DGS Triangle structure.

From the S-parameter responses, it is clear that the filter provides low pass band behavior, with large bandpass from 0.1 to 15 GHz, very low and flat insertion loss of -0.5 dB and the minimum return loss of -10 dB in passband, but the suppression is inadequate because limit on the separation between the insertion loss and return loss in the stopband.

3 Proposed Device of LPF with Periodic DGS Cells

3.1 CPW line based on Three Triangle DGS Cells

In the research, augmentation of DGS elements number were used as a good solution to design a compact microwave filter, [7, 8, 9]. The performance of LPF with periodical DGSs was used here to have a much wider stopband compared with one DGS. Figure 3 depicts the schematic of the proposed structure with periodic cells

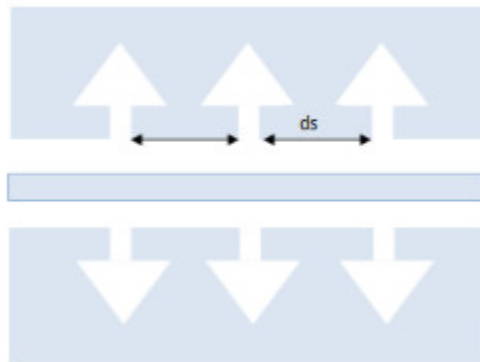


Figure 3. The proposed device of periodic DGS Cells for LowPass filter

The parameters of the initial triangle DGS low pass filter are kept unchanged while two other symmetrical triangle DGS are introduced and separated with $ds=2.9834$ mm distance.

However, the insertion-loss and return-loss performance were inadequate. As a result, a LPF with three cells periodical triangle DGSs was designed in an attempt to improve the performance of S-parameters as shown in Fig.4.

Figure 4 shows the simulated S-parameters of the proposed device of low pass filter with three periodic Cells

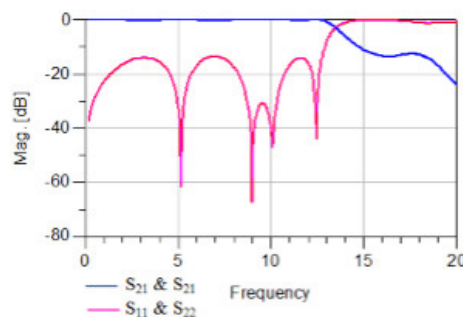


Figure 4. Simulated S-parameter of the proposed periodic DGS cells device

As a result shown in Fig. 4, the cascaded LPF with the three periodic cells present a sharp roll-off with improved stop band and suppression performance. The return loss in pass-band is greater than 15 dB, with

no more than 0.3 dB ripple level in the pass-band, while the stop band rejection level is better than 10 dB with wide stopband of 13 to more than 20 GHz.

3.2 Effect of additional periodic cells on filter response.

The simulation results of three Triangle DGS cells are shown in Figure 4. It is clearly shown in the figure that three-cell in the structure's ground is enough to suppress the spurious response in pass and stop bands and give out a wider stopband. Figures 5 and 6 demonstrates the effect of additional periodic cells on insertion and return loss.

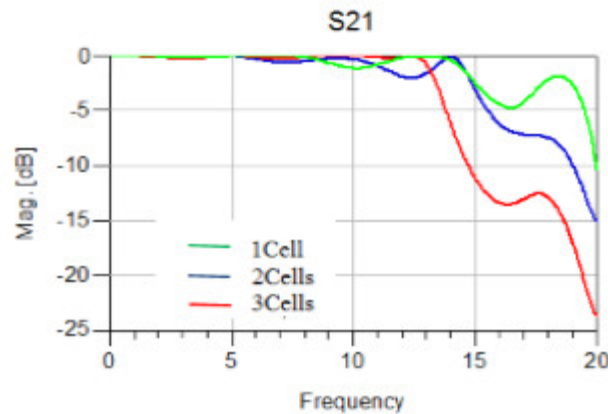


Figure 5. Effect of additional periodic cells on filter insertion loss

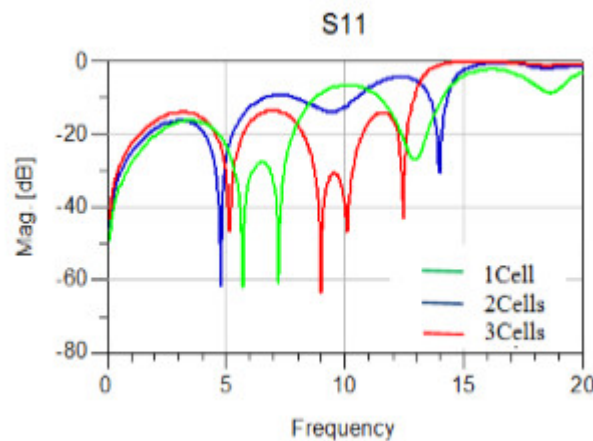


Figure 6. Effect of additional periodic cells on filter return loss.

Figures 5 and 6 demonstrated that the augmentation of periodic triangle DGS cells take a great effect on the filter response. There is a good achieving of attenuation with no ripple level of insertion loss in the pass-band with just 3 cells. Also, the filter present spurious-free response and deep attenuation levels in the return loss -60 dB in passband and rejection level better than -20 dB in the stopband, when the number of DGS cells augmented.

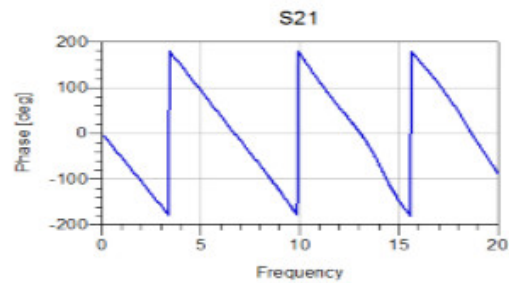


Figure 7. Simulation Phase response of Lowpass Filter Designed.

Figure 7 shows the phase simulation of insertion loss (S_{21}) for UWB bandpass between 0.1 GHz and 20 GHz of designed lowpass filter that throughout the pass and stop bands is acceptably linear for UWB applications.

4 Conclusion

In this paper, a simple compact lowpass filter using triangle defected ground structure is proposed, developed and presented. With 3-Cells DGS series on the same substrate offers the advantages of miniature low-pass filter than a standard CPW transmission line, low insertion loss with no harmonics in the passband, high attenuation levels in the stopband and very easy fabrication, while the cutoff frequency can be adjusted by controlling the dimensions of the triangle DGS cell to obtained others response frequency for more wireless applications.

ACKNOWLEDGMENT

We thank Mr. Mhamed Latrach from ESEO Angers in France, for allowing us to use and to perform simulations by using electromagnetic solvers and measurement instruments

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