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Design of a band pass filter open loop with defected ground structure for microwave applications

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ABSTRACT: This paper presents a design of compact triple-mode resonator with Defected Ground Structure. This resonator consists of a square open-loop half-wavelength resonators and a stepped impedance resonator structured in the middle which is connected to the mid–point of the half-wavelength line where a grounding via is located. The dimension of the resonator is 16.2mm*17.2mm. In this work the different parameters are changed to improve the adaptation band-width occurs for the following Defected Ground Structure as the dumbbell arrowhead as the resonance frequency. The measured filter performances are | S21| less than 0.5dB, |S11| more than 60 dB, and center frequency of proposed filter is around 1.5 GHz. The simulations in this work were performed using CST microwave software.

KEYWORDS: Band pass filters, Triple-mode filters, defected ground structure (DGS), dumbbell arrowhead, Resonator open-loop.

1 INTRODUCTION

In recent years, the research activity has greatly devoted to the study of planar structures that are used for the design and modeling of antennas and filters. The micro-strip technology occupies a privileged place in the design of planar filters. They play an important role in several RF / microwave applications. They are used to separate or combine different microwave signals.

Electromagnetic band-gap (EBG) structures are one of the most rapidly advancing topic in the electromagnetic research. Planar EBG structures have been widely applied in the design of planar filters for the performance optimization and miniaturization of the circuits [1], [2]. Among the different types of planar EBG structures, DGS has been actively studied and applied successfully in the design of various microwave circuits [3], [4].

Recently, defected ground structures (DGS) are one of the most interesting areas of research. DGS is realized by etching off a defected pattern from the backside metallic ground plane and has periodic or non-periodic structure. Since DGS cells have resonant properties, they are useful in the improvement of response of microwave structures such as antenna, coupler, Filter. Also they can be useful in spurious suppression [5].

This article presents the bandpass filters micro-strip open loop technology with DGS (Defected Ground Structure) that are in demand in the telecommunications industries due to their small size, light weight and ease in their design and manufacture. This technology is purposely altered to improve performance.

2 DESIGN OF MICROSTRIP BAND PASS FILTER OPEN LOOP

Fig. 1 shows the triple-mode micros trip open loop resonator. It is the basic element of the proposed filter which has an outer square open-loop structure with a total line length of approximately half-wavelength at resonant frequency and a grounding via located at the mid-point of the line. The structure inside the open-loop is a step impedance resonator connected to the outer open-loop at the position of the via. The grounded via effectively splits the half-wavelength resonator into two quarter-wavelength resonators. The resonator pass band tri-mode to open-loop product three fundamental frequencies of odd and even resonance which can be used to analyze the resonator due to its symmetric structure.

The characteristic of the filter is the substrate FR4 with a thickness of 0.8 mm, a relative dielectric constant of 4.4, a loss tangent of 0.025 and a conductor thickness of 35 um. All the dimensions of the filter are shown in Fig.3.L_1 = 9,5mm, L2 = 18mm, L3 = 5.75mm, L4 = 8,7 mm, L5 = 2.8mm, W1 = 1.2mm, W2 = 1 mm W3 = 0.5mm, W4 = 10,9 mm, g1 = 0,3 et S1 = 0,25mm

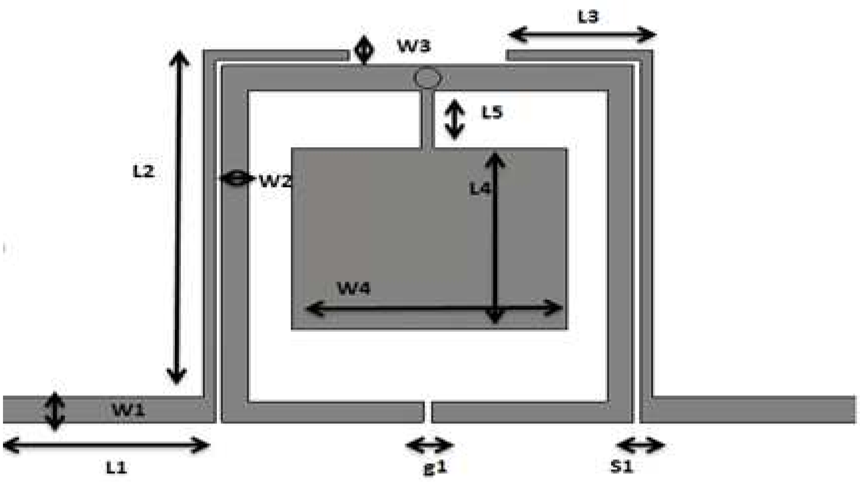

Fig.1. Layout of the third order band pass filter

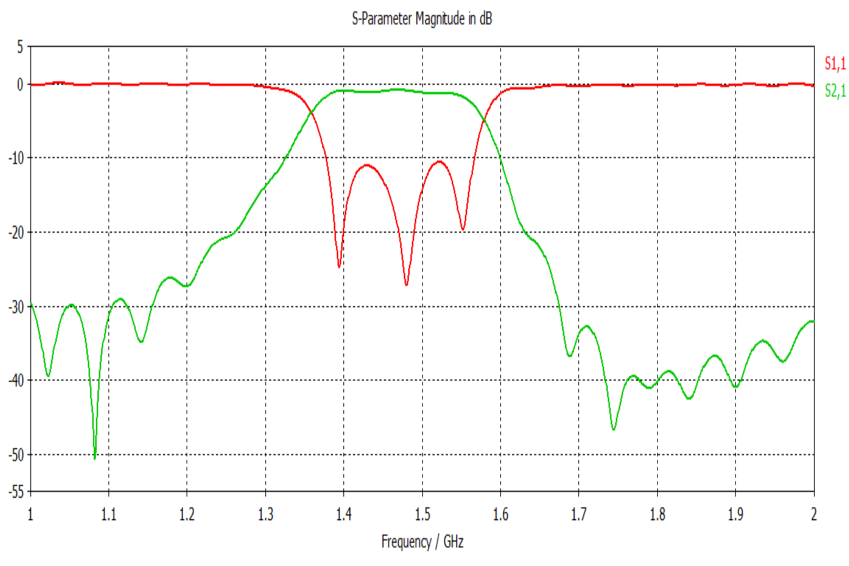

Fig.2. Simulated frequency response of three-pole filter

Fig. 2 shows the band-pass filter open loop simulated using CST software the filter settings are shown in Fig. 4. The insertion loss less than 0.5dB were obtained but the return loss is about 25dB. Note that the performance of the S-parameters is not acceptable in terms of adaptation. To improve the adaptation we proposed to integrate the DGS structures.

3 Using Defected Ground Structure (DGS) Technique to Improve the Filter Characteristics

Research in defected ground structure (DGS) has been highly prominent in radio Frequency/microwave circuits, as it aids in the development of a compact circuitry and spurious response suppression. DGS is realized by etching a defected pattern in the ground plane, this etched pattern interfers with the shield current distribution in the ground plane which affects the characteristics of the transmission line.

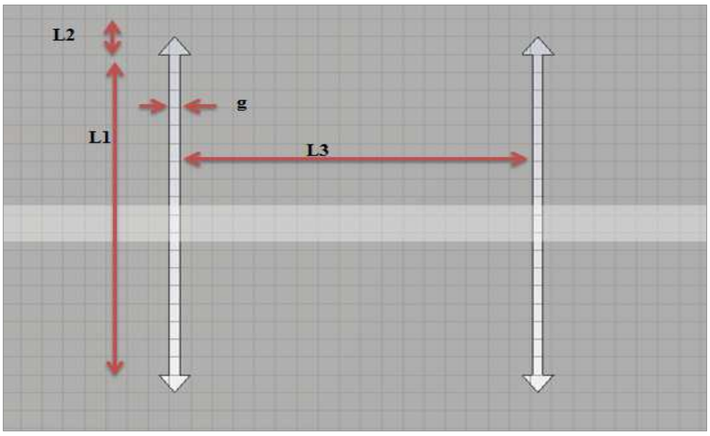

Fig.3. Ground plan with DGS

3.1 Parametric Study

The parametric study of the slot at the width and length are given by the following:

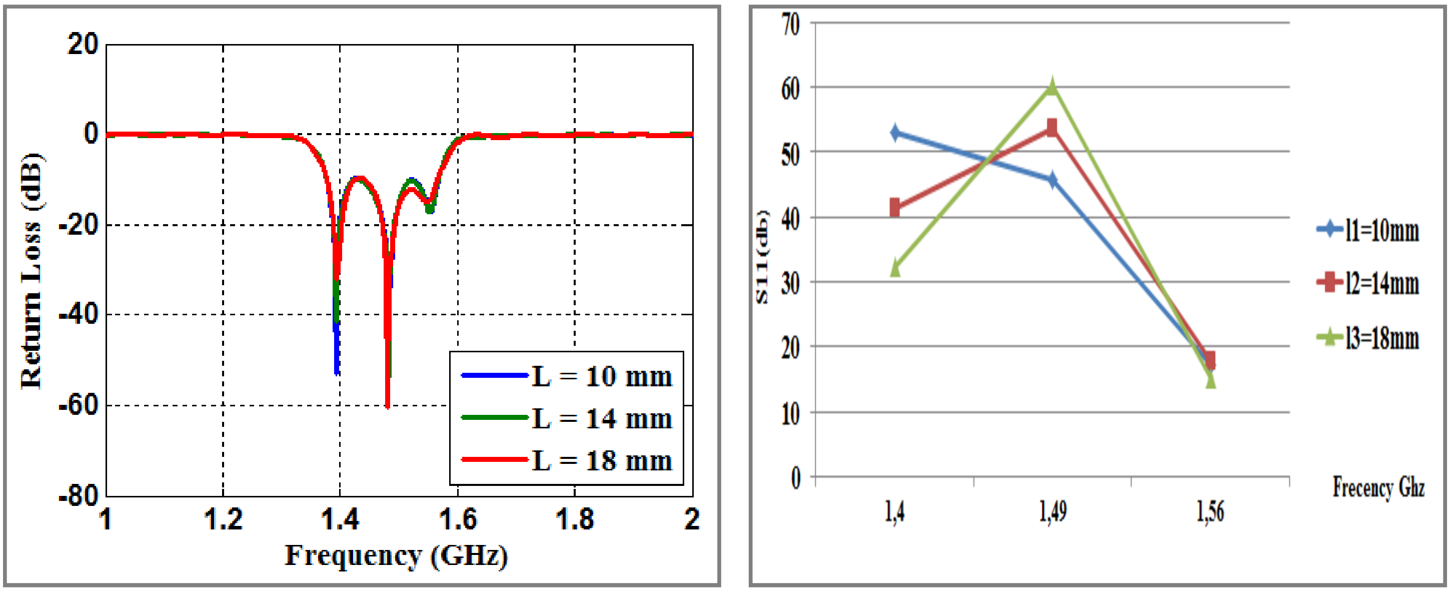

Fig.4. Investigate parameter L1 (varies L1, g=0.5mm, L2=0.5mm)

Fig. 4 shows the changes of the parameter L1 DGS cell according to the coefficient of return loss. We can see that the best result is obtained for L1 = 18mm.

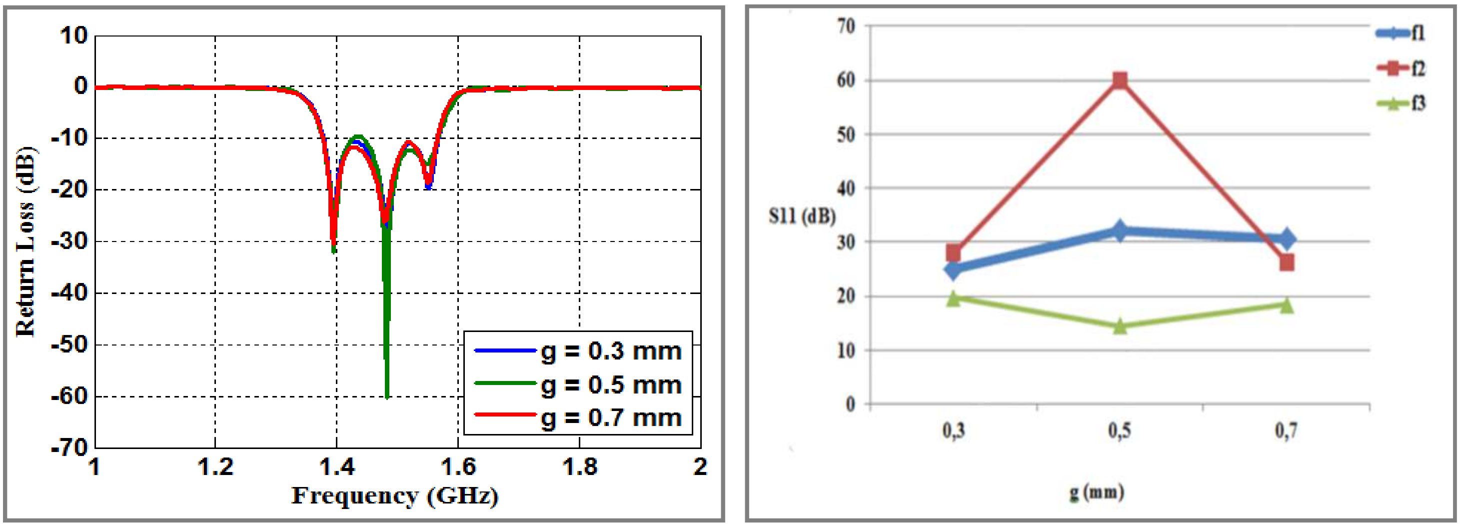

Fig.5. Investigate parameter g (varies g, l2=18mm, l2=0.5mm)

Fig. 5 shown the parameter variation g DGS cell according to the coefficient of return loss. We can see that the best result is obtained for g = 0.5mm.

4 Results

Consequently, the greatest response used to improve the adaptation band-width occurs for the following DGS parameters: L1=18mm, L2=0.5mm, g=0.5mm. Finally, we present the S parameters of the filter bandpass open loop incorporating DGS structures with optimal dimensions. We observe that the return loss of the filter improves significantly with DGS cells.

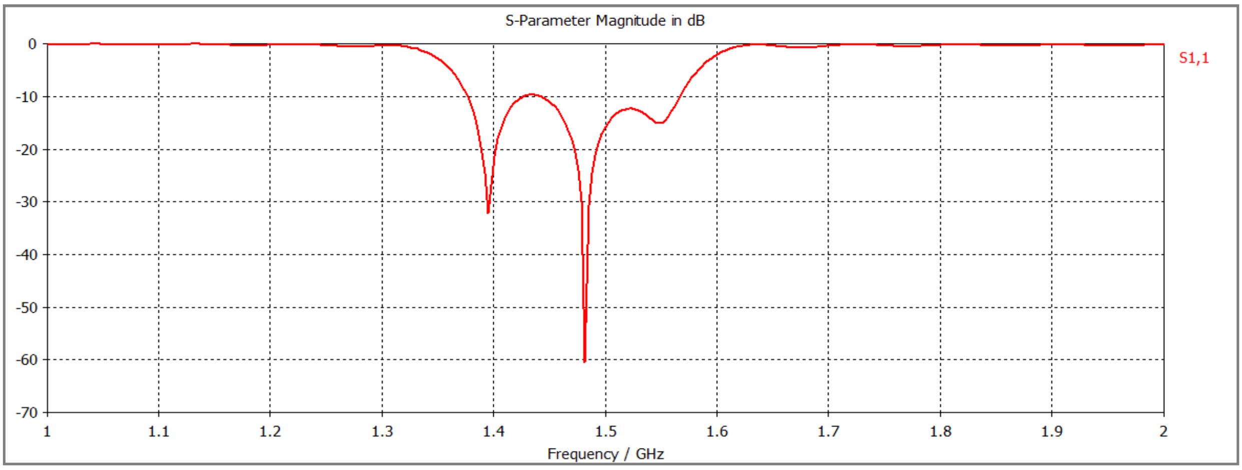

Fig.6. The parameters S11 of band pass filter

Fig. 6 shows the S-parameters of the filter. We note that the slope of the filter back has been improved significantly with the DGS structures. The filter performances |S21| less than 0.5dB, |S11| more than 60 dB, and the center frequency of the proposed filter is around 1.5GHz.

5 CONCLUSION

In this work, we proposed a bandpass filter tri-mode in open loop. The integration of DGS as the dumbbell structures arrowhead improves the adaptation and increases the performance of this filter.

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