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Design Of Compact Lowpass Filter with Wide Stopband using I-Shape

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Abstract

This paper presents a compact micro strip stepped-impedance low pass filter with ultra-wide stop band by using I-shape. Ground plane is etched with I shape. In this case, an wide stop band is achieved using Defected Ground Structures (DGSs) The proposed low pass filter with a cut-off frequency of 2 GHz. suppression level is 20 dB from 4 GHz up to 20 GHz. and the return loss is greater than 25 dB In comparison, with the the conventional SI-LPF. The proposed LPF has deeper stop band. The proposed low pass filter shows not only a size reduction but also a better stop band rejection. The simulated performance has obtained using IE3D software.

Keywords: low pass filter, IE3D software, I-shape

Introduction

Microwave low-pass filters using micro strip stepped- impedance are highly demanded due to their compact size, low fabricated cost, high performance and easy fabrication. Rejection bandwidth, sharp cut-off frequency and wide-stop band are the most important features of a desirable low-pass filter which is recently a subject of interest in new communication systems To realize this kind of LPF, several types of small size low-pass filters have been widely reported in several recent researches. In [1], a wide band elliptic-function low-pass filter using elementary structure has been proposed. This filter provides a Wide-band pass-band with a sharp cut-off frequency response, but a narrow stop-band.DGSs find more common usage interest in microwave filter applications [3]. Various kinds of design are available in literature for different filter types and specific properties like small size [4, 5], sharp rejection [6], wide stop band [7], multi-band response [8].Moreover, a low pass filter with wide rejection band has been proposed using microstrip transmission lines [9]. To increase the width of pass-band, improve the performance and reduce the size, several types of elliptic-function low pass filters have been designed In some of these papers, the pass-band has been increased and in other ones, the authors have mainly focused on the size reduction. Furthermore, a compact composite ultra wide-band elliptic-function low-pass filter has been recently proposed in [2].

Filter Design

Conventional SI-LPF:

For comparison purpose, we also designed a conventional SI-LPF as shown in Figure 1

SI-LPF with its cut-off frequency fc = 2 GHz and passband ripple = 0.1 dB Relative Dielectric Constant εr = 4.4.Height of substrate, h=1.6mm. The loss tangent $\tan\delta$=0.02. The filter impedance Z0 =50Ω.The highest line impedance ZH=ZOL=150Ω. The lowest line impedance Zl=Zoc=20Ω. Ωc=1.We have taken the element value for low pass filters from [9] for n=6. By calculation the dimensions of the conventional SI-LPF are: $l1$ = 6.85 mm, $l2$=2.1 mm, $l3$ = 5.42 mm,$l4$=7.79 mm,$l5$=7.4 mm, $l6$=6.1 mm, $l7$=1.98 mm,$W1$ =3.04 $W2$ = W4=W6=11.39 mm, $W3$ = W5=W7=0.1789 mm,

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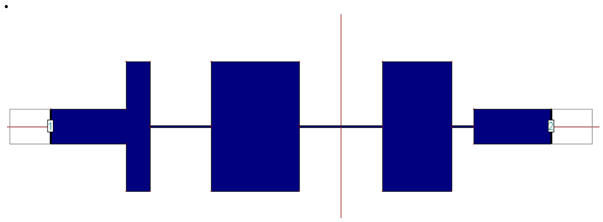

Fig. 1: shows the physical layout of the stepped impedance low pass filter

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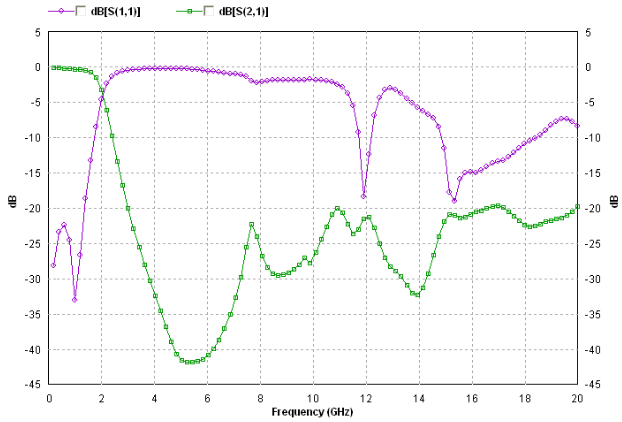

Figure 2 Frequency response of the stepped impedance low pass filter

Result shows the response of the stepped impedance, low pass filter. The graph is plotted by taking gain (dB) on the Y-axis and frequency in GHz on the X-axis. From the graph, it is clear that the cut-off frequency is found to be 2 GHz. return loss is greater than 20 dB from DC to 1 GHz

Conventional SI-LPF using I-shape:

To improve the performance of the conventional SI-LPF, by using I-shaped, we propose an improved SI-LPF as shown in Figure 3. In contrast to the conventional SI-LPF, there are
three I-shaped introduced under the three high-impedance narrow-width microstrip lines. For symmetry, the outer two I-shaped are identical. The dimensions of the outer I-shaped thin slot *ls*1 = 5 mm, *ls*2 = 0.875 mm, *ls*3 = 1.225 mm, *ls*4 = 0 mm, and *Ws*1 = 0.4 mm. Furthermore, the dimensions of the middle I-shaped thin slot are: *ls*1 =5 mm, *ls*2 = 2.4 mm, *ls*3 = 1.7 mm, *ls*4 = 1.6 mm, and *Ws*1 = 0.4 mm.

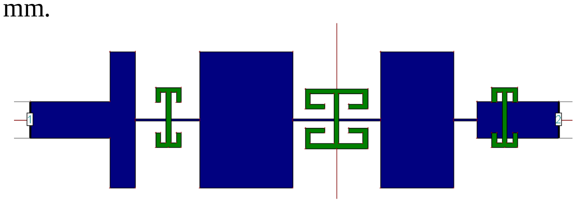

Figure 3. Superimposed view of top layer and ground plane ofthe low pass filter using I-shape

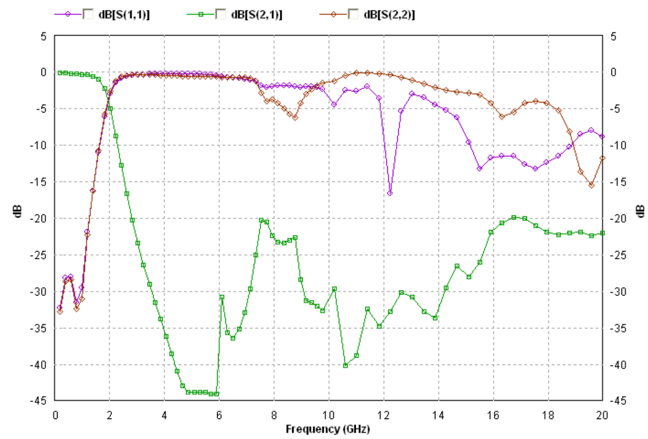

Figure 4 Frequency response of the stepped impedance low pass filter using I-shape

Result shows the response of SI-LPF with I-shape The graph is plotted by taking gain (dB) on the Y-axis and frequency in GHz on the X-axis. From the graph, it is clear that the cut-off frequency is found to be same 2 GHz. suppression level is 20 dB from 4 GHz up to 20 GHz. and the return loss is greater than 25 dB In comparison, with the the conventional SI-LPF. The proposed LPF has deeper stop band.

Result and Discussion

After designing the filter it is physically implemented on FR-4 epoxy glass substrate having dielectric constant (εr) = 4.4, loss tangent (δ) = 0.02 and thickness 1.6 mm. The simulated performance was obtained using IE3D software. From the above response of the filter it is clear that this filter is designed to have 3-dB cut-off frequency of 2 GHz. And obtained deep stop band rejection.

Conclusion

In this paper, low pass microstrip filter is designed with defected ground structures using full-wave electromagnetic design environments. for comparison purpose conventional Step impedance low pass filter also designed. after DGS are etched on ground plane separately and stop band is more deeper up to 20GHz and achieved wide stop band.

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