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Simulation of a Bandstop Filter Derived from an Optimum Bandstop Filter

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ABSTRACT: A microstrip bandstop filter (BSF) is presented. This filter is based on an optimum BSF. Two narrow stubs are attached onto two stubs in the optimum BSF respectively, to form the proposed BSF. This filter is simulated on Sonnet Suite. Simulations show this filter generates a wider stopband without increasing the circuit size.

KEYWORDS: Bandstop Filter, Open Stub, Optimum Bandstop Filter.

I. INTRODUCTION

Microstrip bandstop filters are being widely used in microwave systems, such as local oscillators, mixers, diplexers, switches, and etc. Hong summarized some techniques to synthesize and design BSFs [1]. In general, there are at least three ways to design BSFs [2]. The first way is to place resonators in parallel with and close to the main transmission line. At resonant frequencies, the resonators take energy from the main transmission line through coupling. The second way to design BSFs is to tap resonators, such as open stubs, to the main transmission line. The third way to design BSFs is to use defected ground structures (DGS). In this paper, a novel BSF is formed by attaching two narrow stubs onto the stubs of an optimum BSF. The proposed BSF is simulated on Sonnet Suite software. Simulation results show this BSF generates a wider stopband without increasing the circuit size.

II. RELATED WORK

To change the stopband profile of conventional open-stub BSFs has been a hot research top in recent years [3-5]. Tu and Chang embedded a spurline between the open stubs of a conventional open-stub BSF to get a wider and deeper stopband [3]. Liu, Zheng and Sun embedded a meander spurline between the open-stubs of a conventional open-stub filter [4]. Yang inserted asymmetrical double spurlines between the two open stubs of a conventional open-stub BSF [5]. Optimum bandstop filters have better passband and stopband performances than conventional open-stub BSFs [1]. In this research, stopband performance of an optimum BSF is improved by attaching two narrow stubs.

III. FILTER LAYOUTS AND SIMULATION RESULTS

An optimum BSF filter can provide very low insertion loss or very low reflection in the passband while keeping very deep rejection in the stopband. Such an optimum BSF with three open stubs, having a fractional bandwidth of 0.8 and a midband frequency of 4.9 GHz is designed. The passband return loss is chosen at -20 dB. Design details of this filter can be found elsewhere [6]. Design parameters for this optimum BSF are summarized in Table 1.

Line impedance	Impedance (Ohm)	Width (mm)	Length (mm)
Z_1 and Z_3	73.54	0.47	6.10
Z_2	42.48	1.7	5.75
Z_{12} and Z_{23}	73.88	0.46	6.11
Z_A and Z_B	50	1.20	NA

Table 1. Design parameters for the optimum BSF

Layout of this optimum BSF is shown in Fig. 1. The two narrow vertical stubs on the right and on the left are Z_1 and Z_3 lines, and the wider vertical stub in the middle is Z_2 line. The horizontal connecting lines between the vertical stubs are Z_{12} and Z_{23} lines. The input and output lines on the most left and the most right are Z_A and Z_B 50 Ohm lines. The

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lengths of the three vertical stubs are a quarter of the wavelength at 4.9 GHz. But the Z_2 stub is a little bit shorter than the narrower Z_1 and Z_3 stubs.

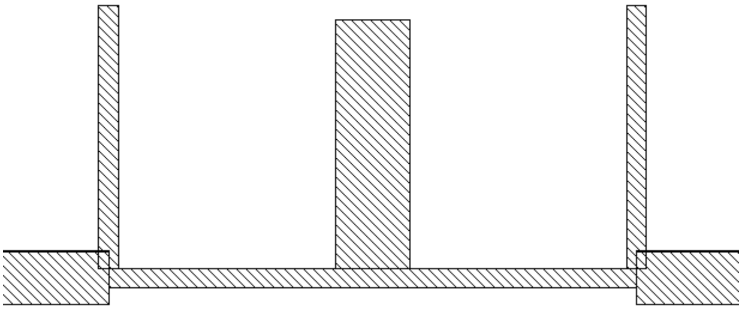

Fig. 1 Layout of an optimum bandstop filter

This optimum BSF is simulated on Sonnet Suite 14.52, and the simulation results are shown in Figure 2. It has a stopband around 4.9 GHz. The deepest rejection at 4.9 GHz is more than -60 dB. In the passbands (lower than 3.0 GHz and higher than 7.0 GHz), the return loss is very low. So that this optimum BSF's characteristic impedance is close to 50 Ohm in these two passbands. The stopband becomes narrow at deep rejection levels. For a wide stopband at deep rejection levels, two narrow stubs are used next.

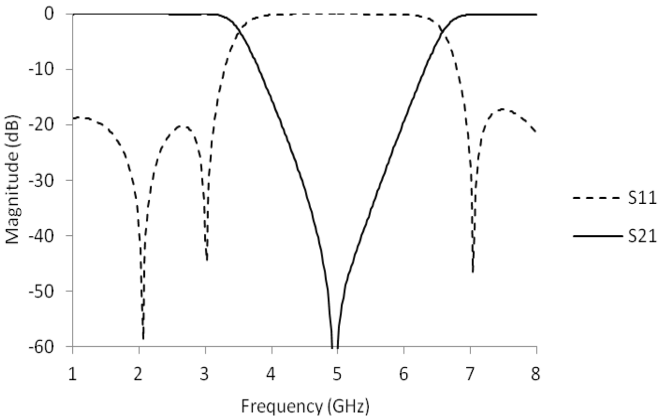

Fig. 2 Simulation results of the optimum BSF

The proposed BSF is based on the optimum BSF mentioned earlier. Layout of the proposed BSF is shown in Fig. 3. Two narrow stubs are attached to the top side of the Z1 and Z3 open stubs respectively. The narrow stubs are 0.1 mm wide and 2.3 mm long. They should be as narrow as possible. So that they will have less influence on passband performance. Each narrow stub and the original stub to which it is attached will form a new longer stub and will generate a new attenuation pole. The two new attenuation poles from the two extended stubs plus the original attenuation pole from the original optimum BSF will form a new stopband.

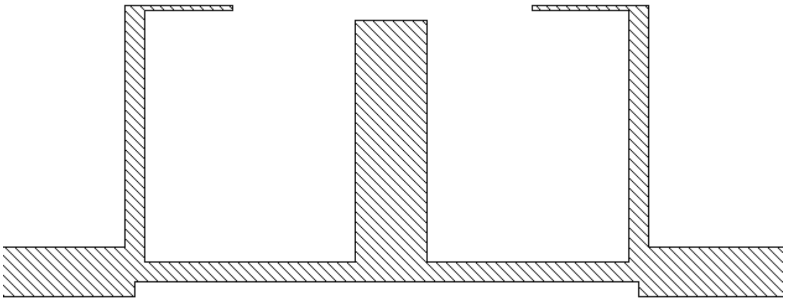

Fig. 3 Layout of the proposed BSF

This proposed filer is simulated on Sonnet Suite 14.52. Simulation results are shown in Figure 4. The new stopband is much wider at rejection levels less than about -40 dB. Each narrow stub and the original stub form an extended open stub, which generates an additional attenuation pole at 4.02 GHz. These two new overlapped attenuation poles are the sources for the changes in the stopband profile.

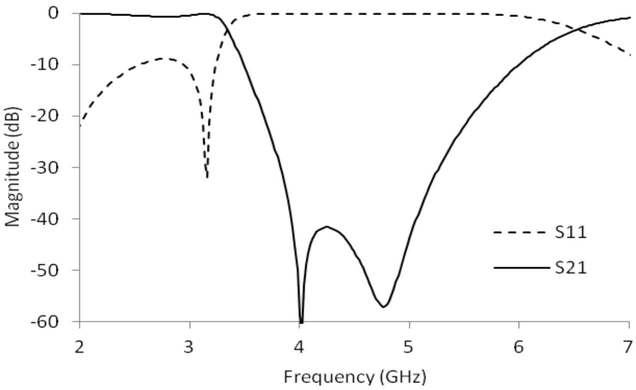

Fig. 4 Simulation results of the proposed BSF

For better comparison, the insertion losses of the conventional filter and the proposed filter are shown together in Fig. 5. The new stopband is much wider at the bottom, such as at -40 dB. The stopband center frequency of the proposed filter is shifted to lower frequency side. This difference can be overcome by moving the midband frequency of original optimum bandstop filter to higher frequencies at the beginning, if it is needed in real applications.

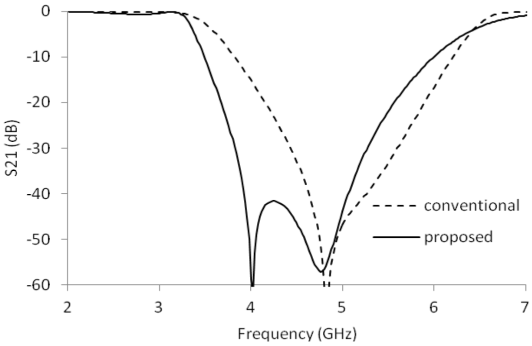

Fig. 5. Insertion losses of the conventional filter and the proposed filter

IV. CONCLUSION

Two narrow stubs are attached onto two stubs of an optimum BSF to form a new filter. The proposed BSF is simulated on Sonnet Suite. Simulation results show the formation of a wider stopband at less than -40 dB rejection levels.

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