Stepped Impedance Resonator Bandstop Filter based on Hairpin Coupling Configurations

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***Abstract*— We designed Stepped Impedance Resonator (SIR) bandstop filter (SIRBSF) with hairpin coupling structures which has good performance and it is compact in size and great advantage having an excellent bandstop property. The center frequency of SIRBSF is 5.1 GHz which is the harmonic of the 2.55GHz band. The 3dB band width of the design is 200MHz with the insertion loss (S21) of 35 dB. The application is used for domestic and international fixed and mobile satellite and mobile communication. The overall size is 10 mm x 20 mm.**

Keywords— Filter, SIR, Microstrip, Bandstop, Resonator

I. INTRODUCTION

A bandstop filter is very important in a wireless communication system which can be used for removing the unnecessary harmonic frequencies. Recently, a miniaturization of device components is a general trend in the communication system [1], It is a tendency to use the bandstop filter in the system which is proposed in this work [2~3]. Since, some wireless devices are being worsen due to the effect of unnecessary radiation, rule and regulation must be strengthened for it. In particular, the compact and a wide or narrow-band bandstop filter characteristics is required which is has an ease of production on the substrate with a low production cost, a small insertion loss and stop a strong band for the removal capability of unnecessary frequencies. It has such a linear response characteristic in the transmission band too. However, by connecting a microstrip line in both input and output of the bandstop filter, we designed Stepped Impedance Resonator (SIR) bandstop filter (SIRBSF) with hairpin coupling structures and tried to make miniaturization with higher efficiency. Therefore, two symmetric SIR based hairpin structures are made coupled in the center microstrip line. [4~6]. The SIR hairpin based bandstop filter is designed with limited bandwidth [7~9]. It can be used to reject the second harmonics in various wireless communication applications such as the domestic and international fixed and mobile satellite communication and mobile communication system.

Therefore, the designed SIRBSF is achieved to reject unnecessary frequency. The SIR configuration is chosen in order to have higher suppression with miniaturization capability. It also exhibits good frequency response. In the next section, we will discuss about design and simulation, and lastly, the conclusion.

II. DESIGN AND SIMULATION

The SIRBSF is designed and simulated on the basis of the FR4 substrate with the dielectric constant of 4.5 and thickness of 1.6 mm. The filter is designed which has a center frequency of 5.1GHz and the input and ouput port is in both sides of the transmission line. The symmetric hairpin type SIR is arranged such that they can couple to the central transmission line. The schematic layout design is shown in Fig. 1. The SIR based hairpin structure coupling effect is used for generating a transmission zero in the bandstop point and it can able to exhibit bandstop characteristics.

In the design and simulation Sonnet EM Simulator is used. The equivalent circuit of the SIRBSF is depicted in Fig. 2 which is composed of parallel combination of inductor and capacitor with parasitic capacitance Cp_1 and Cp_2.

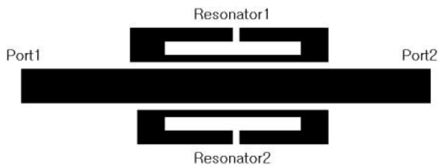

Fig. 1. Designed hairpin structure based SIRBSF.

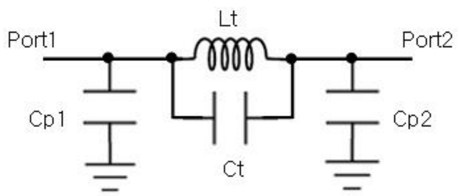

Fig. 2. The simplified equivalent circuit of the designed SIRBSF.

In the filter, transmission characteristics and the reflection coefficient are shown in Figure 3. In the simulation result, the center frequency of the filter is 5.1GHz, transmission characteristics (S21) are the band-stop frequency and the insertion loss (S21) is -35.0dB. The 3 dB bandwidth of this SIRBSF is 200 MHz. The input reflection coefficients (S11) is close to zero and the other pass band is shown very high.

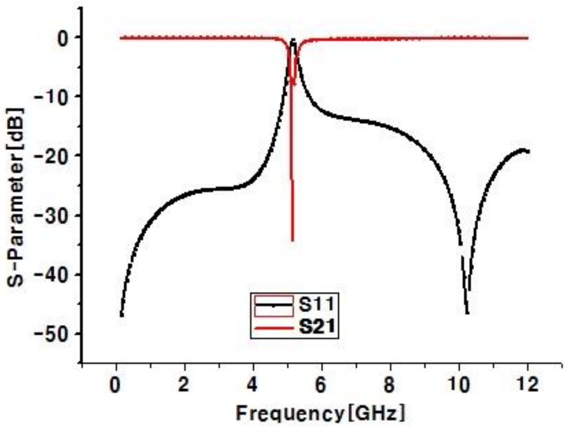

Fig. 3. The simulation result of the designed SIRBSF.

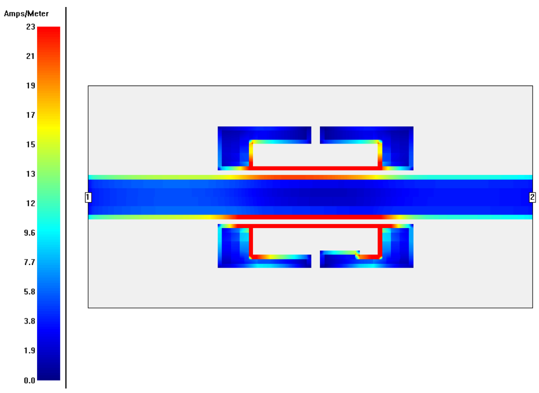

Fig. 4. The current density distribution in the SIRBSF

The current density distribution simulation of SIRBSF is shown in Figure 4. As a result of measuring the simulation result, the center frequency is 5.1GHz in which the current is not flown, that means; the current is totally rejected in that frequency. So, the output of the SIRBSF is almost zero and there is a maximum current flow in the coupling region. As mentioned above, it can be seen that the current density of the output to the input is not transmitted. The overall size is 10 mm x 20 mm.

III. CONCLUSION

In this paper, the SIRBSF based on hairpin coupling configuration is designed and simulated using SONNET EM simulator tool and the simulation result is analyzed. The SIRBSF is designed at a center frequency of 5.1GHz and insertion loss (S21) is of 35.0 dB, with 3 dB bandwidth of 200MHz are obtained and also the distribution of current density is also verified that there is no current flow in the frequency of 5.1 GHz. The SIRBSF can be applied in both domestic and international fixed communication system and mobile satellite communications (2.5 ~ 2.52 GHz) and mobile communications (2.52 ~ 2.535 GHz). In this way, we can remove the harmonics by using bandstop characteristics of the designed SRIBSF.

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