Dual Band Band-stop Filter with Tunable Frequency Ratio

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***Abstract*—this paper presented the design of dual band band stop filter with tuneable frequency ratio, in this there is the use of coupled line sections of different lengths, along with a variable capacitor. In dual band response; the first pass-band can be independently tuned depending on the factors like Zoe, Zoo, Electrical lengths of coupled line; the second pass-band can be easily controlled by varying the capacitance between the coupled linestructures.**

***Keywords*—Dual band stop filter; variable capacitor**

I. INTRODUCTION

In wireless communication, frequency plays an important role. While designing any microwave filter we need to focus on this component. If we keep variable tunable frequency we can use filter for different application. In this paper, second pass-band can be easily controlled by varying the capacitance between the coupled line structures.

There are several designs of dual band stop-band and pass-band filters. In design [1] by using step-impedance microstrip lines, couplings between resonators can be controlled so that the constant bandwidth requirement couldbesatisfiedwithreasonabledesignparametervalues. Lumped inductors are used for input and output coupling networksthe. [2] Use of varactor is presented to tune the electrical length of an open-circuited stub and to meet the wide tuning range, varactor diode SMV1232 is chosen such that the centre frequency can be tuned up to wide tuning range. In design [3] they used compact parallel-coupled transmission line section, connected at their both ends, The zeros can be arranged to design a sharprejection widebandband-stopfilterThesinglefilterunitprovides29 dB stop-band over a fractional bandwidth of 60% at the mid-band frequency of 1.47 GHz. In [4] the filter structure is obtained by replacing the high impedance transmission line section of the low-pass filter structure by a coupled-line section and the rejection depth and bandwidth can be easily controlled by the coupled-lineparameters.

Various filter design has been presented where they have used varactor diode and couple line to achieve tuneable frequency.

This paper presents method of frequency tuning incase of filter by varying capacitance between the coupled line structures.

II. PROPOSED DESIGNSTRUCTURE

Figure [1] shows proposed filter design structure. For Mathematical analysis, the design is further divided into two parts which is illustrated in figure [1].

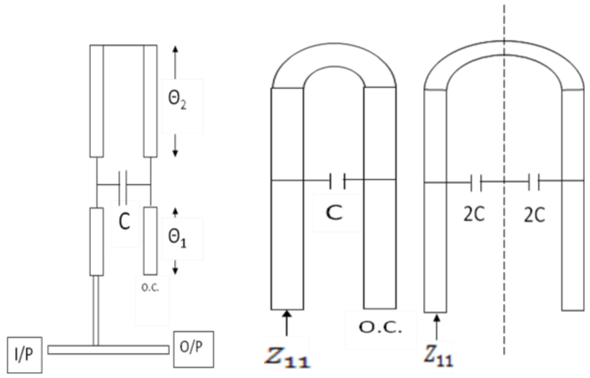

Figure 1. Proposed design of filter.

A. Mathematical Analysis

For analysis of filter, we use even and odd analysis as shown in figure [2].

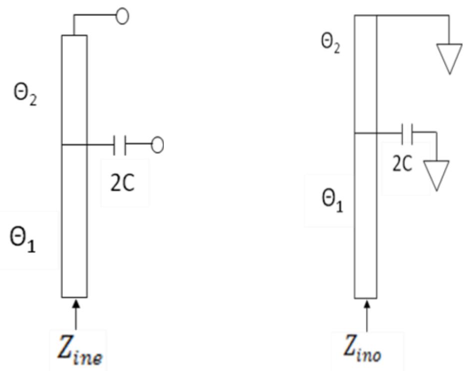

Figure 2.Even and odd Mode analysis.

Input impedance of even and odd mode is given as

$$Z_{ine} = -jZ_{oe}\cot(\theta_1+\theta_2) \quad (1)$$

$$Z_{ino} = \frac{jZ_{oo}\,(\tan\theta_1 + \tan\theta_2 - \alpha\,\tan\theta_1\tan\theta_2)}{(1-\alpha\,\tan\theta_2 - \tan\theta_1\tan\theta_1)} \quad (2)$$

where,

$\alpha = 2\omega C Z_{00}$

ISSN: 2278-0181
NREST - 2021 Conference Proceedings

From input impedance of even and odd mode analysis, we have calculated S11 and S12 which is again useful to calculate Z11 which is given as follows

$$S_{11} = \frac{Z_{ine}Z_{ino} - Z_o^2}{Z_{ine}Z_{ino} + Z_{ine}Z_o + Z_{ino}Z_o + Z_o^2} \quad (3)$$

$$S_{21} = \frac{Z_{ine}Z_o - Z_{ino}Z_o}{Z_{ine}Z_{ino} + Z_{ine}Z_o + Z_{ino}Z_o + Z_o{}^2} \quad (4)$$

$$Z_{11} = Z_o \frac{1 - S_{11}^2 + S_{12}^2}{(1 - S_{11})^2 - S_{12}^2} \quad (5)$$

Using ABCD parameter and S parameter relation we can further calculate S parameters of combined structure. Our final design is shown in figure [3] for θ=0.

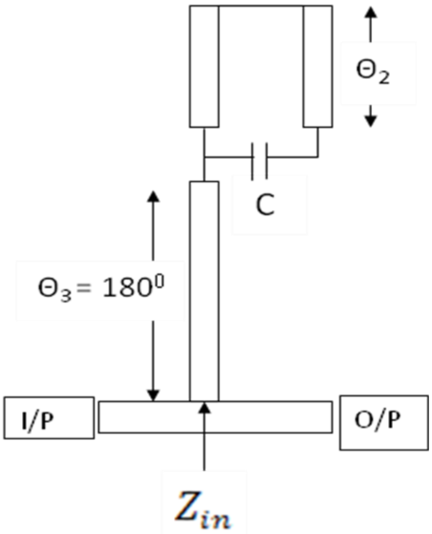

Figure 3.Final design of filter for θ=0.

III. GRAPHICALANALYSIS

We have done analysis and simulated our final design of filter in MATLAB and Ansoft HFSS and observed S21 and S11 parameter for various capacitance values.

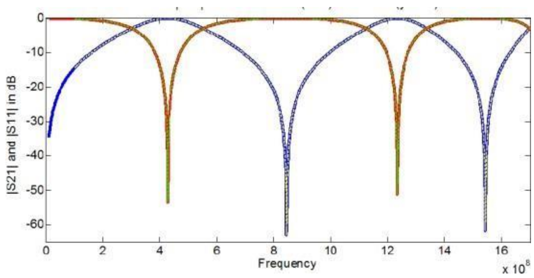

Figure 4. |S12| and |S11| for C=0.6pf

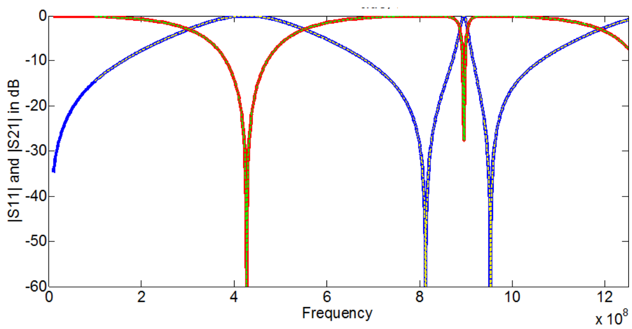

Figure 5. |S12| and |S11| for C= 4.0pf

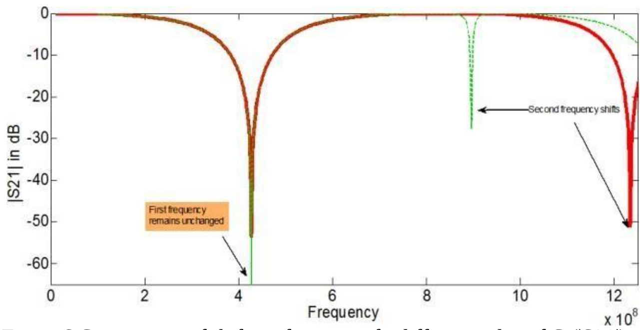

Figure 6.Comparison of shifts in frequency fordifferent value of C (|S21|).

From figure 6, it shows that there is frequency shifts by varying capacitance value from 0.6 pf to 4 pf . and figure7 shows there is slight change in first frequency but second frequency variesdrastically.

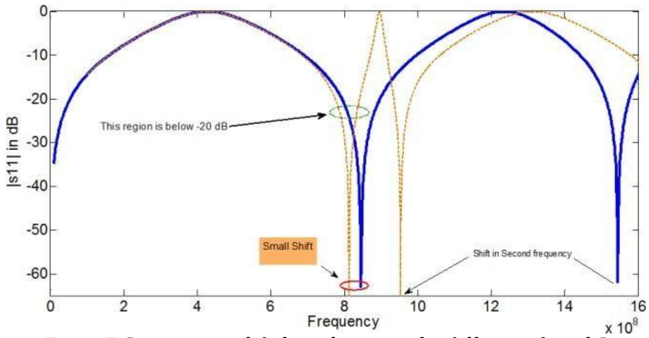

Figure 7.Comparison of shifts in frequency for differentvalue of C (|S11|)

In Ansoft HFSS we have simulated our design and observed |S21| with respect to different capacitance value result is as shown in figure [8].

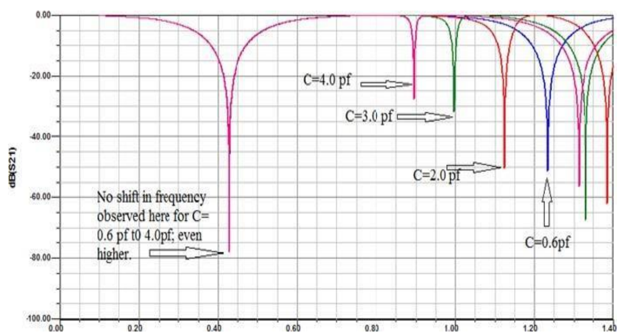

Figure 8.|S21| in dB for C=0.6, 2.0, 4.0 , 6.0 pf

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After observing all results, if we are trying to plot frequency ratio with respect to capacitance ratio, there will be slight decreasinggraph.

IV. Conclusion

Comparing various results from MATLAB and Ansoft HFSS,
it is observed that by varying capacitance between coupled line structures we can achieved frequency tuning in band-stop filter. We can use varactor diode as well for providing different capacitance, Since in the present configuration we cannot bias the varactor (dc voltage) as the microstrip coupled-line section will come in parallel with the varactor. An alternative is to use a combination of a SMD cap and a varactor. Then the SMD cap will maintain the dcisolation

V. References

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