Design and Analysis of Ultra Large Bandwidth Microstrip Filter using SRR Technique

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Abstract- A large bandwidth microstrip filter using Split Ring Resonator (SRR) is presented in this paper for three different configurations. The proposed result is used to verify the performance of filter and effect of introducing split ring resonator on microstrip filter design. In this manuscript out of three proposed design we achieve best result in terms of ultra large bandwidth in third design, where we get a bandwidth of 3290 MHz At Center frequency of 3.7 GHz, which is around 30.55% improved as compared to First design, which has a bandwidth of 2520 MHz at Center frequency 4.2 GHz. Likewise, we get around 65.32% improvement in bandwidth as compared to Second design.

Keywords— Microstrip filter, Insertion loss S_{21}, Return loss S_{11} and Q- Factor.

I. INTRODUCTION

In present communication era the fast growth of microwave device [10,11,12] raise the demand for compact filter [13,14]. The idea of microstrip filter enhanced by the support of its various advantages, compactness is also among them. The main disadvantage of such microstrip filter is its performance for higher frequency range due to the presence of surface wave and mutual coupling [1,2,3]. Mutual coupling exerts adverse effect on various performance parameters such as terminal impedance return loss and insertion loss. Reduce the above effect in microstrip filter we need impedance matching network. Several researchers try to use different techniques such as open circuit, voltage method S-parameter method, element pattern method, full wave method and calibration method. All of them are mathematical models method which gives good result, but beside of this, some simple method are also on the radar of researchers like defected ground structure (DSG) [4,5], meandered line structured, electromagnetic band Gap structure (EBG) [6,7,8] and split ring resonator method (SRR). We have chosen split ring resonator method for different polygonal structure and get the best result in terms of large bandwidth using the same. The rest of the paper is structured in following sections, section II describe different proposed design polygon model, cavity model and SRR based polygon design, whose result is described in Section III and finally a conclusion of the outcome of this research work is presented in section IV.

II. PROPOSED DESIGN

This section is dedicated to the proposed design of microstrip filter, here we present three design all of them are constructed on FR4 substrate with 1.6. mm thickness. The design procedure is started with selecting a polygon of ten sides in first design then after, in second design we introduced rectangular cavity in between the polygons and observe the result and finally we introduced the SRR structure on polygon patch to enhance the bandwidth of filter in third design.

Design A.

In this design we use a polygon having 10 sides on FR4 substrate with 1.6. mm. thickness. The size of choosing 1.6. mm is based on availability of the material in standard size as most of the fabrication units prepared standard size of 1.6. mm substrate only, hence we have chosen this dimension. The overall design of substrate is 32. mm by 26. mm. The polygonal patch is extended by 16.17 mm in x-axis and 14 mm in y-axis as shown in figure 1. On both side of the filter we use two input-output port with dimension of 6mmv by 6mm. This structure of ground plane is simple rectangular shape of dimension 32×26 mm^2 which covers complete structure as shown in figure 2. The material used for grounds structure is copper and finally the excitation port mention is again 6 mm by 1.6 mm in XZ plane, which cover the feed line Dimension completely on both port.

Design B

In this design. We again use the concept of 10 side polygons as we use in design A, the only difference between design A and B is an introduction of rectangular cavity with a dimension of 16.17 mm by 6 mm. Here again we use a substrate of size 32 by 26 mm^2 with the same dielectric constant (ε_r= 4.4), with thickness is 1.6 mm again as of the previous design and the feed line is same as that of the design A that is 6 mm by 6 mm. again, the material used for grounds planes surface is copper.

The excitation port has a dimension of 6 mm by 1.6 mm in XZ plane Which cover completely the feed line on both port as shown in figure 3 below.

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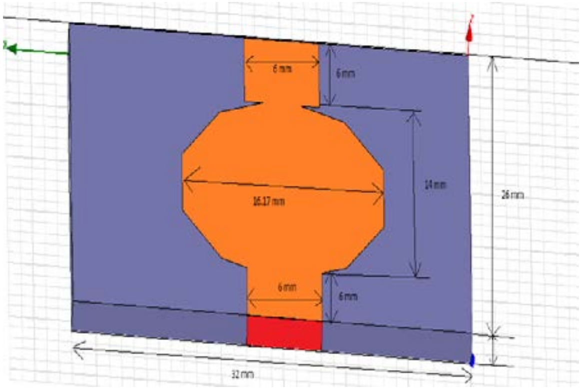

Figure.1 Top view of Design A.

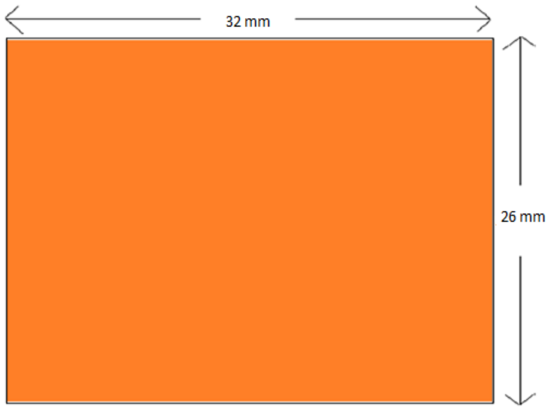

Figure.2 Ground plane of Design A.

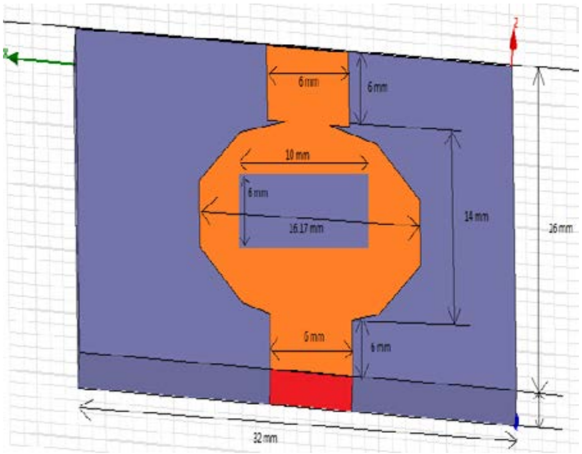

Figure.3 Top view of Design B.

Design C

The structure of design C is again same as that of the previous two design, but here we introduced split ring resonator (SRR) technique and a slot of 4 mm by 6 mm is cut on the left edge of 10 side polygon. as shown in figure 4 given below and rest of the design and structure is same as that of design A and B as without any change.

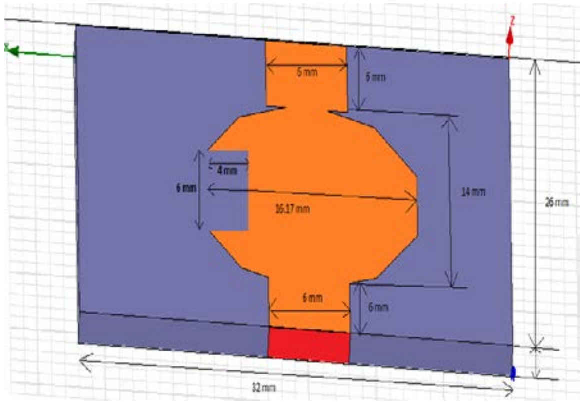

Figure.4 Top view of Design C.

III. RESULTS

In this section, we present various performance parameter for the filter for different Center frequencies we used to find Insertion loss S_{21}, bandwidth, VSWR, return loss S_{11} and Q factor for all of the three proposed design [8,9,10].

In first design we get only one band of radiation, having a center frequency of 4.2 GHz with a bandwidth of 2520 MHz with VSWR 1.4 only, and return loss of -15.4 dB with a Q factor of 1.72.

On the other hand For second design. We are getting two bands of radiation the center frequency 3.0 GHz and 5.4 GHz. and then insertion loss S_{21} of 0.74 and -0.68 respectively. So far as their bandwidth is concerned the impedance bandwidth at frequency 3.0 GHz is 1130 MHz and we get a bandwidth of 1990 MHz at Center frequency 5.4 GHz likewise. We get VSWR of 1.08 and 1.40. for 3.0 GHz and 5.4 GHz, respectively. So far as return loss is concerned.

Table 1: Result analysis of all Proposed designs.

Design	Center frequency (in GHz)	Insertion Loss Maximum	Bandwidth at -10dB in MHz	VSWR minimum	Return loss (dB) minimum	Q-factor
A	4.2	-0.10	2520	1.4	-15.4	1.772
B	3.0	0.74	1130	1.08	-25.58	2.63
	5.4	-0.68	1990	1.40	-15.50	2.77
C	3.7	0.99	3290	1.16	-22.18	1.33

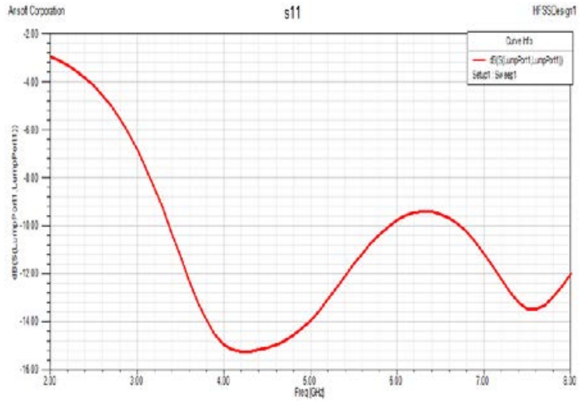

Figure.5 : Return loss of Design A.

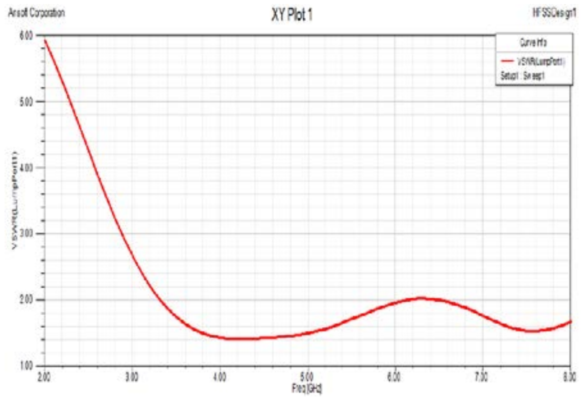

Figure.6 : VSWR of Design A

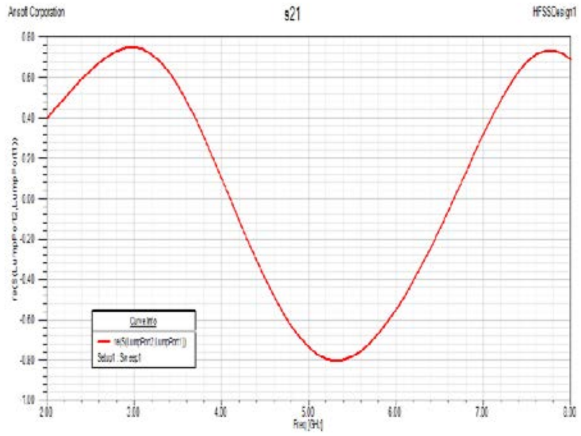

Figure.7: Insertion Loss of Design A.

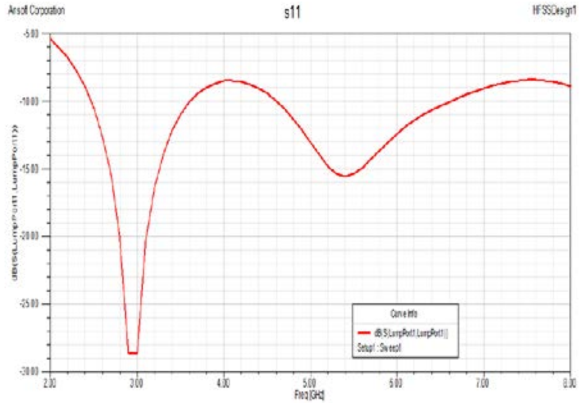

Figure.8 : Return loss of Design B.

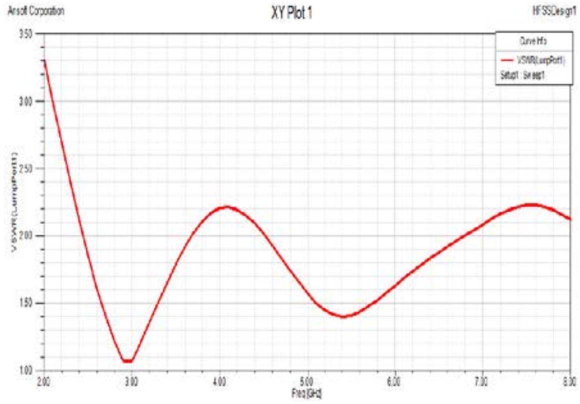

Figure.9 : VSWR of Design B

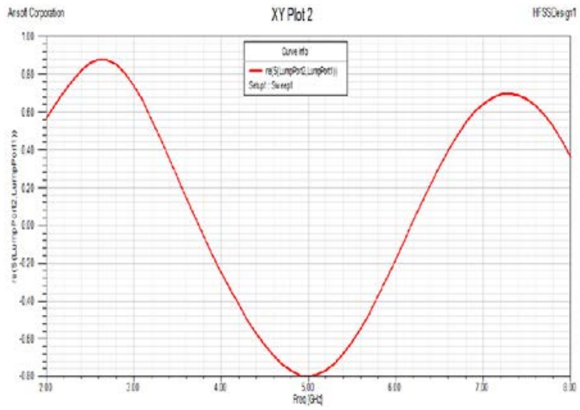

Figure.10: Insertion Loss of Design B.

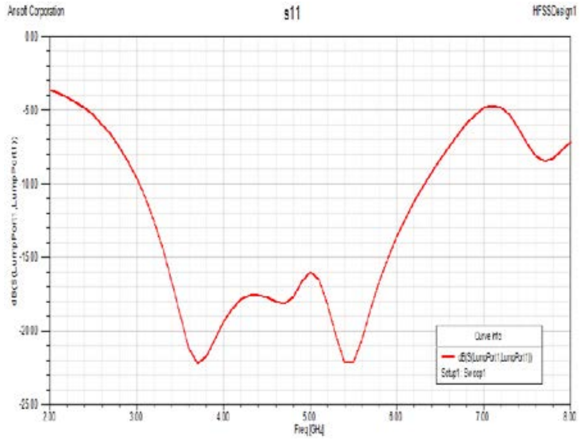

Figure.11 : Return loss of Design C.

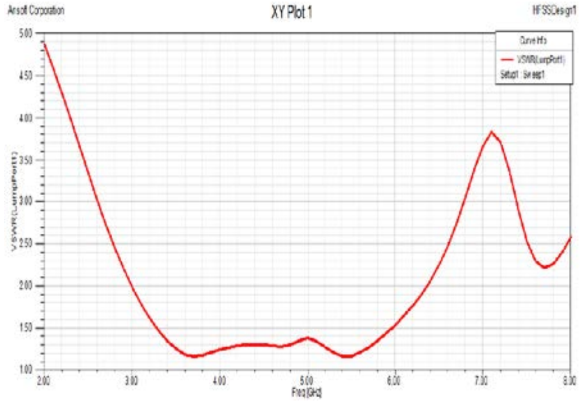

Figure.12 : VSWR of Design C.

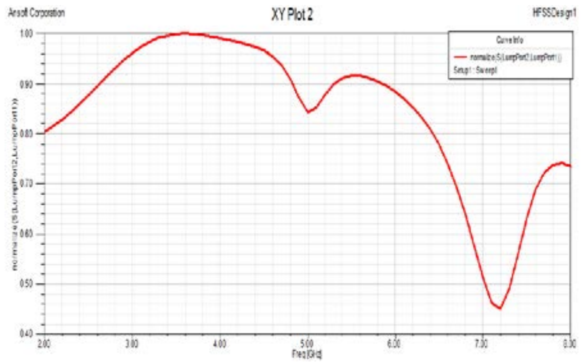

Figure.13: Insertion Loss of Design C.

IV. CONCLUSION

Here we can see that when we are using a raw polygon of 10 sides as our patch for design 1st, the bandwidth is around 2520 MHz Comparing it with the third proposed design. We get a bandwidth of 3290 MHz which is improved by around 30.5% with respect of 1st design and comparing the same result with 2nd design we get an improvement of 61.32% so far as bandwidth is concerned. The Parameters of design 3rd such as insertion loss S_{21} is outstanding as compared to design 1st and 2nd, here we achieve the value of S_{21} equal to 0.99 and return loss is again very good as compared to that of the design 1st, we achieve a return loss of - 22.1 dB in 3rd design. On the other On comparing it with the return loss of design 1st, which is around minus 15.4 dB only. In second design we have two values for return loss first one is -15.50 and -25.58 dB. Thus we can see that the return loss of third design is a very good compromise in exchange of wide bandwidth. In 3rd design Q factor is having a value of 1.33 thus we can see that by introducing split ring resonator concept in a simple polygon improve the bandwidth as well as the insertion loss for a microstrip filter but we can see that introducing a cavity in a polygon as in design 2nd, we get a multiband of operation or dual band of operation but the overall bandwidth is reduced as compared to the basic design as well as for the design in which we introduced SRR concept.

V. REFERENCES

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