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Edge – Coupled DGS Composite Bandpass Filter for Wi-Max Application

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Abstract- In applications like wireless communication and satellite communication microwave filter plays a key role. In most communication systems filter performs signal processing i.e. it select required range of frequencies eliminating all other frequencies. While designing these filters using the microstrip lines, the major limiting factors on filter performance are filter bandwidth and group delay. Several types of microstrip filters exist like edge coupled, stepped impedance, hairpin, interdigital etc. These filters have different type of responses by offering trade- off between filter size, bandwidth, reflection, noise rejection, group delay, jitter etc. A new approach in this work will be tried to design a bandpass filter with low insertion loss and high return loss. In this work proposed bandpass filter is designed with Roger material having permittivity ε_r=10.2 and center frequency=3.5 GHz which is simulated in CST.

Keywords- Parallel Coupled-line, Bandpass filter, Microstrip, Return loss, Insertion loss

I. INTRODUCTION

Electronic filters are circuits that have signal processing functions i.e. they process an input signal to obtain an output signal with the required characteristics. In the frequency domain filters are used to reject unwanted signal frequencies and to pass signals of desired frequencies. Filters are implicit devices, in many systems and applications including wireless broadband, mobile, and satellite communications, radar, navigation, sensing and other systems[1][2]. . There are various types of filter that used in microwave communication systems classified as low-pass filter, high-pass filter, band-pass filter, and band-stop filter [3]. Fig.1 shows the generic block diagram of transmitter

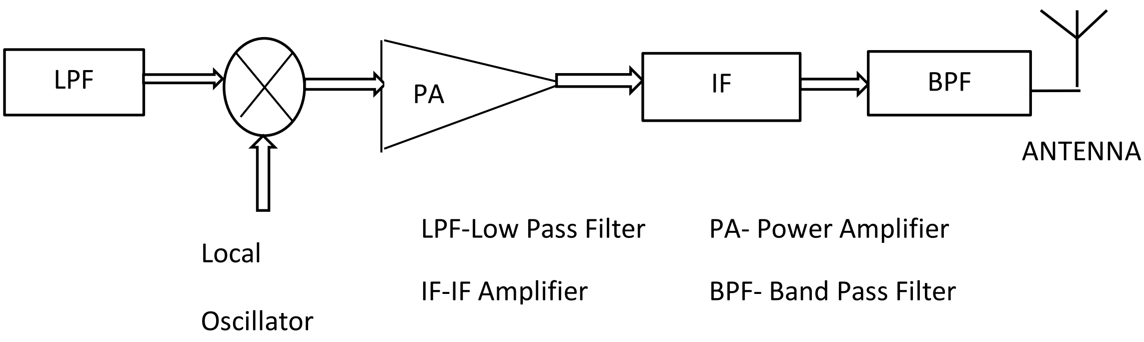

Fig.1 Generic block diagram of Transmitter

In image parameter method use the passband and stopband specifications by cascading two port networks. Hence, this method provides a link between practical filters and infinite periodic structures [3]. But using this method we want iterate the same calculation to obtain desired characteristics.

Parallel-coupled-line filters are the most popular microstrip filters. They can be designed using half wavelength resonators by considering half of their full length. For all types of microstrip filters in which coupling is arranged by parallel coupled lines different phase velocities between even and odd mode in coupled-line region should be taken into account [3].

To harness the advantages from two different types of filters, filter structures are combined to get the composite filters. These composite filters can be optimized and tuned for desired performance [9]. Composite filter means combination of any two types of designing.

Fig.2 General Steps to Follow Filter Design [3]

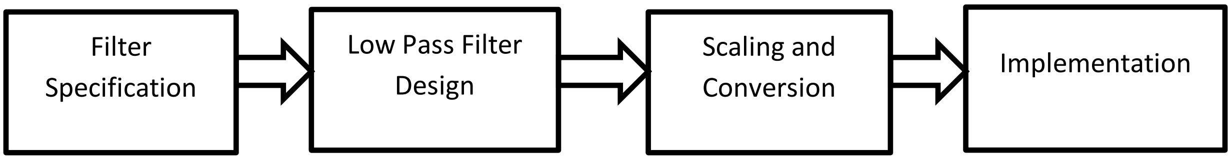

Fig. 2 General steps to design filter

II. DESIGN STEPS

Fig.3 shows a general structure of parallel-coupled line (or edge-coupled) microstrip bandpass filters which uses half-wavelength line resonators [4]. They are positioned such like the adjacent resonators are parallel to each other along half of their length. By using Edge coupling, we can get strong coupling between two resonators. Parallel coupled filter structure is particularly convenient for constructing filters having a wider bandwidth as compared to the structure for the end-coupled microstrip filters. The design equations for this type of filter are given by [4] [5] [6].

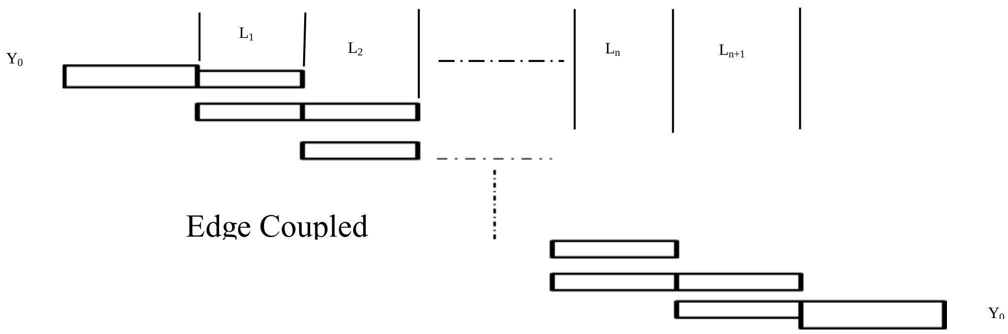

Fig. 3 General structure of parallel (edge)-coupled microstrip bandpass filter

$$\frac{J_{01}}{Y_0} = \sqrt{\frac{\pi\, FBW}{2\, g_0 g_1}} \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots (1)$$

$$\frac{J_{j,j+1}}{Y_0} = \frac{\pi FBW}{2} \frac{1}{\sqrt{g_j g_{j+1}}} \qquad j = 1 \text{ to } n-1 \dots\dots\dots\dots (2)$$

$$\frac{J_{n,n+1}}{Y_0} = \sqrt{\frac{\pi\, FBW}{2\, g_n g_{n+1}}} \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots (3)$$

where g_o, g_1,...g_n are the element of a low-pass prototype with a normalize cutoff $\Omega c= 1$, and FBW is the fractional bandwidth of bandpass filter, $J_{j,j+1}$ are the characteristic admittances of J-inverters and Y_0 is the characteristic admittance of the terminating lines. To realize the J-inverters obtained above, the even- and odd-mode characteristic impedances of the coupled microstrip line resonators are determined by [4] [5] [6].

$$(Z_{0e})_{j,j+1} = \frac{1}{Y_0}\left[1 + \frac{J_{j,j+1}}{Y_0} + \left(\frac{J_{j,j+1}}{Y_0}\right)^2\right] \quad j = 0 \ldots (4)$$

$$(Z_{0o})_{j,j+1} = \frac{1}{Y_0}\left[1 - \frac{J_{j,j+1}}{Y_0} + \left(\frac{J_{j,j+1}}{Y_0}\right)^2\right] \quad j = 0\ t \ldots (5)$$

Table1: Circuit design parameters of the Edge-coupled quarter wavelength resonator filter

J	$J_{(j,j+1)}/Y_0$	$(Z_{0e})_{j,j+1}$	$(Z_{0o})_{j,j+1}$
0	0.24812	65.4802	40.6722
1	0.15969	59.2595	43.2905
2	0.15969	59.2595	43.2905
3	0.24812	65.4802	40.6722
4	0.21708	63.2101	41.5022

III. FILTER SIMULATION AND RESULTS

Once the filter design is ready on paper, then simulate that in CST Microwave Studio. Computer Simulation Technology (CST) Microwave Studio is an equation solver that is based on method of moments (MoM). Using above methodology, parallel coupled line filter is simulated in CST studio with use of DGS to improve the insertion loss. Fig.4 shows the simulated structure of parallel coupled line bandpass filter for Wi-Max Application which works at 3.5 GHz.

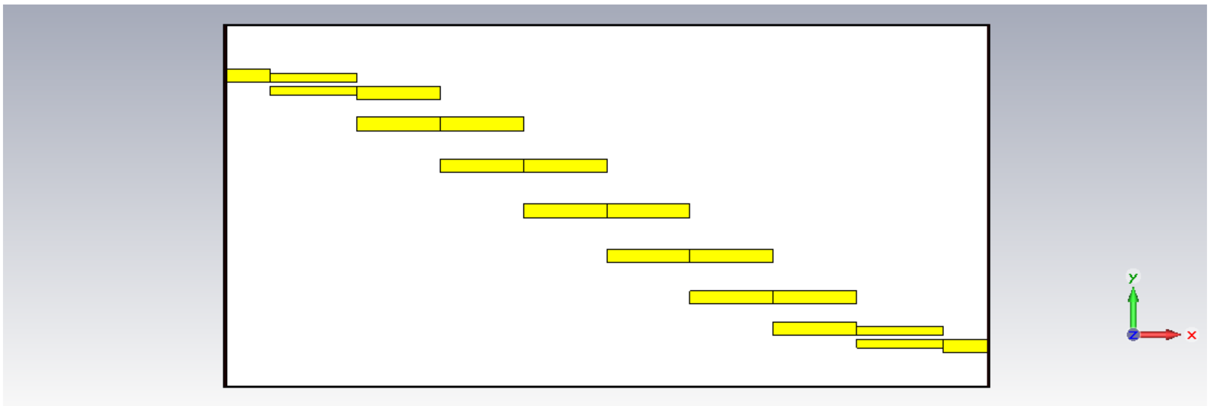

Fig. 4 realized structure of Edge-Coupled microstrip bandpass filter

Fig.4 shows the simulation model for Edge- Coupled Microstrip Bandpass filter. In this model DGS (Defected Ground Structure) is used to improve the insertion loss of the filter.

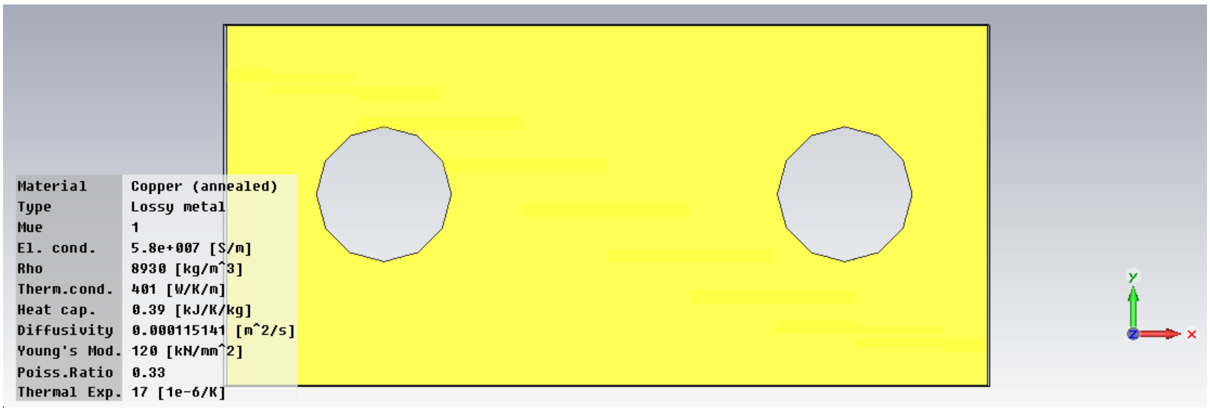

Fig. 5 DGS used in model

Fig.5 shows the ground plane (DGS) model.

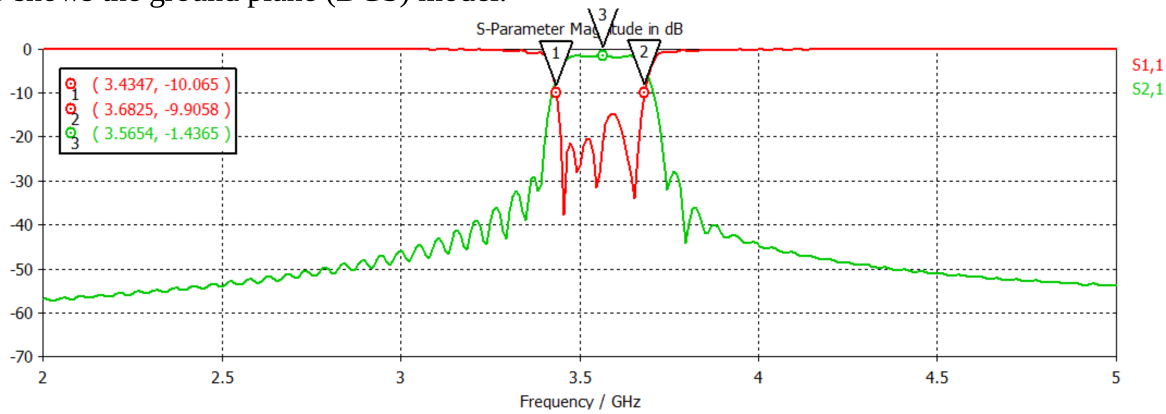

Fig. 6 Return Loss and Insertion Loss Results

Fig. 6 shows the return loss and insertion loss of the filter. Return loss is about greater than or equal to -20 dB which is satisfactory and insertion loss is also less throughout the range.

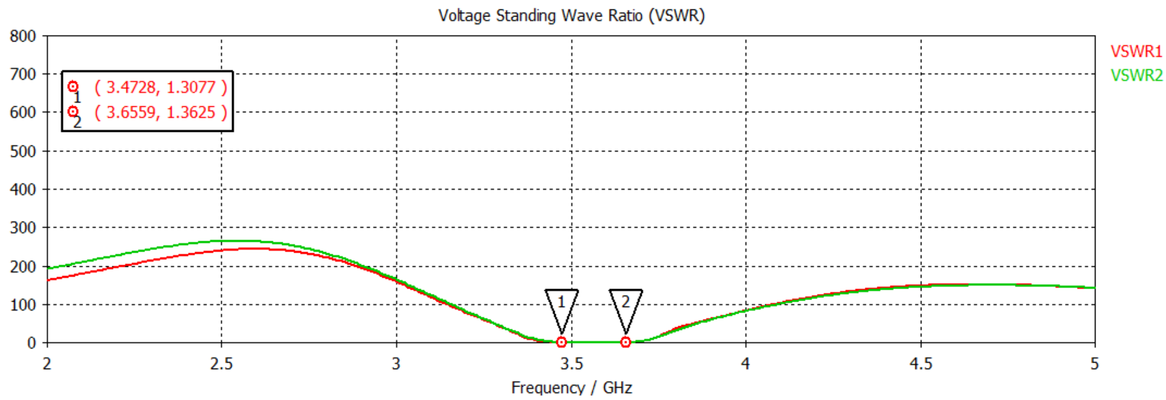

Fig.7 Voltage Standing Wave Ratio Results

Fig. 7 shows the VSWR result which is also satisfactory because it should ideally equals to 1 but practically can considerable up to 2.

IV. CONCLUSION

The filter plays a key role in radio systems to reject unwanted signals. By using filter we can decrease the required processing time. Edge – Coupled DGS Composite Bandpass Filter for Wi-Max Application which provides satisfactory Return loss and very less insertion loss.

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