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A Miniaturized Dms/Dgs Bandpass Filter

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Abstract
In this paper, a bandpass filter is proposed with dumbbell shaped defected ground structure in ground plane of a 50Ω Microstrip line and a closed loop resonator in the conducting strip. This arrangement provides better coupling in pass band. Using DGS structure, forward transmission loss (S21) is -1 dB and return loss (S11) is -20 dB at the centre frequency 3.2 GHz with bandwidth of 200 MHz. A conventional parallel coupled line bandpass filter has also been implemented with exactly same design goals for the sake of comparison. The proposed bandpass filter with DGS is quite promising with 28% size reduction.

Keywords — Bandpass Filter, coupled line, CST 2011, DGS

I. INTRODUCTION

Recent advances in wireless communication demand high performance and compact RF subsystems. Almost all wireless communication systems require compact microwave filters, which can suppress unwanted out-of-band signals. The inherent advantages of defected ground structures (DGS) make it one of the most important techniques to meet compact high performance microwave filters. DGS is an etched periodic or non-periodic cascaded configuration defect in the ground of Microstrip and coplanar lines. DGS disturbs the shield current distribution in the ground plane.

This disturbance will change the characteristics of a transmission line such as line capacitance and inductance [1]. DGS have interesting properties such as size miniaturization, suppression of surface waves and arbitrary stop bands [2-4]. Since DGS cells have inherently resonant properties, many of them have been used in filtering circuits to improve the stop and pass band characteristics [5].All the simulation is carried out in Full EM wave Simulator CST microwave Studio 2011 [6]. In this paper, a Microstrip band pass filter is proposed using the 50 ohm Microstrip line at the center frequency of 3.2 GHz using a closed loop resonator in conducting strip with dumbbell shape DGS is proposed with low insertion .

This DGS provides better coupling. Gap discontinuities in the conducting strip introduce the gap capacitance (gap coupling) that provides the bandpass characteristics [5]
Design goals are shown in table 1.The design goals and parameters have been shown in the Table 1.

TABLE 1. DESIGN GOALS OF THE FILTER

Ordre of the Filtre	3
Frequency	3.2 GHz
ε_r , FR4	4.3
Height of the Substrate	1.56 mm
Thickness of the conducting	0.035 mm
Loss tangent	0.025
Fractional Bandwidth	10% at 3.2 GHz
Bandwidth	>200MHz

II. PARALLEL COUPLED LINES BANDPASS FILTER

Fig.1 gives the circuit implementation of the filter by means of concentrated components like inductors (L) and capacitors (C), for the even and odd filter degree (n).

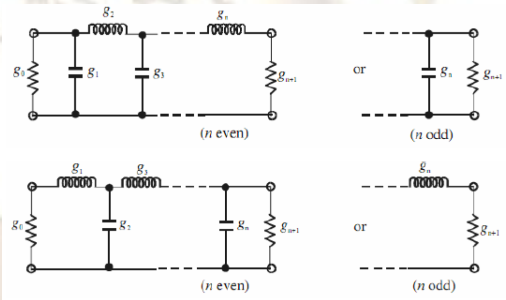


Fig 1: Realization of filter using LC components.

The component values can be calculated with the following rules:

$$g_0 = 1 \quad (1)$$

For i= 1 to n
$$g_i = 2\sin\left(\frac{(2i-1)\pi}{2n}\right) \quad (2)$$

Where n is the order of the filter and the i = 0, 1, 2, 3………..

$$g_{n+1} = 1.0 \quad (3)$$

1. Designing bandpass filter

Figure 2 shows the filter structure observed in this work. This filter type is known as parallel-coupled filter. The strips are arranged parallel close to each other, so that they are coupled with certain coupling factors. We use the following equations for designing the parallel-coupled filter [5].

$$\frac{J_{0,1}}{Y_0} = \sqrt{\left[\frac{\pi FBW}{2g_0 g_1}\right]} \quad (4)$$

$$\frac{J_{j;j+1}}{Y_0} = \frac{[\pi FBW]}{[2\sqrt{g_j g_{j+1}}]} \quad (5)$$

For j = 1 to n = 1

$$\frac{J_{n,n+1}}{Y_0} = \sqrt{\left[\frac{\pi FBW}{2g_n g_{n+1}}\right]} \quad (6)$$

FBW is the relative bandwidth as explained before, $J_{j;j+1}$ is the characteristic admittance of J inverter and Y_0 is the characteristic admittance of the connecting transmission line.

With the data of characteristic admittance of the inverter, we can calculate the characteristic impedances of even- mode and odd-mode of the parallel-coupled Microstrip transmission line, as follows [5, 7].

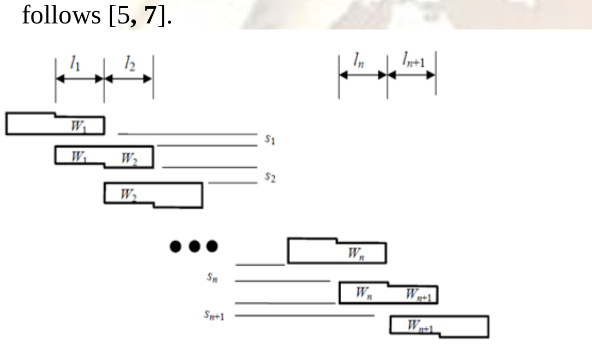


Fig 2: Parallel Bandpass Filter

for j = 0 to n and

$$(Z_{oe})_{j,j+1} = \left(\frac{1}{Y_0}\right)\left[1 + \left(\frac{J_{j;j+1}}{Y_0}\right) + \left(\frac{J_{j;j+1}}{Y_0}\right)^2\right] \quad (7)$$

For j = 0 to n

$$(Z_{oo})_{j,j+1} = \left(\frac{1}{Y_0}\right)\left[1 - \left(\frac{J_{j;j+1}}{Y_0}\right) + \left(\frac{J_{j;j+1}}{Y_0}\right)^2\right] \quad (8)$$

From these values, width, length and spacing of the parallel coupled line are calculated and are shown in Table-2,

TABLE 2. SPECIFICATIONS OF PARALLEL COUPLED MICROSTRIP LINES

n	g_n	$Z_0 J_n$	Z_{oe} (Ω)	Z_{oo} (Ω)	W (mm)	L (mm)	S (mm)
1	1	0.1566	60	44	2.4	12	0.2
2	2	0.069	54	47	2.9	12	1.2
3	1	0.069	54	47	2.9	12	1.2
4	1	0.1566	60	44	2.4	12	0.2

III. SIMULATED S-PARAMETERS

1. *Geometry on simulator*

In this proposed design the height of the substrate is 1.56 mm and relative permittivity 4.3 and the conductor thickness 0.035 mm and loss tangent is 0.025, figure 3 shows the 3-dimensional view of proposed bandpass filter. Proposed design is simulated in CST microwave studio 2011 [6].

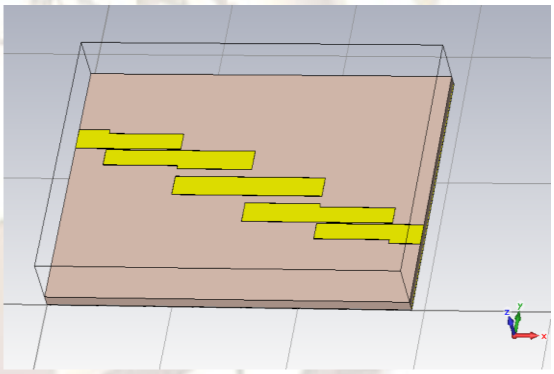


Fig 3: Geometry of Microstrip Bandpass Filter

2. *Simulation Result*

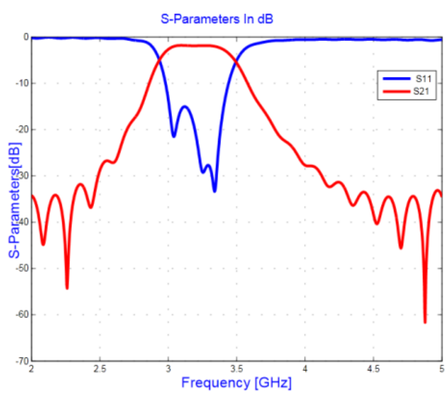


Fig 4: Simulation S-parameters of parallel coupled line Bandpass filter at 3.2 GHz

Fig.4 shows the simulation response of conventional parallel-coupled Microstrip line Bandpass filter with centre frequency 3.2 GHz.

IV. DESIGN CONFIGURATION AND SIMULATED RESULTS

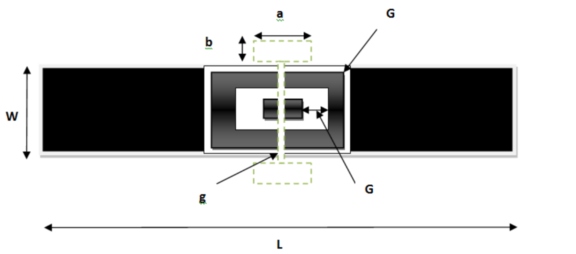
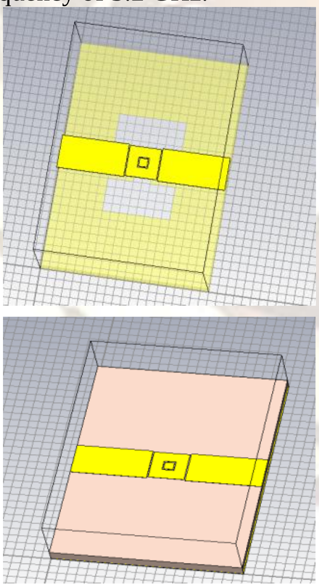


Fig 5: Geometry of proposed Bandpass filter

In this proposed design the height of the substrate is 1.56 mm and relative permittivity 4.3 and the conductor thickness 0.035mm and loss tangent is 0.025; width of conducting strip is 4 mm and 20 mm. the proposed design topology is shown in Fig.4. The transmission line model is used to design bandpass filter for resonant frequency 3.2 GHz. The filter size 28mm×20mm=560 mm^2 is better compatible for the different applications. The creation of a dumbbell shaped DGS in the ground plane of the filter is used for the size reduction of the bandpass filter for working at the frequency of 3.2 GHz.

a)

b)



c)

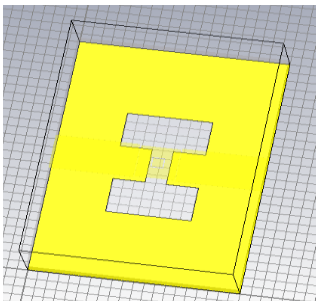


Fig 6: Proposed Bandpass Filter: a) Both View B) Top View C) Bottom View

The optimized dimensions for the band Bandpass filters are a=8.1mm,b=4 mm, g = 2 mm, and G= 0.25 mm The gap (G) in the conducting strip introduces the gap capacitance and due to this capacitance the Bandpass characteristics will appear. The simulated results are shown in the Fig.7, which shows the S21 -1dB at the centre frequency. Hence the total bandwidth of the proposed filter is 200 MHz All the simulations are carried out in CST Microwave Studio EM simulator 2011.

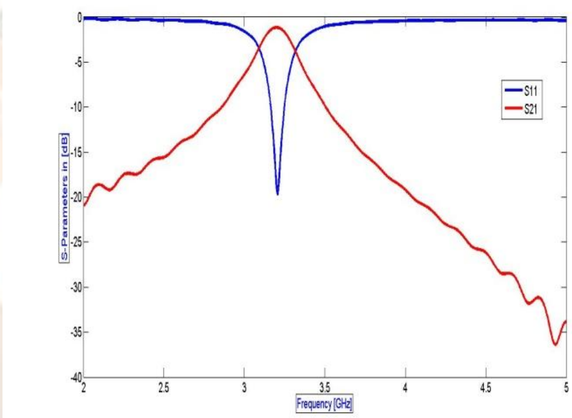


Fig 7: Simulated S-parameters of proposed filter

V. RESULTS AND DISCUSSIONS

Fig.4 and Fig.7 shows the simulated S-parameters for conventional and proposed bandpass filter. Both the simulated results are shown at the center frequency with insertions loss below - 1 dB with. The proposed design meets all the specification with suppressed harmonics as in case conventional type parallel coupled lines bandpass filter.

VI. CONCLUSION

From the simulations the proposed filter with Dumbbell shaped DGS offers a size reduction 28% with reduced harmonics in the passband. It is clear that in conventional parallel coupled bandpass filter the filter size is 2064mm^2 and in proposed design the filter size is 560mm^2.

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