DESIGN AND ANALYSIS OF PARALLEL COUPLED LINE UWB BAND PASS FILTER WITH INCREASING COUPLED LINES

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Abstract: *UWB band pass filter with defected ground and increasing the number of coupled line is proposed. Initially we design a parallel coupled band pass filter then we introduced back side rectangular aperture on ground plane for getting wideband. Later on to take the advantage of coupled lines, increase the number of coupled line to get the UWB on same size of the filter. The passband for proposed filter is from 3.4GHz to 10.6GHz with center frequency 7.8GHz.the total size of proposed filter is 24.1mm.*

Key Words: *Bandpass filter, parallel coupled microstripline (PCML), Backside Aperture, Defected ground*

I.INTRODUCTION

UWB communication systems require key building blocks such as band pass filters and band stop filters, consisting of wider bandwidth, low insertion loss and flat group delay properties. There has been considerable research going on developing ultra-wideband (UWB) technology for high-speed wireless connectivity. Due to this the Federal Communications Commission (FCC) in the USA has permitted unlicensed use of UWB band from 3.1–10.6 GHz with 110% fractional bandwidth at 7.5 GHz for Indoor and handheld systems in 2002 [1][4]. There are several advantages for UWB radio system, such as transmitting higher data rates, lower transmit power requirements, and requirement for simple error control coding. Low losses UWB filter having wide bandwidth and compact size is one of the key components that are presently required for systems.We are trying to develop a new kind of filter structure that have wideband property and good in-band and out-band performance, so the proposed designs are compact, planar, simpler, all the simulation done on the HFSS tool [5]. The substrate is Gilgml1032 used which has relative permittivity $\in_r$ = 3.2, and thickness h = 0.762mm. In this paper we compare the return loss between the PCML filter, PCML with defected ground and PCML with increased coupled line.

II. DESIGN OF PARALLEL COUPLED LINE FILTER

Figure 1 illustrates the schematic diagram of the parallel coupled line wideband bandpass filter with center frequency 7.8 GHz. At the central frequency of the proposed passband, the first and third line are selected equal to one quarter wavelength while the central line is selected equal to one half-wavelength ($\lambda g_0/2$). Wavelength (λg_0) is the guidedwavelength, and it can be calculated by givenequation

$$\lambda_{g0} = \frac{c}{f\sqrt{\in_{eff}}}$$

Where,
c = velocity of light in free space
$\in_{eff}$ = Effective dielectric constant
f = operation frequency

The width and length of transmissionline having the characteristic impedance of 50Ω and Gap and width of the coupled line can be calculated [3][4][1] taking a substrate with relative permittivity ε_r = 3.2, and thickness h = 0.762mm.The ground plane aperture width is approximately $\lambda g_0/8$ and the length of aperture is $\lambda g_0/2 + 2$ G1 [2].

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Input/output lines(50ohm microstrip line)	Width: 1.8 mm Length: 5 mm			
Optimized Filter dimensions	$\lambda_{g0}/4$	W1	G_1	G_2
	6.85mm	0.5mm	0.2mm	0.15mm

Table 1: Optimized dimensions of the PCML filter

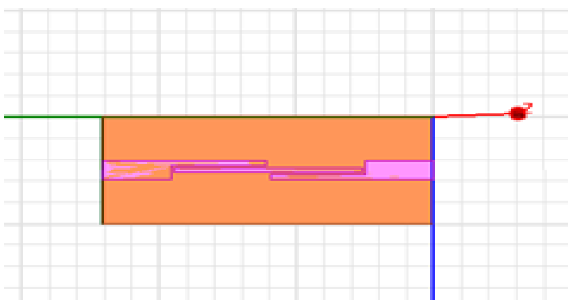

Fig.1 : Design of PCML filter

The optimized parameters are listed in Table 1, and the design of PCML filter is shown in figure 1. The design of PCML filter was analyzed on HFSS tool, and the simulation result is shown in fig.2.

Fig. 2: Simulated result of PCML filter

The simulated result shows insertion loss is almost -0.3dB. The maximum return loss that is -43.98dB at 7.1GHz and bandwidth is approximately 5.9GHz to 8GHz and having the single pole. But this result is not satisfying the UWB bandwidth and total band is available only 2.1 GHz whereas UWB bandwidth should be 7.5 GHz. So this filter is not fulfilling the requirement of bandwidth of FCC, but it shows a good wideband property. For increasing the width of the band, I am using the defected ground technique.

III. DESIGN OF PARALLEL COUPLED LINE FILTER WITH DEFECTED GROUND

The design of parallel coupled line (PLMC) filter with defected ground [6]is shown in fig3. We take the aperture slot on the ground of width is approximately λgo/8 and its length is onehalf wave lengths long(Fig.4(a)).The back side aperture on the ground plane is formed for enhancing coupling between the coupled lines [1][2].All thedimensions are same except the width of slot on ground is calculated and shown in table 2.

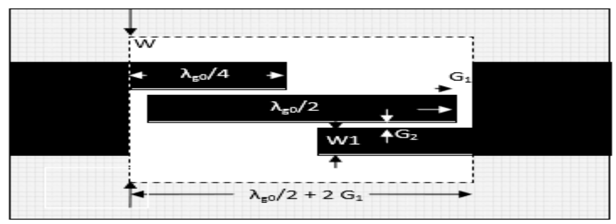

Fig. 3: Design of parallel coupled line filter with defected ground

Input/output lines(50 ohm microstrip line)	Width: 1.8 mm Length: 5 mm				
Optimized Filter dimensions	$\lambda_{g0}/4$	W1	W	G_1	G_2
	6.85 mm	0.5 mm	3.5 mm	0.2 mm	0.15 mm

Table 2: Optimized dimensions of the filter with defected ground

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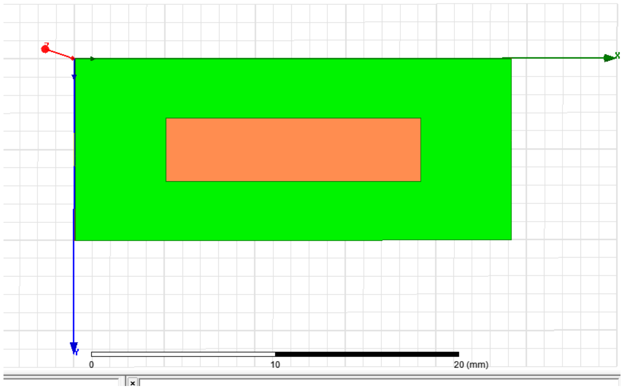
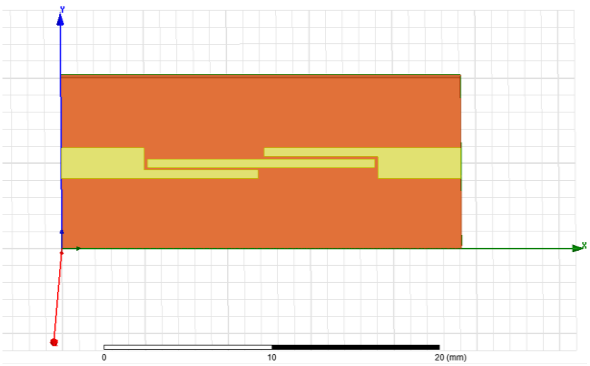


(a)



(b)

Fig. 4: Design of parallel coupled line (PLC) filter with defected ground
(a)Bottom view (b) Top view

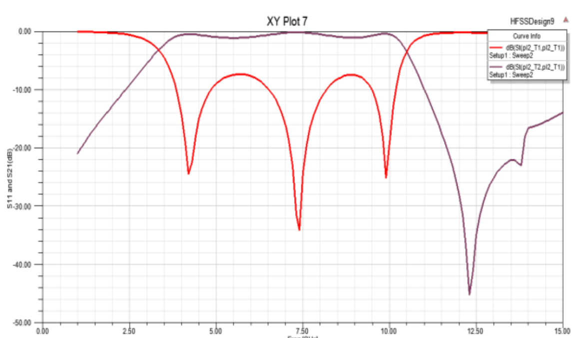


Fig 4(c) : Simulated result parallel coupled line filter with defected ground

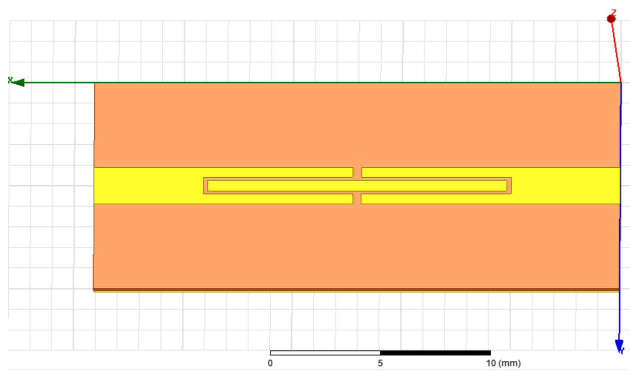
A simulated result of this filter with slot at the ground is shown in figure 4(c), from the simulation result we can easily conclude the effect of change in band by using of back aperture. The maximum return loss of PCML filter with defected ground is -34.0798dB at 7.4GHz.The simulated band width of the filter is from 4.2GHz to 9.9GHz. We got bandwidth only 5.5 GHz whereas UWB bandwidth should be 7.5 GHz. So this filter is not fulfilling the requirement of bandwidth as well as upper and lower cutoff is not sharp and not following the FCC limit.

IV. DESIGN OF PRAPOSED FILTER

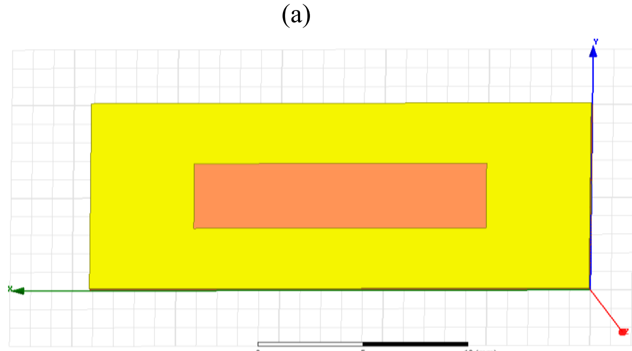
At the conducting surface we are added two more coupled lines on the same structure for getting wide band and increased the performance of filter. All the dimension of this filter is same i.e. the replica of W1 and W2, the calculated [3] dimensions are given in table 3, and the design of parallel coupled line filter with defected ground with increased coupled line is shown in figure 5.

$\lambda g0/4$	W	W_1	W_2	G_1	G_2
6.85	3.5	0.5	0.5	0.2	0.15

Table 3: Optimized dimensions of the proposed filter



(a)



(b)

Fig. 5: Design of filter with defected ground and increased coupled line (a) Top view and (b) Bottom view

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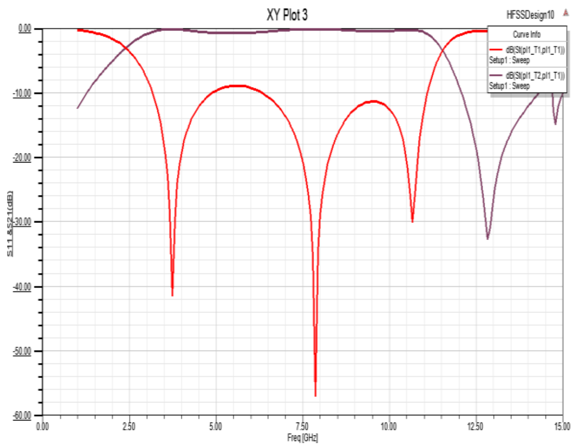

Fig. 6: Simulated result of filter with defected ground and increased coupled lines

From the Simulated result (shown in figure 6), we can conclude the effect of change in band by using of back aperture and increasing coupled lines. The maximum return loss is -56.96dB at 7.8GHz.The simulated band width of the filter is from 3.1GHz to 10.9GHz. Here we got the band width of 7.8GHz, which is so close to the UWB bandwidth which is 7.5GHz. Thus this filter is fulfilled the requirement of bandwidth of FCC.

V. RESULT

The comparison of simulated results is shown in fig 7 and 8. It is seen that the performance of modified

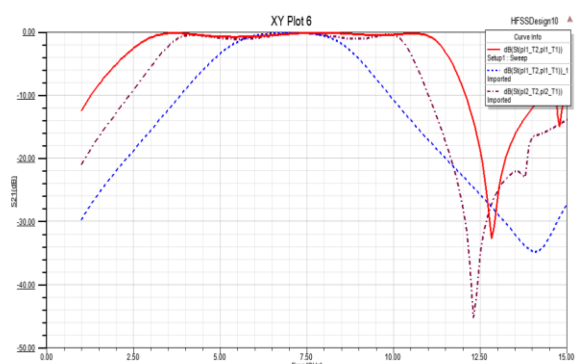

Fig. 7: Comparison result of transmission co-efficient (S21)

filter is better than other two filters. The simulated bandwidth of the proposed filter is from 3.1GHz to 10.9GHz. The simulated results are found to have regionally good agreement accept the upper cutoff frequency.

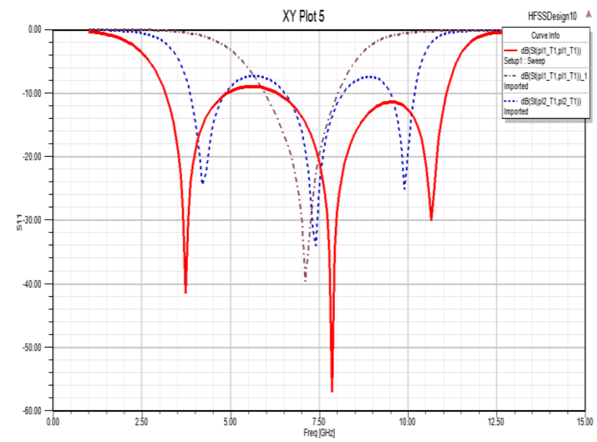

Fig. 8: Comparison result of reflection co-efficients(S11)

VI. CONCULISION

Design and analysis of UWB PLML bandpass filter with defected ground and increased couple line has been proposed.The filter structure is very compact i.e.24.1mm in size. The proposed filter exhibited good passband performance as compare with other filter it has wide band after increasing the coupled line in the same structure.

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