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A Compact CPW Bandpass Filter using Folded Lines for UWB Applications

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Abstract:*A compact CPW bandpass filter with asymmetrical folded parallel lines is proposed. Initially a parallel coupled filter is designed at center frequency then for size miniaturization the parallel lines are folded. thenthe filter convert in to CPW configuration to take the advantages of CPW geometry for achieving sharp cutoff characteristics. Total size of the filter is 7.55x7mm.*

Keywords :*folded lines, CPW, Parallel coupled*

I. INTRODUCTION

Now days in PCB industry main demand is to Size reduction, Easy fabrication, low cost. filters are considered as a main component that reduces the total size of RF front design.In 2002. FCC has released unlicensed band 110% fractional bandwidth and frequency range is from 3.1 to 10.6 GHzfor wireless systems. After that researchers work on components used for UWB system. A bandpass filter is the important component of UWB systems. so many techniques are present in literature for getting wideband or UWB such as open circuited stubs, short circuit stubs, MMR etc. in this work firstly designed a parallel coupled line filter then convert it into the Folded stubs to reduce the overall size of the filter that is the main demand in the printed circuit board technology. this filter gives the multi bands in the uwb band. but our aim is to have wideband and good in band and out band performance and because of the small size easy fabrication also[5][6]. so we convert out filter in to CPW structure. CPW technology gives many advantages as less radiation loss, less dispersion, easy to integrate with the IC's.via hole is not required, not sensitive with substrate thickness and dispersion effect is less.

In CPW structure folded line is placed at the top surface of the substrate then converted into CPW, this structure gives the goodband performance and decreasing the reflection coefficient, After simulation bandwidth has been increased from3.3GHz to 10.1GHz a very good agreement with the fcc limit. also gives the very good in band and out band performance.HFSS tool is used for the all simulations.

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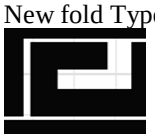
II. DESIGNING OF FOLDED LINE BANDPASS FILTER

Firstly we designed a parallel coupled line bandpass filter using conventional method. In this method parallel lines are λg/4 mm long and center line is λg/2mm long but our aim is to reduce the size of the filter for that we use folded stub technique in which stubs are generally fold from both sides toward the center, and also fold the center conductor toward both sides as shown in Fig. 1[1]. These complicatedstructures require more dimensions. so, we try to fold lines from the center and center line is folded in two parts, as shown in Fig. 2. In this paper we are suggesting new and simple method for folding parallel lines. First, we keep the sides of the all lines same up to λg/8mm length that of the non folded. Second, we fold the remain λg/8mm length line in to two folds both are of λg/16mm long. and then fold the center line.this novel structure reduces the size at least 50% to the conventional filter. The analysis and optimization of this filter has been done on HFSS.In Table 1 All optimized parameters are listed. simulation results are shown in Fig. 3. maximum return loss of the filter is -20dB at 7.65GHz.total bandwidth of the filter is from 7.4GHz to 7.9GHz. that is very narrow band filter. For better out-of band performance and widen the band proposed structure has been converted in to the CPW Structure[2][4]

Fig.1 .(a) Non folded λ/4 series open stub.

(b) Conventional folded λ/4 open stub

(c) New fold Type 1



(d) New fold type 2

Table 1: Optimized dimensions of folded line filter

Dielectric substrate	**substrate Thickness : 1.28mm, εr: 4.4**					
Input/output lines(50 ohm microstrip line)	Width: 2.45 mm Length: 5 mm					
Filter dimensions(mm)	$\lambda_{g0}/4$	*L1*	*L2*	*g1,g5*	*g2,g4*	g_3
	4.8	0.65	0.95	0.1	0.55	0.6

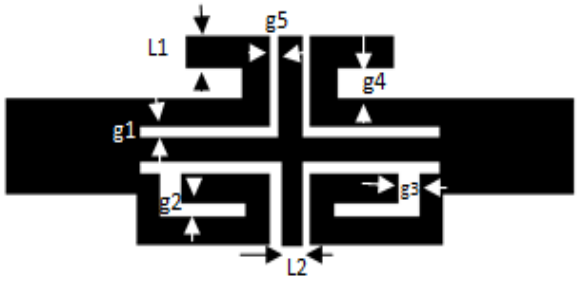


Fig.2 : Folded Line Filter

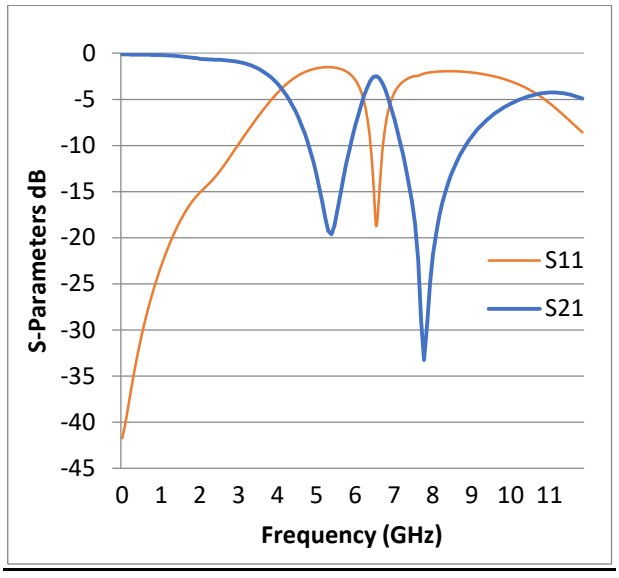


Fig. 3: Simulated result

III. DESIGNINGOF FILTER WITH CPW

In this work, developed a new filter structure with CPW. this filter gives the wideband property and good band performance. Figure 4 shows the Schematic of the filter. CPW is the main part of this filter. CPW is placed at the top surface of the substrate that gives the very good bandwidth and band performance it also gives better reflection coefficient. This filter gives easy fabrication and CPW advantages. The basic section of the filter is same as folded line filter as discussed in section II filter that has folded coupled Microstrip lines separated with a gap [3].

Dimensions of the CPW can be measured with the help of TL calculator. Top view of the CPW filter is shown in fig.4(a). Total length of this filter is less than onewavelength.. The optimized parameters are listed in Table2. CPW at the top of the substrate gives the tight coupling for folded lines [9].

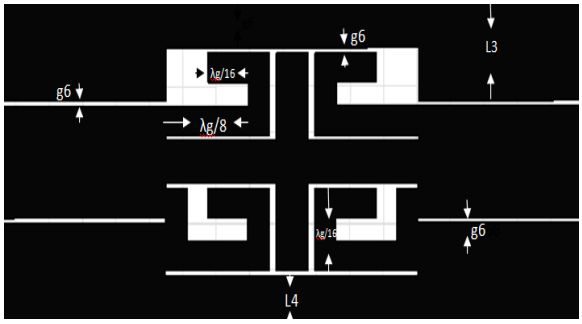


Fig. 4: Schematic of CPW Filter

Table 2: Dimensions of filter with defected ground

Dielectric substrate	**Thickness of substrate: 1.28mm, εr: 4.4**					
Input /output lines	Width: 2.45mm Length: 5 mm					
Filter dimensions Optimized	*λg/4*	*g6*	*L1*	*L2*	*L3*	*L4*
	4.8	0.1	0.65	0.95	2.175	1.021

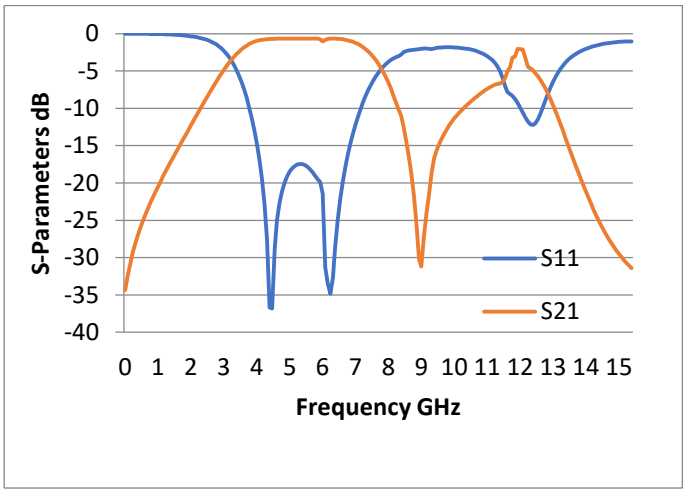


Fig5 : Simulated result with CPW

Changes in the response is shown in fig.5, it shows S21 is more sharp with CPW.Total band width of the filter is approximately from 3.2 to 7.5GHz and from 11.6 to 11.9GHz. So we can choose CPW filter rather than folded line filter.

From the simulated results two bands has been covered. The simulated insertion loss is 1.0dB. The maximum return loss is -38dB. The proposed filter exhibited good passband and out-of band performance.[7][8]

IV. RESULTS AND DISCUSSION

The folded line filter without CPW and with CPW is shown in fig 2 and 4 respectively.

These filters was optimized on FR4 substrate with relative permittivity 4.4 and substrate thickness 1.28mm. Fig 6 shows that S11 is more sharp around 36 dB for CPW filter. It shows two poles that are required for wide band and for folded filter S11 is around 18 dB at 7.65GHz. it shows a good narrow band filter.

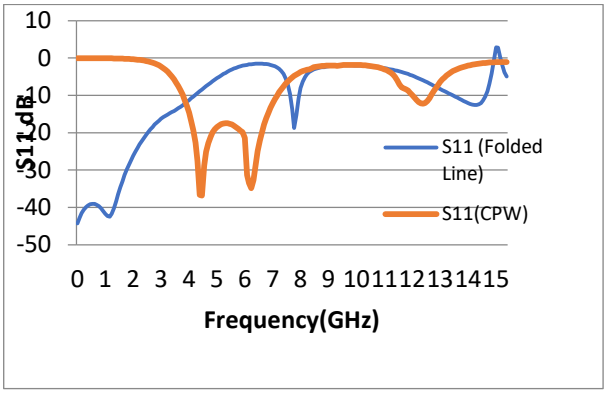


Fig 6. Comparison of S11 for Folded line filter with CPW Filter

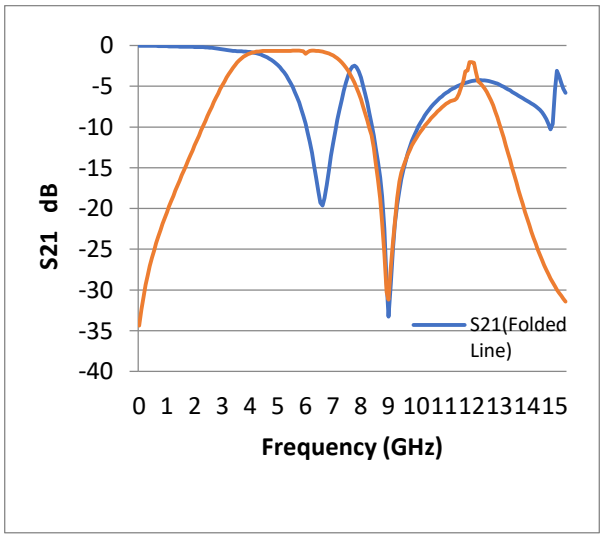


Fig 7. Comparison of S21 Folded line filter with CPW Filter

Fig 7 shows the simulated result for S21 show Bandwidth of CPW filter from 3.2 to 7.5 GHz and 11.6 to 11.9Ghz with average insertion loss is 0.66dB with sharper upper and lower cutoff as compared with the Folded line structure. Band width for folded line filter is from 7.4 to 7.9 (0.5 GHZ) at 7.65 GHz that shows a narrow band. from the above analysis CPW filter is a good wideband filter with comapct size and having CPW advantages.

Table 3.Comparison of various UWB filter

References	Dielectric constant	Size(mm)	Band	Type
This Work	4.4	7.55x7	Dual	CPW
1	4.7	11.5x24	single	CPW
2	2.65	9.15x5.98	Single	short
4	3.05	10.2x15.1	Dual	Short
6	3.55	24.4x11.8	Dual	DGS
10	2.65	7x11.3	single	short
11	10.2	12x12	Dual	Meander

V. CONCLUSION

In this manuscript we work on the folded lines and then transition to CPW. Filter with folded lines shows the narrow band filter after transition to CPW The performance of the filter has been increased, it shows good wideband with one notch at 9 GHz. Because of the compact size and planner structure This filter can be used for semiconductor fabrication. The main feature of this filter design is it has compact size with CPW.Total size of the filter is 7.55x7mm.

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