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Design and Analysis of Multiband Micros trip b and pass Filter

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Abstract

The design of micro strip b and pass filter is presented in this paper. The parallel coupled stepped impedance micro strip structure designed by three subsections of different lengths and coupling factors. The length and coupling factor of the each of those subsections is calculated by theoretical model presented below. Here the total length of the parallel coupled structure is one-third of the effective wavelength at the center of pass b and. The presented band pass filter has a pass b and from 8.18 to 17.53GHz

Keywords: Band pass Filter, Micro strip Filter, Pass band.

Introduction

Micro strip lines which are based on the parallel coupled structure are widely used in microwave systems due to their low cost and simple structure.The presence of the second and third harmonics will givethe wideband of the filter.The difference in the odd and even mode phase velocities of the micro strip parallel coupled structure will gives the second harmonic, suppose the substrate which is having the high dielectric constant is used the difference becomes larger and second harmonic become more serious problem.

In order to overcome the above problem a wide range of methods and techniques were proposed[1]-[6]. A slotted ground plane is used in [2, 4] underneath the coupled lines to ease the narrow gap requirement and to realise up to 70% fractional bandwidth. a slotted ground plane is used underneath the central section in orderto decrease the even-mode capacitor, and thus, to increase the even mode impedance [2, 4], and a lumped capacitor is connected between the two coupled lines at the centre of that section to increase its odd mode capacitor, and thus, to decrease its odd-mode impedance [5, 6].The main drawback of the utilised design is its three-dimensional configuration.

The coupled structure [1] is divided into three subsections that have different coupling factors and lengths to suppress the second and third harmonic. A theoretical model [1] is used to find the length and coupling factor for each of the coupled subsections of the parallel coupled micro strip b and pass filter. The central subsection length is twice of the side subsections length to satisfy the symmetry property. The length of the total coupled structure is one-third of the effective wavelength of the center of the pass b and.

Micro strip line is used to carry Electro-Magnetic Waves (EM waves) or microwave frequency signals. It consists of 3 layers, conducting strip, dielectric and Ground plane. It is used to design and fabricate RF and microwave components such as directional coupler, power divider/combiner, filter, antenna, MMIC etc. Micro strip line will have low to high radiation, will support 20 to 120 ohm impedance,supports Q factor of about 250[7]. Difficult to mount chip in shunt mode but easy in series mode[7]. The RF/microwave product made using micro strip line is less expensive and lighter in weight compare to its waveguide counterpart. Usually FR-4 dielectric substrate is used as PCB for micro strip based etching due to its low cost.

Theory

The coupled structure shown in Fig.1 is divided into three subsections. To obtain a symmetrical configurationthe side subsections has the same length (l_1) and the central subsection have the length(l_2)and the capacitors are connected in between the micro strip lines. By tuning the capacitor value we get the multiple bands of frequency.

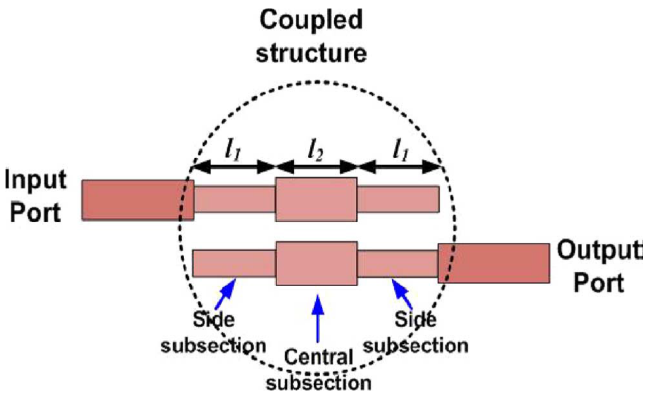

Figure 1: Symmetrical Coupled Structure With Three Subsections

The length and coupling factor of the side and central subsections of the coupled structure have the following relations

$$l_2=2l_1=\lambda_c/6 \quad (1)$$

$$c_2=2.7c_1\,(1-c_1/\sqrt{2}) \quad (2)$$

λ_c: the effective wavelength at the center frequency of the pass b and.

The equation (1) gives the coupled structureof Fig.1have the total length ($2l_2+l_1$) is equal to one-third of the effective wavelength at the center of the pass b and. The side subsections should have the length which is half of the central subsection length. The side subsections are loosely coupled whereas the central subsection has tightly coupled.

The required center frequency for the pass b and is 6.85GHz.The graph which is shown in Fig.2 is obtained by varying the values of coupling factor.The coupling factor(c_2) is calculated by using (2).The transmission line that has a characteristic impedance(Z_c) and length (d) is used to connect the two sections that have a characteristic impedance(Z_o=150 Ohm)

Micro Strip Band Pass Filter Design

The Band pass filter is designed by using Micro strip Coupled-Line Filter Element(MCFIL)lines is shown in Fig.2.The length of the side subsection and central subsection is calculated by using equation (1).By setting C_1=0.43pF through iteration process and C_2 is calculated by using equation (2) and it is defined as 0.81pF.

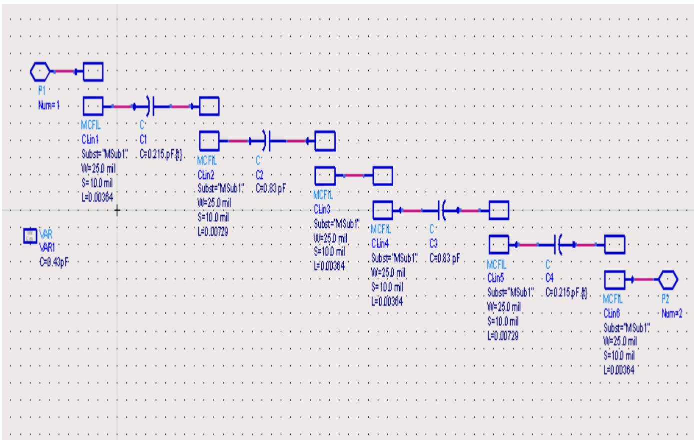

Figure 2: Parallel coupled micro strip b and pass filter by using MCFil Lines

The filter was designed by using the substrate RT6010. Assuming that $s_1= s_2=$ 10mil and $w_1= w_2=$ 25mil, l_1=0.00364m, l_2=0.00729m. The parallel coupled micro strip b and pass filter is realized through a symbol as shown in Fig.3 and is used for scattering parameter analysis. By varyingthe capacitor (C_1) value the design is operated for different bands of frequency as shown in Table I.The layout for the schematic of Fig.2 is generated as shown in Fig.7

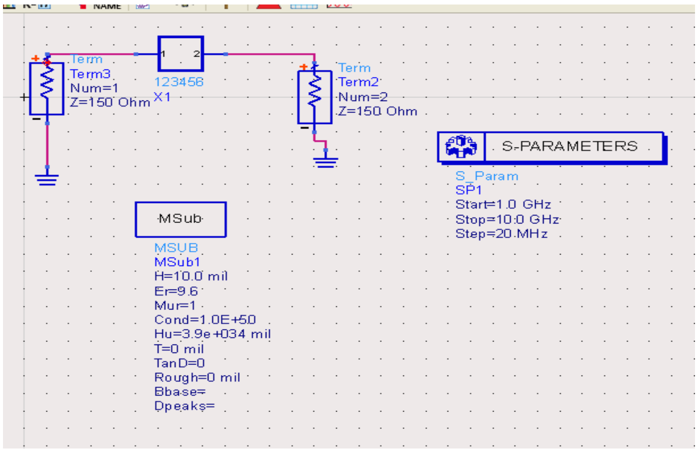

Figure 3: Symbol of The Parallel Coupled Micro Strip b and Pass Filter

Simulation Results

The simulation for parallel coupled micro strip b and pass filter is carried by Advance Design System (ADS) tool and the results are shown below.

Pre-Layout Simulation

The schematic of Fig.2 is simulated for the Forward Transmission Coefficient (S_{21}) parameter analysis. By varying the capacitor values we get the different bands of the micro strip b and pass filter shown below.

The different frequency bands 5.690GHz,6.740GHz, 7.120GHz, 7.500GHz are generated at a particular value of capacitor C_1=0.215pF as shown in Fig.4.

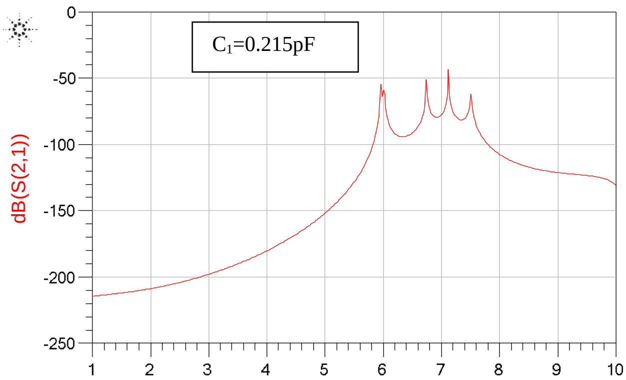

Figure 4: Different bands are generated at a particular value of capacitor c_1=0.215pF

The different frequency bands 5.690GHz ,6.740GHz, 7.500GHz are generated at a particular value of capacitor C_1=0.468pF as shown in Fig.5.

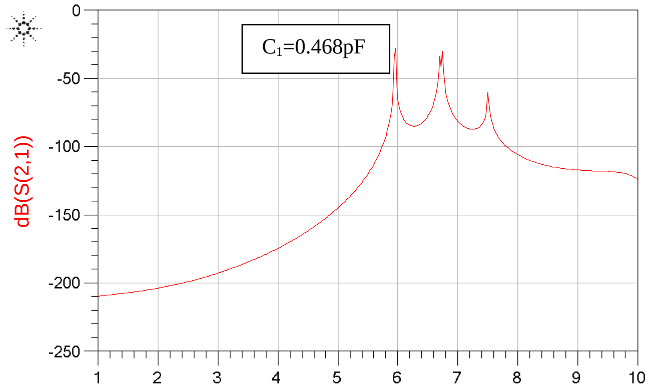

Figure 5: Different Bands are Generated At A Particular Value of Capacitor C_1=0.468pf

The different frequency bands 5.690GHz ,6.520GHz, 6.740GHz, 7.500GHz are generated at a particular value of capacitor C_1=0.645 pF as shown in Fig.5.

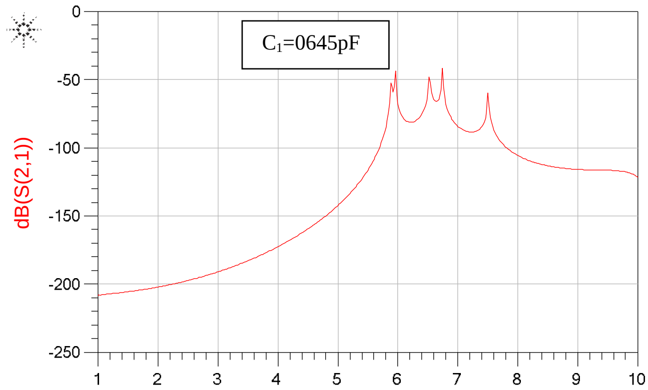

Figure 6: Different bands are generated at a particular value of capacitor c_1=0.645pF

The below Table I inferences the different band of frequencies by varying the capacitor values in the parallel coupled microstripbandpass filter.

Table I

Capacitor (pF)	**Frequency bands(GHz)**	**Gain(dB)**
0.215	5.960	-54.225
	6.740	-51.014
	7.120	-43.141
	7.500	-61.748
0.468	5.960	-27.939
	6.740	-30.072
	7.500	-60.314
0.645	5.960	-43.512
	6.520	-48.044
	6.740	-41.697
	7.500	-51.945

Layout

The layout is generated for parallel coupled micro strip band pass filters shown in Fig.7. By using symmetry plane concept is used in the layout to reduce the solver time.The connecting line between the two sections has d=0.5.

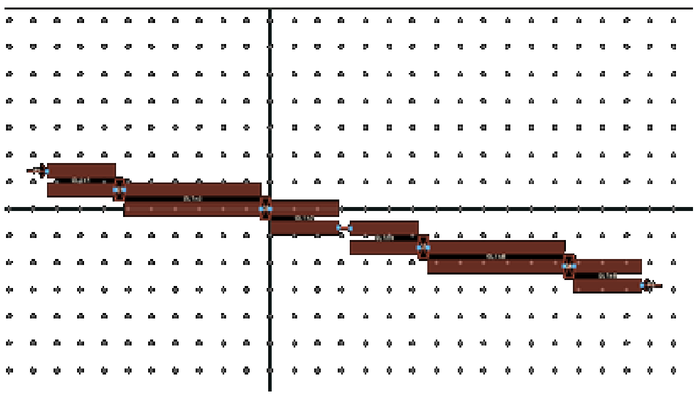

Figure 7: Layout Generated For The Parallel Coupled Micro strip b and pass Filter

Post-Layout Simulation

To verify the symmetry of the micro strip b and pass filter the layout shown in Fig.7 is simulated by using EM simulator or FEM simulator and the scattering parameters are generated is shown in below.The dotted symbols which are present in the below graphs inferences the discrete frequency points and the smooth graph inferences the adaptively fitted points. After the EM simulation the Scattering parameters generated as shown below

To illustrate the symmetrical property of the micro strip b and pass filter the scattering parameters are findout. The below figures (8, 9) indicates that the Forward Reflection Coefficient(S_{11}) and Reverse Reflection Coefficient(S_{22}) has the similar results against the frequency, hence it satisfies the symmetry property and gain is less than -5dB.

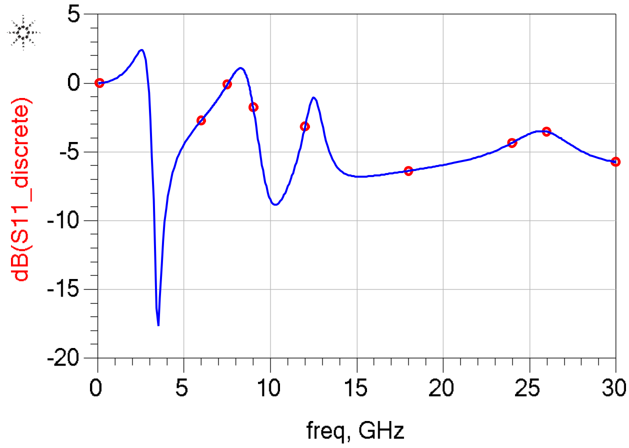

Figure 8: Simulated S_{11} Versus Frequency

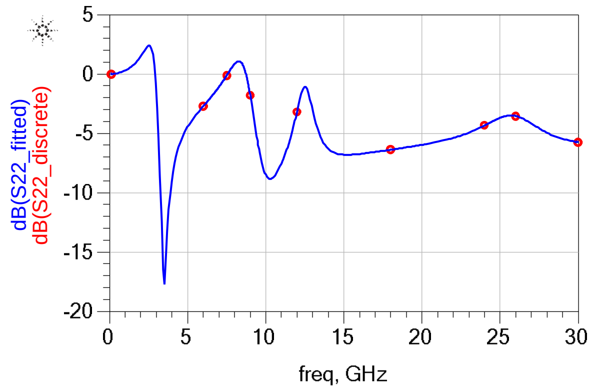

Figure 9: Simulated S_{22} Versus Frequency

The below figures (10,11) indicates that the Forward Transmission Coefficient (S_{21}) and Reverse TransmissionCoefficient (S_{12}) has the similar results against the frequency,hence the port1 and port2 hasthe same impedance matching and gain.

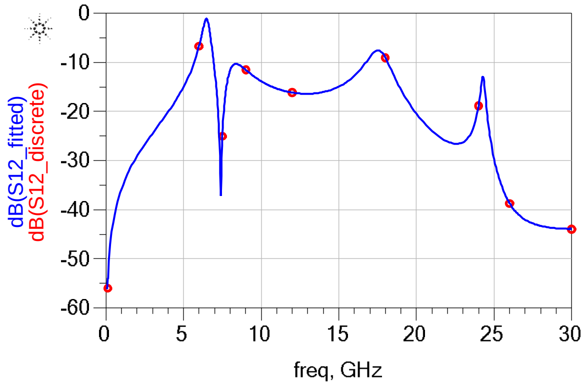

Figure 10: Simulated S_{12} Versus Frequency

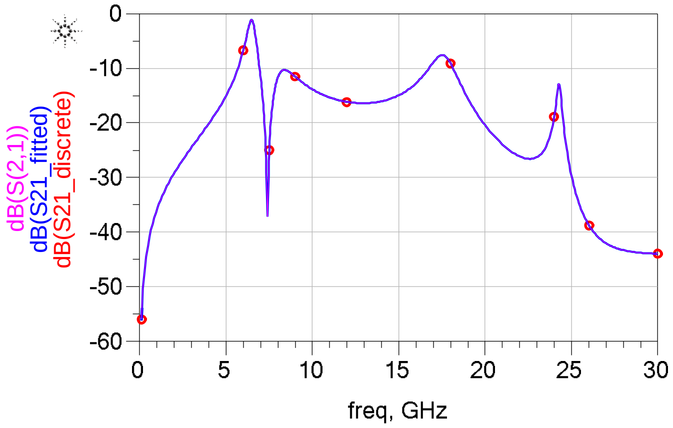

Figure 11: Simulated S_{21} Versus Frequency

After the FEM simulation, by using Field visualization and the PlotProperties tab, select Z: 0.635.The generated mesh for the defined microstripbandpass filter as shown in Fig.9.

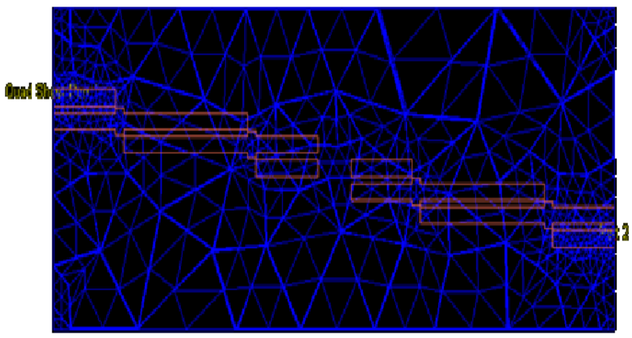

Figure 9: Generated Mesh After The FEM Simulator

The Table II inference shows the solver time is measured for symmetry plane in FEM simulator for parallel coupled micro strip b and pass filter.

Table 2:

	Full FEM Simulation	**FEM Simulation with symmetry Plane**
Delta error	<0.01	<0.01
Solver time	2mins 47 sec	36sec

Conclusion

In this paper Band pass filter based on parallel coupled micro strip lines has been presented. The equations are given to find out the optimum length and the coupling factors of the filter.The coupled structure has the total length is given by one-third of the effective wavelength at the center of pass b and. The presented method is validated by the simulation results.

Acknowledgment

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