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DESIGN OF MICROSTRIP FIVE POLE HAIRPIN MULTI BANDPASS FILTER

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ABSTRACT

In this paper, five pole Hairpin band pass filter with -15.11 dB return loss at 4.6 GHZ, -21.6 dB at 5.14 GHZ, -17 dB at 6 GHZ, -23.75 dB at 6.8 GHZ and -13.6 Db at 7.6 GHZ is designed. The coupled line band pass filter has been simulated using HFSS simulation software on a FR4 substrate with εr = 4.4 and thickness of 1.6mm.The filter provides the wider bandwidth and the compact size of the 4.1 mm × 0.2 mm. The development of band pass filter includes calculation, simulation, testing and measurement of the filter parameters.

Keywords - ***Bandpass filter hairpin filter, five pole hairpin, and substrate*****.**

I. INTRODUCTION

A Filter is a two-port network which is used as a frequency selective component, in communication systems. In communication systems we required the desired frequency band for particular application from the electromagnetic spectrum. An antenna at receiver section can receive a wideband of frequencies, few of which them may be not desired and need to be filtered first before processing the signal. Filters have been used in conjunction with antennas to achieve the desired task. Filters play important roles in many RF/microwave applications. They are used to separate or combine different frequencies. Emerging applications such as wireless communications continue to challenge RF/Microwave filters with ever more stringent requirements-higher performance, smaller size, lighter weight, and lower cost. Oftenly, many practical considerations and limitations determine the actual filter construction. For low selectivity, wideband applications, strip lines and Microstrip line are ideal. Parallel coupled structure with very tight coupling gives higher bandwidth. The resonators sections are placed side by- side for more compactness includes structures like Combline, Interdigital, and Hairpin etc. The hairpin configuration is most preferred in MIC or MMIC filter design process as it doesn't required ground when ceramic substrate is chosen. Higher dielectric constant material can be used to decrease the size of the filter.

II. PROPOSED WORK

There are two types of hairpin structures mainly, the Tapped line input and the coupled line Input. second one is chosen in this paper . Having obtained the low pass parameters, as per the specifications, the bandpass design parameters can be calculated by

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$$Q_{e1} = \frac{g_0\, g_1}{F\, BW} \qquad \text{.....1}$$

$$Q_{en} = \frac{g_n\, g_{n+1}}{F\, BW} \qquad \text{.....2}$$

$$M_{i,i+1} = \frac{F\, BW}{\sqrt{g_i\, g_{i+1}}} \qquad \text{.....3}$$

Where *Qe*1 and *Qen* are the external quality factors of the resonators at the input and the output. *Mi;i*+1 is the coupling coefficient between the adjacent resonators *i* and *i* + 1.For most of the wireless applications high quality and compact sized RF/microwave filters at low cost are required. This purpose can be fulfilled by the use of planar filters. For this planer hairpin line filters are used. These hairpin line filters may conceptually be obtained by folding the resonators of parallel-coupled half-wavelength resonator filters. Their size can further be reduced by folding the two arms of U-shaped micro strip resonator i.e. double-fold hair pin line structure. The filters are designed using the commercially available software HFSS. In present work, design of the five pole hairpin filter is presented.

III. DESIGN METHODOLOGY

The design equations of the hairpin filter consequently may be used to find the physical dimensions realization on EM simulations. A substrate FR4 with a relative dielectric constant of 4.4 mm and a thickness of 1.6 mm for microstrip is taken for realization.

A. Five Pole Hairpin Band Pass Filter

Five pole hair pin band pass filter is design with the help of HFSS software based on dimensions given in table. As its name suggest five pole hairpin band pass filter, it passes frequency bands in the range 4.6 GHz to 5.14 GHz, 5.14 GHz to 6 GHz , 6 GHz to 6.8 GHz , 6.8 GHz to 7.6 GHz. The length of hairpin is 4.1 mm, width of hairpin is 0.2 mm, length of feed line is 1.55 mm, width of feed line is 0.12 mm, gap width is 0.05 mm, internal gap of hairpin is 1 mm, height of copper 0.01 mm, length of substrate is 7 mm, width of substrate is 10.79 mm, height of substrate is 0.3 mm, substrate permittivity is 14.59 and loss tangent is 0.00004. Dimensions of Five-Pole Hairpin Band Pass Filter are shown in table 1.

Table 1: **Dimensions of Five-Pole Hairpin Band Pass Filter**

Parameters	**Value**
Length of Hairpin	4.1 mm
Width of Hairpin	0.2 mm
Length of Feed line	1.55mm
Width of Feed line	0.12mm
Gap width	0.05 mm

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Internal gap of hairpin	1 mm
Height of the Copper	0.01mm
Length of the substrate	7 mm
Width of the substrate	10.79 mm
Height of the substrate	0.3 mm
Substrate permittivity	ε_r = 14.59
Loss tangent Tanδ	0.00004

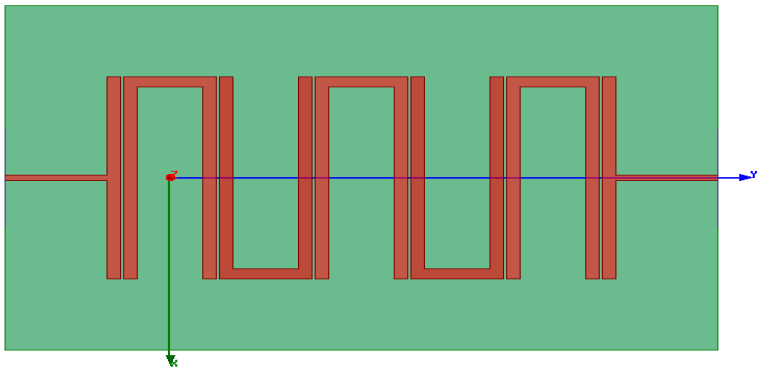
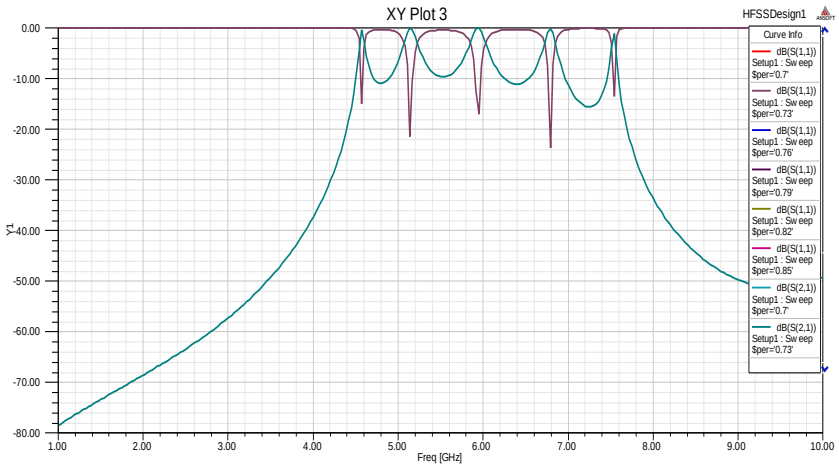


Figure 1: Five pole hairpin bandpass filter

IV.RESULT AND CONCLUSION

The Hairpin filter is simulated. The filter is quite compact with a substrate size of by 4.1 mm × 0.2 mm. The transmission bandwidth is 760 MHz and Reflection bandwidth is 815 MHz Therefore it can be used for wideband filter applications. The input and output resonators are slightly shortened to compensate for the effect of the tapping line and the adjacent coupled resonator.

Figure 2: common graph for transmission band and return loss for five pole hairpin bandpass filter.



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