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Research Article

Design and Performance of Microwave Filters

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ABSTRACT

There is tremendous amount of growth seen in modern communication systems. The advancement in technology could make the communication system faster, better and reliable. Microwave design is quite helpful in taking those challenges to provide such requirements. It is possible to develop components, where size, performance and cost can be adequately minimised. In this paper we propose a micro strip line low pass, band pass filter for ISM band and Ku (8-12GHz) band for satellite communication etc. that comes under microwave range. In this work we also addressed a hair pin filter centred around 1.5 GHz provides a bandwidth of 1000 MHz. This result could be instrumental for many unlicensed band applications. This paper witnesses few micro strip designs that are explicitly useful in microwave domain.

Keywords: Antenna, WMAX, Micro Strip Filter

Introduction

Wireless communication systems find an application in Wi-Fi, Wi-max, broadband personal communication systems, 3G, 4G and more recently 5G technologies. The availability of good satellite systems are assisting mobile environment faster with efficient use of microwave spectrum. Microwave filters, Dielectric Resonant Antenna arrays (DRA), duplexers, smart antenna are used to make the entire system very productive. Hence it is quite indispensable to understand the novel designs and its optimization to meet the demand. Miniaturization, bandwidth, phase linearity and selectivity of the filters are few challenges that must be properly handled to make the system handy. Filters with advanced features have numerous applications in modern days. This paper emphasis on how to design certain microwave filter may be band pass or band rejected for specific application. For example an inter-digital microwave filter here shows a band pass filter characteristics.[1] The result divulged that, filter allows wide range of frequencies in its pass band. Similarly we have inculcated a band pass hair pin filter that shows an excellent return loss at[2] its centre frequency. This second type of filter is a compact structure may conceptually be obtained by folding the resonators of parallel-coupled half wave length structures.[3-6] Additionally we also encountered a low pass step impedance filter. As per the structure is concerned, it is a transmission line of variable impedance connected in cascaded fashion. The section whose impedance is more relative to the other simply takes the equivalence of inductor and vice versa acts as a capacitor. This method is quite superior to the classical methods. The filter size reduces significantly because impedance matching is incorporated in this design.

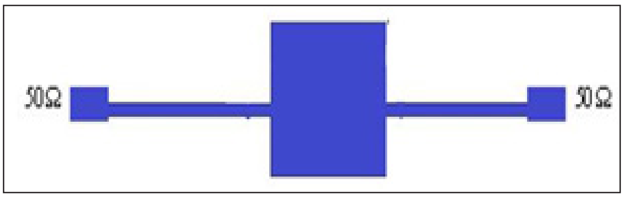

Figure 1.L and C are Normalized Elements Values of Low Pass Filter

Stepped Impedance Filter

Electrical length of inductor and capacitor can be calculated by using the following mathematical equations.

This describes the design of low cost and low insertion loss S-band Low Pass Filter (LPF) by using micro strip layout which works at 2.5 GHz. The order of the filter is n=6. Microstrip technology is used for simplicity and ease of fabrication. Different impedances we have got in our design are characteristics impedance $Z_0 = 50\Omega$, the highest line impedance ZH=ZOL = 120 and the lowest line impedance ZL=ZOC. The response of the low pass filter with alternating sections of high and low impedance line is also plotted. just by developing a code in Matlab which shows the value of insertion loss (S21) of -4dB at cut off frequency 2.5GHz. Hair pin line band pass filter The layout of the proposed hair pin BPF is depicted e in Figure 2. The filter is developed on a FR4 substrate with dielectric constant 4.4 and height equals 1.6 mm. To meet the purpose, we performed simulation by selecting electromagnetic (EM) simulator (HFSS 13.0).To design such filter we have chosen few parameters like mid band frequency fo = 1.5 GHz, cut off frequency Pass band ripple = 0.1 db etc. As it is a 5 pole filter, the corresponding filter specification are of, go= g6=1, g1=g5=1.1468, g2=g4=1.3712 andcg3=1.9750. As per the design is concerned it has got length as l=20.5mm, width w=2 mm, gap between two pin=0.5 mm, length of port=5.16mm and width of port=3.06 mm. The structure is shown in Figure 2 and frequency response is plotted in Figure 4.

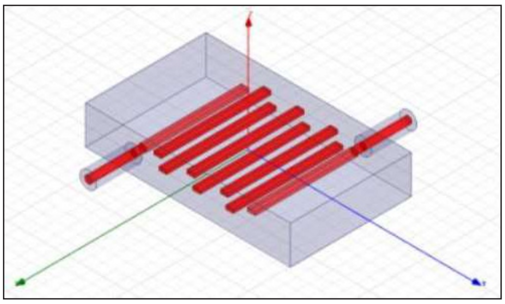

Figure 2.Structure of Hairpin Filter

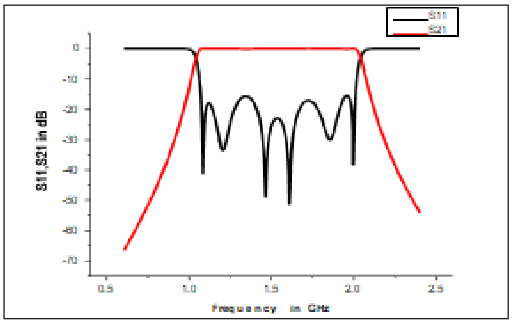

Figure 3.Frequency Response of Hair Pin Band Pass Filter

S parameters for filters will take dissimilar values in response to frequency. S21 should be equal to unity for passband and zero about stop band frequencies. If we consider S11,it needs to be zero for pass band one at stop band. Figure 3 is the simulated forward transmission coefficient S21 and the input reflection coefficient S11 where frequency is plotted in X-axis. The pass band edges are seen at 1 and 2 GHz having, 18 db return loss.

Inter Digital Filter

An inter digital filter is normally composed of pseudo inter digital lines of varying width. equals 0.5mm.As per the structure is concerned there exists a coupling space between pseudo inter digital lines and in our design it is 0.5mm.At both ends two feeding lines are made to be available just to match with 50 ohm input/ output ports. The whole size of the filter is designed on a RT/ Duriod substrate of dimension 15 mm×16.66 mm having a thickness of 1.27 mm and a relative dielectric constant of 10.8.The simulation result is reflected in Figure 4.

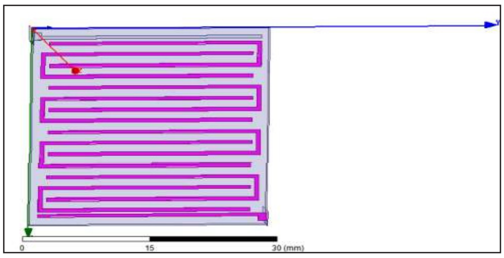

Figure 4.Inter Digital Capacitor Filter

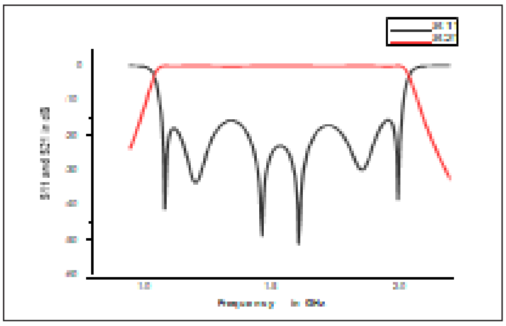

Figure 5.S-Parameter Response of Inter-Digital Band Pass Filter

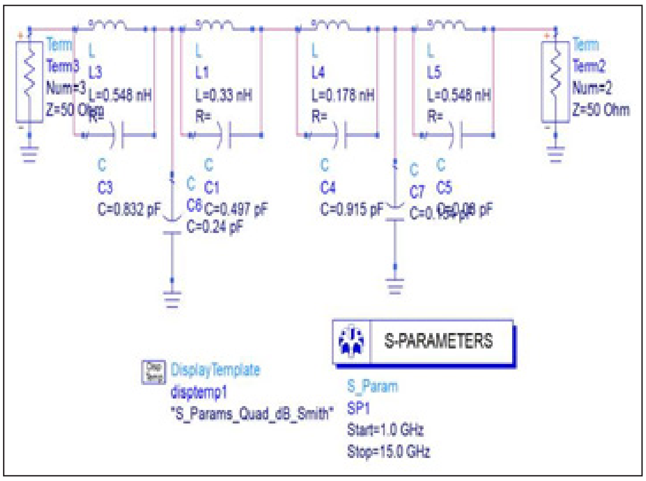

Figure 6.Schematic of Low Pass Filter by using

Low Pass Filter

To suppress the higher order harmonics, low pass filter is designed with cut-off frequency of 12.4 GHz. By considering the following values of inductor and capacitor, we can design a low pass filter with the help of ADS software. L1=0.548 nH, C1=0.832pF, L2=0.33nH, C2=0.497pF, L3=0.178nH, C3=0.9152pF, L4=0.548pF and C4=0.08pF.

ADS

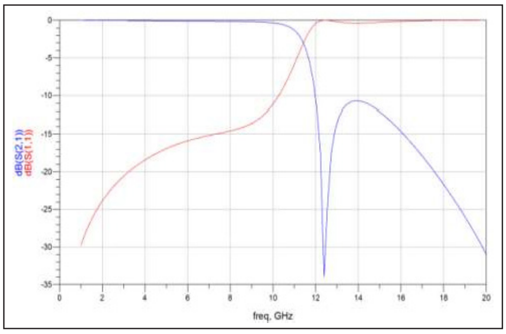

Figure 7.Simulated Result of Low Pass Filter of ADS Software

Discussion

For all simulated results such as low pass and band pass filter the frequency (GHz) is taken in x-axis and magnitude (dB) is taken in y-axis. It shows the plot of s(1,1) and s(2,1) parameter where s(2,1) is called insertion loss and s(1,1) is called return loss curve. The insertion loss curve is almost at 0 dB while the return loss curve is found to be more than -10 dB.

Conclusion

Microwave and RF filters are such an indispensable element, without that communication system is incomplete. We have direct application in radar, satellite and mobile wireless systems. Keeping the importance of filters in those areas we designed and included various types of designs such as micro strip filters, by using electromagnetic simulation process. All the filters are designed by taking suitable parameters and their corresponding simulated result were presented in terms of S11, S21. A good agreement was found in the results for all individual design. The review papers may have Summary and Outlook as the concluding section. Names of the sections are indicative as per the standard practice. The participating authors to the approval of the peer review committee may choose to customize.

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