Bandwidth Enhancement technique for microstrip filter

Shaikh Arif[1] , Dr.Uday Pandit khot[2], Prof. Santosh Jagtap[3]

1. ME Student, Dept of EXTC, Vidyalankar College of Engineering & Technology, wadala (MS)
2. Head of the EXTC Dept. of TSEC College of Engineering, Bandra (MS) INDIA.
3. Asst.prof of Vidyalankar College of Engineering & Technology, wadala (MS) INDIA

Abstract- Microstrip filter used for RF or microwave system need to operate over a wide instantaneous bandwidth with a constant group delay. The conventional Microstrip filter offers the fractional bandwidth less than about 20 percentages. To overcome this problem bandwidth enhancement technique by using short circuited shunt stub is connected between two parallel coupled resonators. It is seen that bandwidth increases from 1GHz to 2.5 GHz.The attenuation in stopband is also increases from -50 dB to -90 dB.

Key words: Enhancement technique, short circuited shunt stub

I. INTRODUCTION

Microwave filters are vital components in a huge variety of electronic systems, including mobile radio, Satellite Communication Receivers and Radar. Due to the advancement in the field of mobile and wireless communications, fully integrated analogue filters for high-frequency applications are now receiving great interest worldwide. The use of microstrip in the design of microwave components and integrated circuits has gained tremendous popularity since the last decade because microstrips can operate in a wide range of frequencies. Furthermore, microstrip is lightweight, easy to fabricate and integrate in a cost effective way. Many researchers have presented numerous equations for the analysis and synthesis of microstrips. But with advent of various Full Wave EM Simulators the designing of Microwave structures have become easier.[1]

Among the variety of band pass filter topologies microstrip parallel-coupled line filter[2] has become one of the most popular owing to their easy calculation and fabrication .The parallel coupled line filter consist of the cascaded of parallel coupled line section, however, this structure offer the fractional bandwidth less than about 20 percentages to achieve good performances . To obtain the wider fractional bandwidth of the filter the parallel-coupled line sections could be tightly coupling to reduce the insertion loss in the pass band that difficult to realize in the low-cost fabrication process.

To overcome the above drawback of small bandwidth in conventional microstrip coupled line filter we have proposed modified structure to enhance the bandwidth of coupled line filter. By connecting a short circuited stub in between two parallel coupled resonator the bandwidth and performance of filter can be enhanced.

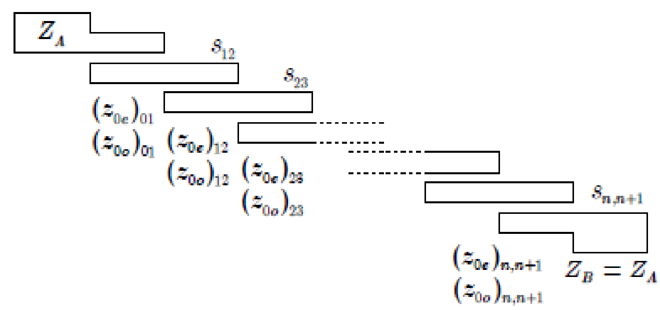

Figure1. The structure of parallel-coupled line resonator filter

II. THEORY OF PARALLEL-COUPLED LINE RESONATOR

The design theory of parallel-coupled line resonator filters was first proposed by Seymour B. Cohn in 1958 [2]. The coupling signal between two parallel-coupled line is both electric and magnetic coupling. This band pass filter consists of series of half-wavelength parallel-coupled resonators. Fig.1 shows a generally parallel-coupled line filter [2] consists of n+1 parallel-coupled line sections. It is noted that the structure contains n resonator which are of quarter-wavelength at the center frequency. The characteristic impedances of parallel coupled line in even and odd-mode impedances are, where θe and θo are the electrical length in even and odd mode Z_{oe} and Z_{0O} respectively. Fig. 2 shows the approximately equivalent circuit of the filter in Fig.1as both series and parallel resonators. Using impedance inverter (K inverter) technique, we can change the parallel resonance to series resonance and thus the equivalent circuit of the filter only shows series resonances. From the design formulas in [2] the structure has been provided good performances for the filter bandwidth only up to 20 percentages in the case of maximally flat response

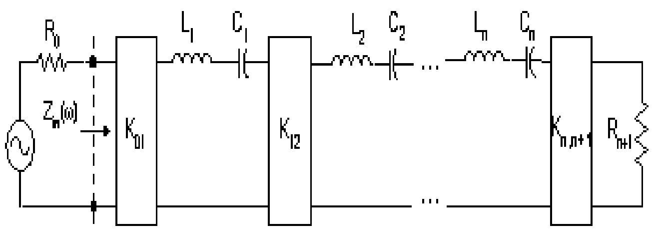

Figure.2 Approximately equivalent circuit of figure1.

III. PROPOSED BANDWIDTH ENHANCEMENT TECHNIQUE BY USING SHORT CIRCUITED SHUNT STUB

The structure shows in figure 3 the proposed wideband parallel-coupled line filter based on the conventional parallel coupled band pass filter. As seen in this figure, the topology is similar to the conventional parallel coupled filter, except only a single shunt stub is inserted in between two parallel-coupled line sections. The shunt stub acts as the parallel resonant circuit at the center frequency.

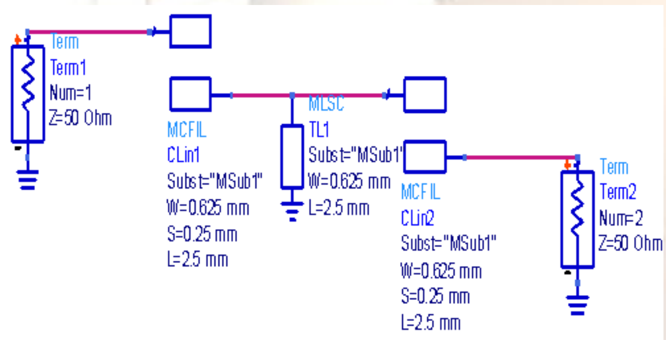

Figure. 3 Coupled line filter with short circuited shunt stub

IV. SIMULATION RESULTS AND COMPARISION

For designing the microstrip conventional coupled line filter we have assume some specification mentioned below

The design specification is

1) Substrate with 3.38 dielectric constant
2) Bandwidth 1 GHz
3) Height of the substrate 32 mil
4) Thickness of conductor is 0.015mil

The layout of conventional microstrip filter as shown in figure 4. is design by using ADS software the dimension of filter are selected as per the above specification .

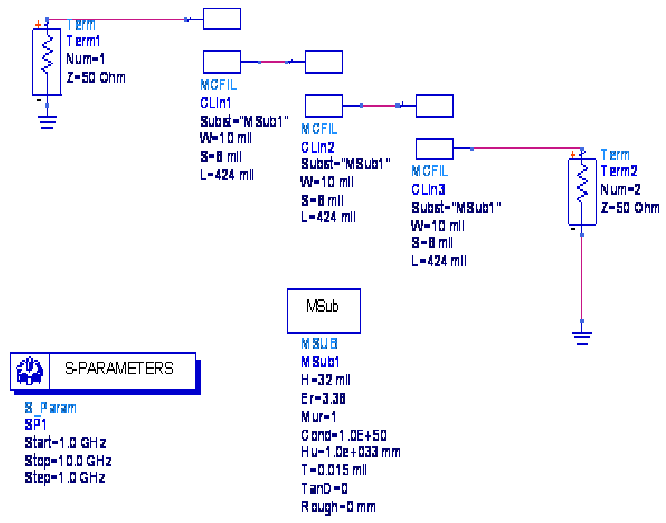

Figure 4.Conventional microstrip filter layout design by ADS software

The simulation result of the conventional microstrip coupled line filter of figure 4 is shown in figure 5 the bandwidth of the filter is 1GHz with attenuation of -45 dB for low frequency and -30 dB for high frequency in the attenuation band. At 4 GHz $S(2,1)$ = -0.008 dB which is denoted by m1 and at frequency 5 GHz $S(2,1)$= -0.001 dB which is denoted by m2 in simulation graph.

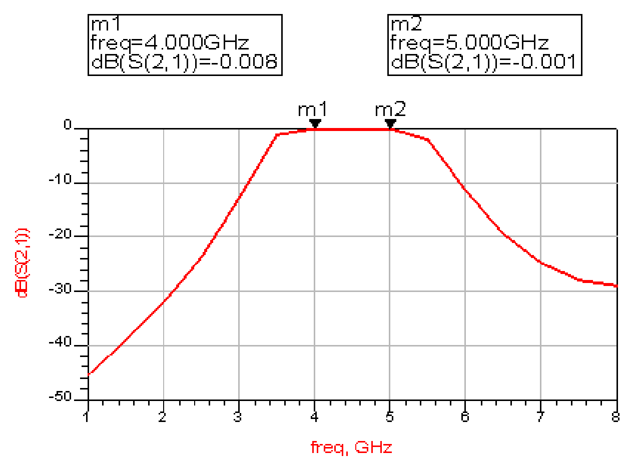

Figure 5 Simulation result of conventional filter

V. SIMULATION RESULT BY USING SHORT CIRCUITED SHUNT STUB METHOD

The figure 6 shows the schematic layout of coupled line filter by using shunt short circuited stub for enhanced bandwidth. The short circuited shunt stub is connected between two parallel coupled line resonators. The width and length are tuned to obtain the desired bandwidth. The layout is designed by using ADS simulation software.

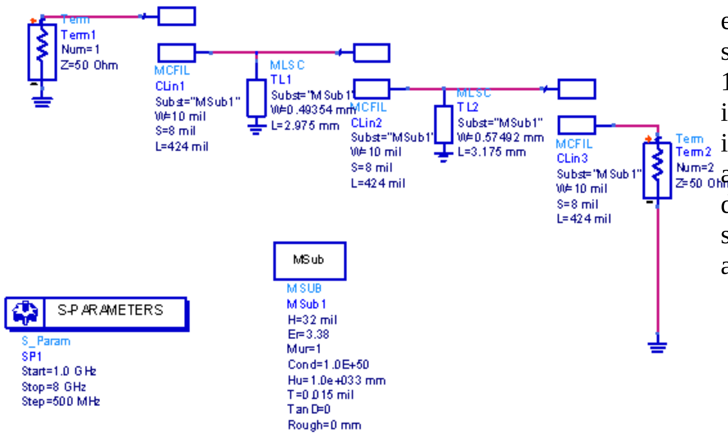

Figure 6 Short circuited shunt stub modified coupled line filter layout

The simulation result of microstrip short circuited stub of figure 6 connected with coupled resonator is shown in figure 7. The above simulation result of modified structure shows enhanced bandwidth and very good attenuation in stop band . At low frequency the attenuation is -90 dB and out of band frequency the attenuation is very high of approximately -50 dB. The total bandwidth achieved is 2.5 GHz. At frequency 2.5GHz *S* (2,1) = - 2.238 dB and at frequency 5GHz *S*(2,1) = - 0.024 dB which is denoted by m1 and m2 .

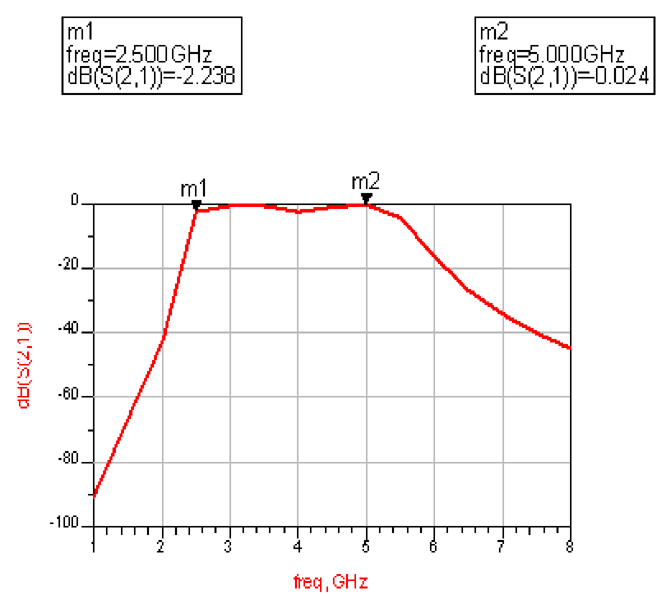

Figure 7 Simulation result of short circuited stub

VI COMPARISION BETWEEN CONVENTIONAL AND MODIFIED PROPOSED STRUCTURE

The comparision of bandwidth response between the conventional microstrip filter and modified bandwidth enhancement technique by using short circuited shunt stub is shown in figure 8. It is seen that bandwidth increases from 1GHz to 2.5 GHz as shown in result of simulation. m4 and m5 indicates the bandwidth of modified structure. m3 and m4 indicates the bandwidth of conventional microstrip filter. The attenuation in stopband is also increases from -50 dB to -90 dB.Thus we conclude that by using the shortcircuited shunt stub enhanced bandwidth with good performance of filter is achieved

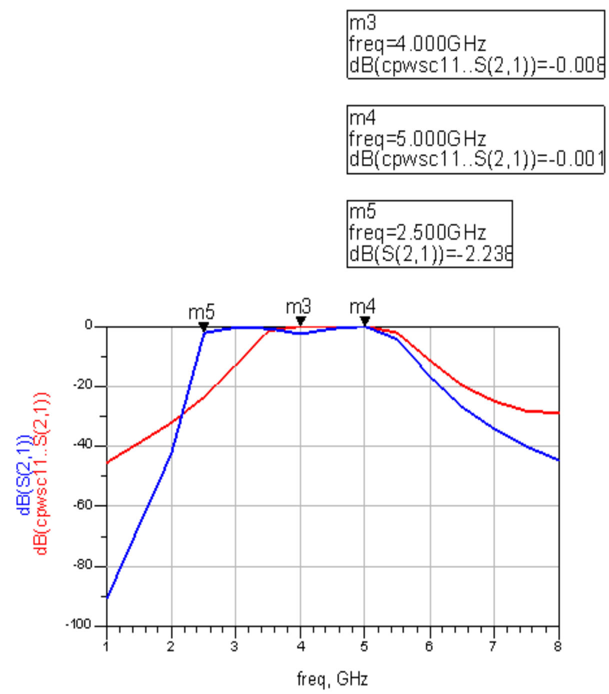

Figure 8 Comparision of simulation result

VII CONCLUSION

The comparision of bandwidth response between the conventional microstrip filter and modified bandwidth enhancement technique by using short circuited shunt stub is shown in figure 6.It is seen that bandwidth increases from 1GHz to 2.5 GHz as shown in the result of simulation. m4 and m5 indicates the bandwidth of modified structure. m3 and m4 indicates the bandwidth of conventional microstrip filter. The attenuation in stopband is also increases from -50dB to -90dB.Thus we conclude that by using the short circuited shunt stub enhanced bandwidth with good performance of filter is achieved

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[5] Electromagnetic simulation software ADS advanced design system by Agilent technology