Wide Band BPF (Band Pass Filter) based on Complementary Square Split Ring Resonator (CS-SRR)

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ABSTRACT

In this paper a Microstrip BPF for C-Band is proposed, which based on λ/4- length Resonator which is 8.8 mm at the center frequency 5 GHz, it has been loaded with Double Square Complementary Split Ring Resonator (CS-SRR). The proposed filter attains an insertion loss of .284dB and return loss greater than of 12.198dB in the pass-band. The proposed filter is having a band width of 4.4GHz. The structure has been simulated using commercially available Full wave simulator tool -HFSS [10].

Keywords— Bandpass filters, C-band, Complementary Square Split Ring Resonator (CS-SRR) , Microstrip , Via.

I. INTRODUCTION

Filters are the devices which are being used to either select or reject a part of the frequency spectrum. C-Band (4GHz – 8 GHz) is one of the most important spectrum bands for the communication. The C-band spectrum finds application in the Satellite communication, nearly all satellites in this band use 3.7GHZ- 4.2 GHz downlink, and 5.925GHz -6.425 GHz for uplinks. The C-band spectrum is also used by some of the Weather Radar Systems. There are various design methods have been introduced for the design of the C-Band Microstrip BPF Filter [1]-[8].

J. B. Pendry firstly proposed CSRR (complementary split ring resonator), which can be used to negative effective permittivity which can help out in preventing the signal flow in the vicinity at the resonant frequency. Compact filters can be designed using CSRR (complementary split ring resonator).

In this paper a compact filter wideband BPF for C- Band application is proposed which is based on the λ/4- length Resonator which is 8.8 mm at the center frequency 5 GHz; it has been loaded with Double Square Complementary Split Ring Resonator (CS-SRR). The proposed filter attains an insertion loss of .284dB and return loss greater than of 12.198dB in the pass-band. The proposed filter is of the size 3.6 X 11.7 mm2 (0.12λg X0.40 λg). The proposed filter have been designed on the FR-4 substrate of thickness 1.6mm (t = 1.6mm) with dielectric constant of 4.4(ε r = 4.4).

II. FILTER STRUCTURE

Fig.1 shows the design of the proposed filter. Table.I shows the dimensions of the proposed filter. The filter consists of a λ/4- length Resonator which is 8.8 mm (center-frequency 5GHz). The strip width has been chosen to be 0.2mm (Length – L2).

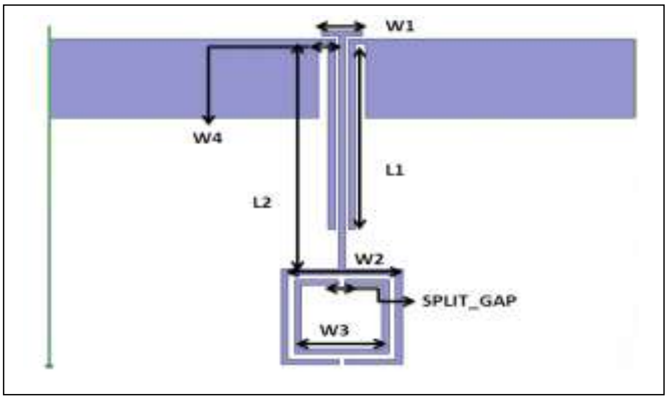

Fig. 1. Structure of proposed C-band filt

er. Substrate: ε_r =4.4, t=1.6mm.

The filter is being feed using 50 ohm feed line using loose coupling (Length – L1 and Width - W4) with a strip width of 0.2mm. The filter has been loaded by CS-SRR (Complementary Square Split Ring Resonator). The outer ring is of length 3.6mm with strip width of 0.2 mmm and a split gap 0.2mm. The inner ring is of length 3.2 mm with strip width of 0.2 mmm and a split gap 0.2mm

Table I. Dimensions of Proposed Filter (in mm)

L1	7.0
L2	8.8
W1	0.8
W2	0.5
W3(OUTER)	3.6
W3(INNER)	3.4
W4(OUTER)	3.2
W4(INNER)	3.0
SPLIT_GAP	0.2

III. RESULT AND DISCUSSION

Fig.2 shows the insertion loss and the return loss characteristics of the proposed filter. The lower cutoff frequency is 3.8 GHz and the higher cutoff frequency is 8.2 GHz. The filter shows three resonant frequencies at 4.2 GHz, 5.1GHz and 7.9 GHz. The proposed filter is having a bandwidth of 4.4 GHz from 3.8 GHz to 8.2 GHz which lies in C-band.

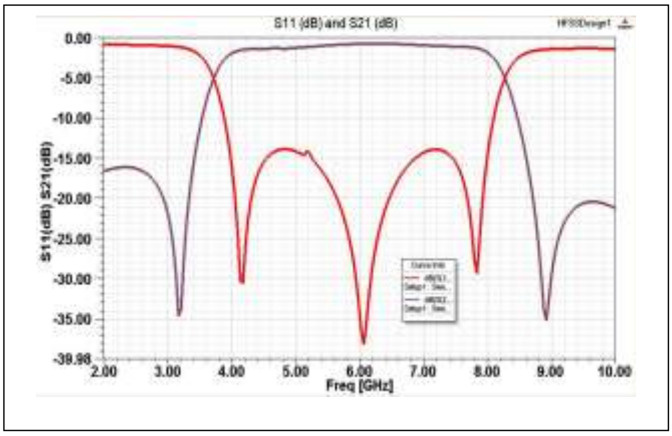

Fig. 2. Insertion Loss and Return loss charactorstics C-band filter.

Fig.3 shows the group delay characteristics of the proposed filter which shows that the group delay for the pass band is approximately equal; near the cutoff frequency the group delay is higher than the pass band frequencies.

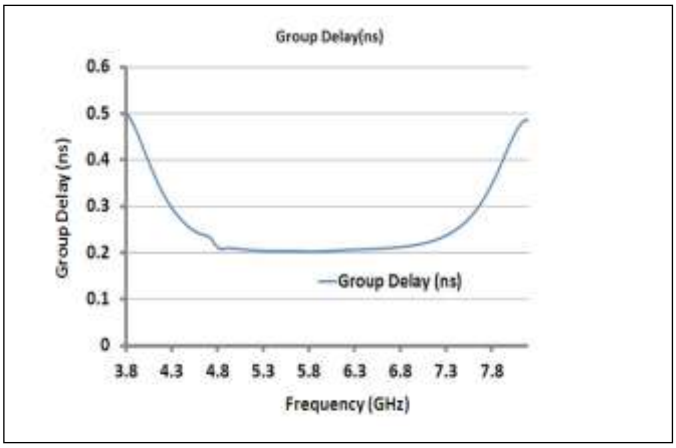

Fig. 3. Group Delay charactorstics C-band filter.

Table II. Comparison with various other topologies

References	S21 (dB)	S11 (dB)	Dielectric constant/ height(mm)
[1]	≤ 1.0	≥ 12.0	2.65 / 0.8
[2]	≤ 1.0	≥ 11.0	10.8 / 1.27
[3]	≤ 1.1	≥ 10.0	10.8 / 0.635
[4]	≤ 1.6	≥ 15.0	10.5 / 0.635
[5]	≤ 2.0	≥ 7.0	2.55 / 0.8
[6]	≤ 2.0	≥ 12.5	10.5 / 0.635
[7]	≤ 1.4	≥ 11.0	2.55 / 0.8
[8]	≤ 1.5	≥ 7.0	2.55 / 0.8
[9]	≤ 0.5	≥ 12.0	2.6 / 0.8
Proposed Work	≤ 0.284	≥ 12.198	4.6 / 1.6

A comparison is made between the previously proposed filter which have been inevstigated earlier. The proposed filter having very simple coupling and have a better bandwidth 4.4 GHz. The proposed filter is also having a better insertion loss which is found to be .284dB (at 6.05GHz; center frequency of the pass band). The return loss charactorstics is found to be greater than 12.198dB.

IV. CONCLUSION

The investigated filter is compact C-Band Microstrip Filter is having an Insertion loss .284dB and Return loss of 12.198 dB in the pass band, the size of the investigated filter is 3.6 X 11.7 mm2 (0.12λg X0.40 λg).The proposed filter finds application for the most of the satellite communication and weather radar systems. The investigated filter shows improved insertion loss and return loss characteristics than the earlier proposed filter also having a better band width of 4.4GHz.

REFERENCES

[1] D. S. La and Wei-Hong Han, "Compact wideband band-pass filter using micro-strip parallel-coupled line structure with complementary split ring resonator," Proc. of IEEE International Conference on Microwave and Millimeter Wave Technology (ICMMT), Beijing, pp. 360-362, June 2016.

[2] H. N. Shaman, "New S-Band Band-pass Filter (BPF) With Wideband Pass-band for Wireless Communication Systems," IEEE Microwave and Wireless Components Letters, Vol. 22, No. 5, pp. 242-244,May 2012.

[3] S. W. Wong and L. Zhu, "Quadruple-Mode UWB Band-pass Filter with Improved Out-of-Band Rejection," IEEE Microwave and Wireless Components Letters, Vol. 19, No. 3, pp. 152–154, March 2009.

[4] H. W. Deng, Y. J. Zhao, L. Zhang, X. S. Zhang and S. P. Gao," Compact Quintuple-Mode Stub-Loaded Resonator and UWB Filter," IEEE Microwave and Wireless Components Letters, Vol. 20, No. 8, pp. 438–440, August 2010.

[5] Q. X. Chu, X. H. Wu, and X. K. Tian, "Novel UWB Band-pass filter using Stub-loaded Multiple-mode Resonator," IEEE Microwave and Wireless Components Letters, Vol. 21, No. 8, pp. 403–405, August 2011.

[6] X. H. Wu, Q. X. Chu, X. K. Tian and X. Ouyang, "Quintuple-mode UWB band-pass filter with sharp roll-off and super-wide upper stop-band," IEEE Microwave and Wireless Components Letters, Vol. 21, No. 12, pp. 661–663, December 2011.

[7] Q. X. Chu and X. K. Tian, "Design of UWB Bandpass Filter using Stepped-Impedance Stub-Loaded Resonator," IEEE Microwave and Wireless Components. Letters, Vol. 20, No. 9, pp. 501–503, September 2010.

[8] Y. C. Chiou, J. T. Kuo and E. Cheng, "Broadband Quasi-Chebyshev Band-pass Filters with Multimode Stepped-Impedance Resonators (SIRs)," IEEE Transactions on Microwave Theory and Techniques, Vol. 54, No. 8, pp. 3352–3358, August 2006.

[9] Aviral Verma and Manish Kumar Improved Coupling Based Wide Pass-band Filter with Double Square Complementary Split Ring Resonator SVIT-ICEEMAS

[10] Ansoft High frequency Structure Simulation (HFSS) ver11.1 Ansoft Corporation, 2005.