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PERFORMANCE ANALYSIS OF BAND PASS FILTER DESIGN TECHNOLOGIES

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ABSTRACT
This research work focuses on different design techniques of bandpass filter and their results are compared. Improvement of filter performance and reduction in components size is became prime concern with rapid advancement of technologies. In this paper, SymmetricallyTriangular Open Loop Resonator, Self-Coupled Folded-Line Resonator, Dual-Stub-Loaded Spiral ResonatorsandStepped Impedance Resonators.

INTRODUCTION

Band Pass Filters can be used to isolate or filter out certain frequencies that lie within a particular band or range of frequencies. The cut-off frequency or fc point in a simple RC passive filter can be accurately controlled using just a single resistor in series with a non-polarized capacitor, and depending upon which way around they are connected, a simple frequency selective filter that allows a selective range of frequencies are Bandpass filter (BPF).

Microwave filters with good frequency selectivity, wide stop-band, compact size, and low insertion loss are very much desirable in the radar and communication field.Bandpass filters are compact with various filters to allow sort of desirable outcomes to perform inline communication. In order to achieve the performance criterion various methods have been proposed. Some methods are used for better communication and channel forecasting, a widely useable mode of communication is based on Pass-Band and stop-band. Placement of finite transmission zeros (FTZ) plays an important role in the designing of filter,and frequency response is also affected by the FTZs locations. FTZs located symmetrically on the real axis on the complex frequency plane give better out of band frequency selectivity. FTZs on the real axis the used for linear phase response in pass-band whilean imaginary axis is used for better stop-band performance.Bandpass filter has a center frequency of passband with half wavelength and its frequency of resonant is differing with three-time of the fundamental frequency. The suppression of the frequency cause more noise with the signal communication with satellite communication mode and channel. In this paper we studied some of known and useful techniques that give a concern of the techniques that are already established and well known with implemented filters

LITERATURE SURVEY

Cheng-Guang Sun [1], Microstripbandpass channel is a significant part in present day remote correspondence frameworks. The advancement of channels created in the printed circuit board has been given a lot of consideration to miniaturization. To fulfill the prerequisites, an assortment of minimal bandpass channels has been considered [2-4]. Famously, a half-wavelength open loop resonator, and in excess of two resonator units are embraced [5]. To acquire high-recurrence selectivity or harmonic suppression, a square open circle resonator is utilized in the bandpass channel structure [6]. This channel is likewise with little in size. Utilizing triangular open circle resonator, a microstripbandpass channel have been created, it is displayed great separating exhibitions. Be that as it may, the littler

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size and sharp dismissal are quite required for the bandpass channel structure.

Zhang JuHou [7],The structure of BPFs is one of the most troublesome difficulties with some trade-offs, for example, insertion misfortune, operation bandwidth, stopband suppression and chip size. Regarding on-chip inactive gadget plans, there are a few plan approaches including altered transmission lines [9], hybrid lumped and conveyed parts [10], edge-coupled [11] and broadside-coupled structures [8] to lessen the chip size of BPFs while maintaining a general required exhibition. To further minimize the chip size, a progression of works have been accounted for by methods for in-band flatness improvement [9], stopband suppression upgrade [12] and chip size miniaturization [8]. In spite of the fact that the BPF based edge-coupled resonator [11] has a low insertion misfortune, its chip size is enormous because of the planar nature of the edge-coupled resonator. Along these lines, it is attractive that both chip size and insertion misfortune are considered, at the same time, for best execution.

Kai-da XU [13], A harmonic-stifled BPF dependent on a triple-mode stub-stacked resonator is proposed in [14], which has the preferred position that the even-mode frequencies can be deftly controlled though the odd-mode frequencies are fixed. Be that as it may, it involves complex structure in the plan procedure. In [15], a triple-mode BPF using a changed roundabout fix resonator is introduced, however the terrible dismissal in the stop-band happens. Reference [16] presents a wideband BPF with controllable bandwidth and suppression of the harmonic band, wherein four same open circle resonators are received. Be that as it may, the recurrence selectivity still should be improved. In [17], a novel deserted open-circle resonator as the slot-line configuration is applied to structure a minimal triple-mode surrendered ground waveguide resonator-based BPF, which is smaller and simple for integration with planar innovation. In addition, a novel triple-mode hexagonal BPF with capacitive loading stubs is introduced in [18], which is created from an ordinary hexagonal circle double mode resonator. In [19], a triple mode channel using a winding resonator stacked with two short-stubs and an open-stub is displayed.

J. Martel [20] A new type of miniaturized stepped impedance resonator (SIR) for bandpass filter applications is proposed in this paper. The new resonator incorporates a ground plane window with a floating conductor in the backside of the substrate. The ground plane window increase the characteristic impedance of the lines used to implement the inductive region of the quasi-lumped resonator, thus allowing some size reduction. Moreover, the presence of a floating conducting patch printed below the capacitive region of the resonator pushes up the first spurious band of the filter. A meaningful improvement of its out-of-band rejection level is then achieved. The coupling between adjacent resonators is also enhanced thus leading to wider achievable.

BANDPASS FILTER DESIGING TECHNIQUES

A triangular open loopresonator, as shown in Fig. 1, consists of an isosceles righttriangular open loop with connecting to two feed lines directly,and it is with a small size usefully. It resonates around 1.64GHz in frequency as given size in the figure. In order to obtainthe lower frequency while holding the smaller in size above,the resonator must be improved. From the figure, we foundsome space inside the loop can be used. Therefore, anadditional open loop is embedded into the space.

Thecapacitive loaded lossless transmission line resonator can bedescribed as in Fig. 3, where C_L is the loaded capacitance; Z_a, β_a, and d are the characteristic impedance, the propagationconstant, and the length of the unloaded line, respectively. Theequations are as follows [5]:

$$\theta_{a0} = 2\tan^{-1}\left(\frac{1}{\pi f_0 Z_a C_L}\right) \quad (1)$$

$$\theta_{a1} = 2\pi - 2\tan^{-1}(\pi f_1 Z_a C_L) \quad (2)$$

From equations above, $\theta_{a0} = \pi$ and $1\theta_{a0} = 2\pi$ when CL = 0.This is for the unloaded half-wavelength resonator. If $C_L = 0$,the resonant frequency reduces as the loading capacitanceincreases.

Fig. 1 A triangular open loop resonator

The ratio of the first spurious resonant frequency tothe fundamental frequency, $f1/f0$ increases with the loadingcapacitance, resulting in wide stop-band. At the same time, sizereduction has been obtained.

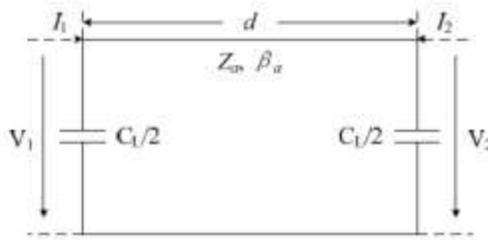

Fig. 2 Capacitive loaded transmission line resonatorequivalent circuit

compact and low-loss BPF using a self-coupled folded-line resonator (SCFLR) provides not only flexible self-resonant-frequency (SRF) to determine the transmission zero (TZ) but also relatively low insertion loss with an ultra-compact size.SCFLR in different layers, as well as in a 3-D view, is shown in Figs. 3(a) and (b), respectively.

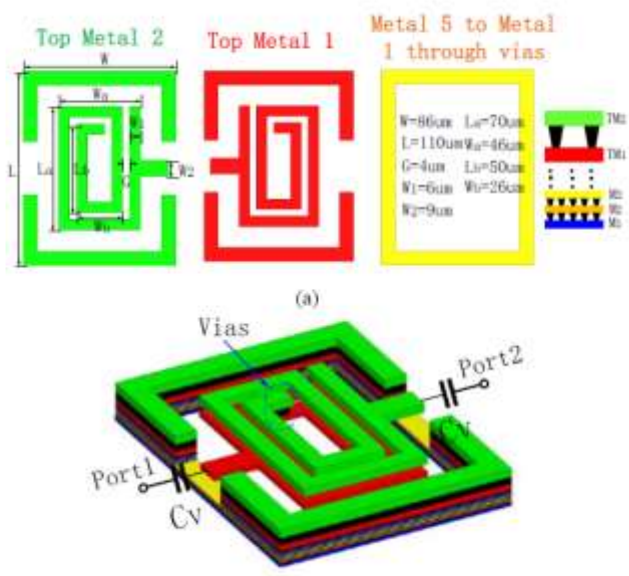

Fig.3 (a) Different layers of the SCFLR (b) 3D view BPF

In this design, a standard 0.13-μm (Bi)-CMOS technology is utilized to implement the BPF by 7 metal layers including two top metal layers with high conductivity. The process-design-kit (PDK) offers metal-insulator-metal (MIM) capacitors, which are sandwiched between Top-Metal 1 (TM_1) and Metal 5 (M_5). Moreover, the dielectric constant of SiO2 is 4.1 and the loss tangent is 0.01. The height of the silicon substrate is 200 μm. As illustrated in Fig. 1(a), the Top-Metal 2 (TM_2) and TM_1 layers are mainly used to implement the top and bottom spiral inductors.

To investigate the insight of the presented SCFLR in Fig. 3(a), an L-C equivalent model is presented in Fig. 4(a). The TM_2 inductor L_{TM2} is connected to TM_1 inductor L_{TM1} by vias. To analyze the SCFLR, the equivalent L-C model is simplified with a pair of inverse-coupled inductors LC and a parasitic capacitor CP as shown in Fig. 4(b).

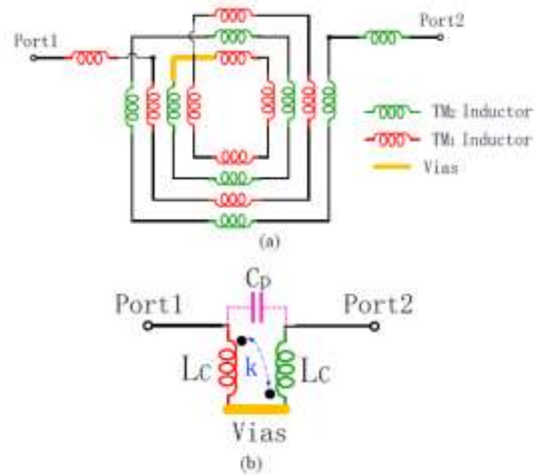

Fig. 4 SCFLR model (a) L-C equivalent circuit (b) simplified circuit

Equivalent inductor L_E of the inverse-coupled inductors could be expressed as follows:

$$L_E = 2(1+k)L_C \quad (3)$$

Here, the equivalent inductor $L_E$and the parasitic capacitor $C_P$illustrate a simplified L-C equivalent circuit of the SCFLR, which could determine the transmission zero by means of a tunable SRF.

The transmission zero is found to satisfy the following equation:

$$f_{tz} = \frac{1}{2\pi\sqrt{2(1+k)L_C L_P}} \quad (4)$$

The schematic layouts of dual-T-stub loadedspiral resonators are shown in Fig. 5, which sharethe same equivalent structure. Because of the spiral structures, when the electrical lengths are fixed, the sizes ofthese two proposed resonators can be reduced greatly.

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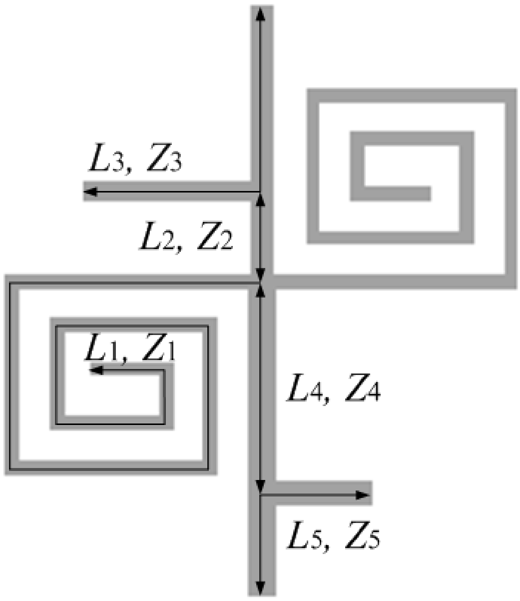

Fig. 5 Centrally Symmetrical Spiral Resonator

Fig. 6(a) illustrates the equivalent configuration ofthe spiral resonators, which is composed ofa uniform microstrip half-wavelength resonator and a pairof T-shaped stubs with different lengths. θirefers to theelectrical length of Li, and Zidenotes the characteristicimpedance of the corresponding strips (i = 1, 2, 3, 4 and 5).As the equivalent configuration is symmetrical instructure, apparently, we could utilize the odd- and evenmodemethod to further analyze this configuration. For theeven-mode excitation, an approximately equivalent circuitis depicted in Fig. 6(b). We simplify the analysis by setting$Z1 = Z3 = 2Z2 = 2Z4 = Z5$, therefore, the input impedances ofthe two even-mode equivalent circuits Zin_even_1 and$Z$in_even_2 can be deduced as follows:

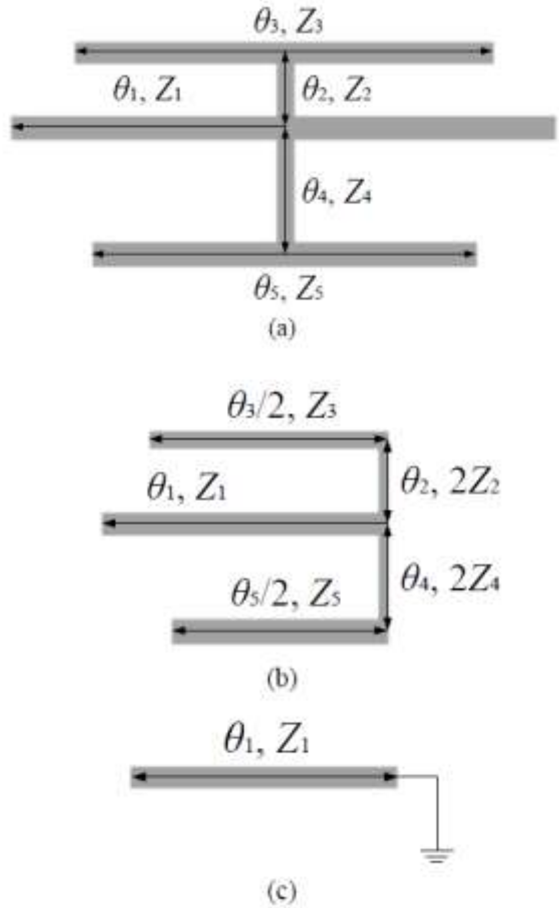

Fig. 6.Equivalent configuration and equivalent circuits of theproposed spiral resonators: (a) Equivalent configuration.(b) Even-mode equivalent circuit. (c) Odd-modeequivalent circuit.

$$Z_{in\_even\_1} = \frac{Z_1}{\mathrm{j}\tan(\theta_1 + \theta_2 + \theta_3 / 2)},$$

$$Z_{in\_even\_2} = \frac{Z_1}{\mathrm{j}\tan(\theta_1 + \theta_4 + \theta_5 / 2)}.$$

Because of the resonance conditions that Im(Zin_even_1) = □and Im(Zin_even_2) = □, we can derive the following results:

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$$f_{\text{even\_1}} = \frac{nc}{2(L_1 + L_2 + L_3/2)\sqrt{\varepsilon_{\text{eff}}}},$$

$$f_{\text{even\_2}} = \frac{nc}{2(L_1 + L_4 + L_5/2)\sqrt{\varepsilon_{\text{eff}}}}$$

where$n$ = 1, 2, 3..., c is the velocity of light in free space,and εeff denotes the effective dielectric constant of thesubstrate.For the odd-mode excitation, its equivalent circuit is depicted in Fig. 4(c). The input impedance of the odd-modecircuit Zin_odd can be obtained as follows:

$$Z_{\text{in\_odd}} = jZ_1 \tan\theta_1$$

The resonance condition is Im(Zin_odd) = □. Therefore,when the odd mode is excited, the resonant frequency canbe deduced as:

$$f_{\text{odd}} = \frac{(2n-1)c}{4L_1\sqrt{\varepsilon_{\text{eff}}}}.$$

When $L2 + L3/2 < L1 < L4 + L5/2$, it can be derived that$f$even_2 <$f$odd<$f$even_1. Following this analysis, a triple-moderesonator is presented. The above analysis shows that theresonant frequencies of two proposed triple-mode resonatorscould be changed by tuning the lengths of $L1$, $L2$, $L3$, $L4$,and $L5$.

A substrate integrated waveguide (SIW) filter for satellite ground terminal is proposed which also shows improvement in the stop band performance. Waveguide components are used widely in the microwave frequency range due to their high Q values and high power capability but they are bulky, costly and not suited for high density integration. Here substrate integrated waveguide overcome all these difficulties arises with waveguide. Substrate integrated waveguide provides low weight, low cost, low profile with high performance maintenance. Substrate integrated waveguide is a dielectric filled waveguide consist of metallic cylinders also called vias used to connect or unite upper metallic plate with ground. Another advantage of SIW is that it can be fabricated on the PCB byusing standard printed circuit board fabrication technique and system-on package [21]. SIW is a potential as well as promising technology for microwave designing. Planar technology (such as microstrip, strip line and coplanar waveguide) of microwave component designing having high transmission losses while SIW provides better electrical shielding apart from that SIW has viability to incorporate active and passive components on same substrate.

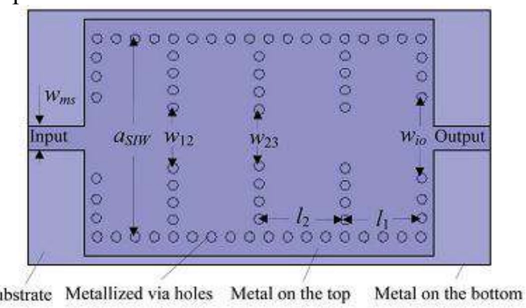

Fig. 7SIW Filter for satellite ground terminal [21]

CONCLUSION

There are several methods are available to design a filter, In this paper some of methods are discussed and compared along with the results and advantages. Compatibility of methods may differ according to the desired filter specification required for the particular use. Discussed filtering techniques led the evolution of number of filters. These filters have been used in wide range of applications.

REFERENCES

1. *Cheng-Guang Sun, Hong-Xing Zheng, Li-Ying Feng, "A Compact Bandpass Filter Design UsingSymmetrically Triangular Open Loop Resonator", 2012 2nd International Conference on Consumer Electronics, Communications and Networks (CECNet).*
2. *D. Cheng, H. -X. Zheng, L. -Y Feng, and F. -Y. Gao, "Investigation ofcompact second-order microstripbandpass filter," Microwave andOptical Technology Letters, vol. 52, 2010, pp. 1970-1973.*
3. *L. -Y. Feng, H. -X. Zheng, C. -G. Sun, and F. -Y. Gao, "Miniaturebandpass filter with wide stopband using open-loop resonators,"Microwave and Optical Technology Letters, vol. 53, 2011, pp. 748-751.*
4. *L.-Y. Feng, H. -X. Zheng, C. -G. Sun, and D. Cheng, "Dual-bandbandpass filter with tunable upper passband," Microwave and OpticalTechnology Letters, vol. 53, 2011, pp. 888-890.*
5. *J. S. Hong and M. J. Lancaster, "Theory and experiment of novelmicrostrip slow-wave open-loop resonator filters," IEEE TransMicrowave Theory Tech, vol. 45, 1997, pp. 2358–2365.*
6. *X.-H. Jiang and G.-H. Li, "Compact designs of a band-pass filter withnovel open-loop*

resonators," Microwave Opt Tech Lett, vol. 49, 2007,pp. 2755-2757.

7. *Zhang JuHou, Yang Yang, Xi Zhu, Yuan Chun Li, ErykDutkiewicz and QuanXue, "A Compact and Low-Loss Bandpass Filter Using Self-Coupled Folded-Line Resonator With Capacitive Feeding Technique", IEEE Electron Device Letters, Volume: 39 , Issue: 10 , Oct. 2018, p1584 - 1587.*
8. *S. Chakraborty, et al., "A broadside-coupled meander-line resonator in 0.13-µm SiGe technology for millimeter-wave application," IEEE Electron Device Lett., vol. 37, no. 3, pp. 329-331, Mar. 2016, doi: 10.1109/LED.2016.2520960.*
9. *Y. Yang, H. Liu, Z. J. Hou, X. Zhu, E. Dutkiewicz, and Q. Xue, "Compact on-chip bandpass filter with improved in-band flatness and stopband attenuation in 0.13-µm (Bi)-CMOS technology," IEEE Electron. Device Lett.,vol.38,no.10,pp.1359-1362,Oct.2017,doi:10.1109/LED.2017.2739186.*
10. *Y. Zhong, Y. Yang, X. Zhu, E. Dutkiewicz, K. M. Shum, and Q. Xue, "An on-chip bandpass filter using a broadside-coupled meander line resonator with a defected-ground structure," IEEE Electron. Device Lett, vol. 38, no. 5, pp. 626-629, May 2017, doi: 10.1109/LED.2017. 2690283.*
11. *Y. Yang, H. Zhu, X. Zhu and Q. Xue, "A low-loss bandpass filter using edge-coupled resonator with capacitive feeding in (Bi)-CMOS technology," IEEE Electron Device Lett, vol. 39, no. 6, pp. 787-790, June 2018.doi: 10.1109/LED.2018.2826782.*
12. *K. Ma, S. Mou, and K. S. Yeo, "Miniaturized 60-GHz on chip multimode quasi-elliptical bandpass filter," IEEE Electron. Devices Lett, vol. 34, no. 8, pp. 945-947, Aug. 2013, doi:10.1109/LED.2013.2265165.*
13. *Kai-da XU, Meng-ze LI, Yan-hui LIU*1, Jing AI, Ye-cheng BAI, "Compact Microstrip Triple-Mode Bandpass FiltersUsing Dual-Stub-Loaded Spiral Resonators", RADIOENGINEERING, VOL. 26, NO. 1, APRIL 2017, DOI: 10.13164/re.2017.0023.*
14. *DAI, G. L., ZHANG, X. Y., CHAN, C.-H., et al. An investigationof open-and short-ended resonators and their applications tobandpass filters. IEEE Transactions on Microwave Theory andTechniques, 2009, vol. 57, no. 9, p. 2203–2210. DOI:10.1109/TMTT.2009.2027173*
15. *SERRANO, L., CORRETA, F. S. A triple-mode bandpass filterusing a modified circular patch resonator. Microwave and OpticalTechnology Letters, 2009, vol. 51, no. 1, p. 178–182. DOI:10.1002/mop.23950*
16. *MA, X. B., JIANG, T. Compact wideband bandpass filter withcontrollable bandwidth and suppression of the second passbandusing a trimode resonator. Microwave and Optical TechnologyLetters, 2015, vol. 57, no. 12, p. 2939–2943. DOI:10.1002/mop.29475*
17. *LIU, H. W., SHEN, L., JIANG, Y., et al. Triple-mode bandpassfilter using defected ground waveguide. Electronics Letters, 2011,vol. 47, no. 6, p. 388–389. DOI: 10.1049/el.2011.0006*
18. *MO, S. G., YU, Z. Y., ZHANG, L. Design of triple-modebandpass filter using improved hexagonal loop resonator. Progressin Electromagnetics Research, 2009, vol. 96, no. 4, p. 117–125.DOI: 10.2528/PIER09080304*
19. *XU, H., XU, K., LIU, Y., LIU, Q. H. Compact triple-modebandpass filter using short-and open-stub loaded spiral resonator.In 2016 IEEE/ACES International Conference on WirelessInformation Technology and Systems (ICWITS) and AppliedComputational Electromagnetics (ACES). Honolulu (USA), 2016,2 p. DOI: 10.1109/ROPACES.2016.7465476*
20. *M. D. C. Velazquez-Ahumada, J. Martel, F. Medina&F. Mesa, "DESIGN OF A BAND-PASS FILTER USING STEPPEDIMPEDANCE RESONATORS WITH FLOATING CONDUCTORS", Electromagnetics Research, Vol. 105, 31{48, 2010.*
21. *Xiao-Ping Chen, Ke Wu, Daniel Drolet, "Substrate Integrated Waveguide Filter with Improved Stopband Performance For satellite Ground Terminal," IEEE Trans. On Microwave and Technique, Vol.57, No.3, pp.674-683 March 2009.*