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Review on Various Design Techniques of Filter

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Abstract:
In this paper, Various Filtering techniques for designing of bandpass filter are compared along with their results. With rapid advancement of communication standards there is need of technology that satisfies performance criterion as well as reduces the size of components. This paper briefly discusses some of techniques that have been accounted in the literature broadly included filter using Triple mode resonator, microstrip quarter-wave resonator, stub-loaded resonator and substrate integrated waveguide (SIW).

Keywords: Bandpass Filter, Triple mode resonator, Microstrip resonator, stub-loaded resonator and Substrate Integrated Waveguide (SIW).

I. INTRODUCTION

Microwave filters with good frequency selectivity, wide stopband, compact size and low insertion loss are very much desirable in radar and communication field. In order to achieve the performance criterion various methods have been proposed. 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 real axis on the complex frequency plane give better out of band frequency selectivity. FTZs on real axis is used for linear phase response in passband while on imaginary axis is used for better stopband performance.

II. DIFFERENT METHODS OF FILTER DESIGNING

In 2000, A band pass Filter using Microstrip $\lambda/4$ Resonator with open stub is proposed, Which is simpler in design point of view as well as having Compact structure. One more advantage of filter is that because of direct coupling is used it is having low insertion and radiation loss. This filter consists of two microstrip Quarter wavelength resonators and a tapped open stub. In this filter resonators are not needed to be shorted to the ground because of tapped open stub. Tapped open stub between the resonators work as K-inverter. In stop band, notch frequency can be controlled by length of open stub. Two direct coupled quarter-wave resonators cause spurious responses at even harmonic frequency and canceled at odd harmonic frequency due to tapped open stub with attenuation pole at odd order harmonic frequencies [6]

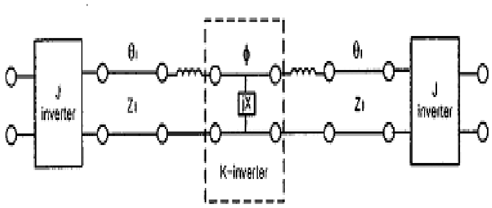

Figure.1. Equivalent Circuit of bandpass Filter using Microstrip Quarter Wave Resonator with open stub [6]

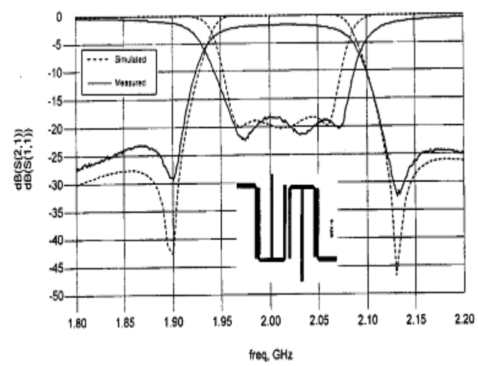

Figure.2. S-parameter plot of bandpass filter [6]

In 2001, A elliptic Microstrip $\lambda/4$-resonator is proposed, In this filter stub configuration is modified by generating two transmission zeros per stub that implement correct value of admittance inverter at center frequency resulting filter is more compact than half wave resonators but having no spurious response at the center frequency. There are three reflection zeros present in the filter one from a 2-resonator filter and other caused by resonance in the combination of two stubs (length approximately $\lambda/2$ at center frequency of filter). In other word not only stop band of filter but passband also improved by adding second zero. This filtering technique can be applied to higher order filters because it does not cause any serious problem [5].

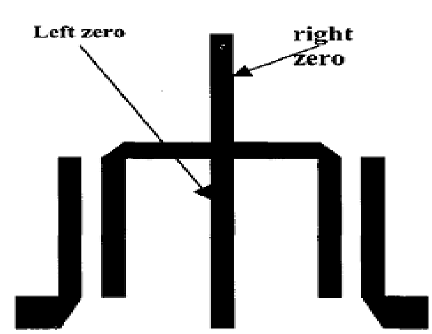

Figure. 3. elliptic Microstrip $\lambda/4$-resonator filter [5]

In 2007, A compact microstrip-line ultra-wideband (UWB) filter is proposed using multiple mode resonator (MMR). Improved microstrip-line UWB bandpass filter formed an alternative MMR by proper loading of three open-ended stubs, Resonator is feed by two parallel coupled lines at two sides and a wideband filter with fractional bandwidth of 60% to 80% achieved. In this filter two identical stubs are placed at two symmetrical positions with respect to central plane, which may provide an additional freedom to relocate the resonant mode while pushing up the other mode aiming to achieve out of band rejection and widened upper stopband performance of filter. UWB bandpass filter using stub-loaded multiple mode resonator weakly capacitive coupled with 50Ω feed lines suffers from high insertion loss in upper UWB passband and a narrow upper stopband. Another UWB bandpass filter with two interdigital parallel coupled lines which are installed in the two sides of the multiple mode resonator with enhanced coupling is used results parameters in the desired range[4].

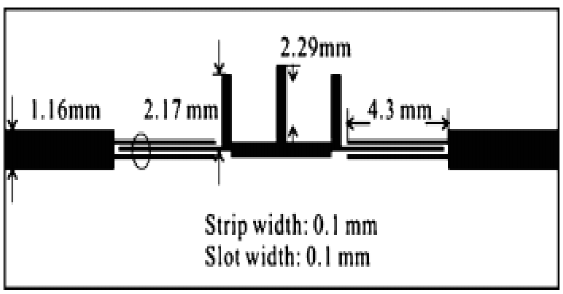

Figure.4. UWB Filter with Stub-Loaded MMR [4]

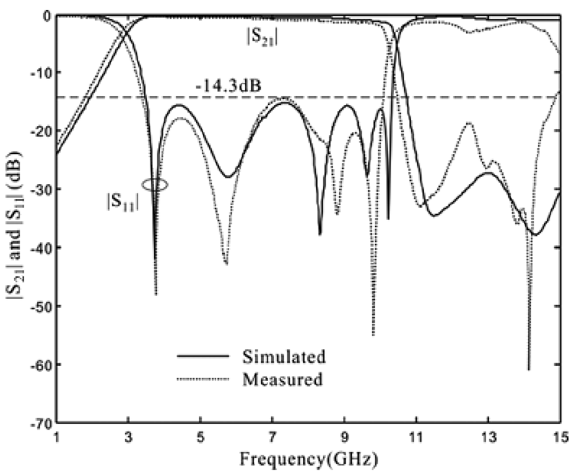

Figure.5. S-parameter plot of UWB Filter with Stub-loaded MMR [4]

In 2009, 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 by using standard printed circuit board fabrication technique and system-on package [3]. 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.

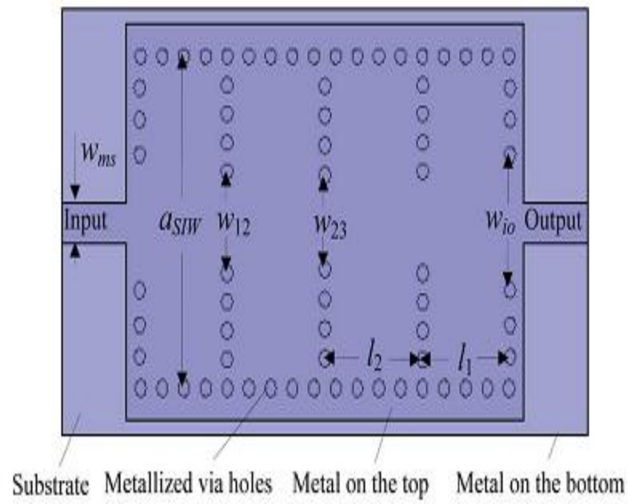

Figure.6. SIW Filter for satellite ground terminal [3]

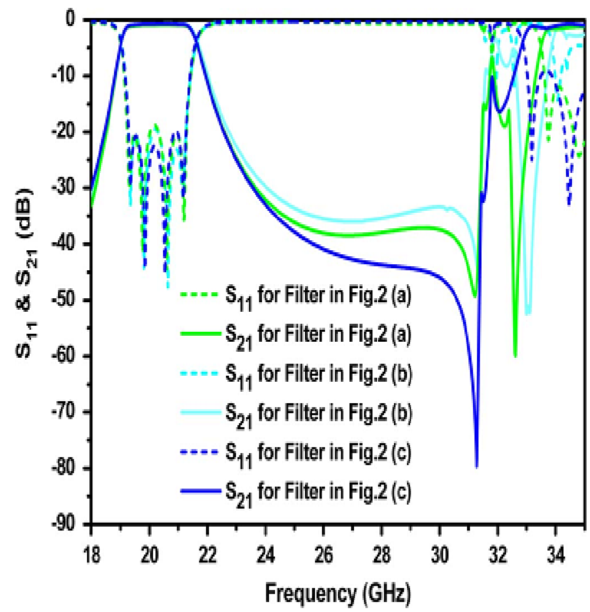

Figure.7. S-Parameter plot of SIW Filter [3]

In case of SIW the conductor losses and radiation losses are also very small as compared to microstrip and strip line. SIW shows excellent immunity to the electromagnetic interference hence used in the microwave and millimeter wave electronics [1]. In 2015, A Novel Ku-band bandpass filter using triple-mode resonator is proposed. This filter has good performance with lower insertion loss, good selectivity and wide stopband shows its application in the radar and communication field. Selectivity and suppression out of band harmonic can be improved by applying transmission zeros to both upper and lower stopband. Broadside-coupled hairpin structure is used to realize an ultra-wideband stopband filter. In this filter adopted triple mode resonator reduced the filter size. Filter has triple transmission poles and two transmission zeros [2].

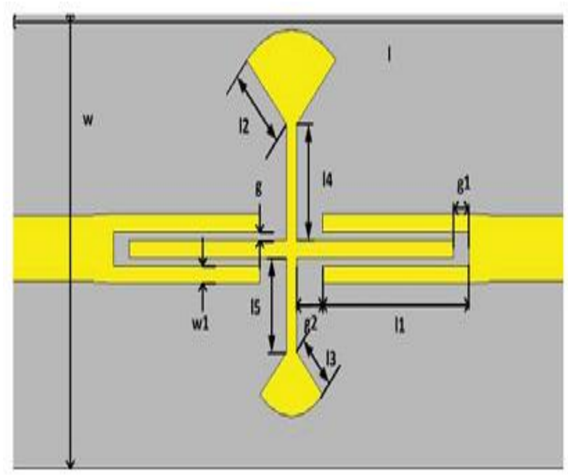

Figure.6. Ku-band Bandpass filter Using Triple Mode Resonator [4]

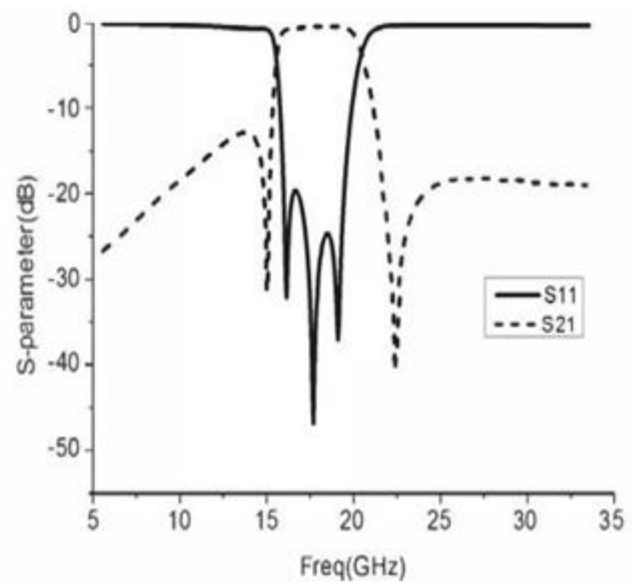

Figure.7. Simulated Result of Ku-band Bandpass Filter [4]

Table.1. shows the result comparison of all the methods discussed in the paper along with result: III. Table 1 Comparison Table of Filtering Methods

S. N O.	Type/Design	Frequency Band	Technology	Results	Advantage
1.	A Novel Ku-band bandpass filter	Ku band 15.6-20.5 GHz	Triple-mode resonator.	S_{11} better than 20 dB; $S_{12=}$ .53dB (approx)	Easy fabrication, Compact size, and good performance.
2.	Bandpass filter for satellite ground terminal	19.2-21.2 GHz	SIW	S_{11} better than 50 dB; S_{12} 0.9dB or better	System on package, miniaturization is possible, low cost, low profile, high performance,
3.	Compact UWB bandpass filter	3.1-10.6 GHz	Stub-loaded multiple-mode – resonator.	S_{11} higher than 14.5dB; $S_{12}<$ 0.8dB; group delay variation < .64 ns	Compact size, widened stopband, small in-band insertion loss.
4.	New elliptic bandpass filter	1.885-2.11 GHz	Microstrip λ/4-Resonator	In band return loss is 23dB.	Passband can be improved by additional resonance.
5.	New Compact bandpass filter	1.99GHz bandwidth 60MHz	Microstrip λ/4-Resonator with open stub inverter	S_{12} 1.32dB in passband	Compact, simpler, low loss.

IV. 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.

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