An Extensive Literature Review on Microstrip Resonator Filter

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Abstract- Address the current mainstream of microwave filters in isolation. The geometrical structures and operational performances of a variety of microwave filters with specific applications are examined. A thorough theoretical analysis of microwave filters is provided. All of the major varieties of microwave filters, including the fundamental low-pass filters like Butterworth and Chebyshev filters, are thoroughly examined and explained. Illustrations and introductions show the transition from low-pass prototype filters to high-pass, band-pass, and band-stop filters. There is a presentation of research on the structures of stepped impedance resonators and asymmetric stepped impedance resonators. Novel multi-standard high performance asymmetric stepped impedance resonator single- and dual-wideband filters with large stop bands have been examined based on the previously described material. Furthermore, a study is conducted on multi-standard high performance triple wideband filters. The suggested filters exhibit great performance and have large bandwidths spanning single or multiple suitable frequency bands, which make them very promising for use in future multi-standard wireless communication applications.

keywords: Microstrip Filter, Low-pass filter, Coplanar Waveguide Filters and stepped impedance resonator.

I. INTRODUCTION

The resonator is the fundamental component needed to create the filter, and the majority of RF and microwave filters consist of one or more connected resonators. Filters can be classified into lumped-element LC filters [1]–[5], planar structure filters like microstrip transmission line filters [6]–[23], coplanar waveguide filters [24]–[28], and so on, and non-planar structure filters like waveguide filters [29]–[30], resonant cavity filters, and so on, based on the various technologies used in filter realization. Regarding the idea, design, and implementation of RF and microwave filters, Cohn, Matthaei, Young and Jones, R. J. Cameron, C. M. Kudsia, and R. R. Mansour are excellent sources of information.

II. COPLANAR WAVEGUIDE FILTERS

The filter design makes use of a coplanar waveguide (CPW) structure as via-holes are not required and it can be easily incorporated into already-existing RFICs on Si substrates. The CPW structure is less susceptible to substrate thickness and substrate dielectric constant than microstrip topologies when it comes to microwave component design.

Instead of utilizing a shunt stub arrangement, series stubs patterned in the center conductor can reduce crosstalk and parasitic radiation in coplanar waveguide based stub systems. However, because they are frequently made to be a quarter-wavelength long, they tend to take up a significant amount of space at low frequencies or on low permittivity substrates. In [24], the idea of folded series stubs is presented as a solution to this issue. Due to the quarter wavelength length of these inner slots at the resonant frequency, a band-stop response from the transfer of a short circuit at point A to an open circuit at point B. The inner slots are only folded back onto themselves twice when using the new method. In doing so, the stub length is essentially decreased from λg/4 to λg/12, and the input port still has the same open-circuit impact. Additionally, the utilization of lumped element capacitors merged with dispersed element, series stubs has decreased due to the bandwidth.

III. LITERATURE REVIEW

A filter with a wide 9GHz bandwidth and just 3.4 dB loss at 40GHz peak transmission was proposed by K.T. Chan [26]. To increase the filter performance, conventional low-resistivity Si is converted to a semi insulating state by an improved proton implantation procedure. In the future, the filter exhibits considerable potential for high-frequency applications as small, low-loss, and inexpensive passive circuits. This is the first example of a high-performance filter operating in the millimeter wave range on silicon using a method that is compatible with existing VLSI technology. A set of filters covering the frequency range of 22–91 GHz was suggested by K. T. Chan in 2003 [27].

The band-stop filter was designed as a double-folded short-end stub structure, whose photographic image is shown in Figure, where the dark area in the photograph is the metal pattern. The bandpass filter is composed of coupled lines to form a series resonator, of which a photographic image is shown in Figure 1. A band-stop response was achieved because the inner slots, at resonant frequencies, convert the corresponding open circuit to a short circuit [24], [25]. By folding stubs and slots in the filter structure, the band-stop filter's double-folded short-end stub shape lowers the filter size.

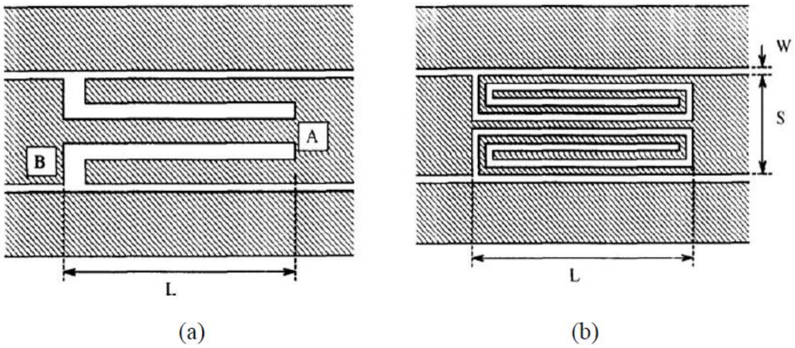

Figure 1 (a) Folded series stubs (b) Folded short-end stubs

The creation of filters has been substantially aided by the quick development of wireless communication networks. New technologies have been developed, and filter design and execution techniques have changed dramatically to enable the creation of current communication systems.

A succinct overview of filter design theory is given, covering the four fundamental filter types' classification based on their attenuation properties, filter design parameters, three classical filter types, four typical filter frequency conversion mechanisms, and other relevant information.

Filters are classified into four fundamental categories based on their features of attenuation: band-pass filters (BPF), band-stop filters (BSF), high pass filters (HPF), and low pass filters (LPF). Figure 2 illustrates the link between the attenuation coefficient and the normalized angular frequency. Here, the normalized frequency of the angular frequency ωc is denoted by parameter Ω= ω/ωc. The cut-off frequency of a low-pass and high-pass filter is represented by ωc, whereas the center frequency of a band-pass and band stop filter is represented by ωc.

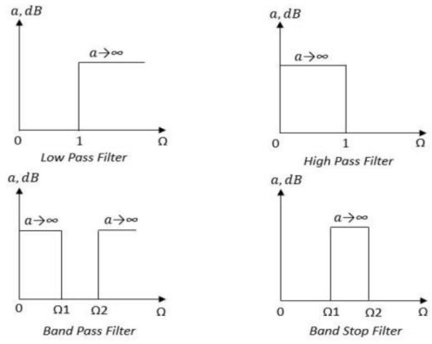

Figure 2. The relationship between the attenuation coefficient and the normalized angular frequency in four types of filters.

It is necessary to take into account the following design characteristics while conducting a thorough analysis of filters [1]:

(a). The filter's operating frequency is called the center frequency.

(b). Insertion loss: Under perfect conditions, there is no power loss in the filter's pass band. However, because of radiation, dielectric, and conductor losses, we are unable to completely remove filter power loss in a practical engineering application. The difference between the response amplitude and the 0 dB standard is quantitatively described by insertion loss L_A [1]: 2011.

$$L_A = 10\,log(P_{in}/PL) = -10log(1-|\Gamma in|^2)\ (1)$$

where PL is the filter load output power, Pin is the input power from the signal source.

Γin is the reflection coefficient observed from the signal source to the filter.

(c) Ripple coefficient: reflecting the flatness in bandwidth.

(d) Bandwidth: for the band-pass filter, bandwidth is defined as the difference in frequency between 3 dB attenuation of upper-side frequency f_{U3dB} and 3 dB attenuation of lower-side frequency f_{L3dB}:

$$BW_{3dB} = f_{U3dB} - f_{L3dB}\ (2)$$

(e) Rectangular coefficient: The ratio of 3 dB bandwidth to 60 dB bandwidth is known as the rectangular coefficient. It explains how steep the filter frequency response curve is in the vicinity of the cut-off frequency.

$$SF = BW_{60dB}/BW_{3dB} = (f_{U60dB} - f_{L60dB})/(f_{U3dB} - f_{L3dB}) \quad (3)$$

(f) The stop-band rejection: a filter can only provide finite attenuation in real-world scenarios, which is correlated with the filter element number. In an ideal world, a filter can give limitless attenuation inside the stop-band. Therefore, engineers typically choose 60 dB as the stop-band rejection design value in real-world scenarios.

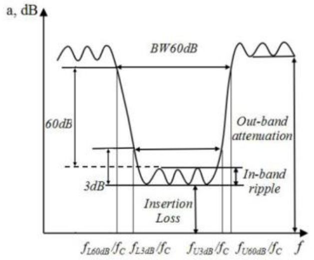

Figure 3.2. The filter design parameters

Figure 3. The filter design parameters

IV. CONCLUSION

A range of microwave filters with different applications are studied in terms of their geometrical structures and operational capabilities. A comprehensive theoretical examination of microwave filters is offered. All of the main types of microwave filters are covered in detail, including the basic low-pass filters like Butterworth and Chebyshev filters. The progression from low-pass prototype filters to high-pass, band-pass, and band-stop filters is depicted in illustrations and introductions. Research on the stepped impedance resonator (SIR) and asymmetric stepped impedance resonator (ASIR) architectures is presented.

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