Chapter 7
Study of Some New Topologies and Associated Techniques Used for the Achievement of Planar Filters

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ABSTRACT

This chapter will treat firstly a summary of the filters synthesis by using Butterworth and chebyshev techniques. After that, a second part will be devoted to the design of planar filters using different techniques; this section will present some examples in bibliography. The aim of this part is to understand the different methods and steps followed to design planar filters, in the same time to discover and to define the different parameters which characterize a filter structure. Therefore, we have chosen some new research studies on low pass filers. The last part will present our contribution in designing planar filter. The first filter structure is a dual bandpass microstrip filter operating for DCS and Wimax applications, this section will introduce the different steps followed to achieve such filter. The second circuit is a novel design low cost microstrip lowpass filter with a cutoff frequency of 2.3 GHz. At the end, we will present a transformation of the microstrip filter to a CPW lowpass filter making it easy for integration with passive and active microwave components.

INTRODUCTION

Microwave system consists of a number of components including filters; they are capable of passing a specific frequency band and suppressing the undesired signals. Recent research on microwave filters is very active because of continuous demands of high-performances circuits for modern wireless communication and electronic systems.

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In recent years, filters have become important components for wireless communication products for microwave frequency bands. For example, global systems for mobile communications, wireless local area network (LAN) and the unlicensed industrial-scientific-medical (ISM) (Miyake, Kitazawa, Ishizaki,Ymanda, & Nagatomi,1997; Kuo, Yeh, & Yeh, 2005; Zhang, Chen, & Xue, 2007; Hong, 2011; Ishii, 1995).

To design such circuits, many techniques and steps are followed (Pozar, 1998; Zverev, 1967; Hong & Lancaster, 2001; Borazjani & Rezaee, 2010; Martin, et al., 2003; Sor, Qian, & Itoh, 2001; Hayati, Sheikhi, & Lotfi, 2010; Xu Ji, Wu, & Miao, 2013; Velidi & Sanyal, 2011; Ma & Yeo, 2011; Wang, Xu, Zhao, Guo, & Wu, 2010; Chen, 2014;Wang, Lin, & Chen, 2004; Kuo, Hsu, & Huang, 2002; Velázquez-Ahumada, Martel, & Medina, 2004). Let's start with the conventional design procedure for microstrip lowpass filters (LPF) which consists mainly of two steps, the lowpass prototype circuit and after that looking for a microstrip achievement that will give nearly the lumped-element filter response (Chen, Sung, & Su, 2015). Generally, passing from lumped elements to microstrip configuration is often simple to reach. Microstrip filters have many adavantages as compact size, sharp roll-off, and wide stopband which are the current trends in the design of microstrip LPFs (Karimi, Lalbakhsh, & Siahkamari, 2013;Wang, Xu, Zhao, Guo, & Wu, 2010). Due to the inherent characteristics of a microstrip line, conventional designs of microstrip LPFs fail to satisfy the requirements of compact size and wide stopband (Hong, 2011). To meet the requirements, recent studies mainly resort to specially designed resonators for realizing their respective equivalent circuit models (Karimi, Lalbakhsh, & Siahkamari, 2013; Wang, Xu, Zhao, Guo, & Wu, 2010). In some studies the two-steps procedure is discarded and each filter structure design is based on many methods and techniques of tuning or optimization. All that make these kind of filters so harder to be designed and fabricated by designers in comparison with the conventional microstrip filters like stepped-impedance LPFs and open-stub LPFs (Hong, 2011). Among the challenge for designing LPFs, we find many studies looking for achieving these kind of filters with wide stopband (Lui, Xu, & Xu, 2015).

However, such filters inherently have a spurious response. Working to resolve this problem, many techniques have been developed and presented (Xue, Shum, & Chan, 2000; Chen & Xu, 2010; Gao & Zhu, 2004; Kim & Yun, 2005). Firstly, we find the use of microstrip resonant cell, based on one-dimensional photonic bandgap cell, presents slow-wave behavior and stopband characteristics. Another technique is the introduction of a defected ground structure into the LPFs structure can present a wide stopband response. Studying other research papers, we can find that the use of the asymmetric parallel-coupled co-planar waveguide stage and the stepped-impedance resonator can enlarge the stopband of the LPFs. The most used configuration is the microstrip hairpin, because for its advantages illustrated in the small size and it is simple for achievement and fabrication. As an example of these kind of filters, we have the elliptic-function LPF (Hsieh & Chang, 2003; Raphika, Abdulla, & Jasmine, 2014) using a multiple cascaded stepped impedance hairpin permitting to reach a sharp cutoff frequency response and low insertion loss.

After introducing LPFs, we pass to the bandpass filter which is an essential component in microwave communication systems, this kind of circuit can be used for receivers and transmitters. Therefore, the design of this microwave filter must take into account many characteristics that the designer must respect. Looking in bibliography for different techniques used for developing bandpass filters, we find firstly, the parallel-coupled microstrip (Abbosh, 2012; Ferh & Jleed, 2014) which is the most popular filters in communication systems because it presents some advantages like the easy fabrication, the known