Chapter 6
The Design of New Structures of Planar Diplexers Using Microstrip Resonators

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ABSTRACT

In this chapter, three planar diplexers based on microstrip resonators are presented. An overview on diplexers is introduced. Then, two designed and fabricated microstrip diplexers with compact size and good performances are exposed. The first diplexer is designed using open loop resonators while the second circuit is achieved based on triangular loop resonators. The third structure represents a compact diplexer designed by using a pair of H-shaped resonators coupled with a coupling patch and two Input/Output (I/O) feed lines. The incorporated slots in the ground plane of the proposed circuit allow the control of the resonant frequencies and enhance its electrical performances. Furthermore, the introduction of these slots represents an interesting solution to miniaturize the microwave filter and diplexer. An analytic method is applied to extract the equivalent LC model of the band pass filters and diplexer. A full wave electromagnetic Analysis is achieved to evaluate the electrical performances of the proposed diplexers by using ADS and CST-MWS.

INTRODUCTION

Microwave and RF filters and diplexers play an important role in the modern wireless communication applications. They are widely used in many microwave applications for selecting or confining the signals within specified spectral range. Microwave filters are two ports circuits that permit a good transmission of the required frequencies while rejecting the unwanted signal frequencies. Diplexer represents another

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application of the filters; this component is a three ports device that can separate different frequency bands. As shown in the Figure 1, this circuit is achieved by connecting two filters with different center frequencies (Matthaei, Young, & Jones, 1963). Thereby, it allows to a single antenna to be shared simultaneously by a transmitter and a receiver operating on different frequency bands (Pozar, 1998).

Diplexer is a key component in many microwave communication system, including wireless communications system, radar systems, cellular phones and satellite communication systems. Diplexers were widely studied in the early 1960's by (Matthaei & Cristal, 1965; Matthaei, Young, & Jones, 1963; Wenzel, 1968). Many approaches are possible to design a diplexer based on different filter configurations such as low pass and high pass filters, two band pass filters or band pass and band stop filters (Yao et al., 1993).

The proliferation of the modern wireless communication systems, radar and satellite systems have boosted the demand of microwave and RF filters and diplexers. In this context, the development of highly selective planar filters and diplexers with low loss levels, compact size and low cost is currently a research area of fundamental interest. In recent years, the research activity was greatly devoted to the study of planar structures. Thanks to their low cost, lightweight and small size, these structures are capable of being fully integrated with the active circuits. However, their main drawback is a poor unloaded quality factor that results in poor selectivity and serious insertion losses.

It is obvious that resonators represent the basic components to design a filter. Thus, several microstrip resonators have been proposed to design (BPFs). One of these resonators is the U-shaped hairpin line resonator which was used by (Srisathit et al., 2005) to design diplexers with high isolation. Thanks to their compact and small size, the microstrip open loop resonators were introduced in order to design filters and diplexers (Hong, Shaman, & Chun, 2007; Konpang, 2009). The hybrid resonators proposed by (Yang, Chi, & Itoh, 2010) were also used to achieve diplexers. Besides, due to the possibilities they can offer to control the spurious response, to reduce the insertion losses and the overall size of the circuit, stepped impedance resonators (SIRs) are the most popular resonators utilized to achieve band pass filter and diplexers (Sheta, Coupez, Tanne, Toutain, & Blot, 1996).

Figure 1. A block-diagram of the diplexer