Abstract

Microwave filters are used in every application of modern communication systems such as radar, wireless communications, radio astronomy, navigation, sensing, and medical instrumentation. The advancements have created the need for microwave filters with more stringent specifications. In order to fulfil these requirements, this thesis presents the analysis and design of high performance microwave bandpass filters designed in substrate integrated waveguide (SIW) technology. The optimization based synthesis method is presented to realize a practical coupling scheme of bandpass filters with desired frequency response. The synthesized result is validated by designing a third-order SIW bandpass filter. Following that, a planar mixed electric and magnetic coupling structure on a single-layer SIW is implemented by introducing three slotlines on the top layer of the SIW cavities. The coupling structure is applied to design bandpass filters with superior selectivity in comparison to filters designed using conventional methods. Another coupling structure is presented by introducing a short-circuited coplanar line between two SIW cavities to realize the desired coupling of TE_{101} and TE_{102} modes of the SIW cavity which is used to design dual-band and wide-stopband bandpass filters. Moreover, a slotline perturbation is introduced to the cavity to adjust the second passband of the dual-band filter. Furthermore, the short-circuited coplanar line is used as a resonator, and a compact three-pole bandpass filter with wide-stopband characteristic is presented. Single- and dual-band bandpass filters with independently tunable passbands using a single perturbed SIW cavity are proposed in order to reduce the overall size and improve the design flexibility of the filters. Finally, a compact SIW cavity resonator is proposed by bisecting the standard SIW circular cavity to obtain further size reduction. The size of the proposed cavity is reduced by 93.75% in comparison to standard SIW circular cavity. The proposed cavity resonator is used to design several compact bandpass filters. The designed filters are fabricated and measured in order to validate the approach presented in the thesis. The filters can be used for mobile satellite services, ISM band applications, wireless networks, radar systems, and space communication applications.

Keywords: Bandpass filters, coupling matrix, dual-band, filter synthesis, frequency-dependent coupling, mixed coupling, substrate integrated waveguide (SIW) cavity, wide-stopband