Abstract

Microwave passive component functions such as dividing and coupling power, filtering, switching, attenuating, and terminating high-frequency signals have been in existence for more than half a century. But surprisingly, they have enjoyed explosion in technological advances only in recent years. Researches are going on to minimize implementation area, increase component bandwidth, and other improved performances. Here, twelve novel designs of several printed components are presented which are superior in performances than corresponding published designs.

Studies are carried out on different types of planar passive components. Slotted ground plane structures (also known as defected ground plane structures), complementary split ring resonators and parallel coupled-line with ground plane aperture are employed for performance improvement of the components. Signal interference technique has been applied to design bandpass as well as bandstop filters. A new concept is used to design reduced length rat-race couplers. Finite difference time domain (FDTD) method, lossless transmission line model and commercial full wave simulator like Zeland's IE3D® have been used to analyze the structures. FDTD has been chosen over other full wave methods because of its efficiency, simplicity and easier implementation. MATLAB® is used to implement FDTD codes.

Some of the printed components presented in this thesis are listed below.

1. ***A Compact Defected Ground Structures (DGS)*:** A new compact slot geometry is presented to serve as a DGS unit element for the microstrip lines. It consists of a main slot; just beneath the microstrip line having its ends joined to 'H' shaped slots. A three pole lowpass filter has been designed using a cross-junction open-stub as an application example. The filter has the advantages of low passband insertion loss, compactness, sharp cutoff and wide rejection bandwidth.

2. ***Lowpass Filter Based on Complementary Split Ring Resonator (CSRR)*:** A new technique has been presented to design a lowpass filter unit using CSRRs. The filter has the advantages of low passband insertion loss, compactness and extremely sharp cutoff.

3. ***Improved Harmonic Suppression of a Patch Antenna*:** Harmonic suppression is an important factor for active microstrip patch antennas radiating harmonic frequencies. A novel compact low pass filter having high filter selectivity and wide stopband is used on the microstrip

feed line of a patch antenna. The fundamental antenna operating frequency falls in the passband of the lowpass filter. Other harmonics fall in the filter stopband and thus attenuated. An example shows up to fourth harmonic are suppressed while total occupying area remains compact.

4. ***Design of Ultra Wideband Filters (UWB)*:** The broadband characteristic of a Microstrip to slot line transition has been used for a UWB bandpass filter design. The filter structure is based on a pair of etched slots in the ground plane of a parallel microstrip feeding arrangement. Further, a simple stub modification is used to take care of higher harmonics.

5. ***Wideband Bandpass Filter Using Broadside Coupled Structures*:** Two quarter wavelength microstrip open-stubs with a shorted slot line resonator etched in the ground plane has been used to design a compact wideband bandpass filter. Wideband characteristics are obtained using broadside-coupling between the stubs and the slot line. 3-dB fractional bandwidth is varied by simply changing the coupled line widths.

6. ***Design of Sharp Rejecting Wideband Bandpass Filter*:** A novel design of wideband bandpass filter having extremely sharp rejection characteristic is presented. Two quarter wavelength long parallel-coupled microstrip lines at the desired passband center frequency are used as the basic filter element. Two half wavelength shunt open-stubs are connected to the input and output points of the parallel-coupled lines respectively. These shunt stubs are used to control the filter transmission response as well as to obtain two finite transmission zeros on both sides of the passband. Design graphs are obtained by even and odd-mode analysis.

7. ***Design of Bandstop and Bandpass Filters Using Signal Interference Technique*:** Two transmission paths of different characteristic impedances and electrical lengths have been used for signal interference. It has been shown that the same structure can be used for band stop as well as bandpass filter design. Further, two open-stubs have been used to improve rejection band characteristics. Simple transmission line models are used for filter analysis.

8. ***Reduced Length Rat-Race Hybrid Ring:*** Solutions are obtained for a rat-race coupler having the three equal arms of arbitrary electrical lengths by even and odd-mode analysis. These couplers have lower characteristic impedances than the conventional 1.5λ coupler and some of them have smaller electrical lengths. Bandwidths in terms of isolation, matching, amplitude and phase imbalances are also studied.

9. ***Dual-Band Rat-Race Hybrid Ring:*** It is shown that dual-band characteristics can be obtained by using only two shunt open-stubs with a conventional coupler.

10. ***Dual-Band Quadrature Hybrid with Enhanced Bandwidth:*** It is shown that dual-band characteristic can be obtained by using an additional transmission line section with the conventional branch line quadrature hybrid. Even- and odd-mode analysis has been carried out to obtain solutions for the electrical lengths and impedances of different branches. This coupler features enhanced bandwidth.