ABSTRACT

The microstrip antenna has received considerable attention in the area of microwave and millimeter wave communication because of its many unique and attractive properties such as having low profile, light weight, easy fabrication and suitability of mass production. It has been found suitable due to compatibility with solid state devices in addition to diversified applications in satellite communication, radar, missile and other strategic defense equipments. However, the patch antenna is associated with some advantages of narrow bandwidth with single band, poor radiation and low gain.

In view of this, dualband microstrip antennas with different patch geometries have been investigated to minimize the shortcomings of the antenna. Such antennas can give very promising results that establish it as a versatile antenna in the broad field of microwave community.

In the opening chapter, the patch antenna has been described along with advantages, limitations and its relevance in many areas. A brief historical review has been given on the topic of the thesis.

The methods of analysis are presented in the second chapter. The entire investigations for the dualband microstrip patch antennas have been made employing circuit theory concept which is derived from the cavity model. Therefore, only cavity model is described in detail along with the network presentation and radiation characteristics of the patch antenna.

Chapter 3 presents, microstrip patch antenna loaded with two symmetrical vertical notches and shorting pin is introduced for dualband operation using circuit theory concept based on modal expansion cavity model. It was observed that on increasing the width of notches from 1 mm to 3 mm, no variations are observed at lower resonance frequency
but there is slight variation on higher resonance frequency. It is also observed that on increasing the distance between the notches from 1.5 mm to 5.5 mm, the lower resonance frequency remains almost constant whereas higher resonance frequency shifts towards higher side. This means that current distribution across the notches width and length varies as a variation in higher resonance frequency are obtained and there is no change in current distribution along normal to patch. It is found that the antenna resonates at 2.84 GHz and 6.33 GHz for upper and lower resonance frequencies respectively. The bandwidth of the compact notch loaded antenna at lower resonance frequency is 9.94% (theoretical) and 6.67% (simulated) whereas at upper resonance frequency, it is 12.99% (theoretical) and 11.59% (simulated). The compact notch loaded antenna characteristics are compared with other proposed radiating structures.

In chapter 4, the analysis of dualband L-strip fed compact semi-circular disk microstrip patch antenna has been presented using circuit theory concept. The antenna parameters such as return loss, VSWR and radiation pattern are calculated. The effect of geometric dimensions of the proposed antenna, such as length of vertical and horizontal portion of L-strip is also investigated. The variation of reflection coefficient with frequency on increasing the width of the L-strip higher resonance frequency shifts towards lower side whereas lower resonance frequency remains almost constant. It is found that antenna resonate at two distinct modes i.e. 1.3 GHz and 6.13 GHz for lower and upper resonance frequencies respectively. The bandwidth of the proposed antenna at lower resonance frequency is 6.61% (simulated) and 10.64% (theoretical) whereas at upper resonance frequency, it is 6.02% (simulated) and 9.06% (theoretical). The theoretical results are compared with IE3D simulation results as well as experimental results and they are in close agreement.
Chapter 5 presents, an analysis of microstrip line fed antennas theoretically using circuit theory concept. The theoretical investigations of F-shape antenna parameters such as return loss, VSWR, gain and efficiency have been calculated. The antenna parameters depend on length of microstrip line, on increasing the length from 15 mm to 15.5 mm, lower and higher resonance frequencies shift towards lower side while on further increasing length up to 16.5 mm, multi-band is obtained as well as it also depends on width of microstrip line, height of the dielectric substrate and dielectric constant of the substrate. It is found that antenna resonates at 2.4 GHz and 5.2 GHz for lower and upper resonance frequencies respectively. The bandwidth of the F-shape antenna at lower resonance frequency is 20.08% (simulated) and 17.05% (theoretical) whereas at upper resonance frequency, it is 5.93% (simulated) and 5.78% (theoretical). The characteristics of the F-shape antenna are compared with other microstrip line fed antennas. It is found that F-shape antenna is linearly polarized along the $x$ direction. The theoretical results are compared with IE3D simulation results as well as reported experimental results and they are in close agreement.

Chapter 6 contains analysis of slot loaded compact rectangular patch antennas using circuit theory concept. The theoretical investigations of L-strip fed slot loaded compact rectangular microstrip patch antenna parameters such as return loss, VSWR, radiation pattern have been calculated. It is observed that an antenna characteristic depends on length of slots thickness $S_1$, $S_2$ and $S_3$ i.e. on decreasing the thickness of slots from 1.0 mm to 0.5 mm lower and higher resonance frequencies shift towards higher side, while on increasing the thickness of slot from 1.0 mm to 2.0 mm, lower and higher resonance frequencies shifts towards lower side whereas on varying the length of slot $S_1$ and $S_3$ from 24 mm to 12 mm, lower and higher resonance frequencies shift towards lower side while frequency ratio of the antenna remains unchanged. It is found that antenna resonates at 2.95 GHz and 6.01 GHz for lower and
upper resonance frequencies respectively. The bandwidth of the L-strip fed slot loaded compact rectangular microstrip patch antenna at lower resonance frequency is 1.16% (simulated) and 10.16% (theoretical) whereas at upper resonance frequency, it is 1.5% (simulated) and 2.51% (theoretical). The characteristics of the L-strip fed slot loaded compact rectangular microstrip patch antennas is compared with other rectangular patch antennas. Circuit diagram of this antenna is proposed, fabricated and simulated using AWR circuit simulator. The theoretical results are compared with IE3D and AWR simulation results along with measured results and they are in close agreement.

In chapter 7 the summary and conclusions of the thesis is presented. A significant achievement in radiation pattern, efficiency and gain has been received from the proposed antennas. From the investigation it is clear that dualband microstrip patch antenna has numerous advantages as compared to other microstrip antennas. The effect of various types of feeding techniques and using the different active devices can be used to further increase the utility of such kinds of antennas.