Dual-Mode Microstrip Antennas with Increased Bandwidth

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Microstrip antennas are widely used in wireless communication systems like satellite navigation and radio frequency identification (RFID) since they are low profile, easy to fabricate, and easy to feed. Limited by their resonant nature, microstrip antennas typically have a comparatively high quality factor (Q) and therefore a narrow bandwidth. Microstrip antennas with an increased bandwidth are proposed here using a dual-mode resonance. The design of a linearly polarized microstrip antenna having an increased bandwidth that is due to a dual-mode resonance is proposed first. Then, using an array composed of two of these patches rotated by 90^{o} and fed 90^{o} out of phase, a circularly polarized dual-mode resonance microstrip antenna is obtained.

The linearly polarized dual-mode microstrip antenna consists of a nearly square patch antenna fed near the diagonal. The antenna layout is very similar to that of the conventional circularly polarized microstrip antenna that is also nearly square and fed on the diagonal. However, the design goal and optimum patch dimensions are different. Instead of choosing the ratio of patch dimensions and the feed location to achieve the best circular polarization, the ratio of patch dimensions and feed position are optimized to obtain the largest possible bandwidth, without regard to polarization. This results in an antenna that has a bandwidth that is about 3.5 times that of a traditional linearly polarized patch antenna on the same substrate. However, as the frequency changes, the direction of the linear polarization radiated at broadside changes. This happens because the dual-mode resonance causes the current flow on the patch to shift from the TM_{10} mode to the TM_{01} mode as the frequency changes. For some applications the changing polarization might be acceptable, whereas for others it is not.

The circularly polarized dual-mode microstrip antenna consists of two identical linearly polarized dual-mode patches designed as described above. The two patches are rotated by 90^{o} and fed 90^{o} out of phase. Each patch radiates a linearly polarized field that rotates with frequency. However, when the radiated fields from both patches are added together, the total field radiated at broadside is a circularly polarized field that retains a nearly perfect circular polarization for all frequencies.

A simple CAD formula is developed to approximately describe the optimum ratio of patch dimensions, to aid in the design of the structure. An efficient scheme for analyzing the structure is also developed, to reduce simulation time in the final optimization.