DEFECTED GROUND STRUCTURE FOR USE IN PHASE SCANNING MICROSTRIP ANTENNAS

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In recent years, an increasing number of publications concerning the use of periodic structures in the form of photonic bandgap structures have been presented as a means to minimize surface wave excitation to enhance radiation characteristics of antennas and minimize losses within microwave circuits, or as alternatives to reduce the size within microwave circuits. A periodically defected ground plane is one such structure.

It is desired to investigate the phase scanning potential of a periodically etched structure in the ground plane beneath an antenna. Initial studies by the above authors involved the simulation of circular ground plane perforations beneath a microstrip patch. A phase shift of 80º in the far-field phase at the point of maximum gain was realized for the largest perforation radius. However, only a perforation size of 10% of the resonant length of the patch achieved a satisfactory return loss at the design frequency, corresponding to a 30º phase change at the point of maximum gain in the far-field (Leili Shafai, *et al.*, *ANTEM*, 471-474, 2002).

Multiple perforations in the ground plane beneath the patch in vertical (*y*-axis) and horizontal (*x*-axis) configurations produced increased phase change, but with differing results, indicating that the change in phase is dependent on the location of the perforation beneath the microstrip patch. Perforation combinations provide the greatest phase change in the far-field when placed where the current magnitude is greatest. Increasing the number of perforations along this direction consistently impinges along a new set of currents within its path, and thus has significant effects on the properties of the patch. In the orthogonal direction the effect was minimal.

When loading the patch with ground plane perforations, the resonance of the structure was affected. With a microstrip transmission line, this effect is equivalent to a change in propagation delay and thus a phase change. Extensive studies of perforations beneath a transmission line included variations in the dimensions of a single perforation, as well as studies involving dielectric constant, substrate thickness, line impedance, and frequency. With small non-radiating perforations, the maximum usable differential phase was 20º, and the insertion loss remained similar to that of the initial transmission line. Multiple ground plane perforations (or slots) provided increasing phase shifts, nearly proportional to their number. Since such a transmission line phase shifter structure does not alter the antenna radiation properties, and does not add to the complexity of an antenna array, it is now being investigated as a technique for implementing phased arrays and their beam scan. Details of the study will be provided during the presentation.