Parametric Study of Dielectric Resonator Antenna Arrays for Waveguide-Based Spatial Power Combining Using FDTD

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A finite-difference time-domain (FDTD) method is used to analyze waveguide-based coaxial probe-fed dielectric resonator antenna (DRA) arrays for use in spatial power combining systems. First, a rectangular waveguide with hard walls (dielectric loading along narrow sides of the waveguide) is analyzed to achieve a uniform field distribution in the waveguide cross-section. This is important for the waveguide-based DRA array in order to provide a uniform (with respect to magnitude and phase) excitation of antenna elements. Next, a single DRA element is studied for operation in the waveguide environment. The input impedance and scattering parameters are studied by varying geometrical and material parameters of the DRA and the coaxial probe feed. The analysis is further extended to the case of the DRA array in order to minimize mutual coupling between antenna elements and provide a uniform coupling of the power to individual DRA elements. The analysis provided the necessary information for the optimization of design parameters such as inter-element spacing and the distance of the array to the waveguide hard walls. This analysis makes it possible to improve the designs of spatial power combiners for optimum array spacing and geometry. The numerical results obtained using our FDTD code that is based on region-by-region approach are compared with those obtained using a commercial three dimensional (3-D) software and exhibit very good agreement.