Broadband, High Efficiency Dielectric Resonator Antenna Array for Satellite Communication

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Satellite communication systems typically rely on a reflector antenna and a high efficiency horn-type feed. The feed has a fixed beam and the antenna must be mechanically pointed at a source of interest. For mobile applications, a moving source can be tracked over a limited angular range by a phased array feed. Phased array feed systems can enhance the tracking rate of a mechanically steered dish, correct for mount misalignment and mispointing, and compensate for changes in the environment that degrade signal quality as well as improve the signal to noise ratio for a given dish aperture area.

We report on the development of phased array feed antennas with characteristics suitable for satellite communications applications. For satellite communications, high antenna efficiency is paramount, but for some services, wide bandwidth is also important. Achieving both high efficiency and broad bandwidth with a phased array antenna is challenging and requires careful attention to the design of array elements. One possible technology for the elements of a phased array feed is the dielectric resonator antenna (DRA). DRAs can be designed in various shapes which can be either low profile or compact size to suit a wide range of physical or electrical requirements. There are many feeding options that can be used to excite the DRAs, such as aperture feed, probe feed, microstrip feed, coplanar feed, and dielectric image guide feed. By carefully choosing appropriate feeding mechanism, we can achieve a wide bandwidth compared to conventional antennas such as patch antennas or dipoles. DRAs can also maintain high radiation efficiency, even at millimeter-waves frequencies due to the lack of surface wave losses and minimal conductor losses.

Two types of passive dielectric resonant antenna arrays were simulated by commercial full wave simulator (HFSS) combined with an in-house physical optics reflector model. The fabricated antennas were characterized using on-reflector SNR tests with a television broadcast satellite and comparisons to commercial horn-type feeds. The first design was an ultra-wideband dual port antenna array with impedance bandwidth of 10 GHz. The second design is a high efficiency dual port antenna array with modeled on-reflector aperture efficiency 72%, spillover efficiency 91%, and total radiation efficiency 88%. On-reflector experimental tests of this antenna and two commercial horn feeds show that the SNR differences are within 4-5 dB. In future work, these passive phased array feed antennas will be integrated into a steered phase array feed system to steer the beam electrically while maintaining high quality signal over a wide bandwidth.