Reconfigurable reflectarrays are a class of antennas that combine the advantages of traditional parabolic antennas and phased array antennas. Similar to phased arrays, reflectarrays utilize a planar array of radiating elements. Each element is excited by a feed horn which illuminates the array aperture as in parabolic antennas. Chapter 1 discusses the basic operational theory of reflectarrays and their design. A review of previous research and the current status is also presented. Furthermore, the inherent advantages and disadvantages of the reflectarray topography are presented.

In chapter 2, a reflectarray utilizing a single resonant element is discussed. While continuous beam scanning was realized at Ka-band, the scanning range was limited and the efficiency low. The operational theory of dual-resonant array elements is introduced utilizing Q theory. An equivalent circuit is developed and used to demonstrate design tradeoffs. The design procedure of a varactor tuned dual-resonant unit cell operating at X-band is presented. Detailed analysis of the design is performed by full-wave simulations and verified via measurements.

In chapter 3, the element is re-designed for array spacing. The effects of varying angles of incidence on the array element are studied using Floquet simulations. Emphasis is laid on the varying responses between each radiating structure as the angle of incidence increases. The beam scanning, cross-polarization and bandwidth performance of a 7×7 element reflectarray is analyzed using full-wave simulations and verified via measurements.

In Chapter 4 a loss analysis of the array element is performed. Major sources of loss are identified utilizing full-wave simulations and an equivalent circuit is utilized to optimize the loss and improve bandwidth performance. A design synthesis procedure is presented to derive a physical model from the optimized equivalent circuit model. Finally, the dual-resonance unit cell is modified to support two linear polarizations.

Overall, the operational and design theory of dual resonant reflectarray unit cells using Q theory is developed. A valuable equivalent circuit is developed and used to aid in array element design as well as optimize the loss and bandwidth performance. The proposed theoretical models provide valuable physical insight through the use of Q theory to greatly aid in reflectarray design.

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The public is welcome to attend.