A Novel X-Band Optically Tunable Transmission Surface Based on Lumped Element Optoelectonic Components

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This work presents a method for optically tuning the transmission properties of a surface that is designed to fit a whole number of unit cells over the cross section of a WR-90 waveguide. The structure consists of a periodic array of electrically small gaps in a copper sheet over a thin RT 6002 substrate. These gaps are then covered with a small patch that is connected to the main copper sheet through a series of pin diodes and phototransistors. These phototransistors allow the pin diodes to be biased, based on an input from an optical source such as a laser or projector. The biasing of the pin diodes may be used to switch the surface between ON and OFF transmission states.

The presentation begins by discussing the theory behind the surface using a simple gap as a canonical analogue. Next the geometry of the unit cell is given and key dimensions highlighted, with an emphasis on the electrically small nature of the surface. Simulation results are presented for the case of an ideal pin diode using both Feko and HFSS solvers for validation to demonstrate the potential tunability of the surface from 7 to 12 GHz. Next, HFSS results are given using realistic values for the pin diode equivalent circuit, and the effects of these non-ideal values on the circuit are analyzed. These simulation results are verified through physical transmission measurements of the surface placed over a section of WR-90 waveguide, which approximates an infinite periodicity though the images of the surface due to the waveguide walls. The simulation data are then used to extract further information on the surface, such as the mutual coupling between adjacent cells, and the potential uses for this structure are discussed.