ABSTRACT

Leaky wave antennas (LWA) radiate from the fast waves propagating along a guided structure. LWAs can be classified as either uniform or periodic type. In contrast to uniform LWAs, which radiates only in the forward quadrant, a periodic LWA offers beam scanning from backwards to forward direction with frequency sweep. It has received much attention in recent times due to their low profile, high directivity, simple feeding and frequency scanning capability. However, traditional periodic LWAs suffer from open stopband problem in the broadside direction. In this thesis, the n = -1 fast spatial harmonic is used to design a backward to forward scanning Substrate Integrated Waveguide (SIW) based periodic LWA. Use of H-plane steps and longitudinal slot provides series inductive and shunt capacitive loading, respectively, thereby suppressing the broadside open stopband. A second antenna configuration based on microstrip line is designed for backfire radiation from the n = - 1 mode. Use of periodic open stubs on the top plane and periodic rectangular slots in the ground plane aligns the radiating electric field on the top and bottom side of the antenna. The alignment helps to obtain perfect backfire beam. For both the antennas, Taylor amplitude tapering is used to reduce the side lobe level. In the third configuration, a Complementary Split Ring Resonator (CSRR) based unit cell is used to design a periodic LWA for fixed frequency beam scanning applications. The unit cells are loaded with switchable stubs to control the propagation constant and hence the main beam angle at a fixed frequency. Further, a second set of series PIN diodes control the beamwidth. Finally, a microstrip line loaded with periodic stepped impedance open-stub is presented for dual-band backfire operation using radiation from both the n = -1 and n = -2 modes. Stub periodicity and impedance steps control the operating frequencies. For all of the designs, transmission line model and dispersion curve based analysis are presented. All the configurations are fabricated and measured validating the simulated results.

Keywords: Backfire, broadside, dual-band, fixed-frequency, leaky wave antenna (LWA), microstrip, electronically reconfigurable antennas, substrate integrated waveguide (SIW), tunable beam-width.