Ultra-Wideband, Compact, and High-Gain Slot Antenna System for Full-Duplex Applications

S. Mohammad Amjadi and Kamal Sarabandi
Radiation Lab, Electrical Engineering and Computer Science Department,
The University of Michigan, Ann Arbor, U.S.A.

A broadband, dual-polarized, and common-aperture 2×2 Cavity-Backed Slot Antenna (CBSA) array with very high level of port isolation for enabling full-duplex wireless communication is proposed. The antenna consists of a thin rectangular cavity appropriately loaded with metallic septa to excite multiple resonances of similar desired field distribution to achieve consistent radiation characteristics over a wide bandwidth. Four pairs of concentric orthogonal radiating slots are cut out on one of the broad-walls of the cavity all of which are fed by two concentric orthogonal slots on the opposite broad-wall of the cavity. A common antenna aperture is used by both Tx and Rx as the radiating aperture which results in a higher gain for a given available area. High isolation is achieved using orthogonal polarizations and a symmetric structure. The cavity is fed by a compact end-launch coaxial-to-waveguide transition to excite one of the channels. The transition is designed to generate a symmetric field distribution across the cavity feeding slot. The other channel is excited by a two-pronged microstrip line symmetrically crossing over the other cavity feeding slot. Due to the out-of-phase coupling from the two prongs of the microstrip line to the other port, this type of excitation is shown to provide an unpredicted level of isolation between the two ports over a wide bandwidth. The proposed decoupling method does not require any kind of hybrid and can potentially provide nearly $90\,\mathrm{dB}$ of channel isolation over 44% fractional bandwidth as shown by simulation. A low-loss air-dielectric microstrip feed is designed which can be integrated with the other parts of the antenna and is amenable to 3D printing technology. To achieve a high-efficiency and fabrication accuracy of this complex architecture, the antenna is 3D printed out of HP PA12 Nylon and is then metalized by silver spraying technology. Keeping its size smaller than $1.3\,\lambda_L \times 1.3\,\lambda_L \times 0.27\,\lambda_L$ (where λ_L is the free space wavelength at the lowest frequency), and its weight less than 70 g, the fabricated antenna provides a minimum isolation of $55\,\mathrm{dB}$ from 4.8 to $7.5\,\mathrm{GHz}$ (44% fractional bandwidth). This is the highest fractional bandwidth reported to date for this level of isolation and for this antenna size. A minimum gain of 10 dB for both polarizations and a minimum polarization isolation of $20\,\mathrm{dB}$ is measured within the main beam over the entire band.