Investigation of Multi-octave Wideband Cavity-Backed Vivaldi Array Antennas

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Abstract

Modern wireless communication systems often rely on high throughput transmission links established with compact size, easily concealed wideband antennas. With the congestion of the electromagnetic spectrum, it becomes more and more difficult to allocate contiguous spectrum over a wide bandwidth. Antennas which are part of these systems are required to maintain specific performances over the entire noncontiguous bandwidth. Broadband antennas such as tightly coupled Vivaldi arrays have been proposed by several researchers as possible candidate to address this problem. The scanning capability of these antennas over wide angles makes them also suitable for radar and defense applications. Most of the Vivaldi arrays presented in open literature are designed for free space operation and do not consider actual operational environment and integration. As integral part of modern platforms, antennas must not only provide the needed electrical functionality, but they must also comply with other requirements including mechanical robustness, concealment, and aesthetics.

In this work, we propose a flush-mountable Vivaldi antenna array electromechanically integrated with a metallic cavity. Detailed analysis of a singly polarized 3×4 array and its interaction with a lossless cavity are discussed. To eliminate deleterious effects of cavity resonances the edge elements of the array are carefully connected (in E-plane) to the cavity walls. Simulated and measured performances of a prototype array show a resonance-free behavior with VSWR < 2, aperture efficiency >90% and side lobe levels < -20dB from 1.5 to 8 GHz. Different approaches of recessing a dual polarized version of this antenna inside a cavity are also presented and size/performance trades are discussed. To assess the scanning capability of this cavity back Vivaldi array, a single polarized 8×8 array is simulated and favorable performance is observed over the entire bandwidth.