A Novel Array with 6:1 Bandwidth and 70° Scanning Using FSS Superstrate

Ersin Yetisir, Nima Ghalichechian, and John L. Volakis
The Ohio State University,
ElectroScience Laboratory
Electrical and Computer Engineering Dept., Columbus, OH

Ultra-wideband antennas and arrays are essential for high data rate communications and for addressing spectrum congestion. Tightly coupled dipole arrays (TCDAs) are of particular interest due to their low-profile, bandwidth and scanning range. But existing arrays still suffer from limited scan range, particularly at angles beyond 45^o from broadside. Almost all previous wideband TCDAs have employed dielectric layers above the antenna aperture to improve scanning. But even so, scanning has been limited to no more than 60^o away from broadside.

In this paper, we propose to replace the dielectric superstrate with frequency selective surfaces (FSS). In effect, the FSS is used to create an effective dielectric layer placed over the antenna array. But unlike conventional dielectric materials, FSS can allow for anisotropic effective media. This allows for more design freedom in using the FSS as an effective superstrate. Another important aspect of the FSS is its low weight and ease of fabrication. Specifically, it can be fabricated using standard printed circuit technology. At the conference, we will discuss the FSS design and its capability to allow for scanning up to 70° in principal and diagonal planes. In addition to the FSS superstrate, a novel balun is also presented. It is a modified version of the stripline-based folded Marchand balun and serves to match the 50Ω coax cable input impedance to the array element's 150Ω impedance. As a result, earlier Wilkinson dividers are eliminated. In the past, these dividers impacted the array's performance at low scan angles.

To verify the proposed array concept, we fabricated a 12x12 tightly coupled dipole array using the modified balun and the new FSS superstrate layer. The design and experimental data showed an impedance bandwidth of 6.2:1 with VSWR<3.2. The latter VSWR was achieved even when scanning down to ±60° in the H-plane, ±70° in the D-plane and ±75° in the E-plane. As noted, the FSS, radiating dipoles and the feed lines are printed on the same PCB that is vertically placed over the array ground plane, resulting in a low-cost and light-weight structure.