Unidirectional Bowtie Array Antenna with Titled Beams for Base Station Applications

Adam Mehrabani*[1,2] and Maria Pour[1]
[1]The University of Alabama in Huntsville, Huntsville, AL 35899
[2]Johns Hopkins University, Baltimore, MD, 21218

The mechanical tilting requirement of conventional antennas for base station applications demands ongoing maintenance and increases the overall cost of the antenna unit. Bowtie antennas with omnidirectional radiation patterns are excellent candidates for such applications. They are wideband and easy to manufacture, which have attracted many researchers to further their gain in quasi-Yagi designs with complex directors (A. Dadgarpour, B. Zarghooni, B. S. Virdee, T. A. Denidni, IET Microwaves, Antennas & Propag., 9, 1254-1259, 2015) as well as a printed ground plane to realize unidirectional radiation patterns (G. Zheng, A. A. Kishk, A. W. Glisson, A. B. Yakovlev, Microwave and Optical Technology Lett., 47, 534-536, 2005). In these designs, the antenna radiation patterns were broadside. Later, attempts were made to tilt the main beams of bowtie antennas using engineered materials, such as electromagnetic bandgap (EBG) structures. For example, an EBG-loaded bowtie antenna with tilted beams was reported in (A. Dadgarpour and et. al., IEEE Trans. Antennas Propag., 62, 2874–2879, 2014). However, the frequency bandwidth was quite narrow up to 5.5%.

Recently, a novel unidirectional tilted beam bowtie antenna was proposed by the authors (W. Ake, A. Mehrabnai, and M. Pour, IEEE Trans. Antennas Propag., DOI: 10.1109/TAP.2018.2880078, 2018), wherein the beam tilt was realized by a geometrical alteration to the antenna such that its new phase line was rotated from its axis of symmetry, which eventually resulted in tilted main beams, as required in based station applications. This was realized by asymmetrically cutting the bowtie arms in half through its axis of symmetry, which in turn shifted the phase line of the antenna structure away from its original axis of symmetry and eventually generated a tilted main beam pattern. In this paper, the asymmetrical half-ellipse bowtie antennas are further investigated in printed phased arrays, as well as arrays of printed Yagi-Uda structures for the ±45 degree linear polarization. It will be shown that the printed versions of these arrays exhibit about 35% impedance bandwidth, along with the maximum 40^{o} beam-tilt angle and the front-to-back ratios of greater than 10 dB. For the ±45 degree linear polarization cases, the effect of mutual coupling on the tilt angles and gain are studied. The results of different case studies will be presented and discussed in the conference.