EBG-dipole Array Antenna Creating Beam-tilt for Base-station Applications

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For a typical base-station, tilted beam towards the ground has been employed in order to increase the signal reception from the mobile device. This can be realized with either an electronically controlled phased array antenna or a mechanically tilted array antenna. These techniques have been used; however, there exists inherent shortcomings with respect to performance at a tilted angle and practical implementation. For a common phased array, an array pattern is tilted toward a desired direction while element pattern stays toward the broadside. This mainly results in antenna gain reduction at the tilted angle. For the mechanically adjusted array, careful and stable installation is often required, which sometimes make it difficult to implement. Therefore, an enhancement in the conventional base-station array antenna is needed in order to achieve improved antenna performance with robust implementation.

In this paper, a novel base-station array element design that consists of a single dipole mounted on an EBG ground plane is presented. Each dipole on an EBG structure provides tilted radiation pattern. This is achieved by employing 6×6 cell miniaturized EBG structure that is modified by connecting four of its unit cells. This EBG structure allows a low profile, high directivity, and beam-tilting single element design. With this dipole-EBG element, the radiation pattern can be steered from the broadside to the desired tilted angle which is suitable for the base-station applications. Based on the element design, an array antenna with four dipole-EBG elements is designed in order to verify the base-station like antenna performance. A down-tilt array pattern incorporated with a progressive phase is utilized in the array along with the tilted element pattern. To validate the proposed array, similar array that consists of non-modified standard EBG unit cell (a broadside element pattern) is employed as a reference. It is observed that the proposed array, compared to the reference case, achieves better performance with respect to the gain and sidelobe characteristics.

The proposed EBG-dipole element incorporated into an array antenna is simulated using full-wave simulator. The proposed EBG antenna operates at 3.5 GHz, which covers part of WiMAX service bands. The directivity of more than 11.5 dB is obtained at the down-tilted angle of 25°. An impedance matching better than -10 dB S-parameter is attained across a reasonable bandwidth. The proposed dipole-EBG element array antenna should allow for performance efficient realization of future base-station antennas.