Examination of the Bandwidth Potential of Electrically-Small Platform-Based Antennas at the HF Band

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The HF band, 3 to 30 MHz, is commonly used in military communications applications due to its favorable propagation characteristics for long-distance communications. In this frequency range, the wavelengths are large, ranging from 10 to 100 meters. As a result, electrically-small antennas are often used because of their favorable physical dimensions. However, these antennas necessarily suffer from a reduced bandwidth. This bandwidth is critical both in communications and electronic warfare applications. Because these antennas are often mounted on metallic platforms, it is possible to take advantage of the presence of the platform to enhance the performance of the antenna. By doing so, the platform itself serves as the primary radiating element, and the judiciously-placed antenna serves primarily as a coupling mechanism between the platform and external circuit. By this method, the bandwidth of the antenna system can be increased. Previous research into bandwidth enhancement of platform-based antennas primarily considers basic capacitive coupling elements consisting of a monopole with or without top hat, and/or inductive coupling elements consisting of simple half-loops. However, by using more complex, carefully designed coupling elements, it is possible to further increase the bandwidth of platform-based antenna designs using electrically-small coupling elements with a given maximum linear dimension. In this presentation, we consider a number of low-Q coupling elements and present a study of their effect on attainable bandwidth.

In addition to coupling element design, coupling element placement will be discussed. Primarily, the ubiquitous case in which one dominant platform mode is present is considered. Due to the geometric dimensions of many vehicles, one mode is of considerably higher modal significance over a given frequency range. These cases present the favorable condition of design simplicity, as this dominant mode is the primary influence on obtainable bandwidth. In these cases, placement of the coupling element is examined relative to achievable bandwidth, and some generalizable results are obtained.

This work builds upon current platform-based antenna design research efforts by focusing primarily on obtainable bandwidth of a given platform excitation. By employing the two techniques discussed above, considerable bandwidth improvements are obtained. To provide comparison, a base case coupling element design and location was presupposed. This is compared to the most bandwidth-effective coupling element and location. Only accounting for changes in placement location, simulated results show an improvement of 600% at 5 MHz. Accounting only for change in coupling element design, simulated results show a bandwidth improvement of 695% at 5 MHz. Details of this study along with simulation and measurement results will be presented at the symposium.