Low-profile Inverted-hat Monopole Antenna for UWB Application

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A novel compact low-profile UWB antenna was presented. The proposed inverted-hat antenna (IHA) operates from the low VHF frequencies up to at least 2GHz (40:1 bandwidth), maintaining excellent vertical polarization down to grazing incidences. The entire structure with its pointed feed section resembles that of an inverted hat, with its lower surface formed by multiple, smoothly connected concave and convex elliptical segments whose curvature is logarithmically related to the distance from the feed point. The operation of the IHA is based on the excitation of a travelling wave between the ground plane and the top portion of the antenna. The higher frequency operational limit is influenced by the electrical distance between the ground plane and the inverted-hat surface, while the lower operational frequency of the IHA is a function of its overall size and curvature. Particularly, the surface profile enhances frequency independence. That is, higher frequencies diffract from region closer to the feed, whereas the lower frequencies diffract from sections farther away from the feed. As a result, the proposed antenna produces frequency-invariant impedance and patterns, necessary for UWB performance.

The fabricated double-ellipse IHA design was 15'' in aperture and 6'' in height, and achieved a gain of -15 dBi at 75 MHz ($\lambda/10$ aperture) when mounted on a 21" finite ground plane. On an infinite ground plane, simulations showed the same performance down to 50 MHz for the same aperture and height. The obtained calculated and measured gain data were found to be in good agreement. A triple-ellipse IHA design was also investigated to resolve impedance matching issues at higher frequencies, and to therefore increase the gain to 5dB above 200MHz or so. Design curves were given as part of this work to provide design guidelines in terms of gain versus aperture and height sizes. The proposed IHA can be ideally integrated into smaller aircraft for communication or imaging applications.