An Antenna Solution for Mitigation of Near-Field Interactions with Devices and Human Operators

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Since cellular phones are typically used in very close proximity to the human head, there have been concerns about possible biological effects of radio-frequency (RF) radiation from a cell phone. RF exposure standards have been developed by various organizations and countries to address these issues. On the other hand, cellular phones can also create interference problems to adjacent devices, not just biological effects. In recent years, electromagnetic interference between cell phones and medical devices, such as hearing aids, electric-powered wheelchairs, and cardiac pacemakers, has been an issue. The interference causes an overwhelming buzz in hearing aids and a potential malfunctioning of electric-power wheelchairs and cardiac pacemakers.

The cell phone interactions with human operators and medical devices arise due to near-field interactions. The thermal effects of cellular phones on the human head are dominantly affected by near electric fields that dominate the near-field energy for most phones. However, devices used in close proximity to a cellular phone can be affected by either electric or magnetic near fields, or both of them if any part of the device acts as an unwanted antenna. Since electric and magnetic near fields are not tightly coupled in the near-field region, the reduction of one type of field does not guarantee the reduction of the other type of field. A solution reducing both electric and magnetic near fields is necessary to solve both human and device interactions.

In this presentation, we investigate an antenna solution to mitigate interaction with both medical devices and humans. We begin by identifying the radiation mechanism based on current-slope discontinuities and the fundamental-limit theory of antennas. After this background material, we demonstrate, through simulations, a potential method to reduce near-field electromagnetic energy generated from a cellular-phone antenna using a low-Q antenna. The simulated specific absorption rate (SAR) with a cell-phone model and the IEEE SAM phantom model are compared with measurement results. Our emphasis is on the demonstration of effectiveness of the proposed low-Q antenna approach, not the specific antenna designs that we used for proof of concept. Specifically, the interaction with a head model is of primary interest in this talk.