User Hand Exposure Assessment of a Highly Resonant Power Transfer System

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While contact-less power charging is becoming a popular feature in modern electronic devices, the exposure to a nearby user from a wireless power transfer (WPT) system should be assessed prior to the commercial availability of such systems. In this study, a 4-link 100 kHz magnetically resonant low power wireless charging system is investigated with respect to the exposure of a user hand. Numerical dosimetry techniques are employed to compute the peak induced spatially averaged electric field (E-field) and specific absorption rate (SAR) in a high-resolution anatomically realistic hand model (based on an adult male hand). The computed peak values are analyzed with respect to the exposure limits recommended by the ICNIRP and IEEE exposure guidelines and standards (i.e., ICNIRP-2010, IEEE C95.6-2002 and IEEE C95.1-2005) to determine the compliance of the investigated WPT system and to derive the critical system parameters which could be adjusted to improve the design of a WPT system.

A generic coil analysis is conducted by modelling a single circular coil with diameter in the range of 40 to 240 mm. An anatomical hand model, discretized with a uniform 1 mm grid resolution, is placed 1 mm above the coil with the center of the palm facing the center of the coil. The peak spatially averaged E-field (volume averaged for ICNIRP and line averaged for IEEE) values are plotted with the peak SAR (averaged over 1 gram or 10 gram) values to derive the transition frequency, above which, the peak spatial SAR becomes more dominant than the peak induced E-field for an exposure compliance assessment. This transition frequency can be regarded as the optimum operating frequency which leads to the highest output power of a WPT system with respect to the relevant exposure limits. Subsequently, the 4-link 100 kHz WPT system is modelled to facilitate the exposure analysis of an actual wireless charging system.

This study provides the frequency-dependent user hand exposure characteristics of a generic circular coil and the exposure analysis of a practical wireless charging system. The computational results indicate that the optimum operating frequency of a WPT system with coil dimensions in the range of 40 mm to 240 mm diameter is approximately 1 MHz based on the peak $2\times2\times2$ mm^3 volume averaged E-field and 10 gram averaged SAR values. The investigated 4-link 100 kHz WPT system is found to be compliant with the ICNIRP and IEEE exposure limits while operating with a 5W output power.