Omni-directional Wireless Power Transfer system for biomedical applications

Francesca Benassi

Dept. of Electrical, Electronic and Information Engineering – University of Bologna.

francesca.benassi9@unibo.it

Providing wireless power to biomedical implants can be considered a breakthrough in modern medicine, since it would provide a safe and less invasive alternative to battery replacement, now performed through surgery. Issues related to system reliability are still under investigation, for both near-field (reactive) and far-field (radiative) implementations. This work proposes a near-field resonant inductive system operating at 13.56 MHz, designed with the goal of being insensitive to every Rx rotation, which is usually unknown. Although the receiver is miniaturized to a volume of about 1 cm^3, the system achieves a reasonable Power Transfer Efficiency (PTE). Previous attempts to solve this problem are available in the literature, but miniaturization constraints, necessary for implantable devices, are not addressed. Indeed, most proposed links are designed assuming a known receiver position, rarely considering possible movements or misalignments; when the coil rotates, the shared flux varies significantly and thus the output power and voltage. In this work, a 3-D miniaturized Rx is adopted to realize the quasi-constant output dc-voltage and power for any possible receiver rotation. It consists of three orthogonal coils wrapped around a plastic sphere, which acts as the capsule; each one is connected to its own optimized class-E rectifier and their dc outputs are series-connected. In this way, a reduced output voltage ripple is obtained for any possible Rx angle, ensuring the continuous powering of the implant. The system design, from the Tx coil to the Rx dc-load, is carried out by means of EM/nonlinear co-simulations. The results confirm that the proposed solution allows to remotely provide at least 2.8V at 5 cm on an optimum load of 2700 Ohm, which is enough to power an implantable device, independently of its rotation with respect to the transmitter. The designed system performs a PTE of about 13% for any rotation in the 3-D. The results in terms of $\eta_{RF-to-dc}$ are plotted in Fig. 1 and the realized miniaturized prototype is shown in Fig. 2.

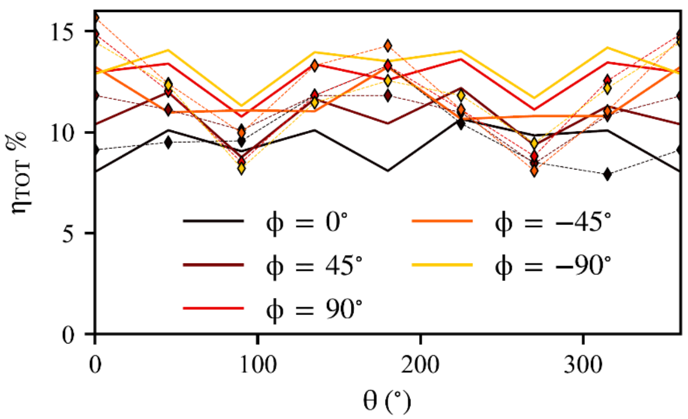

Figure 1 PTE over a 360°- rotation around the angle Θ

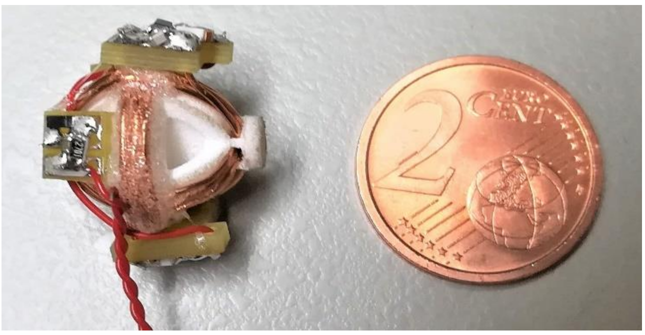

Figure 2 Miniaturized receiver compared to a 2-euro cent coin