Safe and Efficient Powering of Biomedical Implants through Multi-coil Wireless Power Transfer

Erik Saturnino Gámez Rodríguez [1], Manjunath Machnoor [1], Pragya Kosta [1], and Gianluca Lazzi [1]

(1) University of Utah, Salt Lake City, UT 84112

The development of neurostimulators has recently contributed to the dramatic improvement of the lives of many patients suffering from conditions such as chronic pain, deafness, and even blindness. Spinal cord stimulators numb pain for those suffering from chronic pain; partial hearing can be recovered even when a person has become profoundly deaf by using cochlear implants; and retinal neurostimulators help those who have lost their sight to diseases like retinitis pigmentosa recover some form of vision.

All neural stimulators require power, and providing this power can be challenging due to the lack of accessibility to the implantation site. Running wires from the implant to the outside of the body significantly increases the probability of the patient suffering from complications such as infections. Some devices, like the spinal cord stimulator, solve this problem by implanting a large battery; however, this battery has to be replaced after a few years, which requires the patient to undergo additional surgeries. In several active implants characterized by tens or hundreds of electrodes, such as the artificial retina, powering through batteries is not even a possibility.

More and more neural stimulators are therefore resorting to wireless power transfer strategies. Typical wireless power transfer systems consist of a driver circuitry, an external coil, an implanted coil, and a receiver circuitry. Power and data are transferred from the driver to the receiver circuits via the magnetic coupling between the external and receiver coils. This mechanism is efficient as long as a large enough magnetic coupling is maintained, which limits the maximum implantation depth and requires precise positioning of the coils.

In this work, we propose exploring a different implementation of wireless power transfer for neural stimulators: multi-coil wireless power transfer. Multi-coil systems split the transmitter and/or the receiver coils into two coils, one of them is parasitically fed and the other is connected to the transmitter or receiver circuitry. The parasitic coils achieve higher quality factors, as they are not loaded by the transmitter or receiver circuitries, allowing for higher efficiencies even with reduced coupling. Additionally, increased tolerance to misalignment and reduced emissions are achieved due to the additional impedance matching afforded by the extra coils. We will explore the multi-coil system performance in terms of a hypothetical 2-coil wireless power transfer for a brain implant.