Techniques for smaller and efficient design of 3-Coil System for Biomedical Applications

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Wireless power transfer (WPT) has helped the growth of implantable biomedical systems which are used to transfer power or data from the power source of transmitter outside the body to the implanted receiver. WPT techniques enable the implant to operate without the need for bulky implantable battery or cabling requirements from inside the body to outside the body; therefore, it removes the need for battery replacements which would make a number of implantable devices impractical.

WPT is commonly implemented using two inductively coupled coils/antennas. The transmitter coil is connected to the power source while the receiver coil is connected to a load. To make the system efficient and easy to implement, a compensating capacitor is used to resonate the transmitter/receiver at the desired frequency of operation; multi coil systems are used to improve coupling; and load tolerance and impedance matching of the load is employed to deliver the coupled power efficiently to the load.

The physical size of the WPT system for biomedical implants is an important design variable to consider. This calls for an efficient and compact receiver system which can be implanted in the patient with better comfort level. These problems associated with the design of wireless telemetry systems for biomedical implants act as primary motivation of this work: specifically, the goals of this work are to propose a 3-coil WPT configuration that utilizes coils implanted in the body that are characterized by reduced footprint and lower loss compared to traditional WPT systems.

In this work, the causes of performance degradation of existing 3-coil system for smaller receivers are analyzed. The implant footprint and receiver system efficiency are expressed in terms of mutual and reflected impedance of the 3-coil system. An improved 3-coil system architecture, which has higher mutual and reflected impedance, is proposed to further improve the efficiency of 3-coil systems. The enhancements offered by the proposed implementation over existing systems is verified analytically and experimentally.