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Efficient Wireless Power Transfer System at Low frequency for Biomedical Implant Application

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Abstract— *In this paper the wireless recharging of pacemaker's battery for biomedical implant is considered. The Square PCB receiving coil for Wireless power transfer system is found suitable to achieve higher coupling coefficient between primary and secondary coil. The coil is embedded inside the biomedical implant. The coil trace (w), pitch(s), thickness (t), number of turns and outer diameter (D_{out}) are the key parameters in designing the square PCB coil for higher coupling coefficient. The experimentation in simulation environment is carried for two low frequencies as 20 kHz and 300 KHz to comply EMF safety standard limits for biomedical application. The experimental results by simulation are presented for 1KΩ load. Power transfer efficiency for 20 KHz is 69.40% and 300 KHz it is 99.67%. It is observed that the power transfer efficiency is higher for higher frequencies.*

Keywords—*Wireless power transfer, pacemaker, Coupling Coefficient, Resonant Inductive coupling, power transfer efficiency*

I. Introduction

Wireless Power Transfer (WPT) is the technology that enables a power source to transmit electromagnetic energy to an electrical load across an air gap, without interconnecting cords. This technique is rapidly growing and is applicable to the domains, including industrial applications consumer products and biomedical implant. Biomedical implanted devices are becoming popular in health and medical applications in a wide range of areas, such as, cardiac pacemakers, retinal prosthesis, cochlear implants, defibrillator, smart orthopaedic implants, and artificial hearts etc. The traditional approach of supplying power to these devices is implantable batteries, bio-fuel cell and percutaneous links. However, any battery has limited energy storage and life span, similarly bio-fuel cell has low output power and percutaneous links are susceptible to infection and reliability problems [1]-[6][21].

The current implantable devices available in the market consist of non rechargeable large sized batteries. Biomedical implants require high energy batteries to supply power for longer duration therefore bulky size of the battery is required to supply the power to biomedical implant for longer duration. Moreover since the battery is non rechargeable, it has to be removed after its life span. This necessitates costly invasive surgery to replace the battery.

Presently there is a tremendous advancement in developing rechargeable batteries which could improve the life span of pacemaker batteries by recharging wirelessly using magnetic resonance coupling [7]-[9]. In this paper the experimentation is carried out in simulation environment to optimize the geometrical parameter of primary and secondary square PCB coil with aiming to achieve higher coupling coefficient between primary and secondary coil.

1. Principle of WPT System

Wireless power transfer system can be categorized into far field and near field WPT. The radio frequency transmission, microwave applications are the few examples of far field WPT system and Biomedical application [16] [17], whereas inductive coupling, magnetic resonance coupling and capacitive coupling based methods are categorized into near field WPT system [1]-[16][19] [20][21]. In this paper magnetic resonance coupling using SP topology is chosen for higher power transfer efficiency. The general architecture of near field WPT system for biomedical implant is as shown in Fig.1and Fig.2 shows the different topologies for magnetic resonance coupling [1].