Contactless power transmission using two auxiliary coils

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ABSTRACT

I am conducting research to construct a system that enables highly efficient power transmission to implantable medical devices during sleep using wireless charging technology. One of the problems with implantable medical devices used to treat cardiac arrhythmias and other cardiac diseases is that they require replacement surgery when the battery runs out of life, which places a physical and mental burden on the wearer. Wireless power transmission technology that can recharge power from outside the body is an effective solution to this problem. I am conducting research based on reports of extending the transmission distance by using a relay circuit between the transmitting and receiving sides of a magnetic field resonance method of non-contact power transmission that utilizes the magnetic coupling and resonance phenomena of coils. Specifically, I aim to construct a transmission system that minimizes the burden on the wearer during sleep by fabricating a relay coil consisting only of a coil and capacitor in contact with the wearer's skin on the wearer's shirt or other clothing. With this method, when the wearer is lying on his/her back, the magnetic flux from the transmitting side interlocks vertically with the receiving side via the relay coil, and transmission efficiency of more than 70% has been achieved. However, in the 90-degree horizontal position, the magnetic flux does not interlock vertically, resulting in an efficiency of less than 1%. As a solution to this problem, we proposed to add a new relay coil to the flank and connect it to the conventional relay coil with a wire in series. The most important part of the study of this method is the derivation of the transmission efficiency equation. I derived the efficiency equation for each circuit using the Kirchhoff voltage law. Since it is known that the coupling coefficient k of the coil and the Q value of the coil have a large effect on the transmission efficiency.I derived the transmission efficiency only for the coupling coefficient k of the coil and the Q value of the coil. The coil coupling coefficient k expresses how much of the magnetic flux generated by the transmitter coil is chained to the receiver coil in the range of 0 to 1, and the coil Q value is a dimensionless number that expresses the sharpness of the resonance peak of the resonant circuit. The coupling coefficient k was derived using simulation software (Fastmodel) when the wearer actually turned over in bed and the angle of the coil changed, and when the angle of the coil changed in consideration of misalignment during sleep. These simulations were performed using a 1/2-scale version of the actual coil made in a previous study. From the derived coupling coefficient, a simulation of transmission was performed using a circuit simulator (LTspice), and the transmission efficiency was derived taking into account the wearer's turning and misalignment.