EVALUATION OF LOSSES IN COILS FABRICATED USING SEWING TECHNOLOGY FOR WIRELESS POWER TRANSMISSION

No. 2281257 Gai Takahashi
(Supervised by Prof. Shogo Kiryu)

ABSTRACT

In recent years, wireless power transmission has attracted attention as a power supply method for implantable medical devices such as cardiac pacemakers and ICDs . Implantable medical devices require periodic surgery with battery replacement. This is a great physical and mental burden for the users. Wireless power transmission is expected to enable recharging without surgery because power is transmitted without metal contacts. Studies have shown that sewn coils made by sewing Litz wire into fabric are useful for feeding power to implantable medical devices. Among wireless power transmission methods, the magnetic field resonant wireless power transmission utilizes the magnetic coupling and resonance phenomena of coils to enable longer transmission distances. In addition, transmission efficiency can be increased by using relay coils. Therefore, it is thought that power can be supplied to the device during sleep by sewing a coil into the clothing and bed of the implantable medical device users. In the magnetic field resonant wireless power transmission, the efficiency is determined by the product of the coupling coefficient k of the transmitter and receiver coils and the Q value of the circuit. To improve efficiency, it is important to increase the Q value of the coil. To increase the Q value of the coil, it is necessary to reduce the coil loss. However, coil loss is affected by various factors such as the material of the wire used in the coil, proximity effect, skin effect, and stray capacitance. Therefore, until now, coil loss has been a problem that does not match simulation and cannot be calculated. In this study, losses in sewn coils were evaluated in the frequency range from 1 to 15 MHz. As a result of fabricating a one-turn coil with several types of Litz wires with different numbers of strands and evaluating the loss, it was confirmed that the loss in the wires was dominated by the proximity effect, except for 30 wires. The results of loss evaluation of two coils fabricated in meander shape and connected in parallel showed that the proximity effect between wires can be negligible by spacing them about 6 mm apart. When the two coils are connected in series, the loss due to stray capacitance is significant. The relationship between loss and capacitance was evaluated and the results showed that the effect of stray capacitance due to the distance between the wires was limited to 30 mm.