

Efficiency of Multi-loop Wireless Power Transfer System Depending on Switch and Tunable Matching Network Configurations

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Abstract— Magnetic resonance coupling (MRC) technique is useful and attractive for wireless power transfer (WPT) systems, because it allows high efficiency at the longer distance than magnetic induction technique. However, MRC technique exhibits a high efficiency only at the specific distance where the impedance is perfectly matched. In this paper, range-adaptive WPT system is designed and fabricated at 13.56 MHz using multi-loop topology and tunable matching circuit. It can maintain high efficiency along wide distance connecting one of three different-size loops depending on the distance. It reduces the impedance variation ranges, which enables fine impedance matching to be accomplished by using a simple tunable matching network consisting of shunt variable capacitor (shunt C). For the loop selection relay switches were previously used since it shows very low loss and high power handling capability. However, it consumes large DC power with low response time. Therefore, we replace them with the semiconductor-based SP4T switches consisting of three SPDT switches which are fabricated in GaAs pHEMTs. This switch has very low power consumption and high switching speed, compared with relay switches. However, the measured insertion loss of the SP4T switch was as high as 0.5 dB at 13.56 MHz, which significantly reduces the efficiency of the WPT system. In order to minimize the effect of the switch loss and recover the efficiency, we design tunable matching circuit consisting of series varactor diodes and a shunt inductor (series C-shunt L). It maintains high efficiency across the distance from 20 to 90 cm as shown in Fig. 1.

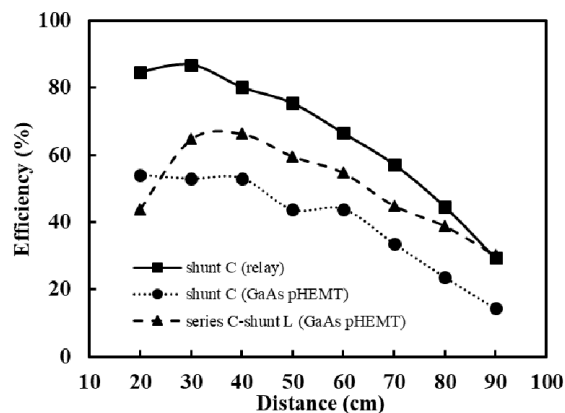


Figure 1: Efficiency of the proposed WPT system depending on the switches and tunable matching networks.