Minimizing Idle Power Losses in Magnetic Resonance Coupling Wireless Power Transfer

Connor Badowich* and Loïc Markley
The University of British Columbia, Kelowna, BC, V1V 1V7

The development of high-efficiency wireless-power-transfer systems over mid-range distances has been a highly researched field in the past decade. Most modern systems are based on magnetic resonance coupling (MRC), with the latest research focusing on creating adaptive matching circuits to maintain high efficiencies. In this work, we propose the introduction of mismatch at the source and receiver that is designed to maintain a high power transfer efficiency (PTE) in the active state while minimizing the radiated and absorbed power in the idle state (i.e. the idle power losses). We show that systems that alternate between active and idle power transfer states should always take into account both the PTE and the idle power losses in order to minimize overall system losses and reduce any unintended health effects related to idling WPT system exposure.

When a small amount of mismatch is introduced at the source, the fraction of power reflected from the transmitter when the system is operating in the idle state will increase. This reduces the power radiated by the transmit antennas, thereby reducing the power lost to the system. With careful design of the power amplifier circuit, this reflected power can be recovered for future use. The source mismatch is introduced by modifying the reactive components and the spacing of the antennas at the transmitter. In order to maintain a high PTE, a similar mismatch must also be introduced at the load. The load mismatch ensures that the overall system is matched from source to load when operating in the active state and a maximum efficiency is maintained.

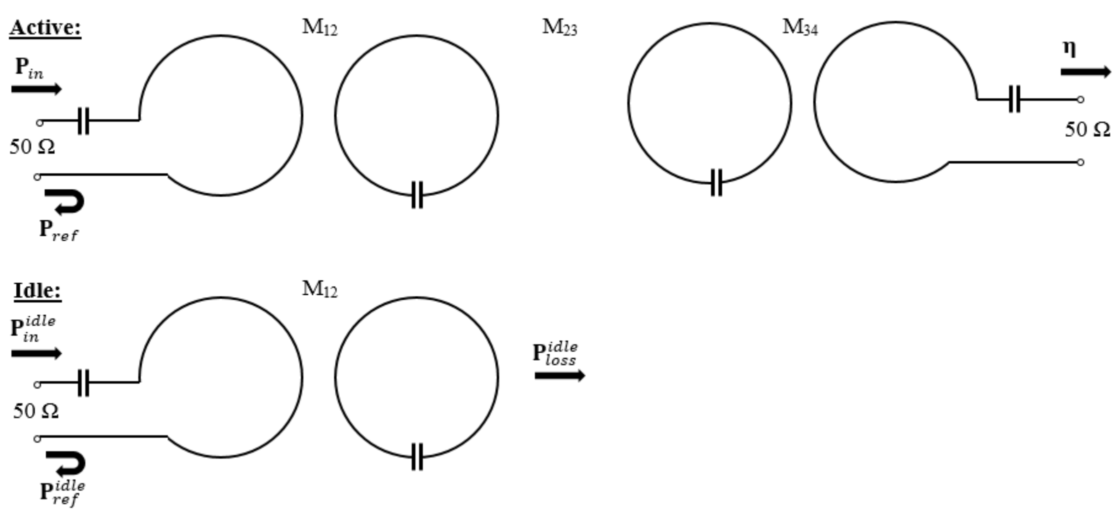

Figure 1: An Active 4-loop WPT system (top) and an Idle 4-loop WPT system (bottom)

We have successfully demonstrated idle power loss suppression using a 4-loop MRC WPT system, as illustrated in Figure 1. The system was modeled using a lumped-element equivalent circuit from which generalized power transfer and idle power loss equations were derived. We simulated the model and were able to obtain a theoretical reduction of 10% in idle power losses while maintaining the PTE within 1% of the maximum efficiency condition.