

# Analysis and Experiments of Parallel Line Feeders as a Practical Inductive Power Transfer System.

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## Abstract

Parallel line feeder (PLF) consisting of a two-wire transmission line operating in the MHz band has been proposed as a proof-of-concept with the promise of drastically reducing the cost and maintenance of inductive power transfer system while further increasing its range thanks to its simple and long structure. However, when it is long enough compared to the input signal wavelength, the PLF has the characteristic of transmission lines and suffers from the standing wave effect. This is an issue for the inductive power transfer as the PLF could not stably charge a receiver because the electromagnetic strength varies dynamically all over its length.

In order to mitigate that standing wave effect, we first adopted a multiple-input multiple-output configuration of the PLF which consists of a series of parallel line feeders side-by-side and shifted in the longitudinal direction to expose and combine their different magnetic fields in a uniform way for better stability and higher output power. However, the use of multiple parallel lines feeders adds up to the cost and complexity of the system. More importantly, the efficiency of that first configuration is quite low due to the dielectric loss caused by the exposure of electric field to the surrounding materials. Therefore as improvement, a modified version of the system, where the PLF is divided into shorter segments which are concatenated and compensated by capacitors in order to mitigate the impact of the standing wave effect have been investigated through simulations and experiments. Their results show that the segmentation could display a near-uniform magnetic field strength capable of charging receivers uniformly regardless of their positions on top of the line. In order for these investigations to be complete enough to show its performance as a practical system, the PLF has also been modeled as a lossy transmission line. In that configuration, the maximum achievable efficiency derived from the extended k-Q product formulation has been used as the upper-bound for the RF-to-RF efficiency of the PLF. The theoretical analysis shows that when the segments' lengths are properly determined, the segmentation scheme is able to improve and stabilize the efficiency all over the PLF length. Experimental results at 27.12 MHz with two different segmentation schemes confirm the theoretical analysis and show that a fairly high efficiency of 70% can be achieved when the segments are sufficiently short compared to the wavelength of the input signal frequency.