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耦合机构设计与优化

部分元等效电路理论在无线电能传输系统中的应用研究

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Application of Partial Element Equivalent Circuit Theory in Wireless Power Transmission System

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摘要

磁耦合谐振式无线电能传输技术凭借其传输距离远、传输效率高等优势逐渐成为了无线电能传输方面研究的热点,而磁耦合谐振系统的设计和优化依赖于准确的参数计算和系统性能计算。针对这一问题提出采用部分元等效电路PEEC(partial element equivalent circuit)法进行计算。首先介绍了PEEC的基本理论以及部分参数的计算方法,然后建立耦合线圈的部分元等效电路模型,对平面矩形螺旋线圈的自感和互感进行计算,通过计算结果和实验结果的对比验证了PEEC法计算参数的高效性和准确性。在此基础上,分别建立了双线圈系统和单共振磁耦合谐振式无线电能传输系统,采用PEEC法结合电路法对2个系统的传输特性分别进行了研究和分析,并通过与有限元法计算结果的对比,验证了所提方法的准确性和快速性。

Abstract

The magnetic coupling resonant wireless power transmission technology has gradually become a hot issue in the field of wireless power transmission owing to its advantages such as a long transmission distance and a high transmission efficiency. However, the design and optimization of a magnetic coupling resonant system relies on the accurate calculations of parameters and system performance. In this paper, the partial element equivalent circuit(PEEC) method is proposed to solve these problems. First, the basic theory of PEEC and the calculation method for partial parameters are introduced. Then, a PEEC model of the coupling coil is established, and the self-inductance and mutual inductance of planar rectangular spiral coils are calculated. The calculation results are compared with experimental results to verify the efficiency and accuracy of the PEEC method. On this basis, a two-coil system and a single resonance magnetic coupling resonant wireless power transmission system are established, respectively, and the transmission characteristics of these two systems are studied and analyzed using the PEEC method combined with the circuit method. Moreover, the accuracy and rapidity of the proposed method were verified by comparing the calculated results with those obtained using the finite element method.

关键词

无线电能传输 / 部分元等效电路 / 有限元 / 线圈参数

Key words

Wireless power transmission / partial element equivalent circuit(PEEC) / finite element / coil parameters

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