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建模与控制策略

磁耦合谐振式无线电能传输系统变电容调谐控制方法研究

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Variable Capacitance Tuning Control Method for Magnetically-coupled Resonant Wireless Power Transfer System

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摘要

在实际应用中,无线电能传输系统两耦合线圈之间的相对位置变化会使系统参数发生改变,导致系统处于失谐状态,电能传输效率降低。针对系统失谐问题,提出了一种变电容调谐控制策略,通过控制电容的充放电时间使该电容等效为一个可变电容,调制等效电容值与线圈感抗满足谐振条件,从而使系统始终处于谐振状态,可使系统发射端线圈和接收端线圈之间的传输效率达到最高。建立仿真模型,搭建基于串联-串联型谐振补偿拓扑结构的磁耦合谐振式无线电能传输系统实验样机,进行了变电容调谐控制实验。实验结果表明,在谐振频率为100 kHz、输入电压为20 V的情况下,样机能够实现无线电能稳定可靠传输,证明了该变电容调谐控制方法的有效性。

Abstract

In practical applications, the relative position change between the two coupling coils of a wireless power transfer system will change the system parameters, resulting in system detuning as well as a lower power transmission efficiency. For the problem of system detuning, a variable capacitance tuning control strategy is proposed. By controlling the charge and discharge time of the capacitor, the capacitance is equivalent to a variable capacitance, so that the equivalent capacitance value and the coil inductive reactance value can meet the resonant condition requirements. As a result, the system is always maintained in a resonant state, and the highest transmission efficiency between the transmitting and receiving coils of system will be kept. A simulation model was established, and an experimental prototype of magnetically-coupled resonant wireless power transfer system based on a series-series resonance compensation topology was built. The variable capacitance tuning control experiments were carried out, and experimental results show that the protype can realize stable and reliable wireless power transfer with a resonant frequency of 100 kHz and an input voltage of 20 V, thus verifying the effectiveness of the proposed variable capacitance tuning control method.

关键词

磁耦合谐振式 / 无线电能传输 / 系统失谐 / 变电容调谐

Key words

Magnetically-coupled resonant / wireless power transfer / system detuning / variable capacitance tuning

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