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电力电子与电力传动

基于互补PWM控制的Buck/Boost双向变换器在超级电容器储能中的应用

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摘要：

超级电容器等快速储能技术在短时大功率应用中具有较好的技术经济性，非常适宜于微型电网运行过程中的瞬时功率平衡控制。提出超级电容器通过Buck/Boost双向变换器与脉宽调制(pulse width modulation，PWM)逆变器相连的储能主电路结构，以实现功率的双向调节并提高超级电容器利用率。为解决直流母线电压易受PWM逆变器工作状态切换而波动的问题，采用互补PWM控制技术，分析其特点及其在提高系统运行稳定性与动态响应的优势；建立互补PWM控制的Buck/Boost双向变换器的小信号模型，应用电压电流双闭环与功率前馈相结合的方法以抑制直流母线电压波动；针对直流母线负载电流不易测量的问题，提出采用最小拍观测器的方法对负载电流进行虚拟测量。仿真和实验证实了该方法的有效性。

关键词： Buck/Boost双向变换器 互补PWM控制技术 最小拍观测器 功率前馈 直流母线电压 超级电容器储能

Research on Complementary PWM Controlled Buck/Boost Bi-directional Converter in Supercapacitor Energy Storage

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Abstract:

Supercapacitor has imponderable advantages on the application of short and high power, and is very suitable for instantaneous power balance control in MicroGrid. In order to improve the utilization, the structure of supercapacitor bank, which is connected to the DC-bus of voltage source inverter (VSI) through Buck/Boost bi-directional converter, was presented in this paper. The DC-bus voltage of the VSI usually fluctuates with the change of the working state of the VSI, which may makes the unstable operation both of the Buck/Boost bi-directional converter and the VSI. The characteristic of complementary PWM control was analyzed and the mathematical model of complementary PWM controlled Buck/Boost bi-directional converter was established. Due to the fact that current and voltage dual-loop control cannot restrain DC-bus voltage fluctuation and improve the transient respond effectively, a power feed-forward compensator was added. Additionally, the beat observer was proposed instead of current sensor to improve load current measure accuracy Experimental and simulation studies were presented to show the effectiveness of the proposed control.

Keywords: Buck/Boost bi-directional converter complementary pulse width modulation (PWM) control beat observer power feed-forward DC-bus voltage supercapacitor energy storage

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