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电力电子与电力传动

一种基于输入/输出反馈线性化的Boost型DC/DC变换器非线性控制方案

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摘要： 针对Boost型DC/DC变换器以电容电压作为输出时存在非线性和不稳定的零动态，从而导致系统带宽较窄、动态响应缓慢等问题，基于输入/输出反馈线性化提出一种新的非线性控制方案。这一控制方案采用以非线性控制的电感电流作为内环、具有PI控制的电容电压作为外环的串级结构。该方案既可以很好地解决以电容电压作为输出进行直接控制时所存在的不稳定零动态问题，又克服了单纯采用电感电流作为输出间接控制电容电压时易受电源波动和负载变化影响的不足。对自制的样机进行实验研究，结果表明，与传统的PI控制方案相比，该方案可以明显改善Boost型DC/DC变换器的诸如输出电压调节范围、稳态静差、动态调整时间等动、静态性能。

关键词： Boost型DC/DC变换器 非线性控制策略 输入/输出反馈线性化 零动态 串级控制

A Novel Scheme of Nonlinear Control Strategy Based on Input-output Linearization for Boost Type DC/DC Converter

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Abstract: In view of nonlinearity and unstable zero-dynamics in Boost type DC/DC converter (BTDC) when taking capacitor voltage as output, that causes a great limitation on its performance such as low-bandwidth and sluggish dynamic response. This paper, based on input-output feedback linearization method, proposed a novel control scheme with inductor current which utilizes nonlinear control as inner-loop, capacitor voltage with proportional-integral (PI) control being taken as outer-loop as well. This novel cascade-structure control scheme can not only solve nonlinearity and unstable zero-dynamics problems in direct method when taking capacitor voltage as output, but also overcome lack due to power source fluctuation and large load variation in indirect method when taking inductor current as output. Experimental results of a self-manufactured prototype show that, compared with traditional cascade proportional-integral (PI) control, this control scheme can significantly improve BTDC’s dynamic and steady-state performances such as output voltage regulation range, steady-state error, and dynamic settling time.

Keywords: Boost type DC/DC converter (BTDC) nonlinear control strategy input-output feedback linearization zero dynamics cascade control

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