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基于前馈电流控制斜坡补偿的Boost功率因数校正零交越失真研究

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Design of Zero-crossing Distortion of Boost Power Factor Correction (PFC) Based on Feedforward Current Control Slope Compensation

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摘要 该文提出了一种前馈电流控制的斜坡补偿方法，将该方法引入到临界导通Boost 功率因数校正(PFC)转换器的设计中，以减小零交越失真问题，改善谐波电流和频率对系统的限制。基于临界导通Boost PFC转换器的拓扑结构，理论分析了前馈电流控制斜坡补偿技术对脉冲宽度调制(PWM)信号占空比的调制作用，推导出补偿斜率与输入线电压的关系式，迫使线电压零交越点附近的电流跟随电压变化。仿真和测试结果表明，该方法可有效抑制零交越失真现象，提高系统的动态性能，尤其在高频及轻负载情况下。测得Boost PFC转换器的总谐波失真(THD)仅为3.8%，功率因数0.988，负载调整率3%，线性调整率小于1%，效率达到97.3%。有效芯片面积为1.61×1.52 mm^2。

关键词： 前馈电流控制 斜坡补偿 Boost功率因数校正(PFC) 零交越失真

Abstract： The method of feedforward current control slope compensation and its circuit structure are proposed. With this method, the zero-crossing distortion of boundary boost Power Factor Correction (PFC) converter is reduced, for improving limits for harmonic current and frequency of the system. Based on boundary boost PFC converter topology, the modulation of Pulse Width Modulation (PWM) signal duty cycle is analyzed theoretically by the feedforward current control slope compensation technology. The relationship between the compensation slope and input line voltage is derived, which forces the current to follow the input voltage in the vicinity of the ac line voltage zero-crossing points. Simulation and experimental results reveal that, the zero-crossing distortion of the system could be suppressed efficiently with this method, as well as improved system dynamic performance, especially under the condition of high frequency or light load. The measured Total Harmonic Distortion (THD) of the Boost PFC converter is only 3.8%, the power factor is 0.988, the load adjust is 3%, the linear adjust rate is less than 1%, and the efficiency is 97.3%. The active die area is 1.61×1.52 mm^2.

Keywords： Feedforward current control Slope compensation Boost Power Factor Correction (PFC) Zero-crossing distortion

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