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作品名稱

三相相控整流器電流源數位控制IC之設計

Design of a Digital Control IC of a Current Source Based on a Three-Phase Controlled Rectifier

隊伍名稱

無盡的供應 Unfailing Supply

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作品摘要

在過去幾年來，三相相控整流器的應用非常廣泛，如直流馬達驅動器，照明控制，電池充電器，直流電源供應器以及交流馬達驅動之前置調整器等。除此，也廣泛地應用在高功率和大電流之工業程序控制中，如電解和電焊系統等。在以上應用當中，其主要訴求是能在額定範圍內產生可調控之直流電流源。本作品提出一個三相相控整流器電流源數位控制IC之設計，可利用此數位控制IC控制三相相控整流器之閘流體以產生一個定電流源，其內部架構包含三部份，分別為：一個三相相位控制的觸發電路、一個反餘弦計算查值表及一個比例積分電流控制器，此三部分之電路設計是以VHDL硬體描述語言來實現，可做為整個三相相控整流器電流與相位觸發數位控制之智財，設計後並在Simulink和ModelSim的共同模擬環境下，建立此三相相控整流器電流源之模型以進行模擬驗證。此外，電流回授採用多重取樣平均值的方法，以減少電流漣波的影響，最後下載到一個Altera FLEX 10K FPGA邏輯元件進行實驗，模擬與實驗結果顯示以此控制IC控制三相相控整流器在不同電流命令與負載變化下仍有穩定之動態響應。

Abstract

Over the last several years, there have been extensive applications of the three-phase controlled rectifier, such as the DC motor driver, the illumination controls, the charger of the battery, the DC supplying device and the adjuster before the AC motor driver, etc. Besides, there have also been extensive applications of the high power and big current in industry process control, such as system of electrolysis and electric welding, etc. In the above-mentioned applications, the main requirement produces the DC current source that can be adjusted and controlled in the specified range. In this work we design a digital control IC which is intended for controlling thyristors to produce a constant current source via a three-phase controlled rectifier. The architecture of the control IC consists of three major parts: a three-phase controlled triggering circuit, an inverse cosine look-up table, and a proportional-integral current controller. All the three parts have been designed using VHDL language and integrated as a control IP (intellectual property). The simulation model for a constant current source based on a three-phase controlled rectifier has also been constructed by using Simulink, ModelSim, and PSIM cosimulation tool. Further, a multiple-sampling and average scheme for the current feedback has been adopted to reduce the current ripple effect. The designed control IC circuit has been implemented on an Altera Flex 10K FPGA logic device. Simulation and experimental result reveal this control IC receives steady dynamic response in changing current reference command and load variation.