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Active power filter for three-phase four-wire electric systems using neural networks

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Abstract

This paper presents the design of neural networks compared with the conventional technique, a hysteresis controller for active power filter for three-phase four-wire electric system. A particular three-layer neural network structure is studied in some detail. Simulation and experimental results of the active power filter with both controllers are also presented to verify the feasibility of such controller. The simulation and experimental result show that both controller techniques can reduce harmonics in three-phase four-wire electric systems drawn by nonlinear loads and can reduce neutral current. The advantage of the neural network controller technique over hysteresis controller technique are less voltage ripple of d.c. bus, and less switching loss. Furthermore, the neural networks controller has better fault tolerance than the hysteresis controller. © 2002 Elsevier Science B.V. All rights reserved.

Keywords: Active power filter; Power quality; Neural networks

1. Introduction

There has been a continuous proliferation of non-linear type of loads due to the intensive use of electronics control in all branches of industry as well as by general consumers. Conventional rectifiers are harmonic polluters of the power distribution system. Non-linear loads, especially power electronics loads, create phase displacement and harmonic currents in the main three-phase power distribution system. Both make the power factor of the system worse. The presence of harmonic currents can also lead to some special problems in three-phase systems. In a three-phase four-wire systems, harmonic currents can lead to large currents in the neutral conductors, which may easily exceed the conductor rms current rating. Harmonic currents tend to flow through shunt-connected power factor correction capacitors. The capacitors may overheat and fail when they are exposed to significant harmonic currents.

The active approaches have proven to be very effective [1–5]. Three single-phase active power filters (APF) can be used for this propose. However, a conventional three-phase, three-wire APF cannot be used in a three-phase four-wire system to eliminate harmonics on the neutral wire. The process of filtering is done in the time domain which is based on the principle of holding the instantaneous source voltage or current within some reasonable tolerance of a sine wave. The harmonic components are compensated instantaneously using current control technique.

The past decade had seen a dramatic increase in interest in neural network systems. The application of neural networks promises high computation rate provided by the massive parallelism, a great degree of robustness or fault tolerance due to the distribution representation, and an ability for adaptation, learning, and generalization to improve performance. Today neural networks are actively explored in artificial

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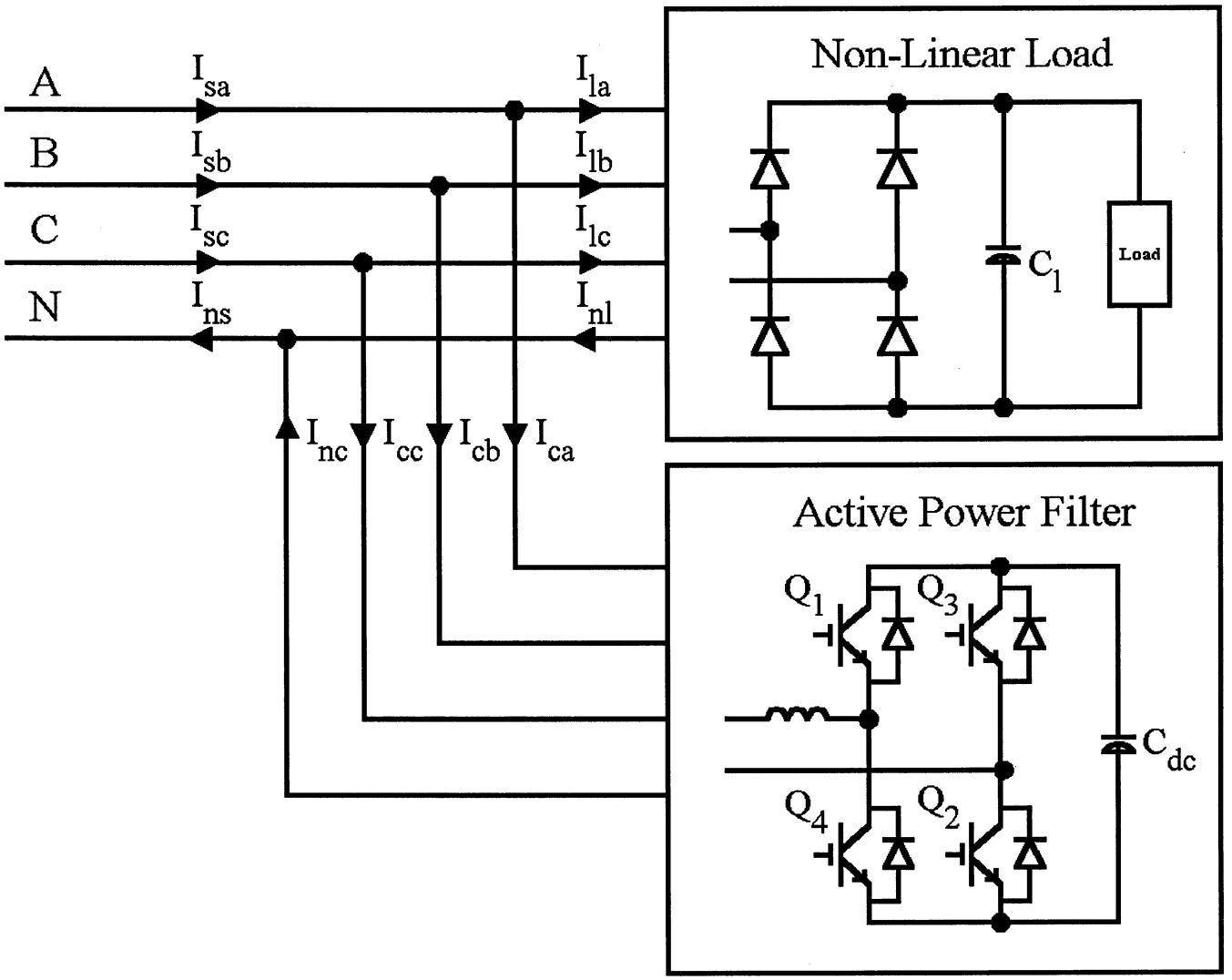

Fig. 1. An APF and nonlinear loads considered in this paper.

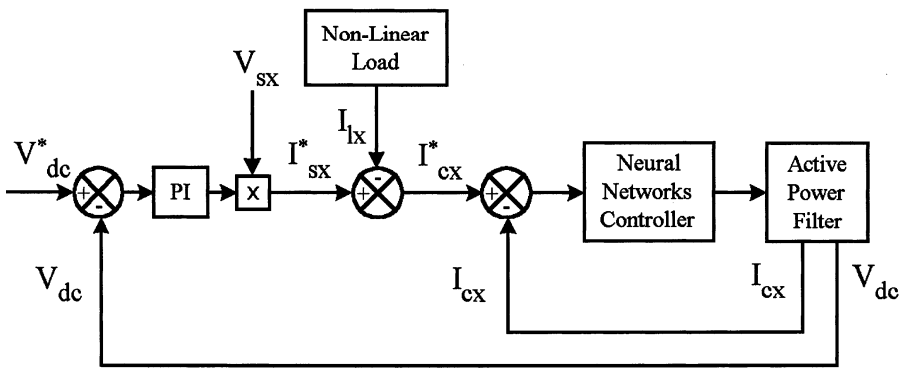

Fig. 2. A controller for APF.