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ORIGINAL ARTICLE

Fuzzy logic controller for three-phase four-leg five-level shunt active power filter under unbalanced non-linear load and distorted voltage conditions

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Abstract This paper presents a five-level inverter which is used as a three-phase four leg shunt active power filter, taking advantages of the multilevel inverter such as low harmonic distortion and reduced switching losses. It is used to suppress harmonic current, compensate reactive power and neutral line current and balance the load currents under unbalanced non-linear load and distorted voltage conditions. The active power filter control is essentially based on the use of self tuning filters for the reference current generation and a fuzzy logic current controller. This study is divided in two parts. The first one deals with the harmonic isolator which generates the harmonic reference currents. The second part focuses on the generation of the switching pattern of the inverter by using a fuzzy logic controller applied and extended to a four leg five level shunt active power filter. The MATLAB Fuzzy Logic Toolbox is used for implementing the fuzzy logic control algorithm. The performance of the proposed shunt active power filter controller is found considerably effective and adequate to compensate harmonics, reactive power and neutral current and balance load currents under distorted voltage conditions.

Keywords Four-leg active power filter · Harmonics isolator · Distorted voltage conditions · Self-tuning filter · Fuzzy logic control

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1 Introduction

The broadness of static converters in industrial activities and public consumers leads to an increase in harmonic injection in the network and a lower power factor. This causes various problems in power systems and in domestic appliances such as equipment overheating, capacitor blowing, motor vibration, excessive neutral currents and low power factor. Active power filter involving two levels voltage source inverters have been widely studied and used to eliminate harmonics and compensate reactive power (Akagi 1994). Due to power handling capabilities of power semiconductors, these active power filters are limited in medium power applications. Then hybrid topologies have been proposed to achieve high power filters (Chiang et al. 2005; Wanfang et al. 2003). The interest in using multilevel inverters for high power drives, reactive power and harmonics compensation has increased (Vodyakho et al. 2008). Multilevel pulse width modulation inverters can be used as active power filter for high power applications solving the problem of power semiconductor limitation. The use of neutral-point-clamped (NPC) inverters allows equal voltage shearing of the series connected semiconductors in each phase.