ACTIVE HARMONICS COMPENSATOR FOR THREE-PHASE SYSTEMS WITH NEUTRAL CONNECTION

CLAUDIO BUSADA, GUSTAVO BORTOLOTTO
Dto. de Ingeniería Eléctrica, Universidad Nacional del Sur, Av. Alem 1253 - (8000) Bahía Blanca, Argentina
e-mail: cbusada@criba.edu.ar

Abstract — An active filter is presented. The filter is able to compensate harmonic currents created by non-linear loads in each of the phases of the utility. The filter also eliminates the circulation of harmonics in the utility neutral line. A method is proposed to obtain the fundamental load voltage and current components in each phase. No phase lags or amplitude errors are introduced in the estimation, even for bounded utility frequency deviations.

Keywords — Active filters, Harmonic Currents, Power Electronics, Inverter.

I. INTRODUCTION

Proliferation of non-linear loads such as adjustable speed drives connected to the main supply affect the quality and the efficiency of the distribution. This is due to the large harmonic currents produced by these devices. Frequently, in loads with neutral connection, the summation of the phase harmonic currents is not null, and in many cases the amplitude of these currents is higher in the neutral line than in the individual phases. This produces energy losses and overheating in the neutral line.

The drawbacks of using passive LC filters to eliminate the harmonic currents are well known (Morán et al., 1995). To circumvent the problem, the use of active power filters (Thanh-Nam Lê, 1991; Y. Komatsu et al., 1997; Dixon et al., 1997; Morán et al., 1995; Dixon et al., 1995) has steadily increased. These filters can be used at the same time to compensate the load power factor.

Comprehensive surveys of the state of the art in active filter topics can be found in B. Singh et al., 1999, and H. Akagi, 1996. Most often, active filters are designed to compensate harmonics in three-phase systems without neutral connection, applied to balanced or unbalanced loads. In this paper an approach that allows the compensation of harmonics in three-phase four wire systems is presented. Previous works in this field can be found in N. Aredes et al., 1997, and in P. Verdelho et al., 1998, where a space-vector-based current controller is presented.

It is customary to use bandpass filters (Aredes et al., 1997) to extract the fundamental component of the current, and perform the compensation based on that information. This approximation is sensitive to variations in the source frequency. Another approach overcomes this difficulty using tunable filters with an external PLL that locks exactly to the net frequency (Bhattacharya et al., 1996, second strategy presented by Aredes et al., 1997).

The method described in this paper allows to obtain the fundamental components of phase voltages and currents with negligible phase distortion or amplitude errors, irrespectively of bounded variations in the line frequency, and without using an additional PLL.

The harmonics compensation is performed individually on each phase, canceling consequently the harmonic currents returning from the load on the neutral line. The active filter is implemented with a three-leg inverter connected to the load via three inductors $L_i$, as shown in Fig. 1.

![Figure 1. Active filter block diagram](image-url)