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Significant insights into the operation of DC-link voltage control of a shunt active power filter using different control algorithms: a comparative study

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Abstract: A comparative study between a conventional DC-link voltage control algorithm (CDVCA) and a self-charging DC-link voltage control algorithm (SDVCA) is presented. It focuses on the principle operation of both algorithms and their impacts on the performance of a shunt active power filter (SAPF) operation. All analyses are based on the step response of DC-link voltages under different start-up times of the SAPF and different initial DC-link voltage values. Other considered parameters are the ripple factor (RP) of DC-link voltages, estimated and measured DC-link charging currents, and total harmonic distortion (THD) value of supply currents. Thus, this study provides new insights into the operation of DC-link voltage control using different control algorithms. According to the simulation results, the SAPF using the SDVCA has shown better performance than using the CDVCA. By using the SDVCA, the charging process of a DC-link capacitor starts almost instantaneously. Additionally, the overshoot, settling time, and RF of DC-link voltages are reduced. Other than that, THD values of supply currents are improved, by generating low ripple of estimated DC-link charging currents. Experimental validation of the SAPF using the SDVCA is also presented.

Key words: Conventional DC-link voltage control, harmonic compensation, self-charging DC-link voltage control, shunt active power filter

1. Introduction

Shunt active power filters (SAPFs) are globally accredited as the most effective tools in suppressing multiple harmonic currents simultaneously. These filters are used to inject specific compensation currents for harmonic current cancellation. Consequently, the shape of distorted supply currents can be reformed to be fully sinusoidal wave shapes. The compensated supply currents consist of almost fundamental components.

The operation of SAPFs depends fully on their control algorithms for current control and DC-link voltage control. However, the current research trends are more concerned with designing or improving current controllers (i.e. fuzzy-adaptive hysteresis controller [1]), voltage controllers (i.e. type-2 fuzzy-proportional-derivative (fuzzy-PD) controller [2], approximated fuzzy-PD controller [3], and proportional-integral (PI) controller with particle swam optimization [4]), and developing new methods of generating SAPFs' reference currents (i.e. ANN-based phase locking [5], ANN based p-q theory [6], and Fryze current computation method [7]). Therefore, this work

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