

Fuzzy Logic-Based Control for Shunt Active Power Filter using Instantaneous PQ Theory

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Abstract: The extensive use of power electronics devices in power systems, including rectifiers and inverters, presents considerable issues regarding power quality. One problem is the creation of current and voltage harmonics, which result in load waveform distortion, voltage fluctuation, voltage drop, and equipment overheating. Harmonic current sources are prevalent in commercial, institutional, and medical establishments, encompassing computer power supplies, fluorescent lights with electronic ballasts, elevator motors, and electrical devices using switch-mode power supplies. Active power filters (APF) represent the most effective method for harmonic reduction and may be used across many applications. This study employs a digital active power filter to eliminate harmonics from the source current in a grid system characterized by non-linear demand. Nonlinear loads are essential components of every power system. The advent of power electronics has resulted in switching components constituting a substantial portion of electrical demand. These features create discontinuities in lines, exacerbating line losses and diminishing power quality and sine wave integrity. Passive filters effectively eliminate harmonics at specified frequencies within the design. Active filters, conversely, operate in accordance with the prevailing harmonics. This work develops a shunt active power filter that mitigates current harmonics generated by non-linear loads. The active filter includes a voltage source converter (VSC) that functions in conjunction with a DC coupling capacitor. The VCS delivers power at the point of common coupling (PCC). The reference current is obtained by the instantaneous power theory. The instantaneous power theory, or PQ theory, has been enhanced with the FIS control system to optimize DC voltage generation over the DC link capacitor. The fuzzy system substituting the PI controller has a 49-rule base structure organized in a 7x7 configuration for the generation of error signals. A comparative study of DC voltage and total harmonic distortions (THDs) is conducted using MATLAB software and the FFT analysis tool.

Keywords: Active Power Filter, Instantaneous Power Theory, Harmonics, Non-Linear Load, MATLAB Simulink and FFT analysis tool, PI Controller, Fuzzy logic Controller

