PLL-less SRF technique for operation of SAPF under unbalanced and distorted supply voltage

ABSTRACT

Shunt active power filter (SAPF) has been recognized as a feasible solution to current harmonics issues. In its controller, due to structure simplicity, synchronous reference frame (SRF) technique is best suited to be applied in generating reference current. However, the existing SRF algorithm performs inefficiently due to limitations of numerical low-pass filter (LPF). Besides, the existing algorithm is as yet considered to have excessive features which are not required in the procedure of generating reference current. Most importantly, its dependency on traditional phase-locked loop (PLL) has greatly degraded its effectiveness when the source voltage is unbalanced and/or distorted. Therefore, this paper presents a PLL-less SRF algorithm for generating reference current to effectively control performance of a SAPF developed based on three-level neutral-point-clamped (NPC) inverter. Specifically, three notable refinements are implemented: (1) eliminate the traditional use of LPF by replacing it with a mathematical-based average current detector; (2) reduce algorithm complexity by removing excessive features; (3) eliminate synchronization error of PLL by integrating a new self-tuning-filter (STF)-based synchronization technique. The proposed algorithm is created and assessed in MATLAB-Simulink. Simulation and experimental results are provided, demonstrating superiority of the proposed PLL-less SRF algorithm over the existing SRF algorithm.

Keyword: Active filter; Harmonics mitigation; Power quality; Reference current generation; Synchronizer