Novel Control Algorithms for Inverter-Based Custom Power Conditioners

by

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Abstract

Power electronic conditioners have been proved to be an effective way to compensate for different current and voltage disturbances in distribution systems. These Custom Power (CP) conditioners, offer flexible solutions for Power Quality (PQ) problems. The challenge in applying CP devices is the calculation of the required compensating signals. The motivation for focusing on adaptive extraction techniques is to overcome the drawbacks of the analogue LPF and HPF. Although the LPF or HPF are easy to implement with analogue circuits, they are characterized by their low detecting precision, sensitivity to change in their circuit parameters, poor adaptation, and their introduction of gain and phase errors in detecting signals. However, the computational burden of the adaptive techniques complicates their implementation requirements. In this sense, control algorithms are required that are capable of tracking and extracting the PQ disturbance, and then constructing the compensating control signal of the CP conditioner.

This thesis presents efficient control algorithms for the inverter based CP devices to compensate for various PQ problems. The proposed techniques are adaptive, feedforward, and simple in overcoming the deficiencies of the available control strategies. One proposed control strategy is based on the instantaneous tracking of the voltage envelope to compensate for the voltage disturbances such as flicker and sag. Both the adaptive linear combiner (ADALINE) algorithm and the Recursive Least Square (RLS) algorithm are utilized for the on-line tracking of the voltage envelope. The difference between the estimated envelope and the required voltage level is used to drive the Distribution STATic synchronous COMpensator (DSTATCOM) to inject the required reactive power to compensate voltage fluctuations.

Another control strategy which is based on the estimation of the symmetrical components is also designed. Novel Multi-Output (MO) structures are developed for both the ADALINE and the RLS algorithms to enable the estimation of the symmetrical components. A processing unit to estimate the harmonics and symmetrical components, as well as to resolve the fundamental positive sequence component to its active and reactive parts, is introduced. This processing unit is employed to control the Dynamic Voltage Restorer (DVR) to compensate for various PQ problems related to the voltage.

The new era of deregulation accounts for the proliferation of Distributed Generation (DG). The increasing trend to utilize DG in distribution systems motivates the development of a new CP device, which is called the Flexible DG (FDG). This proposed FDG utilizes the existing inverter link of distributed resources such as fuel cells, photovoltaics, and micro-turbines to not only control the active power flow, but also to mitigate unbalance, harmonics, flicker and sag and to manage the reactive power of the system. The FDG is similar to the FACTS, but works at the distribution level. The proposed processing unit is further employed to coordinate the different functions of this new CP device.

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