Abstract

Harmonics compensations have become increasingly important in power systems due to wide spread use of adjustable speed drives (ASD), arc furnace, SMPS, UPS etc. Harmonics not only increase the losses but also produce unwanted disturbance to the communication network, more voltage and/or current stress etc. Passive filters tuned at desired frequencies are used in the past to overcome such problems. However, with the availability of low cost and versatile switching devices and also low cost controller ICs such as DSP, FPGA etc., the active power line conditioners are gradually replacing their passive counterparts. This thesis has put some effort to investigate on shunt type active power filters (APF). All the three important aspects of an APF, such as, reference-generation-technique, tracking and topological issues are treated in depth. Understanding that the compensation of reactive power is also a very crucial issue for power system stability, provisions are made such that the APF may be operated as a static compensators (i.e. STATCOM) if required. Special topologies suitable for such applications are explored. Note that an APF must know the nature of current that has to be injected into the point of common coupling (PCC). It is also important to estimate such reference-current quickly in case of a dynamic or fast-changing type of loads. Such current estimation algorithm needs to be sufficiently immune to the distortion in source voltage, variation in grid frequency and also to severe unbalance in loads (such as single-phasing). Three different methods to generate the reference currents have been proposed in this work. The dissertation starts with genetic algorithm (GA) and proceeds further to include two more artificial neural network (ANN) based approaches to fast estimate the reference current. The dynamics of the variation of voltage across the DC link capacitor is studied and a predictive algorithm based on such variation is proposed. The predictive controller is followed by an adaptive tuning (using adalines) to find the reference current and also to regulate the DC link voltage. Note that the voltage source inverter (VSI) needs to track the reference current to inject the right nature of current. A sliding mode controller (SMC) is designed for such purpose. The SMC has the merits of immunity to parameter variation, robustness and stability. While several topological alternatives are exploited in APF, use of two inverters: one to eliminate low order harmonics (LOH) and the other for higher order harmonics, have some advantages. The thesis has presented the operation of two hybrid topologies in parallel. As an extension the reduced switch version of the topology

is also investigated. All the proposed concepts are simulated in MATLAB/SIMULINK and experimentally verified in a laboratory prototype using dspace1104.