ABSTRACT

The wide spread use of non-linear loads such as adjustable speed drives, silicon controlled Rectifiers, furnaces, and uninterruptible power supplies (UPS) inject harmonics into the power system. The non-linear loads draw harmonic and reactive power components of current from the supply. The presence of harmonics may leads to equipment overheating, capacitor blowing, motor vibration, excessive neutral current and low power factor. They also cause harmful disturbance to other sensitive electronic devices and produce interference to nearby communication networks.

To alleviate these problems, conventionally passive filters have been used. However, the passive filters have the demerits of fixed compensation, bulkiness and occurrence of resonance with other elements. Also, in practical applications, the amplitude and the harmonic content of the load current can vary randomly; under such conditions the conventional solution becomes ineffective.

With recent developments in power electronic switches, the Active Power Filters (APFs) have been applied to mitigate the problems created by non-linear loads. One of the most commonly used active filters is the Shunt Active power Filter (SAF) which is used to eliminate the unwanted harmonics and compensate reactive power consumed by non-linear loads by injecting the compensation currents into the AC lines.
The most important task in the development of Shunt Active Filter is the implementation of the current control strategy to derive switching pulses for the Voltage Source Inverter (VSI). Hysteresis current control is the most commonly used method for current control, due to its simplicity in implementation. But, it has the drawbacks of variable switching frequency, high current ripples and acoustic noise. In this thesis, a constant frequency hysteresis current control (CFHCC) technique is proposed to overcome the drawback of the conventional hysteresis control, namely variable switching frequency. The proposed method generates switching pulses based on the value of current error and its slope and the past switching ON/OFF time of the switches in the inverter. The instantaneous p-q theory is used to extract the reference compensation current.

In three phase four-wire system, the single phase loads connected between the phase and neutral cause system unbalance and injects triplen harmonic currents which add up arithmetically with the neutral current. To compensate harmonics and cancel the neutral current, a shunt active filter with fuzzy logic based adaptive hysteresis current control technique is developed. Here the hysteresis bandwidth is varied such that the switching frequency of the inverter is kept constant. The fuzzy-adaptive hysteresis band current controller changes the hysteresis bandwidth based on the supply voltage and the slope of the reference compensator current wave. This control technique maintains a constant switching frequency and it results in reduced switching losses compared to the conventional hysteresis control technique. In this case, the modified instantaneous p-q theory is applied for calculating the reference compensating current since the conventional p-q theory fails to extract the reference current under unbalanced voltage condition.
In practical applications, as the load on the power system varies, there is a need to design an active power filter, which is capable of maintaining the THD limit within the IEEE norms under variable load conditions. A fuzzy logic based PWM current control technique is developed to eliminate harmonics and compensate reactive power under varying load conditions. The performance of the shunt active filter with the proper control strategy is good since the controller does not need an accurate mathematical model; it can work with imprecise inputs and can handle nonlinearity. The performance of the controller is tested for unbalanced voltage and changing load condition. Also, a fuzzy logic-based controller is developed to control the DC voltage of the capacitor.

The presence of noise is unavoidable during the measurement of voltage and current in power system. The performance of the time domain approaches for reference current extraction like p-q theory deteriorates in the presence of noise. A Wavelet Transform based approach is developed to extract the compensating current under noisy voltage condition. In this approach, first the wavelet co-efficients are evaluated from the noisy load current and the signal is reconstructed from the derived coefficients to get the fundamental reference current.

Computer simulations are carried out on a sample power system to demonstrate the effectiveness of the proposed control strategies and reference current extraction techniques for different source and load conditions. Finally, an experimental prototype is built for the proposed controller in DSP platform using TMS320LF2407A processor. The implemented hardware is tested for ideal source voltage condition.