Single-Phase Shunt Active Power Filter with Adaptive Neural Network Method for Determining Compensating Current

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An advanced single-phase active power filter for the compensation of instantaneous harmonic current components in non-linear current load is presented in this paper. A novel signal processing technique using adaptive neural network algorithm is applied and evaluated for the on-line detection of instantaneous harmonic current components generated by non-linear current loads and it can efficiently determine the instantaneous harmonic components in real time. The validity of this active filtering processing system to compensate instantaneous current harmonics is proved on the basis of simulation results.

In adaptive estimation of harmonic current components by neural network, distorted load current is sampled uniformly and one sample is taken at a time. The sampled values are used to determine the magnitude and phase of fundamental and harmonic current components through the adaptive neural network circuit. The objective function of neural network is used to minimize the error that is the difference between the measured samples of the load current $d_k$ at time $t_k$ as shown in Fig. 1 and the output of the neural circuit generated in the adaptive way. In this method, one sample is taken and the corresponding harmonic and fundamental component are determined through neural circuit and is sent back and these values are used for calculation when the next sample is taken. In this fashion, the harmonic current components can be determined within one time period of the fundamental component. Neural circuit for adaptive estimation of $A_l$ and $B_l$ (harmonics current components) is show in Fig. 1.

The harmonic current compensation by active power filtering is implemented in a single-phase power system with the utility power supply voltage of 110 V and current source single-phase diode-bridge rectifier with inductive load as the harmonic current compensation object. The adaptive neural network circuit is implemented using programming language but in practical case it can be implemented through digital signal processing and sampling frequency used was 10 kHz. The compensating current waveform estimated by proposed adaptive neural network is illustrated in Fig. 2. Fig. 2 also demonstrates that adaptive neural network method can exactly keep track the harmonic current components. The utility power source current after the harmonic compensation is shown in Fig. 2. Observing the waveform of the source current after the compensation it can be stated that source current is sinusoidal and instantaneous harmonic currents are compensated quite accurately. The THD is also computed in load current as well as in AC power supply current. The THD is 23.34% before harmonic compensation in load current and 3.24% in utility AC power supply current after harmonic current compensation that is within the specific limit of the harmonic standard regulated by IEEE.

The average switching frequency of the inverter is selected as 10 kHz and thus theoretically it can compensate up to 200th harmonic current components. In order to obtain the best performance from the APF, the system is also tested in transient condition and shows promising result.

Because of the magnitude and phase determination by this proposed adaptive neural network method, it could be implemented not only for harmonic current component correction but also for power factor correction in the nonlinear load.