CHAPTER 9

CONCLUSION

In this thesis the proliferation of power electronic converters on the power systems and its impact on the power quality, especially the harmonic distortion is addressed. A detailed discussion is carried out on the harmonic distortion, its origin, the detrimental effects and the mitigation techniques. A comprehensive survey of literature is made on the harmonics. The objectives of this thesis are fulfilled by developing an efficient and reliable approach for harmonic estimation and elimination methods to improve the power quality in the power electronic converters for both supply current and load voltage harmonics. A summary of the major contributions of this work is presented in the following sections.

9.1 DEVELOPMENT OF AN EXPERT SYSTEM TO IDENTIFY AND ESTIMATE HARMONICS PRODUCED BY POWER ELECTRONIC CONVERTERS

An improved model is proposed to identify the harmonic distortion produced by the different types of power electronic converters. The rules are derived to identify harmonics produced by single phase, three phase fully controlled AC-DC converters, and single phase voltage source inverters. The proposed model provides automatic and intelligent identification of harmonic current/voltage originating from power electronic converters. FFT and fractal analyses of the current waveforms of the nonlinear loads have been carried out to obtain the harmonic characteristic features of the loads. Each type of
power electronic converter is tested for both hardware and simulated models. The simulated results are very close to hardware results for all the important performance parameters.

9.2 HARMONIC ELIMINATION OF SUPPLY CURRENT IN AC-DC CONVERTERS

The line commutated AC-DC converters are widely used in all kinds of industrial and domestic utilities, which produce a distorted supply current. The causes and effects of the distorted supply current are presented. The possible active power filter solutions are addressed. To eliminate the supply current harmonics two different methods are proposed.

In the first method an improved neural network based shunt active power filter is proposed to eliminate the harmonics in a highly distorted line current by creating and injecting appropriate compensation current. The simulation was carried out for single phase and three phase fully controlled converters. In the test cases simulated for different firing angles, the THD of the supply current is improved to less than 5% with the proposed shunt active power filter. In addition to this the simulation was carried out for the additional nonlinear loads (single phase half controlled converter) and the THD in the supply current is also improved to less than 5%. The performances reached by the proposed method are better than those obtained by more traditional techniques.

In the second method the shunt active power filter is implemented by using a conventional PWM based inverter and a new three-phase 11-level cascaded voltage source inverter for harmonic elimination. Their simulated results are verified and compared for the harmonically polluted 500kVA, 11kV, 50Hz power system utility. The comparison results have shown that the
proposed new shunt active power filter provides high quality of both source voltages and currents to the power system utility than the conventional PWM based inverter approach. Simulation results show the validity of the proposed control scheme. The total harmonic distortion for the voltage and current are within the IEEE standards. It has been shown in this project, that the proposed shunt APF is only given a better solution and most suitable for both harmonics mitigation and reactive power (var) compensation in power distribution systems, especially for medium/higher-voltage and high-power applications. In future an 11 level cascaded multilevel inverter based shunt active power filter to be implemented using DSP processors.

9.3 SELECTIVE HARMONIC ELIMINATION IN SINGLE PHASE VOLTAGE SOURCE INVERTERS

A simple and effective minimization technique, to solve the selective harmonic elimination using computed PWM control method for single phase voltage source inverter has been discussed. By solving the harmonic equations, the values of notch angles are obtained, which control the switching instants of the PWM wave. The switching angles obtained by these methods to eliminate harmonics are not as accurately as obtained through the computed PWM technique. The PWM wave generated by the computed PWM technique takes less time when compared to the sine-triangular comparison method. The computed method was applied to developed inverter with 3<N<9 the modulation index of 1.0. The selective harmonic elimination was carried out effectively for all the values of N. The same thing can be extended for other values of modulation index values. The variation of the fundamental RMS voltage for the modulation index value between 0.1 and 1.0 for N=3 is shown and it was found that it is decreasing as the modulations decreases. All the simulation results were upheld with hardware results.
In the next part, the implementation of the selective harmonic elimination is carried out using artificial neural networks and it has many advantages over the conventional techniques. In ANN approach the complex iterations involved in Newton Raphson’s method are eliminated. Using the Back propagation algorithm the net can be trained to give sufficiently accurate notching angles. The conventional lookup table method involves larger memory which is not required in case of neural net. After the weights of the neural net are determined, the net can be implemented online. Parallel neuron units enable parallel processing by reducing the computation time significantly in real time. In this approach the computation time is reduced by 97.32% for N=3 and 96.49% for N=9 respectively. The notching angles thus obtained after training of the network using the direct training method are satisfactory which could be seen clearly in the results produced for both simulation and hardware.

9.4 PERFORMANCE ANALYSIS OF THREE LEVEL DIODE CLAMPED INVERTER WITH TWO LEVEL VOLTAGE SOURCE INVERTER

The important features of using multilevel inverters are discussed. The increase in output voltage does not require an increase in voltage rating of individual switching devices. The three level diode clamp inverter is discussed in detail with experimental results to verify the simulated results. The performance of the proposed three level diode clamp inverter is compared with the conventional two level inverter for both experimental and simulated results. The three level inverter, total harmonic distortion reduced by 57.38% as compared with two level inverter.