Chapter 6
Conclusion and Future Scope

6.1 Conclusion

With a fast increasing number of applications of industry electronics connected to the distribution systems today, including nonlinear, switching, reactive, single-phase and unbalanced three-phase loads, a complex problem of power quality evolved characterized by the voltage and current harmonics, unbalances, low Power Factor (PF).

In recent years active methods for power quality control have become more attractive compared with passive ones due to their fast response, smaller size, and higher performance. For example, Static VAR Compensator (SVC) has been reported to improve the power factor; Power Factor Corrector (PFC) and Active Power Filters (APF) have the ability of current harmonics suppression and power factor correction. In general, parallel-connected converters have the ability to improve the current quality while the series-connected regulators inserted between the load and the supply, improve the voltage quality.

In this dissertation thesis various power quality problems and the available solutions have been discussed briefly while the shunt APF, series APF and the unified power quality conditioner (UPQC), which consists of series and shunt active filters, have been discussed in detail. The modeling of shunt APF, series APF and the UPQC has been carried out. The shunt APF, series APF, and the UPQC have been simulated, using the hysteresis control, for two types of loads one the RL type and the other is DC machine with variable torque using the SIMPOWERSYSTEM (SPS) of MATLAB/SIMULINK models.

The simulation results show that shunt APF, series APF and the UPQC can be used for effectively improving the power quality of an electrical power system. The shunt APF has been used for compensating the source current harmonics and it reduces the source current THD from 21.83 % to 0.42 % for RL load and from 25.43 % to 2.03 % for DC machine load which shows that the quality of source current improves sharply. The series APF has been used for compensating the load voltage harmonics and it reduces the load voltage THD from 15 % to 1.01 % for RL load and 0.88 % for DC machine load which shows that the load voltage quality improves sharply. Similarly, the UPQC which has been used for compensating the source current and load voltage harmonics simultaneously reduces the source current THD from 14.76 % to 0.17 % for RL load and from 23.22 % to 0.28 % for DC machine load and the load voltage THD is reduced from 15 % to 4.33 % for RL load and 3.74 % for DC machine load which shows that using the UPQC the power quality improves effectively. And hence the UPQC can effectively be used for improving the power quality.

6.2 Future Scope

In high power applications, the filtering task cannot be performed for the whole spectrum of harmonics by using a single converter due to the limitations on switching frequency and power rating of the semiconductor devices. Therefore, compensating the reactive harmonic components to improve the power quality of the DG integrated system as well as to avoid the large capacity centralised APF, parallel operation of multiple low power APF units are increasing. Like APF, UPQC can also be placed at the PCC or at a high voltage distribution line as a part of DG integrated network or in microgrid system to work both in interconnected or islanded mode. At this place, capacity enhancement is achieved by using Multi-level topologies to reach the higher power levels.

These options are as follows:

i. Multi-level converter based UPQC

ii. Multi-module converter based UPQC

iii. Multi-module (power cell) unit based UPQC

A multi-level converter is proposed to increase the converter operation voltage, avoiding the series connection of switching elements. However, the multilevel converter is complex to form the output voltage and requires an excessive number of back-connection diodes or flying capacitors or cascade converters.

A multi-module H-bridge UPQC can also be connected to the distribution system without series injection transformers. It has the flexibility in expanding the operation voltage by increasing the number of H-bridge modules isolated through a single-phase multi winding transformer.

These Multi-module techniques allow the symmetrical distribution of the load power among the components of the topology, but the classical design procedure must be modified or refined to ensure the power cell components should be within its maximum ratings. Therefore, a new design procedure of UPQC with a feature of extending capacity based on a modular approach is presented

It is found that research in recent years has placed more emphasis on CPDs, especially on UPQC, and its application in DG or microgrid system. Capacity enhancement has been achieved using multi-level or multi-module and central control mode, however, the flexibility of UPQC to increase its capacity in future and to cope up with the increase load demand in low voltage distribution level has not been achieved.