Scientific Journal Impact Factor (SJIF) : 5.278
International Journal of Modern Trends in Engineering and Research
IJMTER
ISSN (ONLINE) : 2349 - 9745
ISSN (PRINT) : 2393 - 8161

Reduction of harmonic distortion in a microgrid by using ANN and Shunt Active Power Filter Techniques

Ms. Rupali Ravindra Bairagi[*1], Mr. Korake Dattatray Manohar [*2]

[1,2]*Karmayogi polytechnic college Shelve*

Abstract— Power quality is often outlined because the power grid's ability provide to provide to produce a clean and stable power flow as a constantly out there power supply. the facility flow ought to have a pure curving wave form and it ought to stay within given voltage and frequency tolerances. No real-life power supply is good. In this abstract, planned a method for standardization a static power unit compensator for voltage control and reduction of harmonic distortion during a micro grid by using Artificial Neural Network (ANN) and Shunt Active Power Filter Techniques. to increase the performance of the standard controller and benefit of sensible controllers, a feed forward-type (trained by a back-propagation algorithm) ANN-based technique is enforced in shunt active power filters for producing the controlled pulses needed for IGBT electrical converter. This synopsis presents another plan of decreasing current harmonics at the supply aspect of many non-linear loads utilizing and ANN controller.MATLAB/Simulink based mostly simulation results demonstrate satisfactory performance of the given system

Keywords— Microgrid,ANN,SAPF,Non linear load

I. INTRODUCTION

Power quality is a simple term, yet it describes a multitude of issues that are found in any electrical power system and is a subjective term. The concept of good and bad power depends on the end user. If a piece of apparatus functions satisfactorily, the user feels that the power is good. If the equipment does not function as intended or fails prematurely, there is a feeling that the power is bad. In between these limits, several grades or layers of power quality may exist, depending on the view of the power user. The understanding of power quality issues is a The most common types of Power Quality problems are presented below Voltage sag (or dip)

i. Very short interruptions

ii. Long interruptions

iii. Voltage spike

iv. Voltage swell

v. Harmonic distortion

vi. Voltage fluctuation

vii. Noise

viii. Voltage Unbalance

The active power filter topology can be connected in series or shunt or combination of both. Shunt active filter is more well-known than series active filter in light of the fact that the vast majority of industries require harmonic current compensation. Various sorts of active filters have been proposed to build the quality of the power system. The characterization depends upon the following measures

• System parameters to be compensate (for example harmonic currents, power factor and harmonic voltages)

• Technique utilized for evaluating the fundamental current And voltage.

Voltage source inverters which are current controlled can be used with a proper control system to accomplish the active power filter effectively. Power systems are designed to function at frequencies of 50 or 60 Hz. However, some loads can produce voltages and currents with frequencies greater than the fundamental frequency of 50 or 60 Hz. Electric pollution namely, Harmonic distortion can be caused due to this higher frequency components there are two types of harmonics present in a power system:

• Synchronous harmonics

• Asynchronous harmonics

Harmonics are aware to musicians like the nuances of an instrument. These are the integer multiples of the fundamental frequency of the instrument which are formed by a series of standing waves of increasing order. Exactly the same operation occurs in power circuits where non-linear loads create harmonic currents which are integer multiples of the

Fundamental supply frequency.

Active power filters (APF) have the function of generating harmonic currents or voltages so that the network current or the voltage waves retain the original sinusoidal form. The APF can be connected in series (Series APF), shunt (SAPF) to compensate for voltage or current harmonics respectively. Or it can be combined with passive filters to build the hybrid filters (HAPF) which can mitigate both current and voltage harmonics. Active filters are quite new to the world of harmonic removal devices. This type of filters is based on power electronic devices and is much costlier than passive filters. They are used in difficult times where the passive filters do not work properly due to resonance problems and they do not have interference with other elements installed anywhere in the power system. Active filters have many other advantages over the old-style methods of harmonic compensation such as:

- Adapting with the change of the loads.
- Selective compensation of harmonics is possible.
- Limitations of the power compensation.
- Compensation of reactive power is possible

Micro grid:

Converters and are connected to the electrical grid through Micro grid is the cluster of small renewable energy sources and its range is from 100 to 200kW. In earlier days the generating units are in one place and the generated power is transmitted to the load through a long transmission and distribution system, hence there will be a power loss due to long transmission line and the power demand is high which leads reduction in efficiency of the system .In order to overcome the drawbacks of conventional electrical grid system the concept of micro grid system was proposed. Here the general diagram for micro grid system with shunt active power filter was shown in Fig.1.It consists of small micro sources such as PV, battery and wind interconnected with main electrical grid system, AC bus, DC bus, linear and non -linear loads. The micro sources are connected to DC bus bar through power AC bus bar. This system consists of many feeders in which micro sources and different loads are connected. Feeder A consists of PV as an electrical source and is directly connected with DC bus. Feeder B has battery as micro source and Feeder C has wind turbine as its electrical source and is connected to DC bus through AC-DC converter. Loads are connected to AC bus line which may be linear and non-linear loads. The power quality of the system can be improved by interconnecting shunt active power filter in between source and load at the Point of Common Coupling (PCC).

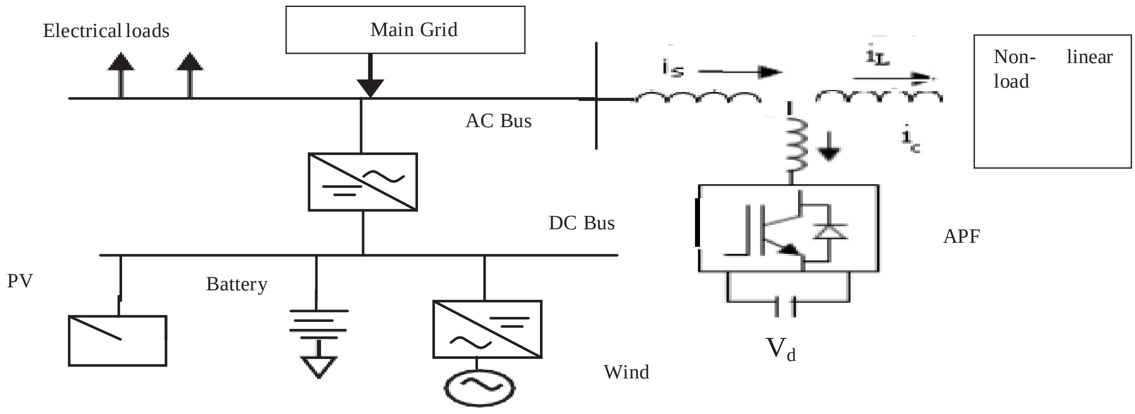


Fig. 1.General diagram of microgrid with shunt active power filter

II.LITERATURE REVIEW

Below could be a literature review of works distributed in previous few years for implementation

[1] J. H. R. Enslin and P. J. M. Heskes, "Harmonic interaction between large number of distributed power inverters and the distribution network," IEEE Trans. Power Electron., vol. 19, no. 6, pp. 1586–1593, Nov. 2004.

- Power quality problems associated with distributed power (DP) inverters, implemented in large numbers onto the same distribution network, are investigated. Currently, these power quality problems are mainly found in projects with large penetration of photovoltaic (PV) on rooftops of houses and commercial buildings. The main object of this paper is to analyze the observed phenomena of harmonic interference of large populations of these inverters and to compare the network interaction of different inverter topologies and control options. These power quality phenomenon's are investigated by using extensive laboratory experiments, as well as computer modeling of different inverter topologies. A complete network simulation study on an existing residential network with large penetration of PVs is included.

[2] U. Borup, F. Blaabjerg, and P. N. Enjeti, "Sharing of nonlinear load in parallel-connected three-phase converters,"IEEE Trans. Ind. Appl., vol. 37, no. 6, pp. 1817–1823, Nov./Dec. 2001

In this paper, a new control method is presented which enables equal sharing of linear and nonlinear loads in three-phase power converters connected in parallel, without communication between the converters. The paper focuses on solving the problem that arises when two converters with harmonic compensation are connected in parallel. Without the new solution, they are normally not able to distinguish the harmonic currents that flow to the load and harmonic currents that circulate between the converters. Analysis and experimental results on two 90-kVA 400-Hz converters in parallel are presented. The results show that both linear and nonlinear loads can be shared equally by the proposed concept.

[3] P. Jintakosonwit, H. Fujita, H. Akagi, and S. Ogasawara,"Implementation and performance of cooperative control of shunt active filters for harmonic damping throughout a power distribution system," IEEETrans. Ind. Appl., vol. 39, no. 2, pp. 556–564,Mar./Apr. 2003.

This paper proposes the cooperative control of multiple active filters based on voltage detection for harmonic damping throughout a power distribution system. The arrangement of a real distribution system would be changed according to system operation, and/or fault conditions. In addition, shunt capacitors and loads are individually connected to, or disconnected from, the distribution system. Independent control might make multiple active filters produce unbalanced compensating currents. This paper presents hardware and software implementations of cooperative control for two active filters. Experimental results verify the effectiveness of the cooperative control with the help of a communication system.

[4] S. B. Kjaer, J. K. Pedersen, and F. Blaabjerg, "A review of singlephase grid-connected inverters, "Overview of control and grid synchronization for distributed power generation systems," IEEE

Renewable energy sources like wind, sun, and hydro are seen as a reliable alternative to the traditional energy sources such as oil, natural gas, or coal. Distributed power generation systems (DPGSs) based on renewable energy sources experience a large development worldwide, with Germany, Denmark, Japan, and USA as leaders in the development in this field. Due to the increasing number of DPGSs connected to the utility network, new and stricter standards in respect to power quality, safe running, and islanding protection are issued. As a consequence, the control of distributed generation systems should be improved to meet the requirements for grid interconnection. This paper gives an overview of the structures for the DPGS based on fuel cell, photovoltaic, and wind turbines. In addition, control structures of the grid-side converter are presented, and the possibility of compensation for low-order harmonics is also discussed. Moreover, control strategies when running on grid faults are treated. This paper ends up with an overview of synchronization methods and a discussion about their importance in the control

[5] J. M. Carrasco, L. G. Franquelo, J. T. Bailiwick, E. Galvan, R. C. P. Guisado, M. Á. M. Prats, J. I. León, and N. M. Alfonso, "Power electronic systems for the grid integration of renewable energy sources: A survey," IEEE Trans. Ind. Electron., vol. 53, no. 4, pp. 1002–1016, Aug. 2006

The use of distributed energy resources is increasingly being pursued as a supplement and an alternative to large conventional central power stations. The specification of a power-electronic interface is subject to requirements related not only to the renewable energy source itself but also to its effects on the power-system operation, especially where the intermittent energy source constitutes a significant part of the total system capacity. In this paper, new trends in power electronics for the integration of wind and photovoltaic (PV) power generators are presented. A review of the appropriate storage-system technology used for the integration of intermittent renewable energy sources is also introduced. Discussions about common and future trends in renewable energy systems based on reliability and maturity of each technology are presented

III. Shunt active power filter

Depending on the system application or electrical problem to be solved, active power filters can be implemented as shunt type, series type, or a combination of shunt and series active filters. These filters can also be combined with passive filters to create hybrid power filters. The shunt-connected active power filter shows the characteristics similar to STATCOM (reactive power compensator of power transmission system) when used with self-controlled dc bus. The shunt active power filters,

Volume 08, Issue 04, [April-2021] ISSN (Online):2349–9745 ; ISSN (Print):2393-8161

acts as a current source, injects harmonic compensating current of same magnitude as the load current harmonics but shifted in phase by 180° and thus compensates load current harmonics.

The series-connected filter mainly compensates voltage in unbalances and sags/swell from the ac supply and thus protects consumer from inadequate voltage quality. These are used for low-power applications. These filters can be used as a substitute to UPS with comparatively very low cost as no energy storing element like battery is used. Moreover overall rating of components is smaller.

The series active filters work as hybrid filter topologies with passive LC filters. In case passive LC filters are connected in parallel to the load then series active power filter operates as a harmonic isolator and forcing the load current harmonics to circulate mainly through the passive filter rather than the power distribution system. The main advantage of this topology is that the rated power of the series active filter is a small fraction of the load kVA rating.

The diagram for shunt active power filter is shown in Fig. 1 The current related power quality issues like harmonics, low power factor and reactive power consumption are mitigated by using shunt active power filter. It is a device which is connected in between source and load at the Point of Common Coupling (PCC). Generally the active power filter consists of inverter topology and it acts as a controlled current source .At the output terminal of VSI a dc link

capacitor is connected which acts as an energy storage element and is used to maintain a constant DC voltage with small ripple in steady state. The dc link voltage of the capacitor has to be maintained as constant in order to achieve a better compensation. This is achieved with the help of closed loop operation that is PI controller. It produces the compensation current which is 1800 out of phase with the harmonics current produced by load. This is accomplished by applying a suitable control technique for VSI. The next section holds the control technique for shunt APF.

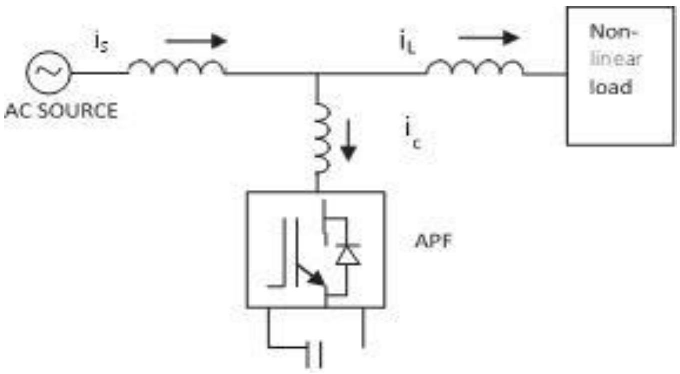


Fig.2. Shunt active power filter

IV. Control Technique

Human brains interpret the real-world context and situations in a way that computers can’t. An artificial Neural Network is a way to simulate the working of the human brain so that the computer will be able to learn like the human brain and make decisions.

ANN is a machine learning algorithm used for classification, regression and clustering problems. It is the building block of deep neural networks. It's majorly used to learn complex non-linear hypothesis when the dataset is too large where we will end up with too many features.

ANN uses different layers of mathematical processing. It has several units organized in several layers. A single unit is called a neuron. The input units in the input layer receive various information from the outside world as inputs. From here the data goes to the hidden unit to transform the data into a form in which output units can use it.

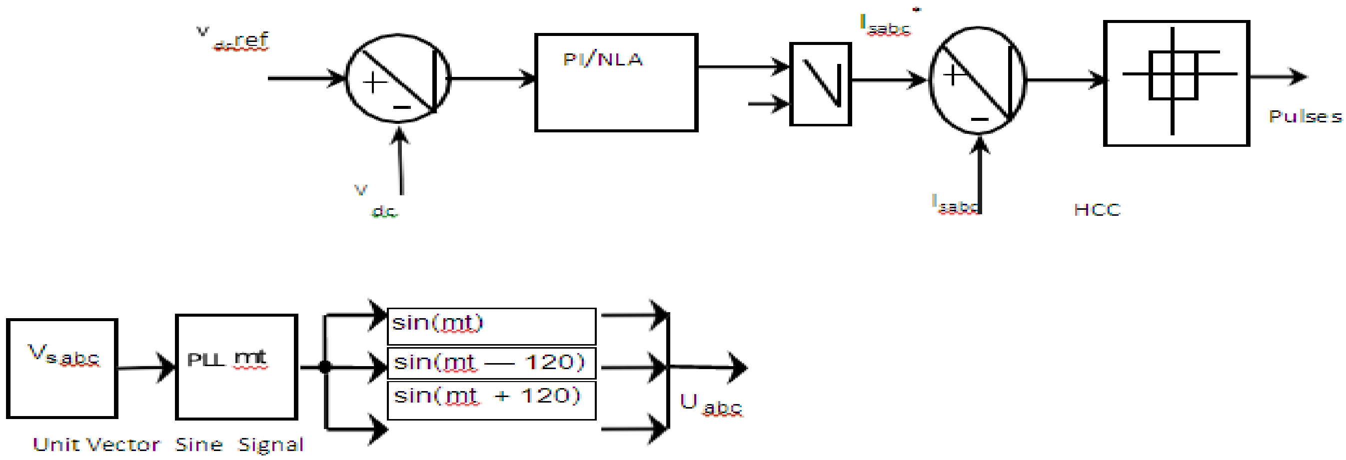


Fig.3. Control technique for shunt active power filter

The estimation of compensation current is an important task in the control of APF. There is different time domain and frequency domain based control techniques are stated by many authors. Among them Unit Vector Template Generation (UVTG) is preferred here. The control technique circuit for shunt active filter is shown in figure 3.It is very simple and easy to implement because it does not needs any complex mathematical model or algorithm to implement. The closed loop operation of shunt APF can be accomplished by PI controller or neural learning network, which is used to maintain the dc link voltage as constant. In PI controller, the accuracy and settling time depends upon the parameter values of Kp and Ki. It requires complex design of parameter value design. So NLA based controller is proposed here. With the help of neural network, the data can be design, train and hence the accuracy of the performance get increased. There are many types of neural learning network are there. Among them back propagation method is a common one. The abilities of real-time learning, parallel computation, flexibility and adaptive property of artificial neural-network (ANN) is used to generate fast reference current for current controller of shunt active power filter strategy. The two layer ANN is trained on line by using proposed learning algorithm in order to generate reference current. The neural network for proposed learning algorithm is highlighted in Fig.

3.The inputs of the network are error, integral of error, which is multiplied with weight function like α,β. The values are summed and are added with bias B. the final output Y is called neural network output, and is feed forward to input side. Until the required result obtained, the data has been trained at number of iterations

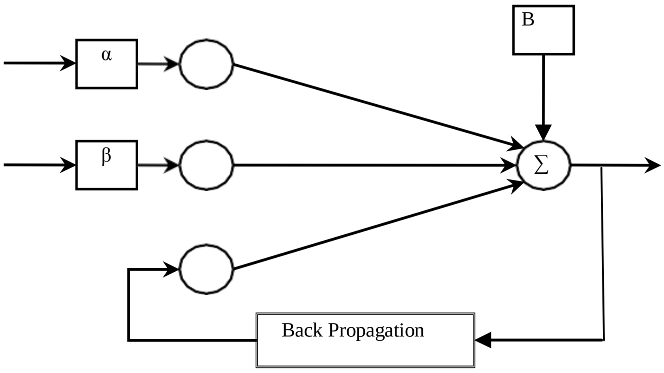


Fig.4 . Neural learning network

For every training the weight function and bias was varied. This can be easily achieved with the help of Mat lab platform. The required reference source current (Isref) can be produced by multiply three phase unit sine vector (1200 phase shift with each other) with the output of the controller. The essential compensation current can be obtained by comparing the actual source current with the resultant reference source current. This compensation

Current is injected at PCC. The final stage of the active filter circuit is pulse generation technique. Pulse generation technique is used to produce the gate pulse required to trigger the semiconductor switches of the inverter circuit. Here hysteresis current control technique is adapted because of its easy and its simplicity.

V. MODELING AND DESIGN

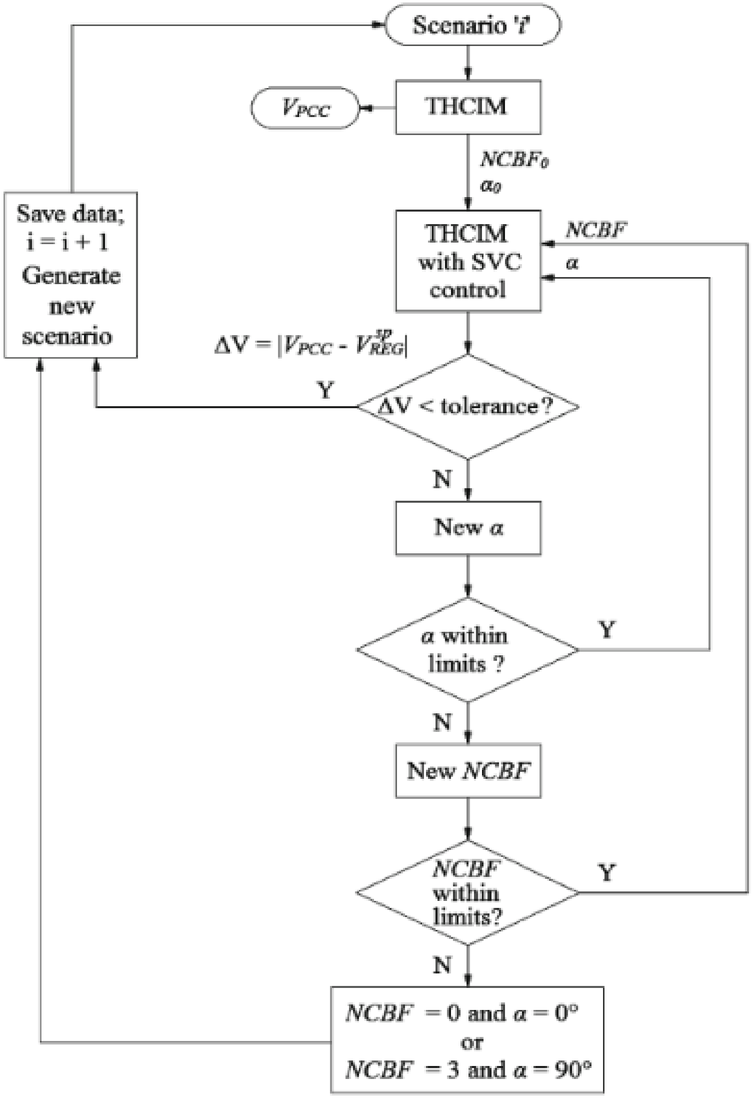
This section includes the modulation and simulation design of the Reduction of harmonic distortion in a micro grid by using ANN and Shunt Active Power Filter Techniques The proposed methodology aims to control the steady-state voltage magnitude and total harmonic distortion (THD) within acceptable limits at the point of common coupling (PCC) of a micro grid The control system must provide the correct number of capacitor banks with additional filtering function (NCBF) and the thyristors firing angle (a) for different system operational scenarios. In order to determine these settings, an artificial neural network (ANN) is applied. The methodology has two parts:

1. Simulation of different loading and DG scenarios for data Gathering;

2. ANN training with the simulation data.

Volume 08, Issue 04, [April-2021] ISSN (Online):2349–9745 ; ISSN (Print):2393-8161

As Follows Algorithm



VI. CONCLUSION

This Paper presents the ANN as an implementation and the THD measurement of three phase voltage and current at grid side is measured. Comparison between the SAPF associated to the grid using with and without controller in this Paper, a DC-coupled System has been studied, to improve the power quality at point of common coupling with micro grid. The grid interface inverter has been shown to be able to be used effectively for power conditioning without affecting the normal operation of actual power transfer. Thus, the current imbalance, the current harmonics and the reactive power of the load, due to an asymmetric and nonlinear load connected to the PCC, are effectively compensated so that the network currents are always kept balanced and sinusoidal at unity power factor. Integrating neural network logic with neural networks and genetic algorithms is now transforming automated intellectual systems in many disciplines

Volume 08, Issue 04, [April-2021] ISSN (Online):2349–9745 ; ISSN (Print):2393-8161

REFERENCES

[1] J. H. R. Enslin and P. J. M. Heskes, “Harmonic interaction between large number of distributed power inverters and the distribution network,” IEEE Trans. Power Electron., vol. 19, no. 6, pp. 1586– 1593, Nov. 2004.

[2] U. Borup, F. Blaabjerg, and P. N. Enjeti, “Sharing of nonlinear load in parallel-connected three-phase converters,” IEEE Trans. Ind. Appl., vol. 37, no. 6, pp. 1817–1823, Nov./Dec. 2001.

[3] P. Jintakosonwit, H. Fujita, H. Akagi, and S. Ogasawara,“Implementation and performance of cooperative control of shunt active filters for harmonic damping throughout a power distribution system,” IEEETrans. Ind. Appl., vol. 39, no. 2, pp. 556–564,Mar./Apr. 2003.

[4] S. B. Kjaer, J. K. Pedersen, and F. Blaabjerg, “A review of singlephase grid-connected inverters for F. Blaabjerg, R. Teodorescu,M. Liserre, and A. V. Timbus, “Overview of control and grid synchronization for distributed power generation systems,” IEEE Trans.

[5] J. M. Carrasco, L. G. Franquelo, J. T. Bailiwick, E. Galvan, R. C. P.Guisado, M. Á. M. Prats, J. I. León, and N. M. Alfonso, “Power electronic systems for the grid integration of renewable energy sources: A survey,” IEEE Trans. Ind. Electron., vol. 53, no. 4, pp. 1002–1016, Aug. 2006.

[6] B. Renders, K. De Gusseme, W. R. Ryckaert, K. Stockman, L. Vandevelde, and M. H. J. Bollen, “Distributed generation for mitigating voltage dips in low-voltage distribution grids,” IEEE Trans. Power.Del., vol. 23, no. 3, pp. 1581–1588, Jul. 2008.

[7] V. Khadkikar, A. Chandra, A. O. Barry, and T. D. Nguyen, “Application of UPQC to protect a sensitive load on a polluted distribution network,” in Proc. Annu. Conf. IEEE Power Eng. Soc. Gen. Meeting, 2006, pp. 867–872.

[8] M. Singh and A. Chandra, “Power maximization and voltage sag/swellride-through capability of PMSG based variable speed wind energy conversion system,” in Proc. IEEE 34th Annu. Conf. Indus. Electron.Soc., 2008, pp. 2206–2211.

[9] J. P. Pinto, R. Pregitzer, L. F. C. Monteiro, and J. L. Afonso, “3phase4-wire shunt active power filter with renewable energy interface,” presented at the Conf. IEEE Renewable Energy & Power Quality, Seville, Spain, 2007.