SPWM CONTROLLED HYBRID GRID FOR MULTIPLE POWER SUPPLIES

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Abstract- In present day applications AC as well as DC power appliances are very much used and are in need as the storage of the energy is possible only in dc mode and of course the electronic appliances. And ac supply is predominantly useful in driving all the other devices. Thus the design of hybrid grid with both AC and DC supply is very much required. The use of sinusoidal modulation in combination with the PWM (SPWM) technique which can yield better results than the ordinary triggering or other PWM's techniques. In this study of SPWM controlled rectifier and inverter are used to feed AC and DC loads simultaneously by designing a hybrid grid. Matlab / Simulink, is used to perform the simulation for validating the performance of the system.
Index Terms-Hybrid grid, PWM, SPWM, Power Electronics.

I. Introduction

Power electronics is an advanced high level technology that results to achieve conversions of electricity of one form to another, with the simple combination semiconductor devices and passive elements, transformers, inductors. The system input and system output can be AC or DC and will vary in magnitude and frequency. Sometimes the conversion involves various multiple stages with 2 or more than 2 converters connected in a cascade. The final expected outcome of a PE converter is to obtain very high efficiency during conversion and to minimize the size and weight, and achieve valid optimal regulation of the output. Any high optimal voltage controller for a 3- phase 4 wire UPS (uninterruptible power supply) system, with an advanced scheme of synchronous reference frame controller is used to compensate or minimize for the voltage distortions which is due to unbalanced loads and nonlinear loads is presented [1]. In a dc-dc converter, both input and output quantities are DC values,. A constant and uniform input power supply is provided with a diode bridge in the front end was followed by a dc-dc converter, this combination converts line frequency ac voltage to several regulated dc voltages.

Explores the basic performance output is associated with the basic use and also to determine and contribute to the transient response of the output and harmonic compensation in any particular situation [2]. Active IDMs are been used to improve the performance [3]. Multiagent system (MAS) is the most impressive important and the fastest growing tool in agent oriented technology it mainly deal with modeling of individual decision making entries. This paper presents an basic output application of (MAS) for distributed energy resource (DER) management in a basic Micro grid. The challenges and opportunities generally associated with DC distribution scheme for heavy load industrial power systems networks which are shown in figures. The use of very low voltage profile DC distribution of a network for the achievement of rural electrification within the efficient intelligent power grid concept is proposed. Analyze the feasibility of DC for supplying to commercial, industrial and household facilities in proposed scheme.

Hybrid power systems thus can be used to neutralize the dependence on conventional systems. These grids may also provide power to small remote communities at a very lower cost with other intelligent traditional alternatives. In this paper an SPWM control strategy is proposed for hybrid grid.

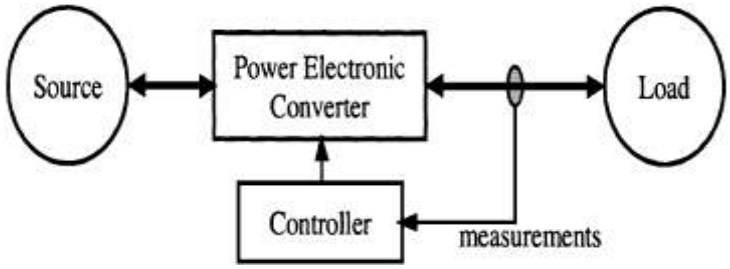

Figure.1 Application of power electronic converters

The requirements of good inverter are:

1. Its output voltage waveform should be sinusoidal.

2. Its gain (ac output voltage/dc input voltage) should be high.

3output voltage and frequency (f) should be always controllable in any desired usage. An inverter must be always keeping the v/f ratio constant for some basic applications.

4. The power required to control the circuit is very low

5. The semiconductor components used for the inverter should always have a minimum conduction losses and switching methodology.

6. The cost must be minimum without affecting the reliability.

7. High lifespan.

8. It should produce minimum electro-magnetic interference.

9. The size of the filter required should be small. Similarly for rectifier the output voltage should be effective and should not contain any ripples.

2. ANALYSIS OF THE KEY ELEMENTS

A. Three-Phase Bridge Converter

For industrial applications the usage of three phase converters are common. The DC supplied by taking from battery or from rectifier if operated as an inverter circuit. In the same manner a rectifier can be constructed by change in the switching. A basic 3-Phase inverter is a series step bridge inverter as shown in Fig.2. The SCR is gated at regular interval of 600 in proper sequence so that a 3-phase AC is synthesized at o/p for six step inverter.

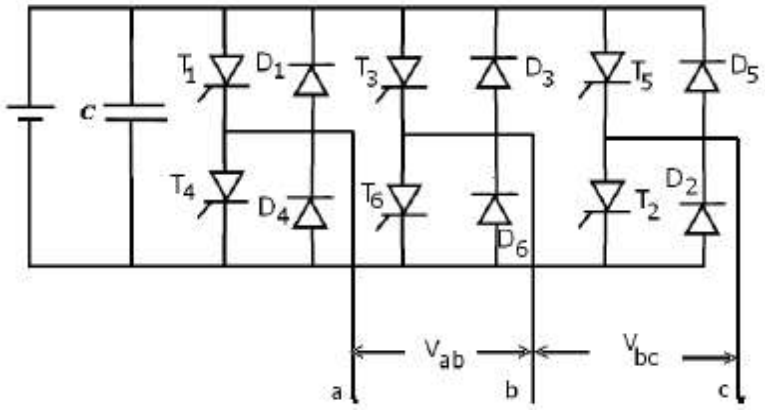

Figure.2 Three phase power electronic converter

B. PWM TECHNIQUES

The DC-AC inverters and AC-DC rectifiers usually operate on Pulse Width Modulation (PWM) technique. The PWM is one of the advanced techniques to be performed to eliminate harmonics.

Three phase inverter switching sequence is shown in Fig.3. Three phase rectifier waveforms are shown in Fig.4.

There are four basic PWM techniques:

1. Single Pulse Width Modulation,
2. Multiple Pulse Width Modulation,
3. Sinusoidal Pulse Width Modulation and
4. Space Vector Pulse Width Modulation.

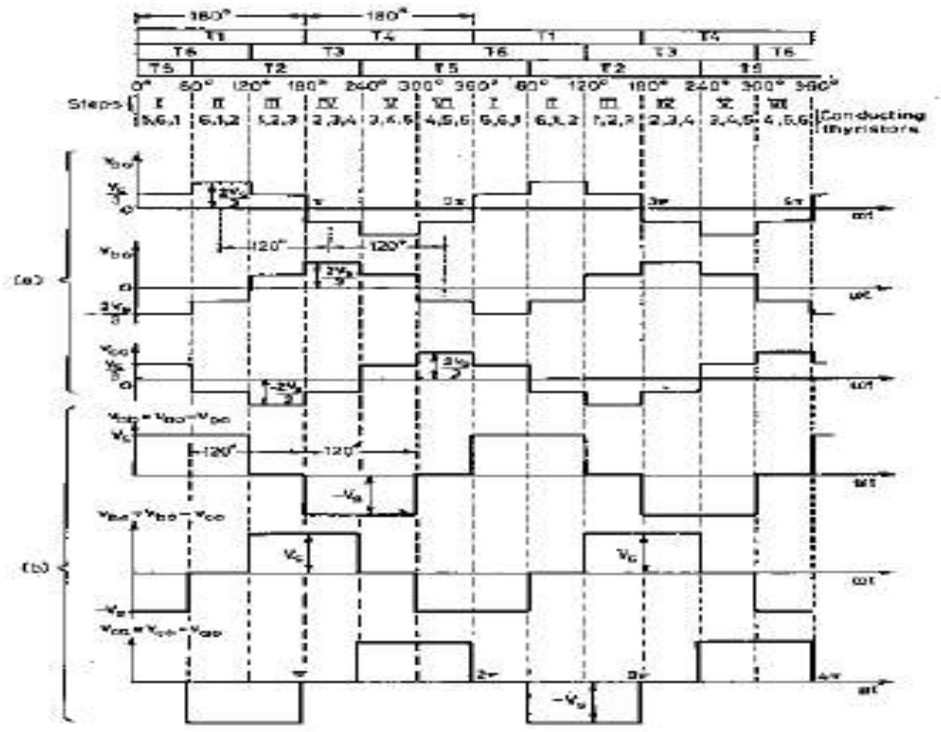

Figure.3 Three phase Inverter switching sequence (a) Phase Voltages and (b) Line voltages

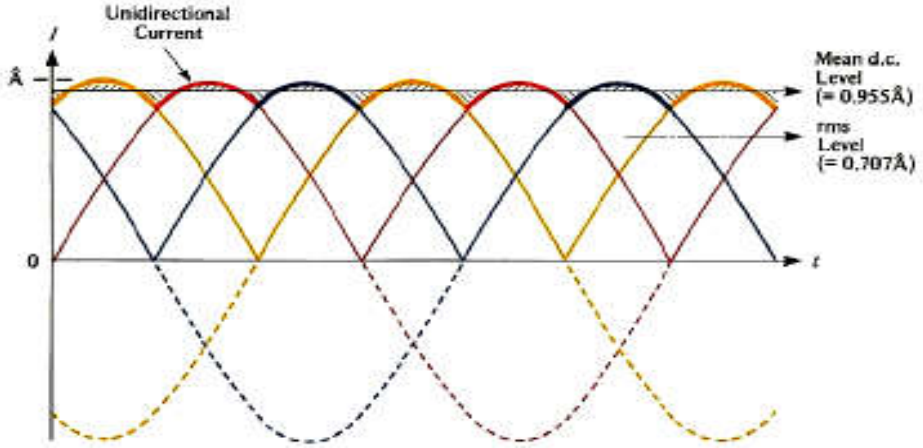

Figure.4 Three phase rectifier waveforms

3. Sinusoidal Pulse Width Modulation

In this modulation technique there are multiple numbers of output pulses per half cycle and pulses are of different width. The width of each pulse varies in proportion with the amplitude of sine wave evaluated at the center of the same pulse.

The triggering signals are obtained by the comparison of a sinusoidal reference with a pretty high frequency triangular signal. Sinusoidal Pulse Width Modulation is the best technique for inverters and rectifiers which are employed for.

This PWM technique involves the production of a digital waveform, in which the duty cycle of the signal can be modulated so that the Average voltage output waveform corresponds is a identical pure sine wave. The simplest way of generating the SPWM signal is by comparing a low quality power frequency sine wave reference with a high quality frequency triangular wave.

This SPWM signal uses basic control switches with the help of an LC filter, the output of Full Wave Bridge Inverter circuit provided with SPWM signal has a scope of generating a waveform that is approximately equal to a sine wave. This technique produces a much more similar AC waveform than that of others.

The preliminary harmonic is also present and there is relatively high induction of higher level harmonics in the signal. The Fig.5 shows SPWM pulses for phase converter.

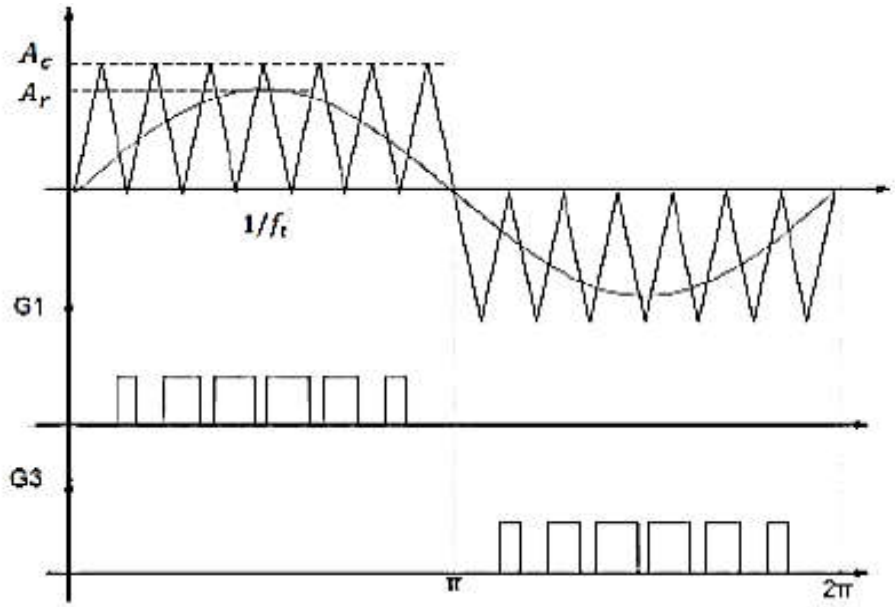

Figure.5 SPWM technique for phase converter

4. Design Strategy

In a hybrid grid AC-DC system there are basically two modes of operation. They are:

1. Grid tied mode
2. Battery powered mode

In grid tied mode the main converter is to provide stable dc bus V and required Q and to exchange P between ac & dc buses. Converter acts as an inverter & injects P - dc to ac (PODC>PLDC) PG<PLDC, the converter injects power from the ac to dc side PG>PL in the hybrid grid, it will inject power to the

utility. Otherwise, Hybrid grid will receive P from the utility. Battery converter is not very important in system operation because power is balanced by the utility grid.

In autonomous mode or simply known as battery powered mode battery plays a very important role for both power balance and voltage stability. Main converter is controlled to provide a stable and high quality ac bus voltage. The Fig.6 shows the block diagram of the hybrid configuration

5. Simulation Results

An AC-DC, DC-AC converter design for hybrid AC-DC power grids has been designed using Matlab/ Simulink by using SPWM control strategy as shown in Fig.7. The converters are controlled based on the load connected to the grid thus creating a hybrid grid power system. The simulation results, line voltages at source in Fig.8, line voltages at load in Fig.9, line voltage waveform at the output of the inverter in Fig.10, output DC voltage in Fig.11, are shown respectively.

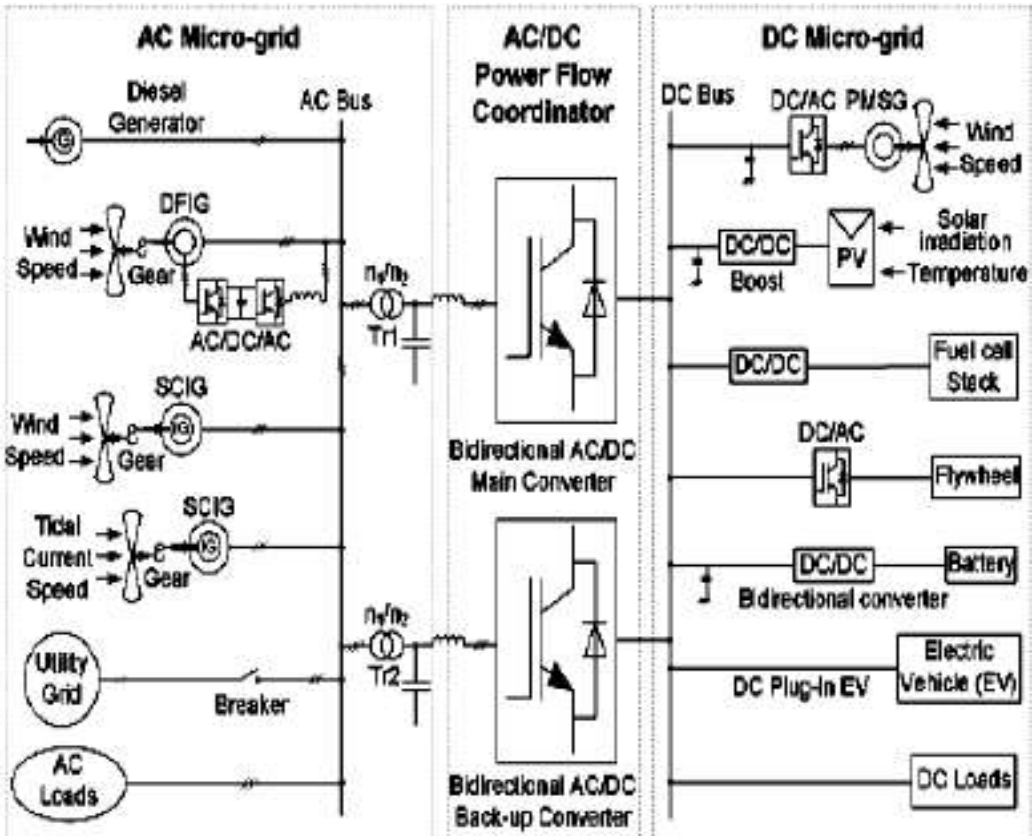

Figure.6 Block diagram of an AC-DC grid system (hybrid)

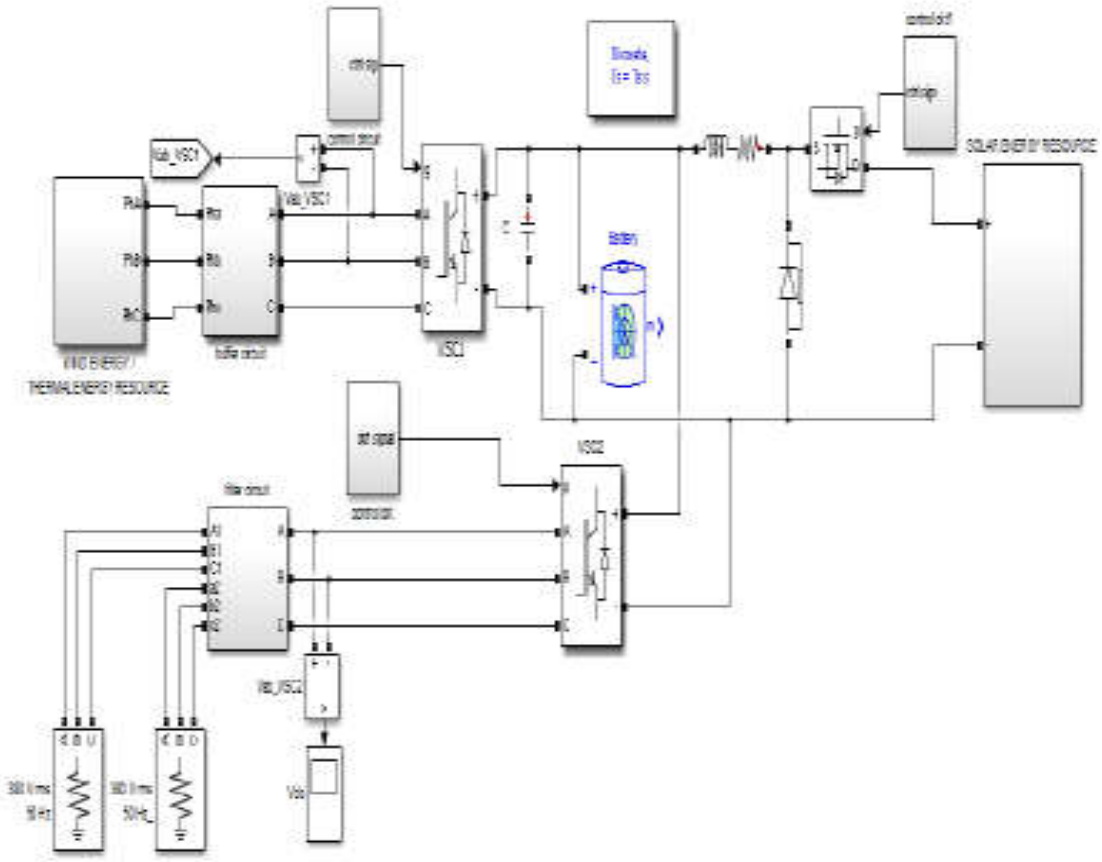

Figure.7 Simulink diagram of the grid system

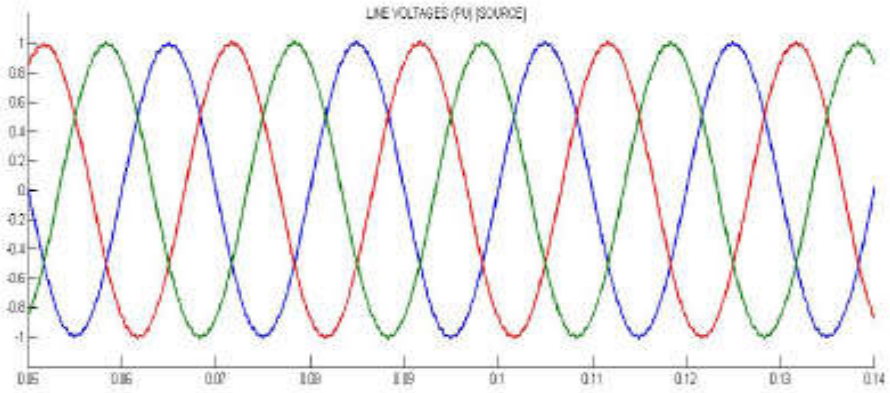

Figure.8 Line voltages at the source (p.u)

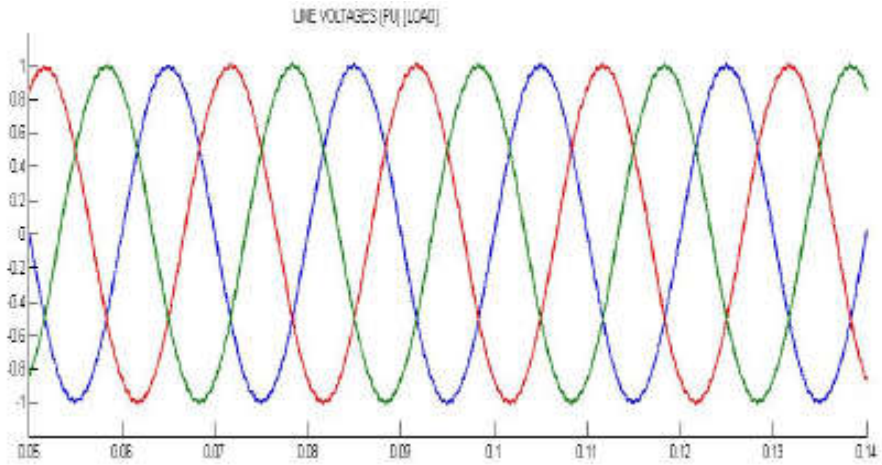

Figure.9 Line voltages at the load (p.u)

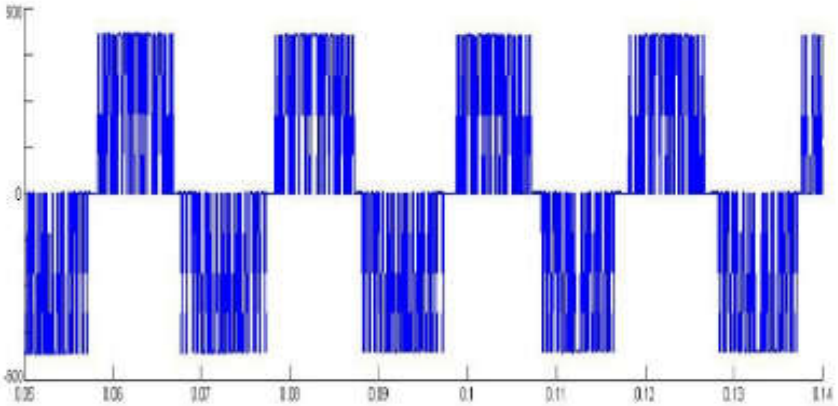

Figure.10 Line voltage waveform at the output of the inverter

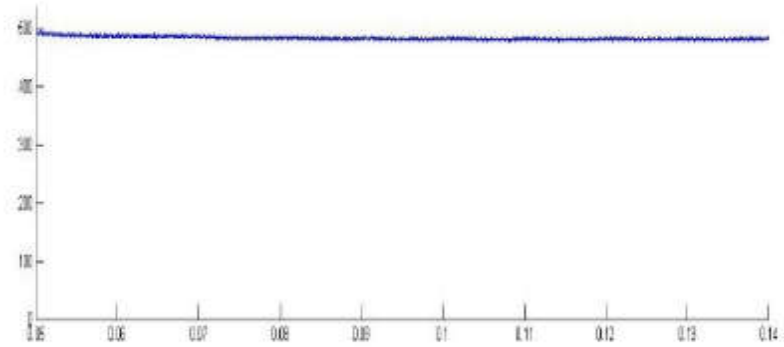

Figure.11 DC voltage at the output of the rectifier with capacitor

6. Conclusion

In this paper an AC-DC, DC-AC converter design for hybrid AC-DC power grids has been designed using Matlab/ Simulink by using SPWM control strategy. Hybrid grid can provide a reliable, high quality and more efficient power to consumer. Hybrid grid may be feasible for small isolated

industrial plants with both AC systems and DC systems as the major power supply. Complete automation and enumeration of this design can be a future scope of this simulation.

References

[1] K. Kyung-Hwan, P. Nam-Joo, and H. Dong-Seok, "Advanced synchronous reference frame controller for three-phase UPS powering unbalanced and nonlinear loads," in Proceedings of Power Electronics Specialists Conference, 2005, pp. 1699–1704.
[2] P. C. Loh, M. J. Newman, D. N. Zmood, and D. G. Holmes, "A comparative analysis of multi loop voltage regulation strategies for single and three-phase UPS systems," IEEE Transactions on Power Electronics, Vol. 18, No. 5, PP. 1176–1185, Sep. 2003.
[3] L. A. C. Lopes and H. Sun, "Performance assessment of active frequency drifting islanding detection methods," IEEE Transactions on Energy Conversion, Vol. 21, No. 1, PP. 171–180, Mar. 2006.
[4] T. Logenthiran, D. Srinivasan and D. Wong, "Multi agent coordination for DER in Micro Grid," in Proceedings of IEEE International Conference on Sustainable Energy Technologies, Nov. 2008, PP. 77–82.
[5]M. E. Baran and N. R. Mahajan, "DC distribution for industrial systems: Opportunities and challenges," IEEE Transactions on Industrial Applications, Vol. 39, No. 6, PP. 1596–1601, Nov. 2003.
[6]Y. Ito, Z. Yang, and H. Akagi, "DC micro-grid based distribution power generation system," in Proceedings of IEEE International Conference on Power Electronics, Motion & Control , Aug. 2004, Vol.3, PP. 1740–1745.
[7]A. Sannino, G. Postiglione, and M. H. J. Bollen, "Feasibility of a DC network for commercial facilities", IEEE Transactions on Industrial Applications, Vol. 39, No.5, PP. 1409–1507, Sep.