Available online at www.scientiaresearchlibrary.com

Scientia Research Library

Journal of Engineering And Technology Research , 2013, 1 (1):65-71

(*http://www.scientiaresearchlibrary.com/arhcive.php*)

Enhancement of Power Quality by an application of DVR

Prashant Kumar[1], A. B.Kumbhar[2], M.B. Shelar[1] Y.R Atre[2]*

M-Tech Power System, Ashokrao Mane Group of Institutions, Kolhapur, Maharashtra, India [1]
[#]M-Tech Power System, Annasaheb Dange College of Engineering and Technology,Sangali, Maharashtra, India [2].

ABSTARCT

This paper narrates the application of DVR to optimize the power quality problems such as voltage sag, voltage swell and harmonics. Among all these three power quality problems, two are identified as the major concern to the customers namely voltage sag and voltage swell. One of the well known solutions to mitigate the power quality problem is to inject the voltage as well as power into the system with the help of DVR.The DVR is a power electronics based device that is commonly for voltage sag and voltage swell mitigation at the point of connection. A control technique based on a proportional integral (PI) controller is implemented. In fact with the aid of Pulse width modulation (PWM) inverters capable of generating accurate high quality voltage waveforms from the power electronic device. Simulation results show the effectiveness of proposed method by MATLAB/Simulink.

Key words: Dynamic Voltage Restorer (DVR); Power quality; Pulse Width Modulation (PWM); Voltage Source Converter (VSC).

INTRODUCTION

Power Quality problem such as voltage sag, voltage swell as well as momentary power loss are vital issues seen from the last decade due to the widespread use of sophisticated electronic equipment. Due to above problems the loads are becoming more sensitive and less tolerant to short term voltage disturbances in the form of voltage sag and voltage swell. A great effort has been made to enhance the power quality either from customer side or utility side.

The most effective way for enhancement of power quality is to install the DVR on a sensitive load side, which restores the line voltage to its nominal value. A DVR is a series connected solid device that injects the voltage to compensate voltage sag and swell. It is normally installed in a distribution network between the supply and a critical feeder at the so called point of common coupling (PCC).Its primary function is to boost up the load side voltage in the event of fault. Apart from voltage sag and swell compensation,DVR can also added other features like line

voltage, harmonic compensation, reduction of transients in voltage and fault current limitations.

Pulse width modulation (PWM) inverters have been applied as a control scheme to mitigate voltage sag and swell in the test system.

This paper is organized as follows: Section II Objective function; Section III Description of DVR; Section IV Proposed Control Technique; Section V Simulation results and waveforms; Section VI Conclusion.

MATERIALS AND METHODS

The two main objective functions are considered in this paper that responsible are responsible for the power quality problems.

First objective function:

***Voltage Sag*:** Voltage sag is a momentary decrease in the *rms* voltage magnitude lasting between half a cycle and several seconds [1].Disruptive voltages sags are usually caused by fault conditions on the utility side or customer side.
A voltage sag is generally described by two essential characteristics such as Magnitude and duration. Balanced voltage sags are due to the three phase faults.

Second objective function:

***Voltage Swell*:** The increase of voltage magnitude between 1-2 and 1-8 p.u. is called voltage swell. The most accepted duration of a swell is from 0.5 cycles to 1 minute. They appear on the switching off of a large load; energizing a capacitor bank or voltage increase of the unfaulted phases during a single line to ground faul
The possible effects of voltage swell are stress on computer components and they shorten their life. Also swell can upset electronic control and electric motor drives.

DESCRIPTION OF DYNAMIC VOLTAGE RESTORER

The Dynamic Voltage Restorer (DVR) is a powerful controller that is connected in series using transformer in delta (Δ) with line distribution system as shown in fig.1. The DVR is a solid state power electronics switching device consisting of either GTO or IGBT, a capacitor bank as a energy storage device and injection transformers. It can maintain load voltage by injecting three phase output voltages whose phase, magnitude and frequency can be controlled [2].The basic idea behind the DVR is to inject a controlled voltage generated by a converter in a series to the bus voltage by means of an injecting transformer. A regulated DC voltage source is used by means of DC capacitor bank. A DC to AC inverter regulates this voltage by sinusoidal PWM technique. The DVR is used to generate or absorb reactive power but active power by means of some external energy source. The DVR expected time response is about 25 millisecond and which is less than some of the traditional methods of voltage correction such as tap-changing transformer.
A Dynamic voltage restorer (DVR) is a distribution voltage DC to AC solid state switching converter that injects three phase voltage in synchronized with the voltages in distribution system. Therefore, energy storage capacity is now become one of the constraint factors in the distribution compensation process, especially for sag and long duration fault.

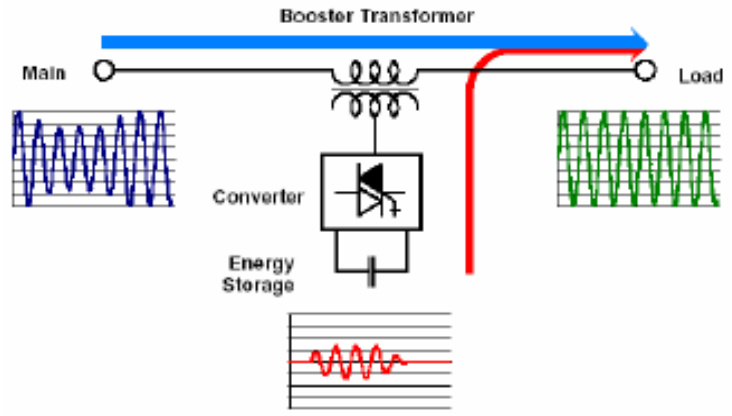


Fig.1 Block diagram of DVR

Moreover, DVR consists of three phase inverter, energy storage and booster transformer. In this paper, section IV deals with the controller to maintain a constant voltage magnitude.

PROPOSED CONTROL TECHNIQUE

The main aim of the control system is to maintain constant voltage magnitude at the point where a sensitive load is connected, under line distribution system. The control system only measures the rms voltage at the load point [3] i.e. no reactive power measurement is required [4]. Here a sinusoidal PWM based control scheme is implemented in the test system to mitigate voltage sag and swell in practical applications. The voltage source converter (VSC) switching strategy is based on a sinusoidal and good response.PWM methods a more flexible option than the fundamental frequency switching (FFS) methods favored in FACTS applications.

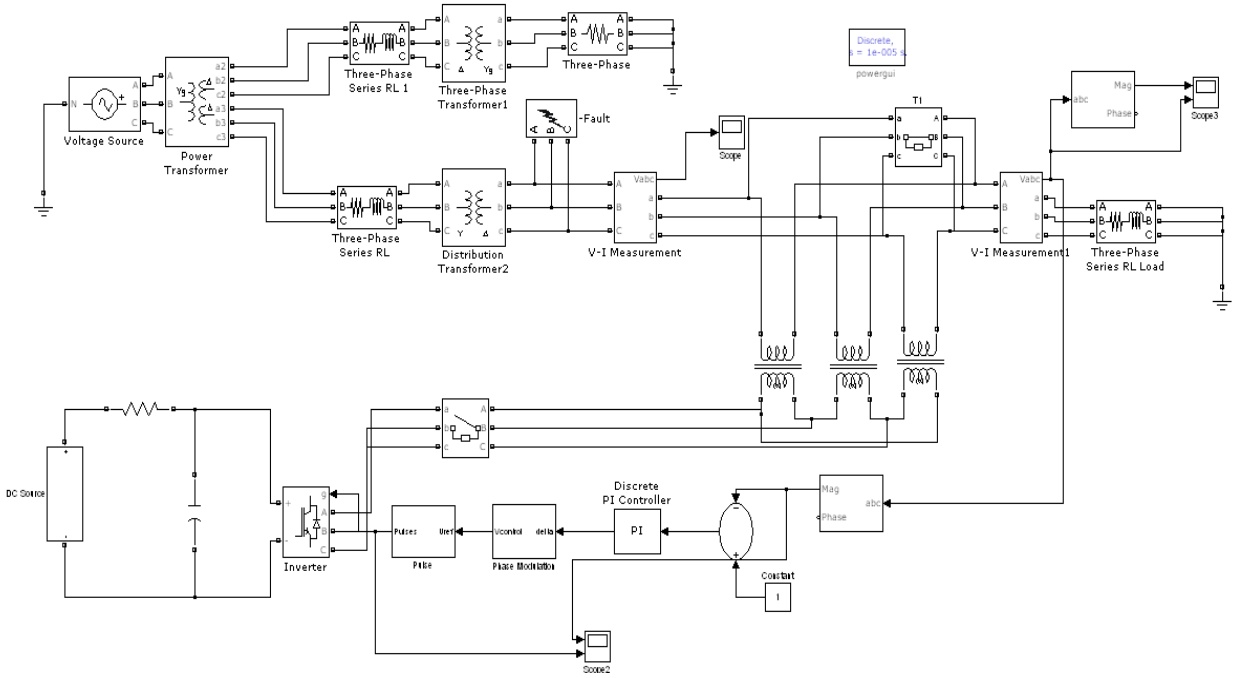


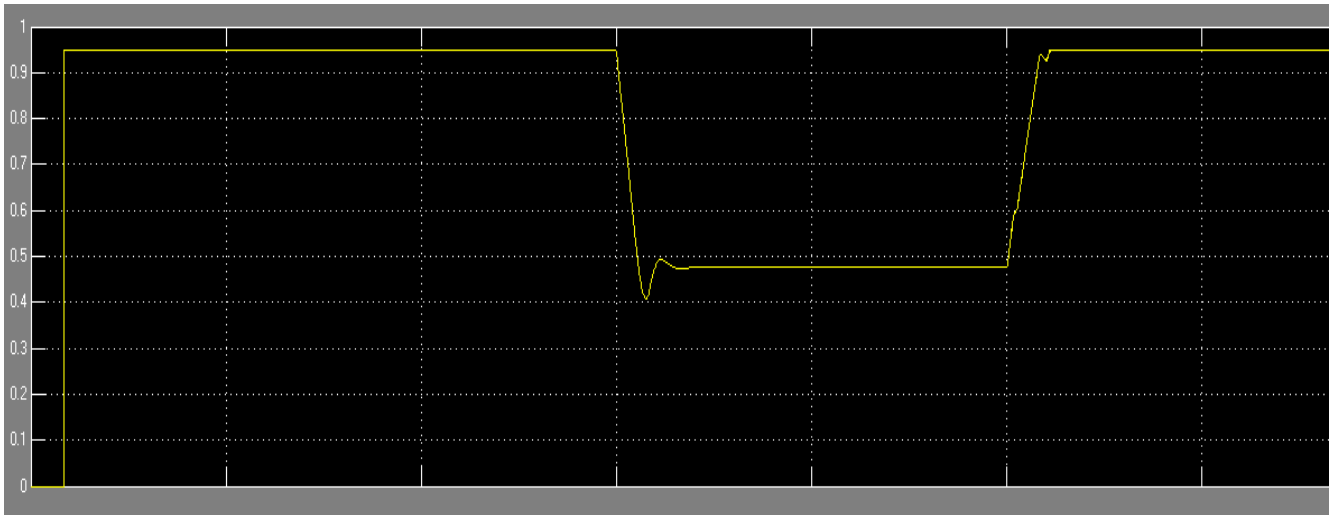
Fig.2 Test system and Control Scheme

Fig.2 shows that the test system and PI controller process the error signal and generates the required

angle δ to derive the error to zero; i.e. the load *rms* voltage is brought back to the reference voltage.
The control scheme for the proposed system is based on the comparison of a reference voltage and the measured terminal voltage. The voltage is detected when the supply drops below 90 % of the reference value whereas the voltage swell is detected when supply voltage increases upto 25 % of reference value.
In PWM generator, the sinusoidal signal $V_{control}$ is compared against a triangular signal carrier in order to generate the switching signals for the VSC valves.
The main parameters of the sinusoidal PWM technique are the amplitude modulation index m_a of signal $V_{control}$ and the frequency modulation index m_f of the triangular signal. The amplitude index m_a is kept fixed at 1p.u. in order to obtain the highest fundamental voltage component at the controller output [10] and [11].

SIMULATION RESULTS

It is assumed that the voltage magnitude is maintained at 1 p.u. during voltage sag and swells condition. Fig. No. 3 and 4 shows the simulation result for voltage sag condition. Fig. No. 5 and 6 represents the voltage swell simulation. Fig.No.3 shows the simulation result without DVR and three phase fault is applied during the period 0.3-0.5 sec. The voltage sag at the load point is 50 % with respect to the reference voltage.
When DVR and PI control is applied the voltage sag problem is almost optimized and required voltage is maintained at the load point.
Similarly, Fig.No.5 shows the voltage swell occurs during the 0.2-0.3 sec and Fig. No. 6 shows the mitigation by applying DVR with PI controller.



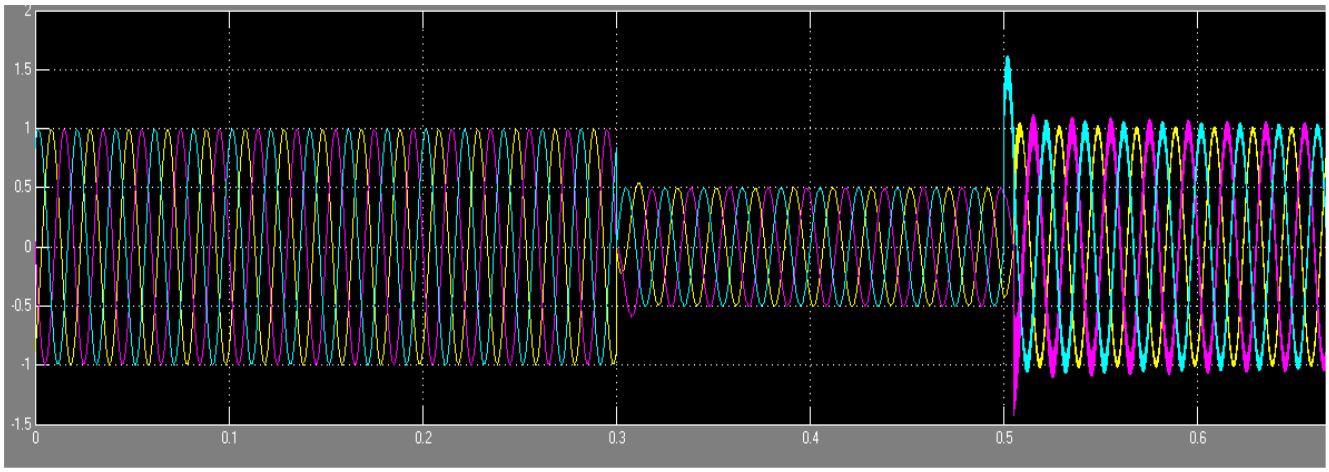


Fig.3 50% Voltage sag without DVR

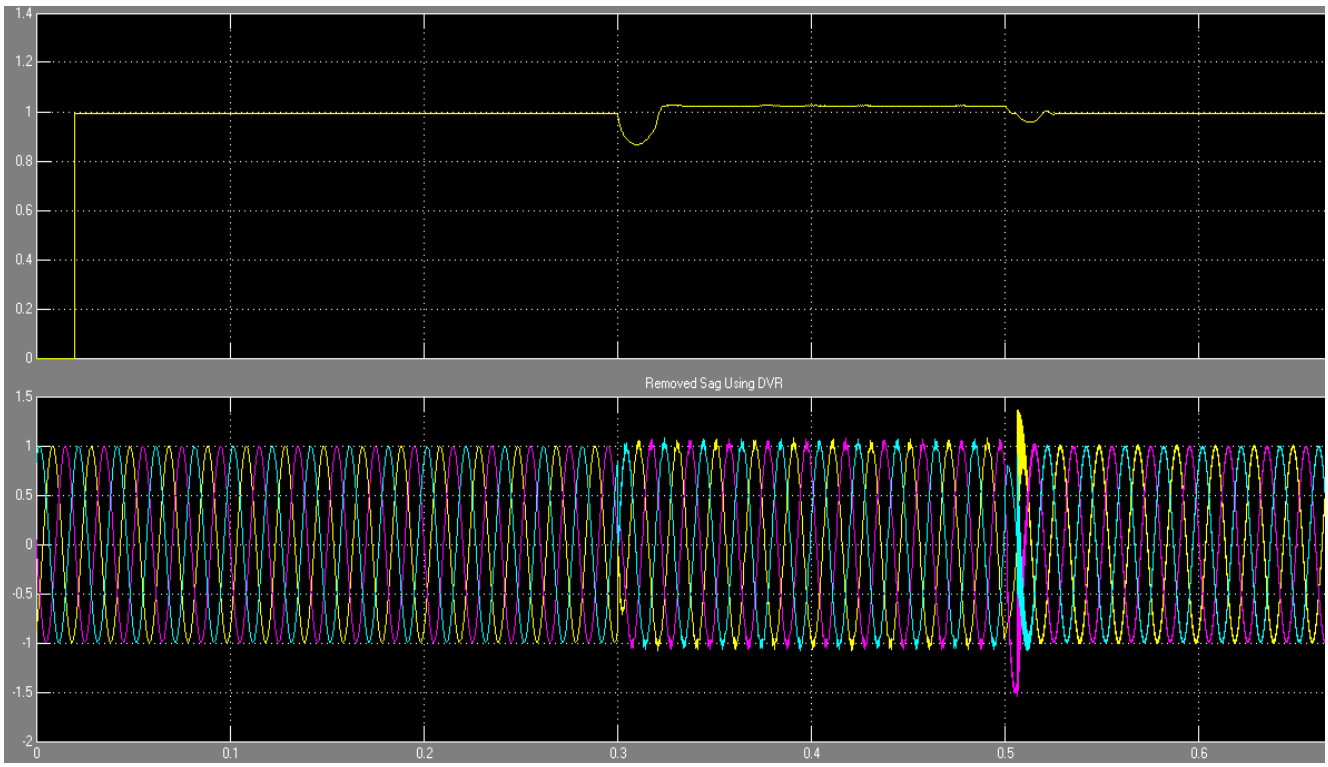
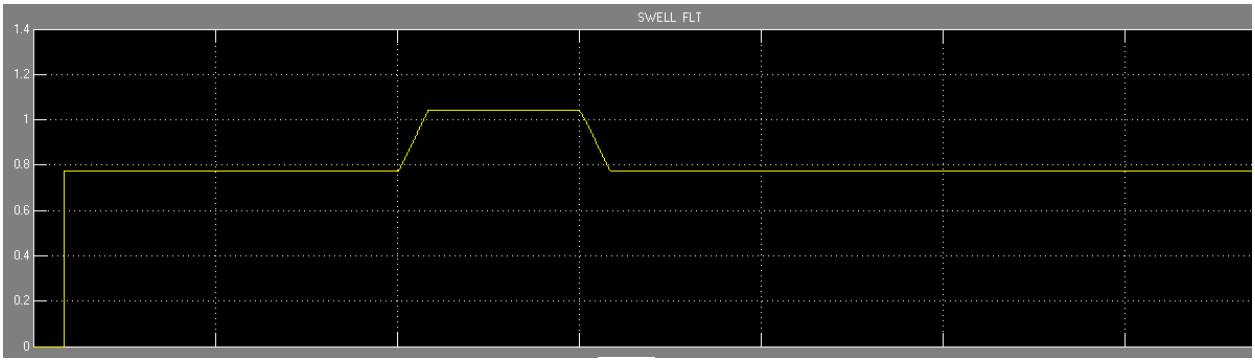


Fig .4 50 % sag correction using DVR based PI controller



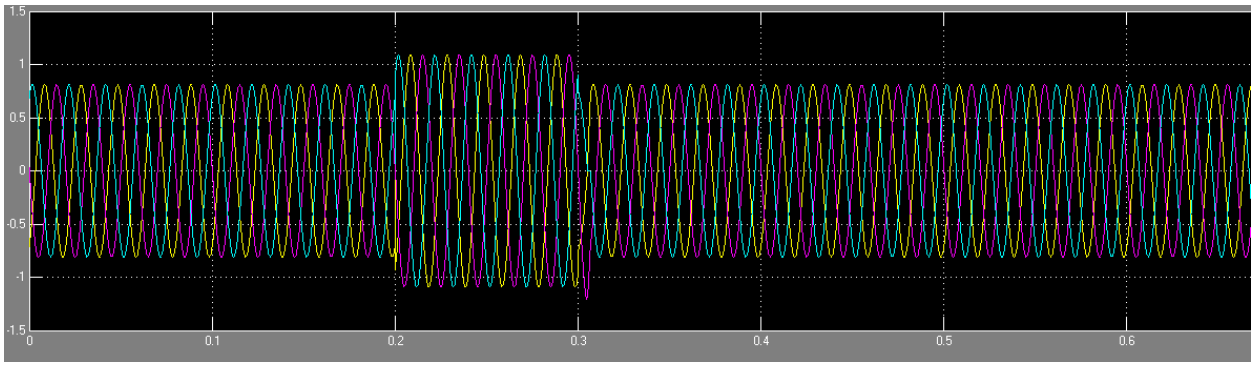


Fig.5 25 % of voltage swell without DVR

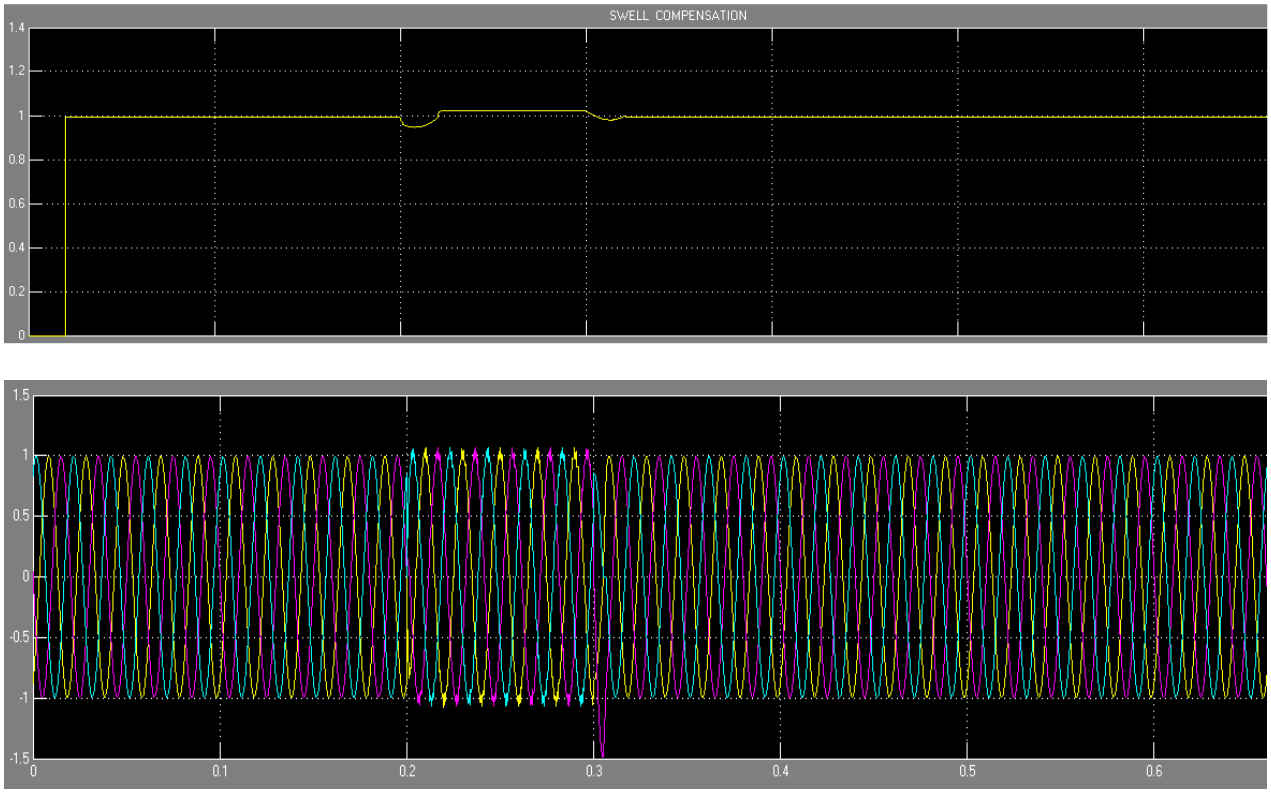


Fig.6 25% Swell mitigation by DVR with PI controller

CONCLUSION

This paper investigates the novel technique to mitigate the power quality problems mainly voltage sag and voltage swell through DVR control scheme and provides excellent voltage regulation. The DVR control system not only to detect the start and end of voltage sag but also to determine the sag and swell depth. Also it handles efficiently handles the balanced and unbalanced situation without any difficulties and inject the voltage to keep the load voltage balanced and constant at the nominal values. The main purpose to use DVR is that its cost is less and control is simple.

The simulation will be using MATLAB software and the mitigation technique to show effectiveness of DVR.

ACKNOWLEDGEMENTS

We would like to thank Dr. M.B. Shelar for kind help during research work and publication.

REFERENCES

[1] M. Bollen, Understanding power quality problem, voltage sags and interruption. Piscataway, NJ: IEEE Press, USA, **1999**.
[2] Francisco Jurado *"Neural Network Control For Dynamic Voltage Restore"* IEEE Transaction on Industrial Electronic. Vol 51,No.3, June **2004**.
[3] A. Hernandez, K. E. Chong, G. Gallegos, and E. Acha, "The implementation of a solid state voltage source in PSCAD/EMTDC," *IEEE Power Eng. Rev.*, pp. 61–62, Dec. **1998**.
[4] I. T. Fernando, W. T. Kwasnicki, and A. M. Gole. Modeling of conventional and advanced static var compensators in electromagnetic transients simulation program.
[5] Rosli Omar and Nasrudin Abd Rahim , ― Mitigation of Voltage Sags/Swells using Dynamic Voltage Restorer (DVR),‖ARPN Journal of Engineering and Applied science,Vol,4,June 2 **2009** .
[6] Margo P.M. Hery P.M. Ashar,, T. Hiyama,―Balanced voltage sag correction using DVR based on Fully polar controller‖, ICICIC **2007** Conference Proceedings, Kumamoto Japan.
[7] A.Ramasamy,K.I.Rengan,V.K. Ramachandaramurthy ―Dynamic Voltage Restorer for Voltage Sag Compensation‖, International Conference on Power Electronics and Drive Systems (PEDS) **2005**, Volume 2, 28-01, Nov.**2005**, pp.1289-1294.
[8] A. Ghosh and G. Ledwich, "Power Quality Enhancement Using Custom Power Devices," Kluwer Academic Publishers, **2002**.
[9] H. Awad, J.Svensson, M. Bollen, "Mitigation of Unbalanced Voltage Dips Using Static Series Compensator", IEEE Trans. On Power Elec., Vol. 19, No. 13, May **2004**.
[10] N.G. Hingorani, "Introducing Custom Power in IEEE Spectrum," 32pp. 4l-48, **1995**.
[11] E. Acha, V. G. Agelidis, O. Anaya-Lara, and T. J. E. Miller, *Electronic Control in Electrical Power Systems*. London, U.K.: Butter- Worth-Heinemann, **2001**.
[12] N. Mohan, T. M. Undeland, andW. P. Robbins, *Power Electronics: Converters,Applications and Design*. New York: Wiley, **1995**.