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Performance analysis of solar based dynamic voltage restorer for voltage sag mitigation

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ABSTRACT

Due to increasing difficulty in the power system operations, voltage sags are creating one of the most considerable power quality problems in the distribution system. The quality of problem for Voltage sag is a fall in voltage from minimum value, which occurs for duration of about 0.5 to 30 cycles. If the voltage sags are increased from two to three cycles, then manufacturing systems making use of electronic equipments are likely to be affected leading to major problems. This can be avoided only by maintaining proper voltage level. This paper deals with solar based Dynamic Voltage Restorer (DVR) which can compensate up to 0.25 p.u. sag in the output voltage. The performance of the system has been analyzed and verified by simulating the circuit using MATLAB/SIMULINK.

Keywords: Dynamic Voltage Restorer (DVR), Solar Photo Voltaic (PV), Voltage Sag Mitigation.

INTRODUCTION

The use of these equipments often requires power supplies with very high quality to maintain which the cost should also be taken into consideration (Piyasak Poonpun, 2008). Voltage sag, which is a momentary decrease in rms voltage magnitude in the range of 0.1 to 0.9 per unit (p.u.), is considered as the most serious problem of power quality due to its frequent occurrence. It is often caused by faults in power systems or by starting of large induction motors. Therefore, the loss resulted due to voltage sag problem for a customer at the load-end is huge. Dynamic voltage restorer (DVR) and Distribution static compensator (DSTATCOM) are recently being used as the active solution for voltage sag mitigation. In this paper, Solar Integrated Dynamic Voltage Restorer is proposed to mitigate the voltage sag. Dynamic voltage restorer is a series compensator which is capable of protecting a sensitive load from the distortion in the supply side during fault or over load in power system.DVR is a proposed series connected circuit with solid state device that injects voltage into the system in order to regulate the load side voltage. It is normally installed in a distribution system between the supply and the critical load feeder at the point of common coupling (PCC) (H.P. Tiwari, 2010). Other than voltage sags and swells compensation, DVR can also add other features like: line voltage harmonics compensation, reduction of transients in voltage and fault current limitations. Sinusoidal PWM and space vector PWM control techniques are used for controlling the DVR. Space vector PWM can utilize the better dc voltage and generates the fewer harmonic in inverter output voltage. Simulation results are compared for both the SPWM and SVPWM.

Basic configuration of DVR: The general configuration of the DVR consists of an Injection/ Booster transformer, Filter circuit, Storage Device and a Voltage Source Converter (VSC)

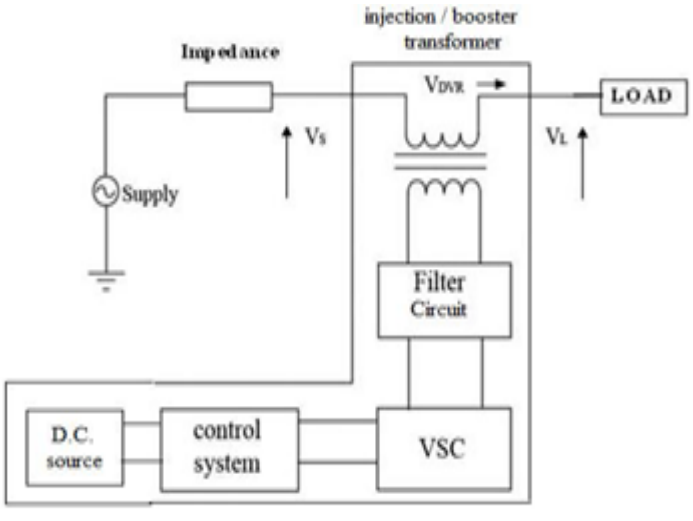

Figure.1.Schematic diagram of DVR

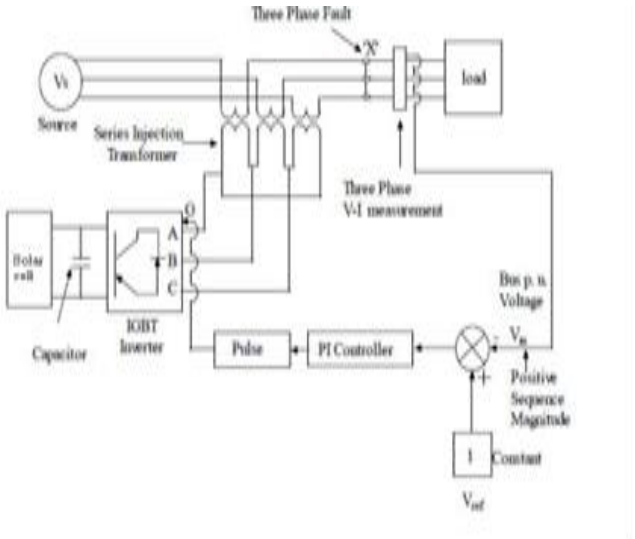

Fig.2.Block Diagram of Renewable Energy Based

DVR

Injection/ Booster transformer: The Injection / Booster transformer is a specially designed transformer that attempts to limit the coupling of noise and transient energy from the primary side to the secondary side.
Harmonic filter: The main task of harmonic filter is to keep the harmonic voltage content generated by the VSC to the permissible level.

Voltage Source Converter: A VSC is a power electronic system that consists of a storage device and switching devices, which can generate a sinusoidal voltage at any required frequency, magnitude, and phase angle. The IGCT is a recent compact device with enhanced performance and reliability that allows building VSC with very large power ratings. Because of the highly sophisticated converter design with IGCTs, the DVR can compensate dips which are beyond the capability of the past DVRs using conventional devices. The purpose of storage devices is to supply the necessary energy to the VSC via a dc link for the generation of injected voltages. The different kinds of energy storage devices are Superconductive magnetic energy storage (SMES), batteries and capacitance.

Control algorithm: When three phase fault occurs voltage sag will be created at load terminals as shown in Fig.5. A sequence analyzer is used to convert the load voltage to per unit quantity. The resultant magnitude is compared with reference voltage (V_{ref}). Then the error signal is given to PI controller.

Simulation results:

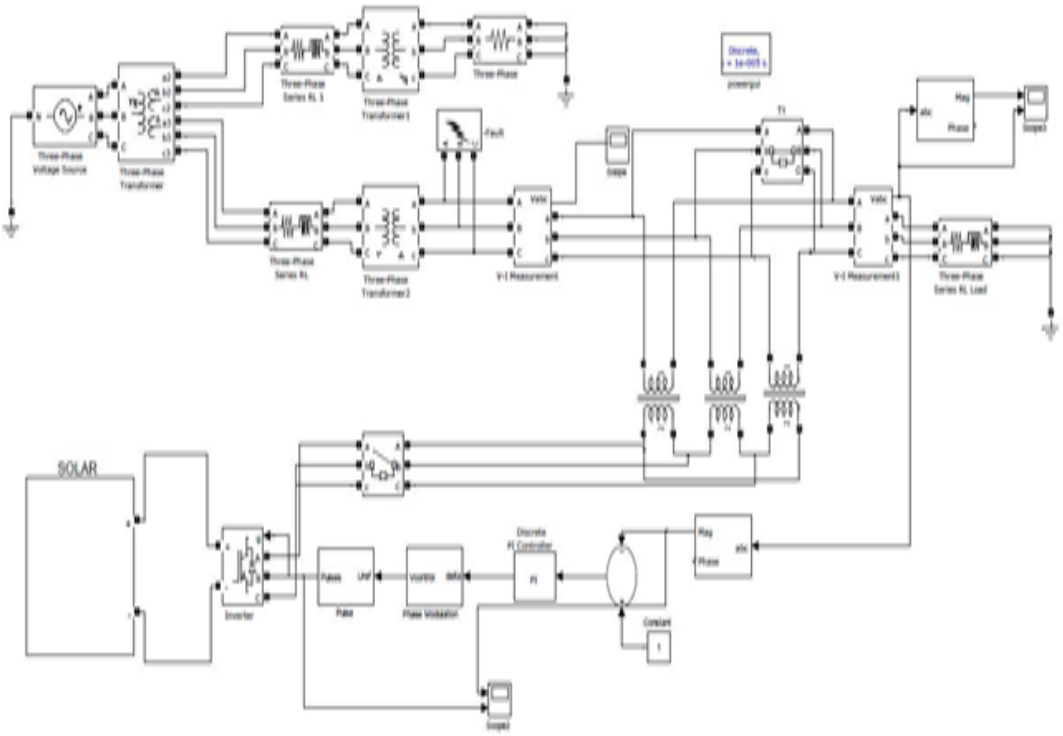

Fig. 3. Simulation Circuit of DVR with solar supply

Fig.4 is MATLAB/SIMULINK diagram of Renewable Energy based DVR for voltage sag compensation. The first simulation was carried out without renewable energy based DVR and a three phase to ground fault is applied to the system at point with fault resistance of 0.44Ω for time duration of 200 ms which results in a voltage sag as shown in Fig.4. The second simulation is carried out at the same scenario as above but now in this case renewable energy based DVR is introduced to compensate the voltage sag occurring due to the three phase to ground fault which is as shown in Fig.4. Fig.4 and Fig.5 are P. U. load voltage profile without & with Renewable energy based DVR.

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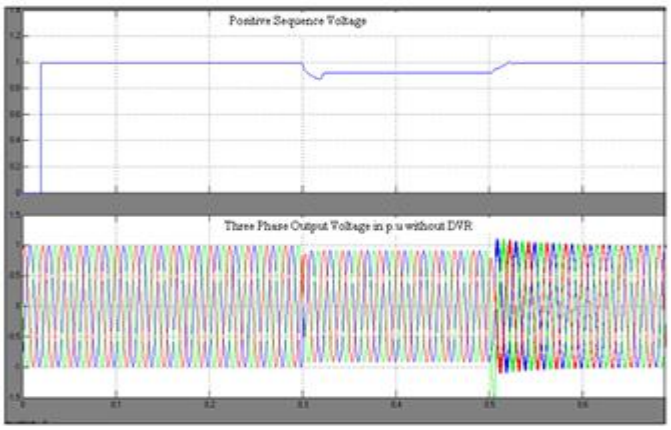

Fig.4 Simulation Result of output voltage without DVR

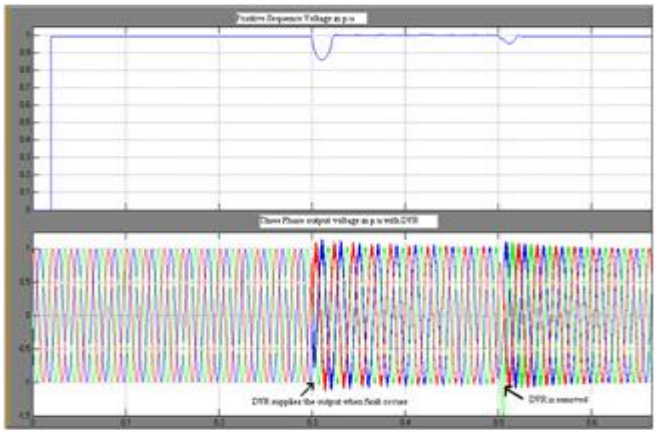

Fig.5 Simulation result of output voltage with DVR

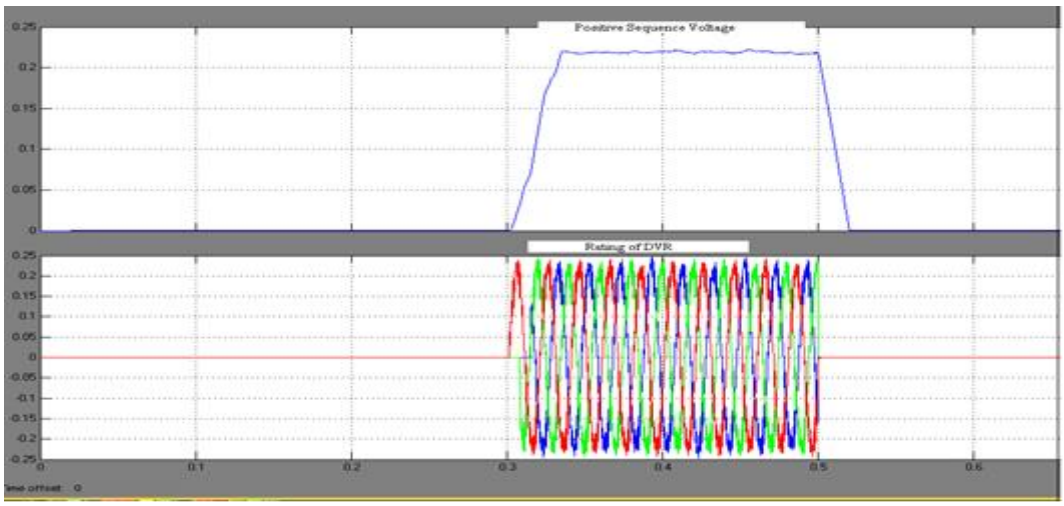

Fig.6.Simulation result of DVR voltage for compensation

CONCLUSION

A new design which incorporates a renewable energy storage module as a DC voltage source to mitigate voltage sags and enhances power quality of a distribution system based on DVR has been presented. The Simulation results prove that the renewable energy can be a useful alternative to a DC source for the DVR. In this paper we are compensating the output voltage till 0.25 p.u. In future this rating can be increased by increasing the rating of the solar cell.

REFERENCES

H.P. Tiwari, Sunil Kumar Gupta, DVR Based On Fuel Cell: An Innovative Back-Up System, International Journal of Environmental Science and Development, 1(1), 2010.

Piyasak Poonpun, Ward T. Jewell, Fellow, IEEE, Analysis of the Cost per Kilowatt Hour to Store Electricity", IEEE transactions on energy conversion, 23(2), 2008.

N. Hamsic, A. Schmelter, A. Mohd, E. Ortjohann, E. Schultze, A. Tuckey, J. Zimmermann, Increasing Renewable Energy Penetration in Isolated Grids Using a Flywheel Energy Storage System, Proceedings of Powering, 2007 - International Conference on Power Engineering, Energy and Electrical Drives, Setúbal, April 2007.

IEEE Task Force on Benchmark Models for Digital Simulation of FACTS and Custom-Power Controllers, T&DCommittee, Detailed Modeling of Superconducting Magnetic Energy Storage (SMES) System, IEEE transactions on power delivery, 21(2), 2006.

M.H.Haque, Compensation of distribution system voltage sag by DVR and DSTATCOM, Power Tech Proceedings, 2001 IEEE Porto, 1, 10-13, 2001, 5.