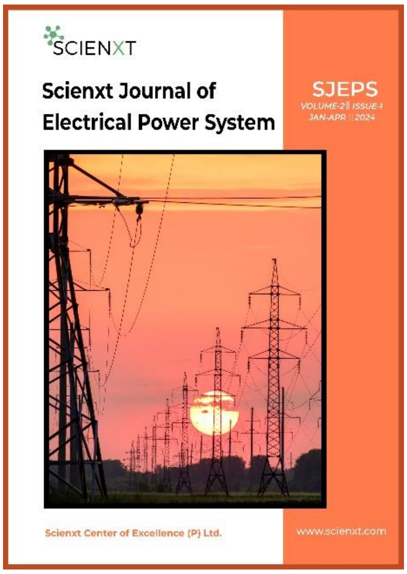

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Power quality improvement using dynamic voltage restorer under different voltage sag

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Abstract:

Power quality has become a noteworthy issue now a day to manage, in order maintain power quality of supplied power. Today's generation enormously relies on upon electrical energy for enhancing their way of life. Present day equipment like computers, electric engines and so on can't keep running without power. Keeping in mind the end goal to enhance the execution, the equipment and modern electronic devices demands quality supply. The power quality is influenced by different components of the electrical network. Control quality issues, for example, voltage and frequency variety, and harmonic contents influence the performance of electrical utility and reduce its life time. Such issue must be repaid to guarantee the quality supply.

Voltage sag/swell is one of the most frequently occurring power quality issues in transmission network. Such problem can bring about heavy flow of current reduces the device lifetime or damage the equipment or can cause over voltage influencing the protection level of the hardware. Numerous cutting edge custom devices are available so as to mitigate such issues. Among them, Dynamic Voltage Restorer (DVR) is proficient and cost effective. In this research work a multilevel DVR has proposed to optimize the issues of power transmission sag/swell power quality improvement.

Keywords:

Multicell Converter; Dynamic Voltage Restorer; Multilevel Power Converters; Power Quality; Voltage Sag.

1. Introduction:

Electrical energy is the simple and well-regulated form of energy, can be easily transformed to other forms. Along with its quality and continuity has to maintain for good economy. Power quality has become major concern for today's power industries and consumers. Power quality issues are caused by increasingly demand of electronic equipment and non-linear loads. Many disturbances associated with electrical power are voltage sag, voltage swell, voltage flicker and harmonic contents. This degrades the efficiency and shortens the life time of end user equipment. It also causes data and memory loss of electronic equipment like computer.

Due to complexity of power system network voltage sag/swell became the major power quality issue affecting the end consumers and industries. It occurs frequently and results in high losses. Voltage sag is due to sudden disconnection of load, fault in the system and voltage swell is due to single line to ground fault results in voltage rise of upfaulted phases. The continuity of power supply can be maintained by clearing the faults at faster rate. Other power quality issues i.e. voltage flickering, harmonics, transients etc has to be compensated to enhance the power quality

Power electronic devices i.e. Distribution Static Compensator (D-STATCOM) and Dynamic Voltage Restorer (DVR) been as of late utilized for voltage droop/swell pay. In this venture DVR is proposed which can shield the end-customer stack from any unbalance of voltage supply. It is an arrangement remunerating gadget, can keep up the heap voltage profile notwithstanding when the source side voltage is distorted.

The mechanical headways have demonstrated a way to the present-day ventures to separate and build up the imaginative advancements inside the cutoff points of their businesses for the satisfaction of their modern objectives. What's more, their definitive goal is to improve the generation while limiting the creation cost and in this manner accomplishing expanded benefits while guaranteeing constant generation all through the period.

Failure to provide the required quality power output may sometimes cause complete shutdown of the industries which will make a major financial loss to the industry concerned [4,5,6]. Thus the industries always demands for high quality power from the supplier or the utility. But the blame due to degraded quality cannot be solely put on to the hands of the utility itself [7]. It has been found out most of the conditions that can disrupt the process are generated within the industry itself. For example, most of the non-linear loads within the industries cause transients which can affect the reliability of the power supply [8,9]. Following shows some abnormal electrical conditions caused both in the utility end and the customer end that can disrupt a process.

1. Voltage sags
2. Voltage interruptions
3. Transients due to Lighting loads, capacitor switching, nonlinear loads, etc.
4. Harmonics

As a result of above abnormalities the industries may undergo burned-out motors, lost data on volatile memories, erroneous motion of robotics, unnecessary downtime, increased maintenance costs and burning core materials especially in plastic industries, paper mills & semiconductor plants.

2. Proposed work:

Power electronic devices contribute an important part of harmonics in all kind of applications, such as power rectifiers, thyristor converters and SVC. The updated PWM techniques used to control modern static converters such as machine derives, power factor compensators, or active power filters do not produce perfect waveforms, which strongly depend on the semiconductors switching frequency. Voltage or current converters as they generate discrete output waveforms, force the use of machines with special isolation, and in some applications large inductances connected in series with the respective load. In other words, neither the voltage nor the current waveforms are as expected. Also, it is well known that distorted voltages and current waveforms produce harmonic contamination, additional power losses, and high frequency noise that can affect not only the power load but also the associated controllers.

The enhancement of three phase voltage and reactive power is carried out with DVR when a non-linear and unbalanced load conditions are connected in the simulink block-set. A multilevel inverter is used to trigger the operation of DVR for the different load disturbance assessment by PWM technique. A practical implementation of the DVR is demonstrated in Fig. 1.

Fig.1 shows the schematic diagram of power distribution line DVR and Phase converter with a different number of levels. It is well known that a multilevel DVR, such as the one shown in Fig. 1, generates an output voltage with two different values (levels) Vc and “zero”, with respect to the negative terminal of the DC source (“0”), while a three-level module, The different positions of the ideal switches are implemented with a number of semiconductors that are in direct relation with the output voltage number of levels.

Extension of Multilevel DVR is demonstrated in Fig.1 having the number of level of voltage restorer to remove and optimize the voltage sags and harmonics and distortions from the grid power source the simulation and output waveform of the distortion free waveform has given in next section. The simulation of the proposed work has done on Matlab simulation tool.

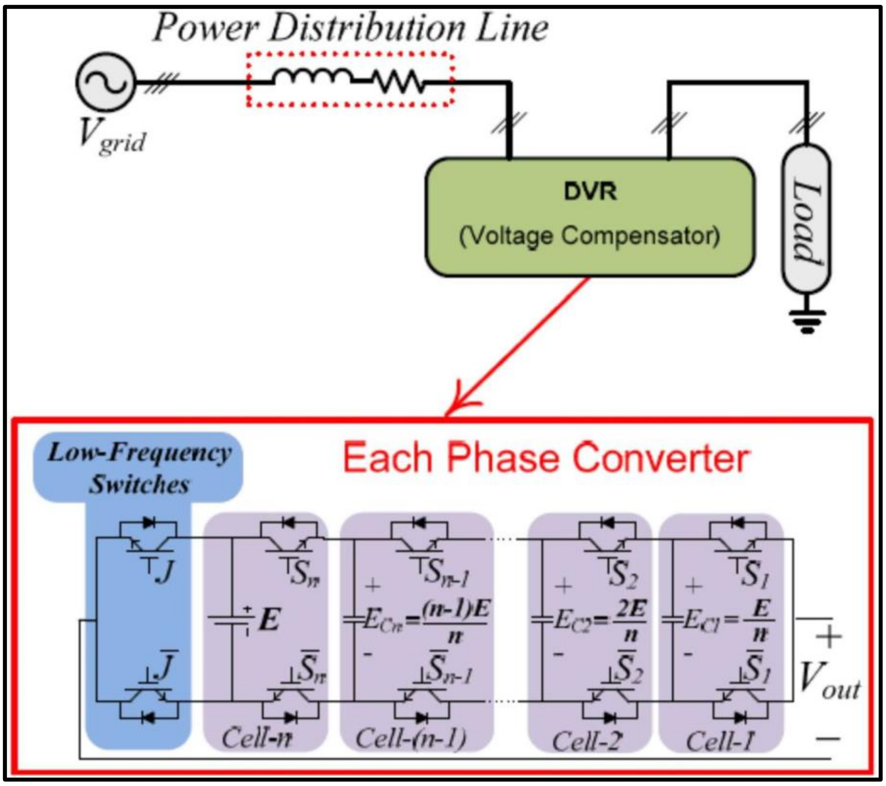

Figure. 1: Proposed DVR based on DFCM converter for medium-voltage application

3. Simulation result:

The THD present in the output of H-bridge-based DVR is high. In order to reduce the THD value further inverter configuration is improved by using a Multilevel DVR. Hence this section presents the usage of multilevel DVR systems for the applications of home appliances. The pulses are designed such that the duration of each mode. The cascaded multilevel DVR has been simulated using MATLAB software. The simulation circuit is illustrated in Fig. 2 and 3. The voltage of the cascaded multilevel DVR can be synthesized from the following switching combinations. The Fig. 2 shows the waveform of the proposed multilevel DVR. THD is further reduced due to the elimination of third harmonic voltage.

Shallow and deep balanced voltage sag with a phase jump in all three-phases of grid voltages is considered to occur as a power quality issue. The system is subjected to shallow balanced voltage sag which takes place.

During this shallow balanced voltage sag, voltage amplitudes drop to 90% of their rated values coinciding with a -15° phase shift in voltage angles in all three- phases. Moreover, to demonstrate deep balanced voltage sag incident demonstrated in Fig. 4 waveform.

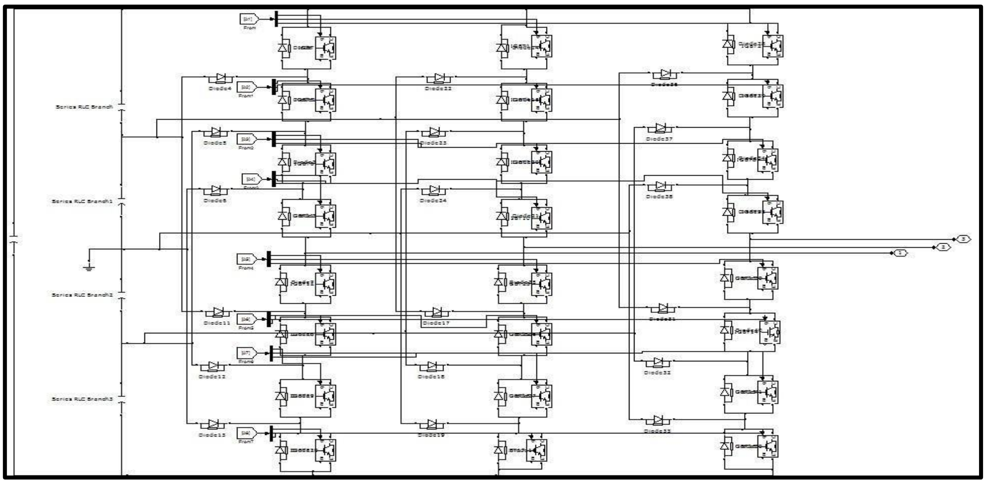

Figure. 2: Extension of Multilevel DVR.

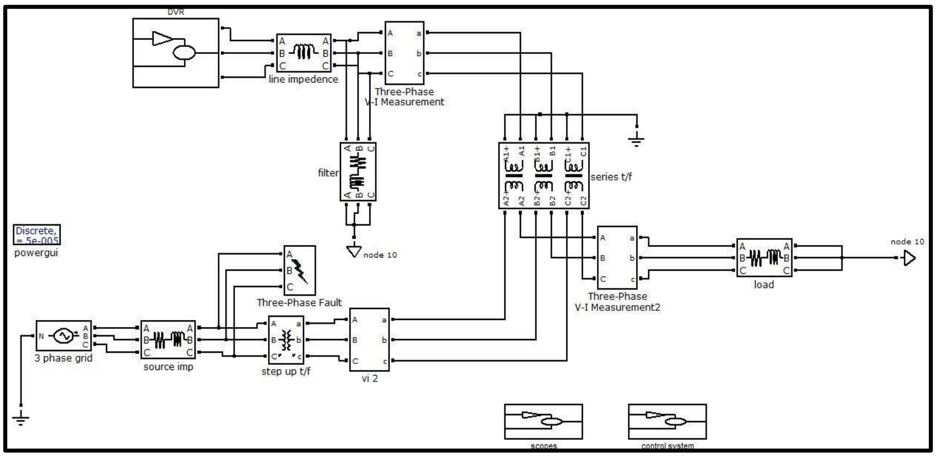

Figure. 3: With sag & swells & external faults still the wave forms are exact without any distortion.

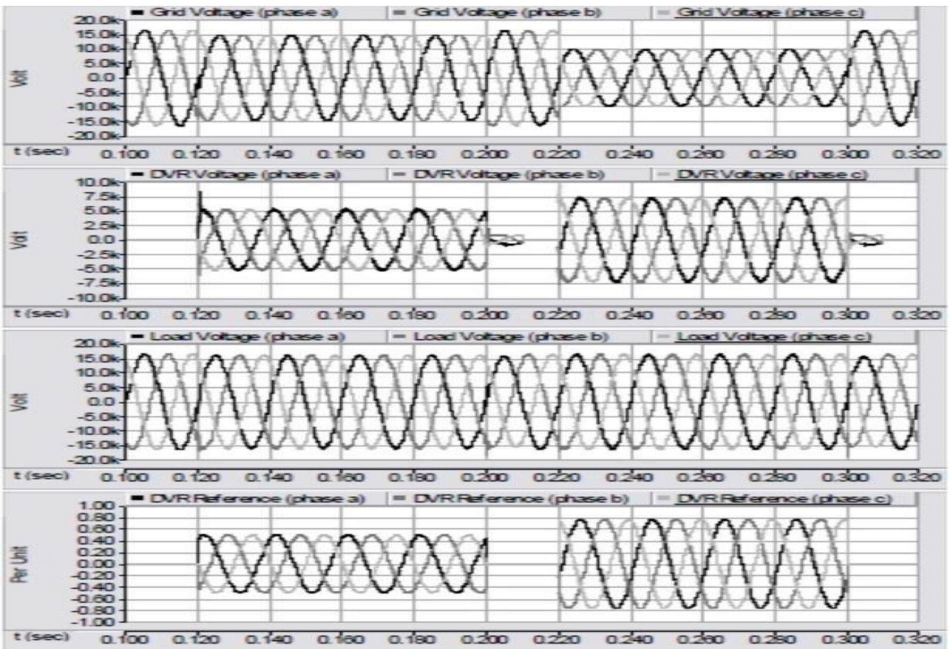

Figure .4: Proposed DVR outputs with sags & swells still reaming.

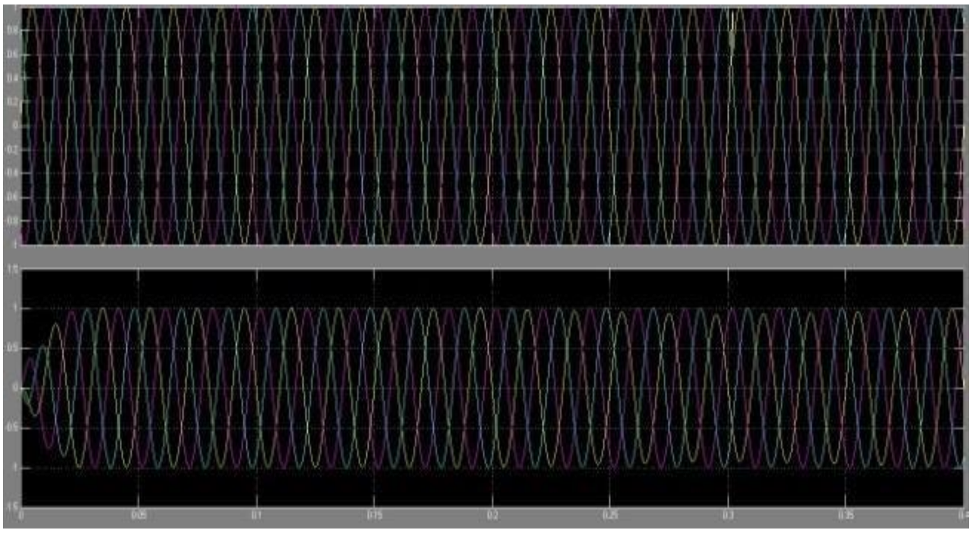

Figure. 5: With LG (AG or BG r CG) fault

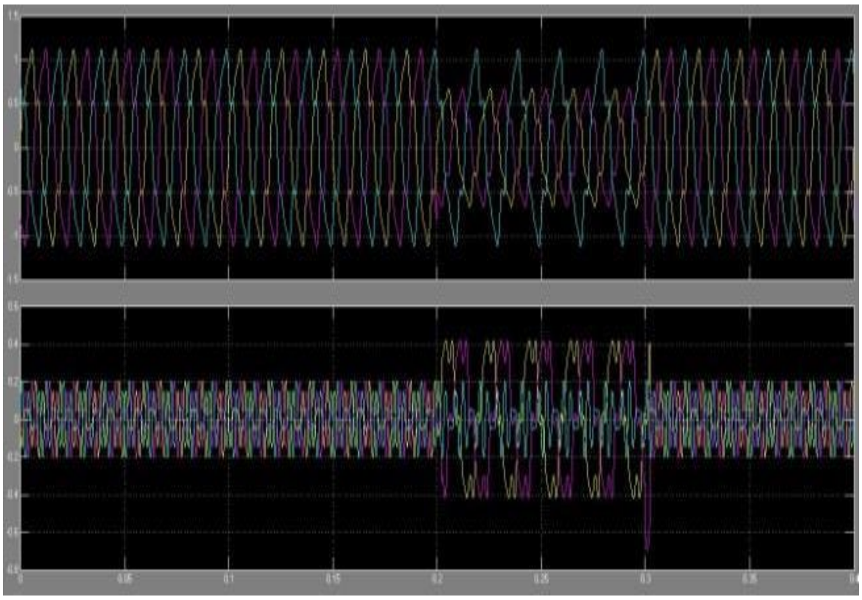

Figure. 6: With multi-level DVR no sags & swells Exact graphs without any distortion

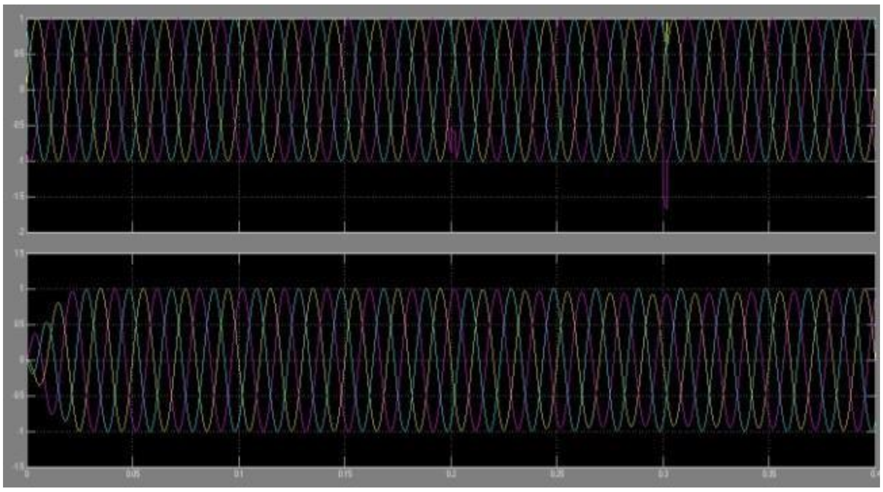

Figure. 7: With LLG (ABG or BCG or CAG) fault

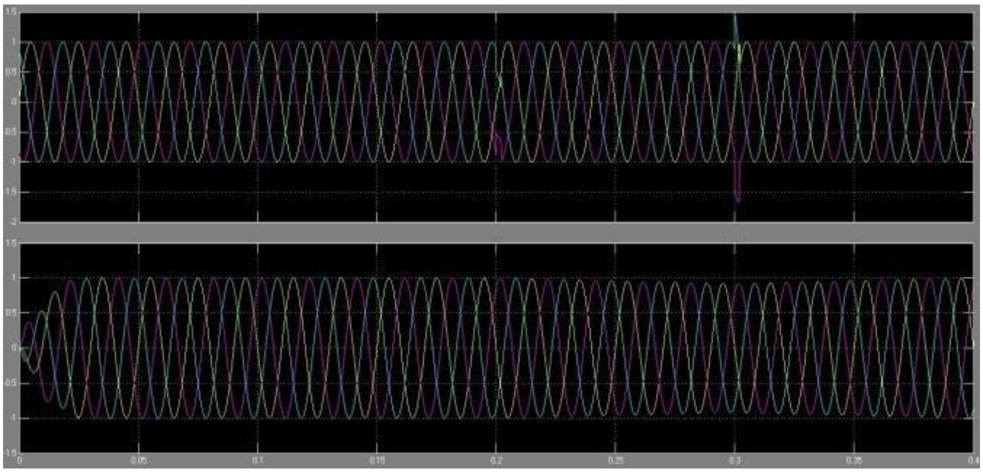

Figure. 8: Voltage sag mitigation using pre-sag compensation in existing system

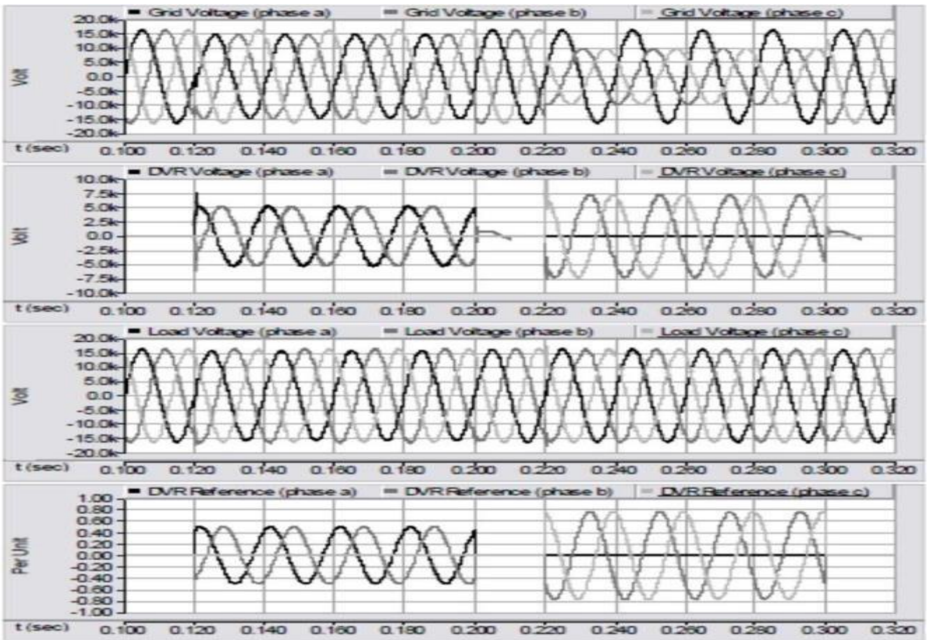

Figure. 9: with multi-level DVR no sags & swells Exact graphs without any distortion

4. Conclusion:

The interest for quality power has turned into a testing issue for mechanical range and customers. Among them voltage unbalance is considered as the major influencing issue leads to degradation in execution of electrical types of gear. Actualities devices utilized for remuneration are the best technique to conquer such issue. Among them DVR considered the most productive and cost effective.

Voltage unbalances, for example, voltage list/swell are considered here. Voltage unbalance under both adjusted and lopsided condition is considered and recreation results are appeared.

Displaying and remunerating method utilized by DVR for repaying such unbalance are additionally exhibited. The simulation result demonstrates that DVR repay list/swell adequately and give great voltage direction. The execution of DVR is satisfactory. Other power quality problem that occurs in power system network has to be compensated. Fuzzy controller and PI controller can be used as a mitigation technique for DVR.

5. References:

(1) V. Dargahi, A. K. Sadigh and K. Corzine, "Medium voltage dynamic voltage restorer (DVR) based on DFCM converter for power quality improvement," 2016 Clemson University Power Systems Conference (PSC), Clemson, SC, 2016, pp. 1-8.

(2) A. Tashackori, S. H. Hosseini and M. Sabahi, "Power quality improvement using a power electronic transformer based DVR," 2015 23rd Iranian Conference on Electrical Engineering, Tehran, 2015, pp. 1597-1601.

(3) T. C. Archana and P. Reji, "Power quality improvement using self-supported Dynamic Voltage Restorer (DVR) in distribution system," 2015 International Conference on Power, Instrumentation, Control and Computing (PICC), Thrissur, 2015, pp. 1- 6.

(4) F. Badrkhani Ajaei, S. Farhangi and R. Iravani, "Fault current interruption by the dynamic voltage restorer," 2013 IEEE Power & Energy Society General Meeting, Vancouver, BC, 2013, pp. 1-1.

(5) P. Kanjiya, B. Singh, A. Chandra and K. Al-Haddad, "“SRF Theory Revisited” to Control Self-Supported Dynamic Voltage Restorer (DVR) for Unbalanced and Nonlinear Loads," in IEEE Transactions on Industry Applications, vol. 49, no. 5, pp. 2330-2340, Sept.-Oct. 2013.

(6) A. Y. Goharrizi, S. H. Hosseini, M. Sabahi and G. B. Gharehpetian, "Three-Phase HFL-DVR With Independently Controlled Phases," in IEEE Transactions on Power Electronics, vol. 27, no. 4, pp. 1706-1718, April 2012.

(7) P. Roncero-Sanchez, E. Acha, J. E. Ortega-calderon, V. Feliu, A. Garcia-Cerrada, P. Roncero-sanchez, and S. Member, “A Versatile Control Scheme for a Dynamic Voltage Restorer for Power-Quality Improvement,” IEEE Trans. Power Deliv., vol. 24, no. 1, pp. 277-284, Jan. 2009.

(8) B. Wang and G. Venkataramanan, “Dynamic Voltage Restorer Utilizing a Matrix Converter and Flywheel Energy Storage,” IEEE Trans. Ind. Appl., vol. 45, no. 1, pp. 222-

231, 2009.

(9) T. Jimichi, H. Fujita, and H. Akagi, “Design and Experimentation of a Dynamic Voltage Restorer Capable of Significantly Reducing an Energy-Storage Element,” IEEE Trans. Ind. Appl., vol. 44, no. 3, pp. 817-825, 2008.

(10) E. Babaei, M. F. Kangarlu, and M. Sabahi, “Mitigation of Voltage Disturbances Using Dynamic Voltage Restorer Based on Direct Converters,” IEEE Trans. Power Deliv., vol. 25, no. 4, pp. 2676-2683, Oct. 2010.

(11) F. M. Mahdianpoor, R. A. Hooshmand, and M. Ataei, “A New Approach to Multifunctional Dynamic Voltage Restorer Implementation for Emergency Control in Distribution Systems,” IEEE Trans. Power Deliv., vol. 26, no. 2, pp. 882¬890, Apr. 2011.

(12) M. Moradlou and H. R. Karshenas, “Design Strategy for Optimum Rating Selection of Interline DVR,” IEEE Trans. Power Deliv., vol. 26, no. 1, pp. 242-249, Jan. 2011.