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Enhancing the Power Quality using Dynamic Voltage Restorer (DVR)

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Abstract: With the developments of computer technology and power electronics, the conflicts between power-quality-sensitive loads and power quality contaminated instruments become more and more considerable, which make concentrated reflection on voltage sags. Custom power technology can provide good solutions for these problems in power distribution system. Among them, dynamic voltage restorer (DVR) is a novel series-connected power electronics device. By injecting compensation voltage, it can compensates for all kinds of dynamic power quality issues such as sags, swells and interruption, thereby enhancing the quality of power supplied to sensitive loads. The research object of this thesis is dynamic voltage restorer based on super capacitor. Through theoretic analysis, Matlab simulation and experiments, the voltage detection, compensation characteristics of DVR, wide-range electrical transformation and design of DVR are studied in this paper. A fast and accurate voltage detection method is the base of dynamic compensation. This paper proposes a novel voltage detection method, which is derivation transformation method. Analysis and simulation verify its accuracy and fast speed. In order to emphasize the influence of energy storage units on DVR's compensation, this paper makes a comparison between DVRs with and without energy storage unit, and concludes that DVR should have an energy storage unit to make sure good compensation effect. Since the energy storage unit is necessary, the issue on its interface with power system is discussed, and a novel wide range electrical transformation system is proposed. Software simulation and hardware tests are implemented to verify the effectiveness of the proposed structure. Then, this paper presents the structure of DVR based on super capacitor energy storage, and system design and control of the DVR are studied in detail. Finally, a large number of digital simulations show that the proposed detection method and control strategy are effective.
Keywords: Power quality, dynamic voltage restorer, control strategies, compensation techniques.

I. INTRODUCTION

"Reliability" is a key word for utilities and their customers in general, and it is crucial to companies operating in a highly competitive business environment, because it affects profitability, which definitely is a driving force in the industry. Although electrical transmission and distribution systems have reached a very high level of reliability, disturbances cannot be totally avoided. Any disturbances to voltage waveform can cause problems related with the operation of electrical and electronic devices. Users need constant sine wave shape, constant frequency and symmetrical voltage with a constant rms value to continue the production. This increasing interest to improve efficiency and eliminate variations in the industry has resulted more complex instruments sensitive to voltage disturbances such as voltage sag, voltage swell, interruption, phase shift and harmonic. Voltage sag is considered the most severe since the sensitive loads are very susceptible to temporary changes in the voltage. In some cases, these disturbances can lead to a complete shutdown of an entire production line, in particular at high tech industries like semiconductor plants, with severe economic consequences to the affected enterprise. The DVR is a power quality device, which can protect these industries against the bulk of these disturbances, i.e. voltage sags and swells related to remote system faults. A DVR compensates for these voltage excursions, provided that the supply grid does not get disconnected entirely through breaker trips. Modern pulse-width modulated (PWM) inverters capable of generating accurate high quality voltage waveforms form the power electronic heart of the new Custom Power devices like DVR. Because the performance of the overall control system largely depends on the quality of the applied control strategy, a high performance controller with fast transient response and good steady state characteristics is required. The main considerations for the control system of a DVR include: sag detection, voltage reference generation and transient and steady-state control of the injected voltage. The typical power quality disturbances are voltage sags, voltage swells, interruptions, phase shifts, harmonics and transients. Among the disturbances, voltage sag is considered the most severe since the sensitive loads are very susceptible to

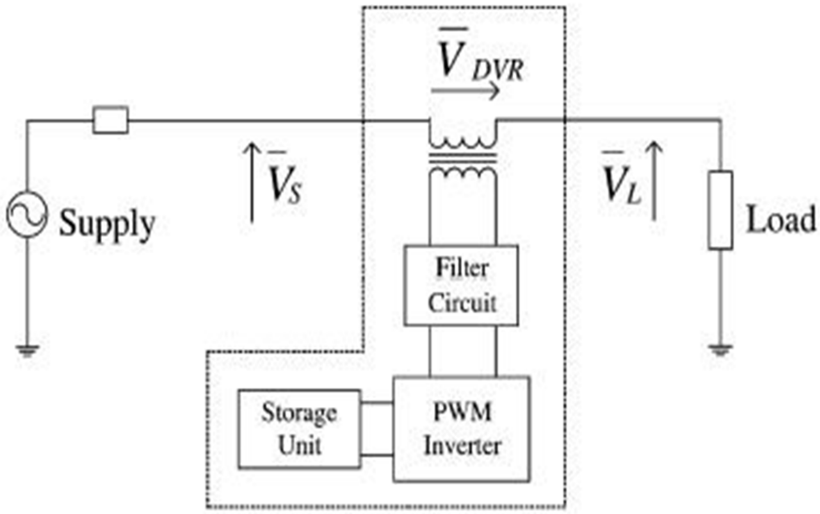

Figure 1. dynamic voltage restorer

temporary changes in the voltage.he wide area solution is required to mitigate voltage sags and improve power quality. One new approach is using a DVR .The basic operation principle is detecting the voltage sag and injecting the missing voltage in series to the bus as shown in Fig.4.1. DVR has become a cost effective solution for the protection of sensitive loads from voltage sags. The DVR is fast, flexible and efficient solution to voltage sag problems. DVR consists of energy storage unit, PWM inverter, and filter and injection transformer as shown in figure 1.

II. POWER QUALITY PROBLEMS

A recent survey of Power Quality experts indicates that 50% of all Power Quality problems are related to grounding, ground bonds, and neutral to ground voltages, ground loops, ground current or other ground associated issues. Electrically operated or connected equipment is affected by Power Quality [9, 10,11, 12, 15, and 16]. Determining the exact problems requires sophisticated electronic test equipment. The following symptoms are indicators of Power Quality problems: Piece of equipment misoperates at the same time of day. Circuit breakers trip without being overloaded. Equipment fails during a thunderstorm

A. Power Surges

A power surge takes place when the voltage is 110% or more above normal. The most common cause is heavy electrical equipment being turned off. Under these conditions, computer systems and other high tech equipment can experience flickering lights, equipment shutoff, errors or memory loss

B. High-Voltage Spikes

High-voltage spikes occur when there is a sudden voltage peak of up to 6,000 volts. These spikes are usually the result of nearby lightning strikes, but there can be other causes as well. The effects on vulnerable electronic systems can include loss of data and burned circuit boards.

C. Transients

Transients are potentially the most damaging type of power quality disturbance that you may encounter. Transients fall into 2 categories.

1) Impulsive
2) Oscillatory

D. Frequency Variation

A frequency variation involves a change in frequency from the normally stable utility frequency of 50 or 60 Hz, depending on your geographic location. This may be caused by erratic operation of emergency generators or unstable frequency power sources. For sensitive equipment, the results can be data loss, program failure, equipment lock-up or complete shut down.

E. Power Sag

Sag is the reduction of AC Voltage at a given frequency for the duration of 0.5 cycles to 1 minute's time. Sages are usually caused by system faults, and often the result of switching on loads with high demand startup currents. For more details about power sags .

III. DYNAMIC VOLTAGE RESTORER

Dynamic Voltage Restorer is series connected voltage source converter based compensator which has been designed to protect sensitive equipments like Programmable Logic Controllers (PLCs), adjustable speed drives etc from voltage sag and swell. Its main function is to monitor the load voltage waveform constantly by injecting missing voltage in case of sag/swell [4] [5]. To obtain above function a reference voltage waveform has to be created which is similar in magnitude and phase angle to that of supply voltage. During any abnormality of voltage waveform it can be detected by comparing the reference and the actual waveform of the voltage. As it is series connected device so it cannot mitigate voltage interruptions. The first DVR was installed for rug manufacturing industry in North Carolina. Another was used in Australia for large dairy food processing plant [4] [5]. A Dynamic Voltage Restorer is basically controlled voltage source converter that is connected in series with the network. It injects a voltage on the system to compensate any disturbance affecting the load voltage. The compensation capacity depends on maximum voltage injection ability and real power supplied by the DVR. Energy storage devices like batteries and SMES are used to provide the real power to load when voltage sag occurs [6]. If a fault occurs on any feeder, DVR inserts series voltage and compensates load voltage to pre-fault voltage. A basic block diagram for open loop DVR is shown in figure 1. Figure 2 shows the equivalent circuit of the DVR, when the source voltage is drop or increase, the DVR injects a series voltage Vinj through the injection transformer so that the desired load voltage magnitude VLoad can be maintained [4].

The series injected voltage of the DVR can be written as:

Vinj = VLoad + Vs (1)

Where, VLoad is the desired load voltage magnitude.

Vs is the source voltage during sags/swells condition.

The basic principle of the dynamic voltage restorer is to inject a voltage of required magnitude and frequency, so that it can restore the load side voltage to the desired amplitude and waveform even when the source voltage is unbalanced or distorted. Generally, it employs a gate turn off thyristor (GTO) solid state power electronic switches in a pulse width modulated (PWM) inverter structure. The DVR can generate or absorb independently controllable real and reactive power at the load side. In other words, the DVR is made of a solid state DC to AC switching power converter that injects a set of three phase AC output voltages in series and synchronism with the distribution and transmission line voltages. The source of the injected voltage is the commutation process for reactive power demand and an energy source for the real power demand [4] [7]. The energy source may vary according to the design and manufacturer of the DVR. Some examples of energy sources applied are DC capacitors, batteries and that drawn from the line through a rectifier.

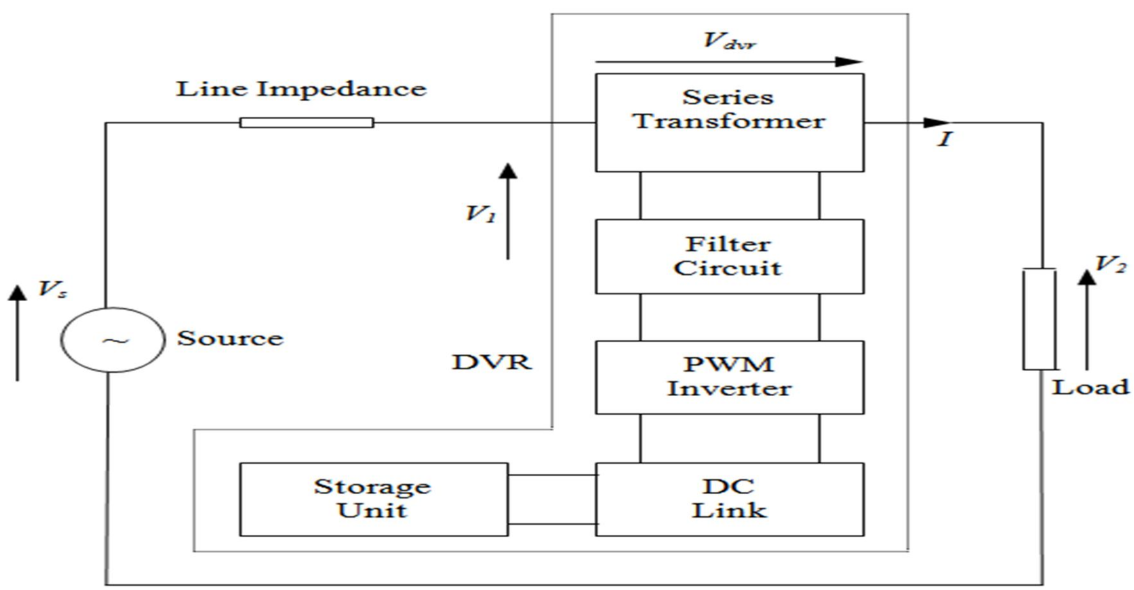

Figure 2. Block diagram of the DVR controller

A. The general Configuration of the dvr Consists of the Following Equipment:
1) Series injection transformer
2) Energy storage unit
3) Inverter circuit
4) Filter unit
5) DC charging circuit
6) A Control and Protection system

IV. SIMULATION RESULTS

System performance is analyzed for compensating voltage sag with Dynamic Voltage Restorer (DVR) so as to achieve the rated voltage at a given load. The DVR model is shown in Fig (3), on which the simulation work is done. To obtain the required output, here two cases are considered. The two cases are as follows:

A. Case I
1) *When DVR is disconnected from the system:* In this case the Dynamic Voltage Restorer is disconnected from the system. This is done by keeping the switch OFF, i.e. the two terminals of the switch are open, this implies that no voltage or current flow is taking place. Due to which the voltage sag is not removed from the transmission line. The graph obtained in this case is show below in figure (1).

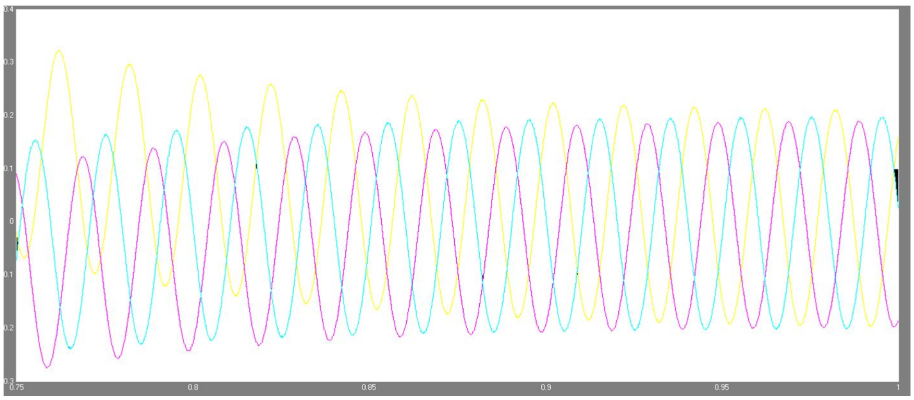

Figure 3. Graph When DVR is disconnected

B. Case II
1) *When DVR is connected to the System:* In this case the Dynamic Voltage Restorer is connected to the system. This is done by keeping the switch ON, i.e. the two terminals of the switch are closed, this implies that the voltage or current flow is taking place. Hence, due to the connection of DVR, the voltage sag is removed from the system and the nominal voltage is obtained at the output terminals. The graph obtained in this case is show below in figure (2).

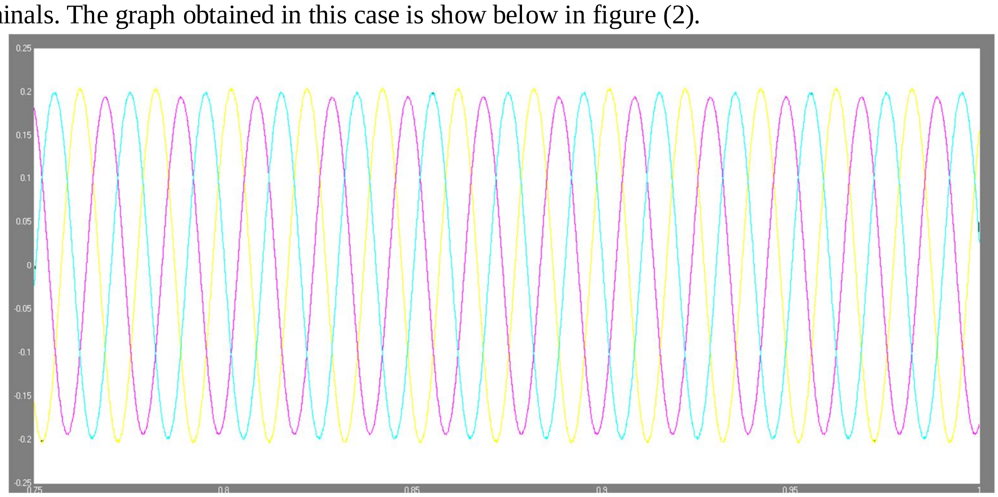

Figure 4. Graph When DVR is connected

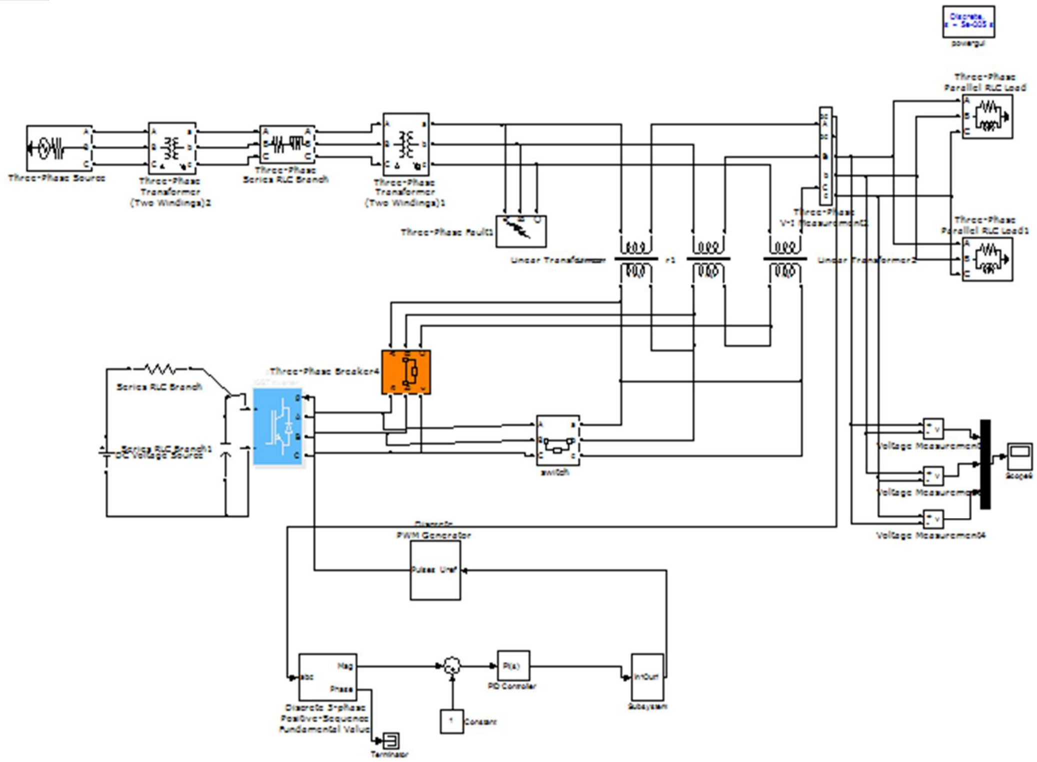

Figure 5. Simulation model of Dynamic Voltage Restorer

Various cases of different load conditions are considered to study [4] the impact DC storage on sag compensation.

V. CONCLUSION

In this paper the simulation results show clearly the performance of DVR in both the conditions. Hence the compensation of Voltage Sag using Dynamic Voltage Restorer (DVR) is done. The power and voltage quality problems such as voltage sag, swells and others are also explained. Also an overview of dynamic voltage restorer (DVR) is presented. DVRs are very effective custom power devices for voltage sag and swell compensation. They inject the appropriate voltage component to rapidly correct any anomaly in the supply voltage to keep the load voltage balanced and constant at the nominal value. The Dynamic Voltage Restorer (DVR) is considered to be an efficient solution due to its relatively low cost and small size; also it has a fast dynamic response.

REFERENCES

[1] T.Sundar and S.Sankar, "Simulation and Investigation of Prototype DVR for Power Flow Control."
[2] Shazly A. Mohammed, Aurelio G. Cerrada, Abdel-Moamen M. A, and B. Hasanin, "Dynamic Voltage Restorer (DVR) System for Compensation of Voltage Sag, State-of-the -Art Review."
[3] R. Ibrahim, A. M. Haidar, M. Zahim "The Effect of DVR Location for Enhancing Voltage Sag" Proceedings of the 9th WSEAS International Conference on Applications of Electrical Engineering, pp. 92-98.
[4] C. Benachaiba, and B. Ferdi "Voltage quality improvement using DVR", Electrical Power Quality and Utilization, Journal Vol. XIV, No. 1, pp. 39-45, 2008.
[5] M. Izhwan M, N. Mariun, and M. Amran M. Radzi, "The effect of Power Quality to the industries", The 5th SCORED, Dec. 2007, Malaysia, pp. 1- 4
[6] Anita Pakharia, Manoj Gupta, "DVR Based Compensation of Voltage Sag due to Variations of Load: A Study on Analysis of Active Power.
[7] Anita Pakharia, Manoj Gupta, Dynamic Voltage Restorer for Compensation of Voltage Sag and Swell: A Literature Review."
[8] P. T. Nguyen, Tapan. K. Saha, "Dynamic Voltage Restorer against Balanced and Unbalanced Voltage Sags: Modelling and Simulation," IEEE Power Engineering Society General Meeting, vol. 1, pp. 639-644, June 2004.
[9] E. Babaei, M. F. Kangarlu,"A New Topology for Dynamic Voltage Restorers without dc Link" IEEE Symposium on Industrial Electronics and Applications (ISIEA 2009), October 4-6, 2009, Kuala Lumpur, Malaysia.
[10] V. S. Mallela, P. S. Solanki, and A. Chaturvedi "Role of a Dynamic Voltage Restorer in Mitigation of Power Quality Problems" International Conference on Communication, Computer & Power (ICCCP'05), Feb. 2005, pp. 161- 166.
[11] P. Boonchiam, and N. Mithulananthan "Understanding of Dynamic Voltage Restorers through MATLAB Simulation" Thammasat I nt. J. Sc.Tech., Vol. 11, No. 3, pp. 1-6, July-September 2006.
[12] M. F. Kangarlu, S. H. Hosseini, A. K. Sadigh "Transformerless DVR topology based on multilevel inverter with reduced number of switches" 1st Power Electronic & Drive Systems & Technologies Conference,IEEE,pp. 371-375,2010.

[13] C.C. Zhan, M. Barnes, V.K. Ramachandaramurthy, and N. Jenkis, "Dynamic Voltage Restorer with Battery Energy Storage for Voltage Dip Mitigation" Power Electronics and Variable Speed Drives, 18-19, Conference Publication No. 475, IEEE September 2000.
[14] Francisco Jurado, Manul Valverde, and Jose Carpio, "Voltage Sag Correction by Dynamic Voltage Restorer Based on Fuzzy Logic Control" IEEE 2003
[15] Kasuni Perera, Daniel Salomon son, Arulampaiam, Atputharajah, Sanath Alahakoon, "Automated Control Technique for A Single Phase Dynamic Voltage Restorer" IEEE, 2006.
[16] S. V Ravi Kumar, S. Siva Nagaraju, "Simulation of D-Statcom and DVR in Power Systems" ARPN Journal of Engineering and Applied Sciences Vol. 2, No. 3, June 2007.
[17] Changjian Zhan,V.K. Ramachandrara murthy, A. Arulampalam, M.Barnes, G.Strbac N.Jekin, "Dynamic Voltage Restorer Based on Voltage Space Vector PWM Control", IEEE 2001.
[18] P Kundur, "Power System Stability and Control", McGraw-Hill 1994.
[19] M. E. C. Brito, M. C. Cavalcanti, L. R. Limongi and F. A. S. Neves, "Low Cost Dynamic Voltage Restorer" International Conference on Renewable Energies and Power Quality, 28th to 30th March, 2012
[20] B.Rajani, P.Sangameswara Raju," Enhancement of Power Quality by Optimal Placement of Dstatcom For Voltage Sag Mitigation Using Ann Based Approach" International Journal of Soft Computing and Engineering (IJSCE) ISSN: 2231-2307, Volume-2, Issue-3, July 2012.
[21] T.Devaraju, Dr V.C.Veera Reddy, Dr M.Vijay kumar " Modelling and simulation of custom power devices to mitigate power quality problems" International Journal of Engineering Science and Technology Vol. 2(6), 2010, 1880-1885
[22] Shairul Wizmar Wahab and Alias Mohd Yusof" Voltage Sag and Mitigation Using Dynamic Voltage Restorer (DVR) System" Elektrika , VOL. 8, NO. 2, 2006, 32-37
[23] Rosli Omar and Nasrudin Abd Rahim "MITIGATION OF VOLTAGE SAGS/SWELLS USING DYNAMIC VOLTAGE RESTORER (DVR)" ARPN Journal of Engineering and Applied Sciences, VOL. 4, NO. 4, JUNE 2009
[24] Chellali BENACHAIBA, Brahim FERDI "Voltage Quality Improvement Using DVR" Electrical Power Quality and Utilisation, Journal Vol. XIV, No. 1, 2008.