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Development and Simulation of Dynamic Voltage Corrector for Voltage SAG Reduction Using PWM Power Protection

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ABSTRACT: Power quality is an important issue today. It gains importance especially with the launch of smart devices with very good performance for good energy. Electrical problems refer to the phenomenon of terminal equipment not working properly due to voltage, current or frequency inconsistency. The biggest problem here is power loss. To solve this problem, special power supplies are used. One such device is the Dynamic Voltage Corrector (DVR), which is the most efficient and effective modern voltage corrector used in power distribution systems. Its appeal includes lower cost, smaller size, and faster response to disturbances. This article describes how to develop, simulate and analyze a digital video recorder (DVR) using MATLAB Simulink. To improve the ability to recover from DVR voltage, this article includes the development of a control model that uses a separate PWM pulse generator. The results show that the DVR design can adjust the voltage level under voltage drop conditions..

Key words: Voltage sag, power quality improvement, dynamic voltage restorer, pulse width modulation.

INTRODUCTION

Most modern devices today rely on electronic devices such as programmable logic controllers and electronic drives. Electronics are very sensitive to disturbances and have a low tolerance for problems such as voltage drops, spikes and harmonics. Voltage dips are considered one of the biggest glitches in home appliances. Voltage support for

loads can be provided by injecting reactive power into the normally connected load point. One of the best ways is to install a transformer shunt capacitor on the primary side of the distributor.

Machine changes may be scheduled with Supervisory Control and Data Acquisition (SCADA) signals at a specific scheduled time, or no changes at all. The disadvantage is that high-speed transitions cannot be compensated. Some drops are not corrected within the time limit of the power supply switch. A transformer tap can be used, but is expensive to replace at load. Another energy efficient solution for energy management is the use of renewable energy sources.

DVR is a class of electronic device designed to provide efficient power distribution. They use a boost system that uses solid state devices to compensate for voltage dips/swells. The DVR application is only used for sensitive loads that may be affected by system voltage fluctuations.

I. DYNAMIC VOLTAGE RESTORER

This section presents a brief description about the basic principles of a dynamic voltage restorer used in transmission system. Figure (1) shows the basic elements of a DVR in a single-phase representation.

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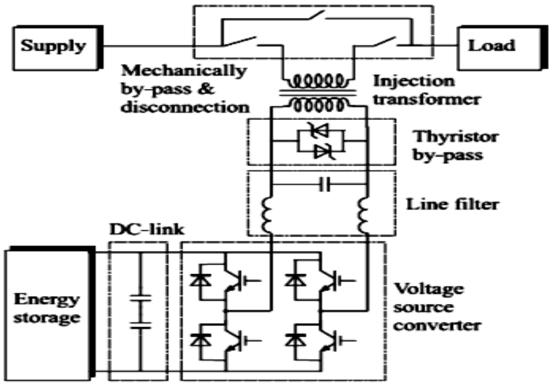

Figure (1)) Basic elements of a DVR in a single-phase representation

The main points of the DVR are:

1) Converter: The converter will usually be a Voltage Source Converter (VSC) that converts the DC link/storage to AC voltage injected into the system via Pulse Width Modulation (PWM).

2) Line filter: Line filter is added to reduce the harmonic distortion produced by PWM VSC.

3) Injection Transformer: In most DVR applications, the DVR is equipped with an injection transformer to provide galvanic isolation and simple converter topology and protection products.

4) DC-link and energy storage: VSCs use DC-link voltage to integrate AC voltage into the grid, and injection voltage is required to adjust the power supply when most of the electricity is lost.

5) Bypass device: During faults, overloads and services, a bypass method for the current load must be guaranteed.

Figure 1 shows mechanical bypass and thyristor bypass.

6) Disconnect Device: DVR etc. during the program. disconnect completely.

A. Control Structure of Developed DVR

[1] Discrete PWM-Based Control Scheme

Send to DVR to reduce simulated voltage sag with all payment methods in the test, and also pay the electricity bill in real demand, control PWM is used according to the decision. The purpose of the control method is to maintain a constant voltage amplitude at sensitive load points in the affected system. For example, the control system only measures the rms voltage of the load and does not need to measure reactive power. Figure (2) shows the DVR controller schematic used in MATLAB/SIMULINK. The DVR control system uses angle control as follows: An error signal is obtained by comparing the voltage with the measured rms voltage at the load point.

For example, the PI controller receives the error signal and creates an angle δ to drive the error to zero; load rms voltage is fed back to the grid.

Note that network and transaction are considered equivalent. The modulation angle δ or delta is used for the PWM generator in phase A, while the angle of phase B and phase C is shifted by 240° or -120° and 120° respectively.

$V_A = \text{Sin}(\omega t + \delta)$ …(3.1)

$V_B = \text{Sin}(\omega t + \delta - 2\pi/3)$ …(3.2)

$V_C = \text{Sin}(\omega t + \delta + 2\pi/3)$ …(3.3)

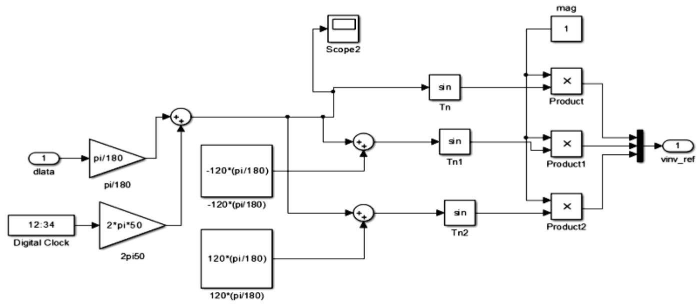

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Figure (2) Firing angle controller scheme

2) Test system for DVR

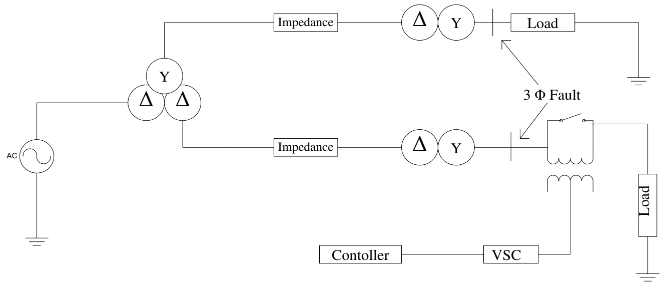
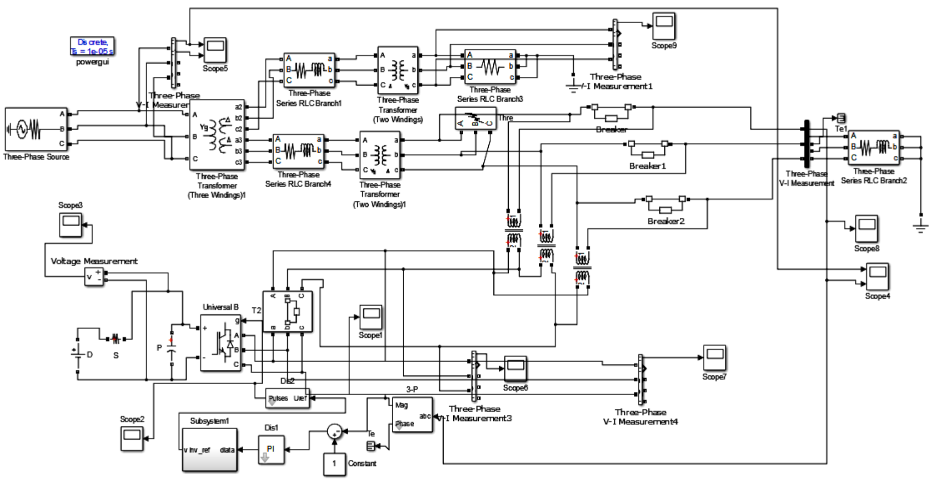


Figure (3) Single line diagram of test system for DVR

Single line diagram of the test system for DVR is shown in figure(3), composed by a 13 kV, 50 Hz generation system, feeding two transmission lines through a three phase winding transformer connected in Y/Δ/Δ, 13/115/115 kV.

Such transmission lines feed two distribution networks through two transformers connected in Δ/Y, 115/13 kV. To verify the working of DVR for voltage compensation a fault is applied at point X at resistance 0.66 U for time duration of 200 ms. The DVR is simulated to be in operation only for the duration of the fault. Figure(4) shows the actual simulation model developed for the proposed work.



Figure(4) Actual simulation model developed for DVR

B. Simulation and Results

The first simulation was made without DVR and a three-phase fault was applied to the system with a 0.66 U fault for 200 ms. The second simulation was performed in the same situation as above, but now a DVR is introduced on the load side to compensate for the voltage drop due to the three-phase fault in the form. Figure (5) shows the rms voltage of the load when the system is operating without DVR and there is a three-phase fault in the system. When the DVR is running, the voltage cutoff is almost complete and the rms voltage of the sensitive load point remains in the normal state shown in figure (6).

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Figure 7 now shows the pulse generated by the pulse width modulator to compensate for the effect of the voltage drop. Also, Figure (8) and Figure (9) show the three-phase voltage at the load point without the DVR design and with the DVR design.

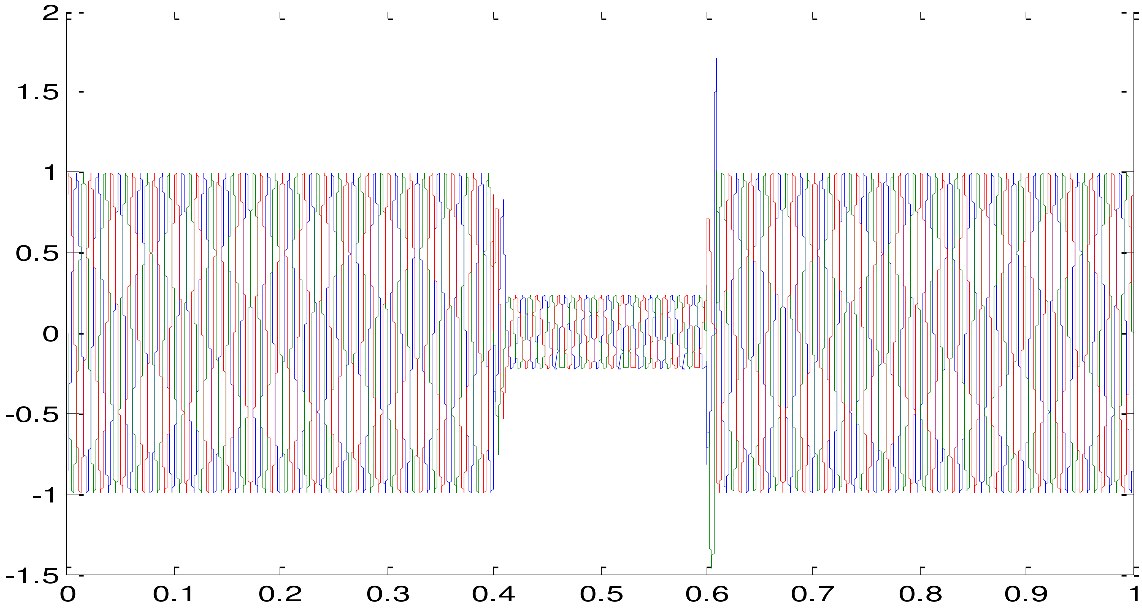

Figure (7) Three phase Voltage at load point, with three phase fault, without DVR

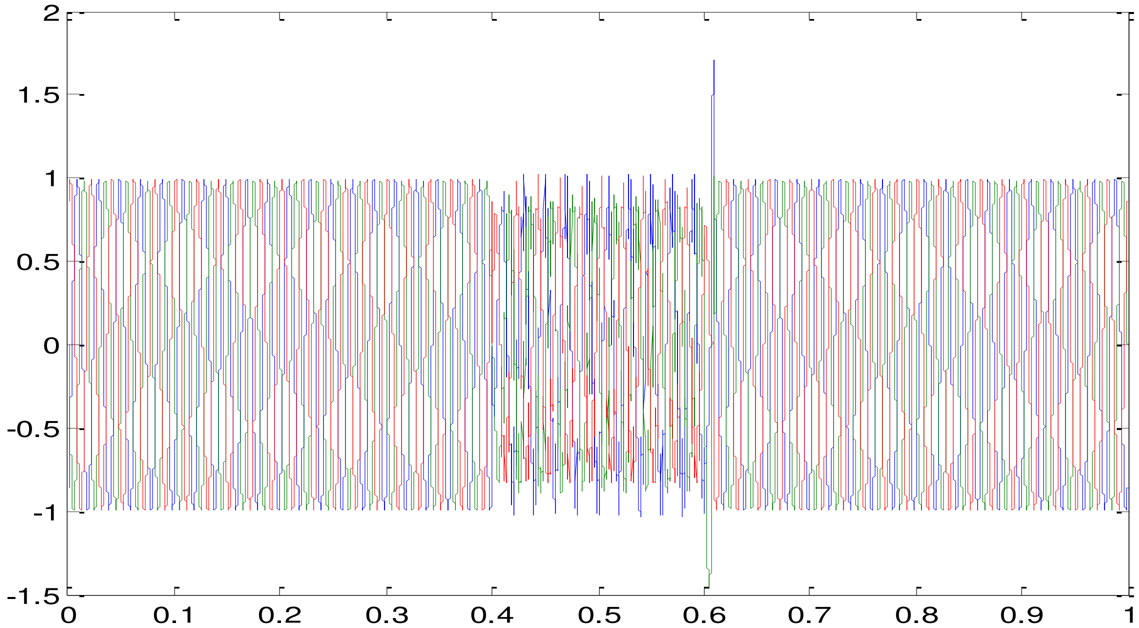

Figure (8) Three phase Voltage at load point, with three phase fault, with DVR

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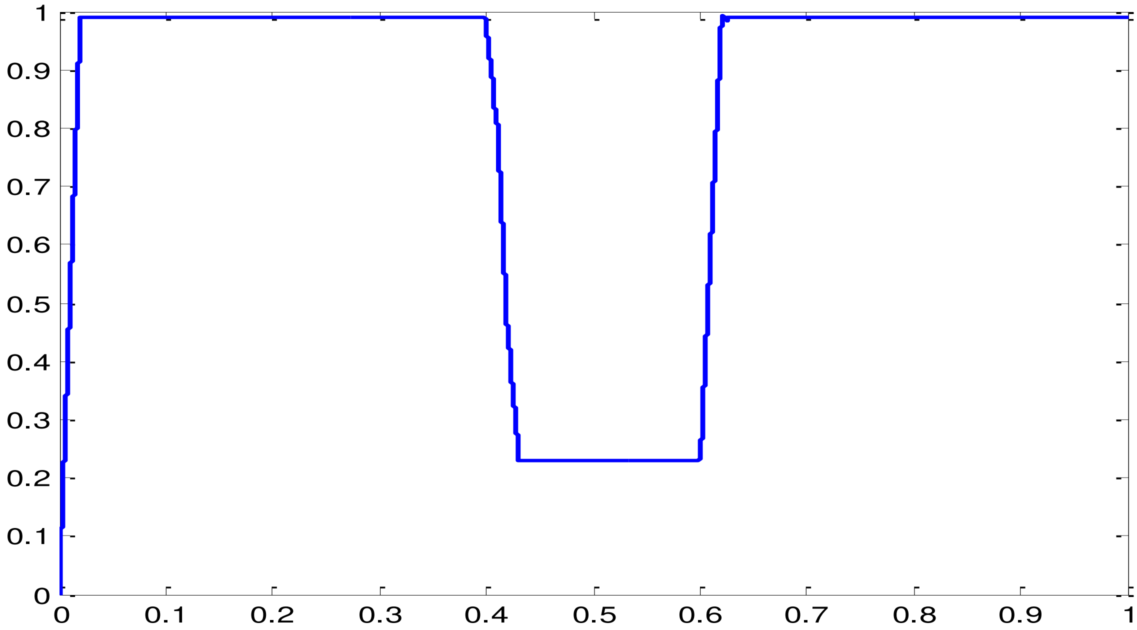

Figure (9) P.U. Voltage at load point, with three phase fault, without DVR

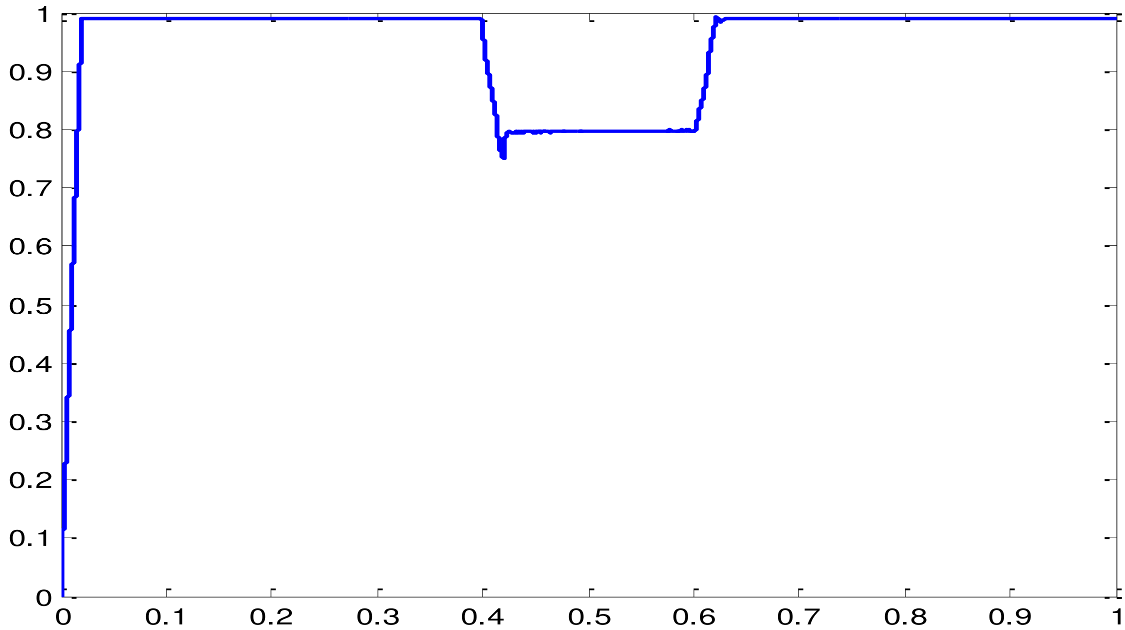

Figure (10) P.U. Voltage at load point, with three phase fault, with DVR

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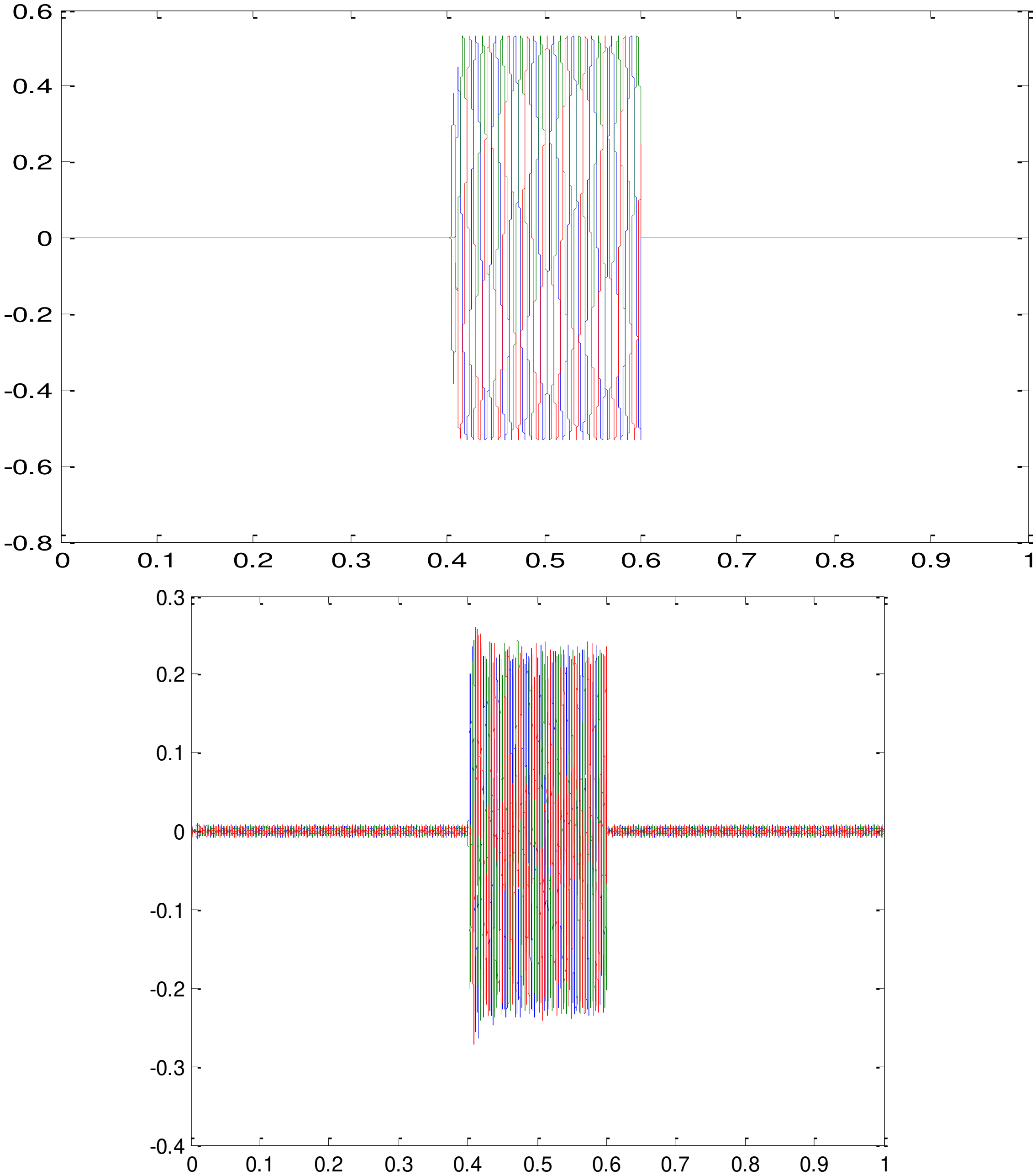

Figure(10) Input voltage at injection transformer, with DVR

Figure(11) Firing pulse generated by discrete PWM generator

II. CONCLUSION

This article deals with the most important voltage sag problem, which often causes weak power in transmission lines. The charging process for the dedicated powerful DVR was implemented and simulated in MATLAB Simulink. PWM based control is used. Unlike the fundamental frequency switching schemes already available in MATLAB/SIMULINK, this PWM control scheme only requires voltage measurement. These features make it ideal for low-power applications.

The results show, in part, that the PWM control system is able to inject sufficient voltage when voltage drop occurs. In the future, this work can be continued with the help of modified PWMs such as DSPWM, GSPWM techniques

C. REFERENCE

[2] Mahesh Ahuja. (2023). Energy Management Strategy for Hybrid Electric Vehicle with Battery Thermal Health Constrained. Scandinavian Journal of Information Systems, 35(1), 789–794. Retrieved from http://sjisscandinavian-iris.com/index.php/sjis/article/view/399

[3] Mahesh Ahuja and and R.P mahobia "Three Phase Shunt Active Power Filter using pq theory Analysis of Stability Problem in Wind Generator by using STATCOM", Neuro Quantology, Volume 20 | Issue 13 | Page 3406-3413, ,2022. SCOPUS (doi: 10.14704/nq.2022.20.13.NQ88420)

[4] Raviprakash Mahobia , Mahesh Ahuja. (2022). MITIGATION APPERTAINING TO ELECTROMOTIVE FORCE SAG USING DYNAMIC ELECTROMOTIVE FORCE RESTORER BASED ON SPACE VECTOR PULSE WIDTH MODULATION. Journal of Pharmaceutical Negative Results, 5242–5248.

[5] Awasthi, M., and M. Ahuja. "HEAVY ALCOHOL USE, PAST MONTH ALCOHOL USE AND MENTALLY UNHEALTHY DAYS AMONG SEXUAL MINORITY POPULATION IN THE STATE OF TENNESSEE." ALCOHOLISM-CLINICAL AND EXPERIMENTAL RESEARCH. Vol. 45. 111 RIVER ST, HOBOKEN 07030-5774, NJ USA: WILEY, 2021

[6] Mahesh Ahuja* & Shailesh M. Deshmukh, "Power Quality Control Using Dynamic Voltage Restorer (DVR)", J. Optoelectron. Laser, vol. 41, no. 5, pp. 668–672, May 2022

[7] Shailesh M Deshmukh, Mahesh Ahuja "Simulink Modelling For Power Quality Control Using Dynamic Voltage Restorer (Dvr)",Journal Of Harbin Institute Of Technology, volume 54, issue 22, MaY 2022.SCOPUS (DOI: 10.11720/JHIT.54052022.19)

[8] Mahesh Ahuja and B. Anjanee Kumar "Development & Simulation of DVR against Voltage Sag Using Matrix Converter". International journal of advanced research in electronics & instrumentation engineering (IJAREEIE), volume 3, issue 3, March 2014.

Research paper **© 2012 IJFANS. All Rights Reserved, UGC CARE Listed (Group -I) Journal Volume 12, Iss 1, Jan 2023**

[9] Mahesh Ahuja, Suman Giri, Anjanee Kumar "Mitigation of Voltage Sag Using Dynamic Voltage Restorer Based on Space Vector Pulse Width Modulation" International Journal of Science, Engineering and Technology Research (IJSETR) Volume 3, Issue 4, April -2014, pp 966-969

[10] Suman Giri, Satyadharma Bharti, Mahesh Ahuja "Development and Simulation of Dynamic Voltage Restorer for Voltage Sag Mitigation Using PWM Firing Control Strategy" International Journal of Advanced Research in Electronics and Communication Engineering, Volume 3, Issue 4, April – 2014

[11] G. Venkataramanan and B. Johnson, "A pulse width modulated power line conditioner for sensitive load centers," IEEE Trans. Power Delivery, vol. 12, pp. 844 - 849, Apr. 1997

[12] Sedaghati, R. ; Ghasemi, M. ; Hayatdavudi, M. "Performance study of Dynamic Voltage Restorer (DVR) in order to power quality improvement" Electrical Power Distribution Networks (EPDC), 2012 Proceedings of 17th Conference on Publication Year: 2012 , Page(s): 1 – 6.

[13] M. Jazayeri, H. Abdollahzadeh, "A Novel DVR Control System Design for Compensating all types of Voltage Sags Based on Pre-Fault Method", European Journal of Scientific Research, ISSN 1450-216X Vol.33 No.1 (2009), pp.70-85, c Euro Journals Publishing, Inc. 2009.

[14] Norbert EDOMAH, "Effects of voltage sags, swell and other disturbances on electrical equipment and their economic implications", Paper 0018, 20th International Conference on Electricity Distribution, Prague, 8-11 June 2009.

[15] N.G. Hingorani and L. Gyugyi, "Understanding FACTS: Concepts and Technology of Flexible AC Transmission Systems", 1st edition, The Institute of Electrical and Electronics Enginee rs, 2000.

[16] F. Z. Peng, H. Akagi, and A. Nabae, "Compensation characteristics of the combined system of shunt passive and series active filters," IEEE Trans. Ind. Applicat., vol. 29, pp. 144 - 151, Jan. /Feb. 1993.

[17] M.H.Haque "Compensation of distribution system voltage sag by DVR and DSTATCOM" Power Tech Proceedings, 2001 IEEE Porto, Volume: 1, 10-13 Sept. 2001 Pages: 5 pp. vol.1

[18] S. S. Choi, B. H. Li, and D. D.Vilathgamuwa, "Dynamic voltage restoration with minimum energy injection," IEEE Trans. Power Syst., vol. 15, pp. 51 - 57, Feb. 2000.

[19] Madhusudan, R. ; Ramamohan Rao, G. "Modeling and simulation of a Dynamic Voltage Restorer (DVR) for power quality problems-voltage sags and swells" Advances in Engineering, Science and Management (ICAESM), 2012 International Conference, Publication Year: 2012 , Page(s): 442 – 447. Cited by: Papers (2).

[20] A. Imam, T. Habetler, R. Harley and D. Divan, "Condition monitoring of electrolytic capacitor in power electronic circuits using adaptive filter modeling," IEEE 36th Annual Power Electronics Specialists Conference, 2005, pp. 601-607.

[21] Marei, M.I.; El-Saadany, E.F.; Salama, M.M.A., "A Flexible DG Interface Based on a New RLS Algorithm for Power Quality Improvement," Systems Journal, IEEE , vol.6, no.1, pp.68,75, March 2012, doi: 10.1109/JSYST.2011.2162930

[22] J. M. Lozano, J. M. Ramirez and R. E. Correa, "A Novel Dynamic Voltage Restorer based on Matrix Converters", Modern Electric Power Systems (2010), Wroclaw, Poland.

[23] Huber, L. and Borojevic, D., "Space Vector Modulated Three-Phase to Three-Phase Matrix Converter with Input power Factor Correction", IEEE Transactions on Industry Applications, Vol. 31, No. 6, November/December 1995.

[24] Prasad, V.H., "Analysis and Comparison of Space Vector Modulation Schemes For Three-Leg and Four-leg Voltage Source Inverters", Masters Thesis, Electrical Engineering, Virginia Tech, May 15, 1997.

[25] B. Wang and G. Venkataramanan, "Dynamic Voltage Restorer utilizing a matrix converter and flywheel energy storage," IEEE Transactions on Industry Applications, Jan-Feb 2009, vol. 45, pp. 222-231.

[26] F.A.L. Jowder, "Design and analysis of dynamic voltage restorer for deep voltage sag and harmonic compensation", Published in IET Generation, Transmission & Distribution Received on 17th October 2008, Revised on 2nd March 2009.